6.6 Water Supply Facilities

6.6.1 Comparative Study of Alternative Water Supply Schemes

Future water supply schemes to be constructed are proposed, as described in the following, based on the least cost solution selected from among possible alternative plans, and also taking into consideration other factors concerning operation and maintenance of the constructed facilities.

The project area can be geographically divided into two supply areas, namely, Amparai and Coastal areas, with the Sammanthurai area included in the latter. Possible water sources are two tanks for the Amparai area, and three rivers for the Coastal area. Therefore, possible alternative supply systems will be composed as briefed below:

Amparai Water Supply Area

1) Alternative A:

Amparai tank -----➤ Treatment Plant -----➤ Amparai area

2) Alternative B:

Kondavattavan tank -----➤ Treatment Plant -----➤ Amparai area

Coastal Water Supply Area

Case I

1) Alternative C (one water source):

Sambuveli anicut -----➤ Treatment Plant -----➤ Entire Coastal area

2) Alternative D (two water sources):

a. Sambuveli anicut -----➤ Treatment Plant -----➤ Sammanthurai area + North Coastal area

b. Kaliodai anicut -----➤ Treatment Plant -----➤ South Coastal area

3) Alternative E (three water sources):

a. Simbuveli anicut ----➤ Treatment Plant ----➤ North Coastal area

b. Kallarachel anicut ----➤ Treatment Plant ----➤ Sammanthurai area

c. Kaliodai anicut ----➤ Treatment Plant ----➤ South Coastal area

Case II

This case is for that the service area between Nintavur and Abbalachenai is excluded from the Coastal area for the Alternatives in Case I. Accordingly, water demand for the area is not included in the alternative schemes.

4) Alternative F (one water source)

5) Alternative G (two water sources)

A schematic flow chart of the above alternatives is shown in Figs. 6.8.1, and 6.8.2.

The construction cost is estimated separately in Stages-I and II in accordance with the Implementation Schedule in Chapter 6.8 for each alternative scheme, which includes the facilities from intake to distribution pipelines required for the target year 2005, together with operation and maintenance costs. The outcome of total costs and operation and maintenance costs is shown in Table 6.10, as below. The breakdowns of the construction cost are shown in Tables E-2 through E-8 in Appendix-E.

Table 6.19 Comparison of Costs for Alternative Schemes

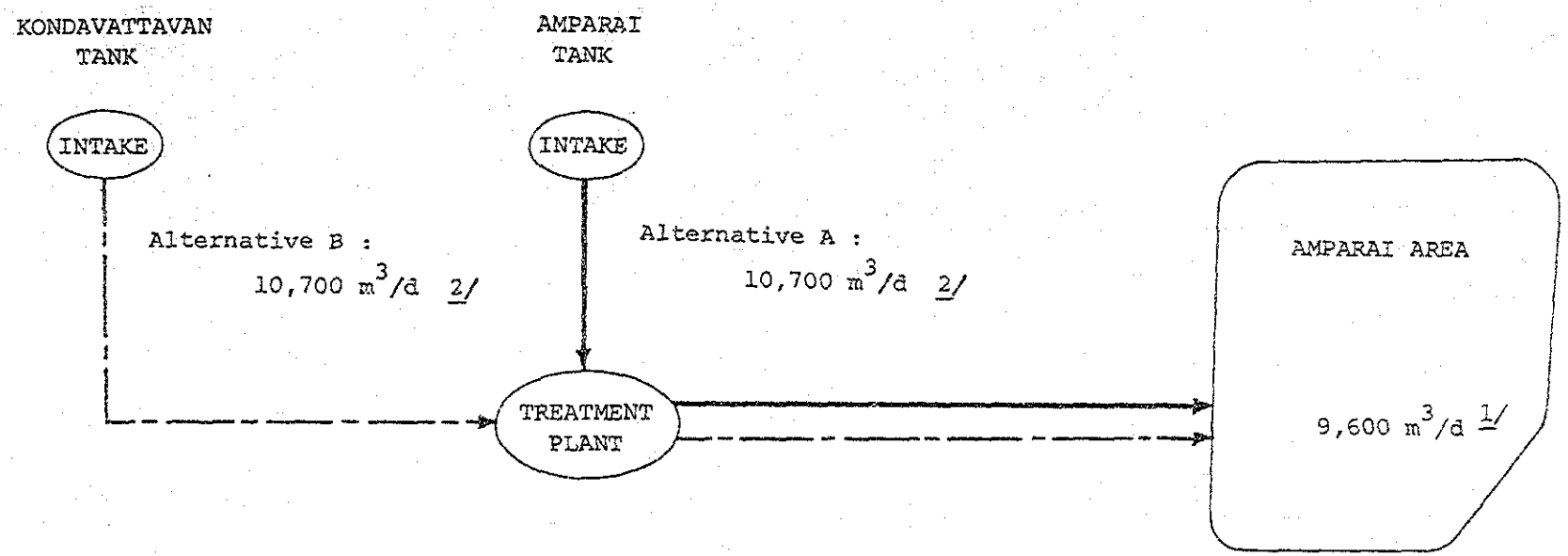
unit: Rs 1,000

Alternatives			Project Costs				Annual Operation/Maintenance Costs**
			Construction*	Taxes	Contingency**	Total	
Amparai Area		A	96,070	16,800	29,110	142,000	3,998
		B	109,350	19,760	31,890	161,000	3,344
Coastal Area	CASE I	C	472,970	70,200	119,830	663,000	7,965
		D	464,960	66,670	119,370	651,000	9,137
		E	489,520	70,480	126,000	686,000	10,152
	CASE II	F	395,540	54,740	100,220	551,000	6,387
		G	394,990	54,390	99,620	549,000	7,549

Note:
* Including costs for intake, treatment, transmission and distribution facilities, and engineering costs.
** Including physical and price contingencies.
*** Including personnel, power and chemicals, operation/maintenance and other costs.

Comparing alternatives A and B for Amparai area and alternatives C and D in Case I, the project costs of both B and C are costlier than the others although their annual operation and maintenance costs are

Fig. 6.8.1 SCHEMATIC FLOW CHART FOR ALTERNATIVE SYSTEMS AMPARAI AREA

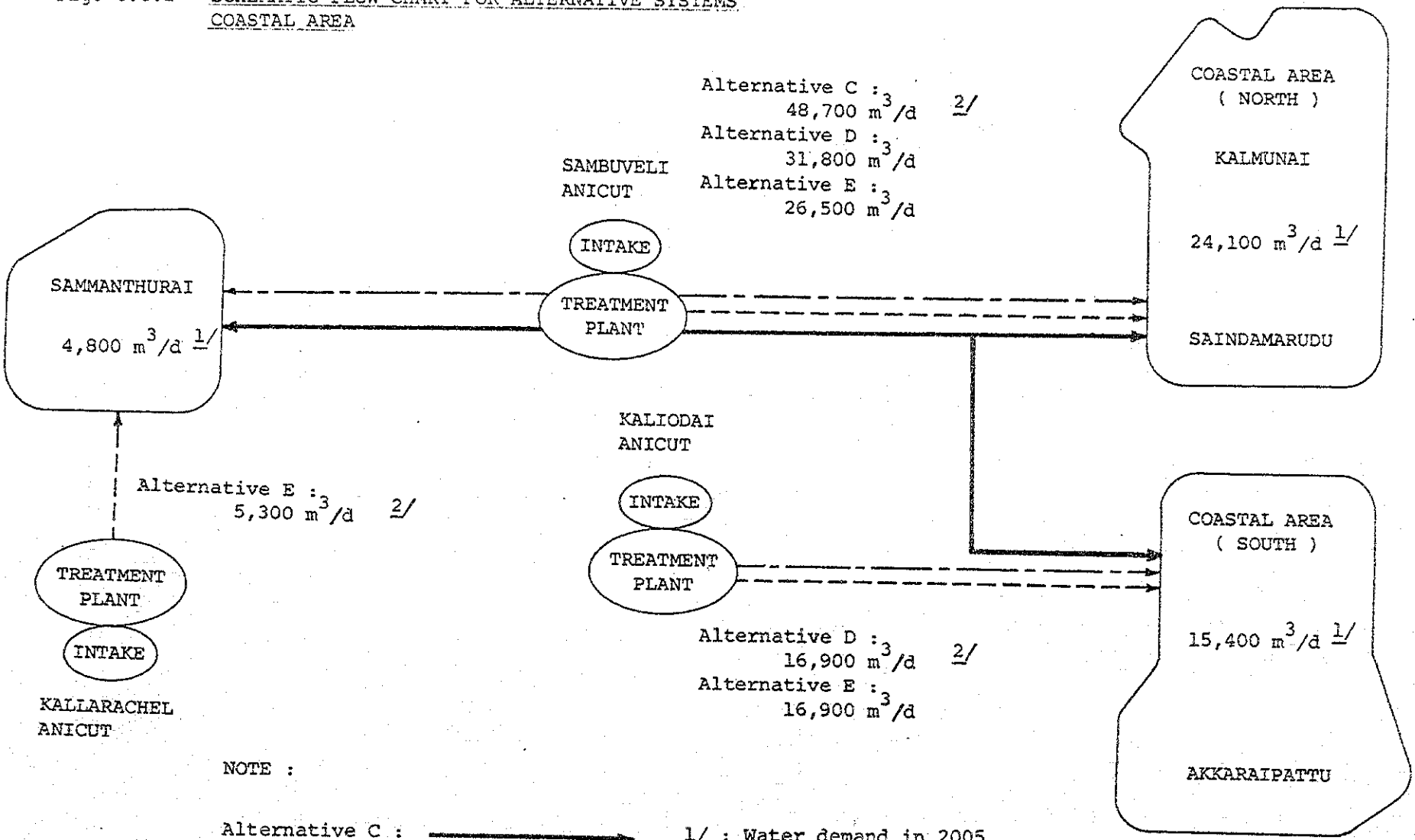


NOTE :

Alternative A : ——————→ 1/ : Water demand in 2005

Alternative B : — - — - — - → 2/ : Water treatment flow rate in 2005

Fig. 6.8.2 SCHEMATIC FLOW CHART FOR ALTERNATIVE SYSTEMS COASTAL AREA



less expensive. Alternative E is excluded from the comparison as both construction and annual operation/maintenance costs are costlier than the others.

For the comparison of alternatives A and B, and C and D on the basis of the least cost solution, the present worth calculation was made for construction cost and operation and maintenance costs assuming discount rates of 8% and 12% and 25 years period of calculation from commencement year of construction in 1983. The result is shown in Table 6.20.

Table 6.20 Present Worth of Alternatives

Unit: Rs million

Items	Discount Rate 8%			Discount Rate 12%		
	Investment	O/M Costs	Total	Investment	O/M Costs	Total
Alternative A	91,228	22,875	114,103	77,395	15,142	92,337
Alternative B	102,906	20,494	123,400	87,128	13,665	100,793
Alternative C	428,981	45,225	474,206	365,691	28,827	395,518
Alternative D	423,684	54,264	477,948	361,994	35,990	397,984

As is clear in Table 6.20, the alternatives A and C have lower present worth than the others. Therefore, the alternative A is recommendable for Amparai area water supply scheme, and the C for Coastal area water supply scheme from the following technical viewpoints as well.

a. One plant is more advantageous in aquisition of man power such as engineers to control the plant facilities and skilled men to maintain the facilities
b. Water quality control and monitoring are easy.
c. Operation and maintenance costs are inexpensive.
d. In Stage II, expansion of the treatment plant and extension of pipelines are scheduled. For this requirement, mere addition of equipment or pipeline will suffice.

6.6.2 Design Criteria

The design criteria to be used in preparation of preliminary designs for stagewise implementation of the long range plan are presented below. The design criteria are prepared based on the criteria used by the NWSDB and taking into consideration the practice of the existing water supply scheme.

1) Water demand

Max. daily demand	:	1.25 x average daily demand
Intake and treatment flow rates	:	1.1 x max. daily demand
Peak hour demand	:	2.0 x max. daily demand/24

A rate 0.8 of average daily demand to maximum daily demand is employed taking into consideration seasonal variations of water usage in dry and rainy seasons. For intake and treatment flow rate, a 10 percent allowance is considered for wastage such as draining from sedimentation basins and backwashing/surface washing of filters. Peak hour demand is assumed at twice of maximum daily demand taking account of that there may be considerable fluctuation in daily demand since domestic use takes a major portion of the demand.

2) Standby pumps

Intake and Transmission pumps	:	50% of pumps in operation
Chemical pumps and other pumps	:	100% of pumps in operation

Taking into consideration difficulty of repairing defective pumps and motors, the above rates of standby are applied.

3) Mixing well

Retention time	:	5 minutes of max. treatment flow rate
Mixing method	:	Hydraulic mixing utilizing the over-and-under baffles type

The function of the mixing well is to flash-mix chemicals with water. From experience 5 minutes retention time is considered appropriate for flash mixing. Mechanical type of mixing facilities will not be adopted because of difficulties in maintenance.

4) Flocculation basin

Retention time : 30 minutes of max. treatment flow rate
Flocculation method : Around-the-end baffles type

Retention time is determined on the basis of common practice applied for flocculation process. Mechanical type flocculators will not adopted because of difficulty of maintenance in future.

5) Sedimentation basin

Retention time : 4 hours of max. treatment flow rate for Amparai area plant
Type : Horizontal flow type

For the sedimentation basin of the Amparai plant, horizontal flow type is employed to facilitate easy operation and maintenance, as broad land is available to construct the basins. Four hours retention time, which is rather long, is applied consideraing the difficulty in treating light floc of plankton algae.

6) Filter

Filtration rate
Primary filter for Amparai plant : 5 $m^3/m^2/hr$
Secondary filter for Amparai plant : 0.2 $m^3/m^2/hr$*
Rapid sand filter for Coastal area plant: 5 $m^3/m^2/hr$

Type : Conventional type

Conventional type filter will be adopted for both treatment plants in Amparai and Coastal areas. The filtration rates depend on common practice.

Note: Filtration rate should be reviewed on the bases of the result of actual operation in Stage I.

7) Elevated tower

Retention time	:	2 hours of max. daily demand
Water depth	:	4.5 m
L.W.L. above ground	:	25.5 m

Taking into account peak hour demand of 200 percent of maximum daily demand, retention time of distribution service reservoir will need 8 hours. Therefore, 2 hours for elevated tower and 6 hours for clear water reservoir in retention time are employed. 2 hours retention time will be enough for water supply on the occasion of power failure.

8) Clear water reservoir (service reservoir)

Retention time	:	6 hours of max. daily demand
Water depth	:	3.0 m

Out of total capacity of 8 hours retention time for max. daily demand, 6 hours capacity is shared by clear water reservoir.

9) Transmission and distribution pipes

Coefficient C value : 130

Pipe material

For 50 mm to 250 mm in diameter (2" to 10")	:	PVC pipe
For 300 mm and more in diameter (12" and more)	:	Ductile iron pipe (DIP)

As the inside surface of DIP is given cement mortar linning and PVC has smooth finishing and both are not corrodible, the coefficient C value may be taken at 130. PVC pipe from 50 mm to 250 mm in diameter is locally available.

10) Service water pressure

Minimum pressure at the end of distribution mains	:	12.0 m

The minimum residual pressure at the far end of primary distribution mains is determined at 12.0 m to supply to two storied houses.

6.6.3 Water Supply Facilities

1) Planned flow rate

The planned flow rate to determine dimensions of the facilities is shown in Table 6.21.

Table 6.21 Planned Flow Rate

Flow Rate	Amparai Tank		Coastal Area	
	1995	2005	1995	2005
Max. daily demand (m^3/day)	5,300	9,600	22,100	44,300
Intake/Treatment (m^3/day)	5,900	10,600	24,300	48,700
Transmission (m^3/day)	330	500	1,380	2,770

2) Water Supply Facilities

The facilities planned are presented in Table 7.1.1 and Table 7.1.2 for Amparai area and Coastal area water supply schemes, respectively, and are described in Section 7.3 Water Supply Facilities.

6.7 Cost Estimates

The project cost estimates for the long range scheme up to the year 2005 are presented in Table 6.22, broken down into foreign and local currency components.

Table 6.22 Cost Estimates for Total Scheme

Unit: Rs1,000

Scheme / Description	Amparai Area (9,600m^3/d) 1/			Coastal Area (44,300m^3/d) 1/			Total		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Intake Facilities	5,280	1,110	6,390	12,580	1,950	14,530	17,860	3,060	20,920
B. Treatment Facilities	18,500	40,500	59,000	57,660	58,430	116,090	76,160	98,930	175,090
C. Transmission Facilities	12,960	1,890	14,850	119,330	15,180	134,510	132,290	17,070	149,360
D. Distribution Facilities	9,800	6,050	15,850	59,130	43,150	102,280	68,930	49,200	118,130
E. Materials (Cement & Reinforcement)	14,020	-14,020 2/	0	25,980	-25,980 2/	0	40,000	-40,000 2/	0
F. Land Acquisition	-	-	-	-	60	60	-	60	60
G. Engineering	-	-	-	99,000	6,500	105,500	99,000	6,500	105,500
Sub-Total	60,560	35,530	96,090	373,680	99,290	472,970	434,240	134,820	569,060
H. Duties and Taxes	-	16,800	16,800	-	70,200	70,200	-	87,000	87,000
Sub-Total	-	16,800	16,800	-	70,200	70,200	-	87,000	87,000
I. Physical Contingency	6,120	5,230	11,350	37,310	16,960	54,270	43,430	22,190	65,620
J. Price Contingency	5,320	12,440	17,760	29,010	35,550	65,560	34,330	47,990	82,320
Sub-Total	11,440	17,670	29,110	66,320	52,510	118,830	77,760	70,180	147,940
Total	72,000	70,000	142,000	440,000	222,000	662,000	512,000	292,000	804,000

Note : 1/ : (m^3/d) shows Maximum daily demand.

2/ : Figures show costs of Cement & Reinforcement in civil works in L/C portion which are transferred to F/C portion.

The total project cost including land acquisition, duties and taxes and contingencies amount to Rs 804 million, out of which the foreign currency component is Rs 512 million and the local currency component is Rs 292 million.

In the estimation of the project costs, unit prices of materials imported or locally produced and labour are broken down into following components:

Materials	Components
Imported	CIF Colombo, customs duty and tax, local direct components of local handling and transportation charges.
Locally available imported	CIF Colombo, customs duty and tax, local direct components of local handling and transportation charges, local profit.
Locally produced	Exfactory price, sales tax, local direct components of transportation and handling charges.
Labour	
Expatriate	Remuneration, per diem and other out-of-pocket expenses.
Local labour	Remuneration and out-of-pocket expenses.

The local currency component includes costs of labour and materials actutually paid in the local currency, namely, it comprises the costs for local labours and materials locally manufactured or produced, including local handling and transportation charge for imported materials, for expatriate's local expenditure, and for imported materials which are locally available.

The foreign currency component represents the costs to be paid in foreign currency such as those of imported materials and equipment (CIF Colombo), cement and reinforcing bar imported to be procured in local market and foreign currency portion of expatriate service fees. Duties and taxes consist of the customs duty and business tax. The customs duties are estimated based on the Customs Notification in the Gazette of the Democratic Socialist Republic of Sri Lanka in November 1981, and are chargeable against the value of the imported goods at the rate from 5 to 100% depending on goods, for example, on the average,

Ductile Iron Pipes	25%
Polyvinyl Chloride Pipes	12.5%
Pumps	50%

The business taxes are at the rate from 15 to 55% depending on the goods.

Physical contingency is allowed for the basic costs of materials and works. Its rate is estimated 10 percent against the construction costs inclusive of the engineering cost.

Price contingency is allowed for the construction costs, duties and taxes for the overall period of each program at the following rate: The rate for the local component is 10% annually. The rate for foreign component is 7% in 1984 and 1985, 6.5% in 1986, 6% in 1987, and thereafter through 1995.

For estimating the construction costs of the proposed water treatment system, the unit prices for labour, materials, equipment, power, transportation and so on have been collected and checked during the course of the present study. All costs are expressed as of December 1981 price level in Colombo. Transportation factors are estimated based on unit rates for transportation from Colombo to each project site.

6.8 Implementation Schedule

The implementation of the present water supply scheme shall be undertaken by stagewise construction in order to avoid a heavy investment to execute at one time the construction of entire facilities for the future scheme in the year 2005. Two stages of implementation are recommended with Stage I for the target year in 1995 and Stage II in 2005.

The reason of two stages implementation is summarised as follows:

1) In general, in planning waterworks facilities, the target year will be set considering 10 years time ahead, on the basis of economical scale of facilities.

2) In the year 1995, maximum daily water demand is found to be approximately half of the ultimate water demand. It is reasonable to divide the stage and set the target in 1995.

3) The cost of investment will be justified on the basis of financial viability.

4) The provision of local budget can be facilitated.

The Stage I Programme is scheduled to commence in June 1983 with the engineering services for detailed design of the project for duration of 8 months, and successively the tendering is to be called for procurement of materials and equipment and construction of civil works. The project will be completed by the end of August 1986.

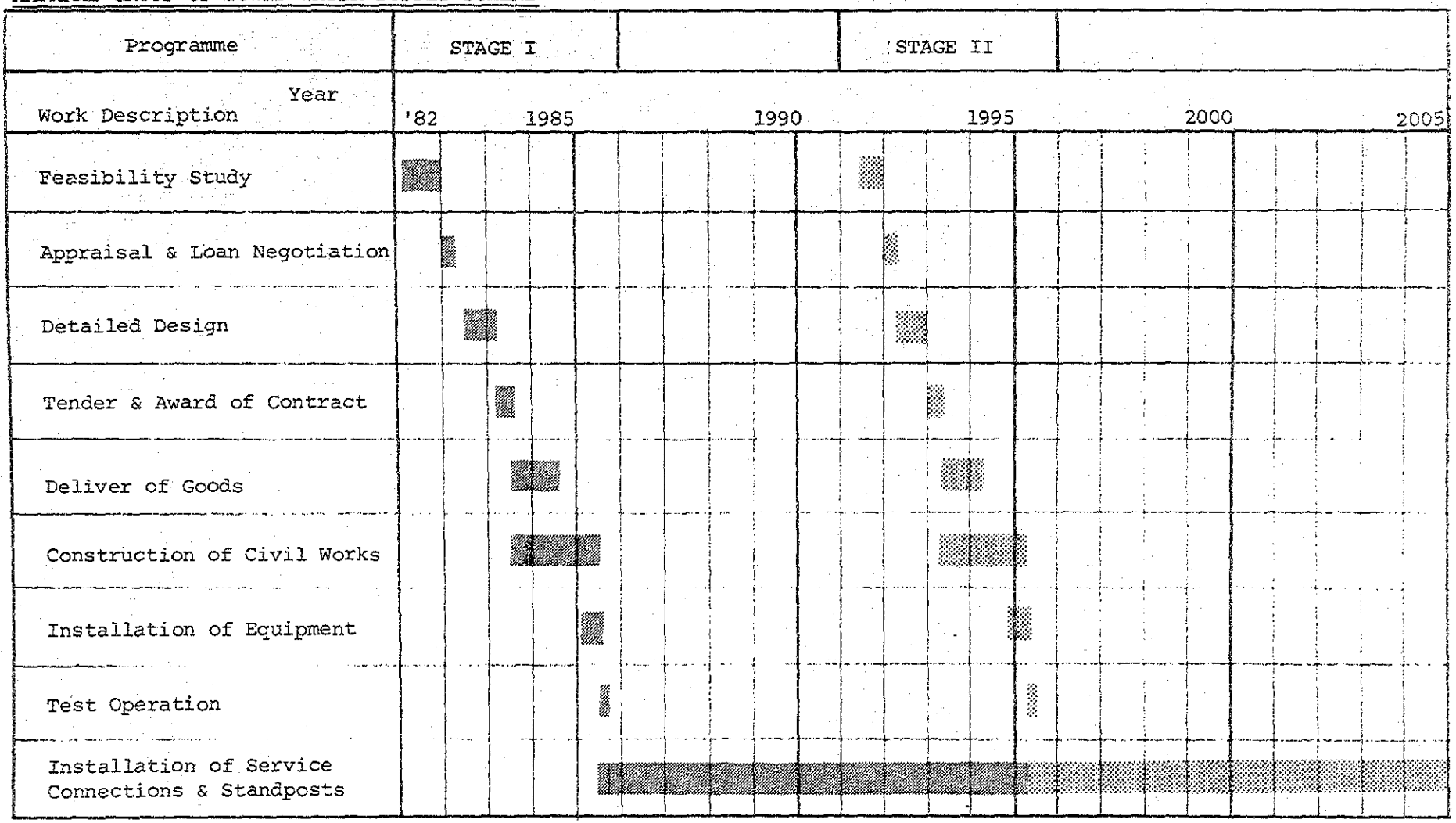
The Stage II Programme is scheduled to commence in April 1991 with the engineering services for a feasibility study and followed by appraisal by the lending agency, loan negotiation, detailed design engineering, and tendering and construction of civil works. The project is allowed twenty eight months period for construction works.

Before the commencement of Stage II Programme, particularly, the review for a future development of the water supply scheme shall be performed at the stage or feasibility study for Stage II Programme on the basis of the tendency of population growth, past records of water consumption and development of each service area.

The implementation schedule for the scheme is shown in Table 6.23.

Table 6.23 Implementation Schedule

AMPARAI GROUP OF TOWNS WATER SUPPLY SCHEME



7. STAGE I PROGRAM

7.1 General

In accordance with the comparative study described in the previous Chapter, the future water supply schemes in the year 2005 will be proposed as follows:

1) Raw water is to be taken from the Amparai tank and after purification in the plant, the treated water is to be supplied to the service area in Amparai U.C.

2) Raw water is to be taken from the Pallanktti Aru (river) at the point of upstream of the Sambuveli anicut, and after purification in the plant, the treated water is to be supplied to three directions of Sammanthurai service area, northern and southern coastal service areas.

This Chapter describes Stage I Program in the target year 1995 for Amparai Group of Towns Water Supply Scheme, covering the water supply facilities, cost estimates, implementation schedule and construction method for the project.

7.2 Service Area

Present congested town areas are shown in Fig. 6.1. The areas to be served in future will expand toward outskirts from the congested area except areas of Kalmunai, Karavahu West and Karavahu South where no land space for residential purpose is available at the present developed land area. Each service area in 1995 is assumed as follows:

1) Amparai service Area:
The existing service area will expand toward northeast along the new road to be constructed under the city planning.

2) Sammanthurai service area:

Sammanthurai T.C. area is built up with houses and few area to be extended, so that service area will expand toward Sammanthurai V.C. area adjoining to T.C. area.

3) Kalmunai, Karavahu North, West and South service areas:

These areas are congested and have little potential for further expansion. So, the present congested area will be the service area.

4) Karativu and Nintavur service area:

Both congested areas will be extended along the national road of route A 4 upto the southern most present land development boundary.

5) Akkaraipattu and Addalachenai service areas:

Congested area of Akkaraipattu will expand toward outskirts of the area and that of Addalachenai toward north direction along the route A 4 upto extreme land development boundary of each V.C. of Addalachenai and Nintavur.

7.3 Water Supply Facilities

1) Planned flow rate

Maximum daily demand of each service area and planned flow rate for treatment plants and transmission lines in the year 1995 are shown in Table 7.1.

Table 7.1 Planned Flow Rate in 1995

Service Area	Max. Daily Demand	Intake/Treatment Flow Rate	Transmission Flow Rate
			m^3/hr
Amparai Plant	5,300 m^3/d	5,900 m^3/day	
Amparai	5,300		333
Coastal Plant	22,100	24,300	
Sammanthurai	2,500		105
North Coastal*	12,300		769
South Coastal**	7,300		456

Note: * including Kalmunai, Karavahu North, West and South, Karativu and Nintavur areas.

** including Addalachenai and Akkaraipattu areas.

2) Facilities of Stage I Scheme

The facilities to be constructed under Stage I program are shown in Table 7.2.

Taking into account the limited local budget for the project, as much reduction as possible in the local currency component is attempted as described below.

a. The cost for the distribution system for the coastal area was reallocated from Stage I to State II. As regards the coastal area between Nintavur and Addarachenai, villages are all scattered, the population is still small, and the present water demand is not significant. Therefore, the construction of the distribution system there is considered more appropriate to be implemented in Stage II when migration from Karavahu South and Akkaraipattu is expected to increase.

b. Filtration rate for slow sand filter in Amparai area will be adopted 15 m/d. Accordingly, area of filter bed is reduced to 600 m^2 from 1,600 m^2 at 5 m/d.

Data of past experiment on removal of odour available for high filtration rate of slow sand filter is max 10.75 m/d as follows:

Past Data for Removal of Odour by Dual Stage Filtration

Raw Water	Odour (T.O. degree) Primary Filter		Slow Sand Filter		
T.O.	F.R.1/ m/d	T.O.	F.R. m/d	T.O.	Operation period
27	83.6	11	8.0	0	10 days
11	83.6	5	10.75	0	11 days
8	83.6	5	10.75	0	12 days

Note: (1) F.R. 1/ : Average filtration rate. (Primary filter: thickness of filter media 500 mm, grain size 3 to 9 mm. Slow sand filter: ordinary media and size.)

(2) T.O. : Threshold odour (degree).

It is considered that removal of odour by the primary filter is related to the contact time with the filter media, and that by the slow sand filter is due to the contact with bio-film formed on the filter media.

Table 7.2-(1) WATER SUPPLY FACILITIES (AMPARAI AREA)

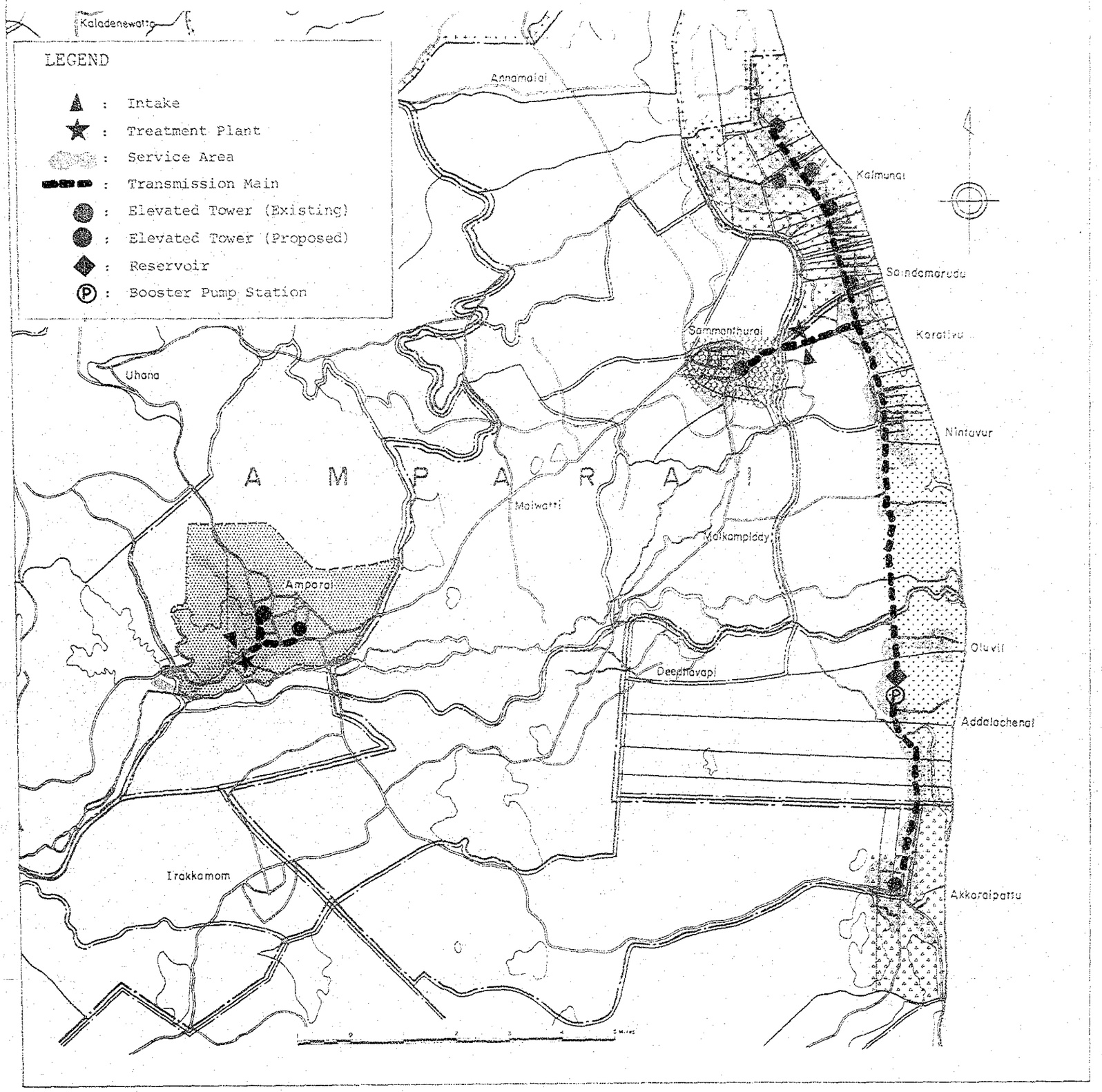
Items	Description	Stage-I	Stage-II	Total
Max Daily Demand		5,300 m^3/d	4,300 m^3/d	9,600 m^3/d
Intake/Treatment Flow Rates		5,900 m^3/d	4,800 m^3/d	10,700 m^3/d
A. LAND ACQUISITION				
1. Intake		100 m^2	-	100 m^2
2. Treatment Plant Site		14,000 m^2	-	14,000 m^2
3. Elevated Tower Site		2,000 m^2	2,000 m^2	4,000 m^2
B. INTAKE				
1. Intake Bay	2.0 m x 2.0 m x 3.4 m	1	-	1
2. Pump House		80 m^2	-	80 m^2
3. Raw Water Pump	4.1 m^3/min x 23 m x 30kW	2 (1)	1	3 (1)
4. Raw Water Main	DIP Ø300	400 m	400 m	800 m
C. TREATMENT PLANT				
1. Receiving and Mixing Well	3.0 m x 5.0 m x 3.5 m with overflow weir and over-and-under baffle plate	1 (R.T. : 13 mins)	-	1 (R.T. : 7 mins)
2. Flocculation Basin	4.0 m x 5.0 m x 3.0 m with around-the-end baffle plate R.T. : 30 mins	3	3	6
3. Sedimentation Basin	4.0 m x 32.5 m x 4 m with four perforated walls and outlet trough. R.T. : 4 hrs Mean velocity 40 cm/min	3	3	6
4. Rapid Sand Filter	Area of filter bed 24 m^2	3	-	3
	- do - 21 m^2	- (F.R. : 5.1 $m^3/m^2/hr$)	2	2 (F.R. : 5.0 $m^3/m^2/hr$)
5. Slow Sand Filter	Area of Filter bed 200m^2	3 (F.R. : 0.6 $m^3/m^2/hr$)	8	11 (F.R. : 0.2 $m^3/m^2/hr$)
6. Clear Water Reservoir	18.0 m x 12.0 m x 3.0 m	2	-	2
	14.0 m x 12.0 m x 3.0 m	-	2	2
	R.T. : 6 hrs			
7. Administration Building	Office space for monitoring of treatment process, chemical feeding equipment and laboratory.	600 m^2	-	600 m^2
8. Chemical Feeding Facility	Alum, lime and chlorine feeding	1	-	1
D. TRANSMISSION				
1. Pump House		50 m^2	30 m^2	80 m^2
2. Transmission Pump	2.8 m^3/min x 49 m x 30kW	3 (1)	3 (1)	6 (2)
3. Transmission Main	DIP Ø350	900 m	900 m	1,800 m
	PVC Ø250	3,400 m	3,400 m	6,800 m
E. DISTRIBUTION				
1. Elevated Tower	R.T. : 2 hrs, Total capacity	250 m^3	600 m^3	850 m^3
2. Distribution Pipe	DIP Ø350	-	10 m	10 m
	DIP Ø300	100 m	50 m	150 m
	PVC Ø250	200 m	140 m	340 m
	PVC Ø200	2,800 m	900 m	3,700 m
	PVC Ø150	5,600 m	2,250 m	7,850 m
	PVC Ø100	800 m	1,270 m	2,070 m
	PVC Ø75	1,500 m	2,530 m	4,030 m
	PVC Ø50	3,900 m	6,350 m	10,250 m
	Total length	14,900 m	13,500 m	28,400 m

Note: ( ) : standby, R.T. : retention time, F.R. : filtration rate

Table 7.2-(2) WATER SUPPLY FACILITIES (COASTAL AREA)

Items	Description	Stage-I	Stage-II	Total
Max. Daily Demand		22,100 m^3/d	22,200 m^3/d	44,300 m^3/d
Intake/Treatment Flow Rates		24,300 m^3/d	24,400 m^3/d	48,700 m^3/d
A. LAND ACQUISITION				
1. Intake Site		150 m^2	-	150 m^2
2. Treatment Plant Site		20,000 m^2	-	20,000 m^2
3. Elevated Tower Site		10,000 m^2	10,000 m^2	20,000 m^2
B. INTAKE				
1. Intake Bay	2.0 m x 3.7 m x 4.3 m	2	-	2
2. Pump House		120 m^2	-	120 m^2
3. Raw Water Pump	8.5 m^3/min x 15 m x 37kW	3 (1)	3 (1)	6 (2)
4. Raw Water Main	DIP Ø500	850 m	850 m	1,700 m
C. TREATMENT PLANT				
1. Receiving and Mixing Well	3.0 m x 8.5 m x 3.6 m with overflow weir and over-and-under baffle plate	1 (R.T. : 5.4 mins)	-	1 (R.T. : 3.0 mins)
2. Flocculation Basin	6.0 m x 11.0 m x 3.0 with around-the-end baffle plate R.T. : 30 mins	4	4	8
3. Sedimentation Basin	6.0 m x 49.0 m x 4.0 m with four perforated walls and outlet trough. R.T. : 3 hrs	4	4	8
4. Rapid Sand Filter	Area of filter bed 65 m^2	4	-	4
	- do - 53.4 m^2	- (F.R. : 5.2 $m^3/m^2/hr$)	4	4 (F.R. : 5.0 $m^3/m^2/hr$)
5. Clear Water Reservoir	20.0 m x 16.0 m x 3.0 m	4	-	
	20.0 m x 16.5 m x 3.0 m	-	4	
	R.T. : 6 hrs			
6. Administration Building	Office space for monitoring of treatment process, chemical feeding equipment and laboratory.	870 m^2	-	870 m^2
7. Chemical Feeding Facility	Alum, lime and chlorine feeding	1	-	1
D. TRANSMISSION				
1. Pump House				
1) Transmission Pump House		150 m^2	60 m^2	210 m^2
2) Booster Pump House		90 m^2	40 m^2	130 m^2
2. Transmission Pump				
1) Pump for Coastal Area	6.8 m^3/min x 52 m x 90kW	5 (2)	4 (1)	9 (3)
2) Pump for Sammanthurai	1.8 m^3/min x 42 m x 18.5kW	2 (1)	1	3 (1)
3) Booster Pump	3.8 m^3/min x 46 m x 50 kW	3 (1)	3 (1)	6 (2)
3. Transmission Main	DIP Ø600	1,800 m	1,800 m	3,600 m
	DIP Ø500	1,600 m	1,600 m	3,200 m
	DIP Ø400	2,500 m	2,500 m	5,000 m
	DIP Ø350	19,300 m	19,300 m	38,600 m
	DIP Ø300	1,900 m	1,900 m	3,800 m
	PVC Ø250	2,500 m	2,500 m	5,000 m
	PVC Ø200	400 m	400 m	800 m
E. DISTRIBUTION				
1. Ground Reservoir	R.T. : 6 hrs, Total capacity	1,800 m^3	2,000 m^3	3,800 m^3
2. Elevated Tower	R.T. : 2 hrs, Total capacity	1,500 m^3	1,600 m^3	3,100 m^3
3. Distribution Pipe	DIP Ø350	100 m	20 m	120 m
	DIP Ø300	600 m	250 m	850 m
	PVC Ø250	1,700 m	860 m	2,560 m
	PVC Ø200	8,700 m	8,020 m	16,720 m
	PVC Ø150	23,400 m	18,100 m	41,500 m
	PVC Ø100	13,800 m	9,640 m	23,440 m
	PVC Ø76	27,400 m	19,350 m	46,750 m
	PVC Ø50	68,800 m	48,060 m	116,860 m
	Total length	144,500 m	104,300 m	248,800 m

Fig. 7.1 WATER SUPPLY SCHEME FOR AMPARAI GROUP OF TOWNS IN STAGE I



REFERENCE

- District Boundary
- D.R.O's Divison Boundary
- Grama Sevaka Division Boundary
- Municipal, Urban, Town & Village Council Limits
- Electoral District Boundary

Remark

Study Area

- KALMUNAI + SAINDAMARUDU
- AMPARAI U.C.
- AKKARAIPATTU T.C.
- SAMMANTHURAI T.C.
- Coastal arera-KARATIVU+NINTAVUR

Taking into account the above experimental result and for the purpose of reducing the cost of local currency component due to the limited local budget for the project, the present filtration rate is recommended to employ 15 m/d.

In practicing the proposed filtration rate, a rather high rate, the following shall be observed:

i. To avoid quick clogging of slow sand filters, turbidity caused by algal plankton should be removed during the stage of pre-treatment consisting of sedimentation and rapid filtration.

ii. To make the above turbidity removal effective, chemicals should be dosed all through the year. Regarding the turbidity to be treated, its concentration is presumed as max. 200 mg/l, min. 20 mg/l and average 50 mg/l, from the past data on turbidity measured by NWSDB. Chemical dosage for average turbidity will be as follows:

Alum	:	55 mg/l
Lime	:	6 mg/l
Chlorine	:	2 mg/l

In this connection, the chemical cost Rs 205,000 estimated in the Draft Final Report will be revised as Rs 447,000.

7.4 Cost Estimates

As described in the previous section, the cost of distribution system in the coastal area between Nintavur and Addalachenai is excluded from the project cost due to limited budget for local component. The total project costs are as follows:

Total project costs	: Rs 423,000,000 (US$20,300,000)
Foreign currency component	: Rs 273,000,000 (US$13,100,000)
Local currency component	: Rs 150,000,000 (US$ 7,200,000)

The breakdown of the cost and the disbursement schedule are shown in Table 7.3 and Table 7.4, respectively.

Table 7.3 Cost Estimates for Amparai Group of Towns Water Supply Scheme

Stage I Programme

unit: Rs 1,000

Programme	Amparai Area			Coastal Area			Total		
Description	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Intake Facilities	3,330	840	4,170	6,290	1,450	7,740	9,620	2,290	11,910
B. Treatment Facilities	11,310	18,720	30,030	31,480	30,950	62,430	42,790	49,670	92,460
C. Transmission Facilities	6,480	960	7,440	60,920	7,820	68,740	67,400	8,780	76,180
D. Distribution Facilities	6,170	2,630	8,800	31,360	20,650	52,010	37,530	23,280	60,810
E. Materials (Cement & Reinforcement)	6,340	- 6,340	0	12,870	- 12,870	0	19,210	- 19,210	0
F. Land Acquisition	-	-	-	-	60	60	-	60	60
G. Engineering	-	-	-	55,000	2,500	57,500	55,000	2,500	57,500
Sub-Total	33,630	16,810	50,440	197,920	50,560	248,480	231,550	67,370	298,920
H. Duties and Taxes	-	10,000	10,000	-	36,660	36,660	-	46,660	46,660
Sub-Total	-	10,000	10,000	-	36,660	36,660	-	46,660	46,660
I. Physical Contingency	3,430	2,680	6,110	19,730	8,730	28,460	23,160	11,410	34,570
J. Price Contingency	2,940	6,510	9,450	15,350	18,050	33,400	18,290	24,560	42,850
Sub-Total	6,370	9,190	15,560	35,080	26,780	61,860	41,450	35,970	77,420
Total Costs	40,000	36,000	76,000	233,000	114,000	347,000	273,000	150,000	423,000

TABLE 7.4 DISBURSEMENT SCHEDULE FOR PROJECT COSTS FOR STAGE-I SCHEME

Unit: Rs 1.0 million

Items	Project Cost		1983		1984		1985		1986	
	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Procurement	176.55	-	-	-	-	-	158.89	-	17.66	-
2. Civil Works and Pipelaying Works	-	64.81	-	-	-	16.20	-	32.41	-	16.20
3. Land Acquisition Cost	-	0.06	-	-	-	0.06	-	-	-	-
4. Engineering Cost	55.00	2.50	27.00	1.20	7.00	0.40	14.00	0.60	7.00	0.30
Sub-total	231.55	67.37	27.00	1.20	7.00	16.66	172.89	33.01	24.66	16.50
5. Duties & Taxes	-	46.66	-	-	-	-	-	42.00	-	4.66
6. Physical Contingency (Approx. 10%)	23.16	11.41	2.70	0.12	0.70	1.67	17.29	7.50	2.47	2.12
7. Price Contingency	18.29	24.56	2.08	0.13	0.54	12.42	13.31	10.58	2.36	1.43
Total	273.00	150.00	31.78	1.45	8.24	30.75	203.49	93.09	29.49	24.71

7.5 Implementation Arrangement

Table 7.5 shows the implementation schedule of Stage-I Programme. Contracts for the Project may be classified into two, 1) Procurement of Equipment and Materials and 2) Civil Works. Further, those procurement and civil works contracts may be split into several contracts according to implementation schedule wherever considered appropriate.

1) Detail Design Engineering

In the later part of 1983, engineering consultants shall be employed for detailed designs. The designs of the structures and pipelines shall be made based on the preliminary designs described in the present feasibility study report, and specifications and tender documents shall be prepared. The design and specifications shall be prepared in such detail that suppliers and contractors can estimate properly the costs for supplies of materials and equipment, of construction works, and execute the work as aimed in the design.

2) Tender Procedure

Procurement of materials and equipment shall be made, in principle, on the international competitive basis, and civil works will be carried out on the local competitive basis. The procedure of tendering will be generally 1) prequalification of the prospective bidders for civil works, where required, 2) tender announcement in accordance with the guidelines of the lending agency, 3) bidding, 4) evaluation of the received tenders, 5) negotiations with a lowest evaluated tenderer, and finally 6) awards of contracts During this series of proceedings, approvals, as required, of the lending agency shall be obtained.

3) Procurement and Bid Evaluation

Evaluation of the bids shall be made by the consultants mainly on three aspects, namely, compliance with administrative requirements, technical standards and bid prices. Regarding the administrative requirements, the tender must meet the requirements set forth in the general conditions in the tender documents and instructions to the tenderers. Regarding the technical standards, all the requirements are stipulated in the technical specifications and drawings of the tender documents. Materials, equipment and works offered by the tenderers must meet the specified requirements. Finally, with regard to the bid price of tender all unit prices, calculations and totals shall be checked with their appropriateness. The unit prices should be reasonable, calculations correct, and the total price should be within the budgetary provision. The consultants shall recommend to the owner the lowest evaluated tenderer based on the results of the afore-mentioned evaluation and checking.

4) Monitoring of the Project

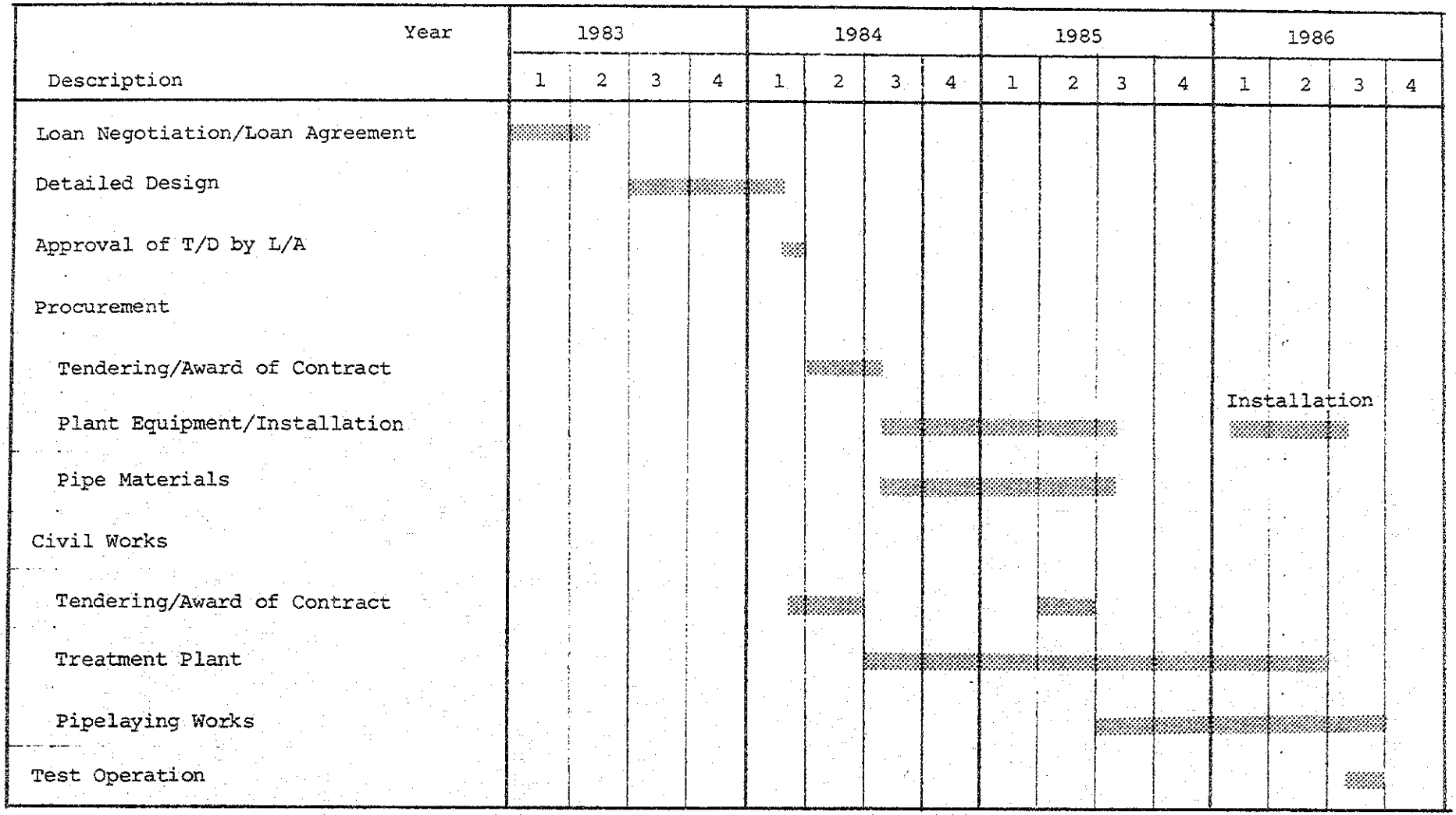
Monitoring of activities and performances of contractors is essential to ensure satisfactory completion of the project. Major items to be monitored are as follows:

a. Procurement of Materials and Equipment
   - Manufacturing and shipping schedules of materials and equipment to be procured.
   - Delivery and installation of materials and equipment at sites.
   - Test operation.

b. Construction of Civil Work
   - Dates of commencement and completion of the whole contractual work, and construction schedules of each facility.
   - Schedules for provision of laborers, machinery and equipment and materials to be used.
   - Performance of contractors and workmanships of the works.

Table 7.5 Implementation Schedule of Stage I Program

AMPARAI GROUP OF TOWNS WATER SUPPLY SCHEME



Abbreviation T/D: Tender document L/A: Lending Agency

Note: The implementation schedule presented here is subject to modification according to the actual need of the Government.

7.6 Methods of Procurement and Construction

The construction of water supply facilities depends upon the own forces of the water supply enterprise or the contract basis. The NWSDB, at present, employs the contract basis inclusive of construction materials and labour forces for the domestic works.

For the projects of bilateral/multilateral aids, in principle, the plant equipment and pipe materials for the water supply scheme have been procured by the open international competitive bidding procedures and the installation of equipment and pipes has been conducted by the local tendering procedures at the NWSDB Head Quarter, Colombo. Occasionally, however, the Turn-Key Method is to be applied for the project aids in terms of the condition of the donor country.

The procedure for construction methods for the Stage I of the Amparai Group of Towns water supply scheme will be considered as follows:

1) International Tendering

The procurement of plant equipment and pipe materials is to be made by the open international competitive bidding procedures in accordance with the guideline of the lending agency. Grouping of the plant equipment and pipe materials for the said tendering will be as follows:

a. plant equipment.
   - screen for the water intake
   - pumps, motors and appurtenances
   - chemical feeding equipment and
   - electrical facilities including power sub-station

b. pipes, fittings, valves, gates, jointing materials and flow meters for the plant facilities and transmission pipeline.

c. pipes, fittings, valves and jointing materials for distribution pipelines, flow meters at elevated towers, and water meters.

The procedure of tendering is described in 7.5.2) Tender Procedure.

2) Local Tendering

All the contractors for civil works have their head offices in the City of Colombo and have regional offices in the major cities/towns in the province.

The contractors are required to register at the Government and obtain the license for business. After registration, the contractors are ranked by the Government according to their qualification on the basis of the evaluation of the capital of the firm, number of qualified engineer, annual contract amounts undertaken and past experience. The contractors will be nominated to the plant equipment and pipelaying works.

Grouping of the civil works for tendering of the systems is to be as follows:

a. civil works of intake and treatment facilities and elevated tower for the Amparai water supply scheme

b. erection of plant equipment including power sub-station for the Amparai plant

c. pipelaying works of transmission and distribution pipelines for the Amparai sheme

d. intake and treatment facilities for the Coastal area water supply scheme

e. erection of plant equipment including power sub-station and booster pumping facilities for the Coastal area scheme

f. elevated towers and civil works of the booster pumping station for Akkaraipattu area in the Coastal area scheme

g. pipelaying works for transmission and distribution pipelines for the Coastal area scheme

The tendering for the above shall be made in accordance with the local tendering procedures.

7.7 Community Participation

In order to let the community appreciate the existence of water supply and further to get their understanding and cooperation, enforcement of public relations and education program is essential. On the basis of such enforcement, participation of people would be effectuated and community as a large be oriented to support the government policy on water supply program.

The fact is that water supplies are one of the public services which have a close relation with community, it is recommended, therefore, that at every stage the NWSDB has a plan in each field as planning, designing and construction of water supplies. People's low appreciation or indifference must be improved or amended. When required, opinions of scholars and experts or a leader of the community should be referred to regarding the management of the Board at the initiation of planning and be incorporated into further stage of implementation of the scheme. At the scheme level, community participation should be oriented to the following:

1) Maintenence of water facilities such as taps, connections and standposts.
2) Monitor on water quality and water supply istallation including meters, connections and mains, when required.
3) Monitor on effective usage of water and save waste of water.
4) Monitor on leakage.

It is evident that the construction cost of the project will be a burden to the NWSDB in implementing the required water supply scheme. In a way of reducing the total cost of the project, it will be an important factor to consider community participation. For good example, labor cost, which gives impact on total cost, would be reduced by participation of people engaged in the scheme on voluntary base.

8. FINANCIAL STUDIES

8.1 General

The financial studies are conducted to check the financial operations of the scheme in line with the construction of the proposed water supply scheme with an investment of fund required. As is discussed in preceding Chapter, implementation of the entire project is divided into two stages, namely, Stage I (1985-1995) and Stage II (1996-2005), taking into account the appropriate magnitude of investment and availability of fund. Since studies are concerned with the financial impact of investment for the first ten years program, the financial projection is, therefore, focused on the Stage I project.

8.2 Funding Requirements for Recommended Program

The NWSDB is the executing agency in implementing Amparai water supply scheme with possible external finance sources. According to the prevailing condition of the present ongoing schemes in other parts of the country, grant aids are remarkable, while the loan aids provided only for the major towns in the country. The present ongoing schemes with finance of external sources are shown in Appendix F. As for financing the proposed project, NWSDB is considering to obtain fund in the form of a grant from the government.

Funds required for construction of the Stage I of the proposed project are estimated, dividing into the foreign currency portion and the local currency portion and are summarized in Table 7.3. The yearly disbursement schedule of the proposed construction program is presented in Table 7.4. The cost estimation was prepared on the basis of the prevailing condition of unit price as of December 1981.

8.3 Sources of Financing

The Government of Sri Lanka intends to receive a fund from the external sources for the foreign currency portion of the project cost. There are two potential sources of financing, which are,

1. Bilateral Lending Agencies in Developed Countries.
2. Multilateral Lending Agencies.

As one of such external sources, a loan from the lending agencies of the bilateral source is preferable. The condition of loan is assumed as follows:

Interest : 2.75 percent per annum
Amortization: 20 years including 10 years grace period

To implement to scheme, according to the current practice of financing for the rural water supply scheme, it is understood that necessary cost for capital works will be financed by the central government in the form of a grant. This means that the NWSDB will construct facilities of capital works such as intake, treatment and transmission facilities, with a grant from the central government.

For the case of the present Amparai Scheme, several financing plans are considered for the purpose of comparing revenues and expenditures, and also water rate. Such financing plans are summarized as follows:

Case 1) All project cost, loan and foreign ..... Loan
Case 2) Project cost of foreign portion ..... Loan
Case 3) Cost of 50 percent of distribution facilities in foreign portion ..... Grant
All local portion, plus foreign portion except cost of 50 percent of distribution facilities in foreign portion ..... Grant

To meet operation and non-operation cost, the NWSDB is required to raise considerably high tariff for Case 1 and Case 2, which are not appropriate financing plan in terms of the present financial condition of the NWSDB and the ability of the consumers to pay for water.

According the present financial position of the Board and consumers' ability, financing plan of Case 3) is employed, since this plan is recommendable to facilitate the NWSDB to compensate operating expenses and also other payment of interest, amortization and depreciation. Financial projection of Case 1) and Case 2) are shown in Appendix F.

8.4 Financial Feasibility

Financial projection was made to find out the financial condition of NWSDB along the implementation of the Stage I program of the proposed scheme. On the basis of revenue and expenditure projection, the financial feasibility of the present project was checked.

The central government grant to capital works is considered necessary under the present financial capability of the Board in order to help reduce the loan amount and alleviate the difficulty of the debt service payments thus placing the project on a sound and viable financial basis. Some portion of distribution cost in the foreign currency portion, as discribed in the preceding section, will be financed in the form of a loan.

Since it is arranged that the major portion of capital cost needed to construct the facilities of the present project is borne by the central government, the NWSDB concentrates its effort to cover the cost of maintenance and operation. Table 8-1 shows the project Income Statement and Table 8-2 shows the Project Cash Flow, from 1986, the year of expected operation of the facilities and ten years thereafter up to 1996, the target year of the Stage I project.

The revenue of water sales is projected from the yearly water sold times the proposed water rate which is worked out considering the costs of production and other maintenance, while the cost of operation covers costs of personnel salary, electricity and fuels, chemical and maintenance. In addition, operation cost includes overhead cost of the Board headquarters to be charged to the Branch office. The water rate, as described in the following section, is projected to be set at minimum only to cover costs of production, considering the ability of consumer, Rs 1.80 for five years from 1986 to 1990, and Rs 2.00 for the rest of the year up to 1995. As can be seen in the Income Statement, balance is in deficit side in the initial stage, that means the revenue cannot cover the expenditure, but later, the revenue can be generated as much as to compensate the deficit in the initial years. In order to recover the initial deficit, NWSDB is required to receive further amount of equity fund during the period of deficit, provided that such equity would be paid back in the later year.

Table 8-1 Projected Income Statement

(Unit: Rs 1,000)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Water Production (1,000m^3)	4,201	4,519	4,863	5,233	5,658	6,060	6,523	7,022	7,560	8,140	8,709
Water Sold (1,000m^3)	1,470*	3,163	3,404	3,663	3,960	4,242	4,566	4,915	5,292	5,698	6,096
Sales to Production %	70	70	70	70	70	70	70	70	70	70	70
Average Water Rate Rs/m^3	1.80	1.80	1.80	1.80	1.80	2.00	2.00	2.00	2.00	2.00	2.00
OPERATING REVENUE											
Water Sales	2,646	5,693	6,127	6,593	7,128	8,483	9,132	9,830	10,584	11,396	12,192
Charges for New Connection	10,478	11,440	12,480	13,572	14,664	15,834	17,082	18,486	19,942	20,228	23,062
Total	13,124	17,133	18,607	20,165	21,792	24,317	26,214	28,316	30,526	31,624	35,254
OPERATING EXPENSES											
Personnel Cost	1,210	2,274	2,274	2,274	2,274	2,274	2,479	2,479	2,479	2,479	2,479
Electricity and Fuel	467	749	796	847	904	959	1,021	1,086	1,157	1,233	1,233
Chemicals	449	966	1,037	1,115	1,203	1,286	1,382	1,483	1,593	1,710	1,710
Maintenance	937	1,909	1,909	1,909	1,909	1,909	1,958	1,958	1,958	1,958	1,958
Overhead	387	727	727	727	727	727	793	793	793	793	793
Cost of New Connections	11,409	12,400	13,470	14,590	15,708	16,905	18,178	19,606	21,083	21,391	24,249
Total	14,859	19,025	20,213	21,462	22,725	24,060	25,811	27,405	29,063	29,564	32,422
Income Before Depreciation and Interest (Deficit)	(1,735)	(1,892)	(1,606)	(1,297)	(933)	257	403	911	1,463	2,060	2,832
Depreciation	454	454	454	454	454	454	454	454	454	454	454
Interest	498	498	498	498	498	498	498	498	498	492	468
Net Income (Deficit)	(2,687)	(2,844)	(2,558)	(2,249)	(1,885)	(695)	(549)	(41)	511	1,114	1,910

* Water sold in 1986 is expected half of the water production.

Table 8-2 Projected Cash Flow Statement

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SOURCES OF CASH														
Internal Cash Generation														
Income Before Depreciation and Interest (Deficit)				(1,735)	(1,892)	(1,606)	(1,297)	(933)	257	403	911	1,463	2,060	2,832
Total				(1,735)	(1,892)	(1,606)	(1,297)	(933)	257	403	911	1,463	2,060	2,832
Loans from National Govt.			18,140											
National Government Grant														
- Foreign portion	31,780	8,240	185,350	29,490										
- Local portion	1,450	30,750	93,090	24,710										
Equity from National Govt.			2,500	2,500	2,000	2,000	2,000	2,000						
Total	33,230	38,990	299,080	54,965	108	394	703	1,067	257	403	911	1,463	2,060	2,832
APPLICATION OF FUNDS														
Capital Expenditure														
- Foreign portion	31,780	8,240	203,490	29,490										
- Local portion	1,450	30,750	93,090	24,710										
Dept Amortization														
- Interest			249	498	498	498	498	498	498	498	498	498	492	468
- Principal			-	-	-	-	-	-	-	-	-	-	908	908
Total Debt Service			498	498	498	498	498	498	498	498	498	498	1,400	1,376
Repayment of Equity												1,000	1,000	1,000
Total Application	33,230	38,990	296,829	54,698	498	498	498	498	498	498	498	1,498	2,400	2,376
Cash Surplus Oor deficit) for year	-	-	2,251	267	(390)	(104)	205	596	(241)	(95)	413	86	(340)	456
Cash at beginning of year			2,251	2,251	2,518	2,128	2,024	2,229	2,825	2,584	2,489	2,902	2,988	2,648
end of year				2,518	2,128	2,024	2,229	2,825	2,584	2,489	2,902	2,988	2,648	3,104

8.5 Water Rate

The sufficient revenues have to be raised for the satisfactory operation as well as maintenance of the water supply system constructed. The revenue should be generated to compensate not only the cost related to physical maintenance of the system but also the financial requirement of debt service payments. After several arrangements of revenue schedule considering factors of grant and loan, an appropriate average water rate was considered. As a result of projection, water rate is found to be Rs. 1.80/m^3 for the first five years and Rs 2.00/m^3 for the rest of the years.

Table 8-3 shows rate distribution by five different categories of consumers. Among them, domestic consumers are further classified into three according to the usage of water. The more water they use, the more charge they have to pay. This is arranged to meet the government policy that rich people can bear more portion of cost for water enabling poor people to use water with low tariff, and at the same time, by doing so, conservation of water at large is intended. Commercial and industry user charge is fixed to be more than double of domestic user of large quantity. It is noted that water usage of standposts user is arranged to be free for the first three years from operation in 1986.

Table 8-3 Proposed Water Rate (1986 - 1996)

Year	Item	Domestic			Commercial	Institution	Industry	Standpost
		Domestic-1 (0 - 10 m^3)	Domestic-2 (10 - 30 m^3)	Domestic-3 (30 m^3 -)				
1986 - 1990	Quantity (m^3/5 years)	4,739,388	1,692,640	338,528	2,901,668	1,301,242	784,420	3,902,114
	Water Rate (Rs/m^3)	0.91	1.37	1.82	4.55	1.82	4.55	0.46
1991 - 1996	Quantity (m^3/5 years)	10,237,609	3,656,288	731,257	6,267,924	2,555,290	1,515,793	5,844,839
	Water Rate (Rs/m^3)	0.96	1.44	1.92	4.80	1.92	4.80	0.48

8.6 Ability of the Community to Pay

The average income of consumers who are expected to receive water by the proposed project is checked to know their ability to pay for water. According to the survey conducted, the average monthly income of consumers is in the range of Rs 600 - Rs 800.

As to per capita consumption, 160 l/day is considered the fullest amount to be used, and monthly consumption of a household will be 24 m^3 per month. This amount is not necessarily consumed in average household. Considering the block wise usage of water, it will be estimated that the amount of usage in the initial block would be 10 m^3 to 15 m^3. According to the policy of the NWSDB, water rate is recommended to be arranged under 3 percent of the average monthly income of consumers. In case the soncumers use 15 m^3 of water in one month, which is 100 l per capita per day, water charge will be Rs 27/month at the rate of Rs 1.80/m^3, and Rs 30/month at the rate of Rs 2.00/m^3, which are in the range of 3 percent of the average income.

9. BENEFITS OF THE PROJECT

9.1 Benefits

Major benefits, direct and indirect, of the project are as follows:

1) Increase of Served Population and Area
Served population in the target year is estimated at 172,300 in the Stage I project and 261,100 in the Stage II against the present served population of 25,000. And the served area will increase from 600 ha to 2,732 ha in the Stage I and 3,325 ha in Stage II target year, respectively.

2) Supply of Safe Water
People who receive water from the existing water supply facilities are supplied intermittently for a few hours a day. Due to deterioation and also mal-function of the facilities, water quality is not always safe free from contamination. When the project is completed and full operation for 24 hours supply is attained, consumers will enjoy potable water any time which is safe in quality free from any contamination.

3) Improvement of Health Condition and Living Environment
Because of lack of running water, majority of population in the area are inevitably leading unsanitary life with the unhygienic storage of drinking water in the house. When the pipe borne water is introduced into the house or the yard, all these conditions can be rectified. All this will further promote the improvement activities of the living environment.

4) Employment Opportunity
The proposed project involves a greater amount of civil works along the construction of the required facilities, which will bring naturally employment opportunity in the area.

5) Rise of Earning by Promotion of Commercial Activities

Amparai is regarded as one of the strategic areas in the country in terms of production and collection center of rice and other agricultural products and also the Urban Council Area is developing as a local center for transportation and land, inviting commercial and industrial activities. But the insufficiency of water supply has been retarding the development. The present implementation of the water supply project will solve this problem and contribute greatly to a rise of earning of the public.

9.2 Financial Internal Rate of Return

Financial evaluation of the project was done by examination of the financial internal rate of return. Initial costs will be the sum of the project cost and the annual benefit will be the balance of annual operating income and annual operating cost. Table 8-4 shows financial internal rate of return of the project. Rate of return is 4.91%, which can be regarded as reasonable.

Table 8-4 Financial Internal Rate of Return

INTERNAL RATE OF RETURN 4.91 %

YEAR	DISCOUNT FACTOR	INVESTMENT	PRESENT WORTH	INCOME	EXPENDITURE OM COST	EXPENDITURE DEPR'TION	BENEFIT	PRESENT WORTH
1985	1.0000	18,140	18,140	0	0	0	0	0
1986	0.9532	0	0	13,124	14,859	0	-1,735	-1,653
1987	0.9086	0	0	17,133	19,025	0	-1,892	-1,718
1988	0.8661	0	0	18,607	20,213	0	-1,606	-1,390
1989	0.8256	0	0	20,165	21,462	0	-1,297	-1,070
1990	0.7870	0	0	21,792	22,725	0	-933	-733
1991	0.7502	0	0	24,317	24,060	0	257	193
1992	0.7151	0	0	26,214	25,811	0	403	288
1993	0.6816	0	0	28,316	27,405	0	911	621
1994	0.6498	0	0	30,526	29,063	0	1,463	951
1995	0.6194	0	0	31,624	29,564	0	2,060	1,276
1996	0.5904	0	0	35,254	32,422	0	2,832	1,672
1997	0.5628	0	0	35,254	32,422	0	2,832	1,594
1998	0.5365	0	0	35,254	32,422	0	2,832	1,519
1999	0.5114	0	0	35,254	32,422	0	2,832	1,448
2000	0.4874	0	0	35,254	32,422	0	2,832	1,380
2001	0.4646	0	0	35,254	32,422	0	2,832	1,316
2002	0.4427	0	0	35,254	32,422	0	2,832	1,254
2003	0.4222	0	0	35,254	32,422	0	2,832	1,196
2004	0.4024	0	0	35,254	32,422	0	2,832	1,140
2005	0.3836	0	0	35,254	32,422	0	2,832	1,086
2006	0.3657	0	0	35,254	32,422	0	2,832	1,036
2007	0.3486	0	0	35,254	32,422	0	2,832	987
2008	0.3323	0	0	35,254	32,422	0	2,832	941
2009	0.3167	0	0	35,254	32,422	0	2,832	897
2010	0.3019	0	0	35,254	32,422	0	2,832	855
2011	0.2878	0	0	35,254	32,422	0	2,832	815
2012	0.2743	0	0	35,254	32,422	0	2,832	777
2013	0.2615	0	0	35,254	32,422	0	2,832	741
2014	0.2493	0	0	35,254	32,422	0	2,832	706
TOTAL			18,140					18,125

10. ORGANIZATION AND ADMINISTRATION

10.1 General

Present water supply schemes in Sri Lanka are undertaken by the National Water Supply and Drainage Board (NWSDB), which is a corporate body established in 1975 in accordance with the National Water Supply and Drainage Board Law, No. 2 of 1974 of the National State Assembly. The duty of the Board is to develop, provide, operate and control an efficient, co-ordinated water supply and to distribute water for public, domestic and industrial purposes.

Previously before the establishment of the NWSDB, management and operation of water supply schemes rested with local government authorities which were administratively supervised and directed by Water Supply Department of the Ministry of Local Government, Housing and Construction.

Since the duty of the Board includes, in its area of authority, to take over and carry on any water supply or sewerage undertaking of any local authority transferred to the Board, it may be said that it is now transitional time that the Board is taking over Nation's any water supply schemes now under responsibility of the local authorities. Up to now, not all of water supply schemes have been taken over by the Board, and there still remain number of schemes operated and maintained by the local authorities in the countries. Under the circumstances, Nation's water supply schemes will be classified into two categories, namely, ones that are under operation and maintenance of the Board and the others under local government authorities.

There are water supply schemes operated and maintained by other authorities. Such authorities and their role of undertaking are summarized in Appendix-E.

Figure 10-1 shows the present organization of the NWSDB. The Board consists of four members who will be appointed by the Minister of Local Government, Housing and Construction, and each has capacity in engineering, finance, public health and administration or law. The Chairman, appointed also by the Minister among the appointed member of the Board, will chair the Board in policy making and decision.

Under the Chairman, the General Manager is in charge of executing the policy of the Board and at the same time has responsibility for overall technical operations. There are four Deputy General Managers supporting the General Manager being in charge for technical, workshop and supplies, administration, and south west coast project. Under Deputy General Manager there are six Assistant General Managers.

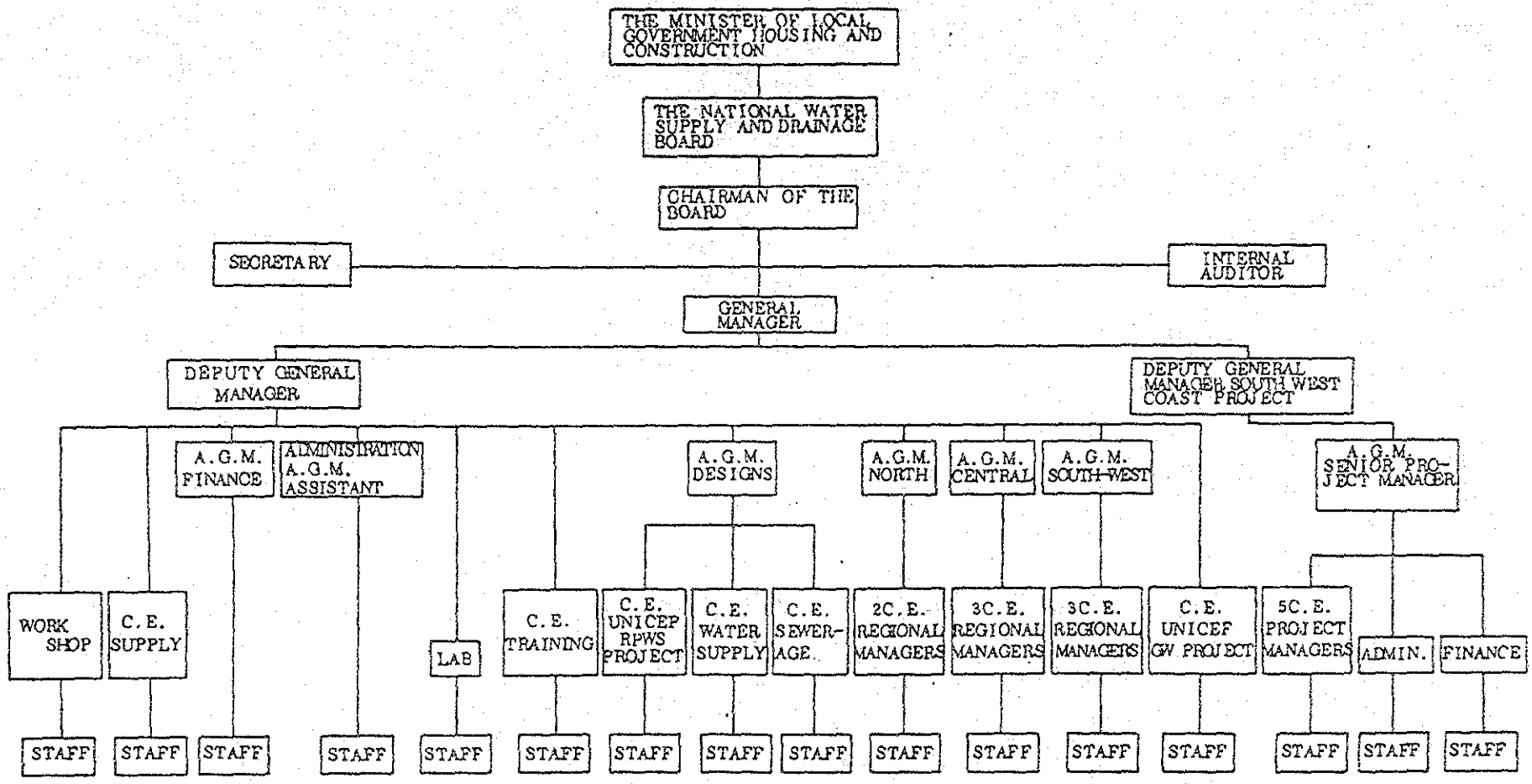
According to the Statistical Division of the Board, there are approximately 5,500 staff in total in the organization including casual staff of about 3,000, out of which one fifth staff are said to be for technical and the remaining for finance and administration. As to the operation of schemes, there are seven regional offices located in the field which are administered by the Regional Manager who, in turn, are under administrative control of the NWSDB headquaters. As the regional offices have only minimal capabilities for field investigations, project design, and logistical supply, almost all functional support and decision making are centralized at headquarters.

In order to strengthen the present organizational capacity of the Board, study on reorganization is under way by a local management consulting firm associating with experts from Pakistan.

10.2 Water Supply Schemes in the Amparai District

Water supply schemes in Amparai District are at present under technical and administrative control of the NWSDB except one small scheme in Karavahu West, which is operated by Karavahu V.C. More specifically, the Eastern Rangion of the Board, Batticaloa, is in charge of day to day operation and maintenance of such schemes.

Fig. 10-1 NATIONAL WATER SUPPLY AND DRAINAGE BOARD



A.G.M.: Assistant General Manager C.E.: Chief Engineer RPWS: Rural Piped Water Supply GW: Groundwater

Not all the towns in the study area have their own water supply scheme. Among the study area, four schemes exist in each of four towns of Amparai U.C., Kalmunai T.C., Karavahu West V.C. and Sammanthurai T.C. The scheme in Sammanthurai T.C., however, is now under construction. In the remaining twons, there are no schemes existing and people resident in those areas rely for their water of both drinking and other miscellaneous uses on nearby shallow wells and rivers. The table below shows the existence of water supply schemes in each town in the study area with related references. Details are given in Chapter 5.

The Amparai Urban Council has up to now not taken any part in the Water Supply Scheme. But, when necessity arises in future it is prepared to give its full cooperation regarding the Water Supply Scheme.

Existence of Water Supply Scheme in Towns

Names of Towns	Water Supply Scheme	O/M under	Installation of Meter	Tariff System
Amparai U.C.	Existing	NWSDB	200	Assessment Billing for minor portion
Kalmunai T.C.	- do -	- do -	No installation	
Kalmunai T.C.	- do -	- do -	No installation	Assessment
Karavahu West V.C.	- do -	V.C.	No installation	Assessment
Sammanthurai T.C.	Under construction	NWSDB	No installation	-
Karativu V.C.	Not existing	-	-	-
Nintavur V.C.	- do -	-	-	-
Akkaraipattu North V.C.	- do -	-	-	-
Akkaraipattu Central V.C.	- do -	-	-	-

10.3 Organization and Operation of Regional Office

The existing water schemes in Amparai and Kalmunai are operated and maintained by NWSDB, through its regional office in Batticaloa.

The Amparai Water Supply Scheme was constructed in 1950s along with the Gal Oya scheme to meet the temporary needs for the then workers who were engaged in the scheme. Later the water scheme came under the Territorial Civil Engineering Organization for maintenance. In 1971, the scheme was to be maintained by the River Valley Development Board for short period of time until 1973 when the water scheme was transferred to the Water Supply Department of the Ministry of Local Government, Housing and Construction. Later in 1975, the water scheme was taken over by the NWSDB and has since then come under its maintenance and operation.

The Kalmunai Water Supply Scheme was constructed in 1981 by the NWSDB and has been under its operation and maintenance.

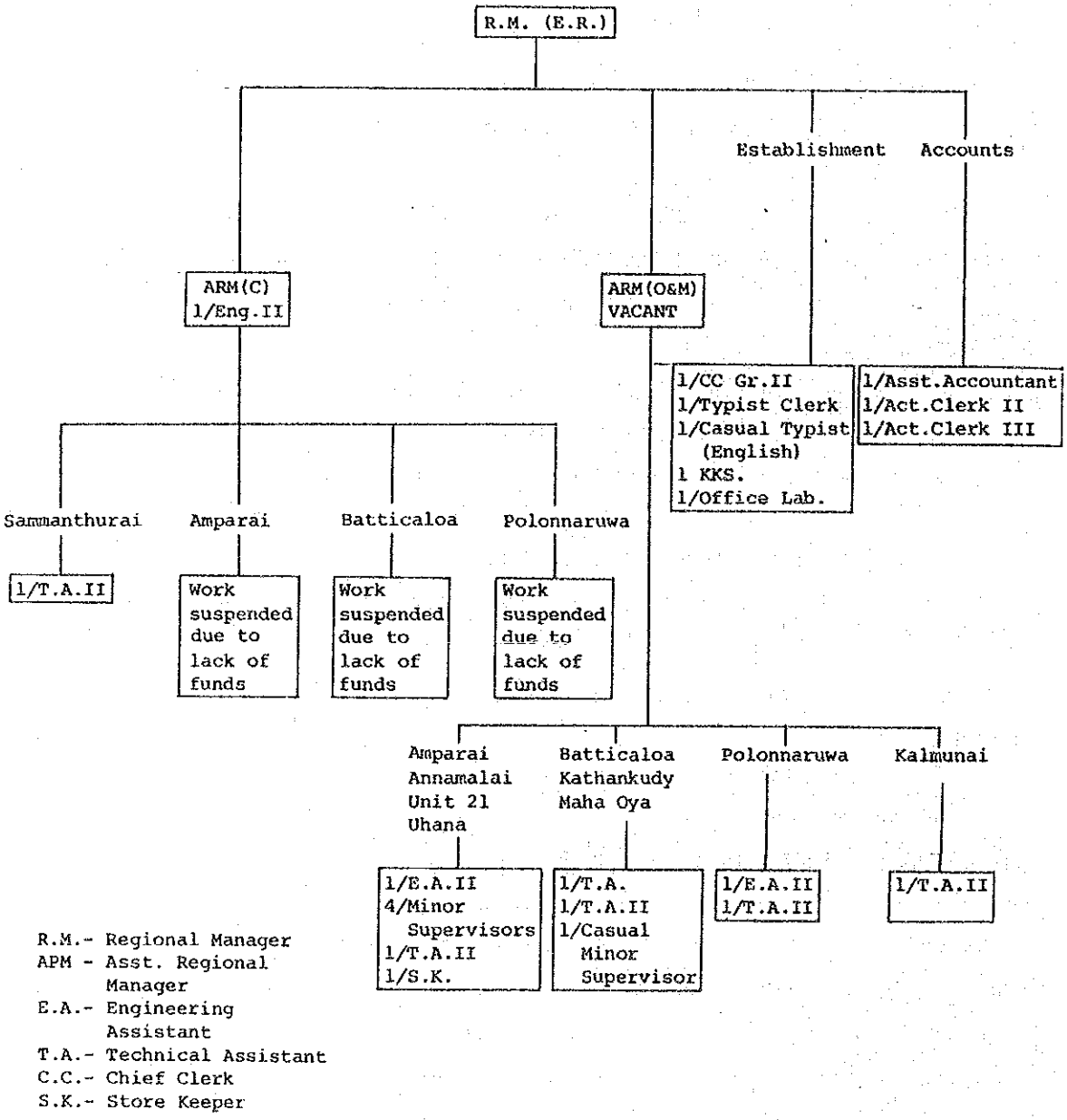
The Naipuddimunai Water Supply Scheme in Karavahu West was constructed in 1968 and is maintained by the Karavahu West V.C.

Present Operation

Since power and responsibility have been rested to NWSDB in 1975, water supplies in Amparai came under the Board. As mentioned earlier, the Eastern Region of the Board has responsibility to look after the operation and maintenance of the existing water supply scheme. Figure 10-2 shows the present organization of the Regional Office which is located in Batticaloa, capital of the Eastern Province. The Regional Office is at present staffed with 10 personnel. The breakdown of the personnel is as follows:

Fig. 10-2 ORGANIZATION CHART

EASTERN REGION - NATIONAL WATER SUPPLY & DRAINAGE BOARD



R.M.- Regional Manager
APM - Asst. Regional Manager
E.A.- Engineering Assistant
T.A.- Technical Assistant
C.C.- Chief Clerk
S.K.- Store Keeper

	Qualification	No. of Personnel
i)	Engineer	1
ii)	Technical Assistant	4
iii)	Technician (Engineers' Assistant)	2
iv)	Accountant	1
v)	Clerk	2
		10

Considering the present service areas widely covered and several schemes now under operation, it can be said that the number of personnel in the Regional Office is insufficient. Particularly shortage of staff is remarkable in each of the scheme, and it seems that those staff engaged in technical operation have not necessarily been trained properly to meet the requirements. Due to these, maintenance and operation of the schemes are not done in proper way.

The present serious drawbacks can be summarized as follows:

Organization

The present organizational set-up is not so arranged to control the schemes as efficiently as possible. It is not intended to supervise closely the daily activities of operation. In order to supervise and take necessary action to cope with daily operation of the schemes, necessary rearrangement of the present organization is inevitable.

Operation and Maintenance

The manner of operation and maintenance of the existing scheme is far from the required standard level of water supply. The present facilities themselves have been badly deteriorated due to long, excessive service as well as misconduct of operation in the past. Necessary repair works of the facilities have been disregarded. The proper dosage of chemical has not been practiced. Because of these unfavourable

operation, it is suspicious that the water supply to customers through pipes is safe in quality. In addition, supply of water is intermittent, only a few hours of a day. The lack of manuals of operation is one of the major causes for unproper and malfunctioning of facilities. The service record of daily operation by operators is neither practiced. The maintenance of facilities including necessary repair and improvement is also disregarded. To bring back to the normal operation from the present retarded practices, special attention should be focussed on the attainment of (i) provision of a technical manual, (ii) preparation of record of operation, and (iii) assurance of facility repair and improvement.

Personnel

There are 10 personnel in the Eastern Region, which is not enough in number comparing to the present work loads. Another fact is that only one engineer who has an engineering degree is stationed in the office. In order to keep the scheme on a desirable level of maintenance to the extent possible, the Regional Office must be strengthened with a required number of staff.

10.4 Recommended Organization Modifications

10.4.1 General

In anticipation of the construction of the proposed water supply scheme in Amparai District, modification in the present system's organization will have to be effected. Such modifications include organization improvement plan, staffing schedule and coordination program with local authority.

10.4.2 Objective

The objective of modification is to strengthen the present organization and to enable the operation of whole scheme in terms of technical, finance

and administration properly in providing safe and adequate water to customers in the project area. The modification also aims at establishment of administrative procedures in order to ensure the effective function of the organization, and, at the same time, to create conditions which will optimize the use of all its resources.

Such objectives are summarized as:

- o To provide an ample amount of safe and potable water to every type of customer when and as needed.
- o To coordinate water supply undertakings with the development of programs and activities aimed at improving the economy and sanitary conditions of the area.
- o To operate and maintain water sources, treatment facilities, transmission and distribution systems, and storage and other water supply facilities.
- o To regulate and control the use as well as prevent the wastage of water.

10.4.3 Organization Modifications

As stated earlier, NWSDB, with necessary legislative power and responsibility, controls operation of the present schemes existing in the project area. Certain practices and manner of operation have been accumulated in the way of system operation for the past several years. In view of the current legislative arrangement and also utilization of now available resources it is not feasible to change this existing system by preparing an entirely new organization to be set up to look after the proposed water supply schemes. Instead, making full use of the present organization with necessary modification, that is reorganization of the Regional Office, NWSDB, seems to be more realistic to operate and maintain the newly proposed scheme in the project area.

The organization modification is shown in Fig. 10-3. The recommended modified organization is intended to supervise the activities on scheme-wise basis from the start of construction to routine operation and maintenance of the facilities after construction. It is also intended to keep close relationship with consumers to a maximum extent through coordination with local authorities, which have a more direct contact with consumers and can handle water supplies, in coordination with the Board, as one of the public services.

In designing the organization modification, the following significant points were taken into considerations:

- o The need to attain the level of technical competence and efficiency necessary to provide a sufficient supply of water for domestic purposes to every owner or occupant of any structure within the limits of the service area as well as the supply for non-domestic purposes.

- o The importance of effective financial management to ensure collection of revenues, provision of adequate funds for operating needs.

The new structure is arranged in such a way as to achieve as much as possible the following features:

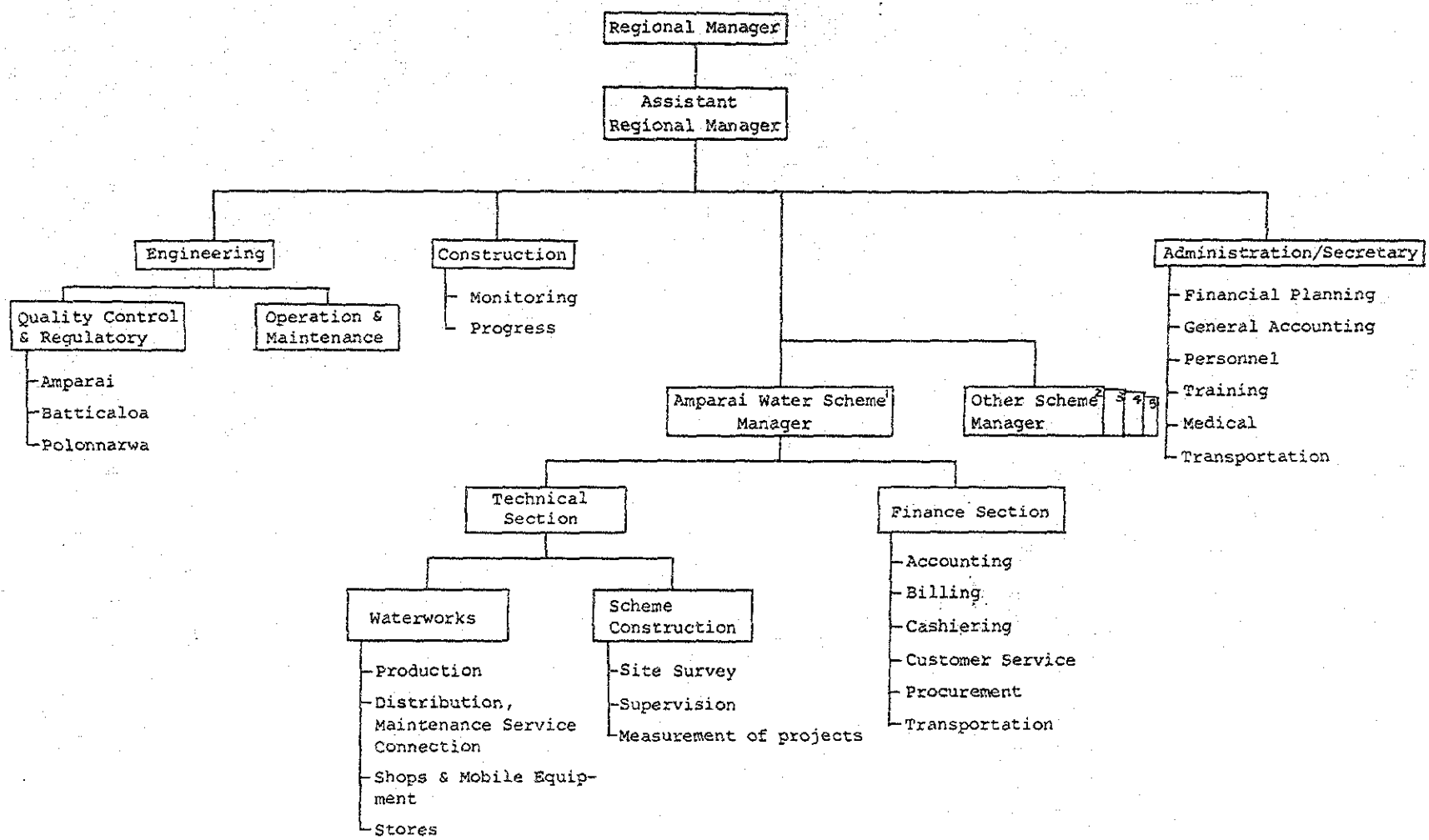
- o Sufficient organizational flexibility to adapt to changing conditions.

- o Effective coordination and control of the system's overall operations. Enabling of realistic positive planning toward the system's goals and objectives.

10.4.4 Organization Structure

Fig.10-3 shows the recommended organization modification of Regional Office. Modification requires provision of four major units

Fig. 10-3 Recommended Organization Modification



under regional manager: (1) Engineering, (2) Construction, (3) Administration/Secretary, and (4) Amparai Water Scheme. Units of Engineering, Construction and Administration/Secretary will in maintaining tasks of regional office of itself extend their function overall schemes in the jurisdiction of the Regional Office keeping close relationship with each scheme. Under units of Water Supply Scheme, there are two units provided which are, (1) Technical, and (2) Finance. Within Technical, (1) Waterworks and (2) Scheme Construction units are prepared. Unit of Waterworks will be responsible for water production, storage, distribution and maintenance of service connection. Unit of Scheme Construction is to supervise activities of construction in the site and measurement of progress. Unit of Finance/Administration is in charge of scheme accounting, billing, cashiering, customer service etc.

In this new modified organizational set-up, Regional Manager will have a direct involvement in the operation of the scheme and give a technical direction and supervision on operation of water supply system and will inform status of operation to Board's headquarters, daily, weekly, monthly and yearly together with the records of operation and ask remedial actions when such are needed.

The functional responsibilities of the different organizational units are described in Appendix F.

10.4.5 Staffing Requirement

The number of waterworks personnel is expected to increase from 140 in 1984 to 272 by the year 1995 for the Stage I project, and from 272 in 1996 to 282 by the year 2005, at the final targe. Employees with the required educational qualifications and experience will be indicated in Appendix F.

The staffing schedule also provides for the gradual recruitments of new staff in accordance with the projected expansion of services. The estimated staffing requirement and the projected number of service connection for the Stage I are shown below:

Year	No. of Service Connections (Direct)	Staffing Requirement
1984	-	140
1985	-	140
1986	8,060	146
1987	8,800	219
1988	9,600	219
1989	10,440	219
1990	11,280	265
1991	12,180	265
1992	13,140	272
1993	14,220	272
1994	15,340	272
1995	15,560	272

The foregoing staffing requirement is broken down into key positions in Table 10-1.

10.5 Management and Administration

Along the construction of new water supply scheme in Amparai District, it is imperative that the present management and administrative procedures should be improved in order to control the scheme and maintain a reliable and efficient recording and reporting system. Especially, the present management information system should be upgraded so as to meet the future required conditions. It should be kept in mind that the close internal relation between headquarters and the Regional Office be maintained. The system to be provided should aim at the following:

1. Provide management with more precise and quicker financial and operating information essential for the effective control of operations and the development of sound plans.

Table 10-1 Schedule of Estimated Staff Requirement

Job Title	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000	2005
Regional Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
Asst. Regional Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
Secretary-Typist	1	1	1	1	1	1	1	1	1	1	1	1	1
Clerk	1	2	2	2	2	2	2	2	2	2	2	2	2
Sub-Total	4	5	5	5	5	5	5	5	5	5	5	5	5
ENGINEERING DIVISION													
Division Head	1	1	1	1	1	1	1	1	1	1	1	1	1
Operation & Maintenance													
Design Engineer	1	2	2	2	2	5	5	5	5	5	5	5	5
Electrical Foreman	1	1	1	1	1	1	1	1	1	1	1	1	1
Electrician	2	2	2	2	2	2	2	2	2	2	2	2	2
Mechanical Foreman	1	1	1	1	1	1	1	1	1	1	1	1	1
Mechanician	2	2	2	2	2	2	2	2	2	2	2	2	2
Draftsmen	1	2	2	2	2	2	2	2	2	2	2	2	2
Qualify Control & Regulatory													
Laboratory Chief	1	1	1	1	1	1	1	1	1	1	1	1	1
Laboratory Assistant	2	2	2	2	2	2	2	2	2	2	2	2	2
Sub-Total	12	14	14	14	14	17	17	17	17	17	17	17	17
CONSTRUCTION DIVISION													
Division Head	1	1	1	1	1	1	1	1	1	1	1	1	1
Monitoring Officer	2	2	2	2	2	2	2	2	2	2	2	2	2
Sub-Total	3	3	3	3	3	3	3	3	3	3	3	3	3

- to be continued -

Job Title	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000	2005
ADMINISTRATION DIVISION													
Financial Officer	1	2	2	2	2	5	5	5	5	5	5	5	5
Personnel Officer	1	2	2	2	2	5	5	5	5	5	5	5	5
Administration Officer	1	2	2	2	2	5	5	5	5	5	5	5	5
Account Clerk	2	2	2	2	2	5	5	5	5	5	5	5	5
Clerk	3	3	3	3	3	10	10	10	10	10	10	10	10
Sub-Total	8	11	11	11	11	30	30	30	30	30	30	30	30
AMPARAI WATER SCHEME													
AMPARAI													
Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
Technical Section													
Section Head	1	1	1	1	1	1	1	1	1	1	1	1	1
Waterworks Section													
Clerk	3	3	3	3	3	3	3	3	3	3	3	3	3
Chemist	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Chemist	1	1	1	1	1	1	1	1	1	1	1	1	1
Technical Foremen	10	10	37	37	37	37	37	41	41	41	41	44	44
Labourer	10	10	10	10	10	10	10	10	10	10	10	10	10
Sub-Total	27	27	54	54	54	54	54	58	58	58	58	61	61
COASTAL													
Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
Technical Section													
Section Head	1	1	1	1	1	1	1	1	1	1	1	1	1

- to be continued -

Job Title	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000	2005
Waterworks Section													
Clerk	3	3	3	3	3	3	3	3	3	3	3	3	3
Chemist	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Chemist	1	1	1	1	1	1	1	1	1	1	1	1	1
Technical Foremen	28	28	74	74	74	74	74	77	77	77	77	84	84
Labourer	10	10	10	10	10	10	10	10	10	10	10	10	10
Sub-total	45	45	81	91	91	91	91	91	94	94	94	101	101
FINANCE/ADMINISTRATION SECTION													
AMPARAI													
Accounting Officer	2	2	2	2	2	5	5	5	5	5	5	5	5
Billing Officer	2	2	2	2	2	5	5	5	5	5	5	5	5
Meter Reader	5	5	5	5	5	10	10	10	10	10	10	10	10
Cash Clerk	2	2	2	2	2	5	5	5	5	5	5	5	5
Sub-Total	11	11	11	11	11	25	25	25	25	25	25	25	25
COASTAL													
Accounting Officer	5	5	5	5	5	10	10	10	10	10	10	10	10
Billing Officer	5	5	5	5	5	10	10	10	10	10	10	10	10
Meter Reader	10	10	10	10	10	15	15	15	15	15	15	15	15
Cash Clerk	5	5	5	5	5	10	10	10	10	10	10	10	10
Sub-Total	25	25	25	25	25	35	35	35	35	35	35	35	35
ConSTRUCTION SECTION													
Head	1	1	1	1	1	1	1	1	1	1	1	1	1
Inspector	4	4	4	4	4	4	4	4	4	4	4	4	4
Sub-Total	5	5	5	5	5	5	5	5	5	5	5	5	5
Total	140	146	219	219	219	265	265	272	272	272	272	272	282

2. Present such information in a form that will direct immediate attention to critical areas requiring managerial action or direction.
3. Fix responsibility for the preparation and submission of management report on a regularly scheduled basis.

To realize the target the following systems be provided:

Uniform System of Account

The Chart of Accounts should provide for adequate control of information in sufficient detail to enable management to identify status of income and expenses.

Management Information System

The management information system should provide relevant and timely information not only for use of management but also for low level of management staff. Information provided should contain enough details, to ensure accuracy in pinpointing problems and measuring performance.

Billing and Collection

The billing and collection procedures should provide data on customers' individual accountabilities. Meter reading and billing and collection procedures should be properly coordinated to ensure prompt collection of account.

Inventory

The inventory procedures should generate detail data on all inventory items of the Amparai Water Supply Scheme. Reorder points must be

established for all materials, particularly fast moving items with long lag time from purchase to receipt, to ensure that the operation of Amparai Scheme is not hampered by lack of spare parts.

10.6 Training

Training will play an important role in the development of the water supply scheme in Amparai. If all utility personnel were to be properly trained, utilities can easily upgrade their standards of service.

The suggested training areas for technical, financial and administrative staff are as follows:

Technical

- Pump operation and maintenance
- Meter installation, testing and maintenance
- Service installation
- Pipe installation and maintenance
- Water treatment
- Safety procedures
- Leak detection
- Equipment maintenance including minor repairs

Finance and Administration

- Budgetting and control
- Accounting and financial analysis
- Report preparation
- Information system

10.7 Coordination with Local Government Authority and Health Department

As indicated earlier, NWSDB is fully responsible for execution of water supply systems in the country and in Amparai District, however, there

has been no exchange of tasks between NWSDB and local authority, as neither the Amparai District nor Urban Council has taken any part in the water supply scheme. Further, there is no direct coordination activities in terms of public health activities with the Health Department. In view of the fact that the water supplied is one of the public services, it is desirable that local authority and the Health Department are involved in the scheme to form up people's oriented scheme.

NWSDB is, therefore, recommended to establish a Coordination Committee consisting of representatives from local authorities concerned and the Health Department in order to maintain inter-agency coordination and collaboration on the matter of water supply implementation, and to implement the scheme effectively.

10.8 Future Modification

The foregoing recommendation for organizational arrangement is considered best suited for implementation in the foreseeable future, under the preset situation with which the present study has been conducted. However this recommendation should be considered flexible to any modification, as in case of any other long range projection, which may be considered necessary according to the changes of the situation up to the year 2005. NWSDB should be prepared to give due consideration on the need of new organizational set-up according to the changing requirement.

LIST OF APPENDICES

SCOPE OF WORK

AGREED BETWEEN THE JICA AND THE NWSDB

1. Introduction

2. Objective of the Study

3. Study Area

4. Scope of the Study

5. Undertaking of the Government of Sri Lanka

6. Reports

7. Tentative Schedule of Study

1. Introduction

In response to the request of the Government of Sri Lanka for the technical co-operation in conducting the feasibility study on the Water Supply Scheme for Amparai Group of Towns in Sri Lanka, the Government of Japan has agreed to provide the service of a team of Japanese experts to undertake the feasibility study in accordance with laws and regulations in force in Japan with regard to the technical co-operation programmes.

The Government of Japan will take necessary measures through the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical co-operation programmes of the Government of Japan, to dispatch at its own expense the Japanese Study Team to Sri Lnaka.

The study Team will carry out the feasibility study in accordance with the Scope of Study herewith, and in close co-operation with the National Water Supply & Drainage Board (hereinafter referred to as "NWSDB") as well as other authorities concerned.

2. Objective of the Study

The objective of the study is to examine and assess the technical and economical feasibility of the Water Supply Scheme for Amparai Group of Towns as the target year of 2005.

3. Study Area

The study area will cover Amparai Urban Council Area, Kalmunai Electorate Area including Saindamarudu town, Sammanthurai Town Area, Akkaraipattu Town Area, Coastal area between Saindamarudu and Akkaraipattu, and their environs. The location map is shown in Appendix 2.

4. Scope of the Study

The study will be composed of filed surveys and data collection in Sri Lanka and of analysis works in Japan. The items to be covered by the study are as follows:

1) Collection of data and information
2) Study of present status of water supply systems
3) Study of socio-economic aspects
4) Estimation of population
5) Estimation of population to be served
6) Estimation of water demand
7) Study of improvement of existing facilities
8) Study of water sources
9) Study of required facilities and their layout
10) Study of design criteria
11) Study of construction materials, labour force, ability of local contractors and construction methods
12) Cost estimation for construction, operation and maintenance
13) Study of tariff systems
14) Study of organization, operation and maintenance plan
15) Economic and financial analysis
16) Preparation of implementation programme
17) Study of Community Participation

5. Undertakings of the Government of Sri Lanka

To facilitate the smooth performance of the study, the Government of Sri Lanka will undertake the followings:

1) To be responsible for dealing with claims which may be brought by third parties against the Japanese Study Team members, and shall hold them harmless in respect of claims or liabilities arising the course of or otherwise connected with the discharge

of their duties in the implementation of the study, except when such claims or liabilities arise from the gross negligence or wilful misconduct of the above mentioned individuals.

2) To provide adequate protection and the security for the team
3) To provide the team with the data and information necessary for the study
4) To provide the team with topographic maps available
5) To provide the team with suitable office space, office equipment and vehicle with driver necessary for study in Amparai
6) To conduct laboratory tests for water quality when necessary
7) To conduct soil testing for the foundations of plants when necessary
8) To conduct ground survey (contour, and longitudinal sections) in accordance with the specification prepared by the team when necessary
9) To make arrangements for accommodation required for field work when necessary
10) To arrange for the quick and smooth customs clearance of the survey equipment and materials which the team will bring into the field covering exception from taxes and duties imposed by the Government on the goods brought in by the team members into Sri Lanka
11) To enable to take all data and materials concerned out of Sri Lanka to Japan
12) To assign the counterpart personnel in the following fields to co-operate with the team in conducting the study effectively:
    1) General Planning
    2) Water Supply Engineering
    3) Surveying
    4) Water Resources
    5) Finance and Accounting

    The number of counterpart personnel and their respective assignment periods should be decided by prior consultation by the team with the authorities concerned at the commencement of the study.

The necessary cost of counterpart personnel should be borne by the Government of Sri Lanka.

13) To make the necessary arrangements to obtain the permission of the authorities concerned for the team to conduct the survey in the study area

14) NWSDB to obtain the permission from the Ministry of Lands, Land Development and Mahaweli to utilise the sources to be selected by the feasibility study team

15) Besides the above, to extend close co-operation to the team in every respect for the smooth execution of the study.

6. Reports

JICA will prepare and present the following reports to NWSDB in the course of the feasibility study:

1) Inception Report
   20 Copies -
   at the beginning of the field survey

2) Interim Report
   20 Copies -
   at the end of the field survey
   NWSDB will provide JICA with their comments within one month after receipt of the report through the Japanese Embassy.

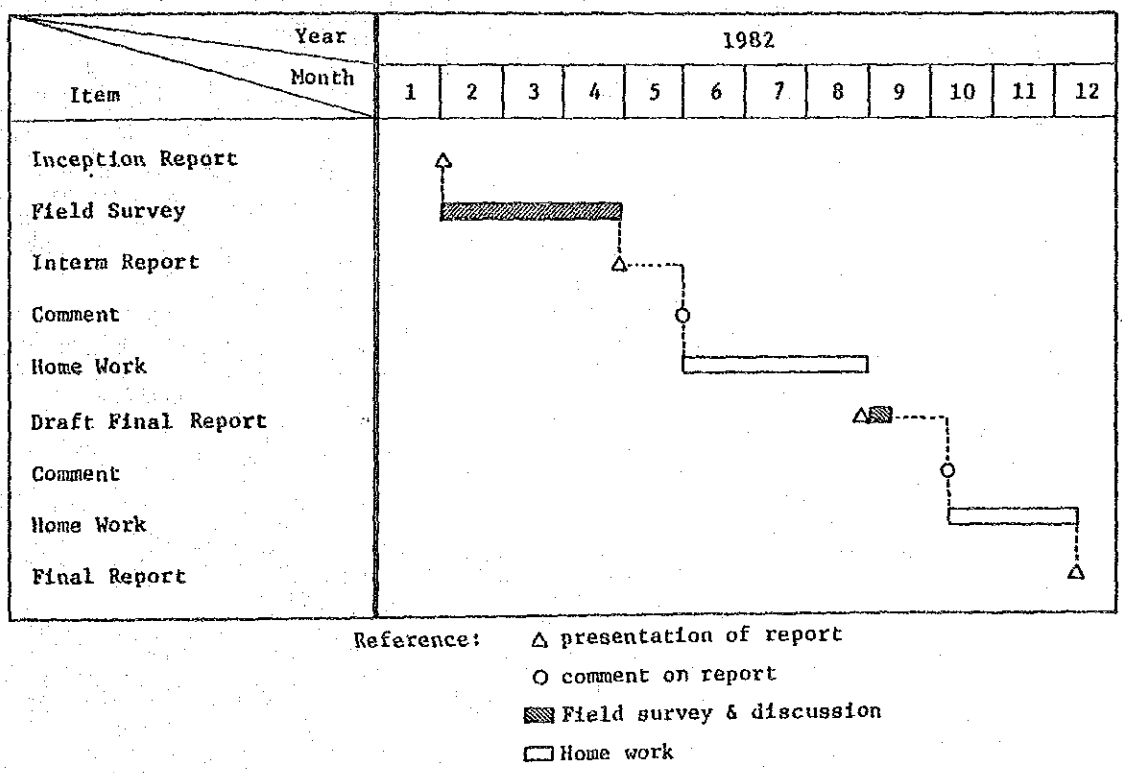
3) Draft Final Report
   20 Copies -
   Within three (3) months after receipt of comments on the Interim Report
   NWSDB will provide JICA with their comments within one month after receipt of the report through the Japanese Embassy.

4) Final Report
   40 Copies -
   Within two (2) months after receipt of comments on the Draft Final Report

7. Schedule of the Study

The study will be conducted in accordance with the study schedule shown in Table A-1.

Table A-1 Tentative Schedule of Study



WATER SOURCE

1. Gal Oya Scheme
2. Senanayake Samudra
3. Kondavattavan Tank
4. Amparai Tank
5. Kallarachel Anicut
6. Sambuveli Anicut
7. Kaliodai Anicut

WATER SOURCE

1. Gal Oya Scheme

Gal Oya Scheme fulfills three main purposes, namely irrigation, domestic water supply and hydropower generation, and indirectly flood control, for the Gal Oya river basin by constructing Senanayake Samudra, other several tanks and a series of systematic canals between existing tanks and new ones in the early 1950's.

There are three primary reservoirs of Senanayake Samudra, Jayanthi Wewa and Namal Oya. Senanayake Samudra is the main water source, and the water to be discharged from this huge reservoir is mainly controlled by irrigation demand under the Irrigation Department and the hydro-power is operated in compliance with the discharged flow rate. The water through the Senanayake Hydro-power Sation is discharged into three ways, LBMC, RBMC and the Gal Oya river.

The flow of 13 m^3/sec through RBMC is used to irrigate the paddy and sugar cane fields, and then flows into the Gal Oya river near Kunduvil Kulam. The water of 42 m^3/sec through LBMC flows down and is re-stored by several reservoirs of Aligalge, Himidurawa, Kondavattavan and Amparai tanks. The inflow into Himidurawa tank is discharged at 25 m^3/sec to Andellaoya tank and 6 m^3/sec to Kondavattavan tank respectively. The inflow into Kondavattavan pours to Amparai tank o.5 m^3/sec and to the Moravil Aru river 4.5 m^3/sec. Thus the re-stored water in the tanks is used to irrigate command areas under these reservoirs flowing down by stages and water flows down rivers and a major portion of it is diverted for irrigation by a series of anicuts. The discharged water of 4 m^3/sec to the Gal Oya river runs down about 35 km distant, and meet the Moravil Aru river, and then spread into four rivers finally flows into the Indian Ocean passing through Kallarachel, Sambuveli and Kaliodai anicuts.

The Gal Oya river springs at the hills to the west of Dambagalla with an elevation of about 1,500 m and flows down to an elevation of 47 m near

Inginiyagala at where the catchment area is 995 km^2. It runs to the Indian Ocean by several different channels between Kalmunai and Akkaraipattu, and the total catchment area is approximately 1,800 km^2. The Gal Oya river basin is located in the dry zone of the Ceylon Island separated from the wet zone by the 1,905 mm (75 inches) mean annual isohyet.

2. Senanayake Samudra

The Senanayake Samudra reservoir is a huge artificial one impounded by a rockfill dam of 1,097 m long constructed at a narrow gap of the Gal Oya upstream by Inginiyagala hills. It is a multipurpose reservoir for Irrigation, domestic water supply and hydropower generation constructed by the assistance from U.S. Government in 1952. Circumference of this reservoir has been specified as a wildlife sanctuary, forming unexplored jungle, for elephants and many other kinds of animals.

This reservoir has a catchment area of 995 km^2, surface area of 77.9 km^2, average depth of 12.2 m and net capacity of 950 million m^3 with 33.53 m head of water. Average annual yield from the catchment area is 873 million m^3, Northeast Monsoon yield amounting to 687 million m^3, while Southwest Monsoon yield is only 186 million m^3. The detail hydrological data is shown in Table B-1.

Impounded water is released into generators of the Senanayake Hydropower Station through a electrically operated sluice gate having an opening of 4.57 m in diameter. After passing through generators, the water flows into LMBC, RBMC and the Gal Oya river.

3. Kondavattavan Tank

Kondavattavan tank is located about 2 km upstream from Amparai tank inlet and receives the discharged water of 6.0 m^3/sec from the Senanayake Samudra reservoir via Aligalge tank and Himidurawa tank in addition to

Table B.1 Hydrological Data on Tanks

ITEM		SENANAYAKE SAMUDRA	ALIGALGE TANK	HIMIDURAWA TANK	KONDAVATTAVAN TANK	AMPARAI TANK
Hydrology						
1. Catchment area		995 km^2	13 km^2	13 km^2	52 km^2	17 km^2
2. Rainfall	N.E. (Sept. - Feb.)	1,524 mm	1,524 mm	1,524 mm	1,397 mm	1,397 mm
	S.W. (Mar. - Aug.)	508 mm	483 mm	483 mm	432 mm	432 mm
3. Yield	N.E. Monsoon	687,000,000 m^3	6,000,000 m^3	6,000,000 m^3	18,000,000 m^3	5,000,000 m^3
	S.W. Monsoon	186,000,000 m^3	500,000 m^3	500,000 m^3	2,000,000 m^3	900,000 m^3
4. Flood run off						
	Normal (C = 650)	1,668 m^3/sec	61 m^3/sec	61 m^3/sec	173 m^3/sec	75 m^3/sec
	Cyclonic (C = 1000)	2,455 m^3/sec	95 m^3/sec	95 m^3/sec	268 m^3/sec	117 m^3/sec
Dam						
1. Bund top level		85.04 m M.S.L.	45.52 m M.S.L.	43.70 m M.S.L.	32.61 m M.S.L.	28.96 m M.S.L.
2. Length		1,097.28 m	1,066.80 m	1,524.00 m	1,371.60 m	57.91 m
3. Top width		9.14 m	9.14 m	5.49 m	1.83 m	2.44 m
Storage Features						
1. Full Supply Level		79.25 m M.S.L.	44.02 m M.S.L.	42.48 m M.S.L.	30.48 m M.S.L.	26.67 m M.S.L.
2. Area at F.S.L.		77.9 km^2	1.1 km^2	1.1 km^2	3.6 km^2	3.6 km^2
3. Sill level of lowest sluice		45.72 m M.S.L.	41.60 m M.S.L.	39.56 m M.S.L.	24.69 m M.S.L.	22.68 m M.S.L.
4. Head of water		33.53 m	2.42 m	2.92 m	5.79 m	3.99 m
5. Gross capacity at F.S.L.		950,000,000 m^3	2,700,000 m^3	7,400,000 m^3	11,300,000 m^3	8,800,000 m^3
6. Net capacity at F.S.L.		950,000,000 m^3	2,100,000 m^3	4,400,000 m^3	11,300,000 m^3	8,800,000 m^3

Source : Irrigation Department

Note : F.S.L. is the abbreviation for Full Supply Level and M.S.L. is for Mean Sea Level.

yield from its own catchment area of 52 km^2, mostly covered with jungle. This tank has a area of 3.6 km^2 at full supply level, average depth of 3.1 m and net capacity of 11.3 million m^3 with 5.79 m head of water. Average annual yield from the catchment area is 20 million m^3, Northeast Monsoon yield amounting to 18 million m^3, while Southwest Monsoon yield is only 2 million m^3, as shown in Table B-1.

The outflow of 4.5 m^3/sec is discharged to the Moravil Aru river through two sluice gates, and then flows down to the Pallankatti Aru river through Kallarachel anicut. The water of 0.5 m^3/sec flows to Amparai tank through the spillway. Combat Training School, situated on the western periphery of the tank, is taking water of 9.1 m^3/d from the tank. The Study Team obtained information from this school that water Kondavattavan tank will be emptied in this August or September to repair the bund because of a leak of water through the bund. The water of this tank is eutrophic, but slightly better than Amparai tank in terms of quality, because the tank water moves continuously from upstream to downstream.

4. Amparai Tank

Amparai tank is situated on the western boundary of Amparai Town and has inflow of 0.5 m^3/sec from Kondavatavan tank also linked to the Senanayake Samudra reservoir by channels via Aligalge tank and Himidurawa tank in addition to yield from its own catchment area of 17 km^2. Northern half of the tank is covered with jungle where wild elephants and many kinds of animals inhabit. As shown in Table B-1, this tank has area of 3.6 km^2 at full supply level, average depth of 2.4 m and net capacity of 8.8 million m^3 with 3.99 m head of water. Average annual yield from the catchment area is 5.9 million m^3, Northeast Monsoon yield amounting to 5 million m^3, while Southwest Monsoon yield is only 0.9 million m^3.

The water of Amparai tank is exclusively used for Amparai Water Supply Scheme which is taking the raw water of 6,500 m^3/d. Inflow rate is small compared with that of Kondavattavan tank and evaporation is said

to be about 60 percent of inflow on the average. It might be said that the tank's water is now under the condition of still water and in the stage of serious eutrophication. The water grass of Salvinia covers the surface of the tank floating in the wind and the dead Salvinia has been accumulated at the bottom of the tank. It seems that deterioration of tank water is remarkable.

Amparai D.D.C. has thus far taken the water preservation measures of removing 30 houses around the tank and prohibiting human as well as animals bathing in the tank. But it seems that these measures have not brought the enough effect to the tank. One of the measures to improve the quality of this tank water, the Team considers that if one part of the discharged water from Kondavattavan tank's sluice gates would allow to flow out through Amparai tank it could avoid the tank water to be under condition of still water. The measure is also under consideration by Amparai D.D.C. The program is now arranged to investigate and study the preservation of the tank water including removal of growing Salvinia by U.S. AID.

5. Kallarachel Anicut

Kallarachel anicut is located at 1.9 km distant south from the elevated tank in Sammanthurai. The water of 4.5 m^3/sec is discharged from Kondavattavan tank to the Moravil Aru river and then flows donw to the Pallankatti Aru and the Kurunalkangi Aru rivers through Kallarachel anicut on the way. The water flow is stable all the year round according to the past record. Minimum flow rate measured by the Team in March, which falls on drought season was found to be 1.5 m^3/sec.

As shown in Table B-2, the anicut is the sliding-timber weir type and has 12 number of gates which are 2.13 m by 2.13 m in size. The still level is 2.53 m., crest level 4.66 m, L.W.L. 2.53 m and H.H.W.L. 5.49 m above mean sea level.

Table B.2 HYDROLOGICAL DATA ON ANICUTS

ITEM	KALLARACHEL ANICUT	SUMBUVELI ANICUT	KALIODAI ANICUT
Sill level	2.53 m M.S.L.	0.23 m M.S.L.	3.38 m M.S.L.
Crest level	4.66 m M.S.L.	1.60 m M.S.L.	5.70 m M.S.L.
No. of gate	12	17	12 { High: 8 Low : 4
Size	2.13 m x 2.13 m	1.22 m x 1.37 m	{ High: 1.83 m x 1.62 m Low : 2.13 m x 2.32 m
L.W.L.	2.53 m M.S.L.	0.23 m M.S.L.	3.38 m M.S.L.
H.H.W.L.	5.49 m M.S.L.	2.74 m M.S.L.	6.77 m M.S.L.
Measured flow rate by the Team	1.5 - 2.5 m^3/sec	1.0 - 2.0 m^3/sec	0.3 - 3.0 m^3/sec
Structure	Sliding - timber weir type	Sliding - tember weir type	Sluice gate type

Source: Irrigation Department
Note : M.S.L. is the abbreviation for Mean Sea Level

6. Sambuveli Anicut

Sambuveli anicut lies along the Kombuanda Aru river at 3.8 km distant downstream from Kallarachel anicut and halfway between Kalmunai and Sammanthurai. The water passed through Kallarachel anicut flows down to the Kombuanda Aru river through Sambuveli anicut on its way. The water flow is stable through the year, minimum flow rate checked by our survey was found 1.0 m^3/sec.

The anicut, shown in Table B-2, is sliding-timber weir type and has 17 number of gates which are 1.22 m by 1.37 m in size. The sill level is 0.23 m, crest level 1.60 m, L.W.L. 0.23 m and H.H.W.L. 2.74 m above mean sea level.

7. Kaliodai Anicut

Kaliodai anicut is situated at 2.2 km distant upstream from Kaliodai bridge along the Kaliodai Aru river,halfway between Akkaraipattu and Karativu of coastal route No. 4. The discharged water from Senanayeke Samudra to RBMC and the Gal Oya river mainly flows down to the Veraiadi Aru river and then to the Kaliodai Aru river through Kaliodai anicut on the way. The past records reveal that the water flow is stable through the year, and minimum flow rate by our measurement was found 0.3 cu m/sec during the initiation period of irrigation for paddy fields.

As shown in Table B-2, the anicut is sluice gate type and has 4 number of low level gates and 8 number of high level gates. The low level gate is 2.13 m by 2.32 m and high level gate is 1.83 m by 1.62 m in size. The sill level is 1.60 m, crest level 5.70 m, L.W.L. 3.38 m and H.H.W.L. 6.77 m above mean sea level.