4.3.5 Typical Crop Budget

Crop budgets of the proposed crops were prepared on the basis of the estimated production cost and gross income in both future with and without project conditions. The results are shown in Tables 4.6 and 4.7.

4.3.6 Settlement

Each settling family will be allocated 1.0 ha farming plot in the low land and 0.2 ha homestead area on the high land, based on the GOSL's settlement programme as discussed in Sub-section 3.6.6. In addition to farmer settlers, about 50 non-farmer settlers including tradesmen, service personnel and the GOSL staff will be allotted to each centre. The proposed number of settlers and centres are given in Table 4.8.

There are about 900 families within the Moragahakanda reservoir area. After construction of the dam, these families should be settled in and/or near the project area due to the inundation by the Moragahakanda reservoir. Therefore, the first priority should be given to helping these families to resettle in the new reclamation area.

All the new lands are extending downstream of the existing colonization schemes where substantial numbers of second generation colonists are being accumulated and where most of them are under-employed. Some of settlers have been staying in the new reclaimed area. Under these circumstances, it would be proper to give the second priority in resettlement to settlers who have been staying in the new reclamation area and to the surplus population in the existing colonies, and to settle the surplus population in the new lands to be developed in their down-stream areas. If this principle is basically accepted, the likely sources of settlers into the new lands in Kaudulla, Kantalai and Parakrama Samudra would be from the existing colonization schemes in their own upstreams.

Among the new lands, Kaudulla is exceptionally large in area and the existing Kaudulla colony in its upstream is relatively underdeveloped. It might be possible to allow the surplus population in the existing Giritale and Minneriya colonies to resettle into the new Kaudulla, on the ground that Giritale and Minneriya colonies have no extra capacity to accommodate any additional population nor downstream extension unlike the other existing colonies. On the other hand, the Kantalai colonization scheme seems to be less congested than Parakrama Samudra.

Settler selection policy as suggested in the above is along the basic guidelines of the Project's downstream development which is chalked out according to the principle of a harmonious inter-relationships between the existing and new lands which belong to the same irrigation system. This is also being reflected in the formation of project management units.

4.4 Irrigation and Drainage Plan

4.4.1 Irrigation Water Requirement

The irrigation water requirements to be diverted at each tank were estimated by calculating potential evapotranspiration, crop consumptive use coefficient, consumptive use, effective rainfall and percolation for various crops and the cropping patterns proposed in Sub-section 4.3.1, allowing irrigation efficiencies.

The average diversion requirement for only the existing fields (48,300 ha) including the sugarcane expansion scheme by the Sugar Corporation was estimated to be 1,429 MCM per annum, of which 62% or 887 MCM would be required in the Yala season, with a maximum average monthly requirement of 220 MCM (82 m^3/sec). And the diversion requirement of 62,200 ha was also estimated to be 1,821 MCM per annum, of which 62% or 1,121 MCM would be required in the Yala season, with a maximum average monthly requirement of 286 MCM (107 m^3/sec) (see Tables 4.9, Figs. 4-2 and 4-3, and ANNEX-F).

Losses of canal conveyance and operation were estimated to be 30% of the diversion requirement. The peak water requirement for the newly reclaimed area was estimated to be 1.91 l/sec/ha (0.0273 cusec/acre).

4.4.2 Drainage Water Requirement

Design flood discharges for respective streams and rivers were estimated by adopting the rainfall intensity duration curve of 5-year return period developed by the ID for Anuradhapura located near the project area, and various runoff coefficients for jungle, paddy and upland areas. Design discharges vary from 4.5 l/sec/ha (0.065 cusec/acre) to 3.1 l/sec/ha (0.044 cusec/acre) depending on the topographic conditions and its vegetation conditions (see ANNEX-F).

4.5 Power Market

4.5.1 Existing Power System

The CEB is presently supplying electric power and energy to consumers both directly and indirectly through the Lanka Electricity Company (LECO). The LECO was established in 1983 to take over and improve the retail supply of power within municipalities previously handled by 218 local authorities who obtained bulk supplies from the CEB.

The CEB power supply system is predominantly dependent on hydropower. Thermal powerplants are used to back up the hydropower and to tide over interim periods between commissioning of hydropower plants.

The total installed capacity of generating facilities owned by the CEB reached 1,116 MW in 1987, consisting of 916 MW of hydropower plants and 200 MW of thermal powerplants. Out of the said facilities, hydropower plants could generate 3,682 GWh under normal hydrological conditions, supplemented by a firm thermal availability of 1,265 GWh, according to the CEB's estimates. The existing power stations are listed in Table 4.10.

The power transmission network in Sri Lanka uses voltages of 220 kV, 132 kV and 66 kV. Voltages of 220 kV and 132 kV are employed for the trunk lines and a voltage of 66 kV is applied for short distance only. The length of transmission lines was 1,593 km as of the end of 1985. There were 31 grid substations as of the end of 1987.

Load dispatching in the generation and transmission system is centralized at the CEB System Control Centre located at Kolonnawa. The existing CEB power system is shown in Fig. 4-4.

The power demand of the CEB system in 1986 is summarized as follows:

Actual Record of Power Demand in 1986

Sold energy (GWh)	2,231	(100%)
- Domestic and religious	369	(16.5%)
- Small and medium industries	480	(21.5%)
- Heavy industries	445	(20.0%)
- Commercial and hotels	381	(17.1%)
- Local authorities	543	(24.3%)
- Street lighting	13	(0.6%)
Energy losses (GWh)	421	
Energy generation (GWh)	2,652	
Peak power demand (MW)	540	
Annual load factor (%)	56.1	

4.5.2 Historical Trend of Power Market

The historical trend of peak power demand, energy sales and generation in the past 16 years are shown in Table 4.11 and Fig. 4-5.

Total energy consumption has increased at an average rate of 9% since 1965. However, the trend for the recent 6 years showed a lower rate of 8% due to insufficient power generating capacity, or in other words, supply constraints in 1980 and 1981. In 1983, a decline in the volume of water stored by the dams due to long-term drought, and the increased unit cost of thermal generation due to increased oil prices resulted in a low growth rate for energy consumption.

4.5.3 Demand Forecast

In August 1987, the CEB published the "Long Range Generation Expansion Plan - 1987". According to this report, power demand growth is anticipated at a rate of 8.2% for 1988 to 1990, 10% for 1991 to 1995, 9.5% for 1996 to 2000 and 8.5% after 2001. The peak power demand and generation forecast are summarized as follows and shown in Figs. 4-6 and 4-7.

Year	Peak Power Demand (MW)	Generation (GWh)	Load Factor (%)
1988	593	2,986	57.5
1990	682	3,495	58.5
1995	1,089	5,629	59.0
2000	1,714	8,861	59.0
2002	2,018	10,431	59.0

4.5.4 Generation Expansion Plan

The Long Range Generation Expansion Plan mentioned in the preceding Sub-section 4.5.3 made an evaluation of different expansion configurations to select the economically optimal expansion plan.

According to the said Expansion Plan, the following three hydropower projects will be commissioned by 1992; Canyon Unit 2 (30 MW), Rantembe (49 MW) and Samanalawewa (120 MW). After 1993, introduction of thermalplants to the system is provisionally scheduled. The scheduled thermalplants consist of diesel plants of 440 MW and coal thermalplants of 900 MW.

In addition to the above, it is noted that the projected peak demand and total installed capacity in 1988 are 593 MW and 1,146 MW respectively as shown in Fig. 4-6. The reserved margin in 1988 is calculated at 93% on the basis of the above two values. The reserved margin will be decreased to 31% in 1996 by growth of power demand. The reserved margin for the CEB system, in which hydropower plants are predominant, will require at least 25 to 30 % in consideration of operation risk due to hydrological conditions.

In such situation, there is a possibility to introduce the Moragahakanda hydropower plant to the CEB system in 1996, instead of the scheduled thermal plant, if the said project is economically feasible. Project evaluation is made in Chapter 7.

4.6 Water Resources Development Plan

4.6.1 Water Demand for Irrigation

There are five major existing tanks in the project area with total effective storage of 563 MCM. Practical tank operation criteria for respective tanks were established to minimize the storage capacity of the proposed reservoir by using the 1950-1977 records, and the details are presented in ANNEX-H. Operation rule curves indicate that substantial water in the tanks is released for four months from May to August in the Yala season and stored during the Maha season from October to January.

The average annual water demand only for irrigation at the proposed Moragahakanda reservoir was estimated to be about 1,260 MCM (40 m^3/sec), varying from 720 MCM (23 m^3/sec) to 1,556 MCM (49 m^3/sec). The average monthly demand is 105 MCM (40 m^3/sec), varying from 77 MCM (30 m^3/sec) to 144 MCM (56 m^3/sec). Monthly water demands only for the irrigation are presented in Table 4.12.

4.6.2 Water Demand for Hydropower Generation

Water stored in the Moragahakanda reservoir will be used primarily for irrigation, and irrigation water will be released to the existing tanks, almost throughout the year as discussed in Sub-section 4.6.1. Water release from the reservoir can be utilized to generate hydroelectric power with the head created by the dam construction. By utilizing created head, an optimization study of the Moragahakanda reservoir with and without hydropower generation will be conducted as described in Sub-section 4.6.4.

4.6.3 Required Capacity of Reservoir

For the existing fields of 48,300 ha including the extension area of sugarcane of 4,200 ha, the water balance between the available runoff and the water requirements at respective headworks was examined by using the existing reservoirs to the maximum extent. The results of analyses show that deficits would occur very frequently, 23 times out of 28 Yala seasons, but only 5 times in the Maha seasons (see Table 4.13). The results of the water balance study indicate that Systems G, D1 and D2 will face the shortage of water even after completion of the Polgolla- Bowatenna complex project (see ANNEX-J).

Reservoir operation combined with the existing five tanks was simulated only for irrigation demands of 62,200 ha in the project. From the results of water balance study, an active storage capacity of 606 MCM would be required only for irrigation of 62,200 ha with success being more than 80% in occurrence and 90% in quantity (see Table 4.14). Principal features of a dam only for irrigation are summarized below:

Description		
High Water Level (H.W.L)	EL. 188	m
Low Water Level (L.W.L)	EL. 154	m
Active Storage	606	MCM
Dead Storage	42	MCM
Gross Storage	648	MCM

4.6.4 Optimization of the Dam

Optimization of the dam with and without hydropower was carried out as discussed in details in ANNEX-J. The following six (6) alternative cases were simulated:

Case	Active Storage (MCM)	H.W.L (EL.m)	L.W.L (EL.m)	Hydropower		
				Installed Capacity (MW)	Plant Factor	Max. Plant Discharge (m^3/sec)
1-1	606	188	154	0	0	0
1-2	606	188	154	23	0	56.6
2-1	686	195	170	26	0.23	56.6
2-2	686	195	170	42	0.14	91.7
3-1	802	200	175	28	0.36	56.6
3-2	802	200	175	69	0.14	138.1

The following operation rules on monthly basis were applied in simulation study:

- If the reservoir water level is above the operation water level, water is released to meet irrigation requirements or to maintain a firm power generation, whichever is the greater;
- If the reservoir water level is below the operation water level, water release will be governed principally to maintain a firm power generation; and
- If the reservoir water level falls to L.W.L. and water requirements are more than the inflow, the inflow will be released without regulation.

The above six alternative plans were preliminarily evaluated in terms of net economic benefit (Benefit-Cost: B-C) value to select the most optimum scale of dam. Economic benefit-cost ratios (B/C) were also calculated for each case for reference. As seen in Table 4.15, the maximum net benefit was achieved in Case 2-1, amounting to US$41.1 x 10^6. Therefore, the plan having reservoir H.W.L and L.W.L at EL. 195 m and

EL. 170 m respectively and an installed capacity of 26 MW is recommended as the optimum scale of the project by employing net benefit maximization criteria.

The principal features of the optimum plan are shown below:

- Reservoir

H.W.L	EL. 195.0 m
L.W.L	EL. 170.0 m

- Dam

	Main	1st Saddle	2nd Saddle
Crest EL.	199.0 m	197.5 m	199.0 m
Crest Length	490.0 m	396.0 m	490.0 m
Max. Height	72.0 m	62.5 m	42.0 m

- Power Generation

Installed capacity	26	MW
Max. discharge	56.6	m^3/sec
Rated head	54.8	m
Dependable peak power	16.1	MW
Firm energy	66.4	GWh/y
Secondary energy	78.9	GWh/y
Annual energy	145.3	GWh/y

4.6.5 Future Installation of Powerplant

The optimization study showed that the installed capacity of 26 MW would be the most economical scale of hydropower plant under the present conditions and assumptions conceivable.

In the future stage, there is a plan to develop parts of NCP areas with provision of water from the Mahaweli river basin through the Moragahakanda reservoir after power generation and NCP canal. In this connection, the peak power station with another unit of 26 MW is conceivable but the construction of a regulating dam would be indispensable. Rough economic analysis in the stage development was made, showing fairly promising results for a future unit installation 5 years after the first unit is put into operation. The dependable peak power would increase from 14 MW produced from 26 MW of installed capacity to 23 MW generated from 52 MW of installed capacity (see ANNEX-J). Therefore, it is recommended that provision be made at the present stage to accommodate an additional unit of 26 MW.

4.7 Proposed Project Facilities

4.7.1 Moragahakanda Dam

The project has three dams, consisting of the main dam, the first saddle dam and the second saddle dam. The main dam is constructed on the main stream of the Amban Ganga and the first saddle dam having the spillway is laid out adjacent to the left abutment of the main dam. The second saddle dam is located on the col beyond a ridge providing the left abutment of the first saddle dam.

The geology of the damsite is classified principally into gneissic and calcareous rock groups. The gneissic rock group is composed of quartz-feldspar gneiss, charnockite, granulite etc. and the calcareous rock group is composed of crystalline limestone and calcic gneiss. The boundary between the components is sometimes not clearly distinguishable because of gradual and continuous variations. There is, however, no special geological problem in the damsite except possibility of a cavity or opening in the calcareous rock, since geological conditions show fairly hard, solid and water tight fresh rock under the overburden of 6 m to 12 m.

In order to determine the most optimum scale for the dam, an economic comparative study was made for several alternative cases of reservoir high and low water levels incorporating installed capacity of powerplant, employing the benefit maximization criteria as discussed in Sub-section 4.6.4 (see details in ANNEX- J). The study revealed that the optimum development scale for the dam was given by the layout having the reservoir high and low water levels at EL. 195 m and EL. 170 m, respectively.

The next step in the optimization was to identify the most suitable layout of main structures. A comparative study was made for several alternative combinations of dam types, applying construction cost minimization criteria. The study indicated that the least cost alternative was a plan having the main dam of rockfill, the first saddle dam of concrete gravity type and the second saddle dam of rockfill (see ANNEX-J).

The reservoir high and low water levels were set at EL. 195 m and EL. 170 m respectively. The reservoir will provide an effective storage capacity of 686 MCM with a 25 m drawdown. The reservoir will allow a surcharge of 0.6 m above H.W.L. with 22 MCM capacity for flood control.

The main dam would be of centre-cored rockfill type with 72 m in height and 490 m in crest length. The dam crest with 10 m in width was set at EL. 199 m. The slope of the embankment would be 1:1.8 for the upstream surface and 1:1.6 for the downstream surface. The total embankment volume was estimated at 2.43×10^6 m^3.

The first saddle dam was designed to be of concrete gravity type, 62.5 m in height and 396 m in crest length. The dam crest with 6 m in width was placed at El. 197.5 m, with 2.5 m freeboard above H.W.L. The dam would have surface slopes of 1:0.05 upstream and 1:0.75 in downstream. The total concrete volume would be 376×10^3 m^3. The spillway, river outlet facilities and power facilities would be provided on this dam.

The second saddle dam would be of centre-cored rockfill type, 42 m in height and 490 m in crest length. The dam crest with 10 m in width was set at EL. 199 m. The slopes of upstream and downstream surfaces would be 1:1.8 and 1:1.6 respectively. The embankment volume would be 430 x 10^3 m^3 in total.

The spillway will be in the middle portion of the first saddle dam with a discharge capacity of 3,400 m^3/sec at 0.6 m surcharge water level above H.W.L. against the peak flood inflow of 4,650 m^3/sec which is 1.2 times of 200-year probable flood. Four sets of radial gate with 8 m in height and 17.5 m in clear span would be installed on the overflow crest at EL. 187 m.

Three sets of river outlet facilities will be furnished in the spillway section of the first saddle dam. The total maximum discharge capacity through the outlets will be the maximum downstream release for irrigation at L.W.L. These facilities would be operated, when the power station be shut down or when water release to the downstream reach be required more than the maximum power plant discharge.

4.7.2 Power Facilities

The power facilities will include power intake, penstock lines, power station, generating equipment and transmission line.

As stated in the preceding Sub-section 4.7.1, the optimum scale of powerplant was examined for several cases of dam height, varying the installed capacity or plant factor. The study revealed that the most economical scale of power station would be 26 MW of an installed capacity with reservoir high and low water levels at EL. 195 m and EL. 170 m, respectively.

Two sets of power intake will be provided on the upstream face of the non-overflow section of the dam and located at the left side of the spillway. The maximum discharge for each intake will be 56.6 m^3/sec. A fixed steel trashrack will be installed at the bell-mouth inlet, 6.0 m high and 6.0 m wide on each intake. Two lanes of steel penstock will be installed with an inside diameter of 3.9 m in the upper portion reducing to 3.2 m at the powerhouse. The total length of penstock will be 87 m.

The powerhouse will be located about 84 m downstream from the first saddle dam. It will be of reinforced concrete, 32 m in height, 27.8 m in width and 41 m length. The powerhouse will have space to accommodate two units of generating equipment. The tailrace channel will be located adjacent to the stilling basin and protected by a guide wall. Two sets of roller gate, 3.5 m in height and 3.6 m in width, will be provided at the end of the draft tube and operated by a gantry crane to be installed on the platform in front of the powerhouse.

One complete set of generating equipment will consist of a vertical shaft Francis turbine of 26 MW at a rated head of 54.8 m and maximum discharge of 56.6 m^3/sec, an alternating generator of 30.5 MVA, control gates and auxiliary equipment. One unit of main

transformer of 30 MVA and switchgears will be installed in the outdoor switchyard behind the powerhouse.

A 16 km, 132 kV single circuit transmission line is proposed between the Moragahakanda power station and the junction with the existing Bowatenna-Ukuwela line at the Bowatenna power station. The transmission line route is shown in DWG. No. 1.

4.7.3 Irrigation and Drainage Facilities

The irrigation area of 62,200 ha consists of 33,500 ha of the existing paddy fields so-called under specification, 3,000 ha of the existing sugarcane fields under specification, 7,600 ha under unauthorized fields, 4,200 ha in another sugarcane expansion scheme, and 13,900 ha of new reclamation were as shown in Figs. 4-8 and 4-10. Irrigation areas of 7,900 ha which were originally planned under the Polgolla-Bowatenna project and 400 ha in Kantalai sugarcane area were exempted to provide facilities under this project. Other than these, upgrading and rehabilitation of the existing fields under specification and unauthorized cultivation areas were considered to some extent, even though the Irrigation System Management Projects in Systems D1 and D2 are on-going with the assistance of the USAID and the IDA.

For the expansion of new irrigation areas, the Elahera- Minneriya canal will be improved to maintain the original design flow capacity. The followings are principal features of each new reclamation areas:

(1) System D1

The intake structure of the existing high land main canal is located on the left bank of the Kaudulla tank. The existing 6.4 km main canal will be improved for the irrigation of 11,500 ha including the existing fields of 2,400 ha. The main canal will bifurcate into the existing branch canal No. 1 to irrigate 7,000 ha including 2,300 ha of existing fields and the new branch canal No. 2 commanding 4,300 ha of new irrigation area. The existing branch canal No. 1 runs for 9.8 km on high land along the left bank of the Kahambiliya Oya, and extends toward the east. Branch canal No. 2 will run for about 8 km northwards, then turns eastwards. Branch canal No. 3 commanding 1,800 ha will be diverted at about 8.8 km point of branch canal No. 2.

The existing main and branch canals will be widened and provided with concrete lining to maintain flow area for the design irrigation requirements within a limited existing conditions, due to the expansion of irrigable area. Other canals will in principle be trapezoidal unlined canals with a side slope of 1:1.5.

(2) System D2

For the extension of the irrigation area in System D2 by 2,200 ha, the existing D1-main, D1-north and D1-east canals will be widened and improved to supply the necessary irrigation water. Extension areas in System D2 which are situated

between the Mahaweli Ganga and the Periya Aru are divided into two blocks. One will be an extension area of 1,600 ha to be commanded by a newly extended canal from the existing D1-north canal, and another is 600 ha extended from the existing D1-east canal.

(3) System A/D

A new intake weir will be constructed on the Minneriya- Kantalai canal to divert water to a newly proposed Kalu Ganga tank which is located upstream of the Kalu Ganga. The regulated flow at the tank will be diverted to System A/D area at a proposed Kalu Ganga anicut located about 7.5 km downstream of the tank.

(4) Drainage Improvement

Locations of drains are dominated by natural streams and rivers crisscrossing in the project area. Among these streams and rivers, the following was selected as major drains to be improved under the project:

Stream of River	Irrigation System	Length (km)
Kalu Ganga	D1	18.5
Thimbiri Ela	D1	12.1
Ambagaha Oya	D1	13.5
Periya Aru	D2	18.0
Sinna Ganga	D2	14.5
Uppu Aru	A/D	7.7
Karappankadawela Aru	A/D	7.1
Total		91.4

(5) Downstream Development

A downstream development programme was prepared for each distributary unit to be irrigated by distributary canal. The downstream system consists of distributary canal (D-canal), and field canals (F-canal) which will respectively command D-canal units (20-300 ha) and F-canal units (10-20 ha). A typical canal layout for downstream development is shown in Fig. 4-11. The following table shows the total required canal length:

Unit: km

Item	D1	D2	A/D	Total
1. Irrigation canal	630	150	180	960
2. Drainage canal	540	130	150	820
3. Farm road	450	110	130	690

(6) Inspection Road

For proper operation and maintenance of the project facilities, well arranged inspection roads will be of vital importance. Since these roads will also be used as village and farm roads after project implementation, the arrangement of inspection roads was made considering the existing and planned roads. Inspection roads along the existing main canal, and the existing and new branch canals are 9 m wide with 3.6 m wide gravel metalling, and 5 m or 3.7 m wide with 2.5 m gravel metalling, respectively. In addition to the above, village connection roads will be provided under the project.

(7) Land Reclamation

The total area to be reclaimed will be around 17,400 ha all of which is covered with common jungle in Systems D1 and D2, and medium jungle in System A/D. For the reclamation of the lands, jungle clearing and uprooting works will be made and followed by burning. Finally rough levelling works will be carried out under the scope of the project. The final levelling, construction of ditches and border ridges will be undertaken by the farmers themselves.

The following table shows the principal facilities to be provided under the project :

Items	System			
	D1	D2	A/D	Others
A. Improvement of Existing Facilities				
1. Elahera anicut	-	-	-	No Improvement
2. Angamedilla anicut	-	Rehabilitation	-	-
3. Elahera-Minneriya canal	-	-	-	21.6 km
4. Main and branch canals	16.3 km	22.1 km	-	-
5. Improvement of on-farm facilities	28,000 ha	10,100 ha	-	-
B. New Construction Works				
1. Branch canals	41.6 km	19.9 km	23.6 km	-
2. Minor branch canals	8.1 km	22.9 km	-	-
3. Major drainage canals	44.1 km	32.5 km	14.8 km	-
4. Related structures	190 Nos.	95 Nos.	118 Nos.	-
5. Inspection roads	50 km	43 km	24 km	-
6. Connecting roads	24 km	5 km	2 km	-
7. Downstream Development	9,100 ha	2,200 ha	2,600 ha	-
- Jungle clearing	11,400 ha	2,700 ha	3,300 ha	-
- Rough levelling	9,100 ha	2,200 ha	2,600 ha	-
- D and F canals	630 km	150 km	180 km	-
- Drainage canals	540 km	130 km	150 km	-
- On-farm roads	450 km	110 km	130 km	-

4.7.4 Social Infrastructure and Community Development Facilities

There are currently no major communities in 13,900 ha of the new irrigation area. The project would provide new settlers with adequate health, educational, and other facilities to provide living standards comparable with the other development areas. The basic project development unit would be a hamlet or unit centre of about 200-300 farmer settler families and about 50 non- farmer settlers. There would be 8-10 such units in each block, and a total of 5 block centres would be developed in the project area. One town center or a project centre would be developed near the village of Migaswewa in southern part of System D1 expansion area to serve the entire new irrigation area. A summary of the proposed centres in each system is presented in Table 4.8 and the proposed location of centres is presented in Fig. 4-12.

As discussed in Sub-section 4.3.6, about 17,000 new families (approximately 85,000 persons) would be settled in the new reclamation areas, including 13,900 farmer settlers and about 3,100 non-farmer settlers including tradesmen, service personnel and GOSL staff. The project would provide basic social infrastructure including development and training centres, educational facilities, medical and health facilities, and other facilities such as a townhall and office, police station, police post, telephone and postal facilities, rural electrification and a piped water supply for the project centre in System D1. A

summary of the infrastructure for respective centres to be provided under the project is given in Table 4.16.

4.8 Implementation Schedule

The MASL will be the executing agency for implementation of the project. The construction works will be conducted by contract system through the international and local competitive tenders in compliance with the Government regulations or guidelines.

Detailed survey and design as well as preparation of tender documents will be commenced in 1989 as soon as financing arrangements have been made. The time required for implementation of the whole project is estimated to be 7 years starting from 1989 through 1995 as shown below:

Stage	Schedule	Period
Pre-construction Activities		
(1) Financial arrangements	1988-1989	One (1) year
(2) Detailed survey and design	1989-1990	One (1) year
(3) Tendering and contract	1989-1990	Six (6) months
Construction		
(4) Dam and power station	1990-1994	Four (4) years
(5) Agricultural development		
- Rehabilitation of the irrigation	1990-1994	Four (4) years
- Main and branch canals of new irrigation system	1990-1994	Four (4) years
- Downstream development	1990-1995	Five (5) years
- Social infrastructure	1990-1995	Five (5) years
Operation & Maintenance		
(6) O&M for the completed facilities	1991 onward (Partially)	-

The proposed implementation schedule is shown in Fig. 4-13 and details in ANNEX-L.

4.9 Future Study

System D2 area will be affected to some extent by the pool created by Kandakadu barrage proposed for System A on the Mahaweli Ganga. The exact location of Kandakadu barrage is uncertain at present. Moreover, new land available in System D2 is subject to annual flooding. Upon completion of the proposed Moragahakanda dam, a series of 6

large reservoirs upstream of the Mahaweli Ganga and the Amban Ganga will significantly reduce the peak flood discharges in this area. Flood impact studies will be essential during the next stage of work.

In the southern parts of System D1, there will be a certain possibility of extending an irrigation area to be commanded by the branch canal No. 1, but of decreasing the area in the northern parts of System D1 through the branch canal No. 2. This will also require study during the next stage of work.

5. PROJECT ORGANIZATION AND MANAGEMENT

5.1 Organization for Project Implementation

The MASL will be the executing agency for implementation of the project. However, the cooperation of other organizations such as the MLLD, ID, CEB, all executing agencies under the MASL, etc. will be essential for successful implementation of the Project. The Moragahakanda dam will be constructed and operated primarily for irrigation but it will be a multipurpose development project including power development and settlement. It is therefore proposed that the Moragahakanda Project Office be responsible for all pre-construction and construction works for the dam and power station, irrigation, as well as settlement.

The MASL will appoint a project director for the Moragahakanda project office to coordinate the execution of the project. Two construction offices under the project office will be established near the damsite and in the town centre in System D1 respectively. The functions of each office will involve approval of construction methods and schedules, preparation of design revision, coordination of contracted works, monitoring of construction progress, work quantities and quality control, approval of payments and completion of the works, etc.

In Systems D1 and D2 there are 38,100 ha of existing fields operated and maintained by the ID. Therefore, it is of vital importance that part of the existing ID office in System D should participate and establish an organization under the System D office responsible for rehabilitation and improvement of the existing facilities. However, in the new land reclamation area, the MECA will be responsible for all design and construction works for the downstream development including public services facilities.

A team of foreign consulting engineers or a foreign consulting engineering firm in association with or with assistance of the CECB will be employed by the MASL to assist the activities of the project director. The Consultants will act as the Engineer for the works to be undertaken by competitive international tenders for the dam, power house, and major irrigation facilities. However, the downstream development and rehabilitation works will be the total responsibility of the MECA and the ID under the Resident Project Director (RPD) of System D construction office with the assistance of the Consultants.

The project office will consist of 2 main offices at the damsite and the proposed town centre in System D1, and 5 block offices in the new reclamation areas, i.e. three in System D1 and one each in Systems D2 and A/D. It is proposed that the main offices be established before getting into major construction works of the project. Block offices will be established at each block in pace with progress of the construction works.

Figs. 5-1 and 5-2 shows the organization during the construction stage.

5.2 Organization for Operation and Maintenance (O&M) of the Project

After completion of the construction, the Moragahakanda Project Office will be re-organized into the project O&M offices under the MEA for irrigation in the newly reclaimed area, the ID for the existing fields and the HA-O&M (MASL) for the dam. The Moragahakanda dam O&M office will be responsible for operation and maintenance of the dam and power station in cooperation with the CEB. Another project office for System D will belong to the MEA, which will be responsible for operation and maintenance of the project facilities, agricultural extension services, credit, marketing and cooperatives, community services, agro-business development, etc. The water user's associations and farmers themselves will be responsible for the operation and maintenance of F-canal units.

The O&M organization for irrigation in the newly reclaimed area will have one main project centre (RPM) office, 5 block centre offices, 8 village centre offices, and 33 unit offices. The main and block offices established during the construction stage will be used as the project O&M offices after completion of construction. The main O&M office will have 8 sections such as agriculture, operation and maintenance, credit-marketing & co-operatives, community, business development and finance & administration sections and block offices.

The main RPM office will be responsible for overall activities necessary for proper operation and maintenance of all project facilities including operation of the overall O&M programme, design and construction of repairing and rehabilitation works, budgeting, training of O&M staff, etc. The proposed organization is presented in Figs. 5-3 and 5-4.

5.3 Agricultural Support Services

Agricultural support services are provided by the MEA after completion of the first stage construction and at the beginning of the first settlement to the new settlement area. The MEA provides a project office to promote new settlers into the project site by means of offering appropriate agricultural support systems.

The project office will have the three service levels: a main project centre (RPM); 5 block centre offices; and 41 unit offices, regarding agricultural support services as well as operation and maintenance of the irrigation and drainage system. Agricultural supporting staffs are enumerated as follows in every service level, as shown in Fig. 5-4: (1) every unit office has a KVS, so the staff of this level aggregated 41 in the project area; (2) every block centre has 2 agricultural staffs, so 10 staffs in total; and (3) RPM office has 2 agricultural deputy managers, one of which has 3 specialists for agricultural services such as marketing, credit and co-operatives and the other has 4 specialists for agricultural subject matter, so 7 staffs in total.

Extension services are executed by a KVS of each unit office by means of T&V system. Among 200-300 farmers in a hamlet, about 10 contact farmers (CFs) will be chosen to get direct extension services from the KVS. Other farmers except CFs are follower farmers (FFs), who get extension services through CFs and through

demonstrations and farm training classes provided by the KVS and/or a block centre office. The KVS staff is dispatched to a unit office by the DAS, in general.

Agricultural credit will be available through the Rural Bank from the People's Bank, and through the ASC from the Bank of Ceylon. The Rural Bank will associate with co-operatives, as the same way as existing areas. A branch of co-operatives settled in every block centre, accompanied with the Rural Bank. The primary co-operative complex and the ASC will provided in the Town Centre. The NCRCS system will also be available through the Regional Rural Development Bank (RRDB) or the Trift and Credit Co-operative Societies (TCCSs) which will be provided in the Town Centre.

Co-operatives works as purchasing agents of the Paddy Marketing Board (PMB) in paddy procurement. The CWE functions as a purchasing and distributing agent of subsidiary food crop in the public marketing channel. Rice millers, wholesaler and retailers handle most of marketed agricultural products in private marketing channels, who are scattered in all centres. The only PMB provides a large warehouse in the Town Centre. The farmer will produce a variety of food crops linked to market demands. However, they have to conduct their marketing operations with many problems such as smaller marketable volumes, perishability of products, non-availability of production and marketing credit, non-availability of transport, lack of market information, low bargaining power of farmers due to lack of farmer organization and lack of adequate storage. Therefore, in order to lead farmers holding small crop field to work with confidence, the agricultural support services are introduced into the new settlement area deliberately.

6. COST ESTIMATE

6.1 Basis of Estimate

The construction costs of the dam, hydropower facilities, and the irrigation system were estimated on the basis of work quantities measured from the preliminary design and unit prices estimated for each item of works. All costs were estimated at the project site as of February 1988 prices and exchange rate of US$1.0 = Rs. 30.5 = J. Yen 140. It was assumed that the construction works would be let to contractors to be selected by international competitive tenders for major works, and by local competitive tenders for minor works as discussed in the preceding Section 4.7.

The construction cost was estimated to cover such direct costs as labours, materials and equipment, as well as indirect costs such as contractors overheads, site expenses and profit. The cost of imported materials and equipment was estimated on the basis of CIF Colombo and inland transportation costs, exclusive of import duties, taxes, etc. Engineering and administration costs were also estimated to cover the costs of detailed investigations and design, the preparation of tender documents as well as supervision of the construction works. Physical contingencies were estimated to be 15% of the construction costs to cover such unknown factors as changes in work quantities, in geological conditions and accuracy in topographic maps, etc. Price contingencies to cover price escalation were estimated to be 8% for costs to be incurred in local currency and 0% in foreign currency on the basis of prevailing trends in Sri Lanka and Japan.

6.2 Investment Costs

The total investment costs were estimated to be US$310 million equivalent comprising US$105 million of local currency and US$205 million of foreign currency. The investment costs for the various works are given in Table 6.1 (see the details in ANNEX-L) and summarized below:

Unit:10^6 US$

Item	Dam & Power			Irrigation			Whole Project		
	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
1. Direct Construction	96	24	120	67	28	95	163	52	215
2. Land Acquisition/ Compensation	-	2	2	-	-	-	-	2	2
3. Government Administration	-	6	6	-	5	5	-	11	11
4. Engineering Services	9	1	10	6	2	8	15	3	18
Sub-total	105	33	138	73	35	108	178	68	246
5. Physical Contingency	16	5	21	11	5	16	27	10	37
Total	121	38	159	84	40	124	205	78	283
6. Price Contingency	0	12	12	0	15	15	0	27	27
Grand Total (Billion J. Yen)	121	50	171 (23.94)	84	55	139 (19.46)	205	105	310 (43.40)

6.3 Disbursement Schedule

The annual disbursement of investment costs was estimated on the basis of the implementation schedule proposed in Section 4.8, and the organization for the project implementation proposed in Section 5.1. The disbursement schedule is given in Table 6.2, and is summarized below:

Unit:10^6 US$

Year	Foreign Currency	Local Currency	Total
1989	6	4	10
1990	42	19	61
1991	38	19	57
1992	38	19	57
1993	47	21	68
1994	29	16	45
1995	5	7	12
Total	205	105	310

6.4 Annual Operation and Maintenance Costs

The annual operation and maintenance costs include the salaries of project administrative and water control staffs, the material and labour costs for operation, repair and maintenance of O&M equipment, and the running costs of project facilities. The annual O&M costs were estimated to be US$2.06 million (Rs. 62.8 million) per annum in total, which correspond to 0.66% of the total investment costs of US$310 million. O&M costs were estimated to be US$0.74 million (Rs. 22.6 million) for dam and power station, and US$1.32 million (Rs. 40.3 million) for irrigation systems, respectively (see details in ANNEX-L).

6.5 Replacement Costs

Some of facilities, especially mechanical and electrical equipment, have shorter useful life than the civil works, and require replacement at a certain time within the project useful life. The replacement costs and the useful lives of these facilities are listed in Tables 6.3 and 6.4.

7. PROJECT EVALUATION

7.1 General

The Project will create a considerable amount of benefits to Sri Lanka due to increase in agricultural production, hydropower output, employment opportunities as well as other multiplied economic effects.

In this Chapter, the results of the economic evaluation and financial analysis are presented. In addition, indirect benefits and socio-economic impact were studied and assessed. The economic viability of the project was analyzed from the view point of the socio-economy as a whole, and the Economic Internal Rate of Return (EIRR), Benefit/Cost (B/C) ratio and Net Present Value (NPV) were computed for this purpose. The financial evaluation was also done through comparison between unit water charge and financial burden of the GOSL.

7.2 Economic Evaluation

7.2.1 Assumptions, Conditions and Criteria

The economic evaluation of the project was made through EIRR, B/C and NPV with the following assumptions and conditions:

- The economic life of the project was taken as 50 years from completion of the project,
- The base period for the cost estimate was set in February 1988,
- The following exchange rates were applied:
  US$1.00 = Rs. 30.50 = J. Yen 140.00, and
- The opportunity cost of capital was taken to be 10% for the standard analysis case.

7.2.2 Economic Cost

The economic evaluation was carried out from a socio- economic view point, while the financial evaluation was made from the point of view of the individual implementing agency. The estimated financial cost based on the market price was adjusted to the economic cost by a Standard Conversion Factor (SCF). The SCF was estimated at 0.85 based on the relevant statistics regarding trade, the Government revenue and expenditures for the period of past few years (see ANNEX-M). Since there is substantial unemployment particularly in rural areas, the shadow wage rate of 70% of market wage for unskilled labour is taken into account in the economic analysis.

Based on the above conversion factor and annual financial cost disbursement as tabulated in Table 6.2, the annual economic capital costs were obtained as presented in Table 7.1. The total economic capital cost was calculated at US$257.1 million, consisting of US$125.2 million of dam cost, US$28.3 million of power facilities cost and US$103.6 million of irrigation facilities cost including settlement cost.

While the economic project life was assumed to be 50 years, some of facilities have shorter life than the civil works. Then, they are assumed to be 30 years for hydromechanical works and generating equipment, 25 years for transmission line and irrigation gates and 10 years for O&M equipment. The replacement cost was considered to be 90% for investment value at the end of each life, because of salvage value of 10% would be remained. The investment values are enumerated in Table 6.3.

The O&M cost for the project was estimated at Rs. 58×10^6 (US$1.9 x 10^6) in economic value at the stage of project completion. The detailed estimation of O&M cost is shown in ANNEX-L. The annual cost stream of O&M as well as capital investment is shown in Table 7.2.

7.2.3 Economic Benefits

(1) Agricultural Benefits

The agricultural benefits were estimated in terms of incremental benefits by a balance of "with" and "without" project conditions. For economic evaluation, economic prices of farm input and products have been estimated by referring to the IBRD price forecast. For estimating the economic costs of production, the Standard Conversion Factor (SCF) was applied (see ANNEX-M). The economic net return was first estimated for each crop and then for each area in accordance with the proposed cropping area.

Based on the above conditions and criteria, the agricultural economic benefit annually accruable from the project was estimated as follows:

(Unit: 10^6 US$)

Item		Without Project		With Project		Net Economic Benefit
		Existing Area	Extension Area	Existing Area	Extension Area	
Paddy	Maha	19.9	0.1	27.0	9.1	16.1
	Yala	19.9	0.0	21.6	7.3	9.0
Onion	Yala	0.0	0.0	5.1	1.7	6.8
Chillies	Yala	0.0	0.0	1.8	0.6	2.4
Others	Yala	0.0	0.0	1.0	0.4	1.4
Total		39.8	0.1	56.5	19.1	35.7

The net economic benefit amounts to US$35.7 million per annum, comprising US$25.1 million from paddy production, US$6.8 million from onion, US$2.4 million from chillies and US$1.4 million from other diversified crops. The matured benefit will be attained after a building-up period of five years.

(2) Power Benefits

The conventional approach to economic analysis of a hydropower project is to define its benefit as the cost saved in construction and operation (fuel cost) of the cheapest alternative facility that could provide a power supply of equivalent quality and quantity to the intended beneficiaries.

There is the cheapest alternative thermal facility to meet system load sharing apportionment, i.e., gas turbine and diesel generator for peak load, oil-fired steam plant for middle load and coal-fired steam plant for base load. For this project, diesel generation, likewise considered as the most viable alternative to hydropower by the CEB, was selected as the cheapest alternative energy source, since the Moragahakanda powerplant is characterized by peak generation, 5.5 hours a day. The necessary construction and operation costs for such facilities required to replace the project are adopted as the project benefit.

Accordingly, peak generation supply under the project will be evaluated on the basis of alternative diesel. Namely, for power output (kW) and firm energy (GWh) which correspond to supply for peak load, a diesel station was considered as an alternative. While for secondary energy, fuel costs of coal thermal stations which are to be introduced before the project are considered as the alternative, since the secondary energy of hydropower will save fuel consumption at coal thermal stations.

As for the secondary energy of the project, the full amount is assumed to be effective for fuel cost saved in coal thermal generation, as there will be abundant thermal generation which can effectively be replaced by generation under the project.

The unit benefit values were calculated to be US$93.04 per kW for capacity value, US$0.0674 per kWh for firm energy value and US$0.0298 per kWh for secondary energy value respectively. Based on the above unit benefit values, dependable peak power and annual energy, the annual benefits are calculated as follows and are expected to be derived from the first year from commissioning:

- Capacity benefit:

  US$ 93.04/kW x 16,100 kW = US$1,498 x 10^3

- Firm energy benefit:

  US$0.0674/kWh x 66.4 GWh x 10^6 = US$4,475 x 10^3

- Secondary energy benefit:

  US$0.0298/kWh x 78.9 GWh x 10^6 = US$2,351 x 10^3

- Total annual benefit = US$8,324 x 10^3

7.2.4 Economic Internal Rate of Return (EIRR)

Applying the economic costs and benefits estimated in the preceding Sub-sections, the cost and benefit streams of the integrated project of agriculture and power generation are shown in Table 7.2.

The results of the economic analysis for the project are shown in the following:

	EIRR (%)	Net Present Value (US$ Million) (discount rate = 10%)	B/C Ratio (discount rate = 10%)
Value	13.0	62.3	1.32

Economic returns from project implementation amount to US$62.3 million in terms of net present value, while the benefit-cost ratio discounted at the rate of 10% is 1.32. Economic internal rate of return (EIRR) is 13.0%. Thus, the implementation of the proposed project can be deemed economically viable.

7.2.5 Sensitivity Analysis

In order to determine the economic viability of the project, sensitivity analyses were carried out by changing the following factors:

- Capital costs : 10% higher
- Capital costs : 5% higher
- Benefits : 5% lower
- Benefits : 10% lower

Results of the sensitivity analysis can be summarized as shown in the following:

Item	Sensitivity Case					
	A	B	C	D	E	F
Capital costs	+0%	+10%	+5%	+0	+0	+10%
Benefit	+0%	+0%	+0%	-5%	-10%	-10%
EIRR (%)	13.0	11.9	12.5	12.4	11.8	10.8
NPV (US$ Million)	62.3	42.8	52.4	49.3	36.6	17.4
B/C Ratio	1.32	1.20	1.26	1.24	1.19	1.08

The analysis indicates the level of these benefits is enough to show that the proposed project will be economically feasible.

7.3 Financial Evaluation

7.3.1 Fund Requirement for Project Implementation

The project costs estimated in Chapter 6 are taken as the fund requirements for project implementation. The annual disbursement schedule of the fund is also shown in Chapter 6.

7.3.2 Net Farm Income and Capacity to Pay

In order to evaluate the project from the standpoint of farmer's economy, farm budget analysis of a typical existing farmer having 1.1 ha of farm size and new settlers having 1.0 ha is made under both future with and without project conditions.

After completion of the project, the project will provide bases for introduction of improved irrigation farming through year round irrigation. Under such situations increase of unit yield of crops and cropping intensity will be much expected in the future with project conditions. Crop yields are expected to be 6 tons of paddy per ha, 1.9 tons of chillie per ha, 15 tons of onion per ha, 12 tons of vegetables per ha and 1.5 tons of pulses per ha. Cropping intensity will increase to about 200% from 146% at present. Under such situation drastic increase on farm incomes in the future with project condition can be expected for the farmers in the project area.

It is estimated that net farm incomes on a typical existing farmer having 1.1 ha of farm size and a new settler having 1.0 ha of farm plot under with project condition amount to Rs. 33,130 per annum and Rs. 30,140 per annum respectively as shown in Table 7.3. This net farm income is about 1.9 times of that under without project condition. And capacity to pay for both typical farmers in the project area is calculated at Rs. 16,210 for the existing farmer and Rs. 13,220 for the new settler.

7.3.3 Financial Evaluation

Financial evaluation is made by the analysis of the financial balance of public investment and procurement. In irrigation project, the water charges on the settlers generally comes into conflict with the subsidy of the Government to the project. To give an incentive to higher productivity to new settlers, water charges are liable to be kept into low level. Yet, in that case, the Government has to burden itself with the deficit of project management. Accordingly, in this section, the financial balance of the irrigation project is first discussed hereinafter.

In financial analysis, though price escalation is an important factor, which effects costs as well as benefits, it is ignored. As a result, prices of water charges and other costs are easily understood and discussed under present conditions. Thus, market prices at the time of project cost estimation are applied as fixed prices. In this light, it must be noted that financial costs in this sub-section are different from actual costs required in the future for project implementation.

As regards water charge, the following alternatives are assumed to estimate the subsidy of the Government:

Case-1 : Present water charge applied to national irrigation system

Case-2 : Water charge covering O&M costs of the project

Case-3 : Water charge covering both O&M costs and loan repayment for the construction costs

Existing unit water charge is set at Rs. 500/ha by the year 1991. Table 7.4 shows cash flow statement under Case-1 condition. In this case, the Government has to be burdened with Rs. 10.7×10^9 by the time of loan repayment completion. In Case-2, unit water charge is estimated at Rs. 920/ha. The Government has to subsidize the capital investment costs and its interest of Rs. 10.0×10^9 in total. In Case-3, unit water charge goes up to Rs. 6,600/ha. The Government subsidy would be eliminated, although the shifting funds for local portion are prerequisite in this case as well as other cases (details in ANNEX-M). The unit water charge is summarized as follows:

	Capacity to Pay (Rs.)	Unit Water Charge (Rs./ha)
Case-1	13,220-16,210	500
Case-2	13,220-16,210	920
Case-3	13,220-16,210	6,600

Water charge to be burdened by the beneficiaries should be within the reasonable range that can still give to the farmer's sufficient incentives for agricultural production to be

increased in the irrigation development area. It is, therefore, considered that less than 20% of the capacity to pay would be the water charges at the maximum. In this sense, Case-3 is not realistic from the farmer's view point.

However, in order to decrease the burden of the Government, the water charge should be raised to more than the level of Case-2. In other words, not only O&M costs but also some portion of capital cost should be covered by the water charges.

Financial evaluation for the whole project including irrigation and hydropower was also evaluated on the basis of revenues from irrigation water charge (Rs. 500/ha) and electric energy charge (Rs. 2.5/kWh). The cash flow statement is presented in Table 7.5. As seen in Table, the Government burden by the time of repayment completion will be substantially mitigated from Rs. 10.7 x 10^9 for only irrigation to Rs. 3.7 x 10^9 for the whole project, owing to abundant revenue from sold electric energy.

7.4 Indirect Benefits and Socio-Economic Impacts

7.4.1 General

In addition to the direct benefits stipulated in the economic evaluation, substantial secondary direct benefits stemming from the project outputs and induced by project inputs and favourable intangible socio-economic impacts are expected from the implementation of the project.

7.4.2 Foreign Exchange Saving

With project implementation, paddy production will increase a certain amount from the present level. Domestic production of grains at present is not sufficient to meet consumption, and as a result, the deficit has to be supplemented by imports. Accordingly, the increased paddy production will contribute the saving of foreign exchange.

The hydropower station will generate annual energy of 145.3 GWh. This generated energy will replace energy to be generated by thermal stations and will result in saving in fuel costs, which will also serve to save the foreign exchange. The annual amount of foreign exchange saving with amount to about US$6.8 million.

7.4.3 Increase in Employment Opportunities

Employment opportunities for the local people will be increased by the project implementation, which will have a favourable impact on the national economy. Furthermore, employees will be able to gain more experience and technical skill in various working fields. These benefits would be applied to the future development of Sri Lanka.

The number of unskilled and skilled local labourers to be employed for construction works is estimated at about 3 x 10^6 man-days in total, about 2 x 10^6 man-days for irrigation and about 1 x 10^6 man-days for dam and power. In addition to this, there will be

considerable effects through employment opportunities created in procurement, transportation, storage, etc. of materials brought to the site. Procurement, transportation, storage, etc. of materials will not only create employment opportunities but also will promote development of linkage industries in these fields.

In addition to the above, another employment opportunities will be created through farming practices after completion of the project. As discussed in Sub-section 4.3.2, the project will create another demands for farm labour requirement accrued from increased farm activities due to intensive use of the land and high productivity. The incremental farm labour requirement is estimated at about 7×10^6 man-days per annum. Moreover, employment opportunities will be increased through the introduction of rural agro-based industry.

7.4.4 Inland Fishery

Regarding inland fishery, Polonnaruwa is one of the major districts in Sri Lanka. According to statistics handbook of Polonnaruwa in 1982, the District produced 3,400 tons of fresh-water fish from 31 lakes. This production represents 12% of the national inland fishery production of 29,100 tons in the same year.

The District has 69.0 km^2 of large inland waters in the total district area of 3,293 km^2. Those inland waters account for only 6.0% of the national total of 1,156 km^2 against 12% of production rate. The Moragahakanda project will create as additional 39 km^2 of reservoir area which is equivalent to two-thirds of the district waters. Although it takes a certain time to mature inland fishery, some increase in inland fishery production may be expected in the proposed reservoir area.

7.4.5 Rural Agro-industry

The GOSL is promoting to introduce rural agro-industries in rural areas, in order to create other employment opportunities through crops diversification. The project area is blessed with natural resources such as climate for agriculture, fertile soils as well as irrigation water upon completion of the project. The proposed cropping pattern would include vegetables such as tomatoes, cucumbers, eggplants, etc. There are certain possibilities to introduce small scale rural agro-industries for production of tomato juice, pickles of cucumbers, etc. being subject to improvement of variety and future studies.

7.4.6 Subsidiary Crops in Homestead

As discussed in Sub-section 4.3.6, the settlers would be allocated 0.2 ha homestead area in addition to 1.0 ha farming plot. In these homesteads, almost settlers will plant subsidiary crops such as coconuts, cashewnuts, papaya, bananas, grapes, mangoes, etc. Since it might be difficult to quantify and identify subsidiary crops, such benefits from the homestead areas are not incorporated in the economic evaluation. However, these will be considered to be indirect benefits through the settlement program.

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2. PUBLIC INVESTMENT 1987 - 1991, MFP

3. IMPLEMENTATION STRATEGY STUDY, MAHAWELI GANGA DEVELOPMENT PROGRAM, 1979, NEDECO

TABLES

Table 1.1 PARTICIPANTS IN THE STUDY

Name	Position	
A. Advisory Committee		
1. Mr. M. Aihara	Chairman of Advisory Committee	(MAFF)
2. Mr. S. Hayashi	Member, Project Evaluation	(OECF)
3. Mr. H. Nakada	Member, Agriculture & Agro-economy	(MAFF)
4. Mr. I. Ueda	Member, Irrigation and Drainage	(MAFF)
5. Mr. N. Enami	Member, Geology and Soil Mechanics	(MAFF)
6. Mr. T. Shino	Coordinator	(JICA)
B. Phase I (February - March 1988)		
- Advisory Team		
1. Mr. M. Aihara	Leader/Chairman of Advisory Committee (MAFF)	
2. Ms. Y. Yamashita	Coordinator, JICA	
Study Team		
1. Mr. S. Yano	Team Leader	
2. Mr. S. Muramoto	Irrigation & Drainage Engineer (I) (Deputy Team Leader)	
3. Mr. H. Ikewada	Agricultural Development Specialist	
4. Mr. K. Yamazaki	Construction Plan/Cost Estimate Engineer	
5. Mr. T. Tashino	Agro/Project-Economist	
6. Mr. E. Araida	Hydro-power Generation Planner	
7. Mr. N. Okabe	Hydrologist	
8. Mr. K. Okuwa	Irrigation & Drainage Engineer (II)	
9. Mr. S. Makino	Pedologist	
Counterpart		
1. Mr. C.W.E. Rosa	Project Director	(MASL)
2. Mr. A. Attanayake	Director, PMU	(MASL)
3. Mr. G.G. Jayawardhane	General Manager	(CECB)
4. Mr. M.N.G. Perera	Chief Project Engineer	(CECB)
5. Mr. A.G.A. Gunawardena	Irrigation Engineer I	(MECA)
6. Mr. A.K.A. Mahinda	Irrigation Engineer II	(MECA)
7. Mr. M.H. Jayasooriya	Agronomist	(MEA)
8. Dr. Anura Ekanayaka	Agro-Economist, PMU	(MASL)
9. Mr. S.W.S.B. Dasanayaka	Agro-Economist	(Uni. of Colombo)
10. Dr. James Handawala	Pedologist	(MADR)
11. Mrs. T.P. Perera	Meteo-Hydrologist I	(ID)
12. Mr. M.C. Liyanagama	Meteo-Hydrologist II	(MECA)
13. Mr. P.D. Hennayake	Cost Estimate Engineer	(CECB)
14. Mr. B.W.N. Rupasinghe	Electrical Engineer	(CECB)

Table 3.1 RESULTS OF SOIL CLASSIFICATION

Mapping No.	Main Soil Unit	Soil Series	Land Form	A/D		D1		D2		G		Total	
				ac	%	ac	%	ac	%	ac	%	ac	%
(1)	Alluvial Soil	Well to moderately well drained	Floodplain	0	0	0	0	3,650	25	570		4,220	4.0
(2)	Alluvial Soil	Imperfectly to poorly drained	Floodplain	3,760	21	1,090	2	10,500	71	0		15,400	14.5
(3)	Low Humid Gley Soils		Old alluviam	1,260	7	13,790	27	0	0	2,050		17,100	16.1
(4)	Reddish Brown Earth	Well drained	Undulating plain	5,510	31	13,100	26	130	1	7,370		26,110	24.6
(5)	Reddish Brown Earth	Imperfectly drained	Undulating plain	5,215	29	16,520	33	0	0	5,470		27,205	25.6
(6)	Reddish Brown Earth	Shallow/rocky phase	Undulating plain	0	0	2,130	4	0	0	3,280		5,410	5.1
(7)	Solonets		Old alluvium	0	0	2,620	5	0	0	0		2,620	2.5
(8)	Rock Knob Plain		Rock knob	2,165	12	250	1	370	3	2,580		5,365	5.0
(9)	Erosion Reminents		Dissected undulating plain	0	0	980	2	0	0	1,860		2,840	2.6
	Total			17,910 (7,250 ha)	100	50,480 (20,430 ha)	100	14,700 (5,940 ha)	100	23,180 (9,380 ha)		106,270 (43,000 ha)	100.0

Tale 3.2 DESCRIPTION OF SOIL CLASSIFICATION

Classification Unit	Soil Unit	Definition
Upland Crop Type	Reddish brown earth (well drained) Alluvial soil (well to moderately well drained)	Suitable for a wide range crops such as cotton, groundnut, sugarcane, pulses, soyabeans, chillies and vegetables.
Lowland and Upland Crop Type	Reddish brown earth (imperfectly drained)	Suitable for intermediate crops, which can tolerate periodic wetness on the surface, such as sugarcane on ridges.
Lowland Crop Type	Low humic gley soils Alluvial soils (imperfectly drained)	Suitable fow lowland paddy.
Unsuitable to Crop Type	Solonetz, reddish brown earth (shallow/rocky phase) Rock knob Erosion remarks	Very poor to poor lands, and unsuitable for crops.

Table 3.3 RESULTS OF LAND CLASSIFICATIN (UNDEVELOPED AREA)

Classification Unit	AD		D1		D2		Total	
	ac	%	ac	%	ac	%	ac	%
Upland Crop Type	5,510	31	13,100	30	3,780	26	22,390	27
Lowland and Upland Crop Type	5,215	29	16,520	33	0	0	21,735	26
Lowland Crop Type	5,020	28	14,880	30	10,550	72	30,450	37
Unsuitable to Crop Type	2,165	12	5,980	7	370	2	8,515	10
Total	17,910 (7,250 ha)	100	50,480 (20,430 ha)	100	14,700 (5,940 ha)	100	83,090 (33,620 ha)	100

Table 3.4 AVERAGE MONTHLY METEOROLOGICAL DATA AT MAHA-ILLUPPALLAMA

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Mean Temperature °C	25	26	28	28	28	28	28	28	28	27	26	26	27
Rainfall, mm	113.8	51.3	89.7	182.9	99.3	19.3	30.2	56.9	66.5	226.1	253.5	238.0	1,427.0
Pan-Evaporation mm	127	157	205	174	205	213	229	220	222	164	123	118	2,157
Relative Humidity, %	79	74	70	76	76	76	73	71	68	76	82	83	75

Table 3.5 AVERAGE MONTHLY NATURAL RUNOFF AND DIVERSION WATER
(1950 - 1977 RECORDS)

Unit: MCM

Month	Average Monthly Natural Runoff			Diversion Water				Inflow to Moragahakanda	
				Polgolla		Nalanda	Bowatenna		
	Polgolla	Elahera	Angamedilla	Before Kotmale	After Kotmale			Before Kotmale	After Kotmale
Jan.	116	142	272	89	114	3.3	23	207	229
Feb.	70	88	162	56	89	1.3	37	119	142
Mar.	64	49	97	49	90	0.7	41	76	101
Apr.	107	46	89	81	119	0.8	42	85	118
May	199	43	75	100	131	3.3	54	90	120
June	299	26	43	119	137	3.4	70	77	92
July	273	24	48	135	145	3.7	66	86	96
Aug.	249	21	34	131	146	3.1	57	93	106
Sep.	239	20	37	123	137	1.8	71	71	83
Oct.	321	54	89	141	146	2.5	15	172	182
Nov.	284	98	172	138	144	1.3	25	209	214
Dec.	218	167	332	121	139	1.4	18	268	287
Total	2,439	778	1,450	1,282	1,538	26.6	519	1,553	1,770

Table 3.6 AVERAGE MONTHLY INFLOW TO TANKS

Unit: MCM

Month	Kantalai	Kaudulla	Minneriya	Giritale	Parakrama Samudra	Total
Catch-ment (km2)	588	83	385	24	73	-
Jan.	19	2	11	1	3	37
Feb.	10	1	6	0	2	19
Mar.	7	1	4	0	1	13
Apr.	13	2	7	1	2	25
May	8	1	5	0	1	15
June	1	0	1	0	0	2
July	5	1	3	0	1	10
Aug.	5	1	3	0	1	10
Sep.	10	1	6	0	1	18
Oct.	20	3	12	1	3	38
Nov.	31	4	18	1	5	59
Dec.	40	5	23	2	6	76
Total	169	27	99	6	26	321

Table 3.7 PRESENT LAND USE

Land Use Category	Developed Area		Undeveloped Area		Total	
	ha	%	ha	%	ha	%
Agricultural Land:	44,100	59.0	300	0.7	44,400	37.7
Paddy						
- Major Irrigation Scheme	41,100	55.0	0	0.0	41,100	34.9
- Minor Irrigation Scheme	0	0.0	300	0.7	300	0.3
Sugarcane	3,000	4.0	0	0.0	3,000	2.5
Non-Agricultural Land:	30,500	41.0	43,000	99.3	73,500	62.3
Homestead	16,400	22.0	500	1.2	16,900	14.3
Marshy	700	1.0	2,000	4.6	2,700	2.3
Tank	0	0.0	100	0.2	100	0.1
Others (Forest/bush/etc.)	13,400	18.0	40,400	93.3	53,800	45.6
Total	74,600	100.0	43,300	100.0	117,900	100.0

1. System Wise Land Use in Developed Area

Land Use Category	Developed Area (74,600 ha)											
	G E-M Canal		D1 Kantalai		D1 Sugar F.		D1 Kaudula		D2 Parakrama Samudra		A/D Kantalai	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Agricultural Land:	6,000	51.3	7,400	54.8	3,000	44.1	17,600	79.3	10,100	49.5	0	0.0
Paddy	6,000	51.3	7,400	54.8	0	0.0	17,600	79.3	10,100	49.5	0	0.0
- Major Irrigation Scheme	6,000	51.3	7,400	54.8	0	0.0	17,600	79.3	10,100	49.5	0	0.0
- Minor Irrigation Scheme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Sugarcane	0	0.0	0	0.0	3,000	44.1	0	0.0	0	0.0	0	0.0
Non-Agricultural Land:	5,700	48.7	6,100	45.2	3,800	55.9	4,600	20.7	10,300	50.5	0	0.0
Homestead	2,600	22.2	3,700	27.4	1,300	19.1	3,000	13.5	5,800	28.4	0	0.0
Marshy	0	0.0	700	5.2	0	0.0	0	0.0	0	0.0	0	0.0
Tank	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Others (Forest/bush/etc.)	3,100	26.5	1,700	12.6	2,500	36.8	1,600	7.2	4,500	22.1	0	0.0
Total	11,700	100.0	13,500	100.0	6,800	100.0	22,200	100.0	20,400	100.0	0	0.0

2. System Wise Land Use in Undeveloped Area

Land Use Category	Undeveloped Area (43,300 ha)											
	G E-M Canal		D1 Kantalai		D1 Sugar F.		D1 Kaudula		D2 Parakrama Samudra		A/D Kantalai	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Agricultural Land:	0	0.0	0	0.0	0	0.0	300	1.3	0	0.0	0	0.0
Paddy	0	0.0	0	0.0	0	0.0	300	1.3	0	0.0	0	0.0
- Major Irrigation Scheme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
- Minor Irrigation Scheme	0	0.0	0	0.0	0	0.0	300	1.3	0	0.0	0	0.0
Sugarcane	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Non-Agricultural Land:	0	0.0	0	0.0	9,000	100.0	22,400	98.7	5,600	100.0	6,000	100.0
Homestead	0	0.0	0	0.0	0	0.0	500	2.2	0	0.0	0	0.0
Marshy	0	0.0	0	0.0	0	0.0	1,100	4.8	900	16.1	0	0.0
Tank	0	0.0	0	0.0	0	0.0	100	0.4	0	0.0	0	0.0
Others (Forest/bush/etc.)	0	0.0	0	0.0	9,000	100.0	20,700	91.2	4,700	83.9	6,000	100.0
Total	0	0.0	0	0.0	9,000	100.0	22,700	100.0	5,600	100.0	6,000	100.0

Table 3.8 PRESENT CROPPED AREA IN THE PROJECT AREA

Unit: ha

	Maha (Oct. - Mar.)				Yala (Apr. - Sept.)			
	1984/85	1985/86	1986/87	Average	1985	1986	1987	Average
1. System G								
Paddy	2,940	3,470	3,810	3,410	1,200	1,010	2,620	1,610
Other field crops	140	90	210	150	430	560	870	620
Sub-total	3,080	3,560	4,020	3,560	1,630	1,570	3,490	2,230
2. Giritale								
Paddy	3,000	2,500	3,000	2,830	2,500	3,000	3,040	2,850
Other field crops	-	200	-	70	200	-	-	70
Sub-total	3,000	2,700	3,000	2,900	2,700	3,000	3,040	2,910
3. Minneriya								
Paddy	8,900	6,900	8,900	8,230	6,900	8,900	8,900	8,230
Other field crops	-	400	-	130	400	-	-	130
Sub-total	8,900	7,300	8,900	8,360	7,300	8,900	8,900	8,360
4. Kaudulla								
Paddy	4,900	4,500	4,500	4,630	730	4,500	1,370	2,200
Other field crops	-	-	-	-	-	-	-	-
Sub-total	4,900	4,500	4,500	4,630	730	4,500	1,370	2,200
5. Parakrama Samudra								
Paddy	10,100	10,100	10,100	10,100	10,100	9,510	10,120	9,910
Other field crops	-	-	-	-	-	200	-	70
Sub-total	10,100	10,100	10,100	10,100	10,100	9,710	10,120	9,980
6. Kantalai *1								
Paddy	6,700	6,280	2,020	5,000	5,600	-	-	1,870
Other field crops (Sugarcane)	2,360	2,090	510	1,650	2,360	2,090	510	1,650
Sub-total	9,060	8,370	2,530	6,650	7,960	2,090	510	3,520
Total								
Paddy	36,540	33,750	32,330	34,200	27,030	26,920	26,050	26,670
Other field crops	2,500	2,780	720	2,000	1,030	2,850	1,380	1,750
(of which sugarcane)	(2,360)	(2,090)	(510)	(1,650)	(2,360)	(2,090)	(510)	(1,650)
Total	39,040	36,530	33,050	36,200	28,060	29,770	27,430	28,420

Note: *1 Including Vendarasan and Kulam.
source: Water Management Secretariat, MASL, 1988.

Table 3.9 YYIELD OF PADDY IN THE EXISTING MAJOR IRRIGATION SYSTEMS

District	Yala					Maha				
	1984	1985	1986	1987	Mean	83/84	84/85	85/86	86/87	Mean
Polonnaruwa	4.0	4.4	3.9	3.8	4.0	4.0	5.0	4.9	5.0	4.7
Trincomalee	3.8	3.9	3.8	-	3.8	2.5	3.8	4.0	3.2	3.4
Sri Lanka	3.6	4.0	3.8	3.8	3.8	3.5	4.2	4.2	4.2	4.0

Source : Department of Census and Statistics, paddy statistics.

Remarks : 5 tanks except Kantalai are in Polonnaruwa district.
Kantalai tank is in Trincomalee district.

Table 3.10 PADDY PRODUCTION IN MAJOR IRRIGATION SYSTEM IN SYSTEMS G AND D

Main Tanks		Maha			Yala		
		1984/85	1985/86	1986/87	1985	1986	1987
Polonnaruwa	Planted Area (ha)	29,840	27,470	30,310	21,430	26,920	26,050
	Yields (ton/ha)	5.0	4.9	5.0	4.4	3.9	3.8
	Production (ton)	149,200	134,603	151,550	94,292	104,988	98,990
Trincomalee (Kantale)	Planted Area (ha)	6,700	6,280	2,020	5,600	-	-
	Yields (ton/ha)	3.8	4.0	3.2	3.9	3.8	-
	Production (ton)	25,460	25,120	6,464	21,840	-	-
Total Production (tons)		174,660	159,723	158,014	116,132	104,988	98,990
Average (tons)			(164,132)			(106,703)	

Remarks: Paddy production in 1986, 1987 Yala in Kantalai tank system was disimpted by the breakage of a dike of Kantalai tank.

Table 3.11 PADDY YIELD IN MINOR IRRIGATION SYSTEM IN POLONNARUWA DISTRICT

(Unit: ton/ha)

	1983/84	1984/85	1985/86	1986/87	Average
Maha	2.7	3.0	3.1	3.8	3.2

Source: Department of Census & Statistics, Paddy Statistics.

Table 3.12 PERFORMANCE OF KANTALAI SUGAR MILL

	1980	1981	1982	1983	1984	1985	1986	1987	Average
Cane Harvested Area (ha)	2,590	2,442	2,446	2,254	2,213	2,356	2,093	510	2,113
Yield of Cane (ton/ha)	51	53	46	48	43	41	40	40	45
Cane Harvested (ton)	132,750	130,655	111,988	107,331	92,758	95,843	82,947	20,400	96,834
Sugar Production (ton)	13,593	11,423	10,720	9,202	8,834	9,232	7,171	1,760	8,992

Table 3.13 LIVESTOCK POPULATION (1982)

Item	Sri Lanka	Trincomalee	Polonnaruwa	Total
Buffalo	879,200	18,405	60,800	79,205
Cattle	1,698,600	50,830	81,140	131,970
Goat	511,600	9,850	10,112	19,962
Swine	75,100	200	508	708
Sheep	28,000	-	-	-
Chicken	-	36,180	102,358	138,538

Source: Census of Agriculture, 1982, Polonnaruwa, Trincomalee districts.

Table 3.14 EXISTING AND NEW IRRIGATION AREAS

Unit: Acres

System	Scheme	District	Under Specification	Under Unauthorized	Other Land	New Land	Total
G	Elahera	P	14,800 *2	-	-	-	14,800
D1	Minneriya *3	P	16,800	6,200	-	-	23,000
	Giritale	P	6,200	1,300	-	-	7,500
	Kaudulla	P	10,500	2,500	-	22,400	35,400
	Kantalai *4	T	22,300 *5	3,300	10,500*6	-	36,100
D2	Parakrama Samudra	P	19,600	5,400	-	5,400	30,400
A/D	Kantalai	T	-	-	-	6,600	6,600
	Total		90,200 (36,500 ha)	18,700 (7,600 ha)	10,500 (4,200 ha)	34,400 (13,900 ha)	153,800 (62,200 ha)

Note: *1 P means Polonnaruwa and T means Trincomallee.
*2 Including on-going project of 10,000 acres to be completed in 1988.
*3 Including Paravipanchankulam and Galamura schemes.
*4 Including Kahambiliya and Wan Ela schemes.
*5 Including existing sugarcane fields of 7,400 acres (3,000 ha) for Sugar Corporation.
*6 Expansion area of 10,500 acres (4,200 ha) for Sugar Corporation.

Table 3.15 BASIC FEATURES OF EXISTING TANKS

Description	Unit	Kaudulla	Minneriya	Kantalai	Giritale	Parakrama Samudra
Catchment Area	km2	83	385*2	588*3	24	73
Capacity	MCM	128.3	136.9	160.6	25.3	135.1
Dead Storage	MCM	4.9	0.0	0.0	0.0	18.5
Active Storage	MCM	123.4	136.9	160.6	25.3	116.6
Area at F.S.L.	km2	25.9	25.5	28.7	3.2	25.7
H.W.L.	m	73.2	93.7	59.3	92.2	59.1
L.W.L.	m	64.0	82.1 '(89.9) *4	42.8	79.0	51.8
Existing Irrigable area *5	ha	4,250	6,800	9,030	2,510	7,930
Dam Length	km	9.2	2.8	3.7	0.5	14.7
Top elevation	m	76.8	97.1	63.4	97.2	61.0
Top width	m	-	7.6	13.7	9.1	3.7

Note: *1 Including Vendarasan Kulam Tank
*2 Including catachment area along Elahera Minneriya Yoda Ela, 145 km2
*3 Including catchment area of Gal Oya 215 km2 and Aluth Oya 73 km2
*4 Still elevation of gates to Kantalai and Kaudulla Tank
*5 Irrigation area under specification

Table 4.1 SOIL CLASSIFICATION AND IRRIGABLE AREA

Main Soil Unit	A/D		D1		D2		Total	
	Gross	Irrigable	Gross	Irrigable	Gross	Irrigable	Gross	Irrigable
1. Alluvial Soil								
- Well to moderately well drained soil	0	0	0	0	3,650	1,400	3,650	1,400
- Imperfectly to poorly drained soil	3,760	1,200	1,090	1,000	10,550	4,000	15,400	6,200
2. Low Humic Gley Soil	1,260	)	13,790	)	0	)	15,050	)
3. Reddish Brown Earth		) 5,400		) 21,400		) 0		) 26,400
- Imperfectly drained	5,215	)	16,520	)	0	) 0	21,735	)
- Well drained	5,510	0	13,100	0	130	0	18,740	0
- Shallow/rocky phase	0	0	2,130	0	0	0	2,130	0
4. Solonets	0	0	2,620	0	0	0	2,620	0
5. Rock Knob Plain	2,165	0	250	0	370	0	2,785	0
6. Erosion Reminants	0	0	980	0	0	0	980	0
Total	17,910 (7,200 ha)	6,600 (2,700 ha)	50,480 (20,400 ha)	22,400 (9,000 ha)	14,700 (59,500 ha)	5,400 (2,200 ha)	83,090 (33,600 ha)	34,000 (13,900 ha)

Table 4.2 PROPOSED FARMING PRACTICES

(1) Major Design Criteria of Proposed Paddy Farming Practices:

Varieties	:	BG-379-2, BG-400-1,
Growing period	:	BG-379-2; 4 months BG-400-1; 4.5 months
Planting method	:	transplanting
Seed sown	:	107 kg/ha
Nursery period	:	20 days
Planting space	:	15 cm x 15 cm
Fertilizing	:	120 kg N/ha 80 kg P2O5/ha 80 kg K2O/ha
Labour requirement	:	87 man-days/ha (26 for family labour and 61 for hired labour)

(2) Major Design Criteria of Proposed Chillie Farming Practices:

Varieties	:	MI-1 (150 days), MI-2 (150 days)
Planting method	:	transplanting
Seed sown	:	1.85 kg/ha
Nursery period	:	25-30 days
Planting space	:	60 x 60 cm or 75 x 60 cm (MI-1) 60 x 45 cm or 60 x 45 cm (MI-2)
Fertilizing	:	150 kg N/ha 100 kg P2O4/ha 100 kg K2O
Labour requirement	:	229 man-days/ha (147 for family labour, 82 for hired labour)

(3) Major Design Criteria of Proposed B. Onion Farming Practices:

Varieties	:	Poona red or early grand
Growing period	:	3 months
Planting method	:	Transplanting
Seed sown	:	8.4 kg/ha
Nursery period	:	1.5 months
Planting space	:	15 x 10 cm or 10 x 10 cm
Fertilizer	:	104 kg N/ha 108 kg P2O5/ha 92 kg K2O/ha
Labour requirement	:	552 man-days/ha
(Family)	:	408 man-days/ha
(Hired)	:	144 man-days/ha

(4) Major Design Criteria of Proposed Sugarcane Farming Practices:

Variety	:	CO-775 (Indian variety)
Growing period	:	plant cane; 12 months ratoon cane; 11 months
Ratoon osage	:	2 seasons
Seed cane	:	12.4 ton/ha
Planting space	:	105 cm between rows
Fertilizing	:	98 kg N/ha 43 kg P2O5/ha 60 kg K2O/ha
Labour/machinery power requirement	:	18,565 Rs./ha equivalent

(5) Major Design Criteria of Proposed Long Beans Farming Practices:

Variety	:	Top Crop, Kentucky Wonder, Lanka Nil
Growing period	:	1.5 to 3.0 months
Seed sown	:	41 kg/ha
Planting space	:	Bush type; 0.6 x 1.5 m Pole type; 0.9 x 0.9 m
Fertilizing	:	28 kg N/ha 199 kg P2O5/ha 74 kg K2O/ha
Labour requirement	:	346 man-days/ha
(family)		(230 man-days/ha)
(hired)		(116 man-days/ha)

(6) Major Design Criteria of Proposed Greem Gram Farming Practices:

Variety	:	MI-5, IPM-79-13-45
Growing period	:	75-90 days
Seed sown	:	26 kg/ha
Planting space	:	30 x (7-8)cm
Fertilizing	:	25 kg N/ha 60 kg P2O5/ha 60 kg K2O/ha
Labour requirement	:	229 man-days/ha
(family labour)		(174 man-days/ha)
(hired labour)		(55 man-days/ha)

Table 4.3 EXPECTED CROP PRODUCTION AND YIELDS

Crops	Planted Area (ha)	Yield (ton/ha)	Production (ton)
Paddy	99,000	6.0	594,000
Onion	2,900	15.0	43,500
Chillies	3,100	1.9	5,890
Sugarcane	7,200	85.0	595,000
Pulses	1,700	1.5	2,550
Vegetables	3,000	12.0	36,000
Sweet potatoes	300	12.0	3,600

Table 4.4 FOOD DEMAND IN 2000 YEAR

Name of food	Per capita consumption in 1985 (kg/per/annum) (1)	Per capita consumption including waste, feed and other use in 1985 (2) (kg/per/annum)	Income elasticity for demand (2)	Income growth rate (3)	Per capita consumption including waste, feed and other use in 2000 (4) (kg/per/annum)	Population in 2000 (5) (thousand)	Demand in 2000 (1,000tons) (6)
National Level							
Paddy	113 (7)	124.2 (7)	0.26	0.033	207.57 (7)	20,295	4213.0
Chillies		3.02	0.48	0.033	3.82	20,295	77.6
Onion	4.03	6.72	0.48	0.033	8.50	20,295	172.5
Pulse	3.91	4.25	0.48	0.033	5.30	20,295	107.6
Project Level							
Paddy	113	124.2	0.26	0.033	207.57 (7)	479	99.4
Chillies		3.02	0.48	0.033	3.82	479	1.8
Onion	4.03	6.72	0.48	0.033	8.50	479	4.1
Pulse	3.91	4.25	0.48	0.033	5.30	479	2.5
Vegetables		59.13	0.48	0.033	74.84	479	35.9
Sweet potato	5.19	7.41	0.48	0.033	9.39	479	4.5

(1) Data source; Food balance sheet for 1985, Dep. of Census and Statistics
(2) Data source; Report on consumer finances and socio economic survey (1981/82), CBC 1984
(3) Income growth rate is estimated as average growth rate of GDP per capita during the period from 1982 to 1986.
(4) Per capita consumption in 2000 is estimated on the basis of the following formula.

$$P = Q*(1+I*G)N$$

where; P = per capita consumption in 2000
Q = per capita consumption in 1985
I = income elasticity
G = income growth rate
N = 15 years

(5) Details are shown in Annex A for national level and in Annex D for project level.
(6) Food demand is estimated multiplying population by per capita consumption in 2000.
(7) This value is indicated by milled rice.
(8) This value is indicated by paddy. Milling rate is 68%.

Table 4.5 SUPPLY OF AGRICULTURAL PRODUCT IN 2000 YEAR

Name of Crop	Production (Ton)		
	1986	Average (1)	2000
Paddy	2,590,000	-	4,180,000 (2)
Chillies	45,400	45,000	77,600 (3)
Onion	78,900	83,000	83,000 (4)
Pulse	57,400	70,700	70,700 (4)

(1) Average value for 6 years from 1981 to 1986

(2) This value is estimated on the basis of the following formula which is shown in NEW MONOGRAPH SERIES No. 1 prepared by Dep. of Census and Statistics in 1987.

$Y=28.29(x-69)x(x-69) + 878(x-69) + 18,984$ (for Yala season)
$Y=39(x-69)x(x-69) + 1923(x-69) + 38,668$ (for Maha season)

where; Y = production, x = year

(3) According to past trend, linear regression curve is formulated as follows:

$Y = (7.11 \times -14,080) \times 1,000$ $(r=0.92)$

where; Y = production, x = year

On the basis of the formula, production of chillies is estimated at 140,000 tons. However, demand in 2000 year is forcasted at 77,600 tons and production of chillies will be restricted by 77,600 tons.

(4) According to the past trend analysis for the period from 1981 to 1986, there is no relation between production and past year. So prospective production in 2000 is considered as average production amounts from 1981 to 1986.

Table 4.6 SUMMARY OF ECONOMIC CROP BUDGET OF DIFFERENT CROPS IN FUTURE WITH AND WITHOUT PROJECT

	Without Project			With Project		
	Gross Income	Production Cost	Primary Profit	Gross Income	Production Cost	Primary Profit
1. Paddy						
Major Irrigation System	27,500	12,179	15,321	33,000	13,001	19,999
Kantale Irrigation System	24,200	12,179	12,021	33,000	13,001	19,999
Minor Irrigation System	17,600	12,179	5,424	33,000	13,001	19,999
2. Chillie	39,000	25,816	13,184	49,400	25,816	23,584
3. Onion	-	-	-	106,500	34,892	71,608
4. Sugar cane	15,171	37,607	-22,436	33,065	22,726	10,339
5. Vegetables	-	-	-	29,600	19,537	10,063
6. Pulses	12,000	11,337	663	18,000	11,881	6,119

Table 4.7 SUMMARY OF FINANCIAL CROP BUDGET OF DIFFERENT CROPS IN FUTURE WITH AND WITHOUT PROJECT

	Without Project			With Project		
	Gross Income	Production Cost	Primary Profit	Gross Income	Production Cost	Primary Profit
1. Paddy						
Major Irrigation System	22,000	13,065	8,935	26,400	13,448	12,956
Kantale Irrigation System	19,360	13,065	6,295	26,400	13,448	12,956
Minor Irrigation System	14,080	13,065	1,015	26,400	13,448	12,956
2. Chillie	46,500	30,758	15,742	58,900	30,758	28,142
3. Onion	-	-	-	124,500	42,174	82,326
4. Sugar	19,500	49,812	-30,312	42,500	24,576	17,924
5. Vegetables *1	-	-	-	34,400	22,651	11,749
6. Pulses *2	14,000	14,084	-84	21,000	14,377	6,623

*1 represented by long beans
*2 represented by green gram

Table 4.8 PROPOSED NUMBER OF SETTLERS AND CENTRES

(Unit: No.)

System	Settlers		Proposed Nos. of Center			
	Farmer families	Non-farmer families	Town Center*1	Area center*2	Village center	Hamlet center
D1	9,100	2,000	1	3	4	22
D2	2,200	500	-	1	2	5
A/D	2,600	600	-	1	2	6
Total	13,900	3,100	1	5	8	33
Proposed O&M Office			System D Office	Block Office	Unit Office	Unit Office

Note: *1 Project center
*2 Block center

Table 4.9 AVERAGE MONTHLY DIVERSION REQUIREMENT AT EACH TANK
(1950 - 1977 RECORDS)

Unit: MCM

Scheme	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
A. Existing Area (48,300 ha)													
1. System G	12	11	18	19	27	23	18	26	25	16	8	7	210
2. Ciritale	8	11	5	1	9	15	15	12	1	3	4	5	89
3. Minneriya	26	33	16	4	28	46	46	38	4	10	12	14	277
4. Kaudulla	15	19	9	3	17	27	27	22	2	6	7	8	162
5. Kantalai	29	40	34	16	42	60	60	49	26	17	13	16	402
6. Parakrama Samudra	26	33	16	4	32	49	49	40	5	9	12	14	289
Total	116	147	98	47	155	220	215	187	63	61	56	64	1,429
B. All Project Area (Area 62,200 ha)													
1. System G	12	11	18	19	27	23	18	26	25	16	8	7	210
2. Ciritale	8	11	5	1	9	15	15	12	1	3	4	5	89
3. Minneriya	26	33	16	4	28	46	46	38	4	10	12	14	277
4. Kaudulla	40	51	25	9	43	71	66	57	8	13	18	22	423
5. Kantalai	36	49	39	19	50	72	70	58	27	20	17	20	477
6. Parakrama Samudra	32	40	19	6	38	59	55	47	9	10	13	17	345
Total	154	195	122	58	195	286	270	238	74	72	72	85	1,821

Table 4.10 EXISTING GENERATION CAPACITY - 1987
(CEB POWER SYSTEM)

	Capacity (MW)		Mean Annual Energy (GWh)		
	Units (No.x Cap)	Total Installed	Firm	Secondary	Total
1. HYDROPOWER*					
Kehelgamu - Maskeli Complex					
Old Laxapana I	3 x 8.33	25	253	42	295
Old Laxapana II	2 x 12.5	25			
New LAxapana	2 x 50	100	439	80	519
Wimalasurendra	2 x 25	50	84	36	120
Samanala	2 x 37.5	75	384	75	459
Canyon I	1 x 30	30	144	35	179
Sub-total:		305	1,304	268	1,572
Mahaweli Complex					
Ukuwela	2 x 19	38	164	-	164
Bowatenne	1 x 40	40	49	15	64
Victoria	3 x 70	210	447	439	886
Kotmale	3 x 67	201	270	232	502
Randenigala	2 x 61	122	304	190	494
Sub-total:		611	1,234	876	2,110
Total Hydropower		916	2,538	1,144	3,682
2. THERMAL POWER					
Kelanitissa Gas turbine	6 x 20	120	725 /1	-	725
Sapugaskanda Diesel	4 x 20	80	540 /2	-	540
Total Thermal		200	1,265	0	1,265
Total System		1,116	3,803	1,144	4,947

/1 Plant factor = 0.69
/2 Plant factor = 0.77

* Inginiyagala Udawalawe and Nilambe plants are not inclued.

Table 4.11 PEAK POWER DEMAND AND ENERGY CONSUMPTION, LOSSES AND GENERATION

Year	Energy (GWh)									Peak Power Demand (MW)	Load Factor (%)
	Domestic and Religious	Small & Medium Industries	Heavy Industries	Commercial and Hotels	Local Authorities	Street Lighting	Total Consumption	Losses	Total Generation		
1961	40	86	-	56	76	-	258	50	308	-	-
1962	41	106	-	57	78	-	282	62	344	69	56.9
1963	42	127	-	57	83	-	309	63	372	74	57.4
1964	44	137	-	60	92	-	333	168	401	83	55.2
1965	46	148	-	65	101	-	360	68	428	89	54.9
1966	48	185	-	72	119	-	424	69	493	105	53.6
1967	57	195	36	75	132	-	489	92	591	122	54.4
1968	55	212	60	81	148	-	556	91	647	135	54.7
1969	59	229	73	82	161	-	604	106	710	147	55.1
1970	63	245	98	88	178	-	662	125	786	163	55.0
1971	65	209	165	93	181	11	722	127	849	173	56.0
1972	73	221	215	97	183	12	810	134	944	200	53.9
1973	82	273	194	108	198	12	866	114	980	199	56.2
1974	83	257	220	118	202	13	892	119	1,011	215	53.7
1975	85	255	268	123	222	13	965	114	1,079	219	56.2
1976	95	255	261	140	237	14	999	134	1,133	240	53.9
1977	107	257	262	148	253	14	1,041	176	1,217	261	53.2
1978	119	292	300	159	276	15	1,161	224	1,385	291	54.3
1979	153	304	328	201	296	16	1,298	228	1,526	329	52.9
1980	191	306	320	223	336	17	1,392	276	1,668	369	51.6
1981	217	331	347	220	381	9	1,503	360	1,872	413	51.8
1982	258	365	374	235	418	9	1,686	380	2,066	431	54.7
1983	305	367	383	244	433	10	1,792	322	2,114	437	55.2
1984	309	404	387	308	458	11	1,877	374	2,251	487	52.7
1985	346	446	404	350	502	12	2,060	404	2,464	515	54.6
1986	369	480	445	381	543	13	2,231	421	2,652	540	56.1

Table 4.12 WATER DEMAND FOR IRRIGATION AT MORAGAHAKANDA DAM

* Reservoir and tank operation for Moragahakanda Irrigation Project
* Release for Irrigation in Million Cubic Meters

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	141.1	135.7	92.9	142.5	76.6	149.6	170.8	150.4	110.5	149.5	72.5	52.2	1452.2	121.0
1951	106.4	123.2	141.7	71.9	92.8	149.6	182.8	147.4	51.6	146.5	86.9	132.2	1432.8	119.4
1952	39.1	122.9	144.8	76.5	106.2	144.7	182.0	155.5	116.0	146.3	138.1	136.9	1508.9	125.7
1953	133.2	123.5	43.7	50.1	35.2	31.9	52.7	53.3	33.6	138.8	129.7	129.2	955.1	79.6
1954	103.4	126.7	50.2	23.6	166.5	161.6	175.6	151.2	153.9	123.6	149.8	102.1	1488.1	124.0
1955	54.9	96.5	81.8	13.3	100.6	102.6	184.6	118.5	41.3	139.4	145.0	192.1	1270.5	105.9
1956	156.1	152.2	147.7	107.4	43.0	56.0	59.7	64.3	65.6	88.0	123.1	132.5	1195.7	99.6
1957	141.8	106.7	149.4	75.3	40.0	91.0	92.9	77.3	47.6	130.1	36.5	0.0	988.7	82.4
1958	87.7	125.1	38.0	49.0	110.6	130.6	180.4	96.0	84.0	133.0	139.3	137.6	1311.2	109.3
1959	146.4	152.5	151.0	142.9	150.5	135.8	164.8	141.6	76.6	105.0	42.4	129.4	1538.9	128.2
1960	80.0	0.0	70.0	4.0	40.7	104.9	90.0	113.8	43.7	70.1	0.0	103.2	720.3	60.0
1961	5.3	60.0	9.9	31.6	137.6	145.3	188.4	151.5	157.5	59.6	64.0	56.5	1067.2	88.9
1962	86.2	131.2	112.4	67.6	125.4	144.5	186.2	150.5	79.5	122.4	135.4	137.3	1478.4	123.2
1963	18.7	47.5	16.6	5.0	124.0	159.9	186.6	153.5	77.4	134.5	2.9	30.3	956.8	79.7
1964	114.1	119.0	39.1	77.3	128.9	165.6	139.0	149.1	109.4	99.4	169.9	143.7	1454.5	121.2
1965	155.5	110.8	142.9	128.5	32.2	145.0	180.9	129.2	82.4	25.0	13.7	36.5	1182.4	98.5
1966	75.1	132.6	80.2	46.6	165.5	166.6	196.8	151.2	55.2	7.2	4.5	129.9	1211.2	100.9
1967	144.5	123.2	142.1	137.5	164.5	163.6	150.5	150.6	110.3	67.5	2.4	42.5	1399.1	116.6
1968	119.5	139.5	88.7	93.4	171.5	165.6	185.7	154.5	98.4	102.0	99.1	138.8	1556.5	129.7
1969	140.7	127.9	149.4	102.0	160.5	161.6	181.5	107.9	54.0	18.0	98.6	1.7	1303.6	108.6
1970	111.9	23.2	62.6	18.0	88.3	114.0	184.2	150.7	92.9	149.1	102.1	127.8	1224.7	102.1
1971	99.3	123.2	124.3	40.5	82.1	129.2	163.9	133.5	90.5	148.1	143.2	70.6	1348.5	112.4
1972	145.9	134.1	148.3	136.5	104.5	149.8	184.7	151.5	51.3	48.7	16.7	108.9	1380.8	115.1
1973	148.0	153.3	166.9	160.1	158.4	115.3	35.5	85.3	33.7	35.3	105.9	123.7	1321.4	110.1
1974	148.0	159.4	72.5	61.7	63.2	77.0	81.7	101.3	113.6	90.0	42.3	97.2	1108.0	92.3
1975	76.0	42.9	48.6	39.0	41.1	77.0	73.7	99.3	95.6	113.0	126.7	132.7	965.7	80.5
1976	141.8	133.8	149.0	110.7	39.7	19.0	37.4	57.3	59.6	146.2	120.9	124.9	1148.3	95.7
1977	147.9	152.5	147.7	144.5	143.2	139.8	144.1	140.9	116.3	9.6	12.5	0.0	1306.9	108.9
TOTAL	3068.6	3179.0	2812.2	2164.8	2892.8	3497.0	4044.9	3494.7	2301.8	2746.0	2324.1	2750.3	35276.3	2939.7
MEAN	109.6	113.5	100.4	77.3	103.3	124.9	144.5	124.8	82.2	98.1	83.0	98.2	1259.9	105.0

Table 4.13 IRRIGATION WATER DEFICIT WITHOUT DAM CONDITION
(EXISTING IRRIGATION AREA: 48,300 ha)

Unit: MCM

YEAR	YALA SEASON			MAHA SEASON		
	IR*	Deficit	% of Deficit	IR	Deficit	% of Deficit
1950	935	120	13	560	-	-
1951	864	56	7	519	-	-
1952	897	34	4	641	-	-
1953	826	301	37	433	-	-
1954	906	55	6	498	-	-
1955	792	-	-	753	-	-
1956	934	440	47	492	-	-
1957	947	124	13	404	-	-
1958	901	-	-	673	-	-
1959	905	85	9	340	-	-
1960	789	-	-	459	-	-
1961	964	72	7	453	-	-
1962	903	7	1	441	3	1
1963	885	41	5	443	-	-
1964	913	73	8	641	11	2
1965	788	-	-	399	-	-
1966	882	67	8	547	-	-
1967	968	80	8	435	-	-
1968	941	124	13	617	-	-
1969	856	44	5	414	-	-
1970	867	-	-	547	-	-
1971	856	-	-	710	-	-
1972	872	158	18	565	-	-
1973	827	222	27	661	48	7
1974	874	285	33	718	73	10
1975	857	248	29	678	7	1
1976	888	425	48	578	-	-
1977	905	84	9			
Total	24,742	3,145		14,619	142	
Average	884	112	13	522	5	1

Note: *IR; Irrigation Requirements

Table 4.14 IRRIGATION WATER DEFICIT WITH DAM CONDITION
(IRRIGATION AREA: 62,200 HA,
IRRIGATION PURPOSE ONLY)
(WITHOUT KOTMALE RESERVOIR CASE)

Unit: MCM

YEAR	YALA SEASON			MAHA SEASON		
	IR*	Deficit	% of Deficit	IR	Deficit	% of Deficit
1950	1,184	-		725	-	-
1951	1,096	-		669	-	-
1952	1,131	-		826	-	-
1953	984	264	27	561	-	-
1954	1,199	-		647	-	-
1955	991	-		959	-	-
1956	1,208	444	37	637	-	-
1957	1,208	331	27	525	-	-
1958	1,143	-		868	-	-
1959	1,163	-		436	-	-
1960	1,008	-		586	-	-
1961	1,195	-		593	-	-
1962	1,149	-		568	-	-
1963	1,122	-		575	-	-
1964	1,159	-		850	-	-
1965	995	-		519	-	-
1966	1,124	-		709	-	-
1967	1,242	-		579	-	-
1968	1,203	-		802	-	-
1969	1,082	-		546	-	-
1970	1,089	-		702	-	-
1971	1,085	-		910	-	-
1972	1,109	-		726	-	-
1973	1,036	39	4	868	48	6
1974	1,112	485	44	915	220	24
1975	1,054	396	38	874	1	-
1976	1,133	511	45	733	-	-
1977	1,150	6	1		-	-
Total	31,354	2,476	223	18,908	269	
Average	1,120	88	8	700	10	1

Note: *IR; Irrigation Requirements

Table 4.15 COMPARATIVE STUDY OF PROJECT DEVELOMENT SCALE

Item	Case 1-1	Case 1-2	Case 2-1	Case 2-2	Case 3-1	Case 3-2
1. Reservoir						
H.W.L. (EL.-m)	180.0	188.0	195.0	195.0	200.0	200.0
L.W.L. (EL.-m)	154.0	154.0	170.0	170.0	175.0	175.0
Operation W.L. (EL.-m)	154.0	154.0	174.4	174.4	182.8	182.8
Net storage capacity (MCM)	606	606	686	686	686	802
2. Dam						
Crest EL. (m)						
Main & 2nd saddle dam	192.2	199.0	199.0	199.0	204.0	204.0
1st saddle dam	190.7	190.7	197.5	197.5	202.5	202.5
Crest length (m)						
Main & 2nd saddle dam	950.0	950.0	980.0	980.0	1,020.0	1,020.0
1st saddle dam	371.0	371.0	396.0	396.0	421.0	421.0
3. Power Generation						
Installed capacity (MW)	-	23.0	26.0	42.0	28.0	69.0
Dependable peak power (MW)	-	0.0	16.1	22.8	16.5	40.2
Firm energy (GWh)	-	0.0	66.4	66.4	91.6	91.6
Secondary energy (GWh)	-	104.4	78.9	78.9	85.1	85.1
Annual energy (GWh)	-	104.4	145.3	145.3	176.7	176.7
4. Construction cost (US$ million)	117.1	147.6	163.6	186.8	184.1	219.2
5. Economic Evaluation (US$ million) in discount rate of 10%						
Economic incremental cost	-	27.1	40.8	60.8	59.3	88.6
Economic incremental benefit	-	30.8	81.9	88.1	92.1	114.0
Net incremental benefit	-	3.1	41.1	27.3	33.8	25.4
Benefit-Cost Ratio	-	1.14	2.00	1.45	1.58	1.29

Table 4.16 SUMMARY OF SYSTEM-WISE INFRASTRUCTURE DEVELOPMENT

	Moragahakanda Project Office	System D1	System D2	System A/D	Total
A. Town (Project) Center	-	1	-	-	1
B. Area (Block) Center	-	3	1	1	5
C. Village (Unit +) Center	-	4	2	2	8
D. Hamlet (Unit) Center	-	22	5	6	33
E. Infrastructure					
1. Schools					
Primary Schools	-	30	8	9	47
Junior Secondary Schools	-	4	1	1	6
Senior Secondary Schools	-	2	-	1	3
Teachers Quarters	-	99	22	30	151
Dormitories	-	40	10	13	63
2. Health Units					
Peripheral Unit	-	1	-	-	1
Central Dispensary with Quarters	-	2	-	1	3
Midwifery Clinic cum Quarters	-	7	3	3	13
Dispensary cum Quarters	-	7	3	3	13
Medical Staff and Nurse Quarters	-	22	-	-	22
3. Service Facilities					
Police Station	-	1	-	1	1
Police Staff Quarters	-	2	-	-	2
Constable Dormitories	-	4	-	-	4
Gramasevaka Office/Quarters	-	4	2	2	8
Post Office and Tele. Comm. Complex	-	2	-	-	2
Sub-Post Office cum Quarters	-	4	2	2	8
Townhall and Office	-	1	-	-	1
Milling - Storage Complex	-	2	-	-	2
Village Hullers	-	2	1	1	4
4. Management and Operational Facilities					
Project Office	-	1	-	-	1
Development Centre	-	1	-	-	1
Trainign Center	-	1	-	-	1
Cricuit Bungalow	-	1	-	-	1
Workshop & Warehouse	-	1	-	-	1
Stores - World Food	-	6	2	2	10
Stores	-	26	7	8	41
Fertilizer Store	-	1	-	-	1
Block Offices	-	3	1	1	5
Unit Office/Service Center	-	26	7	8	41
Staff Quarters	-	158	37	40	235
Dormitories	-	8	2	2	12
Wells	-	156	42	48	246
5. Moragahakanda Dam Project Office					
Project Office	1	-	-	-	1
Staff Quarters	50	-	-	-	50
Circuit Bungalow	1	-	-	-	1
Store	2	-	-	-	2
Workshop/Warehouse	1	-	-	-	1

Table 6.1 SUMMARY OF INVESTMENT COSTS FOR THE PROJECT

(Unit: Million)

Decription	F. Currency US$	L. Currency Rs.	Total Eq. US$
A. Moragahakanda Dam and Power Station			
1. General items	3.1	83.1	5.8
2. Diversion works	2.7	27.6	3.6
3. Main dam	17.6	225.6	25.0
4. First dam	36.8	210.2	43.6
5. Spillway & stilling basin	3.8	35.8	5.0
6. Power intake	0.2	2.8	0.3
7. Second saddle dam	4.9	64.5	7.0
8. Powerhouse and switch yard	3.9	29.5	4.9
9. Hydro-mechanical works	6.4	21.7	7.1
10. Generating equipment	15.2	24.4	16.0
11. Transmission line	0.9	6.8	1.1
Sub-total (A)	95.5	732.0	119.5
B. Irrigation System			
1. General itesm	0.8	20.4	1.5
2. Rehabilitation			
- Earthworks	0.9	14.6	1.3
- Canal lining	1.7	29.5	2.7
- Related structures	0.7	9.0	1.0
- Existing downstream	8.8	185.9	14.9
3. New reclamation area			
- Earthworks	7.4	81.4	10.0
- Related structures	4.4	44.7	5.9
- Drainage canals	8.1	55.4	9.8
- Downstream development	22.2	169.6	27.8
Sub-total (B)	55.0	610.5	75.0
C. Social Infrastructure (Settlement)	12.0	244.0	20.0
D. Land Acquisition and Compensation Cost	0.0	61.0	2.0
E. Government's Administration Cost	0.0	336.0	11.0
F. Engineering Services	15.0	92.0	18.0
Sub-total (A-F)	177.5	2,075.5	245.5
G. Physical Contingency	27.0	311.3	36.8
H. Price Contingency	0.0	834.6	27.3
I. Grand Totall	204.5	3,221.4	310
			(J. Yen 43.4 Billion)

Note: US$1.0 = Rs. 30.50 = J. Yen 140.0

Table 6.2 (1/4) ANNUAL DISBURSEMENT SCHEDULE (DAM)

Unit : FC;Million US$
LC; Million Rs.

Items	1 st year 1989		2 nd year 1990		3 rd year 1991		4 th year 1992		5 th year 1993		6 th year 1994		7 th year 1995		Total	
	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C
1.Direct Cost																
(1)Annual allocation F.C.	0.00		22.80		15.20		15.20		15.20		7.60				76.00	
Annual allocation L.C.		0.0		201.3		134.2		134.2		134.2		67.1				671.0
(2)Physical contl.,F.C.	0.00		3.42		2.28		2.28		2.28		1.14		0.00		11.40	
Physical contl.,L.C.		0.0		30.2		20.1		20.1		20.1		10.1		0.0		100.7
sub total (1)+(2)	0.00	0.0	26.22	231.5	17.48	154.3	17.48	154.3	17.48	154.3	8.74	77.2	0.00	0.0	87.40	771.7
(3)Price escalation F.C.	0.00		26.22		17.48		17.48		17.48		8.74		0.00		87.40	
Price escalation L.C.		0.0		270.0		194.4		210.0		226.8		122.5		0.0		1023.6
Total	0.00	0.0	26.22	270.0	17.48	194.4	17.48	210.0	17.48	226.8	8.74	122.5	0.00	0.0	87.40	1023.6
2.Land acquisition L.C.																
(1)Annual allocation		61.0		0.0		0.0		0.0		0.0		0.0		0.0		61.0
(2)Physical contl.		9.2		0.0		0.0		0.0		0.0		0.0		0.0		9.2
sub total (1)+(2)		70.2		0.0		0.0		0.0		0.0		0.0		0.0		70.2
(3)Price escalation		75.8		0.0		0.0		0.0		0.0		0.0		0.0		75.8
Total		75.8		0.0		0.0		0.0		0.0		0.0		0.0		75.8
3.Gov. admint.cost																
(1)Annual allocation		13.0		50.0		40.0		20.0		20.0		20.0		20.0		183.0
(2)Physical contl.		2.0		7.5		6.0		3.0		3.0		3.0		3.0		27.5
sub total (1)+(2)		15.0		57.5		46.0		23.0		23.0		23.0		23.0		210.5
(3)Price escalation		16.1		67.1		57.9		31.3		33.8		36.6		39.4		282.2
Total		16.1		67.1		57.9		31.3		33.8		36.5		39.4		282.2
4.E/services cost																
(1)Annual allocation F.C.	2.70		1.40		1.40		1.40		1.40		0.70				9.00	
Annual allocation L.C.		9.3		5.0		5.0		6.0		5.0		1.2				30.5
(2)Physical contl.,F.C.	0.41		0.21		0.21		0.21		0.21		0.11				1.35	
Physical contl.,L.C.		1.4		0.8		0.8		0.8		0.8		0.2				4.6
sub total (1)+(2)	3.11	10.7	1.61	5.8	1.61	5.8	1.61	5.8	1.61	5.8	0.81	1.4			10.35	35.1
(3)Price escalation F.C.	3.11		1.61		1.61		1.61		1.61		0.81		0.00		10.35	
Price escalation L.C.		11.6		6.7		7.2		7.8		8.4		2.2		0.0		44.0
Total	3.11	11.6	1.61	6.7	1.61	7.2	1.61	7.8	1.61	8.4	0.81	2.2	0.00	0.0	10.35	44.0
Annual total	3.11	103.5	27.83	343.8	19.09	259.6	19.09	249.1	19.09	269.0	9.55	161.1	0.00	39.4	97.75	1426.6
Total in US$ F.C.+L.C.	6.50		39.10		27.60		27.26		27.91		14.83		1.29		144.49	

Table 6.2 (2/4) ANNUAL DISBURSEMENT SCHEDULE (POWER)

Unit : FC;Million US$
LC;Million Rs.

Items	1 st year 1989		2 nd year 1990		3 rd year 1991		4 th year 1992		5 th year 1993		6 th year 1994		7 th year 1995		Total	
	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C
1.Direct Cost																
(1)Annual allocation F.C.	0.00		0.00		2.50		2.50		10.00		5.00				20.00	
Annual allocation L.C.		0.0		0.0		15.3		15.3		15.3		15.3				61.0
(2)Physical contl.,F.C.	0.00		0.00		0.38		0.38		1.50		0.75		0.00		3.00	
Physical contl.,L.C.		0.0		0.0		2.3		2.3		2.3		2.3		0.0		9.2
sub total (1)+(2)	0.00	0.0	0.00	0.0	2.88	17.6	2.88	17.6	11.50	17.6	5.75	17.6	0.00	0.0	23.00	70.2
(3)Price escalation F.C.	0.00		0.00		2.88		2.88		11.50		5.75		0.00		23.00	
Price escalation L.C.		0.0		0.0		22.1		23.9		25.8		27.8		0.0		99.5
Total	0.00	0.0	0.00	0.0	2.88	22.1	2.88	23.9	11.50	25.8	5.75	27.8	0.00	0.0	23.00	99.5
2.Land acquisition L.C.																
(1)Annual allocation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(2)Physical contl.		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
sub total (1)+(2)		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(3)Price escalation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
3.Gov. admint.cost																
(1)Annual allocation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(2)Physical contl.		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
sub total (1)+(2)		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(3)Price escalation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
4.E/services cost																
(1)Annual allocation F.C.	0.00		0.00		0.00		0.00		0.00						0.00	
Annual allocation L.C.		0.0		0.0		0.0		0.0		0.0						0.0
(2)Physical contl.,F.C.	0.00		0.00		0.00		0.00		0.00						0.00	
Physical contl.,L.C.		0.0		0.0		0.0		0.0		0.0						0.0
sub total (1)+(2)	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0					0.00	0.0
(3)Price escalation F.C.	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
Price escalation L.C.		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0					0.00	0.0
Annual total	0.00	0.0	0.00	0.0	2.88	22.1	2.88	23.9	11.50	25.8	5.75	27.8	0.00	0.0	23.00	99.5
Total in US$ F.C.+L.C.	0.00		0.00		3.60		3.66		12.34		6.66		0.00		26.26	

Table 6.2 (3/4) ANNUAL DISBURSEMENT SCHEDULE (IRRIGATION)

Unit : FC;Million US$
LC;Million Rs.

Items	1 st year 1989		2 nd year 1990		3 rd year 1991		4 th year 1992		5 th year 1993		6 th year 1994		7 th year 1995		Total	
	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C
1.Direct Cost																
(1)Annual allocation F.C.	0.00		11.50		13.40		13.40		13.40		11.00		4.30		67.00	
Annual allocation L.C.		0.0		137.4		170.8		170.8		170.8		144.8		59.4		854.0
(2)Physical contl.,F.C.	0.00		1.73		2.01		2.01		2.01		1.65		0.65		10.05	
Physical contl.,L.C.		0.0		20.6		25.6		25.6		25.6		21.7		8.9		128.1
sub total (1)+(2)	0.00	0.0	13.23	158.0	15.41	196.4	15.41	196.4	15.41	196.4	12.65	166.5	4.95	68.3	77.05	982.1
(3)Price escalation F.C.	0.00		13.23		15.41		15.41		15.41		12.65		4.95		77.05	
Price escalation L.C.		0.0		184.3		247.4		287.2		288.6		264.2		117.1		1388.9
Total	0.00	0.0	13.23	184.3	15.41	247.4	15.41	287.2	15.41	288.6	12.65	264.2	4.95	117.1	77.05	1388.9
2.Land acquisition L.C.																
(1)Annual allocation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(2)Physical contl.		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
sub total (1)+(2)		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
(3)Price escalation		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
3.Gov. admin.cost																
(1)Annual allocation		11.0		40.0		30.0		18.0		18.0		18.0		18.0		153.0
(2)Physical contl.		1.7		6.0		4.5		2.7		2.7		2.7		2.7		23.0
sub total (1)+(2)		12.7		46.0		34.5		20.7		20.7		20.7		20.7		176.0
(3)Price escalation		13.7		53.7		43.5		28.2		30.4		32.8		35.5		237.7
Total		13.7		53.7		43.5		28.2		30.4		32.8		35.5		237.7
4.E/services cost																
(1)Annual allocation F.C.	1.80		0.80		0.80		0.80		0.80		0.60		0.40		6.00	
Annual allocation L.C.		12.4		8.5		8.5		8.5		8.5		8.5		6.1		61.0
(2)Physical contl.,F.C.	0.27		0.12		0.12		0.12		0.12		0.09		0.08		0.90	
Physical contl.,L.C.		1.9		1.3		1.3		1.3		1.3		1.3		0.9		9.2
sub total (1)+(2)	2.07	14.3	0.92	9.8	0.92	9.8	0.92	9.8	0.92	9.8	0.69	9.8	0.48	7.0	6.90	70.2
(3)Price escalation F.C.	2.07		0.92		0.92		0.92		0.92		0.69		0.48		6.90	
Price escalation L.C.		15.4		11.4		12.3		13.3		14.4		15.5		12.0		94.3
Total	2.07	15.4	0.92	11.4	0.92	12.3	0.92	13.3	0.92	14.4	0.69	15.5	0.48	12.0	6.90	94.3
Annual total	2.07	29.1	14.15	249.4	16.33	303.2	16.33	308.7	16.33	333.4	13.34	312.6	5.41	164.6	83.95	1700.9
Total in US$ F.C.+L.C.	3.02		22.32		26.27		26.45		27.26		23.59		10.80		139.72	

Table 6.2 (4/4) ANNUAL DISBURSEMENT SCHEDULE (TOTAL)

Unit : FC;Million US$
LC;Million Rs.

Items	1 st year 1989		2 nd year 1990		3 rd year 1991		4 th year 1992		5 th year 1993		6 th year 1994		7 th year 1995		Total	
	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C
1.Direct Cost																
(1)Annual allocation F.C.	0.00		34.30		31.10		31.10		38.60		23.60		4.30		163.00	
Annual allocation L.C.		0.0		201.3		320.3		320.3		320.3		227.2		59.4		1535.0
Physical contl.,F.C.	0.00	0.0	5.15	0.0	4.67	0.0	4.67	0.0	5.79	0.0	3.54	0.0	0.65	0.0	24.45	0.0
Physical contl.,L.C.	0.00	0.0	0.00	50.8	0.00	48.0	0.00	48.0	0.00	48.0	0.00	34.1	0.00	8.9	0.00	237.9
sub total (1)+(2)	0.00	0.0	39.45	389.5	35.77	368.3	35.77	368.3	44.39	368.3	27.14	261.2	4.95	68.3	187.45	1823.9
(3)Price escalation F.C.	0.00	0.0	39.45	0.0	35.77	0.0	35.77	0.0	44.39	0.0	27.14	0.0	4.95	0.0	187.45	0.0
Price escalation L.C.	0.00	0.0	0.00	454.3	0.00	463.9	0.00	501.1	0.00	541.1	0.00	414.5	0.00	117.1	0.00	2492.0
Total	0.00	0.0	39.45	454.3	35.77	463.9	35.77	501.1	44.39	541.1	27.14	414.5	4.95	117.1	187.45	2492.0
2.Land acquisition L.C.																
(1)Annual allocation	0.00	61.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	61.0
(2)Physical contl.	0.00	9.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	9.2
sub total (1)+(2)	0.00	70.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	70.2
(3)Price escalation	0.00	75.8	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	75.8
Total	0.00	75.8	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	75.8
3.Gov. admin.cost																
(1)Annual allocation	0.00	24.0	0.00	90.0	0.00	70.0	0.00	38.0	0.00	38.0	0.00	38.0	0.00	38.0	0.00	336.0
(2)Physical contl.	0.00	3.6	0.00	13.5	0.00	10.5	0.00	5.7	0.00	5.7	0.00	5.7	0.00	6.7	0.00	50.4
sub total (1)+(2)	0.00	27.6	0.00	103.5	0.00	80.5	0.00	43.7	0.00	43.7	0.00	43.7	0.00	43.7	0.00	386.4
(3)Price escalation	0.00	29.8	0.00	120.7	0.00	101.4	0.00	59.5	0.00	64.2	0.00	69.3	0.00	74.9	0.00	519.8
Total	0.00	29.8	0.00	120.7	0.00	101.4	0.00	59.5	0.00	64.2	0.00	69.3	0.00	74.9	0.00	519.8
4.E/services cost																
(1)Annual allocation F.C.	4.50	0.0	2.20	0.0	2.20	0.0	2.20	0.0	2.20	0.0	1.30	0.0	0.40	0.0	15.00	0.0
Annual allocation L.C.	0.00	21.7	0.00	13.5	0.00	13.5	0.00	13.5	0.00	13.5	0.00	9.7	0.00	6.1	0.00	91.5
(2)Physical contl.,F.C.	0.68	0.0	0.33	0.0	0.33	0.0	0.33	0.0	0.33	0.0	0.20	0.0	0.06	0.0	2.25	0.0
Physical contl.,L.C.	0.00	3.3	0.00	2.0	0.00	2.0	0.00	2.0	0.00	2.0	0.00	1.5	0.00	0.9	0.00	13.7
sub total (1)+(2)	5.18	25.0	2.53	15.5	2.53	15.5	2.53	15.5	2.53	15.5	1.50	11.2	0.46	7.0	17.25	105.2
(3)Price escalation F.C.	5.18	0.0	2.53	0.0	2.53	0.0	2.53	0.0	2.53	0.0	1.50	0.0	0.46	0.0	17.25	0.0
Price escalation L.C.	0.00	27.0	0.00	18.1	0.00	19.6	0.00	21.1	0.00	22.8	0.00	17.7	0.00	12.0	0.00	138.3
Total	5.18	27.0	2.53	18.1	2.53	19.6	2.53	21.1	2.53	22.8	1.50	17.7	0.46	12.0	17.25	138.3
Annual total	5.18	132.5	41.98	593.1	38.30	584.9	38.30	581.6	46.92	628.2	28.64	501.6	5.41	204.0	204.70	3225.9
Total in US$ F.C.+L.C.	9.52	0.0	61.42	0.0	57.47	0.0	57.36	0.0	67.52	0.0	45.08	0.0	12.09	0.0	310.47	0.0

Table 6.3 REPLACEMENT COST

(Unit: million US$)

Item	Durable Period (Year)	Direct Cost			Other Cost			Total		
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
Financial Cost										
1. Dam & Hydropower										
Hydromechanical	30	6,129	681	6,810	1,483	635	2,118	7,612	1,316	8,928
Generat. Equipment	30	14,400	1,600	16,000	3,485	1,491	4,976	17,885	3,091	20,976
Transmission	25	896	224	1,120	227	121	348	1,123	345	1,468
2. Irrigation										
Gate	25	1,232	308	1,540	312	167	479	1,544	475	2,019
O/M Equipment	10	6,750	750	7,500	1,634	699	2,333	8,384	1,449	9,833
Economic Cost										
1. Dam & Hydropower										
Hydromechanical	30	6,129	569	6,698	1,474	609	2,083	7,603	1,178	8,781
Generat. Equipment	30	14,400	1,336	15,736	3,463	1,431	4,894	17,863	2,767	20,630
Transmission	25	896	187	1,083	224	113	337	1,120	300	1,420
2. Irrigation										
Gate	25	1,232	257	1,489	308	155	463	1,540	412	1,952
O/M Equipment	10	6,750	626	7,376	1,623	671	2,294	8,373	1,297	9,670

Table 6.4 O&M EQUIPMENT

Item	Quantity				Unit Price	Amount
	Dam O&M Office	System D RPM Office	Existing ID Office	Total	(1,000 US$)	(1,000 US$)
1. Dragline, 0.6 m3	-	1	-	1	180.0	180
2. Backhoe, 0.6 m3	1	2	2	5	130.0	650
3. Backhoe, 0.3 m3	-	2	2	4	65.0	260
4. Bulldozer, 21 t	-	2	2	4	217.0	868
5. Bulldozer, 11 t	1	2	2	5	101.0	505
6. Dozer shoel, 1.4 m3	-	2	2	4	46.0	184
7. Wheel loader, 1.0 m3	1	2	2	5	57.0	285
8. Motor grader, 3.0 m	1	3	2	6	98.0	588
9. Fuel bowser, 5 kl	-	2	2	4	61.0	244
10. Water bowser, 5 kl	-	6	4	10	61.0	610
11. Vibration roller, 5 t	-	1	1	2	49.0	98
12. Vibration roller, 1 t	-	2	2	4	13.0	52
13. Tamper, 80 kg	-	5	5	10	1.8	18
14. Plate compactor, 90 kg	-	5	5	10	1.7	17
15. Portable concrete mixer, 0.2 m3	1	2	2	5	2.0	10
16. Concrete vibrator, 0 45 mm	2	4	4	10	0.7	7
17. Submersible pump, 0 150 mm	2	5	5	12	1.5	18
18. Generator, 2 kVA	-	5	5	10	2.5	25
19. Generator, 50 kVA	-	1	-	1	22.0	22
20. Trailer truck, 30 t	-	1	1	2	92.0	184
21. Dump truck, 11 t	1	-	-	1	60.0	60
22. Dump truck, 2 t	-	6	10	16	14.0	224
23. Cargo truck w/crane, 8 t	-	1	2	3	55.0	165
24. Ordinary truck, 8 t	1	2	2	5	30.0	150
25. Truck, 1 t D/cab, 4 x 4	-	15	10	25	9.0	225
26. Jeep, 4 x 4	8	15	10	33	15.0	495
27. Sedan car, 5 persons	1	3	2	6	12.0	72
28. Microbus, 20 persons	1	1	1	3	25.0	75
29. Motor cycle	1	30	30	61	2.0	122
30. Office equipment	L.S.	L.S.	L.S.	L.S.	20.0	20
31. Tractor equipment Tractor w/plough, tiler etc., 60-80 HP	-	20	-	20	18.0	360
32. Welder w/engine	-	4	-	4	3.0	12
33. Spare parts	L.S.	L.S.	L.S.	L.S.	L.S.	695
Total						7,500

Table 7.1 ANNUAL DISBURSEMENT OF CAPITAL COST

(Unit: million US$)

Item	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	Total
Financial Cost								
A) Dam	0.00	33.81	22.54	22.54	22.54	11.27	0.00	112.70
B) Power	0.00	0.00	3.45	3.45	12.08	6.33	0.00	25.30
C) Irrigation	0.00	16.11	17.25	17.25	17.25	13.51	4.89	86.25
D) Settlement	0.00	2.30	4.60	4.60	4.60	4.60	2.30	23.00
E) Compensation	2.30	0.00	0.00	0.00	0.00	0.00	0.00	2.30
F) Government	0.91	3.39	2.64	1.43	1.43	1.43	1.43	12.67
G) Engineering	5.99	3.04	3.04	3.04	3.04	1.86	0.69	20.70
H) Price Conti.	0.32	2.77	3.95	5.05	6.58	6.08	2.79	27.55
Total	9.52	61.42	57.47	57.37	67.52	45.08	12.09	310.47
Economic Cost								
A) Dam	0.00	13.52	27.04	27.04	27.04	13.52	0.00	108.15
B) Power	0.00	0.00	3.36	3.36	11.98	6.23	0.00	24.92
C) Irrigation	0.00	15.08	16.15	16.15	16.15	12.64	4.57	80.73
D) Settlement	0.00	1.04	2.08	2.08	2.08	2.08	1.04	10.40
E) Compensation	1.96	0.00	0.00	0.00	0.00	0.00	0.00	1.96
F) Government	0.77	2.88	2.24	1.22	1.22	1.22	1.22	10.77
G) engineering	5.87	2.96	2.96	2.96	2.96	1.81	0.66	20.18
H) Price conti.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	8.59	35.49	53.82	52.80	61.42	37.49	7.48	257.10

Note:Each item includes physical contingency.

Table 7.2 ECONOMIC COST AND BENEFIT STREAM

(Unit: million US$)

	Cost				Benefit			Benefit
	Construc-tion	Replace-ment	O&M	Total	Irriga-tion	Power	Total	- Cost
1. 1989	8.60	0.00	0.00	8.60	0.00	0.00	0.00	-8.60
2. 1990	35.48	0.00	0.00	35.48	0.00	0.00	0.00	-35.48
3. 1991	53.83	0.00	0.11	53.94	1.01	0.00	1.01	-52.93
4. 1992	52.81	0.00	0.35	53.16	4.16	0.00	4.16	-49.00
5. 1993	61.40	0.00	0.65	62.05	8.91	0.00	8.91	-53.14
6. 1994	37.50	0.00	1.09	38.59	14.59	4.16	18.75	-19.84
7. 1995	7.49	0.00	1.47	8.96	23.86	8.32	32.18	23.22
8. 1996	0.00	0.00	1.66	1.66	28.07	8.32	36.39	34.73
9. 1997	0.00	0.00	1.79	1.79	31.56	8.32	39.88	38.09
10. 1998	0.00	0.00	1.87	1.87	34.11	8.32	42.43	40.56
11. 1999	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
12. 2000	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
13. 2001	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
14. 2002	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
15. 2003	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
16. 2004	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
17. 2005	0.00	8.70	1.90	10.60	35.71	8.32	44.03	33.43
18. 2006	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
19. 2007	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
20. 2008	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
21. 2009	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
22. 2010	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
23. 2011	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
24. 2012	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
25. 2013	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
26. 2014	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
27. 2015	0.00	8.70	1.90	10.60	35.71	8.32	44.03	33.43
28. 2016	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
29. 2017	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
30. 2018	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
31. 2019	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
32. 2020	0.00	3.03	1.90	4.93	35.71	8.32	44.03	39.10
33. 2021	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
34. 2022	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
35. 2023	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
36. 2024	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
37. 2025	0.00	27.28	1.90	29.18	35.71	8.32	44.03	14.85
38. 2026	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
39. 2027	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
40. 2028	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
41. 2029	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
42. 2030	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
43. 2030	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
44. 2030	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
45. 2030	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
46. 2030	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
47. 2035	0.00	8.70	1.90	10.60	35.71	8.32	44.03	33.43
48. 2036	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
49. 2037	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
50. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
51. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
52. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
53. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
54. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
55. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13
56. 2038	0.00	0.00	1.90	1.90	35.71	8.32	44.03	42.13

Table 7.3 NET FARM INCOME AND CAPACITY TO PAY OF TYPICAL FARMERS

	Yield (ton/ha)	Unit Price (Rs/ton)	Gross Income per ha (Rs/ha)	Production Cost per ha (Rs/ha)	Net Farm Income per ha (Rs/ha)	Planted Area (ha)	Net Farm Income (Rs)	Living Expense (Rs)	Capacity to Pay (Rs)
(A) A Typical Existing Farmer									
I. With-Project Condition									
Paddy	6.0	4,400	26,400	13,448	12,952	1.98	25,650		
Onion	15.0	8,300	124,500	42,174	82,326	0.058	4,770		
Chillie	1.9	31,000	58,900	30,758	28,142	0.062	1,740		
Pulses	1.5	14,000	21,000	14,377	6,623	0.04	270		
Vegetables	8.0	4,300	34,400	22,651	11,749	0.06	700		
Total						2.2	33,130	16,920	16,210
II. Without-Project Condition									
Paddy	5.0	4,400	22,000	13,065	8,935	1.98	17,690		
Upland Crops	1.0	14,000	14,000	14,084	-84	0.012	-1		
Total						1.992	17,689	16,920	769
III. Incremental Farm Income							15,441		
(B) A New Settler									
I. With-Project Condition									
Paddy	6.0	4,400	26,400	13,448	12,952	1.80	23,310		
Onion	15.0	8,300	124,500	42,174	82,326	0.053	4,360		
Chillie	1.9	31,000	58,900	30,758	28,142	0.056	1,580		
Pulses	1.5	14,000	21,000	14,377	6,623	0.036	240		
Vegetables	8.0	4,300	34,400	22,651	11,749	0.055	650		
Total						2.0	30,140	16,920	13,220

Remark: Average farm holding size; 1.1 ha for typial existing farmer and 1.0 ha for the new settler.
In without-project case, marjor irrigation systems excluding Kantalai are represented.
60% of average living expenditure in rural area is applied referring to itemized expenditure analysis by income group.
Living expense of Rs.960/month in 1982 is equivarent to Rs.1,410/month in 1988, applying inflation index of 164 during six years.

Table 7.4 CASH FLOW STATEMENT FOR IRRIGATIN

(Unit: million Rs.)

No.	Year	Cash Outflow							Cash Inflow					Government Burden
		Capital Cost		Loan Repayment *1			Replacement cost	Total	Construction Fund		Revenue	Government Subsidy	Total	
		Foreign Currency	Local Currency	Interest	Principal	O&M Cost			Foreign Curency	Local Curency				
1.	1989	119.41	100.62					220.03	119.41	100.62		0.00	220.03	100.62
2.	1990	1,096.46	435.81	3.58				1,535.85	1,096.46	435.81		3.58	1,535.85	439.39
3.	1991	923.47	371.80	60.60		1.42		1,357.29	923.47	371.80	2.50	59.52	1,357.29	431.32
4.	1992	923.47	342.34	83.11		5.85		1,354.77	923.47	342.34	16.40	73.66	1,355.87	416.00
5.	1993	923.47	342.34	77.52		12.54		1,355.87	596.82	244.10	19.00	121.12	981.04	365.22
6.	1994	923.47	342.34	119.59		20.53		2,417.92	140.39	94.58	27.50	143.57	406.05	238.15
7.	1995	596.82	244.10	137.49		33.58		406.05			27.50	143.57	171.07	238.15
8.	1996	140.39	94.58	141.70		39.51		602.30			27.50	153.71	181.21	153.71
9.	1997			141.70		44.42		375.83			27.50	158.62	186.12	158.62
10.	1998			141.70		48.01		387.64			27.50	162.21	189.71	162.21
11.	1999			141.70	5.97	50.26		450.51			27.50	170.44	197.94	170.44
12.	2000			141.53	60.79	50.26		549.51			27.50	225.08	252.58	225.08
13.	2001			139.70	106.97	50.26		636.82			27.50	269.43	296.93	269.43
14.	2002			136.49	153.14	50.26		721.36			27.50	312.39	339.89	312.39
15.	2003			131.90	199.31	50.26		786.81			27.50	353.97	381.47	353.97
16.	2004			125.92	229.16	50.26		405.33			27.50	377.83	405.33	377.83
17.	2005			119.04	236.17	50.26	269.92	1,073.78			27.50	647.89	675.39	647.89
18.	2006			111.96	236.17	50.26		789.69			27.50	370.89	398.39	370.89
19.	2007			104.87	236.17	50.26		391.31			27.50	363.81	391.31	363.81
20.	2008			97.79	236.17	50.26		761.35			27.50	356.72	384.22	356.72
21.	2009			90.70	236.17	50.26		377.14			27.50	349.64	377.14	349.64
22.	2010			83.62	236.17	50.26		733.01			27.50	342.55	370.05	342.55
23.	2011			76.53	236.17	50.26		362.97			27.50	335.47	362.97	335.47
24.	2012			69.45	236.17	50.26		704.67			27.50	328.38	355.88	328.38
25.	2013			62.36	236.17	50.26		348.80			27.50	321.30	348.80	321.30
26.	2014			55.28	236.17	50.26		946.25			27.50	314.21	341.71	314.21
27.	2015			48.19	236.17	50.26	269.92	932.08			27.50	577.04	604.54	577.04
28.	2016			41.11	236.17	50.26		647.99			27.50	300.04	327.54	300.04
29.	2017			34.02	236.17	50.26		320.46			27.50	292.96	320.46	292.96
30.	2018			26.94	236.17	50.26		613.68			27.50	285.87	313.37	285.87
31.	2019			19.85	230.20	50.26		300.32			27.50	272.82	300.32	272.82
32.	2020			12.95	175.38	50.26	55.42	481.16			27.50	266.51	294.01	266.51
33.	2021			7.68	129.21	50.26		324.25			27.50	159.65	187.15	159.65
34.	2022			3.81	83.03	50.26		225.54			27.50	109.60	137.10	109.60
35.	2023			1.32	36.86	50.26		145.93			27.50	60.94	88.44	60.95
36.	2024			0.21	7.02	50.26		16,335.89			27.50	29.99	57.49	29.99
	Total	4,723.50	1,931.58	2,791.94	4,723.50	1,512.63	595.25	16,278.39	4,723.50	1,931.58	871.70	8,751.62	16,278.39	10,683.20

Note: *1 Interest: 3.0 %
Grace period: 10 years
Repayment period including grace period: 30 years

Table 7.5 CASH FLOW STATEMENT FOR THE WHOLE PROJECT

(Unit : Rs. Million)

No.	Year	Cash Outflow							Cash Inflow					
		Capital Cost		Loan Repayment *1		O & M	Replacement	Total	Construction Fund		Revenue	Government Subsidy or Revenue *2	Total	Government Burden
		Foreign Currency	Local Currency	Interest	Principal	Cost	Cost		Foreign Currency	Local Currency				
1	1989	157.99	132.50					290.49	157.99	132.50		0.00	290.49	132.50
2	1990	1,280.39	593.10	4.74				1,878.23	1,280.39	593.10		4.74	1,878.23	597.84
3	1991	1,168.15	584.90	73.46		1.78		1,828.28	1,168.15	584.90	2.50	72.73	1,828.28	657.63
4	1992	1,168.15	581.60	113.02		7.32		1,870.09	1,168.15	581.60	8.80	111.54	1,870.09	693.14
5	1993	1,431.06	628.20	109.13		15.68		2,184.07	1,431.06	628.20	16.40	108.41	2,184.07	736.61
6	1994	873.52	501.60	156.17		25.67		1,556.96	873.52	501.60	200.63	-18.78	1,556.96	482.82
7	1995	165.01	204.00	182.38		41.98		593.36	165.01	204.00	390.75	-166.39	593.36	37.61
8	1996			187.33		49.39		236.72			390.75	-154.03	236.72	-154.03
9	1997			187.33		55.53		242.86			390.75	-147.89	242.86	-147.89
10	1998			187.33		60.01		247.34			390.75	-143.41	247.34	-143.41
11	1999			187.33	7.90	62.83		258.06			390.75	-132.69	258.06	-132.69
12	2000			187.09	71.92	62.83		321.84			390.75	-68.91	321.84	-68.91
13	2001			184.93	130.33	62.83		378.09			390.75	-12.66	378.09	-12.66
14	2002			181.02	188.73	62.83		432.59			390.75	41.84	432.59	41.84
15	2003			175.36	260.29	62.83		498.48			390.75	107.73	498.48	107.73
16	2004			167.55	303.96	62.83		534.35			390.75	143.60	534.35	143.60
17	2005			158.43	312.21	62.83	269.92	803.39			390.75	412.64	803.39	412.64
18	2006			149.07	312.21	62.83		524.11			390.75	133.36	524.11	133.36
19	2007			139.70	312.21	62.83		514.74			390.75	123.99	514.74	123.99
20	2008			130.33	312.21	62.83		505.38			390.75	114.63	505.38	114.63
21	2009			120.97	312.21	62.83		496.01			390.75	105.26	496.01	105.26
22	2010			111.60	312.21	62.83		486.65			390.75	95.90	486.65	95.90
23	2011			102.24	312.21	62.83		477.28			390.75	86.53	477.28	86.53
24	2012			92.87	312.21	62.83		467.91			390.75	77.16	467.91	77.16
25	2013			83.50	312.21	62.83		458.55			390.75	67.80	458.55	67.80
26	2014			74.14	312.21	62.83		449.18			390.75	58.43	449.18	58.43
27	2015			64.77	312.21	62.83	269.92	709.73			390.75	318.98	709.73	318.98
28	2016			55.40	312.21	62.83		430.45			390.75	39.70	430.45	39.70
29	2017			46.04	312.21	62.83		421.08			390.75	30.33	421.08	30.33
30	2018			36.67	312.21	62.83		411.71			390.75	20.96	411.71	20.96
31	2019			27.30	304.31	62.83		394.45			390.75	3.70	394.45	3.70
32	2020			18.18	240.29	62.83	55.42	376.72			390.75	-14.03	376.72	-14.03
33	2021			10.97	181.89	62.83		255.68			390.75	-135.07	255.68	-135.07
34	2022			5.51	123.48	62.83		191.82			390.75	-198.93	191.82	-198.93
35	2023			1.81	51.93	62.83		116.56			390.75	-274.19	116.56	-274.19
36	2024			0.25	8.25	62.83		71.33			390.75	-319.42	71.33	-319.42
	Total	6,244.27	3,225.90	3,713.92	6,244.27	1,890.93	595.25	21,914.53	6,244.27	3,225.90	11,950.83	493.54	21,914.53	-3,719.44

Note : *1 Interest : 3.0%
Grace period : 10 years
Repayment period including grace period :30 years
*2 Negative fitures mean revenue of the government.

FIGURES

Fig. 3-1 Soil Map (System DI, Undeveloped Area)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

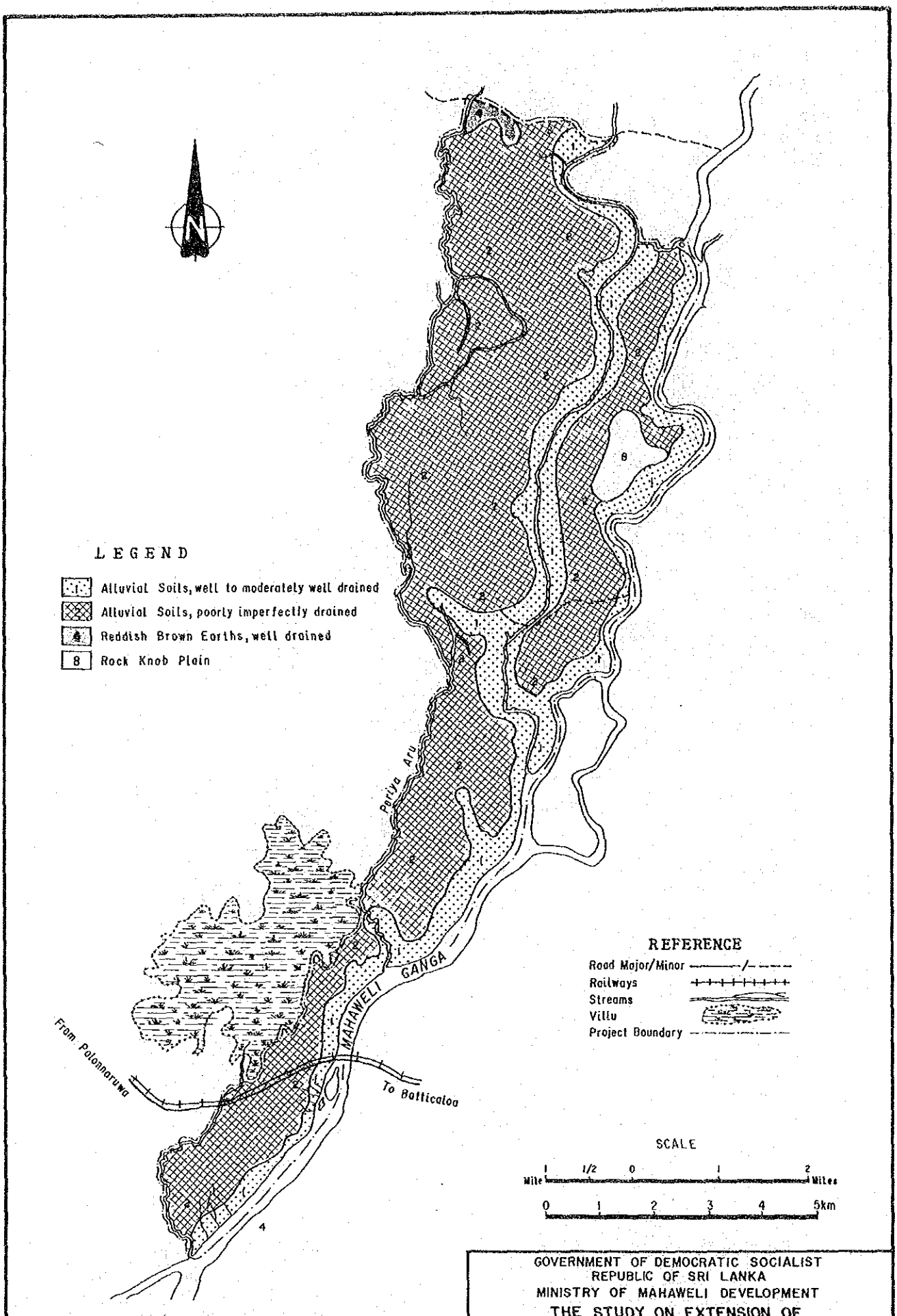

Fig. 3-2 Soil Map
(System D2 Undeveloped Area)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
JAPAN INTERNATIONAL CO OPERATION AGENCY

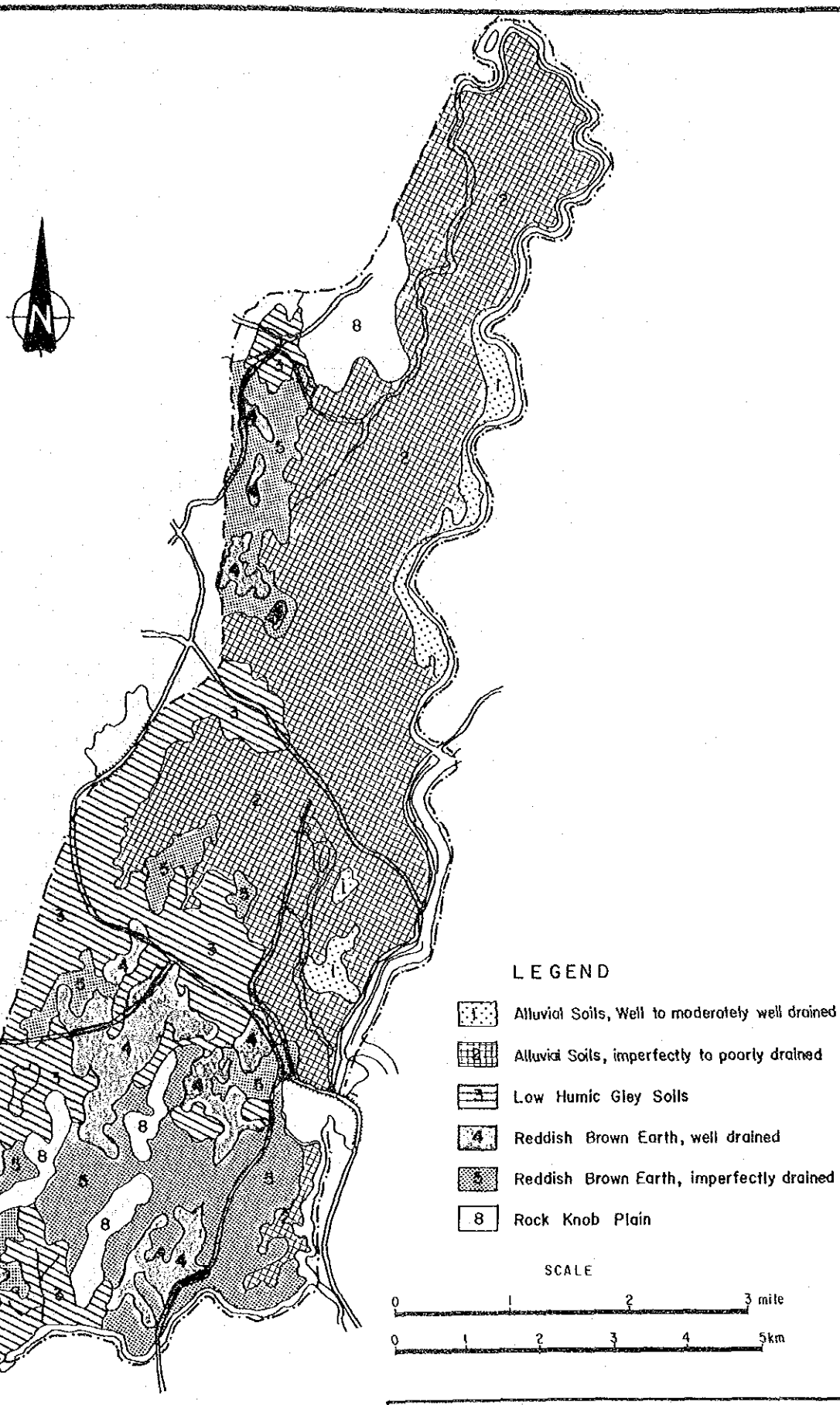

Fig.3-3 Soil Map (System A/D , Undeveloped Area)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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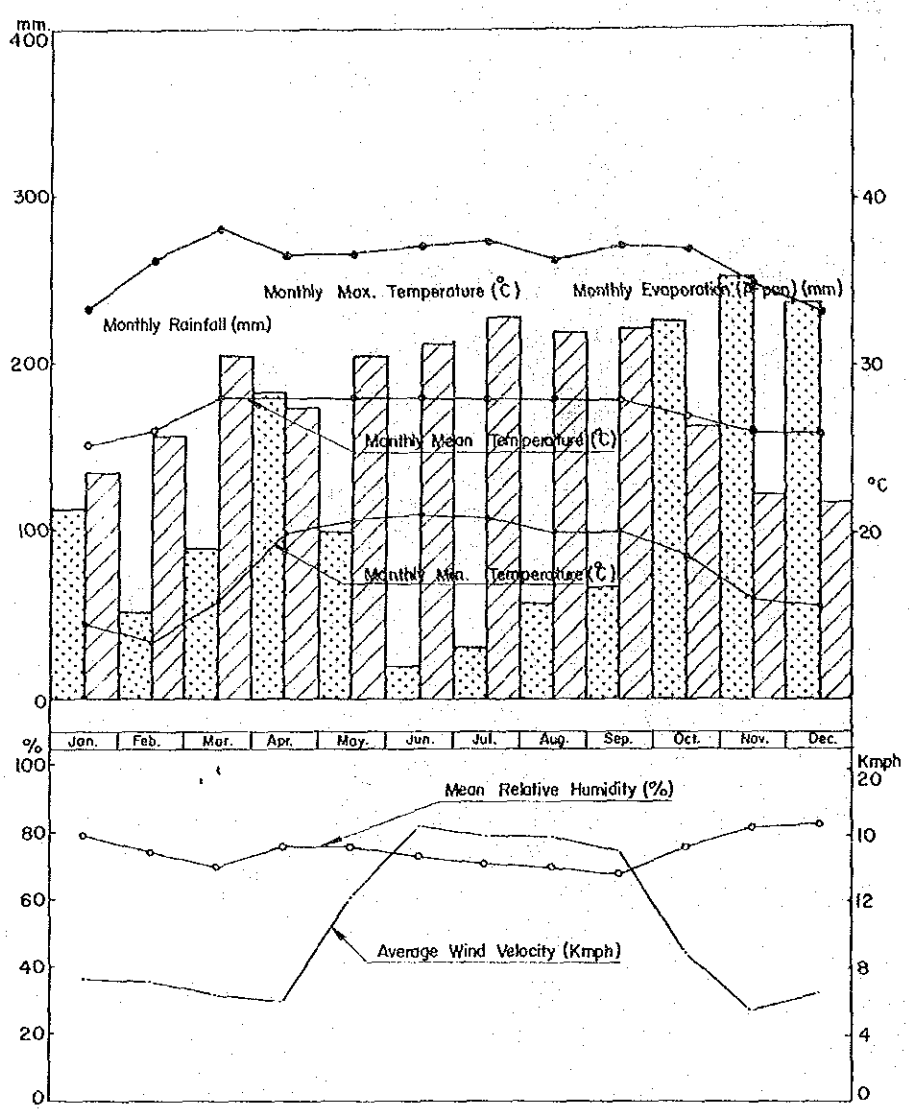

Fig.3-4 Characteristics of Climate at Maha Illuppallama

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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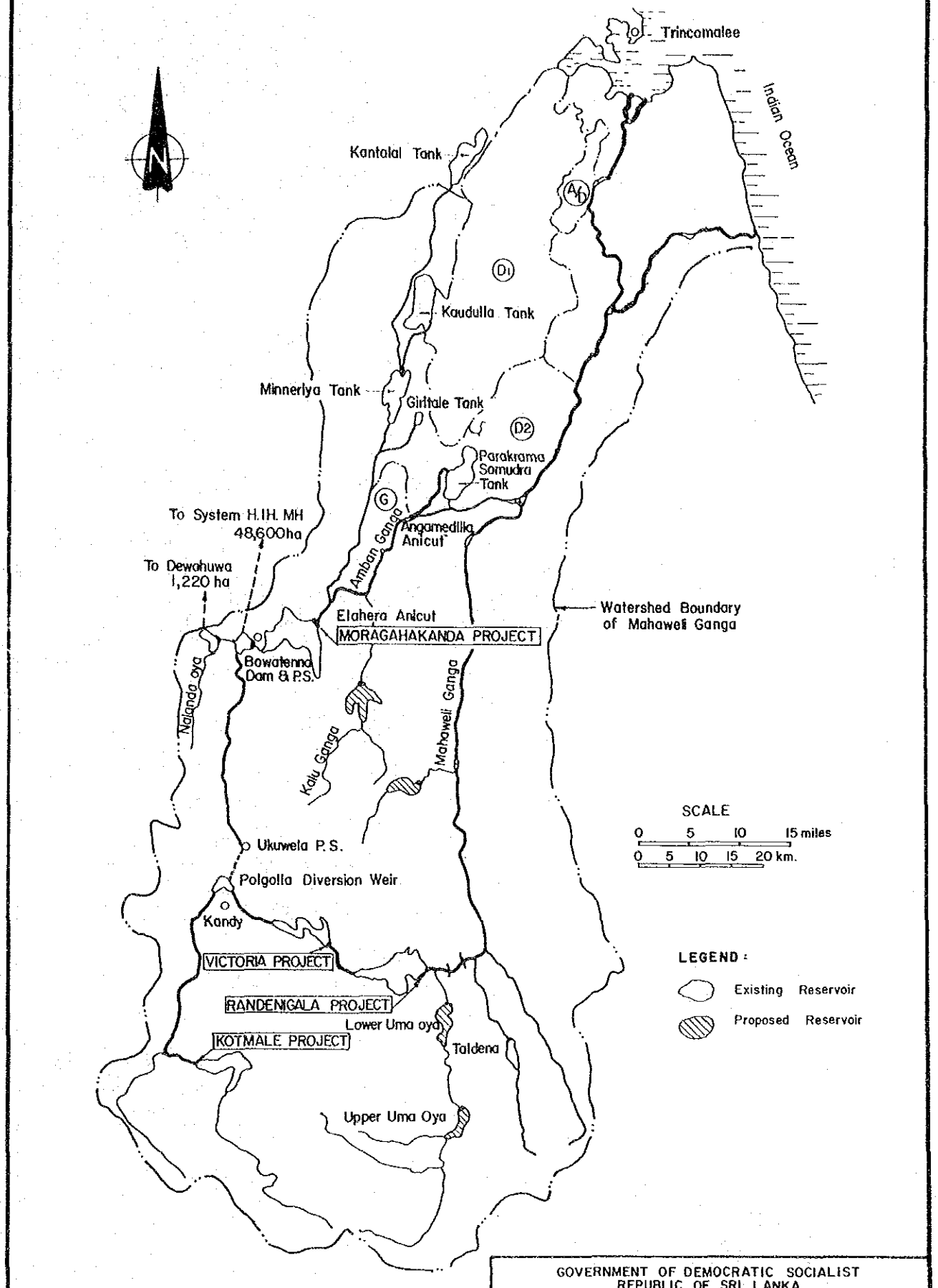

Fig.3-5 Water Flow System

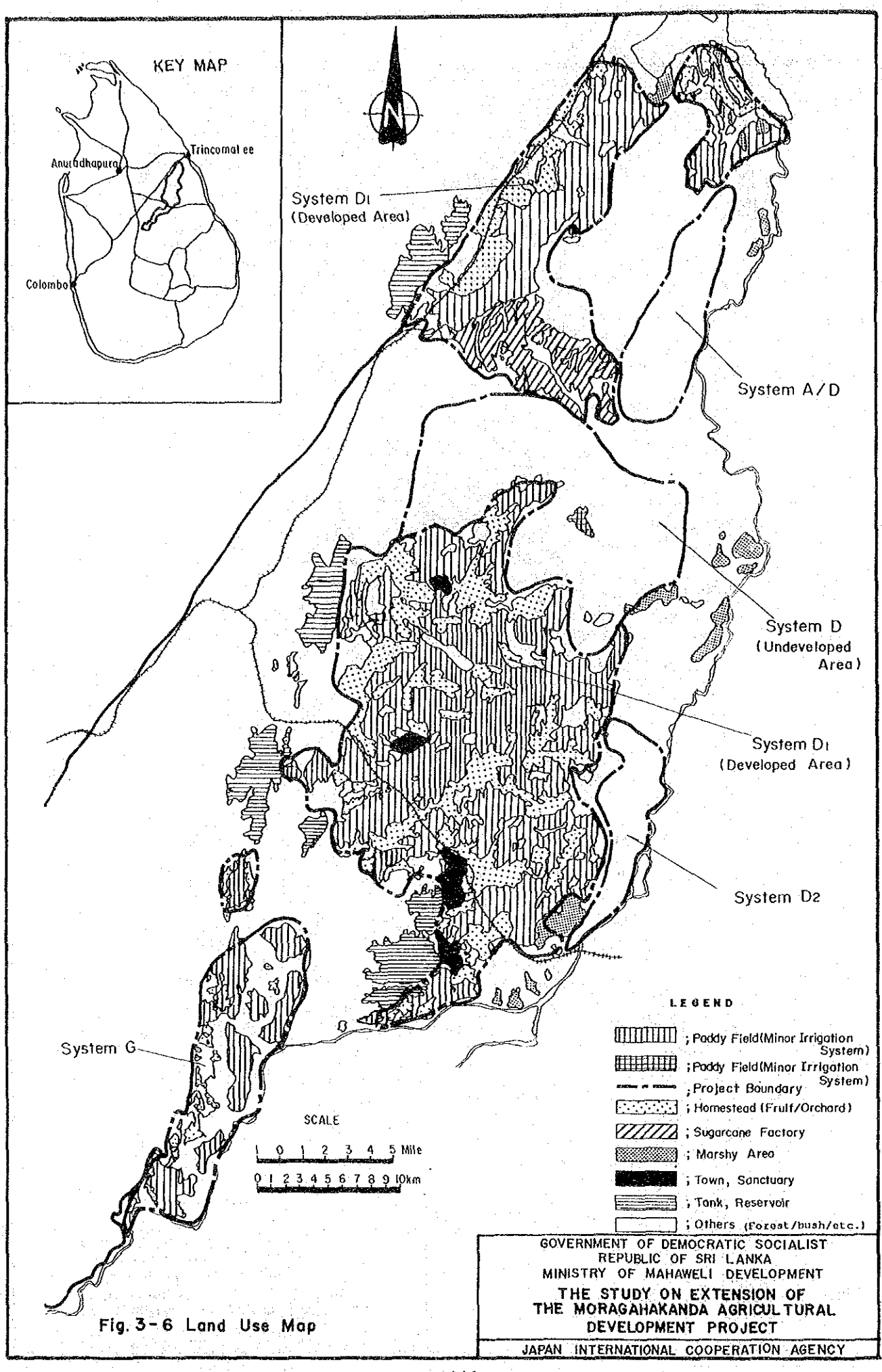

Fig. 3-6 Land Use Map

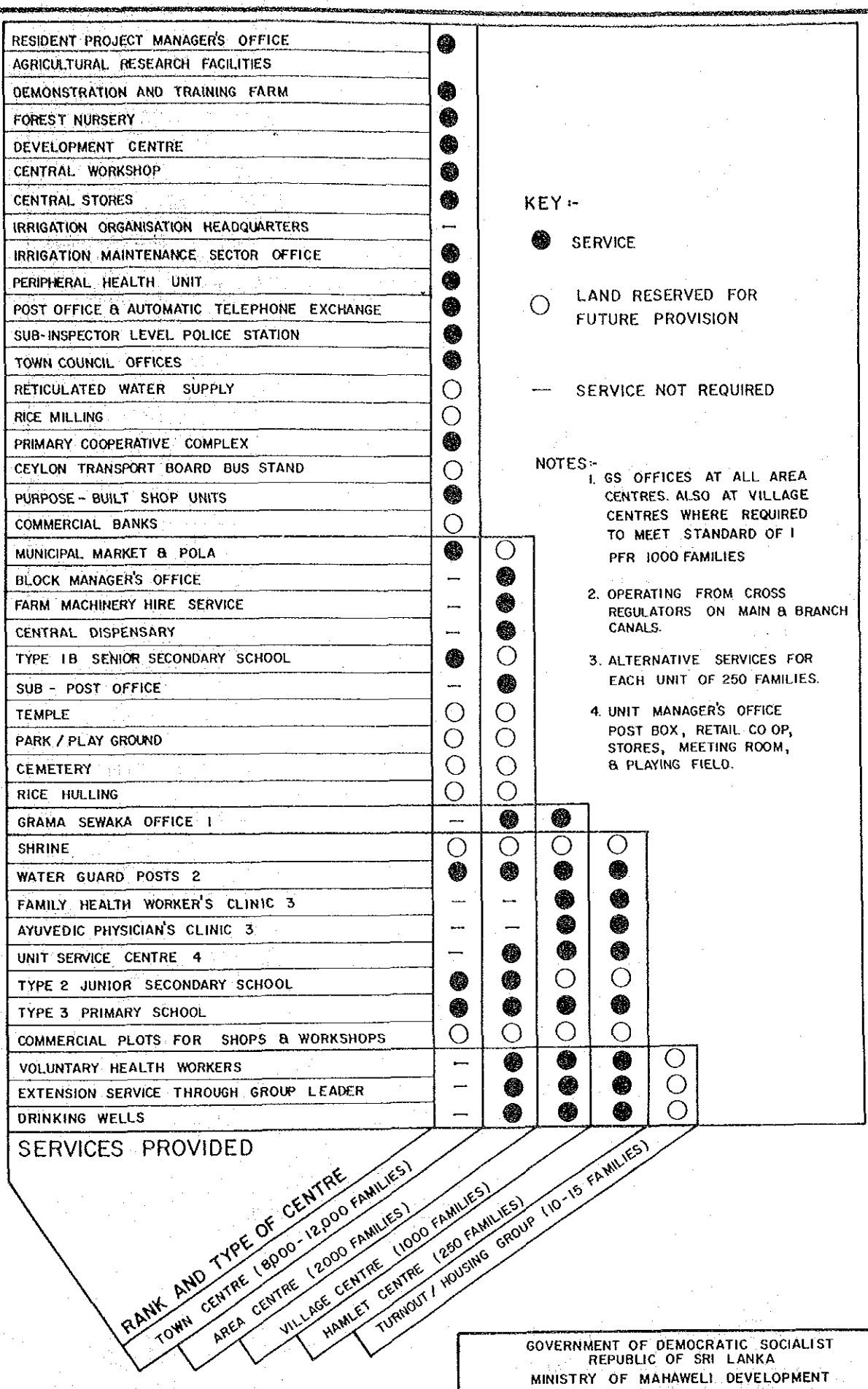

Fig. 3-7 Distribution of Services by Rank of Centre

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
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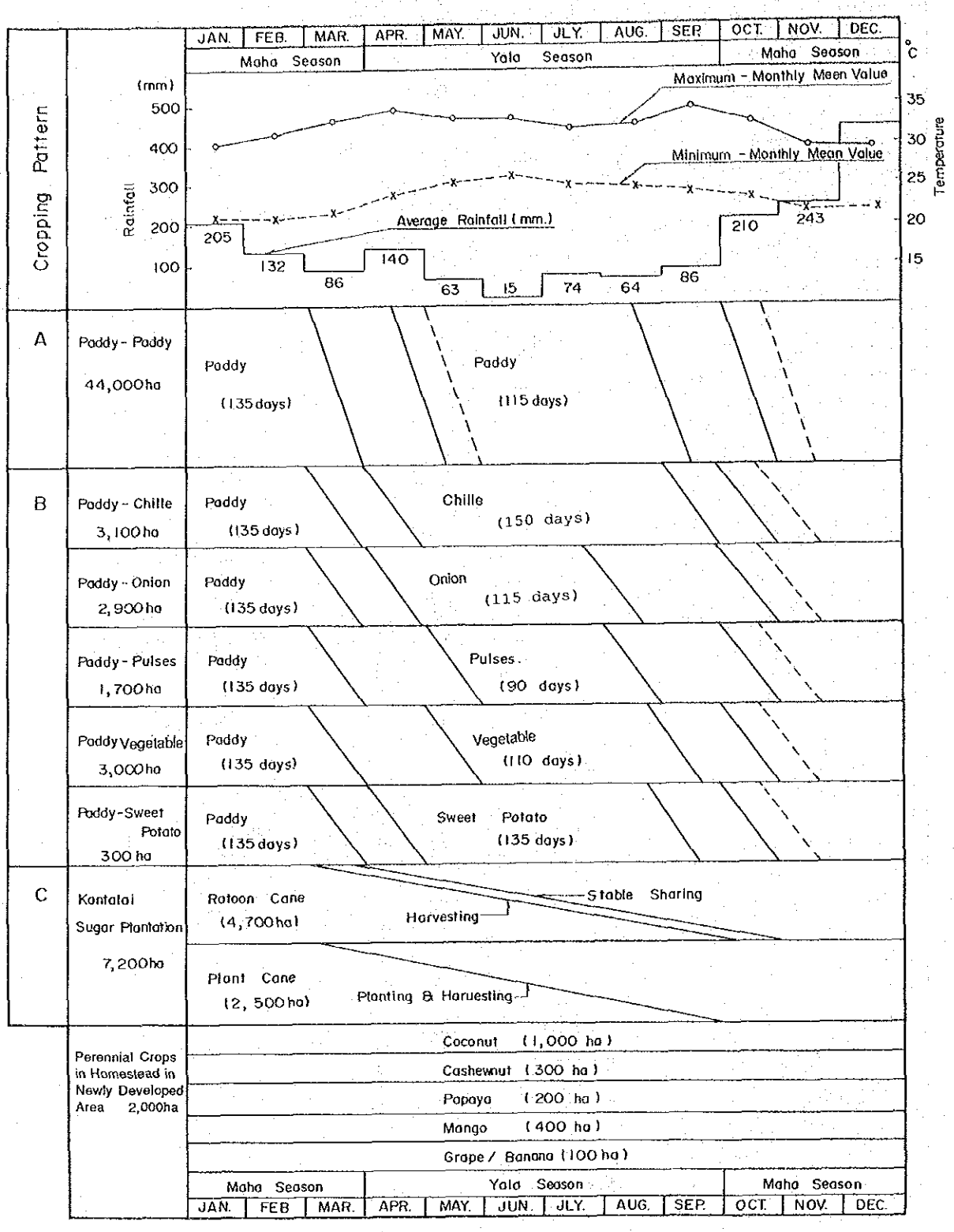

Fig. 4-1 Proposed Cropping Pattern

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
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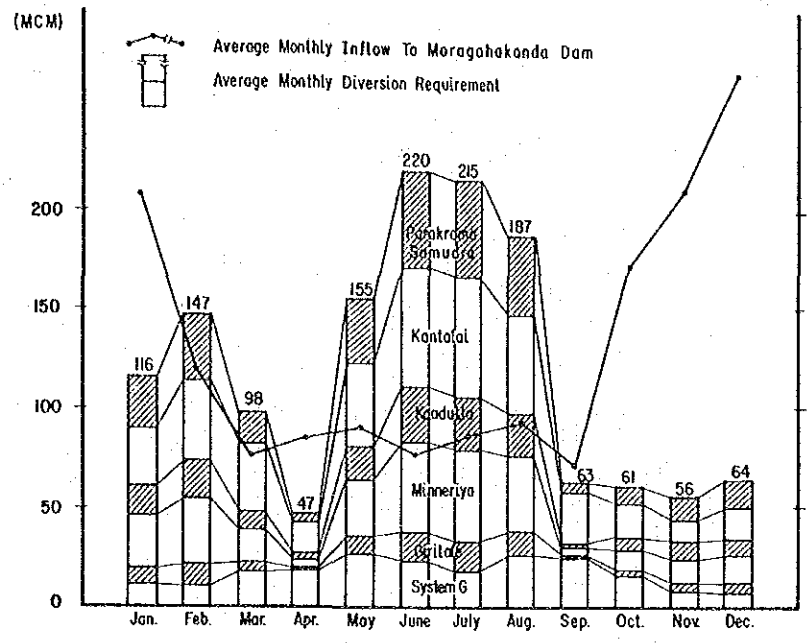
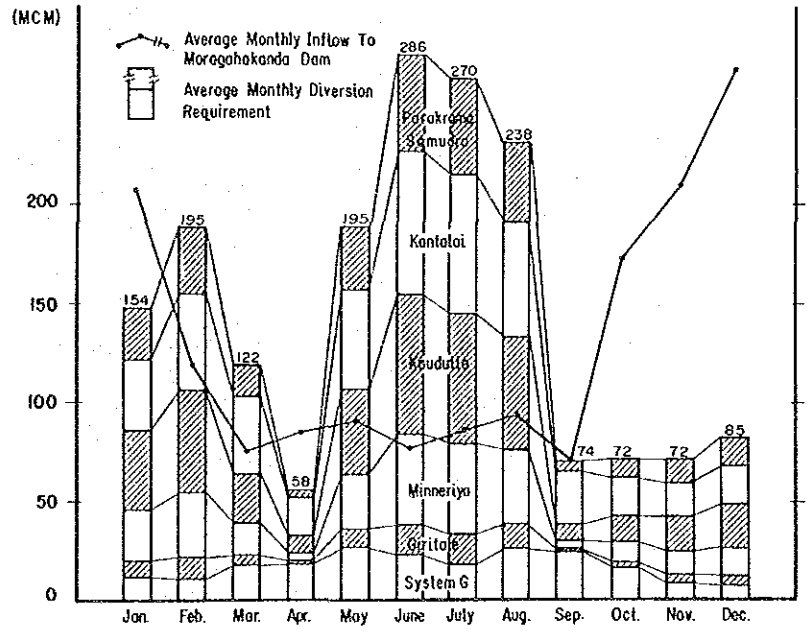


Existing Irrigation Area : 48,300 ha (without Project)



Irrigation Area : 62,200 ha (with Project)

Fig. 4-2 Average Monthly Diversion Water Requirements at Respective Tanks

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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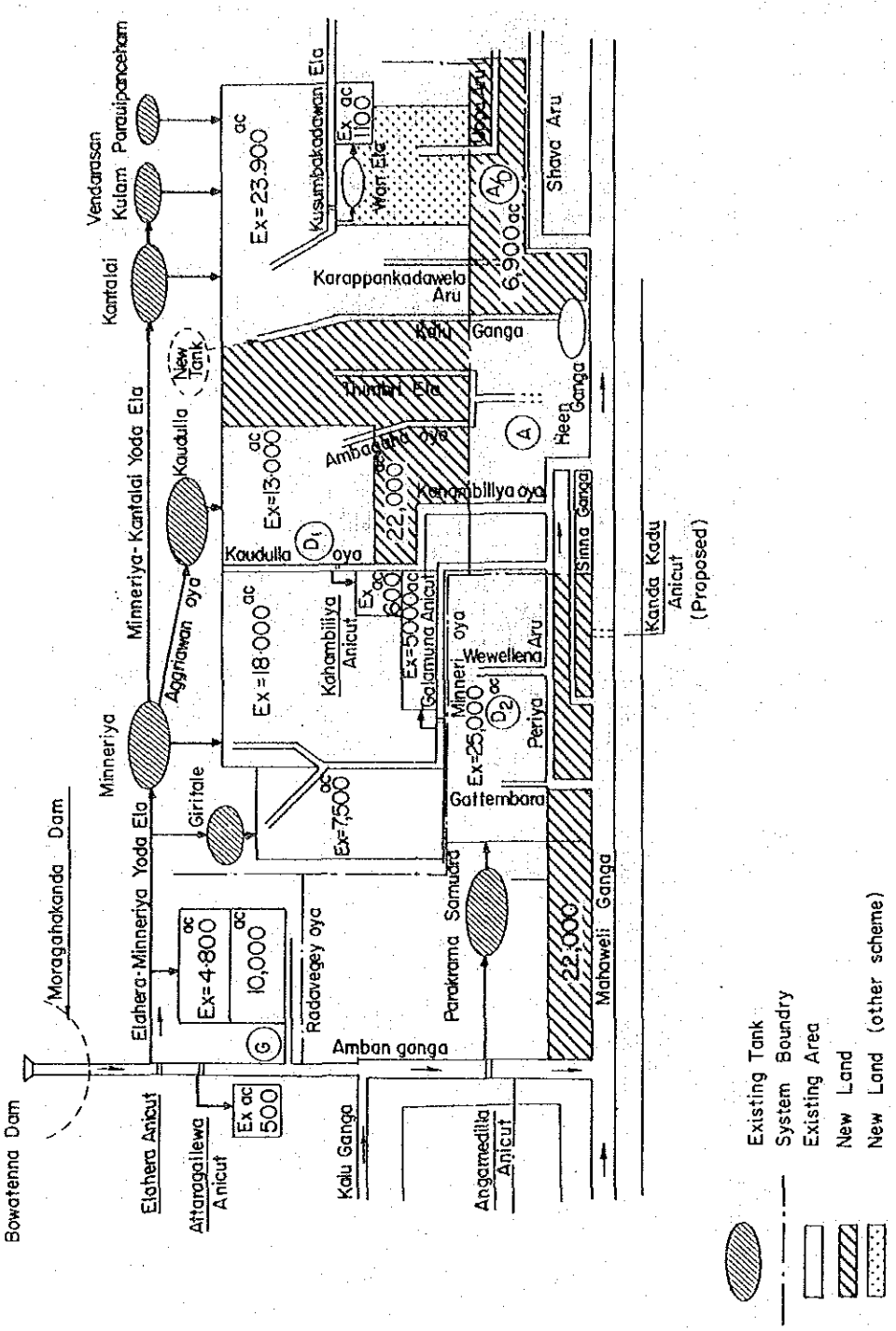

Fig. 4-3 Irrigation and Drainage System

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
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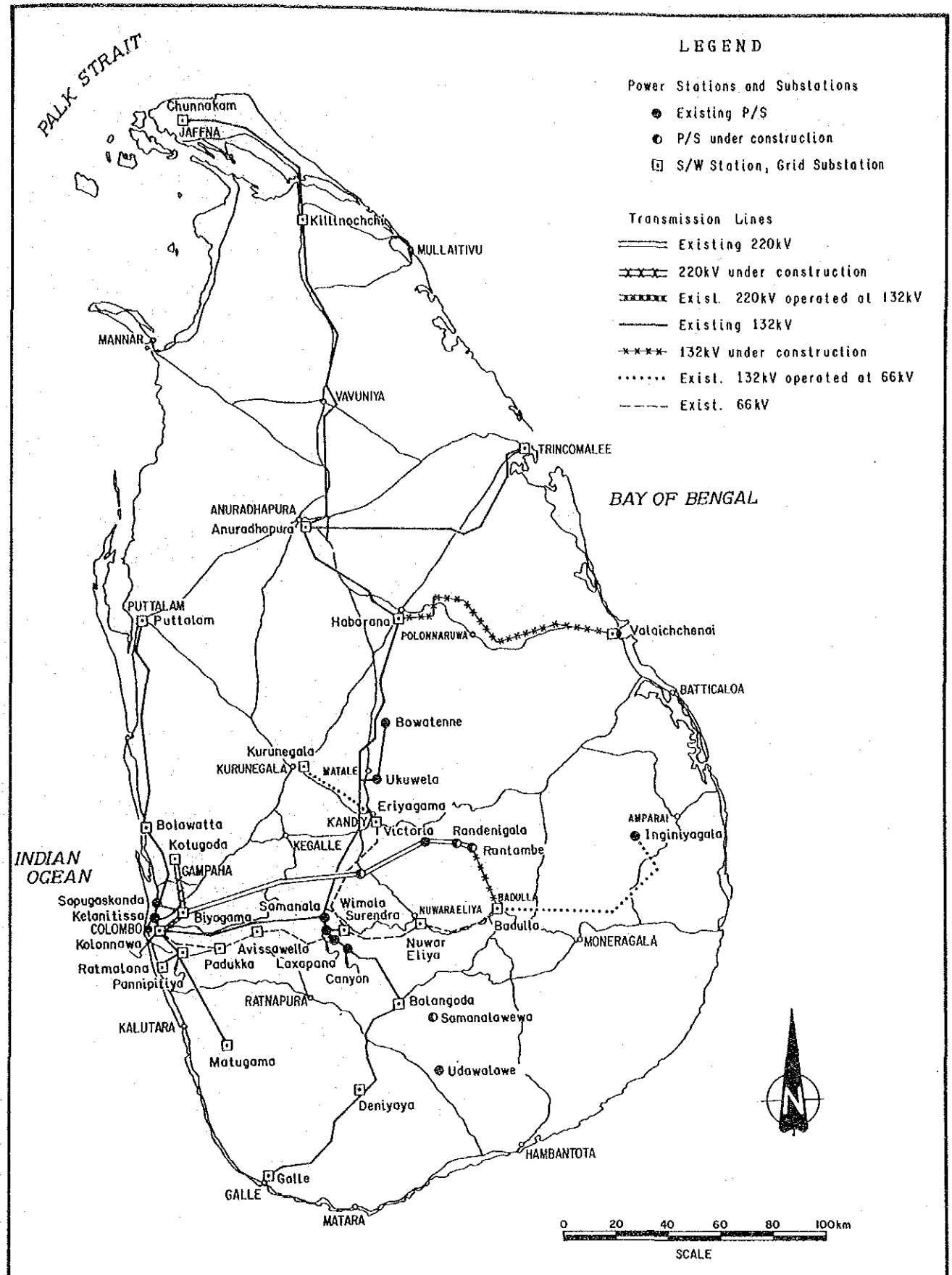

Fig. 4-4 Electricity System of Sri Lanka

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
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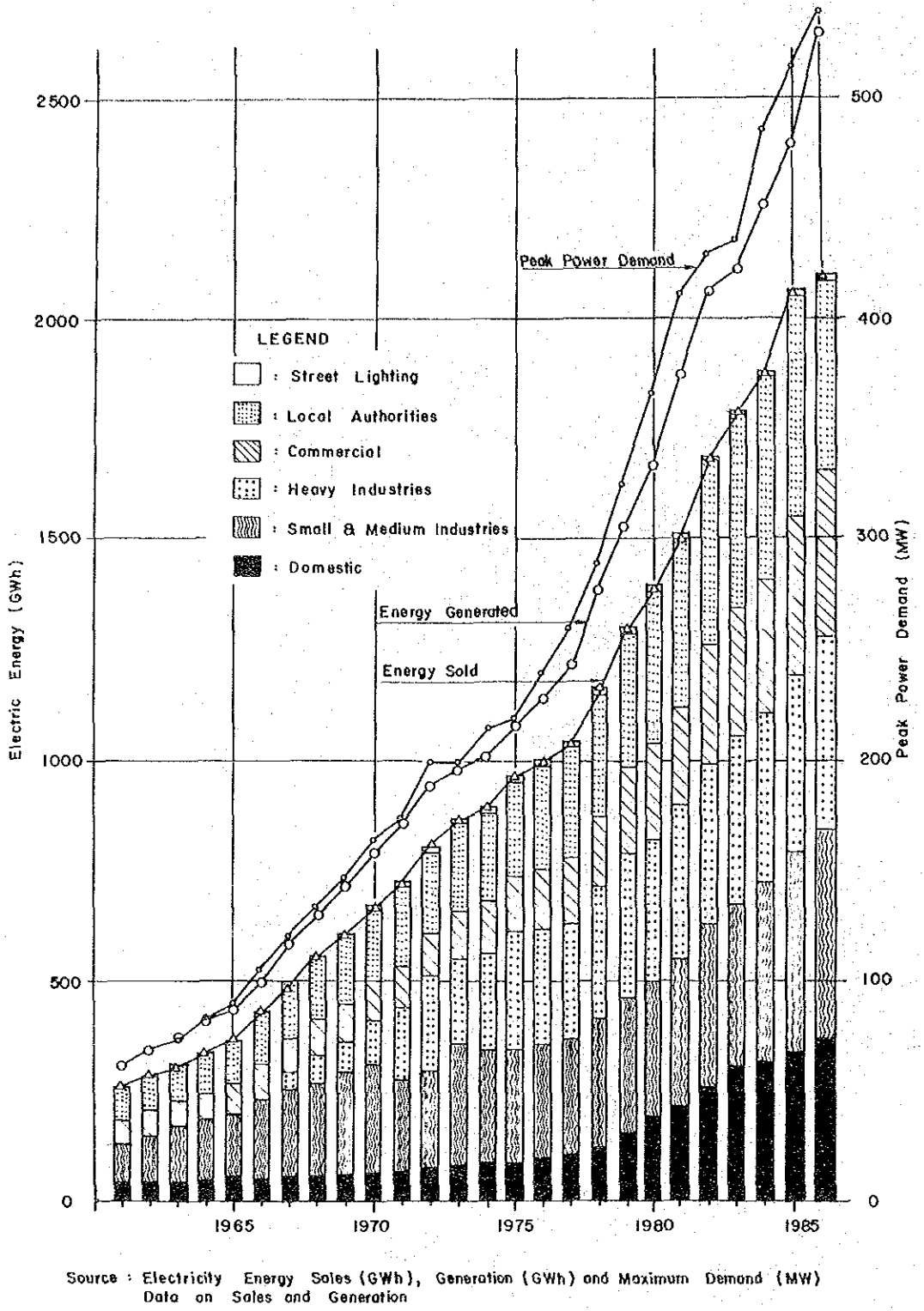

Source : Electricity Energy Sales (GWh), Generation (GWh) and Maximum Demand (MW)
Data on Sales and Generation

Fig. 4-5 Historical Peak Demand and Energy Generated and Sold (1961-86)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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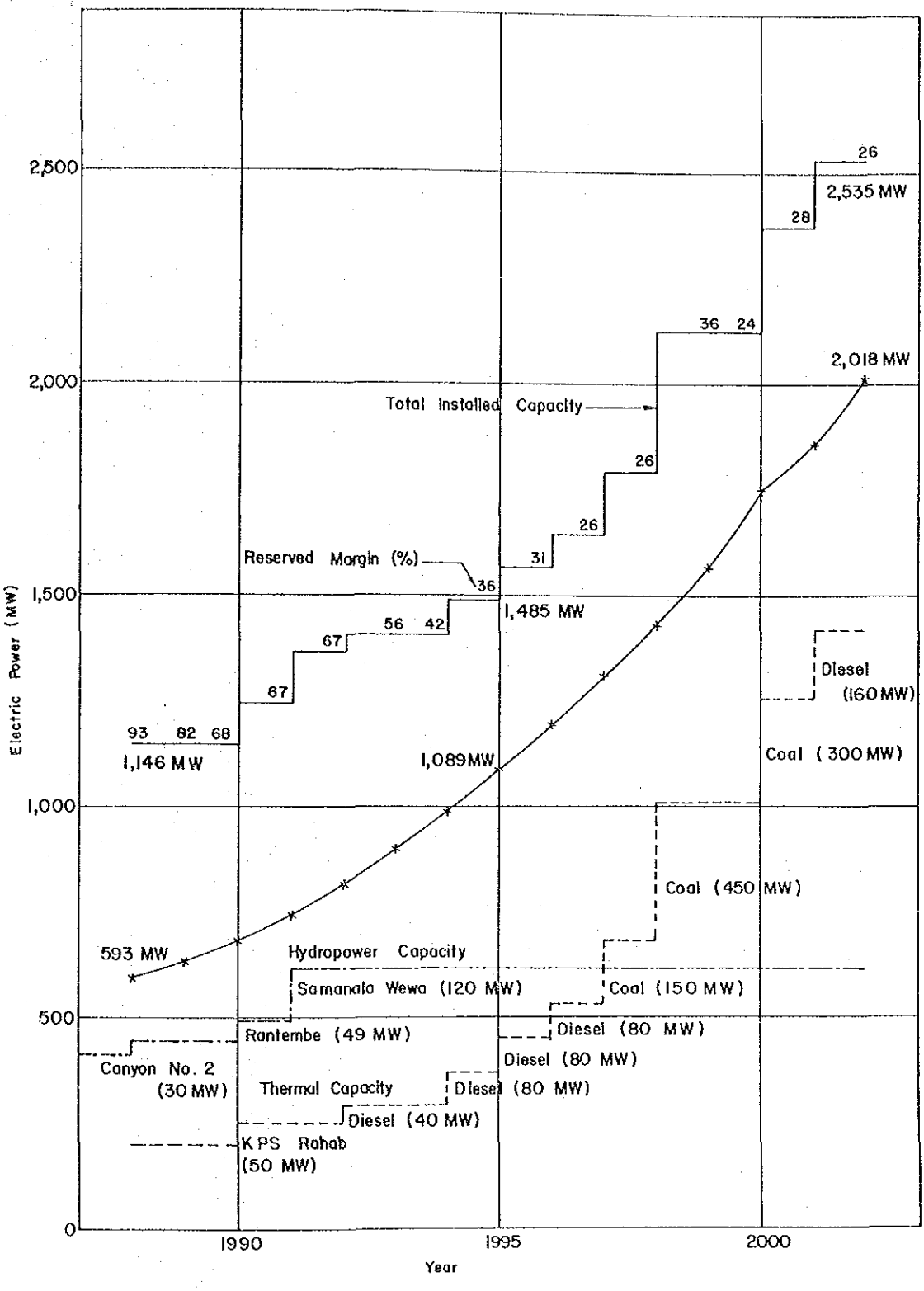

Fig. 4-6 Projected Power Demand And Installed Capacity (1988 - 2002)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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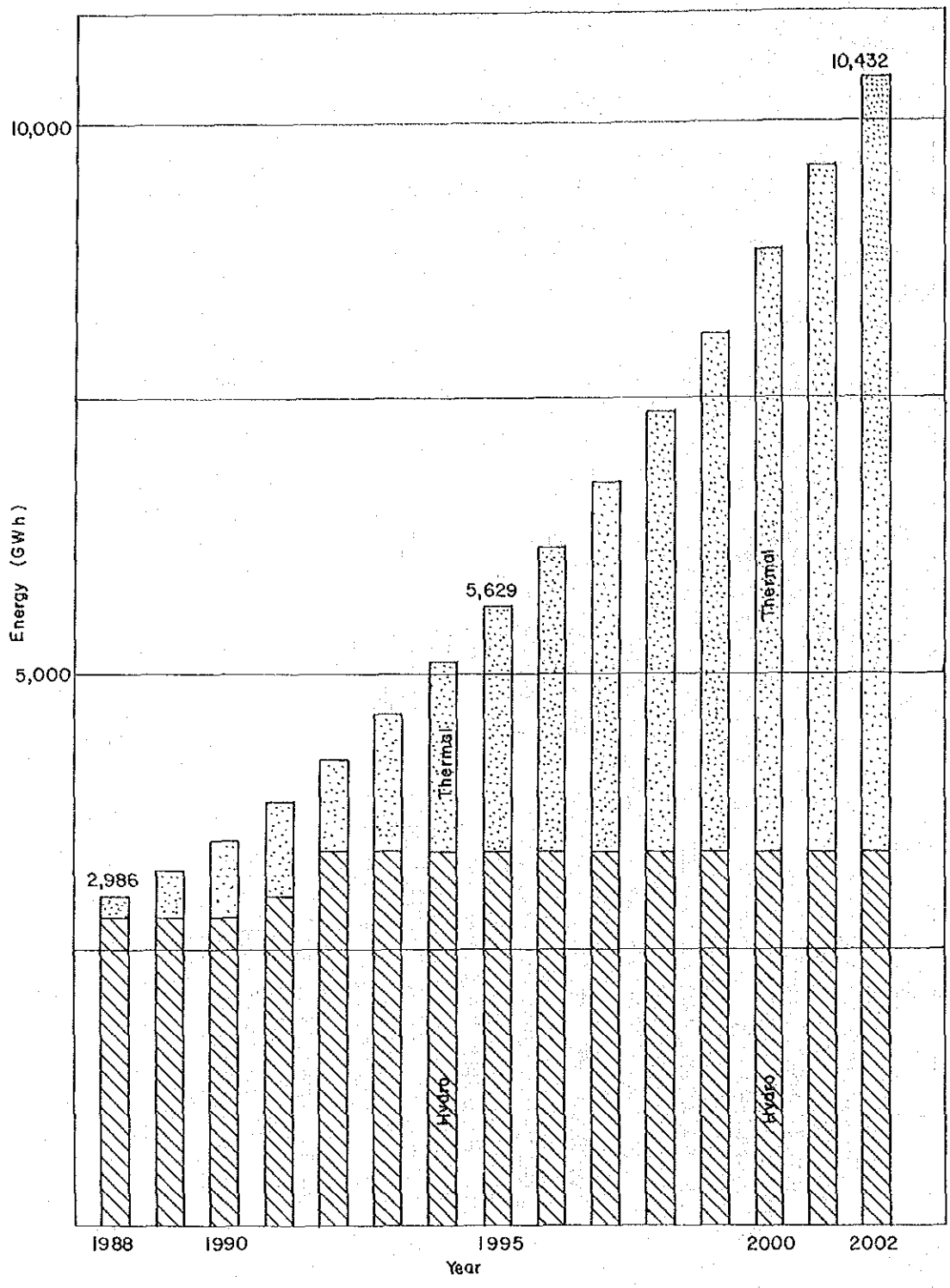

Fig. 4-7 Projected Energy Balance (1988-2002)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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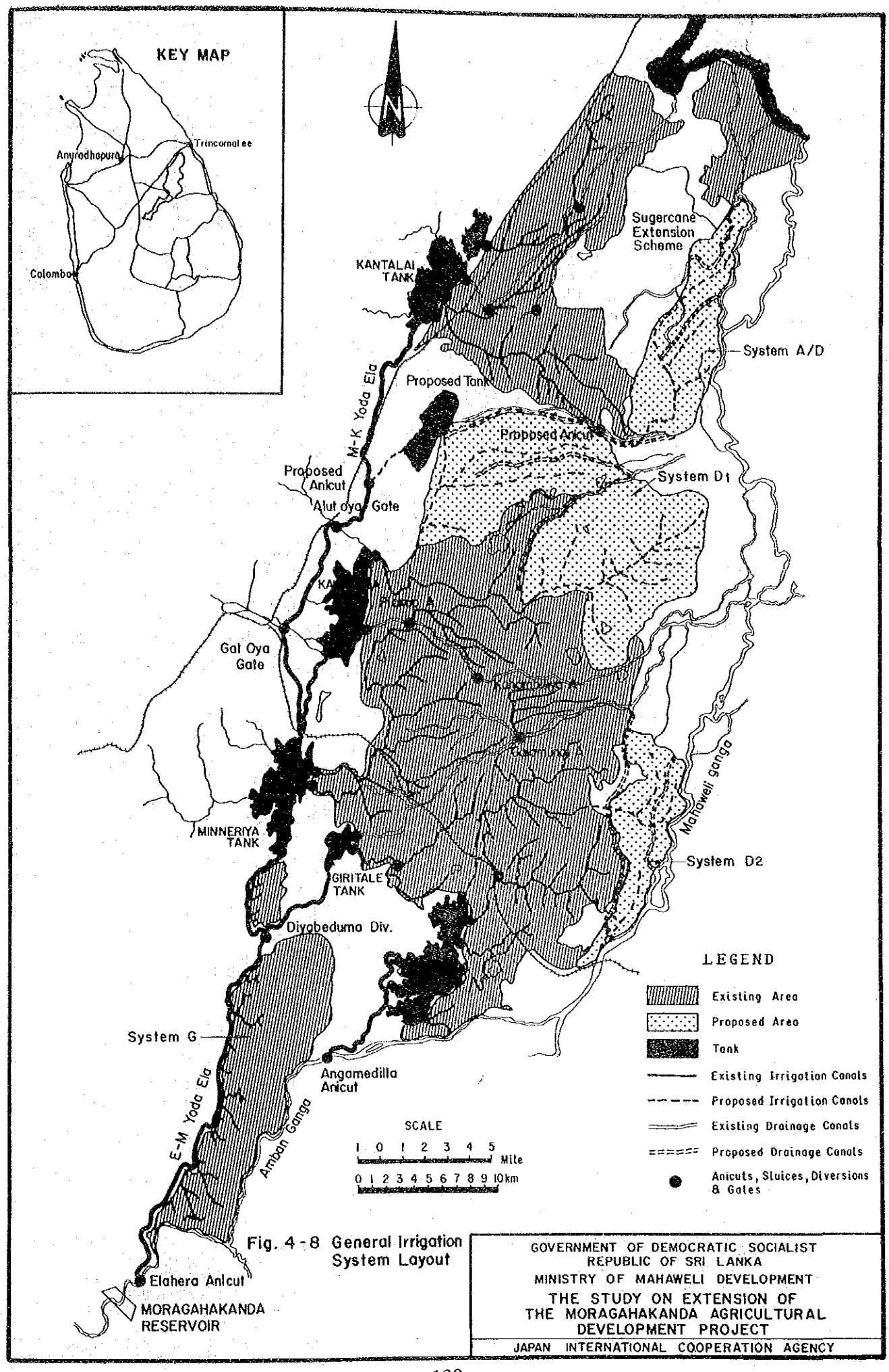

Fig. 4-8 General Irrigation System Layout

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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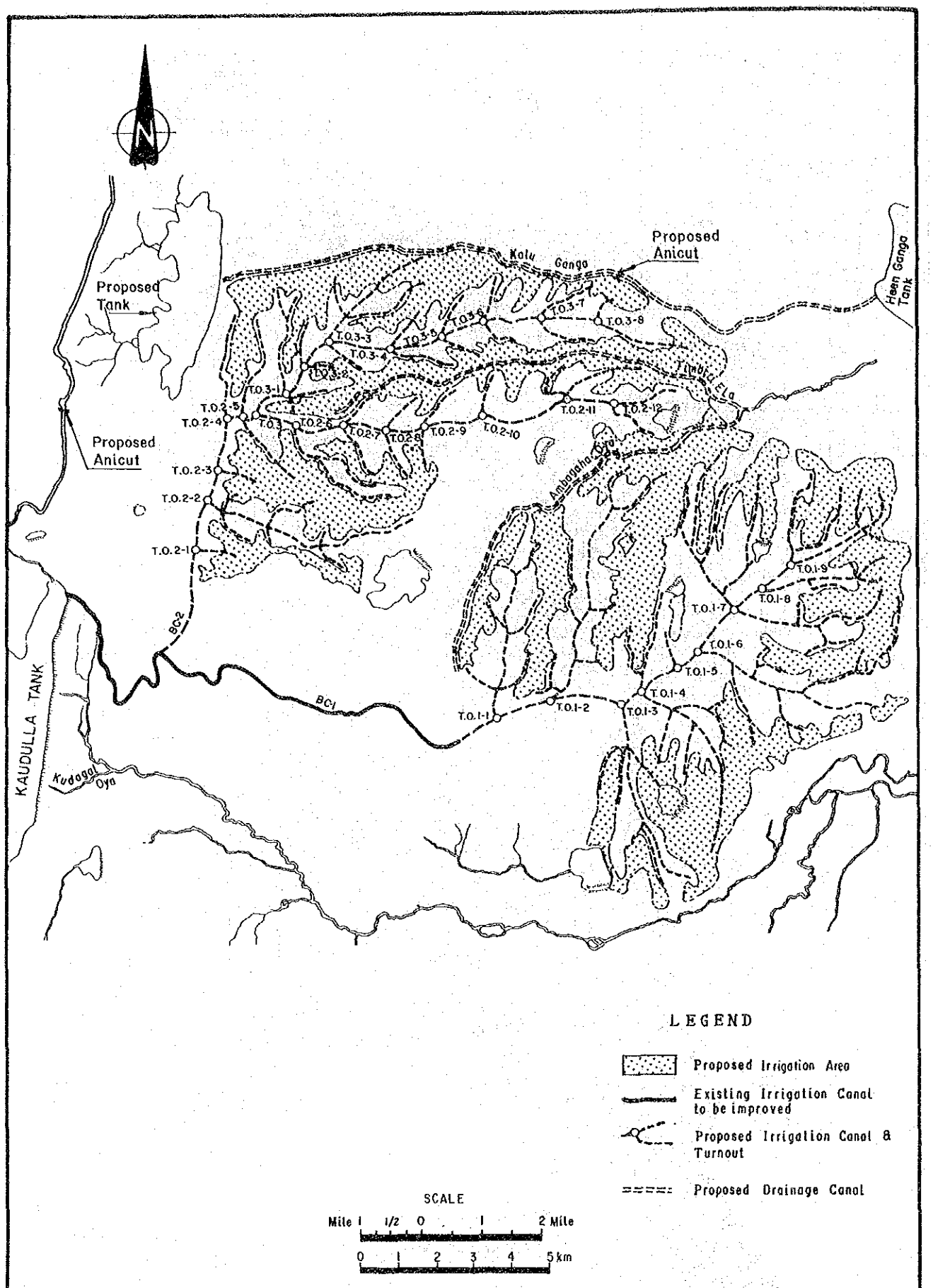

Fig. 4-9(1/3) Irrigation and Drainage Layout (System DI)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
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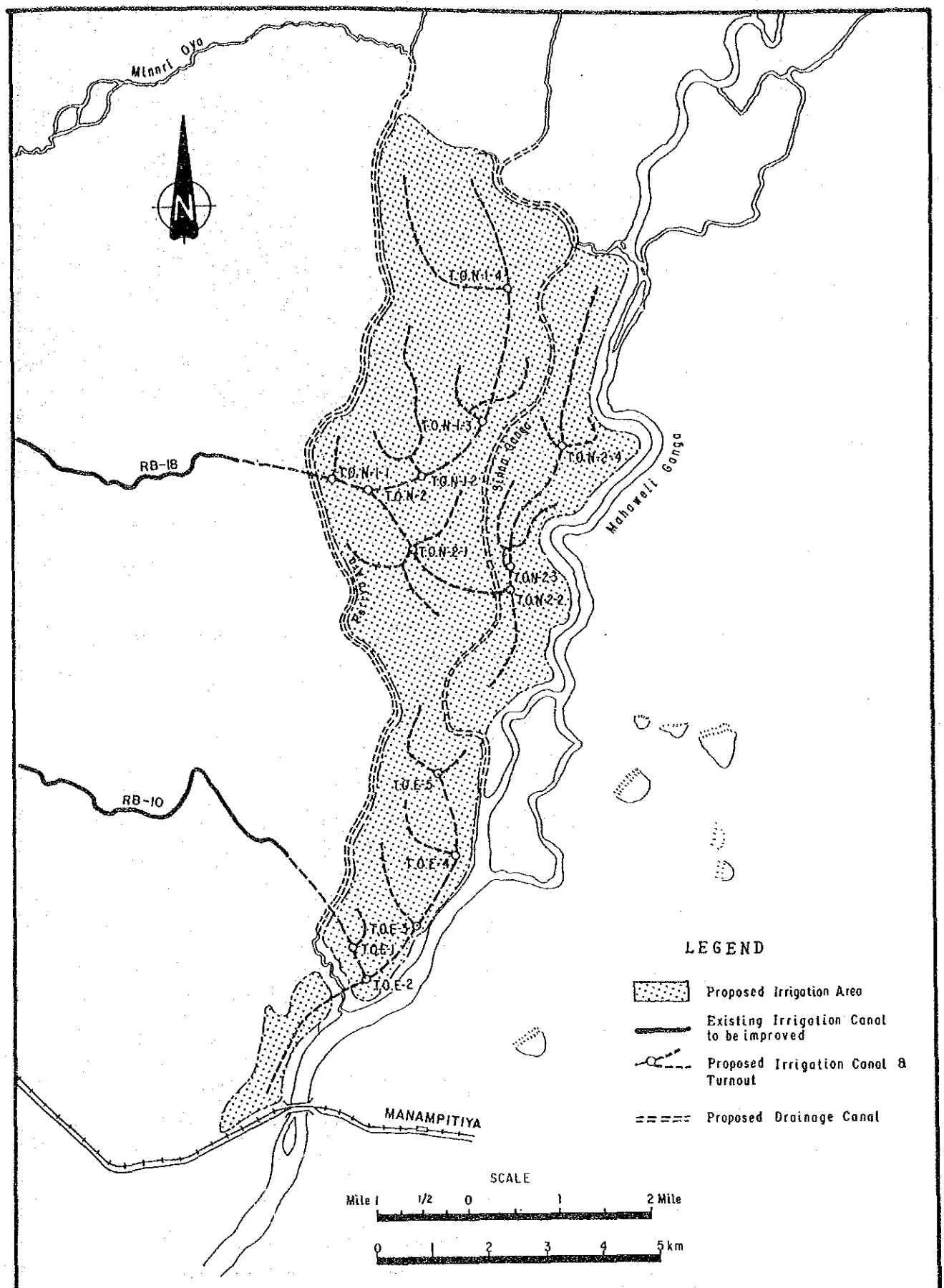

Fig. 4-9(2/3) Irrigation and Drainage Layout (System D2)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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JAPAN INTERNATIONAL COOPERATION AGENCY

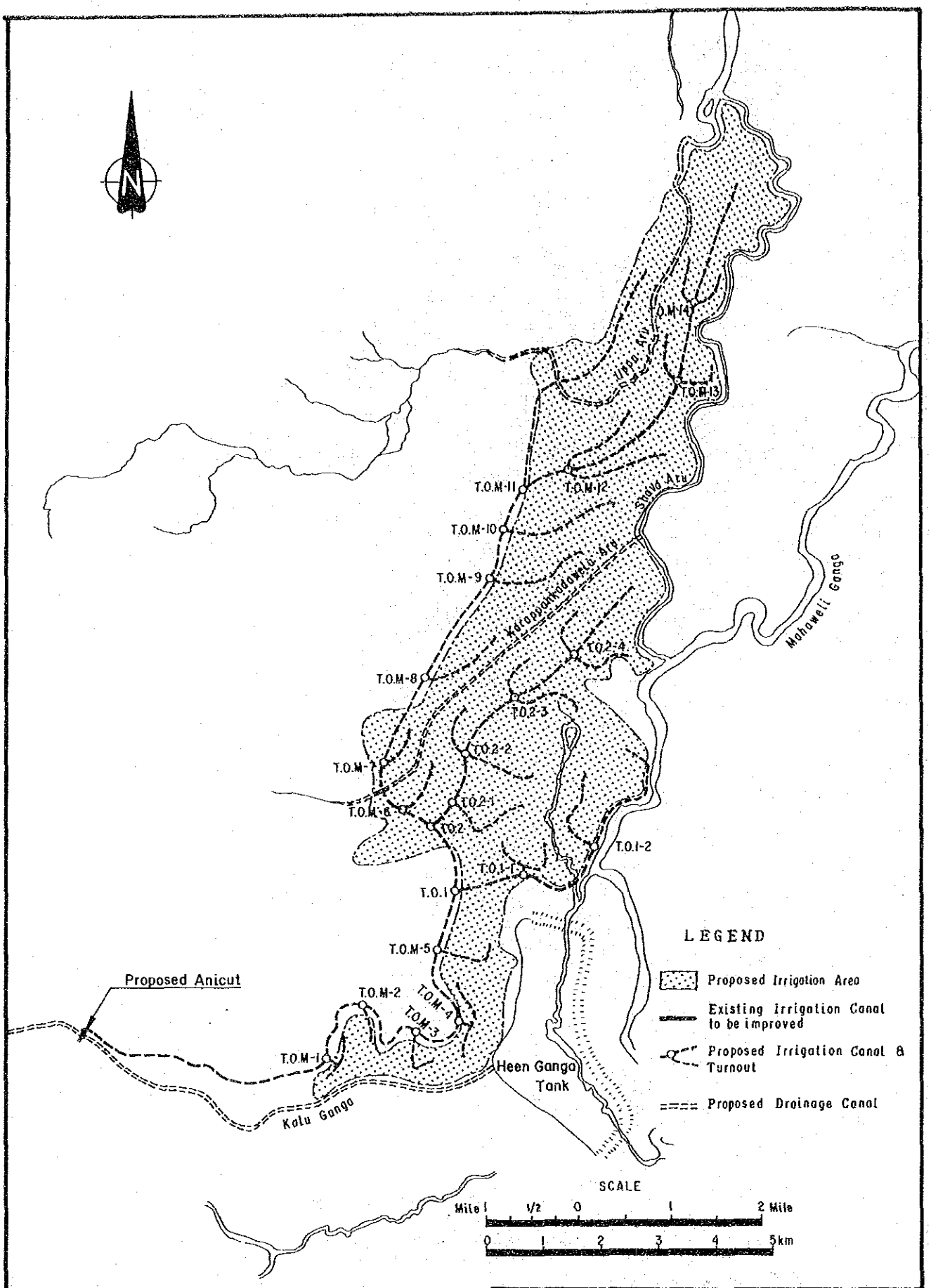

Fig. 4-9(3/3) Irrigation and Drainage Layout (System A/D)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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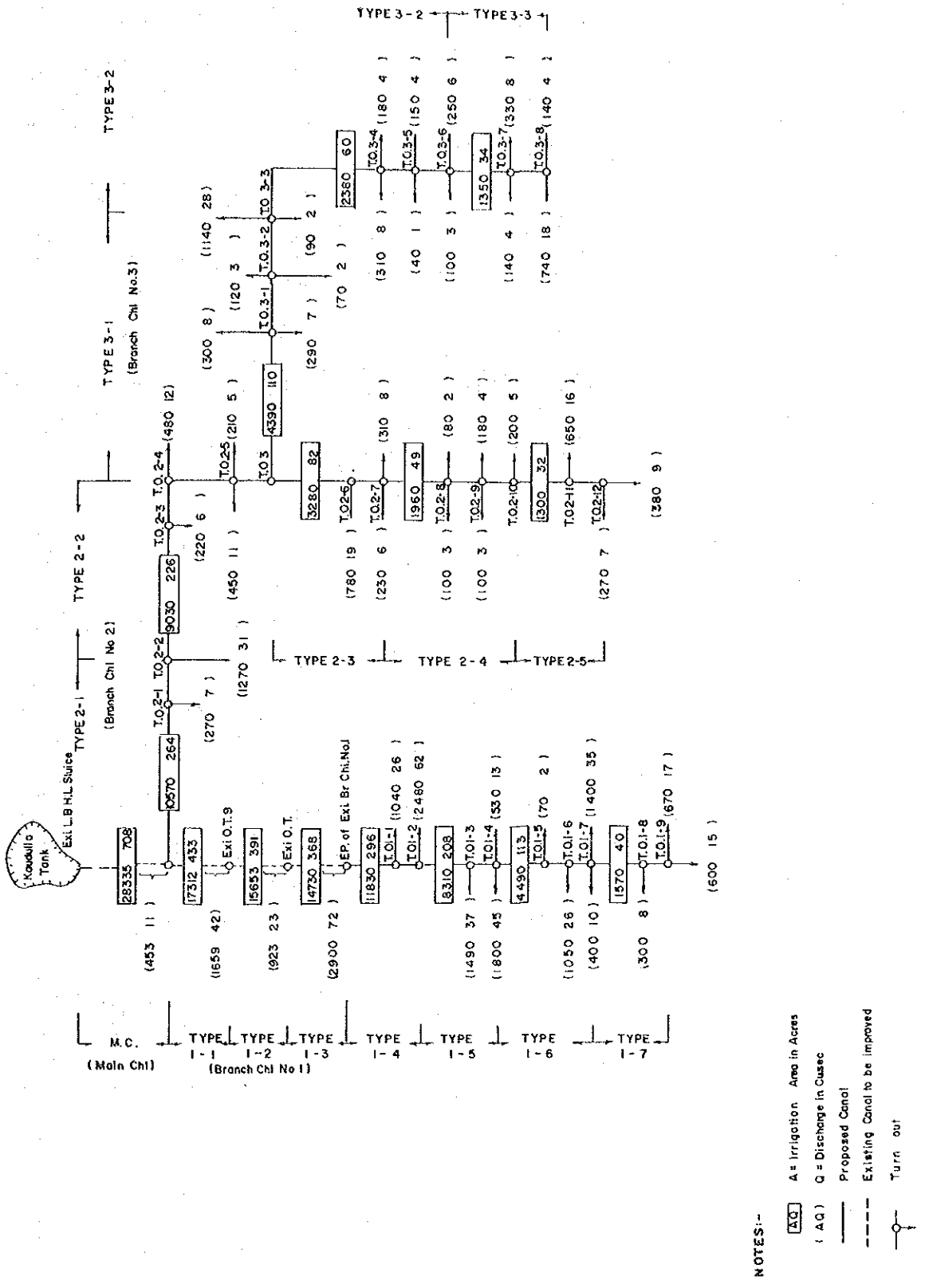

Fig. 4-10(1/3) Irrigation Diagram

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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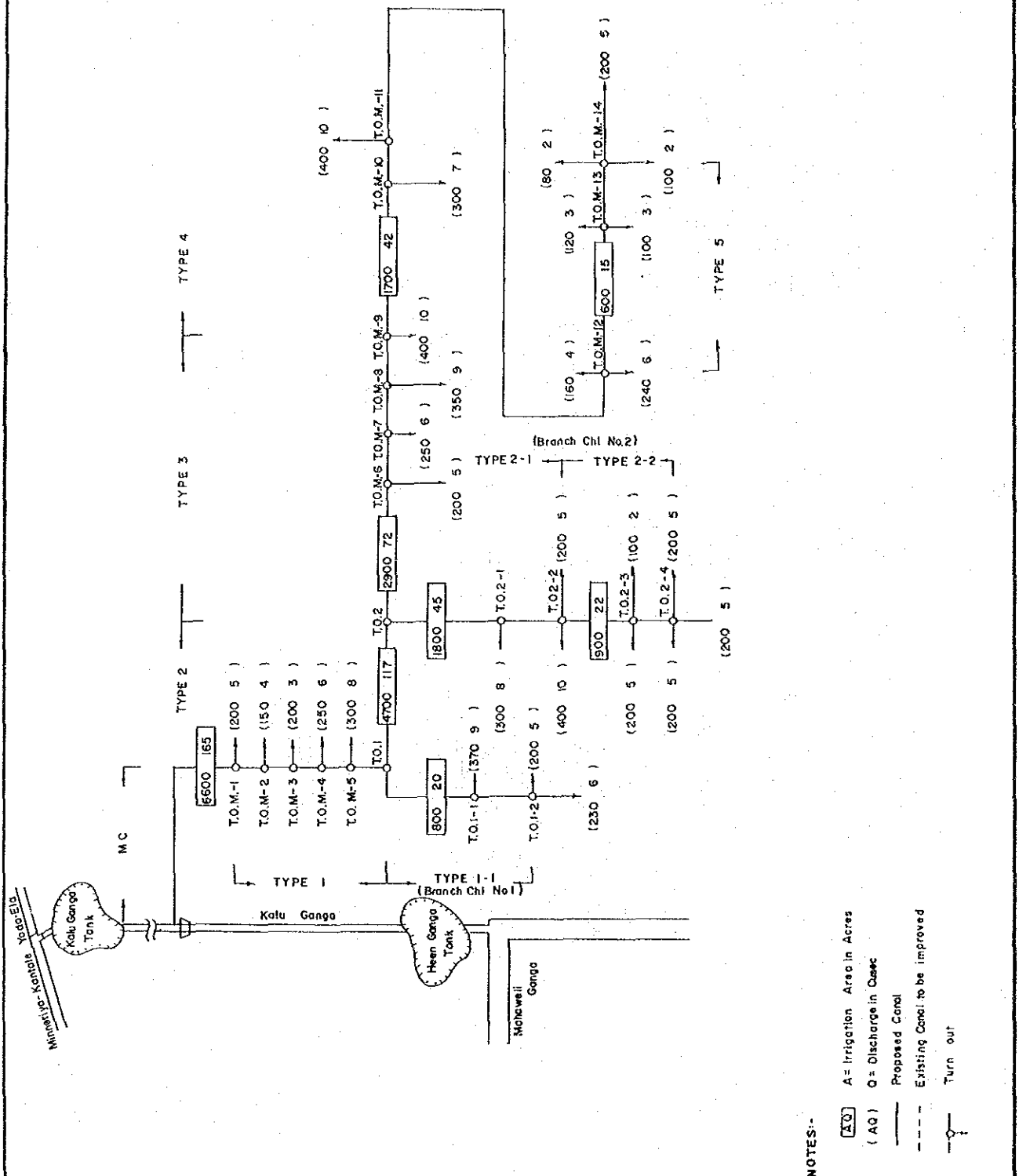

Fig. 4-10 (2/3) Irrigation Diagram

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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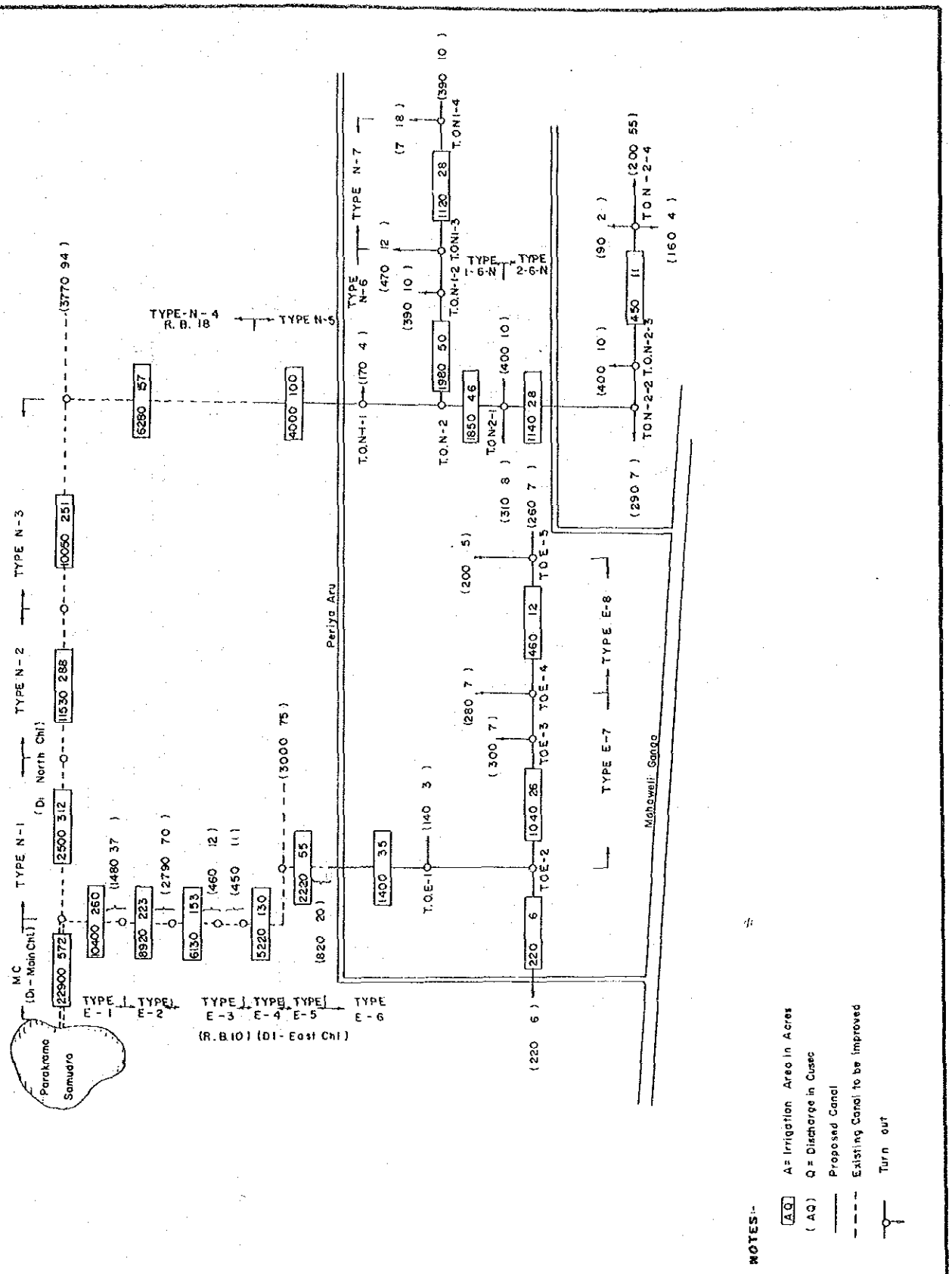

Fig. 4-10(3/3) Irrigation Diagram

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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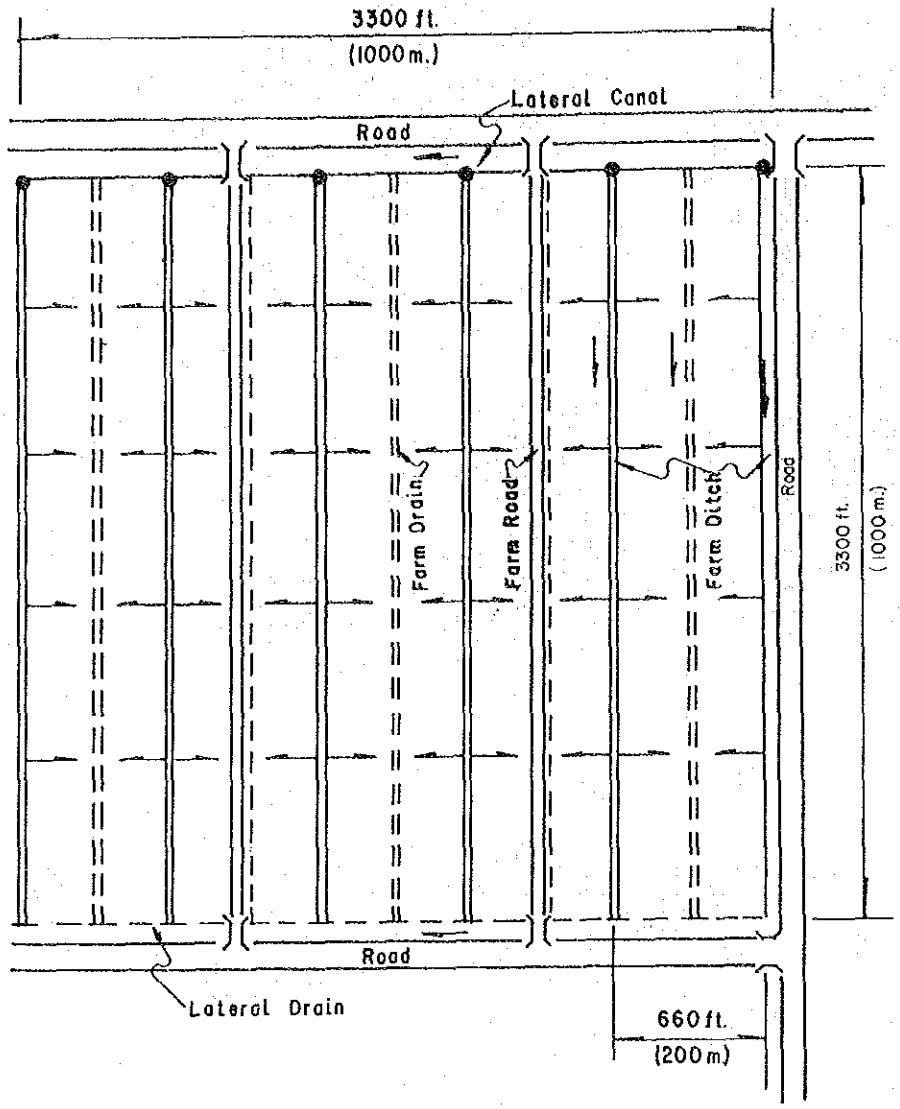

Farm Ditch Intervals 200m

Lateral Canal	$\frac{3300\ ft}{247\ ac}$	= 13 ft/ac
Farm Ditch	$\frac{19800\ ft}{247\ ac}$	= 80 ft/ac
Irrigation Canal Density		= 93 ft/ac
Lateral Drain	$\frac{3300\ ft}{247\ ac}$	= 13 ft/ac
Farm Drain	$\frac{16500\ ft}{247\ ac}$	= 67 ft/ac

Drainage Canal Density		= 67 ft/ac
Road	$\frac{9900\ ft}{247\ ac}$	= 40 ft/ac
Farm Road	$\frac{6600\ ft}{247\ ac}$	= 27 ft/ac
Road Density		= 67 ft/ac

Fig. 4 - 11 Typical Layout of Downstream Development

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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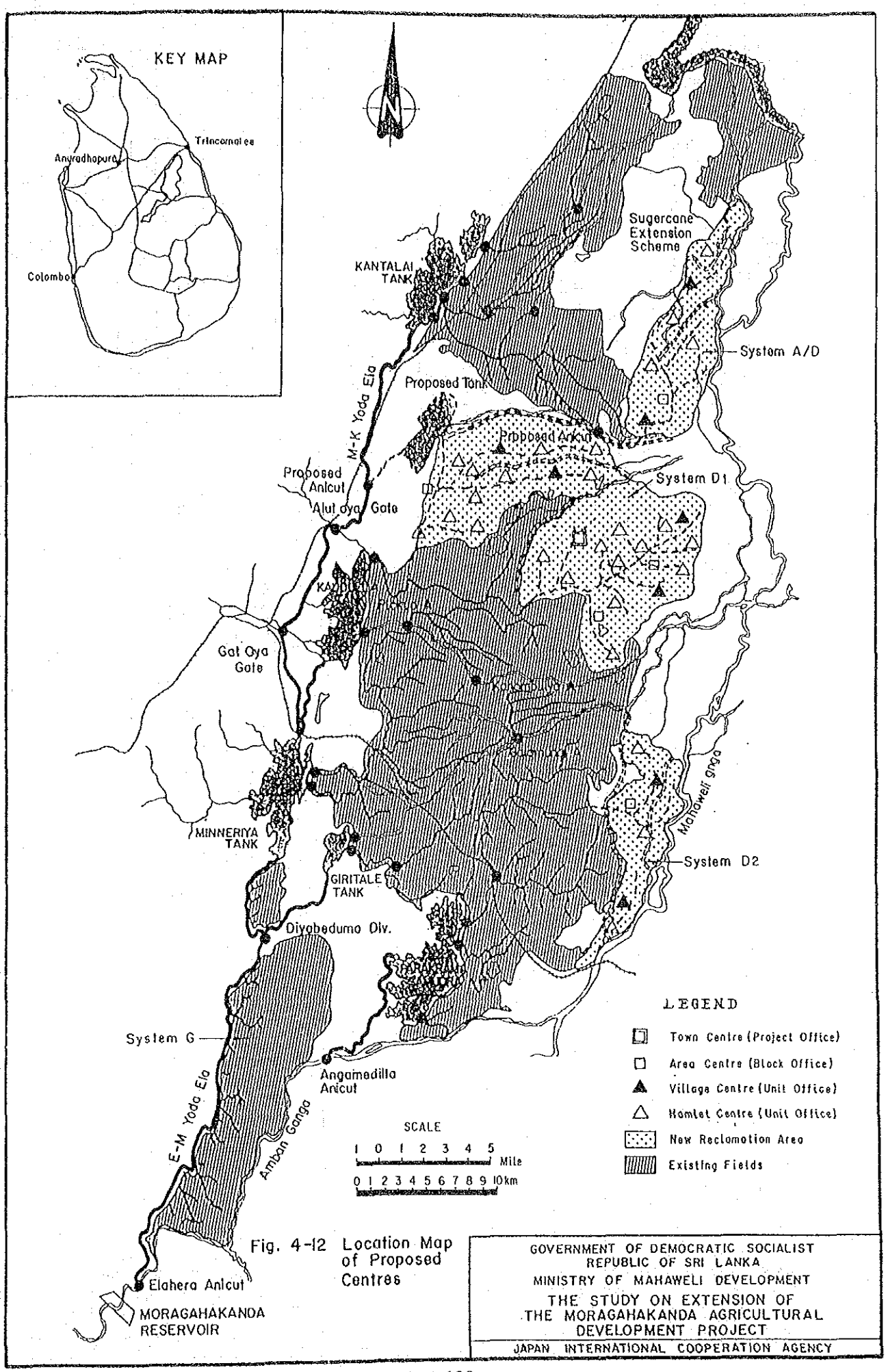

Fig. 4-12 Location Map of Proposed Centres

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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