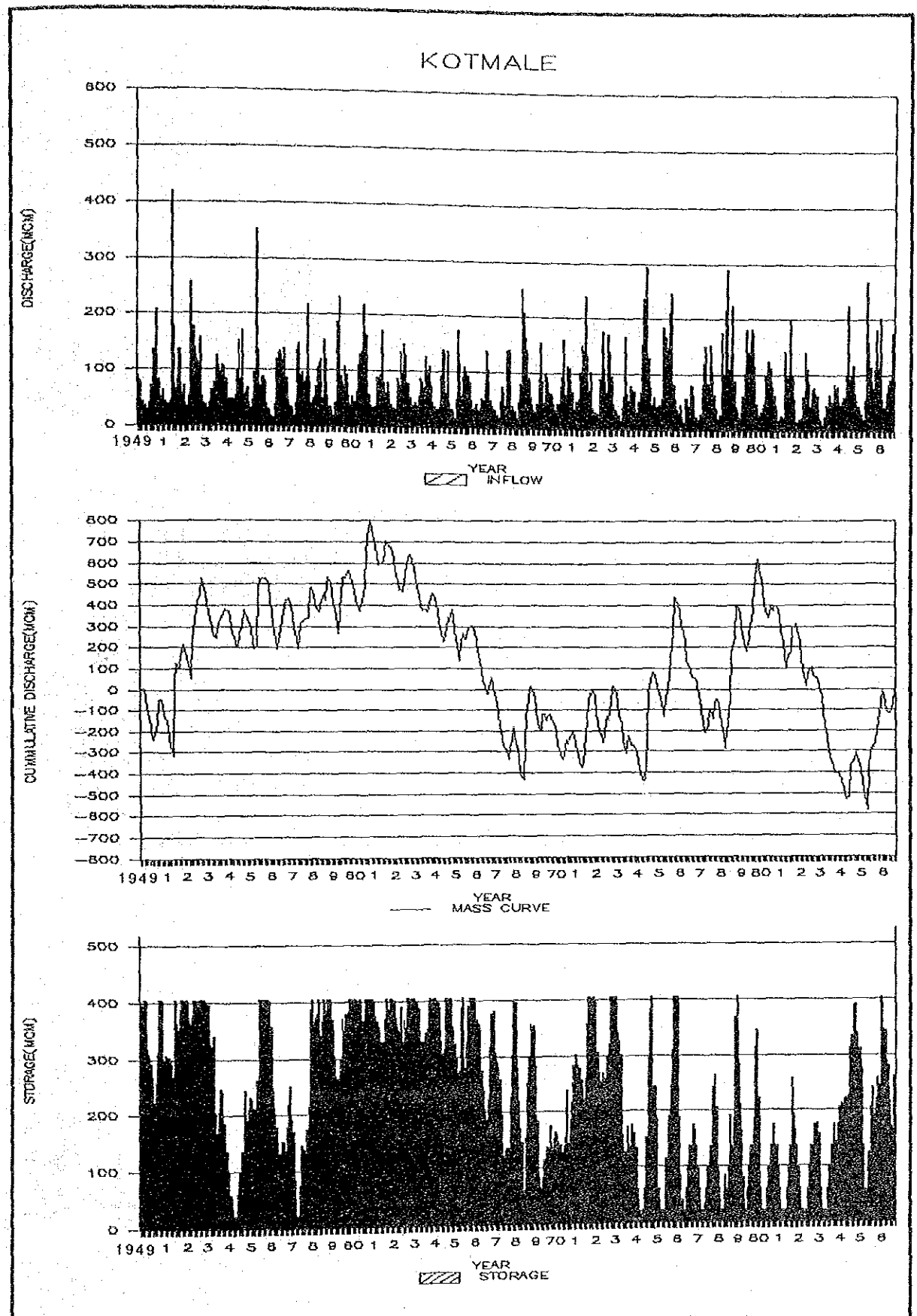

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (1/14)

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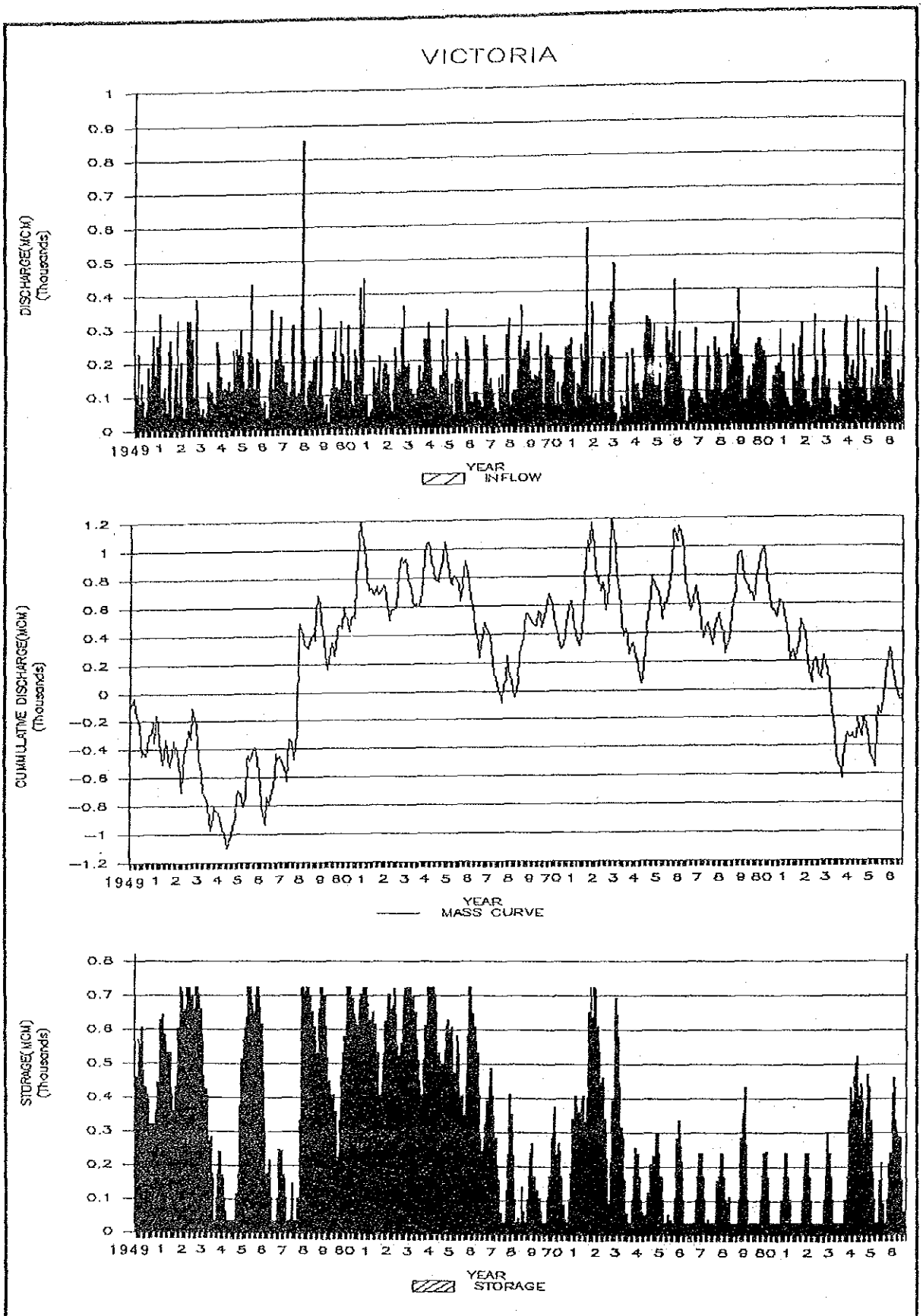

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (2/14)

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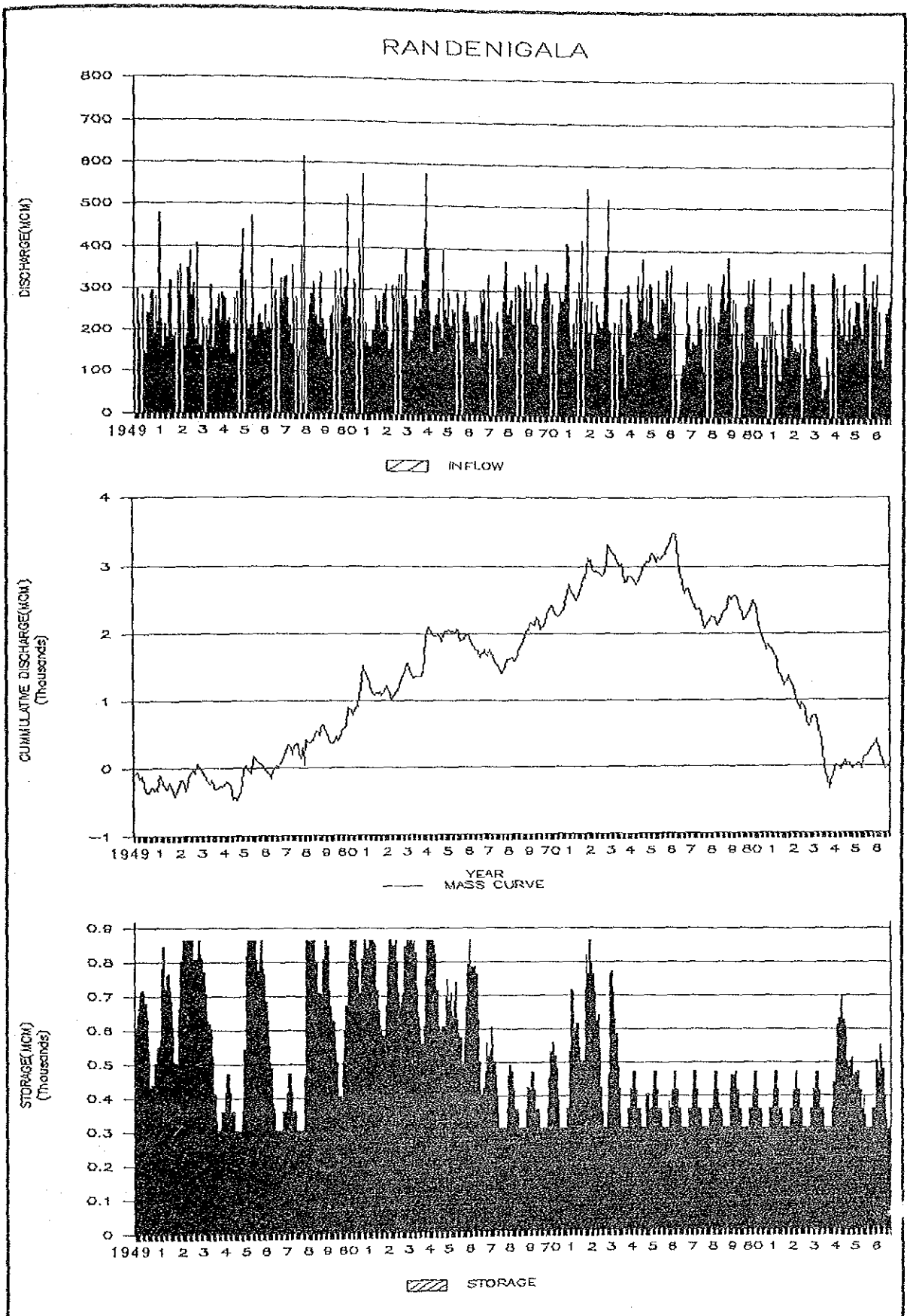

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (3/14)

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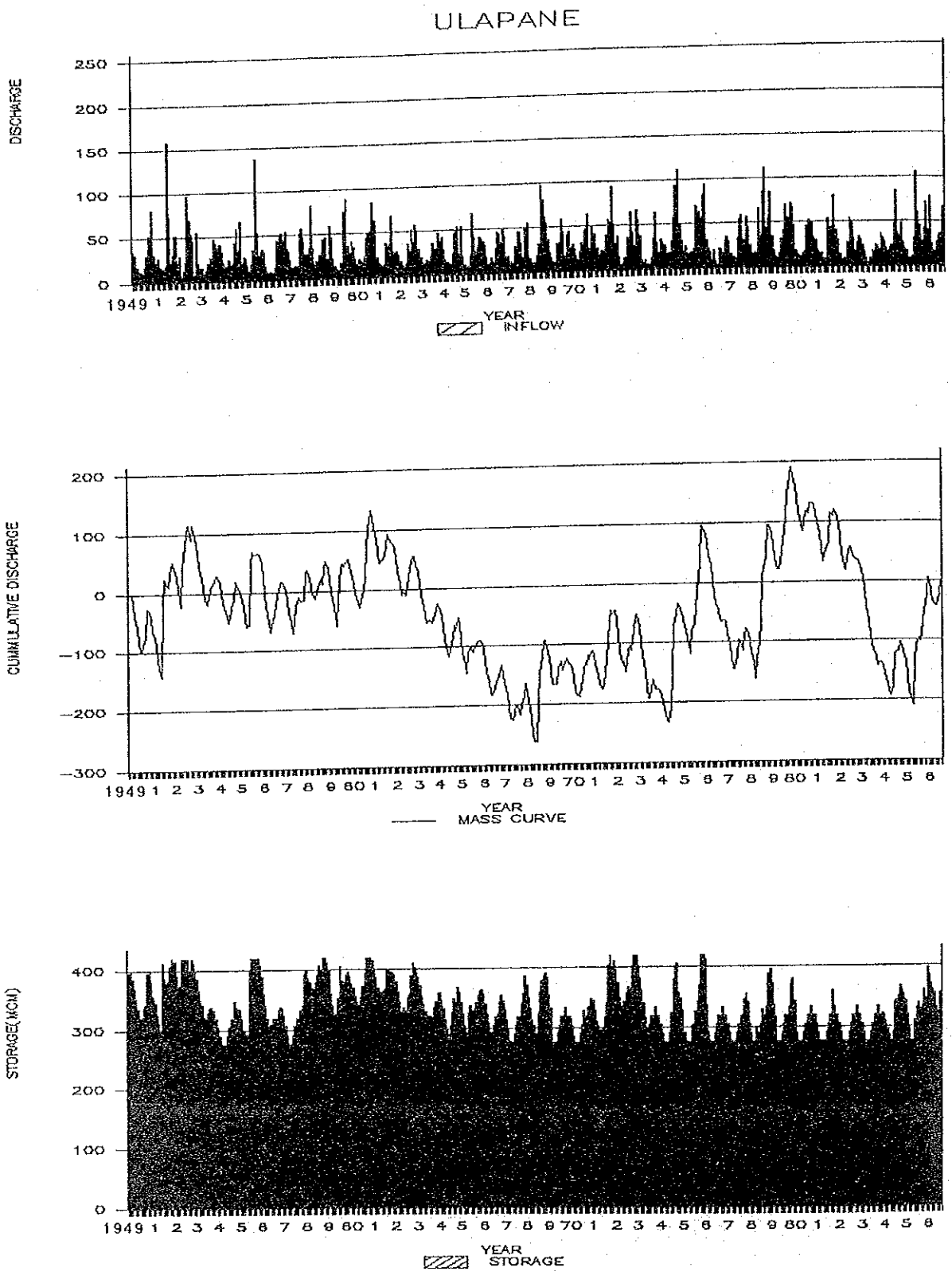

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (4/14)

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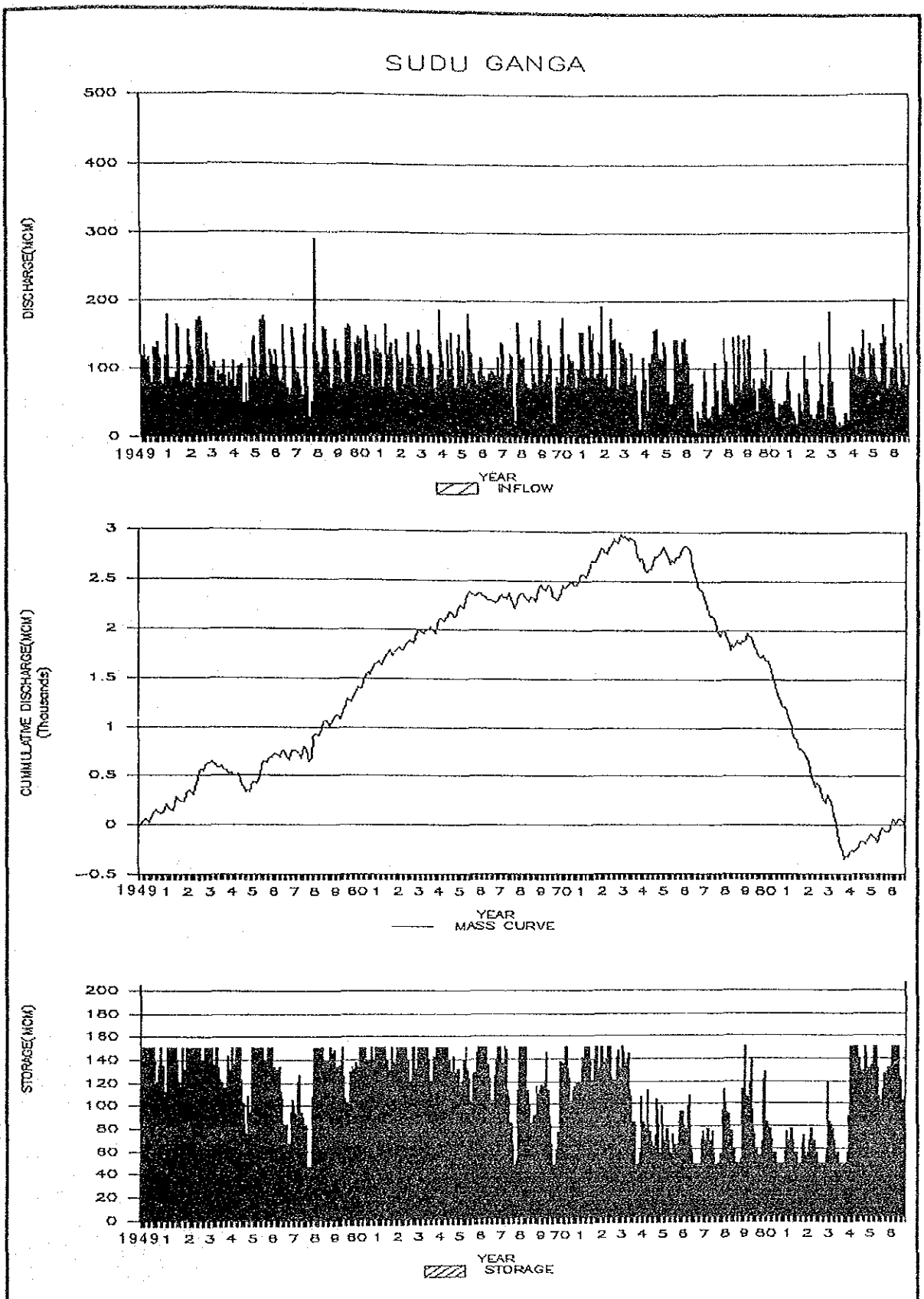

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (5/14)

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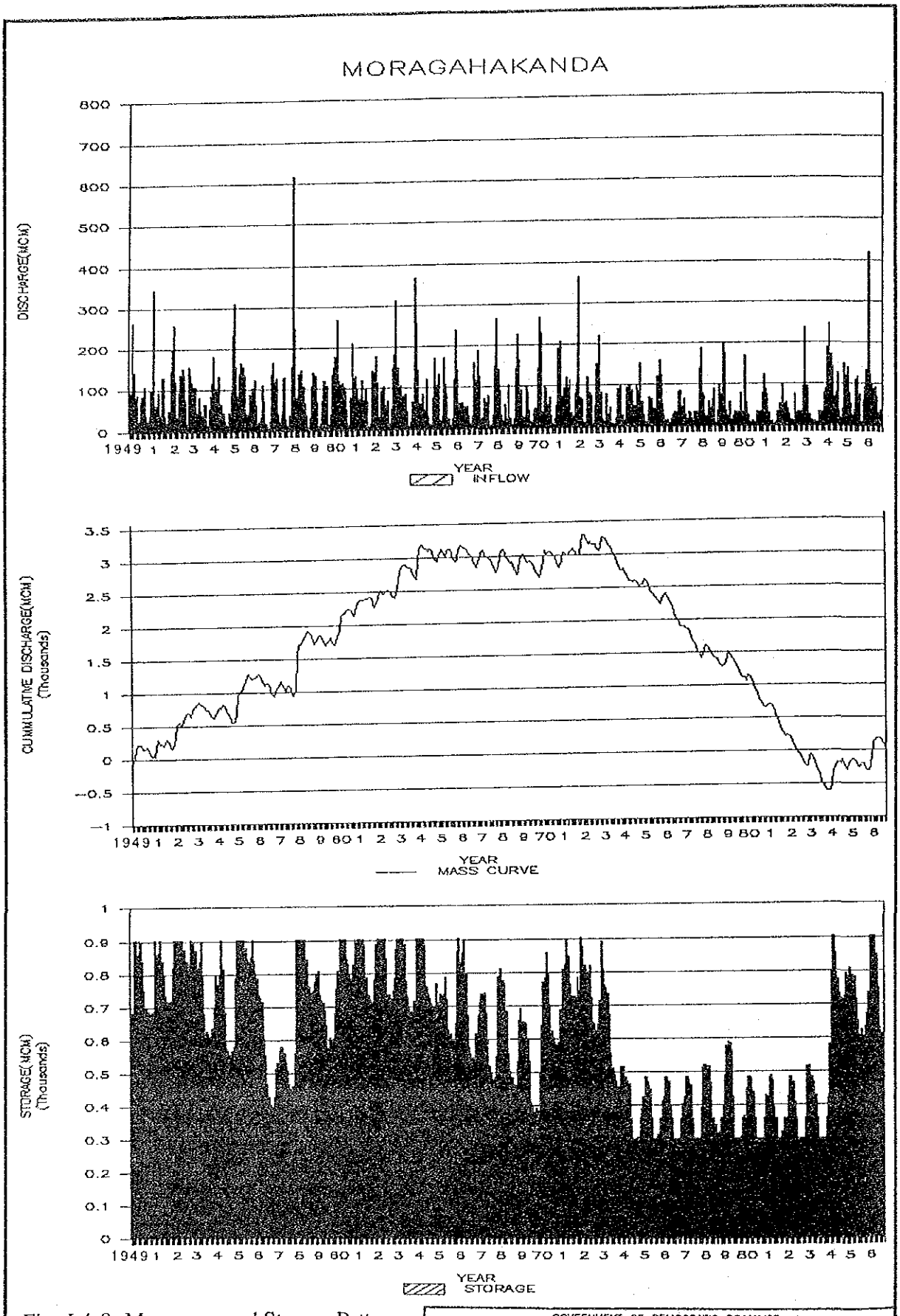

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (6/14)

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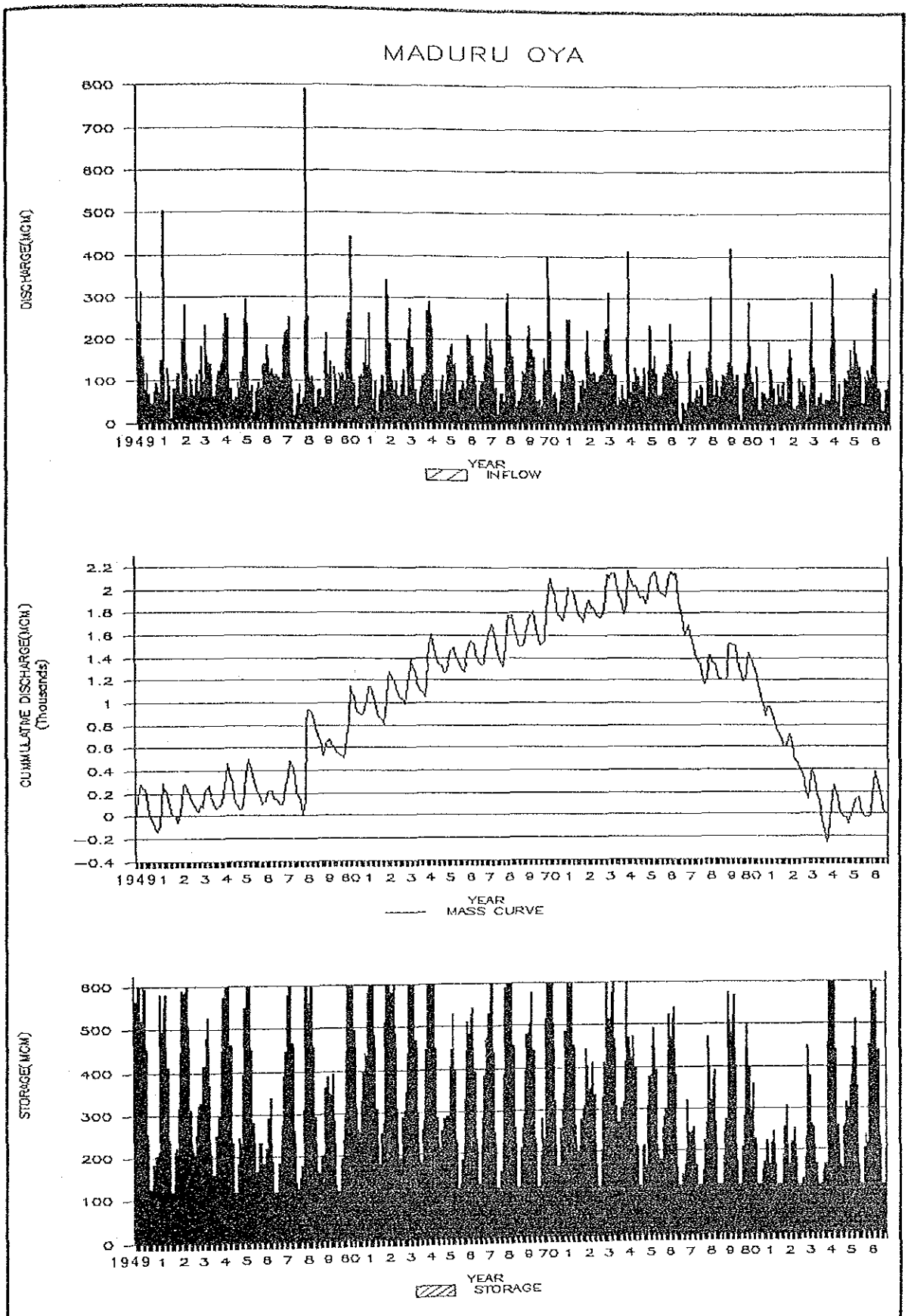

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (7/14)

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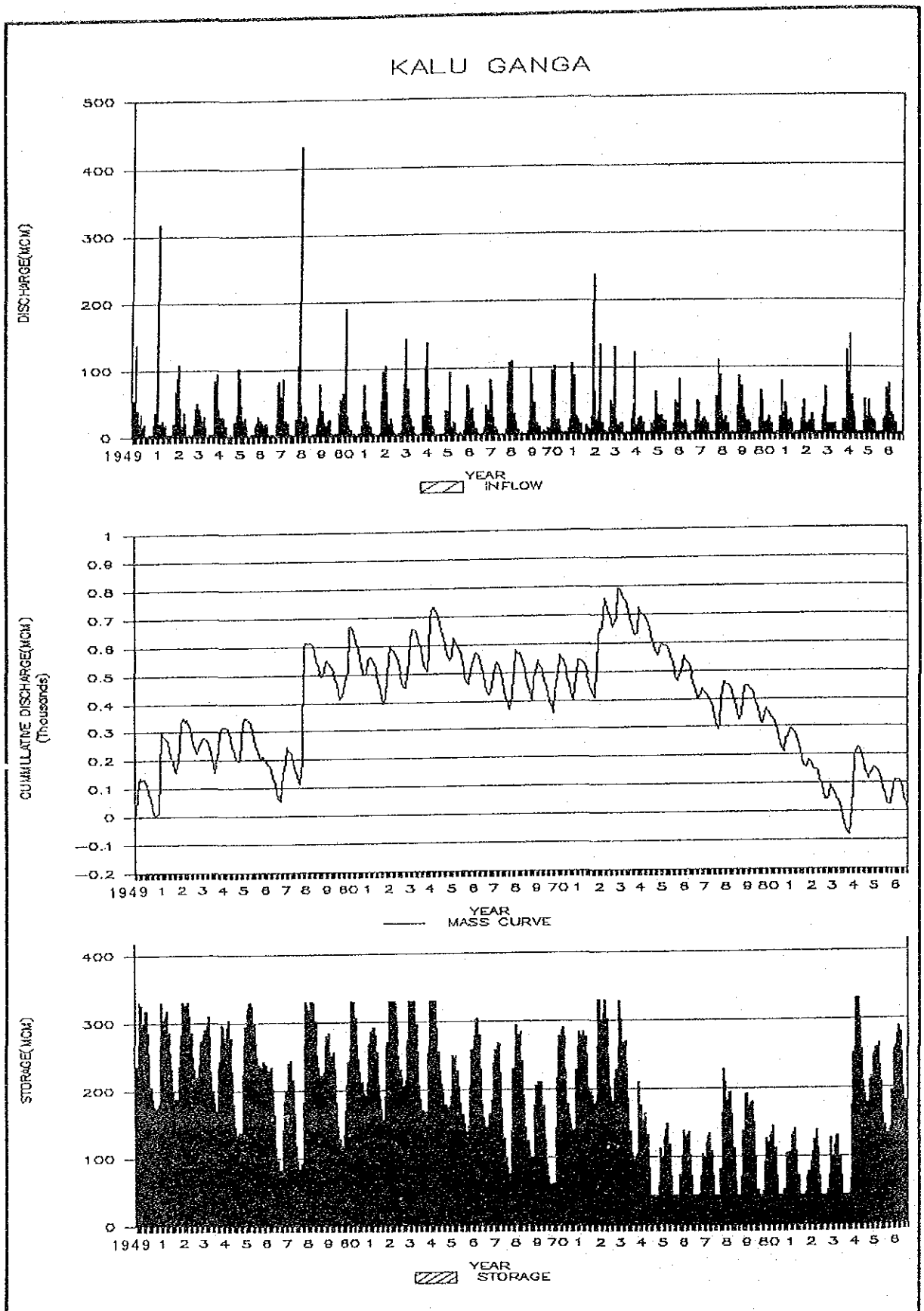

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (8/14)

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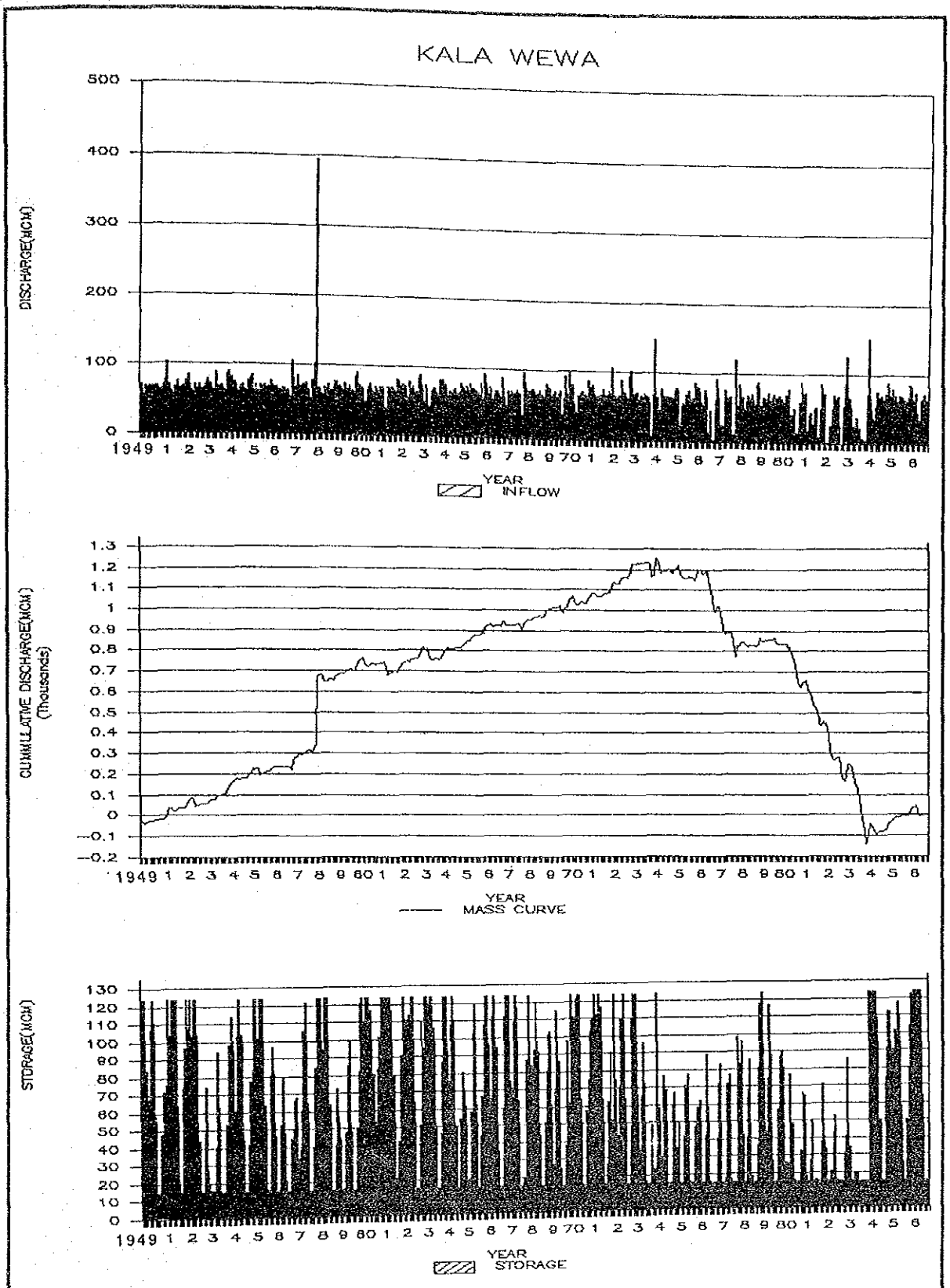

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (9/14)

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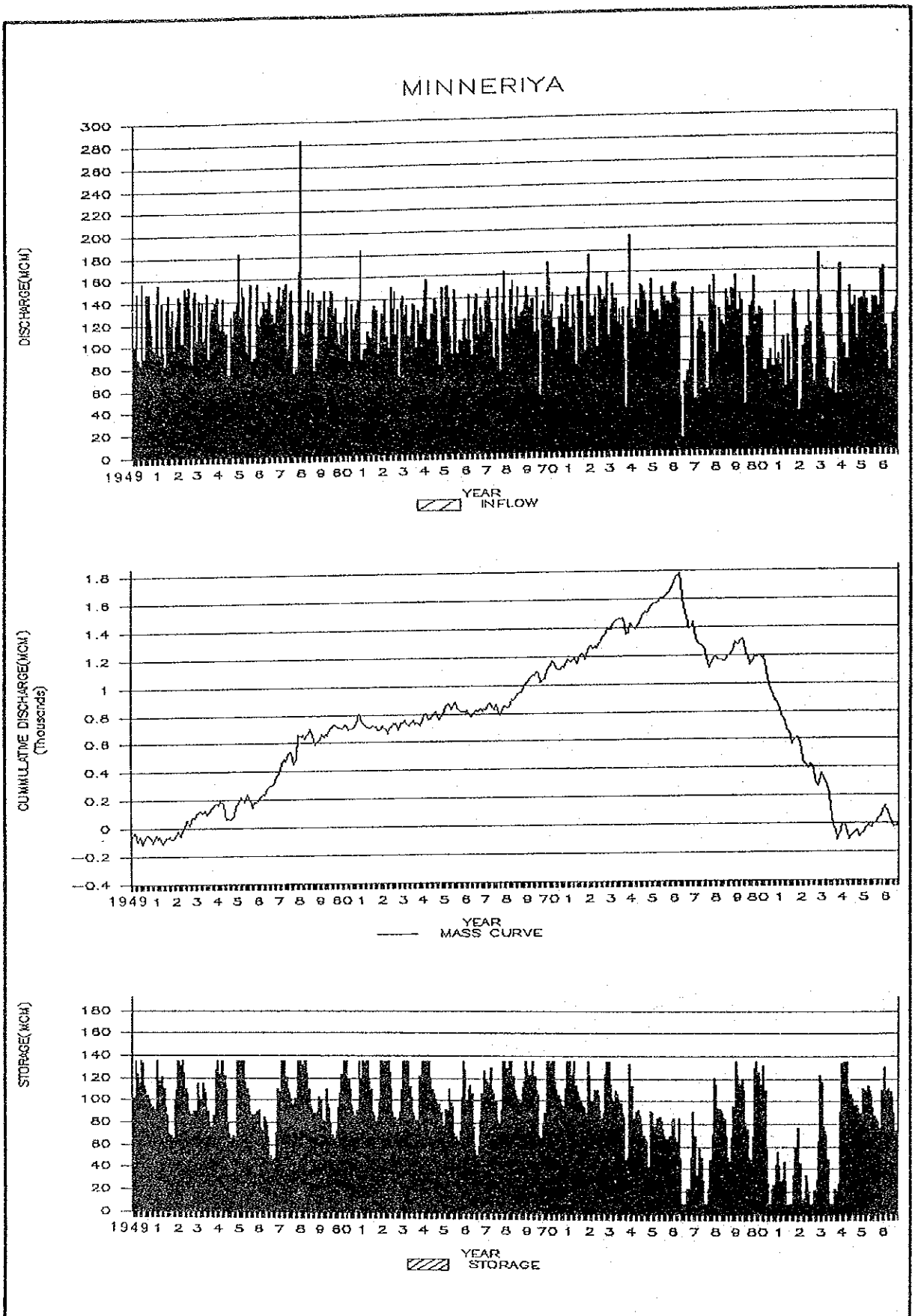

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (10/14)

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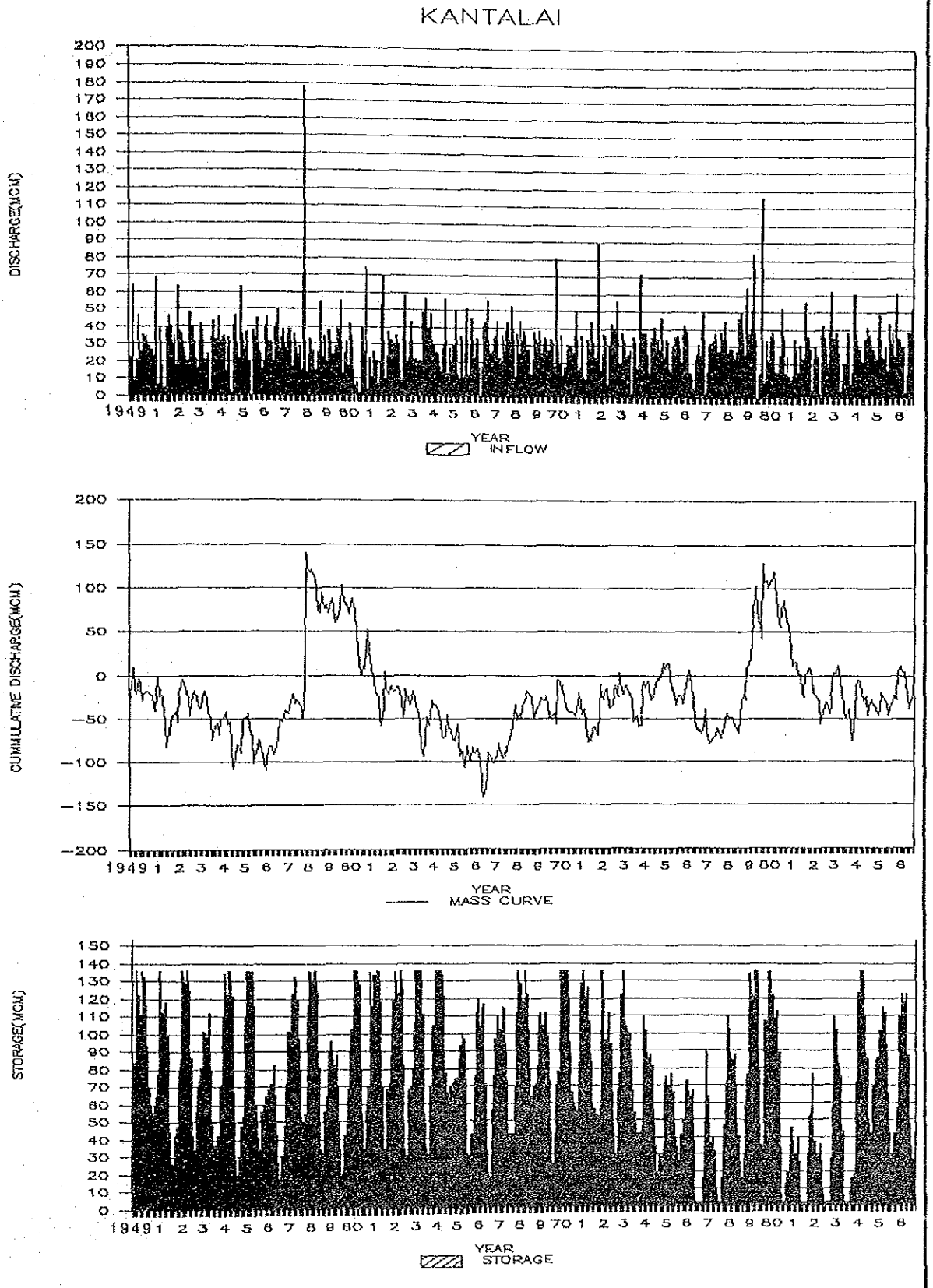

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (11/14)

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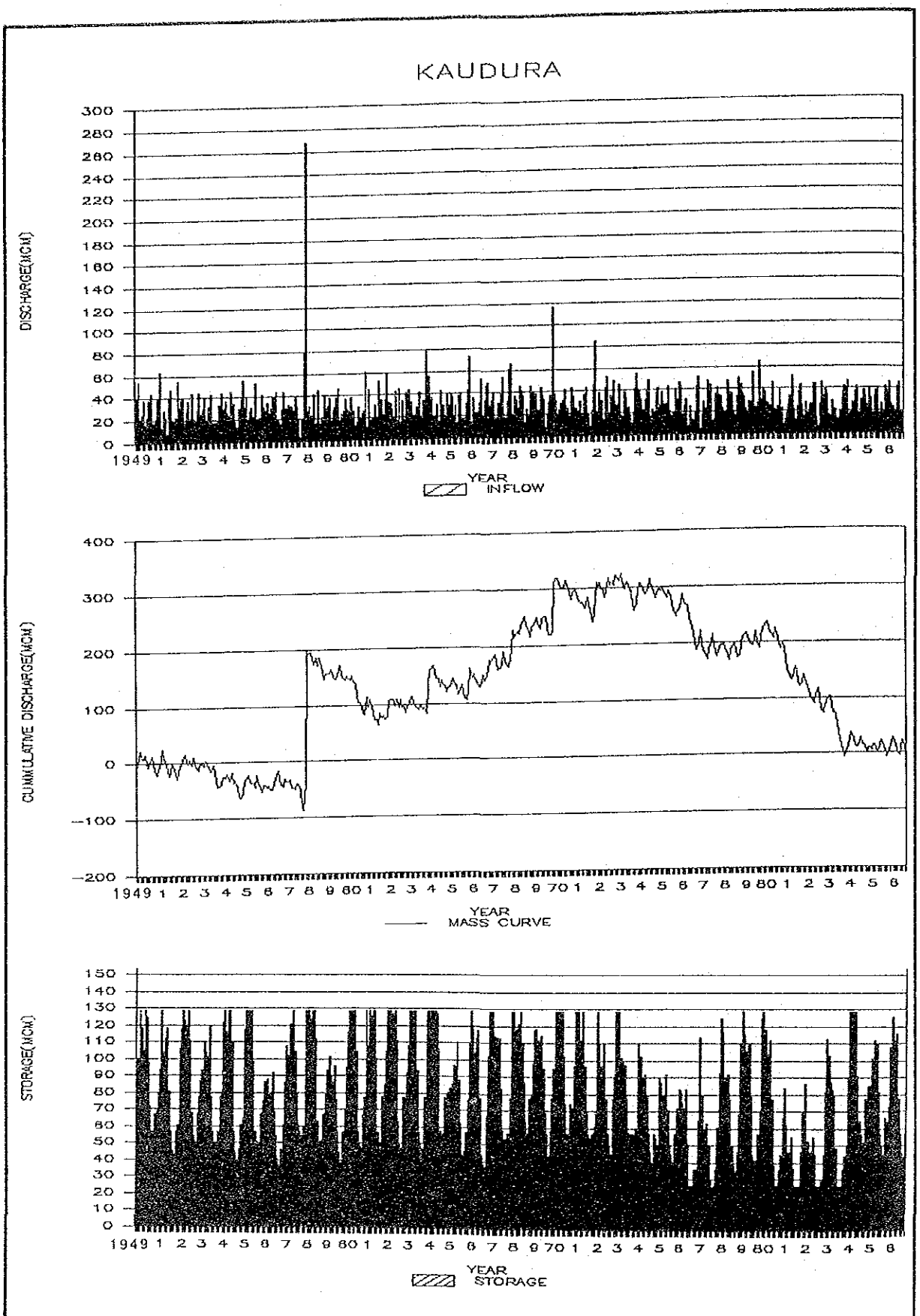

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (12/14)

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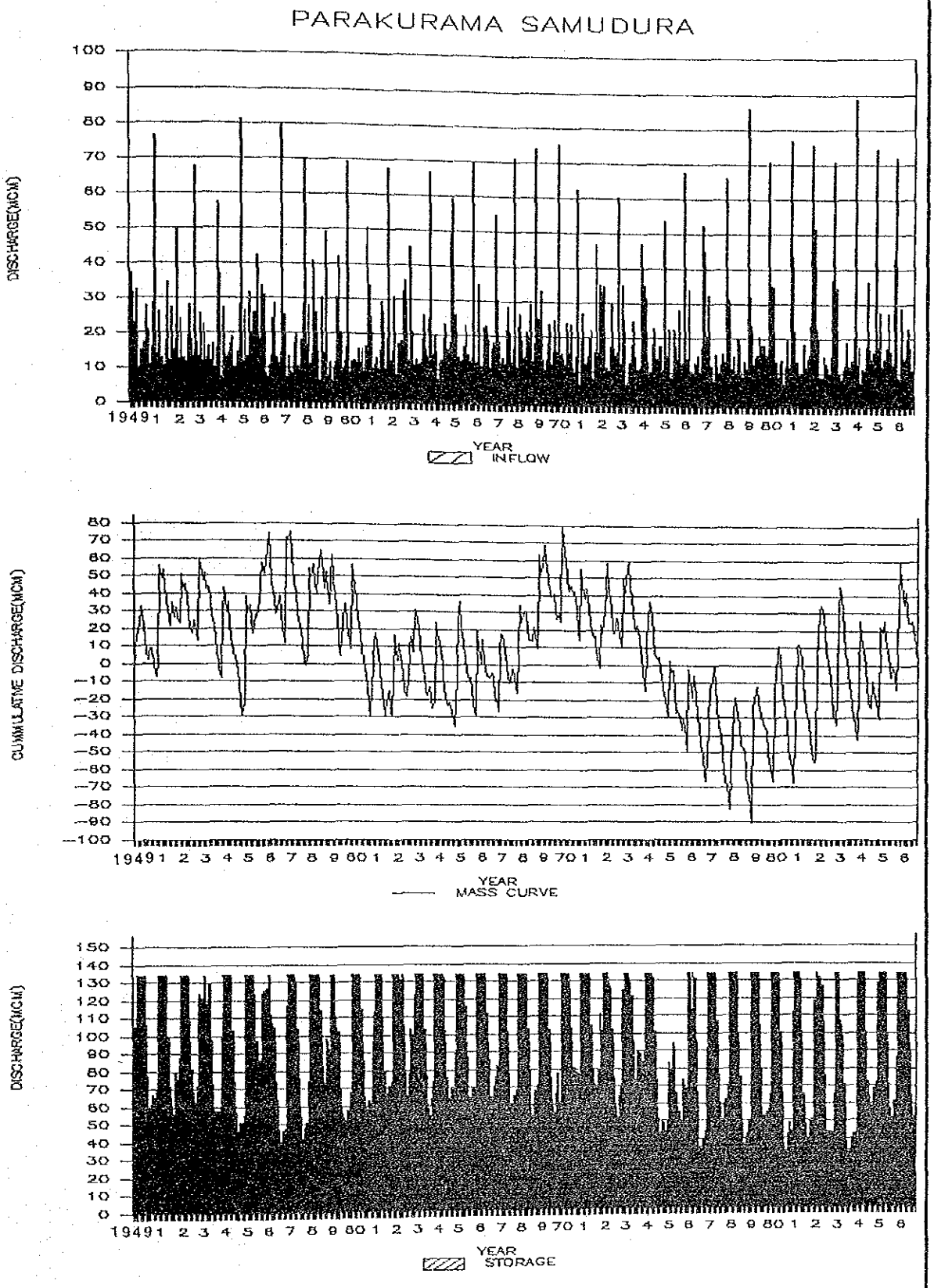

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (13/14)

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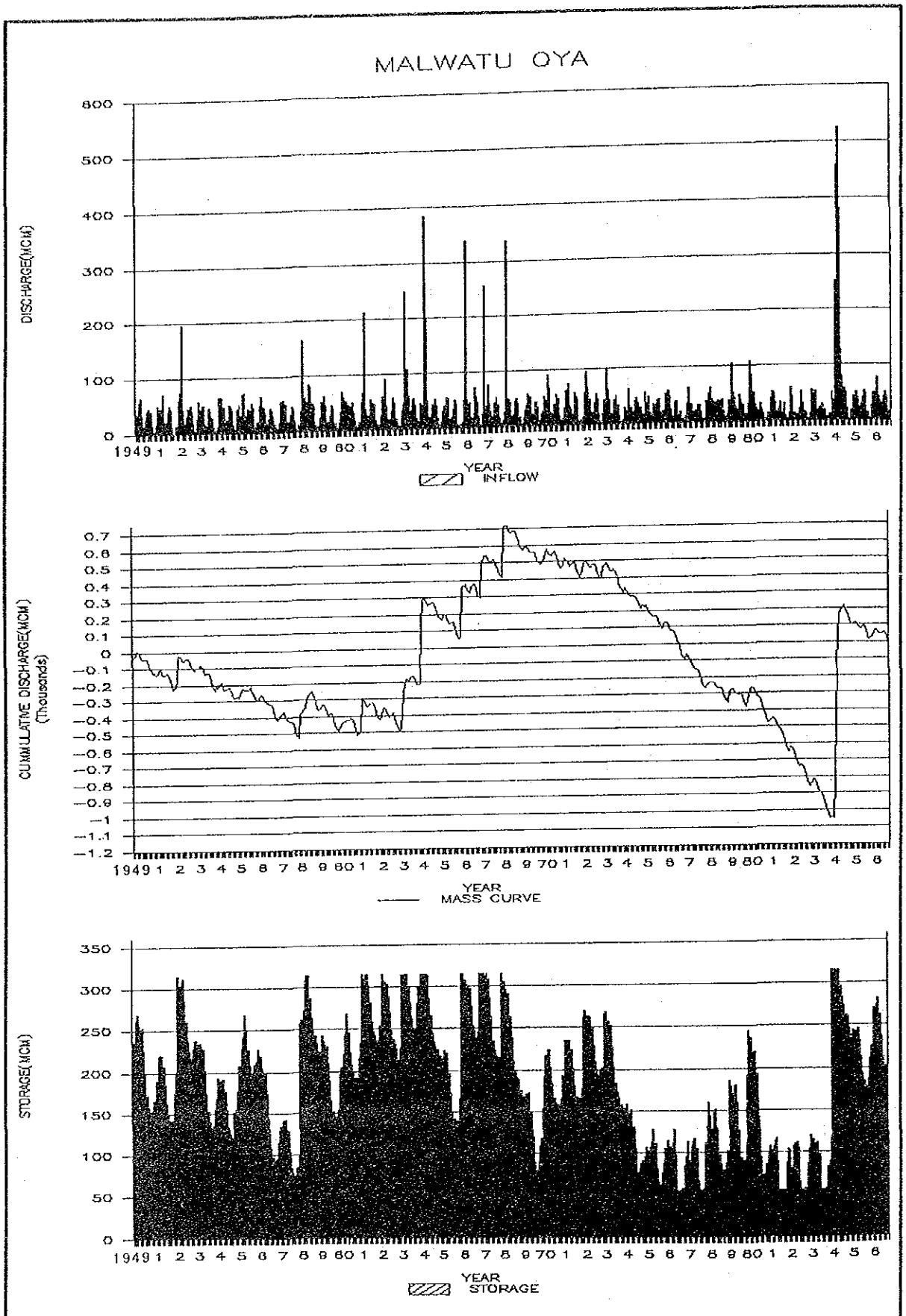

Fig. I.4-8 Masscurve and Storage Pattern (Future Plan: Case A-118) (14/14)

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THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX–J

DESIGN AND COST ESTIMATE

ANNEX - J

DESIGN AND COST ESTIMATE

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ANNEX-J DESIGN AND COST ESTIMATE

J.1 GENERAL

This ANNEX presents the criteria for preliminary design and cost estimate for hydropower dam and irrigation facilities. The design criteria is prepared for the preliminary design of dams, irrigation tanks, transbasin conveyance canals and downstream development including main canals down to field canals. For the design, two inches one mile scale maps (1/31,680) were basically utilized for estimate of work quantity.

Based on the unit rates adopted in the updated Feasibility Study Report on the Moragahakanda Agricultural Development in May 1988, the cost estimate was conducted by applying the following exchange rates: US$1.00 = Rs. 32.50 = Yen 140.

J.2 DESIGN CRITERIA

J.2.1 Basic Data

For the preliminary design, maps in a scale of two inches one mile with a contour of 20 feet interval (1/31,680) were basically utilized, otherwise 1:10,000 map for the Sudu Ganga damsite and 1/63,360 map for a part of System I were utilized . Aerophotographs with a scale of 1/20,000 taken in 1986 were effectively utilized to find out damsites as well as potential irrigation area.

As for Kalu Ganga damsite, the topographic survey was carried out during this study period referring to survey data done in 1969. Map in a scale of 1/1,000 was prepared along the dam axis, and it was utilized for the design of Kalu Ganga dam. In addition to the above, the topographic data for the Master Plan carried out by the UNDP/FAO, the HCP and the TDS were utilized for the study.

J.2.2 Hydropower Schemes

J.2.2.1 General

The major structural components for the hydropower schemes consist of the civil works such as dam, intake, headrace tunnel, surge tank, penstock line, powerhouse and outdoor switchyard, hydromechanical and electrical works such as generating equipment, transmission line and substation.

Layout studies for each scheme to determine damsite, tunnel route, power station site, etc. were carried out on the topographic maps with scales of 1/31,680 or 1/63,360 based on the results of the site reconnaissance and aerophotographs with a scale of 1/20,000.

The preliminary design for the above major structural components was made to estimate the construction cost on the pre-feasibility level, based on the design criteria as described in the following subsections.

J.2.2.2 Design Criteria

(1) Dam Type

Studies were made to determine the suitable dam type for each damsite. For this purpose, only concrete gravity and rockfill types were considered. The study included economic comparison between both types, in consideration of availability of dam construction materials. The design of the dams was made at the pre-feasibility level.

The typical cross selection of the dam was assumed, referring to the existing, under construction and proposed dams in Sri Lanka as follows:

Concrete gravity dam

Width of crest	:	8 m
Upstream surface slope	:	1:0.05
Downstream surface slope	:	1:0.75

Rockfill dam

Central core type		
Width of crest	:	10 m
Core zone slope	:	1:0.30
Filter zone slope	:	1:0.35
Upstream surface slope	:	1:1.80
Downstream surface slope	:	1:1.60

(2) Spillway

A straight open spillway with crest gates was adopted in the design. Design flood of the dams was determined to be a 1000-year probable flood as mentioned in ANNEX-B. The design flood at each damsite is listed below. The spillway was designed to be capable of the peak design flood at the design flood water level of the reservoir.

	Type of Dam	Design Flood (m^3/sec)
Watawala	Concrete	800
Ulapane	Rockfill	6,500
Caledonia	Concrete	2,470*
Talawakele	Concrete	3,500*
Kotmale Extension	Rockfill	5,560
Upper Uma Oya (Scheme - 1000)		
Mahatotila	Rockfil	1,100
Upper Uma Oya	Concrete	1,700
Hal Oya	Concrete	290
Lower Uma Oya (Scheme - 500)		
Lower Uma Oya	Concrete	3,700
Madulla Oya	Concrete	600
Wewatenna	Rockfill	1,500
Sudu Ganga	Rockfill	2,000

Source: * Feasibility Report on Upper Kotmale Hydroelectric Power Development Project, JICA, 1987

A horizontal stilling basin with sub-dam was adopted as the energy dissipator, taking into consideration the economic superiority, and riprapian and social circumstances downstream of the dam.

(3) Reservoir Low Water Level

The low water level of the reservoir was set to be approximately 2.5 times of the diameter of waterway tunnel or conduit higher than the 100-year sedimentation surface in the reservoir. Annual yield of sediment was estimated to be 250 m^3/km^2 as studied in ANNEX-B. It was simply assumed that the sedimentation would accumulate horizontally in the bottom of the reservoir.

(4) Flood Water Level

No flood control space was provided above the high water level except for the Caledonia reservoirs in the study.

(5) Freeboard of Dam

The freeboard above the high water level of the reservoir to the dam crest was fixed to be 2.0 m for the concrete gravity dam and 3.0 m for the rockfill dam.

(6) River Diversion System during Construction

Open channel type or tunnel type was adopted for diversion systems during construction depending on topographical conditions. The following probable floods were applied for diversion systems:

- Rockfill dam : Experienced maximum or 50-year probable flood
- Concrete dam : 10-year probable flood

(7) Headrace Tunnel

The headrace tunnel is of pressure type with the circular cross section. The flow velocity in the tunnel ranges from 2.5 m/sec to 3.5 m/sec. Thickness of the tunnel lining concrete was fixed at 10% of the inside diameter or a minimum of 0.3 m, whichever greater.

(8) Surge Tank

The surge tank was designed to be the restricted orifice type. The inside diameter of the surge tank was determined, referring to those of the existing, under construction and proposed projects. The thickness of lining concrete was fixed at 8% of the inside diameter.

(9) Penstock Line

The flow velocity in the penstock pipe varies from 5.0 m/sec to 7.5 m/sec. The thickness of the pipe shell was calculated by the following formula :

$$t = pD/2TEw + ta$$

Where,
- t : Thickness of pipe shell (cm)
- p : Design water pressure (kg/cm^2)
- D : Inside diameter of pipe (cm)
- T : Allowable tensile stress of steel,
  1,200 kg/cm^2 for low and middle head
  1,600 kg/cm^2 for high head
- Ew : Welding efficiency = 0.9
- ta : Allowance thickness for corrosion = 0.2 cm

(10) River Outlet

River outlet facilities mainly consisting of Hollow jet valve was designed to be provided. The facilities will be used for irrigation purposes in the downstream area, when generating equipment is shut down, or insufficient water is discharged through power waterway and turbine.

Based on the above design criteria, the design of project facilities and structures was made, and the principal features of each scheme are presented in Table J.2.1.

J.2.3 Criteria for Irrigation Tank

J.2.3.1 General

The major function of the irrigation tank is to minimize the design capacity of the conveyance system in the irrigation period as well as to store the surplus water in the rainy season and to release it in the dry season. Therefore the regulating tank is indispensable for the downstream development of each system in the Mahaweli river basin, especially in the NCRB area because of less rainfall. In general, tank adjacent to irrigable area shows the features of low head and long axis dam. Accordingly, the earthfill dam type was proposed for irrigation tanks. The tank with storage capacity less than 5 MCM was not considered due to less impact for the water balance study unless it is located at junction of the system.

The height of dam varies from 10 m to 30 m depending on the topographic condition. The height of dam was designed by the allowable storage of the water for dry season as much as possible in consideration of the least cost per one cubic meter of storage.

The general dimension of tank is divided into three types of its height as tabulated in Table J.2.2.

The dam sites were reviewed on the map with a scale of 1:31,680. The regulating tank was proposed at each system as shown in Fig. J.2-1. Based on the said map, the storage volume and reservoir area were estimated as shown in Figs. J.2-2 to J.2-11.

J.2.3.2 Regulating Water Level

(1) High Water Level

Based on the topographic maps in a scale of 1/31,680 and the information in the previous study, irrigation tank was proposed at the head of each irrigation system. The high water level was decided so as to store water as much as possible, and if topographic conditions allows, storage capacity was kept at about 1,000 - 1,500 mm/ha (unit irrigation area).

Since the detail data for maximum wind velocity at proposed reservoir are not available, the wind velocity of 30 m/sec and fetch distance of 10 km were assumed for the estimate of wave height for the preliminary design. At this stage, assuming that upstream slope of tank as 1:3.5 with riprap protection, freeboard including the height of waving action, the surplus height was estimated at 2.5 m and overflow depth 1.5 m. Therefore, crest elevation was designed at 4 m above Full Supply Level (FSL).

(2) Low Water Level

As described in ANNEX-B, the annual sediment yields were estimated to be 300 to 100 $m^3/km^2/year$, the low water level was designed at least 2 m above the sediment level in 100 years as shown in Table J.2.3.

Based on the area storage volume curve, the active storage of the proposed tanks was fixed as shown in Table J.2.4. The general features of the proposed dam and tank are shown in Table J.2.5.

J.2.3.3 Spillway

Design flood discharge for spillway design was applied at the probable maximum flood of once in 1000 years as shown in Table J.2.6. The general features of the proposed spillway of irrigation tanks are shown in Table J.2.6.

Type of spillway consists of either the fixed weir overflow type or gate control type, and their combined type. The overflow depth was assumed at 1.5 m from the spillway crest for overflow type. The overflow depth of the gate controlled spillway is same as the height of gate.

(1) Overflow Crest Length

By adopting the hydraulic formula, design flood discharge per unit crest length for the fixed weir overflow type was estimated at 3.8 $m^3/sec/m$. Basically, overflow fixed weir type was applied for the tank of flood discharge less than 2,000 m^3/sec. In case of flood discharge more than 2,000 m^3/sec, the gate control type spillway is applied.

(2) Energy Dissipator

There are three types of energy dissipator, namely subdam, roller bucket or free fall dissipator. For the preliminary design the combination of the horizontal stilling pool and subdam type was applied for the estimation of the work quantity.

The major dimensions of the stilling basin as well as subdam are illustrated in Fig. J.2-12.

(3) Diversion during Construction Period

Design flood during the construction period was determined at the 50-year flood discharge as shown in Table J.2.6. Basically an open channel diversion method was considered to be applicable. So as to decide the dimension of diversion works, the allowable flow velocity was decided as follow.

Type	Allowable velocity
Channel	4 m/sec
Tunnel	10 m/sec

J.2.3.4 Intake Gate

The discharge through an intake gate was calculated as pressure free type conduit. In order to release water at the low water level, the centre of a sluice gate was designed at 2 m below the LWL. Size of gate was estimated at conduit size plus 10%.

J.2.3.5 Grouting

The grouting consists of consolidation grouting and curtain grouting. The former is applied for place where seams and joints in rocks are developing and the later is applied for the decrease of permeability in the foundation. At this stage, the consolidation grouting was estimated at 5 m depth in 3 m spacing 3 rows for tanks with the water depth more than 15 m as shown in Fig. J.2-13.

J.2.3.6 Metal Works

As mentioned in the design criteria for the spillway, intake gate and hydraulic metal works were estimated by the head and discharge by adopting the graph presented in Fig. 2-14.

J.2.3.7 Preliminary Design of Kalu Ganga Dam

The Kalu Ganga is one of the tributaries of the Amban Ganga, and the confluence of the Kalu Ganga and Amban Ganga is located at 3 km downstream of the proposed Moragahakanda dam site. The dam site is located at 16 km from its confluence of the

Amban Ganga. The catchment area and the annual runoff are 204 km^2 and 340 MCM, respectively at the proposed dam site as shown in Fig. J.2-15. A masscurve of the runoff is presented in Fig. J.2-16. The major function of the dam is to supply water to the NCRB area through the Kalu Ganga-Elahera and the NCP canals and to supply irrigation water to System F.

As detailed in ANNEX-C, the general geology belongs to the high land series of Pre-Cambrian. The foundation of the dam site is composed of the quartzite, quartz-schist, crystalline limestone, calc-gneiss and charnokites. Since the proposed dam site is located at the mouse of flood plane, terrace deposits are 6 m thick on the bed rock of the left bank foundation and the rock exposure is observed on the right bank. Although the fault seems to be developing at the depression of right bank abutment, the foundation is generally acceptable for the both concrete dam and rockfill dam.

Based on the results of masscurve analysis (Fig. J.2-16) and construction cost per unit storage volume at respect crest elevation as shown in Fig. J.2-17, the crest elevation was fixed at El. 174.0 m. High water level was fixed at El. 170.0 m. Low water level was fixed at El. 148.0 m, in consideration of 100-year sedimentation of 5 MCM and necessary head to divert water to the new NCP canal. The reservoir has a net storage capacity of 290 MCM, created by 22 m drawdown.

As described in ANNEX-B and summarized in Table J.2.6, design flood discharge of 1000-year probable flood was fixed at 2,000 m^3/sec. The combined type of spillway, i.e. gate control and overflow fixed weir type, is adopted. The spillway consists of 3 number of 10 m clear span and 7 m height of gate and 210 m length of overflow fixed weir type at this stage, subject to the hydraulic model test in future. The plan of the Kalu Ganga dam is shown in Fig. J.2-18 and preliminary design is presented in DRAWINGS.

The dam consists of the main dam and 5 saddle dams with crest elevation of El. 174.0 m. Since the crest of the main dam is about 1,200 m long, the main dam is designed by the combined rockfill and concrete gravity dam in consideration of easiness of diversion works during construction. As for construction materials, the core materials will be obtained from the left bank downstream within 5 km distance and rock material will be obtained from the reservoir area within 6 km distance.

J.2.4 Criteria for Canal and Related Structure

J.2.4.1 General

For the preliminary design of the conveyance system, the criteria for design is described in the following subsections. Basically, concrete lining canal and reinforced structures were applied in order to minimize seepage water from canals.

J.2.4.2 Hydraulic Criteria

(1) Open Canal

As shown in Fig. J.2-19, trapezoid canal with 1 on 1.5 side slope, flume section with slope 3:1 and 2R horse shoe type tunnel were applied for the conveyance system. For the hydraulic calculation for the open canal, the Manning formula was applied by using roughness coefficient (n) of 0.015 for concrete lining and 0.030 for earth canal.

The allowable velocity is designed as follows so as to prevent sedimentation and the growth of water plant. The velocity in the related structures was determined to be 1.5 times of that in open canal.

		Allowable Velocity
Open Channel	Earth Canal	0.5 - 0.7 m/sec
	Concrete Canal	0.9 - 1.5 m/sec
Tunnel, Culvert	-	1.5 - 3.0 m/sec
Syphon	-	1.0 - 2.5 m/sec

The ratio between water depth and canal bottom width varies from 1:1 to 1:3 depending on discharges as shown in Table J.2.7 and Fig. J.2-20.

(2) Tunnel

In order to decide a diameter and gradient of a tunnel, the velocity was limited from 1.5 m/sec to 3.0 m/sec. The relationship between discharge and diameter of standard 2R horse shoe type was calculated under free flow condition and the results are illustrated in Fig. J.2-21.

(3) Pipe line

The Hazen Williams formula was adopted for in the pipe line as shown below.

Hazen - Williams

$$V = 0.355\ CD^{(0.63)} \cdot I^{(0.54)}$$

where, C : Velocity coefficient (100; for steel pipe)
D : Diameter of pipe (m)
I : Hydraulic gradient

J.2.4.3 Irrigation Structure

As illustrated in DRAWINGS, reinforced structures were adopted for the conveyance system. As shown in Figs. J.2-22 (1/2) and (2/2), the quantity was assumed

on the following assumptions which were derived from the on-going irrigate projects in Systems C and B. The reinforcement in the structural concrete and concrete in tunnel was assumed at 80 kg/m^3 and 25kg/m^3, respectively.

Structure	Condition	
Bridge	7m width	minimum 5 km interval
Check structure	Radial gate	minimum 2 gates
Regulator/Bridge	Radial gate	minimum 2 gates
DUC	2mx2mx1 barrel	minimum Nos. of barrel/0.7 km
Chute	6 m Height	
Bifurcation	where is diverted to the system	
Spillway	In front of closed canal structure	

(1) Headworks

In this study, head works were planned at Elahera for the intake to the NCP canal. The design flood was estimated at 3,300 m^3/sec which was estimated by the Moragahakanda Feasibility study at once in 100 years probability.

Tail water level of the Moragahakanda was designed at EL. 139.8 m as normal water level and 141.5 m as flood water level.

Flood discharge is to be allowed to pass at flood water level, accordingly, the series of 5 gates and 15 m fixed weir were combined as shown in DRAWINGS. Crest width and length of eplon are assumed by using Bray's correlation.

(2) Pump Station

The installed capacity of pump equipment is calculated as follows:

$$P = 9.8 \times Q \times H \times (1+R)/(np \times ng)$$

P : Required power (kW)
H : Gross head (m) (= ha x 1.1)
ha = Net head
np = Efficiency of pump (0.8)
ng = Efficiency of primary mover (0.96)
R : Allowance (= 0.1)
Q : Discharge (m^3/sec)

Since the discharge and pumping head of a pump unit was planned as more than 10 m^3/sec and about 40 m or more, dimensions of vertical shaft volute type pump was selected by using Figs. J.2-23 and J.2-24.

J.2.4.4 Downstream Development

Downstream development works involve the works for the main canal down to the field canal and land reclamation. At this stage, the concrete lining canals except field canal are designed in order to minimize loss of water.

The canal belonging with this category is classified as follows:

Canal	Commanding Area (ha)	Discharge (m^3/sec)
Main Canal	>2,500	>5.5
Branch Canal	500 - 2,500	1.1 - 5.5
Minor Branch Canal	250 - 500	0.5 - 1.1
Distribution Canal	10 - 250	0.03 - 0.5
Field Canal	<15	<0.03

Although the quantity of conveyance system, main and branch canals as preliminary design is estimated based on the map in a scale of 1 on 31,680. The work quantity for minor branch canal, distributary canal and filled canal, so called on-farm works, is estimated based on actual construction works experienced in the on-going Systems B and C.

J.2.4.5 Drainage Facility

Since the alignment of the transbasin canal is closer to the hilly area with steep slope, the drainage under crossings are required across the canal. The drainage requirement was calculated by adopting the Rational Formula as shown below.

$$Q = 2.75C * IA$$

C : runoff coefficient
- 0.3 Jungle area
- 0.3 Paddy field
- 0.4 Cropped land

A : Catchment area (ha)
I : Intensity of rainfall mm/hr

According to the system A report compiled by the JV Randenigala, maximum rainfall once in 5 years probability is 200 mm for 24 hours duration and 280 mm for 72 hours duration, 103 mm for hourly intensity.

Drainage requirement was calculated at 85 l/sec/ha for drainage requirement from outside area. In case of drainage requirement inside irrigable area was assumed at 5 lit./sec/ha due to surface retention in 5 days.

J.3 COST ESTIMATE

J.3.1 General

The construction cost consists of the direct cost, indirect cost, compensation cost including the relocation cost, land and compensation cost, engineering and administration cost and physical contingencies.

The construction costs were separately estimated for the cost of dam and power, that of conveyance system including conveyance canal and tank, and that of downstream development works comprising of main and branch canals and on-farm works. The unit rates for respective work items were taken from the Moragahakanda Feasibility Study which was updated in May 1988.

J.3.2 Basis of Cost Estimate

The construction costs consist of direct construction cost, compensation cost for the ground facilities including the relocation costs for facilities and land compensation cost, administration cost, engineering service cost, and contingency. The direct construction cost is comprised the civil works cost, hydromechanical works cost and electrical works cost.

The basic conditions and assumptions applied for the cost estimate are mentioned below:

- All the costs were estimated at 1988 price level and no price escalation was also included.

- The following exchange rates were applied:

  US$1.0 = Rs. 32.5 = Japanese Yen 140

- Unit prices of those works were composed of labour cost, material cost, depreciation and operation cost of construction plants and machineries and contractor's overhead. The unit price applied were referred to those in the Updated Feasibility Study of the Moragahakanda Project (Phase I), and in the implementated hydropower and irrigation schemes under the AMDP, as well as in the government fixed unit prices for major work items (MECA). The unit prices for major items are given in Table J.3.1.

- The cost estimate were made under the assumptions that construction works would be performed by international contract system through the competitive tender except on-farm development comprising jungle clearing, rough levelling and construction of distribution and field canals, etc.

- The work quantities of the civil works such as excavation, concrete, dam embankment, transbasin conveyance canals, irrigation tanks, etc. were calculated from the pre-feasibility design as presented in DRAWINGS.

- The cost of generating equipment and transmission line were estimated on the basis of the prevailing international prices.

- The compensation costs were estimated on the basis of the prevailing government exploration cost for land, buildings and other private properties.

- The cost of the government administration and the engineering services for implementation of the project was estimated at 10% of the total estimated direct cost.

- A physical contingency was assumed as 20% of the total estimated project cost.

J.3.3 Construction Cost Estimate

J.3.3.1 Construction Cost for Dam and Power Facilities

The work qualities of the civil works such as excavation, concrete, dam embankment, etc. were calculated from the pre-feasibility design drawings as mentioned in the preceding sub-section J.2.3.

Based on the basic conditions and assumptions stated in the preceding section, the cost estimate was made for each hydropower scheme. The summary and details are shown in Tables J.3.1 and J.3.2 respectively, and the total construction cost for the respective schemes is as follows:

Scheme	Total Construction Cost (US$ Million)
Watawala	44.2
Ulapane	117.0
Caledonia	156.4
Talawakele	215.7
Kotmale, Extension	236.6
Upper Uma Oya (Scheme - 1000)	249.1
Lower Uma Oya (Scheme - 500)	228.5
Wewatenna	83.3
Sudu Ganga	83.1

J.3.3.2 Construction Cost for Irrigation Tank

Work quantities were estimated based on the pre-feasibility design which were prepared in this study and attached in DRAWINGS. Basically, the topographic maps utilized were two inches one mile map (1/31,680) except maps in a scale of 1 to 1,000 for

Kalu Ganga dam site. The work quantities of major items and breakdown of each tank are summarized in Tables J.3.3.

The construction cost for the irrigation tank is shown below:

Name of Tank	Total Construction Cost (US$ million)
Kalu Ganga	142.4
Elahera Regulating Tank	4.8
Kiri Oya Regulating Tank	13.5
Horowupotana	67.1
Yan Oya	72.5
Tammannewa	47.0
Malwatu Oya	37.7
Galgamuwa	16.1
Total	401.1

J.3.3.3 Construction Cost for Conveyance System

Major work quantities for each system were estimated based on the pre-feasibility design attached in DRAWINGS, and are summarized in Table J.3.3. Cost estimate of the alternatives as described in ANNEX-H was made by using the unit rates and work quantities. The breakdown of each route of transbasin conveyance system is presented in Table J.3.3.

The construction costs of respective the alternatives as described in the ANNEXES-H and I, are presented in Tables J.3.6 to J.3.11.

J.3.3.4 Construction Cost for Downstream Development

As for main and branch canal, the work quantities were estimated by the preliminary design on the map in a scale of 1/31,680 as described in ANNEX-F.

The on-farm development is divided into three categories in terms of construction costs depending on the present status of the land, such as the existing irrigation area, the rainfed area and the newly developing area. Referring to the projects under construction and on-going in Systems B and C, the direct construction costs were estimated as follows and detailed in Table J.3.4.

Category	Work Involving	Unit Direct Construction Cost (US$/ha)
Existing irrigation area	Rehabilitation, part of lining and improving structure	200
Development for cashew nut	Land preparation	300
Rainfed or minor irrigation scheme	On-farm development clearing etc.	2,200
New irrigation area	On-farm development	2,500

The construction cost for the irrigation development including engineering and administration costs as well as physical contingencies is summarized as follows and detailed in Tables J.3.6 to J.3.11.

System		New Land (ha)	Rehabilitation (ha)	Cashew (ha)	Total (ha)	Construction Cost (Million US$)
NCRB						
System	F	1,900	-	-	1,900	7.7
	MH	12,000	4,300	10,000	26,300	66.6
	M	25,000	-	-	25,000	123.3
	I	38,600	12,700	10,000	61,300	239.5
	H	-	42,400	-	42,400	11.7
	IH	-	4,700	-	4,700	1.3
Sub-total		77,500	64,100	20,000	161,600	450.1
NWDZ		10,700	2,550	-	13,250	67.7
Total		88,200	66,650	20,000	174,850	517.8

J.3.4 Compensation Cost

The compensation cost was estimated on the basis of the present land use of the tank and reservoir areas where were the aerophotograph taken in 1982. Land acquisition costs were estimated on the basis of the updated report of the Moragahakanda Project as shown below, and the compensation costs for the proposed reservoir sites were shown in Table J.3.5.

Item	Unit	(Rs)
Paddy land	ha	40,000
Upland and Plantation	ha	20,000
Forest	ha	-
Residence	No.	30,000

J.3.5 Operation & Maintenance Cost and Replacement Cost

As shown below, metal works, generating equipment, transmission and substation equipment, pump equipment is to be replaceable with 30 years lifetime. For irrigation facility, gate and other metal works is counted 25 years lifetime. A salvage value of 10% is to be considered.

Items	Useful Life (years)
A. Dam & power	
- Hydromechanical works	30
- Power generating equipment	30
B. Irrigation facilities	
- Gate	25

Operation and Maintenance cost was estimated at 0.5% of the initial investment costs for dam, 2.5% for power and other electrical equipment and 0.75% for transbasin canal and irrigation system as summarized in Tables J.3.12 to J.3.17.

With regard to the running cost for pump station, the energy cost is taken as an average of the firm energy value and the secondary energy value as shown below:

Unit cost of the energy consumed = (US$0.0674 + US$0.0298)/2
= US$0.0486/kWh

J.3.6 Project Cost

J.3.6.1 Construction Cost

Case studies in terms of the development area and conveyance system were conducted, and the construction costs for respective alternatives were estimated based on the conditions and assumptions described in the preceding sections, and the summary of construction costs for respective plans is shown in Tables J.3.6 to J.3.11.

J.3.6.2 Economic Cost

The estimated financial cost based on the market price was adjusted to the economic cost, by adopting a Standard Conversion Factor of 0.85 for the local currency portion. Since there is substantial unemployment in rural areas, the shadow wage rate of 70% of market wage for unskilled labour is taken into account. The economic costs of respective schemes for hydropower and irrigation are presented in Tables J.3.1 to J.3.17.

TABLES

Table J.2.1 MAJOR FEATURES OF CANDIDATE HYDROPOWER SCHEMES (1/2)

Item	Unit	Watawala	Ulapane	Caledonia	Talawakele	Kotmale*1 Extension
1. General						
River		Mahaweli Ganga	Mahaweli Ganga	Kotmale Oya Mahaweli Ganga	Kotmale Oya Mahaweli Ganga	Kotmale Oya Mahaweli Ganga
Catchment area	(km2)	69	220	235	363	562
Annual average Runoff	(m3/s)	3.8	12.1	13.1	20.0	31.2
	(MCM)	119	381	412	631	984
2. Dam						
Type		Concrete gravity	Rockfill with Concrete gravity	Concrete gravity	Concrete gravity	Rockfill
Crest elevation	(EL. m)	1,034	603	1,365	1,203	735
Crest length	(m)	200	500	270	102	945
Height	(m)	60	70	70	20	115
Volume	(1000m3)	92	2,370	250	18	4,270
3. Spillway						
Design capacity	(m3/s)	800	6,500 (782 km2)	2,470 (175 km2)	3,500 (297 km2)	5,560
Dimension nos.xBxH	(m)	2x8x7	3x18x15	-	3x8x12	3x14x15
4. Reservoir						
Flood water level	(EL. m)	1,032	600	1,363.5	1,200	732.8
High water level	(EL. m)	1,032	600	1,360	1,200	731.5
Rated water level	(EL. m)	1,024	597	1,353	1,198	723
Low water level	(EL. m)	1,010	590	1,341	1,193	665
Net storage volume	(MCM)	20	150	30	2	383
5. Headrace Tunnel						
Length	(m)	2,100	5,000	2,982	13,066	6560
Inside diameter	(m)	2.4	4.5	3.9	4.4	4.4
6. Surge Tank						
Height	(m)	55	50	55	93	168
Inside diameter	(m)	7	15	15	15	12
7. Penstock Tunnel/Line						
Type		Above-ground	Above-ground	Tunnel	Tunnel	Tunnel
Length	(m)	220	200	218	734	402
Inside diameter	(m)	2.2-1.7	2.8-2.4	4.1- 3.2	4.7-3.4	4.8-5.5
8. Power Station						
Firm discharge	(m3/s)	2.3	9.5	6.7	9.2	29.8
Max. plant discharge	(m3/s)	11.5	47.5	35.0	50.0	112.3
Gross head	(m)	192-170	120-110	167-141	545-490	251.5-185
Rated head	(m)	179	109	144	468	233
Installed capacity	(MW)	2x9	2x22	1x44	3x68	3x80
Dependable peak power	(MW)	15.9	40.6	44	204	39 *
Annual energy output	(GWh)	49	91	135	674	59 *
Firm		31	75	70	364	209 *
Secondary		18	16	65	310	-150 *
Type		Above-ground	Above-ground	Underground	Underground	Underground
Nos.of unit		2	3	1	3	3
Type of Turbine		Francis	Francis	Francis	Francis	V.Francis
Tailwater level	(EL-m)	840	480	1,200-1,193	703-731.5	480
9. Construction Cost	(US$ 10^6)	44.2	117	156.4	215.7	236.6

Remarks: * shows incremental value.
*1 Referred to 'Kotmale Hydropower Project', Report on Future Raising of Dam and Spillway, October 1985, Halcrow Water

Table J.2.1 MAJOR FEATURES OF CANDIDATE HYDROPOWER SCHEMES (2/2)

Item	Unit	Upper Uma Oya Scheme - 1000	Lower Uma Oya Scheme - 500	Wewatanna	Sudu Ganga
1. General					
River		Uma Oya Mahaweli Ganga	Uma Oya Mahaweli Ganga	Badulu Oya Mahaweli Ganga	Sudu Gganga Mahaweli Ganga
Catchment area	(km2)	421	622	267	305
Annual average	(m3/s)	11.2	16.6	6.6	36.5
Runoff	(MCM)	394	523	207	1,152
2. Dam					
Type		Rockfill with Concrete gravity	Concrete gravity	Rockfill with Concrete gravity	Rockfill with Concrete gravity
Crest elevation	(EL. m)	973	502	233	328
Crest length	(m)	565	150	500	400
Height	(m)	90	25	80	55
Volume	(1000m3)	3,900	15	2,700	1,320
3. Spillway					
Design capacity	(m3/s)	1,700	3,700	1,500	2,000
Dimension nos.xBxH	(m)	3x7x10	3x10x12	3x8.5x12	3x9x12
4. Reservoir					
Flood water level	(EL. m)	970	500	230	325
High water level	(EL. m)	970	500	230	325
Rated water level	(EL. m)	947	498	220	317
Low water level	(EL. m)	910	495	200	300
Net storage volume	(MCM)	60	1.5	90	100
5. Headrace Tunnel					
Length	(m)	12,200	15,000	3,000	-
Inside diameter	(m)	4.5	4.8	3.1	-
6. Surge Tank					
Height	(m)	80	30	50	-
Inside diameter	(m)	15	15	12	-
7. Penstock Tunnel/Line					
Type		Tunnel	Tunnel	Above-ground	Above-ground
Length	(m)	700	1,000	150	120
Inside diameter	(m)	3.8-2.9	4.1-3.0	2.0-1.7	3.5-3.1
8. Power Station					
Firm discharge	(m3/s)	7.9	9.1	4.3	23.6
Max. plant discharge	(m3/s)	39.7	45.5	22.8	101.2
Gross head	(m)	470-400	297-263	125-90	55-30
Rated head	(m)	434	251	114	47
Installed capacity	(MW)	3x50	3x32	2x11	2x22.5
Dependable peak power	(MW)	128.9	96	19.7	23.8
Annual energy output	(GWh)	342	310	69	122
Firm		201	192	36	74
Secondary		141	118	33	48
Type		Above-ground	Under-ground	Above-ground	Above-ground
Nos.of unit		3	3	2	2
Type of Turbine		Pelton	Francis	Francis	Francis
Tailwater level	(EL-m)	500	232-203	105	270
9. Construction Cost	(US$10^6)	249.1	228.5	85.5	83.1

Table J.2.2 SUMMARY OF CRITERIA FOR IRRIGATION TANKS

Height	Rock Fill (Central Core Type) >15m	Earth Fill (1) >15m	Earth Fill (2) 15m<=
Width of Crest (m) 10	10	8	7
Centre core slope	0.35	-	-
Upstream slope	1.8	3.5	3.0
Downstream	1.6	3.0	2.5
Bottom width of Core (m) Min.	10	8	7
Depth of Core	To Firm Rock	H/3	H/3
Berm Interval	-	10 m	10 m
Toe Drain Height	-	H/3	H/3
Filter	-	On Foundation	1 m
Riprap	-	Horizantal 3m	ditto 2m
Surcharge Depth	1.5	1.5	1.5
Freeboard	2.5	2.5	2.5

Table J.2.3 ESTIMATED SEDIMENTATION OF EACH RESERVOIR

Name of Dam and Tank	Catchment Area (Km2)	Sediment Yield Rate (M3/Km2/Year)	100-years Sediment Yield MCM	Assumed Sediment Surface (El.m)
Hydropower Scheme				
Upper Kotmale				
Caledonia	175	500 *	8.8	1,333.5
Talawakele	363 (182)	500 *	9.1	1,191.0
Kotmale Ex.	562 (199)	500	10.0	663.0
Upper Mahaweli				
Watawala	69	250	1.7	990.0
Ulapane	782 (158)	250	4.0	555.0
Sudu ganga				
Sudu 09	305	250	7.6	288.0
Uma Oya				
Mahatotila	168	250	4.2	900.0
Uma Scheme-1000	204	250	5.1	-
Uma Scheme-500	521 (353)	250	8.8	490.0
Badulu Oya				
Wewatenna	267	250	6.7	187.0
Irrigation Tank				
NCRB				
Kalu ganga	204	250	5.1	138.0
Horowupotana	950	250	23.8	35.0
Yan Oya (M)	1,320	250	32.5	25.5
Kitulgala	104	100	1.0	72.0
Mukunuwewa (L)	150	100	1.5	70.5
NWDZ & NCP				
Galgamuwa	10	100	0.1	85.0
Tammannewa	64	100	0.6	104.0
Malwatu Oya (I)	2,100	100	21.0	49.0
Parangi Aru (J)	430	100	4.3	45.0
Pali Aru (J)	100	100	1.0	60.5
Kanagarayan (K)	90	100	0.9	63.5
Gallodai	95	100	1.0	61.0
Maha Oya	230	100	2.3	55.5
Rambukan Oya	140	100	1.4	50.0
Magalawatawan	115	100	1.2	49.5
Kiri Oya	115	100	1.2	98.0

Remark * : Referred to Feasibility Study on Upper Kotmale Hydroelectric Power Development Project, JICA, 1987.

Table J.2.4 DESIGN WATER LEVEL AND STORAGE CAPACITY OF RESERVOIR AND TANK

Name of Reservoir	Catchment (km)	H.W.L. (m)	Storage (MCM)	F.S.L. (m)	Storage (MCM)	L.W.L. (m)	Storage (MCM)	Active Storage (MCM)
Hydropower Scheme								
Caledonia	235	1,360	45.7	1360	45.7	1,341	15.7	30.0
Talawakele	363	1,200	2.6	1200	2.6	1,193	0.6	2.0
Kotmale Extension	562	732.8	408	731.5	405.1	665	22.2	382.9
Watawala	69	1,032	24	1,032	24	1,010	7	17.0
Ulapane	782	600	420	600	420	590	260	160.0
Sudu Ganga	305	325	150	325	150	300	46.5	103.5
Uma Scheme-1000	168	970	65.3	970	65.3	910	5	60.3
Uma Scheme-500	622	500	5.5	500	5.5	498	4.5	1.0
Wewatenna	267	230	122	230	122	200	32	90.0
Irrigation Tank								
Kalu Ganga	204	171.5	350.0	170.0	330.0	148.0	40.0	290.0
Horowupotana	950	67.0	490.0	65.5	410.0	58.0	70.0	340.0
Yan oya	1,320	42.5	380.0	41.0	300.0	30.0	15.0	285.0
Kitulgala	104	86.5	76.0	85.0	55.0	73.0	6.5	48.5
Mukunuwewa	142	92.5	228.0	91.0	197.0	73.0	9.0	188.0
Galgamuwa	11	101.5	64.0	100.0	58.0	90.0	13.0	45.0
Tammannewa	64	115.0	285.0	113.5	236.0	104.0	32.0	204.0
Malwatu	2,113	57.5	405.0	56.0	270.5	49.5	55.0	215.5
Parangi Aru	427	57.5	368.0	56.0	286.0	47.0	26.0	260.0
Pali Aru	91	76.5	166.0	75.0	135.0	64.0	4.0	131.0
Kanagarayan	85	80.5	140.0	79.0	110.0	68.5	11.0	99.0
Gallodai Aru	95	87.0	240.0	85.5	210.0	63.0	7.0	203.0
Maha Oya	230	81.5	270.0	80.0	232.0	62.0	14.0	218.0
Ranbukan Aru	140	81.5	198.0	80.0	170.0	60.0	6.0	164.0
Magalawatawan	115	74.5	200.0	73.0	176.0	50.0	4.0	172.0

Table J.2.5 GENERAL FEATURES OF PROPOSED RESERVOIR AND TANK

Name of Reservoir	Catchment (km)	Dimension of Dam: Crest E.L. (m)	Crest Width (m)	Crest Height (m)	Crest Length (m)	F.S.L. (m)	L.W.L. (m)	Spillway Type	Spillway Q(m^3/s)	Gate Nos.xBxH	Spill Crest Level	Spill Crest Length
- Hydropower and Multipurpose dam on Mahaweli River Basin												
Caledonia	235	1,065	10	70	270	1,360	1,341	C	2,470	-	1,360.0	-
Talawakele	363	1,203	10	20	102	1,200	1,193	G	3,500	3x8x12	-	-
Kotmale Extensic	562	735	10	95	945	731.5	665	G	5,560	3x14x15	-	-
Watawala	69	1,034	10	60	200	1,032	1,010	G	800	2x8x7	-	-
Ulapane	782	603	10	70	500	600	590	G	6,500	3x18x15	-	-
Sudu Ganga	305	329	10	55	400	325	300	G	2,000	3x8.5x12	-	-
Uma Scheme-1000	168	974	10	90	565	970	910	G	1,700	3x7x10	-	-
Uma Scheme-500	622	503	10	25	150	500	498	G	3,700	3x10x12	-	-
Wewatenna	267	234	10	80	500	230	200	G	1,500	3x8.5x12	-	-
- Irrigation Tank												
Kalu Ganga	204	174.0	10	50	3,060	170.0	148.0	G/C	2,000	3x10x7	170.0	300
Horowupotana	950	69.5	8	24	3,100	65.5	58.0	G	5,600	6x15x10	65.5	-
Yan oya	1,320	45.0	7	16	4,420	41.0	30.0	G	7,300	8x15x9.5	41.0	-
Kitulgala	104	89.0	7	18	3,100	85.0	73.0	C	1,100	-	85.0	300
Mukunuwewa	142	95.0	8	32	1,250	91.0	73.0	C	1,200	-	91.0	340
Galgamuwa	11	104.0	7	10	760	100.0	90.0	C	200	-	100.0	60
Tammannewa	64	117.5	8	19	5,600	113.5	104.0	C	700	-	113.5	200
Malwatu	2,113	60.0	7	12	1,720	56.0	49.5	G	8,400	9x15x8	56.0	-
Parangi Aru	427	60.0	8	19	5,600	56.0	47.0	C	2,300		56.0	600
Pali Aru	91	79.0	8	19	6,300	75.0	64.0	C	750	-	75.0	230
Kanagarayan	85	83.0	7	17	3,700	79.0	68.5	C	740	-	79.0	210
Gallodai Aru	95	89.5	8	24	2,000	85.5	63.0	C	1,000	-	85.5	170
Maha Oya	230	84.0	8	31	2,850	80.0	62.0	C	2,000		80.0	520
Ranbukan Aru	140	84.0	8	31	2,600	80.0	60.0	C	950	-	80.0	260
Magalawatawan	115	77.0	8	43	1,900	73.0	50.0	C	1,100	-	73.0	310

Remarks: Type of spillway
* C: Overflow type
* G: Radial gate type

Table J.2.6 DESIGN FLOOD DISCHARGE

Reservoir (Tank)	Catchment Area (km^2)	Return Period: 50 Peak Flood Discharge(m^3/s)	Return Period: 200 Peak Flood Discharge(m^3/s)	Return Period: 1000 Peak Flood Discharge(m^3/s)
Hydropower scheme				
Watawala	69	600	700	800
Kotmale Ex.	562	3,200	3,200	5,560
Ulapane	782	4,400	4,500	6,500
Sudu Ganga	305	1,400	1,700	2,000
Uma Scheme-1000	168	1,200	1,400	1,700
Uma Scheme-500	521	2,500	3,000	3,700
Wewatenna	267	1,000	1,200	1,500
Irrgation Tank				
Kalu Ganga	204	1,400	1,700	2,000
Horowupotana	950	3,700	4,600	5,600
Yan Oya	1,320	4,800	6,000	7,300
Kitulgala Oya	104	800	900	1,100
Mukunuwewa	142	800	1,000	1,200
Galgamuwa	11	100	100	200
Tammannewa	64	500	600	700
Malwatu Oya	2,113	5,700	7,000	8,400
Parangi Aru	427	1,500	1,900	2,300
Pali Aru	91	500	600	800
Kanagarayan Aru	85	500	600	700
Gallodai Aru	220	700	800	1,000
Maha Oya	220	1,300	1,600	2,000
Rambukan Oya	130	600	800	1,000
Magalawatawan	115	700	900	1,100

Source: ANNEX-B

Table J.2.7 DIMENSION OF TRANSBASIN CANAL

Discharge (m^3/sec)	Gradient I	B (m)	D (m)	V (m/sec)	Fb (m)	H (m)
120	10000	18	4.0	1.37	0.5	4.8
100	10000	15	3.8	1.31	0.5	4.6
80	10000	12	3.7	1.25	0.5	4.5
60	10000	12	3.2	1.16	0.5	4.0
50	10000	10	3.1	1.11	0.4	3.8
40	10000	8	3.0	1.05	0.4	3.7
30	10000	6	3.0	1.01	0.4	3.7
20	8000	6	2.5	1.00	0.4	3.2
10	5000	4	1.7	1.04	0.4	2.5

Table J.2.8 GENERAL FEATURES OF CONVEYANCE SYSTEM OF ALTERNATIVE PLAN

Major System	Feature of Conveyance System															
	Case-A145						Case-B151						Case-C145			
	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)
1. NCP Canal																		
- Elahera Head Works																		
- Canal	55	11	3.8	-	10000	2.7	90	14	4.5	-	10000	2.7	45	10	4.3	-	10000	2.7
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Elahera - Kiri Oya																		
- Canal	55	11	3.8	-	10000	38	90	14	4.5	-	10000	38	45	12	4.3	-	10000	21
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	90	14	4.5	-	10000	17
- Tunnel	55	-	3.3	x1	3000	4	90	-	3.9	x1	3000	4	90	-	3.9	x1	3000	4
- Kiri Oya-Hurulu wewa																		
- Canal	90	14	4.5	-	10000	15.3	90	14	4.5	-	10000	15.3	90	14	4.5	-	10000	15.3
- Tunnel	90	-	3.9	x1	3000	3.2	90	-	3.9	x1	3000	3.2	90	-	3.9	x1	3000	3.2
- Hurulu-Mahakandarama																		
- Canal	60	12	4.0	-	10000	7	60	12	4.0	-	10000	7	60	12	4.0	-	10000	7
- Tunnel	60	-	3.4	x1	3000	0	60	-	3.4	x1	3000	0	60	-	3.4	x1	3000	0
- Mahakandarama-Tammannewa																		
- Canal	40	8	3.7	-	10000	31.6	40	8	3.7	-	10000	31.6	40	8	3.7	-	10000	31.6
- Tunnel	40	-	2.8	x1	3000	0.4	40	-	2.8	x1	3000	0.4	40	-	2.8	x1	3000	0.4
- Kalu Ganga-Elahera																		
- Canal	15	3	2.3	-	6000	16.2	80	12	4.5	-	10000	16.2	15	3	2.3	-	10000	16.2
- Tunnel	15	-	1.9	x1	2500	0.7	80	-	3.8	x1	3000	0.7	15	-	1.9	x1	3000	0.7
2. Minipe-LB																		
- Minipe-Angamedilla																		
- Canal	65	12	4.0	-	10000	94.3	65	12	4.0	-	10000	74	65	12	4.0	-	10000	74
- Tunnel	65	-	3.5	x1	3000	0.7	65	-	3.5	x1	3000	0.7	65	-	3.5	x1	3000	0.7
- Angamedilla-Minneriya/wewala																		
- Canal	65	12	4.0	-	10000	16.7	-	-	-	-	-	-	45	9	3.7	-	1000	4.1
- Tunnel	65	-	3.5	x1	3000	1.3	-	-	-	-	-	-	45	-	3.3	x1	3000	5.2
- Angamedilla-Kaudula																		
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	20	6	3.3	-	8000	32
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-
- Kaudula-Kantalai																		
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	10	4	2.5	-	5000	29
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
3. Pump Station																		
- Minneriya	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Hettipola	-	-	-	-	-	-	65	-	-	-	-	-	-	-	-	-	-	-
- Wewala	-	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-
4. NWDZ																		
- Bowatenna																		
- Canal	28	-	-	-	-	-	28	-	-	-	-	-	28	-	-	-	-	-
- Tunnel	28	-	2.5	x1	2500	6.9	28	-	2.5	x1	2500	6.9	28	-	2.5	x1	2500	6.9
- Transbasin Canal																		
- Canal	25	4	2.8	-	8000	29.4	25	4	2.8	-	8000	29.4	25	4	2.8	-	8000	29.4
- Tunnel	25	-	2.3	x1	2000	-	25	-	2.3	x1	2000	-	25	-	2.3	x1	2000	-

Remarks: Q : Discharge
B : Canal Bed Width
H : Canal Height
R : Radius of Tunnel
N : Number of row
L : Length
i : Hydraulic Gradient

Source: ANNEX-I

Table J.2.9 GENERAL FEATURES OF CONVEYANCE SYSTEM OF DEVELOPMENT PLAN

Major System	Feature of Conveyance System																					
	Present Policy															Alternative Policy						
	A118						A145						A209					A242				
	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)	Q (m3/s)	B (m)	HorR (m)	N -	i -	L (km)
1. NCP Canal																						
- Elahera Head Works																						
- Canal	60	12	4.0	-	10000	2.7	55	11	3.8	-	10000	2.7	75	12	4.4	-	10000	2.7	70	12	4.2	- 10000	2.7
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
- Elahera - Kiri Oya																						
- Canal	60	12	4.0	-	10000	38	55	11	3.8	-	10000	38	75	12	4.4	-	10000	38	70	12	4.2	- 10000	38
- Tunnel	60	-	3.4	x1	3000	4	55	-	3.3	x1	3000	4	75	-	3.7	x1	3000	4	70	-	3.6	x1 3000	4
- Kiri Oya-Hurulu Wewa																						
- Canal	90	14	4.5	-	10000	15.3	90	14	4.5	-	10000	15.3	90	14	4.8	-	10000	15.3	90	14	4.5	- 10000	15.3
- Tunnel	90	-	3.9	x1	3000	3.2	90	-	3.9	x1	3000	3.2	90	-	3.4	x1	3000	3.2	90	-	3.9	x1 3000	3.2
- Hurulu-Mahakandarama																						
- Canal	60	12	4.0	-	10000	7	60	12	4.0	-	10000	7	60	12	3.8	-	10000	7	60	12	4.0	- 10000	7
- Tunnel	60	-	3.4	x1	3000	0	60	-	3.4	x1	3000	0	60	-	3.2	x1	3000	0	60	-	3.4	x1 3000	0
- Mahakandarama-Tammannewa																						
- Canal	40	8	3.7	-	10000	31.6	40	8	3.7	-	10000	31.6	40	8	3.7	-	10000	31.6	40	8	3.7	- 10000	31.6
- Tunnel	40	-	2.8	x1	3000	0.4	40	-	2.8	x1	3000	0.4	40	-	2.8	x1	3000	0.4	40	-	2.8	x1 3000	0.4
- Kalu Ganga-Elahera																						
- Canal	15	3	2.3	-	6000	16.2	15	3	2.3	-	6000	16.2	15	3	2.3	-	6000	16.2	15	3	2.3	- 6000	16.2
- Tunnel	15	-	1.9	x1	2500	0.7	15	-	1.9	x1	2500	0.7	15	-	1.9	x1	2500	0.7	15	-	1.9	x1 2500	0.7
2. Minipe-LB																						
- Minipe-Angamedilla																						
- Canal	60	12	4.0	-	10000	94.3	65	12	4.0	-	10000	94.3	55	11	3.8	-	10000	94.3	55	11	3.8	- 10000	94.3
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	55	11	3.8	-	10000	32.3	55	11	3.8	- 10000	32.3
- Tunnel	60	-	3.4	x1	3000	0.7	65	-	3.5	x1	3000	0.7	55	-	3.3	-	3000	0.7	55	-	3.3	- 3000	0.7
- Angamedilla-Minneriya/wewala																						
- Canal	60	12	4.0	-	10000	16.7	65	12	4.0	-	10000	16.7	45	9	3.7	-	10000	4.1	45	9	3.7	- 10000	4.1
- Tunnel	60	-	3.4	x1	3000	1.3	65	-	3.5	x1	3000	1.3	45	-	3.3	x1	3000	5.2	45	-	3.3	x1 3000	5.2
- Angamedilla-Kaudula																						
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
- Kaudula-Kantalai																						
- Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
- Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
3. Pump Station																						
- Minneriya	30	-	-	-	-	-	35	-	-	-	-	-	15	-	-	-	-	-	20	-	-	- -	-
- Hettipola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
- Wewala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-
4. NWDZ																						
- Bowatenna																						
- Canal	28	-	-	-	-	-	28	-	-	-	-	-	28	-	-	-	-	-	28	-	-	- -	-
- Tunnel	28	-	2.5	x1	2500	6.9	28	-	2.5	x1	2500	6.9	28	-	2.5	x1	2500	6.9	28	-	2.5	x1 2500	6.9
- Transbasin Canal																						
- Canal	-	-	-	-	-	-	25	4	2.8	-	8000	29.4	-	-	-	-	-	-	25	4	2.8	- 8000	29.4
- Tunnel	-	-	-	-	-	-	25	-	2.3	x1	2000	-	-	-	-	-	-	-	25	-	2.3	x1 2000	-

Remarks: Q : Discharge
B : Canal Bed Width
H : Canal Height
R : Radius of Tunnel
N : Number of row
L : Length
i : Hydraulic Gradient

Table J.3.1 UNIT RATE FOR MAJOR ITEM

Hydropower		Unit	FC (US$)	LC (Rs)	Total (US$)
Excavation	Common	m^3	2.3	32.5	3.3
	Rock	m^3	5.6	78.0	8.0
Embankment	Core	m^3	4.6	65.0	6.6
	Filter	m^3	9.8	136.5	14.0
	Rock	m^3	5.3	71.5	7.5
Concrete		m^3	90.0	975.0	110.0
R-Bar		ton	595.0	8,287.5	850.0
Metal Works		ton	6,210.0	22,425.0	6,900.0
Grout Consolidate		m	72.8	1,014.0	104.0
Curtain Grout		m	105.0	1,462.5	150.0
Clearing		ha	198.0	4,290.0	330.0

Transbasin & Irrigation	Unit	FC (US$)	LC (Rs)	Total (US$)
Excavation Canal	m^3	1.4	3.3	1.5
Excavation Rock	m^3	5.6	78.0	8.0
Embankment	m^3	2.4	19.5	3.0
Filter	m^3	9.8	136.5	14.0
Concrete Lining	m^3	50.0	650.0	70.0
Concrete Structure	m^3	56.0	780.0	80.0

Table J.3.2 SUMMARY OF DIRECT CONSTRUCTION COST OF CANDIDATE HYDROPOWER SCHEMES

(Unit: US$1,000)

	Watawala			Ulapane			Caledonia		
	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
Direct Construction Cost									
(1) General items	1,800	1,500	3,300	1,800	1,500	3,300	2,900	2,500	5,400
(2) Diversion tunnel/canal	1,100	300	1,400	1,700	600	2,300	-	-	-
(3) Main dam	8,500	1,500	10,000	16,500	7,100	23,600	36,200	6,400	42,600
(4) Spillway	-	-	-	3,100	1,000	4,100	-	-	-
(5) Tributary intake (1)	-	-	-	-	-	-	4,100	700	4,800
(6) Tributary intake (2)	-	-	-	-	-	-	-	-	-
(7) Intake	100	100	200	200	100	300	600	300	900
(8) Headrace tunnel	2,000	1,100	3,100	13,100	7,000	20,100	6,100	3,300	9,400
(9) Surge tank	300	200	500	800	400	1,200	900	400	1,300
(0) Penstock tunnel/line	100	100	200	100	100	200	700	300	1,000
(11) Powerhouse & outdoor s/yard	1,200	500	1,700	3,100	1,300	4,400	15,200	6,500	21,700
(12) Hydromechanical works	2,300	300	2,600	5,500	600	6,100	2,800	300	3,100
(13) Electrical Works	9,100	500	9,600	17,600	900	18,500	13,200	700	13,900
Total	26,500	6,100	32,600	63,500	20,600	84,100	82,700	21,400	104,100

	Talawakelle			Kotmale Extension			Upper Uma Oya Scheme-1000		
	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
Direct Construction Cost									
(1) General items	6,800	6,000	12,800	7,500	2,400	9,900	2,700	2,300	5,000
(2) Diversion tunnel/canal	-	-	-	-	-	-	1,700	500	2,200
(3) Main dam	3,400	600	4,000	128,740	12,260	141,000	25,500	10,900	36,400
(4) Spillway	-	-	-	16,760	2,840	19,600	2,500	800	3,300
(5) Tributary intake (1)	7,900	1,400	9,300	-	-	-	11,800	2,100	13,900
(6) Tributary intake (2)	-	-	-	-	-	-	9,900	1,700	11,600
(7) Intake	1,200	500	1,700	-	-	-	200	100	300
(8) Headrace tunnel	33,000	14,200	47,200	-	-	-	32,000	17,200	49,200
(9) Surge tank	2,500	1,100	3,600	-	-	-	1,300	500	1,800
(0) Penstock tunnel/line	2,500	1,100	3,600	-	-	-	2,300	1,000	3,300
(11) Powerhouse & outdoor s/yard	18,200	7,800	26,000	-	-	-	5,800	2,500	8,300
(12) Hydromechanical works	8,800	1,000	9,800	6,800	700	7,500	21,100	2,300	23,400
(13) Electrical Works	39,100	2,100	41,200	-	-	-	25,900	1,400	27,300
Total	123,400	35,800	159,200	159,800	18,200	178,000	142,700	43,300	186,000

	Lower Uma Oya Scheme-500			Wewatenna			Sudu Ganga		
	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
Direct Construction Cost									
(1) General items	2,300	2,100	4,400	2,100	1,800	3,900	2,100	1,800	3,900
(2) Diversion tunnel/canal	2,200	700	2,900	2,000	700	2,700	2,200	700	2,900
(3) Main dam	14,800	2,600	17,400	19,500	8,300	27,800	13,300	2,300	15,600
(4) Spillway	-	-	-	2,900	900	3,800	2,600	900	3,500
(5) Tributary intake (1)	9,900	1,700	11,600	-	-	-	-	-	-
(6) Tributary intake (2)	-	-	-	-	-	-	-	-	-
(7) Intake	300	100	400	100	100	200	100	100	200
(8) Headrace tunnel	44,000	23,700	67,700	4,000	2,200	6,200	-	-	-
(9) Surge tank	600	200	800	900	400	1,300	-	-	-
(0) Penstock tunnel/line	3,400	1,400	4,800	100	-	100	-	-	-
(11) Powerhouse & outdoor s/yard	5,300	2,200	7,500	1,800	700	2,500	2,900	1,200	4,100
(12) Hydromechanical works	27,100	3,000	30,100	3,100	300	3,400	4,700	500	5,200
(13) Electrical Works	22,500	1,200	23,700	10,800	600	11,400	23,600	1,200	24,800
Total	132,400	38,900	171,300	47,300	16,000	63,300	51,500	8,700	60,200

Remark: All currencies are indicated in US$1,000.

Table J.3.3 MAJOR WORKS FOR TRANSBASIN CANAL AND TANK

(Unit: 1,000 m^3)

Reservoir (Tank)	Excavation		Filling			Concrete	
	Common	Rock	Earth	Filter	Rock	Lining	Struct.
1. Irrigation Tanks							
Kalu Ganga	952.7	155.1	1,878.2	432.6	372.0	0.0	250.0
Horowupotana	754.0	106.0	3,080.0	56.0	168.0	0.0	25.3
Yan Oya	623.0	118.0	2,928.0	96.0	289.0	0.0	19.8
Kitulgala Oya							
Mukunuwewa							
Galgamuwa	116.0	22.0	480.0	73.0	53.0	0.0	8.8
Tammannewa	643.0	95.0	2,267.0	81.0	243.0	0.0	24.3
Malwatu Oya	278.0	86.0	570.0	25.0	74.0	0.0	15.8
2. Transbasin Canal*							
Minipe LB 0-62 km	2,975.0	446.0	2,085.0	54.0	0.0	159.0	23.0
Minipe LB 62-113 km	8,916.0	1,003.0	2,380.0	87.7	0.0	136.0	49.2
Kalu Ganga-Elahera	496.0	130.0	408.0	1.2	0.0	20.8	19.0
Elahera-Head work	349.0	52.0	146.0	5.4	13.0	8.6	12.8
Elahera-Kiri Oya	3,853.0	648.0	1,813.0	73.8	0.0	112.0	55.0
Kiri Oya-Hururu	2,637.0	727.0	823.0	26.5	0.0	50.4	95.0
Hurulu-Tammannewa	3,017.0	352.8	2,418.4	59.7	0.0	120.8	14.7
3. Conveyance Canal to NWDZ	955.6	95.6	765.6	176.0	0.0	49.5	6.5

Remark: * Major work quantities in Case A-118 (Proposed Transbasin Canal System)

Table J.3.4 SUMMARY OF DIRECT CONSTRUCTION COST FOR DOWNSTREAM DEVELOPMENT

System	Sub-system	Rehabilitation (ha)	New Land (ha)		Construction Cost		
			Irrigate	Cashew	F.C (US$10^6)	L.C (Rs.10^6)	Total Eq. (US$10^6)
Under AMDP							
H	Kandarama	4,900			0.8	6.7	1.0
	Dambulu Oya	2,200			0.4	3.0	0.5
	Kalawewa	27,600			4.6	37.7	5.8
	Rajangana	6,700			1.1	9.1	1.4
	Angamuwa	1,000			0.2	1.4	0.2
	(Sub-total)	42,400			7.1	57.9	8.9
IH	Nachchaduwa	2,830			0.5	3.9	0.6
	Nuwarawewa	1,100			0.2	1.5	0.2
	Tissawewa	400			0.1	0.5	0.1
	Bassawakkulam	370			0.1	0.5	0.1
	(Sub-total)	4,700			0.8	6.4	1.0
MH	Huruluwewa	4,300			0.7	5.9	0.9
Total		51,400			8.6	70.2	10.8
NCRB							
F			1,900		4.5	42.3	5.8
I	Mahakandarama	2,800			0.5	3.8	0.6
	Mahakandarama Ext.		8,000		27.4	257.6	35.3
	Malwatu Oya		3,600		16.5	152.5	21.2
	Tammannewa		27,000		92.4	869.8	119.1
	Giant Tank	9,900			1.7	13.5	2.1
	Cashew Land			10,000	2.4	23.9	3.2
	(Sub-total)	12,700	38,600	10,000	140.7	1,321.1	181.4
M	Horowupotana		15,000		42.5	397.3	54.7
	Yan Oya		10,000		30.0	282.1	38.7
	(Sub-total)		25,000		72.5	679.5	93.4
MH	Huruluwewa Ext.		12,000		36.0	339.2	46.4
	Cashew Land			10,000	2.4	23.9	3.2
	(Sub-total)		12,000	10,000	38.4	363.1	49.6
Total		12,700	77,500	20,000	256.1	2,405.9	330.1
NWDZ	Galgamuwa		10,700		39.2	373.8	50.7
	Inginimitiya	2,550			0.4	3.5	0.5
Total		2,550	10,700		39.7	377.2	51.3
Grand Total		66,650	88,200	20,000	304.4	2,853.3	392.2

Table J.3.5 ESTIMATION OF COMPENSATION COST

Reservoir (Tank)	Reservoir Area (ha)	Paddy (ha)	Plantation (ha)	Forest (ha)	Existig Tank (ha)	Home-stead (ha)	Number of House (Nos.)	Land Acquisition & Compensation Cost
Unit rate (Rs.)		40,000	20,000	-	-	20,000	30,000	(1,000 Rs.)
Hydropower								
Watawala	20	20					0	800
Ulapane	70	70					0	2,800
Caledonia	-	-					-	513,500 *
Talawakele	-	-					-	149,500 *
Sudu Ganga	369	369					204	20,882
Uma Scheme-1000	119	110		3			265	12,359
Uma Scheme-500	40	22		18			0	880
Wewatenna	440	65		375				2,600
Irrigation Tank								
Kalu Ganga	1,730	223		1,402		105	100	14,020
Horowupotana	5,349	670		4,161	388	130	65	31,350
Yan Oya	5,112	341	52	4,590	117	12	6	14,060
Kitulgala Oya	1,056	0		1,056				0
Mukunuwewa	2,842	93	21	2,592	136			3,720
Galgamuwa	698	283		180	175.0	60	30	13,420
Tammannewa	3,730	1,695	0	1,291	277.0	467	315	86,590
Malwatu Oya	5,567	267	402	4,400	33	75	30	13,080
Parangi Aru	5,867	69		5,764	29	5	5	3,010
Pali Aru	4,754	44		4,644	61	56	28	3,720
Kanagarayan Aru	5,730	344		5,234	96	56	28	15,720

Remark: * Refer to Feasibility Study on Upper Kotmale Hydroelectric Power Development Project, JICA, 1987

Table J.3.6 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE A-118)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	L/C Rs. (10^6)	Total Eq. US$ (10^6)	E/S Admi. Total US$ (10^6)	Land Acq. Total US$ (10^6)	Contin-gency Total US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	7.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	9.5	80.4	12.0	1.2	0.0	2.6	15.8
2.	Elahera Head Works	60	6.7	55.7	8.4	0.8	0.0	1.9	11.1
3.	NCP Elahera-Kirioya	60	49.1	337.7	59.5	5.9	0.0	13.1	78.5
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.9	47.6
6.	Minipe LB 0-62Km	60	31.1	324.4	41.1	4.1	0.0	9.0	54.2
7.	Minipe LB 62Km-113 Km	60	57.3	439.0	70.8	7.1	0.0	15.6	93.5
C	Pump station	m^3/sec							
1.	Minneriya 23 MW	30	100.3	260.3	108.3	10.8	0.0	23.8	143.0
D	Downstream development	ha							
1.	System-F	1,900	4.5	42.3	5.8	0.6	0.0	1.3	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	807.3	6,895.3	1,019.5	101.9	5.3	225.3	1,352.0
II	NWDZ								
1.	Galgamuwa		0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	Additional Bowatenna Tunnel	24 m3/sec	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.	NWDZ Transbasin Canal	25 m3/sec	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.	System-NWDZ	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NWDZ TOTAL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total		161,600	807.3	6,895.3	1,019.5	101.9	5.3	225.3	1,352.0
Power+Irrigation		161,600	1,589.8	13,166.5	1,994.9	199.5	41.0	447.1	2,682.6

Remarks: *US$1.00 = Rs.32.50 = ¥140

Table J.3.7 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE A-145)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	L/C Rs. (10^6)	Total Eq. US$ (10^6)	E/S Admi. US$ (10^6)	Land Acq. US$ (10^6)	Contin-gency US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	7.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	9.5	80.4	12.0	1.2	0.0	2.6	15.8
2.	Elahera Head Works	55	6.6	54.1	8.3	0.8	0.0	1.8	10.9
3.	NCP Elahera-Kirioya	55	47.0	323.9	57.0	5.7	0.0	12.5	75.2
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.9	47.6
6.	Minipe LB 0-74Km	65	32.4	337.8	42.8	4.3	0.0	9.4	56.5
7.	Minipe LB 74Km-113 Km	65	59.4	458.0	73.5	7.3	0.0	16.2	97.0
C	Pump station	m^3/sec							
1.	Minneriya 27 MW	35	114.8	291.1	123.8	12.4	0.0	27.2	163.4
D	Downstream development	ha							
1.	System-F	1,900	4.5	42.3	5.8	0.6	0.0	1.3	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	823.0	6,943.1	1,036.6	103.7	5.3	229.1	1,374.7
II	NWDZ								
1.	Galgamuwa		8.5	107.7	11.8	1.2	0.4	2.7	16.1
2.	Additional Bowatenna Tunnel	24 m3/sec	10.4	48.0	11.9	1.2	0.0	2.6	15.7
3.	NWDZ Transbasin Canal	25 m3/sec	12.0	128.1	15.9	1.6	0.0	3.5	21.0
4.	System-NWDZ	13,250	39.7	377.2	51.3	5.1	0.0	11.3	67.7
	NWDZ TOTAL	13,250	70.6	661.0	90.9	9.1	0.4	20.1	120.6
Grand Total		174,850	893.6	7,604.1	1,127.6	112.8	5.7	249.2	1,495.2
Power+Irrigation		174,850	1,676.1	13,875.3	2,103.0	210.3	41.5	471.0	2,825.8

Remarks: US$1.00 = Rs.32.50 = ¥140

Table J.3.8 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE B-151)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	Direct Construction Cost L/C Rs. (10^6)	Direct Construction Cost Total Eq. US$ (10^6)	E/S Admi. US$ (10^6)	Land Acq. US$ (10^6)	Contin-gency US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	9.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	80	26.8	178.8	32.3	3.2	0.0	9.1	42.6
2.	Elahera Head Works	90	8.0	70.8	10.2	1.0	0.0	2.2	13.4
3.	NCP Elahera-Kirioya	90	63.8	429.7	77.0	7.7	0.0	16.9	101.7
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.8	47.6
6.	Minipe LB 0-74Km	65	21.7	249.5	29.4	2.9	0.0	6.5	38.8
7.	Minipe LB 74Km-113 Km	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	Pump station	m^3/sec							
1.	Hettipola 84 MW	65	307.8	695.2	329.2	32.9	0.0	72.4	434.5
D	Downstream development	ha							
1.	System-P	1,900	4.5	42.3	5.8	0.6	0.0	1.2	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	981.4	7,021.8	1,197.5	119.7	5.3	264.5	1,587.0
II	NWDZ								
1.	Galgamuwa		8.5	107.7	11.8	1.2	0.4	2.7	16.1
2.	Additional Bowatenna Tunnel	24 m3/sec	10.4	48.0	11.9	1.2	0.0	2.6	15.7
3.	NWDZ Transbasin Canal	25 m3/sec	12.0	128.1	15.9	1.6	0.0	3.5	21.0
4.	System-NWDZ	13,250	39.7	377.2	51.3	5.1	0.0	11.3	67.7
	NWDZ TOTAL	13,250	70.6	661.0	90.9	9.1	0.4	20.1	120.6
Grand Total		174,850	1,052.0	7,682.8	128.4	128.8	5.7	284.6	1,707.5
Power+Irrigation		174,850	1,834.5	13,954.0	2,263.8	226.1	41.5	506.3	3,038.1

Remarks: US$1.00 = Rs.32.50 = ¥140

Table J.3.9 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE C-145)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	Direct Construction Cost L/C Rs. (10^6)	Direct Construction Cost Total Eq. US$ (10^6)	E/S Admi. US$ (10^6)	Land Acq. US$ (10^6)	Contin-gency US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	7.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	9.5	80.4	12.0	1.2	0.0	2.6	15.8
2.	Elahera Head Works	45	6.3	52.2	7.9	0.8	0.0	1.7	10.4
3.	NCP Elahera-Kirioya	45/90	59.5	388.5	71.5	7.1	0.0	15.7	94.3
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.9	47.6
6.	Minipe LB 0-74Km	65	21.7	249.5	29.4	2.9	0.0	6.5	38.8
7.	Minipe LB 74Km-Angamedilla	65	40.7	467.9	55.1	5.5	0.0	12.1	72.7
8.	Angamedilla-Wewala	45	30.3	200.5	36.5	3.6	0.0	8.0	48.1
9.	Angamedilla-Kaudulla	20	13.7	140.8	18.0	1.8	0.0	4.0	23.8
10.	Kaudulla-Kantalai	10	12.2	114.7	15.7	1.6	0.0	3.5	20.8
C	Pump station	m^3/sec							
1.	Wewala 44 MW	45	157.2	347.6	167.9	16.8	0.0	36.9	221.6
D	Downstream development	ha							
1.	System-F	1,900	4.5	42.3	5.8	0.6	0.0	1.3	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	904.4	7,439.9	1,133.3	113.3	5.3	250.4	1,502.3
II	NWDZ								
1.	Galgamuwa		8.5	107.7	11.8	1.2	0.4	2.7	16.1
2.	Additional Bowatenna Tunnel	24 m3/sec	10.4	48.0	11.9	1.2	0.0	2.6	15.7
3.	NWDZ Transbasin Canal	25 m3/sec	12.0	128.1	15.9	1.6	0.0	3.5	21.0
4.	System-NWDZ	13,250	39.7	377.2	51.3	5.1	0.0	11.3	67.7
	NWDZ TOTAL	13,250	70.6	661.0	90.9	9.1	0.4	20.1	120.6
Grand Total		174,850	975.0	8,100.9	1,224.3	122.4	5.7	270.5	1,622.9
Power+Irrigation		174,850	1,757.5	14,372.1	2,199.7	220.0	41.5	492.2	2,953.4

Remarks: US$1.00 = Rs.32.50 = ¥140

Table J.3.10 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE A-209)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	L/C Rs. (10^6)	Total Eq. US$ (10^6)	E/S Admi. US$ (10^6)	Land Acq. US$ (10^6)	Contin-gency US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	7.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	9.5	80.4	12.0	1.2	0.0	2.6	15.8
2.	Elahera Head Works	75	6.8	57.0	8.6	0.9	0.0	1.9	11.3
3.	NCP Elahera-Kirioya	75	58.3	395.5	70.5	7.0	0.0	15.5	93.0
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.9	47.6
6.	Minipe LB 0-62Km	55	29.8	310.7	39.4	3.9	0.0	8.7	52.0
7.	Minipe LB 62Km-113 Km	55	55.2	423.5	68.2	6.8	0.0	15.0	90.1
C	Pump station	m^3/sec							
1.	Minneriya 12 MW	15	54.1	144.6	58.5	5.9	0.0	12.9	77.3
D	Downstream development	ha							
1.	System-F	1,900	4.5	42.3	5.8	0.6	0.0	1.3	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	767.0	6,809.5	976.5	97.7	5.3	215.9	1,295.3
II	NWDZ								
1.	Galgamuwa		0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	Additional Bowatenna Tunnel	24 m3/sec	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.	NWDZ Transbasin Canal	25 m3/sec	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.	System-NWDZ	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NWDZ TOTAL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total		161,600	767.0	6,809.5	976.5	97.7	5.3	215.9	1,295.3
Power+Irrigation		161,600	1,549.5	13,080.7	1,952.0	195.2	41.0	437.6	2,625.9

Remarks: US$1.00 = Rs.32.50 = ¥140

Tale J.3.11 CONSTRUCTION COST FOR PROPOSED TRANSBASIN SYSTEM (CASE A-242)

Item No.	Work Items		Direct Construction Cost F/C US$ (10^6)	L/C Rs. (10^6)	Total Eq. US$ (10^6)	E/S Admi. US$ (10^6)	Land Acq. US$ (10^6)	Contin-gency US$ (10^6)	Const. Cost Total US$ (10^6)
Water Resources Development									
1.	Watawala		26.5	198.3	32.6	3.3	1.0	7.4	44.2
2.	Ulapane		63.5	669.5	84.1	8.4	5.0	19.5	117.0
3.	Caledonia		82.7	695.5	104.1	10.4	15.8	26.1	156.4
4.	Talawakele		123.4	1,163.5	159.2	15.9	4.6	35.9	215.7
5.	Kotmale Extension		159.8	590.0	178.0	17.8	1.4	39.4	236.6
6.	Scheme-1000		142.7	1,407.3	186.0	18.6	3.0	41.5	249.1
7.	Scheme-500		132.4	1,264.3	171.3	17.1	2.0	38.1	228.5
8.	Sudu Ganga		51.5	282.8	60.2	6.0	3.0	13.8	83.1
	POWER SCHEME TOTAL		782.5	6,271.2	975.5	97.5	35.8	221.8	1,330.5
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		79.7	902.4	107.5	10.7	0.4	23.7	142.4
2.	Elahera regulation tank		2.5	29.5	3.4	0.3	0.2	0.8	4.8
3.	Kiri oya Regulating Tank		7.4	86.1	10.0	1.0	0.2	2.3	13.5
4.	Horowupotana		37.2	415.4	50.0	5.0	0.9	11.2	67.1
5.	Yan Oya		40.9	442.0	54.5	5.5	0.4	12.1	72.5
6.	Tammannewa		23.5	314.7	33.2	3.3	2.7	7.8	47.0
7.	Malwatu Oya		22.8	174.8	28.2	2.8	0.4	6.3	37.7
B	Transbasin.canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	9.5	80.4	12.0	1.2	0.0	2.6	15.8
2.	Elahera Head Works	70	6.7	55.7	8.4	0.8	0.0	1.9	11.1
3.	NCP Elahera-Kirioya	70	56.3	382.1	68.1	6.8	0.0	15.0	89.8
4.	NCP Kiri oya- Hurulu wewa	90	46.3	301.7	55.6	5.6	0.0	12.2	73.4
5.	NCP Hurulu wewa- Tammannewa	60/40	28.2	254.9	36.0	3.6	0.0	7.9	47.6
6.	Minipe LB 0-62Km	55	29.8	310.7	39.4	3.9	0.0	8.7	52.0
7.	Minipe LB 62Km-113 Km	55	55.2	423.5	68.2	6.8	0.0	15.0	90.1
C	Pump station	m^3/sec							
1.	Minneriya 15 MW	20	70.2	185.9	75.9	7.6	0.0	16.7	100.2
D	Downstream development	ha							
1.	System-F	1,900	4.5	42.3	5.8	0.6	0.0	1.3	7.7
2.	System-M	25,000	72.5	679.4	93.4	9.3	0.0	20.5	123.3
3.	System-MH	26,300	39.1	368.9	50.5	5.0	0.0	11.1	66.6
4.	System-H	42,400	7.1	57.9	8.9	0.9	0.0	2.0	11.7
5.	System-IH	4,700	0.8	6.4	1.0	0.1	0.0	0.2	1.3
6.	System-I	61,300	140.8	1,321.4	181.5	18.1	0.0	39.9	239.5
	NCRB TOTAL	161,600	781.0	6,836.1	991.3	99.1	5.3	219.1	1,314.9
II	NWDZ								
1.	Galgamuwa		8.5	107.7	11.8	1.2	0.4	2.7	16.1
2.	Additional Bowatenna Tunnel	24 m3/se	10.4	48.0	11.9	1.2	0.0	2.6	15.7
3.	NWDZ Transbasin Canal	25 m3/se	12.0	128.1	15.9	1.6	0.0	3.5	21.0
4.	System-NWDZ	13,250	39.7	377.2	51.3	5.1	0.0	11.3	67.7
	NWDZ TOTAL	13,250	70.6	661.0	90.9	9.1	0.4	20.1	120.6
Grand Total		174,850	851.6	7,497.1	1,082.3	108.2	5.7	239.2	1,435.5
Power+Irrigation		174,850	1,634.1	13,768.3	2,057.7	205.8	41.5	461.0	2,766.0

Remarks: US$1.00 = Rs.32.50 = ¥140

Table J.3.12 SUMMARY OF CONSTRUCRION COST (CASE-A118)

Item No.	Work Items		Const. Cost Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Annual Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	POWER SCHEME TOTAL		1,330.5	1,285.9	-		11,326	210,425	-
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera regulation tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Regulating Tank		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	15.8	15.0	1.2		113	409	1.3
2.	Elahera Head Works	60	11.1	10.6	0.9		79	2,185	0.9
3.	NCP Elahera-Kirioya	60	78.5	75.2	6.1		564	247	6.7
4.	NCP Kiri Oya-Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa-Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe LB 0-62Km	60	54.2	51.1	4.2		383	485	4.6
7.	Minipe LB 62Km-113 Km	60	93.5	89.2	7.3		669	247	8.0
C	Pump station	m^3/sec							
1.	Minneriya 23 MW	30	143.0	140.4	11.5	6.1	3,511	58,169	21.1
D	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCRB TOTAL	161,600	1,352.0	1,283.3	104.8	6.1	11,181	116,682	122.1
II.	NWDZ								
1.	Galgamuwa		0.0	0.0	0.0		0	0	0.0
2.	Additional Bowatenna Tunnel	24 m3/sec	0.0	0.0	0.0		0	0	0.0
3.	NWDZ Transbasin Canal	25 m3/sec	0.0	0.0	0.0		0	0	0.0
4.	System-NWDZ	0	0.0	0.0	0.0		0	0	0.0
	NWDZ TOTAL	0	0.0	0.0	0.0		0	0	0.0
Grand Total		161,600	1,352.0	1,283.3	104.8	6.1	11,181	116,682	122.1
Power+Irrigation		161,600	2,682.6	2,569.2	-	6.1	22,507	327,107	-

Remarks: * Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140

Table J.3.13 SUMMARY OF CONSTRUCRION COST (CASE-A145)

Item No.	Work Items		Const. Cost Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Annual Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	POWER SCHEME TOTAL		1,330.5	1,285.9	-		11,326	210,425	-
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera regulation tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Regulating Tank		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	15.8	15.0	1.2		113	409	1.3
2.	Elahera Head Works	55	10.9	10.4	0.8		78	2,185	0.9
3.	NCP Elahera-Kirioya	55	75.2	72.0	5.9		540	247	6.4
4.	NCP Kiri oya-Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa-Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe LB 0-62Km	65	56.5	53.2	4.3		399	485	4.7
7.	Minipe LB 62Km-113 Km	65	97.0	92.5	7.6		694	247	8.3
C	Pump station	m^3/sec							
1.	Minneriya 23 MW	35	163.4	160.5	13.1	7.1	4,013	58,169	24.2
D	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCRB TOTAL	161,600	1,374.7	1,305.5	106.7	7.1	11,700	116,682	125.5
II.	NWDZ								
1.	Galgamuwa		16.1	14.9	1.2		75	342	1.3
2.	Additional Bowatenna Tunnel	24 m3/sec	15.7	15.2	1.2		114	200	1.4
3.	NWDZ Transbasin Canal	25 m3/sec	21.0	19.8	1.6		148	485	1.8
4.	System-NWDZ	13,250	67.7	64.0	5.2		480	2,090	5.7
	NWDZ TOTAL	13,250	120.6	114.0	9.3		818	3,116	10.1
Grand Total		174,850	1,495.2	1,419.5	116.0	7.1	12,517	119,798	135.6
Power+Irrigation		174,850	2,825.8	2,705.4	-	7.1	23,843	330,223	-

Remarks: * Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140