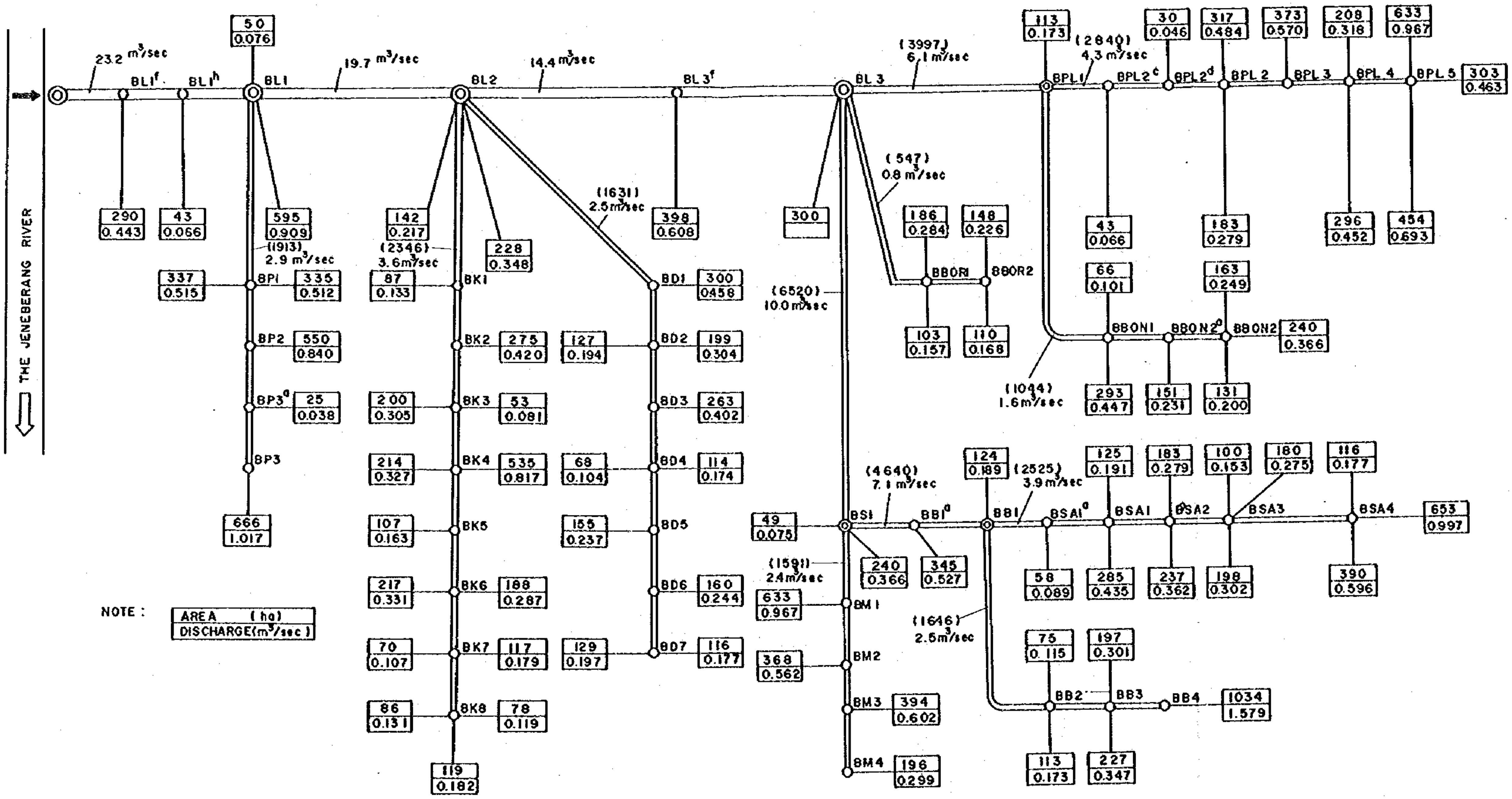


Fig. 8-6

DIAGRAM OF DISTRIBUTION SYSTEM
(KAMPILI BENEFITTED AREA)

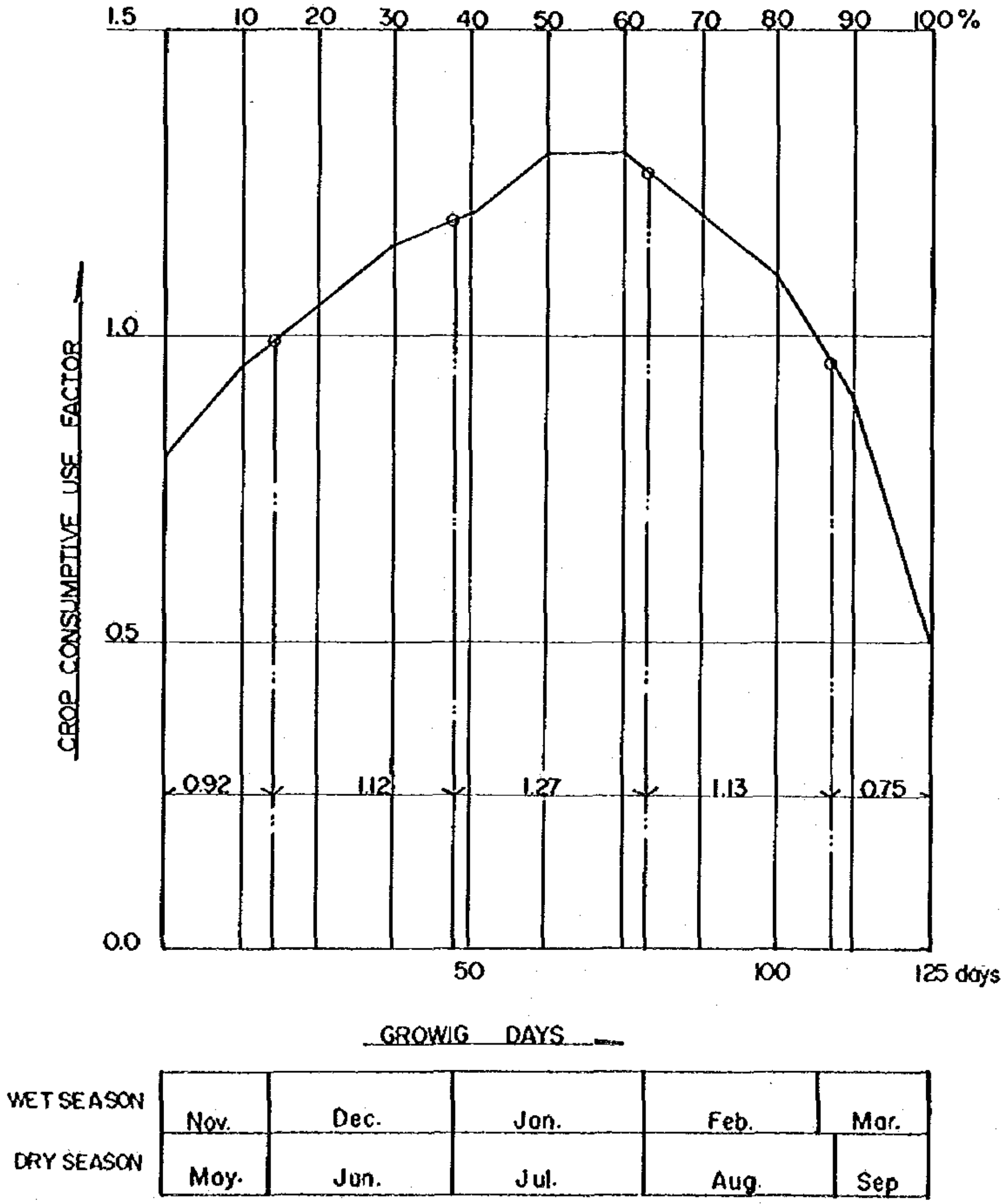
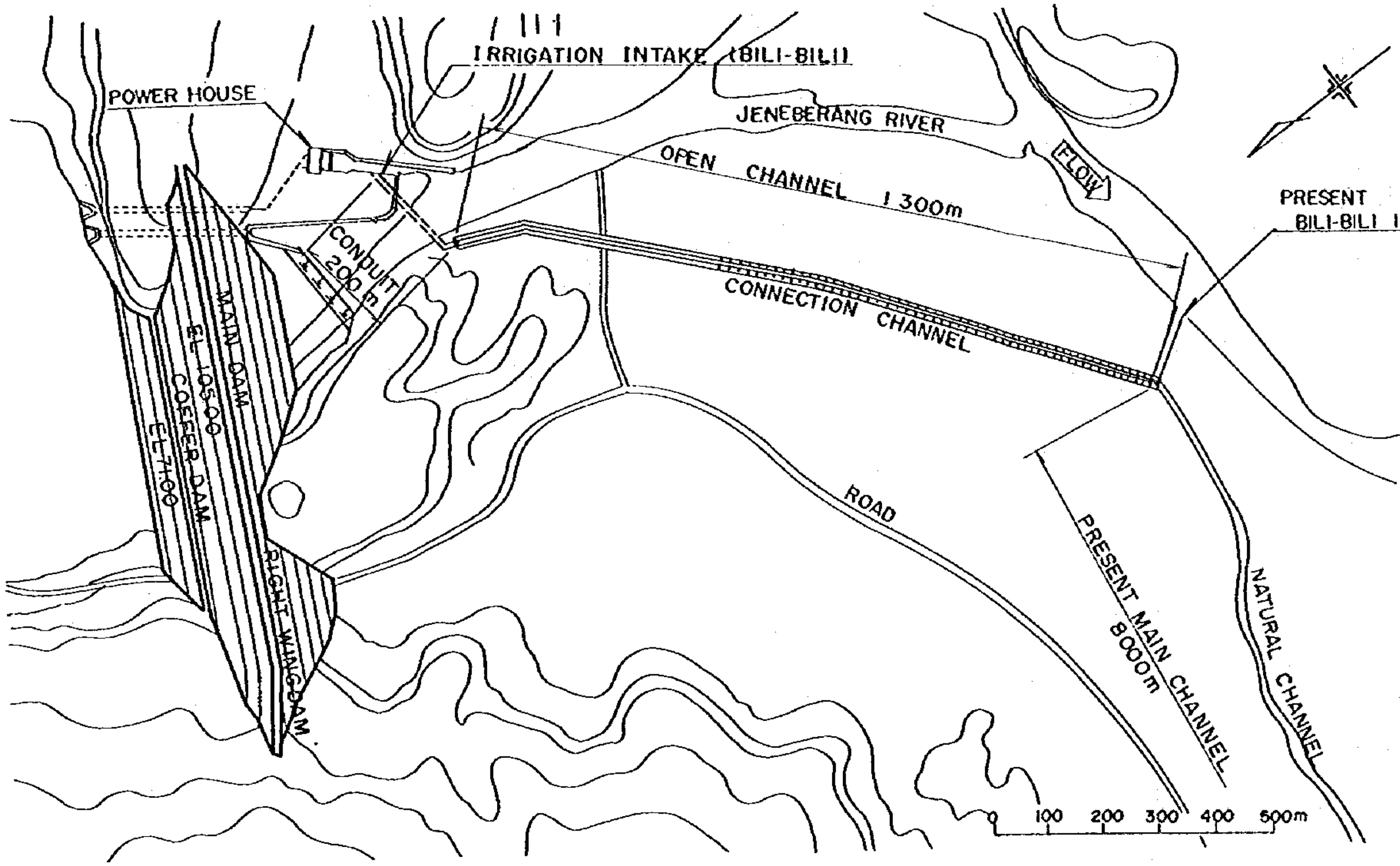
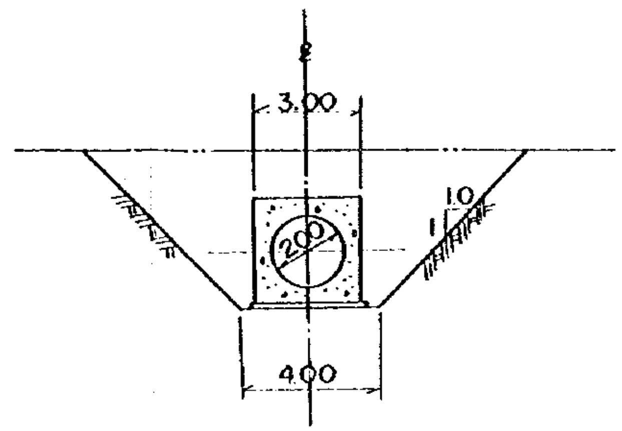


Fig. 8-7

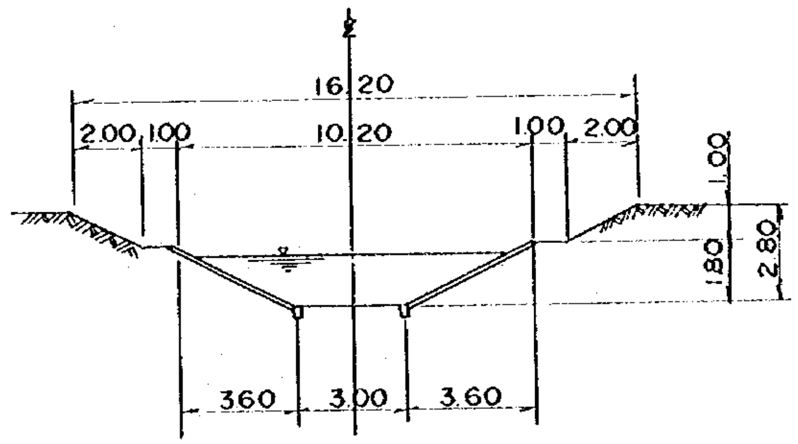
CROP CONSUMPTION FACTOR



BILI-BILI CONNECTION CHANNEL



CONDUIT CROSS SECTON Unit : m



OPEN CHANNEL SECTION Unit : m

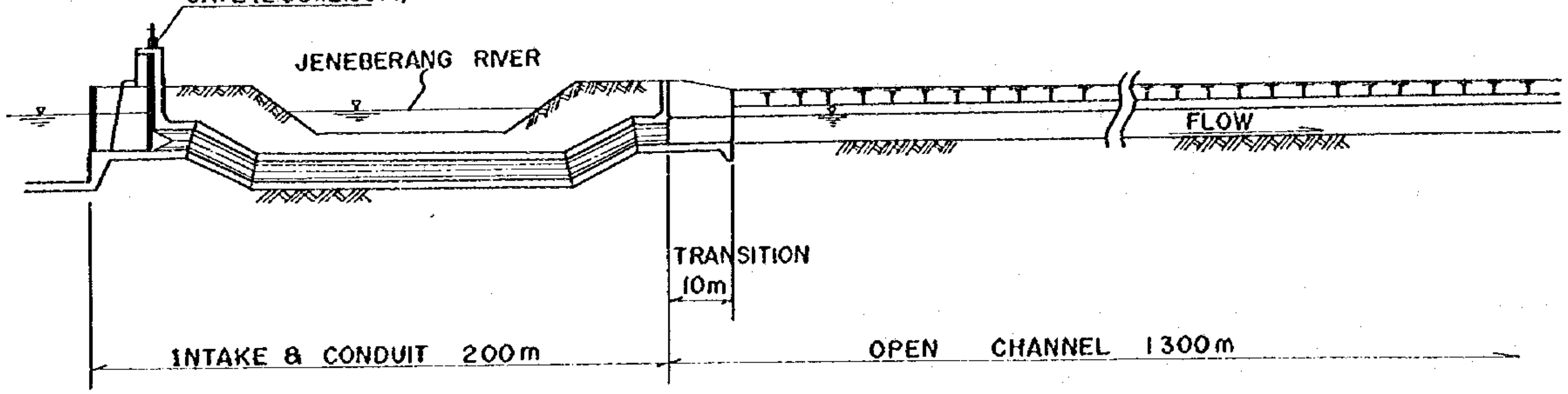
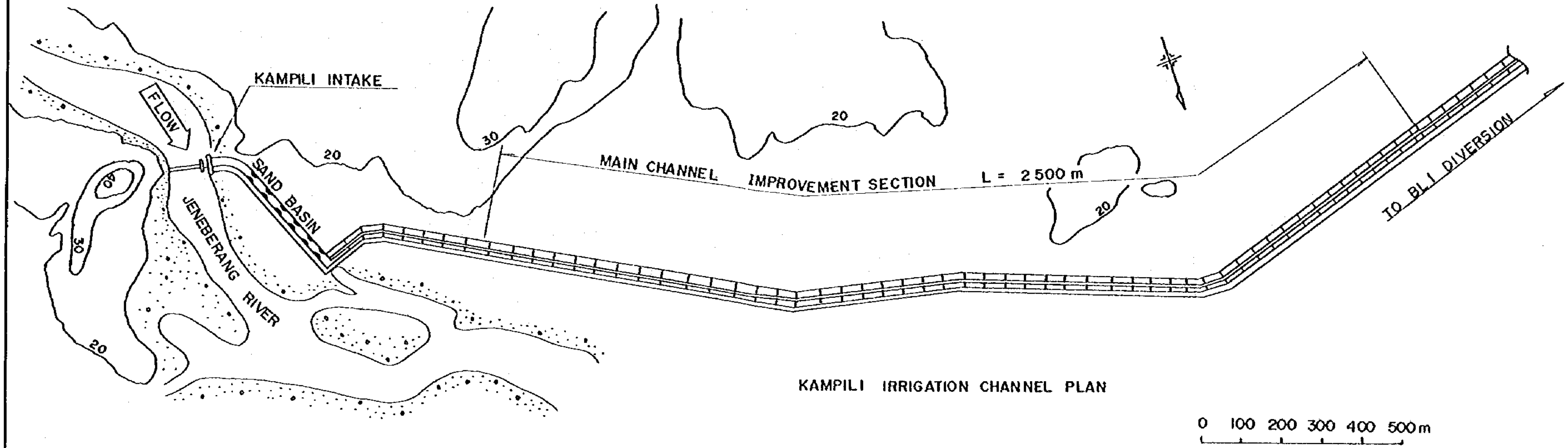
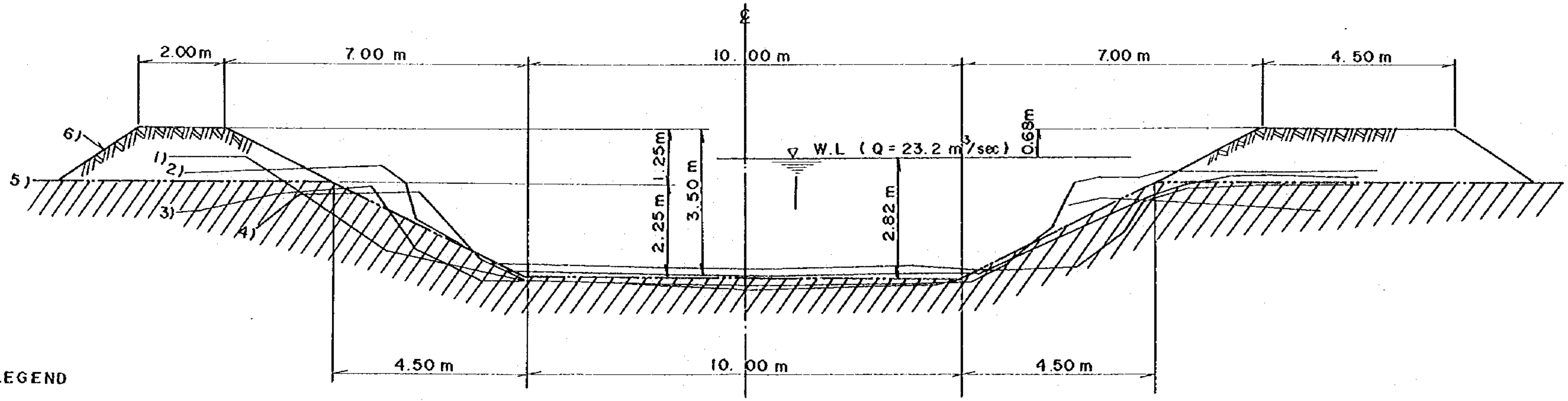


Fig. 8-8

BILI-BILI CONNECTION CHANNEL



KAMPILI IRRIGATION CHANNEL PLAN



MAIN CHANNEL CROSS SECTION

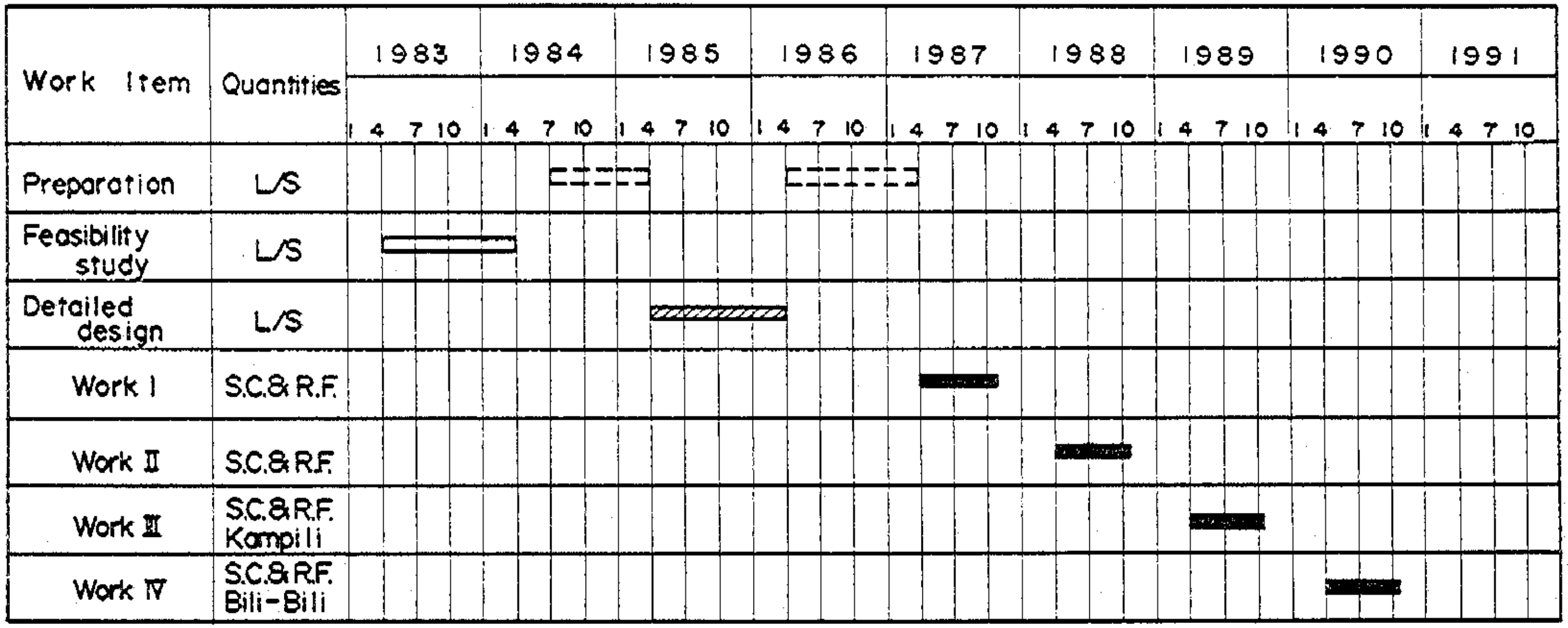
LEGEND

1),2),3),4) : Present cross section of main channel

5) : Standard cross section of main channel

6) : Proposed cross section of main channel

Fig. 8-9
KAMPILI MAIN CHANNEL



Note S.C.& R.F. : Secondary channel and Relevant Facilities

Kampili : Kampili main channel

Bili-Bili : Bili-Bili connecting channel and existing channel

Fig. 8-10

CONSTRUCTION SCHEDULE

9. HYDRO POWER

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1. GENERAL

Generation and distribution of the electric power in South Sulawesi is being operated and maintained under PLN.

Bili-Bili hydro power station proposes to generate electricity by use of the discharge for the irrigation and the municipal/industrial purpose and by utilizing the head made available by Bili-Bili dam.

The proposed Bili-Bili power station is a run-of-river type without any storage capacity of the reservoir for power generation.

Power from the station is transmitted to the nearest Bolrongloe sub-station, and then incorporated into the existing electric power grids.

Hydro power project has been planned on the basis of the preliminary study stage.

2. PRESENT CONDITION

2.1 Power Supply and Demand

Electric power supply in the South Sulawesi depends on the services of WILAYAH VIII of PLN, under two systems, i.e., Ujung Pandang system and Pinrang Pare-Pare system.

The one is in the urban area whose center is Ujung Pandang itself and the other, the rural area where consumers are clustering in so many small villages which are spreading in an inconcentrated manner.

The annual generated energy (1979/1980) at WILAYAH VIII is approximate 170 GWH while annual sold energy is reaching to approximate 126 GWH in the same period. The percentage of each annual increase in generated energy and sold energy the last 5 years is reaching to nearly 20%, and number of consumer in 1980 is 100,000 approximately. Table 9-1 shows annual generated energy and sold energy in the last 5 years.

With regard to Ujung Pandang system, number of consumers is reaching to approximate 47,000 in 1980, and about 20% of households are electrified. The transition during 1976-1980 is shown in Table 9-2.

In the neighbourhood of Ujung Pandang, there exist various kinds of industry among which ship-building, paper, and cement, for instance, are the most important ones. 75% of the total installed capacity is thus concentrated in

Ujung Pandang and the rest in the rural area. Nevertheless the large-scale consumers including flour mill, paper mill and cement factory have been experiencing power shortage so much and so often that some of them felt the need to establish their own independent power stations.

The typical daily load curve taken at Tello sub-station recently (June 1981) gives an indication that a peak time extends for 5 hours from 18:00 to 23:00; during the hours when the industrial and domestic demands for power overlap each other (refer to Fig. 9-1).

2.2 Power Stations

The electrical installations and facilities in South Sulawesi may be more appropriately categorized into (i) those under PLN and (ii) the independent power stations on the factory basis, both of them being in the urban area, and (iii) the individually operated power facilities in the rural area.

The major power stations in the Ujung Pandang are have a generation capacity as given below, which is totalized to 52.1 MW.

Bontoal diesel power station	:	7.0 MW
Tello diesel power station	:	5.7 MW
Tello steam turbine power station	:	25.0 MW
Tello gas turbine Power station	:	14.4 MW
T o t a l	:	52.1 MW

The independent power stations owned by individual enterprises have a total capacity of 14.3 MW, while the accumulated total of the entire rural electric generating capacity amounts to 22.8 MW.

2.3 Transmission Lines

Transmission line system in Ujung Pandang district is fairly well maintained at present with Tello sub-station as a core of the grid but, sooner or later, an increasing demand will surpass its capacity. The existing transmission lines are systematized into the following three:

Tello ss - Kalukuang ss - Bontoala ss	:	30KV 2 lines
Tello ss - Mandai ss - Tonasa ss	:	30KW 2 lines
Tello ss - Sungguminasa ss - Boronglae ss	:	30KV 2 lines

Apart from these three, there is only one system connecting Pare-Pare and Pinrang for rural distribution.

3. FUTURE DEMAND AND ON GOING DEVELOPMENT PROGRAM

3.1 Future Demand

There is no lack of factors indicating that large-scale demand for power will persist and be newly created in the near future. For instance, a new township which is under construction in a part of Ujung Pandang city planning Scheme will create a considerable power demand in the near future and Gowa Paper Mill (Pabrik Kertas Gowa) which is producing 50 tons of paper per day consuming 4.7 MW is planning to expand its capacity five times bigger (250 tons/day) within coming 10 years. Another case of a cement factory may be added. Perum Semen Tonasa cement factory is planning production increase for which PLN is requested to supply 58.0 MW in 1988.

The future power demand curve has been chalked out by PLN in order to establish an appropriate power project to meet the increasing demand in Ujung Pandang area.

The largest future demands for electric power expected to be forthcoming in Ujung Pandang area are from:

1. New township in Ujung Pandang city planning scheme;
2. Gowa paper mill;
3. Tonasa cement factory.

Among these the new township would be the biggest. Fig. 9-2 shows future power demand at WILAYAH VIII which has been programmed by PLN.

3.2 On-going Development Program

<u>Power Stations</u>

PLN is planning to annually increase the installed capacity to support the increasing demand through the expansion programs as follows:

Tello gas turbine power station	:	1 x 25 MW
Tello diesel power station	:	2 x 12 MW
Tello gas turbine power station	:	1 x 25 MW
Bakaru hydro power station (#1,2)	:	4 x 31 MW
Bakaru hydro power station (#3,4)	:	4 x 31 MW

These expansion programs are targeted to provide for a spare capacity of 2 - 3 MW on and above the current demand forecast at the time of construction (refer to Fig. 9-2).

Transmission Lines

Together with such expansion of the installed capacity, the transmission lines are also planned to be extended to new areas. This involves establishment of new sub-stations as well as extension of transmission lines as follows:

Tello ss - Panakkukang ss	:	150 KV 2 lines
Tello ss - Veteran ss	:	70 KV 2 lines
Tello ss - Sungguminasa ss - Gowa ss	:	70 KV 2 lines

In compliance with the completion of a new Bakaru hydro power station construction of new sub-stations and extension or new wiring of the transmission lines are also under planning as follows:

Bakaru ps - Tonasa II ss	:	150 KV 2 lines
Tonasa II ss - Tonasa I ss	:	70 KV 2 lines
Tonasa I ss - Tello ss	:	70 KV 2 lines

The routes of transmission lines are shown in Fig. 9-3.

4. DEVELOPMENT PLAN OF BILI-BILI POWER STATION

4.1 Selection of Generating Method

Hydro power generation principally depends on municipal and industrial water, irrigation water and the vested right water which are subject to the requirement of the benefitted area. When the paddy cultivation of the dry season is over at end of September, the reservoir storage will recover to high water level within a few month every year.

For power generation, three plans as described below may be worth while studing.

Plan 1. The run-of-river type without the recovery rule curve of the reservoir water level.

Plan 2. The run-of-river type with the recovery rule curve of the reservoir water level.

Plan 3. The peak load service by the construction of a regulating pondage

At this present, Plan 2 seemed most feasible of the Plans above, based on the findings of the comparative study as detailed next page.

Comparison of between Plans 1 and 2

Regarding the foregoing Plans 1 & 2, an available energy is calculated under the conditions mentioned below.

- The maximum discharge for the required is fixed at 32 m^3/s which is specified as optimum scale in paragraph 4.2. The discharge is almost equal to the maximum demand of the irrigation and the municipal/industrial water.

- In early May just before the beginning of full irrigation season, the reservoir storage will recover to high water level.

The result of calculation of generated output and energy during 5 years (1976 - 1980), is shown in Fig. 9-4 and Table 9-3 respectively.

The findings indicate that annual generated energy under Plans 1 and 2 is 61,500 MWH and 69,600 MWH respectively in 5 year average. Annual generating energy under Plan 2 is about 13% higher than the one under Plan 1.

Comparison between Plans 2 and 3

In Plan 3, Bili-Bili power station fills the role of a peak load station.

To smooth out fluctuated river discharge caused by peak load operation, it is required to construct a regulating pondage, around $1,700 \times 10^3$ m^3 /1 in capacity, at about 5.5 km downstream of Bili-Bili dam site.

/1: Though peak hours in Ujung Pandang area at present is 6 - 7 hours (refer to Fig. 9-1), the proposed regulating pondage is designed to meet peak hours of 8 hours taking future development of the subject area into consideration.

30 M^3/s: maximum discharge excluding municipal and industrial water

required storage: $(90 - 30) \times 8 \times 60 \times 60 = 1,700,000$ m^3

From the result obtained as below, Bili-Bili power station seems rather not suitable for a peak load station.

	Plan 2	Plan 3
Maximum discharge (m^3/s)	32	90
Maximum generated output (KW)	11,200	29,400
Annual generated energy (MWH)	69,600	59,700
Annual benefit ($x10^6$ US$)	3.9	3.7
Construction cost ($x10^6$ US$)	22.1	48.0
B/C	0.18	0.08

Note: Table 9-4 shows the values mentioned above in detail.

4.2 Expected Generated Output and Energy

Supposing that the power generation system in the foregoing Plan 2 is to be applied, the result of study of the optimum hydro power system is as shown below.

The optimum scale of a hydro power station will be decided upon from its IRR values which have been calculated for each maximum available discharge. Accordingly, the maximum discharge required for operating the turbines has been categorized into 4 cases of 22, 32, 42 and 62, each in m^3/s, to identify the optimum generating capacity. Consequently the following capacity has been ultimately adopted:

Maximum discharge : 32 m^3/s
Maximum generated output: 11,200 KW
Annual generated energy : 69,600 MWH

Fig. 9-5 and Table 9-5 show the relation between IRR and maximum available discharge.

4.3 Transmission Line

A 30 KV transmission line to the nearest Borongloe sub-station will be constructed for a discharge of 15 km along Jl. Malino from the switchgear which will be established outside the power station.

4.4 Benefit

The benefit of Bili-Bili hydro power station is evaluated based on the cost required to produce the equivalent capacity and energy by the most competitive thermal plant.

In this stage, an oil fired steam station with the capacity of 11,000 KW. will be adopted for the alternative.

The capacity value and the energy value are estimated on the basis of the alternative cost as follows:

Capacity Value

Capacity	11,000KW
Investment for alternative thermal power station	US$700/KW
Capital recovery factor (interest: 9%, durable life: 25 years)	0.1018
Fixed O & M cost	2.5%
Adjustment factor	1.179 /1

Annual fixed cost per KW installation
US$700/KW x (0.1018 + 0.025) x 1.179 = US$90/KW

Energy Value

Fuel cost	US$0.124/l
Calorific value	9,600 kcal/l
Station heat rate (thermal efficiency: 35%)	2,457 kcal/KWH
Share of variable cost	0.95
Adjustment factor	1.039 /1

Energy value per KWH

$$US\$0.214 \times \frac{2,475}{9,600} \times 0.95 \times 1.039 = US\$0.054/KWH$$

Annual Benefit

Annual benefit of Bili-Bili hydro power station is estimated at US$3.9 million as shown below:

Capacity benefit (/2 dependable peak power: 2,870 KW)
2,870 KW x US$90/KW = US$258,000

Energy benefit
69,600 MWH x 0.96/3 x US$0.054/KWH = US$3,608,000

Total annual benefit: US$3,866,000

/1: Adjustment factor:

	Hydro	Oil
Loss up to primary substation	4.0	2.0
Auxiliary power use	0.3	6.0
Forced outage	1.0	5.0
Overhaul	2.0	10.0

Capacity adjustment factor:

$$\frac{(1 - 0.04)(1 - 0.003)(1 - 0.01)(1 - 0.02)}{(1 - 0.02)(1 - 0.06)(1 - 0.05)(1 - 0.1)} = 1.179$$

Energy adjustment factor:

$$\frac{(1 - 0.04)(1 - 0.003)}{(1 - 0.02)(1 - 0.06)} = 1.039$$

/2: The 310th largest generated output in a year.
/3: Excluding 4% transmission loss

5. PRELIMINARY DESIGN

5.1 Power Station

Intake

As Bili-Bili hydro power depends on the irrigation and the municipal/industrial water from the reservoir, the intake structure should guarantee an unhampered of them. The common intake is designed as inclined conduit type, is laid on the slope immediate downstream of the mouth of the temporary diversion channel.

The water from the intake will be controlled with the intake gate and sent to the turbine through the steel pipe which will be installed in the diversion tunnel of the dam. The principal specifications in regard to the intake are follows.

Design intake volume	:	32 m^3/s
The lowest intake level	:	EL. 74.00 m
Type of intake	:	Inclined conduit
Penstock	:	Dia, 3,500 mm, L = 120 m
		Dia, 2,400 mm, L = 70 m
		Dia, 1,800 mm, L = 65 m

Waterway and Power House

A power house is to be constructed at a flat ground on the left bank downstream of the outlet of the temporary diversion channel. Its foundation is fresh rock with enough bearing power.

Two generators are accommodated in the power house which is built with reinforced concrete, 38 m in length, 22.0 m in width, 12.0 m above and 20.0 m below the ground levels.

After the water being branched off in two penstocks immediately before the power house, it will operate each one of the turbines. A draft gate will be insalled at the outlet of the turbine draft. A part of the water used for power generation will be sent to the regulatig basin for the municipal/industrial and the remainder will be discharged to the Jeneberang river for the irrigation through a tailrace channel.

The water way and power house are illustrated in Fig. 9-6 and Fig. 9-7 respectively.

5.2 Generating Equipment

Each one of the proposed hydraulic turbines which has been designed under considerations of 16 m^3/s of discharge at 42.0 m design head, will be of vertical shaft, Kaplan type with an elbow-type draft tube. The selection of the turbines has been made by considering the undermentioned items:

High water level	:	EL. 97.60 m
Low water level	:	EL. 74.00 m
Normal tail water level	:	EL. 47.0 m
Effective head	:	48.1 m - 24.5 m

Two generators to be provided for the power station will be of 3-phrase vertical shaft revoloving field type and rated at 6,600 KVA, 6 KV, 50 Hz. The generators will be directly coupled with the water turbines.

5.3 Transmission Line

The steel poles for the 30 KV transmission line will be constructed in every 100 m of 15 km distance, between Bili-Bili power station and Borongloe sub-station (refer to Fig. 9-8).

The conductor will be selected as 120 mm^2 ACSR considering corona discharge.

6. CONSTRUCTION SCHEDULE AND COST ESTIMATE

6.1 Construction Schedule

The commencement of commercial operation of power generation is scheduled for the end of April 1991, simultaneously with the completion of the dam construction.

A construciton works schedule of power station is formed taking time required for manufacture of power generating equipment, transportation to the project site and installation into consideration. The total time required for the above is estimated at 2 years. Based on this, the construction works are scheduled to be started from 1989. The commencement of the construction of transmission line will be started from June 1990 to be in time with the completion of installation of the power generating equipment at the proposed site.

The construction time shedule is shown in Fig. 9-9.

6.2 Cost Estimate

Construction Cost

The hydro power station cost comprises on the contract baiss, civil works, generating equipment, transmission line and sub-station, engineering cost and plus 15% physical contingencies. The construction cost has been estimated on 1981 prices.

The total cost will be US$25.4 million, out of which US$18.1 million is in foreign currency and US$7.3 million in local currency.

Table 9-6 shows the construction cost of hydro power station by work item and Table 9-7 shows annual disbursement schedule.

Operation, Maintenance and Replacement Cost

The operation and maintenance cost will comprise the personnel cost, operation machinery and equipment, automobiles, administrative cost and miscellaneous. The annual operation and maintenance cost is estimated at US$0.17 million for the whole period of the project life. The replacement cost of the generating equipment after 35 years from the initial operation is estimated at US$4.17 million.

Table 9-1 POWER DEMAND & CONSUMPTION AT WILAYAH VIII

Year	Installed Capacity (MW)	Peak Load (MW)	Generated Energy (10^3MWH)	Energy Sold (10^3 MWH)	Number of Consumer (nos.)
1975/1976	37.7	*	78.0	59.6	28,000
1976/1977	37.7	*	96.0	73.6	30,600
1977/1978	52.1	20.8	125.7	94.2	51,200
1978/1979	52.1	22.5	145.3	105.3	70,900
1979/1980	52.1	27.3	171.2	125.6	97,300

Source: PLN

Note : * No figure available

Table 9-2 NUMBER OF HOUSEHOLD ELECTRIFIED IN UJUNG PANDANG SYSTEM

(Unit: Nos.)

Description	1976	1977	1978	1979	1980
1. Number of Consumer	22,688	26,339	31,773	44,267	46,608
- Small consumer	4,772	4,085	3,629	2,747	2,590
- Household	14,959	19,109	24,871	38,139	40,631
- Commercial	2,957	3,145	3,273	3,381	3,387
2. Number of Household	233,310	238,697	241,109	248,342	254,550
3. Number of Household Electrified in Percentage	9.7%	11.0%	13.2%	17.8%	18.3%

Table 9-3 GENERATED ENERGY AT BILI-BILI HYDRO POWER STATION

Plan 1

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1976	8,333	7,795	8,333	3,965	5,690	6,751	7,581	6,561	2,336	289	432	385	58,452
1977	3,259	7,526	8,333	7,451	4,342	5,775	8,307	7,490	2.967	365	1,983	460	58,258
1978	8,333	7,526	7,917	5,309	5,068	4,730	6,873	7,077	2,953	463	1,435	5,808	63,492
1979	8,333	7,526	8,333	6,434	6,266	3,991	7,432	6,959	2,689	380	2,623	458	61,424
1980	8,333	7,795	8,333	8,052	5,214	6,891	7,339	6,349	2,485	342	1,454	3,247	65,835

Plan 2

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1976	8,333	7,795	8,333	4,836	4,074	6,751	7,581	6,561	2,336	557	422	723	58,301
1977	7,883	7,526	8,333	7,800	3,604	5,775	8,307	7,490	2,967	3,853	1,618	5,889	71,041
1978	8,277	7,526	8,333	5,539	4,036	4,730	6,873	7,077	2,953	7,911	6,449	6,521	76,225
1979	8,333	7,526	8,333	6,717	6,110	3,991	7,432	6,959	2,689	4,583	2,085	5,792	70,549
1980	8,269	7,795	8,333	8,064	5,214	6,891	7,339	6,349	2,485	2,483	1,312	7,309	71,843

Table 9-4 ANNUAL BENEFIT AND CONSTRUCTION COST OF PEAK LOAD STATION

(BILI-BILI P.S. PLAN 3)

Annual Benefit

Capacity Benefit	:	6,320 KW x US$90/KW	= US\$ 569 x 10^3
Energy Benefit	:	59,700 MWH x 0.96 x US$0.054/KWH	= US\$3,095 x 10^3
			US\$3,664 x 10^3

Note: The above unit values are given in "Paragraph 4.4".

Construction Cost

Waterway and Generating Equipment	:	US\$38,000 x 10^3
Transmission Line and Sub-Station	:	US\$ 6,000 x 10^3
Regulating Pondage	:	US\$ 4,000 x 10^3
		US\$48,000 x 10^3

Table 9-5 RELATION BETWEEN IRR AND MAXIMUM AVAILABLE DISCHARGE

Maximum available discharge m^3/s	Maximum output KW	Annual generated energy MWH	Construction cost x 10^6 US$	Unit construction cost per kWH (sending end) US$/KWH	Internal Rate of Return %
22	7,700	54,610	17,651	0.323	13.2
32	11,200	69,600	22,052	0.317	13.3
42	14,900	80,580	25,851	0.321	12.9
62	22,200	94,570	31,122	0.329	12.5

Table 9-6 CONSTRUCTION COST OF HYDRO POWER

Work Item	Total Amount ($x10^3$ US$)	Foreign Currencey ($x10^3$ US$)	Local Currency ($x10^3$ US$)
1. Civil Works			
Intake	491	270	221
Headrace tunnel	152	87	65
Penstock	525	254	271
Power house	6,156	3,426	2,730
Tailrace channel	1,021	524	497
Preparatory works	835	456	379
Sub-total	9,180	5,017	4,163
2. Gates & Penstock	1,392	1,182	210
3. Generating Equipment	5,955	5,590	365
4. Transmission line & Sub-station	3,640	2,320	1,320
5. Engineering Service	1,885	1,613	272
Sub-total (1-5)	22,052	15,722	6,330
6. Physical Contingency	3,308	2,358	950
Grand-total (1-6)	25,360	18,080	7,280

Table 9-7 ANNUAL DISBURSEMENT SCHEDULE FOR HYDRO POWER

(Unit: x 10^3 US$)

Work Item	Total		1984		1985		1986		1987		1988		1989		1990	
	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. Main Works																
Intake	270	221	-	-	-	-	-	-	-	-	-	-	270	221	-	-
Headrace channel	87	65	-	-	-	-	-	-	-	-	-	-	87	65	-	-
Penstock	254	271	-	-	-	-	-	-	-	-	-	-	133	142	121	129
Power house	3,426	2,730	-	-	-	-	-	-	-	-	-	-	1,884	1,500	1,542	1,230
Tailrace channel	524	497							-	-	-	-	-	-	524	497
Preparation works	456	379	-	-	-	-	-	-	-	-	-	-	237	193	219	186
Sub-total	5,017	4,163	-	-	-	-	-	-	-	-	-	-	2,611	2,121	2,406	2,042
2. Gates and Penstock	1,182	210	-	-	-	-	-	-	-	-	-	-	285	50	897	160
3. Generating Equipment	5,590	365	-	-	-	-	-	-	-	-	-	-	-	-	5,590	365
4. Transmission Line	2,320	1,320	-	-	-	-	-		-	-	-	-	-	-	2,320	1,320
5. Engineering Service	1,613	272	-	-	-	-	-	-	795	134	-	-	227	38	591	100
Sub-total (1-5)	15,722	6,330	-	-	-	-	-	-	795	134	-	-	3,123	2,209	11,804	3,987
6. Physical Contingency	2,358	950	-	-	-	-	-	-	119	20	-	-	468	331	1,771	599
Grand-total (1-6)	18,080	7,280	-	-	-	-	-	-	914	154	-	-	3,591	2,540	13,575	4,586

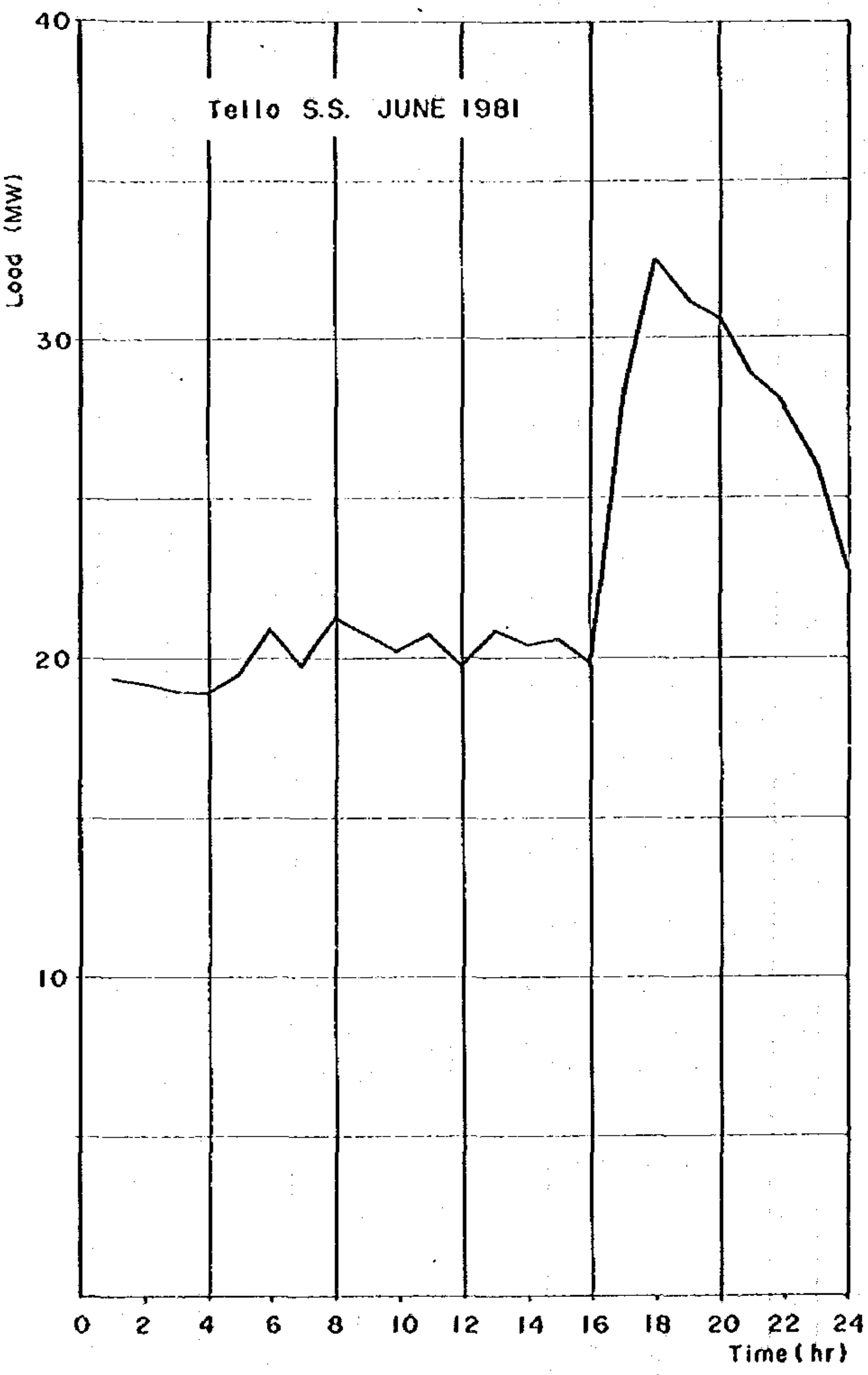


Fig. 9-1

DAILY LOAD CURVE

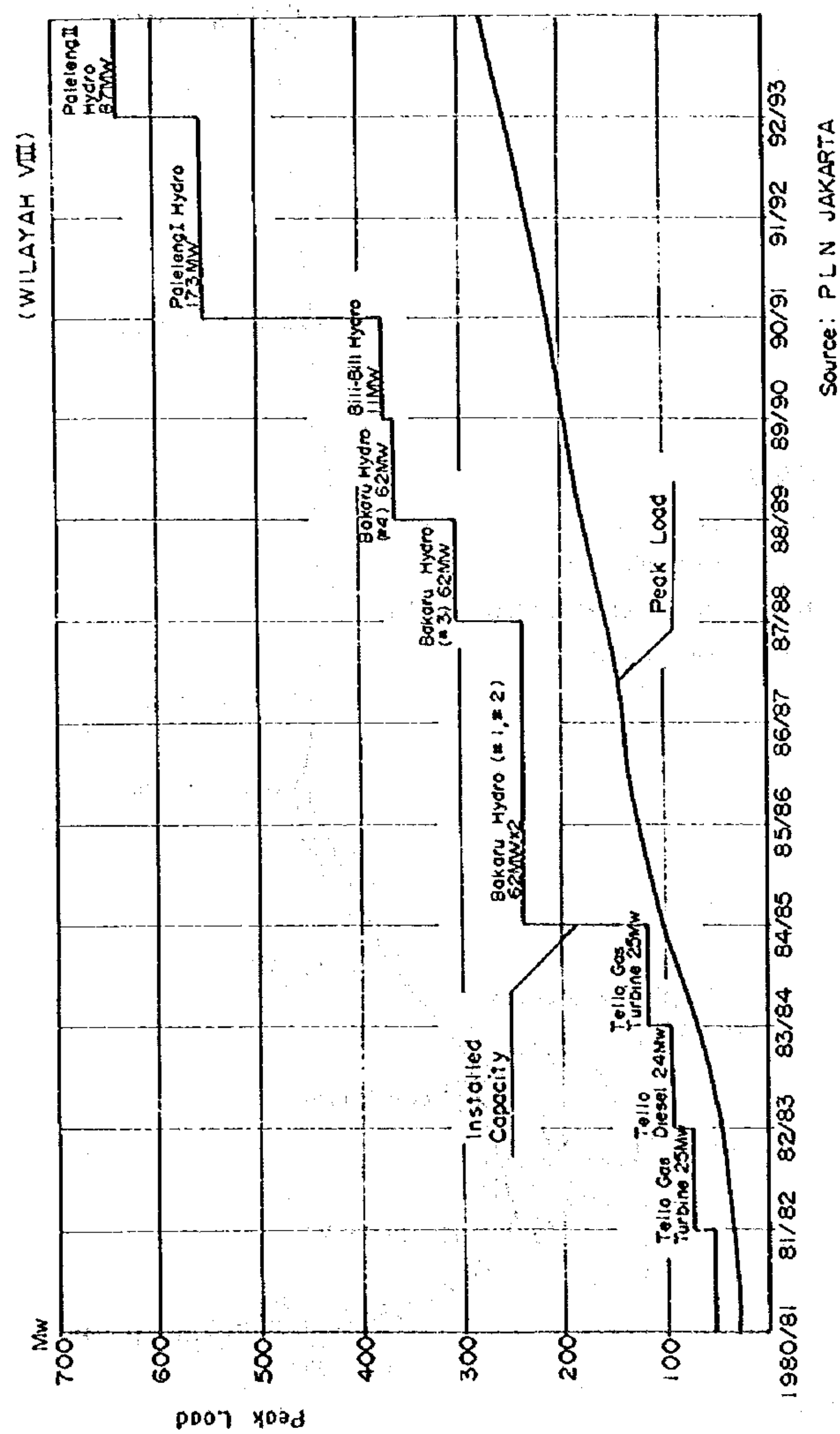


Fig. 9-2

FUTURE DEMAND & EXPANSION PROGRAM

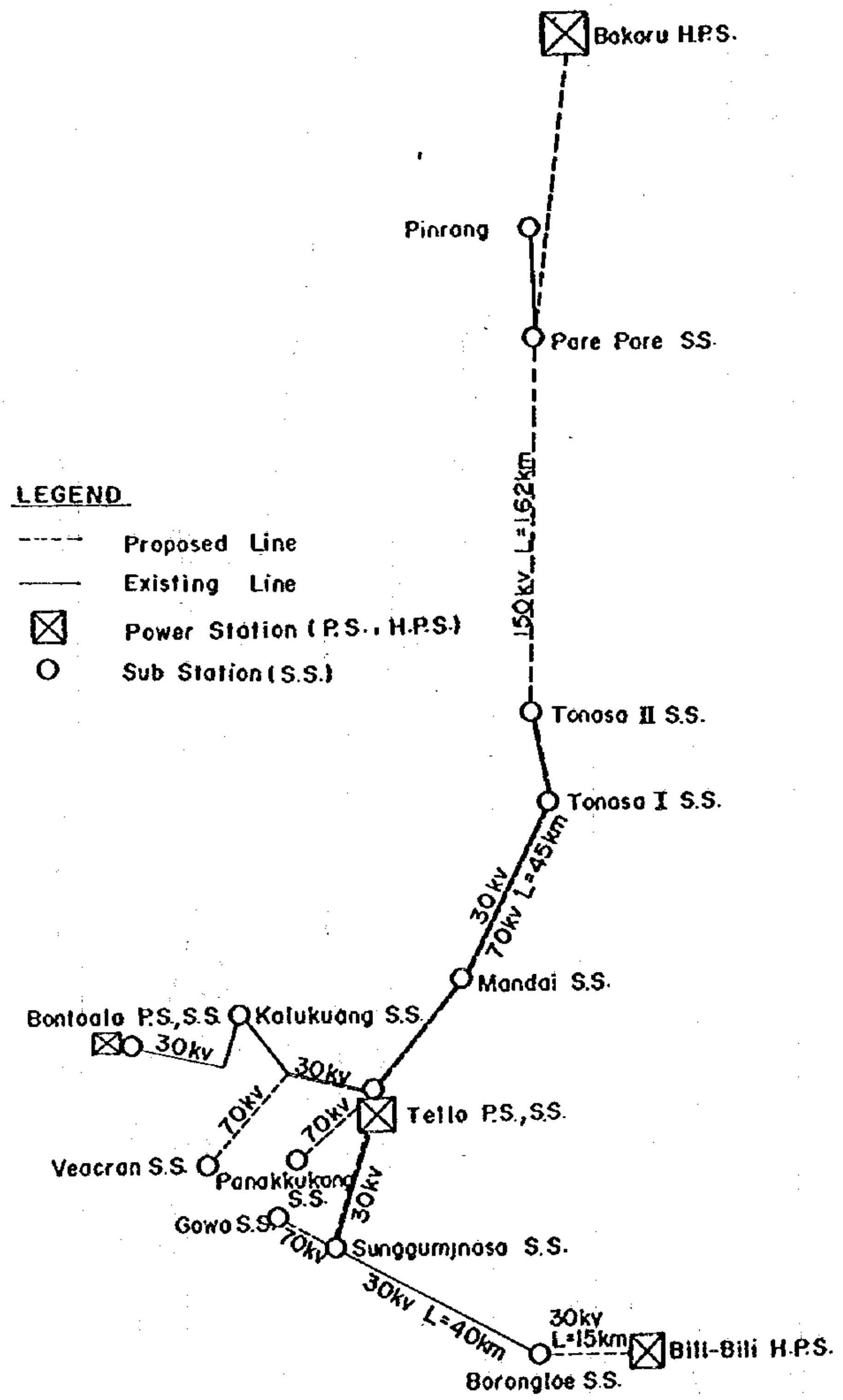


Fig. 9-3

TRANSMISSION LINES

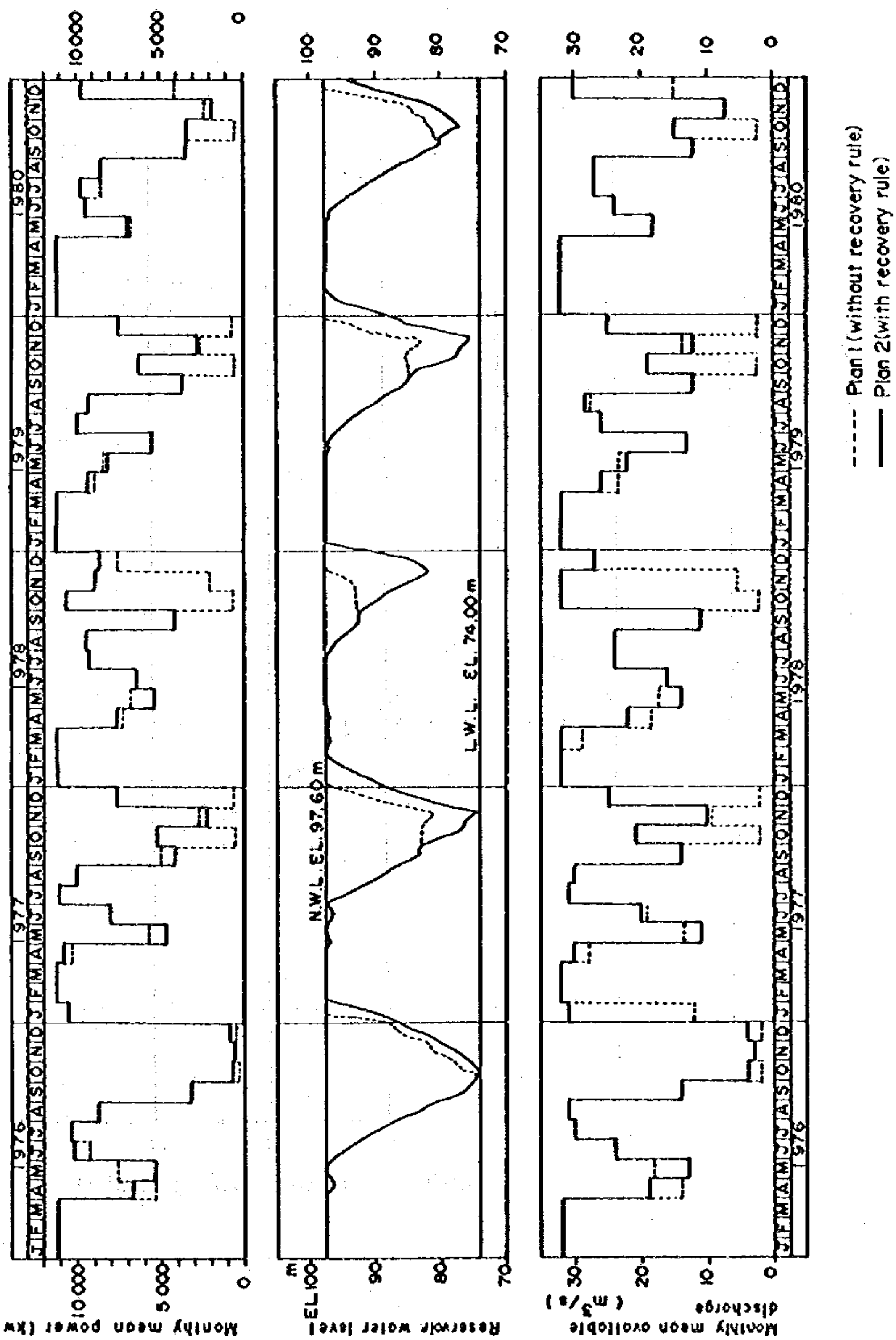


Fig. 9-4

OPERATION DIAGRAM OF HYDRO POWER

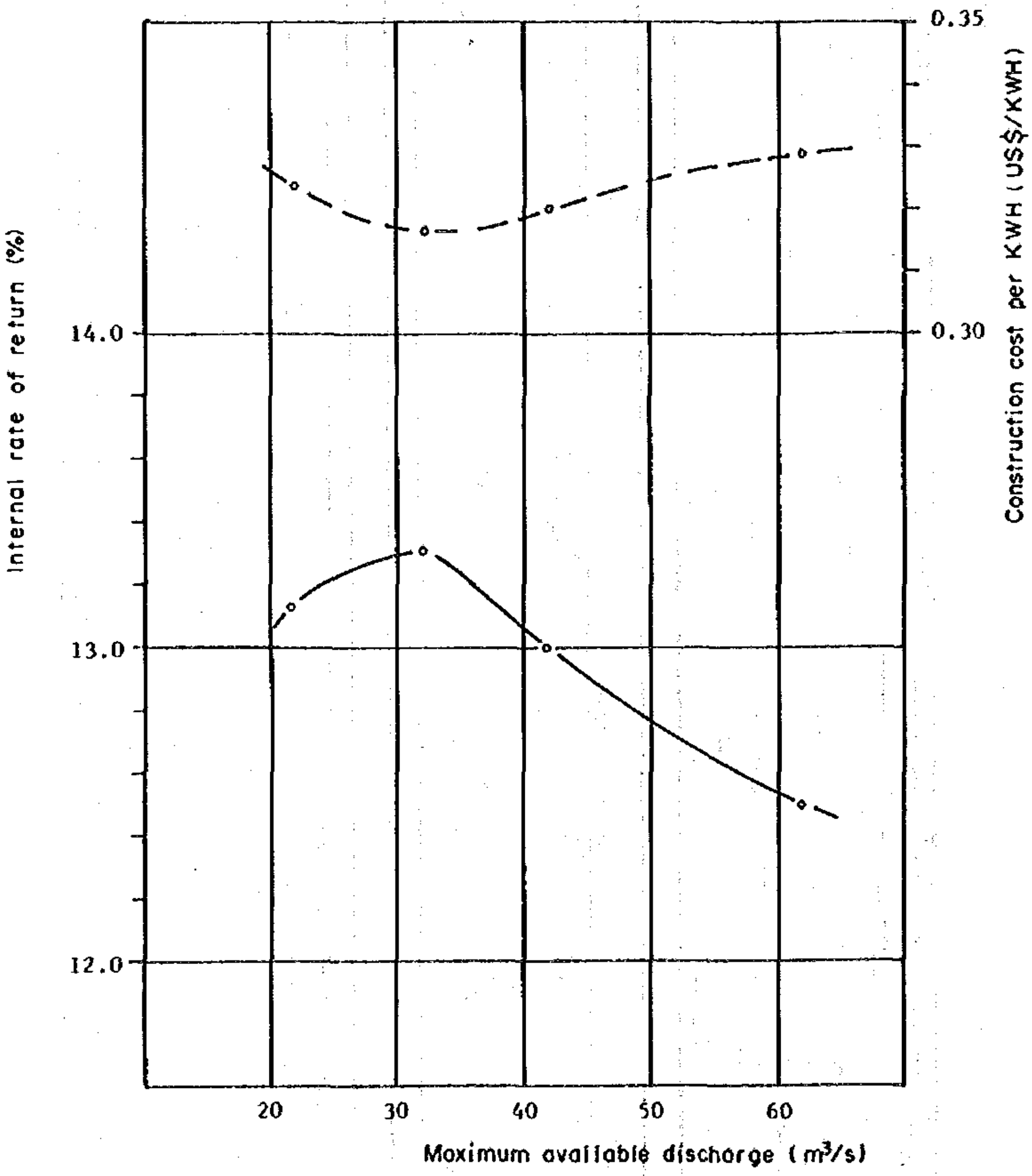
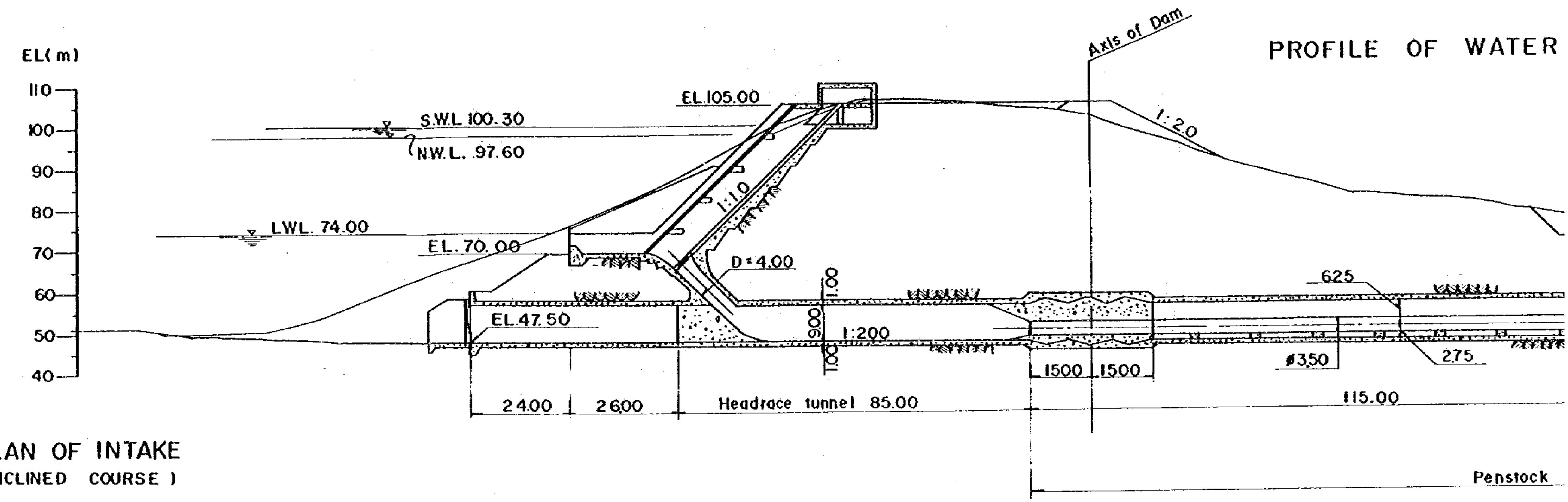
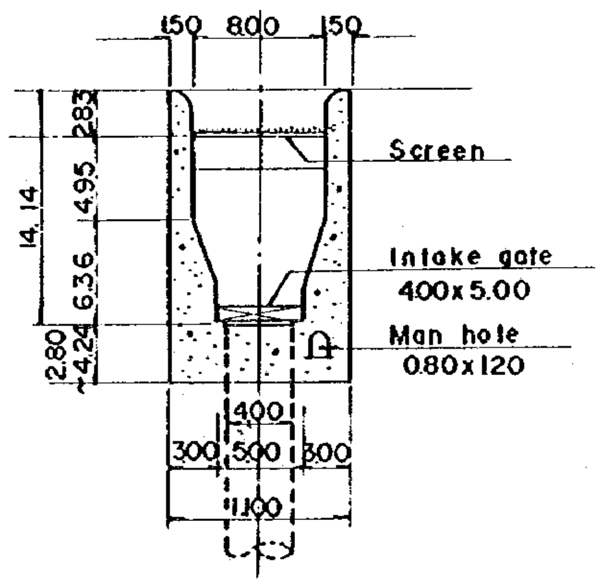


Fig. 9-5

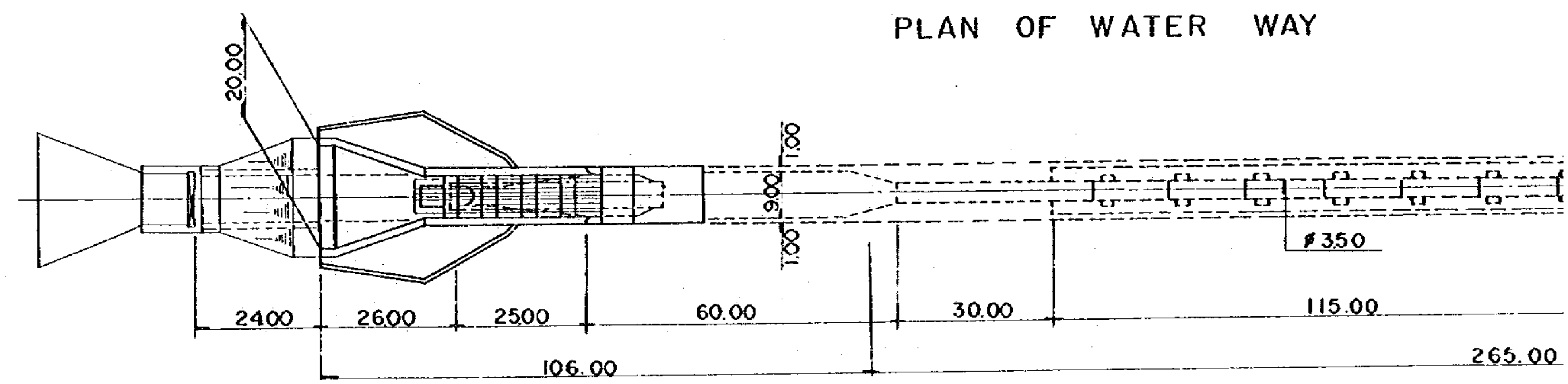
RELATION BETWEEN IRR AND MAXIMUM AVAILABLE DISCHARGE



PROFILE OF WATER
EL(m)
110
100
90
80
70
60
50
40
Axis of Dam
EL.105.00
S.W.L. 100.30
N.W.L. 97.60
LWL. 74.00
EL. 70.00
1:1.0
1:2.0
D=4.00
EL.47.50
1.00
9.00
1.00
1:200
625
275
ø350
1500
1500
2400
2600
Headrace tunnel 85.00
115.00
Penstock

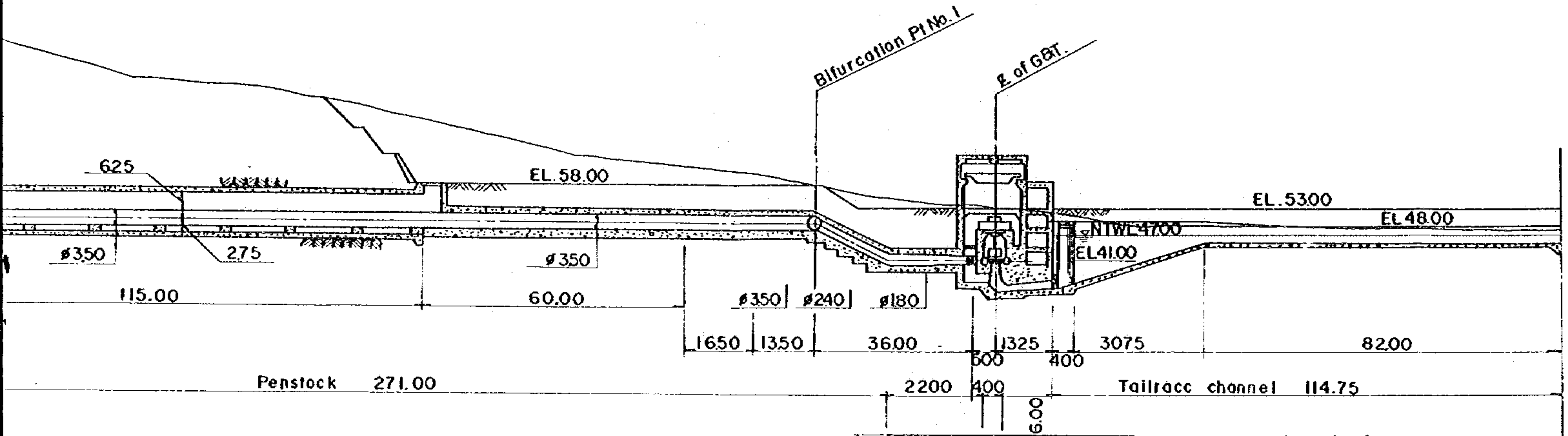


PLAN OF INTAKE
(INCLINED COURSE)
150
800
150
14.14
2.83
4.95
6.36
4.24
2.80
Screen
Intake gate
400x5.00
Man hole
0.80x120
400
300
500
300
1100

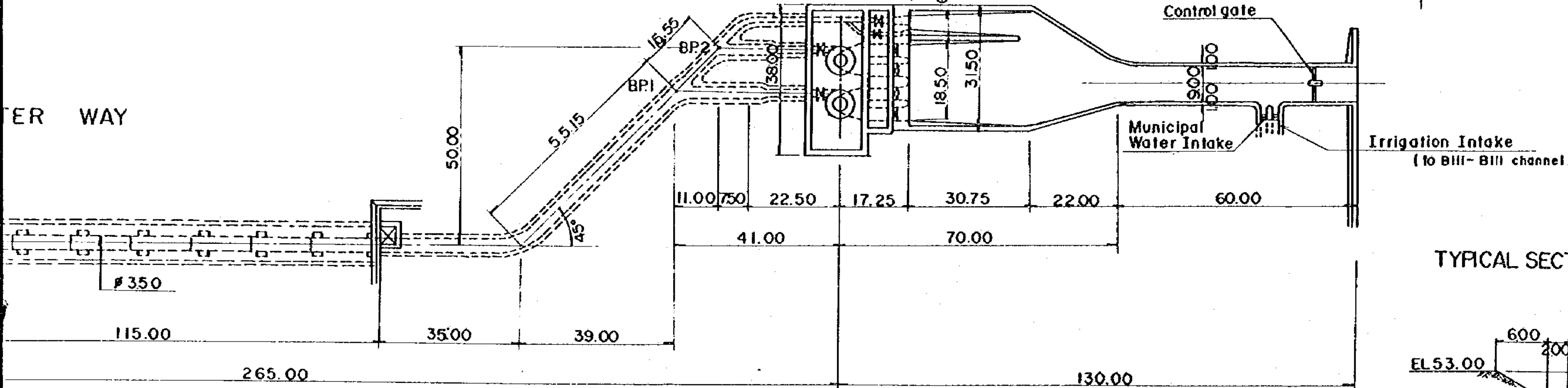


PLAN OF WATER WAY
20.00
1.00
9.00
1.00
ø350
2400
2600
2500
60.00
30.00
115.00
106.00
265.00

PROFILE OF WATER WAY

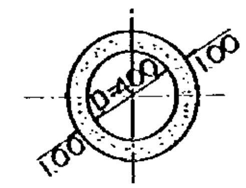


...TER WAY

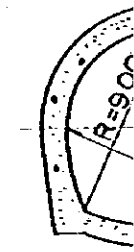


TYPICAL SECTION OF HEAD...

TYPE I

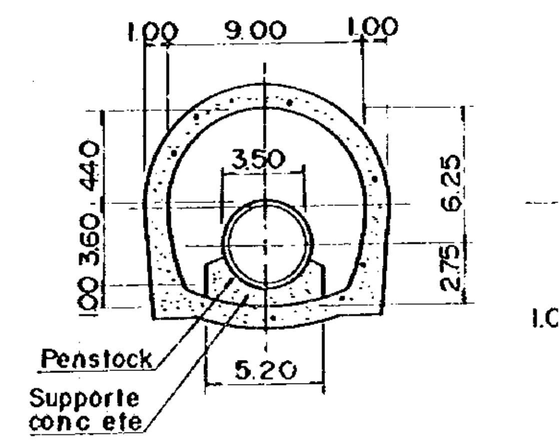


TY...

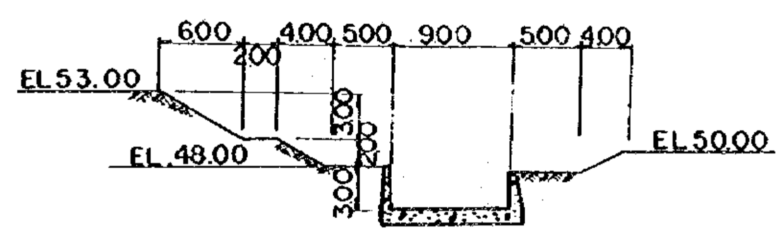


TYPICAL SECTION OF PENST...

TYPE I



TYPICAL SECTION OF TAILRACE CHANNEL



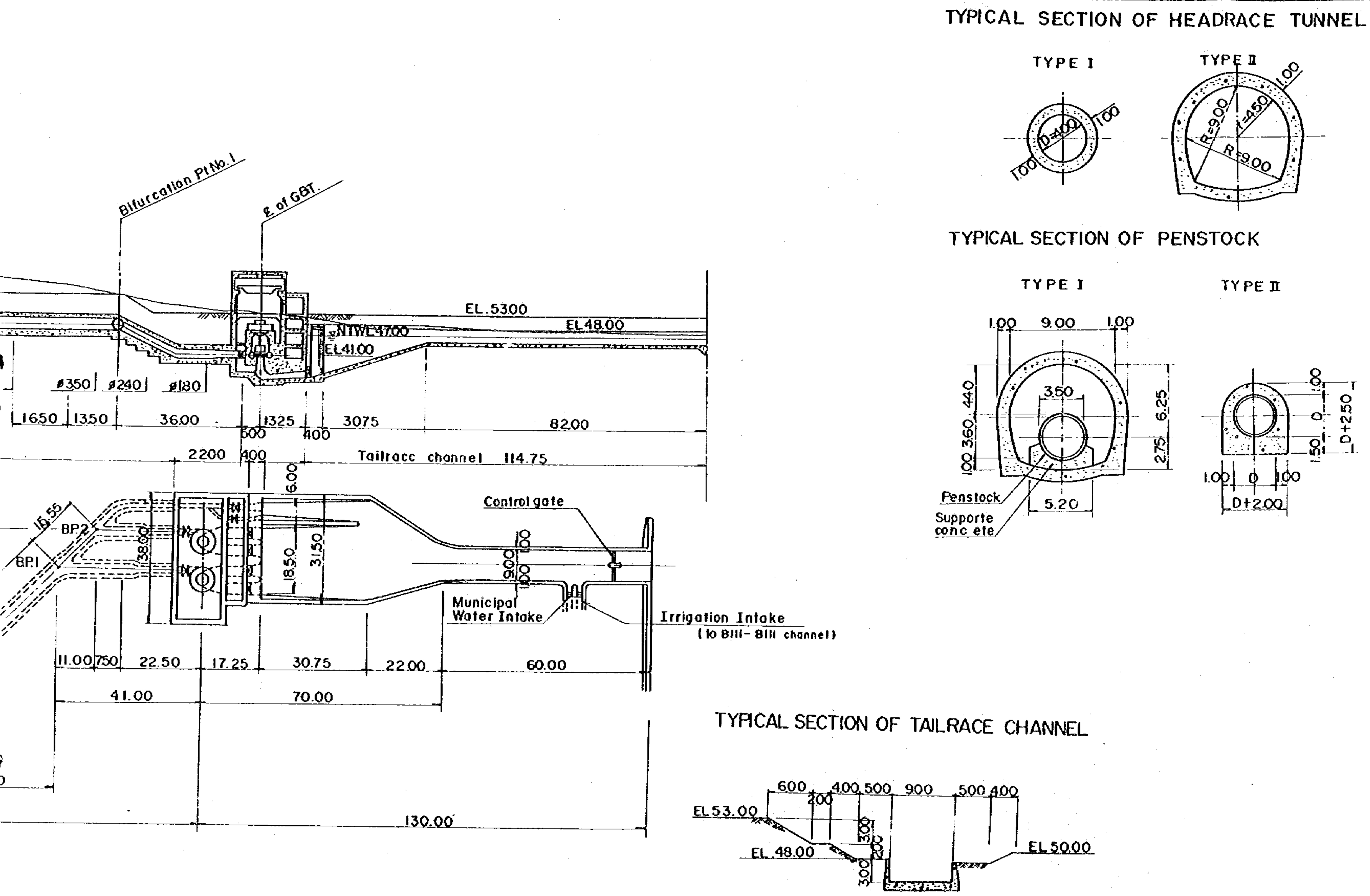


Fig. 9-6

WATER WAY PROFILE OF HYDRO POWER STATION

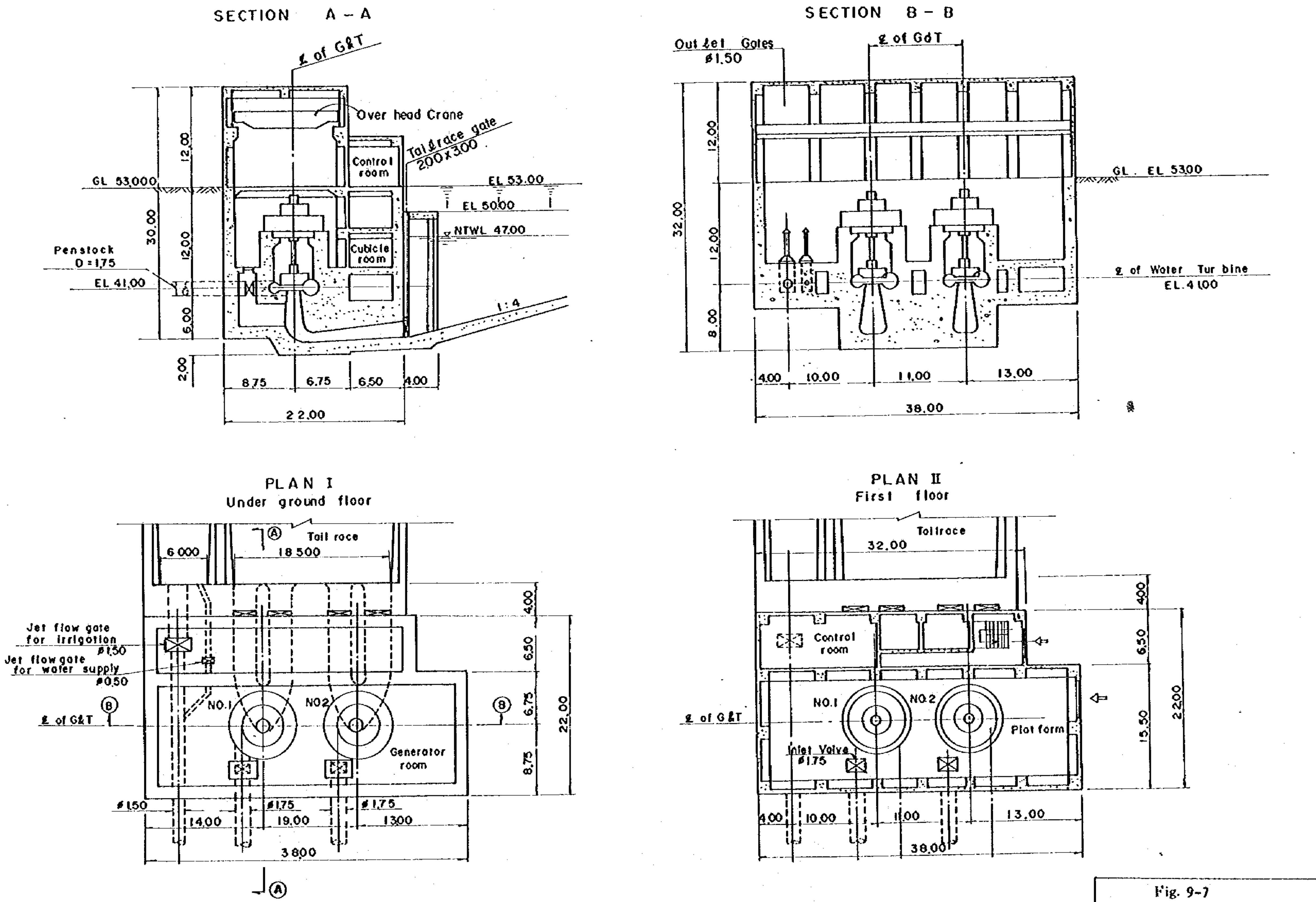


Fig. 9-7

POWER HOUSE

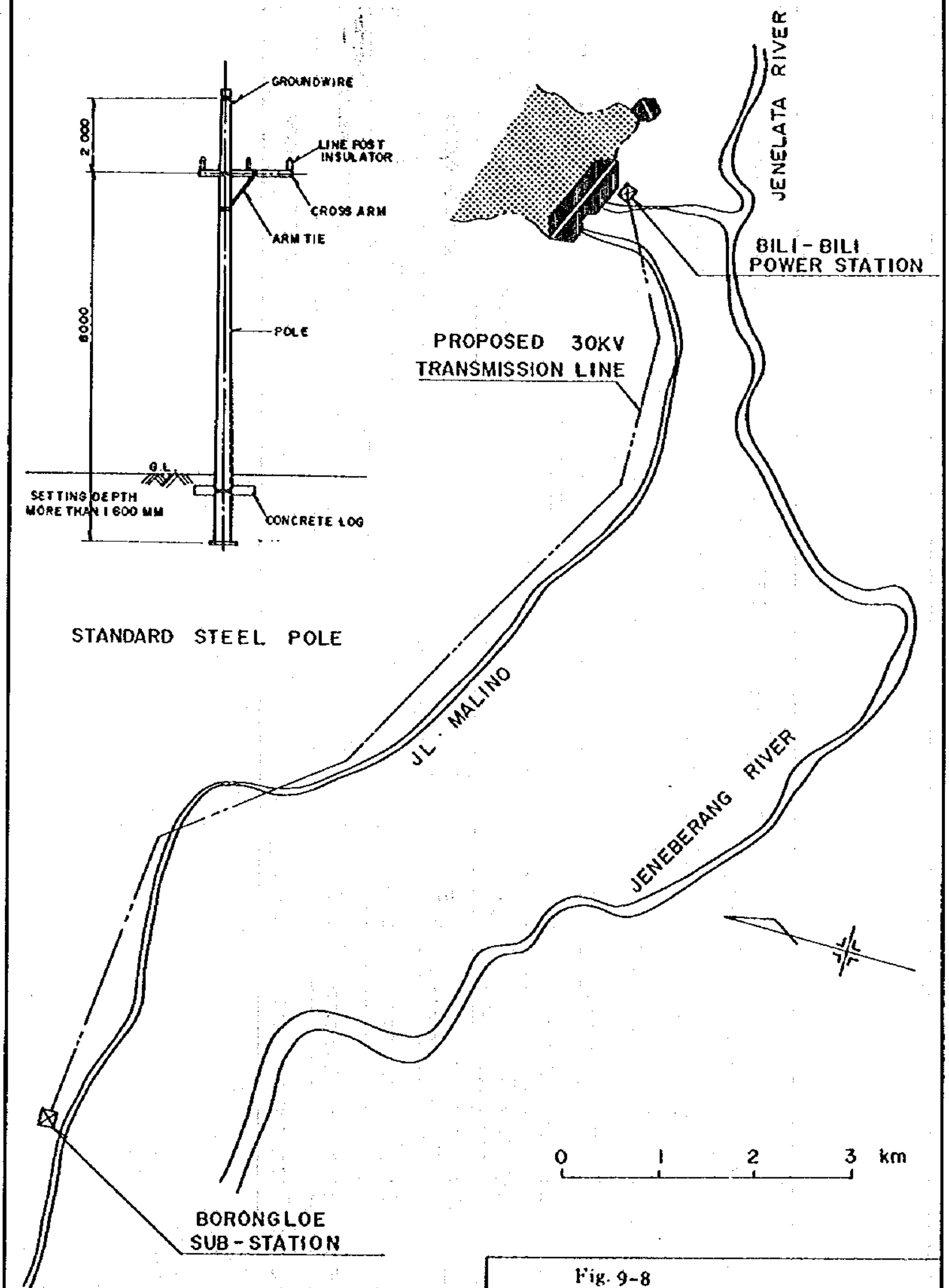


Fig. 9-8

PROPOSED 30KV TRANSMISSION LINE

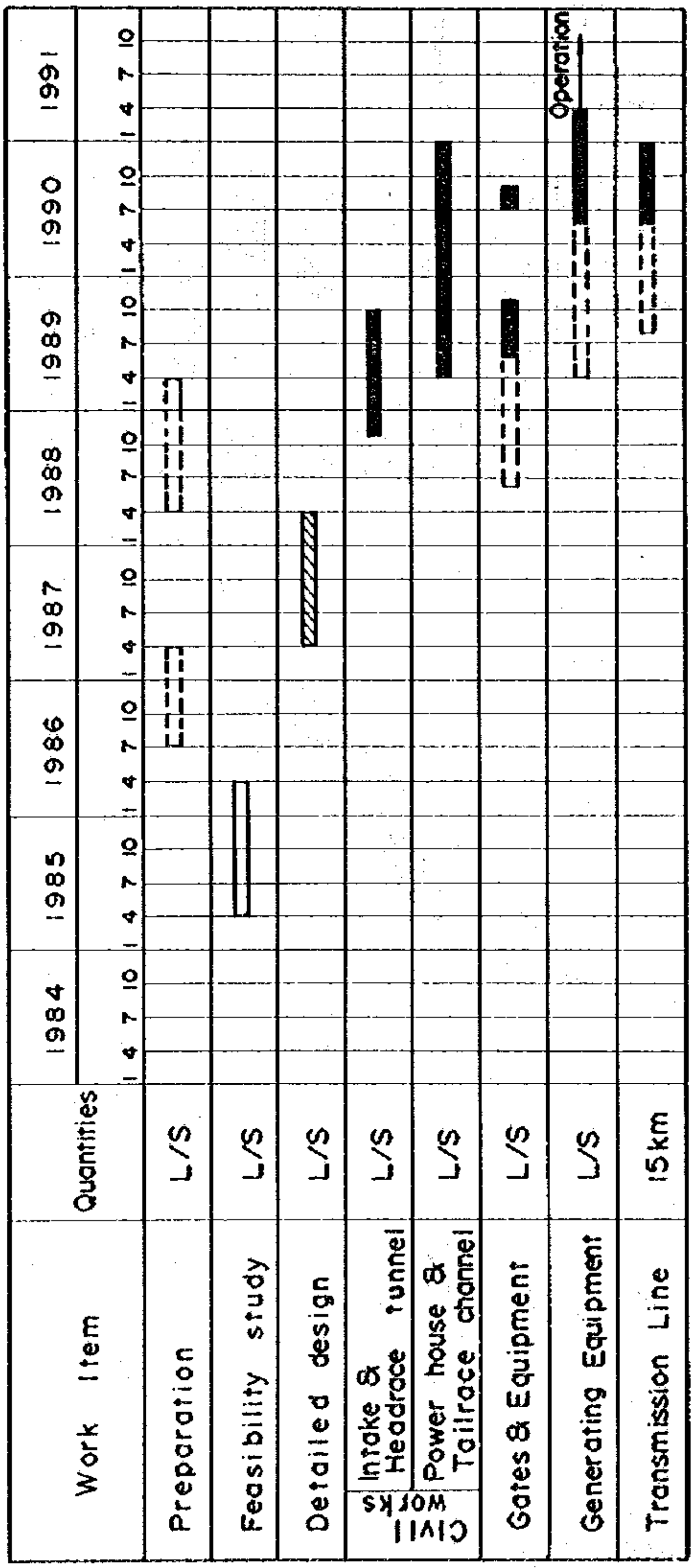


Fig. 9-9

CONSTRUCTION SCHEDULE FOR HYDRO POWER

10. ATTACHMENT

A T T A C H M E N T

SUMMARY AND PRINCIPAL FEATURES

OF

THE LOWER JENEBERANG RIVER FLOOD CONTROL PROJECT

OCTOBER 1980

SUMMARY

1. Introduction

This report presents the results of the feasibility study on the Lower Jeneberang River Flood Control Project.

2. History

Ujung Pandang city has always suffered from flood damge due to a poor drainage system and to the insufficient flow capacity of the Jeneberang river. Under this situation, the Government of the Republic of Indonesia requested the Government of Japan to formulate a flood control and drainage improvement project.

In response to the request, Japan International Cooperation Agency (JICA) dispatched a preliminary survey team to Indonesia in February 1979. The preliminary survey team has certified the necessity of flood control for the area.

3. Scope of Study

The scope of this study is as follows:

a. Formulation of an overall flood control and drainage improvement plan including the possibility of providing reservoirs

b. Formulation of an urgent flood control and drainage improvement plan

c. Preliminary design of urgent flood control and drainage improvement facilities.

4. Socio-economic Background

During a period of the Second Five-Year Development Plan (Pelita II) which commenced in the 1974/75 fiscal year, the average annual growth rate reached to about 6.9%.

The Third Five-Year Development Plan (Pelita III) was formulated in the 1979/80 fiscal year. The annual increased rate of GDP is expected to reach 6.5%. Per capita GDP is estimted to increase by about 24% during five years of the Pelita III.

In accordance with this policy, various development plans are proposed in Ujung Pandang city in order to establish a development center for the eastern Indonesia. The population of Ujung Pandang city which covers most part of the project area is estimated at 604,438 at the present time. According to the statistics, job seekers in South Sulawesi Province amount to 3% approximately. Those who work for 35 hours or less in a week account for about 45%.

5. Project Area

In the project area lie two rivers; namely, Jeneberang and Tallo. The Jeneberang river sometimes inflicts flood damage on the project area. The Tallo river has an insufficient flow capacity due to tidal backwater, though it serves as a drainage river. The drainage system consists of two drainage channels, neither of which have sufficient drainage capacity during a flood.

Under this situation, a regional development plan is now going on in the project area under the national policy. This development plan is divided into three stages, the first and second stages of which are to be completed in 1985 and 2000 respectively.

Climate conditions in the project area are dominated by the tropical monsoons. The annual mean rainfall is estimated at 4,000 mm and 2,800 mm in the mountainous area and low-lying land respectively. The climate is divided into two pronounced seasons; a rainy season and a dry season.

Jeneberang River

The Jeneberang river with a catchment area of 727 km^2 flows in the hilly land down to the Kampili weir and goes down in the low-lying land without a heavy meandering and pours into the Makassar Strait. The river-bed gradient is 1/1400 and 1/2100 in the upper and lower reaches of the Sungguminasa bridge respectively.

The river has partially dikes on the both sides. The bankful flow capacities in the upper and lower reaches of the Sungguminasa bridge are estimated at 600 m^3/s and 1,000 m^3/s respectively.

River-bed materials consist of gravels at Bili-Bili and Kampili and of fine sand at Sungguminasa.

The river provides 31,000 ha of agricultural land with irrigation water. However, it can irrigate only 3,500 ha of paddy field during the dry season.

During the flood in 1967, the right bank collapsed at 9.5 K (above the Sungguminasa bridge) and at 3.0 K. Overtopped water flowed into Ujung Pandang city and inflicted flood damage on the city.

Tallo River

The Tallo river, so-called tidal river, has a mean gradient of 1/10,000 at its lower reaches and its catchment area is 417.3 km^2. The tidal compartment extends more than 10 km from the estuary. The Tallo river, meandering down to the Makassar Strait, has partially low dikes, 0.5 m -1.0 m in height. The flow capacity of the river is so small as 50 m^3/s and 150 m^3/s in the upper and lower reaches of the Tallo bridge respectively.

Inner Basin

The water-shed boundary is the Jeneberang river in the south, the Tallo river in the north and Ujung Pandang old urban area in the west.

The inundation area is divided by the Panakkukang street into a city-side area and a mountain-side area. The lowest land elevations of the city-side area and the mountain-side area are about 1.5 m and 0.3 m above M.S.L. respectively.

The present drainage system in the area consists of the Pampang river, the Panampu and Sinrijala channels, and two sluices along the Jeneberang river. All of those channels have insufficient flow capacities to mitigate the flood damage.

The biggest observed inundation, which corresponds to 8-year return period, occured in January of 1976. The area was ponded for three days at the average inundation depth of 60 cm, or about 1.0 m at maximum. The inundation area is estimated at 35 km2 and the inundation damage at 450 million Rupiah.

6. The Project

6.1 Overall Flood Control

An overall flood control system consisting of flood control of the Jeneberang river and of improving the drainage system was formulated in sphere of the preliminaly stage. The flood control of the Jeneberang river comprises river improvement and dam construction plans.

Even after completion of the urgent flood control project, Ujung Pandang city is still vulnerable to flood damage. In the overall flood control, Jeneberang flood control should be implemented prior to drainage improvement. The drainage improvement should be conducted in accordance with regional development.

Jeneberang River Flood Control

The flood discharge of a 50-year return period, 3,700m^3/s, is employed as the design flood to the overall flood control of the Jeneberang river.

A discharge of 1,200 m^3/s out of 3,700 m^3/s is regulated by the Bili-Bili impounding reservoir and the rest, 2,500 m^3/s is confined in the river channel.

1) River Improvement

The proposed stretch to be improved in this plan extends approximately 20 km from the estuary to the Kampili weir.

The proposed longitudinal profiles are 1/1,270 in the upper reaches of the Sungguminasa bridge and 1/1,900 in its lower reaches.

Compound cross-section is employed for the plan. The cross-section has a low water channel with a flow capacity of 950 m^3/s, which corresponds to 1.5-year return period.

River widths of the upper and lower reaches of the Sungguminasa bridge are 265 m and 325 m respectively. The Sungguminasa bridge is to be extended in length to accord with the proposed new river width.

Riparian structures such as revetments, groynes and groundsills, are proposed in the plan to assure the stability and safety of the proposed river channel.

2) Dam and Reservoir

The proposed Bili-Bili dam site is located in the middle reaches of the Jeneberang river, about 31 km from the estuary. A rock-fill type with a height of 65 m is employed for the Bili-Bili site.

The reservoir of Bili-Bili has a total storage capacity of 320 x 10^6 m^3 and a total effective storage capacity of 262 x 10^6 m^3.

A capacity of 24 x 10^6 m^3 will be allotted for flood control. This volume will regulate 1,200 m^3/s out of 2,750 m^3/s at the dam site. The remaining capacity, 238 x 10^6 m^3, can be used for water utilization purposes.

By using the storage capacity of 238 x 10^6 m^3, it is possible to utilize a discharge of 21 m^3/s at Kampili site. The estimated power to be generated will be approximately 75,000 MWH per annum. A power station will be equipped with two generators with an output of 11,000 KW each.

A regulation pondage equipped with two gates will be constructed at 4 km down to the proposed Bili-Bili dam site to regulate the water volume.

Drainage System Improvement

The system without mechanical drainage cannot be applied to the overall plan, because the minimum elevation of the inundation area is lower than the outlet water stage of the channel.

The optimum pumping capacity is 30 m^3/s in the second development stage and 40 m^3/s in the third development stage. After the installation of a pumping station with the optimum pumping capacity, it is still unavoidable that many effects will be submerged during a flood.

The drainage channels are designed to meet the pumping capacity. The proposed drainage channels have a width ranging from 6 m to 20 m.

The structure of the proposed station can accommodate 8 pumps with a capacity of 5 m^3/s each. For the second development stage, 6 pumps will be installed.

The gates will be installed at Pannara and the Pampang bridge to prevent reverse flow from the Tallo river.

Effectiveness of the Overall Flood Control

The discharge of a 50-year return period flood will be perfectly controlled by the improved Jeneberang river channel and by the proposed reservoir.

Irrigation for 31,000 ha in the rainy season will become stable. The irrigable area in the dry season will increase to 19,000 ha from 3,500 ha, and also 2.5 crops will be possible in a year.

By using the discharge of irrigation water, the power that could be generated is estimated to be 22,000 KW and its generation is 75,000 MWH per annum.

The drainage system proposed in the overall plan will be effective as the project area is developed.

6.2 Urgent Flood Control

It takes a long time and costs a lot to realize the overall flood control. A flood control system is urgently needed for the project area. Based on the overall flood control, an urgent flood control plan has been formulated to mitigate the flood damage. The plan is composed of the Jeneberang river improvement and of drainage system improvement.

Jeneberang River Improvement

The design flood is 2,500 m^3/s at Kampili weir which corresponds to 10-year return period.

The natural buffer having a regulation capacity of 13×10^6 m^3 is located in the upper reaches of the Sungguminasa bridge. The design discharge of 2,500 m^3/s will be regulated to 2,100 m^3/s at the Sungguminasa bridge site.

The proposed stretch extends about 9 km from the Sungguminasa bridge to the estuary. Design high-water stage should not exceed 2 m above the surrounding ground level. The proposed alignment is designed in accordance with the existing course to prevent a social problem derived from house evacuation and land acquisition. The river bed gradient is designed at 1/1,900. Although the river channel may have a sufficient flow capacity by means of raising embankment, only the low-water channel will be prepared to stabilize the channel against the low-water discharge.

Riparian structures such as revetment and groyne are proposed to assure the stability and safety of the proposed river channel.

Drainage System Improvement

From the technical viewpoint, a natural drainage system is employed for the urgent plan, taking into account the topographical condition of the project area.

The Panampu drainage channel will be improved and the Jongaya drainage channel is newly proposed in this project. The Sinrijala drainage channel is only shaped to provide an usual drainage.

The proposed Panampu channel with a drainage capacity of 30 m^3/s in a maximum is 4.9 km in length and 15.5 m in width. The proposed Jongaya drainage channel, having a drainage capacity of 30 m^3/s in maximum is 7.3 km in length and 17.5 m in width. Revetment is prepared in the proposed channels.

Bridges over the Panampu and Sinrijala channels are renewed. The road section which will cross the proposed Jongaya channel will be replaced by new bridges. A sluice gate is installed at 1.0 km of the Sinrijala channel to control the reverse flow from the mountain-side area to the city-side area during a flood.

Effectiveness of the Urgent Flood Control

After the completion of the urgent flood control, the Jeneberang river water will not flow into the project area in the flood below a 10-year return period and the rainfall in the inundation area will be immediately drained through the proposed channels. As a result, the inundation water stage in the city-side area lowers to 1.87 m in M.S.L. in the flood of a 5-year return period, and this means that the city-side area will be released from the damage caused by the flood below a 5-year return period.

7. Evaluation for the Urgent Flood Control

The construction work including the design work for the urgent flood control is planned to be carried out during the period from 1981 to 1985. The construction plan is formulated so that the flood control benefit is brought about from 1986 after the completion of the urgent plan.

The economic construction cost amounts to US$ 11.90 million in total.

Fund requirements for the construction amount to US$ 5,272,300 in foreign currency portion and US$ 12,385,000 in domestic currency portion, provided that the construction works are carried out on a contract basis. If the works are implemented on a force account basis, the fund requirements amounts to US$ 7,139,000 in foreign currency portion and US$ 12,385,000 in domestic currency portion.

In the case that all the constraction cost is estimated in local currency (the foreign engineering service is exceptional), the fund requirements amount to US$ 18,502,000 on the contract basis and to US$ 19,967,000 on the force account basis. The engineering service cost of US$ 1,884,000 is included in the above two cases.

The annual cost necessary for operation, maintenance and replacement of the facilities is estimated at US$0.055 million.

The flood control benefit is US$2.02 million per annum. The internal rate of return of the project is 13.2%.

The sensitivity analysis indicates that the project maintains a relatively high internal rate of return of about 12.1% for the case of 10% increase in the construction cost and about 12.2% for the case of the completion of the first stage regional development plan in 1990.

PRINCIPAL FEATURES OF THE PROJECT

I. Project Features

1.1 Overall Flood Control Project

River Improvement

Standard project flood	2,750 m^3/s at the proposed Bili-Bili dam
	3,700 m^3/s at Kampili weir and Sungguminasa bridge
Design flood	2,500 m^3/s at Kampili weir and Sugguminasa bridge
Stretch to be improved	20 km from the estuary to Kampili weir
Sungguminasa bridge	Expanded to 267 m
Groundsill	1 place at 30 m downstream of Sungguminasa bridge
Revetment	11.1 km long
Groyne	86 places, 4.3 km long in total
Sluice	15 places
Land acquisition	70 ha
House evacuation	220 houses

Bili-Bili Dam and Reservoir

Catchment area	384.4 km^2
Surface area	16.5 km^2
Dam height	65 m
Dam volume	3.0×10^6 m^3
Type of dam	Rockfill, central core type
Total effective storage capacity	262×10^6 m^3
Effective storage capacity for flood control	24×10^6 m^3, 1,200 m^3/s peak discharge cut

Effective storage capacity for water utilization	238 x 10^6 m^3
Utilizable water	21 m^3/s at the Kampili weir
Irrigable area	25,000 ha increase in total
Power station	2 units x 11,000 kW each with vertical shaft Kaplan turbines
Annual energy output	75,000 MWH
Regulation pondage	1.2 x 10^6 m^3 in regulation capacity
Sabo dam	3 places
Road relocation	15 km
Land acquisition	1,400 ha
House evacuation	550 houses

Drainage System Improvement

Pumping station	6 units x 5 m^3/s of pumping capacity at the second stage, 8 units x 5 m^3/s of capacity at the third stage
Drainage capacity	30 m^3/s at the second stage, 40 m^3/s at the third stage
Drainage channel	4.3 km long along the Pampang river at the second stage, 16.9 km long at the third stage.
Sluice	2 places at Pannara and at the proposed pumping station site
Land acquisition	30 ha in the second and the third stage area
House evacuation	20 houses in the second and the third stage area

1.2 Urgent Flood Control Project

River Improvement

Design flood	2,500 m^3/s at the Kampili weir, 2,100 m^3/s at the Sungguminasa bridge

Stretch to be improved	9 km down-stream of Sungguminasa bridge
Natural buffer	1 place, 13×10^6 m^3 of regulation capacity
Revetment	5.7 km long
Groyne	23 places, 1 km long in total
Sluice	3 places
Drainage ditch	2.8 km long
Land acquisition	5 ha
House evacuation	60 houses

Drainage System Improvement

Panampu channel	4.9 km long, 15.5 m wide in maximum, 30 m^3/s in drainage capacity
Jongaya channel	7.3 km long, 17.5 km wide in maximum, 30 m^3/s in drainage capacity
Sinrijala channel	Shaping of the channel, 2.3 km long
Sluice	1 place at Panakkukang road
Bridge	22 places
Land acquisition	15 ha
House evacuation	370 houses

II. Cost and Benefit of Urgent Flood Control Project

Rupiah and Yen are converted to US Dollar at the exchange rates of Rp. 625 = US$ 1 and Y 250 = US$ 1.

2.1 Economic Cost

Unit: $\times 10^3$ US$

Item	Foreign Currency	Local Currency	Total
River Improvement	2,757	3,472	6,229
Drainage Improvement	1,606	4,067	5,673
Total	4,363	7,539	11,902

2.2 Fund Requirement

The fund requirements are estimated at the escalation rates of 7% for foreign currency and of 10% for local currency.

a) Estimation on a contract basis in both foreign and local currencies

Unit: $\times 10^3$ US$

Item	Foreign Currency	Local Currency	Total
River Improvement	3,679	5,905	9,584
Drainage Improvement	2,044	6,480	8,524
Total	5,723	12,385	18,108

b) Estimation on a contract basis all in local currency except for engineering services cost

Unit: $\times 10^3$ US$

Item	Foreign Curreny	Local Currency	Total
River Improvement	1,211	8,646	9,857
Drainage Improvement	673	7,972	8,645
Total	1,884	16,618	18,502

c) Estimation on a force account basis in both foreign and local currencies

Unit: $\times 10^3$ US$

Item	Foreign Curreny	Local Currency	Total
River Improvement	4,849	5,906	10,755
Drainage Improvement	2,290	6,479	8,769
Total	7,139	12,385	19,524

d) Estimation on a force account basis all in local currency except for engineering services cost

Unit: $\times 10^3$ US$

Item	Foreign Currency	Local Currency	Total
River Improvement	1,211	9,841	11,052
Drainage Improvement	673	8,242	8,915
Total	1,884	18,083	19,967

2.3 Benefit

Annual flood control benefit	US$2.02 million
Internal rate of return	13.2%