JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
THE REPUBLIC OF INDONESIA

THE STUDY ON COMPREHENSIVE RIVER WATER MANAGEMENT PLAN IN JABOTABEK

FINAL REPORT

VOLUME VI

SUPPORTING PAPERS

MARCH 1997

NIKKEN CONSULTANTS, INC.
NIPPON KOEI CO., LTD.

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FINAL REPORT

The Final Report consists of the following:

VOLUME I : EXECUTIVE SUMMARY

VOLUME II : MAIN REPORT (MASTER PLAN)

VOLUME III : MAIN REPORT(FEASIBILITY STUDY)

VOLUME IV : ANNEXES I

ANNEX 1	Socio-economy and Economic Evaluation
ANNEX 2	Geology
ANNEX 3	River Survey
ANNEX 4	Topographic Mapping
ANNEX 5	Hydrology
ANNEX 6	Flood Control

VOLUME V : ANNEXES II

ANNEX 7	Urban Flooding and Drainage
ANNEX 8	Design and Cost Estimate
ANNEX 9	Water Resources and River Water Quality
ANNEX 10	Environment
ANNEX 11	Comprehensive River Water Management Plan
ANNEX 12	Institutions

VOLUME VI : SUPPORTING PAPERS

VOLUME VII : DATA BOOK I
(River Survey and Topographic Mapping for Master Plan)

VOLUME VIII : DATA BOOK II
(River Survey and Topographic Mapping for Feasibility Study)

The costs are estimated based on October 1995 price level and the average exchange rate in October 1995. The average exchange rate in October 1995 is as follows:

US$ 1.00 = Rp.2,281
Y 1.00 = Rp.22.70

THE STUDY
ON
COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN
JABOTABEK

FINAL REPORT
VOLUME VI
SUPPORTING PAPERS

1 Comparison between Construction of Eastern Banjir Canal and Improvement of Existing Rivers to Protect Eastern Part of Jakarta from Flooding

2 Brief Note on Ciawi Dam Development for Flood Control Purpose

3 Brief Note on Limo Dam Development for Flood Control Purpose

4 Preliminary Design of Cisadane River for 50-year (Master Plan) Design Scale

COMPARISON
BETWEEN
CONSTRUCTION OF EASTERN BANJIR CANAL
AND
IMPROVEMENT OF EXISTING RIVERS
TO
PROTECT EASTERN PART OF JAKARTA FROM FLOODING

JULY 1996

JICA STUDY TEAM FOR
COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN JABOTABEK

1. INTRODUCTION

This paper is prepared as a material to explain the study result on the option of improvement of existing rivers instead of construction of Eastern Banjir Canal (hereinafter referred to as EBC) to protect the eastern part of DKI Jakarta from flooding, in relation to the Master Plan Study for Comprehensive River Water Management Plan in JABOTABEK.

Figure - 1 shows the general map of the study area..

2. EXISTING RIVERS

Existing rivers flowing through the eastern part of DKI Jakarta and their catchment areas at the point crossing the proposed EBC alignment are as follows:

RIVER NAME	CATCHMENT AREA (upstream of EBC)
- Cipinang	50.5 km^2
- Sunter	73.1 km^2
- Buaran	13.0 km^2
- Jatikramat	16.5 km^2
- Cakung	34.5 km^2
- Residual basins	19.4 km^2
Total	207.0 km^2

These rivers are shown in Figure -2. Figure - 3 shows those rivers in DKI Jakarta.

3. DESIGN DISCHARGE

(1) Design Scale

Design scale of EBC has been determined to be once in 100 year in line with the Flood Control Manual of Indonesia (1993). Design scale of each existing river in DKI Jakarta has been determined to be once in 25 years as drainage channel in line with the same manual.

(2) Present Design Discharge

Design discharge distribution of EBC and existing rivers in eastern part of DKI Jakarta has been as shown in Figure - 4 according to the present Master Plan of Flood Control in DKI

Jakarta by NEDECO.

(3) Proposed Design Discharge

Design discharge distribution of EBC in the present said Study is calculated based on the future land use conditions in the year of 2025. Figure -5 shows the design discharge distribution proposed in the present Study.

(4) Design Discharge Distribution for Existing Rivers

On the other hand, design discharge of each existing river at the point of EBC for the return period of 100 years is calculated with the same conditions. These are shown in Figure-6. When EBC is not constructed, these rivers also receive the run-off from the river basins downstream of EBC. Accordingly the design discharges of these existing rivers are prepared as shown in Figure - 6. Locations of objective rivers for the option of improvement of existing rivers in DKI Jakarta are shown in Figure - 7.

4. RIVER LENGTH

River length of EBC is shown in Figure - 8. On the other hand, the river lengths of existing rivers in the reaches downstream of EBC are shown in Figure -9.

Here the Sunter river in the downstream reaches of the diversion point of canal to Cakung floodway is not included, in consideration of existing land use along the Sunter river in the downstream reaches.

5. CUT-OFF CHANNEL FROM SUNTER TO BUARAN

As shown in Figure - 7, the option of improvement of existing rivers includes construction of floodway from the Sunter to the Buaran in the upstream reaches of the alignment of EBC. This floodway aims to avoid the much discharge load in the downstream reaches of the Sunter river where the area is densely populated and land acquisition is diffuclut.

But the longitudinal profile of both the rivers show that the Sunter river flows in as very deep valley whereas the Buaran river flows in a rather flat plain. The elevations of the river-bed at the proposed alignment of floodway crossing the nartional road of Jakarta to Cikampek are as follows:

El. 13.36 m P.P.	Buaan river
El. 10.47 m P.P.	Sunter river

Accordingly the construction of floodway from the Sunter to Buaran should be abandoned.

6. DESIGN CROSS SECTIONS AND LONGITUDINAL PROFILES OF EBC AND EXISTING RIVERS

6.1 EBC

Design cross-sections of EBC for various design discharges are shown in Figures - 10 to 14. Design longitudinal profile and a typical cross-section are shown in Figure - 15.

6.2 Existing Rivers

Design cross-sections of existing rivers for the option of improvement of existing rivers are shown in Figures - 16 to 22.

7. COMPARISON

For the above-mentioned conditions, the comparison of land acquisition and work volume are presented in Table - 1.

As shown in Table -1, the total length of EBC is about 23.4 km, but the total length of the existing rivers to be improved is about 50.7 km, more than twice of that of EBC.

Regarding land acquisition, the EBC option needs about 180 ha, but the option of improvement of existing rivers needs about 240 ha, about 33 % increase of that of EBC.

Regarding excavation works, the EBC option needs about 4 million m^3, and the option of improvement of existing rivers needs about 6 million m^3, about 50 % increase of that of EBC.

Regarding embankment works, the EBC option needs about 786 thousand m^3, and the option of improvement of existing rivers needs about 278 thousand m^3, about 35 % of that of EBC.

8. CONCLUSION

Above-mentioned features lead the conclusion that the option of construction of Eastern Banjir Canal is desirable one compared with that of improvement of existing rivers in DKI Jakarta.

For the reference, photos of existing rivers in DKI Jakarta are attached for consideration of land use situation along existing rivers.

Table - 1
COMAPRISON OF LAND ACQUISITION AND WORK VOLUME
BETWEEN CONSTRUCTION OF EASTERN BANJIR CANAL
AND IMPROVEMENT OF EXISTING RIVERS

River	Land Acquisition (m^2)	Excavation (m^3)	Embankment (m^3)	Length (m)
1. Improvement of Existing Rivers				
(1) Cipinang	62,992	176,378	0	3,937
(2) Sunter	239,265	669,942	0	5,317
(3) Buaran	73,125	241,312	14,625	4,875
(4) Cakung	606,600	647,040	107,840	13,480
(5) Canal from Sunter to Cakung Floodway	1,300,300	3,640,840	65,015	13,003
(6) Cakung Floodway (upstream)	100,430	451,935	82,170	9,130
(7) Cakung Floodway (downstream)	42,372	169,488	8,667	963
Total	2,425,084	5,996,935	278,317	50,705
2. Construction of Eastern Banjir Canal				
	1,821,125	4,197,161	786,250	23,442

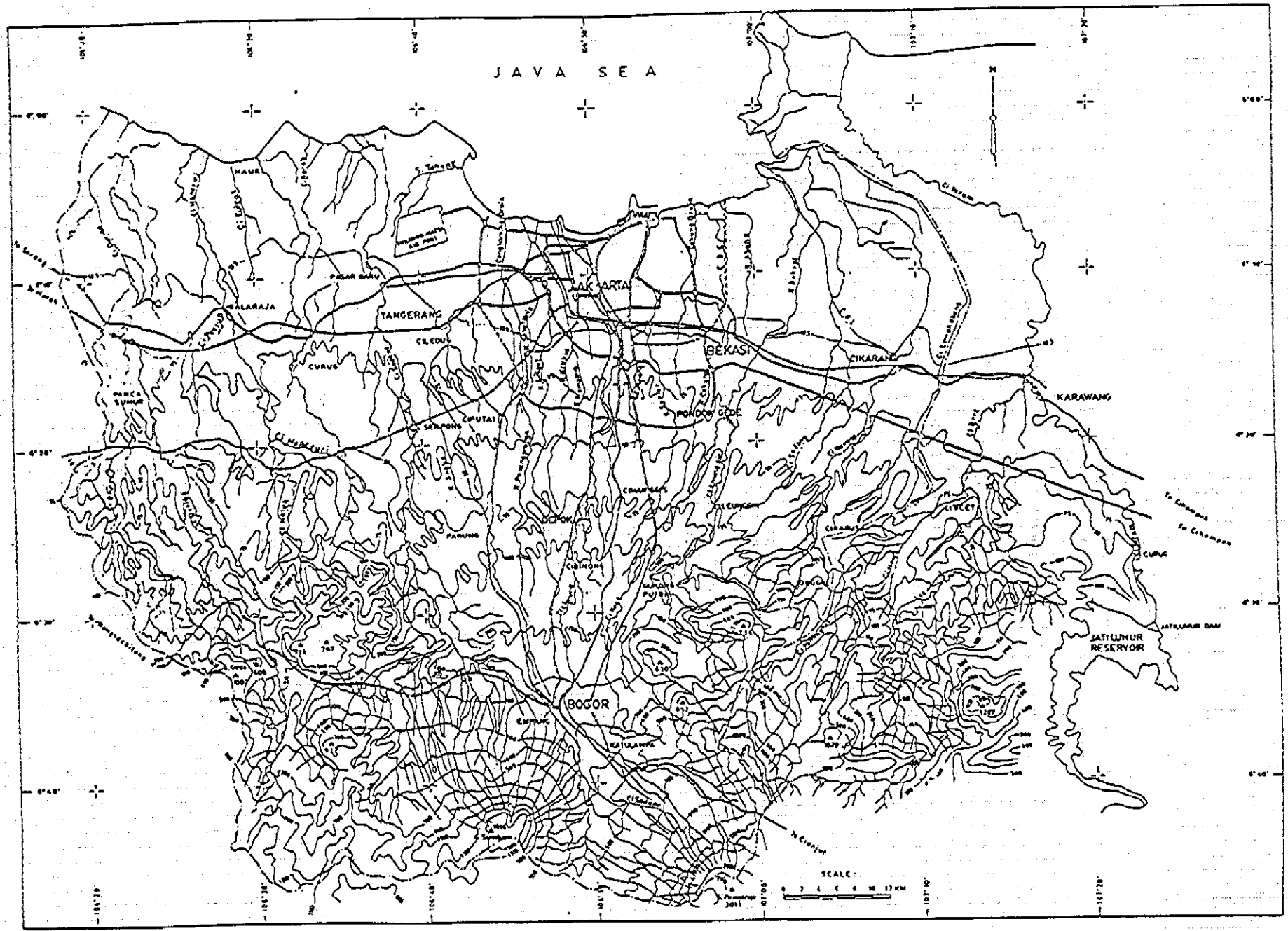


Figure - 1 GENERAL MAP OF STUDY AREA

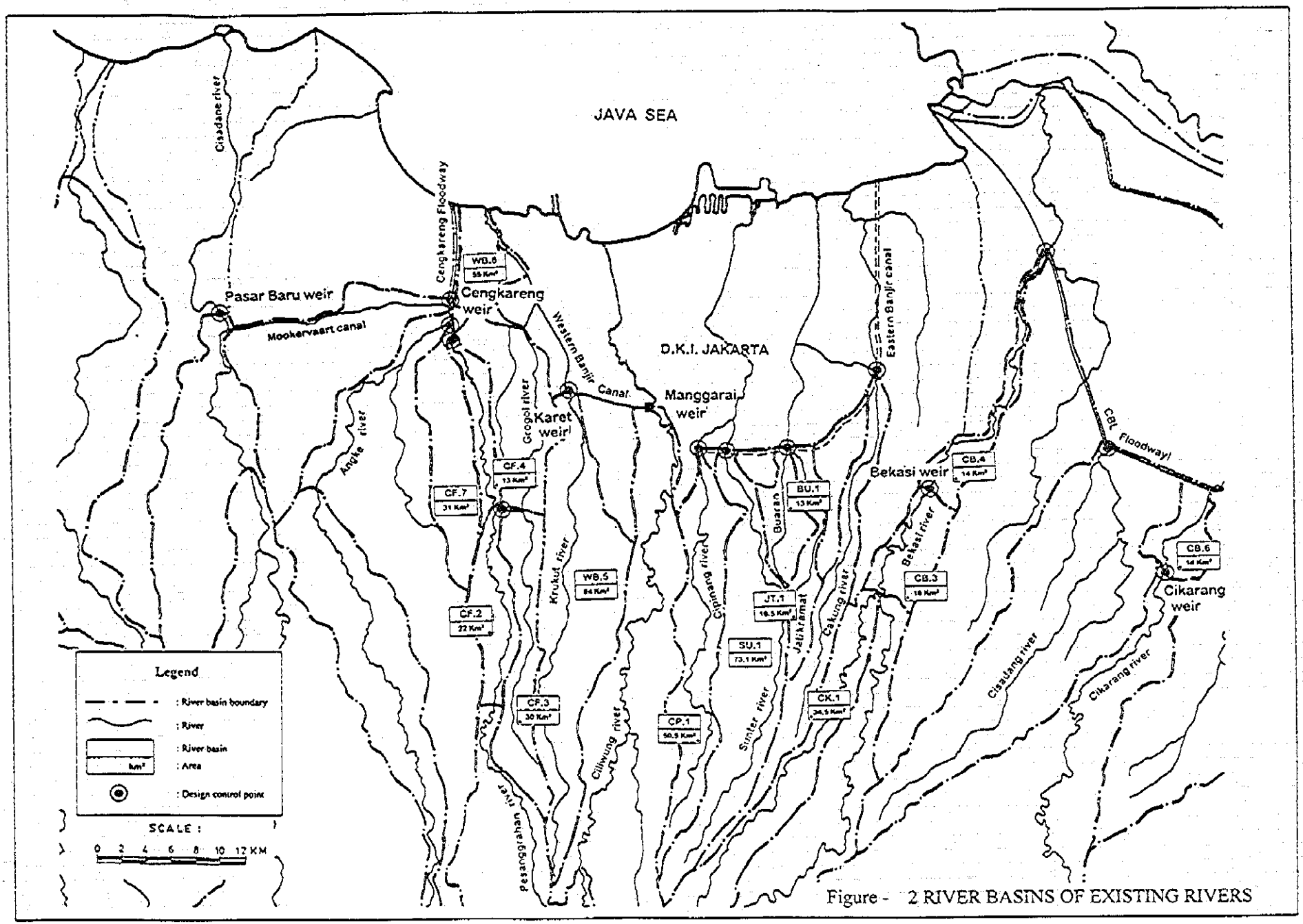


Figure - 2 RIVER BASINS OF EXISTING RIVERS

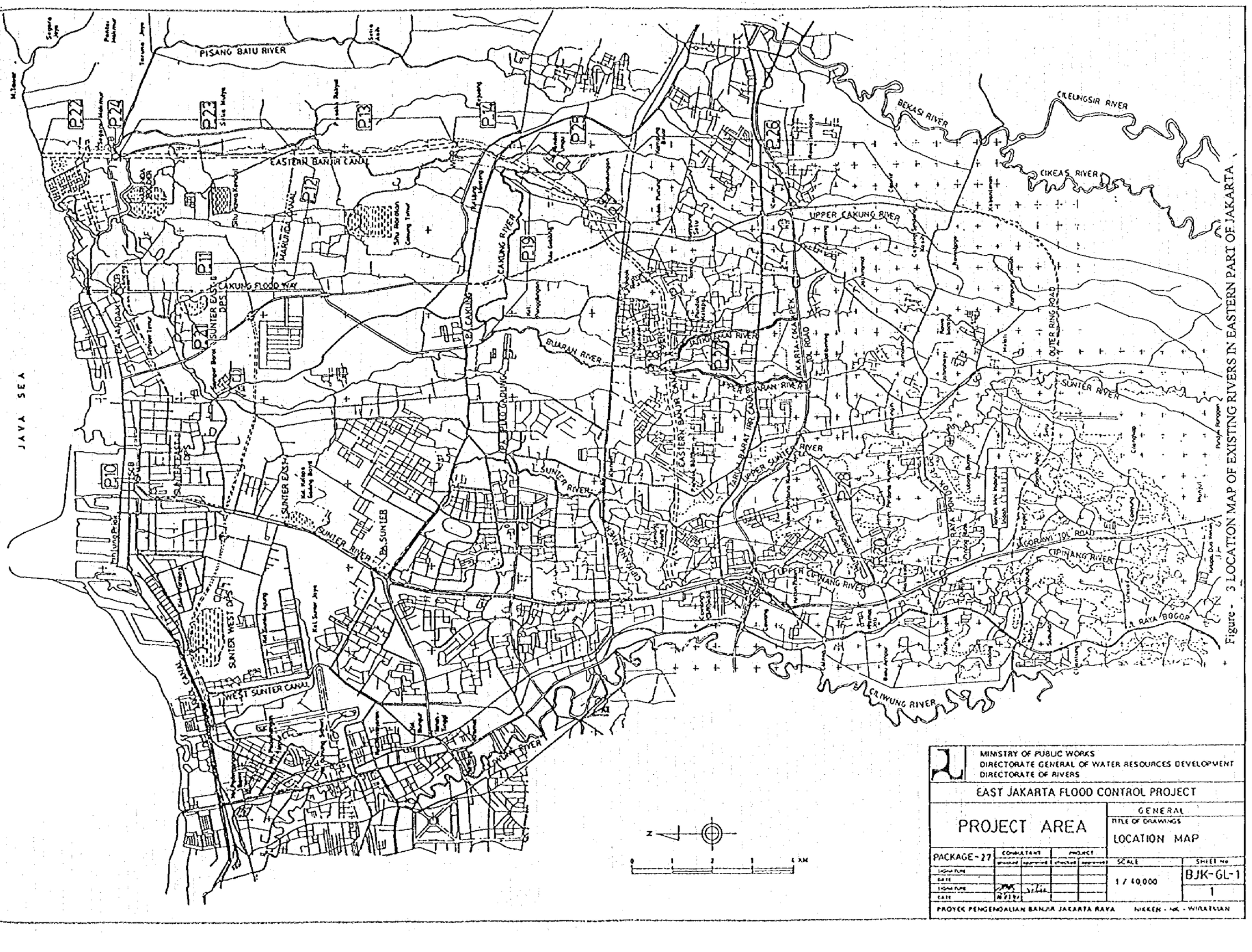


Figure - 3 LOCATION MAP OF EXISTING RIVERS IN EASTERN PART OF JAKARTA

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

EAST JAKARTA FLOOD CONTROL PROJECT

PROJECT AREA

GENERAL
TITLE OF DRAWINGS
LOCATION MAP

PACKAGE-27	CONSULTANT		PROJECT		SCALE	SHEET No
SIGNATURE					1 / 10,000	BJK-GL-1
NAME						1
SIGNATURE						
DATE						

PROYEK PENGENDALIAN BANJIR JAKARTA RAYA NIKKEN - NK - WIRATESUN

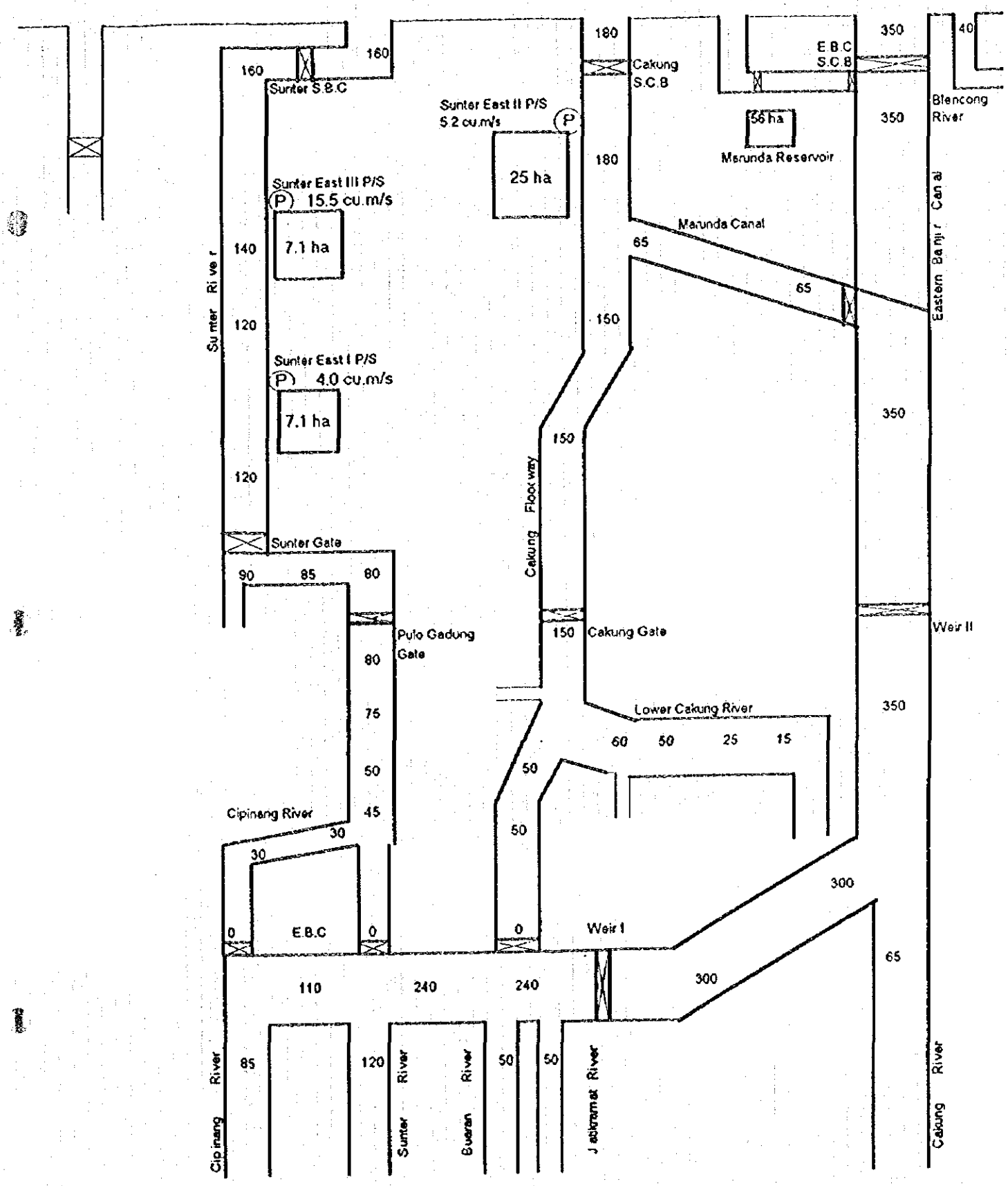


Figure - 4 PRESENT DESIGN DISCHARGE DISTRIBUTION

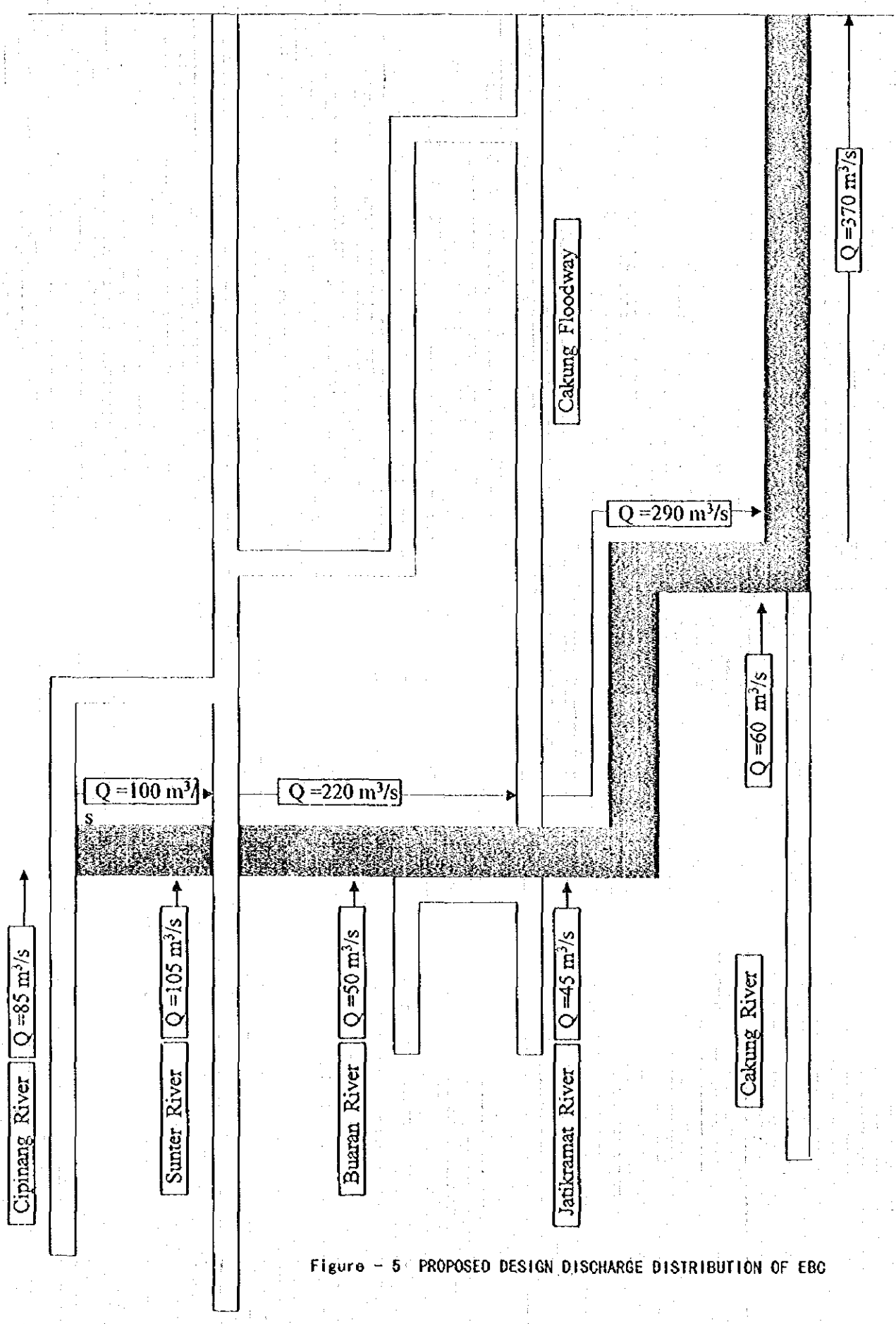


Figure - 5 PROPOSED DESIGN DISCHARGE DISTRIBUTION OF EBC

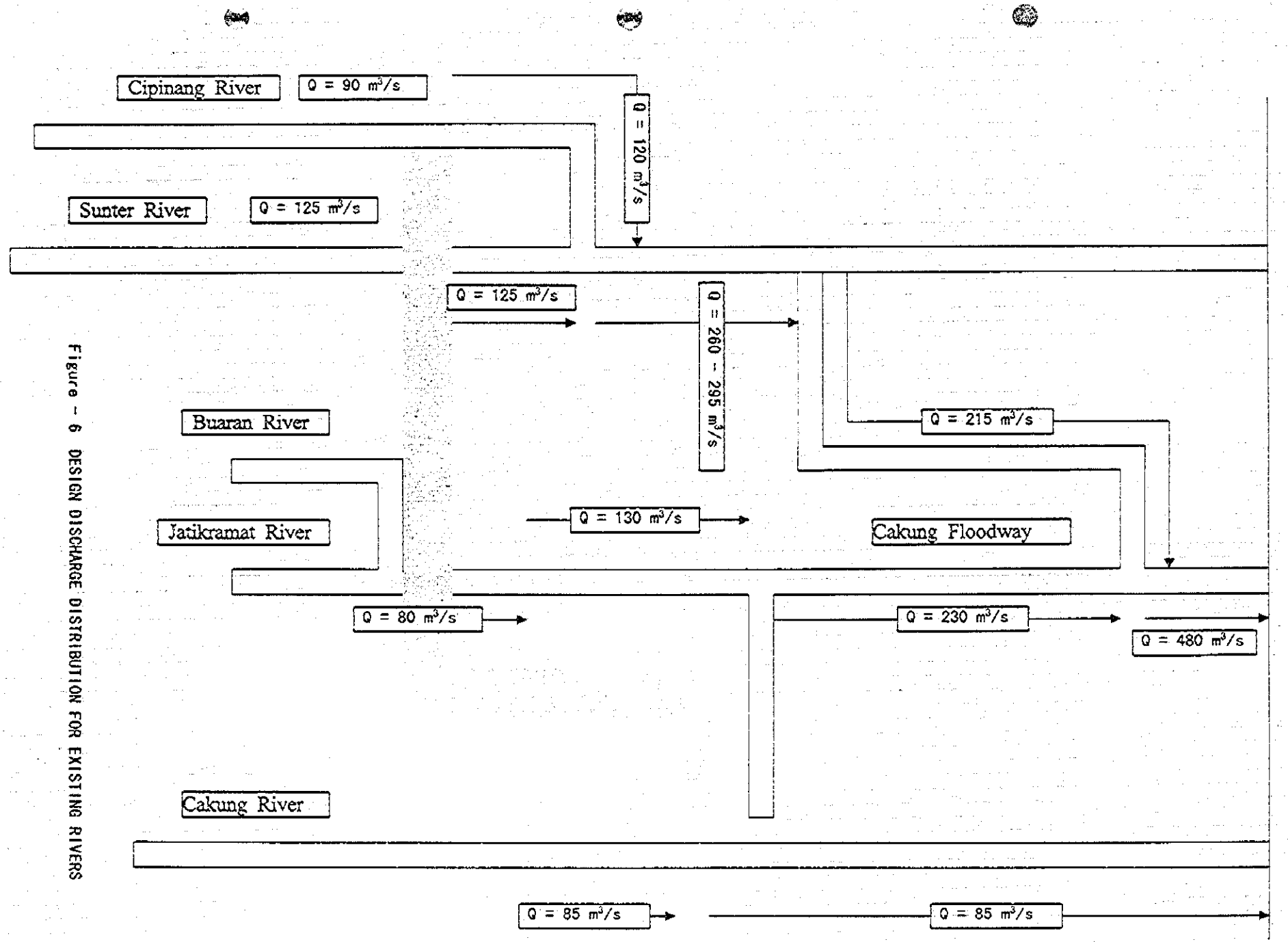


Figure - 6 DESIGN DISCHARGE DISTRIBUTION FOR EXISTING RIVERS

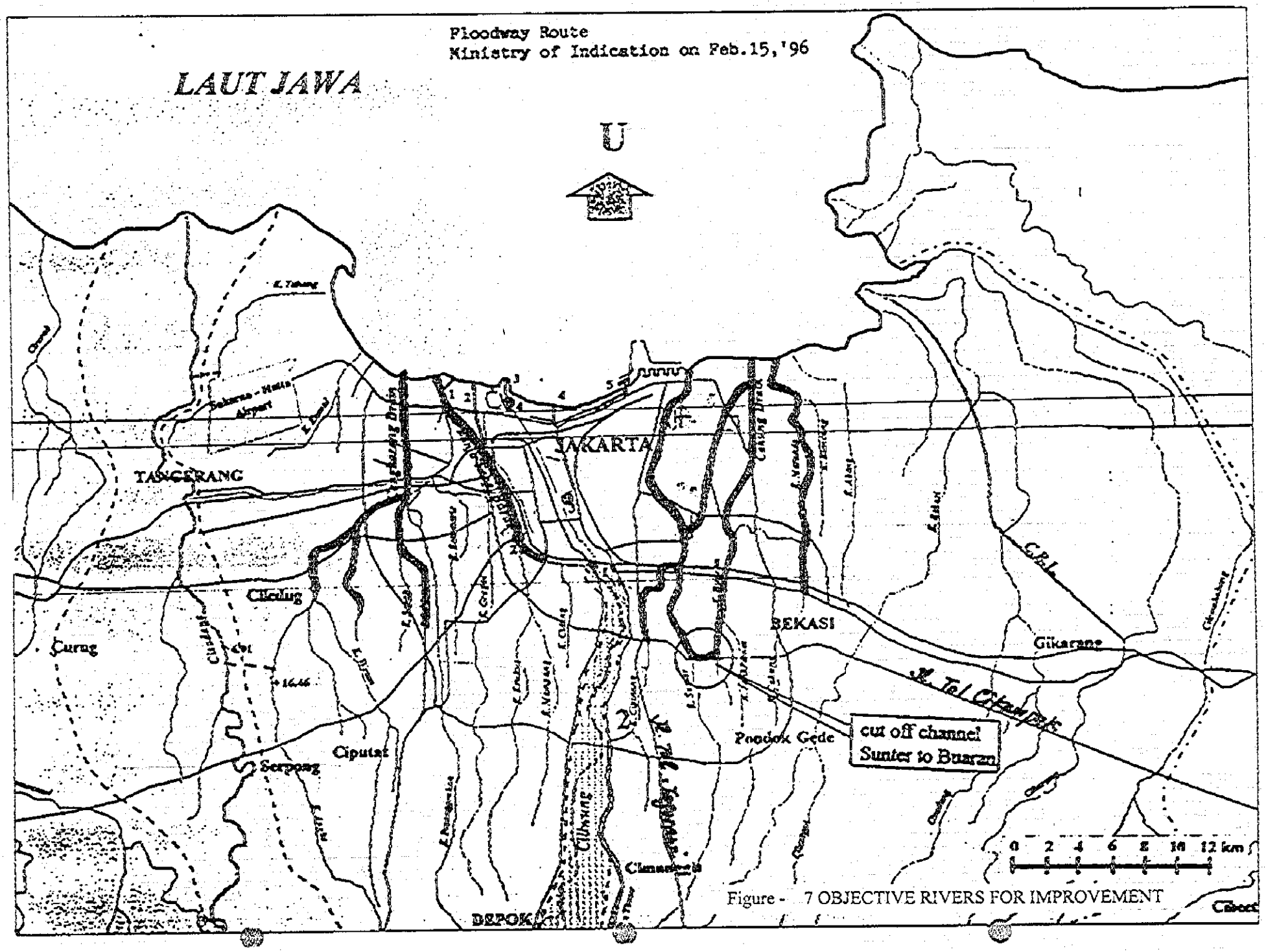


Figure - 7 OBJECTIVE RIVERS FOR IMPROVEMENT

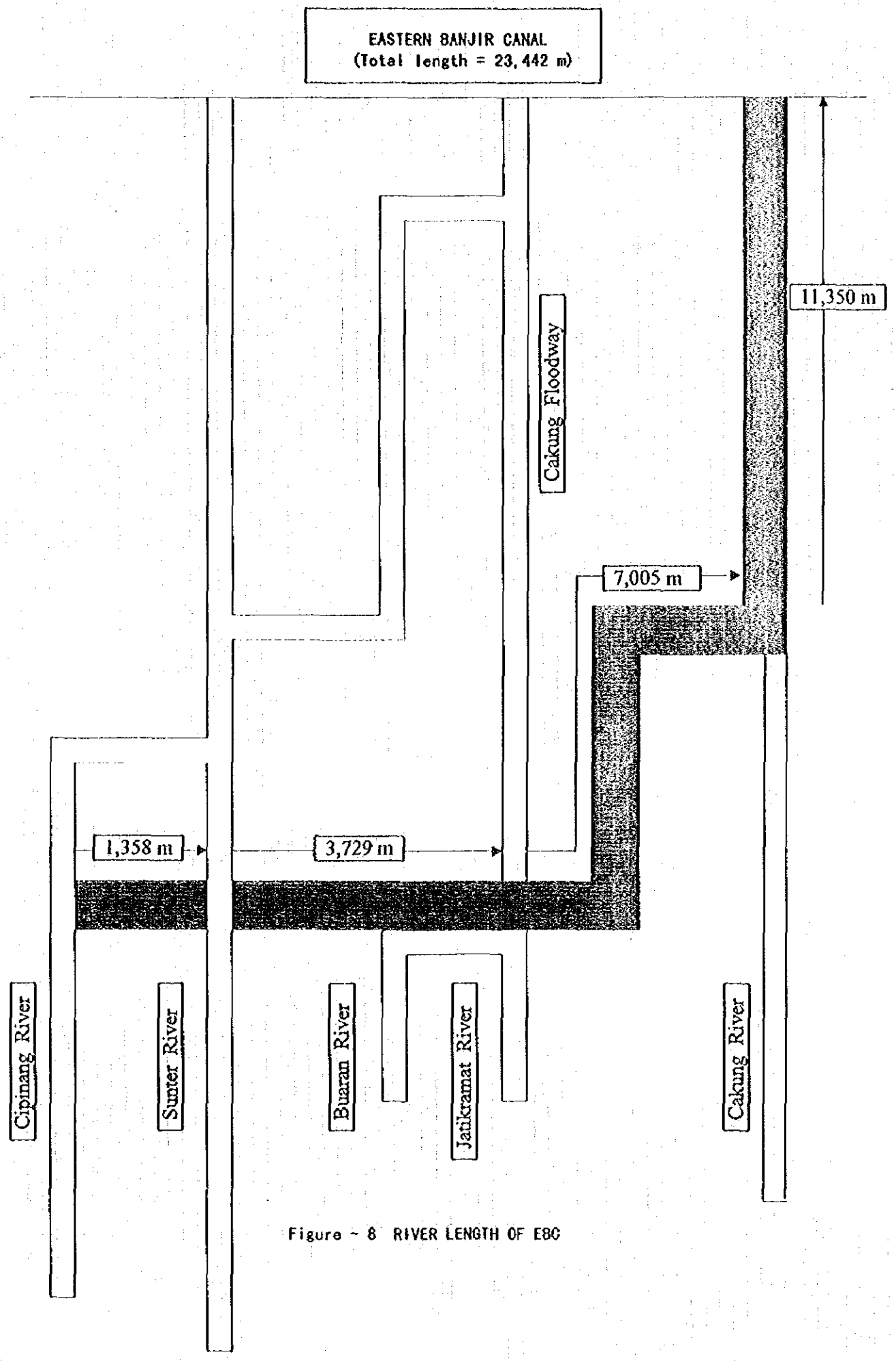


Figure - 8 RIVER LENGTH OF EBC

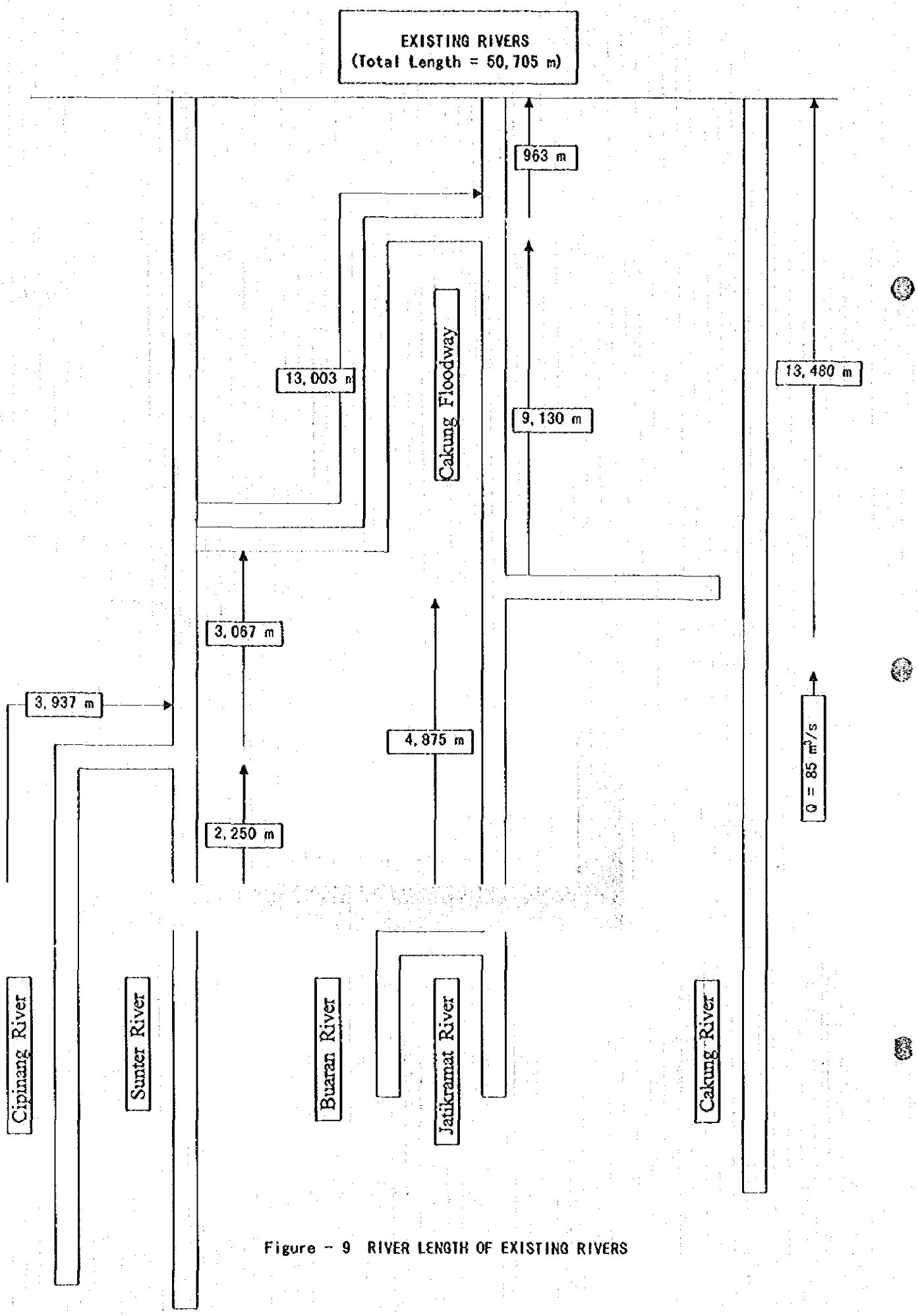


Figure - 9 RIVER LENGTH OF EXISTING RIVERS

Cp-Sn

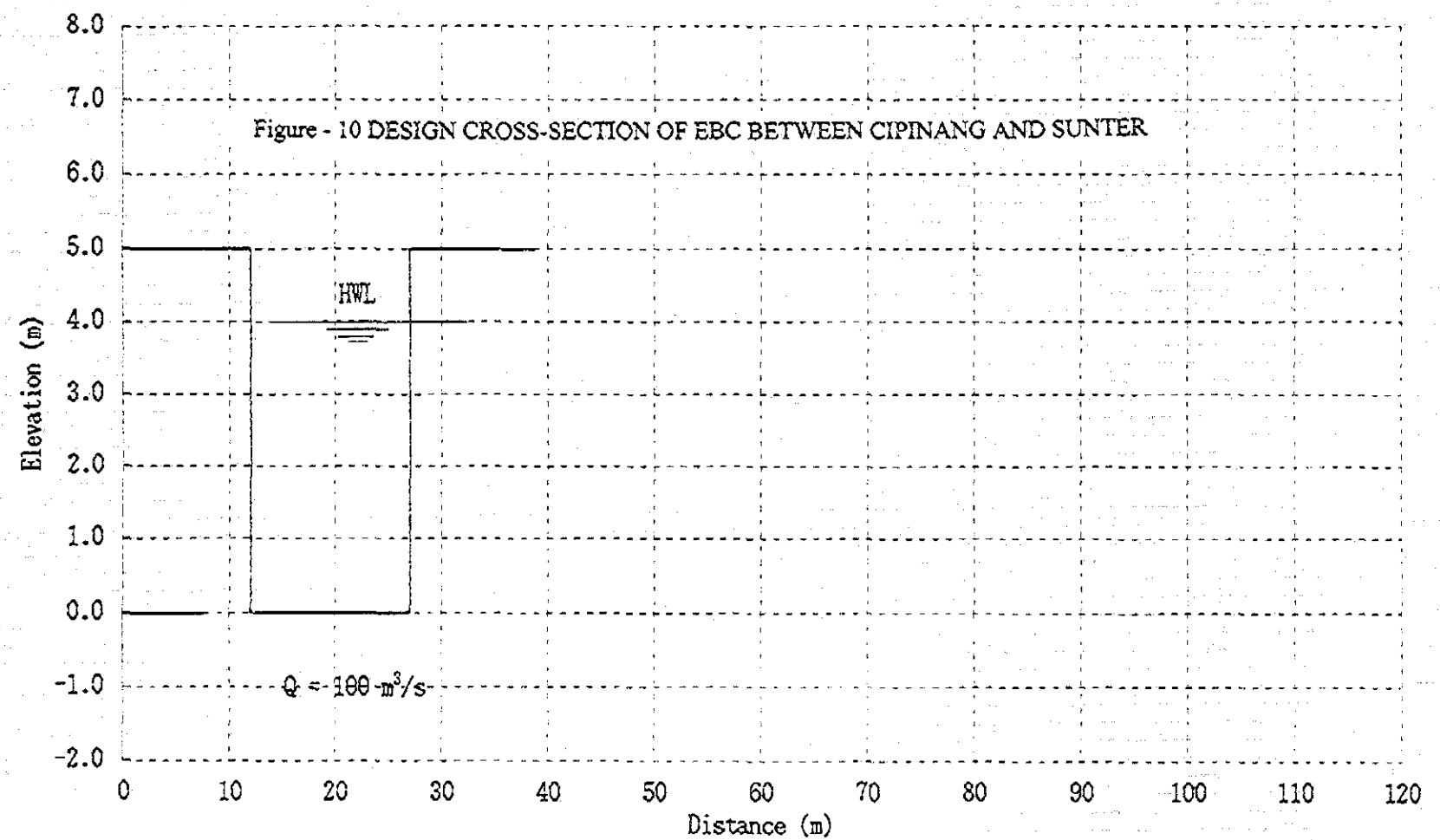
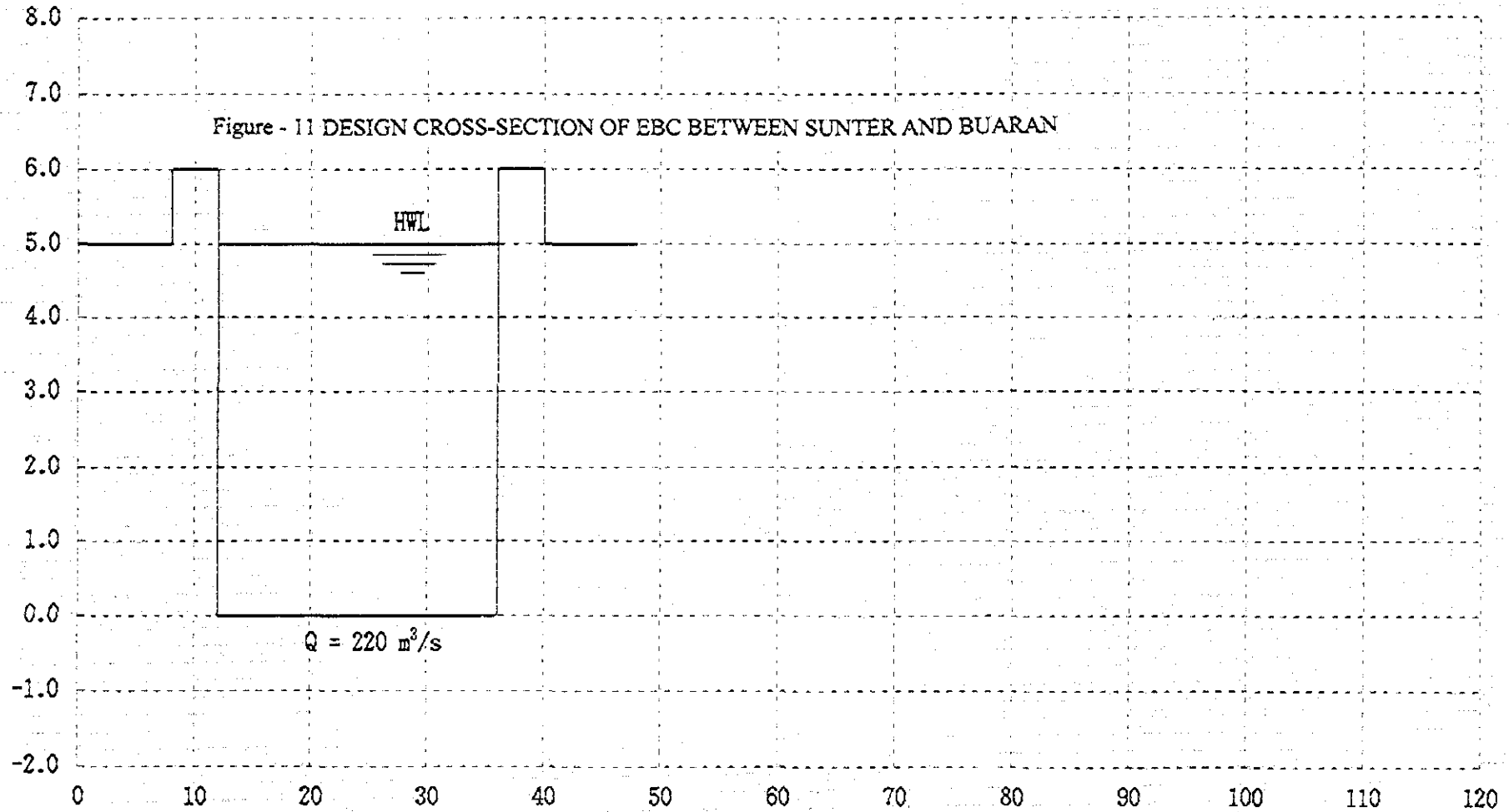


Figure - 10 DESIGN CROSS-SECTION OF EBC BETWEEN CIPINANG AND SUNTER

Figure - 11 DESIGN CROSS-SECTION OF EBC BETWEEN SUNTER AND BUARAN



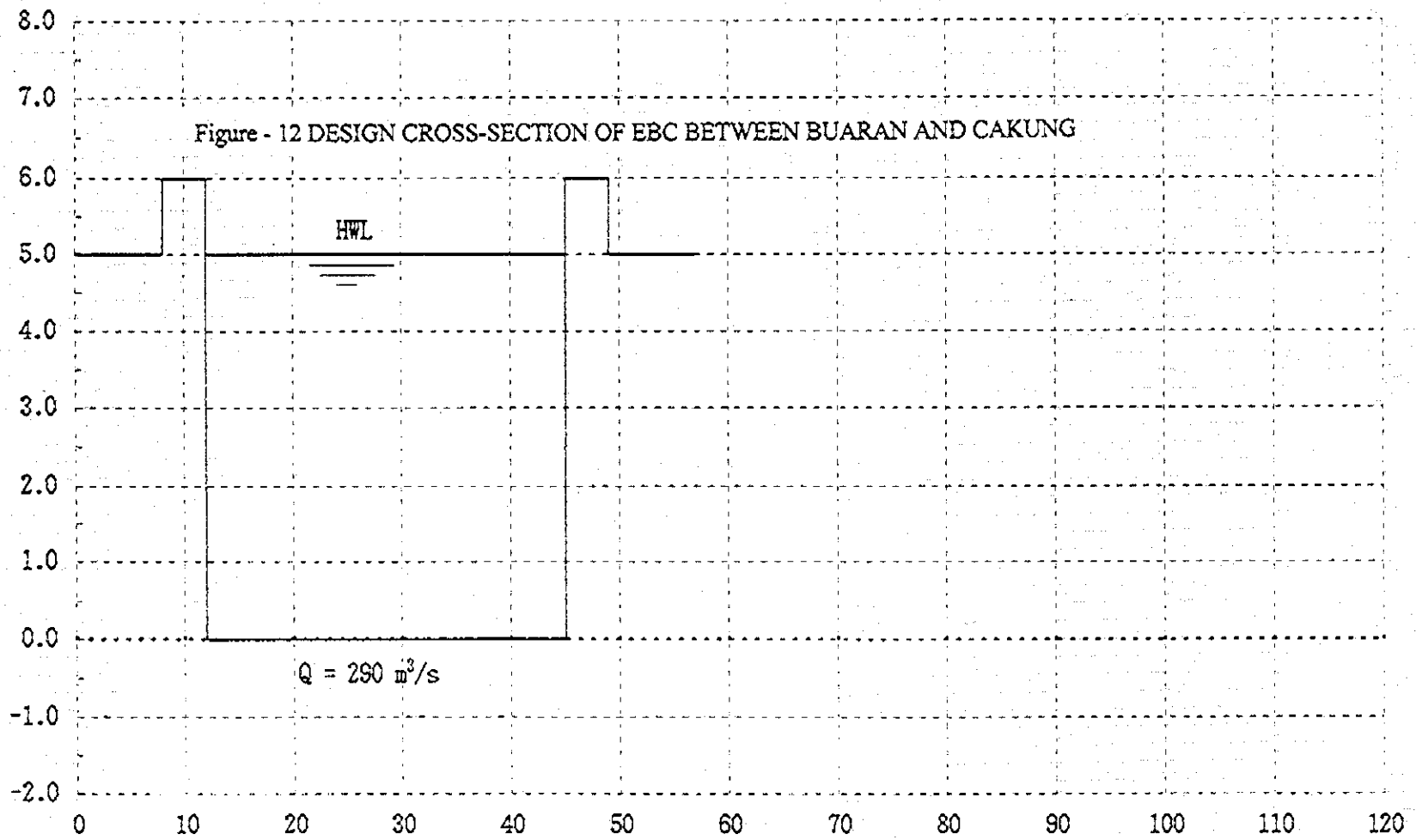
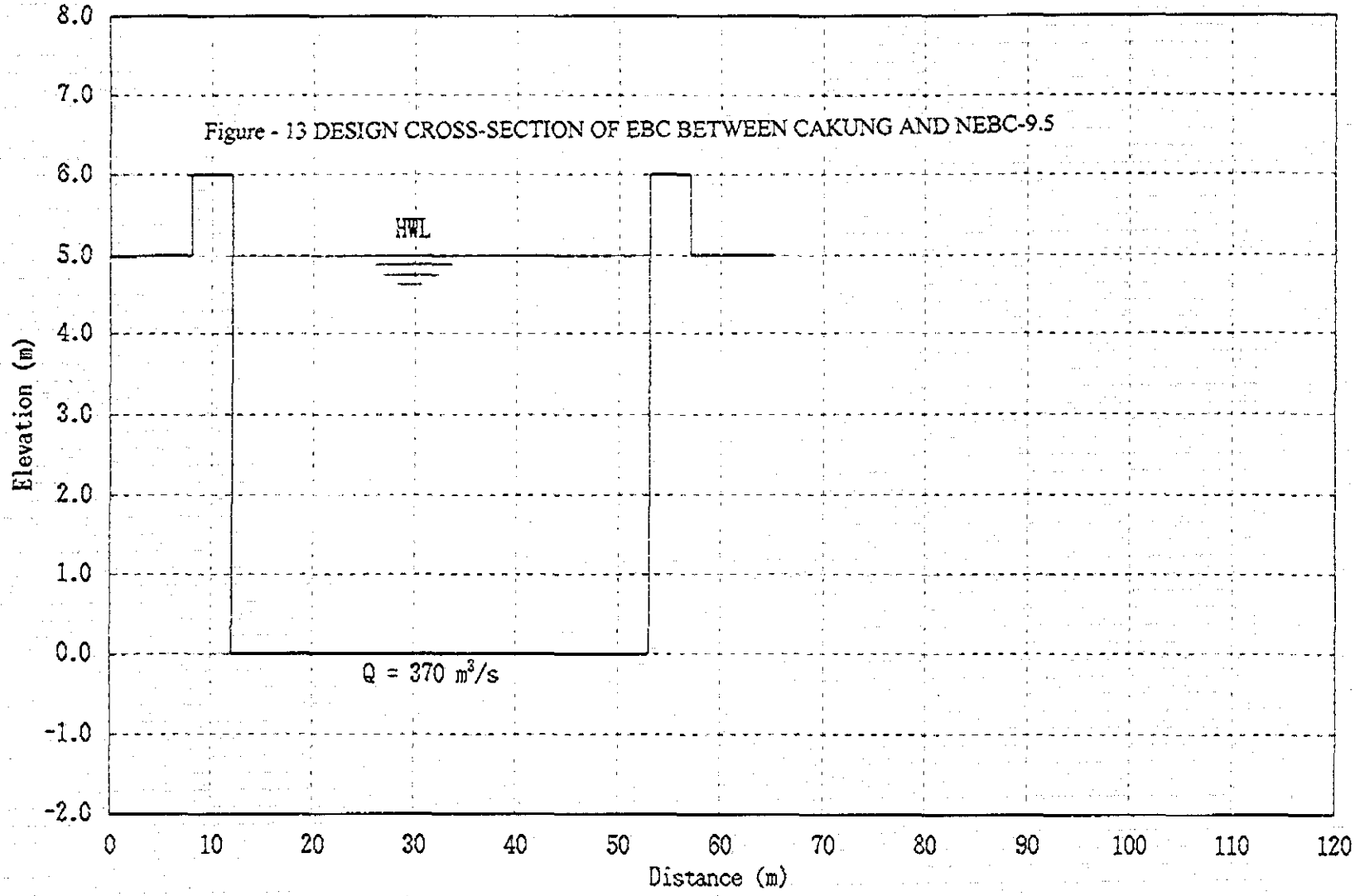


Figure - 12 DESIGN CROSS-SECTION OF EBC BETWEEN BUARAN AND CAKUNG

Dn-ck

Figure - 13 DESIGN CROSS-SECTION OF EBC BETWEEN CAKUNG AND NEBC-9.5



Est

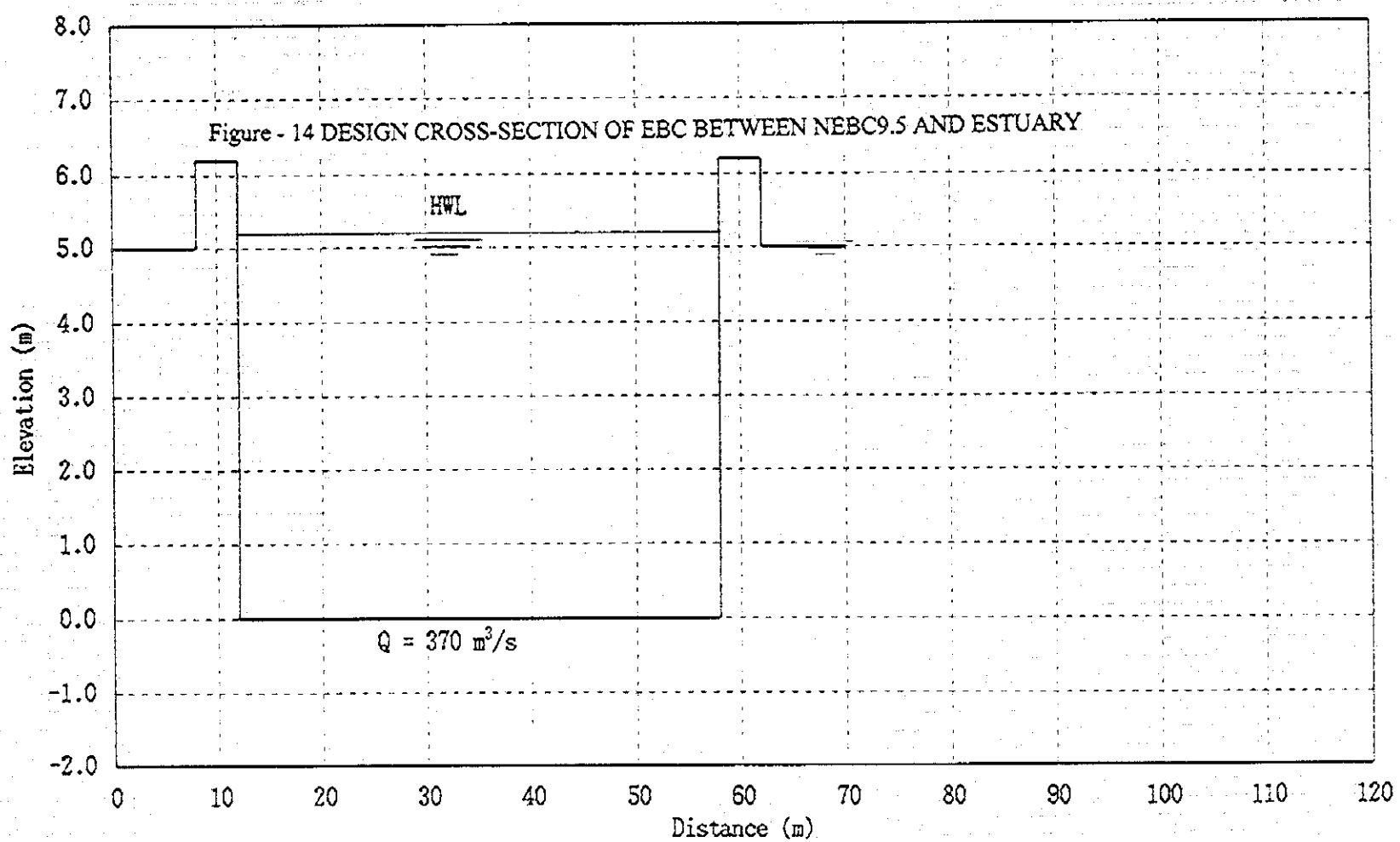
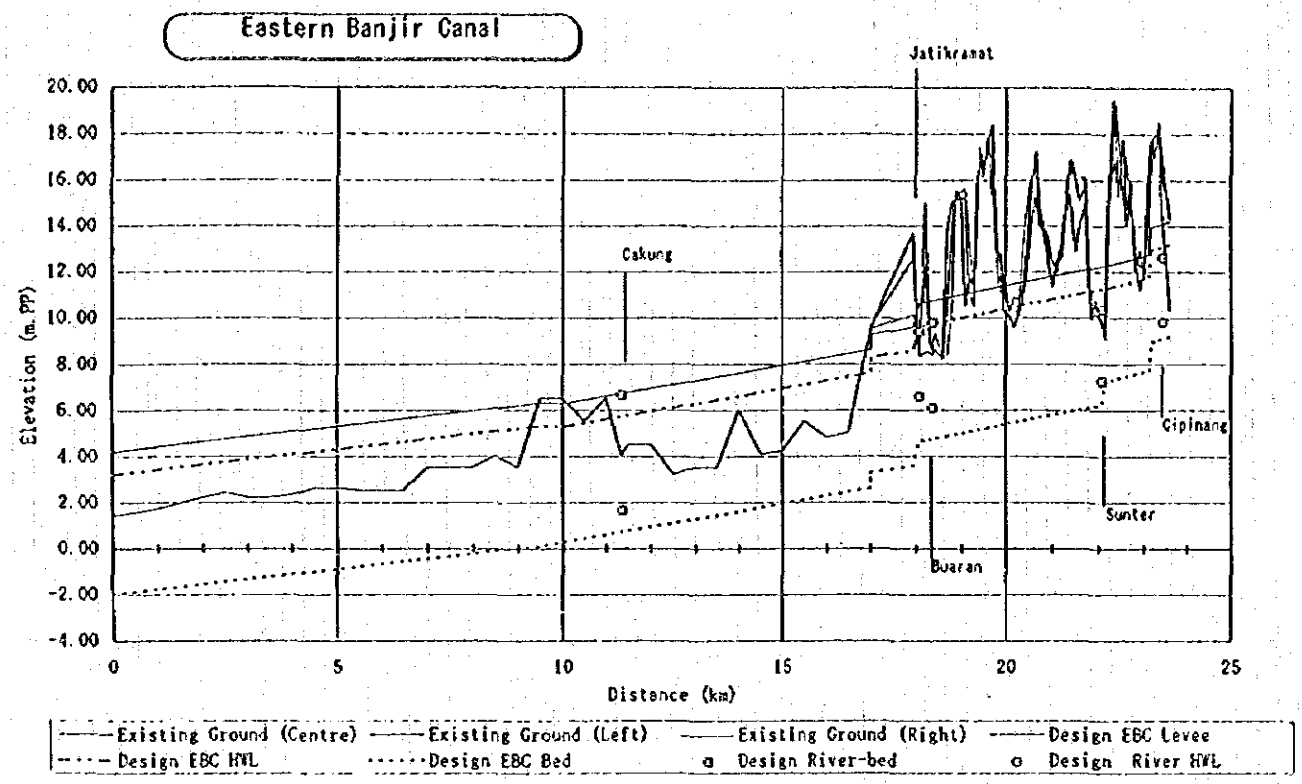


Figure - 14 DESIGN CROSS-SECTION OF EBC BETWEEN NEBC9.5 AND ESTUARY
HWL
Q = 370 m³/s
Elevation (m)
Distance (m)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
0
10
20
30
40
50
60
70
80
90
100
110
120



EASTERN BANJIR CANAL

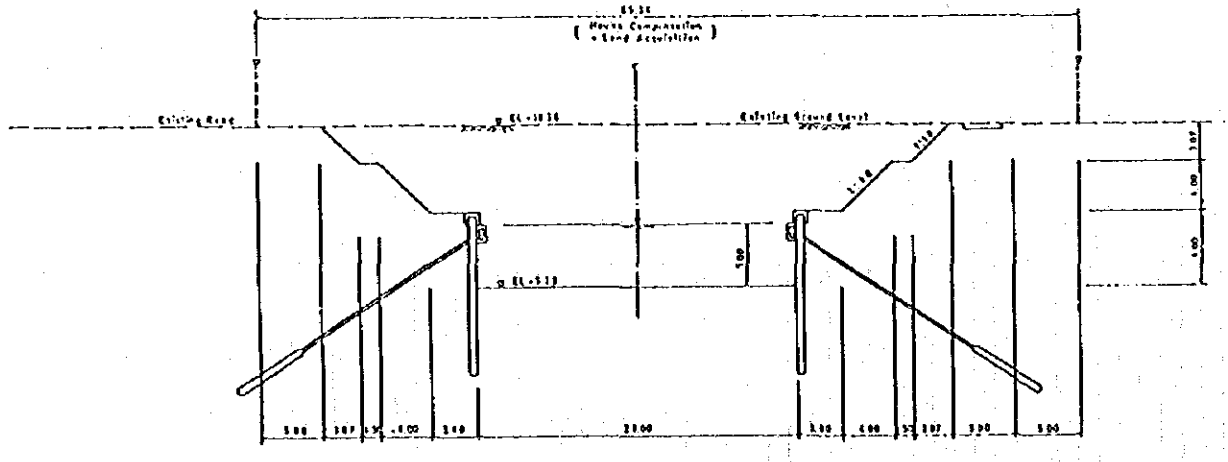


Figure - 15 DESIGN LONGITUDINAL PROFILE AND CROSS-SECTION OF EBC

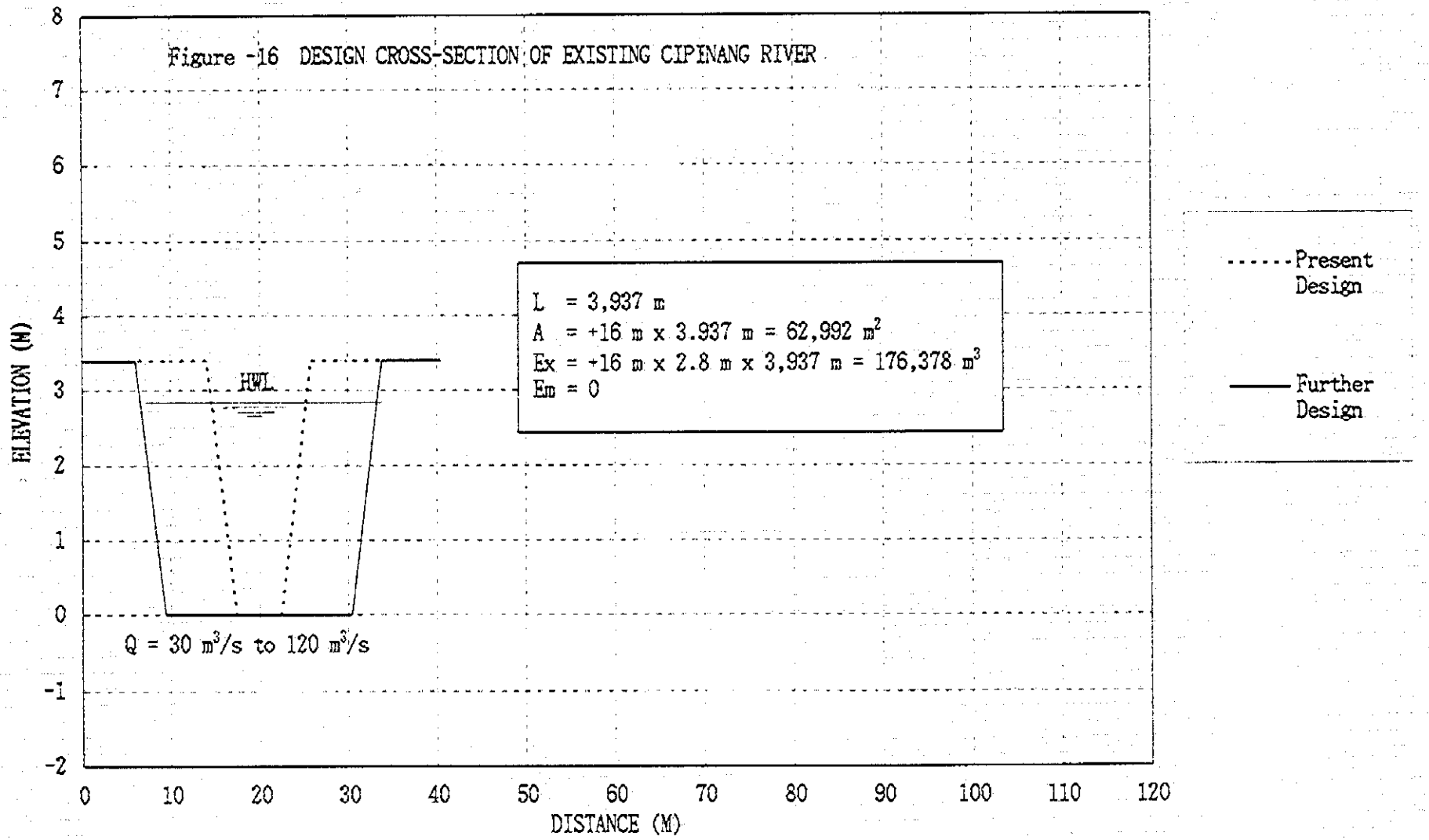


Figure -16 DESIGN CROSS-SECTION OF EXISTING CIPINANG RIVER
ELEVATION (M)
DISTANCE (M)
HWL
L = 3,937 m
A = +16 m x 3.937 m = 62,992 m²
Ex = +16 m x 2.8 m x 3,937 m = 176,378 m³
Em = 0
Q = 30 m³/s to 120 m³/s
Present Design
Further Design

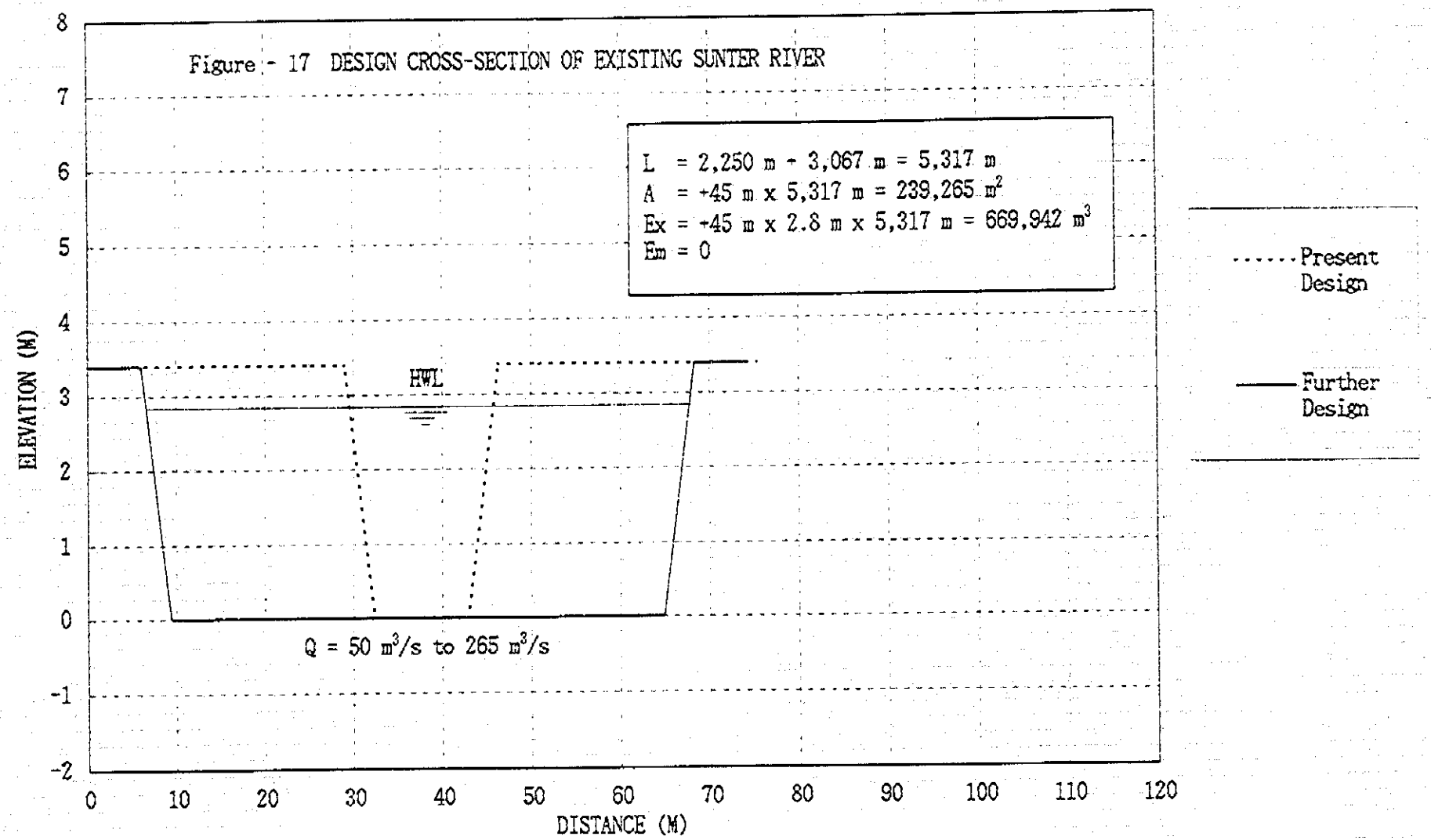
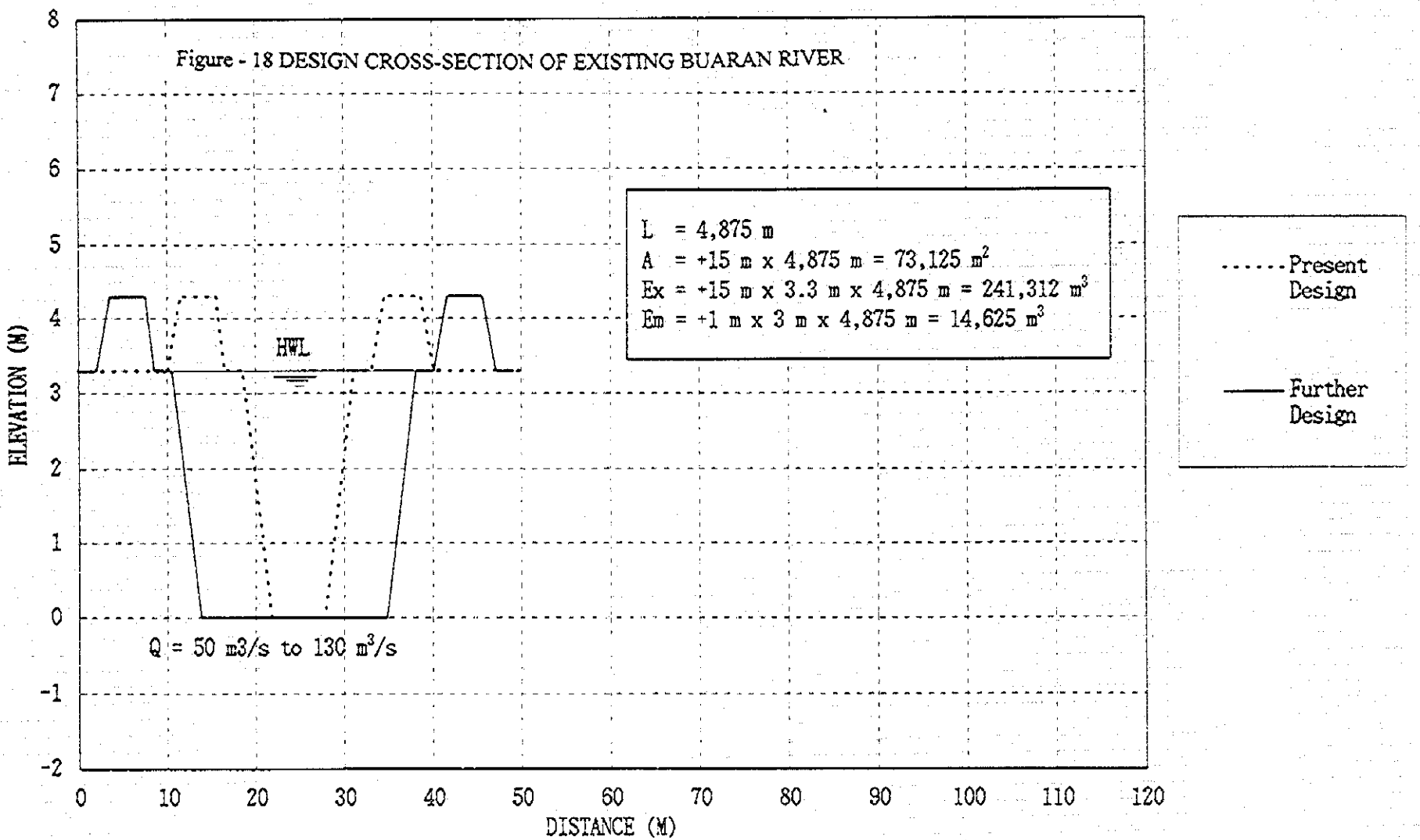


Figure - 17 DESIGN CROSS-SECTION OF EXISTING SUNTER RIVER
L = 2,250 m + 3,067 m = 5,317 m
A = +45 m x 5,317 m = 239,265 m²
Ex = +45 m x 2.8 m x 5,317 m = 669,942 m³
Em = 0
HWL
Q = 50 m³/s to 265 m³/s
ELEVATION (M)
DISTANCE (M)
Present Design
Further Design

Figure - 18 DESIGN CROSS-SECTION OF EXISTING BUARAN RIVER



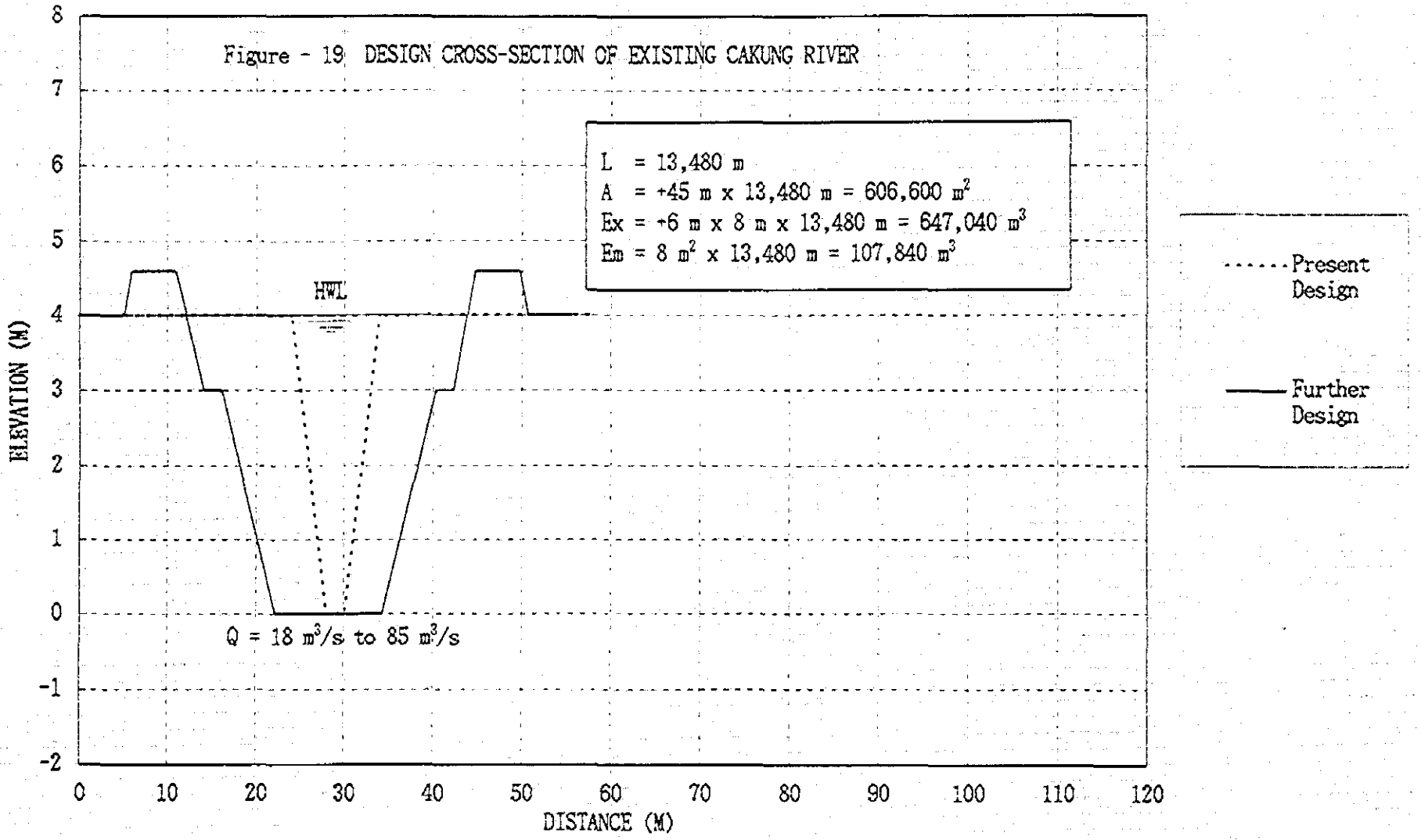


Figure - 19 DESIGN CROSS-SECTION OF EXISTING CAKUNG RIVER
L = 13,480 m
A = +45 m x 13,480 m = 606,600 m²
Ex = +6 m x 8 m x 13,480 m = 647,040 m³
Em = 8 m² x 13,480 m = 107,840 m³
HWL
Q = 18 m³/s to 85 m³/s
ELEVATION (M)
DISTANCE (M)
Present Design
Further Design

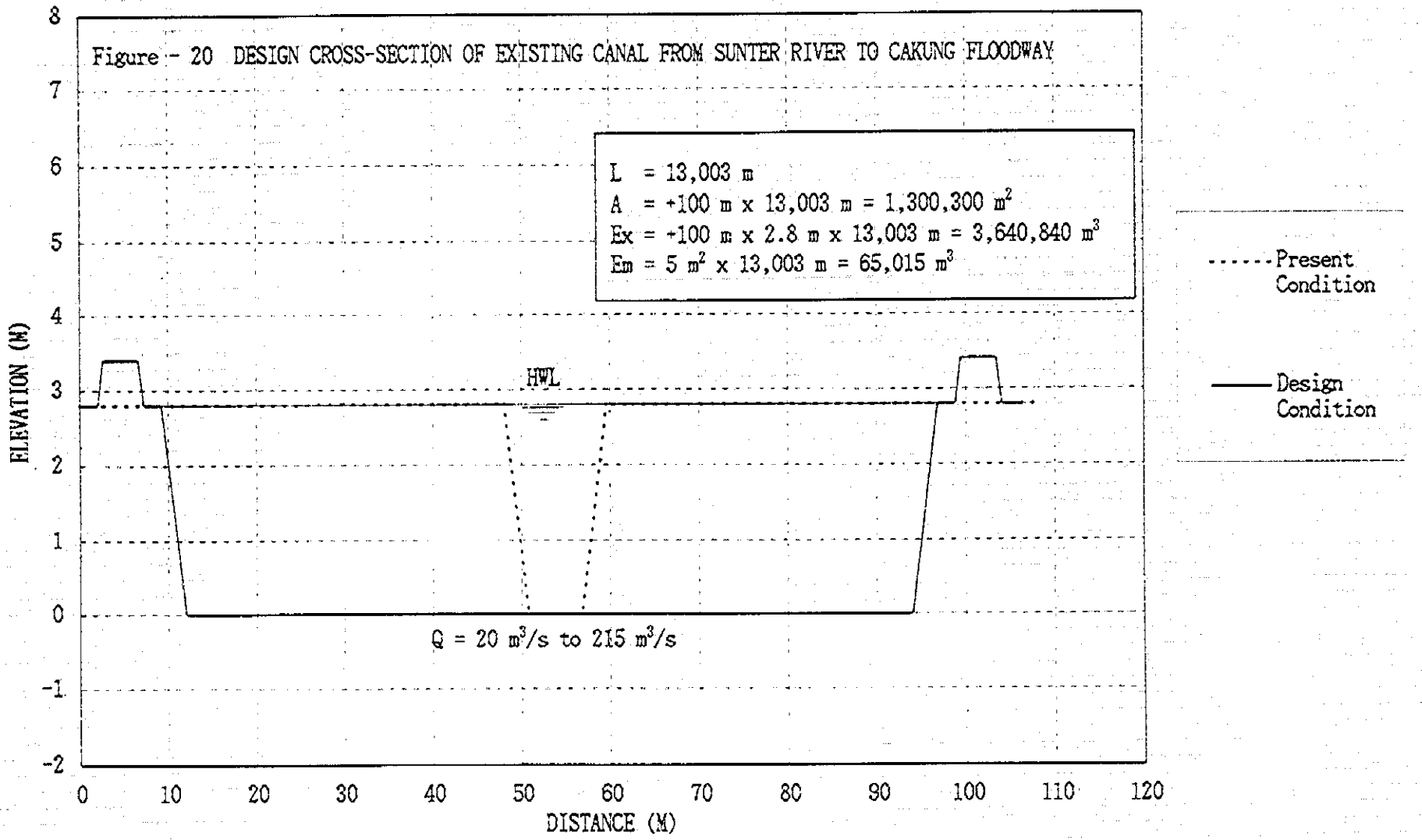


Figure - 20 DESIGN CROSS-SECTION OF EXISTING CANAL FROM SUNTER RIVER TO CAKUNG FLOODWAY
L = 13,003 m
A = +100 m x 13,003 m = 1,300,300 m²
Ex = +100 m x 2.8 m x 13,003 m = 3,640,840 m³
Em = 5 m² x 13,003 m = 65,015 m³
HWL
Q = 20 m³/s to 215 m³/s
Present Condition
Design Condition
ELEVATION (M)
DISTANCE (M)
8
7
6
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100
110
120

Figure - 21 DESIGN CROSS-SECTION OF CAKUNG FLOODWAY (UPSTREAM)

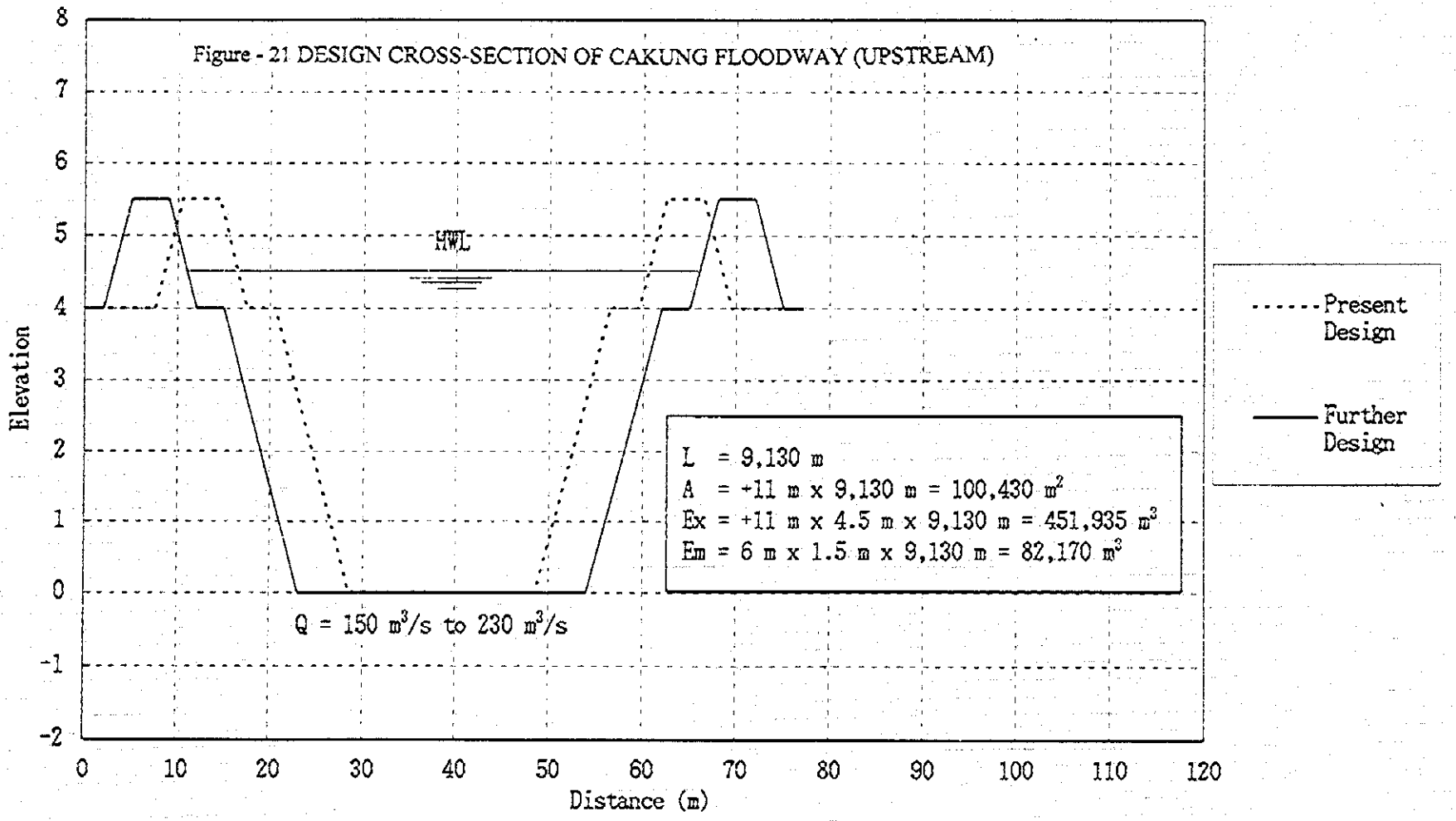
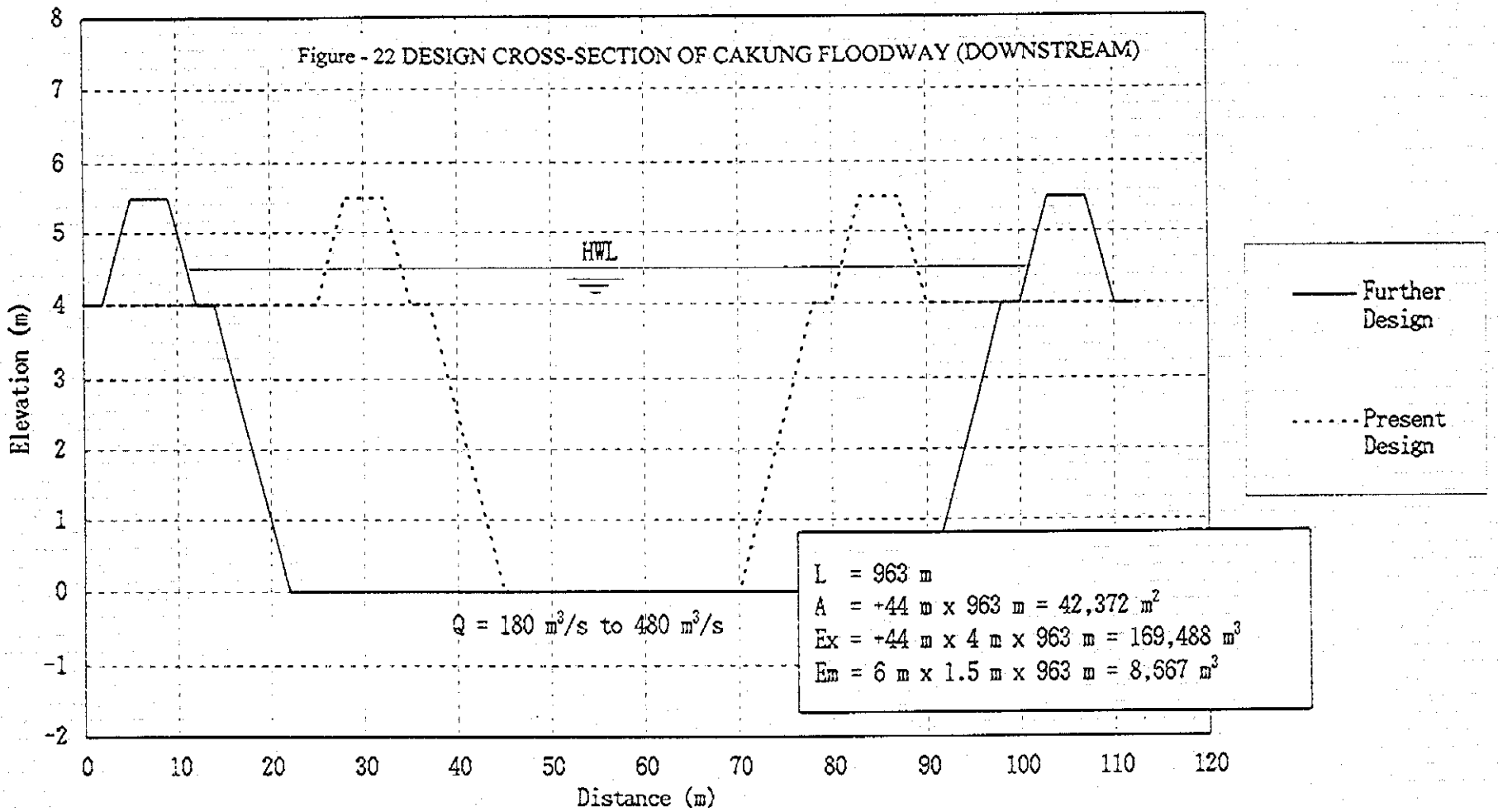
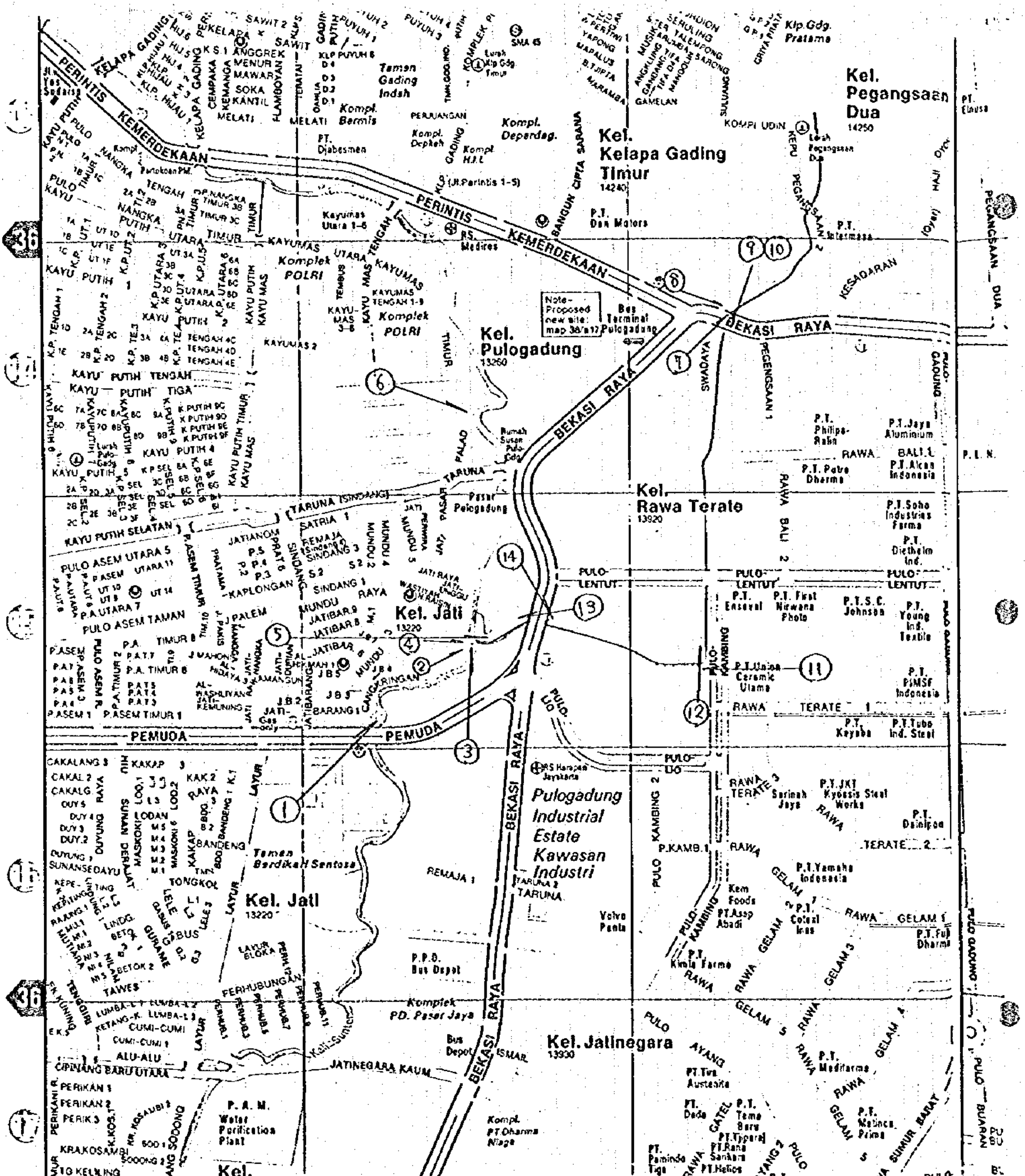


Figure - 22 DESIGN CROSS-SECTION OF CAKUNG FLOODWAY (DOWNSTREAM)



PHOTOS OF EXISTING RIVERS IN DKI JAKARTA

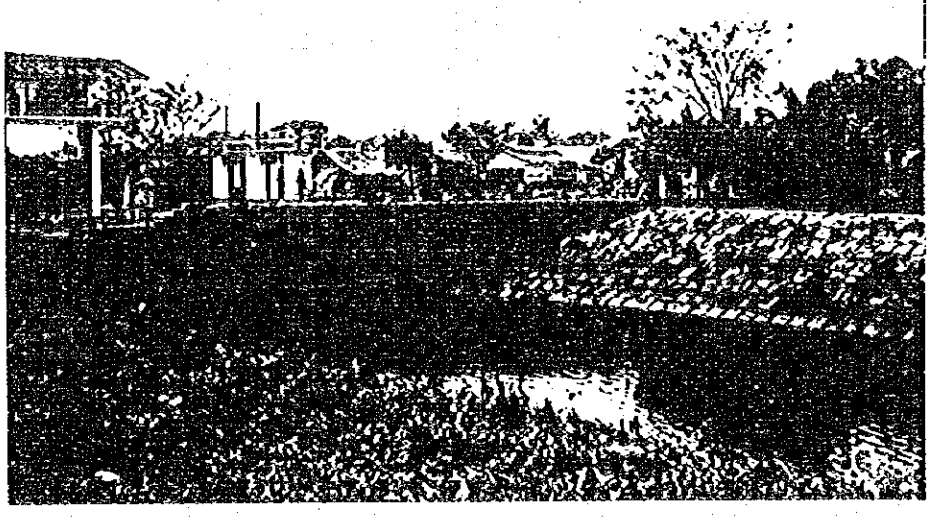
JULY 1996



PERINTIS KEMERDEKAAN
Kel. Kelapa Gading Timur
14240
Kel. Pegangsaan Dua
14250
Kel. Pulogadung
13260
Kel. Rawa Terate
13920
Kel. Jati
13220
Kel. Jatinegara
13930
BEKASI RAYA
PEMUDA
Pulogadung Industrial Estate Kawasan Industri
Bus Terminal Pulogadung
Note- Proposed new site: map 38/a17
Komplek POLRI
Taman Gading Indah
Kompl. Bermis
Kompl. Deperdag.
Rumah Susun Pulo Gdg
Pasar Pulogadung
Taman Berdikari Sentosa
Komplek PD. Pasar Jaya
P.A.M. Water Purification Plant
P.P.D. Bus Depot
RS. Medires
RS Harapan Jayakarta
P.T. Dan Motors
P.T. Philips-Ralin
P.T. Jaya Aluminium
P.T. Petro Dharma
P.T. Alcan Indonesia
P.T. Soho Industries Farma
P.T. Diethelm Ind.
P.T. Enseval
P.T. First Niewana Photo
P.T.S.C. Johnson
P.T. Young Ind. Textile
P.T. Union Ceramic Utama
P.T. PIMSF Indonesia
P.T. Kayaba
P.T. Tube Ind. Steel
P.T. JKT Kyoeis Steel Works
P.T. Dainipon
P.T. Yamaha Indonesia
P.T. Coteal Inas
P.T. Kimia Farma
P.T. Meditarma
KAYU PUTIH
KAYUMAS
PULO ASEM TAMAN
PULO LENTUT
PULO KAMBING
RAWA TERATE
RAWA GELAM
JATINEGARA KAUM
CIPINANG BARU UTARA
KESADARAN
SWADAYA
1 2 3 4 5 6 7 8 9 10 11 12 13 14
36

(1)

(2)



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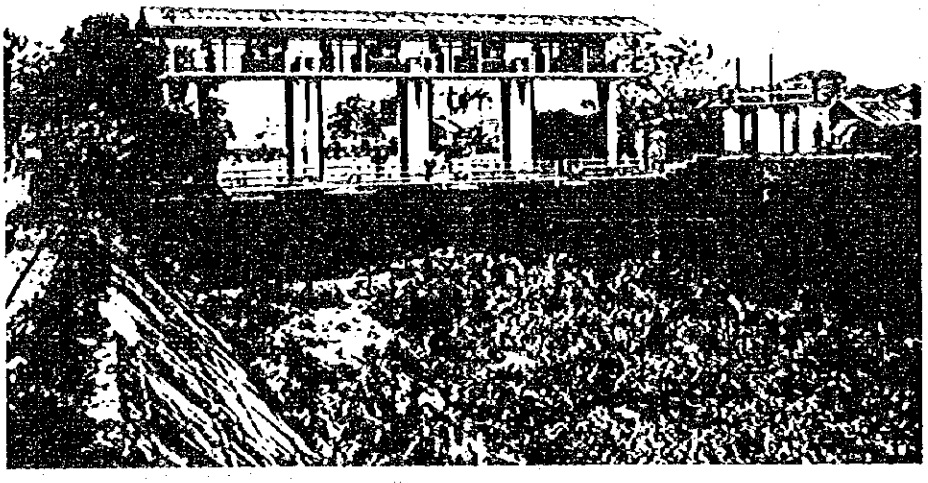

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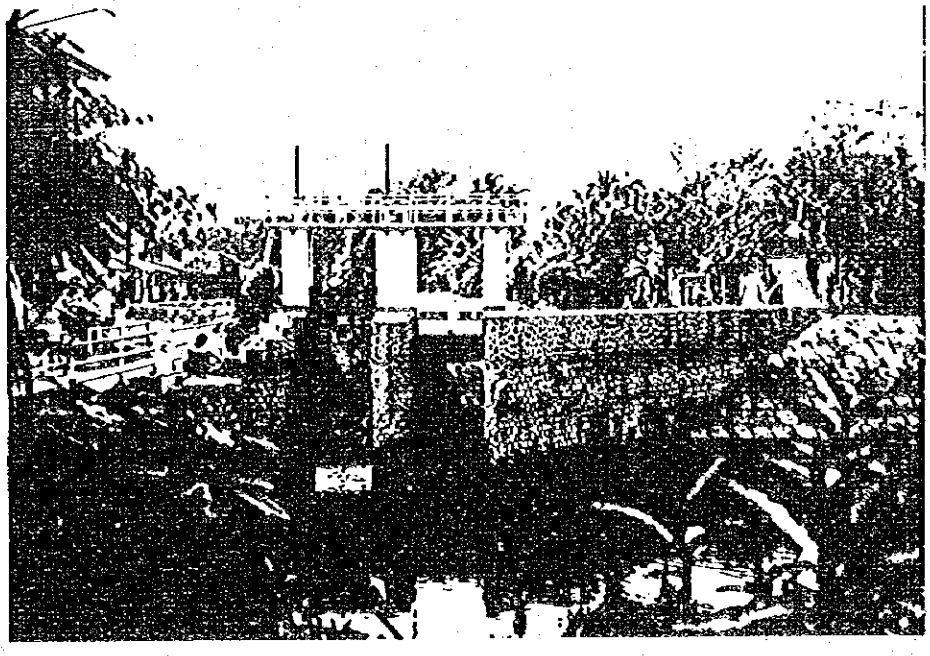

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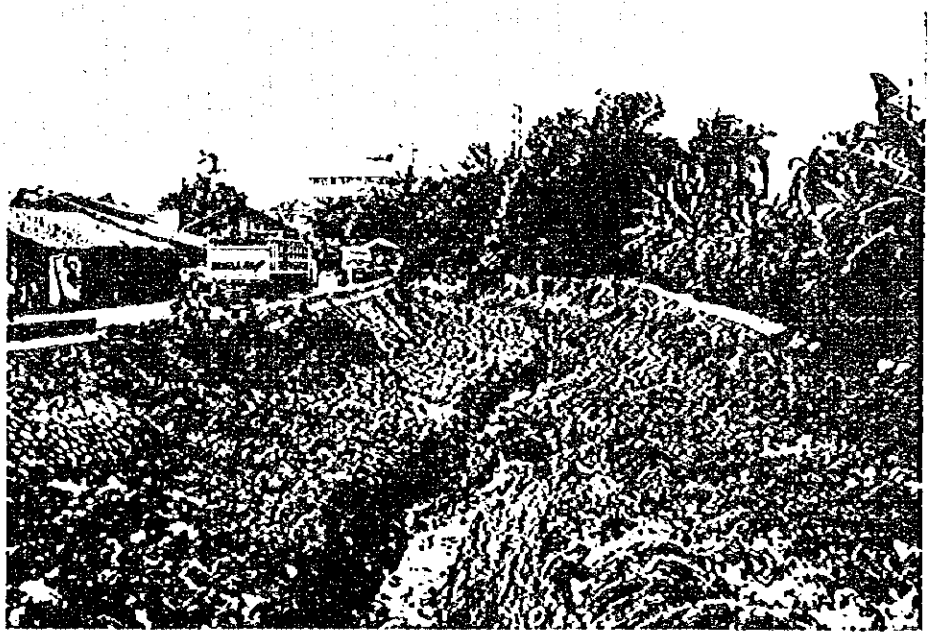

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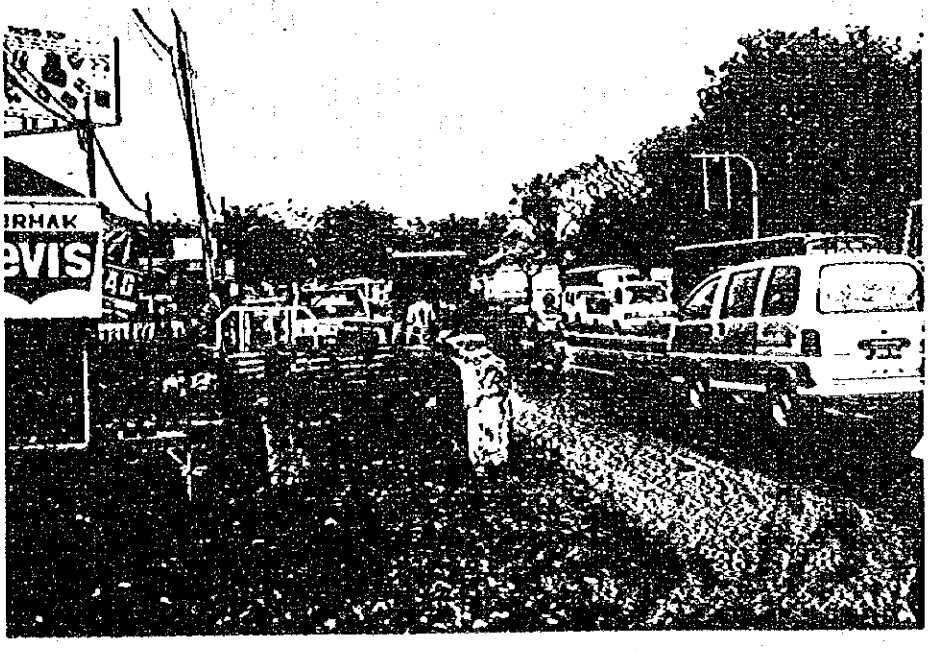
(٨)



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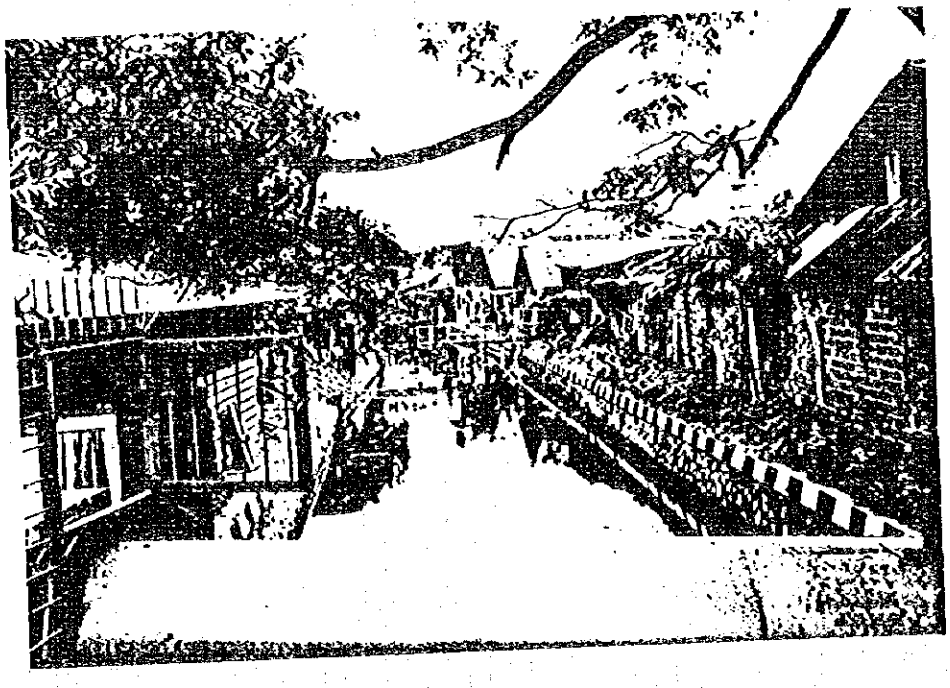

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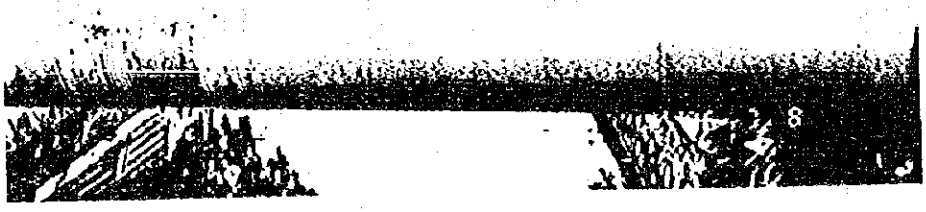

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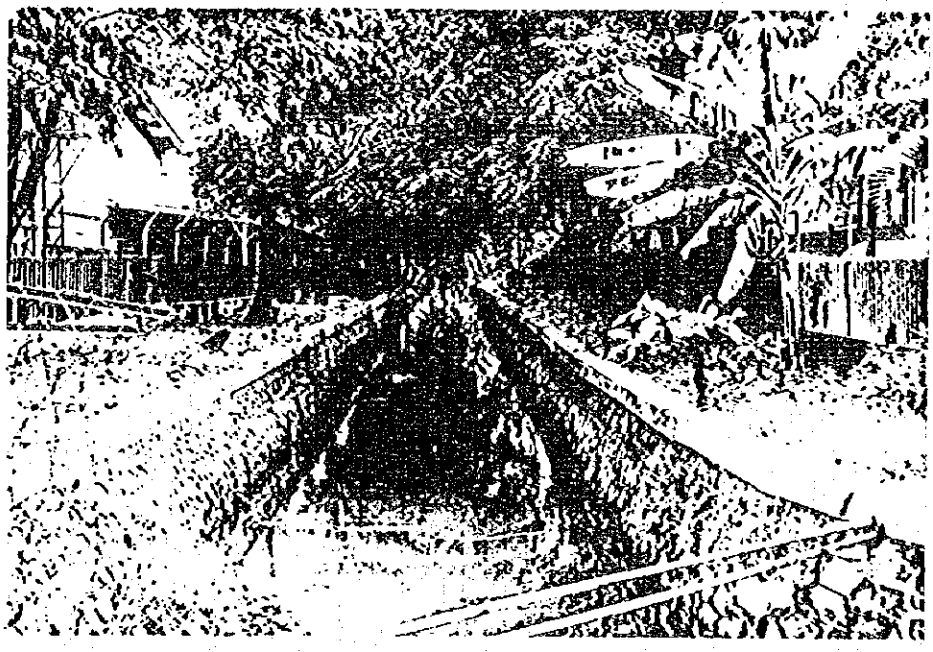

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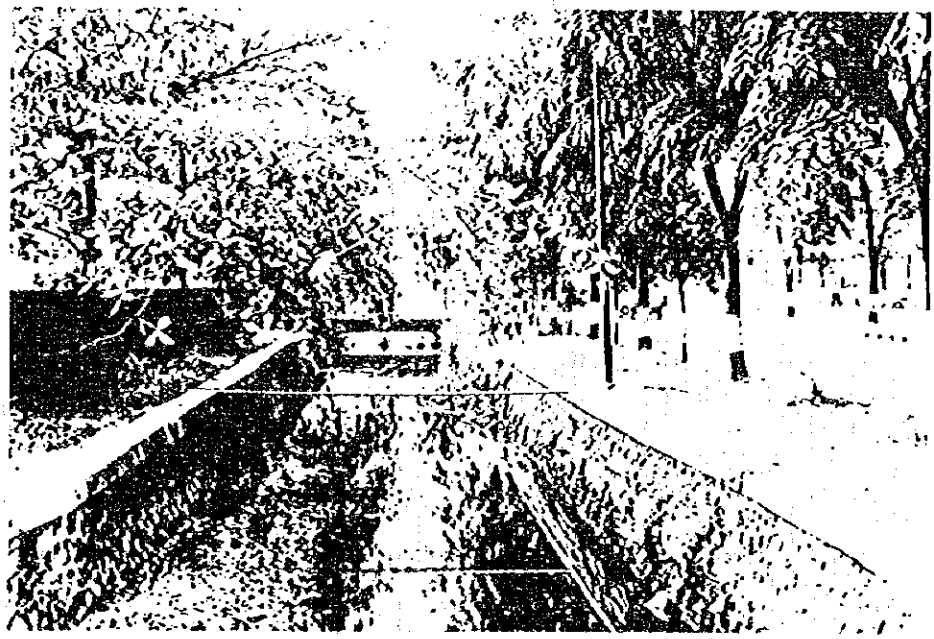

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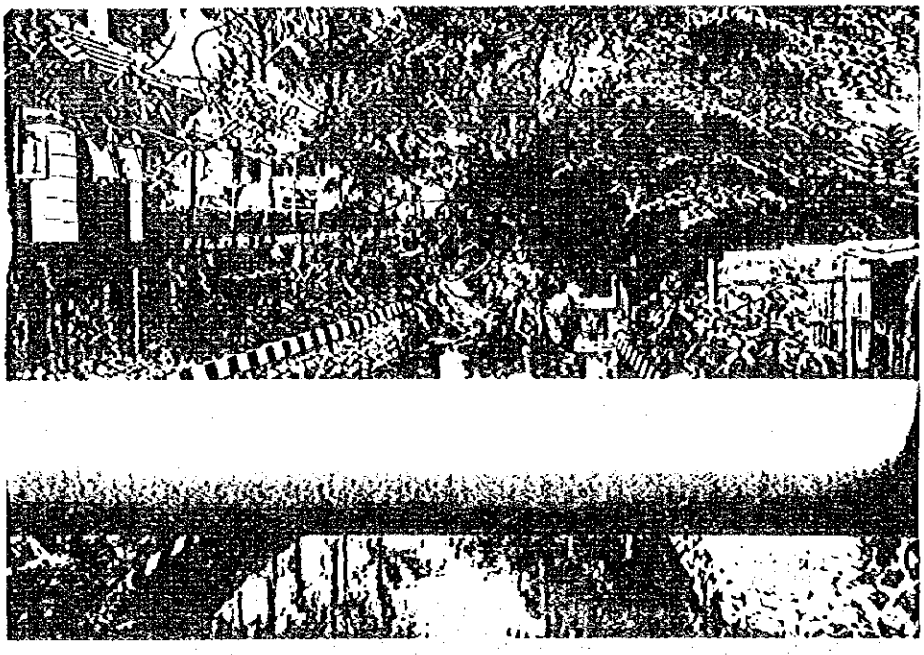

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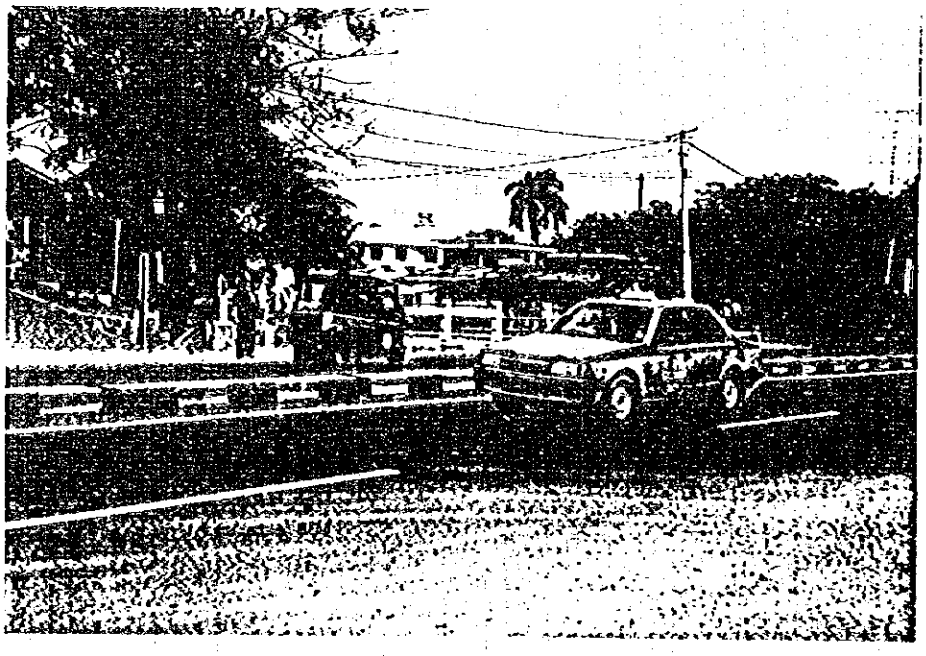

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
THE REPUBLIC OF INDONESIA

BRIEF NOTE
ON
CIAWI DAM DEVELOPMENT
FOR
FLOOD CONTROL PURPOSE

JULY 1996

STUDY TEAM ON COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN JABOTABEK

BRIEF NOTE
ON
CIAWI DAM DEVELOPMENT
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1. OBJECTIVE OF THE DEVELOPMENT

A single purpose dam development for flood control has been proposed as one of the mesures of flood control plan of the Western Banjir Canal(WBC) system. Flood regulation effect by the dam reservoir is expected to mitigate a flood magnitude of the Ciliwun river and the WBC, and also to make it possible that smaller scale river improvement plan will be realized.

2. DAM SITE

2.1 River

The proposed Ciawi dam site is located in the Ciliwun river basin. The Ciliwun river originates on the northern side slope of Mt. Pangrango(3,019m); it flows through the city of Bogor; it is diverted to the WBC at the Manggarai weir. The Ciliwun river has a catchment area of 337 km^2 and a length of about 109 km at Manggarai. In the upper reaches of Manggarai, the Ciliwun river has formed deeply dissected gorge and has almost no floodplain excluding near Manggarai. Downstream reaches of the diversion point with the WBC, the river is treated as an urban drainage channel under the control of the DKI Jakarta.

The general feature of the Ciliwun river basin (upstream of Manggarai) is as follows:

(i)	Catchment area	:	337 km2
(ii)	Length	:	109.0 km
(iii)	Elevation	:	6.3 m to 1,500.0 m
(iv)	Average slope	:	1 / 70

2.2 Dam Site and Present Situation

The following location of the Ciawi dam has been identified as an only possible dam site with flood control function in the Ciliwung river from the viewpoint of topograhy and hydrology:

- Ciliwun river, at Cibogo, 10 km southeast of Bogor with a watershed of 88 km^2.

The location of the avobe dam site is shown in Fig.1.

3. GEOLOGICAL INVESTIGATION

3.1 Field Investigation

In order to obtain the basic geological and geotechnical information on the Ciawi dam, the following geotechnical investigation works were carried out by the local contractor under a subcontract basis.

Dam Site	Drilling Site	Drilling Depth(m)	Remarks
Ciawi Dam	CD - 1	60	Right abutment
	CD - 2	40	River bed
	CD - 3	60	Left abutment
Total	3 holes	160	

Locations of the above drilling works are shown in Fig.2.

Three drillings with standart penetration test (SPT) and permeability test (Constant Head Test) in uncemented deposits, and water pressure test in bedrocks (Lugeon Test) were carried out.

3.2 Geotechnical Consideration for Dam Construction

The Ciawi dam site is composed of Younger Volcanic Rocks of G. Pangrango named in the Geological Map of the Bogor Quadrangle (1986), which consists of old deposits, lahar and lava, andesitic basalt with oligoclase-andesinte, labradorite, olivine etc., mostly strongly weathered.

Core drilling was carried out to a total depth of 160 m at 3 holes at the proposed dam site. The drilling result at both abutments reveals the existence of an intensively weathered layer of approximately 20 m thick, consisting of brownish clay to dark brown sandy silt with N values in the range of 2 to 14.

The lower layer which consists of the Breccia and Lava unit from G. Kencana, is an intercalation of andesite lava, gravelly sand, fine sand, silty clay, andesite and breccia, with N values of more than 50 in general.

The river deposits, with a thickness of about 13 m, consisting of loose sand and gravel with boulders, are found along the riverbed at this dam site. In addition, a rather highly permeable layer composed of gravelly sand or sand layer and breccia, with a Lugeon unit ranging from 10 to 50 exists in the lower portion.

3.3 Construction Material Sources

The potential construction material sources for the proposed filltype dams are shown in Fig.3, which were proposed in the water resources and flood control studies in the past and confirmed by the field reconnaisance in the present study.

(a) Impervious Earth Material

In general it would be rather easy to obtain a large amount of suitable earth materials in the vicinity of the proposed dam site because all the potential borrow sites are composed of weathered volcanic rocks or alluvial fan (overburden), which have been confirmed to be suitable impervious materials, through actual constructions and according to the data of the previous studies.

The engineering properties of impervious materials applied in the previous studies, which correspond to the embankment works for such structures as filltype dam and dike on the river in the Study Area, are as follows:

Density : γ_{wet} = 1.61 ~ 1.68 t/ m^3, γ_{sat} = 1.65 ~ 1.72 t/m^3

Shearing strength : C = 2.0 ~ 5.4 t/m^2, C' = 1.0 ~ 2.0 t/m^2

$\varnothing$ =9.0 ~ 12.5°, $\varnothing'$ = 25.0 ~ 33.0

where,

C: cohesion in term, of total stress

$\varnothing$: internal friction angle in terms of total stress

The compaction of the above materials was performed mostly by tamping roller or pneumatic roller.

(b) Sand and Gravel Material

Sand and gravel to be used for concrete and filter or transition material can be obtained mainly along the Cisadane river, Ciapus river and Cipamingkis river, where large deposits of sand, gravel and stone are available. Several private companies are exploiting these deposits and processing sand and gravel by operating crushing plants. Among these materials, the Cipamingkis river materials are rather inferior in quality for concrete aggregate due to a high/ content of pumice fragments. The engineering properties of materials for filter zone applied in the past studies are as follows:

Density : γ_{wet} = 1.74 t/m^3, γ_{sat} = 1.89 t/m^3

Shearing strength : C(C') = 0 t/m^2 $\varnothing$ ($\varnothing'$) = 35.0°.

(c) Rock Materials

The promising rock quarries are composed of Andesite of Sudamanic Volcano or Older Volcanic Rock named in the Bogor Quadrangle (1986), which are located in the western hilly part (Rumpin) of the Study Area. Private companies are producing sand and gravel, and rock material by operating crushing plants. Other quarries such as the proposed quarries in G. Cibodas and Cibinong Limestone, which are composed of limestone of the Klapanunggal Formation, could be recommended for the inner shell zone of rockfill dams or base materials for roads. The northern steep ridges of G. Salak, around El. 900 m (near Taman, upstream of Ciapus river), are composed of hard andesitic rocks, mainly andesitic lava. It is recommended that this ridge area be further investigated as a source of rock material for the Ciawi dam construction.

All the above rock material sources except the limestone quarries have some difficulties in transportion because most roads are in poor condition. The design engineering properties of

hard andesitic rocks in the past studies are as follows:

Density : γ_{wet} = 1.90 t/ m^3, γ_{sat} = 2.12 t/m^3

Shearing strength : C(C') = 0 t/m^2, Ø (Ø') = 40.0°.

(compacted by vibratory roller).

3.4 Geotechnical Conditions at Ciawi Dam Site

It is concluded that the rockfill dam type with a vertical clay core can be recommended, considering the rather large dam height of the 60 m class. Further, it is important to keep in mind the existence of a rather thick layer of river deposits in the riverbed.

4. HYDROLOGICAL STUDY

4.1 Rainfall Analysis

Through the various rainfall analyses such as probability analysis of annual maximum daily areal rainfall for the basin of the Ciliwun river and others, as well as the probability analysis of annual maximum daily point rainfall at BMG station, the probable rainfalls for several return periods are obtained as summarized below and also shown in Fig.4:

Area	2-year		5-year		10-year		25-year		50-year		100-year	
Point Rainfall	98	(100%)	135	(100%)	160	(100%)	192	(100%)	215	(100%)	238	(100%)
Ciliwung(215km^2)	63	(65%)	85	(62%)	99	(61%)	116	(61%)	129	(60%)	142	(60%)
Ciliwung(442km^2)	67	(69%)	86	(63%)	98	(61%)	114	(59%)	125	(58%)	137	(57%)
Cisadane(1,411km^2)	49	(50%)	67	(50%)	79	(49%)	94	(49%)	105	(49%)	116	(49%)

The rainfall masscurves for several return periods are worked out as shown in Fig.5 based on the predetermined rainfall duration of 24 hours and the time distribution patterns which were adopted in the previous Jakarta Drainage and Flood Control Master Plan.

4.2 Runoff Analysis

The flood runoff calculation model using the storage function method is developed based on the river systems divided into each sub-basin as shown in Fig.6. The schematic diagram of the basin and river channel model for the WBC system is presented in Fig.7.

The calculated hydrographs at the respective design control points of the Ciliwun river under the future land use condition are given in Fig.8. The design peak discharge without regulation at the design control point for the predetermined design scale of each river and those specific discharge are summarized in Fig.9 and Fig.10, respectively.

4.3 Sediment Yield

A sediment yield of the Ciliwun river in the proposed Ciawi dam catchment is assumed to be in a range of 1.5 to 2.0 mm/year in accordance with similar studies for the mountainous area in West Jawa.

5. DAM DEVELOPMENT PLAN

5.1 Dam Development Alternatives

Following 3 alternatives have been studied for the formulation of flood control master plan for the WBC system in which the Ciawi dam development is incorporated in the alternative WBC-2:

(i) River improvement (WBC-1)

(ii) River improvement + Ciawi Dam (WBC-2)

(iii) River improvement + Ciliwun Floodway (WBC-3)

5.2 Dam Development Scale

5.2.1 Dam Type and Height

As described in the preceding Section 3.4, the rockfill dam type with a vertical clay core has been selected for the Ciawi dam. The maximum dam height is determined to be about 60 m from riverbed because of the topographic condition.

5.2.2 Prospective Site

Based on the predetermined dam height limitation, a possible dam scale and a reservoir area of the dam site is designed on the presently available topographical maps scaled of 1: 25,000 as shown in Fig.11.

5.2.3 Reservoir Development Scale

The reservoir storage curve has been worked out based on the aforementioned topographical map as shown in Fig.12.

The reservoir development scale has been determined that the dam height is set at the geotechnically maximum and dam freeboard has been set out at 5 m from dam crest to the maximum waterlevel. The principal development scale is as follows:

(1)	Dam Crest Elevation	:	EL.567.5 m (5.0 m freeboard)
	Dam Height	:	61.0 m from riverbed
(2)	High Water Level	:	EL.562.5 m
	Gross Storage Volume		8.719×10^6 m^3

(3) Riverbed Elevation : EL.506.5 m

As for the sediment volume to be deposited in the reservoir, the following combinations are examined against the gross storage volume of the reservoir shown above:

Case	Catchment Area (km^2)	Sediment Yield (mm/year)	Duration (years)	Sediment Volume ($x10^6m^3$)	Sediment Level (El., m)	Effective Storage Vol. ($x10^6m^3$)
(i)	88.0	2.0	100	17.6	over HWL	-
(ii)	88.0	2.0	50	8.8	over HWL	-
(iii)	88.0	1.5	100	13.2	over HWL	-
(iv)	88.0	1.5	50	6.6	556.0	2.119

As shown in the above, the planned Ciawi reservoir would be full up within about 50 years and 66 years in case of a sediment yield of 2.0 mm/year and 1.5 mm/year, respectively. In only the case of 1.5 mm/year for 50 years, the effective storage volume could be secured for 2.1 million cubic meters.

5.3 Flood Control Effect

The flood regulation effect by the Ciawi dam(reservoir) has been examined for the design peak flood inflow of 400 m^3/sec by assuming the effective flood regulation volume of 1,766,000m^3(2,119,000 m^3/1.2). As being shown in Fig.11, the regulated peak outflow is estimated to be 130 m^3/sec, while the design flood discharge at Manggarai weir would be mitigated from 570 m^3/s to 500 m^3/s, as summarized below:

Principal Point	Catchment Area(km^2)	Alternative :	Design Discharge (m^3/s) : WBC - 1	WBC - 2	WBC - 3
		Measures in Ciliwun Riv. :	Without Dam nor Floodway	Dam only	Floodway only
Ciawi Dam	88.0	Inflow	400	400	400
		Regulated Outflow	-	130	-
		Non-regulated Discharge	400	-	400
Floodway Inlet	152.0		790	660	790 / 190
Manggarai Weir	337.0		570	500	410

5.4 Conclusion

The alternative of WBC-2 which includes the Ciawi dam construction is discarded due to less flood control effect by the flood regulation of the Ciawi dam(reservoir) than the flood diversion through the Ciliwun - Cisadane floodway(Alternative WBC-3). This is concluded in the following aspects:

(1) A certain regulation effect is expected at just downstream of the dam under the condition of a sediment yield of 1.5mm /year and 50 years duration. However, these sediment values seems to be minimum ones, or not enough for dam planning in such area;

(2) Since the Ciawi dam is located in the most upstream reaches of the Ciliwun river(catchment area at the dam site is 88 km^2), the discharge regulation effect is not so distinguished at the Manggarai weir point(catchment area is 337 km^2);

(3) The design discharge in the upstream reaches of the WBC with dam regulation effect is 500 m^3/s. However this discharge exceeds a capacity of the WBC even after the possible river improvement of the WBC.

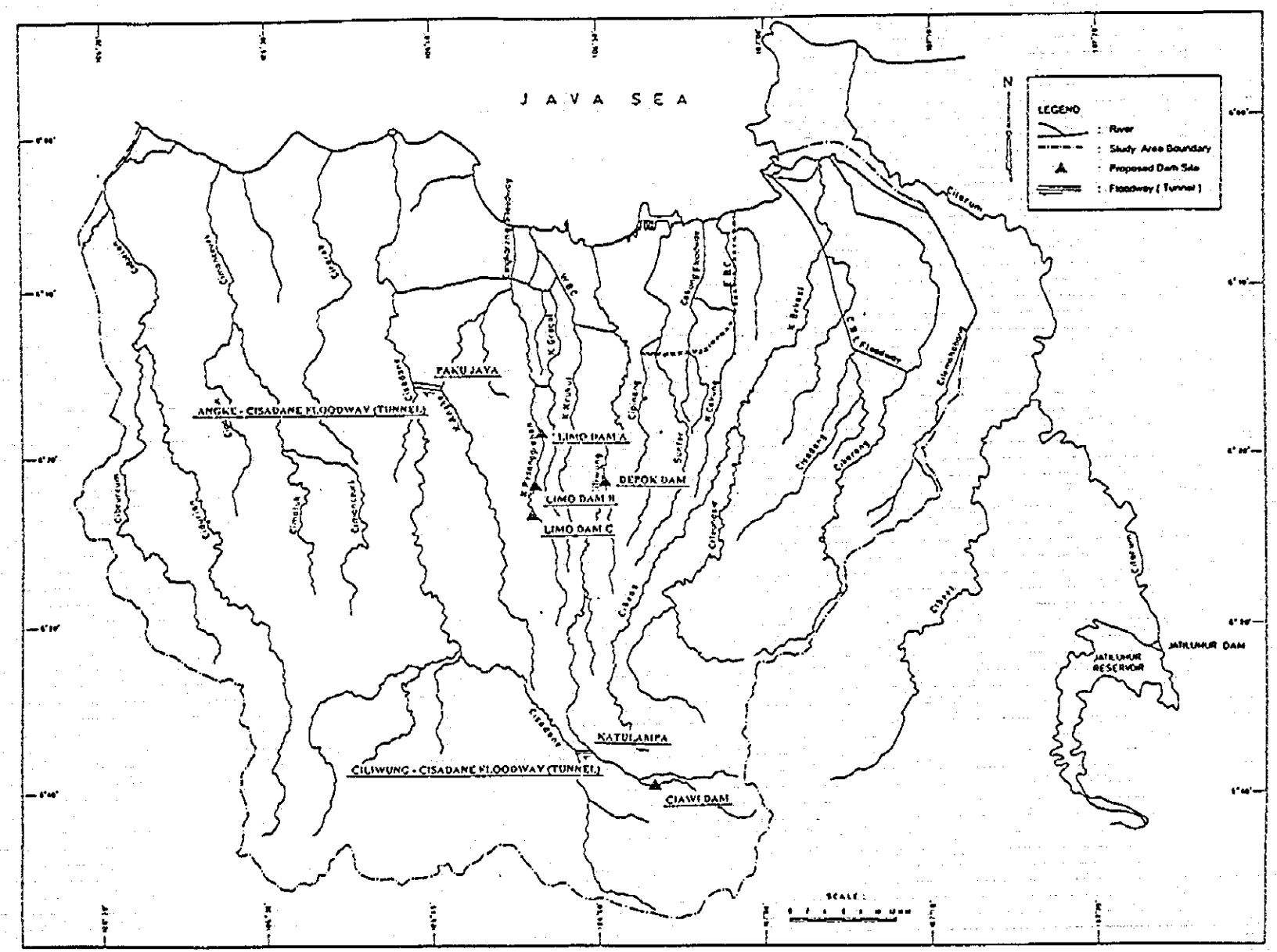


Fig.1 LOCATION OF STUDIED DAM SITES

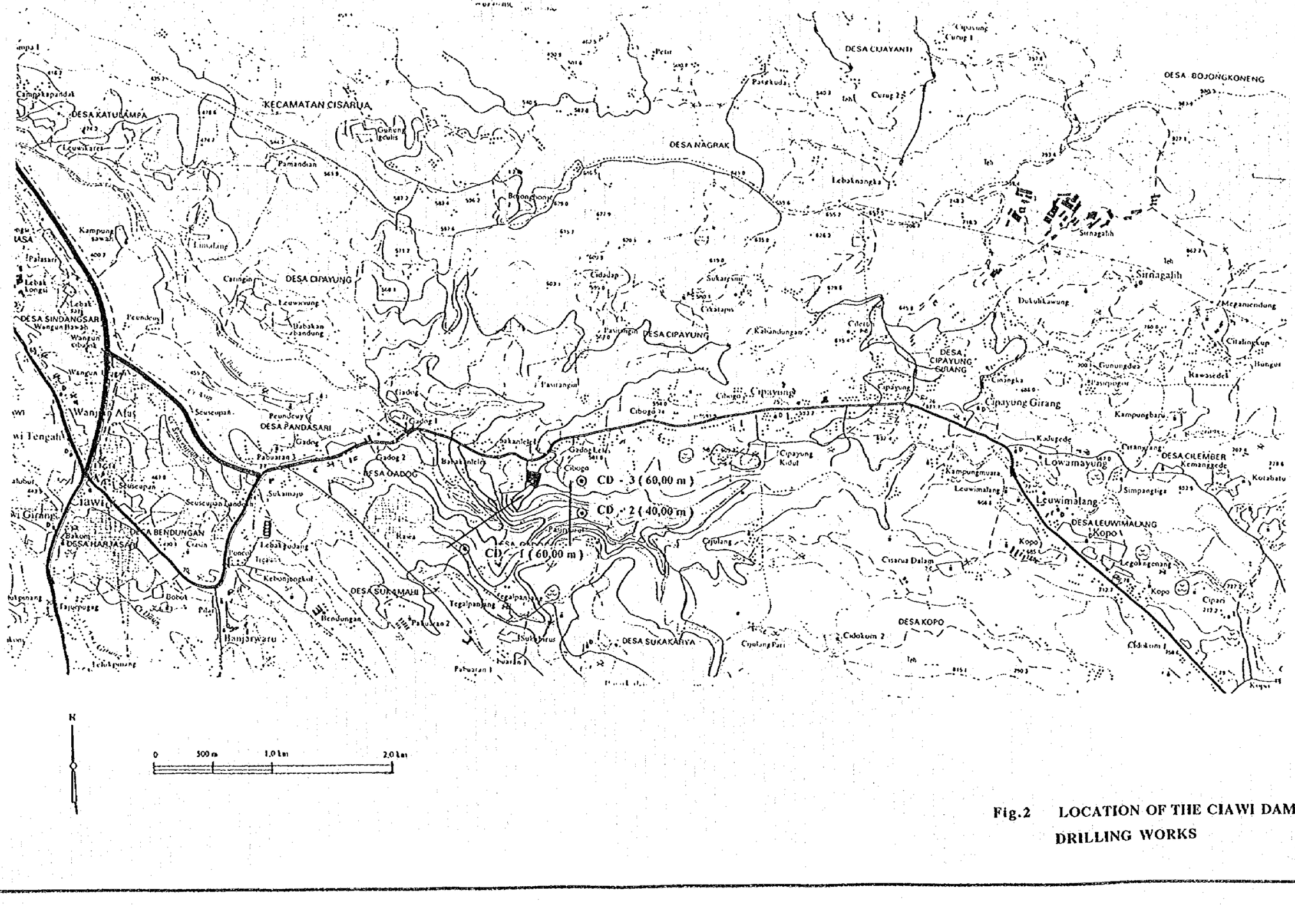


Fig.2 LOCATION OF THE CIAWI DAM DRILLING WORKS

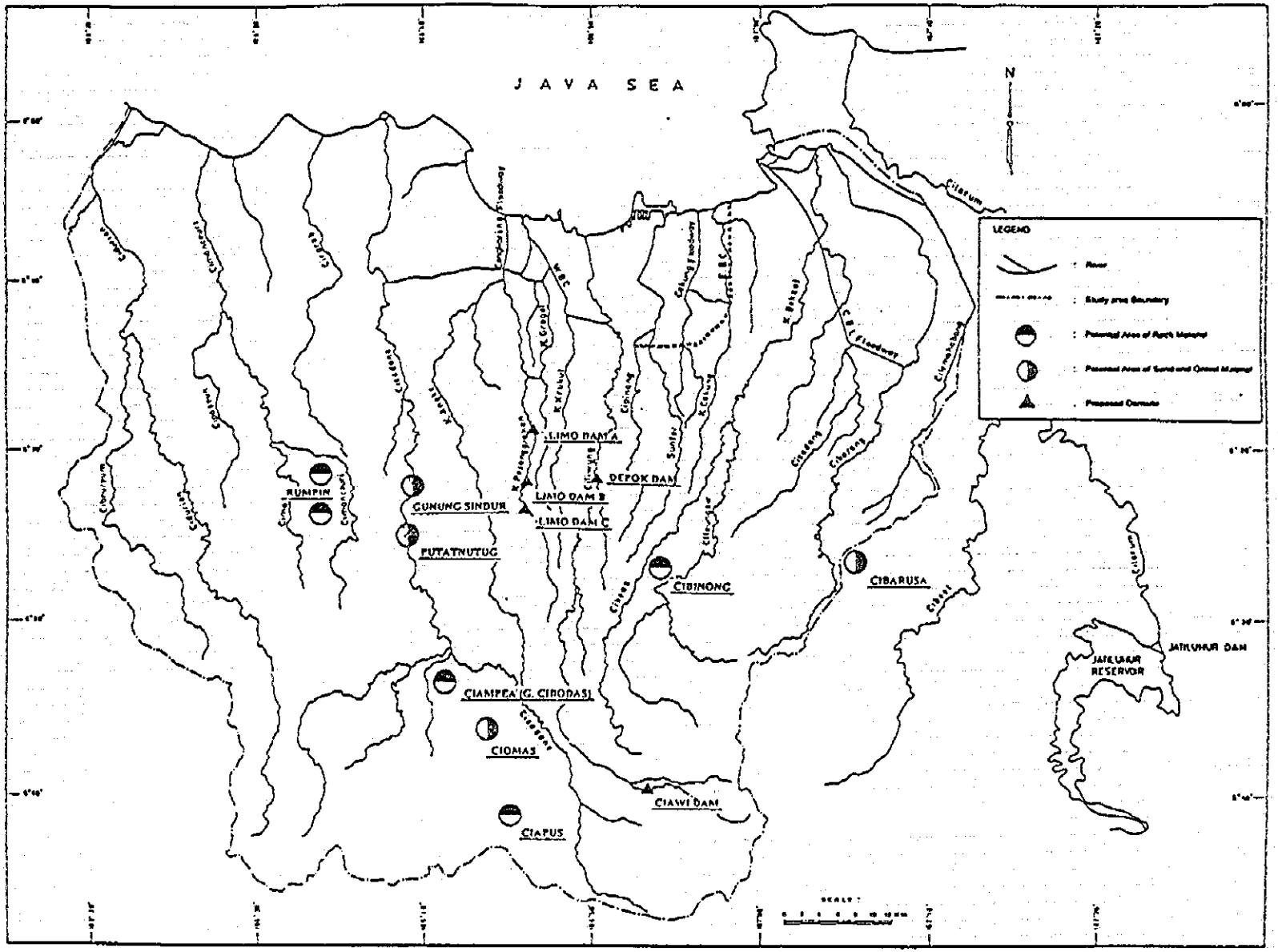


Fig.3 LOCATION OF QUARRY SITES

Return Period (year)	Jakarta Point Rainfall (mm)	Ciliwung A=215 km^2 (mm)	Ciliwung A=442 km^2 (mm)	Cisadane A=1,411 km^2 (mm)
1000	315.2	185.6	174.7	153.1
500	292.1	172.7	163.3	142.0
250	269.1	159.7	151.9	131.0
200	261.6	155.5	148.2	127.5
100	238.5	142.5	136.8	116.4
50	215.3	129.4	125.3	105.3
30	198.1	119.8	116.7	97.1
25	191.9	116.3	113.7	94.1
20	184.3	112.0	109.9	90.5
10	160.3	98.6	98.1	79.0
5	135.4	84.5	85.7	67.1
2	97.7	63.3	67.1	49.1

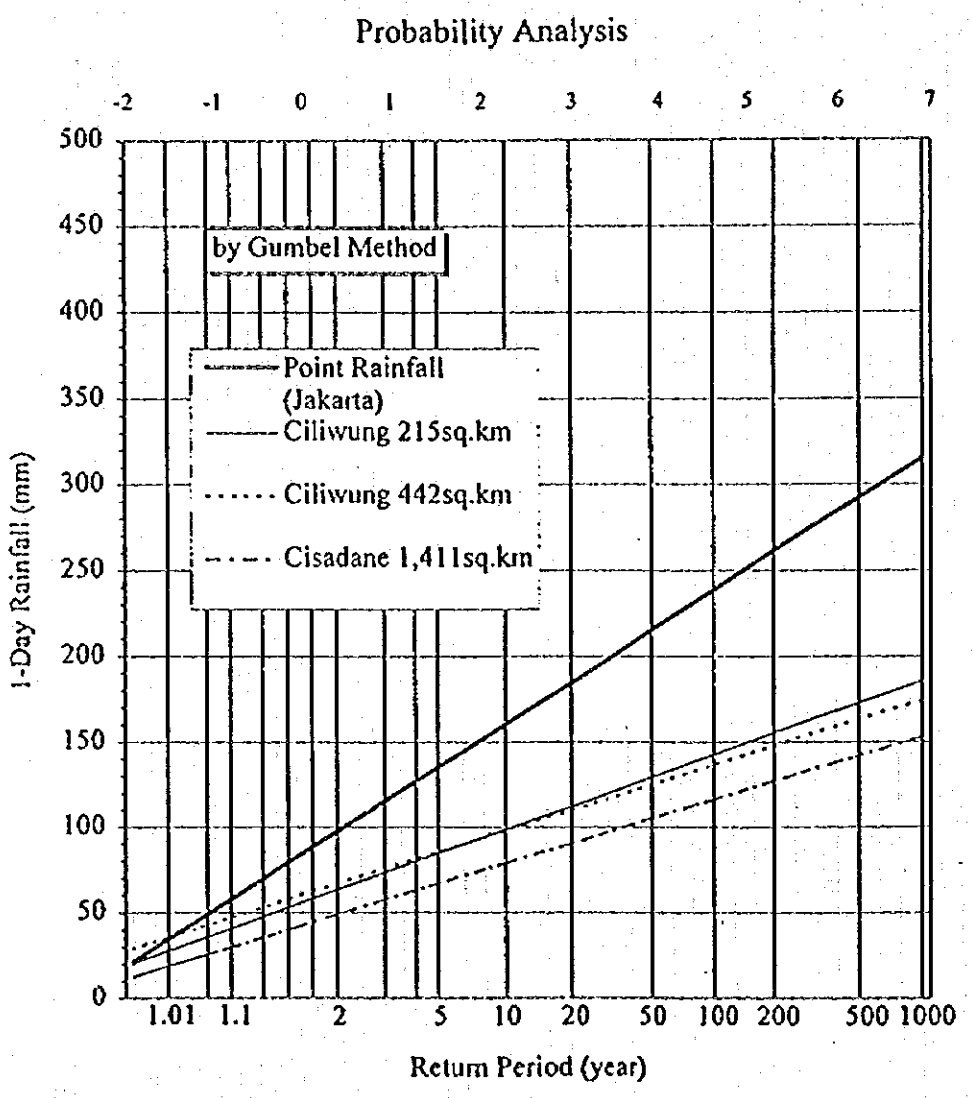


Fig.4 PROBABLE DAILY RAINFALL

	2-yr	5-yr	10-yr	20-yr	25-yr	30-yr	50-yr	100-yr
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	55.4	64.8	72.2	79.1	82.7	84.9	90.8	96.1
2	64.2	79.9	91.8	98.0	105.1	107.0	114.4	134.2
3	69.5	88.8	101.5	113.3	120.4	122.9	130.8	151.4
4	73.0	95.0	108.7	124.1	132.1	134.4	143.5	162.3
5	76.6	100.3	114.9	133.0	140.2	143.2	153.5	170.5
6	79.2	104.8	120.3	140.2	146.5	150.3	161.7	177.7
7	81.0	107.4	125.6	144.7	151.9	155.6	167.1	184.1
8	82.7	110.1	129.2	148.3	156.4	160.0	172.6	190.4
9	84.5	111.9	132.3	151.9	160.0	164.5	178.0	195.9
10	86.2	113.6	135.0	154.6	163.6	168.0	181.7	200.4
11	87.1	115.4	137.6	157.3	166.3	171.5	185.3	204.9
12	88.0	117.2	139.9	160.0	169.0	174.2	188.5	208.6
13	88.9	119.0	142.1	162.7	171.7	176.8	191.2	212.2
14	89.8	120.7	143.9	165.0	173.9	179.5	193.9	214.9
15	90.6	122.5	145.6	167.2	176.1	182.1	196.2	217.6
16	91.5	124.3	147.4	169.4	177.9	183.9	198.5	220.4
17	92.4	126.1	149.2	171.7	179.7	185.7	200.7	223.1
18	93.3	127.4	151.0	173.5	181.5	187.4	203.0	225.8
19	94.2	128.7	152.8	175.3	183.3	189.2	205.3	228.5
20	95.0	130.1	154.6	177.1	185.1	191.0	207.5	231.2
21	95.9	131.4	156.3	178.9	186.9	192.7	209.8	233.0
22	96.8	132.7	157.7	180.7	188.7	194.5	211.6	234.9
23	97.2	134.1	159.0	182.5	190.5	196.3	213.5	236.7
24	97.7	135.4	160.3	184.3	191.9	198.1	215.3	238.5

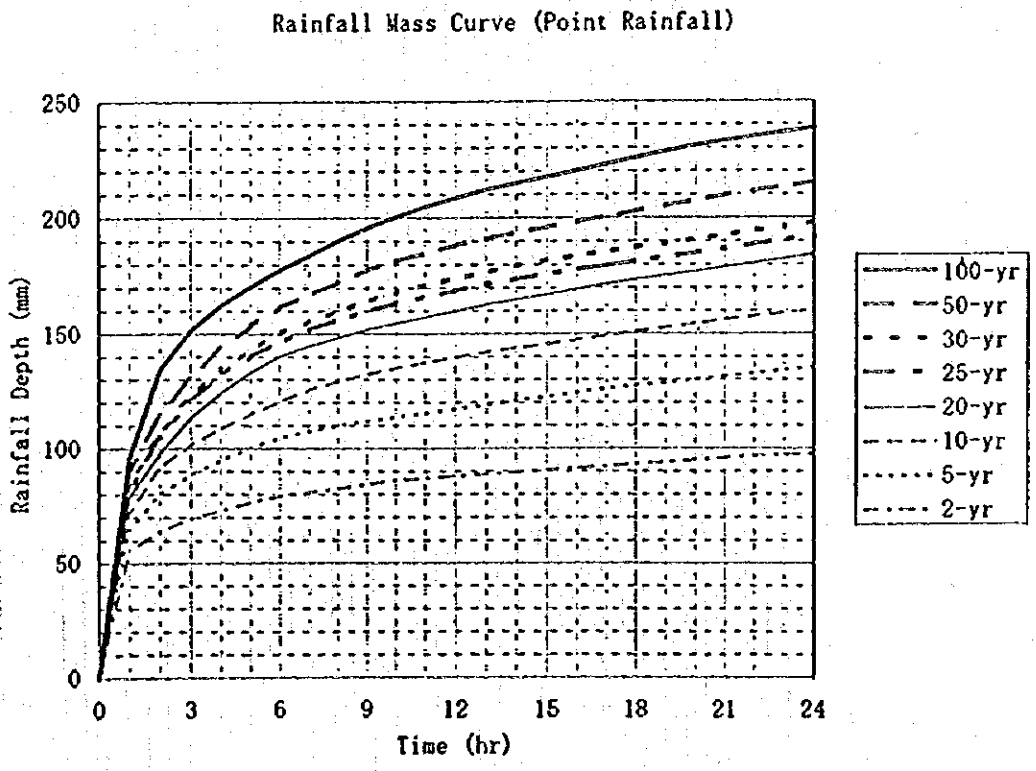


Fig.5 POINT RAINFALL MASS CURVE

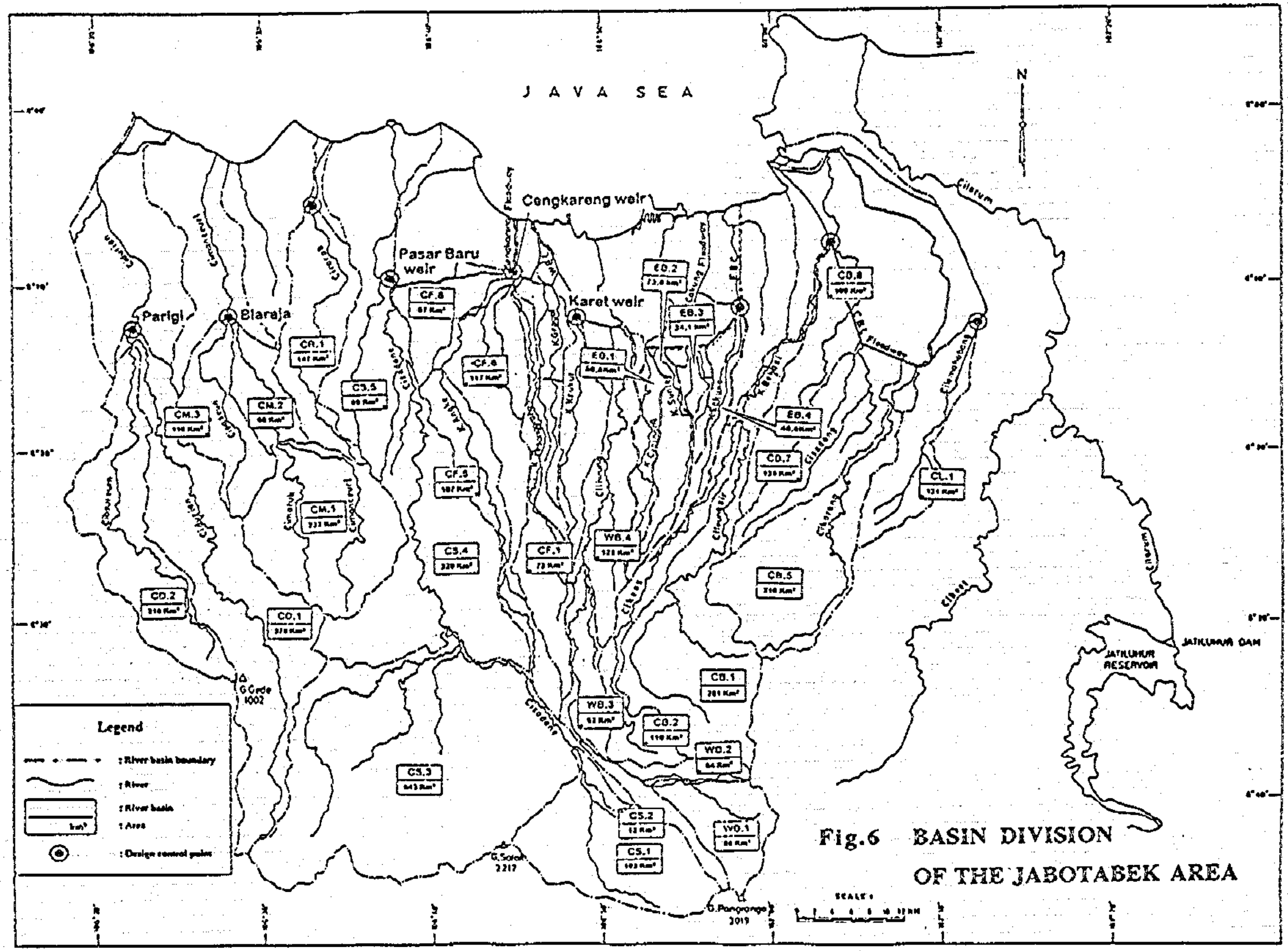


Fig.6 BASIN DIVISION OF THE JABOTABEK AREA

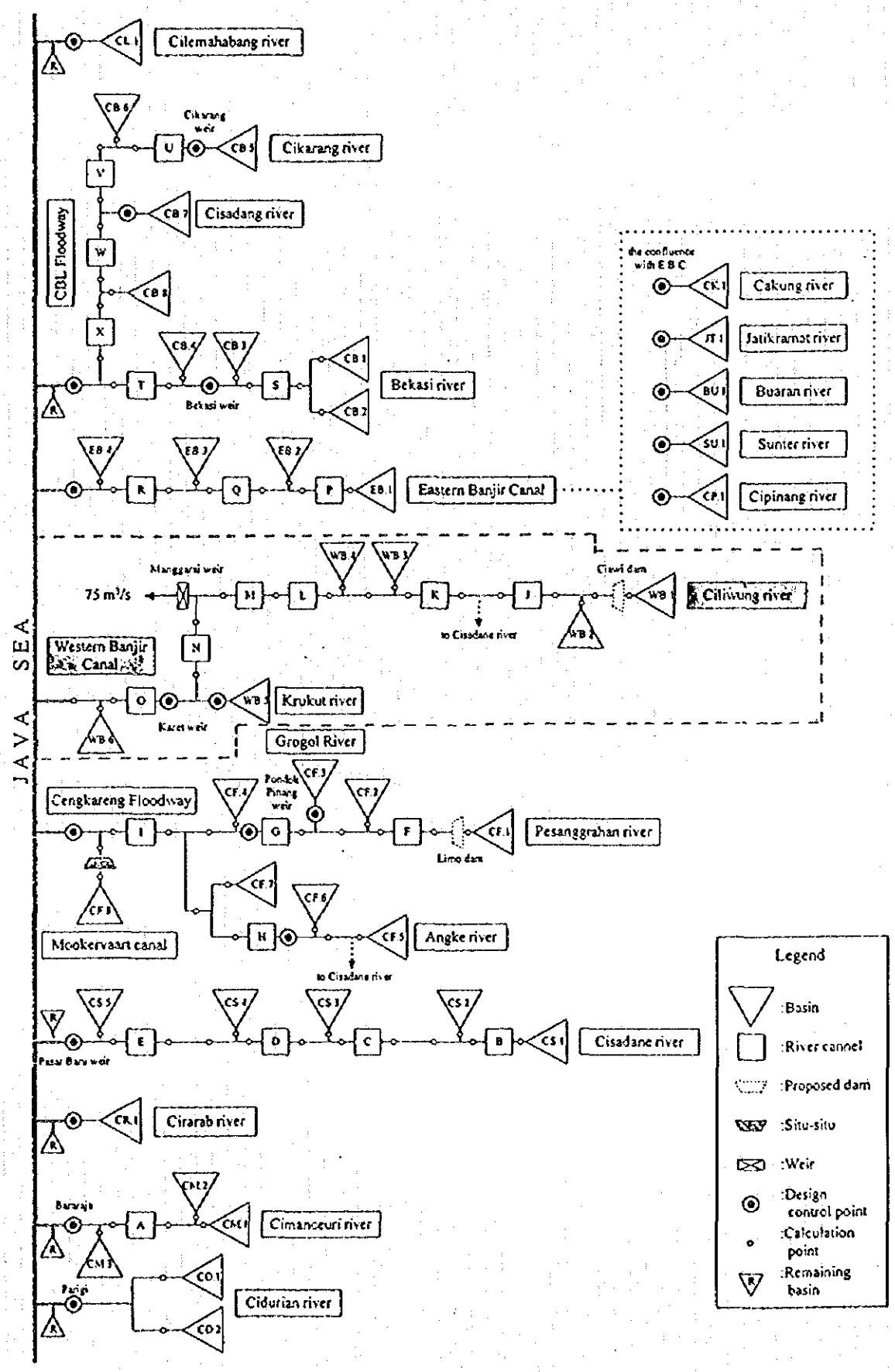


Fig.7 BASIN AND RIVER CHANNEL MODEL

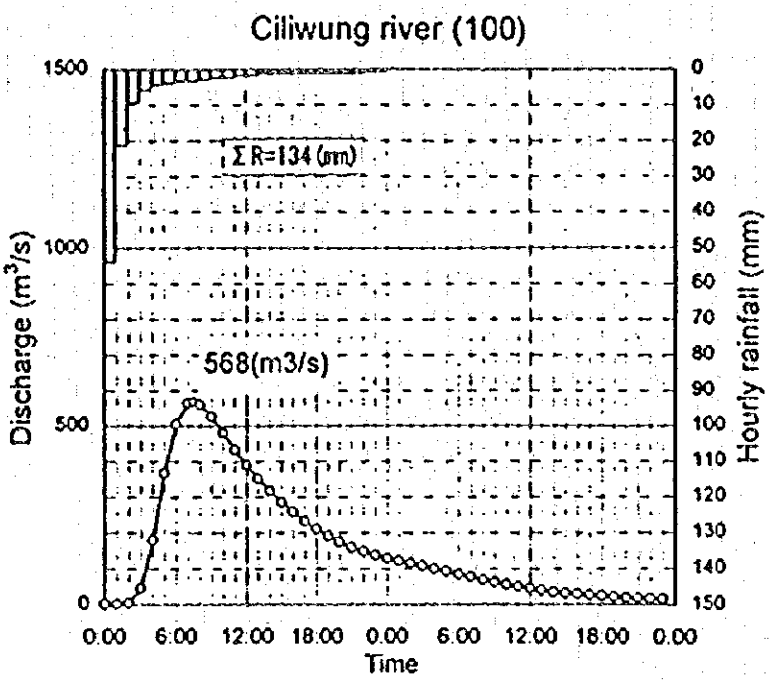


Fig.8 PROBABLE FLOOD RUNOFF OF CILIWUN RIVER

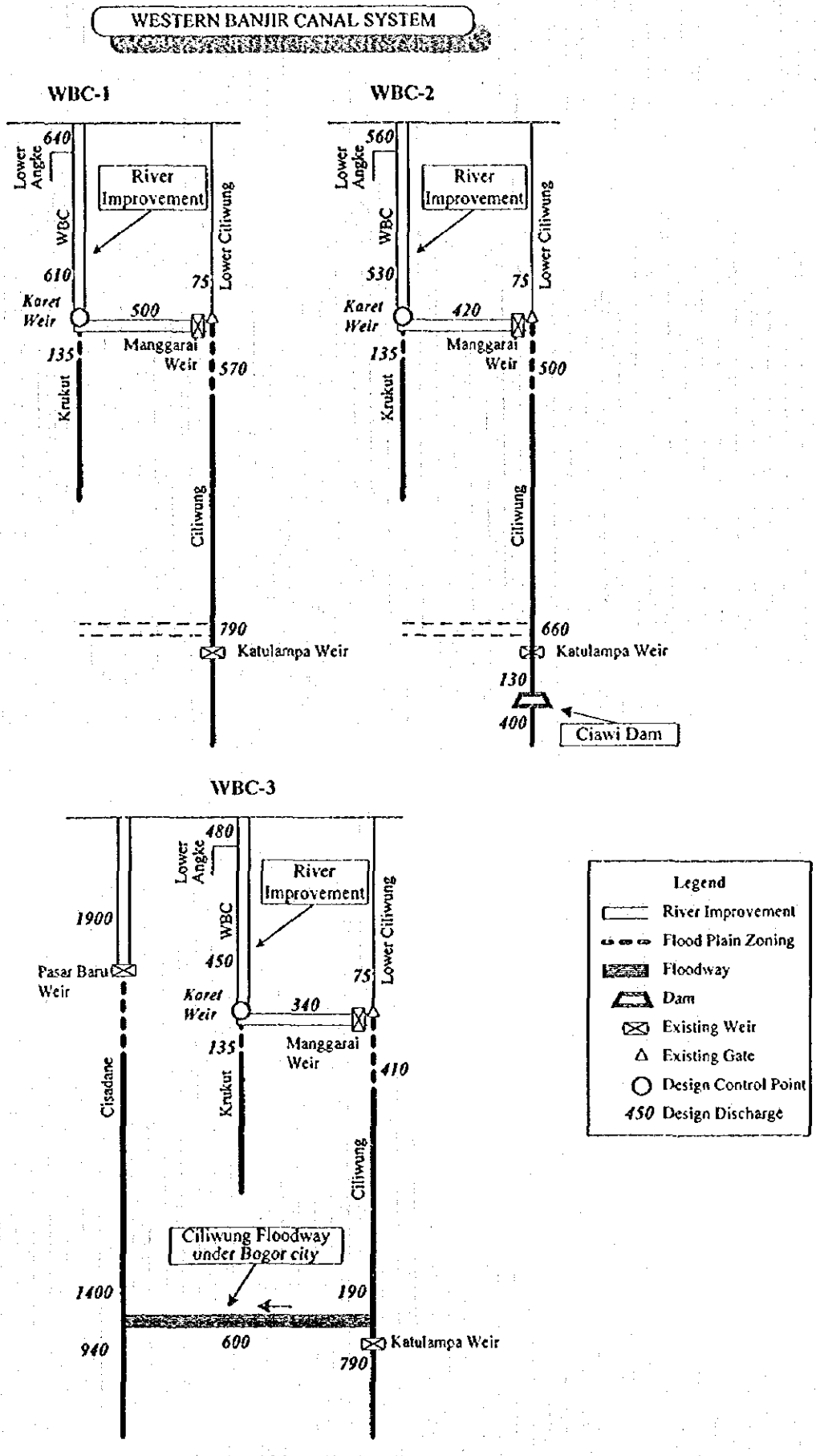


Fig.9 CONCEIVABLE FLOOD CONTROL MEASURES FOR CENGKARENG FLOODWAY SYSTEM

Probable Flood Peak

River system	Design control point	Design scale (year)	Design 1-day rainfall (mm)	Catchment area (km^2)	Peak discharg (m^3/s)	Specific discharg ($m^3/s/km^2$)
Ciduriun river	Iparigi	25	104	596	650	1.09
Cimanceuri river	IBalaraja	25	108	415	290	0.70
Cirarab river	I(Road bridge)	25	121	147	75	0.51
Cisadane river	IPasar Baru Weir	50	108	1.248	1.600	1.28
Cengkareng Floodway system	ICengkareng Weir	100	133	459	620	1.35
Mookervaart Canal	Ithe confience with Cengkareng Floodway	25	132	67	125	1.87
Angke river	Ithe confience with Cengkareng Floodway	100	144	224	290	1.29
Pesanggrahan river	Ithe confience with Cengkareng Floodway	100	152	137	290	2.12
Grogol river	IPondok Pinang Weir	25	144	30	85	2.83
Western Banjir Canal system	IKaret Weir	100	134	421	670	1.59
Ciliwung river	IManggrai Weir	100	134	337	570	1.69
Krukut river	IBefore the confience with W.B.C.	25	129	84	135	1.61
Eastern Banjir Canal System	IAfter the confience with Cikarang river	100	145	207	370	1.79
Cipinang river	IBefore the confience with E.B.C.	25	136	50.5	85	1.68
Sunter river	IBefore the confience with E.B.C.	25	131	73.1	105	1.44
Buaran river	IBefore the confience with E.B.C.	25	158	13.0	50	3.85
Jatikramat river	IBefore the confience with E.B.C.	25	154	16.5	45	2.73
Ckakung river	IBefore the confience with E.B.C.	25	142	34.5	60	1.74
CBL Floodway system	IAfter the confience with Bekasi river	50	112	877	780	0.89
Bekasi river	IBekasi Weir	50	122	389	590	1.52
Cisadang river	IBefore the confience with CBL Floodway	25	122	135	130	0.96
Cikarang river	ICikarang Weir	25	116	216	210	0.97
Cilemahabang river	I(Road bridge)	25	124	121	55	0.45

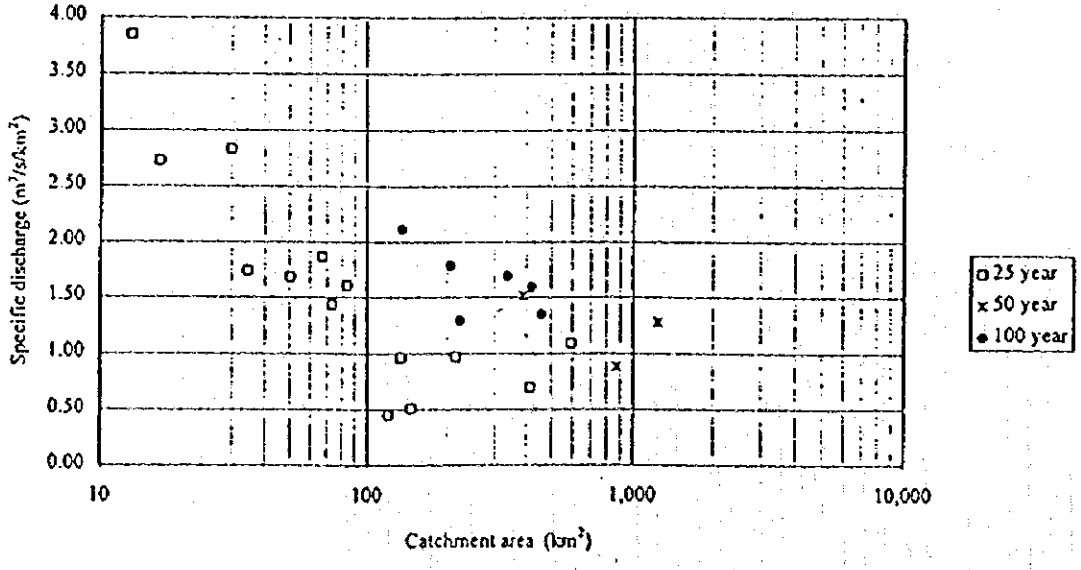


Fig.10 PROBABLE FLOOD PEAK

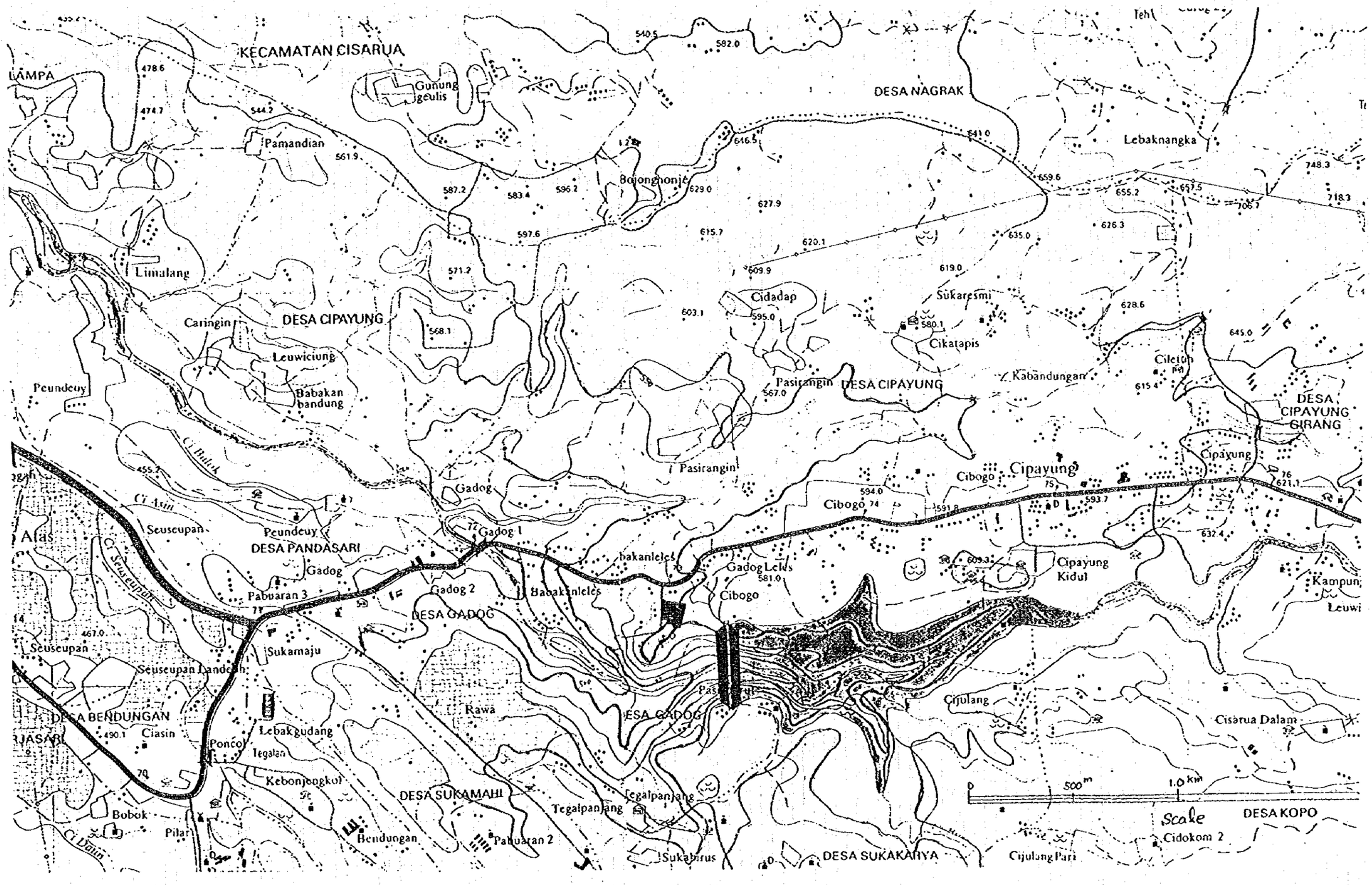
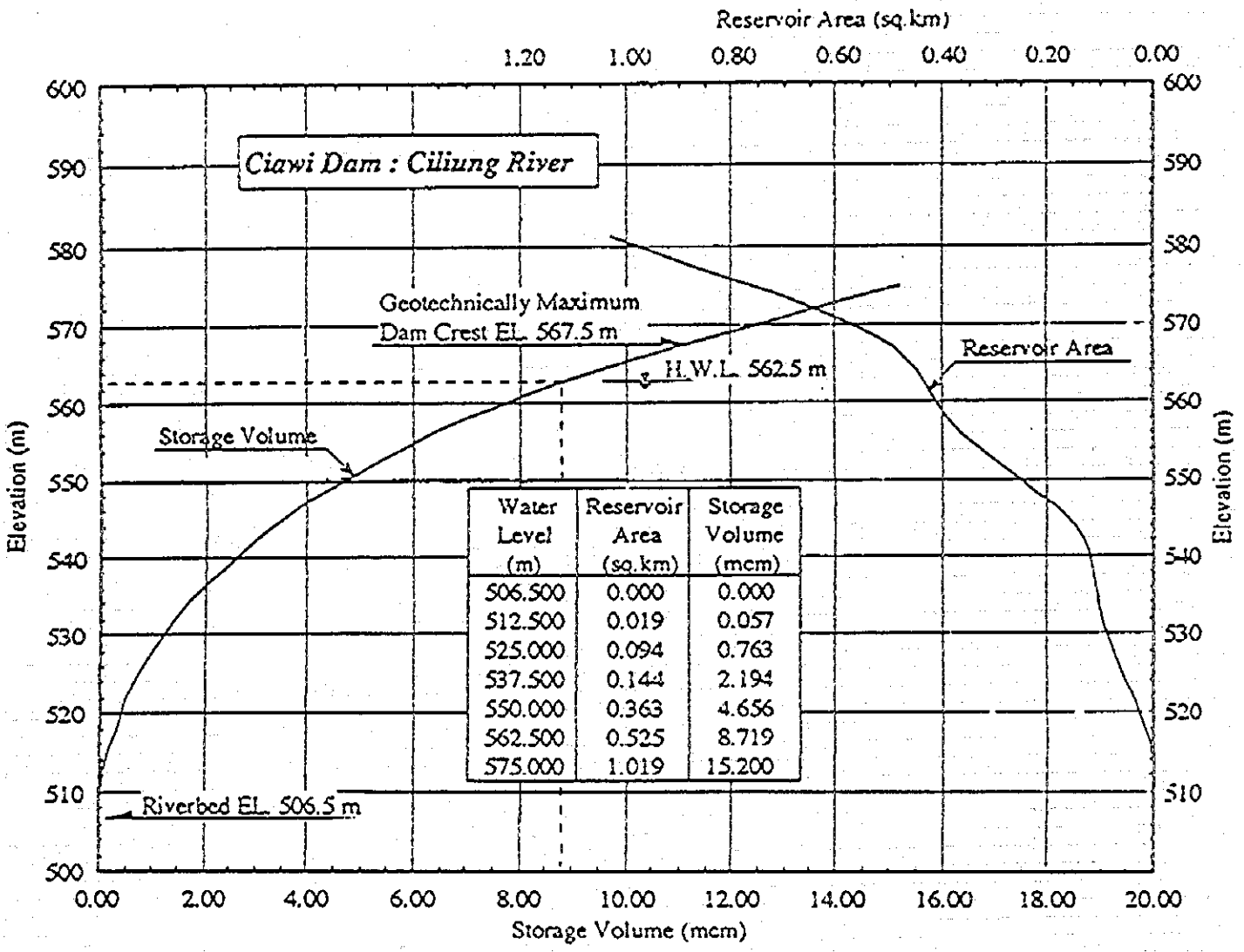


Fig.11 CIAWI DAM SITE AND RESERVOIR AREA



Water Level (m)	Reservoir Area (sq.km)	Storage Volume (mcm)
506.500	0.000	0.000
512.500	0.019	0.057
525.000	0.094	0.763
537.500	0.144	2.194
550.000	0.363	4.656
562.500	0.525	8.719
575.000	1.019	15.200

Fig.12 RESERVOIR WATERLEVEL - AREA - STORAGE VOLUME CURVE