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 III

MAIN REPORT-FEASIBILITY STUDY

MARCH 1997

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

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FINAL REPORT

The Final Report consists of the following:

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
¥ 1.00 = Rp.22.70

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a master plan and feasibility study on Comprehensive River Water Management in JABOTABEK and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Toshikatsu Imai of NIKKEN Consultants, Inc. and composed of members from NIKKEN Consultants, Inc. and Nippon Koei Co., Ltd., three times between July 1995 and March 1997.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

March 1997

Kimio Fujita
President
Japan International Cooperation Agency

March 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the master plan and feasibility report on the Study on Comprehensive River Water Management Plan in JABOTABEK in the Republic of Indonesia. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of flood control master plan and urgent flood control project. Also included are comments made by the Ministry of Public Works of the Government of Indonesia during technical discussions on the draft report which were held in Jakarta.

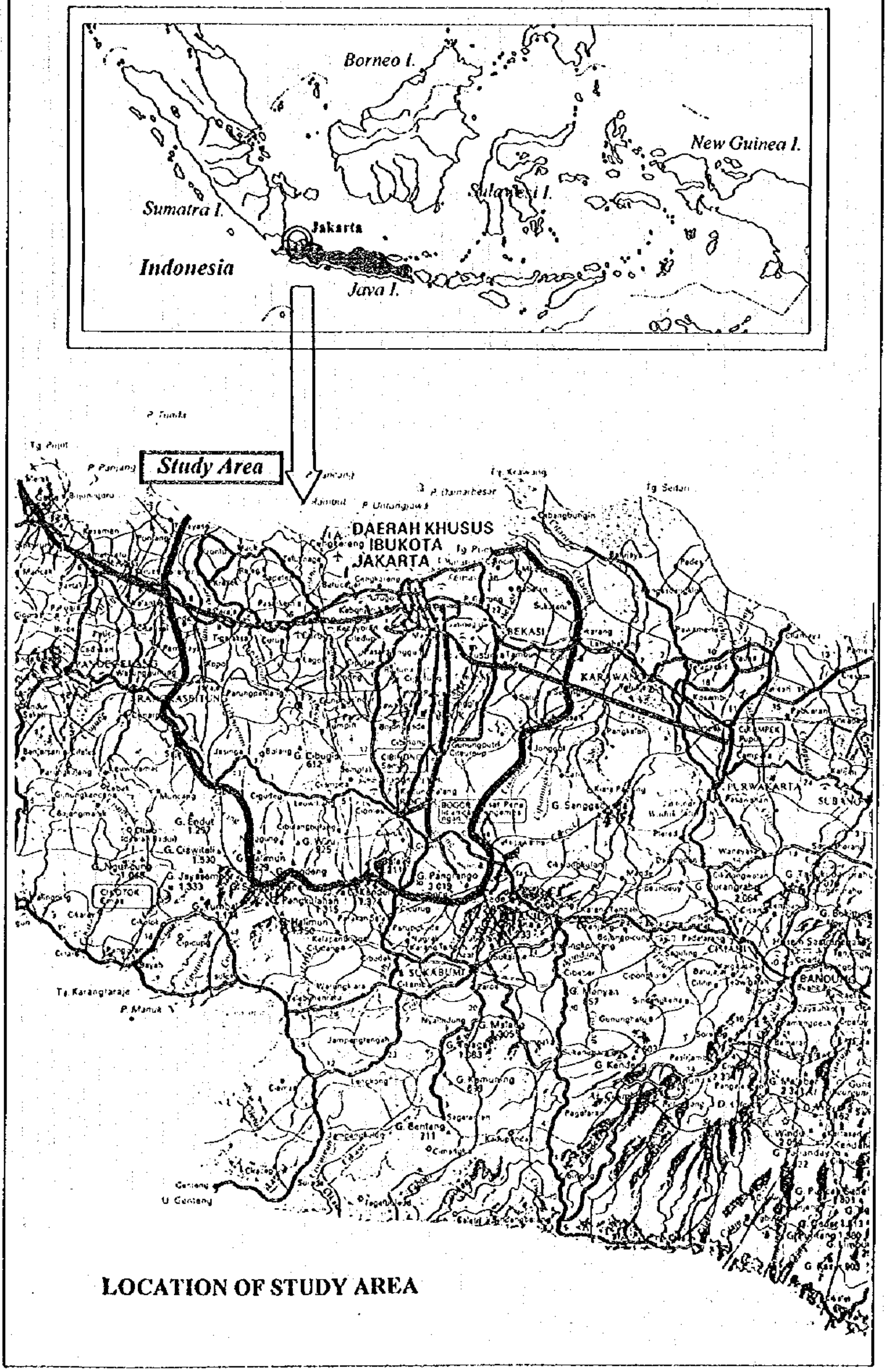
This report presents a scheme of flood control in the basins of the river systems of the Western Banjir Canal and the Cisadane river as the urgent flood control project to mitigate flood damage in DKI Jakarta and the suburbs in Kabupaten Tangerang. The project is proved to be technically viable, economically feasible, socially acceptable, and environmentally sound. After completion of the project, not only the direct damage to properties due to flood, but also indirect damage to political, administrative, economic, and social activities in the metropolis of Indonesia will be greatly decreased.

In view of the urgency of flood control in DKI Jakarta and the suburbs, and the need for socio-economic development of Indonesia as a whole, we recommend that the Government of Indonesia implement this Project as a top priority.

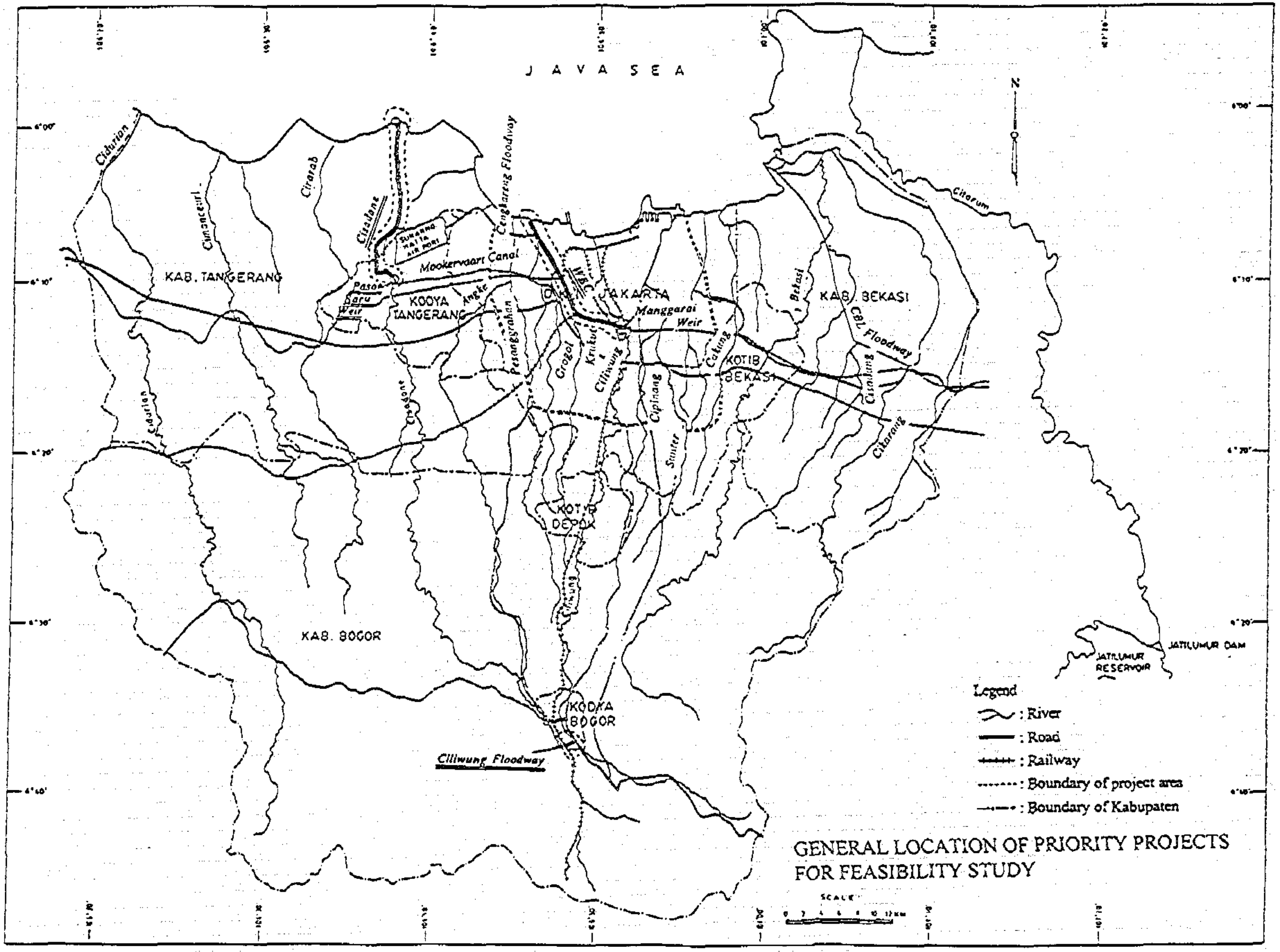
We wish to take this opportunity to express our gratitude to your Agency, the Ministry of Foreign Affairs, and the Ministry of Construction. We also wish to express our deep gratitude to the Ministry of Public Works and other authorities concerned of the Government of Indonesia for the close cooperation and assistance extended to us during our investigations and study.

Very truly yours,

Toshikatsu Imai
Team Leader
The Study on
Comprehensive River Water
Management Plan in JABOTABEK



LOCATION OF STUDY AREA



GENERAL LOCATION OF PRIORITY PROJECTS FOR FEASIBILITY STUDY

THE STUDY
ON
COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN
JABOTABEK

FINAL REPORT
VOLUME III
MAIN REPORT (FEASIBILITY STUDY)

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ABBREVIATIONS

(1) Organization

DPU (Departemen Pekerjaan Umum)	:	Ministry of Public Work
DPUP (Dinas Pekerjaan Umum Propinsi)	:	Provincial Department Office of Public Works
P3SA (Proyek Perancang Pengembangan Sumber-sumber Air)	:	Water Resources Development Planing Project Division
Cipta Karya	:	Directorate General of Housing, Building Planing and Urban Development
DGWRD	:	Directorate General of Water Resources Development
POJ (Perusahaan Umum Otorita Jatiluhur)	:	Jatiluhur Authority Public Corporation
DPMA (Direktorat Penyelidikan Masalah Air)	:	Directorate of Hydraulic Engineering
DEG	:	Directorate of Environmental Geology
DKI Jakarta (Daerah Khusus Ibukota Jakarta)	:	Jakarta Municipal City of Capital = Jakarta Jakarta Municipality
PDAM (Perusahaan Umum Daerah Air Minum)	:	Regional Water Supply Public Corporation
JATS	:	JABOTABEK Advisory Team Services
JICA	:	Japan International Corporation Agency
JMDP	:	JABOTABEK Metropolitan Development Plan
JMDPR	:	JABOTABEK Metropolitan Development Plan Review
JWRMS	:	JABOTABEK Water Resources Management Study
BAPPENAS (Badan Perencanaan Pembangunan Nasional)	:	National Development Planning Agency
BAPPEDA	:	Regional Development Planning Agency
BPS (Biro Pusat Statistik)	:	Central Bureau of Statistics
DBPP (Directorat Bina Program Perencanaan)	:	Directorate of Planning and Programming
PMG (Pusat Metereologi dan Geofisika)	:	Metereological and Geographical Center
PT, or P.T (Perusahaan Terbatas)	:	Co. Limited (private firms)
PPWSCC (Proyek Pengembangan Wilayah Sungai Ciliwung-Cisadane)	:	Ciliwung-Cisadane River Basin Development Project Office

(2) Regional Administration

Propinsi	:	Province
Kab. (Kabupaten)	:	Regency
Kec. (Kecamatan)	:	Subdistrict
Kota	:	City
Kotip (Kota Administratip)	:	Administrative city (Semi municipal city)

Kodya (Kotamadya)	: Municipal city
Desa	: Village
Kp. (Kampung)	: Village (sometimes, smaller administrative community under "Desa" in West Java province)
Kelurahan	: Village, but belongs to "Kota"
Rw. (Rukun Warga)	: Small community belongs to "Kampung"
Rt. (Rukun Tetangga)	: Smallest community belongs to "Rukun Warga"

(3) Place Name or Geographical Name

G. or Gn.(Gunung)	: Mountain (or Mount.)
Pr. (Perkebunan Rakyat)	: Private Plantation (small scale holder plantation)
PTP (Perusahaan Terbatas Perkebunan)	: State owned plantation
Ci- (originated from "Cai = water")	: River
KCC	: Kopo-Cikande-Carenang Irrigation System
TJC	: Tarum Jaya Canal
WBC	: Western Banjir Canal
EBC	: Eastern Banjir Canal
CBL Floodway	: Cikarang-Bekasi-Laut Floodway
WTC	: West Tarum Canal

ABBREVIATIONS OF MEASUREMENT

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
ft	=	foot
yd	=	yard

Area

cm^2	=	square centimeter
m^2	=	square meter
ha	=	hectare
km^2	=	square kilometer

Volume

10^6	=	million
cm^3	=	cubic centimeter
l	=	litre
kl	=	kilolitre
m^3	=	cubic meter
gal	=	gallon

Weight

Gwh	=	Gigawatthour
mg	=	milligramk
g	=	gram
kg	=	kilogram
ton	=	metric ton
lb.	=	pound

Time

s	=	second
min	=	minute
h	=	hour
d	=	day
y	=	year

Electrical Measurement

V	=	Volt
A	=	Ampere
hz	=	Hertz (cycle)
Ghz	=	Gigahertz
W	=	Watt
kW	=	kilowatt
MW	=	Megawatt
GW	=	Gigawatt
pr	=	pair

Other Measures

%	=	percent
PS	=	horsepower
o	=	degree
‘	=	minute
“	=	second
10^3	=	thousand
10^9	=	billion

Derived Measures

m^3/s	=	cubic meter per second
cusec	=	cubic feet per second
mgd	=	million gallon per day
kWh	=	Kilowatthour
Mwh	=	Megawatthour
Wh/y	=	Killowatthour per year
kVA	=	kilovolt ampere
BTU	=	British Thermal Unit
psi	=	pound per square inch
lcd	=	litre per capita per day
Kb/s	=	Kilobot/second
Mb/s	=	Megabit/second

Currency

US$	=	US Dollar
Rp	=	Indonesia Rupia

1 INTRODUCTION

1.1 Introduction

In the master plan study on comprehensive river water management plan in JABOTABEK, flood control master plan for the eight river systems in JABOTABEK have been proposed. Among the flood control master plans, the flood control master plan for the Western Banjir Canal and the Cisadane river has been selected as the priority projects from the financial, economical, technical, social and environmental view points.

The present report (MAIN REPORT - Volume II, Feasibility Study) compiles the feasibility study results of the priority projects.

1.2 Objectives of Priority Projects

The priority projects aim at flood damage mitigation in the western part of DKI Jakarta. In order that, The Western Banjir Canal is to be improved to increase the carrying capacity. But since the Western Banjir Canal is located in the densely populated area of DKI Jakarta, the widening of the river is very difficult from the view point of people's relocation.

Accordingly the river improvement of the Western Banjir Canal is planned in the present right of way to avoid people's relocation problem. But the river improvement of the Western Banjir Canal in the present right of way would not cover the design discharge of 100-year flood. Therefore it is also planned to divert a flood in the upstream basin of the Western Banjir Canal to the Cisadane river. For that purpose, it is planned to construct a floodway from the Ciliwung river to the Cisadane river in Bogor city. The floodway is named as the Ciliwung floodway in this report.

1.3 Scope of Projects

Accordingly the priority projects cover:

1) river improvement of the Western Banjir Canal,
2) river improvement of the Cisadane river,
3) construction of the Ciliwung floodway.

2 BACKGROUND

2.1 Socio-Economy

2.1.1 National Economy

(1) National Development Plan

The Government of Indonesia set a target of an annual economic growth rate of 3.4 % for the agricultural sector, 9.4 % for the industrial sector, 6.0% for other sectors and 6.2 % in total in its sixth National Development Plan (1994-1998). The plan also aims to increase per capita annual income to more than US$ 1,000.

(2) Gross Domestic Products (GDP)

Gross domestic product (GDP) in 1993 was Rp. 302,018 billion (approximately US$ 144 billion) and GDP per capita in 1993 was Rp. 1,609,997 (approximately US$ 770) as shown in Table 2.1. Annual growth rates of GDP since 1989 were high from 6.5 % to 7.2 % on 1983 constant price basis. GDP per capita is also increasing with annual growth rate from 4.7 % to 5.2 % in the same period.

(3) Consumer Price

Movement of the consumer price in DKI Jakarta continued with its upward trend. Average inflation rate during five years from 1990 to 1995 was 9.24 %. This rate is slightly higher than that during 10 years from 1985 to 1995. Especially the price index of housing cost shows higher upward trend than other categories in the latest four years.

Wholesale price index for construction materials shows the same upward trend as that of the consumer price index. However, its average annual increasing ratio in the latest four years is relatively lower than that of the consumer price index.

2.1.2 Regional Socio-Economy

(1) Administrative Unit

The Study Area covers whole area of JABOTABEK which consists of DKI Jakarta, Kabupaten Bogor, Kotamadya Bogor, Kabupaten Tangerang, Kotamadya Tangerang and Kabupaten Bekasi. Left bank of the Cidurian river, that belongs to Kabupaten Serang, is also taken into account for the study on the socio-economy. Administrative boundary of the Study Area is shown in Figure 2.1.

(2) Area and Population

Area and population of the above administrative units are as follows:

District	Area (km^2)	Population in 1990	Population Density ($persons/km^2$)
DKI Jakarta	661	8,227,746	12,447
South Jakarta	145	1,905,283	13,140
East Jakarta	188	2,064,499	10,981
Central Jakarta	48	1,074,997	22,396
West Jakarta	126	1,820,019	14,445
North Jakarta	154	1,362,948	8,850
Kab. Bogor	2,770	3,738,868	1,350
Kodya Bogor	22	271,341	12,334
Kab. Tangerang	1,301	2,764,988	2,125
Kab. Bekasi	1,401	2,104,392	1,502
Kab. Serang	1,781	1,470,838	826

(3) Regional Gross Domestic Products (RGDP)

RGDP in the Study Area in current price in JABOTABEK area is as shown below:

Area	Year	GRDP (Rp. billion)
West Java	1993	46,299
DKI Jakarta	1993	50,999
Kabupaten Bogor	1993	4,814
Kodya Bogor	1993	544
Kabupaten Tangerang	1993	1,980
Kodya Tangerang	1993	2,258
Kabupaten Bekasi	1993	4,359
Kabupaten Serang	1993	4,393

2.1.3 Present Land Use and Future Land Use

The study area is rapidly urbanized. The urbanization of the basin in future is estimated and compared with that at present. The following are the areas of urbanization at present and that estimated in 2025.

District	Present Land Use			Future Land Use		
	Whole Area (km^2)	Urbanized Area (km^2)	Ratio of Urbanized Area (%)	Whole Area (km^2)	Urbanized Area (km^2)	Ratio of Urbanized Area (%)
DKI Jakarta	661	382	58	689	689	100
Tangerang	1,301	148	11	1,301	622	48
Bekasi	1,401	38	3	1,401	639	46
Bogor	2,792	88	3	2,792	805	29

2.2 Hydrology

2.2.1 Floods in 1996

In January and February in 1996, the Ciliwung river basin and the city of Jakarta suffered from serious flood damage. The following are the results of hydrological study on those floods.

(1) Flood in January 1996

(a) Rainfall

At the rainfall gauging station of Citeko located upstream of Bogor city, rainfall amount was 207.9 mm for 18 hours from 22:00 on Jan. 6 to 16:00 on Jan.7. As a point rainfall, this rainfall amount corresponds to about 50 years return period at BMG Jakarta station.

On the other hand, the daily rainfall at BMG Jakarta station was 31.8 mm on Jan. 6 and 99.3 mm on Jan.7. Even if it is assumed that these two days rainfall was within 24 hours, that rainfall amount of 131.1 mm corresponds to about 5 years return period.

In general, it had much rainfall in the area of upstream Ciliwung basin and less rainfall around the Jakarta area of lower Ciliwung basin on 6-7 January.

(b) Water-level

The peak water level at the Katulampa barrage was recorded as 2.5 m above Katulampa barrage crest which gives the discharge of about 730 m^3/s.

The water level at the Depok station in the Ciliwung river rose to 4.35 m on the staff gauge, well above the critical level of 3.5 m. Usually the water level ranges from 1.2 m to 1.5 m during the rainy season from November to March.

Water level hydrograph at several stations in the Ciliwung river and the Western Banjir Canal, and the tide level on 5-8 January are graphically shown in Figure 2.2.

The water level along the Western Banjir Canal was so high especially in the reaches from the Karet barrage to around Grogol bridge that the flood overtopped the dike at about 5 places.

(c) Inundation

The inundation which occurred during January 6th and 7th in Jakarta was caused mainly due to flooding of rivers. In particular the Ciliwung river seriously caused inundation at many places with large scale in the area along the Ciliwung river itself, the Western Banjir Canal and the old Ciliwung.

At the Setiabudi pumping station, control room was also inundated and the pumping facilities were damaged on the east side.

The locations and areas of inundation are shown in Figure 2.3. It is clearly observed that the inundation places were concentrated in the areas related to the Ciliwung river and the Western Banjir Canal. The areas other than the above are in and around the Polder Sunter Barat in North Jakarta as well as the Cipinang/Sunter in North and East Jakarta. The flood also overflowed in the lower Ciliwung river in the reaches downstream of the Manggarai Barrage.

(2) Flood in February 1996

(a) Rainfall

At the rainfall gauging station of Citeko located upstream of Bogor city, rainfall amount was 105.2 mm for 24 hours from 16:00 on Feb.10 to 15:00 on Feb.11. As a point rainfall, this rainfall amount corresponds to about 2 years return period at BMG Jakarta station.

On the other hand, the recorded daily rainfall depth at the BMG Jakarta station was 216 mm which is the daily rainfall depth for about 50-year return period. But when it is considered that this rainfall was during only about 5 hours, this rainfall may corresponds to more than 100 years return period.

In general, it had less rainfall depth in the upper basin and much rainfall depth in the lower basin on 9-10 February 1996.

(b) Water level

The peak water level at the Katulampa barrage was recorded as 1.2 m above Katulampa barrage crest which gives the discharge of about 240 m^3/s.

Water level hydrograph at several stations in the Ciliwung river and the tide level on 9-13 February are graphically shown in Figure 2.2.

The water level along the Western Banjir Canal was also high in the reaches downstream from the Setiabudi Pumping station.

(c) Inundation

Flooding that occurred in the city of Jakarta on 10 and 11 February 1996 was due to the torrential rainfall in the city and also in the catchment area of rivers that flow through Jakarta except the Ciliwung river.

The rain which started at 2:00 am on 10 February 1996 caused overflow in the rivers and canals. Inundation in some areas occurred at 5:00 am and continued to spread throughout the city of Jakarta till the afternoon. The inundation depth was from 30 cm to 150 cm covering an area of approximately 5,000 ha.

The flood overflowed at some places along the Western Banjir Canal but the river flow from the upper Ciliwung river at Manggarai Barrage was relatively small compared with the flood in January 1996. The pumping facilities of Setiabudi pumping station were damaged due to this flood on the west side.

The inundation which occurred over DKI Jakarta area on February 10 have been observed that it is due to various problems of the urban drainage and that the intensity of a daily rainfall on the day exceeded the designed capacity. Most of the habitual inundation area suffered from damage except in the area along the Ciliwung river and old Ciliwung river. According to the survey report prepared by the DPU shows that areas along the Grogol Sekretaris, the Western Banjir Canal, the Cideng river and the Sunter river suffered from rather serious scale of inundation than the habitual ones.

The locations and areas of inundation are shown in Figure 2.4.

(3) Comparison of Flood in January and Flood in February

The rainfall in January flood was much in the upstream basin and less in the downstream basin. But the rainfall in February flood was less in the upstream basin and much in the downstream basin.

Accordingly the peak water levels of the flood in January at the station of Katulampa and Depok were quite high compared with those in the flood in February 1996. The peak discharge of the flood in January at Katulampa barrage was approximately 730 m^3/s on January 6 and that in the February flood was approximately 240 m^3/s on 10 February 1996.

However, the peak water level at the Karet Barrage in the Western Banjir Canal in the February flood was higher than the peak water level in the January flood.

2.2.2 Flow Regime of Ciliwung River

A flow regime of the Ciliwung river is examined to clarify the present flow regime characteristics of the Ciliwung river for the appropriate facility design of proposed Ciliwung Floodway to preserve the present low flow regime characteristics in the downstream reaches.

Accordingly the flow regime of the Ciliwung river is examined on the daily discharge data at the Katulampa barrage station that is located upstream of proposed Ciliwung Floodway site. The available annual daily discharge series from 1980 to 1990 at the Katulampa station are shown in Figure 2.5 in order of magnitude.

The specific discharge such as plenty water discharge, ordinary water discharge and low water discharge are examined, and the average of those discharges from 1980 to 1990 are summarized below;

- Plenty water discharge (discharge of the 95th rank) : 18 m^3/s

- Ordinary water discharge (discharge of the 185th rank) : 13 m^3/s
- Low water discharge (discharge of the 275th rank) : 9 m^3/s

2.2.3 Retarding Effect of Ciliwung Valley Plain

The Ciliwung valley plain lies upstream of the Manggarai barrage and it is about 15 km long along the Ciliwung river. This valley plain is habitual inundation area and that has function of natural retarding basin.

In the M/P study, the retarding function of this valley plain is considered to be kept from the viewpoint of flood control to decrease a flood peak discharge in the urban area of lower reaches. However, inundation problem around this valley plain area will be decreased with a completion of the proposed Ciliwung floodway.

Two cases of flood runoff, to keep the retarding function or to confine the flood water with river improvement, are calculated to clarify the effect of retarding function in this valley plain using the runoff calculation model developed in the M/P study stage.

The result shows that to keep retarding function of the Ciliwung valley plain will decrease the flood peak discharge of 100-year return period by about 50 m^3/s at the Manggarai. This is the effect of the Ciliwung Valley plain in the reaches about 15 km long. The decreasing effect of flood peak of the Ciliwung river channel in the reaches from Depok to Manggarai is not included in this value.

2.3 Priority Projects Sites

2.3.1 Western Banjir Canal

(1) General Situation

The objective reaches of river improvement for the priority projects are the reaches of approximately 17 km from the estuary up to the Manggarai Barrage; the catchment areas at the Manggarai and Karet barrages are 337 km^2 and 421 km^2 respectively.

(2) River

(a) Estuary - Confluence of Angke Drain

The recent biggest change of the WBC river course is the completion of short-cut work at extremely meandering part in Kelurahan Kapuk Muara (0.8 k - 1.1 k) in 1995.

Nature Reserve Muara Angke with mangrove forest is located on the left bank of the WBC near the estuary. The area is now strictly preserved from the environmental aspects. Newly constructed gentle slope embankment with the elevation of about PP 3.5 m (approximately TTG 2.9 m) forms clear boundary between the Nature Reserve and the residential area of Pantai Indah Kapuk.

(b) Confluence of Angke Drain - Karet Barrage

Construction of parapet walls on the embankment has been conducted immediately after the big floods in 1996 by using local budget. The construction work extends from the bridge on Jl. Pangeran Tubagus Angke (5.6 k) southward to the Karet Barrage (12.4 k). The height of the parapet walls ranges from 50 cm to 80 cm.

The high water channel has been utilized mainly as sport grounds and cultivated land. The WBC has relatively wide (around 60 m) and flat high water channel from Aipda K. S. Tubun bridge (11.3 k) up to the Karet Barrage (12.3 k).

From the confluence of the Angke Drain (2.9 k) up to Pangeran Tubagus Angke bridge (5.6 k), many squatters are located without break on high water channel and embankment: the practical flow area is only within the low water channel.

(c) Karet Barrage - Manggarai Barrage

There is almost no embankment on the left bank throughout these reaches: the ground elevation on the left bank is generally higher than that of the right bank.

From the K. H. Mas Mansyur bridge (13.1 k) up to the M. H. Thamrin bridge (13.9 k), the crown of the right embankment is quite wide. High water channel exists only on the right bank in these reaches. Upstream reaches of 15.2 k have no embankment.

From the M. H. Thamrin bridge (13.9 k) up to the Sukabumi bridge (16.0 k), DKI Jakarta has put the right bank in beautiful condition as a riverside park.

(3) Structures

(a) Embankment

The embankment of the WBC exists as follows:

- Confluence of the Angke drain (2.9 k) - Aipda K. S. Tubun bridge (11.3 k) : on both banks
- Aipda K. S. Tubun bridge (11.3 k) - Karet barrage (12.4 k) : on left bank only
- K. H. Mas Mansyur bridge (13.1 k) - Halimun bridge (15.2 k) : on right bank only

(b) Barrage

The Karet barrage has four slide gates and is integrated with a railway bridge. According to PAM Jaya, the main source of raw water at the plant will be the Kali Malang after completion of pipe construction from Cawang to the Pejompongan site.

The Manggarai barrage has two slide gates (Manggarai I gate) and is integrated with a railway bridge and a roadway bridge. It is said that the barrage dammed up the flow by about 3 m in height in January 1996 flood, because the gate is quite narrow.

(c) Bridge

There are 18 roadway bridges and three railway bridges crossing the WBC. Some bridges such as Prof. Dr. Latumeten and Kyai Tapa bridges have extremely low girders hanging down from the river bank. The treatment of these bridges is discussed in Chapter 4.

(4) Present Carrying Capacity

Present carrying capacity of the WBC is estimated by using non-uniform flow formula based on the survey results in 1996. The results are shown in Figure 2.6. The bankfull capacity and the freeboard (minimum 0.8 m) capacity are around 350 m^3/s and 250 m^3/s in average respectively.

In the middle reaches, the carrying capacity has increased by about 70 m^3/s in average from the bankfull capacity by the new parapet wall constructed in 1996.

2.3.2 Cisadane River

(1) General Situation

The objective reaches of the river improvement for the priority projects are the reaches from the estuary to the Pasar Baru barrage (21.3 k); the catchment area at the Pasar Baru barrage is 1,411 km^2. The high water channel is generally covered with rich riverside forest or has been utilized as cultivated land.

(2) River

(a) Condition near the Estuary

There exists a big shoal almost like small island of about 9 ha on the left side of the estuary. In downstream reaches from 2.5 k, the natural levee and the embankment almost disappear and the ground becomes almost flat. Many fish ponds are scattered around the estuary.

(b) Former River Course

There exists a big oxbow lake of the former Cisadane river course with vast water area of around 9 ha on the left bank between 9.2 k and 9.9 k The lake is surrounded by relatively high former embankment of the Cisadane river.

There exists a distinct former river course with a circle shape on the right bank at 13.1 k.

(c) Bed Rock around 17.4 k

Tufaceous bed rock with gravel is exposed on the river bed from 17.4 k to 18.0 k. The bed slope forms stepwise shape in the reaches.

(3) **Structure**

The embanked reaches of the Cisadane river are located from 2.9 k up to 17 k from the estuary.

Pasar Baru barrage is located at the upper end of the objective reaches of the Master Plan (21.3 k). Kali Baru bridge at 6.4 k is the only bridge crossing the Cisadane river.

(4) **Present Carrying Capacity**

Present carrying capacity of the Cisadane river is estimated by using non-uniform flow formula based on the survey results in 1996. The results are roughly summarized as follows (refer to Figure 2.7).

Reaches	Bankfull (m^3/s)	1.0 m freeboard (m^3/s)
0.0 k - 3.5 k	600	200
3.5 k - 12.7 k	1,500	1,200
12.7 k -	1,800	1,500

2.3.3 Ciliwung Floodway

(1) **Location**

The proposed site of the Ciliwung Floodway is located in the hilly area with gentle slope in Kecamatan Bogor Selatan between the Ciliwung river and the Cisadane river as shown in Figure 2.8.

The floodway inlet site is proposed on the left bank of the Ciliwung river of which location is at just downstream of the bridge of the national highway going to Bandung. The left bank side is of crowded residential area which is very close to the river course. Residential complex of middle scale has been extended on the right bank of the Ciliwung river.

The outlet facilities will be located on the right bank of the Cisadane river. Rather crowded residential area have been extended on the slope of hilly area on the right bank, but not very close to the river course. The present river bed elevation of the Cisadane river near the outlet is approximately 256 m. On the right bank of the Cisadane river, the railway is running along the river course.

The floodway route is in the hilly area of the elevation of 275 m to 300 m, mostly under the crowded residential and commercial area. In the midway of the route, a creek and a canal form some shallow gorges flowing from south to north.

(2) River Condition

The catchment areas of the Ciliwung river at the proposed inlet site and the Cisadane river at the proposed outlet site are 152 km^2 and 205 km^2, respectively. The distance between the both rivers becomes shortest of approximately 1,000 m, near the project site. Towards the upstream and downstream, the distance between the both rivers increases.

The average gradient of the rivers is roughly from 1/50 to 1/75. At many portions along the rivers, bedrock is exposed on the river bed; many nick points have been formed reflecting the difference of geological condition along the river course. The bed material consists of cobbles and boulders; some boulders are estimated to be washed out from river bank nearby, which originated in past pyroclastic flows.

The both rivers have formed extremely deeply dissected valley and the city area of Bogor is located on high terrace. The Cisadane river forms bigger and deeper valley than that of the Ciliwung river everywhere around the project site.

2.4 Topographic Survey

2.4.1 River Survey

The objective rivers are the Western Banjir Canal in the whole reaches, the Cisadane River in the reaches downstream of Pasar Baru Barrage, and the Ciliwung and Cisadane Rivers in the reaches near the inlet and outlet facilities of the Ciliwung Floodway. The total number of the survey is 161 cross sections. The objective reaches are shown in Figure 2.9.

2.4.2 Topographic Mapping

The objective river is the Cisadane River in the reaches downstream of Pasar Baru Barrage to the estuary. The objective area of 25 km^2 is shown in Figure 2.9.

2.4.3 Topographic Survey

The objective area is the area along the proposed Ciliwung Floodway route and the Ciliwung and Cisadane rivers in the reaches near the inlet and outlet facilities of the Floodway. The objective area of 0.25 km^2 is shown in Figure 2.9.

2.4.4 Sounding Survey

The objective offshore are 2 km of the Western Banjir Canal and 1 km of the Cisadane river. The objective area of 1.7 km^2 is shown in Figure 2.9.

2.5 Geotechnical Investigation

2.5.1 Introduction

Geotechnical investigation has been carried out in the priority project area of the Ciliwung Floodway, the Western Banjir Canal (WBC) and the downstream reaches of the Cisadane river. The main objectives of the investigation are to obtain the following information:

1) Geological conditions along the WBC and around the downstream reaches of the Cisadane river for the river improvement works,
2) Geological conditions along the Ciliwung Floodway route in Bogor, and
3) Geotechnical feature of foundations, cut slopes and tunnel.

2.5.2 Geology

(1) General Geology

The geology in the Study Area is composed of alluvium of the Holocene age (mainly in the lowland plain), terrace deposits of the Pleistocene age (mainly alluvial fan in the Bogor zone and the lowland plain), tufaceous sedimentary rocks of the Pliocene to Miocene age (mainly in the Bogor zone) and southern volcanoes of the Miocene age.

The geological map and the local stratigraphy in and around the study area are given in Figures 2.10 and 2.11, respectively.

(2) Geology in the Project Area

(a) Downstream Reaches of the Cisadane River

Most of the subsurface layers in this area belongs to Alluvial. This deposit unit is actually a mixture of valley deposit, river deposit and beach deposit, and mainly consists of clay, silt, sand, gravel, pebble and boulder containing organic material, or shell fragments at the local part. Further this unit can be considered as very soft to soft soil (applicable to clay / silt) and very loose to loose soil (applicable to sound).

(b) Western Banjir Canal Alignment

Alluvial (downstream reaches from Grogol) and Alluvial Fan (Grogol to Manggarai) are the majority to subsurface layers. Alluvial Fan deposit is the result of weathering and redepositing of Quaternary volcanic products and mainly composed of bedded tuff and conglometatic tuff and those are interbedded with sandy tuff and pumice tuff in some places.

(c) Ciliwung Floodway Route

The Ciliwung Floodway is located between the Ciliwung river and the Cisadane river in the hilly area of Bogor. The geology of the floodway route is mainly 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, andestic basalt with oligoclase-andesine, labradorite, olivine, pyroxene, and hornblende etc., mostly highly weathered and poorly cemented.

2.5.3 Geotechnical Investigation for Ciliwung Floodway

(1) Field Investigation and Laboratory Test

Locations of the core drillings and the geological profiles are shown in Figures 2.12 and 2.13, respectively.

(2) Geotechnical Consideration for Floodway Construction

In view of the topographic conditions, the tunnel will be encountered to the tufaceous sandy silt layers and tuff breccia. As aforementioned, the both layers are poorly consolidated and loosely cemented, and includes boulders in places.

N-values by SPT ranges 38 to more than 50 m in the upper layer and more than 50 all over in the lower layer.

The elasticity coefficient (Young's modulus) obtained by the borehole lateral load test (LLT) has a wide range from 150 to more than 10,000 kg/cm^2 probably due to the degree of the cementation as well as the components of rocks.

The groundwater level were observed at a depth of 1.0 to 3.0 m in the boreholes of FLD-1, FLD-2, FLD-3, FLD-5 and FLD-7 and 10.0 to 15.0 m in boreholes of FLD-4 and FLD-6. In addition, the artesian water (confined water) with 0.9 and 2.0 m in a height of water pressure from the ground surface appears to come out at a depth of 15 and 20 m of the boreholes of FLD-5 and FLD-7, discharge of which are about 1.0 and 5.0 l/sec, respectively.

Judging from the poorly consolidated condition and the physical properties of the layers such as unconfined compressive strength and elasticity modulus, careful and adequate studies shall be made for tunnel construction in the Younger Volcanic Rocks unit considering the relatively thin overburden and a lot of the groundwater/artesian water.

The cut slopes of the open channels including tunnel inlet and outlet are to be composed of three different layers, namely overburden layers, tufaceous sandy silt and tuff breccia. According to the geotechnical investigation and field reconnaissance, especially from the observation results of the bluff along the Ciliwung river, these layers in normal cut slope is strong enough. No special attention except slope protection against erosion for cut slope is necessary to stabilize the slopes and to reduce maintenance works.

Moderately consolidated rock of tuff breccia is expected to exist under 30 m in depth from the ground surface of the borehole FLD-1 where the control weir is to be designed. In the aforementioned tuff breccia, N-values exceed 50 and permeability coefficient is an order of 10^{-4} cm/sec except about 5 m in depth of surface zone. Tuff breccia core samples were collected from the borehole FLD-1. The confined compressive strength ranges from 23 to 478 kg/cm^2 widely due to the degree of consolidation. These values indicate a rather soft rock condition. Consequently, it is recommended that the surface weathered tuff breccia, about 5 m in depth, are to be removed from the foundation of the weir to improve the bearing capacity and the impervious condition.

2.5.4 Geotechnical Investigation for River Improvement Works

(1) Field Investigation and Laboratory Test

Locations of field work (core drilling) and geological profiles are shown in Figures 2.14 and 2.15, respectively.

(2) Geotechnical Evaluation

The general geological conditions and geological profiles can be seen in Figure 2.15 and categorized in two (2) parts of geological units, namely Holocene (Alluvial) unit and Pleistocene (Alluvial Fan) unit.

(a) Holocene (Alluvial) unit

This deposit is actually mixed of valley deposit, river deposit and beach deposit and mainly consists of clay, silt and some sand and containing organic material or shell fragment at the local part. The downstream reaches of the WBC between the boreholes of WBC-1 and WBC-7 and CSD-1 area of the Cisadane river are dominantly covered by this deposit with a depth of 10 to 15 m. This deposit can be considered as the very soft soil (applicable to clay/silt) and the very loose soil (applicable to sand) with N-values of less than 10 and mostly a range from 1 to 3, and with brownish gray or gray (dark/light) colors.

(b) Pleistocene (Alluvial Fan) unit

This deposit is the result of weathering and redepositing process of Quaternary volcanic products and consists of mainly clay, silt, sand and gravel. This deposit is widely distributed; underlying the Alluvial unit in the downstream reaches of the Cisadane river as well as along WBC as the superficial layers between Grogol and Manggarai with a depth of 10 to 20 m.

N-values of this deposit ranges from 2 to more than 50 due to the degree of the consistency, firm to very stiff or loose to dense and unconsolidated to consolidated (tufaceous). The permeability coefficient ranges from an order of 10^{-5} to 10^{-7} cm/sec, impervious condition in general except the intercalated thin sand layers which is an order of 10^{-4} cm/sec.

Note : details of geological investigation are compiled in the volume of reference data other than the component of the final report.

2.6 Environment

2.6.1 Physical and Chemical Environment

(1) Surface River Quality

- Western Banjir Canal

According to the Decree of the Government of DKI Jakarta, the Western Banjir Canal is included in a part of the Angke river basin which is classified in class B; water shall be suitable as raw water for drinking water. While the Angke river itself is classified in class D; water is suitable for agricultural, commercial, and industrial uses and hydropower generation. The Western Banjir Canal is running through Jakarta with high pollution density, and comparing the result of the water quality analysis of samples taken from the Western Banjir Canal with the standard in DKI Jakarta, it is judged that the present water quality of the Western Banjir Canal is characterized by chemical pollutants caused by domestic and commercial waste water.

- Ciliwung Floodway

According to the Decree of the Government of West Java province, the Cisadane river and the Ciliwung river are classified in class B. Comparing the result of the water quality analysis for samples taken from the Ciliwung and Cisadane rivers with the standard in West Java province, the present water quality is judged to be affected by heavy metals pollutants such as Lead, Cadmium and Hexavalent Chromium.

- Downstream reaches of the Cisadane river (from the Pasar Baru Barrage to the estuary)

Based on the Decree of the Government of West Java province, downstream reaches of the Cisadane river is classified in class C and D. Comparing the result of the water quality analysis for samples taken from the Cisadane river with the standard in West Java province, the present water quality is judged to be affected by chemical pollutants caused by domestic and commercial waste water.

(2) Ground Water Conditions

In the residential areas where the Ciliwung Floodway would be constructed, the shallow groundwater is being utilized as the main water source for domestic water supply. There are about sixty (60) wells of which the depth are ranged form 1.0 m to 18.0 m.

2.6.2 Biological Environment

(1) Flora

According to the field survey for flora, there are small mangrove forests in the estuaries of the Western Banjir Canal and the Cisadane river . However, these mangrove forests have been affected by various problems such as coastal erosion, soil erosion, exhaustion of mangrove forest resources and aqua resources. In particular, around of the estuary of the Cisadane, the mangrove forests have been decreased due to the land use conversion from mangrove forests to fish ponds.

Therefore the density of mangrove have been reduced band types of remaining mangrove are limited, and dominant types are pioneer ones such as *Avicenia marina* and *Rhizophora mucronata*.

(2) Fauna

Some species of birds and reptiles to be protected have been identified through the field survey in and around estuaries of the Western Banjir Canal and the Cisadane river. Remaining mangrove forests in estuaries of these rivers can be considered as a comfortable habitat of water birds.

2.6.3 Socio-economic Environment

(1) Public Facilities

There are many road bridges, railway bridges and pedestrian bridged in the priority project area. Those facilities are considered to be important for not only transportation system but also social communication. Number of crossing locations identified in the project area are as follows:

- Western Banjir Canal : 20 places
- Cisadane River : 2 places
- Ciliwung River : 2 places

(2) Traffic Density

In Jakarta city, traffic jam caused by high traffic density is a common phenomena. According to the field survey, high traffic density occurs during working hours which is between 7:00 a.m. and 15:00 p.m., moreover the largest traffic density per hour at Sultan Agung road, which runs parallel to the left bank of the Western Banjir Canal, recorded more than 5,000 vehicles pre hour.

(3) Public Health

(a) Pattern of Diseases

- DKI Jakarta

According to the LBI report in 1994, the pattern of diseases in Jakarta city is dominated by respiratory tract infection and skin infection, in particular about 40 % of non-hospitalized patients suffer from respiratory tract infection caused by air pollution. While based on the data of hospitalized patients of the Ministry of Health, it is found that intestinal infection, obstetric complication and abortion are dominant diseases.

- Bogor

According to the report of SP3/Mulkes Section of the Health Office of Bogor, the pattern of diseases in Bogor is dominated by respiratory tract infection, diarrhea, gastric disorder, dysentery and anemia.

- *Tangerang*

According to the LBI report in 1994, the pattern of diseases in Tangerang is dominated be respiratory tract infection and skin infection. Most of non-hospitalized patients suffer from respiratory tract infection.

(b) Water Source

The main water source for DKI Jakarta, Kodya Tangerang are municipal water which have been supplied by the PAM Jaya or PDAM system, and the shallow and deep groundwater. However, in the lower reaches of the Cisadane river, the surface river water is utilized as the main water source for domestic water supply.

The main water source for residential areas around the Ciliwung Floodway site have been supplied be using groundwater of shallow and deep wells with a depth of 1 - 18 m. While in the hilly area in Kecamatan Bogor Selatan between the Ciliwung river and the Cisadane river, the main water source is municipal water.

2.7 On-going Flood Control Plans

In order to cope with the serious damage caused by the big floods in January and February 1996, the Government of Indonesia has promoted the program to execute urgent and short-term flood control works. These flood control programs will be executed in line with this present Study.

The work items related to the present Study are listed below:

1) Channel excavation of the Western Banjir Canal : 8 km
2) Embankment improvement of the Western Banjir Canal : 18 km
3) Drainage improvement of the Ciliwung Drain (Manggarai Barrage-Kapitol):8.4km
4) Rehabilitation of slide gates of the Pasar Baru Barrage on the Cisadane river : 7 units

2.8 Review of Design Discharge Distribution

2.8.1 The Western Banjir Canal

Design discharge distribution of the Western Banjir Canal is proposed based on the design discharge distribution between the Ciliwung river and the Ciliwung drain (old Ciliwung river) as shown in Figure 2.16. The design discharge distribution from the Ciliwung river to the Ciliwung drain was once determined to be 75 m^3/s in the master plan formulated in 1973.

This design discharge distribution to the Ciliwung drain was once succeeded in the present study on the flood control master plan in JABOTABEK.

But in consideration of the surrounding situation of the Ciliwung drain, review of this design discharge to the Ciliwung drain has been conducted aiming at decreasing the discharge to the Ciliwung drain.

Decreasing the design discharge to the Ciliwung drain directly leads to the increase of design discharge to the Western Banjir Canal. But since the Western Banjir Canal is located in the very densely populated area of DKI Jakarta, widening of the river for increasing the carrying capacity of the river should be avoided as much as possible. The river improvement of the Western Banjir Canal should be planned in the present right of way in principle.

In consideration of the above, the review of design discharge distribution of the Ciliwung drain has been conducted. The conclusion is that the design discharge distribution of the Ciliwung drain from the Ciliwung river can be decreased from 75 m^3/s to 50 m^3/s. On this condition, new design discharge distribution of the Western Banjir Canal is calculated and is shown in Figure 2.16.

2.8.2 The Cisadane River

In the flood control master plan of the Cisadane river, the design discharge of the Cisadane river in the downstream reaches is proposed to be 1900 m^3/s. This is calculated based on the concept that the flood diversion (600 m^3/s, return period of 100 years) from the Ciliwung river to the Cisadane river and flood diversion (115 m^3/s, return period of 50 years) from the Angke river to the Cisadane river occur simultaneously with the flood occurrence in the Cisadane river with the return period of 50 years. (Refer to Figure 2.17)

The occurrence probability of this situation might be very small. If the probability could be estimated to be very small, the design discharge distribution of the Cisadane river may be decreased to certain extent. But the shortage of available data on rainfall in the basin would not allow the hydrological analysis on the occurrence probability of this situation.

After discussion on this issue with authorities concerned, it is concluded that this design discharge of 1,900 m^3/s should be adopted in order to ensure the maximum safety level of the Cisadane river against the artificial flood diversion from the Ciliwung and the Angke floodways.

2.9 Channel Conditions for Reclamation

2.9.1 Introduction

Sea coast reclamation plans are now underway. One is a reclamation plan along the sea coast of DKI Jakarta, so called PANTURA DKI Jakarta. The other is a reclamation plan along the sea coast of the western part of DKI Jakarta and some part of the West Java Province, so called KAPUKNAGA. The objective reach is tentatively from around the estuary of the Western Banjir Canal to around the estuary of the Cirarab river. The reclamation width towards the sea will be 2.5 km in average.

Here study results are presented on the conditions of the channels to be prepared in the reclaimed area as the continuation of the Western Banjir Canal, the Cengkareng Floodway, and the Cisadane river, so that they would not cause any raise of the design high water level in the flood control master plan in JABOTABEK.

The channel conditions in the master plan presented hereunder are those reviewed ones in this feasibility study stage. (Refer to chapter 4)

2.9.2 The Cisadane River

Though the mangrove forest around the estuary of the Cisadane river will be kept as it is now by the plan, the necessary conditions of the channel as the extension of the Cisadane river to be prepared in the reclamation area are discussed here.

(1) Basic Features of the Cisadane River at the Estuary in the Master Plan

Since the Cisadane river is planned to be improved in the reaches starting from the point 1.8 km upstream from the present estuary, the following channel conditions of the Cisadane river at that starting point in the Master Plan are taken into consideration:

1)	Design Scale	: 50-year return period
2)	Design Discharge	: 1900m^3/s
3)	High water level	: 3.71 m
4)	River-bed elevation	: -4.93 m
5)	Width of low-water channel	: 94 m

(2) Basic Assumptions of the Channel in the Reclaimed Area

Channel conditions in the reclaimed area are studied by using non-uniform formula on the following assumptions:

1) The channel-bed elevation would be maintained as high as the design river-bed elevation at the downstream end of the master plan.
2) The width of low water channel should gradually increase towards the new estuary.
3) The width of high water channel should be the same as that at the downstream end of the master plan.

(3) Result of Calculation

The channel in the reclaimed area as the extension of the Cisadane river, should have the width of low water channel of at least 248 m at the new estuary against the width of 192 m in the master plan to avoid the raise of design high water level in the master plan.

2.9.3 The Cengkareng Floodway

(1) Basic Features of the Cengkareng Floodway at the Estuary in the Master Plan

The following channel conditions of the Cengkareng Floodway at the estuary in the Master Plan are taken into consideration:

1) Design Scale : 100-year return period
2) Design Discharge : $510 m^3/s$
3) High water level : 1.20 m
4) River-bed elevation : -4.55 m
5) Width of low-water channel : 57 m

(2) Basic Assumptions of the Channel in the Reclaimed Area

The same assumptions with those of the case of the Cisadane river are utilized here.

(3) Result of Calculation

The channel in the reclaimed area as the extension of the Cengkareng Floodway should have the width of low water channel of at least 133 m at the new estuary against the width of 120 m in the master plan to avoid the raise of design high water level in the master plan.

2.9.4 The Western Banjir Canal

(1) Basic Features of the Western Banjir Canal at the Estuary in the Master Plan

The following channel conditions of the Western Banjir Canal at the estuary in the Master Plan are taken into consideration:

1) Design Scale : 100-year return period
2) Design Discharge : $500 m^3/s$
3) High water level : 0.85 m
4) River-bed elevation : -4.75 m
5) Width of low-water channel : 53 m

(2) Basic Assumptions of the Channel in the Reclaimed Area

The same assumptions with those of the case of the Cisadane river are utilized here.

(3) Result of Calculation

The channel in the reclaimed area as the extension of the Western Banjir Canal should have the width of low water channel of at least 147 m at the new estuary against the width of 100 m in the master plan to avoid the raise of the design high water level in the master plan.

3 OPTIMUM SCALE FOR URGENT FLOOD CONTROL (1ST STAGE) PROJECT

Implementation of the priority projects selected form the master plan needs a big amount of project cost. Accordingly, effective stepwise implementation of the projects is required. Comparison of four safety degree alternatives is studied here for the optimum scale of urgent flood control project to be implemented immediately as 1st stage project:

3.1 Alternative Schemes

The following four design scale alternative schemes have been examined for optimum scale of the priority projects. The alternative schemes are shown in Table 3.1 and Figure 3.1.

Alternatives	WBC	Ciliwung Floodway	Cisadane
Alt. 1	M/P scale (100-year)	2 tunnels (300 m^3/s x 2 units), discharge volume: 600 m^3/s	50-year (1,900 m^3/s)
Alt. 2	M/P scale (100-year)	1 tunnel (300 m^3/s x 1 unit), discharge volume: 300 m^3/s	25-year (1,500 m^3/s)
Alt. 2'	M/P scale (100-year)	2 tunnels (300 m^3/s x 2 units), discharge volume: 300 m^3/s	25-year (1,500 m^3/s)
Alt. 3	50-year	1 tunnel (300 m^3/s x 1 unit), discharge volume: 300 m^3/s	10-year (1,200 m^3/s)

3.2 Evaluation and Conclusion

3.2.1 Evaluation

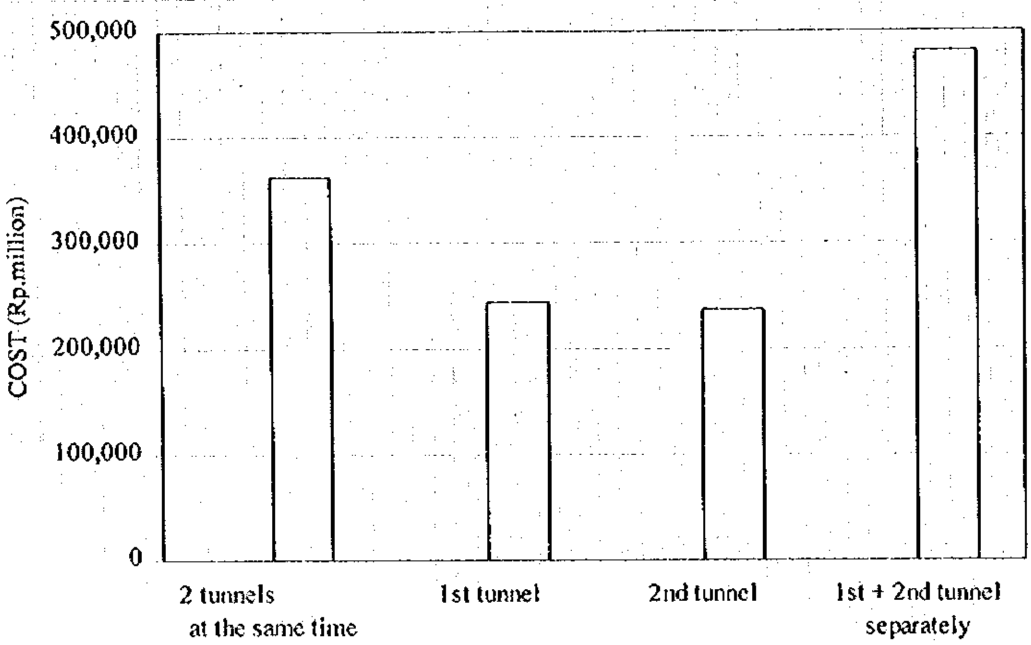
Economic evaluation is conducted for the alternatives as one aspect of project evaluation. The estimated EIRR and B/C are as follows:

Alternatives	Flood reduction benefit (Rp. million)	Economic project cost (Rp. million)	EIRR (%)	B/C (discount rate : 12%)
Alt. 1 (2 tunnels)	85,815	456,332	16.1	1.37
Alt. 2 (1 tunnel)	79,196	365,553	18.0	1.57
Alt. 2' (2 tunnels)	79,196	405,686	16.4	1.41
Alt. 3 (1 tunnel)	68,800	323,684	17.8	1.54

Evaluation of the alternatives from other aspect such as technical aspect, environmental impact, and social impact are conducted as shown in Table 3.1.

3.2.2 Comparison of Construction Cost of Ciliwung Floodway

The comparison of construction cost of the Ciliwung Floodway is studied as shown in the figure below. To construct two tunnels at the same time is cheaper than to construct 1st tunnel in the urgent flood control project and construct 2nd tunnel later in the master plan stage separately.



3.2.3 Conclusion

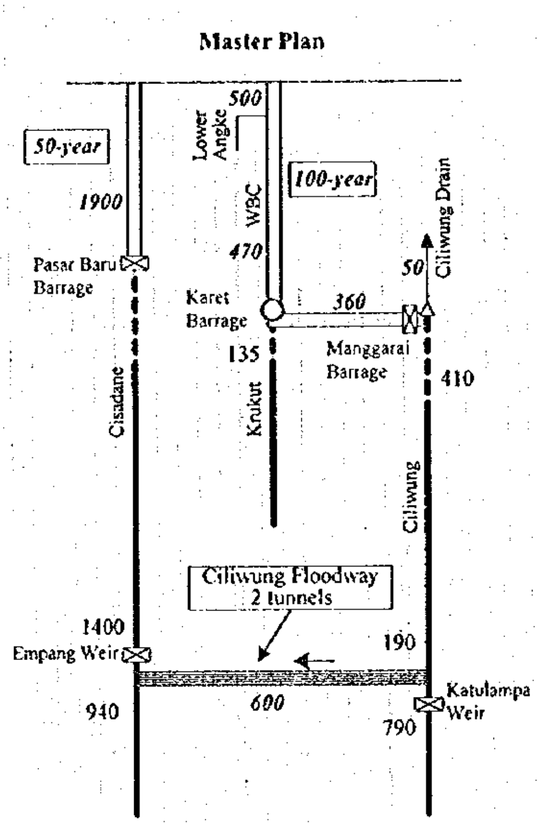
The Alt.2 has the highest EIRR and B/C. However, in view of technical, environmental and social viewpoint on construction of the tunnel, it is concluded that the Alt.2' has higher advantage than the Alt.2. The Alt.2' has still higher EIRR and B/C than that of the Alt.1 i.e. the Master Plan stage and has same design discharge distribution with Alt.2.

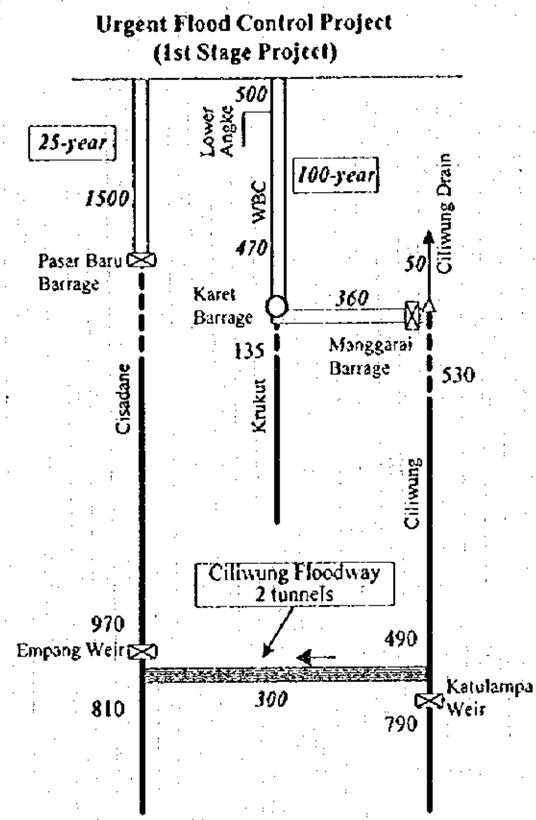
As for the construction of the Ciliwung floodway, the two tunnels proposed in the master plan are to be constructed in advance during the stage of the urgent flood control project. The design discharge to the two tunnels is proposed temporarily to be 300 m^3/s in accordance with the river improvement of the Cisadane river in downstream reaches with 25-year design scale.

The construction of 2 tunnels in advance is proposed with the consideration to the demerits such as various procedures, increase of the cost, negative impact of giving inconvenience to the surrounding residents and the others to be accompanied by future additional works.

Accordingly, the Alt.2' is selected as the optimum scale for the priority project to be implemented as an urgent flood control project (1st stage project).

The design discharge distribution thus proposed is as follows:





4 PRELIMINARY DESIGN FOR URGENT FLOOD CONTROL PROJECT

Preliminary design of the Western Banjir Canal, the Cisadane river, the Ciliwung Floodway and the related structures is conducted for the urgent flood control project (1st stage project) here.

4.1 Western Banjir Canal

4.1.1 Design Criteria

In principle, the design is conducted in accordance with the criteria in "Flood Control Manual in Indonesia" (hereinafter referred to as the Manual), which was prepared by DGWRD in collaboration with Canadian International Development Agency in 1993.

The following criteria in Japan are also referred to:

- Manual for River Works in Japan
- Cabinet Order concerning Structural Standards for River Management Facilities
- Latest Guideline for River Improvement in Japan published in 1996

According to the latest river improvement criteria in Japan (Guideline for River Improvement in Japan, 1996), it is desired to decrease construction and maintenance costs and to preserve environment as much as possible. However the latest guideline is applied for the WBC limitedly because of the following reasons:

- the WBC is an artificial floodway;
- it is necessary to increase the carrying capacity within the present right of way to avoid land acquisition in the densely populated area; and
- it is necessary no to raise the design high water level as much as possible to decrease the number of bridges to be reconstructed.

4.1.2 River Improvement

(1) Basic Improvement Items

The basic improvement items are summarized in Figure 4.1.

(2) Design Discharge

The design discharges are as follows:

- Estuary (0.0 k) - Angke Drain (2.9 k) : 500 m^3/s
- Angke Drain (2.9 k) - Krukut River (12.4 k) : 470 m^3/s
- Krukut River (12.4 k) - Manggarai Barrage (16.9 k) : 360 m^3/s

These are revised values in the feasibility stage as already discussed in Section 2.8.

(3) **Objective Reaches**

The objective reaches of the river improvement for the urgent flood control project (1st stage project) are from the estuary (0.0 k) to up to the Manggarai Barrage (16.9 k).

(4) **Right of Way**

According to the present legislation, the authorities should acquire and control overall land to a distance of 5 meters beyond the outside toe of embankments as a right of way of river. However, this right of way of 5 m is not included as an objective area for land acquisition in consideration of present densely urbanized land use situation and difficulties of land acquisition along the WBC.

(5) **Alignment**

In principle, proposed alignment of the WBC is on the existing one except near the estuary to avoid any land acquisition. The design alignment is shown in Figure 4.2.

(6) **Longitudinal Profile**

The design longitudinal profile is shown in Table 4.1 and Figure 4.3.

(7) **Cross Sectional Profile**

The standard cross sections are prepared as shown in Figure 4.4.

(8) **Manning's Roughness Coefficient**

The following Manning's roughness coefficients (n) are adopted:

- 0.025 : low-water channel
- 0.040 : high-water channel

(9) **Freeboard**

The minimum required freeboard is 0.8 m. However, the freeboard of 1.0 m is adopted taking into account the importance of the to-be protected area and the margin for future envisaged land subsidence.

Freeboard of 0.6 m is adopted where the design high water level is lower than the ground elevation.

(10) **Inspection Road**

Inspection road with minimum 3 m width is provided on both embankments where there is no road available along the WBC at present.

(11) Revetment

Embankment

Revetment of wet masonry on the side slopes of the embankment and asphalt pavement on the crown are provided in the following reaches in the same way as the present.

- Confluence of the Angke drain (2.9 k) - Aipda K. S. Tubun bridge (11.3 k) : both banks
- Aipda K. S. Tubun bridge (11.3 k) - Karet barrage (12.4 k) : left bank only

River channel

Low and high water channel revetments are provided around the confluence of the tributaries and structures.

Low water channel revetment is provided around the water colliding front along the meandering reaches of Muara Angke and steep slope portions of 1:1.0

4.1.3 Bridge

(1) Freeboard

The soffit elevation of bridge girder and required minimum freeboard line are shown in Figure 4.5.

Bridges lower than proposed HWL

The following two bridges have extremely low girders and the girder soffit elevations become lower than that of the proposed HWL. Those bridges are required to be reconstructed.

- Prof. Dr. Latumeten bridge (6.9 k)
- Kyai Tapa bridge (8.4 k)

Bridges lower than freeboard line

The girder soffit elevation of following five bridges are higher than HWL but still lower than minimum freeboard line. Those bridges are fundamentally necessarily to be reconstructed.

- Teluk Gong Raya bridge (5.0 k)
- Railway bridge (future) (7.9 k)
- Railway bridge on Karet barrage (12.4 k)
- K. H. Mas Mansyur bridge (13.1 k)
- Roadway bridge on Manggarai barrage (16.9 k)

(2) Protection of Pier

Protection works for some bridge piers will be needed resulting from the channel widening and excavation works.

4.1.4 Barrages

Improvement of the Karet barrage is not necessary because of it's enough carrying capacity.

Improvement of the Manggarai barrage is necessary because the carrying capacity is not enough for the design discharge of 360 m^3/s and the improvement can also make lower the flood water level of upper side of the barrage.

In view of the present condition, installation of a new opening on the right bank is proposed. The opening width is enough if the width of 5.5 m (same as the present gate width) is adopted.

4.1.5 Proposed Project Works

The major required project work items and quantities in the urgent flood control project (1st stage project) for the priority projects are as follows:

Work Item	Unit	Quantity
1. Land Aquisition and Compensation		
Land aquisition	ha	0.0
House	nos.	0
2. Channel Improvement (L=16.9 km)		
Preparatory	ls	1
Excavation and dredging	m^3	1,354,000
Embankment	m^3	110,000
Low and high water channel revetments (around tributaries and related structures)	m^2	17,100
Low water channel revetment (water colliding front, steep slope)	m^2	24,700
Embankment protection		
-Wet masonry	m^2	72,300
-Sod facing	m^2	42,900
Asphalt pavement of embankment crown	m^2	25,100
Drop structure	nos.	0
Construction of new drainage structure	nos.	4
Improvement of existing drainage structure	nos.	3
Reconstruction of existing bridges	nos.	7
Construction of New Opening at Manggarai Barrage	nos.	1

4.2 Cisadane River

4.2.1 Design Criteria

In principle, the design of the Cisadane river is conducted in accordance with the same criteria as adopted in the design of the WBC.

The following considerations based on the latest river improvement criteria in Japan (Guideline for River Improvement in Japan, 1996) are also introduced positively to determine the design:

- same design high water level is adopted in the urgent flood control project (1500 m^3/s) and Master Plan stage (1900 m^3/s);
- widening and excavation of low water channel should be limited as much as possible in order to maintain the natural stability of present channel, to decrease the construction and maintenance costs, and to preserve the present environment;
- if the present embankment is located extremely close to the water colliding front, setting back of embankment is adopted to avoid failure of embankment due to scoring;
- revetment works should be limited as much as possible;
- former river course and oxbow lake should be treated as a part of river and included within the embankment alignment to preserve it's natural retarding effect and environment: no need to maintain uniform river width; and
- ground clearing of high water channel should be limited as much as possible to preserve riverside forest and environment, since the flood discharge on high water channel is limited and river side forest can decrease the hydraulic energy force against embankment.

4.2.2 River Improvement

(1) Basic Improvement Items

The basic improvement items are summarized as shown in Figure 4.6.

(2) Design Discharge

The design discharge of 1,500 m^3/s (25-year) is adopted.

(3) Objective Reaches

The objective reaches of the improvement are determined from 1.8 k to 16.8 k based on the present carrying capacity. There is no need of river improvement from the estuary to 1.8 k because of the following reasons:

- It is necessary to keep the water of fish pond brackish;
- There will be not so many property to be protected even in future; and
- The geological condition near the estuary will not be suitable for the embankment.

The upstream reaches from 16.8 k to the Pasar Baru barrage are not objective reaches for the urgent flood control project (1st stage project), present roadways along the both river banks should be preserved as inspection road though.

(4) Right of Way

In principle, overall lands to a distance of 5 meters beyond the outside toe of embankments is treated as right of way of river in accordance with the Manual.

(5) Alignment

The proposed embankment alignment is shown in Figure 4.7.

(6) Longitudinal Profile

The design longitudinal profile is shown in Table 4.2 and Figure 4.8.

(7) Cross Sectional Profile

The standard cross sections are prepared as shown in Figure 4.9.

(8) Manning's Roughness Coefficient

The following Manning's roughness coefficients (n) are adopted:

1.8 k - 12.7 k	12.7 k - 16.8 k
n=0.030 : low water channel	n=0.035 : low water channel
n=0.050 : high water channel	n=0.050 : high water channel

(9) Freeboard

The freeboard of 1.0 m is adopted.

(10) Inspection Road

Inspection road of 5 m width is provided on both embankments.

(11) Revetment

Some low water channel revetment works are required in water colliding fronts.

4.2.3 Bridge

There is no necessity to reconstruct or to protect the piers of Kali Baru bridge.

4.2.4 Proposed Project Works

The major required project work items and quantities in the urgent flood control project (1st stage project) for the priority projects are as follows:

Work Item	Unit	Quantity
1. Land Aquisition and Compensation		
Land aquisition	ha	45.3
House	nos.	460
2. Channel Improvement (L=15.0 km)		
Preparatory	ls	1
Excavation and dredging	m^3	825,000
Embankment	m^3	913,000
Low water channel revetment	m^2	8,400
Drop structure	nos.	0
Construction of new drainage structure	nos.	3
Improvement of existing drainage structure	nos.	2
Reconstruction of bridge	nos.	0

The number of houses to be expropriated were counted by using the topographic maps with a scale of 1:5,000 prepared by the Study Team in 1996. The number might include not only human habitation but also warehouse, livestock house and so on, since it is impossible to distinguish the type of house by the maps. Accordingly, it is necessary to investigate and classify those houses in the proceeding detailed design stage.

4.3 Alternative Study on General Ciliwung Floodway Route

4.3.1 Conceivable Route

It is inevitable that the Ciliwung floodway becomes a tunnel floodway to avoid the serious land acquisition problem in the densely populated area of Bogor city. Conceivable alternative routes of the floodway are shown in Figure 4.10.

4.3.2 Comparative Study

In consideration of the following aspects, the Alt.1 is adopted as the optimum floodway route:

Alt.1
- total floodway length is short (approximately 1 km);
- no serious land acquisition problem may be caused because of its short open channel stretch; and
- this route has smooth bifurcation alignment from the Ciliwung river and has smooth

confluence alignment with the Cisadane river.

Alt.2

- total floodway length is long (approximately 1.5 km);
- the Cipaku river which forms downstream reaches of the floodway is a very small river and accordingly overall widening and straightening are required;
- the river-bed of the Cipaku river consists of rock at locations and accordingly there will be difficulties in excavation work even for open channel; and
- land acquisition problem may be caused because many houses are existing along the Cipaku river.

4.4 Ciliwung Floodway

4.4.1 Present Situation of the Objective Area

(1) Location

Approximate route of the floodway is shown in Figure 4.11 and the respective facilities will be located as described below:

(a) Inlet Facilities will be on the left bank of the Ciliwung river at section of about 300 m to 350 m downstream of the bridge of Jl. Pajajaran. A control weir will be at the downstream end of the said section.

(b) Outlet Facilities will be on the right bank of the Cisadane river at about 120 m upstream of the existing suspension bridge.

(c) Floodway Tunnel is planned toward the west from the proposed inlet site almost directly to the outlet site.

(2) Existing Structures in the Area

In and around the inlet and outlet sites, there are several major structures which need to be considered in the design as follows:

(a)	Bridges	:	The road bridge across the Ciliwung river at about 300 m upstream of the proposed inlet site. A suspension bridge for only pedestrian is located at about 120 m downstream of the proposed outlet site of the floodway.
(b)	Railway	:	The railway for Sukabumi running on the slope of hilly area along the Cisadane river passes by the floodway outlet site about 50 m far from the river course.
(c)	Residential Complex	:	Residential complex of middle scale has been extended on the right bank of the Ciliwung river in downstream of the aforementioned bridge.

4.4.2 Design Requirement

(1) Objective Facilities

The proposed floodway will be composed of the following main facilities:

(a)	Inlet Facilities :	(i)	Control fixed weir in the Ciliwung river channel
		(ii)	Inlet structures of the floodway(tunnel)
(b)	Tunnel		
(c)	Outlet Facilities :	(i)	Outlet structures of the floodway(tunnel)
		(ii)	Dike on the left bank of the Cisadane river and river bed protection

Other than the above floodway facilities, the existing suspension bridge across the Cisadane river is designed for replacement.

(2) Design Concept

The following basic requirement have been incorporated as much as possible in the preliminary design :

(a) Flow Regulation

- (i) Design maximum discharge of the floodway is 600 m^3/s or 300 m^3/s per (1) tunnel channel.
- (ii) As the urgent flood control project, a discharge of 300m^3/s is designed to be diverted to the floodway(1 tunnel channel will be closed) and remaining 490 m^3/s will be discharged to the Ciliwung river when an inflow of 790 m^3/s (design flood) is expected.
- (iii) River flow shall be controlled by the non-gated fixed weirs.

(b) Tunnel

- (i) Number of tunnel shall be two.
- (ii) Flow inside a tunnel shall be of non-pressure flow .
- (iii) Specific consideration shall be incorporated in the design that the project area has been densely populated and use of ground water have been developed.
- (iv) Feature of the tunnel including profile, alignment and shape shall be determined referring to both the geological and topographical conditions as well as tunnel construction method.
- (v) Required minimum overburden of the tunnel is 1.0 x D(outside diameter of the tunnel) in case of shield tunneling work, while 1.5 - 2.0 x D for mountain tunneling work.

(c) Inlet/Outlet Structures

(i) Desilting basin to minimize sediment flowing into the tunnel and trashrack or equivalent structure shall be provided in the inlet facilities.
(ii) Stilling basin and/or energy dissipater shall be provided in the outlet facilities.
(iii) Diking shall be studied in left bank side of the Cisadane river not to cause inundation by discharge from the floodway.

4.4.3 Preliminary Design

(1) Floodway Route Alternative

In consideration of the topographic condition as well as profiles of the Ciliwung river and the Cisadane river, a location of the floodway inlet and outlet facilities have been determined as shown in Figure 4.11.

Basic alignment of the floodway tunnel is of a direct way from the inlet to the outlet as Alternative No.2 in Figure 4.11. Advantages of the No.2 route is the shortest length of the tunnel and no complicated hydraulic flow is expected in the tunnel channel. However, No.2 route will pass under the creek and irrigation canal where an overburden is expected rather small due to the existing ground sills near the route. In case that the mountain tunneling is applied for this floodway construction, the required sufficient overburden could not be secured under the said creek.

The alternative No.1 has been studied to keep a sufficient overburden throughout a whole route of the tunnel. The alignment of the No.1 takes a roundabout route which pass under the creek at just upstream of the ground sill. The distance between those two alternative routes is about 120 m at the creek crossing portion as shown in Figure 4.11. This alternative is disadvantageous to have a bend alignment in the steep gradient channel and to increase a length of the tunnel.

The tunnel route will be under rather crowded residential and commercial areas and use of groundwater have been developed. Tunnel construction by the mountain tunneling would cause much spring out of the groundwater and drawdown of groundwater table as well as some subsidence of the ground surface. In order to avoid such problems, the shield works of closed and earth pressure type is proposed for the tunnel construction. Since that the said shield works requires less overburden than that for the traditional tunneling method, the route alternative No.2 is acceptable in technical view point.

Through the aforesaid alternative studies, the alternative No.2 is proposed in the preliminary design stage as shown in Figure 4.12. The proposed floodway alignment has 1,060 m in length including 1,000 m of tunnel portion and channel inlet and outlet structures.

(2) Tunnel

Two tunnel channels of circle shaped with an inner diameter of 8.0 m is preliminarily designed in accordance with the Manual for River Works in Japan and under the following condition:

Discharge capacity	:	300 m^3/s per (1) channel
Gradient of channel	:	1 / 125
Roughness coefficient	:	0.023 (for design of cross section of the channel)

Typical cross section of the channel is presented in Figure 4.13.

(3) Inlet Facilities

The inlet facilities of the floodway are preliminarily designed as shown in Figure 4.14 and general feature of main structures are described as follows:

(a) Control Weir in the Ciliwung river

Weir height	:	6 m from original riverbed elevation
Weir width	:	60 m (crest length)
Flow capacity	:	0 to 490 m^3/s(at total head of El. 275.1 m)

(b) Inlet Weir of the Floodway

Weir height	:	2.2 m
Weir width	:	40 m for (1) channel x 2
Flow capacity	:	0 to 300 m^3/s(per (1) channel, at total head of El. 275.1 m)

(c) Desilting basin : No space to be provided. River bed is designed to be lowered by 1.0 m from the forebay sill of the floodway and the inlet weir(2.2 m higher than the forebay sill) will be expected to prevent bed load and sediment from flowing into the floodway channel.

(d) Trashrack(boom): Such as piles arrangement in the forebay.

(4) Outlet Facilities

The outlet facilities such as a stilling basin and an energy dissipater of the floodway as well as river bank protections are preliminarily designed as shown in Figure 4.13. Other than the bank protection works against outflow of the floodway, dike on the left bank of the Ciliwung river is designed to protect the left bank area partially.

4.5 Related Structures

4.5.1 Manggarai Barrage

(1) Existing Barrage

The existing Manggarai Barrage is located under a railway bridge and a road bridge near Manggarai station yard where there are several tracks and trains pass frequently. The gated structure is not under but just beside these bridges, while most part of sluiceways are under the bridge structures as shown in Figure 4.15.

The existing barrage consists of two sluiceways with gates. One sluiceway is about 5.5 m wide and 50 m in length with a gate of about 8.5m in height. The widths of railway bridge and road bridge are 40 m and 5 m, respectively.

Beside the existing gate structures of the barrage on the right bank, there is a small gate structure which is an inlet of a channel connecting to Surabaya river. This channel is to provide flushing water for Surabaya river.

(2) Design Requirement

(a) Objective Structures

(i) Additional sluiceway with a gate structure.
(ii) Replacement of the sluiceway with a gate structure connecting to Surabaya river.

(b) Design Concept

(i) Additional sluiceway is preferable to be constructed on the right side of the existing barrage in smooth river flow aspect with less deposit in river course.
(ii) Required capacity of the additional sluiceway shall be mostly same as that of the existing one.
(iii) Affected area and modification of the existing structures shall be minimized by the construction.
(iv) Existing structure of the barrage and present flushing function shall be retained.

(3) Preliminary Design

The objective facilities are preliminarily designed in accordance with the design concept mentioned above. A new sluiceway with a gate structure will be constructed on the right side of the existing barrage being parallel with the existing structure. Width and length of the designed sluiceway are same as those of the present one as well as the gate height. The plan of the proposed Manggarai Barrage is presented in Figure 4.15.

The small sluiceway going to Surabaya river is also designed not to change a function of the structure. The existing gate will be totally demolished and to be newly constructed on the right side of the new gate of the barrage. A new pipe culvert will be connected to the existing one under the railway bridge. No modification is expected for outlet of the sluiceway.

4.5.2 Drainage Facilities in the Western Banjir Canal

(1) Existing Drainage Facilities

Along the Western Banjir Canal(WBC) between the river mouth and the Manggarai Barrage, there are various drainage facilities such as drainage pumping stations, inlet or outlet of the drainage rivers with or without gate structures, siphons and many sluice pipe outlets. Most of those are shown in Figure 4.16 and feature of main facilities are detailed in Annex 7.

(2) Design Requirement

(a) Objective Structures

(i) Sluice gate and/or outlet structures of the drainage pumping stations.
(ii) Sluice gate structures at the outlet of the drainage rivers.
(iii) Sluice structure of the drainage channel.

(b) Design Concept

(i) Construction of new structures or replacement of the existing ones shall be made in case that river improvement works require such provision.
(ii) Construction of new structures or replacement of the existing ones shall be made to avoid river water intrusion at the proposed design water level
(iii) Structures in the river course which might be an obstruction of river flow shall be replaced.
(iv) No construction nor improvement of drainage pumping facility itself is provided.

(3) Preliminary Design

Taking account of the proposed river improvement works and design water level, proposed works in the drainage facilities are studied and required preliminary design has been undertaken for the following facilities:

(a) Improvement of Muara Angke Pumping Station
(i) New sluice gates for the existing channel between the existing pumping equipment and the WBC.
(ii) Replacement of the existing gate in the existing channel connecting the reservoir and the WBC.

(b) Replacement of the Existing Gated Structure
(i) Outlet of K. Angke to the WBC

(c) Construction of New Gated Structure
(i) Outlet of K. Krendang to the WBC

(d) Replacement/Improvement of the Existing Outlet Facilities in the Pumping Stations
(i) Rawa Kepa Pumping Station
(ii) Pondok Bandung Pumping Station
(iii) Melati Pumping Station

(e) Improvement of the Existing Sluice Outlet Structure

(f) Installation of miscellaneous sluiceways for local drainage.

The details are presented in Annex 7 including the feature of the required works in the respective facilities as well as plan and profiles of the proposed structures in the Muara Angke Pumping Station.

4.5.3 Drainage Facilities of the Cisadane River

(1) Existing Drainage Facilities

Along the Cisadane river between the river mouth and the Pasar Baru Barrage(Cisadane river), there are several channels used for drainage purpose such as the Sabi river, drainage channels from the irrigation canal and small creeks. The major ones are shown in Figure 4.17 of those locations. There are no existing drainage structures except ones which are small sluice pipes.

(2) Design Requirement

(a) Objective Structures
 (i) Sluiceway with flapgate

(b) Design Concept
 (i) Construction of new structures or replacement of the existing ones shall be made in case that river improvement works require such provision.
 (ii) Construction of new structures or replacement of the existing ones shall be made to avoid river water intrusion at the proposed design water level.

(3) Preliminary Design

Design of sluiceways with flapgate for construction or improvement at the existing channels are preliminarily carried out for 5 locations as shown in Figure 4.17. Miscellaneous sluiceways for small scale local drainage are incorporated on lump sum basis.

The followings are recommendable works to be realized as future improvement of drainage system in the Cisadane river basin:

(a) Construction of a drainage pumping station and gated structures for improvement of urban drainage situation condition in the Sabi river basin where backwater of the Cisadane river affects the condition of urban drainage;

(b) Construction of parapet walls along the drainage channels from the irrigation canal to prevent local inundation in case of high water level of the Cisadane river.

4.5.4 Bridges and Others

Some of the existing road and railway bridges in the WBC require its replacement due to too low elevations of the existing bridge girder comparing to the design water level. Furthermore, several bridges require a certain protection works of those piers due to the river improvement works such as dredging of the river course and excavation of the low water channel. Figure 4.16 shows those bridges and respective required works which is summarized as follows:

(a)	Replacement of the existing bridges	:	7 bridges
(b)	Protection works of the pier(s)	:	9 bridges

The required work cost have been estimated based on the Bina Marga Standard without a design for the respective bridges specifically.