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 II

MAIN REPORT - MASTER PLAN

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
¥ 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).

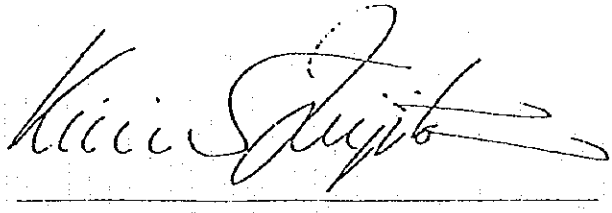
JICA sent to Indonesia a study team headed by Mr. Toshikatsu Imai of NIKKEN Consultants, Inc. and composed of members from NIKKEN Consultants, Inc. and Nippon Koei Co., Ltd., three times between July 1995 and March 1997.

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

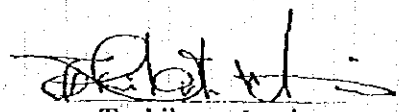
We are pleased to submit to you the master plan and feasibility report on the Study on Comprehensive River Water Management Plan in JABOTABEK in the Republic of Indonesia. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as 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.

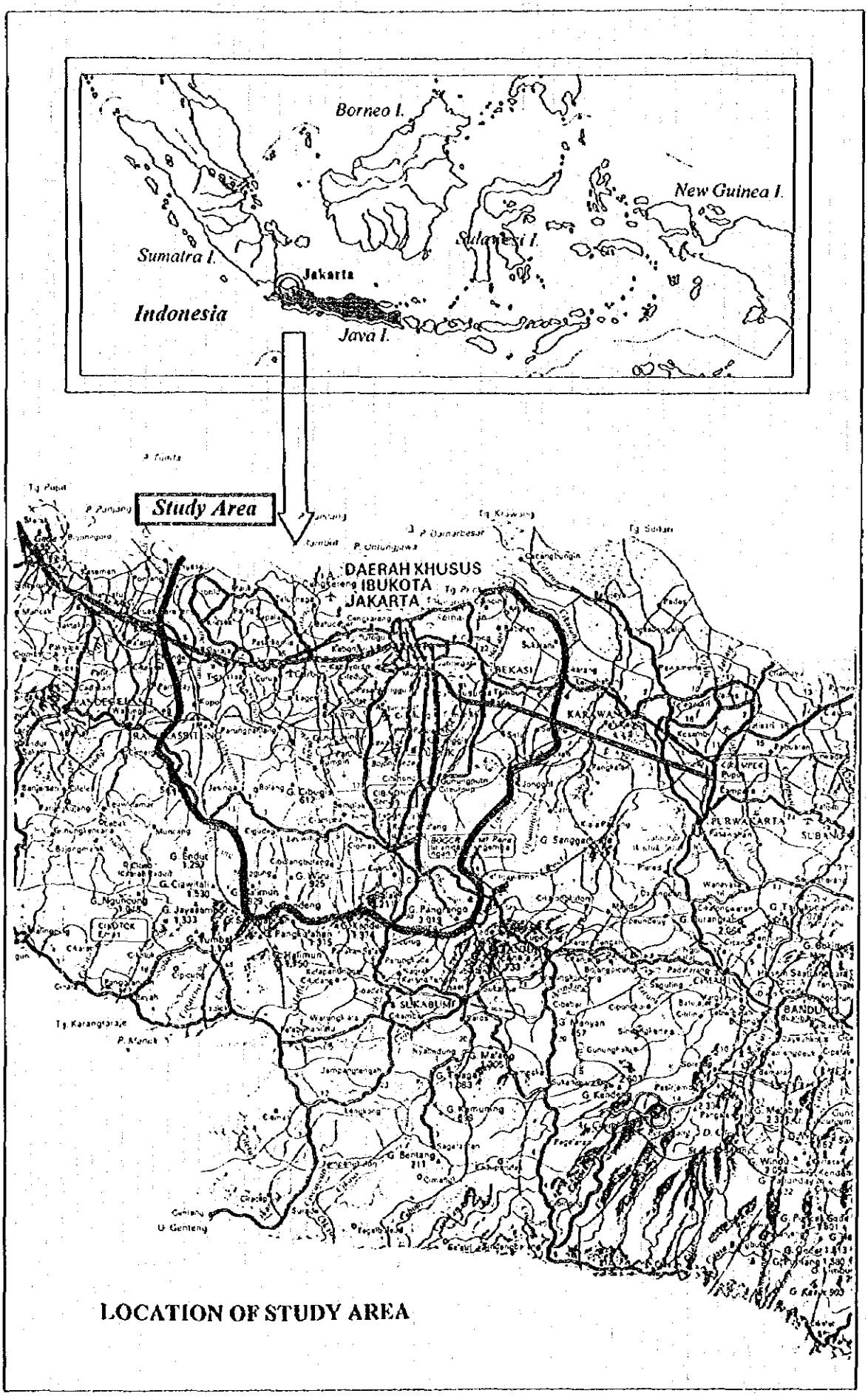
In view of the urgency of flood control in DKI Jakarta and the suburbs, and the need for socio-economic development of Indonesia as a whole, we recommend that the Government of Indonesia implement this Project as a top priority.

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.

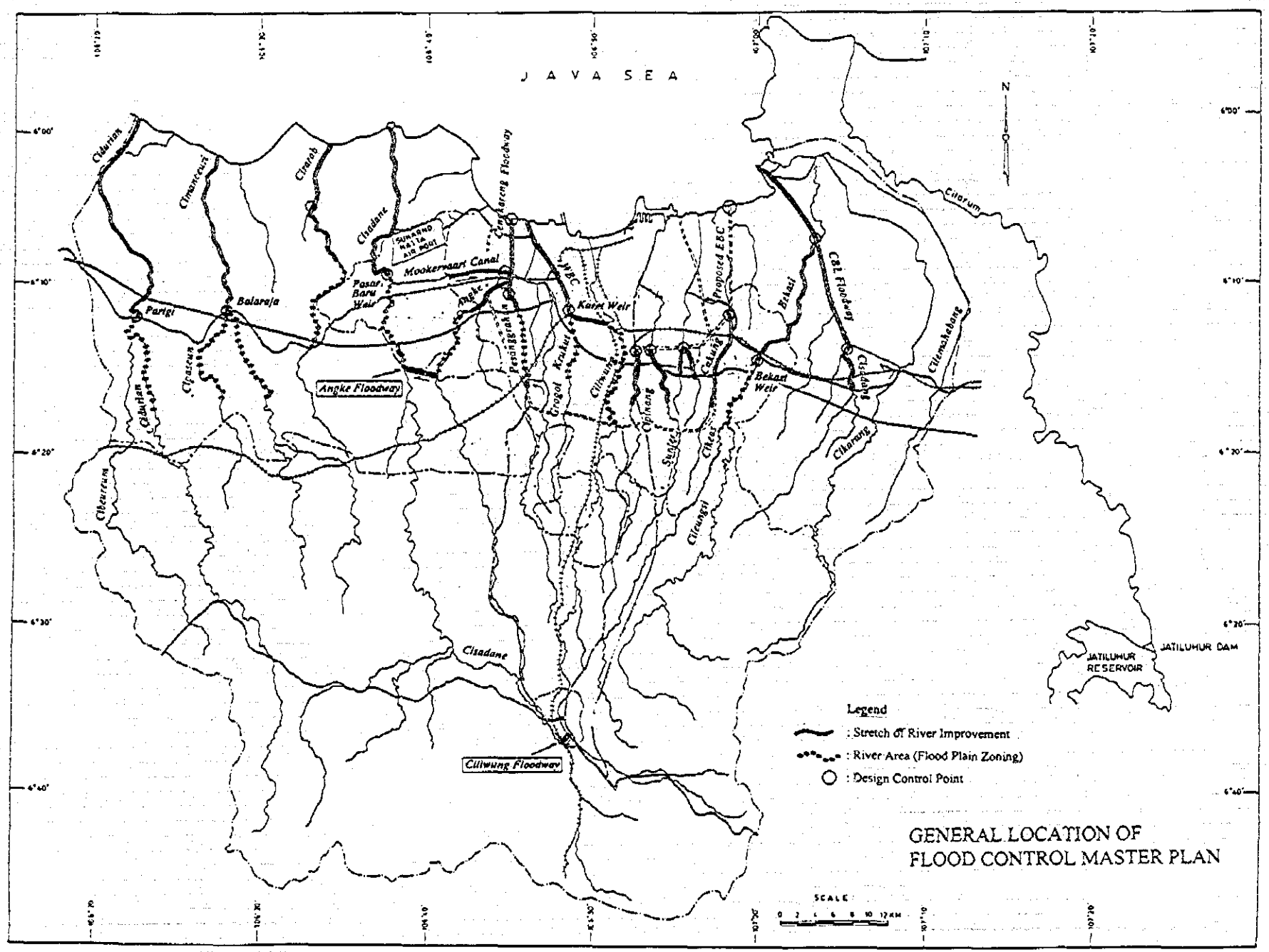
Very truly yours,



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



LOCATION OF STUDY AREA


JAVA SEA
N
Cidurian
Cimanteuri
Cisanah
Cisadane
SUNGAI MALTA AIR BAKU
Mookervaart Canal
Pasar Baru Weir
Angke
Tangerang Floodway
PLTU
Karet Weir
Proposed FBC
Bekasi
C&L Floodway
Citarum
Partigi
Balaraja
Angke Floodway
Pesanggrahan
Grogol
Kanker
Ciliwung
Cipinang
Sunter
Cakung
Bekasi Weir
Cileungsi
Cikarang
Cibeet
Cisadane
Ciliwung Floodway
JATILUHUR RESERVOIR
JATILUHUR DAM
Legend
: Stretch of River Improvement
: River Area (Flood Plain Zoning)
: Design Control Point
GENERAL LOCATION OF
FLOOD CONTROL MASTER PLAN
SCALE
0 2 4 6 8 10 12 KM

THE STUDY
ON
COMPREHENSIVE RIVER WATER MANAGEMENT PLAN
IN
JABOTABEK

FINAL REPORT
VOLUME II
MAIN REPORT (MASTER PLAN)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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

This Final Report is prepared in accordance with Scope of Work for the Study on Comprehensive River Water Management Plan in JABOTABEK which was agreed upon between Directorate General of Water Resources Development (hereinafter referred to as DGWRD), Ministry of Public Works, the Government of Indonesia (hereinafter referred to as GOI) and Japan International Cooperation Agency (hereinafter referred to as JICA) of the Government of Japan (hereinafter referred to as GOJ) on February 2, 1995.

1.2 Background of the Study

The study area that extends to the City of Jakarta and its surrounding area, covering 6,070 km^2 as shown in Fig. 1.1 - 1.3, is situated on the plain formed by numerous rivers originated at rainy mountains. The plain is vulnerable to flooding and the City of Jakarta and its surrounding area have been suffering from flooding damages. In order to cope with this, the Ministry of Public Works formulated a master plan for drainage and flood control of Jakarta in 1973 with a technical assistance of the Netherlands, and implemented several projects in line with the master plan with domestic fund as well as foreign loans from Japan and the World Bank. Besides, the provincial government of West Java also implemented some flood protection works in the areas outside Jakarta.

During last few decades, the area has experienced continuous increase in population and economic activities resulting in a chronic deficiency of infrastructure including flood control works. The remarkable activation of economic development in the area created a strong demand of lands for industrial, commercial and residential purposes causing intensification and expansion of urbanization. As a result, the following problems related to river water have arisen in the area:

1) Potential damage of flooding has increased over the area;
2) Land acquisition in the urbanized area has become so difficult that part of the master plan may not be implemented without modification;
3) Pollution of water in rivers and drains has steadily advanced, and an increased supply of flushing water is needed especially during dry season;
4) Demand of municipal and industrial water is rapidly increasing and is also spreading over the area.

In order to cope with these problems, the Ministry of Public Works has established new organization, the Cisadane-Ciliwung River Basin Development Project. However, comprehensive river water management plan for the project has not been formulated yet.

Study on comprehensive river water management plan is, therefore, necessary for Cisadane, Ciliwung and other rivers, to ensure the safety against flood inundation in consideration of the present and future development of the study area. Feasibility study for selected priority projects will also be needed for the immediate implementation of the projects so as not to

hamper the development and to promote people's welfare in the area.

The study needs to be implemented soon, since the rapid development takes place in the study area and the development of this area is extremely important for the development of the country.

1.3 Objectives of the Study

The objectives of the Study are to formulate a master plan for flood control as a part of the comprehensive river water management plan in JABOTABEK and to conduct a feasibility study for priority projects selected from the flood control master plan.

1.4 Scope of the Study

Study Area

The study area covers DKI Jakarta and 3 districts of Tangerang, Bogor and Bekasi of the West Java province, namely the river basins between those of Cikarang and Cidurian rivers which is about 6,070 km^2 wide as shown in Figure 1.1. The area is called as JABOTABEK area.

Target Year

The target year of the study is set up to be 2025 that corresponds to the target year of JABOTABEK Water Resources Management Study.

Scope of the Study

The Study shall cover, preparation of master plan for comprehensive river water management plan in JABOTABEK, selection of priority projects from the flood control master plan, and feasibility study for priority projects.

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 as shown in Table 2.2. 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.

(4) *Foreign Trade and International Balance of Payment*

The Government of Indonesia set a target of an annual increase ratio of total exports from 13.3 % to 14.7 % in its sixth National Development Plan (1994-1998). Out of the total export, the plan aims to increase the share of non-oil and non-gas exports from 78.1 % to 86.7 % per annum during the same period.

Table 2.3 shows the international balance of payment from 1988/89 fiscal year until 1994/95 fiscal year. In 1994/95 fiscal year, the balance of foreign trade was accounted at US$ 8,039 million in amount. However, in the total current account, the credit exceeds the debit by the amount of US$ 3,488 million in the same fiscal year. Total amounts of exports and exports of non-oil and non-gas items were US$ 42,161 million and US$ 31,716 million, respectively in the same fiscal year. The share of exports of non-oil and non-gas items achieved 75.2 % of the total exports.

On the other hand, the capital account has been kept plus side. However, the debt repayment of the official capital is increasing gradually and its amount reached US$ 5,546 million in 1994/95 fiscal year. The amount is almost 93 % of the inflows of the official capital. The total of international balance of payment amounted to US$ 1,262 million as the excess of cash balance as of 1994/95 fiscal year.

Table 2.4 shows main import and export commodities of Indonesia. In 1995, machinery and vehicles were the major commodities of import, accounting to 40.1 %. On the other hand, exports of garments and other textile have been increasing remarkably, oil, gas and related products still shared largest percentage of total exports, though.

In the Study Area, Tanjung Priok port has been playing an important role for foreign trade of Indonesia. Tanjung Priok port took charge of 59 % of imports and 29 % of exports of Indonesia in 1994 as shown in Table 2.5.

(5) Foreign Currency Exchange Rate

Table 2.6 shows foreign currency exchange rate between US dollar, Japanese Yen and Indonesian Rupiah currencies since January 1989. The exchange rate of Rp.1,735.38 to US$1.00 in January 1989 was gradually depreciated to Rp.2,346 to US$1.00 in October 1996.

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.

(a) DKI Jakarta

DKI Jakarta is bounded by Kabupaten and Kotamadya Tangerang on the west, Kabupaten Bogor on the south, Kabupaten Bekasi on the east and the Java sea on the north. It is the capital city of Indonesia and prospering as a center of politics and economy in Indonesia. The head of DKI Jakarta is a governor (Gubernur). DKI Jakarta has five municipalities (Kotamadya), i.e. Central Jakarta, North Jakarta, West Jakarta, South Jakarta, and East Jakarta. The head of the Each municipality is a Walikota. These municipalities are divided into 43 districts (Kecamatan) of which the heads are called Camats. The smallest administrative unit is Kelurahan. Administrative boundaries of DKI Jakarta to Kecamatan level is shown in Figure 2.2.

(b) Kabupaten Bogor

Kabupaten Bogor is bounded by Kabupaten Lebak on the west, Kabupatens Sukabumi and Cianjur on the south, Kabupaten Purwakarta on the east and Kabupaten Tangerang, DKI Jakarta and Kabupaten Bekasi on the north. Agriculture, manufacturing industry and trade are the major economic activities there. A Bupati is the head of Kabupaten Bogor. It is divided into 33 districts (Kecamatan) and the smallest administrative unit is Desa.

(c) Kotamadya Bogor

Kotamadya Bogor is located almost at the center of Kabupaten Bogor. Trade, transportation, communication and public services are the major economic activities there. The head of Kotamadya Bogor is a Walikota. Kotamadya Bogor is divided into six districts (Kecamatan) and the smallest administrative unit is Kelurahan.

(d) Kabupaten Tangerang

Kabupaten Tangerang is bounded by Kabupaten Serang on the west, Kabupaten Lebak and Bogor on the south, Kotamadya Tangerang and DKI Jakarta on the east, and the Java sea on the north. Manufacturing industry, trade, transportation, communication and agriculture are the major economic activities there. A Bupati is the head of Kabupaten Tangerang. Kabupaten Tangerang is divided into 19 districts (Kecamatan) and the smallest administrative unit is Desa.

(e) Kotamadya Tangerang

Kotamadya Tangerang is a new municipality divided from Kabupaten Tangerang on February 27, 1993. It is bounded by Kabupaten Tangerang on the north, west and south, and DKI Jakarta on the east. Trade and manufacturing industry is the major economic activities there. A Walikota is the head of Kotamadya Tangerang. Kotamadya Tangerang is divided into six districts (Kecamatan) and the smallest administrative unit is Kelurahan.

(f) Kabupaten Bekasi

Kabupaten Bekasi is bounded by DKI Jakarta on the west, Kabupaten Bogor on the south, Kabupaten Karawang on the east and the Java sea on the north. Manufacturing industry, trade and agriculture is the major economic activities of the area. The head of Kabupaten Bekasi is a Bupati. Kabupaten Bekasi is divided into 22 districts (Kecamatan) and the smallest administrative unit is Desa.

(g) Kabupaten Serang

In addition to the above, eastern part of Kabupaten Serang is a part of the Cidurian river basin. Kabupaten Serang is bounded by the Sunda strait on the west, Kabupaten Pandeglang and Lebak on the south, Kabupaten Tangerang on the east and the Java sea on the North. Major economic activities of the Kabupaten Serang is manufacturing industry, agriculture and trade. A Bupati is the head of Kabupaten Serang. It is divided into 15 districts (Kecamatan) and the smallest administrative unit is Desa.

(2) Population

In Indonesia, population censuses were conducted in 1961, 1971, 1980 and 1990 by Biro Pusat Statistik (BPS). The results of the censuses 1971, 1980 and 1990 have been utilized for the study.

According to the population census 1990 by BPS, Indonesia had a population of 179 million. This population increased by 32 million as compared with the census 1980. During 9 years from 1971 to 1980, the average annual growth rate of the population was 2.39 %. During 10 years from 1980 to 1990, the growth rate slowed down to 1.98 %. This rate, however, indicates that the population may double in about 35 years.

Average annual growth rate of population in the Study Area indicates higher increasing trend than that in whole Indonesia. The population in the Study Area increased from 12.9 million in 1980 to 18.5 million in 1990 with an average growth rate of 3.67 %. Figure 2.3 shows population in the Study Area by the censuses 1971, 1980 and 1990.

During 10 years from 1980 to 1990, population in DKI Jakarta increased from 6.4 million to 8.2 million with an average annual growth rate of 2.47 %. Especially in East , North and West Jakarta, population increased with a high rate of 3.55 %, 3.78 % and 3.99 % respectively.

In the Study Area, populations in Kabupatens Bogor, Tangerang and Bekasi indicate very high increasing trend. Average annual growth rates from 1980 to 1990 are 4.10 %, 6.15 % and 6.47 % respectively.

(3) Regional Domestic Products

Table 2.7 shows GRDP in the Study Area by industrial origin in 1983 constant price basis. The table shows that the economic growth rates in the Study Area were higher than that in whole Indonesia reflecting industrialization in the area. Especially in Kabupaten and Kotamadya Tangerang and Kabupaten Bekasi, average annual growth rate came up to more than 10 % in recent years.

2.1.3 Land Use and Land Use Plan

(1) Present Land Use

(a) DKI Jakarta

DKI Jakarta measures 662 km² and is the political and commercial center of Indonesia. The industrial area within DKI Jakarta is found along the Tanjung Priok port area where the ship building business is thriving.

The major industrial companies are the Jakarta Industrial Estate in Pulogadung in the

municipality of Jakarta Timur, and the Kawasan Berikat Nusantara in the municipality of Jakarta Utara.

(b) Bekasi

The Prosijat irrigation area in Bekasi covers approximately 66,000ha. Irrigation water is supplied from the Juanda dam constructed in the Citarum River through the West Tarum Canal (WTC) which is approximately 50km long.

Urbanization and industrialization have reached areas located along the highway, national roads and railway routes. There are fish ponds constructed along the coastal line which mainly produce tiger shrimps and milk fish for export.

(c) Tangerang

In Tangerang a total of approximately 43,000ha of land were developed for irrigation by constructing irrigation canals. The areas are located in Prosida-Cisadane, Cidurian-Rancasumur, and Cicinta.

Urbanization and industrialization have reached areas along highways, national roads and railway routes. An area measuring approximately 6,000ha is being developed in Serpong for housing, tourism and industrial purposes. Tiger shrimps for export are mainly bred in fish ponds measuring approximately 4,000ha in Keronjo, Manuk, Sepetan, and Teluknaga.

(d) Bogor

Bogor is equipped with two irrigation systems located in Empang and Katulampa, servicing an area totaling approximately 9,700ha. The Cisadane, Ciliwung and Bekasi rivers form an alluvial fan; land on this area is cultivated. Vegetables are mainly cultivated in this region. The southern boundary of the study area, which is a mountainous area, is made up of forests and partly of thickets and cultivated lands. Fruit trees, tea, coconut, and rubber are cultivated on the northern hilly area of Bogor.

Agricultural products in the region are mainly marketed in Bogor City. Tourists frequent the historical sites in the city. The area is also known for its favorable climate and resorts. The rapid urbanization of Cibinong City, the capital of Kabupaten Bogor, has made the area the center of the cement and mining industry. A lot of housing developments are carried out in the area as well.

(e) Land Use Map

The present land use map is prepared based on topographic maps at a scale of 1/25,000 and 1/50,000, analysis of landsat images taken on the 22nd of September 1994, interpretation of aerial photographs of the area surrounding Jakarta taken on the 12th of July 1994, and city maps (JABOTABEK - 1/70,000, Tangerang - 1/60,000). Figure 2.4 shows the Present Land Use Map.

(2) Future Land Use Plan

DKI Jakarta and each Kabupaten formulate their own land use plans every ten years with authorization from the Central Government. The duration of the present land use plans of these areas is as follows:

Area	Duration
DKI Jakarta	1995 - 2005
Bekasi	1993 - 2003
Tangerang	1994 - 2004
Bogor	1995 - 2005

Future land use plan map at a scale of 1/250,000 is prepared based on the planning maps of DKI Jakarta and the Kabupatens. Figure 2.5 shows the prepared future land use plan map.

2.2 Topography and Geology

2.2.1 Topography

The Study Area can be divided geomorphologically into four zones : mountainous area, hilly area, valley plain area and coastal plain area. The characteristics of these area are presented below:

(1) Mountainous Area

The southern mountainous area above the 150 m contour line, located south of Kab. Bogor and includes the high volcanoes Salak (2,211 m) and Pangrango (3,019 m).

(2) Hilly Area

The hilly area between the contour lines of 150 m and 6 m; this area spreads out in a wide fan from south to north. The area has been dissected by many rivers having eroded deep and clearly defined valley; the depth of valley generally correspond to the scale of river.

(3) Valley Plain Area

The valley plain area along the river course in hilly area; this area has been formed by dissection of rivers; the boundaries between the hilly area are generally very clear. This area has relatively flat surface and long/narrow shape; the meanderings of rivers have been developed in the area.

(4) Coastal Plain Area

The alluvial coastal plain below the 6 m contour line; in this area, which in general is very

flat and swampy, the rivers are much less clearly defined and often have shifted their courses; natural levees have been distributed along the river course, on which partial embankments have been constructed; some old sand dunes have been distributed running parallel to the coastline; the elevation of inland old sand dunes are about 6 m above the sea-level corresponding to the high sea-level period of about 6,000 years ago. The coastline has moved northwards in historic times due to sedimentation. The width of this coastal plain ranges from 6 to 20 km.

2.2.2 Geology

West Java can be divided physiographically and structurally into four belts (Bemmelen, 1949) extending in the east-west direction and from south to north as below :

- Southern mountains of West Java,
- Bandung zone,
- Bogor zone,
- Lowland plain of Jakarta.

The Study Area (JABOTABEK) lies in the southern mountains comprising volcanoes located in the southern part of the Study Area, the Bogor zone of rolling hills in the southern part of Cibinong and western part of Bogor, and the lowland plain with an elevation lower than 100 m in the northern part of the Study Area.

All the main rivers in the Study Area originate in the southern mountainous area and discharge into the Java Sea after flowing through the hilly area of the Bogor zone and the flat lowland plain.

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

The geological map of the Study Area and the local stratigraphy are shown in Figures 2.6 and 2.7, respectively. (Sources: Geological Map of the Bogor Quadrangle, 1986, Geological Map of the Jakarta and Kepulauan Seribu Quadrangles, 1992),

2.3 Hydrology

2.3.1 Meteorology

The Study Area is located at the latitude 6°00'S to 6°50'S and the longitude 106°15'E to 107°15'E. The data on climate for recent 5 years(1985-1989) are collected from Badan Meteorologi dan Geofisika (BMG). According to the collected data, the feature of climate of the Study area as follows:

(1) Air Temperature

Annual average of monthly mean maximum, mean and mean minimum air temperatures at Tanjung Priok station as a typical station in coastal plain area are 30.3°C, 27.0°C and 24.5°C, respectively. On the other hand, those at Citeko station as a typical station in mountainous area are 25.2°C, 21.2°C and 18.9°C respectively. Much difference of air temperature between coastal plain area and mountainous area can be seen. But air temperature do not differ so much during a year in coastal plain area and mountainous area.

(2) Rainfall

Annual rainfall depth is about 1,800 mm in coastal plain, 2,500 mm in hilly area and more than 3,500mm in mountainous area in the Study area.

Monthly rainfall falls much in January and December and falls less in June to August. Monthly rainfall in mountainous area is, generally not so less in dry season, but that in coastal plain area is very less in dry season.

Average monthly rainfall and air temperature in these 5 years in the Study area are shown in Figure 2.8.

2.3.2 Rainfall

(1) Probable Rainfall

In consideration of the availability of rainfall data, probability analysis of annual maximum daily areal rainfall has been conducted for the basins of the Ciliwung river including that of the Krukut river and of the Cisadane river. At the same time, the probability analysis of annual maximum daily point rainfall at BMG station has been also conducted. These probable rainfalls for several return periods are shown in Figure 2.9 and summarized below:

(Unit: mm)

	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 (421km^2)	67 (69%)	86 (63%)	98 (61%)	114 (59%)	125 (58%)	137 (57%)
Cisadane (1411km^2)	49 (50%)	67 (50%)	79 (49%)	94 (49%)	105 (49%)	116 (49%)

According to these results, the relation between point rainfall and areal rainfall in the Study Area is estimated by following equations;

$P(A, F) = P(0, F)$ for $0 \leqq A < 3$ km^2

$P(A, F) = 1.0935\ A^{-0.1098} \times P(0, F)$ for $3 \leqq A < 1{,}500$ km^2

where $P(A, F)$: Areal rainfall for catchment area A and of frequency F; (mm)

$P(0, F)$: Point rainfall of frequency F; (mm)

(2) Design hyetgraphs

The design rainfall duration is determined to be 24 hours taking into account the rainfall characteristics and the scale of river basin in the Study area. Time distribution patterns prepared by the previous master plan are applied for runoff calculation.

2.3.3 Runoff

Objectives of the runoff analysis are to construct a flood runoff model of the each river system in Jabotabek based on the available hydrological data and to estimate the probable flood runoff for the flood control plans. The storage function method is applied as flood runoff model through calibration of coefficients from the available hydrological data.

(1) Basin and River System Model

Each river system is further divided into sub-basins for the flood runoff analysis taking into account topography, river system, flood control facilities, design control points, etc. The sub-basins divided are shown in Figure 2.10.

(2) Storage Function Method

A storage function model method is employed for calculation of flood runoff from each sub-basin and river channel. In general, there are some differences in runoff characteristics among basins. The parameters of storage function method can express those differences based on topographic data and land use. Schematic diagram of the basin and river channel model for each river system is illustrated in Figure 2.11.

(3) Calibration of Parameters

The parameters in the flood runoff model are calibrated by the actual floods in Cisadane river basin. Figure 2.12 shows comparison of the observed and simulated hydrograph at Btu Blue on several flood events. According to the simulation, both observed and simulated hydrographs coincide well, and parameters of the model are judged applicable.

(4) Influence of Urbanization to Runoff

The influence of future urbanization to runoff is estimated as follows by using established flood runoff model. The future flood runoff peak will be increased by about 50 % in average with that of the present.

Probable Flood Peak unit : m^3/s

River Systems	Design Scale (year)	Present Land Use (1995) <A>	Future Land Use (2025) <B>	B/A
Cidurian river	25	380	645	1.70
Cimanceuri river	25	249	282	1.13
Cisadane river	50	1368	1571	1.15
Cengkareng Floodway	100	242	616	2.55
Western Banjir Canal	100	444	602	1.36
CBL Floodway	50	521	774	1.49

2.3.4 Tide

According to the hourly tide record from 1985 to 1995 at Tanjung Priok station and from 1988 to 1994 at Sunda Kelapa station, monthly maximum and minimum sea levels relative to monthly mean sea level are shown in Figure 2.13 and typical tides are as follows:

Typical Tide	Tanjung Priok Station	Sunda Kelapa Station
Average Monthly Maximum	Mean Sea Level + 0.580 m	Mean Sea Level + 0.620 m
Average Monthly Minimum	Mean Sea Level - 0.558 m	Mean Sea Level - 0.556 m

2.4 Rivers and Related Structures

2.4.1 Watersheds

The Study Area, which has an area of 6,070 km^2 in total, is bounded on the south by the watershed line of the mountains south of Bogor, on the north by the Java Sea, on the east by the watershed between the Cilemahabang and Citarum rivers, and on the west by the watershed between the Cidurian and Ciujung rivers.

2.4.2 River Systems

Investigation of the topographical maps, previous studies and field reconnaissance have identified the present river systems in the Study Area as schematically shown in Figure 2.14.

The Study Area can be generally divided into 8 independent river basins and residual basins which include urban drainage area in DKI Jakarta encompassed by the Western and proposed Eastern Banjir Canals (refer to Table 2.8):

1. Cidurian River Basin (803 km^2)
2. Cimanceuri River Basin (570 km^2)
3. Cirarab River Basin (161 km^2)
4. Cisadane River Basin (1,411 km^2)
5. Cengkareng Floodway System Basin (459 km^2)

6. Western Banjir Canal System Basin (421 km^2)
7. Proposed Eastern Banjir Canal System Basin (207 km^2)
8. CBL Floodway System Basin (1,135 km^2)
9. Residual Basins and Urban Drainage Area in DKI Jakarta(712 km^2)

Total (6,070 km^2)

Principal dimensions of rivers are tabulated in Table 2.9. Characteristics of each river are mentioned below:

(1) Cidurian River

The Cidurian river is located in the westernmost of the Study Area. The Cidurian river originates in Mt. Kendeng (1,764 m) and flows into the Java Sea; the Cibeureum river, the main tributary, joins the main stream at the upstream of crossing point with the toll road from DKI Jakarta to Merak. The Cidurian river has a catchment area of 803 km^2 and a length of about 130 km at the river mouth. A floodway of about 5 km length was constructed from Desa Kedaung to the sea; the former river course was abandoned.

In the upper and middle reaches, the Cidurian river has formed deeply dissected valley. On the other hand, it flows through alluvial coastal plain in the lower reaches; natural levees have been distributed along the river course, on which partial embankments have been constructed.

Overall river improvement works have not been carried out yet; only local portion works such as partial embankment for irrigation area, rehabilitation of the embankment, protection works have been executed. On the right bank at Desa Kandawati, a dike breach portion has remained without rehabilitation.

The coastal floodplain has been utilized for agricultural land mainly composed of paddy field.

(2) Cimanceuri River

The Cimanceuri river originates in the low mountains with an elevation of approximately 600 m and flows into the Java Sea; the Cimatuk and Cipaseun rivers, the tributaries, join the main stream at the upstream of crossing point with the toll road from DKI Jakarta to Merak. The Cimanceuri river has a catchment area of 570 km^2 and a length of about 102 km at the river mouth.

In the upper and middle reaches, the Cimanceuri river has formed dissected valley. On the other hand, it flows through alluvial coastal plain in the lower reaches; natural levees have been distributed along the river course, on which partial embankments have been constructed. On the left bank at Desa Cirumpak and right bank at Desa Rancalabuh, dike breach portions have remained without rehabilitation.

The coastal floodplain has been utilized for agricultural land mainly composed of paddy field. In the middle reaches in and around Tigaraksa, large scale urban developments are now in

progress.

(3) Cirarab River

The Cirarab river originates in the hilly area with an elevation of only 60 m and flows into the Java Sea. The Cirarab river has a catchment area of 161 km^2 and a length of about 49 km at the river mouth.

In the upper and middle reaches, the Cirarab river has formed shallow dissected valley, whereas in the lower reaches, it flows through alluvial coastal plain. The coastal floodplain has been utilized for agricultural land mainly composed of paddy field.

(4) Cisadane River

The Cisadane river is the largest river in the Study Area, which originates on the northern side slope crowned by Mt. Kendeng (1,764 m), Mt. Perbakti (1,699 m) and Mt. Salak (2,211 m). The river flows through the city of Tangerang and flows into the Java Sea; main tributaries like the Cisindangbarang, Ciampea, Cianten and Cikaniki rivers join the main stream in the upper reaches near Parungbadak. The river basin involves vast mountainous area in the upper catchment, more than half of the basin. The Cisadane river has a catchment area of 1,411 km^2 and a length of about 138 km at the river mouth.

In the upper and middle reaches, the Cisadane river has formed extremely deeply dissected valley. On the other hand, it flows through alluvial coastal plain in the lower reaches; natural levees have been distributed along the river course, on which partial embankments have been constructed.

The fluvial terrace with elevation above 12.5 m has been utilized for the city of Tangerang, and the coastal floodplain has been utilized for agricultural land mainly composed of paddy field and for Sukarno-Hatta airport. In the middle reaches, large scale urbanization, like Modern Land, Lippo Village , Bumi Serpong Damai and others, are extending from Kodya Tangerang southward to Kec. Serpong.

Overall river improvement works have not been carried out yet; only local portion works such as partial embankment for irrigation area, rehabilitation of embankments and protection works have been executed.

(5) Cengkareng Floodway System

The Cengkareng Floodway System consists of the floodway, Mookervaart canal, Angke, Pesanggrahan, and Grogol rivers; the canal and rivers should be treated as tributaries of the Cengkareng Floodway. The Cengkareng Floodway System has a catchment area of 459 km^2.

(a) Cengkareng Floodway

In 1983, the Cengkareng Floodway was completed to divert flood of the Mookervaart canal, Angke, Pesanggrahan and Grogol rivers. This floodway, the Grogol Sekretaris Interceptor and Sarinah Thamrin pump station (present Cideng pump station) consist of the alternatives for abandoned extension of the Western Banjir Canal proposed by "Master plan for Drainage and Flood Control of Jakarta" (NEDECO, 1973). The length of the floodway is about 7.9 km. The Cengkareng barrage for flushing purpose is located downstream of the confluence of the Mookervaart canal.

(b) Mookervaart Canal

In 1920, the Mookervaart canal was constructed for the purpose of navigation and irrigation. However, the canal functions only as a drainage channel at present; the canal is under the control of DGWRD. The canal starts at the sewan gate connecting the Cisadane river in Tangerang; flows eastwards and meets the Cengkareng Floodway. The canal crosses at right angles the Cengkareng Floodway and finally joins the Lower Angke river, however, there is a flushing gate at the confluence with the floodway, east side from the floodway is now treated as an urban drainage channel under the control of DKI Jakarta.

The canal has a catchment area of 67 km^2 at the confluence with the Cengkareng Floodway and a length of about 13 km from the sewan gate to the floodway.

(c) Angke, Pesanggrahan and Grogol Rivers

The Angke and Pesanggrahan rivers originate in the hilly area north of the city of Bogor with an elevation of approximately 225 m and 175m respectively, and join the Cengkareng Floodway. Those rivers have catchment areas of 255 km^2 (including the Sepak river basin) and 107 km^2 and a length of about 82 km and 66 km at the confluence with the Cengkareng Floodway respectively.

The Angke river is divided into 2 parts by the Cengkareng Floodway, namely the Upper and Lower Angke rivers. The upper Angke river, upstream reaches of the floodway, is treated as a river under the control of DGWRD; the Lower Angke river, downstream reaches of the floodway, is treated as an urban drainage channel under the control of DKI Jakarta.

In the upper and middle reaches, the Angke and Pesanggrahan rivers have formed dissected valley; these rivers flows through alluvial coastal plain in the lower reaches. The river courses extremely meander.

The coastal floodplains have been mainly utilized for residential area. The upper and middle reaches will be completely urbanized in the near future.

The Grogol river originates in the hilly area, the suburbs of DKI Jakarta, with an elevation of approximately 100 m. The river has a catchment area of 30 km^2 and a length of about 21 km at the bifurcation of the Grogol Pesanggrahan Interceptor.

In 1973, the Grogol Pesanggrahan Interceptor was constructed to divert flood water of the

Grogol river to the Pesanggrahan river. Therefore, the Grogol river is divided into 2 parts; upstream reaches of the interceptor as a river under the control of DGWRD, and downstream reaches of the interceptor as a urban drainage channel under the control of DKI Jakarta.

(6) Western Banjir Canal System

The Western Banjir Canal (WBC) System consists of the present Banjir Canal (Western Banjir Canal), the Ciliwung and Krukut rivers; it has a catchment area of 421 km^2 at the confluence of the Krukut river.

(a) Western Banjir Canal

Flood control and drainage in the city of Jakarta have been a problem from the beginning. In 1918, the present Banjir Canal was constructed, starting at Manggarai on the Ciliwung river, and connecting lower reaches of the Angke river (Muara Angke river), encompassing the city of Jakarta at that time. The purpose of this construction was to collect the floods of the rivers coming down from the mountainous or hilly areas such as the Ciliwung and Krukut rivers and to divert them around the low-lying city towards the Java Sea.

The length of the canal is about 17 km. The Cideng and Grogol drains under the control of DKI Jakarta go under WBC through siphons. The Angke drain (Lower Angke river) joins the WBC at Pluit. The lowest reaches of the WBC extremely meanders leaving original alignment of former Angke river. The Manggarai and Karet barrages for mainly flushing purpose are located on the WBC.

(b) Ciliwung River

The Ciliwung river originates on the northern side slope of Mt. Pangrango (3,019 m); it flows through the city of Bogor; it is diverted to the WBC at the Manggarai barrage. The Ciliwung 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 Ciliwung 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 DKI Jakarta.

(c) Krukut River

The Krukut river originates in the hilly area, the suburbs of DKI Jakarta, with an elevation of about 100 m and joins the WBC at the upstream of the Karet barrage on the WBC. It has a catchment area of 84 km^2 and a length of about 34 km at the confluence with the WBC. In the upper reaches of the confluence with the WBC, the Krukut river has formed dissected valley and has almost no floodplain. Downstream reaches of the WBC, the river is treated as an urban drainage channel under the control of DKI Jakarta. Upper and middle reaches will be completely urbanized in the near future.

(7) Eastern Banjir Canal System

The construction of the Eastern Banjir Canal (EBC) was proposed by "Master plan for Drainage and Flood Control of Jakarta" (NEDECO, 1973). The purpose of this plan is to collect the floods of the rivers coming down from the hilly areas such as the Cipinang, Sunter, Buaran, Jatikramat and Cakung rivers and to divert them around the low-lying city towards the Java Sea. At that time, the alignment of the proposed EBC was determined by long-range expectations concerning the extension of the city eastwards. However, the construction of EBC has not been carried out yet due to budgetary limitation for land acquisition.

Proposed Eastern Banjir Canal System consists of the proposed EBC, and those rivers mentioned above, which will be treated as tributaries of the proposed EBC.

Those rivers originate in the hilly area, the suburbs of DKI Jakarta, with elevation from 30 to 120 m and are planned to join the proposed EBC. The catchment areas of those rivers upstream of the proposed EBC are ranging from 13 km^2 to 73 km^2; total catchment area of the system is 207 km^2.

In the upper reaches of the proposed EBC, those rivers have formed shallow dissected valley and have almost no floodplain. Upper and middle basins of those rivers will be completely urbanized in the near future. Those rivers go under the West Tarum Canal through siphon.

In the lower reaches of the proposed EBC, those rivers will not receive floods from the upper catchment of the EBC but collect only local rainfall in the urban area. The downstream reaches of the rivers will be treated as urban drainage channels.

(8) CBL Floodway System

The CBL Floodway System consists of the CBL Floodway, and the Bekasi, Cisadang, Cikarang and Cilemahabang rivers which should be treated as tributaries of the floodway.

(a) CBL Floodway

In 1985, the CBL Floodway (Cikarang-Bekasi-Laut Floodway) was constructed by Jatiluhur Irrigation Extension Project to divert flood of the Bekasi, Cisadang, and Cikarang rivers. The floodway has a catchment area of 1,135 km^2 and a length of about 29 km. Incidentally, the floodway was used to be called T.B.S Floodway (Tjikarang-Bekasi-Sea Floodway).

(b) Bekasi River

The Cikeas and Cileungsi rivers originate in the mountains with an elevation of about 1500 m. Those 2 rivers join each other in the south of Bekasi city. The downstream of the confluence, the river name becomes the Bekasi river. The Bekasi river flows through the city of Bekasi and joins CBL floodway. The Bekasi river, downstream of the floodway, has been abandoned and the former river course has partly been utilized as agricultural area.

The Bekasi river has a catchment area of 403 km^2 and a length of about 116 km at the confluence with the CBL Floodway.

In the upper and middle reaches, the Bekasi river has formed dissected valley. On the other hand, it flows through alluvial coastal plain in the lower reaches; natural levees have been distributed along the river course, on which partial embankments have been constructed.

The fluvial terrace with elevation above 12.5 m has been utilized for the city of Bekasi ,on which urban developments are now extending. The coastal floodplain has been utilized for agricultural land mainly composed of paddy field.

Overall river improvement works have not been carried out yet; only local portion works such as rehabilitation of embankments and protection works have been executed.

The Bekasi barrage, which was constructed in 1958, is always damming up the water level of the Bekasi river by about 8 m, to convey the water of West Tarum Canal from east to west. Therefore, in the city of Bekasi, upstream of the barrage, water level of the Bekasi river is considerably high. According to the Perum Otorita Jatiluhur office, the gates are kept closed even in flooding time. It is supposed that the gate closure in flood time may be one of the causes of inundation in upstream area of the barrage.

(c) Cisadang River

The Cisadang river originates in the hilly area with elevation of about 90 m and joins the CBL Floodway. As a result of construction of the floodway , the downstream reaches of the floodway remains only as a local drainage channel. The Cisadang river has a catchment area of 135 km^2 and a length of about 37 km at the confluence with the floodway.

The Cisadang river and its tributary go under the West Tarum Canal through culverts. Some portion of culverts has now been clogged by sedimentation. The vast, swampy area located just downstream of the Canal, which was suitable for retarding basin, was already reclaimed for factory construction.

(d) Cikarang River

The Cikarang river originates in the hilly area with an elevation of about 300 m and is diverted to the CBL Floodway by the gate at the city of Cikarang. As a result of construction of the floodway, the Cikarang river, downstream of the floodway, has remained as a drainage channel which collects only local rainfall. The Cikarang river has a catchment area of 230 km^2 and a length of about 66 km at the bifurcation with the floodway.

In the upper reaches of the city of Cikarang, it has formed dissected valley. The fluvial terrace with an elevation above 12.5 m has been utilized for the city of Cikarang, and on which urban developments are now extending.

Overall river improvement works have not been carried out yet; only local portion works such as rehabilitation of embankments and protection works have been implemented.

The Cikarang barrage, which was constructed in 1965, is always damming up the water level of the Cikarang river by about 6 m, to convey the water of the West Tarum Canal from east to west. According to Perum Otorita Jatiluhur office in the city of Bekasi, the gates are kept closed even in flooding time. It is supposed that the gates closure in flood time may cause the inundation in upstream area of the barrage.

(e) Cilemahabang River

The Cilemahabang river is located in the easternmost of the Study Area. The Cilemahabang river originates in the low hilly area with an elevation of only 50 m. The river course near the river mouth is unclear; the main stream joins the Java Sea and a branch is diverted to the Cikarang river. The river course in the lower reaches is very small and accordingly it is difficult to distinguish the river from other drainage channels. The Cilemahabang river has a catchment area of 220 km^2 and a length of about 63 km at the river mouth.

(9) Ponds and Reservoirs

There are 193 ponds and reservoirs, better known as Situ-situ in local name, in the Study Area. The areas of them range from 0.001 to 3.5 km^2; the water depth of them is generally very shallow ranging about 1 to 2 m. Large Situ-situ are concentrated in Kab. Tangerang; Situ Patrasana (3.5 km^2) and Situ Garugak (1.8 km^2) are located near the Cidurian river, and Situ Cipondoh (1.2 km^2) is located near the city of Tangerang. It is supposed that original area of Situ-situ were mostly widened by the embankment for irrigation purpose.

According to "Project Aid Proposal for Conservation Works of Situ-situ in the Jabotabek Area" (DGWRD, August 1994), total existing area of Situ-situ is 21.25 km^2; it accounts for 0.35 % of total Study Area (6,070 km^2). The areas of Situ-situ by districts are summarized as follows:

1) DKI Jakarta (1.68 km^2)
2) Kab. Bogor (5.15 km^2)
3) Kab. Tangerang (13.06 km^2)
4) Kab. Bekasi (1.36 km^2)

Total (21.25 km^2)

Geomorphologically, Situ-situ are generally located in shallow valley plain which are less dissected than those along big rivers. Few Situ-situ are countable in alluvial coastal plain. Many small Situ-situ are located at the upper end of valley plains where probably ground water springs out.

Some of Situ-situ are filled with water only in rainy season; some of them have been integrated into irrigation system, equipped with gates for supplying water.

As is represented by Situ Cipondoh, large Situ-situ near the city of Tangerang, the pond area is a treasure house of wild plants and animals. However, the number and area of Situ-situ have remarkably decreased, especially in recent years, by land reclamation accompanied by urbanization.

(10) Carrying Capacities of River Channel

Carrying capacities of the existing river channels are estimated by using the non-uniform formula based on the results of river survey conducted in the period of August to October 1995 by the Study Team. The estimated results are shown in Table 2.10.

2.4.3 Related Structures

Existing river structures in the objective rivers of the Study Area are principally weir(gated or non-gated), bridge(road or railway), culvert, sluice, siphon and intake gate.

(1) Gated Weir

The existing gated weirs in the objective rivers are being operated for purposes of flood control, irrigation, flushing and drainage. Locations of major gated weirs to be related to flood control plan in the Study Area are shown in Figure 2.15.

The Pasar Baru barrage, as illustrated in Figure 2.16, was constructed in 1937. In spite of rather well maintenance of mechanical equipment, it was investigated that a few units have been not operational and several units cannot be opened fully out of ten(10) units in total. It is mainly due to that floating matters jammed gate slots for its smooth operation. Similar floating matters are not scarce problem in the other gate operations. Replacement or rehabilitation of gates is necessary for an appropriate flood control operation of the Cisadane river.

(2) Culvert

There are so many culverts along the objective rivers at crossing positions with the other rivers or canals as well as roads. It is sometimes observed that the culvert structure prevents river from smooth flow due to clogging of soil and/or garbage deposit or insufficient scale design. Rehabilitation may be necessary for such structure site.

(3) Bridge

Number of existing bridges located along the objective rivers in DKI Jakarta is 232 of road bridges and 12 of railway bridges within a section that river improvement have been studied for flood control purpose. The number of bridges by river is as follows:

River Name	Number of Bridges		River Name	Number of Bridges	
	Road	Railway		Road	Railway
Mookervaart	27	-	Sunter	29	1
Angke	2	-	Buaran	12	-
Pesanggrahan	4	1	Cakung	21	-
Grogol	29	1	Cengkareng Floodway	13	1
Krukut	28	0	Sodetan Grogol	2	-
Ciliwung	35	5	Western Banjir Canal	15	3
Cipinang	15	-			
				232	12

2.4.4 Drainage Facilities

Existing related facilities and structures to the urban drainage system are generally classified into the drainage channels(including river and canal) with related structures including siphon, sluice and culvert, and the other structures such as bridge, gated weir, drainage pump, reservoir, etc.

(1) Pumping Station

In the DKI Jakarta, eighteen(18) pumping stations are existing for the urban drainage purpose. Its total installed capacity is 121.8 m^3/s. The pumping stations under construction is in four (4) locations and 39.7 m^3/s in its total capacity. The main features of those pumping stations and locations are shown in Table 2.11 and Figure 2.17, respectively.

(2) Reservoir (Waduk)

There are eleven(11) reservoirs existing in the DKI Jakarta, which are used as the retarding basin and regulation pond for the pump station. The reservoir total area is approximately 145 ha. Four(4) reservoirs are under construction with its total area of 23 ha. Features and locations of the existing and constructing ones are shown in Table 2.12 and Figure 2.17, respectively.

(3) Gated Weir

Table 2.13 shows the existing gated weirs in DKI Jakarta mainly for urban drainage, flushing and flood control purposes, which locations are shown in Figure 2.15.

2.4.5 Drainage and Wastewater Treatment

(1) Urban Drainage in DKI Jakarta

(a) Urban Drainage Technical Policy

The DKI Jakarta area is divided into two general zones in terms of the urban drainage policy. The first area is the central Jakarta area enclosed by the existing Western Banjir Canal and Cengkareng Floodway, and the proposed Eastern Banjir Canal. This area is mostly located in the low-lying area and always affected by the high tidal intrusion. The drainage condition cannot be improved only by gravity drain measure. The effective countermeasure is a combination one with gravity drain canal, retarding basin, drainage pump, gated weir and tidal gate.

The second area is out of the enclosed area by the banjir canals. The drainage measure is to drain off rain water through gravity flow channels including rivers and canals. Therefore, several low-lying area where area of the place is not so big, suffers rather serious inundation in water depth aspect. Inundation is sometimes caused by overtopping of river flood water in this area.

(b) Zoning

The whole area of DKI Jakarta is divided into the following three(3) regions which is further divided into ten(10) drainage zones:

Region	Drainage Zone	Catchment Area(ha)	Drainage System
I. Western Region	Zone - 1	11,300	Cengkareng Floodway
	Zone - 2	4,500	Grogol - Sekretaris
II. Central Region	Zone - 3	500	Muara Karang
	Zone - 4	17,350	Ciliwung - Banjir Canal
	Zone - 5	1,900	Pluit
	Zone - 6	1,100	Ciliwung - Gunung Sahari
III .Eastern Region	Zone - 7	2,760	Sentiong - Pademangan
	Zone - 8	1,250	Sunter Utara(Barat)
	Zone - 9	12,575	Sunter - Cipinang
	Zone - 10	8,050	Buaran - Cakung

Figure 2.18 shows the above zones and drainage systems.

(c) Urban Drainage System Under Management of DKI Jakarta

According to the agreement between the DPU and the DKI Jakarta, it was agreed that the DKI Jakarta takes a responsibility for the construction, operation and maintenance of the following facilities to be functioned as the urban drainage system:

River, Canal

Sepak riv.	Ciragil riv.	Ciliwung Gajah Mada riv.
Ulujami riv.	Mampang riv.	Anak Ciliwung riv.
Maruya riv.	Cideng riv.	Bara Timur riv.
Mookervaart riv.	Jelakeng riv.	Ancol riv.
Sekretaris riv.	Besar riv.	Sentiong-Sunter riv.
Pluis riv.	Krukut Bawah riv.	Cakung Lama riv.
Grogol riv.	Baru Barat riv.	Mati riv.
Sodetan Grogol Sekretaris	Kalibata canal	Podemangan Barat riv.
Jelambar riv.	Sodetan Bali Matraman	Podemangan Timur riv.
Duri riv.	Lower Ciliwung riv.	Other rivers in DKI Jakarta
Muara Karang riv.	Ciliwung Gunung Sahari riv.	

Gate/Syphon/Trush Rack

Pasar Ikan gate	Tangki gate	Cideng gate
Telukgon trash rack	Kali Duri gate	Bunderan Grogol gate
Pluit syphon/gate	Kampung Gusti gate	Kali Ciden syphone
Bendungan Jagi I&II gate	Jembatan Dua gate	Teluk Gong syphon
Manggarai II gate	Jembatan Merah gate	Gunung Sahari Trash rack
Krukut gate	Pekapuran gate	Other related facilities
Capitol gate		

Reservoir/Pump

Toman Barat res. and pump	Setia Budi Timur res. and pump	Sunter Timur III res. & pump
Grogol res. and pump	Pondok Bandung pump	Sunter Barat Utara res. pump
Rawa Kepa res. and pump	Cideng pump	Sunter Barat Selatan res.
Pluit res. and pump	Istana pump	Teluk Gong res. and pump
Muara Angke res. and pump	Mangga Dua Utara pump	Ancol res and pump
Setia Budi Barat res. and pump	Sunter Timur I res. and pump	Melati res.

Figures 2.19 and 2.20 show the schematic diagram and locations of the drainage rivers and canals, respectively.

(d) Urban Drainage Project

In the DKI Jakarta, various projects to mitigate the urban drainage problems have been carried out since 1920 when the Western Banjir Canal was completed. Major projects implemented to date are summarized as follows:

(i) Master Plan for Drainage and Flood Control of Jakarta(1973)
Stage : Master Plan
Objective Area : Whole Jakarta

(ii) Jakarta Drainage and Flood Control Project Phase II(1974 - 1976)
Stage : Detailed Design
Objective Area : Whole Jakarta

(iii) West Jakarta Flood Control Project(1985- 1992)
Stage : Construction
Status : Completed
Objective Area : (I) ; Menteng, Sarinah, Thamrin(750 ha)
(II); Grogol and Secretaris rivers

(iv) East Jakarta Flood Control Project(1987 -)

Stage : Construction
Status : Under Construction
Objective Area : Eastern part of DKI Jakarta(approx. 267 km^2)

(v) Ancol Drainage Pumping Station Project
Stage : Construction
Status : Under Construction
Objective Area : Ancol-Pademangan Drainage System(635 ha)
Sentiong-Sunter Drainage System(1,915 ha)

(vi) The Study on Urban Drainage and Wastewater Disposal Project in the City of Jakarta, Feasibility Study(1991)
Stage : Feasibility Study
Status : Detailed Design to be implemented in 1996
Objective Area : Cengkareng West(3,823 ha)

(vii) Major Drainage Work Component in Jakarta Urban Development Project II(1991)
Stage : Detailed Design
Objective Area : North Jakarta District and Central Jakarta District(7,500 ha)

Many of the existing urban drainage facilities are concentrated to locate in the already urbanized area of the DKI Jakarta, in other words, in the area of north central Jakarta. At present, a big scale of new construction works have been progressing in the north and east Jakarta to improve serious drainage condition in the area. Even in the other area in the DKI Jakarta, many projects, mainly of river or channel improvement, have been implementing aiming at early completion.

The Table 2.14 and Figure 2.21 show the having recently implemented projects. All of the projects incorporated in the above are categorized in a) under construction, b) detailed design on-going or completed, or c) proposed, as of 1991 when the previous JICA Master Plan Study was being conducted. The present status of implementation is also represented in the said table and figure. The zone numbering system in the table is the one used in the said JICA study (see Figure 2.22)

As seen in Figure 2.21, major problem areas in the north and central DKI Jakarta between Cengkareng Floodway and Cakung Drain are covered by the projects recently completed or ones under construction or ones of completed detailed design. As to the western DKI Jakarta, the previous JICA study conducted the feasibility study for the area of north half of Zone-I(refer to Figure 2.23). For an improvement of four areas in Zone-I shown in Figure 2.23, a detailed design works is expected to be conducted soon.

(2) Urban Drainage in JABOTABEK Urban Area

(a) Tangerang City

Tangerang City has no urban drainage system yet but be partly provided with the isolated local drain channel network in the respective area. Drainage system in this area is generally divided in the following three areas:

Central area on the right bank of the Cisadane river

This area is the most developed area of the city and has rather improved drain network towards the Mookervaart river as shown in Figure 2.26. There are some habitual inundation area which may be due to insufficient capacity of micro-drainage channel.

Area on the left bank of the Cisadane river

The area is between the Cisadane river and the Sabi river. Since the Cisadane river have been keeping high water level due to an operation of the Pasar Baru barrage aiming at irrigation water supply purpose, the most of drainage channel flow down towards the Sabi river, except area being just along the Cisadane river.

Area surrounded by Angke river, Ring road and Jl. Ciledug Raya

Several tributaries channel of the Angke river are used for a local drainage which cause inundation troubles due to its undevelopment. The Angke river may prevent this area from its well drainage condition due to backwater effect .

Improvement works of local drainage channels in the central area have been progressing as shown in Figure 2.26.

(b) Kotip Bekasi

The city area of Bekasi (Kotip Bekasi) has no urban drainage system yet but only isolated local drain channels. Local water of the urban area is drained off through such channels mostly to either Bekasi river or its tributaries.

(3) Wastewater Treatment

(a) Existing Facilities

(i) On-site Sanitation Facilities

Domestic On-site Sanitary Facilities

Toilet waste is either treated by individual septic tank or drained off without treatment. Gray water from kitchen, bathing and laundry is directly discharged to the drain.

On-site Sanitary Facilities of Commerce and Institution

According to the survey conducted by the previous JICA Master Plan Study, only

5.6 % of existing commerce and institutions in DKI Jakarta area as of 1991 have on-site package treatment facilities capable of treating both toilet waste and gray water. The remaining is being equipped with a septic tank only for toilet waste, or without treatment.

(ii) Sludge Treatment

The existing sludge treatment are operated at Pulo Gabang, Kebon Nanas and Duri Kosambi plants ,respectively. A tonal capacity of those plants is 660 m^3/s.

(b) JSSP

The JSSP is the mostly completed sewerage and sanitation project that is also called as the Setiabudi and Tebet pilot project. The area is surrounded by the Western Banjir Canal(north), Jl. Gatot Subroto (south), the Ciliwung river(east) and Jl. Jend. Sudirman (west), as shown in Figure 2.23.

(c) The Study on Urban Drainage and Wastewater Disposal Project in the City of Jakarta (Master Plan Study and Feasibility Study ; JICA ,1991)

The master plan proposed a sewerage development plan which covers an area of 16,604 ha in which the estimated population will be 6.35 million in year 2010. It was proposed that the area would be divided into six(6) sewerage development zones as shown in Figure 2.24. The proposed major facilities in each zone are summarized in Table 2.15.

The feasibility study was conducted for the priority area that is the northern portion of the central zone, while southern portion is the project area of on-going(as of the study period) Jakarta Sewerage and Sanitation Project(JSSP). Out of the area of 6,107 ha of the central zone, the priority area(defined as North Central Sewerage Development Area) have an area of 4,300 ha excluding the JSSP project area. The priority area is shown in Figure 2.23. Out of the priority area, the area to be covered by sewerage development system is 3,847 ha excluding area for rivers, parks, ponds and reserved area.

(d) Sewerage Development Proposal by PAL Jaya in 1995

The Persahaan Daerah Pengelolaan Air Limbah (PD PAL Jaya) prepared the sewerage development proposal for DKI Jakarta. The service area will be 13 areas and about 5,800 ha in total area for which total plant capacity will be about 9,600 l/sec.

2.5 Flooding

2.5.1 Flooding in DKI Jakarta

Many and large areas in the DKI Jakarta have been suffered serious flooding and inundation of long duration due to various factors. Several inundation maps and survey report on inundation data were collected for recent years(during 1991 to date) which information are

integrated in Figure 2.25. The information incorporated and superimposed in the figure are extracted from the following materials:

(a) Inundation data extracted from Buku Daftar Evaluasi Genangan Tahun 1991/1992 di DKI Jakarta
(b) Buku Pedoman Pelaksanaan Pengendalian Banjir Periode 1992/1993, PDKIJ DPU
(c) Peta Genangan Yang Terjadi Tahun 1993/1994, Wilayah DKI Jakarta, DPU DKI Jakarta
(d) Peta Lokasi Genangan Air DKI Jakarta, Tahun 1994/1995, PSAPB(Ciliwung - Cisadane), DPU
(e) Buku Pedoman Pelaksanaan Pengendalian Banjir Periode 1995/1996, PDKIJ DPU
(f) Information from DPU DKI Jakarta on Inundation Factors in each Habitual Area

Major inundation factors identified from the above information are generally summarized as follows:

(a) Low-lying area or located in flood plain
(b) Insufficient carrying capacity of the rivers and the existing drainage system
(c) Improvement/Construction works are not completed yet
(d) Backwater effect of a river on the related drainage canal(s)
(e) Clogging of canal with soil and/or garbage sediment

On Figure 2.25, the inundation locations are classified into the following three categories according to the inundation area and depth:

(a) Class I : Serious area
(b) Class II : Rather serious area
(c) Class III : Light area

It is observed in Figure 2.25 that the class I and class II locations are concentrated in the following area:

(a) East coastal area : It is most north-east part of the DKI Jakarta and between the Sentiong river and the Cakung Drain. This area is very low-lying area where the Sunter east and Sunter west polder projects are on-going. Inundation area seems to be very big but depth is not so high.

(b) Cipinang river area : The area near the confluence with the Sunter river is located in low-lying area where both inundation area and depth are big.

(c) Ciliwung river area : The area along the Ciliwung river where is the upstream reaches of the confluence with the Eastern Banjir Canal suffers serious inundation.

(d) Krukut river area : The area near and upstream reaches with the Mampang river suffers one of the most serious inundation in the DKI Jakarta in terms of inundation area and depth. Some places located in the low-lying area where was previously the flood plain of the Krukut river.

(e) Pesanggrahan river area : There are some serious areas along the Pesanggrahan river. The most conceivable reason of serious inundation may be due to no improvement of the Pesanggrahan river and locations on the flood plain.

2.5.2 Flooding in Kotamadya Tangerang

According to the information in the study report titled "Proyek Perencanaan Teknis Sistem Drainase Kotamadya Tangerang 1993/1994", the habitual inundation area in the Tangerang city is broadly classified in two (2) categories in location aspect. One is in and around the central town area of the city where is in the catchment of Cisadane river or nearby. The second one is in the catchment of the Angke river where is rather recently developed residential area. The all locations are shown in Figure 2.26.

A scale of the inundation in both areas is not so serious in terms of inundation area and depth as well as inundation duration as long as data is available. It is conceivable that the inundation places in the catchment of the Cisadane river may be affected by the high water level of the said river due to the following reason:

(a) Difficulty of drainage of this area toward the Cisadane river since water level of the river is always dammed up by the Pasar Baru barrage.
(b) Backwater effect of the Cisadane river to the Sabi river during a flood of the Cisadane river.

As to the places located between the Angke river and the future Ring Road, it is conceived that the inundation factors are mainly due to the present condition of the local drainage and some effect of the Angke river as follows:

(a) No development yet of the local drainage system
(b) Incomplete or deteriorated structures such as concrete wall, sluice gate, etc.
(c) Obstruction of garbage and soil deposit in river channel, and
(d) Backwater effect of the Angke river to the local drain channel.

2.5.3 Flooding in Tangerang, Bekasi and Bogor Area

In the Study Area, the causes of flooding are classified into several kinds as follows:

(a) overflow from river;
(b) inadequate land use in valley plain along the river functioning as a natural retarding basin;
(c) landside water inundation of tributary due to the influence of backwater effect of the main stream;

(d) overflow from local drainage channels due to the insufficient capacities; and
(e) flooding caused by the operation and maintenance of irrigation facilities such as intake weir, gate and irrigation canal.

Some flooding occurs not only by one cause but also by combination of plural causes mentioned above.

Outside of DKI Jakarta area, availability of past flooding records is limited compared with those in DKI Jakarta. Accordingly, field reconnaissance and interview survey in the field have been carried out carefully to supplement the information. It is especially important to distinguish the cause of flooding between overflow from the rivers and others. Because the former is the target flooding which should be mitigated by the Flood Control Master Plan. On the other hand, the latter should be treated as a local drainage problem.

(1) Flooding in Tangerang Area

Past flooding condition in Tangerang area is compiled as shown in Figure 2.27, by using available past flood area maps prepared by PU Pengairan Tangerang and previous study reports, by supplementing the information through interview survey in the field. Concerning the Cidurian and Cisadane rivers, detailed study on past floodings has been carried out by "Cisadane River Basin Development Feasibility Study" (DGWRD, August 1986).

(a) Cidurian River

Flooding has occurred along the embanked reaches in coastal plain, downstream of the toll road from DKI Jakarta to Merak, due to mainly dike breach and overflow. Flooding in December 1981, February 1985 and December 1993 were the big floodings in these decades.

Dike breach occurred on the right bank in Desa Kandawati in 1981 flood. According to the previous report above mentioned, since 1982, the broken points have been improved twice by the government and then twice by the public. However, the embankment is keeping broken shape still now because of the subsequent repeated flood. Consequently, overflow from the broken point occurs almost every year. In 1993 flood, an army was sent out to rescue the inhabitants in Kec. Kresek.

Flooding also occurred due to operation and maintenance of irrigation facilities such as intake weir, gate and irrigation canal.

(b) Cimanceuri River

Flooding in December 1981 were the big floodings in these decades. Flooding has occurred along the embanked reaches in coastal plain due to mainly dike breach and overflow. Dike breaches have occurred at Desa Rancalabuh on the right bank and Desa Cirumpak on the left bank. The embankments are left without rehabilitation works still now. Consequently, overflow from those broken points occur almost every year and flood water flows down to

the villages located downstream.

In Kota Tigaraksa upstream of the toll road from DKI Jakarta to Merak, flooding has also occurred in the dissected narrow valley plain.

(c) Cisadane River

Flooding has occurred along the embanked reaches in coastal plain, downstream of the toll road from DKI Jakarta to Merak, and the city of Tangerang mainly by dike breach and overflow. Flooding in December 1981 and February 1985 were the big floodings in these decades. The dike breach occurred at Desa Kedaung Wetan in 1981 and 1985 repeatedly.

The Cisadane river has overflowed in the city of Tangerang in 1981 and 1985. One of the reasons of flooding is supposed to be prolonging backwater effect of the Pasar Baru barrage located downstream; dam up of water level reaches by about 10 m. Judging from the maintenance condition at present, it is supposed that the gates could not be operated appropriately in flooding time.

(2) Flooding in Bekasi Area

Information about the past floodings in Bekasi area is limited compared with those in Tangerang area. Past flooding condition in Bekasi area is compiled as shown in Figure 2.28, by using available past flood area maps prepared by Perum Otorita Jatiluhur and by supplementing the information through interview survey in the field.

In the downstream areas of the Bekasi, Cisadang and Cikarang rivers, PROSIJAT irrigation area, the flooding is remarkably decreased by the CBL Floodway constructed in 1985. It is said that 70 % of habitual inundation in the downstream areas is relieved from flooding at present, but remaining 30 % of the area has still been suffering from flooding. In this area, flooding is not caused by the overflow from the mainstream, but by the landside water inundation or the overflow of local drainage channels due to the insufficient capacities.

The Bekasi river has overflowed in the newly developed residential area, which is located in the downstream reaches of confluence of the Cikeas and Cileungsi rivers. In rainy season of 1993 and 1994, flooding occurred in this area; depth of inundation water reached about 1 m. It is supposed that one of the reasons of flooding is prolonging backwater effect of the Bekasi barrage located downstream, because the gates are kept closed even in flooding time and the dam up of water level reaches up to about 8 m.

(3) Flooding in Bogor Area

As a result of the review of previous studies as well as the interview survey in the field, it was confirmed that few floodings have occurred as shown in Figure 2.29.

The reasons above are that the Cisadane river flows along the west margin of the city of Bogor having deeply dissected valley; the Ciliwung river also flows through the center of the

city forming dissected valley; whereas, the city of Bogor is located on the considerably high hilly area high above the rivers.

2.6 Water Resources and River Water Quality

2.6.1 Water Use

(1) Surface Water Use

(a) Water Use Facilities Including Existing Reservoirs and Water Conveyance System

The water supply to municipal and industrial, irrigation and fishery water sectors in JABOTABEK area has been carried out by developing the surface water resources in the Citarum river, which is one of the main water sources for the eastern part of JABOTABEK area, and the objective rivers for the Study, and by providing shallow and deep groundwater wells.

Presently, dam and reservoir for regulating river water flow and for stabilizing water supply are provided only in the Citarum river basin in around JABOTABEK area as shown in Figure 2.30; namely, the Jatiluhur, Cirata and Saguling dams with a total gross storage volume of 5,354 million m^3, which were constructed in 1969, 1985 and 1988 respectively.

Many water conveyance systems have been constructed in order to supply raw water mainly to irrigation sector in JABOTABEK area as indicated in the aforesaid Figure 2.30.

The aforesaid canals and intake structures have been constructed since the beginning of the 20th century and contributed to economic development in the areas. While, since reduction of their capacities due to sedimentation in the canals and slope failure along the canals had been remarkable, the improvement and rehabilitation works were done for some of the canals. In addition, the study team identified through the investigation for the existing weirs that the gate structures at the Pasar Baru barrage in the Cisadane river and the CBL weir in the Cikarang river needs the rehabilitation.

(b) Municipal and Industrial Water Use

The surface water amount taken in for M&I water use from the major rivers in JABOTABEK area which are based on the data provided by the Dinas PU at Bekasi, Tangerang, Bogor and Serang as well as the data obtained by the previous studies are as follows:

(unit : l/s)

Rivers/Conveyance System	DKI Jakarta	Bogor	Tangerang	Bekasi	Total
(1) Citarum/WTC	15,100	-	-	875	15,975
(2) Cibeet	-	-	-	1	1
(3) Cikarang	-	20	-	229	249
(4) Bekasi		682	-	490	1,172
(5) Sunter	50	1	-	-	51
(6) Ciliwung		2,104	-	-	2,104
(7) Angke	5	32			37
(8) Cisadane	2,800	2,163	3,794		8,757
(9) Cimanceuri		10			10
(10) Cidurian			8		8
Total	17,955	5,012	3,802	1,595	28,364

As for commercial use, there are no sufficient data in order to analyze and grasp present commercial use condition even in JABOTABEK area. JWRMS roughly estimated on the basis of production data provided by the water supply companies in JABOTABEK area that total water demands in commercial and service sectors corresponded to about 20 % to 40 % of the municipal water demands.

(c) Irrigation Water Use

The major existing irrigation systems in JABOTABEK area are as follows:

Irrigation System	Water Source	Irrigation Area as of 1990 (ha)
a) Prosijat area	Citarum, Cibeet, Cikarang and Bekasi	65,845
b) Prosida-Cisadane	Cisadane	31,156
c) Empang	Cisadane	5,791
d) Cidurian-Rancasumur	Cidurian	10,805
e) Cicinta	Cicinta	1,371
g) Katulampa	Ciliwung	3,853
Total		118,821

Presently, large scale irrigation areas such as Prosijat and Cisadane areas have higher intensities than those in other areas where the water availability in both the dry and wet seasons is rather limited comparing with their irrigation areas.

(d) Fishery

Two types of inland fishery, namely fresh water fishery in paddy field and river course and brackish water fishery along the coastal area facing the Java Sea, have been carried out in the study area. Water requirement of fresh water fishery is negligibly small comparing with

irrigation and municipal and industrial water demands according to BTA-155 study. On the other hand, intensive fishery developments has been made since 1985 for shrimp production by using the return flow of the existing irrigation areas or river flow, but traditional tambak areas still occupies the major part of the sector as given in the following table showing areas of brackish water fishery in 1988:

Description	Serang	Tangerang	Bekasi	Total
Private firms (PT) in 1985	269	797	11	1,077
Semi-intensive development since 1985	250	379	150	779
Traditional tambaks	5,018	3,478	6,266	14,762
Traditional tumpang sari	-	-	800	800
Total	5,537	4,654	7,227	17,418

Source : Cisadane-Cimanuk Integrated Water Resources development (BTA-155), 1989

(2) Groundwater Use for Municipal and Industrial Water Supply

The shallow and deep groundwater in JABOTABEK area is intensively utilized as the main water source for M&I water supply. Currently, deep groundwater wells of 2,681 in total is registered to the Directorate of Environment and Geology (DEG) and PAM Jaya but there are no data on shallow wells in JABOTABEK area.

Therefore, the JWRMS estimated the amount of groundwater abstraction for M&I water use in JABOTABEK area as of 1992 based on the survey as follows:

(unit : m^3/s)

Groundwater Use	Shallow Groundwater		Deep Groundwater		Total	
	DKI Jakarta	Botabek	DKI Jakarta	Botabek	DKI Jakarta	Botabek
Doniestic	8.8	10.6	0.1	0.1	8.9	10.7
Commercial and Services	2.0	1.9	1.6	0.5	3.6	2.4
Industry	0.5	0.4	2.5	1.8	3.0	2.2
Total	11.3	12.9	4.1	2.4	15.4	15.3

In estimating the above water abstraction amount utilized, the JWRMS assumed the number of real abstraction wells at three (3) to four (4) times of the registered wells to the DEG and PAM Jaya in DKI Jakarta. As seen in the table, the water amount of 15.4 m^3/s is estimated to be abstracted in DKI Jakarta in 1992 while the safe yields in DKI Jakarta was considered to be 3.6 m^3/s by the feasibility study on Cisadane River Basin Development Project. With respect to Botabek area, the current abstraction amount of 15.3 m^3/s, also, exceeds the safe yields of about 11 m^3/s estimated by the mentioned feasibility study.

Among the impacts due to the mentioned over-abstraction of the shallow and deep groundwater, the JWRMS reported that increase of flooding and drainage congestion to be induced by the land subsidence is one of the most significant issues and that it may need further improvement of the existing flood control and drainage systems.

2.6.2 River Water Quality

It has been reported that the water quality of rivers has been deteriorated year by year due to influx of domestic and industrial waste water into the rivers in JABOTABEK area, especially in Bogor and Jakarta, with high population density and industrial activities.

Under the mentioned situation, an intensive water sampling and analysis were carried out by the JUDP-II at the locations shown in Figure 2.31 for 7 months during the dry season in 1992. According to the result of the mentioned investigation, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO) and ammonium (NH_4), which are usually utilized as indicators showing degree of water pollution due to influx of domestic waste water into rivers, are summarized as follows:

(unit : mg/l)

Rivers	BOD	COD	DO	NH_4
1. Cidurian	0.5 to 4.5	5.0 to 30.0	5.0 to 8.5	0.0 to 0.4
2. Cimanceuri	1.0 to 4.0	10.0 to 30.0	3.0 to 6.5	0.0 to 0.6
3. Cirarab	1.0 to 5.0	7.0 to 26.0	2.0 to 8.0	0.0 to 0.9
4. Cisadane	1.0 to 6.0	1.0 to 35.0	4.0 to 9.0	0.0 to 0.6
5. Angke	2.0 to 32.0	5.0 to 60.0	0.1 to 7.0	0.0 to 4.6
6. Pesanggrahan	1.0 to 6.0	5.0 to 50.0	1.5 to 8.5	0.1 to 1.4
7. Grogol	10.0 to 70.0	45.0 to 90.0	0.1 to 1.2	5.0 to 15.0
8. Krukut	10.0 to 35.0	20.0 to 55.0	0.2 to 1.4	1.5 to 13.0
9. West Banjir Canal	3.0 to 8.0	10.0 to 30.0	0.2 to 2.5	0.2 to 3.7
10. Cipinang	15.0 to 30.0	20.0 to 90.0	0.0 to 1.0	1.0 to 5.0
11. Ciliwung	1.5 to 8.0	1.0 to 50.0	2.5 to 7.5	0.1 to 0.8
12. Sunter	5.0 to 20.0	10.0 to 60.0	0.5 to 3.0	0.4 to 1.9
13. Bekasi	2.0 to 30.0	1.0 to 110.0	1.0 to 7.0	0.1 to 2.2
14. Cikarang	1.5 to 6.0	10.0 to 95.0	2.5 to 7.0	0.1 to 0.8
Standard in Java Province and DKI Jakarta	no standard	no standard	more than 3.0	less than 0.5
Standard in Bekasi and Tangerang	20 to 300	40 to 600	no standard	0.02 to 20

All the indicators obviously describe that high values have been observed through the dry season in the downstream of the Angke, Grogol, Krukut, Cipinang and the Bekasi, and the middle reaches of the Sunter, comparing with the standards in JABOTABEK area. These rivers are running through Jakarta and/or Bogor with high population density, and therefore, most of them are judged to be affected mainly by domestic and commercial waste water.

While, the JICA Study Team undertook river water quality investigation at 41 locations for 19 rivers from the Cidurian till the Cikarang in JABOTABEK area in October 1995. The water sampling locations are shown in Figure 2.32. The result of water quality test is summarized as follows:

(unit : mg/l)

Rivers	COD	DO	NH_4
1. Cidurian	3.9 to 27.0	3.7 to 7.4	not detected
2. Cimanceuri	8.7	4.7	not detected
3. Cirarab	56.0	not detected	2.60
4. Cisadane	4.6 to 7.5	4.0 to 6.1	not detected
5. Mookervaart Canal	6.3 to 32.0	not detected	1.48
6. Angke	8.2 to 22.0	2.0 to 3.3	0.0 to 0.24
7. Cengkareng Floodway	23.0	not detected	0.65
8. Pesanggrahan	3.8 to 4.8	1.2 to 2.4	0.28 to 0.33
9. Grogol	6.6	not detected	0.78
10. West Banjir Canal	5.0 to 8.8	0.0 to 2.8	0.22 to 0.28
11. Krukut	6.2	1.4	2.00
12. Ciliwung	3.5 to 7.8	2.2 to 8.7	0.0 to 0.88
13. Cipinang	24.0	not detected	1.02
14. Buaran	43.0	8.0	10.60
15. Sunter	3.3 to 22.0	1.4 to 6.0	0.0 to 1.02
16. Bekasi	3.6 to 44.0	4.0 to 10.0	0.0 to 0.24
17. West Tarum Canal	4.5 to 6.8	4.0 to 7.0	0.0 to 0.20
18. CBL Floodway	5.6 to 30.0	2.3 to 8.0	0.0 to 4.40
19. Cikarang	4.2	8.2	not detected
Standard in Java Province and DKI Jakarta	no standard	more than 3.0	less than 0.5
Standard in Bekasi and Tangerang	40 to 600	no standard	0.02 to 20

It may be concluded on the basis of the water quality analysis carried out by the JUDP-II and JICA study team, that the water quality in the downstream of the rivers flowing down in Jakarta and Bogor has been deteriorated by intrusion of domestic and industrial waste water, as reported by the previous investigations.

2.6.3 Land Subsidence

The possibility of land subsidence in DKI Jakarta has been reported by the previous studies and therefore the DGWRD, DKI Jakarta and the related agencies have provided monitoring wells and leveling survey on elevation of the existing bench marks in Jakarta has been carried out periodically since 1989.

Figure 2.33 shows the lowered depth between 1974/1978 to 1993/1994. The lowered areas with a significant degraded depth of about more than 60 cm are as follows:

Location	Difference between Elevation from 1974/1978 to 1993/1994	Drainage System
Jl. Daan Mogot in Kec. Jakarta Barat	0.6 m to 1.0 m	Mookervaart canal
Jl. Pangeran Jayakarta in Kec. Jakarta Pusat	0.6 m to 0.9 m	Ciliwung river
Jl. Perintis Kemerdekaan in Kec. Jakarta Timur	0.6 m to 0.7 m	Sunter river

The JWRMS preliminarily simulated the future extent of land subsidence under combination of groundwater management strategy with the water demand scenarios as shown in Figure 2.34. According to the result of the simulation, land subsidence was predicted to further be progressed till 2025 even if the groundwater abstraction is stopped in 1995, and lowered depth, currently 50 cm to 100 cm, will become about 200 cm in 2025. Also, If there will be no restriction, lowered depth will exceed 400 cm.

Presently, the Government of Indonesia is managing the groundwater use by specifying the conservation zones of I to IV in DKI Jakarta as shown in Figure 2.5-6, which was set up mainly taking into account the salinization and decline of piezometric groundwater levels at the existing monitoring wells:

(1) Zone I : no restrictions on groundwater pumping
(2) Zone II : groundwater abstraction only permitted below 40 m of depth
(3) Zone III : groundwater abstraction only permitted below 140 m of depth
(4) Zone IV : no groundwater abstraction permitted, except for local fresh water occurrences deeper than 250 m

2.6.4 Previous Studies and Plans

(1) Water Resources Management

(a) Major Studies Related to Water Resources Management

The studies on water resources management including its development in the JABOTABEK area have been carried out by the DGWRD in order to meet the water demands in the various water sectors in JABOTABEK area. The recent studies covering management and development of the surface and/or subsurface water resources are; the feasibility study on Cisadane River Basin Development Project in 1987, financed by the IBRD; Cisadane-Cimanuk Integrated Water Resource Development in 1990 by the Dutch Government, and the JABOTABEK Water Resources Management Study in 1994 by the IBRD.

(b) JABOTABEK Water Resources Management Study (JWRMS)

Scenarios for Water Resources Management Including Development

The JWRMS applied the scenarios for managing both the surface and ground water resources during the period until 2025. The JWRMS set out the conceptual three (3) scenarios for the management as given in Table 2.16; scenario A with high economic growth; scenario B with low economic growth; and scenario C with high economic and managed growth.

With respect to water resources management, the scenarios A and B assumed that the main water source for municipal and industrial (M&I) water supply would be still groundwater, and that development of surface water is delayed due to the low investment of the Government. While, the scenario C would divert the main water source for the M&I water supply from the ground water to the surface water in order to cope with such problems related to the over-abstraction of ground water as land subsidence and lowering of ground water table.

Groundwater Management Strategy

The JWRMS identified that the significant problems related to the groundwater use are; 1) land subsidence induced by over-abstraction of deep groundwater in the northern part of DKI Jakarta, 2) pollution of shallow groundwater due to intrusion of waste water, and 3) lowering of groundwater table predicted to be caused by the intensive and concentrating abstraction. To improve the mentioned situations, the JWRMS recommended the following measures:

Management Issues	Improvement Measures
1) Reducing or controlling the abstraction of medium to deep ground water in the northern part of DKI Jakarta	a) licensing to water users b) provision of high groundwater tariff c) provision of alternative water source (piped water supply system) d) subsidizing piped water supply system
2) Reducing or controlling the abstraction of shallow ground water	a) licensing to water users b) provision of high groundwater tariff c) provision of alternative water source (piped water supply system) d) subsidizing piped water supply system
3) Promoting and extending groundwater abstraction in selected zones	a) licensing to water users b) provision of low groundwater tariff c) provision of alternative water source (piped water supply system) d) subsidizing piped water supply system
4) Groundwater recharge enhancement	a) provision of roof catchment recharge system b) open pavement
5) Groundwater pollution control	a) relocating risky industries b) regulations on production and uses of pollutants c) pollution tax d) obligatory waste water treatment e) provision of sewerage systems f) reclaiming polluted sites

Surface Water Resources Management Strategy

The JWRMS set up priority ranking for water allocation to various water users; 1) the existing irrigation and M&I water demand, 2) additional M&I water demand, 3) new irrigation development, 4) aqua-culture, 5) flushing water, and 6) hydropower generation.

The strategy for surface water resources development during time horizon till 2025 were formulated for both the scenarios of A and C as given in Figure 2.35. The proposed strategy is called as "strategy 5" and has multi-objectives to; 1) balanced water supply to DKI Jakarta, which provides the water supply sources both in the west (the Ciujung and Cidurian) and the east (the Citarum) to DKI Jakarta; 2) safe drinking water sources, which could prevent water pollution along water conveyance system and minimize the use of polluted water in the Cisadane and Bekasi rivers passing through Bogor city area; and 3) maximum gravity supply to Bogor.

(2) Water Quality Management

In JABOTABEK area, the Government of Indonesia has carried out the studies and programs for managing river water quality. In these years, the major ones are; a) Proyek Kali Bersih (PROKASIH: clean river program); b) JABOTABEK Water Resources Management Study, and c) Water Quality Control Management in JABOTABEK.

Outline of the mentioned studies and program is described in the following sub-sections:

(a) PROKASIH

The PROKASIH is going on by the local governments under the BAPPEDAL for specified twenty two (22) river systems in eleven (11) provinces, focusing on industrial sewage. The Provincial Government of West Java and DKI Jakarta are implementing the program for the Ciliwung, Cisadane, Bekasi, and Cipinang rivers and Mookervaart canal among the aforesaid rivers. The program includes monitoring of waste water quality from the industrial factories and provides instruction to the factory owners to give appropriate measures for improving the waste water quality, when the quality exceeds the national standard for industrial sewage.

As a result of the implementation of the PROKASIH, the toxic effluent has been decreased in Jakarta through monitoring of river water quality. While, in Botabek, it, currently, is judged that monitored data are insufficient for evaluation of the program and that further continuous monitoring is necessary.

(b) JABOTABEK Water Resources Management Study (JWRMS)

The JWRMS was carried out by the DGWRD under JUDP-II Project between June, 1991 and February, 1994 as described in the aforesaid section 3.4. The study concluded on the water quality as summarized as follows:

West Tarum Canal

It is identified that there are no significant problems on river water quality of the WTC, which are currently utilized as one of the main water sources for domestic water supply in DKI Jakarta and Bekasi. But, during the period till 2025, it is predicted that river water quality in the WTC will be deteriorated by high concentration of organic material and influx of municipal and industrial waste water in the rivers running through Bogor. From this prediction, it is recommended to upgrade the WTC by provision of syphon structure at the existing Cikarang and Cibeet weirs and pipelines to the water treatment plants for preventing the intrusion of polluted water in the related rivers into the WTC.

Cisadane river

The JUDP-II is constructing a water treatment plant at Serpong, which will take water amount of 3 m^3/s for municipal and industrial water supply to Jakarta. The JWRMS identified that values of dissolved oxygen and BOD in 1990 fully meet the drinking water criteria, but since it is predicted that the significant water pollution is predicted by intrusion of untreated waste water from municipal and industrial water uses, high concentration of organic material and potential problems and risks in the upstream activities such as efflux of heavy metals from the gold mining and waste water from nuclear research station at Serpong, it is strongly recommended to concentrate all pollution control efforts for maintaining the water quality of the Cisadane at acceptable levels.

Flushing water supply to DKI Jakarta

Taking into consideration of the large amount of flushing water required to maintain the river water quality to the acceptable level, it is concluded that construction of dams/reservoirs and conveyance canals are unrealistically expensive, and therefore, no water resources development for flushing water is proposed in the JWRMS.

(c) Water Quality Management in JABOTABEK (WQMJ)

The study on Water Quality Management in JABOTABEK (WQMJ) is being undertaken under financial assistance of the World Bank and the French Government in order to; 1) set up the Cisadane Water Data Center (WDC) and finally develop JABOTABEK WDC, and 2) formulate an integrated and comprehensive master plan for water quality management and pollution control in JABOTABEK area including short term (2005), medium term (2015) and long term (2025) plans.

2.7 River Water Management

2.7.1 Observation Facilities

Observation facilities on rainfall and water-level in the JABOTABEK area are as follows:

Ordinary rainfall gauging station (daily rainfall)	42 places
Automatic rainfall gauging station	16 places

Ordinary water-level gauging station	4 places
Automatic water-level gauging station	16 places
Tide level gauging station	2 places

These gauging stations are under the control of following institutions:

Rainfall

BMG : Badan Meteorologi dan Geofisika
PDSA : Pengembangan Data Sumber Air
(PWSCC: Ciliwung-Cisadane River Basin Development Project)
IHE : Institute of Hydraulic Engineering
PLTA : Pembangkit Listrik Tenaga Air

Tide

Dinas Hidro - Oseanografi TNI - AL
P.T. (Persero) Pelabuhan Indonesia II

Water-level

PDSA : Pengembangan Data Sumber Air
POJ : Perum Otorita Jatiluhur

Other than these, data on weir site such as water-level, discharge and opening of gate are sent to POJ Bekasi in the eastern area, to PWSCC and DKI Jakarta in the central area and to Cabang DPU Tangerang (branch office of public work services of Tangerang) in the western area.

2.7.2 Barrages

Existing major barrages on rivers in JABOTABEK AREA are as follows:

Cilemahabang barrage	Cilemahabang river
Cikarang barrage	Cikarang river
Bekasi barrage	Bekasi river
Katulampa barrage	Ciliwung river
Manggarai barrage	Ciliwung river
Karet barrage	Western Banjir Canal
Pondok Pinang barrage	Grogol river
Koneng barrage	Pesanggrahan river
Polor barrage	Angke river
Cengkareng barrage	Cengkareng floodway
Pasar Baru barrage	Cisadane river
Rancasumur barrage	Cidurian river

2.7.3 High Water Management

(1) Communication

In the DKI Jakarta area, rivers and related facilities of the Angke to Cakung rivers are under the control of PWSCC and DPU DKI Jakarta separately.

In rainy season, both agencies set up flood monitoring and operation teams and both teams have close contact with each other through radio telephone. Communication system is set up as shown in Figure 2.36.

(2) Gate Operation

Gate operation in eastern area is under the control of POJ and that in western area is under the control of Cabang DPU Tangerang.

The gate operation is conducted mainly under the principle that the water-level on the upstream side should be kept at certain level even during high flow. But gate opening is made in consideration of the carrying capacities in downstream reaches. Accordingly low-lying area along the river in upstream reaches may sometimes be inundated.

Gate operation of Manggarai barrage and Karet barrage is under the control of PWSCC but operation is presently conducted by DKI Jakarta.

2.7.4 Low Water Management

Low water management is presently conducted for the purpose of irrigation water supply, municipal and industrial water supply, and flushing water supply.

(1) Eastern Area

In the eastern area, the Lemahabang barrage is for irrigation water supply. Cikarang barrage and Bekasi barrage are both for irrigation water supply, and municipal and industrial water supply. The operation of these barrages is conducted by the instruction of POJ Bekasi

(2) Central Area

In the central area, Katulampa barrage is for Irrigation water supply, Manggarai barrage is for flushing water supply, and Karet barrage is for municipal and industrial water supply.

(3) Western Area

The following barrages are under the control of Cabang DPU Tangerang and the objectives of the barrages are as follows:

Pondok Pinang barrage flushing water supply

Koneng barrage	flushing and irrigation water supply
Cengkareng barrage	flushing and irrigation water supply, and salinity barrier
Polar barrage	irrigation water supply
Pasar Baru barrage	irrigation, and municipal and industrial water supply
Rancasumur barrage	irrigation water supply

2.7.5 River Water Monitoring System

Establishment of Supervisory Control and Data Acquisition (SCADA) System is now underway for the purpose of flood control in the Ciliwung - Cisadane River Basin Development Project. As shown in Figure 2.37, this organization is furnished with 19 remote terminal units (RTU) and the Ciliwung - Cisadane River Basin Development Project is the master control station, and DGWRD is the monitoring station of this organization.

The remaining 17 stations other than the master control and the monitoring stations, consist of the following stations:

	Pumping station	Weir station	Water-level station
	Setiabudi Timur	Cakung	Lama Depok
	Setiabudi Barat	Sunter	Pesanggrahan
	Melati	Katulampa	
	Muara Angke	Manggarai	
	Pluit	Karet	
	Tomang	Cengkareng	
	Grogol		
	Rawa Kepa		
	Cideng		
Total	9	6	2

The master control station can monitor the situation of pumping stations and barrages, receive the data from the 17 stations and analyze the data. The master control station is equipped with display system of maps and graphs.

When this system is completed, it is possible to conduct the overall monitoring and control of these facilities, and the system would contribute much to the flood control in the area.

2.8 Biological Environment

2.8.1 Forest Resources and Ecosystems

The forest areas in Jabotabek, most of which are classified into Production forest, State forest and National forest, are mainly located in Kabupaten Bogor, Kabupaten Tangerang and Kabupaten Bekasi. These forest areas are identified at about 100,000ha based on the statistical data issued by the Kabupatens.

Efforts in conservation and management of wild fauna and flora result in the creation of National and Recreational parks and Protection forest. The protection of theses forest lands has the following main objectives: 1) maintenance essential ecological processes, 2) preservation of genetic diversity, 3) sustainable utilization of species and ecosystems.

The Indonesian Government has made efforts to preserve nature in Jabotabek area by specifying the conservation area for protecting the important fauna and flora as well as providing recreational area.

2.8.2 Nature Conservation Area

The nature conservation areas in Jabotabek area; 1) Gunung Gede Pangrango National Park, 2) Pancaran Mas, 3) Muara Angke, 4) Gunung Halimun, 5)Dungus Iwul, 6) Yani Lapa. The situation of fauna and flora in the major conservation areas is summarized as follows:

(1) Gunung Gede Pangrango National Park

The Gunung Gede Pangrango national park consisting of Situ Gunung Recreational Forest, and Cimungkat and Cibodas-Gunung Gede Nature Reserves is an important for botanical research in Indonesia. This Gunung Gede Pangrango area was established as the first nature reserve in Indonesia in 1925 and afterward, declared as one of the first five Indonesia national parks coinciding with the World Conservation Strategy Day on March 6th 1980.

It is covered by montane tropical rainforest and is the undisturbed example of the Java rainforest. The montane ecosystem of the area is divided into three (3) zones from the botanical situation.

Of 450 bird species present in the Java island, about 250 species inhabit the Park.

(2) Nature Reserve Pancaran Mas

Nature Reserve Pancaran Mas with an area of 6 ha is located in Depok, which has been conserved since 1926. This conservation area is inhabited by species of birds such as *Pynonotus aurigaster, Sturnus contrajalla, Oriolus chinensis*, and reptilian such as *Bungarus candidus, Phyton sp, Dryophis sp, Ptyas sp.*

(3) Nature Reserve Muara Angke

Nature Reserve Muara Angke with an area of 15.4 ha is located at the outfall of the Angke river. There is a small mangrove area, remnant of a vegetation which was formerly common in the north coast of the Java island. This area has been conserved since 1977. About 56 bird species inhabit the area. Some of them such as *Anhing melanogaster, Egretta intermedia, Egretta garzetta, Threskiornis melanocephalus* are protected species in Indonesia.

(4) Nature Reserve Gunung Halimun

An area of 40 ha around the Mt. Halimun in Bogor has been specified as the conservation area since 1979. This conservation area is mainly covered by *Castana argentea, Altingia excelsa, Podocarpus imbricatus, Quercus sp, Nyssa javanica, Schima walichii, Agathis sp, Pinus merkusii, Swietenia mahagony, Tectona grandis*, and so on.

With respect to fauna, the area is inhabited by the species of *Hylobates moloch, Presbytis ayagula, Panthera pardus, Felis pardus, Felis bengalensis, Muntiacus muntjak*, and so on.

2.9 Institutions

2.9.1 Related Regulations

Flood control is a part of water resources management and development. Regarding the water resources management and development, the following are the most basic and important regulations among other laws and regulations in Indonesia.

(1) Law No. 11 year 1974 on Water Resources

Law No.11 year 1974 on Water Resources is the basic regulation that is the emanation from the Constitution 1945. It regulates water and water sources. Article 33 section (3) of the Law states: *Land and water and natural riches contained therein shall be controlled by the States and utilized for the greatest prosperity of the people.*

This Law No.11/1974 stipulates provisions pertaining to planning consisting of :

1) water resources management plan,
2) water resources plan,
3) water resources development plan.

(2) Law No. 22 year 1982 on Water Resources Management

Subsequently, as implementing legislation of Law No. 11/1974, Government Regulation No. 22 year 1982 on Water Resources Management was issued. This Government Regulation contains provisions such as:

1) Water resources management follows principles of public utility, harmony and conservation.
2) One unity of water resources management area is a river territory which can consist of one river basin or more.
3) A development plan on water resources have to be provided by the Minister of Public Works.
4) The Minister of Public Works has the authority and responsibility for implementation of coordination of water management.

(3) Government Regulation No. 35 on Rivers

Further, also as implementing legislation of Law No. 11/1974, Government Regulation No. 35 on Rivers was issued in 1991. This Government Regulation No. 35/1991 stipulates provisions on authority and responsibility of river management including provisions pertaining to construction, demolition, conversion of structures crossing or standing in river area.

2.9.2 Related Agencies

(1) General

As stated in Law No. 11/1974, authority and responsibility of water resources management is undertaken by the Government and the implementation is conducted by the Ministry in charge of water affairs. And based on the Presidential Decree No. 15/1984 and No. 18/1994, the Minister in charge of water affair is the Minister of Public Works.

Based on Ministerial Regulation of MPW No. 39/PRT/1989, rivers in Indonesia are grouped into ninety river basins. When the river basin is located in more than one province region level I, the management of water and water sources is kept by the Minister of Public Works. The day to day management is implemented by Director General of Water Resources Development.

Accordingly the Ciliwung-Cisadane River Basin Development Project is a delegated authority of the Director General of Water Resources Development to conduct the activities pertaining water and water sources management including flood control in the Cisadane-Ciliwung River Basin.

(2) Directorate General of Water Resources Development

Under the Directorate General of Water Resources Development, the Directorate of Technical Guidance and the Directorate of Planning and Programming give guidance in respect of program arrangement, determination of development implementation priority and funding arrangement. The Directorate of Planning and Programming is also in charge of feasibility study of water resources development project.

The Directorate of Water Resources Management and Conservation is in charge of supervision and guidance on data collection, survey, study, investigation, and master plan formulation. For construction and supervision in the Ciliwung-Cisadane River Basin, the Directorate of Technical Guidance and the Directorate of Implementation Guidance Central Region are in charge.

The interrelationship task between the Project and Directorate General of Water Resources Development is illustrated in a scheme as seen in Figure 2.38.

(3) Ciliwung - Cisadane River Basin Development Project

The main tasks of the Project are as follows:

1) To conduct activities pertaining survey, study and planning to support the achievement of development enhancement with respect to water resources potential in JABOTABEK area, for the purposes of flood control, agriculture, raw water supply for domestic household, industry and other fields of development.
2) To conduct activities pertaining construction of flood control structures, drainage networks and other water resources structures in the framework of development of JABOTABEK area.
3) To conduct activities pertaining preparation and supervision of operation and maintenance in respect of completed structures prior to the transfer to authorized institution/agency.
4) To conduct administration for the accomplishment of the scope of task in the effort to develop the project management.

(4) Other Parties

For comprehensive river water management, non-structural measures play an important role. From this view point, watershed management, establishment of flood fighting system, flood plain management by using flood risk map, public education, school education, etc. are suggested. In this context, the Ministry of Forestation, Ministry of People Welfare, Ministry of Education, Ministry of Home Affairs, and the local government should be involved in comprehensive river water management.

3 FRAMEWORK OF STUDY AREA IN 2025

3.1 Population

The future population in JABOTABEK area in the target year of 2025 is prepared based on the previous studies.

The 1980, 1985, and 2015 population estimates were made in the JMDPR and other studies. The table below shows the estimated population growth from 1971 - 2025.

Unit : 1,000

Area	1971	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
DKI Jakarta	3,927	6,445	7,766	8,210	8,964	9,730	10,487	11,178	11,912	12,688	13,502
Bekasi	832	1,124	1,401	2,073	2,697	3,348	4,066	4,802	5,670	6,282	6,534
Tangerang	1,067	1,488	1,881	2,724	3,570	4,506	5,504	6,523	7,732	8,575	8,892
Bogor	1,865	2,748	3,343	3,949	4,805	5,674	6,533	7,407	8,397	9,180	9,681

Sources: Ciujung-Cidurian Integrated Water Resources (JICA) (1971 figures);
JMDPR (1980 -2020 figures);
JABOTABEK Water Resources Management Study (2025 figures)

The table below shows the reference population growth rate.

Reference Growth Rate (%)

Unit : %

Area	80/70	85/80	90/80	85/90	20/95	05/20	10/05	15/10	20/15	25/10
DKI Jakarta	5.66	3.80	2.45	1.77	1.65	1.51	1.28	1.28	1.27	1.27
Bekasi	3.40	4.50	6.31	5.40	4.42	3.96	3.38	3.38	2.07	2.07
Tangerang	3.76	4.80	6.23	5.56	4.77	4.08	3.46	3.46	2.09	2.09
Bogor	4.40	4.00	3.69	4.00	3.38	2.86	2.54	2.54	1.80	1.80

3.2 Land Use

(1) General

Future Land Use is estimated based on previous reports such as JMDPR, JWRMS, and others with respect to urban area expansion, transportation routes, agricultural area, preservation areas, etc., and the land use planning maps of regional governments in JABOTABEK area.

(2) Basic Consideration

According to the report of JMDPR, the transportation system proposed for 1990 - 2010 is shown in Figure 3.1.

For the estimate of future land use, the following consideration is incorporated regarding this proposed transportation system.

(a) DKI Jakarta

Generally speaking, further urbanization is not possible in DKI Jakarta, except for the reclamation or reconstruction of the built-up area to cope with population increase. Urban expansion should be focused towards Bekasi, Tangerang and Bogor.

(b) Bekasi

With the proposed construction of highways and railways in the eastern part, Bekasi will be connected with DKI Jakarta. Urbanization will also be extended to areas along the proposed transport routes. This will connect Bekasi, Cikarang, and other areas to DKI Jakarta.

(c) Tangerang

The proposed construction of highways and railways in the western part will connect Tangerang with DKI Jakarta and Bekasi. Urbanization is estimated to affect the southern and western areas. Cisoka, Tigaraksa, and other areas will also be covered in the urbanization process.

(d) Bogor

The proposed construction of an outer ring road, highways and railways will connect this Kabupaten with DKI Jakarta. The construction of these proposed transportation routes is estimated to accelerate urbanization in the area.

(3) Area for Urbanization (1990 - 2025)

(a) Area for Urbanization (1990 - 2010)

The table below shows the urban agglomeration areas estimated for 1990, 2010, and 2020 in JMDPR.

Unit : km²

Area		1990	1995	2000	2005	2010
DKI Jakarta	JMDPR	622	-	622	-	689
	Measured Area	-	438	-	536	-
Bekasi	JMDPR	210	-	507	-	650
	Measured Area	-	28	-	383	-
Tangerang	JMDPR	283	-	523	-	695
	Measured Area	-	158	-	396	-
Bogor	JMDPR	530	-	640	-	862
	Measured Area	-	85	-	543	-

The target years established for Bekasi (2003) and Tangerang (2004) are changed to 2005 by proportional allotment.

The urban agglomeration area in the above includes the city area and the suburbs. On the other hand, the present Study defines that the urban area includes the housing area, industrial zone, and built-up area of the city to estimate future runoff from urban area.

(b) Population Growth and Urban Area

The population growth and urban area are shown in Figure 3.2. Population growth is generally considered to be proportional to the ratio of areas for urbanization. The calculation of the areas for urbanization is shown in the following table.

Area for Urbanization in 1995 ~ 2025

Unit : km²

Area	1995	2005	2010	2015	2020	2025
DKI Jakarta	158	536	689	689	689	689
Bekasi	28	413	488	576	637	622
Tangerang	158	396	469	556	617	639
Bogor	85	543	618	699	764	805

The calculation is carried out by proportional allotment based on population growth. The population growth trend of these areas is shown in Figure 3.2.

(c) Areas for Urbanization (2025)

The areas to be urbanized in 2025 are calculated based on population growth, and is shown in the table below.

Unit : km²

	Estimated Area Year 2025	Reference: JMDPR	
		Year 2010	Year 2025
Bekasi	622	650	884
Tangerang	639	695	945
Bogor	805	862	1,129

DKI Jakarta, which totals 689 km² including reclamation lands, is not expected to further increase in area in the future.

(4) Estimated Future Land Use Map in 2025

The estimated future land use map in 2025 is shown in Figure 3.3. The characteristics of the estimated future land use are presented below.

(a) DKI Jakarta

With better infrastructure, DKI Jakarta is one of the country's leading financial,

administrative and cultural arena.

To cope with population increase, reclamation of the waterfront (2,700ha) along the north coast of DKI Jakarta was proposed and is now under planning and designing process. In the target year of 2025, new urbanized area along the north coast of DKI Jakarta will have been realized. The reclamation will cover the reaches from around the river-mouth of the Kali Kamal around 3 km west from the river-mouth of the Cengkareng Floodway to around the river-mouth of the proposed Eastern Banjir Canal.

(2) Bekasi

The area in Bekasi along the highway and railway routes has been developed as a satellite city of Jakarta. The central area, on the other hand, is targeted for housing and industrial development. The northern half of Bekasi will be allocated for irrigated paddy fields, while the southern half will be made up of cultivated lands.

(3) Tangerang

Similar to Bekasi, Tangerang is also developed as a satellite city of Jakarta. The northern parts of the area, starting from the Soekarno Hatta International Airport, have been developed for housing and industrial use. Housing development projects are either currently going on in or being planned for Tigaraksa, Cisoka, and Legok. Industries can be seen along the traffic routes and residential area. The northern half of Tangerang will remain as an agricultural area in accordance with the land use plan of the local government.

Reclamation of waterfront along the north sea coast of Kabupaten Tangerang was proposed and is now under planning and designing process in the same manner with the reclamation plan in the north of DKI Jakarta. The area covers the reaches from around the estuary of the Western Banjir Canal to close to the estuary of the Cirarab river. The reclamation plan includes the fish ponds distributed along the north coast of the Kabupaten Tangerang. The reclamation will cover the area of about 8,000 ha including the landside reclamation. The implementation may start in 1997.

(4) Bogor

The southern part of Bogor is mountainous where forests, plantations and tourist spots can be found. The extent of urbanization in this area will cover the area along the highway leading to Jakarta and westward.

Cibinong, the capital of Kabupaten Bogor, constitutes a housing and industrial zone. Cibinong and Depok are undergoing rapid development and are both in close proximity to Jakarta. These cities will be among the main cities in JABOTABEK.

3.3 Regional Gross Domestic Products

Regional gross domestic products (RGDP) in JABOTABEK area in future are estimated with

the assumption that annual average growth rate is 7 % as targeted in the second twenty -five year long-term development plan (PJP II) and shown below. Here those in Kabupaten and Kodya Tangerang are included in Tangerang, and those in Kabupaten and Kodya Bogor are included in Bogor.

	Year	Unit	DKI Jakarta	Bekasi	Tangerang	Bogor	Total
(a) RGDP in	1995	Rp. Billion	59,175	4,991	4,852	6,135	75,153
1993 price	2000	- do -	82,996	7,000	6,805	8,604	105,405
	2010	- do -	163,266	13,769	13,387	16,925	207,347
	2025	- do -	450,457	37,990	36,935	46,696	572,078
(b)Per-capita	1995	Rp. Million	6.6	1.8	1.3	1.3	3.7
RGDP	2000	- do -	8.6	2.1	1.5	1.5	4.5
	2010	- do -	14.6	2.9	2.1	2.3	6.9
	2025	- do -	33.4	5.8	4.2	4.8	14.8