3.4 FLOOD CONTROL MEASURES

3.4.1 Agreement on Flood Control and Urban Drainage

In 1997, the DGWR and the DKI Jakarta have concluded an agreement on the flood control and urban drainage in DKI Jakarta. It is agreed that the responsibility of the DGWR is particularly to the main rivers upstream, while the DKI Jakarta is to the drainage system in its municipalities. This is actually a mechanism to avoid an overlapping of works and responsibility in order to make the administration effective and efficient. The consequence of this agreement is the responsibility of the DGWR to give flood alerts for the DKI Jakarta, when rivers upstream are in flood alert conditions.

3.4.2 Master Plan and Feasibility Study

(1) 1973 Master Plan Study

In this Master Plan for Drainage and Flood Control of Jakarta, flood control of Jakarta was intended to intercept floods from the south by two (2) floodways, namely the Western Banjir Canal and the Eastern Banjir Canal before they flow into the central Jakarta. For the Western Banjir Canal, the existing one was planned to be improved and extended, while for the Eastern Banjir Canal, a new floodway was planned to be constructed (Figure 3.12). Both of the canals were planed to have flow capacity of 100-year return period.

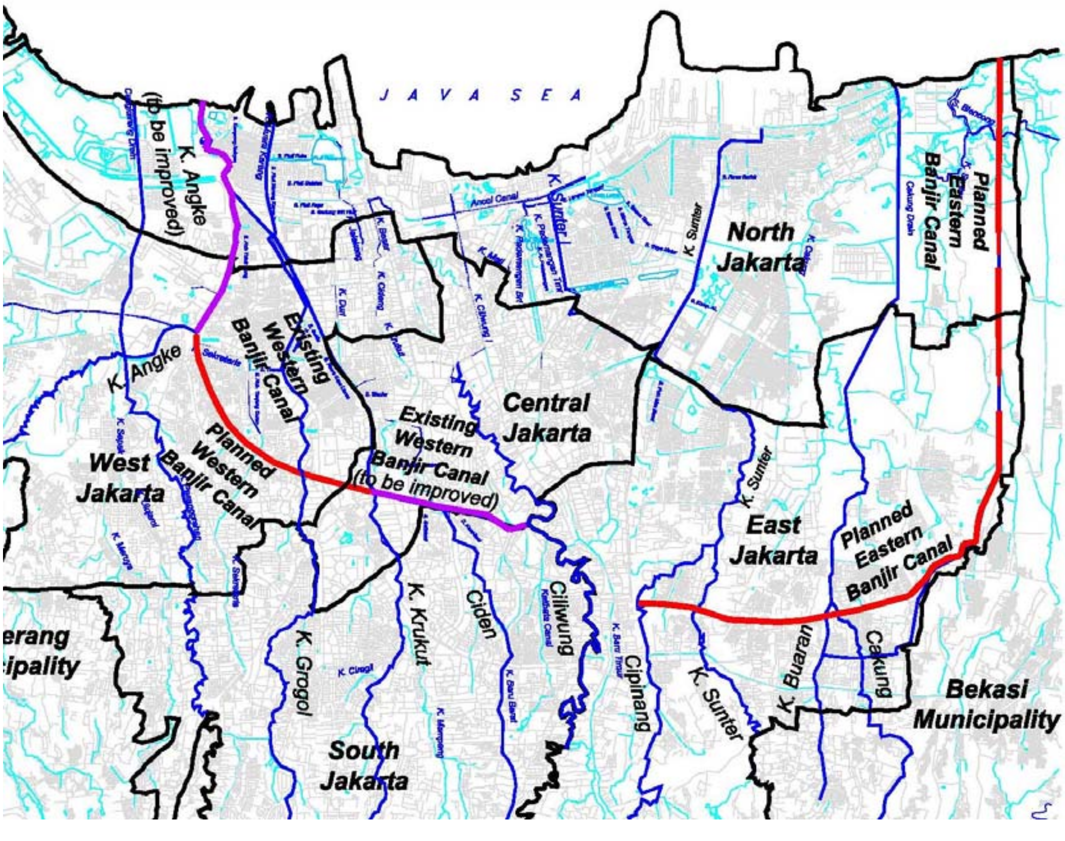

Figure 3.12 Planned Western and Eastern Banjir Canals in 1973 Master Plan

(a) Eastern Banjir Canal

This canal was planed to collect the floods from the Cipinang, the Sunter, the Buaran, (the Jati Kramat) and the Cakung rivers to protect the area of 165 km^2. Total length of the canal is 23.6 km.

The structures, which need to be constructed, are; 2 weirs, flushing outlets and 4 bridges.

Table 3.8 Design Discharge, Design Water Level and Dimension of Eastern Banjir Canal

Distance (km)	Discharge (m^3/s)	Water level (above P.P m)	Bed slope	Bed width (m)	Side slope
Sta. 0 to 1.45	101	8.50	1/2,000	8.0	1:1.5
Sta. 1.45 to 5.40	228	8.50	1/2,500	15.0	1:1.5
Sta. 5.40 to 12.00	269	4.50	1/2,500	16.0	1:1.5
Sta. 12.00 to 13.40	340	4.50	1/2,500	20.0	1:1.5
Sta. 13.40 to 14.30	340	-*	1/2,500	20.0	1:1.5
Sta. 14.30 to 23.60	340	-*	1/3,000	20.0	1:2.0

Note: Influenced by sea level

In the above table, the sea level is set to be High High Water of 1.15 m above P.P.

(b) Western Banjir Canal

The Canal was planed to be extended from the point about 300 m upstream of the Karet weir to join with the Angke River after about 8 km of the Karet weir. The canal would collect flood water of the rivers of the Ciliwung, the Ciden, the Krukut, the Grogol, the Sekretaris and the Angke.

Table 3.9 Design Discharge, Design Water Level and Dimension of Western Banjir Canal

Distance (km)	Discharge (m^3/s)	Water level (above P.P m)	Bed slope	Bed width (m)	Side slope
Sta. 0 to 4.2	290	4.0	1/3,000	13.5	1:1.5
Sta. 4.2 to 9.8	370	4.0	1/3,000	17.0	1:1.5
Sta. 9.8 to 12.2	370	- *	1/3,000	17.0	1:1.5
Sta. 12.2 to 18.2	525	- *	1/4,000	28.0	1:2.0

Note: * Influenced by sea level. Distance is measured from Manggarai Gate.

(2) 1997 Master Plan Study

The two (2) floodways proposed in the 1973 Master Plan could not be materialized due to difficulty of land acquisition. Furthermore, it was judged necessary to formulate a flood control master plan for the developing JABOTABEK. Under these circumstances, the JICA conducted “The Study on Comprehensive River Management Plan in JABOTABEK” from 1995 to 1997 to formulate flood control master plan and to conduct Feasibility Study for the selected projects.

Target Year for Completion and Land Use

Target year of the Mater Plan is the year of 2025. Land use, population and urbanization ratio were estimated as shown in Figure 3.13, Table 3.10 and Table 3.11 in order to estimate runoff discharge and flood damage corresponding to development in JABOTABEK.

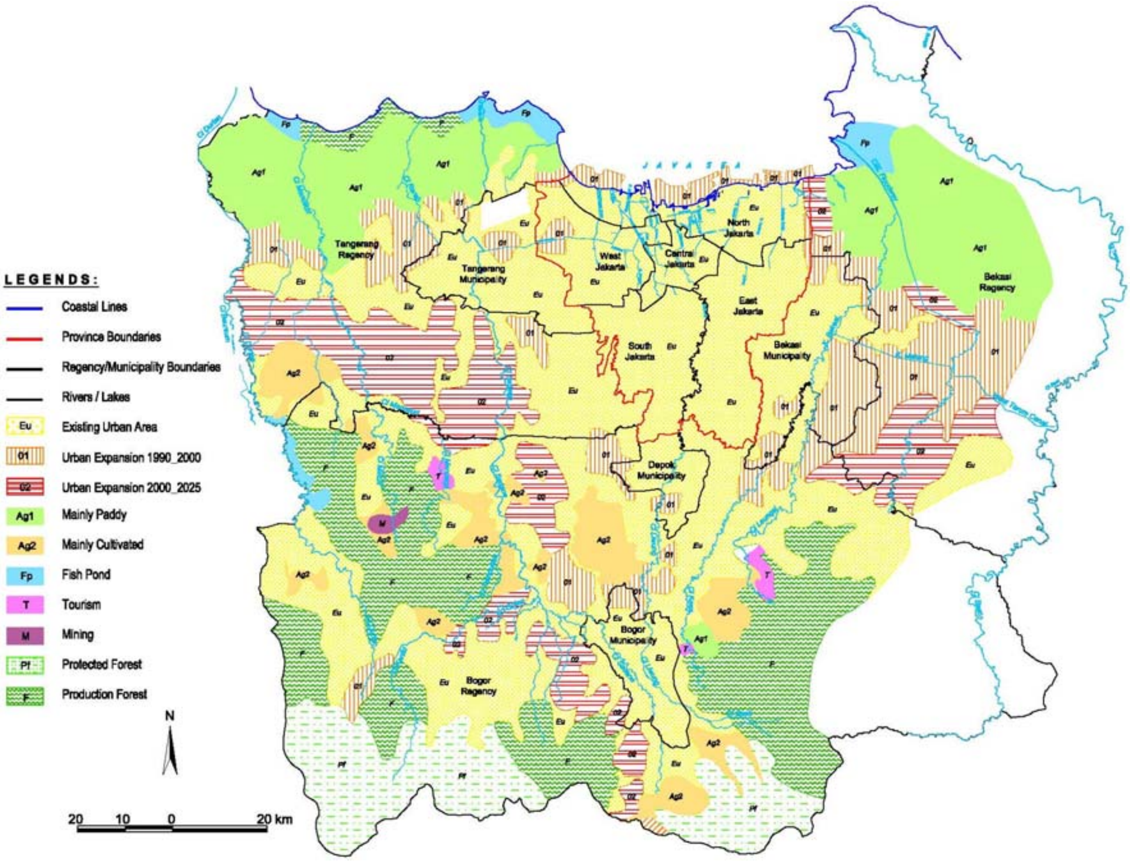

Figure 3.13 Estimated Land Use in 2025

Table 3.10 Estimated Population in JABOTABEK

(Unit: Thousand)

Area	1995	2000	2005	2010	2015	2020	2025
DKI Jakarta	8,964	9,730	10,487	11,178	11,912	12,688	13,502
Bekasi	2,697	3,348	4,066	4,802	5,670	6,282	6,534
Tangerang	3,570	4,506	5,504	6,523	7,732	8,575	8,892
Bogor	4,805	5,674	6,533	7,407	8,397	9,180	9,681
Total	22,031	25,258	28,595	31,920	35,726	38,745	40,634

Table 3.11 Urbanization Ratio in JABOTABEK in 2025

Area	Whole Area (km^2)	Urbanized Area (Km^2)	Ratio of Urbanized Area (%)
DKI Jakarta	689	689	100
Bekasi	1,401	639	46
Tangerang	1,301	622	48
Bogor	2,792	805	29
Total	6,183	2,755	45

Master Plan

The master plan intended to increase safety level of eight (8) river systems in the JABOTABEK to 25-year, 50 year or 100-year return period corresponding to importance of the basins to be protected.

(a) Design Rainfall and Design Discharge Distribution

Design rainfall to compute the design discharge was composed of 24 hourly rainfall. Duration of design hyetograph was 24 hours considering rainfall characteristics and size of the river basins. Time distribution patterns were assumed to have the peak intensity in the beginning of the storm and lined up in descending order.

Figure 3.14 indicates the Mass curve to obtain time distribution pattern. Design hyetograph is obtained by multiplying the area deduction factor (ADF) as shown below

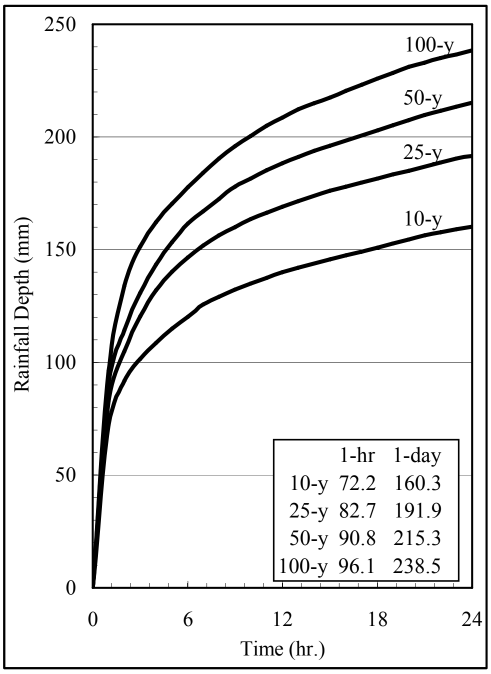

Figure 3.14 Mass Curve

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

Figure 3.15 indicates design hyetograph for the WBC at the reference point, catchment area of which is 421 km^2.

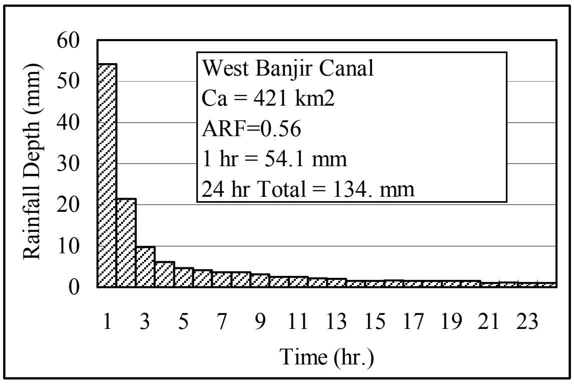

Figure 3.15 Design Hyetograph for Western Banjir Canal

Using the design hyetograph thus obtained, design discharge for the respective rivers was obtained from the runoff model as shown in Figure 3.16.

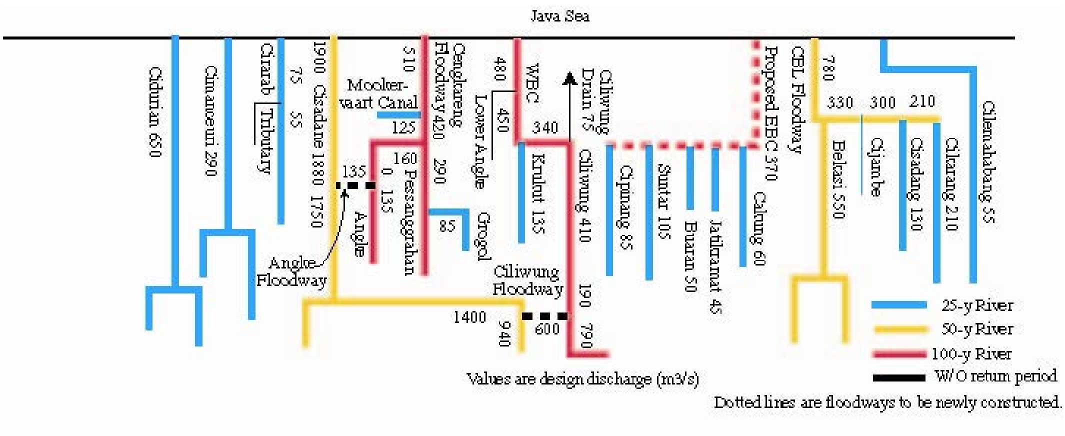

Figure 3.16 Design Discharge Distribution for Eight River Systems in JABOTABEK

(b) Structural Measures

In consideration of the flow capacity of the existing river channels, following river improvement and new construction of floodways were proposed (Figure 3.17) so as to increase the safety level as indicated in Figure 3.16. Followings are lists of stretches for which improvement or new construction of floodways proposed in the Master Plan. Rivers, which are not included in the list, were judged to have enough flow capacity to accommodate the design discharge indicated in Figure 3.16.

<u>Cidurian River System</u>

Improvement for 31.9 km

<u>Cimanceuri River System</u>

Improvement for 22.2 km

Cirarab River System

Improvement for 16.8 km

Cisadane River System

Improvement for 21.0 km

Cengkareng River System

(i) Cengkareng Floodway : Improvement for 8.1 km

(ii) Mookervaart: Improvement for 6.0 km

(iii) Angke: Improvement for 5.0 km

(iv) Pesanggrahan: Improvement for 3.2 km

(v) Angke Floodway: Construction of new floodway of 4.2 km composed of 1) open channel of 1,8 km, 2) box culvert of 1,7 km, and 3) tunnel of 0.72 km

Western Banjir Canal System

(i) Western Banjir Canal: Improvement for 17.4 km

(ii) Ciliwung Floodway: Construction of new floodway of 1.1 km composed of 1) open channel of 0.48 km and 2) tunnel of 0.63 km

Eastern Banjir Canal System

(i) Eastern Banjir Canal: New construction for 23.6 km

(ii) Cipinang: Improvement for 8.5 km

(iii) Sunter: Improvement for 7.2 km

(iv) Buaran: Improvement for 3.4 km

(v) Jatikramat: Improvement for 3.2 km

(vi) Cakung: Improvement for 11.5 km

CBL Floodway System

(i) CBL Floodway: Improvement for 22.1 km

(ii) Bekasi: Improvement for 20.0 km

(iii) Cisadang: Improvement for 7.6 km

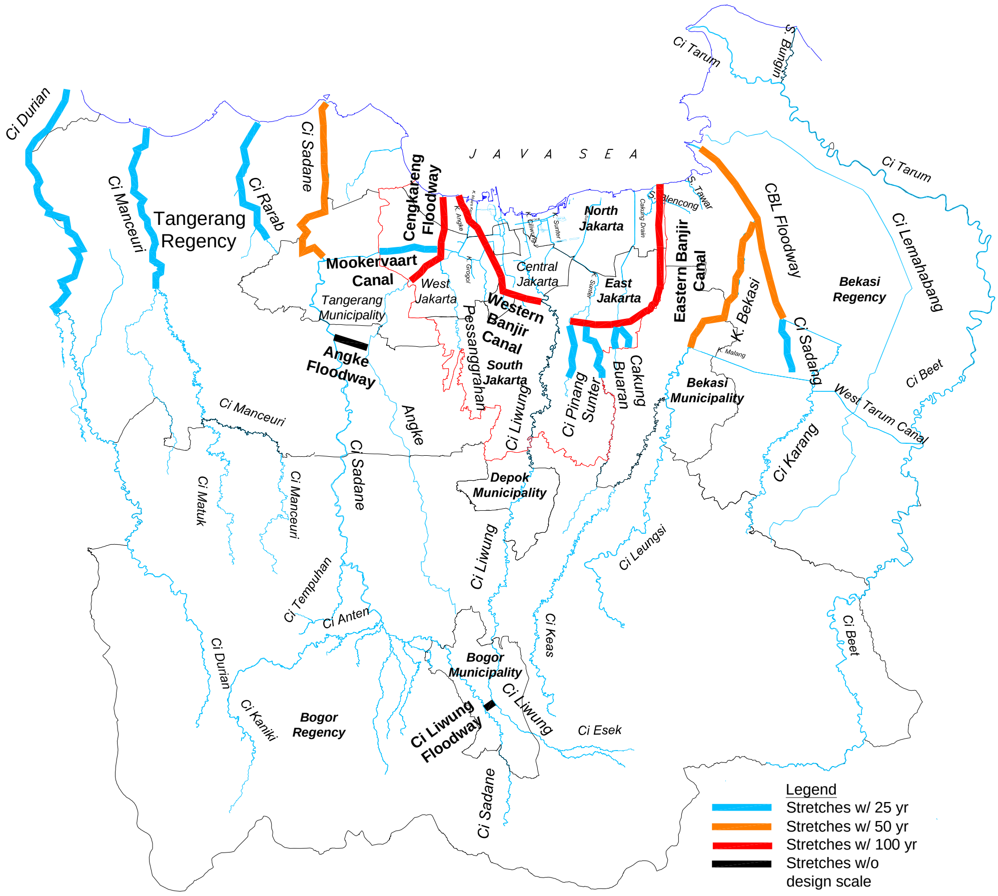

Figure 3.17 Location of New Floodways and Stretches for Improvement

(b) Non-structural Measures

As non-structural measures, followings were proposed to be implemented.

(i) Watershed management

(ii) Flood plain management by publication of flood risk map

(iii) Preparation of flood forecasting and warning system

(iv) Establishment of institutions and organization

(v) Social and school education on flood control

Priority Project

Following projects were selected as priority projects in order to mitigate flood damages in western parts of DKI Jakarta and down stream areas of the Cisadane River in consideration of importance of the areas.

- Improvement of the Western Banjir Canal,
- Construction of the Ciliwung Floodway, and
- Improvement of the lower Cisadane River

Implementation of the priority projects selected from the Master Plan requires a large amount of project cost. Accordingly, stepwise implementation of the projects was proposed as explained hereunder.

(a) 1st Stage Project (Urgent Flood Control Project)

Structural Measures

(i) River improvement of the Western Banjir Canal with design discharge of 100-year design scale

Length: 16.9 km
Gradient: 1/3,600, 1/2,800 and 1/1,600
Cross-section: Compound and single cross-section

(ii) River improvement of the lower Cisadane River with design discharge of 25-year design scale

Length: 15.0 km
Gradient: 1/3,200 and 1/1,490
Cross-section: Compound cross-section

(iii) Construction of the Ciliwung Floodway with flow capacity of 600 m^3/s

Total length: 1,040 m
Length of tunnel: 913 m
Tunnel dimension: inner diameter 8 m x 2

Until the completion of 2nd stage, it was planned to divert 300 m^3/s through the Ciliwung Floodway to the Cisadane River, since the Cisadane River of 1st stage with design discharge of 25-year design scale cannot accommodate the discharge, when 600 m^3/s is added from the Ciliwung Floodway.

Non-structural Measures

(i) Publication of flood risk map for low-lying areas of DKI Jakarta

(ii) Issuance of flood warning along the Cisadane River on diversion of flood water through the Ciliwung Floodway

(b) 2nd Stage Project

2nd stage project is implemented to upgrade the safety level of the Cisadane River from 25-year to 50-year design scale.

(I) River improvement of the lower Cisadane River for design discharge of 50-year design scale

Length: 15.0 km
Gradient: 1/3,200 and 1/1,490
Cross-section: Compound cross-section

The necessary works are widening of the low water channel to accommodate 50-year flood water.

3.4.3 Ongoing Project

(1) Ciliwung-Cisadane River Flood Control Project (1)

Due to the urgent necessity to protect the western part of DKI Jakarta, this project commenced in 1998 under the JBIC Loan (IP-496). Components of the project are; 1) construction of the Ciliwung Floodway and 2) river bank reinforcement (length 15 km) of the lower Cisadane River. However, this project was cancelled due to difficulty in obtaining consensus of stakeholders and land acquisition.

(2) Construction of Eastern Banjir Canal (EBC)

Construction of the EBC commenced on 2004 under the local fund and is on-going at present.

(a) Objectives

The EBC is not only functioned as a floodway to protect northeastern part of DKI Jakarta, but also it will be used for navigation, conservation and water tourism facilities in relation with regional development plan on the northeastern region of DKI Jakarta.

(b) Route

The route of the EBC with total length of about 23.4 km is shown in Figure 3.18. This route has been stated based on Governor's Decree of DKI (No.121, issued on June 17, 1987; No. 2714, issued on September 24, 2001; No. 285, issued on 29, 2003).

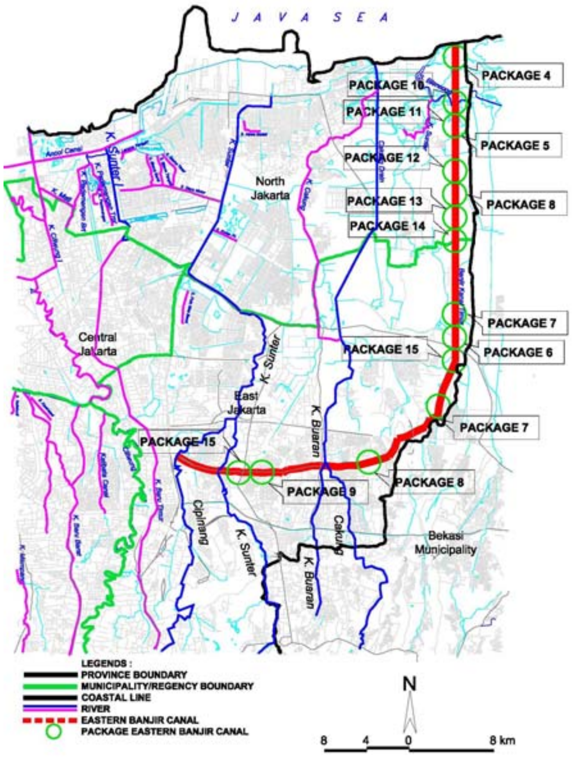

Figure 3.18 Route of Eastern Banjir Canal

(c) Design Discharge Distribution

Design return period of the EBC is determined to be 100 - year, while tributaries joining to the EBC are of 25 year return period as tabulated below.

Table 3.12 Design Discharge of EBC and Tributaries

No.	Name of River	Stretches	Catchment Area (km^2)	Design Discharge (m^3/s)
1	EBC	U/S Sunter Inlet	53.33	136
		D/S Sunter Inlet	118.69	268
		D/S Jatikramat Inlet	150.59	314
		D/S Cakung Inlet	193.99	246
		D/S Blencong to Sea	253.75	384
2	Cipinang		52.54	126
3	Sunter		65.37	146
4	Buaran		11.12	74
5	Jatikramat		16.42	73
6	Cibening		7.28	49
7	Cakung		33.88	122
8	Blencong		54.05	101

(d) Longitudinal Profiles and Cross-sections

Table 3.13 Features of EBC

Reaches	Beginning Point	Ending Point	Length (km)	Flow Capacity (m^3)	1/slope	Bed Width (m)	Canal Depth (m)
0						100	4.45
I	Coastal Line	Weir III	2.090	390	6000	36	4.45
II	Weir III	Marunda bridge	4.207	350	6000	36	6.95
III	Marunda bridge	Weir II	3.694	350	4000	30	6.95
IV	Weir II	Cakung Inlet	1.490	350	3000	30	5.95
V	Cakung Inlet	Cibening Inlet	1.998	330	3000	28	5.95
VI	Cibening Inlet	Weir I	4.461	320	3000	27	5.95
VII	Weir I	Buaran Inlet	0.192	320	2500	25	5.95
VIII	Buaran Inlet	DPS-2	4.066	270	2500	20	5.95
IX	DPS-2	Cipinang Inlet	1.230	135	2000	13	5.95

(e) Construction Cost

The construction of the EBC is divided into 13 packages (this may have been changed into 15 packages as shown in Figure 3.18). Total project cost is estimated at Rp. 1,080 billion based on the price of the year 2003 as shown in Table 3.14.

Table 3.14 Construction Cost and Packages of EBC

Pack-age No.	Canal (m)	Exca-vation (m3)	Back fill (m3)	Revet-ment (m)	Road (m2)	Struc-ture nos	Bri-dge nos	Drain (m)	Cost (Billion Rp)
1	1,654	948,270	55,772	94,174	4,772	2	1	3,572	81
2	677	281,298	102,047	507	404	1		400	54
3	3,665	781,372	492,232	16,334	10,434	2		9,412	121
4	3,255	933,916	377,742	2,214	7,315		2	7,269	95
5	2,091	466,322	43,528	9,660	289	4	1	404	88
6	2,499	581,031	127,400	684	4,150	3	2	413	74
7	1,311	403,403	29,277	3,374	3,310	3	7	3,261	110
8	2,278	1,133,996	14,131	7,414	4,993	5	3	4,974	100
9	669	137,994	3,076	18,944	1,924	7			82
10	1,463	767,362	3,812	2,362	1,397	3	3	4,865	71
11	2,021	585,199	429	3,782	5,487	1	3	5,552	100
12	607	126,566	3,233	1,141	1,656	6	1	1,676	52
13	943	159,676	22,028	1,773	2,572	6	1	2,603	52
Total	23,133	7,306,405	1,274,707	162,363	48,703	43	24	44,401	1,080

(f) Implementation Schedule

The construction of the EBC started in the year of 2004 and is scheduled to be completed in the year of 2010 as shown below.

Package No.	Schedule						
	2004	2005	2006	2007	2008	2009	2010
1	■	■	■				
2					■	■	■
3			■	■	■		
4		■	■	■			
5				■	■	■	
6				■	■	■	
7				■	■	■	
8					■	■	■
9			■	■	■		
10	■	■	■				
11		■	■	■			
12	■	■	■				
13	■	■	■				

Figure 3.19 Construction Schedule of EBC

3.4.4 On-Going and Planned Study

(1) Review Master Plan of Ciliwung – Cisadane River Basin

This is undertaking under the framework of the Java Irrigation and Water Management Project. Under the framework, a Basin Water Resources Planning Project commenced in February 1996 with technical assistance from consultants of the Netherlands to support the Government of Indonesia in formulating Basin Water Resources Plans. Interim Report was issued on July 2004 including Annex I Flood Control

Regarding flood control, followings are included.

(a) River system

(b) Previous study and works on flood control in JABOTABEK Area

(c) Urban drainage

(i) Zoning of major drainage

(ii) Major drainage

(iii) Small lakes (Situ-situ)

(d) Flooding area

(e) Operation and maintenance of flood control system

(f) Proposed measures on flooding in JABOTABEK

3.4.5 Present Flood Control Facilities

(1) Rivers

Present river systems in the JABOTABEK can be classified into eight (8) river systems in consideration of the EBC, which is under construction, as explained in **2.2.3**. Cross-sectional survey of the existing rivers has not been conducted in most of the rivers in the JABOTABEK, since the survey was made by the JICA Study team in the period of August to October 1995. According to the interview survey and existing reports, improvement of the existing rivers and/or construction of floodway, which drastically increase the safe level against floods, have not been implemented in recent years. Therefore, flow capacity estimated in the 1997 Master Plan Study is possibly applicable to the existing rivers. Flow capacity for 17 rivers estimated in the 1997 Master Plan Study is shown in Annex 2. Figures in the Annex indicate, with the flow capacity, estimated discharge of several return periods for the 1995 land use and the 2025 land use taken also from the 1997 Mater Plan Study Report.

(2) Ponds and Reservoirs

In the JABOTABEK Area, there are 202 small lakes or ponds, which are called as “Situ-situ” as listed below. Originally, Situ-situ was developed with three (3) purposes; flood retention, water supply and aesthetic view. At present, most of situ-situ is suffering from several problems as tabulated below.

(a) Structural problems

(i) Decrease in size due to encroachment

(ii) High sedimentation and/or full of weed and grass

(iii) Collapse of dikes

(b) Non-structural problems

(i) Unclear ownership

(ii) Unclear institutional responsibility

(iii) Environmental deterioration

Table 3.15 Number of Situ-situ in JABOTABEK

Area	DkI Jakarta	Tangerang Municipality	Depok Municipality	Bogor Municipality	Bogor Regency
Number	35	45	21	6	95

(3) River Structures

Figure 3.20 indicates existing river structures installed in the rivers running in the JABOTABEK.

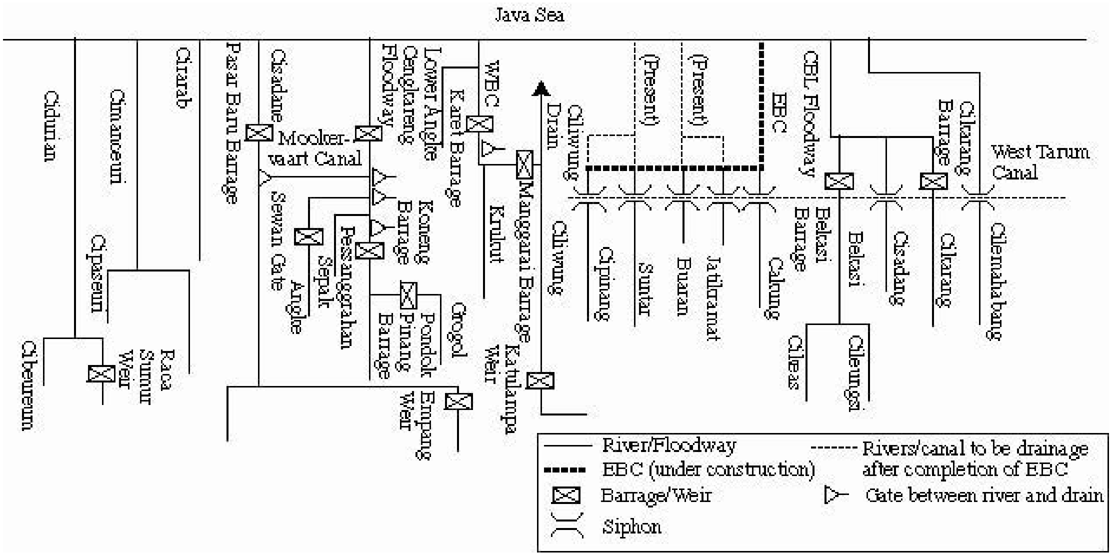

Figure 3.20 Existing River Structures in the Rivers of the JABOTABEK

3.5 DRAINAGE SYSTEM

3.5.1 Master Plan for Drainage and Flood Control of Jakarta (1973)

Drainage in the JABOTABEK can be classified into two (2) categories, namely micro drainage system and macro drainage system. Micro drainage system is a network of gutters and ditches, while macro drainage system consists of open canals and main drains. The target of the 1973 master plan was the main drains among the macro drainage system.

(1) Design Scale

The main drains, which are rivers after upper stretches are connected to and flood water from the southern areas are intercepted by the WBC and the EBC, are designed to cope with flood with scale of 25 year-return period.

(2) Design Rainfall

Through rainfall analysis using daily rainfall and hourly rainfall data observed since end of the 19th century, rainfall intensity duration frequency curve for short duration and mass curve for long duration were established. The rainfall intensity for the short duration is shown below.

Table 3.16 Design Rainfall for 1973 Master Plan (Short Duration)

	2-year	5-year	10-year	25-year	50-year	100-year
10 min.	115.1	132.7	143.6	158.2	170.4	180.3
30 min.	87.1	100.6	108.9	119.5	127.7	137.6
1 hour	61.5	72.9	81.2	90.4	98.5	105.6

Mass curve for 25-year return period, which was used to determine pump capacity and reservoir volume, is shown in Figure 3.21.

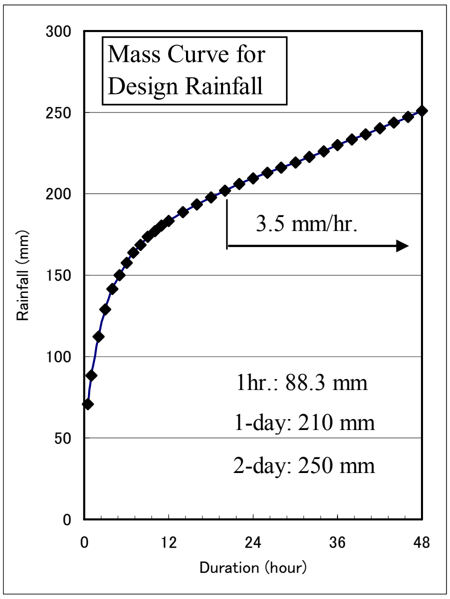

Figure 3.21 Mass Curve for 1973 Master Plan (Long Duration)

(3) Drainage Plan

Drainage Master Plan was composed of the followings, after flood water from the southern area is intercepted by the WBC and the EBC (Refer to Figure 3.12).

- Extensive rehabilitation of the existing open canals to be used as main drains,
- Incorporation of the lower part of the existing WBC into the drainage system of Central and West Jakarta, and
- Construction of two (2) more major evacuation drains for the eastern urban area: the Sunter West Drain and the Eastern Main Drain
- Pump drainage of four (4) drainage areas, the lowest part of the city on the west and on the east side located near the coast

The area to be protected by the WBC and the EBC was planed to be subdivided into six (6) drainage areas as explained below and shown in Figure 3.22. In addition to the existing four (4) pumping stations in western part, four (4) pumping stations were proposed to be installed.

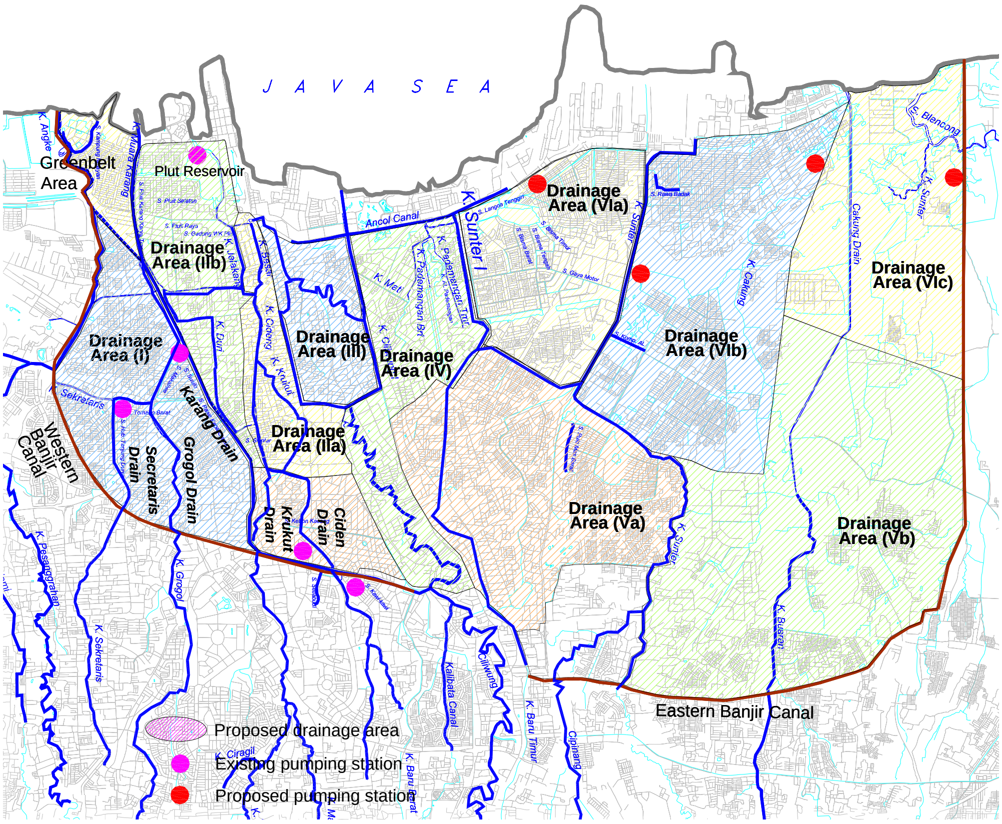

Figure 3.22 Drainage Plan Proposed in 1973 Master Plan

(a) Drainage Area of the Karang Drain (3,240 ha.): I

After the WBC is extended as explained in 1973 Master Plan for flood control, the existing WBC from the Karet weir downwards, was planned to be used as the main drain (Karang Drain), connecting with the Muara Kareng. The Ciden River and the Grogol River are used for the main drain. Northern part shown in Figure 3.22 is used as a greenbelt area

(b) Drainage Area of the Lower Cideng and Krukut Rivers (1,730 ha.)

This area is further divided into to areas as explained below.

(i) Upper Part (700 ha.): IIa

Main drain of this area is the Ciden and the Krukut drains.

(ii) Lower Part (1030 ha.): IIb

This area is drained by the Pluit reservoir with surface area of 75 ha. and pumps of 12 m^3/s.

(c) Drainage Area between the Lower Ciliwung along the Jalan Gajah Mda and Gunung Sahari Canal (760 ha.): III

(d) Drainage Area between Ciliwung – Gunung Sahari Canal and the Sunter West Canal (1,600 ha.): IV

(e) Drainage Area of the Sunter Drain and Fastern Main Drain

(i) Drainage Area of Sunter Drains (2,830 ha.): Va

(ii) Drainage Area of Fastern Main Drain (4,920 ha.): Vb

(f) Drainage Area of Eastern Polder (7,900 ha.)

This low land, in which rain water needs to be pumped out, may be divided into three (3) drainage areas as follows.

(i) Sunter West Polder (1,600 ha.) : VIa

(ii) Sunter East Polder (3,300 ha.): VIb

(iii) Marunda Polder (3,000 ha.): VIc

3.5.2 Present Drainage System

DKI Jakarta has drainage system, but in other municipalities of West Java Province and Banten Province, only limited areas have drainage systems. Hereinafter, drainage system of DKI Jakarta is explained.

(1) Drainage Zones

Table 3.17 Drainage Zones in DkI Jakarta

Drainage 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 – WBC
	Zone-5	1,900	Pluit
	Zone-6	1,100	Ciliwung – Gunung Sahari
III Eastern Region	Zone-7	2,760	Sentiong – Pademanan
	Zone-8	1,250	Sunter Utara (Barai)
	Zone-9	12,575	Sunter – Cipinang
	Zone-10	8,050	Buaran - Cakung

The whole area of DKI Jakarta is divided into three (3) drainage regions, which is further into ten (10) drainage zones as tabulated above. In general, drainage method can be classified into a) pump drainage and b) gravity drainage. Drainage zones are mainly classification based main drains, to which water is drained and covers pump drainage areas and gravity drainage areas.

(2) Pump Drainage Areas

Based on the 1973 Master Plan, drainage systems have been improved. At present, 90.76 km^2 or 14.0 % of the total DKI Jakarta of 649.71 km2 (excluding the Seribu Regency) can be divided into 17 pump drainage areas as shown in Figure 3.23 and tabulated in Table 3.18. Pump capacity of the respective stations is designed to be able to drain of 1-day flood with scale of 25-year return period, design hyetograph of which is established from the mass curve shown in Figure 3.21. Followings explain the characteristics of the existing pump drainage system.

(a) Large Reservoir and Small Pump Capacity

In most drainage areas, a pumping station is characterized by storage of flood in a large reservoir placed at the pumping station so as to minimize pump capacity, thus initial cost and operation cost. Table 3.18 includes data of pump capacity and area of reservoir attached. However, as explained in the 1973 Master Plan Study Report, if pumps are small, the reservoir may not yet empty before the next rainstorm.

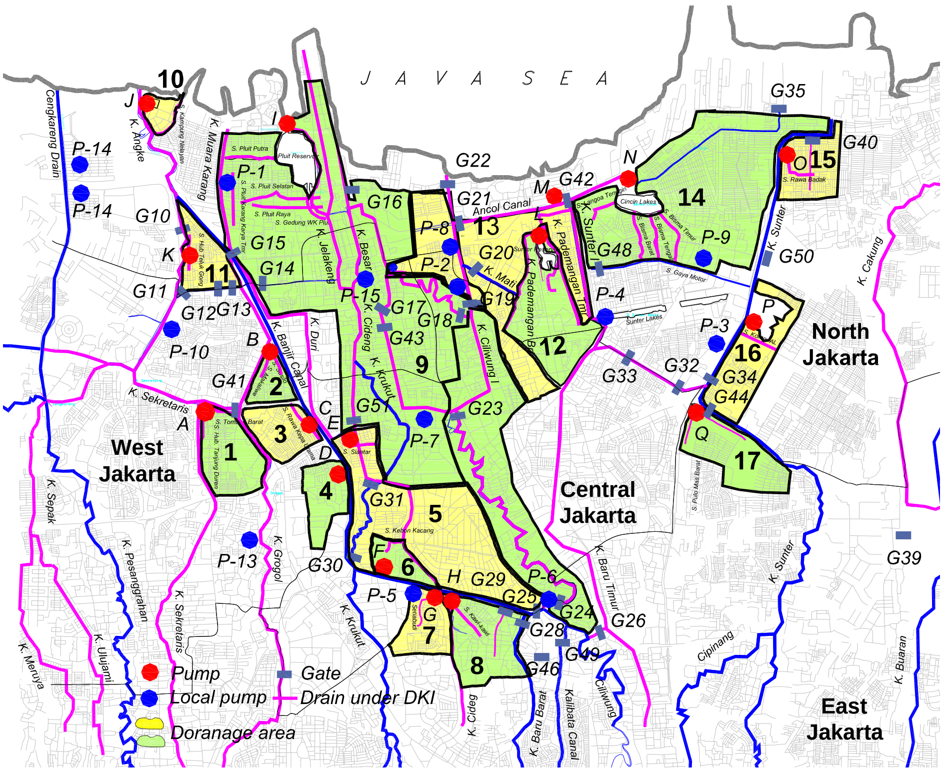

Figure 3.23 Present Pump Drainage Areas in DKI Jakarta

Table 3.18 List of Pump Drainage Areas in DKI Jakarta

D Code	Drainage Zone Name	Drainage Zone Area (ha.)	Outlet River	Reservoir Area (ha.)	P Code	Pump Capacity (m3/s)	Unit of Pump (unit*capacity)	Completion Year	Management
1	Tomang Barat	170	K. Sekretaris	6.0	A	10.96	4*1.00 & 4*1.74	1979, 2003	DPU DKI
2	Grogol	80	K. Grogol	2.0	B	1.70	2*0.5 & 1*0.7	1972, 1979	DPU DKI
3	Rawa Kepa	229	WBC	0.5	C	16.00	4*4.0	1986	SDPU DKI
4	Pondok Bandung	90	WBC	-	D	1.00	2*0.5	1981, 1999	SDPU DKI
5	Cideng-Siantar	750	WBC	-	E	40.00	6*6.67	1989	DPU DKI
6	Melati	110	WBC	3.5	F	4.40	4*1.1	1970	DPU DKI
7	Setiabudi Barat	216	WBC	7.0	G	8.98	5*1.10 & 2*1.74	1979, 1983	DPU DKI
8	Setiabudi Timur	132	WBC		H	8.52	3*1.10 & 3*1.74	1980	DPU DKI
9	Pluit	3159	Java Sea	80.0	I	50.00	4*4.0 & 4*4.0 & 3*6.0	1967, 1986, 1995	DPU DKI
10	Muara Angke	50	K. Angke	1.0	J	1.00	4*0.2	1999	DPU DKI
11	Teluk Gong	90	K. Angke	2.0	K	0.80	4*0.2	1990, 1991, 1992	DPU DKI
12	Kemayoran	850	K. Pademangan	No Data	L	2.00	2*1.0	No Data	DPU DKI
13	Pademangan/Ancol	670	K. Ancol	-	M	15.00	3*5.0	1995	PWSCC
14	Sunter Barat Utara	1250	K. Ancol	30.0	N	9.90	3*3.3	1993	DPU DKI
15	Sunter Timur III (Rawa Badak)	570	K. Sunter	7.0	O	15.00	3*5.0	1995	PWSCC
16	Sunter Timur I (Kodamar)	200	K. Sunter	7.1	P	2.60	3*0.87	1995	DPU DKI
17	Pulomas	460	K. Sunter	1.0	Q	7.50	3*2.5	1976	DPU DKI
	Total	9076				195.36			

(b) Complicated Network of Drainage System

The another characteristics of the pump drainage areas in the DKI Jakarta is complicated network of drains with a lot of gates. Flood water is so controlled by gates to distribute optimum discharge to downstream in consideration of flow capacity of main drain, pump capacity as well as down stream water level including Sea Level. In Annex 3, Table A-3.1 summarizes drains and gates in the respective pump drainage areas, while Table A-3.2 tabulates sizes of the gates and agencies of responsibility. Figure 3.24 indicates drainage system in the areas between the WBC and the Ciliwung Drain. In this pump drainage area, flood water is controlled by around 15 gates. Flood water is pumped out to the WBC by two (2) pumping stations of Merati and Cideng-Siantar. Remaining flood water flows to downstream and drained to the Java Sea by Pluit Pumping Station, if gravity drainage by gate operation cannot be made due to high tide.

(c) Planning without Consideration of Secondary and Tertiary Drains

The other characteristics of drainage system in the DKI Jakarta is that existing pump capacity and starting water level of a reservoir of a pump drainage area are so determined that highest water level or the Design Flood Level along the main drain is lower than the existing bank elevation for one day flood with 25-year return period, assuming that most of rainfall can be drained to the main drain.

However, there are a lot of flood prone areas in pump drainage areas. One cause of inundation in flood prone areas may be improper installation/maintenance of secondary/tertiary drains, though gravity drain can be attained. Also high Design Flood Level of main drain may be other causes why rainwater is difficult to be drained. In several places, the ground elevation is lower than the existing bank elevation of the main drain and thus rain water cannot be drained to the main drain.

Actually, in order to drain flooded water in these places to main drains or directly to rivers, local pumps have been installed as shown in Figure 3.23 and tabulated in Table A.3-3 in Annex 3. Furthermore, pump equipment units composed of 11 mobile handy pumps and 2 trailer-type mobile pumps have been provided as grant-aid from Japan. Pump capacity of these mobile pumps is decided based on 1day rainfall with 1.2 - year return period (35 mm).

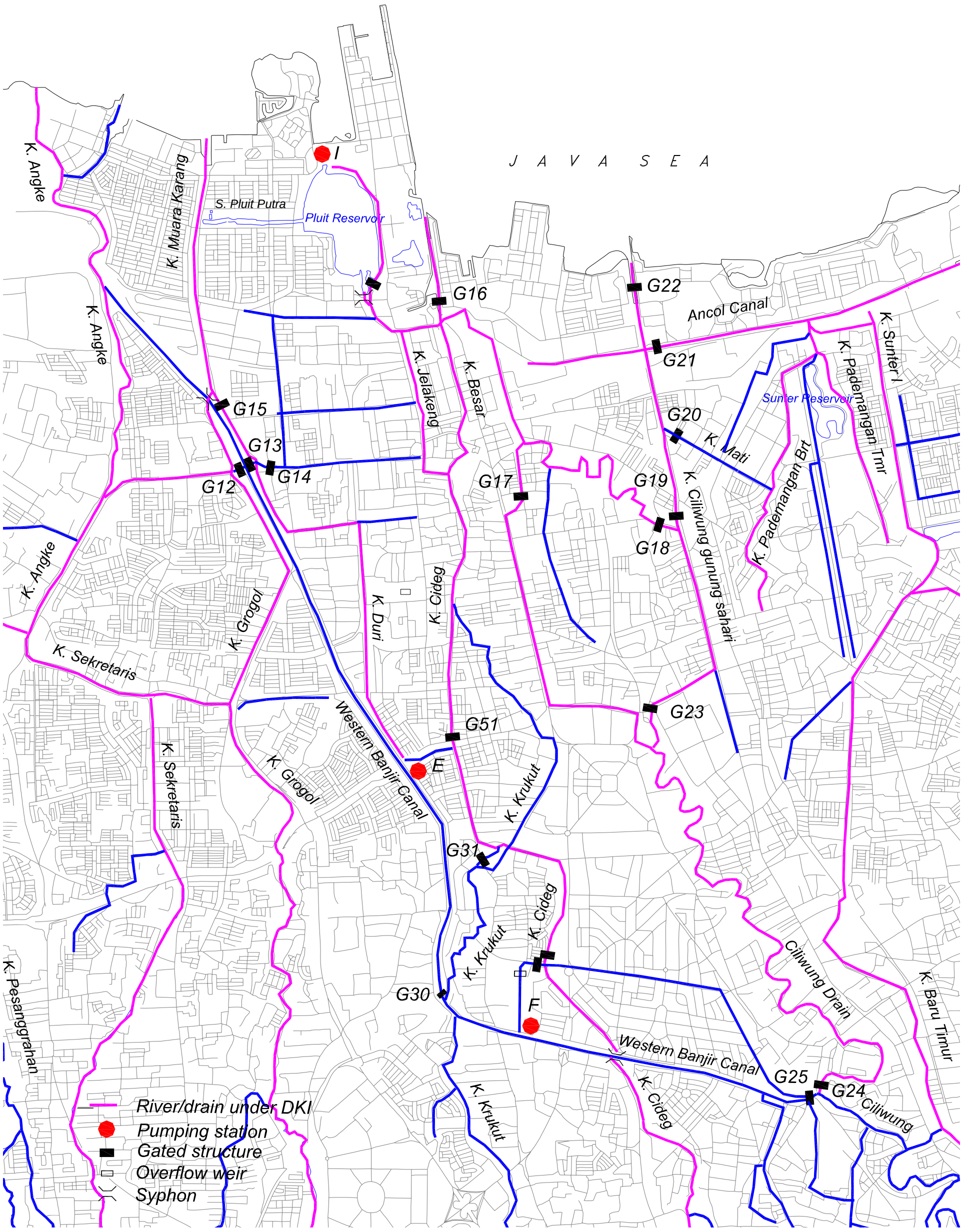

Figure 3.24 Drainage System of WBC - Ciliwung Drain