(ii) Sedimentation and anaerobic digestion in two (2) stages

- Total capacity of the two (2) stages is 9,600 m^3.
- Average BOD is reduced from 3,500 mg/l to 460 mg/l in both stages.

(iii) Facultative/Maturation pond treatment

- Capacity of pond is 1,600 m^3.
- Effluent BOD is reduced from 460 mg/l to 60-120 mg/l.
- The effluent is discharged to the Cakung River.

The treatment process of the Duri Kosambi treatment plant is very similar to that of the Pulo Gebang plant.

7.3 On-going Sewerage and Sanitation Project

The master plan prepared in 1977 on sewage disposal in Jakarta for the WHO recommended a phased construction of conventional sewerage system, discharging untreated sewage into Bay of Jakarta, through ocean outfall.

However, later in 1979 it was decided between the Government of Indonesia and (GOI) and World Bank (IBRD) to conduct initially only an integrated sewerage and sanitation project on a pilot scale encompassing Kecamatan Setia Budi and Tebet Manggarai. The project is known as "Jakarta Sewerage and Sanitation Project" or JSSP.

The project area of JSSP covers about 2000 hectare of area with a population of about 460,000 in 1989. The project will be completed by 1993.

The basic elements of JSSP project are as follows:

(i) Sewerage

The sewerage subsector includes the construction of the following basic elements:

- main sewers and interceptors, the respective secondary and tertiary sewer, shallow sewers and house connections.
- open drain interceptors to collect dry weather flow, known as kampung inlets, an indirect service to low income communities.
- the necessary equipments and their installation to convert Setia Budi West and Setia Budi East ponds to receive and treat the collected wastewater.

The Sewerage development plan in JSSP area is illustrated in Fig. 7.3 and the corresponding main features are as follows.

Population served	:	170,000
Direct House Connections	:	3,700
Total sewer length	:	46,000 m
Wastewater treatment plant capacity	:	400 l/s
Sewerage development cost	:	Rp. 49 billion in 1989

The Setia Budi ponds with a total surface area of 3.7 ha will be used for multiple purpose of both flood control and wastewater treatment. SBR type aerated lagoon will be applied as the method of wastewater treatment. It is expected to attain a treated effluent quality of 30 mg/l as BOD.

(ii) Sanitation

Sanitation subsector includes the construction and/or rehabilitation of the following basic elements:

- individual on-site sanitation facilities like leaching of 3,000 nos. and public water taps.

- communal on-site sanitation facilities of public toilets of 124 nos.
- drains and drain outlets.

(iii) Institution

Institution subsector includes the following basic elements:

- development of an institution to administer, operate and maintain the sewerage facilities.

- staff training on administration, operation and maintenance.

Table 7.1 Service Level of On-Site Sanitation Facilities of Commerce and Institutions

	Package Treatment Facilities (%)	Toilet with Septic Tank (%)	No Treatment Facilities (%)	Total
Shops	3.5	91.7	4.8	100.0
Factories	8.5	81.5	10.0	100.0
Restaurants	3.2	89.7	7.1	100.0
Hotels	16.7	79.1	4.2	100.0
Hospitals	5.1	94.9	0.0	100.0
Offices	1.9	95.2	2.9	100.0
Schools	0.0	98.1	1.9	100.0
Average	5.6	90.0	4.4	100.0

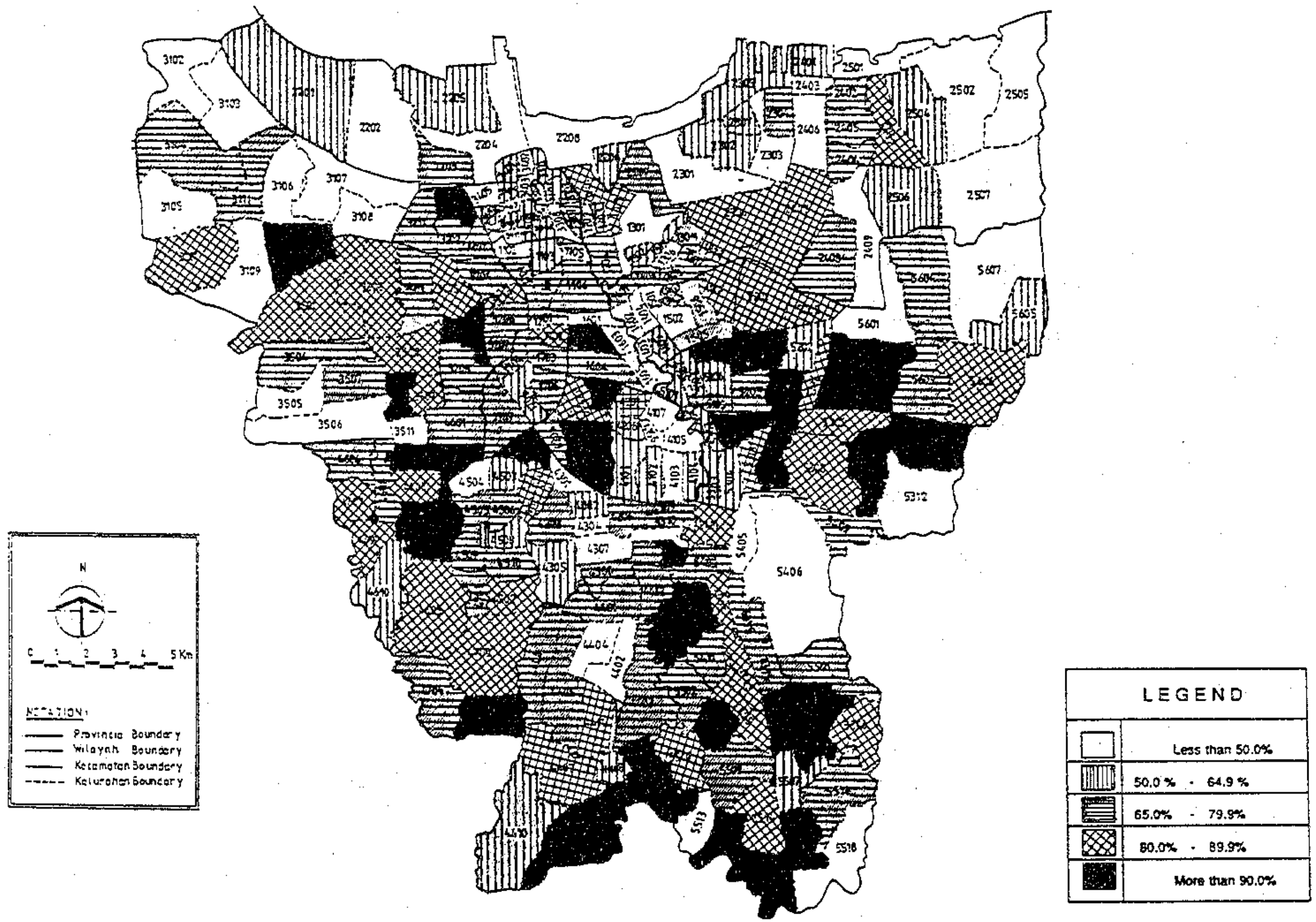


FIG. 7.1	RATIO OF HOUSEHOLDS USING INDIVIDUAL ON-SITE SANITATION FACILITIES WITH TREATMENT IN 1989

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

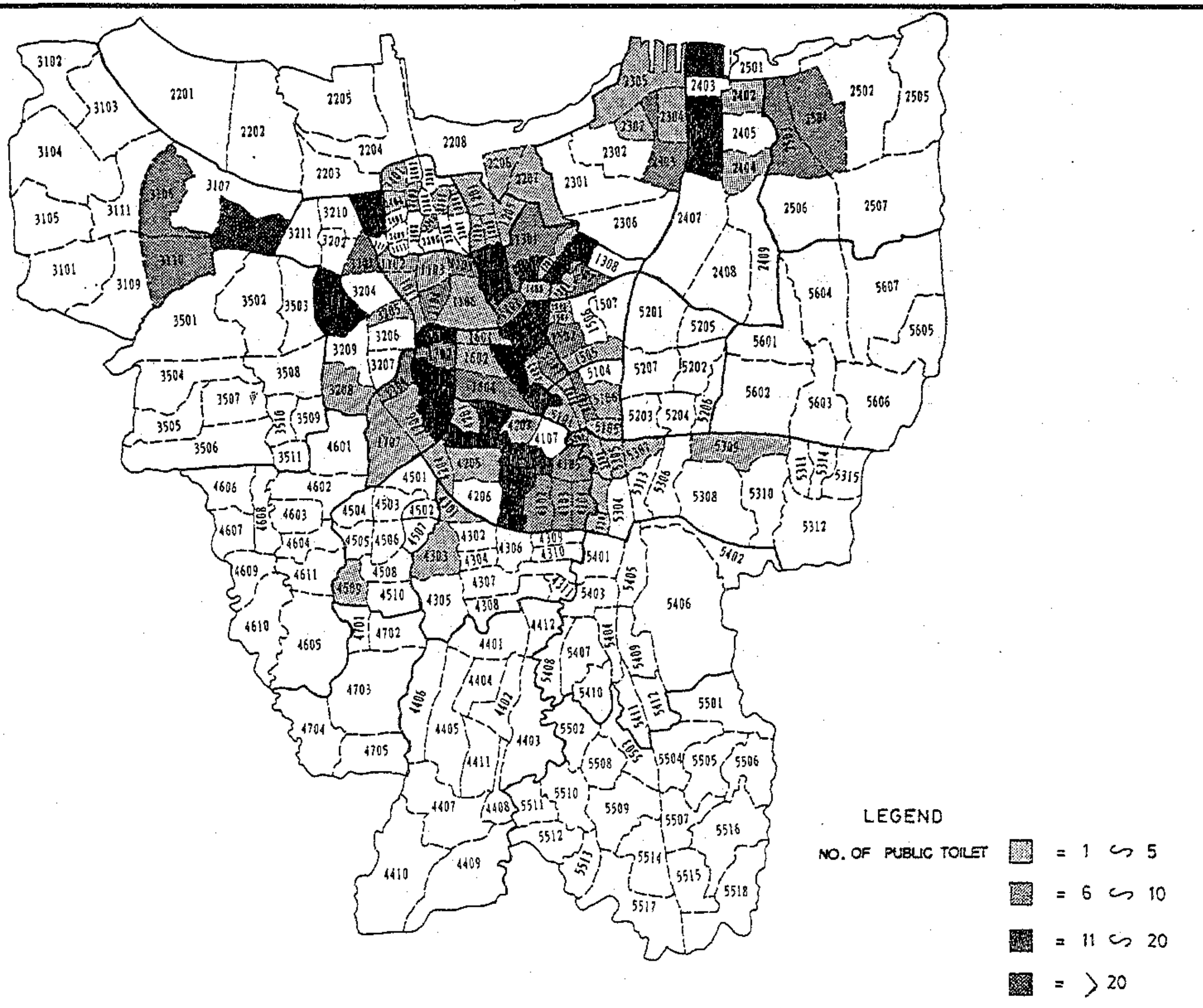


FIG. 7.2 DISTRIBUTION OF EXISTING PUBLIC TOILET

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

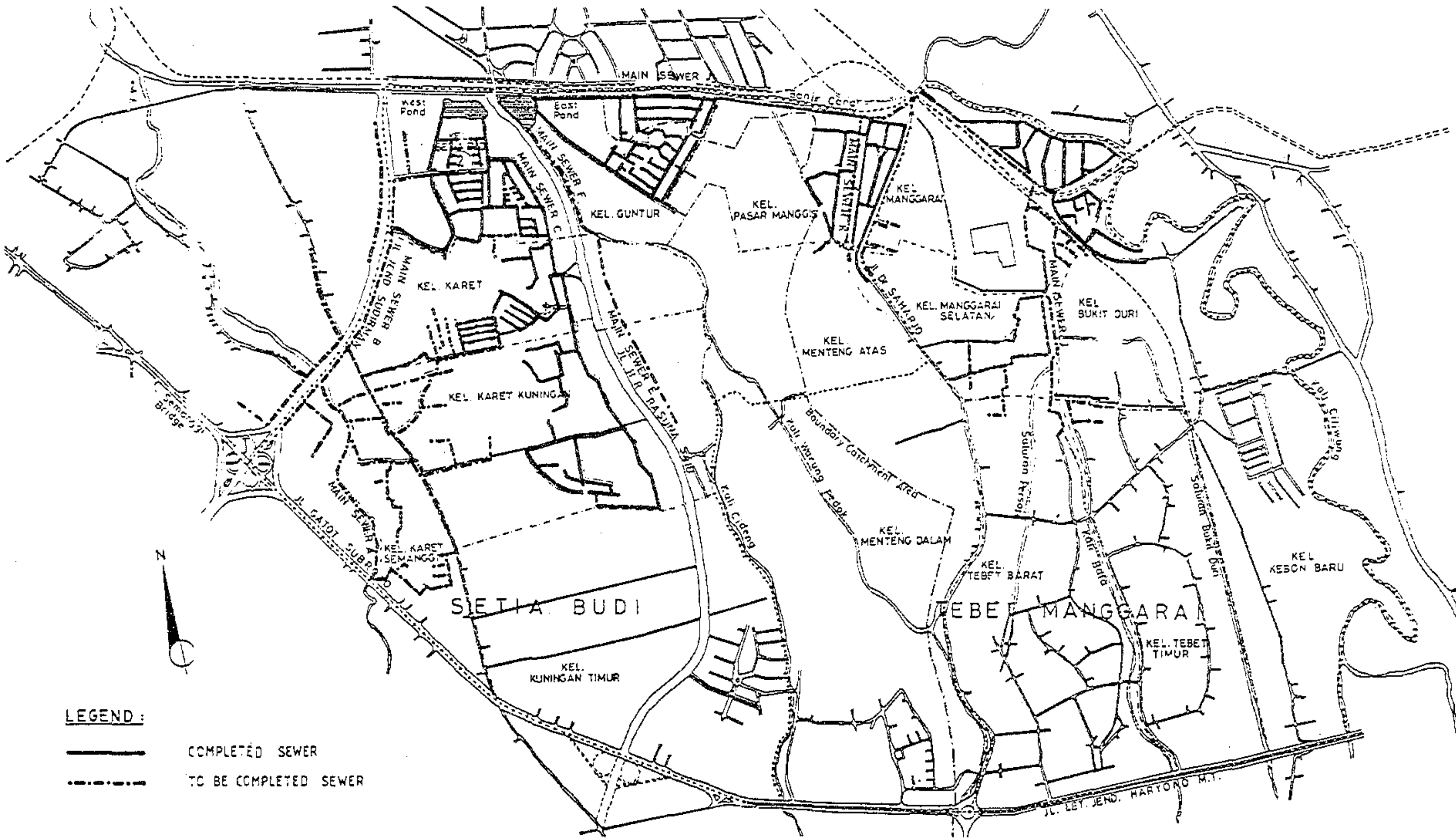


FIG. 7.3 SEWERAGE IN JSSP PROJECT AREA

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 8

URBAN DRAINAGE DEVELOPMENT PLAN

CHAPTER 8 URBAN DRAINAGE DEVELOPMENT PLAN

8.1 Design Flood Discharge

(1) Design Flood Frequency

The design flood frequency of the objective urban drainage channels will be determined, in principle, in accordance with the guidelines prepared by the Ministry of Public Works, the Government of Indonesia. In these guide lines, the design flood frequency of urban drainage channel varies according to the magnitude of catchment area.

In view of the existing land use, expected future land developments and location of the flood prone areas in the Study Area, in general, higher design flood frequency will be applied for the drainage channels inside the existing West and proposed East Banjir Canals than for the channels outside the Banjir Canals as shown below.

Catchment Area (ha)	Design Flood Frequency (Year)	
	Outside Area	Inside Area
less than 10	1	2
$10 \leq A < 100$	2	5
$100 \leq A < 500$	5	10
greater than 500	10	25

However, the design discharge proposed by the Jakarta Flood Control Project will be adhered in this Study to maintain the consistency among the completed, on-going and future projects.

Based on the above considerations, the design flood frequency of all the objective urban drainage channels are determined as shown in Fig.8.1.

(2) Design Flood Discharge

In this Study, design flood discharge of the objective urban drainage channels is established based on the following policies.

(i) The already established design discharges of the 50 on-going channel sections (Group I) are applied for this Master Plan with no revision.

(ii) The design discharges already proposed by JFCP for the 24 channel sections of Group II are applied for this Master Plan with no revision.

(iii) The design discharges for the other 84 channel sections of Group III are determined by using the Rational Formula.

For classification of the objective channel sections into Group I, II and III, refer to Chapter 6.

In calculation of flood run-offs by the Rational Formula, the rainfall intensity-duration curves shown in Chapter 3, Fig.3.2 are adopted and the following run-off coefficients are assumed.

Residential Area	:	f = 0.5
Commercial & Institutional Area	:	f = 0.70
Industrial Area	:	f = 0.60
Other Areas (farmland/open space)	:	f = 0.20

For determined design discharges of the objective channel sections, refer to Appendix G.

8.2 Urban Drainage Development Plan

8.2.1 Division of Drainage Zone

The Study Area is comprised of many complicated urban drainage networks. Some of them area hydraulically independent, while others are mutually connected. The hydraulically connected channels shall be developed as a package to maintain the hydraulic consistency among them.

The Jakarta urban drainage project consists of many small unit projects which will meet their respective local drainage requirements. Such small unit projects are widely distributed over the whole Study Area.

Regional priority sequences shall be made clear to attain the optimum stagewise development of such unit projects.

Based on the above considerations, the Study Area is divided into six (6) drainage zones. The divided drainage zones are shown in Fig.8.2.1.

The main features of the respective drainage zones are described below.

Zone 1: This zone covers a drainage basin of 10,017 ha with a ground level ranging from 2 m to 30 m. A large future population increase from 0.57 million in 1988 to 1.33 million in 2010 is expected. At present, rural land use including agricultural land, swamp and other open spaces is prevailing. However, a large portion of this rural land will be converted into urban land in future. The urban land use ratio will increase from 61 % in 1988 to 81 % in 2010.

Zone 2: This zone covers a drainage basin of 11,023 ha with a total population of 1.65 million in 1988. The ground elevation is in the range of 1 m and 50 m. The land has been already much developed. Existing urban land use occupies 90 % of the total land.

Zone 3: This zone covers an area of 8,356 ha with a ground elevation ranging from 10 m to 60 m. The included population is 1.29 million in 1988. The land has also been developed for urban use with a large extent. Existing urban land use rate is 82 %.

Zone 4: This zone covers the most developed area of 5,125 ha in the Study Area with an elevation ranging from 1 m to 10 m. The land has been fully developed for urban use. Existing urban land use rate is 93 %. The covered population is 1.44 million in 1988 with an average population density of 281 person/ha.

Zone 5: This zone covers the southern east hilly area of 11,119 ha with a ground level ranging from 10 m to 60 m. The included population is 1.1 million. A considerable area of agricultural land and other open spaces still exist in the zone. The urban land use rate is 71 % in 1988. No large urban development is expected in future.

Zone 6: This zone covers a low-lying flat area of 19,510 ha with an elevation of 2 m to 10 m. A large future population increase from 2.74 million in 1988 to 3.90 million in 2010 is expected. This zone have still a large rural land of 5,191 ha or 27 % of the total land. However, half of this existing rural land is expected to be converted into industrial land in future. Estimated future urban land use rate is 87%.

8.2.2 Design Policies for Urban Drainage Works

The following four (4) kinds of works are proposable to meet the requirements of urban drainage development in the Study Area.

(i) Improvement of the existing channels
(ii) Improvement of bridge crossing
(iii) Installation of pumping station
(iv) Installation of new channel

For these improvement works, the following design standards are applied to maximize its economical efficiency, securing its hydraulical and structural safety and maintaining consistency with other completed and on-going improvement works.

(1) *Improvement of the existing channels*

Method 1: Existing natural drainage channel will be provided with revetment of wet masonry type to increase its flow capacity within the existing width and depth.

Method 2: Existing drainage channel will be widened to increase its flow capacity where land acquisition is not difficult. Even in this case, revetment of wet masonry type will be provided to minimize the required land area.

Method 3: Existing drainage channel bed will be deepened to increase its flow capacity by providing revetment of wet masonry type or concrete pile wall.

Method 4: Existing drainage channel bank will be heightened to increase its flow capacity by providing parapet or earth embankment where it will not cause inland floods.

While, the inspection road with side ditch shall be constructed basically at both sides of the drainage channel if there is no existing available road in the surroundings and the land acquisition is not difficult.

(2) Improvement of bridge crossing

Shortage in flow capacity of drainage channel at the existing bridge crossings was calculated in the previous Chapter. Some bridge crossings much interfere with free flood discharge. Such bridges shall be reconstructed to meet the design flood discharge.

Furthermore, some existing bridges shall be extended to meet the design discharge along with widening of the drainage channel.

(3) Installation of pumping station

Inland flood in the Study Area mainly occurs behind levee of the flood control river where ground surface level is lower than high water level of the river. The inland floods behind the urban drainage channel is limited to quite a small area since almost all of the drainage channels are excavated ones. For such inland flood areas, new pump stations with a regulation pond will be provided.

Furthermore, expansion of the existing pump station is also undertaken for the areas where flood runoff volume has been increasing according as land development of its drain area.

(4) Installation of new urban drainage channel

In the eastern and western fringe areas of the Study Area, a large green land of agricultural, swamp and other uses is being developed for urban use, in accordance with the land use policy of the DKI Jakarta Structure Plan 2005. Such urban land developments will increase properties in the flood prone areas on one hand and on the other hand, will increase flood run-off peak of the drainage basin. It will result in creation of new flood problems.

New urban drainage channels shall be installed in advance of such urban developments to cope with expected new flood problems in the future.

The new urban drainage channel shall be prepared based on the following policies.

(i) One (1) primary urban drainage channel will not cover a too large drainage basin so that quick and easy secondary and tertiary drainage can be expected.

(ii) The route of new drainage channel will be determined to use the existing channel such as irrigation water channel as much as possible so that land acquisition or earth work costs can be minimized.

(iii) The revetment of wet masonry type will be applied for construction of new drainage channel. Also, the inspection road shall be attached at the side of the drainage channel for the maintenance and operation purpose.

8.2.3 Development Plan of Drainage Zone

The proposed development plan of the Study Area is composed of:

- improvement works for 32 existing channels with a total length of 76.1 km including improvement of 21 existing bridges

- installation works for two (2) pump stations with a total capacity of 8.7 m^3/s
- installation works for three (3) new channels with a total length of 11.4 km.

Their locations are shown in Fig. 8.3. Main features of the above existing channel improvement and new channel installation works are shown in Table 8.1.

On the other hand, 25 urban drainage projects are on-going mostly by JFCP. The other executing agencies concerned are DKI, JSSP, Sunter Development Authority and Ex-Kemayoran Airport Authority. Their locations are shown in Fig. 8.4.

The on-going and proposed projects by drainage zone are listed below.

(1) Zone 1

1) On-going Project	2) Proposed Project
A. Sepak River Imp.	No.1-1 Kamal River Imp.
	No.1-2 Tanjungan River Imp.
	No.2-1 Kali Gede/Kali Bor Channel Improvement
	No.2-2 Saluran Cengkareng Channel Improvement
	No.2-3 Padongkelan Channel Improvement
	No.3 Semanan River Imp.
	No.4 Kreo Rive Imp.
	No.5 Ulujami River Imp.
	No.6 Sepak River Imp.
	No.7 Pesanggrahan Bawah River Improvement

(2) Zone 2

1) On-going Project	2) Proposed Project	
B. Lower Angke River Imp.	No.10	Kedaung River Imp.
C. Grogol Sekretaris Intercepter	No.14	Cilawe River Imp,
D. Lower Sekretaris River Imp.	No.A	Sekretaris River Imp.
E. Upper Grogol River Imp.	P-1	Kedaung Kali Angke P.S. Const.

(3) Zone 3

1) On-going Project	2) Proposed Project	
F. Setia Budi Reservoir Rehabilitation	No.19	Mampang River Imp.
	No.20	Cideng Atas River Imp.
	No.27	Kali Bata Rive Imp.
	P-2	Menteng Wadas P.S. Const.

(4) Zone 4

1) On-going Project	2) Proposed Project
G. Sarinah Thamrin	- None. -
H. Ciliwung Kota Drain	
I. Pluit Rehabilitation	
J. K.Besar & Duri Canal Imp.	
K. Ciliwung River Imp.	

(5) Zone 5

1) On-going Project	2) Proposed Project
- None -	No.34 Sentiong River Imp.

(6) Zone 6

1) On-going Project	2) Proposed Project
L. Kemayoran Airport Drainage	No.49 Kebon Bawang River Imp.
M. Pademang Canal Imp.	No.50 Lagoa Tenggiri River Imp.
N. Ancol Canal Imp.	No.52 Lagoa Tenggiri River Imp.
O. Sentiong Cut-off Channel	No.54 Lagoa Tenggiri River Imp.
P. Sunter West Polder	No.58 Cipinang River Imp.
Q. Sunter River Imp.	No.72 Tugu Batu River Imp.
R. Sunter East III Polder	No.73 Rawa Badak River Imp.
S. Buaran River Imp.	No.74 Rawa Badak River Imp.
T. Cakung River Imp.	No.75 Pelumpang River Imp.
U. Petukangan Canal	No.76 Cakung Lama River Imp.
V. Cakung Floodway Imp.	No.78 Cakung River Imp.
W. Marunda Canal	No.79 Jati Bening River Imp.
X. Sunter East II Polder	No.U Kali Item River Imp.
Y. Marunda Polder	No.V Sentiong River Imp.
	No.X Sentiong River Imp.
	N-1 Lower Marunda Channel Const.
	N-2 Upper Marunda Channel Const.
	N-3 Upper Marunda Channel Const.

Note: The above project marks correspond to those in Fig. 8.3, Fig. 8.4 and Table 8.1.

8.3 Estimated Cost

The project cost is composed of direct construction costs, land acquisition and compensation cost, engineering service cost, government administration cost and physical contingency.

The estimated total project costs is Rp.676.7 billion with a break-down of Rp.543.0 billion for the on-going project and Rp.133.7 billion for the proposed project at 1990 price. Its break-down by cost item is shown in Table 8.2. Furthermore, the project costs by drainage zone is shown in Table 8.3.

The operation and maintenance cost includes costs for dredging of channel, removal of dumped garbage and other debris, repairing of revetment, embankment and other structures, operation and repairing of pump, gate and other facilities.

The total annual operation and maintenance cost is estimated to be Rp. 2,465 million with a break-down of Rp. 2,040 million for the on-going project and Rp. 425 million for the proposed project at 1990 price.

Table 8.1 (1) Main Features of Channel Improvement

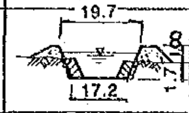
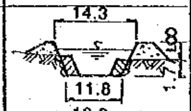
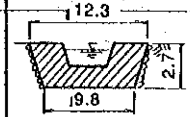
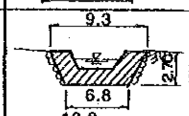
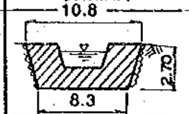
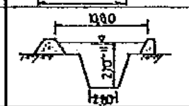
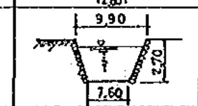
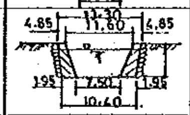
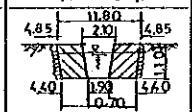
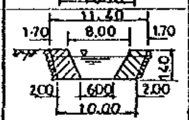
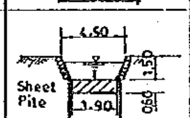
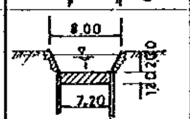
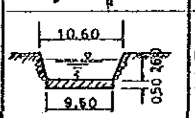
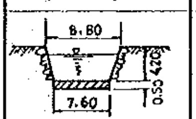
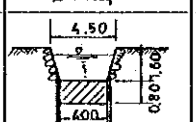
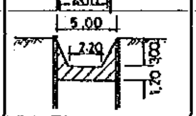
River No.	River Name	Design Discharge (m3/sec)	Improvement Section	Improvement Works	Improvement Length (km)
1 - (1)	Kanal	47		Excavation of Banks, and Embankement, and Wet Masonry	8.10
1 - (2)	Tanjungan	24		-do-	7.20
2 - (1)	Kali Gede Kali Bor	27		Excavation of Banks of Riverbed, and Wet Masonry	4.80
2 - (2)	Saluran Cengkareng	18		-do-	4.50
2 - (3)	Padongkelan	30		-do-	2.90
3	Semanan	10		Embankment and Parapet	0.50
4	Kreo	35		Wet Masonry	0.90
6	Sepak	70		Excavation of Banks, and Wet Masonry	0.60
	Kembangan	20		- do -	1.10
10	Kedaung	10		- do -	1.20
14 - (2)	Cilawe	10		Sheet Pile, and Riverbed, Excavation	0.90
19 - (2)	Mampang	60		- do -	1.00
19 - (3)	Mampang	80		Excavation of Riverbed	2.70
19 - (4)	Mampang	90		- do -	2.30
20 - (1)	Cideng Atas	25		Sheet Pile, and Riverbed Excavation	1.50
20 - (2)	Cideng Atas	45		Concrete Pile Wall, and Banks Excavation	1.00

Table 8.1 (2) Main Features of Channel Improvement

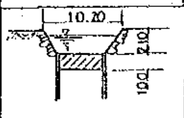
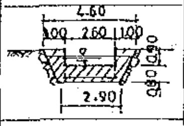
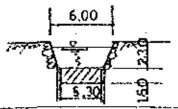
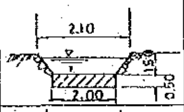
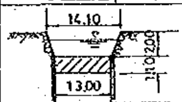
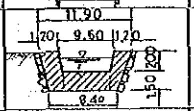
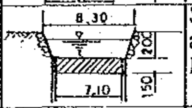
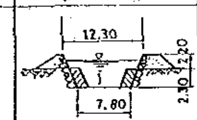
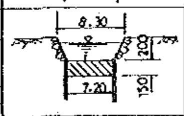
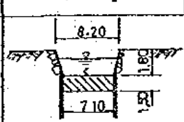
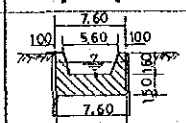
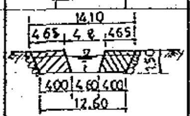
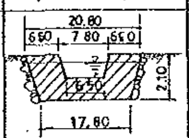
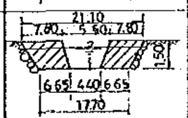
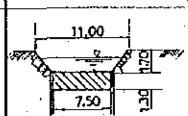
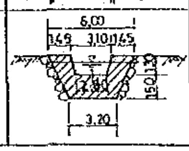
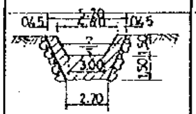
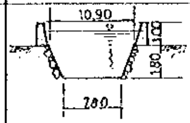
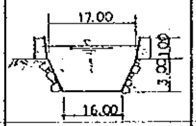
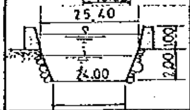
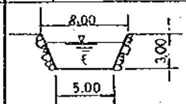
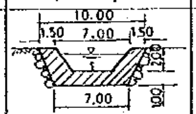
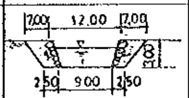
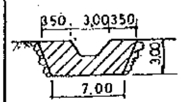
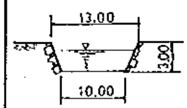
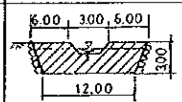
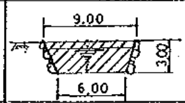
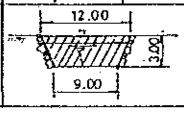
River No.	River Name	Design Discharge (m3/sec)	Improvement Section	Improvement Works	Improvement Length (km)
27	K. Bata	55		Sheet Pile, and Riverbed Excavation	0.40
34	Kramat Jati	15		- do -	1.20
49	Kebon Bawang	15		- do -	1.60
50	Lagoa Tenggiri	30		Riverbed Exacavation	0.60
52	Lagoa Tenggiri	35		Sheet Pile, and Riverbed Excavation	0.70
54	Lagoa Tenggiri	40		Excavation of Banks & Riverbed	1.80
58	Cipinang Lontar	5		Sheet Pile, and Riverbed Excavation	0.70
72	Tugu Batu	45		Excavation of Banks, and Embankment, and Wet Masonry	1.30
73	Rawa Badak	20		Sheet Pile, and Riverbed Excavation	2.00
74	Rawa Badak	20		- do -	1.00
75	Pelumpang	30		Concrete Pile Wall, and Banks & Riverbed Excavation	0.90
76 - (1)	Cakung Lama	40		Excavation of Banks, and Wet Masonry	5.20
76 - (2)	Cakung Lama	50		Excavation of Banks of Riverbed, and Wet Masonry	1.90
78	Cakung	20		Excavation of Banks, and Wet Masonry	5.20
79	Jati Bening	20		Sheet Pile, and Riverbed Excavation	1.40
A - (2)	Sekretaris (1)	25		Excavation of Banks and Riverbed, and Wet Masonry	1.90

Table 8.1 (3) Main Features of Channel Improvement

River No.	River Name	Design Discharge (m3/sec)	Improvement Section	Improvement Works	Improvement Length(km)
A - (3)	Sekretaris (2)	25		- do -	4.10
U	K. Item	20		Parapet	0.60
V - (1)	Sentiong	60		- do -	1.00
V - (2)	Sentiong	60		Parapet and Embankment	0.40
X	Sentiong	65		Parapet	0.30
N - I(1)	Down of Marunda	15		Excavation, and Wet Masonry	1.30
N - I(2)	- do -	25		Excavation of Banks & Riverbed, and Wet Masonry	0.90
N - I(3)	- do -	30		Embankment, and Wet Masonry	1.60
N - 2(1)	Up of Marunda	20		Excavation, and Wet Masonry	1.40
N - 2(2)	Up of Marunda	30		Excavation, and Wet Masonry	0.90
N - 2(3)	- do -	40		- do -	1.80
N - 3(1)	- do -	20		- do -	1.60
N - 3(2)	- do -	30		- do -	1.90

Total 87.50km

Table 8.2 On-going and Proposed Project Costs

(Unit : billion Rp.)

Item	On-going	Proposed	Total
Direct Construction Cost	371.0	72.2	443.2
Land Acquisition & Compensation Cost	101.8	41.7	143.5
Engineering Cost	26.0	5.1	31.1
Administration Cost	7.1	1.7	8.8
Physical Contingency	37.1	7.2	44.3
Sub-total	543.0	127.9	670.9
Miscellaneous Projects Cost	-	5.8	5.8
General Total	543.0	133.7	676.7

Table 8.3 Project Costs of Drainage Zone

(Unit : billion Rp.)

Zone No.	On-going	Proposed	Total
1	1.8	59.6	61.4
2	84.6	9.7	94.3
3	5.2	14.6	19.8
4	165.9	0.0	165.9
5	0.0	0.8	0.8
6	285.5	49.0	334.5
Total	543.0	133.7	676.7

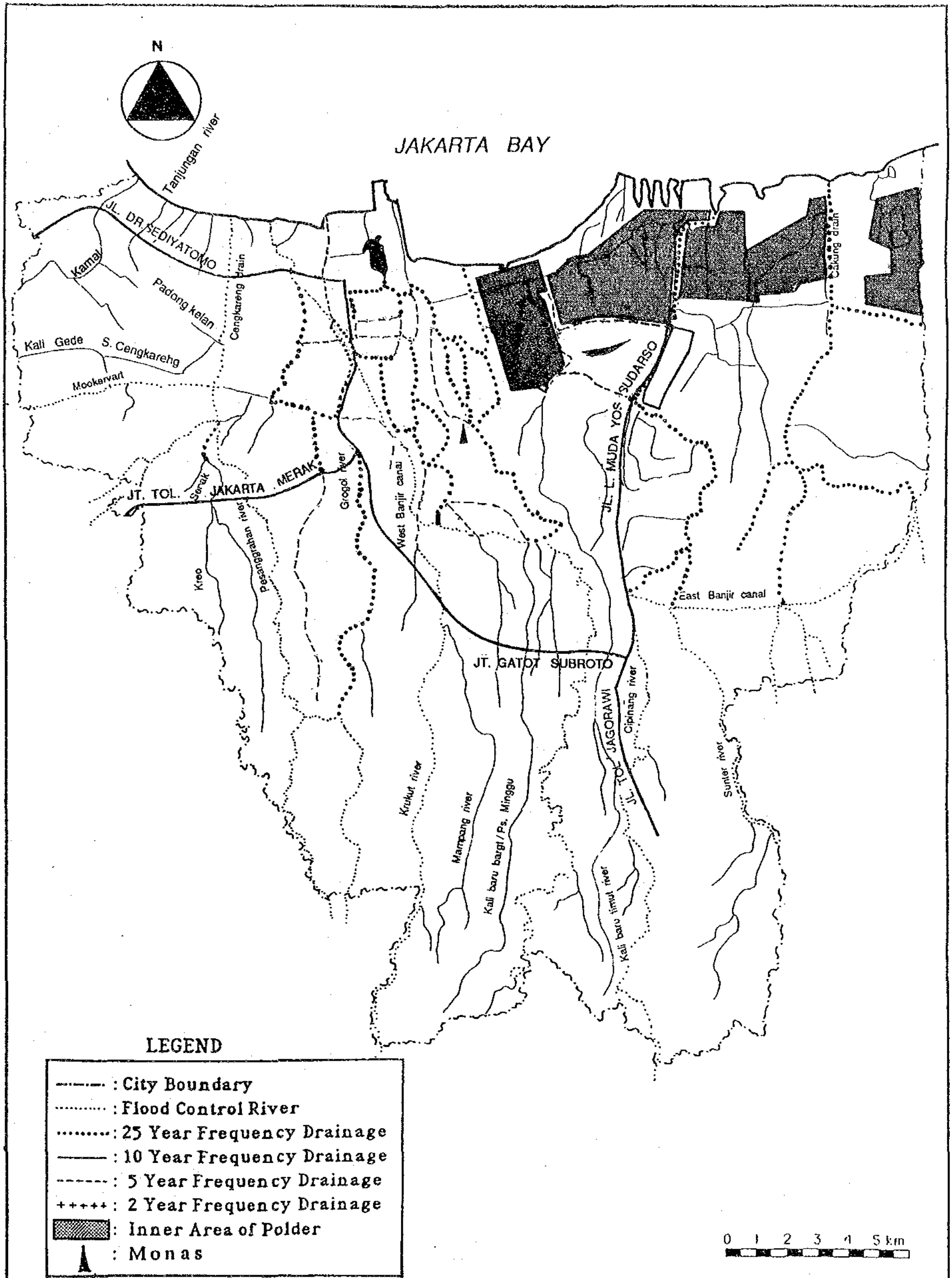
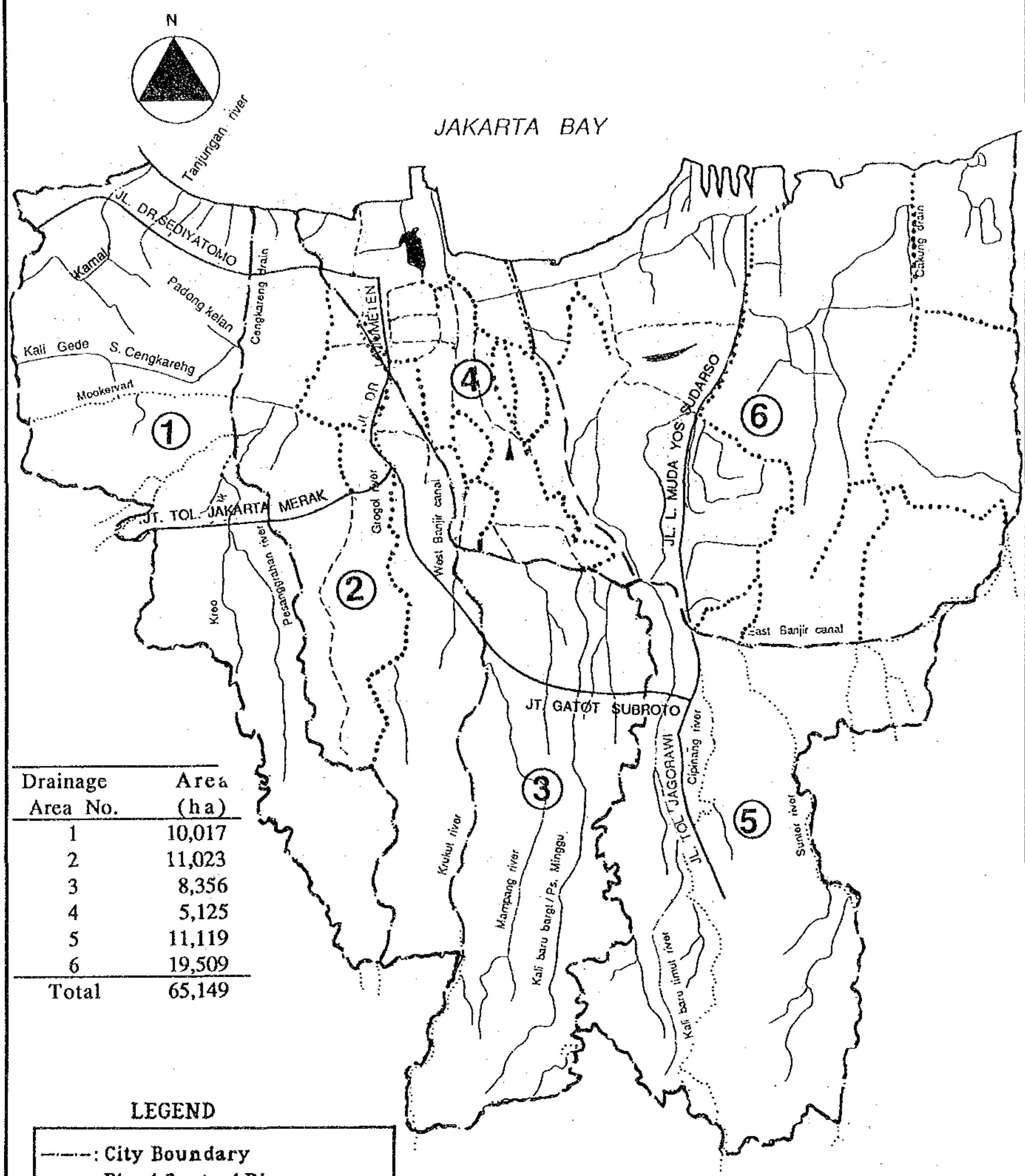


FIG. 8.1 DESIGN FLOOD FREQUENCY OF URBAN DRAINAGE CHANNEL



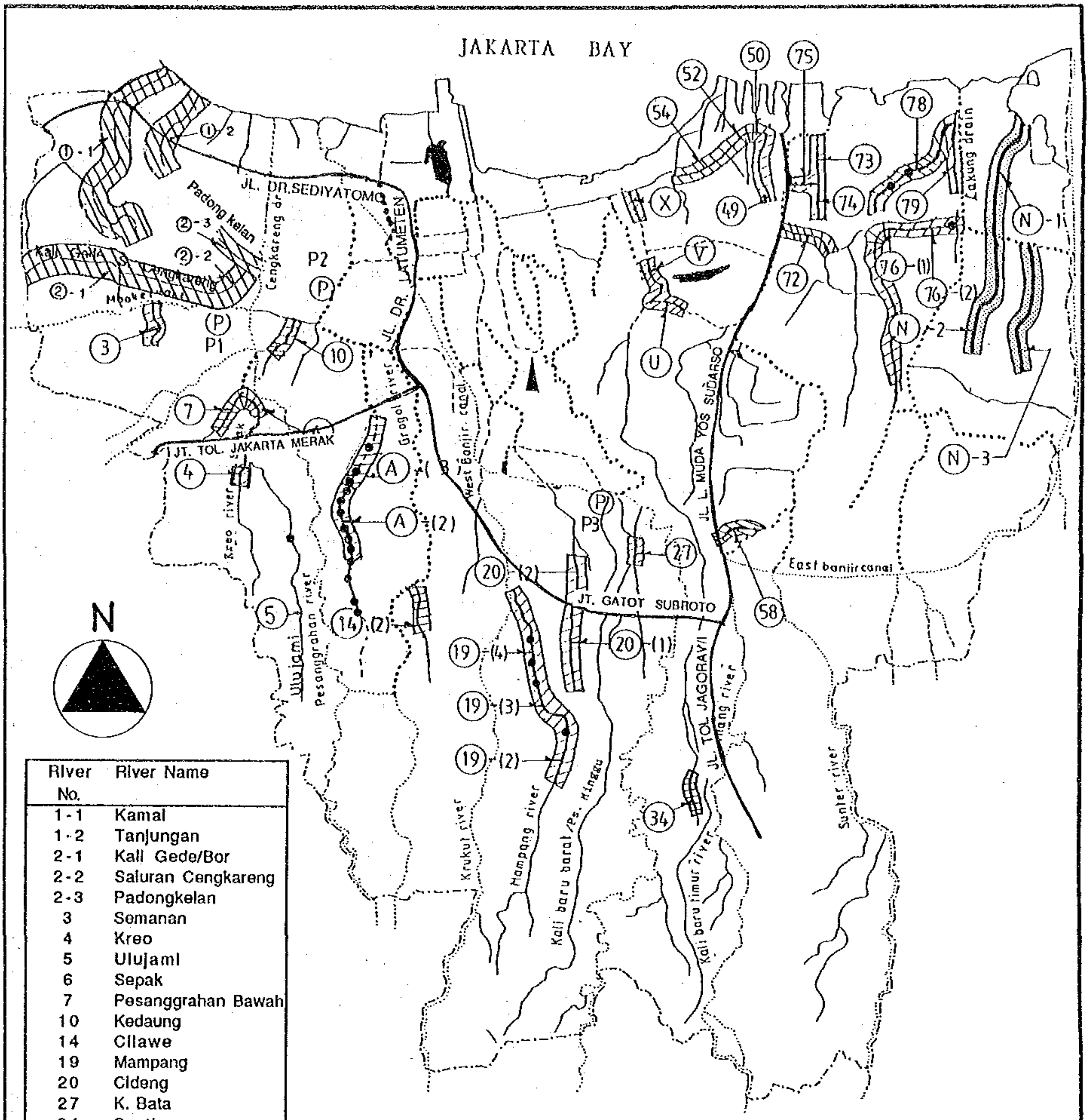
Drainage Area No.	Area (ha)
1	10,017
2	11,023
3	8,356
4	5,125
5	11,119
6	19,509
Total	65,149

LEGEND

- —·—·: City Boundary
- ·········: Flood Control River
- •••••••: Group I Urban Drainage
- - - - -: Group II Urban Drainage
- ———: Group III Urban Drainage
- ▬ ▬ ▬: Boundary of Drainage Zone
- ○ : Drainage Area No.
- ▲ : Monas

FIG. 8.2 DIVIDED DRAINAGE ZONE IN PROJECT AREA

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



River No.	River Name
1-1	Kamal
1-2	Tanjungan
2-1	Kali Gede/Bor
2-2	Saluran Cengkareng
2-3	Padongkelan
3	Semanan
4	Kreo
5	Ulujami
6	Sepak
7	Pesanggrahan Bawah
10	Kedaung
14	Cilawe
19	Mampang
20	Cideng
27	K. Bata
34	Sentiong
49	Kebon Bawang
50,52,54	Lagoa Tinggiri
58	Cipinang
72	Tugu Batu
73,74	Rawa Badak
75	Pelumpang
76	Cakung Lama
78	Cakung
79	Jati Bening
A	Secretaris
U	K. Item
V, X	Sentiong
N-1	Lower Marunda
N-2,N-3	Upper Marunda

LEGEND

- —·—·—·— : City Boundary
- ·········· : Flood Control River
- ·········· : Group I Urban Drainage
- — — — — : Group II Urban Drainage
- ———— : Group III Urban Drainage
- : Proposed Section
- : Proposed New Channel
- (P) : Proposed Pumping Station
- ● : Proposed Improvment Bridges
- : Monas

Scale
0 1 2 3 4 5 km

FIG. 8.3 LOCATION OF PROPOSED PROJECT

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

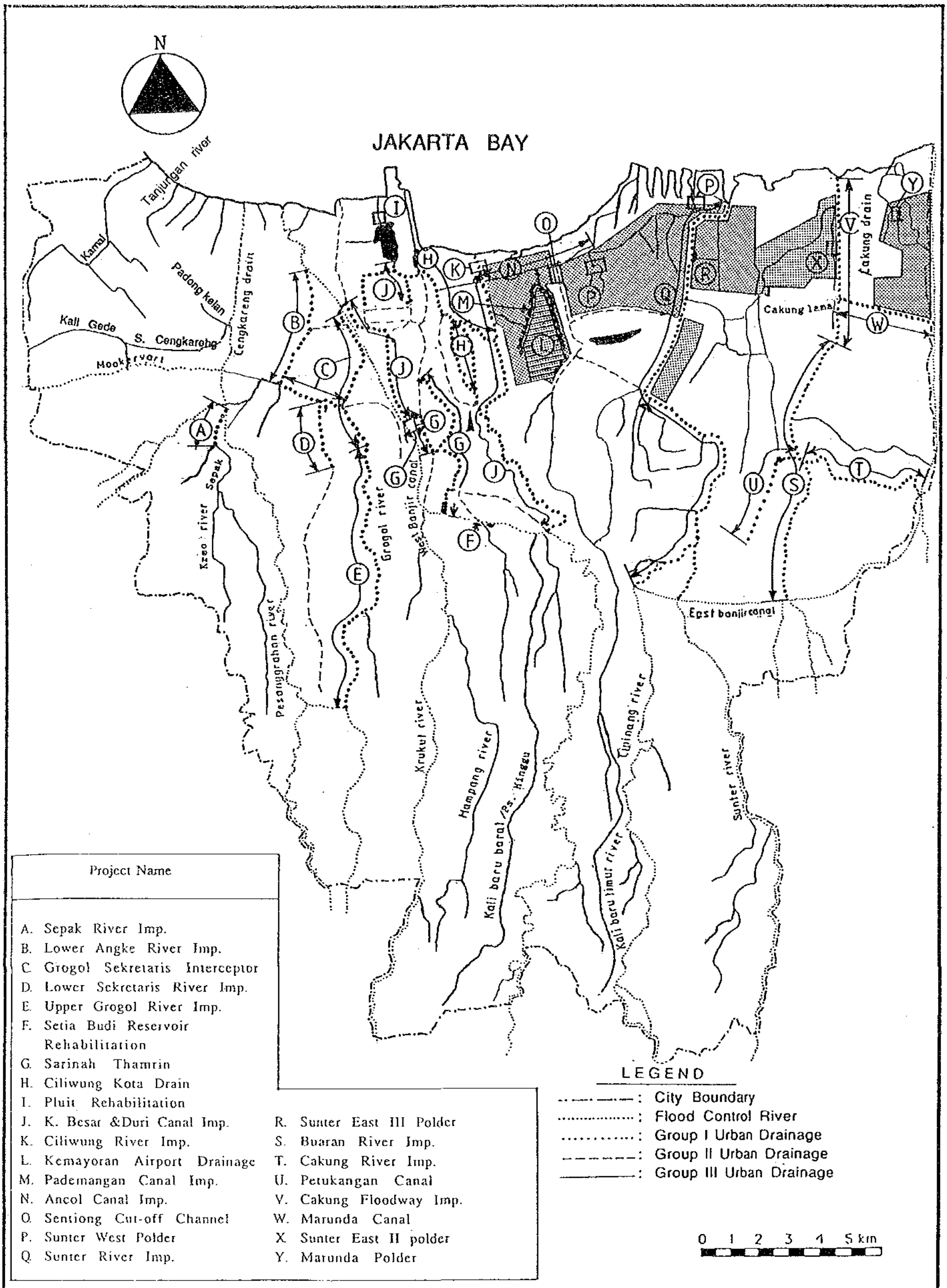


FIG. 8.4 LOCATION OF ON-GOING PROJECT

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 9

SANITATION AND SEWERAGE DEVELOPMENT PLAN

CHAPTER 9 SANITATION AND SEWERAGE DEVELOPMENT PLAN

9.1 Needs for Sanitation and Sewerage Development

9.1.1 Forecasted Future River Water Pollution

Future river water quality of the Study Area in 2010 is forecasted to confirm the requirements of sanitation and sewerage development. The simulation of the river water quality is carried out for the five (5) river basins covering the central part of the Study Area: Ciliwung - Banjir Canal, Grogol, Cideng, Sentiong and Sunter.

These five (5) river basins cover 38,385 ha or 59% of the Study Area with a population of 6.48 million or 74%. These river basins are sub-divided into 15 sub-basins for the simulation analysis (See Fig. 9.1).

The existing wastewater discharge and pollution load run-off as BOD of the respective sub-basins are estimated based on the analysis presented in Appendix D as shown in Table 9.1.

The river water quality at 15 stations of the five (5) river basins was simulated for the above mentioned existing pollution load run-off. The simulated river water quality is shown in Fig. 9.2., comparing with the observed river water quality.

The future river water quality without project at the 15 stations was also simulated for the future pollution load run-off of the river basins. The estimated future wastewater discharge and pollution load run-off of the respective sub-basins in 2010 are shown in Table 9.1. The simulated river water quality at the 15 stations in 2010 is shown in Fig. 9.2.

In 2010, the average river water pollution in the central part of the Study Area will reach a level of 88 mg/l as stream BOD if no pollution control measures are undertaken. The worst water pollution with an average BOD of 126 mg/l will occur in the Cideng River Basin, followed by the Sentiong River Basin with an average BOD of 112 mg/l and in Grogol River Basin with an average BOD of 91 mg/l.

As evident from the above analysis, requirement of sewerage development for the central part of the Study Area is definite.

9.1.2 People's Desire for Sanitation and Sewerage Development

The extent of people's desire of sanitation facilities are estimated based on the sampling questionnaire survey conducted for the ordinary citizens of the Study Area. The estimated ratio of people in desire of a particular type of sanitation facility is 22.2% for sewerage system, 55.8% for toilet with septic tank/leaching system, 12.4% for public toilet, 7.1% for toilet without treatment, and 2.5 % for no facilities and others.

More than 90% of the ordinary citizens of the Study Area desire sanitation facility with treatment system. However, the percentage of those who feel urgent necessity of sewerage system is not so high.

The Study Team further conducted the sampling questionnaire survey for the chiefs of all Kelurahans of the Study Area to know how such public opinion leaders think about the needs of future sewerage development.

33.6% of the respondents feel the urgent needs for all-out sewerage development regardless of budgetary constraints. 54.7% of the respondents recommend gradual approach to sewerage development due to the enormous financial requirements. The remaining 11.7% of the respondents take negative attitude to sewerage development or are convinced that the people and the nation cannot afford a sewerage system.

Nearly 90% of the public opinion leaders of the Study Area feel the necessity of future sewerage development.

9.2 Zoning of On-site Sanitation and Sewerage Development

9.2.1 General

Wastewater treatment system in the Study Area will be developed both to improve sanitary conditions of the communities and to abate water pollution of the public water courses.
River water pollution will become worse in proportion to the increase in population density of its catchment area. Fig.9.3 shows the relationship between river water quality and population density of respective catchment areas in the Study Area. While, sanitary conditions of the communities will also become worse accordingly as their population densities increase under such present conditions as gray water is discharged into the neighboring ditches, channels or lands with no treatment.

Therefore, required wastewater treatment level of each region can be reasonably determined or classified based on its population density.

For treatment of the domestic wastewater, the following three (3) systems are considered to be appropriate.

1) Simple on-site treatment system : treat toilet wastewater only

2) High level on-site treatment system : treat both toilet wastewater and gray water

3) Sewerage system : treat both toilet wastewater and gray water

Among the above systems, the most suitable one shall be applied, depending on the local conditions of the Study Area.

Commercial and institutional wastewater will be treated by the same systems as domestic wastewater. However, industrial wastewater will be treated individually or communally by appropriate treatment system, in principle.

9.2.2 Classification of Wastewater Treatment Level

The target river water quality of the Study Area is set at 30 mg/l as stream BOD, at least to maintain the minimum condition necessary to support aquatic biota in the rivers. To attain the above target river water quality, required wastewater treatment level of an area is determined as follows, according to its population density.

1) Low Population Density Area (Area A)

A low population density area is defined as an area where its population density does not exceed 100 person/ha. The river water quality of such an area is 0-30mg/l as stream BOD.

In these areas, toilet wastewater shall only be treated to a sanitarily acceptable level, while, gray water (BOD 180 mg/l) may be discharged with no treatment as it is, in principle.

However, in some specified areas with a concentrated pollution load generation such as community center large scale housing estate, both toilet waste and gray water will be treated to a BOD level of 60 mg/l.

2) Medium Population Density Area (Area B)

Medium population density areas are those areas with a population density in the range of 100-300 person/ha. The river water quality of such an area is 30-80 mg/l as stream BOD.

In these areas, both toilet wastewater and gray water shall be treated to a moderate level of BOD 60 mg/l to attain the target river water quality of 30mg/l as steam BOD.

3) High Population Density Area (Area C)

High population density areas are those areas with a population density greater than 300 person/ha. The river water quality of such an area is higher than 80 mg/l as stream BOD.

Both toilet wastewater and gray water shall be treated to a high level of at least 30 mg/l as BOD to attain the target river water quality of 30 mg/l as steam BOD.

9.2.3 Application of Wastewater Treatment System

The optimum wastewater treatment system for the above three (3) areas is determined as follows:

(1) Area A

Simple on-site treatment systems like septic tank/leaching pit will be applied for the treatment of toilet wastewater. No treatment system will be introduced for gray water, in principle.

(2) Area B

Both on-site treatment system and sewerage system are applicable for this area, from which the economical one will be selected.

In this comparative study, septic tank with upflow filter is considered as the on-site treatment system to treat a mixture of toilet waste and gray water to a BOD level of 60 mg/l. While as for sewerage system, conventional sewerage system consisting of individual house connections, collection sewer networks and a low level treatment plant is considered.

Unit cost of the sewerage system varies according to magnitude of service area and its population density. Then, cost of the on-site treatment system and sewerage system are compared for the following four (4) cases of service areas and population density.

	Service Area (ha)	Population Density (person/ha)
Case 1	500	100
Case 2	500	300

Case 3	2,500	100
Case 4	2,500	300

The cost comparison is made on present value basis. The estimated construction, and operation and maintenance costs of the on-site treatment and sewerage systems are converted into present value as shown in Table 9.2.

As evident from the above table, on-site treatment system is more economical than sewerage system. Then, on-site treatment system will be applied for Area B.

(3) Area C

Similar to that of Area B, both on-site treatment system and sewerage system are applicable and the economical one will be selected.

In this comparative study, household package treatment plant is considered as the on-site treatment system to treat the wastewater to a BOD level of 30mg/l. This system is composed of sedimentation, contact aeration and disinfection systems. Conventional sewerage system with a high level treatment plant is considered as sewerage system.

Similar to Area B, project costs including construction cost and O & M cost of the on-site treatment and sewerage systems are compared for the following four (4) cases of service area on present value basis. The estimated project costs in present value are shown in Table 9.3.

	Service Area (ha)	Population Density (person/ha)
Case 1	500	300
Case 2	500	500
Case 3	2,500	300

Case 4	2,500	500

As evident from the table, the sewerage system is more economical than the on-site treatment system Hence, sewerage system will be applied for Area C.

9.2.4 Zoning

The above-mentioned three (3) sanitation development areas are delineated based on population density with some modifications. The proposed delineation of the sanitation development areas is shown in Fig. 9.4.

(1) Simple On-site Treatment System Development Area (Area A)

Kelurahans with a population density of less than 100 person/ha will be included. The total number of kelurahan covered, and their area and population in 2010 are:

Nos. of kelurahan	:	37
Area	:	21,159 ha or 32% of the Study Area
Population in 2010	:	1,482,000 or 11% of the Study Area.

(2) High Level On-site Treatment System Development Area (Area B)

Kelurahan with a population density of 100 - 300 person/ha will be included in principle.

The total number of Kelurahan covered, and their area and population in the year 2010 are as follows.

Nos. of kelurahan	:	89
Area	:	27,386 ha or 42% of the Study Area
Population in 2010	:	4,967,000 or 39% of the Study Area

(3) Sewerage Development Area (Area C)

Kelurahans with a population density of more than 300 person/ha will be included in principle. The total number of kelurahan of sewerage development, and their area and population in the year 2010 are as follows:

Nos. of kelurahan	:	140
Area	:	16,604 ha or 26% of the Study Area
Population in 2010	:	6,351,000 or 50% of the Study Area.

9.3. Alternative Studies of Sewerage Development System

9.3.1 General

The objective sewerage development area for the year 2010 covers 16,604 ha located in Central Jakarta and Tanjung Priok region. It includes the on-going sewerage development area of 1,838 ha by JSSP.

The following five (5) alternative systems are considered for the evaluation of sewerage development in the objective area.

(1) Multiple Small Scale On-land Treatment System

The objective area is divided into nine (9) sewerage zones. The wastewater of the objective area will be collected and treated independently for each zone.

(2) Multiple Medium Scale On-land Treatment System

The above multiple small scale systems are integrated into three (3) medium scale systems : central, west and east zones. The wastewater from each zone will be collected and treated independently.

(3) Single Large Scale On-land Treatment System

The above multiple medium scale systems are further integrated into one (1) single large scale system. The wastewater from the whole objective area will be collected and treated at one (1) single location.

(4) Ocean Outfall System

The collection system of wastewater is the same as that of the above single large scale on-land treatment system. However, the collected wastewater will be discharged off-shore through ocean outfall with no treatment.

(5) Modified Ocean Outfall System

This is a modified system of the above ocean outfall. The wastewater will be discharged off-shore through ocean outfall with primary treatment.

These alternative systems are compared and evaluated in the following sections. In this comparative study, it is assumed that all the houses and buildings in the objective area will be connected to sewerage system.

9.3.2 Multiple Small Scale On-land Treatment System

(1) Potential Treatment Plant Sites

This multiple small scale on-land treatment system has much bearing on the available potential areas for treatment plant sites.

The potential treatment plant sites identified by the Study Team through site reconnaissance are shown in Fig. 9.5.

(2) Proposed System

The objective area of 16,604 ha is divided into nine (9) sewerage zones, considering administrative boundaries, topographical conditions, river networks, road networks and available potential treatment sites. The divided sewerage zones are shown in Fig. 9.6.

The area of divided sewerage zone ranges from 1,032 ha in Zone 1 to 3,237 ha in Zone 2 with an average of 1,845 ha. The population of sewerage zone in 2010 is in the range of 0.396 million in Zone 1 and 1.345 million in Zone 2 with an average of 0.706 million.

Total design wastewater discharge of all nine (9) zones is 1,348,000 m^3/d on daily average basis.

The proposed sewer line networks consisting of tertiary, secondary, main and trunk sewer pipes classified by pipe diameter has a total length of 2,223,000 m. Number of house connection to this collection system is 800,000.

Nine (9) wastewater treatment plants are proposed to treat independently the wastewater of the nine (9) sewerage zones. Aerated lagoon treatment is applied for Zone 1 at Melati pond, Zone 2 at Pluit pond, Zone 3 at the green area of Kel. Rembangan, Zone 4 at the green area of Kel. Joglo, Zone 5 at the green area of Kel. Cipinang Besar Selatan and Zone 8 at Sunter East II pond (on-going flood control pond). However for the zones of 6, 7 and 9, conventional activated sludge treatment is considered due to the limited available land space. The treatment sites are proposed for Zone 6 at the green area of Kel. Rawamangun, Zone 7 at the green area including Sunter lake Kel. Sunter Japa and Zone 9 at the residential area of Kel. Setia Budi Guntur.

Note : green area is a classification of the future land use where urban development is restricted.

Location of the treatment plants are also shown in Fig. 9.6.

Salient features of the sewerage development of the respective zones are shown in Table 9.4.

9.3.3 Multiple Medium Scale On-land Treatment System

The objective area of 16,604 ha is divided into three (3) sewerage zones : Central, West and East sewerage zones as shown in Fig. 9.7. The Central Zone covers the zones of 1, 2 and 9 of the multiple small scale system, the West Zone includes the zones of 3 and 4, and the East Zone encompasses the zones of 5, 6, 7 and 8.

The wastewater of the three (3) zones will be collected by the respective collection systems consisting of tertiary, secondary, main and trunk sewer line and will be conveyed to the respective treatment plants.

The proposed collection and conveyance sewer lines have total lengths of 2,209.1 km and 41.5 km.

All the proposed treatment plants are of aerated lagoon type. They will be constructed at Pluit pond for Central Zone, at the green area of Kel. Rembangan for West Zone and at Sunter East II pond for East Zone. Location of the treatment plant sites is also shown in Fig. 9.7.

Salient features of the respective zones including area, population in 2010, design wastewater discharge (daily average), collection sewer line length and conveyance sewer line length are shown below.

	Central Zone	West Zone	East Zone	Total
Area (ha)	6,107	4,186	6,311	16,604
Population (million)	2,466	1,316	2,569	6,351
Design Discharge (m^3/d)	562,000	263,000	523,000	1,348,000
Collection Sewer (km)	810.2	555.8	843,100	2,209,100
Conveyance	10.2	10.9	20.4	41.5

9.3.4. Single Large Scale On-land Treatment System

The objective sewerage development area of 16,604 ha will be covered by a single large scale sewerage system. All the wastewater of the area will be collected by a single collection system consisting of tertiary, secondary, main and trunk sewer lines, and will be conveyed to the treatment plant located at the west coast of the Jakarta Bay.

The proposed collection system is in fact the integrated one of the nine (9) collection systems of the multiple small scale on-land treatment system.

The conveyance sewer line consisting of three (3) major lines has a total length of 52.5 km. Its diameter is in the range of 1,350 mm and 3,500 mm. One (1) booster pump station will be installed along the conveyance sewer lines.

The proposed treatment plant is of aerated lagoon type.

The layout of the system is shown in Fig. 9.8.

9.3.5 Ocean Outfall System

(1) Proposed System

The objective sewerage development area of 16,604 ha will be covered by a single large scale sewerage system.

The wastewater will be collected and conveyed to the west coast of the Jakarta Bay in the same way as the single large scale on-land treatment system. The wastewater will be discharged off-shore of the Jakarta Bay through the ocean outfall and diffuser pipes placed on the sea bed, as the means of final disposal.

The ocean outfall will be extended to 20 km off-shore of the Jakarta Bay to prevent water pollution of the Bay (See Section 9.3.5 (2)) The wastewater will be discharged through three (3) pipes with a diameter of 2,400 mm each.

One (1) outfall pump station with a capacity of 1,230 m3/min. will be installed at the coast to discharge the wastewater off-shore. The required pump head is estimated at 35 m.

The layout of the system is shown in Fig. 9.9.

(2) Assessment of Adverse Effects on Jakarta Bay

Ocean outfall system discharges wastewater with a high COD concentration off-shore. It will aggravate the water quality of the Jakarta Bay.

The initial dilution of the discharged wastewater increases with increasing depth of the point of discharge of outfall resulting in decrease in COD concentration. While, further dilution by subsequent diffusion and dispersion increases with increasing radial distance from the point of wastewater discharge.

The concentration variation of COD in sea water at various radial points from the outfall is estimated by using the Buoyant Jet and Brooks formulas, assuming the depth of discharge point of wastewater.

The simulated sea surface water quality is shown below.

(Unit : COD mg/l)

Off-shore Distance (km)	Water Depth (m)	Radial Distance (m)			
		0	1,000	2,000	3,000
1.7	5	116	42	33	29
3.2	10	92	41	32	29
12.2	20	74	38	30	29
22.2	30	64	36	30	29

As evident from the above simulation results, the ocean outfall system will result in considerable aggravation of seawater quality of the Jakarta Bay.

The ocean outfall should at least be extended to the open sea, 20 km off-shore (outside of the Bay) to prevent water pollution of the Jakarta Bay.

9.3.6 Modified Ocean Outfall System

(1) Proposed System

In principle, this system is basically the same as that of Section 9.4.5, in which the wastewater is discharged 20 km off-shore with no treatment. However in this case, the wastewater is discharged 5 km off-shore with primary treatment.

The wastewater will be discharged through three (3) pipes with a diameter of 2,400 mm. One (1) pump station with capacity of 1,230 m^3/min. will be installed to discharge the wastewater off-shore. The required pump head is estimated at 6.0 m.

(2) Assessment of Adverse Effects on Jakarta Bay

The concentration of COD in sea water at various radial points from the outfall is estimated in the same way as the previous Section 9.3.5. However in this simulation, it is assumed that COD concentration of the wastewater will be reduced by 30 % through the primary treatment.

The simulated sea surface water quality is shown below.

(Unit : COD mg/l)

Off-shore Distance (km)	Water Depth (m)	Radial Distance (m) 0	1,000	2,000	3,000
1.7	5	87	37	31	28
3.2	10	71	36	30	28
12.2	20	58	34	29	28
22.2	30	52	33	28	28

As evident from the above simulation results, even the ocean outfall with primary treatment system will still result in considerable aggravation of seawater quality of the Jakarta Bay.

9.3.7 Comparative Evaluation

The construction and annual O & M costs of the five (5) alternative systems are estimated as follows, at 1990 price.

	Construction (Rp. billion)	Annual O&M (Rp. billion/year)
Multiple Small Scale	2,201.4	25.9
Multiple Medium Scale	2,168.7	20.7
Single Large Scale	2,310.8	21.1
Ocean Outfall	2,509.4	10.7
Modified Ocean Outfall	2,326.9	16.6

Construction cost is the lowest for multiple medium scale on-land treatment system and the highest for ocean outfall system. While, annual O & M cost is the most expensive for multiple small scale on-land treatment system and the cheapest for ocean outfall system.

Project costs of the five (5) alternative systems including construction cost and total O&M cost for the project life time are compared in terms of present values estimated based on the following assumptions to identify the most economical system.

(1) Discount rate is 9% per annum

(2) O & M period (effective project life time) is up to 30 years after full completion of the systems.

(3) Implementation schedule is as described in Appendix H.

The estimated project costs of five (5) alternative systems in present value are shown below.

(Unit: Rp. billion)

	Construction	O & M	Total
Multiple Small Scale	1,157.6	123.7	1,281.3
Multiple Medium Scale	1,145.2	102.5	1,247.7
Single Large Scale	1,323.3	108.2	1,431.5
Ocean Outfall	1,424.5	55.0	1,479.5
Modified Ocean Outfall	1,340.4	84.5	1,424.9

The multiple medium scale on-land treatment system is the most economical one.

9.3.8 Optimization of Sewerage Development system

As concluded in the previous Section 9.3.7, the multiple medium scale system is the most economical one in terms of total cost. However, it is not certain that each of the three (3) zones would also be the most economical independently. Hence, the most economical zoning for each of the three (3) zones is studied independently in order to optimize the whole sewerage development system.

(1) Central Zone

This central zone covers the zones of 1,2 and 9 of the multiple small scale system. The following three (3) systems are compared.

(i) Independent System
Zone 1, Zone 2 and Zone 9 are all independent, which is the same as the multiple small scale system.

(ii) Fully Integrated System
Zone 1, Zone 2 and Zone 9 are fully integrated, which is the same as the multiple medium scale system.

(iii) Partially Integrated System

Zone 1 is incorporated into Zone 2 to be treated at Pluit pond, Zone 9 is independent.

The construction cost and annual O&M cost of the above three (3) systems are shown below.

	Const. Cost (billion Rp.)	O&M Cost (billion Rp./year)
Independent	855.1	10.0
Fully Integrated	727.4	7.8
Partially Integrated	734.8	9.9

As evident from the above table, the fully integrated system is the most economical one. In this system, all the wastewater is treated at Pluit pond by aerated lagoon for which no land acquisition is required.

The fully integrated system is recommended.

(2) West Zone

This west zone includes zone 3 and zone 4 of the multiple small scale system. The following two (2) systems are compared.

(i) Independent System
Zone 3 and Zone 4 are independent, which is the same as the multiple small scale system

(ii) Integrated System
Zone 3 and Zone 4 are integrated, which is the same as the multiple medium scale system.

The construction cost and annual O&M cost of the above two (2) systems are shown below.

	Const. cost (billion Rp.)	O&M Coast (billion Rp./year)
Independent	499.2	4.5
Integrated	527.1	4.4

The independent system is more economical than the integrated one. The treatment plant sites of both zones are available in the green area of the future land use plan where urban development is restricted. Land acquisition for the treatment plant sites is considered not difficult.

The independent system is recommended.

(3) East Zone

This east zone covers zones 5, zone 6, zone 7 and zone 8. The following three (3) systems are compared.

(i) Independent System
Zone 5, Zone 6, Zone 7 and Zone 8 are all independent, which is the same as the multiple small scale system.

(ii) Fully Integrated System
Zone 5, Zone 6, Zone 7 and Zone 8 are fully integrated, which is the same as the multiple medium scale system.

(iii) Partially Integrated System
In the independent system, Zone 5 and Zone 8 are treated by aerated lagoon method. While, conventional activated sludge method is applied for Zone 6 and Zone 7 due to lack of available land space. Integration of the neighbouring Zone 6 and Zone 7 is also studied to obtain more efficient system.

The construction cost and annual O&M cost of the above three (3) systems are shown below.

	Const. Cost (billion Rp.)	O&M Cost (billion Rp./year)
Independent	863.2	11.6
Fully Integrated	930.5	8.6
Partially Integrated	851.1	10.6

The partially integrated system is the most economical one in terms of construction cost, while the fully integrated system in terms of O&M cost.

The total construction and O&M costs in present value for the above three (3) systems are estimated in the same manner of the previous Section 9.3.7 as shown below.

(Unit: Rp. billion)

	Const. Cost	O&M Cost	Total
Independent	617.2	75.1	692.3
Fully Integrated	686.7	56.1	742.8
Partially Integrated	616.8	68.2	685.0

The partially integrated system is the most economical one. Moreover in this system, all the proposed treatment plant sites are located in the green area/pond of the future land use plan. Land acquisition of the treatment plant sites is considered not difficult.

The partially integrated system is recommended.

The optimum sewerage development system is shown in Fig. 9.10.

9.4 Proposed Sewerage Development Plan

9.4.1 Design Wastewater Generation

The proposed sewerage development area covers 16,604 ha in the central part of the Study Area with a total population of 6,351,000 in 2010. The area is divided into six (6) sewerage development zones for each of which an independent sewerage development plan will be prepared as mentioned in the foregone Section 9.3 (See Fig. 9.10).

The design wastewater generation including domestic, commercial and institutional, and industrial wastewater of the sewerage development area is determined to be 1,137,573 m^3/day. The design wastewater generation by zone ranges from 91,492 m^3/day in South East Zone to 480,916 m^3/day in Central Zone with an average of 189,596 m^3/day.

Wastewater generation by zone is shown in Table 9.5.

9.4.2 Collection System

Separate wastewater collection system is applied based on the fact that storm water of the Study Area is drained mainly by open drainage networks.

As separate sewage collection system, two (2) types of collection system are applicable, depending on the land conditions of the objective area. One is conventional separate sewage collection system which is a complete collection system. Another is interceptor sewage collection system which is a partially developed collection system.

Conventional system will be applied for the following areas in principle.

(i) Commercial and institutional areas located along main roads.

(ii) Residential areas where redevelopment has been completed and besides, the existing road width is wider than 2 m which is the minimum width required for laying sewer lines, and other appurtenances.

Interceptor system will be applied for the high population density areas which cannot be covered by conventional system.
This system will collect only gray water through the existing road side ditches and other drains to the proposed interceptor. In the areas covered by this system, toilet waste will be treated by septic tank system.

The proposed interceptor, however, will not receive storm water collected through ditches. Excessive water will overflow to the neighboring rivers or canals.

9.4.3 Treatment Plant

Several practical treatment systems were compared from the view-points of adaptability to overload, technology level of O & M, sludge disposal and land acquisition (Refer to Appendix H).

Aerated lagoon system is the most suitable for this Study Area as far as land space is available. However, for the areas where available land is limited, conventional activated sludge system will be introduced.

The treatment plant capacity is designed to treat both the wastewater of conventional area (BOD 220 mg/l) and interceptor area (BOD 180 mg/l) to a level of BOD 30 mg/l. The required retention time is 48 hours in principle.

Aerated lagoon system will be applied for all the zones except North East Zone. Standard aerated lagoon system consisting of grit chamber, aerated lagoon, facultative pond, disinfection tank and drying bed will be applied for the zones where sufficient land space is available. However, for the zone where available land space is limited, modified aerated lagoon system consisting of grit chamber, aerated lagoon, sedimentation basin, disinfection tank, sludge digestion tank and drying bed is applied.

Conventional activated sludge system is proposed for North East Zone where available land space is very limited. This system consists of grit chamber, primary sedimentation basin, aeration tank, final sedimentation basin, disinfection tank, thickener, sludge digestion tank and dewatering facilities.

9.4.4 Zonewise Development Plan

(1) Central Zone

Total service area is 6,017 ha of which 336 ha or 6% located in the southern part of the zone is covered by JSSP project. Total coverage of conventional and interceptor systems including JSSP project are 3,422 ha or 57% and 2,595 ha or 42%, respectively. Collected wastewater will be transported through a conveyance sewer of 10.2 km in length to the treatment plant. A standard aerated lagoon treatment plant with a capacity of 529,000 m^3/d will be constructed by using 80.0 ha of the existing Pluit pond. This pond will be used for both flood control and wastewater treatment.

The salient features are shown in Table 9.5.

(2) North West Zone

In this zone, interceptor system will cover 1,332 ha or 72% of the total service area of 1,862 ha, while conventional system will cover the remaining 530 ha or 28%. Collected wastewater will be conveyed through a force main of 9.7 km length to the treatment plant. A modified aerated lagoon treatment plant of capacity 124,000 m^3/d will be constructed at the low-lying area of 17.7 ha close to the confluence of the Angke and Pessanggrahan rivers in Kel. Rembangan. The land of the treatment plant site is designated as green area in the future land use plan of DKI, Jakarta where urban development is restricted.

The salient features are shown in Table 9.5.

(3) South West Zone

Total service area is 2,170 ha of which 938 ha or 43% will be covered by conventional system and 1,232 ha or 57% by interceptor. Collected wastewater will be transported through a force main of 3.7 km in length and a conveyance sewer of 2.7 km in length to the treatment plant. A modified aerated lagoon treatment plant with a capacity of 117,000 m^3/d will be constructed in the green area of 16.0 ha in Kel. Joglo.

The salient features are shown in Table 9.5.

(4) North East Zone

Total service area is 3,496 ha of which 1,610 ha or 46% will be covered by conventional system and 1,886 ha or 54% by interceptor. Collected wastewater will be transported through a conveyance sewer of 7.4 km in length to the treatment plant. A conventional activated sludge treatment plant of capacity 261,000 m^3/d will be constructed in the land of 14.0 ha covering the eastern part of the existing Sunter pond and its neighbouring green area located in Kel. Sunter Japa.

The salient features are shown in Table 9.5.

(5) South East Zone

A considerable part of the total service area of 1,243 ha will be covered by interceptor system. The coverage of interceptor and conventional systems are 936 ha or 75% and 307 ha or 25%, respectively. Collected wastewater will be conveyed through a force main of 0.5 km in length to the treatment plant. A modified aerated lagoon treatment plant of capacity 101,000 m^3/d will be constructed at the green area of 13.0 ha in Kel. Cipinang Besar Selatan.

The salient features are shown in Table 9.5.

(6) Tanjung Priok Zone

Total service area is 1,502 ha. The coverage of conventional and interceptor systems are 700 ha or 47% and 802 ha or 53%, respectively. Collected wastewater will be transported through a force main of 1.4 km in length and a conveyance sewer of 1.0 km in length to the treatment plant. A standard aerated lagoon treatment plant of 120,000 m^3/d capacity will be constructed by using 36.0 ha of the on-going Sunter East II pond and its neighbouring green area located in Kel. Semper Timur.

The salient features are shown in Table 9.5.

9.5 Proposed Sanitation Development Plan

The proposed domestic on-site development plan encompasses the whole Study Area, Area A, Area B and Area C as delineated in Section 9.2.4 (ref. Fig. 9.4). However for Area C with six (6) sewerage zones, the on-site development plan will cover those areas that are not designated for conventional sewerage (ref. Fig. 9.10).

The systems planned for domestic on-site sanitation development are :

(i) Individual toilets and treatment units
(ii) Public toilets

In principle, public toilet will be provided to those existing population, living in relatively high population density areas, having no access to toilet facilities. Hence, Area A will not be considered for public toilet facilities.

The remaining population in the planning year 2010, other than those of conventional sewerage of Area C, are considered for the provision/upgrade of their individual toilets and treatment units, wherever necessary.

9.5.1 Concept of Sanitation Planning

The regions of Study Area that are covered entirely by on-site sanitation systems of simple and high level are respectively Area A and Area B (ref. Fig. 9.4).

On-site treatment systems fall into two (2) broad categories, depending on the method of final effluent disposal employed.

- Natural soil based treatment system
- Non natural soil based treatment system

The natural soil based treatment system is generally referred to as on-site system, where partially treated wastewater is infiltrated into natural soil. Suitability of infiltrative disposal depends on soil permeability, level of groundwater table and other local conditions like flooding and land area required.

On the other hand the natural soil independent systems either treat the wastewater to a level so that the effluent could be disposed to surface drains/ditches or utilizes artificially insituted soil layer to supplement the effects of unfavorable natural site conditions.

For the on-site sanitation areas of Area A and Area B the minimum groundwater table level during rainy season is selected as the only critical parameter that would limit the applicability of natural soil based treatment systems to mitigate groundwater pollution. The relatively low population density in these areas is considered to represent the availability of sufficient land space for natural soil based systems.

A rainy season groundwater table level of 5 m below ground surface is selected as the minimum requirement for consideration of natural soil based systems like septic tanks/leaching pits, in an overall sense.

This 5 m level is selected assuming the maximum depth of leaching pit as 3 m and by allowing an additional 2 m depth, based on criteria recommended by United States Environmental Protection Agency (US EPA).

The regions of deep and shallow groundwater table of 5 m, during rainy season, in the Study Area is shown in Fig. 9.11. In this figure, the boundary lines are approximated along those of Kelurahan boundaries.

Provision of natural soil based infiltration system will be restricted to deep groundwater zones of Fig. 9.11, in principle.

9.5.2 Sanitation Development of Area A

Area A (Ref. Fig. 9.4) covers 21,159 ha of 37 Kelurahans located in the fringes of the Study Area. The population of this area in the year 2010 is estimated to be 1,482,000. The corresponding average population density will be about 70 person/ha.

In principle, no specific wastewater treatment measures is proposed, other than the sanitary disposal of toilet waste. However, future septic tanks are recommended to receive the whole wastewater, except when mound is used for final effluent infiltration/disposal. This exception is to minimize the required area of mound.

(1) Sanitation Facilities

The domestic sanitation facility in this area will be restricted to individual septic tanks/leaching pit. No public toilet is planned. The sanitation system proposed varies according to the critical groundwater table level of the kelurahan concerned. Of the 37 kelurahans of Area A, 20 belong to the shallow groundwater table zone.

Accordingly, the population in the year 2010 in each Kelurahan of both the zones of Area A is divided into three (3) categories based on their planned sanitation facility as given below.

(a) Zone of shallow groundwater table

(i) Population to be provided with low grade toilet with pour flush and septic tank cum mound.
(ii) Population to be provided with high grade toilet with cistern flush and septic tank cum mound.
(iii) Population that does not require any major improvement measures to their existing sanitation facilities.

(b) Zone of deep groundwater table

(i) Population to be provided with leaching pit facility.
(ii) Population to be provided with septic tank facility.
(iii) Population that does not require any improvement.

This population delineation of (i), (ii) and (iii) of both the shallow and deep groundwater zones is made based on the following considerations:

- The existing population having no toilets and toilet with no *treatment and the population increase of low income group* that would occur during the planning period until 2010 would be provided with the least cost option of (i).

- The population increase of mid and high income group that would occur until 2010 would opt for (ii), in commensuration with their economic status.

- The existing population having their own toilet facilities with treatment do not require any significant improvement.

The population belonging to each of the above categories of sanitation facilities in each kelurahan, respectively for the shallow and deep groundwater zones are shown in Table H.27 and Table H.28 of Appendix-H.
The population percentage of each sanitation category for the whole Area A is as follows:

(a) Shallow groundwater zone

	Population percentage in 2010
Septic Tank cum mound (pour flush)	317
Septic Tank cum mound (cistern)	19.0
No significant improvement	14.8

(b) Deep groundwater zone

Leaching pit	11.0
Septic tank	8.8
No improvement	14.7
Total - Area A	100.0

The design criteria and consideration of these proposed sanitation systems are illustrated in Section 6.2 and Section 6.3 of Appendix-H, which also conform to those proposed by the Central Java - Small Towns Study, April 1989.

(2) Quantity of Desludging

The quantity of desludging of on-site systems for transport and further treatment is determined based on following considerations.

- Each sanitation facility will serve typically eight (8) person.

- Desludging is necessary only for septic tanks, and the average frequency of desludging is once in three (3) years.

- Due to alternative use of twin leaching pits, the sludge will be completely stabilized at on-site. Hence further transportation and treatment is not necessary for sludge of leaching pits.

Accordingly, the quantity of desludged sludge for further transport and treatment for Area A in the year 2010 is 92,311 m^3/year. Its breakdown in each Kelurahan is shown in Table H.30 of Appendix-H. The corresponding quantity of desludging under the existing conditions in the year 1988 is estimated at 32,776 m^3/year.

9.5.3 Sanitation Development of Area B

Area B (ref. Fig. 9.4) covers 27,176 ha of 89 kelurahans with a population of 4,967,000 in the year 2010. The corresponding average population density is 181 person/ha. In this area both the toilet waste and gray water will be treated to a moderate level using on-site treatment systems.

The treatment systems planned to treat wastewater of domestic origin in this area are;

- Public toilet for the existing population that has no toilet facilities.

- Individual treatment units to treat both toilet waste and gray water for all remaining population and hence neither leaching pit nor septic tank with mound is proposed for domestic systems.

(1) Public Toilet

In the determination of required public toilets for Area B, all those Kelurahans entirely covered by this area are only considered.

The six (6) number Kelurahans, Gunung Sahari Utara, Gunung Sahari Selatan and Kebon Kosong of Central Jakarta, and Pademangan Timur, Papanggo and Semper Barat of North Jakarta, that are separated between Area B and Area C, are considered for their public toilet requirements entirely under Area C.

Considering the moderate population density of this area of 100-300 person/ha, it is presumed that on average one (1) number public toilet could serve only 200 person. Accordingly, the total requirement of public toilets for this area is determined as 1475 units. Their distribution among the Kelurahans concerned, those having population with no sanitation facilities, is shown in Table H.31 of Appendix-H.

In principle, septic tanks of these public toilet will receive the whole wastewater, including that of washing and bathing, to meet the criteria for this area. However, under shallow groundwater table conditions, when distribution of effluent through mound become necessary, an exception to receive only toilet waste only may be admitted to limit the required mound area.

(2) Domestic Treatment System

Septic tank with upflow filter, considered for cost comparison in Section 9.2.3 and shown in Fig. H.38 of Appendix-H, is proposed for those sixty (60) Kelurahans with critical groundwater table level shallower than 5 m. The system will receive both toilet waste and graywater to produce an effluent quality of 60 mg/l as BOD. This is the required treatment level of Area B when effluent is discharged to surface drains/ditches.

While, septic tank with necessary infiltration/drain field to receive the whole wastewater is proposed for all those kelurahans with deep (favourable) groundwater table.

The population in the year 2010 in each Kelurahan is divided among the respective three (3) categories, public toilet population, septic tank with upflow filter population and septic tank with drainfield population. The results are shown respectively in Table H.34 and Table H.35 of Appendix-H for shallow and deep groundwater zones.

The population percentage of each facility for the whole of Area B is as follows :

	Population percentage in 2010
Public toilet	9.5
Septic tank with upflow filter (shallow groundwater zone)	59.9
Septic tank with drainfield (deep groundwater zone)	30.6
Total - Area B	100.0

(3) Quantity of Desludging

The quantity of desludging for transport and treatment is determined based on following considerations.

- Each domestic sanitation facilities will typically serve eight (8) person, while that of public toilet 200 person.
- The average frequency of desludging for domestic facilities is once in three (3) years, while that of public toilet is once a year.

The total quantity of desludging for treatment in Area B is estimated to be 653,079 m^3/year, and its breakdown for each Kelurahan is given in Table H.36 of Appendix-H. The corresponding existing quantity in the year 1988 is estimated to be 160,843 m^3/year.

9.5.4 Sanitation Development of Area C

Area C (Ref. Fig. 9.4) encompasses the high population density centres of Central Jakarta and Tanjung Priok regions with a total area of 16,604 ha. The population in the year 2010 is 6,351,000, with an average population density of 381 person/ha.

As shown in Fig. 9.10, this Area C is divided into six (6) sewerage zones, as the optimum sewerage master plan, with each zone further divided into conventional sewerage area and interceptor area. The on-site sanitation plan will cover only the interceptor area.

The population of conventional sewerage is 2,579,000. Hence the on-site sanitation development will cover the remaining population of 3,772,000.

The treatment system planned for the population with no conventional sewerage are;

- Public toilet for all remaining existing population with no toilet facilities after delineating the conventional sewerage population.
- Upgrading of existing toilets with no treatment and provision of new ones as required for all remaining population to ensure that the toilet waste is sanitarily disposed in septic tanks. However field drain or mound is not considered as a must unlike Area A and Area B. This is in consideration to the availability of interceptors, and the possible limitation in available land space.

(1) Public Toilet

The population of all those Kelurahans covered by Area C will be more than 300 person/ha in the year 2010. Hence it is presumed that in principle on an average, one (1) public toilet can serve 500 person. The total number of public toilets is determined as 713 units. Their distribution among all those concerned Kelurahans having population with no sanitation facilities is shown in Table H.37 of Appendix-H.

(2) Domestic Treatment System

It is assumed by 2010, all remaining population other than those served by conventional sewerage and public toilet would have their own toilet with septic tanks. This population group, which also includes the remaining non sewered existing population having toilet with treatment, is categorized as population of on-site under future conditions.

The population in each Kelurahan belonging to the three (3) categories of public toilet, on-site septic tank, and sewerage for Area C is shown in Table H.38 of Appendix-H, and the corresponding population percentage is given below.

	Population percentage in 2010
Public Toilet	10.8
On-site (septic tank)	48.6
Conventional Sewerage	40.6
Total -Area C	100.0

(3) Quantity of Desludging

The quantity of desludging for transport and treatment for Area C is determined based on the following considerations.

- Each domestic septic tank unit will typically serve eight (8) person, while that of public toilet 500 person.
- The average frequency of desludging for domestic units is once in three (3) years, while that of public toilet is once in six (6) months.

The total quantity of desludging for Area C in the year 2010 is estimated at 290,674 m^3/year, and its breakdown in each Kelurahan is given in Table H.39 of Appendix-H. The existing quantity in the year 1988 is estimated to be 286,550 m^3/year.

The daily average quantity of desludging in the whole Study Area is given below and its yearly breakdown for each Kelurahan in the year 2010 is given in Table H.41 of Appendix-H.

Sanitary Area	Desludging Quantity (m^3/day)	
	1988	2010
A	90	253
B	441	1790
C	785	796
Study Area	1316	2839

9.5.5 Communal Treatment System

A communal treatment plant is either on-site based or off-site based, and in general serves a population equivalent of 20-5,000. The available alternatives for such a system are enormous as it encompasses both the traditional "on-site system" and "off-site system".

The selection of the most suitable system is much influenced by the locality. The basic factor that aid in system selection are:

(i) Population served
(ii) Local environmental conditions
(iii) Availability of skilled manpower
(iv) Economics

Typical communal plants include :
- Septic tank
- Household package treatment plant
- Extended aeration plant
- RBC (Rotating Biological Contactor)

- SBR (Sequencing Batch Reactor)
- Oxidation pond

In the Study Area the selection of the most suitable system is recommended to be based on economics and simplicity so that the requirement of skilled operators could be minimized, if not entirely eliminated. Out of those systems mentioned above, except septic tank and oxidation ponds the remaining ones are elaborate requiring relatively skilled operation and maintenance.

However, in Central Jakarta area, as pointed out in Section 7.1 of Chapter 7, extended aeration systems and RBC are already used by some establishments though their performance is not satisfactory. Such relatively skill demanding systems are inevitable for an area with high population density like the sanitary Area C of the Study Area.

However for Area A and Area B simple systems like septic tank, which can be used for a population equivalent up to 300, or oxidation pond which can serve much higher population, is recommended as far as possible.

The household package treatment plant shown in Fig. H.10 of Appendix-H can serve a population equivalent up to 2,000.

9.5.6 Desludging and Treatment

The total existing (1988) and future (2010) quantity of desludging in the Study Area is determined respectively as 1316 m^3/day and 28.39 m^3/day (ref. Section 9.5.4).

The combined total capacity of both the existing sludge treatment plant in Pulo Gebang and that of Duri Kosambi (under construction) is only a 600 m^3/d. Hence, even under the existing conditions additional treatment plants are necessary.

The service area of desludging and the requirement of additional sludge treatment plants and their capacity and location in the year 2010 are determined based on the following considerations.

- The six (6) number wastewater treatment plants of sewerage will serve their respective interceptor areas, and the on-site areas (Area A and Area B) in their vicinity in order to optimize the extent of service area and number of required sludge treatment plants.

- In principle, existing as well as any future sludge treatment plants will serve only on-site sanitation area of Area A and Area B, in order to ensure their vitality even under the condition that the whole of Area C to become conventional sewerage area.

- Any additional sludge treatment plants shall optimize the distance of sludge hauling and transport.

  Accordingly, the whole study area is divided into ten (10) number service areas, six (6) to be served by the proposed wastewater treatment plants of sewerage, two (2) by the existing plants at Pulo Gebang and Duri Kosambi, and the remaining two (2) by new sludge treatment plants to be constructed in Kecamatan Pasar Minggu and Pasar Rebo, as shown in Fig. 9.12.

The boundaries of services areas are along those of Kelurahans boundaries, and the Kelurahans covered by each service area and their respective quantity for desludging is shown in Table H.42 of Appendix-H.

The requirement of vacuum trucks for desludging and transportation of sludge from the respective service areas to their concerned treatment plants is determined based on following considerations.

- Capacity of typical vacuum truck is 6 m^3
- Operation time is six (6) days a week and eight (8) to nine (9) hours a day
- The number of daily operational cycle of trucks is dependent on the extent of service area
- Standby allowance of 20% is required for maintenance and repair

The total required number of vacuum trucks of capacity 6 m^3 is determined at 266 units. Their breakdown and the extent of service area, along with the daily average quantity of desludging, demarcated between the whole service area and the portion of on-site area (Area A and Area B), is provided in Table 9.8.

The capacity of both the proposed new sludge treatment plant of Pasar Minggu and Pasar Rebo (ref. Fig. 9.12) respectively for Service Area-8 and Service Area-9 is 300 m^3/d.

The existing treatment plant at Pulo Gebang utilizes aerobic digestion followed with land based stabilization pond treatment. The aerobic digestion method used is not only energy intensive but also very demanding with respect to operation and maintenance, as each aeration tank should be loaded, unload and cleaned with a cyclic period of seven (7) days.

Hence a *simple, economic and less energy intensive sludge treatment* system is proposed for both the new treatment plants. The system is entirely stabilization pond based and consists of anaerobic, facultative and maturation ponds, and sludge lagoon for dewatering and drying the *anaerobically digested sludge in the ponds.*

The lay-out of proposed treatment system with a capacity of 300 m^3/d is illustrated in Fig. H.40 of Appendix-H. The required land area of treatment plant is 4.5 ha.

9.6 Alleviation of Water Pollution

9.6.1 Reduction of Pollution Load

(1) Future Pollution Load

The estimated future pollution load discharge of the Study Area in 2010 is 545,245 kg/d with a break-down of 101,494 kg/d in Area A, 213,940 kg/d in Area B and 229,811 kg/d in Area C.

(2) Pollution Load Reduction by Sewerage Development

The proposed sewerage development will treat all future pollution load discharge including domestic, commercial and institutional, and industrial wastes in Area C to a BOD level of 30 mg/l. The pollution load discharge of Area C will be reduced from 229,811 kg/d to 37,560 kg/d with a reduction rate of 84% in 2010.

(3) Pollution Load Reduction by On-Site Treatment System

The proposed on-site treatment system will treat all pollution load discharge of both domestic, commercial and institutional, and industrial sources to a BOD level of 60 mg/l. The pollution load of Area B will be reduced from 213,940 kg/d to 108,621 kg/d with a reduction rate of 49% in 2010.

(4) Pollution Load Reduction by Industrial Waste Control

The effluent quality standards of industry is established at 75 mg/l as BOD by Governor's Decree No. 1608.

This regulation can be applied for industrial wastewater discharge of Area A and Area B.

The industrial pollution load will be reduced from 57,590 kg/d to 9,346 kg/d in Area A and from 55,857 kg/d to 9,065 kg/d in Area B, with a reduction rate of 84 % in both the area.

Effect of the industrial waste control for Area A and Area B is high. Its enforcement is recommended.

(5) Total Pollution Load Reduction

By means of the proposed sewerage development, on-site treatment system development and industrial waste control, pollution load discharge of the Study Area will be reduced from 545,245 kg/d to 141,165 kg/d with a reduction rate of 74% in 2010. Its break-down by Sanitary Area is shown below, in comparison with the existing ones.

(Unit: kg/d)

	Existing	Future	
		Without Project	With Project
Area A	33,204	101,494	41,776
Area B	94,243	213,940	61,829
Area C	138,983	229,811	37,560
Total	266,430	545,245	141,165

9.6.2 Alleviation of River Water Pollution

Alleviation of river water pollution by the proposed project in the year 2010 is estimated for the central part of the Study Area. The objective area of the simulation covers five (5) river basins consisting of 15 sub-basins (Refer to Section 9.1.1).

The simulation of river water quality is made for the following three (3) cases of project development.

Case 1 : Sewerage development only

Case 2 : Sewerage development and on-site treatment system development

Case 3 : Sewerage development, on-site treatment system development and industrial pollution control.

The average alleviation of river water pollution of the objective area in 2010 by the above cases of project implementation is estimated as follows.

Case	Average River Water Quality (BOD : mg/l)
Existing	67
Future Without Project	88
Future With Project	
Case 1	41
Case 2	32
Case 3	30

The average river water quality in the central part of the Study Area will be improved to the target river water quality of 30 mg/l as BOD by the proposed integrated water pollution control measures in future from 88 mg/l as BOD, which would be the case under the conditions without project.

The alleviation of river water pollution at the 15 stations in the central part of the Study Area is shown in Fig. 9.6.

9.7 Estimated Cost

9.7.1 Project Cost

(1) Sewerage Development

Estimated total project cost of the six (6) sewerage developments, consisting of direct construction cost, land acquisition cost, engineering cost, administration cost and physical contingency, amounts to Rp. 1,815 billion or Rp 1,931 billion including house connection cost at 1990 price. Its break-down by cost item is shown below.

Item	Project Cost(billion Rp.)
Direct Construction	1,524
Land Acquisition	8
Administration	23
Engineering	107
Physical Contingency	153
	1,815

Break-down of the project cost by zone is shown in Table 9.7.

(2) On-site Treatment System

Project cost of the on-site treatment system consists of costs for public and private sectors. Project cost of public sector includes direct construction cost of public toilet and sludge treatment plant, procurement cost of collection truck, land acquisition cost, administration cost, engineering cost and physical contingency. Project cost of private sector covers direct construction costs of household treatment facilities including improvement of existing toilet, additional installation of septic tank/leaching pit and additional septic tank with up-flow filter.

The total project cost of on-site treatment system is estimated to be Rp. 1,411 billion with a break-down of Rp. 89 billion for public sector and Rp. 1,322 billion for private sector at 1990 price.

(3) Whole Project

Total project cost for the development of sewerage and on-site treatment systems is estimated at Rp 3,397 billion with a break-down as shown below.

Project	Project Cost (billion Rp.)		
	Public	Private	Total
Sewerage	1,823	163	1,986
On-site Treatment	89	1,322	1,411
Total	1,912	1,485	3,397

9.7.2 Operation and Maintenance Cost

(1) Sewerage System

Total annual O & M cost of the six (6) sewerage systems is estimated at Rp. 18.0 billion at 1990 price. Its break-down by zone is shown in Table 9.7.

(2) On-site Treat System

Total annual O & M cost of public sector including O & M costs for public toilet, sludge treatment plant and collection truck is estimated at Rp. 4.6 billion.

Table 9.1 Existing and Future Wastewater Discharge and Pollution Load Run-off

No of Sub-Basin	Name of Sub-Basin	Area (km2)	Existing Population (Person)	Existing Wastewater Discharge (m3/Sec.)	Existing Pollution Load Run-off (kg/D)	Future Population (Person)	Future Wastewater Discharge (m3/Sec.)	Future Pollution Load Run-off (kg/D)
1	Upper Ciliwung	34.34	481,210	0.762	11,553	627,218	1.289	20,136
2	Kali Bata	15.38	314,034	0.517	8,183	407,543	0.852	13,452
3	Krukut	65.11	791,548	1.292	19,849	1,124,087	2.384	36,316
4	Lower Angke	20.55	107,215	0.254	6,090	227,406	0.597	12,615
5	Upper Grogol	49.69	944,837	1.604	25,158	1,397,826	2.912	44,022
6	Lower Grogol	14.67	430,397	0.736	12,241	477,426	1.079	18,028
7	Upper Cideng	6.66	161,443	0.269	4,091	209,921	0.453	6,943
8	Middle Cideng	8.07	258,839	0.398	5,834	313,227	0.690	10,523
9	Lower Ciliwung	3.91	127,030	0.221	3,512	151,586	0.394	6,435
10	Lower Cideng	18.12	644,597	1.202	19,527	721,715	1.964	32,840
11	Old Angke	0.69	38,370	0.054	850	40,620	0.081	1,287
12	Upper Sentiong	8.20	254,313	0.424	6,286	321,338	0.735	11,289
13	Lower Sentiong	14.39	453,817	0.681	10,749	490,732	1.006	17,069
14	Upper Sunter	101.89	1,297,488	2.199	35,304	1,810,552	4.104	68,411
15	Lower Sunter	22.18	178,603	0.420	9,832	292,895	0.794	17,812
	Total	383.85	6,483,741	11.03	179,059	8,614,092	19.334	317,178

Table 9.2 Total Project Cost of Area B in Present Value (Billion Rupiah)

Served Area (ha)	500		2500	
Population Density (person/ha)	100	300	100	300
Total Project Cost of On-Site Sanitation System in Present Value	20	58	96	288
Total Project Cost of Sewerage System in Present Value	28	58	137	303

Table 9.3 Total Project Cost of Area C in Present Value (Billion Rupiah)

Served Area (ha)	500		2500	
Population Density (person/ha)	300	500	300	500
Total Project Cost of On-Site Sanitation System in Present Value	98	163	487	811
Total Project Cost of Sewerage System in Present Value	61	92	317	501

Table 9.4 Salient Features of Respective Zones
(Multiple Small Scale System)

Zone	Service Area (ha)	Served Pop. in 2010	Design Waste Water Discharge (m3/d)	Sewer Line Length (m)	Type of Treatment Plant
1	1,032	396,000	88,479	136,500	A.L.
2	3,237	1,345,000	324,262	435,000	A.L.
3	2,016	642,000	135,077	271,300	A.L.
4	2,170	674,000	127,808	290,300	A.L.
5	1,243	523,000	110,402	163,800	A.L.
6	1,448	419,000	89,796	190,600	A.S.
7	2,118	964,000	193,414	286,600	A.S.
8	1,502	663,000	130,441	203,000	A.L.
9	1,838	725,000	149,585	245,900	A.S.
Total	16,604	6,351,000	1,349,263	2,223,000	

Note : A.L. : Aerated Lagoon
A.S. : Conventional Activated Sludge

Table 9.5 Main Features of the Project

Zone	Central	North West	South West	North East	South East	Tanjung Priok
Served Area (ha)	6,107	2,016	2,170	3,566	1,243	1,502
Conventional Area (ha)	3,422	530	938	1,610	307	700
Interceptor Area (ha)	2,595	1,332	1,232	1,886	936	802
No Sewerage Area (ha)	90	154	0	70	0	0
Population Served in 2010	2,466,000	642,000	674,000	1,383,000	523,000	663,000
Conventional Area	1,149,000	185,000	244,000	527,000	137,000	337
Interceptor Area	1,317,000	457,000	430,000	856,000	386,000	326
Population Density (person/ha)	410	345	311	396	421	441
Conventional Area	336	349	260	327	446	481
Interceptor Area	508	343	349	424	412	406
Lift Pump Station	1	3	5	0	0	1
Treatment Plant						
Plant Area (ha)	88.0	18.0	16.0	14.0	13.0	37.0
System	A.L & F.P	A.L	A.L	A.S	A.L	A.L & F.P
Capacity (m3/d)	529,000	124,000	117,000	261,000	101,000	120,000
Discharge to	Jakarta B.	Cengka.	Pesangg.	Sunter	Sunter	Cakung

Note : A.L means aerated lagoon
: A.L & F.P means aerated lagoon & facultative pond
: A.S means conventional activated sludge

Table 9.6 River Water Quality Improvement by Each Countermeasures

Drainage Sub Basin No.	River Name	River Water Quality (BOD mg/l)				
		Existing	Future			
			Without Project	Case (1)	Case (2)	Case (3)
1	Ciliwung	19	21	18 (14)	16 (24)	16 (24)
2	Banjir	30	45	33 (27)	28 (38)	27 (40)
3	Krukut	39	55	42 (24)	33 (40)	32 (42)
4	Banjir	47	52	39 (25)	35 (33)	32 (38)
5	Grogol	67	87	52 (40)	40 (54)	40 (54)
6	Grogol	95	99	61 (38)	47 (53)	43 (57)
7	Cideng	165	208	127 (39)	55 (74)	55 (74)
8	Cideng	114	144	60 (58)	29 (80)	29 (80)
9	Ciliwung	21	46	16 (64)	15 (67)	14 (70)
10	Cideng	48	99	33 (67)	27 (73)	26 (74)
11	Old Angke	136	155	10 (94)	10 (94)	10 (94)
12	Sention	65	102	44 (57)	32 (69)	32 (69)
13	Sention	125	128	53 (59)	45 (65)	31 (76)
14	Sunter	28	46	30 (35)	28 (39)	25 (46)
15	Sunter	12	75	40 (47)	37 (51)	30 (60)
Average		67	91	44 (52)	32 (65)	29 (68)

Note Case (1) :with sewerage development
Case (2) :Case (1) + on-site treatment
Case (3) :Case (2) + industrial wastewater quality control
Figures in parentheses means BOD reduction rate with respect to without Project Condition.

Tabel 9.7 Project Cost and Annual O&M Cost of Each Sewerage Zone

(Project Cost)

(Unit: Rp. million)

Sewerage Zone	Central	North West	South West	North East	South East	Tanjung Priok	Total
Cost Item							
A. Direct Construction Cost	523,883	169,154	193,510	398,559	97,110	141,850	1,524,066
(1) Collection Sewer Line	479,801	137,645	149,816	271,808	68,393	115,072	1,222,535
(2) Lift Pump Station	-	10,373	15,747	-	5,251	6,068	37,439
(3) Treatment Plant	44,082	21,136	27,947	126,751	23,466	20,710	264,092
B. Land Acquisition Cost	568	1,944	2,721	710	1,012	1,401	8,356
C. Administration Cost	7,867	2,566	2,943	5,989	1,472	2,149	22,986
D. Engineering Cost	36,672	11,841	13,546	27,899	6,798	9,930	106,685
E. Physical Contingency	52,388	16,915	19,351	39,856	9,711	14,185	152,407
Total	621,378	202,421	232,071	473,013	116,103	169,514	1,814,500
F. House Connection Cost	51,696	8,316	10,980	23,724	6,156	15,156	116,028
Grand Total	673,074	210,737	243,051	496,737	122,259	184,670	1,930,528

(Annual O&M Cost)

Sewerage Zone	Central	North West	South West	North East	South East	Tanjung Priok	Total
A.Collection System	191	49	62	104	30	45	481
B.Lift Pump Station	-	488	581	-	89	127	1,285
C.Treatment Plant	6,698	1,285	1,382	4,113	1,208	1,615	16,301
Total	6,889	1,822	2,025	4,217	1,327	1,787	18,067

Table 9.8 Service Area, Desludging and Tranport of Sludge

Service Area / Treatment Plant		Area (ha)	Average Quantity of Desludging (m3/d)		Vacuum Truck (Nos.)
			Whole Service Area	On-site Area (Area A + Area B)	
	1	10,523	411	121	48
	2	3,597	234	142	16
Wastewater	3	5,931	383	298	30
Treatment	4	5,106	283	98	22
Plant	5	1,243	78	0	5
	6	7,964	237	170	28
	7(DK.)	6,950	300	300	23
Sludge	8	8,245	304	304	35
Treatment	9	9,441	299	299	35
Plant	10(PG.)	6,149	310	310	24
Study Area (Total)		65,149	2,839	2,042	266

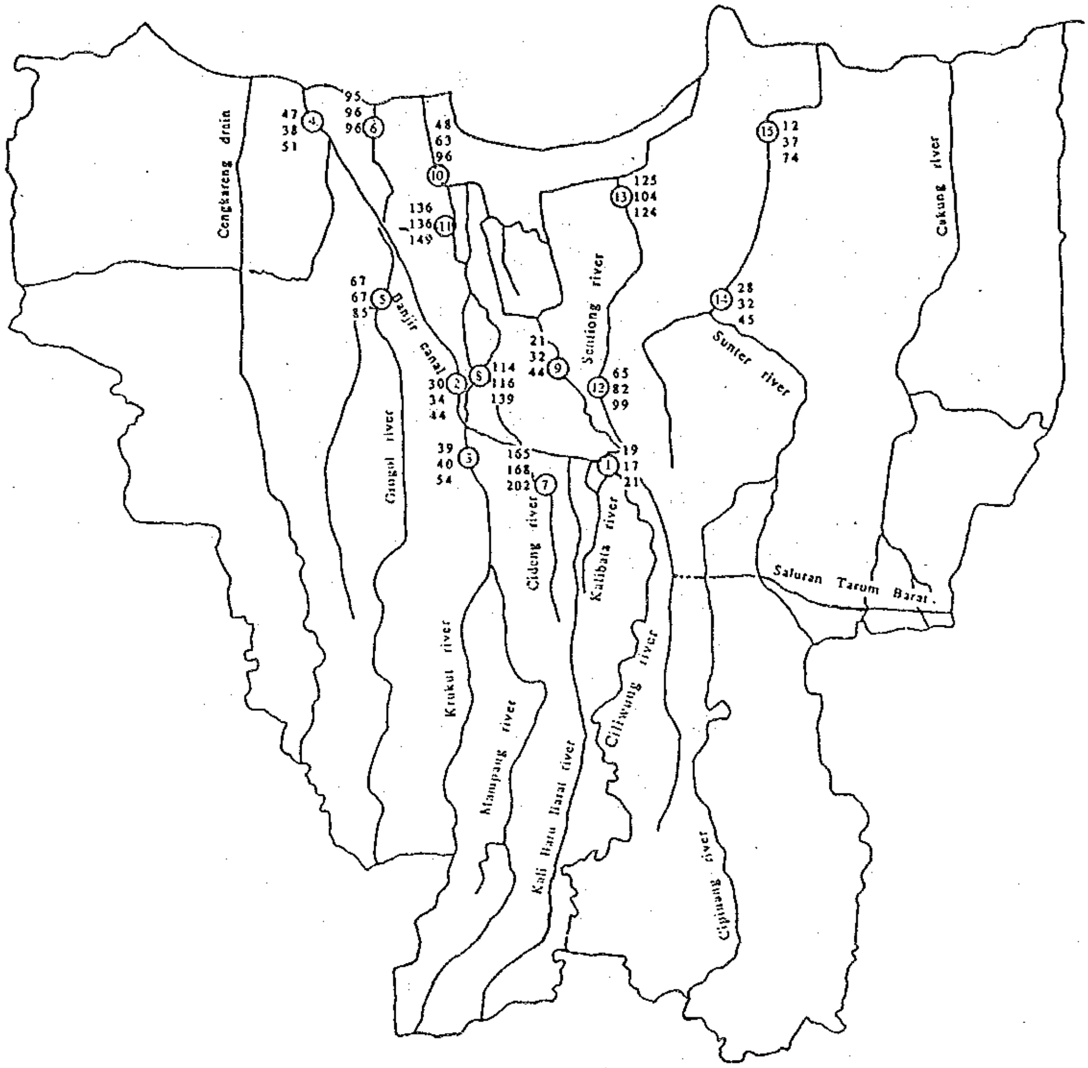
Note : DK. : Sludge treatment plant under construction in Duri Kosambi
PG. : Existing sludge treatment plant at Pulo Gebang
All others to be newly constructed

LEGEND
: RIVER
: CATCHMENT AREA BOUNDARY
: STATION

NO. OF SUB-BASIN	NAME OF SUB-BASIN
1	UPPER CILIWUNG
2	KALI BATA
3	KRUKUT
4	LOWER ANGKE
5	UPPER GROGOL
6	LOWER GROGOL
7	UPPER CIDENG
8	MIDDLE CIDENG
9	LOWER CILIWUNG
10	LOWER CIDENG
11	OLD ANGKE
12	UPPER ANGKE
13	LOWER SENTIONG
14	UPPER SUNTER
15	LOWER SUNTER

FIG. 9.1 DIVISION OF OBJECTIVE RIVER BASIN

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



LEGEND

River

①-⑮ Water Quality Simulated Station

Figures show river water quality of BOD in mg/l

19	Upper:Observed Existing River water Quality
17	Middle:Simulated Existing River water Quality
21	Lower:Simulated Future River water Quality

FIG. 9.2 SIMULATED EXISTING AND FUTURE RIVER WATER QUALITY

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

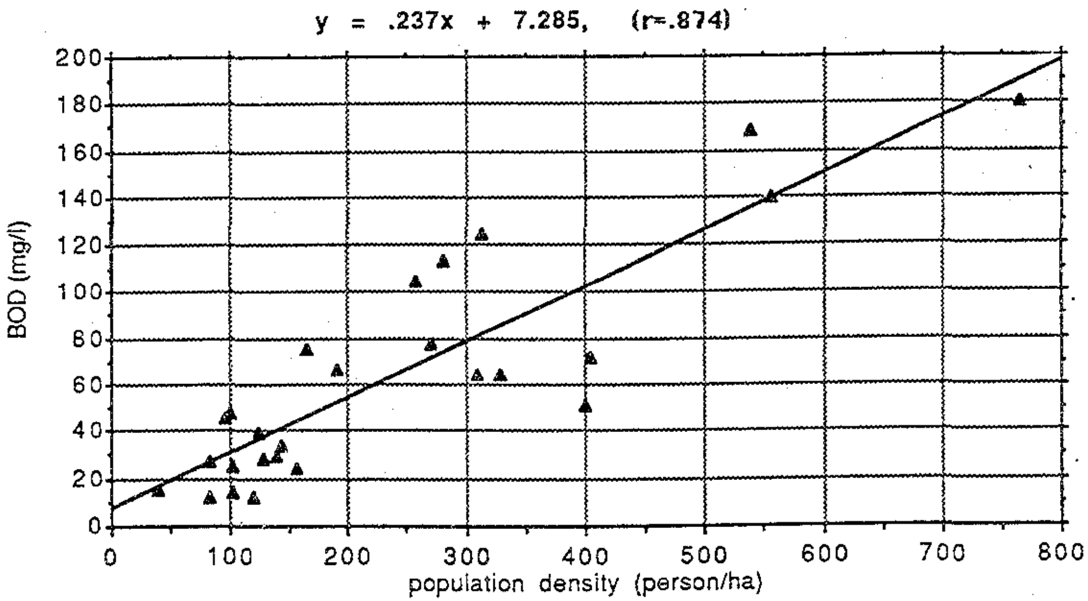


FIG. 9.3 CORRELATION BETWEEN RIVER WATER QUALITY AND POPULATION DENSITY

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

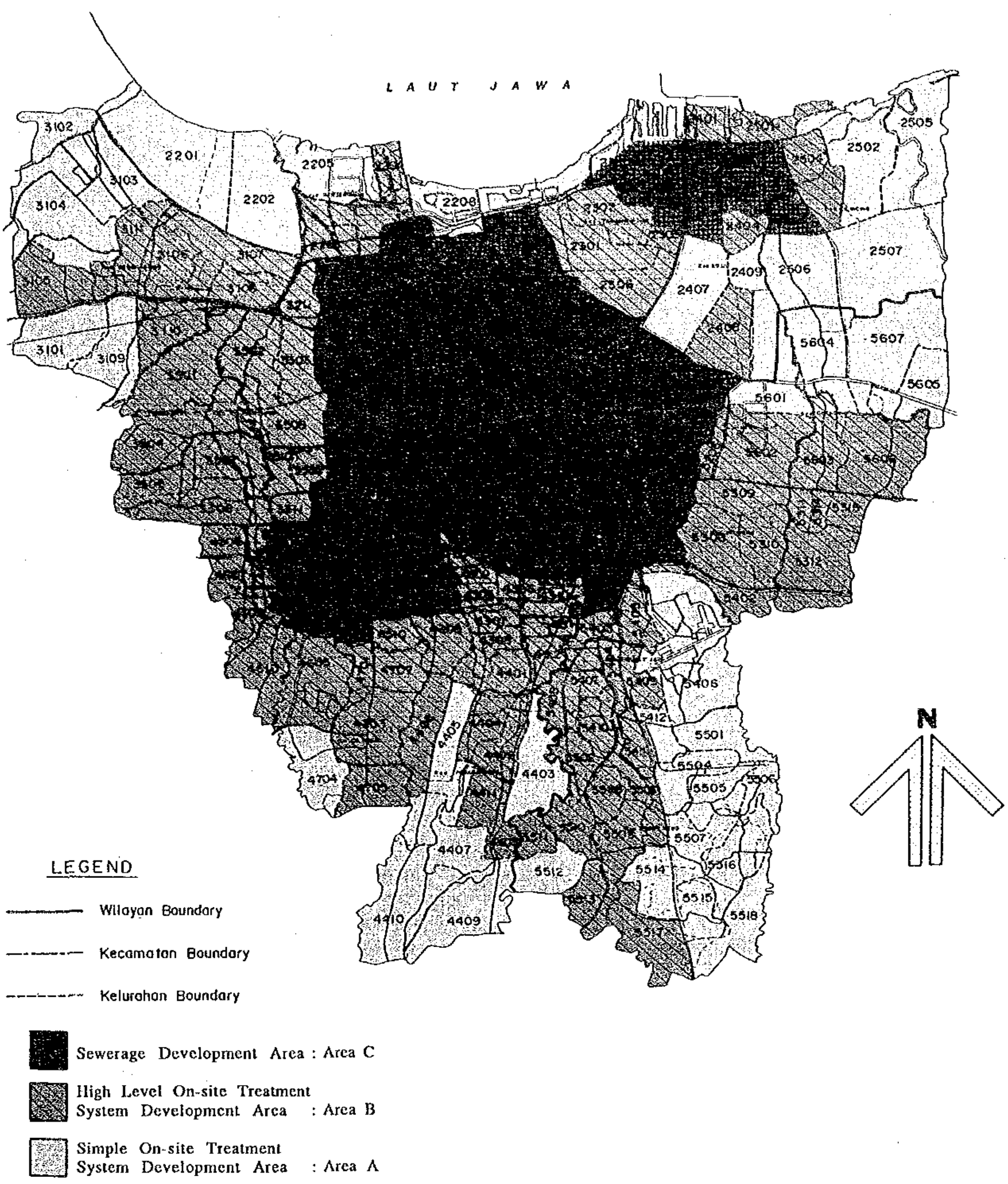


FIG. 9.4 DIVISION OF STUDY AREA BY SANITATION SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

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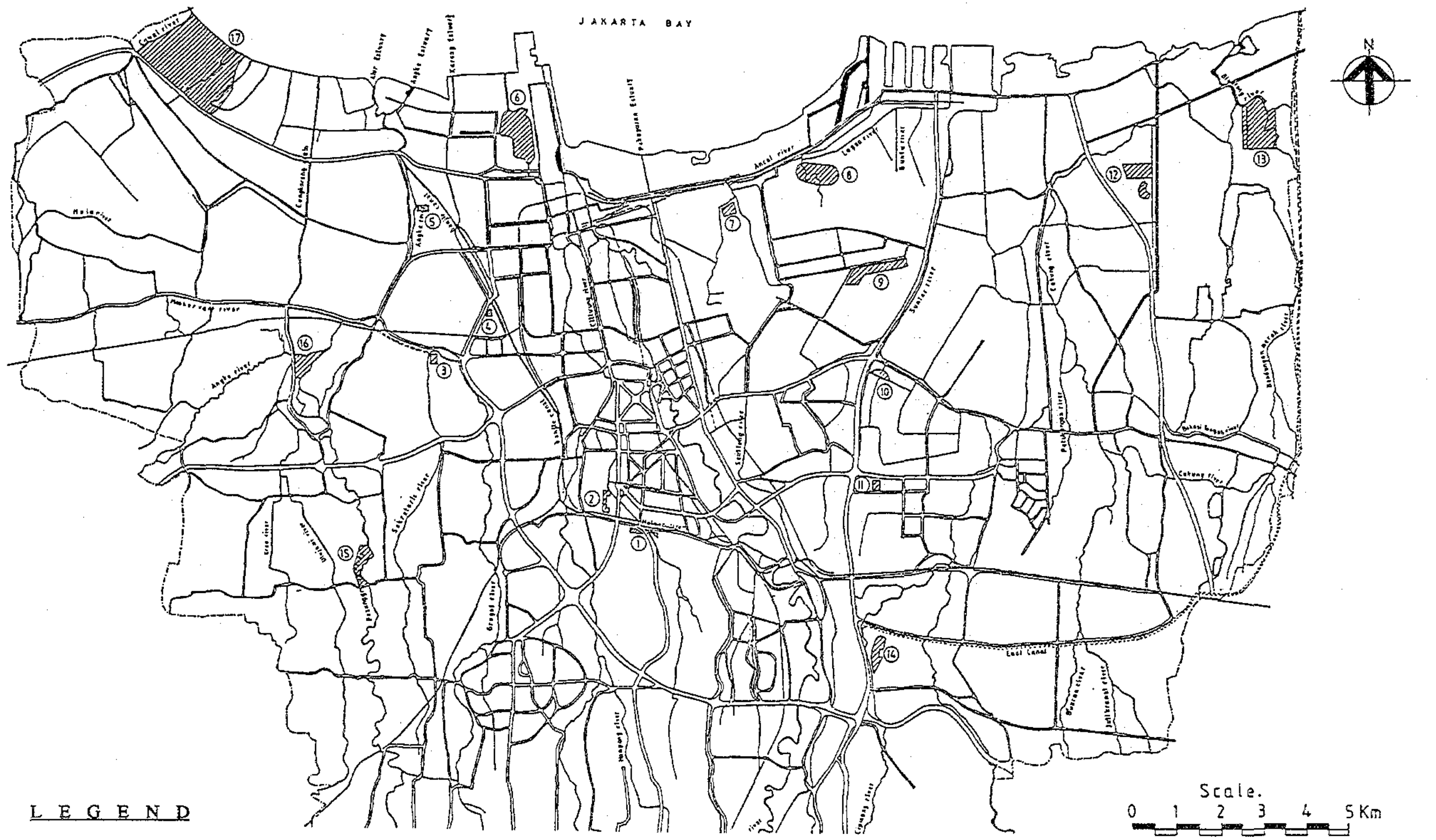


LEGEND

① ~ ⑰ Potential Site of Wastewater Treatment

Rivers and Canals

High-ways and Roads

FIG. 9.5	LOCATION OF POTENTIAL SITES OF WASTEWATER TREATMENT
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA	

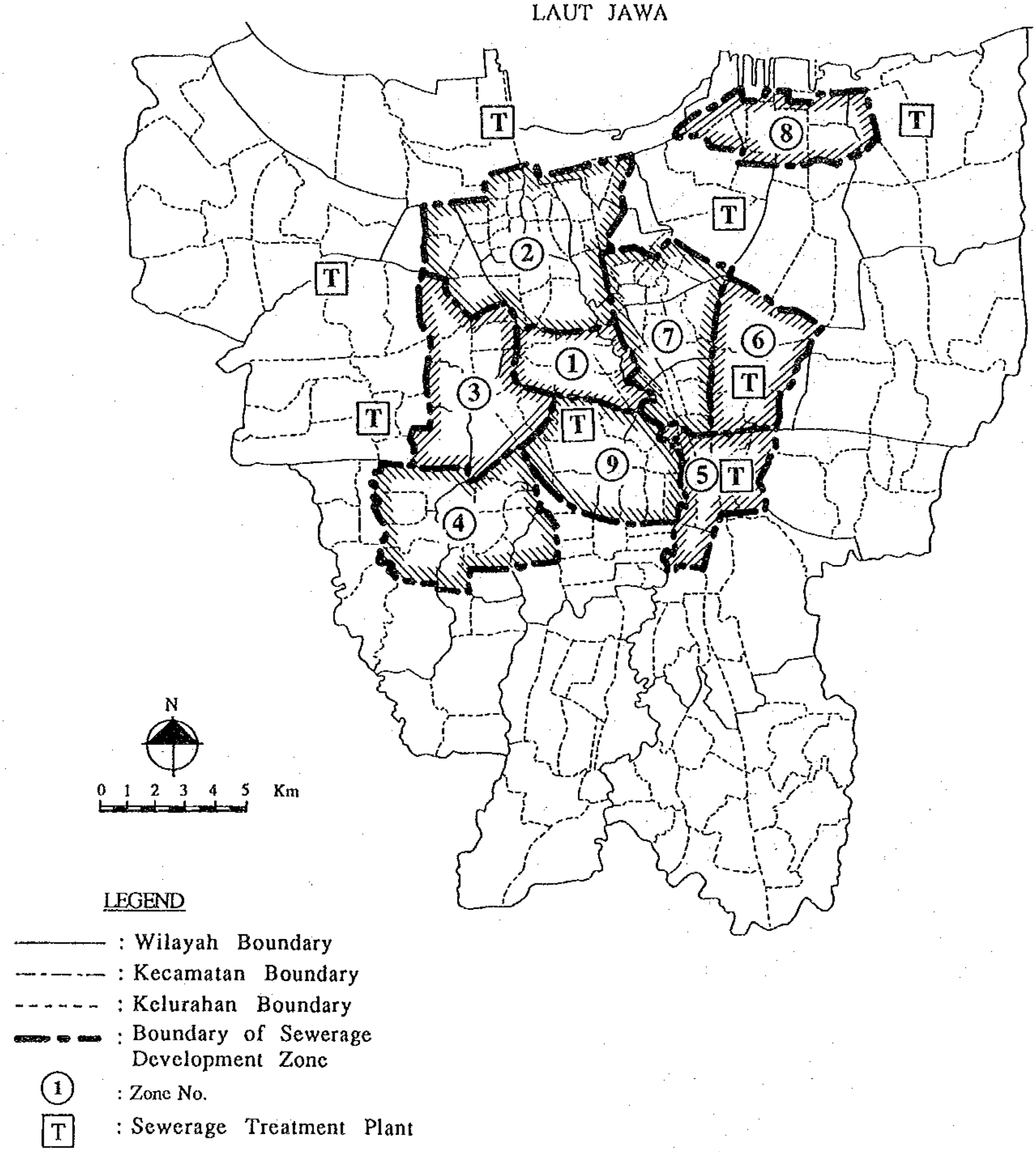


FIG. 9.6 MULTIPLE SMALL SCALE ON-LAND TREATMENT SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

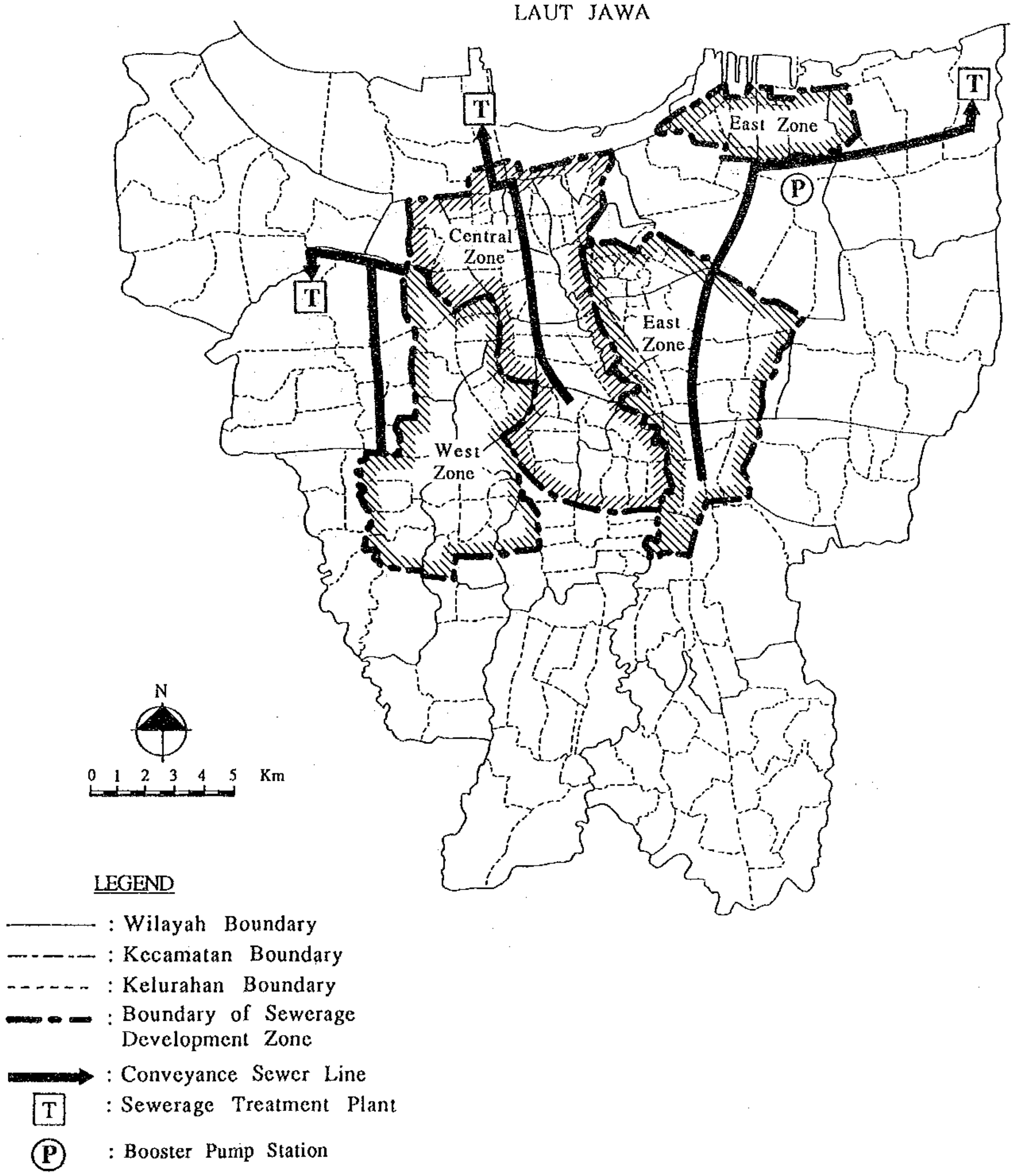


FIG. 9.7 MULTIPLE MEDIUM SCALE ON-LAND TREATMENT SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

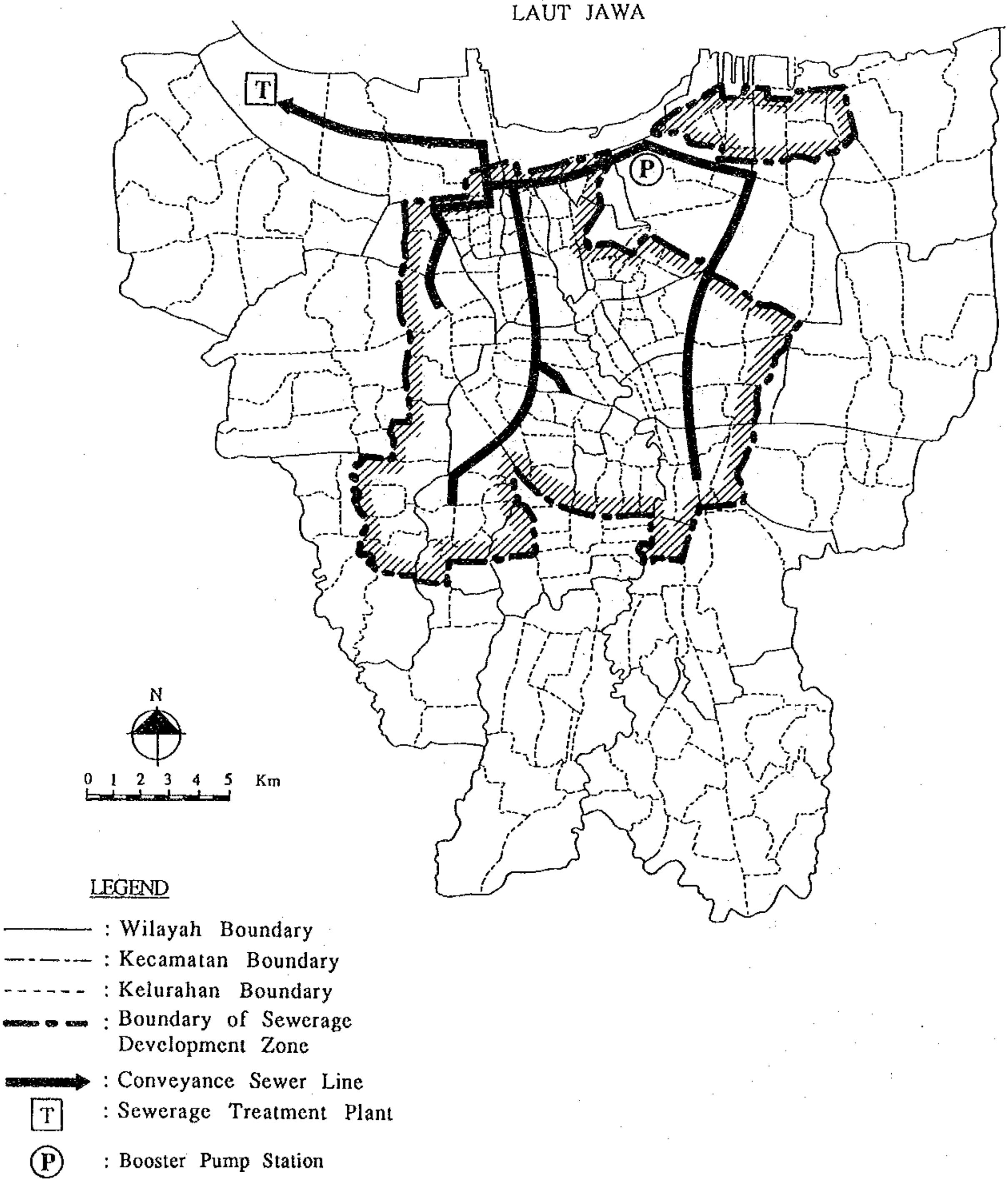


FIG. 9.8 SINGLE LARGE SCALE ON-LAND TREATMENT SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

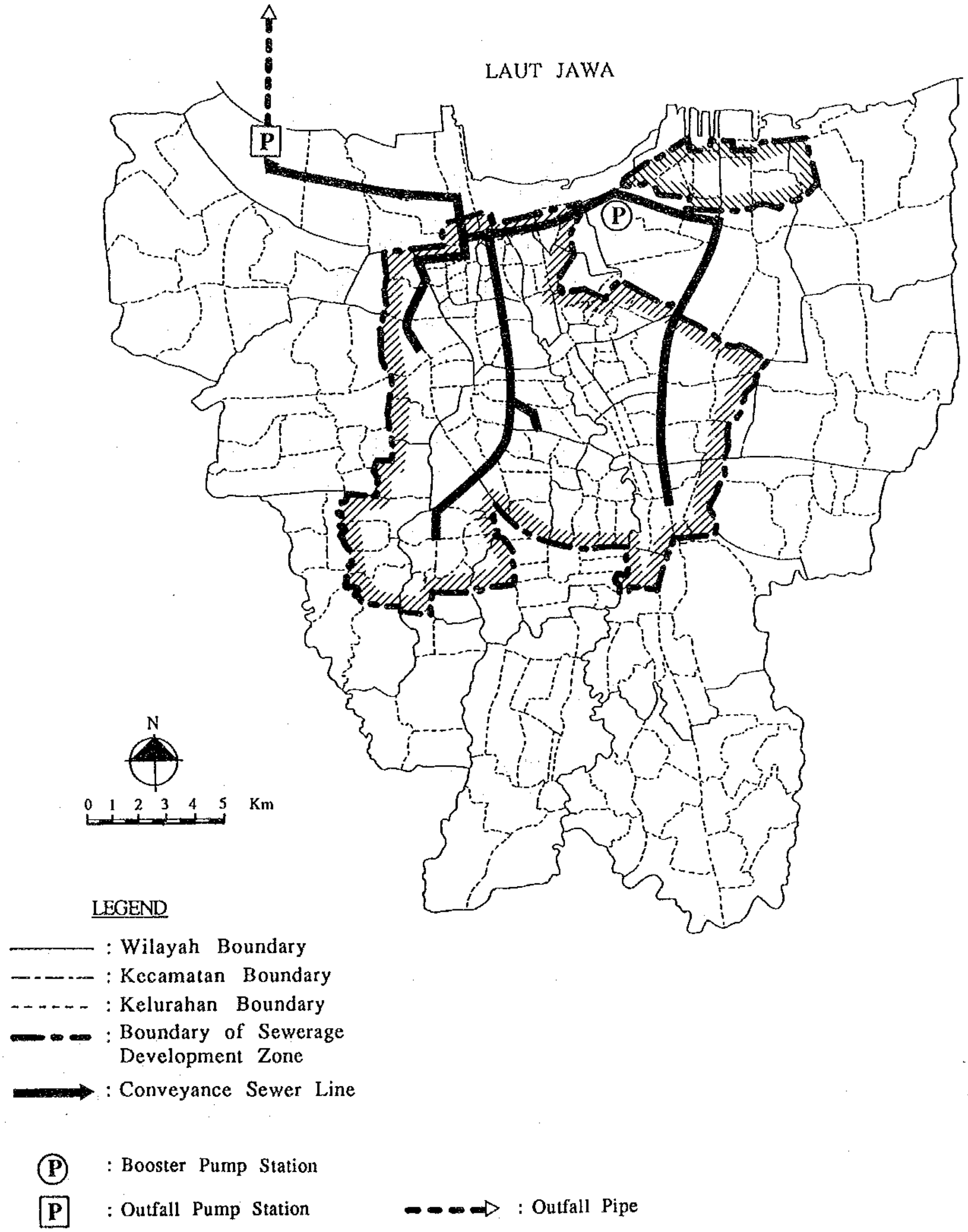
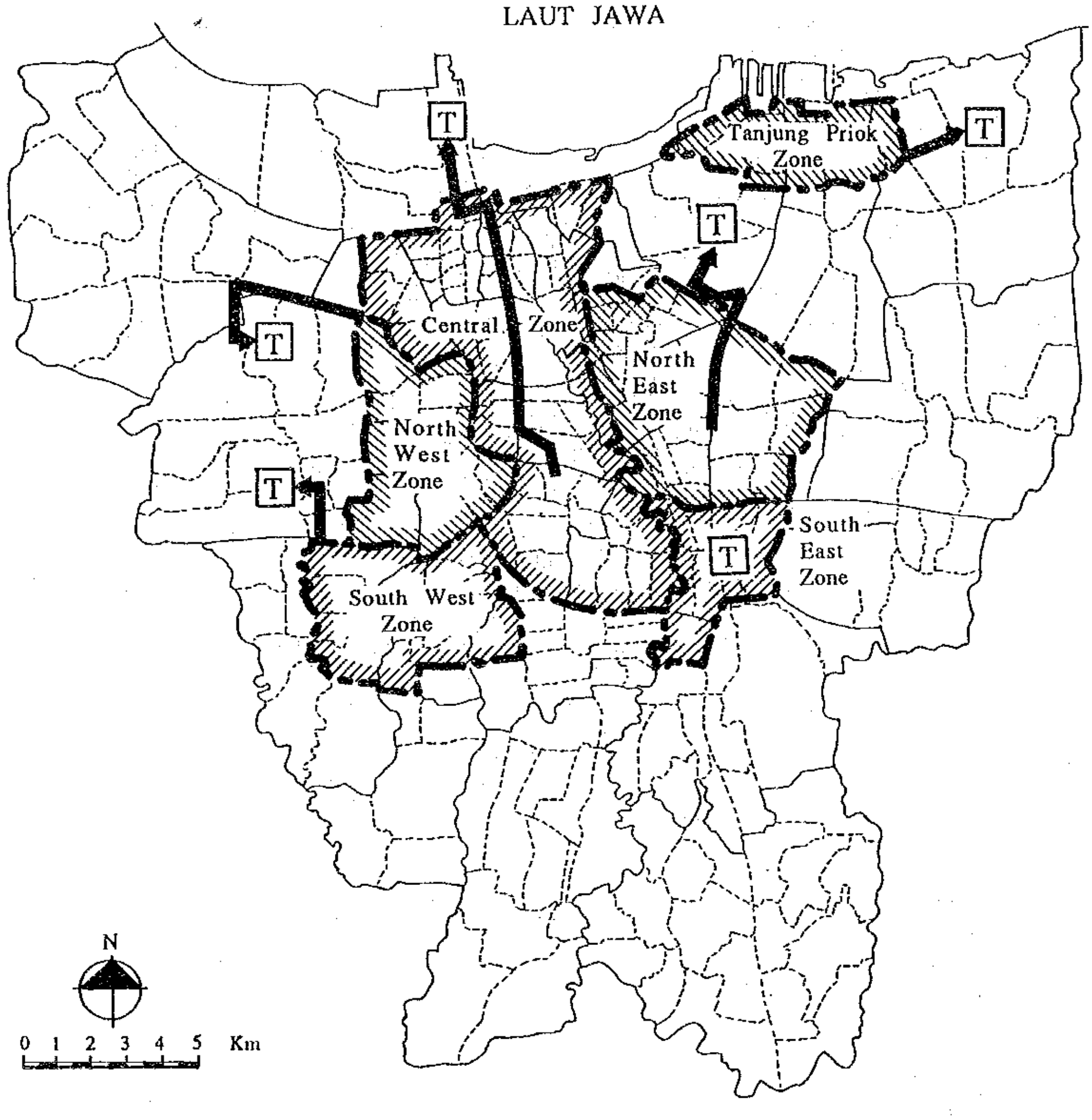


FIG. 9.9 OCEAN OUTFALL SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



LEGEND

- : Wilayah Boundary
- : Kecamatan Boundary
- : Kelurahan Boundary
- : Boundary of Sewerage Development Zone
- : Conveyance Sewer Line
- [T] : Sewerage Treatment Plant

FIG. 9.10 PROPOSED SEWERAGE DEVELOPMENT SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

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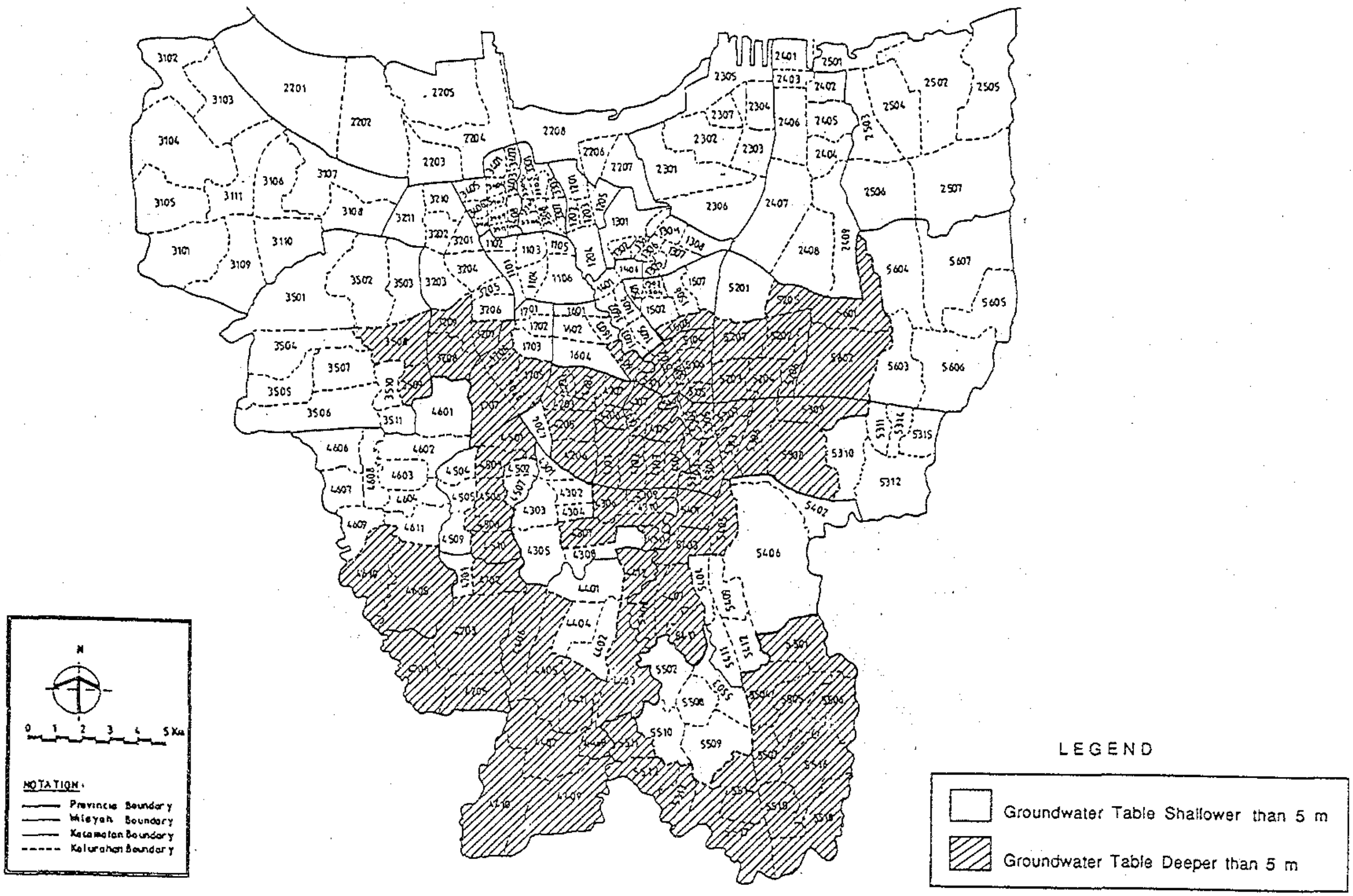

FIG. 9.11	KELURAHAN OF DEEP AND SHALLOW GROUNDWATER

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

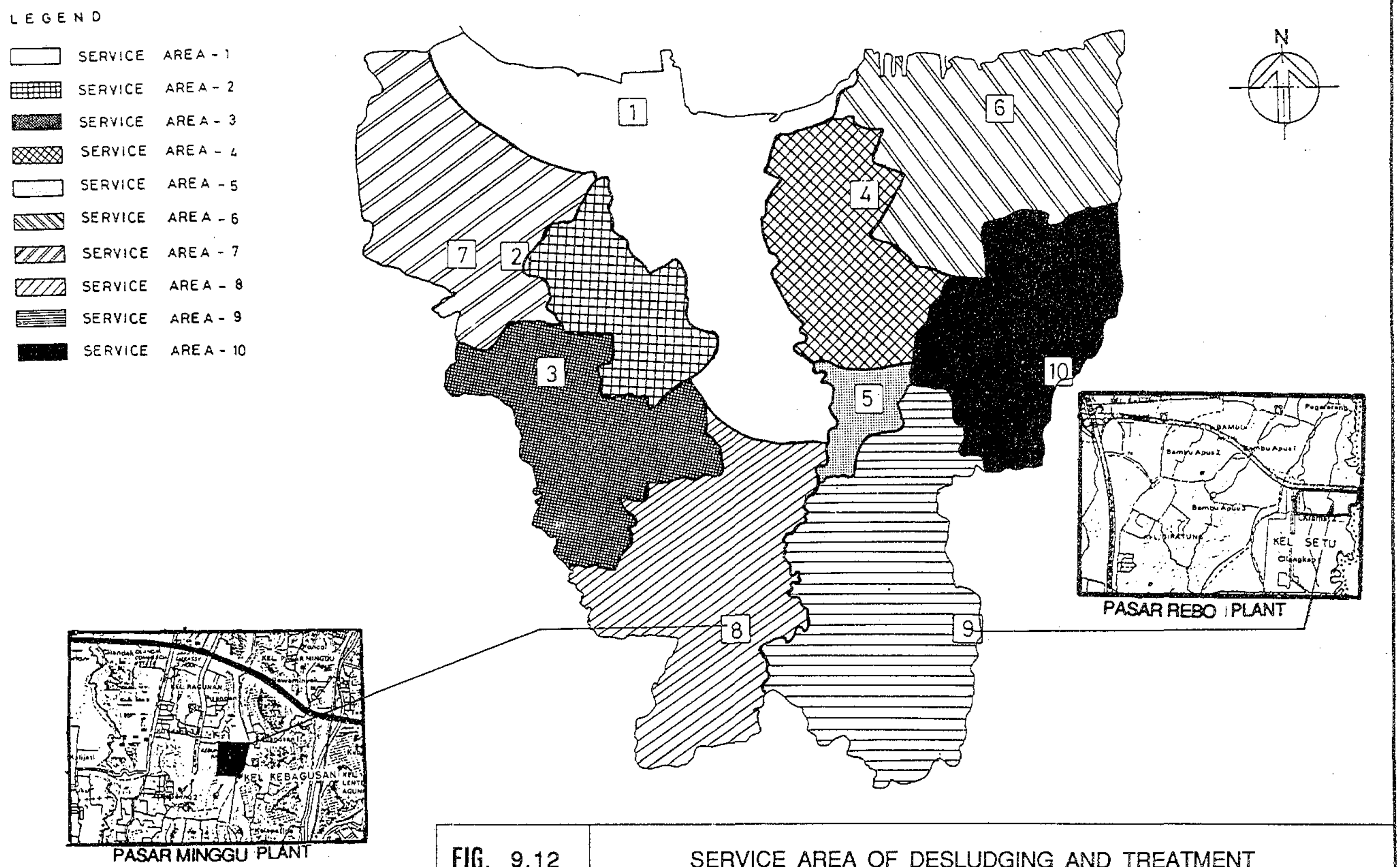

FIG. 9.12 SERVICE AREA OF DESLUDGING AND TREATMENT

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 10

IMPLEMENTATION PROGRAMME

CHAPTER 10 IMPLEMENTATION PROGRAMME

10.1 Implementation Programme of Urban Drainage Development

10.1.1 Prioritization

Priority sequences for implementation of the proposed six (6) packages of urban drainage development are determined from the aspects of needs/benefits, regional equality, environmental quality improvement, and poverty alleviation.

The major evaluation indexes are as follows.

(Needs/Benefits)

(1) Extent of Flood Damage: Higher priority will be assigned to a zone with a high extent of flood damages. Its extent is measured in terms of per capita existing flood damage amount.

(2) Drainage Requirement to Meet Future Land Development: Urban drainage development shall be undertaken in advance of future land development of the drainage zone to prevent occurrence of new flood prone areas. Higher priority will be given to a zone with a high rate of urban land development. The rate is measured in terms of change in land use toward 2010.

(Regional Equality)

(3) Progress Rate of Urban Drainage Development: Higher priority will be given to a zone where its existing progress rate of urban drainage development is low to maintain regional equality. The rate of progress is represented by the ratio of the on-going project cost to the whole project cost.

(Environmental Quality Improvement)

(4) Population Density : Urban drainage development contributes to improvement of the environmental quality of the flood prone area. Higher priority will be given to a zone with a high population density in flood prone area on the assumption that environmental quality of a flood prone area mainly depends on its population density.

(Poverty Alleviation)

(5) People's Income Level : Poverty alleviation is one of the major targets of urban drainage improvement. People's income level in the flood prone area is the typical index for the poverty alleviation. Higher priority will be given to a zone with a low people's income level in flood prone area.

These five (5) factors are evaluated for the respective drainage zones. Integrated evaluation is obtained by assigning indexes ranging from one (1) to four (4) for each factor and by summing up the obtained indices.

The results are shown below.

Zone	Index No.					
No.	(1)	(2)	(3)	(4)	(5)	Total
1	4	4	4	1	4	17
2	3	1	1	2	1	8
3	4	1	3	3	2	13
4	-	-	-		-	-
5	2	1	4	3	2	12
6	3	2	1	2	3	11

Note : Zone No.4 includes no proposed project.

The highest priority is given to Zone 1, followed by Zone 3 and Zone 5.

10.1.2 Implementation Programme

All the on-going projects will be completed before 2000. The proposed projects will commence in 1992 and be implemented based on the above-mentioned priority sequences. The implementation programme of the on-going and proposed projects are shown in Fig.10.1. Their financial disbursement schedules are shown in Table 10.1.

10.2 Implementation Programme of Sewerage Development

10.2.1 Prioritization

Priority sequences for implementation of the sewerage developments are determined from the aspects of demands/benefits, adverse effects and constraints of the respective development projects. Major evaluation indexes for the proposed projects are as follows.

Demands/Benefits

1) Population Density : Populatin density is the typical idex representative to sewerage development requirement. Higher priority will be given to a zone with a high population denisity.

2) Public Land Use Rate : This index represents contribution of sewerage development to public interest. Higher priority will be given to a zone with a high public land use rate.

3) Water Pollution Abatement Effect : Higher priority will be given to a zone of which sewerage development produces high water pollution abatement effects.

4) Communities' Sanitary Improvement Effect : Conventional sewerage system contributes to sanitary improvement of the communities to a full extent. However, interceptor sewerage system can not produce any sanitary imprvoment effects on the communities. Higher priority will be given to a zone with a high coverage rate of conventional sewerage.

5) Waterborne Disease Contraction Rate : This is the typical index representing unsanitary condition of an area, in orther words, extent of sewerage development requirement. Higher priority will be given to a zone with a high waterborne disease contraction rate.

(Adverse Effects)

6) Construction Cost, 7) O & M Cost : These are the typical indexes representing adverse effects of project. Higher priority will be given to a zone with a low construction and O & M costs.

(Constraints)

7) Affordability : Financial vaiability of project depends on affordability of the users. Higher priority will be given to a zone with a high affordability of the users.

8) Treatment Site Availability : A considerable land space is required for provision of the proposed treatment plants. Sucessfull implementation of the projects much depends on land space availability for the treatment plants. Higher priority will be given to a zone where its land acquisition is easy.

These nine (9) items are evaluated for the respective zones. Integrated evaluation is obtained by assigning marks ranging from 1 to 5 on each item and by summing up the given marks.

The results are shown in Table 10.2.

The highest priority is given to Central Zone, followed by South East Zone, North East Zone and Tanjung Priok Zone.

10.2.2 Implementation Programme

All the proposed sewerage development projects will be completed by 2010. Its implementation programme is proposed based on the above-mentioned project priority sequences as shown in Fig.10.2. The financial disbursement schedule is given in Table 10.3.

Table 10.1 Disbursment Schedule of Project Cost for Urban Drainage Development

Year	Zone 1 On-going	Zone 1 Proposed	Zone 2 On-going	Zone 2 Proposed	Zone 3 On-going	Zone 3 Proposed	Zone 4 On-going	Zone 4 Proposed	Zone 5 On-going	Zone 5 Proposed	Zone 6 On-going	Zone 6 Proposed	TOTAL On-gong	TOTAL Proposed
1990	921		21,148		2,593		33,178	0	0		31,725		89,565	
1991	921		21,148		2,593		33,178				31,725		89,565	
1992		19,855	21,148				33,178				31,725		86,051	19,855
1993		19,855	21,148				33,178				31,725		86,051	19,855
1994		19,855					33,178				31,725		64,903	19,855
1995						4,855					31,725		31,725	4,855
1996						4,855					31,725		31,725	4,855
1997						4,855					31,725		31,725	4,855
1998										276	31,725		31,725	276
1999										276				276
2000										276				276
2001												12,241		12,241
2002												12,241		12,241
2003												12,241		12,241
2004												12,241		12,241
2005				3,247										3,247
2006				3,247										3,247
2007				3,247										3,247
2008														
2009														
2010														

Table 10.2 Prioritization of Sewerage Development Project

Sewerage Zone	Central	North West	South West	North East	South East	Tanjung Priok
(Demands/Benefits)	23	11	11	17	15	13
- Population Density	5	1	1	3	5	5
- Public Land Use Rate	5	3	3	3	3	1
- Water Pollution Abatement Effect	5	3	3	3	3	1
- Communities' Sanitation Improvement	5	1	3	3	1	3
- Waterborne Disease Contraction Rate	3	3	1	5	3	3
(Adverse Effect)	10	4	2	2	6	6
- Construction Cost	5	1	1	1	3	3
- O/M Cost	5	3	1	1	3	3
(Constraints)	10	4	4	6	6	6
- Affordability	5	1	1	3	5	1
- Treatment Site Availability	5	3	3	3	1	5
Integrated Evaluation	43	19	17	25	27	25

Table 10.3 Disbursment Schedule of Sewerage Develpoment Project

(Million Rp.)

Sewerage Zone	Project Cost	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Central Zone	621,378	16,046	68,352	80,779	99,420	74,565	68,352	55,924	46,603	40,390	34,176	36,771									621,378
South East Zone	116,103					5,600	26,704	31,348	30,187	22,265											116,103
North East Zone	473,013							14,440	85,142	75,682	94,603	66,222	52,031	37,841	47,052						473,013
Tanjung Priok	169,514											8,670	44,074	49,159	32,208	35,404					169,514
North West Zone	202,421													12,640	54,654	48,581	42,508	44,038			202,421
South West Zone	232,071															14,720	71,942	67,301	53,376	24,732	232,071
Total	1,814,500	16,046	68,352	80,779	99,420	80,165	95,055	101,712	161,932	138,336	128,778	111,663	96,105	99,640	133,913	98,705	114,450	111,338	53,376	24,732	1,814,500

FIG. 10.1 IMPLEMENTATION PROGRAMME OF URBAN DRAINAGE PROJECT

```
                                        1900                   |                 2000
                        90  91  92  93  94  95  96  97  98  99 | 0   1   2   3   4   5   6   7   8   9   10

Zone 1    On-going      ******
Zone 1    Proposed              **********

Zone 2    On-going      *************
Zone 2    Proposed                                                                  **********

Zone 3    On-going      ******
Zone 3    Proposed                          **********

Zone 4    On-going      ****************
Zone 4    Proposed

Zone 5    On-going
Zone 5    Proposed                                      **********

Zone 6    On-going      ******************************
Zone 6    Proposed                                                  *************
```

FIG. 10.2 IMPLEMENTATION PROGRAMME OF SEWERAGE DEVELOPMENT PROJECT

Sewerage Zone	1900										2000										
	90	91	92	93	94	95	96	97	98	99	0	1	2	3	4	5	6	7	8	9	10
Central Zone			*	*	*	*	*	*	*	*	*	*	*								
South East Zone							*	*	*	*	*										
North East Zone									*	*	*	*	*	*	*	*					
Tanjung Priok Zone													*	*	*	*	*				
North West Zone															*	*	*	*	*		
South West Zone																	*	*	*	*	*

Chapter 11

PROJECT EVALUATION

CHAPTER 11 PROJECT EVALUATION

11.1 Economic, Social and Environmental Evaluation

11.1.1 Urban Drainage Development

The average annual flood damages in the "without project" situation are calculated at Rp. 47,061 million in 1988. They are projected to reach Rp. 160,980 million in the target year of 2010. In the "with project" situation, the flood damages are expected to virtually disappear. That is to say, in 2010, people of the study area will get the benefit of Rp. 160,980 million or Rp. 12,577 on the per capita basis.

In time of floods, spilling and spreading of wastewater may cause the breakouts of water-borne diseases. They will be reduced when urban drainages are fully developed.

Also, citizens will be freed from the mental stresses they may suffer during inundations.

Furthermore, land use of the inundation area will be enhanced as a result of urban drainage development. It will be reflected by the rise in land value.

However, in conducting economic analysis of the project, only the benefit of flood damage reduction was considered.

The benefit incorporates all the benefit accruing from the on-going urban drainage projects as well as the newly proposed urban drainage projects. Correspondingly, cost must cover the required total cost.

The initial cost in economic terms is calculated at Rp. 549,647 million. The annual O/M cost comes to Rp. 2,263 million. The cost and benefit streams are shown in Table 11.1.

Project life and opportunity cost of capital were assumed to be 50 years and 10%, respectively.

As a result of economic analysis, it was found out that NPV and B/C work out at Rp. 434,822 million and 2.15, respectively. Also EIRR works out at 20.2%.

It follows from the above results that the urban drainage projects of the Study Area are economically feasible.

11.1.2 Sewerage Development

As a result of sewerage development, pollution load represented by BOD in the sewerage development area (Area C) is estimated to be reduced by 85% to the level of 2.26 kg per ha per day in 2010. In the on-site sanitation area (Area B), it will be reduced by 71.1% to the level of 2.26 kg per ha per day through the combined measures of the proposed project and *industrial effluent control in 2010.* Pollution load of the remaining area (Area A) will be mitigated by 48.5% by industrial effluent control.

Over the entire study area, pollution load is estimated to be reduced by 72.0% as a result of the combined efforts of the proposed project and industrial effluent control.

Using the Kecamatan-wise data collected by the sampling questionnaire survey, the correlationship between water color/smell and the diseases contraction rate was quantitatively determined.

When pollution of river water is reduced as a result of sewerage/sanitation development, water color/smell of rivers will regain their natural conditions. It implies that the diseases contraction rate will be reduced.

When the difference in the diseases contraction rate between the "without project" and "with project" conditions is multiplied by population and the result is again multiplied by average medical cost per patient, the benefit of medical cost reduction will be obtained.

The benefit of medical cost reduction estimated following the above procedures reaches Rp. 90,248 million in 2010 (See, Table 11.2).

Another benefit of sewerage/sanitation development is the creation of pleasant river-side environment free from obnoxious odor and black color of water.

11.2 Financial Evaluation

11.2.1 People's Willingness to Pay

Sampling questionnaire surveys were carried out to know how many people are willing to pay for sewerage/on-site sanitation services.

According to the surveys, the average services charge a household is willing to pay per month is Rp. 574 for public toilet, Rp. 1,316 for individual toilet with treatment and Rp. 1,846 for sewerage. These figures account for 0.22%, 0.51% and 0.71% of the average monthly household income.

Households of High, Middle and Low Income Classes are willing to pay monthly, Rp. 4,962 (0.68% of income), Rp. 2,513 (0.74%) and Rp. 907 (0.60%) for sewerage services, respectively.

Analysis revealed that the extent of people's willingness to pay for sewerage services depends on the size of their income and the floor area of their house.

A shop and a factory are on average willing to pay a monthly sum of Rp. 5,394 and Rp. 6,050, respectively. The average monthly amount for other establishments/institutions ranges from Rp. 5,328 to Rp. 10,332.

It was found out that there is a correlationship between the floor area of an establishment/institution and willingness to pay.

When the number of households in a certain Kelurahan is multiplied by the average willingness to pay per household in the same Kelurahan, the total willingness to pay of houses in the said Kelurahan is calculated. The same procedure can be applied to other types of property.

When the total willingness to pay in a certain Kelurahan is divided by the area in the same Kelurahan, and this procedure is followed in each of other Kelurahans, zonal distribution of affordability level will be obtained as shown in Fig. 11.1.

Sum total of the willingness to pay for all properties over the whole Study Area works out annually at Rp. 39,167 million in 1988 and it will reach Rp. 97,562 million in the target year of 2010 at 1990 prices.

11.2.2 Beneficiaries' Payment

The affordability for sewerage services mentioned in the preceding section expresses the outer limit of the affordability for any other types of wastewater disposal services.

Alleviation of water pollution over the entire Study Area by both sewerage and on-site sanitation developments is estimated to demand initial cost amounting to Rp. 3,341,602 million over the implementation period of 18 years. In addition, O/M cost totaling Rp. 22,662 million will be annually required.

It is apparent from the above that it is difficult for the beneficiaries to bear both the initial and O/M cost. It is also apparent that they are capable of shouldering O/M cost.

The JICA Study Team defends the stance that sewerage is one of the basic human needs to be commonly used like public road. From this standpoint, it seems not advisable to unduly burden the beneficiaries. Moreover, The Government of Indonesia now takes the position that the beneficiaries should at least pay O/M cost.

For these reasons, it is recommended that the beneficiaries shoulder O/M cost.

For the sewerage development area, it is recommended that the tariff of sewerage services charge recently approved by the government be basically applied along with the tariff of environmental charge now actually in force in Bandung.

Sewerage services charge will be collected from the beneficiaries with conventional house connections based on the floor area of their buildings. The monthly charge per m2 of floor area will be Rp. 28 for households, Rp. 50 for shops, hotels and restaurants, Rp. 106 for factories, Rp. 56 for social institutions, and Rp. 182 for large commercial buildings and large hotels.

The total annual sewerage services charge is estimated to reach Rp. 32,930 million in 2010. Its breakdown by property is shown in Table 11.3.

For the beneficiaries in the intercepter area, lump sum environmental charge will be applied. The monthly charge will be tentatively Rp. 1,000 for a house, Rp. 2,500 for an establishment/institution, Rp. 25,000 for a large commercial building and Rp. 50,000 for a large hotel.

The total annual environmental charge will reach Rp. 6,177 million in 2010.

The combined annual income from both charges comes to Rp. 39,107 million, which is sufficient to cover the estimated annual O/M cost of Rp. 18,067 million.

In the on-site sanitation development area, the annual O/M cost to be required is estimated to reach Rp. 4,595 million in 2010. The number of beneficiaries is estimated at 859,500 in the same year. It means that the annual O/M cost will be recovered if Rp. 446 is monthly charged per household.

To promote the construction of domestic individual treatment system it will be advisable for the government to provide subsidy in some form or another.

11.2.3 Required Government Investment

The development expenditure of DKI Jakarta during the nine years from 1980 to 1988 works out at Rp. 259,453 million on average on annual basis. Out of it, Rp. 84,322 million or 32.5% was on average earmarked for urban development. Sub-sectors of the urban development sector consist of urban road, drainage/flood, KIP/MIP, water supply/wastewater and solid wastes.

Out of the urban development sector expenditure, 52.9% has been allocated on average for urban road. The second place is occupied by KIP/MIP with the average share of 17.2%. The remaining three (3) sub-sectors have similar average shares, that is 10.4% for both drainage/flood and solid wastes, and 9.1% for water supply/wastewater.

The development expenditure is mostly financed by the central government out of its own coffer. Another source of development funds for DKI Jakarta is foreign loans. They are provided to DKI Jakarta by way of the central government.

The average annual amount of foreign loans for the last seven (7) years excluding two (2) years of irregular amount works out at Rp. 413,464 million. It is by 59.4% higher than the average annual amount of the development expenditure of DKI Jakarta.

The combined amount of development expenditure and foreign loans comes to Rp. 672,917 million on average per annum. It corresponds to 4.8% of the gross domestic product (GDP) of D.K.I Jakarta.

Using the correlationship between GDP and total development funds (=combined amount of development expenditure and foreign investment), and GDP forecast, total development funds during the project implementation period were projected.

Urban development funds were projected on the assumptions that allocations for the urban development sector will be 32.5% based on the past share for the same sector as the development expenditure.

According to the projection, cumulative amount of urban development funds over 18 years from 1993 to 2010 is calculated at Rp. 12,280,910 million.

Whereas, the initial cost of the wastewater disposal project requiring public funds is estimated at Rp. 1,903,314 million. Thus the share of the allocations for wastewater from the urban development funds during above period works out at 15.5%.

Table 11.1 Cost Benefit Streams of Urban Drainage Development

IC = Initial Costs; OM = O/M Costs; CS = Costs; BF = Benefits
SCF = Cash Flow (=BF - CS)

(Unit : Rp. Million)

NO	YEAR	IC	OM	CS	BF	CF
1	1992	73,692	0	73,692	7,791	-65,901
2	1993	73,692	306	73,998	17,022	-56,976
3	1994	84,072	613	84,685	28,546	-56,139
4	1995	84,072	950	85,022	41,619	-43,403
5	1996	67,079	1,287	68,366	53,794	-14,572
6	1997	31,173	1,556	32,729	62,213	29,484
7	1998	31,173	1,690	32,863	71,213	38,350
8	1999	31,173	1,824	32,997	80,847	47,850
9	2000	26,927	1,958	28,885	90,242	61,357
10	2001	190	2,073	2,263	95,028	92,765
11	2002	190	2,073	2,263	101,679	99,416
12	2003	9,548	2,074	11,622	108,519	96,897
13	2004	9,548	2,112	11,660	115,542	103,882
14	2005	9,548	2,150	11,698	122,748	111,050
15	2006	9,548	2,189	11,737	127,853	116,116
16	2007	2,675	2,227	4,902	133,659	128,757
17	2008	2,675	2,239	4,914	139,523	134,609
18	2009	2,675	2,251	4,926	145,442	140,516
19	2010	0	2,263	2,263	150,624	148,361
20	2011	0	2,263	2,263	155,802	153,539
21	2012	0	2,263	2,263	160,980	158,717
22	2013	0	2,263	2,263	160,980	158,717
23	2014	0	2,263	2,263	160,980	158,717
24	2015	0	2,263	2,263	160,980	158,717
25	2016	0	2,263	2,263	160,980	158,717
26	2017	0	2,263	2,263	160,980	158,717
27	2018	0	2,263	2,263	160,980	158,717
28	2019	0	2,263	2,263	160,980	158,717
29	2020	0	2,263	2,263	160,980	158,717
30	2021	0	2,263	2,263	160,980	158,717
31	2022	0	2,263	2,263	160,980	158,717
32	2023	0	2,263	2,263	160,980	158,717
33	2024	0	2,263	2,263	160,980	158,717
34	2025	0	2,263	2,263	160,980	158,717
35	2026	0	2,263	2,263	160,980	158,717
36	2027	0	2,263	2,263	160,980	158,717
37	2028	0	2,263	2,263	160,980	158,717
38	2029	0	2,263	2,263	160,980	158,717
39	2030	0	2,263	2,263	160,980	158,717
40	2031	0	2,263	2,263	160,980	158,717
41	2032	0	2,263	2,263	160,980	158,717
42	2033	0	2,263	2,263	160,980	158,717
43	2034	0	2,263	2,263	160,980	158,717
44	2035	0	2,263	2,263	160,980	158,717
45	2036	0	2,263	2,263	160,980	158,717
46	2037	0	2,263	2,263	160,980	158,717
47	2038	0	2,263	2,263	160,980	158,717
48	2039	0	2,263	2,263	160,980	158,717
49	2040	0	2,263	2,263	160,980	158,717
50	2041	0	2,263	2,263	160,980	158,717

Table 11.2 Total Medical Cost in "Without Project" and "With Project" Cases

(Unit : Rp. million)

Year	"Without" Project	"With" Project	Benefits
	(1)	(2)	(3) = (1) - (2)
1990	125,242	125,242	0
1991	127,739	127,739	0
1992	130,236	130,236	0
1993	132,733	132,733	0
1994	135,230	135,230	0
1995	137,727	137,727	0
1996	140,224	140,224	0
1997	142,722	133,785	8,937
1998	145,219	128,105	17,114
1999	147,716	123,010	24,706
2000	150,213	118,376	31,837
2001	152,710	114,113	38,597
2002	155,207	110,153	45,054
2003	157,704	106,445	51,259
2004	160,201	102,948	57,253
2005	162,698	99,629	63,069
2006	165,195	96,462	68,733
2007	167,693	93,425	74,268
2008	170,190	90,501	79,689
2009	172,687	87,676	85,011
2010	175,184	84,936	90,248

Source : JICA

Table 11.3 Beneficiaries' Payment - Sewerage Services Charge

(Unit : Rp. million)

Property	No. of Connection	Average Floor Area per Customer * (m2)	Sewerage Service Charge per m2 per Month ** (Rp.)	Total Sewerage Service Charge per Year
House	322,300	133	28	14,403
Shop	16,275	167	40	1,305
Factory	3,213	437	100	1,685
Hotel	36	728	100	31
Restaurant	854	140	60	86
Hospital	763	1,259	100	1,153
Office	813	692	40	270
School	2,758	1,150	40	1,522
Religious Institutions	3,895	513	40	959
Others	3,179	636	40	970
High Rise Building	444	14,138	140	10,546
Total	354,530			32,930

Note : * Based on the questionnaire survey

** Based on the tariff of sewerage services legalized by the Minister of Public Works on July 11, 1989

Source : JICA

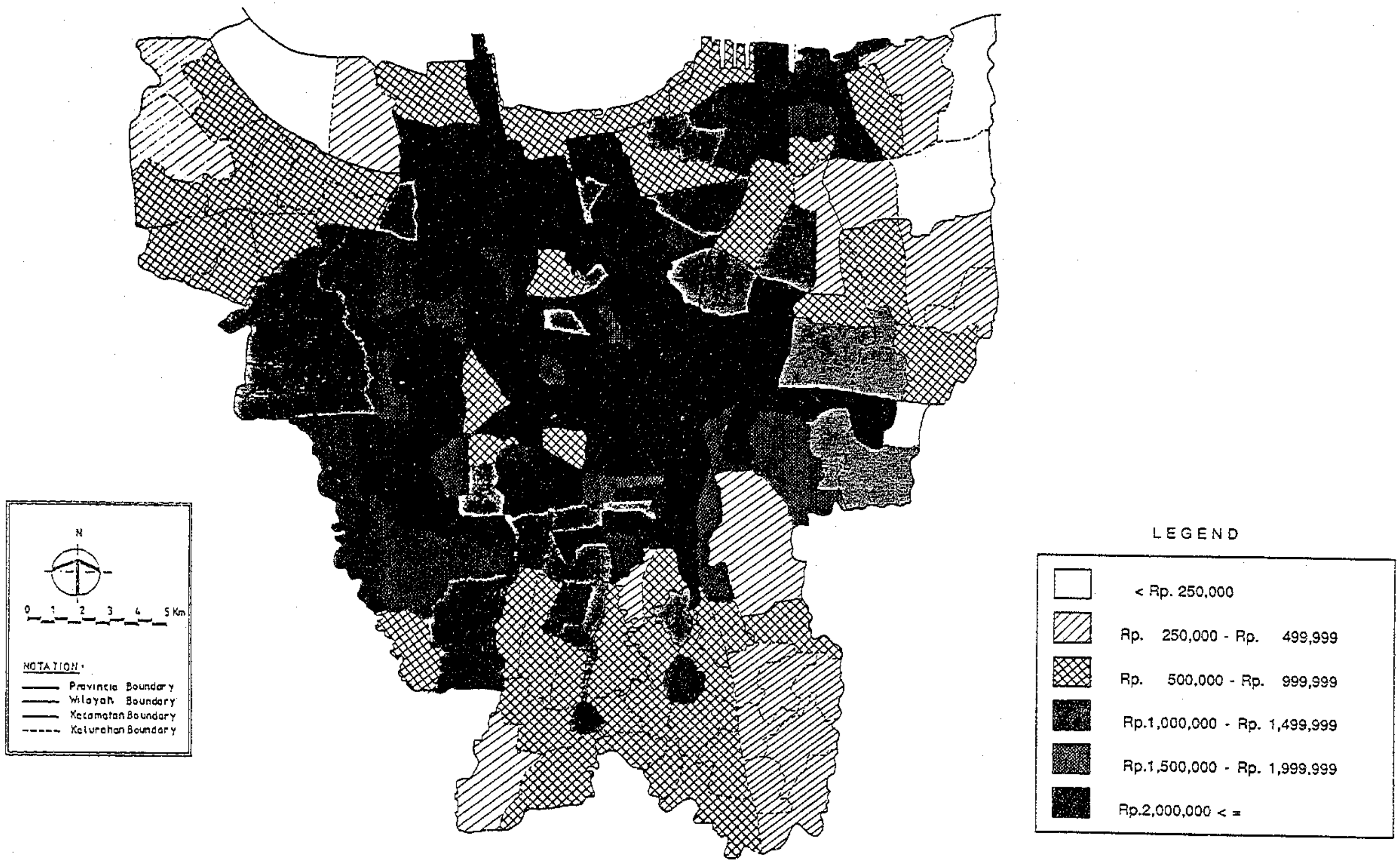

FIG. 11.1 WILLINGNESS TO PAY OF HOUSEHOLD, SHOPS & FACILITIES FOR SEWERAGE FACILITES PER HA BY KELURAHAN IN 2010

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 12

RECOMMENDATIONS

CHAPTER 12 RECOMMENDATIONS

1. Study on Land Subsidence and Storm Water Recharge

Progressing of land subsidence in coastal areas of Central Jakarta has been recognized in recent years based on bench mark survey results of JFCP. If left uncontrolled, this land subsidence may further aggravate the drainage conditions of the Study Area in future.

Land subsidence in urban areas is seemingly caused by excessive pumping of groundwater. Groundwater recharge in combination with regulation of groundwater withdrawal is widely used as control measure of land subsidence.

Artificial infiltration of storm water is an effective means for a concurrent realization of both flood runoff control and groundwater recharge. Hence, it is recommended to investigate on-site flood control by means of artificial infiltration of storm water.

Furthermore, a series of detailed levelling survey of the existing bench marks as well as geohydrological studies shall be carried out over the Study Area to confirm the extent and progressive rate of land subsidence.

2. Improvement of Hydrological Observation Network

The existing hydrological observation networks shall be improved to attain an effective management of the urban drainage system. About six (6) to seven (7) additional automatic rain gauges are recommended to be installed in the Study Area in order to realize a uniform distribution of rain gauges network. Along with such a rain gauges network, automatic water level gauges network will also be improved.

3. Strengthening of O&M Activities of Drainage

The existing Operation and Maintenance (O&M) activities of urban drainage shall be strengthened. Such O&M activities include dredging of channel, removal of dumped garbage and other debris, operation and repairing of facilities.

According to the regulation of the Government of Indonesia, O&M of all the urban drainage systems in the Study Area will solely be under the responsibility of DKI, Jakarta in the near future. The on-going urban drainage projects by JFCP will be transferred to DKI, Jakarta after their completion. Hence the existing organization of the urban drainage in DKI, Jakarta shall be strengthened to cope up with the additional work load accordingly.

4. Enhancement of Public Awareness on Environment

The rivers and waterways are severely polluted principally due to disposal of wastewater of human activities with no treatment. This problem is further compounded by both unintentional and intentional dumping of solid wastes to waterways/rivers, which at least could be attributed a gross lack of public awareness concerning environmental quality.

Hence, enhancement of public awareness on environmental pollution issues is extremely necessary not only to improve the environmental condition of Jakarta but also to gain public support for sewerage development. It is recommended to conduct public campaign by DKI Jakarta or other related organization to enhance the awareness of general populace on the importance of environmental quality improvement and its relation to alteration of behavioral pattern.