REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS (DPU)
DIRECTORATE GENERAL OF HOUSING, BUILDING,
PLANNING AND URBAN DEVELOPMENT (CIPTA KARYA)

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT

VOLUME II

MASTER PLAN REPORT

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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ABBREVIATION

millimeter	mm	kilogram per square centimeter	kg/cm^2
centimeter	cm		
meter	m		
kilometer	km	centimeters per second	cm/sec
		meter per second	m/sec
square centimeter	cm^2		
square meter	m^2	cubic meters per second	m^3/sec
square kilometer	km^2	cubic meters per minute	m^3/min
hectare	ha	cubic meters per day	m^3/d
		liter per capita per day	lpcd
cubic millimeter	mm^3		
cubic centimeter	cm^3	volt	V
cubic meter	m^3	kilovolt	kV
		kilowatt	kW
milliliter	ml	revolutions per minute	rpm
liter	l		
		ampere	A
milligram	mg	kilovolt-ampere	kVA
gram	g	direct current	DC
kilogram	kg	altering current	AC
metric ton	t		

ORGANIZATION

DPU	Ministry of Public Works
PLN	Ministry of Electric Power
Cipta Karya (DGCK)	Directorate General of Housing, Building, Planning and Urban Development
DWS	Directorate of Water Supply
DGWRD	Directorate General of Water Resources Development
POJ	Jatiluhur Authority
DPMA	Institute of Hydraulic Engineering
DEG	Directorate of Environmental Geology
DKI Jakarta	Jakarta Municipality
PDAM Jaya	Jakarta Water Supply Enterprise
JATS	Jabotabek Advisory Team Services
JICA	Japan International Cooperation Agency
OECF	Overseas Economic Cooperation Fund, Japan

OTHERS

JMDP	Jabotabek Metropolitan Development Project
CJC Master Plan	Cisadane-Jakarta-Cibeet Water Resources Development Study
WTC	West Tarum Canal
TJC	Tarum Jaya Canal

CURRENCY EQUIVALENT

U.S.$ 1.0 = R_p 1,004 = Yen 224

(As of March, 1984)

1. INTRODUCTION

1. INTRODUCTION

1.1 Background of the Study

The Government of Indonesia requested the Government of Japan, in 1982, for technical assistance to prepare a master plan and feasibility study of the Jakarta water supply system (the Work) considering the chronic water shortage prevailing in the Metropolitan area. In response to this request, the Government of Japan decided to undertake the work through Japan International Cooperation Agency (JICA) within the frame of the international cooperation of Japan. JICA contracted the work with Nihon Suido Consultants Co., Ltd. on June 7, 1983.

The engineering services were conducted from June, 1983 upto March, 1985 in accordance with the terms and conditions of the contract.

1.2 Objective, Scope and Study Area

1) Objective

The objective of the work is to prepare a Master Plan for phased improvement of the water supply system up to the year 2005 and a Feasibility Study for an urgent project identified in the Master Plan.

2) Scope of Work

The scope of work, as contracted, includes the following:

i) Master Plan

a. Data collection and analysis,
b. Definition of service areas for planning,
c. Estimation of population,
d. Estimation of water demand,
e. Study of present status of water works, including losses and intake problem,
f. Study of water sources,
g. Planning of water supply system,
h. Rough estimation of cost for construction, operation and maintenance,
i. Preparation of implementation schedule,
j. Socioeconomic study and
k. Study of organization, operation and management plan

ii) Feasibility Study

a. Definition of project area
b. Estimation of population to be served
c. Estimation of water demand
d. Study of improvement of existing facilities and proposed program of immediate action
e. Study of water source
f. Study of required facilities and layout of facilities.
g. Study of design criteria,
h. Preliminary design,

i. Preparation of construction schedule,
j. Study of construction materials and labour force and study of construction ability of local contractors,
k. Preparation of construction method and procurement method of materials and equipment,
l. Estimation of costs for construction , operation and maintenance,
m. Estimation of benefits,
n. Financial analysis
o. Study of alternatives of organization operation and management plan and
p. Preparation of implementation program

3) Study Area

The Study Area covers the administrative area of Jakarta City (DKI). The study will touch on those facilities in the immediate environs of the City which are related to the water supply project of Jakarta.

1.3 Composition of the Report

The report of the study will be compiled in the following volumes:

I. Executive Summary
II. Master Plan Report
III. Feasibility Study Report
IV. Appendices for Master Plan Report
V. Appendices for Feasibility Study Report

This volume consists of the above Item II. Master Plan Report.

2. DESCRIPTION OF STUDY AREA

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2.1 Physical Aspect

2.1.1 General

The study area, the administrative area of Jakarta City, is a portion of Jabotabek area which consists of Jakarta, Bogor, Tangerang, Bekasi administrative areas in the West Java province on the western part of the island of Java, Republic of Indonesia. The city of Jakarta lies at 6°12' South Latitude and 106°48' East Longitude with an area of 649.31 km2 including Pulau Seribu (Island).

For study of water sources, evaluation on physiographic, geologic, hydrogeologic aspects are made including the vicinity of Jakarta and the Citarum river basin shown in Fig.2.1.

2.1.2 Physiography

In topographic features the region of Jabotabek and the Citarum river basin is divided into the three areas as shown below and in Fig. 2.2.

1) Jakarta coastal flat plain area
2) Bogor hilly slope area, and
3) Southern mountainous area

The city of Jakarta is located on the coastal deltaic plain of 0 m to 50 m above sea level. The coastal lowlands stretching along the coast area 5 to 10 km in width and no more than 10 m in elevation. This area is practically flat and often swampy. Topographic gradient rarely exceed 1.0 m/km. This plain slopes up from the sea of Java towards the southern inalnd mountains.

The transitional hilly area of piedmont zone lies between the southern mountains and coastal plain, in a narrow belt ranging from 100 m to 400 m in elevation. The slopes of Bogor are made up of volcanic materials.

Southern mountains are made up of volcanoes, more than 1,000 m high above sea level, extending inland for approximately 50 km. The slopes are steep including the particularly preciptous zone of Mt. Pangrango (3,029 m).

2.1.3 Climate

The city of Jakarta is situated on the tropical climate zone with two seasons; the Dry season from June through October with the Southeast monsoon and Rainy season from November through May with the Northwest monsoon. The preciptation and temperature of the area vary considerably in the north-south direction due to topographic conditions, that is, coastal plains in the north and rugged mountains in the south. Meteorological observations are available for Jakarta and contrasting area of Bogor as shown in Table 2.1.

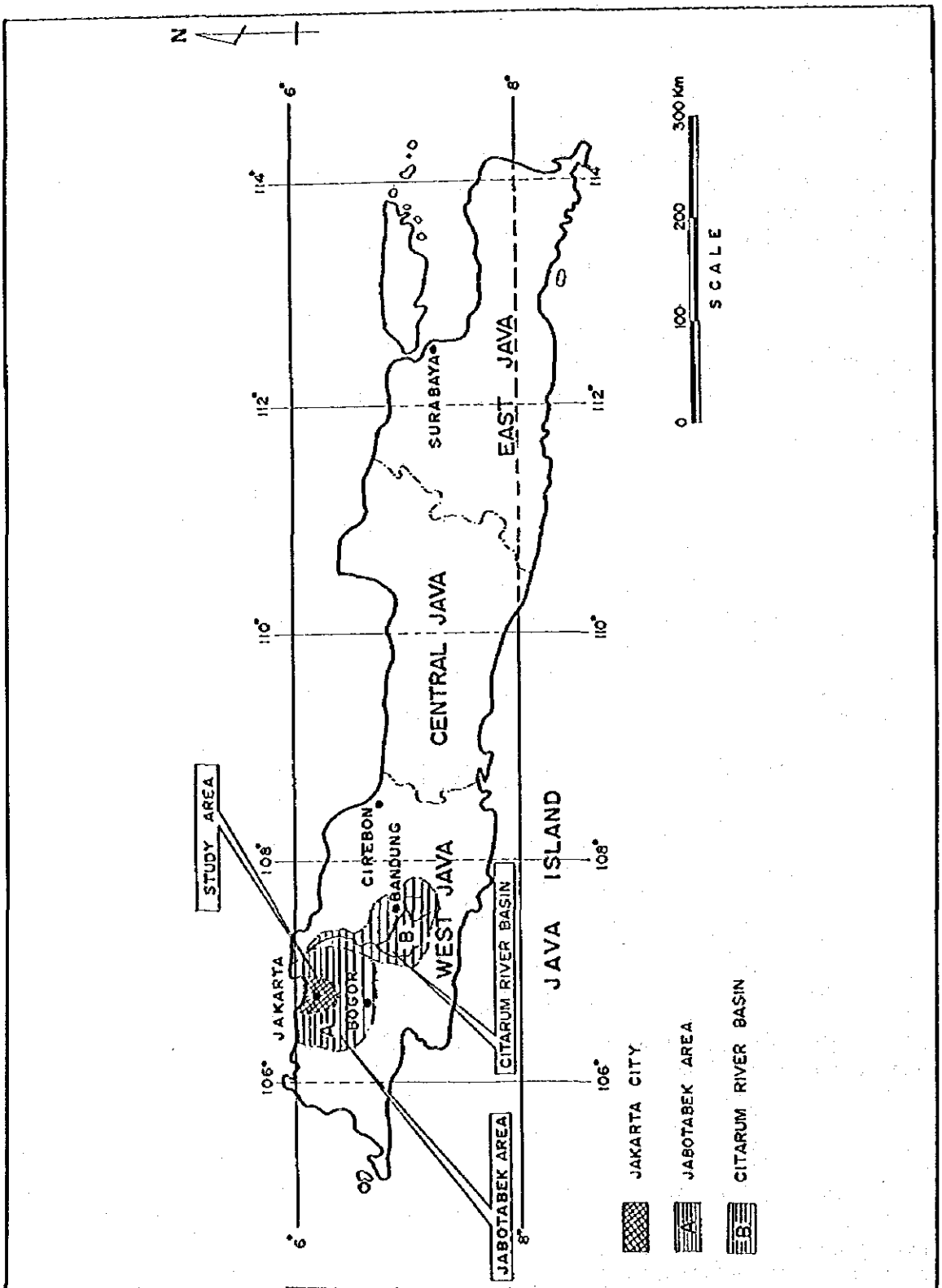

FIG 2.1 LOCATION MAP

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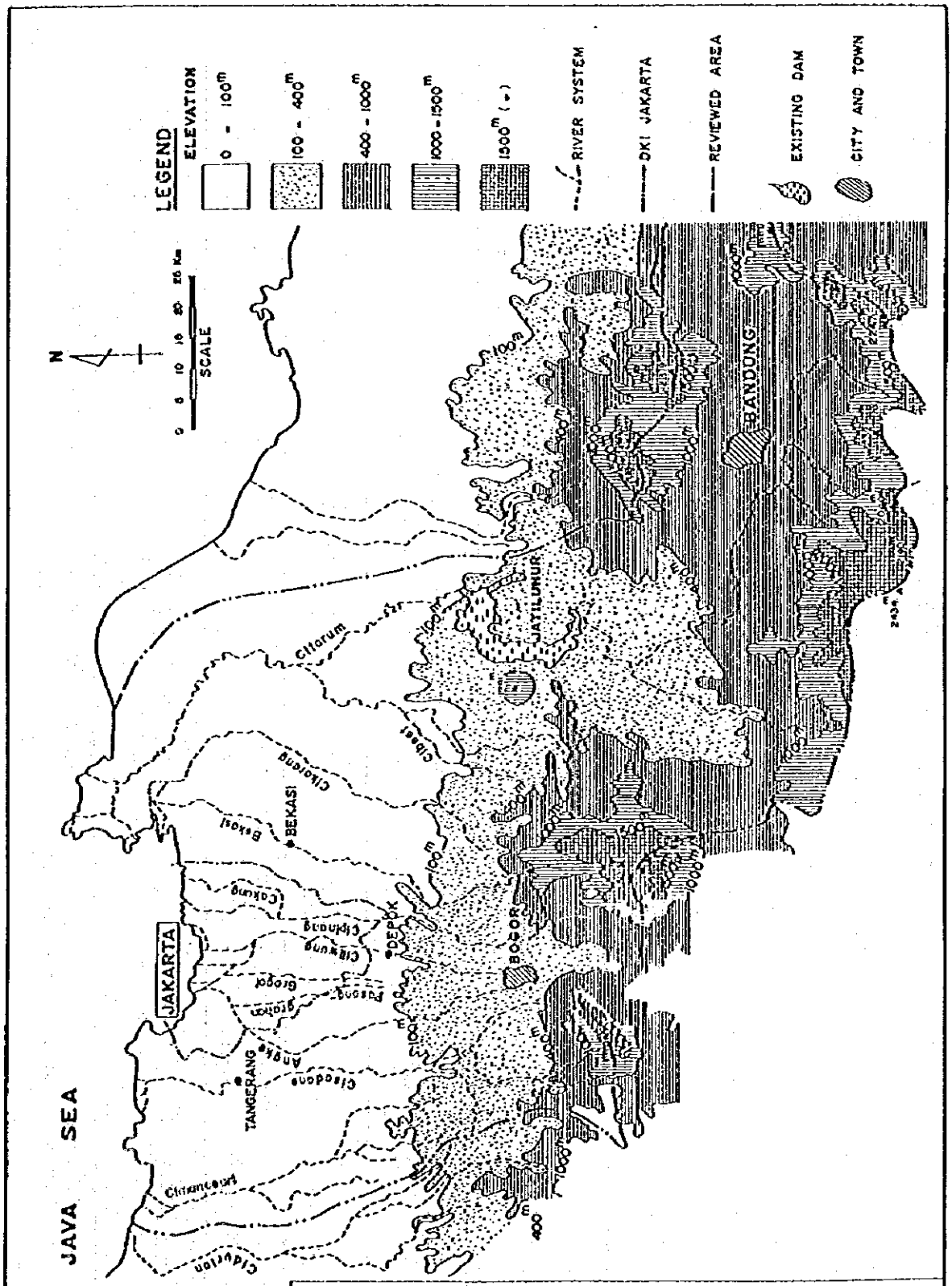

FIG 2.2 TOPOGRAPHIC CONDITION AND RIVER SYSTEM

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Table 2.1 Meteorological Data of Jakarta and Bogor

Meteorological Data	Area	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total/ Average
Rainfall (mm)	Jakarta	390	322	242	126	117	87	56	53	68	92	135	180	1,868
	Bogor	460	447	381	403	117	198	224	224	317	370	328	347	3,816
Mean Temperature (°C)	Jakarta	26.3	26.3	26.9	27.5	27.7	27.2	27.0	27.1	27.6	27.8	27.3	26.7	27.1
	Bogor	25.0	25.1	25.4	25.8	25.9	25.8	25.5	25.4	25.8	26.2	25.7	25.6	25.6
Mean Relative humidity (%)	Jakarta	85	85	83	82	80	78	76	74	73	75	79	82	
	Bogor	91	90	88	89	86	82	91	78	90	81	83	86	
Sunshine (%)	Jakarta	39	47	57	68	70	71	78	83	82	71	56	48	
	Bogor	27	32	51	55	56	51	49	60	63	59	48	41	
Wind direction	Jakarta	NW	NW	NW	E	E	E	E	E	N	N	N	NW	
	Bogor	NW	NW	W	NE	NE	NE	NE	NE	NE	N	N	W	
Wind velocity (m/s)	Jakarta	1.6	1.7	1.5	1.5	1.6	1.6	1.8	1.7	1.8	1.8	1.9	1.5	
	Bogor	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6	
Potential evaporation (mm) (Penman)	Jakarta	127	123	149	147	143	129	143	161	171	174	150	140	1,757(94.0%)*
	Bogor	96	101	130	120	115	99	102	121	132	130	138	121	1,405(36.8%)*

Source : CJC Water Resources Development Plan, Annex D, Sogreah-Coyne & Bellier, 1979 and NEDECO, 1983.
*: Percentage to annual precipitation

1) Precipitation

Precipitation of the area is characterized by significant seasonal variations in each year. The region receives a considerable precipitation varying from 5,500 mm/year in the southern mountains to 1,500 mm/year in the coastal plain. The wet months are November to May when 70% of the yearly precipitation usually occurs. From June to October precipitation is low with monthly below 100 mm and often almost zero. According to the statistics, mean annual precipitations at Jakarta and Bogor are 1,868 mm and 3,816 mm respectively.

2) Temperature

The mean monthly temperature as measured at Jakarta station, is also shown in Table 2.1. The temperature varies slightly throughout the year with an average annual temparature of 27.1 C° at Jakarta and 25.6 c° at Bogor.

3) Evaporation

The monthly mean potential evaporation of Jakarta is shown in Table 2.1. The average annual potential evaporation and precipitation are nearly equal (94.0%) in Jakarta, but the potential evaporation exceeds the precipitation during Dry season through April to November except the Rainy season. Comparing with Jakarta, the pattern of Bogor is different with the annual potential evaporation accounting for only 36.8 % of annual precipitation because of a large difference of total precipitation. Bogor has heavy precipitation in a year reaching more than twice of those in Jakarta.

2.1.4 Hydrology

Hydrologic features of river discharge related to the study of surface water source for Jakarta city are treated on two main factors, precipitation and river system.

1) Precipitation

Yearly average precipitation over Jakarta and the Citarum catchment area has been analysed, based upon the observation records covering the period of more than 100 years from 1880 to 1981, kept by over 50 precipitation stations, and the results are presented in Fig. 2.3 (NEDECO, 1983).

The average annual precipitation of Jakarta and the Citurum catchment areas is considerably different from area to area. It is less than 2,000 mm/year along the northern coastal plain where Jakarta lies, while the southern mountain area receives precipitation over 4,000 mm/year. A specially heavy precipitation over 5,000 mm/year has encountered near Bogor.

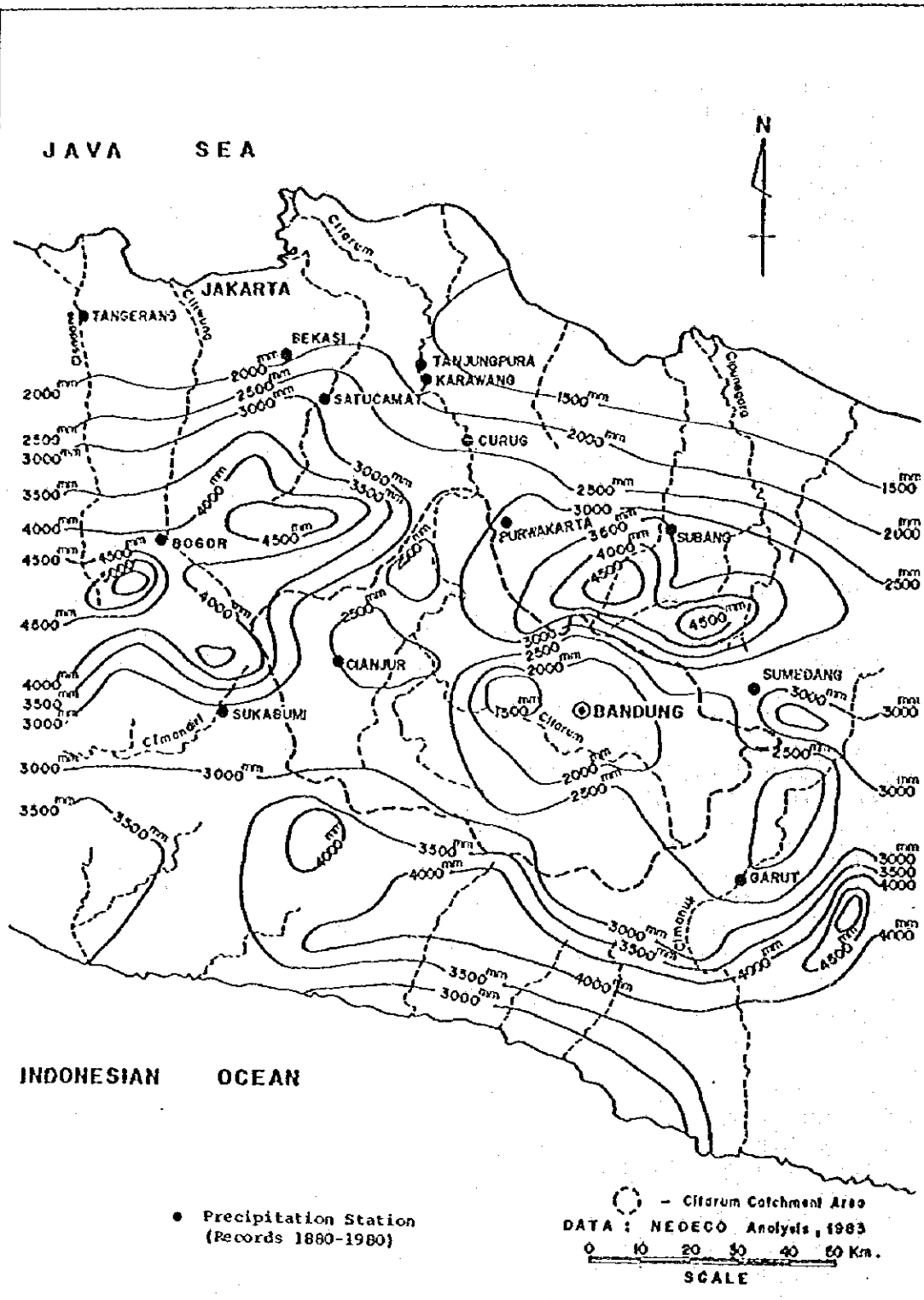

Fig 2.3 AVERAGE ANNUAL PRECIPITATION OF JAKARTA AND CITARUM CATCHMENT AREA

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2) River System

Fig. 2.4 illustrates the river systems serving for the water supply to Jakarta Metropolis and the hydrologic data of these systems surrounding Jabotabek area are presented in Table 2.2.

The Citarum river is the biggest river in the West Java with a catchment area of 4,550 km2 at Jatiluhur damsite and the average annual flow of about 517 billion m3 or 181 m3/sec of average discharge. The Cisadane river is another big river within the region. The mean annual discharge of the Cisadane river is 97.9 m3/sec and its monthly minimum discharge is 62.3 m3/sec at Serpong guaging station with 1,074 km2 catchment, based on the data of Sogreah, 1979. Most of other local rivers contributing to the water supply, such as the Cibeet, the Cikarang, the Bekasi, the Ciliwung and the Cidurian rivers, occur between these two big rivers, flowing northward to the Java Sea.

2.1.5 Geology

The geological conditions of Jakarta and the Citarum river basin are illustrated in Fig. 2.5. The old rocks of Oligo-Eocene sediments slightly crop out in the west of Bandung associating with Miocene and Pliocene sediments. Also, faults and overthrust faults are observed generally in NE-SW and NW-SE directions. Tertiary sediments deposited in the marine and deltaic conditions in the end of Miocene, Pliocene and Quaternary are affected by an intrusive and extrusive volcanic rocks associating with folds and faults.

Jakarta is covered by thick Quaternary sediments, the thickness ranging from 100 m to 300 m and the sediments are mainly deltaic facies. The lowlands and swampy area of coastal plain are mantled with Holocene (Recent) sediments consisting of clay, silt, sand, gravel and pebbles which are mostly of volcanic origin. The thickness is less than 30 m around Jakarta area.

2.1.6 Hydrogeology

The base of Jakarta artesian basin is underlain by Miocene to Pliocene sedimentary rocks, consisting of green to grey marl, limestone and sandstone. These Tertiary rocks are encountered at about 300 m in depth overlain by 200-300 m thick of Quaternary sediments. The hydrogeological cross sections shown in Fig. 2.6 were prepared by Soekardi, DEG 1975 to show the subsurface conditions in Jakarta area.

The Quaternary sediments consists of alternating layers of clay, sand and gravel deposited under deltaic and marine environments. These Quaternary sediments were presumably derived from two sources such as from south and from north, as indicated by the presence of andesitic fragments and quartz grains, respectively.

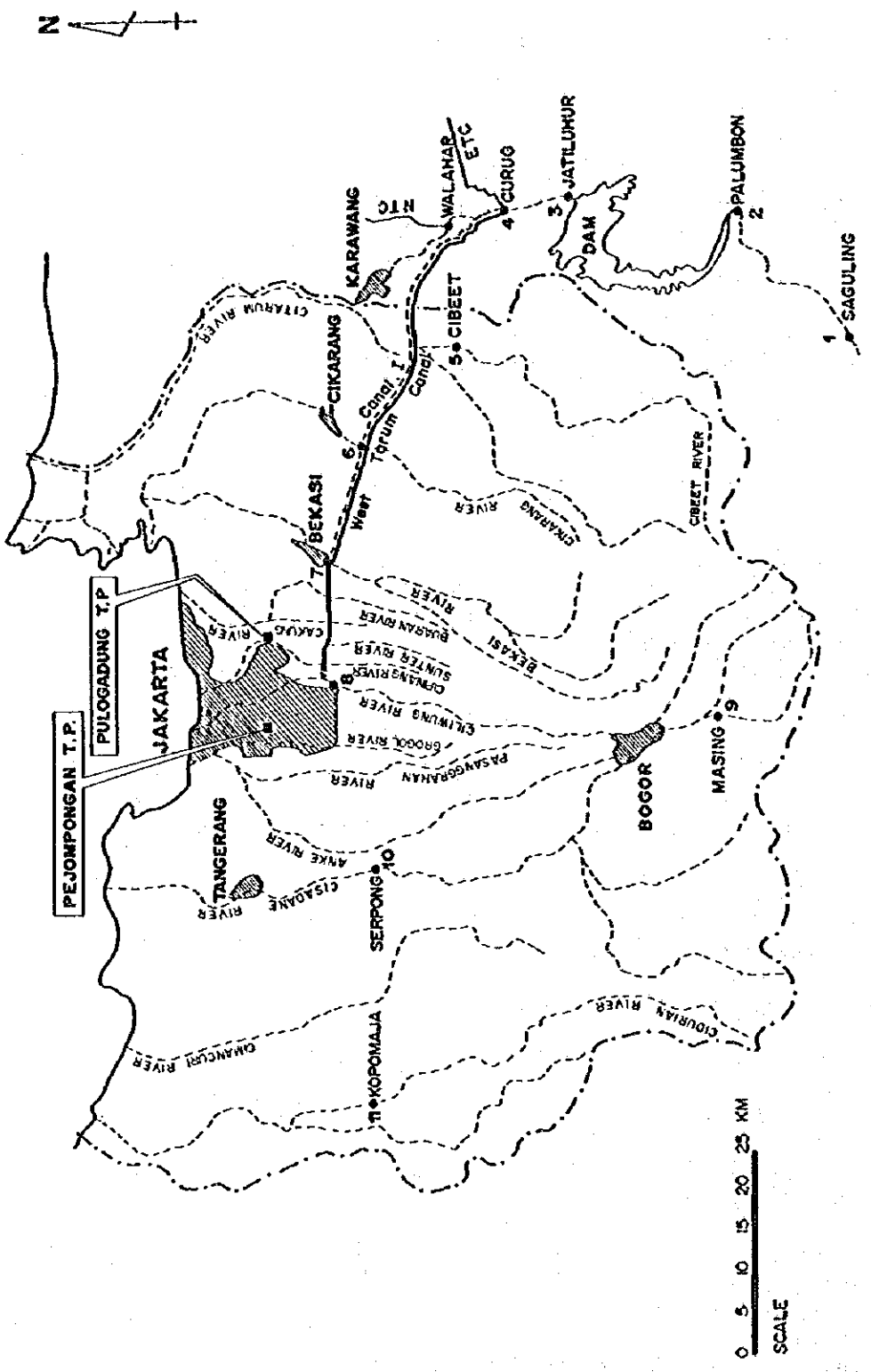

FIG 2.4 RIVER SYSTEM AND RIVER FLOW GAUGING STATIONS IN JABOTABEK AND SURROUNDING AREA

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Table 2.2 Hydrologic Conditions of River System Surrounding Jabotabek Area

No.	River	Station or Location	Catchment Area (Km2)	Mean Annual Rainfall (mm)	Mean Annual Discharge (m3/s)	Monthly Minimum Discharge (m3/s)	Records of Discharge
1.	Citarum R.	Saguling St.	2,315	2,262 *	99.0	26.0	Yearbooks NEDECO, 1983
2.	Citarum R.	Palumbon St.	4,059	2,391 *	160.0	54.0	POJ, 1963-1980
3.	Citarum R.	Jatiluhur Dam	4,550	2,406 *	181.0	64.0	POJ, 1963-1980
4.	Citarum R.	Curug Weir	4,833	2,432 *	185.0	147.0	POJ, 1969-1980
5.	Cibeet R.	Cibeet Weir	507	3,283 **	37.4	11.0	POJ, 1970-1980
6.	Cikarang R.	Cikarang Weir	226	3,467 **	15.9	7.0	POJ, 1970-1980
7.	Bekasi R.	Bekasi Weir	412	3,660 **	32.7	15.0	POJ, 1970-1980
8.	Ciliwung R.	Rawajati St	318	1,950 ***	17.0	9.3	Sogreah, 1979
9.	Cisadane R.	Masing St.	129	4,100 ***	10.7	7.1	Sogreah, 1979
10.	Cisadane R.	Serpong St.	1,074	2,450 ***	97.9	62.2	Sogreah, 1979
11.	Cidurian R.	Kapomaja St.	304	2,550 ***	22.8	15.3	Sogreah, 1979

Note : * Thiessen averages by NEDECO, 1983

** Thiessen average by Sogreah/ Coyne & Bellier, 1979

*** Isohyetal average estimation.

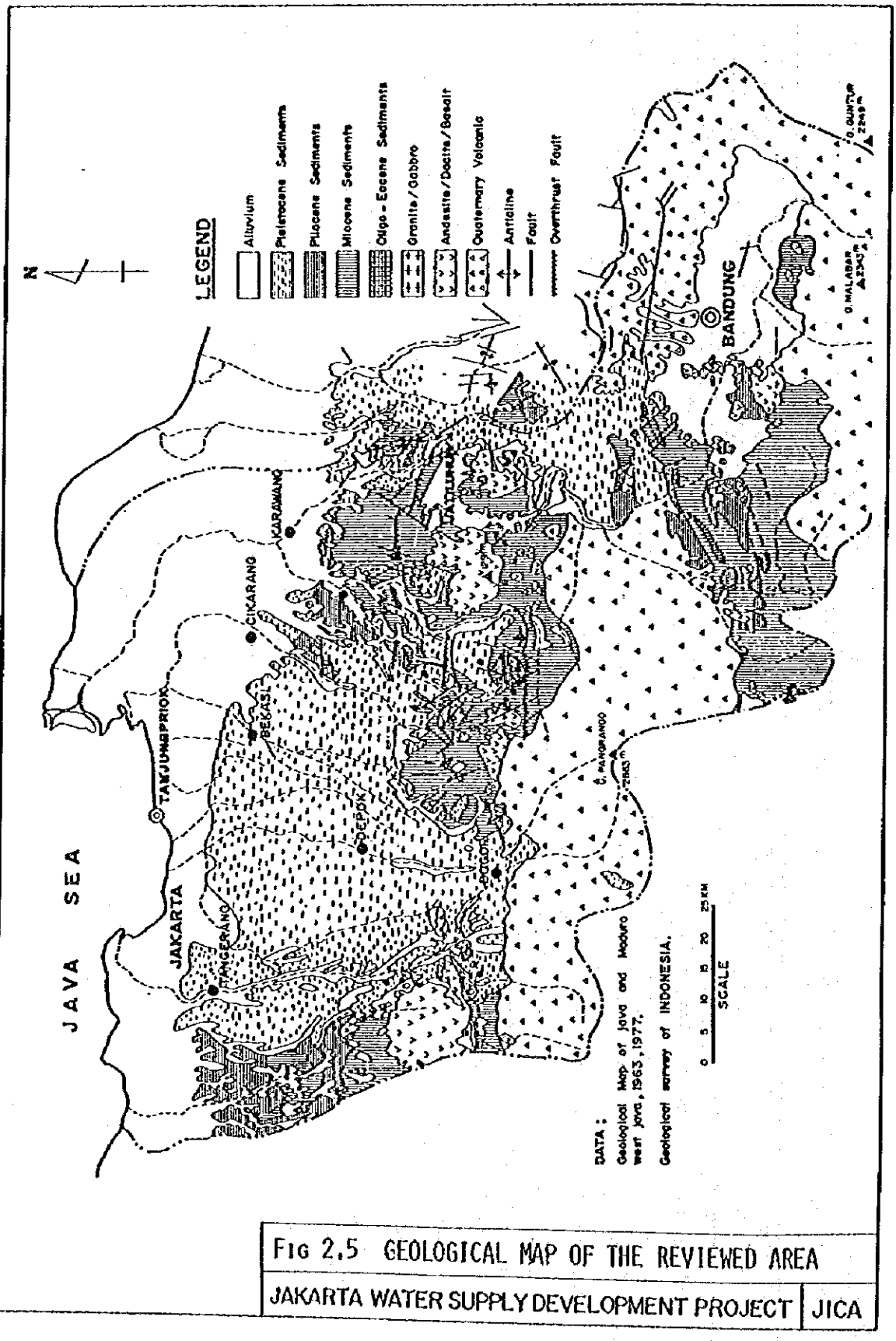

Fig 2.5 GEOLOGICAL MAP OF THE REVIEWED AREA

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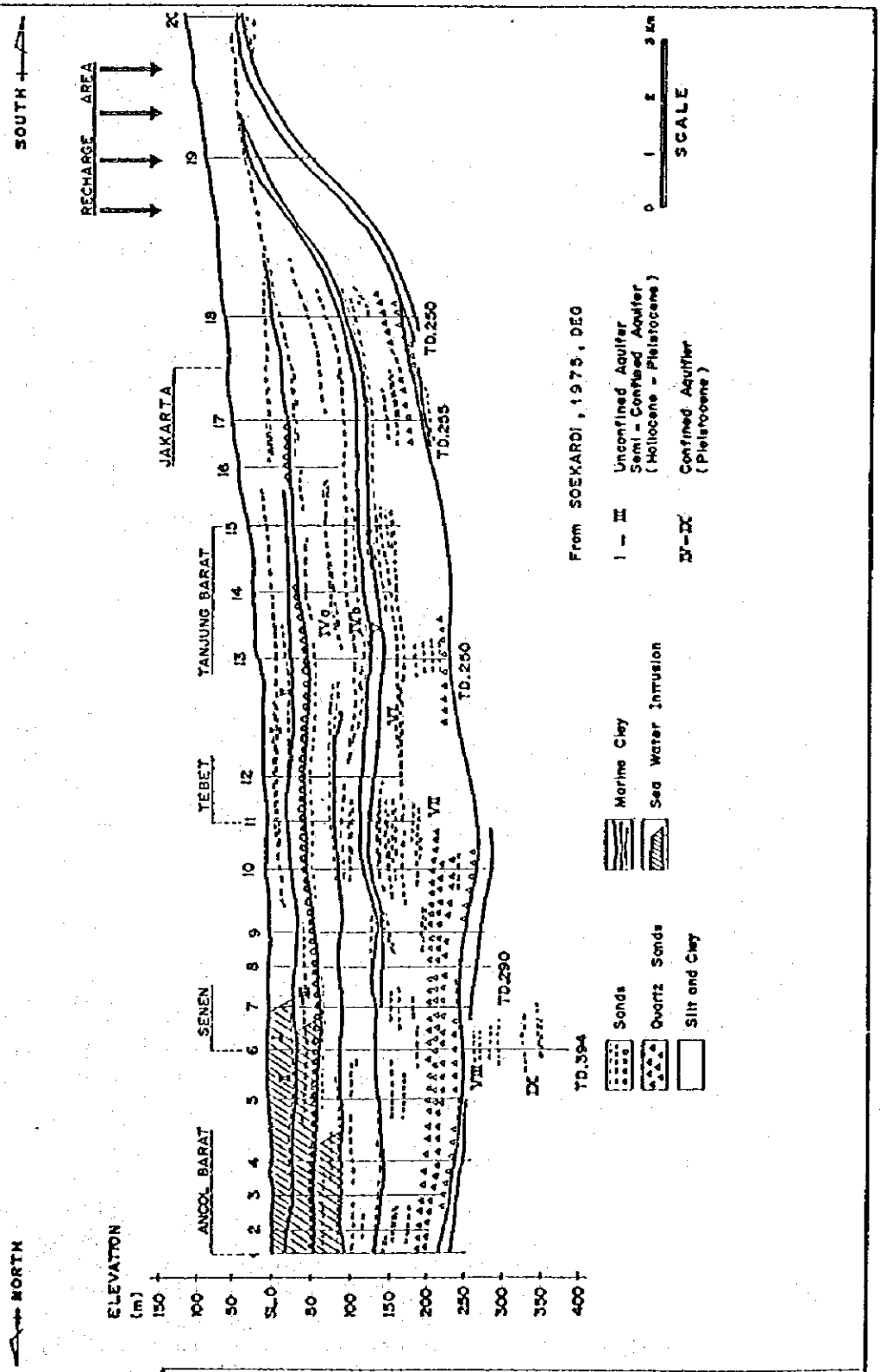

FIG 2.6 HYDROGEOLOGICAL CROSS SECTION IN JAKARTA CITY

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The Quaternary aquifer is considerably important in the Jakarta area, since it has been one of the main sources of domestic and industrial water. The sediments contain relatively freshwater, occasionally saline water near the coast. The study area of Jakarta is hydrogeologically classified into four main aquifer systems as follows:

1) Unconfined and Semi-confined Aquifer

The shallow aquifer is an unconfined one which is located at a shallower depth and tapped by shallow wells for domestic use in densely populated areas. Shallow groundwater can be found almost everywhere under the coastal plain. The thickness of this aquifer rarely exceeds 20 m. The water level fluctuations in the Wet and the Dry seasons are negligible in some areas, while in others the levels may vary from 3 m to 5 m.

2) Confined Aquifer

Groundwater in the deeper aquifer is confined in three principal systems ranging from 20 m to the maximum depth of 394 m. These zones are formed by a series of discontinuous, interfingering permeable strata separeted by layer of low permeable materials.

The aquifers do not continue for long distances and various zones of permeable layers are regularly found throughout the deposits underlying Jakarta city. Water bearing formations are also present at greater depths than 240 m, but these deeper zones produce highly mineralized water and therefore are not considered as suitable water sources. The three water bearing zones are in depths from 20 m to 140 m, 140 m to 240 m and 240 m below ground surface, respecitvely. (Fig. 2.6.)

2.1.7 Groundwater Problems in Jakarta

Groundwater is still an important source for domestic and industrial uses both within and outside the service area. However, groundwater problems such as declining of groundwater level, sea water intrusion and potential land subsidence have ocurred especially in densely populated area in the north.

1) Groundwater Level Decline

Fig. 2.7 illustrates the groundwater piezometric level contour map in Jakarta by Djaeni (DEG), 1982. It is noted there are three parts of serious groundwater withdrawal zones, namely, Tanjung Priok, Pejaringan, and Cengkareng. The continuous lowering of water levels throughout the Jakarta area strongly indicates that the regional deep aquifers are currently being over-exploited and piezometric levels will become progressively deeper. On the other hand, during dry seasons, the unconfined groundwater level also declines below shallow wells or pumps. This caused serious problems for the people who relay on water from shallow well for their domestic purpose.

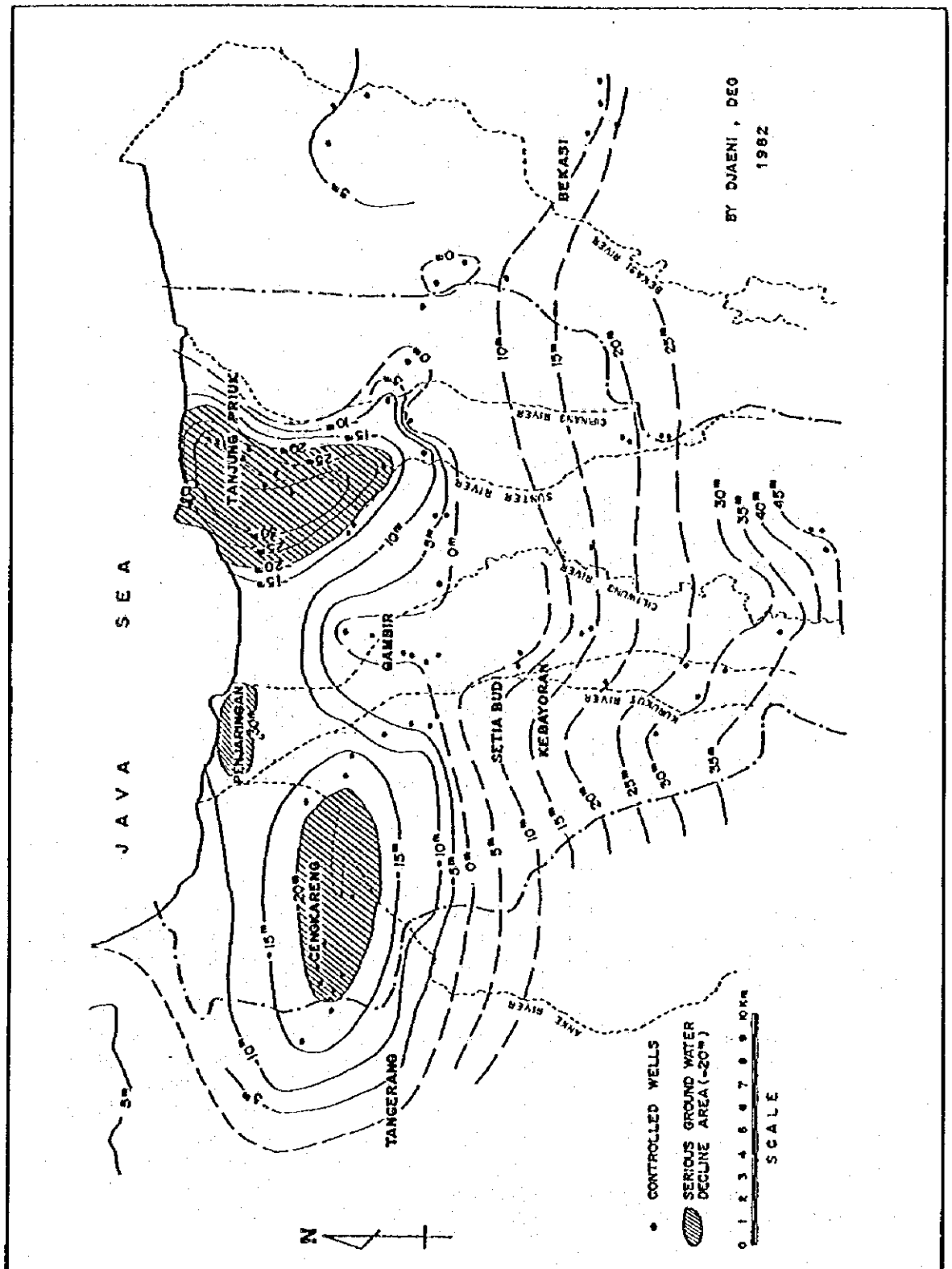

FIG 2.7 GROUNDWATER LEVEL CONTOURS IN JAKARTA CITY

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

2) Saline Water Encroachment

Saline water encroachment has been observed up to 7km inland in the northern coastal zone of Jakarta. Fig. 2.8 shows the expansion of saline water encroachment into the unconfined and semi-confined aquifers, which was prepared by the GHAG/DEG, Bandung 1983. Saline water may not be only caused by sea water, but also by connate water existing in marine clays.

3) Land Subsidence

There are no reports on significant evidence of land subsidence related to groundwater extraction in Jakarta area, while land subsidence is being experienced in large cities of other countries where groundwater is withdrawn in large quantities. However, some signs of land subsidence, a rise of buildings, have slighly been ovserved along Jalan Thamrin. A leveling survey, now being planned under the direction of DEG/PDMA in connection with the presently on-going study on groundwater resources conservation and land subsidence monitoring in Jakarta metropolitan area, should covers Tanjung Priok together with areas of Kota and Thamrin. The results of the survey will be very useful in determining a policy on groundwater management.

4) Groundwater Resources Conservation

As described in the preceding sections, it is of urgent necessity to control the groundwater development to conserve the natural environment. To this end, therefore, the DEG, Bandung designated the groundwater conservation area in 1983 as illustrated on Fig. 2.9. In Zone I and II, further development of groundwater is prohibited or discouraged, and in Zone III, groundwater development is allowed.

2.1.8 Groundwater Study

A groundwater study in the Jakarta area was commenced in the year 1982 by DEG under the assistance of German hydrogeological advisory group at Bangung, and cooperation by government agencies concerned such as DPMA and PDAM.

This study was initiated for the purpose of groundwater resources conservation and to prepare proposal for monitoring system in Jakarta area in terms of fluctuation of water levels, sea water intrusion and land subsidence, and to prepare proposals for related data collection and mobilization and evaluation of data, further process to be made and to make recommendations on the modules to be used for studies in the area. As the results of the study, some data and information for forcasting quantification of groundwater in Jakarta area will be available.

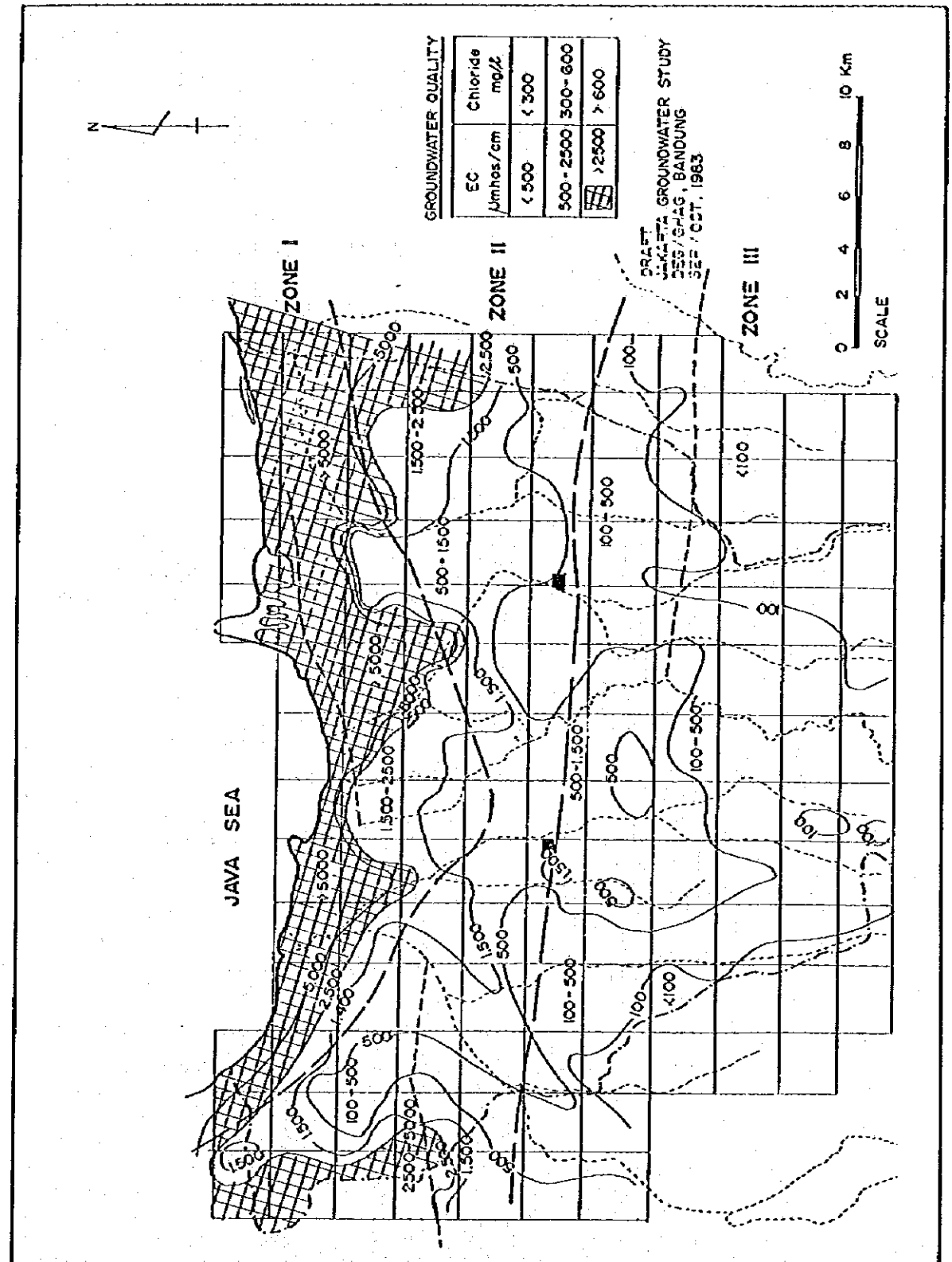

Fig 2.8 SPECIFIC ELECTRIC CONDUCTIVITY OF SHALLOW GROUNDWATER, DRY SEASON 1983

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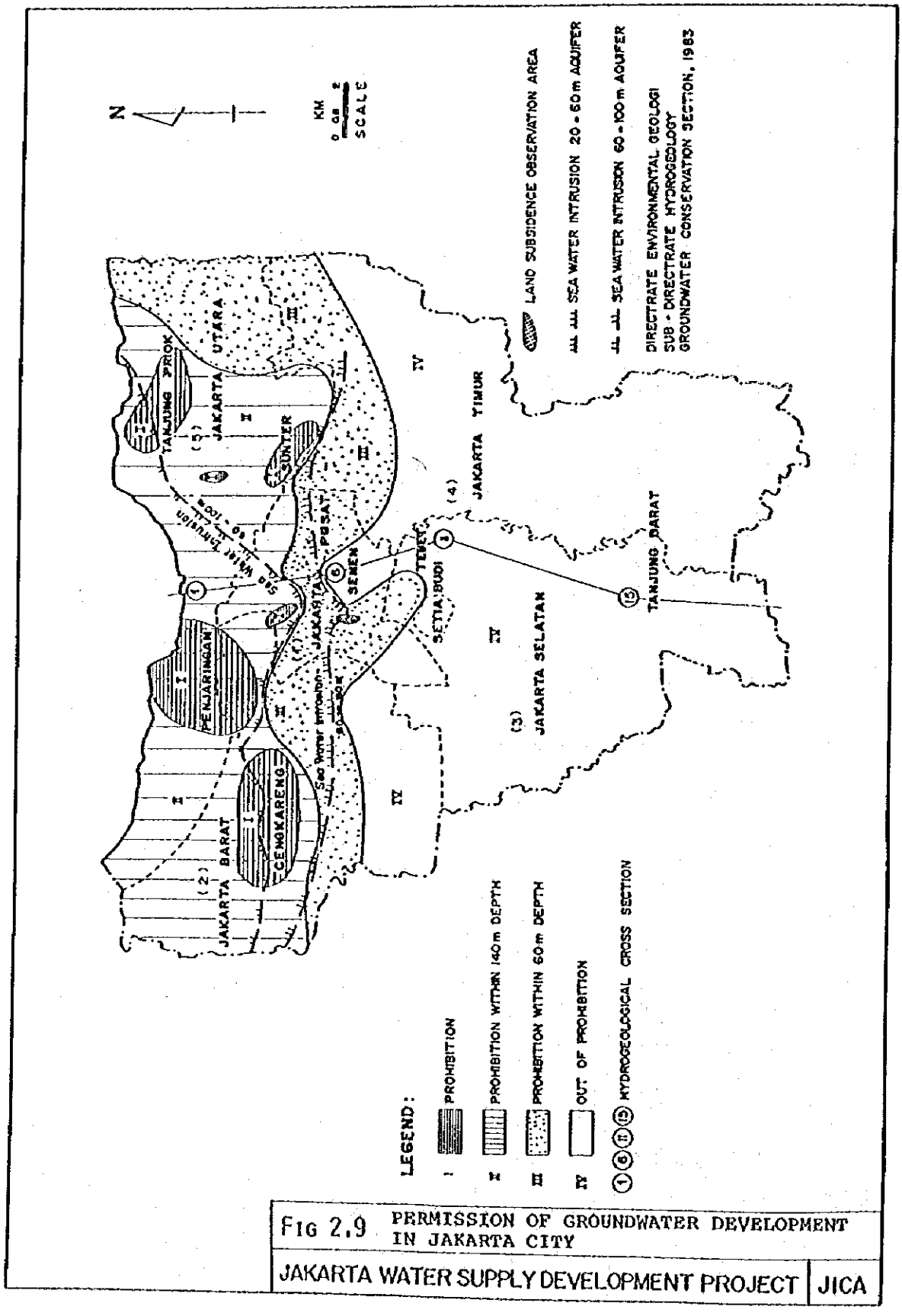

FIG 2.9 PERMISSION OF GROUNDWATER DEVELOPMENT IN JAKARTA CITY

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According to the DEG work schedule, updated in 1984, the study consists of those activities of data collection, mobilization and evaluation of data collected, field survey, core drilling for monitoring, monitoring of groundwater fluctuation in bore holes, quality monitoring, hydraulic analysis, isotope studies, quantification of groundwater resources, modelling, and preparation of final report. The study is scheduled to be completed at the end of 1985.

As of March 1984, data collection was in progress and evaluation and analysis of the well data was also in progress. In parallel to the data collection and the evaluation work, installation of monitoring tubes had been implemented, six single wells were completed and four monitoring wells for shallow aquifer and two monitoring wells for confined aquifer were in progress, and some other monitoring well installation was scheduled to be followed.

2.2 Socioeconomic Aspects

2.2.1 General

Jakarta, the Capital City of the Republic of Indonesia, with a total area of 644 km2, is located in western part of the Java Island encircled with three Kabupaten areas, Bogor, Tangerang and Bekasi, which consist of Jabotabek metropolitan region with a total area of 6,800 km2.

The City of Jakarta is the center of political and economic activities throughout the country and is the largest city with estimated population of 7 million serviced with the developed transportation system including a good road network, railroads, Tanjung Priok seaport and two airports of Kemayorann and Halim Perdanakusuma. A new international airport is under construction at Cengkareng area in west side out of DKI boundary.

2.2.2 Present Economic Activities

Economic activities in Jakarta are predominantly in the trade and service sector including public administration. This is due to level of industrialization yet developing. Gross regional domestic products (GRDP) of Jakarta, and their growth rates and shares are shown on Table 2.3 and 2.4.

Share of the public administration activities as high as 11 % is naturally explained by existence of the central and local governments. Large share of trade sector (44%) and small share of agriculture (1.6%) are also noticeable and considered somewhat similar features common to densely populated urban areas. The growth of the gross domestic products (GDP) throughout Indonesia compared to GRDP of Jakarta are shown on Table 2.5 and 2.6. It is noted that share of trade and services with public administration amounts to more than 85% of Jakarta's GRDP, whereas the same sector share only 38 % in the country. In addition, share of Jakarta's manufacturing industry (13.5 %) is in fact smaller than that of the national average (14.3 %).

It is observed that concluded Jakarta's economy relies mostly upon the tertiary industries, and development of manufacturing sector is behind the national average.

Table 2.3 GROSS REGIONAL DOMESTIC PRODUCT AT 1975 CONSTANT PRICES BY INDUSTRIAL ORIGIN 1975-1979

(Million Rupias)

	1975	1976	1977	1978	1979	1980
Agriculture	21,738.0	17,556.3	28,093.3	26,073.1	26,407.4	26,800.6
Manufacturing	115,335.8	152,453.0	156,018.1	160,137.8	189,323.4	216,827.1
Construction	45,806.2	57,395.2	65,335.1	72,337.2	80,089.7	104,821.5
Electricity ; Gas and Sanitary Water	18,772.5	17,901.3	20,066.5	34,123.9	40,752.9	42,329.5
Transport and communication	78,590.7	88,909.5	94,894.9	100,814.1	121,088.2	134,448.0
Wholesale and Retail Trade	495,207.7	562,456.9	606,926.6	649.960.1	716,862.7	740,583.1
Banking and other Financial Institution	94,662.8	80,462.1	98,262.3	103,813.8	129,076.2	147,551.6
Ownership of Dwelling	29,972.4	31,623.9	32,864.7	33,733.9	34,881.9	35,942.9
Public Administration	105,319.7	109,445.2	121,434.0	124,173.3	149,954.2	190,155.4
Services	31,508.9	33,976.9	36,182.9	38,976.4	38,511.6	46,921.2
	1,036,914.7	1152,230.3	1260,078.4	1344,144.0	1526,948.2	1686,380.

Source : Statistical Year Book of Jakarta 1982

Table 2.4 GROWTH OF GRDP, JAKARTA AT 1975 CONSTANT PRICE

	1975 - 76	76 -77	77 -78	78 -79	79 -80	75 -80	1980 Share
Agriculture	- 19.2 %	60.0 %	- 7.2 %	1.3 %	1.5 %	4.3 %	1.6 %
Manufacturing	32.2	2.3	2.6	18.2	14.5	13.5	12.9
Construction, Electricity, Gas & Water	16.6	13.4	24.7	13.5	21.8	17.9	8.7
Transportation & Communication	13.1	6.7	6.2	20.1	11.0	11.3	8.0
T r a d e	13.6	7.9	7.1	10.3	3.3	8.4	43.9
Public Administration	3.9	11.0	2.3	20.8	26.8	12.5	11.3
Other Services	- 6.5	14.5	5.5	14.7	13.8	8.1	13.7
GRDP, Jakarta	11.1 %	9.4 %	6.7 %	13.6 %	10.4 %	10.2 %	100 %

Table 2.5 GROWTH OF GDP, INDONESIA AT 1973 MARKET PRICES

	1979	1980	1971 - 80	1980 Share
Agriculture	4.0 %	5.5 %	3.7 %	31.4 %
Mining	- 0.2	- 1.2	6.7	9.5
Manufacturing	10.1	21.2	13.1	14.3
Construction, Electricity, Gas & Water	7.8	11.7	14.8	6.4
Services	6.2	12.0	9.1	38.4
GDP, Indonesia	5.3 %	9.6 %	7.5 %	100 %

Source : Central Bureau of Statistics

Table 2.6 SUMMARY OF GROWTH OF GRDP, JAKARTA

	1975 Share	1980 Share	Average Gr/Ann
Agriculture	2.1	1.6	4.3
Manufacturing	11.1	12.9	13.5
Trade	47.8	43.9	8.4
Service	28.8	30.3	11.3
Public Adm.	10.2	11.3	12.5
Total	100 (%)	100 (%)	10.2 (%)

Growth of the Jakarta's GRDP was 13.6% in 1979 and 10.4% in 1980, while that of Indonesia's GDP was 5.3% and 9.6% (world highest). This means Jakarta is enjoying a very high growth despite the world recession. However, the highest growths in both years were interestingly recorded in the public administration sector, and the private trading sector, experienced a low growth of only 3.3 % in 1980.

1) Jabotabek Metropolitan Development Plan

Jabotabek Metropolitan Development Plan (JMDP) is an outstanding regional planning to develop the Jakarta Metropolis and adjacent Kabupatens (Bogor, Tangerang and Bekasi including Kotamadya Bogor) in one concept of the enlarged metropolitan region. The planning is being undertaken in accordance with Presidential Instruction No. 13 of 1976, which calls for the Ministries of EKUIN, Home Affairs and Public Works in conjunction with the Governments of the Provinces of DKI Jakarta and West Java to adjust the development planning of the Jabotabek area in accordance with certain policy principles. The guiding principles of the Presidential Instruction may be summarized as follows:

(1) To reduce the population explosion of DKI Jakarta.

(2) To encourage trade and industry activities especially in areas bordering DKI Jakarta.

(3) To ensure harmonious development in DKI Jakarta and areas boarding directly to it.

(4) To develop centers of urban settlement in Bogor, Tangerang and Bekasi so that such centers may subsequently become centers of new development.

(5) To encourage investment in the growth centers adjacent to DKI Jakarta by promoting communication facilities, land-use regulation and social, economic and cultural facilities.

(6) To utilize available funds in the development budgets of DKI Jakarta, West Java and other second-level governments of the region to encourage development of the Jabotabek region.

(7) In this development planning process the governmental status and obligations of each of the Jabotabek location is to remain unchanged.

Considerable efforts were made in preparing planning studies by the Jabotabek Planning Team, the Jobotabek Technical Advisory Team and their staff supported by domestic and expatriate consultants, who produced tens of volumes of planning reports. A very substantial basis conceived in those plans is referred here that should order priorities and directions of developments in the Jabotabek region. That is the physical zoning system perceived for the purpose of avoiding over investment in the unsuitable areas in respect to the physical features. Such a zoning system is shown on Fig. 2.10.

Zone I through V were delineated in the Jabotabek region taking into consideration topography, easiness of drainage/risk of flooding, availability of ground water and suitability of soils. Southern half of DKI Jakarta is delineated in Zone III, where physical conditions are most suitable for the development, whilst the northern half is in Zones I and II, in which urban development will be limited because of high cost of drainage facilities.

Fig. 2.11 shows outline of a regional structure plan of the whole Jabotabek region. Development centers shown are so projected as to accommodate the allocated population by providing with housing and working places. Detailed distribution of population to such development centers are shown in Table 2.7.

To ensure those distributive planning, a considerable number of implementation projects besides the higher level policy makings and strategies were envisaged. These projects and programs were prepared to give concrete conceptions and methodologies to approach targets set out in the Presidential Instruction. Among such measures, projects and programs concerning especially to Jakarta's development are listed in Appendix MII-1, and the Present Water Supply Master Plan study has taken them into consideration and incorporated whatever appropriate.

2) Jakarta Master Plan

DKI Jakarta is currently engaged in the preparation of its Strategic Developments Plan (SDP) or Jakarta Master Plan (1985-2005), both of which have a same basis on the Jabotabek Metropolitan Plan. These plannings take into account the key issues which influence the form of city structure including past development trends, land availability, sectoral requirements, committed programs and the need to integrate development policies. The SDP provides three alternative physical plans for DKI Jakarta's development, 1985 - 2005, which incorporate, respectively.

(1) Existing trends (across DKI boundaries)

(2) Strong containment of growth within DKI boundaries and controls against north-south development for environmental reasons.

(3) Guided development in an east-west direction, with controls to restrain urban development in the north and the south of the city.

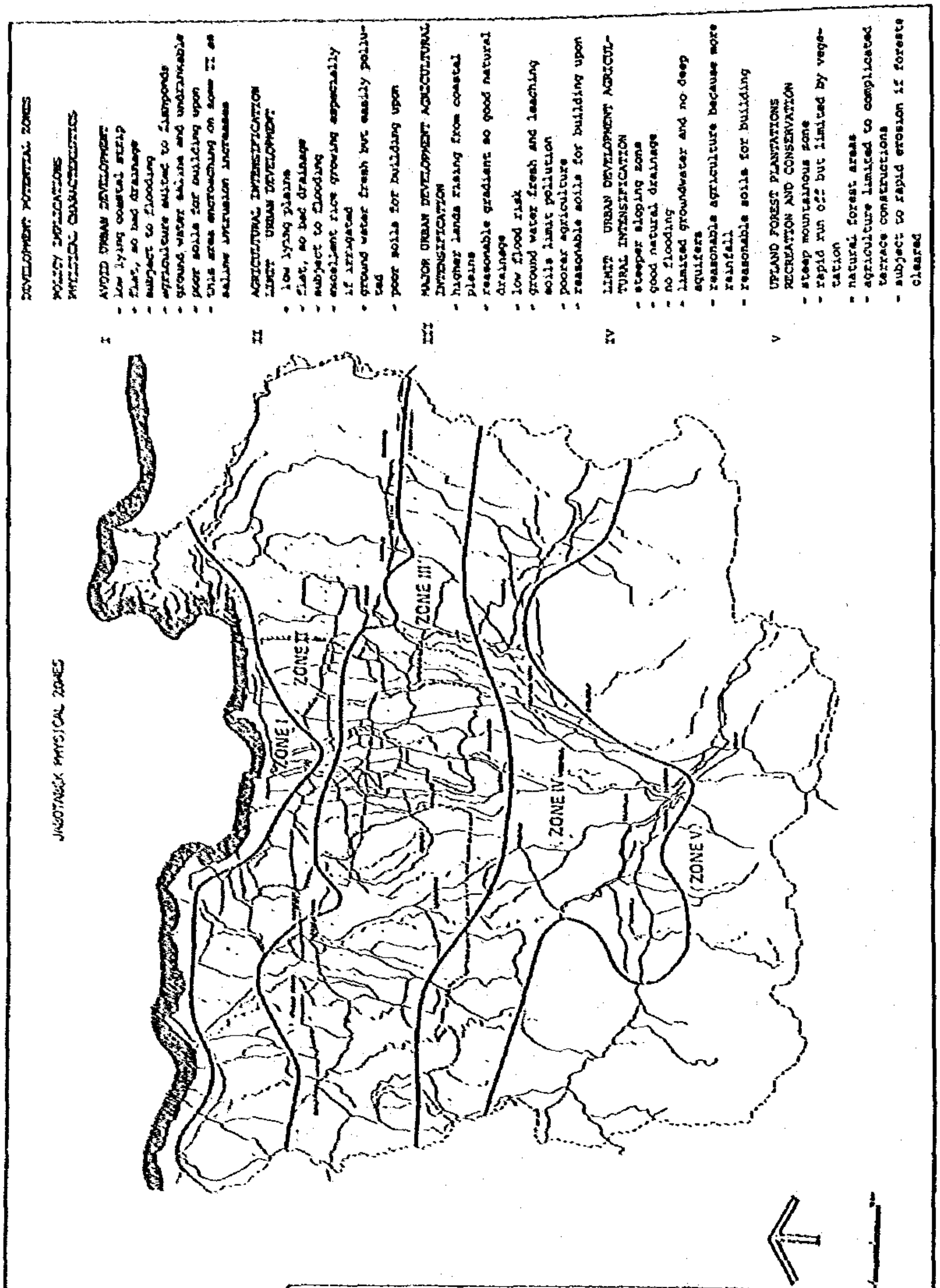

FIG 2.10 JABOTABEC PHYSICAL ZONES

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

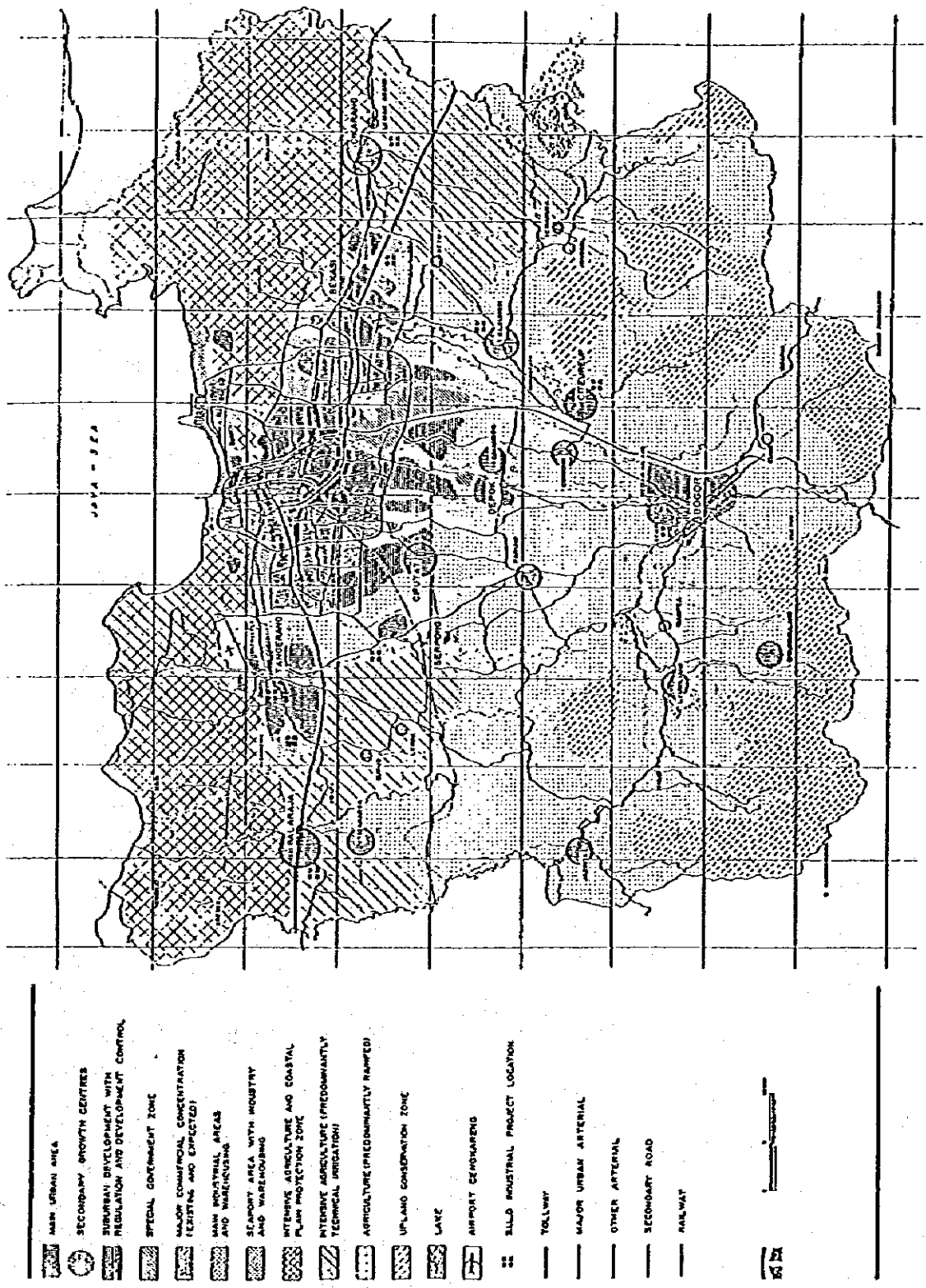

Fig 2.11 OUTLINE OF REGIONAL STRUCTURE PLAN

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

Table 2.7 POPULATION DISTRIBUTION IN THE JABOTABEK SETTLEMENT HIERARCHY, 2005

						Population (No.)
Capital City						
DKI Jakarta						12,000,000
Main Regional Sub-Centre						1,000,000
Bogor Raya						
. Kotamadya Bogor		400,000				
. Environs		600,000				
Main Sub-Centre						2,030,000
. Tangerang/Batuceper (including Cileduk)		850,000				
. Bekasi		350,000				
. Depok		400,000				
. Serpong		180,000				
. Cikarang		250,000				
Secondary Growth Centres						1,470,000
Kabupaten Bogor		Kabupaten Tangerang		Kabupaten Bekasi		
Cibinong (including Citeureup)	200,000	Balaraja	50,000	Pondok Gede	150,000	
Leuwiliang	95,000	Ciputat	150,000	Pondok Ranggon	100,000	
Parung	80,000	Tigaraksa	50,000	Tambun	100,000	
Jonggol	75,000	Pasar Kemis	50,000	Bantar Gebang	100,000	
Cileungsi	120,000	Cikupa	50,000			
Parung Panjang	60,000					
Jasinga	40,000					
Small Towns/Rural Centres						642,000
Kabupaten Bogor		Kabupaten Tangerang		Kabupaten Bekasi		
Semplak	32,000	Legok	25,000	Lembah Abang	35,000	
Ciawi	30,000	Curung	25,000	Setu	35,000	
Ciampea	25,000	Kronjo	20,000	Cibarusa	35,000	
Ciqudeg	25,000	Mauk	20,000	Tarumajaya	20,000	
Rumpin	25,000	Rajeg	20,000	Babelan	20,000	
Gunung Sindur	25,000	Sepatan	20,000	Serengseng	20,000	
Cisarua	25,000	Teluk Naga	20,000	Tambelang	20,000	
Ciasmara	20,000	Kosambi	20,000	Muara Gembong	20,000	
Cariu	20,000	Kresek	20,000	Cabang Bungin	20,000	
Village/Rural Population						6,508,000
Kabupaten Bogor		2,802,700				
Kabupaten Tangerang		1,970,500				
Kabupaten Bekasi		1,734,800				
TOTAL JABOTABEK						23,650,000

(Source: Jabotabek Advisory Team Services)

The SDP recommends alternative (3), recognizing the need to safeguard the south part of Jakarta for environmental reasons, where the aquifer recharge area is located. This has become recently evident since JMDP's physical zoning system was established.

These plans include various socio-economic parameters, which form the future structure of DKI Jakarta. Among such parameters, population, employment and income, and land use plans are significantly related to the present Water Supply Master Plan. These subjects are reviewed in other sections. The land structure plans for 1980 and the future year of 2005 are shown in Figs. 2.12 and 2.13.

2.2.3 Land Use Plan

Land use plan currently being formulated by the Jakarta Master Plan group is shown on Fig. 2.13 and picturized interrelations among 10 sectors as follows:

1) Housing and housing land (UB.GLD)
2) Transportation
3) Industry (SILD)
4) Trade and services
5) Flood control
6) Sewerage and solid waste
7) Water supply and water source
8) Public utilities (Electricity, Gas, Telephone)
9) Public facilities
10) Green open spaces

Among various JMDP studies, 3 programs are especially concerned to the development of DKI Jakarta. Urban Betterment (UB) Programme and Guided Land Development (GLD) Programme are concerned with the residential areas. Staged Industrial Land Development (SILD) Programme is also to be implemented in DKI Jakarta. GLD program seems most important and influential, because it provides a basic methodology for the development in the east-west direction.

Outlines of three programs are quoted as follows:

1) Guided Land Development Programme for Jakarta (GLD)

The objective of GLD program is to provide sufficient planned and serviced urban land in areas selected from the development strategy for city expansion and hence control land prices, order growth and assist in the establishment of low income settlements.

GLD is a government financed and implemented program intended to massively increase the supply of urban land and cater to the 70-80% of the population increase who cannot be accommodated by present programs (either government sponsored or private real estate development). It is planned to accommodate some 815,000 persons in Jakarta and 570,000 persons in urban centers of Botabek between 1981 and the end of Repelita IV (1989).

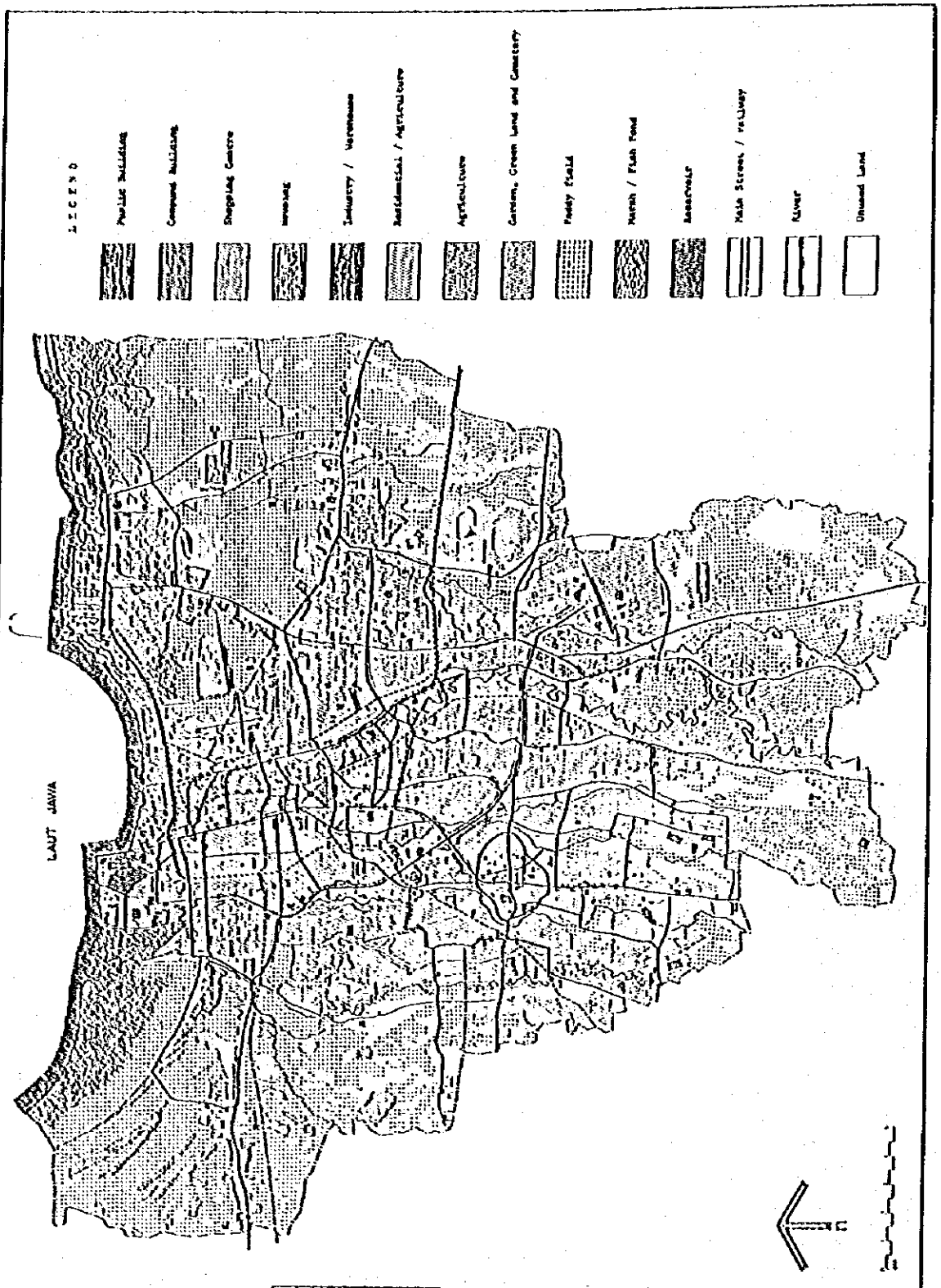

Fig 2.12 LAND USE IN 1980

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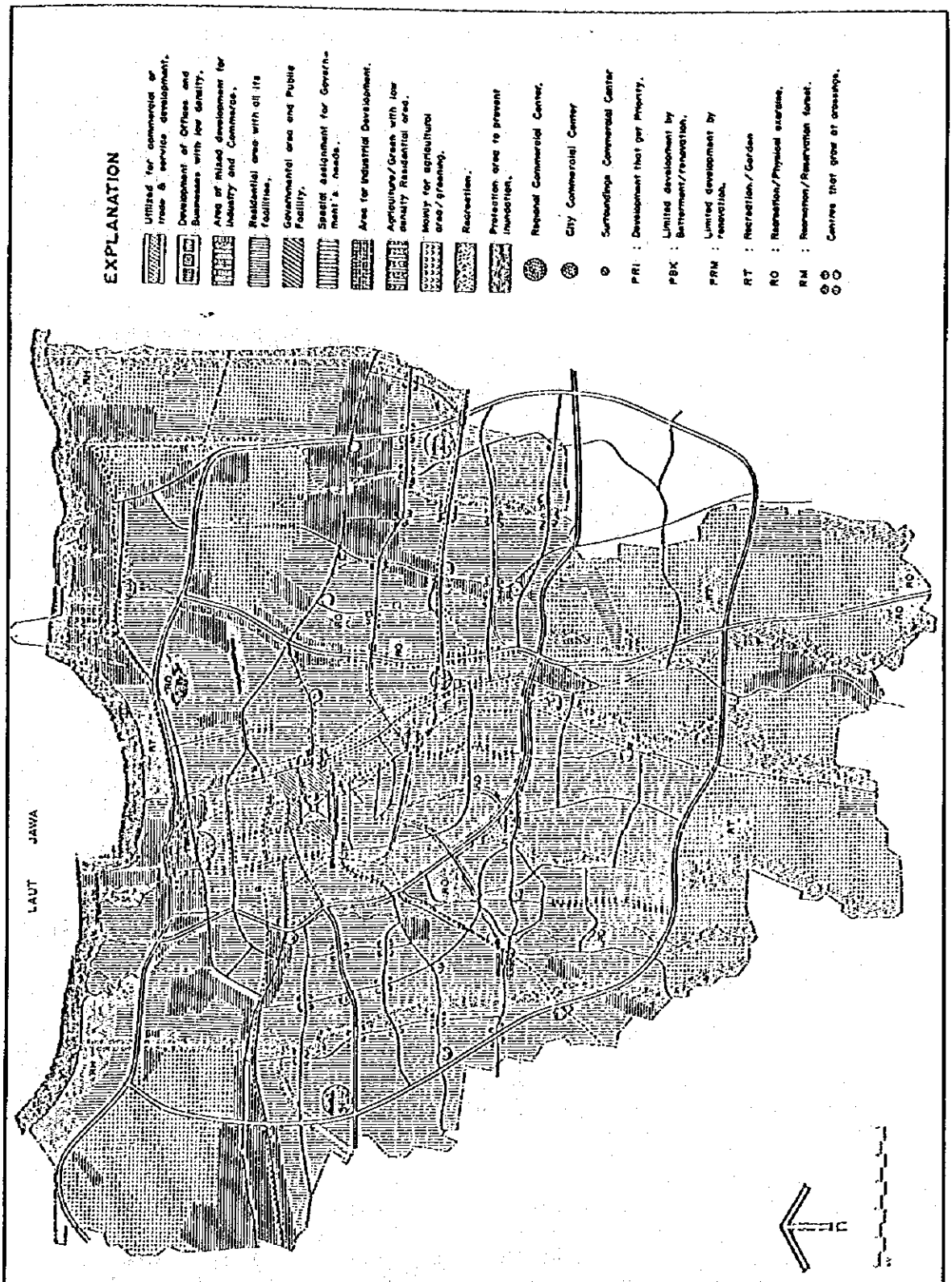


Fig 2.13 FUTURE STRUCTURE PLAN

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

It is not intended that government buy the land (except that needed for essential community facilities) nor construct housing. It would enable government to guide and regulate urban growth into preferred zones of development, at very low cost.

The program in Jakarta is aimed at increasing supply of low cost urban land to assist in accommodating 240,000 population increase per year, and to settle 815,000 population of all income groups between 1981 and 1989, and give particular assistance to those with household incomes less than Rp. 120,000 per month.

2) Urban Betterment Program for Jakarta (UB)

The objectives of UB program is to improve environmental services in existing urbanized areas at district on drainage basin level. This program is to be designed as a successor to the successful Kampung Improvement Project (KIP).

Urban Betterment is a government financed and implemented program that would initially be concentrated in the northern areas of Jakarta. Its purpose is to introduce a coordinated program of improvements to inter-Kampung infrastructure and socio-economic development over broader zones of the city than the individual Kampung. It would be an intermediate stage of improvement between that of the KIP program and a higher standard of environmental servicing which may be achieved by the end of this century.

The concept of the proposed UB program for northern Jakarta involves the simultaneous improvement of area wide urban infrastructure and service so as to make many of the local KIP improvements more effective and to coordinate such improvements that are interdependent, particularly health care, water supply, sanitation, drainage, solid water disposal and flood protection. At the same time, this would bring about reductions in the real costs of living presently experienced by low income households because of those inadequate services.

The program is to improve environmental conditions in Jakarta and reduce living costs for 3.9 million people in period 1981 through 1989.

3) Staged Industrial Land Development Programme (SILD)

The objective of SILD program is to encourage orderly development of industrial activities in preferred areas identified in the development strategy.

SILD is a government financed and implemented program of low cost industrial land development that would allow government to exert more positive pressure on industrialists to locate in specified areas throughout the region thereby allowing more coordination between industrial and urban growth, and to reduce the effects of extensive environmental pollution (particularly to the regions sensitive water cycle). It would be kept to minimum costs so as to be directly competitive with industrialists seeking unimproved land on the private market adjacent to national or provincial roadways, and thus ensure a high attraction rate.

The total Jabotabek program would provide 690 hectares of developed industrial land by the end of Repelita IV (1989) and would be planned to accommodate some 25,000 workers by that date.

2.2.4 Employment and Income

The 1980 census in DKI Jakarta included questions on employment and income. One of its outputs together with that of 1971 is presented in Table 2.8. A noticeable decrease in number of employees is recorded in the agriculture sector and in the trade and hotel industries, while the mining and manufacturing industries achieved very high growth. It is also noted if shares of sectorwise employments are compared with those of the gross domestic products (Table 2.4 and 2.6), a relative productivity per worker of each industry will be known.

Based on the above census data, Jakarta's Strategic Development Planning team prepared the future work place estimated as shown in Table 2.9. It is explained that the discrepancies in number of 1980 employments and work places are due to commuters from Botabek and difference in sampling. These numbers of projected work places were estimated based upon the sectorwise estimates of the future growth of the gross regional domestic product (GRDP).

For the income distribution in Jakarta, the 1980 census data are tabulated in Table 2.10. Income distribution forecast in 2005 is also shown in Table 2.11. This forecast was made on the assumptions that the average income earners behave in this manner, that is, except in such areas as a specific development project is to be executed, each earner's income will grow in proportion of GRDP per worker. In areas where the specific project is scheduled to be executed, economic impact of such project is evaluated and incorporated into the trend of income increase.

Table 2.8 EMPLOYED PERSONS BY INDUSTRY

	1971 Persons	Share (%)	1980 Persons	Share (%)	Average annual Growth rate (%)
Agriculture	42,945	3.4	25,082	1.6	- 5.80
Mining	4,248	0.3	10,891	0.7	11.03
Manufacturing	117,507	9.2	221,129	13.9	7.28
Electricity, Gas and Water	7,414	0.6	10,338	0.7	3.76
Construction	89,176	7.0	92,877	5.8	0.45
Trade and Hotel	315,122	24.8	306,304	19.2	- 0.31
Trasnportation & Communication	135,432	10.6	144,768	9.1	0.74
Banking and Finance	35,441	2.8	40,812	2.6	1.58
Services	452,311	35.5	543,714	34.1	2.07
Others	73,031	5.7	200,703	12.6	11.89
T o t a l	1,272,627	100	1,596,618	100	2.55

Source : Statistical Year Book of Jakarta, 1972 and 1981

Table 2.9 JAKARTA WORK PLACE ESTIMATES 1995 AND 2005

	1980	1995	Growth Rate 1980-95	2005	Growth Rate 1995 - 2005	Average Growth Rate 1980-2005
Agriculture	47,700	52,000	0.6 %	55,000	0.6 %	0.6
Industry	(248,500)	(496,200)	4.7	(646,600)	2.7	3.9
Large & Medium	151,000	262,500	3.8	316,400	1.9	3.0
Small	97,500	233,700	6.0	330,200	3.5	5.0
Government	258,300	402,400	3.0	546,600	3.1	3.0
Trade & Service	1,288,900	2,321,200	4.0	3,436,700	4.0	4.0
Total	1,843,400	3,271,800	3.9	4,684,900	3.7	3.8

Source : DKI Jakarta: Strategic Development Plan
Socioeconomic Parameters Base (Survey) and Forecast Data

Table 2.10 INCOME DISTRIBUTION IN 1980

Kotamadja/Kecamatan	Group I Rp. 0 - 25,000	Group II 25,000 - 50,000	Group III 50,000 - 75,000	Group IV 75,000 - 100,000	Group V 100,000-
I. JAKARTA PUSAT	34.8 %	37.7 %	13.3 %	6.6 %	7.6 %
I.1 Kec. Gambir	35.8	32.1	13.7	7.8	10.4
I.2 Sawah Besar	36.4	35.2	14.0	6.9	7.4
I.3 Kemayoran	34.3	41.2	14.0	5.9	4.4
I.4 Senen	31.1	38.7	14.8	7.7	7.5
I.5 Cempaka Putih	34.1	39.2	12.8	6.4	7.3
I.6 Menteng	35.3	32.8	12.0	7.0	12.8
I.7 Tanah Abang	35.7	39.7	12.0	5.8	6.7
II. JAKARTA UTARA	40.5	39.5	11.2	4.8	4.0
II.1 Kec. Pulau Seribu	-	-	-	-	-
II.2 Penjaringan	43.3	37.3	9.8	4.2	5.2
II.3 Tanjung Priok	35.3	42.7	13.0	5.5	3.4
II.4 Koja	40.9	38.7	11.4	5.0	3.8
II.5 Cilincing	41.7	40.0	10.7	4.5	3.0
III. JAKARTA BARAT	41.7	36.2	10.9	5.2	5.9
III.1 Kec. Cengkareng	51.4	36.1	6.9	2.7	2.8
III.2 Grogol Petamburan	38.6	34.4	12.5	6.7	7.7
III.3 Taman Sari	33.2	36.7	15.2	7.0	7.7
III.4 Tambora	42.3	38.1	10.5	4.7	4.2
III.5 Kebon Jeruk	41.7	37.0	9.7	4.5	7.0
IV. JAKARTA SELATAN	32.7	38.9	12.5	6.6	9.2
IV.1 Kec. Tebet	36.0	32.5	12.5	7.5	11.3
IV.2 Setia Budi	33.6	43.5	12.4	5.4	5.0
IV.3 Mampang Perapatan	34.8	40.0	11.7	5.8	7.5
IV.4 Pasar Minggu	35.3	40.0	12.4	6.5	5.6
IV.5 Kebayoran Baru	37.8	29.0	11.3	6.9	14.7
IV.6 Kebayoran Lama	29.9	41.7	12.8	6.6	8.8
IV.7 Cilandak	30.2	37.5	12.1	7.2	12.8
V. JAKARTA TIMUR	31.6	40.5	13.7	7.3	6.9
V.1 Kec. Matraman	27.7	40.8	15.9	8.0	7.4
V.2 Pulo Gadung	27.6	36.3	14.7	9.3	11.8
V.3 Jati Negara	31.0	39.9	14.6	7.4	6.9
V.4 Kramat Jati	29.8	41.4	14.1	8.1	6.4
V.5 Pasar Rebo	37.8	40.8	11.3	6.1	3.8
V.6 Cakung	39.5	46.6	8.7	2.6	2.4
DKI JAKARTA	35.8	38.6	12.4	6.2	7.0

Note : Income range relates to the monthly income per employed person, although it is assumed that a household has 1.5 employed persons.

Source : Basic data taken from 1980 DKI Census, and modified by Jabotabek Advisory Team Service (JATS)

Table 2.11 FORECAST INCOME DISTIBUTION IN 2005

	Kotamadya/Kecamatan	Group I Rp. 0 - 25,000	Group II 25,000 - 50,000	Group III 50,000 -75,000	Group IV 75,000 - 100,000	Group V 100,000-
I.	JAKARTA PUSAT	11.9 %	22.9 %	17.8 %	11.2 %	36.2 %
I.1	Kec. Gambir	10.7	17.6	16.2	11.6	43.9
I.2	Sawah Besar	12.4	21.5	18.7	11.5	35.9
I.3	Kemayoran	13.4	28.2	21.4	11.6	25.4
I.4	Senen	10.1	21.9	18.8	12.7	36.5
I.5	Cepaka Putih	12.1	24.2	17.2	10.7	35.8
I.6	Menteng	9.8	15.0	13.1	9.9	52.2
I.7	Tanah Abang	12.8	25.2	17.0	10.4	34.6
II.	JAKARTA UTARA	19.5	30.6	18.0	9.6	22.3
II.1	Kec. Pulau Seribu					
II.2	Penjaringan	22.8	26.8	14.9	8.1	27.4
II.3	Tanjung Priok	15.0	33.8	21.1	11.2	18.9
II.4	Koja	17.5	30.7	18.7	10.0	23.1
II.5	Cilincing	21.8	32.9	18.1	9.6	17.6
III.	JAKARTA BAPAT	19.0	26.2	14.6	9.0	31.2
III.1	Kec. Cengkareng	26.5	34.0	12.9	6.6	20.0
III.2	Grogol Petamburan	12.9	20.4	16.8	11.5	38.4
III.3	Taman Saru	10.7	21.0	19.5	11.7	37.1
III.4	Tambora	18.5	28.9	17.3	9.8	25.5
III.5	Kebon Jeruk	20.0	25.6	12.8	8.1	33.5
IV.	JAKARTA SELATAN	10.9	21.8	15.4	10.6	41.3
IV.1	Kec. Tebet	10.5	17.2	14.6	11.0	46.7
IV.2	Setia Budi	13.3	30.5	18.7	10.1	27.4
IV.3	Mampang Prapatan	11.9	23.1	14.7	9.7	40.6
IV.4	Pasar Minggu	12.9	25.7	18.1	12.2	31.1
IV.5	Kebayoran Baru	10.1	14.3	12.0	9.3	54.3
IV.6	Kebayoran Lama	9.1	21.3	15.6	10.9	43.1
IV.7	Cilandak	8.3	18.0	12.7	9.9	51.1
V.	JAKARTA TIMUR	14.2	27.4	16.8	10.9	30.7
V.1	Kec. Matraman	8.7	22.7	19.9	12.9	35.8
V.2	Pulo Gadung	7.2	16.7	15.4	12.7	48.0
V.3	Jati Negara	10.2	24.6	18.1	11.9	35.2
V.4	Kramat Jati	10.2	24.1	18.2	13.1	34.4
V.5	Pasar Rebo	23.0	30.4	15.9	10.2	20.5
V.6	Cakung	20.7	39.8	14.6	6.6	18.3
DKI	JAKARTA	14.8	25.6	16.2	10.3	33.1

Note : Income range relates to the monthly income at 1980 constant price per employed person, although it is assumed that a household has 1.5 employed persons.

Source : JATS; DKI Jakarta Strategic Development Plan, Socioeconomic Parameters Base (Survey) and Forecast Data.

2.2.5 Sanitary Condition and Incidence of Fire

As a parameter of the sanitary conditions within DKI Jakarta, the number of cases of the selected diseases (mainly water-born disease) is presented in Table 2.12. General trend of declining number of occurrences is observed. However, growths are seen in Malaria, Typhoid fever, TBC and others.

It should be noted that figures are of those reported only. Actual numbers are told to be several times of these figures.

Incidences of fire in 1980 and 1975 - 1980 are tabulated in Tables 2.13 and 2.14 respectively.

Table 2.12 Incidence and Number of Death for Selected Diseases Jakarta, 1975 - 1980

	1975 Case(Death)	1976 Case(Death)	1977 Case(Death)	1978 Case(Death)	1979 Case(Death)	1980 Case(Death)
Malaria	63	266	392	147	288	514
Gastro enteritis	1,784(118)	1,378(267)	13,168(137)	11,863(94)	17,023(105)	10,799(73)
Cholera	314(13)	441(8)	521	685	1,048(2)	423
Kusta	1,667(6)	1,663	1,739	1,864	1,995	2,084
TBC	409	2,600	2,201	2,247	2,887	3,971
DHF	409(63)	637(64)	806(72)	836(65)	790(49)	818(21)
Typhoid fever	192(11)	616(14)	1,276(66)	2,311(64)	2,976(94)	2,205
Diphtheria	137(21)	169(17)	148(12)	151(17)	490(124)	498(33)
Measles			15(1)	31(2)	20(2)	169(31)
Rabies	248	126	326	322	483	702

Source: Public Health Service, Jakarta

Table 2.13 INCIDENCE OF FIRE, JAKARTA, 1980

	Fire Outbreak from		Burned		Dislocated		Victims		Estimated Losses
	Houses	Others	Houses	Others	Households	Persons	Dead	Wounded	(000 Rp.)
Jan.	11	13	4	21	9	27	-	1	360,465,000
Feb.	8	13	9	17	10	51	-	1	14,326,000
Mar.	18	26	322	37	449	1,863	1	24	560,299,000
Apr.	21	30	303	48	343	2,062	2	2	163,495,000
May.	12	21	12	31	13	56	3	7	54,028,500
June	25	48	533	70	649	4,418	3	51	2,717,903,500
July	23	37	59	55	164	520	-	1	264,194,500
Aug.	31	36	254	64	463	1,783	3	25	438,047,000
Sept.	21	45	21	59	119	554	-	7	661,440,000
Oct.	19	49	38	58	51	221	2	15	78,562,000
Nov.	7	35	-	17	4	12	-	2	202,120,000
Dec.	12	22	11	31	23	132	-	2	538,066,000
Total	209	375	1,671	503	2,297	11,599	14	138	6,253,046,500

Source : Statistical Yearbook of Jakarta, 1981

Table 2.14 INCIDENCE OF FIRE, JAKARTA, 1973 - 1980

	Fire Outbreak from		Burned		Dislocated		Victims		Estimated losses
	Houses	Other Structures	House	Others	Households	Persons	Dead	Wounded	(000 Rp.)
1973	91	174	325	-	584	2,537	6	42	387,503
1974	104	252	576	-	1,571	8,748	13	42	11,580,050
1975	115	259	1,059	-	2,022	7,125	6	40	1,046,924
1976	150	203	445	-	1,084	5,576	5	37	1,158,610
1977	181	401	1,051	623	1,779	9,578	23	89	1,537,611
1978	138	286	663	945	1,253	5,733	29	61	2,028,331,500
1979	181	350	570	747	1,177	5,197	5	65	8,190,115,000
1980	209	375	1,671	503	2,297	11,699	14	139	6,253,046,500

Source : Statistical Yearbook of Jakarta, 1981

2.3 Demographic Aspects

2.3.1 General

For the Water Supply Master Plan up to year 2005, a demographic consideration is given in regard to the present population with its distribution in the study area, and to the future population growth. The projection of the latter will, more or less, be affected by future development plans currently envisaged by DKI Jakarta. The basic one of those will be the Jakarta Master Plan (or Jakarta Strategic Development Plan), detailed programming of which is currently being prepared by those selected among DKI Jakarta offices. The present population study will hence take up necessary results of their planning and modify them in a format required for the water supply planning.

2.3.2 Population Projection

1) Past Population Growth

In 1961, 1971 and 1980, DKI Jakarta conducted detailed census in the city, and their results with intercensal estimates are shown in Table 2.15, where nearly four times growth is seen from 1951 population through 1981. It is, however, apparently observed that the average annual growth rate was declining like in the following summary:

Year	Population ('000)	Growth Rate
1951	1,661	
		5.76 %
1961	2,907	
		4.64 %
1971	4,576	
		3.98 %
1980	6,503	

2) Population Projection in the Jabotabek Metropolitan Development Plan and Jakarta Master Plan

The Jabotabek Metropolitan Development Planning Team has conducted a number of studies on the enlarged Metropolitan Jakarta including Kabupatens Bogor, Tangerang and Bekasi for the purpose of alleviating burden of population concentration into Jakarta and distributing it to adjoining Botabek in a manner reasonably programmed for an equitable regional development.

Besides studies on development strategies, policy makings and implementation projects proposed, they have developed in several occasions population projections for Jabotabek areas. They developed natural increase of population in Java Island, Jakarta and Botabek taking into account fertility and mortality rates mainly based on the census data, which might be influenced with family planning, malnutrition and other factors.

Table 2.15 Population Growth in Jakarta

Year	Persons X1,000	Growth Rate	Year	Persons X1,000	Growth Rate
1951*	1,661		1966	3,639	5.10
1952	1,782	7.26	1967	3,807	4.60
1953	1,796	0.79	1968	3,982	4.59
1954	1,824	1.56	1969	4,274	7.34
1955	1,885	3.33	1970	4,437	3.82
1956	1,890	0.26	1971*	4,576	3.13
1957	1,946	2.98	1972	4,755	3.92
1958	2,026	4.12	1973	4,973	4.58
1959	2,812	38.79	1974	5,183	4.21
1960	2,911	8.52	1975	5,404	4.27
1961*	2,907	-0.15	1976	5,701	5.51
1962	3,022	3.98	1977	5,925	3.93
1963	3,154	4.38	1978	6,082	2.64
1964	3,302	4.67	1979	6,239	2.59
1965	3,463	4.88	1980*	6,503	4.23
			1981	6,556	0.81

Source : Statistical Year Book of Jakarta 1982.
* : Census year data

Table 2.16 Projected Population in DKI Jakarta

	Population (in million persons)	Average growth rate per annum (%)
1961	2.90	
1971	4.50	4.49
1980	6.50	4.17
1985	7.63	3.26
1990	8.87	3.06
1995	9.95	2.32
2000	11.00	2.03
2005	12.00	1.76

Source: DKI Jakarta Master Plan

The estimates of out-and in-migration trends were also made in conjunction with the evaluation of economic potential of each province, resulting in the degree of concentration into Jakarta and urban Botabek.

Population projections thus developed were adjusted at each step of alternative choices in formulating strategies for JMDP, where the distributive and equitable development throughout the region was the guidepost.

For the Jabotabek Region, three forecasts of population were made in 1980 (JMDP Technical Report No. 15). These outputs are referred as follows:

(1) an existing trend forecast, which shows an increasing concentration in Greater Jakarta and results in a total population of 26 million by 2003;

(2) a modestly distributive forecast, which shows modest deconcentration to other centers, and a decline in the rate of growth of Greater Jakarta although an increase in the absolute level of in-migration ... and results in a population of 24,460,000 by 2003; and

(3) a vigorously distributive forecast, which shows vigorous deconcentration to other centers, holds in-migration constant and results in a population of 20,790,000 by 2003

The population of 24,460,000 was adopted with a constant level of in-migration and adjusted in the later stage for the preparation of implementation of JMDP. To achieve "modest deconcentration to other centers", "the Jabotabek Settlement Hierarchy" was established as a target of various programs.

Subsequently DKI Jakarta has been preparing its Strategic Development Plan (SDP) to pursue targets proposed in the JMDP. This work is currently being compiled in the form of the Jakarta Master Plan (1985 - 2005). The Master Plan Team in collaboration with the Jabotabek Advisory Team Services developed a population projection toward 2005. Draft DKI Jakarta Master Plan provides the population forecasts toward 2005 as shown in Table 2.16.

2.3.3 Population Distribution

DKI Jakarta divides its administrative territory into five districts i.e. Jakarta Pusat (Central), Jakarta Utara (North), Jakarta Barat (West), Jakarta Selatan (South) and Jakarta Timur (East). They are further subdivided into 30 Kecamatan (subdistricts), one of which is Pulau Seribu islands scattered north in the Java Sea and excluded from the present study area.

Outputs of census at district and subdistrict level in 1971 and 1980 are shown in Table 2.17 in respect to the population and density in 1971, and also area in 1980.

Table 2.17 POPULATION FORECASTS BY KECAMATAN 1995 AND 2005

Kotamadya/Kecamatan	Area (ha) in 1980	1971 Population	1971 Density	1980 Population	1980 Density	Average Growth Rate 1971 - 1980	1995 Population	1995 Density	Average Growth Rate 1980 - 1995	2005 Population	2005 Density	Average Growth Rate 1995 - 2005
I. JAKARTA PUSAT	4,852.8	1,275,436	217	1,236,877	255	-0.34	1,350,494	278	0.6	1,408,542	290	0.4
I.1 Kec. Gambir	757.6	170,091	198	144,802	191	-1.77	156,460	207	0.5	162,712	215	0.4
I.2 Sawah Besar	585.2	166,747	158	156,871	269	-0.68	179,884	308	0.9	187,570	322	0.4
I.3 Kemayoran	704.0	192,899	217	229,962	327	1.97	250,538	356	0.6	260,370	370	0.4
I.4 Senen	461.0	163,244	427	135,306	294	-2.06	141,080	306	0.2	144,250	313	0.2
I.5 Cempaka Putih	717.6	191,000	205	215,429	300	1.35	231,760	323	0.5	239,760	334	0.3
I.6 Mantang	613.6	137,626	174	115,503	188	-1.93	129,288	211	0.8	139,520	228	0.8
I.7 Tanah Abang	1,014.8	253,809	263	239,004	235	-0.67	261,482	257	0.6	272,960	269	0.5
II. JAKARTA UTARA	13,208.0	608,347 (416,777)	63	960,915 (976,045)	74	5.23	1,427,289	108	2.7	1,695,958	128	1.7
II.1 Kec. Pulau Seribu	excluded	(8,430)		(12,130)		-						
II.2 Penjaringan	4,323.4	197,090	84	305,133	70	4.98	439,623	102	2.5	531,493	123	1.9
II.3 Tanjung Priok	2,423.0	149,776	65	233,260	96	5.05	357,240	147	2.9	409,675	169	1.4
II.4 Koja	2,203.6	261,481	52	273,865	124	0.52	352,266	160	1.7	393,642	179	1.1
II.5 Cilincing	4,258.0	-	-	151,657	36	-	278,160	65	4.1	361,148	85	2.6
III. JAKARTA BARAT	13,196.8	828,179	62	1,231,188	93	4.50	1,980,387	150	3.2	2,618,538	198	2.8
III.1 Kec. Cengkareng	6,058.0	93,458	14	237,711	39	10.93	393,808	65	3.4	514,948	85	2.7
III.2 Grogol Petamburan	1,763.0	266,609	154	401,544	228	4.66	518,925	294	1.7	577,125	327	1.1
III.3 Taman Sari	430.0	158,057	391	150,102	349	-0.57	157,531	366	0.3	161,996	376	0.3
III.4 Tambora	570.2	238,480	327	270,485	474	1.41	276,047	484	0.1	279,149	489	0.1
III.5 Kebon Jeruk	4,375.6	71,575	17	171,346	39	10.19	634,076	145	9.1	1,085,320	248	5.5
IV. JAKARTA SELATAN	14,640.8	1,051,843	79	1,579,795	108	4.62	2,684,976	183	3.6	3,141,794	215	1.6
IV.1 Kec. Tebet	958.0	209,795	224	257,306	268	2.29	315,342	329	1.4	345,600	361	0.9
IV.2 Setia Budi	792.4	240,671	255	231,071	291	-0.45	273,044	344	1.1	288,020	363	0.5
IV.3 Mampang Prapatan	1,860.4	125,817	68	231,436	124	7.01	446,216	240	4.5	541,860	291	2.0
IV.4 Pasar Minggu	4,803.6	112,817	27	227,967	47	8.13	489,192	102	5.2	579,474	121	1.7
IV.5 Kebayoran Baru	1,258.4	178,343	128	201,700	160	1.38	272,982	217	2.0	305,580	243	1.1
IV.6 Kebayoran Lama	3,169.6	184,400	45	314,047	99	6.09	643,270	203	4.9	795,190	251	2.1
IV.7 Cilandenk	1,798.4	-	-	116,259	65	-	244,930	136	5.1	286,070	159	1.6
V. JAKARTA TIMUR	28,549.4	794,861	32	1,456,750	79	6.96	2,506,509	135	3.7	3,134,059	169	2.3
V.1 Kec. Matraman	480.0	165,988	318	180,070	375	0.91	198,610	414	0.7	204,050	425	0.3
V.2 Pulo Gadung	1,477.0	181,897	62	255,741	173	3.86	351,532	238	2.1	382,970	259	0.9
V.3 Jati Negara	3,188.0	230,505	71	404,111	127	6.44	711,600	223	3.8	881,200	276	2.3
V.4 Kramat Jati	3,419.0	129,908	39	269,364	79	8.44	406,047	119	2.8	466,774	137	1.4
V.5 Pasar Rebo	6,175.2	86,563	16	200,385	32	9.78	462,370	75	5.7	619,754	100	3.0
V.6 Cakung	3,810.2	-	-	147,079	39	-	376,350	99	6.5	579,311	152	4.4
DKI JAKARTA	64,446.2	4,558,666	79	6,468,525	100	3.96	9,949,655	154	2.9	11,998,891	186	1.9

Source : 1971 population taken from Statistic Year Book of Jakarta, 1972.
1980 population taken from Data Pokok Penduduk DKI Jakarta.
1995 and 2005 population projection taken from Jabotabek Advisory Team Service (JATS), Socioeconomic Parameters Base (Survey) and Forecast Data.
Some figures were adjusted for the present study.

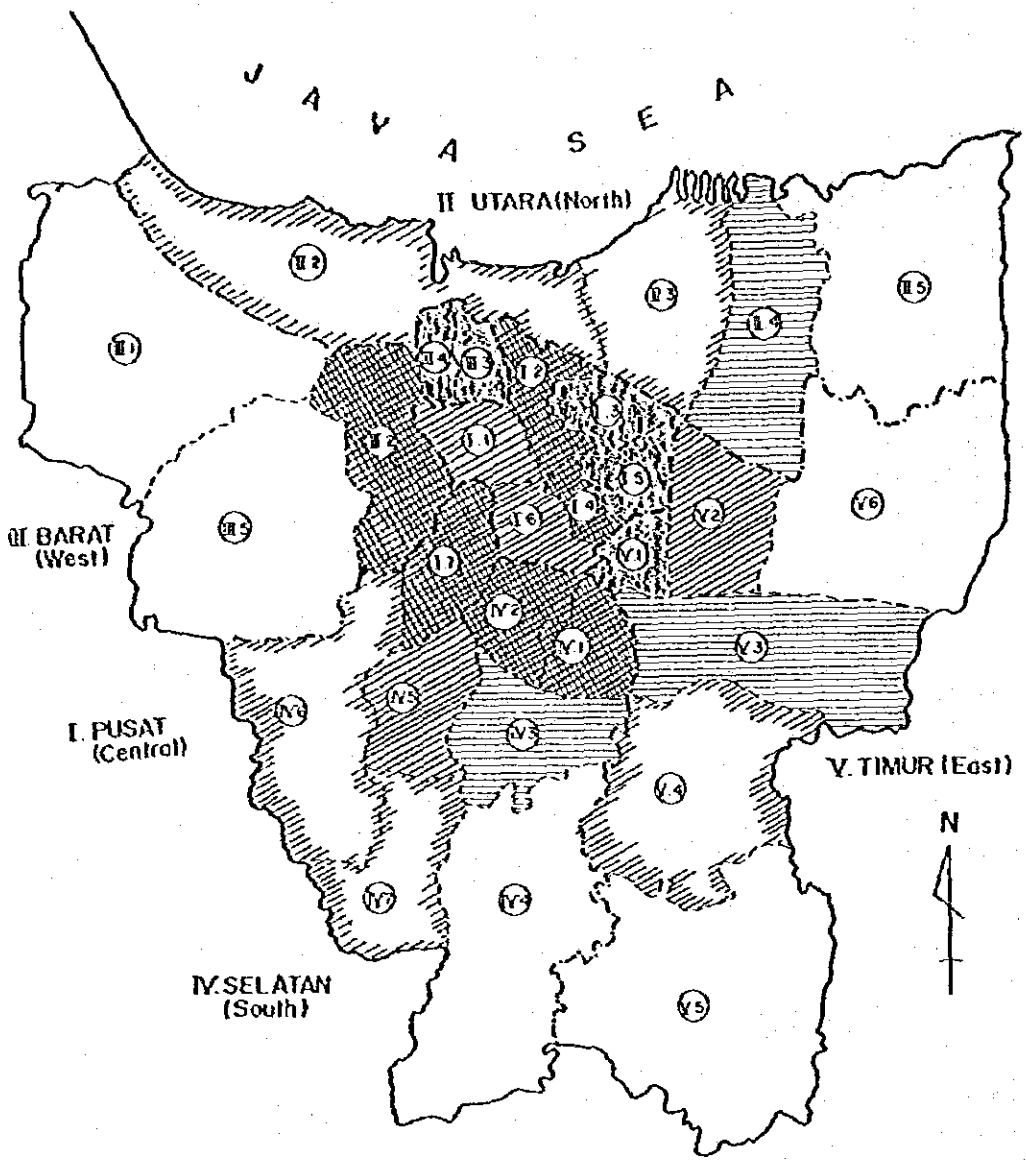
In this simple comparison it is observed that populations were decreasing in most of Central District and some other subdistricts which were, at least in 1980, populated with the densities of some 200 persons per hectare or more. Outstanding decrease seen in subdistricts Gambir and Menteng are attributed to the increase of social use of land. In gross observation, Central District which has the densest population of 255 persons per hectare seems to afford no ample space to support a rapid growth in population. North, West and East Districts, in contrast, with densities less than DKI Jakarta average of 100 persons per hectare, have experienced a quick growth and seem to provide with enough spaces for the future developments. Population density in 1980 at subdistrict level is shown on Fig. 2.14.

As stated earlier, Table 2.17 includes population forecasts by Kecamatan in 1995 and 2005. It is observed that average annual growth rates in the Central District are smaller than 1.0%. Between 1980 and 2005 annual growth rates for the North, West, South and East Districts average 2.3, 3.06, 2.8 and 3.11% respectively. This reflects the basic policy of Jakarta Master Plan to guide developments toward the east-west direction with restriction of urban developments in the north and south. This is seen in Figs. 2.15 and 2.16.

In looking at the population densities in 2005, Subdistricts of Tambora and Matraman accommodate more than 400 persons per hectare, and ten subdistricts out of 29 are of more than 300 persons per hectare. The average density over the whole Jakarta is 186 persons per hectare. This is rather a high population density over a capital city of 64,000 hectares in area. For reference, Tokyo has a population density of 243 persons per hectare in 1980 within its special districts area extending only in 34,364 hectares, where the multi-storeyed apartment houses are prevalent.

For the use of this water supply study, projection at 5 year intervals on subdistrict basis were undertaken. As illustrated in Fig. 2.17, population densities of 5 districts of JATS' sampled years of 1971, 1980, 1995 and 2005 (see Table 2.17) were plotted and the densities at other years were curvilineally projected. Population densities thus projected for 5 districts were broken down proportionately into subdistricts. Table 2.18 shows populations in subdistricts at 5 year intervals projected for this study.

However this is only a micro-scaled reproduction of JATS' population forecast. In case growth trend traces other, maybe, high rates, projections must be reviewed and amended as necessary.



POPULATION DENSITY (1980)

(PERSONS/ha)

	MORE	THAN	300
	200	—	299
	150	—	199
	100	—	149
	50	—	99
	LESS	THAN	49

Fig 2.14 POPULATION DENSITY (1980)

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

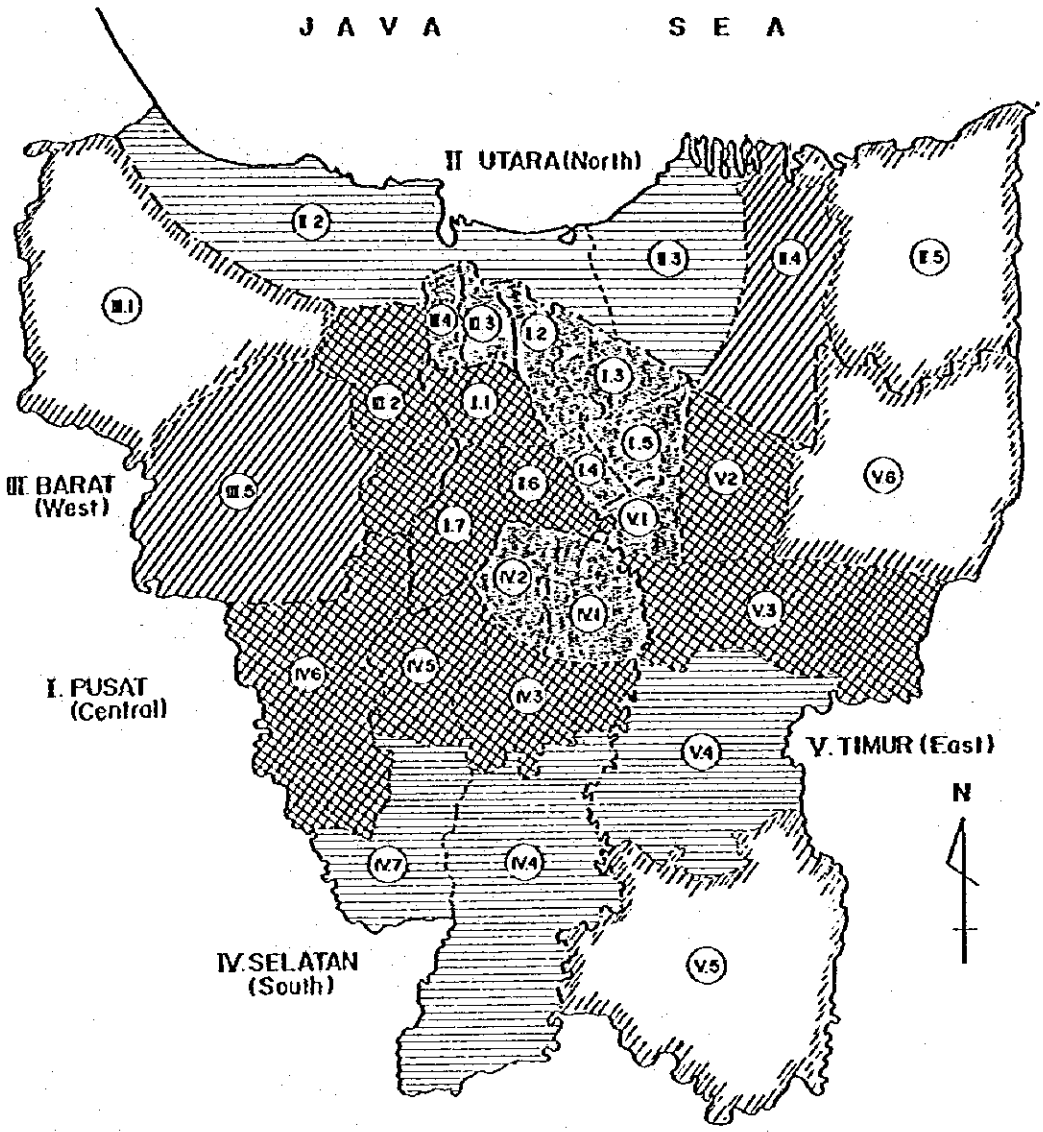
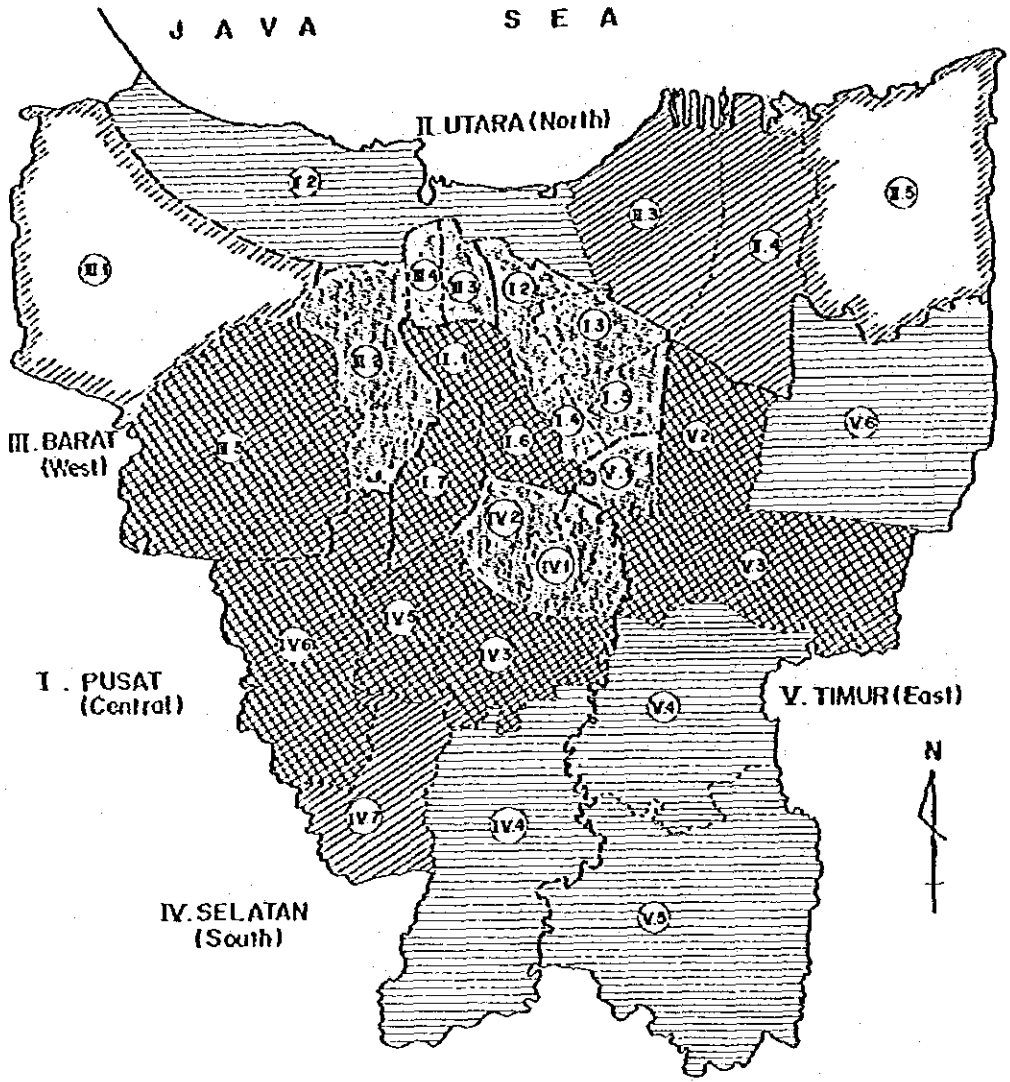


Fig 2.15 POPULATION DENSITY (1995)

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA



POPULATION DENSITY (2005)

(PERSONS/ha)

MORE	THAN	300	
200	——	299	
150	——	199	
100	——	149	
50	——	99	
LESS	THAN	49	

Fig 2.16 POPULATION DENSITY (2005)

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

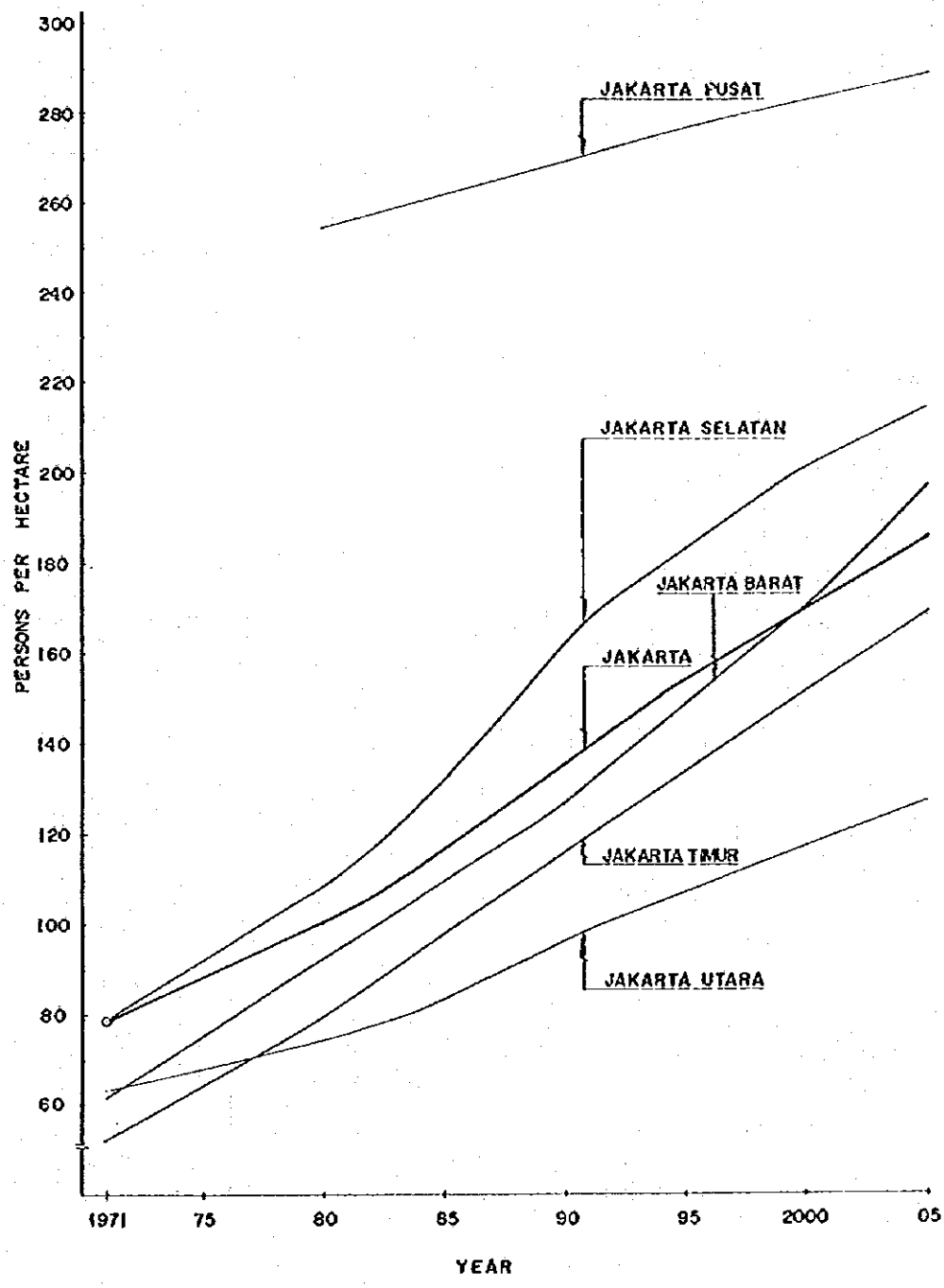


Fig 2.17 POPULATION DENSITY BY DISTRICT

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

Table 2.18 FORECAST POPULATION DISTRIBUTION 1980 - 2005

Kotamadya / Kecamatan	Area (ha) in 1980	1980 Population	1980 Density	1985 Population	1985 Density	1990 Population	1990 Density	1995 Population	1995 Density	2000 Population	2000 Density	2005 Population	2005 Density
I. JAKARTA PUSAT	4,853.8	1,236,877	255	1,274,749	263	1,312,622	270	1,350,494	278	1,379,518	284	1,408,542	290
I.1 Kec. Gambir	757.6	144,802	191	148,687	196	152,572	201	156,460	207	159,586	211	162,712	215
I.2 Sawah Besar	580.2	156,871	269	164,543	282	172,214	295	179,886	308	183,728	315	187,570	322
I.3 Kemayoran	704.0	229,962	327	236,821	336	243,680	346	250,538	356	255,454	363	260,370	370
I.4 Senen	461.0	135,306	294	137,230	298	139,155	302	141,080	306	142,665	309	144,250	313
I.5 Cempaka Putih	717.6	215,429	300	220,873	308	226,318	315	231,760	323	235,760	329	239,760	334
I.6 Menteng	613.6	115,503	188	120,098	196	124,693	203	129,288	211	134,604	219	139,920	228
I.7 Tanah Abang	1,016.8	239,004	235	246,497	242	253,990	250	261,482	257	267,721	263	273,960	269
II. JAKARTA UTARA	13,208.0	963,915 (976,045)	74	1,096,264	83	1,294,384	98	1,427,289	108	1,558,544	118	1,695,958	128
II.1 Kec. Pulau Seribu	excluded	(12,130)											
II.2 Penjaringan	4,323.4	305,133	70	343,543	79	401,041	93	439,623	102	484,512	112	531,493	123
II.3 Tanjung Priok	2,423.0	233,260	96	268,669	111	321,683	133	357,240	147	382,854	158	409,675	169
II.4 Koja	2,203.6	273,865	124	296,256	134	329,701	150	352,266	160	372,478	169	393,642	179
II.5 Cilincing	4,258.0	151,657	36	187,796	44	241,879	57	278,160	65	318,700	75	361,148	85
III. JAKARTA BARAT	13,196.8	1,231,188	93	1,464,845	111	1,675,994	127	1,980,387	150	2,256,653	171	2,618,538	198
III.1 Kec. Cengkareng	6,058.0	237,711	39	286,398	47	330,387	55	393,808	65	446,250	74	514,948	85
III.2 Grogol petamburan	1,763.0	401,544	228	438,155	249	471,238	267	518,925	294	544,120	309	577,125	327
III.3 Taman Sari	430.0	150,102	349	152,458	355	154,533	359	157,531	366	159,291	371	161,596	376
III.4 Tambora	570.2	270,485	474	272,163	477	273,787	480	276,047	484	277,390	486	279,149	489
III.5 Kebon Jeruk	4,375.6	171,346	39	315,671	72	446,069	102	634,076	145	829,602	190	1,085,720	248
IV. JAKARTA SELATAN	14,640.8	1,579,795	108	1,976,508	135	2,401,091	164	2,684,976	183	2,972,084	203	3,141,794	215
IV.1 Kec. Tebet	958.0	257,306	268	278,139	290	300,433	314	315,342	329	334,359	349	345,600	361
IV.2 Setia Budi	792.4	231,071	291	246,138	311	262,261	331	273,044	344	282,456	356	288,020	363
IV.3 Mampang Perapatan	1,860.4	231,436	124	308,533	165	391,039	210	446,236	240	506,328	272	541,860	291
IV.4 Pasar Minggu	4,803.6	227,967	47	321,736	67	422,101	88	489,192	102	545,934	114	579,474	121
IV.5 Kebayoran Baru	1,258.4	201,700	160	227,287	181	254,670	202	272,982	217	293,470	233	305,580	243
IV.6 Kebayoran Lama	3,169.6	314,047	99	432,228	136	558,713	176	643,270	203	738,751	233	795,190	251
IV.7 Cilandak	1,798.4	116,259	65	162,447	90	211,874	118	244,930	136	270,786	151	286,070	159
V. JAKARTA TIMUR	18,549.4	1,456,750	79	1,817,802	98	2,188,829	118	2,506,509	135	2,838,058	153	3,134,059	169
V.1 Kec. Matraman	480.0	180,070	375	186,486	389	192,976	402	198,610	414	201,484	420	204,050	425
V.2 Pulo Gadung	1,477.0	255,741	173	288,684	195	322,546	218	351,532	238	368,141	249	382,970	259
V.3 Jati Negara	3,188.0	404,111	127	509,856	160	618,554	194	711,600	223	801,214	251	881,200	276
V.4 Kramat Jati	3,419.0	269,364	79	316,369	93	364,687	107	406,047	119	438,129	128	466,774	137
V.5 Pasar Rebo	6,175.2	200,385	32	290,482	47	383,093	62	462,370	75	545,516	88	619,754	100
V.6 Cakung	3,810.2	147,079	39	225,925	59	306,973	81	376,350	99	483,574	127	579,311	152
DKI JAKARTA	64,446.2	6,468,525	100	7,630,168	118	8,872,920	138	9,949,655	154	11,004,857	171	11,998,891	186

2.3.4 Potential High Growth Rates

As previously stated this study uses the population estimates formulated by the Jakarta Master Plan studies which are in accord with those of the JMDP studies.

However, it is noted that the population estimates are based on annual growth rates declining from an average of 4.17% between 1971 and 1980 to 1.76% between 2000 and 2005. It is felt that this large reduction is optimistic for a 25 year period. It, also, is noted that one of the JMDP studies states "if JMDP's Distributive Development Strategy is not implemented then it is possible that DKI Jakarta's population level would reach some 18 million persons by the year 2005 (Jabotabek Advisory Team Services, Report J/2, March 1983)." The estimate of a population of 18.5 million by 2005 was made by the JMDP studies based on existing trends. The level of 12 million persons in 2005 is, therefore, assumed based on implementation of various programs and projects proposed under the JMDP and also under the Jakarta Master Plan. It is anticipated that if some of those programs under JMDP or City Master Plan are not implemented or delayed then this target population would be realized several years before 2005.

The present study assumes two alternative cases of declining the average annual growth rates, high growth rates 1 and high growth rates 2. In the high growth rate 1, it is simply assumed that the ultimate average annual growth rate between 2000 and 2005 would be 2.5% instead of 1.76% with the rate declining linearly from 4.17% between 1971 and 1980. In the high growth rates 2, it is assumed that the declining trend of average annual growth rates from 4.49% in the 1961 - 1971 period to 4.17% in the 1971 - 1980 period would continue at this rate of reduction until 2005. These two alternatives are presented in Fig. 2.18 and Table 2.19 respectively.

Fig. 2.18 Average Annual Growth Rates Alternatives

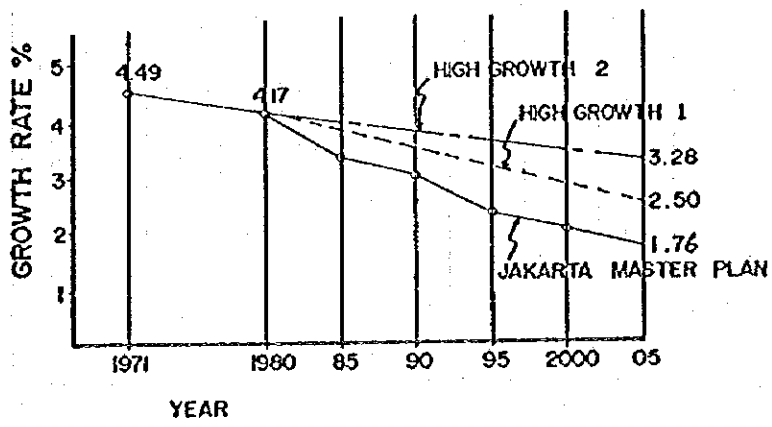
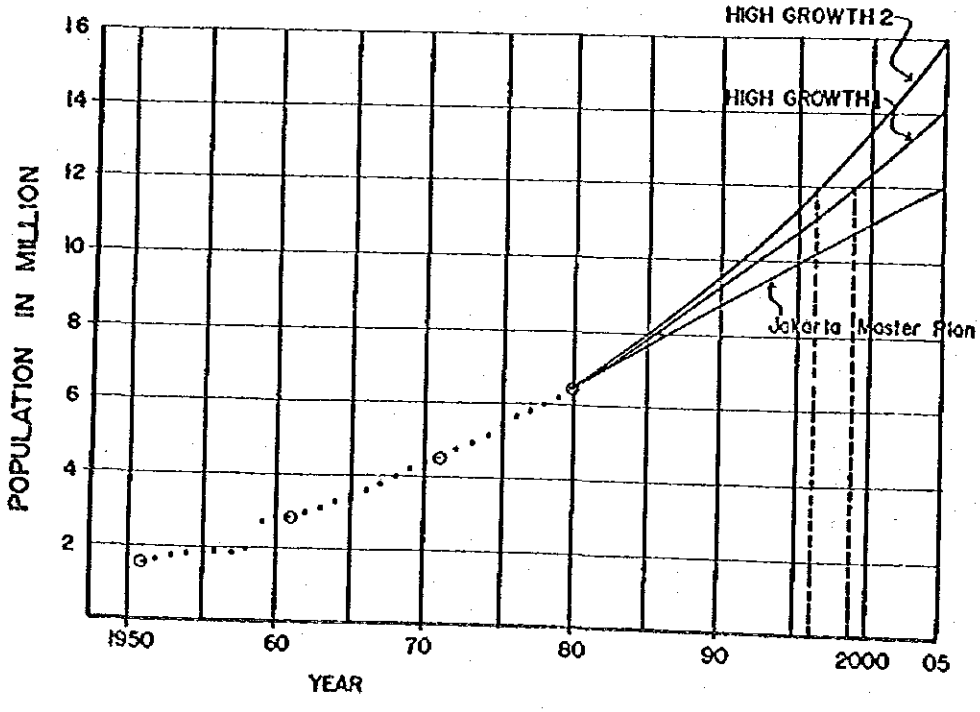


Fig. 2.19 shows the results of the two alternatives with the basic population forecast derived from the Jakarta Master Plan. It is observed that the 2005 target population of 12 million persons could be realized 7 years earlier (high growth 1) or 8 years earlier (high growth 2).

Table 2.19 Forecast Population in Each Growth Rate Pattern

	Jakarta Master Plan			High Growth 1			High Growth 2		
	GR/a	Pop'n	Density	GR/a	Pop'n	Density	GR/a	Pop'n	Density
1961		2.90							
71	4.49	4.50	79						
80	4.17	6.50	100	4.17	6.50	100	4.17	6.50	100
85	3.26	7.63	118	3.84	7.85	122	3.99	7.90	123
90	3.06	8.87	138	3.50	9.28	144	3.81	9.53	148
95	2.32	9.95	154	3.17	10.85	168	3.64	11.39	177
2000	2.03	11.00	171	2.83	12.48	194	3.46	13.51	210
05	1.76	12.00	186	2.50	14.12	219	3.28	15.87	246
	2.48 % (1980-2005 Average)			3.15 %			3.64 %		

Fig. 2.19 Forecast Population Curve



In case of High Growth 2, target population of 12 million is to be reached in 1996. Then, the review of water supply master plan or re-examination of program to be proposed should be preformed before 1995.

A demographic consideration on this Water Supply Master Plan study utilizes a population growth pattern projected in the Jakarta Master Plan (also in JMDP), because it is considered most comprehensive of all the development projects. It includes detailed distribution of population and growing trend of each city subcenter or subdistrict. (These are useful in planning pipeline network.) Unless some influential projects in Jakarta Master Plan fail to be undertaken, it is considered that the pattern of population distribution in future Jakarta remain the same or at least in the same proportion.

However, the total population growth within DKI Jakarta will be influenced by the success of JMDP projects. Therefore, monitoring the progress of JMDP and the population growth before 1995 is definitely necessary for the Water Supply Master Plan.

3. EXISTING WATER SUPPLY FACILITIES

3. EXISTING WATER SUPPLY FACILITIES

3.1 General

To visualize the whole picture of the water supply system and its operation condition of Jakarta, this Chapter describes 1) service area and population served, 2) the existing systems and their condition of operation and maintenance, and 3) supply conditions, features of unaccounted-for water and from the findings, finally mentions urgent works required to improve or rectify deteriorated facilities and supply conditions.

3.2 Service Area and Population Served

3.2.1 Present Service Area

In 1970, service area by PDAM was approximately 103 km2, which covered densely populated areas of Central and North Districts and areas extending toward south-east and south-west from the central area of the city.

The service area has been expanded, since then, along with the water supply development programs such as Emergency project and the First Phase of First Stage Project, completed in 1975 and 1982 respectively.

After completion of the First Stage Project, the service area will be expanded from 103 km2 to 283 km2 including the service areas covered by the mini-plant systems, which is about 44 % of the DKI Jakarta administrative area of 644 km2.

Fig. 3.1 shows the present service area. The present service area is defined based on the information together with drawings of the present trunk mains and distribution pipelines obtained from PDAM.

3.2.2 Population Served in Present Service Area

Based on the population distributed to the areas of Kotamadya and Kecamatan in the DKI boundary as shown in Original Table 2.17 Population Forecast by Kecamatan in Chapter 2, the population in the service area is estimated at 4,957,000 in 1980 which is about 76 % of the population of 6,468,500.

As of 1980, the population served is estimated at approximately 2,100,000. For the estimation, the following assumption is employed since there is no data and information available.

(1) In the record of service connections for 1980, 8 persons are supplied by each household connection.

    Under the above assumption, net per capita demand is calculated as 120 lpcd.

(2) Consumption of small industries is for small size home industries. Actually it is close to the household consumption. The assumption (1) will be applicable.

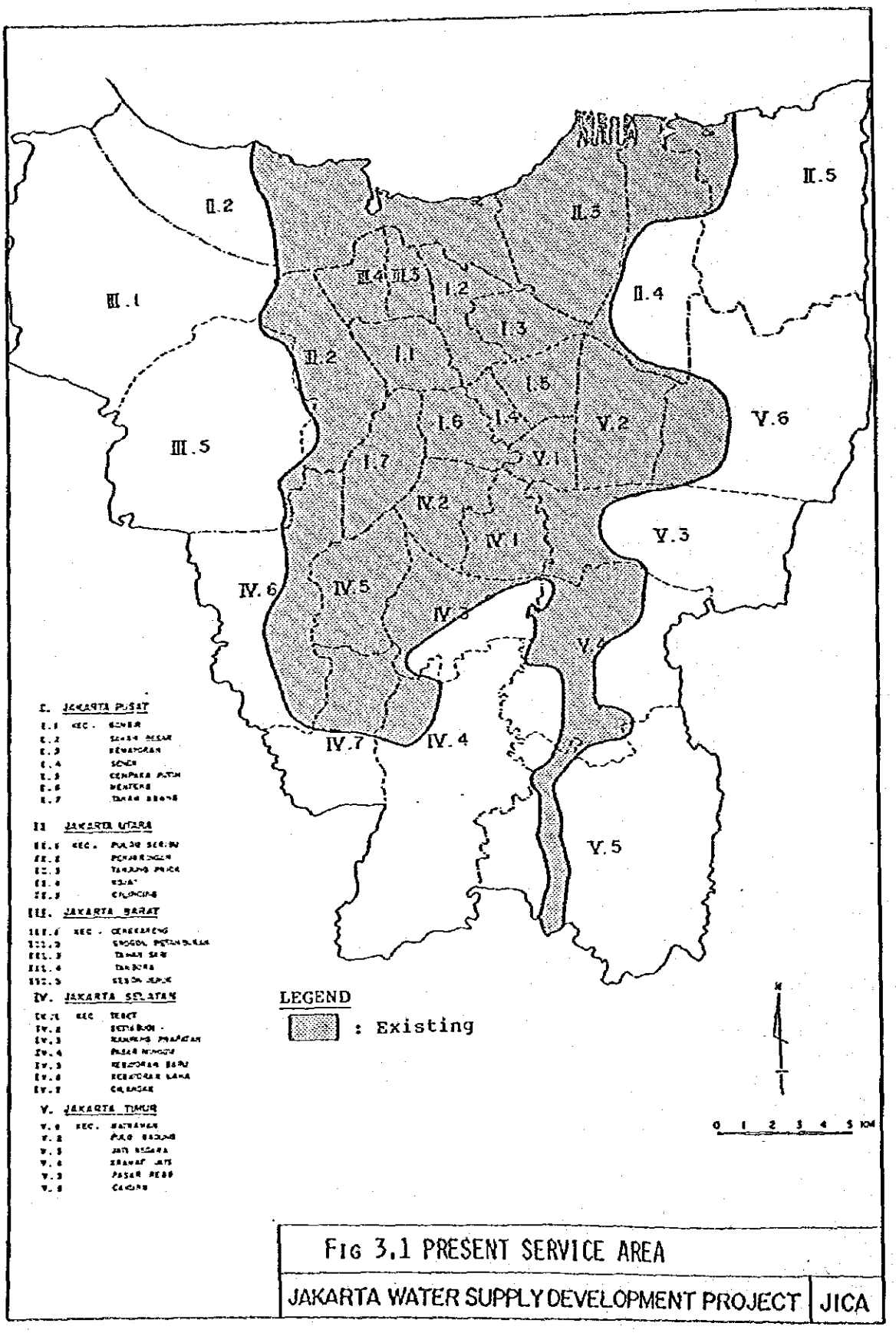


Fig 3.1 PRESENT SERVICE AREA

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(3) The same unit consumption 120 lpcd as (1) will be applicable to the boarding house, such trade enterprise as shop and restaurant, armed forces camp and housing, since consumption for these categories is generally similar to household use.

(4) 10 lpcd will be applicable to public hydrants and water vendors.

Based on the above assumption of unit consumption, the served population for year 1980 is calculated as approximately, 2,100,000, which is about 42 % of the population within the service area in 1980.

3.3 Existing Water Supply System and First Stage Project

3.3.1 Existing Water Supply System

The existing water supply system consists of Bogor spring system, surface water supply system and well water system. The total supply capacity is estimated at about 6,800 l/sec or 580,000 m3/day at present. The surface water supply system includes three large treatment plants and seven mini-plants at various locations in the City as shown on the Fig. 3.2. Table 3.1 shows the summary of the system indicating location, current rated capacity and year of operation and expansion planned.

Bogor Spring System

The Bogor spring system was constructed in 1922 taking water from the spring at Ciburial, Bogor, at the foot of Mr. Salak, about 60 km south of Jakarta. The spring water is transmitted partly through two pipelines, ø 600mm and ø 500 mm in diameter, to the reservoir at Pasar Rebo, east Jakarta from where the water is distributed to the City (a part of south and east Jakarta nearby the reservoir) by gravity. The spring water is also supplied to Depok area located along the transmission pipelines, about 5 km south of Jakarta. The Bogor spring system is shown in Fig. 3.3.

Surface Water Supply System

The Pejompongan System consists of two water treatment plants, Plants I and II, where rated capacities are 2,000 l/sec and 3,000 l/sec respectively. The Plant I has been operating from 1957 and the Plant II from 1970 with the initial capacity of 1,000 l/sec which was expanded to the present capacity in 1973. Rehabilitation works are now under way of the Plant I by PDAM's own funds. The Plant II will be expanded by 600 l/sec, which works are also under way and scheduled to be completed by 1984.

The Pulogadung water treatment Plant was constructed with an initial capacity of 1,000 l/sec and started operation from July, 1982. The Plant is planned to be expanded up to the final capacity of 4,000 l/sec by the end of 1985. A partition wall was currently constructed in the river of Sunter which extends 1.1 km from the confluence of the Sunter and Cipinang Rivers. The purpose of the construction of the wall is to improve raw water to the Pulogadung Plant to avoid the contamination of severely polluted water from Cipinang River.

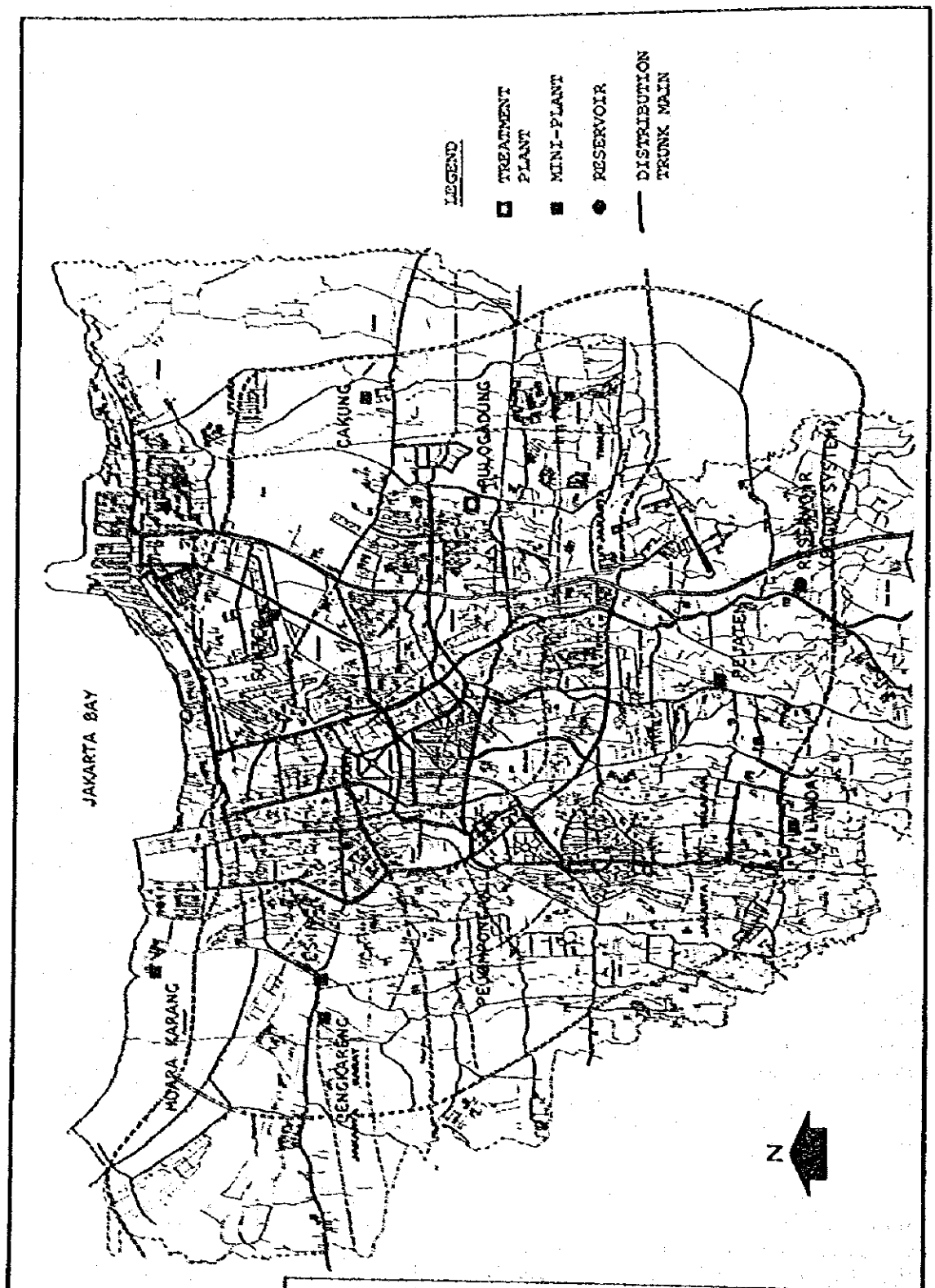

FIG 3.2 GENERAL PLAN OF EXISTING SYSTEM

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Table 3.1 Summary of the System

SYSTEM	LOCATION 1/	RAW WATER SOURCE	RATED CAPACITY (l/sec)	START IN SERVICE	EXPANSION CAPACITY (l/sec)	YEAR OF COMPLETION
SURFACE WATER SYSTEM						
PEJOMPONGAN I	TANAH ABANG, CENTRAL JKT	BANJIR CANAL	2,000	1957	-	-
PEJOMPONGAN II	TANAH ABANG, CENTRAL JKT	BANJIR CANAL	1,000 3,000	1970 1973	600	1984
PULOGADUNG	KRAMT JATI, EAST JKT	SUNTER R.	1,000	1982	3,000	1985
CILANDAK	CILANDAK, SOUTH JKT	KRUKUT R.	200	1977	250	1984
PESING	TAMAN SARI, NORTH JKT	BANJIR CANAL	5	1980	-	-
MUARA KARANG	PENJARINGAN, NORTH JKT	BANJIR CANAL	100	1982	100	1984
CENKARENG	TAMAN SARI, NORTH JKT	PASANGGARAHAN	50	1982	-	-
SUNTER	TANJUNG PRIOF, NORTH JKT	SUNTER	50	1982	-	-
CAKUNG	CAKUNG, EAST JKT	IRRIGATION CANAL	25	1982	-	-
PEJATEN	PASAR MINGGU, SOUTH JKT	CILIWUNG R.	5	1976	-	-
(CONDET)	PASAR REBO, EAST JKT	CILIWUNG R.	-	-	100	1983
(TAROGONG)	KEBAYORAN LAMA, SOUTH JKT	GROGOL R.	-	-	100	1984
SPRING SYSTEM						
BOGOR SPRING	CIBURIAL, BOGOR	CIBURIAL SPRING	300	1922	-	-
DEEP WELL SYSTEM						
DEEP WELL	VARIOUS LOCATIONS	GROUNDWATER	120 2/			

Note: 1) see Fig.3.14
2) 43 wells x 250 m3/day.well

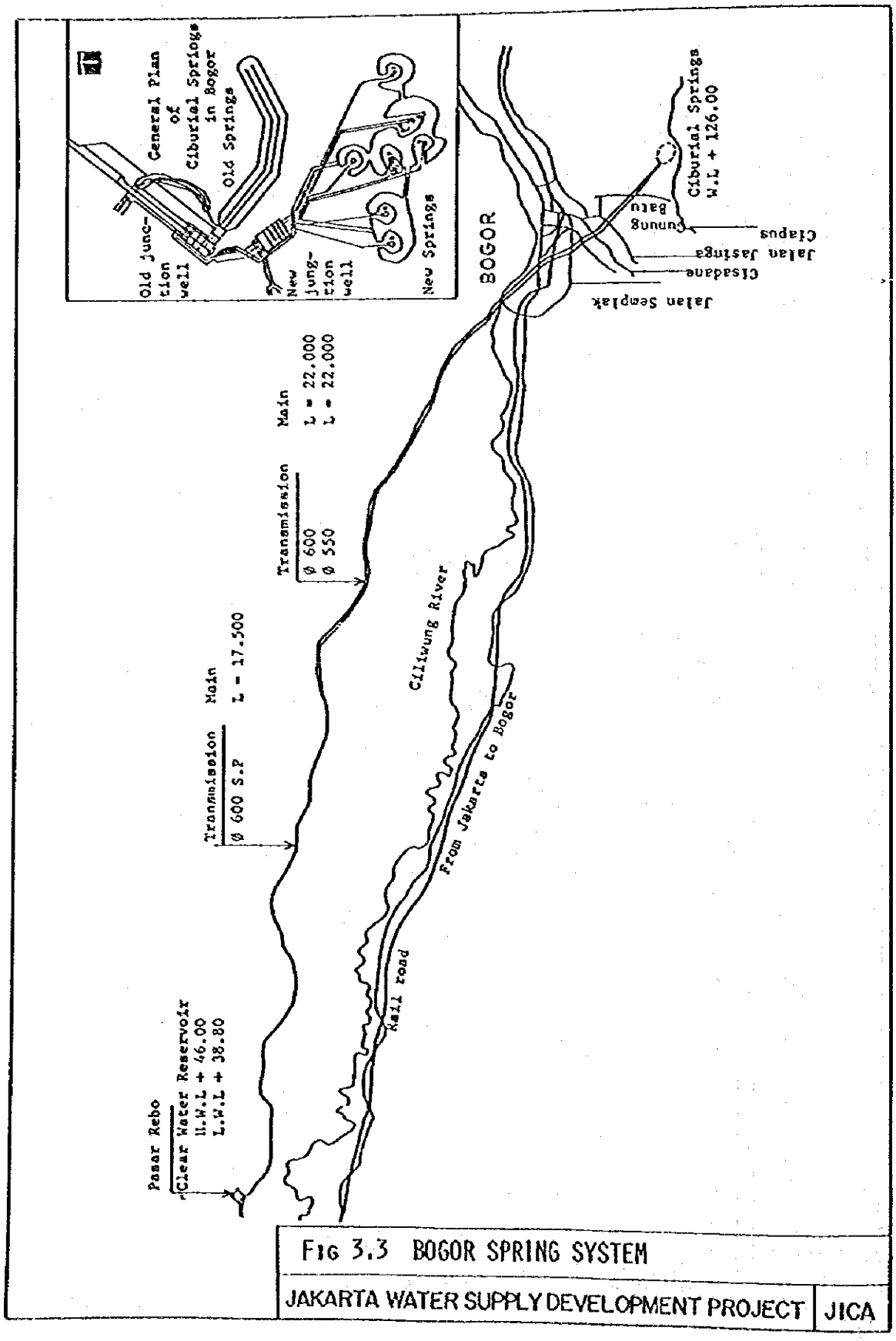

FIG 3.3 BOGOR SPRING SYSTEM

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There are seven mini-plants at various locations in the City whose rated capacities range between 5 and 200 l/sec. The Cilandak Plant is the biggest one among them, whose rated capacity is 200 l/sec, operated from 1977. Other mini-plants were constructed in the recent years as shown in Table 3.1. In addition, two mini-plants will be added to the present system in the near future at Condet in Pasar Rebo, east Jakarta, and Tarogong in Kebayoran Lama, in south Jakarta which are planned to start operation from year 1984 and year 1985 respectively. The rated capacity of the both plants are 100 l/sec.

In general, the western part of Jakarta is planned to be supplied from the Pejompongan Plants, and Pulogadung Plant will serve the eastern part of the City after completion of its full capacity of 4,000 l/sec. These two areas are divided by the Ciliwung River, the biggest river within Jakarta. Mini-plants supply water to the limitted areas which are isolated from the service area of the above plants and to areas newly developed.

Type, number and capacity of the treatment plant facilities for the Pejompongan and the Pulogadung are shown in Table 3.2, and each general layout is shown on Figs. 3.4 and 3.5.

Well Water System

PDAM has 111 deep wells including 22 wind mills located at various areas supplying water to their neighbourhoods. Out of the total, only 43 wells are currently in service. The rest wells have stopped their operation generally due to deterioration of water quality such as salinity water intrusion, contamination by iron, odor, etc. Also the well operation was stopped where distribution pipelines from the treatment plants were laid with enough pressure. PDAM presently has little intension for well development due to limitted production capacity of a well and water quality which is not necessarily good as shown in Appendx MIII-2. Table 3.,3 shows the summary of deep wells as of 1982. The estimated water production is about 10,000 m3/day based on assumed pumping rate of each well as 250 m3/day in average. Beside that, there are 2,028 private deep wells registered to PDAM in March 1983 within the administrative boundary in Jakarta. The total production from these proviate wells was about 69,000 m3/day, used for various purposes such as domestic, commercial and industrial usage.

Table 3.3 Public Deep and Wind Mill Wells (in 1983)
(number)

	DEEP WELL WITH PUMP			WIND MILL		
DISTRICT	WORKING	OUT OF SERVICE	TOTAL	WORKING	OUT OF SERVICE	TOTAL
CENTRAL JAKARTA	1	2	3	-	-	-
NORTH JAKARTA	9	19	28	-	10	10
EAST JAKARTA	12	8	20	1	-	1
WEST JAKARTA	9	10	19	1	7	8
SOUTH JAKARTA	7	12	19	3	-	3
TOTAL	38	51	89	5	17	22

Table 3.2 Facilities for Pejompongan and Pulogadung Treatment Plant

Facilities	Pejompongan I		Pejompongan II		Pulogadung	
	No. Type	Capacity/Dimention	No. Type	Capacity/Dimention	No. Type	Capacity/Dimension
Intake Facilities						
1. Intake Weir	1		-		1 Gate 4m x 1.2m	22m x 1.2 m
2. Intake bay	-		1	3.5mx2mx2months	1	1.8mx1/2mx4 mouses
3. Intake channel	-		-	V=0.23m/s	Box culvert 80m	V=0.49m/s 2.0mx1.1mx2
4. Orit chamber	2	7mx4.7mx3.5mx V=4.1cm/s			2	12mx35mx2.5m V=3cm/s
5. Raw water pump	6 Vertical Centrifugal	500l/sx13.5mx 125kW	6 Vertical Centrifugal	1,100 l/sx16mx 240kW	6 Horizontal Centrifugal	1.05 l/sx15mx250 250kW
6. Raw water main	1920m CIP	ø900x3 lines	1920m CIP	ø900x3 lines Venturi meter	100m	ø1,000x2 lines orifice plate
Treatment Facilities						
1. Presettling basin	-		2 Horizontal flow	Area:774m2 O/R 6 cm/min	-	
2. Receiving well	-	-			1 Circular	ø7.3x6m R/T : 1 min
3. Mixing chamber	-		2 Agitator	Capacity: 80 cm3 R/T : 48 sec	2 water fall	cap : 63 m3 R/T : 30 sec
4. Flocculation basin	-		-		8 Vertical flocculator	R/T : 20 min
5. Sedimentation basin	6 Accelator	Area: 356 m2 O/R 6.2 cm/min	4 Pulsator	Area : 828 m2 O/R : 6 cm/min	8 Horizontal flow	Area : 1,500 m2 O/R : 1.3 m/hr
6. Rapid sand filter	48 Aquazur filter	Area: 36 m2 F/R : 4.7 m2	34 Aquazur filter	Area : 72 m2 F/R : 5.2 m/hr	40 Coventional	Area : 1,500 m2
7. Chemical application		Alum, Lime Chlorine	Alum : max. 60ppm Prelime:max. 6ppm Postlime:max.10ppm	Pre-Chl: Max.4ppm Pos-Chl: Max.4ppm	Alum : max.70ppm Prelime: max.20ppm Postlime:max.10ppm	Pre-Chl: max. 5ppm Int-Chl: max. 2ppm Pos-Chl: max. 1ppm
Distribution Facilities						
1. Clear water reservoir	4	Cap:8,000 m3 R/T:4.4 hrs	1	Cap:28,000 m3 R/T:2.6 hr	3	Cap:19,000 m3 R/T:4 hr
2. Distribution pump	7 Horizontal type	1,000 l/sx53kWx3 500 l/sx248kWx3 100 l/sx110kWx2	8 Vertical Centrifugal	1,500 l/sx925kWx4 750 l/sx485kWx4	7 Horizontal Centrifugal	1,000 l/sx710kWx5 500 l/sx400kWx2
3. Flow meter	1. Venturi meter		1 Vertical		1 Orifice plate	

Note: O/R : Overflow rate, F/R: Filtration rate, R/T: Retention time
Pre-chl: Pre-Chlorination, Int-Chl: Intermediate Chlorine, Pos-Chl: Post Chlorine

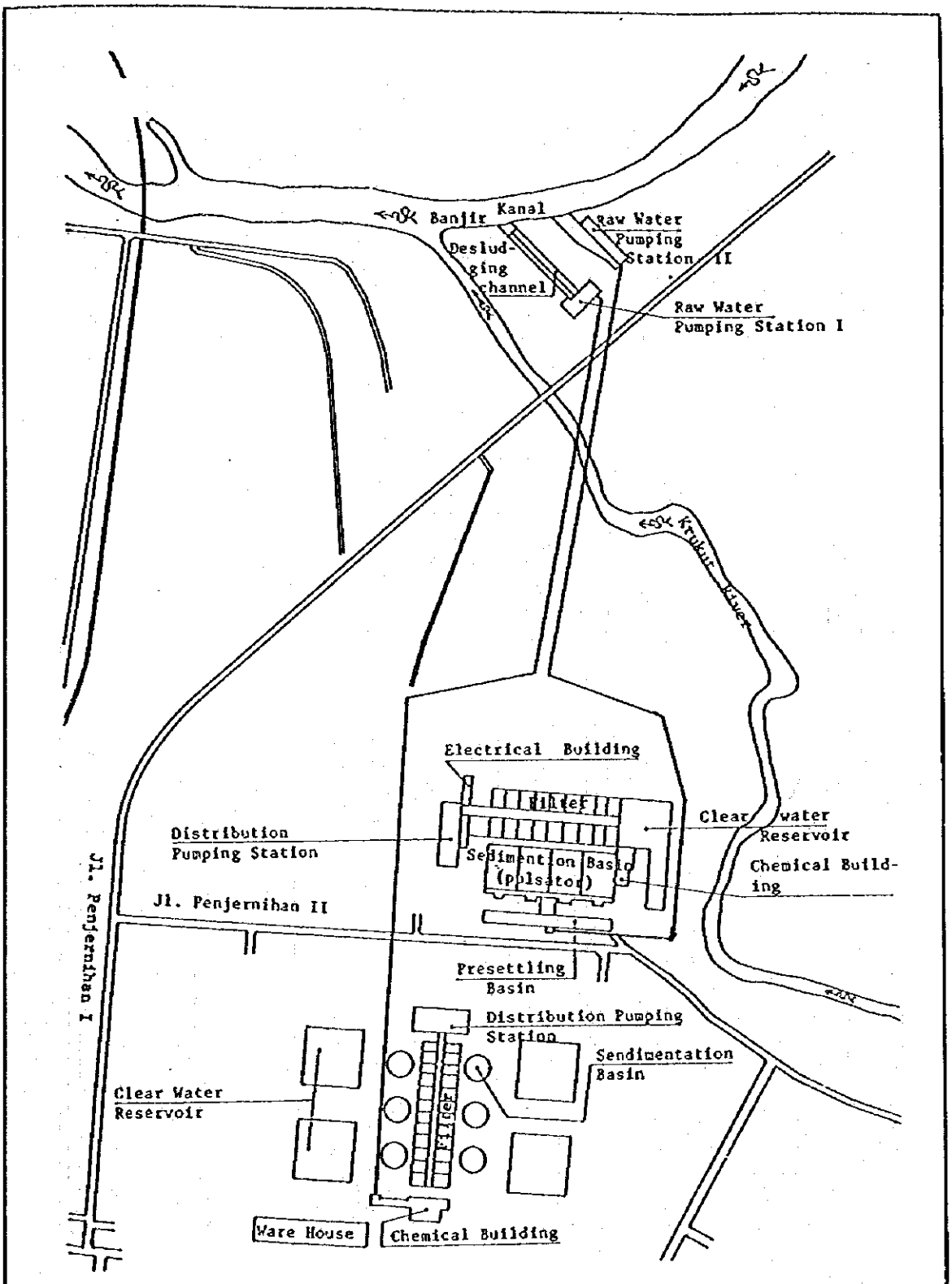

FIG 3.4 GENERAL LAYOUT OF PEJOMPONGAN PLANT I AND II

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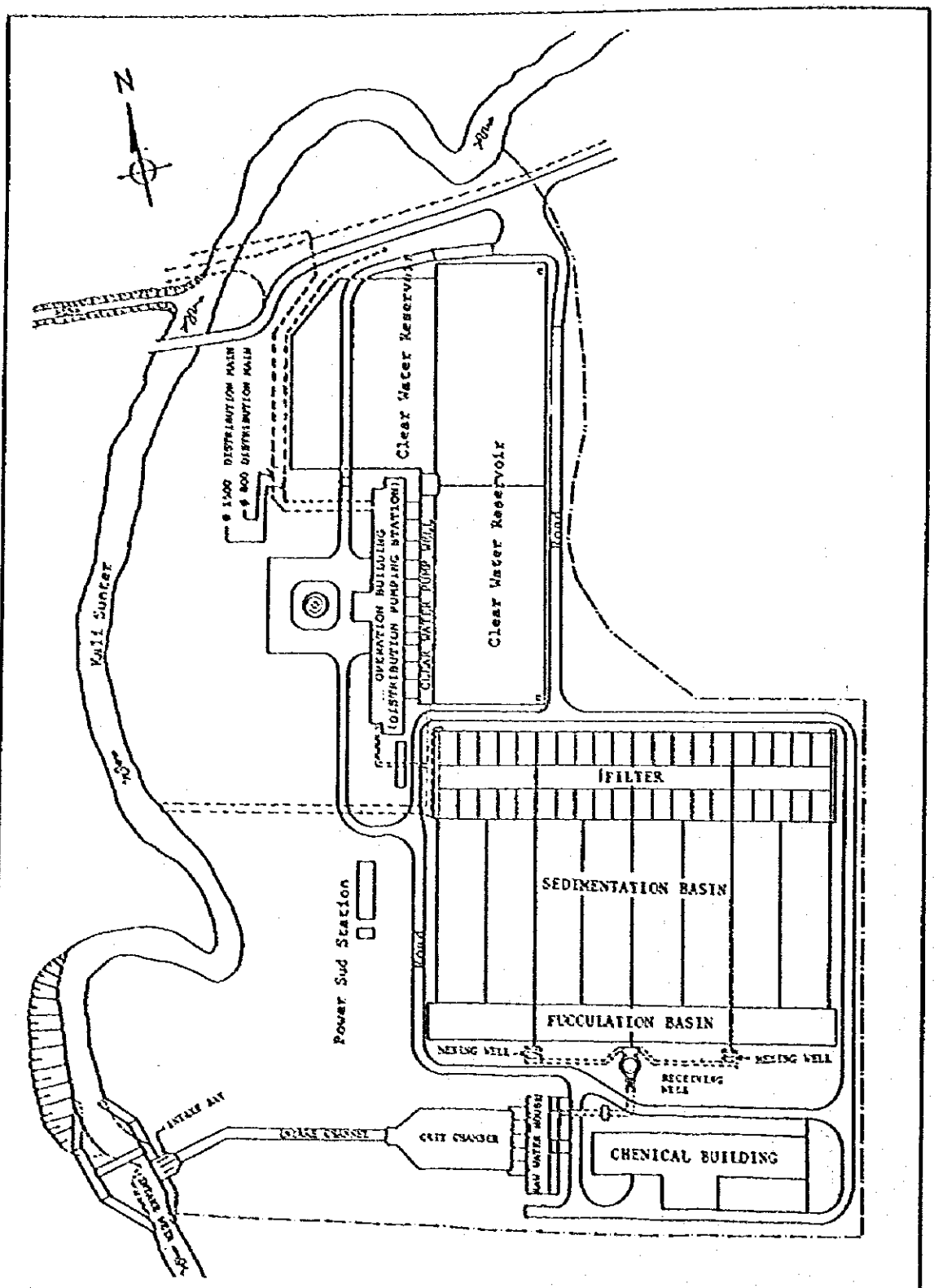

FIG 3.5 GENERAL LAYOUT OF PULOGADUNG PLANT

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Distribution System

Fig. 3.6 shows the general plan of the distribution trunk mains with diameters ranging between 1,250 mm and 300 mm. The total length of the trunk mains is estimated at about 220 km according to the information from PDAM at present. About 26 % and 22 % of the total length of the trunk mains were installed in 1920's and 1950's respectively as shown in Table 3.4. The Table shows a difference between the total length measured on maps and that length given by PDAM, though not so much. It is essentially required that in the future PDAM will prepare more detailed maps of distribution pipelines and keep accurate records thereof for sound management of the system. Besides, about 1,800 km in total length of the secondary and tertiary mains less than 250 mm in diameter is installed as shown Table 3.5. Jakarta water supply expansion project is now under way including production expansion of the Pulogadung treatment plant and distribution trunk and secondary mains. Expansion/reinforcement of the planned distribution trunk mains are also shown on Fig 3.6.

In order to improve the low water pressure in the existing service area, PDAM has constructed several booster pump stations during the past ten years. Presently five booster pump stations with storage reservoirs are in operation as shown in Table 3.6.

Table 3.4 Distribution Trunk Main

DIAMETER (mm)	PDAM's 1920's	1950's	1970's	1980's	TOTAL 1/	PDAM's 2/ INFORMATION
ø 1,250	-	0.2	-	-	0.2	0.2
ø 1,200	-	-	2.5	-	2.5	2.5
ø 1,000	-	-	2.5	-	2.5	2.5
ø 950	-	-	-	-	-	1.1
ø 900	-	8.0	3.9	-	11.9	11.2
ø 800	-	2.3	6.7	7.3	16.3	8.1
ø 600	31.6	17.4	15.3	4.8	69.1	58.4
ø 550	-	-	-	-	-	31.7
ø 500	-	-	11.1	-	11.1	24.2
ø 475	-	-	-	-	-	8.8
ø 450	4.7	-	-	-	4.7	8.9
ø 400	2.8	12.1	20.2	6.4	41.5	27.5
ø 350	14.9	2.4	7.2	1.8	26.3	27.7
ø 300	-	3.8	8.4	7.6	19.8	7.9
TOTAL	54.0	46.2	77.8	27.9	205.9	220.7

Note : 1 measured from the map of distribution trunk mains prepared by PDAM
2 according to the figure in "BUKU DATA, PAM JAYA" by Bidanf Bina Program Evaluasi & Dokumntasi, Bidang Penelitian & Pengembangan, PDAM DKI April 1983

LEGEND

- ▣ : Treatment Plant
- ------- : Installed in 1920's
- ·-·-·- : Installed in 1950's
- ——— : Installed in 1970's
- ═══ : Installed in 1980's
- – – – : Planned Trunk Main as the 2nd Phase of 1st Stage Project
- O : Booster Pump Station

FIG 3.6 DISTRIBUTION TRUNK MAIN

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Table 3.5 Existing Secondary and Tertiary Mains

Diameter (mm)	Length (km)	Pipe Materials (in %) DCIP	GIP	PVC	ACP	Year of Installation (in %) before 1950's	up to 1970's	up to 1975	after 1975
ø 250	103.9	100	-	-	-	15	20	25	40
ø 200	204.6	98	-	-	2	15	15	30	40
ø 150	415.7	96	3	1	-	10	15	25	50
ø 100	629.1	20	70	10	-	10	15	25	50
ø 75	767.6	10	80	10	-	15	20	30	45
ø 50*	1050.0								

Total 1,812.4 km

Note : DCIP, Ductile iron pipe
GIP, Galvanized iron pipe
PVC, Polyvinil Chloride pipe
ACP, Asbestos cement pipe
* Tertiary mains, ø 50 mm and below are estimated at 1,050 km from the maps of distribution pipelines.

Table 3.6 Existing Booster Pump Station

No.	Name of Pump Station	Capacity of storage Reservoir	Booster Pump No.	Capacity	In Operation Year
B-1	Klender	750 m3	2	35 l/s x 50 m	1979
			1	30 l/s x 50 m	1979
B-2	Digue	64	2	20 l/s x 50 m	1979
B-3	Sumur Batu	7,500	3	260 l/s x 50 m 1/	1957
B-4	Sukit Duri	64	2	20 l/s x 50 m	1974
B-5	Rawasari	1,400	4	100 l/s x 50 m	1975

Note : 1/ replaced by new pumps in 1984

3.3.2 First Stage Project

In 1970, Pejompongan Treatment Plant II was completed for a capacity of 1,000 l/sec by a financial aid of the French Government and the extension work of additional capacity of 2,000 l/sec proceeded scheduling to be completed in 1973. In order to distribute water of 3,000 l/sec from the plant after completion, an installation of distribution pipelines was urgently needed. Areas to be supplied were a few particular districts of Pulogadung, Ancol, Pluit, Kebayoran Baru and Tebet where water was extremely short and causing excessive inconvenience in daily life.

The Government planned to prepare the distribution pipeline scheme for urgent need and future water supply program of the City depending upon the Japanese Government's aid. In 1971, the master plan up to the year 2000 and feasibility study for next extension program targeted in 1980 were made together with the detailed design engineering for Emergency Project to install the above distribution pipelines.

Both Projects of Emergency and First Stage were decided to be financed by the OECF. The Emergency Project was executed in 1973 through 1975. The First Stage Project has been executed divided into two phases, and the First Phase was commenced in 1977 and completed in 1982, and the Second Phase was commenced in 1981 and is still in progress scheduled to be completed in 1987. These projects are briefed in the following paragraphs.

Emergency Project

The Emergency Project was planned to distribute water of 3,000 l/sec from the Plant II to the particular districts of Pulogadung Industrial Estate and Ancol and Pluit Housing Districts where were newly being developed and Kebayoran Baru and Tebet residential districts. Total pipe length installed under the Project is as follows:

Diameter (mm)	1200	1000	900	800	600	500	400	350	300	250	200	Total
Length (km)	0.9	3.4	1.8	3.8	7.9	9.8	2.4	7.7	5.9	2.7	7.5	53.8

Note: Tertiary mains were constructed by PAM DKI badget in Pelita I (1969-1973), separately from this Project.

First Stage Project

The First Stage Project was planned to meet the water demand in 1980 constructing a new treatment plant with a capacity of 4,000 l/sec at Pulogadung and associated distribution pipelines. The Project was divided into two phases in its implementation.

The First Phase Project includes construction of the new treatment plant (capacity of 1,000 l/sec) at Pulogadung and distribution pipelines, total length of 171 km ranging ø 50 mm to ø 1,000 mm in diameter. Construction works were executed in 1977 through 1982. The Second Phase Project includes the extension of Pulogadung Plant (capacity of 3,000 l/sec) and construction of distribution pipelines, total length of 275 km ranging ø 50 to ø 1,500 in diameter. The Project has been executed divided into three parts due to a magnitude of the finance by OECF. The construction works were commenced in 1981 and are to be completed in 1987.

Completion of the project is several years behind initial schedule due to delay of internal procedures for the project implementation. The project is summarized below:

Description	Phase I	Phase II		Total
		Part 1	Part 2	Part 3	
Water Source	Sunter R.		Sunter R.		Sunter R.
Treatment Plant	WTC Pulogadung 1,000 l/sec	-	WTC Pulogadung 3,000 l/sec	-	WTC Pulogadung 4,000 l/sec
Distribution Pipe	1/ (km)	2/ (km)	3/ (km)	4/ (km)	(km)
1,500 mm	-	-	0.7	-	0.7
1,350 mm	-	-	1.1	-	1.1
1,200 mm	-	1.2	-	-	1.2
1,000 mm	0.3	-	9.1	5.2	14.6
800 mm	6.6	6.7	3.9	22.6	39.8
600 mm	4.2	5.5	-	17.8	27.5
500 mm	-	-	-	0.7	0.7
450 mm	-	0.8	-	-	0.8
400 mm	6.8	1.3	-	9.4	17.5
300 mm	-	0.1	-	4.9	5.0
Sub-total	17.9	15.6	14.8	60.6	108.9
200 to 250 mm	24.8	23.3	-	41.0	89.1
50 to 150 mm	219.5	119.8	-	-	349.3
Total	272.2	158.7	14.8	101.6	547.3

Note: 1/ were already installed in 1982 to distribute water (1,000 l/sec) from Pulogadung plant to Tanjung Priok area and Pulogadung Industrial Estate.

2/ are installed to distribute water increased (600 l/sec) in Pejompongan Plant II to western and north-western areas, Pluit and Grogor. Under construction.

3/ are installed to distribute water (3,000 l/sec) from Pulogadung Plant to the existing central and eastern areas interconnecting to the existing trunk mains. Under construction.

4/ are to be installed in the existing central area for reinforcement of trunk mains and in newly expanded area, and completed in 1987.

3.4 Present Water Source, Raw Water Quality and Treatment Condition

3.4.1 Present Water Source

The main water sources for Jakarta water supply are rivers flowing through the City, Banjir Canal and West Tarum Canal (which supplies to such rivers and Banjir Canal) as shown on Table 3.7 and Fig. 3.7. Other small rivers are also being utilized as water sources for mini plants.

The existing water treatment plants, together with the related river systems, are indicated in Fig. 3.7 and Table 3.8. In the dry season from June to October, the total river flow in the region reduces to merely 11.3 m3/sec to 15.4 m3/sec. The Ciliwung, the largest river in the area, supplies approximately 5.4 m3/sec to Pejompongan water treatment plants and other two mini-plants of Muara Karang and Pejaten. The Sunter river provides about 1.1 m3/sec to Pulogadung plant and one mini-plant of Sunter.

The extension program of these existing plants is now under way, and on completion in 1987 will enhance the intake from these rivers, namely, to 6.0 m3/sec from the Ciliwung, 4.3 m3/sec from the Sunter and 0.6 m3/sec from other rivers. (In case of the Sunter, the flow is expected to increase by contribution from the West Tarum Canal). In addition, minor rivers such as Grogol and the Angke are expected to supply 0.5 m3/sec to other mini-plants, Cilandak, Cakung, Tarogong, Cengkareng and Pesing.

In addition to these natural streams, the City has some other canals to receive water from the rivers outside DKI Jakarta. The most important one is the West Tarum Canal, which is fed by Jatilufur reservoir and on its way to Jakarta intercepts water from the local rivers such as the Citarum the Cibeet, the Cikarang and the Bekasi. As the result, the water in the last section of the canal, namely, Bekasi - Jakarta, includes the constributions from these four.

For reference, average monthly mixing ratios of the local rivers water and percentage distribution of origin of water in the canal in 1980 are presented in Table 3.9 and 3.10. In the Bekasi - Jakarta section of the canal the flow accounted for 62 to 95 % of the total flow coming from Bekasi river, whereas Jatiluhur reservoir, only 1 to 25 %. On the other hand, the available discharge in 1978 from the West Tarum Canal varied between 4 and 6 m3/sec from June to October, and from November to May between 0 and 4 m3/sec because the flows of the Ciliwung, the Cipinang and the Sunter rivers were large during rainy season.

The streams in Jakarta city have been fully developed for not only drinking, but other uses such as flushing, irrigation and others. To enhance the supply for the increasing demand, a program enlarging the West Tarum Canal is currently ongoing. (Refer to Sec. 4.3.2). Furthermore, the transfer of large volume of water from Jatiluhur reservoir is now under study as a future program. (Refer to Sec. 4.3.2)

Table 3.7 Monthly River Discharge in Jakarta City

Unit : m3/s

No.	River	Wet Season							Dry Season					Year	Note
		N	D	J	F	M	A	M	J	J	A	S	O		
1	Buaran	0.4	0.4	0.9	0.9	0.9	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.5	*B
2	C a k u n g	0.5	0.5	1.0	1.0	1.0	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.6	*B
3	Sunter	1.3	1.3	2.5	2.5	2.5	1.6	1.3	0.8	0.8	0.8	0.8	0.8	1.4	*B
4	Cipinang	0.8	0.8	1.6	1.6	1.6	1.1	0.8	0.5	0.5	0.5	0.5	0.5	0.9	*B
5	Ciliwung (Rawajati 318 km2)	15.6	18.1	24.6	25.4	23.3	23.2	19.0	13.4	10.6	9.3	9.5	12.2	17.0	*A

Note :* A- Monthly Mean Discharges, Coyne et Bellier, 1979
* B- Estimated Reliable Flows, NEDECO, 1983

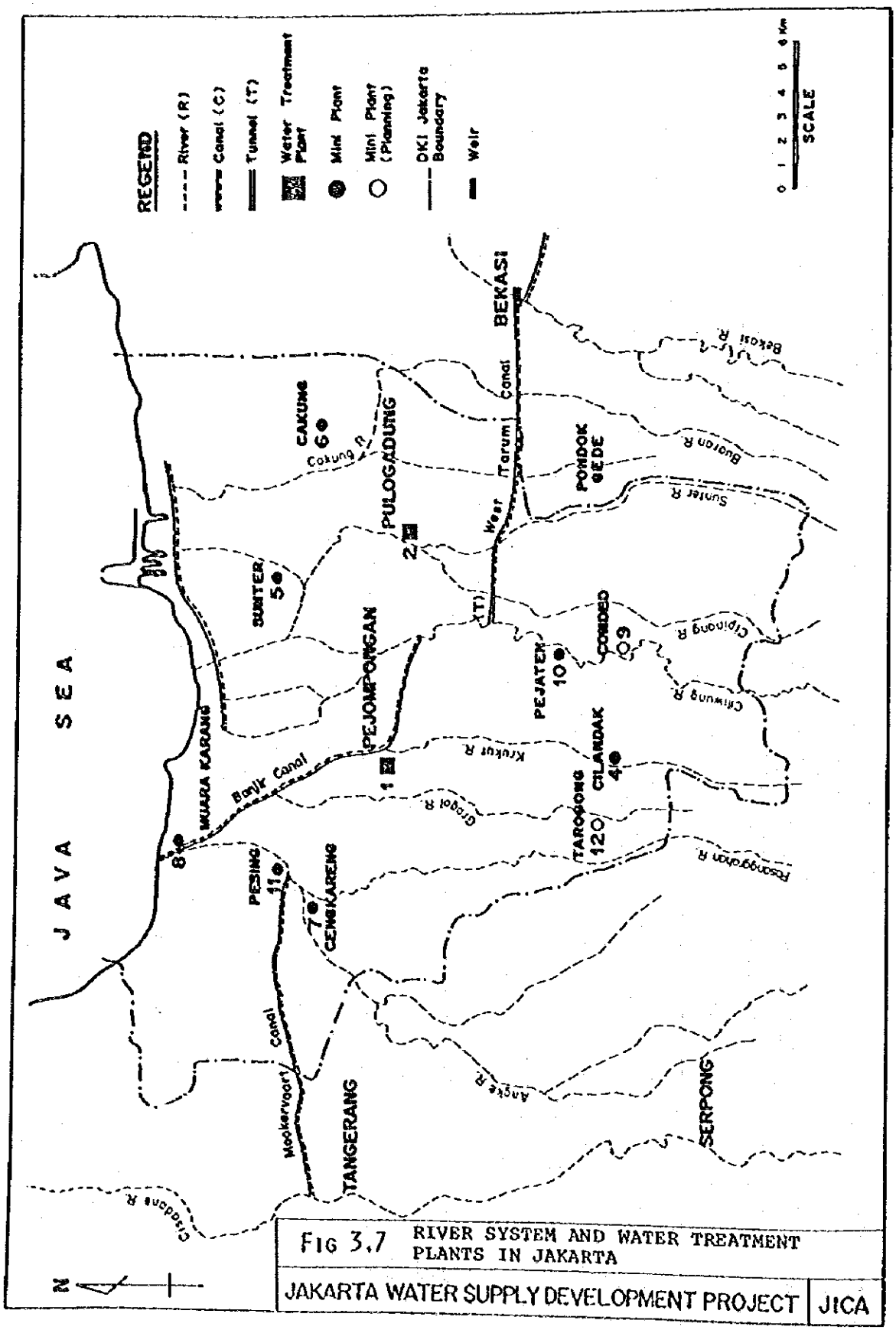

FIG 3.7 RIVER SYSTEM AND WATER TREATMENT PLANTS IN JAKARTA

JAKARTA WATER SUPPLY DEVELOPMENT PROJECT | JICA

Table 3.8 Water Source and Water Treatment

Plants in Jakarta, 1983 - 1987

Plant No.	Name	Water Source	Water* Quality	Production Capacity (L/S)	
				1983	1987
1.	Pejompongan	Banjir Canal	B	5.000	5.600
2.	Pulogadung	Sunter River	B	1.000	4.000
3.	Ciburial	Springs, Bogor	A	300	300
4.	Cilandak	Krukut River	A	200	450
5.	Sunter	Sunter River	B	50	50
6.	Cakung	Irrigation Canal	A	25	25
7.	Cengkareng	Angke River	A	50	50
8.	Muara Karang	Banjir	B	100	100
9.	Condet	Ciliwung River	A	*100	100
10.	Pejaten	Ciliwung River	A	5	5
11.	Pesing	Angke River	B	5	5
12.	Tarogong	Grogol River	A	*	100
TOTAL CAPACITY (L/S)				6,835 = 6,800	10,785 = 10,800

Basic Data from PDAM, July, 1983

* Water Quality, JICA, 1983

A ; Good
B ; Contaminated

Table 3.9 Mixing ratios at weirs on the West Tarum Canal, 1980.

Year	Section Cibeet - Cikarang			Section Cikarang - Bekasi			Section Bekasi - Jakarta		
	Flows (m^3/s)		Mixing Ratio	Flows (m^3/s)		Mixing Ratio	Flows (m^3/s)		Mixing Ratio
1980	Inflow in Canal at Curug	Inflow in Canal at K.Cibeet	Jati-luhur / Cibeet	Outflow of canal sec. Cibeet-Cik.	flow of Cikarang	Canal / Cikarang	Outflow of canal sec. Cik. - Bek.	Flow of K.Bekasi	Canal / K. Bekasi
January	15.4	13.6	1.13	8.2	29.8	0.28	2.1	38.5	0.06
February	12.6	11.1	1.14	5.4	20.7	0.26	3.2	39.6	0.08
March	14.2	8.5	1.67	4.5	20.1	0.22	3.2	40.4	0.08
April	19.6	11.2	1.75	9.3	5.0	0.62	3.5	34.7	0.10
May	21.0	9.6	2.19	5.4	9.8	0.55	2.0	31.3	0.06
June	29.6	6.9	4.29	9.8	4.0	2.47	2.4	9.7	0.25
July	41.3	6.9	5.99	17.2	5.9	2.93	7.4	12.0	0.62
August	33.2	5.7	5.77	15.4	7.7	2.01	6.7	22.7	0.30
September	30.8	7.6	4.06	10.7	2.6	4.10	2.4	28.7	0.08
October	28.1	10.0	2.81	12.6	5.3	2.41	1.8	29.6	0.06
November	29.5	14.0	2.21	11.6	15.5	0.75	2.2	27.7	0.08
December	23.6	13.0	1.82	11.8	10.3	1.15	1.6	33.0	0.05
Average	24.9	9.8	2.9	10.2	12.2	1.48	3.2	29.0	0.15

Table 3.10 Monthly percentage distribution of origin of water in the West Tarum Canal, 1980.

Years 1980	Origin of Water in various sections of the West Tarum Canal (%)								
	Section Cibeet - Cikarang		Section Cikarang - Bekasi			Section Bekasi - Jakarta			
	Jatiluhur	Cibeet	Jatiluhur	Cibeet	Cikarang	Jatiluhur	Cibeet	Cikarang	K. Bekasi
January	53.1	46.9	11.5	10.1	78.4	0.6	0.5	4.1	94.8
February	53.2	46.8	11.0	9.7	79.3	0.8	0.7	6.0	92.5
March	62.6	37.4	11.5	6.8	81.7	0.9	0.5	6.1	92.5
April	63.6	36.4	24.4	13.9	61.7	2.2	1.3	5.6	90.9
May	68.6	31.4	24.4	11.2	64.4	1.5	0.7	3.8	94.0
June	81.1	18.9	57.7	13.5	28.8	11.4	2.7	5.7	80.2
July	85.7	14.3	63.9	10.7	25.4	24.4	4.1	9.7	61.8
August	85.2	14.8	56.9	9.9	33.2	13.0	2.3	7.6	77.1
September	80.2	19.8	64.5	15.9	19.6	5.0	1.2	1.5	92.3
October	73.8	26.2	52.1	18.5	29.4	3.0	1.1	1.7	94.2
November	67.8	32.2	29.1	13.8	57.1	2.2	1.0	4.4	92.5
December	64.5	35.5	34.5	19.0	46.5	1.6	0.9	2.2	95.3
Average	70.0	30.0	36.9	12.8	50.3	5.6	1.4	4.9	88.1

3.4.2 Water Treatment

The water treatment is conducted to be in conformity with the Indonesian Drinking Water Standard which was established on the basis of WHO Standard. The existing water treatment plants of Jakarta are experiencing difficulties in water treatment due to pollution of source waters. To clarify this situation, this Section will first describe the overall condition of raw water, then the present water treatment conditions, mainly based on the data furnished by PDAM, and finally provide recommendation for the improvement of the exisitng water treatment system. Regarding detailed data of the treatment conditions, please refer to Appendix MIII-2.

1) Raw Water Quality

Major characteristics of raw water quality of the plants are described briefly in the following, which have particular influence on water treatment. "Raw Water Standard" established by Ministry of Health is shown in Table 3.11 together with raw water quality of both plants of Pejompongan and Pulogadung. The standard shows merely desirable levels of raw water quality for water supply use, not necessarily limiting the use of lesser quality water.

(1) Raw Water of Pejompongan Plants

Pejompongan Plants I and II take same raw water from Banjir Canal which receives water from both the Ciliwung River and West Tarum Canal. The raw water qualities of the two Plants are shown on Tables 3.12. Characteristics of the quality are summarized below.

a. Color values were 10 to 35 units.
b. Turbidity values were high, 228 NTU in annual average and changable in seasons from 23 to 981 NTU
c. Alkalinity was rather high, 73 mg/l in annual average.
d. Hardness, Calcium and Manganese were comparatively low, always below the Drinking water standard.
e. Iron and Mangamese were above the Raw water standard.
f. Ammonium which is a pollution index was high above the said standard, 0.56 mg/l in annual average. Real concentrations of Amonium may be higher, because the present survey detected 0.29 to 1.29 mg/l of Ammonium.
g. Organic Matter was high, 11 mg/l in annual average and 29.7 mg/l in maximum.
h. Low dissolved oxygen appeared, such as 3.5 mg/l in annual average.
i. Number of Faecal Coli exceeded the Raw water standard.

In treating the raw water of the above qualities, attention is to be paid to the following.

a. Values of Color, Turbidity, Iron and Manganese are rather high, originating mainly from the soils along the source rivers, but they are removable by the ordinary treatment method.

Table 3.11 Raw water standard and Water Quality on WTC, Banjir Canal and Sunter River

Parameter	Unit	Maximum *1) Desirable	Maximum *1) Permissible	WTC at BTB 49 *2) Ave.	WTC at BTB 49 *2) Max.	WTC at BTB 49 *2) Min.	Banjir Canal at Intake *2) Ave.	Banjir Canal at Intake *2) Max.	Banjir Canal at Intake *2) Min.	Sunter River at Intake *2) Ave.	Sunter River at Intake *2) Max.	Sunter River at Intake *2) Min.
A. Chemical												
Total Iron	mg/l		1.0	8.1	32.4	0.41	11.0	86	2.0	6.8	27	3.4
Chromium	"		0.5		ud	ud		0.05	ud		ud	ud
Cadmium	"		0.01		ud	ud		ud	ud		ud	ud
Cobolt	"		1.0									
Manganese	"		0.5	0.17	0.41	ud	0.55	2.25	0.19	0.55	0.93	0.23
Mercury	"		0.005		ud	ud		ud	ud		ud	ud
Copper	"		1.0		0.03	ud		0.09	ud		0.1	ud
Lead	"		0.05		ud	ud		ud	ud		ud	ud
Ammonia	"	0.01	0.5	0.27	0.75	ud	0.72	1.29	0.29	0.73	1.43	0.24
Nitrite and Nitrate	"	nil	10		1.8	0.12		1.9	0.53		1.2	0.1
B. Organic Chemical												
Oil and Greas			nil									
Pesticides												
a. Aldrin	g/l	nil	0.03		ud	ud		0.04	ud		0.011	ud
b. Malthion	"				ud	ud		ud	ud		ud	ud
c. D.D.T.	"	nil	1.0		ud							
d. Lindan	"	nil	3.0		ud	ud		ud	ud		ud	ud
e. BHC	"				ud	ud		ud	ud		ud	ud
f. Dieldrin	"	nil			ud	ud		ud	ud		0.048	ud
g. Endrin	"				ud	ud		ud	ud		ud	ud
h. Parathion					ud	ud		ud	ud		ud	ud
MBAS	mg/l	nil	0.5	0.05	0.2	ud	0.27	0.43	0.09	0.38	0.49	0.08
BOD	"		3	2.5	4.5	1.6	11.0	40.5	2.6	12.3	27	4.0
DO	"	6		6.3	7.1	5.7	2.8	5.4	1.1	2.1	3.7	0
pH		6.5	8.5		8.0	6.9		7.7	6.4		7.4	6.4
C. Microbiological												
Coliform	per 100 ml		10,000									
Faecal Coli	"		2,000	$1.1x10^5$	$4.6x10^5$	$1.5x10^4$	$1.1x10^7$	$1.1x10^8$	$6.4x10^5$	$1.6x10^8$	$2.4x10^9$	$9.3x10^4$

1) Quality of Water From Water Bodies (Raw Water) referred to in Article 2 of Republic of Indonesia Health Minister No. 173/Men.Kes/Per/VIII/77

2) Data carried out by DPMA, Nov 1983 to May 1984, 16 samples

Table 3.12 Water Quality at Pejompongan Plants

	Color (Unit)	Turbidity (NTU)	pH	Alkalinity (mg/l)	O. Matter (mg/l)	Fe (mg/l)	Mn (mg/l)	NH4-N (mg/l)	Faecal Coli (MPN)
	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.
1. Raw Water									
a. March	150/150/150	713/293/105	6.8/6.7/6.7	100/65/50	29.7/13.1/6.8	7.0/1.8/0.5	Pos/neg	0.6/0.5 /0.4	
b. September	150/150/150	185/153/138	7.0/6.9/6.8	110/90/70	18/ 12.6/9.4	2.0/1.3/neg	pos/trc/neg	0.6/0.6 /0.6	
c. Annual	150/150/150	863/228/ 23	7.0/6.7/5.5	110/73/32.5	29.7/11.3/4.7	7.0/1.6/neg	pos	0.6/0.56/neg	
2. Clarified Water of Pejompongan I									
a. March	11/ 8/ 8	5.4/4.6/3.4	6.6/6.3/6.1	90/60/35	11.1/6.2/2.1	0.9/0.3/neg	neg	0.6/0.5/ 0.2	
b. September	12/ 8/ 5	5.4/4.9/4.6	6.5/6.3/6.2	100/80/60	11.0/7.9/6.3	0.65/ /neg	neg	0.6/0.6/ 0.6	
c. Annual	12/8.2/ 5	8.9/4.8/2.7	7.0/6.3/5.9	100/64/30	18.4/6.6/1.5	0.9/ /neg	neg	0.6/0.54/neg	
3. Clarified Water of Pejompongan II									
a. March	10 - 20	4.5/3.3/2.8	6.2/6.0/5.9	40/33/25	11.0/7.8/5.6	neg	-	0.05/0.00/0	
b. September	10 - 20	4.6/3.5/3.2	6.5/6.3/6.3	65/56/10	11.4/9.0/7.9	neg	-	0.5/0.25/0.1	
c. Annual	10 - 20	6.0/3.4/2.8	6.5/6.1/5.9	65/35.6/10	17.6/8.3/2.5	neg	-	0.6/0.1/ 0	
4. Filtered Water of Pejpompongan I									
a. March	7/ 6/ 5	2.1/1.3/0.6	6.3/6.2/6.1	80/52/35	6.7/4.7/3.6	neg	neg	0.6/0.33/0	
b. September	8/ 6/ 5	1.7/1.4/1.2	6.5/6.3.6.1	90/75/70	11/ 6.3/2.3	neg	neg	0.6/0.6 /0.6	
c. Annual	10/5.5/ 5	4.7/1.4/0.6	6.5/6.3/6.0	90/61/35	11/ 4.5/1.5	neg	neg	0.6/0.38/neg	
5. Filtered Water of Pejompongan II									
a. March	0 - 5	0.9/0.5/0.3	6.0/5.9/5.8	40/35/25	7.9/6.2/4.7	neg	-	0/ 0/ 0	
b. September	0 - 5	0.6/0.4/0.3	6.5/6.3/6.3	65/56/45	11.7/7.1/3.8	neg	-	0.3/0.12/ 0	
c. Annual	0 - 5	0.9/0.5/0.3	0.5/6.1/5.8	70/35.7/15	13.3/6.2/1.9	neg	-	0.4/0.045/0	
6. Finisbed Water of Pejompongan II									
a. March	0 - 5	0.9/0.6/0.4	7.5/7.0/6.7	45/35/30	7.9/4.4/1.5	neg	-	0/ 0/ 0	0/ 11
b. September	0 - 5	0.7/0.5/0.4	7.1/7.0/6.9	75/62/55	6.9/4.9/1.8	neg	-	0/ 0/ 0	1/ 11
c. Annual	0 - 5	0.9/0.5/0.3	7.9/7.0/6.7	75/46/20	7.9/4.1/1.5	neg	-	Trc/0/ 0	7/135

Date Source: Monthly Report, "Instalasi" 1983 by PDAM.

b. Concentration of dissolved substances such as Hardness, Conductivity and Chloride are low, and give no problems to water treatment.

c. High Ammonium and Organic Matter concentrations and low dissolved Oxygen content, which show pollution of the water, appeared through the year, especially in the dry season.

Pollution of the water is taking place in all the rivers and canals in the city area and also in the upper reaches of these water ways due to wastewater discharge from the densely populated areas. For details of this matter, please refer to Appendix MIII-2.

(2) Raw Water of Pulogadung Plant

Raw water to this plant is taken from the Sunter River, and when its flow becomes low in the dry season, water of West Tarum Canal is diverted to this river. The raw water quality is shown on Table 3.13. Characteristics of the quality are summarized below.

a. Color values were between 13 and 35 units.

b. Tarbidity values were between 13 and 207 NTU.

c. Hardness, Calcium and Maganium were low, below the Drinking water standard.

d. Dissolved Iron and Manganese were high above the Drinking water standard, 0.85 and 0.31 mg/l respectively.

e. Ammonium concentration was usually high above the Raw water standard, 1.95 mg/l in annual average and besides its concentrations in July to September were over 3 mg/l in monthly average.

f. Organic Matter was high and changable, 17.7 mg.l in annual average and 72.6 mg/l in maximum, and 28.2 and 27.4 of high monthly average in August and September.

g. Dissolved Oxygen was low.

h. Number of Faecal Coli exceeded the raw water standard.

From the above, issues to be considered in water treatment are as follows:

a. Turbidity, Color, Iron and Manganese contents are rather high, but they are removable by the ordinary treatment.

b. Ammonium and Organic Matter concentrations were high and dissolved Oxygen was low.

c. Hardness, Conductivity and Chloride concentrations were low.

Table 3.13 Water Quality at Pulogadung Plant 1983 by PDAM

	Color (Unit)	Turbidity (NTU)	pH	Alkalinity (mg/l)	O. Matter (mg/l)	Fe (mg/l)	Mn (mg/l)	NH4-N (mg/l)	Faecal Coli (MPN)
	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.	Max. Min. Ave.
1. Raw Water									
a. March	150/ 150	207/ 124/54	7.1/6.9/6.5	75/50/40	25.4/13.4/6.2	1.2/0.95/0.8	trc	1.4/0.7/ 0.45	
b. September	150/ 150	25/ 20/ 6	7.3/7.2/7.1	167/118/80	48.9/27.4/11.0	1.3/0.6/0.45	trc	13.5/4.6/ 0.9	
c. Annual	150/ 150	207/53.6/13	7.5/7.0/6.5	167/78.5/35	72.6/17.7/3.4	8.8/1.0/trc	trc	24.1/1.95/0.05	
2. Clarified Water									
a. March		3.8/ 3.0/ 2.0							
b. September		5.1/ 4.0/ 3.2							
c. Annual		18.7/3.55/1.7							
3. Finished Water									
a. March	5 - 10	1.6/1.3/ 0.9	7.9/7.1/6.9	70/45/30	8/8/3.9/1.2	neg	neg	0/35/0.18/trc	
b. September	5 - 10	3.0/2.3/ 1.9	7.5/7.2/6.9	135/98/60	9.9/7.9/2.2	0/15/neg/neg	neg	0.9/ 0.68/0.15	
c. Annual	5 - 10	6.5/2.2/ 0.9	8.1/7.1/6.8	145/63.5/20	10.7/5.9/1.1	neg	neg	0.9/ 0.22/neg	

Date Source: Monthly Report, "Instalasi" 1983 by PDAM.

Heavy pollution of the river water is occuring upstream of the intake point. To alleviate this condition, a wall separating the Sunter water from the more polluted Cipinang water, all through the Sunter River from the confluence down to thie intake, has recently been constructed. Regarding water qualities of the source rivers, please refer to Appendix MIII-2.

(3) Raw Water of Mini-plants

There are seven mini-plants under operation, taking raw water from nearby water sources. Characteristics of the water qualities, taken from Tables 3.14, are summarized below. Their locations are shown on Fig 3.8 together with their water sources.

a. Raw water of the Cilandak and that of Pejaten presently have desirable quality, as the intake points are located in the sparsely populated area.

b. Raw water of Cakung sometimes had high concentrations of pollutants and chloride.

c. Raw water of Pesing, Muara Karang, Cengkarang and Sunter were seriously polluted, because their intakes are located in the congested area of the city. Besides raw water of the Pesing were affected by saline water for three months in 1982. Raw water of the Muara Karang has been colored by discharge of textile factories located along the water-way.

2) Treatment Condition

Treatment conditions of the existing plants, Pejompongan I and II, Pulogadung and mini-plants, and tap water quality will be reviewd, as described in the following, by the data of water quality furnished by PDAM, together with some additional field surveys. Based on the findings of the review, recommendations regarding improvements of the plants will be provided.

(1) Pejompongan I Plant

A. Treatment Conditions

Treatment processes practiced at the plant are pre-chlorination, coagulation using Alum and Polymer, sedimentation by Accelator, rapid sand filtration, pH control and disinfection. Table 3.12 shows water quality of clarified and filtered waters respectively in 1983. Major features of treated water quality are as follows:

a. Turbidity of the raw water was removed sufficiently by sedimentation, with the clarified water terbidity of 4.3 to 5.1 NTU in monthly average. Turbidity of the filtered water was between 1.3 to 1.6 NTU in the average, constantly below the Drinking Water Standard as shown in Table 3.15.

Table 3.14 Summary of the Mini Plants

Plant	Location	Water Source	Rated Capacity (l/sec)	Raw Water Quality: Ammonium (ppm)	Raw Water Quality: Organic Matter (ppm)	Raw Water Quality: Dissolved Oxygen (ppm)	Chemical Applications: Chloride (ppm)	Chemical Applications: Alum (ppm)	Chemical Applications: Chlorine (ppm)	Chemical Applications: Activated Carbon (ppm)	Treatment Condition
Cilandak	South JKT	Krukut R.	200	neg/neg	6.9/6.8	9.9/7.5	7.7/6.45	19.8/17	1.6/0.6	0	Desirable
Pejaten	South JKT	Ciliwung R.	5	trc/trc	20/8.3	10.5/7.3	17.8/10.2	44/38	4.1/3.6	-	Desirable
Cakung	East JKT	Irrigation Canal	25	70.6/-	26/9.9	10.5/7.0	112/14.9	78/52	5.2/2.0		Sometimes Undesirable
Pesing	North JKT	Mokervaart Canal	5	70.6/-	25/12.3	-	510/62	74/55	3.7/2.8	2/-	Undesirable
Muara Karang	North JKT	Banjir Canal	100	1.53/0.59	33.5/15	-	108/26	90/50	12.8/7.0	12/-	Undesirable
Cengkareng	North JKT	Angke R.	50	70.6/-	101/11.5	10.5/7.0	22.7/11.2	49/35	2.9/2.3	1/-	Sometimes Undesirable
Sunter	North JKT	Sunter R.	50	70.6/70.6	37.6/16.2	12/5.3	117/24.8	76/60	7.3/5.0		Undesirable

* maximum / average

Data Source: Monthly Report, "Instalasi" 1982 - 1983 by PDAM
Treatment Condition: Desiable means Treated water quality satisfies drinking water standard
Undesiable means Treated water quality does not satisfy drinking water standard

FIG 3.8 LOCATION OF THE EXISTING PLANTS AND RIVERS

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Table 3.15 Drinking Water Standard

Substances	(Unit)	Indonesia Standard (Highest desirable level)	Indonesia Standard (Maximum permissible level)	WHO International Standards (Highest desirable level)	WHO International Standards (Maximum permissible level)
Chemical Substances					
Total Solids	(mg/l)	500	1,500	500	1,500
Colour (plantinumcobalt)		5	50	5	50
Turbidity		5 mg/l	25	5 JTU	25
Taste		Unobjectionable		Unobjectionable	
Odor		"		"	
Iron (Fe)	(mg/l)	0.1	1.0	0.1	1.0
Manganese (Mn)	(mg/l)	0.05	0.5	0.05	0.5
Copper (Cu)	(mg/l)	0.05	1.5	0.05	1.5
Zinc (Zn)	(mg/l)	1.00	15	5.0	15.0
Calcium (Ca)	(mg/l)	75	200	75	200
Magnesium (Mg)	(mg/l)	30	150	30	150
Sulphates (SO4)	(mg/l)	200	400	200	400
Chlorides (Cl)	(mg/l)	200	600	200	600
pH	-	7.0 - 8.5	6.5 - 9.2	7.0 - 8.5	6.5 - 9.2
Total Hardness	(mg/l)		10°D	100	500
		(Upper limit of concentration)		(Upper limit of concentration)	
Toxic Substances					
Lead (pb)	(mg/l)		0.1	0.1	
Arsenic (As)	(mg/l)		0.05	0.05	
Selenium (Se)	(mg/l)		0.01	0.01	
Chronium (hexavalent) (Cr^{+6})	(mg/l)		0.05	-	
Cynide (Cn)	(mg/l)		0.05	0.05	
Cadmium (Cd)	(mg/l)		0.01	0.01	
Barium (Ba)	(mg/l)			-	
Phonolic Substances	(mg/l)	0.001	0.002	0.001	0.002
Substances which may affect Health					
Mercury (Hg)	(mg/l)		0.001	0.001	
Fluorides (F)	(mg/l)		2.0	0.6 - 1.7	
Nitrates (NO_3)	(mg/l)		20	-	
Chemical Indicators of Pollution					
COD	(mg/l)			-	
BOD	(mg/l)			-	
Total Nitrogen exclusive of NO_3	(mg/l)			-	
Ammonia	(mg/l)		0.0	-	
Carbon chloroform extract	(mg/l)				
Organic Matter ($KMnO_4$)	(mg/l)		10		
Bacteriological					
germs			0.0		
Pathogenic germs			0.0		
Faecal coli	N/100 ml		0.0		

b. Removal of Ammonium was not satifactory in the clarified water having almost same concentrations with that of the raw water. Moreover the filtered water had always positive sign of Ammonium not meeting the said standard.

c. Removal of Organic Matter was not sufficient, as its concentrations of more than 10 mg/l appeared in the clarified water in March, April, June to November and in the filtered water in August and September.

d. Color value of the clarified water was 8.2 units in annual average, and the filtered water sometimes exceede 5 units of the standard in spite of sufficient removals of Iron and Managese.

e. Faecal Coli appeared in 28 samples (22.8 %) out of 123 in the filtered water as seen in Table 3.16. Number of Faecal Coli were 300 and 500 MPN/100ml in the clarified water, and 1,500 and 3,000 MPN/100ml in the filtered water according to the field survey on 11th and 28th July 1984 as shown in Table 3.17.

B. Chemical Applications

a. Alum (17% as Al_2O_3) dosage has been increased year by year, and 30 to 40 mg/l in annual averages in the recent years. Besides monthly dosages of Alum are widely changable, having more dosages in the dry season as seen in Fig. 3.9.

b. Polymer, Zuccular, 0.02 to 0.05 mg/l, has been constantly dosed together with Alum for coagulation. It seems to prove its effectiveness for coagulation from the fact that Alum dosage of the plant was less than that of the Pejompongan II and the clarified water usually had turbidity of less than 10 NTU .

c. Chlorine dosage has been 1.5 to 2.4 mg/l in annual averages. Post-chlroine is constantly dosed though pre-chlorine of less than 1 mg/l is dosed mainly in the dry season. Pre-chlorine dosage is insufficient. Considering much Ammonium Concentration of the raw water, its chlorine requirement will be more than 20 mg/l in the dry season and 10 mg/l in the wet season.

d. Post-lime (50-70% as CaO_2) dosage has been 11 mg/l in annual average to adjust pH value of the finished water to 7.0. pH value of clarified water is between 6.0 and 7.0, average 6.3 according to PDAM's data in 1983 and to adjust pH value more than 7.0, post-lime is constantly dosed.

Pre-lime was not dosed, because sufficient Alkalinity for coagulation was present in the raw water.

e. Activated carbon has been added in the raw water on several days of the dry season to remove odor from the water. But the dosage of 1 to 3 mg/l was not always sufficient to remove odor.

Table 3.16 Positive Number of E. Coli at Clear Water

Plants/Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	%
Pejompongan I	0/11	2/12	4/12	2/12	2/12	2/10	4/8	5/12		3/11	1/12	3/11	28/123	22.8
" II	0/11	0/12	0/12	1/12	0/12	0/10	2/8	2/12		0/11	0/12	0/11	5/123	4.1
Pulogadung	0/4	0/4	0/4	0/4	0/4	1/4	0/4	0/4		0/4	1/5	0/4	2/45	4.4
%	0	7.1	14.3	10.7	7.1	12.5	35.3	25		11.5	6.9	11.5		12
Cilandak	0/1	0/1	0/1	0/1	0/1	0/1	0/1			1/1		0/1	1/10	10
Muara Karang	1/2	0/3	0/4	0/3	0/2	-	1/2	0/2		0/2	0/3	1/2	3/25	12
Sunter	0/2	0/3	0/3	1/2	1/3	0/1	-	0/1		0/2	0/2	0/1	2/20	10
Cengkareng						0/1	0/1	0/1		0/1	1/2	1/2	2/8	25
Cakung	0/4	0/4	0/4	2/4	0/4	0/4	1/4	0/4		0/4	3/6	0/4	6/46	13
Pejaten											0/1	1/1	1/2	50
Pesing	0/1		0/1	0/2	0/2	0/1	1/1	1/2		0/1	0/3	0/1	2/15	13.3
Total	1/36	2/39	4/41	6/40	3/40	3/32	9/29	8/39		4/37	6/46	6/38	52/417	12.5

Data Source: Monthly Report, "Instalasi" 1983 by PDAM.

Table 3.17 Number of Faecal Coli at the Three Plants

(JICA Study Team) (MPN/100 ml)

	Pejompongan I	Pejompongan II	Pulogadung ***
Date	11 July 1984	25 July 1984	27 July 1984
Raw water	6×10^7	5.4×10^5	1×10^7
Clarified water*	300	500	0
Filtered water*	1,500	900	0
Finished water**	-	100	-
Date	28 July 1984	26 July 1984	1 August 1984
Raw water	5.4×10^5	1.5×10^7	
Clarified water*	500	200	400
Filtered water*	3,000	400	0
Finished water	0	0	0

* Residual chlorine of the clarified and filtered water is nil at the Prjompongan and positive at the Pulogadung.

** No analysis is done for finished water for Prjompongan Plant I

*** Intermediate chlorination system is employed in Pulogadung Plant.

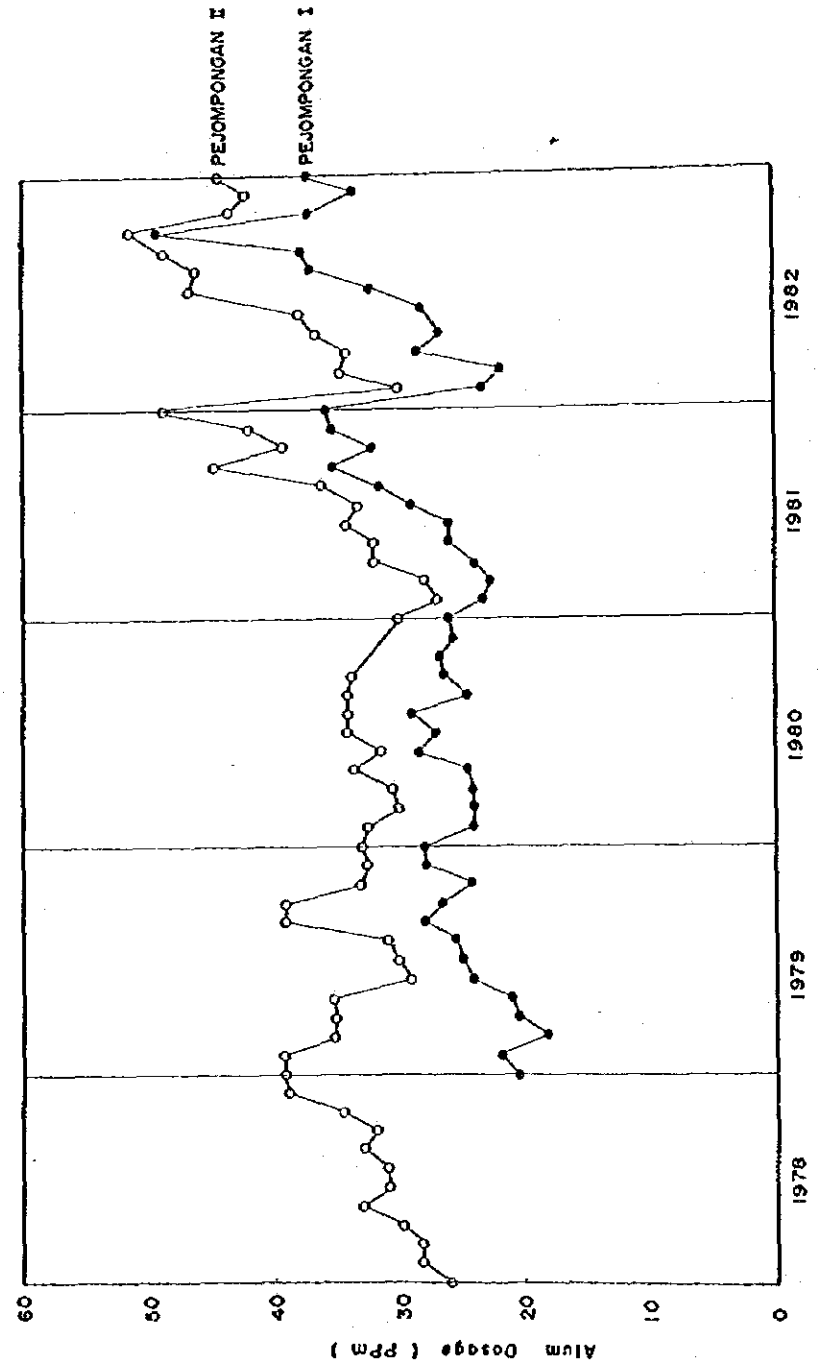

FIG 3.9 ALUM DOSAGE OF THE PEJOMPONGAN PLANTS (I AND II)

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C. Summary of Treatment Conditions

As reviewed above, removal of Ammonium, Organic Matter, Color and Faecal Coli is not satisfactory. This is partly due to insufficncy of chlorine dosage. However, even with an increase of chlorine dosage, safety of the finished water for drinking is jeopardized because of excessive pollution of raw water.

(2) Pejompongan II Plant

A. Treatment Conditions

Treatment processes employed are pre-chlorination, coagulation using Alum, sedimentation by Palsator, rapid sand filteration, pH control and disinfection. Table 3.12 indicates water qualities of clarified, filtered and finished waters respectively in 1983.

a. Removal of Turbidity was sufficient in the clarified water having 3.1 to 3.9 NTU in monthly average, and the Turbidities of the filtered and finished waters were 0.4 to 0.6 NTU in the annual average constantly below the Drinking Water Standard.

b. Ammonium of the clarified and filtered waters was as low as 0.1 and 0.045 mg/l in annual average, compared with 0.56 mg/l of Ammonium of the raw water. However, reliability of these figures is suspected, because Ammonium is not usually removed without pre-chlorination, and further the present field test detected 0.7 mg/l Ammonium in the clarified water and 0.65 mg/l Ammonium in the filtered water.

c. Concentrations of Organic Matter were frequently over 10 mg/l in the clarified water and sometimes exceeded its value in the filtered water.

d. Color values of the filtered and finished waters were always below 5 unit, the permissible value of the standard.

e. Faecal Coli in the finished water appeared in 5 samples (4 %) out of the 123 samples as already shown in Table 3.16. Faecal Coli remained in both clarified and filtered waters.

B. Chemical Applications

Chemical applications in the plant are summarized below according to the data monitored by PDAM.

a. Alum dosage has been raised year and year, and 35 to 45 mg/l in annual average in the recent year as shown in Fig. 3.9.

The increase of dosage may be due to aggravation of raw water pollution as seen from increasing concerations of Ammonium and Organic Matters as seen in Appendix MIII-2.

b. Chlorine dosage has been 1.5 to 4 mg/l in annual averages, and no tendency of annual increase has been seen. Post-chlorine for disinfection has been dosed constantly, though pre-chlorine was occasional in the dry season. These dosages are not enough for removal of Faecal Coli and Ammonium.

c. Post- lime has been dosed at a rate of 11 mg/l in average, to adjust pH value of the finished water. pH value of clarified water is between 5.8 and 6.5, average 6.1 according to PDAM's data in 1983, which is less than that of Pejompongan Plant I due to more Alum dosage.

d. Activated carbon of 1 to 3 mg/l has been occasionally added to the raw water in the dry season.

C. *Summary of Treatment Conditions*

Summary described for Pejompongan I applies to this plant as well.

(3) Pulogadang Plant

A. Treatment Conditions of Each Process

Treatment processes of this plant are pre-chlorination, coagulation using Alum, sedimentation by horizonted type, intermediate chlorination to the clarified water, rapid sand filteration, pH control and disinfection. Difference of the chemical application from the Pejompongan II plant is employment of intermediate-chlorination. Table 3.13 indicates water qualities of clarified and finished waters respectively in 1983.

a. Turbidity was removed sufficiently by sedimentation judging from its low values, 3.55 NTU in annual average and 2.5 to 5.7 NTU in monthly averages in the clarified water. The finished water had constantly low Turbidity below the Drinking Water Standard.

b. Ammonium almost always remained in the finished water not meeting the standard, and its concentrations were high during July to October probably because of its high concnetrations of the raw water in the same months.

c. Organic Matter in the finished water was sometimes above the standard in June to July.

d. Color values of the finished water were 5 to 10 units, generally exceeding the permissible value of 5 units of the standard.

e. Faecal Coli in the finished water appeared in 2 samples (4.4 %) out of 45 samples as described in Table 3.16.

B. Chemical Applications

Chemical applications in the plant are summarized below according to the data furnished by PDAM.

a. Alum dosage has been 40 to 70 mg/l in monthly average in 1983, having higher dosages during the period, July to October.

b. Pre and intermediate chlorines have been between 2 to 10 mg/l with higher dosages in the dry season. However, the dosages were not considered sufficient, as Ammonium, Organic Matter, Color and Faecal Coli remained in the finished water above the standard. Post-chlorine has been constantly dosed between 1 and 4 mg/l.

c. Post-lime for pH control of the finished water has been dosed at a rate of 15 mg/l in annual average through lime sarturation tank.

d. Activated carbon has been added at a rate of less than 3 mg/l for a few days during the dry season. But its dosages were not sufficient as positive of oder in the finished water.

C. Summary of Treatment Conditions

Ammonium, Organic Matter, Color and Faecal Coli are not satisfactorily removed. Although intermediate chlorination is practiced at this plant in addition to pre- and post chlorination, the total chlorination is not sufficient. It is supposed that unless chlorination should be reinforced, production of safe water might not be ensured under such advanced pollution of the present source water.

(4) Mini Plants

Mini Plants system serves drinking water to areas which are not covered by the distribution system of the Pejompongan and Pulogadung; location of seven mini plants are shown in Fig 3.8. Raw water quality and treatment conditions of the mini plants are summarized below based on the data of raw water quality and chemical applications monitored by PDAM as shown in Table 3.14.

a. The Cakung plant has raw water of high Ammonium and Organic Matter due to inflow of wastewater, and the finished water sometimes has positive sign of Faecal Coli.

b. The Cengkareng plant has raw water of very high Ammonium, Organic Matter and Odor in the dry season. Finished water seasonally has positive Ammonium and Odor in spite of dosage of Activated Carbon powder.

c. The Pesing plant has stopped its operation for three months from August to October 1982 due to saline water intrusion, and the raw water of this plant is usually very polluted.

d. The Muara Karang plant takes deteriorated raw water contaminated by domestic and industrial wastes having high concentrations of Ammonium, Organic Matter, Detergent, Color and Odor. Finished water frequently exceeds the Drinking Water Standard on the above quality parameters.

e. The Sunter plant also has polluted raw water, and finished water often has positive Ammonium, Faecal Coli and Odor not meeting the standard.

f. Other plants, Ciladak and Pejaten presently have desirably raw water quality usually below the Raw Water Standard. Both plants have good treatment conditions having good operation and adequate finished water quality.

(5) Tap Water Quality

Number of samples tested in 1981 to 1983 is shown in Tables 3.18 and 3.19. The summary of findings of tap water conditions is as follows:

a. Tap water in the whole served area except the central area shows high positive sign of Faecal Coli more than 20 % of the total samples. (Fig. 3.10)

b. Appearance of positive signs of Faecal Coli was higher in July through December than other months in 1983 in the whole served area.

c. The following are considered to be reasons for presence of Faecal Coli in the tap water.

   i. Faecal Coli remains in the finished water of the existing treatment plants due to insufficient disinfection. This remaining Faecal Coli may be growing in the distribution pipelines.

   ii. As there are areas where water pressure is very low, there may be cases the pressure becomes negative due to suction by pump and polluted ground water infiltrates in the pipes. Then the polluted water containing Faecal Coli may be possibly distributed.

(6) Recommendations

The following are recommendations for improving present undesirable treatment conditions.

a. The water taken in at the existing major treatment plants is so polluted that treatment of such water is almost beyong the capability of ordinary plant. Therefore, the intake sites are recommended to be relocated to upstream of West Tarum Canal where no or little pollution is observed.

Table 3.18 Positive Paecal Coli in Tap Water

Location	Total			Month (1981 - 1983)												Three Years
Jakarta	1981	1982	1983	1	2	3	4	5	6	7	8	9	10	11	12	Total
West																
Positive/Total	20/156	29/131	36/165	5/40	5/42	2/39	7/40	6/38	8/39	9/40	9/26	11/40	9/40	6/40	9/28	85/452
Positive %	12.8	22.1	21.8	12.5	11.9	5.1	17.5	15.8	20.5	22.5	34.6	27.5	22.5	15.0	32.1	18.8
East																
Positive/Total	23/81	14/68	29/95	9/21	4/22	0/20	8/21	2/22	6/22	4/22	7/15	6/21	4/22	7/22	9/14	66/244
Positive %	28.4	20.6	30.5	42.8	18.2	0	38.1	9.1	27.3	18.2	46.7	28.6	18.2	31.8	64.3	27.0
South																
Positive/Total	9/75	12/59	20/71	4/19	2/18	1/18	0.18	5/17	3/18	8/18	4/12	9/19	6/19	2/17	0/12	41/205
Positive %	12.0	20.3	28.1	21.1	11.1	5.6	0	29.4	16.7	44.4	33.3	47.4	31.6	11.8	0	20.0
North																
Positive/Total	27/82	21/71	20/95	4/22	4/23	7/21	4/20	7/21	2/21	10/22	8/15	6/23	9/23	5/22	3/15	68/248
Positive %	32.9	29.6	23.0	18.2	17.4	33.3	20.0	33.3	9.5	45.4	53.3	26.1	39.1	22.7	20.0	27.4
Central																
Positive/Total	4/182	8/148	12/192	0/47	2/44	1/45	1/40	1/47	0/46	8/47	1/31	5/48	2/47	1/48	2/32	24/522
Positive %	2.2	5.4	6.3	0	4.5	2.2	2.5	2.1	0	17.0	3.2	10.4	4.2	2.1	6.3	4.6
Dole Jakarta																
Positive/Total	83/576	84/477	117/613	22/149	17/149	11/143	20/139	21/145	19/146	39/149	29/99	37/151	30/151	21/149	23/101	184/1,666
Positive %	14.4	17.6	18.9	14.8	11.4	7.7	14.4	14.5	13.0	26.2	29.3	24.5	19.9	14.1	22.8	17.0

Table 3.19 Number of Faecal Coli in Tap Water 1983, Monthly Report by PDAM

(MPN/100ml)

Month Location	1	2	3	4	5	6	7	8	9	10	11	12	Positive/ Total
1. West Jakarta	460 4	2,400 23	2,400 4	-	460 43	31 9	75 15 7 4 4	43 21 9 4	460 93 23 4	2,400 1,100 460 240 43 9	93 9 9	93 43 23 4	36/165 (21.8%)
2. Central Jakarta	-	-	4	-	-	-	460 400 93	23	98 4 4	2,400 1,100	-	460 4	12/192 (6.3%)
3. East Jakarta	240 210 43 43	75	-	93 15 9 9	-	43 4	4	43 7	2,400 43 23 4	210 9	210 9	460 240 240 240 93 4 4	 29/95 (30.5%)
4. North Jakarta	21	240	9 4	-	9 4	-	15 4 4	150 93 23 4 4 4	240 4	1,100 1,100 23	-	-	 20/95 (23.0%)
5. South Jakarta	460	-	-	-	93 23	-	1,140 9 4 4	28 21 9 4	2,400 2,400 1,100 7 4	240 43 21 7	-	-	 20/71 (28.2%)

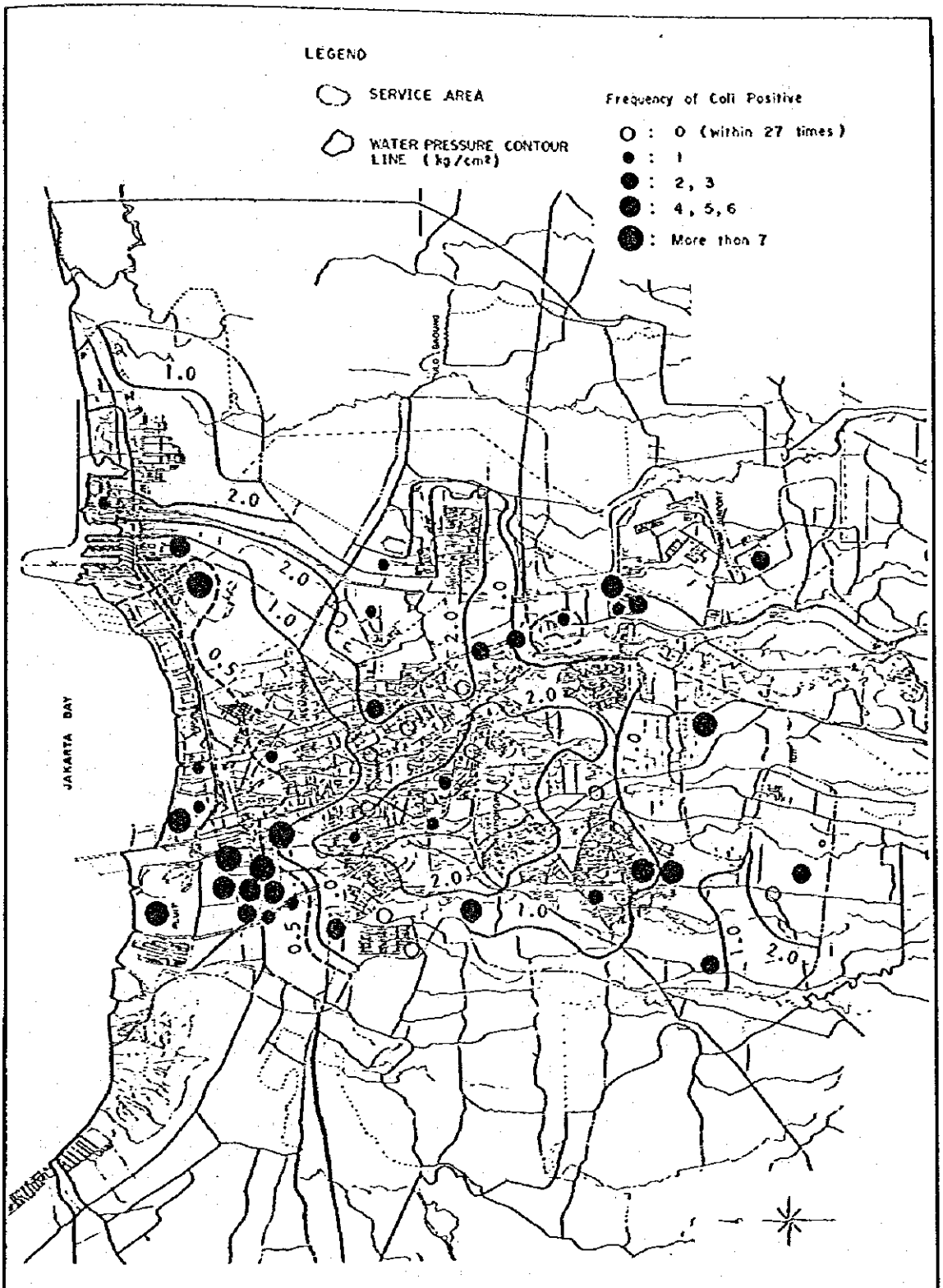

FIG 3.10 DISTRIBUTION OF COLIFORM POSITIVE IN TAP WATER

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b. Until the recommendation of the above item is realized, chlorination should be strengthened so as to eliminate the danger of water-borne diseases.

c. Thick floating scum presently exists at the flocculation and sedimentation basins at the Pulogadung plant. The scum should be removed. To this end, showering system is recommendable.

d. Whether or not to maintain the mini-plants of Muara Karang, Pesing, Sunter, Cakung and Cengkareng should be reviewed when the present expansion projects are completed, considering the present extreme pollution of the raw water,

e. Analyses of Water Quality

   i. Quantitative analysis of Ammonium should be carried out daily at the Pejompongan I and II for grasping condition of raw water quality and dosing optimum chemicals.

   ii. Water quality of the clarified water in some parameters should be measured at the Pulogadung to know treatment condition every day.

   iii. Daily analysis of Faecal Coli in the clarified, filtered and finished waters of the three plants should be carried out together with analysis of free and combined residual chlorines.

f. Training of Plant Operators

   i. Making up operation manual of each treatment plant such as chemical applications desludging and backwashing.

   ii. Training of operators for chemical application and operation of treatment facilities

   iii. Training of laboratory staff on water quality analysis and its implications

   iv. Organizing close operation between plant operation and laboratory staff