The salient features of the conveyance sewer are shown in Table 5.5. The sewer alignment is shown in Fig. 5.6, and its longitudinal profile is shown in Fig. 5.7.

5.3 Treatment Plant

The aerated lagoon treatment plant will be constructed at Pluit Pond. The pond will be used for a multipurpose of flood control and wastewater treatment. The treatment plant will treat wastewater of the integrated area of the Project Area and JSSP Area by 2000. Design influent wastewater to the treatment plant is determined at 441,000 m^3/d for the target year 2000 and 529,000 m^3/d for the year 2010. This design wastewater discharge includes wastewater of the JSSP Area of 124,800 m^3/d for 2000 and 136,000 m^3/d for 2010 respectively. Design water quality of influent and effluent wastewater is 200 mg/l and 30 mg/l as BOD respectively. Design water quality of influent and effluent of wastewater is 200 mg/l and 30 mg/l as BOD respectively.

The proposed treatment plant includes inflow pump station, aerated lagoon, facultative pond, disinfection facilities and drying bed. Among them, disinfection facilities will not be installed until 2000.

(1) Inflow Pump Station

A pump station of 454 m^3/min. capacity will be installed by the year 2000. Additional pumps with a total capacity of 98 m^3/min. will further be provided by 2010. The design pump head is 20m. The salient features of the pump station are shown in Table 5.6. Layout of the pump station is shown in Fig.5.8(1)-5.8(4).

(2) Aerated Lagoon and Facultative Pond

The wastewater will be treated initially by aerated lagoon with a storage capacity of 1,075,000m3 and a surface area of 21.5 ha, and finally with facultative pond. For aeration, 24 units of aerator will be installed by 2000, which would be increased to 59 units by 2010.

The aerated lagoon is designed in such a manner that the existing flood control function of the Pluit Pond remain unaffected. Design water level and other structure level of the aerated lagoon are as follows.

(Unit: P.P.m)

High water level	:	0.90
Normal water level	:	-1.00
Aerated lagoon operation level	:	-1.00
Low water level	:	-1.90
Crown elevation of aerated lagoon embankment	:	+1.50
Elevation of aerated lagoon weir	:	-1.90

The construction of aerated lagoon includes embankment of 1,600m in length and dredging of 340,000m^3.

The effluent of aerated lagoon will finally be treated by the facultative pond with a storage capacity of 2,096,000m^3 having a surface area of 52.4 ha.

The salient features of the aerated lagoon are shown in Table 5.6. Layout of the aerated lagoon is shown in Fig. 5.9. Flow-diagram of the treatment plant is shown in Fig. 5.10. Design water level of the treatment plant and pump station is shown in Fig. 5.11.

Table 5.1 Numbers of House Connection by Sub-Zone

Sub Zone	2000			2010		
	Domestic	Others	Total	Domestic	Others	Total
A	16,500	4,500	21,000	18,200	7,000	25,200
B	9,200	2,000	11,200	9,600	3,000	12,600
C	3,100	300	3,400	4,100	400	4,500
D	7,500	1,300	8,800	7,900	1,700	9,600
E	29,100	8,700	37,800	30,000	11,100	41,100
F	8,600	1,600	10,200	9,400	2,200	11,600
G	22,000	600	22,600	22,800	600	23,400
Total	96,000	19,000	115,000	102,000	26,000	128,000

Table 5.2 Tertiary and Secondary Sewers in Sewerage Area

	Area (ha)	Earth Covering Depth (m)	Sewer Line Length Upper: (m) Lower: (m/ha)					Nos. of Manhole Upper:(Unit) Lower:(Unit/ha)
			ø 150 mm	ø 200 mm	ø 250 mm	ø 300 mm	Total	
Conventional Area (Type = A) Kel. Gondang Dia)	101.8	H < 2.0 m	3,605 (35.4)	4,315 (42.4)	0 (0.0)	0 (0.0)	7,920 (77.8)	109 (1.1)
		2.0 < H < 4.0 m	0 (0.0)	955 (9.4)	1,715 (16.8)	755 (7.4)	3,425 (33.6)	48 (0.5)
		Total	3,605 (35.4)	5,270 (51.8)	1,715 (16.8)	755 (7.4)	11,345 (111.4)	157 (1.5)
Conventional Area (Type B) Kwl. Cideng	99.5	H < 2.0 m	9,950 (100.0)	2,975 (29.9)	55 (0.5)	0 (0.0)	12,980 (130.4)	218 (2.2)
		2.0 < H < 4.0 m	0 (0.0)	1,220 (12.3)	1,700 (17.1)	1,225 (12.3)	4,145 (41.7)	70 (0.7)
		Total	9,950 (100.0)	4,195 (42.2)	1,755 (17.6)	1,225 (12.3)	17,125 (172.1)	289 (2.9)
Interceptor Area Kel. Duri Utara Kel. Duri Selatan	73.4	H < 2.0 m	-	-	1,970 (26.8)	840 (11.4)	2,810 (38.2)	44 (0.6)
		2.0 < H < 4.0 m	-	-	80 (1.1)	1,325 (18.1)	1,405 (19.2)	22 (0.3)
		Total	-	-	2,050 (27.9)	2,165 (29.5)	4,215 (57.4)	66 (0.9)

Table 5.3 Proposed Collection Sewer by Sub-Zone

(unit : m)

Sewer Size (mm) \ Sub-zone	A	B	C	D	E	F	G	Total
150	31,400	12,400	19,900	20,500	61,200	14,900	43,800	204,100
200	27,200	5,200	8,400	8,700	25,800	6,300	18,500	100,100
250	15,000	5,700	3,900	7,100	35,400	6,300	10,200	83,600
300	10,800	5,200	2,800	6,200	33,500	5,700	8,000	72,200
Secondary/Tertiary	84,400	28,500	35,000	42,500	155,900	33,200	80,500	460,000
350	2,105	275	1,390	735	875	315		5,695
400	1,385	710	450	1,120	2,915	550	1,490	9,070
450	980	1,200		635	5,930	805	800	10,350
500	1,360	360		460	3,320	490	1,370	7,360
600	2,430	1,060		485	4,020	2,445	920	11,360
700	2,535	1,080		1,245	1,605	860	1,620	8,945
800	1,085	250	690	1,470	2,630	360	690	7,175
Main	12,330	4,935	2,530	6,150	21,295	5,825	6,890	59,955
900	1,995	35	1,285	1,150	2,545	85	1,420	8,515
1000				20	2,015		955	2,990
1100					1,525			1,525
1200					120		1,090	1,210
1350					2,780		150	2,930
1500					120			120
Trunk	1,995	35	1,285	1,170	9,105	85	3,615	17,290
Force Main	500	-	-	-	-	-	240	740
Total	99,225	33,470	38,815	49,820	186,300	39,110	91,245	537,985

Table 5.4 Lift Pump Station at Kel. Jelambar Baru

Year	2000	2010
Design Discharge	1.051 m3/sec	1.188 m3/sec
Lift Pump	36 m3/min x (1 unit + 1 unit standby) 18 m3/min x 2 units With hydraulic head of 17 m	

Table 5.5 Proposed Conveyance Sewer

Line No.	Location		Diameter	Length	Slope	Design Wastewater
	Origin	End	(mm)	(m)	1/1000	(m3/s)
S1	Jl. Madiun	Hotel Indonesia	1,900	1,385	1.2	3.494
S2	Hotel Indonesia	Jl. Kebon Sirih	2,100	1,110	1.2	4.077
S3	Jl. Kebon Sirih	Jl. Medan Merdeka Utara	2,200	1,460	1.2	4.721
S4	Jl. Medan Merdeka Utara	Jl. Sukarjo Wiryopranoto	2,300	1,300	1.2	5.357
S5	Jl. Sukarjo Wiryopranoto	Jl. Raya Mangga Besar	2,400	1,110	1.2	6.299
S6	Jl. Raya Mangga Besar	Jl. Jembatan Bambu	2,600	1,320	1.1	7.333
S7	Jl. Jembatan Bambu	Jl. Kunir	2,700	560	1.1	8.350
S8	Jl. Kunir	Jl. Pejagalan	2,700	660	1.1	8.549
S9	Jl. Pejagalan	Treatment Plant	2,900	1,435	1.0	9.695
			Total	10,340	-	-

Note : Design wastewater is hourly maximum includung groundwater infiltration.

Table 5.6 Treatment Plant at Pluit Pond

Year	2000	2010
(1) Design Wastewater (including desludge from on site facilities)	441,000 m3/d (190 m3/d)	529,000 m3/d (411 m3/d)
Wastewater Quality in BOD		
Influent	200 mg/l	200 mg/l
Effluent	30 mg/l	30 mg/l
(2) Inflow Pump Station		
Space	2 Station 21m x 37m	2 Station 21m x 37m
Inflow pump	ø 900 x 98 m3/min x 20m(H) 3 units + 1 unit standby	ø 900 x 98 m3/min x 20m(H) 4 units + 2 units standby
	ø 600 x 40 m3/min x 20m(H) 4 units	ø 600 x 40 m3/min x 20m(H) 4 units
(3) Aerated Lagoon	Area ; 21.5 ha, Capacity ; 1,075,000 m3	
Excavation	340,000 m3	
Embankment	1,600 m	
Operational water level	P.P. -1.00 m	
Bottom elevation	P.P. -6.00 m	
Crown elevation of embankment	P.P. +1.50 m	
Elevation of weir	P.P. -1.90 m	
Aerator	24 units x 75 kw	59 units x 75 kw
Retention time	1 day for aerated lagoon and 1.4 days for Faculltative pond	2 days
(4) Faculltative pond	Area ; 52.4 ha, Capacity ; 2,096,000 m3	
Operational water level	P.P. -1.00 m	
Effective water depth	4 m	
Retention time	5 days for maturation pond	4 days
(5) Disinfection Building	-------	660 m2
(6) Chlorine Injection	-------	4 units + 1 unit standby 0~3.8 l / min / unit
(7) Drying Bed	2,000 m2	6,000 m2

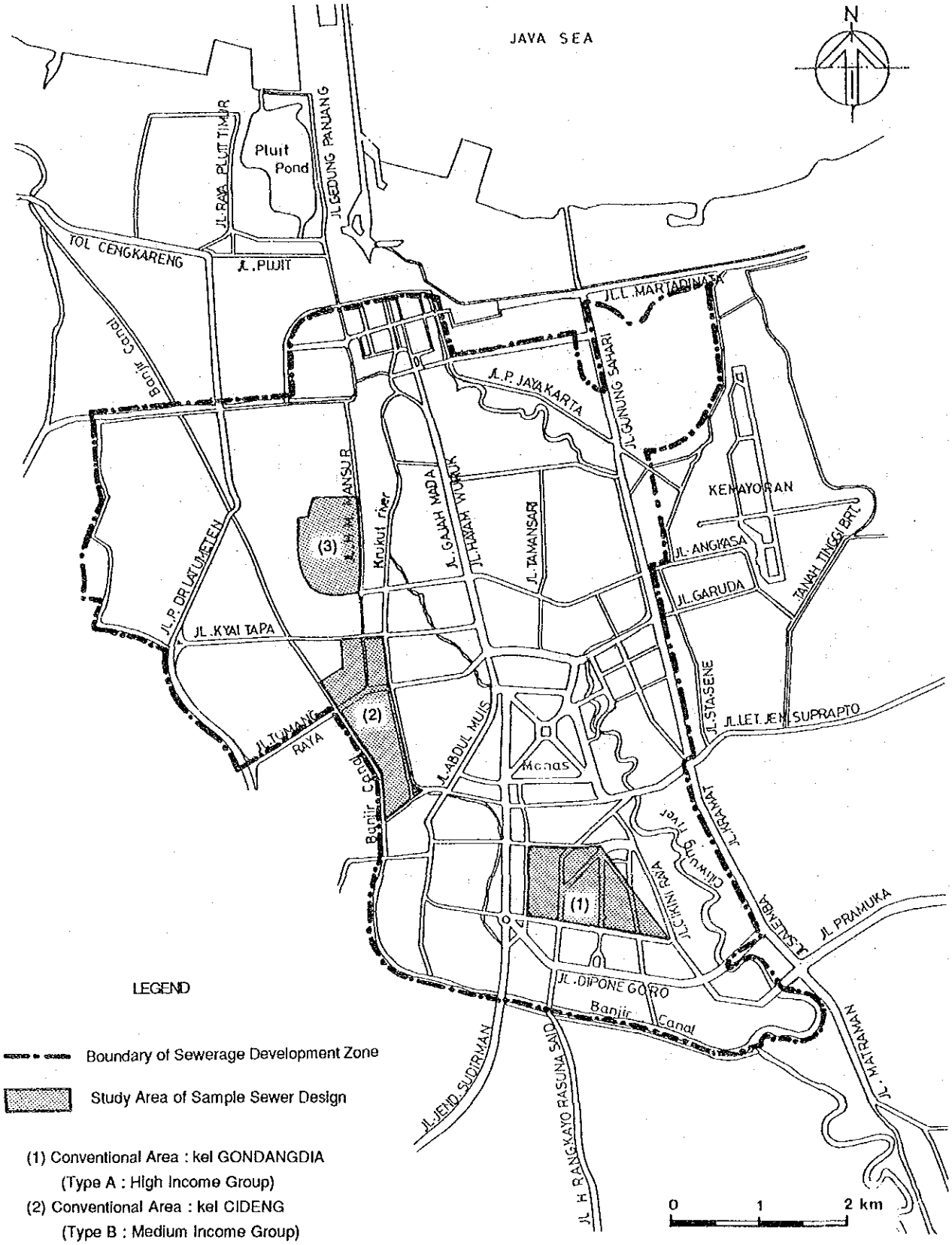
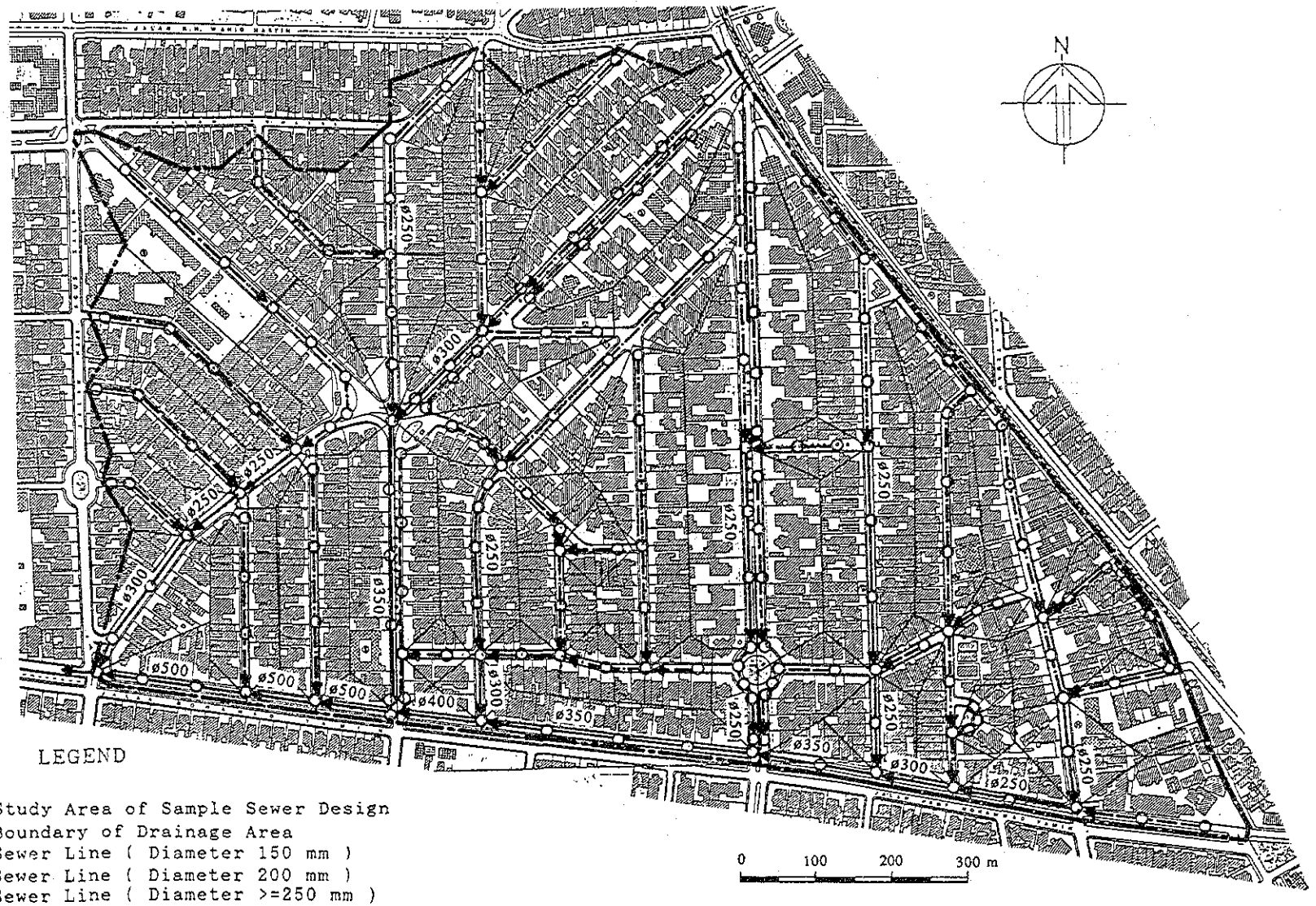


FIG. 5.1 LOCATION OF SAMPLE SEWER DESIGN

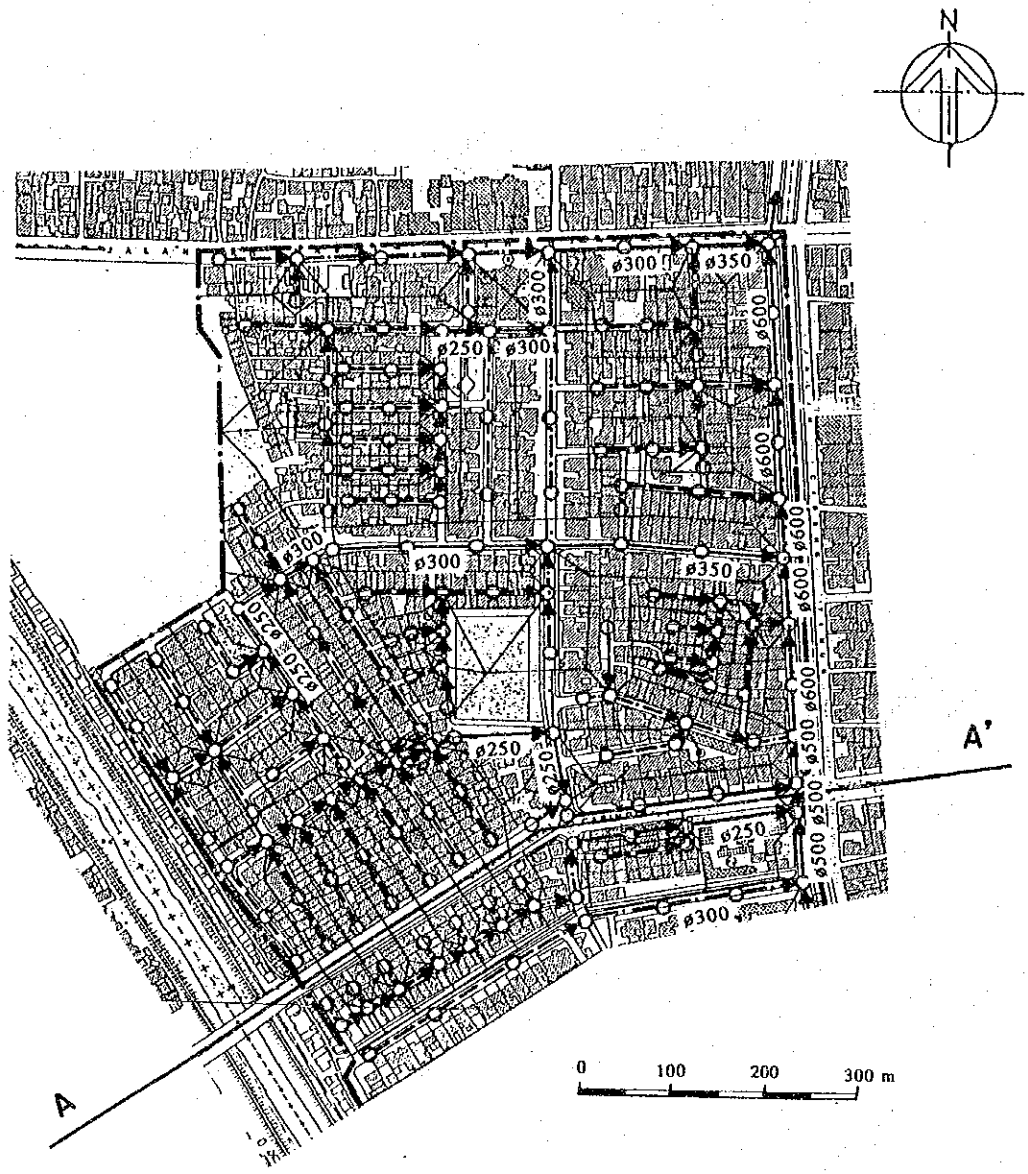
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



LEGEND

- Study Area of Sample Sewer Design
- Boundary of Drainage Area
- Sewer Line (Diameter 150 mm)
- Sewer Line (Diameter 200 mm)
- Sewer Line (Diameter >=250 mm)
- Manhole

FIG. 5.2	SEWER DESIGN IN TYPICAL AREA TYPE A
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA	



LEGEND

- Study Area of Sample Sewer Design
- Boundary of Drainage Area
- Sewer Line (Diameter 150 mm)
- Sewer Line (Diameter 200 mm)
- Sewer Line (Diameter >=250 mm)
- Manhole

FIG. 5.3(1) SEWER DESIGN IN TYPICAL AREA TYPE B (1)

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

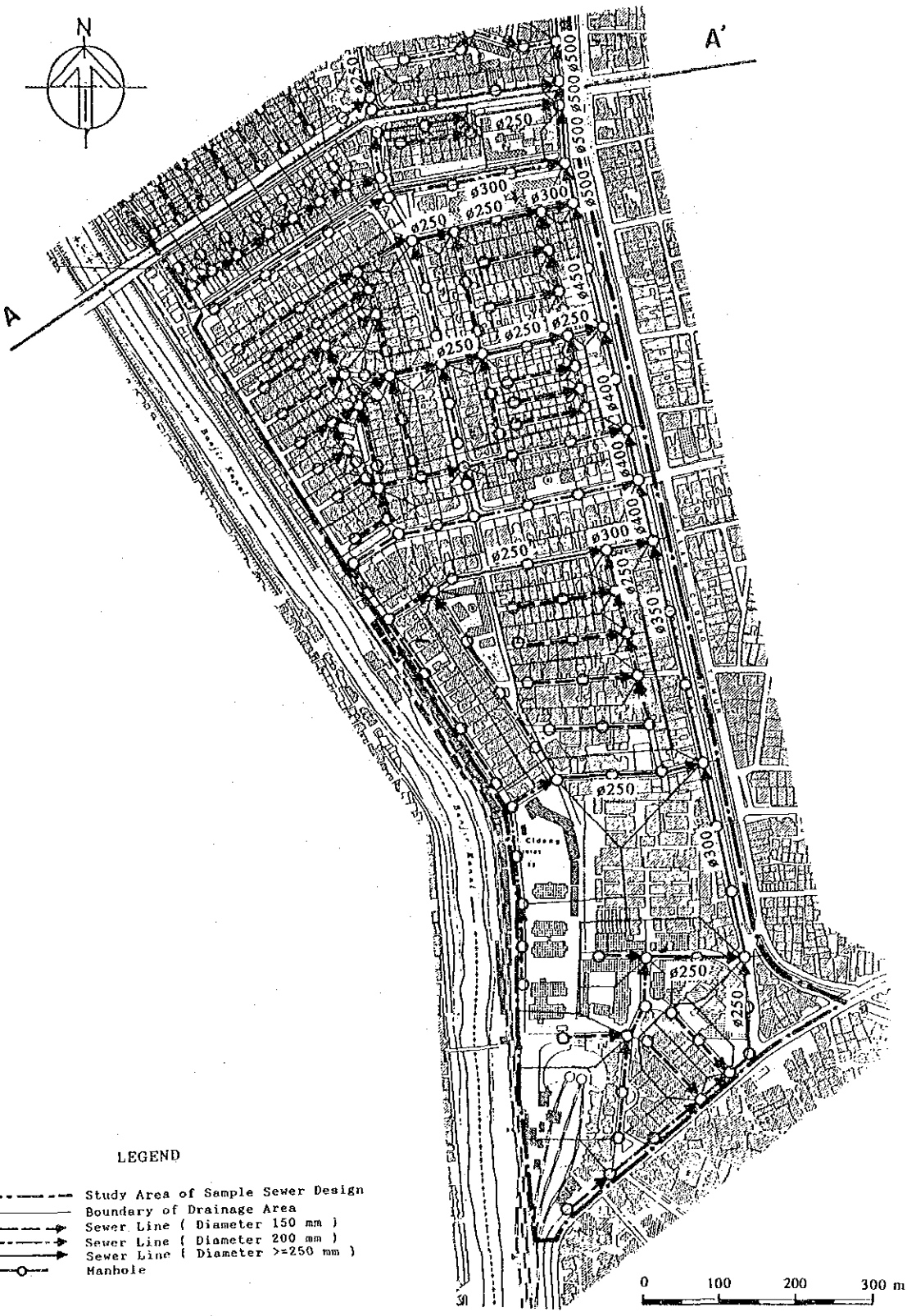
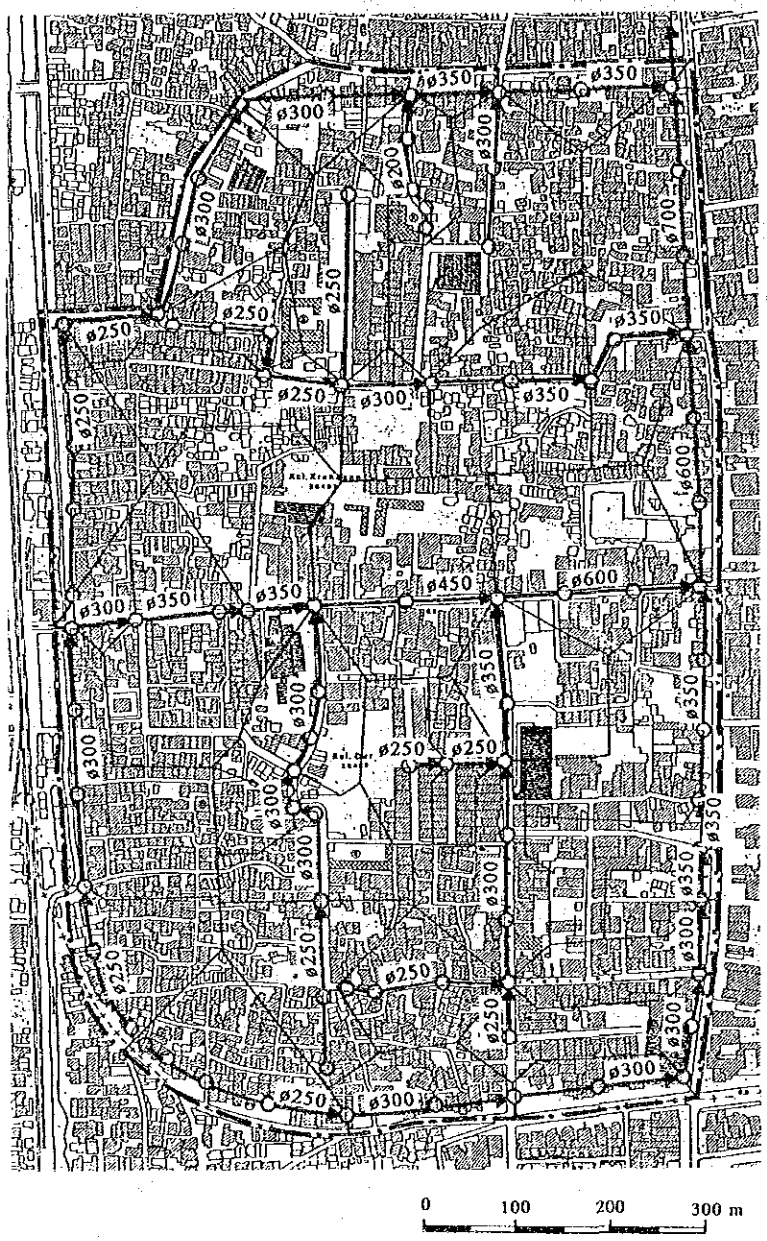


FIG. 5.3(2) SEWER DESIGN IN TYPICAL AREA TYPE B(2)

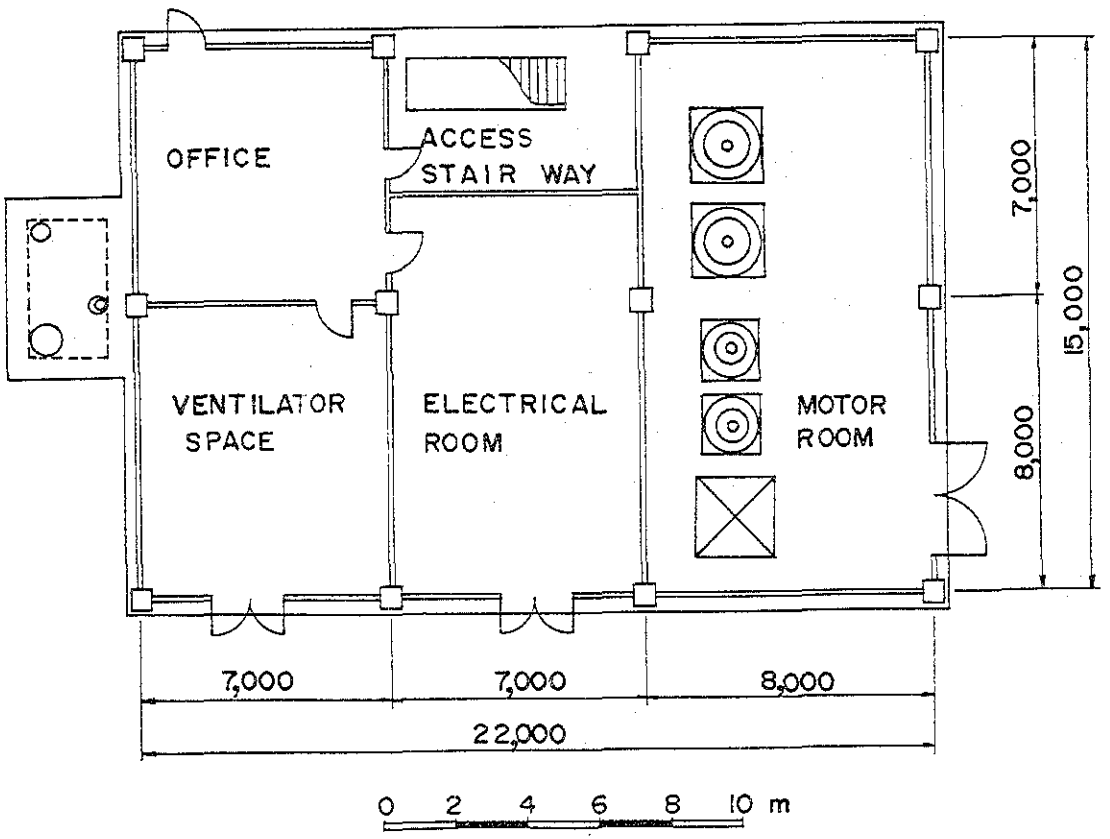
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



LEGEND

- Study Area of Sample Sewer Design
- Boundary of Drainage Area
- Sewer Line
- Manhole

FIG. 5.4 SEWER DESIGN IN TYPICAL AREA TYPE (C)



NOTE
Dimension in mm

LIFT PUMP STATION (KEL. JELAMBAR BARU)

FIG. 5.5(1)	PROPOSED LIFT PUMP STATION

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

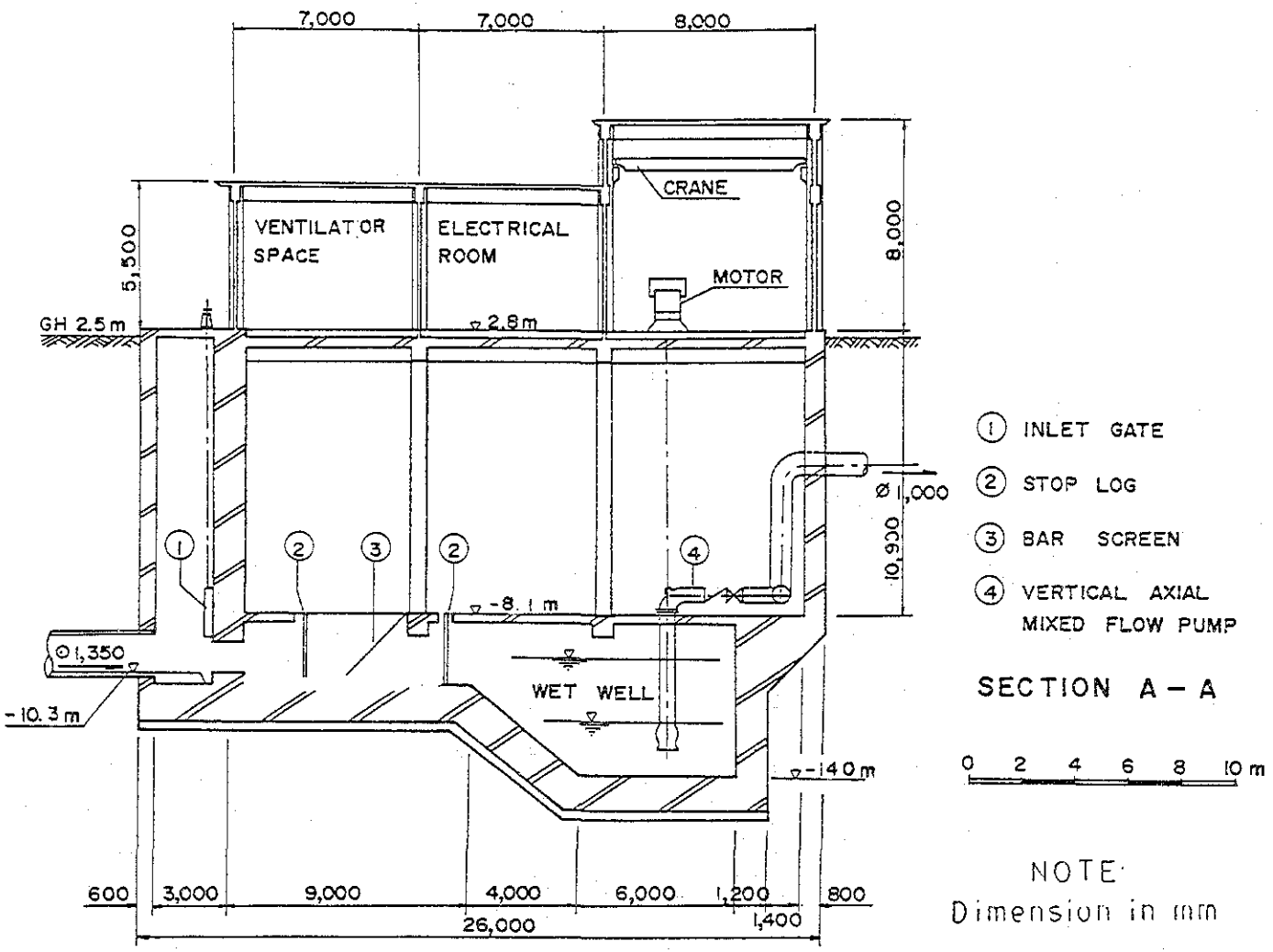
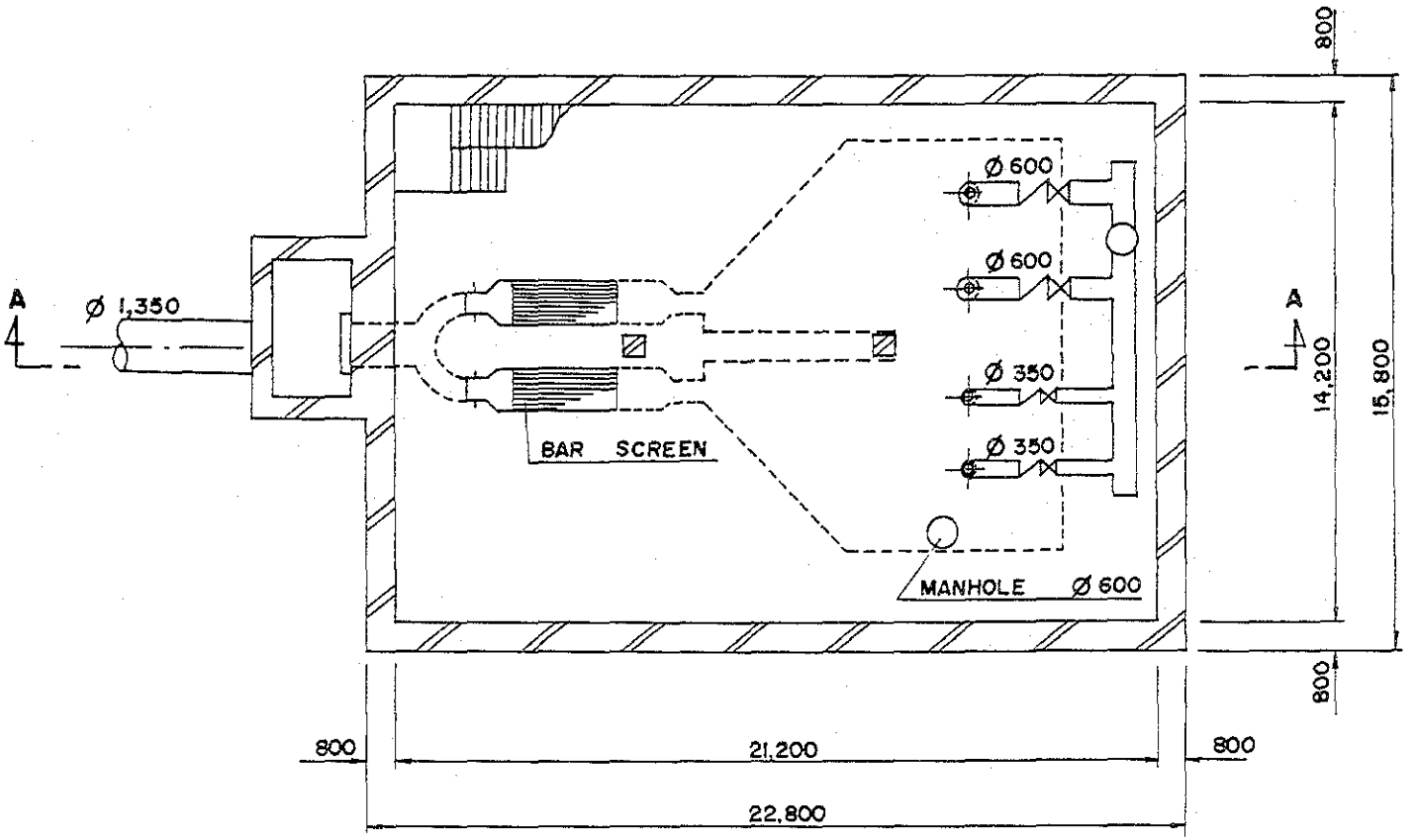


FIG. 5.5(2) PROPOSED LIFT PUMP STATION

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



B - 1 FLOOR

0 2 4 6 8 10 m

NOTE:
Dimension in mm

FIG. 5.5(3) PROPOSED LIFT PUMP STATION

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

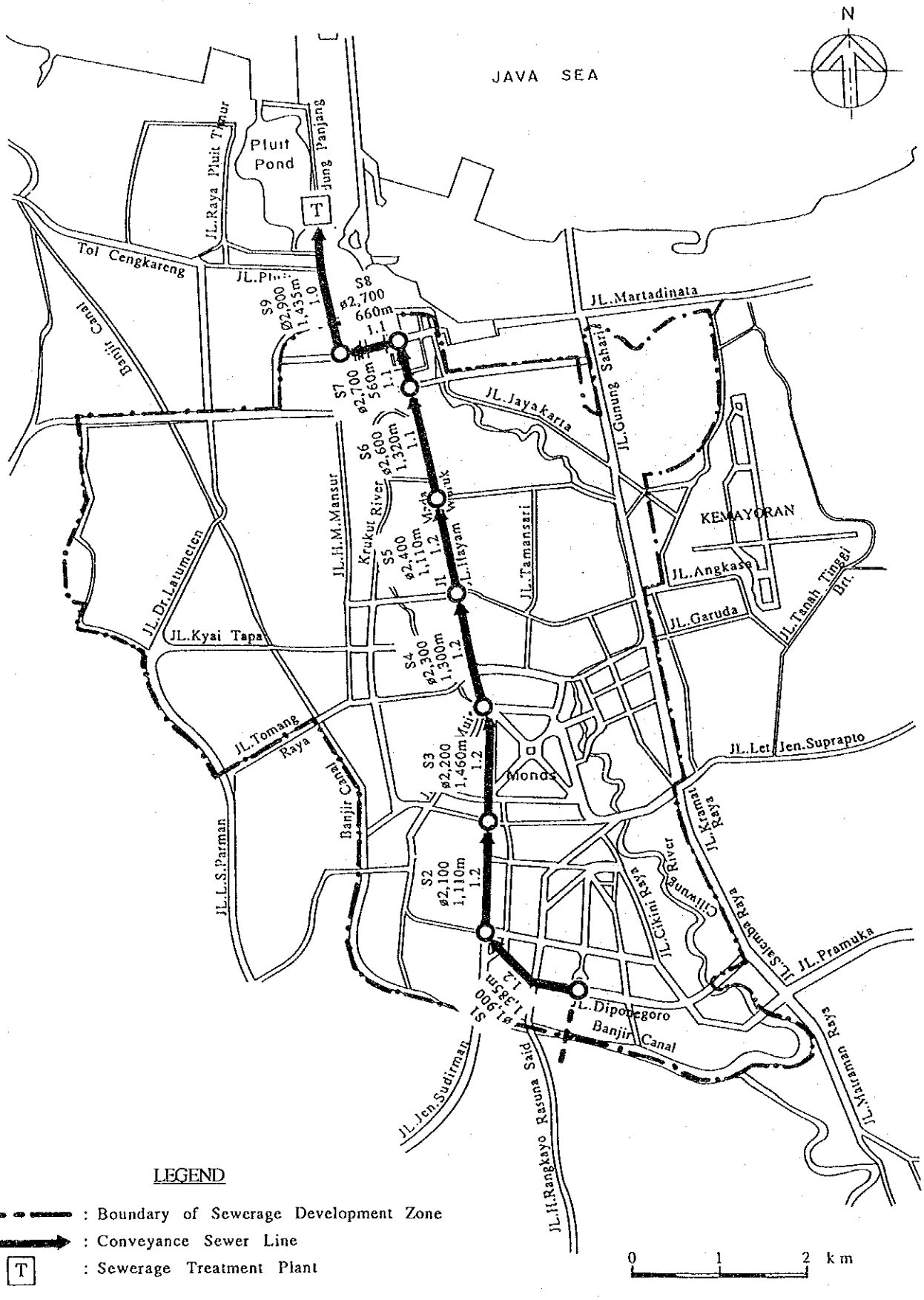


FIG. 5.6 PROPOSED CONVEYANCE SEWER ALIGNMENT

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

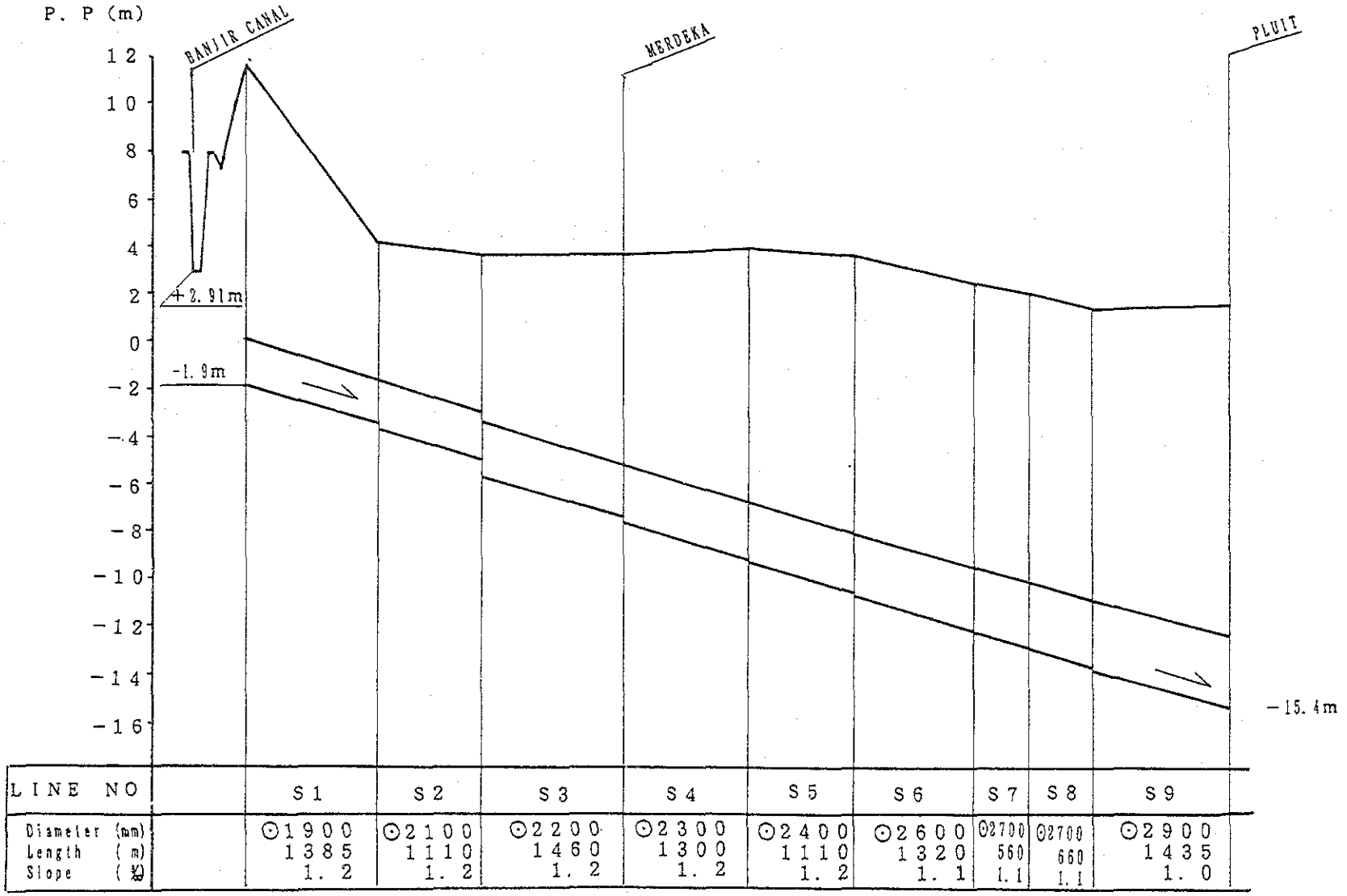
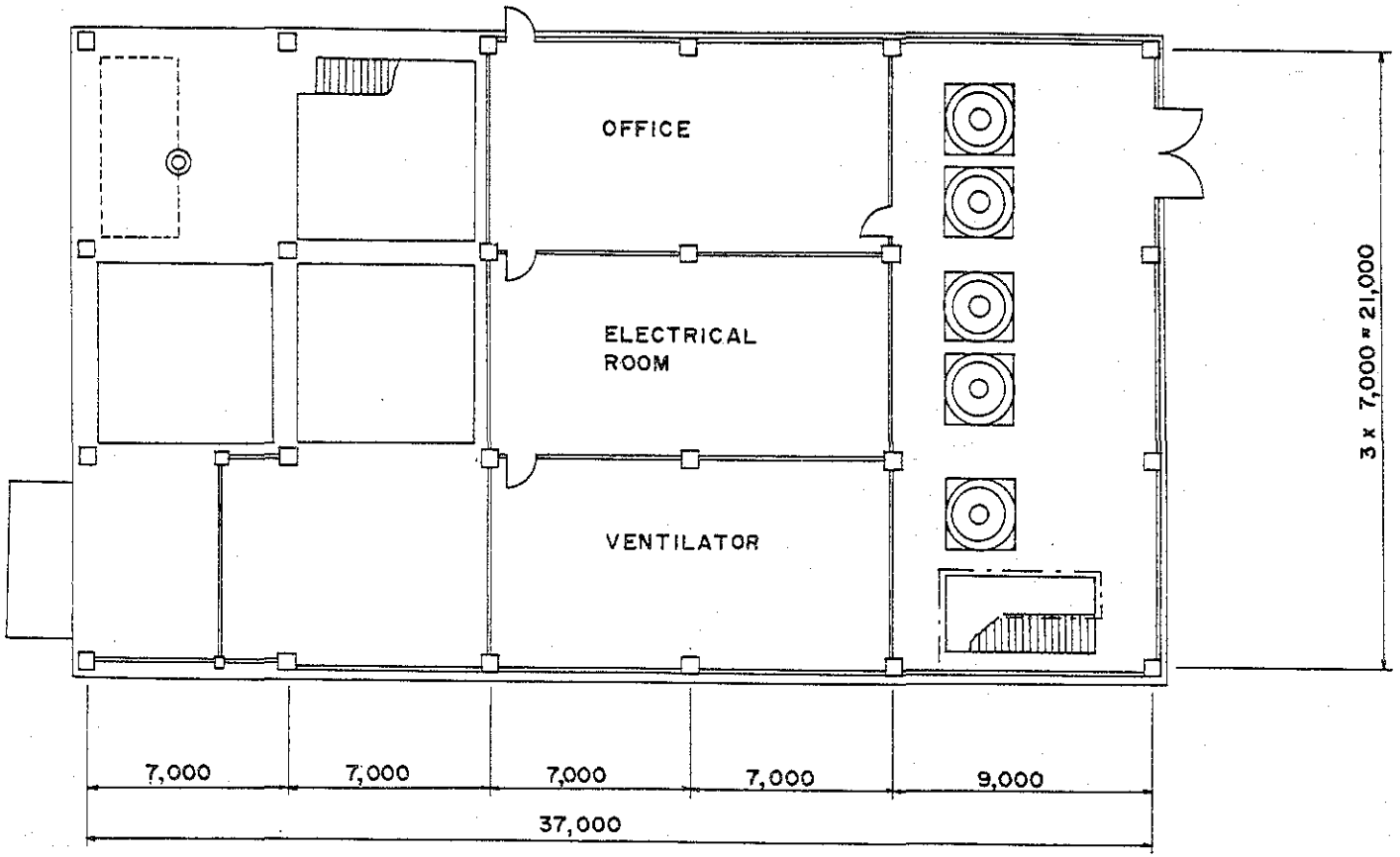


FIG. 5.7 PROFILE OF CONVEYANCE SEWER

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



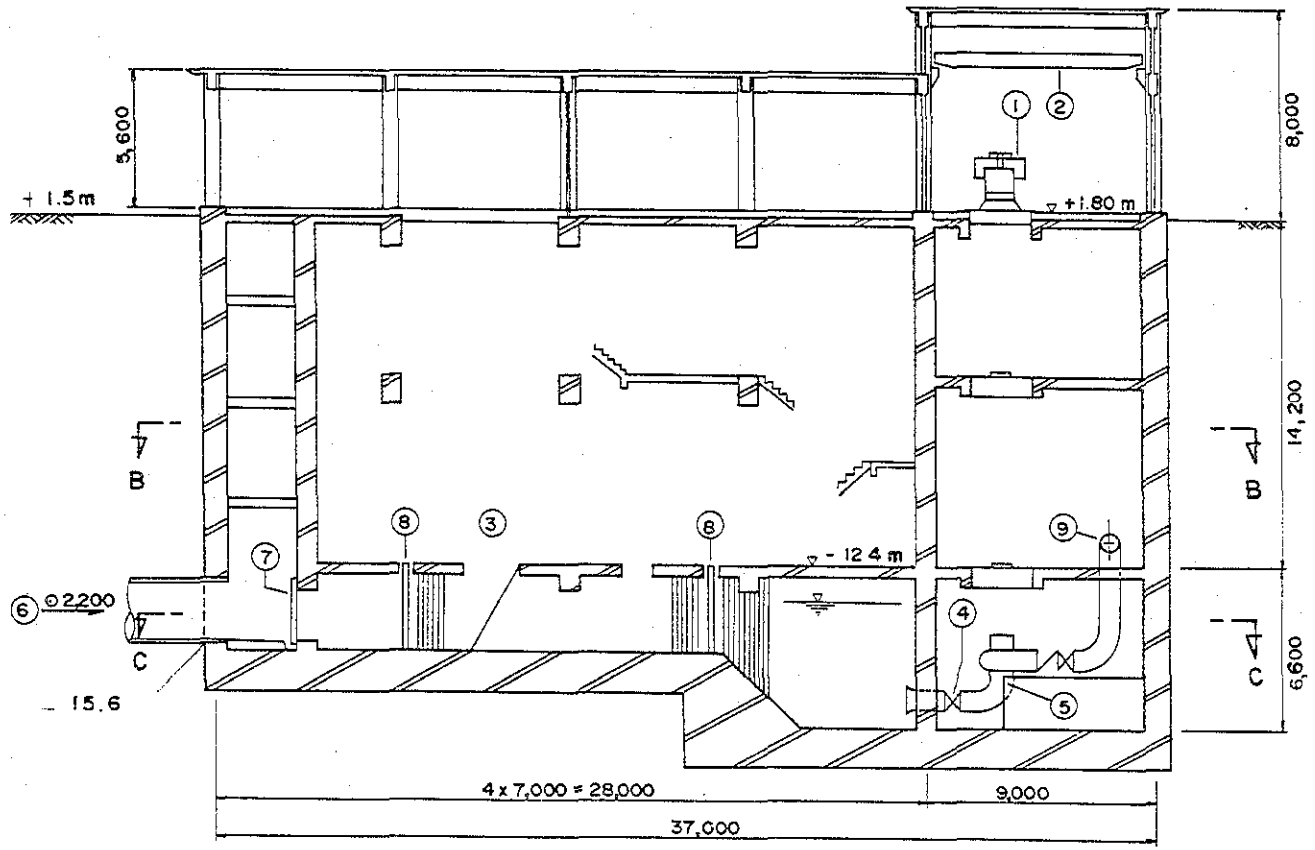
GROUND FLOOR LEVEL

PLUIT PUMP STATION

NOTE
Dimension in mm

FIG. 5.8(1) PROPOSED INFLOW PUMP STATION

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



① Motor
② Crane & Hoist
③ Bar Screen
④ Valve
⑤ Volute Mixed Flow Pump
⑥ Inlet Pipe
⑦ Inlet Gate
⑧ Stop Log
⑨ Outlet Pipe

SECTION A – A

NOTE: Unit in mm

FIG. 5.8(2) PROPOSED INFLOW PUMP STATION

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

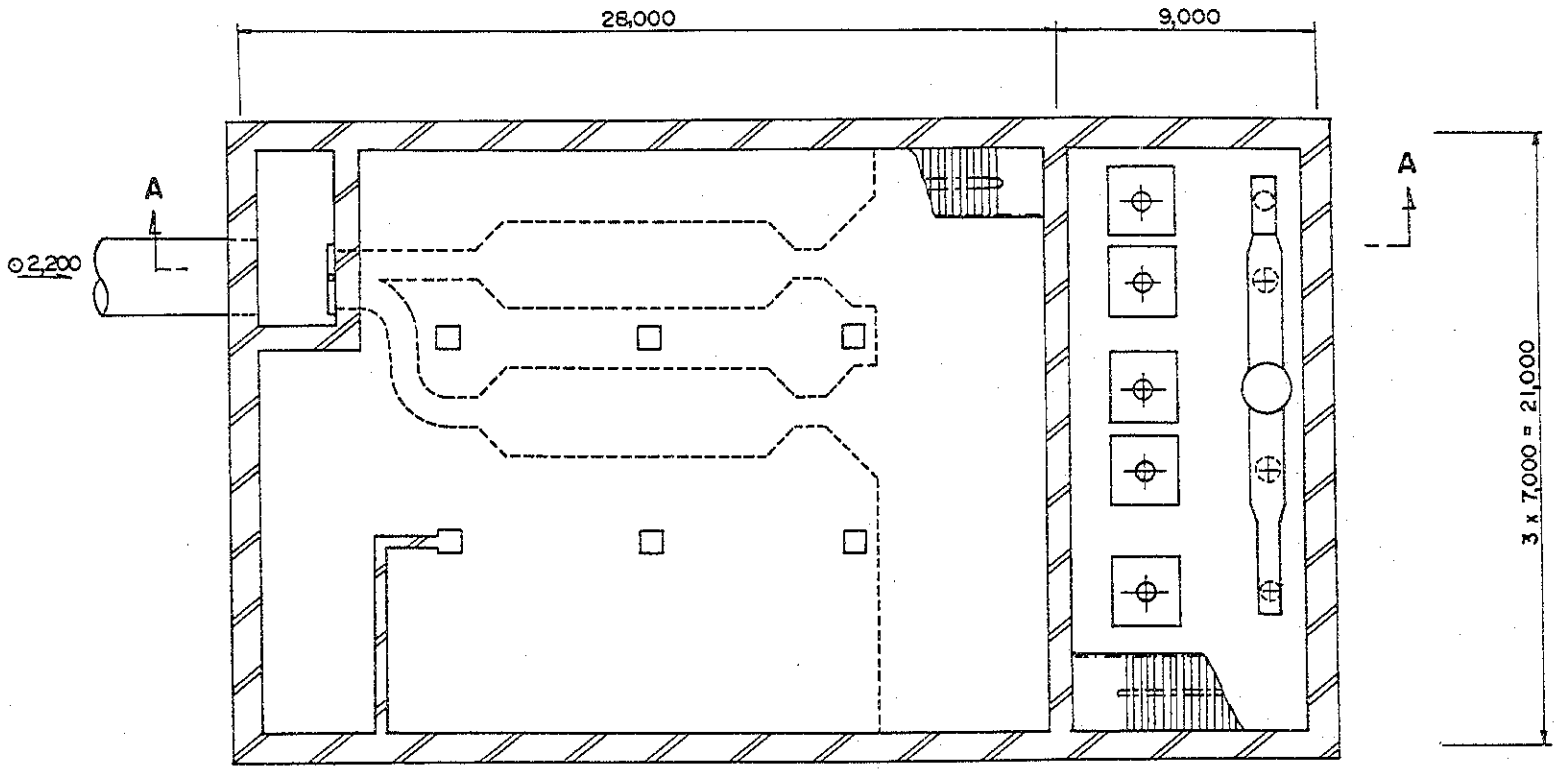
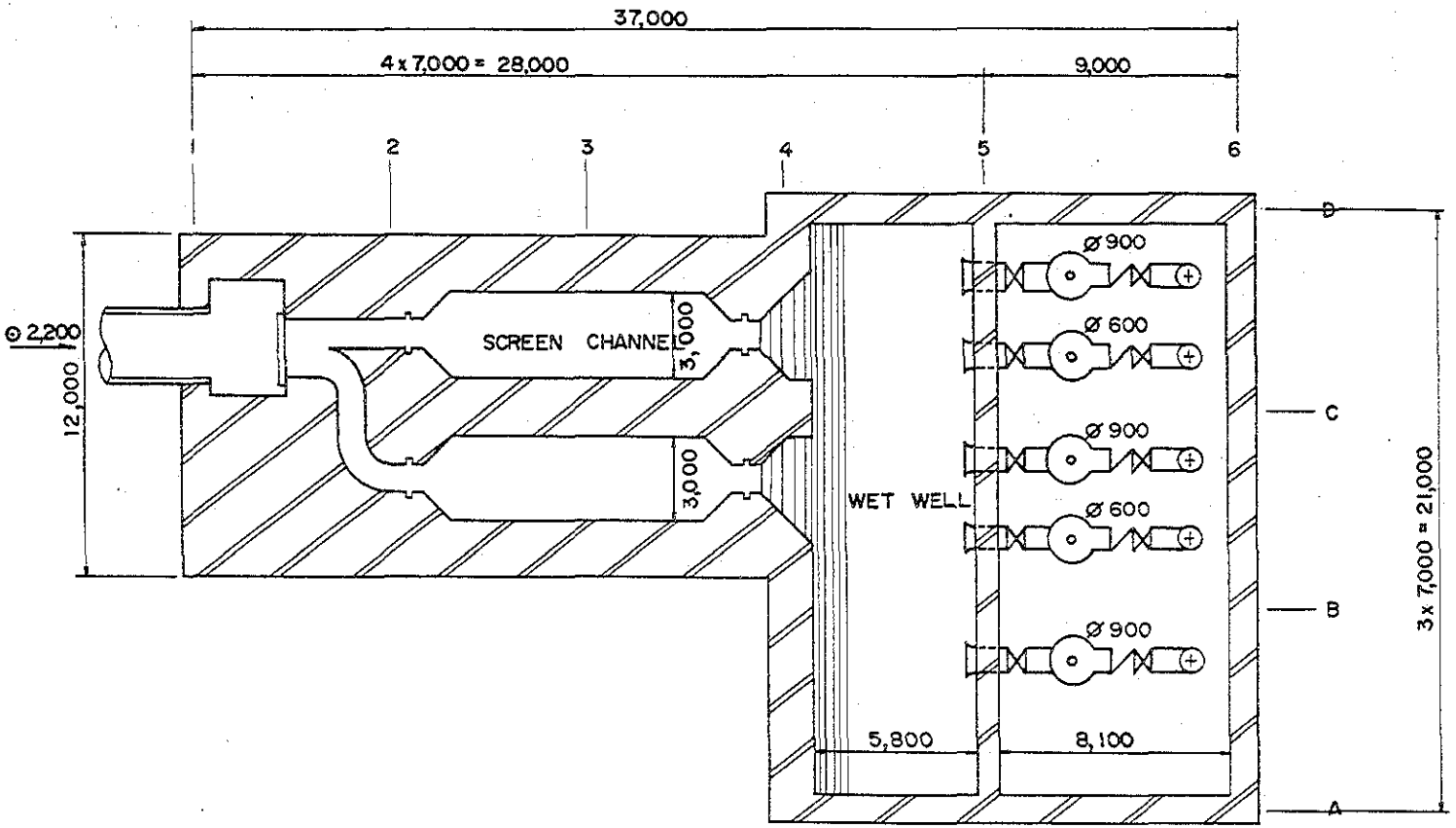


FIG. 5.8(3)	PROPOSED INFLOW PUMP STATION
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA	

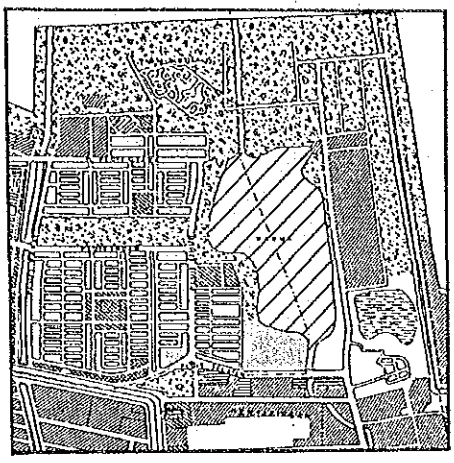


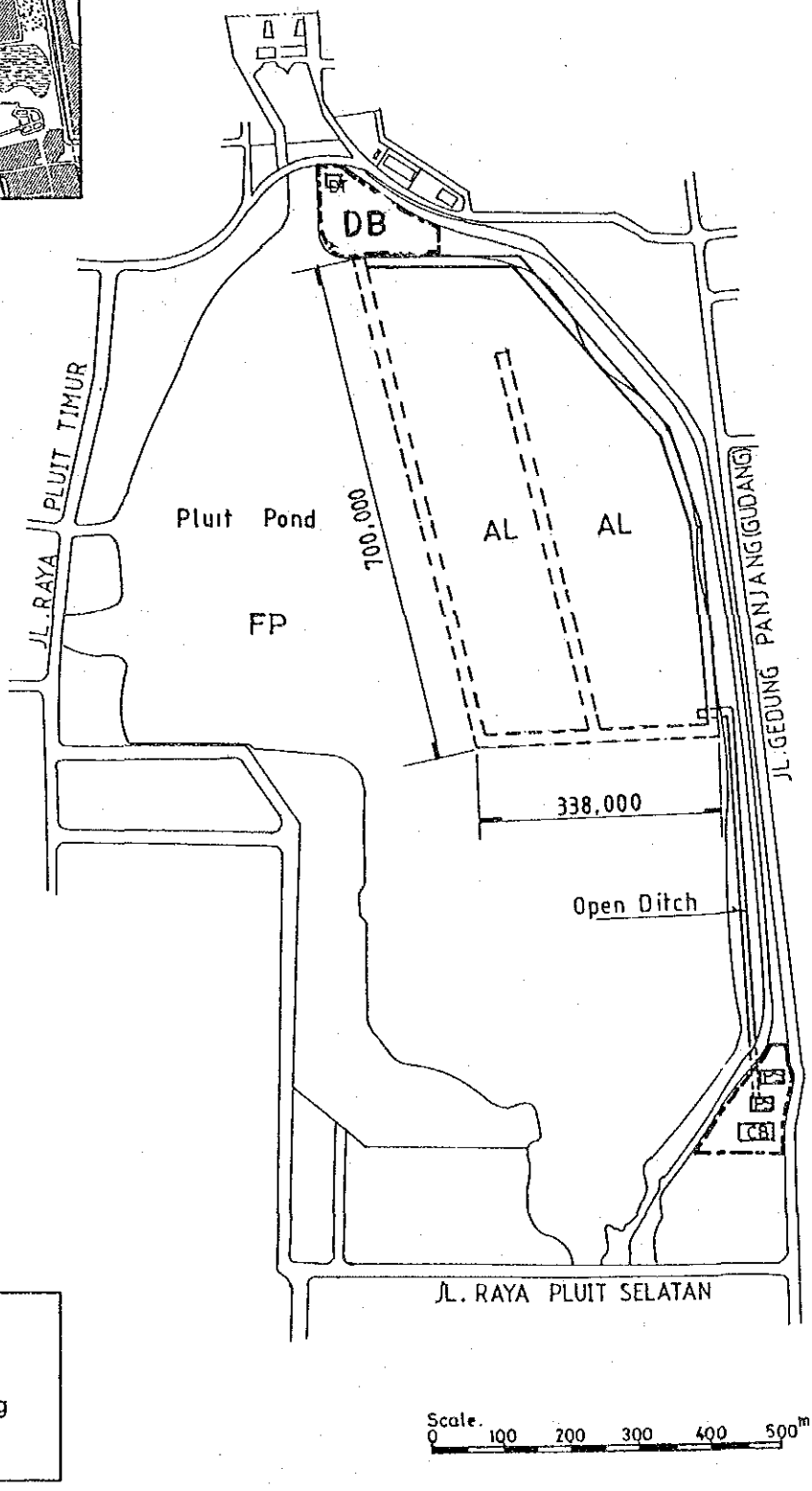
SECTION C – C

NOTE: Unit in mm

FIG. 5.8(4) PROPOSED INFLOW PUMP STATION

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



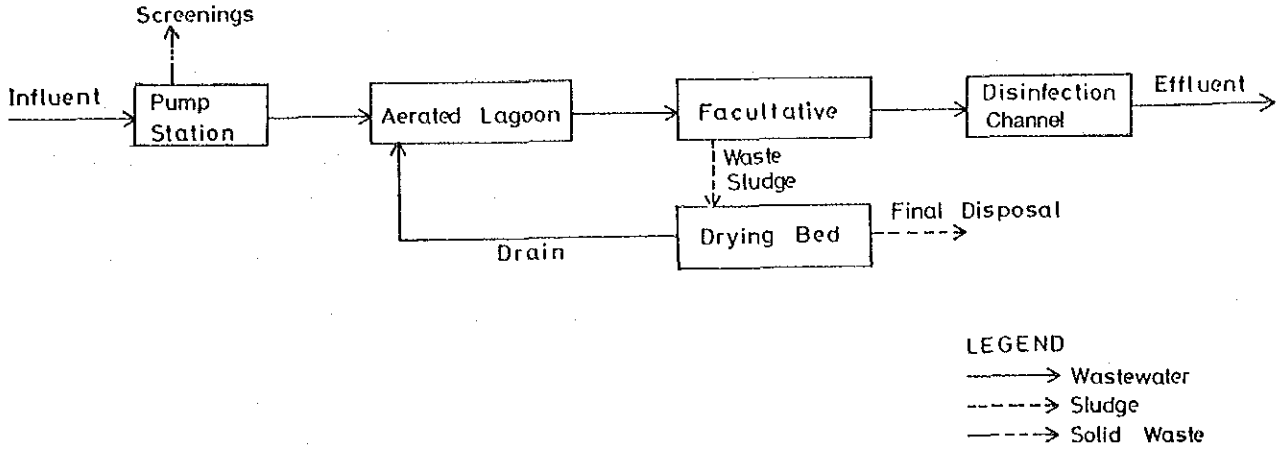


LEGEND

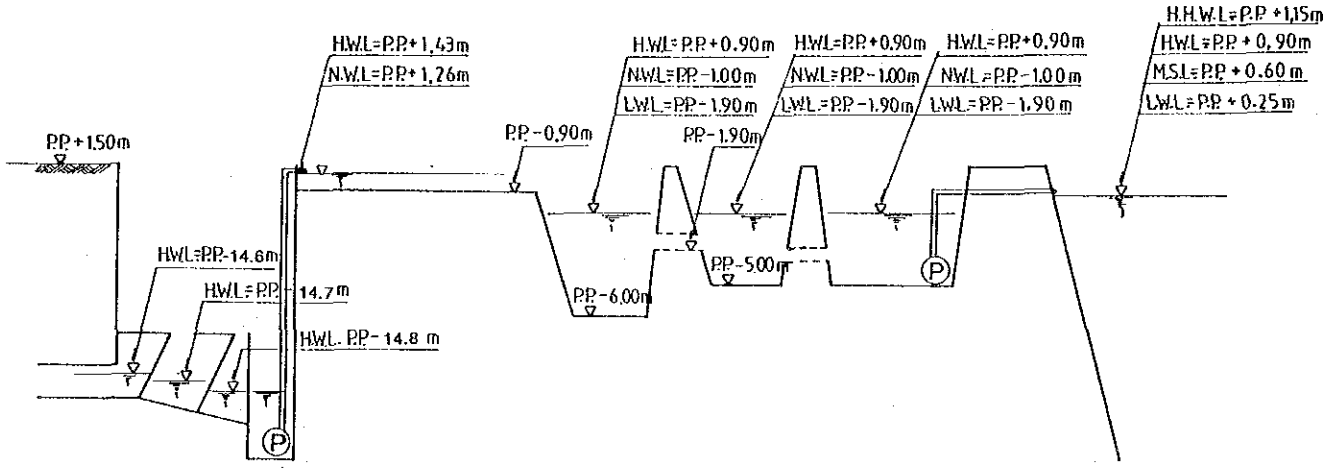
PS	:	Pump Station
AL	:	Aerated Lagoon
FP	:	Facultative Pond
DT	:	Disinfiction Building
DB	:	Drying Bed
CB	:	Control Building

FIG. 5.9 LAYOUT OF TREATMENT PLANT OF CENTRAL ZONE

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



FLOW-DIAGRAM



WATER-LEVEL

FIG. 5.10 FLOW-DIAGRAM AND WATER-LEVEL OF PLUIT TREATMENT PLANT

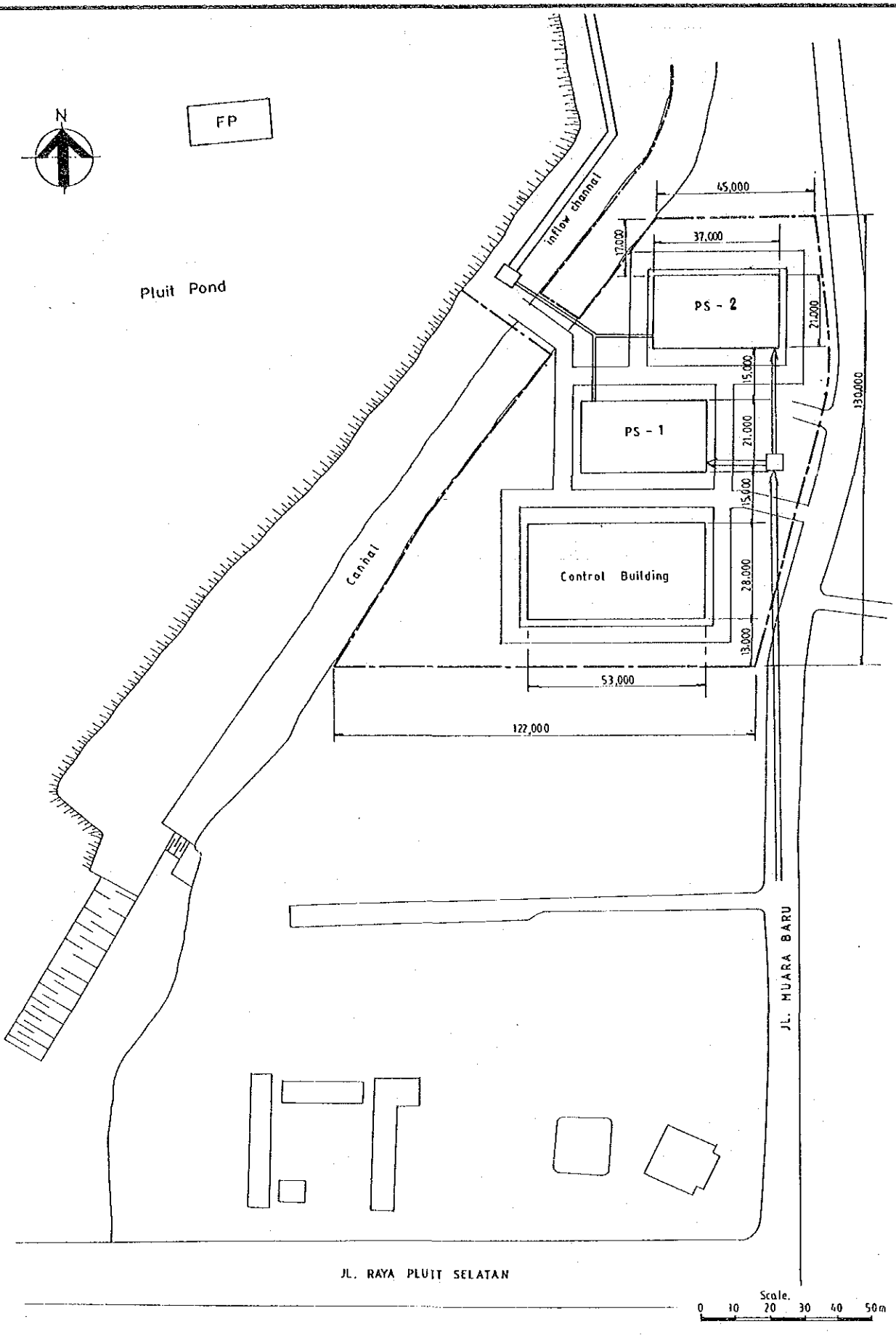


FIG. 5.11 LAYOUT OF PUMP STATION AND CONTROL BUILDING

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

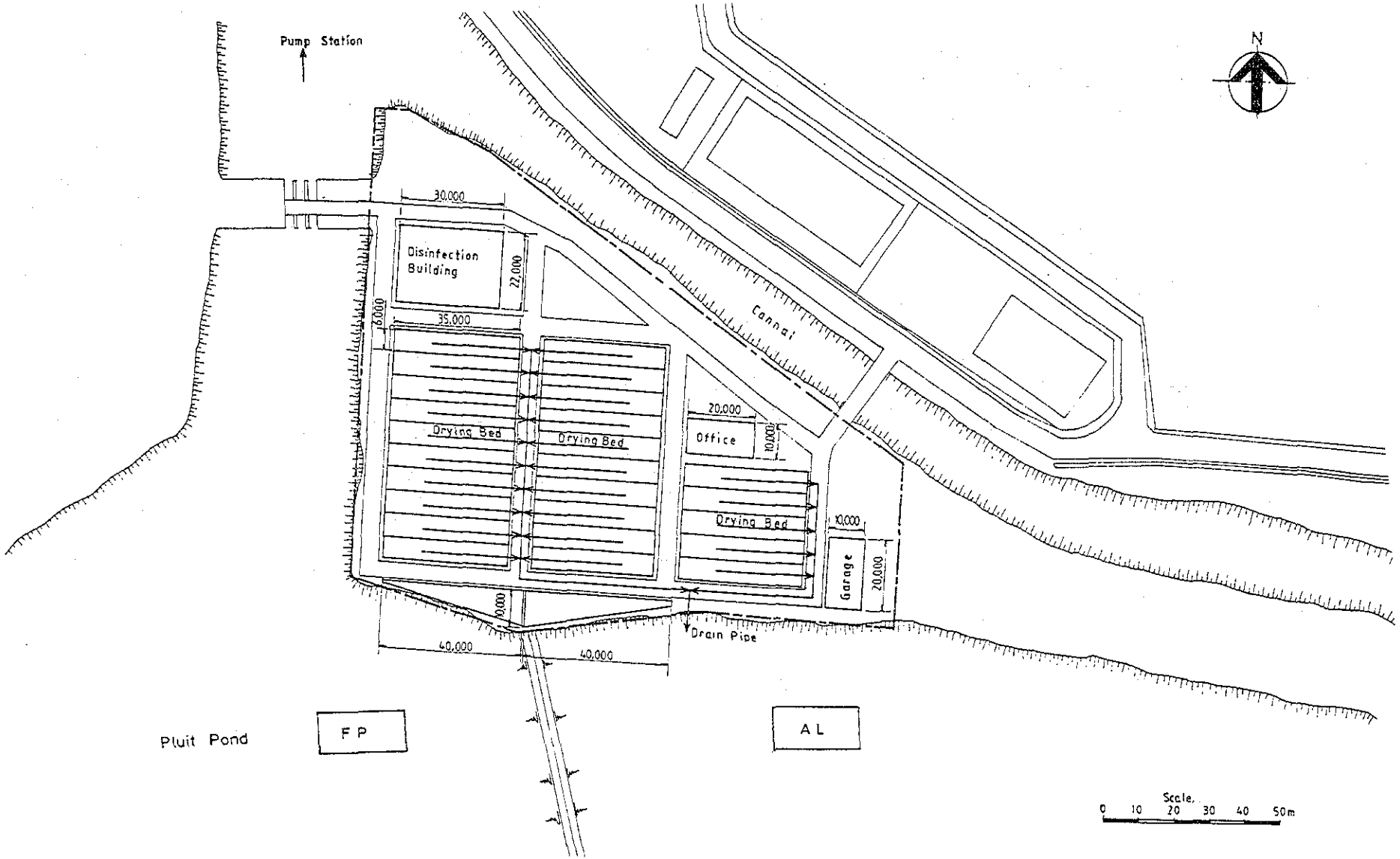


FIG. 5.12 LAYOUT OF DRYING BED

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

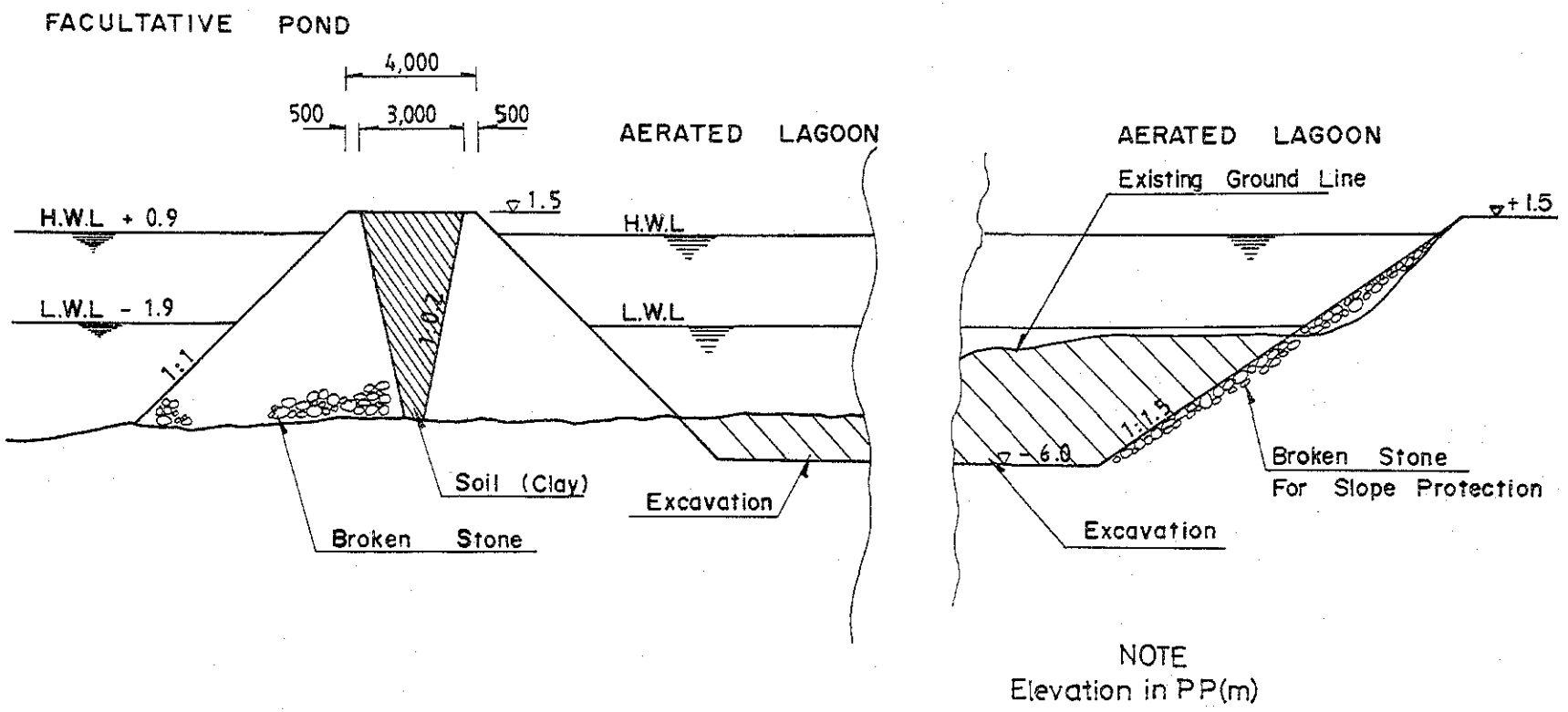


FIG. 5.13 TYPICAL SECTION OF EMBANKMENT OF AERATED LAGOON

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

Chapter 6 PROJECT AND COST ESTIMATE

6.1 Construction Plan

6.1.1 Geology and Topography

The Project Area is in the Jakarta plain, and its geological condition is primarily deltaic. Most of the area is covered by either alluvium or young rocks. The alluvium soils spread mostly along the rivers while the young volcanic rocks cover the rest of the Project Area.

The ground surface in the northern part is almost flat with a low elevation, that declines toward north with a slope in the range of 0.2 m ~ 0.3 m per thousand meter. The level of groundwater table is high, especially in the northern coastal area. While in the southern part of the Project Area, the ground slope is rather steeper with a surface slope of one (1) to two (2) meters per thousand meters.

In the Project Area, geological survey at Pluit Pond and along Krukut River and Abdul Mus Rd. were conducted by local consultants in the year 1986 and 1987 respectively.

At the estuary of Pluit Pond, the soil condition of the topsoil between ground surface of P.P. + 1.50 m and at level of P.P. - 5.50 m is sandy silt with N-value of zero (0). The subsoil strata between P.P. - 5.50 m and P.P. - 16.5 m is predominantly clay with some gravels and silty clay having an average N-value of five (5). At depths deeper than P.P. - 16.5 m, the strata is of very hard silty clay with N-value of more than 50. This layer is considered as the bearing stratum for structures.

The geologic conditions along the proposed conveyance sewer are as follows.

- The uppermost layer of 0.5 to 1.5 meters thickness has a variety of soils; organic humus, silty sand, clayey silt, sandy silt and sandy clay. The soil consistency varies from very soft to soft.

- The thickness of subsoil layer at the southern part of the Project Area ranges from nine (9) to 13 meters. However, it increases to more than 30 meters between Kh. Hasyin Asyhari Rd. and the southern edge of the Pluit Pond.

- The subsoil strata consists of silty clay, silty sand, organic clay, sandy clay, sandy silt and tuffaceous silt. Consistency of subsoil is soft with N-value of seven (7) in an average.

- Bearing strata at the southern part consists of tuff, tuffaceous silt and tuffaceous sand. N-value varies from 60 to more than 100.

Location of soil survey conducted in 1986 and 1987 and geological profile are shown in Figs. 6.1 and 6.2.

6.1.2 Construction Method

(1) Sewer Pipe Installation

Open trench method is adopted for installation of secondary & tertiary, main and trunk sewers in principle. All the secondary & tertiary sewers of 460 km is installed by open trench method. The portions of main and trunk sewers with a total length of 2,650 m those cross rivers, main roads and railways at 47 locations will be constructed by micro tunnelling method. The remaining 74.6 km of main and trunk sewers be constructed by open trench method. At two (2) locations of crossing Bangir Canal and Credang River of Pangeran Tubagus Angke Rd., pipe beam bridges with length of 50 m and 30 m respectively are applied. Conveyance sewers of 10.34 km in length with diameter ranging from 1,900 mm to 2,900 mm are constructed by shield tunnelling method.

(2) Treatment Plant

Proposed treatment plant of aerated lagoon is constructed at Pluit Pond. The baffle and partition wall embankments of aerated lagoon and facultative pond, inside the Pluit Pond, will be constructed with

broken stones and clay core. The underwater excavation works of aerated lagoon will be conducted after the completion of embankments.

6.1.3 Required Major Construction Equipment

Major construction works of sewerage development is installation of sewer pipes which require earth works. Closed face type mechanical shield tunnelling machine is required for conveyance sewer construction. While for the secondary & tertiary, main and trunk sewers, heavy equipment such as backhoe, vibro hammer, and truck crane are required for trench digging, setting and removing of sheet piles and pipe installation.

Dragline with boat or dredges will also be required for dredging of aerated lagoon.

6.1.4 Construction Schedule

(1) Workable Days

Annual workable days is estimated to be 240 days based on the following considerations:

Sunday per annum	:	12 months x 4 days = 48 days
National holiday per annum	:	about 20 days
Rainy day per annum	:	57 days (more than 10 mm/day rainfall)
Total work suspension days per annum	:	125 days

(2) Work Time

Sewer installation works by open trench method along main roads be conducted during night time only. Trench is covered by steel deck in day-time for traffic use. Construction of conveyance sewers by shield tunnelling method is conducted all day with three (3) shifts, each of eight (8) working hours in order to ensure a continued work pace.

Construction works of pump station and treatment plant is conducted for eight (8) hours during day time only.

6.2 Project Cost Estimate

6.2.1 Basis of Cost Estimate

Based on facility plans, the project costs are estimated under the following conditions.

(1) It is assumed that all construction works will be contracted to general contractors by international tender.

(2) All base costs are expressed under the economic conditions that prevailed in August, 1990.

(3) Overhead is assumed at 20% of the total cost of equipment and civil works and incorporated in the direct construction cost.

(4) Engineering service and administration costs are assumed respectively at 7% and 1.5% of the total direct construction cost.

(5) Physical contingency allowance at 10% of the direct construction cost is assumed.

6.2.2 Estimated Project Cost

The total project cost, consisting of direct construction cost, land acquisition cost, administration cost, engineering cost and physical contingency, amounts to Rp. 445.3 billion at 1990 price. Its breakdown is shwon in Table 6.1 ~ 6.16.

6.2.3 Estimated Operation and Maintenance Cost

The annual operation and maintenance cost for the Project Area in 2000, consisting of sewer maintenance, O&M of lift pump station and treatment plant, is estimated at Rp. 3.6 billion at 1990 price. The annual O&M cost for the Central Sewerage Zone covering JSSP Area is estimated to be Rp. 7.0 billion at the year 2010. The cost breakdown is shown in Table 6.17 and Table 6.18.

Table 6.1 Project Cost of Sewerage Development

(Unit : billion Rp.)

A. Direct Costruction Cost	375.3
(1) Collection Sewer Line	334.8
(2) Lift pump Station	4.1
(3) Treatment Plant	36.4
B. Land Acquisition cost	0.6
C. Administration Cost	5.6
D. Engineering Cost	26.3
E. Physical Contingency	37.5
Total	445.3

Table 6.2 Breakdown of Direct Construction Cost

(Unit : billion Rp.)

Itme	Sub-zone							Treatment Plant	Total
	A	B	C	D	E	F	G		
A. Sewer									
Secondary/Tertiary (φ150 ~ φ350)	15.4	5.3	6.0	7.6	29.7	6.1	14.0		84.1
Main (φ350 ~ φ800)	13.3	6.4	2.9	9.9	22.7	5.8	10.6		71.6
Trunk (φ900 ~ φ1500)	4.5	0.1	3.9	5.0	31.7	0.3	16.6		62.1
Conveyance (φ1900 ~ φ2900)	13.4	11.4	15.5	14.3	62.4				117.0
Sub-Total	46.6	23.2	28.3	36.8	146.5	12.2	41.2		334.8
B. Lift Pump Station							4.1		4.1
C. Treatment Plant									
Pump Station								22.5	22.5
Aerated lagoon/others								13.9	13.9
Sub-Total								36.4	36.4
Total	46.6	23.2	28.3	36.8	146.5	12.2	45.3	36.4	375.3

Table 6.3 Construction Cost of Secondary/Tertiary Sewer

Sub-Zone	Conventional Area			Interceptor Area			Construction Cost (million Rp.)
	Area (ha)	Unit Cost (million Rp./ha)	Construction Cost (million Rp.)	Area (ha)	Unit Cost (million Rp./ha)	Construction Cost (million Rp.)	
A	(Type A) 377	20.0	7,540				
	(Type B) 181	29.1	5,267	196	13.5	2,646	15,453
B	(Type B) 124	29.1	3,608	124	13.5	1,674	5,282
C	(Type B) 199	29.1	5,791	13	13.5	175	5,966
D	(Type B) 205	29.1	5,966	126	13.5	1,701	7,667
E	(Type B) 612	29.1	17,809	881	13.5	11,894	29,703
F	(Type B) 149	29.1	4,336	132	13.5	1,782	6,118
G	(Type B) 438	29.1	12,746	90	13.5	1,215	13,961
Total	2,285		63,063	1,562		21,087	84,150

Table 6 .4 Construction Cost of Main / Trunk Sewer

(unit: million Rp.)

Sub-Zone	Main (ø 350~800 mm)			Trunk (ø 900~1,500 mm)		
	Sewer	Manhole	Total	Sewer	Manhole	Total
A	12,750	521	13,271	4,452	83	4,535
B	6,179	174	6,353	76	5	81
C	2,816	88	2,904	3,851	67	3,918
D	9,620	291	9,911	4,872	78	4,950
E	21,967	796	22,763	31,313	432	31,745
F	5,515	284	5,799	255	6	261
G	10,318	308	10,626	16,377	202	16,579
Total	69,165	2,462	71,627	61,196	873	62,069

Table 6.5 Construction Cost of Conveyance Sewer

Line No.	Diameter (mm)	Length (m)	Unit Cost (million Rp./m)	Construction Cost (billion Rp.)
S1	1,900	1,385	9.7	13.4
S2	2,100	1,110	10.3	11.4
S3	2,200	1,460	10.6	15.5
S4	2,300	1,300	11.0	14.3
S5	2,400	1,110	11.4	12.7
S6	2,600	1,320	11.8	15.6
S7	2,700	560	12.3	6.9
S8	2,700	660	12.3	8.1
S9	2,900	1,435	13.3	19.1
Total		10,340		117.0

Table 6.6 Construction Cost of Lift Pump Station

Item	Quantity	Unit Cost (million Rp./m3)	Construction Cost (million Rp.)
1. Civil and Architect			
Temporary Work	6,750 m3	0.13	877
Concrete Work	1,780 m3	0.35	623
2. Mechamical and Electrical Equipment	1 ls	-	2,600
3. Total			4,100

Table 6.7 Construction Cost of Treatment Plant

(Unit : million Rp.)

Item	Civil/Architect			Mechanical/Electrical			Total
	Quantity	Unit Cost	Const. Cost	Quantity	Unit Cost	Const. Cost	
1. Pumping St. (per 1 station)							
Temporary Work	17,280 m3	13,000	2,246				
Concrete Work/others	5,800 m3	35,000	2,030				
Building	483 m2	30,000	145				
Mechanical/Electrical Work				1 ls	-	6,817	
Sub Total			4,421			6,817	
Total of 2 Pump Stations		(4,421 + 6,817) x 2					22,476
2. Split Manhole							
Temporary Work	1,716 m3	130,000	223				
Concrete Work	520	300,000	156				
Sub Total			379				379
3. Aerated Lagoon							
Excavation	340,000 m3	8,800	2,992				
Broken Stone	120,000 m3	39,500	4,740				
Backfill	18,000 m3	9,100	162				
Slope Protection	13,640 m2	14,200	194				
Aerator (75 kw)				24 set	147	3,528	
Sub Total			8,088			3,528	11,616
4. Other Facilities							
Drying Bed	2,000 m2	12,000	24				
Control House	3,000 m2	300,000	900				
Sub Total			924				924
5. Others							
Site Preparation	150,000 m2	2,000	300				
Open Channel	500 m	1,000,000	500				
Force Main	90 m	2,000,000	180				
Sub Total			980				980
Total			19,213			17,162	36,375

Table 6.8 (1) Main Sewer Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Diameter (mm)	Earth Covering Depth (m)	Length (m)			Unit Cost (million Rp./m)	Construction Cost (million Rp.)		
		A	B	C		A	B	C
350	0-2	520	275	505	0.206	107	57	104
	2-4	1,325	0	645	0.302	400	0	195
	4-6	260	0	240	1.643	427	0	394
400	0-2	615	450	20	0.224	138	101	4
	2-4	950	260	430	0.323	307	84	139
	4-6	270	0	0	1.680	454	0	0
450	0-2	25	625	0	0.253	6	158	0
	2-4	500	275	0	0.354	177	97	0
	4-6	455	300	0	1.729	787	519	0
500	0-2	585	155	0	0.278	163	43	0
	2-4	710	105	0	0.382	271	40	0
	4-6	65	100	0	1.774	115	177	0
600	0-2	525	0	0	0.363	191	0	0
	2-4	550	0	0	0.473	260	0	0
	4-6	1,355	1060	0	1.903	2,579	2,017	0
700	2-4	1,300	65	0	0.851	1,106	55	0
	4-6	1,235	645	0	1.993	2,461	1,285	0
	6-8	0	370	0	2.794	0	1,034	0
800	2-4	0	0	0	0.898	0	0	0
	4-6	590	250	0	2.045	1,207	511	0
	6-8	495	0	690	2.869	1,420	0	1,980
300 pressured	0-2	500			0.349	175		
Total		12,830	4,935	2,530	-	12,750	6,179	2,816

Table 6.8 (2) Main Sewer Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Diameter (mm)	Earth Covering Depth (m)	Length (m)				Unit Cost (million Rp./m)	Construction Cost (million Rp.)			
		D	E	F	G		D	E	F	G
350	0-2	0	145	245	0	0.206	0	30	50	0
	2-4	735	730	70	0	0.302	222	220	21	0
400	0-2	175	200	190	320	0.224	39	45	43	72
	2-4	365	2,305	360	1,060	0.323	118	745	116	342
	4-6	580	410	0	110	1.680	974	689	0	185
450	0-2	0	0	0	170	0.253	0	0	0	43
	2-4	535	5,910	805	50	0.354	189	2,092	285	18
	4-6	100	20	0	580	1.729	173	35	0	1,003
500	0-2	0	230	205	0	0.278	0	64	57	0
	2-4	165	1,980	285	420	0.382	63	756	109	160
	4-6	295	1,110	0	950	1.774	523	1,969	0	1,685
600	2-4	140	1,400	1,350	510	0.473	66	662	639	241
	4-6	345	2,460	1,005	410	1.903	657	4,681	1,913	780
	6-8	0	160	90	0	2.712	0	434	244	0
700	2-4	0	0	360	260	0.851	0	0	306	221
	4-6	1,045	1,605	500	480	1.993	2,083	3,199	997	957
	6-8	200	0	0	880	2.794	559	0	0	2,459
800	4-6	320	1,455	360	410	2.045	654	2,975	736	838
	6-8	1,150	1,175	0	0	2.869	3,299	3,371	0	0
	8<	0	0	0	280	4.692	0	0	0	1,314
Total		6,150	21,295	5,825	6,890	-	9,620	21,967	5,515	10,318

Table 6 .9 (1) Trunk Sewer Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Diameter (mm)	Earth Covering Depth (m)	Length (m)			Unit Cost (million Rp./m)	Construction Cost (million Rp.)		
		A	B	C		A	B	C
900	4-6	1,835	35	0	2.165	3,973	76	0
	6-8	160	0	1285	2.997	479	0	3,851
Total		1,995	35	1,285	-	4,452	76	3,851

Table 6.9 (2) Trunk Sewer Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Diameter (mm)	Earth Covering Depth (m)	Length (m)				Unit Cost (million Rp./m)	Construction Cost (million Rp.)			
		D	E	F	G		D	E	F	G
900	4-6	0	300	0	310	2.165	0	650	0	671
	6-8	430	1,615	85	670	2.997	1,289	4,840	255	2,008
	8<	720	630	0	440	4.838	3,483	3,048	0	2,129
1000	4-6	0	0	0	0	2.283	0	0	0	0
	6-8	0	1,645	0	320	3.127	0	5,144	0	1,001
	8<	20	370	0	635	4.991	100	1,847	0	3,169
1100	6-8	0	1,015	0	0	3.255	0	3,304	0	0
	8<	0	510	0	0	5.138	0	2,620	0	0
1200	8<	0	120	0	1,090	5.273	0	633	0	5,748
1350	2-4	0	330	0	0	1.478	0	488	0	0
	4-6	0	1,425	0	0	2.769	0	3,946	0	0
	6-8	0	720	0	0	3.644	0	2,624	0	0
	8<	0	305	0	150	5.574	0	1,700	0	836
1500	6-8	0	120	0	0	3.922	0	471	0	0
1000 (pressured)	0-2				1 ls (240 m)					816
Total		1,170	9,105	85	3,615	-	4,872	31,313	255	16,377

Table 6.10 (1) Manhole Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Sewer Diameter (mm)	Earth Covering Depth	Nos. of Manhole			Unit Cost (million Rp./unit)	Construction Cost (million Rp.)		
		A	B	C		A	B	C
350	0-2	7	3	6	1.11	7.8	3.3	6.7
	2-4	17		8	2.22	37.7	0.0	17.8
	4-6	3		3	2.77	8.3	0.0	8.3
400	0-2	8	7	1	1.11	8.9	7.8	1.1
	2-4	14	3	5	2.22	31.1	6.7	11.1
450	0-2	1	8		1.11	1.1	8.9	0.0
	2-4	7	3		2.22	15.5	6.7	0.0
	4-6	6	4		2.77	16.6	11.1	0.0
500	0-2	7	2		1.11	7.8	2.2	0.0
	2-4	9	2		2.22	20.0	4.4	0.0
	4-6	1	1		2.77	2.8	2.8	0.0
600	0-2	7	0		1.11	7.8	0.0	0.0
	2-4	7	0		2.22	15.5	0.0	0.0
	4-6	17	13		2.77	47.1	36.0	0.0
700	2-4	15	1		4.10	61.5	4.1	0.0
	4-6	16	7		5.10	81.6	35.7	0.0
	6-8		4		6.10	0.0	24.4	0.0
800	4-6	7	4	0	5.10	35.7	20.4	0.0
	6-8	5	0	7	6.10	30.5	0.0	42.7
Manhole with Pump		1			84.00	84.0		
Sub-Total		155	62	30	-	521.3	174.4	87.6
900	4-6	15	1	0	5.10	76.5	5.1	0.0
	6-8	1		11	6.10	6.1	0.0	67.1
Sub-Total		16	1	11	-	82.6	5.1	67.1
Total		171	63	41	-	603.9	179.5	154.7

Table 6.10 (2) Manhole Construction Cost by Sub-zone, by Diameter and by Earth Covering Depth

Sewer Diameter (mm)	Earth Covering Depth	Nos. of Manhole				Unit Cost (million Rp./unit)	Construction Cost (million Rp.)			
		D	E	F	G		D	E	F	G
350	0-2	0	2	3		1.11	0.0	2.2	3.3	0.0
	2-4	10	9	1		2.22	22.2	20.0	2.2	0.0
400	0-2	2	2	2	4	1.11	2.2	2.2	2.2	4.4
	2-4	5	32	4	13	2.22	11.1	71.0	8.9	28.9
	4-6	8	5	0	2	2.77	22.2	13.9	0.0	5.5
450	0-2	0	0	2	2	1.11	0.0	0.0	2.2	2.2
	2-4	7	74	9	1	2.22	15.5	164.3	20.0	2.2
	4-6	1	1		7	2.77	2.8	2.8	0.0	19.4
500	0-2	0	3	3	0	1.11	0.0	3.3	3.3	0.0
	2-4	2	26	4	5	2.22	4.4	57.7	8.9	11.1
	4-6	4	15		10	2.77	11.1	41.6	0.0	27.7
600	2-4	2	17	18	7	2.22	4.4	37.7	40.0	15.5
	4-6	4	32	12	6	2.77	11.1	88.6	33.2	16.6
	6-8		2	1		3.35	0.0	6.7	3.4	0.0
700	2-4	0	0	4	3	4.10	0.0	0.0	16.4	12.3
	4-6	13	20	7	6	5.10	66.3	102.0	35.7	30.6
	6-8	2	0		10	6.10	12.2	0.0	0.0	61.0
800	4-6	4	19	4	5	5.10	20.4	96.9	20.4	25.5
	6-8	14	14		0	6.10	85.4	85.4	0.0	0.0
	8<	0			5	8.90	0.0	0.0	0.0	44.5
Manhole with Pump				1		84.00	0.0	0.0	84.0	0.0
Sub-Total		78	273	75	86	-	291.3	796.3	284.1	307.5
900	4-6	0	2		2	5.10	0.0	10.2	0.0	10.2
	6-8	4	10	1	5	6.10	24.4	61.0	6.1	30.5
	8<	5	4		3	8.90	44.5	35.6	0.0	26.7
1000	6-8	0	10		3	6.10	0.0	61.0	0.0	18.3
	8<	1	3		5	8.90	8.9	26.7	0.0	44.5
1100	6-8		7			6.10	0.0	42.7	0.0	0.0
	8<		4			8.90	0.0	35.6	0.0	0.0
1200	8<		2		7	8.90	0.0	17.8	0.0	62.3
1350	2-4		3			4.70	0.0	14.1	0.0	0.0
	4-6		9			5.70	0.0	51.3	0.0	0.0
	6-8		4			6.80	0.0	27.2	0.0	0.0
	8<		3		1	9.40	0.0	28.2	0.0	9.4
1500	6-8		3			6.80	0.0	20.4	0.0	0.0
Sub-Total		10	64	1	26	-	77.8	431.8	6.1	201.9
Total		88	337	76	112	-	369.1	1,228.1	290.2	509.4

Table 6.11 Unit Construction Cost of Collection Sewer by Diameter and Earth Covering Depth

METHOD : OPEN TRENCH
DEPTH : 1.50 - 10.00 m
MATERIAL: REINFORCED CONCRETE (RC)
POLYVINYL CHLORIDE (PVC)

Unit : Rp./m

NO.	DESCRIPTION	PVC ø 150 mm	PVC ø 200 mm	PVC ø 250 mm	PVC Ø 300 mm	RC Ø 350 mm	RC Ø 400 mm	RC Ø 450 mm	RC Ø 500 mm	RC Ø 600 mm	RC Ø 700 mm	RC Ø 800 mm	RC Ø900 mm	RC Ø 1000 mm	RC Ø 1100 mm	RC Ø 1200 mm	RC Ø 1350 mm	RC Ø 1500 mm
1	EARTH COVERING DEPTH 1.5 M	104.4	131.6	158.3	204.7	205.7	224.2	252.7	277.7	362.5	403.3	438.5	520.1	594.9	724.4	817.7	994.9	1,215.4
2	EARTH COVERING DEPTH 3 M	188.0	218.4	247.0	296.0	301.9	323.0	354.3	382.1	472.6	850.8	898.0	993.8	1,084.1	1,176.9	1,267.8	1,478.4	1,714.7
3	EARTH COVERING DEPTH 5 M	1,445.4	1,491.3	1,534.1	1,598.3	1,642.9	1,679.9	1,729.3	1,774.1	1,903.4	1,992.5	2,045.1	2,164.8	2,282.8	2,402.1	2,514.4	2,768.7	3,038.1
4	EARTH COVERING DEPTH 7 M	2,196.8	2,250.9	2,297.3	2,367.3	2,420.7	2,463.6	2,519.6	2,570.5	2,712.4	2,794.4	2,869.2	2,996.9	3,127.1	3,254.7	3,374.4	3,643.5	3,922.1
5	EARTH COVERING DEPTH 9 M	3,876.6	3,943.2	3,997.9	4,078.4	4,153.4	4,206.8	4,274.6	4,336.6	4,502.4	4,601.0	4,691.8	4,837.8	4,990.6	5,137.8	5,273.4	5,574.4	5,876.1
6	EARTH COVERING DEPTH 10 M	4,285.8	4,355.5	4,411.3	4,494.0	4,571.1	4,626.6	4,696.6	4,760.7	4,930.8	5,031.5	5,124.4	5,272.6	5,429.7	5,578.9	5,716.6	6,021.9	6,325.7

Table 6.12 (1) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Outside of Diameter (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		0.7	0.85	0.9	1	1.1	1.2	1.3	1.4	1.6
Excavation Depth (m)		1.86	1.912	1.965	2.018	2.166	2.22	2.284	2.342	2.474
Volume of Pavement (m^3)		0.504	0.612	0.648	0.72	0.792	0.864	0.936	1.008	1.152
Excavation Backhoe (m^3)		1.302	1.6252	1.7685	2.018	2.3826	2.664	2.9692	3.2788	3.9584
Backfill (granular m^3)		0.30	0.40	0.45	0.54	0.67	0.77	0.88	1.00	1.25
Backfill (original m^3)		0.29	0.36	0.40	0.46	0.59	0.67	0.76	0.86	1.08
Backfill (selected soil m^3)		0.21	0.255	0.27	0.3	0.33	0.36	0.39	0.42	0.48
Residual Soil (m^3)		1.02	1.27	1.37	1.56	1.79	2.00	2.21	2.42	2.88
Pavement (m^2)		1.3	1.45	1.5	1.6	1.7	1.8	1.9	2	2.2
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Backhoe	5.433	7.1	8.8	9.6	11.0	12.9	14.5	16.1	17.8	21.5
Backfill (granular)	31.914	9.6	12.8	14.5	17.2	21.4	24.6	28.1	31.8	39.8
Backfill (original)	2.66	0.8	1.0	1.1	1.2	1.6	1.8	2.0	2.3	2.9
Backfill (selected soil)	12.774	2.7	3.3	3.4	3.8	4.2	4.6	5.0	5.4	6.1
Residual Soil	2.1	2.1	2.7	2.9	3.3	3.8	4.2	4.6	5.1	6.0
Pavement	42.475	55.2	61.6	63.7	68.0	72.2	76.5	80.7	85.0	93.4
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	2.0	2.6	3.1	4.0	4.0	4.4	5.0	5.4	7.1
Total		104.4	131.6	158.3	204.7	205.7	224.2	252.7	277.7	362.5

Table 6.12 (2) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Outside of Diameter (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.6
Excavation Depth (m)		2.58	2.68	2.8	2.92	3.05	3.15	3.35	3.51
Volume of Pavement (m^3)		1.224	1.296	1.368	1.512	1.584	1.728	1.8	1.872
Excavation Backhoe (m^3)		4.386	4.824	5.32	6.132	6.71	7.56	8.375	9.126
Backfill (granular m^3)		1.40	1.55	1.71	2.02	2.20	2.55	2.74	2.91
Backfill (original m^3)		1.25	1.44	1.67	1.97	2.27	2.56	3.09	3.56
Backfill (selected soil m^3)		0.51	0.54	0.57	0.63	0.66	0.72	0.75	0.78
Residual Soil (m^3)		3.13	3.39	3.65	4.17	4.44	5.00	5.29	5.56
Pavement (m^2)		2.3	2.4	2.5	2.7	2.8	3	3.1	3.2
Retaining Wall (m^2)		-	-	-	-	6.1	6.3	6.7	7.02
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Backhoe	5.433	23.8	26.2	28.9	33.3	36.5	41.1	45.5	49.6
Backfill (granular)	31.914	44.6	49.5	54.6	64.6	70.2	81.3	87.3	93.0
Backfill (original)	2.66	3.3	3.8	4.4	5.2	6.0	6.8	8.2	9.5
Backfill (selected soil)	12.774	6.5	6.9	7.3	8.0	8.4	9.2	9.6	10.0
Residual Soil	2.1	6.6	7.1	7.7	8.7	9.3	10.5	11.1	11.7
Pavement	42.475	97.7	101.9	106.2	114.7	118.9	127.4	131.7	135.9
Retaining Wall	8.334	0.0	0.0	0.0	0.0	50.8	52.5	55.8	58.5
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	7.9	8.6	10.2	11.7	14.2	16.0	19.5	23.8
Total		403.3	438.5	520.1	594.9	724.4	817.7	994.9	1215.4

Table 6.12 (3) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		3	3	3	3	3	3	3	3	3
Outside of Diameter (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		0.9	1.05	1.1	1.2	1.3	1.4	1.5	1.6	1.8
Excavation Depth (m)		3.36	3.412	3.465	3.518	3.666	3.72	3.784	3.842	3.974
Volume of Pavement (m^3)		0.648	0.756	0.792	0.864	0.936	1.008	1.08	1.152	1.296
Excavation Backhoe (m^3)		3.024	3.5826	3.8115	4.2216	4.7658	5.208	5.676	6.1472	7.1532
Backfill (granular m^3)		0.39	0.50	0.57	0.66	0.83	0.94	1.06	1.18	1.46
Backfill (original m^3)		1.71	2.01	2.12	2.34	2.61	2.84	3.09	3.33	3.85
Backfill (selected soil m^3)		0.27	0.315	0.33	0.36	0.39	0.42	0.45	0.48	0.54
Residual Soil (m^3)		1.31	1.57	1.69	1.89	2.15	2.36	2.59	2.82	3.30
Pavement (m^2)		1.5	1.65	1.7	1.8	1.9	2	2.1	2.2	2.4
Retaining Wall (m^2)		6.72	6.824	6.93	7.036	7.332	7.44	7.568	7.684	7.948
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Backhoe	5.433	16.4	19.5	20.7	22.9	25.9	28.3	30.8	33.4	38.9
Backfill (granular)	31.914	12.6	16.0	18.1	21.1	26.3	29.9	33.8	37.8	46.7
Backfill (original)	2.66	4.6	5.3	5.6	6.2	7.0	7.6	8.2	8.9	10.3
Backfill (sand)	12.774	3.4	4.0	4.2	4.6	5.0	5.4	5.7	6.1	6.9
Residual Soil	2.1	2.8	3.3	3.5	4.0	4.5	5.0	5.4	5.9	6.9
Pavement	42.475	63.7	70.1	72.2	76.5	80.7	85.0	89.2	93.4	101.9
Retaining Wall	8.334	56.0	56.9	57.8	58.6	61.1	62.0	63.1	64.0	66.2
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	3.7	4.3	4.8	5.8	5.9	6.3	6.9	7.5	9.3
Total		188.0	218.4	247.0	296.0	301.9	323.0	354.3	382.1	472.6

Table 6.12 (4) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		3	3	3	3	3	3	3	3
Outer of Diameter (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		2	2.1	2.2	2.4	2.5	2.6	2.8	2.9
Excavation Depth (m)		4.08	4.18	4.3	4.42	4.55	4.65	4.85	5.01
Sheet Pile (m)		6.12	6.27	6.45	6.63	6.825	6.975	7.275	7.515
Volume of Pavement (m^3)		1.44	1.512	1.584	1.728	1.8	1.872	2.016	2.088
Excavation (Backhoe m^3)		8.16	8.778	9.46	10.608	11.375	12.09	13.58	14.529
Backfill (granular m^3)		1.75	1.93	2.13	2.48	2.69	2.90	3.32	3.55
Backfill (original m^3)		4.37	4.70	5.09	5.68	6.13	6.54	7.40	8.03
Backfill (selected soil m^3)		0.6	0.63	0.66	0.72	0.75	0.78	0.84	0.87
Residual Soil (m^3)		3.79	4.08	4.37	4.93	5.24	5.55	6.18	6.50
Pavement (m^2)		2.6	2.7	2.8	3	3.1	3.2	3.4	3.5
Sheet Pile (m)		12.24	12.54	12.9	13.26	13.65	13.95	14.55	15.03
Sheet Pile (kg)		587.52	601.92	619.2	636.48	655.2	669.6	698.4	721.44
Bracing (kg)		146.88	150.48	154.8	159.12	163.8	167.4	174.6	180.36
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Backhoe	5.433	44.3	47.7	51.4	57.6	61.8	65.7	73.8	78.9
Backfill (granular)	31.914	55.9	61.7	68.0	79.1	86.0	92.5	106.0	113.2
Backfill (original)	2.66	11.6	12.5	13.5	15.1	16.3	17.4	19.7	21.3
Backfill (selected soil)	12.774	7.7	8.0	8.4	9.2	9.6	10.0	10.7	11.1
Residual Soil	2.1	8.0	8.6	9.2	10.3	11.0	11.7	13.0	13.7
Pavement	42.475	110.4	114.7	118.9	127.4	131.7	135.9	144.4	148.7
Sheet Pile	15	183.6	188.1	193.5	198.9	204.8	209.3	218.3	225.5
Sheet Pile	0.25	146.9	150.5	154.8	159.1	163.8	167.4	174.6	180.4
Bracing	0.36	52.9	54.2	55.7	57.3	59.0	60.3	62.9	64.9
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	16.7	17.6	19.5	21.3	23.1	24.9	29.0	33.6
Total		850.8	898.0	993.8	1084.1	1176.9	1267.8	1478.4	1714.7

Table 6.12 (5) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		5	5	5	5	5	5	5	5	5
Outside of Diameter (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		1	1.15	1.2	1.3	1.4	1.5	1.6	1.7	1.9
Excavation Depth (m)		5.36	5.412	5.465	5.518	5.666	5.72	5.784	5.842	5.974
Sheetpile Length (m)		8.04	8.118	8.1975	8.277	8.499	8.58	8.676	8.763	8.961
Volume of Pavement (m^3)		0.72	0.828	0.864	0.936	1.008	1.08	1.152	1.224	1.368
Excavation Crum (m^3)		0.36	0.4738	0.558	0.6734	0.9324	1.08	1.2544	1.4314	1.8506
Excavation Backhoe (m^3)		5	5.75	6	6.5	7	7.5	8	8.5	9.5
Backfill (granular m^3)		0.44	0.55	0.62	0.72	0.90	1.02	1.15	1.28	1.57
Backfill (original m^3)		3.90	4.50	4.71	5.12	5.60	6.03	6.48	6.92	7.84
Backfill (selected soil m^3)		0.3	0.345	0.36	0.39	0.42	0.45	0.48	0.51	0.57
Residual Soil (m^3)		1.46	1.73	1.85	2.05	2.33	2.55	2.78	3.01	3.51
Pavement (m^2)		1.6	1.75	1.8	1.9	2	2.1	2.2	2.3	2.5
Sheetpile Length (m)		40.2	40.59	40.9875	41.385	42.495	42.9	43.38	43.815	44.805
Sheetpile (kg)		1929.6	1948.32	1967.4	1986.48	2039.76	2059.2	2082.24	2103.12	2150.64
Bracing (kg)		482.4	487.08	491.85	496.62	509.94	514.8	520.56	525.78	537.66
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Crum	18.6	6.7	8.8	10.4	12.5	17.3	20.1	23.3	26.6	34.4
Excavation Backhoe	5.433	27.2	31.2	32.6	35.3	38.0	40.7	43.5	46.2	51.6
Backfill (granular)	31.914	14.0	17.7	19.9	23.1	28.8	32.5	36.6	40.8	50.1
Backfill (original)	2.66	10.4	12.0	12.5	13.6	14.9	16.0	17.2	18.4	20.9
Backfill (selected soil)	12.774	3.8	4.4	4.6	5.0	5.4	5.7	6.1	6.5	7.3
Residual Soil	2.1	3.1	3.6	3.9	4.3	4.9	5.4	5.8	6.3	7.4
Pavement	42.475	68.0	74.3	76.5	80.7	85.0	89.2	93.4	97.7	106.2
Sheetpile Driving	15	603.0	608.9	614.8	620.8	637.4	643.5	650.7	657.2	672.1
Sheetpile (kg)	0.25	482.4	487.1	491.9	496.6	509.9	514.8	520.6	525.8	537.7
Bracing	0.36	173.7	175.3	177.1	178.8	183.6	185.3	187.4	189.3	193.6
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	28.3	29.0	30.1	31.3	32.2	32.9	33.5	34.2	36.7
Total		1445.4	1491.3	1534.1	1598.3	1642.9	1679.9	1729.3	1774.1	1903.4

Table 6.12 (6) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		5	5	5	5	5	5	5	5
Outer Diameter (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		2	2.1	2.2	2.4	2.5	2.6	2.8	2.9
Excavation Depth (m)		6.08	6.18	6.3	6.42	6.55	6.65	6.85	7.01
Sheetpile Length (m)		9.12	9.27	9.45	9.63	9.825	9.975	10.275	10.515
Volume of Pavement (m^3)		1.44	1.512	1.584	1.728	1.8	1.872	2.016	2.088
Excavation (Crum m^3)		2.16	2.478	2.86	3.408	3.875	4.29	5.18	5.829
Excavation (Backhoe m^3)		10	10.5	11	12	12.5	13	14	14.5
Backfill (granular m^3)		1.75	1.93	2.13	2.48	2.69	2.90	3.32	3.55
Backfill (original m^3)		8.37	8.90	9.49	10.48	11.13	11.74	13.00	13.83
Backfill (selected soil m^3)		0.6	0.63	0.66	0.72	0.75	0.78	0.84	0.87
Residual Soil (m^3)		3.79	4.08	4.37	4.93	5.24	5.55	6.18	6.50
Pavement (m^2)		2.6	2.7	2.8	3	3.1	3.2	3.4	3.5
Sheetpile Length (m)		45.6	46.35	47.25	48.15	49.125	49.875	51.375	52.575
Sheetpile (kg)		2188.8	2224.8	2268	2311.2	2358	2394	2466	2523.6
Bracing (kg)		547.2	556.2	567	577.8	589.5	598.5	616.5	630.9
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Crum	18.6	40.2	46.1	53.2	63.4	72.1	79.8	96.3	108.4
Excavation Backhoe	5.433	54.3	57.0	59.8	65.2	67.9	70.6	76.1	78.8
Backfill (granular)	31.914	55.9	61.7	68.0	79.1	86.0	92.5	106.0	113.2
Backfill (original)	2.66	22.3	23.7	25.2	27.9	29.6	31.2	34.6	36.8
Backfill (selected soil)	12.774	7.7	8.0	8.4	9.2	9.6	10.0	10.7	11.1
Residual Soil	2.1	8.0	8.6	9.2	10.3	11.0	11.7	13.0	13.7
Pavement	42.475	110.4	114.7	118.9	127.4	131.7	135.9	144.4	148.7
Sheetpile Driving	15	684.0	695.3	708.8	722.3	736.9	748.1	770.6	788.6
Sheetpile (kg)	0.25	547.2	556.2	567.0	577.8	589.5	598.5	616.5	630.9
Bracing	0.36	197.0	200.2	204.1	208.0	212.2	215.5	221.9	227.1
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	38.8	39.2	41.4	43.5	45.6	47.7	52.4	57.4
Total		1992.5	2045.1	2164.8	2282.8	2402.1	2514.4	2768.7	3038.1

Table 6.12 (7) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		7	7	7	7	7	7	7	7	7
Outer Diameter (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		1	1.15	1.2	1.3	1.4	1.5	1.6	1.7	1.9
Excavation Depth (m)		7.36	7.412	7.465	7.518	7.666	7.72	7.784	7.842	7.974
Sheetpile Length (m)		11.04	11.118	11.1975	11.277	11.499	11.58	11.676	11.763	11.961
Volume of Pavement (m^3)		0.72	0.828	0.864	0.936	1.008	1.08	1.152	1.224	1.368
Excavation Crum (m^3)		2.36	2.7738	2.958	3.2734	3.7324	4.08	4.4544	4.8314	5.6506
Excavation Backhoe (m^3)		5	5.75	6	6.5	7	7.5	8	8.5	9.5
Backfill (granular m^3)		0.44	0.55	0.62	0.72	0.90	1.02	1.15	1.28	1.57
Backfill (original m^3)		5.90	6.80	7.11	7.72	8.40	9.03	9.68	10.32	11.64
Backfill (selected soil m^3)		0.3	0.345	0.36	0.39	0.42	0.45	0.48	0.51	0.57
Residual Soil (m^3)		1.46	1.73	1.85	2.05	2.33	2.55	2.78	3.01	3.51
Pavement (m^2)		1.6	1.75	1.8	1.9	2	2.1	2.2	2.3	2.5
Sheetpile Length (m)		55.2	55.59	55.9875	56.385	57.495	57.9	58.38	58.815	59.805
Sheetpile (kg)		3312	3335.4	3359.25	3383.1	3449.7	3474	3502.8	3528.9	3588.3
Bracing (kg)		828	833.85	839.8125	845.775	862.425	868.5	875.7	882.225	897.075
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Crum	18.6	43.9	51.6	55.0	60.9	69.4	75.9	82.9	89.9	105.1
Excavation Backhoe	5.433	27.2	31.2	32.6	35.3	38.0	40.7	43.5	46.2	51.6
Backfill (granular)	31.914	14.0	17.7	19.9	23.1	28.8	32.5	36.6	40.8	50.1
Backfill (original)	2.66	15.7	18.1	18.9	20.5	22.4	24.0	25.7	27.5	31.0
Backfill (selected soil)	12.774	3.8	4.4	4.6	5.0	5.4	5.7	6.1	6.5	7.3
Residual Soil	2.1	3.1	3.6	3.9	4.3	4.9	5.4	5.8	6.3	7.4
Pavement	42.475	68.0	74.3	76.5	80.7	85.0	89.2	93.4	97.7	106.2
Sheetpile Driving	15	828.0	833.9	839.8	845.8	862.4	868.5	875.7	882.2	897.1
Sheetpile (kg)	0.25	828.0	833.9	839.8	845.8	862.4	868.5	875.7	882.2	897.1
Bracing	0.36	298.1	300.2	302.3	304.5	310.5	312.7	315.3	317.6	322.9
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	42.2	43.2	44.0	45.1	46.1	46.8	47.7	48.6	51.1
Total		2196.8	2250.9	2297.3	2367.3	2420.7	2463.6	2519.6	2570.5	2712.4

Table 6.12 (8) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		7	7	7	7	7	7	7	7
Outer Diameter (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		2	2.1	2.2	2.4	2.5	2.6	2.8	2.9
Excavation Depth (m)		8.08	8.18	8.3	8.42	8.55	8.65	8.85	9.01
Sheetpile Length (m)		12.12	12.27	12.45	12.63	12.825	12.975	13.275	13.515
Volume of Pavement (m^3)		1.44	1.512	1.584	1.728	1.8	1.872	2.016	2.088
Excavation (Crum m^3)		6.16	6.678	7.26	8.208	8.875	9.49	10.78	11.629
Excavation (Backhoe m^3)		10	10.5	11	12	12.5	13	14	14.5
Backfill (granular m^3)		1.75	1.93	2.13	2.48	2.69	2.90	3.32	3.55
Backfill (original m^3)		12.37	13.10	13.89	15.28	16.13	16.94	18.60	19.63
Backfill (selected soil m^3)		0.6	0.63	0.66	0.72	0.75	0.78	0.84	0.87
Residual Soil (m^3)		3.79	4.08	4.37	4.93	5.24	5.55	6.18	6.50
Pavement (m^2)		2.6	2.7	2.8	3	3.1	3.2	3.4	3.5
Sheetpile Length (m)		60.6	61.35	62.25	63.15	64.125	64.875	66.375	67.575
Sheetpile (kg)		3636	3681	3735	3789	3847.5	3892.5	3982.5	4054.5
Bracing (kg)		909	920.25	933.75	947.25	961.875	973.125	995.625	1013.625
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Crum	18.6	114.6	124.2	135.0	152.7	165.1	176.5	200.5	216.3
Excavation Backhoe	5.433	54.3	57.0	59.8	65.2	67.9	70.6	76.1	78.8
Backfill (granular)	31.914	55.9	61.7	68.0	79.1	86.0	92.5	106.0	113.2
Backfill (original)	2.66	32.9	34.9	36.9	40.6	42.9	45.1	49.5	52.2
Backfill (selected soil)	12.774	7.7	8.0	8.4	9.2	9.6	10.0	10.7	11.1
Residual Soil	2.1	8.0	8.6	9.2	10.3	11.0	11.7	13.0	13.7
Pavement	42.475	110.4	114.7	118.9	127.4	131.7	135.9	144.4	148.7
Sheetpile Driving	15	909.0	920.3	933.8	947.3	961.9	973.1	995.6	1013.6
Sheetpile (kg)	0.25	909.0	920.3	933.8	947.3	961.9	973.1	995.6	1013.6
Bracing	0.36	327.2	331.3	336.2	341.0	346.3	350.3	358.4	364.9
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	52.5	53.9	56.1	58.3	60.6	62.7	67.5	72.6
Total		2794.4	2869.2	2996.9	3127.1	3254.7	3374.4	3643.5	3922.1

Table 6.12 (9) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		9	9	9	9	9	9	9	9	9
Outer Diameter of sewer (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		1	1.15	1.2	1.3	1.4	1.5	1.6	1.7	1.9
Excavation Depth (m)		9.36	9.412	9.465	9.518	9.666	9.72	9.784	9.842	9.974
Sheetpile Length (m/pcs)		14.0	14.1	14.2	14.3	14.5	14.6	14.7	14.8	15.0
Volume of Pavement (m^3)		0.72	0.828	0.864	0.936	1.008	1.08	1.152	1.224	1.368
Excavation Crum (m^3)		4.36	5.0738	5.358	5.8734	6.5324	7.08	7.6544	8.2314	9.4506
Excavation Backhoe (m^3)		5	5.75	6	6.5	7	7.5	8	8.5	9.5
Backfill (granular m^3)		0.44	0.55	0.62	0.72	0.90	1.02	1.15	1.28	1.57
Backfill (original m^3)		7.90	9.10	9.51	10.32	11.20	12.03	12.88	13.72	15.44
Backfill (selected soil m^3)		0.3	0.345	0.36	0.39	0.42	0.45	0.48	0.51	0.57
Residual Soil (m^3)		1.46	1.73	1.85	2.05	2.33	2.55	2.78	3.01	3.51
Pavement (m^2)		1.6	1.75	1.8	1.9	2	2.1	2.2	2.3	2.5
Sheetpile Length (m)		70.2	70.59	70.9875	71.385	72.495	72.9	73.38	73.815	74.805
Weight of Sheetpile (kg)		7371	7411.95	7453.687	7495.425	7611.975	7654.5	7704.9	7750.575	7854.525
Bracing (kg)		1842.75	1852.987	1863.421	1873.856	1902.993	1913.625	1926.225	1937.643	1963.631
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Crum	18.6	81.1	94.4	99.7	109.2	121.5	131.7	142.4	153.1	175.8
Excavation Backhoe	5.433	27.2	31.2	32.6	35.3	38.0	40.7	43.5	46.2	51.6
Backfill (granular)	31.914	14.0	17.7	19.9	23.1	28.8	32.5	36.6	40.8	50.1
Backfill (original)	2.66	21.0	24.2	25.3	27.5	29.8	32.0	34.2	36.5	41.1
Backfill (selected soil)	12.774	3.8	4.4	4.6	5.0	5.4	5.7	6.1	6.5	7.3
Residual Soil	2.1	3.1	3.6	3.9	4.3	4.9	5.4	5.8	6.3	7.4
Pavement	42.475	68.0	74.3	76.5	80.7	85.0	89.2	93.4	97.7	106.2
Sheetpile Driving	15	1053.0	1058.9	1064.8	1070.8	1087.4	1093.5	1100.7	1107.2	1122.1
Lease of Sheetpile	0.25	1842.8	1853.0	1863.4	1873.9	1903.0	1913.6	1926.2	1937.6	1963.6
Bracing	0.36	663.4	667.1	670.8	674.6	685.1	688.9	693.4	697.6	706.9
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	74.4	75.5	76.4	77.8	79.1	79.8	81.0	82.1	84.8
Total		3876.6	3943.2	3997.9	4078.4	4153.4	4206.8	4274.6	4336.6	4502.4

Table 6.12 (10) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		9	9	9	9	9	9	9	9
Outer Diameter (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		2	2.1	2.2	2.4	2.5	2.6	2.8	2.9
Excavation Depth (m)		10.08	10.18	10.3	10.42	10.55	10.65	10.85	11.01
Sheetpile Length (m/pcs)		15.1	15.3	15.5	15.6	15.8	16.0	16.3	16.5
Volume of Pavement (m^3)		1.44	1.512	1.584	1.728	1.8	1.872	2.016	2.088
Excavation (Crum m^3)		10.16	10.878	11.66	13.008	13.875	14.69	16.38	17.429
Excavation (Backhoe m^3)		10	10.5	11	12	12.5	13	14	14.5
Backfill (granular m^3)		1.75	1.93	2.13	2.48	2.69	2.90	3.32	3.55
Backfill (original m^3)		16.37	17.30	18.29	20.08	21.13	22.14	24.20	25.43
Backfill (selected soil m^3)		0.6	0.63	0.66	0.72	0.75	0.78	0.84	0.87
Residual Soil (m^3)		3.79	4.08	4.37	4.93	5.24	5.55	6.18	6.50
Pavement (m^2)		2.6	2.7	2.8	3	3.1	3.2	3.4	3.5
Sheetpile Length (m)		75.6	76.35	77.25	78.15	79.125	79.875	81.375	82.575
Weight of Sheetpile (kg)		7938	8016.75	8111.25	8205.75	8308.125	8386.875	8544.375	8670.375
Bracing (kg)		1984.5	2004.187	2027.812	2051.437	2077.031	2096.718	2136.093	2167.593
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Crum	18.6	189.0	202.3	216.9	241.9	258.1	273.2	304.7	324.2
Excavation Backhoe	5.433	54.3	57.0	59.8	65.2	67.9	70.6	76.1	78.8
Backfill (granular)	31.914	55.9	61.7	68.0	79.1	86.0	92.5	106.0	113.2
Backfill (original)	2.66	43.5	46.0	48.6	53.4	56.2	58.9	64.4	67.6
Backfill (selected soil)	12.774	7.7	8.0	8.4	9.2	9.6	10.0	10.7	11.1
Residual Soil	2.1	8.0	8.6	9.2	10.3	11.0	11.7	13.0	13.7
Pavement	42.475	110.4	114.7	118.9	127.4	131.7	135.9	144.4	148.7
Sheetpile Driving	15	1134.0	1145.3	1158.8	1172.3	1186.9	1198.1	1220.6	1238.6
Lease of Sheetpile	0.25	1984.5	2004.2	2027.8	2051.4	2077.0	2096.7	2136.1	2167.8
Bracing	0.36	714.4	721.5	730.0	738.5	747.7	754.8	769.0	780.3
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	86.5	88.0	90.5	93.1	95.7	98.1	103.3	108.9
Total		4601.0	4691.8	4837.8	4990.6	5137.8	5273.4	5574.4	5876.1

Table 6.12 (11) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		150	200	250	300	350	400	450	500	600
(1) Quantity										
Earth Covering Depth (m)		10	10	10	10	10	10	10	10	10
Outer Diameter (m)		0.16	0.212	0.265	0.318	0.466	0.52	0.584	0.642	0.774
Width of Excavation (m)		1	1.15	1.2	1.3	1.4	1.5	1.6	1.7	1.9
Excavation Depth (m)		10.36	10.412	10.465	10.518	10.666	10.72	10.784	10.842	10.974
Sheetpile Length (m/pcs)		15.5	15.6	15.7	15.8	16.0	16.1	16.2	16.3	16.5
Volume of Pavement (m^3)		0.72	0.828	0.864	0.936	1.008	1.08	1.152	1.224	1.368
Excavation Crum (m^3)		5.36	6.2238	6.558	7.1734	7.9324	8.58	9.2544	9.9314	11.3506
Excavation Backhoe (m^3)		5	5.75	6	6.5	7	7.5	8	8.5	9.5
Backfill (granular m^3)		0.44	0.55	0.62	0.72	0.90	1.02	1.15	1.28	1.57
Backfill (original m^3)		8.90	10.25	10.71	11.62	12.60	13.53	14.48	15.42	17.34
Backfill (selected soil m^3)		0.3	0.345	0.36	0.39	0.42	0.45	0.48	0.51	0.57
Residual Soil (m^3)		1.46	1.73	1.85	2.05	2.33	2.55	2.78	3.01	3.51
Pavement (m^2)		1.6	1.75	1.8	1.9	2	2.1	2.2	2.3	2.5
Sheetpile Length (m)		77.7	78.09	78.4875	78.885	79.995	80.4	80.88	81.315	82.305
Sheetpile (kg)		8158.5	8199.45	8241.187	8282.925	8399.475	8442	8492.4	8538.075	8642.025
Bracing (kg)		2039.625	2049.862	2060.296	2070.731	2099.868	2110.5	2123.1	2134.518	2160.506
(2) Construction Cost (1000 Rp./m)	Unit Cost									
Excavation Crum	18.6	99.7	115.8	122.0	133.4	147.5	159.6	172.1	184.7	211.1
Excavation Backhoe	5.433	27.2	31.2	32.6	35.3	38.0	40.7	43.5	46.2	51.6
Backfill (granular)	31.914	14.0	17.7	19.9	23.1	28.8	32.5	36.6	40.8	50.1
Backfill (original)	2.66	23.7	27.3	28.5	30.9	33.5	36.0	38.5	41.0	46.1
Backfill (selected soil)	12.774	3.8	4.4	4.6	5.0	5.4	5.7	6.1	6.5	7.3
Residual Soil	2.1	3.1	3.6	3.9	4.3	4.9	5.4	5.8	6.3	7.4
Pavement	42.475	68.0	74.3	76.5	80.7	85.0	89.2	93.4	97.7	106.2
Sheetpile Driving	15	1165.5	1171.4	1177.3	1183.3	1199.9	1206.0	1213.2	1219.7	1234.6
Sheetpile (kg)	0.25	2039.6	2049.9	2060.3	2070.7	2099.9	2110.5	2123.1	2134.5	2160.5
Bracing	0.36	734.3	738.0	741.7	745.5	756.0	759.8	764.3	768.4	777.8
Pipe/Laying	1 ls	24.9	39.0	60.0	96.3	85.5	93.7	111.1	125.1	185.6
Dewatering/Others	1 ls	84.1	85.4	86.5	88.2	89.7	90.8	92.2	93.4	96.8
Total		4285.8	4355.5	4411.3	4494.0	4571.1	4626.6	4696.6	4760.7	4930.8

Table 6.12 (12) Breakdown of Collection Sewer Unit Cost

Diameter (mm)		700	800	900	1000	1100	1200	1350	1500
(1) Quantity									
Earth Covering Depth (m)		10	10	10	10	10	10	10	10
Outer Diameter of sewer (m)		0.88	0.98	1.1	1.22	1.35	1.45	1.65	1.81
Width of Excavation (m)		2	2.1	2.2	2.4	2.5	2.6	2.8	2.9
Excavation Depth (m)		11.08	11.18	11.3	11.42	11.55	11.65	11.85	12.01
Sheetpile Length (m/pcs)		16.6	16.8	17.0	17.1	17.3	17.5	17.8	18.0
Volume of Pavement (m^3)		1.44	1.512	1.584	1.728	1.8	1.872	2.016	2.088
Excavation (Crum m^3)		12.16	12.978	13.86	15.408	16.375	17.29	19.18	20.329
Excavation (Backhoe m^3)		10	10.5	11	12	12.5	13	14	14.5
Backfill (granular m^3)		1.75	1.93	2.13	2.48	2.69	2.90	3.32	3.55
Backfill (original m^3)		18.37	19.40	20.49	22.48	23.63	24.74	27.00	28.33
Backfill (selected soil m^3)		0.6	0.63	0.66	0.72	0.75	0.78	0.84	0.87
Residual Soil (m^3)		3.79	4.08	4.37	4.93	5.24	5.55	6.18	6.50
Pavement (m^2)		2.6	2.7	2.8	3	3.1	3.2	3.4	3.5
Sheetpile Length (m)		83.1	83.85	84.75	85.65	86.625	87.375	88.875	90.075
Weight of Sheetpile (kg)		8725.5	8804.25	8898.75	8993.25	9095.625	9174.375	9331.875	9457.875
Bracing (kg)		2181.375	2201.062	2224.687	2248.312	2273.906	2293.593	2332.968	2364.468
(2) Construction Cost (1000 Rp./m)	Unit Cost								
Excavation Crum	18.6	226.2	241.4	257.8	286.6	304.6	321.6	356.7	378.1
Excavation Backhoe	5.433	54.3	57.0	59.8	65.2	67.9	70.6	76.1	78.8
Backfill (granular)	31.914	55.9	61.7	68.0	79.1	86.0	92.5	106.0	113.2
Backfill (original)	2.66	48.9	51.6	54.5	59.8	62.9	65.8	71.8	75.3
Backfill (selected soil)	12.774	7.7	8.0	8.4	9.2	9.6	10.0	10.7	11.1
Residual Soil	2.1	8.0	8.6	9.2	10.3	11.0	11.7	13.0	13.7
Pavement	42.475	110.4	114.7	118.9	127.4	131.7	135.9	144.4	148.7
Sheetpile Driving	15	1246.5	1257.8	1271.3	1284.7	1299.4	1310.6	1333.1	1351.1
Lease of Sheetpile	0.25	2181.4	2201.1	2224.7	2248.3	2273.9	2293.6	2333.0	2364.5
Bracing	0.36	785.3	792.4	800.9	809.4	818.6	825.7	839.9	851.2
Pipe/Laying	1 ls	212.8	234.4	300.9	348.7	410.0	472.9	626.1	823.5
Dewatering/Others	1 ls	94.1	95.8	98.4	100.9	103.4	105.7	111.0	116.6
Total		5031.5	5124.4	5272.6	5429.7	5578.9	5716.6	6021.9	6325.7

Table 6.13 (1) Unit Construction Cost of Manhole by Diameter and by Manhole Height

Manhole Height	Unit Price (x1,000 Rp.)	Remarks
2.0 m	1,110	Type 1 Sewer Diameter : 150 - 600 mm
2.5 m	1,257	" Manhole Height : 2.0 - 7.5 m
3.0 m	1,378	"
3.5 m	2,220	Type 2 Manhole type is as shown in
4.0 m	2,339	" Drawing Book
4.5 m	2,483	"
5.0 m	2,627	"
5.5 m	2,770	"
6.0 m	2,914	"
6.5 m	3,058	"
7.0 m	3,202	"
7.5 m	3,345	"

Table 6.13 (2) Unit Construction Cost of Manhole by Diameter and by Manhole Height

Manhole Height	700 m	800 m	900 m	1,000 m	1,100 m	1,200 m
4.0 m	4,085	4,099	4,121	4,143	4,198	4,465
6.0 m	5,080	5,100	5,122	5,145	5,199	5,458
8.0 m	6,105	6,126	6,148	6,170	6,224	6,483
10.0 m	8,798	8,824	8,852	8,880	8,949	9,291

Table 6.13 (3) Unit Construction Cost of Manhole by Diameter and by Manhole Height

Manhole Height	Unit Price (x1,000 Rp.)	Remarks
3.0 m	4,027	Sewer Diameter : 1,350 - 1,500 mm
4.0 m	4,512	Manhole Height : 3.0 - 10.0 m
4.5 m	4,740	
6.0 m	5,505	
6.5 m	5,741	
8.0 m	6,530	
8.5 m	6,767	
10.0 m	9,350	

Table 6.14 Labour Wages

Item No	Description	Unit	Unit Cost (Rp.)
1	Common labor	Man-day	3,500
2	Semi skilled labor	Man-day	4,000
3	Skilled labor	Man-day	5,000
4	Mason	Man-day	5,000
5	Plasterer	Man-day	5,500
6	Concrete worker	Man-day	5,500
7	Steel worker	Man-day	5,500
8	Carpenter	Man-day	5,500
9	Foreman	Man-day	8,000
10	Welder	Man-day	6,000
11	Electrician	Man-day	6,000
12	Plumber	Man-day	6,000
13	Operator	Man-day	10,000
14	Assistent Operator	Man-day	6,500
15	Driver (dump truck)	Man-day	6,000
16	Mechanic	Man-day	7,000
17	Surveyor	Man-day	8,000

Table 6.15 Rental Cost of Equipment

Item No	Description	Capacity	Unit Price (Rp./day)
1	Concrete mixer	0.1 m3	32,000
2	Concrete vibrator	dia. 40 mm	25,000
3	Water pump	dia. 75 mm	32,800
4	Excavator / backhoe	0.6 m3	360,000
5	Bulldozer	11 ton	465,000
6	Bulldozer	15 ton	520,000
7	Crawler crane	16 ton	480,000
8	Dump truck	2 ton	122,000
9	Dump truck	8 ton	164,000
10	Vibro hammer	2.4 ton	710,000
11	Tamping rammer	80 kg	34,000
12	Compressor	3 m3/min.	425,000
13	Vibratory compactor	23 ton	320,000
14	Generator set	-	95,000

Table 6.16 Fuel and Materials Cost

Item No.	Description	Unit	Unit Cost (Rp.)
1	Gasoline	lit.	450
2	Diesel oil	lit.	245
3	Hydraulic oil	lit.	5,200
4	Lubricant oil	lit.	6,500
5	Grease	kg	7,750
6	Portland cement	bag	5,400
7	Sand for concrete	m3	24,000
8	Sand for others	m3	20,000
9	Sand gravels	m3	21,000
10	Crushed stone for concrete	m3	24,000
11	Broken stone	m3	21,000
12	Brick	pc	80
13	Selected soil	m3	2,750
14	Meranti Wood (class III) :		
	a. Plank	m3	230,000
	b. Square	m3	210,000
15	Plywood 4 x 8 t 9 mm	sheet	16,000
16	Plywlld 4 x 8 t 12 mm	sheet	21,000
17	Dolken wood dia. 80 mm	pc	1,000
18	Reinforced steel bar	ton	800,000
19	Steel materials :		
	a. Sheet pile type II (48 kg/m)	kg	1,250
	b. Sheet pile type III (60 kg/m)	kg	1,250
	c. Sheet pile type VL (105 kg/m)	kg	1,250
	d. H Shape steel	kg	1,250
20	Concrete wire	kg	1,500
21	N a i l s	kg	1,300
22	Polyvinyl Chloride (pvc) Pipes :		
	a. Diametre 150 mm	m	19,850
	b. Diametre 200 mm	m	31,350
	c. Diametre 250 mm	m	48,350
	d. Diametre 300 mm	m	78,750
23	Reinforced Concrete (RC) Pipes (including rubber joint)		
	a. Diameter 350 mm	m	68,100
	b. Diameter 400 mm	m	75,100
	c. Diameter 450 mm	m	91,100
	d. Diameter 500 mm	m	100,850
	e. Diameter 600 mm	m	146,100
	f. Diameter 700 mm	m	170,000
	g. Diameter 800 mm	m	188,750
	h. Diameter 900 mm	m	247,900
	i. Diameter 1000 mm	m	292,000
	j. Diameter 1100 mm	m	343,300
	k. Diameter 1200 mm	m	399,500
	l. Diameter 1350 mm	m	521,250
	m. Diameter 1500 mm	m	686,200

Table 6.17 O&M Cost for Central Sewerage Zone

(Unit : million Rp./annum)

Item \ Year	2000	2010
1) F/S Area		
Sewer line	164	164
Lift Pump Station	114	126
Treatment Plant	3,311	6,612
Sub Total	3,589	6,902
2) JSSP Project Area		
Sewer line	-	76
Total	3,589	6,978

Table 6.18 Breakdown of O&M Cost for Central Sewerage Zone

(Unit : million Rp./annum)

Item \ Year	2,000 Quantity	2,000 Unit Cost	2,000 Total	2,010 Quantity	2,010 Unit Cost	2,010 Total
A. F/S Area						
(1) Sewer line						
Secondary/tertiary	460,000 m	300 Rp./m	138	460,000 m	300 Rp./m	138
Main pipe	59,955 m	300 Rp./m	18	59,955 m	300 Rp./m	18
Trunk/force main	18,030 m	300 Rp./m	5	18,030 m	300 Rp./m	5
Conveyance	10,340 m	300 Rp./m	3	10,340 m	300 Rp./m	3
Sub total			164			164
(2) Lift Pump Station						
Electricity	792,000 kwh	100 Rp./kwh	79	905,000	100 Rp./kwh	91
Repairing	1 ls	-	26	1 ls	-	26
Personnel expenditure	1 ls	-	9	1 ls	-	9
Sub total			114			126
(3) Treatment Plant						
Electricity	30.5×10^6 kwh	100 Rp./kwh	3,050	56.0×10^6 kwh	100 Rp./kwh	5,600
Chemicals	1 ls	-	-	1 ls	-	614
Repairing	1 ls	-	171	1 ls	-	288
Personnel expenditure	1 ls	-	90	1 ls	-	110
Sub total			3,311			6,612
Total of A			3,589			6,902
B. JSSP Area						
Secondary/tertiary	-	-		126,000 m	300 Rp./m	38
Main/trunk	-	-		59,000 m	300 Rp./m	18
Pump Station	-	-		1 ls		20
Sub total						76
TOTAL			3,589			6,978

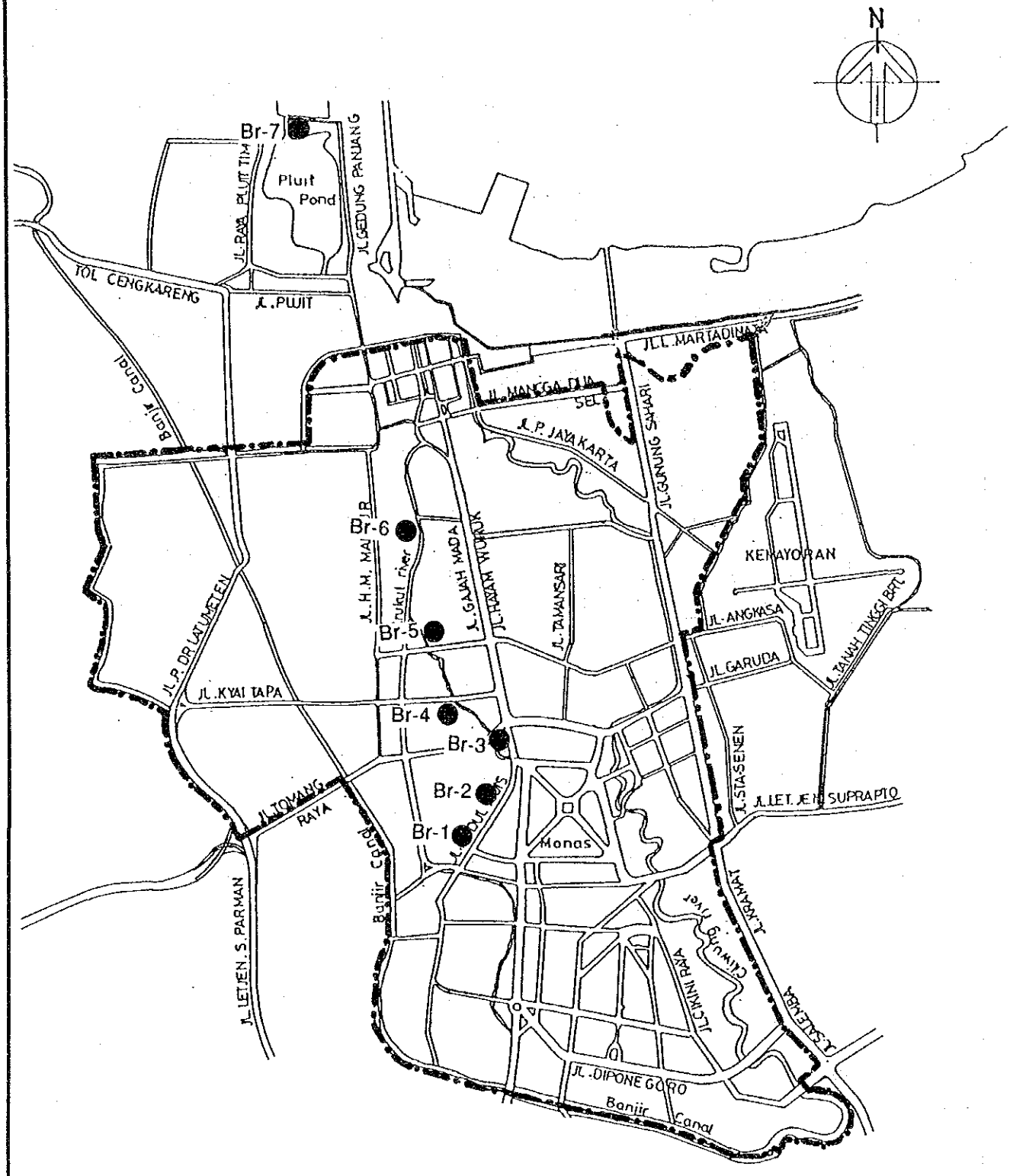


FIG. 6.1 BORING LOCATION

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

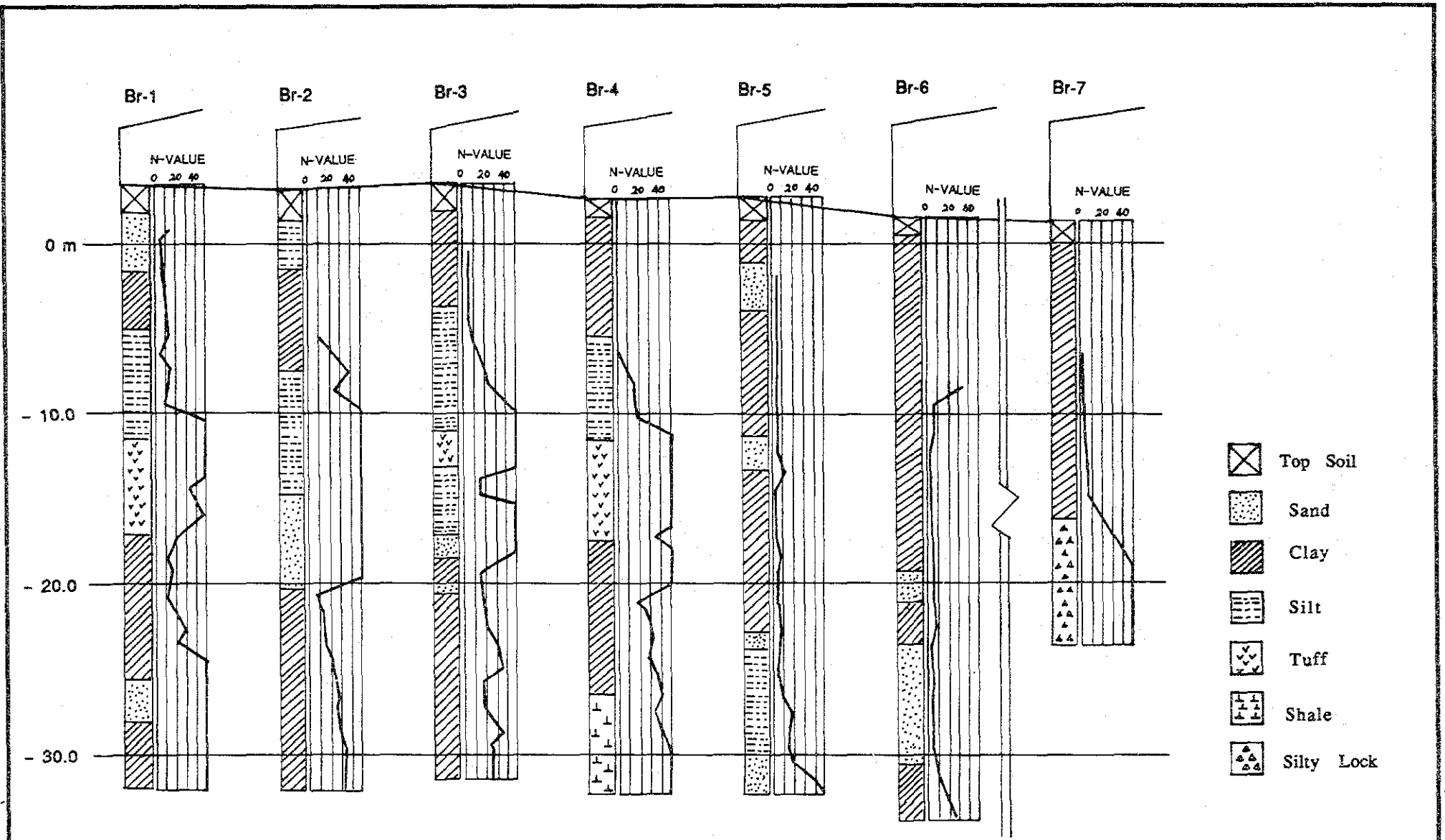


FIG. 6.2 GEOLOGICAL PROFILE

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

Chapter 7 IMPLEMENTATION PROGRAMME

7.1 Project Phasing

7.1.1 General

The proposed sewerage system is planned to not only serve 1,659,000 people in the Project Area but also receive the wastewater of 663,900 people in the JSSP area in 2000. It is because the capacity of the existing Setia Budi aerated lagoon treatment plant is only 34,000m^3/d and will be overloaded after 1993. Hence, the wastewater of the JSSP area will be introduced to Pluit Pond aerated lagoon treatment plant soon after completion of the whole conveyance sewer.

The design wastewater discharge of the Project Area in the year 2000 is estimated at 316,200 m^3/d. While, that of the JSSP area in 2000 is estimated to be 124,800 m^3/d.

The proposed sewerage development project will be implemented in two (2) phases since it requires a large cost of Rp. 445.3 billion at 1990 price and a long construction period of eight (8) years. The first phase will be completed in 1996. The second phase will subsequently be implemented to complete in 2000.

The following two (2) alternative plans are considered for phasing the Project.

(1) The whole distance of the conveyance sewer will be completed along with the collection sewers of some areas located along the conveyance sewer, in the first phase. This plan is in expectation of a high cost recovery of the conveyance sewer construction cost by potential connection to high rise buildings located along the route of conveyance sewer. Moreover, this plan is of advantage to early settlement of the overload of the Setia Budi treatment plant.

(2) The proposed project will be developed from the lowermost area towards upstream in accordance with normal implementation

method. Sewerage system of the lower part area will be completed in the first phase.

Based on the above considerations, two (2) alternative plans for the first phase are compared in the following sections.

7.1.2 Alternative Plan A

The whole conveyance sewer of 10.3 km with a diameter ranging from 1,900 mm to 2,900 mm will be completed.

In the Project Area, 920 ha or 24% of the total area located along the conveyance sewer is covered by sewerage system. As a result, 350,100 person and 112 high rise buildings (building with more than four (4) floors) will receive sewerage service in 1997. Among the 112 high rise buildings, 62 are existing and the remaining 50 are expected to be built until 1997. The service area according to the first phase program is shown in Fig. 7.1.

The wastewater discharge of the first phase of this Alternative Plan A, that enter the sewer system from the Project Area is estimated to be 63,990 m^3/d. This wastewater discharge is 20% of the design discharge (including groundwater infiltration) in the year 2000.

While in the JSSP Area, wastewater of 645,600 person and 64 high rise buildings will be collected by the JSSP sewerage system in 1997. Among the 64 high rise buildings, 55 are existing and the remaining 9 are future ones.

The collected wastewater discharge of 121,400 m^3/d will be introduced to the Pluit Pond treatment plant through the completed conveyance sewer in 1997 when the first phase project will start operation.

Hence, the first phase system of this Alternative Plan A will serve 995,700 person and treat the wastewater of 185,390 m^3/d in total in 1997. As a result, pollution load of 30,170 kg/d as BOD will be reduced.

Half of the total inflow pump capacity, whole aerated lagoon structures and 10 units of aerator will be installed in the first phase.

Total direct construction cost of the first phase plan is estimated at Rp. 204.5 billion with its break-down of collection system of Rp. 64.7 billion, conveyance sewer of Rp. 117.0 billion and treatment plant of Rp. 22.8 billion.

Construction cost per population served, wastewater discharge treated and the construction cost per unit pollution load reduction are respectively Rp. 205,000/person, Rp. 1.10 million m^3/d and Rp. 6.8 million/kg•BOD/d.

Construction cost recovery by Alternative Plan A of first phase project by high rise buildings is estimated based on the following assumptions.

- The maximum affordable cost of a high rise building is equivalent to the construction cost of substitutional individual treatment facility.

- All high rise buildings which will be built in the future (59 buildings) bear the cost equivalent to substitutional individual facility.

- 70% of the existing high rise building which are equipped with only toilet waste treatment units (117 x 0.7 = 82 buildings) bear the cost under the same condition on that of future buildings.

- 25% of the existing high rise building which are not equipped with proper individual treatment system (117 x 0.25 = 29 buildings) bear 50% of the cost of that of substitutional facility.

The total construction cost recovery by high rise buildings by Alternative Plan A (first phase) is estimated at Rp. 22.0 billion at 1990 Price.

7.1.3 Alternative Plan B

The conveyance sewer will be extended over 6.4 km towards Pluit Pond from upstream. The downstream project area of 1,824 ha, which can be connected to this conveyance sewer or 47% of the total area, will be covered by sewerage system in the first phase. As a result, 910,700 person and 59 high rise buildings will be served in 1997. Among the 59 high rise buildings, the existing ones account for 33 and future ones 26. The

sewerage service area according to the first phase project of alternative Plan B is shown in Fig. 7.2.

Wastewater of 172,360 m^3/d or 55% of the total design wastewater in the year 2000 will be collected and treated by the first phase project, resulting in reduction of BOD load of 27,590 kg/d.

In case of Alternative Plan B, no wastewater is introduced from the JSSP area before completion of the second phase in 2000.

In the first phase, half of the total pump capacity, whole aerated lagoon structures and 10 units of aerator will be constructed.

Total direct construction cost of the first phase Alternative Plan B is estimated to be Rp. 206.1 billion. It is broken down into collection system of Rp. 106.6 billion, conveyance sewer of Rp. 76.7 billion and treatment plant of 22.8 billion.

Construction cost per population served, wastewater discharge treated and the construction cost per unit pollution load reduction is estimated to be respectively, Rp. 226,000/person, Rp. 1.20 million/m^3/d and Rp. 7.5 million/kg·BOD/d.

The total construction cost recovery by high rise buildings for this Alternative Plan B (first phase) is estimated to be Rp. 7.4 billion at 1990 price in the same manner as Alternative Plan A.

7.1.4 Comparative Evaluation

The above two (2) alternative plans are comparatively evaluated as follows. For details, refer to Table 7.1.

	Alternative A	Alternative B
Construction Cost (Rp. billion)	204.5	206.1
Served Area (ha)	2,758	1,824
Served Population	995,700	910,700
Treated Wastewater Discharge (m^3/d)	185,390	172,360
BOD Load Reduction (kg/d)	30,170	27,590
Const. Cost per Served Population (Rp./person)	205,000	226,000
Const. Cost per Treated Wastewater Discharge (Rp. million/m^3/d)	1.10	1.20
Construction Cost per Unit BOD Load Reduction (Rp. million/kg/d)	6.8	7.5
Recovery Cost of High Rise Building (Rp. billion)	22.0	7.4

As evident from the above table, Alternative Plan A is more economically efficient than Alternative Plan B.

Furthermore, Alternative Plan A has the following noticeable advantages.

(1) Pollution load reduction in the upper reaches contributed to river water quality improvement more than that in the lower reaches even when the amount of reduction remains the same.

Both alternative plans treat almost the same amount of wastewater. The sewage collection area of Alternative Plan A extends from the lowermost reaches of the Project Area to JSSP area, while that of Alternative Plan B is limited to the lower reaches of the Project Area.

Hence, contribution to river water quality improvement of Alternative Plan A is higher than that of Alternative Plan B.

(2) The whole conveyance sewer will be completed in 1996 in case of Alternative A, four (4) years earlier than in case of Alternative B. Hence, the overload of the existing Setia Budi aerated lagoon treatment plant will be settled earlier.

The following volume of wastewater in the JSSP area will be discharged into the Banjir Canal with no treatment before full completion of the conveyance sewer.

Alternative Plan A: discharge pollution load of 18,637 ton as BOD during 1994 - 1996

Alternative Plan B: discharge pollution load of 44,355 ton as BOD during 1994 - 2000

(3) The first phase project of Alternative Plan A covers the most important institutional and commercial areas of Jakarta city.

(4) Once the whole conveyance sewer is completed, collection system can be optionally developed areawise and timewise.

7.2 Implementation Programme

The proposed sewerage development project will be completed within nine (9) years from 1992 to 2000. The implementation programme of the project is prepared based on the phasing policy discussed in the previous Section 7.1 and conforms to Alternative Plan A, as follows.

The first phase project will be completed within five (5) years from 1992 to 1996. The detailed design will be completed in 1992. The construction works will be commenced in 1993 and be accomplished in 1996. The included major construction works are:

- whole conveyance sewer of 10.34 km
- sewerage collection system of 920 ha in Sub-zones A, B, C, D and E along the area of conveyance sewer
- connection pipe between JSSP area and conveyance sewer (0.5 km)
- half capacity of inflow pump station ($218 m^3/min.$)
- open ditch connecting inflow pump station and aerated lagoon
- aerated lagoon structure including embankment, excavation, etc.
- 10 units of aerator

The second phase project will be completed within five (5) years from 1996 to 2000. The detailed design will be accomplished in 1996. The construction works will be commenced in 1997 and be completed in 2000. The included major construction works are:

- sewerage collection system of 2,927 ha in Sub-zone A, B, C, D, E, F and G
- lift pump station (63.1 m^3/min.)
- remaining capacity of inflow pump (256m^3/min.)
- remaining aerators (14 units)
- dying bed (3,000m^2)

The proposed implementation programme is shown in Table 7.2.

7.3 Disbursement Schedule

The proposed disbursement schedule of the project cost is shown in Table 7.3.

Table 7.1 Alternatives of Project Phasing

Alternative A : Sewerage Development by Conveyance Sewer Precedence

	Covered Area (ha)	Population in 1997 (person)	Wastewater Discharge (m3/d)	Construction Cost (Rp. billion)			
				Collection System	Conveyance sewer	Treatment Plant	Total
A	210	58,400	11,180	9.2	13.4	-	22.6
B	60	45,000	5,410	2.9	11.4	-	14.3
C	150	16,900	3,560	9.1	15.5	-	24.6
D	170	50,000	10,080	11.6	14.3	-	25.9
E	330	179,800	33,760	31.9	62.4	22.8	117.1
F	-	-	-	-	-	-	-
G	-	-	-	-	-	-	-
JSSP	1,838	645,600	121,400	-	-	-	-
Total	2,758	995,700	185,390	64.7	117.0	22.8	204.5

Construction cost per served population : Rp.205,000/person

Construction cost per wastewater discharge : Rp. 1.10 million

Alternative B : Sewerage Development from Downstream Most

	Covered Area (ha)	Population in 1997 (person)	Wastewater Discharge (m3/d)	Construction Cost (Rp. billion)			
				Collection System	Conveyance sewer	Treatment Plant	Total
A	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-
D	331	97,300	19,630	22.5	14.3	-	36.8
E	1,493	813,400	152,730	84.1	62.4	22.8	169.3
F	-	-	-	-	-	-	-
G	-	-	-	-	-	-	-
JSSP	-	-	-	-	-	-	-
Total	1,824	910,700	172,360	106.6	76.7	22.8	206.1

Construction cost per served population : Rp.226,000/person

Construction cost per wastewater discharge : Rp.1.20 million

Table 7.2 Implementation Programme of Sewerage Development

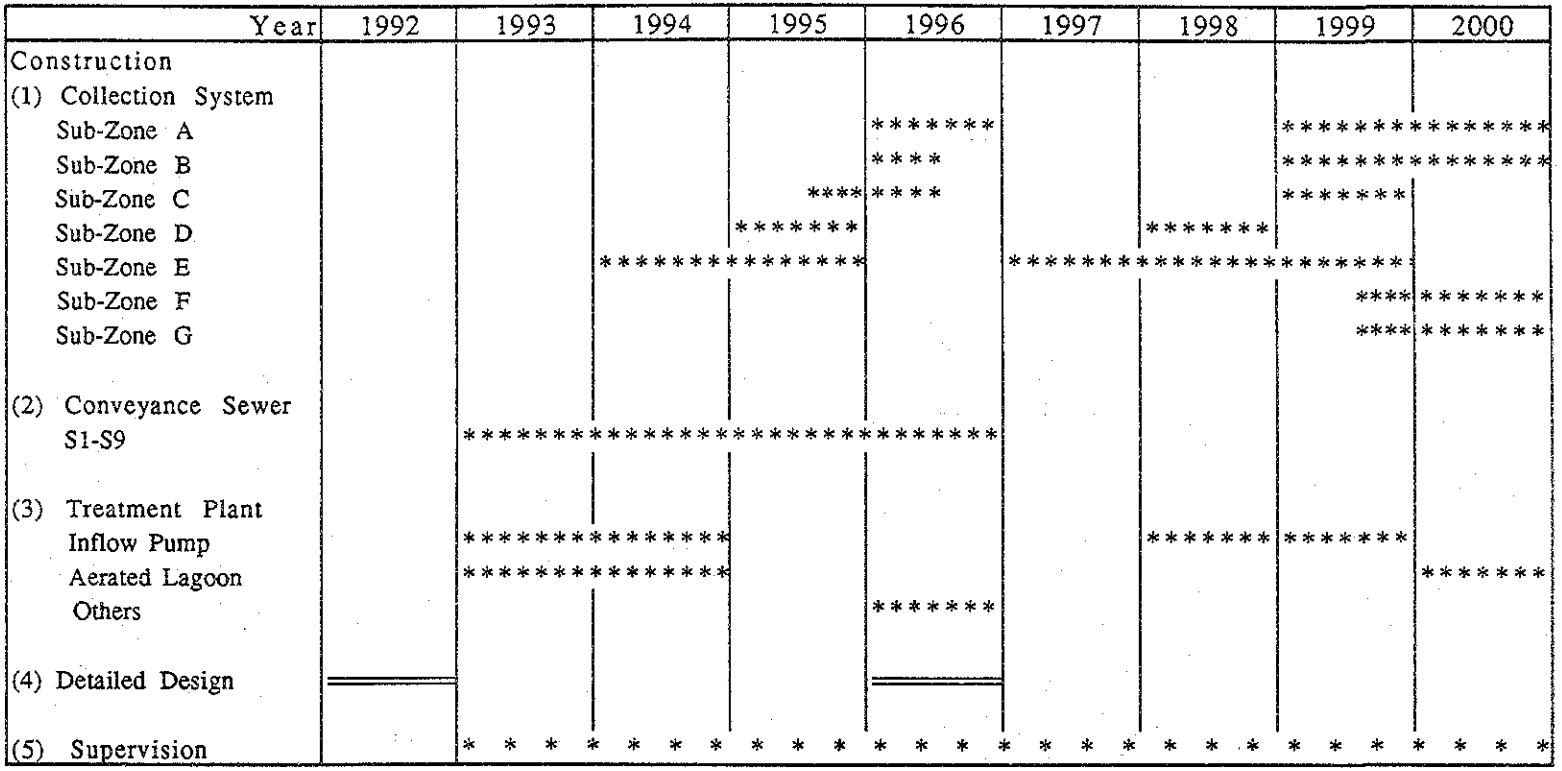


Table 7.3 Disbursemsnt Schedule

(Unit: Rp. billion)

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
1. Direct Cost		29.2	49.1	66.8	55.3	19.0	30.3	65.0	60.6	375.3
(1) Collection System										
Collection Sewer			15.0	32.6	17.1	17.0	27.9	62.0	46.2	217.8
Lift Pump Station									4.1	4.1
(2) Conveyance Sewer		29.2	29.2	29.2	29.4					117.0
(3) Treatment Plant			4.9	5.0	8.8	2.0	2.4	3.0	10.3	36.4
(4) Connection Pipe										
2. Land Acquisition & Compensation	0.6									0.6
3. Administration Cost	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	5.6
4. Engineering Services	8.3	2.0	2.0	2.0	6.0	1.5	1.5	1.5	1.5	26.3
5. Physical Contingency		2.9	4.9	6.7	5.5	1.9	3.0	6.5	6.1	37.5
6. Total	9.5	34.7	56.6	76.1	67.4	23.0	35.4	73.7	68.9	445.3

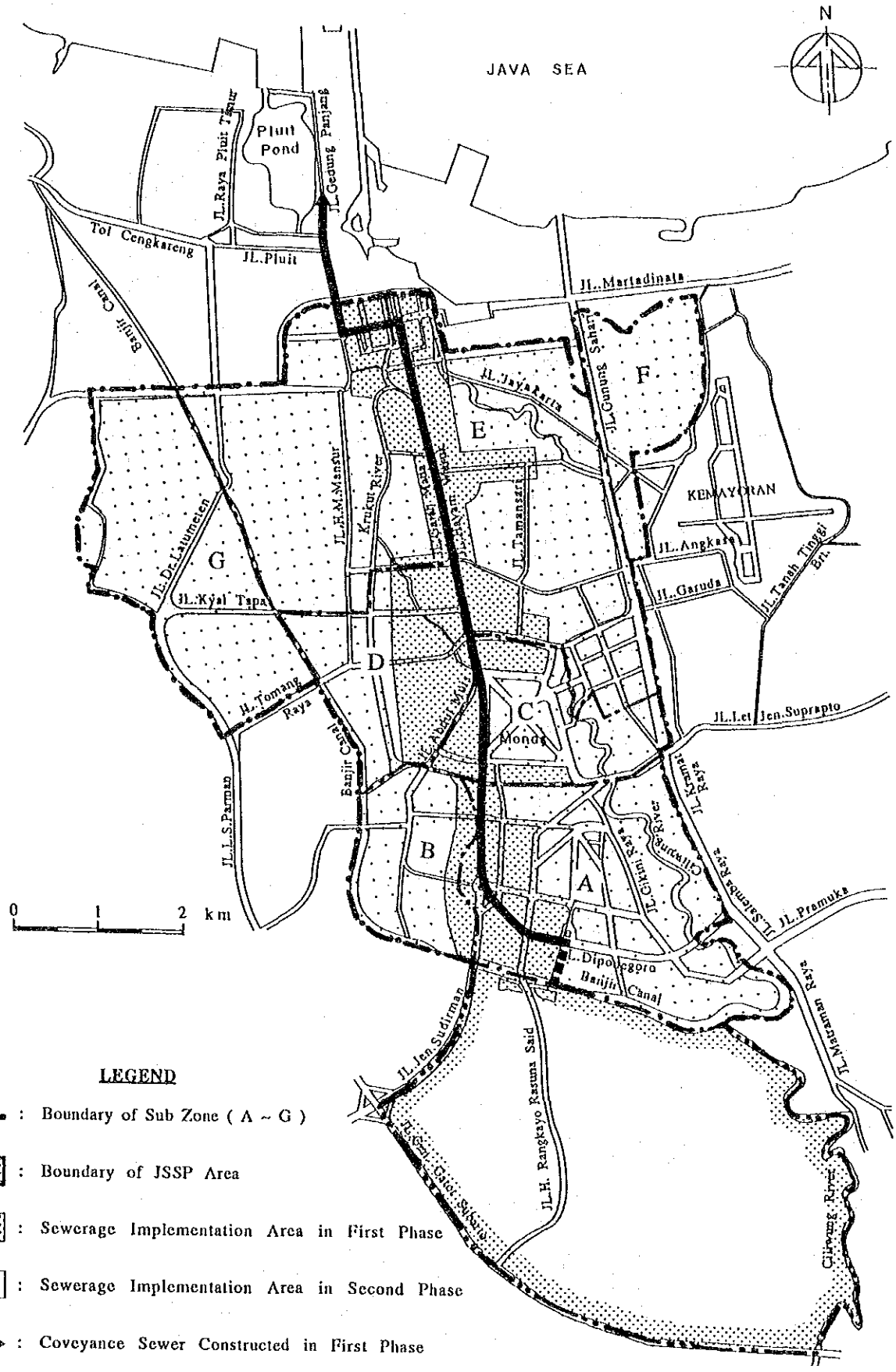


FIG. 7.1 SERVICE AREA IN THE FIRST PHASE OF ALTERNATIVE A

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

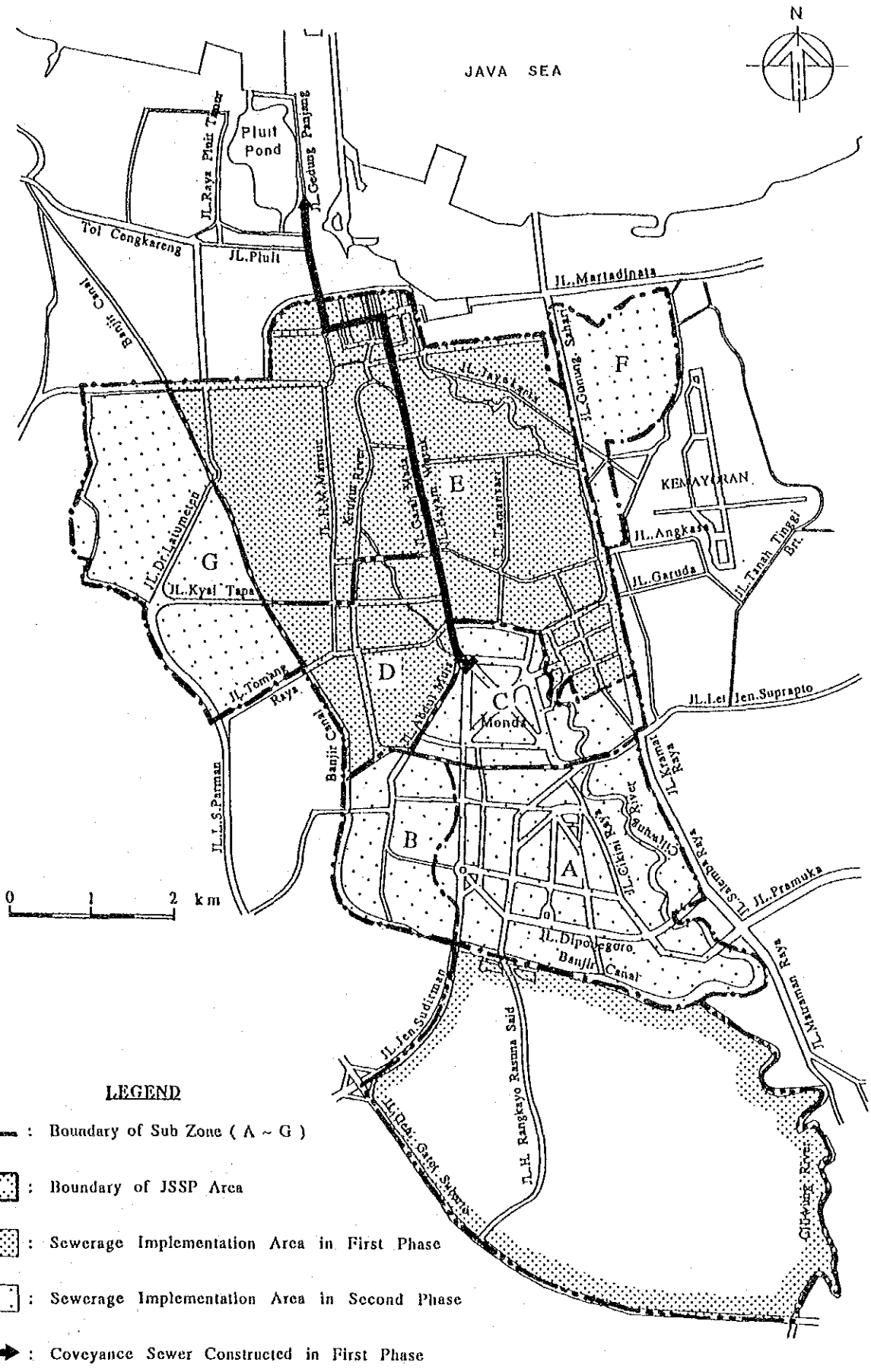


FIG. 7.2 SERVICE AREA IN THE FIRST PHASE OF ALTERNATIVE B

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

Chapter 8. ECONOMIC, SOCIAL AND ENVIRONMENTAL EVALUATION

8.1 Nos. of Beneficiaries

Beneficiaries of sewerage services were divided into 11 categories of houses, shops, factories, hotels, restaurants, hospitals, offices, schools, religious institutions, others and high rise buildings.

Shops, factories, hotels, restaurants, private hospitals, private offices and some of "others" and "high rise buildings" can be classified as commercial establishments, while public hospitals, government offices, schools, religious institutions and some of "others" and "high rise buildings" can be categorized as social institutions.

A high rise building is defined as a building having more than four (4) stories, the categorization of which became necessary as it would be a potential source of revenue for sewerage enterprise.

The total number of beneficiaries of sewerage across the entire categories in the Project Area works out to 203,818 for 1988 and 225,773 for 2000, of which houses account for respectively 95% and 91.5% in 1988 and 2000. Shops and offices occupy the second and third places respectively with the share of 2.0% and 1.0% for 1988, and 3.7% and 1.7% for 2000. High rise buildings account for 0.04% (89 buildings) for 1988, and 0.08% (264 buildings) for 2000.

The number of commercial establishments is expected to grow by 95.2% from 6,752 in 1988 to 13,180 in 2000. Likewise, the number of social institutions is expected to increase by 68.9% from 3,494 to 5,000 and that of houses by 12.4% from 193,572 in 1988 to 217,627 in 2000.

However by the year 2000 as the JSSP Area would also be integrated into the Project Area, the total number of beneficiaries of all categories would expand to 312,147 by the year 2000 and 338,605 by the year 2010. Out of these, houses account for 93% in 2000 and 91% in 2010, shops for 3.2% in 2000 and 4.1% in 2010, and offices for 1.3% in 2000 and 1.6% in 2010.

The number of properties in the Poject Area and in the JSSP Area on a Kelurahan basis is shown in Table 8.1.

8.2 Reduction of Pollution Load

8.2.1 Existing and Future Pollution Load without Project

(1) Existing Pollution Load

Existing pollution load as BOD in the Project Area is estimated to be 44,572 kg/d, and the breakdown is shown in Table 8.2 .

The share of pollution load from resident is 71.3%, from commerce and institution is 24.8% and from industry is 3.9%. The total pollution load from resident is 31,762 kg·BOD/d, of which toilet waste accounts for 4,690 kg·BOD/day and gray water the remaining 27,072 kg·BOD/d.

(2) Future Pollution Load

Future pollution load discharge of the Project Area without project in the year 2000 is estimated to be 59,145 kg·BOD/d under the following assumptions.

- The ratio of sanitary disposal of toilet waste by households in septic tank/leaching systems remains the same as existing conditions with a 74%.

- Gray water, commercial and institutional wastewater and industrial wastewater are discharged to the public water bodies under the same conditions as existing.

Future pollution load as BOD, discharged from each pollution sources are as follows:

(Unit: kg·BOD/d)

Domestic Waste		Commercial & Institutional	Industry	Total
Toilet Waste	Gray Water			
4,852	33,663	19,016	1,614	59,145

8.2.2 Reduction of Pollution Load by Sewerage Development

Reduction of pollution load by sewerage development is estimated assuming the following conditions.

- All domestic and commercial and institutional wastewater in conventional sewerage areas are collected, treated and discharged to the rivers and canals nearby treatment plant with a BOD of 30 mg/l.

- All gray water discharged by domestic, commercial and institutional sources in interceptor area is collected, treated and discharged with a BOD of 30 mg/l.

- All toilet wastewater in interceptor area is treated by on-site sanitation facilities.

Accordingly, it is estimated that the pollution load of 59,145 kg/d as BOD discharged from the Project Area will be treated to 9,486 kg/d by the proposed wastewater treatment plant at Pluit Pond with a net pollution load reduction of 49,659 kg/d. This implies that sewerage development would contribute toward a BOD removal efficiency of 84% in the year 2000. Furthermore, the pollution load of 24,960 kg/d as BOD discharged from JSSP Area in the year 2000 will be also treated to 3,750 kg/d with a reduction of 21,210 kg/d by the proposed Pluit Pond treatment plant. Consequently, the total pollution load reduction by the proposed sewerage system comes to 70,869 kg/d as BOD in the year 2000.

8.3 Reduction of Waterborne Disease

8.3.1 Disease Contraction Ratio

Based on field investigation, questionnaire survey and statistical data of disease contraction, waterborne disease contraction ratio in the project area and JSSP Area is determined to be 72.34 and 40.55 per 1000 person respectively. Moreover, the correlation between water color/smell of river/canal and disease contraction ratio for each area is represented by the following equations:

$Y_1 = 32.9602 + 0.1907X_1 + 0.82926X_2$ (Project Area)
$Y_2 = 27.3599 + 0.1907X_1 + 0.82926X_2$ (JSSP Area)

Where

X_1 : Percentage of respondents who replied that water color of near-by rivers/canals was black (%)

X_2 : Percentage of respondents who replied that water smell of near-by rivers/canals was strong (%)

Y : No. of those who contracted major water-borne diseases in the last three years (cases/1,000 population)

After the completion of sewerage development, disease contraction ratio of the project area and JSSP area will be reduced to 32.96 and 27.36 per 1000 person respectively.

8.3.2 Medical Costs

Medical costs consist of medication cost and economic losses resulting from unworkable days and death of patient, on the basis of each patient. Medical cost of waterborne disease per patient ranges from Rp. 60,000 for Cholera to Rp. 460,000 for Tuberculosis, with an average of Rp. 229,000 (Ref. Table J.20 of Appendix J, Supporting Report of Master Plan).

Reduction of medical costs is estimated from the difference in the total medical costs between the "without" and "with" project cases.