IV. STUDY ON WATER QUALITY

CONTENTS

1. GENERAL

In connection with the preparation of Master Plan and Feasibility Study of the water supply system of Ujung Pandang, water qualities of the existing and the proposed water sources, groundwater and the treatment plants were surveyed over the period from August 1984 to January 1985. The present report describes all the findings of the survey and recommendations concluded therefrom, which will be incorporated in the planning of the water supply system.

2. WATER QUALITY STANDARDS

Drinking water is to meet the basic requirements for water quality, that is, 1) to be clear, 2) to be palatable, free from objectionable odor, 3) to be safe, free from pathogens and toxicants, and 4) not to contain excessively high contents of dissolved matter.

Drinking water standards in general are specified from the above viewpoint, with slight differences from country to country. The Indonesian Drinking Water Standards, prepared similarly, are presented in Table 2.1, together with that of WHO. The Indonesian Standards are almost same with that of WHO except a few items. For reference, the Indonesian Standards of raw water is presented in Table 2.2.

TABLE 2.1 **DRINKING WATER STANDARD**

Substances	(Unit)	Indonesian Standard (Highest desirable level)	Indonesian Standard (Maximum permissible level)	W H O International Standard (Highest desirable level)	W H O International Standard (Maximum permissible level)
Chemical Substances					
Total Solids	(mg/l)	500	1,500	500	1,500
Colour (plantinum cobalt)		5	50	5	50
Turbidity	(JTU)	2 (mg/l)	10 (mg/l)	5 (JTU)	25 (JTU
Taste		unobjectionable		unobjectionable	
Odour		unobjectionable		unobjectionable	
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)	1.0	15.0	5.0	15.0
Calcium (Ca)	(mg/l)	75	200	75	200
Magnesium (Mg)	(mg/l)	30	150	30	150
Sulphates (SO_4)	(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)		$10^{o}D$	100	500
Toxic Substances		(Upper limit of concentration)		(Upper limit of concentration)	
Lead (pb)	(mg/l)	0.10		0.1	
Arsenic (As)	(mg/l)	0.05		0.05	
Selenium (Se)	(mg/l)	0.01		0.01	
Chronium (hexaralent)(Cr^{+6})	(mg/l)	0.05		-	
Cyanide (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					
Marcury (Hg)	(mg/l)	-		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	(mg/l)	10		-	
Bacteriological					
Germs		0,0		-	
Pathogenic germs		0,0		-	
Faecal coli	N/100 ml	0,0		-	

TABLE 2.2 **RAW WATER STANDARDS IN INDONESIA**

Parameter	Unit	Maximum Desirable	Maximum Permissible
A. Chemical			
Total Iron	mg/l		1.0
Chromium	"		0,5
Cadmium	"		0,01
Cobolt	"		1.0
Manganese	"		0.5
Mercury	"		0.005
Copper	"		1.0
Lead	"		1.05
Ammonia	"	0.01	0.5
Nitrite and Nitrate	"	nil	10
B. Organic Chemical			
Oil and Grease			nil
Pesticides:			
a. Aldrin	ug/l	nil	0.03
b. Malthion	"		
c. D.D.T	"	nil	1.0
d. Lindan	"	nil	3.0
e. BHC	"		
f. Dieldrin	"	nil	
g. Endrin	"		
h. Parathion			
MBAS	mg/l	nil	0.5
BOD	"		3
DO	"	6	
pH		6.5	8.5
C. Microbiological			
Coliform	per 100 ml		10,000
Faecal Coli	"		2,000

Note: This water quality of Raw Water for water supply is taken from Article 2, No.173/Men.Kes./Per/VIII/77, Ministry of Health.

3. EXISTING AND POSSIBLE WATER SOURCES

Sampling in the present survey was made as shown in Table 3.1 and on Figure 3.1. The sampling covered the existing water sources, i.e., the Leko Pancing intake of the Maros River and the Sungguminasa intake of the Jeneberang River; potential intake points at Bili-Bili of the Jeneberang River; and other rivers and lakes. In addition, tests of groundwater were also made.

3.1 EXISTING WATER SOURCES

3.1.1 SUNGGUMINASA INTAKE

The Jeneberang River flows through the southern part of Ujung Pandang, and is tapped at Sungguminasa for water supply and water taken in is transmitted to the Ratulangi treatment plant. The basin of the River upstream of Sungguminasa has an area of 650 km^2, where are small villages scattered and many farmlands.

The results of the survey, as shown in Table 3.2, indicate ammonia contents of 0.08 - 0.10 mg/l, coliform bacteria of 300 - 1,800 MPN, and total colonies of 840 - 1,584/l. The above values imply that the water at the intake is contaminated by organic pollutants, but the contaminated water to such a degree can be treated satisfactorily by the treatment plant.

Organic pollution of the river water is anticipated to increase in the future, since the intake is located close to the urban area of Ujung Pandang, and urbanization is taking place rapidly. Considering the above, pre-chlorination is advisable for better treatment.

Turbidity increases abnormally in the transit period from the dry season to the wet season because of the river flow increase.

TABLE 3.1 Sampling Points

No.	Sampling Point
ST. 1	Maros River (Lekopancing Intake)
ST. 2	Bantimurung River (Upstream)
ST. 3	Maros and Bantimurung Rivers (Junction)
ST. 4	Jeneberang River (Bili-Bili Dam)
ST. 5	Jeneberang River (Bili-Bili Intake)
ST. 6	Jeneberang River (Sungguminasa)
ST. 7	Tallo River (near the existing transmission canal)
ST. 8	Tallo River (near the existing transmission canal)
ST. 9	Tallo River (near Daya district)
ST. 10	Tallo River (near the Steam Power Plant intake)
ST. 11	Tonjong Lake
ST. 12	Mawang Lake
ST. 13	Marsh (Eastern of Ujung Pandang)

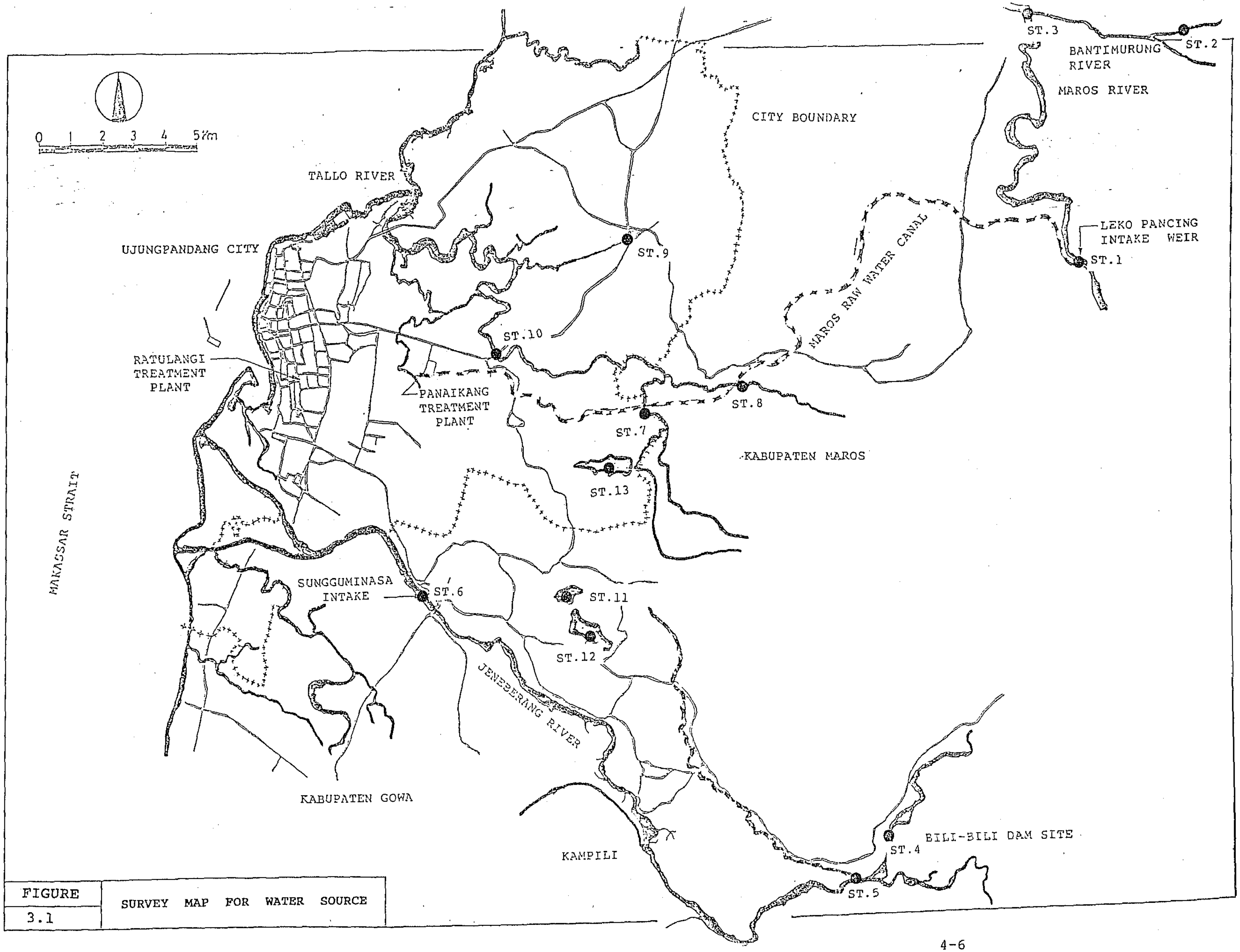


FIGURE	SURVEY MAP FOR WATER SOURCE
3.1	

TABLE 3.2 WATER QUALITY ANALYSIS OF JENEBERANG RIVER

I t e m s		S u n g g u m i n a s a I n t a k e (St 6)							
Sampling Date		5-9-84	11-10-84	21-11-84	10-12-84	12-12-84	19-12-84	21-12-84	17-1-85
Water Temperature	°C	25.0	29.2	27.5	29.5	29.5	24.2	25.0	27.6
PH		7.2	4.4	7.2	7.2	7.0	7.0	7.0	7.2
Turbidity	Degree	175	22	630	62	150	130	260	55
Electric Conductivity	/cm	-	-	-	-	-	-	-	90
Alkalinity	mg/l	48	60	34	54	48	28	30	34
Total Hardness	°D	2.9	2.9	2.5	2.0	1.5	1.6	1.6	1.7
Chloride Ion	mg/l	7	6	4	-	-	-	4	6
Ammonia	mg/l	0,10	0.08	-	-	-	-	0.06	0.06
Dissolved Iron	mg/l	0.30	0.20	-	-	-	-	-	0.25
Manganese	mg/l	0.03	0.03	-	-	-	-	-	0.03
Coliform Group	N/100 ml	300	1300	800	700	1600	1500	300	1400
Total Colonise	N/ml	-	1584	1260	1512	1512	1260	840	792
Residual Chlorine	mg/l	-	-	-	-	-	-	-	-
Dissolved Oxygen	mg/l	-	-	-	-	-	-	6.8	6.6
Potassium Permanganate consumed	mg/l	-	-	138.1	6.3	25.6	13.1	8.4	7.0
C O D	mg/l	-	-	34.5	1.6	6.4	3.3	2.1	1.8

As regards toxic substances such as cyanide, phenol and heavy metals, there are no mines and factories to discharge such substances into the river.

3.1.2 LEKO PANCING INTAKE

Maros River flows through northern part of Ujung Pandang city and is presently supplying the raw water, 52,000 cu m/day for water supply. The water from Leko Pancing Intake is delivered to the treatment plant through the raw water transmission canal of 30 km. The basin area at Leko Pancing of Maros River is 280 km^2 with forest and scarce inhabitants.

As a result of the survey, Ammonia content is detected by the value of 0.04 - 0.06 mg/l and coliform group is detected with 500 - 900 MPN as shown in Table 3.3. The above figures are well within the permissible range of the standard mentioned before. Contamination may rather occur in the transmission canal.

Regarding turbidity, the results of the survey show rather low values, namely, 5 to 6 degrees in the dry season and 9 to 21 degrees in the wet season. When the value of 21 degrees was recorded, there were heavy rains from the previous day to the morning, even though the turbidity was low. The reason for this is supposed due to the fact that the river water is impounded by the dam and sedimentation takes place during the impoundment.

Considering the above fact and also the time period and small gradient of transmission, the raw water to the treatment plant is supposed not to have high turbidity even in the heavy rain.

TABLE 3.3 WATER QUALITY ANALYSIS OF MAROS RIVER

I t e m s		Leko Pancing Intake (St 1)					
Sampling Date		20-8-84	4-10-84	16-10-84	27-11-84	22-12-84	16-1-85
Water Temperature	°C	26.8	26.0	28.6	25.5	24.2	25.8
PH		7.4	7.4	7.2	7.4	7.4	7.6
Turbidity	Degree	5	6	6	21	9	8
Electric Conductivity	/cm	163	-	165	-	-	103
Alkalinity	mg/l	86	68	60	70	54	60
Total Hardness	°D	-	3.5	3.5	4.0	3.0	3.1
Chloride Ion	mg/l	2	1	2	1	1	2
Ammonia	mg/l	0.06	0.04	0.04	0.04	0.04	0.04
Dissolved Iron	mg/l	-	-	-	-	0.20	0.15
Manganese	mg/l	-	-	-	-	0.03	0.03
Coliform Group	N/100 ml	500	800	900	300	0	500
Total Colonise	N/ml	92	728	278	588	434	408
Dissolved Oxygen	mg/l	-	-	-	7.2	-	7.6
Potassium Permanganate consumed	mg/l	-	-	-	8.3	3.4	2.3
C O D	mg/l	-	-	-	2.1	0.9	0.6

3.1.3 GROUNDWATER

The groundwater is presently utilized by many residents in Ujung Pandang as mentioned before. The results of the present testing are shown in Table 3.4 and it was found that at places the groundwater is seriously contaminated by coliform groups and total colonies. The main causes for above are (1) the wells are located near the toilets and (2) there are no drainage systems and the used water is likely to enter again underground.

The PDAM performed the investigation of 300 wells in the city in 1983. As a result of above investigation, the distribution of electric conductivity was found as shown on Figure 3.3 which indicates the high conductivity of more than 1,000μ℧cm (minimum value for salty taste) in the outfalls of Tallo River and Jeneberang River and southern half of Panakkukang.

As for the use of the groundwater as a source, the quality is not so adequate and, especially, the quantity is not sufficient for water supply, even for the supplemental water supply in the dry season.

It is considered, however, that there is groundwater sufficiently supplied to individual houses and small villages and it can be utilized outside the service area and is important for emergent use in drought years.

3.2 POSSIBLE WATER SOURCES

3.2.1 BILI-BILI DAM

The Dam is programmed to be constructed by 1995 at Bili-Bili district of Jeneberang River for the purpose of irrigation, municipal water supply and river control. The basin area is 348.4 km^2; the dam reservoir has a surface area of 18 km^2, total capacity, 360 x 10^6 m^2, and average depth, 20 m. The basin is forestall and sparcely inhabited.

TABLE 3.4 WATER QUALITY ANALYSIS OF GROUND WATER

Sampling Point No.	Depth of Well (m)	Season *)	Water Quality						
			W.T. °C	PH	E.C /cm	Chloride Ion mg/l	Total Hardness °D	Coliform Group N/100 ml	Total Colonise N/ml
St 1	3	D	-	-	-	137	-	200	259
		R	27.3	7.4	1,600	156	31.4	0	432
St 2	2	D	-	-	-	60	-	200	1,008
		R	27.0	7.4	870	64	18.5	700	3,696
St 3	6	D	-	-	-	-	-	0	0
		R	28.0	7.2	850	36	15.1	0	0
St 4	5	D	-	-	-	34	-	0	315
		R	27.4	7.4	461	17	9.8	1,100	1,044
St 5	5	D	-	-	-	128	-	400	3
		R	27.0	6.8	1,100	53	18.5	300	231
St 6	6	D	-	-	-	-	-	0	0
		R	28.8	7.2	1,100	121	18.8	0	1,164
St 7	2	D	-	-	-	1,065	-	100	2,100
		R	29.3	7.0	6,000	1,385	72.8	1,000	1,932
St 8	2	D	-	-	-	9	-	300	1,260
		R	28.8	5.8	200	9	3.1	0	172
St 9	3	D	28.9	5.8	155	14	1.9	-	-
		R	28.6	5.6	139	7	1.3	400	564
St 10	3	D	-	5.8	-	11	2.4	-	-
		R	-	-	-	-	-	-	-
St 11	3	D	27.5	-	387	-	-	-	-
		R	-	-	-	-	-	-	-
St 12	2	D	27.5	6.0	450	51	5.4	-	-
		R	32.5	6.2	325	28	4.0	2,100	427
St 13	6	D	27.8	6.4	560	56	8.4	-	-
		R	-	-	-	-	-	-	-
St 14	5	D	27.8	5.8	200	21	2.6	-	-
		R	-	-	-	-	-	-	-
St 15	7	D	-	-	-	14	-	0	2,520
		R	-	-	-	-	-	-	-
St 16	3	D	-	-	-	15	-	1,400	2,100
		R	-	-	-	-	-	-	-
St 17	6	D	-	-	-	25	-	2,500	924
		R	-	-	-	-	-	-	-
St 18	11	D	-	-	-	92	-	1,400	336
		R	26.0	5.4	280	32	3.7	400	357
St 19	3	D	29.5	6.4	650	80	6.7	50,400	1,260
		R	-	-	-	-	-	-	-
St 20	11	D	-	-	-	16	-	0	1,008
		R	28.8	5.8	375	48	3.5	1,200	456
St 21	5	D	27.0	5.8	-	9	3.0	-	-
		R	-	-	-	-	-	-	-
St 22	5	D	-	7.2	-	373	28.0	-	-
		R	-	-	-	-	-	-	-
St 23	4	D	-	7.4	-	3,994	106.4	-	-
		R	-	-	-	-	-	-	-

*) Season - D = Dry Season
R = Rainy Season

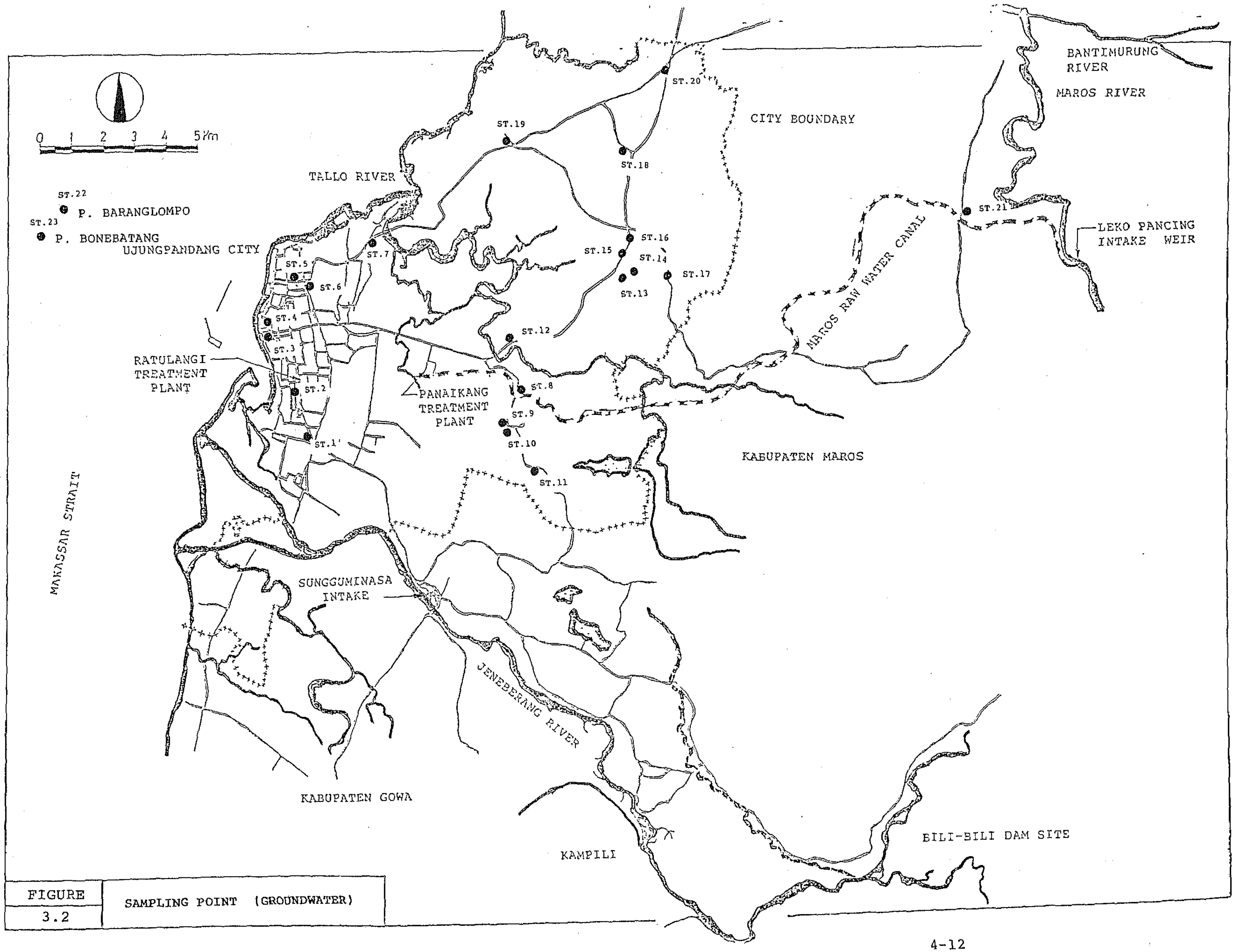


FIGURE 3.2 SAMPLING POINT (GROUNDWATER)

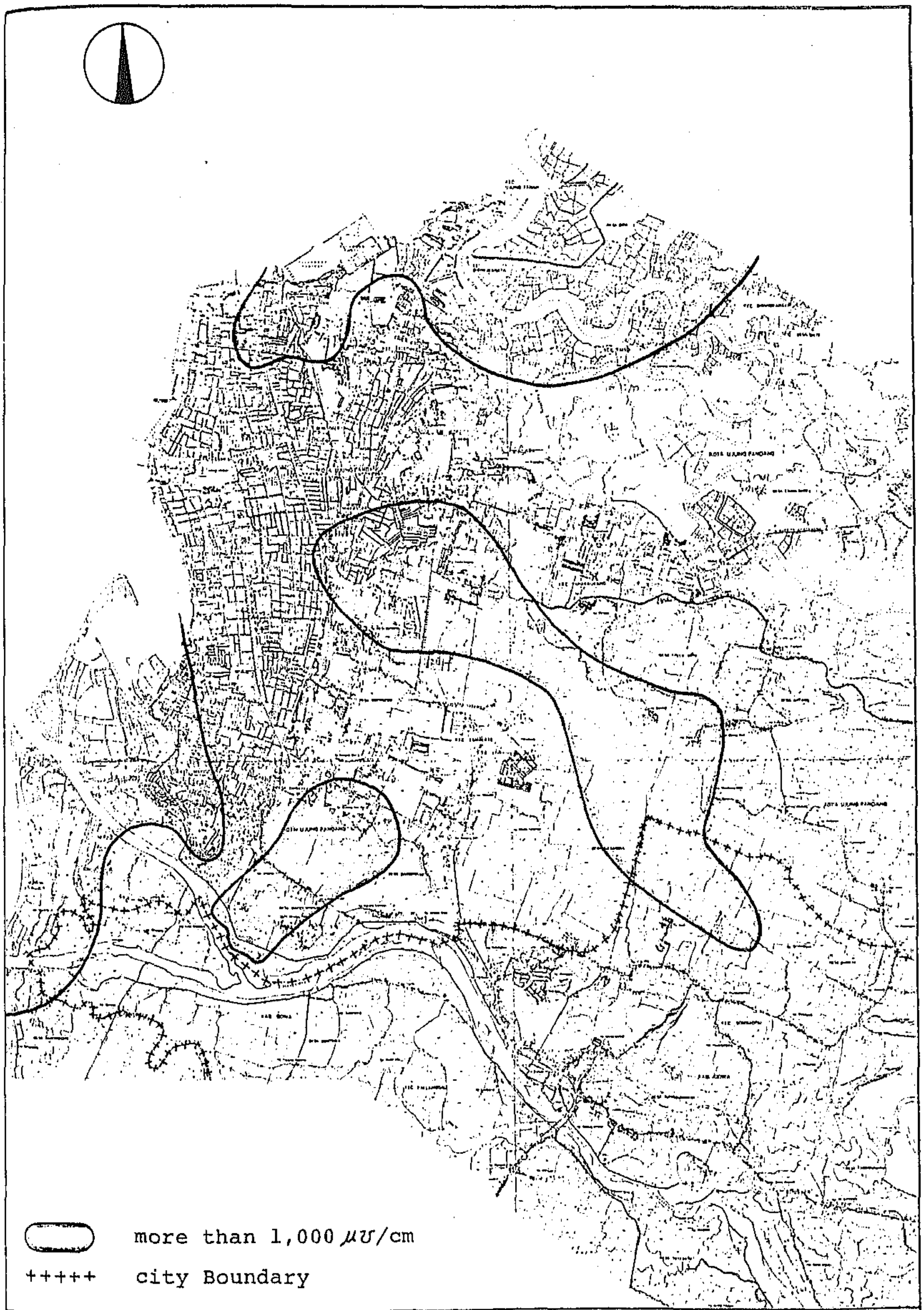


FIGURE 3.3 AREA WITH ELECTRIC CONDUCTIVITY OF GROUNDWATER

The water quality tested at this location is good for use of water supply, as shown in Table 3.5. However, the water quality may change worse when impounded by the proposed dam.

The anticipated problem, among others, is eutrophication of the impounded water. Even though organic pollution may not occur, eutrophication will take place three or four years after the commencement of impoundment.

The causes for this are 1) nutrient and organic substances will dissolve and be discharged into the dam reservoir, 2) the remains of various organisms, especially, the plants dissolve in the water and produce nutrients. The solution of these substances will reduce over the years and be discharged out of the reservoir without accumulating therein, resulting in temporary eutrophication.

Problems foreseen of the water treatment are as follows:

(1) Settlability of turbidity particles is not good, because floc composed of silt and plant plankton is light.

(2) The filter is easily clogged because of carryover of floc.

(3) Iron, manganese and ammonia contents are likely to increase, and give objectionable odor to the water.

In designing the water treatment processes, therefore, attention should be given to the above problems.

TABLE 3.5 WATER QUALITY ANALYSIS OF JENEBERANG RIVER

Items		Bili-Bili Dam Proposed Site (St 4)						
Sampling Date		1-9-84	11-10-84	21-11-84	10-12-84	19-12-84	21-12-84	17-1-85
Water Temperature	°C	26.0	27.4	25.0	28.5	24.5	23.5	27.0
PH		7.4	7.8	7.8	7.4	7.0	7.0	7.2
Turbidity	Degree	5	5	33	28	130	79	15
Electric Conductivity	/cm	-	-	-	-	-	-	90
Alkalinity	mg/l	68	52	52	54	26	30	30
Total Hardness	°D	2.3	2.8	3.1	2.0	1.3	1.7	1.5
Chloride Ion	mg/l	2	1	1	1	1	1	2
Ammonia	mg/l	0.06	0.06	-	-	-	-	0.04
Dissolved Iron	mg/l	0.10	0.15	-	-	-	-	0.10
Manganese	mg/l	0.03	0.03	-	-	-	-	0.03
Coliform Group	N/100 ml	200	900	100	200	600	100	400
Total Colonise	N/ml	172	444	588	460	1260	588	371
Dissolved Oxygen	mg/l	-	-	-	-	-	7.2	7.0
Potassium Permanganate consumed	mg/l	-	-	10.3	5.8	10.0	6.3	3.0
C O D	mg/l	-	-	2.6	1.5	2.5	1.6	0.8
T-N	mg/l	1.24	-	-	-	-	0.21	-
T-P	mg/l	0.06	-	0.122	0.039	0.011	0.106	-
D-T-P	mg/l	-	-	0.098	0.032	0.037	0.033	-
PO_4-P	mg/l	-	-	0.084	0.025	0.032	0.032	-

3.2.2 BILI-BILI INTAKE

It is under consideration among agencies concerned to utilize the existing Bili-Bili intake for provisional use of water supply, until the completion of Bili-Bili Dam in 1995. This intake is located 1.5 km downstream of the proposed dam site, and presently in use of irrigation.

The water quality at this point is considered to be similar to that shown in Table 3.5, and for this quality water, most ordinary treatment methods will be applicable.

3.2.3 BANTIMURUNG RIVER

Bantimurung river is one of the tributaries of the Maros River and joins with the main river in the Maros town and flows into the sea. The upper stream of this river (adjacent to Bantimurung) is the zone of limestone and contains high value of pH, Alkalinity, hardness due to the water soaked through the limestone, as shown in Table 3.6.

The Bantimurung River is utilized for the irrigation and therefore the water flow prior to the joining with main river is not sufficient. The water quality of the joining point above is not suitable for the drinking water source since it contains much chloride ions contents, high hardness and dissolved contents.

3.2.4 TALLO RIVER

The Tallo River flows through the central area of the City and its water is presently utilized as cooling water for the power plant. The results of the water quality testings performed around the intake of this river indicate (as shown in Table 3.7) high conductivity, chloride ion concentration and hardness affected by saline lake and high value of Ammonia contents (1.6 mg/l), coliform groups (4,500 MPN) affected by nearby human waste disposal of the residents.

TABLE 3.6 WATER QUALITY ANALYSIS OF BANTIMURUNG RIVER

Items		Upstream (St 2)		Junction of Maros River (St 3)
Sampling Date		17 - 10 - 1984	22 - 12 - 1984	16 -10-1984
Water Temperature	°C	26.0	24.5	30.5
PH		8.2	7.8	7.8
Turbidity	Degree	2	36	15
Electric Conductivity	/cm	-	-	-
Alkalinity	mg/l	150	130	144
Total Hardness	°D	8.4	8.1	29.1
Chloride Ion	mg/l	1	1	959
Ammonia	mg/l	-	0.04	-
Dissolved Iron	mg/l	-	0.15	-
Manganese	mg/l	-	0.03	-
Coliform Group	N/100 ml	-	0	-
Total Colonise	N/ml	-	420	-
Dissolved Oxygen	mg/l	-	-	-
Potassium Permanganate consumed	mg/l	-	3.4	-
C O D	mg/l	-	0.9	-

TABLE 3.7 WATER QUALITY ANALYSIS OF TALLO RIVER

I t e m s		Near the Steam Power Plant Intake (St 10)			
Sampling Date		20 - 8 - 1984	5 - 9 - 1984	19-9-1984	17-10-1984
Water Temperature	°C	30.5	28.5	30.5	30.7
PH		-	7.0	-	-
Turbidity	Degree	10	38	-	-
Electric Conductivity	/cm	28.000	9500	393	1030
Alkalinity	mg/l	-	50	-	-
Total Hardness	°D	179.2	61.6	-	-
Chloride Ion	mg/l	9408	3124	-	-
Ammonia	mg/l	-	1.6	-	-
Dissolved Iron	mg/l	-	-	-	-
Manganese	mg/l	-	-	-	-
Coliform Group	N/100 ml	-	4500	-	-
Total Colonise	N/ml	-	-	-	-
Dissolved Oxygen	mg/l	-	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-	-
C O D	mg/l	-	-	-	-

The water from this intake is not recommendable for the drinking water supply. The other testings have been therefore performed in other locations not affected by detrimental environment, i.e., two locations (st 7, st 8) at the intersection with Maros raw water canal and the pond (st 9) at Daya.

The testing results are shown in Tables 3.8 and 3.9. As a result of above testings at above three locations, no serious problem was found. However, the water at locations of st 8 and st 9 can not be utilized for the water sources due to insufficient water quantity.

It was difficult to estimate the quantity of the water available at the location of st 7 because there are no sufficient past data for the water quantity at this location although there was a flow (3-7 m^3/l) at the time of testings.

Further there is an anticipated problem of water quality at this location since a pulp factory at 7 - 8 km upstream is discharging coffee colored wastewater at the flow of about 0.25 m^3/sec. It is therefore considered that the water from Tallo River is not adequate for the water source with respects of water quality and quantity.

The water from st 7 is possibly utilized to supplement water supply in dry season, providing that some measures are implemented to detour the factory's wastewater to other river.

3.2.5 OTHER WATER SOURCES

There are no major rivers around or inside Ujung Pandang City except for the previously mentioned three rivers.

The two fish ponds and a marsh at Kab. Gowa and the eastern part of Ujung Pandang are only those which may be utilized for water sources. The water quantities of above locations are however, very small because they have no inflow from the river except for the rain water. The ponds were dried up in the past (in 1972).

TABLE 3.8 WATER QUALITY ANALYSIS OF TALLO RIVER

I t e m s		Near the existing transmission Canal (St 7)		
Sampling Date		19 - 9 - 1984	4 - 10 - 1984	17 -10-1984
Water Temperature	°C	30.5	28.9	29.3
PH		6.8	6.8	7.0
Turbidity	Degree	56	64	40
Electric Conductivity	/cm	177	-	184
Alkalinity	mg/l	42	32	60
Total Hardness	°D	1.8	1.7	2.2
Chloride Ion	mg/l	16.3	15.6	25.6
Ammonia	mg/l	-	-	0.08
Dissolved Iron	mg/l	-	-	-
Manganese	mg/l	-	-	-
Coliform Group	N/100 ml	-	-	800
Total Colonise	N/ml	-	-	2772
Dissolved Oxygen	mg/l	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-
C O D	mg/l	-	-	-

TABLE 3.9 WATER QUALITY ANALYSIS OF TALLO RIVER

Items		Near the existing transmission Canal (St 8)	Near Daya district (St 9)
Sampling Date		4 - 10 - 1984	22 - 9 - 1984
Water Temperature	°C	28.0	32.4
PH		6.6	6.4
Turbidity	Degree	40	60
Electric Conductivity	/cm	-	125
Alkalinity	mg/l	20	30
Total Hardness	°D	0.8	1.5
Chloride Ion	mg/l	2	19.2
Ammonia	mg/l	-	-
Dissolved Iron	mg/l	-	-
Manganese	mg/l	-	-
Coliform Group	N/100 ml	-	-
Total Colonise	N/ml	-	-
Dissolved Oxygen	mg/l	-	-
Potassium Permanganate consumed	mg/l	-	-
C O D	mg/l	-	-

The results of the water quality testings are shown in Table 3.10 and details are mentioned below.

1) DANAU TONJONG

Danau Tonjong is a fish pond located at Desa Tamarunang of Kab. Gowa and has an area of 300,000 m^2, with total capacity of 300,000 m^3, depth of 1 m. The water has low pH (5.2), high turbidity (650 mg/l) and brown color.

2) DANAU MAWANG

Danau Mawang is a fish pond located close to Danau Tonjong and has an area of 700,000 m^2, total capacity of 1,000,000 m^3, and an average depth of 1.4 m. The water has very low conductivity (36$\mu\upsilon$/cm), high turbidity (180 mg/l) and greenish brown color.

3) MARSH

The marsh zone is located at the eastern part of the Ujung Pandang City and has an area of 700,000 m^2 and average depth of 0.3 - 0.5 m with many marsh plants in the water. The water quality is not so different from those of above two ponds.

TABLE 3.10 WATER QUALITY ANALYSIS

Items		Tonjong Lake (St 11)	Mawang Lake (St 12)	Marsh (St 13)
Sampling Date		20 - 9 - 1984	10 - 9 - 1984	20 - 9 - 1984
Water Temperature	°C	34.5	35.3	31.1
PH		5.2	7.8	7.2
Turbidity	Degree	650	180	20
Electric Conductivity	/cm	100	36	195
Alkalinity	mg/l	-	14	-
Total Hardness	°D	1.2	0.6	5.0
Chloride Ion	mg/l	11	6	28
Ammonia	mg/l	-	-	-
Dissolved Iron	mg/l	-	-	-
Manganese	mg/l	-	-	-
Coliform Group	N/100 ml	-	-	-
Total Colonise	N/ml	-	-	-
Dissolved Oxygen	mg/l	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-
C O D	mg/l	-	-	-

3.3 CONCLUSION

Suitability of the surveyed water sources for water supply use is assessed as shown in Table 3.11. In this assessment, available quantity and possible conflict with other uses are taken into consideration.

Results of the assessment are summarized as follows:

1) The existing Leko Pancing intake is satisfactory in both water quality and quantity.

2) Bili-Bili Dam is the most promising water source in the future.

3) The Sungguminasa intake is satisfactory, only except for drought periods when water intake is difficult.

4) Irrigation water at the existing Bili-Bili intake is good for water supply use. Its diversion is subject to approval and decision of agencies concerned.

5) Surface water of the Tallo River at the crossings with the Leko Pancing water transmission canal may be usable as a supplementary source in the dry season. But the river water quality should be examined before taking the water.

6) Use of groundwater as a water source for public water supply is not considered possible, but groundwater is usable for individual household consumption and for supply to small communities.

TABLE 3.11 COMPARISON OF RAW WATER SOURCE

Water Source	ST.No.	Pollution	Sea Water Intrusion	Entroplication	Raw Water Use for Irrigation	Quantity	Evaluation	Remarks
Maros River (Lekopancing Intake)	ST.1	○	○	○	○	○	○	Countermeasures preventing from human pollution should be taken in the future
Bantimurung River (Upstream)	ST.2	○	○	○	●	●	●	It is considered too far from the service area, even if Water Supply would be able to get raw water from the Bantimurung River after negotiation with agencies concerned
Bantimurung & Maros River (Junction)	ST.3	○	●	○	●	✪	●	
Jeneberang River (Bili-Bili Dam)	ST.4	○	○	✪	●	○	○	
Jeneberang River (Bili-Bili Intake)	ST.5	○	○	○	●	✪	✪	This will be one proposed water sources. Negotiation with the irrigation department is needed in order to get enough quantity of water
Jeneberang River (Sungguminasa Intake)	ST.6	✪	○	○	●	✪	✪	Presently utilized as the water source for the Ratulangi Plant. Water is contained during the rainy season
Tallo River (near the existing transmission canal)	ST.7	✪	○	○	✪	✪	✪	Available data on water quantity and water quality are absent
Tallo River (near the existing transmission canal)	ST.8	✪	○	○	✪	●	●	
Tallo River (near Daya district)	ST.9	✪	○	✪	○	●	●	
Tallo River (near the Steam Power Plant Intake)	ST.10	●	●	○	✪	✪	●	
Tonjong Lake	ST.11	○	○	●	○	●	●	
Mawang Lake	ST.12	○	○	●	○	●	●	
Marsh	ST.13	○	○	✪	○	●	●	
Ground Water		✪	○	○	○	●	●	Quantity is not enough for public water supply

Legend:
- ○ Good
- ✪ Tolerable
- ● Not usable

4. RAW WATER TRANSMISSION

4.1 RATULANGI SYSTEM

The raw water from the Sungguminasa intake is, via grit chamber, conducted through a concrete pipeline to the Ratulangi treatment plant located 7.5 km away therefrom.

Water quality tests were performed with samples from the intake and the receiving well of the treatment plant, as shown in Table 4.1. The test results show that there is not much difference between the two samples. This implies that there is almost no contamination during the transmission.

In the wet season, seepage water in the plant premises is used as raw water in addition to the river water. This seepage originates from the rain water in the premises.

4.2 PANAIKANG WATER SYSTEM

The raw water taken in at the Leko Pancing intake is conducted through a canal to the Panaikang treatment plant located 30 km away. This canal is presently utilized by many inhabitants living nearby for washing, bathing and waste disposing, and by cattle for drinking and bathing. Under these circumstances, the canal water is being contaminated to a considerable extent. This was verified by comparison of two samples, as shown in Table 4.2, namely, one from the Leko Pancing intake and the other from the mixing well of the plant. Ammonia contents and COD at the receiving well are fairly higher that at the intake.

The increase of the population living along the canal will further deteriorate the canal water, and in that case the existing chlorination facility at the plant should be used for pre-chlorination.

TABLE 4.1 WATER QUALITY ANALYSIS OF RATULANGI WATER SYSTEM

Items		Sungguminasa Intake (S)		Ratulangi (R)	
		S	R	S	R
Sampling Date		5 - 9 - 1984		11 - 10 - 1984	
Water Temperature	°C	25.0	27.5	29.2	3.0
PH		7.2	7.2	7.4	7.4
Turbidity	Degree	175	155	22	25
Electric Conductivity	/cm	-	-	-	-
Alkalinity	mg/l	48	46	60	64
Total Hardness	°D	2.9	2.7	2.9	3.6
Chloride Ion	mg/l	7	-	6	7
Ammonia	mg/l	0.10	0.10	0.08	0.06
Dissolved Iron	mg/l	0.30	0.30	0.20	0.25
Manganese	mg/l	0.03	0.03	0.03	0.03
Coliform Group	N/100 ml	300	500	1300	1200
Total Colonise	N/ml	-	850	1584	696
Dissolved Oxygen	mg/l	-	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-	-
C O D	mg/l	-	-	-	-

TABLE 4.2 WATER QUALITY ANALYSIS OF PANAIKANG WATER SYSTEM (1)

Items		Leko Pancing (L)			Panaikang (P)		
		L	P	L	P	L	P
Sampling Date		20 - 8 - 1984		4 - 10 - 1984		27 - 11 - 1984	
Water Temperature	°C	26,8	28,8	26,0	28,5	25.5	28.7
PH		7,4	8,2	7,4	7.8	7.4	7.6
Turbidity	Degree	5	26	6	31	21	55
Electric Conductivity	/cm	163	172	-	-	-	-
Alkalinity	mg/l	86	66	68	66	70	64
Total Hardness	°D	-	-	3,5	3.6	4.0	3.9
Chloride Ion	mg/l	2	4	1	2	1	2
Ammonia	mg/l	0,06	0,08	0.04	0.06	0.04	0.08
Dissolved Iron	mg/l	-	-	-	-	-	-
Manganese	mg/l	-	-	-	-	-	-
Coliform Group	N/100 ml	500	2800	800	1300	300	1400
Total Colonise	N/ml	92	151	728	364	588	1176
Dissolved Oxygen	mg/l	-	-	-	-	7.2	6.8
Potassium Permanganate consumed	mg/l	- -	-	-	-	3.7	5.2
C O D	mg/l	-	-	-	-	0.9	1.3

TABLE 4.2 WATER QUALITY ANALYSIS OF PANAIKANG WATER SYSTEM (2)

Items		Leko Pancing (L)		Panaikang (P)	
		L	P	L	P
Sampling Date		22 - 12 - 1984		16 - 1 - 1985	
Water Temperature	°C	24.2	25.5	25.8	29.0
PH		7.4	7.4	7.6	7.6
Turbidity	Degree	9	29	8	23
Electric Conductivity	/cm	-	-	103	160
Alkalinity	mg/l	54	60	60	58
Total Hardness	°D	3.0	3.4	3.1	3.1
Chloride Ion	mg/l	1	3	2	5
Ammonia	mg/l	0.04	0.08	0.04	0.06
Dissolved Iron	mg/l	0.20	0.15	0.15	0.15
Manganese	mg/l	0.03	0.03	0.03	0.03
Coliform Group	N/100 ml	0	1500	500	600
Total Colonise	N/ml	434	1260	408	772
Dissolved Oxygen	mg/l	-	-	7.6	7.6
Potassium Permanganate consumed	mg/l	3.4	4.4	2.3	3.7
C O D	mg/l	0.9	1.1	0.6	0.9

5. WATER QUALITY OF THE TREATMENT PLANT

Presently the Panaikang water treatment plant and Ratulangi water treatment plant are in operation in Ujung Pandang; the outline of both plants is shown on Table 5.13.

TABLE 5.1 OUTLINE OF TREATMENT PLANT

I t e m	Ratulangi Treatment Plant	Panaikang Treatment Plant
1. Water Source	Jeneberang River	Maros River
2. Intake	Sungguminasa	Leko Pancing
3. Capacity	50 l/sec	600 l/sec
4. Facilities		
1) Chemical mixing method	-	Diffusion method
2) Coagulation method	Horizontal zig-zag flow type	-
3) Sedimentation basin	Horizontal flow type	Up flow type (Pulsator)
4) Filteration basin	Gravity filteration	Garivity filteration (Aquazur)
5. Chemicals		
1) Coagulant	Aluminium Sulfate	Aluminium Sulfate
2) Alkaline	Calcium Hydroxide	-
3) Chlorine	Chlorinated lime	Chlorinated lime

5.1 RATULANGI TREATMENT PLANT

The test results of raw water and treated water in the Ratulangi plant are shown in Table 5.2. The quality of the treated water satisfies the Indonesian drinking water standards.

The plant has comparatively large facilities as mentioned previously, and it has a potential capacity to treat more water than presently treating.

5.2 PANAIKANG TREATMENT PLANT

As shown in Table 5.1, this plant has pulsators for sedimentation. The test results of raw water and treated water are shown in Table 5.3, which indicate that the treated water meets the requirements of the Indonesian drinking water standards.

During the observation of operation of the plant, it was found that the turbidity of settled water is fairly high, and so the filters are having a rather high turbidity load.

To find out a cause(s) for the high turbidity of settled water, a field survey on turbidity and temperature of the settled water was conducted on September 13, 1984, as shown in Table 5.4. The relation between the rise of temperature per hour and the turbidity of settled water is shown on Figure 5.1, as obtained from the survey. Turbidity increases in proportion to the rise of temperature.

The above phenomenon will be explained as follows. That is, when water with a higher temperature flows into the settling basin, this flow goes up at a higher rate than prevailing in the basin. This upflow will push up some portion of the blanket zone, resulting in carryover of floc.

When carryover occurs, the interval of backwash of the filter is shortened.

TABLE 5.2 WATER QUALITY ANALYSIS OF RATULANGI TREATMENT PLANT

I t e m s		Raw Water (R.W)				Treated Water (T.W)			
		R.W	T.W	R.W	T.W	R.W	T.W	R.W	T.W
Sampling Date		20 - 8 - 1984		5 - 9 - 1984		11 - 10 - 1984		12-12 - 1984	
Water Temperature	°C	27.7	29.3	27.5	29.0	30.0	29.5	29.0	26.8
PH		7.6	7.2	7.2	7.2	7.4	7.4	6.8	7.0
Turbidity	Degree	32	4	155	4	25	3	73	3
Electric Conductivity	/cm	-	-	-	-	-	-	-	-
Alkalinity	mg/l	84	64	46	44	64	68	120	70
Total Hardness	°D	3.9	-	2.7	3.0	3.6	4.0	7.7	5.6
Chloride Ion	mg/l	-	-	-	-	7	7	-	-
Ammonia	mg/l	0.06	0.05	0.10	0.05	0.06	0.05	0.06	0.05
Dissolved Iron	mg/l	0.15	0.05	0.30	0.05	0.25	0.10	0.25	0.10
Manganese	mg/l	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Coliform Group	N/100 ml	200	0	500	0	1200	0	1000	0
Total Colonise	N/ml	2060	1	850	0	696	7	2016	6
Residual Chlorine	mg/l	-	0.4	-	0.3	-	0.2	-	0.2
Dissolved Oxygen	mg/l	-	-	-	-	-	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-	-	-	-	7.8	3.8
C O D	mg/l	-	-	-	-	-	-	2.0	1.0

TABLE 5.3 WATER QUALITY ANALYSIS OF PANAIKANG TREATMENT PLANT (1)

Items		Raw Water (R.W)			Treated Water (T.W)		
		R.W	T.W	R.W	T.W	R.W	T.W
Sampling Date		21 - 8 - 1984		3 - 9 - 1984		1 - 10 - 1984	
Water Temperature	°C	25.5	26.5	26.5	27.0	28.0	28.5
PH		7.8	7.2	7.8	7.2	7.8	7.2
Turbidity	Degree	22	2	27	3	55	3
Electric Conductivity	/cm	-	-	-	-	-	-
Alkalinity	mg/l	64	50	60	52	72	60
Total Hardness	°D	3.2	-	3.0	3.1	3.8	3.8
Chloride Ion	mg/l	-	-	2	-	2	2
Ammonia	mg/l	0.06	0.05	0.06	0.05	0.06	0.05
Dissolved Iron	mg/l	0.30	0.05	0.20	0.05	0.25	0.10
Manganese	mg/l	0.05	0.03	0.03	0.03	0.03	0.03
Coliform Group	N/100 ml	1800	0	200	0	6200	0
Total Colonise	N/ml	525	0	350	0	840	2
Residual Chlorine	mg/l	-	0.8	-	0.4	-	0.05
Dissolved Oxygen	mg/l	-	-	-	-	-	-
Potassium Permanganate consumed	mg/l	-	-	-	-	-	-
C O D	mg/l	-	-	-	-	-	-

TABLE 5.3 WATER QUALITY ANALYSIS OF PANAIKANG TREATMENT PLANT (2)

Items		Raw Water (R.W)		Treated Water (T.W)			
		R.W	T.W	R.W	T.W	R.W	T.W
Sampling Date		27 - 11 - 1984		24 - 12 - 1984		19 - 1 - 1985	
Water Temperature	°C	28.7	28.9	25.5	27.5	25.5	26.0
PH		7.6	7.0	7.4	6.8	7.4	7.0
Turbidity	Degree	55	3	29	3	20	3
Electric Conductivity	/cm	-	-	-	-	-	-
Alkalinity	mg/l	64	56	60	48	56	48
Total Hardness	°D	3.9	4.0	3.4	3.4	3.2	3.1
Chloride Ion	mg/l	2	-	3	-	-	-
Ammonia	mg/l	0.08	0.05	0.08	0.05	0.06	0.05
Dissolved Iron	mg/l	0.10	0.10	0.15	0.10	0.20	0.10
Manganese	mg/l	0.03	0.03	0.03	0.03	0.03	0.03
Coliform Group	N/100 ml	1400	0	1500	0	1600	0
Total Colonise	N/ml	1176	0	1260	0	798	0
Residual Chlorine	mg/l	-	0.6	-	0.3	-	0.6
Dissolved Oxigen	mg/l	6.8	-	-	-	-	-
Potassium Permanganate Consumed.	mg/l	5.2	0.8	4.4	2.8	3.3	1.7
C O D	mg/l	1.3	0.2	1.1	0.7	0.8	0.4

TABLE 5.4 TURBIDITY AND WATER TEMPERATURE OF SETTLED WATER

Time	Water Temperature	Temperature Increase per hour	Turbidity of Settled Water
8:00	26.9	-	5
9:00	26.9	0.0	5
10:00	27.1	0.2	5
11:00	27.6	0.5	10
12:00	28.2	0.6	12
13:00	28.7	0.5	10
14:00	29.0	0.3	7
15:00	29.2	0.2	5

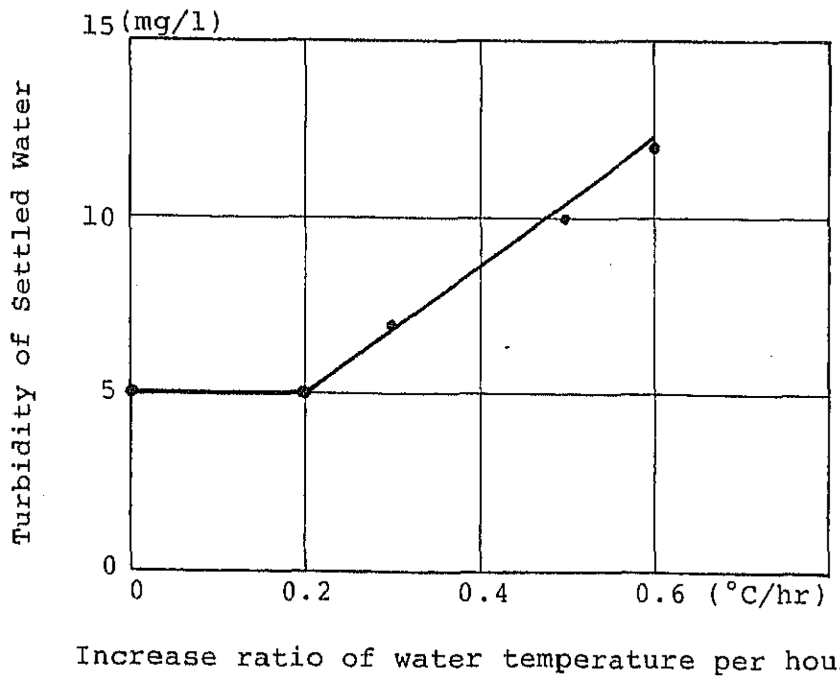


FIGURE 5.1 **RELATION OF TURBIDITY AND WATER TEMPERATURE PER HOUR**

6. WATER QUALITY AT SERVICE TAP

In order to investigate the quality of supplied water at service tap, sampling was made at 13 service taps in the served area. Test items are residual chlorine, coliform group and total colony. The test results are shown in Table 6.1.

Residual chlorine with a value more than 0.05 mg/l was detected at every tap, and no coliform groups were detected.

As far as the survey results are concerned, the water quality at service tap is satisfactory. However, it must be noted that some consumers have pumps on their service systems to take water from the public mains where water pressure is very low. It may possibly cause negative pressure in the pipe, leading to infiltration of contaminated groundwater therein.

TABLE 6.1 WATER QUALITY AT SERVICE TAP

No.	Old or New System	Residual Chlorine	Coliform Group	Total Colonise
1	N	0.25 mg/l	0 N/100 ml	0 N/ml
2	N	0.10 "	0 "	0 "
3	N	0.15 "	0 "	0 "
4	N	0.05 "	0 "	0 "
5	N	0.25 "	0 "	1 "
6	O	0.05 "	0 "	25 "
7	O	0.05 "	0 "	1 "
8	O	0.05 "	0 "	0 "
9	O	0.05 "	0 "	0 "
10	O	0.05 "	0 "	0 "
11	O	0.05 "	0 "	1 "
12	O	0.05 "	0 "	0 "
13	N	0.30 "	0 "	0 "

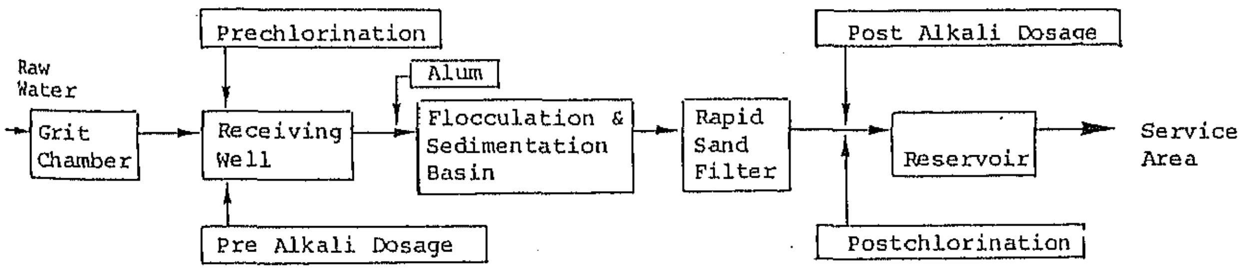
N : NEW System

O : OLD System

7. PROPOSED TREATMENT METHOD

The proposed treatment plant in the master plan is to treat initially the Jeneberang River water and eventually the impounded water of the Bili-Bili Dam reservoir. As the reservoir is not constructed yet, treatment method for the impounded water cannot firmly be proposed. However, the following treatment processes will be provisionally applied for planning the treatment plant of the future system.

Figure 5 FLOW SHEET OF TREATMENT PROCESSES



The processes are outlined below.

1) Pre-chlorination

Pre-chlorination will be required to prevent growth of algae in the treatment facilities, kill plankton and remove iron and manganese in the raw water.

2) Pre-alkali Treatment

Alkalinity in the raw water in the wet season may be 20 to 30 mg/l, when turbidity of source water rises. For treatment of such water, pre-alkali dosage is necessary. In the dry season, alkalinity may be rather high, 50 to 70 mg/l, not requiring pre-alkali treatment.

3) Post-alkali Treatment

Alum consumes alkalinity in water treatment, (alum of 1 mg/l consumes alkalinity of 0.45 mg/l), and pH value falls accordingly. Therefore, to protect pipe of the water supply system from corrosion, pH value of water for distribution must be raised by alkali treatment.

4) Post-chlorination

To ensure the safety of the treated water, post-chlorination will be needed, even though break-point pre-chlorination should be applied, considering chlorine consumption during treatment processes.

V. ALTERNATIVE STUDY

TABLE OF CONTENTS

1. OBJECTIVE

The objective of this study is to select an optimum water supply plan from among possible alternatives up to the year of 2005 through comparison thereof from technical and economical viewpoints.

2. BASIC CONSIDERATION

Requirements or conditions to be met by the water supply plan for Ujung Pandang are as enumerated below.

1) The water supply development plan should be cost-effective and its cost be least.
2) Operation and maintenance of the system should be as simple as possible.
3) Until the completion of Bili-Bili Dam in 1995, raw water for water supply will be taken from the Bili-Bili intake which was constructed for irrigation, as confirmed by the agencies concerned.
4) After 1996 raw water will be taken directly from the Bili-Bili Dam reservoir, replacing the Bili-Bili Intake
5) Ratulangi treatment plant will be abandoned after the completion of the new treatment plant in 1995, because it has outlived its useful life and is so deteriorated that its rehabilitation is almost impracticable.
6) The capacity of existing Panaikang treatment plant will be expanded to 1,100 l/sec in 1986 and to 1,200 l/sec in 1989.

3. ALTERNATIVE PLANS

The following four plans are taken up as alternatives comparison, which are considered to meet the requirements described in the preceding section. They are presented on figures 1.1 to 1.4, and their particulars are summarized in Table 1 and described as follows :

ALTERNATIVE I

1) Raw water is taken by pumping under Stage I and by gravity from Bili-Bili Dam under Stage II,

2) Location of new treatment plant is at Desa Samata in Kabupaten Gowa and its elevation is about 28 m above sea level,

3) Capacity of the new treatment plant to be constructed during Stage I is 900 1/sec, and during Stage II 1,800 1/sec, and,

4) Distribution of treated water is by gravity for both Stages I and II.

ALTERNATIVE 2

1) Intake of raw water is by gravity under both Stages I and II,

2) Location of the new treatment plant is at Desa Mangngasa in the south of Ujung Pandang, and its elevation is about 3 m above sea level,

3) Capacity same as in Alternative 1, and

4) Distribution of treated water is by pumping in both Stages I and II,

ALTERNATIVE 3

1) Intake of raw water and capacity of the plant are same as in 1) and 3) of Alternative 1,

2) Location of the new plant is at Desa Romang Loe near the Bili-Bili intake, and

3) A distribution reservoir is located at Desa Samata in Kabupaten Gowa, and its elevation is about 28 m above sea level,

ALTERNATIVE 4

1) Intake of raw water is by gravity under both Stages I and II,

2) Expansion of the existing Panaikang Plant will be made for the additional capacity during Stages I and II.

3) Intake of raw water is by pumping at the Panaikang intake during Stages I and II, and

4) Distribution of treated water by pumping in both Stages I and II,

All the above alternatives adopts pipeline for raw water transmission and its pipeline installed under phase 1 of each Stage has a conveyance capacity to meet the raw water requirement at the target year of each Stage. Its advantage is confirmed from the comparison of installation cost as shown in Appendix.

Any significant difference in cost is not seen between two alternatives. However, pipeline system is considered more adequate and preferable than open channel for the following reasons:

1. Pipeline system is free from biological contamination such as wastes, garbages and excrements, and also free from losses due to usage by the inhabitants nearby,

2. Water losses by evaporation is expected none.

4. COST COMPARISON BY PRESENT VALUE METHOD

Prior to the comparison by present value method, construction costs including those of intake facilities, transmission pipeline, treatment plant and distribution facilities are estimated on the basis of unit costs valid in Ujung Pandang as of December 1984. The results are given in Table 1.2. From this Table, it is known that construction costs for alternative 2 are the cheapest among the four.

Operation and maintenance costs are estimated annually up to 2005, 10 years after project completion date, based on units costs obtained from the financial records of PDAM, Costs contain those of chemicals, power and personnel salaries.

All the above costs are computed at the present value, employing discount rates of 10 %, 15 % and 20 %. The results are given in Figure 1.5. It shows that the least cost solution is alternative 2 in the whole range of 10 % to 20 %.

5. CONCLUSION

In addition to the least cost as mentioned above, Alternative 2 has the following advantages :

1) Construction of the treatment plant is convenient because of its close location to the main road to Sungguminasa City from Ujung Pandang, This also enables the new system to supply water easily the Sungguminasa City.

2) Land around the new treatment plant is a vast paddy field and its acquisition is relatively. These matters facilitate the system expansion in case needs arise.

3) Since the treatment plants independently located at Panaikang and at Mangngasa, it is able to supply water continuosly in case of emergency such as power failure and other serious accidents at one system.

In consideration of the above, Alternative 2 is recommended to be adopted as a future water supply plan and shown on Figure 1.6 Profile of Future Water Supply.

TABLE 1.1

Discreption of Alternative Plans

Facility	Stage	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Intake	I	- Pumping up	- Gravity	- Pumping up	- Gravity
	II	- Gravity	- Gravity	- Gravity	- Gravity
Treatment plant	I	- Desa Samata (Kab.Gowa) - 900 l/sec with reservoir	- Desa Mangngasa - 900 l/sec with reservoir	- Desa Romang Loe (Kab.Maros) - 900 l/sec	- Expansion of Panaikang Plant - Raw water pumping - 900 l/sec with reservoir
	II	- 1,800 l/sec with reser-voir	- 1,800 l/sec with reser-voir	- 1,800 l/sec	- 1,800 l/sec with reser-voir
Distribution	I	- Gravity	- Pumping up	- Gravity	- Pumping up
	II	- Gravity	- Pumping up	- Gravity	- Pumping up

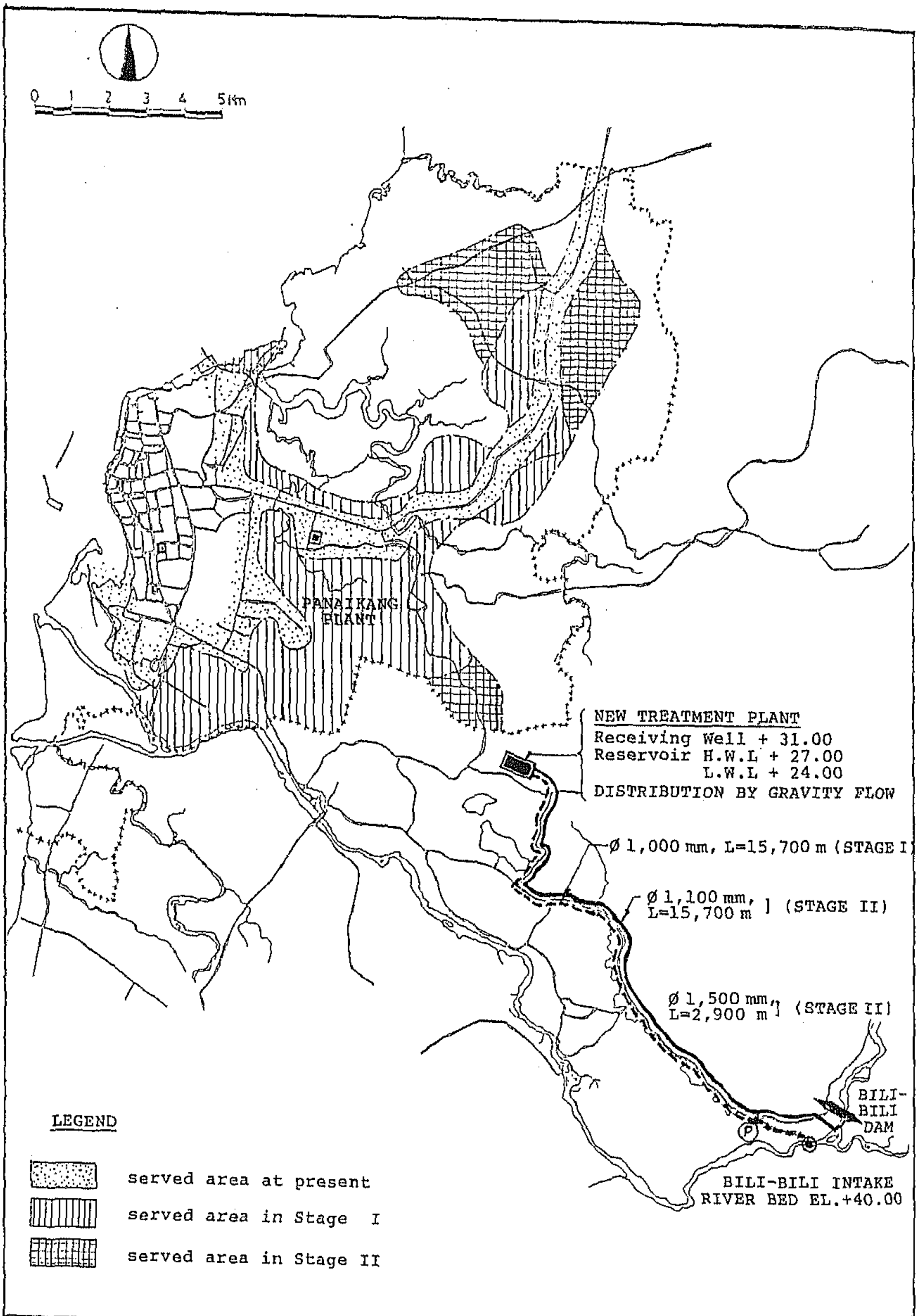


FIGURE 1.1	ALTERNATIVE 1

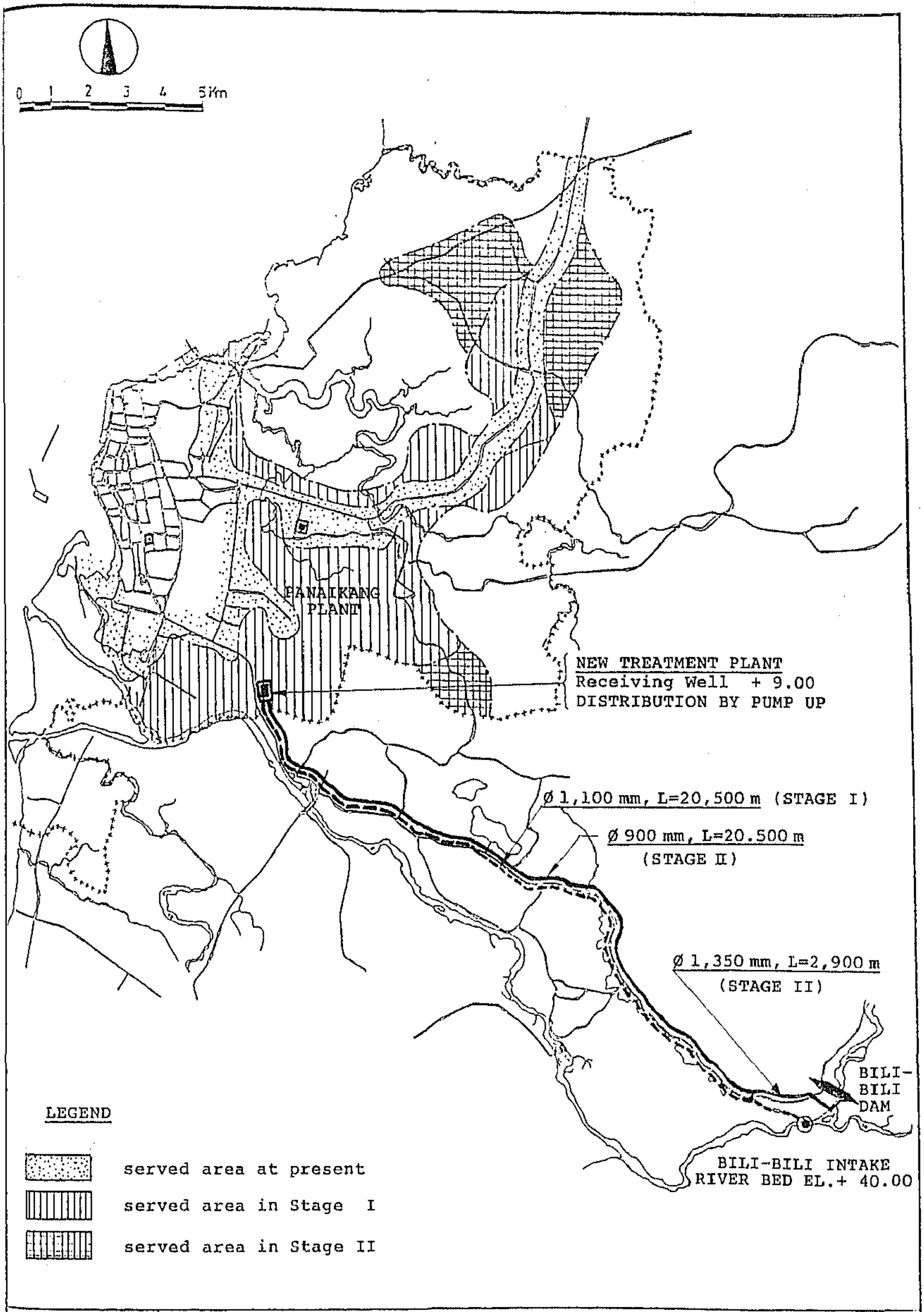


FIGURE	ALTERNATIVE 2
1.2	

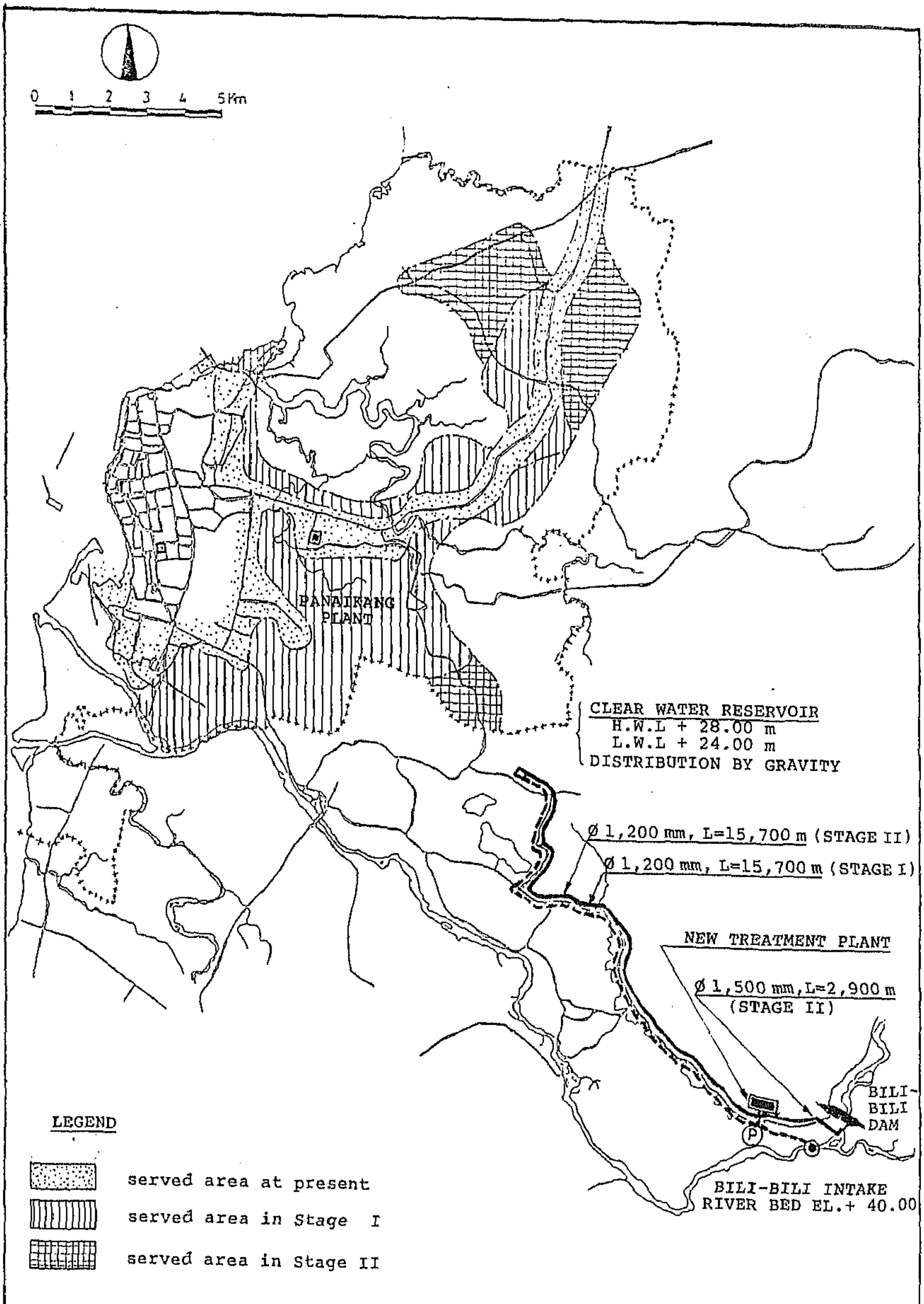


FIGURE 1.3	ALTERNATIVE 3

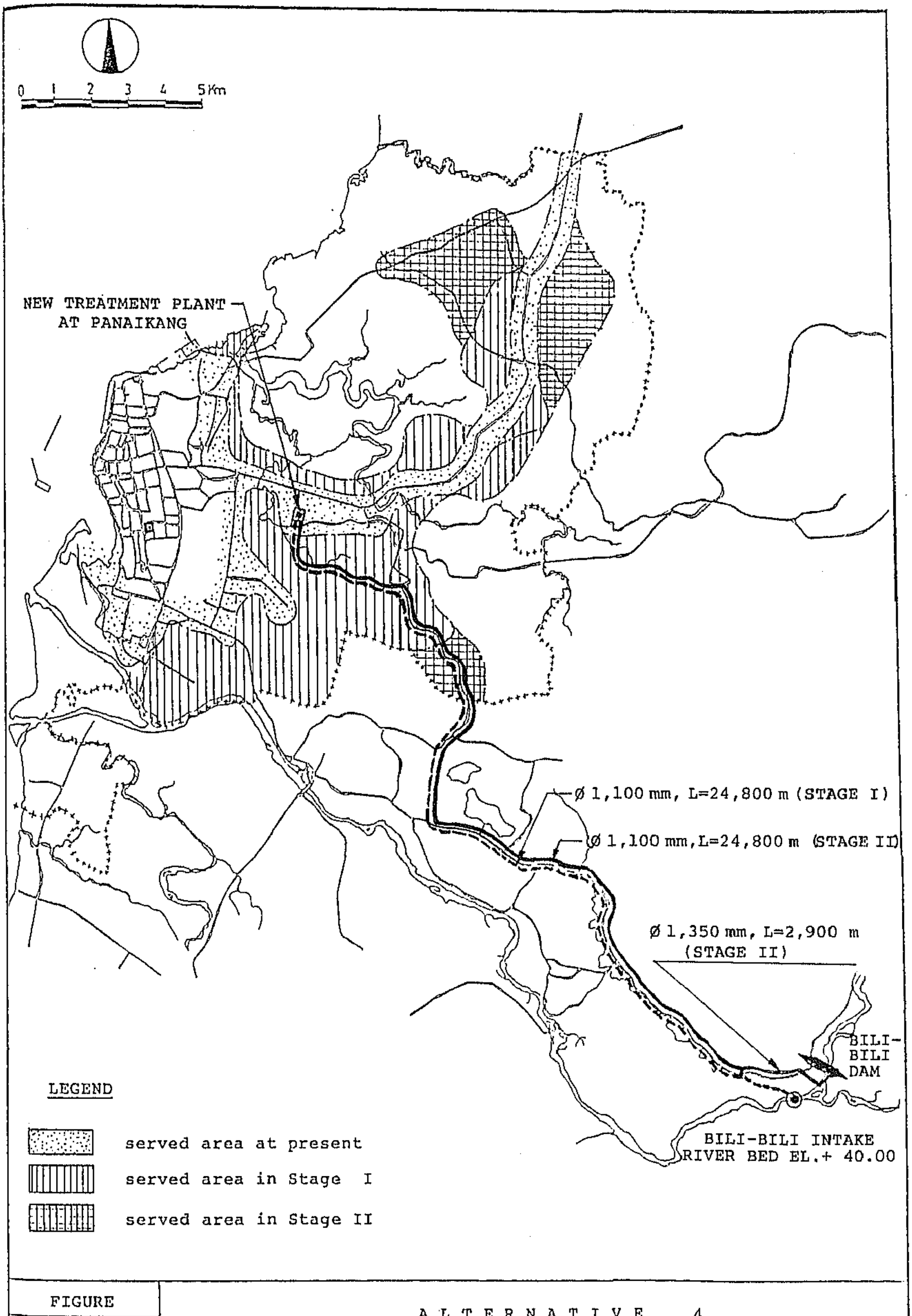


FIGURE	A L T E R N A T I V E 4
1.4	

TABLE 1.2

CONSTRUCTION COST OF ALTERNATIVES

Item	Alternative 1	2	3	4
1. Bili-Bili Intake	1,500	1,000	1,500	1,000
2. Raw water Transmission	12,320	14,460	2,530	19,220
3. Treatment Plant	14,030	17,710	13,050	16,220
4. Treated Water Transmission	-	-	12,180	-
5. Distribution Reservoir	- 1)	- 1)	1,130	- 1)
6. Distribution Pipelines	50,210	38,630	50,210	44,540
7. Contingency (15%)	11,709	10,770	12,090	12,147
8. Engineering (10%)	8,977	8,257	9,269	9,313
TOTAL	98,746	90,827	101,959	102,440

Note: 1) Construction cost of Distribution reservoir is included in the treatment plant construction cost.

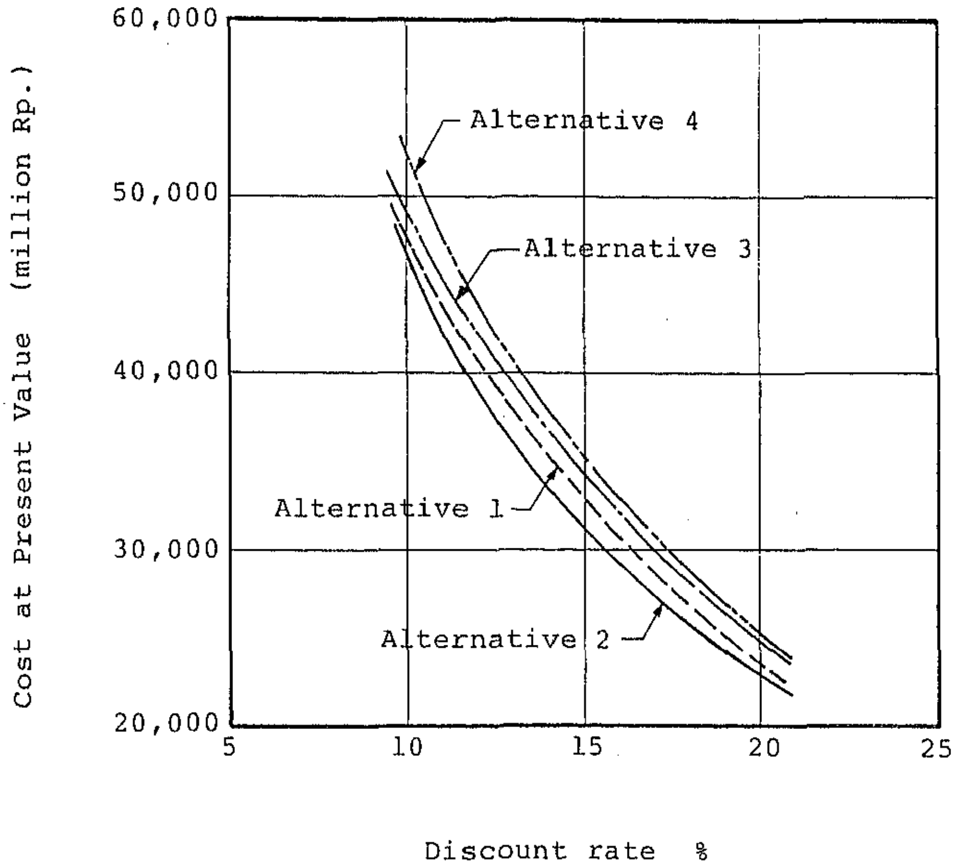


FIGURE	COST COMPARISON BY PRESENT VALUE METHOD
1.5	

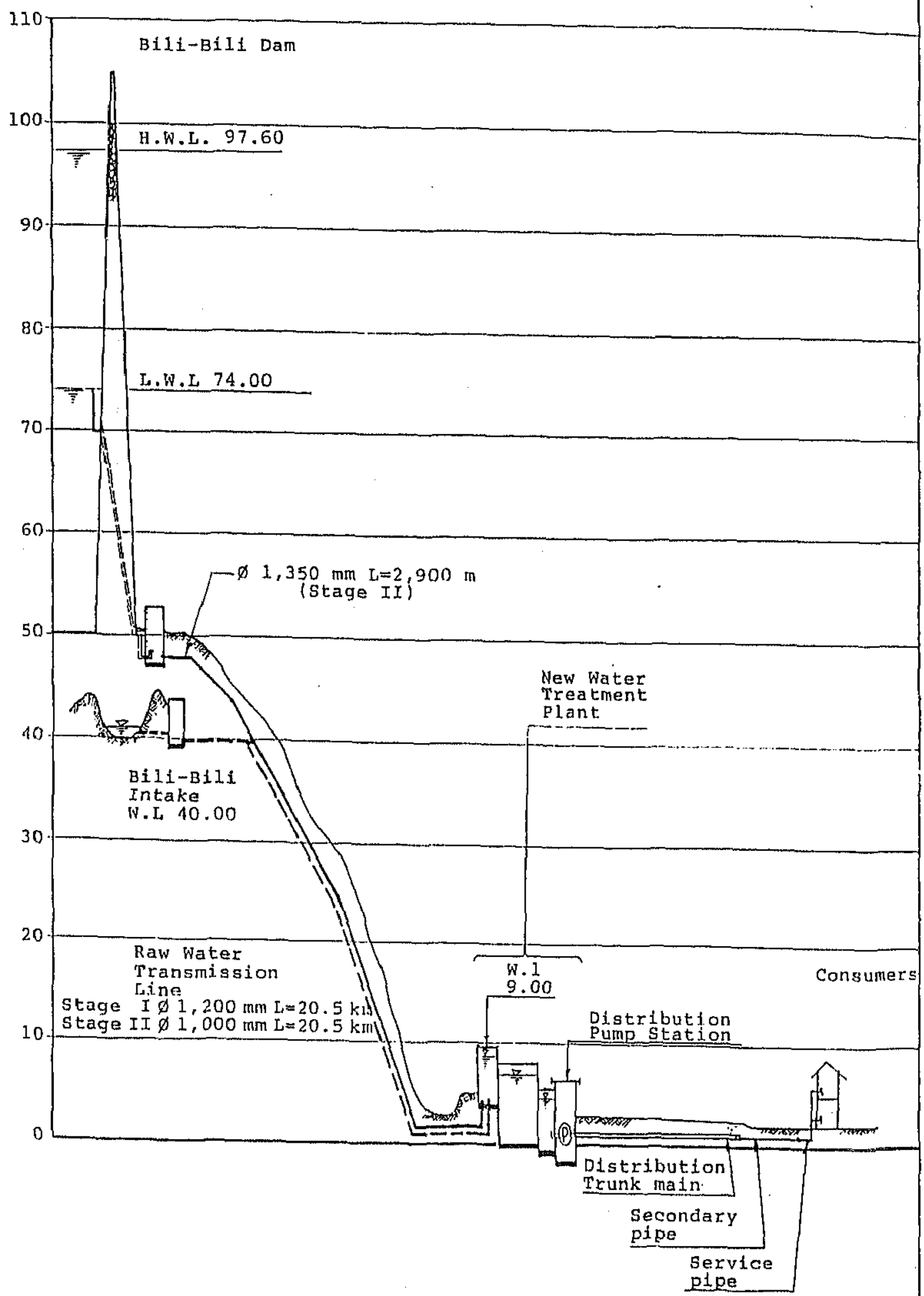
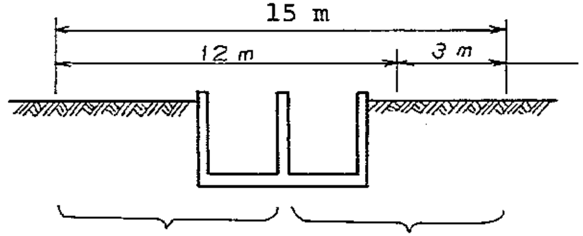


FIGURE	PROFILE OF FUTURE WATER SUPPLY SYSTEM
1.6	

Comparison of Open Channel and Pipeline

Description	Open Channel		Pipeline	
1. Typical Section				
2. Land acquisition (million Rp.)	57	17	0	0
3. Construction (million Rp.)	240	150	310	240
4. Present Value (15%) (million Rp.)	442		492	

Note : Construction cost of 1 km length

VI. SURVEYS ON WATER USAGE, ETC.

CONTENT PAGE

1. HOUSEHOLD SURVEY

In planning a water supply development, detailed information, if available, of water usage is very useful and necessary. From this viewpoint, household survey was conducted to obtain such information on domestic water usage in particular, since this usage accounts for the majority of the total water consumption. Procedures and results of the survey are described in the following Sections.

1.1 Objective of Survey

Presently, reliable and useful information of water usage is scarce. This is mainly due to that 1) the present water usage in Ujung Pandang is diversified from sole use of piped water to combined use of piped water and shallow well water, and 2) records of water use available are insufficient. The present survey is, therefore, intended to obtain more information of water use at households and to supplement the insufficiency of data, for the master planning of future water supply.

Further, along with the present survey, sanitary conditions at households were surveyed considering implications thereof in the improvement of living environment aimed at by water supply projects.

Information to be obtained by the survey will be utilized in the following manner.

Information Obtained		Master Plan
Water usage	→	Water demand projection
Supply sources at households	→	Water source development
	→	Distribution network plan
Standard and mode of living	→	Financial analysis
	→	Service type of connection

1.2 Survey Method

1.2.1 Method of Data Collection

Considering the following conditions, the survey method selected for the present study is "interview" by a pair of interviewers basically composed of one member of the Team and one PAB or PDAM staff.

The conditions considered are as follows:

1) Interview at households helps observe the actual state of water usage, standards of living, facilities of connection, shallow wells, etc. This information is useful for planning the water supply system.

2) Technology of household survey can be transferred to the local staff assigned.

3) Availability of answers to questionnaire by other methods may not be high.

4) Other methods may have the following risks:

   a. Method by Post

      - It will take much time.
      - Sample size cannot be calculated because of lack of precedents.

   b. Method by Telephone

      - Biased sampling may arise of living standards.

   c. Combined Method by Post and Interview

      - Time saving may not be achieved, because the public are not used to answer in writing.

1.2.2 Sampling Procedures

A. Sample Size

The sample size taken for the present survey is 530, i.e., 1/250 of the whole households, which is considered sufficient for master planning the future water supply system. In determining this size, it was duly considered that the interview method is very advantageous, and on the other hand it is time-and manpower-consuming.

B. Sampling

Sampling was made covering both the present served area and not-served area, because the whole municipal area is to be covered by the future water supply master plan.

In sampling survey, random sampling is a necessary condition. It is not easy to do a perfect random sampling, since the time available for survey is limited. To attain randomness as much as practicable, the following procedures are employed.

That is, the whole area was divided into two areas characterized by population density: densely built-up area (including old 8 kecamatans), and sparsely settled area (including new 3 kecamatans). The afore-mentioned 530 samples were allocated to the two areas, namely, 400 samples to the former and 130 samples to the latter, considering the population share of the two.

Regarding the former area, meshed zones (200 sq m each) were employed for sampling, and interview was made with 10 households per mesh. Regarding the latter, 25 hamlets were selected for survey. Sampling meshes and hamlets are shown on Figures 1.1 and 1.2.

1.2.3 Survey Items

Survey items by interview are roughly classified into 3 groups, namely, 1) standard and mode of living, 2) water usage and 3) supply source and type of connection.

Concrete items are enumerated as follows in line with the above classifications.

(1) Standard and Mode of Living

1) Occupation
2) Household size
3) Religion
4) Structure type of house
5) Income
6) Disposal of night soil
7) Garbage disposal

(2) Water Usage

1) Supply sources used
2) Water tanks
3) Treatment of water for drinking
4) Daily water consumption

(3) Supply Sources and Type of Connection

1) Sufficiency of supply source
2) Quality of water being used
3) PDAM's water pressure
4) Use of pump
5) Water meter
6) Average monthly payment to PDAM

7) Willingness to connect with the public supply

8) View about PDAM's service

The format of questionnaire is attached (pages 6-8 to 6-11).

1.3 Result of Survey

After examining collected data, analyses by frequency table and cross reference table were made, which provided various information on master planning of water supply.

The major results of analyses are described one by one on Figures 1.3 to 1.25.

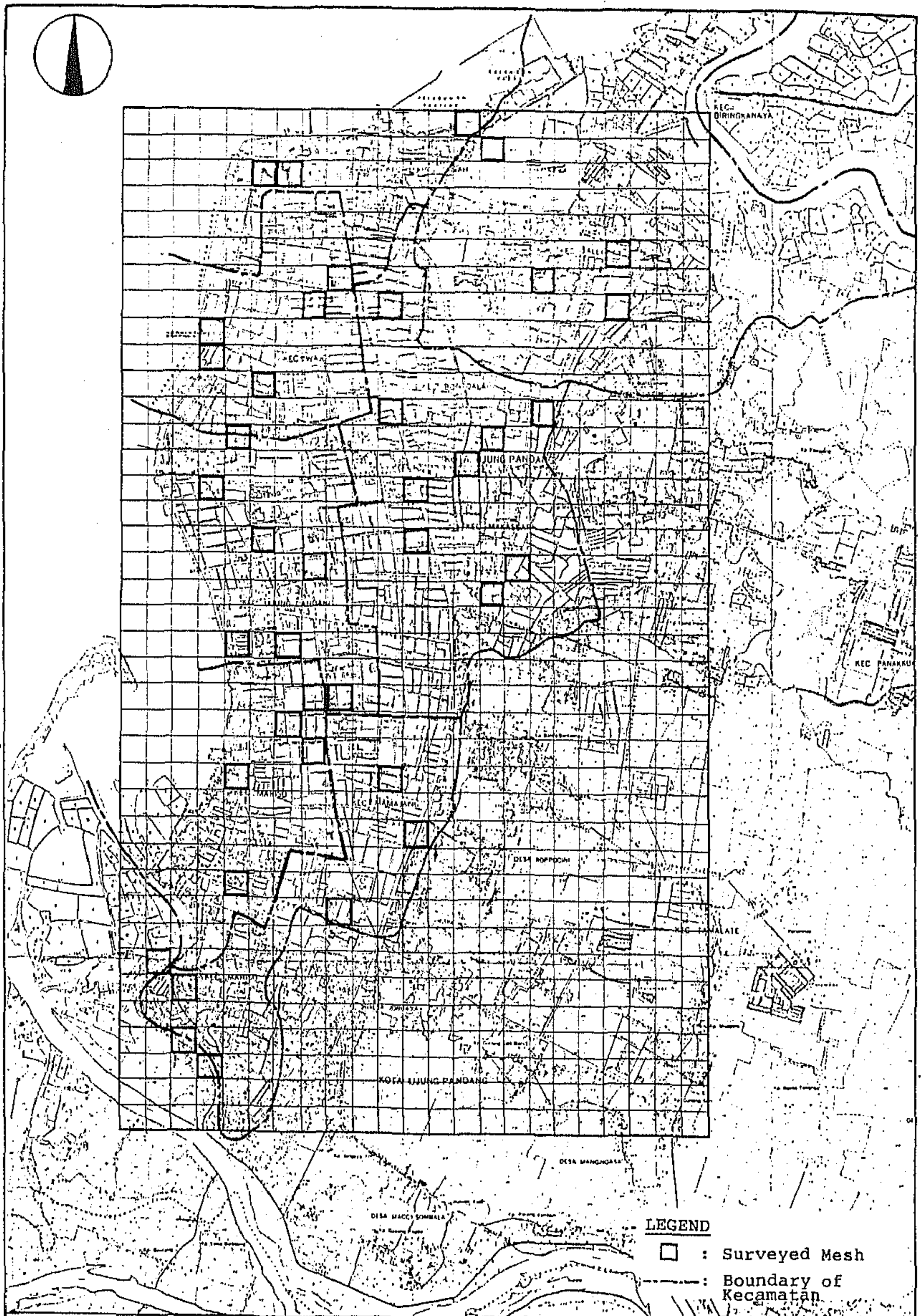


FIGURE	MAP OF SURVEYED ZONE
1.1	(Built-up Area)

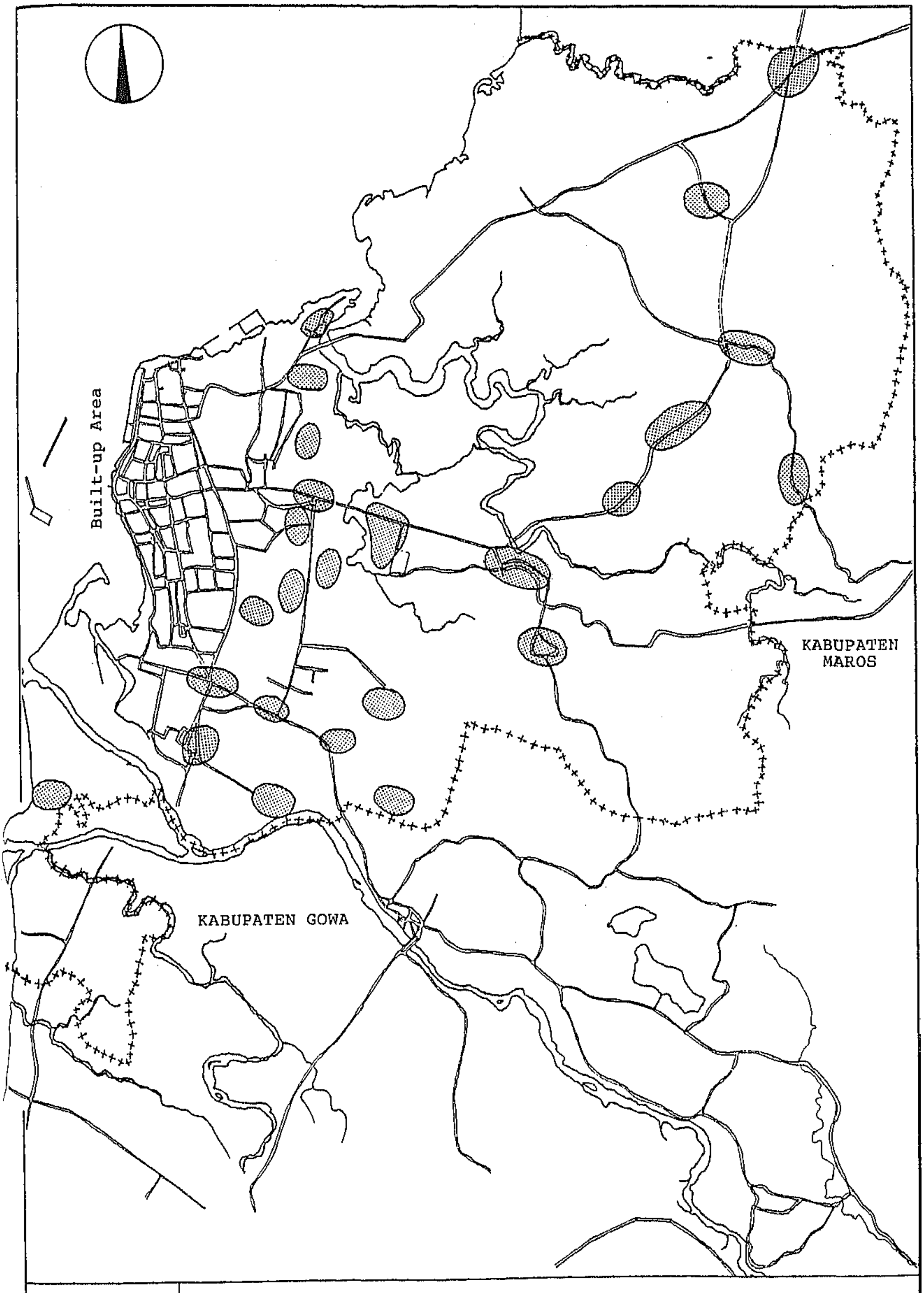


FIGURE	MAP OF SURVEYED ZONES (The Suburbs)
1.2	

QUESTIONNAIRE

Number :
Date :

SURVEY

ON PRESENT WATER CONSUMPTION

AND

INCOME LEVEL

The result of this Study will be used as a basic Information in preparing the Master Plan and Feasibility Study on Water Supply Development Project in Ujung Pandang

N a m e : ....

Address : ....

Occupation : ....

1. Number of family members : .... persons

2. Religion : a. Moslem b. Christian
c. Budha/Hindu d. ....

3. Type of house occupied : a. Permanent
b. Semi permanent
c. Temporary

4. Water Sources : a. From PD. Air Minum KMUP
b. Other sources

4.1

Type of Usage	P D A M			WELL		RIVER	NEIGHBORS SUPPLY		Others
	House Connection	Public Standpipe	Water Wagon	Shallow	Deep		Charged	Not charged	
DRINKING									
COOKING									
BATHING									
LAUNDERING									
OTHER USE									

4.2 Can you get water enough for daily use?

a. Yes

b. No (Time : .... till .... in a day)
(Month : .... till .... in a year)

4.3 Is there a water reservoir?

a. Drum/water jar b. Water tower

c. Underground tank d. ....

4.4 How is the condition of the water?

a. Good/clear
b. Color ....
c. Not clear/trouble
d. Table ....

4.5 Before drinking, is the water being :

a. Boiled
b. Straight used
c. Being filtered/cleared
d. ....

4.6 When water from the above source is not available, where are you getting it from?

a. PDAM : a1. House connection
a2. Public standpipe
a3. Water Wagon
b. well : b1. Shallow
b2. D e e p
c. Neighbors supply : c1. Charged
c2. Not charged
d. O t h e r s : ....

4.7 How much water do you use for drinking, cooking, washing, bath and other purposes daily in your family?

.... Liters/cubic/buckets

4.8 How is the pressure of water at your house?

a. L o w
b. Average
c. H i g h
d. ....

4.9 Do you have a pump to take piped water?

a. Y e s : a1. Straight from the pipe after the meter.
a2. ....
b. N o

4.10 How much tariff do you pay for water?

Rp. ..../month

4.11 Is there a water meter?

a. Y e s : a1. Functioning a2. Not functioning

b. N o

5. How is the faecal disposal? How far is it from the Well to the disposal spot : ...... Meter(s).

a. Ceptic tank   b. Pit latrine

c. R i v e r   d. ....

6. How is the garbage disposal system?

a. Collected to be burned.

b. Disposed into the earth pit.

c. Collected periodically into a truck.

d. ....

7. How much are you earning (per family) :

a.	Less than Rp.10,000			(Rp. ..../month)
b.	Rp. 10,000	-	Rp. 25,000	(Rp. ..../month)
c.	Rp. 25,000	-	Rp. 50,000	(Rp. ..../month)
d.	Rp. 50,000	-	Rp.100,000	(Rp. ..../month)
e.	Rp.100,000	-	Rp.150,000	(Rp. ..../month)
f.	more than Rp.150,000			

8. Are there any intensions to become a customer and get water from PDAM?

a. Y e s : a1. House connection

a2. Tank (truck)

a3. Public standpipe

a4. ....

b. N o

Why?

9. How do you feel about the service by PDAM?

a. Quantity of water

a1. Enough

a2. Not enough

b. Quality of water

b1. G o o d

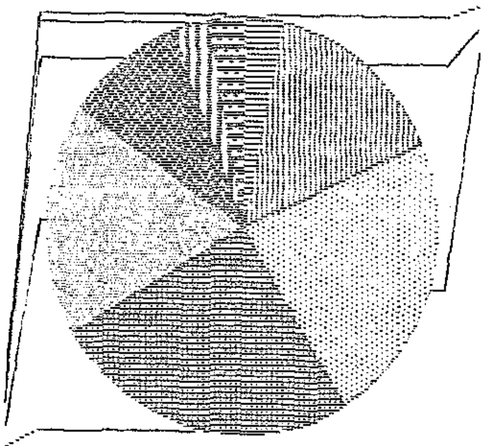
b2. Not good

c. F a r e : c1. Reasonable

c2. Alegate

THANK YOU

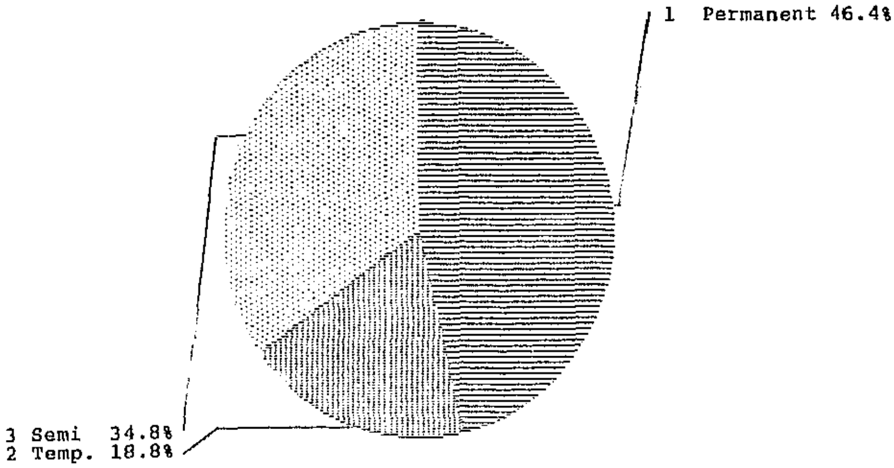
On an average, there are 6.6 members per household, higher than the average family size: 6.0 in the 1980 Census, because some households contain 2 or more families.



Category	Sample	%	Remarks
1	17	3	1 - 2 Persons
2	80	15	3 - 4 Persons
3	121	23	5 - 6 Persons
4	134	25	7 - 8 Persons
5	96	18	9 - 10 Persons
6	51	10	11 - 12 Persons
7	15	3	13 - 15 Persons
8	16	3	16 Persons or More

FIGURE 1.3 HOUSEHOLD SIZE

The numbers of permanent and semi-permanent types of houses account for 81% of the total.

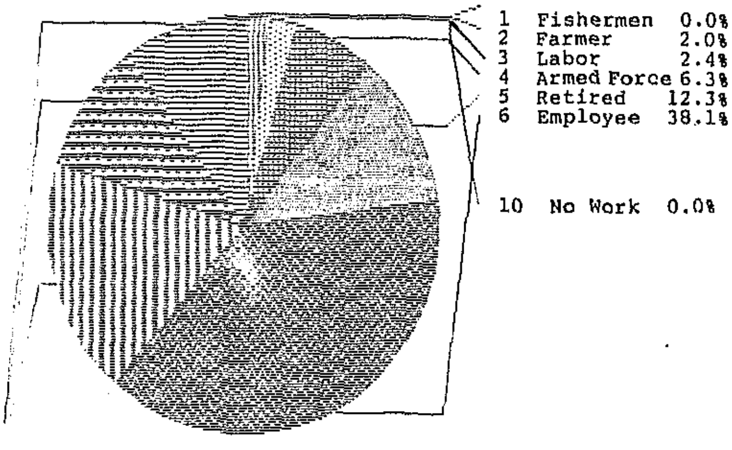


Cate-gory	Sample	%	Remarks
1	245	46	Permanent
2	184	35	Semi-Permanent
3	99	19	Temporary
4	2	0	No Answer

Note:
Houses are classified into three types, i.e., permanent, semi-permanent and temporary types based on the national standard.

FIGURE	STRUCTURE TYPE OF HOUSE
1.4	

A characteristic of this figure is the share of more than one third occupied by employee. And, public sector worker including ABRI (Armed Forces), the retired, and part of employees have 40% of the total, which indicates that Ujung Pandang is a center of administration in East Indonesia.

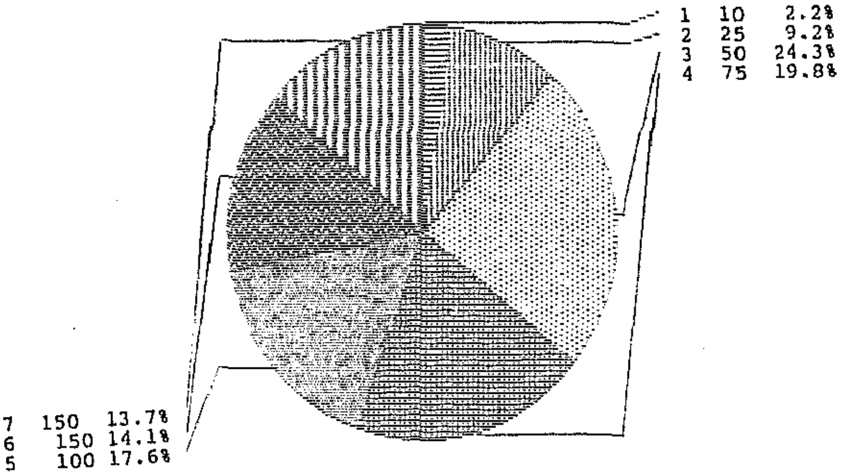


Category	Sample	%	Remarks
1	0	0	Fisherman
2	10	2	Farmer
3	12	2	Labour
4	32	6	Armed Force
5	62	12	Retired
6	193	36	Employee
7	94	18	Businessman
8	52	10	Merchandise
9	51	10	Etc.
10	24	5	Not Working

Note :
Employees are composed of 61% for public works and 39% for private enterprise.

FIGURE 1.5	OCCUPATION

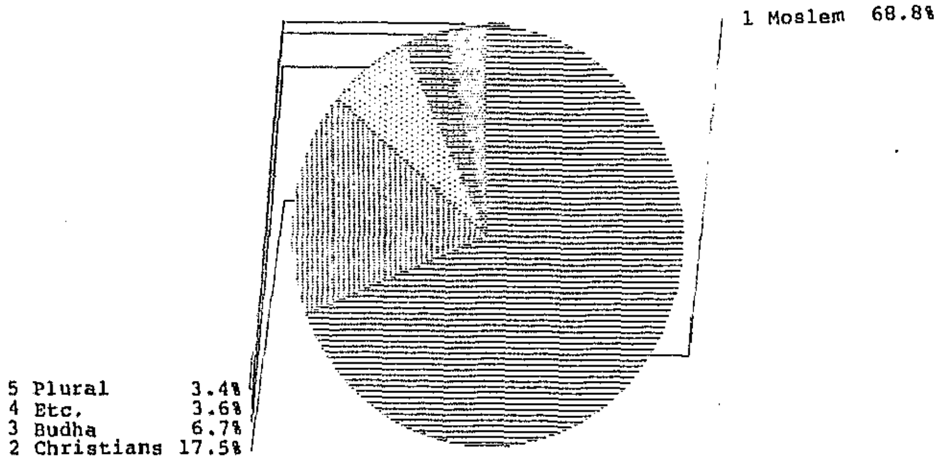
The average monthly income in Ujung Pandang is estimated Rp.98,000 , varying from a low of Rp.1,000 to a high of Rp.1,000,000. Monthly income of 50% of the households is as low as Rp.75,000.



Category	Sample	%	Remarks
1	11	2	Not Exceeding 10,000 Rp.
2	47	9	10,001- 25,000 Rp.
3	124	23	25,001- 50,000 Rp.
4	101	19	50,001- 75,000 Rp.
5	85	16	75,001-100,000 Rp.
6	72	14	100,001-150,000 Rp.
7	70	13	More than 150,000 Rp.
8	20	4	No Answer

FIGURE 1.6 INCOME (PER HOUSEHOLD PER MONTH)

This figure indicates more than two third of people are Muslims. As composition of religion is close to the statistic, which shows that the sampling was appropriate.

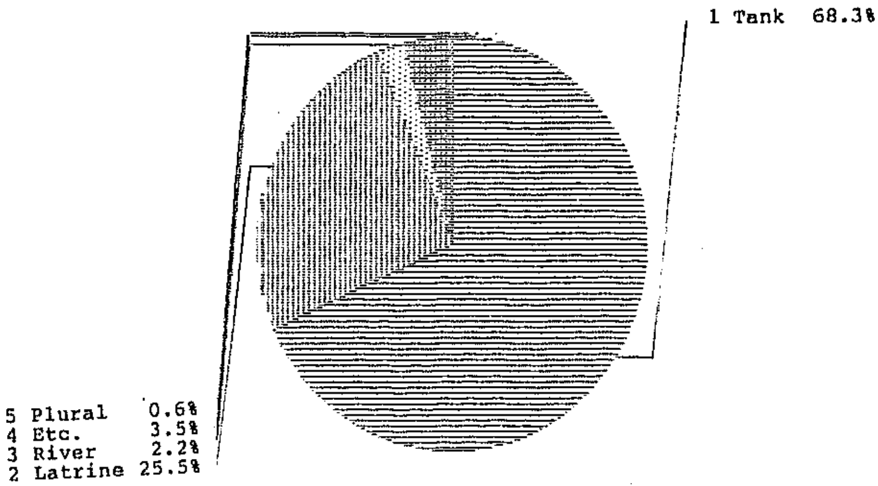


Category	Sample	%	Remarks
1	361	68	Moslem
2	92	17	Christian
3	35	7	Budha/Hindu
4	19	4	Etc.
5	18	3	Plural Answer
6	5	1	No Answer

FIGURE 1.7

RELIGION

More than a quarter of the total are occupied by pit latrine, unfavorable disposal for environment. And 80% of the disposal point are located within the guidelined distance of 10 m from well.

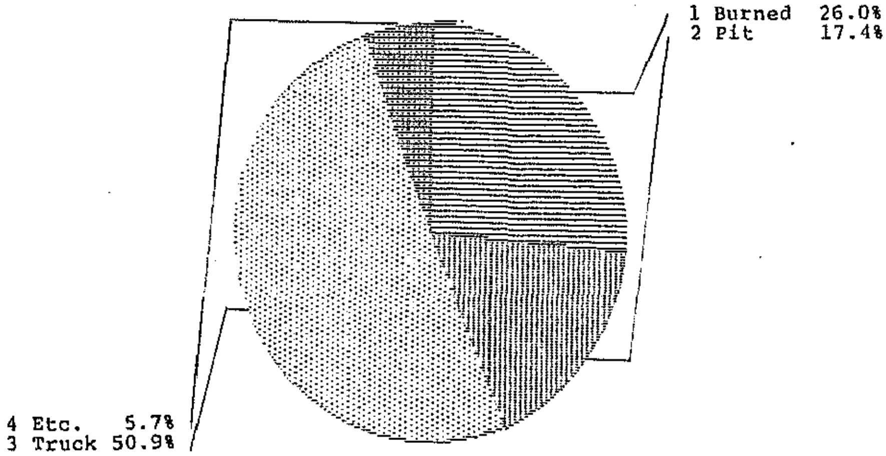


Category	Sample	%	Remarks
1	316	60	Ceptic Tank
2	118	22	Pit Latrine
3	10	2	River
4	16	3	Etc.
5	3	1	Plural Answer
6	67	13	No Answer

FIGURE 1.8

DISPOSAL OF NIGHT SOIL

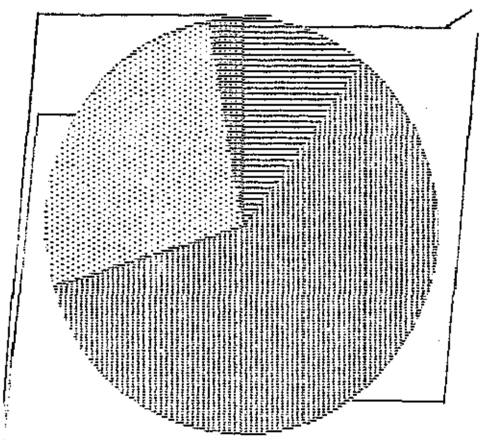
Nearly one fifth of people bury garbage in the ground. This disposal method is not desirable.



Category	Sample	%	Remarks
1	138	26	Collected to be Burned
2	92	17	Disposed into the Earth Pit
3	270	51	Collected periodically into a truck
4	30	6	Etc.

FIGURE 1.9	GARBAGE DISPOSAL

It is noted that 90% of the households use shallow wells or other water sources.



Category	Sample	%	Remarks
1	55	10	PDAM
2	318	60	Well
3	142	27	Both PDAM & Well
4	15	3	No Sources

Note :
PDAM Ujung Pandang supplies treated water to 34% of the total population, which is almost similar to the above results. This confirms the accuracy of the sampling method employed in the household survey.

FIGURE 1.10 WATER SUPPLY SOURCE AT HOUSEHOLD

For cooking and drinking purposes, the majority of the inhabitants will depend on piped water from PDAM rather than groundwater from shallow wells.
On the contrary, people tends to use groundwater for washing and bathing.

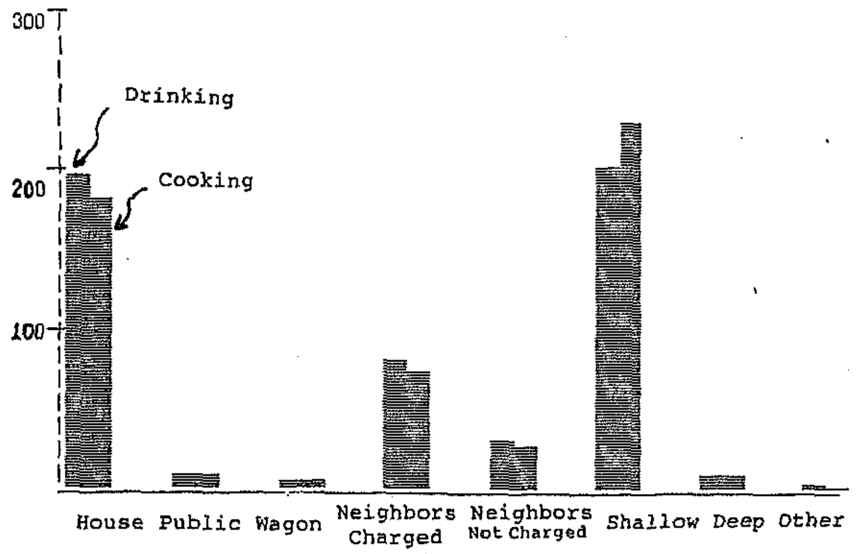


FIGURE A

RATIO OF SOURCE FOR DRINKING AND COOKING

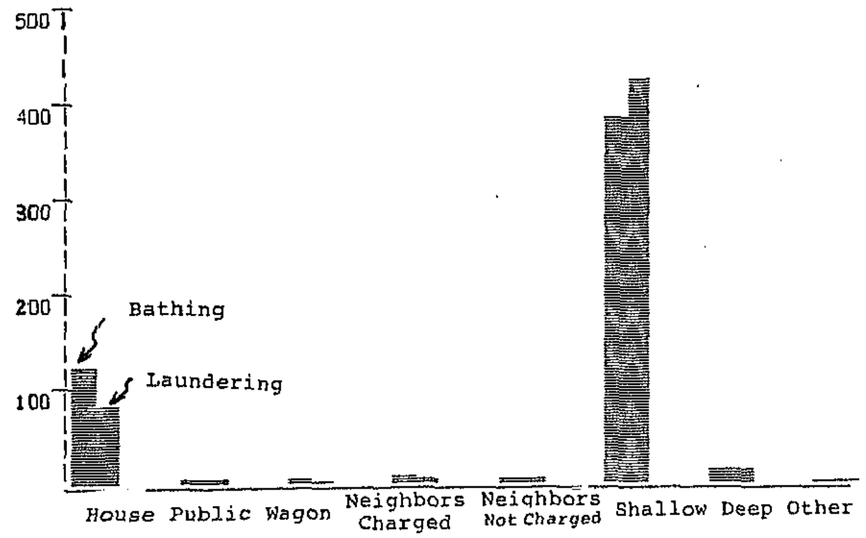


FIGURE B

RATIO OF SOURCE FOR BATHING AND LAUNDERING

Note :

Figure A shows about half of the households use piped water for drinking and cooking.
Figure B represents groundwater from shallow wells are dominantly utilized for bathing and laundering against piped water.
Figure D shows most of piped water supplied from neighbors is used for drinking and cooking

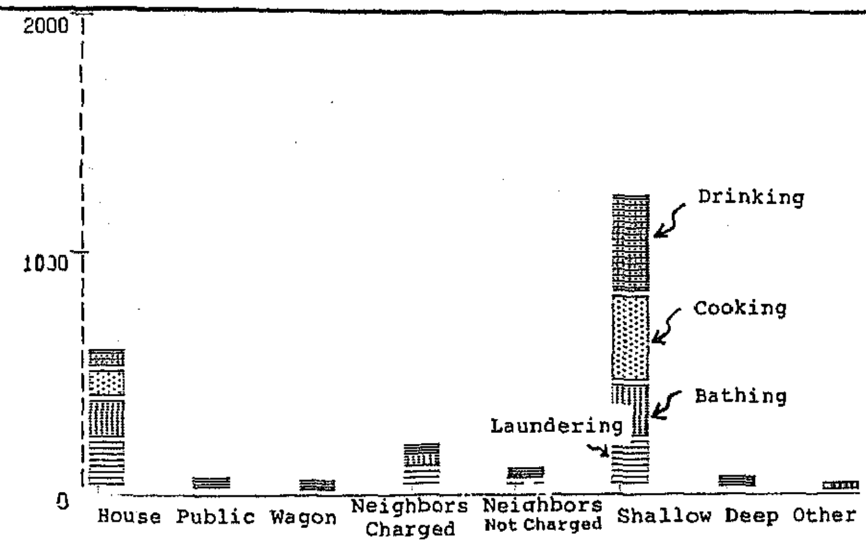


FIGURE C

WATER SOURCE BY PURPOSE

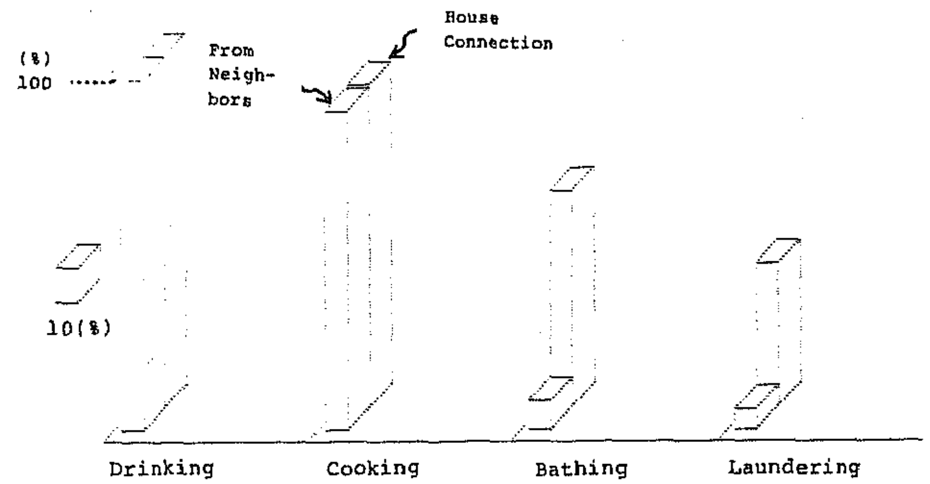


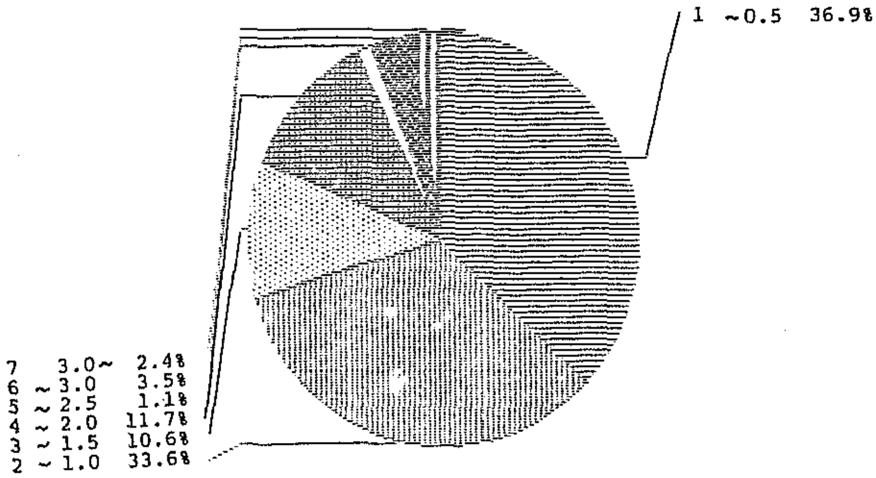
FIGURE D

RATIO OF PDAM CONSUMPTION TO TOTAL CONSUMPTION

Cate-gory	DRINGKING Sample	%	COOKING Sample	%	BATHING Sample	%	LAUNDERING Sample	%	Remarks
1	197	37	182	34	122	23	81	15	PDAM/House Connection
2	8	2	7	1	4	1	4	1	PDAM/Public Standpipe
3	4	1	2	0	1	0	1	0	PDAM/Water Wagon
4	80	15	74	14	6	1	4	1	Neighbors Supply/Charged
5	30	6	26	5	3	1	3	1	Neighbors Supply/Not Charged
6	202	38	231	44	383	72	424	80	Well/Shallow
7	8	2	8	2	11	2	12	2	Well/Deep
8	0	0	0	0	0	0	0	0	River
9	1	0	0	0	0	0	1	0	Other Sources

FIGURE 1.11	SUPPLY SOURCES USED

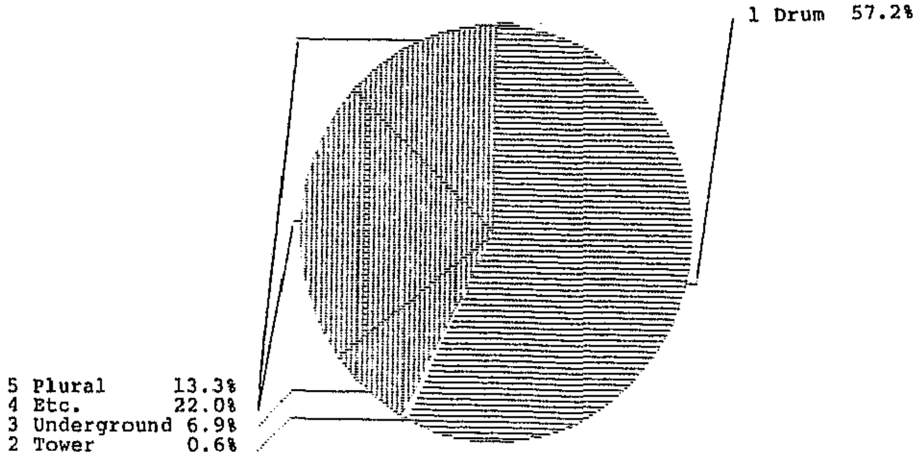
The majority of households consume water less than 1 m^3/day. This means the average daily consumption per capita is around 100 liters.



Category	Sample	%	Remarks
1	167	32	Not Exceeding 0.5 cu m/day
2	152	29	0.5 - 1.0
3	48	9	1.0 - 1.5
4	53	10	1.5 - 2.0
5	5	1	2.0 - 2.5
6	16	3	2.5 - 3.0
7	11	2	More than 3.0
8	78	15	No Answer

FIGURE 1.12 DAILY WATER CONSUMPTION

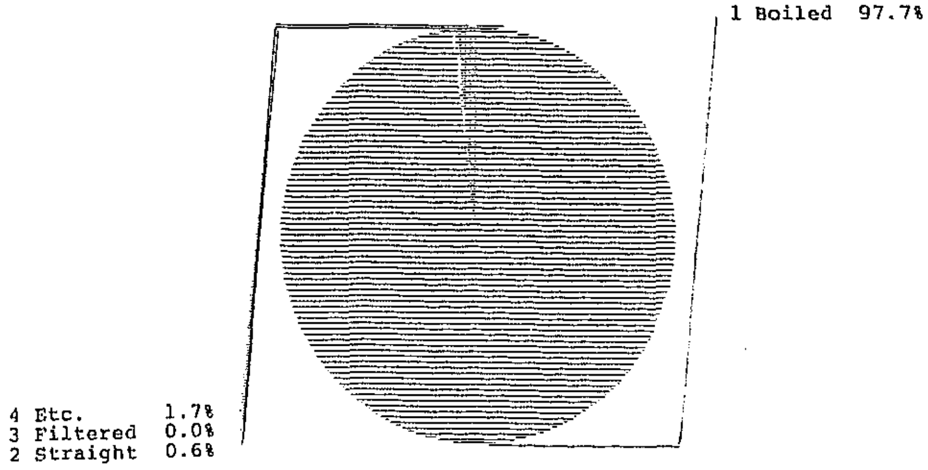
It is remarkable almost every household reserves some water by some means.
It implies the amount of PDAM's supply is not necessarily adequate to users.



Category	Sample	%	Remarks
1	297	56	Drum/Water Jar
2	3	1	Water Tower
3	36	7	Underground Tank
4	114	22	Etc.
5	69	13	Plural Answer
6	11	2	No Answer

FIGURE 1.13 WATER RESERVATION

It is also remarkable almost all the inhabitants drink water after boiled, which is favorable from sanitary viewpoint.

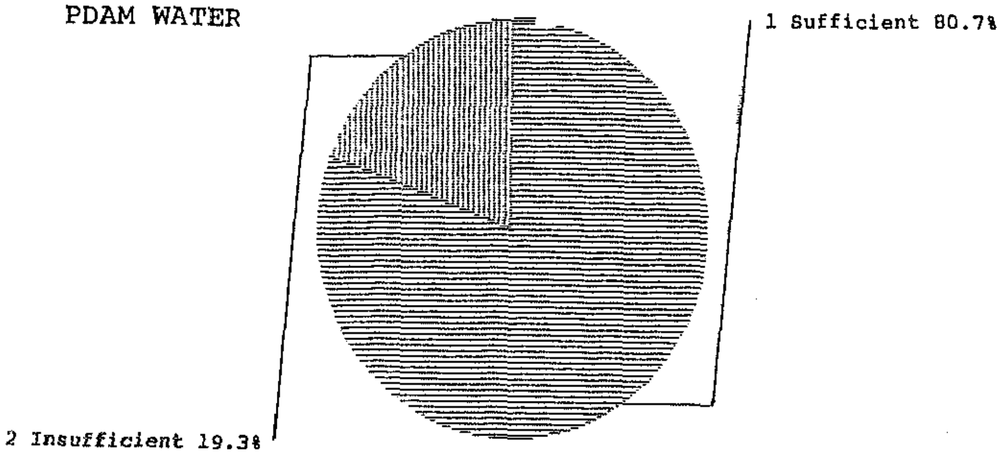


Category	Sample	%	Remarks
1	518	98	Boiled
2	3	1	Straight Used
3	0	0	Filtered/Cleared
4	9	2	Etc. including Plural Answer

FIGURE 1.14 TREATMENT FOR DRINK

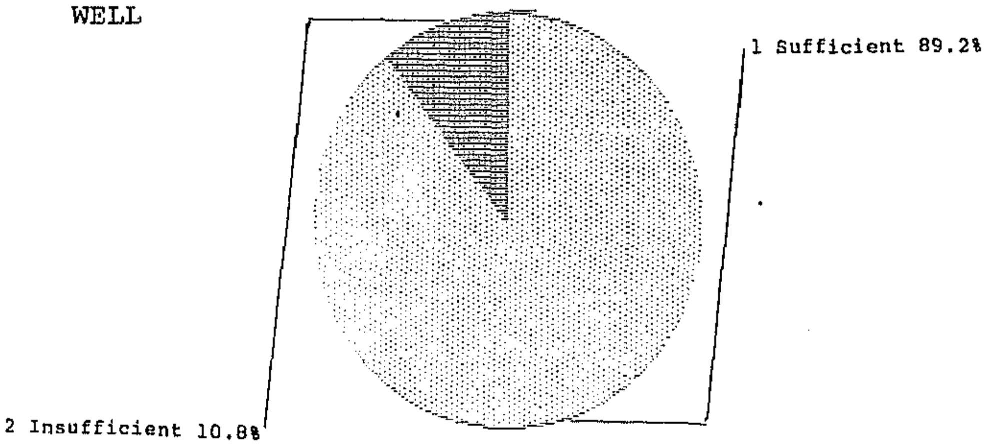
Figure below explains that one in 5 households complains of insufficient supply of piped water, on the contrary only one in 15 households complains of shortage of well water.

PDAM WATER



Cate-gory	Sample	%	Remarks
1	196	37	Sufficient
2	47	9	Insufficient
3	287	54	No Answer

WELL

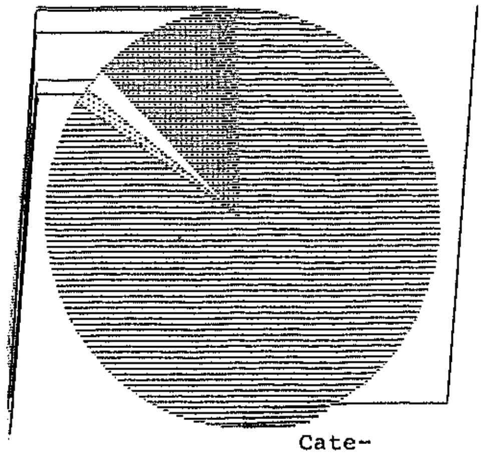


Cate-gory	Sample	%	Remarks
1	281	53	Sufficient
2	34	6	Insufficient
3	215	41	No Answer

FIGURE 1.15 — SUFFICIENCY OF SUPPLY SOURCE

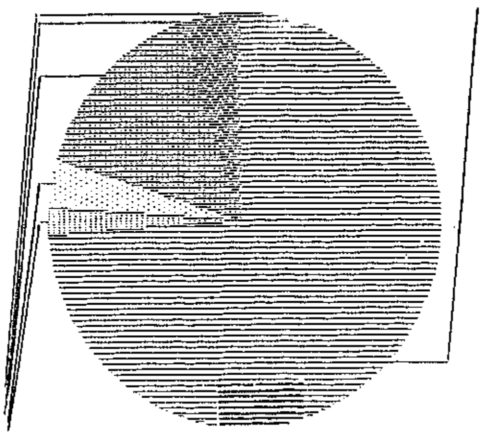
15% of piped water user complains of water quality. This figure is considered to be large in comparison with other cities. On the other hand, more than 70% of users answer "clear". But it was observed the criterion of clearness differs evidently from person to person.

PDAM



Category	Sample	%	Remarks
1	222	42	Good/Clear
2	3	1	Not Clear/Trouble
3	5	1	Color
4	26	5	Taste
5	2	0	Not Clear & Color
6	5	1	Not Clear & Taste
7	267	50	No Answer

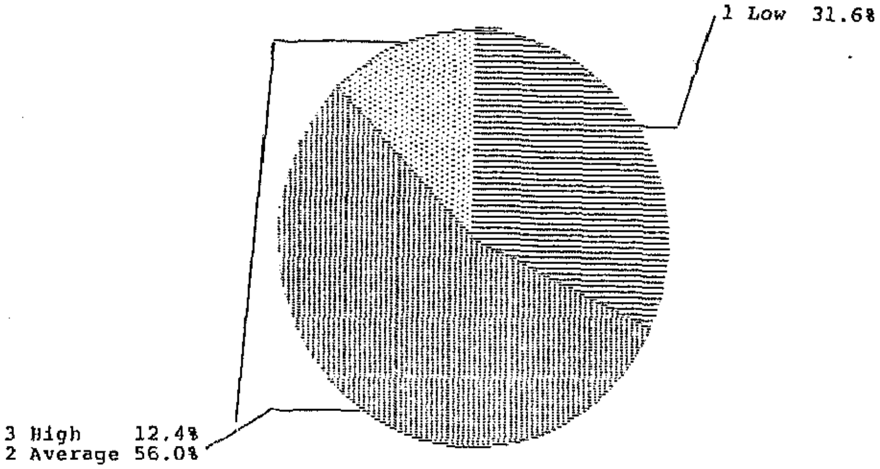
WELL



Category	Sample	%	Remarks
1	250	47	Good/Clear
2	7	1	Not Clear/Trouble
3	13	2	Color
4	50	9	Taste
5	1	0	Not Clear & Color
6	15	3	Not Clear & Taste
7	2	0	Color & Taste
8	192	36	No Answer

FIGURE 1.16 QUALITY OF WATER BEING USED

About 30% of households complain of low water pressure, which is consistent with the answers to "sufficient water supply". Regarding the area under low pressured supply, refer to Figure 5.1 in Supporting Report "Surveys on Water Usage, etc."

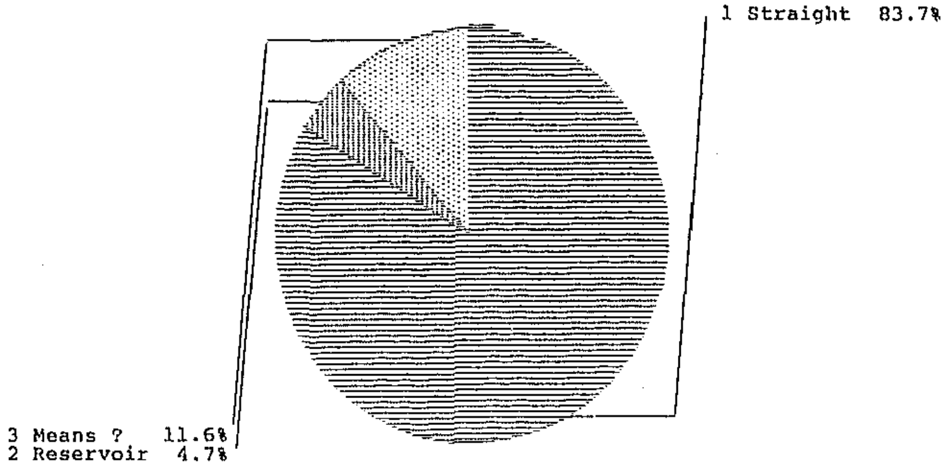


Cate-gory	Sample	%	Remarks
1	61	12	Low
2	108	20	Average
3	24	5	High
4	8	2	Etc.
5	329	62	No Answer

FIGURE 1.17

PDAM's WATER PRESSURE

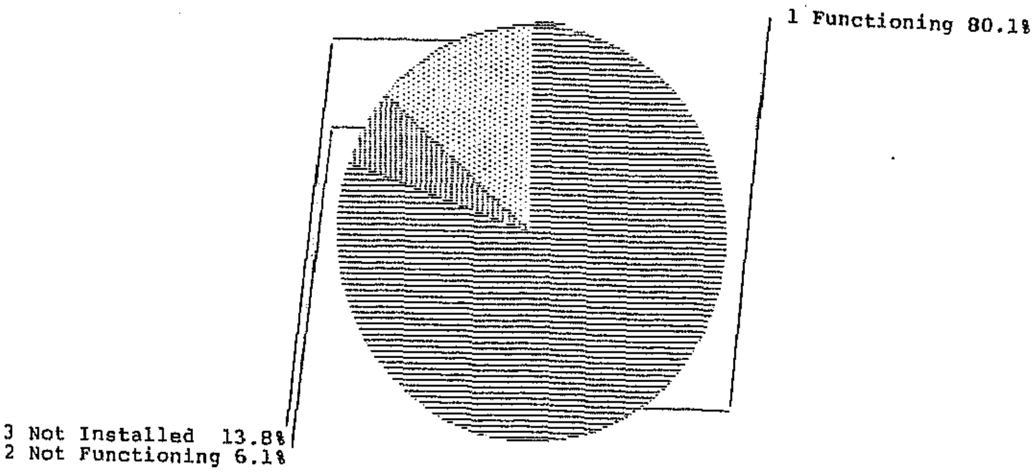
20% of house connections are equipped with water pump. Almost all such users are pumping up directly. Main reason for this is low water pressure, i.e., limited water availability. This pumping usage must be improved as early as possible, taking into consideration leakage at service pipe and the situation of flood in rainy season.



Category	Sample	%	Remarks
1	36	7	In Use/Straight from Pipe
2	2	0	In Use/After Reservoir
3	5	1	In Use/No Answer for Means
4	152	29	No Use of Pump
5	335	63	No Answer

FIGURE 1.18 USE OF PUMP

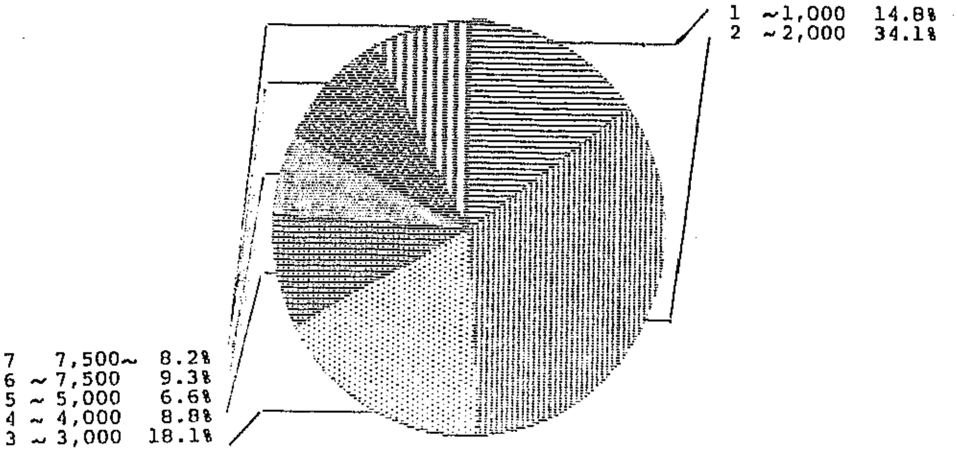
One in five connected households are not measured correctly. This situation will worsen the financial position of PDAM.



Cate-gory	Sample	%	Remarks
1	157	30	Installed/Functioning
2	12	2	Installed/Not Functioning
3	27	5	Not Installed
4	334	63	No Answer

FIGURE 1.19 WATER METER

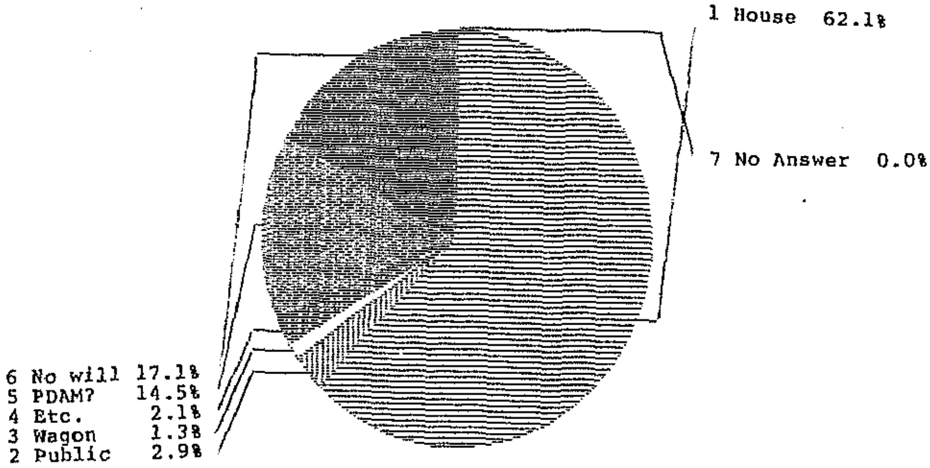
Monthly payment for water supply averages Rp.3,400/ month/household. From the above, the ratio of average monthly payment to the average income is computed as 3.5%, which is considered almost maximum share of living expenses.



Category	Sample	%	Remarks
1	27	5	Not Exceeding 1,000 Rp.
2	62	12	1,001 - 2,000 Rp.
3	33	6	2,001 - 3,000 Rp.
4	16	3	3,001 - 4,000 Rp.
5	12	2	4,001 - 5,000 Rp.
6	17	3	5,001 - 7,500 Rp.
7	15	3	More than 7,500 Rp.
8	348	66	No Answer

FIGURE 1.20 AVERAGE MONTHLY PAYMENT TO PDAM

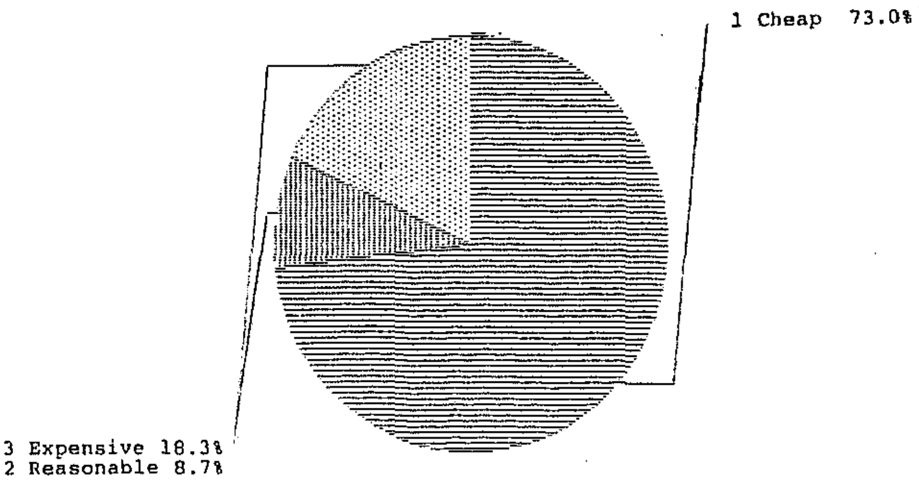
It is to be noted that nearly one-fifth of the households gave negative reply to "willingness to connect". This may show that public education on water supply is of vital importance, and that some measure is required to set a rather low water rate for the low income group.



Category	Sample	%	Remarks
1	239	45	Willing/House Connection
2	11	2	Willing/Public Standpipe
3	5	1	Willing/Water Wagon
4	8	2	Willing/Etc.
5	56	11	Willing/No Answer to Type
6	66	12	Not Willing to Connect
7	145	27	No Answer

FIGURE 1.21 WILLINGNESS TO CONNECT WITH THE PUBLIC SUPPLY

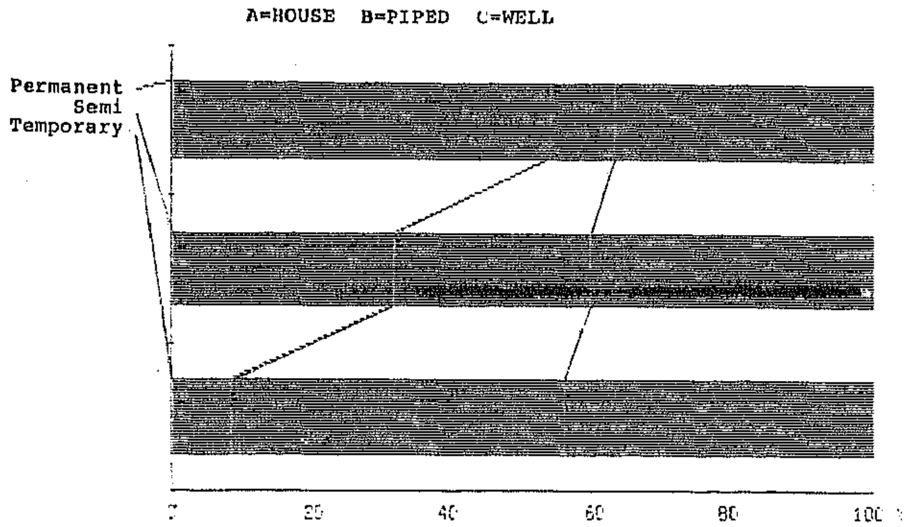
Figure below indicates three in four users answer that water tariff is cheap. This result suggests there is a possibility of raising rates for improving supply facilities.



Category	Sample	%	Remarks
1	92	17	Cheap
2	11	2	Reasonable
3	23	4	Expensive
4	404	76	No Answer

FIGURE 1.22	VIEW ABOUT PDAM's TARIFF

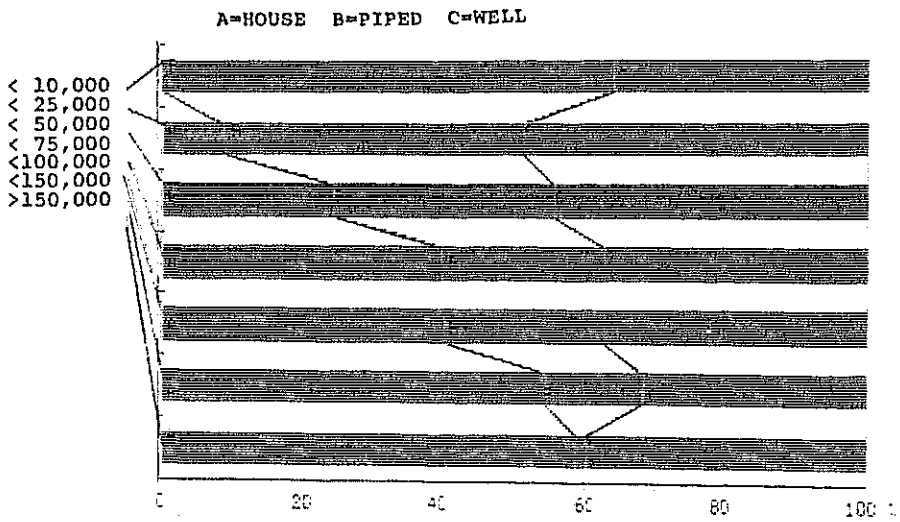
Percentages of people depending on treated water are about 60% for all three structure types of house. Although most of people in permanently-structured house depend on water from house connection, people in wooden house do on indirect water supply. This indicates that the type of structure of house relates to that of service of water supply.



Water Source (for Drinking)		Structure Type of House: Permanent 1	Semi-Permanent 2	Temporary 3	No Answer 4	TOTAL
PDAM/House Connection (A)		131	58	8	0	197
PDAM/Public Standpipe	Other Piped Water (B)	0	4	4	0	8
PDAM/Water Wagon		3	0	1	0	4
Neighbors Supply/Charged		9	37	34	0	80
Neighbors Supply/Not Charged		11	10	8	1	30
Well/Shallow	Well and Others (C)	86	71	44	1	202
Well/Deep		4	4	0	0	8
River		0	0	0	0	0
Other Sources		1	0	0	0	1
TOTAL		245	184	99	2	530

FIGURE 1.23	STRUCTURE TYPE OF HOUSE VS. WATER SOURCE

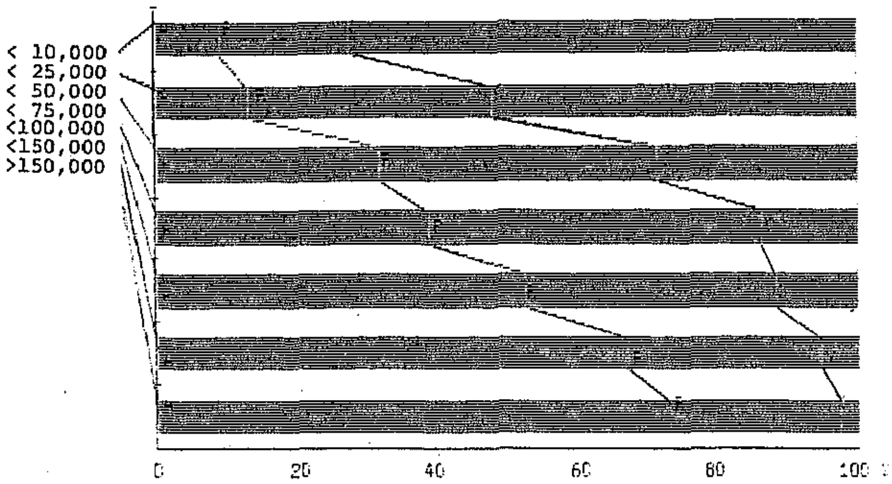
The relationship between types of service of water supply and income levels is similar as shown on Figure 1.21. That is, the higher the income level, the higher the percentage of people who depend on house connection.



Water Source (for Drinking)		Income (per Household per Month): 1 Not Exceeding 10,000 Rp.	2 10,001 - 25,000 Rp.	3 25,001 - 50,000 Rp.	4 50,001 - 75,000 Rp.	5 75,001 - 100,000 Rp.	6 100,001 - 150,000 Rp.	7 More than 150,000 Rp.	8 No Answer	TOTAL
PDAM/House Connection (A)		0	4	30	40	34	39	41	9	197
PDAM/Public Standpipe	Other Piped Water (B)	0	1	4	2	1	0	0	0	8
PDAM/Water Wagon		0	0	1	0	1	0	0	2	4
Neighbors Supply/Charged		4	15	26	16	14	5	0	0	80
Neighbors Supply/Not Charged		3	4	8	5	3	5	1	1	30
Well/Shallow	Well and Others (C)	3	22	55	36	29	23	26	8	202
Well/Deep		1	1	0	2	3	0	1	0	8
River		0	0	0	0	0	0	0	0	0
Other Sources		0	0	0	0	0	0	1	0	1
TOTAL		11	47	124	101	85	72	70	20	530

FIGURE 1.24 INCOME VS. WATER SOURCE

This figure shows very reasonable relation: people with high level income live in house equipped with house connection.



(per Household per Month) Structure Type of House	Permanent (A) 1	Semi-Permanent (B) 2	Temporary (C) 3	No Answer 4	TOTAL
Not Exceeding 10,000 Rp.	1	2	8	0	11
10,001 - 25,000 Rp.	6	16	24	1	47
25,001 - 50,000 Rp.	39	49	36	0	124
50,001 - 75,000 Rp.	39	48	14	0	101
75,001 - 100,000 Rp.	44	30	10	1	85
100,001 - 150,000 Rp.	48	20	4	0	72
More than 150,000 Rp.	51	17	2	0	70
No Answer	17	2	1	0	20
TOTAL	245	184	99	2	530

FIGURE 1.25	STRUCTURE TYPE OF HOUSE VS. INCOME

2. PUBLIC STANDPIPE SURVEY

In Kotamadya Ujung Pandang, 555 public standpipes are installed as of December, 1983 to supply clear water to rather low income groups. The area covered by public standpipes is an eastern part of the urbanized area.

There are 6 types of public standpipes in Ujung Pandang, i.e., MCK, KIP, PEMDA, UNICEF, BANGDES and AMD. These abbreviations reflect their respective financing sources. Prevailing types are the former four, adding up to 548, namely, 99% of the total. Maintenance of the public standpipes after installation is usually turned over to the inhabitants, resulting in an in-hygienic condition around the standpipes.

2.1 Objective of Survey

The objectives of the survey are to identify the present water consumption pattern of the people served by the standpipes and maintenance level thereof, and to provide data and information to be used for planning future water supply system.

2.2 Survey Method

2.2.1 Survey Area

The area where public standpipes are installed to date is largely divided into three, i.e., north-east, east, and south-east area as shown on Figure 2.1. The survey was conducted in October, 1984 by visiting public standpipes selected at random in each area.

2.2.2 Sample Size

Out of 555 public standpipes, 55 samples were selected, namely 10% of the total. This sample size was determined by the need to have survey data of the same level of accuracy as that used elsewhere in the Master Plan Report.

2.2.3 Questionnaire

The questionnaire for public standpipe survey is attached here to as an appendix. Major items contained in the questionnaire are related to daily consumptions, sufficiency of piped water, and purpose of water usage. Important issues such as type of standpipes, dimension of structure, and maintenance of meters and standpipes which are not contained in the questionnaire are examined by the Team's inspection and measurement.

2.3 Result of Survey

Data obtained through public standpipe survey are shown in Table 2.1 and the typical types of standpipes are illustrated on Figures 2.2 and 2.3. Major findings are described below:

1) Many defective meters are observed in the survey. Unmetered connections including defective meters counts up to 22, 40% of the total. This high percentage is mainly attributed to the absence of authorities responsible for maintenance of standpipes.

2) The number of households served at one public standpipe is 10 as an average (about 60 persons). It is assumed from this figure that total population served by standpipes may be around 33,000. It is to be noted that half of the standpipes serve less than 5 households (about 30 persons) and some standpipes (about 10%) are occupied by one household because of their close distance.

3) Approximately 50% of the households carry water twice a day. But, in the area of the relatively low water pressure, households are obliged to take water once in early morning.

4) Average water consumption per capita is 30.0 l/c/d. This figure was obtained from consumption records of each public standpipe and survey result on the number of consumers served by the respective standpipe.

5) Water rate charged on consumers are illustrated on Figure 2.4. Most of the water rates center upon a small range from 5 to 15 times higher ones than the PDAM tariff. The highest rate charged by the standpipe keeper is Rp.3,000/m^3, 40

times higher than the water tariff set by the PDAM. The cheapest water rate is still three times as high as the standard one.

6) Almost half of the public standpipes are able to supply water continuously, whereas 40% are obliged to stop service for 12 hours or more in a day because of extremely low water pressure.

7) Water usage pattern clearly reflects the existence of shallow wells. Where shallow well groundwater is available, the households are apt to use piped water only for drinking and cooking purpose.

8) Most of the standpipes, the Team considers, are not necessarily maintained in sanitary condition: 1) garbage and wastes around the standpipes, 2) spilt water due to water leakage and lack of drainage, 3) broken meters, and 4) illegal connections by removing meters from the service pipes.

All the above situations may be attributable to the following causes:

1) To evade water charge,

2) Too low water pressure,

3) Imperfect design and poor materials and workmanship,

4) Poor knowledge of sanitation,

5) Insufficient inspection,

6) Poor water service, and

7) Poor Municipal.

2.4 Recommendation

On the basis of the above findings, remedial measures to be taken by the PDAM are enumerated hereunder.

1) To institute regulations on: design, materials, inspection, disconnection and other penalty,

2) To strengthen inspection.

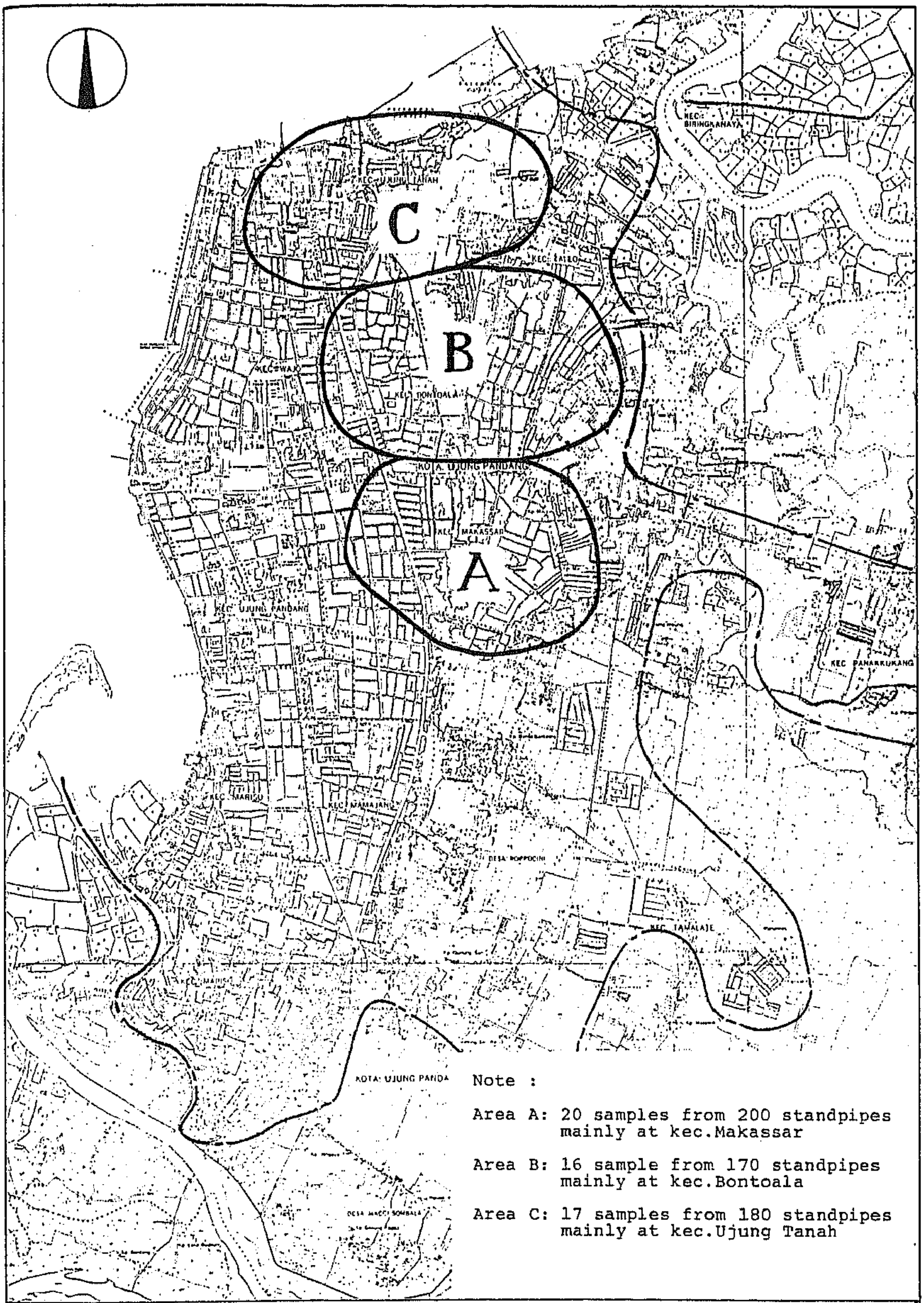
3) To conduct public education,

4) To prepare standard design. An example of standard design was prepared as shown on Figure 2.5,

5) To train technicians in skill,

6) To upgrade water service, and

7) To strengthen sanitation services.



Note :

Area A: 20 samples from 200 standpipes mainly at kec.Makassar

Area B: 16 sample from 170 standpipes mainly at kec.Bontoala

Area C: 17 samples from 180 standpipes mainly at kec.Ujung Tanah

FIGURE	AREA FOR STANDPIPE SURVEY
2.1	

TABLE 2.1

DATA OBTAINED THROUGH PUBLIC STANDPIPE SURVEY

SAMPLE	TYPE				METERED		NUM.	FREQUENCY			WATER		INSUF	PURPOSE				MAITE.	
NO.	MC	KKIP	UNI	AND	YES	NO	HOUS	1	2	3	m3/M	Rp/l	hour	DR	CO	BT	LA	G	B
A1	1	0	0	0	1	0	2	0	1	0	-	0.2	7	1	1	1	1	0	1
A2	0	1	0	0	0	1	6	0	1	0	-	0.5	0	1	1	0	0	0	1
A3	0	1	0	0	1	0	7	0	1	0	-	0.5	0	1	1	1	1	0	1
A4	0	1	0	0	0	1	20	0	0	1	-	0.3	0	1	1	0	0	0	1
A5	0	1	0	0	0	1	5	1	0	0	43	0.5	0	1	1	1	1	0	1
A6	0	1	0	0	0	1	10	0	1	0	69	1	5	1	1	0	1	0	1
A7	0	1	0	0	0	1	5	0	1	0	76	1	14	1	1	0	0	0	1
A8	0	1	0	0	1	0	20	0	1	0	-	2.5	0	1	1	0	0	0	1
A9	0	1	0	0	1	0	4	1	0	0	-	1	20	1	1	0	0	0	1
A10	0	1	0	0	1	0	20	0	1	0	-	1.3	10	1	1	0	0	0	1
A11	0	1	0	0	1	0	4	0	1	0	-	3	20	1	1	1	1	0	1
A12	0	0	1	0	0	1	12	1	0	0	35	0.5	0	1	1	1	1	0	1
A13	0	0	1	0	1	0	20	0	0	1	52	0.5	0	1	1	1	1	1	0
A14	1	0	0	0	1	0	8	0	1	0	-	0	6	0	0	1	0	0	1
A15	1	0	0	0	1	0	4	1	0	0	-	0.5	0	1	1	1	1	0	1
A16	0	1	0	0	1	0	4	0	1	0	-	0.5	0	1	1	1	1	0	1
A17	1	0	0	0	1	0	15	0	0	1	-	0.5	0	1	1	1	1	0	1
A18	0	1	0	0	1	0	10	0	1	0	-	0.8	0	1	1	0	0	0	1
A19	0	1	0	0	0	1	3	0	1	0	-	0.5	17	1	1	1	1	0	1
A20	0	1	0	0	1	0	4	1	0	0	-	1	0	1	1	0	0	0	1
B1	0	1	0	0	1	0	10	0	1	0	32		17	1	1	0	0	0	1
B2	0	1	0	0	1	0	17	1	0	0	135	0.5	17	1	1	0	0	0	1
B3	0	1	0	0	1	0	5	1	0	0	21	0.8	16	1	1	0	0	0	1
B4	0	1	0	0	1	0	3	1	0	0	41	1	0	1	1	0	0	0	1
B5	1	0	0	0	1	0	10	1	0	0	28	0.5	13	1	1	0	0	0	1
B6	1	0	0	0	1	0	10	1	0	0	32	1	15	1	1	0	0	0	1
B7	0	1	0	0	0	1	2	0	1	0	-	0	17	1	1	0	0	0	1
B8	1	0	0	0	0	1	50	0	1	0	-	0	6	1	1	0	0	0	1
B9	1	0	0	0	1	0	5	1	0	0	57	1.1	16	1	1	1	1	0	1
B10	1	0	0	0	0	1	1	1	0	0	-	0	18	1	1	1	1	0	1
B11	0	1	0	0	0	1	12	0	1	0	-	1	20	1	1	0	0	0	1
B12	0	1	0	0	1	0	2	1	0	0	15	1	21	1	1	0	0	0	1
B13	1	0	0	0	1	0	5	1	0	0	25	1	18	1	1	0	0	0	1
B14	0	1	0	0	1	0	5	1	0	0	74	0.5	19	1	1	0	0	0	1
B15	0	1	0	0	1	0	10	0	0	1	29	1	18	1	1	0	0	0	1
B16-18	1	2	0	0	0	3	0	0	0	0	-	0	0	0	0	0	0	0	3
C1	0	1	0	0	1	0	4	0	1	0	33	1	9	1	1	0	1	0	1
C2	0	1	0	0	1	0	1	0	0	0	64	0	0	1	1	0	0	0	1
C3	1	0	0	0	1	0	30	0	0	0	22	1	8	1	1	1	1	0	1
C4	0	1	0	0	1	0	5	1	0	0	-	1	20	1	1	0	0	1	0
C5	0	1	0	0	1	0	5	0	1	0	19	1	12	1	1	0	0	0	1
C6	1	0	0	0	1	0	1	0	0	0	30	0	20	1	1	1	1	0	1
C7	0	1	0	0	0	1	6	1	0	0	24	1.7	6	1	1	0	1	0	1
C8	0	0	1	0	0	1	6	1	0	0	35	1.3	0	1	1	0	0	0	1
C9	0	0	1	0	1	0	10	0	1	0	59	1	0	1	1	0	0	0	1
C10	0	0	1	0	0	1	1	0	0	0	65	0	16	1	1	0	0	0	1
C11	0	0	1	0	0	1	1	0	0	0	66	0	0	1	1	1	0	0	1
C12	0	0	0	1	1	0	10	0	1	0	150	0.3	0	1	1	1	1	0	1
C13	1	0	0	0	0	1	12	0	1	0	40	0.5	0	1	1	1	1	0	1
C14	0	0	0	1	1	0	30	0	1	0	142	0.3	0	1	1	1	1	0	1
C15	0	0	1	0	0	1	10	0	0	0	95	0.5	0	1	1	1	1	1	0
C16	0	1	0	0	0	1	4	0	1	0	30	0.5	0	1	1	1	1	0	1
C17	1	0	0	0	0	1	30	0	1	0	128	0.5	0	1	1	0	0	0	1
TOTAL	15	31	7	2	33	22	10*	18	24	4			29**	51	51	21	22	3	52

* --- The figures denotes the average number of households served by standpipes excluding defective standpipes.

** --- It shows the number of public standpipes where water cannot be supplied all day.

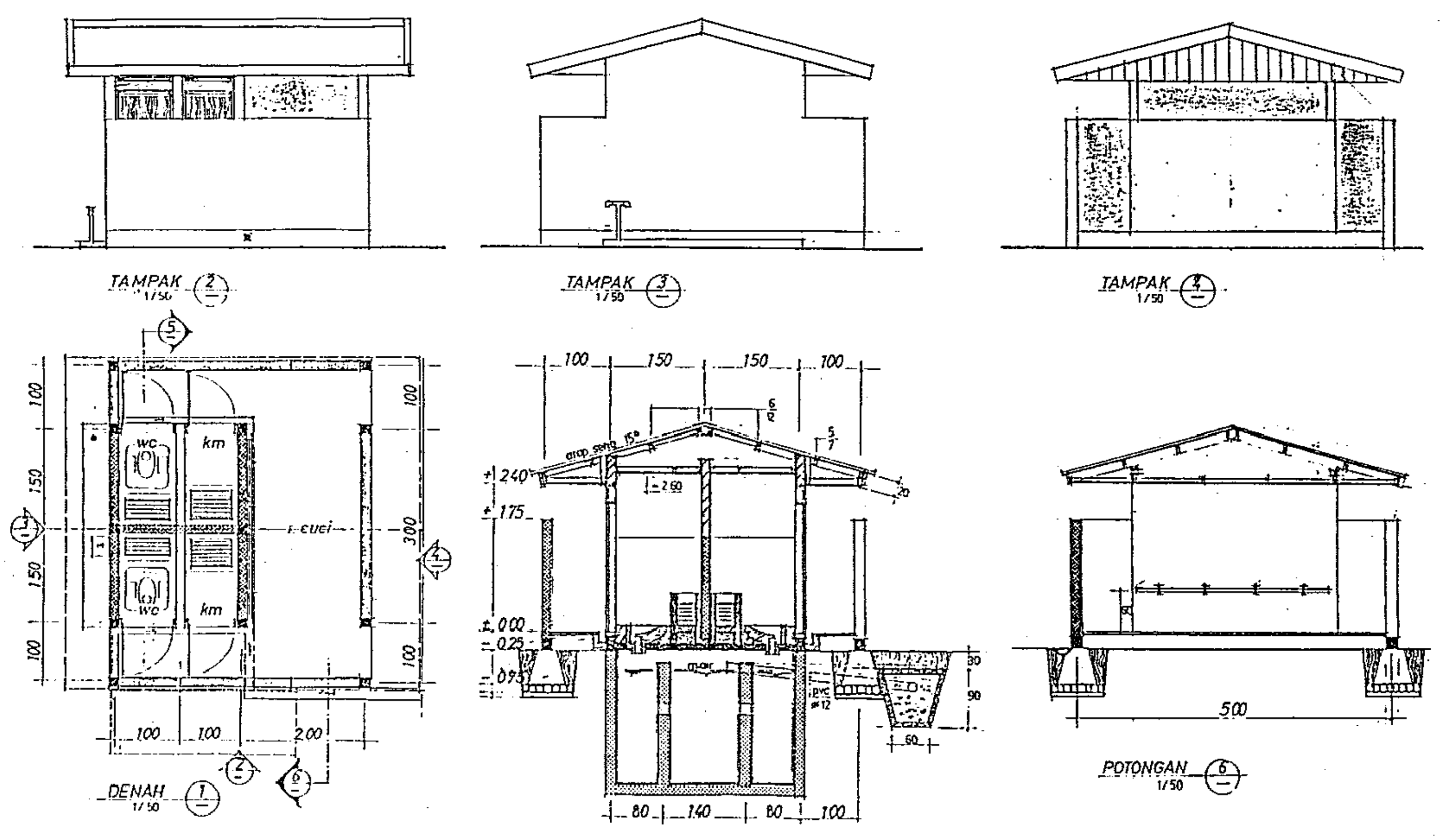
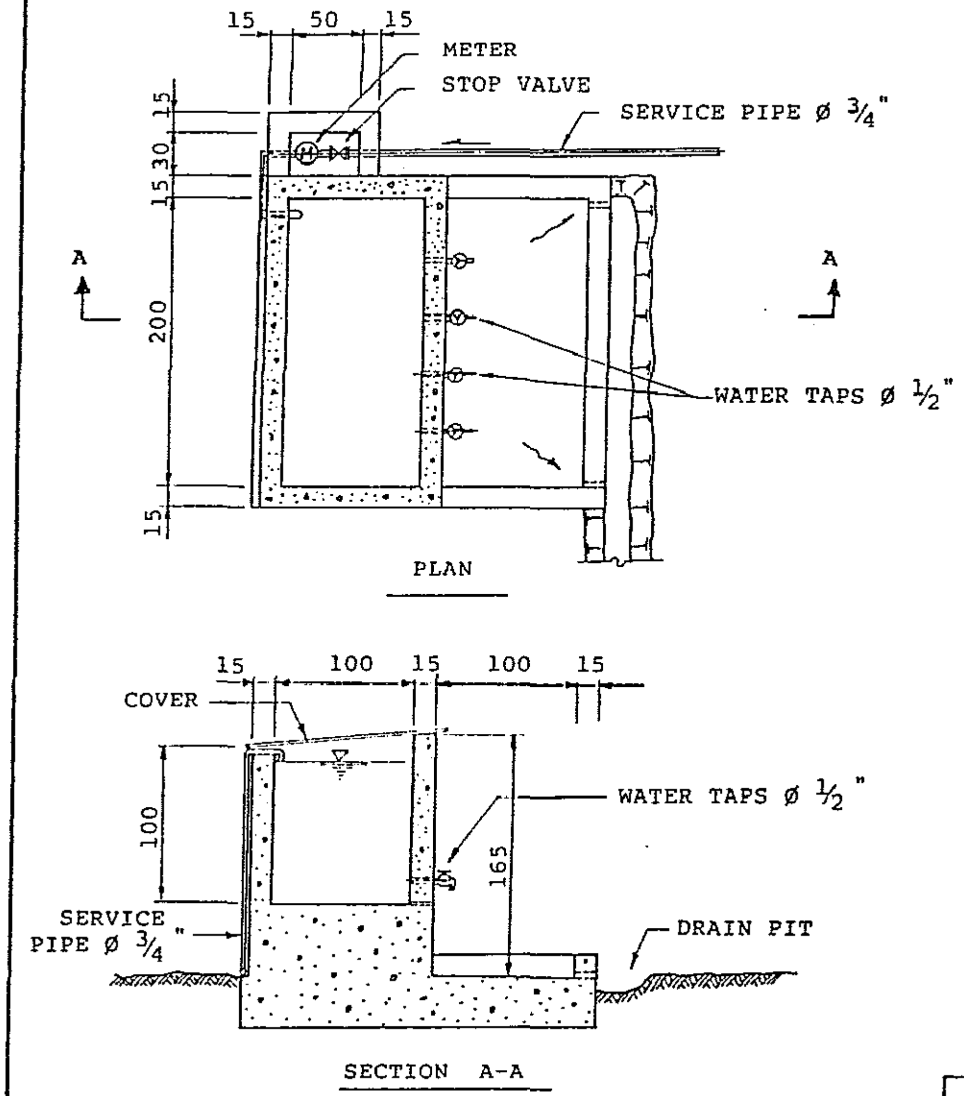
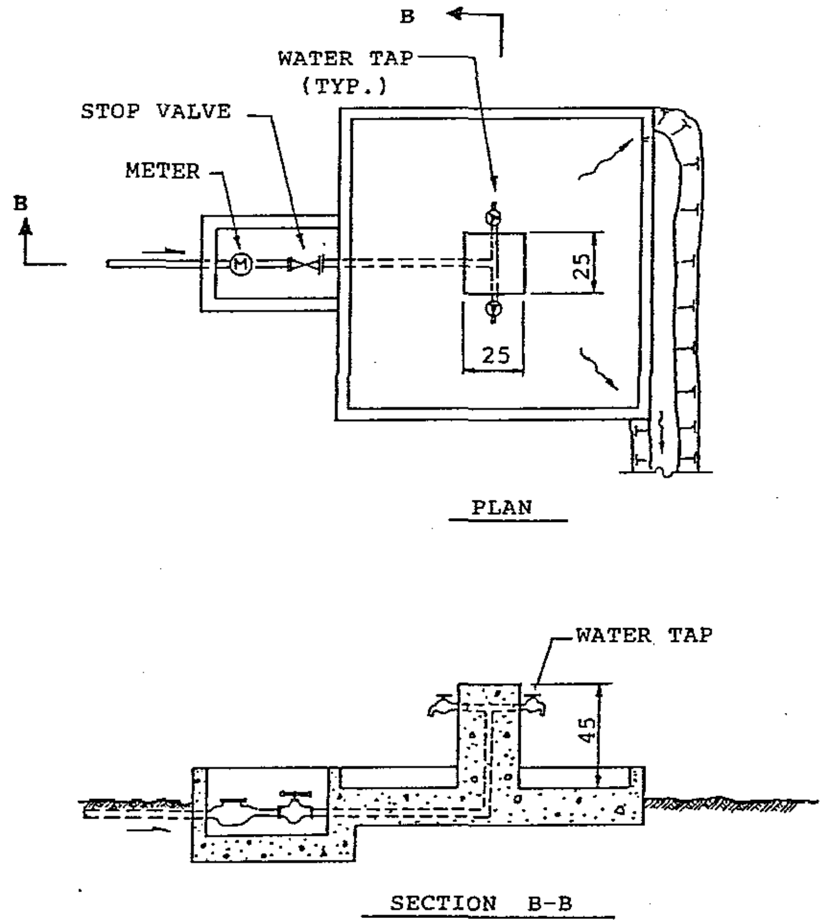


FIGURE 2.2 TYPICAL TYPE OF PUBLIC TAPS(1)



PUBLIC TAP TYPE 2 (BAK UMUM)



PUBLIC TAP TYPE 3 (UNICEF TYPE)

NOTE : UNIT CM

FIGURE	TYPICAL TYPE OF PUBLIC TAPS
2.3	

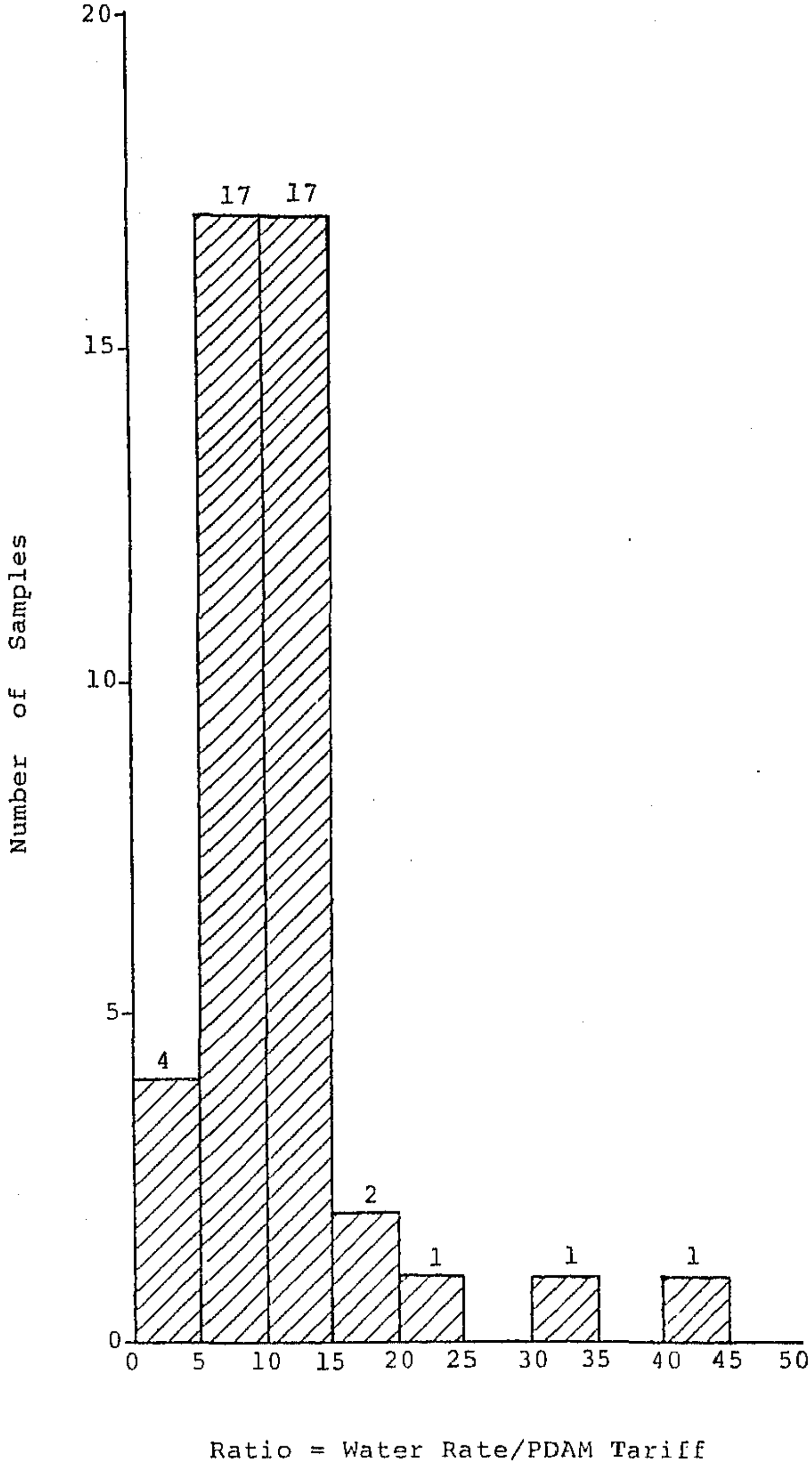


FIGURE	WATER RATE (PUBLIC STANDPIPES)
2.4	

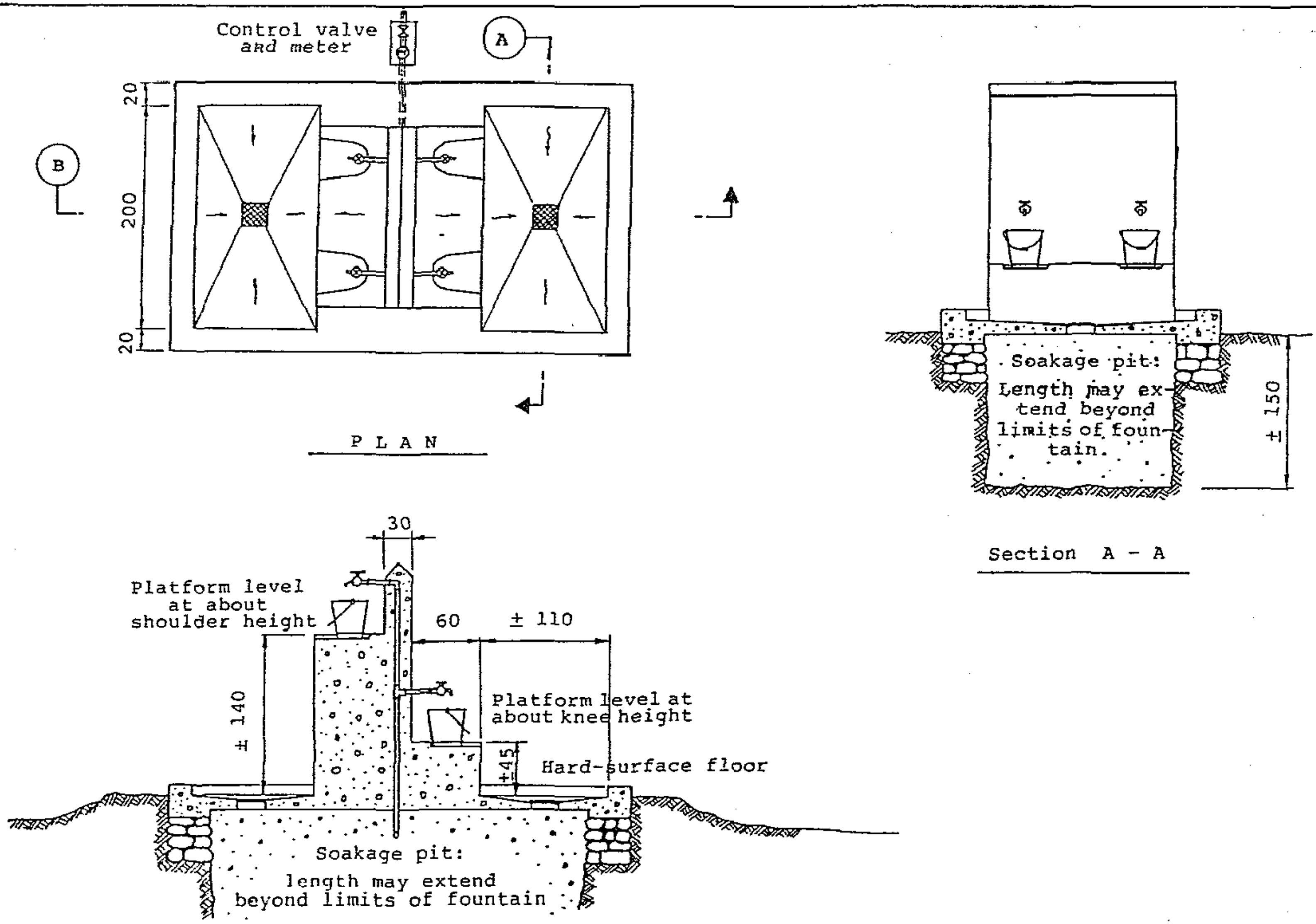


FIGURE 2.5

SAMPLE DESIGN OF STANDPIPE

Appendix - Questionnaire

1. Berapa banyak Rumah-tangga yang mengambil air dari Kran Umum ini ?

2. Berapa kali dalam sehari mereka mengambil air dari Kran Umum ini ?
   - Satu kali dalam sehari
   - Dua kali dalam sehari
   - Tiga kali dalam sehari
   - ....

3. Apakah airnya mereka ambil pada :
   - Pagi hari
   - Siang hari
   - Malam hari

4. Berapa banyak air (ember/liter) mereka ambil setiap kali ?
   - 1 ember/ ..... liter
   - 2 ember/ ..... liter
   - 3 ember/ ..... liter

5. Berapakah yang Anda bebankan untuk pengambilan air tersebut ? (Harga per ember)

6. Apakah airnya sering tidak keluar dari Kran Umum ini; bila demikian, pada jam-jam berapa ?

7. Air yang diambil oleh rumah-tangga^2 tersebut digunakan untuk keperluan apa ?
   - Minum
   - Memasak
   - Mandi
   - Mencuci

3. WATER LOSSES AT EXISTING TRANSMISSION CANAL

The PDAM Ujung Pandang often experienced serious water shortage in the past dry seasons. The PDAM was forced to decrease water production to a remarkably low level, when it occured.

Panaikang treatment plant has a capacity of 600 l/sec, 92.3% of the PDAM production capacity. Raw water is transmitted by gravity through the existing canal, 29 km in length from Leko Pancing Intake to Panaikang treatment plant. During flowing down through the canal, excessive volume of raw water are wasted by seepage and trans-evaporation from the canal.

3.1 Objective of Survey

Objectives of the survey are to compute volume of water losses and leak points/spans of the transmission canal and to provide supporting data and information for the Master Plan and Feasibility Study.

3.2 Gauging Points and Method Applied

3.2.1 Gauging Points

Several gauging points were selected as seen in Figure 3.1. No.1 Point was determined at 2.7 km from Leko Pancing intake to gauge water flow at the downstream of irrigation diversion and No. 5 Point near at Panaikang treatment plant. Remainings were selected to measure flow rate and area of cross section as accurately as possible. Components of canal sections such as syphon, culvert and open channel were also considered in this selection.

3.2.2 Gauging Method

Gauging method applied here is described below:

1) Firstly, depth of the canal was metered in each 50 cm of the cross section. The area of cross section was computed from measured depth and width of the canal.

2) Secondly, flow rate at 1.0 m span of cross section was measured, using Hiroi flow meter commonly employed in similar surveys in Japan.

3) Flow discharge was computed by the product of the area and the flow rate measured.

3.3 Result of Survey

Results of the survey are summarized in Table 3.1 and also illustrated in Figure 3.2. Water losses from the existing canal are 0.48 m^3/sec, approximately 31% of the total flow. It should be noted that major losses are occurring at the downstream span of a few kilometer near the Panaikang treatment plant.

TABLE 3.1

RESULT OF SURVEY

No. of Survey Point	Velocity (m/sec)	Area of Canal Section (m^2)	Discharge (m^3/sec)
1	0.577	2.67	1.54
2	0.607	2.42	1.47
3	0.755	1.92	1.45
4	0.469	2.77	1.30
5	0.226	4.78	1.08

3.4 Conclusion and Recommendation

The above results were obtained from the survey conducted in October, 1984. The canal has a discharge of 1.5 m^3 at Leko Pancing.

Meanwhile, the volume of raw water in dry season extracted at Leko Pancing drops to 0.9 m^3/sec as described in the Supporting Report on Water Source. It seems probable that the flow conditions may vary and percentage of water losses will differ from the figure stated above in the severe dry seasons. Hence, the PDAM is recommended to gauge the canal flow periodically.

It is appropriate that the rehabilitation work to reduce water losses is being undertaken under finance of the local Government. For the purpose of effective loss reduction, the Team recommends that rehabilitation work should be initiated from the downstream of the canal near Panaikang treatment plant, where water losses are remarkable.

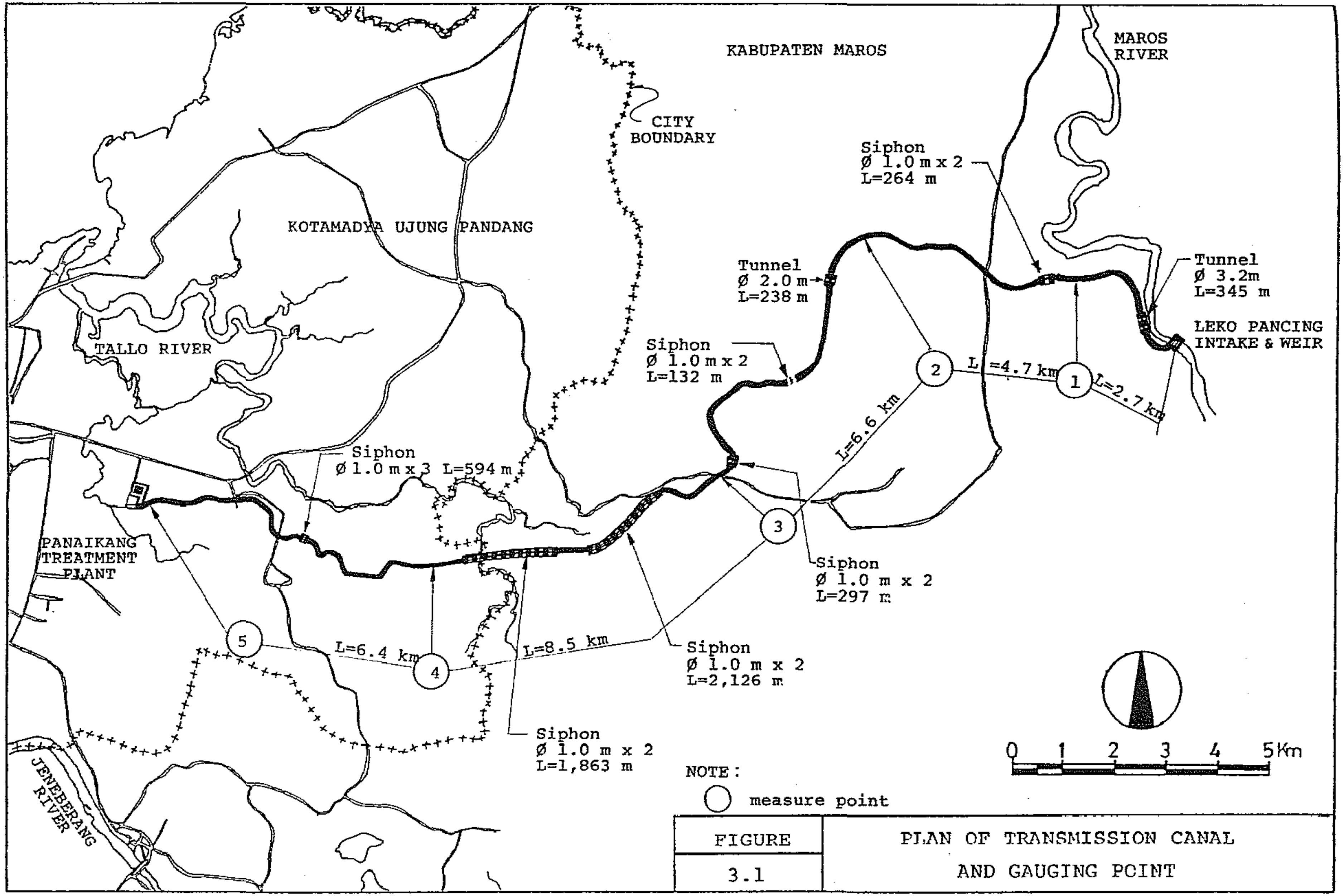
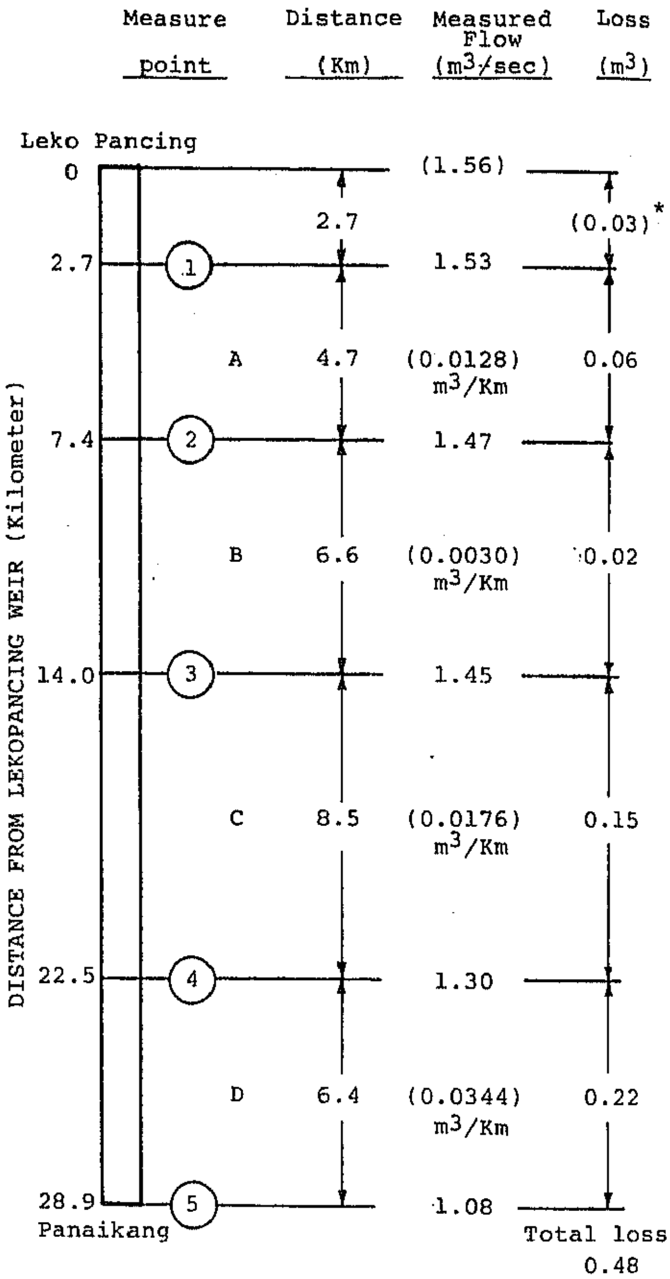


FIGURE 3.1 PLAN OF TRANSMISSION CANAL AND GAUGING POINT

Present Canal Condition and Length (m)	
Open	2,257
Tunnel Ø 3.2 m	345
Duct	98
Open	4,215
Siphon Ø 1.0 m x 2	264
Duct	151
Open with lining	73
Open	4,690
Tunnel Ø 2.0 m	238
Siphon Ø 1.0 m x 2	429
Open with lining	55
Siphon Ø 1.0 m x 2	3,989
Duct	549
Open	3,962
Siphon Ø 1.0 m x 3	594
Open	5,803



Open	20,927 m	(72.4%)
Siphon	5,276 m	(18.3%)
Duct	1.986 m	(6.9%)
Tunnel	583 m	(2.0%)
Open with lining	128 m	(0.4%)
Total	28,900 m	(100%)

FIGURE 3.2 MEASUREMENT OF WATER FLOW IN TRANSMISSION CANAL

4. HOURLY VARIATION OF WATER CONSUMPTION

There are two treatment plants currently operated by the PDAM, which are located at Ratulangi and Panaikang. The production capacity of these systems are 75 l/sec and 600 l/sec respectively. Hence, the capacity of Panaikang system amounts to about 90% of the total.

A clear water reservoir and an elevated tank of the old Ratulangi treatment plant has a capacity of 1,800 m^3 and 750 m^3 respectively. The new treatment plant at Panaikang has relatively large capacity of clear water reservoirs (2 basins), 10,000 m^3 in total and distribute clear water by gravity at present.

As described above, most of clear water is produced at the Panaikang treatment plant and distributed by gravity to the consumers. Therefore, it can be assumed that variation of outflow from the reservoirs at Panaikang may explain that of water consumption in Kotamadya Ujung Pandang. From this reason, the survey was conducted at Panaikang treatment plant to show hourly variation of water production. This section provides the outline of the survey method, data obtained, and the results of analyses.

4.1 Objective of Survey

The objective of the survey is to obtain data regarding hourly variation in the rate of water consumption as a basis for designing the distribution system.

4.2 Results of Survey

According to the monthly records on accounted-for water in recent years, the water consumptions in Septembers and Octobers are the largest in the year. It would be preferable if survey could be conducted on the very day of 'daily maximum'. The survey was conducted twice: for one week of September (21st to 27th) and another week of October (from 18th to 25th).

Following are the steps taken in the course of the survey and analyses.

1) To gauge hourly fluctuation of water level in the clear water reservoir and to record the time of back washing of each basin,

2) To measure water depth every hour at the existing notches between filters and reservoirs,

3) To calculate hourly change of stored water in the reservoirs,

4) To calculate the rate of inflow to the reservoir using following formula:

Ishihara.Ida formula

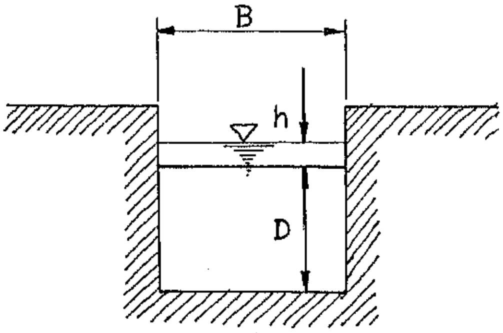
$$Q = C \times B \times H^{3/2}$$

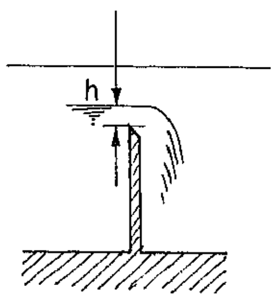
where,

- Q : flow rate (m^3/sec)
- B : width of the weir (m)
- H : height of the sheet of water (m)
- C : capacity coefficient = $1.785 + (0.00295/H + 0.237 \times H/D)(1 + a)$
- a : correction term
  - when D is 1 m or less $a = 0$
  - when D is more than 1 m $a = 0.55 \times (D - 1)$

Note : the above formula shall be applied within the following range.

$B \geq 0.5$ m, D = 0.3-2.5 m, H = 0.03～D m (Provided, H shall not be larger than 0.8 m, nor than B/4 m)





5) To estimate volume of supplied water by the following equation.

$$Q_{out,\ t+1} = V_t - V_{t+1} + Q_{in,\ t+1} - Q_{b,\ t+1}$$

where,

$Q_{out,t}$: Outflow rate from the reservoirs at time = t (m^3/h)

$Q_{in,t}$: Inflow rate to the reservoirs at time = t (m^3/h)

$Q_{b,t}$: Outflow rate for backwashing filters at time = t (m^3/h)

V_t : Volume of water stored in the reservoirs at time = t (m^3)

t : Time in hour

6) To compute hourly variation of water production.

4.3 Result of Survey

The data on water depth gauged at each notch and reservoir are given in Tables 4.1(1)-(15).The hourly fluctuation of water consumption (water production) are shown on Figures 4.1 to 4.4. The results are summarized below.

1) Hourly variation in a rate of water consumption is 1.3 (peak consumption/average consumption).

2) Water hourly consumed in the daytime is bigger than that consumed at night.

3) This hourly variation in each day of the week shows almost same pattern even on Sundays and Fridays.

4) The existing reservoirs have a sufficient storage capacity to meet daily water demand even if the Panaikang treatment plant is expanded to have a capacity of 1,100 l/sec.

4.4 Recommendation

To obtain data on water production, the PDAM staff and personnel had once tried to measure dimensions of clear water reservoirs and fluctuation of water level thereof at the Panaikang treatment plant. But the data obtained were not necessarily sufficient to estimate water production because of fluctuation of the inflow.

In the course of the survey, the Team paid special attentions to technology transfer to the PDAM's staff and personnel. Methods to gauge inflow and outflow rates and to calculate the volume of water production were precisely explained. For further survey and study, the PDAM is recommended as follows:

1) To study the cost and availability of spare parts for the damaged portion of the bulk meter, which is out of order at present.

2) To conduct survey at least once a month at Panaikang and Ratulangi treatment plants and compile data for future development of the system.

TABLE 4.1

GAUGING DATA AND HOURLY PRODUCTION (1)

NOTE:

- Q(CMH) means outflow rate of reservoir (m^3/hour).
- *W1 to W5 and RWDep show gauging data at five notches* and reservoir.
- ql (1) to q5 (1) imply rate of inflow from each filter to reservoir.

21 SEP. 1964

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	17	18	16	16	14	3.90	109	122	97	97	70	1385
2	17	18	16	16	13	4.10	109	122	97	103	65	1388
3	17	18	16	17	13	4.30	109	122	103	109	60	1413
4	17	18	17	17	12	4.50	109	122	109	109	50	1500
5	17	18	17	17	11	4.65	109	122	109	109	45	2183
6	17	18	17	17	11	4.45	109	122	109	109	45	1983
7	17	18	17	17	11	4.35	126	141	109	109	60	2672
8	20	21	17	17	14	4.00	148	161	103	109	80	2369
9	20	21	16	17	15	3.90	148	161	97	109	86	2268
10	20	21	16	17	15	3.85	148	161	97	109	86	2168
11	20	21	16	17	15	3.85	148	155	116	122	97	2694
12	20	20	19	19	17	3.65	148	148	128	128	109	2381
13	20	20	18	18	17	3.65	148	148	122	122	109	2335
14	20	20	18	18	17	3.65	128	141	141	128	103	2311
15	17	19	21	19	16	3.65	109	128	148	141	97	2346
16	17	18	19	20	16	3.60	112	122	141	158	103	2392
17	17.5	18	20	21.5	17	3.55	112	122	148	165	109	2363
18	17	18	20	21	17	3.55	109	122	148	161	109	2340
19	17	18	20	21	17	3.55	109	122	122	135	92	2085
20	17	18	16	17	14	3.55	109	122	97	109	97	2028
21	17	18	16	17	18	3.50	109	128	97	103	97	1929
22	17	19	16	16	14	3.50	109	135	97	97	75	1650
23	17	19	16	16	14	3.60	109	128	97	97	75	1527
24	17	18	16	16	14	3.75	122	128	109	116	65	1342
0	19	19	18	19	12	3.80						
											TOTAL	49552

TABLE 4.1 (2)

22 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	19	18	16	16	14	3.75	135	126	109	116	65	1886
1	19	19	18	19	12	3.80	135	135	122	135	55	1689
2	19	19	18	19	12	4.00	135	135	122	135	50	1472
3	19	19	18	19	11	4.30	135	135	122	128	45	1632
4	19	19	18	18	11	4.50	135	128	122	122	45	2186
5	19	18	18	18	11	4.40	128	122	122	116	45	2017
6	18	18	18	17	11	4.35	116	122	126	109	45	1973
7	17	18	19	17	11	4.30	109	116	122	109	45	1805
8	17	17	17	17	11	4.30	103	109	109	109	45	1317
9	16	17	17	17	11	4.25	97	109	109	109	41	1980
10	16	17	17	17	10	4.10	155	146	122	116	60	3233
11	25	23	19	18	19	3.60	190	176	109	97	135	2545
12	21	21	15	14	19	3.60	161	161	86	75	135	2227
13	21	21	15	14	19	3.60	161	161	86	80	135	2246
14	21	21	15	15	19	3.60	155	155	86	86	135	2217
15	20	20	15	15	19	3.60	148	148	109	116	116	2490
16	20	20	19	20	16	3.50	148	128	116	135	116	2310
17	20	17	16	18	19	3.50	148	116	103	122	122	2197
18	20	18	17	12	17	3.50	141	122	122	122	122	2462
19	19	18	19	18	19	3.40	135	128	135	122	109	2463
20	19	19	19	16	15	3.30	135	126	135	135	80	2205
21	19	18	19	20	14	3.30	135	122	135	135	80	1982
22	19	18	19	18	15	3.40	135	122	135	122	60	1936
23	19	18	19	18	14	3.50	135	128	135	122	75	1839
24	19	19	19	18	14	3.65						
											TOTAL	50907

TABLE 4.1 (3)

23 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	19	19	19	19	14	3.65	122	128	122	128	86	1909
1	17	18	17	18	16	3.75	109	122	109	122	97	1715
2	17	18	17	18	16	3.90	109	122	109	122	97	1715
3	17	18	17	18	16	4.05	109	122	109	122	97	1715
4	17	18	17	18	16	4.20	109	122	109	122	97	1815
5	17	18	17	18	16	4.30	109	119	109	122	92	1983
6	17	17.5	17	18	15	4.30	109	112	103	116	86	2096
7	17	17	16	17	15	4.20	109	109	103	103	86	1842
8	17	17	17	16	15	4.20	109	122	109	122	116	2880
9	17	19	17	20	20	3.80	103	135	109	148	148	2515
10	16	19	17	20	20	3.70	97	135	109	141	141	2446
11	16	19	17	19	19	3.60	97	135	103	128	128	2130
12	16	19	16	18	18	3.60	86	141	97	116	109	1979
13	14	20	16	17	16	3.60	75	148	97	109	97	1898
14	14	20	16	17	16	3.60	75	148	97	109	97	1898
15	14	20	16	17	16	3.60	75	135	86	116	109	1874
16	14	18	14	18	18	3.60	103	109	97	109	92	2241
17	19	16	18	16	13	3.40	141	116	122	103	65	1967
18	20	19	18	17	13	3.40	148	135	122	109	65	2181
19	20	19	18	17	13	3.35	148	135	122	97	65	2139
20	20	19	18	15	13	3.30	151	135	125	92	60	1923
21	20.5	19	18.5	16	12	3.35	144	128	119	97	80	1949
22	19	18	17	16	17	3.40	125	116	109	95	97	1751
23	17.5	17	17	15.5	15	3.50	112	112	103	100	89	1663
24	17	17.5	16	17	15.5	3.60						
											TOTAL	48226

TABLE 4.1 (4)

24 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	17	17.5	16	17	15.5	3.60	109	125	103	116	78	2112
1	17	19	17	18	13	3.50	109	135	109	122	65	1743
2	17	19	17	18	13	3.60	116	131	119	122	72	1715
3	18	18.5	18.5	18	14.5	3.75	122	128	128	125	80	2000
4	18	18.5	18.5	18.5	14.5	3.80	122	125	128	128	78	1591
5	18	18	18.5	18.5	14	4.05	122	125	128	125	78	2079
6	18	18.5	18.5	18	14.5	4.05	116	119	119	125	78	2000
7	17	17	17	18.5	14	4.05	109	122	103	112	80	1799
8	17	19	16	16	15	4.10	109	128	92	97	80	2026
9	17	18	15	16	14	4.00	116	155	80	92	109	2786
10	18	23	14	15	20	3.60	122	183	70	135	141	2540
11	18	22	13	23	19	3.50	116	176	60	176	128	2555
12	17	22	12	21	18	3.40	109	176	55	161	116	2020
13	17	22	12	21	17	3.50	109	168	55	155	109	2147
14	17	21	12	20	17	3.50	109	161	55	148	109	2198
15	17	21	12	20	17	3.45	109	161	55	141	109	2074
16	17	21	12	19	17	3.45	103	161	55	135	109	2129
17	16	21	12	19	17	3.40	122	148	80	135	97	2396
18	20	19	17	19	15	3.25	148	135	109	122	75	2119
19	20	19	17	17	13	3.25	148	135	109	109	65	2137
20	20	19	17	17	13	3.20	148	135	109	109	65	2137
21	20	19	17	17	13	3.15	131	128	109	103	70	1851
22	17.5	18	17	16	14	3.20	112	122	103	97	75	1736
23	17	18	16	16	14	3.25	109	128	103	109	70	1572
24	17	19	17	18	13	3.40						
											TOTAL	49462

TABLE 4.1 (5)

25 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	17	19	17	18	13	3.40	122	135	122	128	70	2374
1	19	19	19	19	14	3.25	135	141	135	135	75	1932
2	19	20	19	19	14	3.40	135	148	135	128	70	1914
3	19	20	19	18	13	3.55	135	148	135	122	65	1872
4	19	20	19	18	13	3.70	135	148	135	122	65	1972
5	19	20	19	18	13	3.80	135	148	128	122	65	2149
6	19	20	18	18	13	3.80	135	148	122	122	65	2126
7	19	20	18	18	13	3.80	122	131	116	122	86	2175
8	17	17.5	17	18	17	3.75	109	112	106	122	109	2114
9	17	17	16.5	18	17	3.70	109	109	100	122	109	2081
10	17	17	16	18	17	3.65	116	141	103	116	128	2873
11	18	22	17	17	20	3.30	109	168	109	103	135	2251
12	16	21	17	16	18	3.30	103	155	103	92	122	2069
13	17	20	16	15	18	3.30	109	148	97	86	122	2025
14	17	20	16	15	18	3.30	109	148	92	80	116	1962
15	17	20	15	14	17	3.30	109	148	80	75	109	1880
16	17	20	14	14	17	3.30	103	141	75	75	97	2372
17	16	19	14	14	15	3.00	122	135	109	103	86	2199
18	20	19	20	19	15	2.90	155	135	161	135	80	2597
19	21	19	22	19	14	2.80	161	128	161	135	75	2379
20	21	18	20	19	14	2.80	155	122	148	135	75	2282
21	20	18	20	19	14	2.80	141	122	141	128	75	1786
22	19	18	19	18	14	3.00	135	122	135	122	75	1916
23	19	18	19	18	14	3.10	135	122	135	122	75	1816
24	19	18	19	18	14	3.25						
											TOTAL	51115

TABLE 4.1 (6)

26 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	19	18	19	18	14	3.25	122	122	116	122	80	1721
1	17	18	16	18	15	3.40	109	122	97	122	86	1631
2	17	18	16	18	15	3.55	109	122	97	122	86	1631
3	17	18	16	18	15	3.70	109	122	97	122	86	1631
4	17	18	16	18	15	3.85	109	122	97	122	86	1831
5	17	18	16	18	15	3.90	109	122	97	122	86	1931
6	17	18	16	18	15	3.90	109	122	97	122	86	1931
7	17	18	16	18	15	3.90	109	116	103	103	92	2184
8	17	17	17	15	16	3.75	109	109	109	86	97	2142
9	17	17	17	15	16	3.60	109	116	109	92	92	1964
10	17	18	17	16	15	3.55	109	122	109	97	80	1967
11	17	18	17	16	14	3.50	109	116	103	97	75	1903
12	17	17	16	16	14	3.45	109	109	97	97	75	1860
13	17	17	16	16	14	3.40	141	135	97	97	122	2733
14	22	21	16	16	22	3.10	161	155	86	80	155	2294
15	20	20	14	13	19	3.10	155	155	75	65	135	2100
16	21	21	14	13	19	3.10	155	155	75	60	128	2259
17	20	20	14	12	18	3.00	148	141	75	55	116	1923
18	20	19	14	12	17	3.00	148	128	70	55	109	1835
19	20	18	13	12	17	3.00	148	122	60	55	97	1733
20	20	18	12	12	15	3.00	148	135	65	80	92	1769
21	20	20	14	17	16	3.05	148	148	75	109	97	1979
22	20	20	14	17	16	3.10	148	148	75	109	97	1879
23	20	20	14	17	16	3.20	148	148	75	109	97	1879
24	20	20	14	17	16	3.30						
											TOTAL	46711

TABLE 4.1 (7)

27 SEP. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
0	20	20	14	17	16	3.30	148	148	75	109	103	1801
1	20	20	14	17	17	3.45	148	155	75	103	109	1825
2	20	21	14	16	17	3.60	148	161	70	92	109	1888
3	20	21	13	15	17	3.70	148	161	65	86	109	1849
4	20	21	13	15	17	3.80	135	155	86	97	97	2053
5	18	20	17	17	15	3.80	122	148	109	109	86	2068
6	18	20	17	17	15	3.80	122	148	109	109	86	2268
7	18	20	17	17	15	3.70	122	135	109	103	86	2199
8	18	18	17	16	15	3.60	103	128	116	103	86	2131
9	15	19	18	17	15	3.50	86	135	122	109	86	2036
10	15	19	18	17	15	3.45	86	135	122	109	86	1936
11	15	19	18	17	15	3.45	86	128	122	109	83	1903
12	15	18	18	17	14.5	3.45	92	116	122	116	72	1761
13	16	17	18	18	13	3.50	97	116	122	125	60	1869
14	16	18	18	18.5	12	3.50	109	119	128	125	75	2402
15	18	17.5	19	18	16	3.30	122	112	135	122	97	2117
16	18	17	19	18	16	3.30	122	109	122	116	97	2038
17	18	17	17	17	16	3.30	122	109	109	109	97	2071
18	18	17	17	17	16	3.25	122	109	109	109	97	2071
19	18	17	17	17	16	3.20	122	109	109	109	97	1971
20	18	17	17	17	16	3.20	122	109	109	109	97	1971
21	18	17	17	17	16	3.20	122	109	109	109	92	1950
22	18	17	17	17	15	3.20	122	109	103	103	86	1486
23	18	17	16	16	15	3.40	122	109	97	97	86	2044
24	18	17	16	16	15	3.30						
											TOTAL	47707

TABLE 4.1 (8)

18 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(I)	q2(I)	q3(I)	q4(I)	q5(I)	Q(CMH)
1	19	20	18.5	18	16.5	3.80	148	158	141	131	116	2098
2	19	19.5	18.5	17.5	16.5	4.00	148	155	141	128	116	2074
3	19	19.5	18.5	17.5	16.5	4.20	148	155	141	128	116	2074
4	19	19.5	18.5	17.5	16.5	4.40	148	155	138	128	116	2162
5	19	19.5	18	17.5	16.5	4.55	148	155	135	128	116	2350
6	19	19.5	18	17.5	16.5	4.60	148	151	144	125	128	2708
7	19	19	19.5	17	18.5	4.50	148	135	138	109	144	2627
8	19	17	17	15	19	4.40	148	122	122	97	148	2492
9	19	17	17	15	19	4.30	141	122	116	92	148	2425
10	18	17	16	14	19	4.20	135	122	103	86	148	2137
11	18	17	15	14	19	4.20	161	148	103	128	135	3031
12	22	21	16	21	17	3.90	190	176	109	161	116	2907
13	22	21	16	19	16	3.80	183	176	109	141	109	2585
14	21	21	16	18	16	3.80	176	168	109	128	109	2487
15	21	20	16	17	16	3.80	176	168	103	148	103	2615
16	21	21	15	21	15	3.75	168	168	122	161	116	2948
17	20	20	19	19	18	3.60	161	161	148	148	135	2911
18	20	20	19	19	18	3.50	161	161	148	148	135	2611
19	20	20	19	19	18	3.55	161	161	148	148	135	2611
20	20	20	19	19	18	3.60	161	161	148	155	135	2536
21	20	20	19	20	18	3.70	161	161	135	161	128	2390
22	20	20	17	20	17	3.85	148	161	122	161	119	2160
23	18	20	17	20	16.5	4.05	141	161	122	161	119	2036
24	19	20	17	20	17	4.30	148	161	122	161	119	2360
0	19	20	17	20	16.5	4.40						
											TOTAL	59338

TABLE 4.1 (9)

19 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(I)	q2(I)	q3(I)	q4(I)	q5(I)	Q(CMH)
1	19	20	17	20	16.5	4.40	141	161	119	161	116	2314
2	18	20	16.5	20	16.5	4.50	131	158	116	161	112	2244
3	17.5	19.5	16.5	20	16	4.60	135	151	125	161	122	2298
4	18.5	19	18	20	18	4.70	141	148	135	161	135	2391
5	18.5	19	18	20	18	4.80	141	148	135	155	135	2566
6	18.5	19	18	19	18	4.80	138	141	135	148	128	2682
7	18	18	18	19	17	4.70	135	135	135	148	122	2624
8	18	18	18	19	17	4.60	135	135	135	148	122	2624
9	18	18	18	19	17	4.50	135	135	135	148	122	2624
10	18	18	18	19	17	4.40	135	135	135	148	122	2424
11	18	18	18	19	17	4.40	141	128	135	135	128	2600
12	19	17	18	17	18	4.30	148	122	135	122	135	2478
13	19	17	18	17	18	4.25	141	143	122	141	122	2925
14	18	21	16	20	16	4.00	161	176	109	161	109	2982
15	22	21	16	20	16	3.80	190	176	103	161	103	2441
16	22	21	15	20	15	3.90	190	168	97	155	97	2548
17	22	20	15	19	15	3.90	190	161	97	148	97	2699
18	22	20	15	19	15	3.80	190	161	135	148	122	3120
19	22	20	21	19	19	3.60	176	155	168	148	135	2811
20	20	19	20	19	17	3.60	155	148	148	141	128	2590
21	19	19	18	18	18	3.60	155	155	135	148	135	2614
22	20	20	18	20	18	3.60	161	161	135	161	135	2413
23	20	20	18	20	18	3.75	161	161	135	161	135	2413
24	20	20	18	20	18	3.90	161	161	135	161	135	2513
0	20	20	18	20	18	4.00						
											TOTAL	61941

TABLE 4.1 (10)

20 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	20	20	18	20	18	4.00	161	161	135	161	135	2513
2	20	20	18	20	18	4.10	161	161	135	161	135	2613
3	20	20	18	20	18	4.15	161	161	135	161	135	2413
4	20	20	18	20	18	4.30	161	161	135	161	135	2513
5	20	20	18	20	18	4.40	155	155	128	155	128	2592
6	19	19	17	19	17	4.40	148	148	122	148	122	2573
7	19	19	17	19	17	4.35	148	148	119	148	116	2540
8	19	19	16.5	19	16	4.30	148	141	138	141	128	3306
9	19	18	20	18	19	3.90	148	128	161	128	148	2768
10	19	17	20	17	19	3.80	148	122	161	122	148	2522
11	19	17	20	17	19	3.80	141	122	161	122	148	2598
12	18	17	20	17	19	3.75	135	122	161	122	148	2475
13	18	17	20	17	19	3.75	128	148	161	148	148	2839
14	17	21	20	21	19	3.65	122	176	161	176	148	2815
15	17	21	20	21	19	3.65	122	168	161	176	148	2790
16	17	20	20	21	19	3.65	122	161	161	176	148	2765
17	17	20	20	21	19	3.65	109	155	161	168	141	2646
18	15	19	20	20	18	3.65	128	148	155	161	135	2716
19	20	19	19	20	18	3.60	161	155	148	155	128	2688
20	20	20	19	19	17	3.60	161	161	141	148	122	2641
21	20	20	18	19	17	3.60	161	161	135	148	116	2395
22	20	20	18	19	16	3.70	161	161	135	155	109.	2397
23	20	20	18	20	16	3.80	161	161	135	161	109	2422
24	20	20	18	20	16	3.90	161	161	135	161	109	2422
0	20	20	18	20	16	4.00						
											TOTAL	62965

TABLE 4.1 (11)

21 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	20	19	18	20	16	4.00	161	148	135	161	109	2373
2	20	19	18	20	16	4.10	161	148	135	161	109	2373
3	20	19	18	20	16	4.20	161	148	135	161	109	2373
4	20	19	18	20	16	4.30	148	155	155	148	135	2662
5	18	20	21	18	20	4.30	135	161	176	135	161	2663
6	18	20	21	18	20	4.35	135	161	176	135	161	2963
7	18	20	21	18	20	4.25	135	148	176	128	161	2791
8	18	18	21	17	20	4.20	135	128	176	148	161	2991
9	18	17	21	21	20	4.05	131	122	176	176	161	2956
10	17.5	17	21	21	20	3.95	125	116	176	176	161	2811
11	17	16	21	21	20	3.90	116	109	176	176	161	2855
12	16	16	21	21	20	3.80	109	125	176	176	161	2789
13	16	18.5	21	21	20	3.75	109	141	176	176	161	2847
14	16	18.5	21	21	20	3.70	109	141	176	176	161	2747
15	16	18.5	21	21	20	3.70	109	138	168	168	161	2884
16	16	18	20	20	20	3.60	116	135	155	141	148	2697
17	17	18	19	17	18	3.50	122	135	148	122	135	2378
18	17	18	19	17	18	3.50	122	135	148	116	135	2556
19	17	18	19	16	18	3.40	122	128	128	141	128	2730
20	17	17	16	21	17	3.20	122	122	135	168	122	2406
21	17	17	20	20	17	3.20	122	122	155	155	116	2606
22	17	17	19	19	16	3.10	122	122	155	155	109	2184
23	17	17	20	20	16	3.20	122	122	161	161	135	2324
24	17	17	20	20	20	3.30	122	122	161	161	161	2621
0	17	17	20	20	20	3.30						
											TOTAL	63580

TABLE 4.1 (12)

22 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	21	17	19	19	21	3.50	183	122	148	148	176	2392
2	22	17	19	19	21	3.70	190	122	148	148	176	2418
3	22	17	19	19	21	3.90	176	116	141	141	176	2596
4	20	16	18	18	21	3.95	161	109	135	135	168	2451
5	20	16	18	18	20	4.00	141	135	135	128	161	3020
6	17	20	18	17	20	3.75	122	161	135	122	161	2524
7	17	20	18	17	20	3.75	75	161	148	141	161	2773
8	9	20	20	20	20	3.60	70	161	161	155	161	2651
9	16	20	20	19	20	3.55	103	161	155	141	161	2899
10	15	20	19	18	20	3.40	70	161	148	135	161	2430
11	10	20	19	18	20	3.40	86	161	148	144	155	3000
12	18	20	19	19.5	19	3.15	141	161	128	158	128	2481
13	19	20	16	20	16	3.20	148	155	116	155	116	2377
14	19	19	17	19	17	3.25	148	148	122	148	122	2473
15	19	19	17	19	17	3.25	148	141	122	141	122	2525
16	19	18	17	18	17	3.20	148	135	122	135	122	2378
17	19	18	17	18	17	3.20	155	135	141	128	116	2626
18	20	18	20	17	16	3.10	148	148	141	135	116	3173
19	18	20	17	19	17	2.75	135	161	122	148	122	2475
20	18	20	17	19	17	2.75	135	155	122	148	116	2328
21	18	19	17	19	16	2.80	135	148	122	148	109	2181
22	18	19	17	19	16	2.90	135	148	122	148	109	2161
23	18	19	17	19	16	3.00	135	148	122	148	109	1981
24	18	19	17	19	16	3.20	135	148	122	148	109	1981
0	18	19	17	19	16	3.40						
											TOTAL	60316

TABLE 4.1 (13)

23 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	18	19	17	19	16	3.40	135	148	122	148	109	1981
2	18	19	17	19	16	3.60	135	141	122	141	109	2133
3	18	18	17	18	16	3.70	128	135	122	135	109	1863
4	17	18	17	18	16	3.90	122	135	122	135	109	2040
5	17	18	17	18	16	4.00	116	135	116	135	109	2195
6	16	18	16	18	16	4.00	109	135	109	128	109	2327
7	16	18	16	17	16	3.90	128	141	128	128	122	2630
8	19	19	19	18	18	3.75	148	148	148	128	128	2619
9	19	19	19	17	17	3.70	190	183	122	168	103	3558
10	25	24	15	24	14	3.30	235	220	97	220	86	3091
11	25	24	15	24	14	3.30	235	220	97	220	86	3091
12	25	24	15	24	14	3.30	235	220	97	220	86	3091
13	25	24	15	24	14	3.30	235	220	97	220	86	3091
14	25	24	15	24	14	3.30	220	197	128	197	122	3312
15	23	21	20	21	20	3.20	176	161	148	148	155	2834
16	19	19	18	17	19	3.20	148	141	141	122	148	2519
17	19	18	19	17	19	3.20	148	128	148	116	148	2574
18	19	17	19	16	19	3.15	141	122	148	103	148	2383
19	18	17	19	15	19	3.15	128	148	141	128	141	2571
20	17	21	18	20	18	3.10	122	176	135	161	135	2621
21	17	21	18	20	18	3.10	122	176	135	161	135	2421
22	17	21	18	20	18	3.20	122	176	135	161	135	2421
23	17	21	18	20	18	3.30	122	176	135	161	135	2421
24	17	21	18	20	18	3.40	122	168	135	155	128	2247
0	17	20	18	19	17	3.55						
											TOTAL	62033

TABLE 4.1 (14)

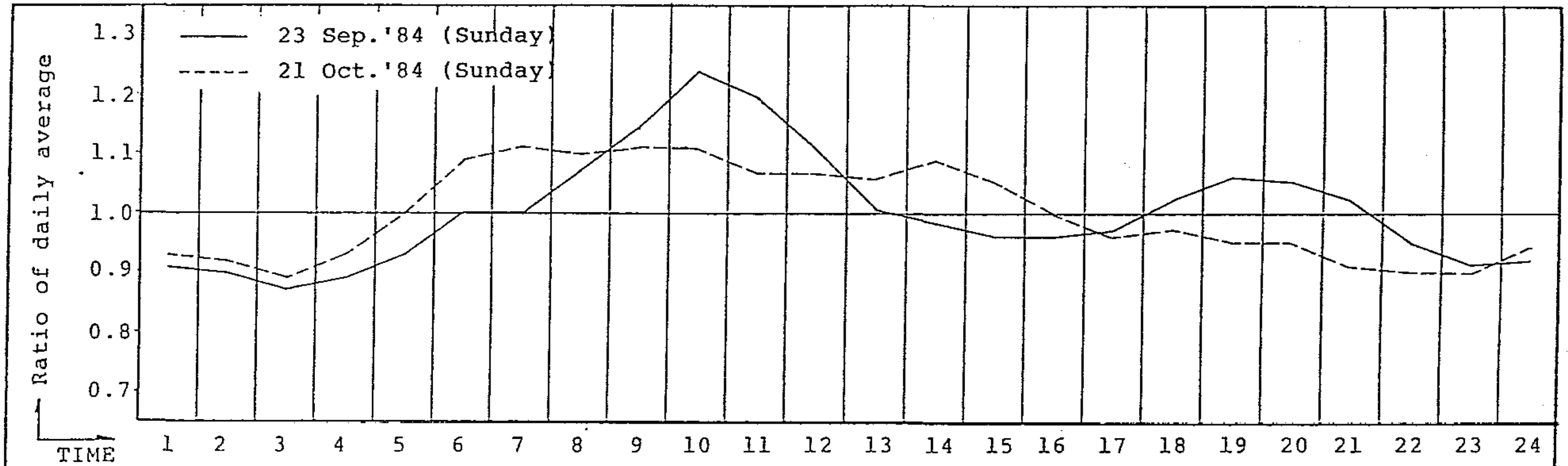
24 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	17	20	18	19	17	3.55	122	161	135	148	122	2175
2	17	20	18	19	17	3.70	122	161	135	148	122	2175
3	17	20	18	19	17	3.85	122	161	135	148	122	2175
4	17	20	18	19	17	4.00	122	161	135	148	122	2275
5	17	20	18	19	17	4.10	122	161	135	148	122	2375
6	17	20	18	19	17	4.15	116	161	128	155	116	2531
7	16	20	17	20	16	4.10	168	168	116	168	109	3329
8	25	21	16	21	16	3.75	205	168	116	168	122	2804
9	21	20	17	20	18	3.75	168	161	135	155	141	3237
10	20	20	19	19	19	3.50	161	161	148	148	148	2859
11	20	20	19	19	19	3.45	161	161	148	148	148	2759
12	20	20	19	19	19	3.45	161	161	148	148	148	2859
13	20	20	19	19	19	3.40	161	161	148	148	148	2859
14	20	20	19	19	19	3.35	161	161	148	148	148	2759
15	20	20	19	19	19	3.35	161	155	148	135	148	2687
16	20	19	19	17	19	3.35	155	161	148	148	148	3034
17	19	21	19	21	19	3.20	148	176	148	176	148	2960
18	19	21	19	21	19	3.15	135	176	135	176	135	2617
19	17	21	17	21	17	3.20	122	176	122	176	122	2579
20	17	21	17	21	17	3.20	122	176	116	176	122	2656
21	17	21	16	21	17	3.15	122	176	109	176	122	2434
22	17	21	16	21	17	3.20	128	168	116	168	116	2306
23	18	20	17	20	16	3.30	135	161	122	161	109	2279
24	18	20	17	20	16	3.40	135	161	122	161	109	2279
0	18	20	17	20	16	3.50						
											TOTAL	63003

TABLE 4.1 (15)

25 OCT. 1984

Time	W1	W2	W3	W4	W5	RWDep	q1(l)	q2(l)	q3(l)	q4(l)	q5(l)	Q(CMH)
1	18	20	17	20	16	3.50	135	161	122	161	109	2179
2	18	20	17	20	16	3.65	135	161	122	161	109	2179
3	18	20	17	20	16	3.80	135	161	116	155	109	2232
4	18	20	16	19	16	3.90	135	155	109	148	109	2161
5	18	19	16	19	16	4.00	135	148	109	148	122	2581
6	18	19	16	19	18	3.90	135	148	109	141	135	2603
7	18	19	16	18	18	3.80	135	148	109	141	141	2427
8	18	19	16	19	19	3.80	135	148	109	148	148	2675
9	18	19	16	19	19	3.70	128	148	109	148	148	2652
10	17	19	16	19	19	3.60	155	168	86	168	148	3211
11	22	22	12	22	19	3.30	190	190	103	190	148	3556
12	22	22	19	22	19	3.00	183	183	148	190	148	3063
13	21	21	19	22	19	3.00	176	176	148	176	141	2936
14	21	21	19	20	18	3.00	168	176	148	161	135	2836
15	20	21	19	20	18	3.00	161	168	148	161	128	2762
16	20	20	19	20	17	3.00	161	161	148	161	122	2814
17	20	20	19	20	17	2.95	161	161	148	161	122	2714
18	20	20	19	20	17	2.95	168	161	161	155	141	3234
19	21	20	21	19	20	2.75	176	161	176	148	161	2858
20	21	20	21	19	20	2.80	176	161	176	148	161	2858
21	21	20	21	19	20	2.85	161	151	155	141	155	2647
22	19	18.5	18	18	19	2.90	148	138	135	135	148	2130
23	19	18	18	18	19	3.10	148	135	135	128	148	2295
24	19	18	18	17	19	3.20	148	135	135	122	148	2472
0	19	18	18	17	19	3.20						
											TOTAL	64076



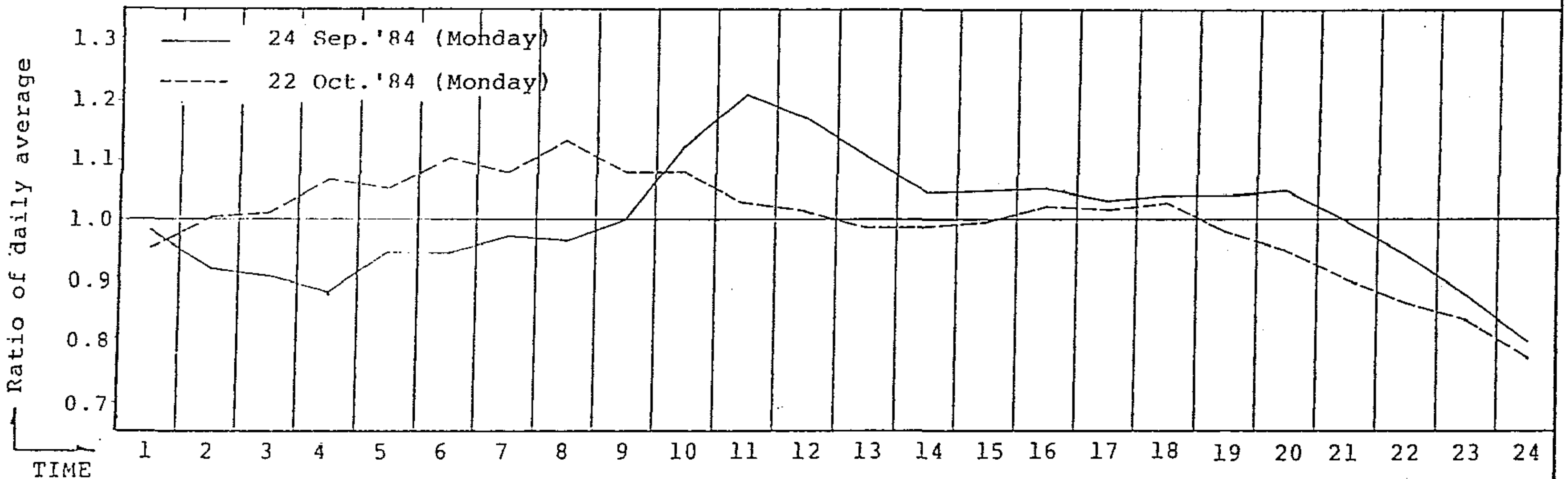


FIGURE	HOURLY FLUCTUATION OF WATER CONSUMPTION (WATER PRODUCTION)
4.1	

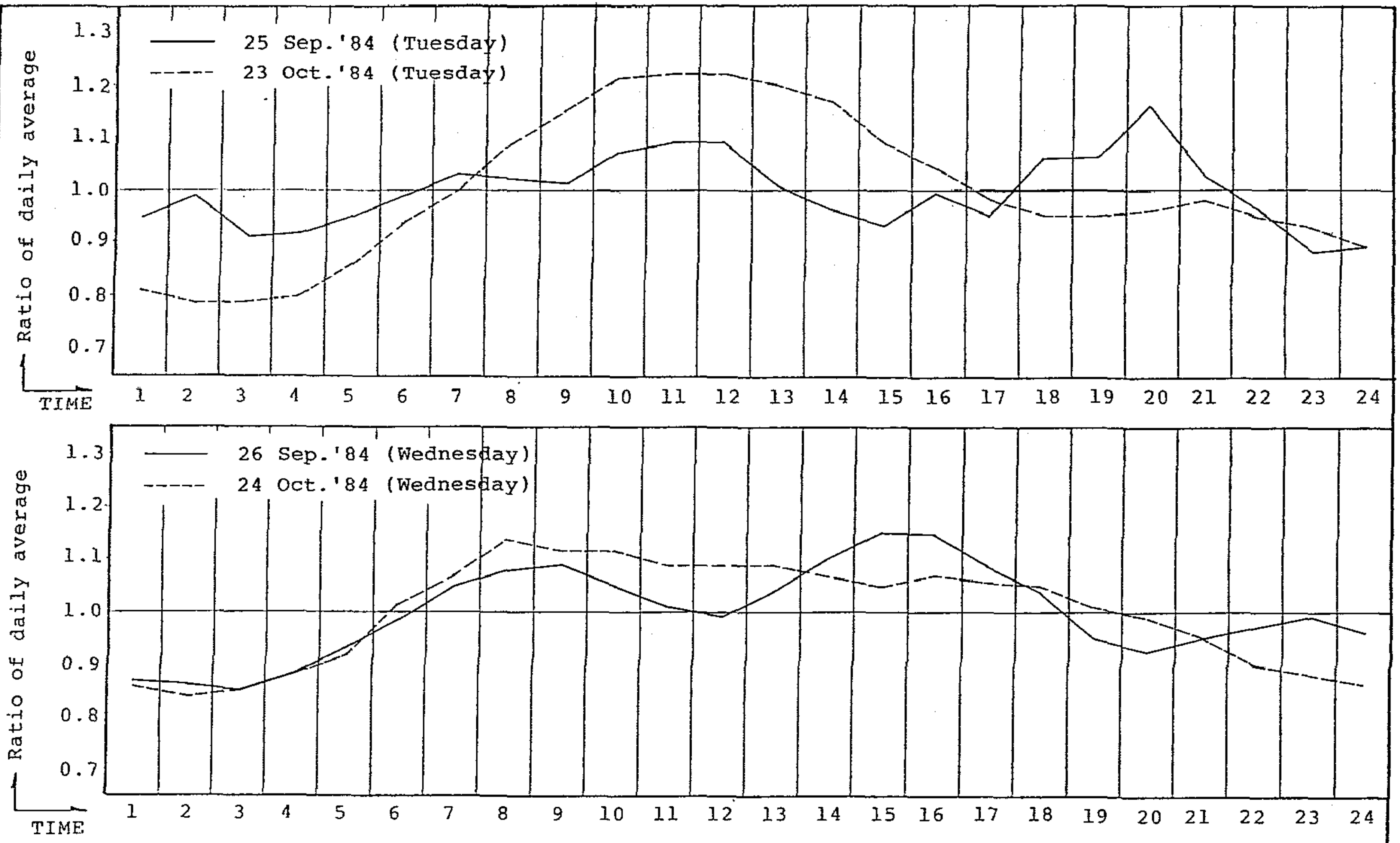


FIGURE	HOURLY FLUCTUATION OF WATER CONSUMPTION (WATER PRODUCTION)
4.2	

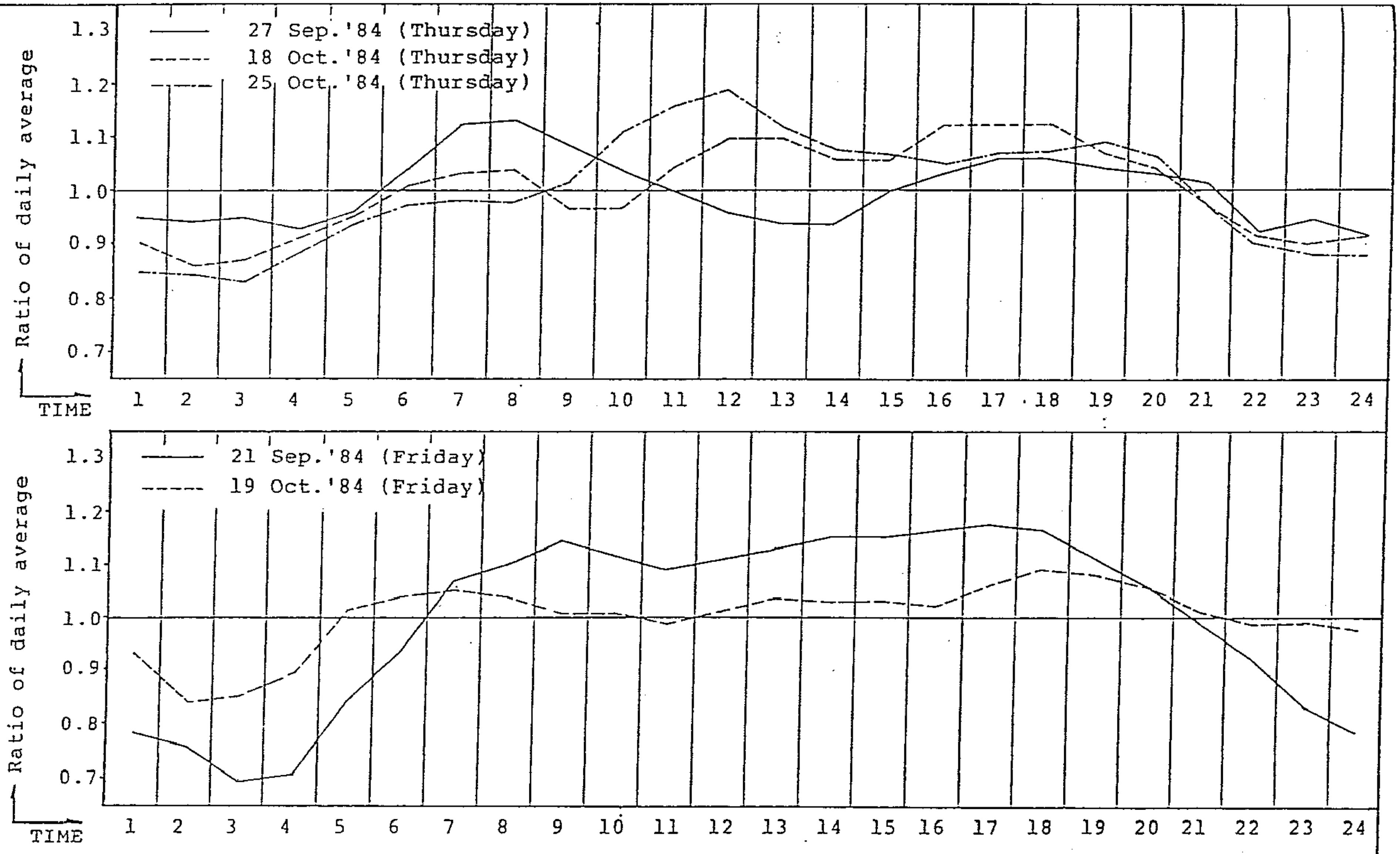


FIGURE 4.3	HOURLY FLUCTUATION OF WATER CONSUMPTION (WATER PRODUCTION)

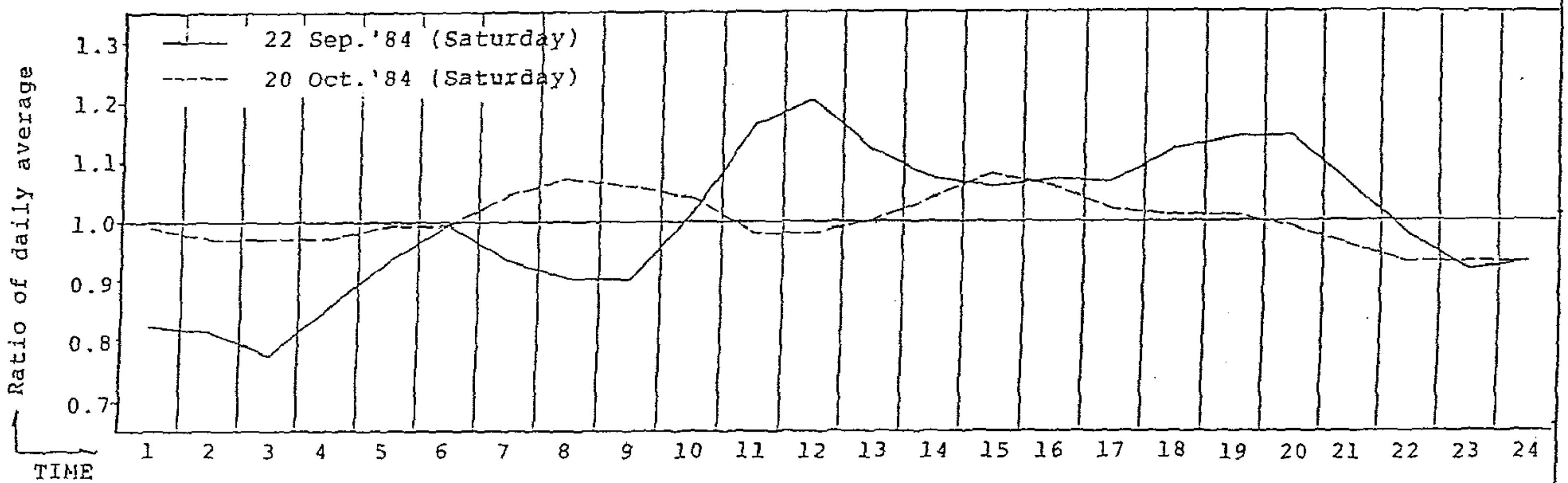


FIGURE	HOURLY FLUCTUATION OF WATER CONSTUMPTION (WATER PRODUCTION)
4.4	

5. WATER PRESSURE IN THE DISTRIBUTION NETWORK

As water pressure in the distribution pipeline is low, people inhabited in the fringe area of distribution network hardly get piped water from PDAM system. This section describes the outline of the survey conducted by the Team.

5.1 Objective of Survey

The objective of the survey is to know water pressure distribution and supply condition in the service area, by gauging actual water pressure at several points in the distribution network, testing water quality and having interviews with the inhabitants.

5.2 Survey Method

The survey was conducted in the following manner.

1) Several points for water pressure gauging are selected considering the present condition of the distribution network such as location of old and new pipelines and distribution mains.

2) Water pressure was so low that pressure gauge could not sense. So, the Team measured manometric height from the ground using 2 m of plastic hose, where necessary.

3) Inquiries were made about house-pumps and availability of piped water during interviews to the inhabitants.

4) Water sampled at each point was analyzed in terms of residual chlorine, coliform groups, and total bacteria.

5.3 Results of Survey

The result of survey is summarized in Table 5.1. The Team further identified the area where piped water was hardly available as shown in Figure 5.1.
Major findings through the present survey are itemized below.

1) At approximately 40% of the service area, piped water is not available in the day-time.

2) Water pressure in the distribution pipeline installed in the urban area is 0.2 kg/cm^3 at most.

3) In a part of the service area, water is not available at all unless extracted by pumping.

4) Coliform groups and total bacteria do not exceed the level of Indonesian standard for potable water, so far as Team's observation goes.

5) Residual chlorine contained in the water ranges from a low of 0.1 mg/l to a high of 0.3 mg/l at the new distribution network, whereas at the old distribution pipelines it does not exceed 0.05 mg/l and sometimes decreases to zero. It may be attributable to the fact that incrustation grown in the old pipes consumes considerable residual chlorine in the water.

5.4 Recommendation

Many households in the service area where water pressure is excessively low are likely to have house pumps to extract piped water easily. On the contrary, their neighbors who do not have any pumps are always suffering from water shortage.

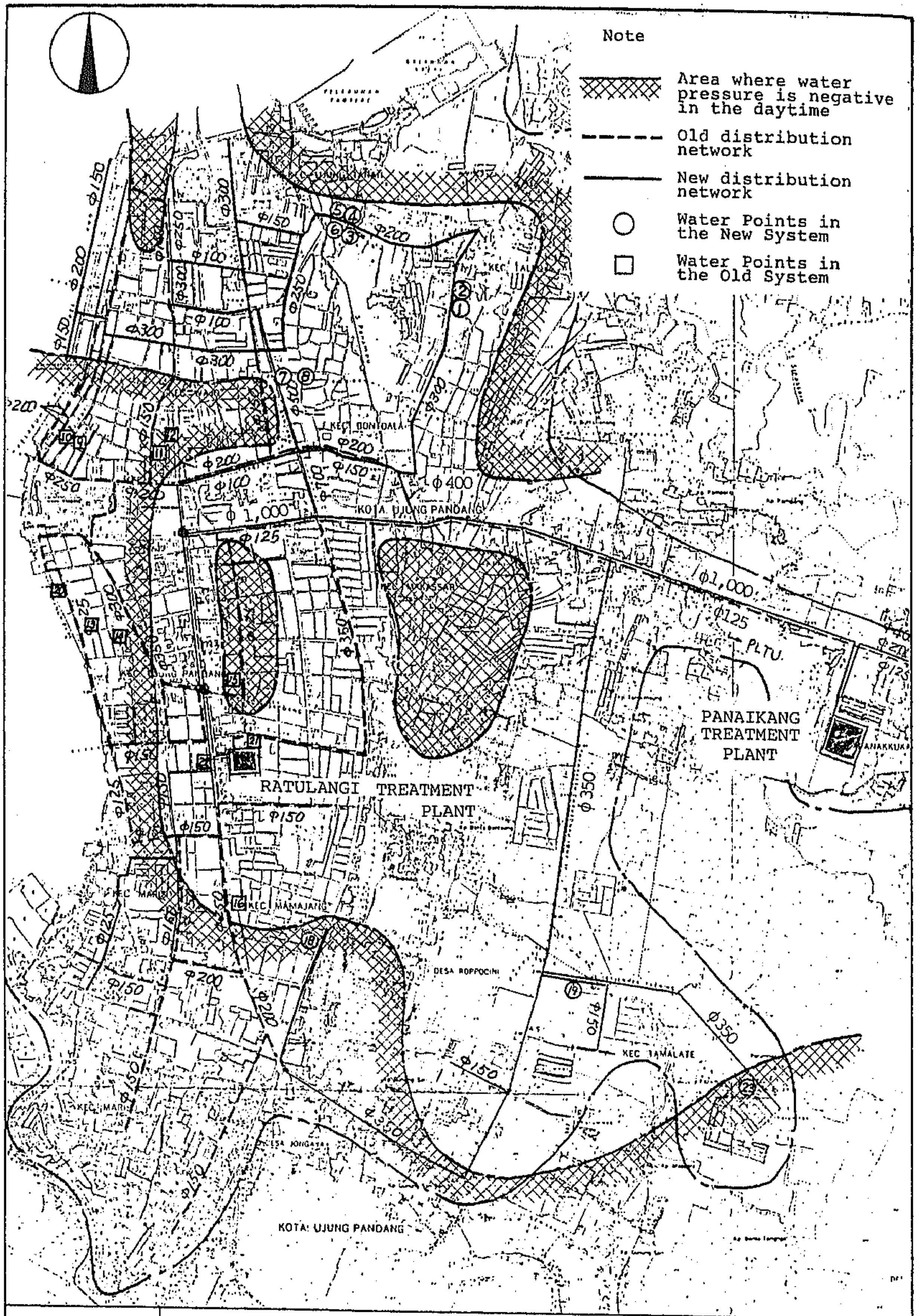
Pumping makes water pressure in the service pipes lower and sometimes affects even recording of meters in the neighborhood. Moreover, domestic waste water enters into the pipes through leakage points, as service pipes are usually laid in the ditch and gutter. Such occasions take place after heavy rain that are illustrated on Figure 5.2 . Under the circumstances, it is not desirable to install house pumps.

In the future water supply plan, rehabilitation of old distribution network should be carried out so as to improve the above situation as expeditiously as possible and treated water should be supplied in such high pressure that every household does not feel any necessity of using pumps.

TABLE 5.1 RESULT OF SURVEY

Sample No.	Old or New Pipelines	Diamater of Secondary Main	Installation of House Pump	Water Pressure	WATER QUALITY			Level of Availability 1/
					Residual Chlorine	Coli-Groups	Total Bacteria	
1	New	250 mm	NO	1.3 m	-	0/100 ml	0/ml	I
2	New	250 mm	NO	1.3 m	0.1 mg/l	-	-	I
3	New	200 mm	NO	1.0 m	-	0/100 ml	0/ml	II
4	New	200 mm	NO	1.8 m	0.25 mg/l	-	-	I
5	New	200 mm	NO	1.7 m	-	-	-	I
6	New	200 mm	NO	1.8 m	-	-	-	I
7	New	500 mm	NO	1.2 m	0.20 mg/l	0/100 ml	1/ml	II
8	New	500 mm	YES	-	-	-	-	I
9	Old	200 mm	NO	.0 m	-	-	-	II
10	Old	200 mm	NO	.0 m	-	-	-	II
11	Old	150 mm	YES	-	-	-	-	III
12	Old	150 mm	YES	-	-	-	-	III
13	Old	125 mm	YES	-	-	-	-	III
14	Old	300 mm	YES	-	0.05 mg/l	0/100 ml	0/ml	III
15	Old	125 mm	YES	-	0.05 mg/l	0/100 ml	0/ml	-
16	Old	250 mm	NO	1.0 m	0.05 mg/l	0/100 ml	2/ml	II
17	New	350 mm	-	-	-	-	-	I
18	New	350 mm	NO	.0 m	-	-	-	II
19	New	150 mm	NO	1.1 m	0.30 mg/l	0/100 ml	0/ml	I
20	Old	125 mm	YES	-	-	-	-	III
21	Old	-	-	-	-	-	-	-
22	Old	150 mm	NO	1.8 m	0.05 mg/l	0/100 ml	0/ml	-
23	New	350 mm	NO	0.5 m	-	-	-	II

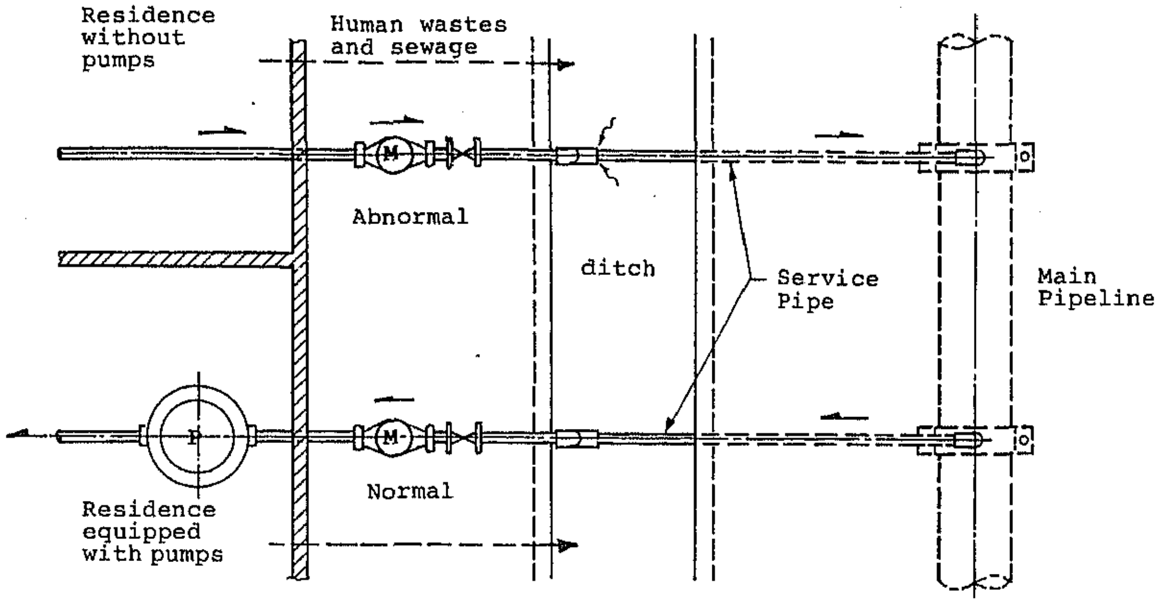
1/ : Level I means, piped water is available for 24 hours,
Level II shows intermittent supply, and
Level III means no water available at all times unless otherwise extracted by house pumps.



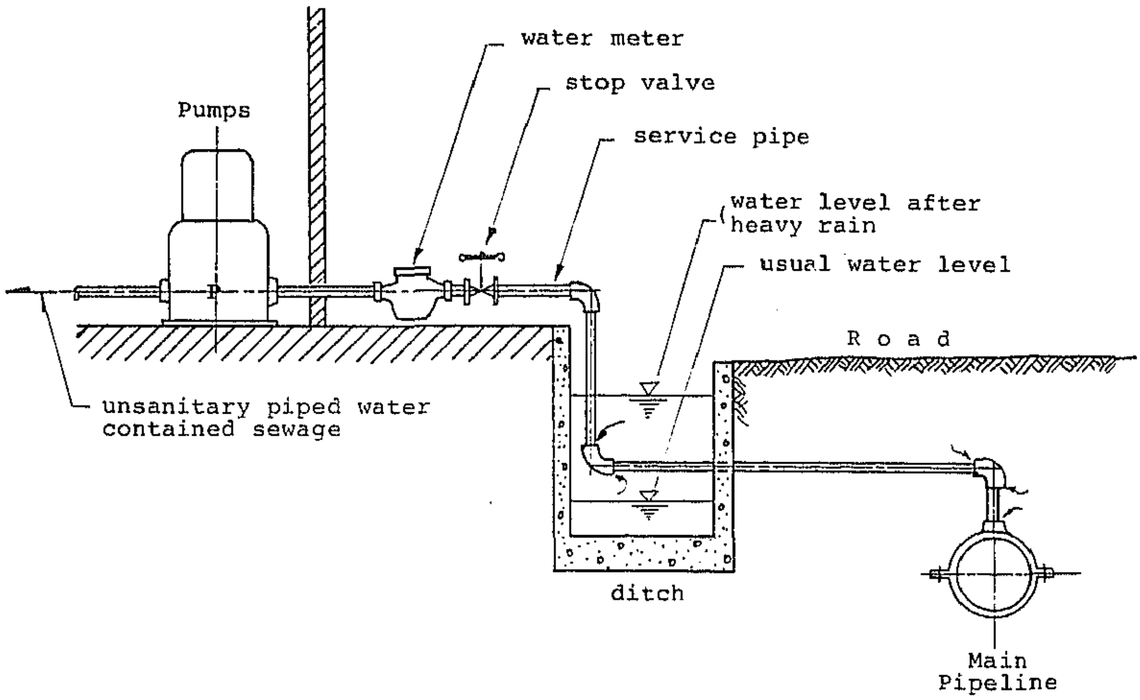
FIGURE

5.1

WATER PRESSURE DISTRIBUTION



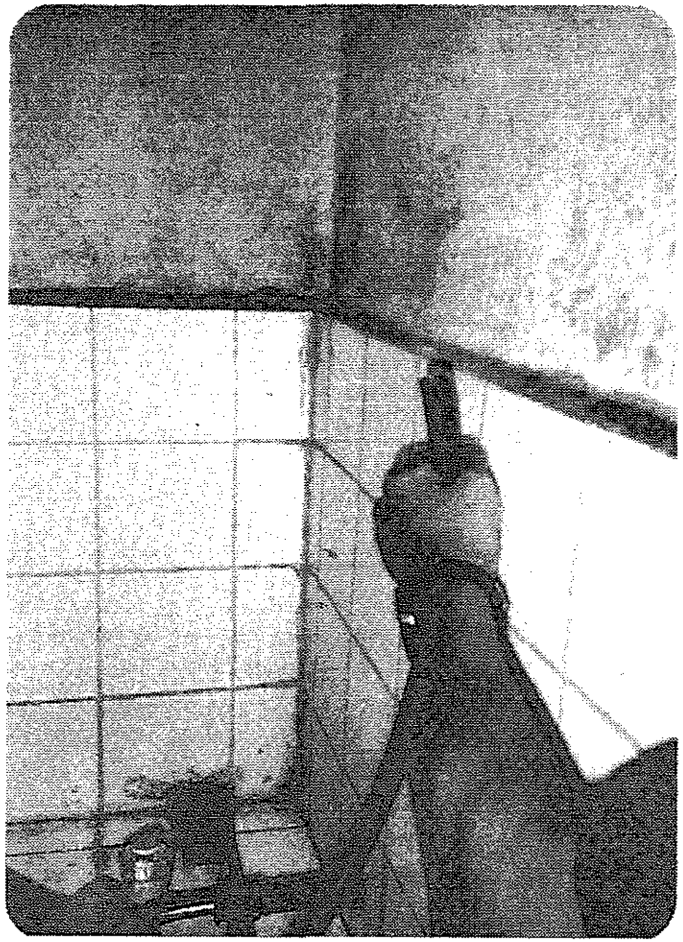
PLAN OF HOUSE CONNECTIONS



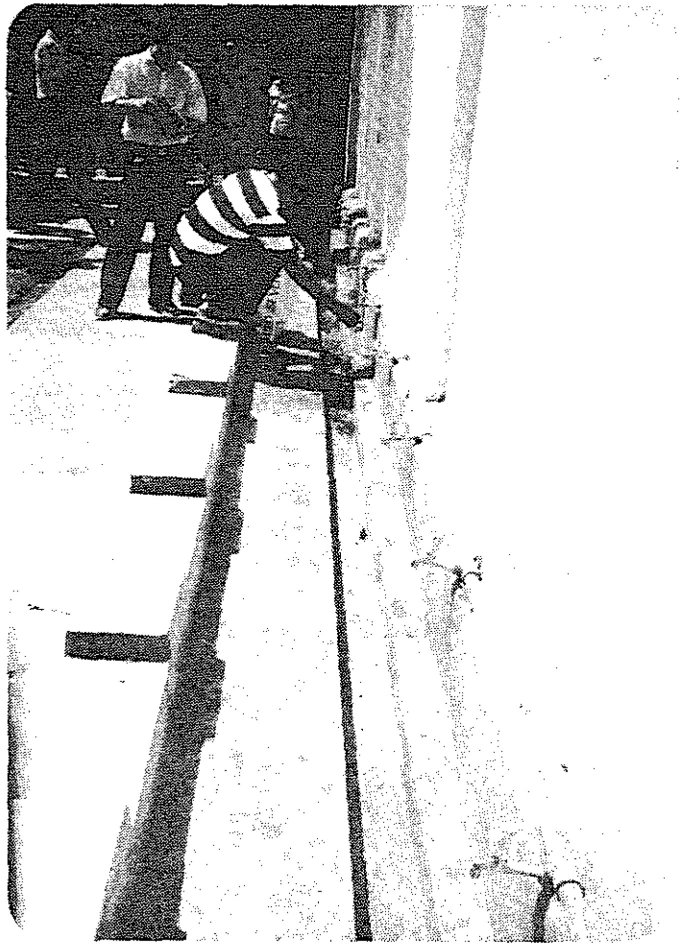
PROFILE OF HOUSE CONNECTION

FIGURE	INFLUENCE OF HOUSE PUMPS TO THE NEIGHBORS
5.2	

DIFFICULT PRESSURE GANGING
DUE TO EXTREMELY LOW WATER PRESSURE



WATER PRESSURE MEASUREMENT
USING PLASTIC HOSE



WATER TESTING AT IMPORTANT SAMPLING POINTS
(RESIDUAL CHLORINE,BACTERIA,COLIFORM,ETC.)

6. SURVEY ON UNACCOUNTED-FOR WATER

Unaccounted-for water in Kotamadya Ujung Pandang, as stated in the Master Plan Report, was in excess of 50 % of the total production in 1983. The reduction of the unaccounted-for water is therefore a primary requisite for proper water supply for the citizens and sound management of the waterworks.

6.1 Objective of Survey

The objective of the present survey is to obtain figures/percentages of categorized unaccounted-for water to be used for loss reduction activities.

6.2 Survey Method

In the present survey, the volume of unaccounted-for water was classified into the following five categories, which are considered appropriate in view of the present supply conditions in the city:

1) Meter error.
2) Illegal use.
3) Billing loss (Malfunctioning of meters).
4) Public use.
5) Leakage.

In order to estimate the percentages of unaccounted-for water by these categories, the existing data obtained previously and new data obtained by the present survey were used, as shown in Table 6.1. Leakage was assumed as a balance between the total unaccounted-for water and summation of 1) to 4).

The survey was carried out in the manner shown in Figure 6.1, sampling about 100 points, on 25th and 26th June 1985 at the sites which were selected by map study and pre-site observation. (See Figure 6.2).

1) Selection of Sites

The sites for preliminary field reconnaisance that show typical patterns of water usage, were carefully selected with reference to i) maps of billing blocks called "Wilayah", ii) drawings of distribution pipelines, and iii) data of billed consumption classified by Wilayah. Some of the survey sites were located in the old distribution networks, and others in the newly-developed distribution networks.

2) Preliminary Field Reconnaissance

A preliminary reconnaissance on the sites was carried out and the sites for the actual survey were selected considering the following:

- whether houses of different kinds are rather uniformly composed and household income are on an average level.

- Whether the areal distribution of meter brands coincides with the records of PDAM.

- Whether the sites are supplied with sufficient water pressure for meter error test.

3) Survey

Survey was carried out by conducting a questionnaire interview with individual consumers. The interview was made separately by four groups which consist of a Team member and a staff of PDAM. Besides, inspection of meters and survey of illegal connections were conducted. The accuracy of working meters were tested by comparison of meter measurements with the volumes of water discharged into a bucket through a plastic hose for a fixed duration of time measured by a stop watch.

6.3. Results of Survey

From the results of the previous household survey and the data obtained by the current survey, the following facts were found.

6.3.1 Meter Error

The meter test resulted as shown in Figure 6.3 that meter error gets larger when supply pressure reduces.

In view of the supply condition that most areas in the city are presently supplied with comparatively low pressure, the total volume of meter errors is assumed to be considerable. In the future when pumping supply is provided with a normal level of pressure, such meter error is considered to reduce.

In this study, unaccounted-for water resulting from meter errors is estimated at 3 % of the total production, taking into consideration the present supply pressure and the study results given in Section 5. WATER PRESSURE IN THE DISTRIBUTION NETWORK of CHAPTER VI.

6.3.2 Illegal Connections

The Team found no examples of illegal connections during the current survey. However, judging from data of PDAM, the consumption by illegal connections is tentatively assumed to stand at around 2 to 5 % of the total production.

6.3.3. Billing Loss

The inspection of 102 water meters revealed that 80 % (81 meters) of the total were functioning normally, and 20 % (21 meters) out of order or service, as shown in Figure 6.4.

It was found that the average per capita consumption of consumers with functioning meters was 115 lcd, while that of those with malfunctioning meters was 94 lcd, namely 18 % smaller than the former.

In this study, water of billing loss due to malfunctioning meters was assumed to be 3 % of the total production, when the number of unmetered consumers were taken into consideration (11 % of total consumers).

6.3.4. Public Use

According to PDAM's record in 1984, the percentage of public water use including fire fighting water, gardening water, etc. amounted to 0.2 % of the total production. This figure is negligible.

6.3.5. Leakage

Based on the figures estimated above, the percentage of leakage is calculated as below:

Leakage (%) = (Total amount of unaccounted-for water) - ((Meter error) + (Illegal connection) + (Billing loss) + (Public use))
= 50 % - (3% + 2 to 5% + 3% + (-))
= 39 to 42 %

Leakage thus assumed stands at 39 to 42 % of the total production.

6.3.6 Other Findings

Besides the above results, following problems were found during the present field survey.

1) Improper meter installation causes troubles such as difficulty in meter reading, meter submerged in sewage, etc.

2) Meters inversely run due to direct pumping by neighbours.

3) Some consumers complain PDAM's poor maintenance service. PDAM dose not swiftly deal with their request for the repair work of leaks at the service connections.

4) Poor service of water supply causes consumers' poor sense of duty to pay water charge.

5) Some cross-connections were observed between the service connection pipe and private shallow well pipe, which may possibly cause contamination of piped water.

6.4 Conclusion and Recommendation

6.4.1 Conclusion

The current survey revealed that unaccounted-for water was composed as shown in Table 6.3. This table indicates that water loss by leakage accounts for about 80 percent of unaccounted-for water. A large portion of treated water is being lost as leakage. This result is similar to that shown in the Master Plan report which was obtained on the basis of the household survey during the former study period.

TABLE 6.3 BREAKDOWN OF UNACCOUNTED-FOR WATER

Category	Percentage of Production
1) Meter Error	3 %
2) Illegal use	2 to 5 %
3) Underestimation	3 %
4) Public use	-
Subtotal 1)-4)	8 to 11 %
5) Leakage	39 to 42 %
Total 1)-5)	50 %

6.4.2 Recommendation

The most effective countermeasure to reduce unaccounted-for water to the target figure of 20 % of the total production is reduction of leakage. Stress, therefore, is to be put on leakage abatement.

Measures to reduce leakage are proposed hereunder considering its location: 1) leakage at service pipes and meters, and 2) leakage at distribution pipelines.

1) Measures for service pipes and meters

i) To provide for, in the regulation, the responsibility of PDAM for repair work of service pipe and meter, and to establish a section for this work in the PDAM organization.

ii) To detect leaks by periodical patrol of members of the above-said secton.

iii) To encourage customers to bring in complaints, whereby PDAM can get information on water supply conditions.

iv) To carry out leak repair or replacement of service pipe as required.

2) Measures for distribution pipes and their accessories

i) To replace old distribution pipes installed in 1920's with new ones.

ii) To organize a section taking charge of survey, planning, patrol and repair work for leakage prevention in PDAM.

iii) To conduct regular patrol for leak detection in the service area.

iv) To start supplying water by pumps with sufficient pressure so as to improve supply conditions and to make the leakage reduction easy.

v) To isolate the service mains from trunk/secondary mains by control valves.
By this measure, water pressure of each isolated block can be controlled, and further the area to be affected by water suspension during repair work will be minimized.

Measures to reduce unaccounted-for water due to causes other than leakage are listed below.

1) Measures related to meter

i) To give colored painting to meters showing the year installed and repaired.

ii) To install meters horizontally in appropriate positions taking into account the following points:

- Easiness to reading and inspection
- Protection from soiled water
- Position of meter, which can prevent air accumulation

iii) To procure meters based on the periodical meter testing.

iv) To reduce meter underregistration by keeping sufficient pressure.

2) Measures to prevent from illegal water use

i) To establish regulations against illegal connections.

ii) To install meters in meter boxes.

iii) To patrol periodically.

In enforcement of all the above measures, it is of vital importance to keep records on where and when trouble happened, how repairs were made, and others. By analysing the records, a priority area of activities can be decided. To achieve the loss reduction target as early as possible, the above approach is essential.

TABLE 6.1 SURVEY ITEM

Survey Item / Category of Unaccounted-for Water	Present Survey					Previous Survey	
	Meter Error Test	Meter Inspection	Interview to Consumer	Check of Billing Table	Interview to PDAM	Household Survey	Water Pressure in the Distribution Network
(1) Meter Error	○						○
(2) Illegal Connection		○					
(3) Billing Loss by Underestimation		○	○	○		○	
(4) Public Water Use					○		

Note 1 : refer to '1. HOUSEHOLD SURVEY'
2 : refer to '5. WATER PRESSURE IN THE DISTRIBUTION NETWORK'

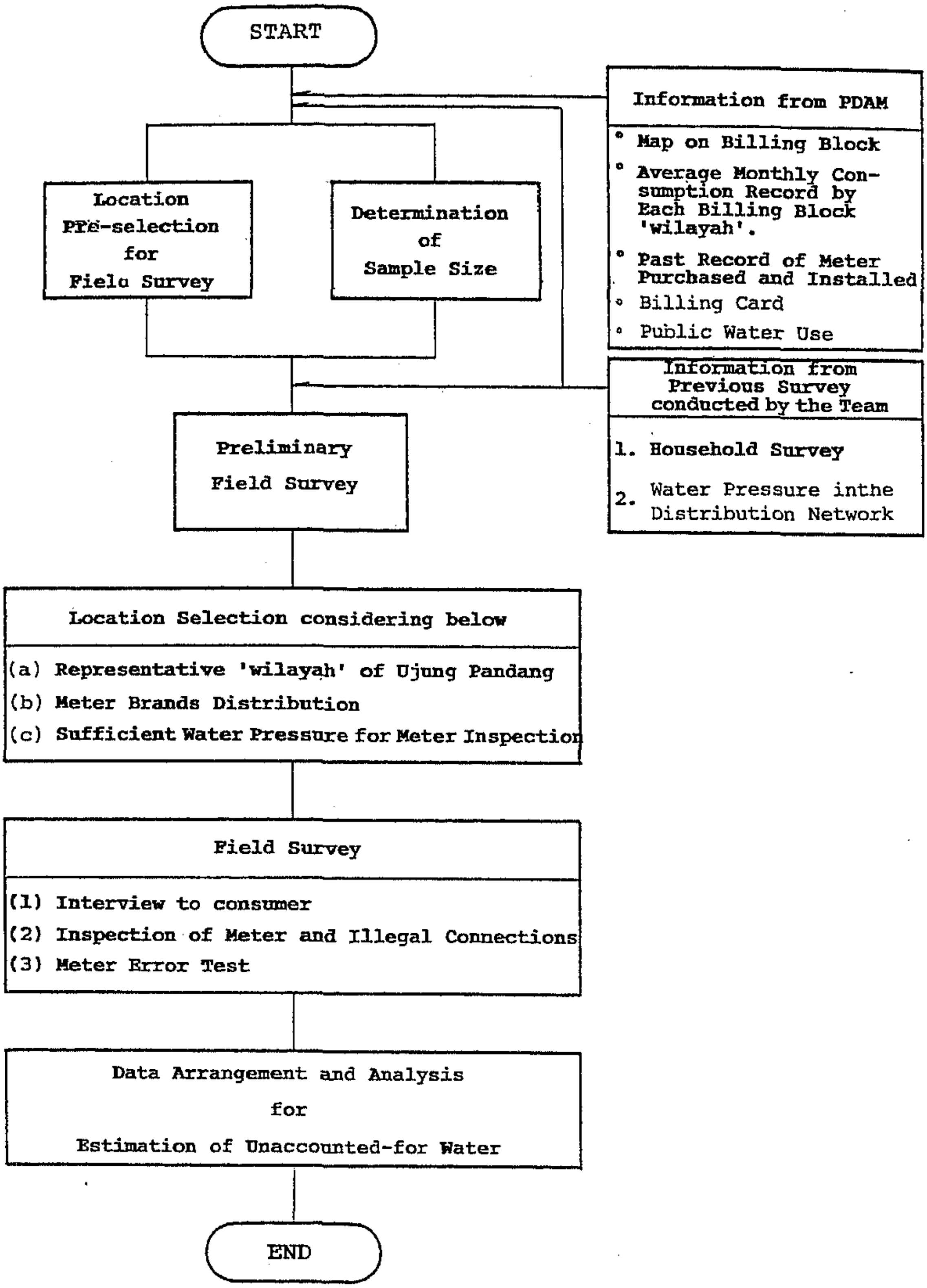


FIGURE 6.1	FLOW CHART OF FIELD SURVEY

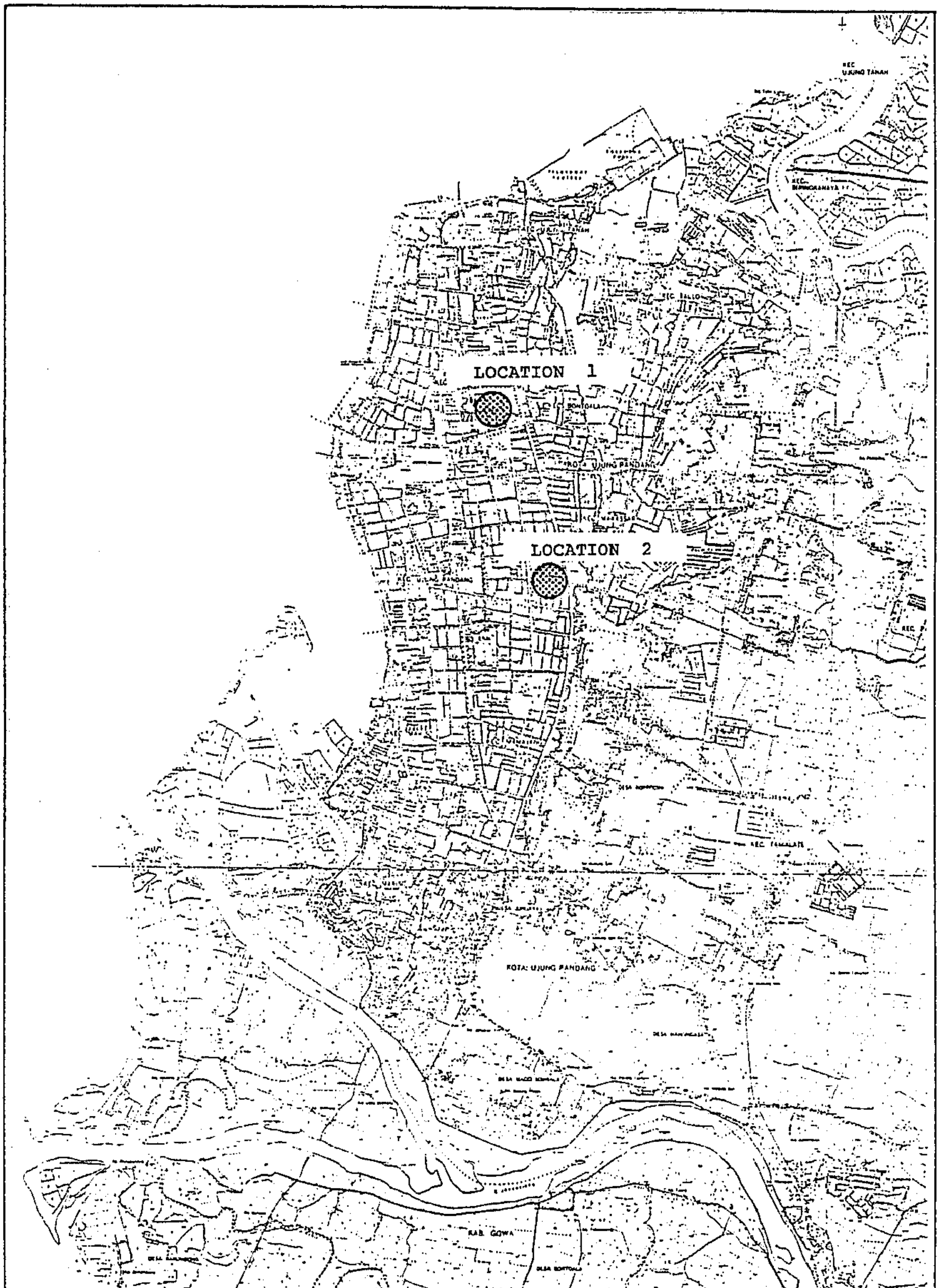


FIGURE	MAP OF SURVEY LOCATION
6.2	

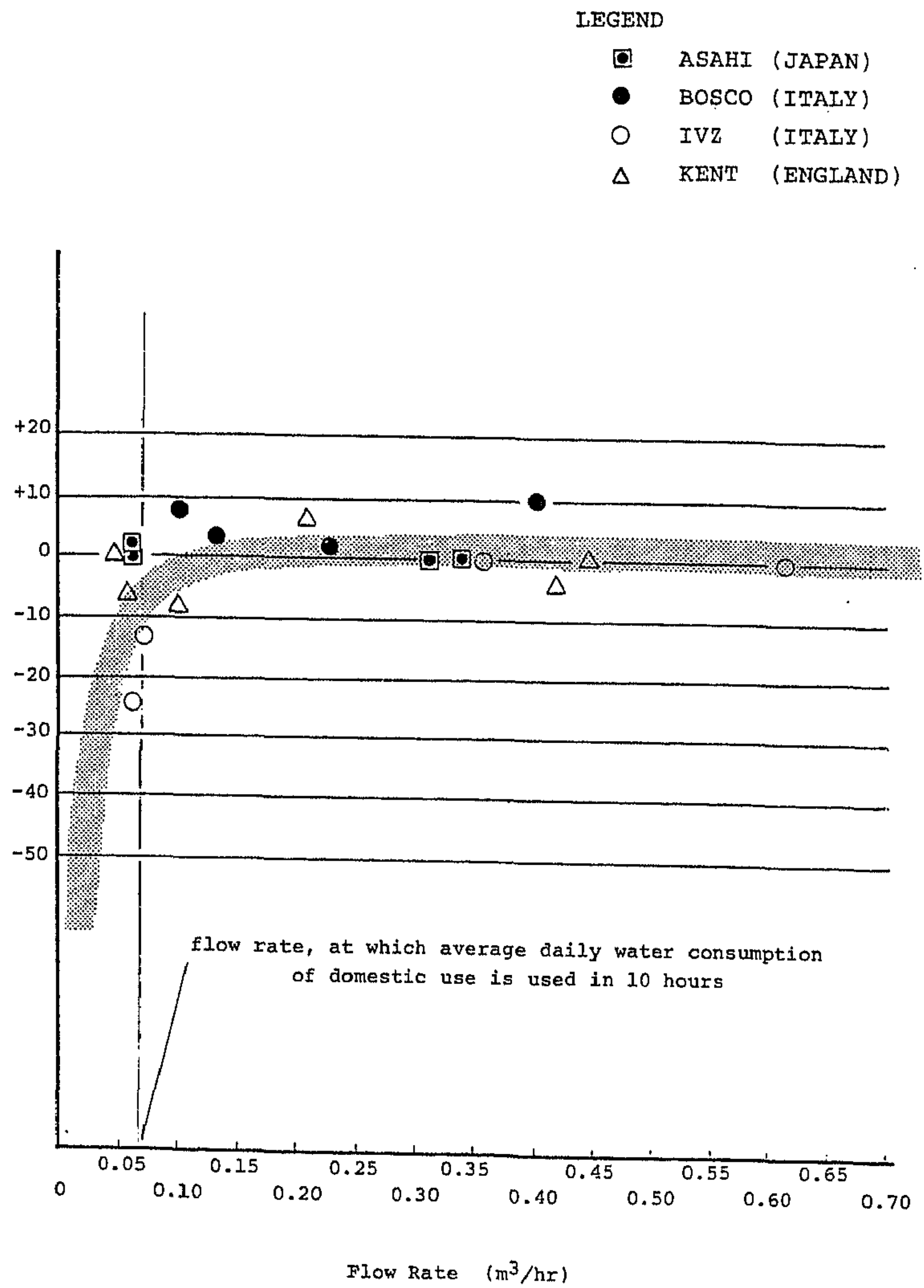
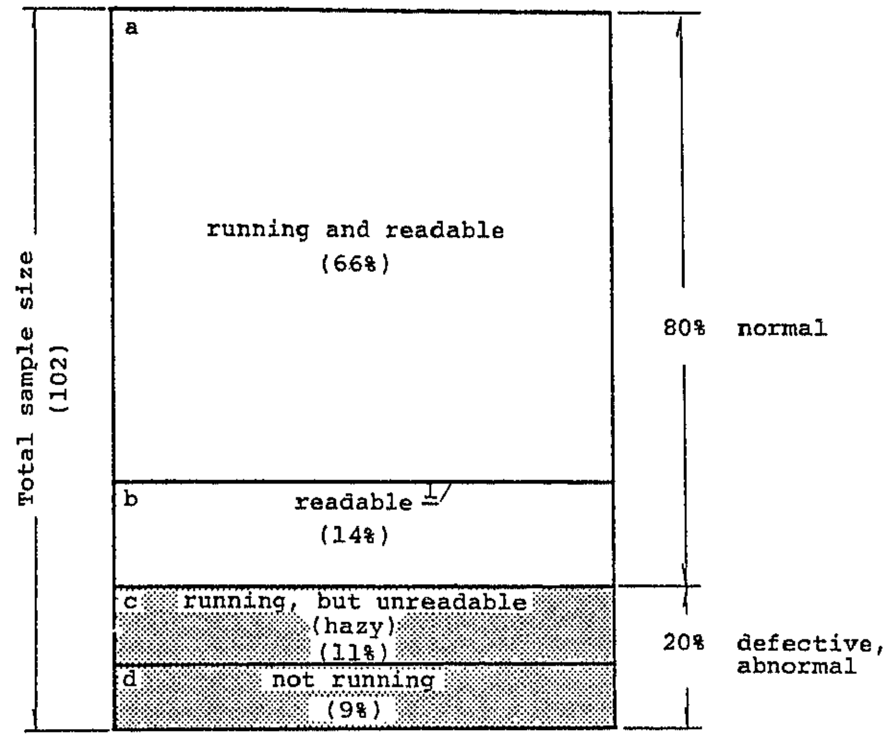
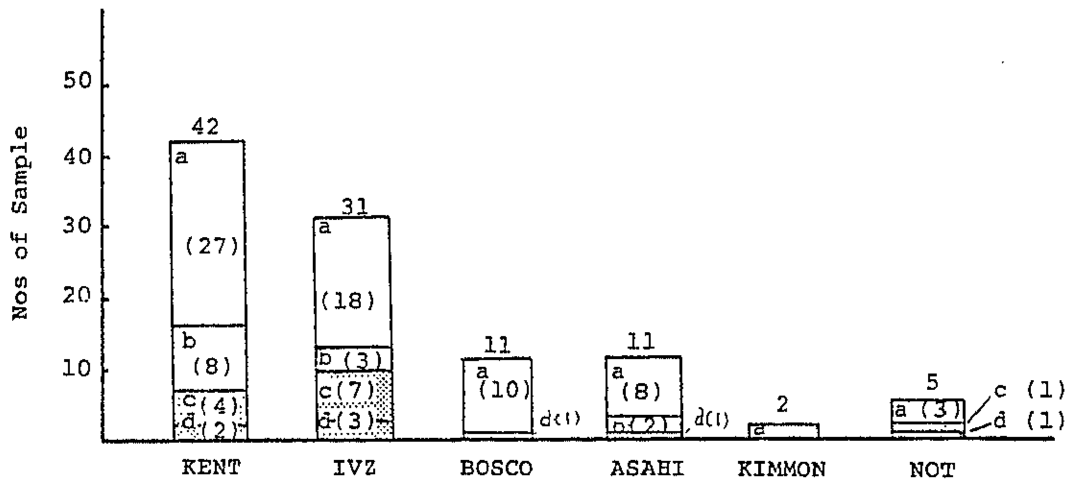


FIGURE	METER ERROR CURVE ($^1/_2$" in diameter)
6.3	



(a) General

Note 1/: Although consumer said "running", "running" could not ensured due to low water pressure.



(b) Difference in Brands

FIGURE	PRESENT CONDITION OF EXISTING WATER METER
6.4	

TABLE 6.2 UNDERESTIMATION BY METER READER

Survey Area	(1) Unit Consumption in Normal Reading	(2) Unit Consumption by Meterreader's estimate	(3)=((2)-(1))/(1) Underestimation
	lcd	lcd	%
LOCATION (NEW SYSTEM)	100	80	-20
LOCATION (NEW SYSTEM)	129	107	-17
MEAN	115	94	-18

Appendix

QUESTIONNAIRE

1. Identification of Consumer

Check Column

(1) Name : ____________________ ☐

(2) Address : No.__ Jl.__________ ☐

(3) Consumer Code: ____________________ ☐

(4) Billing Block: ____________________ (Wilayah) ☐

(5) House Type : a. Permanent ☐

b. Semi Permanent

c. Temporary

(6) Number of family members : _____ ☐

(7) Supply PDAM water to neighbors? ☐

a. Yes ⟶ (8)

b. No ⟶ 2

(8) Number of families : _____ ☐

2. Inspection 1 : Whether a water meter exists or not? ☐

a. Exists (Brand: Dia. :) ⟶ 3

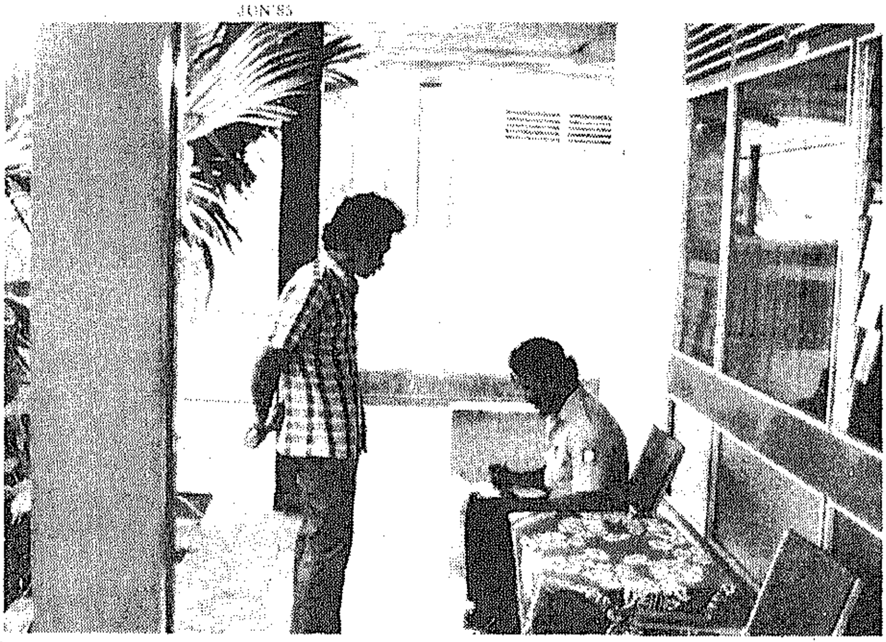
b. No ⟶ 4

3. Inspection 2 : The meter is functioning ? ☐

a. Functioning ⟶ (Meter Error Test)

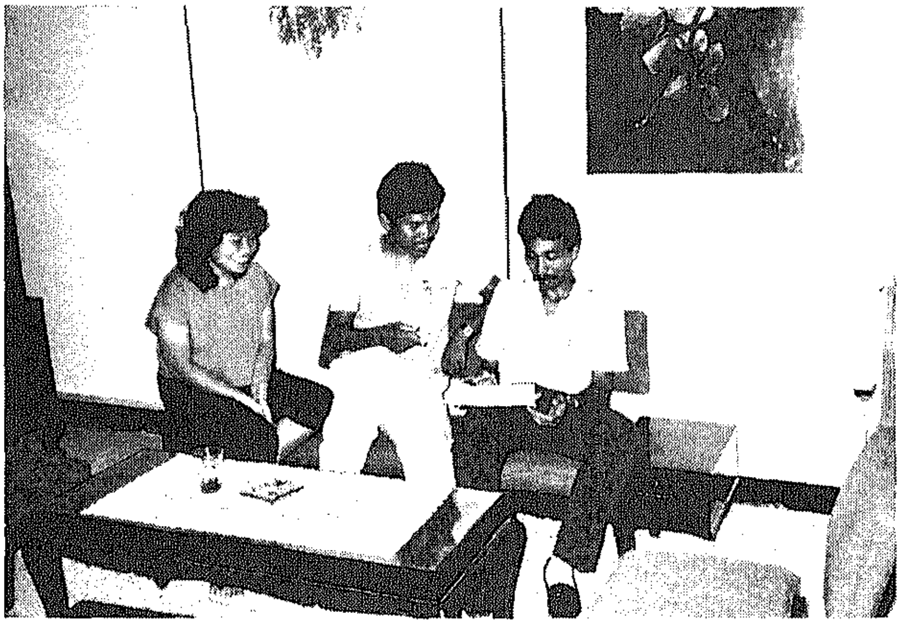
b. Not Functioning ⟶ 4

4. Check Answers OK? ⟶ END ☐

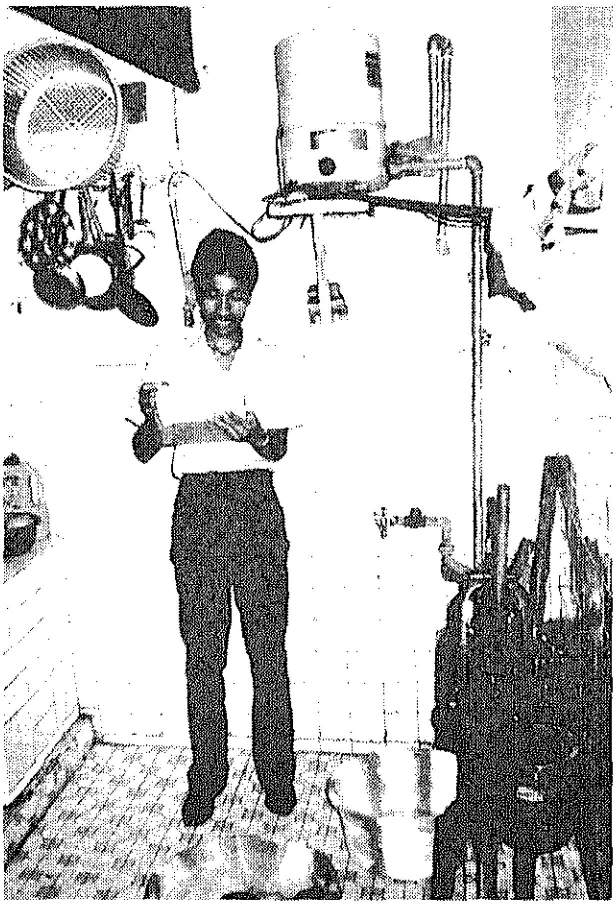


INTERVIEW TO HOUSEHOLD
(BY PDAM STAFF AND THE STUDY TEAM MEMBER)

INTERVIEW TO HOUSEHOLD
(BY PDAM STAFF AND THE STUDY TEAM MEMBER)

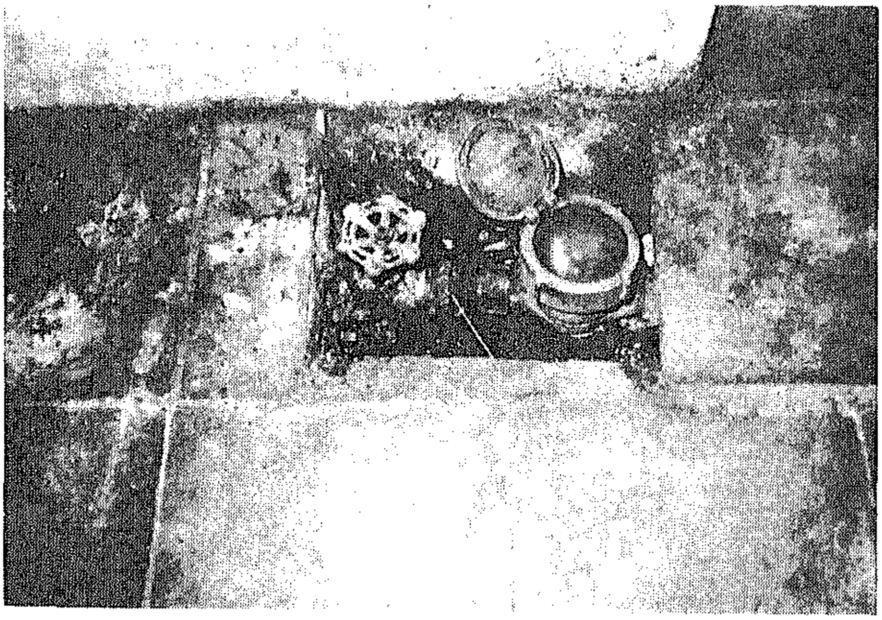


INTERVIEW TO HOUSEHOLD
(BY PDAM STAFF AND THE STUDY TEAM MEMBER)



INTERVIEW TO HOUSEHOLD
(BY PDAM STAFF AND THE STUDY TEAM MEMBER)

APPROPRIATE METER PROTECTION



METER INSTALLED INSIDE RESIDENCE

JICA