5. STUDY ON IMPROVEMENT OF WATER QUALITY

STUDY ON IMPROVEMENT OF WATER QUALITY

CONTENTS

1. PURPOSE

As described in **Section 3.1** " BASIC POLICY AND STRATEGY" of the Main Report supply of drinkable water is one of key issues of the master plan for Jakarta water supply system. The purpose of this study is, in order to realize the above, to propose improvement of water quality for the existing water supply system and to also propose qualitative consideration on future water supply system.

2. QUALITY STANDARD

2.1 THE EXISTING STANDARD

There are several standards on water quality in Indonesia. They are the standards issued by, 1) Secretary of the President for Population and Environment, 2) Ministry of Health, and 3) DKI Jakarta.

Firstly, environmental standard of water quality was issued by the Secretary with four categories as listed in the **Table-2.1** in June, 1990 reviewing the existing standard so far.

After careful research of the above standard and considering current practices of water supply in the country, Ministry of Health issued quality standard for water supply with four categories in September, 1990. As shown on the **Table-2.2**, Category A "Potable water" of Secretary's standard is classified into two categories in the Ministry's standard, namely potable and clean water . Other two standards for swimming pools and public bathes are omitted in the table.

The potable water of Ministry's standard is applied for finished water of treatment plants in big cities, and the clean water, drinkable after boiling, is applied for tap water in big cities and for both finished and tap water in other areas. The Ministry intends to revise the standard in next year considering WHO guidelines .

To each city/area, the Ministry recommends to issue its own standard referring to the above two standards. Jakarta city on the basis of the Secretary's standard, prepared and issued quality standard in June, 1995 as described in the **Table-2.3.**

Tentatively PAM JAYA is applying Ministry's standard not DKI's standard despite that it is an organization of Jakarta city, considering present conditions of raw water, water supply system and quality monitoring.

However, even quality of tap water of Jakarta water supply system is satisfied with the standard II "Clean Water" of the Ministry, it is not regarded as drinkable considering magnitude of allowable limit of such quality parameters as turgidity, color, detergent etc. Every water tap in Jakarta city shall be satisfied with the standard I "Potable Water" in the future, so as to obtain reliability of Jakarta water supply system by consumers, citizen of the city.

2.2 COMPARISON OF QUALITY STANDARD

WHO recommended the following when establishing the drinking water guideline for 1993. The water quality standard for drinking water should be established to ensure a desirable level for drinking water and dis-satisfied water will not directly harm the people who take it. Also this standard has established as a signal to prepare a methodology to maintain the desirable level.

Hence, improvement of Category I "Potable Water" of quality standards by Ministry of Health as listed in the **Table-2.2** is discussed comparing with WHO guideline for drinking water.

The quality standard consists of physical parameters, inorganic chemical parameters, organic chemical parameters, microbiological parameters and radiological parameters. All other parameters than inorganic chemical parameters have not much necessity for improvement, for values of parameters are almost same level as WHO guideline. However, it is considered appropriate to improve values of two parameters such as arsenic (As) and lead (Pb) among inorganic parameters.

Table-2.1 WATER QUALITY STANDARD BY SECRETARY OF PRESIDENT

No.	Quality Items	Parameter	Unit	Category A	Category B	Category C	Category D
	A.FISIKA	A.Physical					
1	Bau	Odor	-	Unobjectionable	-	-	-
2	Zat padat terlarut(TDS)	Total disolve solid	mg/L	1000	1000	1000	2000
			Skala	5	-	-	-
3	Kekeruhan	Turbidity	NTU				
4	Rasa	Tasted	-	Unobjectionable	-	-	-
5	Suhu	Temperature		Air temperature +-3C	Suhu air normal	Suhu air normal +-3C	Suhu air normal
			Skala	15	-	-	-
6	Warna	Color	TCU				
7	Daya hantar listrik	umhos/cm(25C)	-	-	-	-	2250
	B.KIMIA	B.Chemical					
	a.Kimia Anorganik	a.Unorganic chemical					
1	Air raksa	Mercury	mg/L	0.001	0.001	0.002	0.005
2	Amoniak Bebas	NH4-N	mg/L	-	0.5	0.020	1
3	Aluminium	AL	mg/L	0.2	-	-	-
4	Arsen	As	mg/L	0.05	0.05	1.0	-
5	Barium	Ba	mg/L	1.0	1.0	-	-
6	Besi	Fe	mg/L	0.3	5.0	-	-
7	Flourida	F	mg/L	0.5	1.5	1.50	-
8	Boron	B	mg/L	-	-	-	1
9	Kadmium	Cd	mg/L	0.005	0.01	0.010	0.010
10	Kesadahan CaCO3	Hardness(CaCO3)	mg/L	500			-
11	Klorida	CL	mg/L	250	600		
12	Kobalt	Co	mg/L				0.2
13	Kromium Valensi 6	Cr-6	mg/L	0.05	0.05	0.05	1.0
14	Mangan	Mn	mg/L	0.1	0.5		2.0
15	Natrium	Na	mg/L	200			60.0
16	Nitrat,sebagai N	NO3	mg/L	10	10		
17	Nitrit,sebagai N	NO2	mg/L	1.0	1.0	0.060	
18	Perak	Ag	mg/L	0.05			
19	Nikel	Ni	mg/L				0.5
20	Oksigen terlarut	DO	mg/L		6	-	
21	pH	pH		6.5-8.5	5-9	6.0-9.0	5.0-9.0
22	Selenium	Se	mg/L	0.01	0.01	0.050	0.050
23	Seng	Zn	mg/L	5	5	0.020	2.0
24	Sianida	SN	mg/L	0.1	0.1	0.020	
25	Sulfat	SO4	mg/L	400	400		
26	Sulfida,sebagai H2S	H2S	mg/L	0.05	0.1	0.002	
27	Sodium Absorption Ratio(SAR)		mg/L				18
28	Tembaga	Cu	mg/L	1.0	1.0	0.020	0.20
29	Timbal	Pb	mg/L	0.05	0.1	0.030	1
30	Residual Sodium Carbonat(RSC)		ml/L				1.25-2.50
	b.Kimia Organik	b.Organic chemical					
1	Aldrin dan dieldrin		mg/L	0.0007	0.017		
2	Benzene		mg/L	0.01			
3	Benzo (a) pyrene		mg/L	0.00001			
4	Chlordane (total isomer)		mg/L	0.0003	0.003		
5	Chloroform		mg/L	0.03			
6	2,4-D		mg/L	0.10			
7						0.21	
8	DDT		mg/L	0.03	0.042	0.002	
9	Detergen		mg/L	0.5			
10	1,2 Dichloroethane		mg/L	0.01			
11	1,1 Dichloroethene		mg/L	0.0003			
12	Endrine		mg/L		0.001	0.004	
13	Fenol		mg/L		0.002	0.001	
14	Heptachlor dan heptachlor epoxide		mg/L	0.003	0.018		
15	Karbon Kloroform Ekstrak		mg/L		0.5		
16	Hexachlorobenzene		mg/L	0.00001			
17	Gamma-HCH(Lindane)		mg/L	0.004	0.056		
18	Methoxychlor		mg/L	0.03	0.035		
19	Minyak dan Lemak		mg/L		ND	1.0	
20	Organofosfat dan Carbamate		mg/L		0.1	0.10	
21	PCB		mg/L		ND		
22	Senyawa Aktif Biru Metilen		mg/L		0.5	0.20	
23	Toxaphene		mg/L		0.005		
24	Pentachlorophenol		mg/L	0.01	-		
25	Pestisida total		mg/L	0.10	-		
26	2,4,6-Trichlorophenol		mg/L	0.01	-		
27	Zat Organik(KMnO4)		mg/L	10	-		
	Microbiologi		jumlah/100ml		-		
1	Koliform bnja	Fecal coliform	jumlah/100ml	0	2000		
2	Total Koliform(MPN)	Total coliform	jumlah/100ml	3	10000		
	Radioactivitas						
1	Aktivitas Alpha(Gross Alpha Activity)		Bq/L	0.1	0.1	0.10	0.10
2	Aktivitas Beta(Gross Beta Activity)		Bq/L	1	1	1.0	1.0

Table-2.2 WATER QUALITY STANDARD BY MINISTRY OF HEALTH

No.	Quality Items	Parameter	Unit	Ministry of Health	
				Potable water	Clean water
	A.FISIKA	A.Physical			
1	Bau	Odor	-	Unobjectionable	
2	Zat padat terlarut(TDS)	Total disolve solid	mg/L	1000	1500
3	Kekeruhan	Turbidity	Skala NTU	5	25
4	Rasa	Tasted	-	Unobjectionable	
5	Suhu	Temperature		Air temperature +-3C	Air temperature +-3C
6	Warna	Color	Skala TCU	15	50
	B.KIMIA	B.Chemical			
	a.Kimia Anorganik	a.Unorganic chemical			
1	Air raksa	Mercury	mg/L	0.001	0.001
2	Aluminium	AL	mg/L	0.2	-
3	Arsen	As	mg/L	0.05	0.05
4	Barium	Ba	mg/L	1.0	-
5	Besi	Fe	mg/L	0.3	1.0
6	Flourida	F	mg/L	1.5	1.5
7	Kadmium	Cd	mg/L	0.005	0.005
8	Kesadahan CaCO3	Hardness(CaCO3)	mg/L	500	500
9	Klorida	CL	mg/L	250	600
10	Kromium Valensi 6	Cr-6	mg/L	0.05	0.05
11	Mangan	Mn	mg/L	0.1	0.5
12	Natrium	Na	mg/L	200	-
13	Nitrat,sebagai N	NO3	mg/L	10	10
14	Nitrit,sebagai N	NO2	mg/L	1.0	1.0
15	Perak	Ag	mg/L	0.05	-
16	pH	pH		6.5-8.5	6.5-9.0
17	Selenium	Se	mg/L	0.01	0.01
18	Seng	Zn	mg/L	5	15
19	Sianida	SN	mg/L	0.1	0.1
20	Sulfat	SO4	mg/L	400	400
21	Sulfida,sebagai H2S	H2S		0.05	-
22	Tembaga	Cu		1.0	-
23	Timbal	Pb	mg/L	0.05	0.05
	b.Kimia Organik	b.Organic chemical			
1	Aldrin dan dieldrin		mg/L	0.0007	0.0007
2	Benzene		mg/L	0.01	0.01
3	Benzo (a) pyrene		mg/L	0.00001	0.00001
4	Chlordane (total isomer)		mg/L	0.0003	0.007
5	Chloroform		mg/L	0.03	0.03
6	2,4-D		mg/L	0.10	0.10
7	DDT		mg/L	0.03	0.03
8	Detergen		mg/L	0.05	0.5
9	1,2 Dichloroethane		mg/L	0.01	0.01
10	1,1 Dichloroethene		mg/L	0.0003	0.0003
11	Heptachlor dan heptachlor epoxide		mg/L	0.003	0.003
12	Hexachlorobenzene		mg/L	0.00001	0.00001
13	Gamma-HCH(Lindane)		mg/L	0.004	0.004
14	Methoxychlor		mg/L	0.03	0.1
15	Pentachlorophenol		mg/L	0.01	0.01
16	Pestisida total		mg/L	0.10	0.10
17	2,4,6-Trichlorophenol		mg/L	0.01	0.01
18	Zat Organik(KMnO4)		mg/L	10	10
	Microbiologi				
1	Koliform tinja	Fecal coliform	jumlah/100ml	0	50
2	Total Koliform(MPN)	Total coliform	jumlah/100ml	0	10
	Radioactivitas				
1	ktivitas Alpha(Gross Alpha Activity)		Bq/L	0.1	0.1
2	Aktivitas Beta(Gross Beta Activity)		Bq/L	1	1

Table-2.3 WATER QUALITY STANDARD BY DKI JAKARTA

No.	Quality Items	Parameter	Unit	Category A	Category B	Category C	Category D
	A.FISIKA	A.Physical					
1	Bau	Odor	-	Unobjectionable	-	-	-
2	Zat padat terlarut(TDS)	Total dissolve solid	mg/L	1000	500	-	1000
3	Kekeruhan	Turbidity	Skala NTU	5	-	-	-
4	Rasa	Tasted	-	Unobjectionable	-	-	-
5	Suhu	Temperature	-	Air temperature +-3C	Air temperature +-3C	Suhu air normal +-3C	Suhu air normal
6	Warna	Color	Skala TCU	15	-	-	-
	Daya hantar listrik	umhos/cm(25C)					1000
	B.KIMIA	B.Chemical					
	a.Kimia Anorganik	a.Unorganic chemical					
1	Air raksa	Mercury	mg/L	0.001	0.0005	0.002	0.0005
	Amoniak Bebas	NH3-N	mg/L		0.5	0.020	
2	Aluminium	AL	mg/L	0.2	-		
3	Arsen	As	mg/L	0.05	0.05	0.500	0.050
4	Barium	Ba	mg/L	1.0	1.0		
5	Besi	Fe	mg/L	0.3	2.0		
6	Flourida	F	mg/L	0.5	1.5	1.50	
	Boron	B	mg/L				1
7	Kadmium	Cd	mg/L	0.005	ND	0.010	0.010
8	Kesadahan CaCO3	Hardness(CaCO3)	mg/L	500			
9	Klorida	CL	mg/L	250	250	0.003	
	Kobalt	Co	mg/L				0.02
10	Kromium Valensi 6	Cr-6	mg/L	0.05	ND	ND	0.050
11	Mangan	Mn	mg/L	0.1	0.5		1.0
12	Natrium	Na	mg/L	200	-		63.0
13	Nitrat,sebagai N	NO3	mg/L	10	5		
14	Nitrit,sebagai N	NO2	mg/L	1.0	0.1	0.060	
15	Perak	Ag	mg/L	0.05	-		
	Nikel	Ni	mg/L				0.05
	Oksigen terlarut		mg/L		6	3	
16	pH	pH	-	6.5-8.5	6-8.5	6.0-8.5	6.0-9.5
	Residual Sodium CArbonat RSC)		ml/L				1.25-2.50
17	Selenium	Se	mg/L	0.01	0.01	0.050	0.050
18	Seng	Zn	mg/L	5	9	0.020	1.0
19	Sianida	SN	mg/L	0.1	0.05	0.010	
20	Sulfat	SO4	mg/L	400	50		
21	Sulfida sebagai H2S	H2S		0.05	0.1	0.002	
	Sodium Absorption Ratio(SAR)		mg/L				10
22	Tembaga	Cu		1.0	0.05	0.020	0.10
23	Timbal	Pb	mg/L	0.05	0.05	0.030	0.05
	b.Kimia Organik	b.Organic chemical					
1	Aldrin dan dieldrin		mg/L	0.0007	0.017		
2	Benzene		mg/L	0.01	-		
3	Benzo (a) pyrene		mg/L	0.00001			
4	Chlordane (total isomer)		mg/L	0.0003	0.003		
5	Chloroform		mg/L	0.03	-		
6	2,4-D		mg/L	0.10	-		
	BHC		mg/L			0.21	
7	DDT		mg/L	0.03	0.042	0.002	
8	Detergen		mg/L	0.5	-		
9	1,2 Dichloroethane		mg/L	0.01	-		
10	1,1 Dichloroethene		mg/L	0.0003	-		
	Endrine		mg/L		0.001	0.004	
	Fenol		mg/L		0.002	0.001	
11	Heptachlor dan heptachlor epoxide		mg/L	0.0003	0.018		
	Karbon Kloroform Ekstrak		mg/L		0.5		
12	Hexachlorobenzene		mg/L	0.00001			
13	Gamma-HCH(Lindane)		mg/L	0.004	0.056		
14	Methoxychlor		mg/L	0.03	0.035		
	Minyak dan Lemak		mg/L		ND	0.500	
	Organofosfat dan Carbamate		mg/L		0.1	0.100	
	PCB		mg/L		ND		
	Senyawa Aktif Biru Metilen		mg/L		0.5	0.20	
	Toxaphene		mg/L		0.01		
15	Pentachlorophenol		mg/L	0.01	-		
16	Pestisida total		mg/L	0.10	-		
17	2,4,6-Trichlorophenol		mg/L	0.01	-		
18	Zat Organik(KMnO4)		mg/L	10	-		
	Microbiologi		jumlah/100ml		-		
1	Koliform Tinja	Fecal coliform	jumlah/100ml	0	2000	-	
2	Total Koliform(MPN)	Total coliform	jumlah/100ml	3	10000		
	Radioactivitas						
1	Aktivitas Alpha(Gross Alpha Activity)		Bq/L	0.1	0.1	0.10	0.10
2	Aktivitas Beta(Gross Beta Activity)		Bq/L	1	1	1.0	1.0

3. PRESENT CONDITION ON WATER QUALITY

3.1 QUALITY OF RAW WATER

3.1.1 Jatiruhul Dam

Jatiruhur dam which is a major source for Jakarta water supply system has started storing water in June 1962. Major dimensions of the dam is as described below.

Table-3.1 DIMENSIONS OF JATIRUHUR DAM

ITEMS	DIMENSIONS
DEPTH	Maximum 82 m to Minimum 67 m
CAPACITY	Maximum 2,556 mil. m3 to Minimum 766 mil. m3
SURFACE AREA	2,600 ha

Quality of the dam water is described in the **Table-3.2.** It is said that the water quality has been deteriorated, and eutrophication is much developed in these days. Cause for these phenomena will be inflow of natural load and of pollutant by human activities upstream.

As shown on the **Figure-3.1**, value of BOD and pH has been increasing year by year. **Table-3.3** which describes results of quality analysis of Jatiruhur dam water by the Study Team in Sept.1995, shows that chlorophyll-a ranges 28.9 to 377 mg/l which exceeds limit of threshold of eutrophication, 10 to 30 mg/l.

These data are thought evidence of development of eutrophication of the dam water. And moreover, development of deoxidization in bottom zone of the dam water is investigated, and such materials as Fe, Mn, Nh4-N, P and H2S are considered re-dissolving from silt accumulated on the bottom of the dam lake.

Acquisition of good quality raw water is undoubtedly one of the best way for safe potable water production, and moreover Jatiruhur dam is the biggest source for Jakarta water supply system, it is preferable to improve quality of the dam water in the future.

Table–3.2 WATER QUALITY OF JATILUHUR DAM

	Temperature	Daya Hantar Listrik	KMnO4	Turbidity	Color	pH	Alkalinity	Asiditi	Oksigen Terlarut	Na	K	Ca	Mg	Cl	SO4	NH4-N	NO2-N	NO3-N	B	SiO2	PO4	BOD	COD	KMnO4	Cr	Cu	Fe	Mn
	°C	umhos/cm	mg/l	NTU	TCU		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1992/1	26	115	20	2.0	1.2	7.1	65.0	2.23	6.50	9.20	2.10	12.3	5.900	9.5	3.1	0.090	0.001	0.020	0.010	22.30	0.010	1.1	2.2	0.9	0	0	0.500	0
1992/2																												
1992/3	24	155	62	2.0	1.2	7.2	9.0	0.50	6.50	1.56	0.25	8.5	4.100	4.8	4.2	0.000	0.000	0.002	0.000	15.00	0.000	0.5	2.6	0.2	0	0	0.300	0
1992/4	26	165	75	3.0	2.0	7.2	15.0	1.20	6.21	2.35	0.42	11.0	4.500	5.1	2.1	0.001	0.000	0.010	0.005	20.00	0.009	0.9	2.2	0.5	0	0	0.350	0
1992/5	27	155	50	5.0	1.0	7.1	5.1	1.20	6.50	1.25	0.32	9.0	4.800	8.2	5.9	0.001	0.005	0.005	0.005	19.00	0.009	0.9	3.2	0.2	0	0	0.250	0
1992/6	26	175	45	3.0	1.2	7.2	4.7	1.10	6.20	1.02	0.28	7.6	2.800	6.2	4.1	0.000	0.000	0.005	0.000	15.00	0.005	1.1	3.5	0.5	0	0	0.150	0
1992/7	26	185	98	2.0	1.1	7.9	4.1	1.20	6.85	1.05	0.22	6.2	2.100	6.1	4.3	0.000	0.000	0.002	0.005	10.00	0.005	1.2	4.2	0.5	0	0	0.150	0
1992/8	27	95	35	3.0	0.9	7.2	6.7	0.60	6.80	0.97	0.08	6.4	1.800	6.8	3.5	0.000	0.000	0.000	0.000	10.00	0.000	1.1	2.6	0.3	0	0	0.120	0
1992/9																												
1992/10	27	110	55	2.0	1.1	7.2	9.1	1.50	6.30	0.62	0.64	3.8	0.590	3.2	5.7	0.000	0.000	0.000	0.005	10.00	0.005	1.1	2.3	0.5	0	0	0.180	0
1992/11	18	188	94	2.0	0.8	7.5	7.5	1.10	7.50	0.92	0.05	5.2	0.950	5.6	2.8	0.000	0.000	0.000	0.000	8.00	0.000	0.9	2.1	0.2	0	0	0.100	0
1992/12	26	85	20	5.0	0.5	7.1	5.2	0.50	6.50	0.86	0.10	6.2	2.300	2.9	3.4	0.000	0.000	0.000	0.000	12.00	0.000	1.5	3.1	0.5	0	0	0.130	0
1993/1	28	120	60	15.0	1.0	7.3	10.0	1.50	6.20	2.10	0.76	25.6	2.100	4.7	5.8	0.000	0.002	0.520	0.010	20.00	0.005	3.1	7.8	2.2	tt	tt	0.650	0.01
1993/2	27	196	90	4.5	1.0	7.8	8.0	1.50	6.80	1.80	0.62	15.0	2.800	2.9	6.7	0.000	0.000	0.008	0.007	15.00	0.010	7.8	8.6	1.1	tt	tt	0.080	0.01
1993/3	23	120	60	10.0	1.0	7.3	15.0	1.30	6.30	0.72	0.75	9.1	0.820	4.2	4.5	0.000	0.000	0.005	0.002	5.00	0.003	1.1	2.4	0.5	tt	tt	0.260	0
1993/4	30	190	95	5.0	0.0	7.4	13.0	1.10	6.10	0.92	1.21	8.7	0.760	4.1	6.7	0.000	0.000	0.050	0.008	8.00	0.009	2.3	5.3	1.3	tt	tt	0.080	0.02
1993/5	27	150	75	20.0	1.0	7.2	20.0	2.10	6.30	1.62	0.78	22.0	2.500	8.6	5.9	0.000	0.005	0.550	0.010	15.00	0.010	4.3	8.2	2.2	tt	tt	0.350	0.01
1993/6	27	170	85	15.0	0.0	7.2	35.0	2.30	6.60	1.05	0.83	15.0	1.100	6.3	7.2	0.000	0.001	0.011	0.010	10.00	0.010	4.3	7.2	1.9	tt	tt	0.280	tt
1993/7	28	130	65	5.0	0.0	7.3	50.0	2.50	6.30	0.82	0.76	20.0	0.961	5.2	6.8	0.000	0.000	0.010	0.010	5.00	0.010	3.9	8.3	1.8	tt	tt	0.190	tt
1993/8	27	192	86	10.0	1.0	8	42.0	2.60	6.40	1.60	3.20	25.0	1.400	8.2	11.8	0.000	0.003	1.400	0.020	15.00	0.020	4.1	8.4	2.2	tt	tt	0.040	tt
1993/9	29	110	55	5.0	0.0	7.7	15.0	1.80	6.90	1.70	1.40	25.0	1.800	8.2	7.0	0.050	0.001	1.000	0.015	10.00	0.010	3.2	6.9	1.8	tt	tt	0.050	tt
1993/10	27	154	77	8.0	0.0	7.4	24.0	2.20	6.40	0.99	1.20	20.0	0.830	8.2	12.0	0.002	0.003	0.550	0.010	5.00	0.010	2.3	5.5	1.7	tt	tt	0.030	tt
1993/11	26	144	72	5.0	0.0	7.2	55.0	4.30	6.20	1.42	2.00	20.0	0.970	6.8	14.0	0.005	0.003	3.500	0.010	15.00	0.010	3.6	7.2	1.8	tt	tt	0.030	0.04
1993/12	29	160	80	13.0	1.0	7.3	29.0	2.30	6.30	1.29	1.40	23.0	0.730	11.2	14.0	0.022	0.023	0.570	0.020	10.00	0.020	4.3	7.5	3.7	tt	tt	0.020	tt
1994/1	26	124	62	2.0	1.0	7.2	50.0	2.60	6.20	0.51	1.02	12.0	2.800	7.2	5.1	0.000	0.000	1.800		20.00	0.009	1.7	3.4	1.1	tt	tt	0.080	0.01
1994/2	26	178	69	4.0	0.0	7.2	43.0	2.90	6.50	0.98	0.72	12.0	1.300	7.6	5.4	0.003	0.005	0.810		28.00	0.015	2.1	5.1	0.8	tt	tt	0.150	0.05
1994/3	27	196	98	5.0	1.0	7.4	40.0	3.40	6.50	1.42	3.00	13.0	1.100	6.8	4.1	0.001	0.001	2.300		15.00	0.008	3.1	6.4	1.7	tt	tt	0.060	0.01
1994/4	27	168	84	4.0	0.0	7.3	42.0	3.20	6.50	1.20	1.86	13.0	1.200	7.2	4.8	0.002	0.003	1.555		22.00	0.012	2.6	5.8	1.3	tt	tt	0.060	0.01
1994/5	28	160	104	11.0	0.0	7.3	30.0	2.00	6.30	1.10	0.90	16.0	1.300	6.1	6.3	0.000	0.002	0.165		10.00	0.010	3.5	7.3	1.6	tt	tt	0.225	0.008
1994/6	28	151	104	9.0	0.0	7.6	36.0	2.30	6.60	1.34	1.55	21.0	1.300	7.0	8.2	0.010	0.001	0.600		10.01	0.010	3.6	7.7	1.9	tt	tt	0.100	0
1994/7																												
1994/8																												
1994/9																												
1994/10																												
1994/11																												
1994/12																												
1995/1																												
1995/2																												
1995/3																												
1995/4																												
1995/5																												
1995/6																												
1995/7	27	240	143	101.0	3.0	7.3	63.0	4.30	5.80	1.36	2.14	26.0	2.100	9.4	21.4	0.025	0.062	2.182		30.00	0.022	5.6	11.2	3.2	tt	tt	0.261	0.094

Figure-3.1 RECORD OF BOD AND pH VALUE

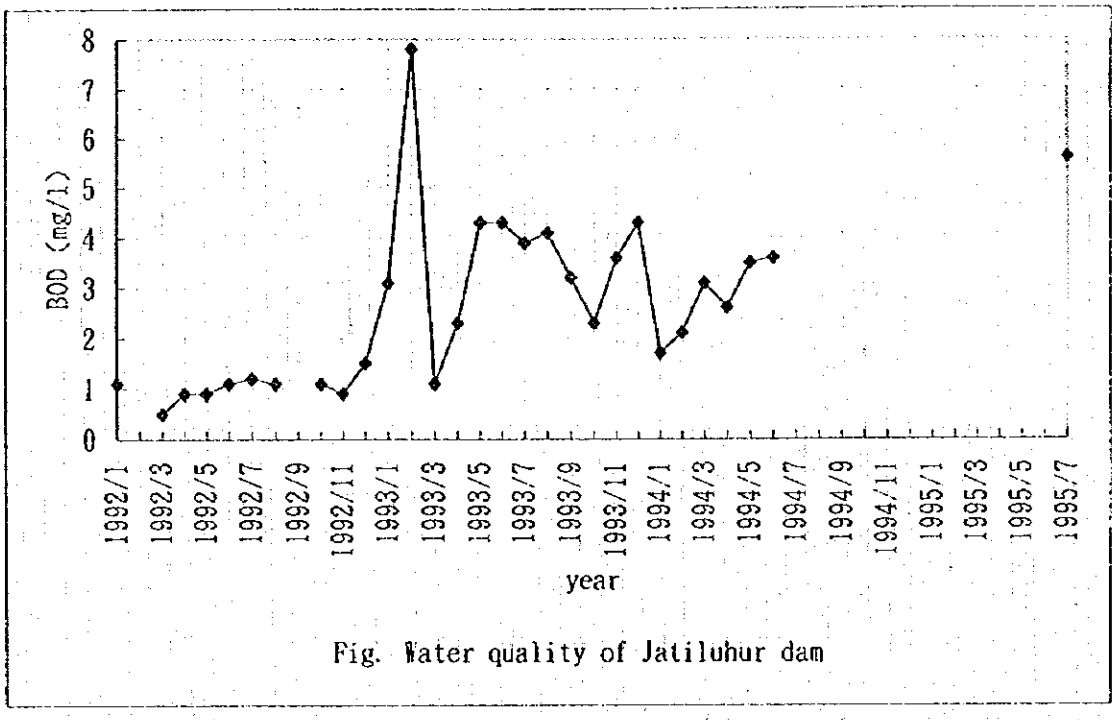


Fig. Water quality of Jatiluhur dam

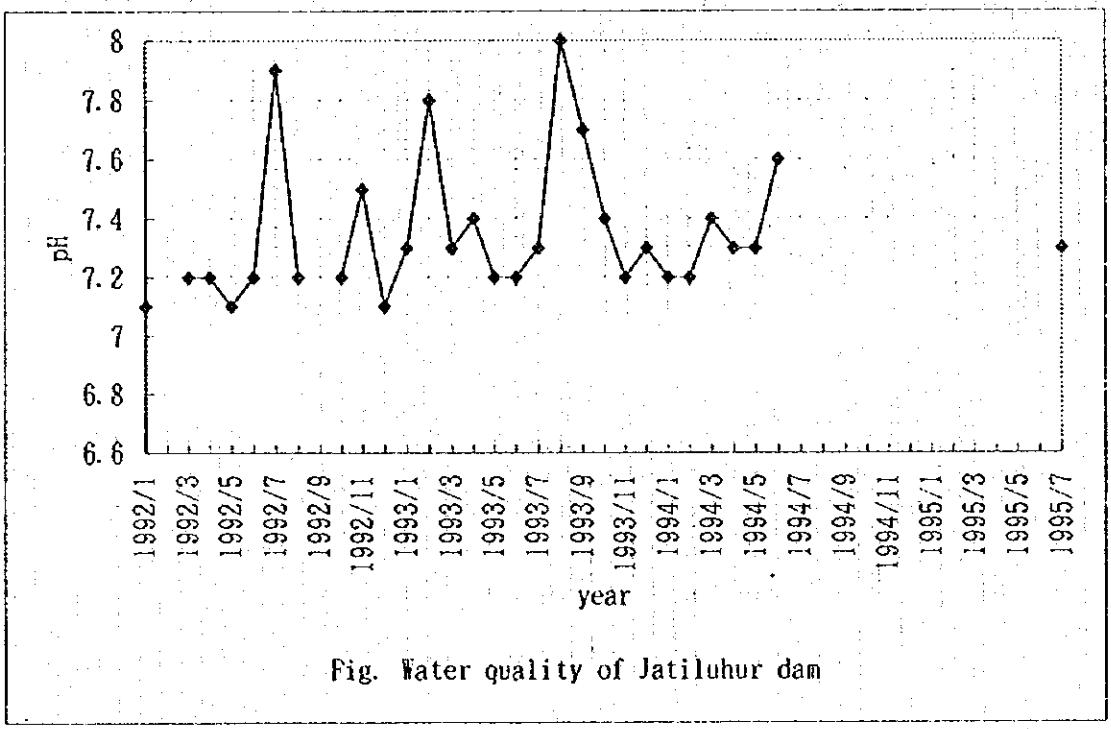


Fig. Water quality of Jatiluhur dam

Table-3.3 RESULTS OF QUALITY ANALYSIS OF JATILUHUR DAM WATER

	Influent	Point of Influent		Center	Damsite		Effluent
Sampling Depth (m)	Surface	0.2	1.5		0.2	1.5	
Total Depth (m)	1	6			90		100
Sampling Time	11:50	12:20		13:00	16:15		16:50
Water Temperature(℃)	31.5	31.2	30.8	30.9	30.0	29.8	28.0
pH	8.4<	8.3	8.3	8.3	8.4<	8.4	7.1
Transparency (cm)	10	37			90		
DO (mg/L)	9.0	9.0	9.0	9.5	9.5	10.0	3.5
Color		green		green	green		green
Odor	none	none			none		rotten egg smell
Turbidity (NTU)	60	12	14	9	11	10	6
T-P (mg/L)	0.03>	0.03>	0.03>	0.03>	0.03>	0.03>	0.03>
T-N (mg/L)	1.35	1.2	1.2	1.05	1.05	1.8	3.3
CODcr (mg/L)	16.19	8.1	8.1	6.48	8.1	8.1	6.48
Chlorophyl a (μ g/L)	377.0	49.6	55.8	29.7	28.9	32.2	3.3

Note: Sampling on 24 Sept. 1995 Cloudy Temperature 30 ° C

3.1.2 River and Canal Water

(1) West Tarum Canal

Biological oxygen demand (BOD) and Anmonia-nitrogen (NH4-N), both of which indicate extent of water contamination, of Jatiruhur dam water and West Tarum canal (WTC) water for recent two years are plotted in the **Figure-3.2**. **Figure-3.3** shows the same values as in the **Figure-3.2** with a different axis of water sampling locations. Locative relation of the dam, the canal , etc. and location of sampling points of water are illustrated in the same **Figure**.

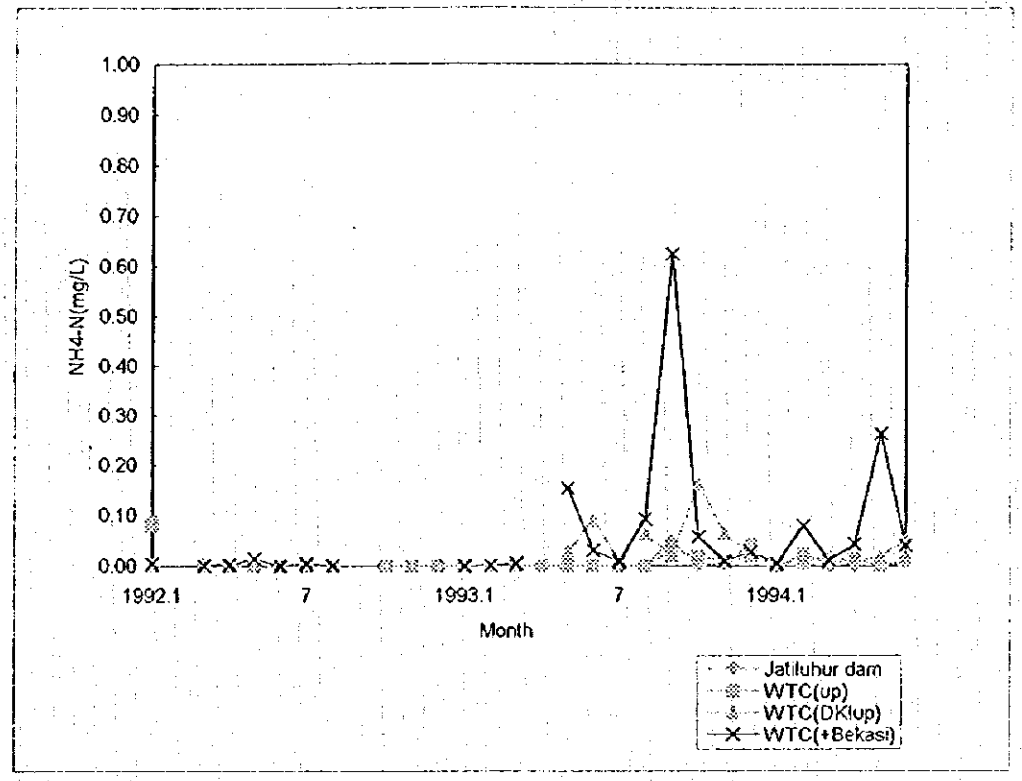
Figure-3.2 indicates that quality of raw water has been deteriorated year by year, and **Figure-3.3** shows more downstream of the canal, the more contamination of water.

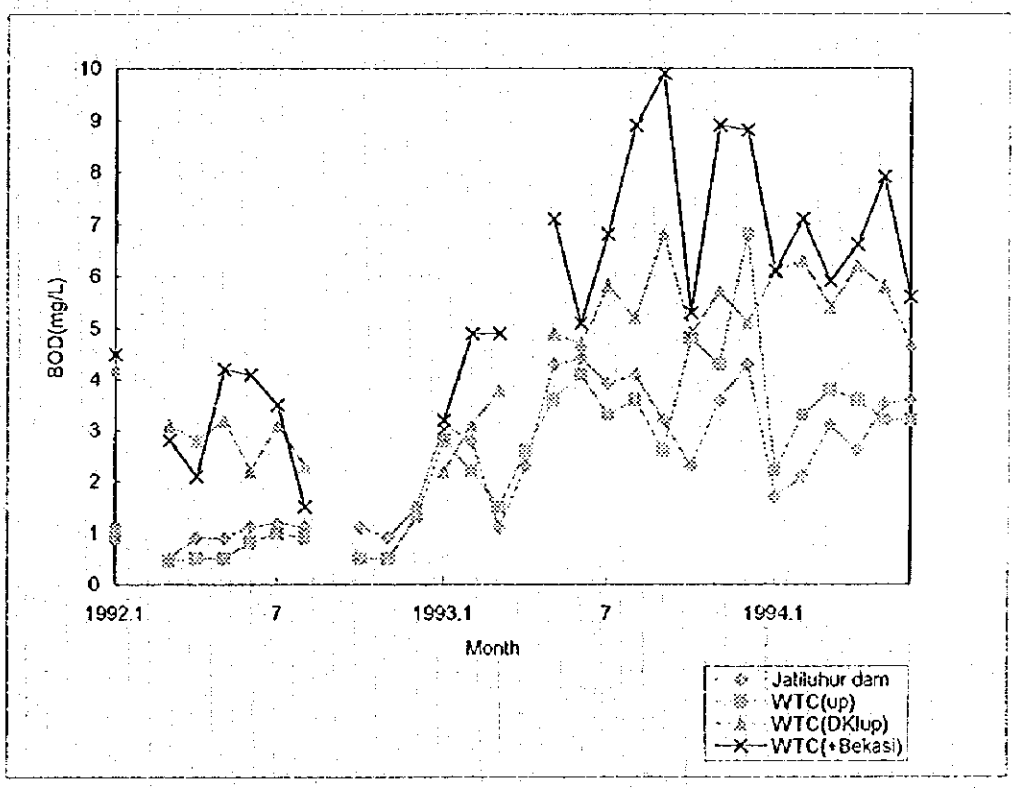
BOD concentiation at location No.4 and more down stream exceeds 5 mg/l in the most period of the year. It is considered by past experience that an ordinary method of conventional water treatment is able to treat raw water with maximum BOD of 3 to 5 mg/l.

As to concentration of Ammonia-nitrogen of raw water of location No.4 and niore upstream, it is almost lower than 0.5 mg/l which is the upper limit of Category B of the quality standard for raw water for water supply by DKI as shown on the **Table-2.3**. But NH4-N at location No.5 and No.6 exceeds the standard value leading to proper chlorine dosing at treatment plants difficult. Considering the above, it is preferable to take raw water for the treatment plants at the location or its upstream of WTC.

Buaran treatment plant has experienced raw water intake with very high turbidity. As listed in the **Table-3.4**, turbidity over 1,000 NTU appeared 37 times in 1994, and the maximum has exceeded 10,000 NTU. Conventional water treatment plant, in general, is designed for the maximum turgidity of raw water of about 1,000 NTU. Raw water with higher turbidity than this may lessen the production, and the plant may interrupt its operation with 5,000 to 10,000 NTU raw water. A major cause for the above high turbidity is thought poor maintenance of the silt trap basin in Bekasi river.

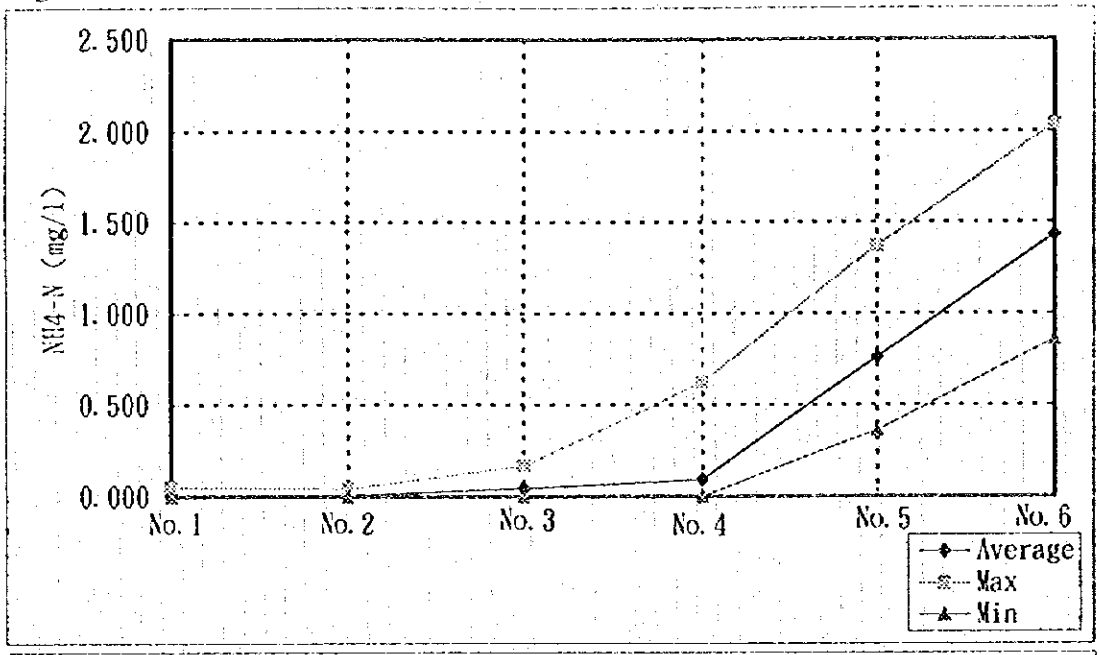
Figure-3.2 RECORD OF BOD AND NH_4-N OF WTC WATER

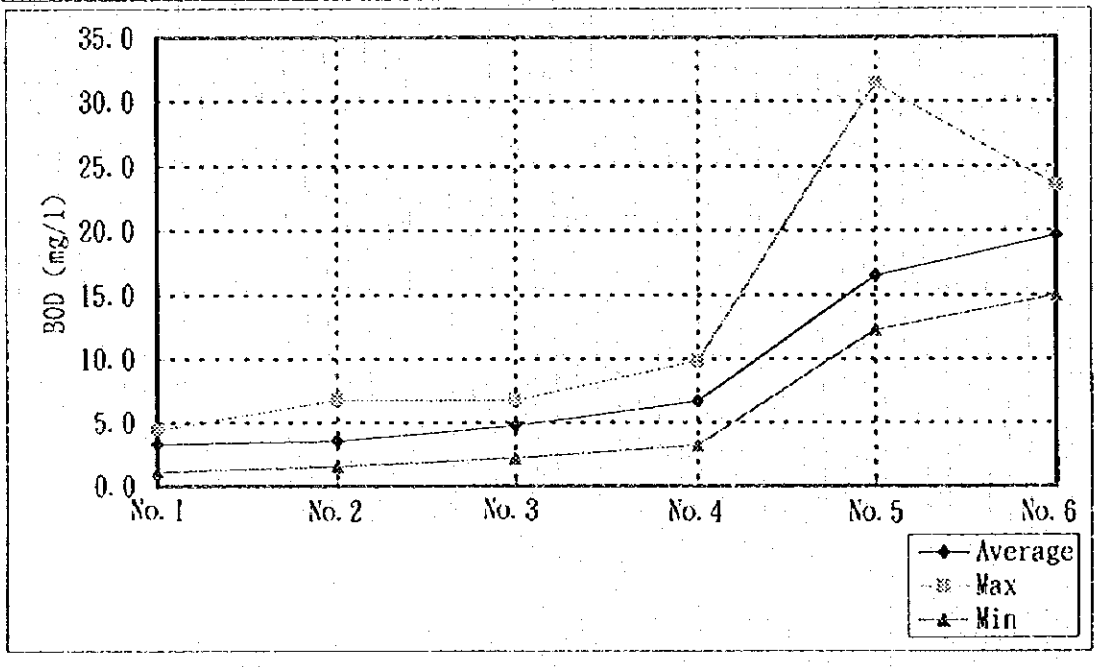




Note : Data from POJ

Figure-3.3 RECORD OF BOD AND NH_4-N OF WTC WATER





Note : Data from POJ

LOCATION OF SAMPLING POINTS

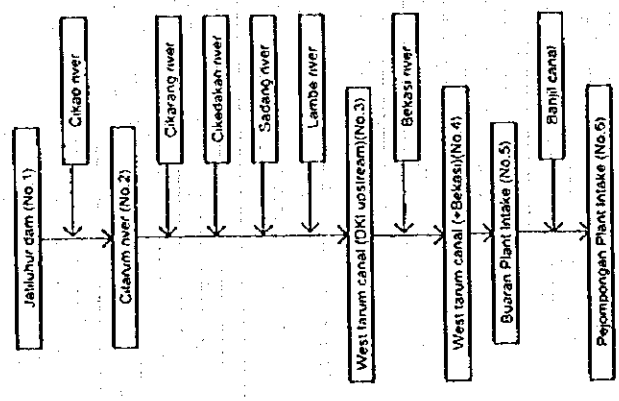


Table-3.4 HIGH TURBIDITY RECORD OF RAW WATER OF BUARAN TREATMENT PLANT

Date 1994	Time when turbidity exceeded 1,000 NTU	Maximum Turbidity
31-Jan	5	>2000 NTU
7-Feb	7	1890
8-Feb	9	1828
9-Feb	3	2880
13-Feb	7	3876
15-Mar	9	1079
22-Mar	5	2598
23-Mar	15	1059
31-Mar	17	1792
3-Apr	7	1826
4-Apr	7	6080
5-Apr	continued from previous day	> 5000
6-Apr	continued from previous day	2400
7-Apr	16	1269
8-Apr	9	2150
19-Apr	9	2416
21-Apr	5	1960
22-Apr	5	3346
23-Apr	23	3448
25-Apr	5	1499
26-Apr	7	3226
11-May	5	2724
12-May	7	1173
14-Jun	9	1328
19-Sep	9	2958
22-Sep	7	5169
17-Oct	7	3408
21-Oct	23	1337
22-Oct	7	1680
27-Oct	9	6212
28-Oct	1	1020
1-Nov	9	2825
2-Nov	11	2000
3-Nov	3	4472
28-Nov	7	> 10000
29-Nov	continued from previous day	5712
30-Nov	continued from previous day	1872
TOTAL	37 days	

Note : Data in 1994

(2) Cisadane River

Quality of raw water of Cisadane river is described in the **Table-3.5**. Although numbers of data, especially recent data are not enough, color seems rather high, and the other parameters are thought within limit for application of conventional water treatment.

Measures to keep present quality level or to improve the quality of the raw water will be necessary.

(3) Other Rivers and Canals in the City

Water in Banjir canal which is raw water of Pejompongan treatment plants is most contaminated among the above water sources. As shown on the **Table-3.6**, concentration of BOD is as high as 15 to 25 mg/l, and NH4-N often exceeds 1.0 mg/l sometimes reaching to 3 to 4 mg/l. Other than the above items, high concentration of Color (130 to 400 TCU), Detergent (0.3 to 0.1 mg/l) and Manganese (0.03 to 0.3 mg/l) are also remarked.

Water of the rivers and canals in the city other than Banjir canal, which is taken by small scale treatment plants, will be contaminated almost to the same level as Banjir canal water.

Table-3.5 WATER QUALITY OF CISADANE RIVER WATER

	Unit	1985	1988	1995
Num. of Sample	Nos.	7	4	1
Temperature	°C	27.8	27.4	
pH		6.9	7.3	6.8
Turbidity	FTU	68.7	74.3	8.0
Suspended solids	mg/l	91.0	153.5	
Color total	Pt/Co Unit	60.2	117.5	42.0
Color soluble	Pt/Co Unit		68.8	
KMnO4	mg/l	10.1	5.5	3.0
Oxygen	mg/l	7.1	7.1	
Chloride	mg/l	4.6	2.1	
Iron total	mg/l	2.60	2.35	0.03
Iron soluble	mg/l		0.89	
Mangan total	mg/l	0.20	0.18	0.61
Mangan soluble	mg/l		0.01	
Anmonium	mg/l	0.20		<0.04
Nitrite	mg/l	0.018	0.019	3.110
Nitrate	mg/l		1.25	0.09

Table-3.6 WATER QUALITY OF BANJIL CANAL (1990 - 1993, PEJOMPONGAN I RAW WATER)

Month	BOD(mg/L)		COD(mg/L)		BOD/COD		NH4-N(mg/L)				Turbidity(NTU)				Color(TCU)				pH				Mn(mg/L)				Detergen(mg/L)	
	1992	1993	1992	1993	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993	1992	1993
1	21.2	17.0	13.9	26.2	0.0	0.1		1.45	0.62	1.23	60	65	46	71	150	258	250	210	7.0	6.7	6.7	6.7	0.300	0.032	0.070	0.088	0.039	0.079
2	21.4	23.0	18.7	17.7	0.0	0.1		0.65	0.22	1.59	70	106	84	71	145	210	275	356	7.1	6.7	6.7	6.9	0.019	0.023	0.075	0.091	0.043	0.066
3	19.5	18.2	21.4	14.2	0.0	0.1	0.85	0.40	0.31	1.54	59	54	42	41	157	187	410	253	7.1	6.7	6.7	6.7		0.060	0.092	0.050	0.037	0.101
4	14.5	22.6	26.3	21.2	0.0	0.2	0.20	2.80	0.35	1.50	24	53	15	70	160	189	210	325	7.1	6.7	6.5	6.7		0.040	0.050	0.088	0.037	0.101
5	21.0	17.1	31.0	26.4	0.0	0.2	0.35	2.65	0.50	1.29	57	93	38	66	155	195	303	216	7.0	6.7	6.8	6.7	0.023	0.120	0.106	0.118	0.138	0.130
6	22.0	17.8	16.4	14.0	0.0	0.4	0.41	0.96	0.75	0.86	62	19	30	36	187	188	289	226	6.7	6.8	6.7	6.7	0.127	0.512	0.160	0.066	0.159	0.173
7	22.3	20.5	35.3	35.9	0.0	0.2	2.50	1.88	1.88	2.04	17	35	27	29	150	273	175	364	6.9	6.7	6.6	6.7	0.086	0.158	0.175	0.206	0.100	0.227
8	19.5	22.2	37.8	31.4	0.0	0.2	1.63	3.25	3.90	1.17	42	29	29	72	199	131	220	242	6.8	6.8	6.8	6.7	0.153	0.208	0.132	0.237	0.130	0.170
9	20.8	18.1	16.8	27.7	0.0	0.5	2.50	1.00	2.58	1.40	27	18	28	74	189	160	323	129	6.8	6.9	6.8	6.7	0.067	0.084	0.262	0.037	0.107	0.118
10	16.5	23.5	24.5	33.2	0.0	0.4	1.55	1.57	1.06	1.47	22	35	59	89	185	232	185	412	6.8	6.9	6.8	6.7	0.104	0.334	0.080	0.237	0.130	0.207
11	17.0	20.6	25.2	32.3	0.0	0.4	0.25	0.86	1.08	1.60	32	48	79	136	298	297	283	175	6.7	6.9	6.7	6.7	0.015	0.120	0.076	0.080	0.077	0.170
12	17.5	15.0	33.3	19.3	0.0	0.4	5.30	0.78	1.17	1.48	63	46	32	52	158	163	217	241	6.8	6.7	6.8	6.8	0.098	0.110	0.112	0.041	0.079	0.101
Max	22.3	23.5	37.8	35.9	0.0	0.5	5.30	3.25	3.90	2.04	70	106	84	136	298	297	410	412	7.1	6.9	6.8	6.9	0.300	0.512	0.262	0.237	0.159	0.227
Min	14.5	15.0	13.9	14.0	0.0	0.1	0.20	0.40	0.22	0.86	17	18	15	29	145	131	175	129	6.7	6.7	6.5	6.7	0.015	0.023	0.050	0.037	0.037	0.066
Average	19.4	19.6	25.1	25.0	0.0	0.3	1.55	1.52	1.20	1.43	45	50	42	67	178	207	262	262	6.9	6.8	6.7	6.7	0.099	0.150	0.116	0.112	0.090	0.137

Source:Pejompongan I Treatment Plant

3.1.3 Groundwater

Quality of groundwater is described and evaluated in several previous reports including JWRMS. So in the paper, quality of groundwater is discussed only on representative items for human health such as Chloride, Nitrate and Nitrite. It is said that very high concentration of chloride gives adverse effect on human heart condition and high concentration of Nitrite and Nitrate is harmful for a baby health condition.

Generally, shallow well water in Jakarta city area is contaminated by pollution from ground surface and deep well water has been deteriorated due to sea water intrusion by its excessive abstraction.

As shown on the **Table-3.7**, many of samples of shallow wells exceed standard value of Ministry of Health. Quality of shallow wells are inferior to deep wells in almost every quality items.

Together with problem of excessive abstraction of groundwater, its restriction especially of shallow wells must be considered in the future.

Table-3.7 COMPARISON OF WELL WATER QUALITY

WELLS	ITEMS	UNIT	CHLORIDE	NITRITE	NITRATE
Shallow	Numbers of Samples	Nos.	59	59	59
	Numbers Exceed Limit	Nos.	22	1	35
	Ratio Over Limit	%	37	2	59
	Average Value	(mg/l)	491	0.21	20.6
	Highest Value	(mg/l)	4,000	1.8	73.2
Deep	Numbers of Samples	Nos.	72	72	72
	Numbers Over Limit	Nos.	7	0	0
	Ratio Over Limit	%	10	0	0
	Average Value	(mg/l)	370	0.17	1.8
	Highest Value	(mg/l)	16,897	0.7	9.9
Standard "Potable"		(mg/l)	250	1.0	10

Note: The above average value means average value of detected samples.

3.2 FINISHED WATER

3.2.1 Quality in General

Quality of finished water of four treatment plants namely, Pejompongan I and II, Puro Gadung and Buaran, is listed in the **Table-3.8.** Concentration of each quality parameter is different from plant to plant, but, in general, Buaran plant produces finished water of better quality among them.

Detergent of Pejompongan I and II sometimes exceeds the standard value, and Color and Mn of Pejompongan I and II and Puro Gadung plants, also exceed the standard value of potable water of Ministry of health.

Finished water quality of Pulo Gadung plant in 1994 and 1995 shows improvement compared with the quality so far. Reasons for the improvement is considered by shift of water intake which is described in the **Section 5.1.** Shift of water intake upstream for better raw water quality is very effective to produce treated water of good quality as well as strengthening of Chlorine control at treatment plant. Thus, shift of water intake of Pejompongan plants which is now underway of execution shall be completed as quickly as possible.

3.2.2 Residual Chlorine and E.Coli Group

Quality index which directory represents drinkability is presence of residual chlorine and negative E.Coli group in the water. E.Coli in finished water of the four plants are shown in the **Table-3.9.** Buaran plant always produces potable finished water with negative coliform group, and the other plants produce positive E.Coli though very seldom.

Quality of finished water of the small scale treatment plants located in the north of the city is deteriorated severely because of very hard pollution of the raw water. Such plants are Sunter, Muara Karang and Cenkaren, and these must be provided with adequate remedial measures as quick as possible.

Table-3.9 CONDITION OF E.COIL AND RESIDUAL CHLORINE OF FINISHED WATER

PLANT NAME	SAMPLE	E.COLI GROUP			RESIDUAL CHLORINE	
	Nos.	0 Nos.	+ Nos.	+ Percentage	Range(mg/l)	Mean (mg/l)
Pejompongan I	327	326	1	0.3%	0.03 ~3.6	1.09
Pejompongan II	327	326	1	0.3 %	0.05 ~3.0	1.28
Puro Gadung	108	106	2	1.9 %	0.05 ~1.7	0.73
Buaran	59	59	0	0.0 %	0.10 ~1.5	0.76

Note:Data of PAM JAYA in 1993

3.3 TAP WATER

Quality of tap water in terms of bacteriologic and chemical features is listed in the **Table-3.10** below. Although number of samples seems not always enough, chemical aspects of tap water is almost satisfactory, while bacteriologic feature of tap water is not always good.

Table-3.10 QUALITY DATA OF TAP WATER FROM 1990 TO 1993

	YEAR	SAMPLE NOS.	GOOD SAMPLE NOS.	GOOD SAMPLE (%)
Bacteriological Quality	1990	2,893	782	27.0
	1991	1,030	812	78.9
	1992	2,710	413	15.2
	1993	1,611	1,207	74.9
Chemical Quality	1992	400	386	96.5
	1993	141	118	83.7

Table-3.11 shows residual chlorine and coliform group of tap water sampled from each zone. Although each zone is not hydraulically independent, sampling points of tap water are carefully checked and selected to zone which they belong to.

Quality of tap water from Buaran treatment plant is best among other plants. Quality of tap water supplied from Pulo Gadung plant is not good compared with one from Buaran, since quality data from Puro Gadung is in 1993 when its water intake has not been shifted from Sunter river to WTC.

Table-3.8 TREATED WATER QUALITY

YEAR 1990		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.71	0.76	0.95	-	5
Color	TCU	10.8	13.4	19.0	-	15
pH		7.3	7.2	7.1	-	6.5-8.5
Mn	mg/l	0.146	0.118	0.365	-	0.1
Detergent	mg/l	-	-	-	-	0.05
KMnO4	mg/l	5.28	4.68	5.91	-	10
Fe	mg/l	0.04	-	0.05	-	0.3
Total Coliform		-	-	-	-	0
YEAR 1991		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.71	0.66	0.54	-	5
Color	TCU	15	16	26	-	15
pH		7.1	7.2	7.0	-	6.5-8.5
Mn	mg/l	0.165	0.157	0.080	-	0.1
Detergent	mg/l	-	-	-	-	0.05
KMnO4	mg/l	5.94	5.83	4.19	-	10
Fe	mg/l	0.13	0.06	ttd	-	0.3
Total Coliform		25.5	21.7	12.0	-	0
YEAR 1992		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.87	0.88	0.95	-	5
Color	TCU	17.0	17.0	15.1	-	15
pH		7.2	7.3	7.2	-	6.5-8.5
Mn	mg/l	0.128	0.120	0.043	-	0.1
Detergent	mg/l	0.045	0.044	0.028	-	0.05
KMnO4	mg/l	4.37	4.15	4.24	-	10
Fe	mg/l	ttd	ttd	ttd	-	0.3
Total Coliform		-	-	-	-	0
YEAR 1993		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.87	0.92	0.72	0.52	5
Color	TCU	14.3	18.2	10.0	10.2	15
pH		7.1	7.2	7.1	7.3	6.5-8.5
Mn	mg/l	0.124	0.115	0.033	0.036	0.1
Detergent	mg/l	0.050	0.048	0.029	0.031	0.05
KMnO4	mg/l	3.38	3.58	4.14	4.88	10
Fe	mg/l	ttd	0.04	ttd	ttd	0.3
Total Coliform		-	-	-	-	0
YEAR 1994		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.75	1.14	0.99	0.55	5
Color	TCU	14.9	17.3	3	4.1	15
pH		7.0	7.1	-	7.3	6.5-8.5
Mn	mg/l	0.21	0.134	ttd	0.059	0.1
Detergent	mg/l	-	0.330	-	0.016	0.05
KMnO4	mg/l	5.34		-	-	10
Fe	mg/l.	0.19		-	-	0.3
Total Coliform		0		-	-	0
YEAR 1995		Pejompongan I	Pejompongan II	Pulo Gadung	Buaran	Standard
Turbidity	NTU	0.79		1.22	1.89	5
Color	TCU	7.0		2.0	3.2	15
pH		6.9		7.0	7.4	6.5-8.5
Mn	mg/l	0.19		ttd	0.05	0.1
Detergent	mg/l	0.296		-	-	0.05
KMnO4	mg/l	5.72		3.17	3.72	10
Fe	mg/l	0.14		-	0.04	0.3
Total Coliform		0.71		-	0	0

Note: Data from Each Plant. Standard means "Potable Water Standard" by Ministry of Health

Comparing with quality of finished water mentioned in **Section 4**, it is clear that deterioration of quality between finished and tap water is happened. Cause for worsening the tap water quality is considered deterioration of distribution and service mains and contamination of receiving tanks of each consumer.

Table-3.11 RESIDUAL CHLORINE AND COLIFORM GROUP OF TAP WATER

ZONE	SAMPLE NOS.	RE.CL2=0 SAMPLES	RATIO OF RE.CL2=0 (%)	AVERAGE RE.CL2 mg/l	POSITIVE E.COLI NOS	RATIO OF +E.COLI (%)	WATER SUPPLY SOURCE
1	191	25	13.1	0.39	25	13.1	Pejompongan
2	41	4	9.8	0.36	6	14.6	Pulo Gadung
3	43	6	14.0	0.24	11	25.6	Puro Gadung
4	62	3	4.8	0.47	8	12.9	Pejompongan
5	70	17	24.3	0.16	13	18.6	Pejompongan
6	26	1	3.8	0.28	4	15.4	Buaran

Data from 1993

3.4 QUALITY MONITORING

Monitoring of water quality for water supply is executed by two agencies concerned. Quality of intake to treated water is examined at each treatment plant of PAM JAYA, and raw and tap water is examined by Balai Latihan Kerja DKI (BLK: Training Center), and its results are reported to Ministry of Health and Ministry of Home Affair through agencies concerned.

3.4.1 Monitoring at Treatment Plant

Each treatment plant of PAM JAYA examines quality of raw water, clarified water, filtered water and finished water for proper operation of treatment facilities.

Quality data is prepared in the form of monthly and annual reports at the plant and reported to the head quarter of PAM JAYA. However parameters examined and form of reporting are different with each other. Evaluation of quality of treated water is not made, and causes of

quality problems either by raw water quality or by treatment process, or by plant operation is not always identified.

Quality items regularly examined at the plants are described in the **Table-3.12**. As shown on the **Table**, quality items examined are only 10 to 22 out of 51 parameters at large scale treatment plant, and other items are consigned to private firms for examination.

As the producer of potable water, PAM JAYA shall examine all the quality parameters of the standard. Quality samples shall also be taken and analyzed from distribution networks in order to identify degree of quality deterioration between treatment plant and distribution mains and also between distribution mains and water taps.

3.4.2 Monitoring of Tap Water

Tap water quality analysis has been conducted by two agencies, namely by Ministry of Health and by the City of Jakarta involving the PAM JAYA.

Procedures of analysis and reporting for both agencies are shown on **Figure-3.4**, respectively. The procedure, are defined as shown on the figure, however, actual procedure concerning tap water quality monitoring hove not been conducted perfectly conforming to the figure.

Numbers of samples for tap water examination is determined by Ministry of health as shown in the **Table-3.13**. Sample numbers for the present Jakarta water supply are 240 (=2,300,000/10,000 + 10).

Table-3.13 NUMBERS OF NECESSARY SAMPLES OF TAP WATER

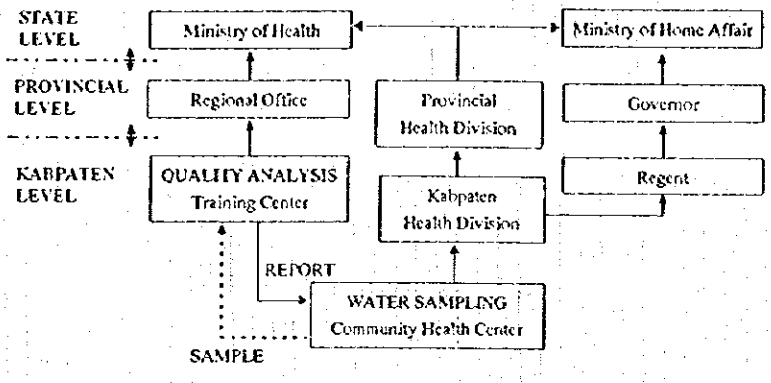
POPULATION SERVED	NOS. OF MONTHLY SAMPLES
Less than 5,000	1 Sample
5,000 - 100,000	1 Sample per 5,000 caps
More than 100,000	1 Sample per 10,000 caps + 10 Additional Samples

Table-3.12 QUALITY ITEMS EXAMINED BY EACH TREATMENT PLANT

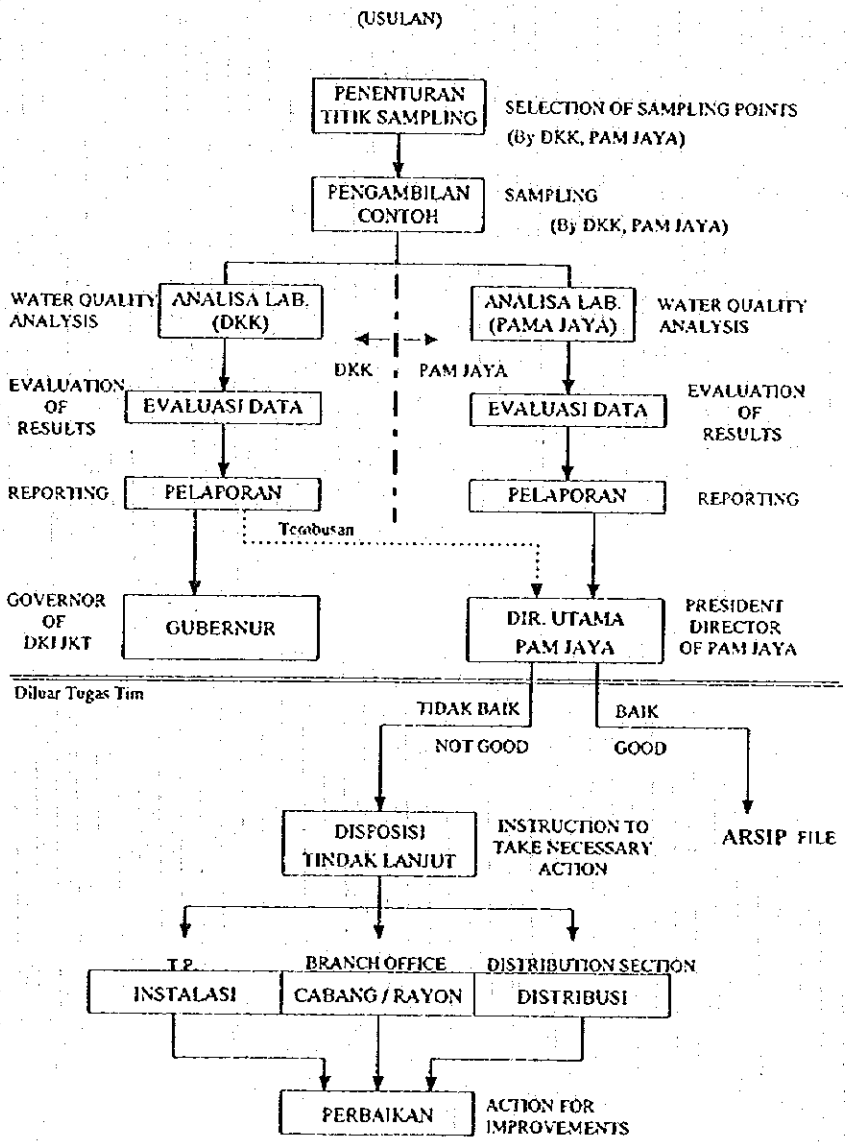
No.	Parameters	Parameters	Unit	PEJOM -PONGAN I	PEJOM -PONGAN II	PULO -GADUNG	BUARAN	Daily	Monthly	Yearly
	A FISIKA	A Physical								
1	Bau	Odor	-	O	×	O	×		O	O
2	Zat padat terlarut(TDS)	Total disolved solid	mg/L	O	×	×	×		O	O
3	Kekeruhan	Turbidity	Skala NTU	O	O	O	O	O	O	O
4	Rasa	Tasted	-	×	×	×	×		O	O
5	Suhu	Temperature		O	×	×	O		O	O
6	Warna	Color	Skala TCU	O	O	O	O	O	O	O
	B KIMIA	B Chemical								
1	Air raksa	Mercury	mg/L	×	×	×	×			O
	Amoniak Bebas	NH4-N	mg/L							O
2	Aluminium	AL	mg/L	×	×	O	×			O
3	Arsen	As	mg/L	×	×	×	×			O
4	Barium	Ba	mg/L	O	×	×	×			O
5	Besi	Fe	mg/L	O	O	O	O		O	O
6	Flourida	F	mg/L	×	×	×	×			O
7	Kadmium	Cd	mg/L	×	×	×	×			O
8	Kesadahan CaCO3	Hardness(CaCO3)	mg/L	O	O	O	O		O	O
9	Klorida	Cl	mg/L	O	O	O	O		O	O
10	Kromium Valensi 6	Cr-6	mg/L	O	×	×	×			O
11	Mangan	Mn	mg/L	O	O	O	O		O	O
12	Natrium	Na	mg/L	O	×	×	×			O
13	Nitrat sebagai N	NO3	mg/L	O	×	×	O		O	O
14	Nitrit sebagai N	NO2	mg/L	O	O	O	O		O	O
15	Perak	Ag	mg/L	×	×	×	×			O
16	pH	pH		O	O	O	O	O	O	O
17	Selenium	Se	mg/L	×	×	×	×			O
18	Seng	Zn	mg/L	×	×	×	×			O
19	Sianida	SN	mg/L	×	×	×	×			O
20	Sulfat	SO4	mg/L	O	×	×	O			O
21	Sulfida sebagai H2S	H2S		O	×	×	×			O
22	Tembaga	Cu		O	×	×	×			O
23	Timbal	Pb	mg/L	×	×	×	O			O
	b Kimia Organik	b Organic chemical								
1	Aldrin dan dieldrin		ng/L	×	×	×	×			O
2	Benzene		ng/L	×	×	×	×			O
3	Benzo (a) pyrene		ng/L	×	×	×	×			O
4	Chlordane (total isomer)		ng/L	×	×	×	×			O
5	Chloroform		ng/L	×	×	×	×			O
6	2,4-D		ng/L	×	×	×	×			O
7	DDT		ng/L	×	×	×	×			O
8	Detergen		ng/L	O	×	×	×		O	O
9	1,2 Dichloroethane		ng/L	×	×	×	×			O
10	1,1 Dichloroethene		ng/L	×	×	×	×			O
11	Heptachlor dan heptachlor epoxide		ng/L	×	×	×	×			O
12	Hexachlorobenzene		ng/L	×	×	×	×			O
13	Gamma-HCH(Lindane)		ng/L	×	×	×	×			O
14	Methoxychlor		ng/L	×	×	×	×			O
15	Pentachlorophenol		ng/L	×	×	×	×			O
16	Pestisida total		ng/L	×	×	×	×			O
17	2,4,6-Trichlorophenol		ng/L	×	×	×	×			O
18	Zat Organik(KMnO4)		ng/L	O	O	O	O		O	O
	Microbiologi	Microbiology	jumlah/100ml							
1	Koliform tinja	Fecal coliform	jumlah/100ml	O	O	×	×		O	O
2	Total Koliform(MPN)	Total coliform	jumlah/100ml	O	×	×	×		O	O
	Radioactivitas	Radioactivity								
1	Aktivitas Alpha(Gross Alpha Activity)		Bq/L	×	×	×	×			
2	Aktivitas Beta(Gross Beta Activity)		Bq/L	×	×	×	×			

Note O : Analysis possible × : Analysis not possible

Figure-3.4 ANALYSIS AND REPORTING PROCESS ON WATER QUALITY



FLOW OF REPORTING WATER QUALITY
TATAALIR PELAKSANAAN PEMANTAUAN KUALITAS AIR MINUM PAM JAYA



DKK ; Public Health Section of DKI JKT

4. SUMMARY OF PROBLEMS ON WATER QUALITY

Problems on water quality of Jakarta water supply system mentioned so far are summarized as shown in the **Table-4.1** by categories from quality standard to analysis and monitoring.

Table-4.1 SUMMARY OF PROBLEMS ON WATER QUALITY OF JAKARTA WATER SUPPLY SYSTEM

SUMMARY OF PROBLEMS ON WATER QUALITY	Tap Water of Jakarta Water Supply System is not Potable at Present.	Bacteriological quality is not good, chemical almost good. Zero Re. Cl2 is 3 to 24% and Plus E. Coli is 13 to 25%
ITEMS RELATED	EXISTING CONDITIONS ON WATER QUALITY OF THE SYSTEM	PROBLEMS FACING AT JAKARTA WATER SUPPLY SYSTEM
QUALITY STANDARD	Potable for treated water, Clean water for house tap	Water from tap must be boiled for drinking.
	Values are same with WHO guideline except for Pb & As.	High concentration thereof may cause disease.
WATER SOURCES		
JATILUHUR DAM	Eutrophication and deoxidization is developed.	Problems on odor and treatment process be occurred.
CISADANE RIVER	Quality seems fair but data numbers are not enough.	Future quality and its preservation is hard to estimate.
RIVERS IN DKI	More downstream poorer quality, sometimes BOD 20 mg/l.	Conventional treatment is not applicable any more.
GROUNDWATER	Quality of groundwater is deteriorated.	Quality of shallow wells is poor, sometimes harmful.
RAW WATER CONVEYANCE		
WEST TARUM CANAL	Quality becomes very poor after Bekasi river confluence.	Conventional treatment is difficult. Cl2 consumed.
CANALS IN DKI	Very poor quality, sometimes BOD over 20mg/l.	Conventional treatment is not applicable any more.
WATER SUPPLY FACILITIES		
TREATMENT PLANT	Detergent and Mn sometimes over limit.	Existing plants not always produce potable water.
	Other plants than Buaran record + E.Coli seldom.	
MINI PLANT	Plants in north parts produce poor finished water.	Conventional treatment is not applicable any more.
DISTRIBUTION PIPES	Deteriorated secondary tertiary mains much exist.	Deteriorated pipes worsen treated water quality.
	Very poor quality around boundary of distribution zones.	Long retention of water worsens quality.
SERVICE CONNECTION	Cross connection with private well still exists.	Deteriorated well water will enter into pipelines.
	Direct pumpage form distribution mains still exists.	Suction of dirt water from pipe exterior be occurred.
	Many service pipes are deteriorated.	Deteriorated pipes worsen treated water quality.
	Receiving tanks are very popular throughout the City.	Long retention in the tanks worsens water quality.
OPERATION & MAINTENANCE		
WEST TARUM CANAL	Desludging Bekasi silt-trap causes high turbid water.	Filter run shortens much, sometimes plant operation stops.
TREATMENT PLANT	Chlorine control for oxidization is not adequate.	Mn sometimes and E. Coli seldom exist in finished water.
SERVICE CONNECTION	Cleaning of receiving tanks is not always done.	Poor maintenance of the tanks worsens water quality.
		Long retention of water in the tanks worsens quality.
ANALYSIS AND MONITORING		
CENTRAL LABORATORY	Only half parameters are analyzed in central labo.	Space and equipment for analysis of labo are not enough.
REPORTING	Reporting procedures are complicated and not followed.	Quality problem and its remedial measure not obtained.
DISTRIBUTION PIPES	Quality in distribution mains is not monitored.	Quality deterioration by pipe or connection is not known.

5. IMPROVEMENT OF THE EXISTING SYSTEM FOR BETTER WATER QUALITY

Measures to recover or reduce problems on water quality stated in the previous section is described hereunder. Firstly, measures taken recently or under way are mentioned and secondly those shall be taken in the future is studied.

5.1 MEASURES TAKEN OR UNDER WAY

5.1.1 Raw Water

(1) Bypass Channel Construction

A plan of WTC improvement with bypassing Bekasi river is proposed in JWSSP. The plan is very effective not only for reducing BOD and NH4-N values but also for reduction of very high turbidity, both of which are described in the section 3.1. Construction of the bypass channel in early occasion is expected.

(2) Prokasih

Prokasih (Program Kali Bersih) is going on by the local government under supervision of BAPEDAL for specified 22 rivers focusing on industrial sewage conditions. DKI together with Provincial government of West Jawa is implementing the program for Ciliwung, Cisadane, Bekasi and Cipinang rivers and Mookervaat canal.

The program includes monitoring of waste water quality from industrial factories and provides instruction to the factory owners to give appropriate measures for improving the waste water quality, when the quality exceeds the national standard for industrial sewage.

As a result of implementation of PROKASIH, the toxic effluent has been decreased in Jakarta through monitoring of river water quality.

5.1.2 Water Supply System

(1) Shift of Intake Site

Shift of water intake site for Pull Gaduing treatment plant was completed in 1993. New water intake is located at Pondok Kelapa Indah of WTC, and the transmission main connecting the intake and the plant is of concrete pipelines with a 2,200 mm diameter and 8,500 m long.

Shift of intake for Pejompongan plants I and II is under implementation by PAM JAYA with new intake site at Cipinang Muara of WTC and two transmission mains of 1,600 mm in diameter and 11,500 m in length. Its construction shall be completed as quick as possible to supply good quality water to consumers.

(2) Dosing of Powdered Carbon at Mini Plants

Such drastic improvement of the system as the above (1) is not always practicable, especially for small scale treatment plants. Instead, the plant are equipped with powdered carbon, and fed it with 2 to 3 mg/l usually. As an immediate step, it is preferable to increase of its dosing ratio to 5 to 10 times than the present practice.

(3) PAM JAYA System Improvement Project (PJSIP)

PAM JAYA System Improvement Project has two major purposes. One is to raise service coverage and the other is to reduce unaccounted-for water. Goal of the project is to increase number of service connections approximately 360,000 and to decrease unaccounted-for water to 30 % in the year 2000. The project is divided into to phases, namely PJSIP-1 and -2, and the former is underway of implementation.

By replacement of distribution mains and service connections, contamination of pipe interior is removed and deterioration of water quality through pipelines is expected to decrease greatly. Cross connection or direct pumpage on service mains will also be detected and mended by the replacement.

5.2 MEASURES TO BE TAKEN

5.2.1 Raw Water

(1) Jatiruhur Dam Water

Jatiruhur dam has been biggest water source for Jakarta water supply system, and will also be the biggest even in the future. Thus, maintaining quality of the dam water in suitable range is very important to produce potable water at treatment plants and supply the same to the consumers.

Measures for maintaining the water quality in good condition includes construction of a small reservoir where raw water is given appropriate quality improvement measure such as artificial aeration systems, construction of sewerage system in upper city including Bandung and construction of multilevel water intake so as to take good quality surface water.

(2) Cisadane and Western Rivers

As previously described, quality data of raw water of Cisadane and other rivers located western part of Jakarta is insufficient to study future water treatment method or necessity of improvement of the river water quality. Quality data related to Jakarta water supply shall be accumulated as much as possible.

However, it is said important to keep the present level of or to improve water quality of Cisadane and other rivers. For the purpose, such measures as construction of sewerage system or measures to prevent the river basin from dumping contaminants in it.

On going Jabotabek water quality management project is considered to study Cisadane and western rivers, and it is expected to obtain appropriate measures for the above purposes.

(3) Groundwater

In order to decrease both quality and quantity problems, abstraction of groundwater water shall be restricted in the future. As to magnitude of the restriction, refer to ANNEX-36 of the master plan.

5.2.2 Water Treatment

Chlorination in treatment process has two roles, namely oxidization and disinfection. Considering from rather high concentration of manganese and wide distribution of residual chlorine in finished water as described in the **Table-3.8** and **Table-3.9,** chlorine, especially pre-chlorine, feeding has not been always controlled properly, and oxidization of pollutant in raw water is though not always perfect. A cause for the above will be high concentration of anmonia nitrogen and improvement of raw water such as mentioned in **5.1.1 (1)** and **5.1.2 (1)** shall be realized to lower its concentration to about 1mg/l.

Thus, consumption of chlorine by the finished water may continue even in the distribution networks. This phenomenon may be a cause of tap water of poor quality. Control of chlorine feeding at each treatment plant shall be strengthened.

5.2.3 Distribution and Service facilities

(1) Zoning of Service Area

Chlorine concentration in distribution mains decreases in line with detention time in the mains. In case of such a common net work system as Jakarta water distribution system, it is difficult to identify service areas from treatment plants, and detention time of water until taps of a house or a building can hardly analyzed.
Consequently, chlorine concentration in distribution mains becomes zero which is experienced in some areas at present.

In order to lessen deterioration of water quality in the distribution mains, service area of Jakarta water supply system shall be isolated into appropriate number of zones.

(2) Maintenance of Receiving Tanks

Existence of a receiving tank regulates fluctuation of flow caused by hourly water use of each house or building and it is very useful for a stable supply of water where capacity of the public water supply systems is not sufficient or interruption of supply occurs frequently. However, it sometimes worsens quality of tap water, since it is generally installed at such a place where its maintenance is not easy and keeping its sanitary conditions well is not easy.

Distribution of the receiving tanks in the city and their conditions shall be investigated, and appropriate measures including the followings shall be taken in the future when water supply conditions of the city becomes sufficient enough.

i) Establishment of regulation for maintaining sanitary conditions of the tank.
ii) Direct connection of service facilities eliminating the receiving tanks.

6. QUALITATIVE CONSIDERATION ON FUTURE WATER SUPPLY SYSTEM

6.1 TARGET QUALITY AND ITS REALIZATION

Quality of tap water shall be potable. However, tap water nor finished water of treatment plants of Jakarta water supply system is not always drinkable. Considering variety of the problems on water quality as listed in the **Table-6.1**, it is difficult and unrealistic to obtain potable tap water within a short period.

Of course, the target on quality is placed on realization of potable water throughout the City for public health and welfare as well as for recover reliability of water supply operation of PAM JAYA. For realization of the target, a concept of stepwise improvement of water quality is employed in the Master Plan.

As shown in the table 6.2, Three steps of quality improvement from upstream to down stream of the water supply facilities, namely,

Step 1: Potable finished water at all treatment plant and distribution center,

Step 2: Potable water at the and of distribution mains, and,

Step 3: Potable tap water in the City,

are planned. As to implementation of the steps, it is also planned that Step 1 shall be realized urgently, Step 2 shall be under middle term project and Step 3 shall be until the target year of the Master Plan.

Major improvement works for realization of the target quality of each step are planned as below, and all the necessary work items are thought out and summarized in the **Section 6.5**.

Step 1: Improvement of raw water conveyance and strengthening of chlorine control at each treatment plant and distribution center,

Step 2: Improvement of distribution mains and equipment of quality monitoring system, and,

Step 3: Quality Improvement of water source and improvement of service connection including proper maintenance of receiving tanks of each consumer.

Table 6.1 STEPWISE QUALITY IMPROVEMENT AND FACILITIES FOR IMPROVEMENT

ITEMS		WATER SOURCE	RAW WATER COVEYANCE	TREATMENT PLANT	DISTRIBU-TION MAINS	SERVICE CONNECTION	REMARKS
PRESENT QUALITY				Δ	×	×	Not potable
TARGET QUALITY	STEP 1			O	×	×	Drinkable at plant
	STEP 2			O	O	×	Drinkable at pipes
	STEP 3			O	O	O	Potable tap water
FACILITIES FOR IMPROVEMENT	STEP 1		■	■			Urgently realized
	STEP 2				■		For middle term
	STEP 3	■				■	For target yaer

NOTE: O GOOD, Δ NOT ALWAYS GOOD, × POOR

6.2 QUALITY STANDARD

Water quality standard should lead in realization of potable water supply which is a goal of water supply business for every consumer. Therefore, the existing quality standard for clean water shall be omitted and the standard for water supply shall be united to the quality standard for potable water in the future, when the above Steps 1 and 2 have been completed.

As described in the **Section 2.2**, values of arsenic and lead among inorganic parameters should be improved as described in the followings.

Ministry's standard value of arsenic (As) is 0.05 mg/l which is five times higher than that of WHO guideline because IARC (International Agency for Research on Cancer) put standard of arsenic into high rank of importance defining arsenic as "carcinogenic to human being". The standard value of lead (Pb) is 0.05 mg/l which is five times that of WHO guideline. Lead is harmful substance known to cause lead poisoning and its standard value recommended to be revised to 0.01 mg/l.

As also described in the **Section 2**, Ministry of health is going to revise the existing quality standard along with WHO guideline, and improvement of the above two parameters should be included in the revision.

It is considered important to grade up the standard, but more important item is strengthening of quality monitoring performance/system which will be discussed in the latter paragraph.

6.3 RAW WATER QUALITY AND WATER TREATMENT METHOD

6.3.1 Future Raw Water Quality

Considering that treatment of raw water with present quality by conventional rapid sand filtration is almost reaching performance limit, it is necessary to maintain the present level of raw water quality or to improve it in the future. It is feared, however, from the past trend that quality of raw water might be more deteriorated in the future.

Thus, the present quality of raw water of West Tarum canal at the upstream of confluence of Bekasi river, point No. 4 as shown in the **Figure-3.1** is set up as the future quality for planning

of water treatment method. To secure the raw water quality such measures including separation of WTC and Bekasi river by bypass channel construction or by other means, preparation of proper fencing or covering of WTC for prevention of further contamination of the raw water and promotion of PROKASIH should be taken.

6.3.2 Water Treatment Method

By implementation of the above measures, conventional method with rapid sand filtration can be applied for water treatment of future water in the future. However, the following three provisions are considered necessary.

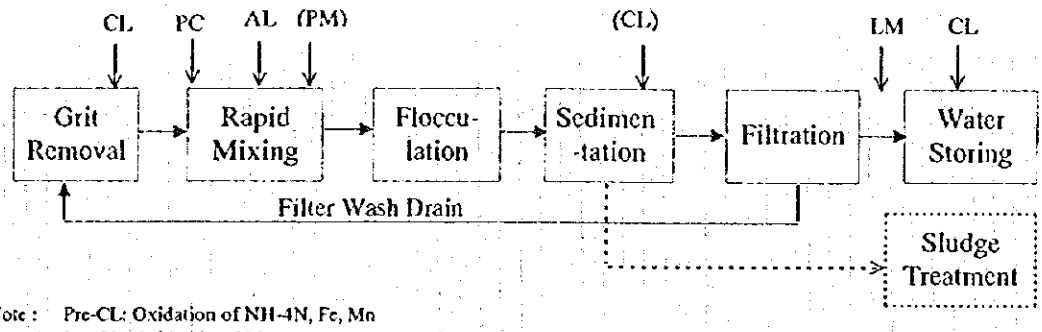
i) Pre, Post and intermediate (if necessary) chlorination shall be equipped and its operation shall be properly made introducing breakpoint chlorination methodology so as to oxidize NH4-N, Organic substance, Fe and Mn and to disinfect filtered water.
ii) For supporting coagulation and flocculation in case poor performance of alum, possibility of Polymer dosage shall be considered.
iii) Powdered carbon shall be equipped against sudden problems of raw water quality.

Discharging waste water into public watershed is controlled by issued by Ministry of Environment and Human Welfare in 1990. Although categories to be applied is not fixed yet, waste water from treatment plants of Jakarta water supply system is also controlled by the regulation.

As for waste water treatment, wash drain of filters is planned to pump back to the treatment process, and not to discharge out of the plant, for saving raw water quantity as experienced at Cisadane plant. Sludge from sedimentation basins is planned to be treated.

Thus, water treatment method for the future is planned as shown on the **Figure-6.1.**

Figure-6.1 FUTURE WATER TREATMENT METHOD



Note : Pre-CL: Oxidation of NH-4N, Fe, Mn
Int.-CL: Oxidation of Mn
Post-CL: Disinfection
PC : Sudden problem of raw water quality
AL : Coagulant
LM: pH control

6.4 MONITORING OF WATER QUALITY

6.4.1 Monitoring of Distributed Water

In order to evaluate deterioration of treated water quality in the distribution system, samples of treated water quality shall be taken not only from treatment plants and distribution centers, but also from distribution pipelines.

Basic parameters for monitoring water quality in the distribution pipelines are residual chlorine and E. Coli group. Their sampling will be from fire hydrants located on the small pipes, where retention time of water from a treatment plant or distribution center is longest. Numbers and frequency of sampling will be a few for each zone and 4 to 6 per year respectively.

6.4.2 Monitoring of Tap Water

To have responsibility on quality of water supply, PAM JAYA shall prepare a complete quality monitoring/examination system. For the purpose, apparatus and qualified personnel to analyze entire parameters in the quality standard shall be prepared at least at the existing central laboratory by some improving modification or at the newly established central laboratory.

Frequency of analysis of each quality parameter is listed in the right column of the **Table-4.1.** Parameters for daily and monthly analysis shall be analyzed regularly and commonly at each of the four large scale plants except for such parameters as TDS, CL and Detergent.

6.5 SUMMARY OF NECESSARY MEASURES FOR QUALITY IMPROVEMENT

Necessary measures for improvement quality of water supply including tentative costs for the improvements are summarized as described in the **Table-6.1.** In the table, priority for implementing the measures are also marked aiming at acquiring potable tap water at the target year of the Master Plan.

Table-6.1 NECESSARY MEASURES FOR WATER QUALITY IMPROVEMENT OF JAKARTA WATER SUPPLY SYSTEM

ITEMS RELATED	EXISTING CONDITIONS ON WATER QUALITY	NECESSARY MEASURES FOR WATER QUALITY IMPROVEMENT	PRIORITY		
			Step1	Step2	Step3
QUALITY STANDARD	Potable and clean water standard.	Standard of clean water be abandoned in future.		○	
	Pb & As values shall be smaller.	Revision of the standard for Pb&As in the future.		○	
WATER SOURCES					
		Construction of sewerage system in upper cities			○
JATILUHUR DAM	Eutrophication and deoxidization.	Equipment of artificial aeration system in Jatilufur.			○
CISADANE RIVER	Quality data are not enough.	Accumulation of quality data of raw water.	○	○	
		Study & implement quality preservation & improvement.		○	○
		Promotion of PROKASIH.	○	○	
RIVERS IN DKI	More downstream poorer quality.	Shift of raw water intake to WTC.	○		
GROUNDWATER	Groundwater quality deteriorated.	Restriction of excessive groundwater abstraction.		○	○
		Shifting promotion from groundwater to PAM JAYA water.		○	○
RAW WATER CONVEYANCE					
WEST TARUM CANAL	Quality becomes poor after Bekasi.	Bypass channel construction of WTC.	○		
		Preventive measure dumping pollutant into WTC.	○		
CANALS IN DKI	Very poor quality(BOD=20mg/l).	Shift of raw water intake to WTC.			
WATER SUPPLY FACILITIES					
TREATMENT PLANT	Detergent and Mn over limit.	Improvement of water quality of WTC.	○		
	+ E.Coli in treated water seldom.	Strengthening chemical control incl. Cl2 and carbon.	○		
MINI PLANT	Plants in north poor finished water.	Mini plants in northern Jakarta abandoned in future.		○	○
DISTRIBUTION PIPES	Deteriorated pipelines much exist.	Implementation of PJSIP throughout service area.	○	○	
	Poor quality near zone boundary.	PJSIP and Zoning of distribution network.		○	○
SERVICE CONNECTION	Cross connection still exists.	Implementation of PJSIP throughout service area.			
	Direct pumpage still exists.	Implementation of PJSIP throughout service area.			
	Many service pipes deteriorated.	Implementation of PJSIP throughout service area.			
	Receiving tanks are popular in City.	Proper maintenance of receiving tanks.		○	○
		Direct connection to house taps in the future.			○
OPERATION & MAINTENANCE					
WEST TARUM CANAL	Bekasi silt-trap causes turbidity.	Bypass channel construction of WTC.			
TREATMENT PLANT	Chlorine control is not adequate.	Application of break-point chlorination.	○		
SERVICE CONNECTION	Poor maintenance receiving tanks.	Proper maintenance of receiving tanks.			
		Direct connection to house taps in the future.			
ANALYSIS AND MONITORING					
CENTRAL LABORATORY	Central labo tests half parameters.	Preparation of space and equipment for Central labo.	○	○	
REPORTING	Reporting procedures not followed.	Curry out proper reporting and checking.	○	○	
DISTRIBUTION PIPES	Quality in pipe not monitored.	Application of quality monitoring on pipelines.		○	

6. POSSIBILITY OF CONSTRUCTION OF NEW TREATMENT PLANT AT JATILHUR

POSSIBILITY OF CONSTRUCTION OF NEW TREATMENT PLANT AT JATILHUR

Recent preliminary study on Conveyance 2 System by one private consortium recommended to construct a new water treatment plant at Pasir Gombong beside the Jatilhur Dam site far from Jakarta City and treated water is transmitted to Jakarta through the Conveyance 2.

In the preliminary study, several alternatives were considered and compared. Among the alternatives, representative options are as follows:

Option 1 (Recommended Option by the preliminary study)

Construct a new treatment plant at Pasir Gombong beside the Jatilhul Dam and treated water is conveyed from Pasir Gombong to Babakan in the south of Jakarta. Conveyance 2 is treated water transmission of which length is about 52.5 km.

Option 2

Construct a new treatment plant at Babakan in the south of Jakarta. Conveyance 2 is raw water transmission of which length is about 52.5 km from Jatilhur Dam to Babakan.

The results of cost comparison, according to the preliminary study, between the Option 1 and Option 2 is as follows:

Option 1	:	Construction cost	667,125	
		Land acquisition cost	9,825	
		Resettlement cost	7,425	
		Total	684,375	Million Rp.
Option 2	:	Construction cost	667,125	
		Land acquisition cost	13,225	
		Resettlement cost	7,425	
		Total	687,775	Million Rp.

Note : Cost shown above were calculated based on the production capacity of 10 m3/sec.

As shown above, cost difference is found in the "Land acquisition cost" and the cost difference is about 3,400 Million Rp.

In the cost comparison, cost for construction of pipeline was calculated based on the assumption that the pipe material for the transmission pipeline was RC pipe for both cases, namely as raw water transmission and treated water transmission. Therefore the cost difference is found in the item of "Land acquisition" only.

It is possible to employ open canal system or concrete pipeline system for raw water conveyance from Jatilhur to Jakarta City. However, the JICA Study Team considered that, in the case of treated water transmission from Pasir Gombong at Jatilhur to Jakarta City, conveyance system should be reliable water tight pipeline system to avoid leakage and deterioration of treated water quality. For this kind of treated water transmission pipeline, adoptable pipe material will be steel or ductile cast iron pipe. In the case of steel pipeline system, not only pipe material costs but also costs for cathodic protection are required.

In the above cost comparison, unit cost of RC pipeline construction is 5,125,000 Rp./m for the diameter 2,200 mm. On the other hand, if the pipe material is ductile cast iron pipe, unit cost of DIP pipeline construction will be about 7,700,000 Rp./m for the same diameter calculated based on the actual contract price for Buaran II Project. Difference of the unit cost becomes about 2,575,000 Rp./m.

In the case that ductile cast iron pipe is employed for the treated water transmission pipeline in the Option 1, additional cost will be calculated as follows:

2,575,000 Rp./m x 52.5 Km x 2 lines* = 270,375 Million Rp. (rounded)

Note : Option 1 required Dia. 2,200 mm x 2 lines

Comparing the additional cost, 270,375 Million Rp., and cost difference in "Land acquisition cost" which is 3,400 Million Rp. stated above, between the Options 1 and 2, the difference of the land acquisition cost becomes negligible. Total costs for Options 1 and 2 will become as follows.

Option 1	:	954,750 Million Rp.
Option 2	:	687,775 Million Rp.

Therefore, the Option 1 which propose the site of the new treatment plant at Pasir Gombong at Jatilhur is not recommendable not only from the results of cost comparison explained above but also reasons listed below.

i) Elasticity of Conveyance 2

It is recommended to convey raw water from Jatilhur to Jakarta through Conveyance 2 in order to maintain elasticity of the Conveyance 2. When small scale industrial estate or agricultural area along the Conveyance 2 required water, raw water may be able to share to these demand area. However, if the Conveyance 2 convey treated water only for drinking water supply, these water demand will not be satisfied.

ii) Far from Service Area

The location of water treatment plant is usually decided at the upstream of the service area. Treated water will be distributed in the service area along the water flow from upstream to down stream. However, in this case, area between Jatilhur and Jakarta City is rural area and does not included in the service area of PAM JAYA, and furthermore, the distance from Jatilhur to Jakarta City is more than 50 km. Water treated at the Jatilhur just pass by the area between Jatilhur and Jakarta without distribution of the treated water.

To secure sound operation of treatment plant, it is recommended to locate the treatment plant at near or in the service area. In the case that the treatment plant is constructed far from the service area and required long treated water transmission, serge control will be required.

iii) Difficulties on quick response for emergency

All chemicals and materials required including spare parts should be transfer 50 km from Jakarta to Jatilhur. In addition to the difficulties of routine activities because of long distance from Jakarta, it should be noted that quick response against sudden accident will be very difficult in terms of dispatching specialist or engineer or transferring required parts.

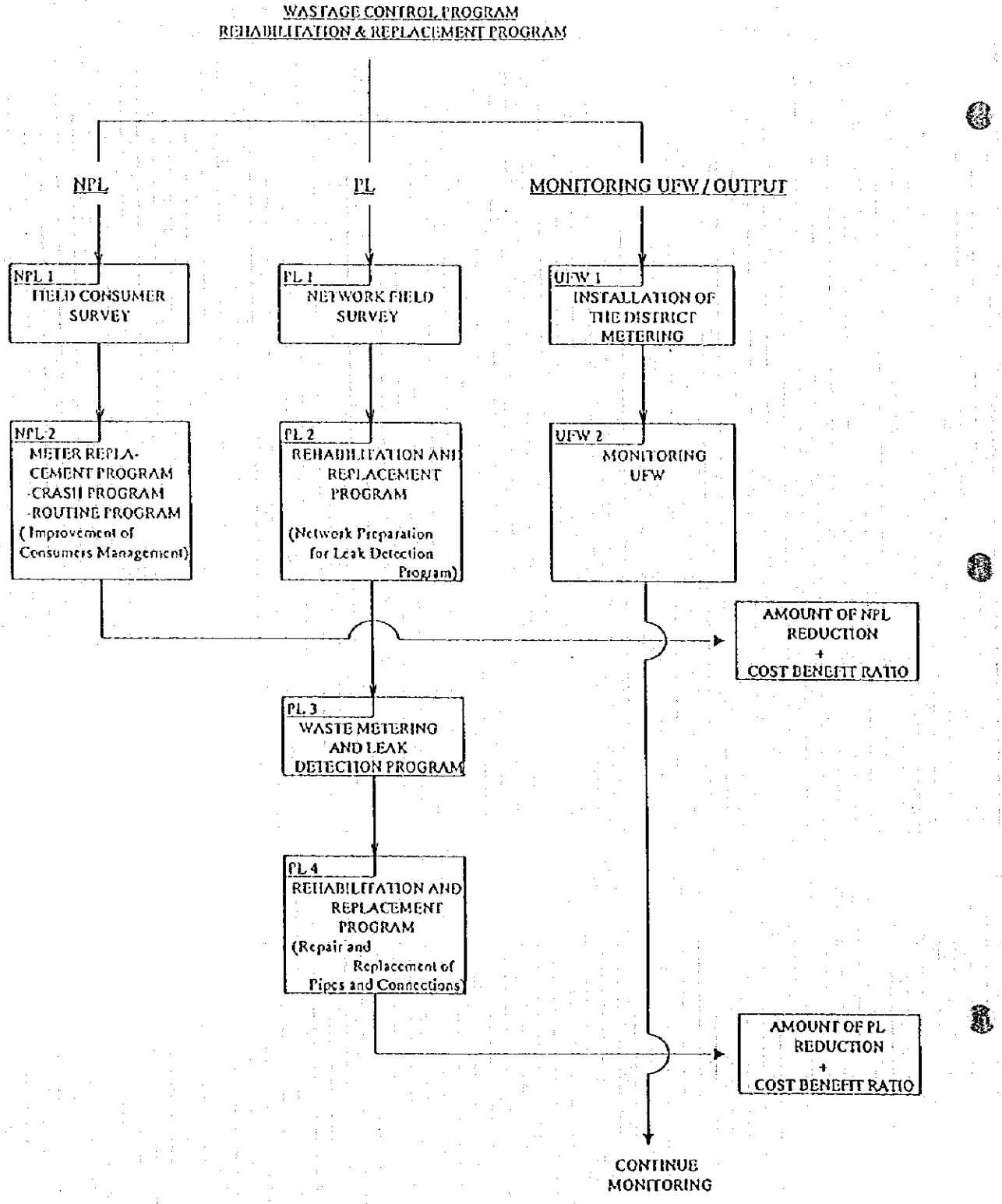
Based on the results of consideration, the option which recommends construction of new treatment plant at Jatilhur is not included as alternative plan in this study.

ANNEX-38

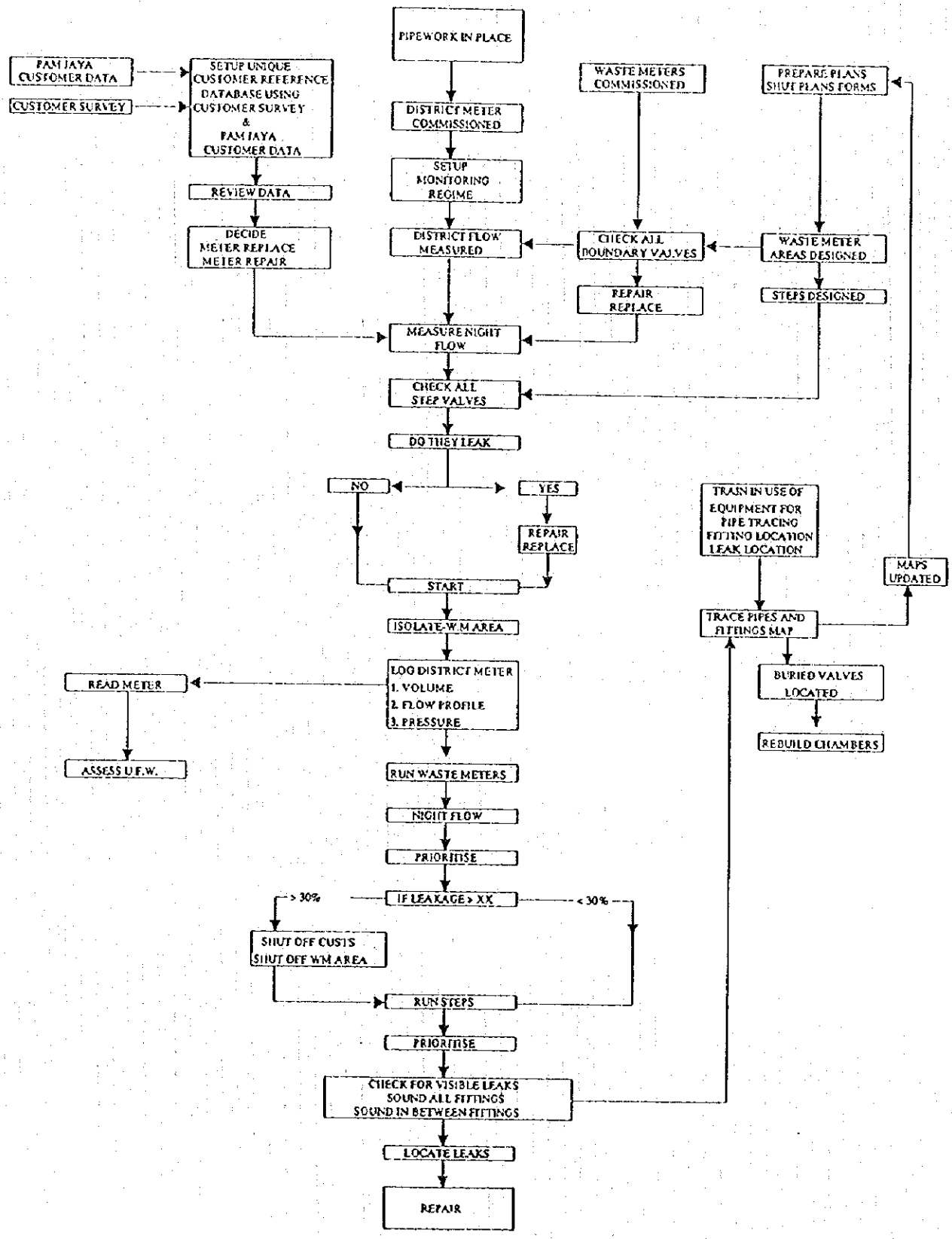
REDUCTION OF UNACCOUNTED - FOR WATER

CONTENTS OF ANNEX-38

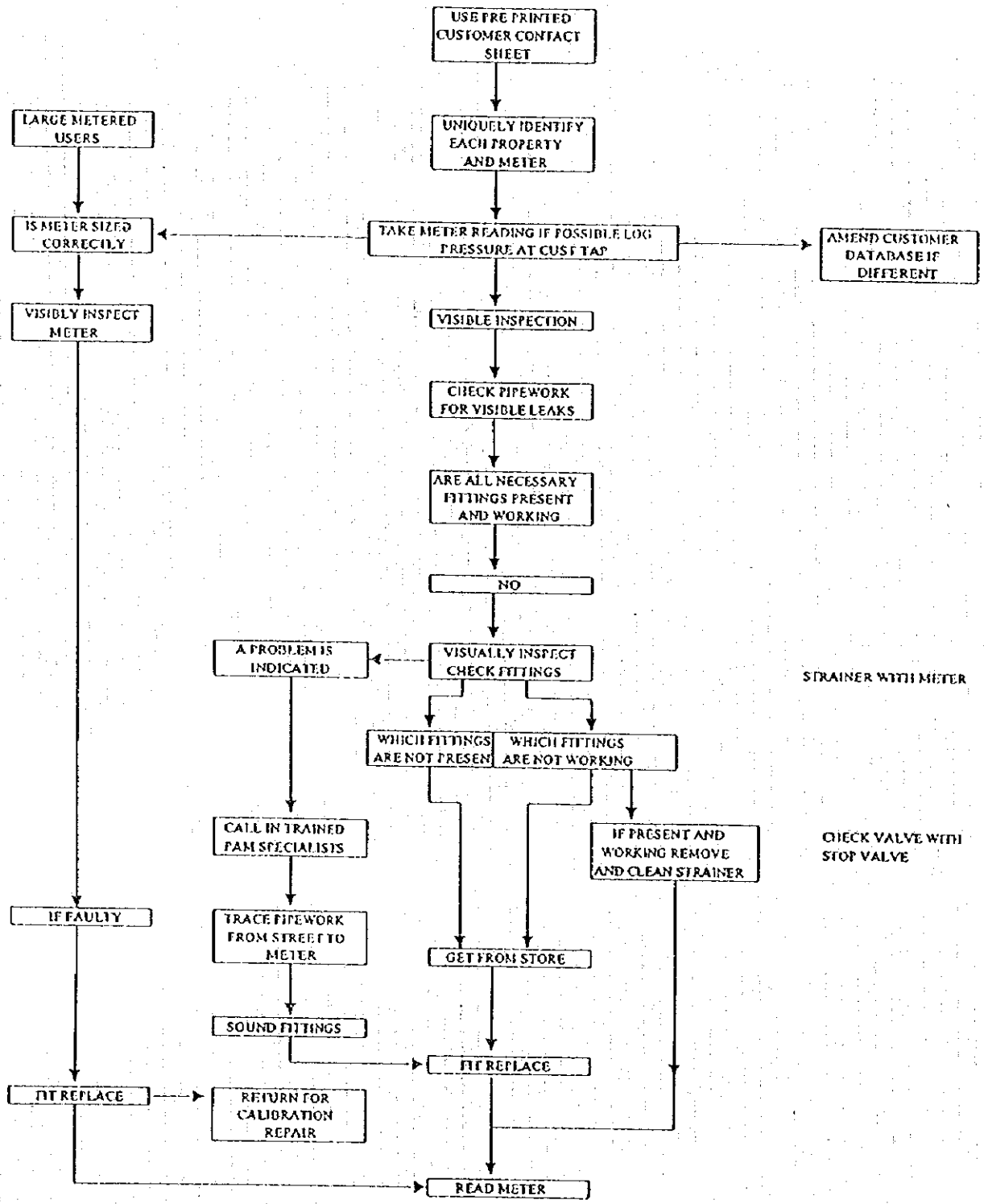
GENERAL PROGRAM OF WASTAGE CONTROL PROGRAM (IBRD)



GENERAL SEQUENCE OF PIPEWORK REHABILITATION



GENERAL WORK SEQUENCE OF METER & FITTING REHABILITATION



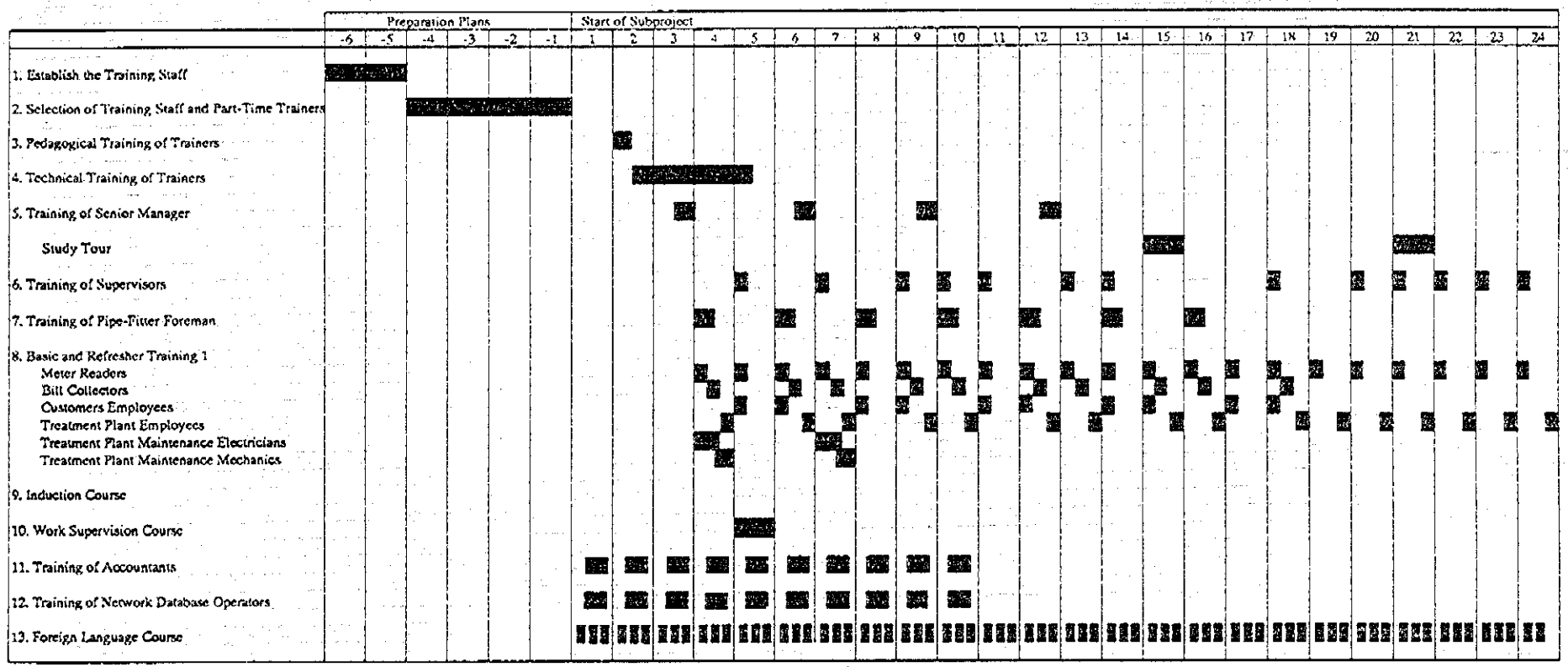
ORGANIZATION FOR UFW REDUCTION

The organization for UFW reduction should include above mentioned functions, and posts of organization should be assigned clearly the above. Therefore the present organization of PAM JAYA is recommended to improve in consideration of above mentioned each function. The style of organization of leakage protection crew varies from utility to utility; an instance is shown in **Table-O1.** (here, the total amount of survey per year is supposed 260km).

Table-O.1 EXAMPLE OF ORGANIZATION FOR UFW REDUCTION

Leakage Protection Engineer			8
Chief - Senior Engineer(Planning)	Supervisor on site		3
	Assistant to Supervisor		1
	Work scene Sketch Instructor		2
Contractor			35
Engineer in Charge	Work Chief	Assist.Chief	8
		Workmen	16
		Driver	3
	Clerical Chief	Clerk	1
	Chief Draft Man	Draft Man	3

SHORT TERM TRAINING PROGRAM



TRAINING PROGRAM PROPOSED BY PJSIP(IBRD)

(Extracted from Project Preparation Report)

1. Proposed Training Component

PDAM Jaya is in need of a strong Training Development Policy:

- the increase in manpower required
- the necessary upgrading of existing staff skills and the recruitment of new staff
- the follow-up of the Human Resources Development Program over the next 8 years

1.1 Training Organization and Method

a. A training Team will be set up in order to :

- conduct the review and assessment of the training needs
- plan training resources for both technical and non-technical staff
- define the programs of overseas training
- supervise the activities of the Training Section

b. The Training Section will fulfill its duties through full-time training supervisors, part-time in house trainers and external trainers and training organizations.

c. The Training methods to be used will be specific to the PDAM Jaya content, with direct applicability to jobs and major involvement of managers and supervisors.

1.2 Types of Training

The order of priority, the following types of training will be set up :

- management training ; for top management first, then down the line of management levels, in a carefully planned program;
- introduction/orientation training and test period, for newly appointed staff;
- pipe fitter foreman training, to be trained for the improvement project and later on to be trainers for their staff;
- basic and refresher training.

Table 2.5.3 summaries the recommended training sessions, staff to be trained and training organizations.

Annex C gives details for training equipment, aids and required facilities.

1.3 Training Implementation Program

This program is expected to start during the first year of the 6-year program (tentatively by beginning 1990) . The recommended two-year implementation program shown in Table 2.5.4 taken into account the urgent need for a Training Development Policy, the inadequacy of PDAM Jaya's present capability and the availability of the P.U.-DAB Training Center, with the cooperation of the Human Resources Development Project (HRDP).

2. Technical Assistance and Other Supporting Actions

2.1 General

In order to successfully implement the proposed rehabilitation and extension program and to complement the actions proposed in the field of management , the following supporting elements are necessary :

a. Technical assistance for the various management fields

b. Technical assistance for training

c. Complementary studies

d. Building construction

2.2 Technical Assistance

a. Due to the present lack of skilled experienced specialists in PDAM Jaya and the necessity of training present personnel quickly and efficiently, it is recommended that a Technical Assistance program be set up in order to reinforce management staff in the coming period.

An effective program should :

- provide assistance in all fields of activity, in defining objectives and targets and the procedures to meet them, and in monitoring implementation and effectiveness.

- ensure through personnel example and appropriate training the transfer of sills and know-how in order to progressively increase the staff's autonomy from the Technical Assistance and attain permanent strengthening of sills.

- provide for the management of new problems and contingencies as they arise, through the implementation of specific assistance from the appropriate specialist over the required period.

Given this framework, a particularly attractive solution could be the agreement between PDAM Jaya and an overseas water utility able to offer a broad based reservoir of skills. The overseas utility could provide practical on-site technical assistance coupled with training sessions within its own working structure, in order to reinforce PDAM Jaya's staff training abroad.

This type of "training" generally gives good results; it would include three components :

- permanent presence in PDAM Jaya of Technical Assistants working full-time in daily cooperation with PDAM Jaya Staff on particular activities (for instance water production);

- temporary short-term presence of specialists needed to implement a particular technique (for instance leak detection);

- training program.

The proposed program for Technical Assistance (T.A.) is as follows :

b. T.A. for Operation and Maintenance

The main functions would be :

- to assist the Technical Directors and the Head of Department in their daily work, in the implementation of the new program and in the commissioning of new facilities :

The estimated foreign manpower required is as follows :

- one principal technical advisor at the Board of Directors level (4 years)
- one water treatment specialist (1 year)
- one Senior distribution engineer (5 years) and three distribution engineers (2 years)

In addition, five Indonesian distribution engineers will be assisting during the 5 years.

c. T.A. for Engineering

The main function would be to assist the Head of the Engineering and Project, in the supervision of the works and in field training for the staff.
This requires one foreign senior water supply engineer for 5 years.

d. T.A. for Financial ,Management

The main function will be to implement the accounting system as described by previous consultants.
The estimated manpower requirements are as follows :

- one foreign senior financial advisor (3 years)
- one local senior financial advisor (3 years)

e. T.A. for Personnel Management

The main function will be to assist the Head of the Manpower Planning Section in implementing the Anticipate Personnel Management.
This assistance would be provided by a foreign expert over 12 months, and a local expert for 18 months.

f. Implementation schedule

The schedule foe Technical Assistance is shown in Figure 2.5.3. The corresponding cost estimates are given in section 2.5.6.below.

2.3 Supporting actions for training

a. In order to assist PDAM Jaya in the implementation of the proposed 24 months training program, technical assistance should be provided over the same period. This T.A. would comprise :

- one foreign senior consultant (18 months)
- one foreign consultant (10 months)
- Local consultants (20 months)

b. This component also includes the costs of :

- sessions outside PDAM Jaya
- Running costs
- Miscellaneous (equipment, training aids, etc)

c. The corresponding cost estimates are given in section 2.5.6 below.

ANNEX-39

OPERATION / MAINTENANCE AND MONITORING SYSTEM

CONTENTS OF ANNEX-39

RECOMMENDED MAINTENANCE PERIOD AND ITEMS (MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Transmission/ Distribution Pump	Daily Inspection	Bearing, Gland Packing' Meters, Operation Status
	Annual Inspection	Gland Packing, Lubrication Oil, Meters
	Periodical Overhaul	Bearing (1-5years) Gear Coupling (1-5years) Case (5-10years) Impeller (5-10years)
Slurry Pump	Daily Inspection	Delivery Pressure, Flow Rate Noise, Vibration, Bearing Electrical Current
	Monthly Inspection	Gland Packing, Bearing
	Periodical Overhaul (1-2years)	Disassembling Check, Attrition Liner Ring, Motor Bearing
Vacuum Pump	Daily Inspection	Vacuum Meter,Noise,Vibration Electrical Current, Supplement Water
	Monthly Inspection	Gland Packing, Bearing
	Periodical Overhaul (1-2years)	Disassembing Check, Damage Liner Ring
Motor Valve	Monthly Inspection	Drive Unit
	6-Month Inspection	Drive Unit, Screw
	Annual Inspection	Opening Indicator, Motor, Limit Switch, Painting
	Periodical Overhaul	Lubrication Oil (2years) Drive Unit (6years) Disassembling Check (3-5years)
Flush Mixer	Daily Inspection	Drive Unit, Meter, Bearing
	Annual Inspection	Drive Unit, Mixer
	Periodical Overhaul	Drive Unit, Mixer, Painting
Crane	Monthly Inspection	Rail, Hook Block, Wirerope, Brake, Grease, Motor, Switch, Fuse, Magnetic Contactor, Relay, Controller, Limit Switch No Load Test
	Annual Inspection	Structure, Rail, Coupling, Gear Wheel, Bearing, Hook Block, Wirerope, Grease, Motor, Fuse Switch, Magnetic Contactor, Relay, Resister, Electric Wiring Limit Switch, Trolly, No Load Test, Insulation Test
Power Receiving/ Distribution Panel	Weekly Inspection	Surface Dirt, Switches, Noise Locking Device
	Annual Inspection	Terminal, Wiring, Supporting Insulator, Bolt-Nut, Foreign Matter, Dirt, Measurement of Insulation Resistance/ Grounding Resistance
Motor and Control Panel	Daily Inspection	Meters, Indication Lamp, Indicator, Relay
	Annual Inspection	Dirt, Wiring, Terminal, Tag, Accuracy of Meter, Relay

RECOMMENDED MAINTENANCE PERIOD AND ITEMS
(MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Protection Relay	Weekly Inspection	Appearance, Noise, Vibration Target Indication
	Annual Inspection	Terminal, Manual Reset, Inside Dirt, Control Spring Contactor, Gear, Measurement of Insulation Resistance, Performance Test, Confirmation of Setting Value
Air Circuit Breaker	Weekly Inspection	Appearance, Packing
	Annual Inspection	Appearance, Packing
	Periodical Overhaul	Disassemlying Check (5years) Function Test (3years)
Disconnector	Weekly Inspection	Appearance,Indicator Operating Structure
	Annual Inspection	Supporting Insulator, Contactor Connector, Supplementary Switch, Interlock, Measurement of Insulation Resistance
Switch	Weekly Inspection	Appearance
	Annual Inspection	Supporting Insulator, Contactor Connector, Measurement of Insulation Resistance
Contactor	Weekly Inspection	Appearance, Noise, Abnormal Heat
	Annual Inspection	Abnormal Heat, Spring, Case, Supplemental Switch, Measurement of Insulation Resistance
Potential Transformer	Weekly Inspection	Appearance, Noise, Oil Leakage
	Annual Inspection	Terminal, Grounding, Measurement of Insulation Resistance /Grounding Resistance
Underground Cable	Weekly Inspection	Insulation Condition, Ground Condition, Cable Head, Manhole, Connector, Indicator, Other Construction Work
	Annual Inspection	Terminal, Grounding, Conduit Pipe, Measurement of Insulation Resistance/ Grounding Resistance
Surface Cable	Weekly Inspection	Cable Protection, Ground Sinking, Indicator
	Annual Inspection	Drainage, Pull Box, Terminal Grounding, Measurement of Insulation Resistance/ Grounding Resistance
Transformer	Daily Inspection	Voltage, Frequency, Current, Power Factor, Temperature Load Consumption, Dirt, Noise, Vibration, Abnormal Odor, Terminal

RECOMMENDED MAINTENANCE PERIOD AND ITEMS (MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Transformer	Weekly Inspection	Insulator, Foreign Matter, Vibration, Cooling Fan, Oil Level Nitrogen Pressure, Humidity Absorber, Oil Leakage, Water Leakage, Temperature of Cooling Water
	Annual Inspection	Appearance, Insulator, Terminal Anti-shock Device, Cooling Fan Temperature, Relay, Valve, Measurement of Insulation Resistance/Grounding Resist. Oil Level and Pressure, Gas Detecting Relay, Cooling Water Purity of Nitrogen, Insulation Test of Oil, Toal Oxidation Test of Oil
Motor	Daily Inspection	Operation Status, Bearing, Cooling Facility, Environment
	Annual Inspection	Appearance, Bearing, Slip Ring
Flow Meter (Differential Pressure Type)	Annual Inspection	Appearance of Wiring, Piping, Transformer, Measurement of Insulation Resistance, Air Release, Zero Point Adjust-ment, Span Adjustment,Calibration
Level Meter (Pressure Type)	Annual Inspection	Appearance of Wiring, Piping, Transmitter, Measurement of Resistance, Air Release,Zero Point Adjustment, Span Adjustment, Calibration
Level Meter (Electrode Type)	Annual Inspection	Appearance of Wiring, Connector, Electrode, Relay Test
Pressure Meter	Annual Inspection	Appearance of Wiring, Senser, Transmitter, Measurement of Insulation Resistance, Zero Point Adjustment, Span Adjustment, Calibration
Temperature Meter	Annual Inspection	Appearance of Wiring, Senser, Transmitter, Measurement of Insulation Resistance, Zero Point Adjustment, Span Adjustment, Calibration
pH Meter	Weekly Inspection	Apperance of Wiring, Transmitter, Zero Point Adjustment, Span Adjustment, Calibration
	6-Month Inspection	Appearance of Wiring, Connector
	Annual Inspection	Appearance of Wiring, Connecter, Measurement of Insulation Resistance
Turbidity Meter	Daily Inspection	Appearance of Lamp, Cleaner
	Weekly Inspection	Appearance of Transmitter, Zero Point Adjustment,Debubbling Case

RECOMMENDED MAINTENANCE PERIOD AND ITEMS (MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Turbidity Meter	Monthly Inspection	Appearance of Transmitter, Zero Point Adjustment, Calibration, Debubbling Case
	6-Month Inspection	Appearance of Piping
	Annual Inspection	Appearance of Piping, Measurement of Insulation Resistance
Residual Chlorine Meter	Daily Inspection	Appearance of Metering Pump, Reagent Volume, Cleaning
	Weekly Inspection	Overflow Tank,
	3-Month Inspection	Appearance of Transmitter, Zero Point Adjustment, Span Adjustment, Calibration
	6-Month Inspection	Appearance of Piping, Connector
	Annual Inspection	Appearance of Piping, Connector, Measurement of Insulation Resistance
Indicator/Recorder	Daily Inspection	Appearance of Recorder, Pen, Ink
	6-Month Inspection	Appearance of Moving Part, Sliding Part
	Annual Inspection	Appearance of Piping, Connector
Mixing Chamber	Annual Inspection	Working Condition of Valve
	Periodical Inspection (2-3years)	Crack of Concrete, Leakage, Cleaning of Chamber
Flocculation Basin	Annual Inspection	Working Condition of Valve, Crack of Concrete, Leakage
	Periodical Work (3-5years)	Cleaning of Basin, Painting
Sedimentation Basin (Horizontal Flow Type)	1-3 Month Inspection	Accumulating Condition of Sludge
	Annual Inspection	Crack of Concrete, Cleaning of Basin
Filter	2-6 Month Inspection	Condition of Wall, Trough, Washing Drain, Cleaning, Damage of Surface Water Washing
	Annual Inspection	Crack of Concrete, Investigation of Filter Media, Movement of ,Filter Media, Underdrain
	Periodical Work	Supplement of Filter Media (when 10% decrease in hight) /Replacement of Filter Media (10-20years)
Chlorination Facility A. Cylinder	Daily Inspection (3 times a day)	Leakage, Appearance, Abnormal Pressure, Room Temperature/Humidity
	(once a day)	Condition of Cylinder Fixing, Stock Volume
	6-Month Inspection	Adjustment of Platform Weigh Scale
	Annual Inspection	Checking of Corrosion, Damage of Facility, Checking of Hoist Inspection of Cylinder

RECOMMENDED MAINTENANCE PERIOD AND ITEMS (MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Chlorination Facility (Evapolator)	Daily Inspection (3 times a day)	Abnormal Pressure, Abnormal Temperature, Checking of Heater Delivery Pressure of Circulating Pump Temperaturetion Oil, Noise, Leakage from Gland
	6-Month Inspection	Test of Moving, Pressure Test of Piping, Gas Tube, Cleaning of Filter
	Annual Work	Replacement of Water
	Periodical Inspection (2-4years)	Disassembling Check of Piping/Gas Tube, Painting
C. Chlorinator	Daily Inspection (3 times a day)	Checking of Leakage, Meter, Abnormal Pressure, Temperature of Heater, Water Supply Pressure, Confirmation of Feeding Rate
	6-Month Inspection	Flow Meter Test,/Adjusting Device/ Alarm System
	Annual Work	Replacement of Filter Media
	Periodical Work (3-5years)	Disassembling Check of Control System Painting
D. Valve and Piping	Daily Inspection (3 times a day)	Appearance and Moving Condition of Valve, Leakage, Moving Condition of Safety Valve, Opening Indicator
	6-Month Inspection	Moving and Pressure Test of Emergency Shut Off Valve/ Other Valves
	Annual Inspection	Moving Test of Safety Valve, Disassembling Check of Isolation Valve of Safety Valve,Replacement of Spiral Tube/Silver Plate of Safety Valve/Receiving Flexible Pipe
	Periodical Work (3-5years)	Painting
E.Neutralization Facility	Inspection in Operation	Leak from Neutralization Tower/ Fraange, Flow Condition of Caustic Soda, Damage and Vibration of Piping, Abnormal Noise Electrical Current, Temperature, Volume of Lubricating Oil, Delivery Pressure
	Daily Inspection	Liquid Level of Caustic Soda
	6-Month Inspection	Appearance, Corrosion, Damage, Appearance of Function of Pump/Exhaust Fan Total Operation Test
	Annual Work	Cleaning of Neutralization Tower
	Periodical Work (2-5years)	Dis assembling Check of Exhaust Fan, Painting
	Occasional Work (on occasion)	Flushing of Neutralization Tower, Measurement of Density and Temperature of Caustic Soda

RECOMMENDED MAINTENANCE PERIOD AND ITEMS (MAJOR EQUIPMENT AND FACILITIES OF TREATMENT PLANT)

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
F.Air Compressor	Inspection in Operation	Abnormal NNoise, Odor, Vibration, Slackness of Belt, Checking of Lubrication Oil/ Delivery Pressure/Electrical Current/Temperature of Dehumidifier/ Disconnection of Heater/Noise of Blower/ Leakage from Valve, Abnormal Noise of Air Chamber, Condition of After -Cooler Flow
	3-Month Inspection	Measurement of athe Dew Point of Dehumidifier
Clear Water Reservoir	Daily Inspection	Water Level, Water Quality, Protection Facility of Pollution, Flow Rate of Transmission
	Monthly Inspection	Function Test of Level/Flow Meter, Corrosion of Chlorine Injection
	Annual Inspection	Crack of Concrete, Function Condition
Yard Piping	Refer to the recommended maintenance period and items if transmission /distribution facility	

Maintenance Period and Items of Transmission/Distribution Facility

NAME OF EQUIPMENT	KIND OF INSPECTION	INSPECTION ITEMS
Pipe and Fittings	Monthly Inspection	Leakage, Manhole Cover, Road Condition
	Annual Inspection	Valve, Valve Chamber
	Periodical Check and Work (1-3years)	Ground Water Leakage, Cleaning of Chamber
Pipe Bridge	Monthly Inspection	Leakage, Condition of Fence/ Sign Board
	Periodical Work (3-5years)	Painting

INFORMATION MANAGEMENT OF WATERWORKS PIPELINE

INFORMATION MANAGEMENT OF WATERWORKS PIPELINE

In order to improve the customer service and to take prompt action against pipeline accident it is necessary to establish an Information Management System of Waterworks Pipeline including management of drawings.
The Information Management is divided into two categories of direct management and indirect management as shown in **Figure-1.**

The Master Plan provides detail of Direct Management because this is essential of management of pipeline including house connection and customer services.

1. SCALE OF DRAWING

Generally the scale of drawing is divided into three categories of large, medium, and small scale, as shown on **Table-1.**

Table-1 Example of Scale for Pipeline Drawing

CATEGORY	SCALE	ACTUAL LENGTH	LENGTH ON DRAWING
Large Scale	1/500	5 m of pipe	10 mm
	1/1000	5 m of pipe	5 mm
Medium Scale	1/2500	5 m of pipe	2 mm
	1/5000	5 m of pipe	1 mm
Small Scale	1/10000 and under	5 m of pipe	0.5 mm and under

2. CLASSIFICATION OF DRAWING AND LEDGER

The various kinds of drawings and ledgers are necessary for management of pipeline, and example is shown in **Table-2.**

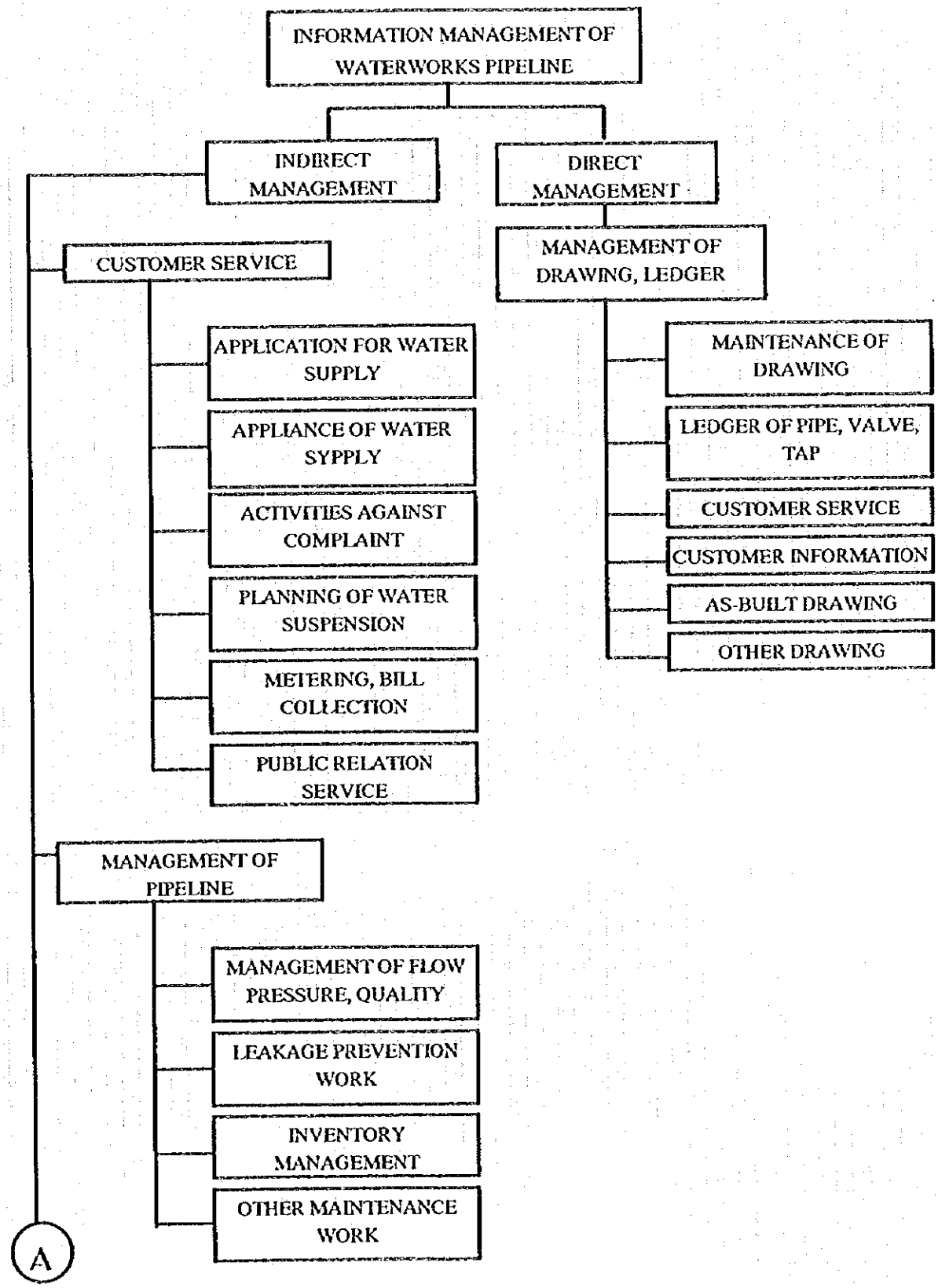
3. Correction and Preservation of Drawing

The drawing should be corrected periodically to keep accuracy of drawing for maintenance of the facility.

1) Organization
The organization for drawing correction work should be established to smooth execution of correction work.

2) Filing of Drawing
There are three kinds of filing method of map locker, micro film, and electronic filing, the each characteristics of filing is described in **Table-3, Table-4,** and **Table-5.**

Figure-1 INFORMATION MANAGEMENT OF WATERWORKS PIPELINE



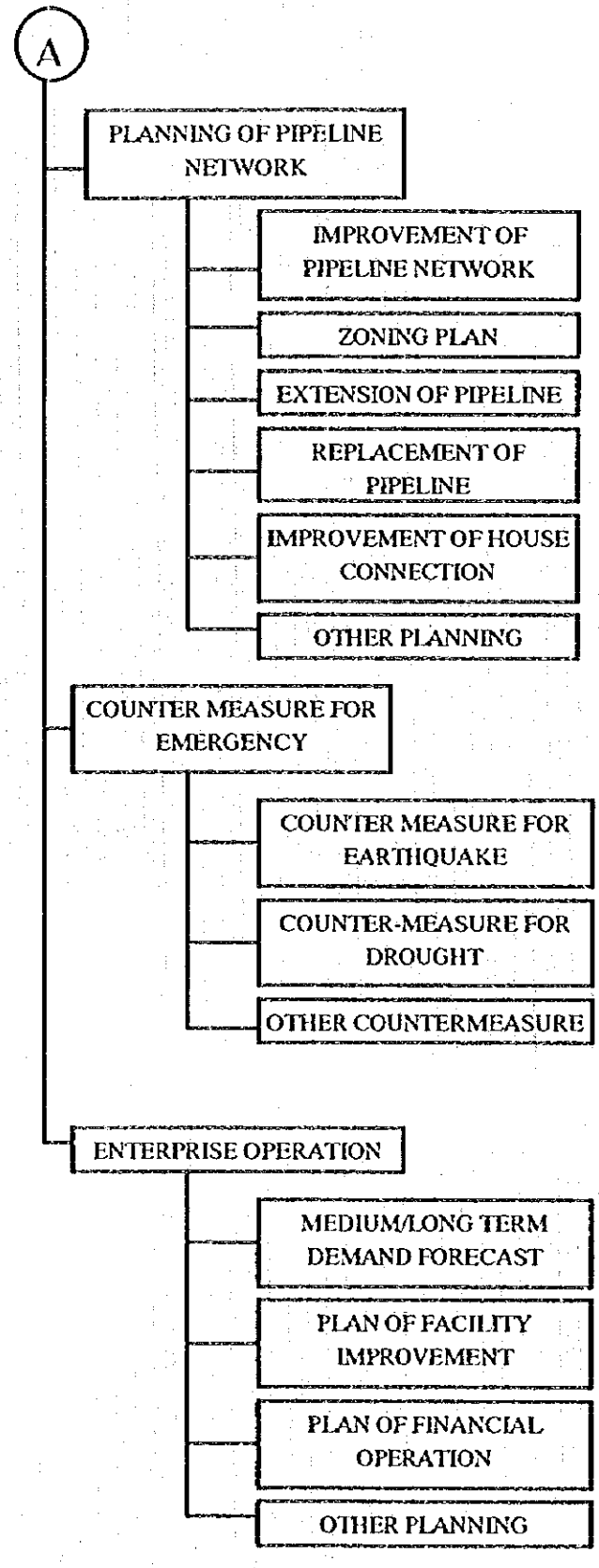

A
PLANNING OF PIPELINE NETWORK
IMPROVEMENT OF PIPELINE NETWORK
ZONING PLAN
EXTENSION OF PIPELINE
REPLACEMENT OF PIPELINE
IMPROVEMENT OF HOUSE CONNECTION
OTHER PLANNING
COUNTER MEASURE FOR EMERGENCY
COUNTER MEASURE FOR EARTHQUAKE
COUNTER-MEASURE FOR DROUGHT
OTHER COUNTERMEASURE
ENTERPRISE OPERATION
MEDIUM/LONG TERM DEMAND FORECAST
PLAN OF FACILITY IMPROVEMENT
PLAN OF FINANCIAL OPERATION
OTHER PLANNING

Table-2 Example of Classification of Drawing and Ledger

CLASSIFICATION	NAME	CONTENTS
Drawing of Pipeline	Drawing of House Connection	Large Scale Drawing (1/500) House Connection, Meter
	Large Scale Pipeline Drawing	Distribution Pipeline, Fittings, Detail of Pipe, Premise (1/500 - 1/1000)
	Medium Scale Pipeline Drawing	Distribution Pipe, Fittings, Major Building (1/2500 - 1/5000)
	Small Scale Pipeline Drawing	Raw Water Intake, Treatment Plant Clear Water Reservoir, Transmission Trunk Main Distribution Trunk Main (1/10000 - 1/50000)
	Others	Planned Pipeline, Old Pipeline Pipe Bridge, Cross Section on Railway Crossing, Drawing of Pressure Distribution, Drawing of Leakage Distribution, Drawing of Pipe Occupation
	Records	Number of Pipe, Type of Pipe, Diameter, Function ,Valve Operation
Ledger of Fittings	Ledger of Valve	Valve, Drain Valve, Air Valve Pressure Reduction Valve
	Ledger of Hydrant	Fire Hydrant
	Ledger of Monitoring	Flow Meter, Pressure Meter
	Others	Pump, Pipe Bridge
Ledger of Customer	Ledger of Customer	Appliance, Name of Customer
	Others	Installation of Receiving Tank
Record of Information	As-built Drawing of Pipeline	Status of Completion
	Daily Report of Construction	Progress of Construction
	Daily Report of Maintenance	Work Item
	Pressure Record	Pressure Measurement Data
	Flow Record	Flow Measurement Data
	Water Quality Record	Water Quality Measurement Data
	Record of Accident	Contents of Accident, Activities
	Record of Disaster	Contents of Disaster, Countermeasure
Others	Ledger of Fixed Asset	Status of Fixed Assets
	Ledger of Tools and Materials for Disaster	Storage Status of Tools and Materials for Disaster

Tab-3 MAP LOCKER AND CHARACTERISTICS

TYPE	CHARACTERISTICS
Hanger Folder	a. Easy movement and replacement
	b. Large space is necessary
Map Locker	a. Easy retrieval
(Cylinder)	b. Large space is necessary
Map Locker	a. Small space is enough
(Cabinet)	b. Retrieval needs time

Table-4 TYPE OF MICROFILM AND CHARACTERISTICS

TYPE	CHARACTERISTICS
Roll Film	a. Map is retrieved in time sequence
	b. Retrieval is in -efficient
Aperture Card	a. Large space is necessary
Microfiche	a. Large number of map can be stored

Table-5 COMPARISON BETWEEN MICROFILM AND ELECTRONIC FILE

ITEM		MICROFILM	ELECTRONIC FILE
Type	Record	Photograph	Electric Signal
	Media	Photograph Film	Optical Disk
Operation	Retrieval Speed	Slow	Fast
	Retrieval Method	Limited	Numerous Method can be applied
	Hard copy	High Price	Low Price
	Less-space ability	Effective	Highly Effective
Others	Long Term Storage	Semi-permanent	About 10 years (permanent for copied data)
	Mapping System	Difficult for on-line operation	Easy for on-line operation