CHAPTER 6

EXISTING CONDITION OF WATER SUPPLY SYSTEM

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6.1 General

Water supply systems of Sleman Regency and Bantul Regency are managed, operated, and maintained by respective regencies' PDAMs and PU. PDAM is mostly in charge of urban areas and PU has responsibilities for community water supply system in rural area. Respective PDAMs in Sleman and Bantul were established in 1982 as BPAM under PU. BPAM had been operated and managed with emphasizing service area expansions. In 1992, BPAM was turned into an enterprise organization named PDAM, for aiming a self-supporting accounting system and has been managed up to the present.

Yogyakarta water supply system was transferred to PDAM Yogyakarta from Dutch company by authority of the regulation (Perda 3/1976) enforced in 1976. In 1992, Kotagede water supply facility was devolved by PU and transferred to the PDAM Yogyakarta. Furthermore, in 2002, PDAM constructed water treatment facility at Bedog water supply facility that was originally designed and operated with use of groundwater as water sources.

In 2004, PDAM constructed additional treatment facility for Karamgayam water supply facility to treat Iron and Manganese. Karamgayam system was originally designed for groundwater supply system without treatment. At present, PDAM Yogyakarta owns and operates four (4) water supply facilities including Gemawang reservoir and supply water to inhabitants in Yogyakarta Municipality.

According to Memorandum of Water Program and Drinking Water Project (Memorandum Program Dan Proyek Air Minum hereinafter the "Memorandum Report") which was prepared by Departmen Pederjaan Umum Directorat Jenderal Cipta Karya in order to support the target of PRJM (Development plan for 2004-2009) and MDGs (Millennium Development Goals for 2010-2015) for DIY in 2006, outline of the water supply systems in the study area are described as follows:

(1) Yogyakarta Municipality Water Works: PDAM Yogyakarta

Yogyakarta Municipality is an urbanized area, having an administrative area of 32.5 km2 and about 394,000 populations in 2004.

A water supply system in the municipality is managed by PDAM. Service ratio of the piped water supply system is around 40%.

Major water sources are Umbulwadon spring water and groundwater in Sleman Regency and groundwater in Yogyakarta Municipality.

(2) Sleman Regency Water Works: PDAM Sleman

Sleman Regency is located north of Yogyakarta Municipality, having an administrative area of 574.82 km2 and about 895,000 populations in 2004. Around 50% of the residents are living in urbanized area. Service ratio by individual house connection remains about 10 %.

Major water sources are Umbulwadon spring water and groundwater. Some portion of spring water from Umbulwadon is transmitted to service reservoirs in PDAM Yogyakarta directly, pass through the Sleman Regency.

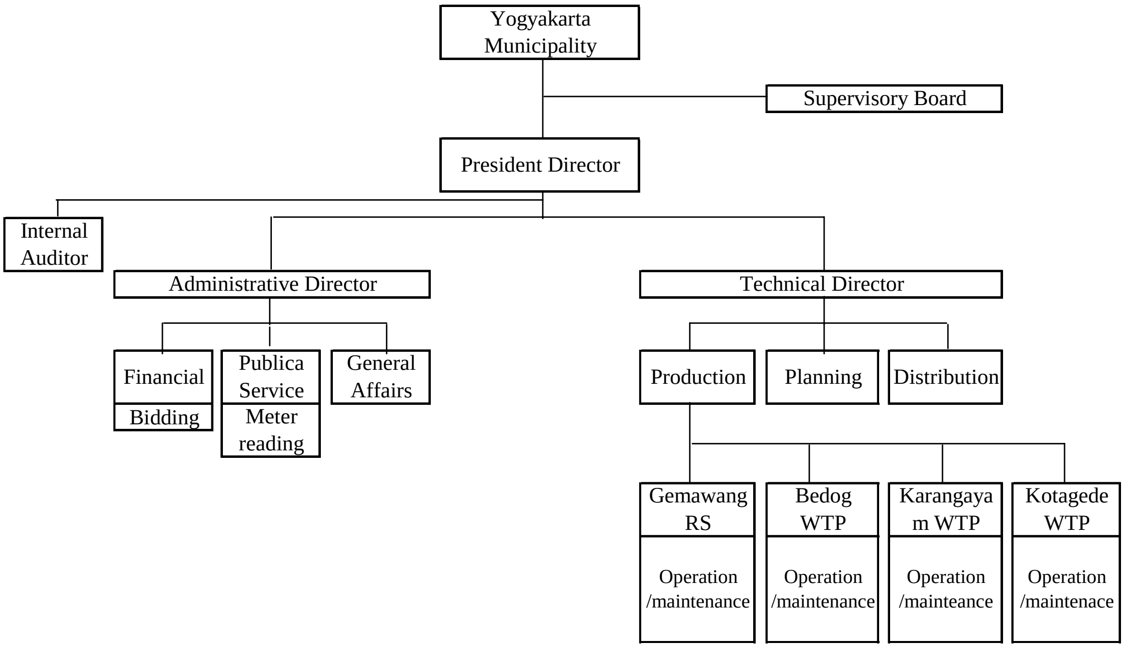
(3) Bantul Regency Water Works: PDAM Bantul

Bantul Regency is located south of Yogyakarta Municipality, having an administrative area of 506.85 km2 and about 799,000 populations in 2004. Around 31% of the residents are living in semi-urban area. Service ratio by individual house connection remains less than 10 %.

6.2 PDAM Yogyakarta System

6.2.1 Organization

PDAM Yogyakarta is a water supply enterprise organization, having 151 technical staffs and 146 administrative staffs. An organization chart of PDAM Yogyakarta is shown in Figure 6.2.1.

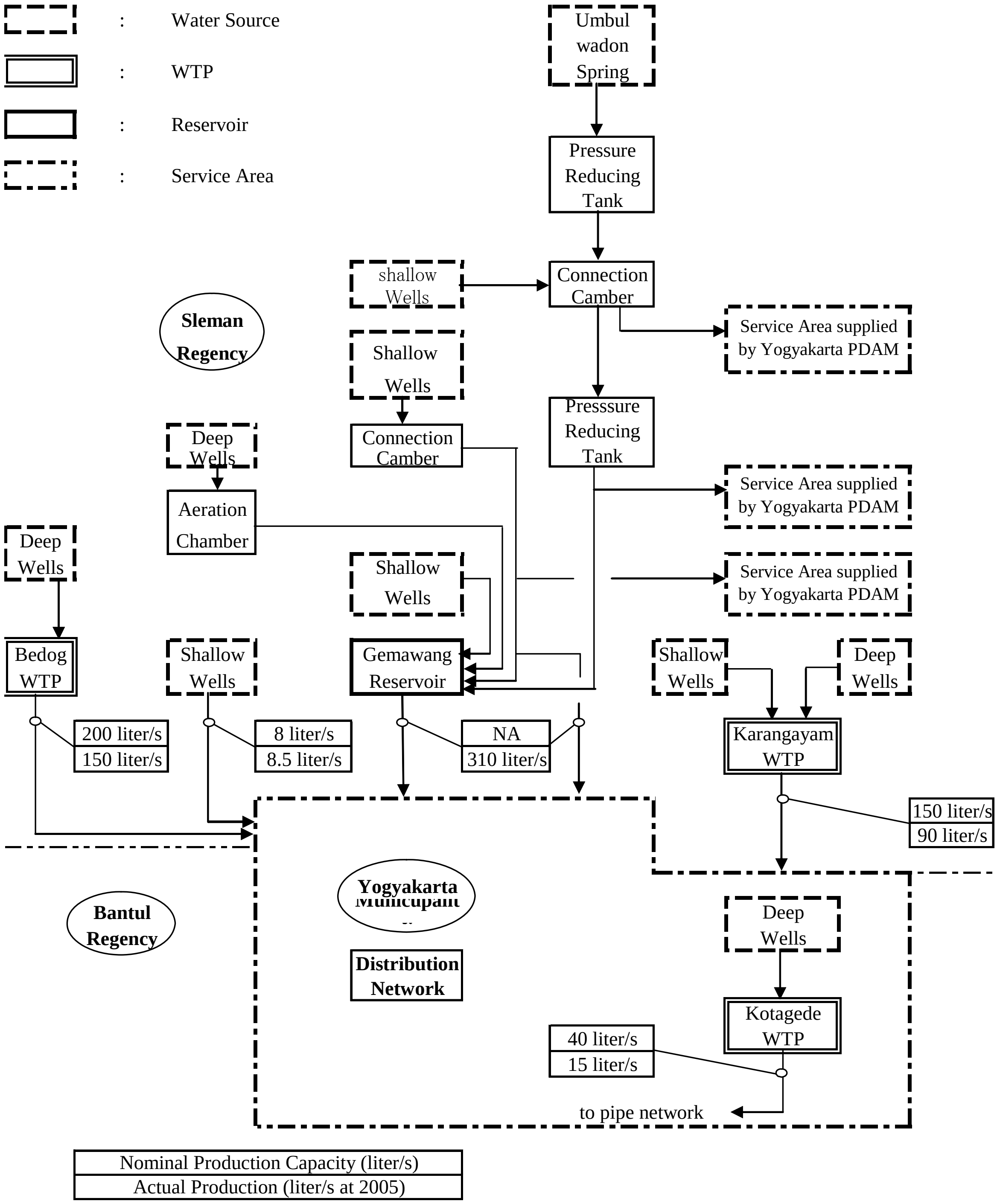


Source: PDAM Yogyakarta

Figure 6.2.1 Organization Chart of PDAM Yogyakarta

6.2.2 Water Supply System

A schematic flow of water sources and water transmission system is shown in Figure 6.2.2. As shown on this figure, most of the water sources exist in Sleman Regency and they are transmitted to Yogyakarta Municipal area. Major inputs from the Sleman Regency are from Gemawang Reservoir (spring water from Umbul Wadon Spring), Bedog WTP and Karangayam WTP. Only one system named Kotagede WTP exists in jurisdiction of Yogyakarta Municipality.



Source: PDAM Yogyakarta

Figure 6.2.2 Schematic Flow of Water Sources and Water Transmission

It should be noted that PDAM Yogyakarta has its service area in Sleman Regency along the transmission pipeline from Umbulwadon spring in Sleman to Yogyakarta. Althrough these service areas exist in Sleman Regency, they are managed by PDAM Yogyakarta

A typical treatment process flow is shown in Figure 6.2.3. Since Iron and Manganese concentration are rather high, treatment plant has aeration system and filters for oxidization and removal of these substances.

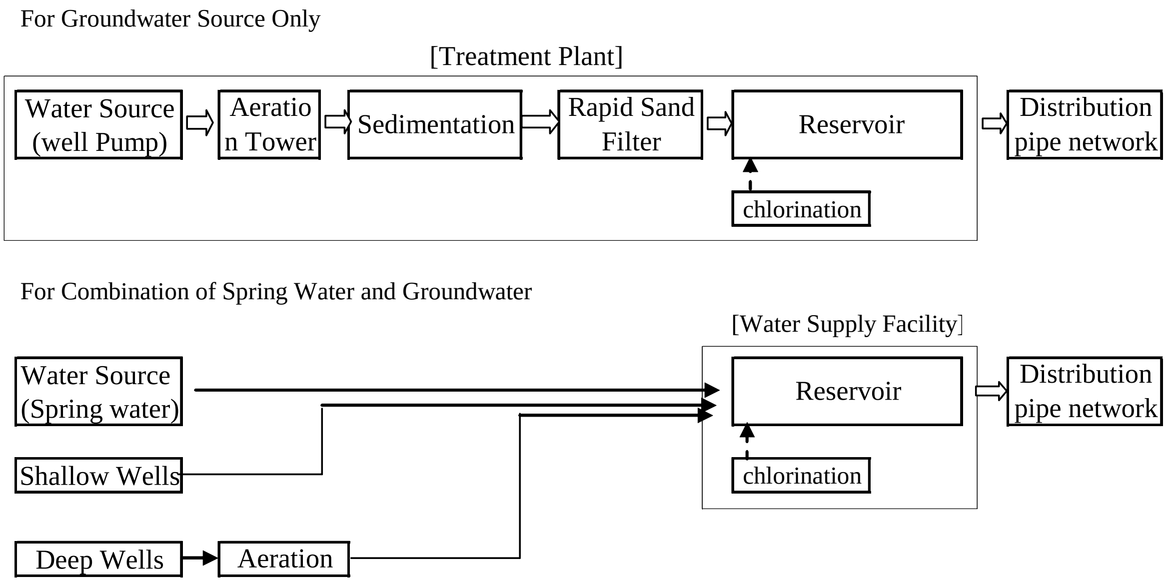


Figure 6.2.3 Treatment Process Flow

Water production facilities are summarized in Table 6.2.1. As shown in this table, three (3) of four (4) production facilities depend their water source on groundwater from deep wells and shallow wells.

Table 6.2.1 List of Water Production Facilities

	Water Unit				*SW
	1.Bedog	2.Karangayam	3.Kotagede	4.Gemawang	
1.Construciton	2002 (treatment facility)	2004(treatment facility)	1992 (constructed by PU)	NA	NA
2.Water source	DW(14 wells)	DW(5 wells)	DW(2 wells)	Spring water/DW(8 wells)/SW(11 wells)	SW
3.Treatment process	Aeration, Sedimentation, Rapid Sand Filter	Aeration, Sedimentation, Rapid Sand Filter	Aeration, Sedimentation, Rapid Sand Filter	No treatment Facility	No Treatment Facility
4.Nominal Production capacity	200 liter/s	150 liter/s	40 liter/s	NA	8 liter/s
5. Actual Production (at 2005)	150 liter/s	90 liter/s	15 liter/s	310 liter/s	8.5 liter/s
6.Chlorination	Chlorine Gas	Chlorine Gas	Chlorine Gas	Chlorine Gas	NA
7. Resevoir	2,500 (m3)	1,000 (m3)	200 (m3)	4,000 (m3)	-

DW: Deep Well
SW: Shallow Well
*SW: for water adding to Bedog water supply area in case of shortage (intermittent operation)

Source: PDAM Yogyakarta

Table 6.2.2 shows breakdown of pipe length by its diameter and materials. Total length of pipeline in PDAM Yogyakarta is about 290 km including transmission pipeline from Sleman Regency. As shown in Figure 6.2.4, the length of old ACP and CI pipes exceed 50% of total pipe length. Aged pipes installed before handover from Dutch company in 1976 are still in use in PDAM Yogyakarta system, while data for the installation year of pipelines are not available.

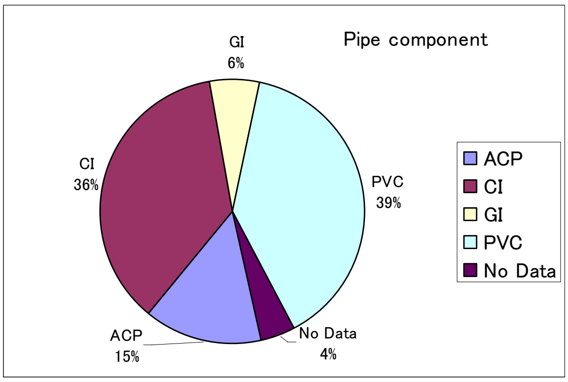


Figure 6.2.4 Component of Pipe Material

To carry out pipe network analysis, the pipe data, obtained from drawings and database in the "Memorandum Report" are utilized. However further data could not be collected from PDAM Yogyakarta. The ground elevation data read from the above drawing are used for hydraulic calculation.

Hydraulic calculation was done for evaluating pipe network capacity of Kotagede WTP area. PDAM informed that the area is isolated from the other area and reliability of data required for the calculation is relatively high. Production capacity for the area is considered as daily maximum demand and 1.2 is applied for the hourly peak factor, which is discussed in Section 6.2.3.

The results of the calculation are shown in Appendix 6.1–6.2 and summarized in the Figure 6.2.5.

Table 6.2.2 Pipe Length and Materials

Diameter (mm)	Material	Length (meter)	% to total	Diameter (mm)	Material	Length (meter)	% to total	Diameter (mm)	Material	Length (meter)	% to total	Diameter (mm)	Material	Length (meter)	% to total	
50	ACP	-	-	150	ACP	5,604	13.2%	300	ACP	6,568	15.4%	500	ACP	5,255	12.4%	
	CI	-	-		CI	26,269	24.9%		CI	3,929	3.7%		CI	-	-	
	GI	5,932	32.1%		GI	-	-		GI	-	-		GI	-	-	
	PVC	10,759	9.5%		PVC	4,843	4.3%		PVC	431	0.4%		PVC	-	-	
	No Data	336	2.7%		No Data	696	5.6%		No Data	27	0.2%		No Data	-	-	
	total	17,027	5.8%		total	37,411	12.8%		total	10,955	3.8%		total	5,255	1.8%	
75	ACP	-	-	175	ACP	-	-	350	ACP	-	-	600	ACP	5,464	12.8%	
	CI	168	0.2%		CI	3,784	3.6%		CI	3,075	2.9%		CI	-	-	
	GI	6,492	35.1%		GI	-	-		GI	-	-		GI	-	-	
	PVC	18,188	16.1%		PVC	-	-		PVC	-	-		PVC	-	-	
	No Data	575	4.7%		No Data	410	3.3%		No Data	595	4.8%		No Data	-	-	
	total	25,423	8.7%		total	4,195	1.4%		total	3,670	1.3%		total	5,464	1.9%	
100	ACP	10,472	24.6%	200	ACP	7,088	16.7%	400	ACP	1,458	3.4%	No Data	ACP	280	0.7%	
	CI	46,688	44.3%		CI	8,939	8.5%		CI	-	-		CI	1,190	1.1%	
	GI	3,730	20.2%		GI	-	-		GI	-	-		GI	2,325	12.6%	
	PVC	66,247	58.7%		PVC	5,942	5.3%		PVC	5,073	4.5%		PVC	1,449	1.3%	
	No Data	4,876	39.5%		No Data	572	4.6%		No Data	-	-		No Data	2,255	18.2%	
	total	132,013	45.2%		total	22,541	7.7%		total	6,532	2.2%		total	7,499	2.6%	
125	ACP	167	0.4%	250	ACP	188	0.4%	450	ACP	400	0.9%	**Total Length**	ACP	42,544	100.0%	14.6%
	CI	7,353	7.0%		CI	3,342	3.2%		CI	-	-		CI	105,503	100.0%	36.2%
	GI	-	-		GI	-	-		GI	-	-		GI	18,479	100.0%	6.3%
	PVC	-	-		PVC	-	-		PVC	1,600	1.4%		PVC	112,932	100.0%	38.7%
	No Data	2,013	16.3%		No Data	-	-		No Data	-	-		No Data	12,355	100.0%	4.2%
	total	9,534	3.3%		total	3,530	1.2%		total	2,000	0.7%		total	291,812	100.0%	100.0%

ACP: Asbestos Cement Pipe
CI: Cast Iron Pipe
GI: Galvanized Iron Pipe
PVC: Polyvinyl Chloride Pipe

Source: the Memorandum Report

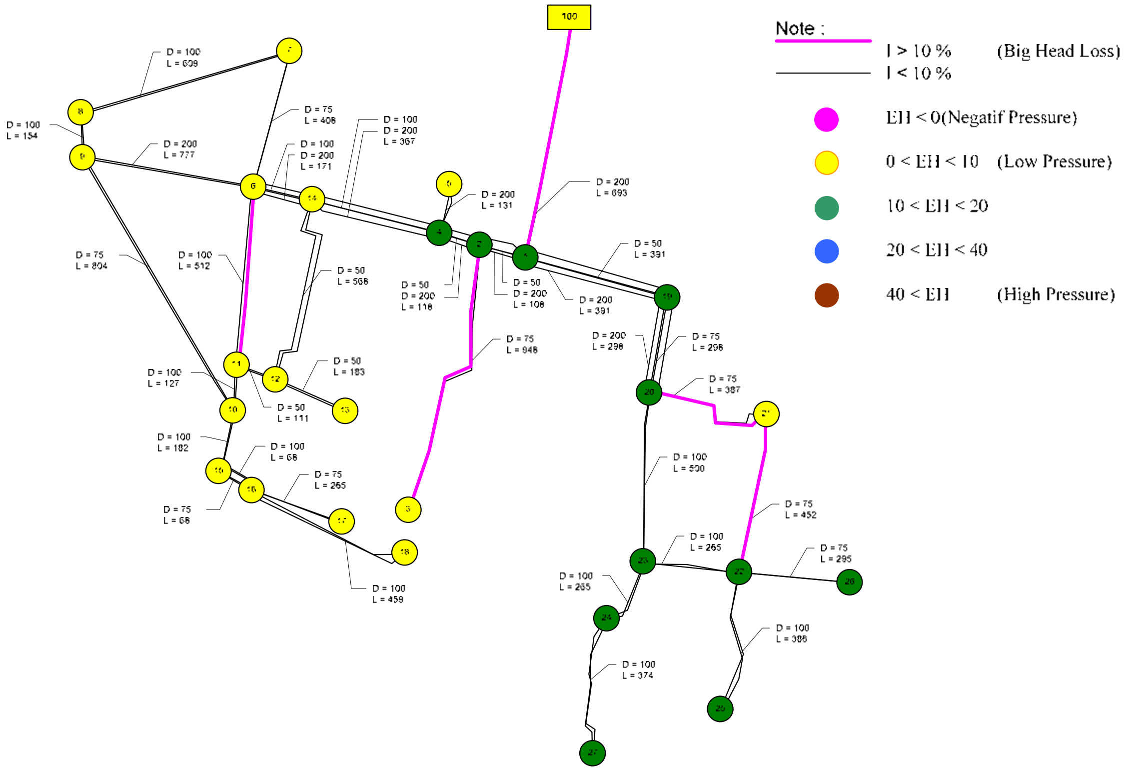


Figure 6.2.5 Hydraulic Calculation Results

The calculation results show relatively low pressure in west area during the hourly peak period. However the pipe capacity in the area is generally considered to be sufficient for distributing the current production volume.

Pipe volume of PDAM Yogyakarta can also be considered as moderate when it is compared with the "pipe volume in a unit service population" and "pipe volume in a unit water supply quantity" of the same size cities in Japan. The details of comparison are shown in Appendix 6.3.

However, actual capacity of pipe system will be insufficient due to aged CI pipes and ACP pipes, which generally reduce actual nominal diameters by clogging and cause water leakage from aged and damaged connections and pipe bodies.

6.2.3 Performance of PDAM Yogyakarta

(1) Water Production

Table 6.2.3 shows water production by water production facilities. Each water production system has several distribution systems and the table shows breakdown of water quantity of each distribution system.

Table 6.2.3 Water Productions by Water Source

(m3/year)

Water Supply Facility	Year									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1.Gemawang Reservoir										
1)Umbulwadon (by gravity)	2,353,942	2,631,568	2,940,297	2,849,107	2,842,374	2,796,810	2,827,784	2,566,594	1,944,442	1,829,015
2)Padasan Barat (by gravity)	859,813	798,832	910,526	956,022	1,020,914	953,585	712,957	735,652	926,459	1,131,103
3)Padasan Timur (by gravity)	0	0	338,882	211,373	543,531	647,703	447,093	421,746	337,208	515,454
4)Sumur Besi I (by gravity)	524,179	402,541	321,685	336,668	321,945	486,813	560,481	359,226	437,765	447,955
5)Sumur Besi II (by gravity)	444,658	331,199	224,811	499,605	402,920	555,702	907,199	648,841	630,038	596,789
6)Sumur Kentungan (by gravity)	222,814	171,500	217,401	302,700	256,680	237,580	0	0	0	0
7)Chamber Ngaglik(by electric pump)	3,994,603	4,539,854	3,804,938	3,376,093	3,086,112	3,155,947	2,903,765	3,303,284	3,536,645	3,787,365
8)Sumur Jongkang I(by electric pump)	682,702	414,233	425,325	656,295	907,553	920,323	863,165	735,806	763,900	633,751
9)Sumur Jogkang II(by electric pump)	0	0	0	0	0	0	0	0	0	263,610
10)Sumur Karangaaayam(by electric pump)	397,935	271,680	327,792	46,177	623,762	680,499	619,038	325,829	358,778	0
11)Sumur Gemawang(by electric pump)	0	0	0	0	0	0	0	0	0	143,912
12)Sumur A (by electric pump)	0	0	0	0	0	0	0	0	0	62,275
13)Sumur G (by electric pump)	0	0	0	0	0	0	0	0	0	186,253
14)Sumur Gandi (by engine pump)	42,923	67,706	27,778	40,568	16,779	18,292	64,943	74,905	75,190	57,979
15)Sumur Bulusan (by engine pumpl)	34,155	0	64,049	65,725	40,025	23,175	53,432	83,403	105,706	48,870
16)Gemawang (by engine pump)	141,703	108,696	23,931	46,310	115,094	95,142	33,344	29,914	30,253	3,373
17)Sumur Jongkang I (by engine pump)	0	174,506	222,553	151,144	8,517	0	0	0	0	0
18)Sumur Nandan (by engine pump)	0	0	0	0	3,338	163,028	155,903	96,318	83,328	76,796
19)Sumur G (by engine pump)	0	0	0	0	0	0	12,272	110,639	88,200	0
Sub-total (1-19)	9,699,427	9,912,315	9,849,968	9,537,787	10,189,544	10,734,599	10,161,376	9,492,157	9,317,912	9,784,500
2.Bedog WTP										
1)Bedog (by electric pump)	3,103,942	4,454,757	4,957,514	5,382,371	4,139,035	4,467,079	3,481,979	4,048,729	4,730,912	4,852,836
Sub-total	3,103,942	4,454,757	4,957,514	5,382,371	4,139,035	4,467,079	3,481,979	4,048,729	4,730,912	4,852,836
3.Karanggayam WTP										
1)Res Karanggayam(by electric pump)	3,200,902	2,939,802	3,115,654	2,779,259	2,692,974	2,642,900	2,628,365	3,193,733	2,628,517	2,362,556
2)Sumur Kr.Garam I(by electric pump)	0	0	0	0	0	0	0	0	0	581,988
3)Sumur Kr.Gayam II(by electric pump)	0	0	0	0	0	0	0		0	14,003
4)Sumur Karanggayaman I(by engine pump)	59,904	156,259	66,471	98,541	29,738	31,957	10,537	2,125	0	0
5)Sumur Karang wuni (by engine pump)	0	0	0	0	0	0	0	0	0	0
Sub-total (1-5)	3,260,806	3,096,061	3,182,125	2,877,800	2,722,712	2,674,857	2,638,902	3,195,858	2,628,517	2,958,547
4.Kotagede WTP										
1)Kotagede I(electric pump)	23,745	183,507	189,387	167,139	131,119	338,237	323,322	295,828	329,862	185,072
2)Kotagede II(lelctric pump)	0	0	73,472	30,865	0	0	0	0	106,456	239,706
3)Genzei Kotagede (engine pump)	0	0	0	0	0	0	0	0	0	0
Sub-total (1-3)	23,745	183,507	262,859	198,004	131,119	338,237	323,322	295,828	436,318	424,778
5.Shallow Well (direct connection to pipe network)										
1)Winogo (List) (by electric pump)	0	0	0	0	0	0	116,458	121,344	192,443	270,257
2)Sumur Winongo(by engine pump)	0	0	0	0	56,282	223,743	113,937	0	0	0
Sub-total (1-2)	0	0	0	0	56,282	223,743	230,395	121,344	192,443	270,257
Total	16,064,175	17,646,640	18,252,466	17,995,962	17,238,692	18,438,515	16,835,974	17,153,916	17,306,102	18,290,918

Source: PDAM Yogyakarta

Total water production by PDAM Yogyakarta in last 10 years (1996 to 2005) is summarized as shown on Table 6.2.4 and Figure 6.2.6.

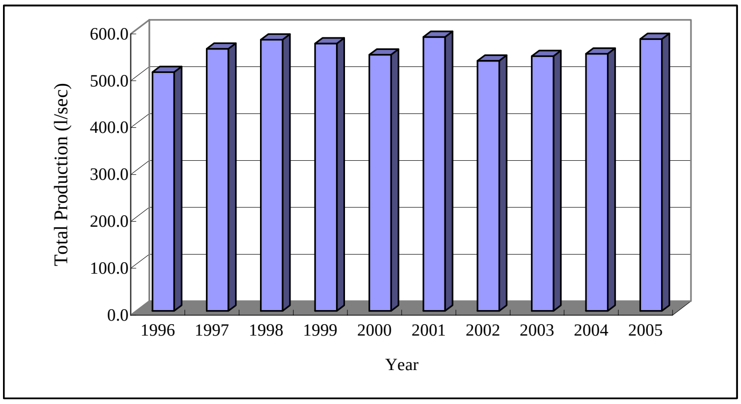
Table 6.2.4 Annual Water Production (m3/year)

Year	1996	1997	1998	1999	2000
Total Production (m3/year)	16,064,175	17,646,640	18,252,466	17,995,962	17,238,692
Year	2001	2002	2003	2004	2005
Total Production (m3/year)	18,438,515	16,835,974	17,153,916	17,306,102	18,290,918

(in l/sec)

Year	1996	1997	1998	1999	2000
Total Production (l/sec)	509.4	559.6	578.8	570.6	546.6
Year	2001	2002	2003	2004	2005
Total Production (l/sec)	584.7	533.9	543.9	548.8	580.0

Source: PDAM Yogyakarta



Source: PDAM Yogyakarta

Figure 6.2.6 Annual Water Production (l/sec)

(2) Water Consumption

Metered water consumption by category for the last decade is shown on Table 6.2.5.

Table 6.2.5 Metered Water Consumption by Category

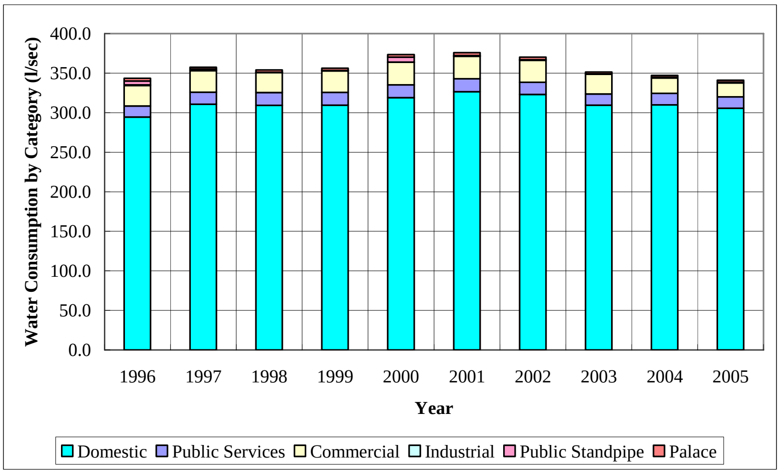
(m3/year)

Category	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
I A	401,665	404,542	350,944	354,336	353,547	362,643	343,044	315,445	328,694	321,250
I B	43,641	78,859	163,957	160,877	158,492	157,149	140,047	130,550	128,268	131,111
II A	2,300,694	5,549,098	8,496,341	8,417,530	8,531,613	8,739,445	8,702,123	8,418,609	8,454,533	8,392,167
II B	5,971,355	3,272,820	182,406	296,315	478,676	475,938	463,030	454,103	463,432	441,525
II C	1,013,063	974,981	1,072,394	1,044,081	1,048,209	1,078,208	1,022,835	889,361	856,726	807,449
III A	481,801	519,230	517,878	531,600	553,449	574,730	569,184	541,067	443,036	392,394
III B	339,066	336,661	277,692	320,910	343,565	317,526	306,596	242,803	173,462	166,486
IV A	1,553	1,300	1,534	3,601	2,844	3,575	4,071	3,701	3,364	3,175
IV B	21,221	9,865	4,026	3,726	11,531	12,366	10,461	7,445	6,611	3,155
V (Palace)	105,567	72,049	86,189	86,864	94,788	117,466	96,009	70,819	75,381	72,302
Public	21,833	14,794	11,925	17,825	197,545	16,098	15,404	13,743	20,073	21,408
Others	127,400	42,408	0		0	0	0	0	0	0
Total	10,828,859	11,276,607	11,165,286	11,237,665	11,774,259	11,855,144	11,672,804	11,087,646	10,953,580	10,752,422

Category I: Public Services (mosques, schools, public standpipes, other public facilities)
II: Domestic (house connection)
III: Commercial
IV: Industrial
V: King's palace
Categories A,B,C depends on income and/or revenues

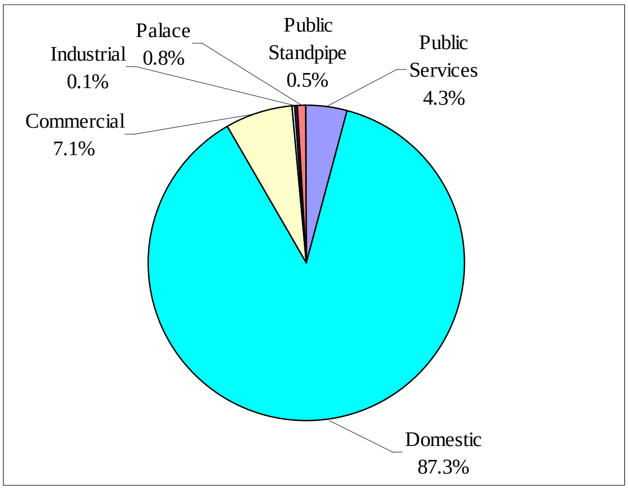
Source: PDAM Yogyakarta

Figures 6.2.7 and 6.2.8 also show past record of water consumption by category in last 10 year (1996 to 2005) in l/sec and its proportion respectively.



Source: PDAM Yogyakarta

Figure 6.2.7 Water Consumption by Category in Last 10 Years (1996 to 2005)



Source: PDAM Yogyakarta

Figure 6.2.8 Average Proportion of Water Consumption by Category in Last 10 Years (1996 to 2005)

(3) NRW Ratio

From total production in Table 6.2.4 and total consumption in Table 6.2.5, NRW can be calculated as shown on Table 6.2.6 and Figure 6.2.10. NRW ratio is fluctuated between 31% and 40% while gradual increase is observed in these three years.

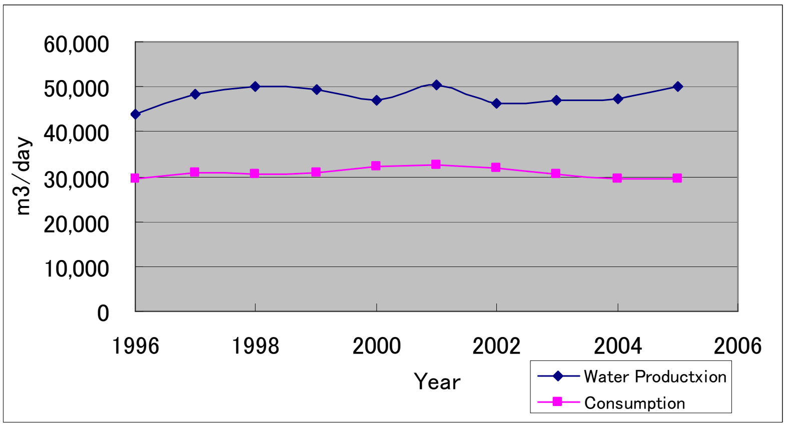
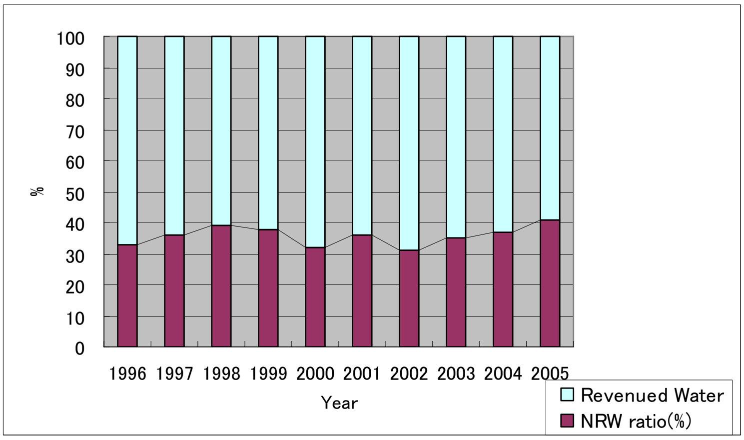


Figure 6.2.9 Trend of Production and Consumption

Table 6.2.6 Non-Revenue Water

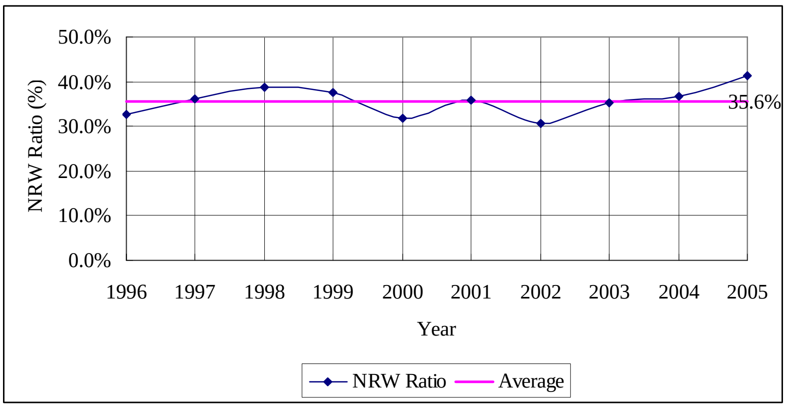
(m3/year)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Water Productxion	16,064,175	17,646,640	18,252,466	17,995,962	17,238,692	18,438,515	16,835,974	17,153,916	17,306,102	18,290,918
Consumption	10,828,859	11,276,607	11,165,286	11,237,665	11,744,259	11,855,144	11,672,804	11,087,646	10,853,580	10,752,422
NRW amount	5,235,316	6,370,033	7,087,180	6,758,297	5,494,433	6,583,371	5,163,170	6,066,270	6,452,522	7,538,496
NRW ratio(%)	33	36	39	38	32	36	31	35	37	41



Source: JICA Study Team based on PDAM Yogyakarta

Figure 6.2.10 Trend of Non-Revenue Water



Source: PDAM Yogyakarta

Figure 6.2.11 Fluctuation of NRW Ratio in Last 10 Years (1996 to 2005)

As shown on figure above, average NRW ratio is 35.6% in last 10 years from 1996 to 2005.

These NRW ratios are calculated based on data provided by PDAM Yogyakarta. Although the accuracy of master water meter at the outlet of each reservoir is not confirmed, total quantity of water distributed from respective reservoirs are measured. Hence, these NRW ratio derived from data of PDAM Yogyakarta is considered reasonable.

(4) Number of Connections

Number of house connection by category is shown in Table 6.2.7 for last decade. House connections are categorized into five (5) categories such as Public Service (public office, institutions, religious places etc.), Domestic, Commercial, Industrial, and Kings Palace. Major portion of connection is category "Domestic" and it occupies about 90% in year 2005.

As shown on this table and Figure 6.2.12, number of house connection has rapidly increased until year 2001 and it does not change at around 34,500 after year 2002.

Table 6.2.7 Number of House Connection by Category

(unit:number)

Category	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
I A	487	376	412	412	413	421	414	404	401	390
I B	54	259	266	275	298	310	316	316	319	324
II A	7,801	27,791	28,105	28,030	28,835	29,426	29,763	29,789	29,905	29,934
II B	19,700	457	513	1,287	1,258	1,329	1,357	1,401	1,394	1,384
II C	495	521	1,112	1,120	1,119	1,100	1,094	1,086	1,088	1,080
III A	1,152	1,239	1,255	1,318	1,331	1,368	1,354	1,326	1,295	1,253
III B	279	268	242	237	232	225	216	211	203	194
IV A	4	5	6	7	7	7	7	7	7	8
IV B	3	3	3	4	4	4	4	4	4	4
V (Palace)	8	11	11	11	11	11	11	11	11	11
Public	1	1	1	1	1	1	1	1	1	1
Others	9	0	0	0	0	0	0	0	0	0
Total	29,993	30,931	31,926	32,702	33,509	34,202	34,537	34,556	34,628	34,583

I: Public Services
II: Domestic
III:Commercdial
IV:Industrial
V:King's Palace

* Categories A,B,C depens on income and/or revenues.

Source: PDAM Yograyarta

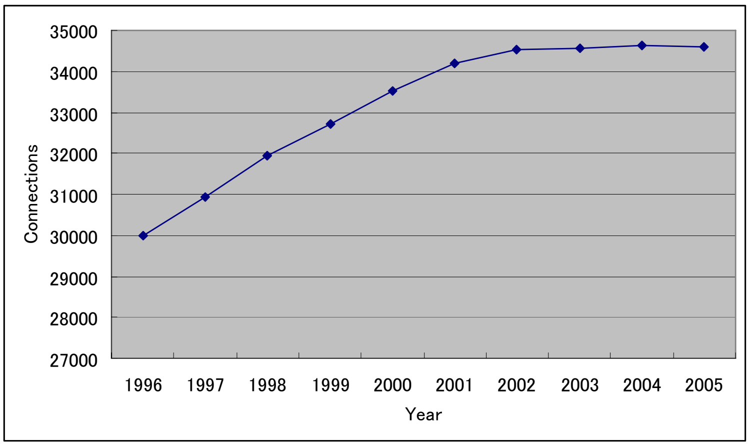


Figure 6.2.12 Trend of House Connections

Numbers of domestic connections in last 10 years (1996 to 2006) are as shown on Table 6.2.8 and Figure 6.2.13.

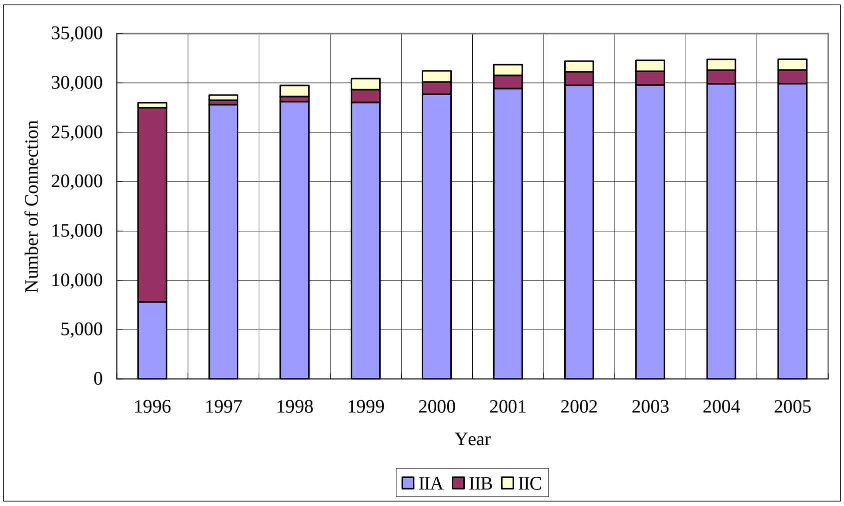
Table 6.2.8 Number of Domestic Connections and Their Proportion by Category

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
IIA	7,801	27,791	28,105	28,030	28,835	29,426	29,763	29,789	29,905	29,934
IIB	19,700	457	513	1,287	1,258	1,329	1,357	1,401	1,394	1,384
IIC	495	521	1,112	1,120	1,119	1,100	1,094	1,086	1,088	1,080
Sub-Total	27,996	28,769	29,730	30,437	31,212	31,855	32,214	32,276	32,387	32,398

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
IIA	27.9%	96.6%	94.5%	92.1%	92.4%	92.4%	92.4%	92.3%	92.3%	92.4%
IIB	70.4%	1.6%	1.7%	4.2%	4.0%	4.2%	4.2%	4.3%	4.3%	4.3%
IIC	1.8%	1.8%	3.7%	3.7%	3.6%	3.5%	3.4%	3.4%	3.4%	3.3%
Sub-Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: PDAM Yogyakarta

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class



Source: PDAM Yogyakarta

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class

Figure 6.2.13 Number of Domestic Connections by Category

(5) Number of Served Population and Service Ratio

1) Family Size

According to the results of socio economic survey (refer to Chapter 10), average family size is estimated as 5 people per family.

2) Number of Served Population

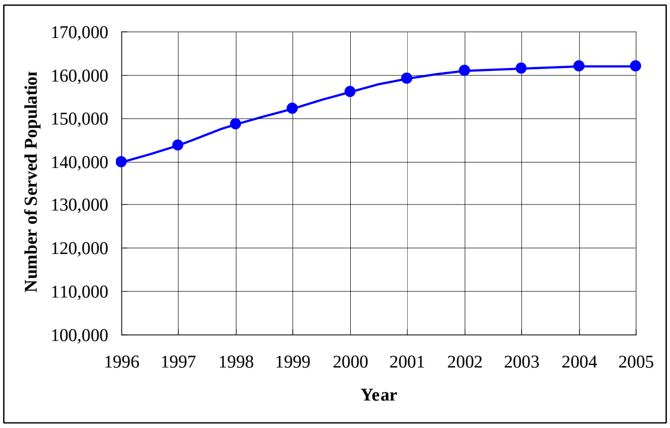
From number of domestic connections and average family size, served population is calculated as follows.

Table 6.2.9 Number of Served Population

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
IIA	39,005	138,955	140,525	140,150	144,175	147,130	148,815	148,945	149,525	149,670
IIB	98,500	2,285	2,565	6,435	6,290	6,645	6,785	7,005	6,970	6,920
IIC	2,475	2,605	5,560	5,600	5,595	5,500	5,470	5,430	5,440	5,400
Sub-Total	139,980	143,845	148,650	152,185	156,060	159,275	161,070	161,380	161,935	161,990

Source: PDAM Yogyakarta

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class



Source: PDAM Yogyakarta

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class

Figure 6.2.14 Number of Served Population

As shown on figure above, number of served population has become stable after 2002. This may be because that population is also stable and water supply capacity has not been improved. Furthermore, many people has own well in their premises, according to the results of questionnaire survey (Chapter 10), and they depend on groundwater for daily use.

3) Service Ratio

Service ratio, served by PDAM Yogyakarta through individual house connection, is calculated from total population and served population.

Table 6.2.10 Served Population and Service Ratio

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Population	406,735	406,856	406,995	407,142	407,306	407,484	407,673	407,881	408,096	408,332
Served Population	139,980	143,845	148,650	152,185	156,060	159,275	161,070	161,380	161,935	161,990
Service Ratio	34.4%	35.4%	36.5%	37.4%	38.3%	39.1%	39.5%	39.6%	39.7%	39.7%

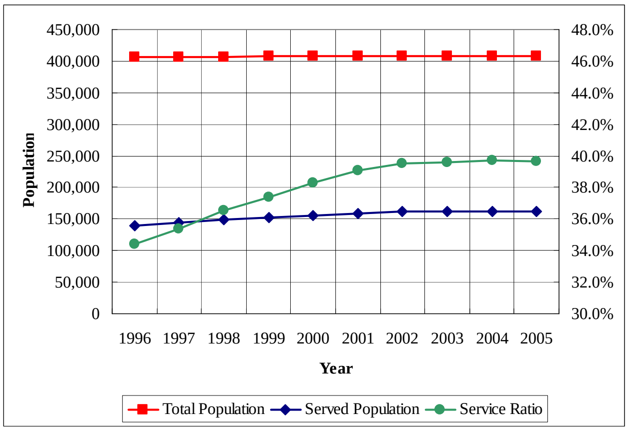


Figure 6.2.15 Total and Served Populations and Service Ratio

As shown on figure above, service ratio remains less than 40 % staidly in recent four years.

(6) Domestic Per Capita Water Consumption

From total domestic water consumption and number of domestic served population, domestic per capita water consumption (lpcd: litter per capita day) is calculated as shown below.

Table 6.2.11 Domestic Per Capita Water Consumption (lpcd)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average
Domestic Per Capita Water Consumption	182	187	180	176	177	177	173	166	165	163	174

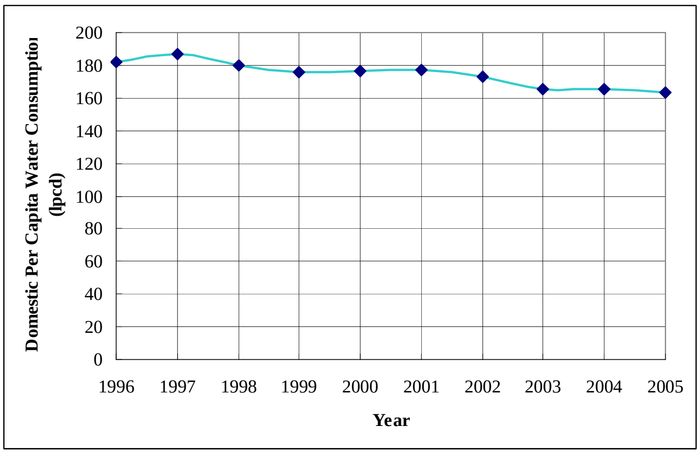


Figure 6.2.16 Domestic Per Capita Water Consumption (lpcd)

(7) Fluctuation of Daily Water Consumption

Daily fluctuation of water consumption throughout a year is observed by using monthly data since daily data are not available. Figure 6.2.17 and Table 6.2.12 show the consumption fluctuation throughout the year of 2004 and 2005.

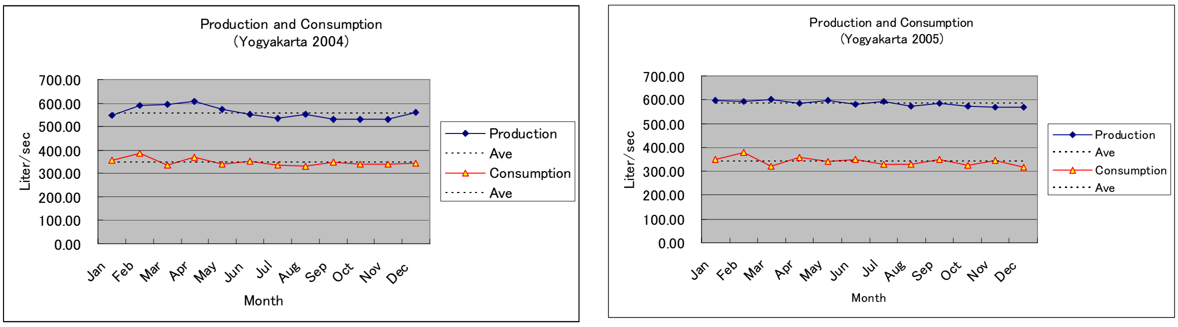


Figure 6.2.17 Fluctuation of Water Consumption throughout a Year

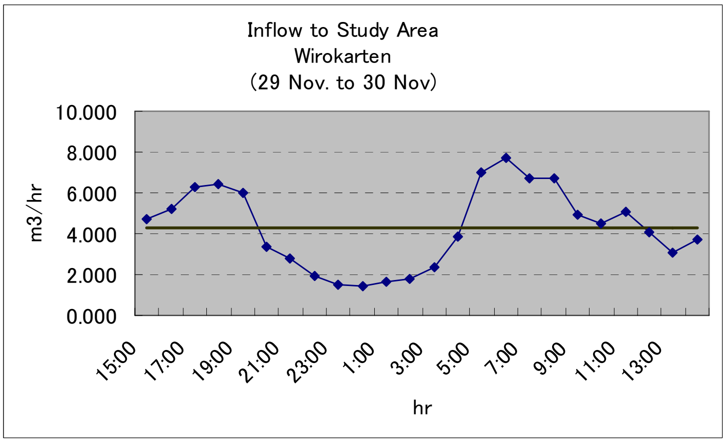
Table 6.2.12 Fluctuation of Water Consumption in a Year

	Consumption		Production	
	2004	2005	2004	2005
Max.(l/sec)	387.60	377.71	604.72	602.15
Ave.(l/sec)	347.34	340.96	557.33	584.41
Peak factor	1.12	1.11	1.09	1.03
Month of peak	February	February	April	March

Source: JICA Study Team

Fluctuation of water consumption in a year is around 1.1 and not high. It was suspected that water supply system does not satisfy the maximum water demand due to limitation of the supply capacity.

Hourly fluctuation of water consumption is considered by using the continuous monitoring of water flow into Wirokarten Area in Yogyakarta Municipality, which was conducted by the JICA Study Team for 24 hours from 29 to 30 November 2006 as explained in Section 6.7 NRW Survey. The results of hourly fluctuation are summarized in the Figure 6.2.18.



Source: JICA Study Team

Figure 6.2.18 Monitoring Results of Water Flow

The figure above shows that there are two peaks of water consumption in a day, which are in the morning and in the evening. Peak flow is 7.70 m^3/hr at 6 a.m. while the average is 4.28 m^3/hr and hourly peak factor in the area is calculated as 1.80. The figure cannot be directly applied for Yogyakarta Municipality since large fluctuation is generally observed in a small area. Daily supply in the observed area is 102.65m3/d while the water supply in Yogyakarta Municipality is 50,112 m3/d.

The relation of water supply volume and hourly peak factor, obtained from 250 water supply area in 35 cities in Japan (JWWA Guideline), shows below:
When Water Supply is 102.65m3/d, Peak Factor is 2.37.
When Water Supply is 50,112m3/d, Peak Factor is 1.61. (0.68 times of the above)

When the same tendency is applied, peak factor in Yogyakarta Municipality can be calculated as:

1.80 x 0.68 = 1.22

This will be adequate when it is considered that most of the house has its own storage tank and hourly peak are decreased.

6.2.4 Operation and Maintenance

(1) Staffs in a water production division at PDAM Yogyakarta station at three (3) treatment plants and one (1) reservoir operate and maintain the facilities.

(2) In each water supply system, intake water capacities by well pumps and distribution quantities from reservoirs are measured and recorded monthly as well as hourly. The facilities are operated under 24 hour basis.

(3) There are no standby generators. Therefore in case of electric failure occurred, operation of intake pumps and treatment facilities would be suspended.

(4) Maintenances of transmission and distribution pipes are carried out by a distribution division in the PDAM. A water leakage survey and a rehabilitation of pipes are not conducted. A distribution pressure becomes relatively high at night and low at daytime.

(5) The public service division is in charge of meter reading and the financial division is in charge of billing.

(6) A transmission pipeline is placed in Sleman Regency from Umbulwadon spring to Gemawang reservoir; several areas alongside the transmission pipe are supplied by PDAM

Yogyakarta even though the areas are in Sleman Regency. Each branch from the transmission main has bulk water meter.

(7) PDAM Yogyakarta is preparing a distribution pipe network zoning. Up to now, the distribution pipe networks by Kotagede water supply facility and Karangayam water supply facility are isolated from neighboring system and are independent supply zone.

(8) Results obtained by site survey and hearings at major water supply facilities are as follows:

1) Bedog water treatment plant has 200 liters/s in nominal treatment capacity, which composes composing of lifting pumps, an aeration tower, sedimentation basins, rapid sand filters and a service reservoir. A chlorination facility is provided for pre-chlorination at the sedimentation tank inlet and post-chlorination in the service reservoir. One (1) ton-liquid chlorine container is used for the above services.
   Treatment facilities and equipment are maintained relatively well and records of the intake water quantity and the water production were kept.
2) Karangayam water treatment plant has 150 liters/s in nominal treatment capacity. Treatment process is the same as Bedog treatment plant mentioned the above.
3) Kotagede water treatment plant was tranfered from PU to PDAM in 1992. The treatment facility of Kotagede composes of deep wells, an aeration tower, sedimentation tanks, rapid sand filters, reservoirs, distribution pump sets and chemical dosing and chlorination equipment. This plant is located in east-southern part of Yogyakarta Municipality and covers water supply services in this area. At present, the sedimentation tanks and chemical dosing equipment are not operated in full capacities due to malfunction of them. In addition, sand filters are not functioned well.
4) Gemanwang Reservoir receives waters from two (2) different water sources, that is, Umbulwadon spring water and groundwater and then distributed after chlorination. The groundwater is divided into two (2) sources, i.e. deep well water and shallow well water. Due to containing of Iron and Manganese in the deep well water, water from the deep wells is treated with aeration process on the way to Gemanwang Reservoir.
5) A water quality analysis is carried out by three (3) independent organizations respectively, that is, PDAM Yogyakarta Laboratory, BBTKL and Health/Sanitary Division in Yogyakarta Municipality (Dinas Kesehatan).

   a) Analyzed parameters and frequency by PDAM Yogyakarta Laboratory are as follows:
   - Daily
     Sampling points: Four (4) major reservoirs (Gemawang, Bedog, Karangayam and Kotagede)
     Analyzing parameters: Turbidity, Iron and Manganese

- Twice a year (January and July)

  Sampling points: All wells and reservoirs (Gemawang, Bedog, Karangayam, Kotagede, Pokoh, Candi and Winogo)

  Analyzing parameters: 13 items of chemical

- Five (5) times a year (February, April, June, September and November)

  Sampling points: Well (1 point), reservoir (1 point), tap water (3 points; near the reservoir, middle point and far point from the reservoir)

  Analyzing parameters: 13 items of chemicals

- Five (5) times a year (March, May, August, October and December)

  Sampling points: Reservoirs and water taps in each reservoir such as; 10 samples for Bedog, 9 samples for Gemawang, 9 samples for Karangayam, 6 samples for Kotagede, 6 samples for Pokon, and 6 samples for Candi and 4 samples for Winongo.

  Analyzed parameters: Total coliform and fecal coliform

b) Analyzed parameters and frequency by BBTKL are as follows:

- Once a year

  Sampling points: Each well, reservoir and water tap

  Analyzing parameters: Six (6) of general parameters such as smell, TDS, NTU, Taste, Temperature and Color

  Twenty (20) of chemical items such as Hg, As, Fe, Detergent, F, Cd, Hardness($CaCO_3$), Cl, Cr^{+6}, Mn, Na, NO_3-N, NO_2-N, Ag, PH Zn, CN, Sulfate (SO_4), Pb and $KMnO_4$

c) Analyzed parameters and frequency by Dinas Keshatan are as follows:

   Sampling points: Approx. 890 water taps and four (4) reservoirs (be in planning in 2007)

   Analyzing parameters: Total coliform and fecal coliform

6) The water supply facilities were operated to keep 0.2 to 0.5 mg/liter residual chlorine at water taps. In case of over chlorine dosage, complains from customers would be occurred.

6.2.5 Summary of Problems Identified

(1) In dry season, groundwater abstraction from the shallow wells for Gemawang reservoir is declining and it will cause water shortage in Candi service area. A stable water supply in the above area is an important issue to be resolved.

(2) Every year, approx. 40% of distributed water is lost in the distribution pipe network. According to information from PDAM, total water loss will reach at about 60% if the loss on transmission pipe from Umbulwadon spring (production point) to Gemawang reservoir

is added. Measures for reduction of NRW are required to be adopted as soon as possible.

(3) Main water sources (e.g., Umbulwadon Spring) for PDAM Yogyakarta are located in Sleman Regency. However, there is no clear agreement between both parties about sharing of water source (e.g., there is no clear agreement if the PDAM Yogyakarta maintain using existing water sources or increase intake volume from existing water sources in Sleman Regency when necessary in future). It is required consultations on sharing of spring water among related organizations including Sleman Regency.

(4) Some servce areas in Sleman Regency (e.g., alongside the transmission main from Umbulwadon Spring to Gemawang Reservoir) are supplied by PDAM Yogyakarta. There migh arise difficulties in terms of O&M in case multiple number of service providers exist in same area (e.g., it may be difficult to take necessary action promptly for possible damage or accident in case it is difficult to identify which PDAM is responsible for the damaged properties). It is necessary to have mutual understandings between PDAM Yogyakarta and PDAM Sleman with respect to:
    - Reviewing existing service area and considering restructure of service area in future.
    - Demarcation of responsibilities for O&M

(5) At Kotagede water treatment plant, an actual production is less than the nominal production capacity. It is caused by malfunction of treatment facilities and equipment, this condition should be rectified.

6.3 PDAM Sleman System

6.3.1 Organization

PDAM Sleman is a water supply enterprise organization, having 83 technical staffs and 115 administrative staffs. The PDAM Sleman organization chart is shown on Figure 6.3.1.

6.3.2 Water Supply System

Location of water unit is shown on Figure 6.3.2. As shown on the figure, small scale water units are dotted through whole area. In the urban area adjacent to Yogyakarta Municipality, several water units gather and others are scattered in rural area.

Typical treatment process flow is shown on Figure 6.3.3. In case of groundwater sources, water treatment process composing of aerations, sedimentations and filters were operated to treat Iron and Manganese.

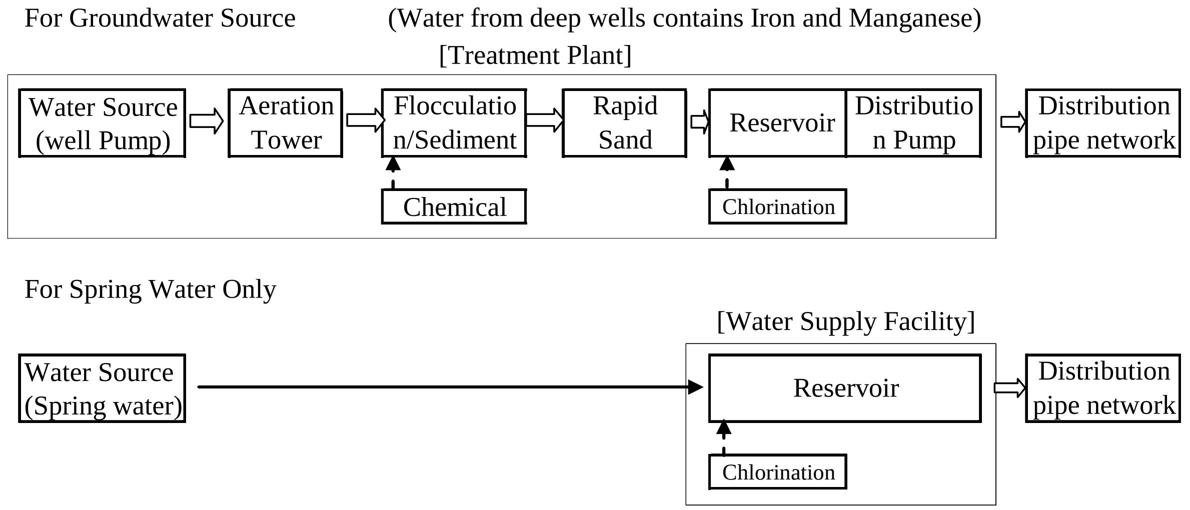
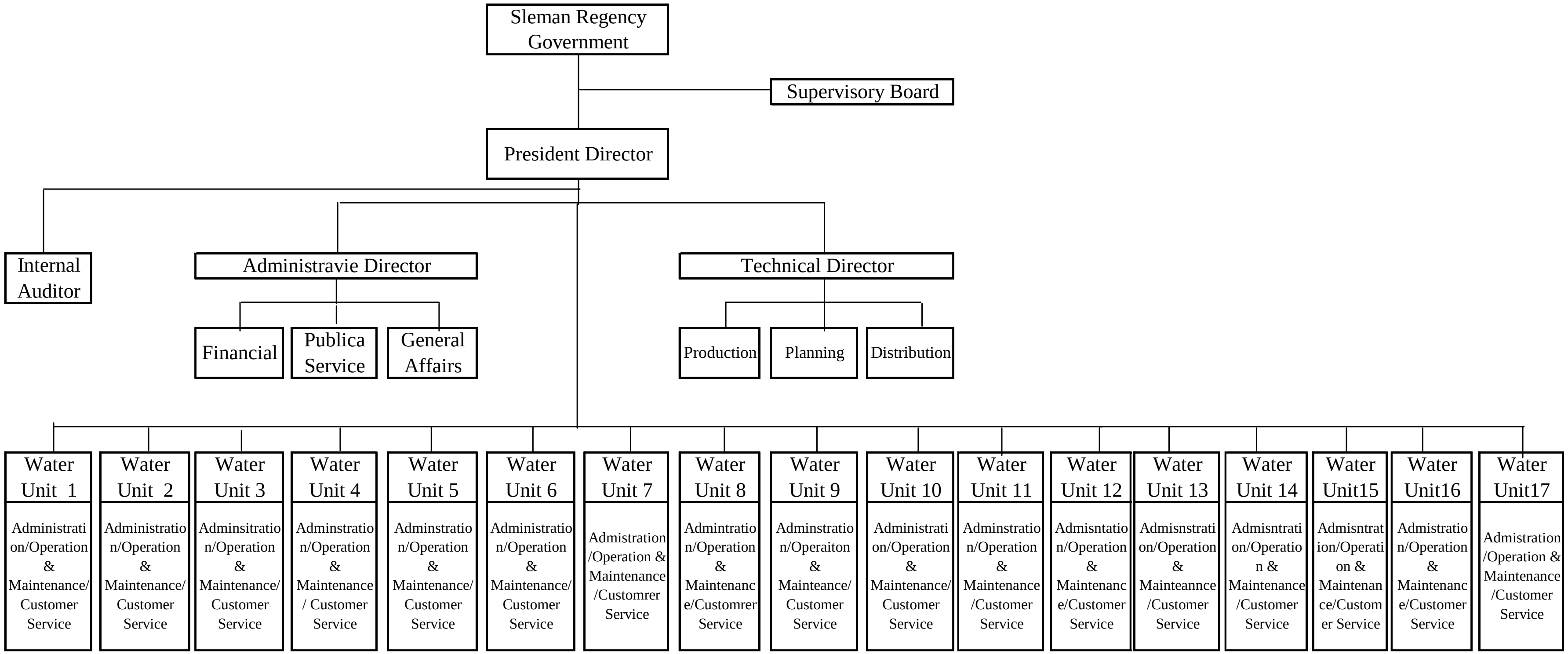


Figure 6.3.3 Treatment Process Flow



Souce: JICA Study Team based on PDAM Sleman

Figure 6.3.1 Organization Chart of PDAM Sleman

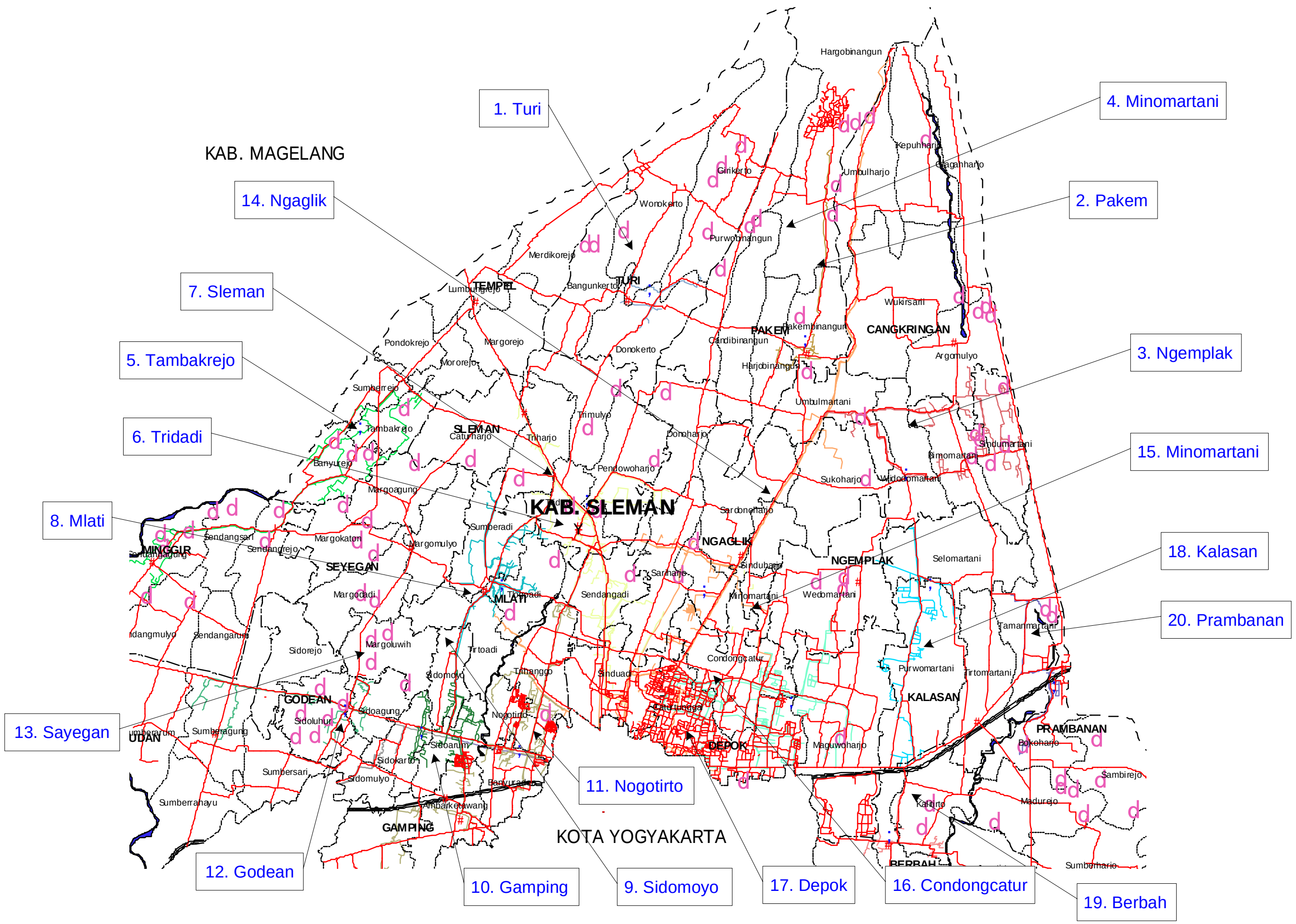


Figure 6.3.2 Location of PDAM Water Units

Water production facilities are summarized in Table 6.3.1. As shown on this table, fifteen (15) of twenty (20) water unit depend their water sources on groundwater from deep wells and combination of deep wells and shallow wells. Remaining water sources are spring water.

Table 6.3.1 List of Water Production Facilities

Item	Water Unit									
	1. Turi	2. Pakem	3. Ngemplak	4.Bimomartani	5.Tambakrejo	6. Tridadi	7. Sleman	8. Mlati	9. Sidomyoyo	10. Gamping
1.Construction	1987	1988	2005	1991	1991	1991	1990	1993	2004	2005
2.Water source	DW	Spring	Spring	DW	DW	DW,SW	Spring,DW	DW	DW,SW	DW,SW
2.Capacity of Pump (liter/s)	10	7.27	14.77	25	14.5	15	25.25/28/5	14	12/13	13/10
3. Treatment process	No Tteatment Facility	No Treatment Facility	No Treatment Facility	Built in type,aeration,flocculation,sedimentation, sand filter	Built in type,aeration,flocculation,sedimentation,sand filter	Aerator,flocculation,sedimentation,sand filter	Aeration	Aeration,flocculation,sedimentation, sand filter	No Treatment Facility	No Treatment Facility
4.Nominal treatment capacity (ℓ/s)				10	10	10	10	10	4/7.5	
5.Operation hours	11	24	24	12.97	7.97	21	24/24/24	22	22.68/20.61	22/24
6.No. of House Connection	265	191	1,118	297	417	452	2,932	707	829	1,336
7,.No.of Staffs	5	2	6	6	8	6	14	8	9	12

Item	11. Nogotirto	12. Godean	13. Sayegan	14. Ngaglik	15. Minomtn	16. Condongctr	17 .Depok	18 Kalasan	19. Berbah	20. Prambanan
1.Construction	2005	1984	NA	2005	2005	NA	2005	2005	2004	2005
2.Water source	DW,SW	DW	NA	DW	DW,SW	Spring	DW,SW	DW,SW	DW,SW	DW,SW
2.Capacity of Pump (liter/s)	13/15/6	5/8	12.5	10	17.5/2/17.31	17.31/5	15/10/40	20.66/1.5	15	20
3. Treatment process	Aeration, flocculation,sedimentation,sand filter	Aeration,flocculation, sedimentation,sand filter	NA	No Treatment Facility	Aeration,flocculation, sedimentation,sand filter	NA	Aeratopm, flocculation,sedimentation,sand filter	Not used	Aeration,flocculation,sedimentation,sand filter	NA
4.Nominal treatment capacity (ℓ/s)	15	10			20			100	15	15
5.Operation hours	17.2/16.3/17.2	24/24	4	23	9.45/19.2/4.38	19.62/11	12.5/24/23	24/23	11.93	14.94
6.No. of House Connection	1,695	670	38	562	1,451	1,171	1,632	1,603	99	411
7,.No.of Staffs	11	8	1	5	12	8	9	13	0	5

DW: Deep Well
SW: Shallow Well

Source: JICA Study Team by PDAM Sleman

While pipe data for Slaman Regency are not available, pipeline length is measured from the drawing in the ”Memorandum Report” and used for hydraulic calculation.

Mulati water supply unit in the south area and Turi water supply unit in the north area are selected for the hydraulic calculation. For the calculation, production capacity is considered as daily maximum and 1.2 is applied for the hourly peak factor while ground elevation was read from the map.

The results of the calculation are shown in Appendix 6.1-6.2 and summarized in the Figure 6.3.4

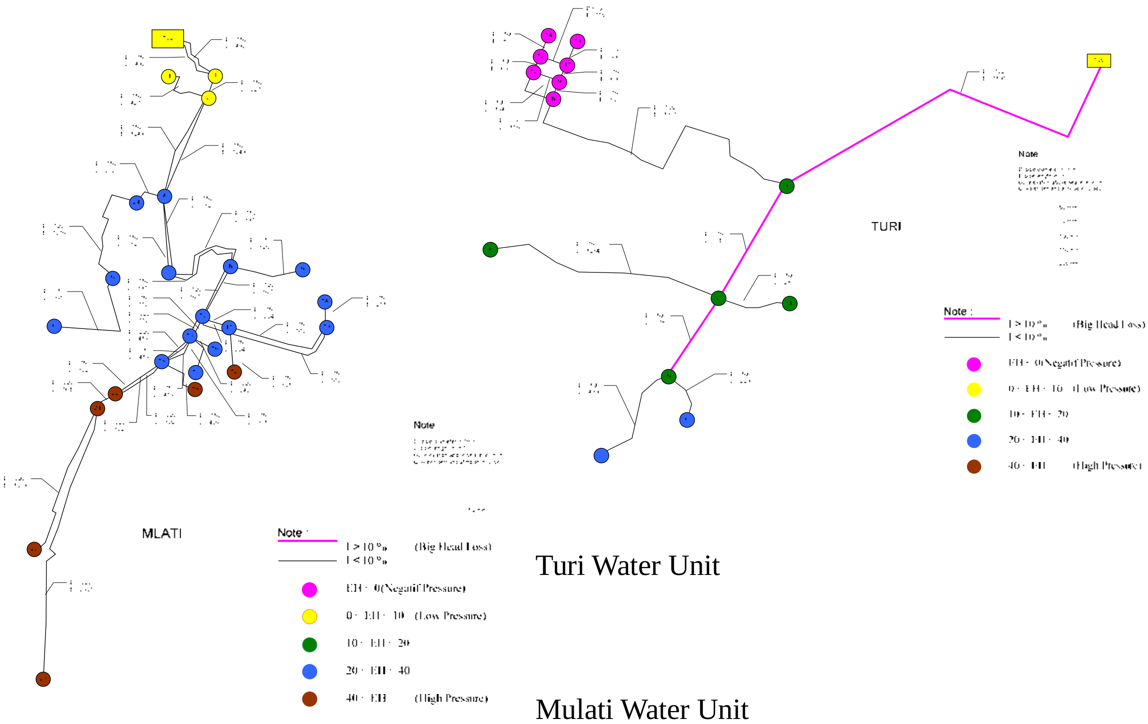


Figure 6.3.4 Results of Hydraulic Calculation (Sleman)

The calculation results for Mulati system show high pressure in downstream even at the hourly peak time. Pipe size of downstream is relatively large and installation of pressure reducing equipment may be required to avoid excessive high pressure.

The calculation results for Turi system show negative pressure at high elevation places and relatively high pressure at low places during hourly peak period. Water will not be available at high places when water consumption is high. It will be necessary to reinforce the system by installing some pipes and pressure reducing equipment in order to keep adequate pressure even during peak flow period.

It is anticipated that improvement of pipe system will be required in order to distribute sufficient water with adequate water pressure.

6.3.3 Performance of PDAM Sleman

(1) Water Production

Total water production by PDAM Sleman in last 2 years (2004 and 2005) is as shown on Table 6.3.2 and Figure 6.3.5.

Table 6.3.2 Annual Water Production

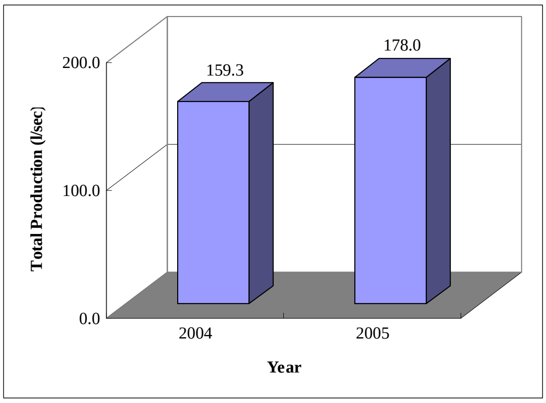
(m3/year)

Year	2004	2005
Total Production (m3/year)	5,023,620	5,612,405

in (l/sec)

Year	2004	2005
Total Production (l/sec)	159.3	178.0

Source: PDAM Sleman



Source: PDAM Sleman

Figure 6.3.5 Annual Water Production (l/sec)

(2) Water Consumption

Table 6.3.3 shows past record of water consumption by category in last 2 years (2004 and 2005) in m^3/year and l/sec respectively.

Figures 6.3.6 and 6.3.7 also show past record of water consumption by category in last 2 years (2004 and 2005) in l/sec and its proportion respectively.

Table 6.3.3 Water Consumption in Last 2 Years by Category (m3/year)

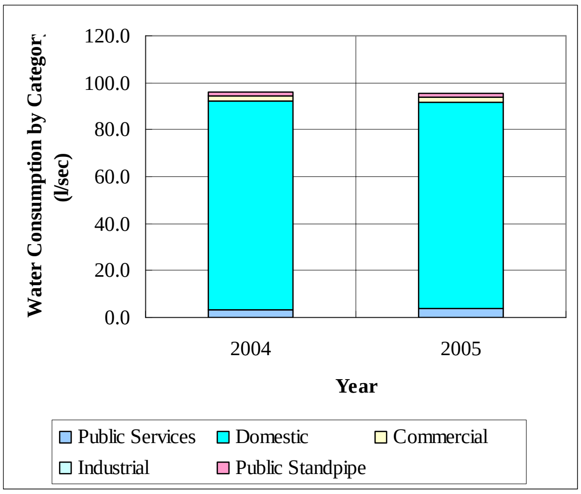
	Category	2004	2005
I	Public Services	105,310	125,006
II	Domestic	2,802,587	2,767,121
III	Commercial	67,646	58,322
IV	Industrial		
V	Public Standpipe	56,383	57,643
	Total	3,031,926	3,008,092

Source: PDAM Sleman

in (l/sec)

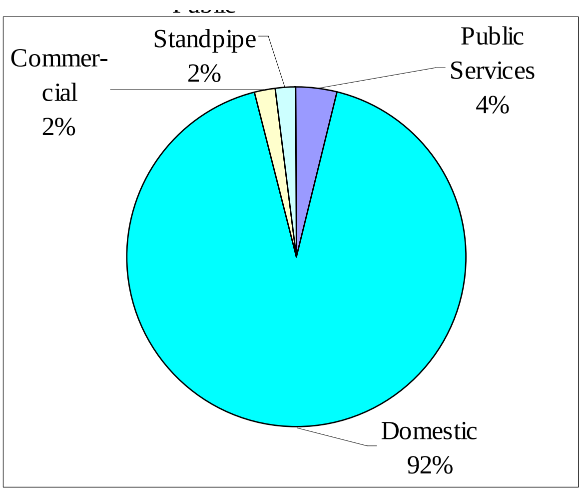
	Category	2004	2005
I	Public Services	3.3	4.0
II	Domestic	88.9	87.7
III	Commercial	2.1	1.8
IV	Industrial	0.0	0.0
V	Public Standpipe	1.8	1.8
	Total	96.1	95.4

Source: PDAM Sleman



Source: PDAM Sleman

Figure 6.3.6 Water Consumption by Category in Last 2 Years (2004 and 2005)

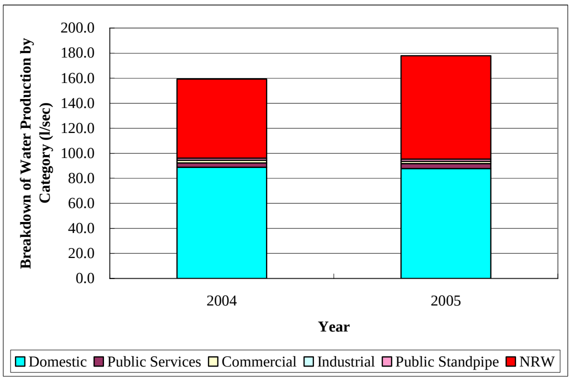


Source: PDAM Sleman

Figure 6.3.7 Average Proportion of Water Consumption by Category in Last 2 Years (2004 2005)

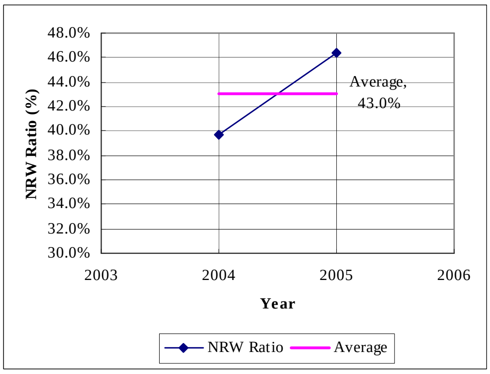
(3) NRW Ratio

The balance of total water production and total water consumption is Non Revenue Water (NRW) and the NRW ratios for respective years are calculated as shown below.



Source: PDAM Sleman

Figure 6.3.8 Breakdown of Water Production including NRW



Source: PDAM Sleman

Figure 6.3.9 Fluctuation of NRW Ratio in Last 2 Years (2004 to 2005)

As shown on figure above, average NRW ratio is 43 % in last two years and this level of NRW is higher than the one of PDAM Yogyakarta.

These NRW ratios are calculated based on data provided by PDAM Sleman. Accuracy of water production quantity seems rather low since many water units are not equipped with master water meter. Under such condition, the production quantity was cross checked by respective pump capacity and duration (hours) of pump operation. According to the results of the cross checking, quantity of water production was judged reasonable. Concerning quantity of water consumption, PDAM Sleman is now implementing water meter installation to individual house connections, hence, quantity of water consumption and the calculated NRW ratio is considered to be reasonable.

(4) Number of Domestic Connections

Number of domestic connections in last 2 years (2004 and 2006) are as shown on Table 6.3.4 and Figure 6.3.10.

Table 6.3.4 Number of Domestic Connections

	2004	2005
Sub-Total	18,788	18,994

Source: PDAM Sleman

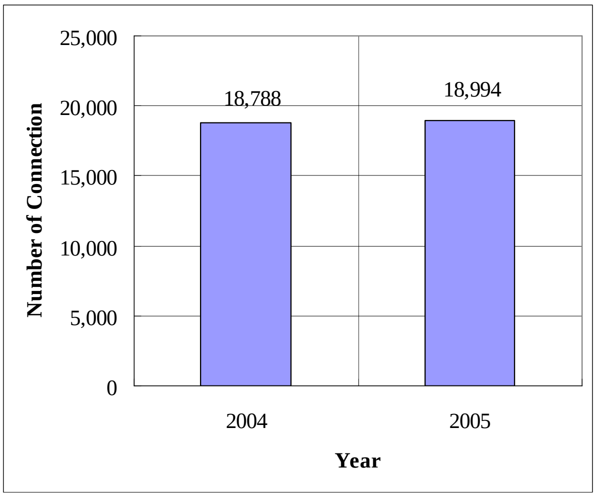


Figure 6.3.10 Number of Domestic Connections

(5) Number of Served Population and Service Ratio

1) Family Size

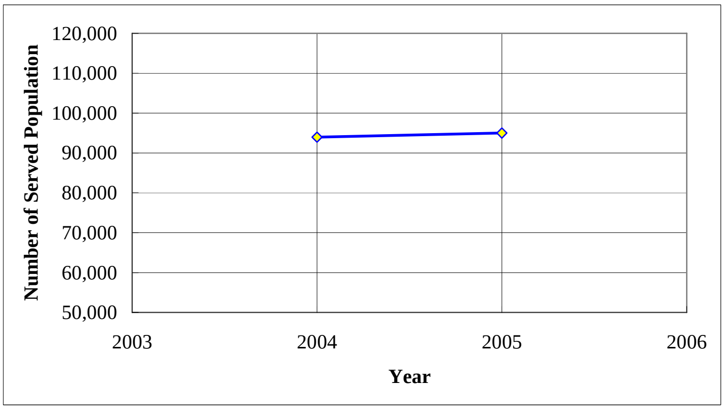
According to the results of socio economic survey (refer to Chapter 10), average family size is estimated as 5 people per family.

2) Number of Served Population

From number of domestic connections and average family size, served population is calculated as follows.

Table 6.3.5 Number of Served Population

	2004	2005
Sub-Total	93,940	94,970



Source: PDAM Sleman

Figure 6.3.11 Number of Served Population

3) Service Ratio

Service ratio, served by PDAM Sleman through individual house connection, is calculated from total population and served population.

Table 6.3.6 Served Population and Service Ratio

	2004	2005
Total Population	948,146	960,803
Served Population	93,940	94,970
Service Ratio	9.9%	9.9%

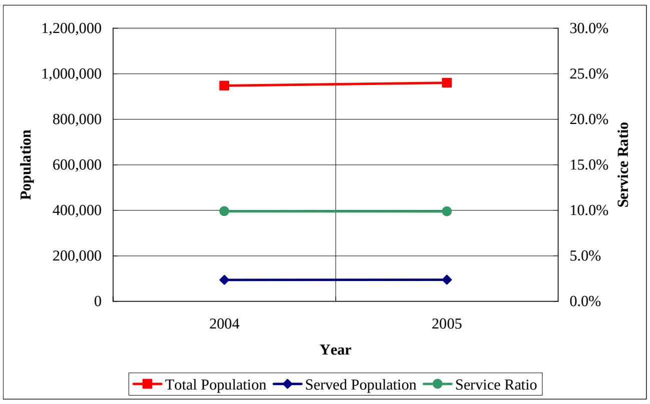


Figure 6.3.12 Total and Served Populations and Service Ratio

(6) Domestic Per Capita Water Consumption

From total domestic water consumption and number of domestic served population, domestic per capita water consumption (lpcd: litter per capita day) is calculated as shown below.

Table 6.3.7 Domestic Per Capita Water Consumption (lpcd)

	2004	2005	Average
Domestic Per Capita Water Consumption	82	80	81

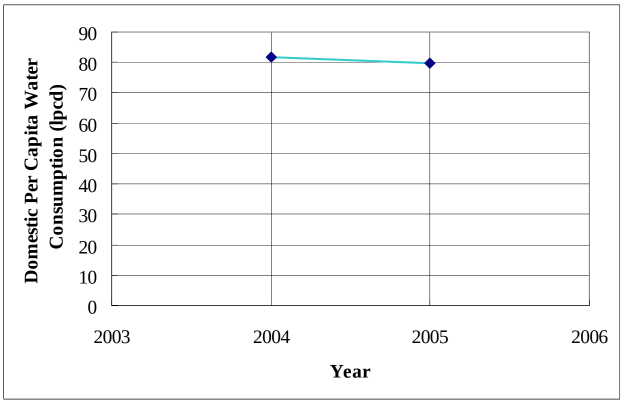


Figure 6.3.13 Domestic Per Capita Water Consumption (lpcd)

6.3.4 Operation and Maintenance

(1) PDAM Sleman has 17 water units (20 water supply facilities) and each unit is operated, managed, maintained by PDAM staffs. One(1) to twelve(12) staffs station at each water unit for the facility operation and customer services such as meter reading. Personnel development trainings were held by biannual. A technical transfer was made by senior staffs on OJT at each water unit.

(2) A repair plan was planned and carried out by a planning division in PDAM. On the other hands, a planning of master plan and rehabilitation program were not performed in PDAM.

(3) Some water sources and treatment plants are facing intake water shortages and insufficient treatment capacity. And water systems constructed in the 1980's to 1990's became superannuated. A correspondence to the above matters by routine maintenances seems difficult.

(4) Results obtained by site survey and hearings at major water supply facilities are as follows:

1) Minomatani water treatment plant is composing of deep well pump, aeration towers, sedimentation basins, rapid sand filters, reservoirs and distribution pumps. At present, an intake well operation was canceled due to a) high electric energy cost of deep well pump operation and b) difficulty of water treatment containing Iron and Manganese. So, water sources for the water supply system were changed to a) spring water (15 liters/s) from Umbulwadon Spring and b) shallow well (3 liters/s) constructed near by site. Water from Umbulwadon and shallow well are directly supplied to customers without water treatment and chlorination.

In the plant, there are no signs of a dosage and storage of chemicals to treat groundwater for a long time. Furthermore, chlorine was not dosed because customers complain chlorine smell in tap water. Operators in the plant have knowledge of water treatment process. But it would be difficult to operate properly them because of deteriorations of the facilities and the equipment.

2) On a major portion of intake water at Depok water supply plant, it is introduced from Umbulwadon spring and the rest is from groundwater initially constructed. This plant was initially planned and constructed to treat Iron and Manganese contained in the groundwater. At present, water treatment facilities such as sedimentation and filters are not used. Difficulty of treatment of the groundwater containing Iron and Manganese would be a reason for changing of water sources. There is no inventory and operational record of the water supply facility therefore it would be difficult to confirm actual conditions of facilities and equipment and operation.

(5) A water quality analysis is carried out by both BBTKL and Dines Kesharan respectively.
The water quality analysis by BBTKL is as follows;

Sampling points:	Reservoirs – Twice a year
	Water taps – 3 to 4taps/month
Analyzing parameters:	Chemical parameters such as Iron and Manganese

Denes Kesharan carries out total coliform analysis at 3 to 4 taps every month.

6.3.5 Summary of Problems Identified

(1) In PDAM Sleman, a master plan, rehabilitation programs were not implemented except house connection meters replacement. It seems that PDAM is busy with routine business. Furthermore, an inventory on water supply system was not provided. Consequently it would be difficult to have a clear grasp of the actual condition of existing facilities. Considering the above, it would be desirable to prepare a inventory of water supply facilities including pipe networks.

(2) A training program for personnel development was carried out by biannual. And, technical staff trainings for operation and maintenance were made by OJT. To improve operator’s capability, it would be needed to provide operation and maintenance manuals both general matters and particulars.

(3) Difficulties of operation and maintenance were appeared in some water units, caused by equipment malfunctions. From the public service point of view, it would be desirable to maintain facilities properly.

(4) Because of complains from consumers on chlorine smell at tap water, chlorination at some water unit were not carried out. From a safety water point of view, it is required to conduct chlorination dosing.

(5) Reduction of NRW is to be carried out for energy saving on the water supply system and conservation of natural resources as soon as possible.

(6) There are several leak points on transmission pipe (dia. 400 mm x 1,700 m) in Depok water unit. The transmission pipe is made of Fiber Glass Plastic Pipes. A cause of the damage is seemed its thin thickness of the pipe and/or its quality. Replacement of the above material pipes is required. Pipe material and specifications should be considered and decided carefully taking account of characteristics of the location of pipe installation. During the pipe installation work, construction supervision should also be carefully implemented to avoid unsuitable installation which will cause future leakage.

(7) Clogging by fine materials adhered to inner surfaces of pipes caused insufficient flow in distribution network. It is seemed that an unsatisfactory operation at water supply facilities would be major reason. Rehabilitation of facilities, equipment and pipes of the water supply system is required as soon as possible.

(8) As mentioned in section 6.2.5, it is required to have understandings among related organizations including Yogyakarta Municipality with respect to management of water source or service area restructuring.

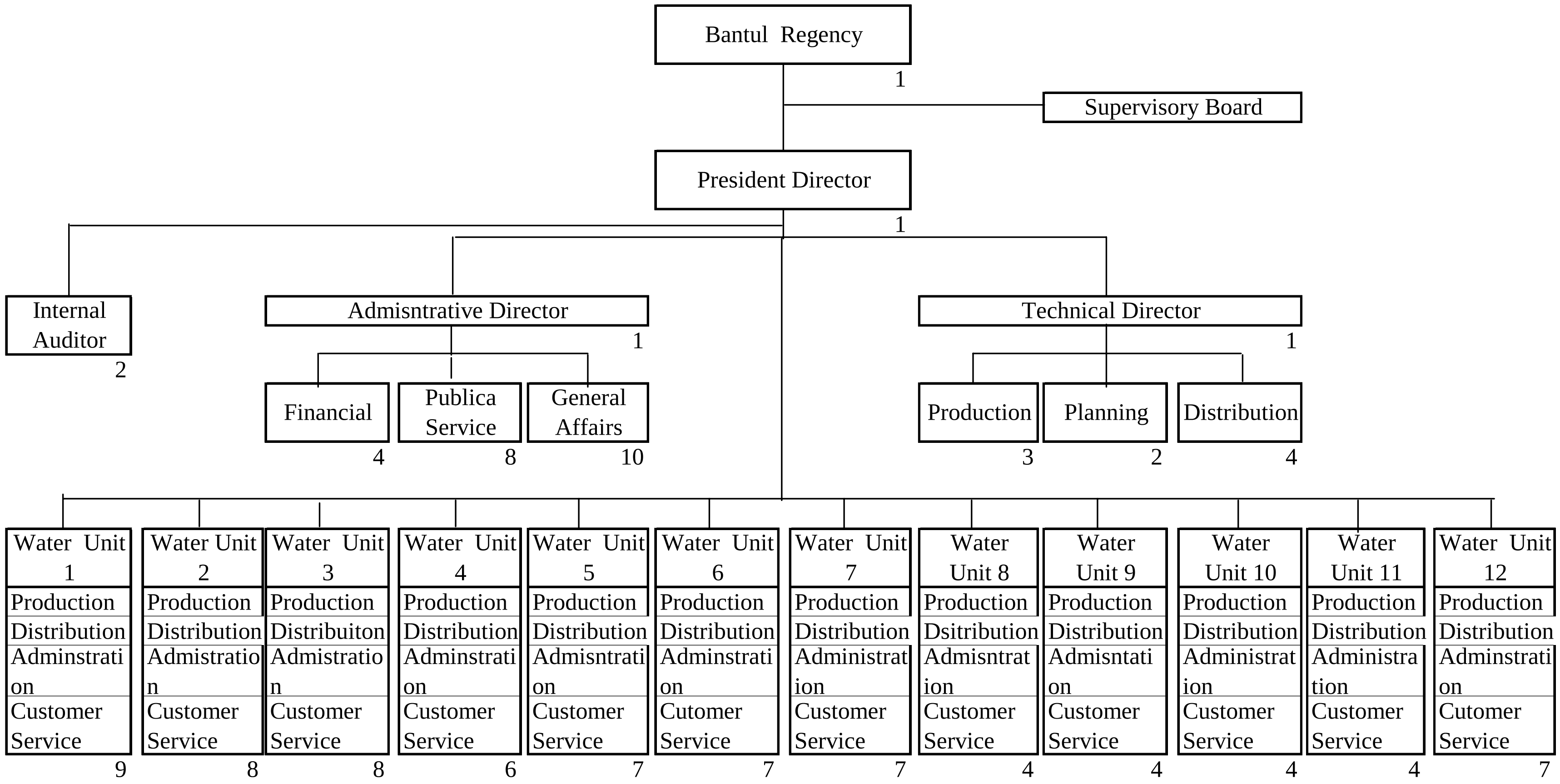
6.4 PDAM Bantul System

6.4.1 Organization

PDAM Bantul is a water supply enterprise organization, having 50 technical staffs and 56 administrative staffs. The organization chart of PDAM Bantul is shown on Figure 6.4.1

6.4.2 Water Supply System

Location of water unit is shown on Figure 6.4.2. As shown on this figure, water units having several type and water production capacity are dotted in through whole Regency.



Note: Figure under each organization shows number of staffs
Source: JICA Study Team based on PDAM Bantul

Figure 6.4.1 Organization Chart of PDAM Bantul

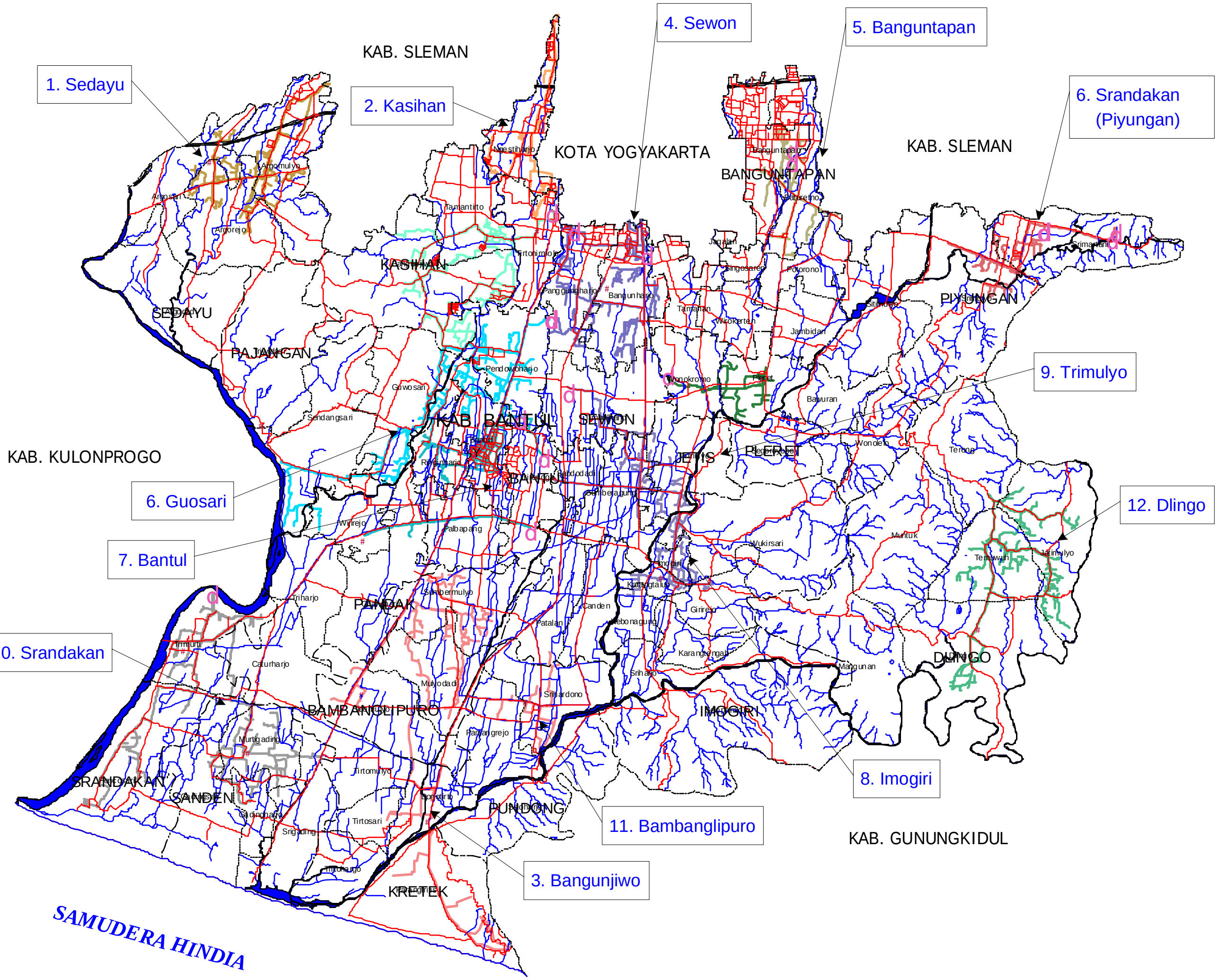


Figure 6.4.2 Location of PDAM Water Units

Typical treatment process flow is shown on Figure 6.4.3. To cope with Iron and Manganese in water sources, treatment facilities composing of aerations, sedimentations and sand filters were provided. In case, spring water is available, no treatment was provided. At Sedayu unit, grit chambers and coagulation/sedimentation process were employed to treat high turbidity.

For Groundwater Source (Water from deep water contains Iron and Manganese)

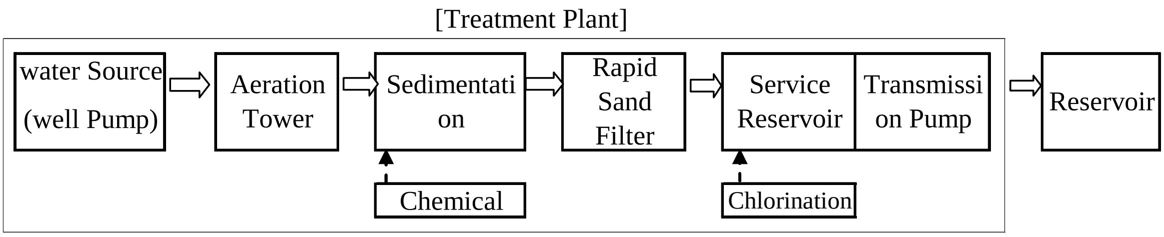


Figure 6.4.3 Treatment Process Flow

Water production facilities are summarized in Table 6.41. As shown on this table, water sources are groundwater such as deep wells and shallow wells except Dlingo water unit.

Table 6.4.1 List of Water Production Facilities

	Water Unit											
	1.Sedayu	2.Kasihan	3.Bangunjiwo	4.Sewon	5.Banguntapan	6.Guosari	7.Bantul	8.Imogiri	9.Trimulyo	10.Standakan	11.Bambanglipuro	12.Dlingo
1.Construciton	2003	1994	1993	1990	1995	1993	1983	1991	1997	1997	1991	1988
2.Water source	SW	DW	DW	DW	DW	DW	SW	DW	SW	SW	DW	Spring
3.Treatment process	Grit chamber, Mixing ,Coagulation,Pressure type filter	Aeration(diffuser), Flocculation,Sedimentation,Rapid sand filter	Aeration(diffuser),Flocculation,Sedimentation,Rapid sand filter	Aeration (diffuser), Flocculation,Sedimentation,Rapid sand filter	Aeration (multi),Rapid sand filter	Aeration (diffuser),Flocculation ,Sedimentation,Rapid sand flter	No treatment Falility	No treatment Facility	Flocculation,Sedimentation,Rapid sand filter	Rapid sand filter	No treatment Facility	No treatment Facility
4.Nominal treatment capacity	20 liter/s	20 liter/s	20 liter/s	10 liter/s	10 liter/s	20 liter/s	NA	NA	10 liter/s	10 liter/s	NA	NA
3.Chlorination	sodium hypo	Cl2(gas)	CL2(gas)	sodium hypo	Cl2(gas)	CL2(gss)	sodium hypo	CL2(gas)	CL2(gas)	CL2(gas)	CL2(gas)	Cl2（gas）
4House connection	1,556	1,265	1,597	1,196	484	1,491	1,003	306	554	401	223	556
5.Transmission main	GI 250Φ	PVC 200Φ	PVC 150Φ	PVC 150Φ	PVC 150Φ	PVC 200Φ	Asbestos 250Φ	PVC 150Φ	PVC 300Φ	PVC 150Φ	PVC 150Φ	PVC 150Φ

DW: Deep Well
SW: Shallow Well

Source: JICA Study Team based on PDAM Bantul

Table 6.4.2 shows breakdown of pipe length by its diameter and water unit. Total length of pipeline in PDAM Bantul is about 790 km. Diameter size ranges between 25mm and 300 mm.

Table 6.4.2 Pipe Length by Water Unit

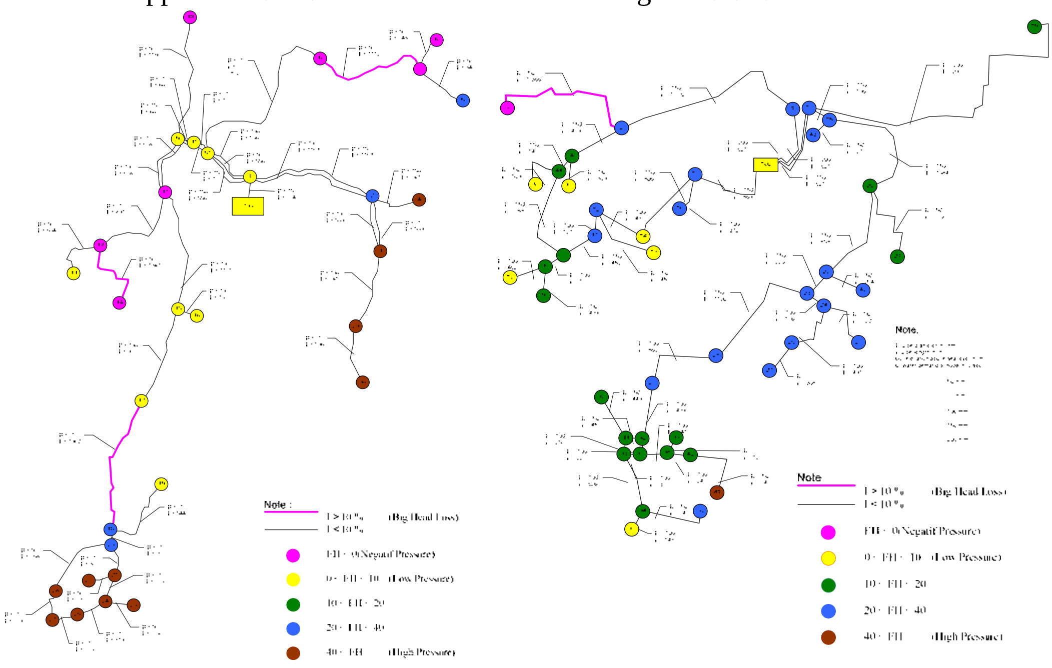
By Diameter and Water Unit (unit:m)

Water Unit / Dia.(mm)	Sedayu	Kasihan	Bangunjiwo	Sewon	Banguntapan	Piyungan	Guosair	Bantul	Imogiri	Srandakan	Bambanlipuoro	Dlingo	Total
13	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-
25	2,308	367	3,072	7,544	692	8,464	4,196	1,451	16,138	11,687	No Data	81,010	136,929
40	7,388	-	11,625	17,152	570	4,089	11,218	-	5,669	10,356	No Data	73,556	141,623
50	4,564	6,809	8,123	5,052	9,657	2,853	8,730	8,129	3,148	8,977	No Data	76,858	142,900
75	7,979	3,465	895	5,843	7,888	1,084	8,175	7,838	1,597	6,726	No Data	61,816	113,306
100	4,585	9,839	4,211	6,495	-	893	8,605	3,387	1,242	5,673	No Data	62,197	107,127
150	-	7,154	9,489	2,813	2,358	1,187	8,123	8,096	10,417	6,111	No Data	57,843	113,591
200	-	-	-	-	-	-	4,381	1,396	-	6,054	No Data	16,522	28,353
250	-	-	-	-	-	-	-	638	-	-	No Data	638	1,276
300	-	4,873	-	-	-	-	-	-	-	-	No Data	4,873	9,746
Total	26,824	32,507	37,415	44,899	21,165	18,570	53,428	30,935	38,211	55,584	No Data	435,313	794,851

Source: the Memorandum Report

The above pipe data are obtained from the drawing in the "Memorandum Report", and further data could not be obtained from PDAM Bantul. The data are also used for hydraulic calculation.

Dlingo water supply unit in the hilly area in west and Bangunjiwo water supply unit in relatively flat area in south are selected for the hydraulic calculation. Renewal of water treatment plant for Dlingo is included in EPP. Production capacity for the area is considered as daily maximum for the calculation and 1.2 is applied for the hourly peak factor. Elevation data for the calculation are read from the above mentioned drawing. The results of the calculation are shown in Appendix 6.1-6.2 and summarized in the Figure 6.4.4 .



Dlingo Water Unit

Bangunjiwo Water Unit

Figure 6.4.4 Results of Hydraulic Calculation (Bantul)

The results of hydraulic calculation for Dlingo system show negative pressure at high elevation places and very high pressure at low places. It will be necessary to reinforce the system by installing some pipes and pressure reducing equipment in order to keep adequate pressure.

The calculation results for the Bangunjiwo system show some low or negative pressure points at the end of pipe system during hourly peak period. However the pipe capacity in the area is considered to be nearly adequate for distributing the current production volume.

Actual hydraulic condition of distribution system will be severe than the results of hydraulic calculation since PDAM Bantul informed that water distribution pipes are clogged due to water quality such as high concentration of Iron, Manganese and Calcium. It will be required to reinforce distribution system in the area of poor service especially in higher altitude locations.

6.4.3 Performance of PDAM Bantul

(1) Water Production

Total water production by PDAM Bantul in last 2 years (2004 and 2005) is as shown on Table 6.4.3 and Figure 6.4.5.

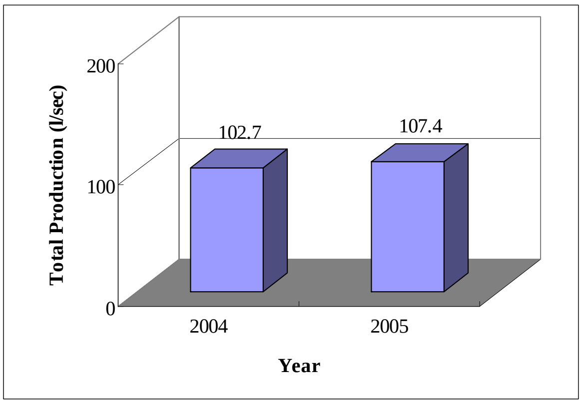
Table 6.4.3 Annual Water Production (m3/year)

Year	2004	2005
Total Production (m3/year)	3,237,981	3,385,821

in (l/sec)

Year	2004	2005
Total Production (l/sec)	102.7	107.4

Source: PDAM Bantul



Source: PDAM Bantul

Figure 6.4.5 Annual Water Production (l/sec)

(2) Water Consumption

Table 6.4.4 shows Metered Water Consumption by Monthly & Category in 2004 and 2005. In year of 2004, the average value of monthly consumption reached nearly 162,000 m3. Minimum consumption recorded nearly 142,000 m3 at March (approx.88% of the average value) and maximum consumption recorded nearly 177,000 m3 at November (approx.110% of the average).

In year of 2005, the average value of monthly consumption reached nearly 164,000m3. Minimum consumption recorded nearly 149,000 m3 at March (approx.91% of the average value) and maximum consumption recorded nearly 174,000 m3 at June (approx.106% of the average).

Seasonal fluctuation of water consumption is not recognized definitely because of limited supply capacity against increasing water demand.

Table 6.4.4 Metered Water Consumption by Monthly & Category

Year 2005

Category	Connection	Consumption (m3/month)												
		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1.Domestic														
Hight														
Medium	141	1,791	2,000	2,362	2,173	2,395	2,625	2,334	2,406	2,073	2,174	2,217	2,173	26,723
Medium low	3,347	40,874	39,690	38,912	42,703	43,318	47,900	43,828	46,752	49,193	48,970	52,314	48,459	542,913
Low	6,845	113,280	112,704	101,205	116,573	110,515	114,889	105,515	106,070	110,730	105,962	110,001	97,407	1,304,851
Sub-total	10,333	155,945	154,394	142,479	161,449	156,228	165,414	151,677	155,228	161,996	157,106	164,532	148,039	1,874,487
2. Non-domestic														
Gov't office	82	3,982	4,863	3,877	4,346	5,023	5,337	4,209	4,207	5,136	4,626	5,399	5,541	56,546
Schools														
Hospitals	72	2,381	2,818	2,267	3,122	2,742	2,735	2,683	2,519	2,818	2,232	1,854	1,803	29,974
Commertical(small scale)	21	644	614	736	629	608	700	711	737	815	883	896	675	8,648
Commertical(large scale)	2	333	196	221	255	213	214	209	287	247	195	149	308	8,648
Industry (small scale)	2	385	258	89	69	4	3	52	317	332	404	187	191	2,291
Industry (large scale)														
Social	120													
Others														
Sub-total	299	7,725	8,749	7,190	8,421	8,590	8,989	7,864	8,067	9,348	8,340	8,485	8,518	100,286
3.Public hydrant														
4.Total	10,632	163,670	163,143	149,669	169,870	164,818	174,403	159,541	163,295	171,344	165,446	173,017	156,557	1,974,773

Year 2004

Category	Consumption (m3/month)												
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1.Domestic													
Hight	114,305	116,711	102,058	111,225	113,977	117,010	111,973	115,782	118,099	114,416	119,799	117,216	1,372,571
Medium	33,464	31,810	30,647	31,941	33,895	34,944	34,285	38,026	40,607	38,027	42,554	38,029	428,229
Low	1,180	1,688	1,342	1,570	1,465	1,471	1,943	1,738	1,655	1,899	2,531	2,134	20,616
2. Non-domestic													
Gov't office	3,702	417	3,295	3,509	4,020	3,652	3,599	3,530	3,470	4,115	5,025	5,072	43,406
Schools													
Hospitals													0
Commertical(small scale)	76	673	557	590	549	683	537	661	844	670	626	592	7,058
Commertical(large scale)	415	57	57	213	10	363	372	494	533	491	267	327	3,599
Industry (small scale)	119	127	176	219	240	300	162	423	267	337	254	350	2,974
Industry (large scale)													
Special Social	2,512	1,792	1,784	2,005	2,099	2,098	1,783	1,996	2,510	2,549	2,434	2,239	25,801
Public Social	3,087	3,148	2,744	2,841	2,962	4,346	2,833	3,425	3,085	3,991	3,921	3,379	39,762
Others													
3.Public hydrant													
4.Total	158,860	156,423	142,660	154,113	159,217	164,867	157,487	166,075	171,070	166,495	177,411	169,338	1,944,016

Source: JICA Study Team based on PDAM Bantul

Table 6.4.5 show past record of water consumption by category in last 2 years (2004 and 2005) in m^3/year and l/sec respectively.

Figures 6.4.6 and 6.4.7 also show past record of water consumption by category in last 2 years (2004 and 2005) in l/sec and its proportion respectively.

Table 6.4.5 Water Consumption in Last 10 Years by Category (m3/year)

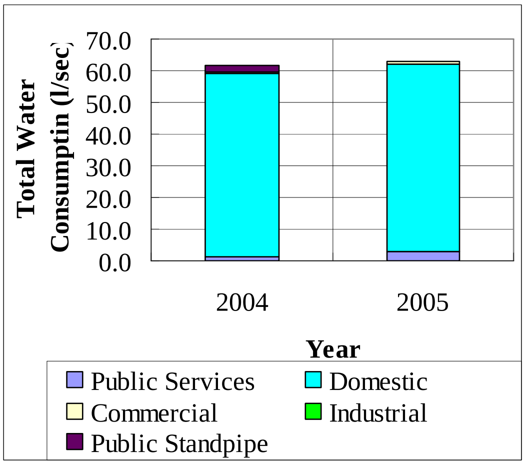
	Category	2004	2005
I	Public Services	43,406	86,520
II	Domestic	1,821,416	1,874,487
III	Commercial	10,657	17,296
IV	Industrial	2,974	2,291
V	Public Standpipe	65,563	0
	Total	1,944,016	1,980,594

Source: PDAM Bantul

in (l/sec)

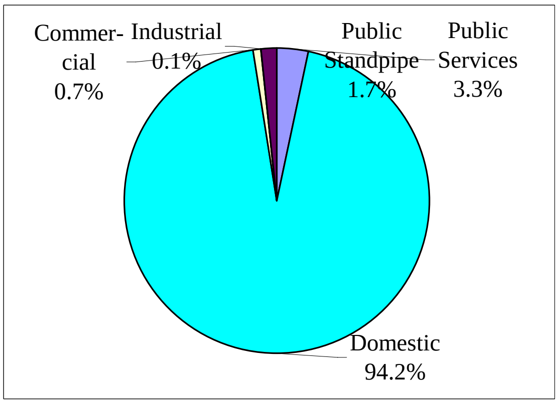
	Category	2004	2005
I	Public Services	1.4	2.7
II	Domestic	57.8	59.4
III	Commercial	0.3	0.5
IV	Industrial	0.1	0.1
V	Public Standpipe	2.1	0.0
	Total	61.6	62.8

Source: PDAM Bantul



Source: PDAM Bantul

Figure 6.4.6 Water Consumption by Category in Last 2 Years (2004 and 2005)

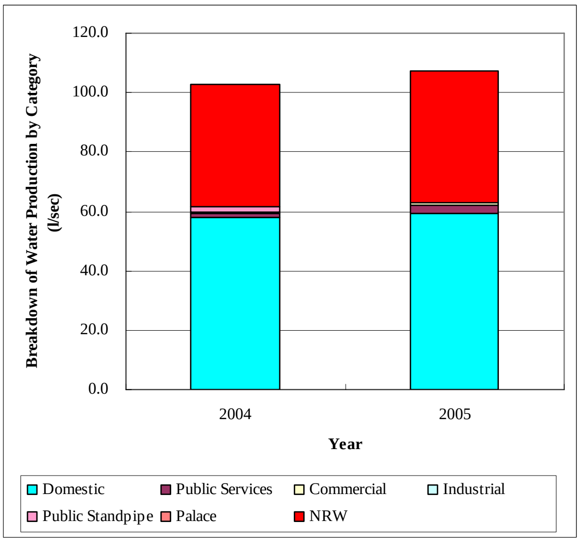


Source: PDAM Bantul

Figure 6.4.7 Average Proportion of Water Consumption by Category in Last 2 Years (2004 2005)

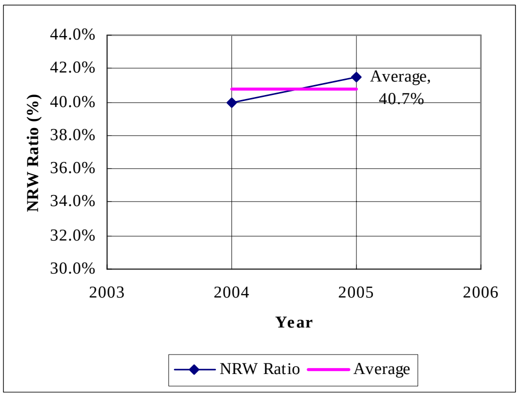
(3) NRW Ratio

The balance of total water production and total water consumption is Non Revenue Water (NRW) and the NRW ratios for respective years are calculated as shown below.



Source: PDAM Bantul

Figure 6.4.8 Breakdown of Water Production including NRW



Source: PDAM Bantul

Figure 6.4.9 Fluctuation of NRW Ratio in Last 2 Years (2004 and 2005)

As shown on figure above, average NRW ratio is 40.7% in last two years.

These NRW ratios are calculated based on data provided by PDAM Bantul. Accuracy of water production quantity seems rather low since many water units are not equipped with master water meter. Under such condition, the production quantity was cross checked by respective pump capacity and duration (hours) of pump operation. According to the results of the cross checking, quantity of water production was judged reasonable. Concerning quantity of water consumption, water meters on respective house connections are not periodically replaced and maintained, accuracy of data seems rather low. However, since the NRW ratio in Bantul is in similar range of ones in Yogyakarta and Sleman, NRW ratio shown above is considered as not far different from actual ratio.

(4) Number of Domestic Connections

Number of domestic connections in last 2 years (2004 and 2006) are as shown on Table 6.4.6 and Figure 6.4.10.

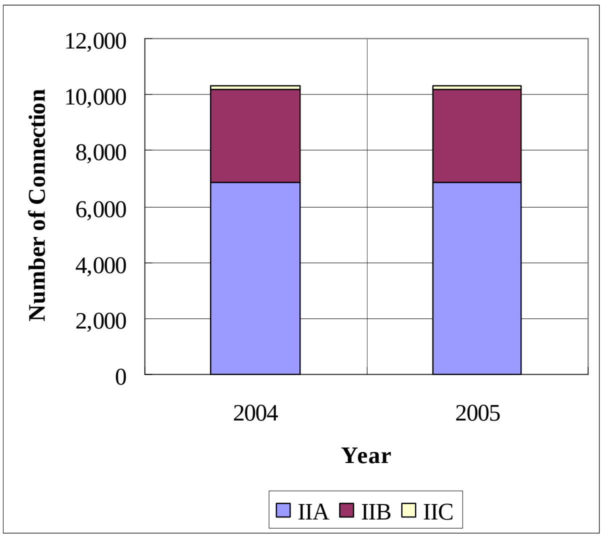
Table 6.4.6 Number of Domestic Connections and Their Proportion by Category

	2004	2005
IIA	6,845	6,845
IIB	3,347	3,347
IIC	141	141
Sub-Total	10,333	10,333

	2004	2005
IIA	66.2%	66.2%
IIB	32.4%	32.4%
IIC	1.4%	1.4%
Sub-Total	100.0%	100.0%

Source: PDAM Bantul

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class



Source: PDAM Bantul

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class

Figure 6.4.10 Number of Domestic Connections by Category

(5) Number of Served Population and Service Ratio

1) Family Size

According to the results of socio economic survey (refer to Chapter 10), average family size is estimated as 5 people per family.

2) Number of Served Population

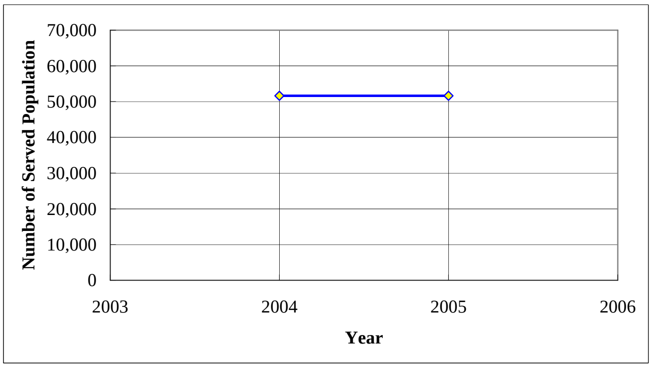
From number of domestic connections and average family size, served population is calculated as follows.

Table 6.4.7 Number of Served Population

	2004	2005
IIA	34,225	34,225
IIB	16,735	16,735
IIC	705	705
Sub-Total	51,665	51,665

Source: PDAM Bantul

Note: IIA: High Income Class, IIB: Medium Income Class, IIC: Low Income Class



Source: PDAM Bantul

Figure 6.4.11 Number of Served Population

3) Service Ratio

Service ratio, served by PDAM Bantul through individual house connections, is calculated from total population and served population.

Table 6.4.8 Served Population and Service Ratio

	2004	2005
Total Population	816,100	825,285
Served Population	51,665	51,665
Service Ratio	6.3%	6.3%

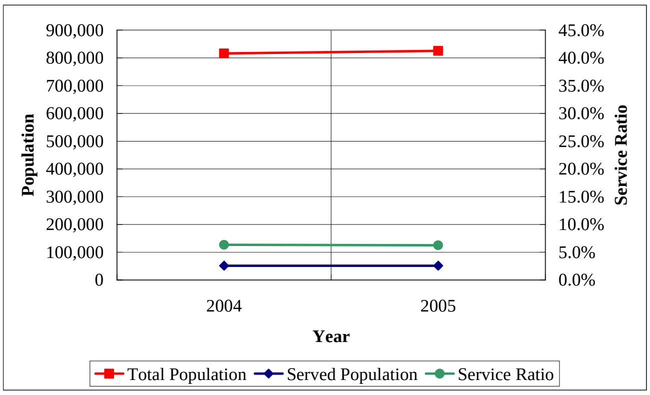


Figure 6.4.12 Total and Served Populations and Service Ratio

(6) Domestic Per Capita Water Consumption

From total domestic water consumption and number of domestic served population, domestic per capita water consumption (lpcd: litter per capita day) is calculated as shown below.

Table 6.4.9 Domestic Per Capita Water Consumption (lpcd)

	2004	2005	Average
Domestic Per Capita Water Consumption	97	99	98

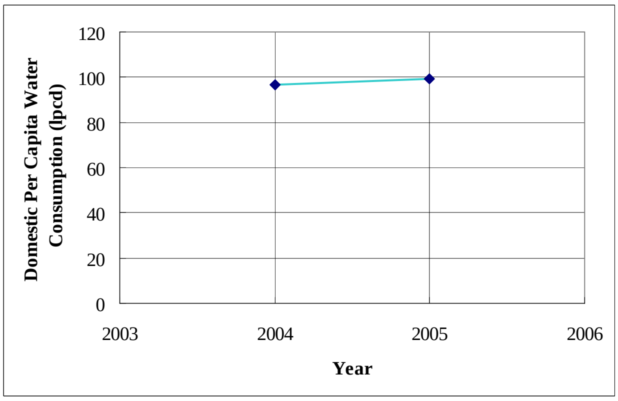
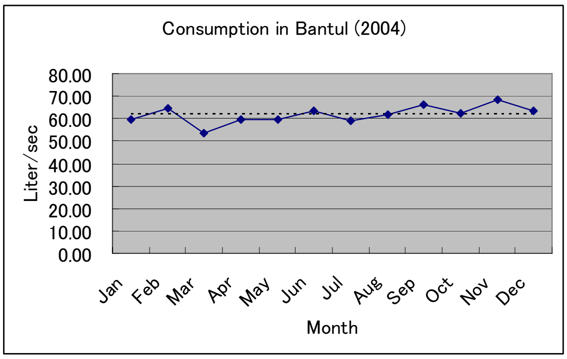
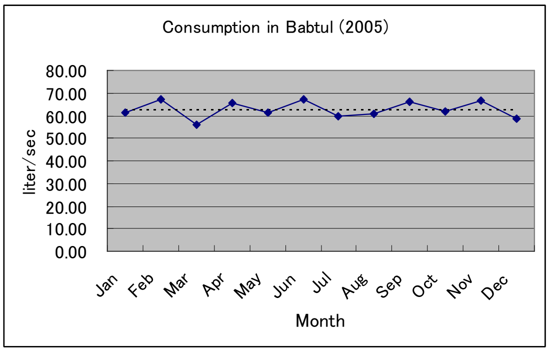


Figure 6.4.13 Domestic Per Capita Water Consumption (lpcd)

(7) Fluctuation of Water Consumption

Daily fluctuation of water consumption throughout a year is observed by using monthly data since daily data are not available. Figure 6.4.14 and Table 6.4.10 show the consumption fluctuation throughout the year of 2004 and 2005.





Source: JICA Study Team

Figure 6.4.14 Fluctuation of Water Consumption Throughout a Year

Table 6.4.10 Fluctuation of Water Consumption in a Year

	2004	2005
Max (l/sec)	68.45	67.44
Ave (l/sec)	61.64	62.62
Peak factor	1.11	1.08
Month of peak	November	February

Source: JICA Study Team

Fluctuation of water consumption in a year is around 1.1 and not big. It will be due to limitation of water supply capacity.

6.4.4 Operation and Maintenance

(1) They have 12 water units and each water unit is operated, managed, maintained by PDAM staffs. Several staffs station at each water unit for the water facility operation and customer services such as meter reading. In 2002, an explanation with water supply business for PDAM employees was performed. A technical transfer to new staffs was made by senior staffs on OJT at each water units.

(2) Some water sources and treatment plants are facing intake water shortage and insufficient treatment capacity. Water supply facilities constructed in the 1990's became deterioration. A correspondence to the above matters by routine maintenances seems difficult.

(3) Results obtained by site surveys and hearings at major water supply facilities are as follows;

1) Bangunliwo water treatment plant and Guosari water treatment plant are a packaged type water purification plant, composing of aeration towers, sedimentation tanks and rapid sand filters to treat groundwater containing Iron and Manganese in deep wells. A nominal treatment capacity of the packaged water treatment unit is 10 liter/s (approx.800m3/d). However, to deal with water demand increase, water production was increased exceeding

the above nominal capacity, that is, approx. 990 to 1,450m3/d. It would bring treated water quality worth.

2) A large number of malfunctioned water meters were reported. Especially in Sewon and Dilingo water unit, many meters were not workable because of clogging. It would be prospected that Sewon groundwater contains Iron and Manganese and Dilingo groundwater contains Calcium.
3) House connection meters were not replaced and/or repaired so far from initial installation.
4) In Bangunjiwo and Guosari water treatment plant, proper operation and maintenance seems difficult due to deteriorated facilities and equipment.

(3) A water quality analysis is carried out by BBTKL (Bali BesarTeknik Keseharan Lingkungan) and Dines Kesharan respectively.

The water quality analysis by BBTKL is as follows;

Sampling points: Reservoirs and water taps (approx. 300 samples/year)

Analyzing parameters: Twenty (20) parameters of chemicals

The water quality analysis by Dines Kesharan is as follows;

Sampling points: Same as BBTKL samplings

Analyzing parameters: Six (6) general parameters (Smell, TDS, NTU, Taste, Temperature and Color)

6.4.5 Summary of Problem Identified

(1) In PDAM Bantul, preparation of a master plan, future water demand estimation, rehabilitation program were not conducted. PDAM seems busy with routine business. Furthermore, an inventory with water supply facilities was not provided. Consequently it would be difficult to have a clear grasp of the existing facilities. Considering the above, it is desirable to prepare a clear inventory of each water supply facility.

(2) Trainings for personnel educations and technical trainings were not planed and carried out periodically so it would become one reason of difficulty of proper operations and maintenances of water facilities, house connection meter readings and billing. Therefore, it is needed to establish a training system.

(3) A replacement and/or repair of water meters, which were installed in 1990's, were not made. Malfunctions of water meters were reported and PDAM already grasp actual condition of the meters. There would be some possibility of breaking relationship of mutual trust between PDAM and customers due to billing to consumers based on

non-reliable meter reading.

(4) A poor operation and maintenance was appeared in some water units, caused by insufficient operation/maintenance technique, knowledge on water supply system and water treatment equipment malfunctions. From public service point of view, it is desirable to maintain water supply facility properly.
For the above, an establishment of technical training system and a rehabilitation of facilities, equipment and pipe are required.

(5) Because of complains from consumers of chlorine smell in supplied water, chlorination injection to treated water was not made in some water unit. From a point of view of safety water supply, it is required to conduct chlorination dosage.

(6) NRW ratio reaches approximately 40%. Reduction of NRW is to be carried out by proper measures for energy saving purpose and conservation of natural resources.

6.5 Comparison of Three PDAMs, Yogyakarta, Sleman, and Bantul

Comparison of three PDAMs, Yogyakarta, Sleman, and Bantul is shown below in aspect of respective PDAM's performance and problems identified.

Table 6.5.1 Summary of PDAM Sleman Performance

		2004	2005
Total Population	person	948,146	960,803
Total Water Production	l/sec	159.3	178.0
Total Water Consumption	l/sec	96.1	95.4
Public Services	l/sec	3.3	4.0
Domestic	l/sec	88.9	87.7
Commercial	l/sec	2.1	1.8
Industrial	l/sec		
Public Standpipe	l/sec	1.8	1.8
Palace	l/sec		
Non Revenue Water (NRW)	l/sec	63.2	82.6
NRW Ratio	%	39.6%	46.4%
Number of Domestic Connection	Nos	18,788	18,994
Served Population	person	93,940	94,970
(1 connection for 5 family members)		5	5
Service Ratio	%	9.9%	9.9%
Domestic Per Capita Water Consumption	lpcd	82	80

Source: PDAM Sleman

Table 6.5.2 Summary of PDAM Bantul Performance

		2004	2005
Total Population	person	816,100	825,285
Total Water Production	l/sec	102.7	107.4
Total Water Consumption	l/sec	61.6	62.8
Public Services	l/sec	1.4	2.7
Domestic	l/sec	57.8	59.4
Commercial	l/sec	0.3	0.5
Industrial	l/sec	0.1	0.1
Public Standpipe	l/sec	2.1	2.1
Palace	l/sec		
Non Revenue Water (NRW)	l/sec	41.0	44.6
NRW Ratio	%	40.0%	41.5%
Number of Domestic Connection	Nos	10,333	10,333
Served Population	person	51,665	51,665
(1 connection for 5 family members)		5	5
Service Ratio	%	6.3%	6.3%
Domestic Per Capita Water Consumption	lpcd	97	99

Source: PDAM Bantul

Table 6.5.3 Summary of PDAM Yogyakarta Performance

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Population	person	406,735	406,856	406,995	407,142	407,306	407,484	407,673	407,881	408,096	408,332
Total Water Production	l/sec	509.4	559.6	578.8	570.6	546.6	584.7	533.9	543.9	548.8	580.0
Total Water Consumption	l/sec	343.4	357.6	354.0	356.3	373.4	375.9	370.1	351.6	347.3	341.0
Public Services	l/sec	14.1	15.3	16.3	16.3	16.2	16.5	15.3	14.1	14.5	14.3
Domestic	l/sec	294.4	310.7	309.2	309.4	319.0	326.4	323.1	309.6	310.0	305.7
Commercial	l/sec	26.0	27.1	25.2	27.0	28.4	28.3	27.8	24.9	19.5	17.7
Industrial	l/sec	0.7	0.4	0.2	0.2	0.5	0.5	0.5	0.4	0.3	0.2
Public Standpipe	l/sec	4.7	1.8	0.4	0.6	6.3	0.5	0.5	0.4	0.6	0.7
Palace	l/sec	3.3	2.3	2.7	2.8	3.0	3.7	3.0	2.2	2.4	2.3
Non Revenue Water (NRW)	l/sec	166.0	202.0	224.7	214.3	173.3	208.8	163.7	192.4	201.4	239.0
NRW Ratio	%	32.6%	36.1%	38.8%	37.6%	31.7%	35.7%	30.7%	35.4%	36.7%	41.2%
Number of Domestic Connection	Nos	27,996	28,769	29,730	30,437	31,212	31,855	32,214	32,276	32,387	32,398
Served Population	person	139,980	143,845	148,650	152,185	156,060	159,275	161,070	161,380	161,935	161,990
(1 connection for 5 family members)		5	5	5	5	5	5	5	5	5	5
Service Ratio	%	34.4%	35.4%	36.5%	37.4%	38.3%	39.1%	39.5%	39.6%	39.7%	39.7%
Domestic Per Capita Water Consumption	lpcd	182	187	180	176	177	177	173	166	165	163

Source: PDAM Yogyakarta

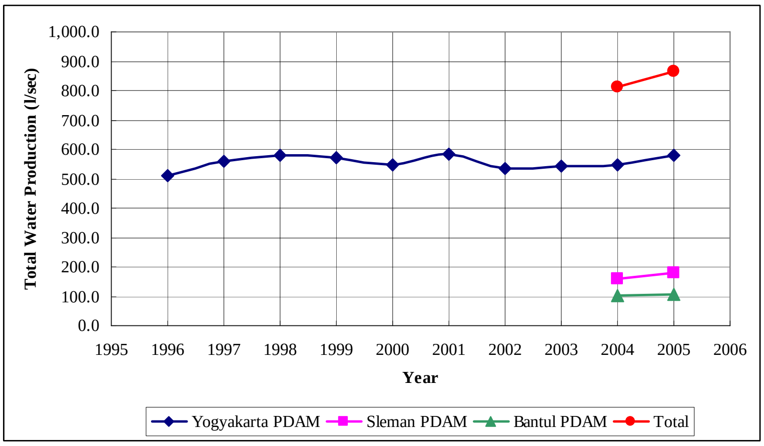


Figure 6.5.1 Total Water Production (l/sec)

Water production of Sleman and Bantul is far smaller than one of Yogyakarta. However, it should be noted that PDAM Yogyakarta depends on its water source on spring/wells in Sleman Regency mainly.

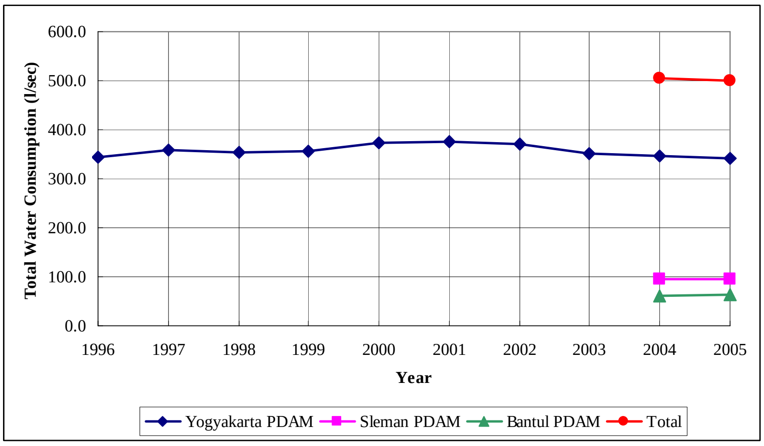


Figure 6.5.2 Total Water Consumption (l/sec)

Total water consumption in these three PDAMs is about 500 l/sec. On the hand, total water production shown above is about 850 l/sec.

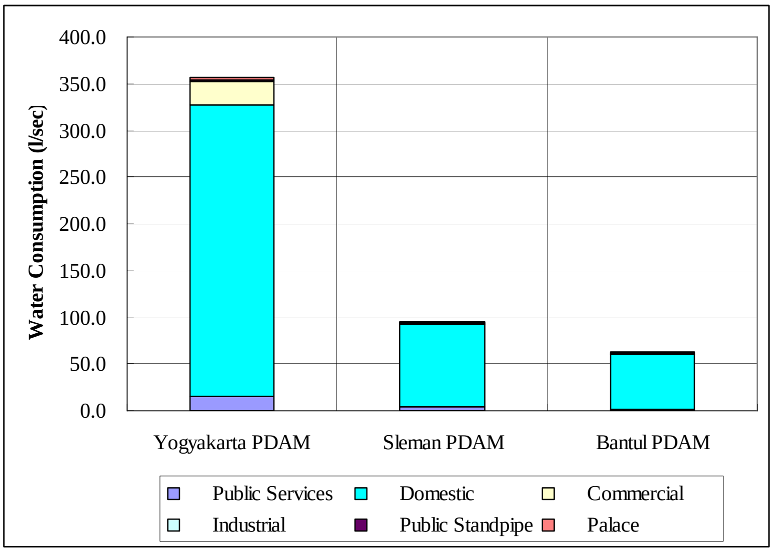


Figure 6.5.3 Water Consumption by Category (l/sec)

This figure shows breakdown of water consumption shown above. Portion of domestic water consumption is the highest. Non-domestic water consumption (other than domestic water consumption) is rather high in Yogyakarta, but the ratio of non-domestic water consumption is low in these three PDAMs.

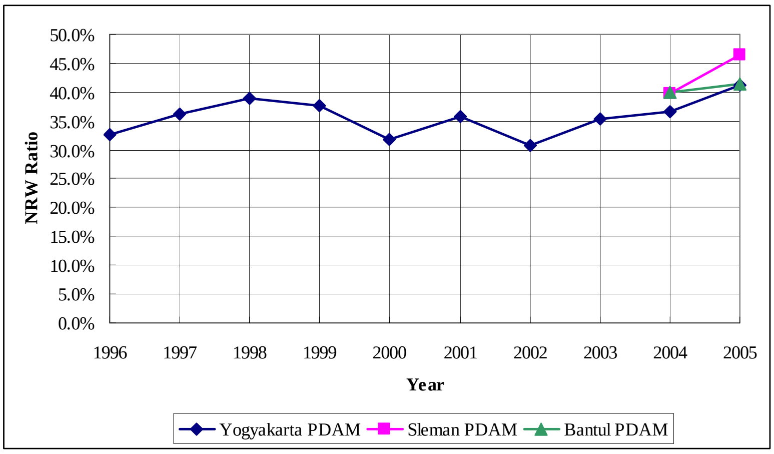


Figure 6.5.4 Non Revenue Water Ratio

NRW ratios in these three PDAMs show high level, 40 % to 50 %. Measures for reduction of the NRW ratio should be planned and implemented.

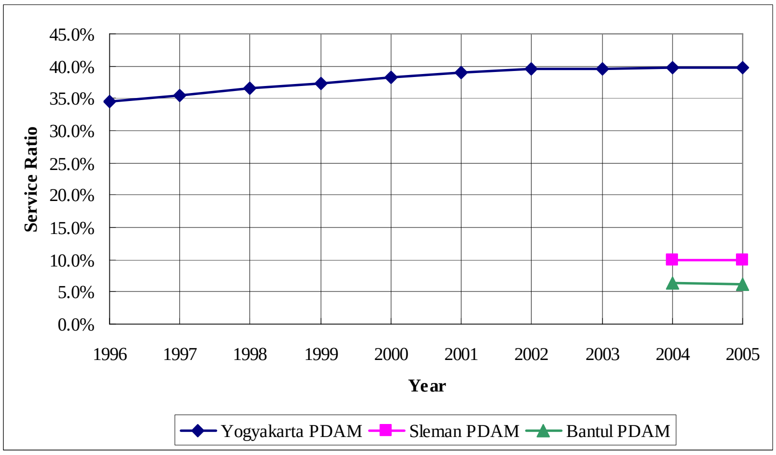


Figure 6.5.5 Service Ratio

Service ratio of PDAM Yogyakarta is the highest and the other two PDAMs show very low service ratio by individual house connection.

Including Yogyakarta PDAM, service ratios in these three PDAMs are still very low comparing to National Target.

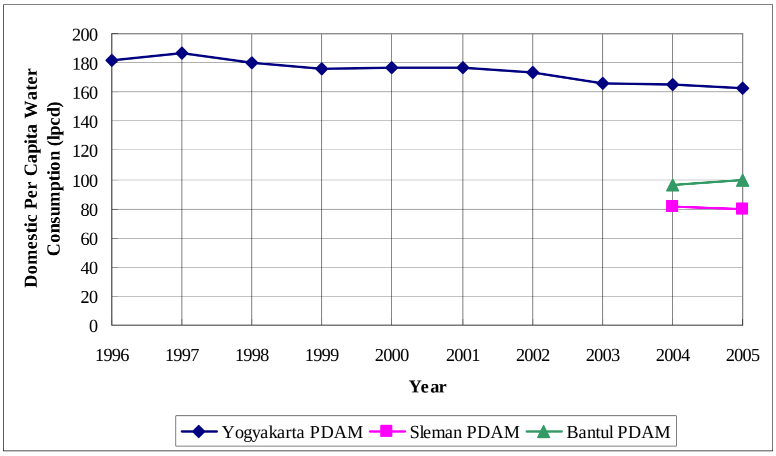


Figure 6.5.6 Domestic per Capita Water Consumption (l/sec)

Domestic per capita water consumption in Yogyakarta is the highest and about 160 l/sec. Per capita water consumptions in Sleman and Bantul Regencies are low comparing to one of Yogyakarta. Per capita water consumption in these two PDAMs are average figure of respective PDAMs, therefore, per capita in rural area is also counted. (Yogyakarta is only urban area)

Table 6.5.4 Comparison of Problems Identified in Respective PDAMs

Field	***Yogyakarta PDAM***	***Sleman PDAM***	***Bantul PDAM***	***Remarks***
Availability of long-term development plan, system rehabilitation plan	Not available	Not available	Not available	Long-term development plan and system rehabilitation plan shall be prepared by respective PDAM based on diagnosis of existing conditions/problems for sustainable and better service.
Availability of asset data	Complete asset data is not available	Complete asset data is not available	Complete asset data is not available	More attention should be paid on asset management for adequate operation/ maintenance and for preparation of the long-term development plan and system rehabilitation plan mentioned above.
Human resource development	Only OJT is executed.	Personnel development plan is prepared and implemented occasionally. OJT is also conducted	Training plan is not available.	Policy of human resource development should be established first and development plan should be prepared based on the policy. It should be noted that Sleman PDAM prepared personnel development plan.
Asset condition	Some deterioration of mechanical/electrical equipment is observed.	Some deterioration of mechanical/electrical equipment is observed.	Some deterioration of mechanical/electrical equipment is observed.	Routine inspection of asset condition should be required and the inspection results should be used as a basis of system rehabilitation plan mentioned above.
Water meter condition	Implementation of meter replacement program has started. But many old metes are still under operation.	Meter replacement program is under implementation.	Meter replacement activities are not implemented.	Specially in Bantul PDAM, meter replacement program should be prepared and executed as soon as possible. Routine (periodical) meter replacement program should be prepared and implemented conforming to the regulations concerned.
Availability of O/M manual	Not available	Not available	Not available	O/M manual for respective facility/unit should be required for adequate O/M.
Disinfection	Chlorine is dosed to distributed water	Insufficient disinfection	Insufficient disinfection	According to the drinking water quality standard of Indonesia, residual chlorine should be detected from tap water. However, disinfection is insufficient due to complain from the consumers who do not understand the importance of disinfection.
Pipeline maintenance and leak reduction	Distribution section is in charge of pipeline maintenance work.	Pipe repair plan is prepared.	Distribution section is in charge of pipeline maintenance work.	Generally, passive leak repair is conducted by PDAM. Preventive and aggressive leak reduction activities are required.

Water quality analysis	PDAM has own Laboratory Health Department checks biological parameters.	PDAM does not have Laboratory Health Department checks biological parameters	PDAM does not have Laboratory Health Department checks biological parameters	The frequency of water quality analysis is insufficient. Laboratory in Yogyakarta PDAM can assist other PDAM when the agreement is arranged and the capacity is increased.
Location of water sources and Service Area	Majority of water sources exist in Sleman Regency. Yogyakarta PDAM has supply areas in Sleman Regency.	All water sources are in Sleman Regency. Yogyakarta PDAM has supply areas in Sleman Regency.	All water sources are in Bantul Regency. The supply area is in Bantul Regency.	PDAM Yogyakarta has service areas in Sleman Regency. These areas are supplied from Umbul Wadon spring in Sleman Regency. Royal palace is also supplied from Umbul Wadon spring. Coordination between Yogyakarta PDAM and Sleman PDAM will be required to make the system simple.

6.6 Community Water Supply System

6.6.1 Organization

Community Water Supply System (or *Air Minum Desa* in Indonesian, hereinafter referred to as "AMD") has been constructed by budget of responsible regency's PU. In some cases, AMDs are co-financed by provincial and regency's PU. In construction stage, community people are to provide labor force for construction work of AMD on a voluntary basis.

Beneficiaries of AMD are advised by PU to organize Water User Organization (hereinafter referred to as "WUO"), which is organized by residents who receive the benefit of the water supply service through AMD. After the completion of construction, AMD is handed over to WUO. This means that daily management, operation and maintenance of the facilities are responsible of WUO. For example, repair and/or replacement of pump, electricity costs for pump operation or leak repair are covered by revenue of water charge or occasional contribution by the members of WUO when necessary. Figure 6.6.1 gives typical organization structure for WUO.

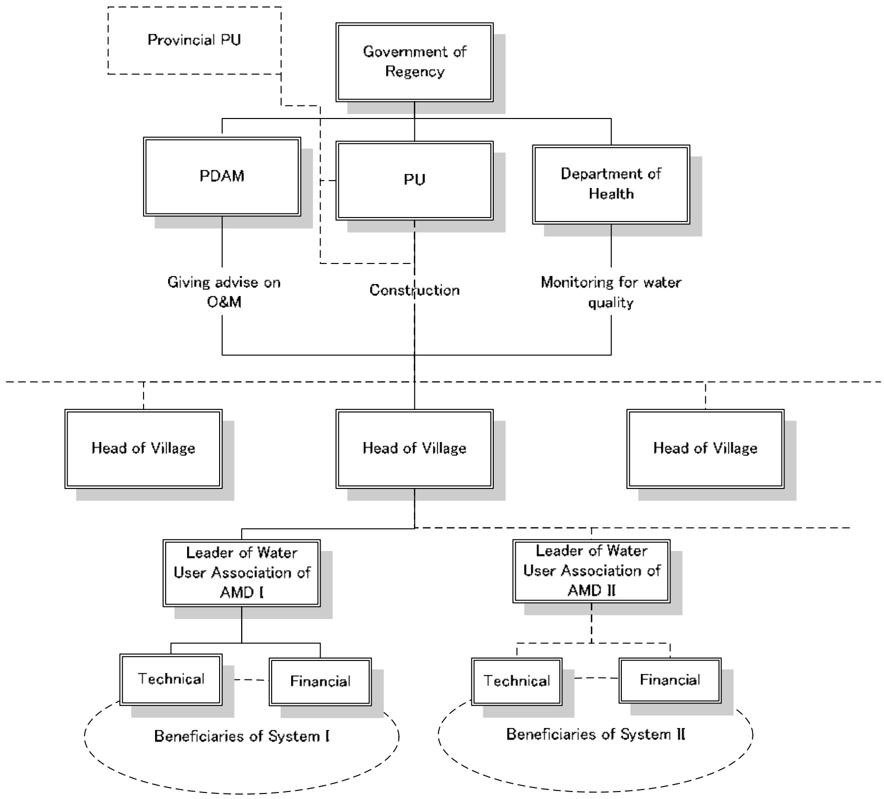


Figure 6.6.1 Typical Organization Structure for Water User Organization (WUO)

For instance, in case there are two AMDs in a village, WUOs for each AMD are organized under the head of village. The head of village acts as a coordinator among WUOs and concerned departments of responsible regency to facilitate a smooth handover of AMD from PU after completion of construction or requesting PDAM to dispatch its staff for operation and maintenance training for WUO. In addition, a head of village may request advise to the above mentioned department concerning on operation and maintenance whenever necessary.

6.6.2 General Features of Existing Community Water Supply System

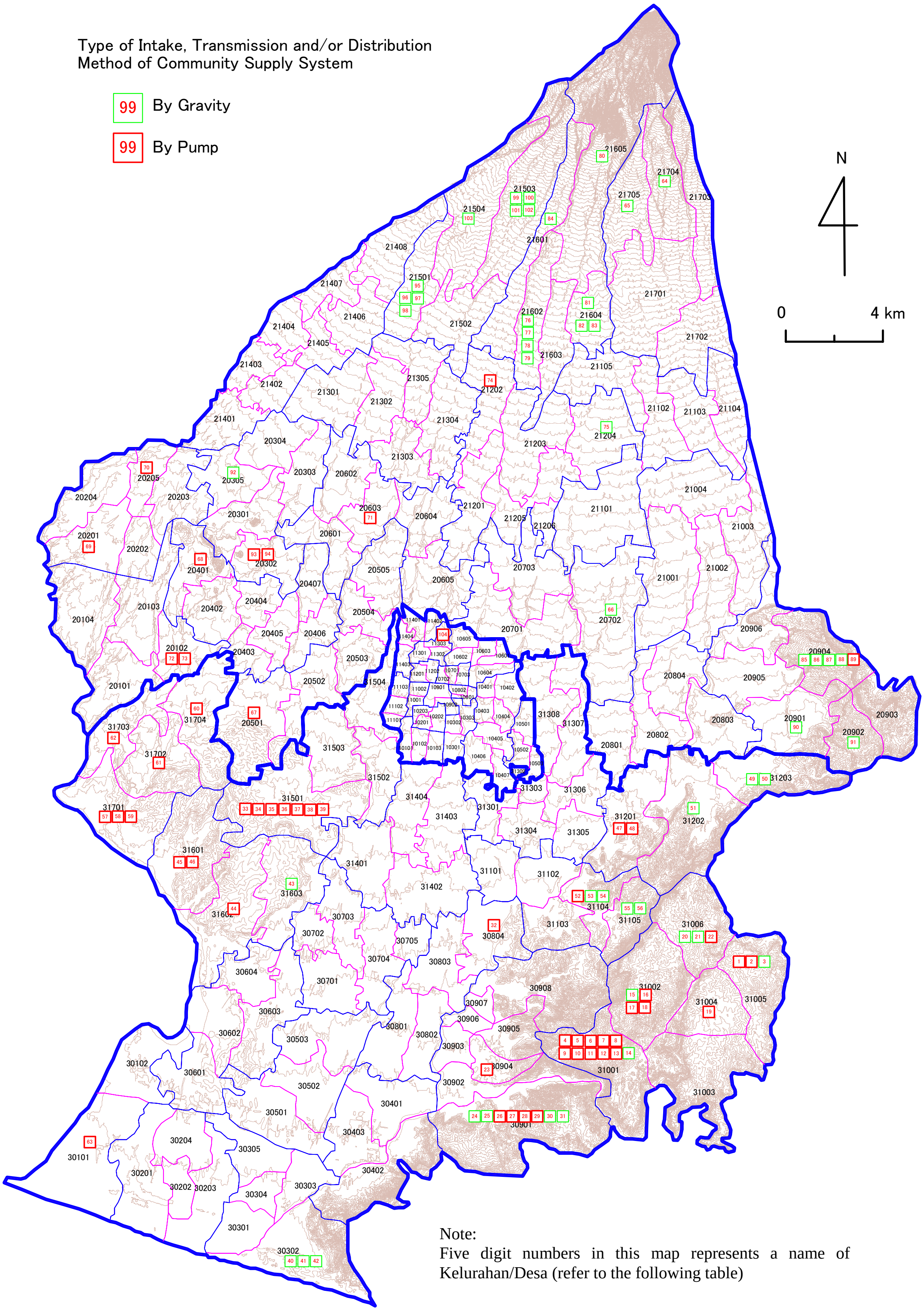
Inventory of existing facilities of AMDs in the Study Area, which would be basic information with respect to operation and maintenance, is not kept in record systematically. Only limited and fragmental information on existing facilities at the time of construction is available in responsible PU. This would be because of following background:

- PU is responsible only for construction of facility.
- Once constructed, facilities are handed over to WUO
- Therefore responsibility for O&M is also handed over to WUO
- Accordingly, PU does not necessarily feel the necessity of record keeping of AMDs

For the above backgrounds, basic data such as type of water source, location, scale of system, type/quantity/specification of facilities, construction year and so on, is not kept as inventory in electronic or written form.

In order to organize list of AMDs in the Study Area, the Study Team interviewed with the officials in PU Bantul, PU Sleman and PU DIY, and made site visitings to numbers of AMDs in the Study Area. Figure 6.6.2 shows locations and distribution of AMDs in the Study Area and Table 6.6.1 gives ID number which represents a name of Kelurahan/Desa in this location map. In addition, Table 6.6.2 outlines general feature of respective AMD in the Study Area and these data gives following specific aspects in the Study Area:

- As of July 2007, there are totally 106 numbers of AMD in the Study Area (61 in Bantul, 44 in Sleman and 1 in Yogyakarta).
- There are approximately 50 to 60 numbers of household in most of AMDs.
- Breakdown by type of primary water source shows that 62 AMDs use springs, 29 AMDs use sallow wells, 10 AMDs use deep wells and 5 AMDs use river. This indicates that most of AMDs in the Study Area rely on groundwater/spring.
- Breakdown by type of method for transmission/distribution shows that 50 AMDs employ pumping system while 56 AMDs can supply by gravity.
    - Breaking down this figure further according to regency, approximately 70 % of AMDs needs pump for transmission/distribution in Bantul.
    - On the contrary, 70 % of AMDs can transmit/distribute water by gravity in Sleman since its ground level declines from north to south to enjoy suitable conditions to apply gravity system, compared to Bantul.



Note:
Five digit numbers in this map represents a name of Kelurahan/Desa (refer to the following table)

Figure 6.6.2 Location of Community Water Supply System in the Study Area

Table 6.6.1 List of ID Number for Name of Kelurahan/Desa (1/2)

	ID No.	Kecamatan	Kelurahan/Desa
1	10101	MANTRIJERON	Gedongkiwo
2	10102	MANTRIJERON	Suryodiningratan
3	10103	MANTRIJERON	Mantrijeron
4	10201	KRATON	Patehan
5	10202	KRATON	Panembahan
6	10203	KRATON	Kadipaten
7	10301	MERGANGSAN	Brontokusuman
8	10302	MERGANGSAN	Keparakan
9	10303	MERGANGSAN	Wirogunan
10	10401	UMBULHARJO	Semaki
11	10402	UMBULHARJO	Muja-muju
12	10403	UMBULHARJO	Tahunan
13	10404	UMBULHARJO	Warungboto
14	10405	UMBULHARJO	Pandeyan
15	10406	UMBULHARJO	Sorosutan
16	10407	UMBULHARJO	Giwangan
17	10501	KOTAGEDE	Rejowinangun
18	10502	KOTAGEDE	Prenggan
19	10503	KOTAGEDE	Purbayan
20	10601	GONDOKUSUMAN	Demangan
21	10602	GONDOKUSUMAN	Kotabaru
22	10603	GONDOKUSUMAN	Klitren
23	10604	GONDOKUSUMAN	Baciro
24	10605	GONDOKUSUMAN	Terban
25	10701	DANUREJAN	Suryatmajan
26	10702	DANUREJAN	Tegalpanggung
27	10703	DANUREJAN	Bausasran
28	10801	PAKUALAMAN	Gunungketur
29	10802	PAKUALAMAN	Purwokinanti
30	10901	GONDOMANAN	Ngupasan
31	10902	GONDOMANAN	Prawirodirjan
32	11001	NGAMPILAN	Notoprajan
33	11002	NGAMPILAN	Ngampilan
34	11101	WIROBRAJAN	Patangpuluhan
35	11102	WIROBRAJAN	Wirobrajan
36	11103	WIROBRAJAN	Pakuncen
37	11201	GEDONGTENGEN	Pringgokusuman
38	11202	GEDONGTENGEN	Sosromenduran
39	11301	JETIS	Bumijo
40	11302	JETIS	Gowongan
41	11303	JETIS	Cokrodiningratan
42	11401	TEGALREJO	Kricak
43	11402	TEGALREJO	Karangwaru
44	11403	TEGALREJO	Tegalrejo
45	11404	TEGALREJO	Bener
46	20101	MOYUDAN	Sumberahayu
47	20102	MOYUDAN	Sumbersari
48	20103	MOYUDAN	Sumberagung
49	20104	MOYUDAN	Sumberarum
50	20201	MINGGIR	Sendangmulyo
51	20202	MINGGIR	Sendangarum
52	20203	MINGGIR	Sendangrejo
53	20204	MINGGIR	Sendangagung
54	20205	MINGGIR	Sendangsari
55	20301	SAYEGAN	Margodadi
56	20302	SAYEGAN	Margoluwih
57	20303	SAYEGAN	Margomulyo
58	20304	SAYEGAN	Margoagung
59	20305	SAYEGAN	Margokaton
60	20401	GODEAN	Sidorejo
61	20402	GODEAN	Sidoluhur
62	20403	GODEAN	Sidomulyo
63	20404	GODEAN	Sidoagung
64	20405	GODEAN	Sidokarto
65	20406	GODEAN	Sidoarum
66	20407	GODEAN	Sidomoyo
67	20501	GAMPING	Balecatur
68	20502	GAMPING	Ambarketawang
69	20503	GAMPING	Banyuraden
70	20504	GAMPING	Nogotirto
71	20505	GAMPING	Trihanggo
72	20601	MLATI	Tirtoadi
73	20602	MLATI	Sumberadi
74	20603	MLATI	Tlogoadi
75	20604	MLATI	Sendangadi
76	20605	MLATI	Sinduadi
77	20701	DEPOK	Caturtunggal
78	20702	DEPOK	Maguwoharjo
79	20703	DEPOK	Condongcatur
80	20801	BERBAH	Sendangtirto
81	20802	BERBAH	Tegaltirto
82	20803	BERBAH	Jogotirto
83	20804	BERBAH	Kalitirto
84	20901	PRAMBANAN	Sumberharjo
85	20902	PRAMBANAN	Wukirharjo
86	20903	PRAMBANAN	Gayamharjo
87	20904	PRAMBANAN	Sambirojo
88	20905	PRAMBANAN	Madurojo
89	20906	PRAMBANAN	Bokoharjo
90	21001	KALASAN	Purwomartani
91	21002	KALASAN	Tirtomartani
92	21003	KALASAN	Tamanmartani
93	21004	KALASAN	Selomartani
94	21101	NGEMPLAK	Wedomartani
95	21102	NGEMPLAK	Widodomartani
96	21103	NGEMPLAK	Bimomartani
97	21104	NGEMPLAK	Sindumartani
98	21105	NGEMPLAK	Umbulmartani
99	21201	NGAGLIK	Sariharjo
100	21202	NGAGLIK	Donoharjo
101	21203	NGAGLIK	Sardonoharjo
102	21204	NGAGLIK	Sukoharjo
103	21205	NGAGLIK	Sinduharjo
104	21206	NGAGLIK	Minomartani
105	21301	SLEMAN	Caturharjo
106	21302	SLEMAN	Triharjo
107	21303	SLEMAN	Tridadi
108	21304	SLEMAN	Pandowoharjo
109	21305	SLEMAN	Trimulyo
110	21401	TEMPEL	Banyurejo
111	21402	TEMPEL	Tambakrejo
112	21403	TEMPEL	Sumberejo
113	21404	TEMPEL	Pondokrejo
114	21405	TEMPEL	Mororejo
115	21406	TEMPEL	Margorejo
116	21407	TEMPEL	Lumbungrejo
117	21408	TEMPEL	Merdikorejo
118	21501	TURI	Bangunkerto
119	21502	TURI	Donokerto
120	21503	TURI	Girikerto
121	21504	TURI	Wonokerto
122	21601	PAKEM	Purwobinangun
123	21602	PAKEM	Candibinangun
124	21603	PAKEM	Harjobinangun
125	21604	PAKEM	Pakembinangun
126	21605	PAKEM	Hargobinangun
127	21701	CANGKRINGAN	Wukirsari
128	21702	CANGKRINGAN	Argomulyo
129	21703	CANGKRINGAN	Glagaharjo
130	21704	CANGKRINGAN	Kepuharjo
131	21705	CANGKRINGAN	Umbulharjo
132	30101	SRANDAKAN	Poncosari
133	30102	SRANDAKAN	Trimurti
134	30201	SANDEN	Gadingsari
135	30202	SANDEN	Gadingharjo
136	30203	SANDEN	Srigading
137	30204	SANDEN	Murtigading
138	30301	KRETEK	Tirtohargo
139	30302	KRETEK	Parangtritis
140	30303	KRETEK	Donotirto

Table 6.6.1 List of ID Number for Name of Kelurahan/Desa (2 /2)

	ID No.	Kecamatan	Kelurahan/Desa
141	30304	KRETEK	Tirtosari
142	30305	KRETEK	Tirtomulyo
143	30401	PUNDONG	Seloharjo
144	30402	PUNDONG	Panjangrejo
145	30403	PUNDONG	Srihandono
146	30501	BAMBANGLIPURO	Sidomulyo
147	30502	BAMBANGLIPURO	Mulyodadi
148	30503	BAMBANGLIPURO	Sumbermulyo
149	30601	PANDAK	Caturharjo
150	30602	PANDAK	Triharjo
151	30603	PANDAK	Gilangharjo
152	30604	PANDAK	Wijirejo
153	30701	BANTUL	Palbapang
154	30702	BANTUL	Ringinharjo
155	30703	BANTUL	Bantul
156	30704	BANTUL	Trirenggo
157	30705	BANTUL	Sapdodadi
158	30801	JETIS	Patalan
159	30802	JETIS	Canden
160	30803	JETIS	Sumberagung
161	30804	JETIS	Trimulyo
162	30901	IMOGIRI	Selopamioro
163	30902	IMOGIRI	Sriharjo
164	30903	IMOGIRI	Kebonagung
165	30904	IMOGIRI	Karangtengah
166	30905	IMOGIRI	Girirejo
167	30906	IMOGIRI	Karangtalun
168	30907	IMOGIRI	Imogiri
169	30908	IMOGIRI	Wukirsari
170	31001	DLINGO	Mangunan
171	31002	DLINGO	Muntuk
172	31003	DLINGO	Dlingo
173	31004	DLINGO	Temuwuh
174	31005	DLINGO	Jatimulyo
175	31006	DLINGO	Terong
176	31101	PLERET	Wonokromo
177	31102	PLERET	Pleret
178	31103	PLERET	Segoroyoso
179	31104	PLERET	Bawuran
180	31105	PLERET	Wonolelo
181	31201	PIYUNGAN	Sitimulyo
182	31202	PIYUNGAN	Srimulyo
183	31203	PIYUNGAN	Srimartani
184	31301	BANGUNTAPAN	Tamanan
185	31302	BANGUNTAPAN	Jagalan
186	31303	BANGUNTAPAN	Singosaren
187	31304	BANGUNTAPAN	Wirokerten
188	31305	BANGUNTAPAN	Jambidan
189	31306	BANGUNTAPAN	Potorono
190	31307	BANGUNTAPAN	Baturetno
191	31308	BANGUNTAPAN	Banguntapan
192	31401	SEWON	Pendowoharjo
193	31402	SEWON	Timbulharjo
194	31403	SEWON	Bangunharjo
195	31404	SEWON	Panggungharjo
196	31501	KASIHAN	Bangunjiwo
197	31502	KASIHAN	Tirtonimolo
198	31503	KASIHAN	Tamantirto
199	31504	KASIHAN	Ngestiharjo
200	31601	PAJANGAN	Triwidadi
201	31602	PAJANGAN	Sendangsari
202	31603	PAJANGAN	Guwosari
203	31701	SEDAYU	Argodadi
204	31702	SEDAYU	Argorejo
205	31703	SEDAYU	Argosari
206	31704	SEDAYU	Argomulyo

Table 6.6.2 List of Community Water Supply System in the Study Area (1/5)

ID No. in Map	Kec.	Desa	Name of System	Construction Year	Type of Water Source	Method of Transmission (Distribution)	Number of HH	System Outline (Flow)	Public Hydrant
Bantul									
1	Dlingo	Jatimulyo	Badegan	1996	Spring	Pump	N. A.	Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
2	Dlingo	Jatimulyo	Banyuurip	2005	Spring	Pump	217	Spring (0.75 L/sec) → P → BP → BP →Res (8 m3) → HU	· 4 m3 tank x 6 units · No damage by the earthquake
3	Unused Number								
4	Dlingo	Mangunan	Cempluk I	2005	Spring	Pump	120	Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 4 units · No damage by the earthquake
5	Dlingo	Mangunan	Cempluk II	2002	Spring	Pump	24	Spring (0.75 L/sec) → P → BP → BP → Res (8 m3) → HU	· 3 m3 tank x 3 units · No damage by the earthquake
6	Dlingo	Mangunan	Gumelan	N. A.	Spring	Pump	40 to 70	Spring (1.5 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 5 units
7	Dlingo	Mangunan	Kanigoro	2004	Spring	Pump	88	Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 4 m3 tank x 4 units · Platform is seriously damaged by the earthquake · No damage in main unit
8	Dlingo	Mangunan	Kediwung (New)	2004	Spring	Pump	30	Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 4 m3 tank x 4 units · No damage by the earthquake
9	Dlingo	Mangunan	Kediwung I (Old)	1998	Spring	Pump	40 to 60	Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 4 m3 tank x 4 units · No damage by the earthquake
10	Dlingo	Mangunan	Lemahabang	2003	Spring	Pump	30	Spring (0.75 L/sec) → P → BP → Res (8 m3) → HU	· 4 m3 tank x 4 units · Partially damaged by the earthquake (L = approx. 200 m)
11	Dlingo	Mangunan	Mangunan	2004	Shallow Well	Pump	75	Shallow Well (0.75 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 4 units · No damage by the earthquake · House connection from HU
12	Dlingo	Mangunan	Mangunan I	2003	Shallow Well	Pump	20	Shallow Well / Spring (0.75 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 4 units · No damage by the earthquake
13	Dlingo	Mangunan	Mangunan II	2003	Spring	Pump	42	Spring (0.75 L/sec) → P → BP → Res (8 m3) → HU	· 3 m3 tank x 4 units · No damage by the earthquake
14	Unused Number								
15	Dlingo	Muntuk	Banjarharjo / Nglinggseng	2001	Spring	Gravity	30 to 45	Spring (0.5 to 1.0 L/sec) → Res (8 m3) → HU (w/ 3 m3 Tank, 3 Tanks)	· 3 m3 tank x 3 units
16	Dlingo	Muntuk	Seropan I	2006	Spring	Pump	50 to 70	Spring → P → Res (8 m3) → HU	· 3 m3 tank x 6 units
17	Dlingo	Muntuk	Seropan II	1998	Spring	Pump	30 to 50	Spring → P → BP → Res (4.5 m3) → HU	· 3 m3 tank x 4 units
18	Dlingo	Muntuk	Seropan III	2002	Spring	Pump	40 to 60	Spring → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
19	Dlingo	Temwuh	Klepu	2003	Shallow Well	Pump	50	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units

Table 6.6.2 List of Community Water Supply System in the Study Area (2/5)

ID No. in Map	Kec.	Desa	Name of System	Construction Year	Type of Water Source	Method of Transmission (Distribution)	Number of HH	System Outline (Flow)	Public Hydrant
20	Dlingo	Terong	Rejosari	2004	Spring	Gravity	60	Spring → Res (8 m3) → HU	· 3 m3 tank x 4 units · Partially distibuted to house and mosque
21	Dlingo	Terong	Saradan	2003	Spring	Gravity	20 to 40	Spring → Res (8 m3) → HU	· 3 m3 tank x 3 units
22	Dlingo	Terong	Terong I	2001 (well) 2003 (reservoir)	Shallow Well	Pump	75	Shallow Well (0.75 L/sec) → P → Res (8 m3) → HU	· 4 m3 tank x 4 units · 1 unit is inclined after the earthquake (no damage in main unit)
23	Imogiri	Karangtengah	Karangrejek	2006	Shallow Well	Pump	60 to 70	Subsystem 1: Shallow Well → P → Sump Well → P → Res (8 m3) → HU Subsystem 2: Shallow Well (shared with Subsystem 1) → P → Sump Well → P → →Res (8 m3) → HU	· 3 m3 tank x 6 units
24	Imogiri	Selopamioro	Kalidadap I	2003	River	Gravity	50 to 70	River → Sump Well → Res (8 m3) → BPT → HU	· 3 m3 tank x 3 units
25	Imogiri	Selopamioro	Kedungjati	N. A.	Spring	Gravity	40 to 60	Spring 1 (0.5 L/sec) and Spring 2 (0.5 L/sec) → Reservoir (8 m3) → HU	· 3 m3 tank x 4 units
26	Imogiri	Selopamioro	Lanteng	2006	Deep Well	Pump	50 to 70	Deep Well → P → Sump Well → P → →Res (8 m3) → HU and Concrete Tank (4.5 m3)	· 3 m3 tank x 5 units · 4.5 m3 tank x 1 units
27	Imogiri	Selopamioro	Nawungan II	2004	Spring	Pump	110	Shallow Well → P → BP →Res (8 m3) → HU	· 3 m3 tank x 4 units
28	Imogiri	Selopamioro	Siluk I	2003	Shallow Well	Pump	60	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
29	Imogiri	Selopamioro	Siluk II	2003	Shallow Well	Pump	45	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
30	Imogiri	Selopamioro	Srunggo I	1995	River	Gravity	30	River → Sand Filter → BPT → BPT → HU	· 3 m3 tank x 6 units
31	Imogiri	Selopamioro	Srunggo II	2002	River	Gravity	30 to 50	River → Sump Well → Res (8 m3) → BPT → HU	· 3 m3 tank x 3 units
32	Jetis	Trimulyo	Sindet/Kembangsongo	2006	Shallow Well	Pump	50 to 70	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 6 units
33	Kasihan	Bangunjiwo	Bangen Bibis	2004	Shallow Well	Pump	45	Shallow Well (0.75 L/sec) → P → Res (8 m3) → HU	· 4 m3 tank x 4 units · Minor damage by the earthquake
34	Kasihan	Bangunjiwo	Kaliasem	N. A.	Shallow Well	Pump	25 to 40	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
35	Kasihan	Bangunjiwo	Kalinongko	2002	Shallow Well	Pump	40	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
36	Kasihan	Bangunjiwo	Kenalan	2004	Shallow Well	Pump	40 to 55	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 4 units
37	Kasihan	Bangunjiwo	Kenalan/Banyuuripan	2000	Shallow Well	Pump	N. A.	Shallow Well → P → Res (8 m3) → HU (w/ 3 m3 Tank, 3 Tanks)	· 3 m3 tank x 3 units
38	Kasihan	Bangunjiwo	Petung	2003	Shallow Well	Pump	30	Shallow Well → P → Res (8 m3) → HU	· 1 m3 tank x 3 units
39	Kasihan	Bangunjiwo	Sambikerep	2004	Shallow Well	Pump	60 to 70	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 4 units
40	Kretek	Parangtriris	Grogol VIII	N. A.	Spring	Gravity	20 to 40	Spring (1.5 L/sec) → Break Pressure Tank (0.5 m3) → Reservoir (8 m3) → HU	· 3 m3 tank x 3 units
41	Kretek	Parangtriris	Grogol IX	N. A.	Spring	Gravity	40 to 50	Spring (2.0 L/sec, shared with Grogol X) → Reservoir (8 m3, shared with Grogol X) → HU	· 3 m3 tank x 3 units
42	Kretek	Parangtriris	Grogol X	N. A.	Spring	Gravity	30 to 50	Spring (2.0 L/sec, shared with Grogol IX) → Reservoir (8 m3, shared with Grogol IX) → HU	· 3 m3 tank x 3 units

Table 6.6.2 List of Community Water Supply System in the Study Area (3/5)

ID No. in Map	Kec.	Desa	Name of System	Construction Year	Type of Water Source	Method of Transmission (Distribution)	Number of HH	System Outline (Flow)	Public Hydrant
43	Pajangan	Guwosari	Watugedug	N. A.	Spring	Gravity	20 to 40	Spring (1.5 L/sec) → Reservoir (8 m3) → HU	· 1 m3 tank x 3 units
44	Pajangan	Sendangsari	Serut/Gupakwarak	2006	Spring	Pump	40 to 70	Spring → P → Res (8 m3) → HU	· 3 m3 tank x 5 units
45	Pajangan	Triwidadi	Jojoran	2000	Shallow Well	Pump	17	SW → P → BP → Res (16 m3) → HU (w/ 3 m3 Tank, 2 Tanks)	· 3 m3 tank x 2 units
46	Pajangan	Triwidadi	Nanggul	2001	Shallow Well	Pump	40 to 60	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
47	Piyungan	Sitimulyo	Banyakan II / Kedungwalikukun	2005	Deep Well	Pump	40 to 70	Deep Well → P → Sump Well → Res (8 m3) and HU (w/ 3 m3 Tank, 2 Tanks) → BP → Res (8 m3) → HU	· 3 m3 tank x 6 units
48	Piyungan	Sitimulyo	Pagergunun	1996	Shallow Well	Pump	60	Shallow Well → P → Res (8 m3) → HU (w/ 3 m3 Tank, 3 Tanks)	· 3 m3 tank x 3 units
49	Piyungan	Srimartani	Bulusari	N. A.	Spring	Gravity	40 to 70	Spring (2.0 L/sec) → Reservoir (8 m3) → HU	· 3 m3 tank x 4 units
50	Piyungan	Srimartani	Mojosari	N. A.	Spring	Gravity	20 to 30	Spring (1.0 L/sec) → Reservoir (8 m3) → HU	· 2 m3 tank x 3 units
51	Piyungan	Srimulyo	Plesedan	2004	Spring	Gravity	90 to 120	Shallow Well → Res (8 m3) → HU	· 3 m3 tank x 5 units
52	Pleret	Bawunan	Jambon	1997	Shallow Well	Pump	20 to 50	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
53	Pleret	Bawunan	Kedungrejo	N. A.	Spring	Gravity	40 to 60	Spring 1 (0.5 L/sec) and Spring 2 (0.5 L/sec) → Break Pressure Tank (1.5 m3) → Reservoir (8 m3) → HU	· 3 m3 tank x 4 units
54	Pleret	Bawunan	Sentulrejo	N. A.	Spring	Gravity	40 to 60	Spring 1 (0.5 L/sec) and Spring 2 (0.5 L/sec) → Break Pressure Tank (1.5 m3) → Reservoir (8 m3) → HU	· 3 m3 tank x 4 units
55	Pleret	Wonolelo	Cegokan	N. A.	Spring	Gravity	30 to 50	Spring (2 L/sec) → Break Pressure Tank (1 m3) → Res (4.5 m3) → HU	· 3 m3 tank x 3 units
56	Pleret	Wonolelo	Ploso	2003	Spring	Gravity	50 to 70	Spring 1 (1.5 L/sec) and Spring 2 (0.5 L/sec) → Junction Well → Break Pressure Tank (1.5 m3) → Reservoir (8 m3) → Reservoir (8 m3) and HU	· 3 m3 tank x 4 units
57	Sedayu	Argodadi	Bentangan	N. A.	Shallow Well	Pump	20 to 40	Spring (2 L/sec) → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
58	Sedayu	Argodadi	Dingkikan	2002	Shallow Well	Pump	40 to 50	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
59	Sedayu	Argodadi	Selogedong	1998	Spring	Pump	50 to 60	Spring → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
60	Sedayu	Argomulyo	Kaliberot	N. A.	Shallow Well	Pump	20 to 40	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
61	Sedayu	Argorejo	Metes	1996	Shallow Well	Pump	30 HH	Shallow Well → P → Res (8 m3) → HU	· 4 m3 tank x 2 units · No damage by the earthquake
62	Sedayu	Argosari	Jambon/Tonalan	N. A.	Shallow Well	Pump	20 to 40	Shallow Well → P → Res (8 m3) → HU	· 3 m3 tank x 3 units
63	Srandakan	Poncosari	Kuwaru	2006	Shallow Well	Pump	50 to 70	Shallow Well (0.75 L/sec) → P → Res (10 m3) → (HU and 10 Public Taps) and {Res (8 m3) → 10 Public Taps}	· 3 m3 tank x 5 units
Sleman									
64	Cangkringan	Kepuharjo	Kepuharjo	2004	Spring	Gravity	902	Spring → Reservoir (100 m3, damaged by volcanic explosion and under rehabilitation by NGO (DIAN DESA))	· 3 units
65	Cangkringan	Umbulhajo	Umbulhajo	1996	Spring	Gravity	1170	Spring (10.0 L/sec)	· 3 units
66	Depok	Maguwoharjo	Tajem	1998	Spring	Gravity	30 to 50	Spring (1.0 L/sec)	· 3 units

Table 6.6.2 List of Community Water Supply System in the Study Area (4/5)

ID No. in Map	Kec.	Desa	Name of System	Construction Year	Type of Water Source	Method of Transmission (Distribution)	Number of HH	System Outline (Flow)	Public Hydrant
67	Gamping	Balecatur	Sembung	2005	Deep Well	Pump	100 to 150	Deep Well (4.0 L/sec) → P → Res (5 m3) → HU + 1 temporary supply for earthquake disaster victims	· 2 m3 tank x 5 units
68	Godean	Sidorejo	Bletuk	1996	Shallow Well	Pump	60 to 75	Shallow Well (1.5 L/sec) → Res (9 m3) → HU	· 3 units
69	Minggir	Sendangmulyo	Sendangmulyo	2004	River	Pump	30 to 50	River (2.0 L/sec)	· 5 units
70	Minggir	Sendangsari	Sendangsari	1996	Shallow Well	Pump	20 to 40	Shallow Well (0.6 L/sec)	· 3 units
71	Mlati	Tlogoadi	Tlogoadi	1996	Shallow Well	Pump	30 to 60	Shallow Well (0.4 L/sec)	· 3 units
72	Moyudan	Sumbersari	Dukuh Nglahar	1997	Spring	Pump	50 to 70	Spring (0.6 L/sec)	· 3 units
73	Moyudan	Sumbersari	Sombangan	1996	Spring	Pump	50 to 70	Spring (1.0 L/sec)	· 3 units
74	Ngaglik	Donoharjo	Donoharjo	1996	Shallow Well	Pump	40 to 60	Shallow Well (1.0 L/sec)	· 3 units
75	Ngaglik	Sukoharjo	Gemutri	1997	Spring	Gravity	30 to 50	Spring (0.6 L/sec)	· 3 units
76	Pakem	Candibinangun	Cemoroharjo	1997	Spring	Gravity	30 to 50	Spring (2.0 L/sec)	· 3 units
77	Pakem	Candibinangun	Kemput	1997	Spring	Gravity	60 to 100	Spring (2.5 L/sec)	· 3 units
78	Pakem	Candibinangun	Kuweron	1997	Spring	Gravity	80 to 100	Spring (2.0 L/sec)	· 3 units
79	Pakem	Candibinangun	Nepen	2004	Spring	Gravity	100 to 200	Spring (1.5 L/sec)	· 2 m3 tank x 3 units (1 unit is for standby)
80	Pakem	Hargobinanggun	Purworejo	1998	Spring	Gravity	60 to 70	Spring (1.0 L/sec)	· 3 units
81	Pakem	Pakembinangun	Kertodadi/Balong	2004	Spring	Gravity	70 to80	Spring (1.0 L/sec)	· 3 units
82	Pakem	Pakembinangun	Banjarsari	1998	Spring	Gravity	70 to 90	Spring (1.0 L/sec)	· 3 units
83	Pakem	Pakembinangun	Purwodadi	1998	Spring	Gravity	70 to 90	Spring (0.8 L/sec)	· 3 units
84	Pakem	Purwobinangun	Wringin Lor	2004	Spring	Gravity	60 to 80	Spring (0.8 L/sec)	· 3 units
85	Prambanan	Sambirejo	Dawangsari	2005	Deep Well	Gravity	150 to 200	Deep Well (11.0 L/sec) → P → Res (20 m3, not for consumer) → BP 1 → Res (100 m3) → BP 2 → Res (100 m3)	· 3 m3 tank x 45 units
86	Prambanan	Sambirejo	Gedang	2005	Deep Well	Gravity	70 to 100		
87	Prambanan	Sambirejo	Gunungcilik	2004	Deep Well	Gravity	80 to 100		
88	Prambanan	Sambirejo	Kikis	2005	Deep Well	Gravity	70 to 80		
89	Prambanan	Sambirejo	Sumberwatu	2005	Deep Well	Pump	97		
90	Prambanan	Sumberharjo	Pereng	1997	Spring	Gravity	200	Spring (9.0 L/sec)	· 3 units
91	Prambanan	Wukirharjo	Losari	2005	Deep Well	Gravity	200 to 300	Deep Well (9.0 L/sec) → Res (20 m3)	· 5 units
92	Seyengan	Margokaton	Susukan III	1997	Spring	Gravity	30 to 50	Spring (1.5 L/sec)	· 3 units
93	Seyengan	Margoluwih	Klaci III	1996	Spring	Pump	30 to 40	Spring (1.0 L/sec)	· 3 units
94	Seyengan	Margoluwih	Klangkapan II	1996	Spring	Pump	30 to 40	Spring (2.0 L/sec) → Res (2 x 2 x 1.35 m3) → P → HU	· 2 m3 tank x 2 units
95	Turi	Bangunkerto	Bangunsari I	1997	Spring	Gravity	60 to 80	Spring (2.0 L/sec) → Gravity → HU	· 2 m3 tank x 3 units (1 unit is broken)

Table 6.6.2 List of Community Water Supply System in the Study Area (5/5)

ID No. in Map	Kec.	Desa	Name of System	Construction Year	Type of Water Source	Method of Transmission (Distribution)	Number of HH	System Outline (Flow)	Public Hydrant
96	Turi	Bangunkerto	Bangunsari II	1997	Spring	Gravity	30 to 50	Spring (1.5 L/sec)	· 3 units
97	Turi	Bangunkerto	Kendal	1997	Spring	Gravity	50 to 60	Spring (1.0 L/sec)	· 3 units
98	Turi	Bangunkerto	Ledoknongko	1998	Spring	Gravity	40 to 50	Spring (0.6 L/sec)	· 3 units
99	Turi	Girikerto	Girikerto	1996	Spring	Gravity	50 to 60	Spring (2.0 L/sec)	· 3 units
100	Turi	Girikerto	Nangsri	2000	Spring	Gravity	40 to 60	Spring (1.0 L/sec)	· 3 units
101	Turi	Girikerto	Ngangkring	1997	Spring	Gravity	100 to 200	Spring (2.5 L/sec)	· 3 units
102	Turi	Girikerto	Pelem/Sidorejo	1997	Spring	Gravity	60 to 100	Spring (2.0 L/sec)	· 3 units
103	Turi	Wonokerto	Sempu	1996	Spring	Gravity	70 to 90	Spring (0.8 L/sec)	· 3 units
201	Pakem	Hargobinanggun	Kaliurang Timur	2006	Spring	Gravity	400	Spring, Dia 50 mm - 2600 m, Dia 25 mm - 2400 m	N. A.
202	Prambanan	Sumberharjo / Gayamharjo	Umbulsari / Parangan	N. A.	Deep Well	Pump	200	Deep Well	N. A.
203	Sayegan	Margoluwih	Klangkapan	N. A.	Spring	Gravity	25	Spring	N. A.
204	Turi	Wonokerto	Kapingrejo	2006	River	Gravity	42	River, dia 100 mm - 3000 m	N. A.
Yogyakarta									
104	Jetis	Code Utara	UAB Titra Kencana	1991	Spring	Pump	115	Spring 1 and Spring 2 → Public Tap → Lower Res (Under Ground, 66 m3) → Chlorination → P → Upper Res (Elevated, 8.2 m3) → House Connection	None (House Connections are available)

Note:

- HH: Households, P: Pump, BP: Booster Pump, Res: Reservoir
- ID Number 3 and 14 are skipped

Source:

- Information in this table is generally based on interview with officials in PU Bantul, PU Sleman and PU DIY Province, as of July 2007
- Number of HH for ID No. 66, 67, 80, 81 and 82 is based on results of Socioeconomic Survey conducted in the course of the Study
- Information for ID No.104 is based on site visiting and report on “Technical Manual, Small Community Water Supply Based on Almuni Demonstration Project, CEA-UEMA”

6.6.3 Operation and Maintenance

With reference to the inventory drafted by the Study Team based on available data provided by relevant PUs, assessment of the existing water supply facilities (such as raw water intake, treatment plants, mechanical and electrical equipment) and condition of operation and maintenance have been undertaken in eight sample systems in Yogyakarta Municipality, Sleman Regency and Bantul Regency. Sample systems were randomly selected in consideration of type of water source, number of households method of transmission and distribution. Following AMDs are selected for assessment of the existing facilities and condition of O&M and outlined in Table 6.6.3:

- For Bantul: Rejosari, Srunggo I, Bangen Bibis, Pagergunun
- For Sleman: Nepen, Sumberwatu, Bangunsari I
- For Yogyakarta: UAB Titra Kencana

Table 6.6.3 Condition of O&M of Community Water Supply System in the Study Area (1/2)

Kecmatan	*Desa*	*Name of System*	*Tariff Structure*	*Major Facilities*	*Existing Condition of Facilities / Situation of O&M*
Bantul					
Dlingo	Terong	Rejosari	•Rp. 5,000 / HH for registration •Rp. 1,000 / month / HH (fixed rate)	• Intake well • GIP (50 mm, 400 m) for transmission (from intake to reservoir) • Reservoir (8 m3) • GIP (50 mm, 50 m) and PVC (25 mm) for distribution • HU (3 m3 tank, 4 units)	• Water revenue is sufficient for normal O&M. • Intake well is damaged by the previous earthquake and not sufficiently distributed since then. • Residents cannot afford to fix facilities because they are busy in repairing their own house. • Those who do not have private well need to go water source for their daily consumption.
Imogiri	Selopamioro	Srunggo I	•Water charge is not collected regularly	• Intake well (shared with Srunggo II and Kalidadap I) • GIP (25 mm, 50 m, from intake to sand filter) • Sand filter (1 unit) • Break Pressure Tank (2 units) • PVC (25 mm) from sand filter to HU • HU (3 m3 tank, 4 units)	• Water source is River and it is shared with Srunggo II and Kalidadap I. • In principle, water is supplied free of charge under normal circumstances. In case of minor defect or damage, cost for repair or replacement is covered by occasional contribution by the members of WUO, whenever necessary. • Filter surface is scraped to clean in every 3 months by the members of WUO. • Joint of pipe is sometimes dislocated due to high pressure and it is fixed on each occasion. • Intake volume decreased due to the damage in intake facility caused by the previous earthquake and WUO has not fixed yet. • Break Pressure Tanks and some part of pipes which were damaged by the previous earthquake have been repaired by the assistance of religious association. • Water supply system is changed over from irrigation system in daytime to supply for HU in nighttime after the previous earthquake, because irrigation pipe is damaged and residents have not repaired yet.
Kasihan	Bangunjiwo	Bangen Bibis	• Rp. 100,000 / HH for registration. • Approximately Rp. 8,000 to 10,000 / month / HH	• Pump (H =60 m, Q = 0.75 L/sec) • GIP (25 mm, 600 m, from intake to reservit) • PVC (25 mm) • Reservoir (8 m3) • HU (4 m3, 4 units)	• Water bill is charged according to electricity consumption. • Motor for pump has burnt down repeatedly due to idle operation caused by dropping down of water level of well and leader of WUO arrange repair worker in case of trouble. • Pump operation hours: − 6:00 to 10:00 − 12:00 to 16:00 (operation hour extended to 18:00 on demand of users)
Piyungan	Sitimulyo	Pagergunun	• Registration fee: none • Rp. 5,000 / month / HH (fixed)	• Pump (H =60 m, Q = 0.75 L/sec) • GIP (25 mm, 600 m) • PVC (25 mm) • Reservoir (8 m3) • HU (3 m3 tank x 3 units)	• Toilet is next to the well (toilet room is pump house) • 1 Pump was provided by PU at the construction, however it was broken. Then WUO purchased 3 new pumps with the water level sensor • Transmission pipe was replaced in 2004 • 25% of HH have dug private well in front of their house, due to lack of water volume for existing shallow well especially in dry season • Pump operation hours: − 6:00 to 10:00 − 12:00 to 16:00 (operation hour will be extended to 18:00 on demand of users)

Table 6.6.3 Condition of O&M of Community Water Supply System in the Study Area (2/2)

Kecmatan	*Desa*	*Name of System*	*Tariff Structure*	*Major Facilities*	*Existing Condition of Facilities / Situation of O&M*
Sleman					
Pakem	Candibinangun	Nepen	・Rp. 50,000 / HH for registration ・Rp. 2,000 / month / HH (fixed)	・Intake well ・GIP (25 mm, 100 m) ・PVC (50 mm, 2,000 m) ・HU (2 m3, 3 uint (1 unit for standby))	・Spring discharge 7 L/sec in wet season and 3 to 4 L/sec in dry season ・Water quality is good enough to drink without boiling ・2 HU in use and 1 HU for standby ・Water revenue has been sufficient for normal O&M before, however, number of minor leakage in PVC pipes are increasing and cannot catch up to fix all in these days.
Prambanan	Sambirejo	Sumberwatu	・Rp. 10,000 / HH for registration ・Rp. 200/hand-carry-tank (approx.5 L capacity)	・Pump (for Intake, Q = 11 L/sec) ・Pump (for Booster, 11 L/sec) ・Pump (for Booster, 10 L/sec) ・GIP (6 inch, 2,000 m from intake to Booster Pump 1, approx. 700 m from Booster Pump 1 to Booster Pump 2, approx. 700 m from Booster Pump 1 to Highest Reservoir) ・PVC (25 mm) ・Reservoir 1 (20 m3, not for consumer) ・Reservoir 2 (100 m3) ・Reservoir 3 (100 m3) ・HU (3 m3, 45 uint) ・Above facilities are shared with the systems of Dawangsari, Gedang, Gunungcilik and Kikis	・Deep well discharge is approx. 7 L/sec ・User pays water charge whenever they take water to the responsible household for each HU, who lives nearby HU and a member of WUO ・Collected money by each responsible for HU will be aggregated in monthly meeting of WUO ・WUO are considering to install water meter for house connection for those who would like to do so. ・Pump operation hours: - Dry season : 8:00 to 13:00. - Wet season: Not regularly operated in wet season. Pump is operated on demand of customers. Most of necessary water can be covered by rain water (most of houses have rain tank)
Turi	Bangunkerto	Bangunsari I	・Rp. 50,000 / HH for registration ・Rp. 1,000 / month / HH (fixed)	・Intake well ・PVC (50 mm, approx. 2,000 m) ・PVC (25 mm) ・HU (2 m3, 3 units)	・1 unit of HU is broken and not fixed. ・Exposed pipes running through in coconut plantation are often damaged by agricultural activity and/or coconut falling and it is fixed whenever necessary.
Yogyakarta					
Jetis	-	Code Utara	・Rp. 600,000 / HH for registration ・Rp. 1,500 / HH / month for meter rental ・Water is charged according to consumption (Rp. 9,000/m3 up to first 15 m3, additional Rp. 700/m3 up to 30 m3 and Rp. 1,000/m3 for over 30 m3)	・Pump (4 Units) ・Public Taps for washing and bathing ・Transmission Pipeline (L = 254 m) ・Distribution Pipeline (L = 1,150 m) ・Chlorination facility ・Lower Reservoir (underground, 66 m3) ・Upper Reservoir (elevated, 8.2 m3) ・Water Meter	・History: - 1991: Initial construction by community (for 6 HH) - 1999: First involvement by PU, providing pump and pipes (for 23 HH) - 2001: Expanded by PU's assistance (for 55 HH) - 2006: Expanded by CIDA and AIT's assistance (for 115 HH) ・People uses water for bathing & washing Chlorination is available after expansion in 2006 ・This system is expanded by international donor's support (CIDA and AIT) in planning and construction for expansion work completed in 2006. So far existing facilities are in good condition.