CHAPTER 4

FEASIBILITY STUDY

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4.1 PRIORITY PROJECTS IDENTIFIED IN THE MASTER PLAN

In this section, planning horizon for the feasibility study is described before entering detail discussion of the feasibility study. Priority projects identified in the Master Plan, proposed implementation schedule, target year of the feasibility study, service area for priority projects, population and water demand forecast until the respective target year are described.

4.1.1 Priority Projects Identified in the Master Plan

According to the recommendation in the Master Plan, the Second Phase of the Second Stage Project was identified as the priority projects, to meet the required future water demand, and it was recommended to conduct Feasibility Study for the identified Priority Projects. Upon completion of the Feasibility Study, it was also recommended that the Priority Projects should be implemented immediately.

4.1.2 Facilities Required for the Priority Projects

The Second Phase of the Second Stage as the priority projects which includes two parts of implementation programs are as follows.

(1) Part 1

- Expansion of existing Buaran Treatment Plant with the capacity of 5,000 l/sec taking raw water from the upgraded WTC.
- Expansion of existing Distribution Center R1 with the capacity of 2,000 l/sec receiving treated water from Buaran Treatment Plant (Treated water transmission pipeline will use existing transmission pipeline).
- New Distribution Center R6 with the capacity of 2,100 l/sec receiving treated water from Buaran Treatment Plant through Distribution Center R1.
- Treated Water Transmission Pipeline from Distribution Center R1 to R6 with the total pipeline length of 33.5 km.

(2) **Part 2**

- New construction of Cipayung Treatment Plant with the capacity of 5,000 l/sec taking raw water from the WTC through raw water transmission pipeline of which length will be 20.0km.
- Expansions of existing Distribution Centers R4 and R5 with the capacity of 2,600 l/sec and 1,600 l/sec, respectively, receiving treated water from Cipayung Treatment Plant.
- Treated Water Transmission Pipeline from Cipayung Treatment Plant to Distribution Centers R4 and R5 with the total pipeline length of 41.5 km.

In each program, implementation of installation of distribution mains and service mains are also included for expansion of service area.

Facilities required for each part are outlined on the **Figure-3162.1** and **3162.2**, respectively.

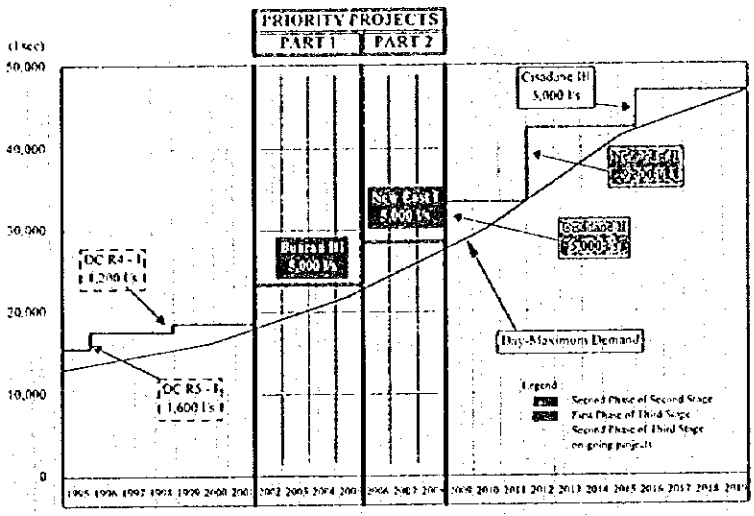
Although the expansion works of the existing Buaran Treatment Plant was confirmed as the Part 1 Project, the Indonesian side pointed out other possible location of new treatment plant in Bekasi area instead of the expansion of Buaran Treatment Plant. According to the explanation by the Indonesian side, in the event of the Indonesian side encountering difficulties on additional land acquisition around existing Buaran Treatment Plant premises, there will be a possibility to shift the location of the treatment plant from Buaran to Bekasi.

4.1.3 Proposed Implementation Schedule and Target Year in the Master Plan

Figure-413.1 shows a implementation schedule of Jakarta Water Supply Development together with Day-Maximum Water Demand and capacity of Treatment Plants with timing of construction of proposed treatment plants until the Year of 2019. As shown on the **Figure-413.1**, target year for each Priority Project is as follows.

Part One, Second Phase of Second Stage : **Target Year 2005**
Part Two, Second Phase of Second Stage : **Target Year 2008**

Figure-413.1 PROPOSED IMPLEMENTATION SCHEDULE



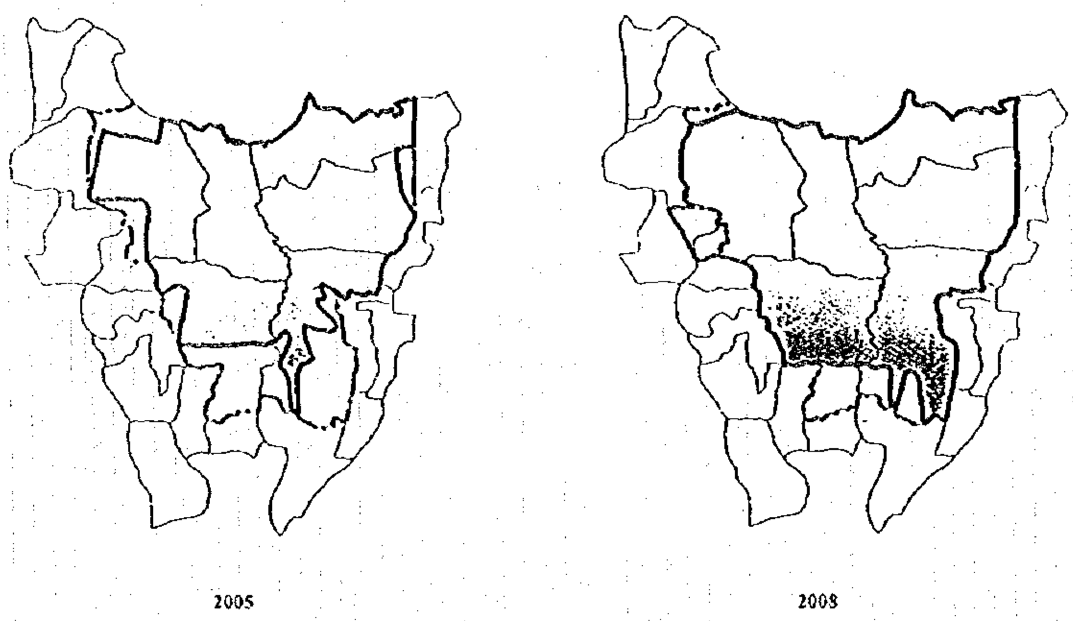
4.1.4 Service Area in Year 2005 and Year 2008

According to the results of the Master Plan, service area in Year 2005 which is the target year of the Part One, Second Phase of Second Stage, will be expanded widely from the existing service area. Direction of the service area expansion will be mainly to the west and to the east. The most of area inside the Outer Ring Highway will be covered as the service area. Southern part of Jakarta, outside of the Outer Ring Highway, will be still remained unserved area.

After completion of the Part One Project, service area will continuously expand beyond the Outer Ring Highway, and the most of DKI Jakarta will be included in the PAM JAYA service area in Year 2008 which is the target year of the Part Two Project. Because of expanding developing activities from the center of DKI Jakarta to outside of Jakarta beyond the administrative boundary, PAM JAYA service area will cover part of Kotamadya Tangerang, part of Cipondoh and Ciledug, in year 2008.

Service areas in Year 2005 and Year 2008 are shown on **Figure-414.1**.

Figure-414.1 FUTURE SERVICE AREA



4.1.5 Population and Water Demand until Year 2008

In this section, future population and future water demand until the target year 2008 are described as basic figures for the Feasibility Study.

Data shown on the following tables are separated by area. Data for Jakarta is divided into two area, namely West of Jakarta and East of Jakarta. Boundary of West and East is the Cilliung River. Data for Fringe Area is also divided West of Fringe Area and East of Fringe Area by the Cilliung River. Data for new reclamation area is shown as Water Front City.

All data shown below are derived from the results of the Master Plan.

Total Population in the Study Area,

Table-415.1 and Figure-415.1

Total population in the Study Area which covers DKI Jakarta and 17 fringe Kecamatans.

Served Population,

Table-415.2 and **Figure-415.2**

Served population was calculated based on the number of house connection and public hydrant. Number of person per house connection is 7.6 person in 1995 and will decrease to 5.8 person in 2019. Number of person per public hydrant is 380 person and will decrease to 250 person in 2019. For Water Front City, constant figure as 5.8 person per house connection is used for calculation.

Service Ratio,

Table-415.3 and **Figure-415.3**

Service ratio is calculated as served population divided by total population in service area in respective year. Service Ratio for the Water Front City is assumed to be 100 %.

Day-Average Water Demand,

Table-415.4 and **Figure-415.4**

From the results of the Master Plan, Day-Average Water Demand is calculated for each year.

Unaccounted-for Water Ratio,

Table-415.5 and **Figure-415.5**

Unaccounted-for Water Ratio is assumed as shown on the Table and Figure.

Table-415.6 and **Figure415.6**

From Day-Average Water Demand shown on **Table415.4**, Unaccounted-for Water Ratio shown on **Table-415.5** and peak factor which is assumed to be 1.15 in the Master Plan, Day-Maximum Water Demand is calculated.

Table-415.1 TOTAL POPULATION IN THE STUDY AREA

x 1,000

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
West of Jakarta	4,790	4,838	4,886	4,934	4,982	5,030	5,076	5,122	5,168	5,214	5,260	5,302	5,344	5,386
East of Jakarta	4,010	4,082	4,154	4,226	4,298	4,370	4,424	4,478	4,532	4,586	4,640	4,698	4,756	4,814
Total of Jakarta	8,800	8,920	9,040	9,160	9,280	9,400	9,500	9,600	9,700	9,800	9,900	10,000	10,100	10,200
West of Fringe Area	1,590	1,686	1,782	1,878	1,974	2,070	2,166	2,262	2,358	2,454	2,550	2,642	2,734	2,826
East of Fringe Area	710	714	718	722	726	730	736	742	748	754	760	766	772	778
Total of Fringe Area	2,300	2,400	2,500	2,600	2,700	2,800	2,900	3,000	3,110	3,210	3,300	3,410	3,510	3,600
Water Front City	0	0	0	0	0	0	39	79	118	158	197	237	276	316
Grand Total	11,100	11,320	11,540	11,760	11,980	12,200	12,439	12,679	12,928	13,168	13,397	13,647	13,886	14,116
Total of West	6,380	6,524	6,668	6,812	6,956	7,100	7,242	7,384	7,526	7,668	7,810	7,944	8,078	8,212
Total of East	4,720	4,796	4,872	4,948	5,024	5,100	5,160	5,220	5,280	5,340	5,400	5,464	5,528	5,592

Table-415.2 SERVED POPULATION

x 1,000

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
West of Jakarta	1,231	1,428	1,625	1,822	2,019	2,216	2,402	2,587	2,773	2,958	3,144	3,311	3,478	3,644
East of Jakarta	1,746	1,894	2,042	2,190	2,338	2,486	2,623	2,760	2,896	3,033	3,170	3,296	3,422	3,549
Total of Jakarta	3,000	3,322	3,667	4,012	4,357	4,700	5,024	5,347	5,669	5,992	6,300	6,607	6,900	7,193
West of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	75	150	224
East of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	70	150	220
Water Front City	0	0	0	0	0	0	39	79	118	158	197	237	276	316
Grand Total	3,000	3,322	3,667	4,012	4,357	4,700	5,064	5,426	5,787	6,149	6,497	6,914	7,326	7,729
Total of West	1,231	1,428	1,625	1,822	2,019	2,216	2,402	2,587	2,773	2,958	3,144	3,386	3,627	3,869
Total of East	1,746	1,894	2,042	2,190	2,338	2,486	2,623	2,760	2,896	3,033	3,170	3,296	3,422	3,549

(7.6 - 5.8 person/domestic connection, 380 - 250 person/public hydrant)

(for Water Front City, fixed at 5.8 person/domestic connection)

Table-415.3 SERVICE RATIO (SERVED POPULATION / POPULATION IN SERVICE ARE IN RESPECTIVE YEAR)

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
West of Jakarta	43%	46%	50%	53%	56%	59%	62%	65%	67%	70%	73%	74%	75%	76%
East of Jakarta	67%	68%	69%	70%	72%	73%	75%	77%	79%	80%	82%	82%	83%	83%
Total of Jakarta	55%	57%	59%	62%	64%	66%	68%	70%	73%	75%	77%	77%	78%	79%
West of Fringe Area	-	-	-	-	-	-	-	-	-	-	0%	7%	15%	22%
East of Fringe Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total of Fringe Area	-	-	-	-	-	-	-	-	-	-	0%	7%	15%	22%
Water Front City	-	-	-	-	-	-	100%	100%	100%	100%	100%	100%	100%	100%
Grand Total	55%	57%	59%	62%	64%	66%	68%	71%	73%	75%	77%	77%	78%	78%

Table-415.4 DAY-AVERAGE WATER DEMAND (l/sec)

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
West of Jakarta	2,600	2,985	3,370	3,755	4,139	4,524	4,959	5,394	5,829	6,265	6,700	7,210	7,721	8,231
East of Jakarta	2,717	3,004	3,291	3,578	3,865	4,152	4,480	4,808	5,136	5,464	5,792	6,194	6,596	6,998
Total of Jakarta	5,300	5,989	6,661	7,333	8,004	8,700	9,439	10,202	10,966	11,729	12,500	13,404	14,317	15,229
West of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	166	331	497
East of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	170	330	500
Water Front City	0	0	0	0	0	0	94	189	283	378	472	570	667	765
Grand Total	5,300	5,989	6,661	7,333	8,004	8,700	9,534	10,391	11,249	12,106	13,000	14,144	15,314	16,494
Total of West	2,600	2,985	3,370	3,755	4,139	4,524	4,959	5,394	5,829	6,265	6,700	7,376	8,052	8,728
Total of East	2,717	3,004	3,291	3,578	3,865	4,152	4,480	4,808	5,136	5,464	5,792	6,194	6,596	6,998

Table-415.5 UNACCOUNTED-FOR WATER RATIO (%)

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
UFW	53.5%	51%	48%	45%	43%	40.0%	38.0%	36.0%	34.0%	32.0%	30.0%	29.6%	29.2%	28.8%

Table-415.6 DAY-MAXIMUM WATER DEMAND (l/sec)

	YEAR													
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
West of Jakarta	6,431	6,879	7,327	7,775	8,223	8,671	9,138	9,605	10,073	10,540	11,007	11,761	12,515	13,270
East of Jakarta	6,721	6,968	7,216	7,463	7,711	7,958	8,270	8,581	8,893	9,204	9,516	10,105	10,694	11,283
Total of Jakarta	13,200	13,847	14,543	15,238	15,934	16,600	17,408	18,187	18,965	19,744	20,500	21,866	23,209	24,552
West of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	265	529	794
East of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total of Fringe Area	0	0	0	0	0	0	0	0	0	0	0	260	530	790
Water Front City	0	0	0	0	0	0	155	310	465	620	775	927	1,079	1,230
Grand Total	13,200	13,847	14,543	15,238	15,934	16,600	17,563	18,497	19,430	20,364	21,300	23,053	24,818	26,573
Total of West	6,431	6,879	7,327	7,775	8,223	8,671	9,138	9,605	10,073	10,540	11,007	12,026	13,044	14,063
Total of East	6,721	6,968	7,216	7,463	7,711	7,958	8,270	8,581	8,893	9,204	9,516	10,105	10,694	11,283

Figure-415.1 TOTAL POPULATION IN THE STUDY AREA

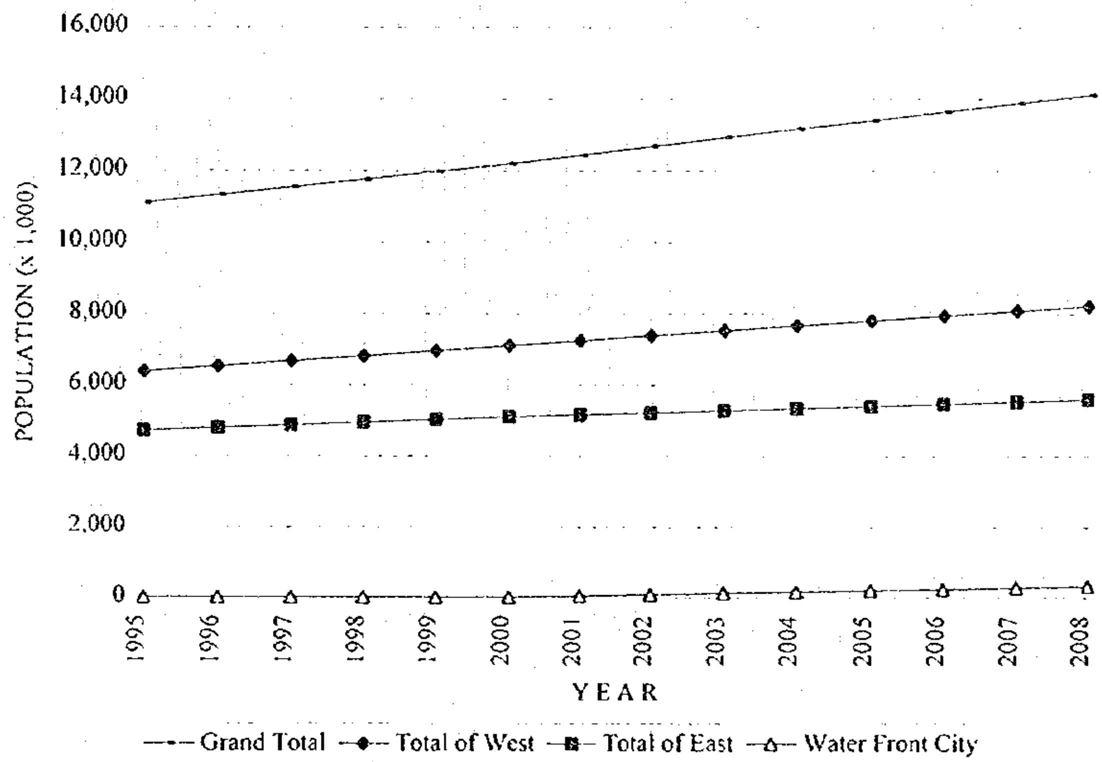


Figure-415.2 SERVED POPULATION

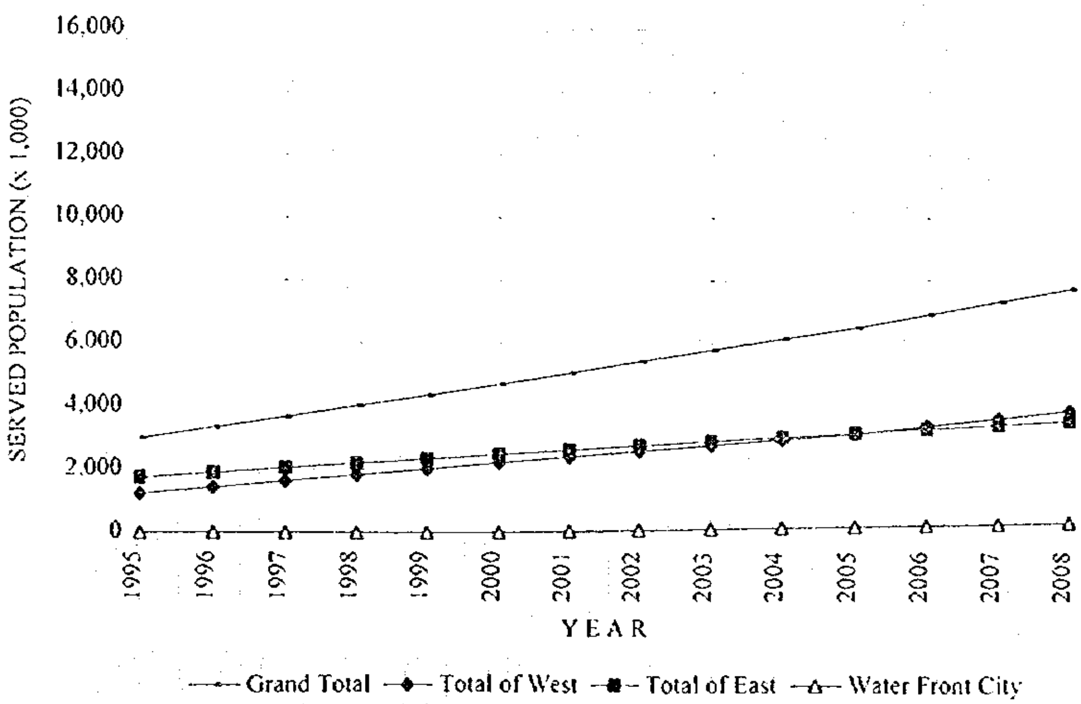


Figure-415.3 SERVICE RATIO

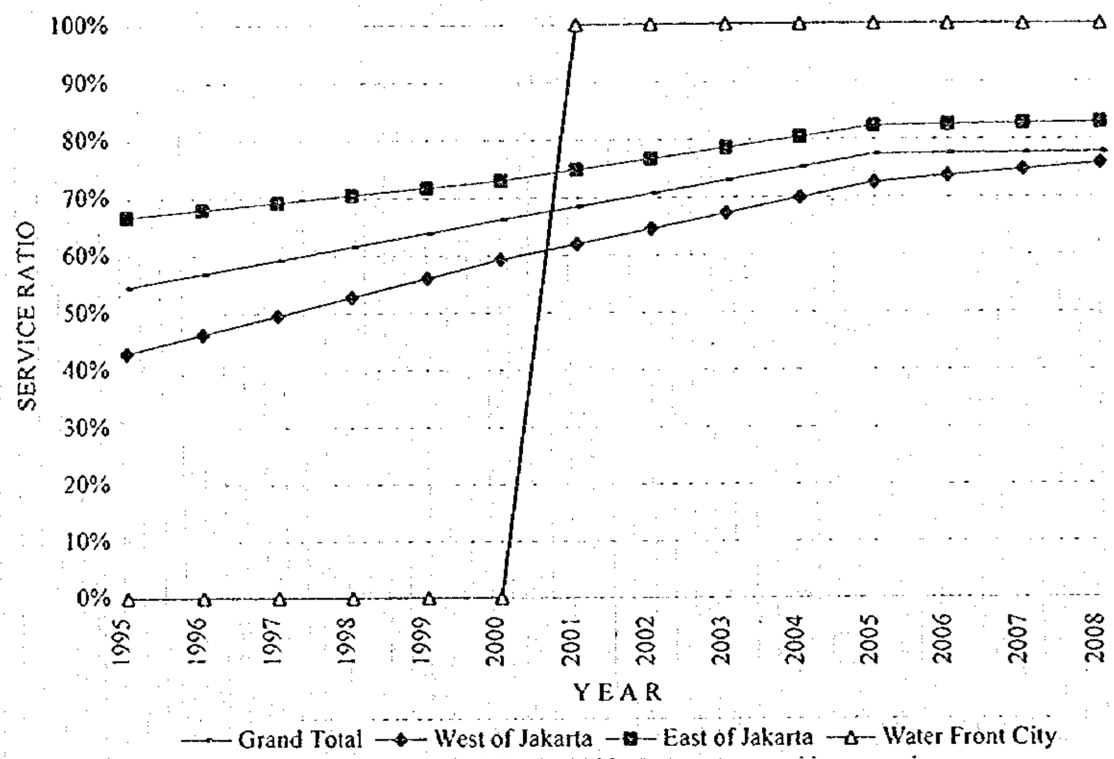


Figure-415.4 DAY-AVERAGE WATER DEMAND

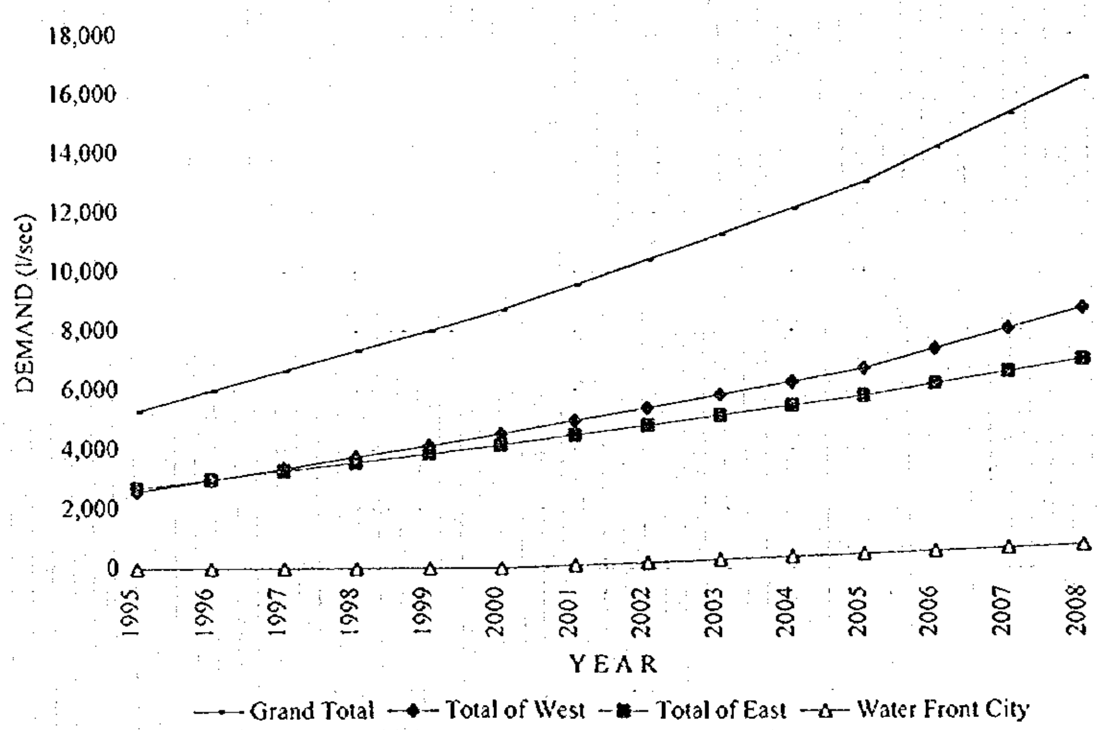


Figure-415.5 UNACCOUNTED-FOR WATER RATIO (%)

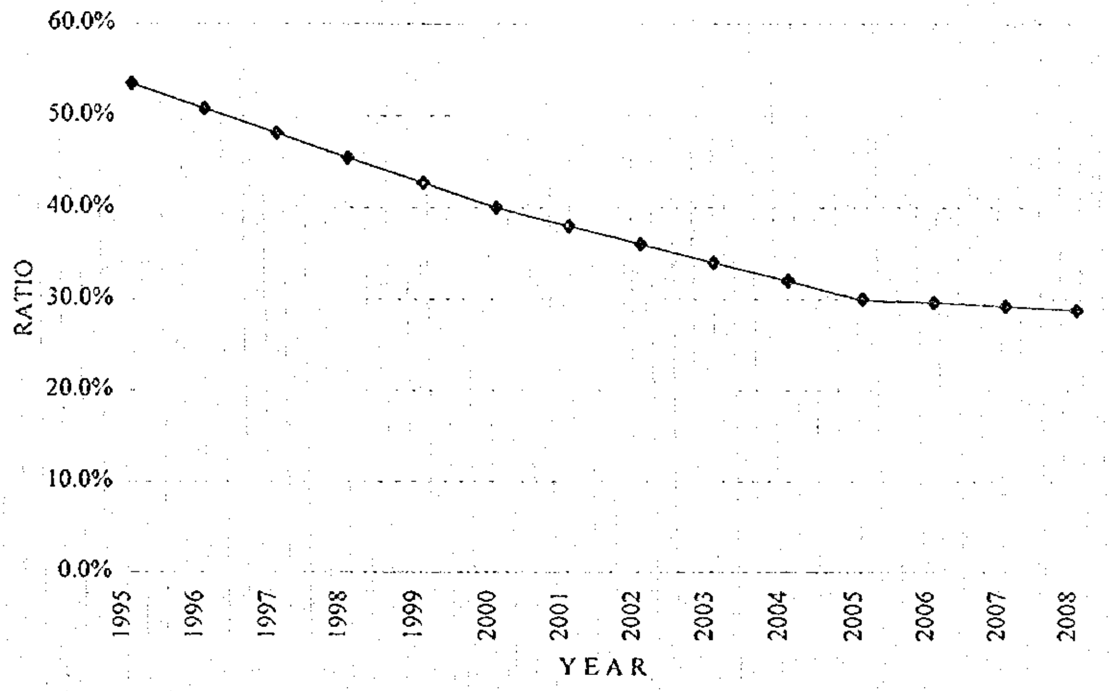
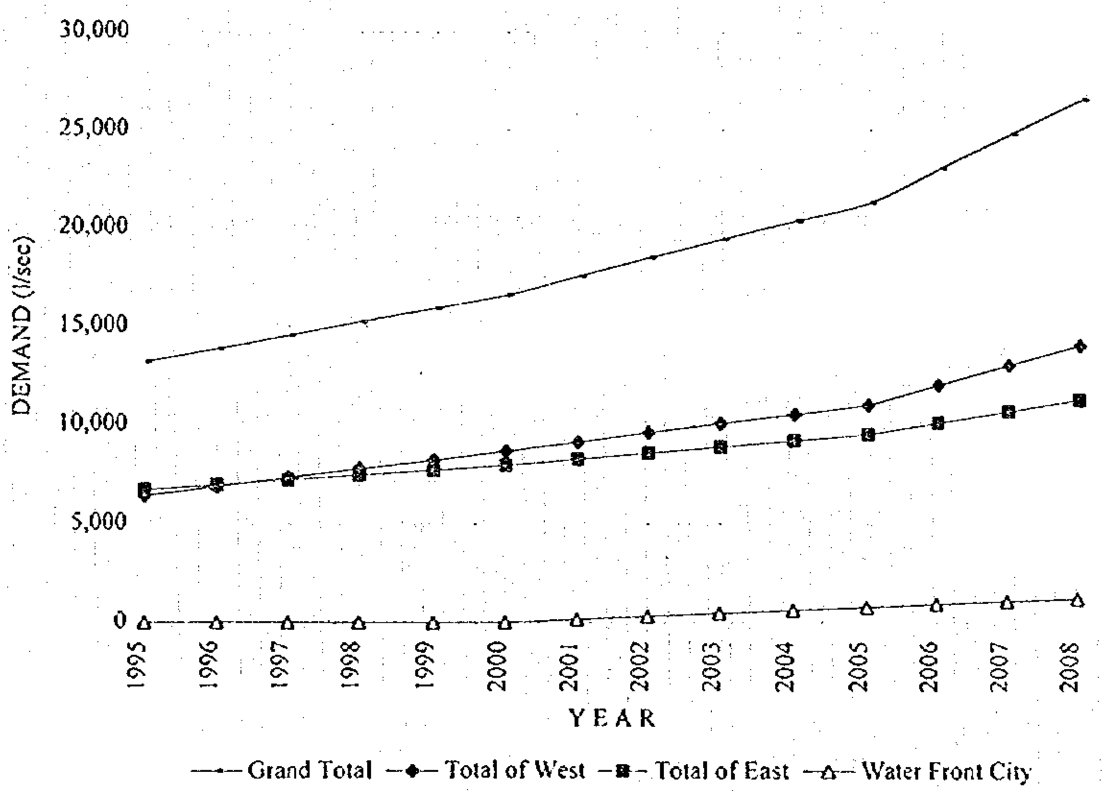


Figure-415.6 DAY-MAXIMUM WATER DEMAND



4.2 WATER QUALITY IMPROVEMENT

In the Master plan, it is planned that improvement of water quality is implemented in three steps and the target of each step is as shown below. Necessary measures for the improvement are also studied in the plan.

Step 1	Potable Water at Treatment Plant Effluent
Step 2	Potable Water at The End of Distribution Mains
Step 3	Potable Water at Each Tap of All Consumers

In the Feasibility Study, realization of the Step 1 and Step 2 improvement are planned.

4.2.1 Basic Concept

In order to realize Step 1 improvement, that is to secure potable water at treatment plants, there will be two basic measures for achievement of the target as follows.

① To obtain raw water of good quality.

② To apply specialized treatment method such as ozonation and granular activated carbon adsorption.

In case of Jakarta water supply system, the above ①, acquisition of good quality raw water is employed as the basic measure to achieve the target of Step 1 in due consideration of the followings:

a. Raw water quality of WTC in upstream before confluence with Bekasi river is acceptable to apply conventional treatment method with rapid sand filtration,

b. Raw water quality for all the existing treatment plants except Cisadane will be improved by isolation of WTC from Bekasi river,

c. Very high turbidity of the raw water may be caused by silt trap at Bekasi will be decreased also by isolation of WTC from Bekasi river,

d. Application of the specialized treatment is costly in construction and operation, and

e. Application of the specialized treatment is required not only for new plants but also for all the said exiting ones.

4.2.2 Present Quality of Raw Water of West Tarum Canal

Present quality of raw water of West Tarum canal is outlined in the **Section 2.1.7** of the Master Plan. As shown in the **Figure-217.3** the water quality upstream of WTC is acceptable to allow conventional treatment of water using rapid sand filtration, but it is deteriorated after Bekasi river confluence to the canal. From this point of view, the basic concept described in the **Section 4.2.1** is employed.

Raw water quality of West Tarum canal in the upstream and downstream of Bekasi river confluence is compared with each other in the **Table-422.1** and in the **Figure-422.1**. As shown in the table and figure, it is clear that contaminated Bekasi river water worsens raw water of WTC remarkably. Concentration of all other quality parameters than Turbidity, pH and Detergent in the upstream water is far smaller than that of the downstream.

Table-422.1 QUALITY OF RAW WATER OF WTC AROUND BEKASI RIVER

Parameters	UNIT	Downstream Quality			Upstream Quality		
		Max.	Average	Min.	Max.	Average	Min.
Turbidity	NTU	191	75	13	138	68	15
Color	TCU	12	10	7	10	4	1
pH		7.6	7.0	6.6	7.9	7.2	6.6
BOD	mg/l	31.4	14.5	6.0	6.8	4.5	2.2
COD	mg/l	29.8	17.2	2.7	12.6	9.0	4.1
KMnO4	mg/l	22.9	11.4	5.1	3.8	2.5	1.1
NH4	mg/l	2.25	1.01	0.17	0.16	0.02	0.00
Fe	mg/l	6.20	1.89	0.26	0.85	0.30	0.05
Mn	mg/l	0.10	0.05	0.01	0.05	0.02	0.00
Detergent	mg/l	0.47	0.12	0.01			
E. Coli	100ml	660000	41400	350	88000	26000	5000

Turbidity values of the upstream and the downstream in the table, both of which are monthly analysis data, are not much different, and the downstream turbidity is rather low side comparing with daily analysis data. Turbidity by daily analysis at both upstream and downstream, Tambun and Buaran plants, is much bigger, 223 and 101 NTU in average respectively as is seen in the **Figure-422.2.** The reason may be the value in the table does not include those of higher turbidity by desludging activity of Bekasi silt trap.

Higher BOD, KMnO4, NH4 and Detergent concentration will be by confluence of Bekasi river of which water is highly contaminated by human activities along the river basin.

4.2.3 Water Treatment Method and Planned Raw Water Quality

(1) Target Water Quality for Ordinary Treatment

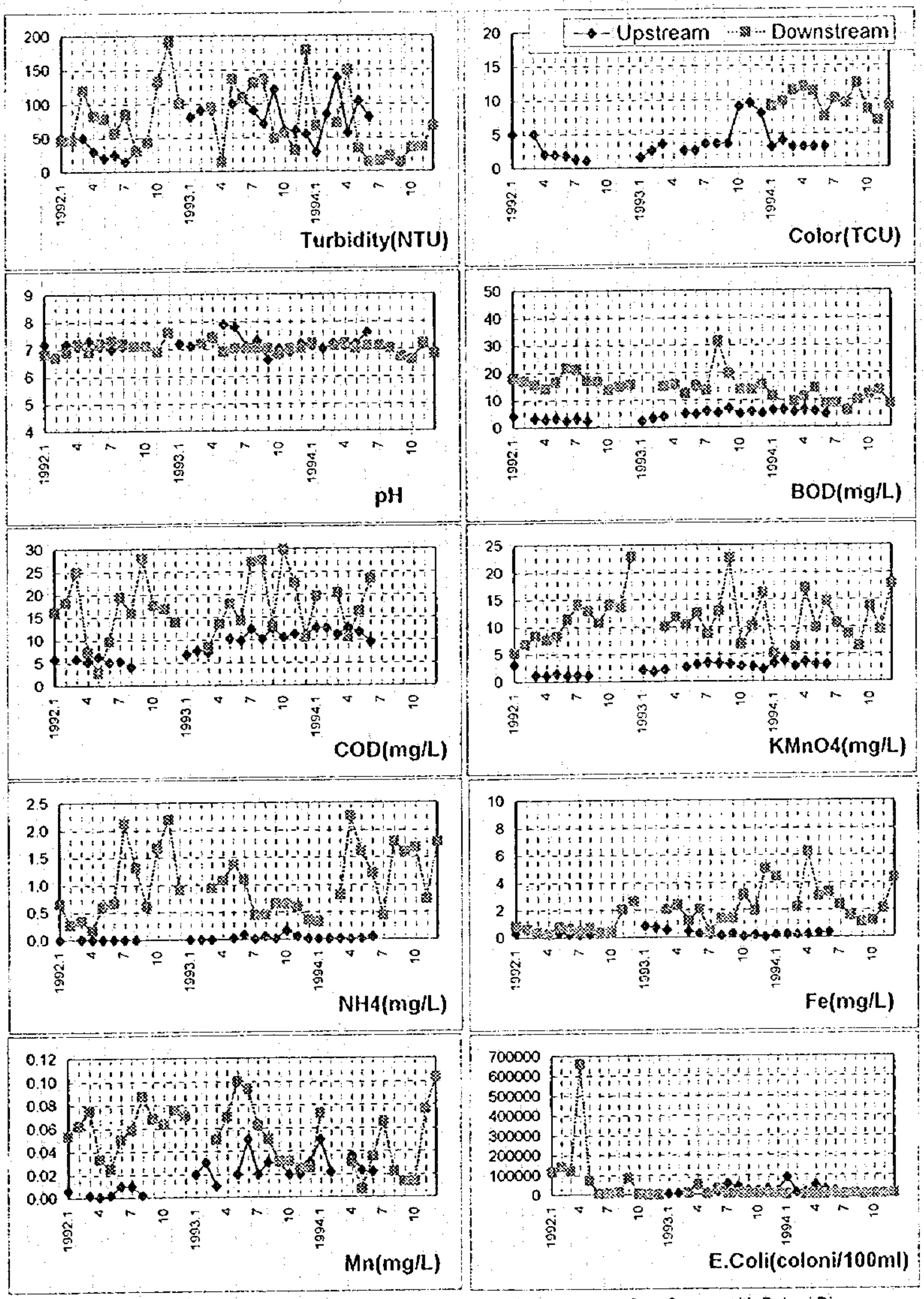
As described in the previous section, water treatment for the feasibility study is to apply conventional treatment with rapid sand filtration with raw water of improved quality instead to apply the costly specialized treatment processes. For the purpose, allowable extent of raw water quality is studied as shown in the **Table-423.1** on the basis of the water quality standard by Ministry of Health and by the past experience of JICA study team.

The conventional treatment is able to treat such quality parameters as Turbidity, KMnO4, NH4, Fe, Mn and E.Coli while Color and Detergent can not always be removed by the treatment. Color value in the table is quoted from the quality standard of Ministry of Health, and Detergent value is from consideration of the forming limit of approximately 0.3 mg/l, though the quality standard prescribes the value as 0.05 mg/l.

Table-423.1 RAW WATER QUALITY FOR ORDINARY TREATMENT

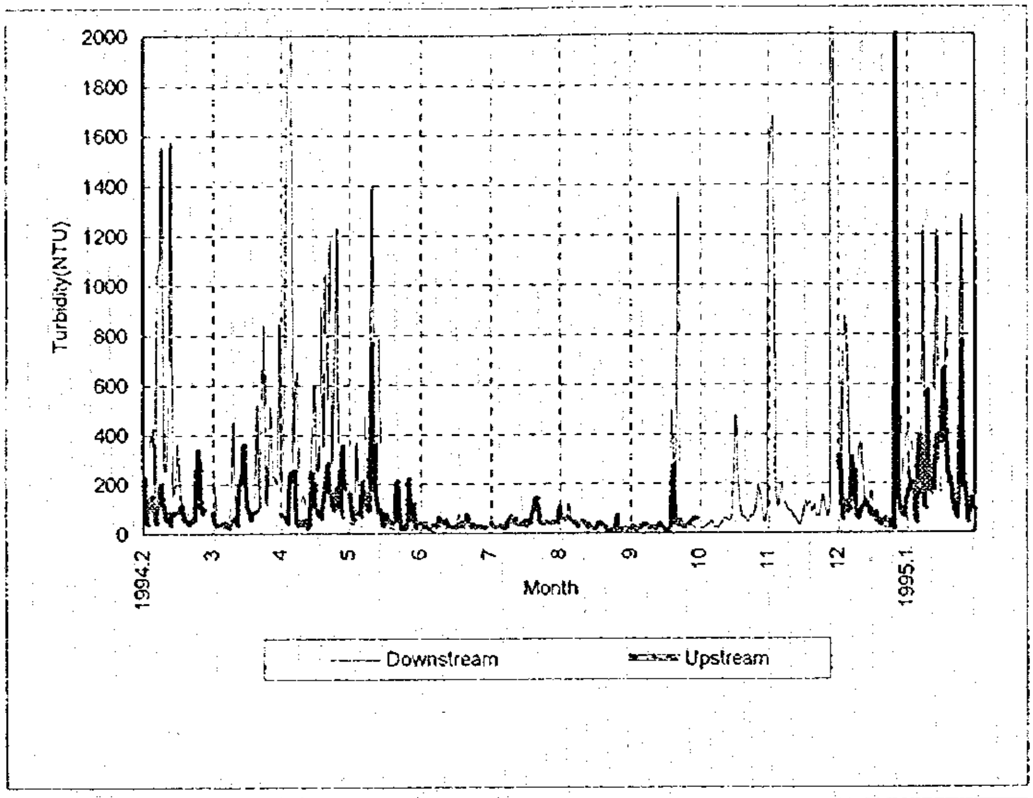
Parameter	Unit	Range of Conc.	Parameter	Unit	Range of Conc.
Turbidity	NTU	10 - 1000	NH4	mg/l	less than 1.0
Color	TCU	* less than 15	Fe	mg/l	0.05 - 2.0
pH		6.5 - 8.0	Mn	mg/l	0.02 - 0.2
KMnO4	mg/l	less than 20	Detergent	mg/l	* less than 0.2

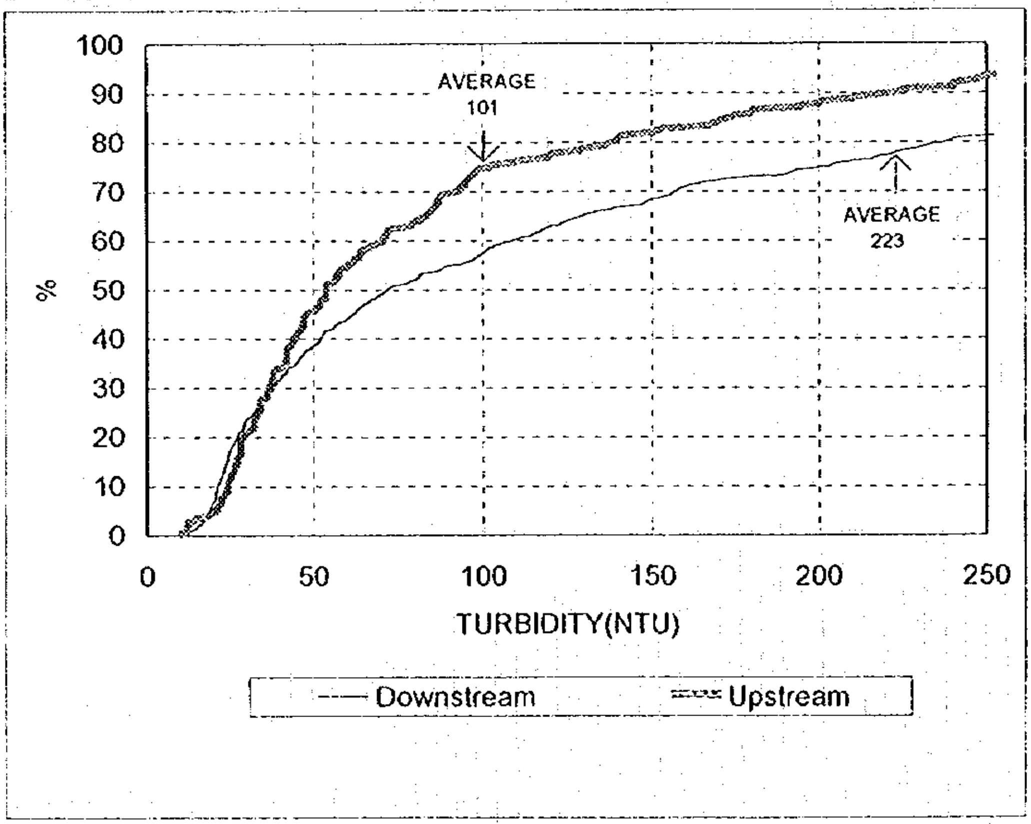
Figure-422.1 COMPARISON OF WATER QUALITY OF UPSTREAM DOWNSTREAM



NOTE) UPSTREAM :Sample was taken from WTC at about 1km upstream of confluence with Bekasi River.
DOWNSTREAM:Sample was taken from WTC at intake of Buaran Treatment Plant,about 8km downstream of confluence with Bekasi River.

Figure-422.2 TURBIDITY OF WTC WATER





(2) Water Treatment Method

It is clear that all the range of upstream water quality of WTC water as shown in the **Table-422.1** is within the above quality ranges for conventional water treatment. Even considering the fact that the raw water quality is slightly deteriorated in these years and the quality data is of monthly sampling basis, the upstream water quality will still remain inside the quality range as listed in the **Table-423.1**.

Thus, conventional method with rapid sand filtration is employed to the water treatment method for the Priority Projects with the provisions for strengthening of chemical application for the water treatment and for isolation of WTC from Bekasi river as well.

(3) Planned Raw Water Quality

For planned raw water quality, the present upstream quality of WTC as shown in the **Table-422.1** is basically applied. After slight modification of the ranges of the present upstream quality in consideration of the description in the above, the quality values as listed in the **Table-423.2** is applied for future quality of the raw water for planning of the water treatment process for the Priority Projects.

Table-423.2 FUTURE QUALITY OF RAW WATER OF WTC

Parameter	Unit	Range	Average	Remarks
Turbidity	NTU	10 - 1000	50 100	Dry Season Rainy Season
Color	TCU	1.0 - 15	5.0	
pH		6.5 - 8.0	7.2	
KMnO4	mg/l	1.0 - 10	5.0	
NH4	mg/l	0.0 - 1.0	0.1	
Fe	mg/l	0.05 - 1.0	0.4	
Mn	mg/l	0.0 - 0.1	0.03	
Detergent	mg/l	0.01 - 0.2	0.1	
E.Coli	mg/l	5000 - 200000	30000	

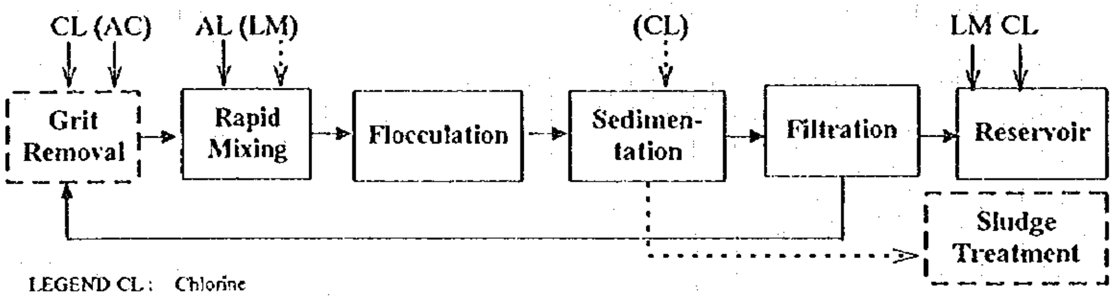
Considering seasonal difference of raw water turbidity as shown in the **Figure-422.1**, two different values of average turbidity are planned. Although, there is no analyzed data available for Detergent of the upstream water, its target value is planned approximately a half of the present downstream water quality considering the decrease of concentration of KMnO4 and NH4 as shown in the **Table-422.1**.

4.2.4 Water Treatment process

(1) Treatment Process Flow

On the basis of the treatment method as described in the previous section, the process flow of water treatment of the Priority Projects is planned as shown in the **Figure-424.1**.

Figure-424.1 FUTURE WATER TREATMENT METHOD



LEGEND CL : Chlorine
AL : Alum
LM : Lime
AC : Powdered Activated Carbon

Pre-chlorination is applied for oxidation of NH_4-N, Fe, Mn and organic substances, and in case of higher concentration of organic substances, intermediate chlorine is applied for supplement of pre-chlorination. Post-chlorination is for disinfection of filtered water.

Alum is of course dosed for coagulant. Pre-lime is for adjusting lower pH of water in case much alum is fed, and post-lime is for adjusting pH value of the treated water. Powdered activated carbon system is equipped and will be fed against such water quality accidents of raw water as caused by higher detergent, heavy metals, etc.

(2) Chemicals and Their Dosage

Based on the planned raw water quality as described in the **Table-423.2** and chemicals selected as shown in the **Figure-424.1**, dosage of the chemicals is studied using experimental equations and considering the performance of chemical treatment at the existing treatment plants.

Dosage of chemicals is planned as described in the **Table-424.1**.

Table-424.1 PLANNED DOSAGE OF CHEMICALS

Chemical	Unit	Maximum	Average	Minimum	Remarks
Pre-chlorine	mg/l	10	2.0	0.5	Liquid Chlorine
Int.-chlorine	mg/l	10	2.0	0.5	Liquid Chlorine
Post-chlorine	mg/l	3.0	1.0	0.5	Liquid Chlorine
Coagulant	mg/l	150	30	10	Aluminum Sulfate
Pre-lime	mg/l	40	10	5	Powdered Slaked Lime
Post-lime	mg/l	10	3	1	Powdered Slaked Lime
Activated Carbon	mg/l	70	20	5	Powdered Carbon

(3) Sludge Treatment

In order to preserve river water quality and at the same time to save precious raw water by decreasing water treatment loss, sludge treatment is studied.

In 1991, 'Standard Quality for Waste Liquids for Operational Activities' has been put in force by the Decree of State Minister for Environmental and Population Affairs. The decree says the standard quality should be determined by districtwise considering difference of environment of each district.

In June 1995, Governor of DKI Jakarta established the standard on waste water for various industries. Among them, the standard quality for water supply industry is also defined as shown in **Annex-42**.

All other quality parameters except Suspended solid contained in waste water from a treatment plant including sedimentation sludge is thought far smaller in their concentration than the above standard values. While, Suspended solid in the waste water will sometimes reach 10,000 mg/l.

Direct discharging of the waste water to a river basin will raise turbidity of the water, and also sludge contained in it may accumulate on its bottom which will cause inundation in its upper stream. Hence, re-use of filter wash drain and sedimentation sludge treatment of the treatment plants for the priority project is planned.

1) Re-use of Wash Drain of Filters

Usually wash drain of filters which is 2 to 3 % of the production is discharged out from a treatment plant. The wash drain will not only worsen the environment to receive the discharge, but also waste precious raw water stored in very expensive dam reservoir.

Different from the sedimentation sludge, suspended solid in the wash drain of filters is easily precipitated because it receives long period flocculation and compression in the filter media. Recycling supernatant of the filter wash drain after settling the suspended solid is widely practiced because it is implemented with inexpensive cost.

This practice is already employed at Cisadane treatment plant, and it is planned that re-use of the filter wash drain is applied to the treatment plant for the Priority Projects.

2) Sludge Treatment Method

Lagoon or sludge drying bed system and mechanical desludging system are the typical sludge treatment methods which are widely practiced. Examples of two methods are illustrated in the **Annex-42**.

The former needs vast land space and the latter requires very expensive cost. The lagoon system is employed when vast land is available with inexpensive cost and the mechanical system vice versa. According to simplified comparison made in the **Annex-42**, the mechanical system is more realistic for the Jakarta water supply system considering availability and cost of necessary land area.

Table-424.2 COMPARISON OF SLUDGE TREATMENT

Comparative Items	Lagoon System	Mechanical System
Capacity of System	5.0 m3/sec	5.0 m3/sec
Raw Water Turbidity	80 NTU	80 NTU
Necessary Land Space	72,000 m^2	3,500 m^2
Construction Cost	Rp. 66 mil	Rp. 57 mil

Note: Unit land cost applied is Rp. 800,000/m^2

4.2.5 Improvement of Raw Water Quality

Improvement of raw water quality of West Tarum canal by isolation of the canal from Bekasi river is indispensable for water treatment under the Priority Projects. The canal isolation is explained in **Chapter 4.3**.

4.2.6 Improvement of Distributed Water Quality

After achievement of the target of Step 1 improvement of water quality, that is to secure potable water at the treatment plant, next target of quality improvement, Step 2, for obtaining drinkable water at the end of distribution mains will be conquered.

As described in the Master plan, there exists various quality problems on distribution mains as follows. These must be solved for the step 2 improvement of water quality.

① Deteriorated secondary and tertiary mains much exist.
② Many service pipes are deteriorated.
③ Cross connection with private still exists.
④ Direct pumpage from distribution mains still exists.
⑤ Water quality is very poor around the boundary of distribution zones.
⑥ Quality in distribution main is not monitored.

(1) Improvement by PJSIP

Among other measures for the Step 2 improvement, on-going PAM JAYA System Improvement Project (PJSIP) and its follow-up activity are the most fundamental ones and are considered indispensable for realization of the target.

Purpose of the PJSIP is to increase number of connections for raising service coverage and to reduce unaccounted-for water throughout the present service area. For the purpose, extension and rehabilitation of distribution and service mains including installation of necessary meters, valves, etc. are executed by site checking of the existing conditions of water supply.

PJSIP is divided into two phase project, namely PJSIP I and II. Progress of the project is approximately 60% of PJSIP I. It is expected that PJSIP I is completed as soon as possible and succeedingly PJSIP II is to be put into implementation. Needless to say, the follow-up activity including leakage survey shall be executed as routine works.

(2) Additional Chlorination at Distribution Center

In case of distance between a treatment plant and a distribution center is big or insufficient performance of water treatment process, residual chlorine may be consumed in the transmission main until arriving the treated water at the distribution center. Considering the above, the existing R1 and R5 distribution centers are equipped with chlorine feeding system, and it is planned that distribution centers to be constructed for the priority project are also equipped with chlorine feeding system.

(3) Zoning of Distribution Network

At present, Jakarta water supply system has six distribution zones and water supply management including billing and collection of the tariff is made on the zone basis. However, distribution mains are composed of an entire network for the whole service area and not isolated to each zone. Under these conditions, it is hardly known exact service area of a treatment plant or a distribution center, or it can be said that boundary of the service area fluctuates hour by hour.

This may cause ⑤ problem.

Composition of elementary zones of secondary distribution mains which consists of 1000 to 2000 connections are under way by PJSIP financed by OECF. Planning of the distribution zones is studied in **Chapter 4.5.**

(4) Monitoring of Water Quality in Distribution Network

By completion of the step 1 improvement and also completion of PJSIP II, treated water of the Jakarta water supply system will be potable up to the end of distribution mains. Confirmation of quality of the distributed water should be made by monitoring of concentration of its residual chlorine.

In early stage, the distributed water will be sampled from fire hydrants or blow-off valves and analyzed at the central laboratory described in the next section. In the future, however, sampling and analyzing of residual chlorine of the water will be integrated in the total monitoring system of Jakarta water supply system which is studied in **Chapter 4.6.**

4.3 PRELIMINARY STUDY ON RAW WATER SOURCES

4.3.1 General

The preliminary study on water resources for the DKI Jakarta water supply system in this Chapter aims to play an assistance to efficiently, effectively and timely proceed implementation of the immediate measure on water sources supplied from the West Tarum Canal. **Figure-431.1** illustrates the work flow of the preliminary study on water resources for the DKI Jakarta water supply system.

4.3.2 Preliminary Study on Immediate Measure for Raw Water Source

(1) Existing West Tarum Canal

The upgrading of the West Tarum Canal in quantity aspect has been proposed to be the immediate measure for raw water sources to the DKI Jakarta water supply system as mentioned in **Section 3.16**. The background and outlines of the West Tarum Canal are mentioned as follows.

The West Tarum Canal originates at the Curug Intake locating at 10 km downstream point on the Citarum river from the Jatiluhur Dam and laid along the existing railway and highway. The West Tarum Canal takes the water of 82 m3/sec at the Curug Intake and the said discharge gradually decreases up to 31.1 m3/sec by distributing the water for irrigation and industry at the individual intakes composing gated intake structures and diversion weirs up to the confluence with Bekasi river. The West Tarum Canal finally takes water of 21.1 m3/sec from the Bekasi Intake after distributing water for requirement of the downstream reach of the Bekasi river from the diversion weir and conveys the above amount of water to the Buaran Intake for the existing treatment plant. The flow chart of the West Tarum Canal is illustrated in **Figure-432.1.**

The West Tarum Canal having a total length of about 70 km intercepts three (3) major rivers consisting of the Cibeet, Cikarang and Bekasi rivers. Out of the said interceptings, the West Tarum Canal directly diverts the water to the Cikarang and Bekasi river courses. The West

Figure-431.1 WORK FLOW OF PRELIMINARY WATER RESOURCES STUDY

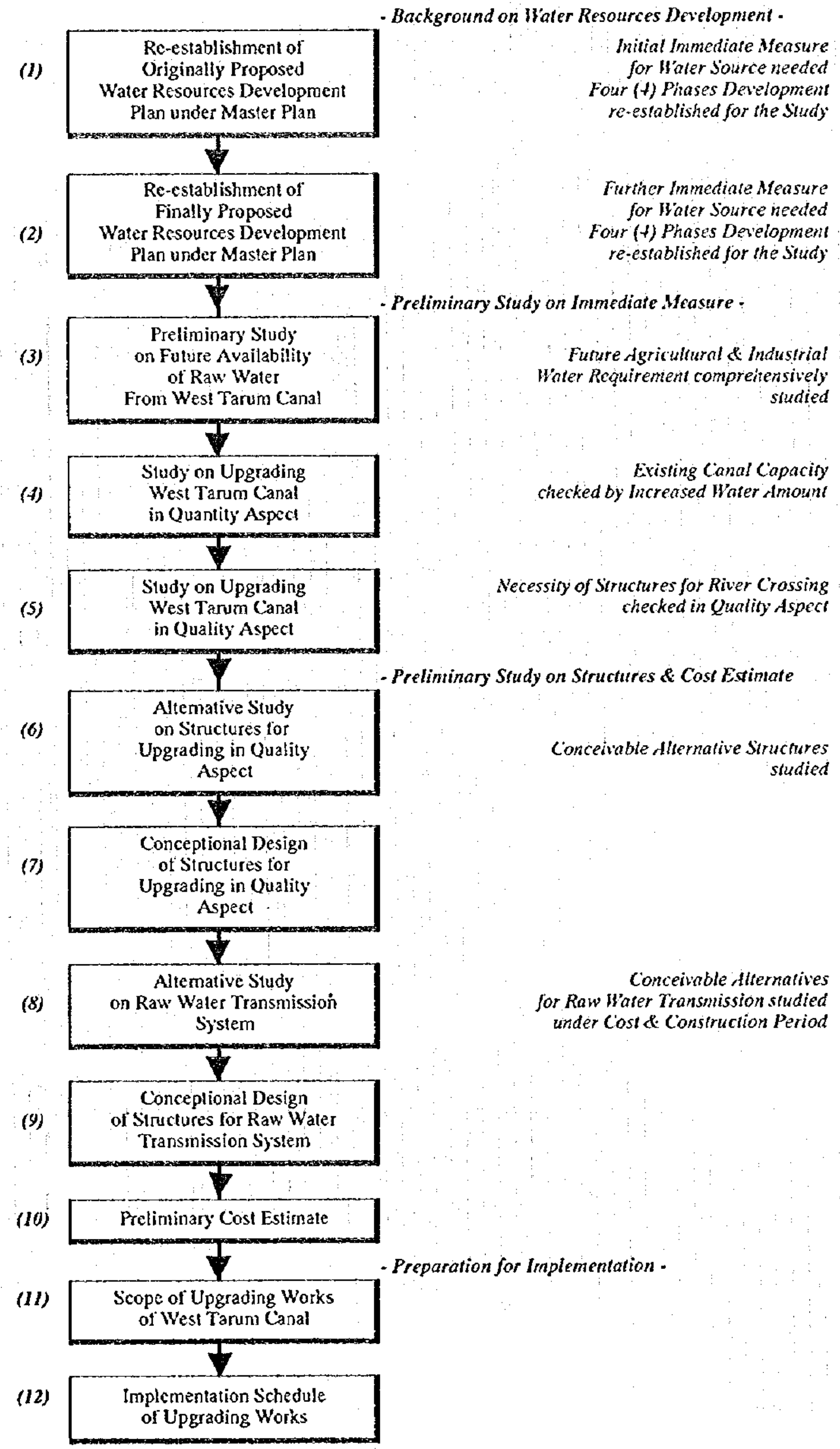


Figure-432.1 FLOW CHART OF EXISTING WEST TARUM CANAL

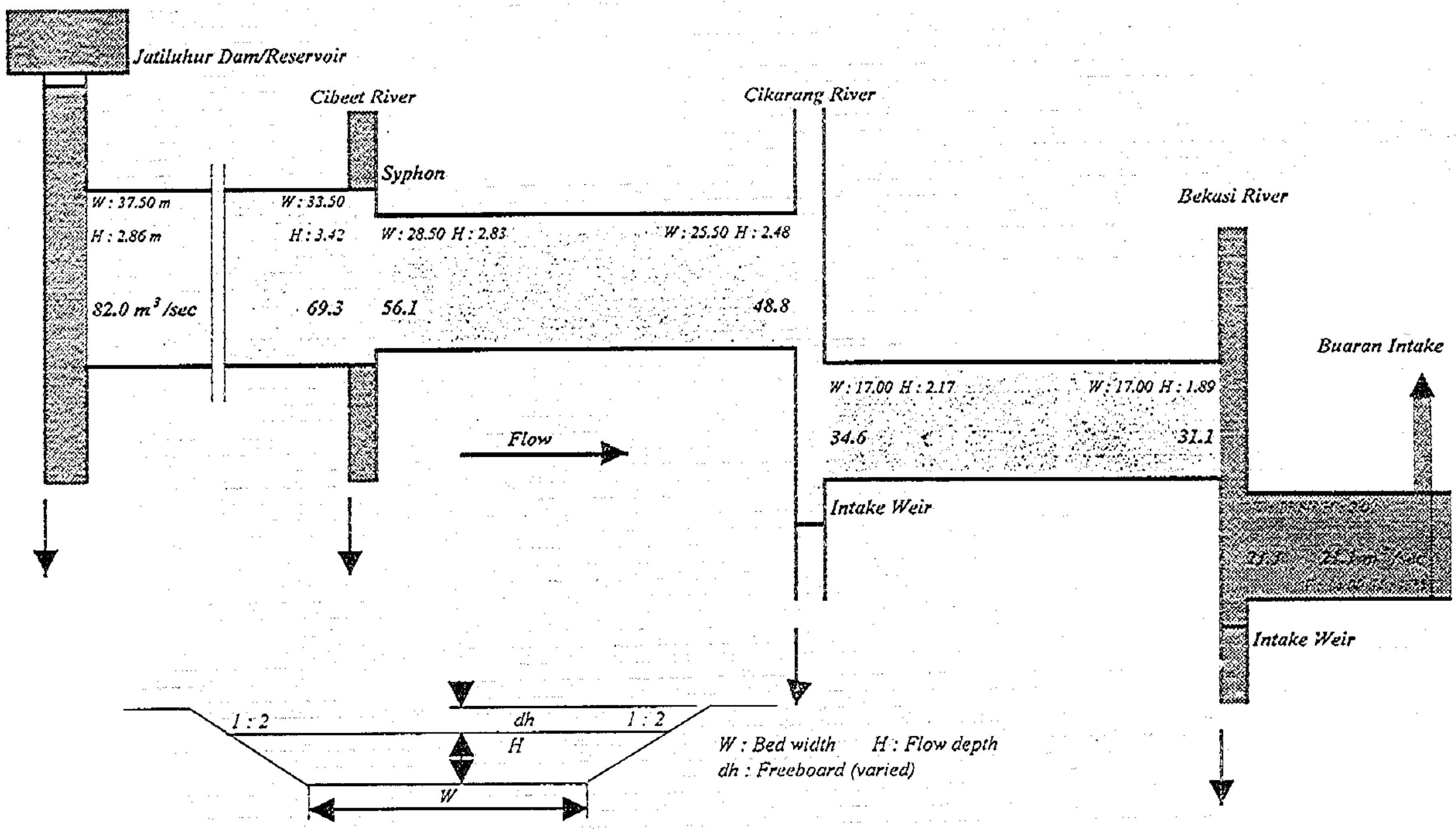
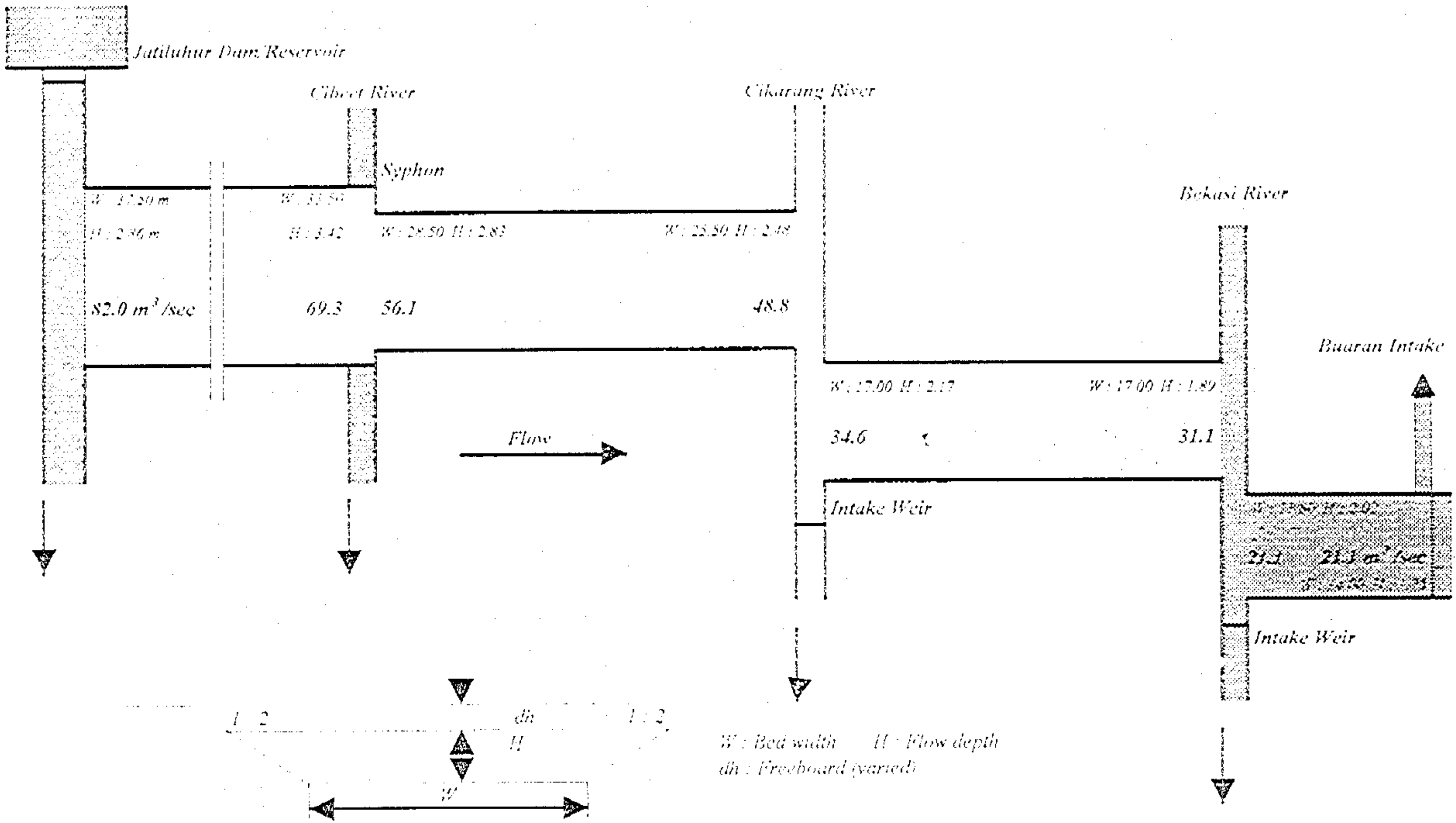


Figure-432.1 FLOW CHART OF EXISTING WEST TARUM CANAL



Tarum Canal takes the water again from their intake (diversion) weirs. Such direct water diversion on the river courses is causing a worse water quality conditions for the M & I water supply to the DKI Jakarta water supply system.

(2) Future Availability of Raw Water from West Tarum Canal

The Steering Committee clarified in compliance with the questionnaire made by the JICA with his letter No. 270/JICA/7/96 dated July 15, 1996 that the future availability of raw water from the West Tarum Canal amounting to 10 m^3/sec has been preliminarily ascertained for the immediate measure to the DKI water supply system without any quantitative justification. Under such circumstances, the Study Team discussed with the Jatiluhur Authority to confirm future availability of the said additional water provision and finally the following results were obtained on this matter :

There are two (2) factors to make water balance study for checking future availability of raw water from the West Tarum Canal under past, present and future conditions ; 1) deduction of irrigation water demand by decreasing irrigation area, and 2) industrial water demand additionally increased by industrial development along and surrounding the West Tarum Canal. The following are the preliminary water balance study based on the said two (2) factors :

		1990	1995	2000	2005
1)	Irrigation Area (ha)	68,500	59,690	50,790	41,890
			-8,900	-17,800	-26,610
				(-8,900)	(-8,900)
				(1.0)	(1.0)
				57,820	52,530
				-10,680	-15,970
				(0.6)	(0.6)
			(100 to 60 % of 1990-1995 deduction)		
2)	Deduction of Irrigation Water (m^3/sec)		8.9	17.8 to 10.7	26.6 to 16.0
				(Unit water use : 1 l/sec/ha)	
3)	Industrial Water (m^3/sec) (Additional)		1.0 (Present demand estimated)		6.0
					(12,000 ha x 0.5 l/sec/ha)

- Optimistic value for development estimated by POJ -

4) **Future Availability for DKI Jakarta Water Supply System (m^3/sec)**

(2) - (3) **<u>20.6 to 10.0</u>**

In addition to the above information, the Jatiluhur Authority has estimated that an additional water with an amount of 2 to 3 m^3/sec out of 5 m^3/sec for the initial immediate measure might be already available at present, obtaining by reducing the irrigation area in Bekasi and it is predicted that availability of the remaining 3 to 2 m^3/sec for the initial measure is very sure before the end of Year 2001. The said information means that the initial immediate measure with an amount of 5 m^3/sec will be allocated by reducing only from the water use for the Bekasi irrigation area. Therefore, the total amount of supplied water from the West Tarum Canal before the confluence with the Bekasi river, having an amount of 31.1 m^3/sec, will be newly allocated to 5 m^3/sec for the Bekasi area and 26.1 m^3/sec for the DKI Jakarta.

Figure-432.2 exhibited the future water availability trend from the West Canal for the DKI Jakarta water supply system as the immediate measure.

(3) Study on Upgrading of West Tarum Canal in Quantity Aspect

<u>**Amount of Additional Water**</u>

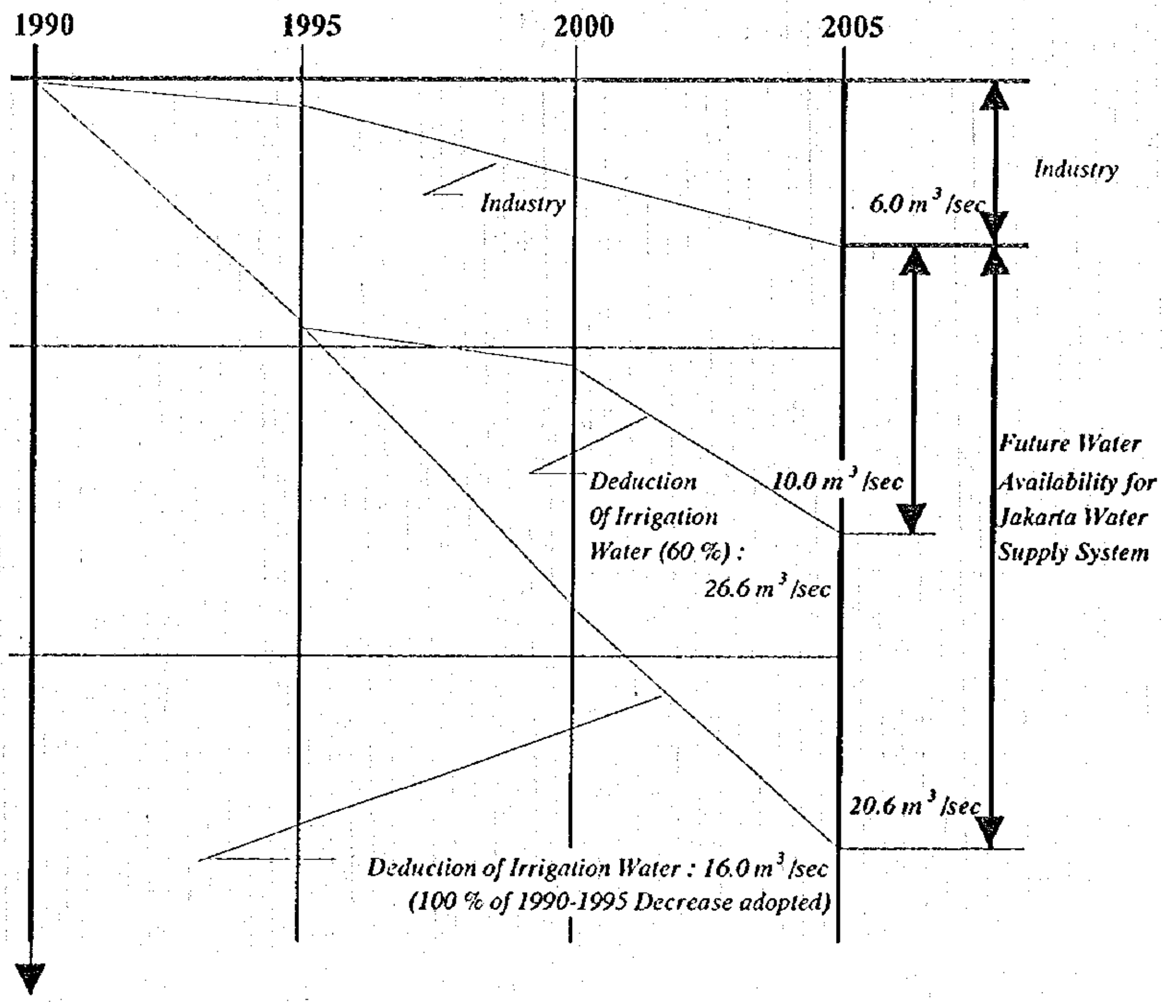
As mentioned in the preceding Section, the West Tarum Canal will generate an additional water of 10 m^3/sec, out of which 5 m^3/sec each will be available in the Years 2002 and 2006 respectively.

The following assumption was applied to the preliminary study on upgrading of the West Tarum Canal :

i) The entire section of the West Tarum Canal (WTC) is divided into the following four (4) sections :

Section I	Curug Intake - Cibeet Syphon
Section II	Cibeet Syphon - Confluence with Cikarang river
Section IV	Confluence with Cikarang- Confluence with Bekasi river
Section V	Confluence with Bekasi river - Buaran Intake

Figure-432.2 FUTURE WATER AVAILABILITY FROM WEST TARUM CANAL FOR JAKARTA SUPPLY SYSTEM



Future Water Availability for Jakarta Water Supply System :
10.0 to 20.6 m^3/sec

ii) The present water distribution amount from the WTC to the area in Section I is maintained.

iii) An additional water generation from the Cibeet sysphon to the Confluence with the Bekasi river is linearly increased from 0 m^3/sec to 5 m^3/sec.

iv) An additional water from the Confluence with the Bekasi river to the DKI Jakarta water supply system through Section IV of the WTC is provided, dividing 5 m^3/sec each into the two stages; stage I from Year 2002 and Stage II from Year 2006.

Under such assumption, an additional water amount from the West Tarum Canal for the respective origins/destinations were calculated as follows :

Table-432.1 AMOUNT OF ADDITIONAL WATER AT RESPECTIVE POINTS OF WEST TARUM CANAL

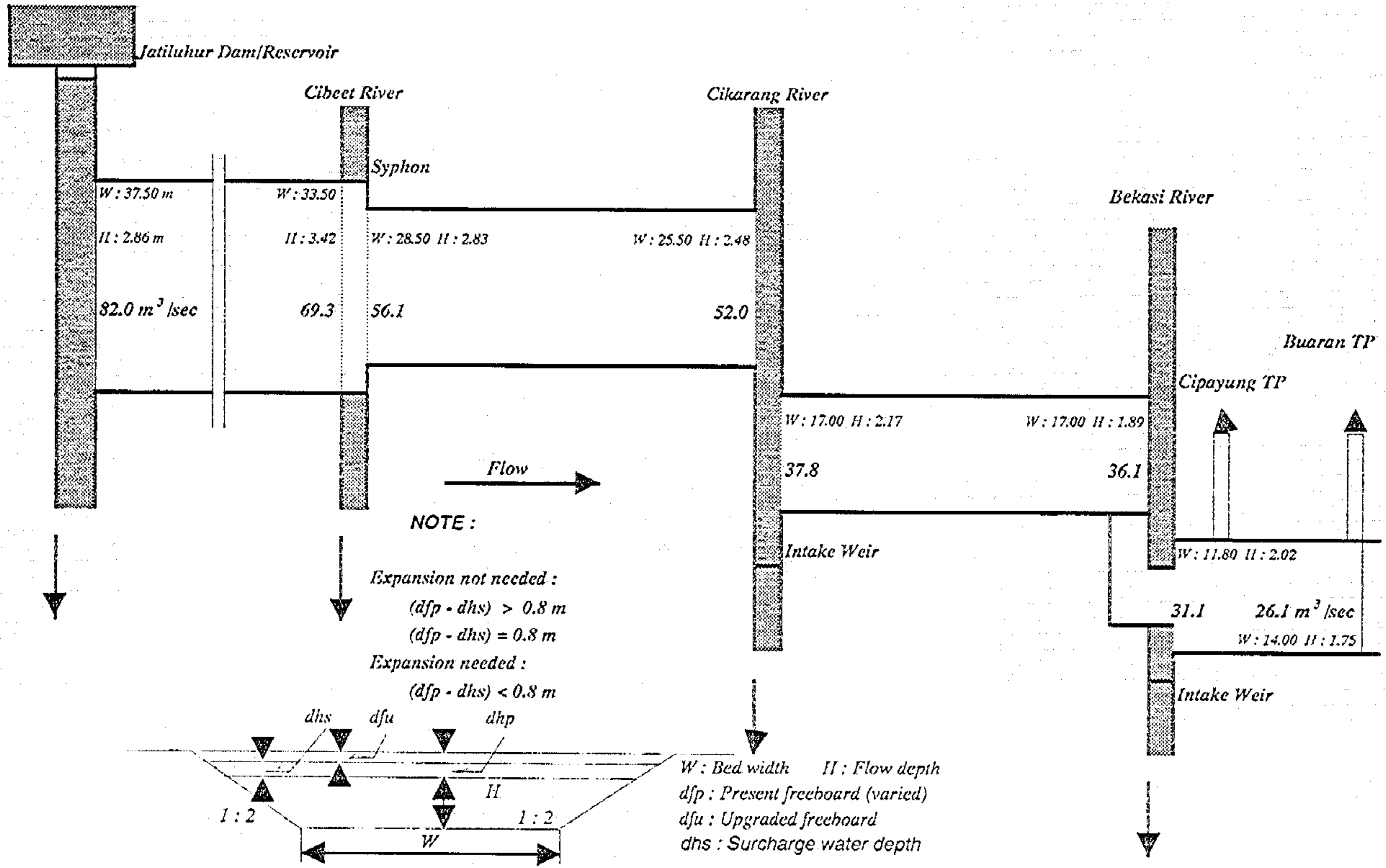
Section	Origin/Destination	Distance (km)	Accumulate Distance (km)	Amount of Additional Water (m^3/sec)
I	Curug Intake	0.0	0.0	0.0
	Cibeet Syphon	25.2	25.2	0.0
II	Cibeet Syphon	0.0	25.3	0.0
	Confluence with Cikarang River	14.1	39.4	3.2
III	Confluence with Cikarang River	0.0	40.0	3.2
	Confluence with Bekasi River	14.4	54.4	5.0
IV	Confluence with Bekasi River	0.0	55.7	5.0
	Buaran Intake	7.9	63.6	5.0

Figure-432.3 shows the flow chart of the flow chart of upgraded West Tarum Canal.

Study on Necessity of Expansion Works for Upgrading

The study on necessity of expansion works of the West Tarum Canal for upgrading was to check whether or not the existing canal cross section can allow increasing discharge, which is the sum of the existing allocated discharge and the additionally generated discharge.

Figure-432.3 FLOW CHART OF UPGRADED WEST TARUM CANAL



The existing freeboard of the canal, which is the height from normal water level to crest of canal, varies from the minimum required height, say 0.5 m to 4 m, according to the site investigation results. The said existing conditions indicate that the existing freeboard may be enough to secure water surcharge depth, which is caused by flowing additional, in some sections of the canal. In such observation, the following criteria was employed to make judgment whether or not the existing freeboard is enough to flow additional discharge as referred to in **Figure-432.3** :

Sufficient Capacity : No expansion works needed

0.80 m < (Existing Freeboard) - (Surcharge water depth)
0.80 m = (Existing Freeboard) - (Surcharge water depth)

Insufficient Capacity : Expansion works needed

0.80 m > (Existing Freeboard) - (Surcharge water depth)

For the said study purpose, the site investigation to measure the existing freeboard was conducted for entire section from the confluence with the Cibeet river to the Buaran intake of the existing Treatment Plant for the period in May and from July to August 1996.

Table-432.2 is the check for necessity of expansion works for upgrading for the respective sections of the West Tarum Canal .

The check shows the following results on necessity of the expansion works for the upgrading of the West Tarum Canal :

Section I — Not needed

Curug Intake - Confluence with Cibeet River

Section II — Not needed

Confluence with Cibeet River - Confluence with Cikarang River

Section III — Not needed

Confluence with Cikarang River - Confluence with Bekasi River

Section IV

Confluence with Bekasi River - Buaran Intake

1.5 km downstream section from entrance of existing silt trap — **Needed**

0.6 km upstream section from Buaran intake	**Needed**
Other sections	Not needed

For the sections, which require the expansion works, the cross section of the West Tarum Canal should be changed from trapezoid shape to rectangular shape. As an appropriate construction methodology, it is proposed that sheet piles are driven at the shoulders of both sides of the canal and that the remaining portions inside the sheet piles driven is removed by dredging.

Table-432.2 NECESSITY OF EXPANSION WORKS FOR RESPECTIVE SECTIONS OF WEST TARUM CANAL

Section	Distance (kn)	Accum. Distance (km)	Add. Discharge (Q) (m³/sec)	Flow Width (W) (m)	Present Freeboard (hfp) (m)	Surcharge dhs = Q/v W (m)	Upgraded Freeboard (Hhfu) (m)	Expansion Works
I	-	0.0	0.0	48.2	-	-	-	No
	-	25.2	0.0	47.2	-	-	-	No
II	-	25.3	0.0	33.3	-	-	-	No
	14.1	39.4	3.2	29.3	2.0 - 3.0	0.2	1.8 - 2.8	No
III	-	40.0	3.2	26.6	2.7	0.2	2.5	No
	3.0	43.0	3.6	26.2	2.7	0.2	2.5	No
	2.0	45.0	3.8	25.8	2.5	0.2	2.3	No
	3.0	48.0	4.2	25.4	2.2	0.2	2.0	No
	3.0	51.0	4.6	25.2	1.8	0.3	1.5	No
	2.9	53.9	4.9	25.0	1.8	0.3	1.5	No
	2.9	53.9	4.9	24.8	2.3	0.3	2.0	No
	0.5	54.4	5.0	24.6	2.3	0.3	2.0	No
IV	-	55.7	5.0	19.9	0.8	0.4	0.4	No
	1.5	57.2	5.0	19.9	0.8	0.4	0.4	No
	1.5	57.2	5.0	19.9	1.4	0.4	1.0	No
	2.5	59.7	5.0	20.0	1.4	0.4	1.0	No
	2.5	59.7	5.0	20.0	1.8 - 2.	0.4	1.4 - 2.1	No
	1.9	61.6	5.0	20.0	1.8 - 2.	0.4	1.4 - 2.1	No
	2.0	61.6	5.0	20.1	1.0	0.4	0.6	Yes
	0.6	63.6	5.0	20.1	1.0	0.4	0.6	Yes

(4) Study on Upgrading of West Tarum Canal in Quality Aspect

The options for conveying raw water of an acceptable quality and in sufficient quantities to DKI Jakarta and its surrounding area (BOTABEK) have been studied by the Jabotabek Water

Resources Management Study (JWRMS) financed by World Bank loan. The study concluded that upgrading of the present configuration of the West Tarum Canal to safeguard the water quality is the cheapest solution to satisfy a major part of the raw water demand of DKI Jakarta and Bekasi for the immediate future.

The rapid urbanization and industrialization have caused a rapid deterioration of the water quality in the West Tarum Canal and its surrounding rivers, Cibeet, Cikarang and Bekasi as well as Cikao river of the Curug intake. Water currently available at the tail end of the West Tarum Canal is more polluted, incurring higher cost for water treatment. One of the main reasons for the poor water quality at the tail end of the West Tarum Canal is to intercept contaminated water from the said rivers and small drainage along the course of the West Tarum Canal. Also, high terbidity and the sudden fluctuations in turbidity levels, caused by floods in the rivers intercepted by the West Tarum Canal, is a heavy burden to the treatment plant process.

Prevention of inflow of water into the West Tarum Canal from the major rivers consisting of Cibeet, Cikarang and Bekasi intercepting the canal is not in line with the original design concepts. This concept was based on interception of as much water as possible from the intercepted rivers in order to command an irrigation area as large as possible. However, the original design does not anticipate increased raw water supply and the water quality problems caused by the intercepted rivers.

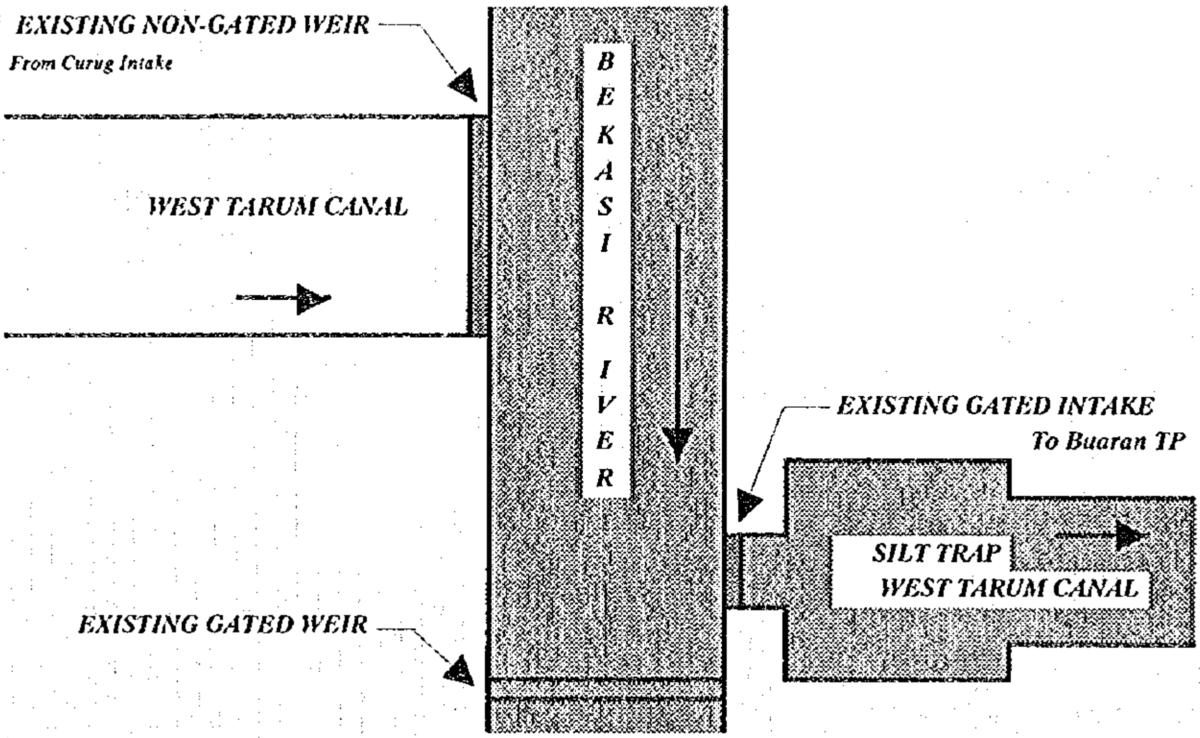
The short term and medium term measures is to keep the quality of West Tarum Canal water acceptable levels preventing inflow from the intercepted rivers and drainage into the West Tarum Canal. The solution to meet the original design concept can be accomplished by keeping the West Tarum Canal water separated from the intercepted water, while diverting the intercepted water directly to the relevant irrigation sectors, which can also be supplied from the West Tarum Canal in case of water shortage. To realize the said concept, an appropriate structures such as syphon, pipe bridge, etc. have to be constructed at the locations where the West Tarum Canal intercepts the rivers or where intercepted water has to cross the West Tarum Canal.

Following the JWRMS, the Jatiluhur Water Resources Management Project (JMP), Jatiluhur Water Resources Management Project Study (JMPS), has commenced and is being carried out the study on water management in accordance with the Terms of Reference as of October 1996. The said study has included water quality improvement of the West Tarum Canal for providing safe drinking water to parts of the DKI Jakarta and Botabek as immediate measure. In such situation, the JICA Study Team has closely coordinated with the JMPS through the Jatiluhur Authority, especially on scope of works under the said management study, of which the JICA Study Team shall undertake the most urgent works. Finally, it was proposed that the JICA Study Team would perform assistance works to implement the upgrading works, in quality aspect, only for the intercepting portion of the West Tarum Canal with the Bekasi river, which can be made as the consolidated works with the upgrading works, in quantity aspect, of the West Tarum Canal for the section from the Bekasi intake to the Buaran intake and raw water transmission by pipeline from the Bekasi intake to the proposed treatment plant. The following are the present conditions, observation and consideration on the upgrading works, in quality aspect, for the intercepting portion with the Bekasi river :

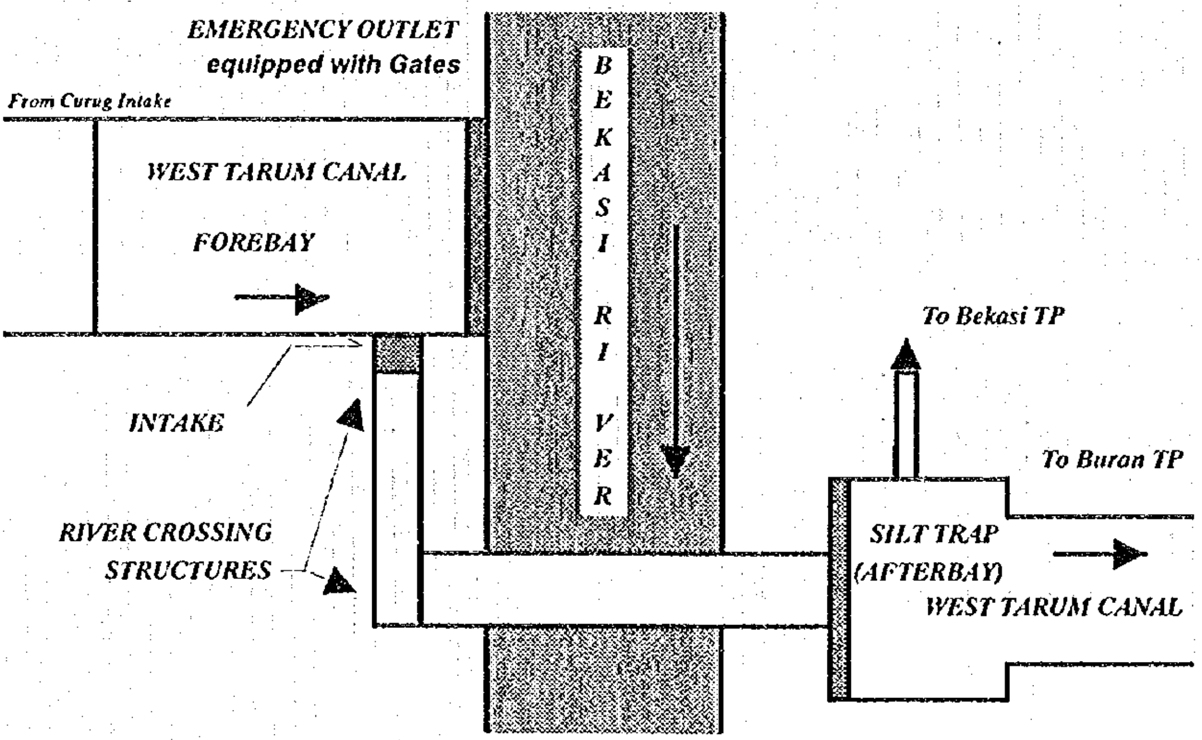
In water quality aspect in the West Tarum Canal, biological oxygen demand (BOD) and Anmonia-nitrogen (NH4-N) suddenly increases after the interception with the Bekasi. In addition, the Buaran treatment plant has experienced raw water intake with very high turbidity. In principle, such high turbidity was originated in the Curug intake, but more high turbidity was caused by intercepting water with the Bekasi river during rainy season. The present silting capacity of the existing silt trap, with poor maintenance, located in the downstream portion from the Bekasi intake, might be insufficient under the said turbidity condition.

In such observation and consideration, it is recommended applying the same concept as above-mentioned that the water conveyed through the West Tarum Canal up to the confluence with the Bekasi river should be directly diverted to the existing silt trap, which is located at the entrance portion of the West Tarum Canal by constructing an appropriate crossing structure over the Bekasi river. In such case, water in the outlet portion of the West Tarum Canal to the Bekasi river should be controlled by constructing an appropriate structures to avoid affection of backwater from the Bekasi river. **Figure-432.4** illustrates the flow of existing and upgraded structures for Bekasi river crossing.

Figure-432.4 EXISTING AND UPGRADED STRUCTURES FOR BEKASI RIVER CROSSING



- EXISTING STRUCTURES -



- UPGRADED STRUCTURES PROPOSED -

4.3.3 Preliminary Study on Raw Water Transmission System and Upgrading of West Tarum Canal in Quantity Aspect

(1) Alternative Study on Raw Water Transmission

The alternative study on raw water transmission consisting of upgrading of the West Tarum Canal and pipe lines has to be conducted under the comprehensive evaluation of the facilities consisting of raw water transmission, clear water transmission and treatment plant to formulate the most attractive treatment plant location. The result of the said comprehensive evaluation is to justify adoption of upgrading of the West Tarum Canal instead of pipeline. The following are the description of the comprehensive evaluation of the water supply facilities :

Base on the treatment plant locations and conveyance system, the following Alternatives as shown in **Figure-372.10** were selected for the comprehensive evaluation.

Alternative R1

Part 1 : Buaran plant expansion and treated water transmission through north route

Part 2 : Bekasi plant construction and treated water transmission through south route

Alternative R2

Part 1 : Bekasi plant construction and treated water transmission through north route

Part 2 : Bekasi plant expansion and treated water transmission through south route

Alternative R3

Part 1 : Buaran plant expansion and treated water transmission through north route

Part 2 : Buaran plant expansion and treated water transmission through south route

Alternative R4

Part 1 : Buaran plant expansion and treated water transmission through north route

Part 2 : Buaran plant construction, raw water transmission through south route and treated water transmission to west from east plant

The comprehensive evaluation were made on the items related to land acquisition, construction, operation and maintenance, existing facilities, preparatory works, sludge treatment as well as cost items. For selection of the best alternatives, scoring criteria was employed. The scores given to each alternative are shown in **Table-372.13**. As seen in the said table, the most attractive plan is given to Alternative R4 with the highest score, which is proposed as the priority project. **Figure-3162.2** illustrates the layout of water supply system for 2008, based on the said priority project.

For the Alternative R4, it is required to install raw water transmission pipeline from Bekasi Weir to Cipayung Treatment Plan. Study and preliminary design on the raw water transmission are included in **Annex-43**.

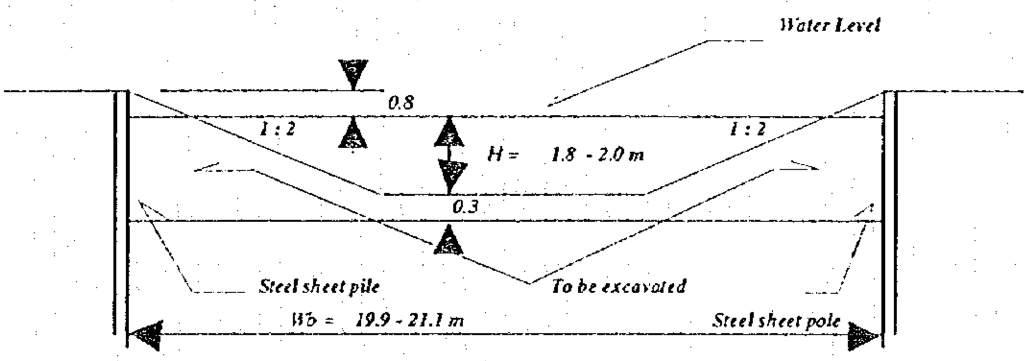
(2) Conceptional Design and Preliminary Cost Estimate for Upgrading of West Tarum Canal

The upgrading works for the West Tarum Canal in quantity aspect is composed of sheet pile driving works at both left and right shoulder of the canal and dredging and excavation works inside the canal. The said upgrading works will be required only for 2.1 km against a total length of the canal from the outlet of the existing silt trap to the Buaran intake. The typical canal sections for upgrading and other related works are shown in **Figure-433.1**. The total direct construction cost was preliminarily estimated to be US$ 11.0 million equivalent consisting of Yen 847 million (US$ 7.7 million equivalent) in foreign currency portion and Rp. 7.26 billion (US$ 3.3 million equivalent) in local currency portion as summarized below :

Table-433.1 DIRECT CONSTRUCTION COST OF UPGRADING WEST TARUM CANAL IN QUANTITY ASPECT

No.	Item	Foreign Currency (Yen 10^3)	Local Currency (Rp. 10^3)	Total (US$ 10^3)
(1)	Preparatory Works	38,500	330,000	500
(2)	Steel Sheet Piling	639,100	5,478,000	8,300
(3)	Dredging/Excavation	26,950	231,000	350
(4)	Improvement Works for Canal Crossing Structures	77,000	660,000	1,000
(5)	Miscellaneous Works	65,450	561,000	850
	Total Direct Construction Cost	**847,000**	**7,260,000**	**11,000**

Figure-433.1 UPGRADING OF WEST TARUM CANAL IN QUANTITY ASPECT



TYPICAL CROSS SECTION

NO.	ITEM
1.	**TOTAL LENGTH FOR UPGRADING BY EXPANSION OF CANAL CROSS SECTI(: 2.1 KM**
2.	**HYDRAULIC CALCULATION**
	(Discharge Capacity, Q) = (Wb) x (H) x (Flow Velocity,v)
	For minimum cross sectior : Q = 21.1 x 2.17 x 0.65 = 29.8 m^3/sec > 26.1 m^3/sec
	For maximum cross sectioi : Q = 19.9 x 2.32 x 0.66 = 30.5 m^3/sec > 26.1 m^3/sec
3.	**QUANTITY CALCULATION**
(1)	Sheet Piling : 2,100.00 / 0.40(w) x 7.50(l) x 2 nos. x 1.05 = 82,688 m say 83,000 m
(2)	Dredging/excavation : (2.80 x 2.80 x 2 + 0.3 x 2.20) x 2,100 = 34,314 m^3 say 35,000 m^3
4.	**COST ESTIMATE**

	Item	Quantity	Unit Cost (US$)	Amount (US$)
(1)	Preparatory Works	L. S.		500,000
(2)	Sheet Piling	83,000 m	100/m	8,300,000
(3)	Dredging/excavation	35,000 m^3	10/m^3	350,000
(4)	Improvement Works for Canal Crossing Structures (10 %)			1,000,000
(5)	Miscellaneous (10 %)			850,000
	TOTAL DIRECT CONSTRUCTION COST			***11,000,000***

(3) Considerations on Other Water Transmission Alternatives

The Steering Committee suggested in the meeting held on August 22, 1996 to make a study on the following water transmission alternatives for comparison with the proposed upgrading of the West Tarum Canal as above-mentioned :

Alternative I

Upgrading of West Tarum Canal for entire section with sheetpiling

Alternative II

Upgrading of West Tarum Canal for 2 km section with sheetpiling to be maximized

Alternative III

Upgrading of West Tarum Canal for entire section with concrete lining

Alternative IV

Combination of pipeline and upgrading of West Tarum Canal with sheetpiling

1) Alternatives I and II

The maximum capacity of the West Tarum Canal in the section between the Bekasi intake and Buaran intake is controlled by maximum discharge in the initial 1.5 km and the last 0.6 km sections, for which upgrading by sheetpiling and dredging is made. The said maximum discharge amounting to 29.8 m^3/sec as calculated in **Figure-433.1** is obtained under the present water level conditions, which should be maintained for reserving the required freeboard and for not affecting intake water level condition for the existing Buaran treatment plant. As the maximum discharge capacity in the upgraded sections should have an allowance in addition to the maximum supply discharge, the design capacity of the upgraded West Canal should be 26.1 m^3/sec. The canal in the middle section can divert the increased discharge of 26.1 m^3/sec without any upgrading. It can be said that any upgrading of the West Tarum Canal in the middle section having a length of about 6 km. Therefore, these two alternatives cannot be practically adopted to comparison purpose with the proposed upgrading of the West Tarum Canal.

2) Alternative III

This upgrading works require the shutting-down of the West Tarum Canal operation during the construction works and/or another temporary water conveyance from the Bekasi intake to the Buaran intake of the existing treatment plant. However, no shutting-down is allowed and no another water conveyance is practically considered. Accordingly, this upgrading is meaningless to be adopted as an alternative, though the concrete lined canal can physically produce 25 percent higher discharge capacity than the existing canal. It is concluded under the considerations for Alternatives I to III that no other practical upgrading than the proposed one is conceivable.

3) Alternative IV

The increasing capacity by combination of pipeline and upgrading of the West Tarum Canal is studied in the comprehensive evaluation of water supply facilities consisting of raw water transmission, clear water transmission and treatment plant to formulate the most attractive treatment plant location as stated in Section 4.3.3.

4.3.4 Alternative Study on Structures for Upgrading in Quality Aspect

(1) Alternatives on Structural Series

The upgrading in quality aspect is to divert the water of the West Tarum Canal in the upstream reach from the confluence with the Bekasi river directly to the existing silt trap located at the downstream portion from the Bekasi intake. For such purpose, the following three (3) alternatives with structural series as illustrated in **Figures-434.1** to **434.3** were selected for formulating the most technically and economically attractive :

Alternative I (Figure-434.1)

Intake structures consisting of forebay, gated control weir for emergency to be located before confluence with Bekasi river and gated intake weir, open channel, open channel bridge and outlet structures at entrance of existing silt trap

Alternative II (Figure-434.2)

Intake structures consisting of forebay, gated control weir for emergency to be located before confluence with Bekasi river and gated intake weir, syphon and outlet structures at entrance of existing silt trap

Alternative III (Figure-434.3)

Intake structures consisting of forebay and gated control weir for emergency to be located before confluence with Bekasi river, pumping equipment, pipe bridge and outlet structure at entrance of existing silt trap

Preliminary Evaluation

The following three (3) items were initially adopted for the preliminary evaluation for screening for further evaluation :

1) Availability of required land for construction
2) Affected items due to land acquisition
3) Necessity for resettlement of local residents

Alternative I

As for Alternative I, it requires land with 40 meters wide from the confluence of the West Tarum Canal with the Bekasi river to the existing road bridge along the river as right-of-way for construction of rectangular open channel. The land with 10 meters wide along the Bekasi river is available and remaining 30 meters, which has the relatively densely populated urban area having more than 40 numbers of owned houses by the local residents, should be acquired for this construction. The said conditions will result that local regidents affected by the construction of structures are obliged to move to new land with housing construction. Considering such future situation, the structures construction in this area may encountered some difficulty to acquire the land with resettlement, which may cause delay of its implementation. In addition, the most important factor for this construction is to involve closure of public traffic on the existing road during construction period, unless detour is provided, since the open cannel is constructed crossing the said road at two points as shown in **Figure-434.1**. However, it is noted for this condition that a possibility to provide the detour is only to construct another temporary bridge downstream from the existing bridge. Such additional construction surely arise further land acquisition with resettlement and additional construction cost. Under the above-mentioned unfavorable future conditions and situation, it is concluded that Alternative I is deleted from further evaluation.

Alternatives II and III

While, as for Alternatives II and III, the required land for construction is available within the related land to the West Tarum Canal. In case of Alternative II, the inlet

Figure-434.1 ALTERNATIVE PLANS FOR UPGRADING OF WEST TARUM CANAL IN QUALITY ASPECT ALTERNATIVE II, WATERWAY BRIDGE PLAN

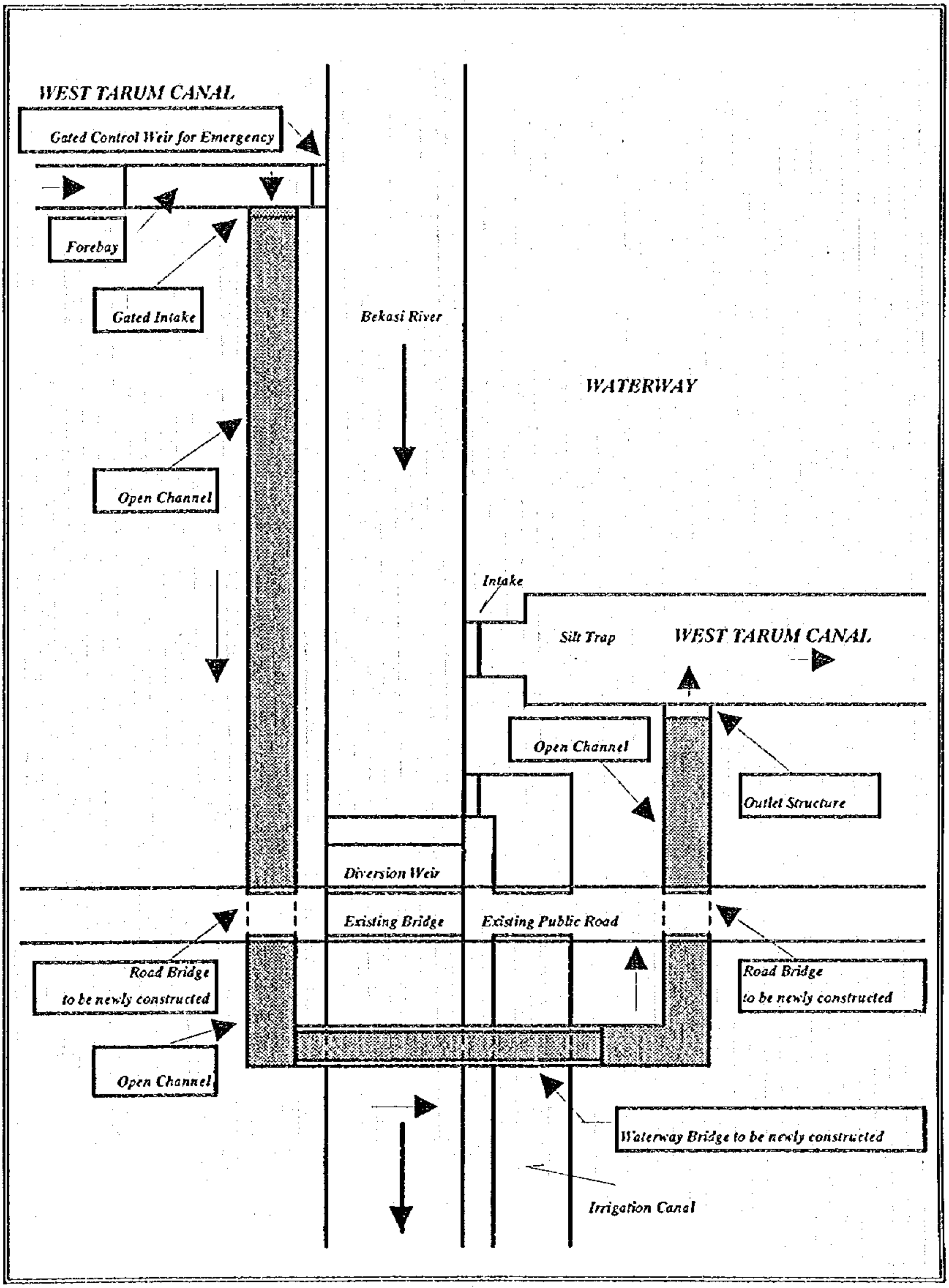


Figure-434.2 ALTERNATIVE PLANS FOR UPGRADING OF WEST TARUM CANAL IN QUALITY ASPECT ALTERNATIVE II, SYPHON PLAN

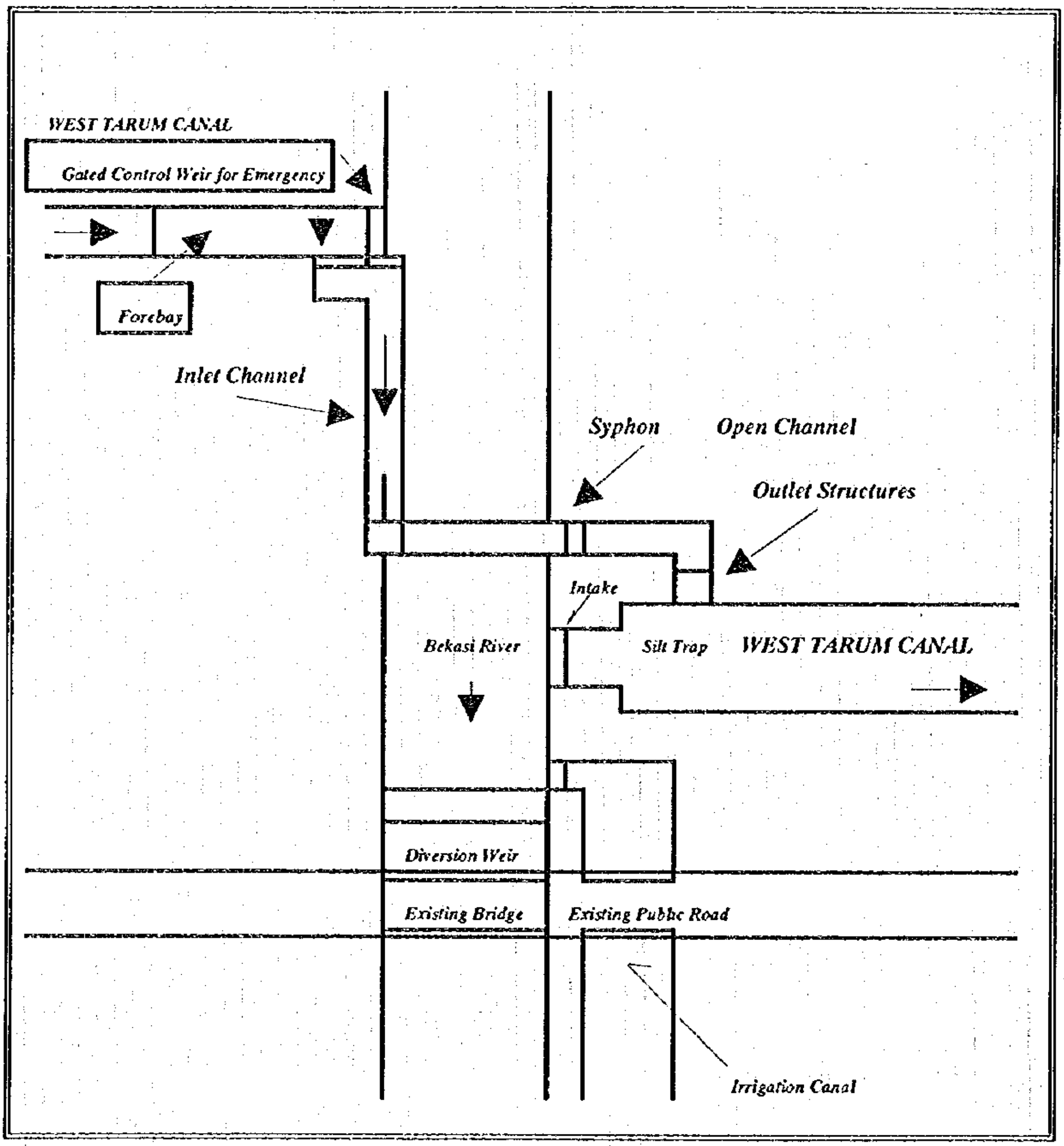
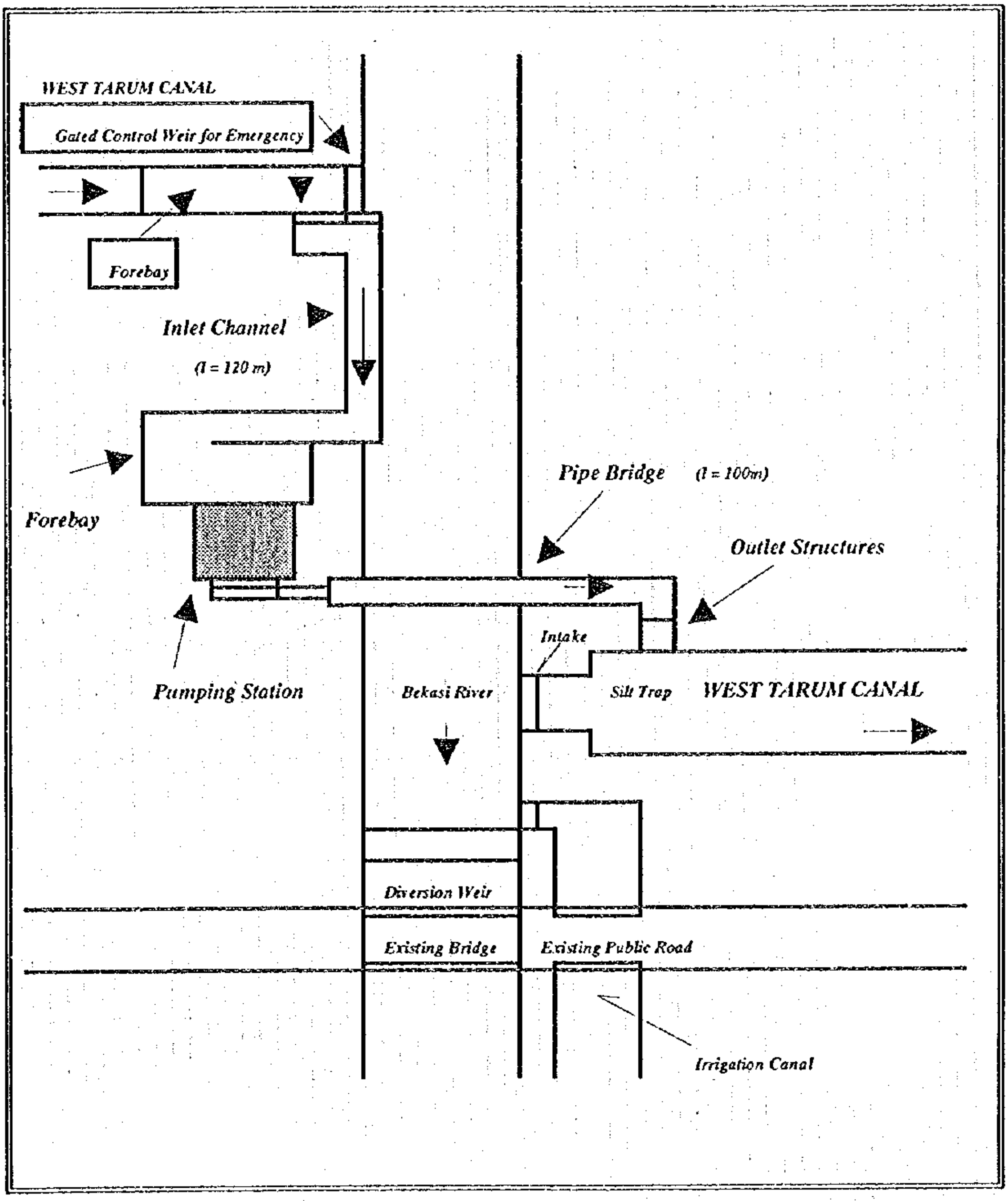


Figure-434.3 ALTERNATIVE PLANS FOR UPGRADING OF WEST TARUM CANAL IN QUALITY ASPECT ALTERNATIVE III, PIPE BRIDGE PLAN



structures is located within the existing service road and inside the river course, where temporary coffering with dewatering is provided for construction purpose and the outlet structures can be constructed in the land available in the left bank of the Bekasi river. As for Alternative III, the construction works for laying pipeline, bridge crossing the Bekasi river and outlet structures can be made in the available land. Therefore, selection of Alternatives II and III does not cause any disturbance and/or problem for public traffic and present operation of the West Tarum Canal. In such conditions, it is resulted that Alternatives II and III are proceeded to make further evaluation.

Final Evaluation

The final evaluation to select more technically and economically favorable structural series between Alternatives II and III took the two (2) steps : 1) Comparison in technical aspects and 2) Comparison in direct construction cost aspect as stated below :

Step I : Comparison in Technical Aspects

1) Construction methodology

Alternative II

Syphon structure consisting of inclined shafts for inlet and outlet portions and horizontal culvert portion as shown in **Figure-434.2** is of quite common type in the civil structures. For construction of the structure in the Bekasi river course, a cofferdam is constructed surrounding the structure to make dry condition with continuos dewatering. Such construction methodology is also commonly applied for like this construction without any complicated construction sequence and method. Under this considerations, it is concluded that the construction of siphon structure is proceeded to be compared with that of pipe bridge structures in cost aspect

Alternative III

There is no difficulty in construction methodology aspect for pipe bridge as quite common structure, because all works can be made in open air condition.

2) Operation and Maintenance

Alternative II

The siphon structure is usually designed under a hydraulic conditions with 2 to 3 m/sec of inside flow velocity, which produce higher washing energy than the design sediment load. Such design condition will eliminate frequent maintenance of the structure, especially inside cleaning. In addition, there is no other special operation and maintenance item for this structure. Therefore, this structure has no substantial problem in operation and maintenance aspect to reject it from this comparison.

Alternative III

The maintenance for this structure and pumping equipment is quite common to periodically make it with very short time duration, which will not cause adverse conditions for normal operation. During the periodical maintenance, the water of the West Tarum Canal is to be temporarily released through the gated control weir for emergency located at just upstream portion from the confluence with the Bekasi river and the water temporarily released to the Bekasi river course is to be taken through the existing intake to the silt trap.

3) Initial Conclusion

In the above-mentioned conditions and consideration, it is concluded to proceed the final evaluation for the two (2) alternatives in cost aspect.

Step II : Comparison in Direct Construction Cost Aspect

The cost estimate for the two (2) Alternatives was made in **Tables-434.1** and **434.2** as summarized below :

(Unit : US$ 10^5)

		Alternative II "Siphon Plan"	Alternative III Pipe Bridge Plan
1.	Civil Works	7,210	21,000
2.	Metal Works	1,250	14,700
	Total Direct Construction Cost	8,460	35,700

From the above comparison, it is quite distinct that Alternative II, which gives the much less direct construction cost than Alternative III, is the most attractive construction plan for upgrading of West Tarum Canal in quality aspect.

(2) Conceptional Design of Structures and Cost Estimate

Conceptional Design

As mentioned in preceding **Section 4.3.4**, the proposed plan on structural series for crossing the Bekasi river has the following structures :

1) Intake structures
   i) Forebay, ii) Gated intake, ii) Gated Control Weir for Emergency
2) Inlet open channel
3) Syphon

4) Outlet open channel
5) Outlet Structure

In the Intake structures, the Forebay having a length of 200 m is constructed by driving sheet piles on the shoulders in both the left and right banks and by making dredging the portion inside the driven sheet piles. The Gated control weir for emergency with a flow capacity of 32 m^3/sec to be located at just upstream portion from the confluence of the West Tarum Canal with the Bekasi river is used during closing of syphon and as spillway for control the water level of the Forebay. In case of closing of the syphon, the existing intake is used by opening the gates for taking water for the West Tarum Canal in order to maintain continuos water supply for the DKI Jakarta system. The intake structure equipped with three (3) gates is located at the left bank portion of the Forebay just upstream from the Gated control weir.

The syphon structure consists of inlet open channel, syphon and outlet open channel. The Outlet structure having concrete wing walls and slab in the bottom portion is constructed in the existing Silt trap.

The conceptional design for the structures is exhibited in **Figure-434.4**.

<u>**Preliminary Cost Estimate**</u>

The preliminary cost estimate was made in **Table-434.1**, based on the rough work quantities under the conceptional design of the structures.

4.3.5 Proposed Scope of Upgrading Works

The following are the proposed scope of upgrading works as summarized :

(1) Upgrading Works, in quantity aspect, for expansion of canal cross section for 2.1 km
1) Preparatory works
2) Sheet piling at shoulders on both left and right banks
3) Dredging/excavation inside canal
4) Improvement work for crossing structures such as road bridges, etc.

Table-434.1 COST ESTIMATE
ALTERNATIVE III, SIPHON PLAN

ITEM NO.	WORK ITEM	AMOUNT (US$)
1.	CIVIL WORKS	7,210,000
1.1	Coffering & Dewatering	1,600,000
1.2	Forebay	500,000
1.3	Gated Control Weir for Emergency	110,000
1.4	Inlet Channel	2,300,000
1.5	Siphon	2,100,000
1.6	Outlet Channel & Outlet Structures	600,000
2.	METAL WORKS	1,250,000
2.1	Gated Control Weir for Emergency	350,000
2.2	Intake	350,000
2.3	Siphon	200,000
2.4	Outlet Structures	350,000
	TOTAL CONSTRUCTION COST	*8,460,000*

Table-434.2 COST ESTIMATE
ALTERNATIVE III, PIPE BRIDGE PLAN

ITEM NO.	WORK ITEM	AMOUNT (US$)
1.	CIVIL WORKS	21,000,000
(1)	Forebay	500,000
(2)	Gated Control Weir for Emergency	200,000
(3)	Inlet Channel	4,500,000
(4)	Forebay for Pumping Station	2,000,000
(5)	Pumping House	7,300,000
(6)	Pipe Bridge	5,500,000
(7)	Outlet Channel	1,000,000
2.	METAL WORKS AND HYDROMECHANICAL & HYDROELECTRICAL WORKS	14,700,000
(1)	Gate Control Weir for Emergency	600,000
(2)	Intake	400,000
(3)	Pumping Station	8,300,000
(4)	*Pipeline*	*5,000,000*
(5)	Outlet Structures	400,000
	TOTAL CONSTRUCTION COST	*35,700,000*

(2) Upgrading Works, in quality aspect, on construction of structures for crossing the Bekasi river

Civil Works

1) Coffering
2) Forebay
3) Gated Control Weir
4) Gated intake structure
5) Inlet Channel
6) Siphon
7) Outlet Channel
8) Outlet structure

Metal Works

1) Gates
2) Stoplogs
3) Steel Structures

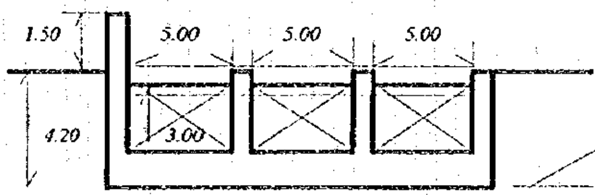
Table-434.3 DIRECT CONSTRUCTION COST UPGRADING WORKS IN QUALITY ASPECT

No.	Item	Foreign Currency (Yen 10^3)	Local Currency (Rp. 10^3)	Total (US\$ 10^3)
1.	Civil Works	555,170	4,758,600	7,210
(1)	Coffering & Dewatering	123,200	1,056,000	1,600
(2)	Forebay	38,500	330,000	500
(3)	Gated Control Weir for Emergency	8,470	72,600	110
(4)	Inlet Channel	177,100	1,518,000	2,300
(5)	Siphon	161,700	1,386,000	2,100
(6)	Outlet Channel & Outlet Structures	46,200	396,000	600
2.	Metal Works	96,250	825,000	1,250
(1)	Gated Control Weir for Emergency	26,950	231,000	350
(2)	Intake	26,950	231,000	350
(3)	Siphon	15,400	132,000	200
(4)	Outlet Structures	26,950	231,000	350
	Total Direct Construction Cost	**651,420**	**5,583,600**	**8,460**

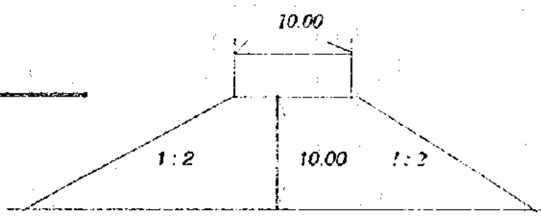
Figure-434.4 CONCEPTIONAL DESIGN OF UPGRADING OF WEST TARUM CANAL IN QUALITY ASPECT

NO.	ITEM

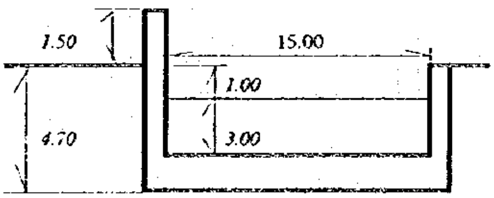
Structural Dimensions



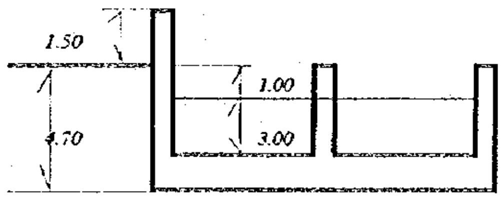
Cross Section of Intake Weir
Upstream View



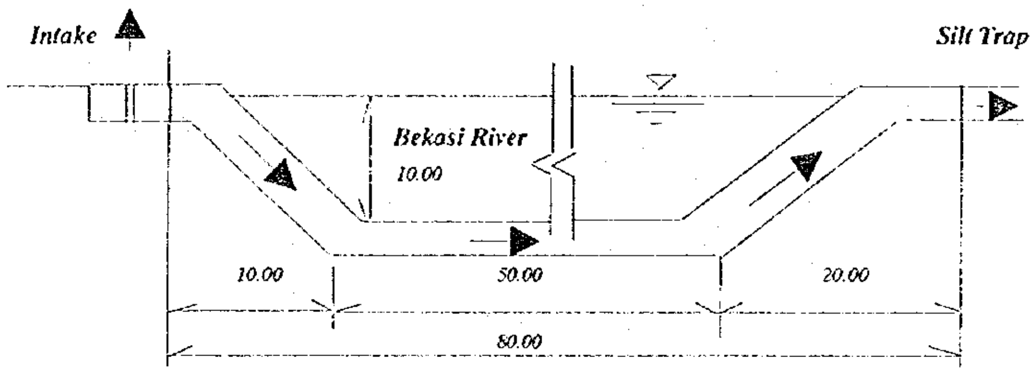
Cross Section of Coffer Dam



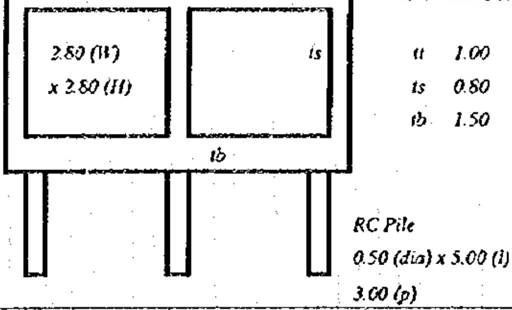
Cross Section of Inlet Open Channel
Upstream View



Cross Section of Syphon Inlet
Upstream View



Cross Section
Downstream View



4.3.6 Economic Evaluation

(1) Project Benefits

The benefits derived from the Project consist of : 1) Demand benefit selling water, and 2) Incremental quality benefit saving additional treatment plant cost and treatment cost (operation and maintenance cost).

As the demand benefit, the raw water cost in the Jakarta water supply system, which was calculated in the Master Plan Study, was adopted for this evaluation. The raw water cost varies from Rp. 25/m^3 in 2002 to Rp. 83/m^3 in 2019 as shown below :

Year	2002 - 2008	2009 - 2015	2016 - 2018	2019 -
Raw Water Cost (Rp. /m^3)	25	50	75	83

The total demand benefit was calculated on the basis of the said raw water price multiplied by water demand.

Table-436.1 ANNUAL DEMAND BENEFIT

Year	2002	2003	2004	2005	2006	2007	2008	2009 - 2015	2016 - 2018	2019 - 2047
Water Demand (m^3/sec)	0.55	1.54	2.53	3.52	5.37	7.23	9.08	10.00	10.00	10.00
Annual Benefit (Rp. 10^6)	434	1,214	1,995	2,775	4,234	5,700	7,159	15,768	23,652	26,175
Annual Benefit (US$ 10^3)	189	528	867	1,207	1,841	2,478	3,112	6,856	10,283	11,380

The incremental quality benefit is defined as the second alternative cost consisting of the construction cost of additional testament plant and treatment cost (operation and maintenance cost), in case that upgrading structures are not constructed. The construction cost of additional treatment plant with a capacity of 26.1 m^3/sec was estimated to be US$ 2.3 to 3.86 million, based on the actual cost data and information in Japan, and US$ 3.1 million as an average value was adopted for estimating the incremental quality benefit. While the unit treatment cost was assumed to be US$ 0.051 per m^3. The details for the said cost estimate is made in ANNEX. The following are the annual incremental quality benefit flow :

Table-436.2 ANNUAL INCREMENTAL QUALITY BENEFIT

Year	2002	2003	2004	2005	2006	2007	2008	2009 - 2051
Water Demand (m^3/sec)	16.65	17.64	18.63	19.62	21.47	23.33	25.18	26.10
Annual Benefit (O & M) (US$ 10^3)	0	0	29,963	31,556	34,531	37,522	40,498	41,978
Annual Benefit (Construction Cost) (US$ 10^3)	0	3,000	0	0	0	0	0	0
Total Annual Benefit (US$ 10^3)	**0**	**3,000**	**29,963**	**31,556**	**34,531**	**37,522**	**40,498**	**41,978**

Based on the benefits as calculated in **Table-436.1** and 436.2, the total annual benefit for each year is obtained as follows :

Table-436.3 TOTAL ANNUAL BENEFIT

(Unit : US$ 10^3)

Year	2002	2003	2004	2005	2006	2007	2008	2009 - 2015	2016 - 2018	2019 - 2047
Demand Benefit	189	528	867	1,207	1,841	2,478	3,112	6,856	10,283	11,380
Quality Benefit	0	3,000	29,963	31,556	34,531	37,522	40,498	41,978	41,978	41,978
Total Annual Benefit	**189**	**3,528**	**30,830**	**32,763**	**36,372**	**40,000**	**43,610**	**48,834**	**52,261**	**53,358**

(2) Financial Construction Cost

Based on the preliminary cost estimate as mentioned in **Section 4.3.4**, the financial project cost was estimated as given in **Table-436.5** and the following is its summary :

Table-436.4 FINANCIAL CONSTRUCTION COST

No.	Item	Foreign Currency (Yen 10³)	Local Currency (Rp. 10³)	Total (US$ 10³)
1.	Basic Cost	1,998,420	22,953,600	28,630
	(1) Direct Construction Cost	1,498,420	12,843,600	19,460
	Upgrading in Quantity Aspect	847,000	7,260,000	11,000
	Upgrading in Quality Aspect	651,420	5,583,600	8,460
	(2) Engineering Services	500,000	1,400,000	5,200
	(3) Government Administration	0	2,570,000	1,170
	(4) Compensation Cost	0	1,000,000	460
	(5) Tax	0	5,140,000	2,340
2.	Contingency	525,000	4,500,000	6,830
	(1) Physical Contingency	225,000	1,930,000	2,930
	(2) Price Escalation	300,000	2,570,000	3,900
3.	Interest during Construction	226,580	1,946,400	2,930
	Total Financial Project Cost	**2,50,000** *US$ 25,000 equivalent*	**29,400,000** *US$ 13,390 equivalent*	**38,390**

(3) Economic Construction Cost

To evaluate the proposed water resources development schemes from the economic aspects, the financial costs was converted into economic costs by foreign and local currency portions deducting such transfer costs as income tax, contractor's profit and so on. Also, it considered some parameters as shadow wage rate, and shadow prices of equipment and materials both in foreign and local currency portions. The following are the description on the respective items, which was applied in the "The Study on Ciujung-Cidurian Integrated Water Resources in Indonesia"

Table-436.5 SUMMARY OF FINANCIAL COST ESTIMATE FOR UPGRADING WORKS OF WEST TARUM CANAL (1/2)

ITEM NO.	ITEM	FOREIGN CURRENCY (Yen 10^3)	LOCAL CURRENCY (Rp. 10^3)	TOTAL (US$ 10^3)
I.	BASIC COST	1,998,420	22,953,600	28,630
1.	DIRECT CONSTRUCTION COST	1,498,420	12,843,600	19,460
1.1	UPGRADING WORKS IN QUANTITY ASPECT	847,000	7,260,000	11,000
	(1) Preparatory Works	38,500	330,000	500
	(2) Sheet Piling	639,100	5,478,000	8,300
	(3) Dredging/Excavation	26,950	231,000	350
	(4) Improvement Works for Canal Crossing Structures	77,000	660,000	1,000
	(5) Miscellaneous Works	65,450	561,000	850
	Total for 1.1	847,000	7,260,000	11,000
1.2	UPGRADING WORKS IN QUALITY ASPECT	651,420	5,583,600	8,460
1.2.1	Civil Works			
	(1) Coffering & Dewatering	123,200	1,056,000	1,600
	(2) Forebay	38,500	330,000	500
	(3) Gated Control Weir for Emergency	8,470	72,600	110
	(4) Inlet Channel	177,100	1,518,000	2,300
	(5) Siphon	161,700	1,386,000	2,100
	(6) Outlet Channel & Outlet Structures	46,200	396,000	600
	Total for 1.2.1	555,170	4,758,600	7,210
1.2.2	Metal Works			
	(1) Gated Control Weir for Emergency	26,950	231,000	350
	(2) Intake	26,950	231,000	350
	(3) Siphon	15,400	132,000	200
	(4) Outlet Structures	26,950	231,000	350
	Total for 1.2.2	96,250	825,000	1,250
2.	ENGINEERING SERVICES	500,000	1,400,000	5,200
3.	ADMINISTRATION	0	2,570,000	1,170

Table-436.5 SUMMARY OF FINANCIAL COST ESTIMATE FOR UPGRADING WORKS OF WEST TARUM CANAL (2/2)

ITEM NO.	ITEM	FOREIGN CURRENCY (Yen 10^3)	LOCAL CURRENCY (Rp. 10^3)	TOTAL (US$ 10^3)
4.	COMPENSATION COST	0	1,000,000	460
5.	TAX (PPN)	0	5,140,000	2,340
II.	CONTINGENCY	525,000	4,500,000	6,830
1.	Physical Contingency (15 % of Direct Construction Cost)	225,000	1,930,000	2,930
2.	Price Escalation (20 % of Direct Construction Cost)	300,000	2,570,000	3,900
III.	INTEREST DURING CONSTRUCTION (15 % Of Direct Construction Cost)	226,580	1,946,400	2,930
	TOTAL FINANCIAL COST	2,750,000	29,400,000	38,390
	US$ equivalent	25,000	13,390	

Internal Transfer Cost

Internal transfer, which is just a shift of money from one party to another and is not related with substantial economic activities, should be excluded in converting the financial construction cost to economic cost of the project. Such transfer costs as value added tax (PPN in local term) and contractor's profit are exempted from the financial costs.

Shadow Wage Rate

Labor costs sharing with certain rate are estimated on the basis of wages to be actually paid to labors to be converted to economic costs. This economic cost for labors depends on its shadow wage of unskilled labors employed for the constructions works. The shadow wage rate is assumed to be 75 percent of the actual market wage taking into account of the employment opportunity of labors in Indonesia. In this case, the share rates of skilled and unskilled labor costs to the total labor cost are assumed to be 30 percent and 70 percent respectively. The following are the proportions for each cost in the direct construction cost :

Labor : 10 %   Equipment : 50 %   Materials : 40 %

Shadow Price of Equipment and Materials

As a conversion factor, a shadow price rate of local currency portion to be applied for local commodities is assumed to be 0.968 based on export and import statistics in recent years. While the shadow price rate of 1.000 for foreign currency portion is applied because that those are border prices.

Land and House Compensation Cost

Regarding compensation , the following matters to be sacrificed are considered as economic cost from the economic point of view ; a) in case of farm land, annual production value is taken as negative benefit, and b) in case of residents, prices to be newly built are applied as economic compensation cost.

Contingency

Price escalation is excluded from the financial costs, while physical contingency is included in the economic costs. In this case, average allocation rate of labor, equipment and materials to the total cost were applied for converting to the economic cost. Interest of the loan should be exempted for the economic evaluation.

The economic project cost was obtained by deducting the costs as above-mentioned from the financial project cost as summarized below :

Table-436.6 ECONOMIC CONSTRUCTION COST

No.	Item	Total (US$ 10^3)
1.	Basic Cost	24,870
	(1) Direct Construction Cost	18,040
	(1.00 - 0.1 x 0.7 x 0.75 - 0.9 x 0.7 x 0.032 = 0.9271)	
	(2) Engineering Services	5,200
	(3) Government Administration	1,170
	(4) Compensation Cost	460
2.	Contingency	2,930
3.	Interest during Construction	2,930
	Total Economic Construction cost	**30,730**

(4) Annual Allocation of Economic Cost

The annual allocation of economic cost is made for the annual disbursement for economic construction cost and operation and maintenance cost.

The following are the annual fund requirement for economic construction cost assuming pre-construction stage for one year and half and the construction period for three years and half :

Year	Proportion (%)	Annual Fund Requirement (US$ 10^3)
1999	5	1,540
2000	10	3,070
2001	20	6,150
2002	35	10,760
2003	30	9,210
Total	**100**	**30,730**

The annual operation and maintenance cost of the Wets Tarum Canal was assumed as follows :

For existing facilities for additional 10 m^3/sec :

Rp. 25/m^3 x 0.4 x 10 m^3/sec x 3,600 sec x 24 hrs. x 365 days / Rp. 2,300/US$
= US$ 1.4 million

where,

Rp. 25/m^3 : Water tariff
0.4 : Additional O & M cost factor
(Original O& M factor : 0.8)

For new facilities :

(Total economic cost) x 0.005 = US$ 30.73 million x 0.005 = US$ 0.2 million

Total annual O & M cost : US$ 1.6 million

(5) Economic Evaluation

Economic evaluation of projects is generally made by comparison of benefit and cost. The economic evaluation was demonstrated by calculating Economic Internal Rate of Return (EIRR), Net Present Value (B-C) and Benefit-Cost Ratio (B/C). The stream of economic cost and benefit is shown in **Table-436.7.**

Under the above stream of economic cost and benefit, the following indicators for economic evaluation were obtained as shown in **Table-436.7**

1) Economic Internal Rate of Return (EIRR) : 56 %

2) Net Present Value (B-C)	:	US$ 161.254 million (Discount Rate : 12 %)	US$ 41.755 million (Discount Rate : 22 %)
3) Befit-Cost Ratio (B/C)	:	7.07 (Discount Rate : 12 %)	3.69 (Discount Rate : 22 %)

It is easily seen from the above indicators that the benefit exceeds the cost under the discount rate of 12 % and that the value of EIRR is extremely high. It is said from the viewpoint of the above indicators that this upgrading works is economically feasible.

4.3.7 Implementation Program

Prior to the consultancy services on preparation of the required reports and documents, an executive governmental agency should prepare a "*Project Implementation Program*" as the project justification for its implementation, for financial arrangement for consultancy services cost and construction cost.

It is recommended that this report is taken up as the pre-feasibility study for financial arrangement for international financing agency. The project feasibility to justify the said pre-feasibility study shall be made in the following definite study.

For implementing the said upgrading works, the cosultancy services consisting mainly of the following scope of works should be performed by consultant and the Terms of Reference is shown as follows :

(1) Preparation of Design Report

1) Field investigation in detailed design level consisting of topographic survey, geotechnical survey, foundation and material survey
2) Definite study on future water availability of additional discharge from West Tarum Canal
3) Assistance to governmental agency on undertaking Environmental Impact Assessment
4) Detailed design of structures for upgrading
5) Construction Plan
6) Cost Estimate
7) Technical viability studies and economic and financial feasibility studies

Table-436.7 STREAM OF ECONOMIC COST AND BENEFIT

(Discount Rate : 12 %)

Year Order	Year	Cost			Benefit			Cash Balance
		Construction Cost	O&M Cost	Total	Demand Benefit	Quality Benefit	Total	
0	1998	0		0			0	0
1	1999	1,540		1,540			0	-1,540
2	2000	3,070		3,070			0	-3,070
3	2001	6,150		6,150			0	-6,150
4	2002	10,760	1,600	12,360	189	0	189	-12,171
5	2003	9,210	1,600	10,810	528	3,000	3,528	-7,282
6	2004		1,600	1,600	867	29,963	30,830	29,230
7	2005		1,600	1,600	1,207	31,556	32,763	31,163
8	2006		1,600	1,600	1,841	34,531	36,372	34,772
9	2007		1,600	1,600	2,478	37,522	40,000	38,400
10	2008		1,600	1,600	3,112	40,498	43,610	42,010
11	2009		1,600	1,600	6,856	41,978	48,834	47,234
12	2010		1,600	1,600	6,856	41,978	48,834	47,234
13	2011		1,600	1,600	6,856	41,978	48,834	47,234
14	2012		1,600	1,600	6,856	41,978	48,834	47,234
15	2013		1,600	1,600	6,856	41,978	48,834	47,234
16	2014		1,600	1,600	6,856	41,978	48,834	47,234
17	2015		1,600	1,600	6,856	41,978	48,834	47,234
18	2016		1,600	1,600	10,283	41,978	52,261	50,661
19	2017		1,600	1,600	10,283	41,978	52,261	50,661
20	2018		1,600	1,600	10,283	41,978	52,261	50,661
21	2019		1,600	1,600	11,380	41,978	53,358	51,758
22	2020		1,600	1,600	11,380	41,978	53,358	51,758
23	2021		1,600	1,600	11,380	41,978	53,358	51,758
24	2022		1,600	1,600	11,380	41,978	53,358	51,758
25	2023		1,600	1,600	11,380	41,978	53,358	51,758
26	2024		1,600	1,600	11,380	41,978	53,358	51,758
27	2025		1,600	1,600	11,380	41,978	53,358	51,758
28	2026		1,600	1,600	11,380	41,978	53,358	51,758
29	2027		1,600	1,600	11,380	41,978	53,358	51,758
30	2028		1,600	1,600	11,380	41,978	53,358	51,758
31	2029		1,600	1,600	11,380	41,978	53,358	51,758
32	2030		1,600	1,600	11,380	41,978	53,358	51,758
33	2031		1,600	1,600	11,380	41,978	53,358	51,758
34	2032		1,600	1,600	11,380	41,978	53,358	51,758
35	2033		1,600	1,600	11,380	41,978	53,358	51,758
36	2034		1,600	1,600	11,380	41,978	53,358	51,758
37	2035		1,600	1,600	11,380	41,978	53,358	51,758
38	2036		1,600	1,600	11,380	41,978	53,358	51,758
39	2037		1,600	1,600	11,380	41,978	53,358	51,758
40	2038		1,600	1,600	11,380	41,978	53,358	51,758
41	2039		1,600	1,600	11,380	41,978	53,358	51,758
42	2040		1,600	1,600	11,380	41,978	53,358	51,758
43	2041		1,600	1,600	11,380	41,978	53,358	51,758
44	2042		1,600	1,600	11,380	41,978	53,358	51,758
45	2043		1,600	1,600	11,380	41,978	53,358	51,758
46	2044		1,600	1,600	11,380	41,978	53,358	51,758
47	2045		1,600	1,600	11,380	41,978	53,358	51,758
48	2046		1,600	1,600	11,380	41,978	53,358	51,758
49	2047		1,600	1,600	11,380	41,978	53,358	51,758
50	2048		1,600	1,600	11,380	41,978	53,358	51,758
Total		30,730	75,200	105,930	430,463	1,856,190	2,286,653	2,180,723
Present Value at 12 % :				26,525			187,779	161,254
Economic Internal Rate of Return (EIRR) :							55.45%	

Table-436.7 STREAM OF ECONOMIC COST AND BENEFIT

(Discount Rate : 22 %)

Year Order	Year	Cost			Benefit			Cash Balance
		Construction Cost	O&M Cost	Total	Demand Benefit	Quality Benefit	Total	
0	1998	0		0			0	0
1	1999	1,540		1,540			0	-1,540
2	2000	3,070		3,070			0	-3,070
3	2001	6,150		6,150			0	-6,150
4	2002	10,760	1,600	12,360	189	0	189	-12,171
5	2003	9,210	1,600	10,810	528	3,000	3,528	-7,282
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49	2047		1,600	1,600	11,380	41,978	53,358	51,758
50	2048		1,600	1,600	11,380	41,978	53,358	51,758
Total		30,730	75,200	105,930	430,463	1,856,190	2,286,653	2,180,723
Present Value at 12 % :				15,558			57,334	41,775
Economic Internal Rate of Return (EIRR) :							55.45%	

(2) Preparation of Tender Documents

(3) Assistance Works on Tender Procedures and Contracting

(4) Construction Supervision

The following procedures and actions including the above items with the required period are taken for implementation of the Upgrading Works Project as shown in **Figure-437.1** :

(1) Financial Arrangement for Environmental Impact Assessment Study, Definite Study and Construction Cost
: Two (2) years

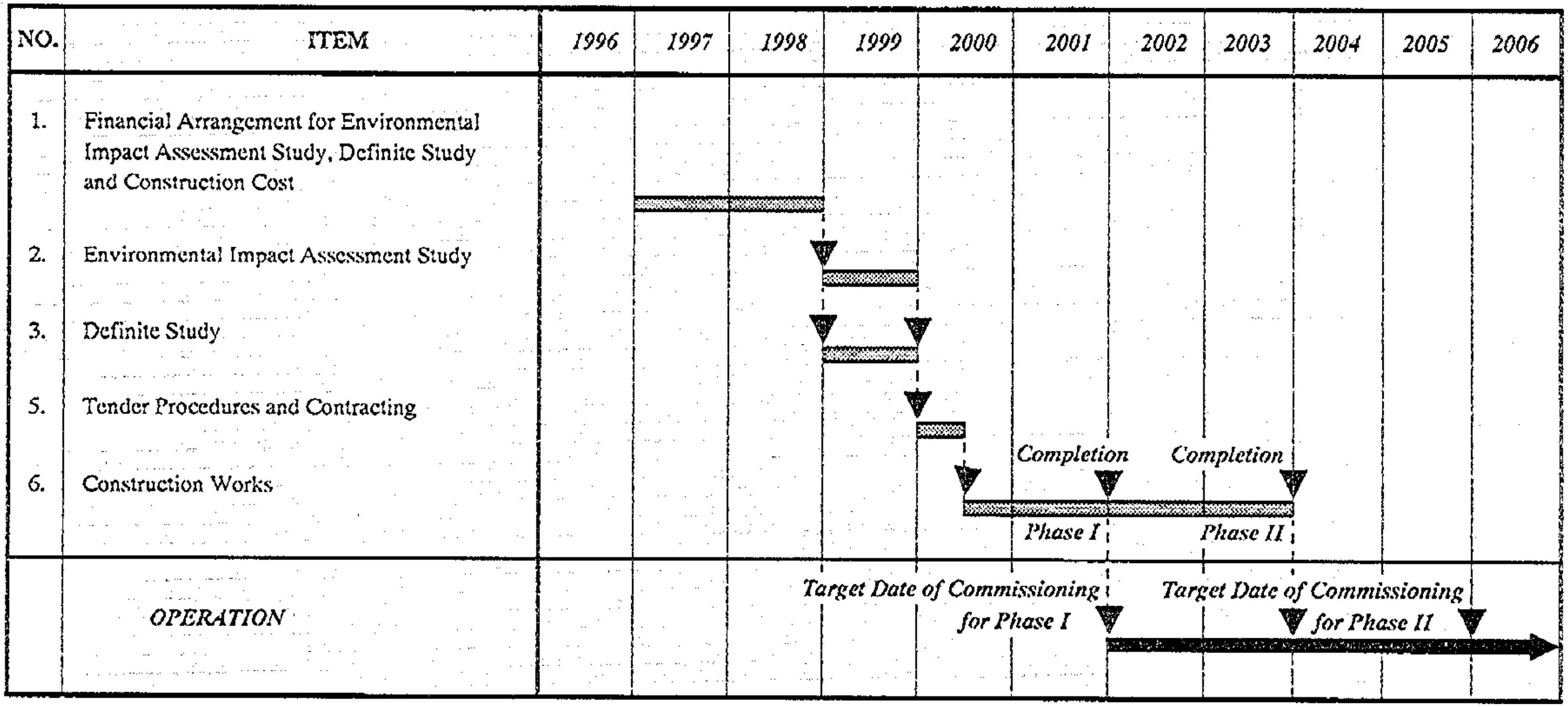
(2) Environmental Impact Assessment Study
One (1) year

(3) Definite Study consisting of Preparation of Design Report and Tender Documents
: One (1) year

(4) Tender Procedures and Contracting
: One (0.5) year

(5) Construction Works
: One and half (1.5) years for Phase I
Two (2) years for Phase II

Figure-437.1 TENTATIVE IMPLEMENTATION SCHEDULE ON UPGRADING PROJECT OF WEST TARUM CANAL



4.4 TREATMENT FACILITIES

4.4.1 Planning Concept

Under the priority projects, two treatment plants will be constructed, namely;

Buaran III Treatment Plant :	Capacity 5,000 l/sec, and
Cipayung Testament Plant :	Capacity 5,000 l/sec.

Location of these treatment plants are shown on **Figure-441.1**

For design of the new treatment plant, following concepts were taken into account:

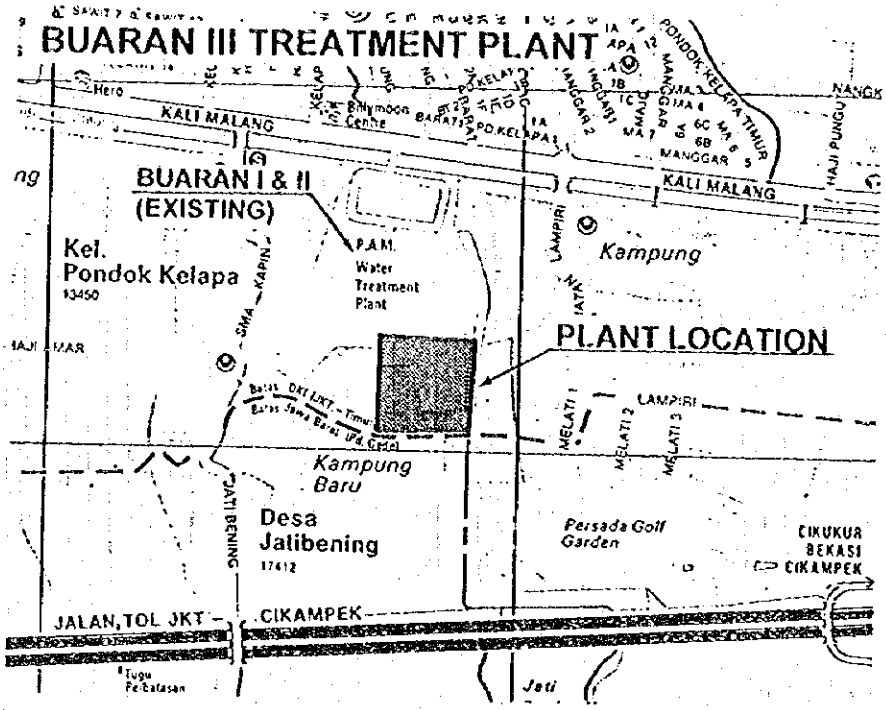
- Easy operation and maintenance
- Reduction of treatment plant loss
- Conforming to the existing facilities to be able to establish united system, for Buaran III
- Considering future expansion, for Cipayung
- Matching topographical and geographical condition

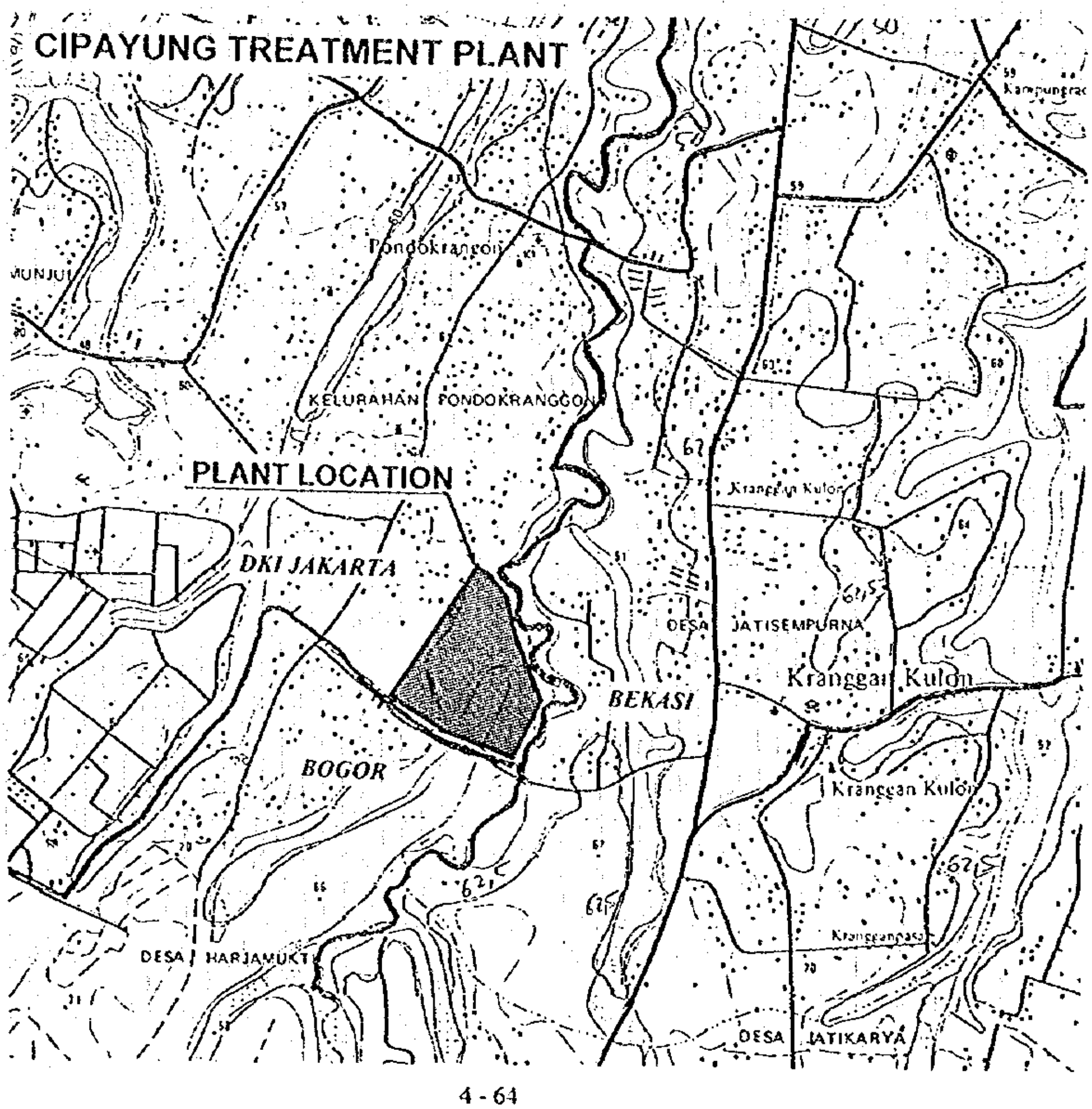
Because of nature of raw water from dam lake, fluctuation of raw water quality may be small and sudden quality change will not be foreseen. Under the circumstance, operation of the plants will be stable and constant, therefore, treatment system should be designed as simple system which will not require skilled or special know-how or control.

To reduce treatment plant loss, it should be considered to return backwash water from filter basin which is the major portion of the plant loss to intake or receiving well. Sludge treatment plant will be required in future to protect environment around the plants. Supernatant of sludge thickener which will be a part of sludge treatment plant in future, will not be recommended to return to intake or receiving well to avoid too complicated plant operation.

It is recommended to arrange or include land space required for the future sludge treatment plant when land for the treatment plant is acquired.

Figure-441.1 LOCATION OF TREATMENT PLANTS





4.4.2 Raw Water Quality.

Raw water source for both two new treatment plants will be taken from WTC. To improve raw water quality of the WTC, isolation works of the WTC from Bekasi River will be implemented in near future. Detail information about the isolation works are available in **Section 4.3 "PRELIMINARY STUDY ON RAW WATER SOURCE"**.

Although water sources for the new treatment plants, from WTC, is same as for the existing treatment plants, raw water quality will be different from existing condition because of implementation of the isolation works mentioned above.

Raw water for Buaran III Treatment Plants will be taken from the WTC directly. On the other hand, for Cipayung Treatment Plant, raw water will be conveyed from silt trap at Bekasi to the Plant through raw water transmission pipeline of which length will be about 20 km. In a strict sense, raw water quality for Buaran III and Cipayung might be different because of occurrence of oxidation reaction in the raw water transmission pipeline to Cipayung. Since the quality difference will be very small and quality change will shift to safer side, raw water quality for both treatment plants are assumed to be same.

4.4.3 Treatment Process

Discussions on treatment process are described in **Section 4.2 "Water Quality Improvement"**. In the Section, it is recommended to employ conventional treatment process which consists of flocculation, sedimentation, and filtration.

4.4.4 Design Criteria

In this section, design criteria for each facilities are described as a basis of preliminary design. Exact figures to be employed should be decided taking account of operational condition of existing Buaran WTP.

(1) Flow Rate

Calculation of capacities and dimensions of treatment facilities should be based on the quantity of Day-Maximum Water Demand.

In a strict sense, treatment flow rate will be bigger than intake flow rate because backwash water will be returned to the intake or mixing well. However, for preliminary design, intake flow rate and treatment flow rate are assumed to be same, since each facility has some allowance capacity. Actual production rate will be bigger than nominal production rate when the backwash water is returned.

Basic flow rates for two new treatment plants, Buaran III and Cipayung, are as follows:

Intake flow rate :	5,250 l/sec (105 % of Day Maximum Water Demand)
Treatment flow rate :	5,250 l/sec
Production rate :	5,000 l/sec (Day Maximum Water Demand)

(2) Facilities

Design criteria for each facilities is explained hereunder. Criteria of facilities for treated water transmission and distribution system are described in **Section 4.5 "Transmission and Distribution System"**.

1) Intake (Buaran III)

At Buaran III, raw water will be taken from WTC directly by gravity. Coarse screen and fine screen should be installed at the intake. It is also required to install emergency shut-down valves at the intake to react promptly for accidents of extreme water flow, water level and water quality accident in WTC.

2) Mixing

Mixing is the dominant process which will affect performance of following flocculation, sedimentation, and filtration. In Indonesia, water temperature is constant in high level comparing with other northern countries, therefore, required detention time will not be as long as other northern countries. However, for ideal mixing and contact with chemicals dosed, sufficient mixing intensity and detention time should be secured. Required G-value will be about 500 sec^{-1} and detention time should not be shorter than 40 seconds in two staged mixing.

Compartment :	two (2)
G-value :	about 500 sec^{-1}
Detention time :	40 seconds or more

3) Flocculation and Sedimentation

Various alternative method or system will be available for flocculation and sedimentation basin. Up flow type of sedimentation is recommended from the reasons mentioned below.

- Counter measure for density flow should be considered because assumed turbidity for design is rather high. Density flow will not occur in upflow type sedimentation basin.
- Upflow type sedimentation basin will not require large land space comparing with conventional horizontal flow sedimentation basin.

Pulsator type clarifier as same as existing facility in Buaran treatment plant is recommended. In the clarifier, flocculation occurs to promote formation of floc and sludge blanket through which upward flow of water passes and effective clarification be made. Sludge blanket is regulated by sludge extraction system with sludge concentrator. Sludge from sludge concentrators and sludge extracted by bottom wash system are drained to the sludge drain.

In Annex, horizontal shaft flocculator for flocculation basin and tube settle type for sedimentation is also discussed as another recommendable type.

4) Filtration

Flawless performance in terms of reduction of turbidity is expected as the last facility of the treatment process. In order to maintain suitable condition of the filter bed, efficient backwash system should be designed. Backwash rate should be carefully decided because of high water temperature.

Filtration basin should be carefully design to allow enough expansion of sand bed during backwash period. Thickness of sand bed should be sufficiently thick to achieve high reduction rate. For the thicker sand bed, air scouring type is recommended for backwash system to be able to wash sand bed uniformly instead of mechanical type surface wash system.

There are two types of flow control for filtration, such as inflow control and outflow control. To distribute water to each sand bed, water should be divided at the inflow weir equally to each bed. This type will be much easier and will fit the condition that the fluctuation of production rate is small. In this case, respective condition of sand bed will not affect other sand bed. This inflow weir type has also advantage in terms of operation and maintenance.

Filtration rate will be about 170 m3/m2/day considering the existing process and following points:

- Balancing filtration period (about 48 hours) and maximum filtration resistivity (about 2m)
- Low viscosity coefficient because of high temperature
- Minimize size of filtered water basin for backwashing

The figure is subject to change by further observation of existing treatment. Area of each filter bed should not be more than 100 m2 to secure uniform filtration.

Flow rate control	:	Equal water distribution at inflow weir
Filtration rate	:	about 170 m3/m2/day
Filtration period	:	48 hours
Backwash system	:	Self backwash, water + air scouring
Sand bed	:	Thickness : 80 - 100 cm
		Effective size : 0.8 - 1.0 mm
		Uniformity coefficient : 1.4

Self backwash system using filtered water from another sand bed is also recommendable, since the system has advantages of saving energy and easy operation and maintenance while basin reserving filtered water for backwashing should have enough area to avoid rapid rate down of backwash.

5) Waste Water Basin

Backwash water will be returned to intake in Buaran III and returned to receiving well in Cipayung.

To minimize fluctuation of water quality, backwash water should be return to each point constantly. Waste water basin should have enough capacity as a buffering basin for backwash water to regulate quantity of return water constantly.

Capacity of the waste water basin should be one third (1/3) of quantity of backwash water from the assumption as follows.

Backwash will be conducted during day time (about 8 hours)
Constant return will be conducted in half day (about 12 hours)

Waste water basin should consist of 2 basins. In case of filtration period become shorter because of high turbidity, return period should be prolonged.

(3) Facility Layout and Hydraulic Profile

Plural basins should be allocated symmetry in order to distribute water equally to each basin with minimum control. Number of basin should be even number basically.

For Buaran III, land scaping works should follow same ground level as existing level. To establish united system with existing treatment plant, HWL and LWL of clear water reservoir should be fixed as same level as existing plant.

For Cipayung, ground level in the premises is varied. To use this geographical condition effectively, facility design should be matched the variation of the ground level.

4.4.5 Required Facilities

The capacity, volume and dimension of the facilities, planned on the basis of criteria, are described below:

Intake(Buaran)

Intake Bay	2	unit
Intake Canal	2	unit
Flow Rate	5.25	m^3/sec/unit

Coarse Screen, Fine Screen, Emergency Shut-off Valve, Flow Control Valve

Receiving Well(Cipayung)

Numbers of units	1	unit
Flow Rate	5.25	m^3/sec/unit
Width	7	m
Length	9	m
Depth	5	m
Volume	315.0	m^3
Detention time	60.0	sec

Mixing Basin

Numbers of units	2	units
Flow Rate	2.63	m^3/sec/unit
Compartments	2	
(First mixing)		
Type : Stirring by vertical type agitator		
Width	4.6	m
Length	4.6	m
Depth	3.8	m
Volume	80.4	m^3

Detention time	30.6	sec
Mixing energy : G	500	sec^{-1}

(Second mixing)

Type : Stirring by vertical type agitator

W	4.6	m
L	4.6	m
H	3.8	m
Volume	80.4	m^3
Detention time	30.6	sec
Mixing energy : G	500	sec^{-1}

Clarifier Process

Type : Upflow / Pulsator type

Number of Units	8	units
Flow Rate	2,363	m3/hr/unit
Width	42.0	m
Length	23.4	m
Depth	4.2	m
Surface area	982	m2
Effective surface area	835	m2
Volume	4,124	m3
Overflow rate	2.83	m/hr
Contact time in sludge blanket	51	min

Desludge : Vacuum Pump

Filter

Numbers of units	32	units
Flow Rate	14,175	m^3/day/unit
Surface area	84	m^2
Filtration rate	about 170	m/day

Filter media : Single media of filter sand

Effective size	0.8 - 1.0	mm
Uniformity coefficient	1.4	

Thickness	80 - 100	cm
Supporting Gravel : Grading 4 - 40 mm		
Thickness	20 - 50	cm
Under drain : Nozzle type		
Washing : Backwash + Air scouring		

Waste Water Basin

Numbers of units	2	units
Volume	1,500	m^3/unit

Sludge Drain Basin

Numbers of units	2	units
Volume	600	m^3/unit

Clear Water Reservoir(Buaran)

Numbers of units	6	units
Total Area	20,750	m^2
Depth	4.0	m
Volume	83,000	m^3

Clear Water Reservoir(Cipayung)

Numbers of units	2	units
Width	50.0	m
Length	55.0	m
Depth	5.0	m
Unit Volume	13,750	m^3
Volume	27,500	m^3

Transmission and Distribution Pump(Buaran)

(Transmission)

Large

Numbers of units	2	units
Discharge	90	m^3 /min

Total head	40	m
Power	790	KW
<u>Small</u>		
Numbers of units	3	units
(Use existing pumps, including one stand-by)		
Discharge	60	m^3 /min
Total head	40	m
Power	550	KW
(Distribution)		
<u>Large</u>		
Numbers of units	4	units
Discharge	86	m^3 /min
Total head	54	m
Power	1,020	KW
<u>Small</u>		
Numbers of units	2	units
(Use existing pumps, including one stand-by)		
Discharge	48	m^3 /min
Total head	54	m
Power	600	KW

<u>Distribution Pump(Cipayung)</u>

Numbers of units	3	units
*Including one stand-by		
Discharge	32	m^3 /min
Total head	40	m
Power	280	KW

<u>Operation Building(Buaran)</u>

*Expansion of existing building

<u>Operation Building(Cipayung)</u>

Numbers of floors		2	floors
First floor	20m*40m	800	m^2
	*Electric room, etc.		
Second floor	20m*40m	800	m^2
	*Control room, Office, etc.		

Pump Station Building(Buaran)

*Existing building

Pump Station Building(Cipayung)

Numbers of floors		2	floors
Basement floor	15m*50m	750	m^2
	*Pump room		
First floor	15m*50m	750	m^2
	* Electric room, Control room, etc.		

Chemical Building(Buaran)

*Storage and feeding equipment for chlorine, alum, lime, etc.

Numbers of floors		2	floors
First floor	40m*70m	2,800	m^2
Second floor	40m*70m	2,800	m^2

Chemical Building(Cipayung)

*Storage and feeding equipment for chlorine, alum, lime, etc.

Numbers of floors		2	floors
First floor	40m*70m	2,800	m^2
Second floor	40m*70m	2,800	m^2

4.4.6 General Layout

General layout of the Buaran treatment plant and Cipayung treatment plant are presented on **Figure-446.1** and **Figure-446.2** respectively.

4.4.7 Central Laboratory

(1) Necessity of Central Laboratory

Although, Jakarta water supply system is to be managed and operated by private sector, responsibility for the water supply will still remain on Pam Jaya who works as the regulator for the private sector. Responsibility on water quality for Pam Jaya is considered to secure that the water supplied to consumers satisfies the standard quality by Ministry of Health.

For the purpose, central laboratory to analyze all the parameters of the quality standard shall be realized as soon as possible. The present central laboratory which is located in administration building of Pejompongan plant is suffering from insufficient space and equipment for analysis, and moreover it is of common use for the central laboratory and for treatment process operation of the plant.

Construction of the new central laboratory which is to analyze all the quality parameters other than Radio Activities in the quality standard by Ministry of Health has just started by Pam Jaya, and it is expected to complete as soon as possible.

(2) Layout of Central Laboratory

Layout of the central laboratory to be constructed is as shown in the drawing attached in **Figure-447.1.**

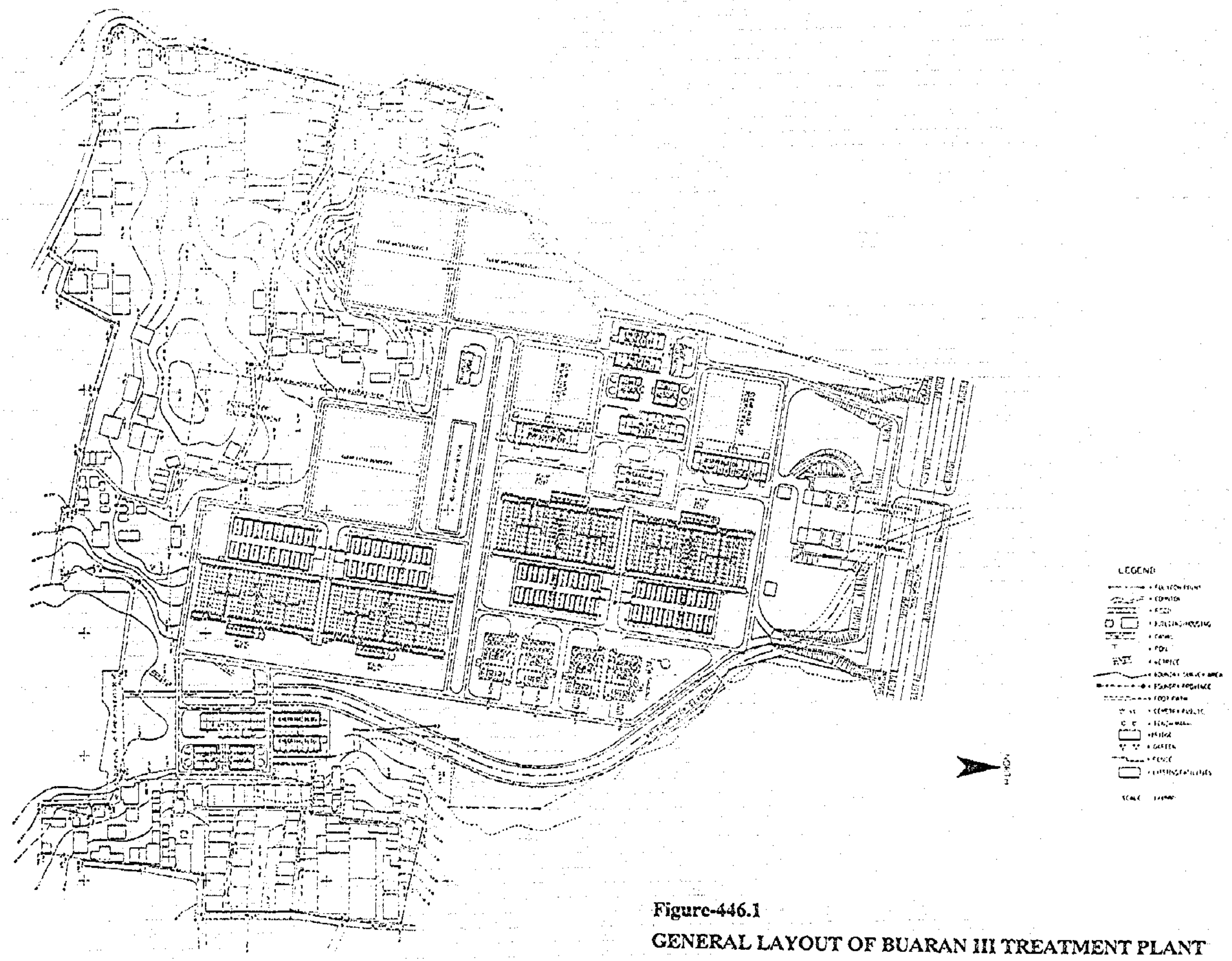
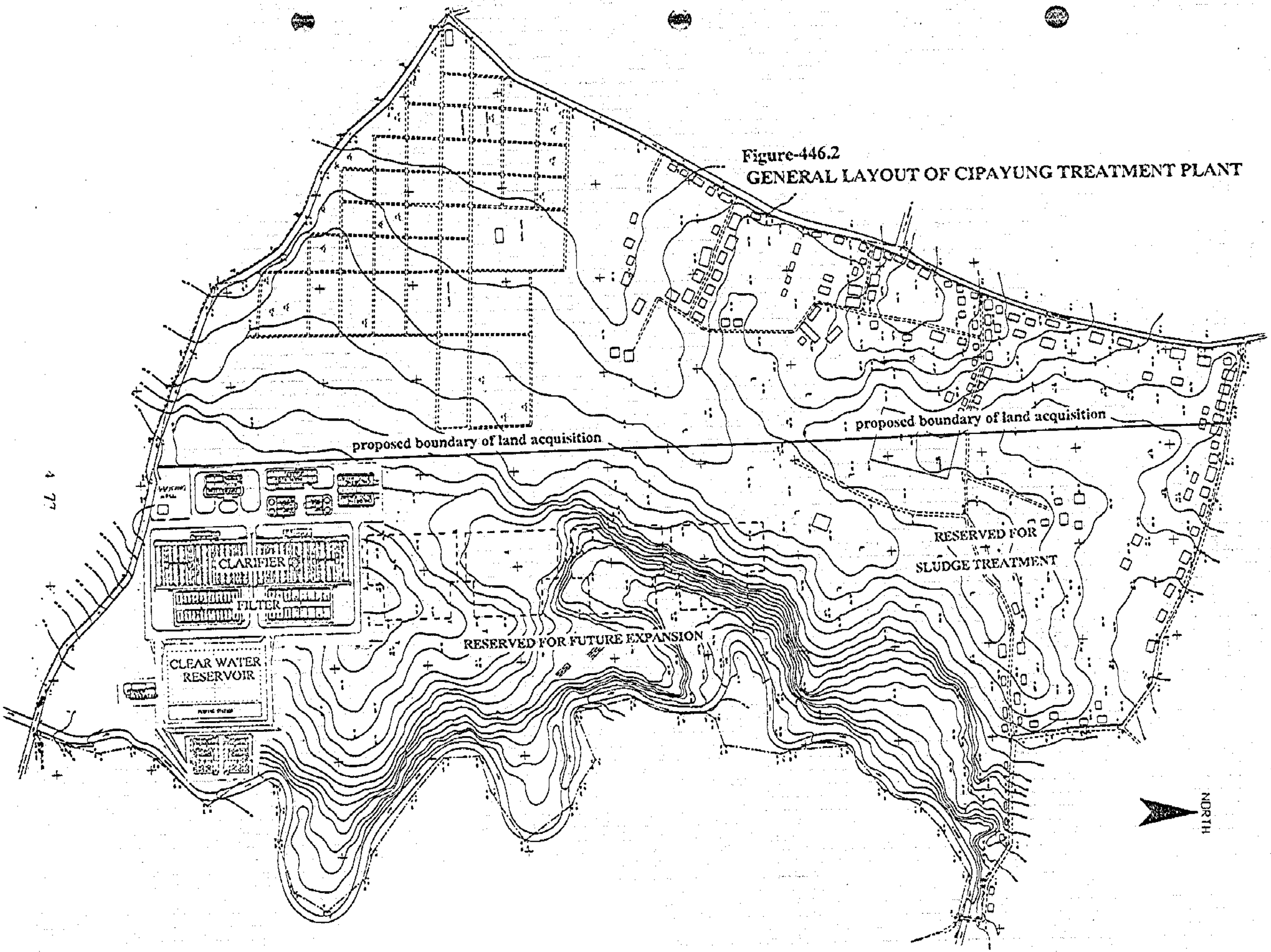


Figure-446.1
GENERAL LAYOUT OF BUARAN III TREATMENT PLANT

Figure-446.2
GENERAL LAYOUT OF CIPAYUNG TREATMENT PLANT



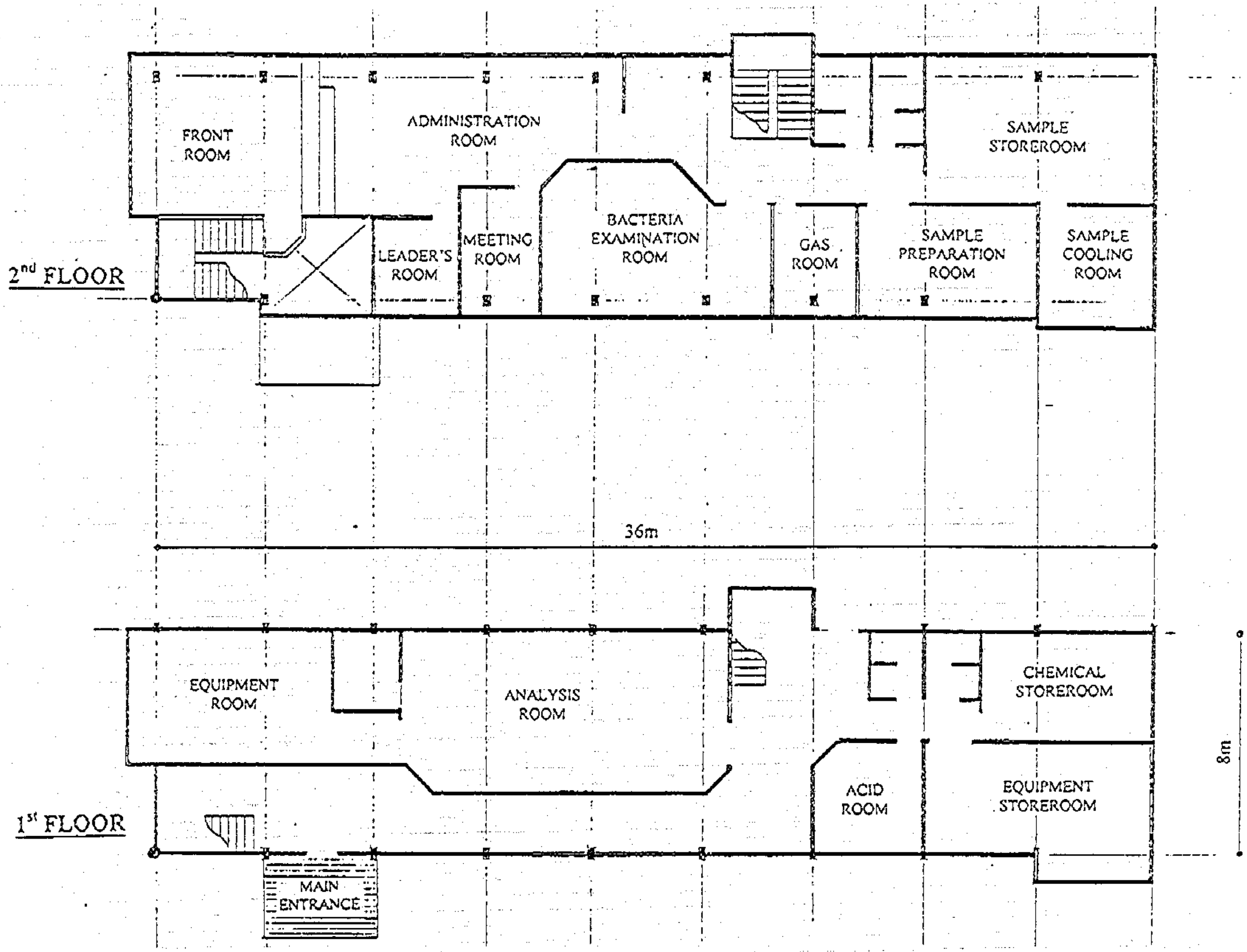


Figure-447.1 LAYOUT OF CENTRAL LABORATORY

4.5 TRANSMISSION AND DISTRIBUTION SYSTEM

4.5.1 General Concept

The roles of treated water transmission and distribution systems are to convey and distribute treated water continuously to consumers without deterioration of water quality nor without much waste. Adequate adjustment or control of water quantity, pressure and quality in the system is very important to satisfy the purpose. Hydraulically separated zoning system is recommended to be introduced in the Mater Plan as a suitable method for the control of distribution system. Although the whole service area will not be able to be separated into proposed seven zones during the priority project period, the area should be hydraulically separated gradually.

(1) Priority Projects

During the period of priority project, water treatment plants are planed to be constructed at Buaran and Cipayung in the eastern area. Treated water should be transmitted from the new treatment plants to western area of Jakarta in order to satisfy the increasing water demand in the area. Scope of priority projects are as follows:

Part One, Second Phase of Second Stage, Target Year 2005

Existing Buaran Treatment Plant is planed to be expanded with the capacity of 5,000 l/sec to make total capacity of 10,000 l/sec during Part One program. The whole service area is to be divided into four zones instead of seven zones. They are;

one for zone 1, one for zone 2 and zone 3, one for zone 4 and zone 7, and one for zone 5 and zone 6. The Separation of zones for Part One program is shown in **Figure-451.1.**

- Expansion of existing Distribution Center R1 with newly required capacity of 2,000 l/sec that makes distribution and transmission capacity of 5,000 l/sec in total. Treated water will be transmitted from Buaran Treatment Plant to Distribution Center R1 through existing treated water transmission pipeline.
- Construction of new Distribution Center R6 with the capacity of 2,100 l/sec receiving treated water from Buaran Treatment Plant through Distribution Center R1.
- Installation of treated water transmission pipeline from Distribution Center R1 to R6 with length of 33.5 km

Part Two, Second Phase of Second Stage, Target Year 2008

Cipayung (New East) Treatment Plant with the capacity of 5,000 l/sec is planned to be constructed during Part Two program. The whole service area is to divided into five zones instead of seven zones. they are;
one for zone 1, one for zone 2 and zone 3, one for zone 4 and zone 7, one for zone 5 and one for zone 6. The Separation of zones for Part Two program is shown in **Figure 451.2** .

- Expansion of existing Distribution Center R5 with newly required capacity of 1,600 l/sec to make distribution capacity of 3,200 l/sec in total receiving treated water from Cipayung Treatment Plant
- Expansion of existing Distribution Center R4 with newly required capacity of 2,600 l/sec to make distribution capacity of 3,800 l/sec in total receiving treated water from Cipayung Treatment Plant
- Installation of treated water transmission pipeline from Cipayung Treatment Plant to Distribution Center R5 to R4 with the total pipe length of 43.0 km

General layout of proposed water supply facilities in 2005, the target year of Part One program, and that in 2008, the target year of Part 2 program are presented in **Figure-3162.1** and **Figure-3162.2** respectively.

(2) Zoing

The concept and structure of zoning system is revised and confirmed hereunder.
By introducing zoning system and constructing simple water supply system, operation and control of flow rate, water pressure and detention time will become easier. This will lead to the prevention of water leakage increase and of water quality deterioration.

Zoning structure is recommended as follows :

a. Zone / Sub-zone

Although the whole service area is recommended to be divided into seven supply zones which are consisted of six existing zones and one new zone for Kabupaten Tangerang, some zones are better to be separated into sub-zones because the boundary of zones is not suitable for hydraulic independence of the zones. In the southern part of Jakarta, zone 5 and zone 6 have greater difference in geographical ground level and are to be divided into high and low sub-zones in order to avoid high static head at pipes. Zones with numeral water supply terminals such as

Figure-451.1
Z0NING SYSTEM FOR PART ONE PROGRAM, YEAR 2005

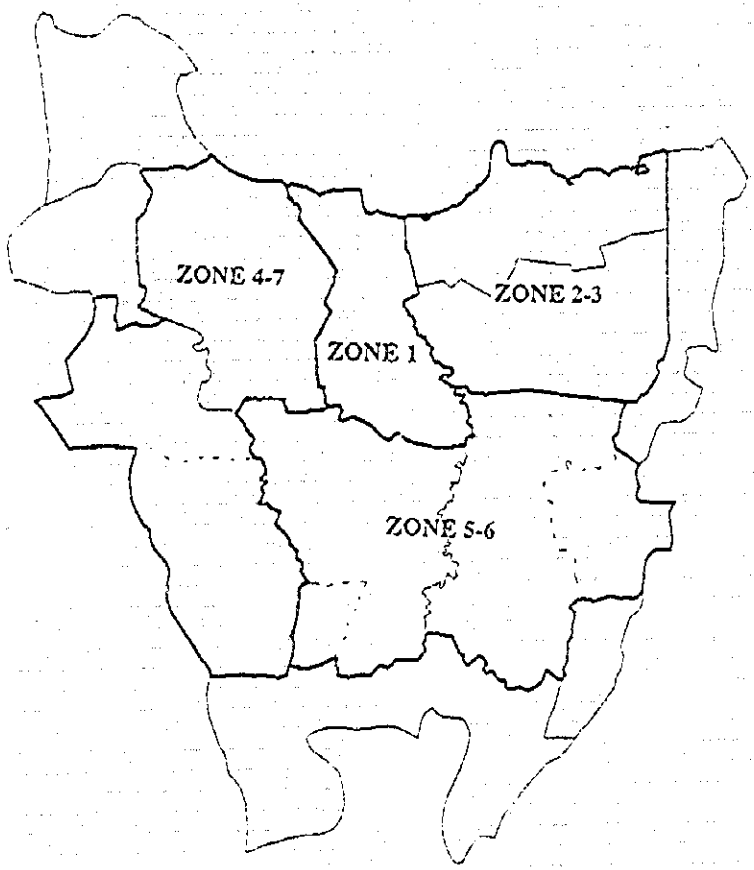
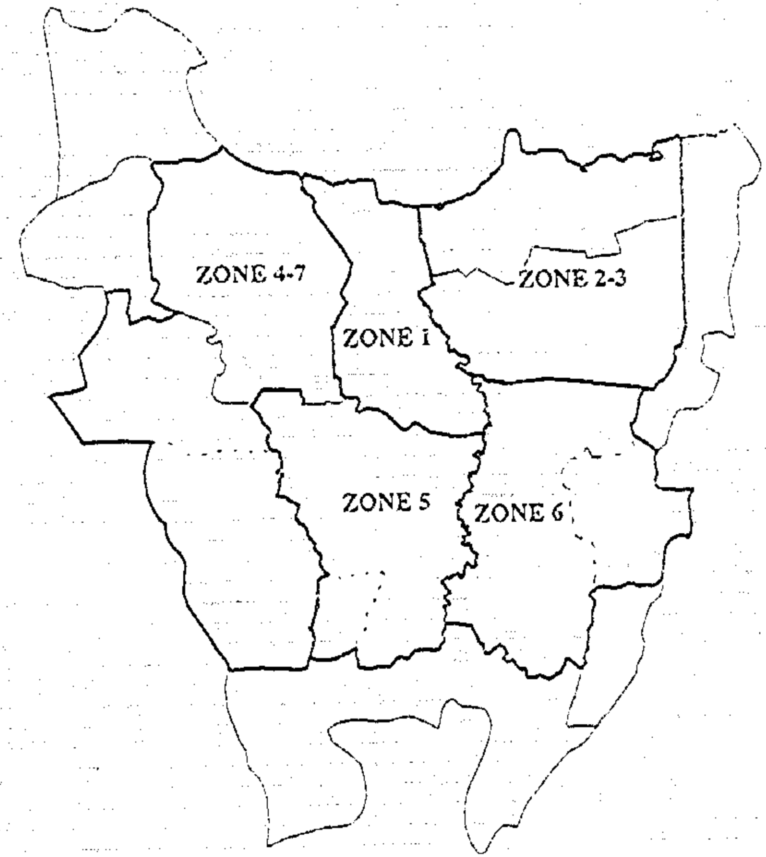


Figure-451.2
Z0NING SYSTEM FOR PART TWO PROGRAM, YEAR 2008



treatment plants and distribution centers are also to be divided into sub-zones. Considering the above, zone 1, zone 2, zone 5 and zone 6 are recommended to be divided into sub-zones. Each zone and sub-zone are to be interconnected by not only transmission pipes but also distribution pipes to supplement water to each other in case of emergency case while operation of each zone is made independent from others by closing valves installed on interconnection pipes in normal condition.

b. Primary Cell

PAM JAYA has divided each zone into 10 to 50 Primary cells which are separated by primary mains, and it was recommend that rehabilitation and infill/expansion works of service main would be carried out cell by cell in SAPROF projects.

c. Elementary zone

Each primary cell is composed of elementary zones consisted of 1000 to 2000 house connections. Elementary zones, which are composed of secondary mains, should be separated each other and each elementary zone can have similar range of water pressure by operating valves installed at inlet of each elementary zone. The water pressure control will contribute to prevention of leakage increase.

d. Waste Meter District

Each elementary zone is recommended to be further divided into waste meter district with 300 to 500 house connections which is composed of tertiary main pipes. Water meter should be set at inlet of each waste meter district to measure water flow into the district during water leakage detection. Comparing the quantity of inflow and total consumption measured by customer meters, it will be easy to know the leakage volume. The results will be usefull to identify priority area of rehabilitation works.

PAM JAYA has already started to divide zones into elementary zones and waste meter districts by on-going PJSIP Project. Such works should be continued and executed in all the service area.

(3) Peak Factor

There are fluctuations in water demand seasonally and hourly.
Among these variations, the following peak factors are used for the preliminary design.

- Day Maximum Water Demand : 115 % of day average water demand
  Transmission Pipe is designed on day maximum water demand basis.
- Hourly Maximum Water Demand : 130 % of day maximum water demand
  Distribution Pipe is designed on hourly maximum water demand basis.

4.5.2 Consideration of Pipe Material

In this section, pipe materials for the proposed, raw water transmission pipeline, treated water transmission pipeline, distribution primary main and service main for the priority projects are discussed.

(1) Basic Consideration

Materials used for proposed pipeline were considered from the aspects as follows;

- The strength of the pipe, as measured by its ability to resist internal pressures and external loads.
- The life or durability of the pipe, as determined by the resistance to corrosion and erosion.
- The ease or difficulty of transporting and laying the pipe under different topographic conditions, soil and the availability of skilled labor in the construction for different kinds of pipelines.
- The requirements of maintenance and repair.
- The existing pie materials which have been used and present practice of pipe installation in Jakarta.
- Functions of each pipeline category such as distribution primary main and service main.

Soil condition and topographic features of pipeline route and traffic condition are the major factors for selection of pipe materials.

(2) Categories of Pipeline

Categories of pipeline are classified as follows:

Raw Water Transmission Pipeline

Convey raw water from intake pump station to the treatment plant

Treated Water Transmission Pipeline

Convey treated water from treatment plant to Distribution Center which is as water terminal for water distribution in each Zone.

Primary Main

Distribute treated water from treatment plants to distribution network as a trunk main. Range of diameter is 300 mm and larger.

Secondary Main (Service Main)

Distribute treated water to tertiary main by forming secondary network within a grid formed by the primary main. Range of diameter is 150 mm to 250 mm.

Tertiary Main (Service Main)

Distribute treated water to each connection from the secondary main. Connection will be allowed only from the tertiary mains in size ranging from 50 mm to 100 mm in diameter.

(3) Factors to be Considered for Selection of Pipe Material

1) Soil Corrosiveness

Corrosion of metal occurs through the direct contact with the soil be way of electrochemical mechanism, and the possibility of corrosion depends on the degree of resistivity of soil against the transmission of such current, together with the degree of pH, redox potential, sulfides existence and moisture contents.

In 1984, soil survey was conducted to grasp corrosibity of soil in the entire service area in Jakarta. Soil was sampled at 101 points uniformly throughout service area and they were tested in accordance with the test method of ANSI 21.5 for evaluation of soil corrosibity.

According to the results of the soil investigation, the corrosive area extends whole northern part of Jakarta and in its eastern part other corrosive area further extends to the south.

2) Groundwater Level

Measurement of groundwater level was also conducted during above survey. However, level of groundwater has been changed in the last decade because of excessive abstraction of groundwater.

3) Road and Traffic Conditions

The service mains will be installed elsewhere in the project area and most of them in the residential area. Therefore the road conditions will be variety depending on the area. However, the most of the service mains will be installed along the roads which traffic will not be heavy because of mostly in residential area. And also the space required for installing the service mains will be small due to small sizes pipes and shallow depth for installation. Therefore the problems of difficulty to install service mains will not be significant.

On the other hand, the pipeline routes of the raw water transmission pipeline, treated water transmission pipeline, and primary mains shall be carefully selected because wider space is required for installation.

(4) Recommendations

Although surrounding condition such as soil corrosiveness, groundwater level, and traffic condition, along the pipeline route should be reviewed by the results of investigation during proceeding detail design stage, preliminary consideration on pipe materials for each pipeline are explained hereunder.

Characteristic and major feature of each pipe material is attached at the end of this section.

1) Raw Water Transmission, Treated Water Transmission and Primary Main

Usually, raw water transmission pipeline and clear water pipeline such as treated water transmission and primary mains are considered separately. However, in this case, raw water transmission pipeline from silt trap at Bekasi to New East Treatment Plant at Cipayung will be required to be pressurized more than 40 m by intake pumps and booster pumps which will be constructed on the way to Cipayung. Therefore, it is required to use reliable pipe material for the raw water transmission as same as clear water pipeline.

From the important role of the raw water transmission, treated water transmission, and primary mains which will be installed along the major roads, the strength and durability of pipes are firstly to be considered. In this mean, DIP or SP will be selected as the pipe materials of the primary mains.

When the soil nature is taken into account, the DIP which has better corrosions resistance properties than SP will have advantage.

In addition to the above the following advantages to apply the DIP will be considered :

- Easier maintenance and repair comparing with SP which requires removal of coating and replace it when new branch is provided from the existing mains or existing pipe is required to be cut for repair and jointed again.
- Pipe laying practice prevailing in the Jakarta Water Supply System
- Quick and easier installation even by unskilled labor using push-on or mechanical joint where traffic is heavy.
- Flexible joint which allows adjustment of pipeline alignment in accordance with shapes of road in limited space and avoiding unforeseeable underground obstacles during pipe laying work which sometimes happens.
- The size of pipeline which are less than ¢ 600 mm in diameter and when SP is used for these size of pipes, no repair of lining after welding can be applied.
- Weather condition and existence of high groundwater table will not be critical for jointing work of DIP.

Conclusively the DIP is recommended to be applied for transmission and the primary mains of this project although SP may be applicable for the limited routes where the soil is not corrosive providing that the coupling such as dresser type joint is used for connection and adequate external coating is applied together with cathodic protection. The careful handling for transportation and installation of SP shall be subject to applied avoiding the damage to the flexible membrane of coating.

As for jointing of pipes, push-on type of joint is recommended for smaller size of pipes, i.e. ϕ 400 mm or smaller considering faster installation. On the other hand, mechanical joint is recommended for pipes which size is ϕ 450 mm or larger taking more reliable joint and easy installation even by unskilled labor. Mechanical joint is also recommended for fittings of all size of pipes.

However, taking advantage of SP, which is lighter weight, high strength and flexibility, it is recommended that SP will be applied for above-ground piping such as river crossing by pipe bridge with appropriate coatings.

2) Service Mains

Considering the soil nature of project area and present practice prevailing in water supply of Jakarta as well as economy, Polyvynilchloride Pipe (PVC) is recommended to apply for the service mains. However, the special consideration shall be taken for such part of pipe laying as heavy traffic, joint with different pipe materials such DIP or SP and valves to avoid the damage of PVC due to less strength of pipes comparing with ferrous pipe materials.

3) House Connection

PE is recommended for house connection considering also soil nature as corrosive in the project area. However careful measures shall be taken for piping around meter box and crossing of ditch. Protective sleeve pipes shall be applied at ditch crossing to void shock and vandalism to the pipes and ultraviolet rays under strong sunshine.

Galvanized Steel Pipe (GSP) may be applicable where soil is less corrosive taking the advantage of strength provided that adequate protective measures, such as bituminous coating or protective tape will be taken for external surfaces of thread and damaged part of galvanized coating.