CHAPTER 2 FORMULATION OF THE MASTER PLAN

2 FORMULATION OF THE MASTER PLAN

Formulation of the Master Plan consists of improvement for the existing facilities and extension projects to supply water for the non-water service area.

2.1 IMPROVEMENT OF THE EXISTING FACILITIES

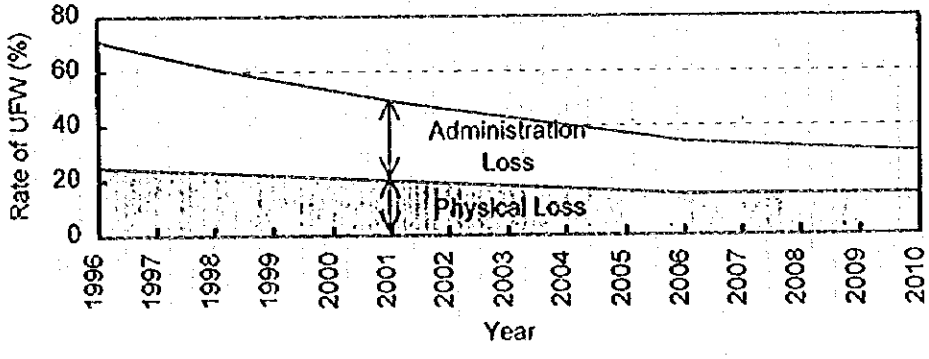
2.1.1 Improvement of the Unaccounted-for Water (UFW)

With regard to improvement of UFW, the Master Plan formulated in this Study will basically follow the program of ongoing 1A project, after the year 2000. UFW improvement plan consists of renovation of distribution pipelines, installation of water meters and improvement of water billing system.

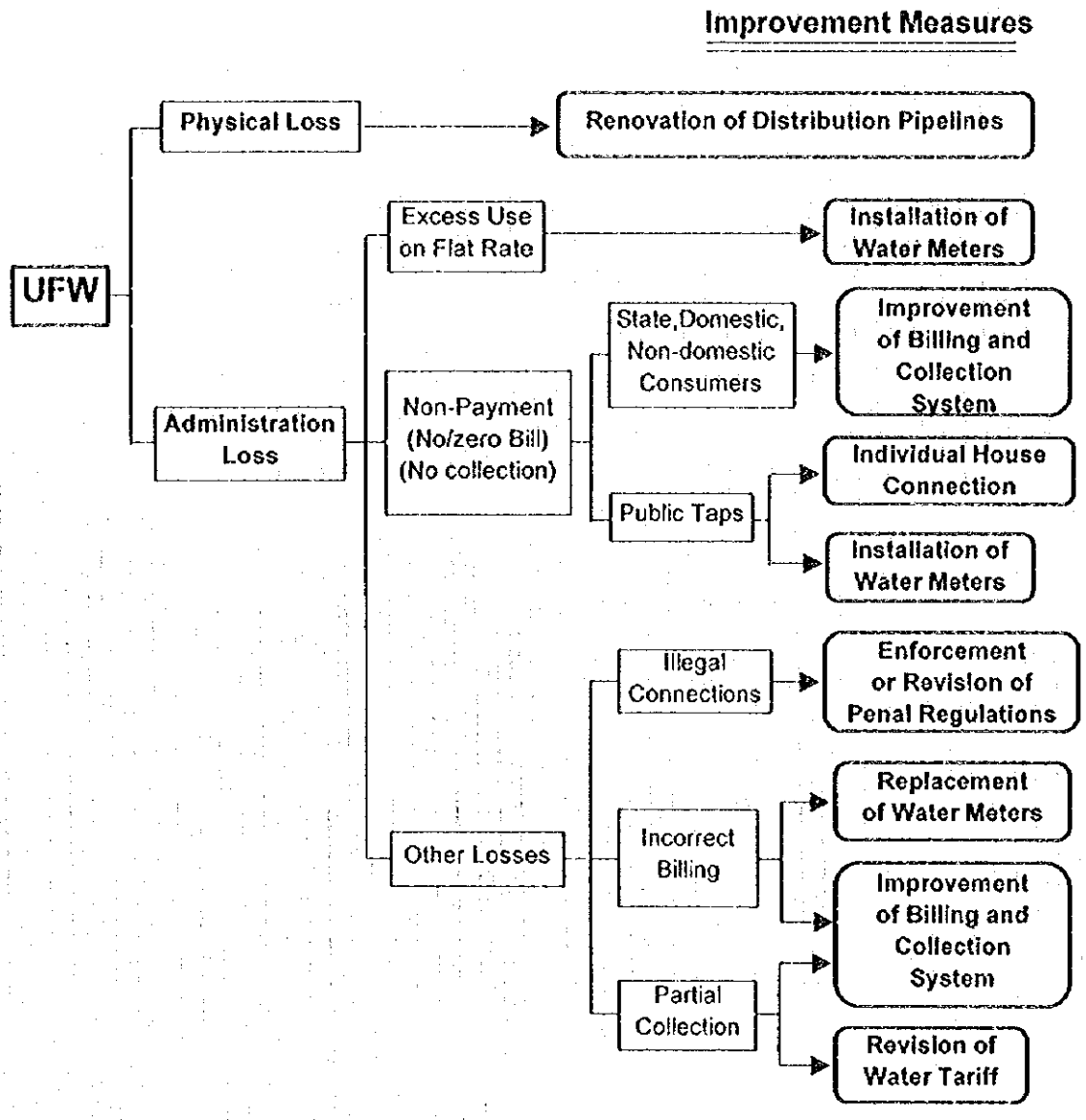
Taking both 1A Project and this Master Plan into account, UFW consisting of the physical leakage loss and the administration loss was projected as given below:

UFW	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Physical Loss	(%)	25	24	23	22	21	20	19	18	17	16
Administration Loss	(%)	46	42	38	35	32	29	27	25	23	21
Total		71	66	61	57	53	49	46	43	40	37

2006	2007	2008	2009	2010
15	15	15	15	15
19	18	17	16	15
34	33	32	31	30



Contents of the improvement plan are shown as follows



(1) Physical loss

1) Present

The JICA Study Team carried out the leakage survey during April - May 1996 on eight (8) blocks selected within the existing service area in urban districts. (For detail, please refer to "Water Leakage Survey Report" in Appendix.)

The Study Team estimated the rate of leakage to be 25 - 30% in old networks (constructed before 1985) area, and 10 - 15 % in new networks (constructed or replaced during 1985 - 1995); and average in the whole city was 20 - 25%, or rather 25%.

2) Improvement plan

As to the leakage rate, a smaller rate is naturally better than a large one. However, it has a physical limit. A large rate of leakage can be reduced easily in terms of cost and time; however, a small rate is very difficult to be reduced. In this planning, the ultimate rate of leakage is proposed to be 15%, considering various conditions (in Japan, it is generally targeted at about 10%). The rate of 25% at present (1996) in Hanoi is planned to be reduced to 15% in coming 10 years; that is, 1.0% reduction per annum.

As a concrete measure, the renovation work of distribution pipelines will be continuously extended from the year 2001 to 2005 to follow up the program of ongoing 1A Project. Physical loss is expected to be reduced to 15% when the work is completed.

(2) Administration loss

1) Present

According to HWBC's records, billed water was accounted at 29% of total production water; hence, UFW was 71%. Therefore, the rate of administration loss was estimated at 46% as follows:

(Total production) - (Billed water) = 100% - 29%
= 71% (UFW)

(UFW) - (Physical loss) = 71% - 25%
= 46% (Administration loss)

The administration loss is considered to consist of following categories:

A. Excess Use on Flat Rate

In the case of non-metered connections or damaged meters, billing is made based on a fixed consumption rate (flat rate) of 4 m^3/month for domestic customers. This is equivalent to 133 lcd which seems to be less than actual consumption. The flat rate attributes to excess use of water, wastage of water, ignorance of overflowing water of private storage tanks, etc.. Furthermore, number of actually-living persons may be more than that of registered persons to be accounted. This causes billed water less than actual use.

B. Non-Payment

Out of the registered customers, about 30% are reportedly unbilling or billing of zero.

Currently, water supplied from public taps is not paid by beneficiaries of public taps, but by HPC. Public taps are not equipped with water meters and the current method of water use seems to be same as the above-mentioned flat rate method. The public taps shall be at least equipped with water meters for control of water use. HWBC now executes a policy to reduce the number of public taps by 20% annually. When a public tap is removed, houses nearby are to be connected by individual service pipelines. Such change from public taps to individual connections will contribute to reduce the rate of UFW.

C. Other Losses

Although no statistical figure is available, illegal connections are mainly done among unregistered household consumers and other individuals like job-seekers by connecting private pipes to the network without official permissions.

Water charge is incorrectly billed, because some water meters are incorrect or out of order or some meter readers mistakenly read water meters.

Water charges are collected by collectors who visit each customer and collect charge by cash. This way of collection is not so efficient as 100% of collection is expected.

Water tariff in Hanoi has been kept lower than full cost recovery level. Water charge for domestic customers is just one third of the production costs. The shortage is cross-subsidized by non-domestic customers, however, earliest effort to raise water charge is required.

2) Improvement plan

The administration loss, characteristics of which is different from physical loss, is able to be reduced greatly without large investment but with administrative efforts and revision of regulations. The rate is proposed to be reduced from present 46% (in 1996) to 15% (ultimate target in 2010). Its reducing rate will be 4% per annum for the administration loss of more than 40%, 3% per annum for the loss of 40-30%, 2% per annum for the loss of 30-20% and 1% per annum for the loss of 20-15%.

As a concrete measure, water meters will be installed/replaced to all individual customers or public taps in the service areas after the year 2000 in order to measure water consumption accurately and to bill customers for water charge rationally. Furthermore, a new water billing and collection system will be adopted based on improvement of institutional/managerial systems and water tariff. As for illegal connection, penal regulations will be strictly enforced. Administration loss is expected to be reduced to 15% in the year 2010 by these measures.

As presented in the appendix of "Water Leakage Survey Report", the JICA Study Team carried out the leakage survey in 1996. At the same time, progress and planning of pipe renovation work to reduce leakage, which was implemented by FINNIDA or was proposed to be done by the World Bank Program, was studied. As a result of the study, it was found that the pipe renovation work would cover until the year 2000 about 80 % of the present service area. Accordingly, the area necessary for the pipe renovation work to be covered by the Master Plan is about 20% of the whole service area. It is almost equivalent to the capacity of 74,000 m3/day (370,000 m3/d (whole Hanoi capacity) x 20% = 74,000 m3/d). Construction cost of new pipelines/networks for 740,000 m3/d capacity will be US$ 36,000,000 and pipe renovation cost is supposed to be 20% of new construction cost.

Therefore, cost for the pipe renovation work for the Master Plan will be :

US$ 36,000,000 x 20% = US$ 7,200,000

2.1.2 Security Mains in Central Hanoi

In order to contribute to emergency operation at the time of water shortage happened in a particular area, security main pipes have been equipped in the central and north-east parts in central Hanoi. However, these pipes are not connected to the west-south part of Hanoi.

The existing security mains already meet the emergency purpose, although they are still at the minimum level. Further improvement of the security mains is surely desirable, but water supply to the current non-piped-water-supplied areas should be more emphasized.

Considering that a balance between an investment on the plan to extend this security mains, which would require a considerably large amount of budget, and a water revenue increase to be gained from this extension, it could be that the plan would threaten to aggravate the managerial situation of the HWBC.

For this reason, this plan should be considered as a recommendation in this Master Plan, although it is placed outside the formulating scope of Master Plan.

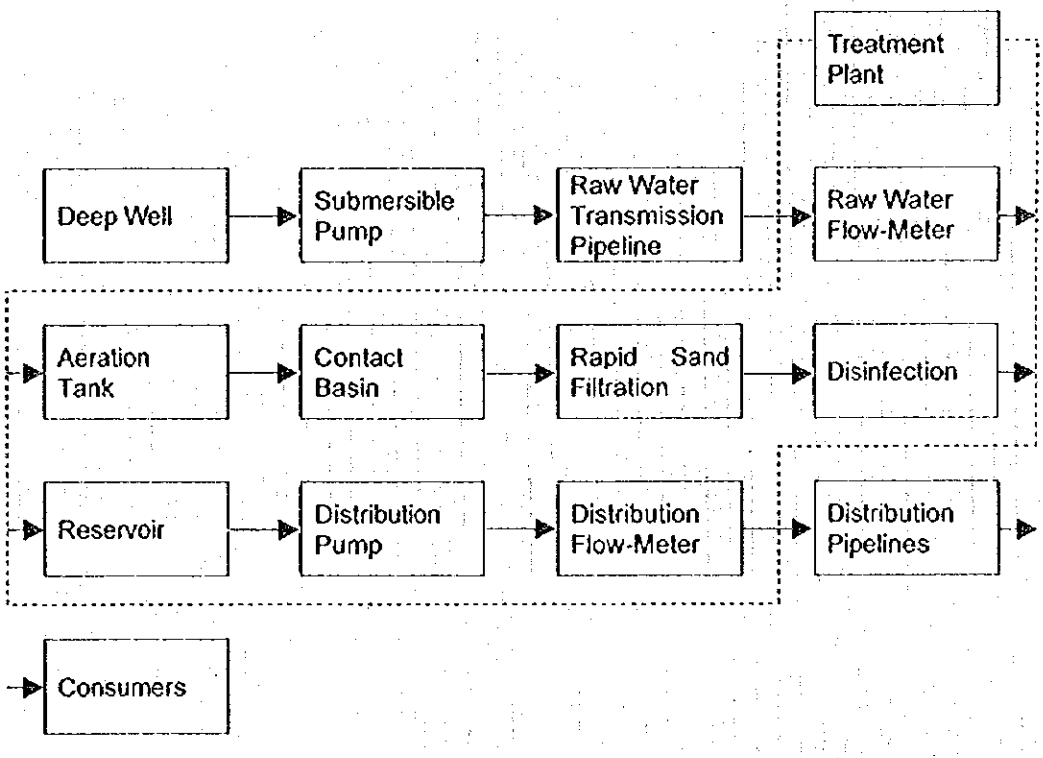
2.2 EXTENSION PROGRAM FOR URBAN WATER SUPPLY

2.2.1 Service Area

Service area of the urban water supply systems which have distribution pipelines and individual house connections are proposed and shown on the map of "Areas for Urban Water Supply".

2.2.2 System and Facilities

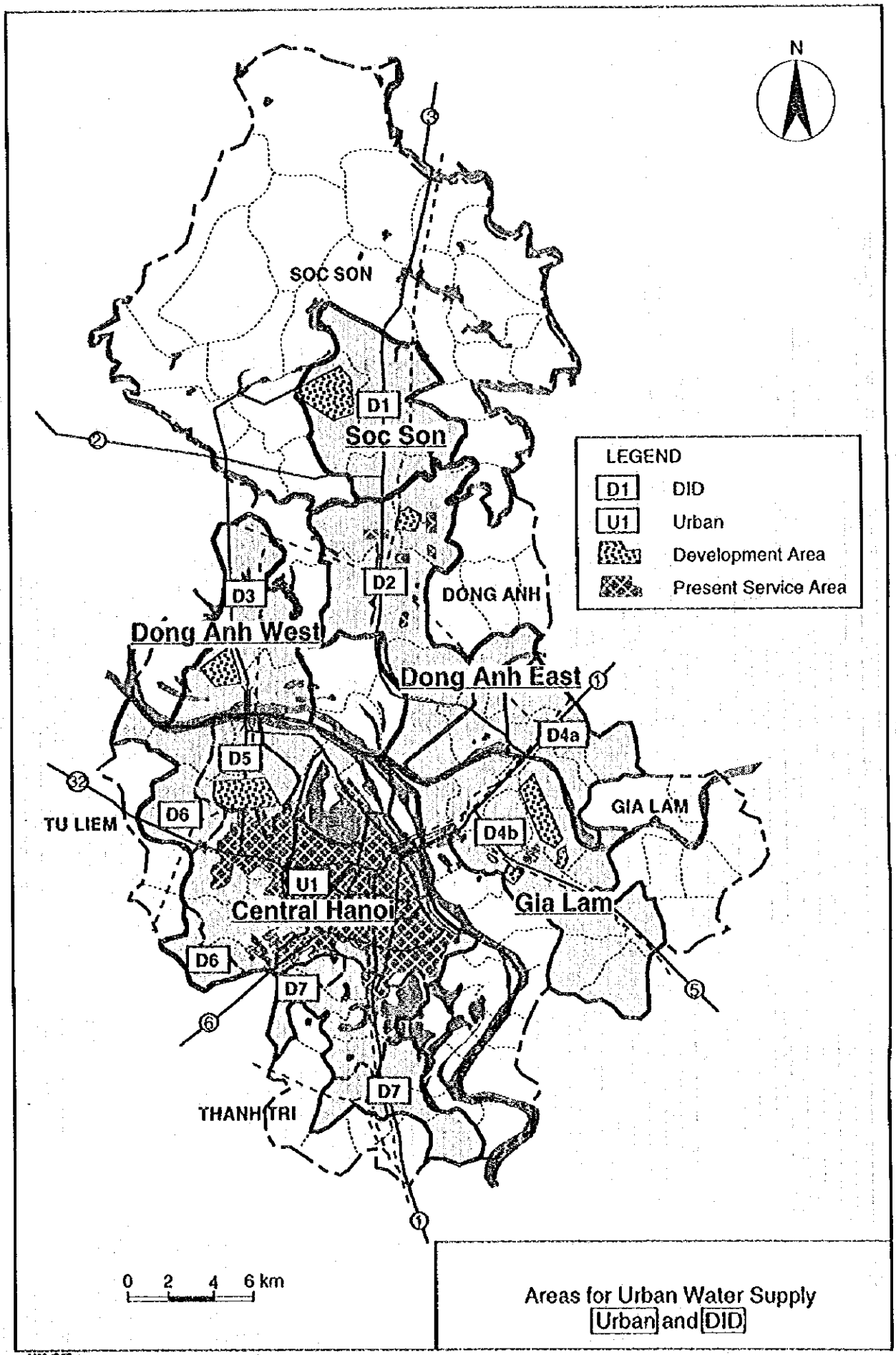
The water supply system and its facilities for the future are proposed to be almost same as the current one, as shown below.



The treatment processes of the new plants will be designed for the removal of iron and manganese so that the treated water will comply with the Vietnamese standard of the safe drinking water quality. This means that the iron concentration needs to be reduced from about 3 – 10 ppm down to below 0.3 ppm and manganese content from about 1 ppm to below 0.2 ppm. Ammonia removal requires a complicated and expensive treatment process. Therefore, excessive ammonia concentration in raw

water should be avoided by careful selection of the raw water source.

Based on the available data, it is concluded that the design criteria applied for the existing water treatment plants, recently constructed in Hanoi, seem to be appropriate for the characteristics of the available groundwater. The same criteria will generally be followed in the design of the new plants. The treatment process shall include aeration, contact/sedimentation, rapid sand filtration and disinfection.


N
SOC SON
D1
Soc Son
LEGEND
D1 DID
U1 Urban
Development Area
Present Service Area
D3
D2
DONG ANH
Dong Anh West
Dong Anh East
D4a
D5
D6
TU LIEM
GIA LAM
D4b
U1
Central Hanoi
Gia Lam
D6
D7
D7
THANH TRI
0 2 4 6 km
Areas for Urban Water Supply
Urban and DID

2.2.3 Facilities Plan

Extension schedule of facilities for the urban water supply systems is proposed based on the following criteria.

- The first year in that new facilities will be completed and operated is the year 2003 at the earliest.
- The period between the time of the completion of the facilities and the time of the next extension is three years at the shortest.
- The minimum capacity of the system facilities is for 30,000 m3/day.
- The size for extension capacity of the system is 30,000 - 100,000 m3/day.

Considering the above criteria, the extension schedule was planned by area: shown in the drawing of "Extension Schedule Schematic", and location of treatment plants proposed in "Location of Proposed Plants".

As a principle, the plants will be located near water sources, wellfields for exploitable groundwater. In the North Hanoi (Gia Lam, Dong Anh and Soc Son), the plants will be placed in certain lands where supply of treated water is needed.

In the South Hanoi (Central Hanoi), however, location of the proposed treatment plants is considerably limited, because of area restriction for wellfields of exploitable groundwater. The areas for the plants are : Wellfield (i) Thuong Cat – Cao Dinh and Wellfield (ii) Nam Du Thuong. In these areas, facilities are planned for water supply to the D5, D6, D7 and U. Taking into account of the water demand and the locations of the wellfields, the design capacity is defined as below :

(m3/d)

	D5	D6	D7	U	Total
Wellfield (i)					
Daily Maximum Distribution Capacity	(36,000)	(23,000)		(74,000)	(133,000)
Design Capacity	40,000	25,000		75,000	140,000
Wellfield (ii)					
Daily Maximum Distribution Capacity			(31,000)	(76,000)	(107,000)
Design Capacity			31,000	79,000	110,000
TOTAL	40,000	25,000	31,000	154,000	250,000

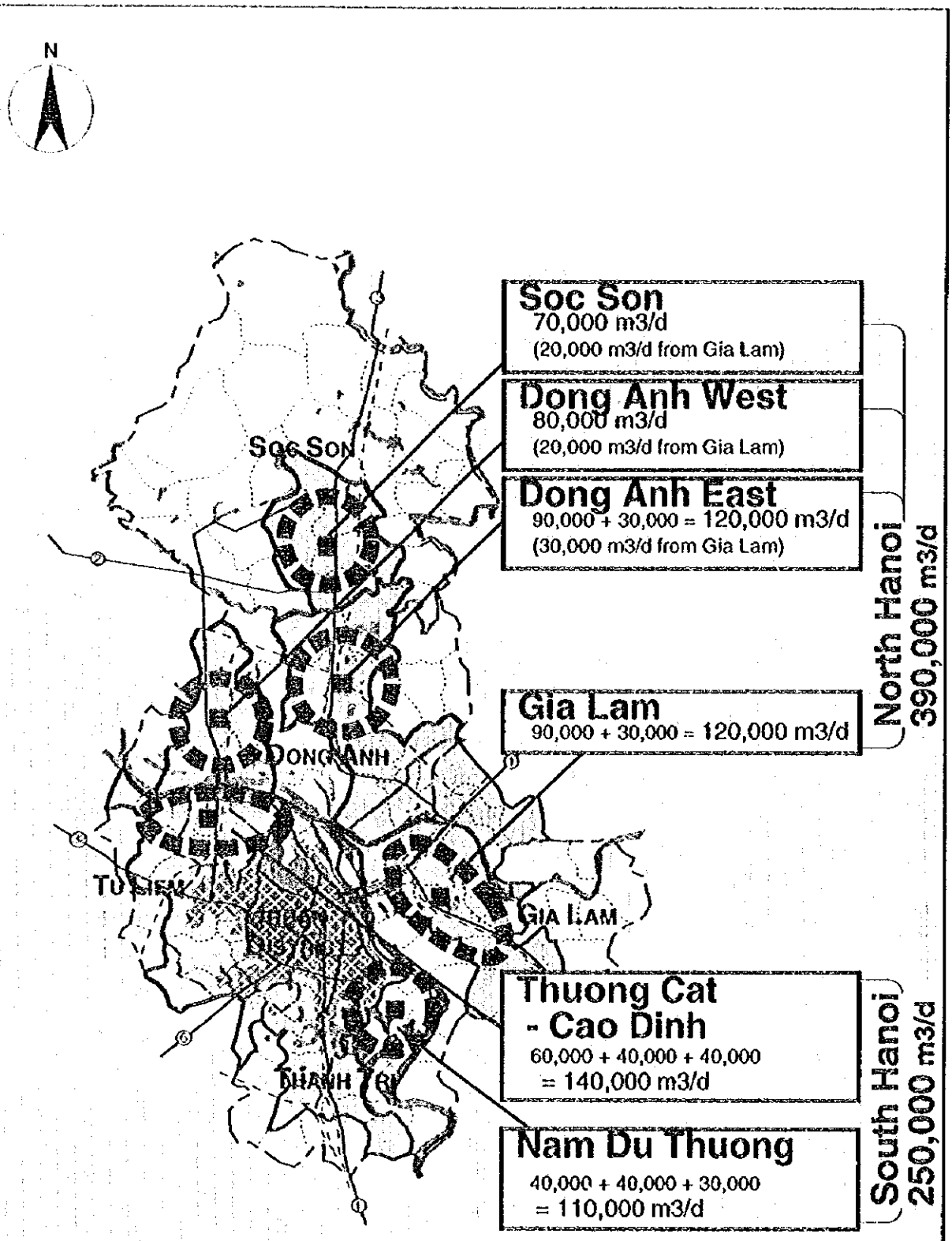
The above extension capacity will be constructed by the following three stages : Stage I 100,000 m3/d, Stage II 70,000 m3/d and Stage III 80,000 m3/d. The extension plan by service areas are shown below:

(m3/d)

	D5	D6	D7	U	Total (Production Capacity)
STAGE I					
Phase 1 – 60,000	40,000			20,000	60,000
Phase 2 – 40,000			31,000	9,000	40,000
STAGE II					
Phase 1 – 40,000				40,000	40,000
Phase 2 – 30,000				30,000	30,000
STAGE III					
Phase 1 – 40,000		25,000		15,000	40,000
Phase 2 – 40,000				40,000	40,000
TOTAL	40,000	25,000	31,000	154,000	250,000

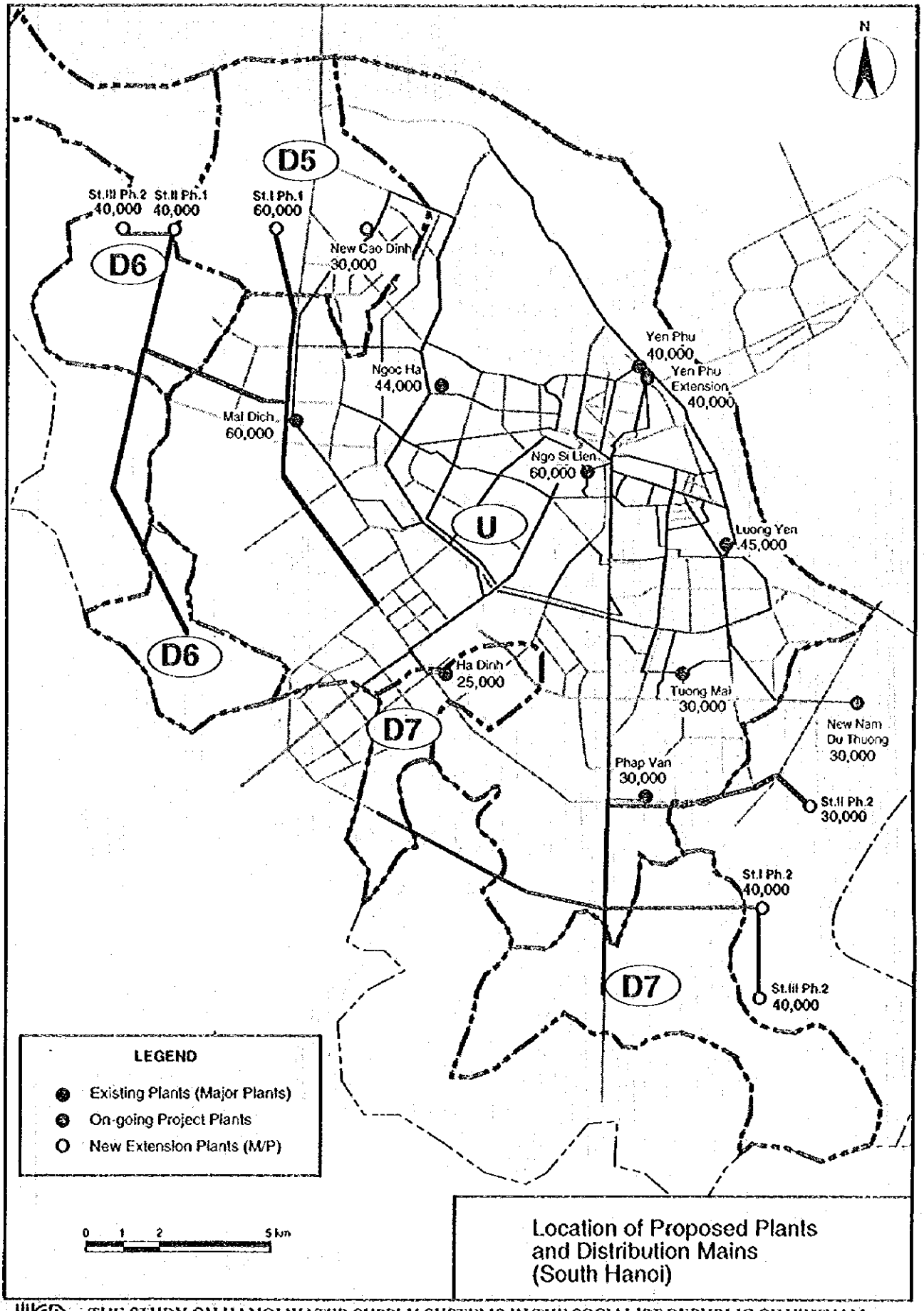
Since the distribution mains in the existing service area are to be improved by the World Bank project, "Construction of New Transmission Mains", the main distribution pipelines from plants to group U are planned to be connected with those distribution mains. The main pipelines for D5, D6 and D7 are planned to be constructed additionally.

The locations of the proposed plants and the distribution mains in the South Hanoi are shown as the map of "Location of Proposed Plants and Distribution Mains".

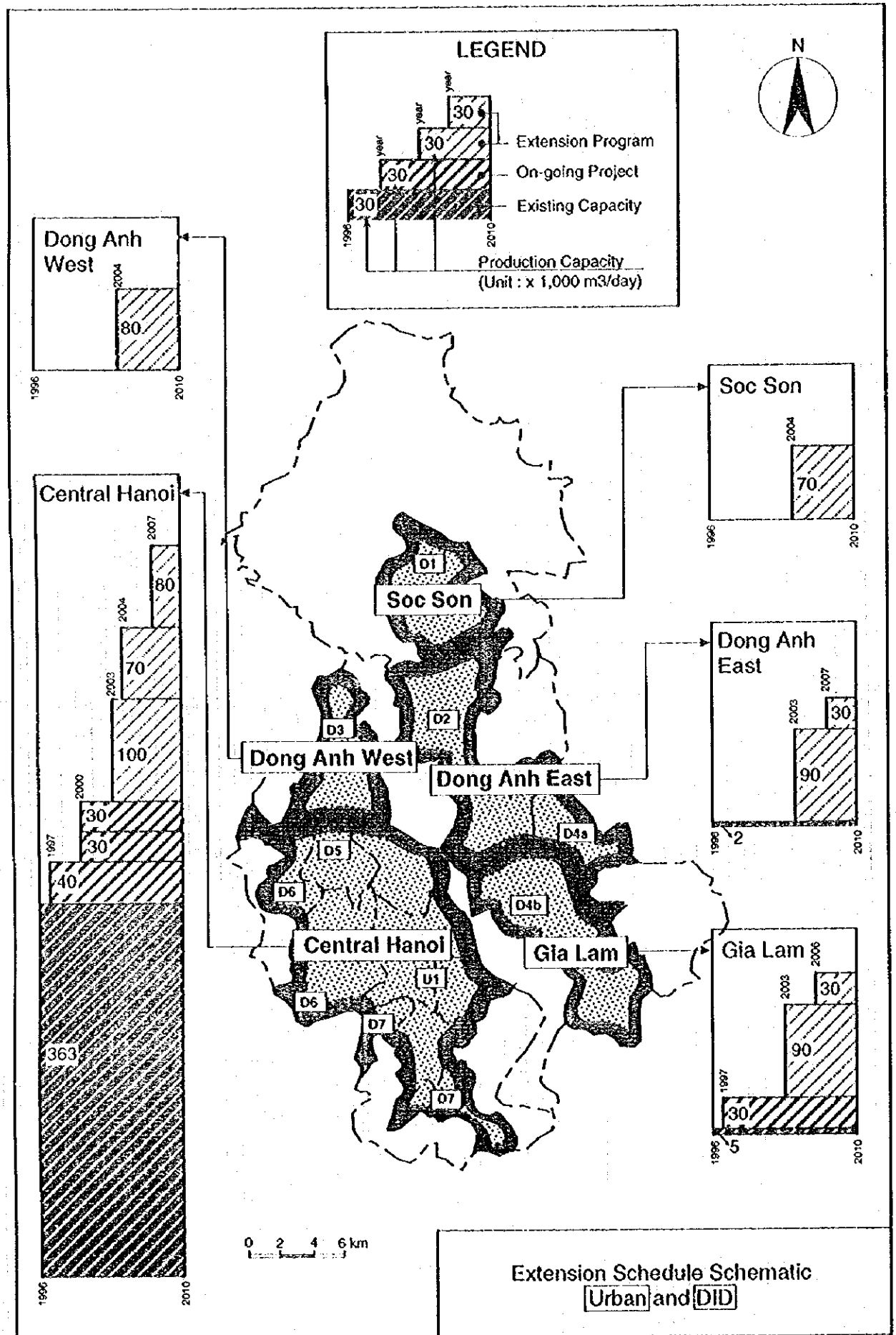


Note : Plant caapaacity is the Daily Maximum basis.

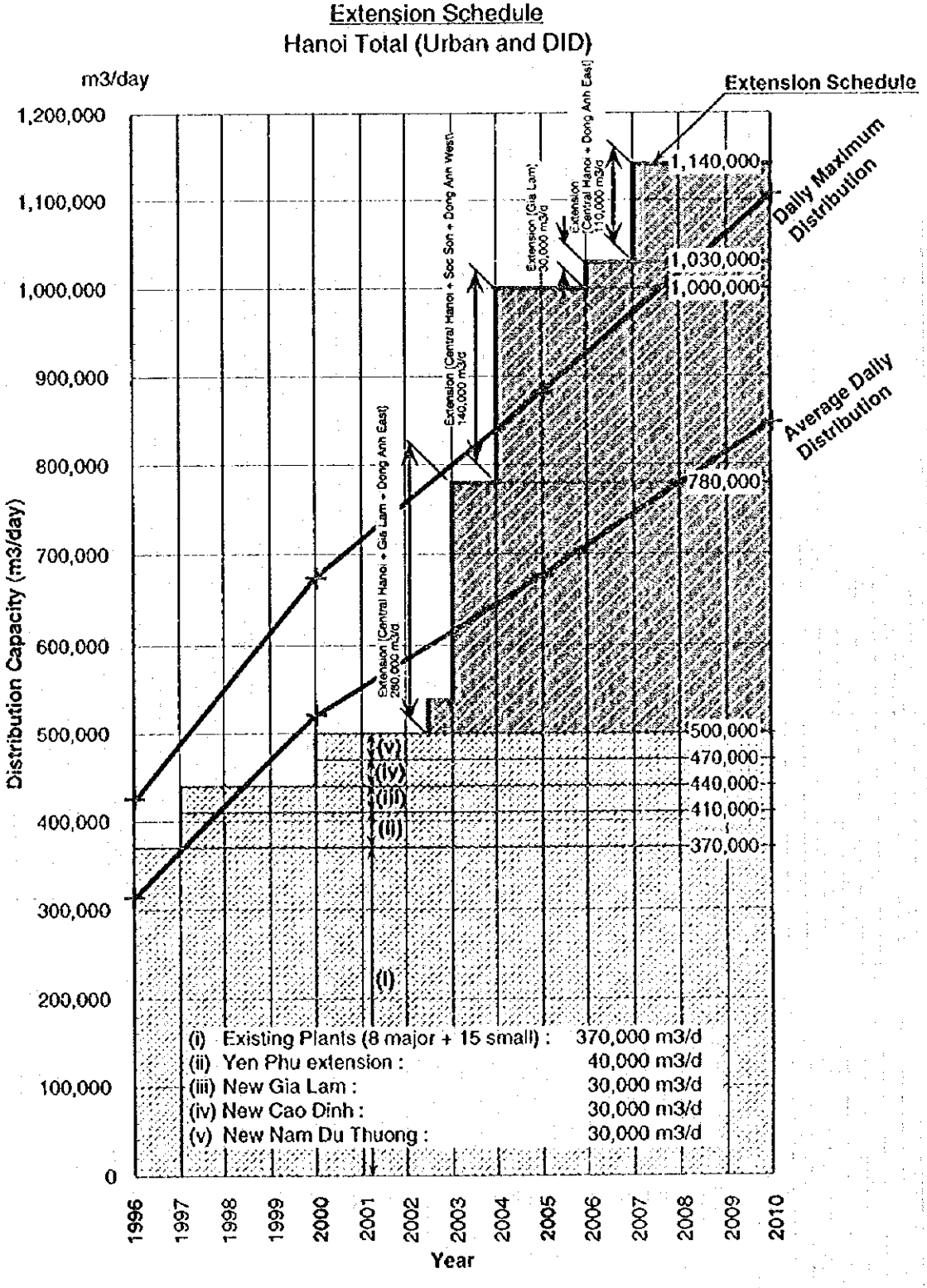
Locations of Proposed Plants



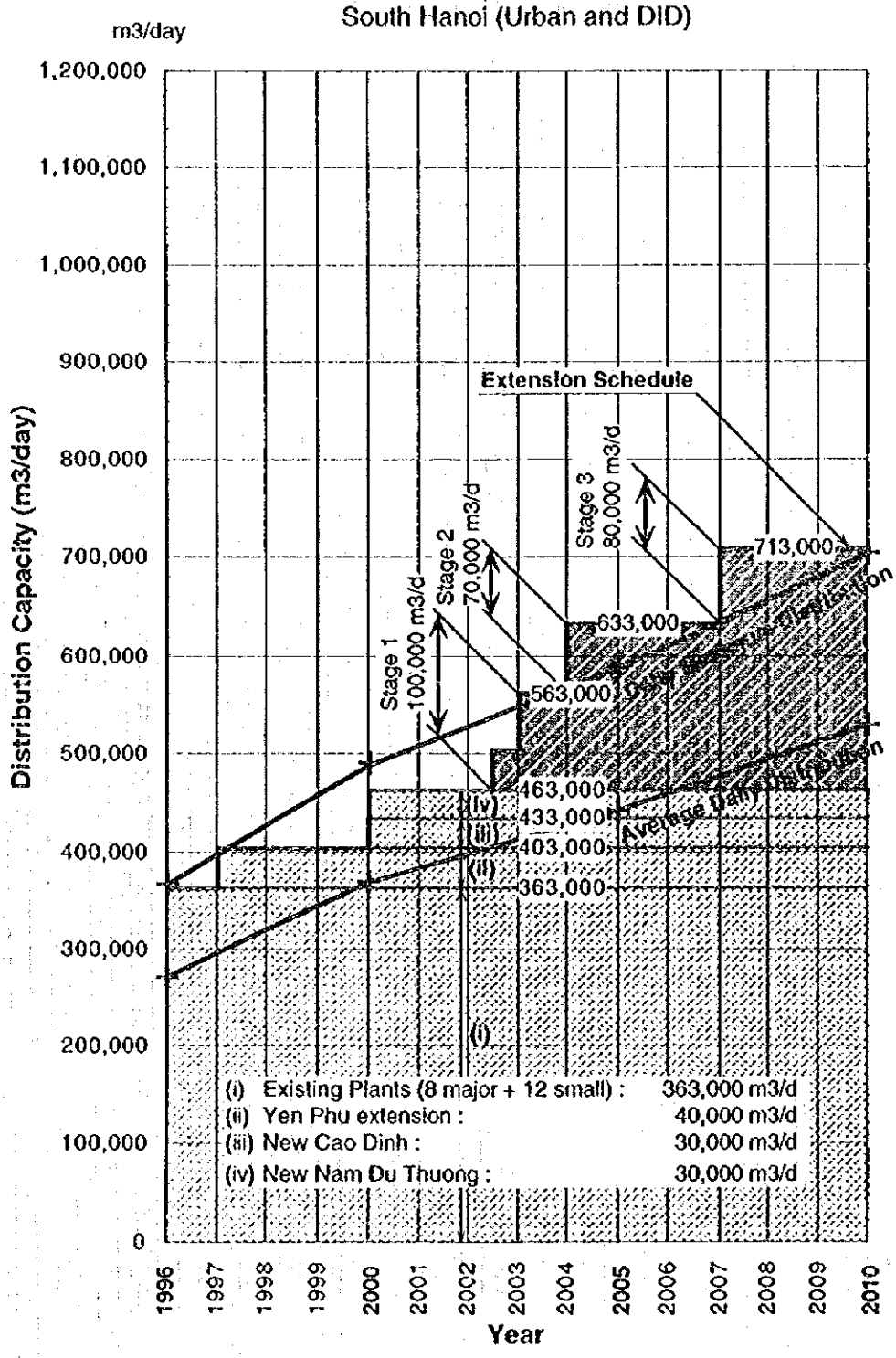
Location of Proposed Plants and Distribution Mains (South Hanoi)



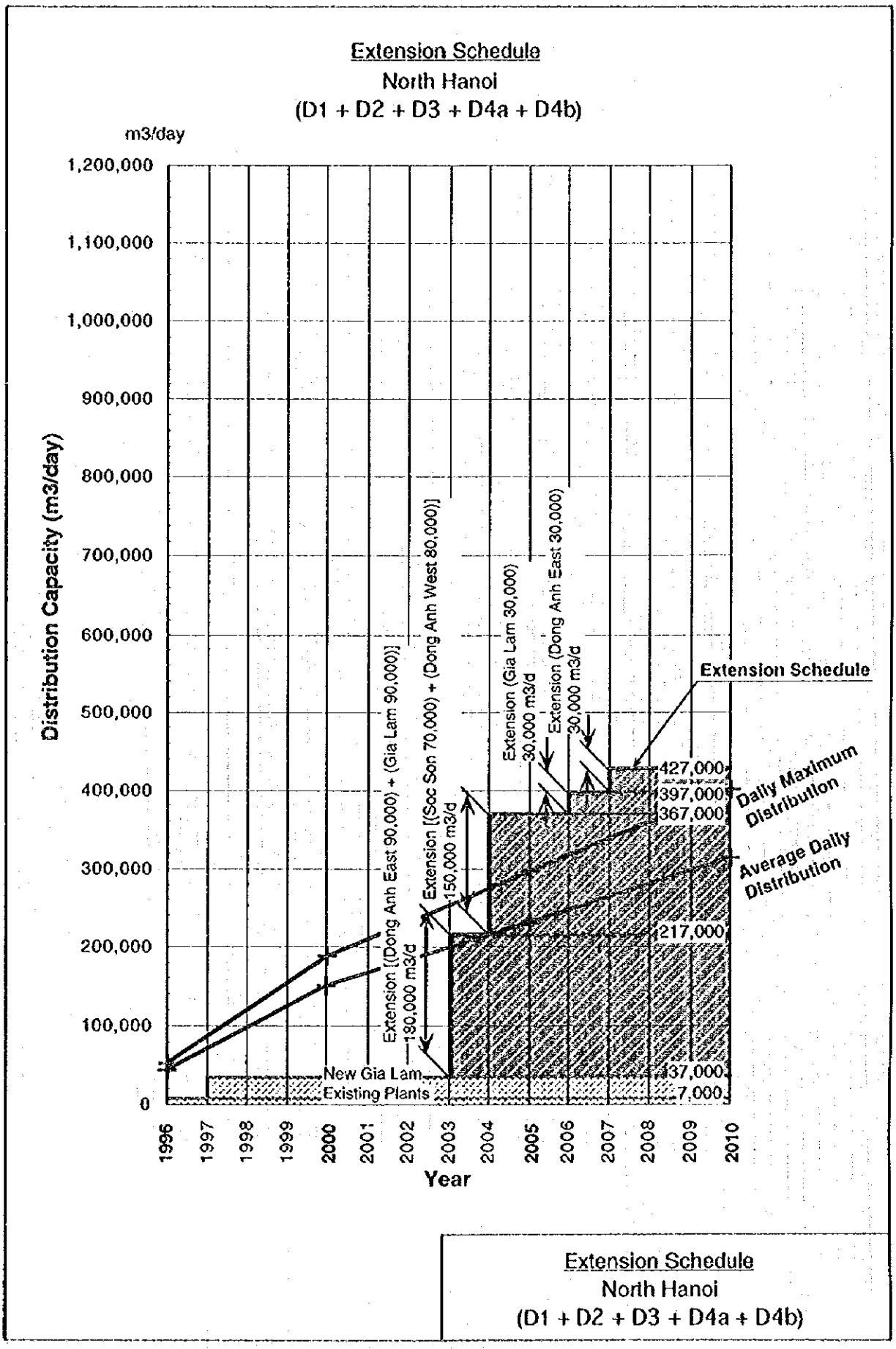
Extension Schedule Schematic
Urban and DID



Extension Schedule
Hanoi Total (Urban and DID)



Extension Schedule
Central Hanoi (U1 + D5 + D6 + D7)
South Hanoi (Urban and DID)

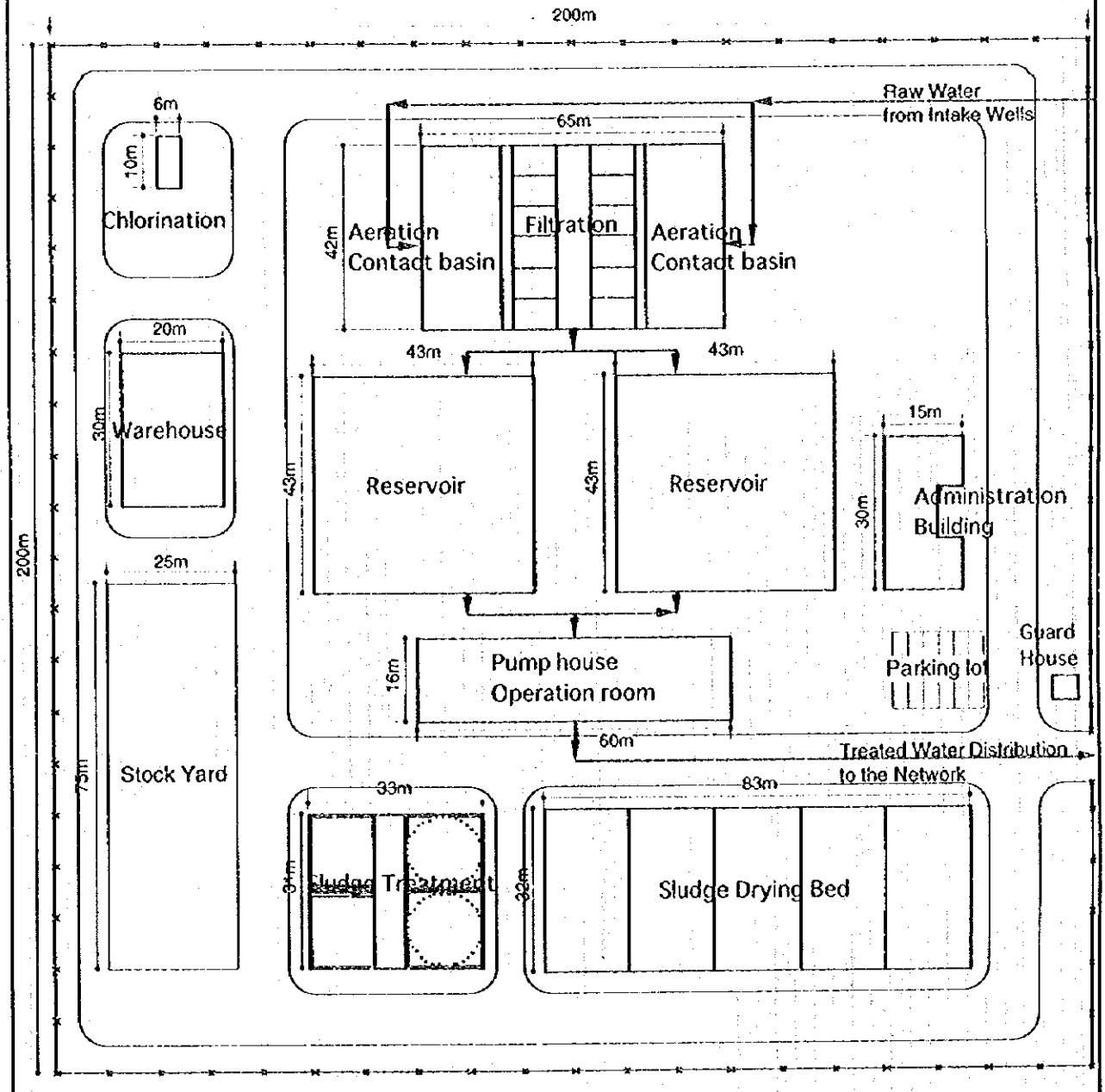


Extension Schedule
North Hanoi
(D1 + D2 + D3 + D4a + D4b)

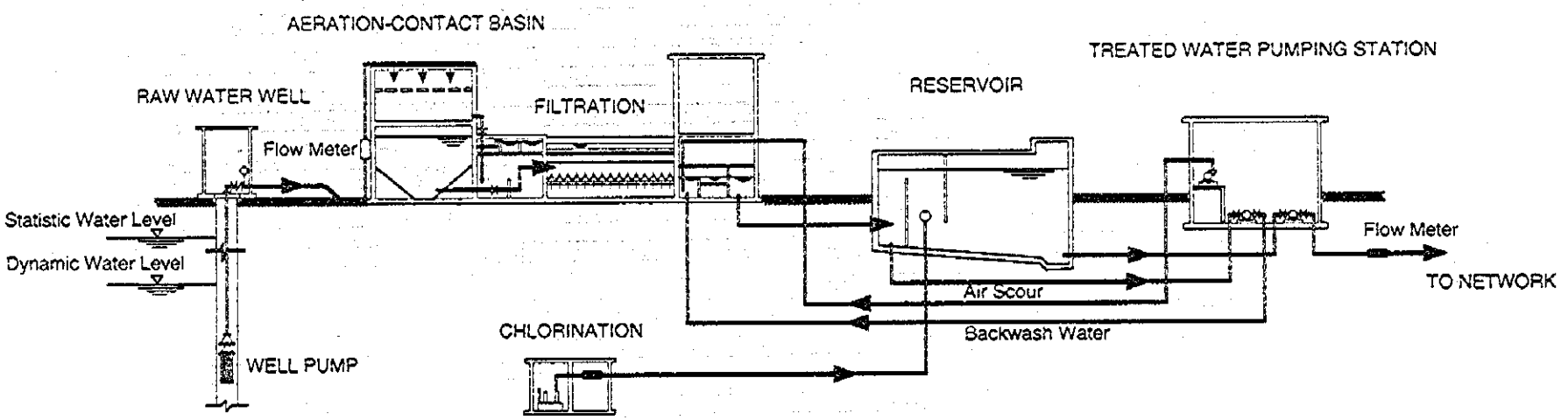
New Construction and Extension Schedule

Location	Place		No	Legend	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
South of Red River	Central Hanoi		(1)	U1 + D5 + D6 + D7	-	-	-	-	-	100,000	70,000	-		80,000	-	-	-
North of Red River	South of Duong River	Gia Lam	(2)	D4b	-	-	-	-	-	90,000	-	-	30,000	-	-	-	-
	North of Duong River	Soc Son	(3)	D1	-	-	-	-	-	-	70,000	-	-	-	-	-	-
		Dong Anh West	(4)	D3	-	-	-	-	-	-	80,000	-	-	-	-	-	-
		Dong Anh East	(5)	D2 + D4a	-	-	-	-	-	90,000	-	-	-	30,000	-	-	-
		Total (3 + 4 + 5)			-	-	-	-	-	90,000	150,000	-	-	30,000	-	-	-
	Total (2 + 3 + 4 + 5)				-	-	-	-	-	180,000	150,000	-	30,000	30,000	-	-	-
Grand Total (1 + 2 + 3 + 4 + 5)					-	-	-	-	-	280,000	220,000	-	30,000	110,000	-	-	-
				Accumulation	-	-	-	-	-	280,000	500,000	500,000	530,000	640,000	640,000	640,000	640,000

Remark :
Yen Phu extension (40,000 m3/d) , New Gia Lam (30,000 m3/d) and the World Bank projects for two treatment plants (Cao Dinh : 30,000 m3/d and Nam Du Thuong : 30,000 m3/d) are excluded from the above table.



Tentative Layout Plan of Treatment Plant (Q = 60,000 m3/d)



Schematic Flow Sheet of a New Treatment Plant
Q = 30,000 m3/day - 100,000 m3/day

Note :
This drawing is tentatively taken from "Hanoi Water Supply and Environment Project Feasibility Study" November 1995, and modified as the reference.

2.2.4 Water Transmission from Gia Lam to Dong Anh and Soc Son

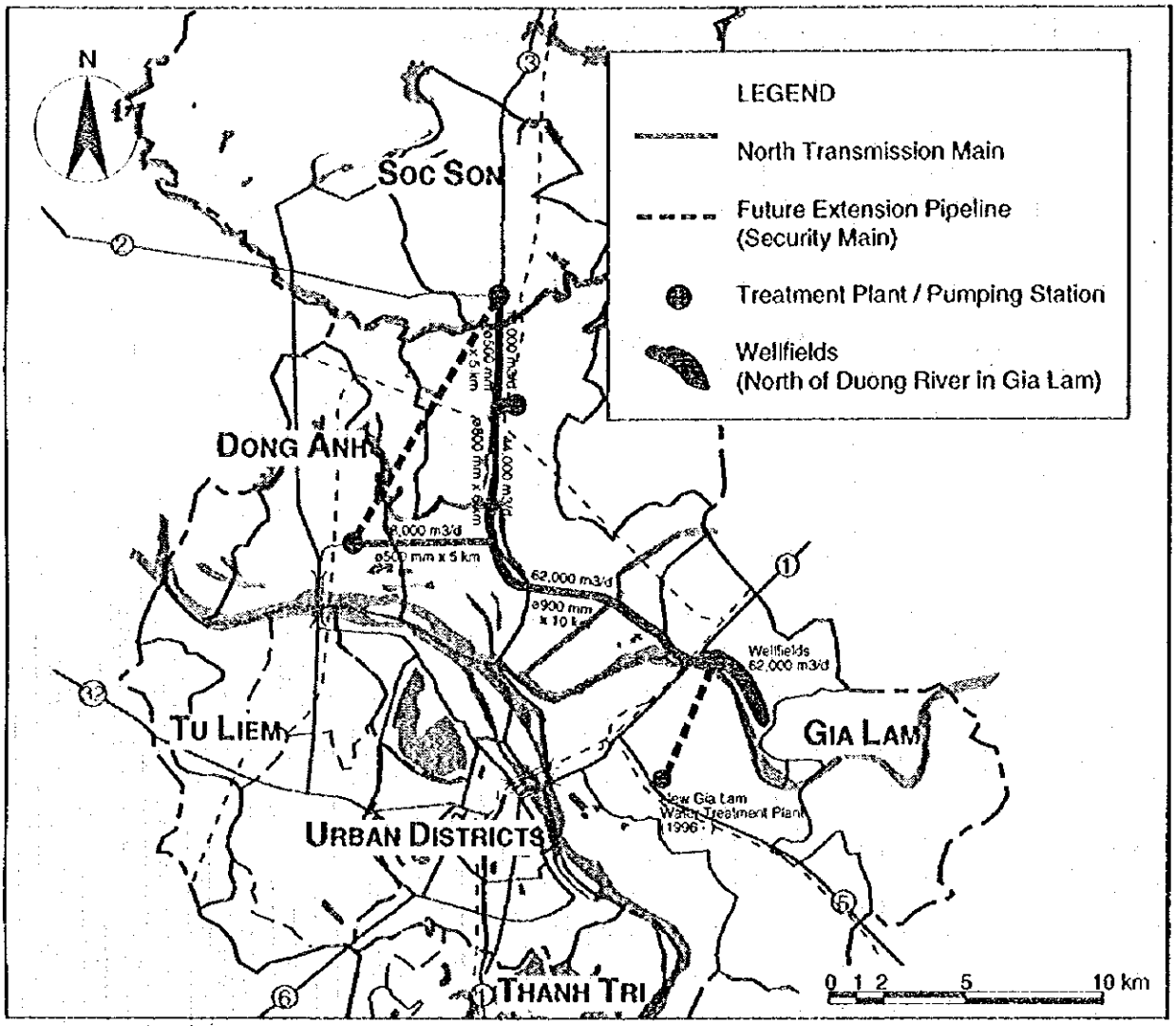
As described in the chapter of "Framework for the Master Plan", Dong Anh and Soc Son will have shortage in groundwater as water source. There, it is planned that treated water in Gia Lam be transmitted to Dong Anh and Soc Son.

The design capacity to be transmitted, by the year 2010, is 83,700 m3/day (59,400 m3/day for Dong Anh and 24,300 m3/day for Soc Son). For this purpose, construction of transmission pipeline and pumping stations is required, which connect Gia Lam and Soc Son via Dong Anh. The construction work is programmed in 2002 - 2003.

The outline of the plan is summarized in the table below. Its location map is shown in the figure in the following page.

In calculating for facility planning, the daily maximum capacity is taken basis for it.

	Gia Lam to Dong Anh	Dong Anh to Soc Son
Capacity (Average Daily)	62,000 m3/d	18,000 m3/d
Capacity (Daily Maximum)	83,700 m3/d	24,300 m3/d
Pipeline	Dia. 900 mm x 10,000 m Dia. 800 mm x 6,000 m Dia. 500 mm x 5,000 m	Dia. 500 mm x 5,000 m
Distribution Pump	180 kW x 4 units	130 kW x 3 units
Construction Cost		
- Pipeline	US$ 8,988,000	US$ 1,204,000
- Pump Station	US$ 1,184,000	US$ 624,000
Total Construction Cost = US$ 12,000,000		



North Transmission Main and Future Plan of the Security Main

Security Main

In view of continuous water supply, it is desirable to construct security mains in the north area of the Red River which connect two or more treatment plants. The figure above illustrates its basic concept, which is presented as the future plan.

Even though it is desirable, however, taking into account of the vast investment to be required, it is recommended that its construction would be done in future after constructing of the North Transmission Main.

2.2.5 Cost Estimates

Based on the new construction and extension schedule for the urban water supply, construction costs were tentatively estimated and their investment schedule was programmed.

Until the year 2010, total investment cost of US$ 500.7 million will be required for the additional capacity of 640,000 m3/day for the urban water supply systems.

Further, annual costs on operation and maintenance for the systems were estimated by unit capacity.

These costs estimated are tabulated in the following pages. (All costs are in the year 1996 price level.)

(Note)
For estimation, the World Bank program (Data of Preappraisal on 8 July 1996) is referred. Taking into account of economic merit of scale, the costs of the other system capacity are estimated in accordance with its pattern of the cases in Japan.

Schedule of Construction and Investment
(Urban Water Supply Systems)

South Hanoi

Place		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (1996 – 2010)
Central Hanoi (1)	Construction	-	-	-	($72,100,000)				(100,000 m3/d)	-	-	-	-	-	-	-	100,000 m3/d
Stage I	Investment	-	-	-	$10,815,000	$10,815,000	$25,235,000	$25,235,000	-	-	-	-	-	-	-	-	$72,100,000
Central Hanoi (2)	Construction	-	-	-		($54,200,000)				(70,000 m3/d)	-	-	-	-	-	-	70,000 m3/d
Stage II	Investment	-	-	-	-	$8,130,000	$8,130,000	$18,970,000	$18,970,000	-	-	-	-	-	-	-	$54,200,000
Central Hanoi (3)	Construction	-	-	-	-	-	-	-	($60,300,000)				(80,000 m3/d)	-	-	-	80,000 m3/d
Stage III	Investment	-	-	-	-	-	-	-	$9,045,000	$9,045,000	$21,105,000	$21,105,000	-	-	-	-	$60,300,000
Accumulation of the Capacity		-	-	-	-	-	-	-	100,000 m3/d	170,000 m3/d	170,000 m3/d	170,000 m3/d	250,000 m3/d	250,000 m3/d	250,000 m3/d	250,000 m3/d	250,000 m3/d
Annual Investment		-	-	-	$10,815,000	$18,945,000	$33,365,000	$44,205,000	$28,015,000	$9,045,000	$21,105,000	$21,105,000	-	-	-	-	
Accumulated Investment *		-	-	-	$10,815,000	$29,760,000	$63,125,000	$107,330,000	$135,345,000	$144,390,000	$165,495,000	$186,600,000	$186,600,000	$186,600,000	$186,600,000	$186,600,000	$186,600,000

North of Red River

Place		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (1996 – 2010)
Gia Lam (1)	Construction	-	-	-	($66,300,000)				(90,000 m3/d)	-	-	-	-	-	-	-	90,000 m3/d
	Investment	-	-	-	$9,945,000	$9,945,000	$23,205,000	$23,205,000	-	-	-	-	-	-	-	-	$66,300,000
Gia Lam (2)	Construction	-	-	-	-	-	-	($27,500,000)				(30,000 m3/d)	-	-	-	-	30,000 m3/d
	Investment	-	-	-	-	-	-	$4,125,000	$4,125,000	$9,625,000	$9,625,000	-	-	-	-	-	$27,500,000
Soc Son	Construction	-	-	-	-	($54,200,000)				(70,000 m3/d)	-	-	-	-	-	-	70,000 m3/d
	Investment	-	-	-	-	$8,130,000	$8,130,000	$18,970,000	$18,970,000	-	-	-	-	-	-	-	$54,200,000
Dong Anh West	Construction	-	-	-	-	($60,300,000)				(80,000 m3/d)	-	-	-	-	-	-	80,000 m3/d
	Investment	-	-	-	-	$9,045,000	$9,045,000	$21,105,000	$21,105,000	-	-	-	-	-	-	-	$60,300,000
Dong Anh East (1)	Construction	-	-	-	($66,300,000)				(90,000 m3/d)	-	-	-	-	-	-	-	90,000 m3/d
	Investment	-	-	-	$9,945,000	$9,945,000	$23,205,000	$23,205,000	-	-	-	-	-	-	-	-	$66,300,000
Dong Anh East (2)	Construction	-	-	-	-	-	-	-	($27,500,000)				(30,000 m3/d)	-	-	-	30,000 m3/d
	Investment	-	-	-	-	-	-	-	$4,125,000	$4,125,000	$9,625,000	$9,625,000	-	-	-	-	$27,500,000
Groundwater	Construction	-	-	-	-	-	-	($12,000,000)		-	-	-	-	-	-	-	-
Transmission	Investment	-	-	-	-	-	-	$6,000,000	$6,000,000	-	-	-	-	-	-	-	$12,000,000
Accumulation of the Capacity		-	-	-	-	-	-	-	180,000 m3/d	330,000 m3/d	330,000 m3/d	360,000 m3/d	390,000 m3/d	390,000 m3/d	390,000 m3/d	390,000 m3/d	390,000 m3/d
Annual Investment		-	-	-	$19,890,000	$37,065,000	$63,585,000	$96,610,000	$54,225,000	$13,750,000	$19,250,000	$9,625,000	-	-	-	-	
Accumulated Investment		-	-	-	$19,890,000	$56,955,000	$120,540,000	$217,150,000	$271,475,000	$285,225,000	$304,475,000	$314,100,000	$314,100,000	$314,100,000	$314,100,000	$314,100,000	$314,100,000

Standard Constrution Cost by System Capacity

System Capacity	Consturuction Cost of the System (Treatment plant, Water source and Networks)		
	Total Construction Cost	Local Currency Portion	Foreign Currency Portion
120,000 m3/d	$83,400,000	$34,200,000	$49,200,000
110,000 m3/d	$77,800,000	$31,900,000	$45,900,000
100,000 m3/d	$72,100,000	$29,600,000	$42,500,000
90,000 m3/d	$66,300,000	$27,200,000	$39,100,000
80,000 m3/d	$60,300,000	$24,700,000	$35,600,000
70,000 m3/d	$54,200,000	$22,200,000	$32,000,000
60,000 m3/d	$47,900,000	$19,600,000	$28,300,000
50,000 m3/d	$41,400,000	$17,000,000	$24,400,000
40,000 m3/d	$34,600,000	$14,200,000	$20,400,000
30,000 m3/d	$27,500,000	$11,300,000	$16,200,000

Tentative Cost Estimates of Operation and Maintenance for Urban Water Supply Systems

(Case of Non-Industrial Water : Daily maximum factor = 1.35)

(Constant price of 1996 level, US$1.00 = VND 11,000 VND:Vietnamese Dong)

System Capacity	(A) Daily Maximum Production Capaciy (m3/day)	(B) Daily Maximum Consumption (m3/day)	Operation and Maintenance Cost (VND/year) (C) Staff	(D) Chemical	(E) Electric	(F) Repair	(G) Others	(H) Total	(I) Operation and Maintenance Cost per Consumption (VND/m3)
120,000 m2/d	120,000	102,000	316,800,000 1.4%	153,300,000 0.7%	9,733,333,200 43.7%	9,174,000,000 41.2%	2,906,614,980 13.0%	22,284,048,180 100.0%	808
110,000 m3/d	110,000	93,500	316,800,000 1.5%	140,525,000 0.7%	8,922,222,000 43.3%	8,558,000,000 41.5%	2,690,632,050 13.0%	20,628,179,050 100.0%	816
100,000 m3/d	100,000	85,000	277,200,000 1.5%	127,750,000 0.7%	8,111,111,400 42.9%	7,931,000,000 41.9%	2,467,059,210 13.0%	18,914,120,610 100.0%	823
90,000 m3/d	90,000	76,500	277,200,000 1.6%	114,975,000 0.7%	7,300,000,200 42.4%	7,293,000,000 42.3%	2,247,776,280 13.0%	17,232,951,480 100.0%	833
80,000 m3/d	80,000	68,000	277,200,000 1.8%	102,200,000 0.7%	6,488,889,000 41.8%	6,633,000,000 42.7%	2,025,193,350 13.0%	15,526,482,350 100.0%	845
70,000 m3/d	70,000	59,500	237,600,000 1.7%	89,425,000 0.6%	5,677,777,800 41.3%	5,962,000,000 43.3%	1,795,020,420 13.0%	13,761,823,220 100.0%	855
60,000 m3/d	60,000	51,000	237,600,000 2.0%	76,650,000 0.6%	4,866,666,600 40.5%	5,269,000,000 43.8%	1,567,487,490 13.0%	12,017,404,090 100.0%	872
50,000 m3/d	50,000	42,500	237,600,000 2.3%	63,875,000 0.6%	4,055,555,400 39.6%	4,554,000,000 44.4%	1,336,654,560 13.0%	10,247,684,960 100.0%	892
40,000 m3/d	40,000	34,000	198,000,000 2.4%	51,100,000 0.6%	3,244,444,200 38.6%	3,806,000,000 45.3%	1,094,931,630 13.0%	8,394,475,830 100.0%	913
30,000 m3/d	30,000	25,500	198,000,000 3.0%	38,325,000 0.6%	2,433,333,600 37.2%	3,025,000,000 46.2%	854,198,790 13.0%	6,548,857,390 100.0%	950

Remarks :

(B) = (A) x (1 - 0.15) [Leakage loss : 15%]

(C) = [Number of Staff] x 660,000(VND/month/person) x 12(months/year)

(120,000 - 110,000 m3/d : 40 persons, 100,000 - 80,000 m3/d : 35 persons, 70,000 - 50,000 m3/d : 30 persons, 40,000 - 30,000 m3/d : 25 persons)

(D) = (A) x 1.05[Plant loss : 5%] / 1.35[Daily maximum factor : 135 %] x 365 (days/year) x 1/1000(kg/m3)[Chlorine dosage : 1 ppm] x 4,500(VND/kg)[Liquid chlorine price]

(E) = (A) / 1.35[Daily maximum factor] x 365(days/year) x 0.5(KW/m3) x 600 VND/kWh

(F) = [Construction Cost] x 1%

(G) = ((C) + (D) + (E) + (F)) x 15%

(H) = (C) + (D) + (E) + (F) + (G)

(I) = (H) / (B) x 1.35[Daily maximum factor] / 365(days/year)

Tentative Cost Estimates of Operation and Maintenance for Urban Water Supply Systems

(Case of Industrial Water : Daily maximum factor = 1.1)

(Constant price of 1996 level, US$1.00 = VND 11,000 VND:Vietnamese Dong)

System Capacity	(A) Daily Maximum Production Capaciy (m3/day)	(B) Daily Maximum Consumption (m3/day)	Operation and Maintenance Cost (VND/year) (C) Staff	(D) Chemical	(E) Electric	(F) Repair	(G) Others	(H) Total	(I) Operation and Maintenance Cost per Consumption (VND/m3)
120,000 m3/d	120,000	102,000	316,800,000 1.3%	188,140,909 0.8%	11,945,454,600 48.0%	9,174,000,000 36.9%	3,243,659,326 13.0%	24,868,054,835 100.0%	735
110,000 m3/d	110,000	93,500	316,800,000 1.4%	172,462,500 0.7%	10,950,000,000 47.6%	8,558,000,000 37.2%	2,999,589,375 13.0%	22,996,851,875 100.0%	741
100,000 m3/d	100,000	85,000	277,200,000 1.3%	156,784,091 0.7%	9,954,545,400 47.3%	7,931,000,000 37.6%	2,747,929,424 13.0%	21,067,458,915 100.0%	747
90,000 m3/d	90,000	76,500	277,200,000 1.4%	141,105,682 0.7%	8,959,090,800 46.7%	7,293,000,000 38.0%	2,500,559,472 13.0%	19,170,955,954 100.0%	755
80,000 m3/d	80,000	68,000	277,200,000 1.6%	125,427,273 0.7%	7,963,636,200 46.2%	6,633,000,000 38.5%	2,249,889,521 13.0%	17,249,152,994 100.0%	764
70,000 m3/d	70,000	59,500	237,600,000 1.6%	109,748,864 0.7%	6,968,181,600 45.6%	5,962,000,000 39.0%	1,991,629,570 13.0%	15,269,160,034 100.0%	773
60,000 m3/d	60,000	51,000	237,600,000 1.8%	94,070,455 0.7%	5,972,727,000 44.9%	5,269,000,000 39.6%	1,736,009,618 13.0%	13,309,407,073 100.0%	786
50,000 m3/d	50,000	42,500	237,600,000 2.1%	78,392,045 0.7%	4,977,273,000 44.0%	4,554,000,000 40.2%	1,477,089,757 13.0%	11,324,354,802 100.0%	803
40,000 m3/d	40,000	34,000	198,000,000 2.1%	62,713,636 0.7%	3,981,818,400 43.0%	3,806,000,000 41.1%	1,207,279,805 13.0%	9,255,811,841 100.0%	820
30,000 m3/d	30,000	25,500	198,000,000 2.8%	47,035,227 0.7%	2,986,363,800 41.5%	3,025,000,000 42.0%	938,459,854 13.0%	7,194,858,881 100.0%	850

Remarks :

(B) = (A) x (1 - 0.15) [Leakage loss : 15%]

(C) = [Number of Staff] x 660,000(VND/month/person) x 12(months/year)
(120,000 - 110,000 m3/d : 40 persons, 100,000 - 80,000 m3/d : 35 persons, 70,000 - 50,000 m3/d : 30 persons, 40,000 - 30,000 m3/d : 25 persons)

(D) = (A) x 1.05[Plant loss : 5%] / 1.1[Daily maximum factor : 110 %] x 365 (days/year) x 1/1000(kg/m3)[Chlorine dosage : 1 ppm] x 4,500(VND/kg)[Liquid chlorine price]

(E) = (A) / 1.1[Daily maximum factor] x 365(days/year) x 0.5(kW/m3) x 600 VND/kWh

(F) = [Construction Cost] x 1%

(G) = ((C) + (D) + (E) + (F)) x 15%

(H) = (C) + (D) + (E) + (F) + (G)

(I) = (H) / (B) x 1.1[Daily maximum factor] / 365(days/year)

2.3 EXTENSION PROGRAM FOR RURAL WATER SUPPLY

2.3.1 Planning Criteria

Public water supply systems to be planned and constructed in the study area are classified into two major categories : urban water supply and rural water supply.

"The rural water supply" in this Report means supply of drinking water through pipelines operated by public organizations to people in rural communes (phuong or xa) in the study area where public water supply systems have not been available.

Requirements for the rural water supply systems are considered as follows :

- Low cost for construction and operation.
- Easiness for operation of facilities.
- Earlier implementation of the project, or speedy period for facilities' construction work.

The following are basic policy and criteria for planning the rural water supply systems.

(1) The System

The water supply system proposed here for the rural area is an independent water supply system to be operated by each commune (phuong or xa). The system consists of facilities for water source, treatment and distribution.

Note 1
In principle, the system is independent by itself and is not connected to other systems in adjacent communes. However, from a view point of geographical conditions of the communes, some communes would be better to organize a bigger system combined with each other. It would be further studied at the time of the project implementation.

Note 2
When a transmission pipeline of raw water or treated water of other urban water

supply system passes through a commune for the rural water supply system, this commune would be planned to receive water from the transmission pipeline.

(2) Unit Demand and Coverage Rate

The unit demand, i.e. per capita consumption is set at 90 liters/capita/day on the daily average basis for the year 2010. The coverage rate (percentage of the served population to administrative population in the commune) is set at 85%.

(3) Water Source

Water source is planned to be deep groundwater, and the groundwater necessary for the commune, 1,500 m3/d at the maximum for one commune, is supposed to be obtainable within the commune area. The availability of the groundwater is to be confirmed at the time of the project implementation, with test well method or other appropriate way.

(4) Deep Wells

The groundwater is to be taken through a deep well to be equipped with a submersible pump. The number of the deep well is planned to be one for operation and additional one for standby; totaling two deep wells to one commune.

(5) Treatment

Groundwater in the area contains iron and manganese, concentration of which is higher than the drinking water standard. Accordingly, the groundwater needs treatment.

Treatment process, aim of which is removal of iron and manganese, is to be composed of aeration, filtration and disinfection. The treatment plant is planned to be located on the same place as deep wells for groundwater source.

(6) Disinfection

Disinfection is proposed to be done with hypo-chloride liquid as same presently

used in small plants of HWBC. It is fed to the inlet chamber of the reservoir, or into the inlet pipe (filtrated water pipe) of the reservoir.

(7) Power Source

Power necessary for mainly raw water intake pumps and distribution pumps is planned to be of the public electricity. Generators for the time of power failure will not be considered and not installed in the system, due to economical reason. (Accordingly, water will not be supplied during the period of the public electricity's power failure).

(8) Public Taps

Water is to be supplied to consumers through public water taps (public stand posts) equipped with a water meter each. The public taps will be located within a distance of less than 100 m. Each tap will serve about 100 people.

(9) Pipe Material

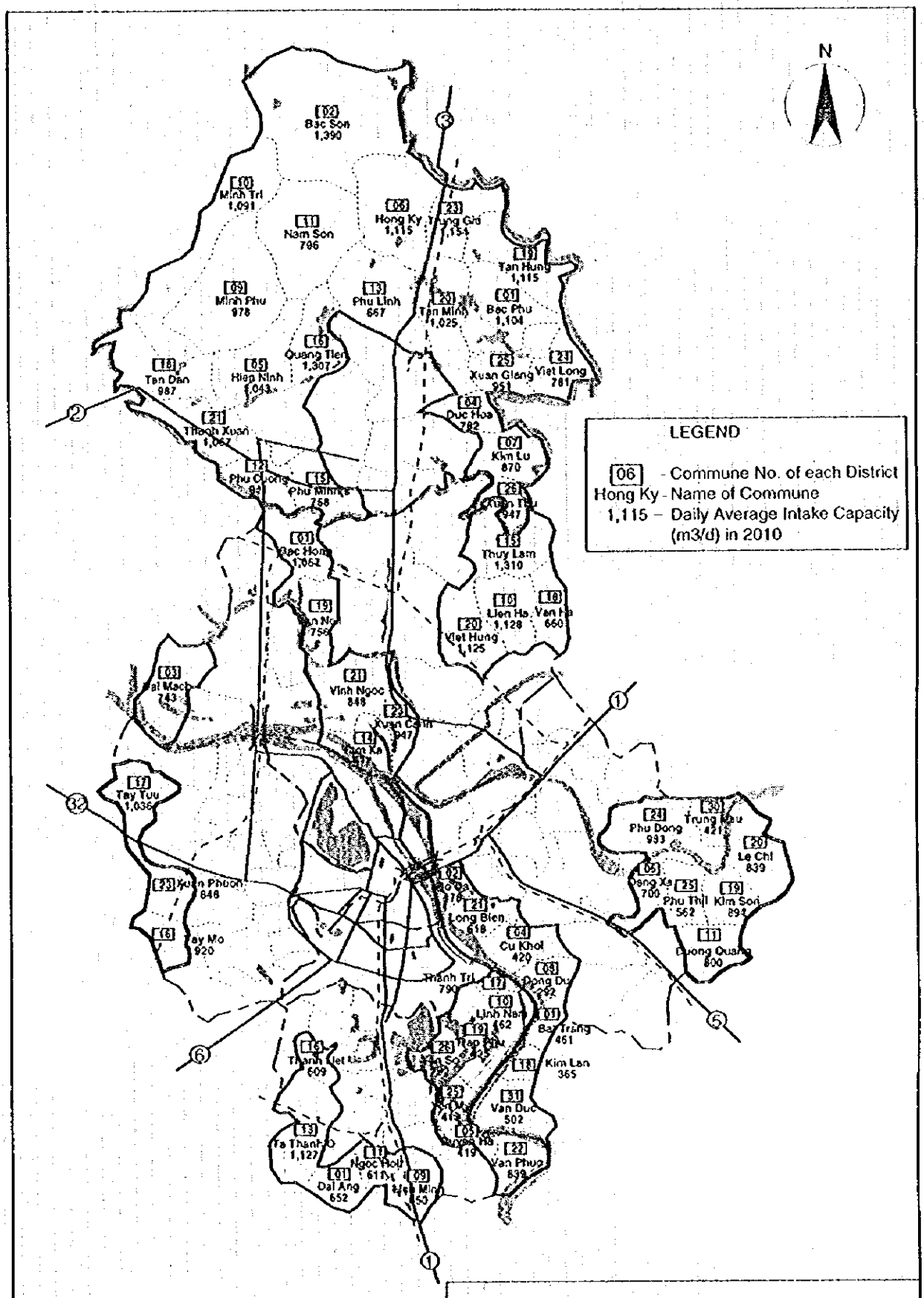
Pipe material for distribution pipelines, the maximum diameter of which is 225-200 mm, is proposed to be plastic pipes (PVC or PE) which are locally available and cheaper in procurement cost than that of ductile cast iron pipes used in the central Hanoi.

(10) Leakage

Leakage in distribution pipelines is assumed to be 15% of the distribution capacity, taking consideration of that the pipelines will be newly constructed and have no individual house connections.

(11) Fire Hydrants

From an economical viewpoint, water and facilities for fire fighting activities, such as fire hydrants and water storage tank for the fire, will not be considered and not included in this system.


N
LEGEND
06 - Commune No. of each District
Hong Ky - Name of Commune
1,115 - Daily Average Intake Capacity (m3/d) in 2010
0 2 4 6 km
Communes for Rural Water Supply System

2.3.2 Communes for the Rural Water Supply System

Communes (phuong or xa) for the planning of the rural water supply system are listed in the Tables on the following pages, together with water demand and capacities of facilities required.

Sizes of the system is summarized below :

- Number of communes : 60 communes in total
  (Soc Son : 21)+(Dong Anh : 10)+(Gia Lam : 14)+(Tu Liem : 3)+(Thanh Tri : 12)
  = 60 communes.

- Total population in a commune (Year 2010) :
  14,711 (max.) - 3,090 (min.); and 8,658 persons on average.

- Population served (Year 2010) :
  12,504 (max.) - 2,627 (min.); and 7,359 persons on average.

- Water Demand in a commune on the daily average basis (Year 2010) :
  1,125 m^3/day (Max.) - 236 m^3/day (Min.); and 662 m^3/day on average.

- Capacity of raw water intake and treatment plant on the daily maximum basis (Year 2010):
  1,841 m^3/day (Max.) - 387 m^3/day; and 1,083 m^3/day on average.

For the sake of convenience of the basic planning of rural water supply systems, the 60 communes are classified into 3 classes. They are Class A (20 larger communes), Class B (20 middle communes), and Class C (20 smaller communes), as tabulated below:

Classification of Rural Water Supply Systems by Commune

Class	Number of Communes	Population of a commune in 2010			For Representative Commune (Year : 2010)						Typical Design Capacity					
		Maximum Population among the Class (persons)	Minimum population among the Class (persons)	(A) Average population (presentative) among the Class (persons)	(B) Population Served (persons)	(C) Unit Water Demand (liters/cap/day)	(D) Daily Average Water Demand (m3/d)	(E) Daily Average Production and Distribution Capacity (m3/d)	(F) Daily Average Raw Water Intake and Treatment Capacity (m3/d)	(G) Daily Maximum Raw Water Intake and Treatment Capacity (m3/d)	(H) Intake and Treatment Capacity (m3/d)	(I) Production and Distribution Capacity (m3/d)	(J) Peak Hour Capacity (m3/hour)	(K) Average Area of Commune (ha)	(L) Average Road Distance per Area (m/ha)	(M) Average Roac Distance in a Commune (m)
Class A	20	14,711	10,068	11,695	9,940	90	895	1,053	1,105	1,492	1,500	1,429	83.3	1,227	7.6	8,466
Class B	20	10,029	7,864	8,872	7,541	90	679	798	838	1,132	1,100	1,048	61.1	815	10.8	6,601
Class C	20	7,416	3,090	5,406	4,595	90	414	487	511	690	700	667	38.9	408	13.0	4,953

Remarks :

(B) = (A) x 85% (Coverage rate = 85%)

(D) = (B) x (C)

(E) = (D) / 0.85 (Leakage loss = 15%)

(F) = (E) x 1.05 (Loss in plant = 5%)

(G) = (F) x 1.35 (Peak day factor = 1.35)

(H) = Rounded figure of (G)

(I) = (H) / 1.05

(J) = (I) x 1.40 (Peak hourly factor = 1.40)

Water Demand, Production and Raw Water Capacity for Rural Water Supply Systems

District		Commune	(A) Area (ha)	(B) Population (persons)	(C) Population Served (persons)	(D) Daily Average Unit Demand (liter/cap/day)	(E) Daily Average Water Demand (m3/day)	(F) Daily Average Production Capacity (m3/day)	(G) Daily Average Raw Water Capacity (m3/day)	(H) Daily Maximum Production Capacity (m3/day)	(I) Daily Maximum Raw Water Capacity (m3/day)	Classification	(J) Total Road Distance (m)	(K) Road Distance per Area (m/ha)	(L) Road Distance per Person Served (m/person)
Soc Son	01	Bac Phu	993.1	11,668	9,918	90	893	1,051	1,104	1,419	1,490	Class A	5,600	5.6	0.6
	02	Bac Son	3,630.6	14,711	12,504	90	1,125	1,324	1,390	1,787	1,877	Class A	13,000	3.6	1.0
	04	Duc Hoa	716.2	8,277	7,035	90	633	745	782	1,006	1,056	Class B	4,600	6.4	0.7
	05	Hien Ninh	697.1	11,029	9,375	90	844	993	1,043	1,341	1,408	Class A	10,290	11.5	1.1
	06	Hong Ky	1,800.0	11,800	10,030	90	903	1,062	1,115	1,434	1,505	Class A	8,180	4.5	0.8
	07	Kim Lu	470.9	9,219	7,836	90	705	829	870	1,119	1,175	Class B	6,880	14.6	0.9
	09	Minh Phu	2,181.0	10,344	8,792	90	791	931	978	1,257	1,320	Class A	11,970	5.5	1.4
	10	Minh Tri	2,435.1	11,537	9,806	90	883	1,039	1,091	1,403	1,473	Class A	13,940	5.7	1.4
	11	Nam Son	2,900.0	8,420	7,157	90	644	758	796	1,023	1,075	Class B	7,500	2.6	1.0
	12	Phu Cuong	901.7	9,956	8,463	90	762	896	941	1,210	1,270	Class B	10,700	11.9	1.3
	13	Phu Linh	1,496.0	9,177	7,800	90	702	826	867	1,115	1,170	Class B	8,000	5.3	1.0
	15	Phu Minh(s	743.8	8,112	6,895	90	621	731	768	987	1,037	Class B	9,353	12.6	1.4
	16	Quang Tien	1,469.7	13,832	11,757	90	1,058	1,245	1,307	1,681	1,764	Class A	21,890	14.9	1.9
	18	Tan Dan	998.1	10,450	8,883	90	799	940	987	1,269	1,332	Class A	5,070	5.1	0.6
	19	Tan Hung	899.9	11,808	10,037	90	903	1,062	1,115	1,434	1,505	Class A	4,000	4.4	0.4
	20	Tan Minh	1,072.4	10,846	9,219	90	830	976	1,025	1,318	1,384	Class A	12,540	11.7	1.4
	21	Thanh Xuan	726.6	11,293	9,599	90	864	1,016	1,067	1,372	1,440	Class A	9,480	13.0	1.0
	23	Trung Gia	833.3	12,215	10,383	90	934	1,099	1,154	1,484	1,558	Class A	4,536	5.4	0.4
	24	Viet Long	695.4	8,264	7,024	90	632	744	781	1,004	1,054	Class B	2,530	3.6	0.4
	25	Xuan Giang	835.5	10,068	8,558	90	770	906	951	1,223	1,284	Class A	4,450	5.3	0.5
	26	Xuan Thu	641.3	10,021	8,518	90	767	902	947	1,218	1,278	Class B	7,690	12.0	0.9
	Total (21 communes)		27,342.7	223,047	189,689	90	17,063	20,075	21,079	27,104	28,455		182,199	6.7	1.0
Dong Anh	01	Bac Hong	710.0	11,300	9,605	90	864	1,016	1,067	1,372	1,440	Class A	4,930	6.9	0.5
	03	Dai Mach	920.0	7,864	6,684	90	602	708	743	956	1,003	Class B	1,920	2.1	0.3
	10	Lien Ha	870.0	11,928	10,139	90	913	1,074	1,128	1,450	1,523	Class A	5,500	6.3	0.5
	14	Tam Xa	510.0	5,469	4,649	90	418	492	517	664	698	Class C	1,900	3.7	0.4
	15	Thuy Lam	1,000.0	13,870	11,790	90	1,061	1,248	1,310	1,685	1,769	Class A	10,500	10.5	0.9
	18	Van Ha	540.0	6,995	5,946	90	535	629	660	849	891	Class C	6,100	11.3	1.0
	19	Van Noi	640.0	7,994	6,795	90	612	720	756	972	1,021	Class B	12,000	18.8	1.8
	20	Viet Hung	630.0	11,891	10,107	90	910	1,071	1,125	1,446	1,519	Class A	11,600	14.0	1.1
	21	Vinh Ngoc	960.0	8,979	7,632	90	687	808	848	1,091	1,145	Class B	5,600	5.8	0.7
	23	Xuan Canh	610.0	10,029	8,525	90	767	902	947	1,218	1,278	Class B	6,500	10.7	0.8
	Total (10 communes)		7,590.0	96,319	81,872	90	7,369	8,668	9,101	11,703	12,287		66,550	8.8	0.8
Gia Lam	01	Bat Trang	180.0	4,878	4,146	90	373	439	461	593	622	Class C	4,200	23.3	1.0
	02	Bo De	310.0	5,032	4,277	90	385	453	476	612	643	Class C	4,380	14.1	1.0
	04	Cu Khoi	360.0	4,449	3,782	90	340	400	420	540	567	Class C	3,600	10.0	1.0
	06	Dang Xa	570.0	7,416	6,304	90	567	667	700	900	945	Class C	3,000	5.3	0.5
	08	Dong Du	300.0	3,090	2,627	90	236	278	292	375	394	Class C	2,800	9.3	1.1
	11	Duong Quang	500.0	8,472	7,201	90	648	762	800	1,029	1,080	Class B	11,800	23.6	1.6
	18	Kim Lan	260.0	3,874	3,293	90	296	348	365	470	493	Class C	3,780	14.5	1.1
	19	Kim Son	560.0	9,448	8,031	90	723	851	894	1,149	1,207	Class B	3,460	6.2	0.4
	20	Le Chi	870.0	8,874	7,543	90	679	799	839	1,079	1,133	Class B	3,600	4.1	0.5
	21	Long Bien	530.0	6,553	5,570	90	501	589	618	795	834	Class C	8,200	15.5	1.5
	24	Phu Dong	1,090.0	10,407	8,845	90	796	936	983	1,264	1,327	Class A	3,800	3.5	0.4
	25	Phu Thi	440.0	5,943	5,052	90	455	535	562	722	759	Class C	5,530	12.6	1.1
	30	Trung Mau	370.0	4,456	3,788	90	341	401	421	541	568	Class C	5,670	15.3	1.5
	31	Van Duc	460.0	5,311	4,514	90	406	478	502	645	678	Class C	6,700	14.6	1.5
	Total (10 Communes)		6,800.0	68,203	74,974	90	6,746	7,936	8,333	10,714	11,250		70,620	10.4	0.9
Tu Liem	16	Tay Mo	580.0	9,738	8,277	90	745	876	920	1,183	1,242	Class B	3,790	6.5	0.5
	17	Tay Tuu	530.0	10,967	9,322	90	839	987	1,036	1,332	1,399	Class A	5,450	10.3	0.6
	23	Xuan Phuon	550.0	8,980	7,633	90	687	808	848	1,091	1,145	Class B	7,170	13.0	0.9
	Total (3 communes)		1,660.0	29,685	25,232	90	2,271	2,671	2,804	3,606	3,786		16,410	9.9	0.7
Thanh Tri	01	Dai Ang	490.0	6,900	5,865	90	528	621	652	838	880	Class C	7,030	14.3	1.2
	05	Duyen Ha	340.0	4,437	3,771	90	339	399	419	539	566	Class C	1,880	5.5	0.5
	09	Lien Minh	420.0	6,873	5,842	90	526	619	650	836	878	Class C	1,700	4.0	0.3
	10	Linh Nam	552.1	4,888	4,155	90	374	440	462	594	624	Class C	5,770	10.5	1.4
	11	Ngoc Hoi	330.0	6,477	5,505	90	495	582	611	786	825	Class C	8,670	26.3	1.6
	13	Ta Thanh O	740.0	11,926	10,137	90	912	1,073	1,127	1,449	1,521	Class A	2,660	3.5	0.3
	16	Thanh Liet	334.2	6,441	5,475	90	493	580	609	783	822	Class C	9,470	28.3	1.7
	17	Thanh Tri	260.4	8,355	7,102	90	639	752	790	1,015	1,067	Class B	11,700	44.9	1.6
	19	Trap Phu	357.9	4,283	3,641	90	328	386	405	521	547	Class C	4,670	13.0	1.3
	22	Van Phuc	670.0	8,579	7,547	90	679	799	839	1,079	1,133	Class B	4,640	6.1	0.6
	25	Yen My	498.4	4,362	3,708	90	334	393	413	531	558	Class C	4,000	8.0	1.1
	26	Yen So	710.7	8,385	7,127	90	641	754	792	1,018	1,069	Class B	2,580	3.6	0.4
	Total (12 communes)		5,603.7	82,206	69,876	90	6,288	7,398	7,769	9,989	10,490		64,710	11.6	0.9
Total (60 communes)			48,996.4	519,460	441,542	90	39,737	46,748	49,085	63,116	66,268		400,389	8.2	0.9

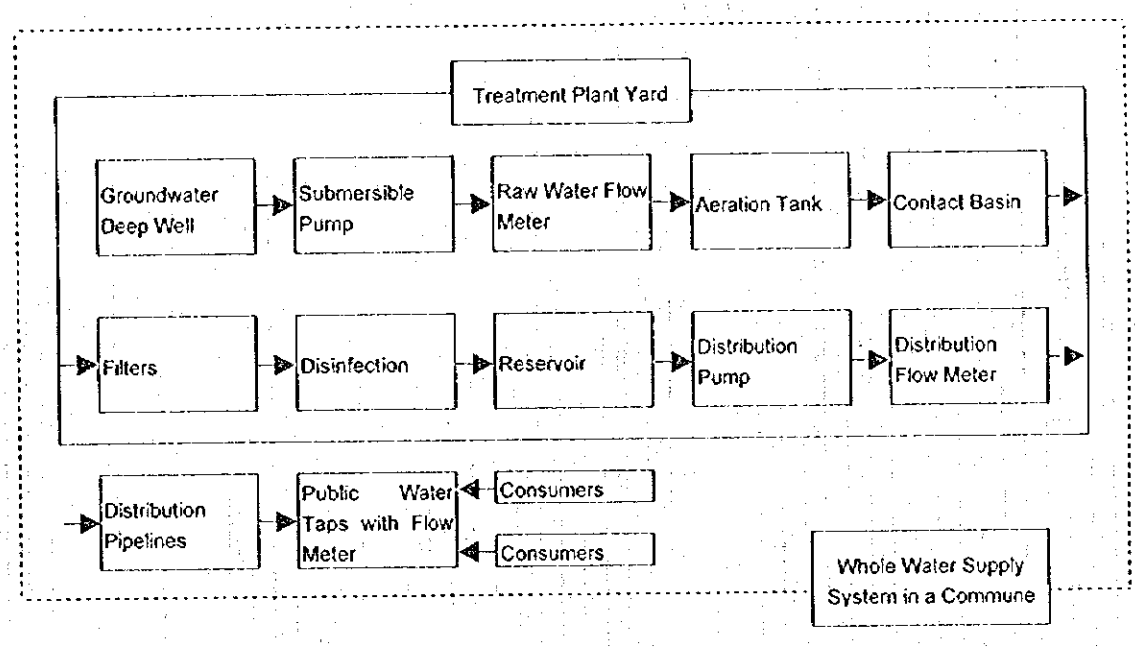
Remarks :
(C) = (B) x 85%
(E) = (C) x (D)
(F) = (E) / 85%
(G) = (F) x 1.05
(H) = (F) x 1.35
(I) = (G) x 1.35
(K) = (J) / (A)
(L) = (J) / (C)

2.3.3 Basic Planning of the Rural Water Supply Systems

Systems are preliminarily planned in this section for a typical commune system which would represent typically each class (Classes A, B and C).

(1) Flow Chart of the System

The flow of the system is shown below, including treatment process.



The above flow is common among three classes.

(2) Facilities Planning

Facilities for the rural water supply systems are planned for typical representatives of Class A, B and C, as their standards, and summarized in the Table of "Facilities of Typical Rural Water Supply System", together with construction cost tentatively estimated.

(3) Distribution Pipelines

The treated water is supplied to consumers through distribution pipelines on which public taps are to be installed.

The pipelines are planned to be installed on the road. Total length of the distribution pipelines, i.e. road distance varies by community. Therefore, the road distances were measured on the available maps with scale of 1/25,000 for all the 60 communes. After that, they were adjusted and summarized as shown bellow :

Distribution Pipelines

Class	Total	Diameter and Length				No. of Public Taps
		200 – 150 mm	150 mm	100 mm	75 – 50 mm	
Class A	12,600 m	4,200 m	–	4,200 m	4,200 m	126
Class B	9,900 m	3,300 m	–	3,300 m	3,300 m	99
Class C	7,500 m	–	2,500 m	2,500 m	2,500 m	75

2.3.4 Implementation Schedule and Cost Estimates

(Construction Period)

One water supply system be constructed within 12 months, from viewpoints of both size of the construction work and its construction cost. It is proposed that 10 systems can be simultaneously constructed in a year; 60 systems (for total 60 communes) be constructed in six (6) years. Construction years will be 1998-2003 (6 years).

(Construction Cost)

One system will cost US$ 558,100 on the average. Annual investment for 10 systems therefore is $ 5,581,000. Total cost for 60 systems is $ 33,486,000.

(Operation and Maintenance Cost)

Costs for operation and maintenance of the system are tentatively estimated by each Class.
They are :

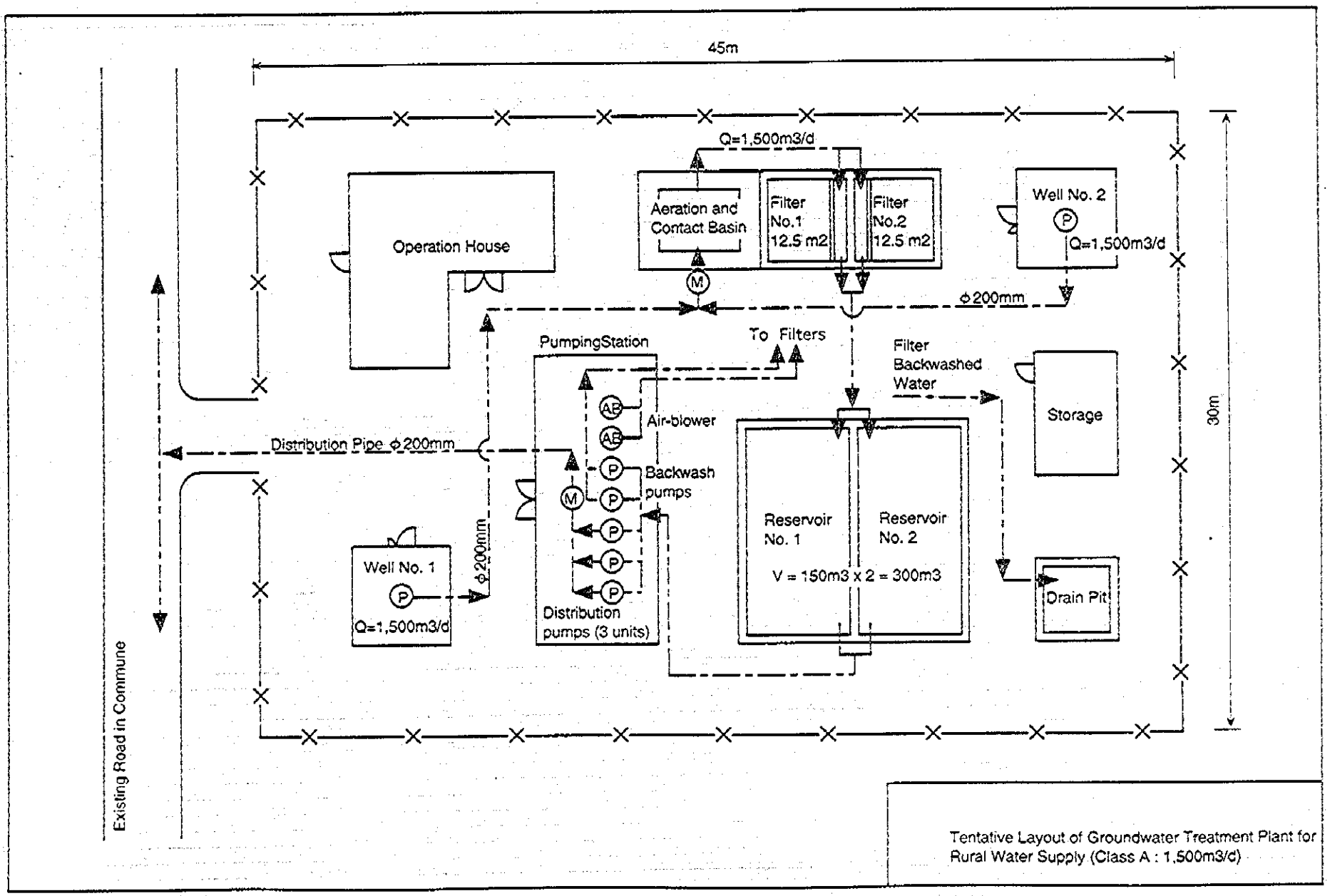
- Class A = 382,375.000 VND/year (= $ 34,760/year)
  (Equivalent to 1,165 VND/m3)

- Class B = 283,993.000 VND/year (= $ 25,810/year)
  (Equivalent to 1,179 VND/year)

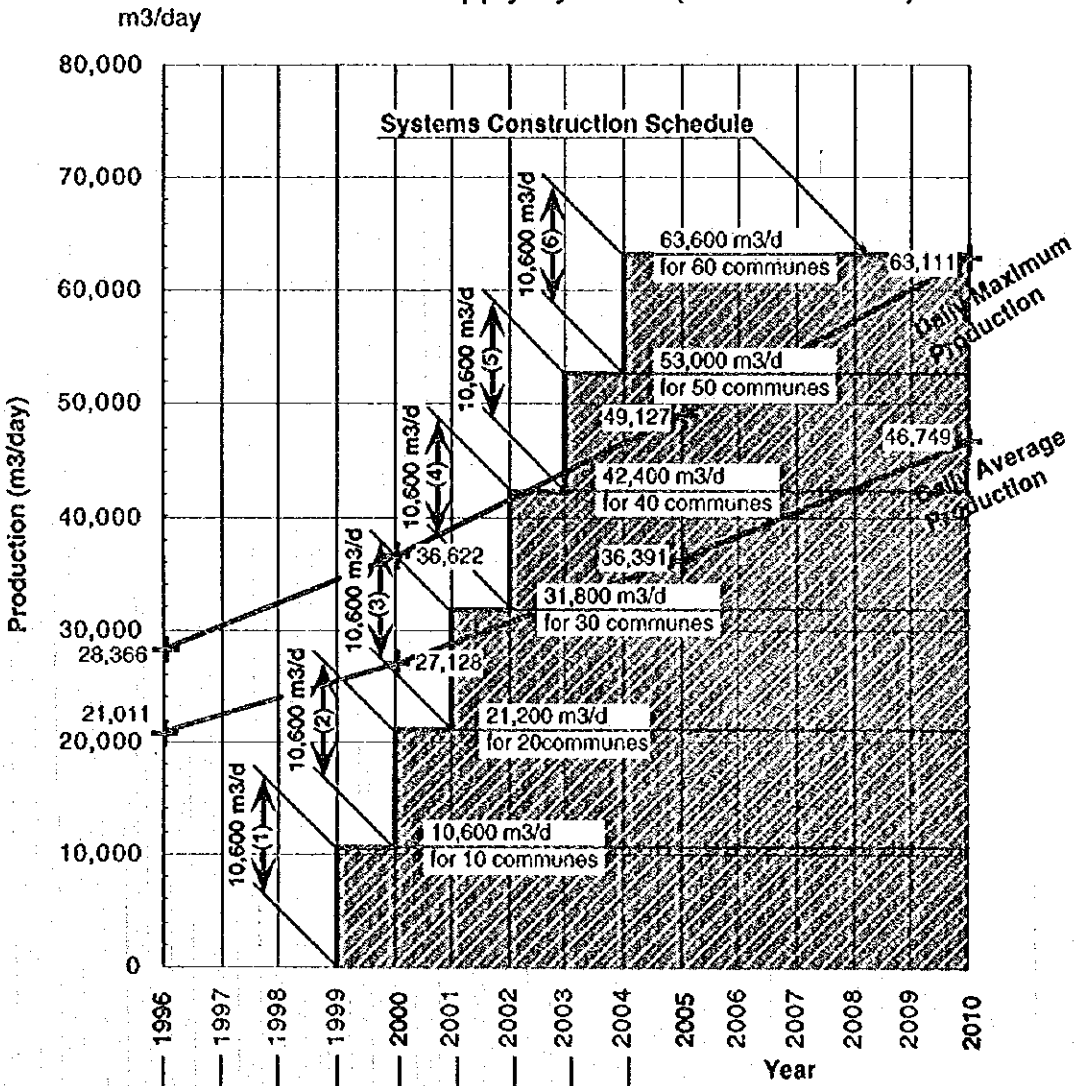
- Class C = 205,980.000 VND/year (= $ 18,730/year)
  (Equivalent to 1,344 VND/year)

Facilities of Typical Rural Water Supply System

Item	Class A	Class B	Class C
Population in the commune	11,695 persons	8,872 persons	5,406 persons
Population to be served	9,940 persons	7,541 persons	4,595 persons
Intake and treatment capacity	1,500 m3/day	1,100 m3/day	700 m3/day
Distribution capacity	1,429 m3/day	1,048 m3/day	667 m3/day
Peak hour flow	84.9 m3/hour	62.2 m3/hour	39.6 m3/hour
Major Facilities			
0) Land area of treatment plant	50 m x 30 m = 1,500 m2	1,250 m2	1,000 m2
1) Deep well	70 m depth x 2 Nos.	70 m depth x 2 Nos.	70 m depth x 2 Nos.
2) Submersible intake pump	1,500 m3/d, 11k W x 2 Nos.	1,100 m3/d, 7.5 kW x 2 Nos.	700 m3/d, 5.5 kW x 2 Nos.
3) Aeration and contact basin	12.5 m2 x 1 basin	9.2 m2 x 1 basin	5.9 m2 x 1 basin
4) Filter	12.5 m2 x 2 beds	9.2 m2 x 2 beds	5.9 m2 x 2 beds
5) Reservoir	150 m3 x 2 = 300 m3	110 m3 x 2 = 220 m3	70 m3 x 2 = 140 m3
6) Distribution pump	H = 30 m, 7.5 Kw x 3 units	H = 25 m, 3.7 Kw x 3 units	H = 20 m, 2.2 Kw x 3 units
7) Backwash pump	19 kW x 2 units	15 kW x 2 units	11 kW x 2 units
8) Distribution pipeline	L = 12,600 mm	L = 9,900 m	L = 7,500 m
9) Number of public taps	127 Nos.	99 Nos.	75 Nos.
Tentative Construction Cost Estimates			
i) Water source facilities	$73,500	$61,600	$44,100
ii) Treatment facilities	$367,500	$308,000	$220,500
iii) Distribution facilities			
Pipes 200 - 150 mm @27.9 $/m	x 4,200 m = $117,200	x 3,300 m = $92,100	
Pipes 150 mm @21.5 $/m			x 2,500 m = $53,800
Pipes 100 mm @16.1 $/m	x 4,200 m = $67,600	x 3,300 m = $53,100	x 2,500 m = $40,300
Pipes 75 - 50 mm @7.7 $/m	x 4,200 m = $32,300	x 3,300 m = $25,400	x 2,500 m = $19,300
Public taps @200 $/pc	x 126 pcs = $25,200	x 99 pcs = $19,800	x 75 pcs = $15,000
Sub total	$242,300	$190,400	$128,400
iv) Land cost	$15,000	$12,600	$10,250
Total Cost	$698,300	$572,800	$403,250
Per Capita Construction Cost	70.3 $/person	76.0 $/person	87.8 $/person
Personnel of Organization			
a) Operator	6 persons	5 persons	4 persons
b) Worker	4 persons	3 persons	2 persons
c) Manager	1 person	1 person	1 person
d) Administration	1 person	1 person	1 person
Total	12 persons	10 persons	8 persons
Total Construction Cost (tentative) for 60 Communes	($698,300 x 20) + ($572,800 x 20) + ($403,250 x 20) = $33,486,000 for 60 Communes		
Average Construction Cost for One System	$558,100 for one Commune		


45m
Q=1,500m3/d
Operation House
Aeration and Contact Basin
Filter No.1 12.5 m2
Filter No.2 12.5 m2
Well No. 2
Q=1,500m3/d
φ200mm
To Filters
PumpingStation
Filter Backwashed Water
Storage
Air-blower
Backwash pumps
Distribution Pipe φ200mm
Reservoir No. 1
Reservoir No. 2
V = 150m3 x 2 = 300m3
Drain Pit
Well No. 1
Q=1,500m3/d
φ200mm
Distribution pumps (3 units)
30m
Existing Road in Commune
Tentative Layout of Groundwater Treatment Plant for Rural Water Supply (Class A : 1,500m3/d)

Construction Schedule
Rural Water Supply Systems (60 Communes)



Investment Schedule

0	0	
(1) 10@$558,100 = for 10 communes	$5,581,000	
(2) 10@$558,100 = for 10 communes	$5,581,000	
(3) 10@$558,100 = for 10 communes	$5,581,000	
(4) 10@$558,100 = for 10 communes	$5,581,000	
(5) 10@$558,100 = for 10 communes	$5,581,000	
(6) 10@$558,100 = for 10 communes	$5,581,000	
Total (1 - 6) =	$33,486,000	

Construction Schedule
Rural Water Supply Systems
(60 Communes)

Tentative Cost Estimates of Operation and Maintenance for Rural Water Supply Systems

(Constant price of 1996 level, US$1.00 = VND 11,000 VND:Vietnamese Dong)

Class	(A) Water Consumption (m3/year)	(B) Operation and Maintenance Cost (VND/year) (B1) Staff	(B2) Chemical	(B3) Electricity	(B4) Repair	(B5) Others	(B) Total	(C) = (B)/(A) Cost of Operation and Maintenance per Consumption (VND/m3)
Class A 1,500 m3/d	328,307	95,040,000 24.9%	8,110,000 2.1%	114,130,200 29.8%	115,219,500 30.1%	49,874,955 13.0%	382,374,655 100.0%	1,165
Class B 1,100 m3/d	240,758	79,200,000 27.9%	5,950,000 2.1%	67,201,800 23.7%	94,512,000 33.3%	37,029,570 13.0%	283,893,370 100.0%	1,179
Class C 700 m3/d	153,210	63,360,000 30.8%	3,790,000 1.8%	45,426,600 22.1%	66,536,250 32.3%	26,866,928 13.0%	205,979,778 100.0%	1,344

Calculation Note :

(A) Water Consumption (Daily maximum factor : 135 %, Plant loss : 5 % and Leakage loss : 15 %)

Class A = 1,500 m3/d + 1.05 + 1.35 x (1-0.15) x 365 days = 328,307 m3/year

Class B = 1,100 m3/d + 1.05 + 1.35 x (1-0.15) x 365 days = 240,758 m3/year

Class C = 700 m3/d + 1.05 + 1.35 x (1-0.15) x 365 days = 153,210 m3/year

(B1) Staff Cost

(Base salary = 660,000 VND/month, 1996 price)

Class A = 12 persons x 660,000 VND/month x 12 months = 95,040,000 VND/year

Class B = 10 persons x 660,000 VND/month x 12 months = 79,200,000 VND/year

Class C = 8 persons x 660,000 VND/month x 12 months = 63,360,000 VND/year

(B2) Chemical Cost

Chemical for disinfection : Hypochloride

Unit cost of Hypochloride = 650 VND/ℓ (liquid)

Chlorine concentration of the Hypochloride liquid = 65 g/ℓ = 6.5 %

Chlorine cost = 650 VND/ℓ ÷ 6.5 % = 10,000 VND/kg

Chlorine dosage = 2 ppm = 2 g/m3 = 0.002 kg/m3

Class A = 1,500 m3/d + 1.35 x 365 days x 0.002 kg/m3 x 10,000 VND/kg
= 405,556 m3/year x 0.002 kg/m3 x 10,000 VND/kg = 8,111,000 VND/year

Class B = 1,100 m3/d + 1.35 x 365 days x 0.002 kg/m3 x 10,000 VND/kg
= 297,407 m3/year x 0.002 kg/m3 x 10,000 VND/kg = 5,950,000 VND/year

Class C = 700 m3/d + 1.35 x 365 days x 0.002 kg/m3 x 10,000 VND/kg
= 189,259 m3/year x 0.002 kg/m3 x 10,000 VND/kg = 3,790,000 VND/year

(B3) Electricity Cost (Hourly Peak Factor : 140 %)

(Use : One unit of submersible intake pump and two units of distribution pump)

Electricity unit cost = 600 VND/KW

Class A = {11 kW + (7.5 kW x 2 units ÷ 1.40)} x 24 hours x 365 days x 600 VND/kW
= 190,217 kW/year x 600 VND/kW = 114,130,200 VND/year

Class B = {7.5 kW + (3.7 kW x 2 units ÷ 1.40)} x 24 hours x 365 days x 600 VND/kW
= 112,003 kW/year x 600 VND/kW = 67,201,800 VND/year

Class C = {5.5 kW + (2.2 kW x 2 units ÷ 1.40)} x 24 hours x 365 days x 600 VND/kW
= 75,711 kW/year x 600 VND/kW = 45,426,600 VND /year

(B4) Repair Cost

(Annual repair cost = 1.5 % of total construction cost)

Class A = $698,300 x 0.015 x 11,000 VND/$ = 115,219,500 VND/year

Class B = $571,600 x 0.015 x 11,000 VND/$ = 94,512,000 VND/year

Class C = $403,250 x 0.015 x 11,000 VND/$ = 66,536,250 VND/year

(B5) Others

Other cost = 15 % of (B1 + B2 + B3 + B4)

2.3.5 Procedure of Implementation

In rural areas, there has been no existing public water supply systems. Households' income in rural areas is generally lower than that of urban areas. Considering the above, it is required that rural water supply systems be constructed in brief period and with low cost.

For these purposes, standardization of design for rural water supply systems is strongly proposed. It means that standard design (design drawings and technical specifications) be applied to construction of deep wells and treatment plants by Classes A, B and C.

In the case of distribution pipelines, distance of pipelines depends on topography of each commune, although diameters of pipes can be standardized. For this subject, a design method of pipelines is presented in the following section of "Model Design for a Commune".

The practical procedure for implementation of the rural water supply systems is illustratedly shown in the "Chart of Implementation Procedure (Rural Water Supply).

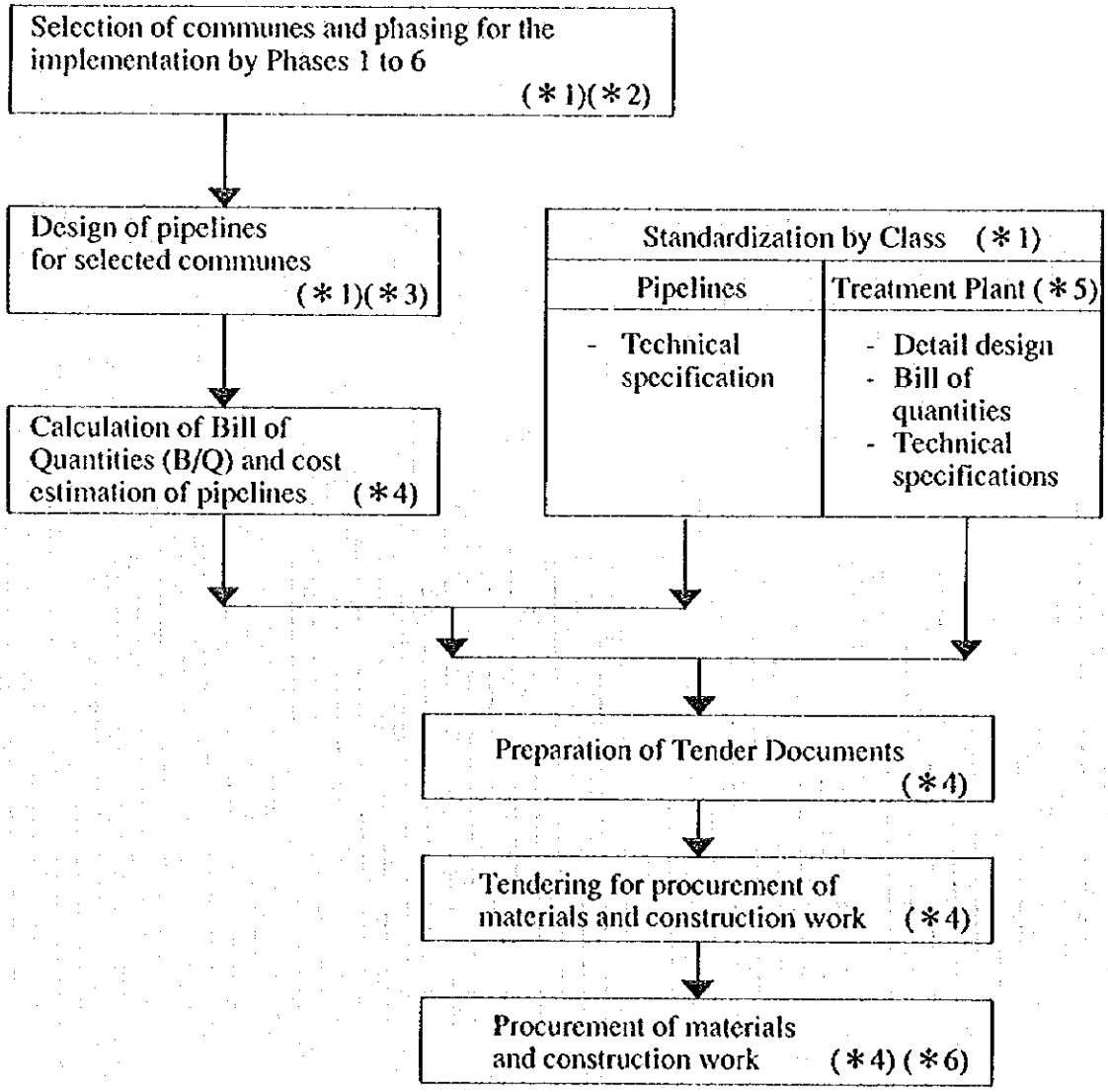
However, at the time of the implementation practice, the following communes must be carefully studied in more detail.

Groundwater to be exploited in 8 communes (01, 10, 11, 13, 16, 17, 19 and 25) of Thanh Tri District may contain high value of ammonia due to soil condition. In these communes, therefore, construction of the ammonia treatment process facilities (contact oxidization or biological filtration) will be required, in addition to the conventional iron/manganese treatment process. Otherwise, whether these communes would be more feasible, if they receive treated water from the urban water supply systems, should be carefully studied at the time of feasibility study. (As technical reference, The ammonia removal system is suggested in drawings/diagram given in the end of this section.

Six communes (02, 06, 09, 10, 11, and 13) in Soc Son District are situated in the mountainous area, where groundwater may not be obtainable enough. Therefore,

these communes would be planned collectively, taking groundwater in the south of Soc Son, i.e. by way of a combined system. Otherwise, whether these communes would be more feasible, if they receive treated water from the urban water supply systems, should be carefully studied at the time of feasibility study.

Chart of Implementation Procedure
(Rural Water Supply)



Note

(＊1) Classification (Class A, B or C) of each commune is given in Table of "Classification of Rural Communes".
(＊2) One phase of tendering/construction work will consist of ten (10) communes.
(＊3) See the section of "Model Design for a Commune".
(＊4) For 10 communes (one phase)
(＊5) Including deep wells (water source)
(＊6) Construction period : 1 year for 10 communes (one phase)

Chart of Implementation Procedure (Rural Water Supply)

2.3.6 Model Design for a Commune

For the purpose of reference to engineers who will carry out the implementation of the rural water supply systems, a preliminary model design for a commune is presented in this section.

A commune designated for the model design is Xa Lien Ha located in Dong Anh District.

From the table of "Water Demand, Production and Raw Water Capacity for Rural Water Supply System" in 4.3.2, the commune of Lien Ha is defined as Class A. Accordingly, the following conditions are given as basic figures.

- Name of Commune: Xa Lien Ha in Dong Anh District
- Classification: Class A
- Capacity = 1,500 m3/ day
- Water source: Deep groundwater
- Number of treatment plant: One (1)
- Number of deep wells: Two (2)
- Distribution pipe: Diameter = ϕ 200 mm - ϕ 50 mm
  Total length = 12,600 m
- Number of public taps = 126 Nos.

Keeping the above conditions in the engineers' mind, he should collect a latest topographic map (scale of 1/10,000 or 1/5,000) and visit the commune for field reconnaissance.

The following shows a method of the basic design of the rural water supply system for Xa Lien Ha.

First Step : Water distribution and location of the treatment plant. (Basic Design)

(1) Sub-communes to be served are decided on the map. In Lien Ha, eight (8) sub-communes will be served. (See the drawing of "Service Area of Lien Ha").

(2) Measure the residential land area (ha) of sub-communes and calculate percentage of the area of each sub-commune and water distribution capacity to each sub-commune. Total capacity (1,500 m3/ day) should be allocated to each sub-commune in proportion to the percentage of the residential land area, providing that water demand for domestic use corresponding to population served is in proportion to the residential land area of 8 sub-communes, and the total area of 60.7 ha corresponds to 1,500 m3/d. The biggest sub-commune of Gia Tac (with 16.0 ha = 26.3% of 60.7 ha) will receive 395m3/d (=26.3% of 1,500m3/d). (See the table given in the drawing of "Service Area of Lien Ha").

(3) Select the location of the treatment plant site, taking the following conditions into consideration.

The plant site shall:

- be placed on the vacant space or agricultural land nearby a sub-commune located in
  the central part of the commune.
- be able to be supplied with public electricity.
- face a wide main road or be easily accessible.
- have land area: about 50 m x 30 m, or preferably more.

Note:

- basic layout of the treatment plant is given in a drawing of "Tentative layout of Groundwater Treatment Plant for Rural Water Supply (Class A: 1,500 m3/d)".

- Two (2) deep wells (one is on duty and another for standby) are to be constructed in the plant yard.

The diameter of the casing pipe is 200 mm, and the depth is 60 m, since Xa Lien Ha is situated in Dong Anh District. (See the drawing of " Well Design for Xa Lien Ha" and the following Table.)

Standard Dimension of Deep Wells for Rural Water Supply
(Q = 1,500 m3/d - 700 m3/d)

District	Dong Anh	Gia Lam	South Hanoi
Diameter of well (Casing pipe)	200 mm	200 mm	200 mm
Depth of well	60 m	80 m	80 m
Static water level below GL	2.6 m	4.9 m	8.0 m
Dynamic water level below GL	8.2 m	6.9 m	10.3 m
GL (Ground elevation) above sea water level	+6.5 m	+7.5 m	+6.1 m

Second Step : Design of Pipelines

(4) Plan route of pipelines from the plant to sub-communes. Pipelines shall be installed on public roads. Most of all roads will have pipelines on which public taps be installed.

(5) Measure the distance of pipelines on the map, and decide locations for public taps. A public tap shall be located within 100 m distance from a nearby tap, (Compare the above result with a standard quantity. In the case of the Class A, total standard distance of pipelines is about 12,600 m and standard number of public taps is 126. On the other hand, preliminary design for Xa Lien Ha showed 12,360 m of pipelines' distance and 121 numbers of public taps. Please refer to Table of "Distribution Pipelines and Public Taps (Xa Lien Ha)".

(6) Decide Diameters of Pipes.

Diameters range 200 mm (maximum) to 50 mm (minimum) for Class A. For the purpose of decision of diameters the following table is prepared.

Diameter	ϕ 200 mm	ϕ 150 mm	ϕ 100 mm	ϕ 75 mm	ϕ 50 mm
% of flow	100%	50 %	15%	10%	3%
Standard flow	1,500 m3/d	750 m3/d	225 m3/d	150 m3/d	45 m3/d

By use of the above table, all diameters were given. (Please see the drawing of " Distribution Pipelines and Public Taps for Xa Lien Ha").

(7) Visit the site of Xa Lien Ha and carry out field reconnaissance. If some discrepancies are found by the site survey, correct or change the preliminary design.

In the case of Xa Lien Ha, the following were found by the field reconnaissance.

- Between northern sub-communes ((1), (2), (3), (4) and (5)) and southern sub-communes ((6), (7) and (8)), a new public road linking them was already constructed. (This road shall be used for a pipeline which supply to the southern sub-communes).

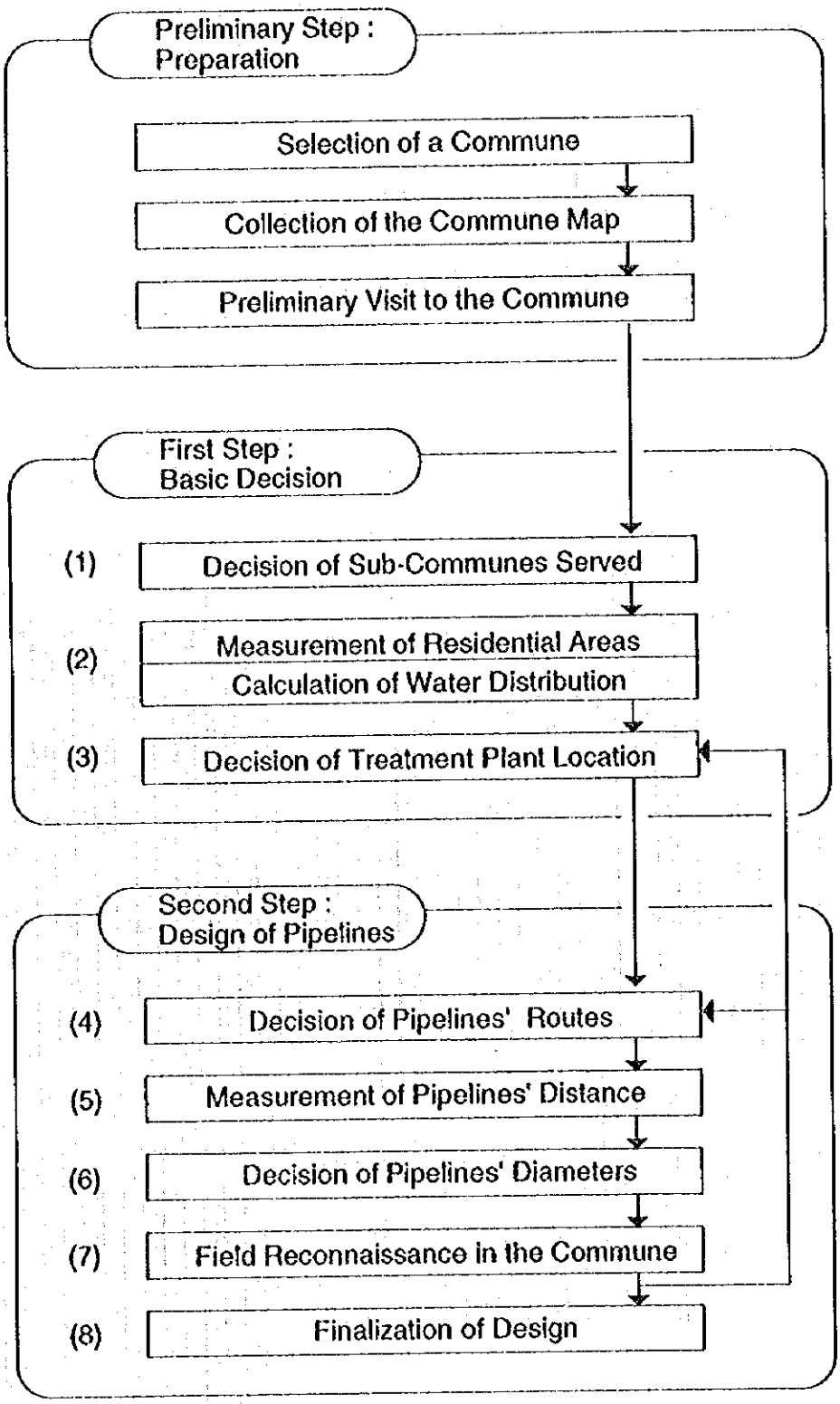
- For location of s treatment plant, originally-proposed site (west of (5)) was non-recommendable form viewpoints of accessibility and land acquisition. On the other hand, a suitable place (present paddy field) for the plant was found in north of (4), where is more close to the commune center. The plant location shall be reconsidered.

(8) Finalize the design, taking finding by the field reconnaissance into due consideration, and make bill of quality of pipelines and public taps. For Xa Lien Ha, the revised design is given in drawing of "Distribution Pipelines and Public Taps for Xa Lien Ha. (Final Design Revised)".

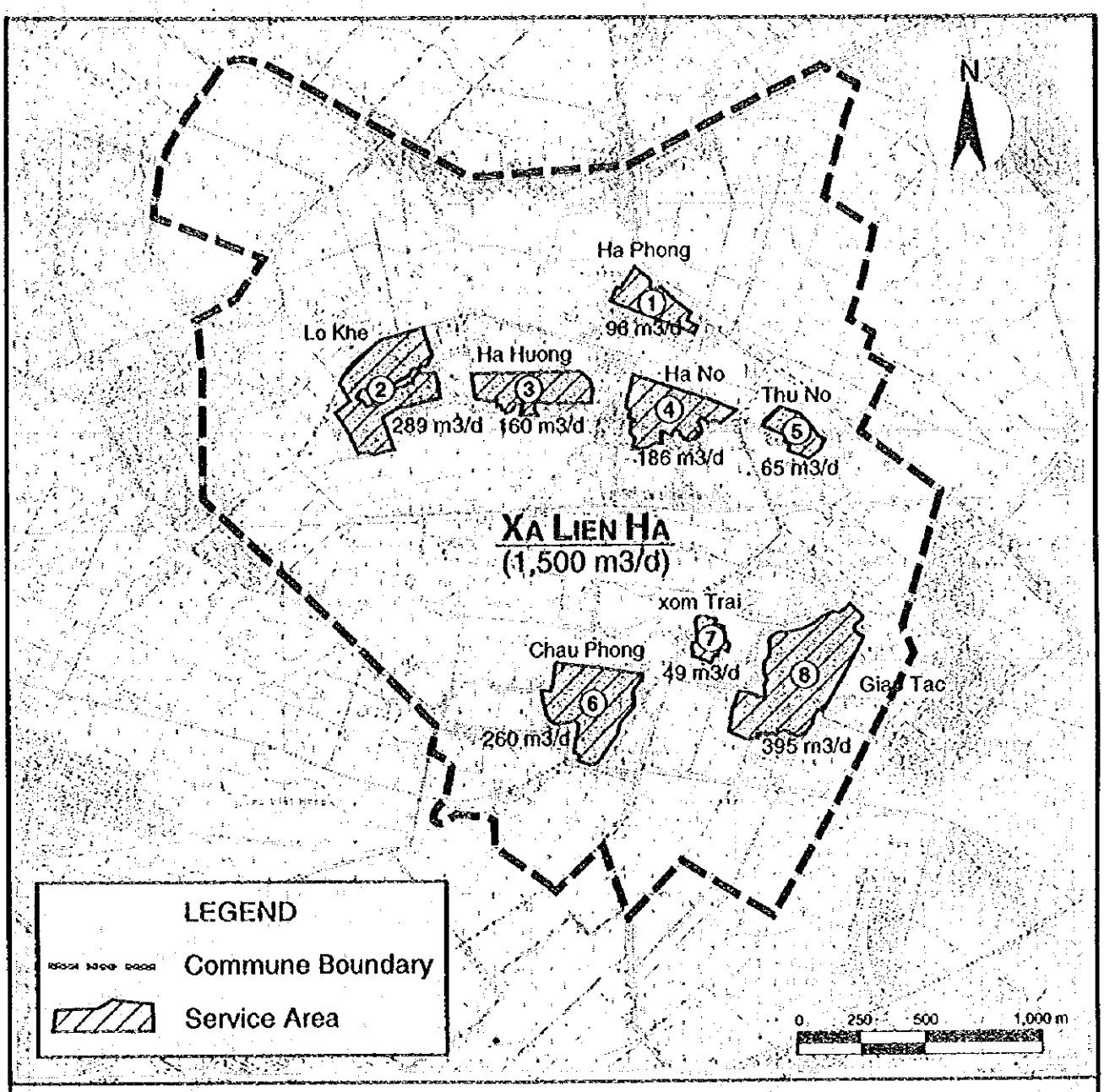
Note:

- The above mentioned process is shown illustratedly in the chart of "Technical Process of Basic Design".

- The method and procedure mentioned above does not include administrative procedure.
  At the time of the project implementation, various administration procedures will be required: such as approval/ decision of the construction of the public water supply system, land acquisition, location of public taps, etc.



Technical Process of Basic Design (Rural Water Supply)

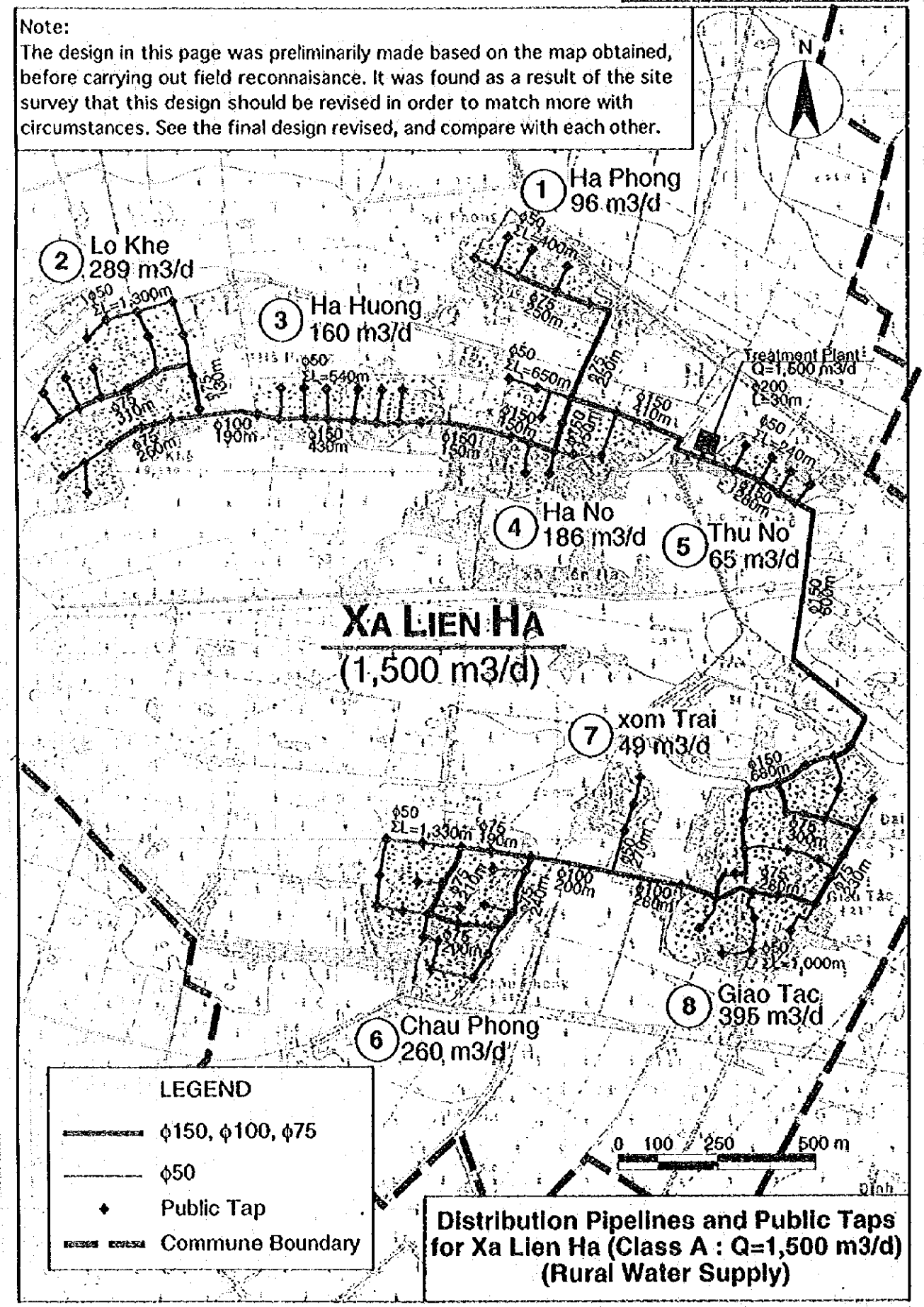


No.	Sub-Commune	Area (ha)	%	Water Distribution
①	Ha Phong	3.9 ha	6.4	96 m3/d
②	Lo Khe	11.7 ha	19.3	289 m3/d
③	Ha Huong	6.5 ha	10.7	160 m3/d
④	Ha No	7.5 ha	12.4	186 m3/d
⑤	Thu No	2.6 ha	4.3	65 m3/d
⑥	Chau Phong	10.5 ha	17.3	260 m3/d
⑦	xom Trai	2.0 ha	3.3	49 m3/d
⑧	Giao Tac	16.0 ha	26.3	395 m3/d
	Total	60.7 ha	100.0	1,500 m3/d

Service Area of Lien Ha (Rural Water Supply)

BEFORE REVISED

Note:
The design in this page was preliminarily made based on the map obtained, before carrying out field reconnaisance. It was found as a result of the site survey that this design should be revised in order to match more with circumstances. See the final design revised, and compare with each other.



Distribution Pipelines and Public Taps for Xa Lien Ha (Class A : Q=1,500 m3/d) (Rural Water Supply)

Before Revised

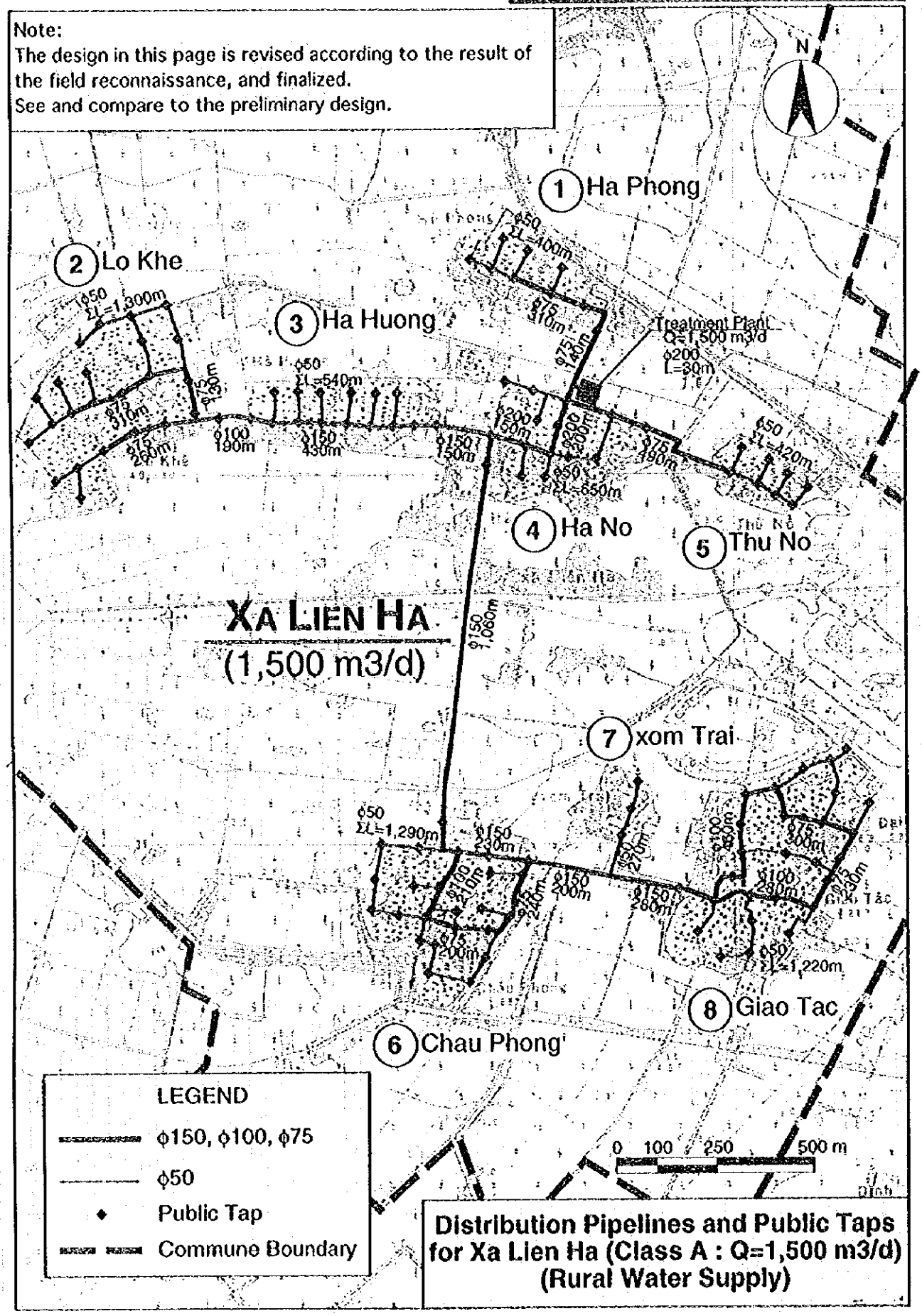
Distribution Pipeline and Public Tap
(Xa Lien Ha : Q = 1,500 m3/d)

Location	Distribution Pipelines					Public Taps
	ϕ200mm	ϕ150mm	ϕ100mm	ϕ75mm	ϕ50mm	
Plant	30 m	–	–	–	–	1 No.
Plant – (4)	–	410 m	–		–	–
In (4) : Ha No	–	310 m	–	–	650 m	14 Nos.
(4) – (1)	–	–	–	250 m	–	–
In (1) : Ha Phong	–	–	–	250 m	400 m	8 Nos.
(4) – (3)	–	150 m	–	–	–	–
In (3) : Ha Huong	–	430 m	–	–	540 m	14 Nos.
(3) – (2)	–	–	190 m	–	–	–
In (2) : Lo Khe	–	–	–	720 m	1,300 m	23 Nos.
In (5) : Thu No	–	280 m	–	–	240 m	8 Nos.
(5) – (8)	–	800 m	–	–	–	–
In (8) : Giao Tac	–	680 m	–	810 m	1,000 m	27 Nos.
(8) – (6)	–	–	480 m	–	–	–
In (6) : Chau Phong	–	–	–	840 m	1,330 m	23 Nos.
In (7) : xom Trai	–	–	–	–	270 m	3 Nos.
Total	30 m	3,060 m	670 m	2,870 m	5,730 m	
Grand Total	12,360 m					121 Nos.

Note :
The above list was prepared to the preliminary design.
See and compare to the revised list for the final design.

REVISED AND FINALIZED

Note:
The design in this page is revised according to the result of the field reconnaissance, and finalized.
See and compare to the preliminary design.



Distribution Pipelines and Public Taps for Xa Lien Ha (Class A : Q=1,500 m3/d) (Rural Water Supply)

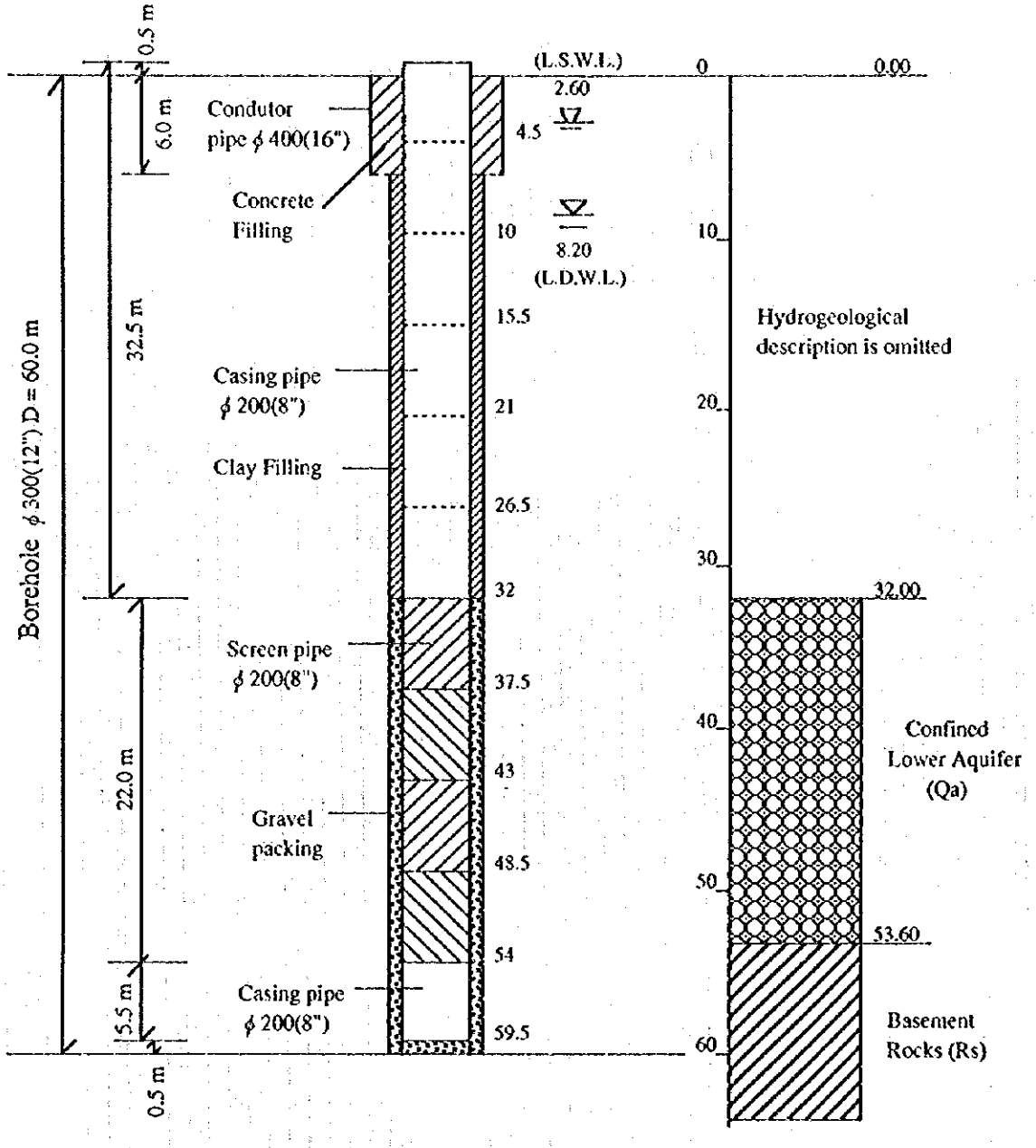
Revised and Finalized

Distribution Pipeline and Public Tap
(Xa Lien Ha : Q = 1,500 m3/d)

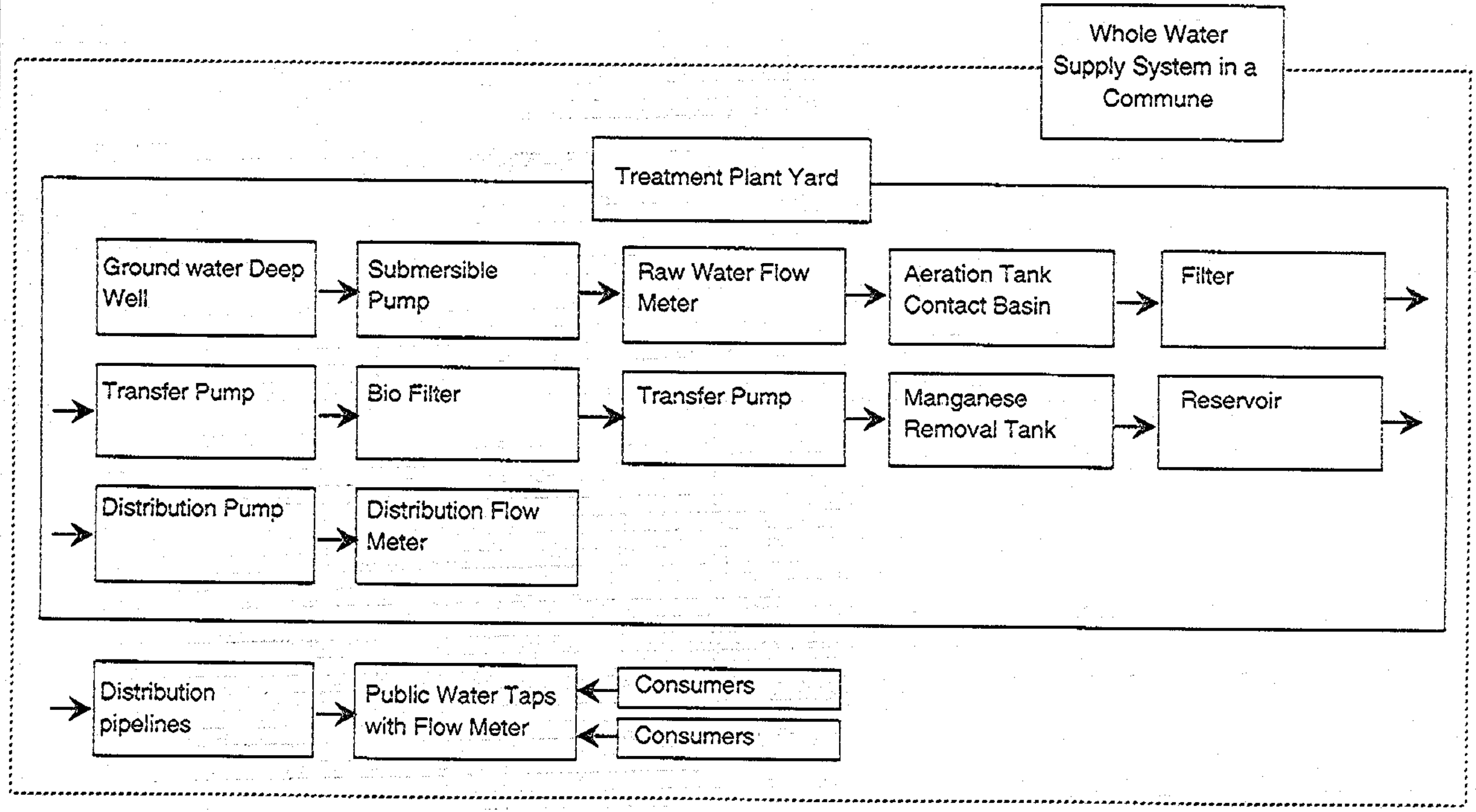
Location	Distribution Pipelines					Public Taps
	ϕ200mm	ϕ150mm	ϕ100mm	ϕ75mm	ϕ50mm	
Plant	30 m	–	–	–	–	1 No.
Plant – (1)	–	–	–	190 m	–	–
In (1) : Ha Phong	–	–	–	310 m	400 m	9 Nos.
In (4) : Ha No	350 m	–	–	–	650 m	16 Nos.
(4) – (3)	–	150 m	–	–	–	–
In (3) : Ha Huong	–	430 m	–	–	540 m	15 Nos.
(3) – (2)	–	–	190 m	–	–	–
In (2) : Lo Khe	–	–	–	720 m	1,300 m	24 Nos.
(4) – (5)	–	–	–	490 m	–	–
In (5) : Thu No	–	–	–	–	420 m	8 Nos.
(4) – (6)	–	1,060 m	–	–	–	–
In (6) : Chau Phong	–	230 m	210 m	440 m	1,290 m	24 Nos.
(6) – (7)	–	200 m	–	–	–	–
In (7) : xom Trai	–	–	–	–	270 m	3 Nos.
(7) – (8)	–	280 m	–	–	–	–
In (8) : Giao Tac	–	–	740 m	530 m	1,220 m	27 Nos.
Total	380 m	2,350 m	1,140 m	2,680 m	6,090 m	
Grand Total	12,640 m					127 Nos.

Note :
The above list was prepared to the revised final design.
See and compare to the list for the preliminary design.

Well Design for Dong Anh District
(Rural Water Supply)

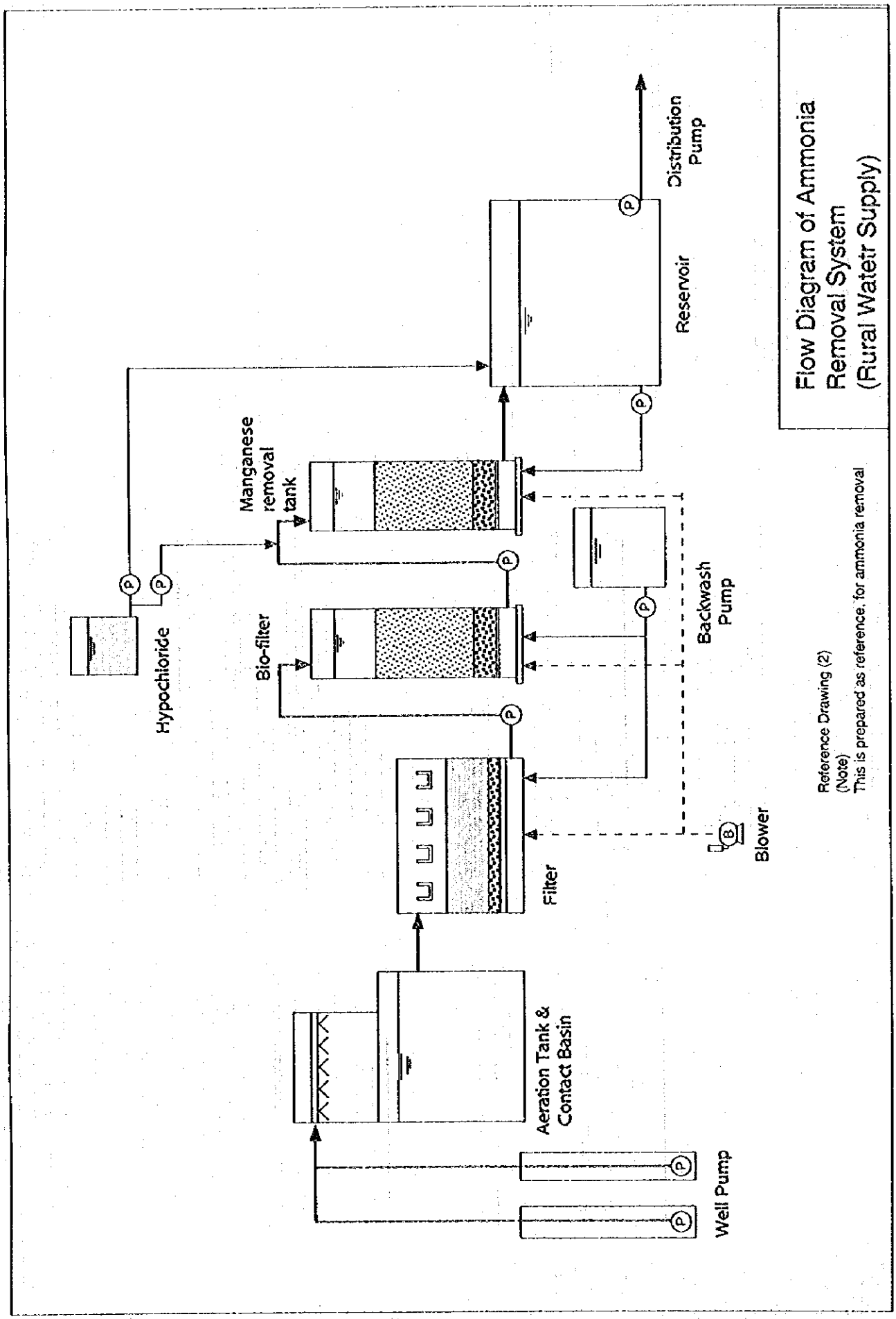


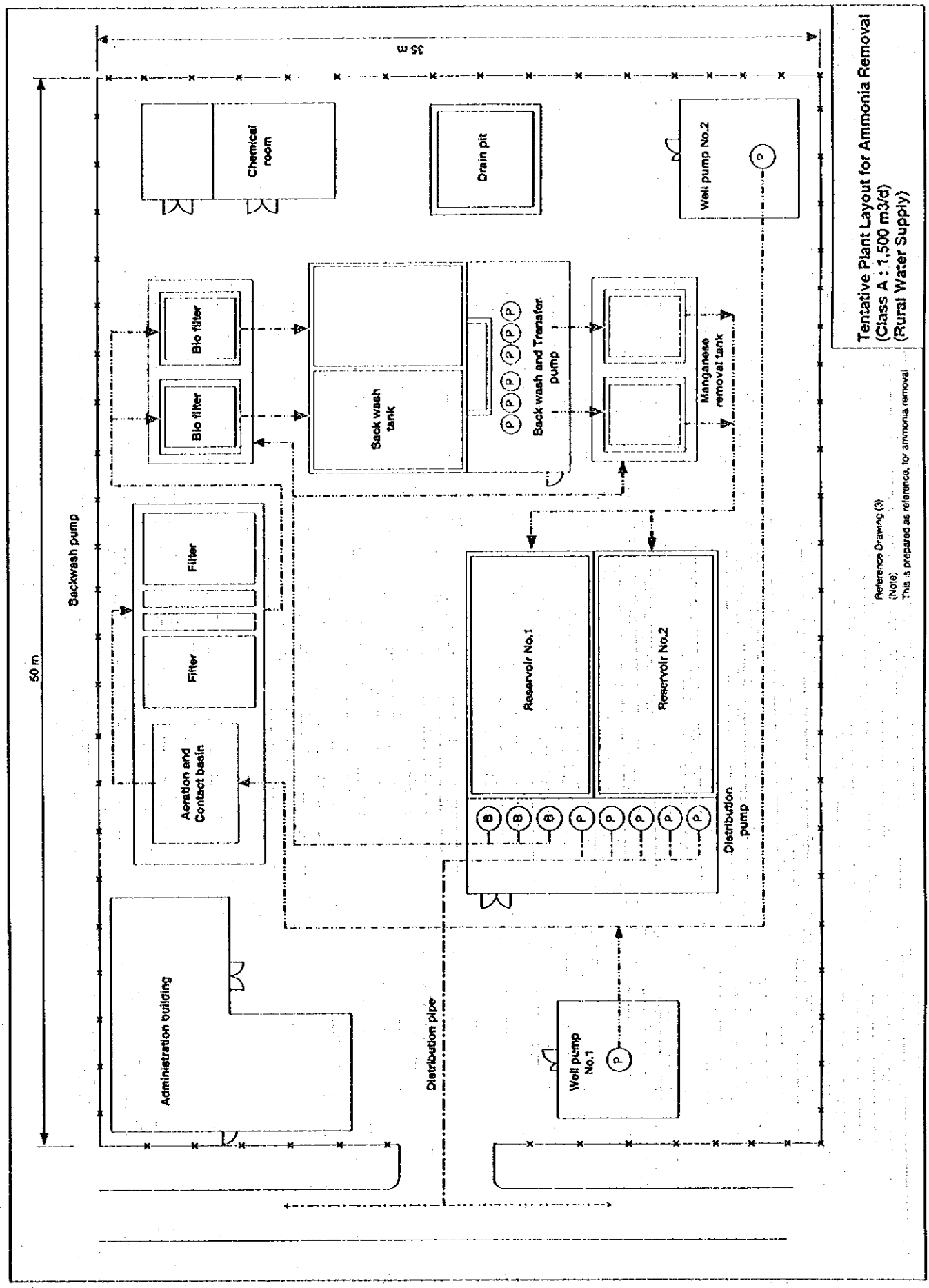
Well Design for Xa Lien Ha (Rural Water Supply)



Reference Drawing (1)
(Note)
This is prepared as reference, for ammonia removal

System Flow Chart for Ammonia Removal (Rural Water Supply)


Flow Diagram of Ammonia Removal System (Rural Watetr Supply)
Distribution Pump
Reservoir
Manganese removal tank
Hypochloride
Bio-filter
Backwash Pump
Blower
Filter
Aeration Tank & Contact Basin
Well Pump
Reference Drawing (2)
(Note)
This is prepared as reference, for ammonia removal


Tentative Plant Layout for Ammonia Removal
(Class A : 1,500 m3/d)
(Rural Water Supply)
Reference Drawing (3)
(Note)
This is prepared as reference, for ammonia removal
35 m
50 m
Backwash pump
Chemical room
Drain pit
Well pump No.2
Bio filter
Bio filter
Back wash tank
Back wash and Transfer pump
Manganese removal tank
Filter
Filter
Aeration and Contact basin
Reservoir No.1
Reservoir No.2
Distribution pump
Administration building
Distribution pipe
Well pump No.1