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

(1) Present Physical Leakage Loss

The JICA Study Team carried out the leakage survey during April-May 1996 on eight blocks selected in the existing service area. The expert who executed the leakage survey 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 in 1985 – 1996); and average in the whole city was 20 – 25 %, or rather 25%.

(2) Physical Loss in Future

In this plan, the ultimate rate of leakage is proposed to be 15%. The present rate of 25% is planned to be reduced to 15% in coming 10 years; that is, 1.0% reduction per annum.

(3) Unaccounted-for Water (UFW) and Administration Loss

According to HWBC's records, billed water was accounted at 29% of total production water. Hence, unaccounted-for water (UFW) was 71%. The UFW included physical loss of 25%; thus, administration loss was estimated at 46 % (71 %- 25%). The administration loss consists of illegal connections, underestimation of supplied water due to flat rate method in billing system, non-payment by consumers, etc..

(4) Administration Loss in Future

The administration 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). 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%.

(5) Unaccounted-for Water (UFW) in Future

UFW	Year	1996	2000	2005	2010
Physical Loss	(%)	25	21	16	15
Administration Loss	(%)	46	32	21	15
Total	(%)	71	53	37	30

(6) Improvement for UFW

Improvement for UFW is to be carried out by the World Bank Program as on-going projects. The improvement plans are that (a) The improvement for physical loss intends to renovate old pipes on the distribution pipelines, and (b) water meters are to be supplied and installed to all households in the service area.

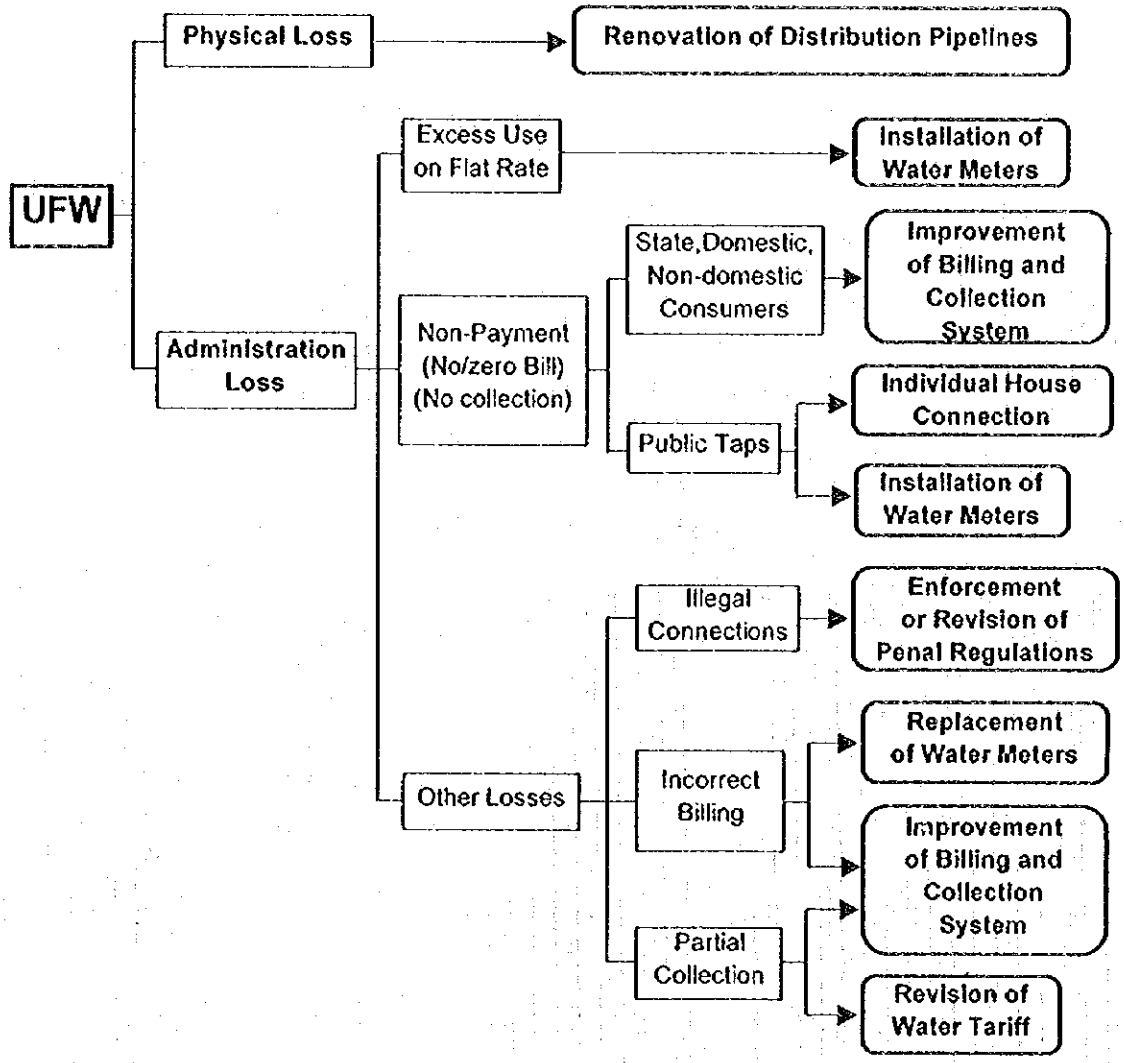
This master plan is formulated to follow the above manner from the year 2001 onward. That is :

a) The pipe renovation work is continuously extended to follow the World Bank's program; however, the work will be completed in the year 2005 when the physical loss be reduced to less than 15%.
b) The improvement of the administration loss from 2001 onward is to supply and install water meters in new water development areas.
c) New billing system shall be considered including setting up institution and water tariff.

The cost for the implementation work will be estimated at US$7,200,000.

The schematic flow chart of the improvement measures are illustrated in the following page.

Improvement Measures



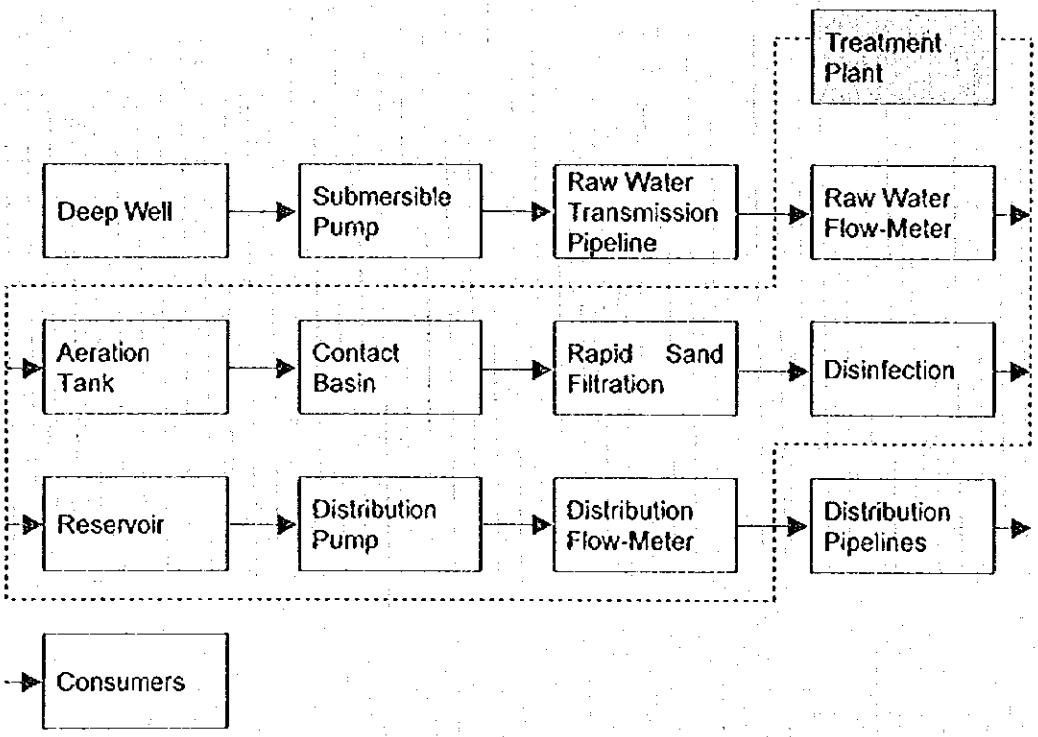
2.2 EXTENSION PROGRAM FOR URBAN WATER SUPPLY

(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) 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.



(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".

(4) Water Transmission from Gia Lam to Dong Anh and Soc Son

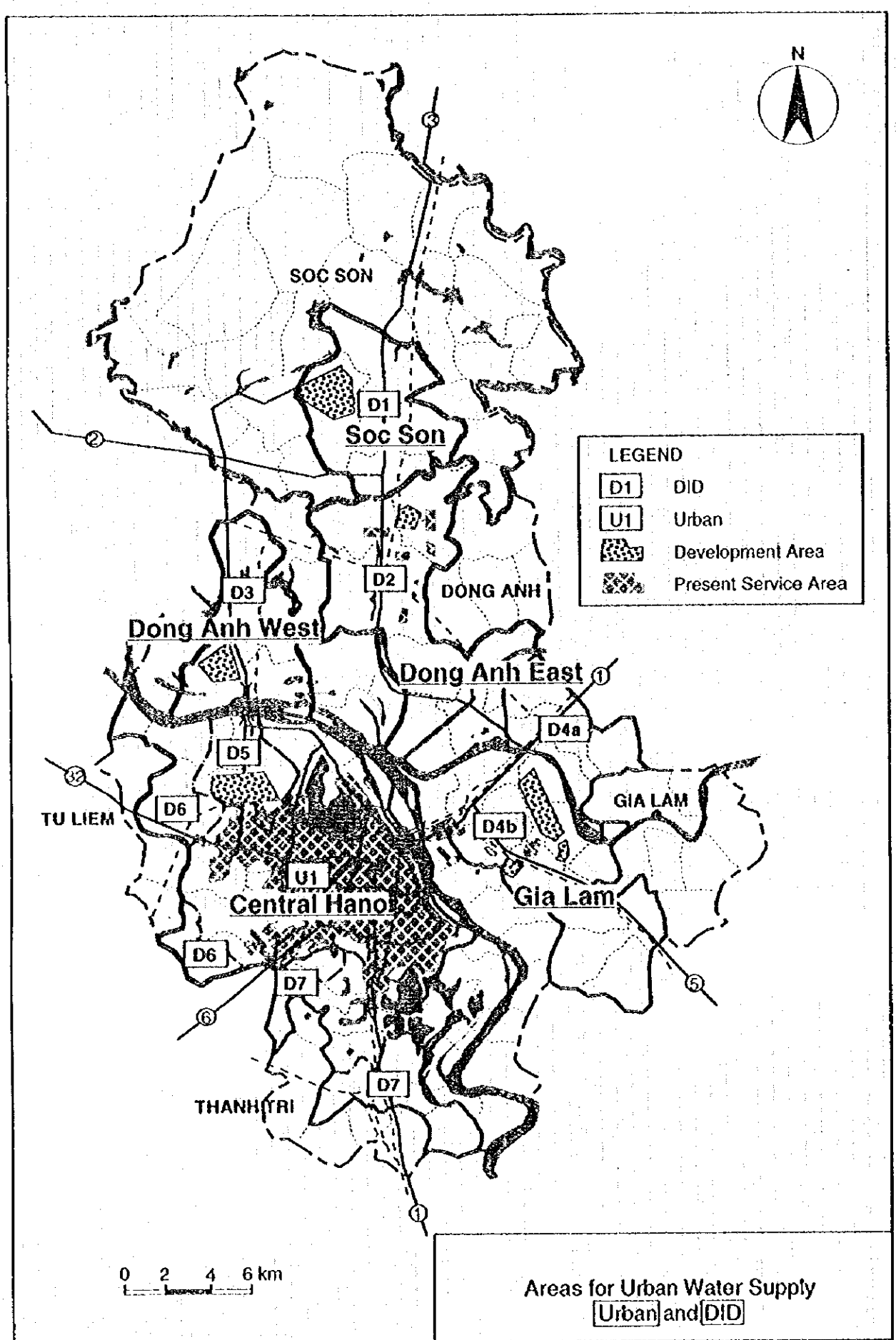
As described in Chapter 1, Dong Anh and Soc Son will have shortage in groundwater as water source. There, it is planned that treated water in Gia Lam be transmitted to Dong Anh and Soc Son.

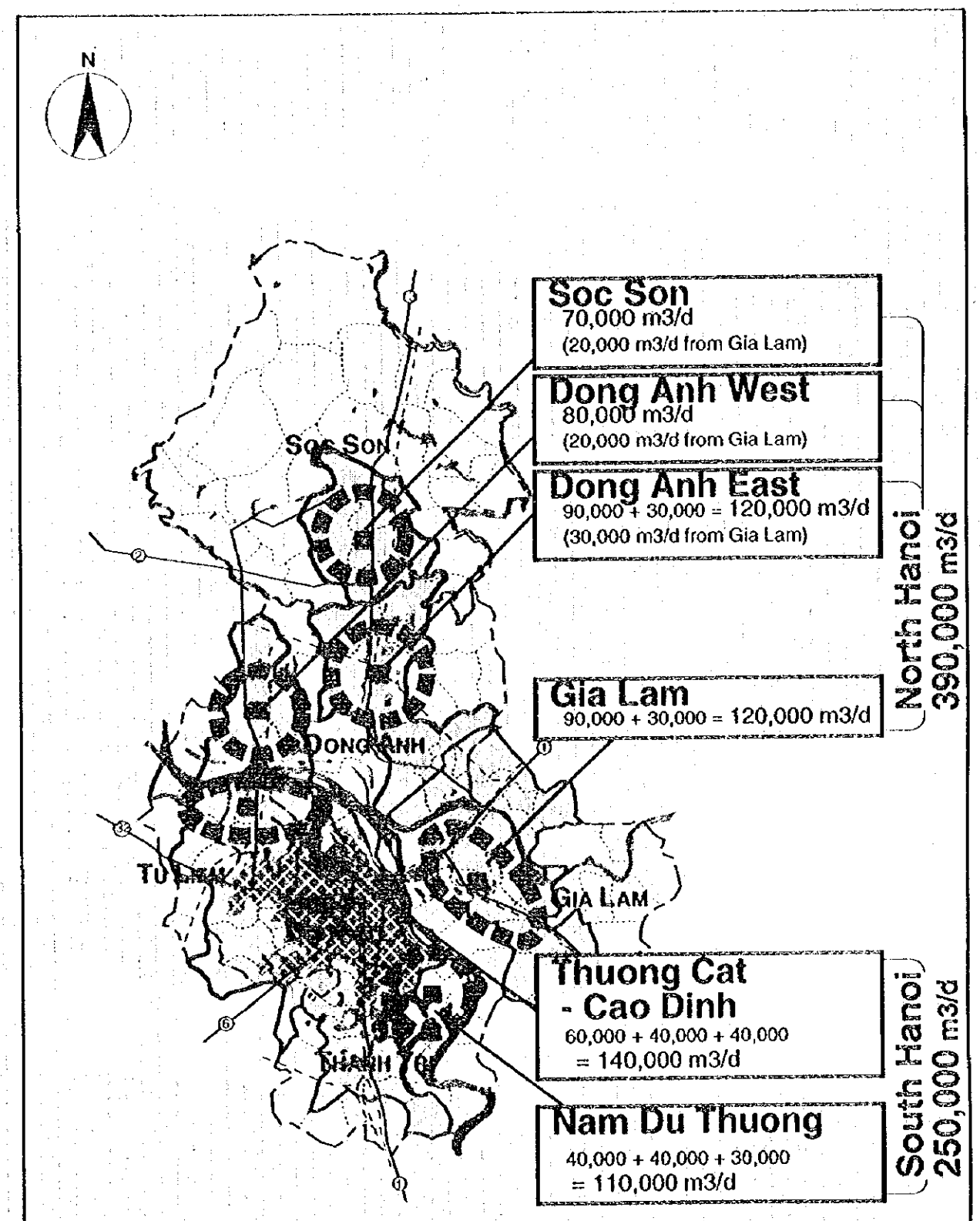
The design capacity to be transmitted, by the year 2010, is 83,700 m3/day. For this purpose, construction of transmission pipeline and pumping stations is required, which connect Gia Lam and Soc Son via Dong Anh. The construction work is programmed in 2002 - 2003.

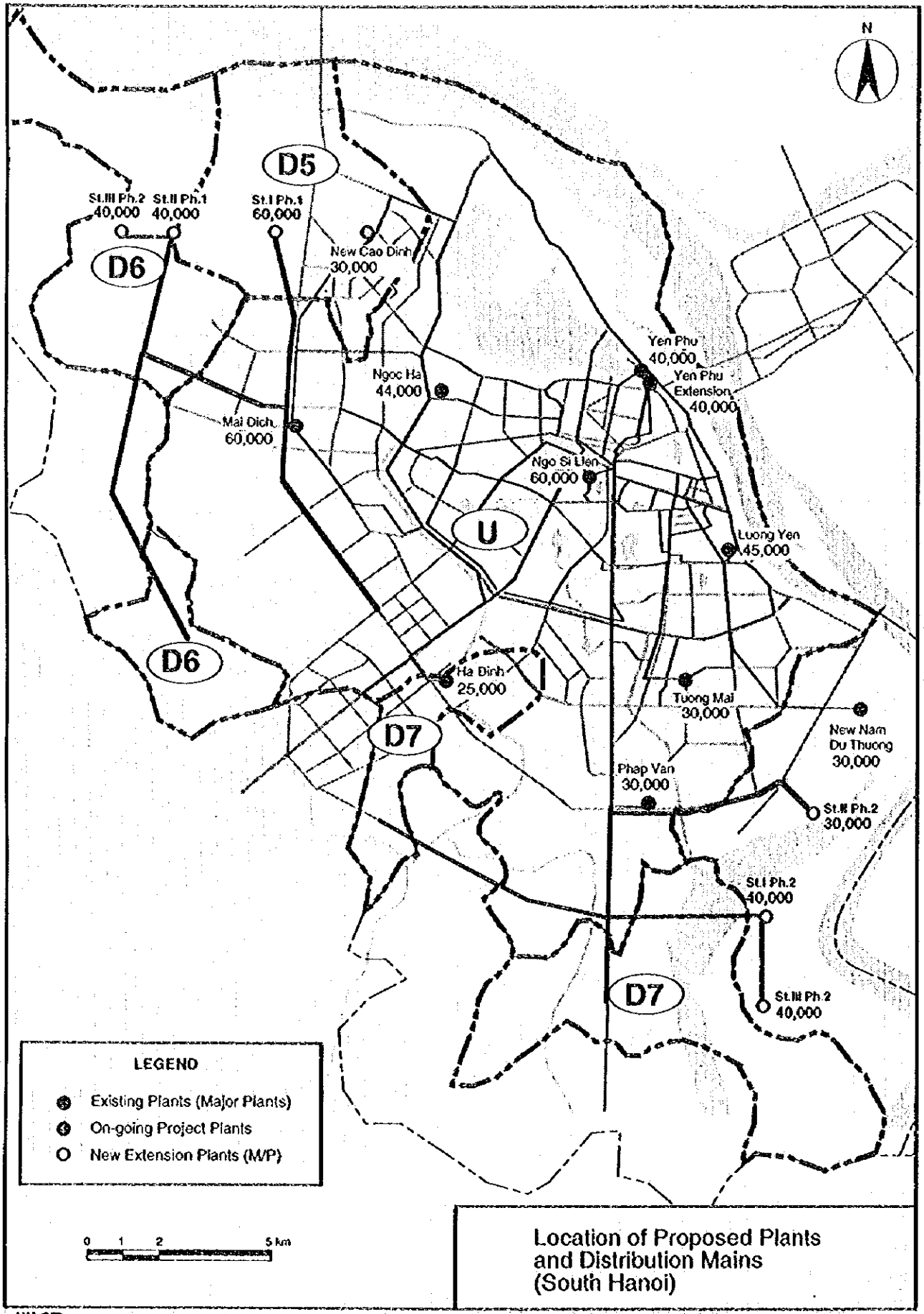
(5) Cost Estimates

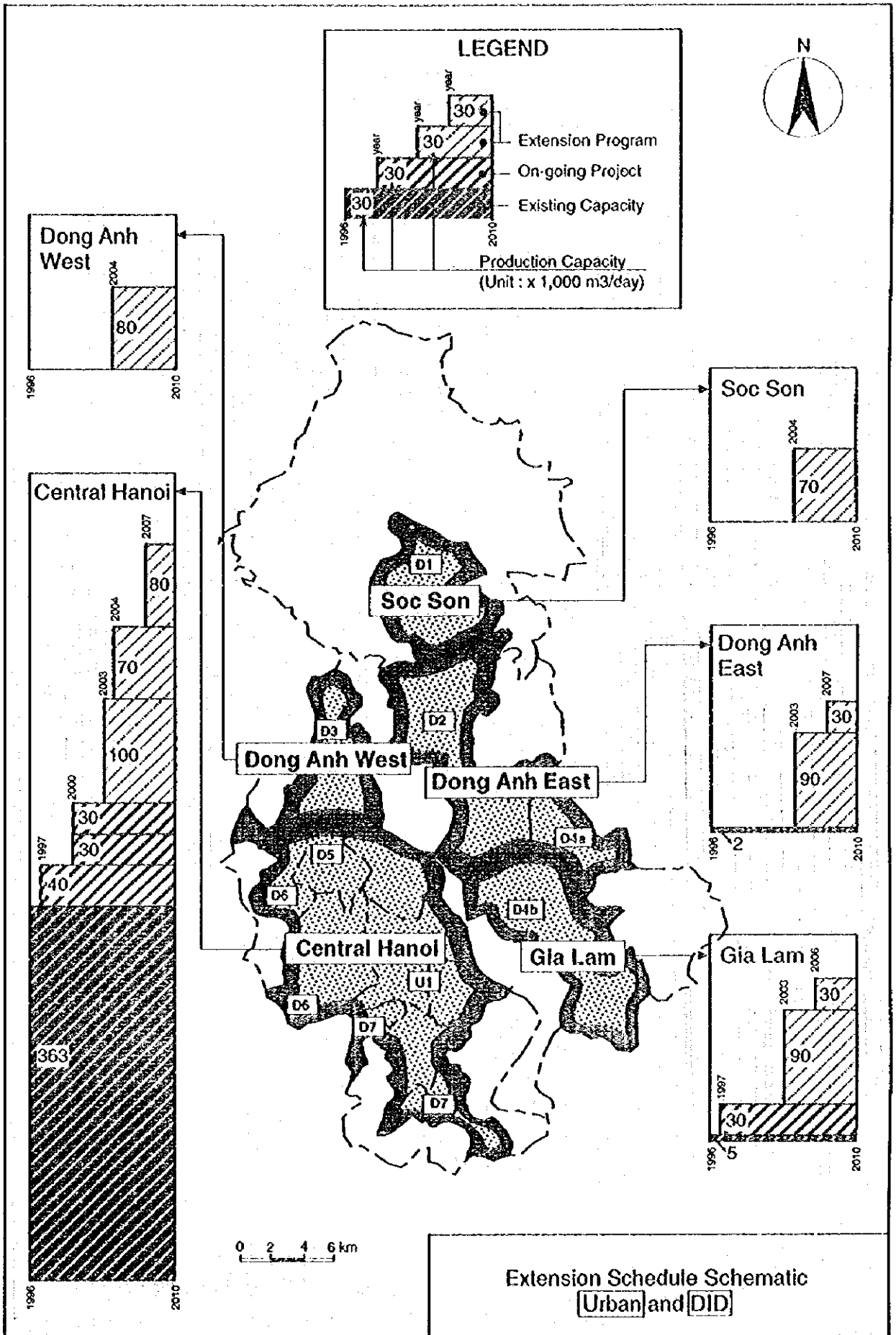
Based on the new construction and extension schedule for the urban water supply, construction costs were tentatively estimated and their investment schedule was programmed.

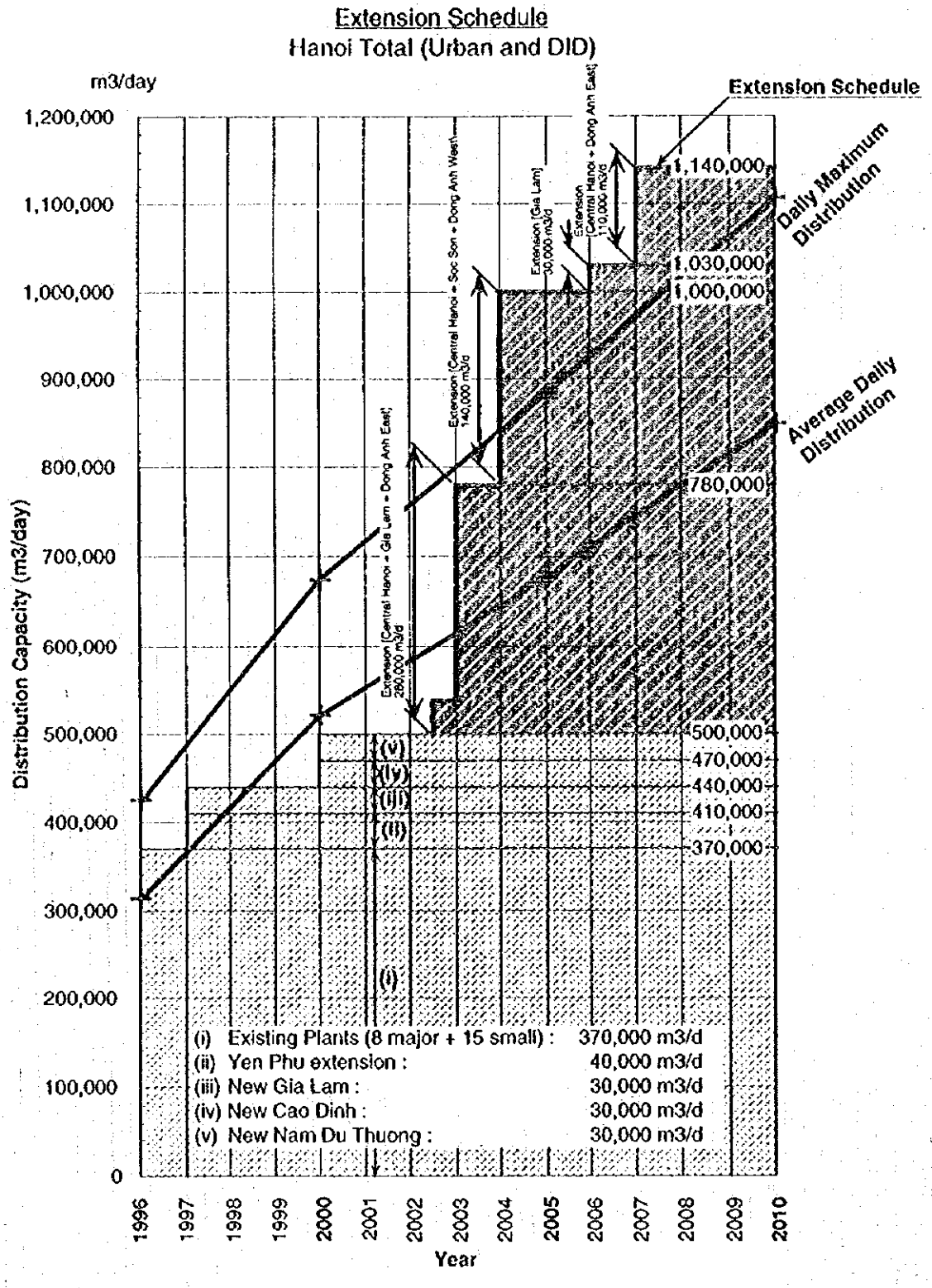
Until the year 2010, total investment cost of US$ 500.7 million will be required for the additional capacity of 640,000 m3/day for the urban water supply systems.


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

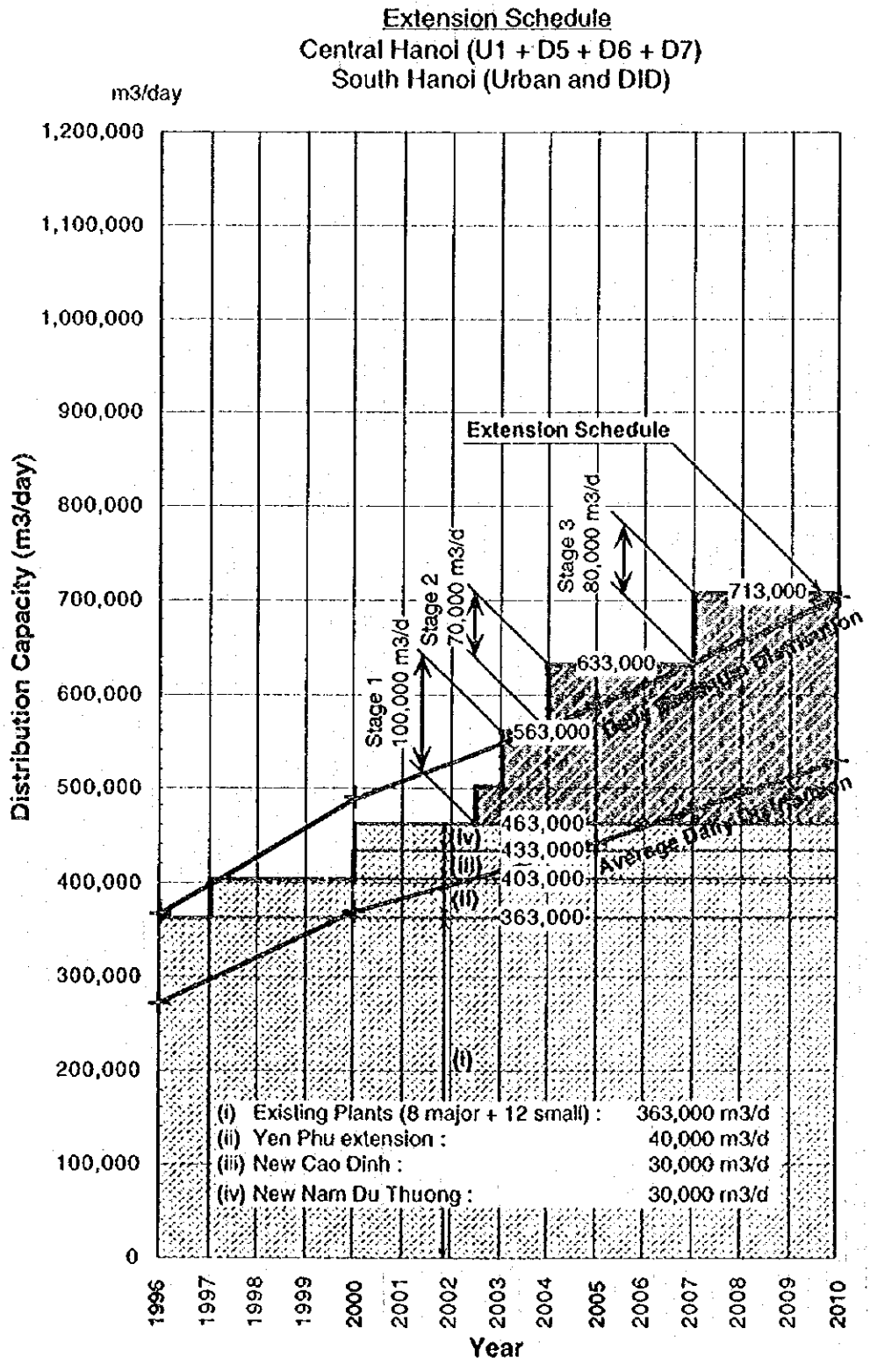

N
Soc Son
70,000 m3/d
(20,000 m3/d from Gia Lam)
Dong Anh West
80,000 m3/d
(20,000 m3/d from Gia Lam)
Dong Anh East
90,000 + 30,000 = 120,000 m3/d
(30,000 m3/d from Gia Lam)
North Hanoi
390,000 m3/d
Gia Lam
90,000 + 30,000 = 120,000 m3/d
SOC SON
DONG ANH
GIA LAM
Thuong Cat
- Cao Dinh
60,000 + 40,000 + 40,000
= 140,000 m3/d
Nam Du Thuong
40,000 + 40,000 + 30,000
= 110,000 m3/d
South Hanoi
250,000 m3/d
0 2 4 6 km
Note : Plant caapaacity is the Daily Maximum basis.
Locations of Proposed Plants


N
D5
D6
D6
D7
D7
U
St.III Ph.2
40,000
St.II Ph.1
40,000
St.I Ph.1
60,000
New Cao Dinh
30,000
Ngoc Ha
44,000
Mai Dich
60,000
Yen Phu
40,000
Yen Phu
Extension
40,000
Ngo Si Lien
60,000
Luong Yen
45,000
Ha Dinh
25,000
Tuong Mai
30,000
New Nam
Du Thuong
30,000
Phap Van
30,000
St.II Ph.2
30,000
St.I Ph.2
40,000
St.III Ph.2
40,000
LEGEND
Existing Plants (Major Plants)
On-going Project Plants
New Extension Plants (M/P)
0 1 2 5 km
Location of Proposed Plants
and Distribution Mains
(South Hanoi)

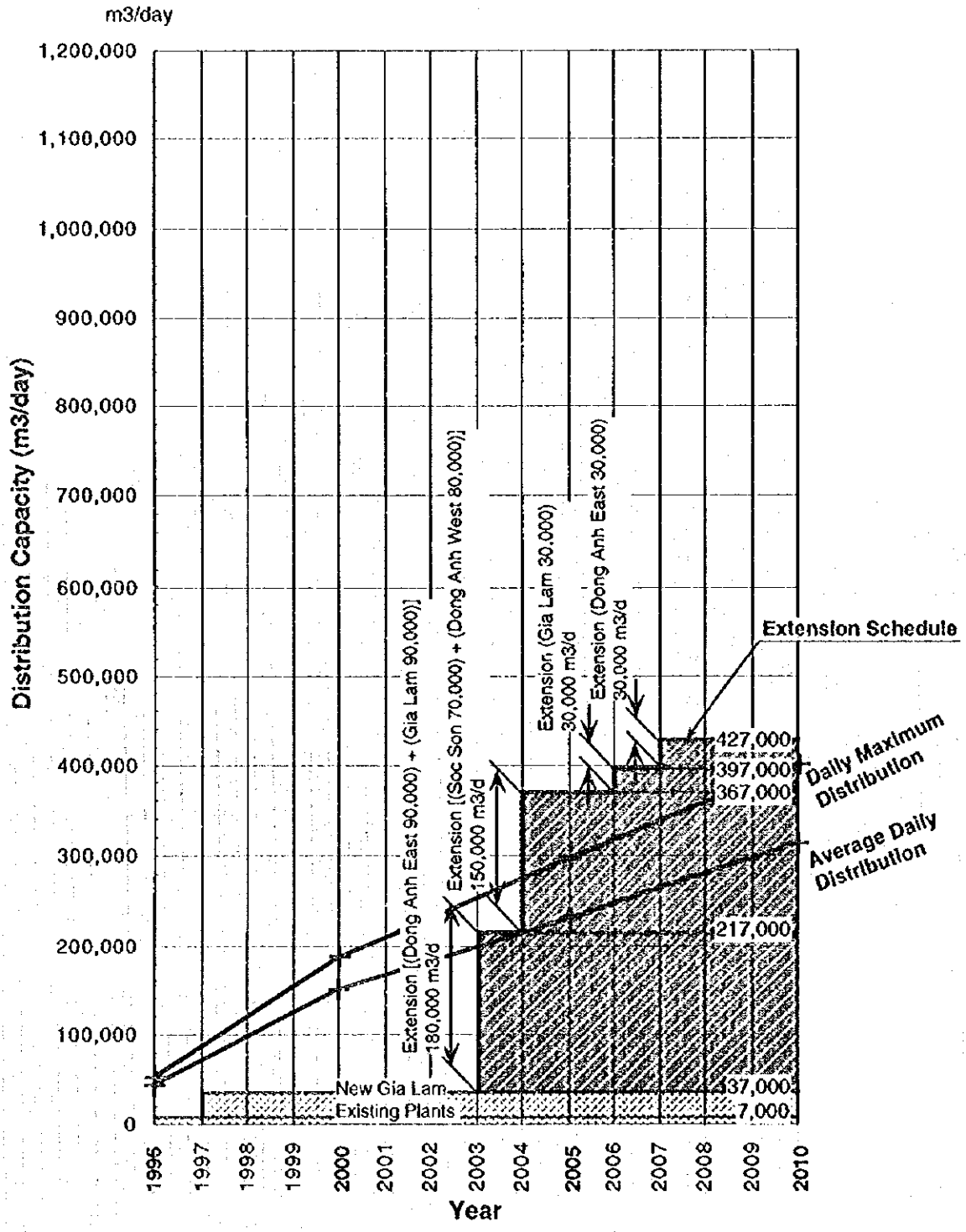

LEGEND
Extension Program
On-going Project
Existing Capacity
Production Capacity
(Unit : x 1,000 m3/day)
N
Dong Anh West
Central Hanoi
Soc Son
Dong Anh East
Gia Lam
D1
D2
D3
D4a
D4b
D5
D6
D7
U1
0 2 4 6 km
Extension Schedule Schematic
Urban and DID



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)

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) Stage I	Construction	-	-	-	($72,100,000) →				(100,000 m3/d)	-	-	-	-	-	-	-	100,000 m3/d
	Investment	-	-	-	$10,815,000	$10,815,000	$25,235,000	$25,235,000	-	-	-	-	-	-	-	-	$72,100,000
Central Hanoi (2) Stage II	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
Central Hanoi (3) Stage III	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
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 Transmission	Construction	-	-	-	-	-	-	($12,000,000) →		-	-	-	-	-	-	-	-
	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	$54,325,000	$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

2.3 EXTENSION PROGRAM FOR RURAL WATER SUPPLY

(1) Areas for Rural Water Supply System

For rural areas, where there are no existing public water supply systems, new water supply systems for future are planned with separation from the urban water supply systems. The proposed service area, communes (phuong or xa) are listed with classification (Classes A, B and C)classified by population) in the Table of "Water demand, Production and Raw Water Capacity for Rural Water Supply Systems".

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 system proposed is summarized below :

- Number of communes :	60 communes in total
- Population in a commune (Year 2010) :	14,711 (Max.) – 3,090 (Min.)
	(8,658 persons on average)
- Population served (Year 2010) :	12,504 (Max.) – 2,627 (Min.)
	(7,3359 persons on average)
- Water demand in a commune (Year 2010, average daily) :	
	1,125 m3/d(Max.) – 236 m3/d(Min.)
	(662 m3/day on average)

(2) System

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

The unit water demand (per capita consumption) is set at 90 liters/capita/day on the daily average basis for the year 2010.

Water source is planned to be deep groundwater. The groundwater necessary for the commune, 1,500 m3/d at the maximum for one commune, is obtainable within the commune area. The availability of the groundwater is to be confirmed at the time of the project implementation. The groundwater is to be taken through a deep well 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.

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

Power necessary for mainly raw water intake pumps and distribution pumps is planned to be of the public electricity.

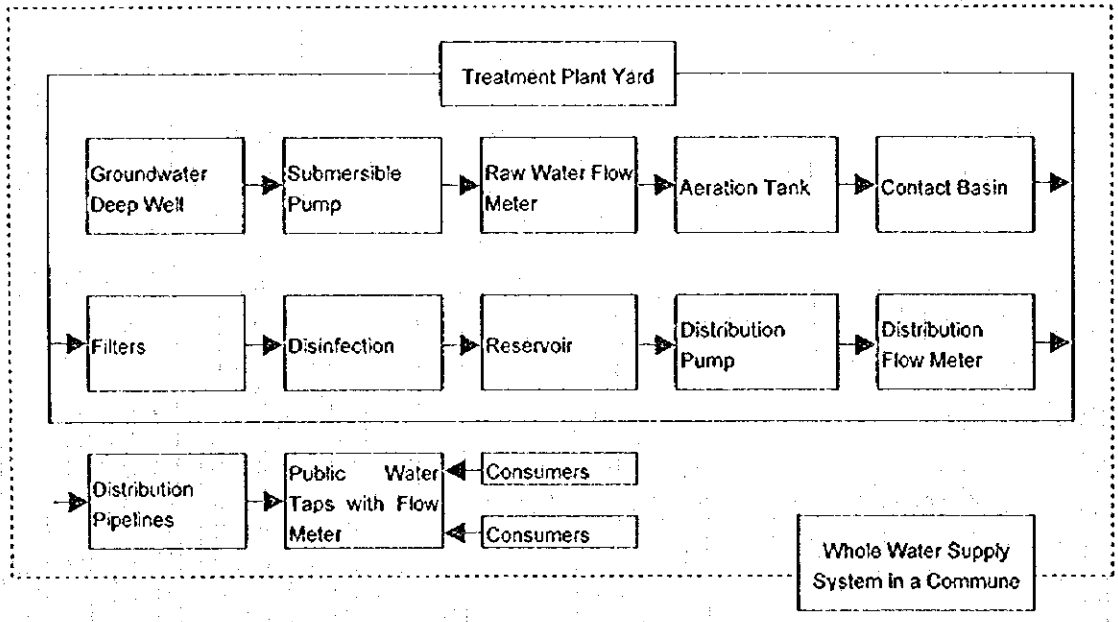
Water is to be supplied to consumers through public water taps equipped with a water meter each. The public taps will be located within a distance of less than 100 m. Each tap will serve about 100 people.

The treated water is distributed through distribution pipelines on which public taps are to be installed. The maximum diameters of the pipeline will be 200 – 150 mm.

(3) Basic Planning

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

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



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

(4) Construction Period

One system for one commune can be constructed within 12 months. It is proposed that 10 systems can be simultaneously constructed in one year; 60 systems (for total 60 communes) be constructed in 6 years. Construction years will be 1998 -- 2003.

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

(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".

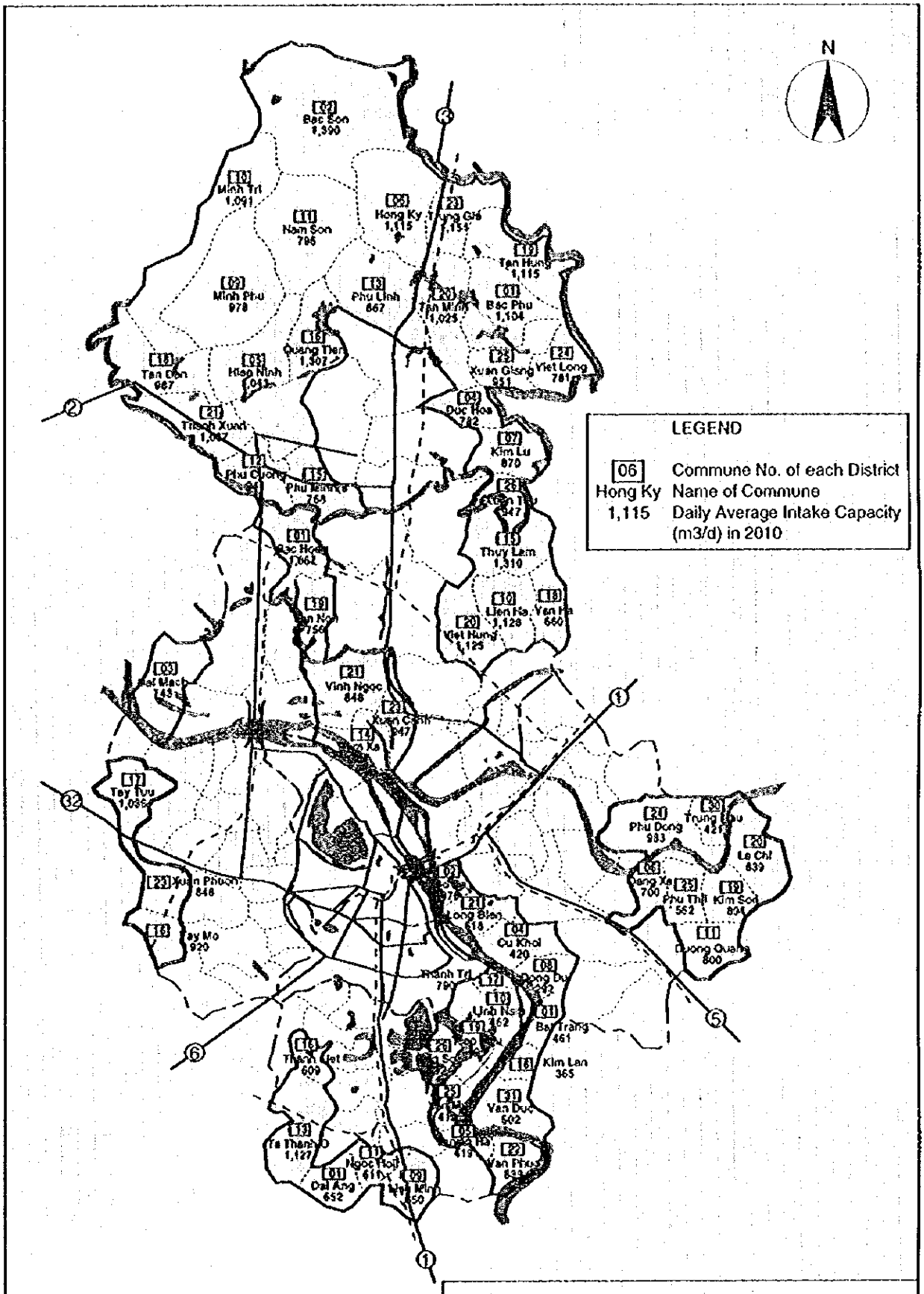
The practical procedure for implementation of the rural water supply systems is illustratedly shown in the "Chart of Implementation Procedure (Rural Water Supply).

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.


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

Classification of Rural Water Supply Systems by Commune

Class	Number of Communes	Population of a commune in 2010			For Representative Commune (Year : 2010)											
		(A)			(B)	(C)	(D)	(E)	(F)	(G)	Typical Design Capacity (H)	(I)	(J)	(K)	(L)	(M)
		Maximum Population among the Class (persons)	Minimum population among the Class (persons)	Average population (presentative) among the Class (persons)	Population Served (persons)	Unit Water Demand (liters/cap/day)	Daily Average Water Demand (m3/d)	Daily Average Production and Distribution Capacity (m3/d)	Daily Average Raw Water Intake and Treatment Capacity (m3/d)	Daily Maximum Raw Water Intake and Treatment Capacity (m3/d)	Intake and Treatment Capacity (m3/d)	Production and Distribution Capacity (m3/d)	Peak Hour Capacity (m3/hour)	Average Area of Commune (ha)	Average Road Distance per Area (m/ha)	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

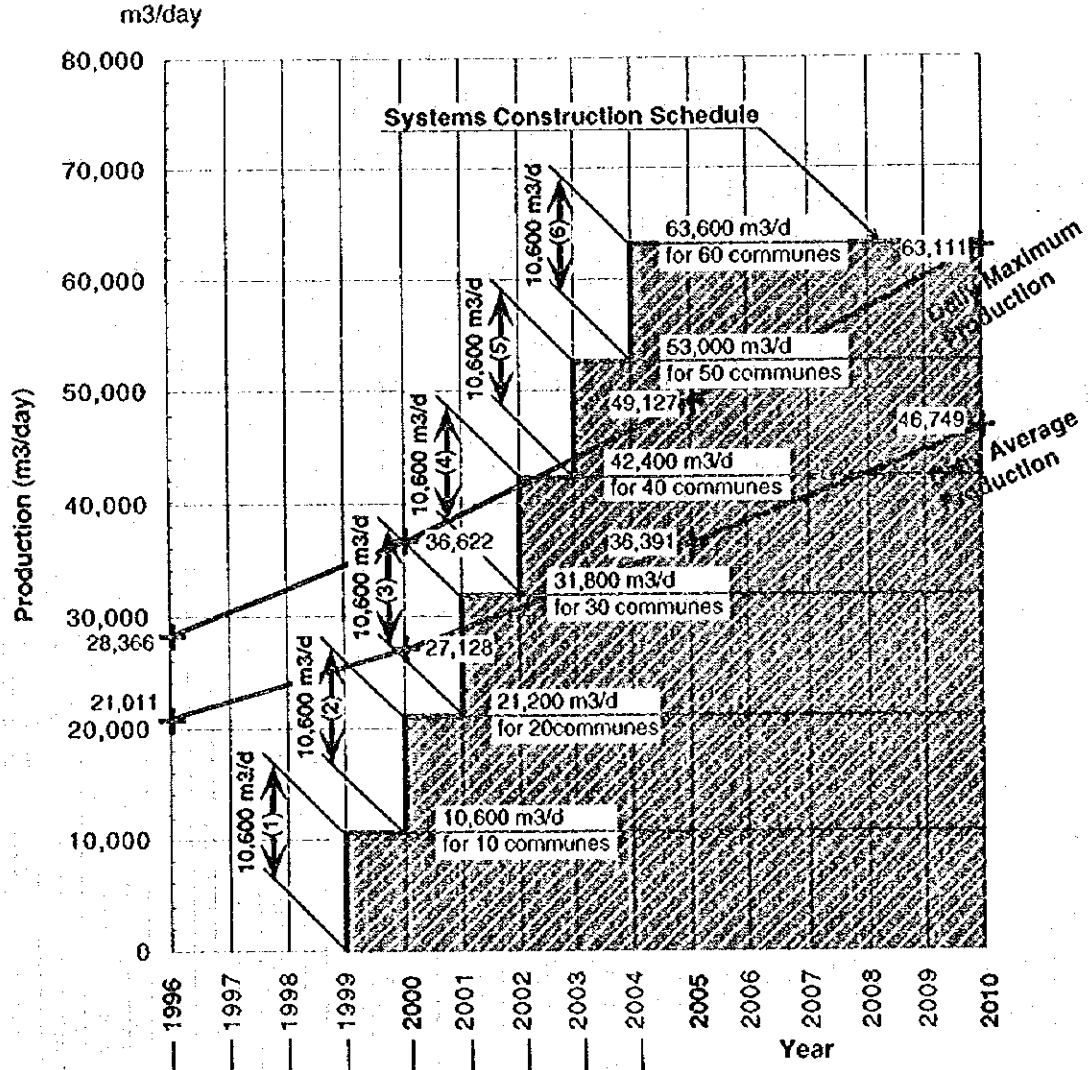
(J) = (I) x 1.40 (Peak hourly factor = 1.40)

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	998.1	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	897.1	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	1,506	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	1,506	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	633.3	12,215	10,383	90	934	1,099	1,154	1,484	1,558	Class A	4,596	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	189,589	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	830.0	11,691	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	8,846	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		70,520	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	8,960	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	4,688	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	2,600	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	570.0	8,879	7,547	90	679	799	839	1,079	1,133	Class B	4,640	8.1	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	8,365	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	69,875	90	6,288	7,398	7,769	9,989	10,490		64,710	11.5	0.9
Total (60 communes)			48,906.4	519,460	441,542	90	39,737	46,748	49,086	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 1.06
(H) = (F) x 1.35
(I) = (G) x 1.35
(K) = (J) / (A)
(L) = (J) / (C)

Construction Schedule
Rural Water Supply Systems (60 Communes)



Investment Schedule

1996	0	
1997	0	
1998	(1) 10@$558,100 = for 10 communes	$5,581,000
1999	(2) 10@$558,100 = for 10 communes	$5,581,000
2000	(3) 10@$558,100 = for 10 communes	$5,581,000
2001	(4) 10@$558,100 = for 10 communes	$5,581,000
2002	(5) 10@$558,100 = for 10 communes	$5,581,000
2003	(6) 10@$558,100 = for 10 communes	$5,581,000
2004	Total (1 - 6) =	$33,486,000

Construction Schedule
Rural Water Supply Systems
(60 Communes)

2.4 INSTITUTIONAL FRAMEWORK AND MANAGEMENT PLAN

2.4.1 Summary and Recommendations

This chapter aims mainly to improve the management efficiency of Hanoi Water Business Company (HWBC) till the year 2010, which is the monopolistic water supply company in Hanoi city belonging to Hanoi People's Committee (HPC: municipal government). The biggest problem which HWBC is facing is that non revenue water estimated to reach 70% of production owing to physical leakage, lack of operating meters and weak billing system.

(1) Under the circumstances of the government subsidies being reduced, Hanoi Water Business Company (HWBC) has became the status of semi-corporatization with partly subsidies and with half autonomy. HWBC should proceed steadily to full-corporatization with strong company cash flow (=self-financing capability) and with autonomy towards the year 2010. Full-corporatization means that HWBC should have the management autonomy and self-accountability separating from the control of HPC. This process can be defined as commercialization which a state run enterprise such as HWBC seeks profit-based efficiency. However it should be noted that corporatization and commercialization are quite different from equitization (initial public offering) and privatization (listing of majority of shares on the stock exchange). The last two stages may not be taken place in the water sector of Hanoi till the year 2010.

Otherwise credit quality will become higher when HWBC will become an excellent company with strong cash flow in the commercialization process. This will result in HWBC's diversity of fund raising including foreign official funds, concession contracts, joint ventures and BOTs.

(2) It is necessary that HWBC should work more closely with customers whom it serves rather than work too much closely with HPC . If HWBC will not seek sufficient customer-oriented activities and will continue to have huge amount of non revenue water resulting from physical leakage, lack of operating meters and weak billing system, HWBC will have the new entry of efficient foreign private water suppliers to meet the rapid water demand in Hanoi.

(3) It is effective that the performance oriented salary system should be strengthened in order to increase collecting water charges and reduce system losses. Under this system, performance targets should be set by each unit in consultation between managers and workers. Each unit on HWBC should make detailed benchmark figures on income target and expenditure target in its business plan. The results will be evaluated based on benchmarks and performance. The evaluation should be reflected in salaries and bonuses.

(4) As shown in other countries' cases especially in China, the involvement of several governmental agencies in the water supply business would have been produced poor results, such as sluggish management decision-making, lagging improvements in managerial efficiency, and delays in trimming supply costs. It is recommendable that the authorities in Vietnam should suitable concentrate and unify several governmental authorities involved in the water supply business.

(5) The board of directors of HWBC seems presently to involve in the combination of ownership and management. Ownership function results from the present situation that fixed assets of HWBC belong to the government authorities and that directors, managers of HWBC are mostly appointed or approved by the HPC. Potential conflicts of interest have existed because that the board of directors not only perform the ownership function on behalf of HPC, but also is responsible for managing HWBC toward profit based efficiency. Under the circumstances the board of directors would face a dilemma whether water charges should be kept at an affordable level, or, at the level that allow the company to cover costs and make future investments. It is desirable that ownership function should shift from HWBC to the government authorities. Especially, the government authorities should establish the State budget system to give straight subsidies to water management boards in rural district for constructing rural water supply system.

(6) It is effective that the water plants and business enterprises should be not only defined at the present as internal cost units, but also redefined in the future as internal profit units. This means to place workers profit responsibility and motivation to reduce water leakage and increase collecting water charges.

(7) The fixed assets of HWBC are formally owned by the government authorities, although they are stated in the balance sheet of HWBC. This is different from the international accounting standards. It is recommendable that HPC should transfer the asset's ownership to HWBC in exchange of holding equity ownership of HWBC. HPC should have indirect control of HWBC through its equity ownership. In this case it is desirable that HWBC should pay dividend to HPC (equity owner) in the future.

(8) It is necessary that foreign official funds should not be provided as subsidies from HPC to HWBC, but should be provided as loans through governmental financial institutions with guarantee by the central government. In this case HWBC should pay interest to the financial institutions. In the far future, it may be advisable that foreign official funds should be onlent to HWBC near at commercial lending rates and not on concessional terms.

(9) In order to use foreign funds in the future, HWBC will need to establish a strong balance sheet, sufficient cash flows, and to obtain a good rate of return. In addition to this sound financial condition, HWBC will need to provide adequate financial statement to lenders, financial institutions. Financial statements must be prepared in accordance with international accounting standards. It is necessary that fixed assets should be re-valuated and under-estimation of depreciation cost should be corrected. It is not sufficient for HWBC to provide its financial statements audited and certified by a government internal auditor. Financial statements should be audited each year by competent, independent auditors.

2.4.2 Future Organizational Structure

In August 1996, HWBC has split into HWBC and HWBC No.2. HWBC No.2 inherits the eastern business territory across the Red River which Gia Lam Water Business Enterprise is. HWBC No.2 is ready to enlarge the business territory to the northern rural areas in the future. On the other hand, HWBC inherits the western business territory of the Red River which the center of the city is. HWBC will expand the business territory to the southern rural areas in the future.

Longer-term amendment might be need for improving management efficiency. The following countermeasures will be introduced in HWBC.

(a) The cost units so-called "departments" with business capability will change to profit units so-called "enterprises" gradually.
(b) Every major district will have one business enterprise in the future.
(c) The water plants will get revenue by wholesaling water to business enterprises in the future.

Two ways will be taken place toward the future in HWBC No.2.

(a) The decentralization will be preceded. HWBC No.2 is ready to enlarge the business territory to the northern rural areas including Dong Anh district and Soc Son district. These two districts will have each water plants and each water business enterprises.
(b) New departments will be established along with the expansion of the business.

Because of the small volume of water to be supplied in each communes of rural areas, the water revenue will not be able to cover the construction cost. Therefore, it causes the issue who should manage and finance the rural areas. The optimum alternative may be that the water management board of rural might construct water facility there through subsidies provided by rural districts and should transfer water facility to HWBC or HWBC No.2 after completion. HWBC or HWBC No.2 could conduct operation and maintenance through taking over water facility. There may be two reasons. One reason is due to the social priority for the development of the rural water supply system. The other reason is due to the good impact of profitability on HWBC and HWBC No.2.

As for work force, the employees of current HWBC are divided into four (4) job categories as follows :

Category 1 : Water production
Category 2 : Marketing activities, specifically, meter reading, billing and money collection
Category 3 : Operational support service activities
Category 4 : Planning, organization, accounting, engineering, project management, security and other administrative

In this study, future work force by water supply system have been estimated as shown in Table 2.4-1.

Table 2.4-1 Outlook for the Number of Workers by Water Supply System

Year 1995

Job Category	HWBC	HWBC No.2	Rural	Total
Total Employees	1,780	-	-	1,780
Piped Watered Population	1,251,787	17069	0	1,268,856
Distribution Capacity (m3/d)	363,000	7000	0	370,000
Restructuring Rate (%)	0	-	-	-
Efficiency (Population/Worker)	713	-	-	713

Year 2000

	HWBC	HWBC No.2	Rural	Total
Total Employees	1,390	104	200	1,694
Piped Watered Population	1,529,472	114,623	222,477	1,866,572
Distribution Capacity (m3/d)	463,000	37,000	21,200	521,200
Restructuring Rate (%)	37.6	41.6	-	57.9
Efficiency (Population/Worker)	1,100	1,102	1,112	1,102

Year 2005

	HWBC	HWBC No.2	Rural	Total
Total Employees	1,361	617	600	2,578
Piped Watered Population	1,701,308	771,571	412,446	2,885,325
Distribution Capacity (m3/d)	633,000	367,000	63,600	1,063,600
Restructuring Rate (%)	55.3	65.1	-	57.9
Efficiency (Population/Worker)	1,250	1,251	687	1,119

Year 2010

	HWBC	HWBC No.2	Rural	Total
Total Employees	1,271	688	600	2,559
Piped Watered Population	1,779,058	963,192	441,542	3,183,792
Distribution Capacity (m3/d)	713,000	427,000	63,600	1,203,600
Restructuring Rate (%)	62.9	66.5	-	57.9
Efficiency (Population/Worker)	1,400	1,400	736	1,244

2.4.3 Training for Work Force

In order to keep the work forces required for the proposed organization, rationalization and employment of staff will be needed. At the same time, training and education for the staff would be necessary to maintain and develop the water supply systems. The following training and education courses are proposed.

Managing staff:
learn how to manage an organization and to acquire knowledge of new technology

Water supply engineer:
to learn how to plan a water supply scheme and how to manage water sources and water quality, and to acquire techniques of water treatment and plant operation

Staff in charge of construction and maintenance of facilities:
to learn how to control a time-schedule and quality of work, and how to inspect and repair equipment, machines and facilities

Staff in charge of business and public relations:
to learn how to effectively collect water charge and how to pleasingly serve users

Staff in charge of finance and accounting:
to learn how to keep accounts, how to plan a financial scheme, and how to finance

At present, the Ministry of Construction has a plan to establish a training center for water supply and sanitation. The plan includes technical courses for water supply engineers, therefore water supply systems in Hanoi should actively utilize these training courses for their staff.

Engineers/workers for operation and maintenance of water treatment facilities in rural water supply systems should be trained by an on-the-job way at the existing plants. Therefore HWBC and HWBC No.2 should provide a training section in their organizations.

Training for HWBC's staff in charge of finance and accounting is to be carried out by the year 2000 as a component of the project financed by the World Bank.

HWBC No.2 should enroll the staff to be transferred to HWBC No.2 in the training course and develop the talents in this field by the year 2000.

It is imperative in the future that a training system be established in the Gia Lam new water treatment plant that train the staffs of HWBC No.2.

Staff in charge of water quality monitoring should be trained mainly at the existing water quality laboratory of HWBC. Main training courses should be a lecture of chemistry and a practical training of water quality analysis. Analysis of special substances such as heavy metals or agricultural chemicals should be subcontracted to special institutes which have sufficient devices for chemical analysis. However, higher level of knowledge of chemistry should be acquired through training and education in order to examine and evaluate the results.

2.5 FINANCIAL PLAN

2.5.1 Discussion on the Water Tariff

Water tariff should meet two contradictory objectives – financial and social objectives. Water tariff should make a water company financially sound, yet at the same time price level should be kept low enough for even low income households. In 1995, National Water Tariff Policy Study in Viet Nam (NWTS) was carried out funded by the Asian Development Bank and was participated by the Central Government including the Ministry of Construction and 53 provincial water companies in order to determine optimum water tariffs. As of March 1996, nevertheless, water tariffs throughout the country turned out to be too low considering financial viability of water companies in Vietnam. Therefore necessary increases in tariffs were recommended in the NWTS together with improvements in billing & collection system and consumers education.

The Government used to provide big funding for water supply sector, but now the policy has changed to make the urban water sector more self-financing through various methodologies such as appropriate tariff policies.

In this report, the calculation of the Water Production Cost will be conducted as the basis of future tariff forecast, which should be quite logical context given the prevailing policy in Vietnam of self-financing Water Companies.

The projected water tariff is presented in Table 2.5-1 in Chapter 2.5.2.

2.5.2 Financial Planning Procedures

(1) Common Procedures

For formulating the financial aspect of the Master Plan, the following steps will be undertaken :

1 **Determination of the Project Cost**
2 **Determination of the Total Financing Required**
3 **Determination of the Water Tariff by adjusting the Annualized Costs concept**
4 **Calculation of IRR based on the estimated Revenue and Cost figures**
5 **Financial Analysis including the Profit & Loss and Funds Application / Source projection**

The above procedure is applicable to the related three plans. Namely, for plans in the south Hanoi, the north Hanoi, and the rural area.

Exchange rate is fixed at 11,000 VND/US $. (Government of Vietnam will bear the foreign exchange risk)

Throughout the Financial Plan, all the figures are presented in real-terms at price level of year 1997 (not nominal, unless stated otherwise).

(2) Common Assumptions for Project Cost Calculation

1) O&M Cost

A. Rehabilitation of the Existing Facilities

This M/P includes the rehabilitation program of the existing facilities of the south Hanoi after the World Bank finishes their project. Thus there will be incremental O&M Costs by rehabilitation to carry out the program in the south Hanoi.

B. New Plant Extensions

The following three types of O&M Costs are to be involved :

(a) Plant O&M	O&M Costs born in the New Water Treatment Plant Consists of (a1) Staff cost, (a2) Chemical cost, (a3) Electric cost, (a4) Repair cost and (a5) Other cost
(b) WBE O&M	O&M Costs accrued for the Water Business Enterprise 15% of (a) Plant O&M
(c) Head Office O&M	O&M Costs allocated to the HWBC Head Office 10% of (a) Plant O&M

(Note)
In the rural Hanoi project, different terms are defined on account of the different character of the water supply organization. They are, (a) Facility O&M and (b) Marketing O&M.

2) Investment (Construction) Related Cost

In addition to the construction costs, physical contingency and price contingency should be taken into consideration. Main assumptions are as follows :

(a) Physical contingency would be 10% of the construction costs.

(b) F/C portion will account for 59% of total construction whereas L/C portion 41%.

(c) Price contingency (inflation) shall be composed of F/C portion and L/C portion as follows :

Future Price Index

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
F/C	100.00	102.00	104.04	106.12	108.24	110.41	112.62	114.87	117.17	119.51
L/C	100.00	109.00	118.81	129.50	141.16	153.86	167.71	182.80	199.26	215.20

(Note) 2% p.a. inflation is applied to F/C portion and 9% p.a. inflation is applied to L/C portion

(3) Determination of Total Financing Required

1) Total Financing Required

All the investment cost is equivalent to the total financing required. Given it, financial obligations shall be calculated.

2) Depreciation

The straight line method with lifetime 20 years for all construction is assumed based on information of a big Six Accounting Firm .

3) Financing

The external loan funding source shall be assumed. The loan conditions would be :

Loan Period	30 years (no grace period assuming repayments to the Governmental Financial Institution)
Repayment	semi-annual installments
Interest Payment	2.3% p.a.
Draw Down	at the beginning of the year of construction

(4) Determination of Water Tariff

1) Annualized Water Price

In this study, Annualized Water Prices are to be used for the basis of water tariff calculation. Annualized Water Prices mean unit water prices for each year to cover the all project related costs per production. Calculation processes of the annualized prices for new plant extensions are shown below.

[Annualized Water Price] = [O&M Costs : (Plant O&M)+(WBE O&M)+(HO O&M)]
+ [Debt Services : (Principal + Interest)]
+ [Regulated Profit : 5%]

(Note)
[Debt Services (VND/m3)] = [Annual Repayment Amount (Principle and Interest) (VND/year)]
/ [Accounted for Water (m3/day)] / 365 (days/year).

2) Tariff Setting

The projected water tariff is tabulated in Table 2.5-1.

Table 2.5-1 Projected Water Tariff

(VND/m3)

Customer Category	1997	1998	1999	2000	2001	2002	2003
Domestic	1,375	1,650	2,000	2,425	2,775	3,050	3,350
SEs/ Public Services	2,750	3,300	4,000	4,850	5,550	6,100	6,700
Private Businesses	5,500	6,000	6,750	8,000	8,400	9,200	10,000
Foreigners	5,500	6,000	6,750	8,000	8,400	9,200	10,000

2004	2005	2006	2007	2008	2009	2010
3,625	3,750	3,900	4,100	4,300	4,500	4,700
7,750	8,135	8,550	8,970	9,420	9,900	10,390
10,800	11,340	11,900	12,500	13,120	13,790	14,470
10,800	11,340	11,900	12,500	13,120	13,790	14,470

(Note) Until year 2004, figures are almost same as Estimated Financial Plan by HWBC. After year 2004 for domestic customers tariffs are close to the forecast in the World Bank Final Report and for other customer categories, average 5% per annum increases are assumed.

(5) Financial Analysis

1) Cash Flow Analysis

Based on the calculated revenues, the free cash flow is calculated in the table. IRR rates for the projects are also presented in the table.

2) Profit & Loss Statement

The Profit & Loss statement of each project until year 2030 will be presented based on the above calculations. The table shows break-even point as well.

3) The Applications and Sources of Funds

The applications and sources of funds until year 2030 will be calculated in the table to illustrates the fund flows.

2.5.3 Financial Plan for the South Hanoi

(1) Free Cash Flow Analysis

Free Cash Flows are presented in Table2.5-2.

The calculation results in reasonable IRR of 14.12% for the period of 30 years inclusive of the new plants and rehabilitation.

Table 2.5-2 Free Cash Flow of the South Hanoi

(million VND)

Year	Cash In Flow	Cash Out Flow		Free Cash Flow
	Incremental Revenue	Investment	O&M	
1999		118,965	0	-118,965
2000		208,395	0	-208,395
2001		367,015	0	-367,015
2002		486,255	0	-486,255
2003	139,326	308,165	55,776	-224,615
2004	173,490	99,495	63,573	10,421
2005	215,078	232,155	71,092	-88,169
2006	254,800	232,155	80,596	-57,951
2007	298,732		90,888	207,844
2008	345,878		85,818	260,060
2009	396,637		97,284	299,352
2010	450,548		109,501	341,047
2011	473,075		111,744	361,332
2012	496,729		114,060	382,669
2013	521,566		116,451	405,115
2014	547,644		118,920	428,724
2015	575,026		121,470	453,557
2016	603,778		124,102	479,675
2017	633,966		126,821	507,146
2018	665,665		129,628	536,037
2019	698,948		132,527	566,421
2020	733,895		135,522	598,374
2021	770,590		138,436	632,154
2022	809,120		141,438	667,682
2023	849,576		144,529	705,046
2024	892,054		147,714	744,340
2025	936,657		150,994	785,663
2026	983,490		154,373	829,117
2027	1,032,664		157,852	874,812
2028	1,084,298		161,437	922,861
2029	1,138,513		165,128	973,384
2030	1,195,438		168,931	1,026,507

IRR =	14.12%

(2) Profit & Loss Statement

Table 2.5-3 presents the Profit & Loss statement of the south Hanoi project until year 2030 based on the above calculations. The table shows break-even point would be year 2006 which is a little late due to early start depreciation and no grace assumption on interest payments.

Table 2.5-3 Profit & Loss Statement of the South Hanoi

(million VND)

Year	Total Revenue	Total O&M Costs	Depreciation	Interest Costs	Profit & Loss
1999			5,948	68,809	-74,757
2000			16,368	66,515	-82,883
2001			34,719	64,222	-98,940
2002			59,032	61,928	-120,960
2003	139,326	55,776	74,440	59,634	-50,524
2004	173,490	63,573	79,415	57,341	-26,839
2005	215,078	71,092	91,022	55,047	-2,084
2006	254,800	80,596	102,630	52,754	18,821
2007	298,732	90,888	102,630	50,460	54,754
2008	345,878	85,818	102,630	48,166	109,264
2009	396,637	97,284	102,630	45,873	150,850
2010	450,548	109,501	102,630	43,579	194,838
2011	473,075	111,744	102,630	41,285	217,416
2012	496,729	114,060	102,630	38,992	241,048
2013	521,566	116,451	102,630	36,698	265,786
2014	547,644	118,920	102,630	34,405	291,689
2015	575,026	121,470	102,630	32,111	318,816
2016	603,778	124,102	102,630	29,817	347,228
2017	633,966	126,821	102,630	27,524	376,992
2018	665,665	129,628	102,630	25,230	408,177
2019	698,948	132,527	91,022	22,936	452,462
2020	733,895	135,522	79,415	20,643	498,316
2021	770,590	138,436	74,440	18,349	539,365
2022	809,120	141,438	59,032	16,055	592,594
2023	849,576	144,529	34,719	13,762	656,565
2024	892,054	147,714	16,368	11,468	716,504
2025	936,657	150,994	5,948	9,175	770,541
2026	983,490	154,373	0	6,881	822,237
2027	1,032,664	157,852	0	4,587	870,225
2028	1,084,298	161,437	0	2,294	920,568
2029	1,138,513	165,128	0	0	973,384
2030	1,195,438	168,931	0	0	1,026,507

(3) Applications and Sources of Funds

Table 2.5-4 illustrates the applications and sources of funds until year 2030. As seen from the table projected fund flows are quite smooth, represented by the positive net cash position throughout the period.

Table 2.5-4 Applications and Sources of Funds of the South Hanoi

(million VND)

Year	Application				Source			Net Cash Position
	Total O&M Costs	Investment	Interest Costs	Loan Repayment	Cash Position from the Previous Year	Water Revenue	Loan Advance	
1999		118,965	68,809	99,724	0		2,991,708	2,704,210
2000		208,395	66,515	99,724	2,704,210		0	2,329,576
2001		367,015	64,222	99,724	2,329,576		0	1,798,615
2002		486,255	61,928	99,724	1,798,615		0	1,150,708
2003	55,776	308,165	59,634	99,724	1,150,708	139,326	0	766,735
2004	63,573	99,495	57,341	99,724	766,735	173,490	0	620,091
2005	71,092	232,155	55,047	99,724	620,091	215,078	0	377,151
2006	80,596	232,155	52,754	99,724	377,151	254,800	0	166,722
2007	90,888		50,460	99,724	166,722	298,732	0	224,382
2008	85,818		48,166	99,724	224,382	345,878	0	336,552
2009	97,284		45,873	99,724	336,552	396,637	0	490,308
2010	109,501		43,579	99,724	490,308	450,548	0	688,052
2011	111,744		41,285	99,724	688,052	473,075	0	908,374
2012	114,060		38,992	99,724	908,374	496,729	0	1,152,328
2013	116,451		36,698	99,724	1,152,328	521,566	0	1,421,020
2014	118,920		34,405	99,724	1,421,020	547,644	0	1,715,616
2015	121,470		32,111	99,724	1,715,616	575,026	0	2,037,338
2016	124,102		29,817	99,724	2,037,338	603,778	0	2,387,472
2017	126,821		27,524	99,724	2,387,472	633,966	0	2,767,370
2018	129,628		25,230	99,724	2,767,370	665,665	0	3,178,453
2019	132,527		22,936	99,724	3,178,453	698,948	0	3,622,213
2020	135,522		20,643	99,724	3,622,213	733,895	0	4,100,220
2021	138,436		18,349	99,724	4,100,220	770,590	0	4,614,301
2022	141,438		16,055	99,724	4,614,301	809,120	0	5,166,204
2023	144,529		13,762	99,724	5,166,204	849,576	0	5,757,764
2024	147,714		11,468	99,724	5,757,764	892,054	0	6,390,912
2025	150,994		9,175	99,724	6,390,912	936,657	0	7,067,677
2026	154,373		6,881	99,724	7,067,677	983,490	0	7,790,190
2027	157,852		4,587	99,724	7,790,190	1,032,664	0	8,560,690
2028	161,437		2,294	99,724	8,560,690	1,084,298	0	9,381,534
2029	165,128		0	0	9,381,534	1,138,513	0	10,354,918
2030	168,931		0	0	10,354,918	1,195,438	0	11,381,426

2.5.4 Financial Plan for the North Hanoi

(1) Free Cash Flow Analysis

Financial projection is made as shown in Table 2.5-5. This trial has resulted in the reasonable IRR of 14.71% for the period of 30 years.

Therefore, Water Tariff of Table2.5-1 can be justified for the north Hanoi area as well.

Table 2.5-5 Free Cash Flow of the North Hanoi

(million VND)

Year	Cash In Flow	Cash Out Flow		Free Cash Flow
	Total Revenue	Investment	O&M	
1999		218,790		-218,790
2000		407,715		-407,715
2001		699,435		-699,435
2002		1,062,710		-1,062,710
2003	213,439	597,575	64,734	-448,870
2004	258,513	151,250	74,269	32,994
2005	295,106	211,750	83,745	-389
2006	333,421	105,875	95,586	131,960
2007	376,322		107,676	268,645
2008	422,257		118,918	303,340
2009	471,692		130,883	340,808
2010	524,053		143,632	380,420
2011	550,255		146,580	403,675
2012	577,768		149,625	428,143
2013	606,657		152,772	453,885
2014	636,990		156,024	480,966
2015	668,839		159,383	509,456
2016	702,281		162,855	539,426
2017	737,395		166,443	570,952
2018	774,265		170,152	604,113
2019	812,978		173,985	638,993
2020	853,627		177,946	675,681
2021	896,308		181,736	714,573
2022	941,124		185,639	755,485
2023	988,180		189,659	798,521
2024	1,037,589		193,800	843,789
2025	1,089,468		198,064	891,404
2026	1,143,942		202,457	941,484
2027	1,201,139		206,982	994,157
2028	1,261,196		211,643	1,049,553
2029	1,324,255		216,443	1,107,813
2030	1,390,468		221,387	1,169,081

IRR =	14.71%

(2) Profit & Loss Statement

Table 2.5-6 means the Profit & Loss statement of the north Hanoi project until year 2030 based on the above calculations. The table shows break-even point is estimated as late as year 2009 largely owing to depreciation caused by huge investments and no grace assumption on interest payments .

Table 2.5-6 Profit & Loss Statement of the North Hanoi

(million VND)

Year	Total Revenue	Total O&M Costs	Depreciation	Interest Costs	Profit & Loss
1999			10,940	112,283	-123,223
2000			31,325	108,540	-139,865
2001			66,297	104,797	-171,094
2002			139,851	101,055	-240,906
2003	213,439	64,734	210,568	97,312	-159,174
2004	258,513	74,269	238,549	93,569	-147,874
2005	295,106	83,745	249,136	89,826	-127,602
2006	333,421	95,586	254,430	86,084	-102,679
2007	376,322	107,676	254,430	82,341	-68,125
2008	422,257	118,918	254,430	78,598	-29,689
2009	471,692	130,883	254,430	74,855	11,523
2010	524,053	143,632	254,430	71,113	54,878
2011	550,255	146,580	254,430	67,370	81,876
2012	577,768	149,625	254,430	63,627	110,086
2013	606,657	152,772	254,430	59,884	139,570
2014	636,990	156,024	254,430	56,142	170,394
2015	668,839	159,383	254,430	52,399	202,627
2016	702,281	162,855	254,430	48,656	236,340
2017	737,395	166,443	254,430	44,913	271,608
2018	774,265	170,152	254,430	41,170	308,513
2019	812,978	173,985	254,430	37,428	347,136
2020	853,627	177,946	249,136	33,685	392,860
2021	896,308	181,736	238,549	29,942	446,081
2022	941,124	185,639	210,568	26,199	518,718
2023	988,180	189,659	139,851	22,457	636,213
2024	1,037,589	193,800	66,297	18,714	758,778
2025	1,089,468	198,064	31,325	14,971	845,108
2026	1,143,942	202,457	0	11,228	930,256
2027	1,201,139	206,982	0	7,486	986,671
2028	1,261,196	211,643	0	3,743	1,045,810
2029	1,324,255	216,443	0	0	1,107,813
2030	1,390,468	221,387	0	0	1,169,081

(3) Application and Sources of Funds

Table2.5-7 presents the applications and sources of funds until year 2030 . The projected fund flows are quite smooth, represented by the positive net cash position throughout the period.

Table 2.5-7 Applications and Sources of Funds of the North Hanoi

(million VND)

Year	Application				Source			Net Cash Position
	Total O&M Costs	Investment	Interest Costs	Loan Repayment	Cash Position from the Previous Year	Water Revenue	Loan Advance	
1999		218,790	112,283	162,729	0		4,881,865	4,388,063
2000		407,715	108,540	162,729	4,388,063		0	3,709,079
2001		699,435	104,797	162,729	3,709,079		0	2,742,117
2002		1,062,710	101,055	162,729	2,742,117		0	1,415,624
2003	64,734	597,575	97,312	162,729	1,415,624	213,439	0	706,713
2004	74,269	151,250	93,569	162,729	706,713	258,513	0	483,409
2005	83,745	211,750	89,826	162,729	483,409	295,106	0	230,464
2006	95,586	105,875	86,084	162,729	230,464	333,421	0	113,611
2007	107,676		82,341	162,729	113,611	376,322	0	137,187
2008	118,918		78,598	162,729	137,187	422,257	0	199,199
2009	130,883		74,855	162,729	199,199	471,692	0	302,423
2010	143,632		71,113	162,729	302,423	524,053	0	449,002
2011	146,580		67,370	162,729	449,002	550,255	0	622,579
2012	149,625		63,627	162,729	622,579	577,768	0	824,365
2013	152,772		59,884	162,729	824,365	606,657	0	1,055,637
2014	156,024		56,142	162,729	1,055,637	636,990	0	1,317,732
2015	159,383		52,399	162,729	1,317,732	668,839	0	1,612,060
2016	162,855		48,656	162,729	1,612,060	702,281	0	1,940,101
2017	166,443		44,913	162,729	1,940,101	737,395	0	2,303,410
2018	170,152		41,170	162,729	2,303,410	774,265	0	2,703,624
2019	173,985		37,428	162,729	2,703,624	812,978	0	3,142,460
2020	177,946		33,685	162,729	3,142,460	853,627	0	3,621,727
2021	181,736		29,942	162,729	3,621,727	896,308	0	4,143,629
2022	185,639		26,199	162,729	4,143,629	941,124	0	4,710,185
2023	189,659		22,457	162,729	4,710,185	988,180	0	5,323,521
2024	193,800		18,714	162,729	5,323,521	1,037,589	0	5,985,867
2025	198,064		14,971	162,729	5,985,867	1,089,468	0	6,699,571
2026	202,457		11,228	162,729	6,699,571	1,143,942	0	7,467,098
2027	206,982		7,486	162,729	7,467,098	1,201,139	0	8,291,040
2028	211,643		3,743	162,729	8,291,040	1,261,196	0	9,174,121
2029	216,443		0	0	9,174,121	1,324,255	0	10,281,934
2030	221,387		0	0	10,281,934	1,390,468	0	11,451,015

2.5.5 Financial Plan for the Rural Hanoi

(1) Cash Flow Analysis

Based on the projected tariffs, annual water revenue is calculated in Table 2.5-8. This has resulted in the somewhat low IRR of 6.76% for the period of 30 years.

Table 2.5-8 Revenue Forecast and Free Cash Flow of the Rural Hanoi

(million VND)

	Annual Revenue		Free Cash Flow			
	ADD (m3/day)	Revenue (million VND)	Cash In Flow	Cash Out Flow		Free Cash Flow
			Total Revenue	Investment	O&M	
1998	(24,681)			30,696		-30,696
1999	25,905	13,237	13,237	30,696	13,993	-31,451
2000	27,128	16,808	16,808	30,696	15,401	-29,289
2001	28,981	20,548	20,548	30,696	17,321	-27,469
2002	30,834	24,028	24,028	30,696	19,433	-26,101
2003	32,687	27,977	27,977	30,696	21,759	-24,478
2004	34,540	31,990	31,990		24,325	7,665
2005	36,391	34,867	34,867		27,157	7,710
2006	38,463	38,326	38,326		30,462	7,865
2007	40,535	42,462	42,462		34,122	8,341
2008	42,607	46,810	46,810		38,179	8,631
2009	44,679	51,370	51,370		42,680	8,690
2010	46,749	56,139	56,139		47,674	8,464
2011	46,749	58,945	58,945		49,376	9,568
2012	46,749	61,893	61,893		51,159	10,733
2013	46,749	64,987	64,987		53,023	11,964
2014	46,749	68,237	68,237		54,972	13,264
2015	46,749	71,649	71,649		57,012	14,637
2016	46,749	75,231	75,231		59,145	16,086
2017	46,749	78,993	78,993		61,378	17,615
2018	46,749	82,942	82,942		63,713	19,229
2019	46,749	87,089	87,089		66,157	20,932
2020	46,749	91,444	91,444		68,714	22,729
2021	46,749	96,016	96,016		70,506	25,510
2022	46,749	100,817	100,817		72,351	28,466
2023	46,749	105,858	105,858		74,252	31,606
2024	46,749	111,150	111,150		76,209	34,941
2025	46,749	116,708	116,708		78,226	38,482
2026	46,749	122,543	122,543		80,303	42,241
2027	46,749	128,671	128,671		82,442	46,229
2028	46,749	135,104	135,104		84,645	50,459
2029	46,749	141,859	141,859		86,914	54,945
2030	46,749	148,952	148,952		89,252	59,700

IRR =	6.76%

(2) Profit & Loss Statement

Table 2.5-9 is the Profit & Loss statement of the rural Hanoi until year 2030. The result shows break-even point is estimated as late as year 2018 largely owing to rather high O&M costs and depreciation.

Table 2.5-9 Profit & Loss Statement of the Rural Hanoi

(million VND)

Year	Total Revenue	Total O&M Costs	Depreciation	Interest Costs	Profit & Loss
1998			3,070	5,559	-8,629
1999	13,237	13,993	6,139	5,374	-12,268
2000	16,808	15,401	9,209	5,188	-12,990
2001	20,548	17,321	12,278	5,003	-14,055
2002	24,028	19,433	15,348	4,818	-15,571
2003	27,977	21,759	18,417	4,633	-16,832
2004	31,990	24,325	18,417	4,447	-15,199
2005	34,867	27,157	18,417	4,262	-14,969
2006	38,326	30,462	18,417	4,077	-14,629
2007	42,462	34,122	18,417	3,891	-13,968
2008	46,810	38,179	18,417	3,706	-13,492
2009	51,370	42,680	18,417	3,521	-13,248
2010	56,139	47,674	18,417	3,335	-13,289
2011	58,945	49,378	18,417	3,150	-12,000
2012	61,893	51,159	18,417	2,965	-10,649
2013	64,987	53,023	18,417	2,780	-9,232
2014	68,237	54,972	18,417	2,594	-7,747
2015	71,649	57,012	18,417	2,409	-6,189
2016	75,231	59,145	18,417	2,224	-4,555
2017	78,993	61,378	18,417	2,038	-2,841
2018	82,942	63,713	15,348	1,853	2,028
2019	87,089	66,157	12,278	1,668	6,987
2020	91,444	68,714	9,209	1,482	12,038
2021	96,016	70,506	6,139	1,297	18,074
2022	100,817	72,351	3,070	1,112	24,284
2023	105,858	74,252	0	927	30,679
2024	111,150	76,209	0	741	34,200
2025	116,708	78,226	0	556	37,926
2026	122,543	80,303	0	371	41,870
2027	128,671	82,442	0	185	46,044
2028	135,104	84,645	0	0	50,459
2029	141,859	86,914	0	0	54,945
2030	148,952	89,252	0	0	59,700

(3) Applications and Sources of Funds

Table 2.5-10 presents the applications and sources of funds until year 2030. The projected fund flows statement demonstrates positive net cash positions.

Table 2.5-10 Applications and Sources of Funds of the Rural Hanoi

(million VND)

Year	Application				Source			Net Cash Position
	Total O&M Costs	Investment	Interest Costs	Loan Repayment	Cash Position from the Previous Year	Water Revenue	Loan Advance	
1998		30,696	5,559	8,057	0		483,408	439,097
1999	13,993	30,696	5,374	8,057	439,097	13,237	0	394,215
2000	15,401	30,696	5,188	8,057	394,215	16,808	0	351,681
2001	17,321	30,696	5,003	8,057	351,681	20,548	0	311,152
2002	19,433	30,696	4,818	8,057	311,152	24,028	0	272,176
2003	21,759	30,696	4,633	8,057	272,176	27,977	0	235,009
2004	24,325		4,447	8,057	235,009	31,990	0	230,170
2005	27,157		4,262	8,057	230,170	34,867	0	225,561
2006	30,462		4,077	8,057	225,561	38,326	0	221,292
2007	34,122		3,891	8,057	221,292	42,462	0	217,685
2008	38,179		3,706	8,057	217,685	46,810	0	214,553
2009	42,680		3,521	8,057	214,553	51,370	0	211,665
2010	47,674		3,335	8,057	211,665	56,139	0	208,737
2011	49,378		3,150	8,057	208,737	58,945	0	207,098
2012	51,159		2,965	8,057	207,098	61,893	0	206,809
2013	53,023		2,780	8,057	206,809	64,987	0	207,937
2014	54,972		2,594	8,057	207,937	68,237	0	210,550
2015	57,012		2,409	8,057	210,550	71,649	0	214,721
2016	59,145		2,224	8,057	214,721	75,231	0	220,526
2017	61,378		2,038	8,057	220,526	78,993	0	228,046
2018	63,713		1,853	8,057	228,046	82,942	0	237,365
2019	66,157		1,668	8,057	237,365	87,089	0	248,573
2020	68,714		1,482	8,057	248,573	91,444	0	261,763
2021	70,506		1,297	8,057	261,763	96,016	0	277,919
2022	72,351		1,112	8,057	277,919	100,817	0	297,215
2023	74,252		927	8,057	297,215	105,858	0	319,838
2024	76,209		741	8,057	319,838	111,150	0	345,981
2025	78,226		556	8,057	345,981	116,708	0	375,850
2026	80,303		371	8,057	375,850	122,543	0	409,664
2027	82,442		185	8,057	409,664	128,671	0	447,650
2028	84,645		0	0	447,650	135,104	0	498,109
2029	86,914		0	0	498,109	141,859	0	553,054
2030	89,252		0	0	553,054	148,952	0	612,754

2.5.6 Financial Evaluation

(1) Financial Evaluation on the Master Plan

1) Drawbacks

Overall estimated FIRR of the Master Plan in the study area are reasonable until year 2030(14.12% in the South Hanoi, 14.71% in the North Hanoi), but FIRR of Rural Hanoi is expected rather low criteria of 6.76% even after the half of the investment cost subsidies.

Considering the present financial status of HWBC, fund raising ability in the three areas remains vulnerable at least until target year of 2010.

2) Mitigants

Stable water supply is definitely required to meet the Basic Human Needs (BHN), especially for Low Income Household such as rural Hanoi people.

Estimated FIRRs are at least higher than the anticipated financing cost of 2.30%. Assumptions in the calculations are fairly conservative, like 15% administration loss even for the brand new water supply systems.
Because of its primitive financial market in Vietnam, the yield curve is inverted, as such low FIRR for the long term project can be justified.

(2) Selected Sensitivity Tests

Regarding items to be reviewed, (a) O&M Costs, (b) UFW and (c) Water Tariffs are selected as the most influential parameter.

Table 2.5-11 shows the calculation outcomes.

Naturally, Water Tariff change has the biggest impact on IRR of the project. The table points out that in order to achieve high IRR, drastic jump up of Water Tariff is required.

Table 2.5-11 Sensitivity Analysis

O & M Costs

Factor	IRR		
	South	North	Rural
0.90	15.02	15.73	8.12
0.95	14.56	15.27	7.69
1.00	14.12	14.71	6.76
1.05	13.02	13.75	6.05
1.10	12.05	13.16	5.22

UFW

Factor	IRR		
	South	North	Rural
0.80	15.02	15.65	7.93
0.90	14.58	15.18	7.25
1.00	14.12	14.71	6.76
1.10	13.44	14.39	5.95
1.20	13.00	14.06	5.31

Tariffs

Factor	IRR		
	South	North	Rural
1.20	16.59	17.21	9.64
1.10	15.36	15.93	8.11
1.00	14.12	14.71	6.76
0.90	12.78	13.40	5.08
0.80	11.43	12.14	3.27

(3) Affordability Analysis

The affordability projection was conducted for average income and low income households. Generally speaking, it is arguable what should be the maximum affordable level of water charge costs to incomes because it could vary depending on social circumstances. For Hanoi, both World Bank and Asian Development Bank use 4% of Monthly Household Income as a cap rate. Adopting this standard, projection analysis implies that water charge level will be within the cap rate until 2010.

(4) Conclusions

Due to big investment plan and water charge increase strain owing to social conditions, projected FIRRs for three study areas in Hanoi are moderate, at best. But taking the social purpose of the plan, financial environment in Vietnam, and fairly conservative assumptions into account , those figures are considered acceptable.

Affordability does not seem the problem by the projection until year 2010.

Therefore from the point of financial aspect, the Master Plan is considered viable.

2.6 INITIAL ENVIRONMENTAL EXAMINATION (IEE)

The IEE study was conducted following the requirement outlined in implementing the Article 18 of the Law on Environmental Protection. The IEE could be one of important performance needed for consideration and approval of the next development stage of the project. EIA (Environmental Impact Assessment) should be carried out in the next stage of feasibility study based on the results of IEE. Sensitive environmental aspects as well as exact degree of impacts will be determined and possible measures including monitoring will be proposed to mitigate negative impacts on natural, physical, ecological and socio-economic environment.

2.6.1 Environmental Impact

A construction of new water supply facilities as well as upgrading of existing ones, is certain to cause some effects on the environment. In general, most impacts are considered to be positive, but some might be negative and monitoring and special mitigation measures would be required.

Environmental impacts caused by the projects were identified according to the relations with existing environmental conditions at the sites proposed. Then the extent of impacts was examined using an impact matrix table as shown in Table 2.6-1, and the master plan in this study was comprehensively evaluated.

(1) Preconstruction Stage

- Planning of water supply projects will generally bring beneficial effects on social environment such as economic activities, land use and living conditions. Especially, the project for stable supply of good quantity/quality of water would strongly lead residential, industrial and commercial development.

- If the facilities for water supply are designed without careful consideration, they may cross the reserved/restricted area, divide communities, affect land use, damage river dikes, affect scenic views, excessively discharge groundwater resulting in land subsidence, or cause the problems of noise, vibration and offensive odor to adjacent houses.

- Site acquisition would displace inhabitants at the project sites, reduce an agricultural potential, and affect living conditions, cultural/historical sites and land use. However, the sites to be acquired would be limited, therefore the extent of loss would be minor.

- Site clearing and demolition may affect living facilities, topography and geology, soil erosion and wildlife. However, the area of the site and the extent of demolition would be limited, therefore the extent of damage would be minor.

(2) Construction Stage

- Construction works may interfere water use and traffic in an adjacent area, damage living facilities, flood control facilities or historical/cultural relics, change natural conditions of groundwater, surface water, wildlife and scenic views, affect air quality or groundwater quality, and cause noise and vibration. Construction wastes may be illegally dumped around the construction sites.

(3) Operation Stage

- Excessive discharge of groundwater caused by poor management may seriously lower the groundwater level resulting in land subsidence and increase of inundation risk, and deteriorate groundwater quality. Water intake facilities such as pump may cause problems of noise and vibration to an adjacent area.

- Treatment facilities will supply good quantity/quality of water to domestic and industrial customers, which would improve living conditions and accelerate economic activities in Hanoi. Transportation of dried sludge to dump would not affect traffic condition near the water treatment plant, because the volume of dried sludge would not be so big. A treatment plant will be constructed and stand out in vast and flat areas such as rice fields, and would affect scenic views in the suburbs. Dried sludge disposal without proper control may cause soil contamination. Operation of facilities may cause noise to adjacent areas.

- Distribution facilities will make it easier to use safe and stable water, which would improve living conditions, accelerate economic activities and widen a possibility of land use. However, if drainage/sewerage systems will not be prepared in parallel with water supply systems, the increase of wastewater would affect groundwater, surface water and urban scenic views, and cause water pollution or offensive odor.

2.6.2 Measures against the Negative Impact

(1) Preconstruction Stage

- Locations, capacities and sizes of all facilities will be designed paying attention to the existence of the residential areas, the reserved/restricted areas, communities and structures, and the features of land use, scenic views, not to cause problems of environmental pollution, or not to affect or damage them.

- Although the extent of loss caused by site acquisition or site clearing/demolition would be limited in this project, an appropriate compensation will be made for the affected persons according to the governmental decision.

- Locations and capacities of the production wells will be planned paying special attention to the present groundwater level or the predicted exploitable discharge volume not to cause land subsidence.

(2) Construction Stage

- Construction works in the residential areas will be managed not to cause the residents a great deal of inconvenience. Alternative ways will be prepared if construction work seriously affect the living conditions.

- Although any historical relics or cultural sites will not overlapped with the sites of the proposed facilities, construction areas will be set up not to touch those historical or cultural sites.

- Slurry or muddy wastewater generated by the work of drilling wells will be controlled at the sites not to affect water quality of water bodies or water use in the adjacent areas, and the wells will be drilled not to disturb hydraulic conditions of aquifers or not to contaminate groundwater.

- During the construction period of the facilities, watchman will be put at the site to control the traffic and construction material will be supplied through several routes by well-controlled operation not to cause a traffic jam.

- Construction wastes will be dumped to the designated landfills and controlled not to be scattered around the sites.

- Construction works will be managed not to gather equipment at the same place in order to avoid an accumulation of air/water pollutants or noise/vibration generated by the equipment.

(3) Operation Stage

- Groundwater level will be periodically monitored, and the discharge volume will be controlled not to cause serious depression of groundwater.

- Water treatment plant will be designed taking the distance from the adjacent area and the appearance into account in order to mitigate the problem of noise and scenic views.

- New water treatment plant proposed in this study will have sludge treatment process and backwash water will not be discharged directly to a drain. At the final process of sludge drying bed, water in sludge will be filtered and discharged to a drain. Remained sludge will be dried and dumped to a designated landfill.

2.6.3 General Assessment

Whether public water supply systems are developed or not, Hanoi will rapidly grow and develop because of its economic development which has already begun to run. However, Hanoi would not soundly develop if this water supply master plan would not be implemented.

In general, most impacts caused by the implementation of the master plan are considered to be positive and negative impacts seem to be small. Most negative impacts will be controlled or mitigated if the measures proposed in this study are taken appropriately.

Among the facilities for water supply systems, main facility that needs land acquisition to some extent is water treatment plant. However, it is not necessary to construct a water treatment plant in a densely populated area, or transmission mains or distribution pipes are generally laid under/along the existing roads. Therefore, number of houses or residents that should be relocated or displaced is considered to be limited.

The total volume of groundwater discharge proposed in this master plan falls within the limited exploitable capacity that was predicted by the Vietnamese Geological Survey and has been accepted in Hanoi. However, land subsidence and deterioration of groundwater quality caused by excessive discharge of groundwater seems to be the most sensitive impact among all environmental factors. Therefore, all possible measures should be taken against those problems of groundwater, even if a risk of such environmental impacts is not predicted.

Urban drainage and sewerage systems should be prepared in parallel with the development of water supply systems. The development of urban drainage and sewerage systems has been already started according to the master plan. Therefore, it is desired to arrange the original implementation schedule of urban drainage and sewerage systems and accelerate the implementation.

Table 2.6-1 Potential Environmental Impacts resulting from Master Plan for Hanoi Water Supply Systems

Impacts		Environmental Factors																				
		Social Environment								Natural Environment						Pollution					
Phase	Items	Displacement of people	Economic activities	Living conditions	Division of community	Historical or cultural sit	Land and resources use	Traffic	Risk of disaster	Topography and geolog	Soil erosion	Ground water	Surface water	Wildlife	Aesthetics and landscap	Air Quality	Water Quality	Soil contamination	Noise and vibration	Land subsidence	Offensive odors
Preconstruction	Planning		00	00			00	00													
	Design				X	XX	XX		XX			XX			XX				XX	XX	X
	Site acquisition	X	X	X		X	X														
	Site clearing and demolition			X						X	X			X							
Construction	Intake			X		XX	X	XX	XX			X		X	X	XX	XX		XX		
	Raw Water Transmission			X		XX		XX						X	X	XX	XX		XX		
	Treatment			X		XX		XX						X	X	XX	XX		XX		
	Transmission			XX		XX		XX						X	X	XX	XX		XX		
	Distribution			XX		XX		XX							X	XX	XX		XX		
Operation	Intake								XXX			XXX					X		X	XXX	
	Raw Water Transmission																				
	Treatment		000	000				X							XX			X	XX		
	Transmission																				
	Distribution		000	000			00					XX	XX		X		XX				X

Note:
000 : major positive impact
00 : moderate positive impact
0 : minor positive impact
XXX : major negative impact
XX : moderate negative impact
X : minor negative impact

CHAPTER 3 SELECTION OF THE PRIORITY PROJECT

3 SELECTION OF THE PRIORITY PROJECT

3.1 OBJECTIVES OF THE PRIORITY PROJECT

For development of the Hanoi water supply systems, a priority project is to be selected for the Feasibility Study. The priority project should be qualified in considering the following objectives:

(a) Urgent necessity

The project should have urgent necessity.

(b) Commercialization

The project should contribute to commercialization of HWBC.

(c) Population Served

The project should contribute to the increase of rate of population served.

(d) Living Standard and Socio-economy

The project should contribute to improvement of living standards and to promotion of healthy socio-economic activities.

(e) Environment

The project should satisfy the environmental aspects.

3.2 SELECTION OF THE PRIORITY PROJECT

(1) General Conditions

In the M/P, the study area is categorized into the following three groups:

A. Group U

This area covers the existing service area and its surroundings. In the meanwhile, groundwater lowering has been pointed out recently at the wellfields in the southern area. From environmental consideration, it is necessary to restrict groundwater intake from these wellfields.

B. Group D

According to the population forecast and the urban development plan, the areas in group D will be rapidly developed and urbanized in future. In spite of the high water demand in the areas, the present water supply conditions in the areas are poor.

C. Group R

Group R is constituted of 60 rural communes where the population is smaller and the living conditions is lower than the other groups. Although to construct the rural water supply system has urgent necessity, it seems that contribution to the rate of population served would be lower than the other groups because the population are small even in total of 60 communes.

(2) Basic Concept of the Service Extension

Considering the project efficiency, the above examination implies that Group D has the highest priority. Still, preservation of groundwater lowering in Group U has high priority as well. Therefore, these two groups are focused on.

(3) Project Evaluation

Table 3.2-1 gives evaluation on the project sites. Based on the evaluation, the project for Central Hanoi is turned out to be as the highest priority project. For, according to the urban planning, this area is planned to be developed towards west and developed along the Ring Road No.3. Based on the concept of the urban planning, Central Hanoi is regarded as the next extension of the existing service area.

Table 3.2-1 Evaluation on the Project Sites

	Soc Son (D1)	Dong Anh East (D2+D4a)	Dong Anh West (D3)	Gia Lam (D4b)	Central Hanoi (D5, U)
Urgent Necessity	4 pt EPZ has started	2 pt Development plan is not clear	4 pt F/S has been prepared	2 pt Development plan is not clear	6 pt Commercial area and Resident are planned
Commercialization	3 pt Revenue from industrial water is large	3 pt Revenue from industrial water is large	3 pt Revenue from industrial water is large	3 pt Revenue from industrial water is large	2 pt Revenue from commercial use is large
Population Served	2 pt 89,140 persons in 2005	3 pt 273,351 persons in 2005	2 pt 131,776 persons in 2005	3 pt 277,304 persons in 2005	2 pt 126,542 persons in 2005
Living Standard	3 pt All domestic users will raise their living condition	3 pt All domestic users will raise their living condition	3 pt All domestic users will raise their living condition	3 pt All domestic users will raise their living condition	3 pt All domestic users will raise their living condition
Environment	2 pt Minor negative environmental impact	2 pt Minor negative environmental impact	2 pt Minor negative environmental impact	2 pt Minor negative environmental impact	3 pt Possible to recover the draw downed wellfields
Total Evaluation	14 pt	13 pt	14 pt	13 pt	16 pt The highest priority

Note :
Each item is evaluated by giving three-grade-points. As for the item of urgent necessity, doubled points are given on account of its great importance.

3.3 THE PRIORITY PROJECT

In the previous section, Central Hanoi was selected for the priority project area. In addition to supplying water to the project area, it is required to supplement to the Mai Dich plant where the lowering of the groundwater level is observed and to supply water to the new development area adjacent to the project area.

As the water supply conditions are different each other, the scope of water supply should be divided corresponding to the condition. For it, the following three scopes are proposed :

(a) Project Area (Current non-service area)

All domestic users as well as non-domestic users in the area are planned to be supplied with piped water by house connections.

(b) Mai Dich Supplement (Supplement to the existing water supply system)

In order to prevent lowering of the groundwater level in the Mai Dich wellfields, it is proposed to supplement treated water to the Mai Dich treatment plant.

(c) New Development Area (Commercial and Residential area in D5)

Since a clear plan on the new development area adjacent to the project area has not been established yet, the bulk water supply system is proposed for this area.

The proposed project site is shown in the following map.

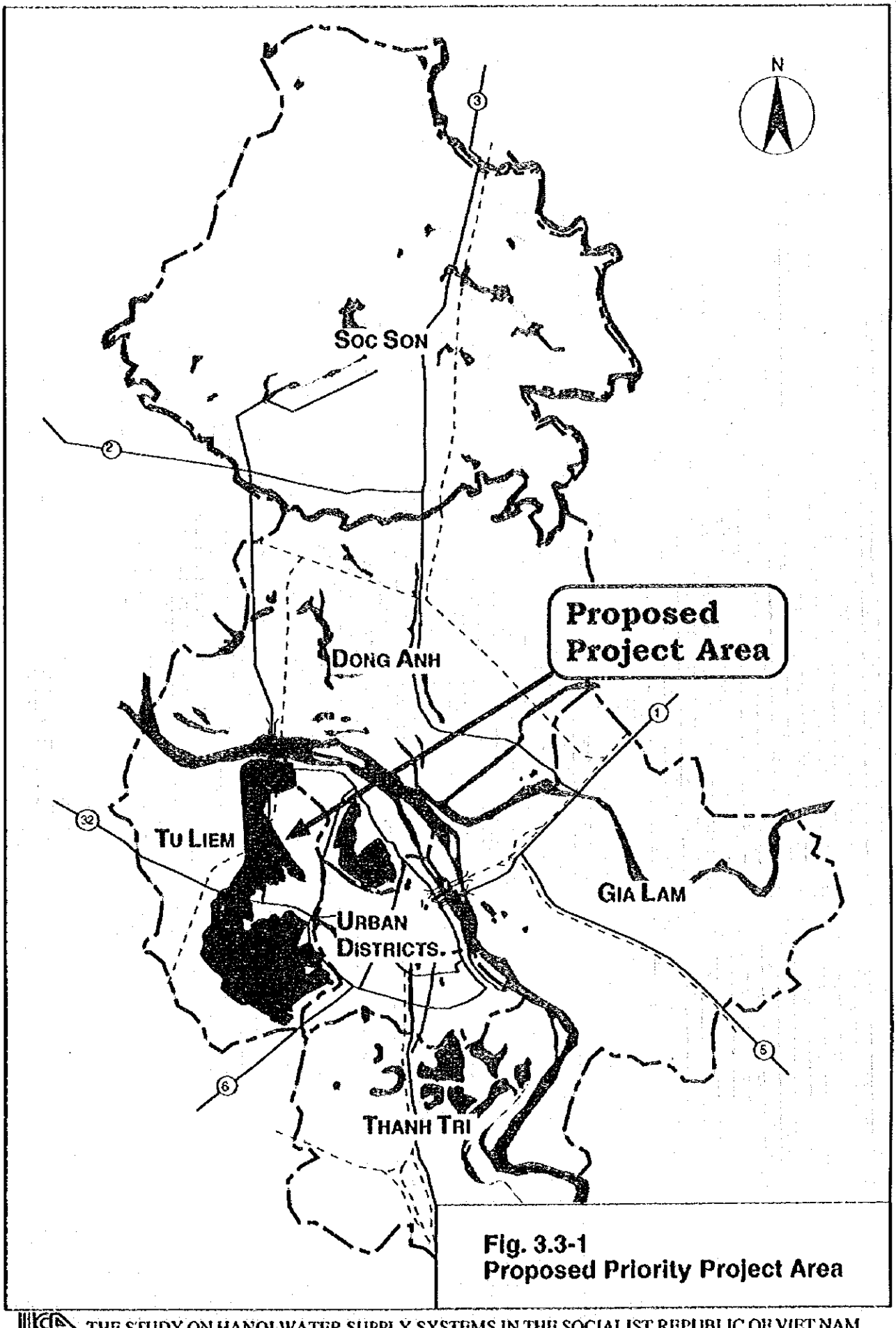


Fig. 3.3-1
Proposed Priority Project Area

PART III

FEASIBILITY STUDY

FOR

URBAN WATER SUPPLY SYSTEM

PART III FEASIBILITY STUDY FOR URBAN WATER SUPPLY SYSTEM

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CHAPTER 1 BASIC CONDITIONS OF THE PROJECT

1 BASIC CONDITIONS OF THE PROJECT

1.1 OBJECTIVE OF THE PROJECT

(1) Background

The priority project selected through the Master Plan study is planned in this Feasibility Study (F/S) with the target year of 2005.

1) Urbanization of Hanoi

Urbanization of Hanoi tends to spread out toward west, north and south. Especially, new urban development plan seems to put stress on the west. Urbanization toward the west will probably reach the Nhue River within the coming decade. The National Sports Complex, Diplomatic Area, New Business Center will be developed to support the urban functions of the capital city of Hanoi. For all that, several minor developments are still going on but almost all of the above major developments will be realized beyond the year 2005. New development for commercial or residential purpose will be probably concentrated along the planned Ring Road No.3.

2) New Development Plan

Not a few development plans have been in the north-east side of the project area. However, new city master plan has not been officially announced yet, or the layout of the development plan has not yet been clarified in detail. Nevertheless the area undoubtedly has high potential for commercial or residential development.

3) Groundwater Lowering

Production capacity of the existing wells should be reduced in order to recover the depressed groundwater level and to control land subsidence in the central part of Hanoi.

(2) Proposed Water Supply System

Considering the above mentioned background, the water supply system proposed by F/S will have to meet three major categories of the water demand. Basic contents of the goal in the year 2005 are as follows :

A. Water supply to the project area

The project area being adjacent to the existing water service area needs piped water supply system for basic human needs and future development, since the project area is still non-water service area.

B. Supplement to Mai Dich system

Mai Dich water supply system has supplied water to urban district area being adjacent to the project area. At present, Mai Dich system seems to have sufficient capacity to meet the demand of its own service area and to allocate water to the other service areas. However, Mai Dich system itself has to reduce the groundwater discharge from its well field by around 20,000 m^3/day to prevent the groundwater from lowering. Therefore, Mai Dich system needs supplemental water to sustain the present service conditions.

C. Water allocation to the new development area

Vietnamese authorities of urban planning have prepared a new city development plan, but the plan has not been disclosed in detail. Although the new urban development plan has not been cleared, the new development plan will be certainly realized in the near future. Therefore, the water distribution system will be planned in F/S to support the new development plan actively. The service area will be supplied with the clean water by way of bulk water supply system, because the development plan seems to be implemented as a package project which will construct all infrastructure.

1.2 PROJECT AREA AND POPULATION

The project area consists of nine communes: Thuy Phuong, Dong Ngac, Co Nhue, Mai Dich, Dich Vong, Me Tri, My Dinh, Trung Hoa and Yen Hoa. Some parts of these communes which have been already covered by the existing water supply systems or the on-going projects are excluded from the F/S.

Parts located in the west side of the Nhue River are also excluded, because the water supply for these areas is expected to be carried out in the next stage of the development plan.

Determination of the future population based on the development direction was formulated under the following conditions :

(a) The population of the project area was applied in the same manner and growth rates as the population projection study in the Master Plan.

(b) Yen Hoa and Trung Hoa communes in Cau Giay are supposed as if in one group for a reason of unity with the same characteristics and integrated land use, for population estimate.

The trend of population by Commune (Xa) in every five years is shown in Table 1.2-1.

Table 1.2-1 Area and Population of the Priority Project Area

District	Commune	Area (ha)							Population of Whole Commune					Population of Priority Project Area					
		Whole ommune (A)	Present Service Area (B)	% (B)/(A)	Non Service Area (D)	% (C)/(A)	Priority Project Area (D)	% (A)/(C)	Year 1995 (E)	Year 2000 (F)	Growth Ratio (1995 ~ 2000)	Year 2005 (G)	Growth Ratio (2000 ~ 2005)	Year 1995 (H)	Ratio of Newly Served (H)/(E)	Year 2000 (J)	Ratio of Newly Served (J)/(F)	Year 2005 (K)	Ratio of Newly Served (K)/(G)
Tu Liem	Thuy Phuong	250.0	0.0	0.0%	250.0	100.0%	125.0	50.0%	5,945	6,459	1.7%	6,973	3.2%	2,973	50.0%	3,230	50.0%	3,487	50.0%
	Dong Ngac	366.4	0.0	0.0%	366.4	100.0%	366.4	100.0%	17,982	19,737	1.9%	21,491	3.6%	17,982	100.0%	19,737	100.0%	21,491	100.0%
	Co Nhue	570.0	230.0	40.4%	340.0	59.6%	340.0	59.6%	12,437	14,078	2.5%	15,719	4.8%	7,419	59.7%	8,397	59.6%	9,376	59.6%
	My Dinh	460.6	46.0	10.0%	414.6	90.0%	414.6	90.0%	7,357	8,768	3.6%	10,179	6.7%	6,622	90.0%	7,892	90.0%	9,162	90.0%
	Me Tri	706.6	50.0	7.1%	656.6	92.9%	656.6	92.9%	12,645	15,734	4.5%	18,823	8.3%	11,750	92.9%	14,621	92.9%	17,491	92.9%
	Sub Total	2,353.6	326.0	13.9%	2,027.6	86.1%	1,902.6	80.8%	56,366	64,776	2.8%	73,185	5.4%	46,746	82.9%	53,877	83.2%	61,007	83.4%
Cau Giay	Mai Dich	187.9	94.0	50.0%	93.9	50.0%	93.9	50.0%	13,493	13,870	0.6%	14,247	1.1%	0	0.0%	188	1.4%	377	2.6%
	Dich Vong	349.1	269.0	77.1%	80.1	22.9%	80.1	22.9%	8,340	13,755	10.5%	19,170	18.1%	0	0.0%	1,242	9.0%	2,485	13.0%
	Yen Hoa & Trung Hoa	443.1	177.2	40.0%	265.9	60.0%	265.9	60.0%	13,878	16,909	4.0%	19,940	7.5%	0	0.0%	1,819	10.8%	3,637	18.2%
	Sub Total	980.1	540.2	55.1%	439.9	44.9%	439.9	44.9%	35,711	44,534	4.5%	53,357	8.4%	0	0.0%	3,249	7.3%	6,499	12.2%
	Total	3,333.7	866.2	26.0%	2,467.5	74.0%	2,342.5	70.3%	92,077	109,310	3.5%	126,542	6.6%	46,746	50.8%	57,126	52.3%	67,506	53.3%

Note:

1) Target population of the priority project area was applied in the same manner and growth ratio of the population projection.
2) Service population of each commune in the priority project area is estimated by the area ratio of project area to whole commune area.
3) Present population with "0" (zero) is nobody in the settled area under the agricultural land use in Cau Giay District which was recognized by site reconnaissance.
4) Yen Hoa and Trung Hoa communes in Cau Giay district are designated in one commune for a reason of unity with the same characteristics and integrated land use.

1.3 WATER DEMAND

1.3.1 Unit Water Demand

According to the M/P study, every unit water demand has been formulated as shown in Table 1.3-1.

Table 1.3-1 Unit Water Demand

	2000		2005	
	Domestic Water (l/c/d)	Non-Domestic Water (ratio to domestic water, %)	Domestic Water (l/c/d)	Non-Domestic Water (ratio to domestic water, %)
Group U	150	30	165	30
Group D	105	17.5	135	17.5

1.3.2 Water Demand

The water demand is estimated based on the following conditions:

(1) Project area

The average daily water demand is estimated to be 8,900 m3/day in the year 2000, and 12,600 m3/day in the year 2005.

(2) Supplemental water to Mai Dich system

Mai Dich system will need supplemental water to sustain the present service level. It is estimated to be constant 20,000 m3/day at the average daily distribution capacity.

(3) Future development area

According to partial information, water demand of NBC (New Business Center) of 200 ha is estimated to be 9,900 m^3/day.

According to Master Plan of Urban Hanoi Transportation assisted by JICA, water

demand of the Central Business District in the year 2005 is estimated to be 12,600 m^3/day.

Considering these figures, the water demand of the new city development plan such as NBC or CBD is estimated about 11,000 m^3/day on average.

Average daily water demand in year 2005 is summarized in Table 1.3-2.

Table 1.3-2 Average Daily Water Demand in the Priority Project (Year 2005)

Category of Water Demand	Average Daily Water Demand (m^3/day)	Average Daily Water Distribution (m^3/day)
(1) Project Area	12,600	14,800
(2) Mai Dich Water Supply System	-	20,000
(3) Future Development Area	(11,000)	12,900
Total	-	47,700

Note: A physical loss of 15% is included in a distribution volume, that is, [Distribution] = [Water Demand] / (1-0.15)

1.4 WATER SOURCE

1.4.1 Wellfield

In the "Water Master Plan" of FINNIDA, through the simulation, it is reported that the discharge of 700,000 m^3/d (exactly 725,000 m^3/d, including Ha Dong) can be exploited from the lower main aquifer Qa in the area south and west of the Red River without causing serious environment impacts and it proposes the location of the wellfields (including existing ones) and the their most feasible exploitation discharge as shown in Table 1.4-1 and Fig.1.4-1. This has been approved by the State Council for Approval of Mineral Reserves.

According to the Table 1.4-1 and Fig.1.4-1, Cao Dinh - Bac Chem - Thuong Cat area is the most favorable wellfield area for the project to the proposed water supply area from the view points of location and development potential. Therefore, Cao Dinh - Bac Chem - Thuong Cat area has been selected as the wellfield considering the relation to the on-going project (1A project, World Bank Program), etc.

Table 1.4-1 Wellfields and Exploitation Water (m^3/d)

No.	Wellfield	FINNIDA M/P, 1993	JICA M/P, 1996 [1]	JICA F/S, 1996 [2]
1	Yen Phu	110,000	44,500	80,000 (increased)
2	Luong Yen	80,000	79,500	79,500
3	Mai Dich	45,000	64,200	44,200 (decreased)
4	Ngoc Ha	30,000	50,300	50,300
5	Ngo Si Lien	30,000	43,200	43,200
6	Tuong Mai	30,000	29,200	29,200
7	Phap Van	30,000	27,700	27,700
8	Ha Dinh	25,000	27,200	27,200
9	Thuong Cat	60,000 (not exploited)	-	38,800[3] (proposed by JICA)
10	Bac Chem	30,000 (not exploited)	-	11,400[3] (proposed by JICA)
11	Cao Dinh	80,000 (not exploited)	-	30,000 (proposed by 1A)
12	Nam Du Thuong	120,000 (not exploited)	-	30,000 (proposed by 1A)
13	An Khanh	15,000 (not exploited)	-	-
14	Ha Dong	40,000 (out of Hanoi)	-	(22,000)
12 Small Wellfields		-	23,600	23,600
300 Private Wells		-	100,000	100,000
Total		725,000	489,400	615,100 (637,100[4])

1) Raw water discharge in 1995

2) HPC's plan at JICA F/S stage

3) Total average daily intake, 50,200 m^3/d is divided in proportion to well number in the area, for convenience.

4) Including Ha Dong

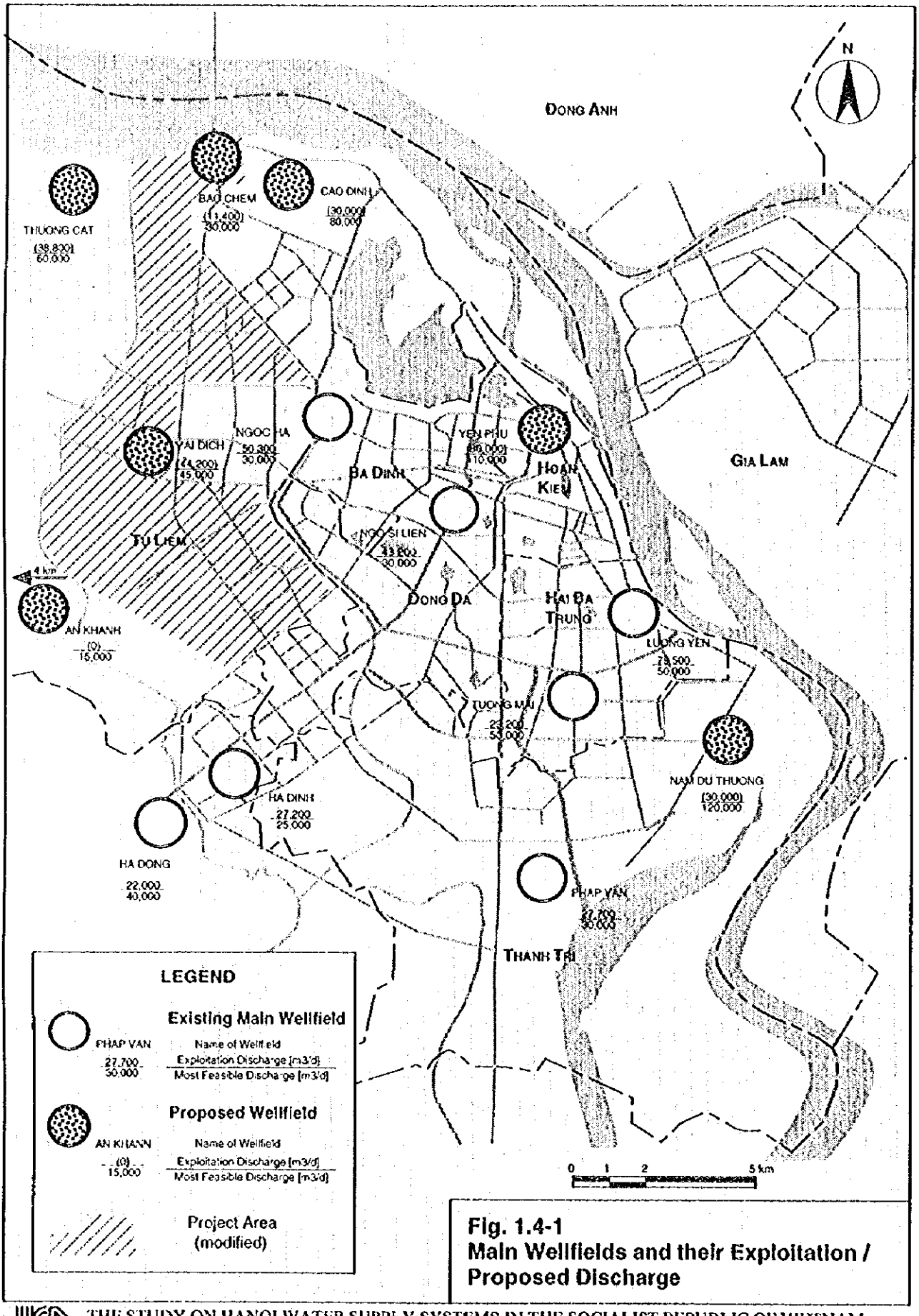

Fig. 1.4-1
Main Wellfields and their Exploitation / Proposed Discharge

1.4.2 Groundwater Potential

According to Table 1.4-1, exploitable groundwater on the south Hanoi are approximately 700,000 m3/d (exactly, 725,000 m3/d including Ha Dong) and 170,000 m3/d of them are in Cao Dinh - Bac Chem - Thuong Cat wellfields area (Northwest Area of the south Hanoi).

The exploitation groundwater of 50,200 m^3/d in Cao Dinh - Bac Chem - Thuong Cat wellfields area (Northwest Area of S.H) is proposed in this project. Therefore, this proposed exploitation groundwater volume is studied whether exploitable or not in this area in three(3) cases.

Case I and Case II are studied based on the results of the study in FINNIDA "Water Master Plan" in 1993 as shown in Fig.1.4-2. Case III, however, is studied based on the results of the study in JICA "Master Plan" in 1966, through the reallocation of the exploitable groundwater of six(6) wellfields in future as shown in Table 1.4-2. According to the Table 1.4-2 the exploitable groundwater in Cao Dinh - Bac Chem - Thuong Cat wellfields area is 117,000 m^3/d.

Table 1.4-2 Results of reallocation (Case III)

	Wellfield	Original Allocation (m^3/d)	Reallocation (m^3/d)
1	Thuong Cat	60,000	41,000
2	Bac Chem	30,000	21,000
3	Cao Dinh	80,000	55,000
	Sub Total	170,000	117,000
4	Nam Du Thuong	120,000	82,000
5	An Khanh	15,000	10,000
6	Ha Dong	40,000	27,000
	Grand Total	345,000	236,000

In any case, the exploitation groundwater of 50,200 m3/d proposed in this project, is feasible in Cao Dinh – Bac Chem – Thuong Cat wellfields area.

Case I : Northwest Area of South Hanoi

60,000 (Thuong Cat)	+	30,000 (Bac Chem)	+	80,000 (Cao Dinh)

170,000 m³/d — Exploitable G.W

4,000m³/d (10 private wells) — Existing Exploitation G.W.

50,200 (Thuong Cat + Bac Chem) proposed by JICA	+	30,000 (Cao Dinh) proposed by 1A

80,200 m³/d — Proposed Exploitation G.W

4,000 + 80,200 = 84,200 m³/d

170,000 - 84,200 = 85,800 > 0.....OK

Case II : All South Hanoi Area

South Hanoi 725,000 m³/d — Exploitable G.W.

365,800 (8 Main Wellfields)	+	23,600 (12 Small Wellfields)	+	100,000 (300 Private Wells)

489,400 m³/d — Existing Exploitation G.W.

30,000 (Cao Dinh) proposed by 1A	+	30,000 (Nam Du Thuong) proposed by 1A	+	50,200 (Thuong Cat + Bac Chem) proposed by JICA

110,200 m³/d — Proposed Exploitation G.W.

22,000 m³/d — Current Exploitation G.W. in Ha Dong

15,500 m³/d — Difference between Yen Phu & Mai Dich

489,400 + 110,200 + 22,000 + 15,500 = 637,100 m³/d

725,000 - 637,100 = 87,900 > 0 ..... OK

Fig.1.4-2
Groundwater Balance

1.4.3 Water Quality

As periodic sampling data, data for four existing monitoring wells were used for this study. Occasional sampling data were quoted from the existing survey reports made by the Subdivision 64 - Hydrogeological Division II (Vietnam Geological Survey). Additionally, some parameters such as Al, Cd and Pb were checked in this Study to confirm groundwater quality at the project site. The data are shown in Appendix of the Supporting Report.

Design raw water quality is basically estimated referring the graphs of concentration appearance probability such as non-excess probability of 75%. As for some substances such as Al, Cd and Pb, the values checked at the project site in this Study are used for design concentration. The results are summarized in Table 1.4-3.

Table 1.4-3 Results of the Check at the Project Site

Parameter	Unit	Criteria for Drinking Water		Design Concentration (Maximum)
		Vietnamese (Urban Area)	WHO Guidelines	
pH	-	6.5~8.5	-	6.0~7.0
Fe^{2+}	mg/l	-	-	8.3
Fe^{3+}	mg/l	-	-	0.9
Total Iron	mg/l	0.3	0.3	9.2
Mn	mg/l	0.1	0.5	0.5
NH_4^+	mg/l	3	1.5	1.2f
NO_2^-	mg/l	0	3	0.1
NO_3^-	mg/l	10	50	0.6
Hardness	mg/l	500	-	30
Al	mg/l	0.2	0.2	0.1
As	mg/l	0.05	0.01	0.007
Zn	mg/l	5	3	0.01
Cd	mg/l	0.005	0.003	0.005
Pb	mg/l	0.05	0.01	0.002
CN	mg/l	0.1	0.07	0.01
Hg	mg/l	0.001	0.001	0.0001
Cu	mg/l	1	2	0.01
Cr	mg/l	0.05	0.05	0.003
Phenols	mg/l	-	-	0.001

1.4.4 Arrangement of the Wells

Fig.1.4-3 shows the location map of the existing wells around the proposed wellfield and the arrangement of the proposed wells.

Arrangement of wells for water supply in a wellfield is usually decided considering the hydrogeological conditions, water supply area, water demand, land acquisition conditions, etc.

(1) Wellfields, Hydrogeological Conditions and Well Design

Cao Dinh - Chem - Thuong Cat area which is in the northwest of the south Hanoi, has been selected as the wellfield as described before.

Typical hydrogeological conditions of the wellfield are shown in Fig. 1.4-4 together with the well design. The conditions were based on the data of the existing wells .

(2) Hydrogeological Parameters

Hydrogeological parameters were estimated from the existing data.

Average transmissivity, T = 1.63×10^{-2} m^2/sec. Storativity was presumed to be 1.0×10^{-3} which is used as a general value of storativity due to the lack of available data and was lower one power of ten than the order of the transmissivity in m^2/sec.

(3) Drawdown (s)

The proposed pumping discharge is 50 lit/sec (50×10^{-3} m^3/sec) and the designed continuous pumping time (t) is 20 hours ($20 \times 3,600 = 7.2 \times 10^4$ sec). Therefore, the calculated drawdown (s) is 4.39 m.

(4) Distance between wells (D)

The distance between the adjacent wells was set 250 m referring to the existing main wellfields in the south Hanoi. If the distance between wells is 250 m, the drawdown (x) at the middle point of the adjacent wells is calculated as $x = 1.18$ m.

(5) Designed Well Number

As the proposed daily maximum production is 60,000 m^3/d and the proposed discharge a well, a day is 3,600 m^3/d/well (50 lit/sec, 20 hrs pumping), required well number is 16.7 (60,000/3,600). Therefore, designed well number is 22 ($16.7 \times 1.3 = 21.7 \fallingdotseq 22$), including 30% standby.

(6) Arrangement of Wells

The wells were arranged on a line which is almost parallel to the Red River dike, keeping the distance more than 700 m (ten times of the proposed well depth) from it. Although the arrangement on plural lines is supposed alternatively, as the lowering of drawdown of the wells arranged on the land side and the bad influence to the land side existing wells seem to occur, because of the groundwater flow line from the river to the land as studied in the JICA Master Plan, the wells were arranged on a single line. Furthermore, the use of the existing roads for construction and maintenance of the proposed wells were considered as much as possible.

The arrangement of wells are presented in Chapter 2 " Preliminary Design".

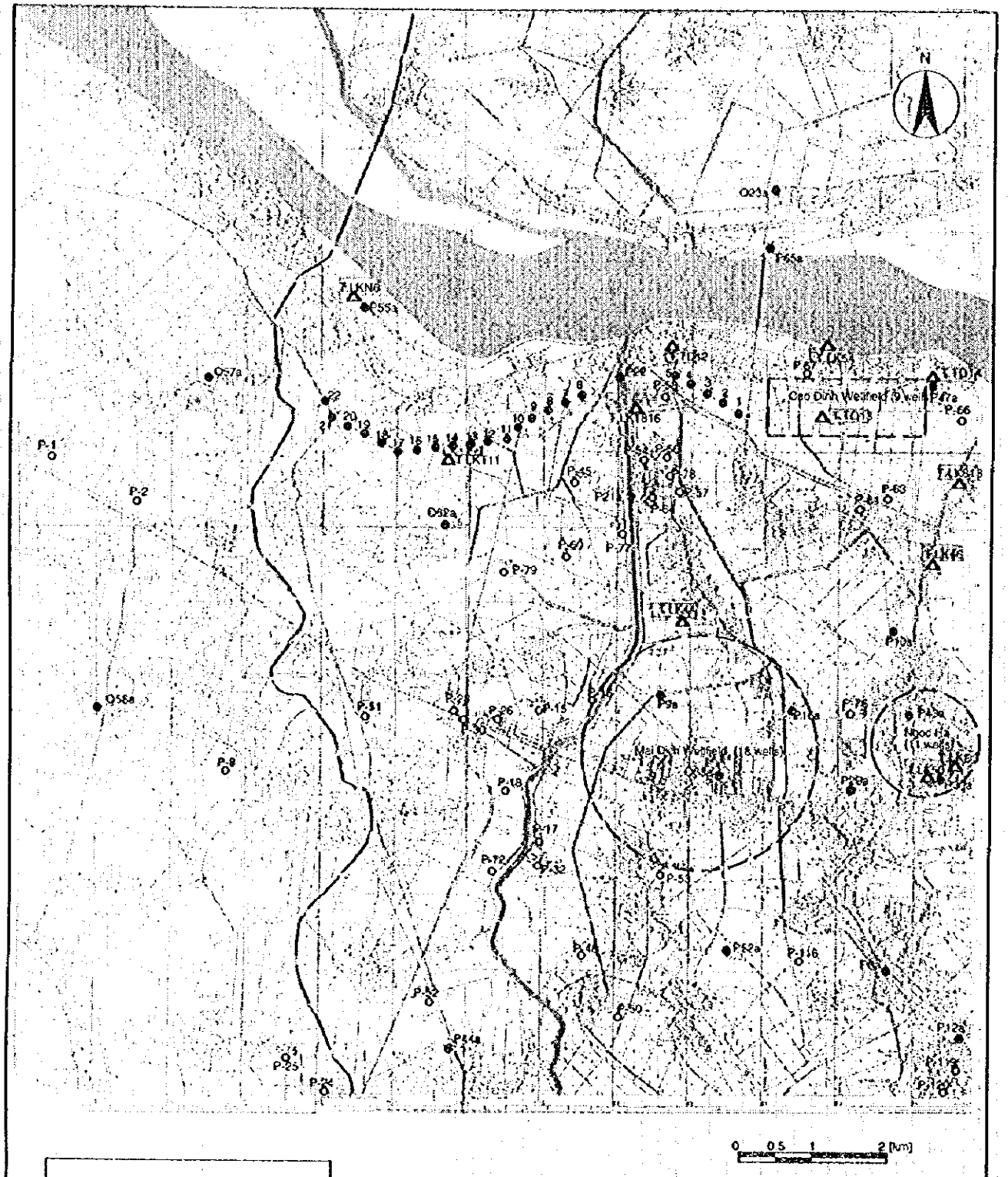

Fig. 1.4-3
Location Map of Existing Wells around the Proposed Wellfield

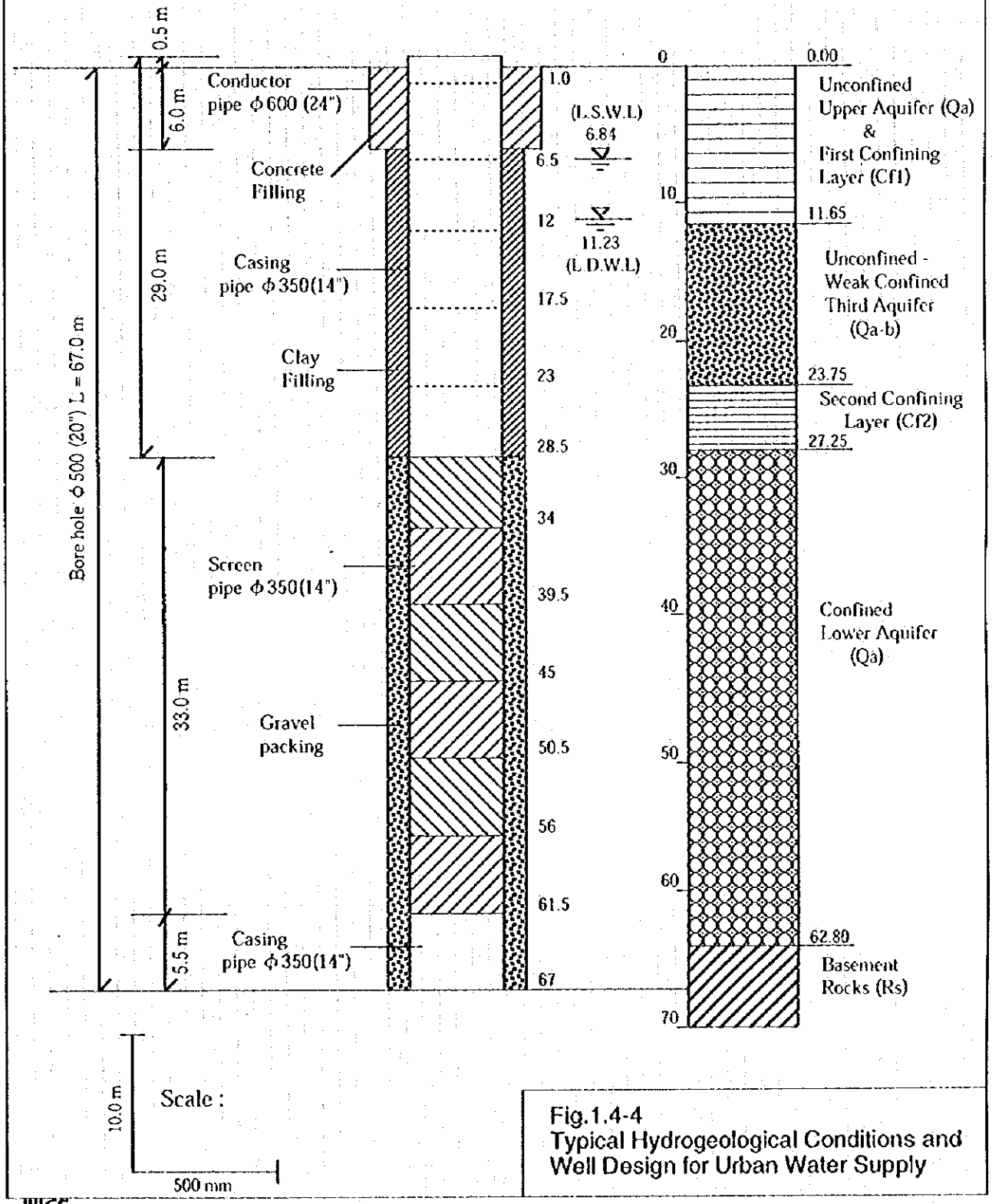

Fig.1.4-4
Typical Hydrogeological Conditions and Well Design for Urban Water Supply

CHAPTER 2 PRELIMINARY DESIGN

2 PRELIMINARY DESIGN

2.1 DESIGN CRITERIA

Design criteria applied for the project are presented in this section. The criteria do not have major difference compared to those of latest or on-going projects implemented by HWBC, and also those proposed in the Master Plan.

2.1.1 Service Level

(1) Service Hours

The system, all facilities for raw water intake, treatment and distribution, is to be planned by 24 hours continuous operation basis.

(2) Type of Service

Water is to be supplied through individual house connection to all consumers. All connections (service pipes) shall be equipped with water meters for billing purpose.

Installation of public taps for people is not considered in the project.

(3) Water Quality

Water quality of treated water shall comply to the Vietnamese drinking water standard.

2.1.2 Capacity

(1) Peak Day Factor

The peak day factor, (Daily Maximum) : (Average Daily), which will be applied to size dimensions of facilities of water treatment and raw water intake is to be 1.35 (135%).

(2) Peak Hour Factor

The peak hour factor which will be applied to determine diameters of distribution pipelines is to be 1.40 (140%) of the daily maximum distribution capacity.

(3) Raw Water Intake Capacity

Taking consideration of plant loss in the course of treatment, i.e. filter back-wash water and other miscellaneous use in the treatment plants, raw water intake capacities is set to be 105% of the production capacity. (Plant loss = 5% of treatment capacity)

2.1.3 Water Source Facilities

(1) Water Source

Water source is planned to be deep groundwater, being available in the south area of the Red River.

(2) Deep Wells and Intake Pumps

The groundwater is to be taken through deep wells to be equipped with submersible pumps (one pump to one well). The safe yield of one well is determined at 50 l/sec (180 m3/hr). Assuming 20 hours' operation of pump, 3,600 m3/day of water is available from a single well. Number of standby pump/well is proposed to be 30% of operating pumps.

Operation of a pump is to be done at the control room in the treatment plant with remote operating system, as well as done at the pump station site.

(3) Raw Water Transmission

Raw water taken from deep wells is planned to be transmitted to a treatment plant by way of a pressurelized pipeline. Its material is of ductile cast iron pipe with mortar lining.

(4) Power Supply

Power necessary for raw water intake pumps (submersible pumps) is planned to be of the public electricity.

2.1.4 Treatment Facilities

(1) 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, sedimentation, filtration and disinfection.

(2) Basic Criteria for Facilities

- Aeration:
  10 m3/m2/h of surface load, at the maximum
- Contact and Sedimentation:
  60 minutes of detention time and 55mm/min of surface load
- Filtration:
  120 m/day of filtration rate

(3) Disinfection

Disinfection is to be done with liquid chlorine, as same as currently used in the existing plants of HWBC. It is fed into a chlorine-mixing chamber to be constructed at a place between filters and reservoirs.

(4) Sludge Treatment

Sludge drained from filter-backwash water and drainage of coagulation/ sedimentation shall be treated in the yard of treatment plant, in prior to disposal, from a viewpoint of environmental protection. The sludge treatment is planned to be processed by the sludge-drying bed system.

Clear water generated through the sludge treatment process is to be returned to the aeration towers to save raw water.

(5) Reservoir

Capacity of the distribution reservoir is planned to be 20%-volume, or 4.80 hours' equivalent volume, of the daily maximum production. The reservoir, to be of reinforced concrete, will be constructed on the ground level in the treatment plant yard.

(6) Distribution Pumps

Total capacity for the pump shall meet the peak hour demand.

Power for pumps will be from public electricity. In the case of the electric failure, a generator in the plant will be operated for one distribution pump operation.

(7) Flow Measurement

Water flow shall be measured with flow meters to raw water, distribution water, and clear water returned from sludge treatment system to sedimentation.

2.1.5 Distribution Facilities

(1) Water Pressure

Static pressure in distribution pipes will be 55.0 (5.5 kg/cm2) m at the maximum from an economical viewpoint such as pump power required, volume of leakage in pipelines, strength of pipe materials/ joints, pipe maintenance, etc..

Minimum dynamic pressure is planned to be 20 - 30 m in main distribution pipelines, considering direct supply to 3 - 4 storied buildings.

(2) Diameters of Pipelines

Diameters of distribution pipelines is to be determined based on the peak hour flow. Hydraulic calculation of distribution pipelines will be made by Hazen-William Formula which is widely used among the world. Velocity coefficient (C) in the formula is proposed 110 (C=110).

(3) Pipe Materials

Ductile cast iron pipes with mortar lining (push-on type joint) will be used for diameters of 100 mm or larger. Polyvinyl chloride pipes (PVC pipes or VP) with rubber ring joint type will be used in principle for 75 mm pipes or less. However, in the case of heavy traffic roads or strategical roads, ductile cast iron pipes will be used even in small diameters.

(4) Leakage

Leakage in distribution pipelines is assumed to be 15% of the distribution capacity, considering that the pipelines is to be newly constructed with intact materials and workmanship of pipe installation work will be more improved than old days.

(5) Fire Hydrants

For the purpose of fire-fighting work, fire hydrants will be installed to pipes of 150 mm in diameter or larger and in strategic points at 300 m intervals in principle.

Type of the fire hydrants will be partly underground one.

(6) Stop Valves

For the convenience of pipeline maintenance, stop valves will be installed at strategical points, mainly at branching points. There, stop valves will be installed in principle at downstream sides of pipelines.

(7) House Connections

House connection will be made from network pipes of diameter 200 mm or smaller in principle by way of branch saddles. In the case of Highways or busy roads which have wide width and heavy traffic volume, branched distribution pipelines (100 - 75 mm) will be installed on the both sides of the roads in order to facilitate installation of house connection service pipes.

Pipe material of service pipes will be in principle polyethylene pipes (PE). Diameters of service pipes will be 20 mm for ordinary houses and 40 mm for apartment-type building or the like.

All service pipes shall be equipped with water meters for billing purpose.