

JAPAN INTERNATIONAL COOPERATION AGENCY  
THE SOCIALIST REPUBLIC OF VIET NAM  
HA NOI PEOPLE'S COMMITTEE  
TRANSPORTATION AND URBAN PUBLIC WORKS SERVICE

**BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT FOR THE WATER SUPPLY SYSTEM  
IN  
GIA LAM AREA, HA NOI CITY  
IN  
THE SOCIALIST REPUBLIC  
OF VIET NAM**

**OCTOBER, 1993**

**PACIFIC CONSULTANTS INTERNATIONAL**

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## Preface

In response to a request from the Government of the Socialist Republic of Viet Nam, the Government of Japan decided to conduct a basic design study on the project for the Water Supply System in Gia Lam Area, Ha Noi City in the Socialist Republic of Viet Nam and entrusted the study to the Japan International Cooperation Agency (JICA).

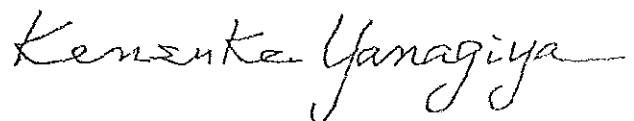
JICA sent to Viet Nam a study team headed by Mr. Haruo Iwahori, of JICA and constituted by members of Pacific Consultants International, from 24 April to 7 June, 1993.

The team held discussions with the officials concerned of the Government of Viet Nam, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Viet Nam in order to discuss a draft report, and as the result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Socialist Republic of Viet Nam for their close cooperation extended to the team.

October 1993



President

Japan International Cooperation Agency





October 1993

Mr. Kensuke Yanagiya  
President  
Japan International Cooperation Agency  
Tokyo Japan

Letter of Transmittal

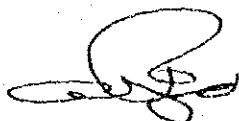
We are pleased to submit to you the basic design study report on the Project for the Water Supply System in Gia Lam Area, Ha Noi City in the Socialist Republic of Viet Nam.

This study was conducted by the Pacific Consultants International, under a contract to JICA, during the period 30 March to 15 October, 1993. In conducting the study, we have taken into full consideration of the present situation in Viet Nam, and have designed the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincerest gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, the Ministry of Health and Welfare and the Embassy of Viet Nam in Japan. We would also like to express our deep gratitude to the officials concerned of the Department of Urban Public Work and Transportation of Ha Noi City, and the Embassy of Japan in Viet Nam for their close cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

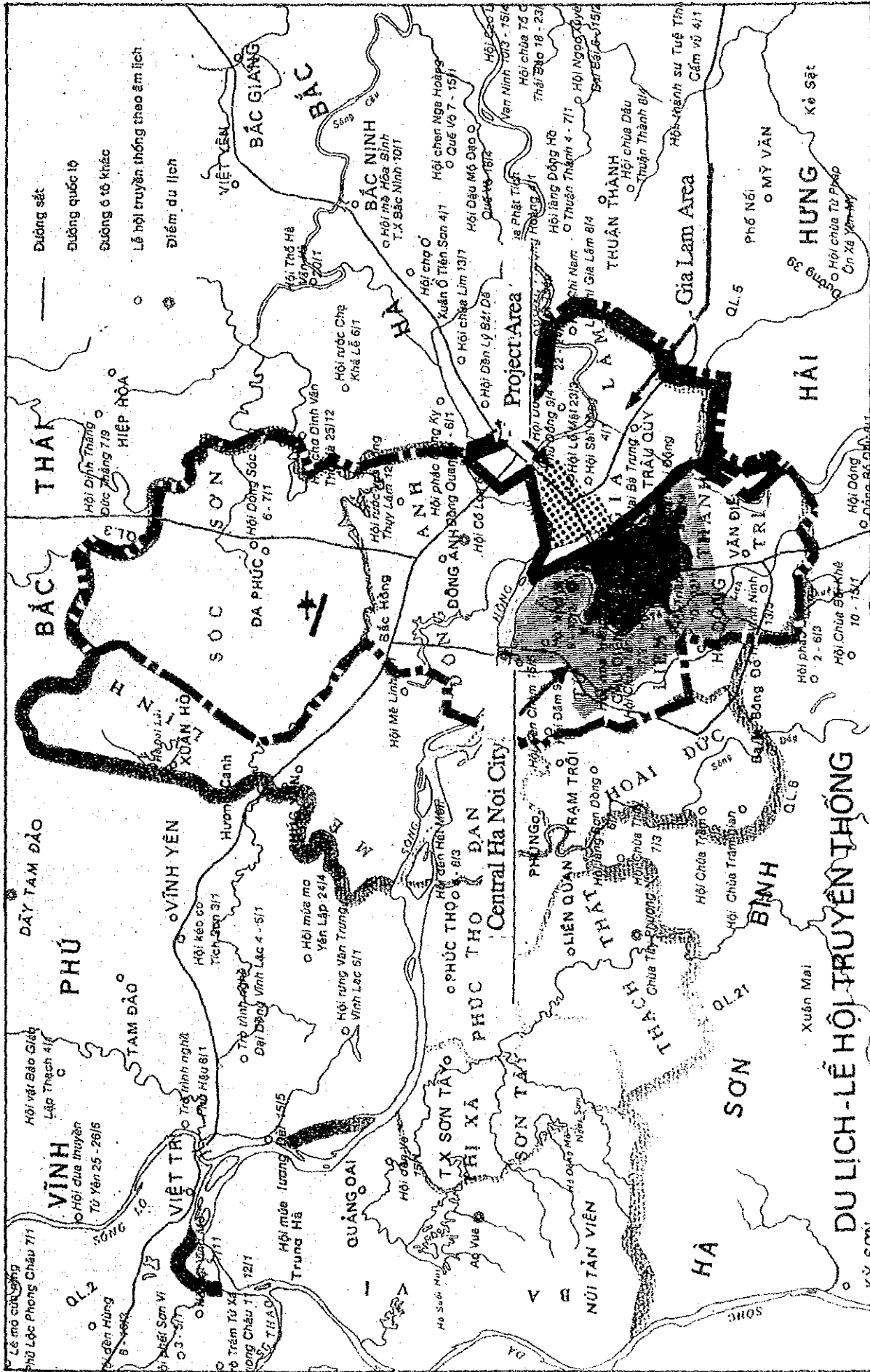


Akihiko Togo  
Project manager  
Basic design study team on the  
project for the Water Supply System in Gia Lam Area,  
Ha Noi City in the Socialist Republic of Viet Nam

Pacific Consultants International



Location Map of Project Area



Boundary of Ha Noi City

Boundary of Gia Lam



## Summary



## SUMMARY

The principle of market economy has recently introduced to the national economy of the Socialist Republic of Viet Nam and it just started to take its way toward the destiny to utilize the natural and social resources in full swing.

For this purpose, the government is deeply concerned over improvement of social infrastructures which have been left behind during the prolonged centrally planned economy.

Of these infrastructures, water supply systems have been deteriorated in many cases in large cities in the republic. There are 436 cities with population more than 5,000. Out of these, only 100 cities are able to provide piped water to their citizens. Only six million of people corresponding to 47 % of the total urban population is served by the piped water in the republic. Even these limited water supply systems are aged and insufficient in their design capacity to meet current demand. The remaining population is taking domestic water from shallow wells, springs, stored rainwater and ponds.

In order to improve present situation of urban water supply, the government determined the target of the urban water supply development aiming at 2000. According to the plan, 78 cities were selected for the first priority of the urban water supply improvement. The population served by the piped water supply will increase to 85 % of the total urban population at the metropolis of Ha Noi, Hai Phong and Ho Chi Minh and 50 % to 70 % of the urban population in the rest of cities, by 2000.

Upon completion of the plan, additional 4 million urban population will be served by the piped water and total population to have access to the piped water will be ten million in 2000. However, a large amount of capital investment is required for implementation of the plan. It is estimated that the total cost of the plan will be 850 million US dollars for ten years while an average annual budget of water supply and sanitation of the republic has been in an order of 500 thousand US dollars in recent years. Therefore, it is expected to receive cooperation of various international financial institutions and countries.

Under the circumstance, international cooperation is extended to the urban water supply by Finland, France, Canada and Australia. International cooperation for the urban water supply in Ha Noi City has been being extended by Finland since 1985. This Ha Noi City Water Supply Program is supposed to be completed in 1994, however, the completion of the third phase is extended until 1995. The urban population of Ha Noi City was 900,000

in 1990 which is projected to be 1,400,000 in 2010 and the design capacity of the water supply facilities is 330,000 m<sup>3</sup>/day in 2010.

The project area of this basic design study is Gia Lam area in the north eastern corner of Ha Noi City beyond the Red River. The size of the project area is approximately 900 ha. where many factories have constructed since the 1950's. The national highways No.1 and No.5 are running through the area in parallel with the national railways.

Although this area has been playing an important role of commercial cum industrial area of Ha Noi City as well as the terminal point of the land transportation, it was excluded by the project area of Ha Noi City Water Supply Program since it was beyond the Red River.

There are four urban centers in the project area. The urban population including the suburban areas is 100,000 at present and it is projected to be 170,000 in 2010, however, there are tiny and aged facilities serving domestic water to only 15 % of the present population.

Under the circumstance, Ha Noi City formulated the Gia Lam Water Master Plan for improvement of urban water supply in the area aiming at achievement of the national target of the urban water supply together with the Ha Noi Water Supply Program.

For this purpose, a request was made by the government of the Republic to the Government of Japan to extend international cooperation for the implementation of the Gia Lam Water Master Plan.

Upon the request of the government of the Republic, the Government of Japan sent an official mission to Viet Nam from December 6 to December 26, 1992, for confirmation of the background, contents and intention of the government of the Republic. The mission discussed with officials concerned about the contents of cooperation to be extended to the project by the Government of Japan.

In conclusion, the Government of Japan determined that the project was suitable for international cooperation under the grant aid program and sent the basic design study team to the project site from April 24 to June 7, 1993. Thorough field investigation, discussions and analyses of the project, it was concluded that the contents of the Gia Lam Water Master Plan were confirmed to be acceptable.

The service area of the project was determined based on the land use plan formulated by the Institute of Planning of Ha Noi City and approved by the City authority in 1993. The



service area consists of 845 ha. of four urban centers and 343 ha. of suburban areas adjacent to their related urban centers totaling 1,188 ha..

The projected population and water demand are summarized as shown below:

Year	1995	2000	2010
Population	103,400	121,500	177,000
Water demand (m <sup>3</sup> /day)	13,162	18,761	34,338

The target year of the master plan is 2010, however, the urban infrastructure in a part of the service area is to be completed in future and it is hardly obtainable the foresight of the area that is rapidly developing. For this reason, it is determined to provide the water supply facilities to meet the water demand in 2000 on condition that an extension plan is formulated in 2000 incorporating the urban conditions at that time.

The design capacity of the water supply facilities to meet the water demand in 2000 is determined at 32,100 m<sup>3</sup>/day at daily maximum rate.

Major components of the project is summarized as shown below:

#### Water Source

The water source is the ground water of the aquifer development in the alluvial deposits of the Red River which is providing a considerable amount of the ground water in the area. To secure the design capacity 12 water wells are required including three stand-by wells. The design capacity of the water source is 32,100 m<sup>3</sup>/day.

The well field is determined by the city authority at the river side area, however, as the size of the well field is insufficient to accommodate all wells, four wells will be located at the yard of the treatment plant.

#### Raw Water Transmission

The raw water transmission line is planned from the well field of the river side to the treatment plant for about 7.5 km along the national highways No.1 and No.5.

#### Treatment plant

The raw water contains high concentration of iron that requires to be removed to produce potable water to meet the drinking water quality standards.

It contains also ammonia which consumes chlorine for sterilization. To save the chemical cost and confirm effect of chlorination, this has to be also removed.

Minimizing application of chemicals for treatment process, two-step filtration system is proposed after aeration. The design capacity of the treatment plant is two series of 16,050 (m<sup>3</sup>/day).

Since the raw water contains high concentration of iron a large volume of sludge is produced. The sludge treatment facility is provided consisting of thickeners and drying beds.

### Distribution System

The service area is 1,188 ha., however, a part of area is to be developed in future. Therefore, distribution pipes will be laid along the existing roads with sufficient design capacity including the water demand of the adjacent areas to be developed soon.

Major water supply facilities to be provided by the project are summarized as shown below:

1. Water Source  
Water wells : Ø350 mm, 80 m deep,  
50 l/sec, 12 Nos.
2. Raw Water Transmission  
Pipe line : Ø250 - 600 mm, 7.75 km
3. Treatment Plant  
Aeration facility : 16,050 m<sup>3</sup>/day x 2 series  
Facility for iron  
and manganese removal : 16,050 m<sup>3</sup>/day x 2 series  
Chlorination device : 32,100 m<sup>3</sup>/day x one unit  
Sludge treatment facility : 1,381 kg/day
4. Distribution Lines  
Ductile iron pipes : Ø75 mm - 700 mm, 52.16 km  
Vinyl chloride pipes : Ø50 mm - 100 mm, 41.31 km
5. House Connection  
Water meters : Ø20 mm - 40 mm, 7,070 pics  
Connecting pipes : 10 m - 50 m, 7,140 pics

The responsible organization of the project is Ha Noi City. The city is governed by the people's committee. Ha Noi City has eight departments to maintain daily services. The Department of Transportation and Urban Public Works Service (TUPWS) is one of these eight departments responsible for municipal water supply.

The international cooperation for Ha Noi Water Supply Program is extended to TUPWS by Finland and construction of works has been undertaken by Viet Nam side with equipment and machinery imported by Finland. Ha Noi City is also ready to undertake its contribution to the project implementation as shown below:

Item	Undertaken by	
	Viet Nam	Japan
1. Water source		
Procurement of drilling equipment		○
Procurement of equipment and materials		○
Construction of wells	○	
2. Raw water transmission		
Procurement of materials		○
Construction of transmission	○	
3. Treatment plant		○
4. Distribution facilities		
Distribution Reservoir	○	
Procurement of materials		○
Construction of distribution lines	○	
5. Construction of administration building	○	

The water supply facilities constructed by the project will be maintained and operated by a new water supply company under supervision of Ha Noi City authority.

The company will be able to supply 13,636 m<sup>3</sup>/day corresponding 96 % of the water demand in 1996 and after 1997 onward 100 % of the water demand of the project area can be supplied by the facilities with the design capacity of 32,100 m<sup>3</sup>/day until 2005. After 2005, the amount of water production remains the same so that extension of the project will be necessary incorporating the latest urban conditions into the plan.

The central government has determined to maintain financial self sustenance of water supply companies since 1988. Along with this guideline, the water tariff has been revised several times and at present it is set in Ha Noi City as shown below;

Item	Price (dong/m <sup>3</sup> )
1) Foreigner	0.45 US\$
2) Car Washing	5,000
3) Industry	3,000
4) Public use	1,200
5) Domestic	800

Ha Noi Water Supply Company obtained 20.1 billion dong water charge revenue and recorded 1.7 billion dong of profit with the above water tariff in 1992. The above water price of domestic water is assumed to be within 3 to 5 % of an average monthly family income in the urban area and regarded to be affordable for beneficiaries.

The production cost of water of the project in 1997 is estimated at 2,954 million dong/year while the revenue of sales of water is estimated at 6,374 million dong/year taking the same water tariff of the current Ha Noi Water Supply. The profit, a balance of revenue and production cost, will increase toward 2005.

The project appears to be profitable, however, the profit is only able to cover the production costs and it is far insufficient to cover the depreciation cost of the project facilities.

Generally speaking, the water supply scheme requires a large amount of initial capital investment. For this reason, either central or local government subsidize is provided in many cases. The capital investment provided by the grant portion would be regarded as a sort of government subsidize to produce sufficient reserve for rehabilitation cost of the machinery and equipment of the project.

For this reason, it is necessary to increase the water price within an affordable level of family income. Assuming the increase in the production cost is the same level at the actual growth rate of national product (3.5 %) and the water price is increased every three years at an annual rate of 5 %, the financial situation is forecasted.

In the above forecast, it is assumed that the company will obtain 2.1 billion dong profit in 1996 and 11 billion dong in 2010. Cumulative profit for 15 years is estimated at 102 billion dong which is sufficient to meet the rehabilitation cost of machinery and equipment of the project although the total profit is far insufficient to cover the depreciation costs of civil works.

The necessity and effects of the project is clearly identified and the company's profit out of revenue of water sale is sufficient to cover the production cost and depreciation cost of machinery and equipment, however, the government subsidize is required to cover the expenses of civil engineering works.

It is, therefore concluded that the project is suitable to be undertaken under the grant aid program of the Government of Japan.

The following items are recommended to ensure successful results of the project, and with understanding of these recommendations, the project can be regarded as a model of the medium scale urban water supply schemes in Viet Nam:

1. Although it is definitely required to increase the water tariff in near future in accordance with increase in production costs of water and income level of beneficiaries, the water tariff is set to maintain financial self sustenance of the water company.
2. For this purpose, it is strongly recommended to establish a new financially and institutionally independent water supply company under supervision of TUPWS.
3. In order secure water charge collection, house connections shall be completed in an early stage of the project implementation.

For this purpose, construction of the distribution pipeline shall be completed within the construction period of the project.

4. As special attention shall be paid at construction of distribution pipelines to prevent leakage through joints, a special inspection team shall be organized.
5. In 2006 an extension of the project facilities will be required to meet the future water demand. Prior to the extension of facilities, a new water supply plan shall be formulated incorporating the urban conditions at that time.
6. In order to prevent environmental deterioration caused by the water pollution, it is strongly recommended to take necessary measures for drainage and sewerage system in the project area.



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## 1. Introduction



## 1. Introduction

The Government of the Socialist Republic of Viet Nam requested the Government of Japan to provide an international cooperation for the water supply system in Gia Lam area of Ha Noi City.

The Government of Japan determined to undertake a preliminary study on the requested project and directed Japan International Cooperation Agency (JICA) to despatch a preliminary study team led by Mr. Haruo Iwahori, Technical Advisor, to the site from 6 December to 26 December, 1992.

Based on the result of the above preliminary study, the Government of Japan reached the conclusion that the requested project is suitable for the grant aid cooperation of the Government of Japan and determined to under take the basic design study of the project.

Upon the decision of the government on this matter, JICA dispatched the basic design study team led by Mr. Haruo Iwahori to the site for further site investigation and discussions with the officials concerned from 24 April to 7 June, 1993.

Through the basic design study, the following items were confirmed:

1. The Department of Transportation and Urban Public Works Service (TUPWS) of Ha Noi City is the responsible organization for implementation of the project. TUPWS is also the counterpart of the Ha Noi Water Supply Program under implementation in cooperation with Finland for improvement of the water supply of the central part of Ha Noi City.
2. The production capacity of the Ha Noi Water Supply is 120,000 m<sup>3</sup>/day operated by Ha Noi Water Supply Company under supervision of TUPWS. A new water supply company will be organized with practically experienced staff for the project.
3. The project formulation for the grant aid program of the Government of Japan is based on the Gia Lam Water Master Plan formulated by Ha Noi City. The service area of the master plan is determined according to the land use plan for 2010.

The service area of the project is one of the industrial cum commercial centers of Ha Noi City and it is also playing an important role of the terminal point of land transportation.

4. Objective of the project is to provide potable water for the service area to meet the demand in 2000.
5. Ha Noi City is keen to contribute the project and the construction of water wells, raw water transmission line, distribution reservoirs, sludge drying beds and distribution pipelines will be undertaken by Ha Noi City while the government of Japan will undertake installation of water source equipment, construction of the treatment plants and provision of all materials and equipment for the project not available in Viet Nam.

This is the basic design study report to provide potable water for the project area to meet the water demand in 2000.

The list of the study team, itinerary of site survey, officers concerned of Ha Noi City and minutes of discussions are attached in annex at the end of this report.

## **2. Background of the Project**



## 2. Background of the Project

### 2.1 Background of the Project

#### 2.1.1 Brief Description of Viet Nam

The Socialist Republic of Viet Nam extends from north to south on the eastern side of the Indochina Peninsula. There is the national border with China on the northern end and the national border with Cambodia and Laos on the western side runs on the mountain range at 2,000 to 3,000 m above sea level.

The climate is under the tropical monsoon regime. The average annual minimum air temperature is 20.9°C centigrade at Da Lat and the average annual maximum air temperature is 27°C at Hue.

Annual rainfall is in a range between 1,500 mm/year and 2,000 mm/year, however, the driest area is Nha Tran receiving only 1,374 mm/year and the wettest area is Hue where an average annual rainfall is 3,039 mm/year. In general, the climate is humid and hot except the mountainous area and the northern area where there is cool winter.

The distance from the northern end to the southern end of the Republic is 1,650 km and its width is in a range between 50 km and 600 km. Total area of the Republic is 330,363 km<sup>2</sup>. The Republic used to consist of 44 regions, however, nine regions were established in 1991 and total number of regions is 53 at present. Each region consists of towns and districts and each district consists of communes. There are 467 districts and 9,765 communes in the whole country.

According to the national census in 1989, total population was 64.4 million including approximately one million working abroad with long term contract.

The urban population more than 5,000 is 12.7 million (20 % of total national population) and the rest is rural population. The population growth rate during 10 years from 1979 is estimated at 2.13 %. The population growth rate toward 2000 is estimated at 4.2 % in urban areas and 1.5 % in rural areas.

There are 436 towns and Ha Noi, Ho Chi Minh and Hai Phong are the major towns of the Republic holding 37 % of the national urban population. There are 24 towns with population between 150,000 and 350,000 and 56 towns with population between 90,000 and 150,000. Towns with population less than 90,000 are 356.

Since 1976, the five years national development programs have been formulated. In the 1970's, major national industry was traditional agriculture and the three fourth of the national population used to engage in agriculture which produced 44 % of GNP during that period. Thanks to the government's effort made along the national development plan, the GNP in 1990 was increased by 71.8 % compared with that in 1976 which was equivalent to 3.6 % of annual growth rate.

In 1976, external loans and grant consisted of 21.5 % of the national budget, however, it decreased to 17.2 % in 1980 and 10.2 % in 1985.

The Republic required to import one million tons of foods in the 1970's, however, more than one million tons of rice was exported in 1990.

The production capacity of major industries in 1990 was summarized as shown below:

Power generation	:2,700 MW
Textile	:450 Million meter
Paper mill	:160,000 tons
Cement	:4.5 million tons
Coal mine	:9 Million tons
Steel	:200,000 tons
Tin	:2,200 tons
Railways	:3,219 km
Highways	:87,267 km

However, the above production rate is only 60 % of the production capacity due to aged facilities and shortage of funds. The major hindrance of Viet Nameese economic development are summarized as shown below:

1. Lack of social infrastructure in quantity and quality.
2. High quality labor force is available, however, there is little access to modernization and market economy system.
3. Shortage in the national budget.
4. Necessity of transfer of the centrally planned economy to the market economy.
5. High rate of inflation.

Under the circumstance, the Government determined to introduce market economy since 1989 and estimated the GDP growth rate towards 2000 as shown below:



Year	GDP billion Dong	Growth Rate %
1991	28,465	3.8
1992	29,888	5.0
1993	31,681	6.0
1994	33,836	6.8
1995	36,373	7.5
1996	39,283	8.0
1997	42,622	8.5
1998	46,458	9.0
1999	50,872	9.5
2000	55,959	10.0

## 2.1.2 General Description of Water Supply

### 2.1.2.1 Present State of Water Supply

There are 436 towns with population more than 5,000 in the Republic. Out of these towns, there are only 100 towns being supplied by piped water. Total amount of water supplied by the piped water is estimated at 1,670,000 m<sup>3</sup>/day at present. The number of population supplied by the piped water is 6 million which corresponds to 47 % of the total urban population. The rest of the people rely their domestic water on shallow wells, stored rain water, rivers and ponds.

There are abundant water sources for water supply in the Republic. The whole country is under tropical monsoon regime and total discharge of rivers is estimated at 85 billion m<sup>3</sup>/year. However, most of the rivers are subject to heavy floods during the rainy seasons and the draught discharge during the dry seasons which requires a rather heavy civil engineering works for intake structure. In addition, heavy siltation would require significant amount of chemicals for purification of water.

For this reason, the source of urban water supply is usually taken from ground water. The safe yield of the ground water in the Republic is estimated to be 140 million m<sup>3</sup>/day by the General Department of Mines and Geology. The ground water distributes almost evenly over the Republic, however, it is a little less available in the alluvial plain of the Red River.

At present, about 30 % (500,000 m<sup>3</sup>/day) of the national urban water supply source is relying on the ground water in the Republic which corresponds to only 1 % of total ground water available. Out of this, 70 % is used for Ha Noi water supply.

About 47 % of the urban population is served by the piped water supply systems, however, most of them have suffered from turbid water. This is mainly caused by aged facilities. The aged water supply facilities easily cause leakage mainly at joints of pipes. Generally, it is estimated that approximately 40 % to 50 % of produced water is lost by leakage. Therefore, the service level of urban water supply is assumed to need much of improvement.

During the years from 1983 to 1986, about 1.5 % of the national budget was allocated to the urban water supply and sanitation amounting approximately 20 billion dong. Most of these budget is assumed to be spent by water supply. Recently the budget for the water supply is increased to 6 % of the national budget since 1989 and the budget allocated to water supply and sanitation was 1.8 billion dong in 1990.

An average water production cost of urban water supply was 1 dong/m<sup>3</sup> in Ha Noi, Hai Phong and Ho Chi Minh in 1986 which was increase to 27 dong/m<sup>3</sup> in 1988 mainly caused by increase in the power price. Then it was further increased to 161.4 dong/m<sup>3</sup> in 1991 and 384 dong/m<sup>3</sup> in 1993 at Ha Noi. This rapid increase in water production cost is partly caused by inflation especially increase in power price.

At present, major components of water production cost in large towns are in a range shown below:

Energy cost	:25-50 %
Chemicals	:20-40 %
Salaries	:10-30 %

Since 1989, the government has introduced market economy in Viet Nam. Accordingly, financial self sustenance is required for the water supply companies. For this reason, Ha Noi Water Supply Company increased its water charge rate to absorb 50 % increase in power price.

The water charge of Ha Noi Water Supply Company in 1993 is as shown below:

Category	Water Price dong/m <sup>3</sup>
Domestic	800
Industry	3,000
Public	1,200
Foreigners	US \$ 0.45

In general, these water supply companies which have large consumers of industry or public use tend to maintain favorable financial conditions.

#### 2.1.2.2 Institutional Aspects of Water Supply

The responsible institution of water supply in the central government is the Ministry of Construction. The responsibilities of the central government for water supply are determination of sector policy, development plan, standards and engineering criteria.

The responsibilities of the local government are implementation of projects according to the central government's decisions and supervision and control of design and construction of facilities undertaken by the related engineering and construction companies.

The local government is also taking responsibility to supervise management, operation and maintenance of water supply companies including determination of water tariff and financial aspects.

There are also engineering and construction companies under the Ministry of Construction. These institutional structure is illustrated in Fig 2.1.

Ha Noi City has the authority in the same level of the ministries in the central government. There are eight departments and more than 30 different companies under the Ha Noi Peoples' Committee as shown in Fig.2.2.

Among these eight departments of Ha Noi City, the Department of Urban Public Works and Transportation Service (TUPWS) is responsible for water supply. Day to day management and operation of water supply for Ha Noi City is undertaken by Ha Noi Water Supply Company under supervision of TUPWS.

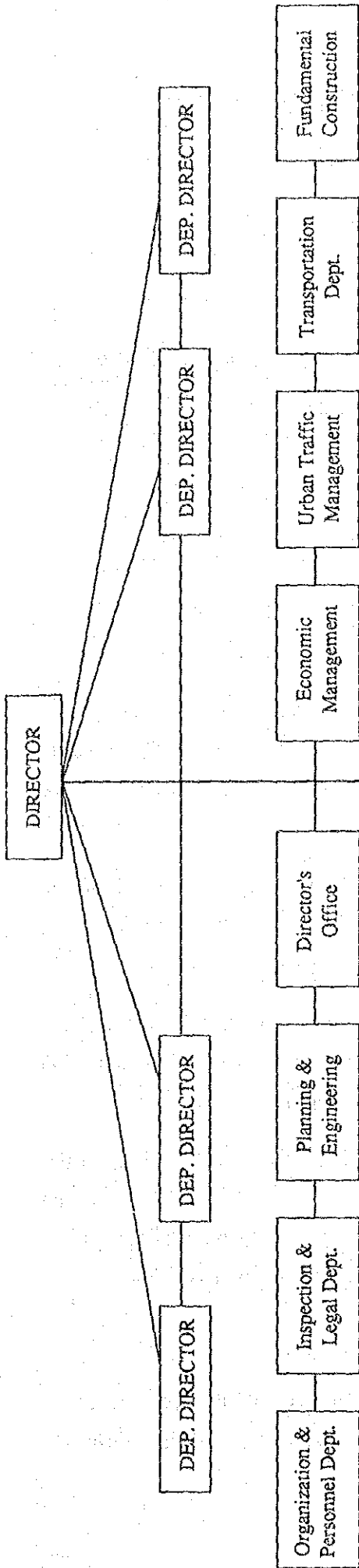
#### 2.1.2.3 Development Plan of Water Supply

In order for harmonious national economic development, improvement of social infrastructure is one of the key importance. Especially, improvement of water supply services is urgently required as one of the basic human needs.

For this reason, the Ministry of Construction has set the target of water supply development towards 2000 in corporation with the State Committee for Science and Technology.

In order to cope with this urgent task, 78 towns were selected based on the following criteria:





ADMINISTRATION MANAGEMENT		TRANS. & URBAN PUBLIC WORKS MANAGEMENT		PRODUCTION AND BUSINESS		
<ul style="list-style-type: none"> <li>- TUPW Inspectors Board</li> <li>- Management Board for Administrative Management Budget</li> <li>- Management Board of Traffic Project</li> <li>- Management Board of Streets &amp; Pavement</li> <li>- Board of Registration &amp; Licensing</li> <li>- Center of Research &amp; Training</li> <li>- INVESC</li> </ul>		Transport <ul style="list-style-type: none"> <li>- Urban Road &amp; Bridge cons. Enter.</li> <li>- Road &amp; Bridge Cons. Enter. 1</li> <li>- R &amp; B cons. Enter. 2</li> <li>- Public Bus Co.</li> </ul>	Urban Public Works <ul style="list-style-type: none"> <li>- <u>Water Supply Co.</u></li> <li>- Drainage &amp; Sewerage Co.</li> <li>- Urban Environmental Co.</li> <li>- Public Lighting Co.</li> <li>- Park, Plantation &amp; Zoo Co.</li> </ul>	Installation & Cons. <ul style="list-style-type: none"> <li>- TUPW investigation &amp; Design Co.</li> <li>- TUPW Install &amp; Cons. Co.</li> <li>- Road &amp; Bridge Cons. Co.</li> </ul>	Transportation <ul style="list-style-type: none"> <li>- Oversea Trans. Co.</li> <li>- River Trans. Co.</li> <li>- Cargo Trans. Co.</li> <li>- Passenger Trans. Co. for the North</li> <li>- Passenger Trans. Co. for the South</li> <li>- Tourist Car Co.</li> <li>- Tram Co.</li> </ul>	Mechanics <ul style="list-style-type: none"> <li>- Electro-mechanic Project Co.</li> <li>- Ship Building Enter.</li> <li>- Bus Building Enter.</li> <li>- Vehicle Repair Enter.</li> </ul>

Fig. 2.2 Organization of TUPWS

- 1) Towns with population more than 15,000.
  - 2) The rural population is less than 25 % of the total population.
  - 3) Population density is more than 100 people/ha.
- The set target is summarized as shown below:

Target of Water Supply Development

City	Unit Consumption (l/cap/day)	House connection (%)	Public tap (%)	Others (%)	Total (%)	Sewerage coverage (%)
I Ha Noi Hai Phong Ho Chi Minh	150	85	12	3	100	50
II Towns >90,000	100-120	70	20	10	100	35
III Towns <90,000	70-80	50-60	25-30	15-20	100	20

According to the above development plan, 85 % of urban population in Ha Noi, Hai Phong and Ho Chi Minh will be supplied by piped water by the year 2000. Seventy percent of the urban population in the towns with population more than 90,000 will be served by piped water and 50-60 % at towns with population less than 90,000.

Through achievement of this development plan, additional 3.9 million urban population in these towns will be served by piped water supply and 3.5 million urban population will have access to the urban sewerage system.

However, capital requirement for this plan is large:US\$ 400 million and US\$ 700 million for extension of water supply and sewerage system respectively:US\$ 450 million and US\$ 250 million for rehabilitation of water supply and sewerage system respectively.

In order to achieve this set target during ten years time from 1990 to 2000, an annual flat rate capital requirement is estimated to be US\$ 180 million which is beyond the national budget and various cooperation and assistance will be required to be extended from international financial institutions and other countries. Further details are to be determined.

## 2.2 Outline of the Request

The government determined to increase the urban population served by piped water to 85 % of the total urban population in the three major towns, Ha Noi, Hai Phong and Ho Chi Minh by 2000.

In order to achieve this target, the improvement of Ha Noi water supply has been undertaken in cooperation with Finland since 1985. The third phase of the project is supposed to be completed in 1995.

The population of Ha Noi City was 900,000 in 1990 which is projected to be 1.4 million in 2000. The project includes rehabilitation and extension of facilities as well as improvement of operation and maintenance.

The project has completed Maidich, Phap Van and Ngocha treatment plants and related distribution mains increasing in production capacity to 120,000 m<sup>3</sup>/day. In the last stage of the project, Yen Phu treatment plant and related distribution mains will be constructed by 1994.

The project area of the above water supply improvement in Ha Noi City is the central part of Ha Noi City. However, water supply improvement in the eastern part of Ha Noi City beyond the Red River has been left behind. The study area of this basic design study is the eastern part of Ha Noi City beyond the Red River called as Gia Lam area.

The size of the project area is approximately 900 ha. Since 1954, many factories have been constructed in the area. The national highway No.1 passes through the central part of the project area communicating Ha Noi and further eastern inland areas. There is the junction of the national highway No.1 with the national highway No.5 in the central part of the project area. The national highway No.5 extends to Hai Phong. The railways run in parallel with the both highways.

Therefore, the project area is playing an important role functioning Ha Noi's industrial cum commercial area and terminal point of land transportation. Due to introduction of market economy, the area is becoming increasingly important for economic development of the northern part of Viet Nam.

Population in the project area is 100,000 at present including densely populated suburban areas adjacent to urban areas. This population is projected to be 170,000 in 2010. However, existing water supply facilities are so old and production capacity is so small that only 15 % of present population in the project area is served by piped water.

In order to achieve the set target of the urban water supply development, Ha Noi City formulated Gia Lam Water Supply Master Plan for which an international cooperation was requested to the Government of Japan by the Government of Socialist Republic of Viet Nam.

## 2.3 Outline of the Project Area

### 2.3.1 Socio-economic Conditions

The project area is the north eastern part of Ha Noi City beyond the Red River. The project area is combined with the central part of Ha Noi City by two bridges; Long Bien and Chuong Duong. The traffic volume of these bridges are heavy every day due to transportation of commercial commodities and people from home to working places.

The national highways No.1 and No.5 have their junction in the central part of the project area in parallel with the railways.

The area has been playing an important role of economic and industrial area and also terminal point of land transportation of Ha Noi City. Since 1954, the train factory has been producing trains and locomotives, although recent activity is minimum. In addition, there are many factories and terminals of commercial commodities in the study area.

There are four urban centers along the highways in the project area. These urban centers are surrounded by several sub urban areas. In these urban centers and suburban areas, land transportation and electricity as basic social infrastructure are available except water supply.

Name	Present Population	Size of Area
Ngoc Thuy	650	51 ha.
Gia Lam	25,790	137 ha.
Duc Giang	16,950	238 ha.
Sai Dong	12,000	251 ha.
Total	55,390	677 ha.

### 2.3.2 Natural Conditions

The project area is surrounded by the two rivers: the Red River and the Duong River. The whole area extends over the alluvial plain formed by these two rivers. Riverine land forms are developed here and there and generally it is very flat. The altitude of the ground surface is in a range between 4 to 10 m above sea level.

The area is used to be subject to periodical floods, however, since construction of flood control dams upstream of the rivers, most of floods are kept below the height of the river dikes (13 m above sea level). The water level during the dry season is 1.73 m above sea level and 12.50 m above sea level during the rainy seasons.



Climate is under the tropical monsoon regime; north or north east winds predominates from November to March. Annual rainfall is in a range between 1,200 mm and 2,000 mm and most of the rain is received during the months from May to October. Monthly rainfall exceeds 300 mm/month in July and August.

An average monthly air temperature is 28°C. The lowest air temperature is observed in January at 17°C. The highest monthly air temperature is found in July and August at 28°C. During summer it is very humid and hot.

### 2.3.3 Land Use Plan

Since the government's decision of market economy introduction in 1989 and opening of diplomatic relationship with many countries in 1990, the economy of Viet Nam seems to be accelerated its development. Due to activated economic activities, Gia Lam area is becoming increasingly important as industrial and commercial strategic zone of Ha Noi.

For this reason, the Institute of Planning of Ha Noi City formulated the land use plan in 1993 aiming at rationalized land use accommodating various kinds of industries by 2010. This plan was approved by the city authority for the basis of the future planning of the area.

In formulation of the land use plan of the project area, the following concepts were considered to attain an optimum utilization of the land resources:

- 1) Natural conditions,
- 2) Productivity of the land,
- 3) Existing land use pattern,
- 4) Present state of social infrastructure and
- 5) Environmental aspects.

According to the land use plan, 2010, there are four urban centers consisting of six types of land use units:

1. Residential area,
2. Industrial area,
3. Public use,
4. Office area,
5. Storage area and
6. Parks and green zone.

Each urban center is classified by the above landuse unit (Table 2.1) as summarized below:

Land Use Unit	No. of Unit	Total Area
Ngoc Thuy	3	61 ha.
Gia Lam	24	188 ha.
Duc Giang	25	300 ha.
Sai Dong	23	296 ha.
Total	57	845 ha.

Socio-economic spatial conditions of these four urban centers are slightly different to one another. Characteristics of each urban center is summarized as shown below:

#### Ngoc Thuy

At present 54 ha is utilized as an urban area in this urban center. It would be extended to 61 ha by 2010. There is a railway station and an airport. The airport is under the military control at present, however, in future it is scheduled to be civilian control for domestic flights. Therefore, this urban center would be a commercial and transportation terminal point of the area. It would also play an important role as residential area of the project area.

#### Gia Lam

Present land use is 96 ha which will be extended to 188 ha in 2010. The area to be developed in future is the area along Nguen Van Cu road where it will be utilized as industrial area and residential area including related public service areas.

#### Duc Giang

Present land use area is 253 ha. In this area, there are already industrial areas and storage. Objective of land use in this area is restructuring for intensive land use of existing industrial area and storage and extension of commercial and residential areas on the southern side of the national highway No.1. Construction of industrial area in the area toward Ngoc Thuy is another objective of future land use in this area.

#### Sai Dong

Present land use in this area is 99 ha, however it will be extended to 296 ha in 2010. The extension area consists of industrial areas to be transformed from paddy fields. Related commercial and residential area are also planned. In 1993 land development for an electronic factory was commenced in 80 ha.

The type and size of each land use plan unit at each urban center in 2010 are summarized as shown below:

## Land Use Plan 2010

Item	Residential (ha.)	Industry (ha.)	Public (ha.)	Business (ha.)	Storage (ha.)	Parks (ha.)	Roads (ha.)	Total (ha.)
Ngoc Thuy	19	13	4	2	3	0	10	61
Gia Lam	77	21	11	12	2	14	51	188
Duc Giang	75	69	17	11	43	23	62	300
Sai Dong	80	117	18	12	3	21	45	296
Total	251	220	60	37	51	58	168	845

Detailed land use plan is summarized in Table 2.1 and Fig. 2.3.

### 2.3.4 Present State of Water Supply

There are two tiny water supply systems in the project area operated by Ha Noi Water Supply Company: Gia Lam and Sai Dong Water Supply Systems.

#### Gia Lam Water Supply System

The water supply system was constructed in 1958 with design capacity of 4,000 m<sup>3</sup>/day. The water source is ground water pumped by two wells. These wells were reconstructed in 1985 and 1989.

The ground water contains high iron so that it is designed to remove iron by a rapid sand filter after contact basin of raw water aeration.

In spite of aged facility, the system is well maintained. However, the iron content is so high that it is required to backwash two times a day which resulted in low efficiency of water treatment. In addition, the raw water contains ammonia that consumes high chlorine. Due to aged distribution system leakage is estimated at about 50 % of total water production.

Total length of distribution pipelines is 7 km. Since the design capacity is so small, only a small service area is maintained:

Consumer	Number
Domestic House Connection	681
Public Use	65
Public Taps	34

### Sai Dong Water Supply System

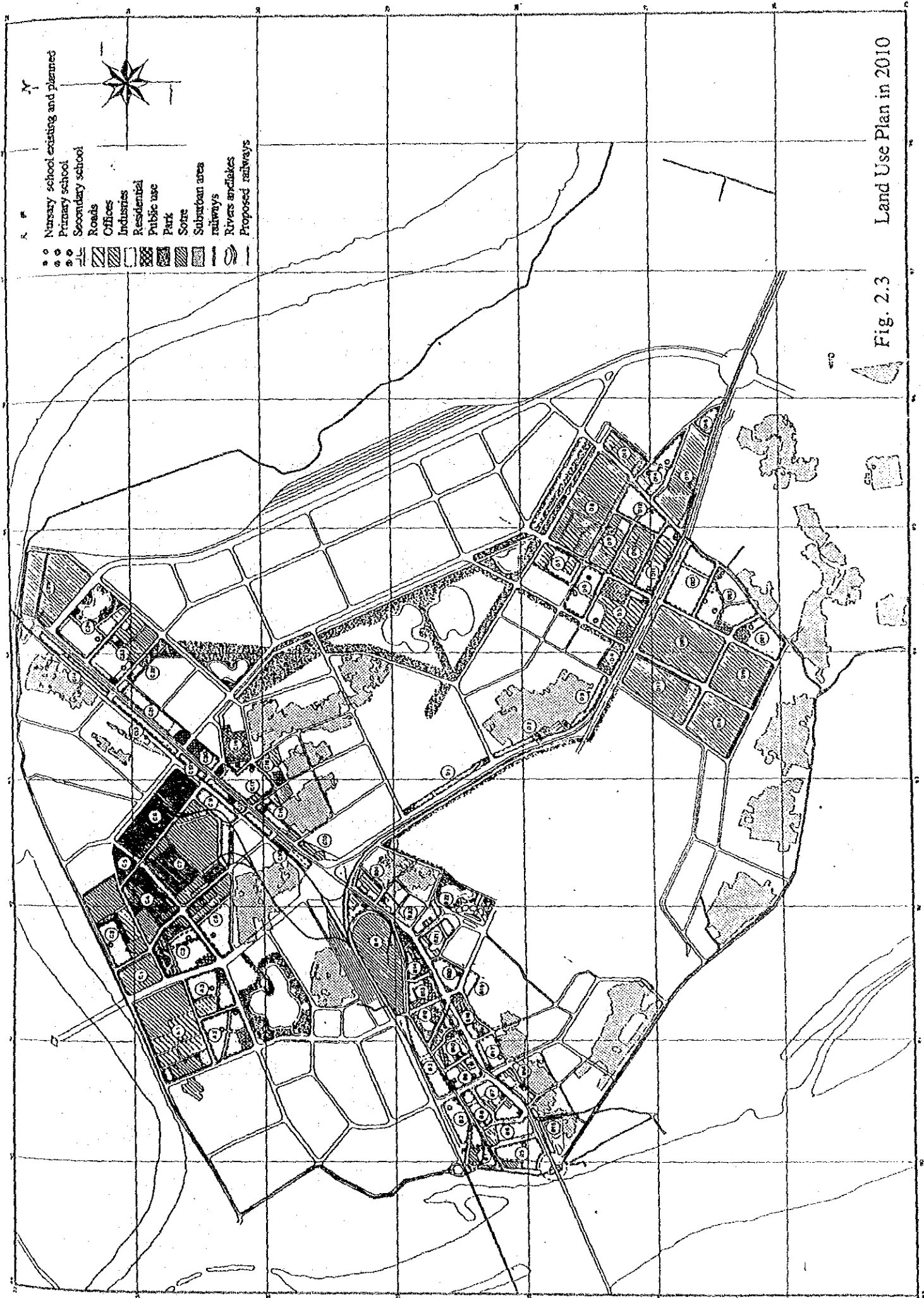
This water supply system was constructed in 1976 with the design capacity of 2,500 m<sup>3</sup>/day. The treatment system is similar to the Gia Lam water supply system. Accordingly, it has the same problem of the Gia Lam system.

Total length of distribution pipelines is 7 km. Beneficiaries are:

Consumer	Number
Public Use	10
House Connection	158

Existing facilities can afford only 15 % of present demand and all facilities are too aged and the treatment system is inefficient so that these facilities need to be replaced by new facilities to suit removal of high content of iron.

There are ten private water supply facilities in the area. These are operated by factories. Of these, two locate in Gia Lam, seven in Duc Giang and one facility in Sai Dong. Total design capacity of these facilities is 5,700 m<sup>3</sup>/day, however, all facilities are old and have the same problem as water supply facilities under Ha Noi Water Supply Company to remove high contents of iron.



- N  
 Nursery school existing and planned  
 Primary school  
 Secondary school  
 Roads  
 Offices  
 Industries  
 Residential  
 Public use  
 Park  
 Sports  
 Suburban area  
 railways  
 Rivers and lakes  
 Proposed railways

Fig. 2.3 Land Use Plan in 2010

Table 2.1 Land Use Plan

Ngoc Thuy

Block No.	Total	Residential	Office	Public	Industry	Store	Park
A 1	28.28	0.78	11.60	0.00	13.00	3.00	0.00
A 2	12.04	10.84	0.00	1.20	0.00	0.00	0.00
A 3	10.58	7.38	2.40	0.80	0.00	0.00	0.00
Total	50.90	19.00	14.00	2.00	13.00	3.00	0.00

Table 2.1 Land Use Plan

Gia Lam

Block No.	Total	Residential	Office	Public	Industry	Store	Park
B 1	5.12	3.40	0.00	0.12	0.00	1.60	0.00
B 2	6.10	4.70	0.00	0.30	0.00	0.00	1.10
B 3	23.00	5.84	0.00	0.16	0.00	0.00	2.00
B 4	8.00	1.90	0.80	0.30	20.00	0.00	0.00
B 5	8.66	8.26	0.00	0.00	0.00	0.40	0.00
B 6	7.00	6.10	0.90	0.00	0.00	0.00	0.00
B 7	7.24	5.70	0.54	0.30	0.70	0.00	0.00
B 8	3.92	3.62	0.20	0.10	0.00	0.00	0.00
B 9	5.24	4.27	0.45	0.52	0.00	0.00	0.00
B10	6.00	2.15	0.25	3.00	0.00	0.00	0.00
B11	3.20	2.54	0.66	0.00	0.00	0.00	0.00
B12	5.40	1.00	0.00	0.90	0.00	0.00	3.50
B13	5.20	1.20	0.00	2.80	0.00	0.00	1.20
B14	5.17	0.22	0.00	1.00	0.30	0.00	3.65
B15	1.90	1.90	0.00	0.00	0.00	0.00	0.00
B16	4.10	1.82	1.98	0.30	0.00	0.00	0.00
B17	1.20	0.95	0.00	0.25	0.00	0.00	0.00
B18	4.30	1.80	1.00	1.50	0.00	0.00	0.00
B19	2.10	2.10	0.00	0.00	0.00	0.00	0.00
B20	4.32	4.02	0.00	0.30	0.00	0.00	0.00
B21	5.23	4.25	0.98	0.00	0.00	0.00	0.00
B22	3.25	1.70	0.40	0.00	0.00	0.00	1.15
B23	7.05	5.51	0.74	0.00	0.00	0.00	0.80
B24	4.00	1.45	2.10	0.15	0.00	0.00	0.30
Park and Green Zone	0.3	0.00	0.00	0.00	0.00	0.00	0.30
合 計	137.00	76.40	11.00	12.00	21.00	2.00	14.00

Table 2.1 Land Use Plan

Duc Giang

Block No.	Total	Residential	Office	Public	Industry	Store	Park
C 1	7.60	0.00	0.00	0.00	7.60	0.00	0.00
C 2	19.50	5.60	2.75	0.00	9.85	0.00	1.30
C 3	16.00	8.60	0.00	1.00	0.00	1.90	4.50
C 4	14.04	0.00	0.00	0.00	4.50	9.54	0.00
C 5	3.00	0.00	0.00	0.40	0.00	2.60	0.00
C 6	14.03	8.30	0.00	0.00	3.30	1.90	0.53
C 7	29.89	0.00	3.83	0.00	16.00	10.06	0.00
C 8	17.00	0.00	0.00	0.00	0.00	17.00	0.00
C 9	5.60	5.60	0.00	0.00	0.00	0.00	0.00
C10	2.20	0.80	1.00	0.00	0.00	0.00	0.40
C11	3.70	2.40	0.00	0.30	0.00	0.00	1.00
C12	1.50	1.10	0.00	0.00	0.00	0.00	0.40
C13	4.45	3.20	0.00	0.00	0.00	0.00	1.25
C14	4.80	3.00	0.00	0.00	0.00	0.00	1.80
C15	2.00	0.20	1.80	0.00	0.00	0.00	0.00
C16	5.31	2.51	1.05	0.35	1.40	0.00	0.00
C17	8.20	7.10	0.40	0.40	0.00	0.00	0.30
C18	3.68	2.08	1.00	0.60	0.00	0.00	0.00
C19	6.50	1.70	0.00	4.80	0.00	0.00	0.00
C20	3.00	1.90	0.00	1.10	0.00	0.00	0.00
C21	7.50	5.26	0.00	1.00	0.00	0.00	1.24
C22	3.18	0.00	0.00	0.00	0.00	0.00	3.18
C23	13.00	5.90	4.37	0.40	2.33	0.00	0.00
C24	18.90	9.75	0.00	0.65	1.40	0.00	7.10
C25	23.42	0.00	0.80	0.00	22.62	0.00	0.00
Total	238.00	75.00	17.00	11.00	69.00	43.00	23.00



Table 2.1 Land Use Plan

Sai Dong

Block No.	Total	Residential	Office	Public	Industry	Store	Park
D 1	3.80	2.60	0.40	0.80	0.00	0.00	0.00
D 2	3.30	2.70	0.60	0.00	0.00	0.00	0.00
D 3	2.75	2.75	0.00	0.00	0.00	0.00	0.00
D 4	3.00	1.90	0.00	0.70	0.00	0.00	0.40
D 5	15.20	1.30	6.55	7.35	0.00	0.00	0.00
D 6	8.20	8.00	0.00	0.00	0.00	0.00	0.00
D 7	7.35	4.65	2.70	0.00	0.00	0.00	0.00
D 8	25.38	0.00	2.40	0.00	22.98	0.00	0.00
D 9	7.30	0.00	0.00	0.00	4.31	0.00	2.00
D10	9.20	0.00	1.90	0.00	7.10	0.00	0.00
D11	9.45	6.70	2.10	0.65	0.00	0.00	0.00
D12	7.85	7.85	0.00	0.00	0.00	0.00	0.00
D13	6.76	0.00	1.35	0.00	3.41	0.00	2.00
D14	9.63	7.43	0.00	0.00	1.00	0.00	1.20
D15	16.56	1.30	0.00	0.00	12.26	3.00	0.00
D16	3.70	2.50	0.00	0.00	0.00	0.00	1.20
D17	17.70	0.00	0.00	0.00	14.90	0.00	2.80
D18	14.64	0.00	0.00	0.00	12.64	0.00	2.00
D19	16.28	0.00	0.00	0.00	14.40	0.00	1.88
D20	24.00	0.00	0.00	0.00	24.00	0.00	0.00
D21	6.80	5.80	0.00	1.00	0.00	0.00	0.00
D22	14.32	12.52	0.00	1.50	0.00	0.00	0.30
D23	12.00	12.00	0.00	0.00	0.00	0.00	0.00
Park and Green Zone	5.59	0.00	0.00	0.00	0.00	0.00	5.59
Total	250.76	80.00	18.00	12.00	117.00	3.00	19.37

Table 2.1 Land Use Plan

Summary

Block No.	Total	Residential	Office	Public	Industry	Store	Park
Ngor Thuy	51.00	19.00	14.00	2.00	13.00	3.00	0.00
Gia Lam	137.00	76.40	11.00	12.00	21.00	2.00	14.00
Duc Giang	238.00	75.00	17.00	11.00	69.00	43.00	23.00
Sai Dong	250.76	80.00	18.00	12.00	117.00	3.00	20.00
Total	676.76	250.40	60.00	37.00	220.00	51.00	57.00

### **3. Outline of the Project**



### 3. Outline of the Project

#### 3.1 Objective

Objective of this study is to formulate the basic design of the water supply system for Gia Lam area according to the Gia Lam Water Master Plan formulated by Ha Noi City.

The project period of the Water Master Plan is set up at the year 2010, however, urban development of some part of the project area is to be completed in future. In addition, restructuring of some part of the existing urban area is also required according to the urban planning formulated by the Institute of Planning of Ha Noi City.

Under the circumstance, it is very difficult to draw a clear picture of the urban conditions of the project area in a long time projection. Therefore, it is proposed to formulate the basic design of the water supply in the project area to meet the water demand at 2000 and future extension will be replanned incorporating actual urban conditions developed by that time and future projection at that time.

#### 3.2 Study and Examination of the Request

The request for the project made by the Government of Socialist Republic of Viet Nam has been carefully studied and concluded that the content of the request is provision of the water supply facilities to meet the water demand in 2000(30,000 m<sup>3</sup>/day).

The water demand is prudently determined based on the Gia Lam Water Supply Master Plan formulated by Ha Noi City.

The central government determined to maintain financial self sustenance of the water supply in 1989. Since then much effort has been made by the Ha Noi Water Supply Company and the water charge has been revised several times.

As water supply requires a large amount of capital investment, water supply needs the government subsidize or issuance of bonds in many countries. At present, although the Ha Noi Water Supply Company makes a profit on water supply in Ha Noi City, the company still needs government subsidize.

When this project is implemented, the water supply is supposed to be managed by the same type of the water supply company as the Ha Noi Water Supply Company under supervision of Ha Noi City. It is assumed that this company will make profit on its water sales based on a preliminary financial forecast of the project making assumption that the

same water tariff of Ha Noi City is applied to the project. It is further assumed that accumulated profit on water sales will be able to produce the reserve for rehabilitation of these equipment and facilities with short life time.

For this purpose, it is recommended to complete construction of distribution lines in an early stage of the project. The request indicates supply of distribution pipeline materials for 60 km; 20 km for distribution mains and 40 km for branch lines.

According to the study of the service area, total length of distribution lines in the proposed service area is 93 km; 52 km of distribution mains and 41 km of branch lines. In this respect, it is proposed to supply pipe materials of distribution lines for 93 km to maintain optimum service level and to ensure water charge collection for establishment of financial self sustenance in an early stage of the project.

### 3.3 Project Description

#### 3.3.1 Executing Agency and Operational Structure

This project will be operated by the Gia Lam Water Supply Company under supervision of Ha Noi City. Ha Noi City is governed by the people's committee of Ha Noi City. The authority of people's committee in the central government is in the same level as the ministries. There are eight departments in Ha Noi City. The department of transportation and urban public works service (TUPWS) is responsible for water supply. The Ha Noi Water Supply Company is operating the water facilities of Ha Noi City under control of TUPWS.

The production capacity of water supply facilities of Ha Noi City is 330,000 m<sup>3</sup>/day serving one million people. When the Ha Noi Water Supply Program is completed in 1995, the production capacity will be 433,000 m<sup>3</sup>/day to serve 1.4 million people.

The organization of Ha Noi Water Supply Company is illustrated in Fig. 2.2.

There are five departments in the company as summarized below:

<u>Department</u>	<u>No. of Staff</u>
1) Administration	200
2) Water source	96
3) Treatment plants	950
4) Distribution	450
5) Workshop	51

Total number of employee of the company is 1,747.

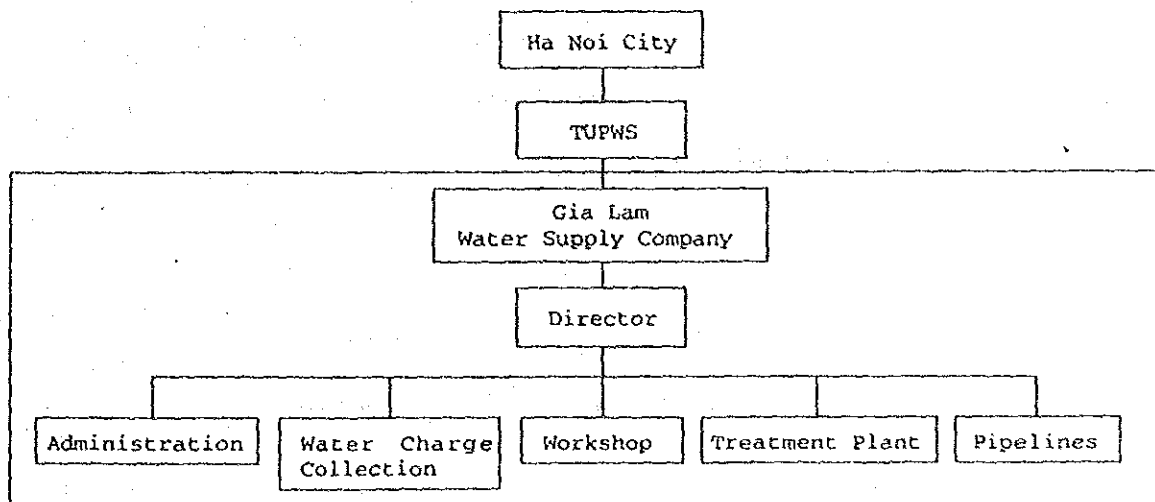
This large number of employees is attributed to the fact that the company is operating 12 treatment plants, 130 water source wells and aged distribution pipelines which requires frequent repair and technical services to maintain day to day services. On an average 50 employees operate ten thousand cubic meter/day.

When the project is implemented, all facilities will be operated by the same type of the water supply company as Ha Noi Water Supply Company.

Whether Hanoi Water Supply Company undertakes Gia Lam water supply or an independent water supply company is established independent from Ha Noi Water Supply Company is subject to Ha Noi City's decision. However, it is recommended that the facilities to be constructed by the project be operated by an independent company since Gia Lam water supply is completely independent from the water supply system of Ha Noi City. It is also preferable to establish its financial sustainability in an early stage of the project.

For this purpose, it is proposed to organize Gia Lam Water Supply Company with an organization as shown below:

#### Proposed Organization of Gia Lam Water Supply Company



The company consists of five department as same as Ha Noi Water Supply Company. The members of each department are proposed as listed below:

- 1) Administration including personnel and finance 17
- 2) Water charge collection 20

3)	Workshop	41
	Superintendent	1
	Deputy superintendent	1
	Sanitary engineer	2
	Electric engineer	2
	Mechanical engineer	2
	Piping engineer	3
	Workers	30
4)	Treatment plant	24
	Superintendent	1
	Deputy superintendent	1
	Water quality specialist	1
	Workers	20
	Plant attendant	56
	Foreman	1
	Water source	1
	Electro-mechanical	2
	Guardsman at water source	2
	Guardsman at Plant	2
5)	Pipelines	26
	Superintendent	1
	Deputy superintendent	1
	Plumber	2
	Surveyor	2
	Worker	26
	Grand total	160



### 3.3.2 Plan of Operation

#### 3.3.2.1 Service area

The service area of the project is Gia Lam area of Ha Noi City. This area locating opposite to the central Ha Noi beyond the Red River has been playing an important role of commercial and industrial area of Ha Noi City. Since the national roads of No.1 and No.5 are running through the central part of the service area in parallel with the national railways, it is becoming increasingly important as terminal point of land transportation.

The land use plan of the project area toward 2010 was formulated by the Institute of Planning of Ha Noi City in 1993 and approved by the city authority. Ha Noi city further formulated Gia Lam Water Master Plan aiming at the target year of 2010 based on the above land use plan.

The service area of the project almost corresponds to the area proposed in the Master Plan, however, the suburban areas are included in the proposed service area of the project.

The suburban areas are densely populated area adjacent to the urban area of the land use plan. These areas are villages in the suburbs of Gia Lam urban centers. As urban centers expand, the farm lands have been changed for urban areas and the boundaries between the urban centers and villages became obscure. These suburban areas will be urbanized in future. For this reason 14 sub urban areas totaling 343 ha is included in the service area of the project. The service area of the project consists of four urban centers and associated suburban areas as summarized below:

Service Areas

Name	Urban areas ha.	Suburban areas ha.
Ngoc Thuy	61	5.5
Gia Lam	188	85.5
Duc Giang	300	140.0
Sai Dong	296	112.0
Total	845	343.0

### 3.3.2.2 Water Demand

#### (1) Water Demand Classification

The classification of consumers of municipal water supply is different from place to place, however, it is classified into six categories in Viet Nam:

- 1) Domestic Water
- 2) Public Use  
Offices and schools  
Hotels, hospitals and restaurants  
Small scale industries, commercial area
- 3) Industry
- 4) Road cleaning
- 5) Irrigation for parks and green areas
- 6) Leakage and other use

#### 1) Domestic water

For Ha Noi City water supply program, a socioeconomic survey was undertaken to identify the present service level and consumers' attitude towards the water supply. It is found that a unit consumption of domestic water is in a wide range between 100 l/cap/day and 400 l/cap/day. The high consumption rate is assumed to be caused by wastage of water by the consumers since many taps are left open due to low hydraulic pressure of taps.

The Quality Control Department of the Ministry of Construction determined the design criteria of domestic water consumption as shown below:

Unit Consumption Rate of Domestic Water

Type of Consumption	Consumption Rate l/cap/day
1) Public Tap	40-60
2) Yard Tap	80-100
3) House Connection with sewerage system	120-150
4) 3)+ flush toilet and bath room	150-200
5) 4)+ water heater	200-300

Domestic water consumption in urban areas in South-East Asian countries is summarized as shown below:

### Domestic Water Consumption in South-East Asian Countries

Name of City	Project Time		
	1988 l/cap/day	2000 l/cap/day	2010 l/cap/day
Langoon			125
Vientian	160	225	
Kualalumpur			220
Colombo			240
Manila	200	250	
Jakarta	150		220
Saigon	220	250	

Ha Noi Water Supply Program estimates the unit consumption rate of domestic water as shown below:

#### Domestic Water Consumption in Ha Noi City

Year	1990	2000	2010
Unit Consumption (l/cap/day)	70	150	180

Considering that the dwelling pattern of the project area is similar to that of Ha Noi City, the above water consumption rate of domestic water is applied for the project.

Population of Ha Noi City in 1960 was 913,000 and 2,095,000 in 1991. There was a rapid increase in population of Ha Noi City in 1960:

#### Population In Ha Noi City

Year	Population (1,000person)	Natural Growth %	Social Growth %
1960	913	3.89	11.93
1965	1,061	2.36	2.65
1970	1,187	2.74	2.27
1979	1,732	-	-
1980	-	2.26	-
1985	1,826	1.15	0.88
1990	2,052	1.51	2.36
1991	2,095	1.73	2.24

The natural growth rate of population in Ha Noi City was very high in 1960 (3.89 %), however, it decreases as time goes on. In 1989, it is found to be 2.26 % and in 1991, it is 1.73 % which is assumed to be 1.1 in 1995 and 0.65 in 2010. This is due to the government's decision of family planning. The retired people relying on pension tend to gather to Ha Noi City.

The social growth rate of population was extremely high in 1960, however, it generally tends to decrease. Recent government decision to introduce market economy may provide an incentive to investment of various sectors in Ha Noi which may easily result in increase in social growth of population. The social growth rate of population of Ha Noi in 1990 was in an order of 2 % while the Institute of Planning of Ha Noi City intends to keep at 1 % in its future plan.

Population in the four urban centers in the project area is summarized in the table below:

Population of Urban Centers  
(x 1,000)

Year	Population (%)	Natural Growth (%)	Social Growth (%)
1960	913	3.89	11.93
1965	1,061	2.36	2.65
1970	1,187	2.74	2.27
1979	1,732	-	-
1980	-	2.26	-
1985	1,826	1.50	0.88
1990	2,052	1.51	2.36
1991	2,059	1.73	2.24

The population growth rate of these urban centers was very steady from 1985 to 1989, however, there was significant increase in population in 1990. Since then, the population growth rate is rather steady indicating 2 to 3 %.

The Institute of Planning of Ha Noi City intends to prevent drastic increase in population in the project area. In the land use plan of the project area, the future population growth rate is projected to be 1.02 % in the natural growth and 1.1 % in the social growth rate.

The concept of an optimum population density of residential area is also introduced in the land use plan. The population density of the residential area to maintain amenity of urban dwelling is estimated to be in a range between 300 persons/ha and 400 persons/ha and the upper limit is 500 persons/ha.

In the central part of Ha Noi City, there is an area where population density is extraordinary high. In such area, there is difficulty in improvement of social infrastructure such as drainage, sewer system and roads.

Even in the project area, there are also some limited areas where population density exceeds 500 persons/ha(Block No.B3,B9 and B21 in Gia Lam, No.C10 in Duc Giang). In the land use plan of the project area, it intends to reduce the number of population of such areas to the acceptable level.

The size of residential area and the planned population in each urban center is summarized in Table 3.1.

## 2) Public Use

This category of demand is water consumption of offices, schools, hotels, restaurant, hospitals and all other public water use. It is very difficult to estimate the water demand of this category especially in the service area like Gia Lam which is developing rapidly.

For this reason, Ha Noi Water Supply Program made a survey based on questionnaire of public water consumers of more than 1,000 m<sup>3</sup>/month consumption to determine the consumption rate in Ha Noi City. The consumption rate of public water in Ha Noi City was determined in this way as shown below in relation with the size of service population:

Consumption Rate of Public Water  
(l/cap/day)

1995	2000	2010
16	16	20

The Water Master Plan of Gia Lam Area also applies the above rate and it is considered to be acceptable in this project.

## 3) Industrial Water

This category is the water consumed as domestic water in the factories. Each factory is supposed to have water supply system for its own use, however, major water source is groundwater which contains high iron. It is difficult to remove the iron to the level of potable water.

Table 3.1 Projected Population in Each Residential Area

Gia Lam

Block No.	Area (ha)		Population		
	Total area	Residential	1 9 9 2	2 0 0 0	2 0 1 0
B 1	5.12	3.40	1,360	1,360	1,360
B 2	6.10	4.70	1,500	1,627	1,786
B 3	23.00	5.84	3,000	2,731	2,394
B 4	8.00	1.90	600	604	608
B 5	8.66	8.26	1,500	1,935	2,478
B 6	7.00	6.10	1,630	1,746	1,891
B 7	7.24	5.70	2,280	2,229	2,166
B 8	3.92	3.62	2,200	1,866	1,448
B 9	5.24	4.27	1,500	1,440	1,366
B 10	6.00	2.15	2,100	1,668	1,127
B 11	3.20	2.54	1,200	1,118	1,016
B 12	5.40	1.00	1,100	780	380
B 13	5.20	1.20	0	171	384
B 14	5.17	0.22	40	71	110
B 15	1.90	1.90	500	616	760
B 16	4.10	1.82	350	502	691
B 17	1.20	0.95	380	422	475
B 18	4.30	1.80	150	363	630
B 19	2.10	2.10	0	299	672
B 20	4.32	4.02	1,800	1,625	1,407
B 21	5.23	4.25	2,000	1,768	1,478
B 22	3.25	1.70	0	227	510
B 23	7.05	5.51	400	853	1,419
B 24	4.00	1.45	200	127	35
Parks and Green Zone					
Total	136.70	76.40	25,790	26,148	26,591

Table 3.1 Projected Population in Each Residential Area

Duc Giang

Block No.	Area (ha)		Population		
	Total area	Residential	1 9 9 2	2 0 0 0	2 0 1 0
C 1	7.60	0.00	0	0	0
C 2	19.50	5.60	220	744	1,400
C 3	16.00	8.60	1,875	2,321	2,879
C 4	14.04	0.00	0	0	0
C 5	3.00	0.00	0	0	0
C 6	14.03	8.30	2,225	2,417	2,656
C 7	29.89	0.00	320	178	0
C 8	17.00	0.00	0	0	0
C 9	5.60	5.60	480	1,013	1,680
C 10	2.20	0.80	600	511	400
C 11	3.70	2.40	600	760	960
C 12	1.50	1.10	200	297	418
C 13	4.45	3.20	900	1,040	1,216
C 14	4.80	3.00	900	1,007	1,140
C 15	2.00	0.20	50	72	100
C 16	5.31	2.51	50	418	878
C 17	8.20	7.10	2,272	2,272	2,272
C 18	3.68	2.08	800	722	624
C 19	6.50	1.70	0	0	0
C 20	3.00	1.90	0	320	720
C 21	7.50	5.26	0	795	1,788
C 22	3.18	0.00	0	0	0
C 23	13.00	5.90	2,084	1,895	1,652
C 24	18.90	9.75	2,516	2,828	3,217
C 25	23.42	0.00	858	477	0
Total	238.00	75.00	16,950	20,087	24,000

Table 3.1 Projected Population in Each Residential Area

Sai Dong

Block No.	Area (ha)		Population		
	Total area	Residential	1 9 9 2	2 0 0 0	2 0 1 0
D 1	3.80	2.60	120	644	1,300
D 2	3.30	2.70	100	500	1,000
D 3	2.75	2.75	70	650	1,375
D 4	3.00	1.90	0	422	950
D 5	15.20	1.30	200	273	364
D 6	8.20	8.00	1,280	1,778	2,400
D 7	7.35	4.65	180	722	1,400
D 8	25.38	0.00	100	56	0
D 9	7.30	0.00	616	342	0
D10	9.20	0.00	760	422	0
D11	9.45	6.70	1,960	2,042	2,144
D12	7.85	7.85	1,515	1,714	1,962
D13	6.76	0.00	0	0	0
D14	9.63	7.43	2,177	2,134	2,080
D15	16.56	1.30	900	789	650
D16	3.70	2.50	842	857	875
D17	17.70	0.00	300	167	0
D18	14.64	0.00	0	0	0
D19	16.28	0.00	0	0	0
D20	24.00	0.00	0	0	0
D21	6.80	5.80	0	902	2,030
D22	14.32	12.52	500	1,878	3,600
D23	12.00	12.00	380	1,931	3,870
Parks and Green Zone	5.59	0.00			
Total	250.76	80.00	12,000	18,223	26,000



Therefore, the industrial processing water is treated by the factory's plant but the water for domestic purpose in the factory is supplied by the municipal water supply.

In the land use plan of the project area, there is 220 ha. of industrial area. Occupancy rate the of industrial land by industries is 30 % in 1995. This occupancy rate is projected to be 50 % in 2000 and 85 % in 2010.

#### Industrial Land

Area	1995 ha.	2000 ha.	2010 ha.	Final Plan ha.
Ngoc Thuy	3	6	11	13
Gia Lam	6	10	18	21
Duc Giang	18	34	59	69
Sai Dong	35	58	99	117
Total	63	108	187	220

The water consumption of industry area is estimated at 45 m<sup>3</sup>/ha/day based on a survey of 32 industries consuming water more than 5,000 m<sup>3</sup>/day in Ha Noi City. It is assumed that 45 m<sup>3</sup>/ha/day may include 28-50 % of losses mainly consists of leakage within the industry's yard.

Considering the above conditions, the Gia Lam Water Master Plan proposed 30 m<sup>3</sup>/ha/day in 2000 and 35 m<sup>3</sup>/ha/day in 2010 for industrial area which is considered to be acceptable for the project.

#### 4) Cleaning of roads

In Viet Nam, roads are periodically washed by water in urban area. The design criteria of water demand for cleaning roads is 1 l/m<sup>2</sup>/day.

The occupancy rate of roads in the town area is 20 % in the land use plan of the project area. Usually it is 10 to 20 % of the whole urban area and a high rate(30 %) is observed at towns like Washington in the United States of America.

The construction of the road network is to be completed in accordance with the urban development so that the completion rate of the road network in the project area is estimated to be 40 % in 2000 and 95 % in 2010. Based on this assumption, the water demand of road cleaning is estimated as shown below:

### Water Demand for Road Cleaning

Year	Population	Unit Consumption (l/cap/day)	Amount (m <sup>3</sup> /day)	Road Area (ha)	Demand (l/m <sup>2</sup> )
2000	67,000	10	666	67	1.0
2010	81,000	20	1,620	160	1.0

#### 6) Irrigation

In order to maintain aesthetic urban conditions and amenity of residential area, many parks and green zones are planned in the land use plan of the project area. Total area of parks and green zones in the service area is 57 ha.

During the rainy seasons, there is sufficient rainfall to keep green, however, supplementary irrigation is required during the dry seasons. Assuming that the evapotranspiration is 1,400 mm/year, supplementary irrigation will be required 50 % of it during the dry season:

$$1,400 \text{ mm/yea}/365 \times 10,000/1,000 = 20 \text{ m}^3/\text{ha}/\text{day}$$

It is assumed that 40 % of these parks and green zones will be completed by 2000 and 80 % by 2010, the required irrigation water is estimated as shown below:

$$2000 \quad 20 \text{ m}^3/\text{ha}/\text{day} \times 0.4 = 8 \text{ m}^3/\text{ha}/\text{day}$$

$$2010 \quad 20 \text{ m}^3/\text{ha}/\text{day} \times 0.8 = 16 \text{ m}^3/\text{ha}/\text{day}$$

#### 7) Domestic Water for Suburban Area

The land use plan of the project area covers these urbanized residential and industry areas, however, there are some densely populated areas adjacent to the urbanized areas. These suburban areas are villages of farmers in the suburbs of urban centers. Due to outward expansion of urbanized areas the boundary between the urban area and villages disappeared in many places. The destiny of these suburban areas adjacent to the urban area is assumed to be the bed towns or residential area of the urban areas and the source of labor force for urban centers in future.

For this reason, these suburban areas adjacent to the urban areas are included in the service area of the project. There are 14 suburban areas:

### Suburban Areas

Area	Name of Suburban Area	Size (ha)
Ngoc Thuy	Gia Thong	5.5
	Gia Lam	12.5
Duc Giang	Gia Thuy	17.0
	Ngoc Lam	26.0
	Lam Du	30.0
	Viet Hung	64.0
	Thuon Cat	25.0
	Duc Giang	12.0
	Thanh Am	14.0
Sai Dong	Mai Phuc	25.0
	Xon Duhg	8.0
	Long Caie	23.0
Total		343.0

The size of population of these suburban areas are as shown below:

#### Population of Suburban Area

Name	Area (ha)	1985	1988	1990	1993	2000
Long Bien	46	5,900	6,100	6,800	6,900	7,700
Viet Hung	64	5,600	5,600	6,300	6,600	7,300
Gia Thuy	25	4,000	4,500	5,200	5,500	6,100

Considering the population growth in the records, it is assumed that the population growth rate in suburban areas is estimated at 1.4 % and the population density is assumed to be 140 person/ha on an average.

In the suburban area, each house has its own domestic water source, however, these water source are either shallow well or pond which is subject to seasonal fluctuation of available water and contamination. Therefore, it is assumed that the cooking and drinking water will be served by the municipal water and the other purpose of water will be obtained from conventional water source so that the unit consumption rate of the municipal water supply is estimated at 60 l/cap/day.

#### 8) Leakage and Other Use

The water supply facilities in Ha Noi City are so aged that the unaccounted-for water is regarded as leakage and other uses, including water consumption at treatment plant and leakage through distribution lines. These leakage and other water use are estimated to be equivalent to 50 % of total production of water. This volume of

water is a significant amount so that it is emphasized to reduce the water unaccounted for in the Ha Noi Water Supply Program:

Year	Leakage and Other Use
1990	50 %
2000	40 %
2010	28 %

Since all facilities of Gia Lam Water Supply are to be newly constructed by the project, the leakage through pipelines is assumed to be 20 % of the total amount of water supplied at 20 years after construction. Therefore, the leakage is assumed to be 10 % of total water supplied immediately after construction of works and it would be increasing by 0.25 % in each year:

$$\text{Losses} = (10 \% + 0.25 \% \times n) \times \text{water supplied}$$

n: number of years after construction

The water consumption in the treatment plant is calculated to be 7 % of the total amount of water production. Major portion of this amount is consumed by back wash of the filters.

Therefore, the loss of water in the first year after construction of works is estimated to be 7 % of water production and 10 % of the water supplied.

#### 9) Water Demand Forecast

Based on the above assumption the water demand of the project area in 2000 and 2010 estimated as is summarizes as shown below:

Water Demand  
(m<sup>3</sup>/day)

	1995	2000	2010
Domestic			
Urban Area	6,647	9,986	21,509
Suburban	2,868	3,293	3,784
Industrial	1,980	3,304	6,545
Public Use	884	1,065	1,738
Road Cleaning	555	666	869
Irrigation	228	447	893
Total	13,162	18,761	34,338

Further details are shown in Table 3.2 a,b,c, and Fig. 3.1

Table 3.2a Water Demand in 2000

NGOC THUY

Block No.	Population			Domestic		Public Use 16 l/cap/day	Cleaning 10 l/cap/day	Irrigation 20 m <sup>3</sup> /ha.40%	Total m <sup>3</sup> /day
	1992	2000	2010	Residential 150 l/day	Industry 30m <sup>3</sup> /ha*50%				
	A1	125	156	195	23				
A2	155	1028	2120	154	0	16	10	0	181
A3	370	932	1635	140	0	15	9	0	164
Total	650	2116	3950	317	195	34	21	0	567

GIA LAM

B1	1,360	1,360	1,360	204	0	22	14	0	239
B2	1,500	1,627	1,786	244	0	26	16	9	295
B3	3,000	2,731	2,394	410	0	44	27	16	497
B4	600	604	608	91	300	10	6	0	406
B5	1,500	1,935	2,478	290	0	31	19	0	341
B6	1,630	1,746	1,891	262	0	28	17	0	307
B7	2,280	2,229	2,166	334	11	36	22	0	403
B8	2,200	1,868	1,448	280	0	30	19	0	329
B9	1,500	1,440	1,366	216	0	23	14	0	253
B10	2,100	1,668	1,127	250	0	27	17	0	294
B11	1,200	1,118	1,016	168	0	18	11	0	197
B12	1,100	780	380	117	0	12	8	28	165
B13	0	171	384	26	0	3	2	10	40
B14	40	71	110	11	5	1	1	29	46
B15	500	616	760	92	0	10	6	0	108
B16	350	502	691	75	0	8	5	0	88
B17	380	422	475	63	0	7	4	0	74
B18	150	363	630	54	0	6	4	0	64
B19	0	299	672	45	0	5	3	0	53
B20	1,800	1,625	1,407	244	0	26	16	0	286
B21	2,000	1,768	1,478	265	0	28	18	0	311
B22	0	227	510	34	0	4	2	9	49
B23	400	853	1,418	128	0	14	9	6	156
B24	200	127	435	19	0	2	1	2	24
Park&green				0	0	0	0	2	2
Total	25,790	26,150	26,990	3,923	316	418	262	112	5,030

Duc Giang

Block No.	Population			Domestic	Industry	Public Use	Cleaning	Irrigation	Total
	1992	2000	2010	Residential 150 l/day	30m <sup>3</sup> /ha* 50%	16 l/cap/day	10 l/cap/day	20 m <sup>3</sup> /ha	m <sup>3</sup> /day
C1	0	0	0	0	114	0	0	0	114
C2	220	744	1,400	112	148	12	7	10	289
C3	1,875	2,321	2,879	348	0	37	23	36	444
C4	0	0	0	0	68	0	0	0	68
C5	0	0	0	0	0	0	0	0	0
C6	2,225	2,417	2,656	363	50	39	24	4	479
C7	320	178	0	27	240	3	2	0	271
C8	0	0	0	0	0	0	0	0	0
C9	480	1,013	1,680	152	0	16	10	0	178
C10	600	511	400	77	0	8	5	3	93
C11	600	760	980	114	0	12	8	8	142
C12	200	297	418	45	0	5	3	3	55
C13	900	1,040	1,216	156	0	17	10	10	193
C14	900	1,007	1,140	151	0	16	10	14	191
C15	50	72	100	11	0	1	1	0	13
C16	50	418	878	63	21	7	4	0	95
C17	2,272	2,272	2,272	341	0	36	23	2	402
C18	800	722	624	108	0	12	7	0	127
C19	0	0	0	0	0	0	0	0	0
C20	0	320	720	48	0	5	3	0	56
C21	0	795	1,788	119	0	13	8	10	150
C22	0	0	0	0	0	0	0	25	25
C23	2,084	1,892	1,652	284	35	30	19	0	368
C24	2,516	2,828	3,217	424	21	45	28	57	576
C25	858	477	0	72	339	8	5	0	423
Total	16,950	20,084	24,000	3,013	1,036	321	201	182	4,753

## SAI DONG

Block No.	Popuoation			Domestic		Public Use	Cleaning	Irrigation	Total
	1992	2000	2010	Residential	Industry				
				150 l/day	30m <sup>3</sup> /ha* 50%	16 l/cap/day	10 l/cap/day	20 m <sup>3</sup> /ha, 40%	m <sup>3</sup> /day
D1	120	644	1,300	97	0	10	6	0	113
D2	100	500	1,000	75	0	8	5	0	88
D3	70	650	1,375	98	0	10	7	0	114
D4	0	422	950	63	0	7	4	0	74
D5	200	273	364	41	0	4	3	0	48
D6	1,280	1,778	2,400	267	0	28	18	0	313
D7	180	722	1,400	108	0	12	7	0	127
D8	100	56	0	8	345	1	1	0	355
D9	616	342	0	51	65	5	3	16	141
D10	760	422	0	63	107	7	4	0	181
D11	1,960	2,042	2,144	306	0	33	20	0	359
D12	1,515	1,714	1,962	257	0	27	17	0	302
D13	0	0	0	0	51	0	0	16	67
D14	2,177	2,134	2,080	320	15	34	21	11	402
D15	900	789	650	118	184	13	8	0	323
D16	842	857	875	129	0	14	9	10	161
D17	300	167	0	25	224	3	2	22	275
D18	0	0	0	0	190	0	0	16	206
D19	0	0	0	0	216	0	0	15	231
D20	0	0	0	0	360	0	0	0	360
D21	0	902	2,030	135	0	14	9	0	159
D22	500	1,878	3,600	282	0	30	19	2	333
D23	380	1,931	3,870	290	0	31	19	0	340
Park & Green	0	0	0	0	0	0	0	45	45
Total	12,000	18,223	26,000	2,733	1,757	292	182	153	5,117

SUMMARY

Block No.	Population		Domestic		Public Use 6 l/cap/day	Cleaning 10 l/cap/day	Irrigation 20 m <sup>3</sup> /ha, 40%	Total m <sup>3</sup> /day
	1992	2000	Residential 150 l/day	Industry 0m <sup>3</sup> /ha * 50%				
Ngoc Thuy	650	2116	317.4	195	33.856	21.16	0	567.416
Gia Lam	25790	26150	3922.5	316	418.4	261.5	112	5030.4
Duc Giang	16950	20084	3012.6	1036	321.344	200.84	182	4752.784
Sai Dong	12000	18223	2733.45	1757	291.568	182.23	153	5117.248
Total	55390	66573	9985.95	3304	1065.168	665.73	447	15467.85
A1	Gia Thuong	5.5	52.8					
B1	Gia Quat	12.5	120					
B2	Gia Thuy	17	163.2					
B3	Ngoc Lam	26	249.6					
B4	Lam Du	30	288					
C1	Viet Hung	64	614.4					
C2	Thuong Cat	25	240					
C3	Duc Diang	12	115.2					
C4	Thanh Am	14	134.4					
C5	Mai Phut	25	240					
D2	Xon Dang	8	76.8					
D3	Thon Ngo	35	336					
D4	Xon Long Bien	46	441.6					
D5	Ong Cae	23	220.8					
Total		343	3292.8					
G. Total		121453	13278.8	3304	1065.168	665.73	447	18760.65



Table 3.2b Water Demand in 2010 (m<sup>3</sup>/day)

NGOC THUY

Block No.	Population			Domestic		Public Use 20 l/cap/day	Cleaning 10 l/cap/day	Irrigation 20 m <sup>3</sup> /ha, 80%	Total m <sup>3</sup> /day
	1992	2000	2010	Residential 180 l/day	Industry 35m <sup>3</sup> /ha* 85%				
A1	125	156	195	35	387	4	2	0	428
A2	155	1028	2120	382	0	42	21	0	445
A3	370	932	1635	294	0	33	16	0	343
Total	650	2116	3950	711	387	79	40	0	1,217
<b>Gia Lam</b>									
B1	1,360	1,360	1,360	245	0	27	14	0	286
B2	1,500	1,627	1,788	321	0	36	18	18	393
B3	3,000	2,731	2,394	431	0	48	24	32	535
B4	600	604	608	109	595	12	6	0	723
B5	1,500	1,935	2,478	446	0	50	25	0	520
B6	1,630	1,746	1,891	340	0	38	19	0	397
B7	2,280	2,229	2,166	390	21	43	22	0	476
B8	2,200	1,868	1,448	261	0	29	14	0	304
B9	1,500	1,440	1,366	246	0	27	14	0	287
B10	2,100	1,668	1,127	203	0	23	11	0	237
B11	1,200	1,118	1,016	183	0	20	10	0	213
B12	1,100	780	380	68	0	8	4	56	136
B13	0	171	384	69	0	8	4	19	100
B14	40	71	110	20	9	2	1	58	90
B15	500	616	760	137	0	15	8	0	160
B16	350	502	691	124	0	14	7	0	145
B17	380	422	475	86	0	10	5	0	100
B18	150	363	630	113	0	13	6	0	132
B19	0	299	672	121	0	13	7	0	141
B20	1,800	1,625	1,407	253	0	28	14	0	295
B21	2,000	1,768	1,478	266	0	30	15	0	310
B22	0	227	510	92	0	10	5	18	125
B23	400	853	1,418	255	0	28	14	13	311
B24	200	127	435	78	0	9	4	5	96
Park&green						0	0	5	5
Total	25,790	26,150	26,990	4,858	625	540	270	219	6,512

DUG GIAN

Block No	1992	2000	2010	Domestic		Public Use	Cleaning	Irrigation	Total
				Residential 180 l/day	Industry 35m <sup>3</sup> /ha* 85%	20 l/cap/day	10 l/cap/day	20 m <sup>3</sup> /ha.80%	m <sup>3</sup> /day
C1	0	0	0	0	226	0	0	0	226
C2	220	744	1,400	252	293	28	14	21	608
C3	1,875	2,321	2,879	518	0	58	29	72	677
C4	0	0	0	0	134	0	0	0	134
C5	0	0	0	0	0	0	0	0	0
C6	2,225	2,417	2,656	478	98	53	27	8	664
C7	320	178	0	0	476	0	0	0	476
C8	0	0	0	0	0	0	0	0	0
C9	480	1,013	1,680	302	0	34	17	0	353
C10	600	511	400	72	0	8	4	6	90
C11	600	760	960	173	0	19	10	16	218
C12	200	297	418	75	0	8	4	6	94
C13	900	1,040	1,216	219	0	24	12	20	275
C14	900	1,007	1,140	205	0	23	11	29	268
C15	50	72	100	18	0	2	1	0	21
C16	50	418	878	158	42	18	9	0	226
C17	2,272	2,272	2,272	409	0	45	23	5	482
C18	800	722	624	112	0	12	6	0	131
C19	0	0	0	0	0	0	0	0	0
C20	0	320	720	130	0	14	7	0	151
C21	0	795	1,788	322	0	36	18	20	395
C22	0	0	0	0	0	0	0	51	51
C23	2,084	1,892	1,652	297	69	33	17	0	416
C24	2,516	2,828	3,217	579	42	64	32	114	832
C25	858	477	0	0	673	0	0	0	673
Total	16,950	20,084	24,000	4,320	2,053	480	240	368	7,461

SAI DONG

Block No.	Population			Domestic		Public Use	Cleaning	Irrigation	Total
	1992	2000	2010	Residential 180 l/day	Industry 35m <sup>3</sup> /ha* 85%	20 l/cap/day	10 l/cap/day	20 m <sup>3</sup> /ha, 80%	m <sup>3</sup> /day
D1	120	644	1,300	234	0	26	13	0	234
D2	100	500	1,000	180	0	20	10	0	210
D3	70	650	1,375	248	0	28	14	0	289
D4	0	422	950	171	0	19	10	0	200
D5	200	273	364	66	0	7	4	0	76
D6	1,280	1,778	2,400	432	0	48	24	0	504
D7	180	722	1,400	252	0	28	14	0	294
D8	100	56	0	0	684	0	0	0	684
D9	616	342	0	0	128	0	0	32	160
D10	760	422	0	0	211	0	0	0	211
D11	1,960	2,042	2,144	386	0	43	21	0	450
D12	1,515	1,714	1,962	353	0	39	20	0	412
D13	0	0	0	0	101	0	0	32	133
D14	2,177	2,134	2,080	374	30	42	21	22	489
D15	900	789	650	117	365	13	7	0	502
D16	842	857	875	158	0	18	9	19	203
D17	300	167	0	0	443	0	0	45	488
D18	0	0	0	0	376	0	0	32	408
D19	0	0	0	0	428	0	0	30	458
D20	0	0	0	0	714	0	0	0	714
D21	0	902	2,030	365	0	41	20	0	426
D22	500	1,878	3,600	648	0	72	36	5	761
D23	380	1,931	3,870	697	0	77	39	0	813
Park & Green	0	0	0	0	0	0	0	89	89
Total	12,000	18,223	26,000	4,680	3,480	520	260	306	9,246

## SUMMARY

Block No.	Population			Domestic		Public Use	Cleaning	Irrigation	Total
	1992	2000	2010	Residential 180 l/day	Industry 35m <sup>3</sup> /ha* 85%	20 l/cap/day	10 l/cap/day	20 m <sup>3</sup> /ha, 80%	m <sup>3</sup> /day
Ngoc Thuy	650	2116	3950	711	387	79	40	0	1,217
Gia Lam	25,790	26,150	26,990	4,858	625	540	270	219	6,512
Duc Giang	16,950	20,084	24,000	4,320	2,053	480	240	368	7,461
Sai Dong	12,000	18,223	26,000	4,680	3,480	520	260	306	9,246
Total	55,390	65,641	80,940	14,569	6,545	1,619	809	893	24,435
Additional recommendation									
			33,000	5,940		118.8	59.4		
Suburban									
343*1.014*10	394.16	63,066	3,784						
Grand Total			177,006	24,293	6,545	1,738	869	893	34,338

Table 3.2c Water Demand up to 2010

Item	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Residential	6,647	7,314	7,961	8,649	9,317	9,986	11,038	12,090	13,142	14,194	15,246	16,298	17,350	18,403	19,456	20,509
Sub Urban	2,668	2,953	3,038	3,123	3,208	3,293	3,342	3,391	3,440	3,489	3,538	3,587	3,636	3,685	3,734	3,784
Industry	1,980	2,244	2,508	2,772	3,036	3,304	3,628	3,952	4,276	4,600	4,924	5,248	5,572	5,896	6,221	6,545
Public	884	920	956	992	1,028	1,065	1,132	1,199	1,266	1,333	1,400	1,467	1,534	1,602	1,670	1,738
Cleaning	555	577	599	621	643	666	686	706	726	746	766	786	806	827	848	869
Irrigation	228	272	316	360	405	447	491	535	579	623	668	713	758	803	848	893
Total	13,162	14,280	15,398	16,517	17,637	18,761	20,317	21,873	23,429	24,985	26,542	28,099	29,656	31,216	32,777	34,338

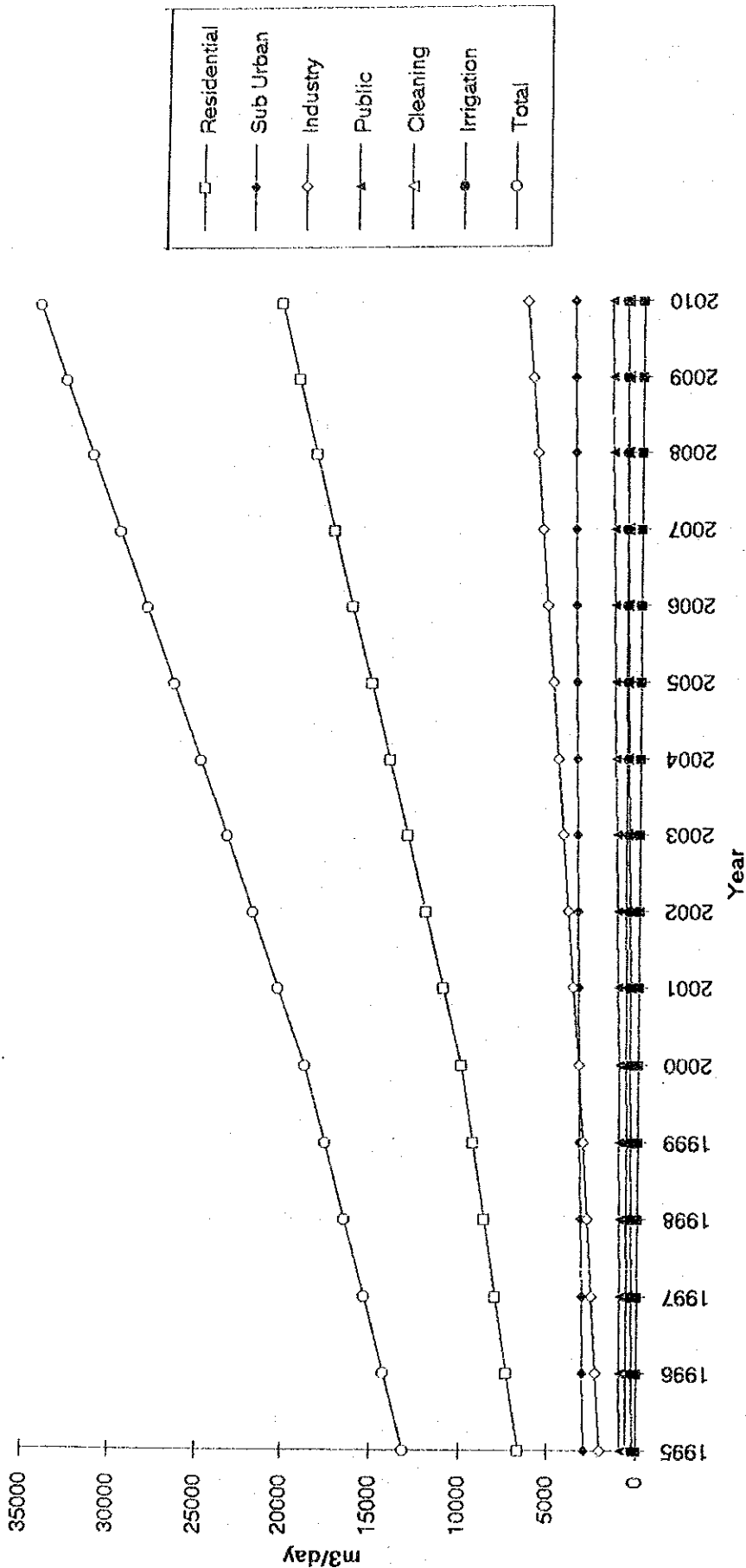


Fig. 3.1 Water Demand

### 3.3.2.3 Facility Plan

#### (1) Water Source

There are two potential water sources in the project area; the surface water and the ground water. The Red River and the Duong River are running by the project site, however, the water of both rivers contain extraordinary silt as shown in Tables 5 and 6 of Appendix 6. The water level varies in wide range which requires a rather heavy structure of intake facility. For this reason, Ha Noi City authority determined to take the ground water for the water source of the project and the surface water will be considered when analysis of the river water behavior is completed and a large amount of water demand is required.

The Ha Noi City authority has determined to develop well fields in the areas along the rivers due to the following reasons:

- 1) Location of wells is near to the recharge source.
- 2) More efficient land use other than well fields.
- 3) Free from contamination of human activities in production areas.

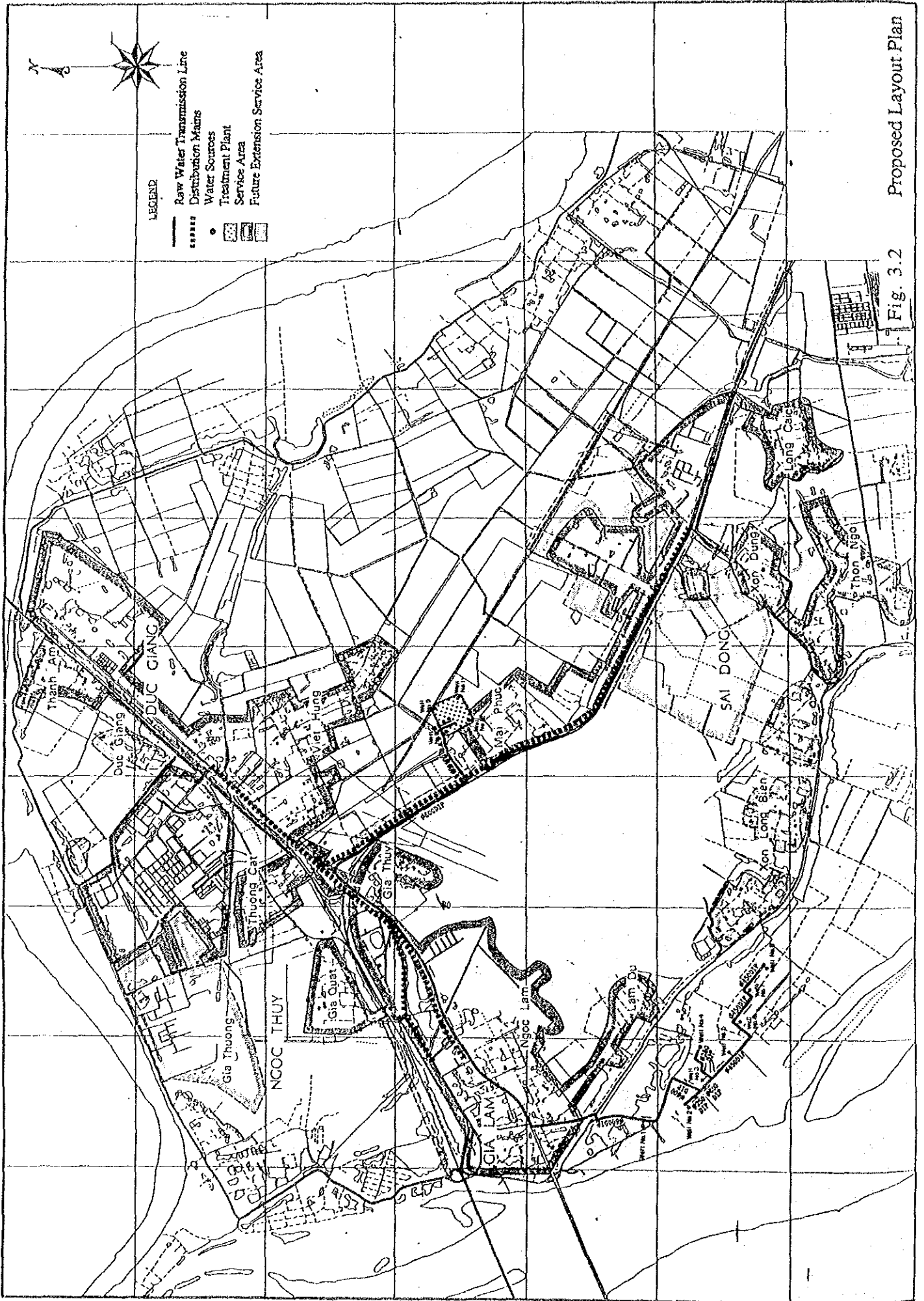
The city authority has located the well field for the project in the area along the Red River. Based on the hydrogeological analysis of the aquifers, it is assumed that the safe yield of unit well is 50 l/sec and the distance among the wells to prevent harmful influence of draw down is 125 m.

In order to obtain the water source for the design capacity of 32,100 m<sup>3</sup>/day (daily maximum demand), a total of 12 wells are required including the three stand-by wells.

However, the well field located by the city is too narrow to accommodate all 12 wells so that it is proposed to locate 8 wells in the well field along the Red River and the remaining 4 wells are to be constructed in the treatment plant.(Fig. 3.2)

#### (2) Raw Water Transmission Line

For transmission of raw water from the well field to the treatment plant, a raw water transmission line is to be constructed. The raw water transmission line is proposed to be laid along the national highway No. 1 from the bridge to the junction with the highway No. 5 and then after along the highway No. 5 up to the treatment plant on the eastern side of the highway No. 5.



LEGEND

- Raw Water Transmission Line
- - - - - Distribution Mains
- Water Sources
- ▨ Treatment Plant Service Area
- ▤ Future Extension Service Area

Proposed Layout Plan

Fig. 3.2



### (3) Treatment Plan

The water source of the project is the ground water to be obtained from the aquifers developed in the alluvial deposits of the Red River. However, the ground water contains high concentration of iron which requires treatment to produce potable water to meet the drinking water quality standards of Viet Nam.(Table 5.4)

For this purpose, the design quality of the raw water is determined as shown in Table 5.3 based on interpretation of the existing water quality data and discussions with related officers of the city authority.

Based on the results of test plant experiment undertaken by the city authority and supplementary field experiment of the study team, it is concluded that removal of iron and manganese is required and also ammonia shall be removed to prevent wastage of chlorine. For this purpose it is proposed that two step filtration is applied to minimize use of chemicals.

Since high content of iron in the raw water results in a large volume of sludge, it is also proposed to provide the sludge treatment facility consisting of thickeners and drying beds.

### (4) Distribution Plan

The service area of the project is 845 ha of urban centers and 343 ha of suburban areas totaling 1,188 ha.

The urban centers consist of existing urban areas and future extension areas. The suburban centers are located adjacent to each urban center. Some of them have access road on the river dike along which it is not allowed to lay pipes. Therefore, it is proposed that distribution pipes will be installed along the existing roads with sufficient design capacity of the water demand in the future extension area of urban centers and the suburban areas of which access roads be constructed.

### (5) Proposed Layout Plan of Water Supply Facilities

The service area of the project distributes along the national highways, No.1 and No.5. The water source is located in the area along the Red River and in the treatment plant. Therefore, the raw water transmission will be laid along the highway No.1 to the junction of the two highways and then along the highway No.5 up to the treatment plant on the eastern side of the highway No.5.