6.3.2 Intake Site

There may exist three or four alternative sites for the Da River water intake. Their sites are i) Bat Bat, ii) Da Chong, and iii) Ky Son or another place; all of them are located on the right bank of the Da River and between Hoa Binh and Trung Ha.

Among them, the most appropriate site for the water intake site was decided to be Da Chong site as a result of a comparative study. The Da Chong intake site plan presents most economical costs for construction and operation than others.

6.3.3 Features of the Da River

(1) The Red River System

The Da River is one of the tributaries of the Red River. The Red River is the biggest river system in North Vietnam. The Red River consists of 3 big tributary rivers: namely, the Thao River, the Da River and the Lo River. All these 3 big rivers originate in the high mountainous regions of Van Nam province in China and flow into Vietnam territory toward Viet Tri where they join together and create a big river named the Red River, which flows to the sea via Ba Lat rivermouth.

(2) The Da River

The Da River, originating at a high mountainous region near Nguy Son mountain chain, is named Ba Bien, Ly Tien in China. The Da River flows parallel to the Thao River in the North-West to South-East direction. From Hoa Binh town, the river changes its direction towards the north and joins the Red River at Trung Ha. The Da River is 1,010 km long, and the basin area is 52,900 km^2; in Vietnam territory its length is 570 km and its catchment area is 26,800 km^2.

The Da River flows through a narrow valley between high mountains, having many falls and rapids. The slope of water surface is very big; the average slope of Ta Bu to Van Yen reach is 0.65 m/km, Van Yen to Hoa Binh reach is 0.25 m/km, and Hoa Binh to Trung Ha reach is 0.1 m/km.

Big tributaries, such as Nam Na, Nam Po on the right riverbank, are located at the upstream of the Da River. The density of the Da River network in Vietnam territory is 0.17 km/km^2. Only from Hoa Binh town downward, the Da River has large overbank flow fields. The people have built dykes to protect the fields along the river from Hoa Binh downwards.

At Hoa Binh town, on the Da River, the Hoa Binh Reservoir was built for water supply, flood control and power generation. At the end of 1986, the river was blocked for the second stage of construction. Since 1991 the reservoir has started operations for flood control, flow regulation and power generation.

(3) Flow Discharge of the River

The annual run-off varies very little. Water volume in wet years is only two or three times larger than in dry years. Wet years and dry years occur alternately and two to three consecutive dry years are very seldom. The Red River and its tributaries have similar monthly flow pattern. All the rivers have the highest flow in August and the lowest in March (See Table 6.3.1 and Table 6.3.2).

Table 6.3.1 Flow Volume (1902 - 1989)

River	Catchment	Water	Discharge (m^3/s)		
Station	Area (km^2)	Volume (km^3)	Mean	Maximum (Year)	Minimum (Year)
Da River Hoa Binh	51,800	55.4	1,760	2,180 (1971)	1,260 (1980)
Thao River Yen Bai	48,000	24.2	766	1,300 (1971)	583 (1981)
Lo River Phu Ninh	37,000	32.6	1,036	1,460 (1971)	749 (1977)
Red River Son Tay	143,600	118.0	3,740	5,090 (1971)	2,950 (1963)

Source: NCST

Table 6.3.2 Monthly Flow Distribution (%)

Month Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Da River Hoa Binh	2.7	1.9	1.7	1.8	3.6	10.9	20.4	23.2	14.5	9.0	5.8	3.8
Thao River Yen Bai	3.6	2.8	2.8	2.9	4.5	9.6	14.5	30.3	15.7	11.5	7.4	4.8
Lo River Phu Ninh	2.7	2.6	2.6	3.1	6.0	11.9	17.8	19.6	14.0	8.9	6.1	3.9
Red River Son Tay	3.0	2.3	2.1	2.4	4.5	10.6	18.2	21.5	15.6	10.0	6.3	3.9

Source: NCST

6.3.4 Capacity

A capacity of the water supply facilities will be, at the first stage, some 200,000 m^3/d or the like which can supply to a new town having population of 500,000. The timing of requiring the amount is estimated as the year 2020 in the Hoa Lac and Xuan Mai Urban Area. Therefore, comparative studies will be made in the M/P to determine the scale of the first phase development, taking into consideration the possibility of supplying the surplus water to the HMA.

6.3.5 Water Treatment and Transmission

Raw water taken from the Da River will be lifted by intake pumps to a treatment plant. The river water shall be treated for drinking purpose. The treatment plant will be located adjacent to the intake site. The treatment process will follow a conventional method for surface water treatment of rapid sand filtration. It will consist of coagulation, sedimentation, filtration and chlorination.

The treated water will be transmitted towards the Hoa Lac Urban Area through a pressurized transmission pipeline with sufficient energy given by transmission pumps to be installed in the treatment plant. The transmission pipeline (total distance: 30 to 35 km) will be constructed under the existing major public roads (earth covering depth of the pipe = 1.2 m on average) linking the intake site and the Study Area.

6.3.6 Comparative Study on the Da River Intake Site

(1) Alternative Intake Sites

For decision of the intake site of the Da River, which is a possible water source for the Hoa Lac project area, several alternative sites were proposed. They were selected with consideration of the following conditions.

1) The site shall be located between Trung Ha and Hoa Binh

Trung Ha is the most northern point, before the Da River joins with another river of Thao River. Hoa Binh is the most southern point, after the water used for hydropower generation in Hoa Binh Power Plant is released into the Da River. In places between Trung Ha and Hoa Binh, water quality of the Da River shows no significant difference.

2) The site shall be accessible by vehicles by way of a major public road

In the vicinity of the intake site, a water treatment plant is to be constructed. There, about 30 to 50 operators/staff will be engaged in the plant operation including intake/transmission pumps operation. Further, the treated water is to be transmitted to the Hoa Lac Urban Area. The transmission pipeline will be constructed on the public road, which is able to accommodate the pipeline with a diameter of 1,500 mm or so. Therefore, the site is required to be easily accessible by construction vehicles and to be adjacent to a major public road. The possible public roads approaching to the Da River are i) Road No. 423, ii) Road No.422 and iii) NR6.

3) Suitable land shall be available

For construction of a new treatment plant, some land with an area of 7 to 10 ha will be required. The plant is to be located inside the dyke of the Da River bank, being adjacent to the intake site. Present status of land use along the Da River is mainly paddy fields; therefore, land acquisition of the existing paddy fields will be needed for the new treatment plant construction. Considering the above conditions, the following three alternative intake sites were selected for comparison.

Alternative-A : Bat Bat (Access road: Road No. 423)

Alternative-B : Da Chong (Access road: Road No. 422)

Alternative-C : Ky Son (Access road: NR6)

There lie mountains between the Da River and Hoa Lac, the Study Area (Figures 6.3.1 and 6.3.2). The elevation of the mountains ranges several hundred meters above MSL (mean sea water level). The route of the transmission pipeline shall avoid passing high mountain areas as this would require huge amounts of construction cost and operation cost. If the pipeline would pass over such high mountains, it would result in waste of high electric power cost for operation of transmission pumps. Fortunately, the existing major public roads pass topographically-lower-elevation places in the territory. The above alternative sites were selected in order that the transmission pipelines be able to take routes of the existing major roads.

(2) Transmission Pipelines

Routes of the treated-water transmission pipelines from the treatment plant toward the Hoa Lac Study Area are given in the drawing of Figure 6.3.3 together with locations of the three alternative intake sites.

The distance of the each pipeline is:

Alternative-A : 47,060 meters,

Alternative-B : 36,280 meters, and

Alternative-C : 48,020 meters.

The terminal of the pipelines is set at a supply reservoir from which water can be distributed to consumers by gravity force, without help of additional energy, such as booster pumps, and without construction of particular facilities, such as elevated-tower tanks. The reservoir will be constructed on a hill or a low mountain having an elevation of +80 meters to +100 meters above Mean Sea Water Level (MSL). The high water level (HWL) of the reservoir is tentatively set at +85.00 meters above MSL. Since the treatment plant will be located at the lower land, nearby Da River, elevation of which will be about +20 meters above MSL, installation of transmission pumps shall be required to allow the treated water from the treatment plant to flow to the supply reservoir in Hoa Lac.

The electric power required is tentatively estimated as follows:

Alternative-A : 4,370 kW,

Alternative-B : 3,920 kW, and

Alternative-C : 5,100 kW.

(3) Comparison

For the purpose of comparison of these three alternatives, a comparison table was prepared in Table 6.3.3). In this case, the deciding factor for the recommendable alternative plan is the cost of construction and operation, as far as the other conditions have no remarkable differences. According to the preliminary cost estimate, the Alternative-B (Da Chong intake) shows comparatively-lower costs than others, because of a shorter distance of the transmission pipeline and lower electric power of the transmission pumps. The costs will be:

Construction Cost:	Alternative-B=100 %,	-A=125 % and	-C=130 %, and
Operation Cost:	Alternative-B=100 %,	-A=110 % and	-C=125 %.

(4) Conclusion

It is proposed that the Alternative-B (Da Chong intake) be implemented for the Da River water use for the Hoa Lac Urban Area.

(5) Recommendation

As for public water supply in Hanoi City, locally-available groundwater has been currently used as water source. In the future, however, perhaps the year 2010, Hanoi City could take the Da River water as additional water source. Its capacity will be in a range of 100,000 to 400,000 m^3/d, which will be almost the same quantity as that of this development. Accordingly, it is recommended that water intake, treatment and transmission for this development be integrated or combined with the scheme of Hanoi City waterworks, to save on costs and personnel required. For example, 200,000 m^3/d capacity for this development and another 200,000 m^3/d for Hanoi City waterworks makes 400,000 m^3/d in total (See Figure 6.3.4).

Construction of one system with 400,000 m^3/d will be more economical than construction of the two separate systems with 200,000 m^3/d each. In that case, a tentative cost estimate reveals about 25 % cost-saving on transmission pipeline construction.

Integration with Hanoi City waterworks on the Da River intake plan is therefore strongly recommended.

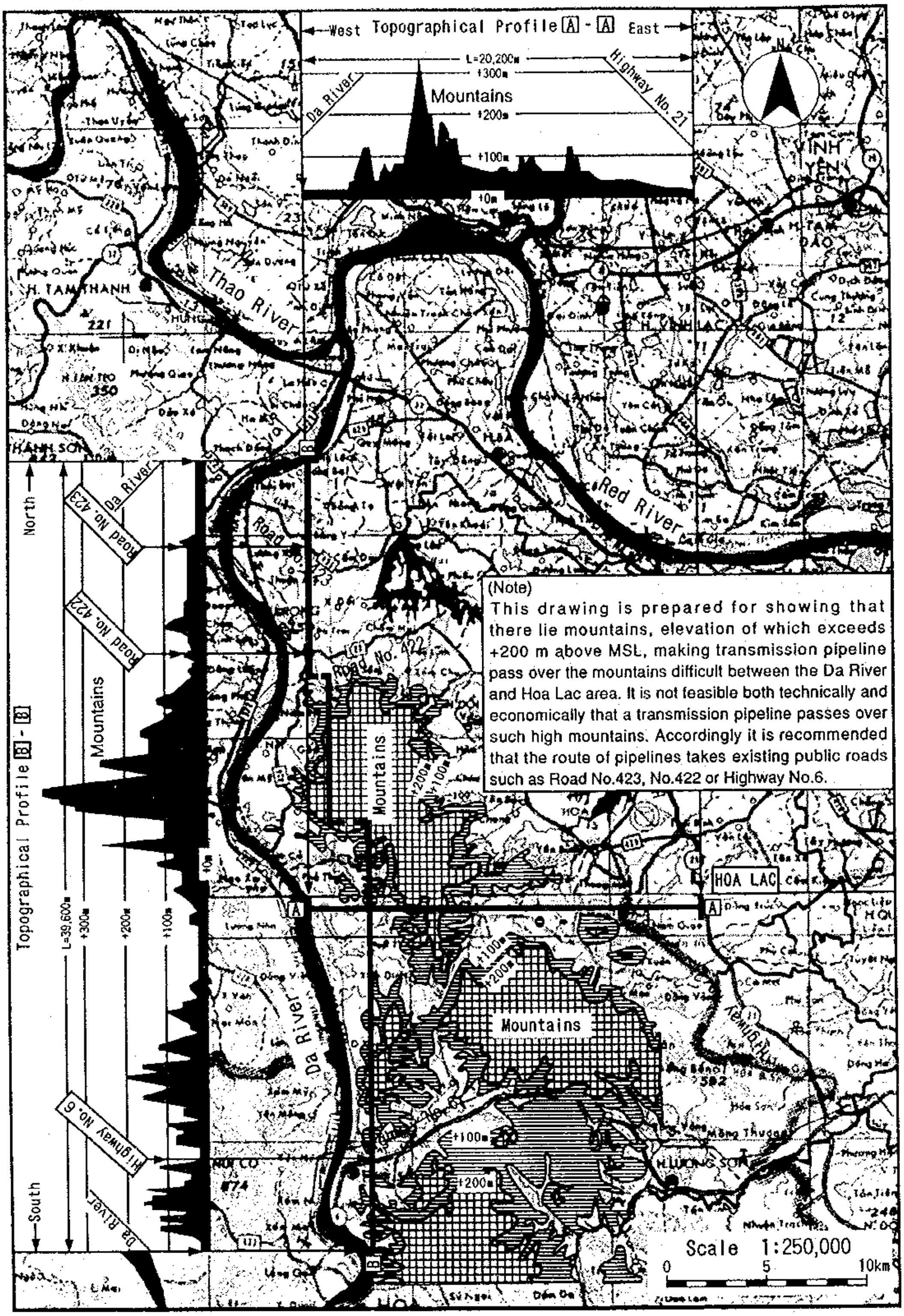


Figure 6.3.1 Topography: Da River to Hoa Lac Area for Da River Intake Study

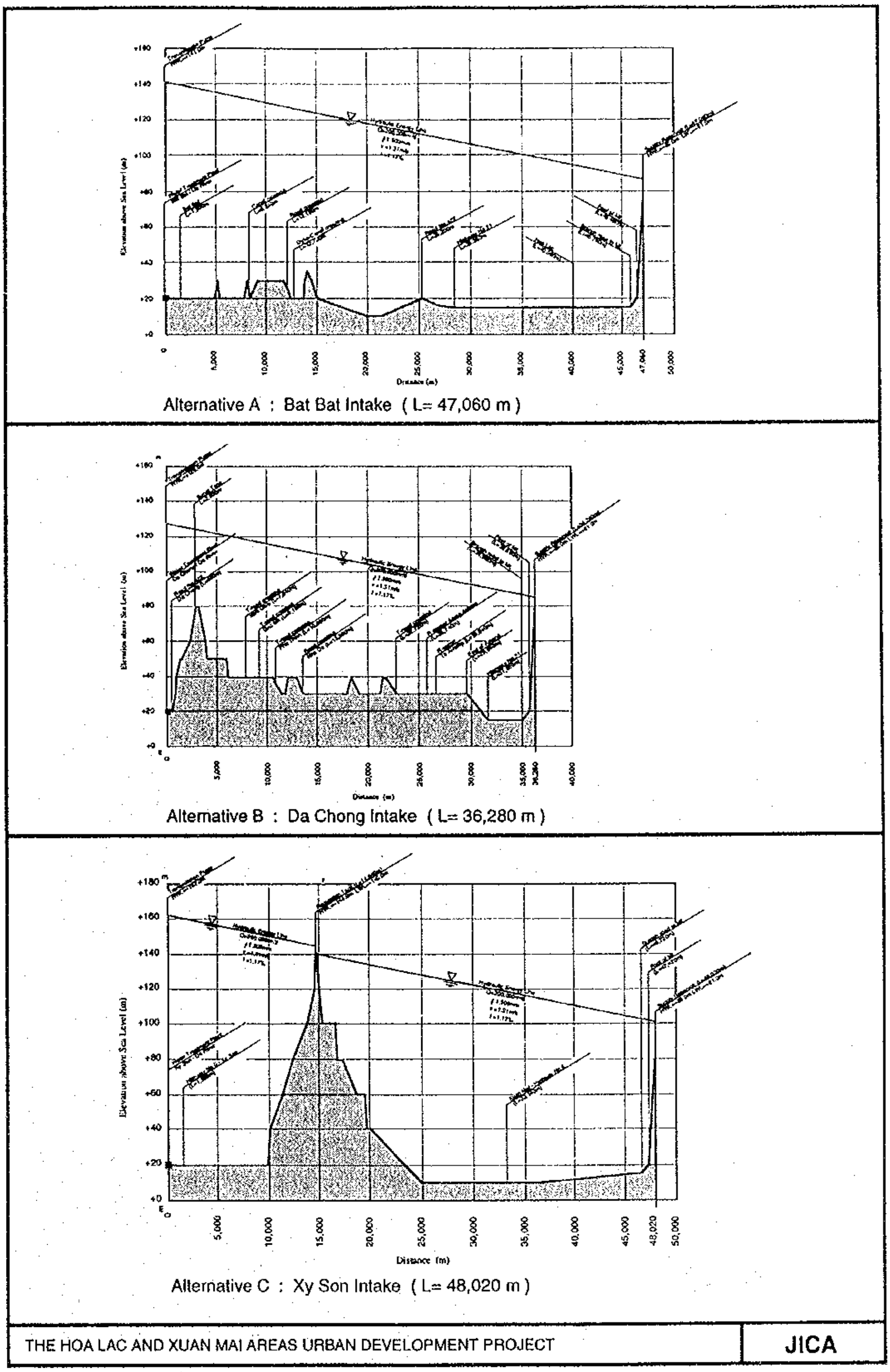


Figure 6.3.2 Hydraulic Profile of Transmission Pipelines

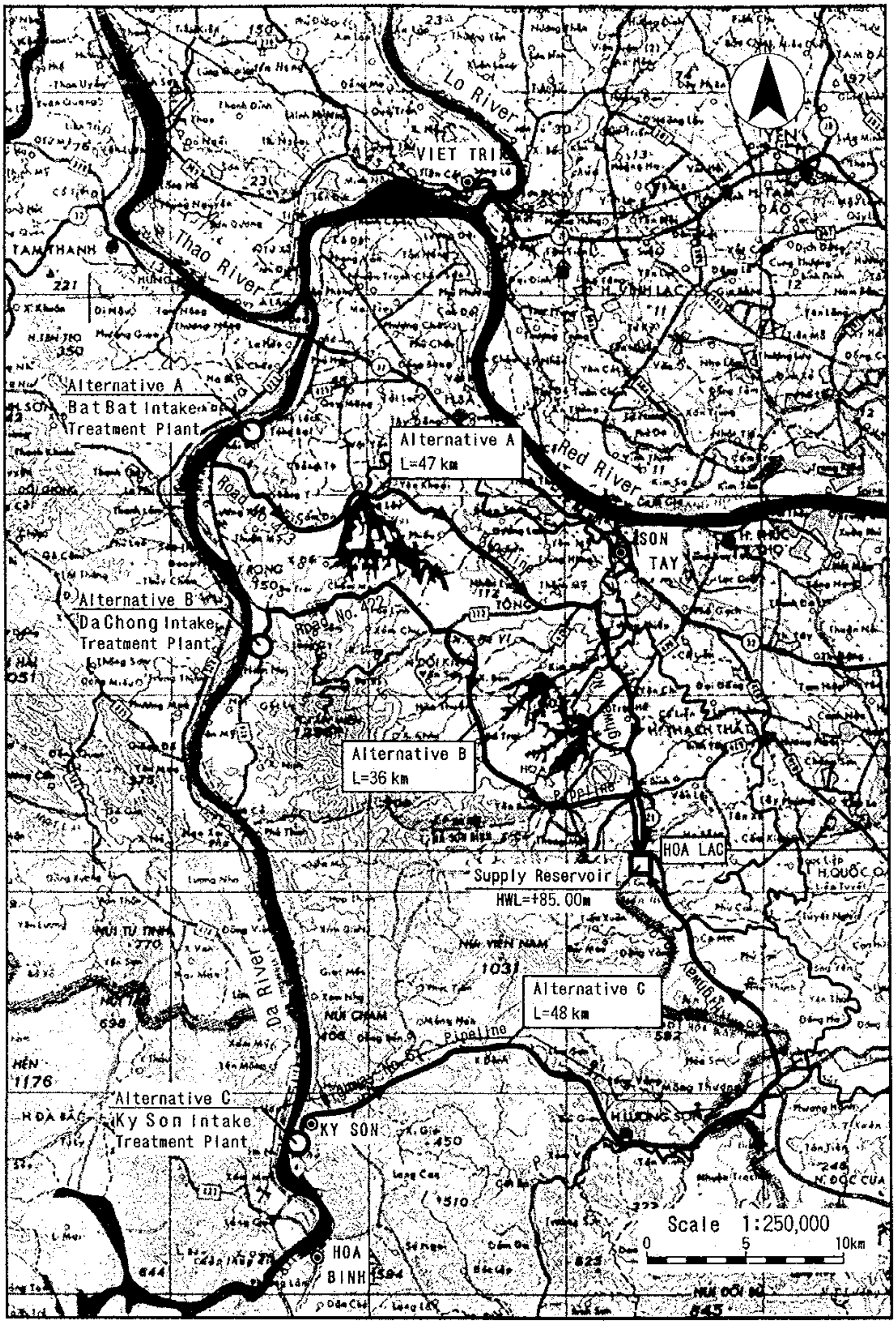


Figure 6.3.3 Alternative Plans of Da River Water Intake

Table 6.3.3 Comparison of the Alternative Plan

Item \ Alternative	Alternative A Bat Bat Intake	Alternative B Da Chong Intake	Alternative C Ky Son Intake
Water Source	Surface water of Da River		
Water Flow	Abundant enough more than 1,260 m^3/sec		
Water Quality	Good for water source		
Treatment Method	Rapid sand filtration system		
Site for Intake and Treatment Plant	Bat Bat	Da Chong	Ky Son
Proposed Route of Transmission of	Road No. 423 and National Road 21	Road No. 422	National Road 6 and national Road
Distance of Transmission Pipeline	L=47,060 m (139 %)	L=36,280 m (100 %)	L=48,020 m (132 %)
Topographical Particulars on the Pipeline Route	Almost flat (+30 m to 15 m)	Must pass a crest point of +80 m, which requires construction of a surge tank	Must pass high elevation lace of + 140 m, which requires excess power energy
Power Required for Water Transmission to	4,370 kW (111%)	3,920 kW (100 %)	5,100 kW (130 %)
Construction Cost	125 (%)	100 (%)	130 (%)
Operation Power Cost	110 (%)	100 (%)	125 (%)
Recommendation	Second (No.2)	First (No.1) Recommendation	Third (No.3)

Source: JICA Study Team

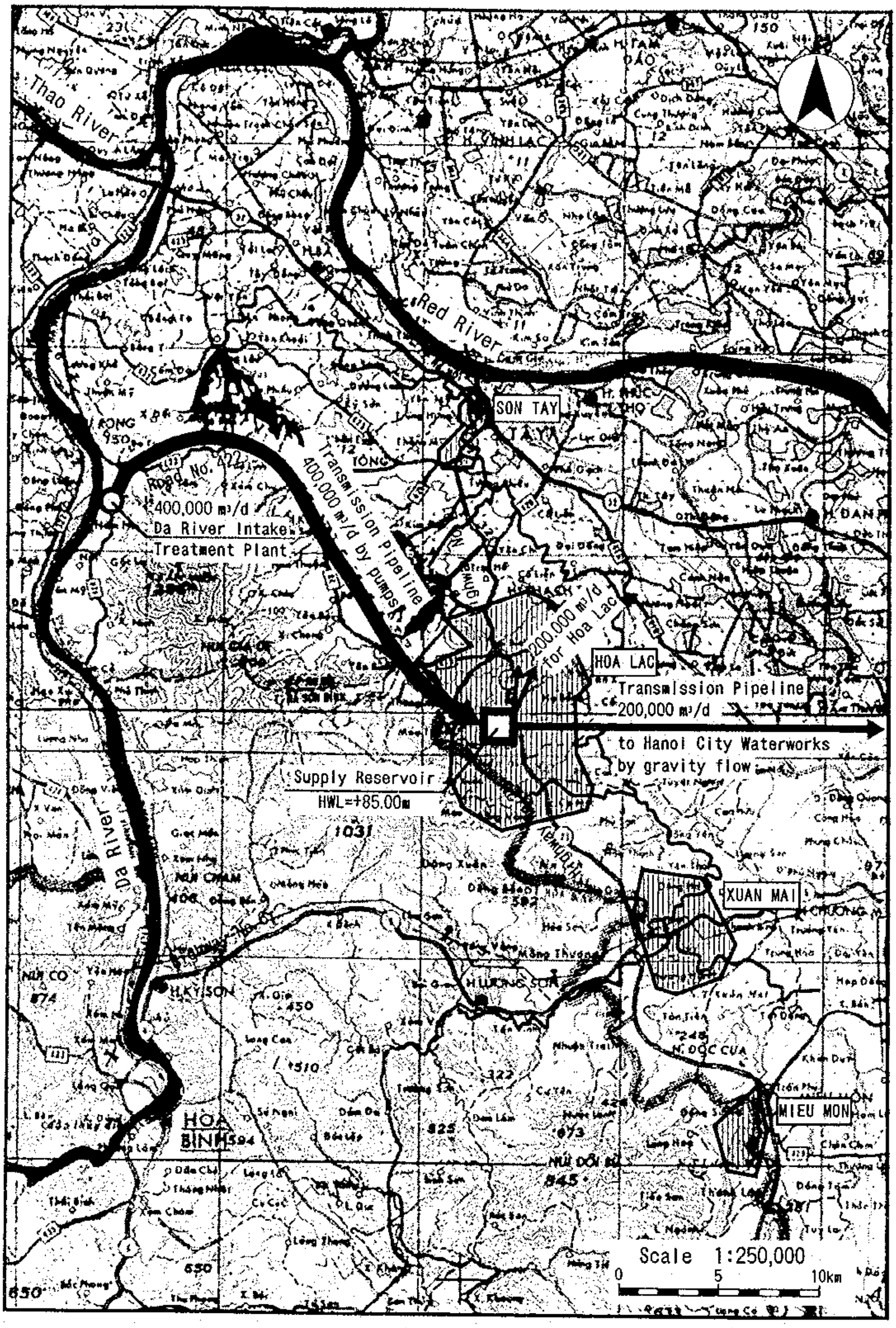


Figure 6.3.4 Recommended Combined System with Hanoi City Waterworks

6.3.7 Supply Reservoir

The treated water transmitted from the treatment plant through the transmission pipeline to the Study Area will be once stored in a supply reservoir for storage purpose. The reservoir will be constructed on a hill site located around or nearby the center of the Study Area. It will be planned that water be supplied to consumers from the reservoir by gravity flow. For this purpose, water level of the reservoir is to be about 50 to 60 meters higher than service areas. As the Study Area ranges ground elevation about +15 to +20 meters above the MSL, required water level of the reservoir will be +80 to +85 meters. By keeping the above water level of the reservoir, water will be able to be supplied by gravity force to about 10 to 15 km away, covering areas from northern end of the HHTP Area to southern end of the Phu Cat Area.

6.3.8 Distribution Pipelines

Water stored in the distribution reservoir will be supplied to consumers by way of distribution pipelines consisting of distribution mains, secondary mains and tertiary pipes, and finally through service pipes. All of consumers will have individual service connections equipped with water-meters for the billing purpose, and public standpipes without water-meters will not be installed.

All pipelines, excepting house connections, will be constructed under public roads with average earth covering depth of 1.2 meters.

6.3.9 Planning Criteria

For planning the water supply system for the new town, the following criteria will be employed. The criteria will mainly follow the design criteria for the Hanoi City waterworks, since the Hoa Lac new town is considered a satellite town of Hanoi City, having large population.

(1) Raw Water Intake Capacity

Taking consideration of loss in the course of treatment, i.e. filter back-wash water, drain from sedimentation tanks and other miscellaneous use in the treatment plant, raw water intake capacity is set to be 10 % of the production.

(2) Volume of Supply Reservoir

Volume of supply reservoir is to be 20 % of the daily maximum capacity (4.8 hours equivalent).

(3) Peak Day Factor

The peak day factor, which will be applied to size dimensions of facilities of a treatment plant and raw water intake, is to be 1.35/times or 135%.

(4) Peak Hour Factor

The peak hour factor, which will be applied to determine diameters of distribution pipelines, is to be 1.40 times or 140 % of the peak day demand.

Note-1: Supply to industrial zone is to be planned on the 24 hours constant supply basis, and peak factors are:

- Peak day factor = 1.10 (110 %)
- Peak hour factor = 1.00 (100 %)

Note-2: In the case that factories located in the industrial zone need storage facilities, the storage reservoirs shall be constructed by each factory in the factory yard and by the expense of the factory in order to receive public water for 24 hours a day at a constant rate.

(5) Water Pressure

The supply pressure in distribution pipelines is to be 15 meters (1.5 kg/cm^2).

(6) Unaccounted-for Water

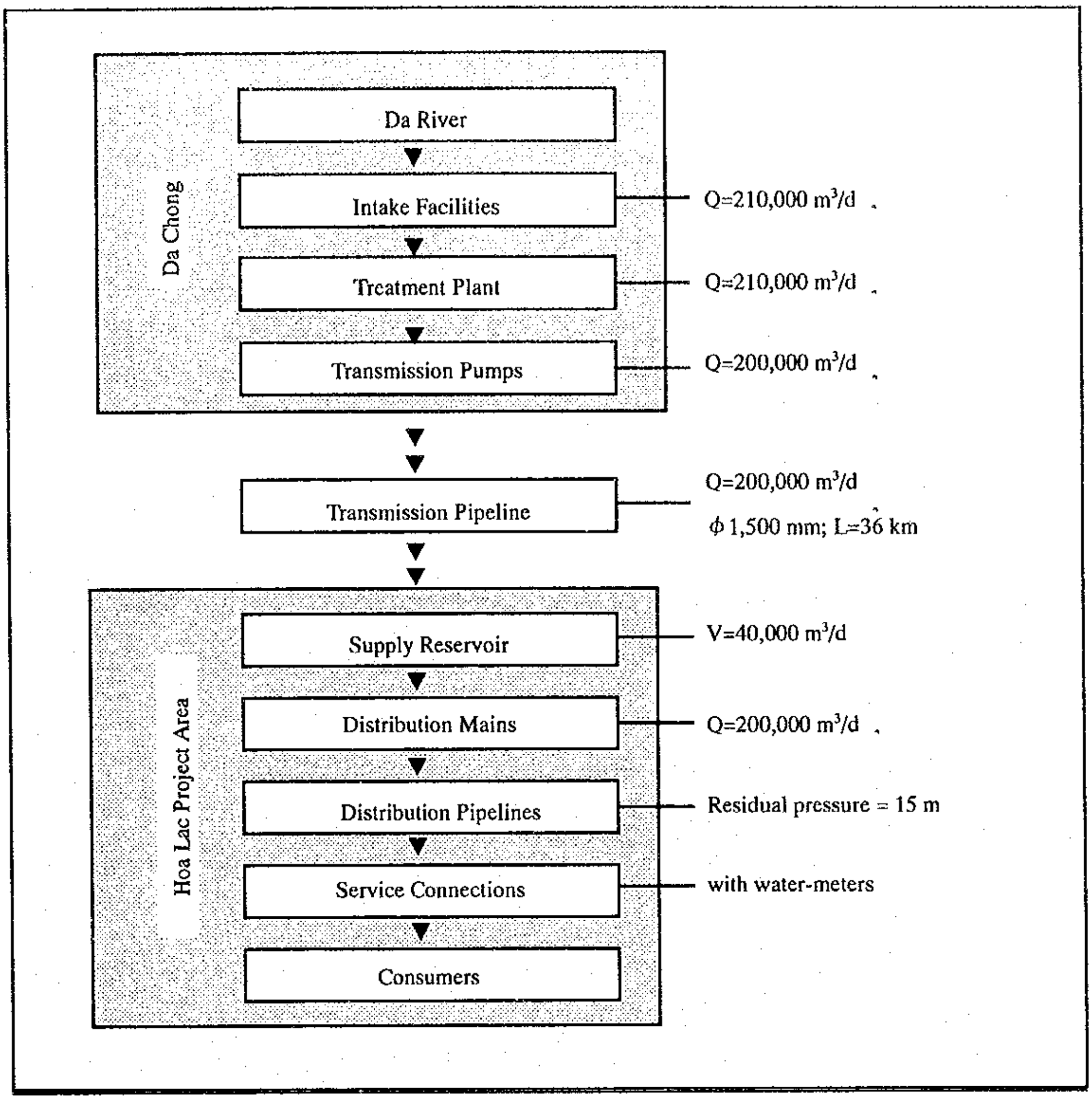
Unaccounted-for water, which includes physical leakage loss, administration loss and so on, is tentatively set at 15 % of daily distribution capacity.

(7) Service Area

Service area to be covered by this water supply system is to be Hoa Lac, Xuan Mai, Mieu Mon, and it excludes Son Tay town, since the town has its own existing public water supply system and its own future extension program taking groundwater which is locally available.

6.3.10 Water Supply System

The conceptual plan of the public water supply system for the Hoa Lac Urban Area can be formulated as given below and illustrated in Figures 6.3.5.



Source: JICA Study Team

Figure 6.3.5 Conceptual Plan of Water Supply System

6.4 Concept Plan of Sewerage System

The sewerage system for waste-water and the drainage system for rain-water will be constructed separately from each other in the Study Area.

6.4.1 General Conditions

All of domestic waste-water shall be treated in the sewerage treatment plant. Firstly the waste-water will be discharged from households to sewerage collection pipes to be constructed under public roads. Then the waste-water will collectively flow by gravity force into the sewerage treatment plant to be placed on a lower-ground-elevation site.

As for industrial waste-water and the like containing hazardous or toxic substances, the factories or the enterprises shall have their own facilities for treatment or pre-treatment basically, prior to discharge of the waste-water into public waterways. Direct waste-water discharge from factories without treatment will not be allowed.

6.4.2 Sewerage Treatment Plant

The location of the sewerage treatment plant will be decided taking the following into consideration:

(a) To be near the development area,

(b) To be near the river to which the treated water is to be disposed,

(c) To be easy for land acquisition, and

(d) To be hardly flooded.

As for the size of the plant, a big-scaled plant will have more advantages than the small-scaled one, in viewpoints of economy (both construction cost and maintenance cost per unit (m^3/day) are cheaper in the case of the big-scaled plant) and operation and maintenance (variation and fluctuation on water quality and flow volume is little in the case of the big-scaled plant, which will lead to easy operation). However, the big-scaled one will give such issues as development period of the new town, aerial odor of the development, landfill-development planning criteria, and so on.

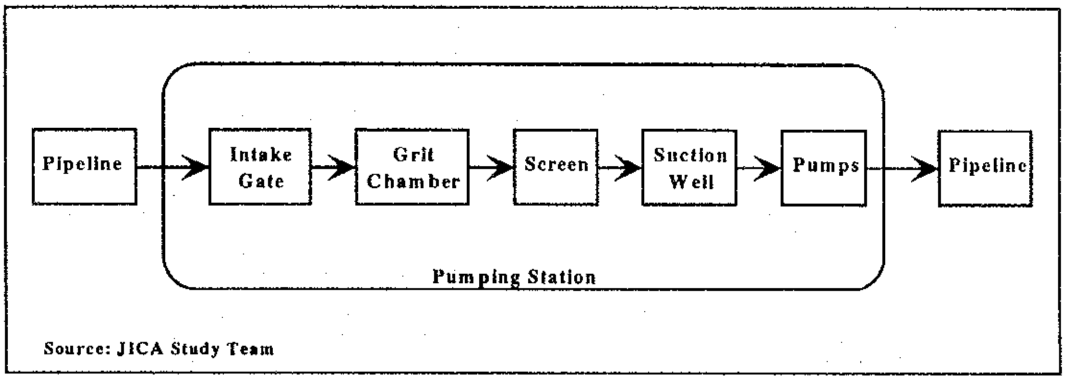
The treatment method will be i) oxidation ditch process, or ii) long-term aeration process, or iii) activated sludge method, which will meet the specified standard of waste-water disposal (See Table 6.4.1). Location and number of the sewerage plant will be studied and decided in the Master Plan study, as well as the treatment method.

Finally the treated waste-water will be discharged into the Tich River which runs east of the Study Area, in north-toward-south direction. The Tich River is a sole river in/around in the Study Area flowing into the sea.

6.4.3 Pumping Station

In the case that waste-water pipelines would be forced to be constructed so deeply as 10 meters underground or more, construction of a pumping stations will be proposed, considering construction cost and convenience of maintenance.

The flow process of the pumping station is showing the Figure 6.4.1.



Source: JICA Study Team

Figure 6.4.1 The Process of Pumping Station

6.4.4 Planning Criteria

For planning the sewerage facilities for the new town, the following criteria will be adapted.

(a) Peak Day Factor

The peak day factor, which will be applied to size a sewerage treatment plant, is to be 1.35 times (135 %).

(b) Peak Hour Factor

The peak hour factor, which will be applied to determine diameters of pipelines and to size a pumping station, is to be 1.40 times (140 %).

(c) Pipeline Capacity

It will have 100 % allowance of peak hour flow.

(d) Hydraulic Calculation

The hydraulic calculation on pipelines will follow the Manning's formula. Coefficient of roughness is set at n=0.013 for reinforced concrete pipes and n=0.010 for vinyl pipes.

(e) Depth of Pipes

Minimum earth covering depth of pipes will be 1.2 meters from road's surface.

(f) Size of Pipes

Minimum diameter of pipes will be 200 mm, considering maintenance.

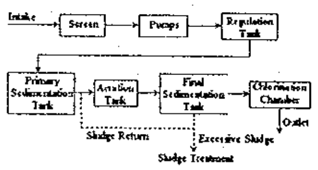
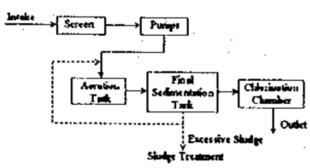
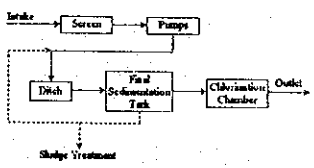
(g) Velocity in Pipes

Velocity in pipes will be 0.6 m/sec at the minimum and 3.0 m/sec at the maximum.

(h) Manholes

Manholes for maintenance will be constructed at places of starting points, variation points of gradient, variation points of diameters, junction points of several pipelines, and so on Even on direct-straight line, the manholes will be located at 100 meters interval at the maximum distance.

Table 6.4.1 Comparison of Sewerage Treatment Methods

	Activated Sludge Method	Long-Term Aeration Process	Oxidation Ditch Process
Flow Diagram			
Merit	- Smaller land area than other methods - Better efficiency of sludge sedimentation - Manifold operation	- Operative for fluctuation of load - Smaller volume of sludge generated - No necessity of primary sedimentation	- Operative for fluctuation of load - Smaller volume of sludge generated - No necessity of primary sedimentation tanks - Easy operation
Demerit	- Requiring skillful and complicated operation - Difficult operation for fluctuation of load - Large volume of sludge generated	- Requiring bigger power consumption - Large land area - Lower efficiency of sludge sedimentation	- Requiring large land area - Lower efficiency of sludge sedimentation

Source: JICA Study Team

6.5 Concept Plan of Electricity System

6.5.1 Electric Power Demand Forecast

The total maximum power demand for the development of the urban series Xuan Mai and Hoa Lac was estimated as summarized below.

Electric maximum power demand forecast in 2005, 2010 and 2020 is estimated by the relations between per capita power consumption and annual growth rate of populations, and between industrial zone and power demand (See Table 6.5.1).

Table 6.5.1 Electric Maximum Power Demand Forecast

	Population (1,000)			Max. Power Demand (MW)		
	2005	2010	2020	2005	2010	2020
Son Tay	50	60	90	11.3	17	34
Hoa Lac	40	145	400	31	168	290
Xuan Mai	45	55	100	36	44	72
Mieu Mon	1.5	2	4	1	1.5	3
Total	16.5	262	594	79.3	230.5	399

Source: JICA Study Team

Figure 6.5.1 shows a planned route map of 220 kV transmission lines including location of 220 kV Xuan Mai and Hoa Lac Substations.

6.5.2 Capacity of Substation

(1) Son Tay Substation

At present, the capacity of the existing 110 kV Son Tay substation is 32 MVA (16 MVAÅ~2 units). There is a plan by MOC to increase the capacity to 80 MVA (40 MVAÅ~2 units) by the year 2000; the work has been underway as programmed. If the work proceed with the schedule, the capacity of the station will meet the power demand of the Son Tay Urban Area up to 2020.

(2) Xuan Mai and Hoa Lac substations

MOC has designed and proposed to construct two 220/110 kV substations of the Xuan Mai (125 MVAÅ~2 units) and Hoa Lac (250 MVAÅ~2 units). The planned 220/110 kV Xuan Mai substation will have an enough capacity to meet the power demand for the Hoa Lac, Xuan Mai and Mieu Mon Urban Areas up to 2010. If the whole development plan of the Xuan Mai and Hoa Lac Urban Areas is implemented as programmed, another new substation (220/110 kV Hoa Lac substation) will be required to be constructed in the Hoa Lac Urban Area by the year 2010.

Therefore, the capacity of Xuan Mai and Hoa Lac new substations will be enough for power supply to the three areas in 2020.

6.5.3 Capacity for 110 kV and 220 kV Transmission Lines

The route map of 220 kV and 110 kV transmission lines are showing the Figure 6.5.1.

(1) 110 kV Transmission Line

The capacity of the existing 110kV transmission line between Son Tay and Ha Dong substations is obtained about 40 MW based on the existing ACSR 120 mm^2 conductor. Then the line is possible supply the power for the power demand (34 MW) up to 2020.

(2) Two-circuit of 220 kV Transmission Lines

MOC has also proposed to construct two 220 kV transmission lines as follows:

First line: Hoa-Binh - Xuan Mai - Ha Dong line (single-circuit, conductor of ACSR 500 mm^2)

Second line: Hoa Binh - Hoa Lac - Soc Son line (single-circuit, conductor o ACSR 500 mm^2)

The above transmission capacity of the each line is calculated about 300 MW respectively (150 MW from the Hoa Binh Hydropower Plant and also 150 MW from the substation of Ha Dong or Soc Son). Therefore, the capacity of the two 220 kV transmission lines has totaled to 600 MW and is enough for power supply to the maximum power demand (365 MW) of Xuan Mai, Hoa Lac and Mieu Mon Urban Areas up to 2020.

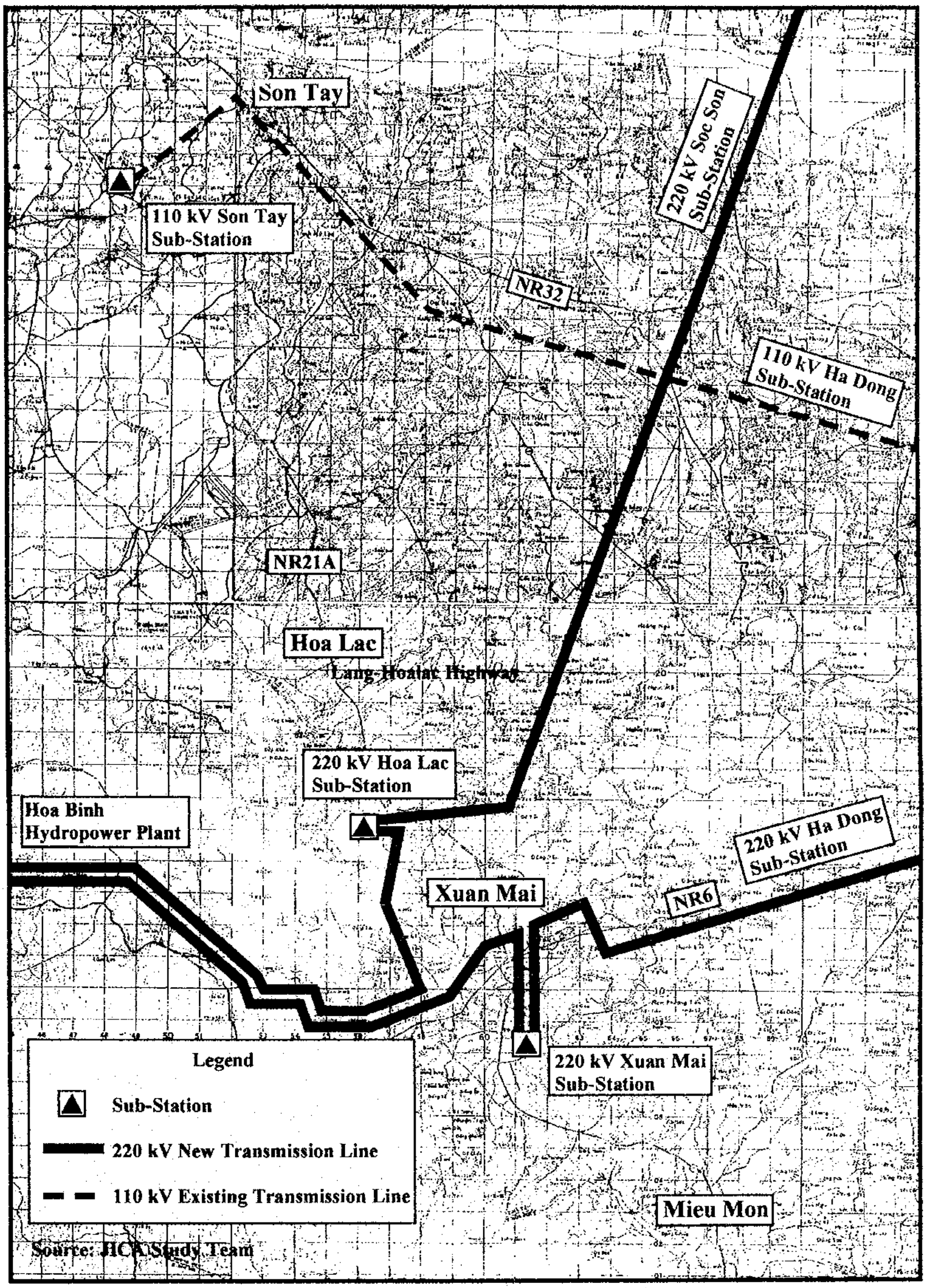


Figure 6.5.1 Route Map of 220kV/110kV Transmission Lines

6.6 Concept Plan of Telecommunication System

6.6.1 Demand Forecast

Telephone demand forecast for four Urban Areas of Son Tay, Hoa Lac, Xuan Mai and Mieu Mon have been made by the M/P and the F/S for HHTP in 1998. According to the Report, the telephone demand is estimated in Table 6.6.1.

Table 6.6.1 Telephone Demand Forecast

Unit: lines

	Telephone Demand (lines)		
	Short term 2005	Medium term 2010	Long term 2020
Son Tay	12,000	20,000	40,000
Hoa Lac	31,900	132,000	254,400
Xuan Mai	12,000	25,000	68,000
Mieu Mon	3,000	7,500	24,000
Total	58,900	184,500	386,400

Source: HHTP JICA Study Report

This numerical value of demand forecast is indicated as the reference, then it is necessary to calculate demand for the line in the future study according to the forecast of demand for population and number of houses on this plan.

In the Study Area, the telecommunication facility shall surely cater for the demand, and shall provide users with integrated services. This leads the following C/P.

6.6.2 Concept Plan

(1) Basic Concept

Hanoi City and Study Area may be in some contrast of the telecommunications. Wire-line technologies just extend the industrial-age paradigm in which the economics of infrastructure drives people into overcrowded, overburdened urban congregations, in which the today's situation in Hanoi City. The telecommunications system in Son Tay, Hoa Lac, Xuan Mai, and Mieu Mon should help people choose where they live and work based on such considerations as family, community and quality of life rather than access to infrastructure.

(2) Network Plan

Figure 6.6.1 shows a conceptual telecommunications plan, that four areas shall be organically connected by fiber optic cable involving Hanoi City. This so called "Hoa Lac Xuan Mai Fiber Ring" can be contributed to value added communications represented by integrated services digital network (ISDN). This features a high-speed data communication and large capacity transmission, which enable to provide a better working and living environment for the people staying in the area.

1) For business

It can have an access to the world business base by voice, pictures, and data through the networks. This will help the commercial and industrial activities in the area to be vivid.

2) For life

There can be two-way communications, which means people can transmit some information to the world as well as receiving the information.

In addition to the fiber optic networks, wireless local loop is essential. It can deliver telecommunications to the people on the go, and it can be used as fixed telephone, too. There are two advantages in wireless local loop system. The first is cost. Many of the facilities necessary for a conventional wire-line access network are typically engineered for 20 to 30 years of service expansion. As a result, the cost of building such a network where no infrastructure exists may be high.

With a "fixed wireless" network geared for access rather than mobility, a service provider can cover a large region with base stations and a single unit for switching and control - a smaller investment. Subscribers can then connect to the global network using portable telephones, wireless public telephones, or terminals mounted on buildings and wired to conventional telephones. As the number of subscribers grows, the service provider can easily add more base stations to split the area covered by the network into smaller segments.

The second benefit is time. Wireless networks can be installed in months rather than the years required to install copper wires.

(3) Evaluation of telecommunications networks

1) Economy

Wireless networks can be less cost for installation.

2) Reliability

Digital network can secure higher reliability.

3) Serviceability

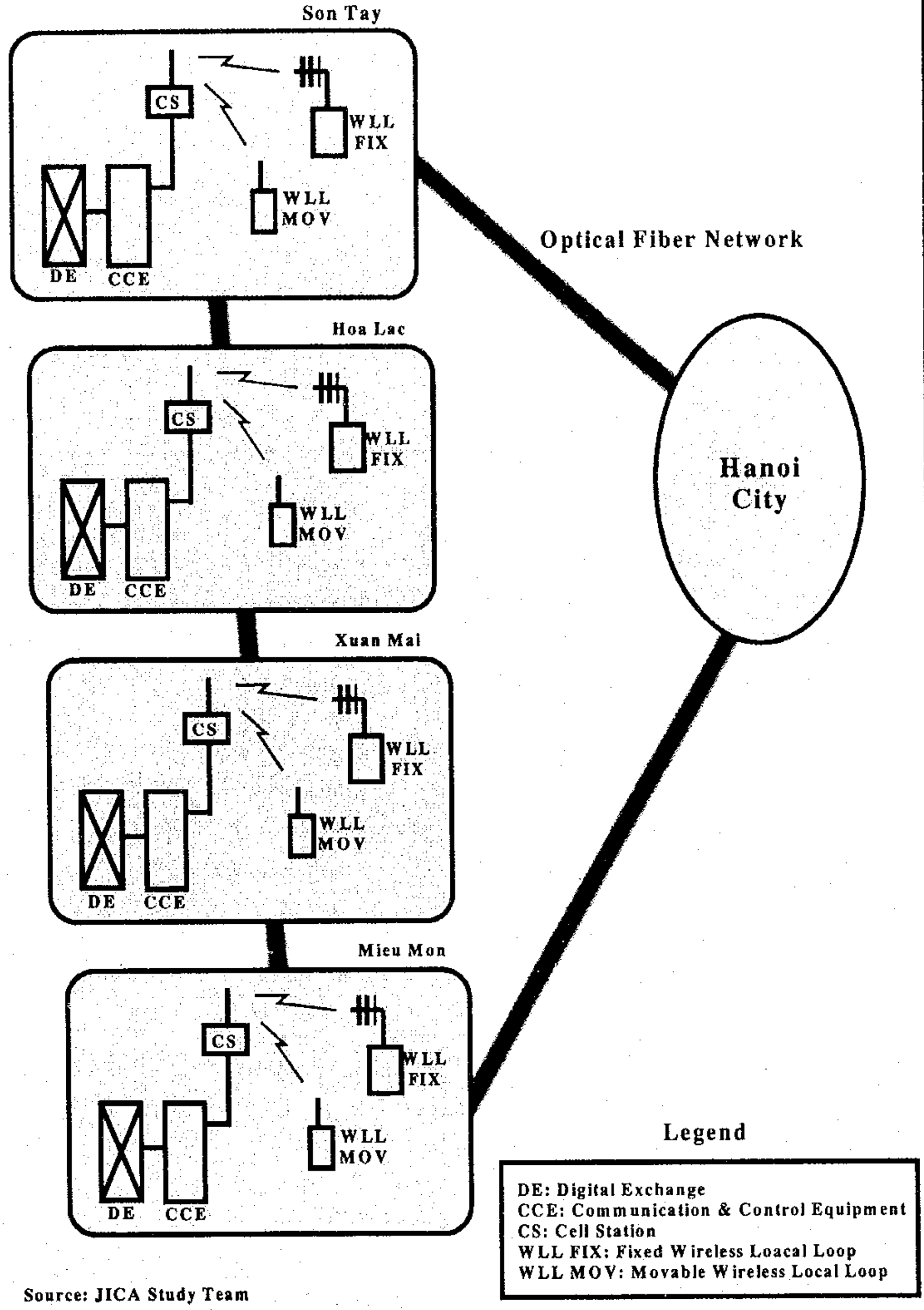
This system can provide users with some value added services applying such cases to computer's communication, distance education, and remote medical care.

4) Expandability

The network can be easily expandable according to an increase to the population and the demand.

5) Environmental Aspects

The effect to the human body by electro-magnetic field caused by wireless telecommunications equipment has not always been clear yet. There may be some unknown risks to the health.



Source: JICA Study Team

Figure 6.6.1 Conceptual Telecommunication Plan

6.7 Concept Plan of Drainage and Waste Disposal System

The sewerage system for waste-water and the drainage system for rain-water will be constructed separately form each other in the Study Area. A sanitary land fill site will be selected outside the Study Area to dispose solid waste generated by the urban development.

6.7.1 Drainage System

The rain-water will be collected by drainage pipeline networks to be formulated and constructed under public roads separately from the waste-water pipeline networks in the whole Study Area.

The collected rain-water will be led by drainage pipelines to drainage pumping stations to be constructed in the place nearby the river. Pumps will be operated when water level of the river is higher than that of the pumping stations.

On the other hand, retention ponds keeping sufficient storage volume will be constructed in order not to cause the increase of peak flow along the downstream of discharge waterways at the same time of heavy rain. The retention ponds will work to mitigate occasional heavy loads given to drainage pipelines and pumping stations during the heavy rain time.

The retention ponds will be provided on the existing surface water bodies such as small lakes, ponds and the like by construction of new dykes with 1 or 2 meters height on such existing water bodies. Those surface green network as an environmental friendly city. Locations and number of the drainage pumping stations and the retention ponds will be dealt with in the M/P study.

6.7.2 Solid Waste Disposal

Generally, solid wastes are classified into two categories: i.e. i) municipal solid waste generated as a result of human-daily-life activities, and ii) industrial solid waste generated form industrial activities.

As for the municipal wastes, they will be planned to be collected, transported and disposed by the central/local agencies or the public corporation/venture companies entrusted by the agencies. The disposal method of the municipal waste will be sanitary land filling and some hazardous waste such as hospital wastes will be treated by incineration. The disposal site will be selected by the government or local government considering the access to the landfill site and the surrounding environmental conditions outside of the Study Area.

As for the industrial wastes, administrative entity or the company entrusted by the entity will be responsible for all waste collection, transportation and disposal activities. Treatment and disposal of wastes, after they are sorted by factories will be entrusted to the entity/company will charge fees to the waste generators. The treatment facilities will be constructed by the entity/company.