5.6.3 Phased Development

There are a number of existing villages and communities in the Xuan Mai Area, and as such, the area shall be developed by involving and improving them. The development process should start from the Xuan Mai Center and its precinct to ensure compact and convenient urban development. The main theme is how to develop new residential zones in harmony with the existing villages and communities.

(1) Phase-1A Development

The targeted incremental population in the phase is 10,000 and two neighborhood units are created. That is, about 7,000 people live in Type-1 neighborhood unit (in new residential zone), and incremental 3,000 people settle down in Type-2 neighborhood unit for the Village Improvement and Expansion Zone. The new residential zone, which is adjacent to Xuan Mai Center and NR6 has convenient access to various urban services. The industrial development in this Phase is the area of around 63 ha west of NR21A.

(2) Phase-1B Development

The targeted incremental population in the phase is also 10,000. This incremental population is divided into Type-1 and 2 neighborhood units. The industrial development frame is to expand the additional area of 35 ha in the west of Phase-1A area.

(3) Phase-2 Development

The targeted incremental population in the 10 years is 45,000 people allocated to four Type-1 neighborhood units and six Type-2 neighborhood units. At Phase-2, 200 ha are developed as an industrial zone, and the total area of the industrial zone in Xuan Mai Area becomes around 300 ha, including 18 ha of the industrial center.

The land use of Xuan Mai Area is shown in the following table.

Table 5.6.1 Land Use Area: Xuan Mai Area

Land Use	Phase-1A		Phase-1B		Phase-2		Total	
	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
1 Public Space	172.7	56	89.0	45	359.2	41	620.9	45
NR21A/NR21 Bypass/NR6	62.9		-		31.4		94.3	
Other Arterial and Collector Roads	32.6		25.8		91.8		150.2	
Parks and Open Space	61.9		36.9		179.0		277.8	
Water Surface (River, Pond, and	8.3		6.3		49.0		63.6	
Others	7.0		20.0		8.0		35.0	
2 Industrial Facility Area	62.5	20	35.1	18	200.0	23	297.6	22
Industrial Center	8.5		-		9.5		18.0	
Industrial Facility Area	54.0		35.1		190.5		279.6	
Reserved Industrial Facility Area	-		-		-		0.0	
3 Residential Area	57.1	18	61.6	31	282.6	32	401.3	29
Type-1 Neighborhood Units	20.1		16.4		108.6		145.1	
Public Facilities in Type-1 Neighborhood Units	6.7		6.7		36.0		49.4	
Type-2 Neighborhood Units	24.8		31.5		112.9		169.2	
Public Facilities in Type-2 Neighborhood Units	5.5		7.0		25.1		37.6	
4 Xuan Mai Center	6.4	2	11.5	6	18.8	2	36.7	3
5 Existing University and College	10.0	3			15.0	2	25.0	2
Grand Total	308.7	100	197.2	100	875.6	100	1,381.5	100
Main Sub-station in Xuan Mai							20	
Reserved Hill in the Central Area of Xuan Mai							159	

Source: JICA Study Team.

Note: Type-1 Neighborhood Unit is developed in the New Residential Zone.
Type-2 Neighborhood Unit is located in the Village Improvement and Expansion Zone.
Main Sub-station, which is planned to serve for the whole C21 Development, is located on the west of NR21A and Bypass in the middle of Hoa Lac and Xuan Mai.

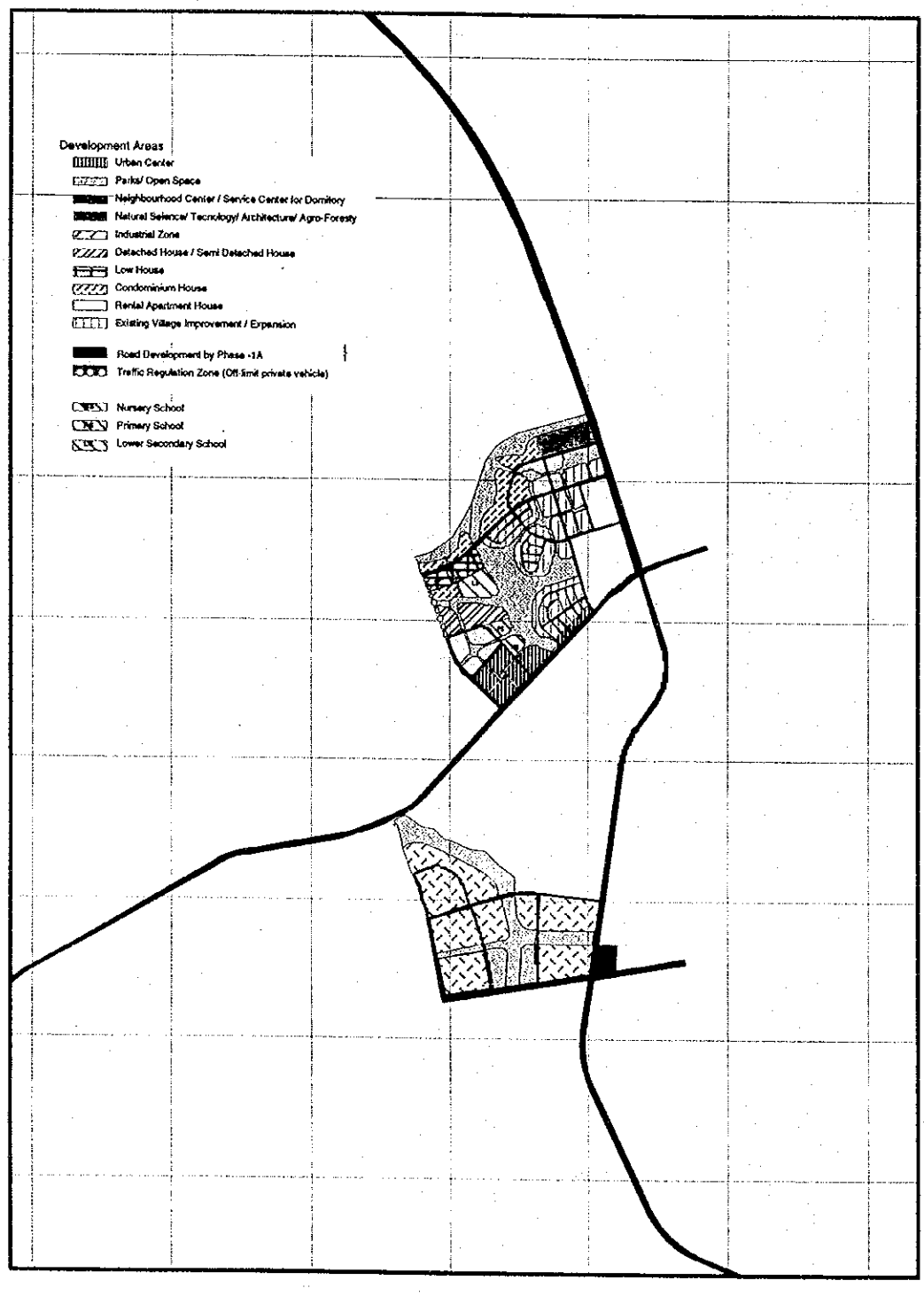


Figure 5.6.3 Phased Development Plan of Xuan Mai Area: Phase-1A

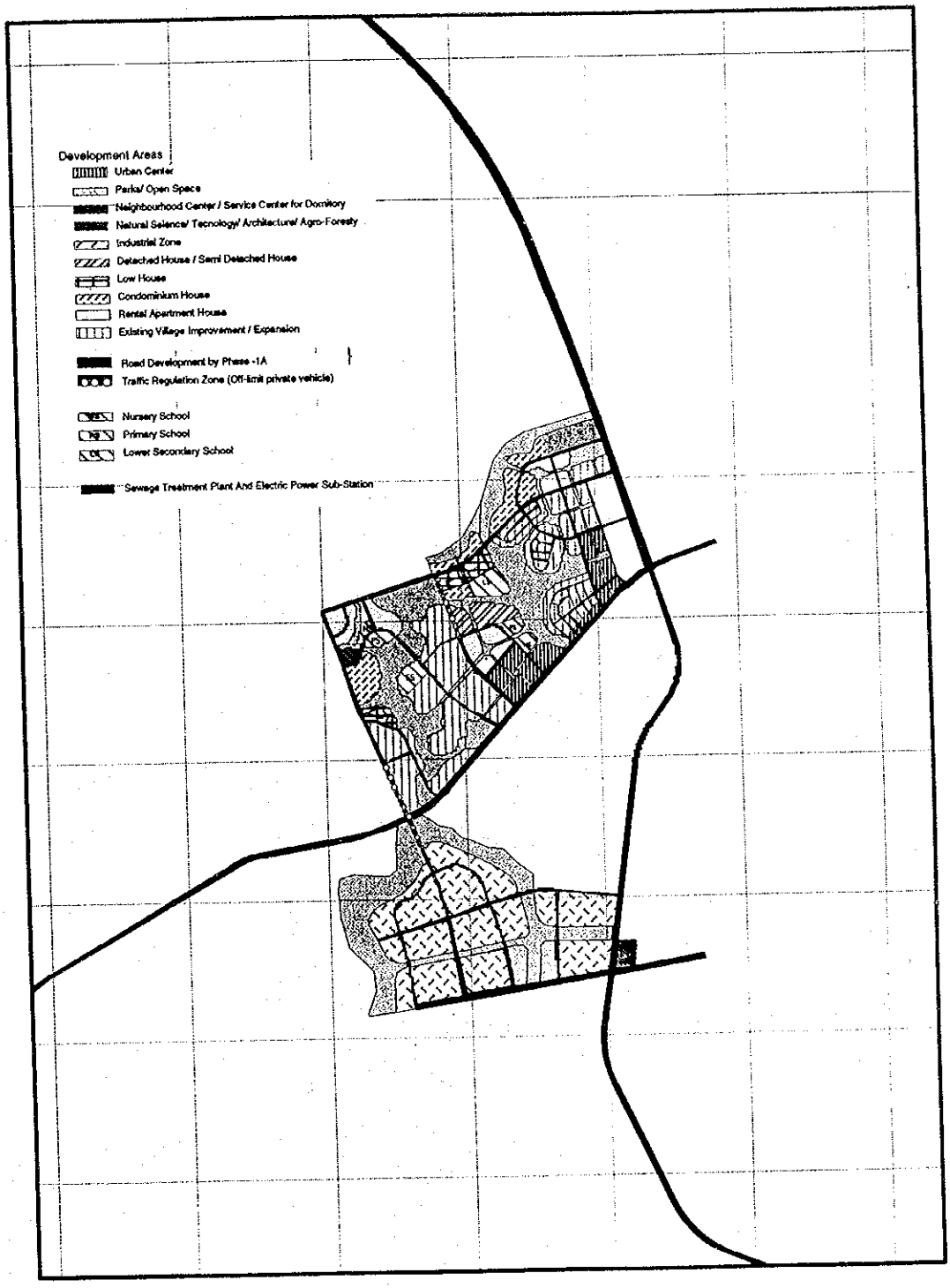


Figure 5.6.4 Phased Development Plan of Xuan Mai Area: Phase-1B

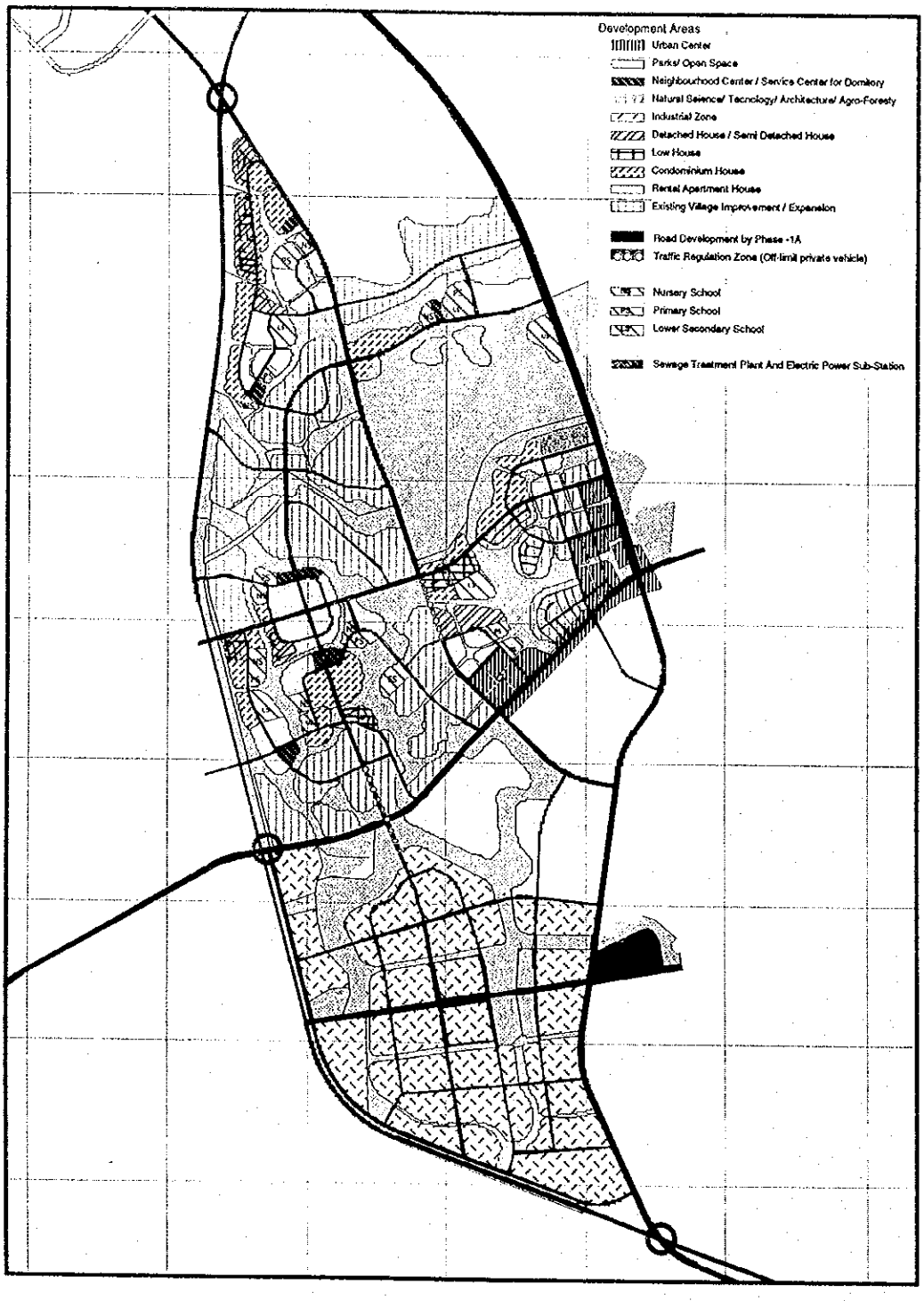


Figure 5.6.5 Phased Development Plan of Xuan Mai Area: Phase-2

5.7 Summary of Land Use and Phased Development Plan

5.7.1 Land Use

The land use and phased development plans are proposed, based on the framework, which is determined by the facility and functional layout and planning approaches mentioned in each section of Chapter 4 and 5 in consideration of existing conditions of Hoa Lac and Xuan Mai Areas.

The existing population data of 1996 is based on the area of the MOC master plan, which is different from the Master Plan Area of the Study. The existing population within the Master Plan Area might be smaller than the MOC master plan because eastern part of Hoa Lac and Xuan Mai Areas is excluded from the Master Plan Area due to flood and there are many existing villages and settlements. While the population density of Type-1 is 135 persons/ha, that of Type-2 is 100 persons/ha.

The Mater Plan Area, which include the reserved area for VNU expansion and the preservation area of urban hill forest park in Xuan Mai, is around 8,000 ha in the total. In the case exclude the above two areas, total development area of Hoa Lac Area by Phase-2 is approximately 6,000 ha and about 1,400 ha for Xuan Mai Area. The total development area of Hoa Lac and Xuan Mai Areas become roughly 7,400 ha. If 500,000 people live in the areas, the gross population density becomes 68 persons/ha. The total net urban development area except the reserved areas and water surface of lakes and rivers and green belt network is approximately 5,000 ha, and the population density is about 100 persons/ha.

The area of green and open spaces, including water surface of rivers, preserved hill in Xuan Mai, and the Olympic game complex, is approximately 2,000 ha, which is 27 % of 7,400 ha. This ratio of the green and open space is appropriate to call the New Town as the "Garden City". About 20 % of the development area, which is shared by the parks, open space, and the green belt along the rivers, excluding reserved green space and water surface. The road and transportation facilities area occupies roughly 15 % that do not include residential service roads, which are narrower than 10 meter. If the residential service roads are included, the road area occupies about 20 % of the Hoa Lac and Xuan Mai Areas. The rate of green space at Hoa Lac and Xuan Mai is almost same if the reserved hill in Xuan Mai is excluded from the count. The rate of road area of Xuan Mai is slightly high than that of Hoa Lac because there are many wider roads in Xuan Mai than in Hoa Lac.

The industrial zone of Xuan Mai Area occupies about 20 % of the whole development area. On the other hand, both the industrial zone of HHTP Area and the industrial zone of Phu Cat

Area within Hoa Lac Area occupy approximately 9 %, which implies that the industry of Xuan Mai Area represent the characteristics of the industry of the Hoa Lac and Xuan Mai Areas.

The rate of the area related to the university within VNU Area of Hoa Lac is 12.7 %. If the dormitory area is excluded, the rate becomes 9.1 %. The rate of the area related to HHTP Zone is 6.3 %. This rate does not include the residential zone within HHTP zone.

The area used for housing, which does not include parks, open space, water surface, arterial roads, and public facilities within the residential zone, is about 790 ha in Type-1 neighborhood units, which is 10.6 % of the total development area, and 730 ha in Type-2, which is 9.8 % of the total development area. The sum is 1,520 ha, which is 20.4 % of the whole development area.

5.7.2 Phased Development Plan

The residential and industrial zones in Hoa Lac Area are developed along NR21A and around the urban center at Phase 1A. Partly, Type-2 neighborhood units are developed along NR21A in Hoa Lac North and South. A neighborhood unit of HHTP Area is adjacent to the urban center, and the other one is located in the north.

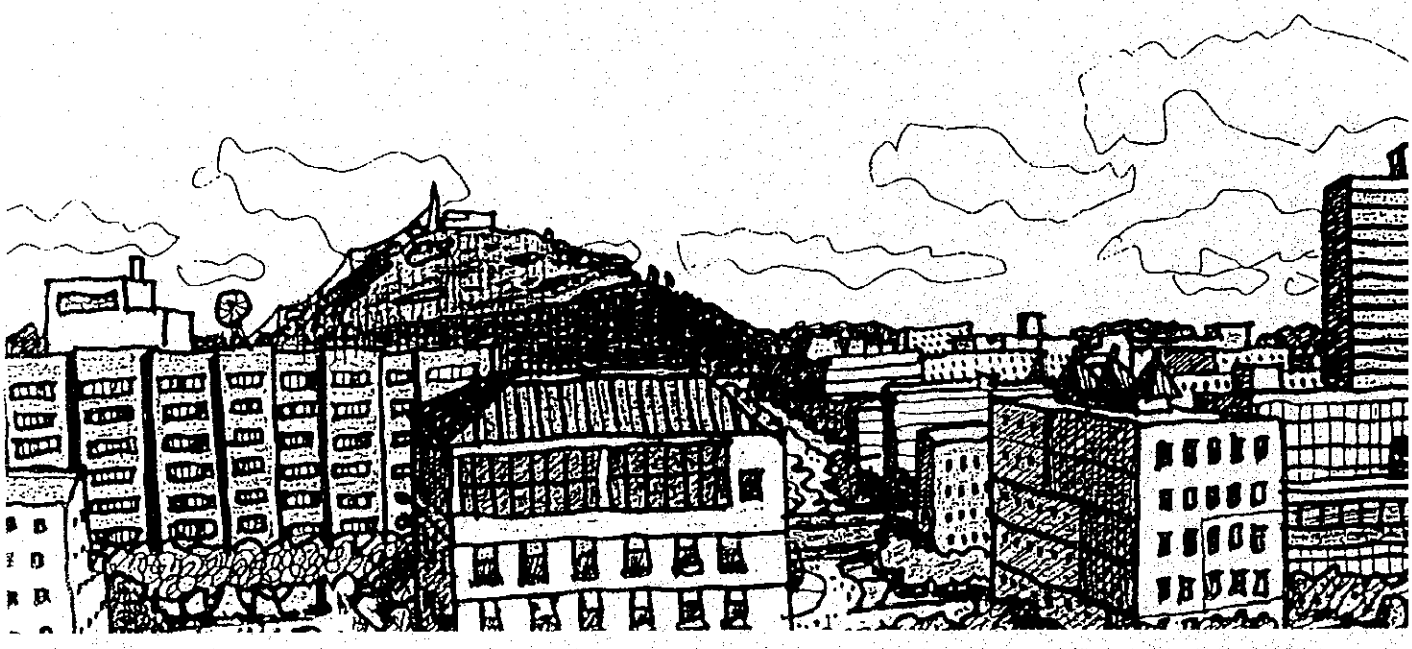
At Phase 1B, the residential zone is developed around the urban center and spreads out to south along NR21A. The residential zone of Dong Xuan Area is developed adjacent to the residential zone developed at Phase 1A. Two neighborhood units adjacent to the golf course at HHTP in Hoa Lac North are developed.

Table 5.7.1 Land Use Plan of Hoa Lac and Xuan Mai Area by Phases

Development Component	C21 Urban Center		VNU Area		HHTP Area		Dong Xuan Area		Phu Cat Area		Sub-Total		Xuan Mai Area		Grand Total	
	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
Public Area	167	52	318	24	894	46	562	46	550	45	2,491	41.5	621	10.3	3,112	51.8
Urban Arterial Roads (incl. Railway)	33	10	38	3	63	3	25	2	59	5	218	3.6	94	6.7	313	4.2
Regional Roads and Open Space	40	12	103	8	256	13	177	15	118	10	695	11.6	150	10.7	845	11.4
Parks and Openn Space	49	15	136	10	448	23	313	26	226	19	1,173	19.5	278	19.8	1,451	19.6
Olympic Game Complex	-		-		-		-		50	4	50	0.8	0	0.0	50	0.7
Green Hills in the Urban Center	33	10	-		-		-		-		33	0.5	0	0.0	33	0.4
Surface of Rivers, Ponds, and Lakes	11	3	41	3	82	4	46	4	74	6	254	4.2	64	4.5	317	4.3
Others (sewage treatment plant and	-		-		44	2	2	0	22	2	68	1.1	35	2.5	103	1.4
Urban Center Area	156	48	13	1	31	2	15	1	18	1	232	3.9	37	2.6	268	3.6
Facility Area of the Urban Center	145	45	-		-				-		145	2.4		0.0	145	2.0
Reserved Facility Area of the Urban Center	11	3	-		-				-		11	0.2		0.0	11	0.1
South Center	-		-		-		15		18	1	33	0.5		0.0	33	0.4
North Center (Type 2)	-		13	1	31	2			-		44	0.7		0.0	44	0.6
Xuan Mai Center	-		-		-				-		-		37	2.6	37	0.5
VNU Zone			761	57							761	12.7		0.0	761	10.3
Campus			423	32							423	7.0		0.0	423	5.7
Guest House and Dormitory			214	16							214	3.6		0.0	214	2.9
Other Technology Universities			124	9							124	2.1		0.0	124	1.7
HHTP Zone					380	20					380	6.3		0.0	380	5.1
R&D, Research Center, etc.					270	14					270	4.5		0.0	270	3.6
HHTP Industries					110	6					110	1.8		0.0	110	1.5
Phu Cat Industry Zone									420	35	420	7.0	298	21.2	718	9.7
Industrial Center									19	2	19	0.3	18	1.3	37	0.5
Industry Zone									330	27	330	5.5	280	20.0	610	8.2
Reserved Area for Industry Expansion									71	6	71	1.2		0.0	71	1.0
Residential Zones			233	18	622	32	639	53	226	19	1,720	28.6	401	28.6	2,121	28.6
Type-1 Neighborhood Units			86	6	95	5	294		168	14	642	10.7	145	10.4	787	10.6
Public Facilities in Type-1 Neighborhood			21	2	30	2	69		46	4	165	2.7	49	3.5	214	2.9
Reserved Type-1 Neighborhood Units			126	9	105	5	-		-		231	3.8		0.0	231	3.1
Type-2 Neighborhood Units			-		321	17	227		10	1	558	9.3	169	12.1	727	9.8
Public Facilities in Type-2 Neighborhood			-		71	4	50		2	0	124	2.1	38	2.7	162	2.2
Existing College and University													25	1.8	25	0.3
Main Sub-tation													20	1.4	20	0.3
G. Total	323	100	1,325	100	1,926	100	1,216	100	1,214	100	6,003	100.0	1,402	100.0	7,405	100.0
Reserved Area VNU after 2020			430								430				430	
Reserved Hill in the Central Area of Xuan Mai													159		159	
(including the above 2 reserved areas)	323		1,755		1,926		1,216		1,214		6,433		1,561		7,994	

CHAPTER 6

INFRASTRUCTURE DEVELOPMENT PLAN FOR THE HOA LAC AND XUAN MAI URBAN DEVELOPMET



CHAPTER 6 Infrastructure Development Plan for the Hoa Lac and Xuan Mai Urban Development

6.1 Transport

6.1.1 Concept for Transport Network System

Along with the urban development of Hoa Lac Area, it is significant to provide the adequate transport infrastructure facilities for residents, commuters and visitors. This provision should be made mainly in consideration of the future populations, urban scale, facilities and functions based on the development framework of the Study Area.

The Hoa Lac urban center area is possibly to be developed as a core of the New Town with academic, residential, industrial and cultural activities. In this regard, the provision of improved access road to the Study Area should be made to cope with their needs. The main purposes of trip for users are assumed as follows;

- daily life trips of residents within the Hoa Lac area
- weekend trips of residents/students for Hanoi
- cargo traffic for distribution between Hoa Lac area and cities, airports and seaports
- commuter's daily trips for academic or employment purpose
- outside visitors for amusement trip (ex: Ba Vi national park and cultural village)

Along with the construction of the Lang-Hoa Lac Highway, the major urban access road National Road (NR) 6 and NR32 should be improved for the New Town. In addition, the improvement of NR 21A should be considered, which will serve as a major urban corridor in the Hoa Lac New Town. Moreover, a provision of additional north-south road in parallel with the existing NR 21A as a Bypass should be considered in order to separate daily life traffic for residents from for mainly cargo distribution and through traffic. This proposed 21 Bypass is considered to serve as a partial section of future regional ring road route in HMA in the long-term view.

6.1.2 Regional Access Road from the Study Area to Seaports and Airports

With the future urban development of Hoa Lac New Town, it is considered that the truck traffic volume will increase between High-tech Park/ Put Cat Industrial Area and other cities, airport/seaport as a cargo distribution routes. The improvement of these routes is significant for the promotion of industrial activity of the New Town. It is noted that the cargo distribution route for other cities and airport/seaport should be provided with direct access to the destination without penetrating into the central Hanoi to relive urban traffic. Thus, the connection with ring road or Bypass road network should be highly considered in Hanoi area to conduct efficient cargo traffic movement.

The regional access road routes for mainly cargo distribution service between Hoa Lac Area and seaports and airports in the Hanoi region are considered as follows (Figure 6.1.1). The high priority should be given for the development of these roads along with the Hoa Lac New Town.

Hoa Lac District : Noi Bai International Airport Route

- Hoa Lac Area / Lang-Hoa Lac Highway / Hanoi Ring Road / Noi Bai International Airport
- Hoa Lac Area / NR 21A / Son Tay / NR 2 / Noi Bai International Airport

Hoa Lac Area-Hai Phong Seaport/Cai Lan Seaport Route

- Hoa Lac Area / Lang-Hoa Lac Highway / Hanoi Ring Road 3 / NR 5 / Hai Phong Seaport
- Hoa Lac Area / Lang-Hoa Lac Highway / Hanoi Ring Road 3 / NR 1 / NR 18 / Cai Lan Seaport
- Hoa Lac Area / Lang-Hoa Lac Highway / Hanoi Ring Road 3 / NR 5 / NR 183 / NR 18 / Cai Lan Seaport
- Hoa Lac Area / NR 21A / NR 10 / Hai Phong Seaport

Hoa Lac Area / NR 21A / Son Tay / NR 2 / Bac Ninh-NR 18 / Cai Lan Seaport

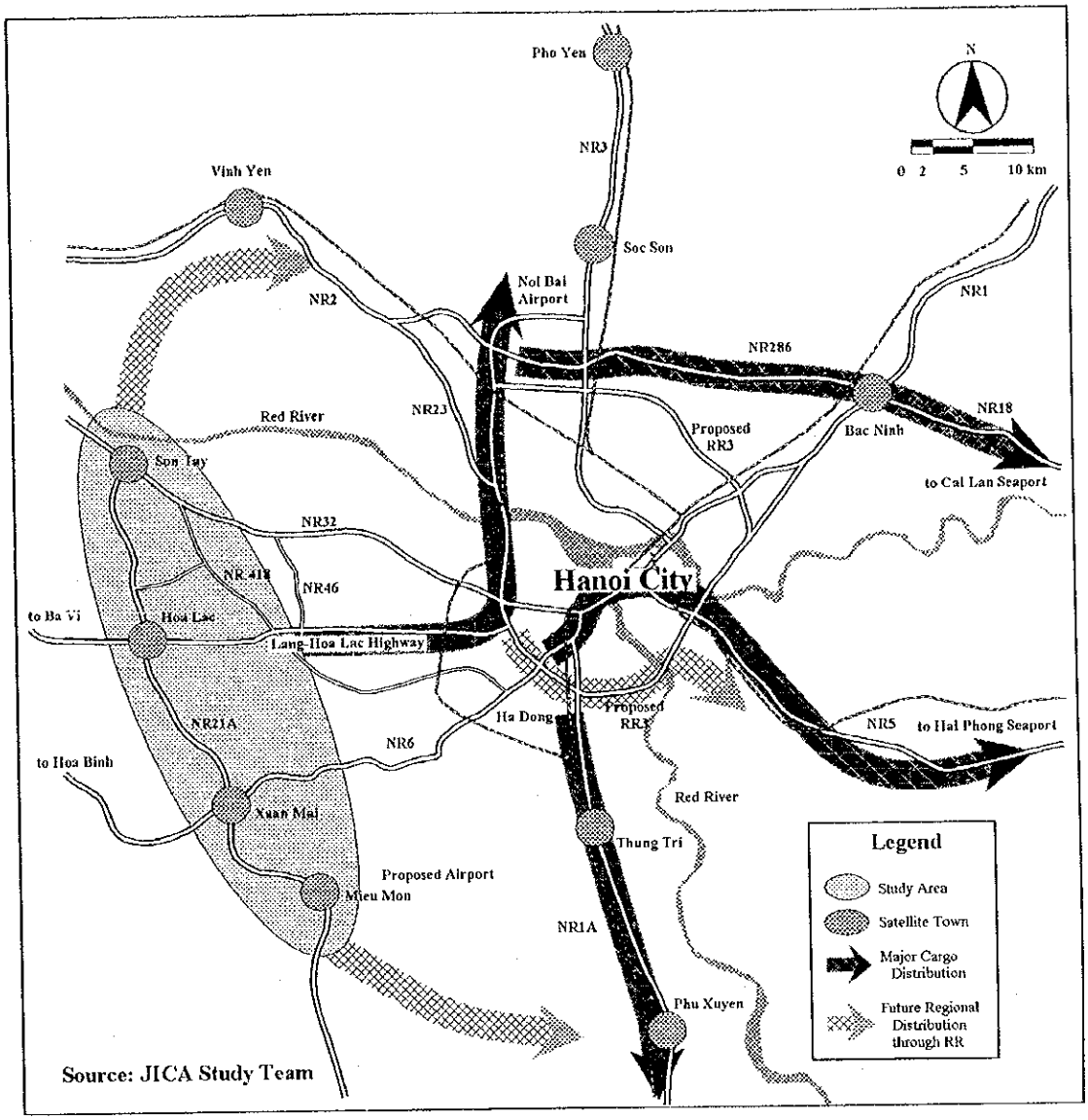


Figure 6.1.1 Regional Transport Network for Distribution

6.1.3 Traffic Demand Forecast

(1) Existing Traffic Volume

According to the traffic volume survey between 1992-1997 by Traffic Management Service in the Ha Tay Transport Authority, the existing traffic volume of the access roads of the Study Area is shown in Table 6.1.1. In addition, the surveying spots on NR32, NR6 and NR 21A are illustrated in Figure 6.1.2.

In 1997, traffic volume on NR6 at Got Town, about 20km west of Hanoi, is about 2,700 vehicles/day, counting only 4-wheel vehicles. When converted whole traffic vehicles including motorcycles and bicycles into Passenger Car Unit (PCU), the traffic on this road is about 6,380PCU per day. Of which, the shares of motorcycle and bicycle account for almost 53%.

Also, the traffic volume on NR32 at Tram Troi, 16km west of Hanoi, is about 3,500 vehicles/day, excluding 2-wheel vehicles. When converted all types of vehicle including motorcycles and bicycles into PCU, the traffic volume becomes about 10,200PCU/day. Of which, the shares of motorcycle and bicycle account for almost 70%.

Furthermore, the traffic volume on NR 21A at Hoa Lac and near Xuan Mai Junction are observed as about 634 vehicles and 988 vehicles per day, respectively when counting only 4-wheel vehicles. When converted all types of vehicle into PCU, the traffic volume becomes 2,540PCU/day and 3,050PCU/day. Of which, the shares of motorcycle and bicycle account for almost 73% and 65%, respectively.

Table 6.1.1 Existing Traffic Volume of the Access Road in the Study Area

NR6 (at Got)

Unit: Number of Cars

Survey Year	Type of Vehicle									
	Car	Small Truck	Medium Truck	Heavy Truck1)	Heavy Truck2)	Mini Bus	Bus	Sub-Total	Motorcycle	Bicycle
1992	318	222	822	177	39	-	177	1,755	-	-
1993	271	237	699	71	18	-	159	1,455	-	-
1994	221	155	742	76	18	-	131	1,343	-	-
1995	223	182	784	79	33	-	175	1,476	-	-
1996	232	201	669	98	36	-	266	1,502	-	-
1997	572	436	958	292	35	194	227	2,714	6,243	3,929

NR21A (at Xuan Mai)

Unit: Number of Cars

Survey Year	Type of Vehicle									
	Car	Small Truck	Medium Truck	Heavy Truck1)	Heavy Truck2)	Mini Bus	Bus	Sub-Total	Motorcycle	Bicycle
1992	154	186	412	34	6	-	26	818	-	-
1993	173	195	398	48	7	-	28	849	-	-
1994	159	153	440	105	13	-	30	900	-	-
1995	142	193	454	52	13	-	39	893	-	-
1996	266	280	585	220	132	-	173	1,656	-	-
1997	134	181	368	134	10	93	68	988	2,597	3,346

NR21A (at Hoa Lac)

Unit: Number of Cars

Survey Year	Type of Vehicle									
	Car	Small Truck	Medium Truck	Heavy Truck1)	Heavy Truck2)	Mini Bus	Bus	Sub-Total	Motorcycle	Bicycle
1994	266	65	199	39	18	-	21	608	-	-
1995	371	91	210	24	8	-	12	716	-	-
1996	257	83	303	18	7	-	22	690	-	-
1997	194	97	284	12	2	22	23	634	2,696	2,869

NR32 (at Tram Troi)

Unit: Number of Cars

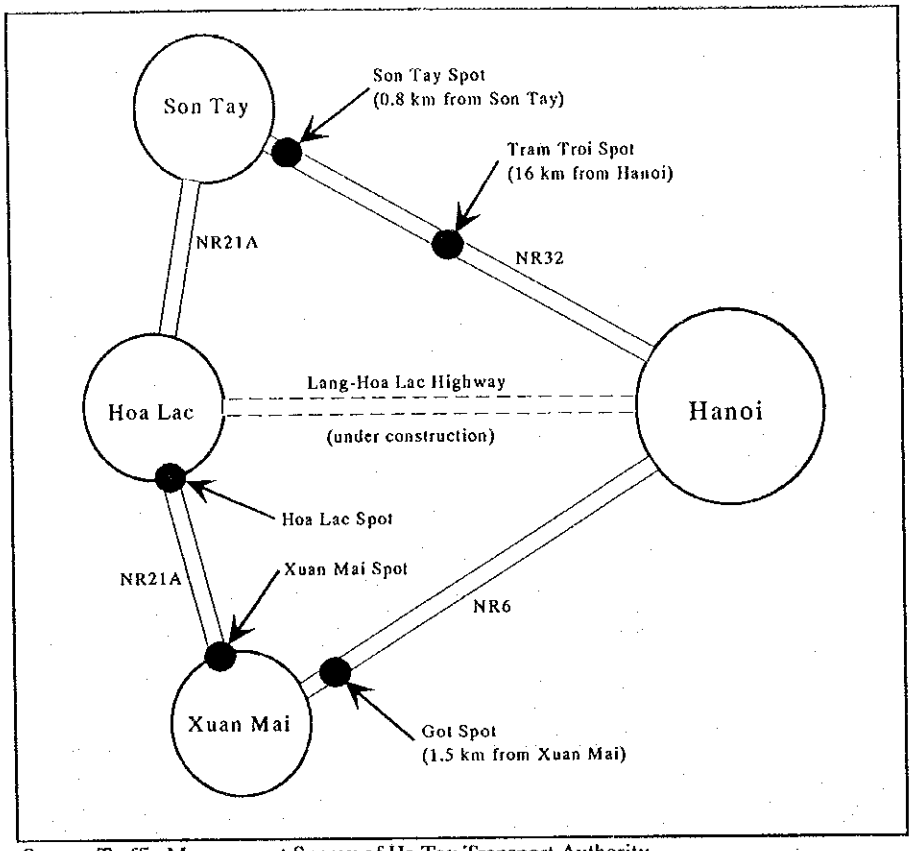
Survey Year	Type of Vehicle									
	Car	Small Truck	Medium Truck	Heavy Truck1)	Heavy Truck2)	Mini Bus	Bus	Sub-Total	Motorcycle	Bicycle
1992	464	194	373	104	67	-	171	1,373	-	-
1993	542	322	434	128	85	-	228	1,739	-	-
1994	613	412	623	259	172	-	537	2,616	-	-
1995	482	352	556	184	134	-	404	2,112	-	-
1996	515	310	385	170	150	-	445	1,975	-	-
1997	558	605	432	156	151	354	311	2,567	7,717	13,722

NR32 (at Son Tay)

Unit: Number of Cars

Survey Year	Type of Vehicle									
	Car	Small Truck	Medium Truck	Heavy Truck1)	Heavy Truck2)	Mini Bus	Bus	Sub-Total	Motorcycle	Bicycle
1992	203	156	390	24	7	-	96	876	-	-
1993	238	129	214	26	7	-	121	735	-	-
1994	808	172	189	44	25	-	138	1,376	-	-
1995	645	198	281	33	14	-	179	1,350	-	-
1996	780	390	390	30	9	-	247	1,846	-	-
1997	742	878	826	48	9	499	470	3,472	13,713	17,250

Source: Traffic Management Survey of Ha Tay Transport Authority



Source: Traffic Management Survey of Ha Tay Transport Authority

Figure 6.1.2 Traffic Volume Survey Spot on Access Road

(2) Traffic Demand Forecast

1) Concept

According to socio-economic framework of the Hoa Lac New Town proposed through this Study, the traffic demand of the Study Area is forecasted. In consideration of prospective interrelation between Hoa Lac New Town and Hanoi area, the traffic demand of east-west traffic section axis including NR32, NR6 and the Lang-Hoa Lac Highway is projected. In addition, the traffic demand of north-south traffic section axis on NR 21A is also forecasted to serve as a main corridor of the New Town. As a result of the traffic demand projection, the necessity of road improvement is examined to cope with the future transport infrastructure facility.

2) Method

The future traffic demand on each traffic section axis comprises of following two components.

- The traffic demand attributed to natural increase
- The traffic demand attributed to development of the New Town

The future traffic demand on each traffic axis is projected as a total of two components above. For the traffic demand forecast of east-west section axis, Son Tay, Xuan Mai and Mieu Mon is considered in the aspects of mainly natural increase because the development plan is conducted focusing on Hoa Lac area. In the result of traffic demand by mode, three cases are reviewed in consideration of modal change of vehicles along with future trend of developing public transport (mainly bus) in the area as follows:

Case 1) No transferring motorcycle mode into bus system,
Case 2) Transferring 50% of motorcycle traffic into bus system,
Case 3) Transferring 100% of motorcycle traffic into bus system

(a) East-West Section Axis (Lang-Hoa Lac Highway, NR6 and NR32)

The traffic demand attributed to natural increase

According to the existing traffic volume on NR6 and NR32 in 1997, the total traffic volume on the sections of both national roads is about 5,000-6000 vehicles/day excluding motorcycles and bicycles. Based on the ratio of current natural increase of traffic volume, the future natural demand is forecasted by regression analysis. As the result of the forecast by natural increase, the traffic demand will reach 14,800 vehicles/day in 2005, 17,000 vehicles/day in 2010, and 21,000 vehicles/day in 2020 (Table 6.1.2).

The share of modal split is applied based on the result of social survey conducted in this Study. Furthermore, the modal split in 2010 and 2020 is applied to the growth ratio in consideration of future vehicle growth rate in Hanoi. As a result, the ratio of modal split by phase is shown below as Table 6.1.3.

Table 6.1.2 Traffic Demand Projection by Natural Increase

East-West Section — Unit: Vehicle/day

	Passenger Car	Truck	Bus	Sub-total	Motorcycle	Total
Vehicle Mode Ratio	5.0 %	13.3 %	5.3 %		76.3%	
1997	1,314	3,482	1,390	6,186	19,956	26,142
Phase-1A	2,477	6,565	2,621	11,662	37,623	49,285
Phase-1B	2,568	6,805	2,717	12,090	39,002	51,092
Phase-2	2,694	7,138	2,850	12,682	40,912	53,594

East-West Section — Unit: Vehicle/day

	Passenger Car	Truck	Bus	Sub-total	Motorcycle	Total
Vehicle Mode Ratio	3.7 %	19.3 %	4.5 %		72.4 %	
1997	134	693	161	988	2,597	3,585
Phase-1A	191	793	317	1,409	3,703	5,112
Phase-1B	202	837	334	1,486	3,907	5,394
Phase-2	216	897	358	1,594	4,189	5,783

Source: JICA Study Team

Table 6.1.3 The Share of Modal Split by Development Phase

Unit: %

	Passenger car	Truck	Bus	Motorcycle
Ratio (social survey)	13.5	0.0	13.9	72.5
Phase-1A	13.5	0.0	13.9	72.5
Phase-1B	15.2	0.0	15.5	69.2
Phase-2	17.9	0.0	18.3	63.7

Source: JICA Study Team

The traffic demand attributed to development of New Town

a) Development Framework

The traffic demand by the development is confined to Hoa Lac area. For the trip purpose, three components are considered; commutation to work and school, and work-related business and private business purpose. The purpose of work-related business trip is for commercial/office facilities and high-tech industrial facilities. Based on the development framework of the Hoa Lac New Town, the future commuting population from/to Hoa Lac area, land use area and development area, etc by phase are summarized in Table 6.1.4.

Table 6.1.4 Development Framework of Hoa Lac New Town

Framework \ Year	Phase-1A (2005)	Phase-1B (2010)	Phase-2 (2020)
Commuter to school & work from /to outside of Hoa Lac Urban Area (including Hanoi area)	7,700 persons	9,400 persons	35,700 persons
Commuter to school & work within Hoa Lac Urban Area	48,500 persons	76,000 persons	136,000 persons
Development area for commercial and office (floor area)	27 ha	54 ha	115 ha
Development lot for high-tech industrial zone	50 ha	80 ha	130 ha
Development lot for Put Cat industrial area	80 ha	100 ha	300 ha

Source: JICA Study Team

b) Trip generation and attraction

Commutation to work and school

According to the framework, the person trip of commuter to work and school from outside of Hoa Lac area including Hanoi area is available as shown in Table 6.1.4. Nevertheless, the person trip to school is included in the number of work commutation because the school commuters between Hanoi and Hoa Lac area is a minor factor within the range of 150-300 students in 2005-2020. The person trip by commuters to work is 15,000 trip/day, 19,000 trip/day and 71,000 trip/day in 2005, 2010 and 2020, respectively. In addition, the person trip to work and school from Hoa Lac area is 97,000 trip/day in 2005, 152,000 trip/day in 2010 and 260,000 trip/day in 2020.

Business (commercial and office)

According to the manual of "Transport plan for the large-scale development district" by the Ministry of Construction in Japan, the average trip generation and attraction model unit in commercial facility is about 16,000 trip end/ha/day. Under the assumption of long distance from railway station, the modified unit is 12,000 trip end/ha/day. From the same source, the average trip generation and attraction model unit (per floor area) of office is about 4,500 trip end/ha/day. Under the assumption of long distance from railway station and no commercial area around office, the modified unit is 2,400 trip end/ha/day.

In addition, according to the manual of "The Survey on trip generation and attraction of building" by the Ministry of Construction in Japan, the average model unit of trip generation and attraction per floor area is; office (1,700 trip end/ha/day), commercial facility (department store:6,800 trip end/ha/day), Hotel (mixed-use: 1,200 trip end/ha/day) and public hall and cultural center (2,200 trip end/ha/day).

This model unit is for mainly commutation for office/commercial, business and shopping. As the trip for commutation to school and work is already considered above, the trip for shopping is only taken into account. Nevertheless, the shopping trip is assumed to conduct within the Hoa Lac area, the trip to outside of Hoa Lac area is not considered. The accurate share of trip for business and commutation is not available with current data. For this reason, the trip for business purpose is assumed to be tentatively 50% of trip. Thus, the model unit (per floor area) of person trip for business is about 1,200 trip end/ha/day.

Based on the building coverage for commercial use, the trip generation and attraction is estimated as about 32,000(trip end per day), 64,000 (trip end per day) and 137,000 (trip end per day) in 2005, 2010 and 2020, respectively as shown in Table 6.1.5.

Industry (High-tech industry)

The cargo traffic demand of industrial estates from "M/P and F/S on the High-tech park (HHTP) project in Hoa Lac" by JICA, (January 1998), is utilized for the traffic demand in HHTP. In addition, the traffic demand for Put Cat industrial estates was estimated based on the development area for industrial use by HHTP project as shown Table 6.1.6. As a result of cargo demand of the industrial area, the total cargo demand was calculated. The proportion of cargo truck is assumed to be 3-ton truck (50%) and 4-ton truck (50%). The future cargo traffic of HHTP and Put Cat industrial estates is 1,600 trucks/day in 2005, 1,900 trucks/day in 2010 and 6,400 trucks/day in 2020, in total as shown in Table 5.2.7 under the assumption of loading capacity of truck (50%), of which the truck loading ratio is considered as 100%.

c) Trip Distribution

The trip distribution from outside of Hoa Lac area for commutation to work, school and business is estimated as shown in Figure 6.1.3 based on the Gravity Model method in consideration of the interrelation of population and distance of each area. The trip

distribution by purpose from/to Hanoi area accounts for about 90% in 2010. In addition, the trip distribution for Son Tay and Xuan Mai direction occupies about 5%, respectively.

In terms of industrial distribution from HHTP and Put Cat industrial estates, the direction of cargo traffic movement is considered for only Hanoi area on the assumption that the destination of cargo traffic is made for mainly Hai Phong seaport and Noi Bai International Airport.

Table 6.1.5 The Total Generation and Attraction of commercial and Office

	Phase-1A (2005)	Phase-1B (2010)	Phase-2 (2020)
Commercial/office development floor area (ha)	27	54	115
Person trip model unit (TE/ha/D)	1,200	1,200	1,200
Generation trip and attraction (TE/day)	32,040	64,560	137,880

Source: JICA Study Team

Table 6.1.6 Cargo Demand by HHTP Report (by JICA)

Unit: ton/day

	Phase-1A (2005)	Phase-1B (2010)	Phase-2 (2020)
Cargo Demand (outflow)	540	710	1,630
Cargo Demand (inflow)	600	780	1,790
Average	570	745	1,710

Source: JICA Study Team

Table 6.1.7 The Traffic Generation and Attraction by Cargo Truck

	Phase-1A (2005)	Phase-1B (2010)	Phase-2 (2020)
The average cargo volume in Vietnam (ton/vehicle)	3.5	3.5	3.5
Cargo loading ratio (%)	50 %	50 %	50 %
Average capacity of truck loading (ton/vehicle)	1.75	1.75	1.75
Traffic generation by cargo truck (vehicle/day)	847	958	3,232
Traffic generation and attraction by cargo truck (vehicle/day)	1,600	1,900	6,400

Source: JICA Study Team

Table 6.1.8 Person Trip by Mode and Purpose (Development)

Business and Others		Person Trip (trip end/day)	Person Trip by vehicle mode (trip/day)			
			Passenger Car	Truck	Bus	Motorcycle
Phase-1A	East-West	28,881	3,928	0	4,014	20,939
	North-South	1,503	204	0	209	1,090
Phase-1B	East-West	57,997	8,823	0	9,031	40,143
	North-South	3,153	480	0	491	2,183
Phase-2	East-West	118,845	21,262	0	21,797	75,785
	North-South	10,066	1,801	0	1,846	6,419

Work		Person Trip (trip end/day)	Person Trip by vehicle mode (trip/day)			
			Passenger Car	Truck	Bus	Motorcycle
Phase-1A	East-West	9,501	1,292	0	1,321	6,888
	North-South	722	98	0	100	524
Phase-1B	East-West	16,889	2,569	0	2,630	11,690
	North-South	918	140	0	143	636
Phase-2	East-West	61,543	11,010	0	11,288	39,245
	North-South	5,212	933	0	956	3,324

Source: JICA Study Team

Table 6.1.9 Traffic Demand by Development

Total Person Trip of Section Unit: Trip/day

East-West Section	Passenger Car	Truck	Bus	Sub Total	Motorcycle	Total
Phase-1A	5,220	0	5,335	10,555	27,827	38,382
Phase-1B	11,393	0	11,661	23,054	51,833	74,887
Phase-2	32,273	0	33,085	65,358	115,030	180,388

Total Person Trip of Section Unit: Trip/day

North-South	Passenger Car	Truck	Bus	Sub Total	Motorcycle	Total
Phase-1A	303	0	309	612	1,613	2,225
Phase-1B	619	0	634	1,253	2,818	4,071
Phase-2	2,733	0	2,802	5,535	9,743	15,278

Total Traffic Volume of Section Unit: Vehicle/day

East-West Section	Passenger Car	Truck	Bus	Sub Total	Motorcycle	Total
Phase-1A	1,338	1,600	213	3,151	19,877	23,028
Phase-1B	2,921	1,900	466	5,287	37,023	42,310
Phase-2	8,275	6,400	1,322	15,997	82,164	98,161

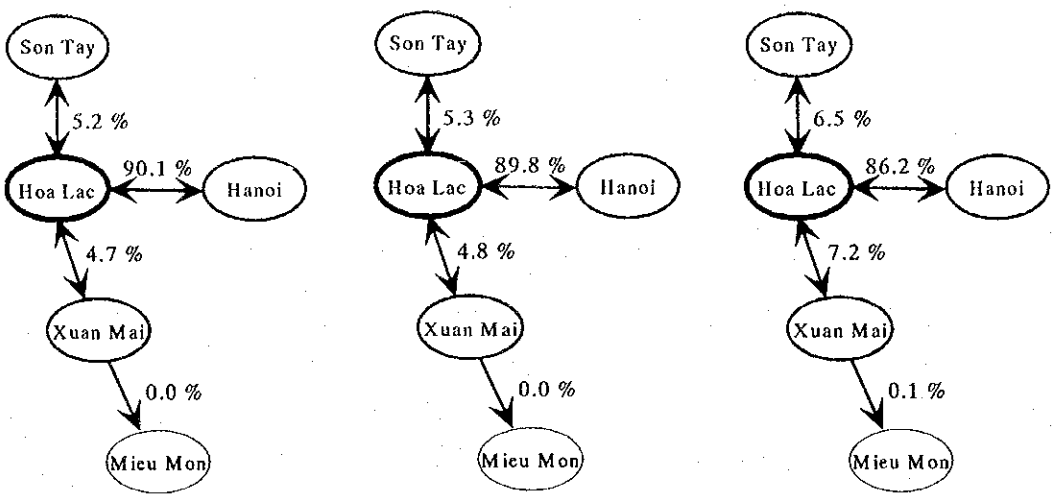
Total Traffic Volume of Section Unit: Vehicle/day

North-South	Passenger Car	Truck	Bus	Sub Total	Motorcycle	Total
Phase-1A	78	0	12	90	1,152	1,242
Phase-1B	159	0	25	184	2,013	2,197
Phase-2	701	0	112	813	6,959	7,772

Average Occupancy Rate Unit: Persons

Passenger Car	Truck	Bus	Motorcycle	Bicycle
3.90	2.18	25.03	1.40	1.05

Source: JICA Study Team



Source: JICA Study Team

Figure 6.1.3 The Ratio of Trip Distribution

d) Modal Split

The mode of vehicles is classified into 4 categories; passenger car, truck, public transport (ex: bus, etc) and motorcycle. As the result of the social survey conducted by this Study Team through interview of residents both in Hanoi and Hoa Lac, the identical future modal split ratio is applied to the work and private business as shown in Table 6.1.8. In addition, the traffic for industrial activity to/from high-tech industrial park is assumed to use only truck mode. The traffic demand by mode and purpose is shown in Table 6.1.9.

3) Traffic Demand Forecast

(a) Traffic Demand by modes

The total of person trip and traffic demand (vehicle/day) by development is summarized in Table 6.1.10. In consideration of number of trips and average occupancy rate, the traffic demand by mode is calculated. The traffic demand of High-tech Park is projected based on the average truck occupancy rate and number of trucks converted from cargo volume. The average occupancy rate of vehicles is applied

based on the "M/P of Hanoi Urban Transport Plan" by JICA in 1996. The average occupancy rate of modes is as follows: passenger car (3.9 persons/vehicle), truck (2.2 persons/vehicle), public transport (25.1 persons/vehicle) and motorcycle (1.4 persons/vehicle).

(b) The result of traffic demand by modes

The result of total traffic demand with a total of natural increase and development by modes is summarized in Table 6.1.10. In the section of east-west axis, the traffic demand including motorcycle is about 72,000 vehicles/day in 2005 and 93,000 vehicles/day in 2010. In addition, traffic demand including motorcycle in 2020 is 151,000 vehicles/day. When converted this traffic volume into Passenger Car Unit (PCU), the traffic demand is estimated about 50,000 PCU/day in 2005, 62,000 PCU/day in 2010 and 101,000 PCU/day in 2020. The PCU is assumed as passenger car (1.0 vehicle), truck (2.5 vehicle), bus (1.5 vehicle) and motorcycle (0.3 vehicle) based on the "M/P of Hanoi Urban Transport Plan".

(c) North-South Section Axis (NR 21A)

Basically, identical concept (total of natural increase and development) is applied to the traffic demand projection for north-south section axis by utilizing same method as that of east-west section axis.

The traffic demand attributed to natural increase

According to the existing traffic volume on NR 21A 1997, the total traffic volume on the sections of both national roads is less than 1,000 vehicles/day excluding motorcycles and bicycles. As the result of the forecast by natural increase, the traffic demand including motorcycle will reach about 5,000 vehicles/day in 2005, 5,500 vehicles/day in 2010, and 10,000 vehicles/day in 2020. The share of future vehicle mode is decided by applying to future vehicle growth ratio used for the traffic forecast in east-west section axis.

The traffic demand attributed to development of New Town

The share of trip distribution among four towns in the Study area and Hanoi area by purpose is estimated based on the Gravity Model method (Figure 6.1.3). The trip

distribution between Hoa Lac and Son Tay occupies about 5%, and Hoa Lac-Xuan Mai direction occupies about 5% in 2005 and 2010.

Table 6.1.10 Traffic Demand by Natural Increase and Development

(Case 1: No transferring motorcycle traffic into public transport)

East-West Section Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	17,799	21,317	91,181	130,297	76,059	206,356
Phase-1B	25,954	24,519	111,177	161,650	99,482	261,132
Phase-2	50,174	38,647	155,624	244,445	160,923	405,368

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	9,778	3,643	17,985	54,328	72,313
Phase-1B	6,655	11,247	4,442	22,344	71,059	93,403
Phase-2	12,865	17,728	6,217	36,810	114,945	151,755

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	24,446	5,464	34,474	16,298	50,772
Phase-1B	6,655	28,118	6,663	41,436	21,318	62,754
Phase-2	12,865	44,320	9,326	66,511	34,483	100,994

North-South Section Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	1,262	2,653	7,743	11,658	6,306	17,964
Phase-1B	1,743	3,068	9,353	14,164	7,509	21,673
Phase-2	4,131	3,762	13,666	21,559	14,314	35,873

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	1,217	309	1,850	4,504	6,354
Phase-1B	447	1,407	374	2,228	5,363	7,591
Phase-2	1,059	1,726	546	3,331	10,224	13,555

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	3,042	464	3,830	1,351	5,181
Phase-1B	447	3,518	561	4,526	1,609	6,135
Phase-2	1,059	4,314	819	6,192	3,067	9,259

Source: JICA Study Team

6.1.4 Concept for the First Phase Center Area Development

(1) The necessity of road improvement

The road improvement is one of the most significant infrastructure facilities for the development of Hoa Lac New Town. In this regard, improvement plan of the access road

for the New Town should be provided to cope with urban population, scale and functions. In addition, the road network will be improved in accordance with the development phase of Hoa Lac area in 2005, 2010 and 2020, respectively with high priority.

Although three main access roads including the Lang-Hoa Lac Highway, RN 6 and RN 32, extend between Hanoi and the New Town in east-west direction, the first priority for the improvement is given to the Lang-Hoa Lac Highway because the highway provides direct linkage between Hanoi and the New Town.

As the result of the future traffic demand, the necessity of road improvement plan is reviewed by comparing future road capacity and traffic demand as shown in Table 6.1.13. In the regional context of the transport network of Hoa Lac area, the traffic is classified into east-west axis and north-south axis.

1) East-West Section Axis (Lang-Hoa Lac Highway, NR6 and NR32)

According to the estimation of traffic capacity (PCU/day) of the access road as shown in Table 6.1.11, the road capacity is about 30,000 PCU /day on the east-west section axis. This capacity is estimated under the condition that the completion of the Lang-Hoa Lac Highway is completed with 2-lane by 2000 and expansion plan of NR 6 to 4-lane by 2005. The result of total traffic demand on the east-west section axis shows about 50,000 PCU /day, 62,000 PCU /day and 101,000 PCU /day in 2005, 2010 and 2020, respectively.

Considering the change of vehicle mode share in consideration of future trend, another two alternatives are made as shown in Table 6.1.12 to Table 6.1.13. On the assumption that 50% of motorcycle traffic is transferred into public transport (bus), the traffic demand is estimated about 45,000 PCU /day in 2005, 55,000 PCU /day in 2010 and 88,000 PCU /day in 2020 in the east-west section. Furthermore, a similar assumption was made to transfer 100% of motorcycle traffic into bus system. This result shows the traffic demand of about 39,000 PCU /day in 2005, 47,000 PCU /day in 2010 and 76,000 PCU /day in 2020, respectively.

Although the road capacity is expected to reach about 50,000 PCU/day in 2005, the traffic demand exceeds the future road capacity. Under the MOT improvement plan, the Lang-Hoa Lac Highway will be 2-lane, NR 6 will be 4-lane and NR 32 will be 2-lane by 2005. Nevertheless, the Lang-Hoa Lac Highway should be improved to 4-lane highway with the

highest priority by 2005 to serve as a major direct access highway between Hanoi and Hoa Lac area.

The road capacity seems to cope with traffic demand in 2010 under the development plan: the Lang-Hoa Lac Highway (4-lane), RN 6 (4-lane) and NR 32 (2-lane). Also, the road capacity manages to cope with traffic demand under the development plan in 2020: the Lang-Hoa Lac Highway (6-lane), RN 6 (4-lane) and NR 32 (4-lane) as shown in Figure 6.1.4 and Table 6.1.11 on the condition that the public transport system is reinforced.

Table 6.1.11 The Road Traffic Capacity

Name of Road	Road Class	Lane	Design Capacity (vehicle/day)	Proposed Capacity (vehicle/day)	Proposed Capacity (PCU/day)	Implementation Period Phase-1A 2005	Phase-1B 2010	Phase-2 2020
Lang-Hoa Lac Highway	Class I-II	2	9,000	9,000	6,500	○		
		4	36,000	36,000	25,900		○	
		6	54,000	54,000	38,800			○
NR6	Class I-II	2	8,000	6,400	4,600			
		4	32,000	25,600	18,400	○	○	○
NR32	Class I-III	2	8,000	6,400	4,600	○	○	
		4	32,000	25,600	18,400			○
East-West Section Axis			Future			29,500 (PCU/d)	48,900 (PCU/d)	75,600 (PCU/d)
NR21A	Class I-II	2	8,000	6,400	4,600			
	Class I-II	4	36,000	28,800	20,700	○	○	○
North-South Section			Future			20,700 (PCU/d)	20,700 (PCU/d)	20,700 (PCU/d)

Source: JICA Study Team

Table 6.1.12 Traffic Demand by Natural Increase and Development

(Case 2: Transferring motorcycle traffic (50%) into public transport)

East-West Section

Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	17,799	21,317	129,210	168,326	38,030	206,356
Phase-1B	25,954	24,519	160,918	211,391	49,741	261,132
Phase-2	50,174	38,647	236,085	324,906	80,461	405,367

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	9,778	5,162	19,504	27,164	46,668
Phase-1B	6,655	11,247	6,429	24,331	35,529	59,860
Phase-2	12,865	17,728	9,432	40,025	57,472	97,497

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	24,446	7,743	36,753	8,149	44,902
Phase-1B	6,655	28,118	9,644	44,417	10,659	55,076
Phase-2	12,865	44,320	14,148	71,333	17,242	88,575

North-South Section

Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	1,262	2,653	10,897	14,812	3,153	17,965
Phase-1B	1,743	3,068	13,108	17,919	3,754	21,673
Phase-2	4,131	3,762	20,822	28,715	7,157	35,872

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	1,217	435	1,976	2,252	4,228
Phase-1B	447	1,407	524	2,378	2,682	5,060
Phase-2	1,059	1,726	832	3,617	5,112	8,729

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	3,042	653	4,019	676	4,695
Phase-1B	447	3,518	786	4,751	805	5,556
Phase-2	1,059	4,314	1,248	6,621	1,534	8,155

Source: JICA Study Team

Table 6.1.13 Traffic Demand by Increase and Development

(Case 3: Transferring motorcycle Traffic (100%) into Public Transport)

East-West Section Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	17,799	21,317	167,240	206,356	0	206,356
Phase-1B	25,954	24,519	210,659	261,132	0	261,132
Phase-2	50,174	38,647	316,546	405,367	0	405,367

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	9,778	6,682	21,024	0	21,024
Phase-1B	6,655	11,247	8,416	26,318	0	26,318
Phase-2	12,865	17,728	12,647	43,240	0	43,240

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	4,564	24,446	10,022	39,032	0	39,032
Phase-1B	6,655	28,118	12,624	47,397	0	47,397
Phase-2	12,865	44,320	18,970	76,155	0	76,155

North-South Section Unit: trip/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	1,262	2,653	14,050	17,965	0	17,965
Phase-1B	1,743	3,068	16,862	21,673	0	21,673
Phase-2	4,131	3,762	27,979	35,872	0	35,872

Unit: vehicle/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	1,217	561	2,102	0	2,102
Phase-1B	447	1,407	674	2,528	0	2,528
Phase-2	1,059	1,726	1,118	3,903	0	3,903

Unit: PCU/day

Phase	Passenger Car	Truck	Bus	Sub-Total	Motorcycle	Total
Phase-1A	324	3,042	842	4,208	0	4,208
Phase-1B	447	3,518	1,011	4,976	0	4,976
Phase-2	1,059	4,314	1,677	7,050	0	7,050

Source: JICA Study Team

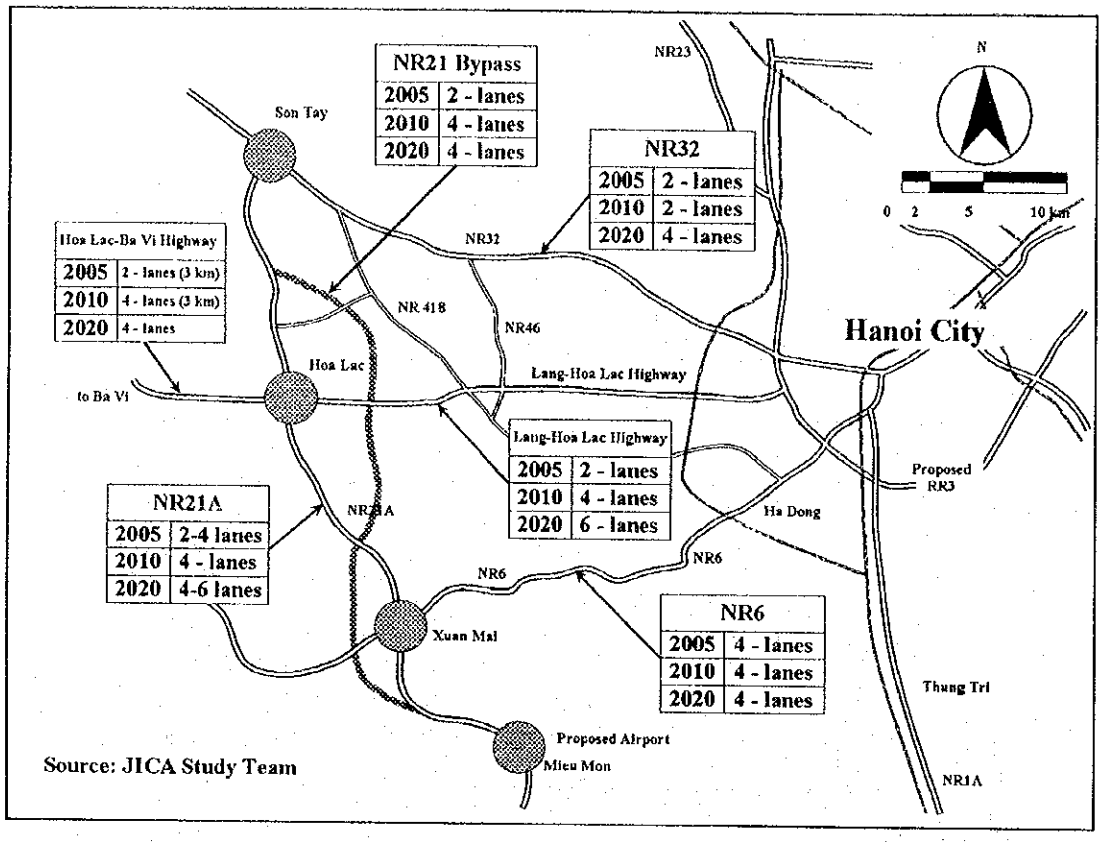


Figure 6.1.4 Improvement Plan of Access Road by Development Phase

Furthermore, the road improvement plan should include mass public transit facility reserve along the highway in consideration of introducing railway system in the future. The road improvement plan by development phase in 2005, 2010 and 2020 is illustrated in Figure 6.1.4.

The main concept of road design in the Lang-Hoa Lac Highway is to separate 4-wheel vehicles from motorcycle to enhance the traffic capacity. Furthermore, the exclusive bus lane system should be provided to conduct the efficient mass transit. In addition, the motorcycle access on the Lang-Hoa Lac Highway should be strictly controlled to function as a major highway. For this, the exclusive motorcycle lane should be provided along the highway and separated from 4-wheel vehicles by means of green stripe.

As NR6 and NR32 run through several villages, it seems to be difficult to separate motorcycle lane from 4-wheel vehicles completely due to the insufficient road expansion width. However, it is desirable that exclusive motorcycle lane should be separated by means of guardrail.

2) North-South Section Axis (NR 21A)

According to the estimation of traffic capacity (PCU/day) of road as shown in Table 6.1.11. The result of total traffic demand on NR 21A shows about 4,000 PCU /day, 6,000 PCU /day and 9,000 PCU /day in 2005, 2010 and 2020, respectively, while the existing NR 21A has the road capacity of about 5,000 PCU /day.

Considering the future transformation of modal split, another two alternatives are made similar to the case of east-west section traffic as shown in Tables 6.1.12 and 6.1.13. On the assumption that 50% of motorcycle mode is transferred into public transport (bus), the traffic demand is estimated about 5,000 PCU per day in 2005, 6,000 PCU per day in 2010 and 8,000 PCU per day in 2020. In addition, the traffic demand is forecasted as about 4,000 PCU per day in 2005, 5,000 PCU per day in 2010 and 7,000 PCU per day in 2020 on the assumption that 100% of motorcycle traffic in transferred into bus system. The comparison of traffic demand and road capacity is shown in Figure 6.1.5.

In accordance with concept plan of urban development in the Hoa Lac area, the development corridor will be formed toward south-north axis along NR 21A. Moreover, NR 21 Bypass is proposed towards south-north axis in parallel with NR 21A in the east to separate daily life traffic from mainly industrial and through traffic. As the result of the traffic demand forecast, the north-south section traffic demand is not that high, compared to the east-west traffic demand. Nevertheless, the road infrastructure improvement in Hoa Lac area is proposed in consideration of urban population, function and scale by development phase.

(a) Improvement of NR 21A

NR 21A will be developed as a main corridor of Hoa Lac New Town. The main function of NR 21A is to serve mainly for daily life route for the Hoa Lac New Town. The NR 21A will serve as a major corridor, linking to Son Tay, Hoa Lac, Xuan Mai and Mieu Mon town.

The main concept of NR 21A road plan is to meet the traffic needs and urban function in Hoa Lac areas, particularly in the Center Area. The road capacity is planned to cope with increasing traffic demand of internal trips in Hoa Lac area along with the development. As for the road section plan in north-south axis, the exclusive bus lane in the central section of this road is also offered. The space for the exclusive bus lane can

be possibly converted into railway in the future. In addition, the motorcycle and passenger car traffic can share the lane in each side of carriage-way. However, it is desirable to control motorcycle traffic from passenger car by means of guardrail.

In terms of the road section plan, the segment of boulevard with about 3km long is provided for exclusive bus system with 2-lane along with the center of road. In addition, 6-lane road will be offered for motorcycle and passenger car on this road. Furthermore, bicycle lane and pedestrian street will be provided along the carriage-way as shown in Figure 6.1.9.

As for the improvement plan by phase, the improvement of exclusive bus lane has the first priority. In this sense, the improved NR 21A can be utilized the bus lane. Moreover, the road for motorcycle and passenger car, and pedestrian street should be developed by the phases.

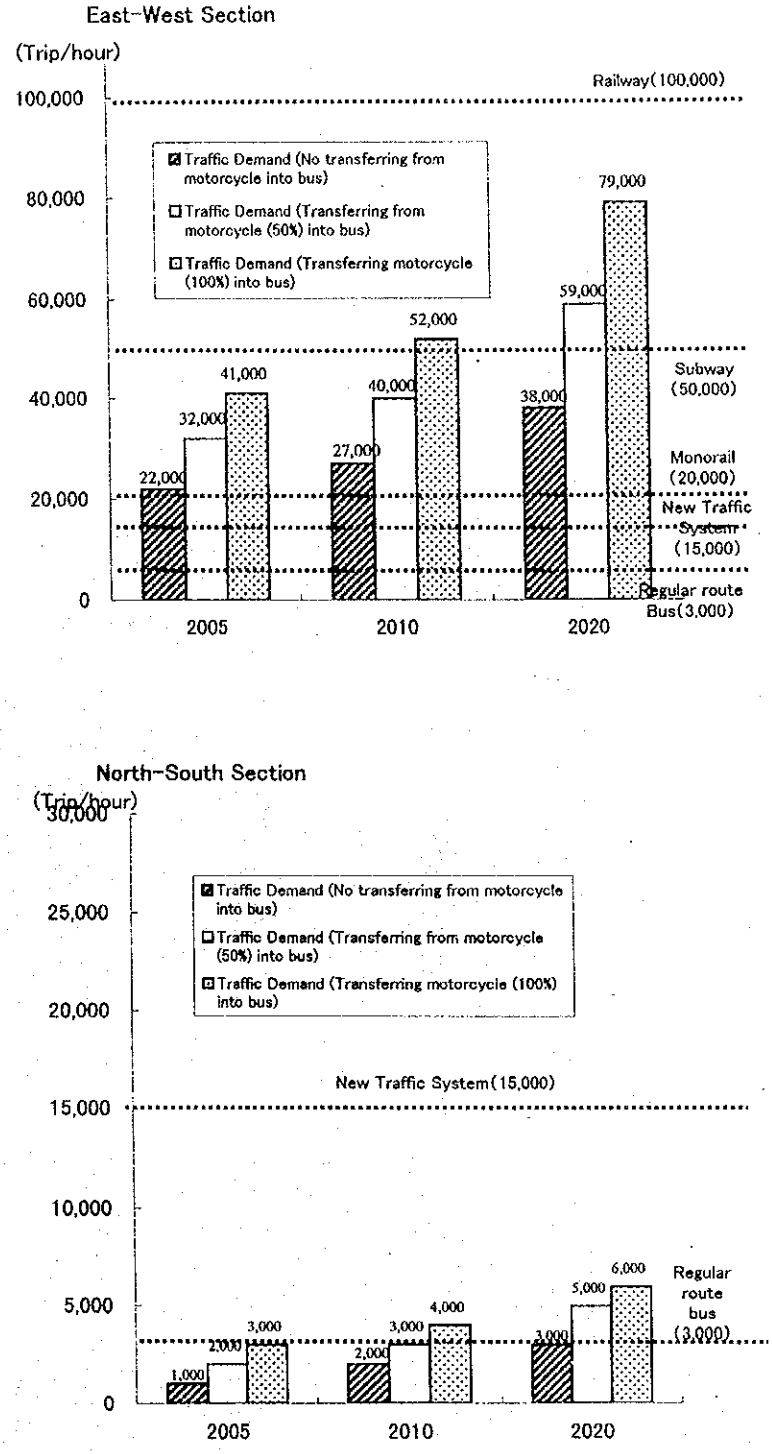
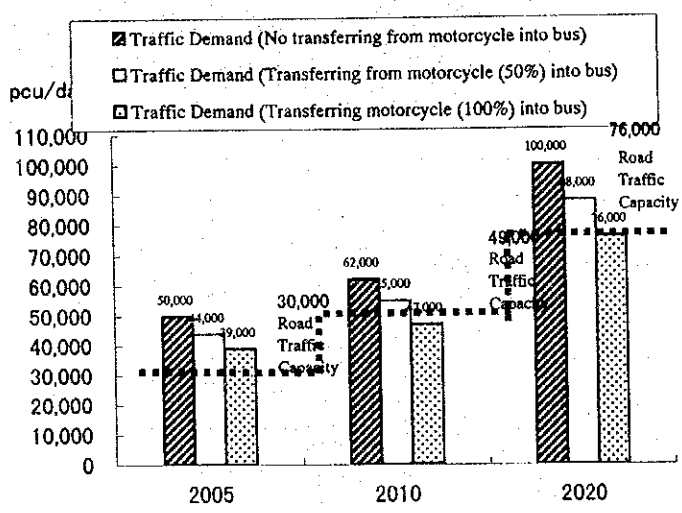


Figure 6.1.5 A Comparison of Traffic Demand and Transporting Capacity by Public Transport

East-West Section



North-South Section

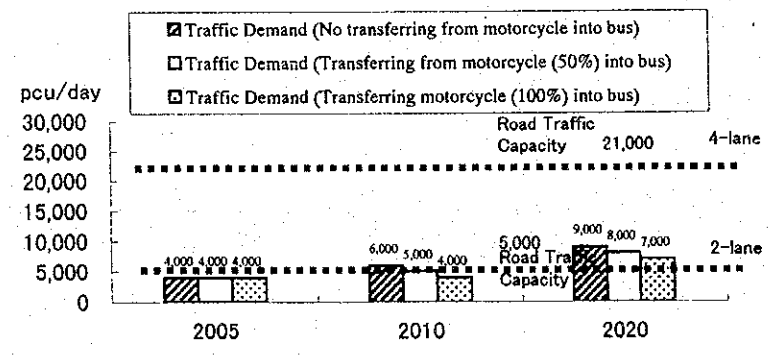


Figure 6.1.6 A Comparison of Traffic Demand and Road Capacity

(b) Improvement of NR 21 Bypass

The main role of this Bypass is to serve as a regional industrial road. The improvement of NR 21 Bypass implies significance because the Bypass is directly connected with the Lang-Hoa Lac Highway without penetrating into Hoa Lac Center Area. For this reason, the cargo distribution service by truck of HHTP and Put Cat Industrial Area is expected to be efficiently carried out through proposed NR 21 Bypass. Furthermore, the through traffic in the north-south direction can use this Bypass, which will relieve the traffic congestion in NR 21A. In the future, this NR 21 Bypass will be linked toward north as a part of outer ring road in Hanoi region. Moreover, the NR 21 Bypass will be linked to the proposed North-South Highway to the southward in the future.

As for the Bypass road plan by development phase, the improvement of this Bypass is necessary to promote industrial activity in this area in accordance with development of the industrial zone and high-tech park in the future. Nevertheless, the arterial road that will be constructed in the early stage, in parallel with the proposed NR 21 Bypass, seems to cope with the traffic demand in the near future. The full completion of proposed NR 21 Bypass with about 14km is expected to be after 2020.

(2) The Necessity of Public Transport System

The necessity of public transport system is reviewed based on the traffic demand forecast. In consideration of changing current vehicle mode ratio along with future trend, three cases are reviewed. The case-1 is no change of modal ratio as forecasted, while case-2 is transferring 50% of motorcycle traffic into public transport mode. The third case is transferring 100% of motorcycle traffic into public transport mode. A comparison is made between traffic demand and transporting capacity of public transport system as shown in Figure 6.1.5.

1) East-West Section Axis (Lang-Hoa Lac Highway, NR6 and NR32)

The traffic demand of total public transport is about 91,000 trip/day, 111,000 trip/day and 155,000 trip/day in 2005, 2010 and 2020, respectively as shown in Table 6.1.10. Under the assumption that the traffic demand is concentrated in the morning peak time (per hour) in one way with 50% of total traffic demand, the traffic demand of public transport is considered about 22,000 trip/hr., 27,000 trip/hr. and 38,000 trip/hr. in 2005, 2010 and 2020

(Figure 6.1.5), respectively. Also, under the assumption of transferring 50% of motorcycle traffic into public transport, the traffic demand of public transport is estimated 32,000 trip/hr. in 2005, 40,000 trip/hr. in 2010, and 59,000 trip/hr. in 2020, respectively. The higher traffic demand is observed in case of transferring 100% of motorcycle traffic into public transport.

2) North-South Section Axis (NR 21A)

The traffic demand of total public transport is about 8,000 trip/day, 10,000 trip/day and 14,000 trip/day in 2005, 2010 and 2020 (Table 6.1.10), respectively. Moreover, on the assumption that 50% of motorcycle is transferred into bus system, the traffic demand of public transport is about 11,000 trip/day, 13,000 trip/day and 21,000 trip/day in 2005, 2010 and 2020 (Table 6.1.12), respectively.

Under the identical assumption of east-west section traffic axis for traffic demand in peak hour, the traffic demand of public transport is 2,000 trip/hr., 3,000 trip/hr. and 4,000 trip/hr. in 2005, 2010 and 2020, respectively. In case that 50% of motorcycle mode is transferred into bus system, the traffic demand of public transport is 3,000 trip/hr., 4,000 trip/hr. and 5,000 trip/hr. in 2005, 2010 and 2020, respectively. The maximum transport capacity of a bus on a regular route is about 3,000 trip/hour in general. Based on this result, the public transport by bus system seems to cope with the public transport demand by 2005. However, more efficient bus network is necessary after 2005 to make the best of public transport system.

3) Public Transport Network

Along with the road improvement plan, the transport policy should be offered to conduct efficient transport system. In case of the Lang-Hoa Lac Highway, the future road improvement plan includes 6-lane highway in 2020. Although the total road capacity of the access roads (Lang-Hoa Lac Highway, NR 6 and NR 32) seems to cope with traffic demand in east-west section in 2010-2020, the traffic volume is possibly concentrated on the Lang-Hoa Lac Highway in consideration of easy access and minimal trip distance between Hanoi and Hoa Lac area. For this reason, the reinforcement of public transportation is required on the Lang-Hoa Lac Highway to realize efficient transport system.

Among the public transport, bus system is considered as one of the most economic and flexible transport mode. However, the rapid transformation from motorcycle mode to

public transport seems to be difficult due to the lifestyle with high dependency on motorcycle mode in Vietnam. Thus, the partial control of motorcycle access in highway and arterial road is necessary to reinforce bus system.

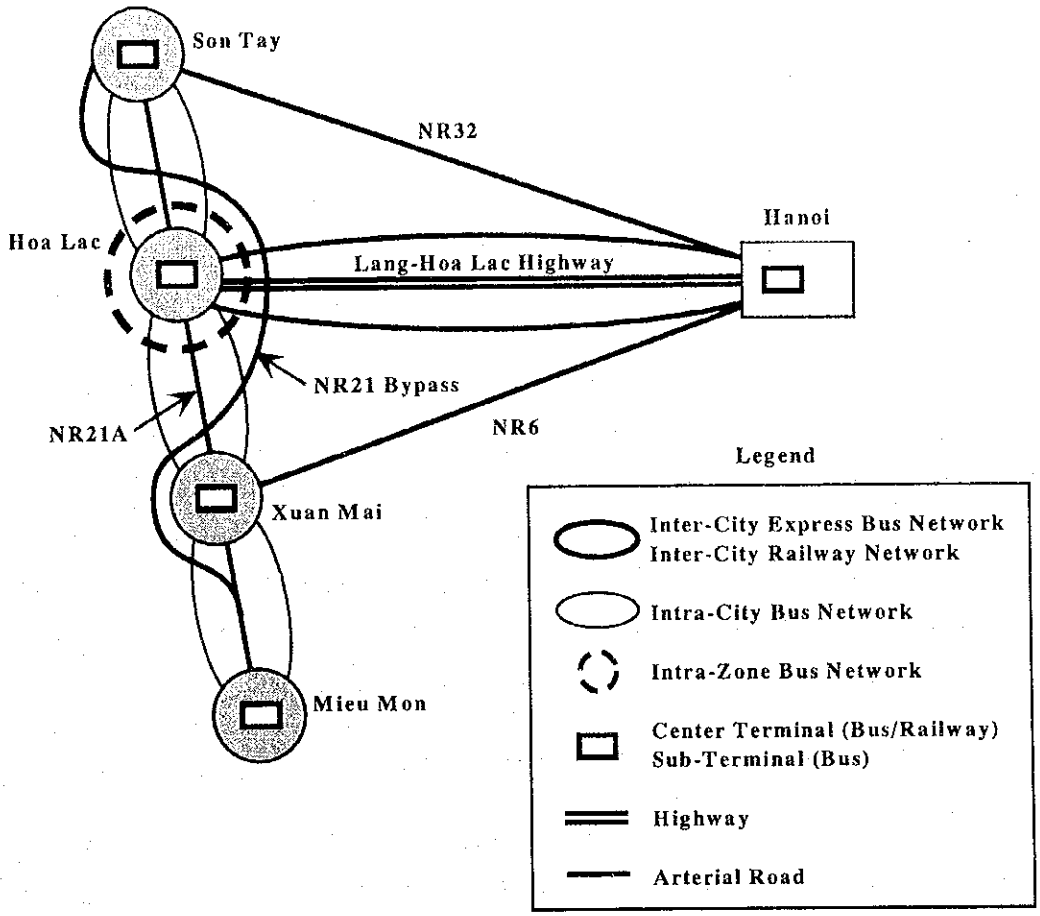


Figure 6.1.7 The Concept of Public Transport Network

In addition, the railway system should be introduced in east-west section in the long-term view. However, it is noted that the first priority of public transport system by bus in the initial development stage should be highly taken into consideration. This idea implies that public transport system by bus mode reflects the minimal capital investment compared with other public transport system. Furthermore, the bus system can be applied to flexible route modification in accordance with the future traffic demand. In this regard, the following measures should be carefully considered in order to encourage public bus transportation system.

A successful phenomenon by public bus system has been observed in Curitiba City with a population of approximately 1.6 million in Brazil. The transportation system has been secured in consideration of bus-oriented road network and land use control, etc. In addition, various countermeasures have been taken by introducing articulated buses, efficient bus terminal layout and exclusive bus lane to encourage efficient public transport and release traffic congestion in urban areas.

(3) Considerations to encourage Public Transportation by Bus System

1) Separation of 4-wheel vehicles from motorcycle

Currently, one of the major constraints of traffic congestion in urban areas of Vietnam is the mix of various vehicle modes on the arterial road. In order to solve this constraint, the motorcycle traffic should be controlled on the major arterial road. In particular, 4-wheel vehicles lane should be separated from motorcycle lane on the Lang-Hoa Lac Highway for smooth traffic flow of 4-wheel vehicles. For this reason, it is desirable to provide additional motorcycle and local traffic lane in parallel with the highway. Nevertheless, the separation can be temporarily made by means of guardrail if the construction cost for exclusive motorcycle and local traffic lane is high as a subsidiary road.

2) Introduction of exclusive bus lane / priority bus lane

The exclusive bus lane / priority bus lane system is required for an express bus service on the highway. In order to introduce the express bus system on the Lang-Hoa Lac Highway, the minimum 4-lane road should be secured in the early stage. If there is a difficulty in providing exclusive bus lane (in the first stage) due to the volume of truck and passenger car traffic, the priority bus lane system can be applied to the highway during the rush hours as an alternative countermeasure of exclusive bus lane system.

As an illustration of bus system in Curitiba City mentioned above, the maximum transporting capacity by articulate bus is estimated as about 15,000 passengers/hour/lane in Curitiba, while regular bus can carry about 3,000 passengers per hour.

3) Provision of Express Bus Terminals

Under the assumption that the bus system occupies 100% of public transport mode as a result of traffic demand, about 13 regular buses should operate per minute in east-west section during peak-hours in 2005. Also, about 17 regular buses should operate per

minutes in 2010. If bus operates by one terminal, the congestion may cause during the peak-hours. For this reason, approximately 4-5 terminals with regular bus operation are required to accommodate passengers in Hanoi and Hoa Lac areas, respectively. Nevertheless, the number of terminals can be adjusted by introducing articulated bus with upgraded transporting capacity. Furthermore, the smooth traffic flow is expected on the highway with exclusive bus lane system. The terminals are composed of a main terminal, sub-terminals and district sub-terminals (Figure 6.1.9).

The express bus terminals should be located nearby the Lang-Hoa Lac Highway entrance. The express main bus terminal is directly linked to the highway and, this allows direct access to the highway. Also, access of the truck and passenger car is also allowed from local road. In addition, motorcycle traffic is controlled on the highway.

According to the Master Plan of Hanoi in 2020 by MOC, Me Tri on the junction of ring road 3 and the Lang-Hoa Lac Highway will be a focal point of train station toward Hoa Lac area to the west. Also, as there is a green space reserve around Me Tri, the ideal location of bus terminal can be considered near Me Tri. In the future, Me Tri is expected to be a hub of transportation including road and railway station.

Introduction of articulated bus

The introduction of special bus such as double and triple articulated bus are highly considered rather than regular bus operation to increase the transporting capacity of passengers. A triple-articulated bus has the capacity of carrying maximum 270 passengers/hour while a regular bus can carry about 50 passenger/ hour. In case of introducing articulated bus system, the proposed number of bus terminals can be decreased.

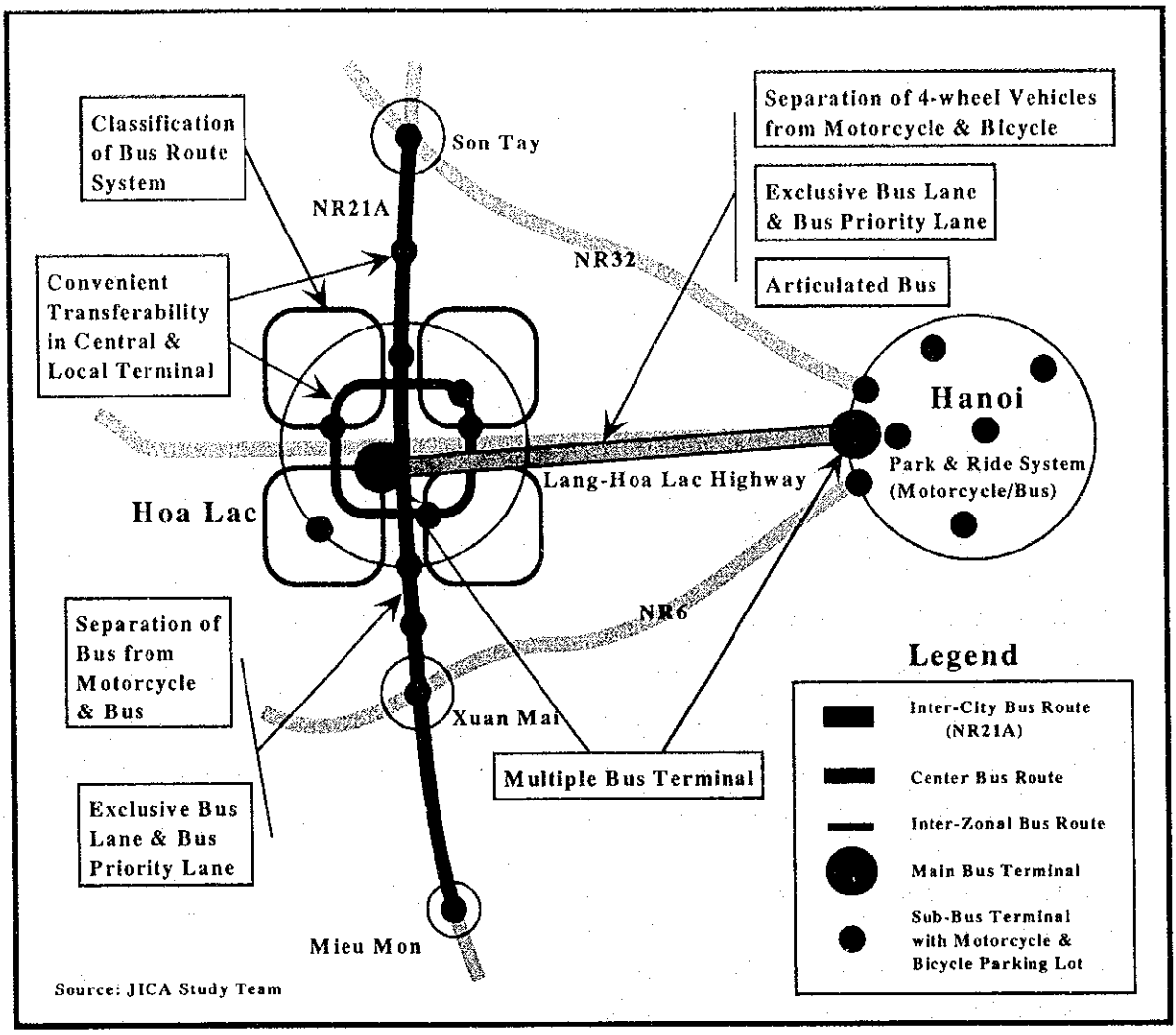
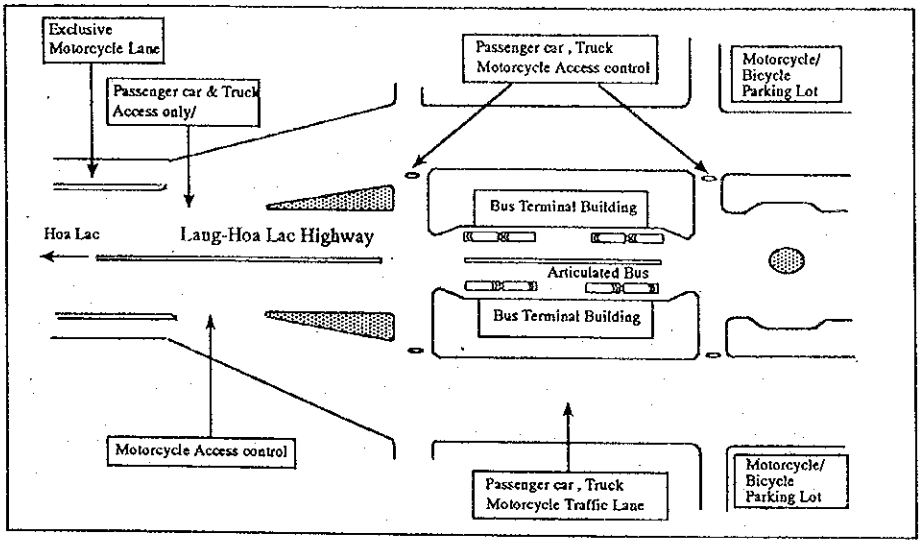
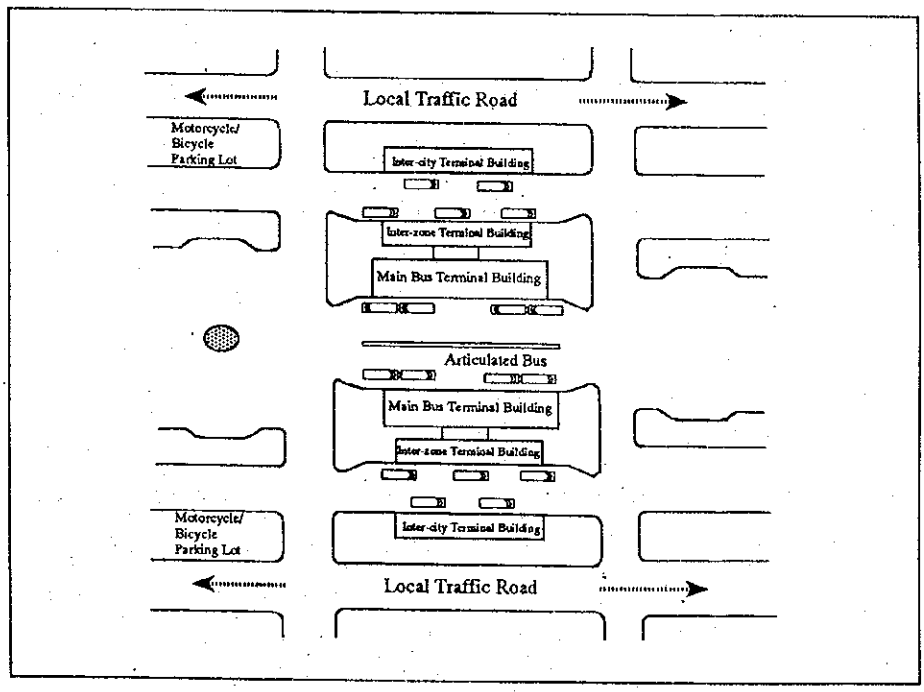


Figure 6.1.8 The Consideration on Reinforcing Public Transportation By Bus System



Hanoi Main Bus Terminal Layout



Hoa Lac Main Bus Terminal Layout

Figure 6.1.9 Bus Terminal Layout Plan

4) Convenient Transferability of Bus Network

The terminals of inter-city, intra-city, inter-zone and intra-zone route should be physically connected in same or adjacent buildings in order to carry out convenient transferability in order to easily accessible to the final destination between Hanoi and Hoa Lac area. Moreover, the one-ticket service is desirable to reach final destinations conveniently regardless of the number of transfer.

5) Provision of park-and-ride system

The bus terminals should be located at the outskirts of Hanoi to relieve traffic congestion in the central Hanoi. The motorcycle and bicycle are considered as the major access transport mode for commuter to the terminals for Hoa Lac in the near future. Considering this trend, the parking lots for motorcycles and bicycles also should be secured near the bus terminals. Nevertheless, the link between central Hanoi to and terminals should be provided by public bus or train (subway) system in the future to relieve traffic congestion in the Central Hanoi.

6) Provision of road/railway reserve for future

The reserved space for road/railway expansion should be provided to meet the traffic demand in the future. In the long-term view, the railway reserve should be secured to introduce mass-transit system in this section. However, the railway reserve space can be temporarily utilized for exclusive bus lane.

(4) Consideration on Introducing Railway

According to the Master Plan of Hoa Lac New Town development by MOC, the population of the town is estimated approximately 1 million people in 2020. The completion of the Lang-Hoa Lac Highway is expected to serve as a major access highway along with the improvement of NR6 and NR32 for the New Town. However, it is necessary to consider the development of mass transit system on the condition that the road capacity is fully occupied on a long-term basis. Also, advanced mass transit system should be introduced to promote the New Town's development and ensure efficient mobility of the resident, commuters and visitors between Hanoi and the New Town in the future.

Although initial investment cost for railway development is high, this railway system is regarded as one of the most efficient transport modes by conducting rapid and mass transit service. Therefore, an introduction of Mass Railway Transit (MRT) system is considered

in the middle-and-long term development stage to meet the future traffic demand for the scale of the New Town. The outline of railway system includes type of train, transporting capacity, rail alignment, location of station, construction and major factors for construction cost estimate, etc.

1) Type of train

The introducing mode of train will be electrically-operated standard train formation rather than monorail, Light Rail Transit (LRT) or Hi-Speed Surface Transport (HSST) systems in consideration of operational distance, capacity of transporting passengers and construction cost, etc.

2) Transporting capacity

The transporting capacity is decided mainly based on the traffic demand forecast. In this Study, the railway system is considered only passenger transport purpose. For the new railway construction, the provision of facilities that includes railway, bridges, station and type of train are important factors. During the peak hour, the occupancy ratio is assumed to be about 150 %. In addition, the formation of rail car is considered as maximum10-12 cars in general. The running interval is assumed to be 10-15 minutes at peak hours. Also, about maximum 30 minutes interval is desirable at off-peak hours to enhance service level. With this railway system, the transporting capacity can reach about 100,000 passenger per hour.

3) Rail alignment

Basically, the railway alignment will be designed in parallel with the Lang-Hoa Lac Highway route to the west without at-grade cross-section. In general, tunnel construction cost occupies the highest proportion for the civil construction of railway. In most section of Hanoi-Hoa Lac, the railway can be constructed on the ground level due to topographically flat agricultural areas. Nevertheless, over-cross bridge in the intersection of RN 418 and RN 46 should be constructed. Also, the construction of bridge in the intersection of Day River and Tich River are necessary, as well.

Furthermore, detailed study should be conducted focusing on natural conditions such as topographic, geographic and hydrological survey, etc. as well as social and economic study in order to determine the optimal alignment of new railway for the reason that the engineering design criteria of highway and railway are different.

The underground level section will be constructed with several kilometers before the proposed interchange at the NR 21 Bypass and the Lang-Hoa Lac Highway to avoid crossing at-grade at the interchange and Hoa Lac intersection. This underground railway extends to Ba Vi area by way of the Hoa Lac central station in the center area in the future.

4) Location of station

The JICA Study of "M/P for Urban transport for Hanoi City" has completed in 1997. the study includes the plan of Central Hanoi-Me Tri section route by railway is proposed for urban Hanoi. In this regard, the railway runs through Central Hanoi, Me Tri, sub-regional town near Quoc Oai, Hoa Lac Center, University area and Ba Vi area. The existing Quoc Oai has a locational potential to be a sub-regional town such as an agricultural distribution core between Hanoi and Hoa Lac area. The location of proposed station of the Lang-Hoa Lac railway is considered as followings.

Central Hanoi-Me Tri (the Junction of Ring Road 3) Station-Potential Sub-regional Town Station-Hoa Lac Central Station (near northeast end of residential zone)-VNU Station (1 or 2 stations)-Cultural Village Station-Ba Vi National Park Station.

5) Construction Period (2015-)

In the first stage, the construction route will be Hanoi-Hoa Lac section with approximately 31 km long from 2015. In the next stage, the Hoa Lac-Ba Vi section with about 12km long will be constructed along with the development of Ba Vi National Park and the Cultural Village in the New Town.

(5) Road Improvement Cost Estimate

1) Lang-Hoa Lac Highway

Although the construction cost of the Lang-Hoa Lac Highway is not directly included for the development of the New Town, the cost is reviewed because the highway serves as a major access road for the New Town. For this project, the feasibility study on the Lang-Hoa Lac Highway has been conducted by the Transport Engineering Design Incorporation (TEDI) under the Ministry of Transport in August 1995. The cost estimate for the Lang-Hoa Lac Highway is available from the feasibility study.

The construction scope includes the total construction of highway from Hanoi to Hoa Lac NR 21A Intersection with a length of 30km. The urban segment between Hanoi and the

junction of HN Ring Road 3 is provided with 8-lane road, while the segment between the junction of HN Ring Road 3 and NR 21A intersection is provided with 6-lane road as shown in Table 6.1.14.

Table 6.1.14 Construction Scope of Lang-Hoa Lac Highway

Section	Road length	Road width	Cross-section
Hanoi-Ring Road 3	1.9km	60.0m	8-lane
Ring Road 3-NR 21A intersection	28.1km	35.5m	6-lane
Total (Hanoi- NR 21A intersection)	30.0km		

According to the feasibility study, the cost estimate is summarized as follows. However, the construction cost is the rate in 1995, the cost was converted into the price of 1997 in consideration of GDP annual growth rate by 10 % per annum.

Table 6.1.15 Construction Cost Estimate of Lang-Hoa Lac Highway

Description	Phase I (- 2005) VND billion	Phase II (2006-2010) VND billion	Phase I and Phase II VND billion	Phase I and Phase II US$ million
Construction and Installation	762.41	0.00	762.41	54.85
Other Construction	129.35	0.00	129.35	93.06
Preservation Budget	86.37	0.00	86.37	6.21
Outside-fence Total (1995 price)	978.13	138.33	1,116.46	80.32
Outside-fence Total (1998 price)	1,301.89	183.97	1,484.89	100.68

The investment consists of inside item (inside boundary) and outside item (outside boundary). The outside item was counted on existing facilities in consideration of social aspect. The total construction cost is approximately VND 1,484.89 billion (equivalent to US$ 100.68 million) in 1998 price.

2) On-Site Road Improvement Cost Estimate

The cost for the road improvement of the Hoa Lac and Xuan Mai New Town is estimated. The improving road is classified into internal and external road. The internal road includes four zones around center area and external road includes the Lang-Hoa Lac Highway access segment with 4.5km, NR 21A and NR6 in Hoa Lac and Xuan Mai area. In addition, the construction of an interchange and bus terminals is considered.

The improving road length by type of road and its road area in Hoa Lac area is shown in Tables 6.1.16 and 6.1.17. Also, the improving road length and its road area in Xuan Mai area is shown in Tables 6.1.18 and 6.1.19.

The unit cost of road construction per square meter includes direct and indirect cost at the price of 1998. Furthermore, the unit cost also includes engineering design and supervision cost with the ratio of 12% of the total direct and indirect cost. Nevertheless, the land acquisition and compensation cost are not considered in this Study.

Based on the above result, the road improvement cost is estimated by development phase. The total cost for the road improvement by 2005 is approximately US$ 131,684,000. In the mid-term phase between 2006 and 2010, the cost estimate is about US$ 107,910,000. Furthermore, the cost estimate for the road improvement in 2011-2020 is approximately 226,219,000. As a result, the total cost of the road improvement for the Hoa Lac and Xuan Mai New Town is estimated approximately as US$ 465,813,000 (equivalent to6,474.8 billion VND) as shown in Table 6.1.20.

3) Railway Cost Estimate

From the recent experience of railway improvement study in Asian countries, the railway cost is estimated. The construction cost for single track is approximately US$ 1,558,000 per kilometer including rail, sleeper and civil construction materials, etc. In case of double track railway, the construction cost per kilometer is approximately US$ 2,641,000 (1.7 times of single track cost). In consideration of safety coefficient (2.0), the construction cost for single track per kilometer is approximately US$ 3,116,000, while the construction cost for double track per kilometer is approximately US$ 5,282,000.

In addition, signal and communication facility cost is approximately US$ 2,117,000 per kilometer. Furthermore, the cost for electric facilities is approximately US$ 883,000 per kilometer for double track in case of introducing electric railway system. From above, the total railway construction cost between Hanoi and Hoa Lac with 30km is US$270.5 million for single track and US$335.5 million for double track, respectively as shown in Table 6.1.21.

Table 6.1.16 Road Length for Improvement in Hoa Lac Area

Hierarchy (function) of Road / Specific Road/Area	Planned ROW (w=m)	Phase-1A Length (m)	Phase-1A Imp. width (m)	Phase-1A Area (m2)	Phase-1B Length (m)	Phase-1B Imp. width	Phase-1B Area (m2)	Phase-2 Length (m)	Phase-2 Imp. width	Phase-2 Area (m2)
I Regional Road		0		0	0		0	18,500		518,000
NR21 Bypass	28	0	0	0	0	0	0	18,500	28	518,000
II Urban Arterial Road-1		26,680		796,090	24,380		751,985	13,230		103,200
1 Lang-Hoa Lac Highway (side of the center)	90	4,150	51	211,650	4,150	8	31,125	0	(90: railway)	
(Urban Center Area)	55	2,300	55	126,500	0	0	0	0	(Underground-railway)	
2 Hoa Lac-Ba Vi Highway (outside the Area)	70	7,000	13	87,500	7,000	43	297,500		(70: railway)	
3 NR 21A (Urban Center Area)	80	2,790	28	78,120	2,790	32	89,280	2,790	20	55,800
(Center to the South)	70	4,740	28	132,720	4,740	32	151,680	4,740	10	47,400
(Center to the North)	60	5,700	28	159,600	5,700	32	182,400	5,700	0	0
III Urban Arterial Road-2		19,930		818,700	15,560		620,750	22,050		849,650
Planned ROW =45m	45	12,240	45	550,800	6,330	45	284,850	3,210	45	144,450
1 Vietnam National University (VNU)		1,440		64,800	820		36,900	0		0
2 Hi-tech Industrial Park		5,830		262,350	2,030		91,350	0		0
4 Dong Xuan Area		1,480		66,600	970		43,650	0		0
3 Put Cat Industrial Area		3,490		157,050	2,510		112,950	3,210		144,450
Planned ROW = 40 m	40	3,720	40	148,800	5,900	40	236,000	14,000	40	560,000
1 Vietnam National University (VNU)		2,090		83,600	1,720		68,800	3,150		126,000
2 Hi-tech Industrial Park		180		7,200	1,100		44,000	7,620		304,800
4 Dong Xuan Area		1,090		43,600	1,550		62,000	3,230		129,200
3 Put Cat Industrial Area		360		14,400	1,530		61,200	0		0
Planned ROW = 30 m	30	3,970	30	119,100	3,330	30	99,900	4,840	30	145,200
1 Vietnam National University (VNU)		0		0	640		19,200	710		21,300
2 Hi-tech Industrial Park		3,970		119,100	2,020		60,600	1,460		43,800
4 Dong Xuan Area		0		0	0		0	1,710		51,300
3 Put Cat Industrial Area		0		0	670		20,100	960		28,800
IV Urban Arterial Road-3	23	11,780	23	265,050	8,780	23	197,550	17,430	23	392,175
1 Vietnam National University (VNU)		6,320		142,200	3,580		80,550	4,420		99,450
2 Hi-tech Industrial Park		2,750		61,875	1,220		27,450	5,330		119,925
4 Dong Xuan Area		2,710		60,975	2,240		50,400	2,470		55,575
3 Put Cat Industrial Area		0		0	1,740		39,150	5,210		117,225
V Collector Road	17	7,400	17	122,100	8,020	17	132,330	23,690	17	390,885
1 Vietnam National University (VNU)		0		0	0		0	4,590		75,735
2 Hi-tech Industrial Park		1,570		25,905	1,740		28,710	5,160		85,140
4 Dong Xuan Area		2,600		42,900	550		9,075	6,400		105,600
3 Put Cat Industrial Area		3,230		53,295	5,730		94,545	7,540		124,410
VI Access Road	7.5/6.0	9,790		73,425	10,370		77,775	29,720		222,900
1 Vietnam National University (VNU)		0		0	0		0	4,400		33,000
2 Hi-tech Industrial Park		3,530		26,475	4,510		33,825	5,060		37,950
3 Dong Xuan Area		3,460		25,950	1,330		9,975	16,800		126,000
4 Put Cat Industrial Area		2,800		21,000	4,530		33,975	3,460		25,950
Total of Categories III to VI		48,900		1,279,275	42,730		1,028,405	92,890		1,855,610
1 Vietnam National University (VNU)		9,850		290,600	6,760		205,450	17,270		355,485
2 Hi-tech Industrial Park		17,830		502,905	12,620		285,935	24,630		591,615
3 Dong Xuan Area		11,340		240,025	6,640		175,100	30,610		467,675
4 Put Cat Industrial Area		9,880		245,745	16,710		361,920	20,380		440,835
VII Total		75,600		2,075,365	67,100		1,780,390	41,019		2,477,000

Remark: Imp. Width (m) are the proposed improvement width within the Planned Right of Way on each Phase.

Table 6.1.17 Road Area for Improvement in Hoa Lac Area

Hierarchy (function) of Road / Specific Road/Area	Planned ROW (w=m)	Phase-1A Length (m)	Phase-1A Imp. width	Phase-1A Area (m2)	Phase-1B Length (m)	Phase-1B Imp. width	Phase-1B Area (m2)	Phase-2 Length (m)	Phase-2 Imp. width	Phase-2 Area (m2)
I Regional Road		3,220		124,600	1,820		36,400	9,600		268,800
NR21 Bypass	28.0							9,600	28.0	268,800
NR6	50.0	1,400	50.0	70,000	0	0.0	0	0	0.0	0
Temporal improvement		1,820	30.0	54,600	1,820	20.0	36,400	0		0
II Urban Arterial Road		15,200		432,000	14,000		423,000	11,580		312,150
Urban Arterial Road-1: NR21A	60.0	10,000	28.0	280,000	10,000	32.0	320,000	0	0.0	0
Temporal improvement		400	20.0	8,000	400	40.0	16,000	0		0
Urban Arterial Road-2 (w=30m	30.0	4,800	30.0	144,000	800	30.0	24,000	6,880	30.0	206,400
Urban Arterial Road-3 (w=22.5	22.5	0	22.5	0	2,800	22.5	63,000	4,700	22.5	105,750
III Collector Road (w=16.5m)	16.5	2,070	16.5	34,155	5,400	16.5	89,100	10,900	16.5	179,850
IV Access Road (w=7.5/6.0m)	7.5/6.0	750		5,400	250		1,800	2,500		18,000
III Total		21,200		596,000	21,500		550,000	34,600		779,000

Remark: Imp. Width (m) are the proposed improvement width within the Planned Right of Way on each Phase.

Table 6.1.18 Road Length for Improvement in Xuan Mai Area

(unit:m)

	2005				2010				2020			
	Type of Road (ROW)				Type of Road (ROW)				Type of Road (ROW)			
	30m	22.5m	16.5m	Total	30m	22.5m	16.5m	Total	30m	22.5m	16.5m	Total
I Internal Road Xuan Mai Area	0	4700	2,070	6,770	0	6,470	5,400	11,870	0	6,010	10,900	16,910
II External Road 1 NR 6	1400	0	0		0	0	0		1820	0	0	
New Expansion of NR6 2 NR 21A	400	0	0		0	0	0		10,000	0	0	
New Expansion of NR21A 3 Sub-total	1,800	0	0		0	0	0		11,820	0	0	
III Total	1,800	4,700	2,070	6,770	0	6,470	5,400	11,870	11,820	6,010	10,900	16,910

Note: /1 NR21A&NR6 section is considered only expansion area.

Table 6.1.19 Road Area for Improvement in Xuan Mai Area

(unit:m2)

	2005				2010				2020			
	Type of Road (ROW)				Type of Road (ROW)				Type of Road (ROW)			
	30m	22.5m	16.5m	Total	30m	22.5m	16.5m	Total	30m	22.5m	16.5m	Total
I Internal Road Xuan Mai Area	0	105,750	34,155	139,905	0	145,575	89,100	234,675	0	135,225	179,850	315,075
II External Road 1 NR 6	42,000	0	0	42,000	0	0	0	0	1820	0	0	1,820
NR6 (Widening) 2 NR 21A	12,000	0	0	12,000	0	0	0	0	10,000	0	0	10,000
NR21A (Widening) 3 Sub-total	54,000	0	0	54,000	0	0	0	0	11,820	0	0	11,820
III Total (m2)	54,000	105,750	34,155	193,905	0	145,575	89,100	234,675	11,820	135,225	179,850	326,895
Total (ha)	5.4	10.6	3.4	19.4	0.0	14.6	8.9	23.5	1.2	13.5	18.0	32.7

Table 6.1.20 Cost Estimate for Road Improvement

	Unit	Length of Road				Development Area/Number				unit cost	Construation Cost (US$1,000)			
		Phase-1A	Phase-1B	Phase-2	Total	Phase-1A	Phase-1B	Phase-2	Total	($/m2)	Phase-1A	Phase-1B	Phase-2	Total
I Regional Road		1,600	1,960	28,100	31,660	131,400	41,200	786,807	959,400		14,700	6,500	78,800	100,000
Hoa Lac Area		0	0	18,500	18,500	0	0	518,005	518,000		0	0	51,900	51,900
1 21 Bypass	m2	0	0	18,500	18,500	0	0	518,000	518,000	100	0	0	51,800	51,800
2 Interchange	LS					0	0	5		10,000	0	0	100	100
Xuan Mai Area		1,400	1,820	9,600	12,820	124,600	36,400	268,802	429,800		9,300	2,700	26,900	38,900
1 NR 6 (Widening)	m2	1,400	1,820	0	3,220	124,600	36,400	0	161,000	75	9,300	2,700	0	12,000
2 21 Bypass	m2	0	0	9,600	9,600	0	0	268,800	268,800	100	0	0	26,900	26,900
3 Interchange	LS							2		10,000	0	0	0	0
Bridges	m2	200	140	0	340	6,800	4,800	0	11,600	800	5,400	3,800	0	9,200
II Urban Arterial Road-1		15,530	21,550	0	37,080	1,084,090	1,087,985	103,200	2,275,275		86,400	82,100	7,700	176,200
Hoa Lac Area		15,530	11,150	0	26,680	796,090	751,985	103,200	1,651,275		64,800	56,900	7,700	129,400
1 Lang-Hoa Lac Highway	m2	2,300	4,150	0	6,450	338,150	31,125	0	369,275	90	30,400	2,800	0	33,200
2 Hoa Lac-Ba Vi Highway	m2	0	7,000	0	7,000	87,500	297,500	0	385,000	75	6,600	22,300	0	28,900
3 NR 21A(Widening)	m2	13,230	0	0	13,230	370,440	423,360	103,200	897,000	75	27,800	31,800	7,700	67,300
Xuan Mai Area		0	10,400	0	10,400	288,000	336,000	0	624,000		21,600	25,200	0	46,800
2 NR 21A(Widening)	m2	0	10,400	0	10,400	288,000	336,000	0	624,000	75	21,600	25,200	0	46,800
III Urban Arterial Road-2		24,730	16,360	28,930	70,020	962,700	644,750	1,056,050	2,663,500		61,700	41,200	67,600	170,500
Hoa Lac Area		19,930	15,560	22,050	57,540	818,700	620,750	849,650	2,289,100		52,500	39,700	54,400	146,600
1 VNU Area	m2	3,530	3,180	3,860	10,570	148,400	124,900	147,300	420,600	64	9,500	8,000	9,400	26,900
2 HHTP Area	m2	9,980	5,150	9,080	24,210	388,650	195,950	348,600	933,200	64	24,900	12,500	22,300	59,700
3 Dong Xuan Area	m2	2,570	2,520	4,940	10,030	110,200	105,650	180,500	396,350	64	7,100	6,800	11,600	25,500
4 Phu Cat Area	m2	3,850	4,710	4,170	12,730	171,450	194,250	173,250	538,950	64	11,000	12,400	11,100	34,500
Xuan Mai Area		4,800	800	6,880	12,480	144,000	24,000	206,400	374,400	64	9,200	1,500	13,200	23,900
IV Urban Arterial Road-3		11,780	11,580	22,130	45,490	265,050	260,550	497,925	1,023,525		17,000	16,700	32,000	65,700
Hoa Lac Area		11,780	8,780	17,430	37,990	265,050	197,550	392,175	854,775		17,000	12,700	25,200	54,900
1 VNU Area	m2	6,320	3,580	4,420	14,320	142,200	80,550	99,450	322,200	64	9,100	5,200	6,400	20,700
2 HHTP Area	m2	2,750	1,220	5,330	9,300	61,875	27,450	119,925	209,250	64	4,000	1,800	7,700	13,500
3 Dong Xuan Area	m2	2,710	2,240	2,470	7,420	60,975	50,400	55,575	166,950	64	3,900	3,200	3,600	10,700
4 Phu Cat Area	m2	0	1,740	5,210	6,950	0	39,150	117,225	156,375	64	0	2,500	7,500	10,000
Xuan Mai Area		0	2,800	4,700	7,500	0	63,000	105,750	168,750	64	0	4,000	6,800	10,800
V Collector Road		9,470	13,420	34,590	57,480	156,255	221,430	570,735	948,420		10,000	14,200	36,500	60,700
Hoa Lac Area		7,400	8,020	23,690	39,110	122,100	132,330	390,885	645,315		7,800	8,500	25,000	41,300
1 VNU Area	m2	0	0	4,590	4,590	0	0	75,735	75,735	64	0	0	4,800	4,800
2 HHTP Area	m2	1,570	1,740	5,160	8,470	25,905	28,710	85,140	139,755	64	1,700	1,800	5,400	8,900
3 Dong Xuan Area	m2	2,600	550	6,400	9,550	42,900	9,075	105,600	157,575	64	2,700	600	6,800	10,100
4 Phu Cat Area	m2	3,230	5,730	7,540	16,500	53,295	94,545	124,410	272,250	64	3,400	6,100	8,000	17,500
Xuan Mai Area		2,070	5,400	10,900	18,370	34,155	89,100	179,850	303,105	64	2,200	5,700	11,500	19,400
VI Access Road		10,540	10,620	32,220	53,380	78,825	79,575	240,900	399,300		5,000	5,100	15,500	25,600
Hoa Lac Area		9,790	10,370	29,720	49,880	73,425	77,775	222,900	374,100		4,700	5,000	14,300	24,000
1 VNU Area	m2	0	0	4,400	4,400	0	0	33,000	33,000	64	0	0	2,100	2,100
2 HHTP Area	m2	3,530	4,510	5,060	13,100	26,475	33,825	37,950	98,250	64	1,700	2,200	2,400	6,300
3 Dong Xuan Area	m2	3,460	1,330	16,800	21,590	25,950	9,975	126,000	161,925	64	1,700	600	8,100	10,400
4 Phu Cat Area	m2	2,800	4,530	3,460	10,790	21,000	33,975	25,950	80,925	64	1,300	2,200	1,700	5,200
Xuan Mai Area		750	250	2,500	3,500	5,400	1,800	18,000	25,200	64	300	100	1,200	1,600
VII Other Facilities		530	460	1,470	2,460	37,000	34,900	55,900	52,800		13,400	11,700	28,500	53,600
1 Bridge(Hoa Lac&Xuan Mai)	m2	530	460	1,470	2,460	12,000	9,900	30,900	52,800	800	9,600	7,900	24,700	42,200
2 Transportation Terminal	m2					25,000	25,000	25,000		150	3,800	3,800	3,800	11,400
G. Total		74,180	75,950	147,440	297,570	2,715,320	2,370,390	3,311,517	8,322,220		208,200	177,500	266,600	652,300

Table 6.1.21 Railway Construction Cost Estimate

	Unit price per km (US$)	Construction Cost (30km) (million US$)	Construction Cost (30 km) (billion VND)
Construction: (Single Track)	1,558,000 (safety coefficient:2.0)	93.5	1,300
Construction: (Double Track)	2,641,000 (safety coefficient:2.0)	158.5	2,203
Signal, communication facilities	2,117,000	127	1,765
Electric facilities	883,,000	50	695
Sub-Total (double track)		335.5	4,663
Train car	416,000	33.3	463
Grand Total		368.8	5,126

In term of train car, one new train car costs approximately US$ 416,000. If one train formation is 8 cars, the total cost is approximately US$ 3,328,000. Under the assumption that the average speed of train is 30km/hour, the Hanoi-Hoa Lac section will take one hour. Also, supposing operation interval is counted as every 20 minutes, the total train car formation will be (1 hour+20 minutes)x2(two ways)/20 minutes=8 train formulation with 20 minutes stand-by period in the final station. In addition, the total formation will be 10 on the assumption that the operation rate is 1.15. As a result, 10 formation of a train of 8 cars is necessary. In this regard, the total cost for train car will be US$ 33.3 million.

Finally, the total cost for double track railway and train cars between Hanoi and Hoa Lac is estimated as approximately US$ 368.8 million (equivalent to 5,126 billion VND). For the cost estimation, the construction cost of station facility and electric sub-station is not included.

6.2 Electricity Supply

6.2.1 Basic Development Concepts

(1) Power Generating Facilities in Northern Region

The grid in northern Vietnam has a total installed capacity of 2,685 MW as of the end of 1994. The present capacity consists of hydroelectric generators rated at 2,040 MW, or 76 percent of the grid, and thermal power units rated at 645 MW, or 24 percent. The major power generating facilities are as follows:

Table 6.2.1 The Main Power Generating Facilities

Station	Installed Capacity (MW)
Hydro-electric generator	2,040
Hoa Binh Hydro-power Station	1,920
Thac Ba Hydro-power Station	120
Thermal power (coal) station	645
Pha Lai Thermal Power (Coal) Station	440
Uong Bi Thermal Power (Coal) Station	105
Ninh Binh Thermal Power (Coal) Station	100
Total	2,685

Notes: There are also a few small diesel fired stations linked to the grid.

At present, the generating capacity is adequate to meet all the demands of the northern region. The North - South 500kV transmission system was constructed to interconnect the three regions of the country for national interchange of power and to transfer the surplus power in the North to the South where is suffering from power shortage.

Additionally, Institute of Energy (IOE) which is a unit of Electricity of Vietnam (EVN) has planned to develop an additional power generation system as follows:

Table 6.2.2 Additional Power Generation System

Source	Capacity (MW)
Pha Lai (2) Thermal Power (Coal) Station	600 (by the year 2000)
Son La Hydro Power Station	3,600
Ban Mai Hydro Power Station	600
Total	4,800

Consequently, there would be no shortage in the power generation side including energy to be supplied to the central and southern regions by 500kV transmission line though the future power capacity of EVN should be considered.

(2) Power Supply System

The transmission system of Northern Vietnam comprises 220kV and 110kV lines together with the 500kV line from Hoa Binh to Ho Chi Minh City.

The existing power supply system in the Study Area is connected to the 220kV grid through the 220/110kV and 110/10kV substations, 10 or 35kV distribution lines. The power is supplied to the consumers through the 10 or 35kV distribution lines.

At present, the electricity supply networks in Hanoi, Ha Tay province and Hoa Lac - Xuan Mai areas are as follows:

(3) Hanoi

The consumers in Hanoi can receive electricity from three major 220kV substations of Ha Dong (2x125MVA), Chem (2x125MVA) and Mai Dong (2x125MVA).

(4) Ha Tay Province

Ha Tay province receives electricity from 110kV via Ha Dong and Mai Dong 220/110kV Substations.

(5) The Study Areas

1) Son Tay and Hoa Lac areas

At present, the substation (2x16MVA) located at Son Tay Town is supplied with electric power from Ha Dong Substation by a 110kV single line transmission line (ACSR 120mm^2).

Son Tay and Hoa Lac Urban Areas are being supplied with electricity from the Son Tay substation via 35/10/0.4 kV distribution system

2) Xuan Mai and Mieu Mon Urban Areas

Xuan Mai and Mieu Mon Urban Areas receive electricity from Ha Dong Substation by a 35kV distribution line (ACSR 95mm^2).

3) 220kV transmission lines

220kV transmission lines of single circuit (ACSR 500mm^2) and of double circuits (ACSR 500mm^2) are running across the North of Xuan Mai town. One of them is the Hoa Binh - Chem line, and the other is Hoa Binh - Ha Dong line.

Power supply system diagram of the 500 and 220kV system of northern Vietnam are shown in Figure 6.2.1.

(6) Basic Design Concept

Electricity power for the Study Area will be supplied from EVN power grid. The basic design concepts essential for the Study Area as follows

(a) Sufficient power supply system
(b) High reliable power supply system

(c) High stability of supplying voltage

(d) Environmental harmony

(7) Electric Power Demand Forecast

Electric power demand forecast for each phase is estimated by the relation between per capita power consumption including industrial demand and the population framework.

Target values for electric power consumption of peoples in the Study Area summarized as follows.

The 1993 electric power consumption of 110 kWh/capita was 224 percent increase over 1980 figure of 49 kWh/capita in Vietnam. The demand growth rate is 6.4 percent per annum for the period 1980 - 1993 (source: OEPIS, 1995)*. Then the demand growth rate in each phase after 2000 are expected to 8.0 percent per annum. The power demand for the Son Tay, Hoa Lac, Xuan Mai and Mieu Mon Urban Areas are calculated on the bases of each development phase as follows.

Table 6.2.3 Target Values for Electric Power Consumption

Unit: (kWh/capita)

	Phase1A	Phase-1B	Phase-2
For domestic use	250	450	800
For factory employment	3,500	3,500	3,500
For specialized high-tech employment	6,500	6,500	6,500

(*) OEPIS: Overseas Electric Power Industry Statistics.

The total maximum power demand for the Corridor 21 development is calculated as summarized below (Table 6.2.4).

Table 6.2.4 Electric Power Demand Forecast

	Pop. Frame (1,000)			Land Dev't Frame (ha)			Power Demand (MW)		
	Phase-1A	Phase-1B	Phase-2	Phase-1A	Phase-1B	Phase-2	Phase-1A	Phase-1B	Phase-2
1. Son Tay Urban Area	50	60	90				11.2	18.2	43.0
2. Hoa Lac Urban Area	59.2 135.0	90.4 205.0	151.3 400.0	800	1,660	3,480	78.8	151.9	323.0
VNU Area	44.1 32.0	61.0 43.0	95.0 93.0	300	500	700	13.8	26.3	59.2
HHTP Area	21.0 30.3	30.3 42.8	47.0 71.8	200	500	80	40.0	65.4	112.1
Dong Xuan Area	12.7 46.3	16.5 82.8	24.5 171.0	250	450	1,400	6.9	18.8	68.9
Phu Cat Area	13.6 26.4	26.7 36.4	49.7 64.2	50	210	580	18.1	41.4	82.8
3. Xuan Mai Urban Area	45	55	100				35.1	43.2	74.2
4. Mieu Mon Urban Area	1.5	2	4				1.0	1.5	3.0
5. Total	186.5	262	594				126.1	214.8	443.2

Source: JICA Study Team

Note: Pop. Frame in the Hoa Lac area = employment/population

6.2.2 Development Plan of Electric Power Supply

(1) Required Facilities

A requirement for all electrical facilities can be divided into two facilities: external and internal electric powers supply facilities.

The required electrical facility is estimated on the forecasted power consumption in MWh. The electrical facilities are summarized as follows,

Table 6.2.5 Required Electrical Facilities

	Particulars	Phase-1A	Phase-1B	Phase-2	Total
1.	Lines (circuit - km)				
	220kV	130	47	-	177
	110kV	70	42	26	138
	22kV (underground cable)	220	135	233	588
2.	Substation (MVA)				-
	220/110kV	250	250	250	750
	110/22kV	350	175	275	800
3.	Switching station (Unit)				-
	22kV station	14	12	19	45
	22kV ring main	154	132	209	495

(2) External Facilities

The Hoa Binh Hydro Power Station (1,920MVA) is located 35km west of Xuan Mai. The generated electric power of the station is a main source for EVN's national grid, and has an enough capacity for power supply to the M/P Area.

In order to cope with the estimated power demand, the Ministry of Construction (MOC) designed and proposed to construct two 220kV-transmission lines as follows:

Table 6.2.6 220kV Transmission Lines Proposed by MOC

Specifications		Quantity
220kV transmission line	Double circuits (ACSR 500mm^2) Hoa Binh – Xuan Mai – Ha Dong	65 km
	Single circuit (ACSR 500mm^2) Ha Dong – Soc Son	47 km
220kV switch-gear	Hoa Binh Power Station	2 feeders
	Ha Dong Substation	1 feeder
	Soc Son Substation	1 feeder

Note: ACSR = Aluminum cable steel reinforcement

For power supply to the projected area, four (4) additional 220kV switchers for feeders will be required to construct in the existing switchyards at Hoa Binh hydropower Station, Ha Dong and Soc Son substations.

Route and location of 220kV transmission lines from Hoa Binh Power Station to Ha Dong and Soc. Son Substations are shown in Figure 6.2.2.

(3) Internal Facilities

In order to cope with the power demand of the Study Area, the following major Electric power supply facilities are required within the Master Plan Area.

Table 6.2.7 Major Electric Power Supply Facilities

Specifications				Quantity
110kV transmission line	Double circuits (ACSR 185mm^2 – double conductors)			49 km
	Single circuit (ACSR 185mm^2 – double conductors)			40 km
Main substation	Hoa Lac	220/110kV	(2x250MVA)	1 station
		110/22kV	(2x10MVA)	
	Xuan Mai	220/110kV	(2x125MVA)	1 station
		110/22kV	(2x10MVA)	
Substation	Son Tay	110/35kV	(2x40MVA)	1 station
	Hoa Lac	110/22kV	(3x40MVA)	1 station
	Hoa Lac	110/22kV	(3x25MVA)	4 stations
	Hoa Lac	110/22kV	(2x25MVA)	1 station
	Hoa Lac	110/22kV	(3x10MVA)	1 station
	Hoa Lac	110/22kV	(2x10MVA)	2 stations
	Xuan Mai	110/22kV	(3x40MVA)	1 station
	Xuan Mai	110/22kV	(2x10MVA)	1 station

MOC has proposed to construct two 220/110kV main substations of Xuan Mai (2x125MVA) and Hoa Lac (2x250MVA) for supply power to the C21 Development. The planned Xuan Mai main substation is programmed to be completed by the year 2005, and will have an enough capacity for extra power supply to the Hoa Lac area, initial stage.

Therefore, power for VNU, HHTP, Dong Xuan and Phu Cat Areas in Hoa Lac Urban are supplied from the 220/110kV Xuan Mai main substation and transmitted by two 110kV-transmission lines within Phase-1A.

MOC has decided to adopt 20kV as the future standard for medium tension voltage covering the whole country. Under the above condition, the 22kV distribution line could be applied in the Master Plan Area.

The proposed schematic diagram and layout plans for the power supply system for the Master Plan Area are shown in Figure 6.2.3 and Figure 6.2.4.

1) Hoa Lac area

Nine (9) new substations (110/22kV) are proposed around VNU, HHTP, Dong Xuan and Phu Cat Areas in Hoa Lac Urban Area.

The 5 of new 9 substation will receive an electric power from the New Xuan Mai main substation 220/110kV (2x125MVA) via double circuits 110kV new transmission line (ACSR 185mm2 double conductors), within Phase-1A. The each substation cover the respective service zone of VNU, HHTP, Dong Xuan and Phu Cat Areas in Hoa Lac Urban Area through the 22kV switching stations and 22kV underground distribution cables.

The 22kV distribution lines are proposed to utilize double circuits in order to secure the reliable power supply and to increase the line capacity. 22kV switcher units are also recommended to install at the service entrance point to consumers or the branch point of the distribution lines. All 22kV distribution lines in Hoa Lac are also proposed to use an underground cable.

The street lighting facilities are proposed on the arterial roads in the Hoa Lac area.

2) Xuan Mai area

A 220/110kV Xuan Mai main substation was planned by MOC to be located in Xuan Mai district, and will be constructed one 125MVA transformer in 2000 and another 125MVA transformer in Phase-1A. The substation will supply power to Xuan Mai, Mieu Mon Urban Areas and will also supply power to Hoa Lac Urban Area for Phase-1A.

All 22kV distribution lines in Xuan Mai Urban Area are propose to utilize underground power cables. (The power for the Mieu Mon area will be supplied from the Xuan Mai substation by the 22kV overhead distribution line by Phase-2).

The distribution network system should avoid a voltage drop and loss of line, and it is to improve a quality and reliability of electricity supply. Though the number of distribution transformer in a certain area should have to be increased.

The low voltage system near consumers is proposed to utilize with PVC insulated conductors for prevention of surreptitious use of electricity.

3) Son Tay area

At present, electric power for the Son Tay area is supplied from the existing 110kV Son Tay substation 32MVA (2x16MVA).

MOC was planned to expand the capacity to 80MVA (2x40MVA) by the year 2000. The Implementation of the plan has been underway as programmed. If the original planned capacity will implement, the capacity of the station will meet the power demand of the Son Tay Urban Area development for Phase-2.

Voltage ratio of existing and new transformers is the same 110kV/35kV/10kV. Therefore, 35kV system will be applied for long distance power distribution and 10kV for city area in Son Tay.

The distribution system is also planned with overhead lines taking into account the present situation. The low voltage system near consumers will be used with PVC insulated conductors for safety.

6.2.3 Phased Development Plan

Development facilities for each phase are as follows on the base of the external and internal facilities of the Master Plan.

Table 6.2.8 Phased Development Plan of External Electricity Facilities

Phase-1A	Quantity	Route/Location
220kV transmission line	65 km (130 km)	Hoa Binh – Xuan Mai – Ha Dong (double circuits, ACSR 500mm^2)
220kV switch-gear	1 feeders	Hoa Binh Power Station
	1 feeder	Ha Dong Substation

Phase-1B	Quantity	Route/Location
220kV transmission line	47 km	Ha Dong – Soc Son (single circuit, ACSR 500mm^2)
220kV switch-gear	1 feeder	Hoa Binh Power Station
	1 feeder	Soc Son Substation

Table 6.2.9 Phased Development Plan of Internal Electricity Facilities in Hoa Lac Urban Area

Phase-1A	Quantity	Route/Location
Substation	1 station	University, 110/22kV (2x10MVA)
	1 station	Hi-Tech Park, 110/22kV (2x40MVA)
	1 station	Residential area, 110/22kV (2x10MVA)
	1 station	Industrial area, 110/22kV (2x25MVA)

Phase-1B	Quantity	Location
Substation	1 station	University, 110/22kV (2x25MVA)
	1 station	Hi-Tech Park, 110/22kV (2x10MVA)
	-	Hi-Tech Park, 110/22kV (1x40MVA)
	-	Residential area, 110/22kV (1x10MVA)
	-	Industrial area, 110/22kV (1x25MVA)
110kV transmission line	2 km	Hoa Lac s/s – Existing 110kV line (double-circuits)
	8 km	Interconnection (single-circuit)

Note: 110/22kV (1x40MVA), (1x10MVA) and (1x25MVA) transformers shall be installed in the existing substations of Hi-Tech Park, Residential and Industrial areas, additionally, by the year 2010

Phase-2	Quantity	Route
Main substation	1 station	Hoa Lac, 220/110kV (2x250MVA) 110/22kV (2x10MVA)
Substation	-	University, 110/22kV (1x25MVA)
	1 station	Hi-Tech Park, 110/22kV (2x25MVA)
	1 station	Residential area, 110/22kV (3x25MVA)
	1 station	Industrial area, 110/22kV (3x25MVA)
110kV transmission line	2 km	Hoa Lac s/s – Existing 110kV lines (double circuits)
	12 km	Interconnection (single circuit)

Note: 110/22kV (1x125MVA) transformer shall be constructed in the existing substation of University additionally by the year 2020.

Table 6.2.10 Phased Development Plan of Internal Electricity Facilities in Xuan Mai Area

Phase-1A	Quantity	Route
Main substation	1 station	Xuan Mai, 220/110kV (2x125MVA) Xuan Mai, 110/22kV (2x10MVA)
110kV transmission line	30 km	Xuan Mai s/s – HHTP/Industrial, and Xuan Mai s/s – University/Residential (double circuits)
	10 km	Xuan Mai s/s – New substation, in town (single circuit)
Substation	1 station	in town, 110/22kV (2x40MVA)

Phase-1B	Quantity	Route
Substation	1 station	Xuan Mai, 110/22kV (2x10MVA)
110kV transmission line	10 km	Xuan Mai s/s – New station (single circuit)

Phase-2	Quantity	Route
Substation	-	Xuan Mai s/s – Xuan Mai 110/22kV (1x40MVA)

Note: 110/22kV (1x40MVA) transformer shall be constructed in the Xuan Mai substation additionally by the year 2020.

Table 6.2.11 Phased Development Plan of Internal Electricity Facilities in Son Tay Area

Phase-1A	Quantity	Route/Location
Substation	1 station	Son Tay, 110/35/10kV (2x40MVA)

6.2.4 Development Cost Estimate

Construction cost for the proposed facilities for Hoa Lac and Xuan Mai Urban Development Project including the external facilities such as 220kV transmission lines and 220kV switch-gears are estimated for each development phase. The construction cost is calculated on the 1998 bases. Summary of necessary cost is as follow.

Table 6.2.12 Summary of Necessary Cost

Unit: US $1,000

Particulars	Phase-1A	Phase-1B	Phase-2	Total
1. External facilities	13,400	7,000	-	20,400
220kV transmission line (including 220kV switch-gear)	13,400	7,000	-	20,400
2. Internal facilities	108,100	64,700	101,600	274,400
220/110kV substation	17,300	1,000	10,000	28,300
110kV transmission line	4,000	2,600	1,600	8,200
110/22kV substation	19,300	16,600	18,400	54,300
22kV distribution system	67,500	44,500	71,600	183,600
3. Total	121,500	71,700	101,600	294,800

Notes: i) Equipment and facilities of the substation and distribution line for Son Tay and Mieu Mon are not included. ii) The 220kV and 110kV transmission lines will be constructed by steel structure.

Table 6.2.13 Power Demand Proiection

	2005				2010				2020			
	Power Consumption (MWh)		Operating Hours per	Max. Electric	Power Consumption (MWh)		Operating Hours per	Max. Electric	Power Consumption (MWh)		Operating Hours per	Max. Electric
	Per Annum	Max Per Month	Month (hrs)	Demand (MW)	Per Annum	Max Per Month	Month (hrs)	Demand (MW)	Per Annum	Max Per Month	Month (hrs)	Demand (MW)
	<E>	<N>	<T>	<P>	<E>	<N>	<T>	<P>	<E>	<N>	<T>	<P>
1) Son Tay	22,250	2,040	364	11.2	36,150	3,314	364	18.2	85,500	7,838	364	43.0
2) Hoa Lac												
University	27,300	2,503	364	13.8	52,200	4,785	364	26.3	117,400	10,762	364	59.2
Hi-Tech Park	77,800	7,132	364	40.0	129,700	11,890	364	65.4	222,400	20,387	364	112.1
Residential Area	14,800	1,357	364	7.5	40,200	3,685	364	20.3	108,800	9,974	364	54.9
Industrial Area	35,900	3,291	364	18.1	82,100	7,526	364	41.4	164,300	15,061	364	82.8
3) Xuan Mai	69,750	6,394	364	35.1	85,750	7,860	364	43.2	147,500	13,521	364	74.2
4) Mieu Mon	2,000	183	364	1.0	3,057	278	364	1.5	5,900	541	364	3.0

Note: N = (E/12) x 1.1 [MWh]

T = {6[day] x 14[hours/days] x 52[week]}/12[month] [hours]
P = (N/T) x (1/L) x 100 [MW]
L : Monthly load factor = 50 [%]

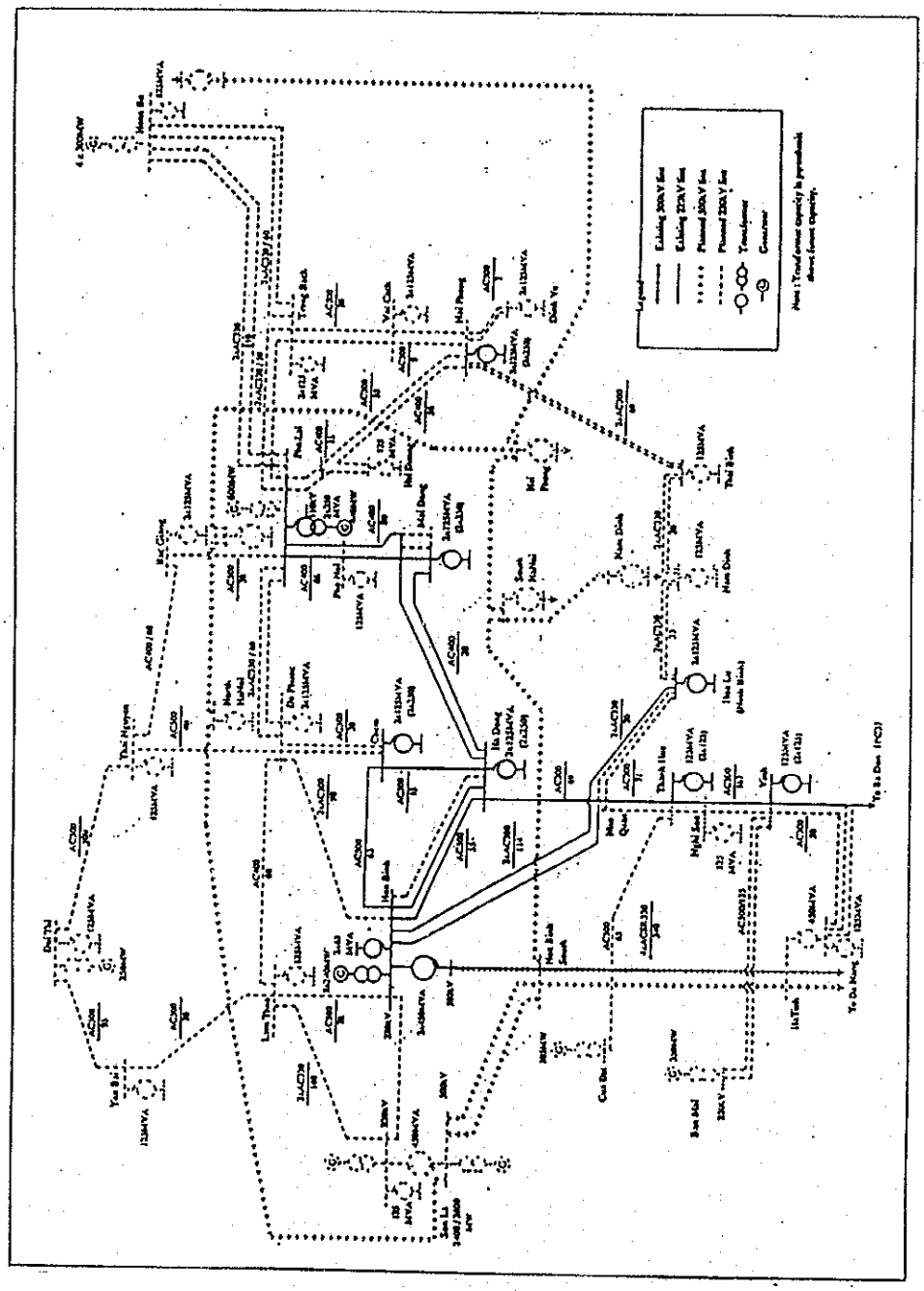


Figure 6.2.1 500/220kV Power Supply System on the Northern Vietnam

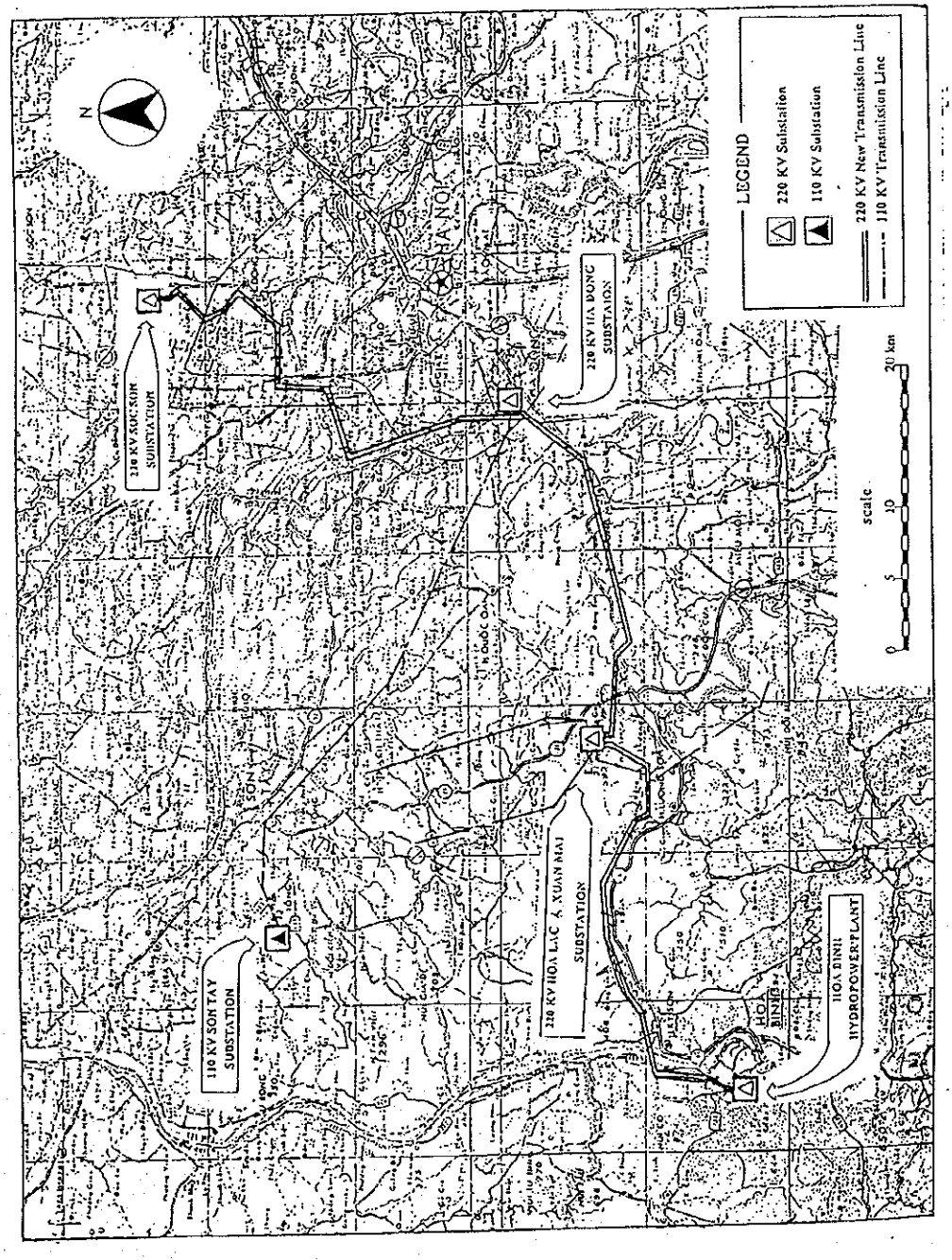


Figure 6.2.2 Proposed 220kV Transmission Lines from Hoa Binh Power Station

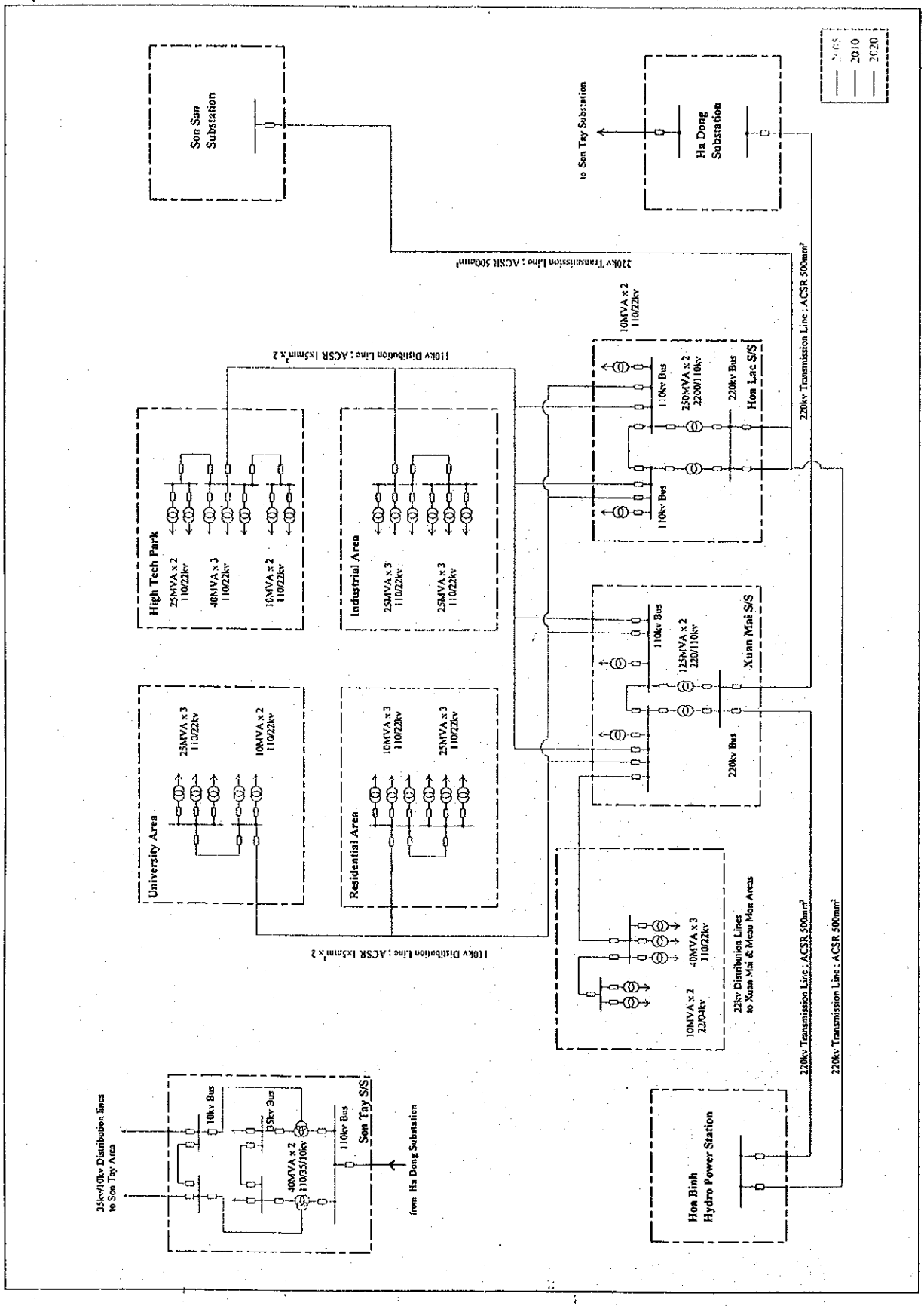


Figure 6.2.3 Schematic Power Supply Diagram for C21 Development

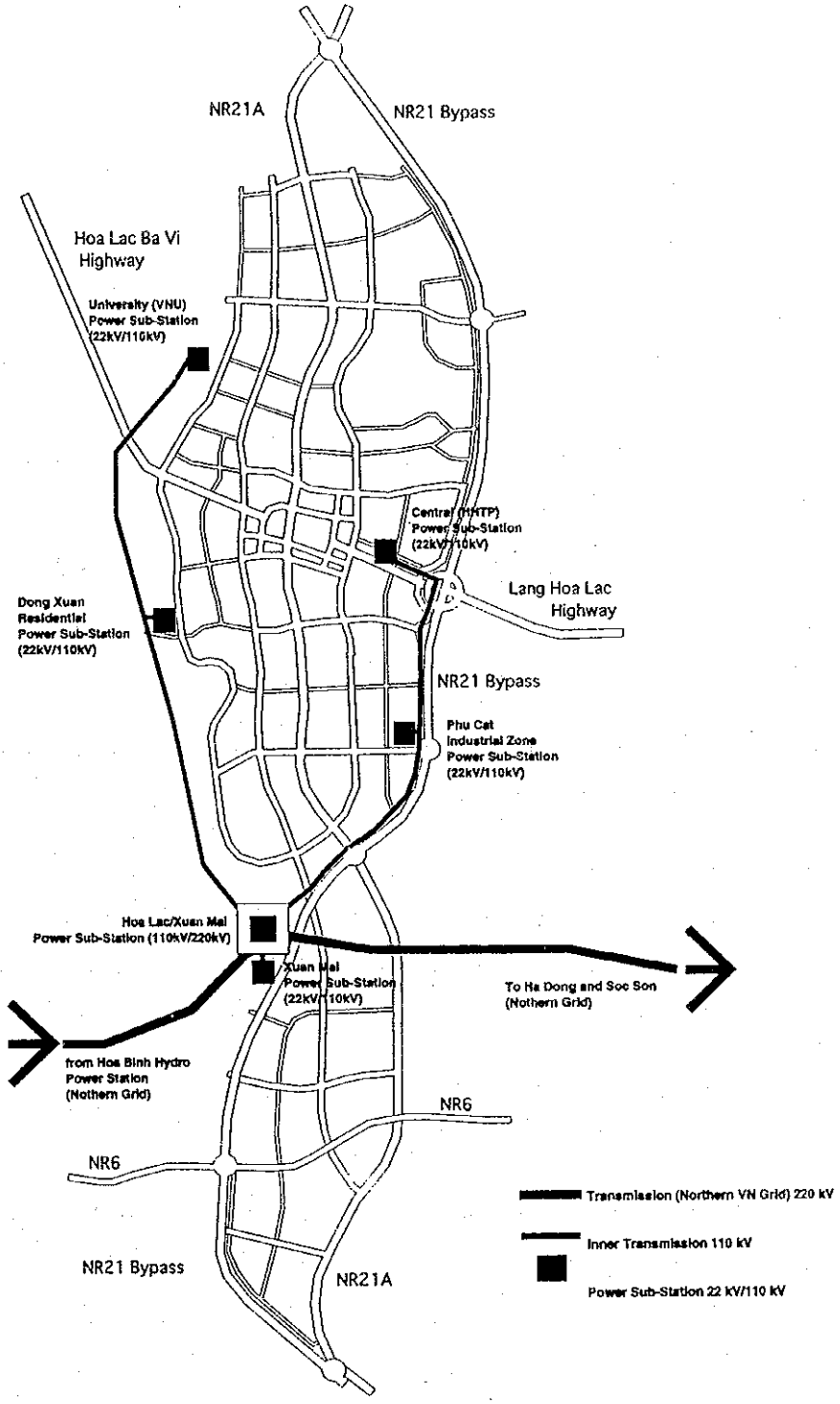


Figure 6.2.4 Preliminary Power Supply Network Plan for the Master Plan