JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

VIETNAM RAILWAYS (VR)

STUDY FOR THE FORMULATION OF HIGH SPEED RAILWAY PROJECTS ON HANOI – VINH AND HO CHI MINH – NHA TRANG SECTION

FINAL REPORT

VOLUME II PART A

DETAILED STUDY ON HANOI-VINH SECTION OF NSHSR

June 2013

ALMEC CORPORATION
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD.
ORIENTAL CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.
JAPAN TRANSPORTATION CONSULTANTS, INC.

Exchange rate used in the Report

USD 1 = JPY 78 = VND 21,000

(Based on rate on November 2011)

PREFACE

In response to the request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct the Study for the Formulation of High Speed Railway Projects on Hanoi – Vinh and Ho Chi Minh – Nha Trang Section and entrusted the program to the Japan International cooperation Agency (JICA).

JICA dispatched a team to Vietnam between April 2011 and June 2013, which was headed by Mr. IWATA Shizuo of ALMEC Corporation and consisted of ALMEC Corporation, Japan International Consultants for Transportation Co., Ltd., Oriental Consultants Co., Ltd., Nippon Koei Co., Ltd. and Japan Transportation Consultants, Inc.

In the cooperation with the Vietnamese Counterpart Team including the Ministry of Transport and Vietnam Railways, the JICA Study Team conducted the study which includes traffic demand analysis, natural and socio-economic conditions, alignment planning, consideration of various options including the upgrading of existing railway, technical standards for high speed railway, implementation schedule and institutions, and human resource development. It also held a series of discussions with the relevant officials of the Government of Vietnam. Upon returning to Japan, the Team duly finalized the study and delivered this report in June 2013.

Reflecting on the history of railway development in Japan, it is noted that Japan has indeed a great deal of experience in the planning, construction, operation, etc., and it is deemed that such experiences will greatly contribute to the railway development in Vietnam. JICA is willing to provide further cooperation to Vietnam to achieve sustainable development of railway sector and to enhance friendly relationship between the two countries.

It is hoped that this report will contribute to the sustainable development of transport system in Vietnam and to the enhancement of friendly relations between the two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government of Vietnam for their close cooperation.

June 2013

Kazuki Miura
Director, Economic Infrastructure Department
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AFC	Automatic Fare Collection
AC	Alternating Current
ADB	Asian Development Bank
AGR	Average Growth Rate
ALOS	Advanced Land Observing Satellite Data
(ALOS)	Advanced Visible and Near – Instrument for Stereo
AVNIR-2	Mapping
(ALOS)	Panchromatic Remote – sensing Instrument for Stereo
PRISM	Mapping
ASK	Available Seat Kilometer
ATC	Automatic Train Control system
BOT	Build-Operate-Transfer
CPRGS	Comprehensive Poverty Reduction and Growth Strategy
CTC	Centralized Train Control
DCC	District Compensation Committee
DMS	Detailed Measurement Survey
DoLISA	Department of Labor, Invalids and Social Affairs
DPC	District People's Committee
DS-ATC	High-speed railway signal system in Japan
DWT	deadweight tonnage
E&M	Construction work at site
EBIT	Earning before interest (after depreciation)
EBITDA	Earning before interest, tax and depreciation
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ELP	Electric light power
EP	Electric power
EVN	Vietnam Electric Power Company
F/S	Feasibility Study
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRDP	Gross Regional Domestic Product
GSO	General Statistics Office
HCMC	Ho Chi Minh City
HDM	Highway Design and Maintenance
HHs	Households
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HSR	High Speed Railway
I & A	Electronic Interlocking and Automatic Train Control System
IC	Integrated Circuit
ICAO	International Civil Aviation Organization
IEE	Initial Environmental Examination
IRR	Internal Rate of Return
IWT	Inland Waterway Transport
IZ	Industrial Zone
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
JRTT	Japan Railway Construction, Transport and Technology Agency
JST	JICA Study Team
Km	Kilometer

KOICA	Korean International Cooperation Agency
LURC	Land Use Right Certificate
MC	Motorcycle
MD	Maintenance Depot
MM & TE	Maintenance Machine & Training Education equipment
MOC	Ministry Of Construction
MOLISA	Ministry of Labour, Invalids and Social Affairs
MONRE	Ministry Of Natural Resources And Environment
MOT	Ministry Of Transport
mppa	Million Passengers Per Annum
MRT3	Manila Rail Transit System
N – S corridor	North – South corridor
NA	Not Available
NBIA	Noi Bai International Airport
NH	National Highway
NSHSR	North – South High Speed Railway
O&M	Operation and Maintenance
OCC	Operation Control Center
OD	Origin – Destination
OFC	Optical Fiber Cable
OH	Overhead line equipment
PAP	Project Affected Persons
PC	People's Committee
PC box	Pre-stressed Concrete box
PCI	Provincial Competitive Index
PCM	Optical Carrier System (SDH)
PCT	Pre-stressed Composite Truss
PMU	Project Management Units
POP	Population
PPC	Provincial People's Committee
PPP	Public – Private Partnership
PRC	Programmed Route Control System for Station
PT	Passing Truck
R	Radius
RAP	Resettlement Action Plan
RC	Reinforced Concrete
RL	Rail Level
ROB	Road Over Bridges
ROI	Rate of Investment
ROW	Right of Way
RRD	Red River Delta
RRPF	Resettlement and Rehabilitation Policy Framework
SCADA	Supervisory Control and Data Acquisition System
SCH	Signaling & Telecom. House
SDH	Synchronous Digital Hierarchy
SE	South East
SERF	Shadow Exchange Rate Factor
SHM	Stakeholder Meeting
SPW	Sound Protection Wall
SS	Substation
T2	Terminal 2
TEBH	Tunnel Entrance Buffering Hood
TGV	Train A Grande Vitesse – high speed train
TR	Train Radio System (base)
UMRT	Urban Mass Rapid Transit
UPOPi	Urban Population of zone i

USD	United States Dollar
V	Volts
VAT	Value Added Tax
VHSRS	Vietnam High Speed Rolling Stock
VITRANSS2	The Comprehensive Study on the Sustainable Development of Transport System in Vietnam
VND	Vietnam Dong
VOC	Vehicle Operating Cost
VoT	Value of Time
VR	Vietnam Railways

1 INTRODUCTION

1.1 Purpose and Structure of the Report

1.1 The purpose of this report is to present the results of the detailed study on Hanoi – Vinh Section of the north-south high-speed railway. While Volume I intends to provide an overall picture of the development of north-south railways from a broad perspective including the development of other modes of transport, Volume II looks more into detail the new high-speed line on the priority sections, for Hanoi – Vinh section in Part A and HCMC – Nha Trang section in Part B.

1.2 Study Area and Coverage

1.2 The study area comprises 5 provinces and cities, including Hanoi City, Ha Nam Province, Nam Dinh Province, Ninh Binh Province, Thanh Hoa Province, and Nghe An Province with 6 stations planned (see Figure 1.2.1). The total length of the route is 284km.

Source: JICA Study Team.

Figure 1.2.1 Location Map of HSR North Section

2 SITUATION OF THE PROJECT INFLUENCE AREA

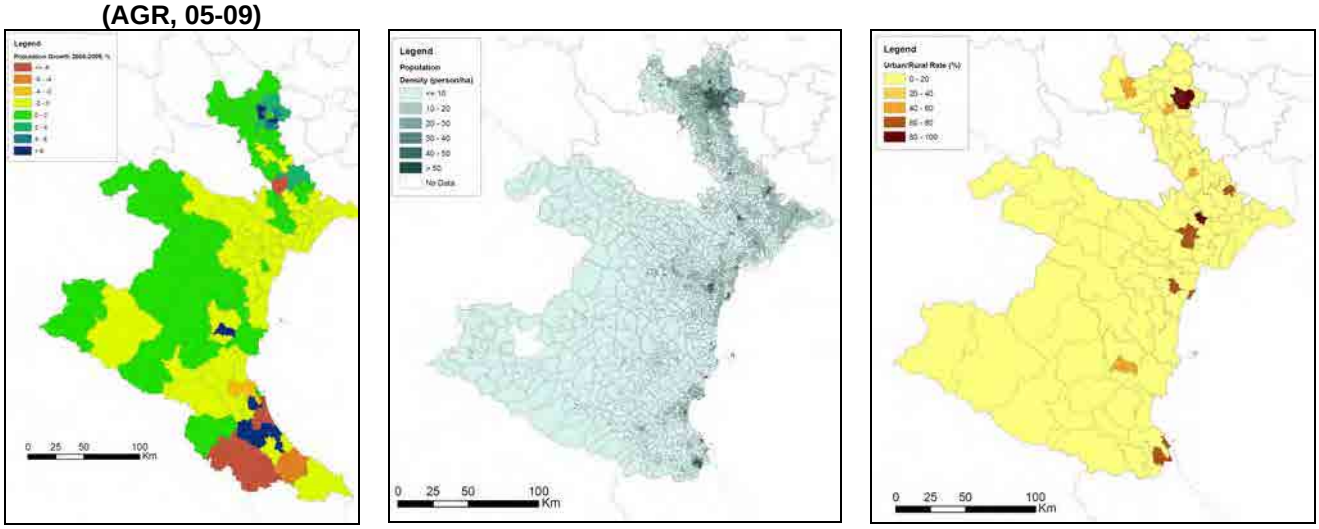
2.1 Socio-economic Development Characteristics

1) Population

2.1 The total population in the Hanoi – Vinh Corridor is 16.3 million, equal to 19% of the national total. Currently the average population growth rate in the region is 0.8%. Population growth is prominent in Hanoi, but this was due to the expansion of the growth boundary to the original Ha Tay Province. Ha Nam and Nam Dinh Provinces see a slight decrease in population.

2.2 Population is distributed around main cities in the region, namely Hanoi, Phu Ly, Nam Dinh, Ninh Binh, Thanh Hoa, and Vinh. Population density is generally quite low. Although overall, the urbanization rate is low for all provinces (only 40.8% even for Hanoi), urbanization is occurring around these main cities, and the rate of growth for urbanization is actually high.

Growth (AGR, 05-09) | **Density (no./ ha)** | **Urbanization Rate (%)**



Source: National Census, 2009.

Figure 2.1.1 Population along the Hanoi – Vinh Corridor

Table 2.1.1 Demographic Indicators for Hanoi – Vinh Corridor

		Hanoi		Ha Nam		Nam Dinh		Ninh Binh		Thanh Hoa		Nghe An		Total	
		2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09
Population	Total (000)	6,472	19.9	786	-0.2	1,826	-0.3	900	0.2	3,405	-0.2	2,919	0.2	16,309	5.8
	Urban (000)	2,642	6.6	77	5.0	324	3.4	161	3.7	355	1.2	369	2.5	3,927	5.2
	Rural (000)	3,831	37.0	709	-0.6	1,503	-1.1	739	-0.5	3,050	-0.4	2,551	-0.1	12,382	6.0
	Urbanization (%)	40.8	-11.1	9.8	5.1	17.7	3.7	17.9	3.5	10.4	1.4	12.6	2.3	24.1	-0.6
Density (no./ha)	Total	34	-13.2	9	-0.4	11	-0.5	6	0.1	3.0	-0.3	2	0.2	5	5.8
	Urban	-	-	-	-	-	-	-	-	-	-	312	-		

Source: National Census, 2009.

2) Economic Development

2.3 **GDP growth:** Although Hanoi is leading the economic growth of the region, all provinces in the region register high growth rates, namely 10.5%, 12.0%, 10.1%, 14.9%, 10.0%, and 9.4% for Hanoi, Ha Nam, Nam Dinh, Ninh Binh, and Thanh Hoa, and Nghe An, respectively. However, there is a discrepancy between Hanoi and other provinces in terms of per capita GDP.

2.4 **Sector share:** Most provinces are dependent on secondary and tertiary sectors, especially Hanoi. Nghe An is most dependent on the primary sector, and is the least dependent on secondary sector as it is behind in terms of industrial development compared to other provinces.

2.5 **Industrial Development:** The Nghi Son Refinery is the second planned oil refinery in Vietnam. It is planned to be located about 200km south of Hanoi in Thanh Hoa Province. The planned capacity is 200,000 barrels per day, slightly greater than that of Vietnam's first Dung Quat refinery. The target operation year is 2014, and is seen to lead the region's future industrialization.

2.6 **Investment:** FDI projects are concentrated in Hanoi, however in terms of value, Thanh Hoa province is at par with Hanoi. PCI ranking is generally low in this region, although Ninh Binh is ranked 11th place. Ha Nam is the lowest in ranking at 56th place.

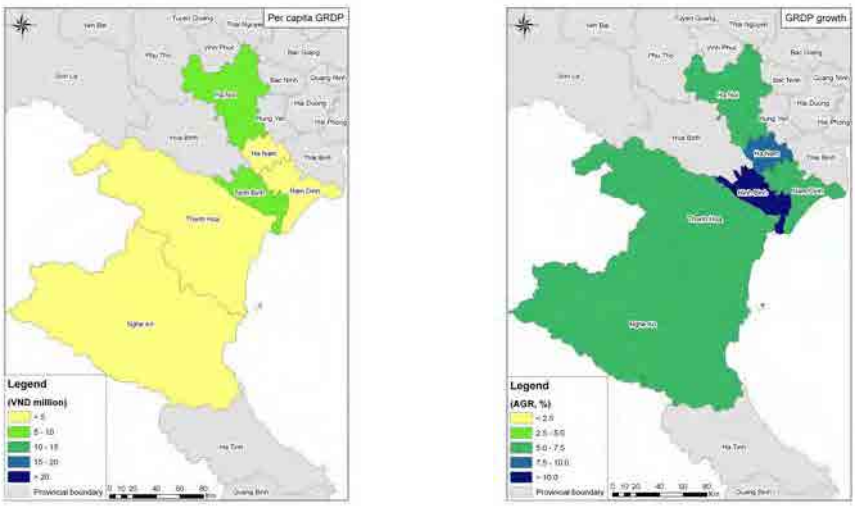
Table 2.1.2 Economic Indicators for Hanoi – Vinh Corridor

		Hanoi		Ha Nam		Nam Dinh		Ninh Binh		Thanh Hoa		Nghe An		Total	
		2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09
GRDP (VND bil.)[1]	Primary	11,721	1.6	2,438	2.9	6,031	4.8	2,681	4.1	10,805	2.8	9,741	4.6	43,418	3.2
	Secondary	78,568	12.6	4,627	20.3	7,714	16.9	6,182	21.3	14,609	14.7	10,681	13.2	122,381	13.8
	Tertiary	100,293	10.2	2,722	10.5	7,277	8.8	4,631	15.6	13,209	12.4	12,279	10.7	140,410	10.5
	Total	190,582	10.5	9,787	12.0	21,021	10.1	13,493	14.9	38,624	10.0	32,701	9.4	306,208	10.5
GRDP share (%)[1]	Primary	6.2	-8.1	24.9	-8.2	28.7	-4.8	19.9	-9.4	28.0	-6.6	29.8	-4.4	14.2	-6.6
	Secondary	41.2	1.9	47.3	7.4	36.7	6.2	45.8	5.5	37.8	4.3	32.7	3.5	40.0	3.0
	Tertiary	52.6	-0.3	27.8	-1.4	34.6	-1.2	34.3	0.6	34.2	2.2	37.5	1.2	45.9	0.0
Per capita GRDP (VND mil.)		29	-7.8	12	12.2	12	10.4	15	14.7	11	10.2	11	9.2	19	4.4
Tourists (000, annual)[2]	Domestic	6,718	-1.0	131	51.5	250	18.5	131	30.6	1,605	5.8	2,198	10.8	11,034	2.7
	International	1,019	-1.9	1	13.3	13	-14.2	21	34.2	10	11.4	36	-4.2	1,101	-1.7
	Total	7,737	-1.1	131	51.0	263	15.0	153	31.1	1,615	5.8	2,235	10.5	12,134	2.3
Turnover (VND bil., annual)		7.619	17.3	17	31.3	997	109.0	76	30.1	335	21.2	373	17.2	9,417	20.5
Import (USD mil.)		18,951	15.4	112	47.7	175	17.8	151	30.7	92	26.4	124	4.2	19,605	15.6
Export (USD mil.)		6,328	20.5	145	38.1	226	14.9	68	32.7	199	28.6	104	4.7	7,069	20.5
FDI (88 - 09, USD mil.)		22,307	-	217	-	120	-	578	-	7,040	-	371	-	30,633	-
PCI Index Ranking[3]		43	-	56	-	45	-	11	-	44	-	54	-	-	-

Source: General Statistics Office.

1) GRDP in 2008 prices. 2) No. of tourists serviced by accommodation establishments. 3) PCI index for 2010.

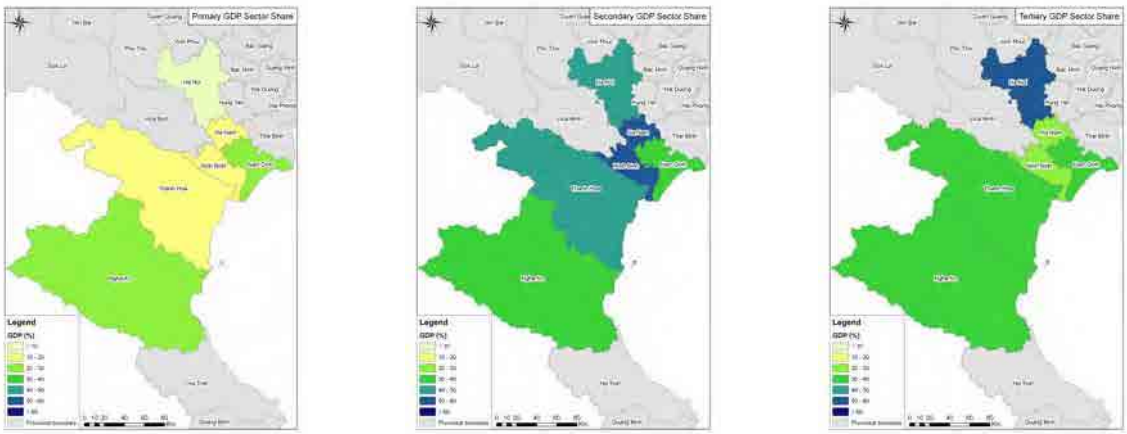
Per Capita (VND million) **Growth (AGR, 00-10)**



Source: General Statistics Office, 2010.

Figure 2.1.2 GDP along the Hanoi – Vinh Corridor

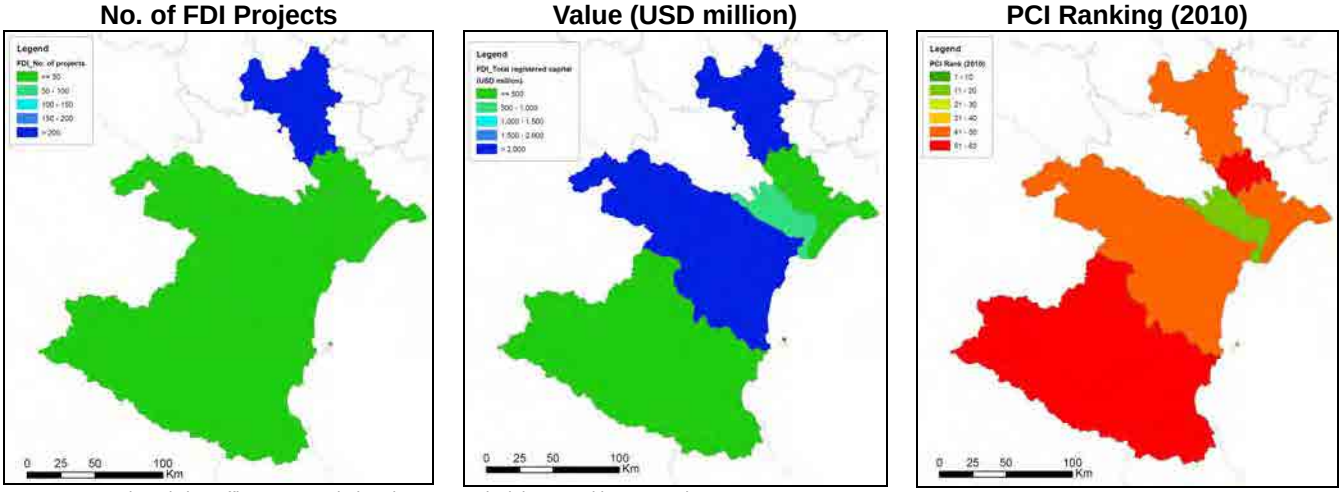
Primary **Secondary** **Tertiary**



Source: General Statistics Office, 2010.

Figure 2.1.3 GDP Sector Share along the Hanoi – Vinh Corridor

No. of FDI Projects **Value (USD million)** **PCI Ranking (2010)**



Source: General Statistics Office, 2009 and The Vietnam Provincial Competitiveness Index, 2010.

Figure 2.1.4 Investment and PCI Index along the Hanoi –Vinh Corridor

3) Social Aspect

2.7 **Employment:** The employment by sector in this region is composed as follows: 55%, 20%, 25% for primary, secondary, and tertiary sectors, respectively. It is clearly observed that although GDP share is balanced among sector, more than half of the employments in most areas are from the primary sector. The distribution of secondary and tertiary sector employment corresponds well with the urbanization map in Figure 3.2.6. Secondary sector employment is high in areas which accommodate industrial zones. Unemployment is high in urban areas (rural unemployment is not considered in GSO statistics).

2.8 **Income and Poverty:** Since the implementation of the Doi Moi policy in 1986 in general and since 1993 in particular the poverty ration decreased significantly and constantly. The Comprehensive Poverty Reduction and Growth Strategy (CPRGS, 2001-2005) clearly spelled out that the poverty reduction will progress with economic growth. As targeted in this policy, economic growth effectively reduced poverty in general, and this region is not an exception.

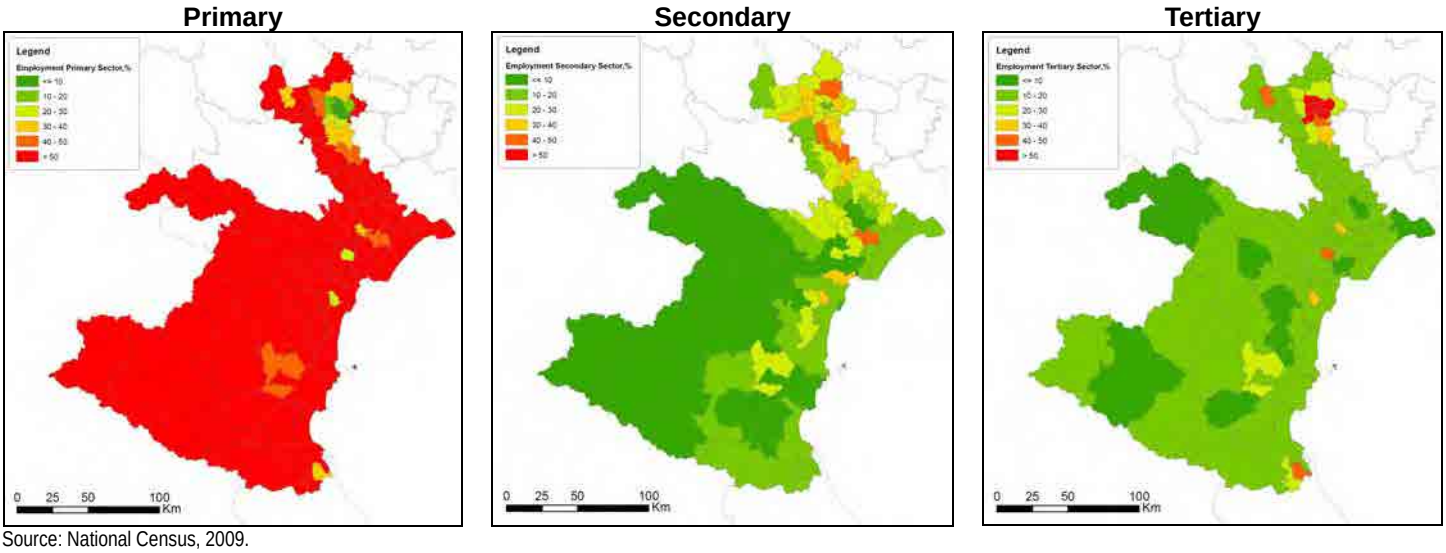
2.9 However, the situation differs greatly by province. While Hanoi has an average income of more than 1 VND million/ month, some provinces are as low as 0.6 VND million/ month. Poverty rates are high in Thanh Hoa and Nghe An provinces, with more than 20% of the population under DoLISA standards. Inequality among different income quintiles is greatest in Hanoi, i.e. the average income of the highest income quintile is 7.1 times that of the lowest.

Table 2.1.3 Social Indicators for Hanoi – Vinh Corridor

		Hanoi		Ha Nam		Nam Dinh		Ninh Binh		Thanh Hoa		Nghe An		Total	
		2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09
Employment (000)	Primary	1,096	-	263	-2.6	690	-0.9	293	-1.8	1,467	1.6	1,122	-0.2	4,931	-
	Secondary	875	-	109	10.1	207	9.0	125	12.4	254	4.2	204	7.9	1,774	-
	Tertiary	1,317	-	83	6.7	156	3.9	97	12.2	305	2.5	284	10.9	2,242	-
	Total	3,288	-	456	1.4	1,052	1.4	516	3.2	2,025	2.0	1,609	2.3	8,947	-
	Unemployment (%)	2.2	-	2.4	-	1.9	-	2.6	-	2.1	-	3.2	-	2.4	-
Income	Per capita (000 VND/month)[1)]	1,297	-	740	-	855	-	761	-	605	-	640	-	816	-
Poverty	Poverty rate (%)[2)]	2.4	-10.6	11.6	-4.8	10.6	-6.0	13.0	-4.7	24.9	-4.8	22.5	-7.0	14.2	-5.7
Education	Literacy rate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

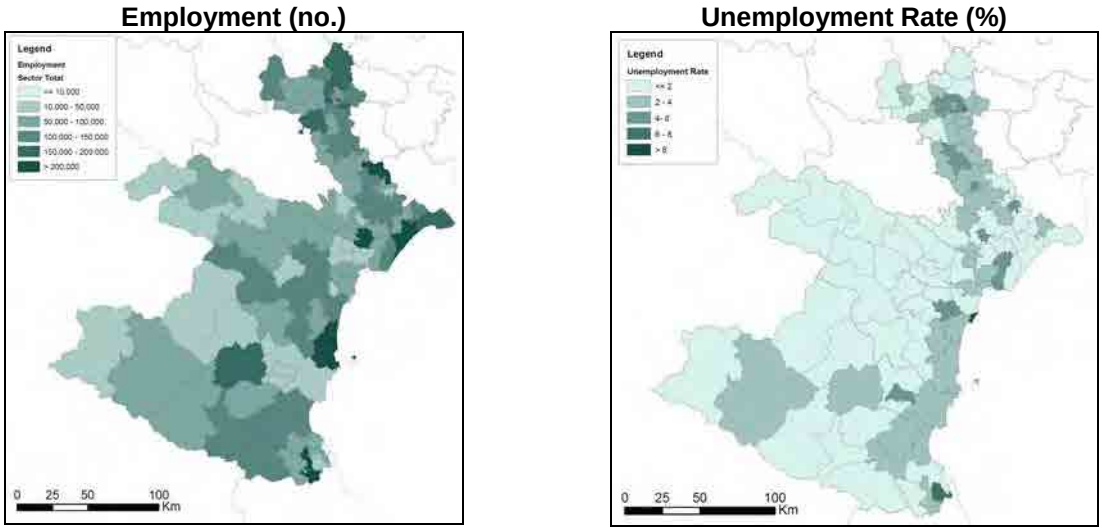
Source: General Statistics Office.

1) Income in 2008 at current prices. 2) Poverty rates in 2006 and 2008.



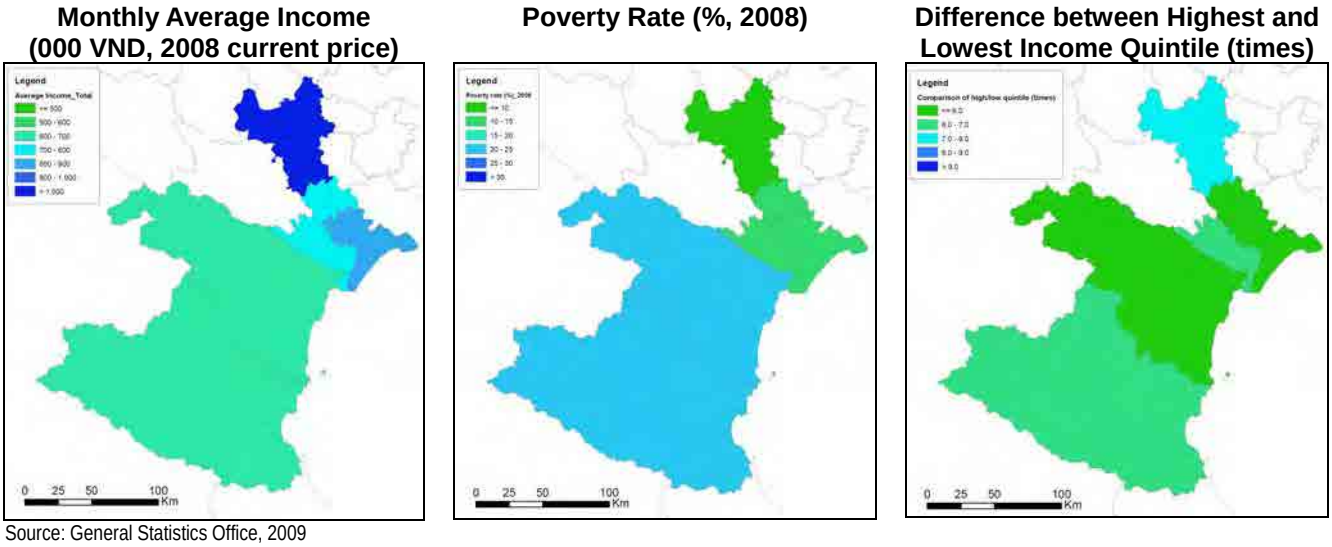
Source: National Census, 2009.

Figure 2.1.5 Employment Sector Share along the Hanoi – Vinh Corridor



Source: National Census, 2009.

Figure 2.1.6 Employment Distribution along the Hanoi – Vinh Corridor



Source: General Statistics Office, 2009

Figure 2.1.7 Income and Poverty along the Hanoi – Vinh Corridor

2.2 Environmental Situation

(1) Topography

2.10 The six provinces in the Hanoi – Vinh Corridor, namely Hanoi, Ha Nam, Nam Dinh, Ninh Binh, Thanh Hoa and Nghe An, has a total area of 34,872km^2, equal to 10.6% of the national total. While Thanh Hoa and Nghe An provinces have steep highland areas in the west, the other four provinces are rather flat and low.

(2) Geology

2.11 The geology in this region is mainly composed of Paleozoic and Mesozoic sediments. The Sichuan earthquake and Yunnan earthquake in China has caused a strong lineament along the Red River stretching from northeast to southwest direction from China. This region is subdivided into five areas based on the petrology.

(3) Climate

2.12 The rainy season for this region is roughly from April to September, and the dry season is from October to March. In the rainy season the almost all areas have more than 100mm rainfall per month. Some differences can be seen in the dry season, as the northern areas are relatively drier than the southern areas.

2.13 Hanoi, Ha Nam, Nam Dinh, and Ninh Binh are all vulnerable to floods. For Hanoi and other urban areas, normally drainage is the problem. Mountainous flash floods seem to be rare in the region. Certain areas in Thanh Hoa and Nghe An provinces are prone to droughts.

(4) Protected Area

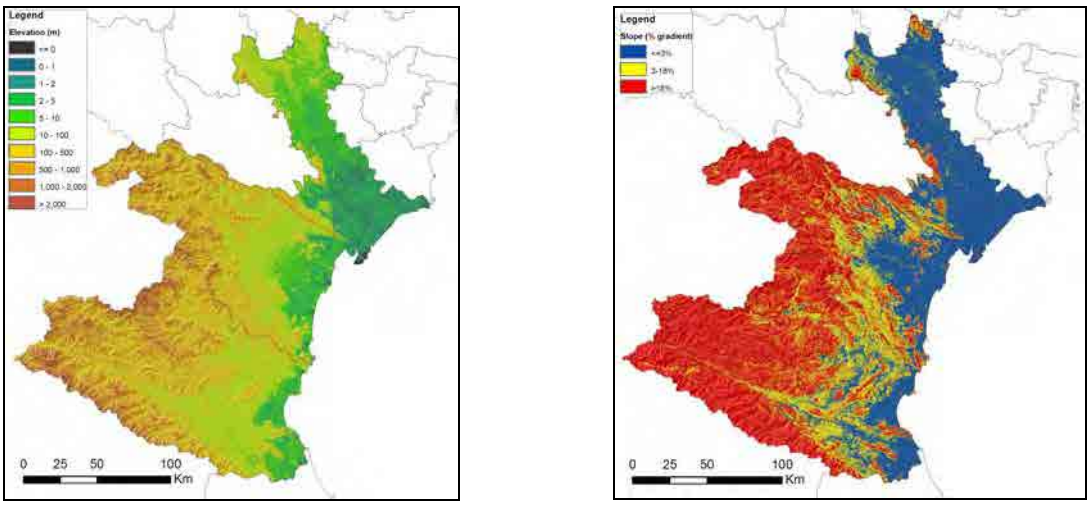
2.14 Protected areas (national parks, natural reserves, protected forests, etc.) in this region are distributed in mountainous areas of Thanh Hoa and Nghe An Provinces. Protected areas in this corridor totals to 3,623km^2.

(5) Hazard Area

2.15 Much of Hanoi, Ha Nam, Nam Dinh, and Ninh Binh Provinces are prone to floods, especially the area along the coast. While most of these floods are external water flooding, Hanoi also experiences internal water flooding due to the lack of sufficient drainage facilities. Landslide is a local issue in certain areas in Nghe An and Thanh Hoa Provinces. Flood prone areas in this corridor totals to 8,790km^2, while that of landslide prone areas are 926km^2.

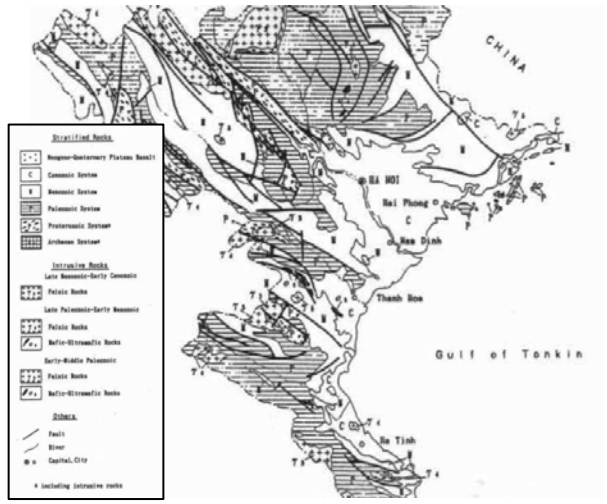
(6) Land Use

2.16 The corridor has a vast area for rice production, as the RRD is one of the major national producers for rice. While the forest area in the west is mostly natural, there are also large pockets of grassland (shrub areas) between these forests.



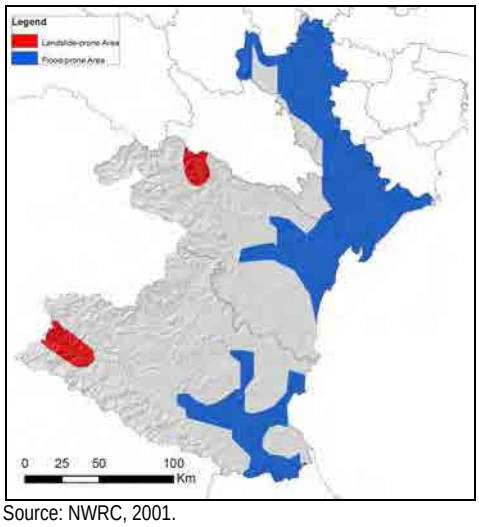
Source: MONRE, 2000.

Figure 2.2.1 Topographic Conditions of the Hanoi – Vinh Corridor



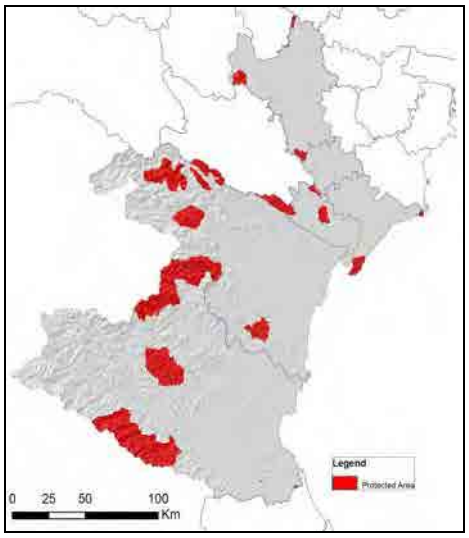
Source: VITRANSS2.

Figure 2.2.2 Geology of the Hanoi – Vinh Corridor



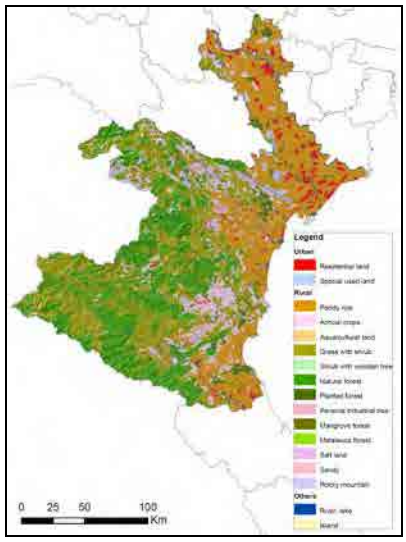
Source: NWRC, 2001.

Figure 2.2.3 Flood and Landslide-prone Areas of the Hanoi – Vinh Corridor



Source: MONRE, 2000.

Figure 2.2.4 Protected Areas of the Hanoi – Vinh Corridor



Source: MONRE, 2000.

Figure 2.2.5 Landuse of the Hanoi – Vinh Corridor

2.3 Current Transport Network and Service

1) Traffic Infrastructure

2.17 The major cities on Hanoi – Vinh section are Hanoi, Phu Ly, Nam Dinh, Ninh Binh, Thanh Hoa, and Vinh. Hanoi, the capital of Vietnam and the biggest city in the section, is targeting to become an 8 million city by 2020, and a 9 million city by 2030 and, thus, neighboring cities are also expected to grow in line with this development.

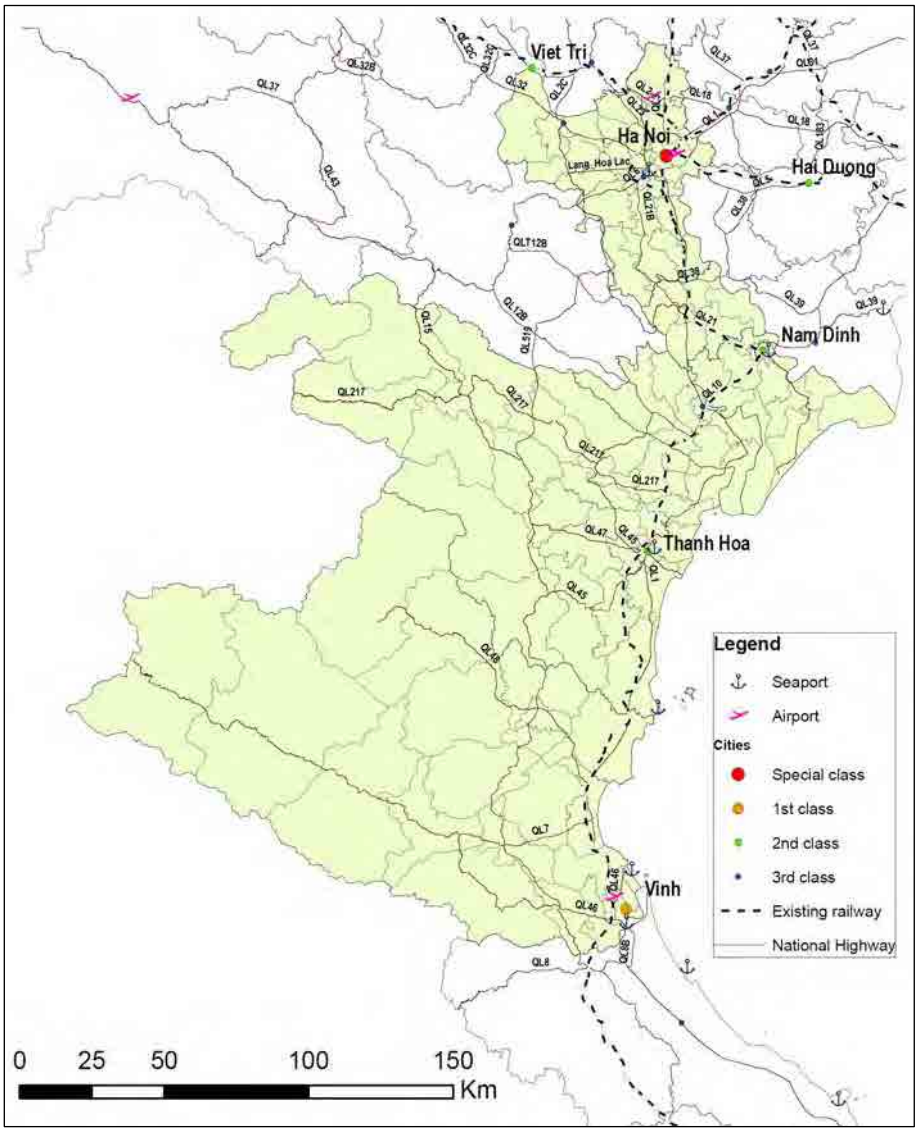
2.18 The region is connected to neighboring provinces by many national highways: NH1 and NH15 (Ho Chi Minh Highway) for the north-south direction and other feeder roads. Although NH1 is the main road corridor on the section, most of its section has only 2 lanes as of now, and planned to be expanded to 4 lanes in the future and, in addition, north-south expressway is planned to be developed along NH1. The north-south railway stretches from Hanoi to the south, which is connected to other lines reaching to Lao Cai, Lang Son and Hai Phong.

2.19 Noi Bai International Airport (NBIA) in Hanoi has passenger handling capacity of 6 million passengers per annum (mppa), which is short to the actual volume of 9.5 mppa as of 2010, and, thus, Terminal 2 (T2), which will add additional capacity of 10 mppa, is now under construction (as of August 2012) and expected to be completed in 2015. Vinh Airport, on the other hand, is a small local airport with the capacity of 100 thousands passengers per annum.

Table 2.3.1 Road Condition in the Adjacent Provinces on Hanoi-Vinh Section

		Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An
Road							
Total Road Length	NH (km)	N/A	122	118	138	793	1,042
	PH (km)	N/A	215	391	198	1,023	600
Road Density (NH&PH) (km/km^2)		N/A	0.39	0.31	0.24	0.16	0.10
NH1 (365 km)	Width	4 Lane:15%, 2 Lane: 85%					
	Surface Condition	Good: 50%, Fair: 18%, Bad: 32%					
	Bridges (no./length (m))	56 / 3,810					
Railway							
Track Length (km)		319 (meter gauge)					
Crossings (no.)		294					
Bridges(length (m))		3,390					
Airport							
Main airport		Noi Bai	-	-	-	-	Vinh
Destinations (cities in Vietnam)		16	-	-	-	-	5
Annual passenger capacity (000)		6,000	-	--		-	100
Seaport							
Main Seaport		-	-	-	-	Nghi Son	-
Max. Vessal Size (DWT)		-	-	-	-	10 - 30,000	-

Source: JICA Study Team



Source: MONRE, General Statistics Office, other sources.

Figure 2.3.1 Spatial Structure and Transportation along the Hanoi – Vinh Corridor

2) Operational Conditions

2.20 **Bus Transport:** Bus is the dominant mode of transport from short to long distance trips in the section and Vietnam. In Hanoi, there are 4 main inter-provincial bus terminals serving for 331 routes in total. Bus transport connects the both ends of HSR section, Ha-noi and Vinh, by 6-7 hour of travel time with cost of 150-170 thousand Vietnam Dong. Be-sides Hanoi, bus service is provided for various routes with high frequency also in other cities; Vinh Bus Station, for example, offers 228 buses for 24 routes including 11 buses serving for Vinh-Hanoi route.

2.21 **Railway Transport:** Compared to bus service mentioned above, the frequency of railway transport is limited: 10 trains a day for one-direction. Railway trip for Hanoi-Vinh takes about 5 – 8 hours and cost 140 thousand Vietnam Dong. While railway transport is less convenient than bus, especially, in terms of frequency, it is believed in general that railway is much safer than road transport modes.

2.22 **Air Transport:** Hanoi and Vinh are also connected by air transport; for this route, only Vietnam Airlines offers the service, with the frequency of two flights a day. While the

travel time on air is only 1 hour, the access time to Noi Bai airport, 40-60 minutes, and waiting time at the airport with high fare rate makes air transport less competitive.

Table 2.3.2 Profile of Bus Services at Main Terminals

		All Routes		Specific Route		
		No. of Routes	No. of Bus Operated per day	No. of Bus Operated per day	Travel Time	Fare (000 VND)
				Route: Hanoi – Vinh		
Hanoi	My Dinh	142	1248	38	7h15	170
	Giap Bat	95	1105	-	-	-
	Yen Nghia	80	413	-	-	-
	Nuoc Ngam	14	81	27	6h	150
				Route: To Hanoi		
Ninh Binh Bus Station		27	113	48	1h45	60
Thanh Hoa Bus Station		5	34	9	3h50 – 4h	75-80
Vinh Bus Station		24	228	11	7h	130

Source: Interviews with bus terminal operating companies

Table 2.3.3 Time Table of Trains at Main Stations in Hanoi-Vinh Section

Province	Station	Departure Time									Fare from Hanoi (SE1, Soft Seat with air conditioner)
		SE1	SE3	SE5	SE7	TN1	TN3	SE19	NA1	NA3	
Hanoi	Hanoi	19.00	23.00	15.45	6.15	10.05	14.30	19.30	21.30	21.55	-
Ha Nam	Phu Ly			16.50/16.53	7.19/7.22	11.17	16.13				-
Nam Dinh	Nam Dinh	20.36/20.39		17.28/17.31	7.56/7.59	11.57	16.50	21.06	23.12/23.15		54
Ninh Binh	Ninh Binh			18.03/18.06	8.30/8.33	12.34	17.22	21.39			-
Thanh Hoa	Bim Son			18.39/18.42		13.28					-
	Thanh Hoa	22.15/22.18		19.19/19.22	9.40/9.43	14.09/ 14.12	18.29	22.46	2.37/2.45	3.17	107
	Cho Sy			21.00/21.03							-
Nghe An	Vinh	0.44/0.49	4.07/4.12	22.10/22.16	11.56/12.01	16.42	21.09	2.13	5.35/5.45	6.15	1194

Source: Vietnam Railways

Note: SE19 : Hanoi – Danang; NA3: Operated in peak season

Table 2.3.4 Profile of Air Service for Hanoi-Vinh Section

Route	Frequency/week	Travel Time	Fare (000 VND)
Hanoi-Vinh	14 flights/week	1 hour	1,248

Source: Vietnam Airlines (as of Oct, 2011)

2.23 **Access time and fare to terminals:** Table 2.3.5 shows average access time to transport terminals in 4 cities of Hanoi-Vinh section. In Hanoi, access time to the airport is about 1 hour. As for other cities, access time to railway station is as much as 51 minutes in Thanh Hoa, while the one to bus station is 55 minutes in Vinh, indicating many passengers of those modes came from outside of city area.

Table 2.3.5 Average Access Time to Transport Terminals (Hanoi-Vinh Section)

(Unit: minutes)

	Bus	Railway	Air	All	No. of Sample
Hanoi	29.3	33.7	60.4	35.1	1,205
Ninh Binh	18.9	-[1)]	-[1)]	18.9	105
Thanh Hoa	17.2	50.6	-[1)]	41.0	283
Vinh	54.7	37.2	-[1)]	42.9	304
Average	29.7	40.7	60.4	36.3	1,897

Source: Interviews in November 2011

Note: 1) No data obtained

Table 2.3.6 Approximate Travel Time between Provinces along North-South Corridor

From	To	Travel Time (hour)			Fare (VND 000)		
		Road[1)]	Existing Railway[3)] (SE1)	Air	Bus[2)]	Existing Railway[4)]	Air
Hanoi	Phu Ly	1.5	1.1	-	30	40	-
	Nam Dinh	2.3	1.6	-	50	63	-
	Ninh Binh	2.3	2.3 (SE7)	-	50	83	-
	Thanh Hoa	3.8	3.3	-	80	126	-
	Vinh	7.3	5.7	1.0	150	228	1,248
	Dong Hoi	12.2	9.5	1.7	260	394	1,309
	Hue	16.4	13.0	1.1	340	520	1,481
	Danang	19.0	15.5	1.2	400	597	1,481
	Qui Nhon (Dieu Tri)	26.6	21.3	1.4	560	790	2,244
	Nha Trang	32.0	25.5	1.5	670	940	2,227
	Phan Rang-Thap Cham	34.6	27.1	-	730	1,062	-
	Phan Thiet	38.3	N/A	-	800	1,096	-
	Bien Hoa	42.4	29.4 (SE7)	-	890	1,153	-
	HCMC	43.0	33.0	1.8	900	1,160	2,227
HCMC	Bien Hoa	0.8	-	-	20	-	-
	Phan Thiet	4.7	-	-	100	64	-
	Phan Rang-Thap Cham	8.4	5.5 (SE8)	-	180	98	-
	Nha Trang	11.0	7.5	1.0	230	220	1,100
	Qui Nhon (Dieu Tri)	16.4	11.3	1.1	340	370	1,100
	Danang	24.0	16.9	1.1	500	563	1,481
	Hue	26.6	19.7	1.2	560	640	1,481
	Dong Hoi	30.8	22.7	1.4	650	766	1,524
	Vinh	35.7	26.6	1.5	750	932	2,227
	Thanh Hoa	39.2	29.3	-	820	1,034	-
	Ninh Binh	40.7	30.7 (SE8)	-	850	1,077	-
	Nam Dinh	42.3	31.3	-	890	1,097	-
	Phu Ly	41.5	31.9 (SE8)	-	870	1,120	-
	Hanoi	43.0	33.0	1.8	900	1,160	2,227

1) Assumed average speed: 40 km/h

2) Assumed fare rate of bus transport: 525 VND/km

3) Travel time by SE1

4) Fare for soft seat with air conditioner

2.4 Traffic Demand Characteristics

1) Traffic Volume in each province

2.24 Transportation indicators of 5 provinces and a city along Hanoi-Vinh section is shown in the following table. Hanoi generates most of the passenger traffic in the section and nearly half of freight traffic. Although Nghe An follows, its volumes are far smaller than those of Hanoi.

Table 2.4.1 Transportation Indicators for Hanoi – Vinh Section (Passenger & Freight)

		Hanoi		Ha Nam		Nam Dinh		Ninh Binh		Thanh Hoa		Nghe An		Total	
		2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11	2011	AGR 09-11	2011	AGR 08-11	2011	AGR 08-11
Passen-gers	no. (mil.)	804.7	17.1	4.6	21.6	10.0	12.6	11.5	13.5	16.0	22.7	39.0	14.3	885.8	16.9
	pax-km (mil.)	11,609	11.6	281	22.4	1,150	15.5	650	17.5	963	16.0	3,542	11.8	18,195	12.1
Freight	ton (mil)	137.2	9.5	19.8	21.9	16.6	14.8	33.3	17.5	30.3	16.9	38.4	14.7	275.6	12.3
	ton-km (mil)	5,286	10.3	687	25.6	3,103	17.2	3,641	24.3	1,989	14.4	2,147	17.0	16,853	15.4

Source: JICA Study Team based on GSO

2) Trip distribution and Modal Share in the target section

2.25 Trip distribution among 5 provinces and a city alongside with HSR line is shown in the following table. As for trips among those 5 provinces and a city, three-fourths of trips have origin or destination in Hanoi. Hanoi-Ha Nam has the highest volume, 21,000 passenger per day followed by Hanoi-Nam Dinh, 8,100 and Hanoi-Nghe Anh, 6,200.

Table 2.4.2 Trip Distribution (2010, both-direction)

(Unit: No. of passenger per day)

	Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An	Other Provinces in the Central and the South
Other Provinces in the North	224,872	4,214	6,647	3,699	6,001	2,454	22,258
Hanoi	-	20,790	8,130	2,012	4,384	6,169	23,441
Ha Nam	-	-	501	208	491	104	1,135
Nam Dinh	-	-	-	1,394	1,525	369	3,920
Ninh Binh	-	-	-	-	1,092	167	1,698
Thanh Hoa	-	-	-	-	-	975	3,325
Nghe An	-	-	-	-	-	-	15,612

Source: JICA Study Team (OD table based on VITRANSS2 and supplemental traffic survey)

2.26 The following table shows modal shares of trips from/to Hanoi. In the section, bus is the dominant mode of transport having the share of 50-80 % excluding Hanoi-Ninh Binh pair. The high share of car for Hanoi-Ninh Binh pair is probably because of tourism traffic often utilizing minivans operated by tourism companies.

Table 2.4.3 Modal Share (2010, both-direction)

OD pair (both direction)	Unit	Transport Mode				Total
		Car	Bus	Railway	Air	
Hanoi-Ha Nam	(000)	4,158	16,596	36	-	20,790
	(%)	20	80	-	-	100
Hanoi-Nam Dinh	(000)	2,037	5,653	440	-	8,130
	(%)	25	70	5	-	100
Hanoi-Ninh Binh	(000)	1,277	673	62	-	2,012
	(%)	63	33	3	-	100
Hanoi-Thanh Hoa	(000)	1,222	2,472	690	-	4,384
	(%)	28	56	16	-	100
Hanoi-Nghe An	(000)	1,070	3,204	1,801	94	6,169
	(%)	17	52	29	2	100

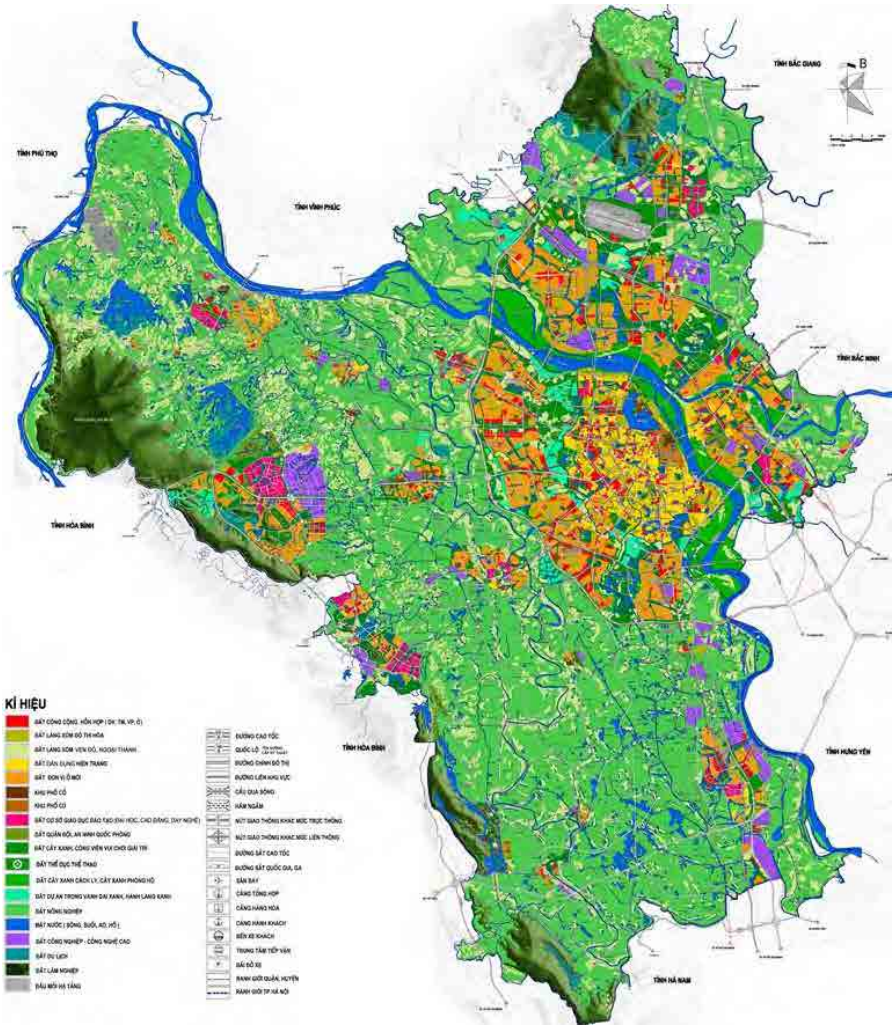
Source: JICA Study Team (OD table based on VITRANSS2 and supplemental traffic survey)

2.5 Related Urban and Regional Plans

2.27 Upon developing rapid, reliable and safe mass-transit, one of the issues raised in the National Assembly was that the high speed railway project must coordinate and integrate with current plans at central and local levels. Therefore, the latest regional and urban plans were collected in order to reflect these plans to alignment and station location planning. Such plans include the Socio-Economic Development Plan, Construction Plan, Land Use Plan, Transport Development Plan, and other sectorial plans. In addition, development plans and situation of area in vicinity of the station was carefully studied.

1) Hanoi City

2.28 The city has recently updated its “Hanoi General Construction Plan by 2030 and Vision to 2050” which includes the spatial development. This plan notes the development following the urban cluster model including central urban area and five satellite towns. These towns will be connected by transport systems including ring roads having link to the national and regional transport network. The plan also mentions the development of a UMRT network to promote mass transit public transport. With regards to station development, it notes Ngoc Hoi Station to become a central terminal station for the HSR. The target population of the city is 9,135,000 by 2030, with an urbanization rate of 70%.

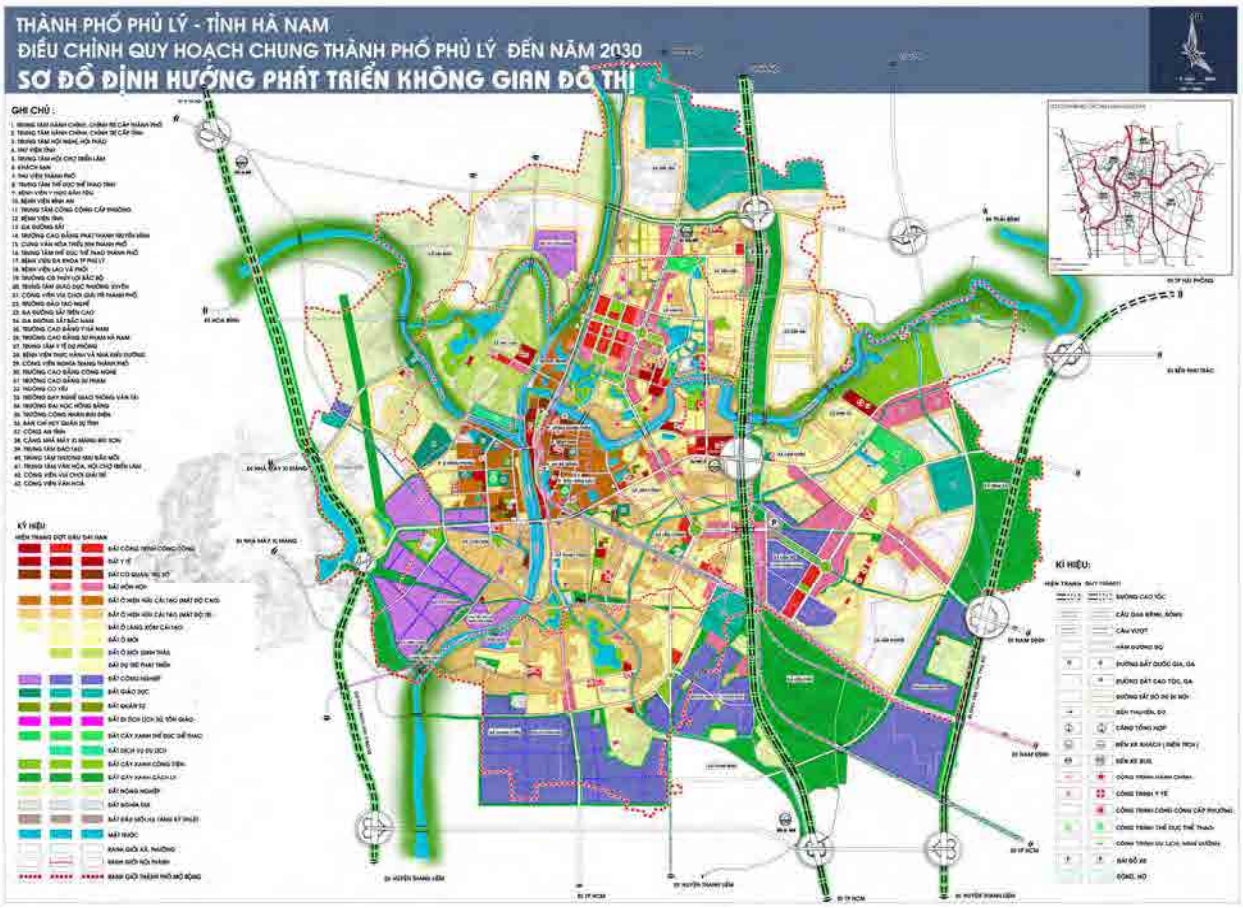


Source: Hanoi City People's Committee.

Figure 2.5.1 Hanoi City Master Plan up to 2030

2) Ha Nam Province

2.29 The main urban area sandwiched between NH01 and the new expressway leading to Hanoi is referred to as the "Ha Nam Avenue" and is the utmost priority for development in Phu Ly City, the province's central city. According to the Transportation Development Master Plan, the existing railway station will be moved to the east side of the city, along with the new expressway leading to Hai Phong, bus terminal, and logistics services. Land has been allotted and secured and a 300m clearance from this expressway has been reserved for high speed railway development. This location has been set due to the accessibility from neighboring provinces such as Hoa Binh, Hung Yen. The target population of the city is 185,000 by 2020, with an urbanization rate of 86%.

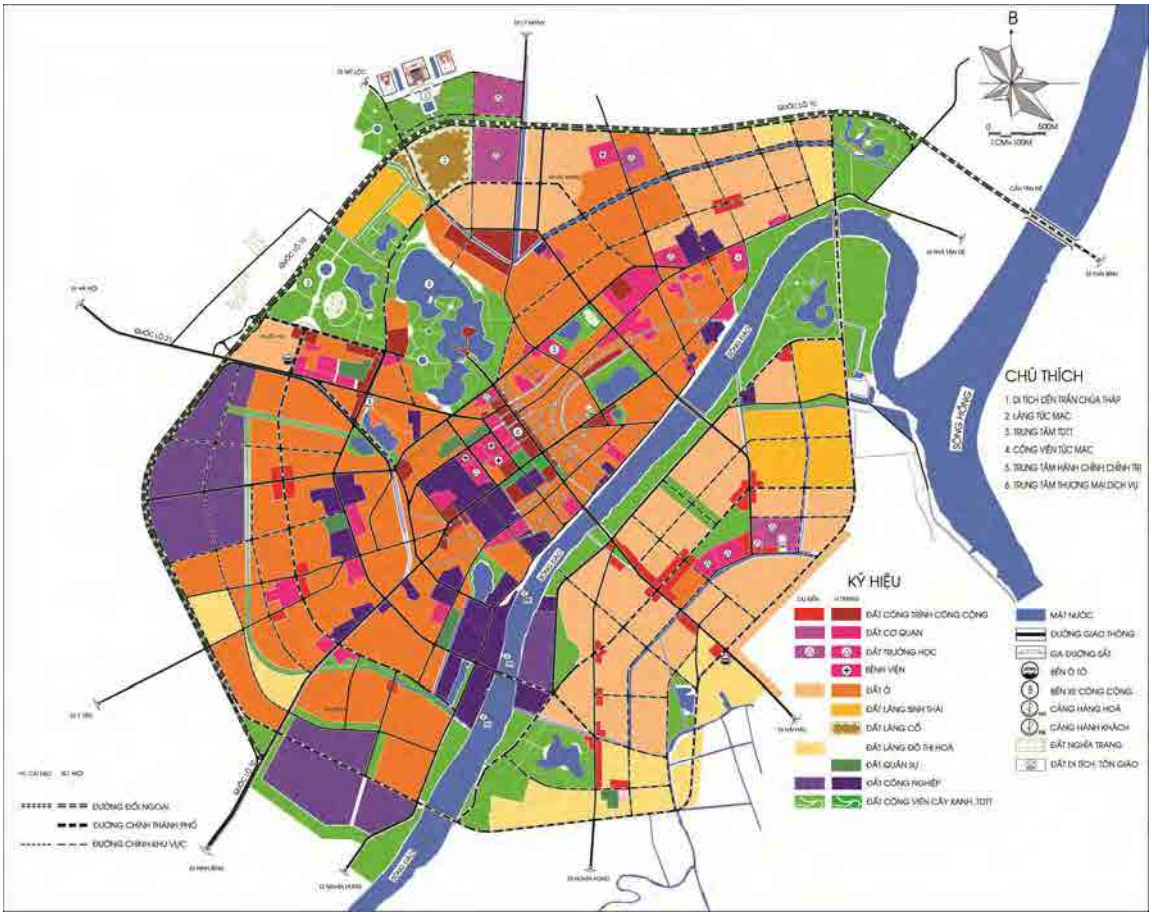


Source: Ha Nam Provincial People's Committee.

Figure 2.5.2 Phu Ly City Master Plan up to 2030

3) Nam Dinh Province

2.30 The city has radial roads which are connected to the outer ring road which limits the city boundary as well. Urban expansion to the east side of Dao River is planned, while the west side locates industrial zones. The alignment for the HSR is planned and stated in the Transport Development Master Plan, which follows closely to the KOICA Study and Pre F/S. According to the province, there are plans to move the current Nam Dinh Station of the existing railway to the location of Dan Xan Station to be used as the main station of Nam Dinh City. Whether to utilize the old tracks and station location in the inner city section has not been decided yet. The target population of the city is 570,000 by 2025, with an urbanization rate of 60%.

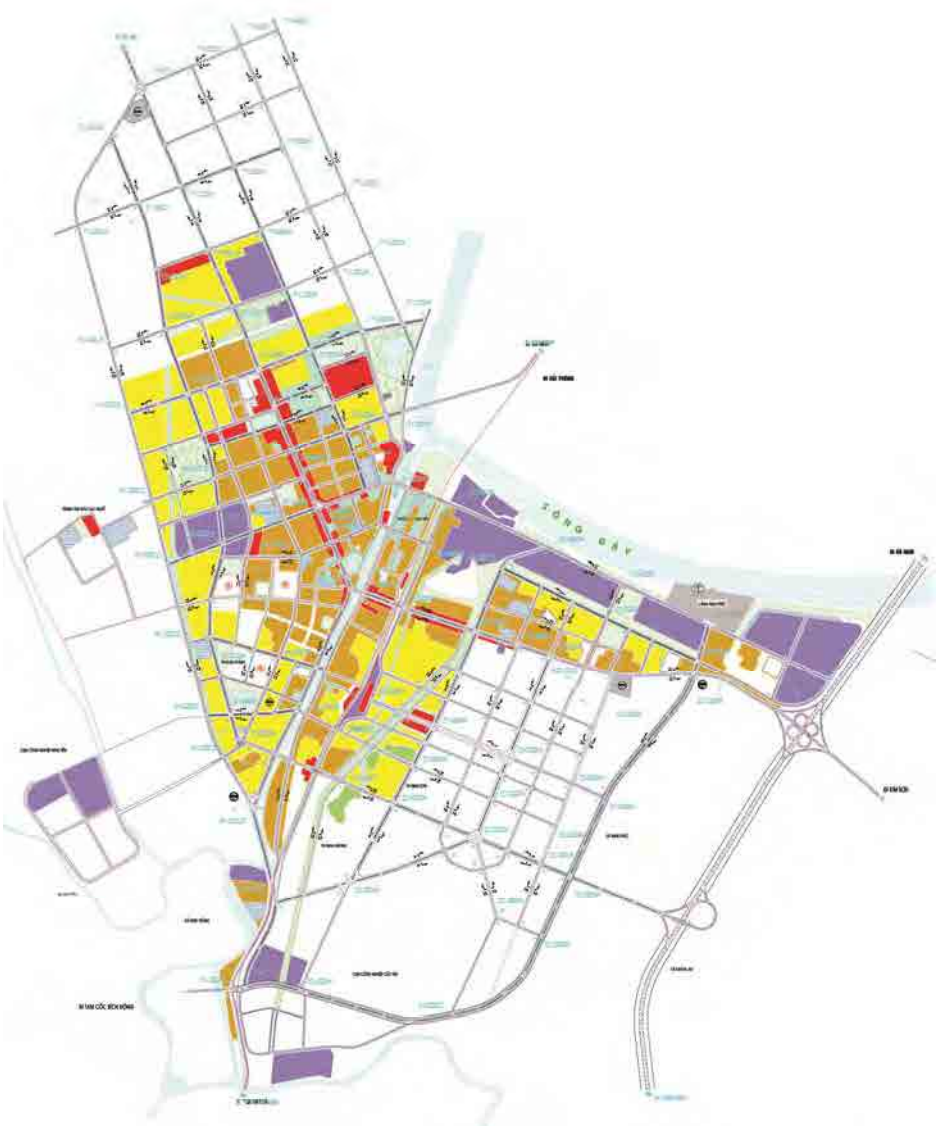


Source: Nam Dinh Provincial People's Committee.

Figure 2.5.3 Nam Dinh City Master Plan

4) Ninh Binh Province

2.31 The Ninh Binh City General Plan states two directions for spatial development, i.e. rehabilitation of current built-up areas in the inner city, and construction of new urban area in the south. Neighboring communes have been merged to expand the boundary of Ninh Binh City following this plan. The Ninh Binh Urban Development Plan 2020 was already approved by the PPC, which proposed two large cities namely: Ninh Binh and Tam Diep. Regarding the existing railway, currently there are three railway stations (Ninh Binh, Cau Yen and Dong Giao) which need to be taken into consideration account to ensure the connectivity between the existing railway and the high speed railway. The province plans to develop Cat Xi Airport, covering 400 hectares. Regarding the HSR station, the province expects that the station should be located at the east of the city, as specified in the Ninh Binh Transportation Master Plan (2020).



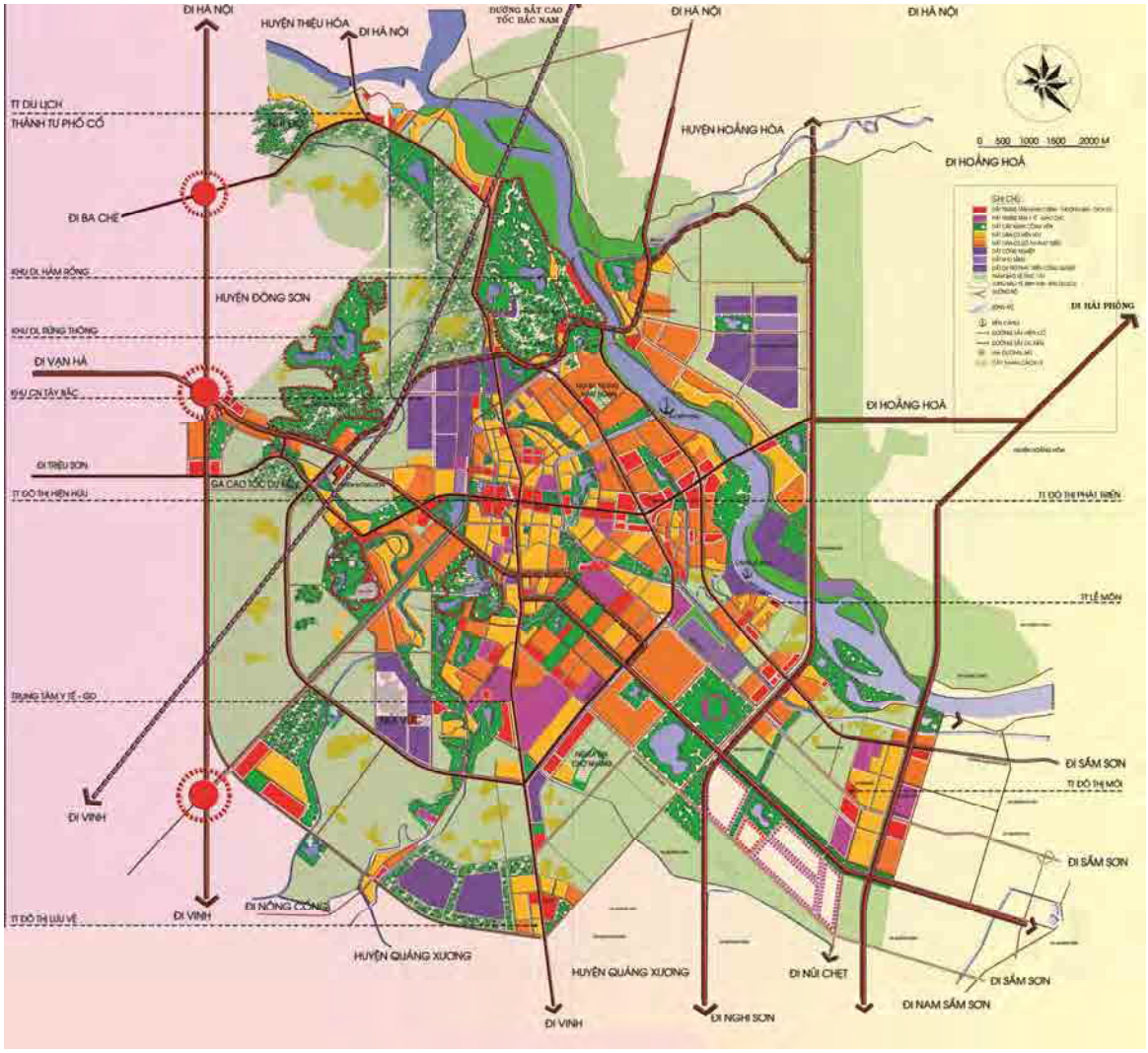
Source: Ninh Binh Provincial People's Committee.

Figure 2.5.4 Ninh Binh City Master Plan

5) Thanh Hoa Province

2.32 The development of the Hanoi – Hai Phong – Quang Ninh growth triangle development will promote the development of Nghi Son and Hoang Mai Industrial Zones. Thanh Hoa City's role would be to support this industrial development, especially the Nghi Son key economic zone located in the south of the province.

2.33 Thanh Hoa City is bordered by a ring road on the west side and a river on the east side, along with expressways for regional transport. It has a clear concept of restricting urban sprawl by such road arrangements, and locating industrial areas in the city fringe areas to maintain good living environment in the inner city areas. Regarding the HSR station, the province expects that the station should be located at the west of the city where geological conditions are good. The target population of the city is 500,000 by 2020, with an urbanization rate of 76%.

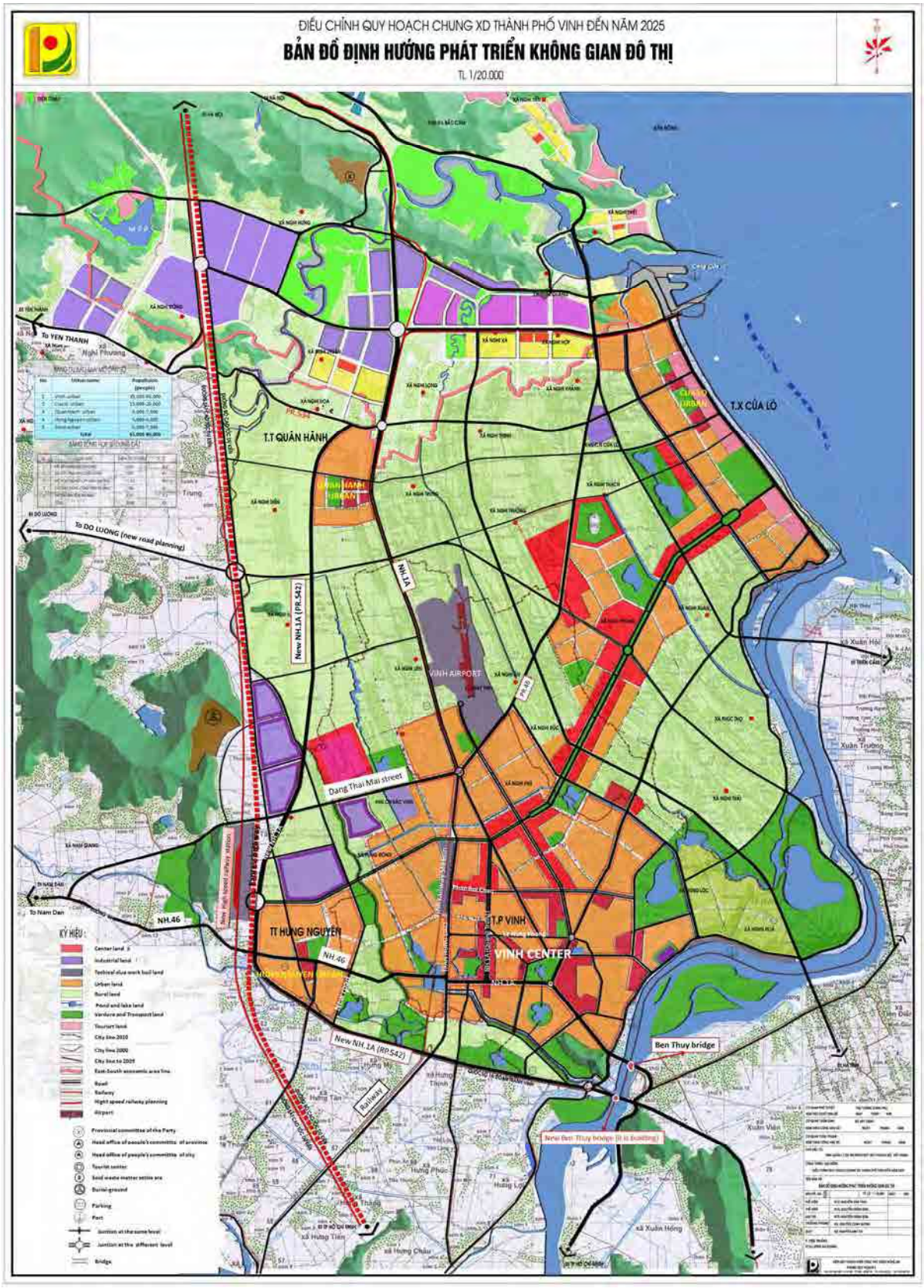


Source: Thanh Hoa Provincial People's Committee.

Figure 2.5.5 Thanh Hoa City Master Plan

6) Nghe An Province

2.34 Vinh City is a Class I City and is one of the key urban centers of the region. It has an airport in the center of the city, and also serves as a gateway city to Laos. The west side of the city is planned for regional transport, such as expressways, high-speed railway, bus terminals, logistic centers, etc. The target population of the city is 800,000 in 2025, with an urbanization rate of 86%. Other than Vinh City, Hoang Mai Town has high potential for development as it is planned to be upgraded to a Provincial Town in the future and to be expanded by integrating surrounding areas as one of the important urban centers of the province. The center of the new Hoang Mai Town is planned along NH1A and it is in the accessible distance from Nghi Son IZ.



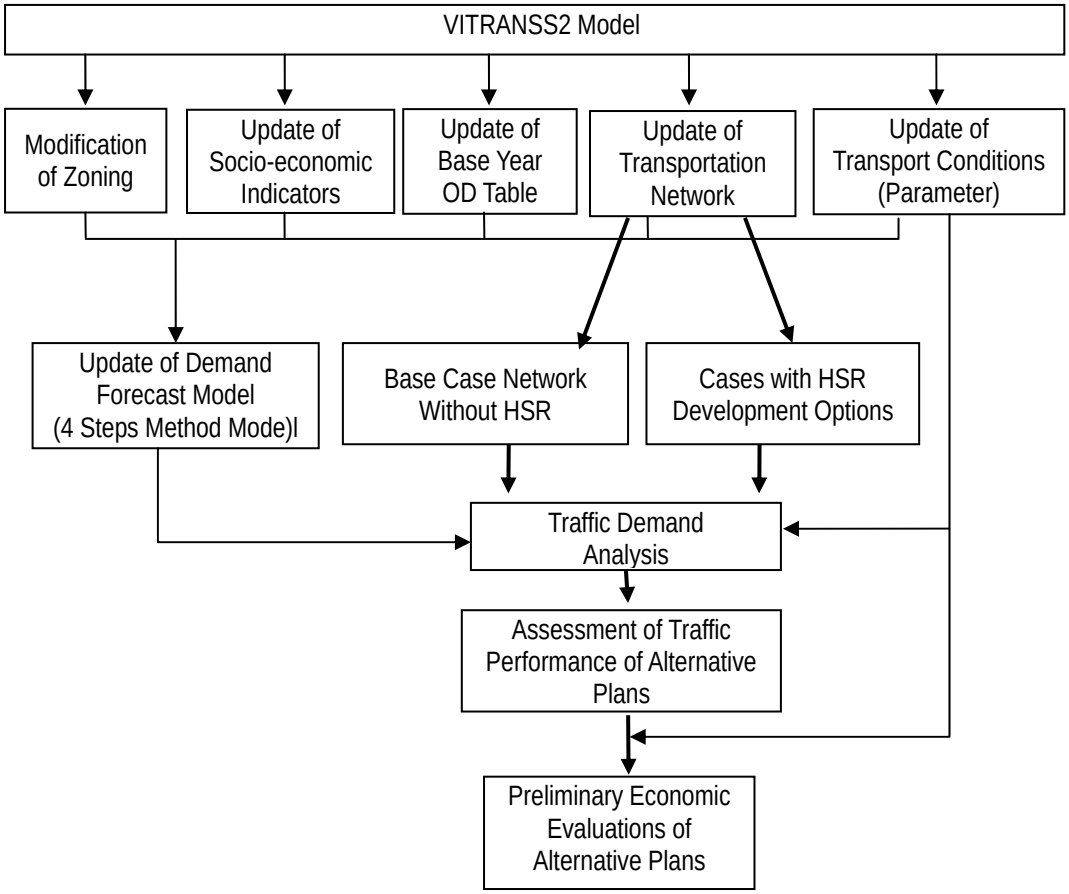
Source: Nghe An Provincial People's Committee.

Figure 2.5.6 Vinh City Master Plan

3 TRAFFIC DEMAND ANALYSIS

3.1 Approach

3.1 For the purpose of traffic demand analysis of the HSR, the model developed in VITRANSS2 was modified based on the latest traffic data and information available. The basic update was conducted on 1) Modification of Zoning, 2) Update of Socio-economic Indicators, 3) Update of Base Year OD Table, 4) Update of Transportation Network, 5) Update of transport Conditions (parameters such as fare/cost, access time and travel speed) and 6) Update of Four Steps Method Model. The traffic demand forecast for the improvement Option A2 was applied as a based case for the assessment of HSR development. Figure 4.2.1 shows the entire flow for traffic demand analysis for HSR.



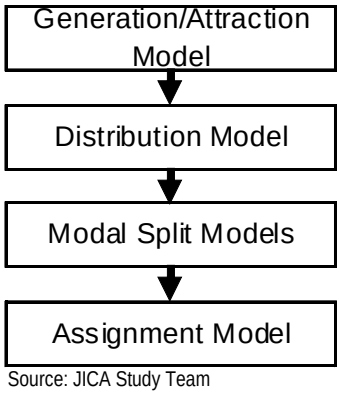
Source: JICA Study Team

Figure 3.1.1 Flow of Traffic Demand Analysis

3.2 Methodology

1) Outline

3.2 Applied demand forecast models follows the traditional four-step method, namely (i) trip generation/attraction, (ii) trip distribution, (iii) modal split, and (iv) traffic assignment. Although trip generation/attraction model is often used in combination with the trip production model to control the total number of trips generated in a study area, the output of the trip generation/attraction model was used as is in VITRANSS2.

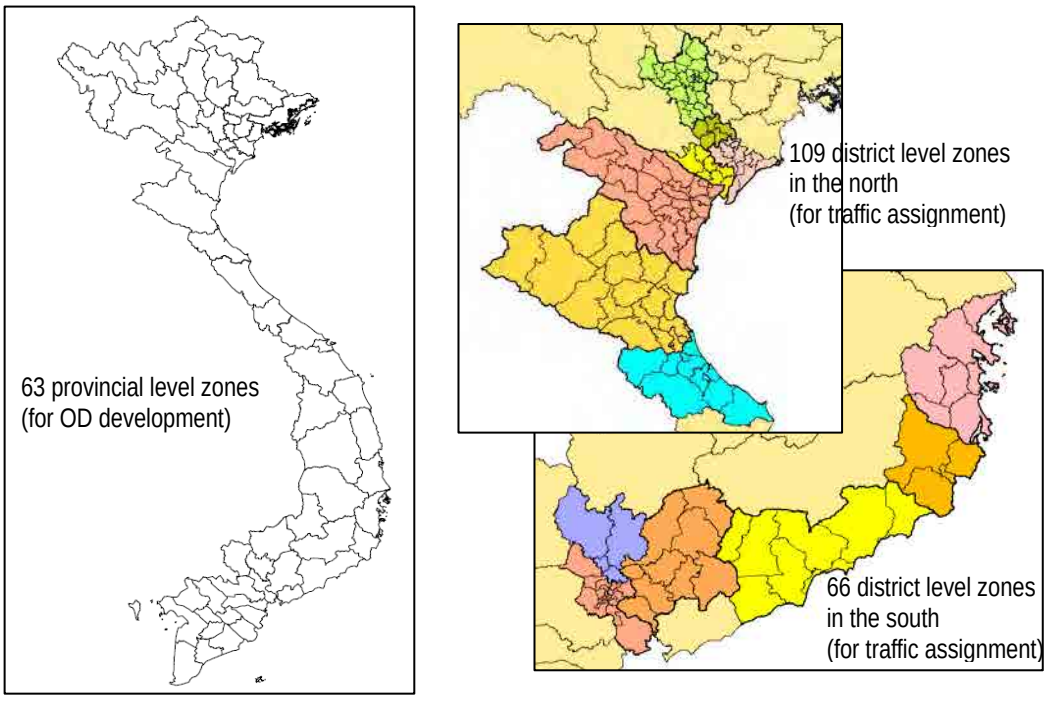


Source: JICA Study Team

Figure 3.2.1 Demand Forecasting Flow

2) Zoning

3.3 Applied zones for OD development are provincial administrative boundaries in the whole Vietnam (63 zone), targeting the analysis of traffic flows not only in the project areas but also over the country, especially, on the north-south corridor. On the other hand, district boundaries are applied in the provinces along expected HSR routes (Hanoi-Vinh & HCMC-Nha Trang) and adjacent provinces (Ha Tinh & Binh Duong) for traffic assignment (district .level OD is created based on the distribution of urban populations).



Source: JICA Study Team

Figure 3.2.2 Applied Zoning

3) Socio-economic Framework

3.4 Current and future socio-economic indicators for the demand forecast is summarized in Table 3.2.1. The basis of the forecast is explained in detail in Technical Report 2 Demand Forecast and Transportation Cost.

Table 3.2.1 Socio-economic Indicator (2010 and 2030)

Province	Urban population (000)			GDP (Billion VND, 1994 constant)		
	2010	2030	Annual Growth 2010-2030	2010	2030	Annual Growth 2010-2030
Ha Noi	2,710	5,048	3.2%	50,091	186,595	6.8%
Vinh Phuc	231	449	3.4%	8,589	29,154	6.3%
Bac Ninh	247	505	3.7%	6,492	25,327	7.0%
Hai Duong	327	615	3.2%	8,951	25,957	5.5%
Hai Phong	859	1,395	2.5%	16,327	50,379	5.8%
Hung Yen	140	467	6.2%	6,142	26,468	7.6%
Thai Binh	174	377	4.0%	7,467	21,609	5.5%
Ha Nam	82	258	5.9%	3,559	12,488	6.5%
Nam Dinh	326	563	2.8%	6,927	15,991	4.3%
Ninh Binh	161	391	4.5%	4,655	20,852	7.8%
Ha Giang	106	130	1.1%	1,665	6,723	7.2%
Cao Bang	87	132	2.1%	1,991	7,144	6.6%
Bac Kan	48	80	2.6%	852	3,480	7.3%
Tuyen Quang	95	173	3.0%	2,807	12,645	7.8%
Lao Cai	133	220	2.6%	1,984	8,836	7.8%
Yen Bai	145	217	2.0%	2,490	8,530	6.3%
Thai Nguyen	294	380	1.3%	4,238	11,959	5.3%
Lang Son	141	218	2.2%	3,045	9,462	5.8%
Quang Ninh	603	759	1.2%	9,028	36,506	7.2%
Bac Giang	147	212	1.9%	3,980	9,359	4.4%
Phu Tho	211	302	1.8%	4,932	13,892	5.3%
Dien Bien	76	111	1.9%	1,330	3,963	5.6%
Lai Chau	54	77	1.8%	725	2,546	6.5%
Son La	153	245	2.4%	2,890	12,943	7.8%
Hoa Binh	119	145	1.0%	3,569	13,296	6.8%
Thanh Hoa	358	491	1.6%	13,511	39,097	5.5%
Nghe An	376	613	2.5%	10,798	30,496	5.3%
Ha Tinh	184	311	2.7%	4,479	12,433	5.2%
Quang Binh	129	204	2.3%	2,435	6,300	4.9%
Quang Tri	171	317	3.2%	1,987	5,276	5.0%
Thua Thien - Hue	434	543	1.1%	4,144	12,440	5.7%
Da Nang	805	1,110	1.6%	7,052	28,811	7.3%
Quang Nam	271	592	4.0%	6,079	23,384	7.0%
Quang Ngai	178	448	4.7%	5,804	25,998	7.8%
Binh Dinh	413	831	3.6%	6,138	17,179	5.3%
Phu Yen	203	417	3.7%	3,105	11,582	6.8%
Khanh Hoa	520	1,015	3.4%	8,306	30,941	6.8%
Kon Tum	151	461	5.7%	1,656	6,166	6.8%
Gia Lai	382	889	4.3%	4,385	16,332	6.8%
Dak Lak	431	898	3.7%	8,257	29,754	6.6%
Dak Nong	76	182	4.4%	2,676	11,984	7.8%
Lam Dong	458	1,080	4.4%	7,623	34,137	7.8%
Ninh Thuan	205	430	3.8%	1,950	5,491	5.3%
Binh Thuan	460	759	2.5%	5,105	19,001	6.8%
Binh Phuoc	150	207	1.6%	3,913	19,203	8.3%
Tay Ninh	168	437	4.9%	8,631	29,294	6.3%
Binh Duong	513	1,307	4.8%	11,054	49,501	7.8%
Dong Nai	859	2,001	4.3%	24,182	90,081	6.8%
Ba Ria - Vung Tau	507	985	3.4%	24,386	62,507	4.8%
Ho Chi Minh	6,158	8,333	1.5%	103,583	305,694	5.6%
Long An	255	548	3.9%	8,368	26,409	5.9%
Tien Giang	232	474	3.6%	9,037	27,095	5.6%
Ben Tre	126	274	4.0%	6,376	18,159	5.4%
Tra Vinh	155	385	4.7%	5,347	16,536	5.8%
Vinh Long	158	307	3.4%	5,112	15,011	5.5%
Dong Thap	297	491	2.6%	9,341	38,155	7.3%
An Giang	611	1,272	3.7%	11,361	30,131	5.0%
Kien Giang	458	747	2.5%	12,206	41,430	6.3%
Can Tho	790	1,262	2.4%	11,737	47,953	7.3%
Hau Giang	151	328	4.0%	4,149	16,059	7.0%
Soc Trang	280	463	2.6%	7,420	27,659	6.8%
Bac Lieu	230	533	4.3%	5,652	21,053	6.8%
Ca Mau	259	404	2.3%	9,535	29,490	5.8%
Vietnam	26,224	45,818	2.8%	551,609	1,854,326	6.2%

Source: JICA Study Team

4) Update of Base Year OD Data

3.5 Present 2010 OD date is developed based on 2008 OD data formulated in VITRANSS2 utilizing following statistics data and survey results;

(i) Roadside traffic count and OD interview data (road side and terminals) (obtained in November 2011)

(ii) 2010 railway station OD data

(iii) 2010 airport passenger demand, flight schedule and aircraft capacity

3.6 The difference of base year OD data of VITRANSS2 and this study is shown in Table 3.2.2. Reflecting the transition of traffic demand in the last few years, air traffic demand is increased significantly while railway traffic demand is slightly decreased in the updated data.

Table 3.2.2 Comparison of Base Year OD Data

	Mode	Car	Bus	Railway	Air	Total
VITRANSS2 (2008)	Passenger (thousand/day)	291	645	31	17	985
	Share (%)	29.5	65.5%	3.1%	1.7%	-
Updated Data (2010)	Passenger (thousand/day)	304	675	30	25	1,034
	Share (%)	29.4%	65.3%	2.9%	2.4%	-

Source: VITRANSS2 and JICA Study Team

5) Trip Generation/Attraction

3.7 For the trip generation/attraction model, the urban population and GRDP were adopted as explanatory variables in the following regression equations:

$$Gi \text{ or } Ai = 1.112 * UPOPi * (GRDPi/Upop)\ 1.0392$$

Where, Gi: Generation of Zone *i*
Ai: Attraction of Zone *i*
UPOPi: Urban Population of Zone *i* (unit: 000)
GRDPi: GRDP of Zone *i* (VND billion)

Table 3.2.3 Trip Generation/Attraction Model

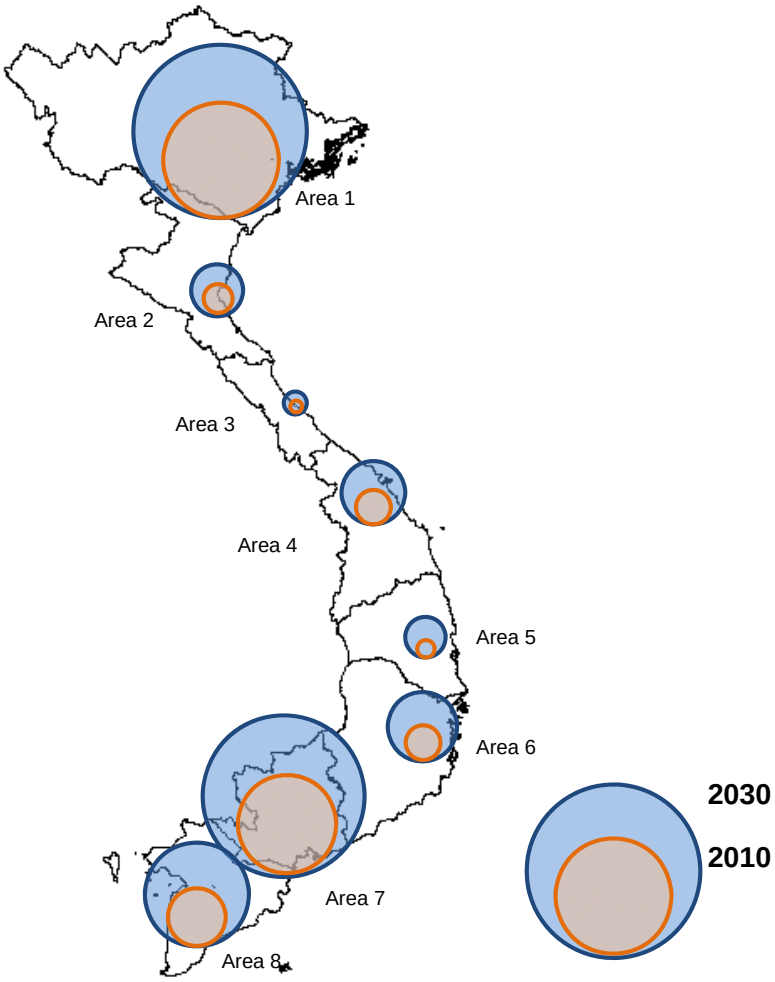
Variable	Generation Model	
	Coefficient	t Value
Constant	1.112	0.17
(GRDP/Urban population)	1.0392	5.11
Multiple correlation coefficient	0.8317	
Number of samples	63	

Source: JICA Study Team

3.8 The difference of actual value to theoretical value was used as adjustment factor similarly to the VITRANSS 2

3.9 Figure 3.2.2 shows the estimated trip generation/attraction in Vietnam. Area 1 (including Hanoi) in the north and Area 7 (including HCMC) in the south are the biggest generators of traffic demand in Vietnam.

Area	Generation/Attraction (000)	
	2010	2030
1	469	1,003
2	29	100
3	6	15
4	39	132
5	9	49
6	44	169
7	335	879
8	102	381
Total	1,032	2,728



Source: JICA Study Team

Figure 3.2.3 Trip Generation/Attraction per day (2010 & 2030)

6) Trip Distribution

3.10 Same with VITRANSS2, symmetric pattern was assumed for both directions. The following equation with a dummy parameter was adopted.

$$T_{ij} = \frac{C \times G_i^a \times A_j^b \times (dum)^d}{GC_{ij}^c}$$

Where,
C: Constant
Tij: No. of trips between Zone i and j
Gi: Average of Trip Generation and Attraction of Zone i
Aj: Average of Trip Generation and Attraction of Zone j
GCij: Generalized Cost between Zone i and j
GCij = (time)*VoT + (cost)
dum: a dummy constant
a, b, c, and d: parameters

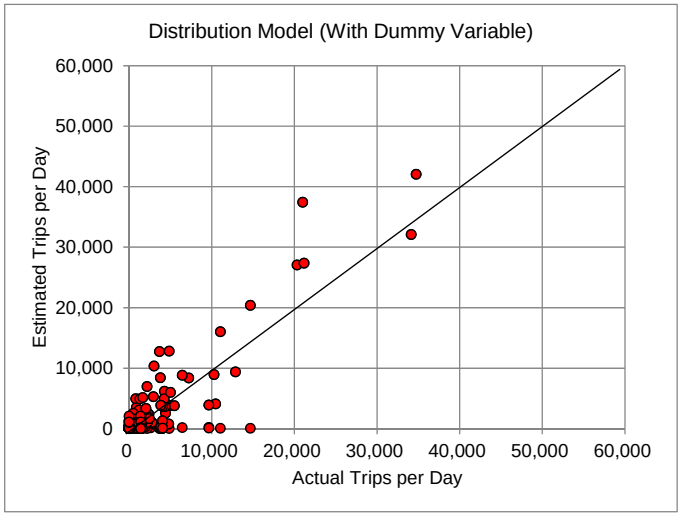
Note: Value of Time (VoT) was determined at VND 387/min and VND1096/min for 2010 and 2030 (2010 value), respectively, as a weighted average of car and bus passengers

Table 3.2.4 Trip Generation/Attraction Model

Variable	Coefficient	t-Value
Constant	1.8244	5.51
Generation	0.4020	18.82
Attraction	0.4020	18.82
Generalized Cost	0.8712	36.31
Dummy	1.6350	36.68
Multiple Correlation Coefficient	0.8318	
Number of Samples	1678	

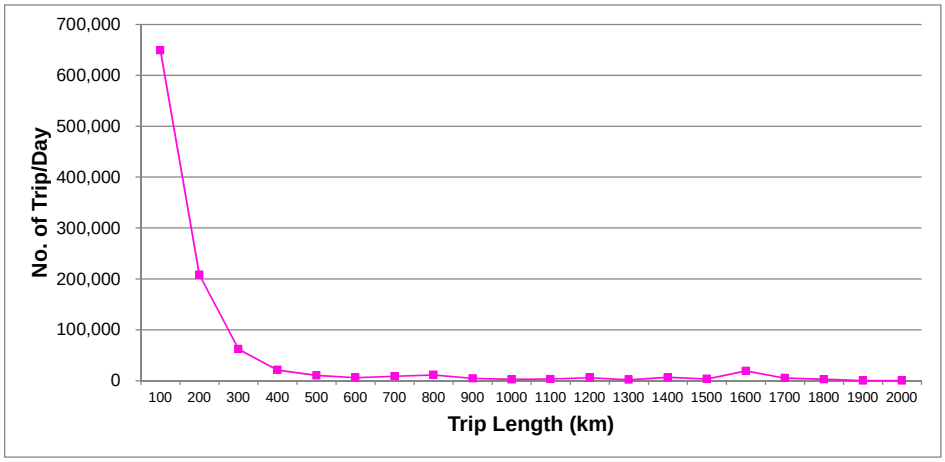
Source: JICA Study Team

3.11 After applying the trip distribution model mentioned above, the Fratar convergence calculation was conducted to adjust the OD values to the trip generation/attraction estimated earlier.



Source: JICA Study Team

Figure 3.2.4 Comparison of distribution model value (with dummy variable) and No. of actual trips



Source: JICA Study Team

Figure 3.2.5 Trip Distribution Model

3.12 After applying the trip distribution model mentioned above, the Fratar convergence calculation was conducted to adjust the OD values to the trip generation/attraction estimated earlier.

3.13 Trip distribution is summarized in Table 3.2.5, Table 3.2.6 and Figure 3.2.5. Although the OD pairs with short distances tend to have higher traffic volume, the traffic volume between Area 1 and Area 7 is quite high; over 75,000 passenger/day/both-way for about 1,500km distance.

Table 3.2.5 Summary of Trip Distribution (2010)

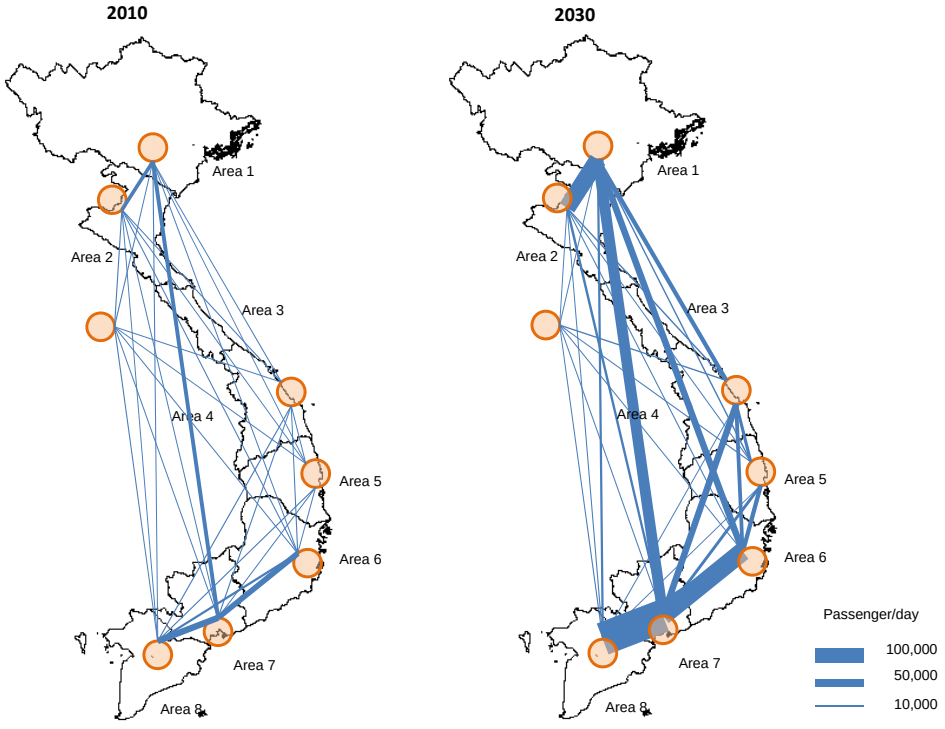
	Area 1 (Hanoi)	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7 (HCMC)	Area8
Area 1	432,634	25,326	1,300	7,698	1,712	8,332	28,023	2,817
Area 2	-	11,120	1,447	1,578	367	1,283	5,904	40
Area 3	-	-	895	5,133	87	184	1,521	308
Area 4	-	-	-	23,583	3,028	2,929	10,052	179
Area 5	-	-	-	-	809	6,095	4,639	159
Area 6	-	-	-	-	-	7,574	39,365	14,526
Area 7	-	-	-	-	-	-	268,595	44,018
Area 8	-	-	-	-	-	-	-	70,526

Source: JICA Study Team

Table 3.2.6 Summary of Trip Distribution (2030)

	Area 1 (Hanoi)	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7 (HCMC)	Area 8
Area 1	847,950	118,338	4,105	37,135	13,078	51,081	73,603	15,218
Area 2	-	19,208	4,502	9,914	1,665	9,575	16,381	330
Area 3	-	-	1,039	7,937	758	2,833	5,964	936
Area 4	-	-	-	55,301	20,235	28,684	48,403	899
Area 5	-	-	-	-	3,697	27,059	26,079	960
Area 6	-	-	-	-	-	32,444	132,928	20,466
Area 7	-	-	-	-	-	-	607,874	238,763
Area 8	-	-	-	-	-	-	-	242,298

Source: JICA Study Team

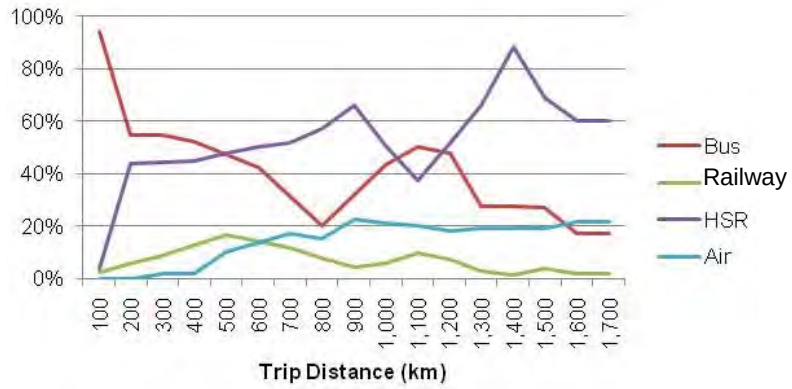


Source: JICA Study Team

Figure 3.2.6 Passenger Trip Distribution (2010 and 2030)

7) Modal Split

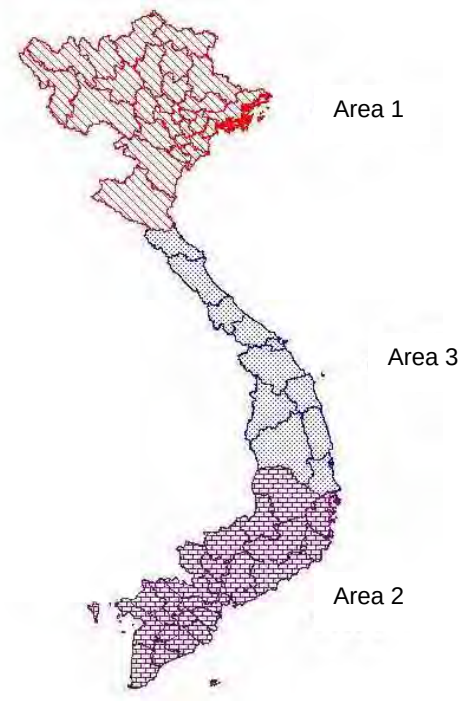
3.14 Although the main purpose of the demand analysis is the forecast of HSR Demand, the demand could not be estimated directly from demand model from present condition, since HSR does not exist at present. Therefore, virtual base year passenger OD which is including HSR demand is prepared as the base of modal split model utilizing the data of stated modal choice preference obtained by terminal survey and base year OD data.



Source: JICA Study Team
Note: 1) Based on the data obtained by terminal Survey in Hanoi and HCMC, 2) Given HSR fare level is the half of the one of Air

Figure 3.2.7 Modal Share based on Stated Preference

3.15 For the modal split model, following VITRANSS2 model, the aggregate logit model was applied (the model is shown below). Modal choice process is modeled for each of three types of trips: type 1 for intra-movement in the north (Area 1 in Figure 3.2.8), type 2 for intra movement in the south (Area 2 in Figure 3.2.8) and the others.



Source: JICA Study Team

Figure 3.2.8 Distinguished Area for Modal Split Model

3.16 The utility function by mode is expressed in the following formula:

Car : $V_1 = a \times Time_1 + b \times Cost_1$
Bus : $V_2 = a \times Time_2 + b \times Cost_2 + const_2$
Rail : $V_3 = a \times Time_3 + b \times Cost_3 + const_3 + d_3 \times (GDP/POP)$
Air : $V_4 = a \times Time_4 + b \times Cost_4 + const_4 + d_4 \times (GDP/POP)$
HSR: $V_5 = a \times Time_5 + b \times Cost_5 + const_5 + d_5 \times (GDP/POP)$

3.17 The probability function by mode is expressed in the following formula.

$$Pi = \exp(v_i)/\{ \exp(v_1)+\exp(v_2)+\exp(v_3)+\exp(v_4)+\exp(v_5) \}$$

3.18 GDP/POP factor was added in some of the equations to reflect the preference of rapid transportation mode such as air transportation as economy grows. This is the geometrical means of GDP per capita of origin and destination zones. The network data is utilized in estimating the probability function by mode.

Table 3.2.7 Parameters for the Modal Split Model

Parameter	Coefficient	t-Value
Type 1		
a (Time : min)	-0.003132	-1.60
b_0 (Cost : VND 000)	-0.034587	-9.97
$b=b_0/td$		
d_3 (GDP/POP for Rail)	-0.26627	-2.11
d_4 (GDP/POP for HSR)	0.033803	10.18
d_5 (GDP/POP for Air)	0.037187	25.45
$const_2$ (for Bus)	0.347455	5.11
$const_3$ (for Rail)	0.648785	1.57
$const_4$ (for HSR)	-0.54423	-6.39
$Const_5$ (for Air)	-1.48783	-43.93
Type 2		
a (Time : min)	-0.001443	-6.67
b_0 (Cost : VND 000)	-0.003893	-14.26
$b=b_0/td$		
d_3 (GDP/POP for Rail)	-0.12791	-3.84
d_4 (GDP/POP for HSR)	0.002579	3.71
d_5 (GDP/POP for Air)	0.005432	2.29
$const_2$ (for Bus)	0.18298	7.36
$const_3$ (for Rail)	0.081243	0.86
$const_4$ (for HSR)	0.140312	7.64
$Const_5$ (for Air)	0.147549	2.60
Type 3		
a (Time : min)	-0.003056	-1.15
b_0 (Cost : VND 000)	-0.029576	-4.58
$b=b_0/td$		
d_3 (GDP/POP for Rail)	-0.00914	-1.19
d_4 (GDP/POP for HSR)	0.019464	3.46
d_5 (GDP/POP for Air)	0.004403	0.24
$const_2$ (for Bus)	0.4784	18.71
$const_3$ (for Rail)	-0.00044	-0.00
$const_4$ (for HSR)	-0.49032	-3.20
$Const_5$ (for Air)	-0.5237	-1.25

Source: JICA Study Team
Note: td(time distance decided by per capita GDP ratio)= 1.00 (2010), 2.83 (2030)

3.19 As shown in Table 3.2.7, the increase of time-value (represented as the increase of GDP per-capita) is considered on calculation of the parameter “b”. The increase of the GDP per capita is shown in Table 3.2.8.

Table 3.2.8 Summary of the Increase of GDP per Caipita

		2010	2020	2030
GDP	bil USD, 2010 Constant	106.4	199.8	357.8
	tri VND, 2010 Constant	1,981	3,718	6,659
Population Total (thousand)		86,928	96,159	103,155
GDP per Capita	USD, 2010 Constant	1,224	2,078	3,468
	Thou VND, 2010 Constant	22,788	38,670	64,555
	[Ratio to GDP per Capita in 2010]	[1]	[1.70]	[2.83]

Source: JICA Study Team

3.20 Table 3.2.15 summaries the parameters applied to analysis.

Table 3.2.9 Assumed Operating Condition by Mode

Mode			PCU/Veh Ratio	Average Occupancy 1)	Fare/Cost (VND/Pax-km	Travel Speed (km/h)	Time at terminal (waiting time) (min)
Road	Road	Car	1	3.2	527	40	0
		Bus	2.5	20.5	525	32	20
	Expressway	Car	1	3.2	855	80	0
		Bus	2.5	20.5	653	64	20
Railway	Existing Railway		-	-	584	70 2)	20
	High Speed Railway 3)		-	-	873	280	20
Air Transport			-	-	1,745	600	60

Source: JICA Study Team

Note: 1) Based on traffic survey (2011) (The same condition is assumed for the future), 2) Assumed level of improvement of existing railway is "A2" 3) For base case

8) Traffic Assignment

3.21 As for traffic assignment, Do Something Network is applied as base network for transport modes other than railway and HSR. In Do Something Network, the following upgrades of network are considered; (i) the national expressway network is assumed to be developed excluding sections along Ho Chi Minh Route, namely: Dong Hung – Hoa Lac – Pho Chau, Hong Ling – Huong Son, and Ngoc Hoi – Chon Thanh – Rach Gia; (ii) National Highway No.1 is assumed to be upgraded to 4-6 lanes in between Hanoi and HCMC; and (iii) Since airports in Hanoi and HCMC are considered to be bottlenecks for air traffic in the future, the capacity expansion is considered based on the future plans (new Long Thanh International Airport and the expansion of Noi Bai Airport).

3.22 The capacity of the VITRANSS2 road network was determined based on relevant highway capacity manual and inventory data (HDM Road Inventory) and related future plans. The same methodology is also applied in this study (Details are provided in Technical Report 2 Demand Forecast and Transport Cost).

3.23 As for traffic assignment, incremental assignment (distributing traffic by dividing it to 10 times) is applied. As the fare level for expressway network in Vietnam, 5 US Cent per km (for bus, 12.5 US Cent per km) is assumed considering international practices as shown in Table 3.2.10. As for willingness-to-pay for use of expressway, the result of road side survey conducted in the study is applied as shown in Table 3.2.11.

Table 3.2.10 Expressway Toll (per Passenger-distance)

	Expressway Fare	
	(VND/km/veh)	(VND/km/pax)
Car	1,050	328
Bus	2,625	128

Source: JICA Study Team

Table 3.2.11 Willingness to pay for Expressway

	Willingness to pay for Expressway (VND/hr/veh)	
	2011	2030[1)]
Car	37,669	101,216
Bus	56,143	150,853
Truck	55,508	149,147

Source: JICA Study Team
Note: 1) Figures for 2030 are assumed based on estimated increase of per-capita GDP

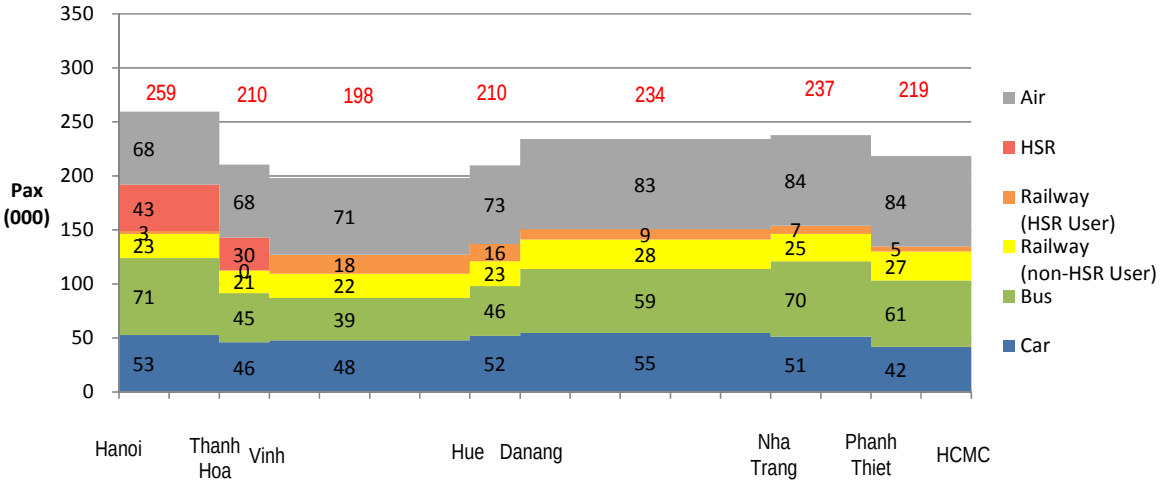
3.24 It should be noted that in case air traffic demand reaches to its capacity, the air traffic demand is fixed at its possible maximum traffic volume and modal split for other transport modes is recalculated excluding the potion for air transport (probability function for Air (P5) is not used in such case). Thus, the excess of traffic to the capacity is distributed to other modes.

3.3 Traffic Demand Forecast

1) Base Case Demand

3.25 Hanoi-Vinh HSR section is approximately 284 km long with 6 stations and the major cities such as Hanoi, Nam Dinh, Ninh Binh and Vinh are located in the section. The estimated HSR passenger demand in case HSR is operated for this section are shown as follows.

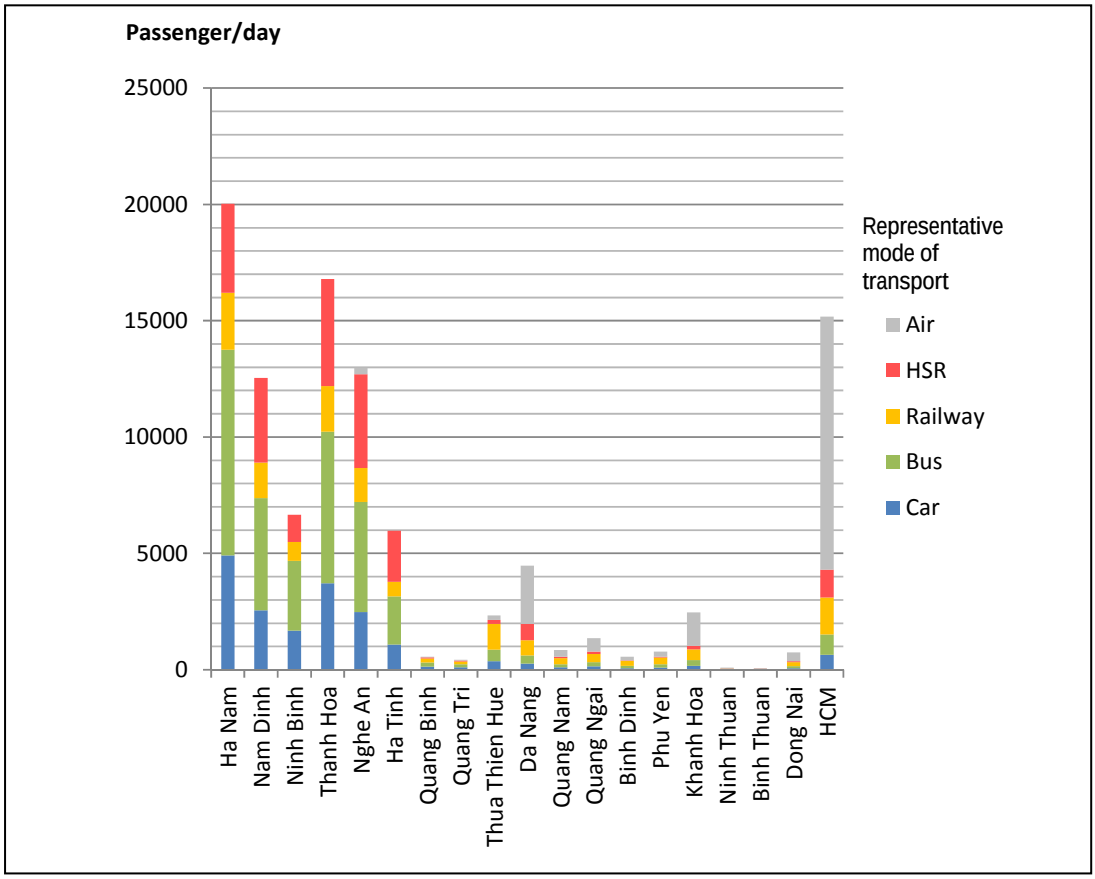
3.26 **Cross Sectional Traffic in the North-South Corridor**: Cross-sectional traffic of North-South corridor (coastal corridor) in 2030, in case Hanoi-Vinh section is under operation, is shown in the following figure. The cross-sectional traffic demand of HSR account for approximately 15% among all modes and 43 thousands and 30 thousands on Ninh Binh/Thanh Hoa and Thanh Hoa/ Vinh borders, respectively. The demand will be generated along the section where HSR exists (Hanoi-Vinh) and North Central Coast area (provinces between Thanh Hoa and Thua Thien Hue).



Source: JICA Study Team

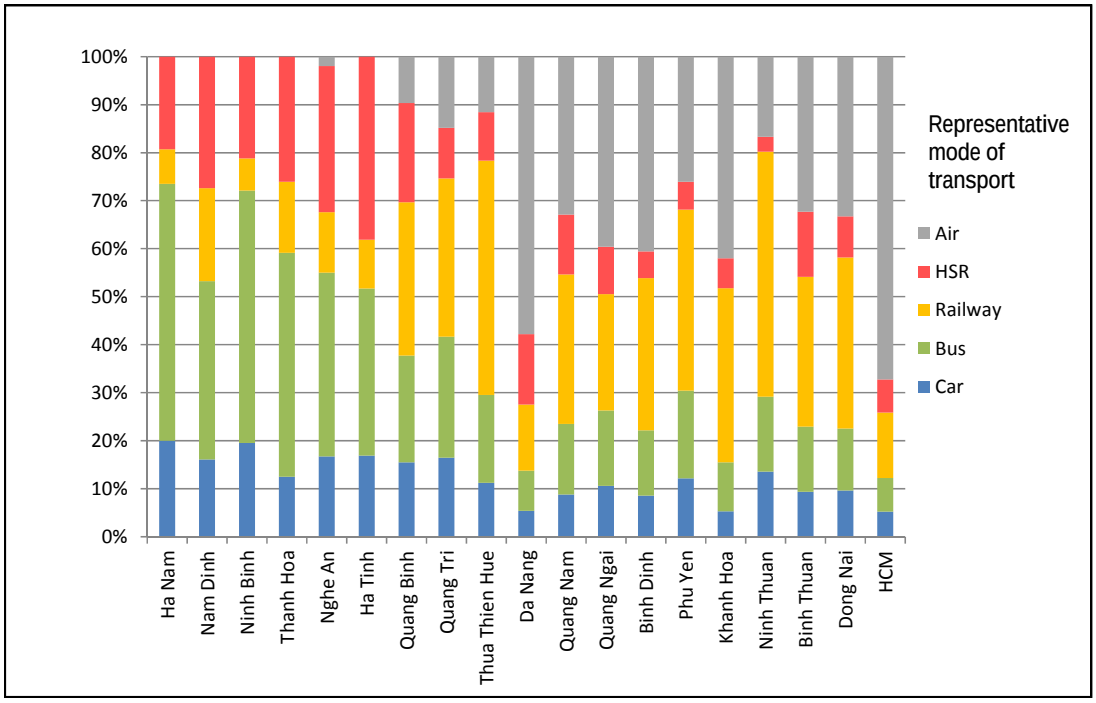
Figure 3.3.1 Cross Sectional Traffic in North-South Corridor (HSR: Hanoi-Vinh is under operation), 2030

3.27 **Traffic Demand from Hanoi:** The modal share from Hanoi, the capital city, to the South, in case Hanoi-Vinh section is under operation in 2030, is shown in Figure 3.3.2 and Figure 3.3.3. The share of HSR for Hanoi – Nam Dinh, Hanoi- Thanh Hoa and Hanoi – Vinh is as high as approximately 30%. Hanoi - Ha Tinh also shows relatively high share of HSR, approximately 35% because of the proximity to Vinh HSR station. On the other hand, the share of HSR for Hanoi–Ha Nam and Hanoi-Ninh Binh is lower, approximately 20% of share, because of relatively high competitiveness of road transport for these OD pairs.



Source: JICA Study Team

Figure 3.3.2 Mode Share for Trips from Hanoi to the South (Hanoi-Vinh is under operation), 2030, No. of passenger



Source: JICA Study Team

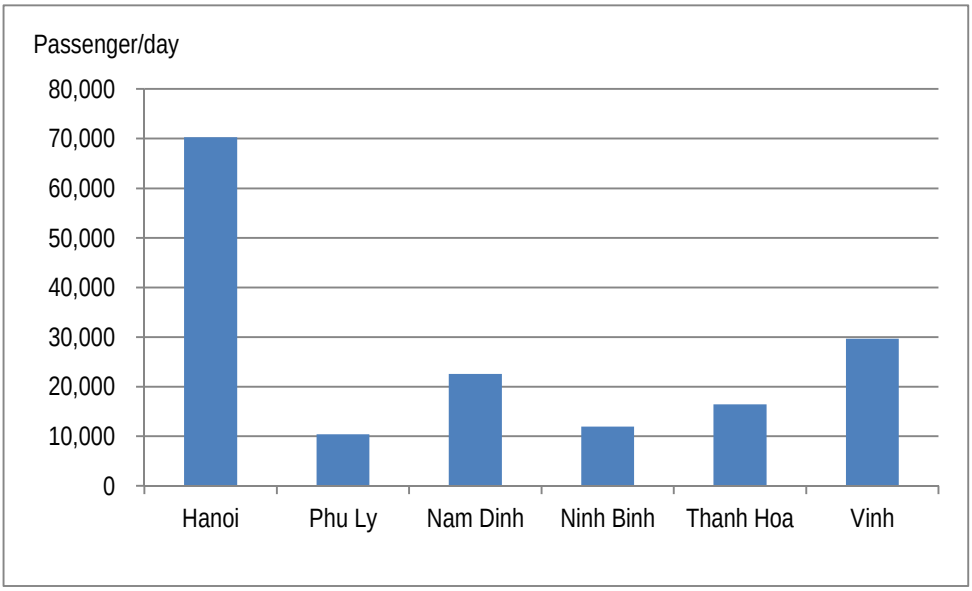
Figure 3.3.3 Mode Share for Trips from Hanoi to the South (Hanoi-Vinh is under operation), 2030, percentage

3.28 **Demand between and at Stations:** The HSR passenger demand between stations (station OD table) is shown in Table 3.3.1 for the case in which Hanoi-Vinh section is under operation. Figure 3.3.4 and Figure 3.3.5 & Figure 3.3.6 show the no. of passenger at stations and cross-sectional demands for each section between stations, respectively. Among all stations, the passenger volume at Hanoi station is the most, about 70,000 passengers per day, and, as clearly shown in Figure 4.8.5 & Figure 4.8.6, most HSR passengers are from or to Hanoi, while the passenger demand volume between other provinces are limited.

Table 3.3.1 Daily No. of HSR passengers between Stations (Hanoi-Vinh is under operation)

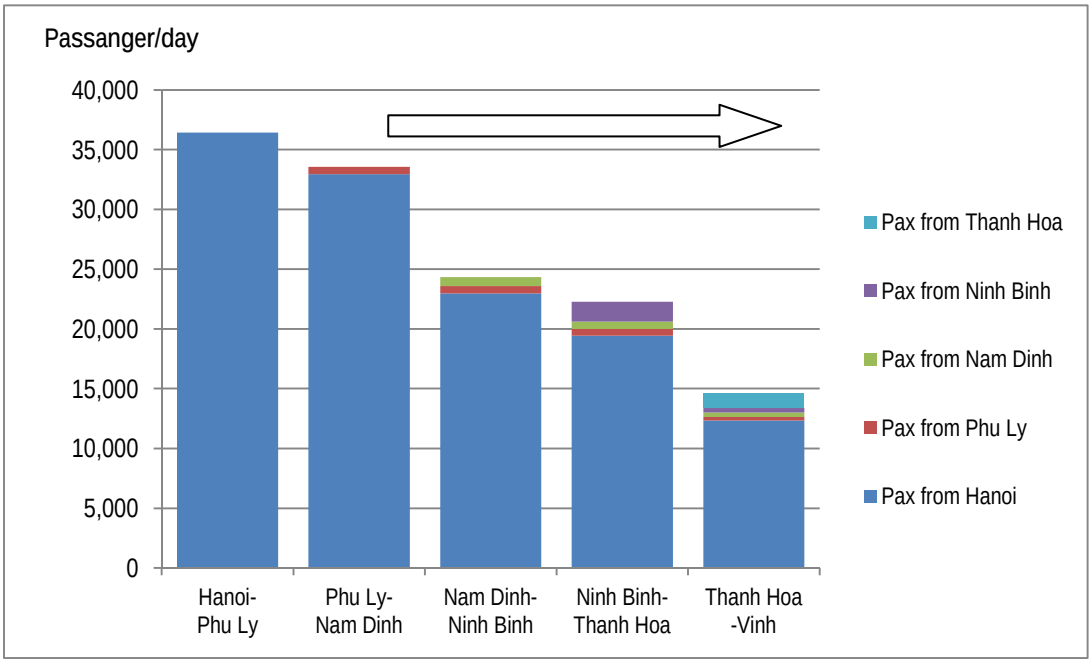
Station		1	2	3	4	5	6
		Hanoi	Phu Ly	Nam Dinh	Ninh Binh	Thanh Hoa	Vinh
1	Hanoi	--	9,027	19,902	6,711	10,421	24,229
2	Phu Ly	-	-	0	86	547	732
3	Nam Dinh	-	-	-	410	659	1,631
4	Ninh Binh	-	-	-	-	3,265	1,469
5	Thanh Hoa	-	-	-	-	-	1,580
6	Vinh	-	-	-	-	-	-

Source: JICA Study Team



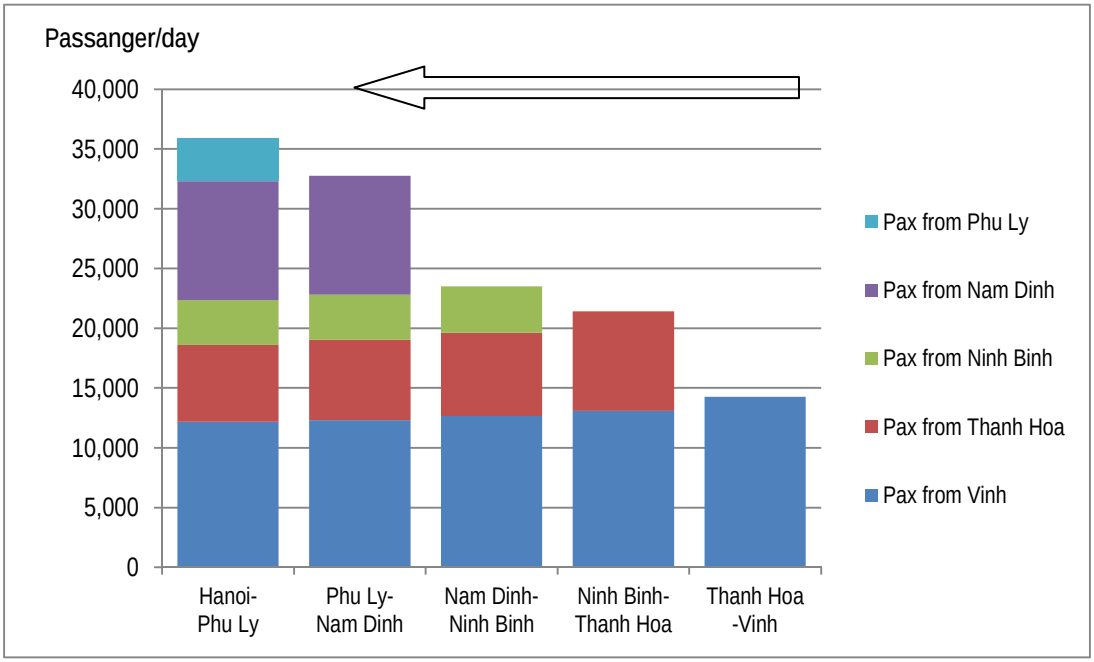
Source: JICA Study Team

Figure 3.3.4 No. of Passenger at Stations (HSR: Hanoi-Vinh is under operation)



Source: JICA Study Team

Figure 3.3.5 Daily No. of Passenger between Stations (Hanoi to Vinh Direction Only)(HSR: Hanoi-Vinh is under operation)

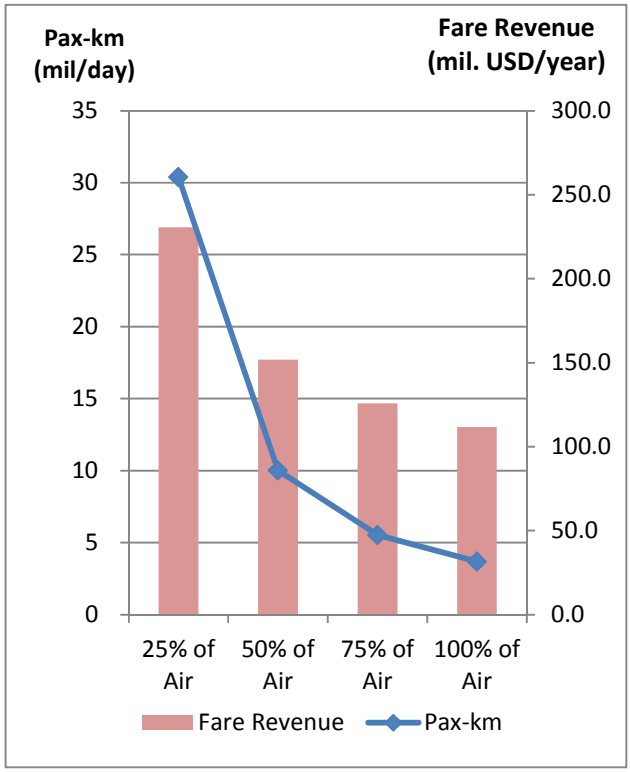


Source: JICA Study Team

Figure 3.3.6 Daily No. of Passenger between Stations (Vinh to Hanoi Direction Only)(HSR: Hanoi-Vinh is under operation)

2) Sensitivity Analysis

3.29 **Fare Rate:** To find the most appropriate fare rate, the different levels of fare are applied on demand forecast analysis; four fare levels, 25%, 50%, 75% and 100% of air fare, are examined. The figure below shows the relation between passenger-km and fare revenue by HSR fare level setting, which indicates the fare revenue is higher if fare level is set on a lower standard (at least to the level of 25% of air fare). At 25% of air fare, the passenger-km in Hanoi-VInh section will rise significantly compared to the case of 50% of air fare.



Source: JICA Study Team
Note: 50% of air fare is assumed to be 0.041 USD (873 VND) per passenger-km based on the air fare between Hanoi-HCMC (as of Oct 2011)

Figure 3.3.7 Relation between Fare Level & Fare Revenue (based on 2030 demand)

3.30 **Intensive Urbanization:** The promotion of the urbanization in the cities along the route is one of the most significant positive impacts expected to be brought by HSR development although the quantitative evaluation methodology of such impact is yet to be established in general. On the other hand, the urban population along the route is primary determinative factor of HSR ridership. To secure the certain level of HSR ridership, the urban development policy in line with HSR development has to be prepared.

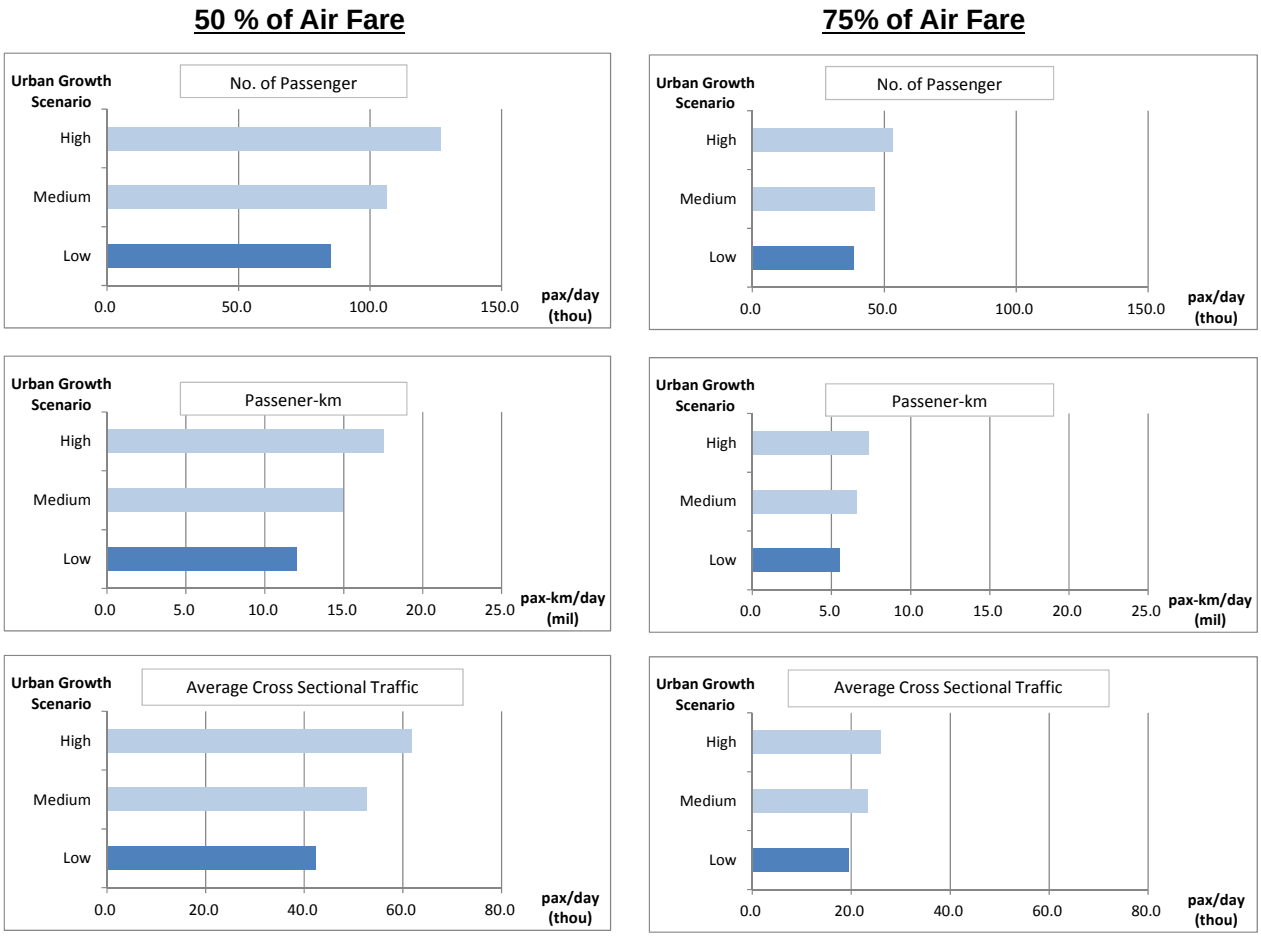
3.31 To assess the HSR ridership by the progress of urban development in the cities along the HSR route, in addition to the “base” case (referred as “low” case hereafter), two additional intensive urbanization scenarios are assumed, which are named “Medium” and “High” case (for the detail of the assumption, see Technical Report No. 2 Demand Forecast and Transportation Cost Chapter 4.3). Based on the assumed indicators, the demand analysis was conducted for the purpose of sensitivity analysis.

3.32 Table 3.3.2 and Figure 3.3.8 show the result of the analysis, in case HSR fare level is 50% and 75% of Air. In Medium and High case, the demand on passenger-km basis increases by 24% and 46% at 50% of air fare and 20% and 33% at 75% of air fare, respectively, , compared to Low case..

Table 3.3.2 Traffic Demand by Urbanization Scenario

		Fare level: 50% of Air Fare			Fare level: 75% of Air Fare		
		pax/day (thou)	pax-km/day (mil)	cross section demand/day (thou)	pax/day (thou)	pax-km/day (mil)	cross section demand/day (thou)
Urban	Low (base case)	84.9	12.0	42.4	38.6	5.5	19.4
Growth	Medium	106.4	15.0	52.7	46.5	6.6	23.3
Scenario	High	126.8	17.5	61.7	53.2	7.4	25.9

Source: JICA Study Team



Source: JICA Study Team

Figure 3.3.8 Traffic Demand by Urbanization Scenario

4 PLANNING OF HSR ROUTES

4.1 Approach

4.1 In order to propose the alignment and station locations which are consistent with national and regional long-term development plans, the JICA Study Team has updated the existing information through various ways, as follows:

(a) **Review of Past Projects on High-speed Railway:** The proposed alignment and station locations are based on two past studies on high-speed railway development, namely the KOICA study in 2007 and the prefeasibility study in 2009. The concept for and approach in setting the alignment and station locations in both of these studies, as well as the locations' advantages and disadvantages, were reviewed by the JICA Study Team in detail.

(b) **Collection and Review of Regional and Urban Plans:** The latest regional and urban plans were collected in order to reflect them in planning the alignment and station locations. These plans include the socio-economic development plans, construction plans, land use plans, transport development plans, and others. In addition, the respective situations of areas around the stations were carefully studied.

(c) **Site Survey:** The JICA Study Team carried out site surveys in all the cities and provinces along the HSR alignment in order to have a full understanding of the situation which is necessary when reviewing the previous studies and planning the appropriate route of the HSR. The JICA Study Team has taken careful consideration not only of the station locations in all cities/provinces, but also of the sensitive factors that affect route alignment such as under-construction plan, densely populated areas, nature conservation areas, etc.

(d) **Updating of Topographic Maps at 1/10,000 Scale:** The topographic map at 1/10,000 scale was updated based on latest satellite images dating from 2009 to 2011. The final images can be considered as the most updated base maps that can be used for this study. A comprehensive topographic database was also developed by updating existing information and the Advanced Land Observing Satellite Data (ALOS), specifically, ALOS PRISM (resolution: about 2.5 m) and ALOS AVNIR-2 (resolution: about 10 m) of the survey area.

(e) **Formulation of Environmental Sensitivity Maps:** A set of environmental sensitivity maps was prepared to identify potentially sensitive areas which may require environmental and social mitigation and to contribute to alignment planning. These maps also helped in ensuring that the alignments were selected based on a due consideration of environmental and social aspects. After using the maps in deciding the alternative route (including the alignment and the location of stations), the maps were also utilized to help stakeholders visualize the environmental and social considerations of this study. Details of these maps can be referred to in the Technical Report No. 4.

4.2 Preparatory Work for Route Planning

1) Overall

4.2 The basic policy adopted in the alignment and station study for the HSR's north route is as follows:

(i) To prepare for future train operation between Hanoi and Ho Chi Minh City, the Ngoc Hoi to Vinh section was designed as the first stage of the HSR in Vietnam. Therefore, the minimum curve radius of 6,000 m and the maximum gradient of 15% will be used for future HSR V=350 km/h operation;

(ii) To carry out this study, the JICA Study Team studied two past HSR studies, namely the KOICA study in 2007 and the Pre F/S in 2009, and discussed them with every provincial government and organizations concerned, such as the MOT, VNR, and others. The JICA Study Team designated the Pre F/S alignment as Alternative 2 and the KOICA study alignment as Alternative 3;

(iii) To plan the alignment, densely built-up areas, military property, factories, nature reserves, schools, cultural sites, temples, churches, cemeteries, and other important facilities were avoided to the extent possible;

(iv) To plan the alignment, low areas along the coastline were avoided considering the potential impacts due to climate change and sea level rise;

(v) To agree to every city's development plan, coordination and consultation with related agencies, i.e., MOT, MOC, VNR, and every province, were implemented; and

(vi) To reduce cost, the angles for crossing rivers and roads will be enlarged as much as possible to shorten bridge lengths.

4.3 As basic concept for station location selection along the HSR alignment, JICA Study Team has set the station in areas which meet one or more of the following criteria:

(i) Provincial capitals, if alignment allows.

(ii) Major urban areas along the alignment.

(iii) Special location for passengers' convenience.

(iv) Other stations may be developed later if there is 1) enough demand with 2) potential of integrated development

4.4 Other factors for station setting include; total length of alignment (straight and short as possible), construction cost, interval of stations, etc.

Source JICA Study Team:

Figure 4.2.1 Location Map of Stations along the North HSR Route

2) Site Survey

4.5 For an in-depth understanding of the surrounding environment along the Hanoi–Vinh HSR alignment, site surveys on board a car from Hanoi to Vinh were conducted. Presented below and on succeeding pages are pictures taken along the route..

(1) Site Survey of Hanoi–Ngoc Hoi Section (30 August in 2011)

Level Crossing (KM 5+490)
(View toward Hanoi)

Road Over Bridge (Ring Road No.3)
(View toward Ngoc Hoi)

Level Crossing (KM 9+103)

(View toward Hanoi)

(View toward Ngoc Hoi)

Level Crossing (KM10+100)

(View toward Hanoi)

(View toward Ngoc Hoi)

Source: JICA Study Team

Figure 4.2.2 Hanoi–Ngoc Hoi Section

4.6 As Study Team, it isn't planned to set up the station in Ngoc Hoi in the first stage based on a view of the present situation wherein development and improvement have not progressed in the area.

(View toward Hanoi)

(View toward Phu Ly)

Source: JICA Study Team

Figure 4.2.3 Vicinity of the Proposed Ngoc Hoi Station

(2) Site Survey on Ngoc Hoi–Vinh Section (31 August & 1 September in 2011)

Between Ngoc Hoi and Phu Ly
(Left: Phu Ly Direction)

Station Site proposed for Pre-F/S
(Approx.1km from St. Phu Ly)

Source: JICA Study Team
Note: There are many lakes, ponds, and wet areas including fields.

Figure 4.2.4 Ngoc Hoi–Phu Ly Section

Between Phu Ly and Nam Dinh
(Left : Nam Dinh Direction)

(Development Work Started)

Source: JICA Study Team
Note: There are many lakes, ponds, and wet areas including fields.

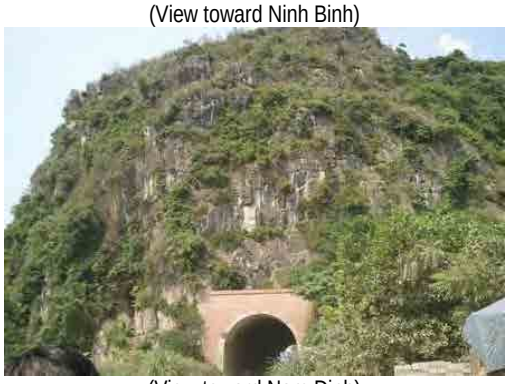
Figure 4.2.5 Phu Ly–Nam Dinh Section

Between Nam Dinh and Ninh Binh

(View toward Nam Dinh)

(View toward Ninh Binh)

(Right: Nam Dinh)



(View toward Nam Dinh)

Source: JICA Study Team

Notes: 1. The top left and right photo show the planned crossing for the existing railway and NSHSR proposed by the JICA Study Team. The site is located at about 7-8 km from Nam Dinh Station to the south. The bottom two pictures show the boundary between Nam Dinh and Ninh Binh provinces has mountain passes.
2. There are many lakes, ponds, and wet areas including fields.

Figure 4.2.6 Nam Dinh–Ninh Binh Section

Between Ninh Binh and Thanh Hoa

(Left: Thanh Hoa Direction)

(Left: Thanh Hoa Direction)

Ninh Binh River

Source: JICA Study Team

Notes: 1. There are many fields and steep highland areas. This area has many small rural towns.
There is a railway bridge across a middle scale river a number of kilometers north of Thanh Hoa Station.

Figure 4.2.7 Ninh Binh–Thanh Hoa Section

Between Thanh Hoa and Vinh

(Left: Vinh Direction)

(Left: Vinh Direction)

(Left: Vinh Direction)

(Left: Vinh Direction)

(Ma River in Thanh Hoa City)

(Lake under dam)

Source: JICA Study Team

Notes:

1. There are many lakes, ponds, and wet areas including fields.
2. This area has steep highland areas in the west and many rivers.
3. This area has many small rural towns.

Figure 4.2.8 Thanh Hoa–Vinh Section

Hanoi Station

View of Hanoi Station's Platform

Phu Ly Station

Ninh Binh Station

Nam Dinh Station

Than Hoa Station

Source: JICA Study Team

Figure 4.2.9 Existing VNR Stations

Front View of the Station

Inside the Station Building

Platform View (1)

Platform View (2)

Overall View of Vinh Station (from road flyover)

Street in Front of Station

Source: JICA Study Team

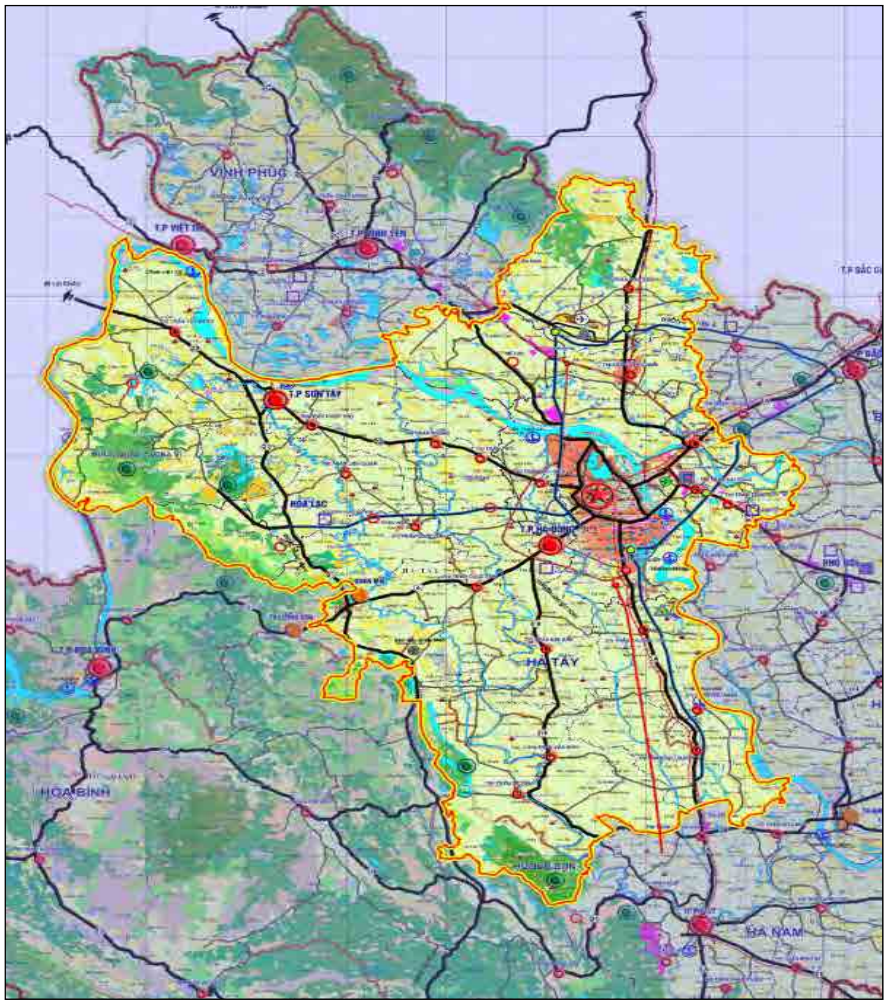
Figure 4.2.10 Existing Vinh Station

3) Data Collection and Meetings with Related City/Provincial Authorities

4.7 Development plans were gathered from each of the affected province and design the HSR alignment plan and station location. (Hanoi City's Development Plan is following)

4.8 In stakeholder meetings in the provinces, the JICA Study Team showed the proposed alignment and the location of stations in a map with a 1/10000 scale which included the concerned city's development plan.

4.9 Discussions held in the provinces are described in Chapter 4.2. The JICA Study Team's final alignment drawings were made based on these discussions.



Source JICA Study Team

Figure 4.2.11 Development Plan for Hanoi City

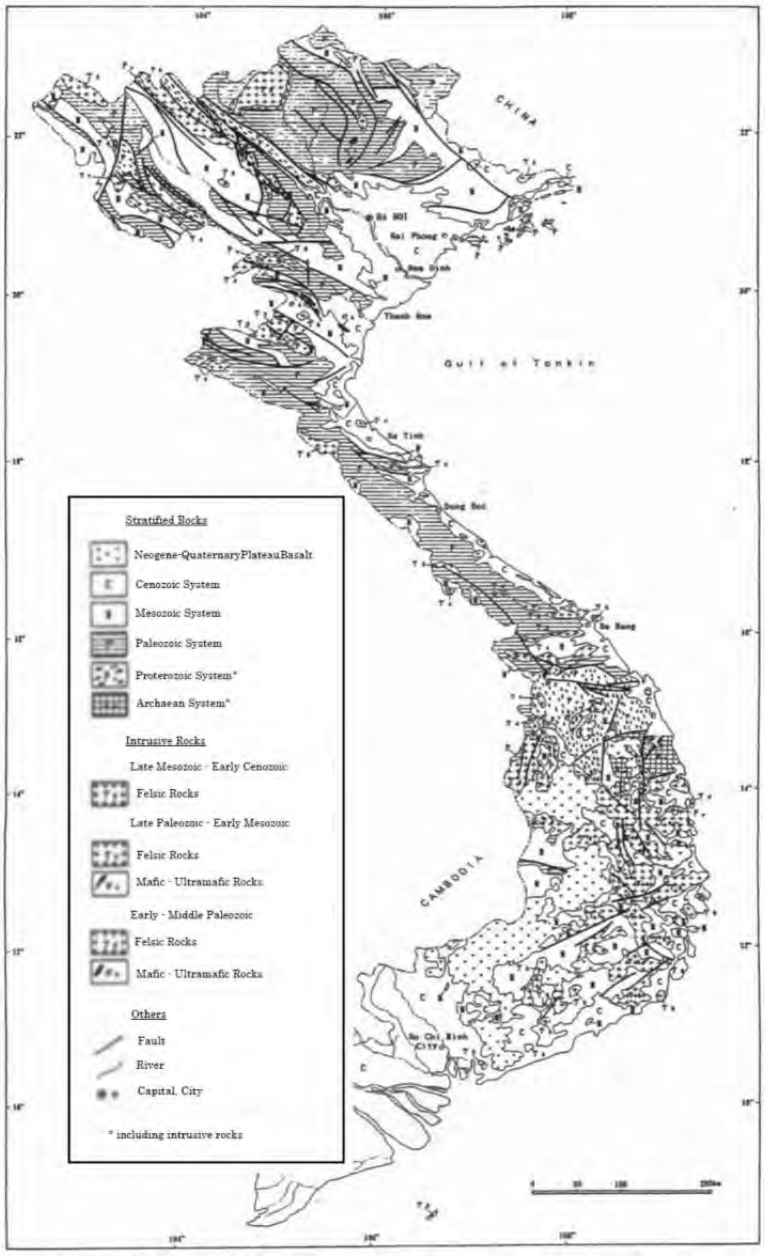
4) General Geological Information on Hanoi–Vinh Section

4.10 Vietnam's geology is roughly divided into the North-Middle region and the southern region at the border around latitude 15°30" north near Quang Nam province.

4.11 The geology of the North-Middle region is mainly composed of Paleozoic and Mesozoic sediments. North of the region is characterized by a strong lineament along the Red River (Song Hong) from northeast to southwest direction from China which was cause by the Sichuan and Yunnan earthquakes in China. This region is subdivided into five areas based on their petrology.

4.12 In the south region, Precambrian (Archean and Poterozoic) sediments and intrusives are widely distributed from latitude 15°30" north to 14° north and forming "Kontun Massif". Mesozoic sediments and intrusive rocks are predominant southward of this area. A plateau basalt of tertiary and quaternary periods is distributed at the border of Cambodia. This region is subdivided into two areas based on their petrology.

4.13 Two large deltas, famously known as the Song Hong Delta and Mekong Delta, are located in the north and south of the country. These deltas are formed by fluvial deposits. The depth of soft ground sometimes reaches more than 40 m.

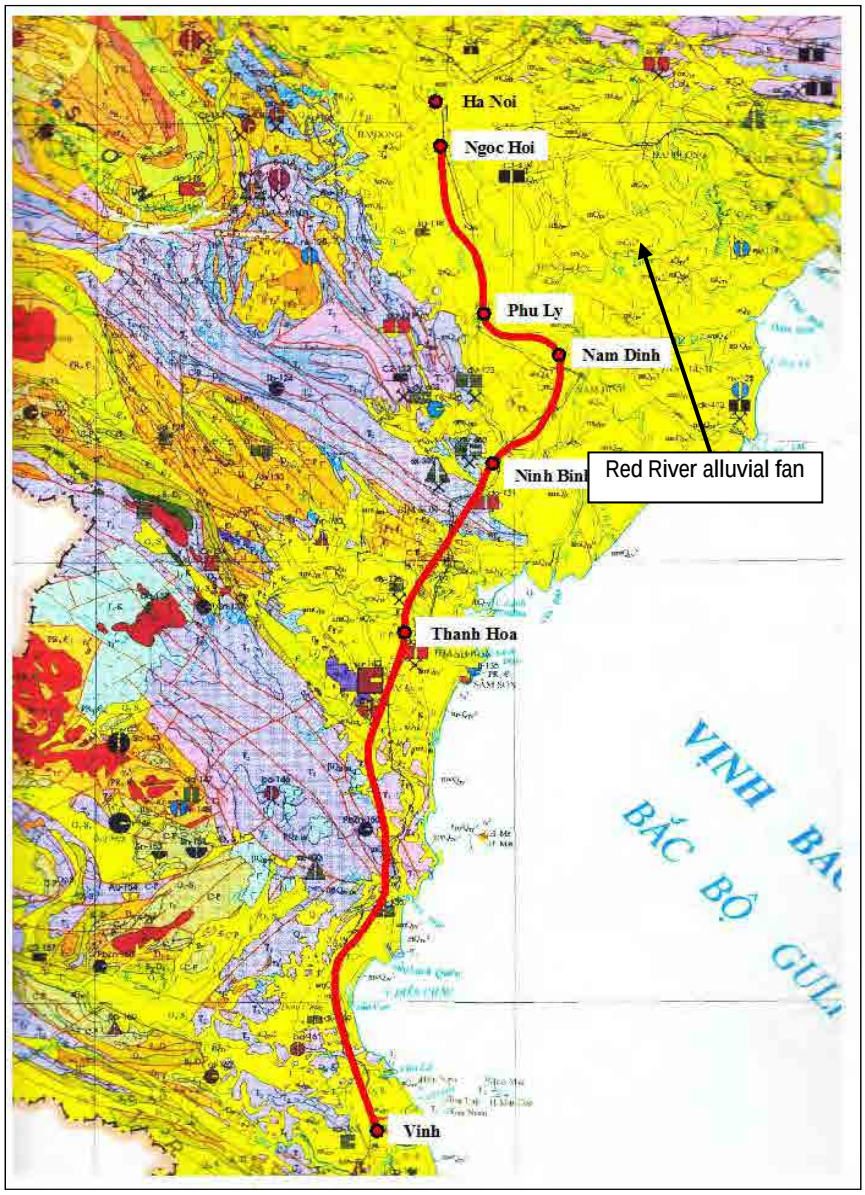


Source JICA Study Team

Figure 4.2.12 Geological Map of Vietnam

4.14 The planned HSR alignment has the geological features as shown below.

4.15 Yellow alluvial layer has been heaped up thickly, especially in the Red River alluvial fan area. Soft ground condition at Nam Dinh–Ninh Binh section is specially evident. The alluvial thickness is approximately 50–70 m with N=-0–10. Therefore, embankment structure will not be used in this section due to influences of land subsidence. However, alluvial thickness in the Hanoi section is approximately 20–30 m with N value = 10–20. Therefore, embankment will be planned in this section. Low priced embankment planning location and length will be limited and viaducts will be planned in a wide range in the north section.



Source JICA Study Team

Figure 4.2.13 Geological Features in the HSR's North Section

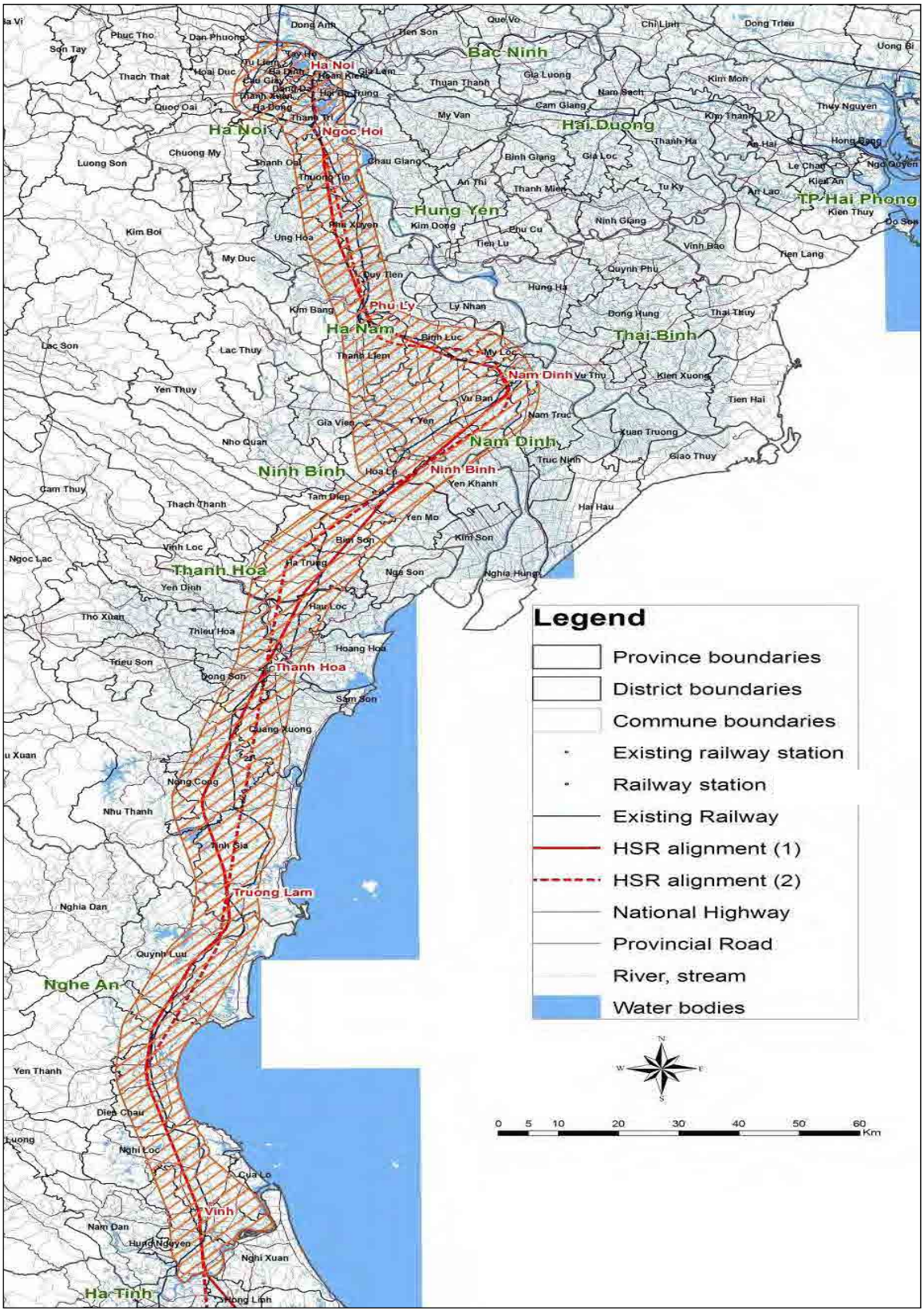
5) Preparation of Topographic Maps

(1) General

4.16 A topographic survey was carried out to support the development of a comprehensive topographic database with a view to updating existing information and the Advanced Land Observing Satellite Data (ALOS), specifically the ALOS PRISM (resolution: about 2.5 m) and ALOS AVNIR-2 (resolution: about 10 m) of the survey area. Topographic database is updated using these data. Thus, plans with 1/10,000 scale can be developed. Furthermore, elevation data covering the area were also procured to enhance the existing elevation data for the study area. Thus, it is possible to develop 1/10,000 to 1/25,000 scales of cross-sections and profile drawings.

(2) Mapped Area

4.17 Figure 4.2.14 below shows the mapped area, in shaded portion, for the HSR's north section.



Source: JICA Study Team

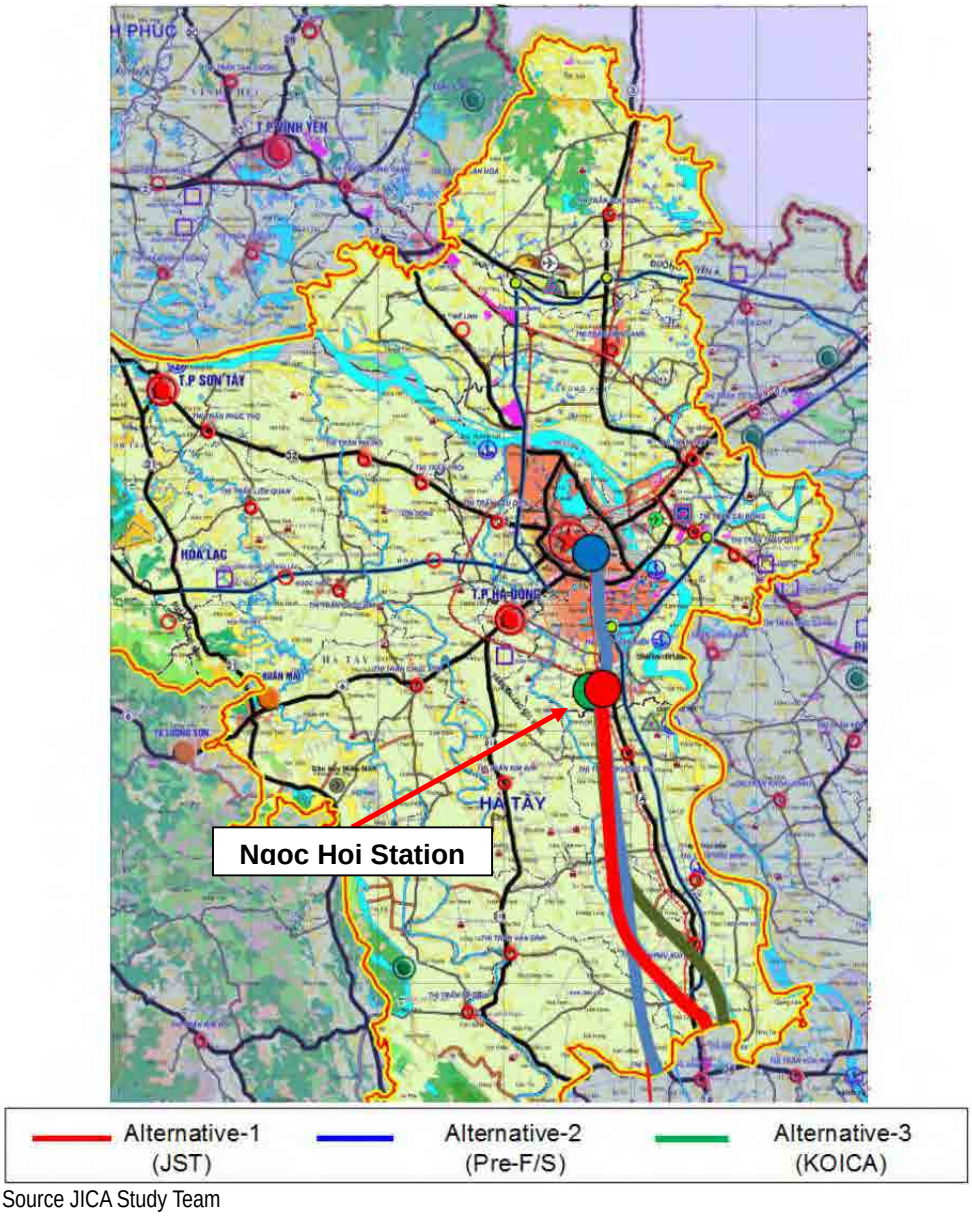
Figure 4.2.14 Mapped Area along HSR's North Section

4.3 Description of Alternative Routes and Station Locations and Selection

1) Comparison and Selection of Station Locations per Province/City

(1) Hanoi City (Ngoc Hoi Station)

- The HSR starts from Ngoc Hoi Station;
- Passengers can transfer to urban railway, Line-1, local railway, roads such as No. 4 and others at Ngoc Hoi Station;
- The alignment from Ngoc Hoi Station is planned to pass through the west side of the highway;
- Hanoi Station is currently not considered because of technical complexity which will lead to high cost and uncertainty in policy decision; and
- Future extension to Hanoi will be considered as an underground alignment such as the Tokyo to Ueno section of Japan's Shinkansen.

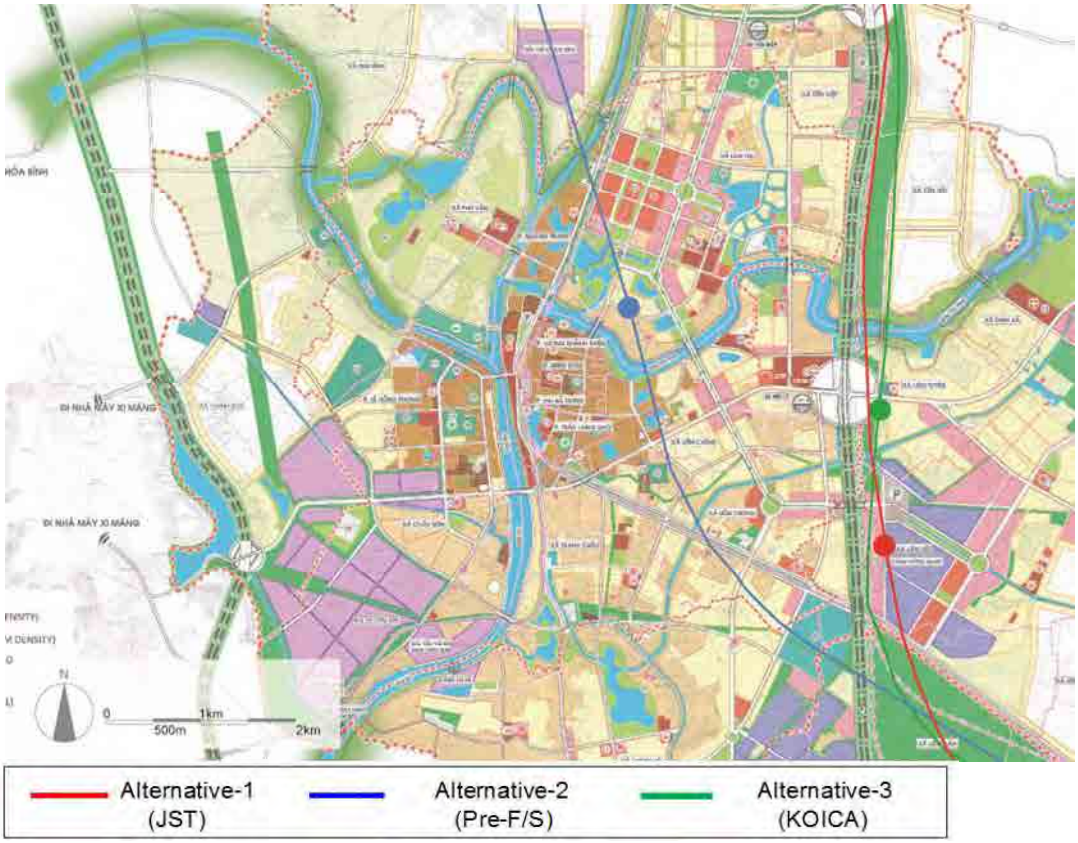


Source JICA Study Team

Figure 4.3.1 Hanoi Development Plan

(2) Ha Nam Province (Phu Ly Station)

- Alt. 1 and Alt. 3: Located outside the future development area, making transfers inconvenient to passengers;
- Alt. 2: Located in a development area close to the city center, so land acquisition will be difficult;
- Alt. 3 is reflected in the provincial master plan and the city's development plan, the development plan will be located between National Road Line-1 and highway. The planned access road to the HSR station was already incorporated. Therefore, Alt. 3 will be more suitable in this place and Alt. 1 should be set up in a similar route.

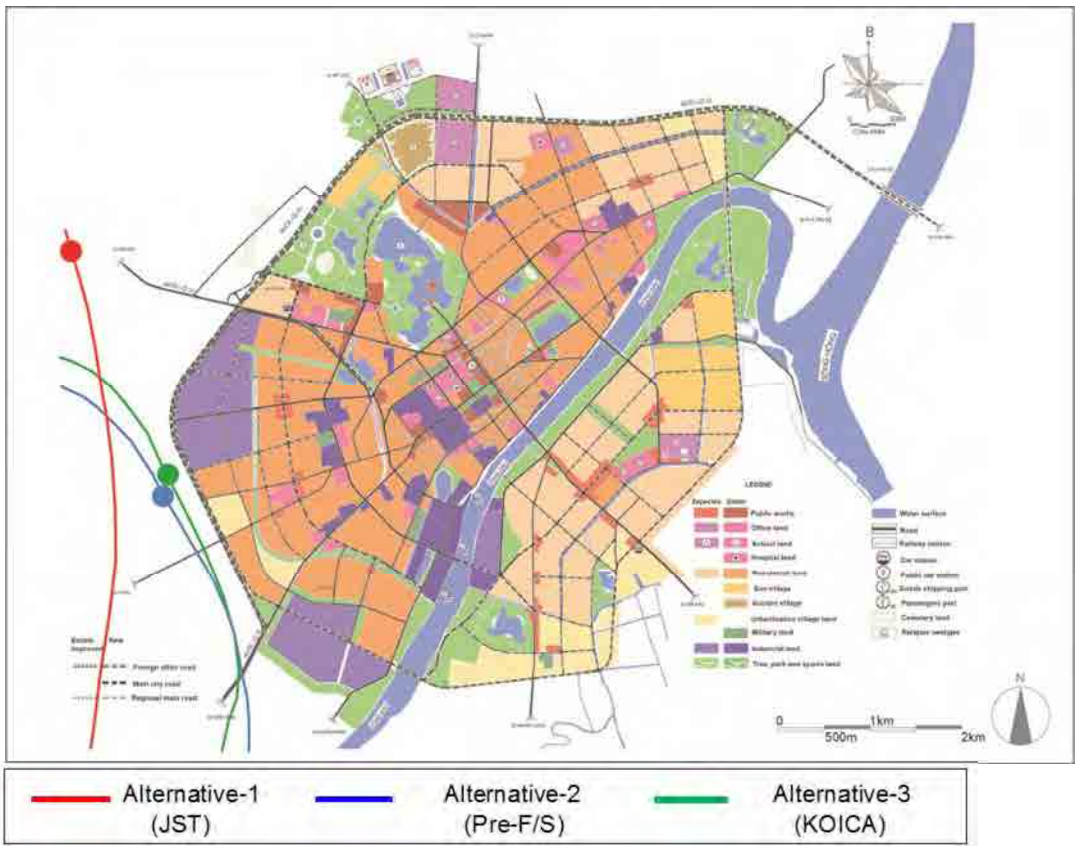


Source JICA Study Team

Figure 4.3.2 Phu Ly Development Plan

(3) Nam Dinh Province (Nam Dinh Station)

- The station for Alt. 1 will be planned at a crossing with the local railway for easy passenger transfer. This area has been considered important for future development (Province).
- Alt. 2 and Alt. 3: No connection to existing station, hence Alt. 1 is considered as a superior plan (Province).
- Alt. 1 requires an elevated station. Since the alignment is outside the existing industrial zone and the future development area, land acquisition will be easier (Province).



Source JICA Study Team

Figure 4.3.3 Nam Dinh Development Plan

(4) Ninh Binh Province (Ninh Binh Station)

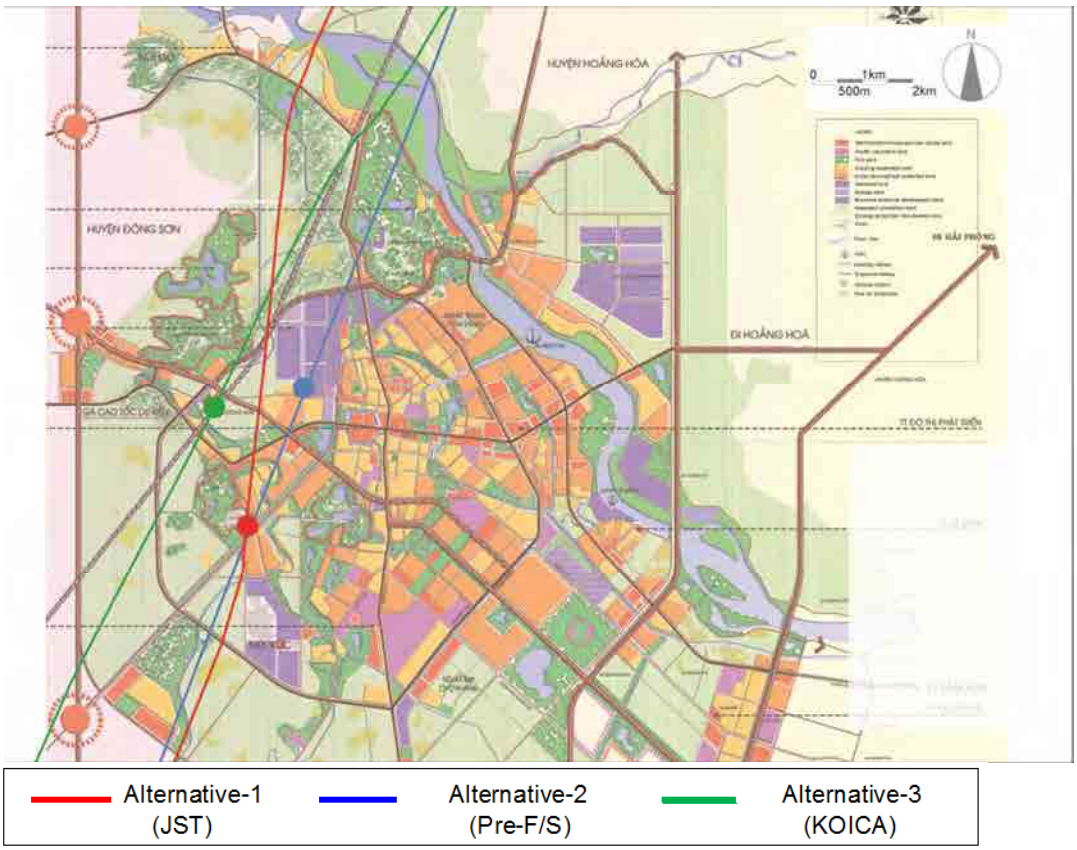
- The station for Alt. 1 will be constructed beside the existing railway and station for easy passenger transfer;
- Alt. 2 and Alt. 3: No connection to existing railway.

Source JICA Study Team

Figure 4.3.4 Ninh Binh Development Plan

(5) Thanh Hoa Province (Thanh Hoa Station)

- The station for Alt. 1 will be constructed at a crossing with the local railway for easy transfer.
- Alt. 1 and Alt. 3 considered the land use plan, i.e., their respective alignments avoided a protected forest.
- Alt. 2 will pass through a protected forest.

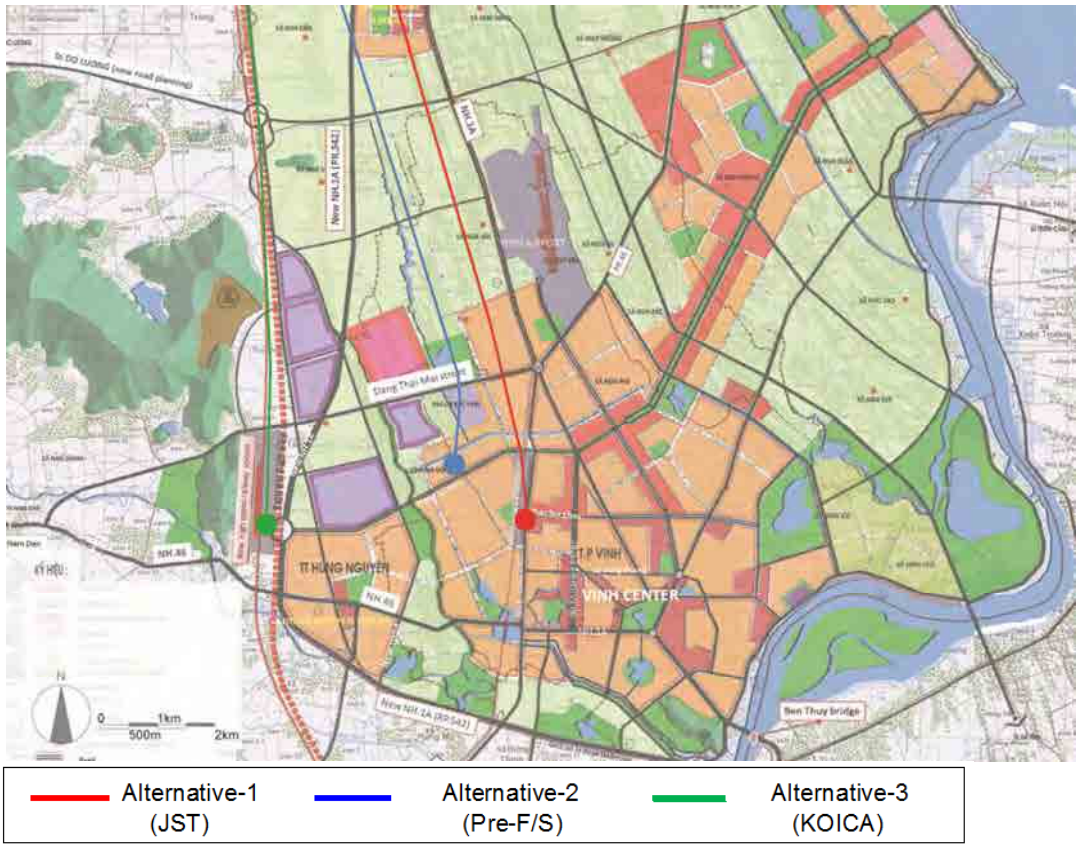


Source JICA Study Team

Figure 4.3.5 Thanh Hoa Development Plan

(6) Nghe An Province (Vinh Station)

- Alt. 1: The terminal station will be constructed on the site of the current railway station for easy passenger transfer;
- The station for Alt. 2 and Alt. 3 will be constructed far from the existing station.
- The station for Alt. 2 and Alt. 3 will be planned outside of the development area**.**



Source JICA Study Team

Figure 4.3.6 Vinh Development Plan

2) Comparison of Alternative Routes and Selection by Province/City

(1) Comparison of Alignment

4.18 All the curved radius in the alignment for Alt. 1 are R≧6000m for considering high-speed operation, i.e., V=350 km/h, in the future.

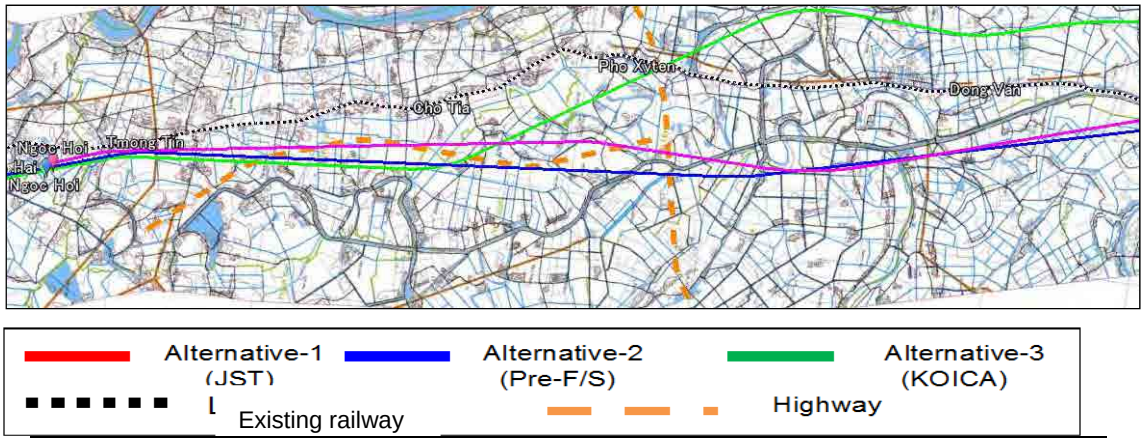
Table 4.3.1 Comparison of Small Radius (R≦6000 m)

Alternative	No. of Curves with Radius R≦6000 m	Total Curved Length (Km)	Total Route Length (km/%)	Detail of Small Radius
Alternative 1	0	0	283.38 (0 %)	
Alternative 2	3	8.13	282.25 (2.9 %)	2000 m:1- point 3000 m:1-point 4000 m:1- point
Alternative 3	21	48.40	281.21 (17.2 %)	2000 m:2 -points 2500 m:1 -point 5000m:18 -points

Source JICA Study Team

(2) Hanoi City

- Alt. 1: Ngoc Hoi Station is planned to be located adjacent to the UMRT station. (Hanoi connection by tunnel is costly, to which the city government agrees.)
- Alt. 2 and Alt. 3 planned the station in the same location as Alt. 1.
- The alignment will be revised after considering the highway's route. (City)

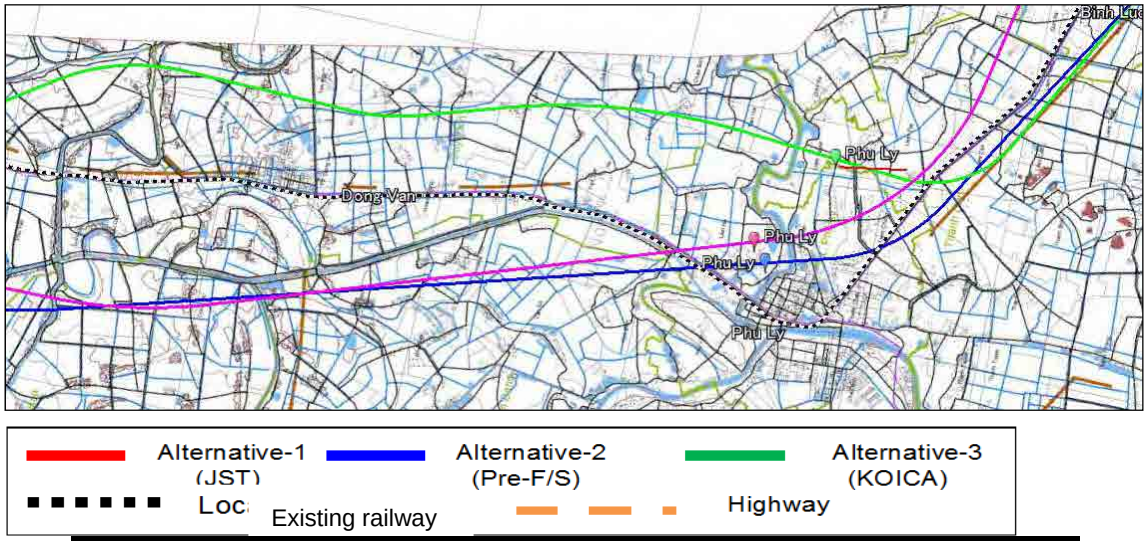


Source JICA Study Team

Figure 4.3.7 Alternative Routes for Ngoc Hoi–Phu Ly Section

(3) Ha Nam Province (Phu Ly–Nam Dinh Province)

- The development plan has been started with reference to the KOICA study, i.e., access road plan, bus terminal plan, and so on. Hence, Alt. 3 is suitable for this area. (Province)
- Eastern part with 300 m width of highway has been secured for HSR; hence the environmental problem will be minuscule. (Province)
- Alt. 1 shifted by adopting the route plan of Alt. 3.

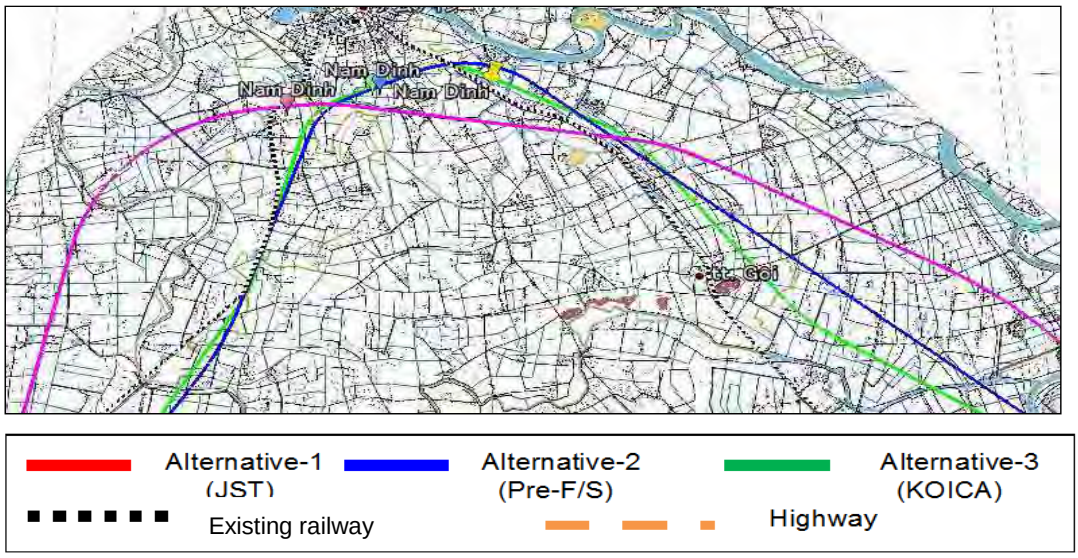


Source JICA Study Team

Figure 4.3.8 Alternative Route Plan for Ngoc Hoi–Phu Ly Section

(4) Nam Dinh Province

- Alt. 1 is superior to Alt. 2 and Alt. 3, because the latter will pass through densely built-up areas where land acquisition will be hard.
- The planned station for Alt. 1 is also superior because of its good connection with the current railway.

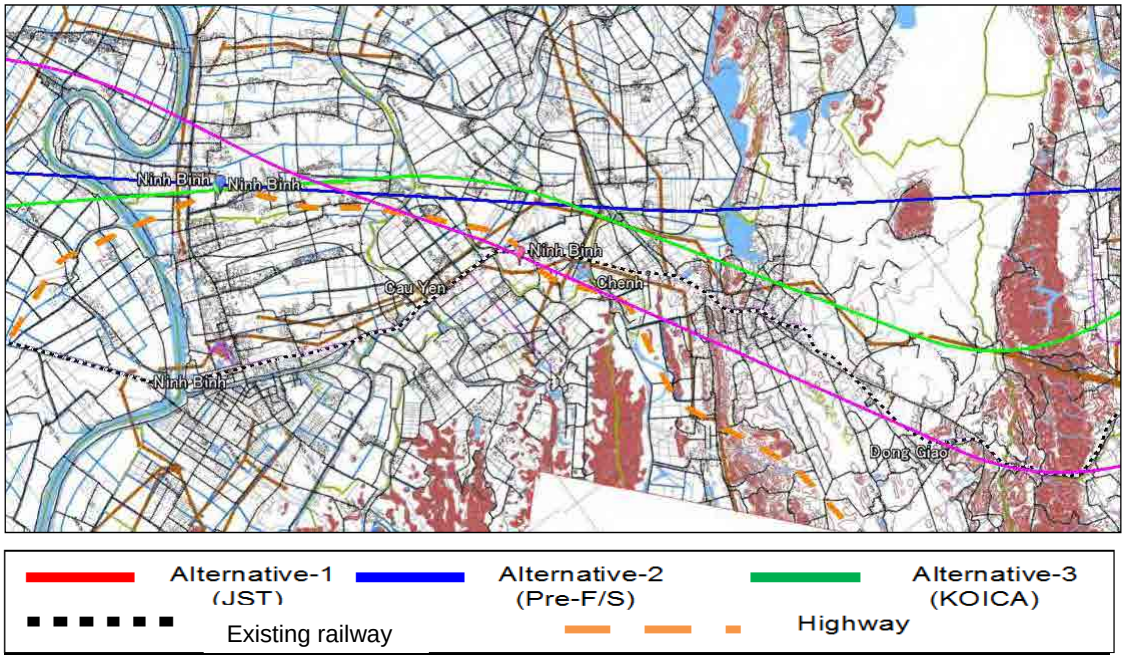


Source JICA Study Team

Figure 4.3.9 Alternative Route Plan for Nam Dinh–Ninh Binh Section

(5) Ninh Binh Province

- The HSR route should consider the city development plan, industrial areas, tourist sites, and so on. Alt. 1 seems superior because it avoided these important areas. (Province)
- Tam Dep City is an important city and should be avoided. (Province)
- Ninh Binh province has three local stations; hence, connection to the local railway seems quite important. (Province)
- Alt. 1 shifted to exclude Tam Diep City and revised the station's location by ensuring good accessibility to the current railway.

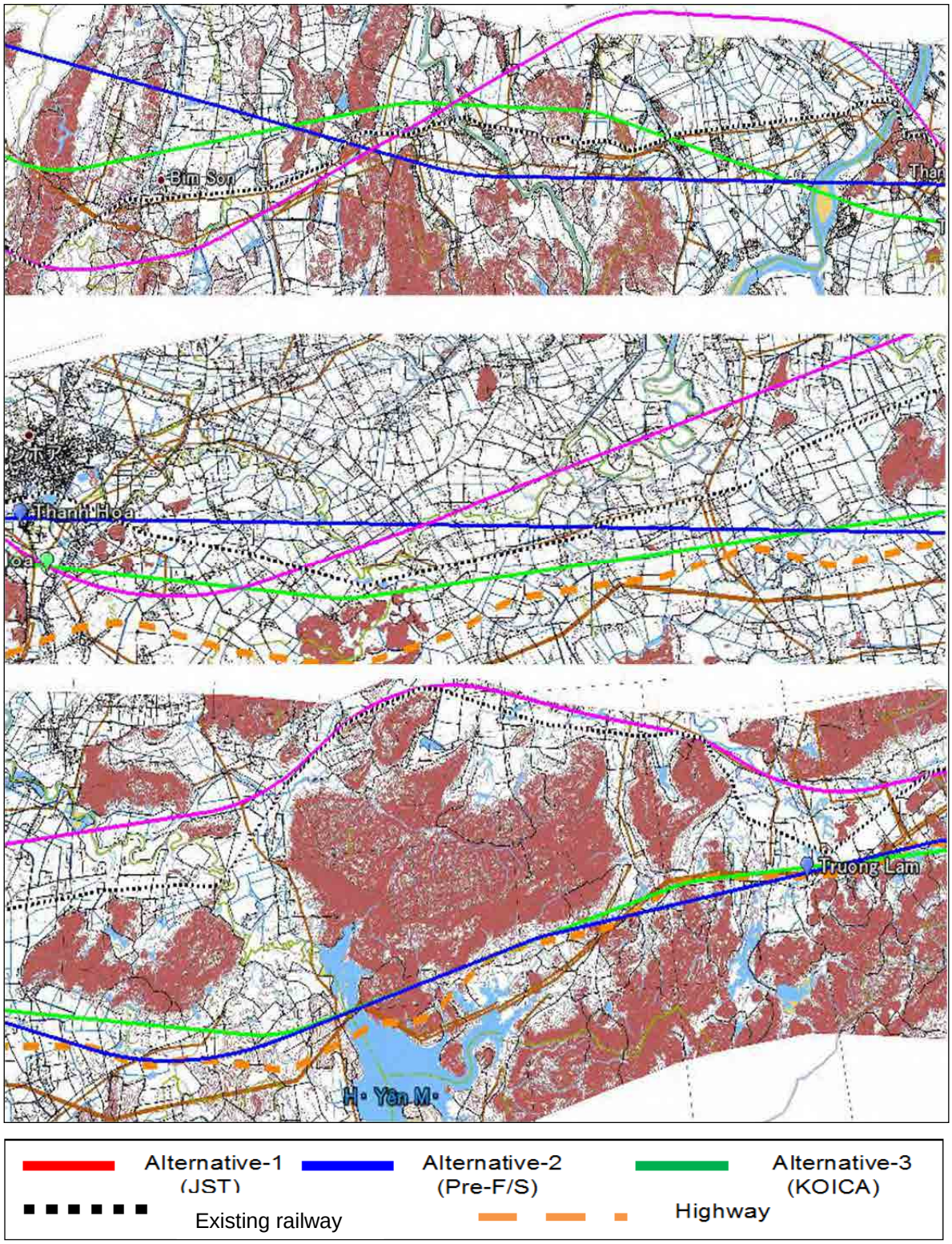


Source: JICA Study Team

Figure 4.3.10 Alternative Route Plan for Ninh Binh–Thanh Hoa Section

(6) Thanh Hoa Province

- Alt. 1 will be finalized by considering the provincial and city development plan. (Province)
- The south side of Ham Rong Bridge and the east side of the national highway of Line-1 has many farmlands and villages; hence, land acquisition will entail huge costs. Generally speaking, soil condition is superior in the west. (Province)
- The province has agreed to Alt. 3; therefore, many city development plans have been formulated based on Alt. 3., hence Alt. 1 and Alt. 2 will obstruct these plans.
- Alt. 1 should connect to the local railway; but, the distance of 4 km between stations in Alt. 3 seems not far. (Province)

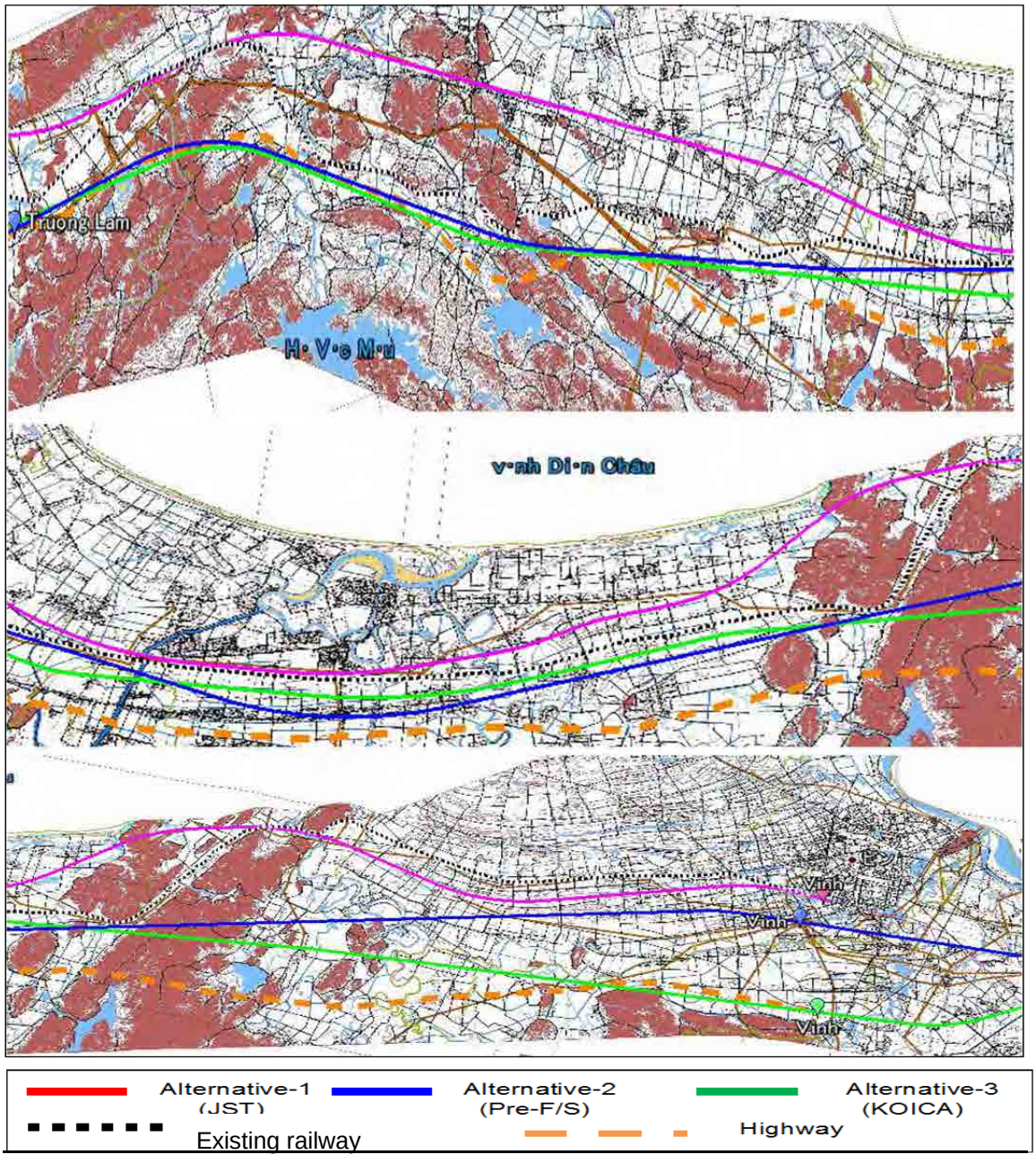


Source JICA Study Team

Figure 4.3.11 Alternative Route Plan for Thanh Hoa–Vinh Section

(7) Nghe An Province (–Vinh)

- The Province's & City's Development Plan has been referred Alt. 3 (Province).
- The distance between new HSR's station local railway station is only 4–5 km in Alt. 3 and this distance seems not so far distance and can be constructed by cheap cost (Province).
- New station will be required at industrial district for promote the industrial growth (Province).



Source JICA Study Team

Figure 4.3.12 Alternative Route Plan for Thanh Hoa–Vinh Section

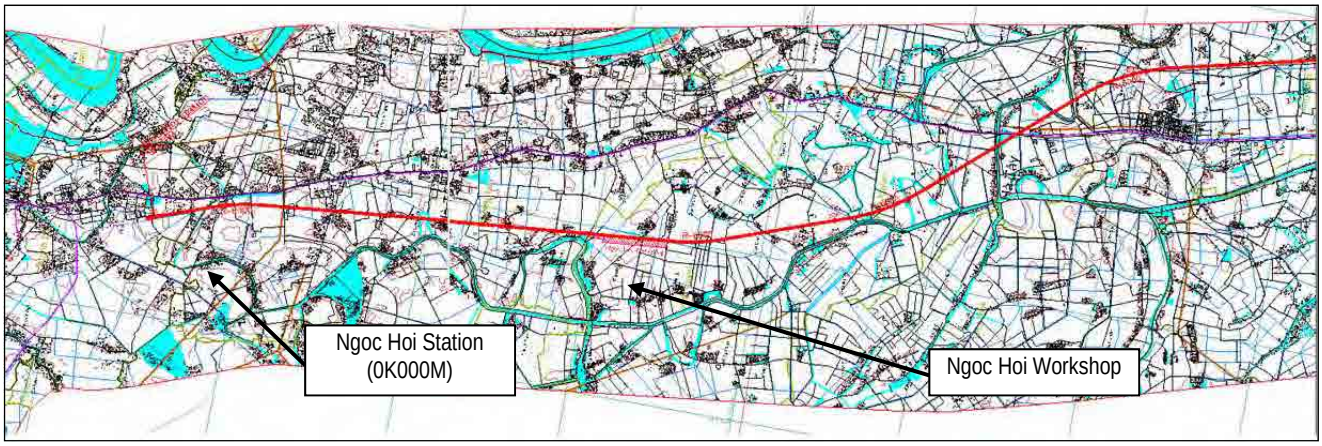
4.4 Description of Alignments of Selected Routes

1) Selected Route by Province/City

4.19 Alt. 1's final alignment plan is decided by the discussion on Stakeholder Meeting in every province and the follow-up meeting in every province using revised alignment plan to reply every comment from every province and the related organizations.

(1) Hanoi City (Ngoc Hoi Station–Ha Nam Province)

- The HSR's terminal station, i.e. Ngoc Hoi station will be planned at the adjacent center point to the UMRT Line-1 Station.
- The alignment from Ngoc Hoi Station will be planned at west side of the planning Highway alignment route. (Almost matching with HSR's alignment plan in City's Development Plan)
- HSR's workshop Depot will be planned at approximately 10 km from Ngoc Hoi Station with considering the future planning Highway's alignment.
- The alignment plan from current Hanoi station to the Ngoc Hoi section will be studied at necessary time in future. The access plan will be used underground alignment such as Ueno to Tokyo of Tohoku Shinkansen in Japan.
- For increase the HSR's passengers ridership, the coordination with urban railway, i.e. Line-1 will be highly appreciated.
- Because of road access to Noi Bai Airport, i.e. the road No.4, the connection plan for Ngoc Hoi station is also important.



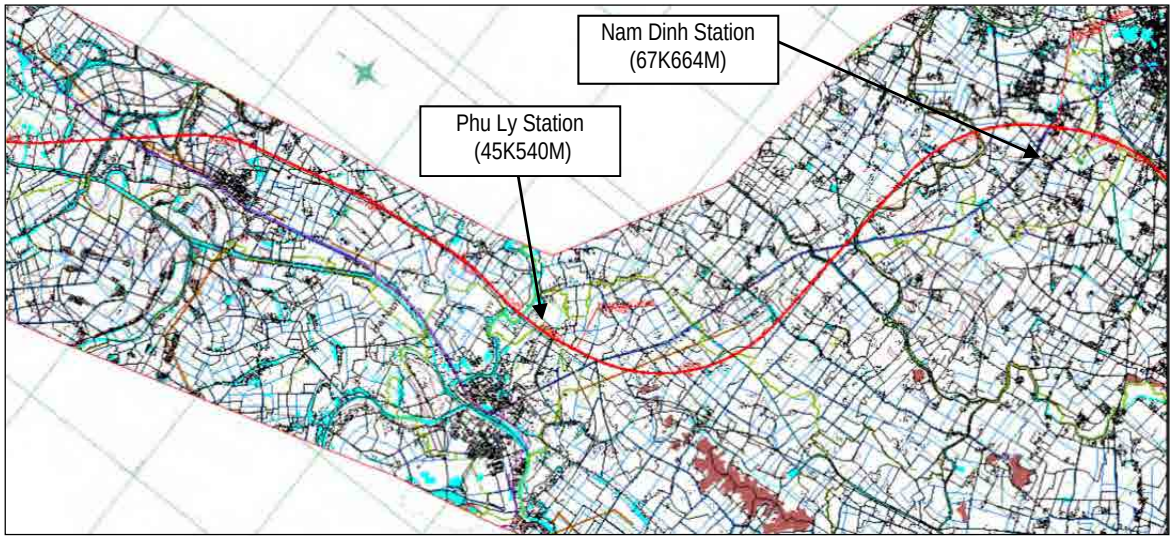
Source: JICA Study Team.

Figure 4.4.1 Final Route Alignment Plan: Ngoc Hoi Station

(2) Ha Nam Province (Phu Ly Station–Nam Dinh Station)

- Final Alignment plan will be shifted to western side from the point of passing through Highway's interchange location.
- In the City Development Plan of Ha Nam Province, HSR was planned at east side of current Highway and the other part had not been used for HSR alignment therefore, the Final Alignment will be shifted to east side before expanded Industrial Park zone for matching the City's development plan and go south with parallel to the current Highway.

- The new station will be constructed outside of the city and the Province have a move plan of current railway station, therefore JICA Study Team recommend to move current railway station to adjacent place of HSR station for easy passenger's transfer.

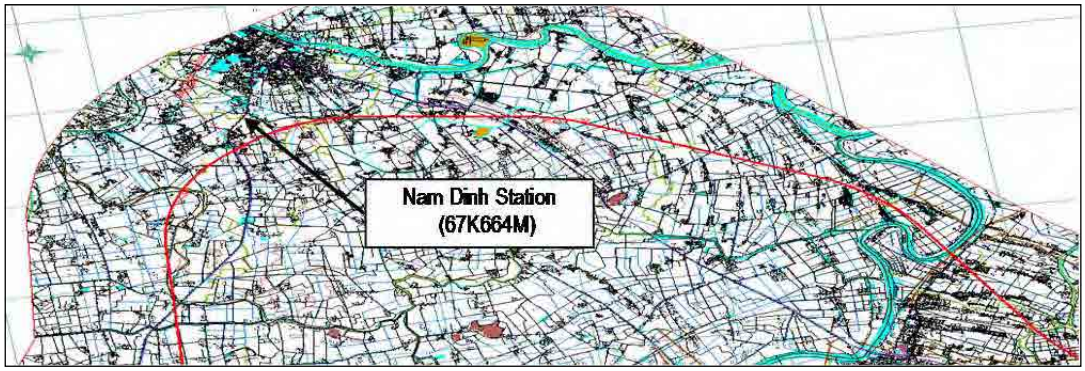


Source: JICA Study Team

Figure 4.4.2 Final Route Alignment Plan: Phu Ly Station–Nam Dinh Station

(3) Nam Dinh Province (Nam Dinh Station–Ninh Binh Station)

- The Nam Dinh station will be planned approximately 5 km of westward from current station at crossing point with current railway.
- The Nam Dinh province has a moving plan of current railway station in the city's Development Plan at adjacent place of HSR station. For convenient of passengers transfer, both station should be constructed at same place.
- Crossing with Highway will not be avoided, HSR will be crossed highway by over Bridge with high necessary vertical alignment.
- The alignment curve radius will be planned more than 6000m before and behind the station, but the Nam Dinh Station will be constructed on the straight section.
- The alignment will be gone to south avoid to the Industrial area at west side of Nam Dinh City**.**

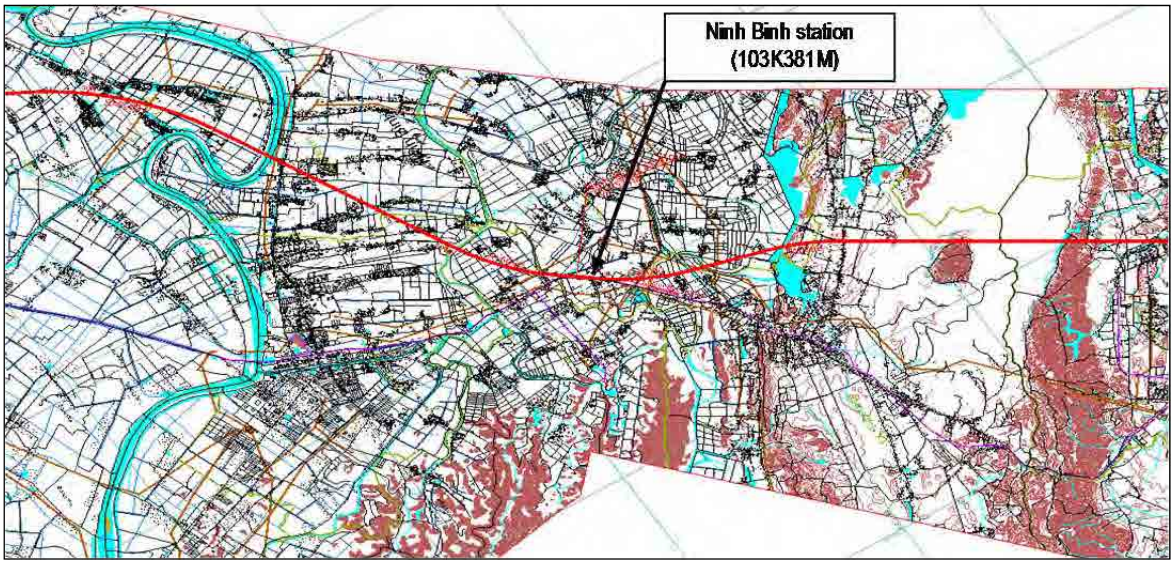


Source JICA Study Team

Figure 4.4.3 Final Route Alignment Plan: Nam Dinh Station

(4) Ninh Binh Province (Ninh Binh Station–Thanh Hoa Station)

- The final alignment will be pass through parallel with current railway and HSR station will be planned at adjacent place with local station.
- The new alignment at station area will be crossed by underpass with under constructed new Highway viaduct..
- After the Ninh Binh Station the alignment will be turned to left side avoid for the military installations and turn to the right toward mountain are after pass through the lake by big bridge with span of approximately 250m.

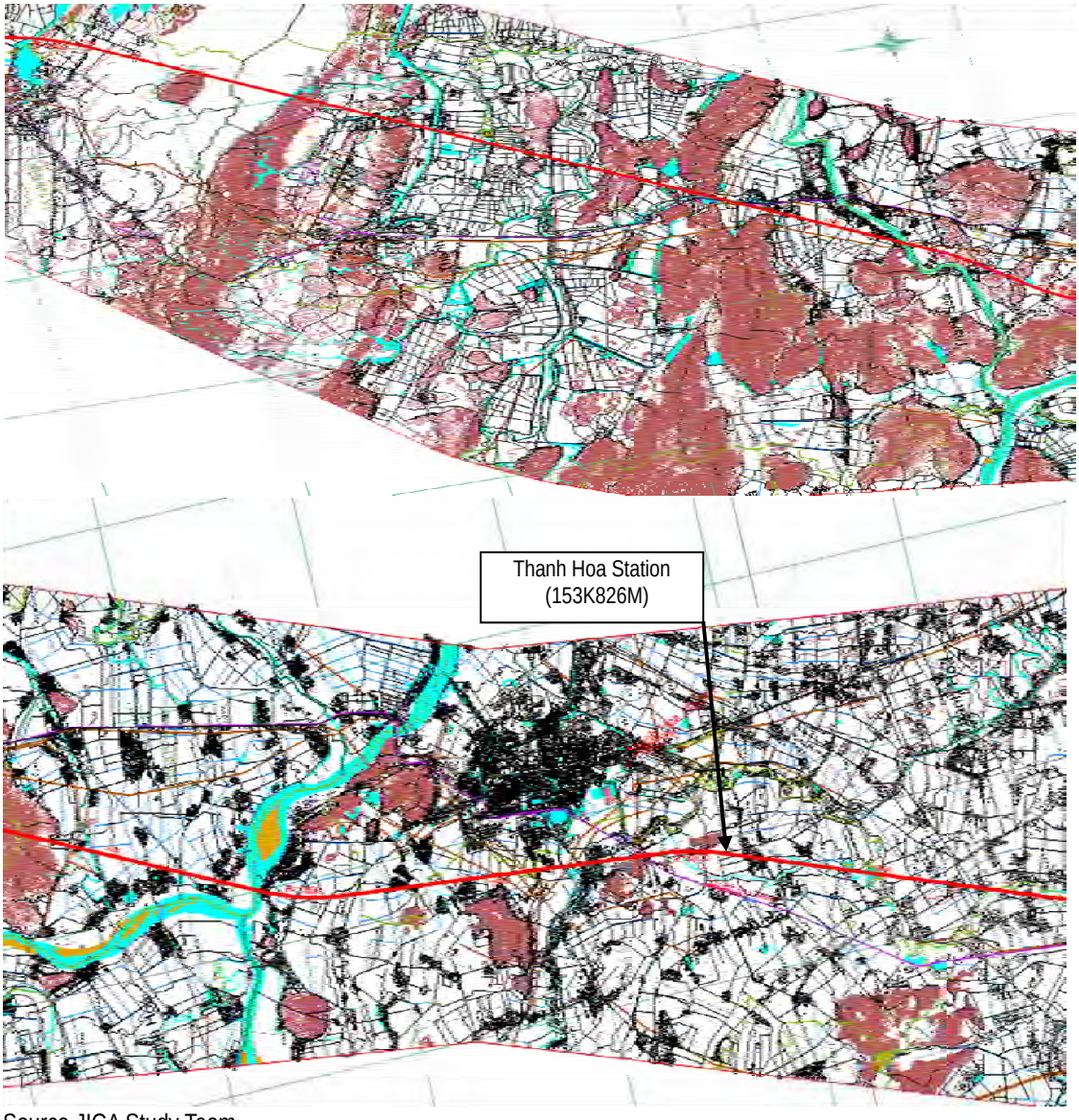


Source JICA Study Team

Figure 4.4.4 Final Route Alignment Plan: Ninh Binh Station

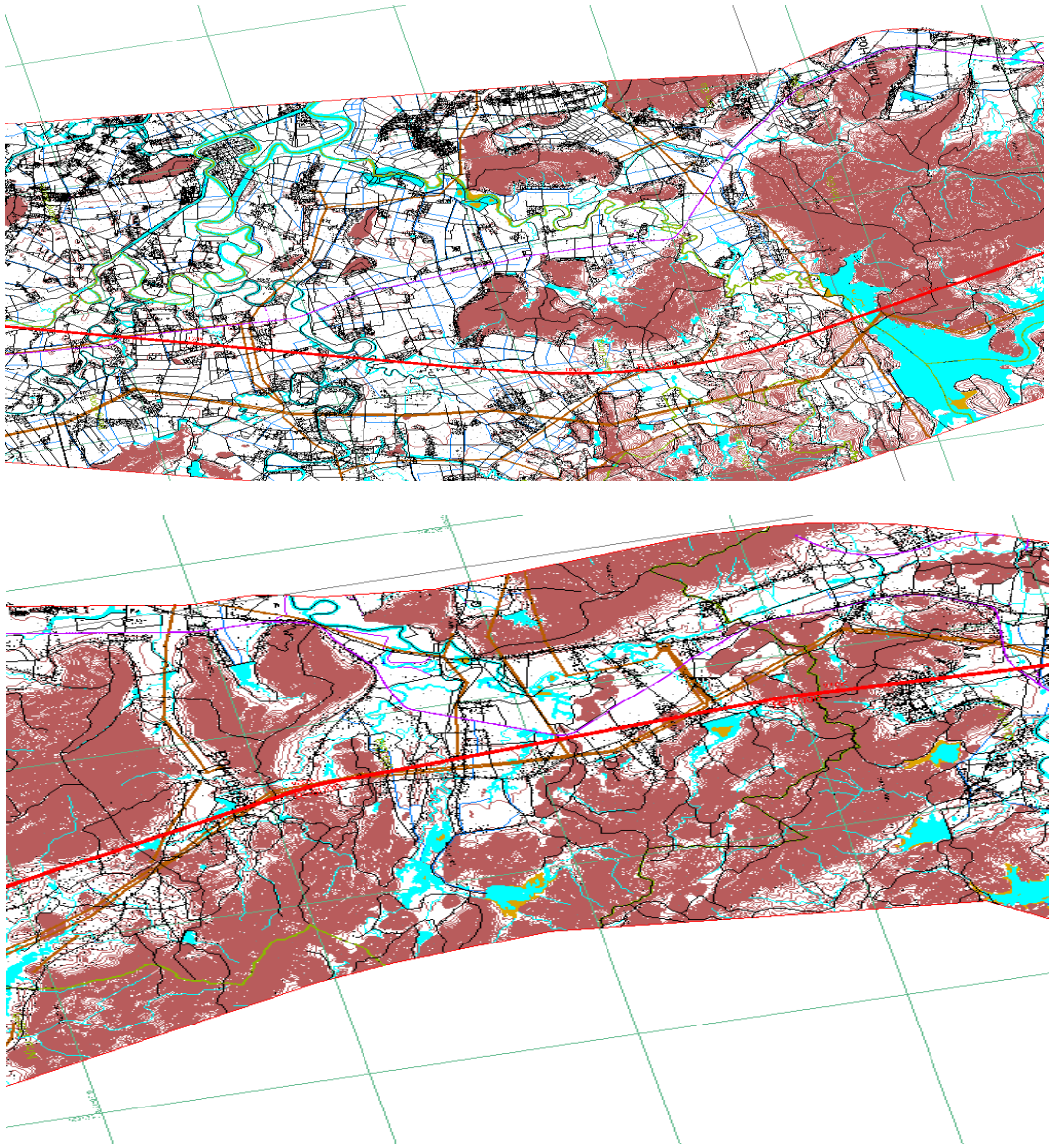
(5) Thanh Hoa Province (Than Hoa Station–Hoang Mai Depot/Station in future)

- The final alignment plan is confirmed City's development Plan and avoids some important facilities such as factories.
- The final drawing will be passed through tunnel at mountain area and cross over the lake at dam site with large span bridge with bridge length of approximately 1.0 km such as rigid frame bridge, extra-dozed bridge, arch bridge and so on.
- The distance between Thanh Hoa Station and Vinh station is approximately 130 km, i.e. too long distance for HSR operation. For maintenance requirement at emergency, the Hoang Mai Depot will be planned and new station will be planned at necessary time in future around this area.



Source JICA Study Team

Figure 4.4.5 Final Route Alignment Plan: Thanh Hoa Station

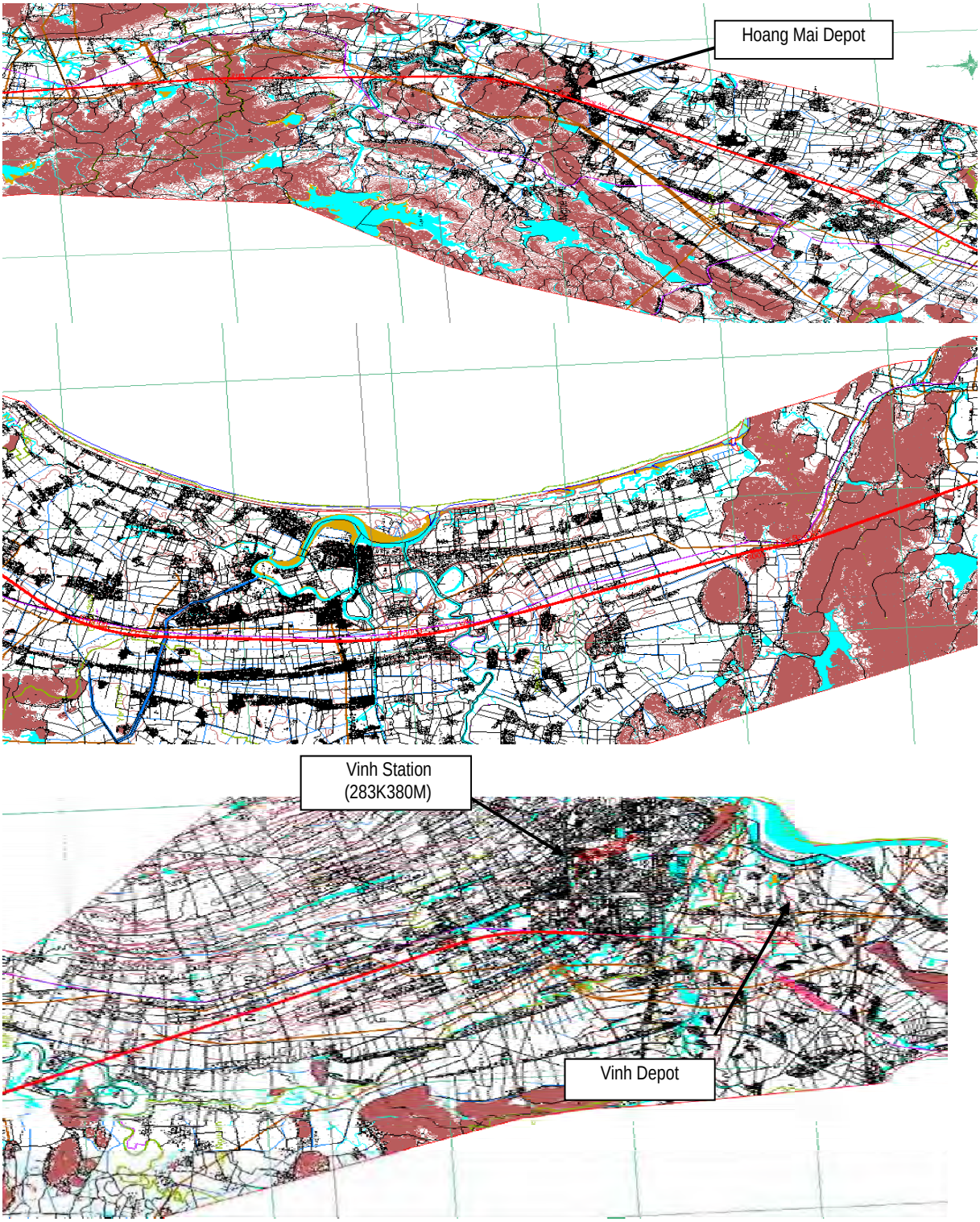


Source JICA Study Team

Figure 4.4.6 Final Route Alignment Plan: Thanh Hoa Station–Provincial Border

(6) Nghe An Province (Vinh Station)

- HSR's new Vinh Station will be planned on the current Vinh railway station for easy passenger's transfer.
- Vinh Station is Terminal station for the time being, therefore the local railway's passenger's connection should be quite important issue in the long plentiful experiences in Japanese Shinkansen.
- The access viaduct to the Depot at Vinh area will be utilized for main route viaduct to Ho Chi Minh City in future.



Source JICA Study Team

Figure 4.4.7 Final Route Alignment Plan: Hoang Mai Depot–Vinh

2) Alignment Information of Selected Routes

(1) Horizontal Alignment

4.20 The minimum curve radius is applied to 6,000 m or more for the realization of operating speed with 320 km (design speed with 350 km) on each selected section.

4.21 Table 4.4.1 shows the horizontal alignment of the north section.

Table 4.4.1 Horizontal Alignment of HSR North Section

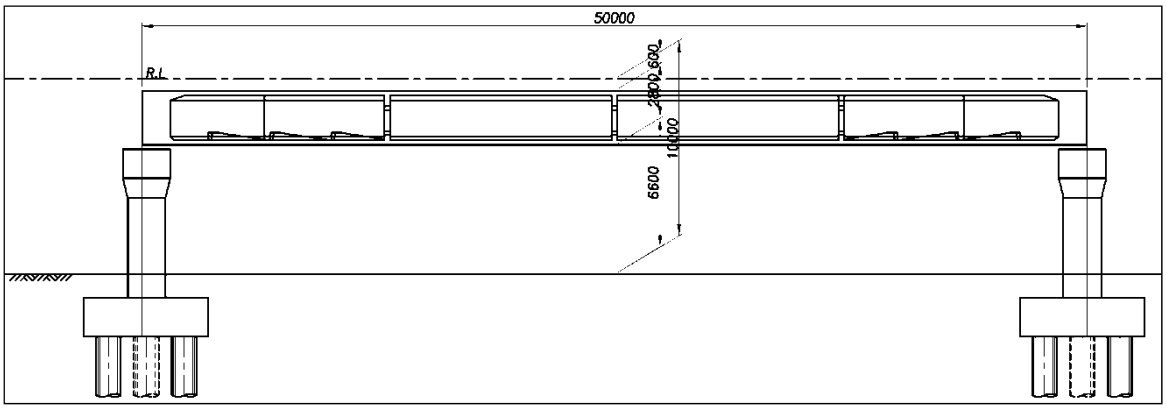
No.	Type of Curve	Kilometerage			Curve Radius	Curve Length
		Begin of Curve	End of Curve	Center of Curve		
1	Curve R	1 k 507 m	3 k 133 m	2 k 320 m	6,000 m	1,626 m
2	Curve L	15 k 102 m	16 k 647 m	15 k 875 m	6,000 m	1,545 m
3	Curve L	20 k 449 m	22 k 687 m	21 k 568 m	6,000 m	2,238 m
4	Curve R	28 k 274 m	31 k 188 m	29 k 731 m	6,000 m	2,914 m
5	Curve R	35 k 436 m	36 k 235 m	35 k 836 m	6,000 m	799 m
6	Curve R	39 k 513 m	41 k 028 m	40 k 271 m	6,000 m	1,515 m
7	Curve L	42 k 026 m	42 k 920 m	42 k 473 m	6,000 m	894 m
8	Curve L	43 k 774 m	44 k 970 m	44 k 372 m	6,000 m	1,196 m
9	Curve L	46 k 093 m	53 k 979 m	50 k 036 m	6,000 m	7,886 m
10	Curve R	61 k 252 m	67 k 103 m	64 k 178 m	6,000 m	5,851 m
11	Curve R	68 k 164 m	72 k 266 m	70 k 215 m	6,000 m	4,102 m
12	Curve R	77 k 966 m	80 k 087 m	79 k 027 m	6,000 m	2,121 m
13	Curve R	88 k 473 m	93 k 326 m	90 k 900 m	8,000 m	4,853 m
14	Curve L	100 k 226 m	102 k 881 m	101 k 554 m	6,000 m	2,655 m
15	Curve L	103 k 881 m	106 k 324 m	105 k 103 m	6,000 m	2,443 m
16	Curve R	108 k 156 m	110 k 028 m	109 k 092 m	6,000 m	1,872 m
17	Curve R	132 k 771 m	133 k 962 m	133 k 367 m	6,000 m	1,191 m
18	Curve L	135 k 489 m	137 k 321 m	136 k 405 m	6,000 m	1,832 m
19	Curve L	143 k 948 m	146 k 142 m	145 k 045 m	6,000 m	2,194 m
20	Curve R	154 k 326 m	155 k 922 m	155 k 124 m	6,000 m	1,596 m
21	Curve L	178 k 232 m	186 k 228 m	182 k 230 m	13,000 m	7,996 m
22	Curve R	199 k 556 m	200 k 719 m	200 k 138 m	6,000 m	1,163 m
23	Curve R	208 k 928 m	209 k 524 m	209 k 226 m	6,000 m	596 m
24	Curve R	216 k 373 m	219 k 553 m	217 k 963 m	6,000 m	3,180 m
25	Curve R	230 k 272 m	231 k 336 m	230 k 804 m	6,000 m	1,064 m
26	Curve L	236 k 591 m	240 k 555 m	238 k 573 m	6,000 m	3,964 m
27	Curve L	245 k 520 m	250 k 610 m	248 k 065 m	15,000 m	5,090 m
28	Curve R	258 k 573 m	259 k 127 m	258 k 850 m	6,000 m	554 m
29	Curve L	260 k 109 m	261 k 201 m	260 k 655 m	6,000 m	1,092 m
30	Curve R	280 k 101 m	282 k 880 m	281 k 491 m	6,000 m	2,779 m

Source JICA Study Team.

(2) Vertical Alignment

4.22 Vertical alignment has been designed by using checking following control points:

- Crossing points with railway and main roads such as Highway;
- Railway clearance is supposed 6.0 m with considering the electrification in future.
- Main road such as Highway is supposed same clearance with railway.
- PC-Box girder with L=50 m is supposed as superstructure, girder height is H-2.80 m, with refer to the standard design height in Kyusyu Shinkansen.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height of G.L～R.L is used 10m for vertical alignment design.

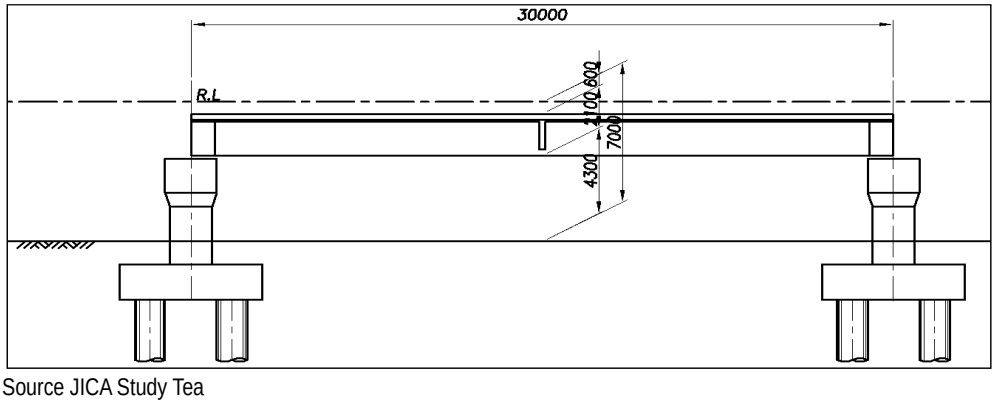


Source JICA Study Team

Figure 4.4.8 Viaduct-1 for Crossing Roads

(3) Crossing with General Roads and Farm Roads

- Road clearance is supposed 4.70 m
- PCT girder with L=30 m is supposed s superstructure, girder height is used H=2.1m, with refer to standard design height in Kyusyu Shinkansen.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height of G.L～R.L is used 17.5 m for vertical alignment design.

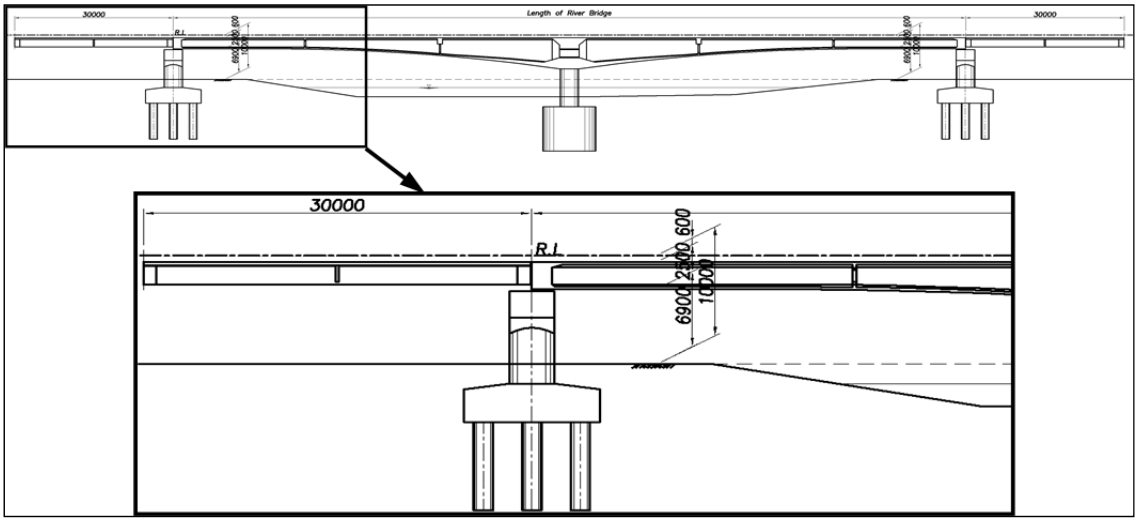


Source JICA Study Tea

Figure 4.4.9 Viaduct-2 for Crossing Roads

(4) Crossing with Large and Middle-scale Rivers

- The height of 6.0 m, same as Main road crossing, is supposed with considering the main road will be provided in future.
- PC Continuous Bridge or Rigid Frame Bridge will be supposed as superstructure, girder height is used 2.5 m, with refer to standard design in Kyusyu Shinkansen.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height of G.L～R.L is used 10.0 m for vertical alignment design.
- Before & Behind of river bridge, PCT girder with L= 30 m is supposed;

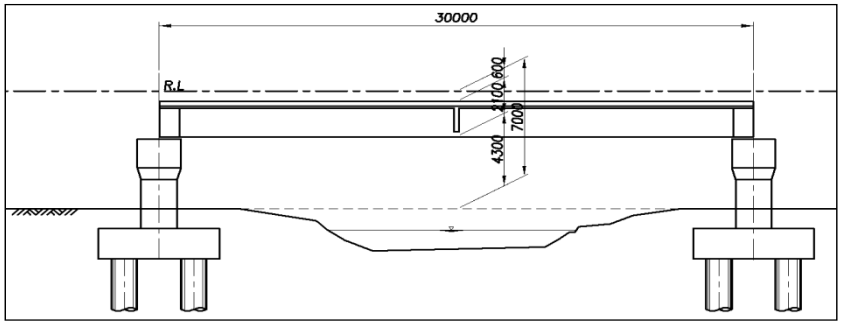


Source JICA Study Team

Figure 4.4.10 Bridge Crossing Large and Middle-scale Rivers

(5) Crossing Points with Small Size River

- The height under girder is supposed 4.7 m
- PCT girder with L=30 m is supposed s superstructure, girder height is used H=2.1 m, with reference to standard design height in Kyusyu Shinkansen.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height of GL～RL is assumed 7.5m for vertical alignment design.

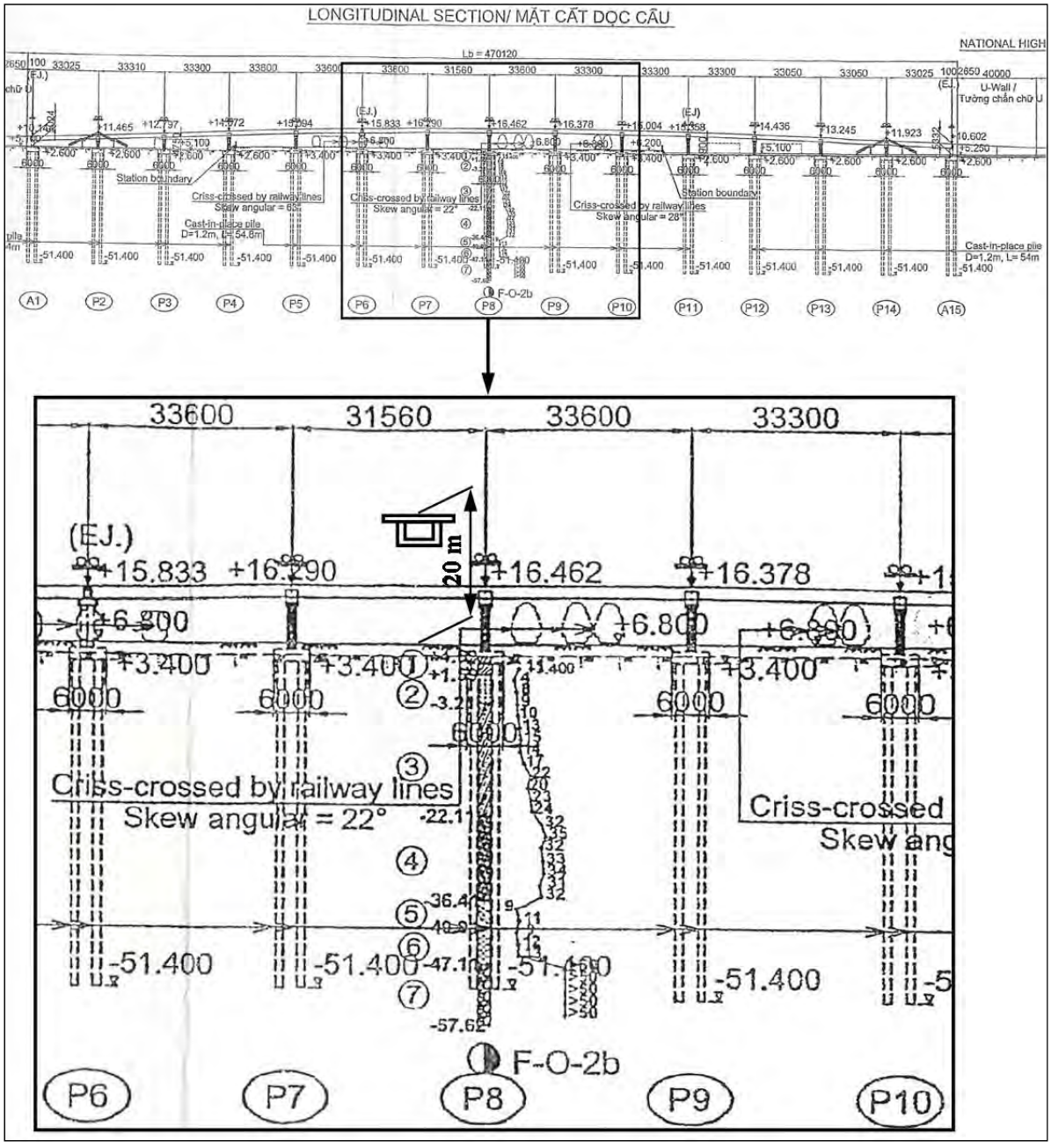


Source JICA Study Team

Figure 4.4.11 Bridge Crossing Small Rivers

(6) Crossing with Flyover at Ngoc Hoi Station

- The height of G.L～road surface of Fly-over is assumed 10m and covers the height of 5.0m on the road. (16.462-6.800 = 9.662 →10.0 m)
- PC-Box girder with L= 50 m is supposed as superstructure, girder height is H-2.80 m,
- With refer to the standard design height in Kyusyu Shinkansen.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height of G.L～R.L is used 20.0 m (10.0+5.0+2.8+0.6=18.4 m)



Source JICA Study Team

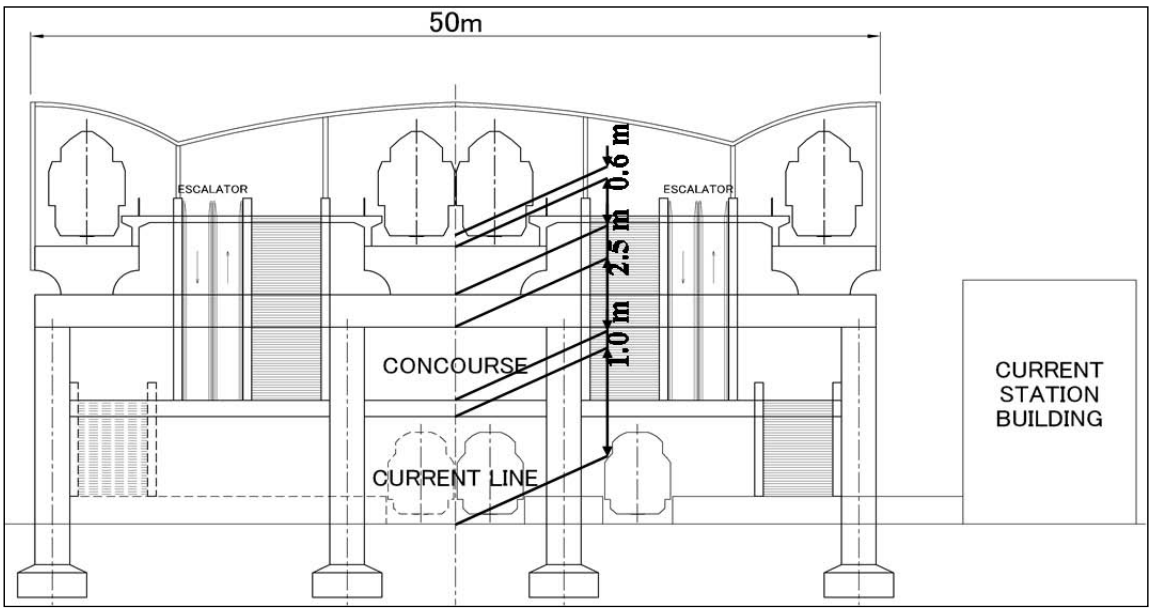
Figure 4.4.12 Longitudinal Alignment at Ngoc Hoi Station

(7) Vinh Station Structure

4.23 The HSR station will be constructed at the current station location.

- Railway clearance is supposed 6.0m with considering the electrification in future.
- The thickness of concourse slab is assumed 1.0 m and internal height is 4.50 m.
- The thickness of Girder supporting beam in rigid frame pier is assumed 2.50 m.
- PC-Box girder is assumed as superstructure, and the height of girder is assumed 3.0m, because of station structure.
- The height of S.L～R.L is used 600 mm, refer to the 595 mm in Kyusyu Shinkansen.
- Therefore, the height between R.L. of current line and R.L of HSR line is assumed 18.0 m (6.0+1.0+4.5+2.5+3.0+0.6=17.6 m →18.0 m)
- Changing point of Vertical Gradient

4.24 Table 4.4.2 shows the specification of longitudinal alignment on the north section.



Source JICA Study Team

Figure 4.4.13 Longitudinal Alignment at Vinh Station

Table 4.4.2 Longitudinal Alignment of HSR North Section

No.	Transition Point in Gradient		Gradient (%)		V.C.L (m)
	Kilometerage	Elevation (m)	Before	After	(R = 25,000 m)
1	-0 k 308 m	24.0		0	
2	1 k 158 m	24.0	0	-12	300
3	2 k 199 m	11.5	-12	0	300
4	12 k 440 m	11.5	0	-5	125
5	13 k 542 m	6.0	-5	0	125
6	19 k 334 m	6.0	0	4	100
7	20 k 628 m	11.2	4	0	100
8	26 k 060 m	12.5	0	-3	75
9	27 k 047 m	9.5	-3	0	75
10	28 k 715 m	9.5	0	4	100
11	30 k 590 m	17.0	4	-5	225
12	31 k 783 m	11.0	-5	0	125
13	41 k 260 m	11.0	0	1	25
14	45 k 040 m	16.3	1	0	25
15	46 k 040 m	16.3	0	-4	100
16	46 k 989 m	12.8	-4	0	100
17	56 k 920 m	10.6	0	3	75
18	57 k 840 m	12.9	3	-2	125
19	59 k 216 m	10.1	-2	0	50
20	66 k 084 m	10.1	0	4	100
21	67 k 164 m	14.5	4	0	100
22	68 k 164 m	14.5	0	-2	50
23	70 k 795 m	9.2	-2	0	50
24	75 k 721 m	9.2	0	2	50
25	76 k 620 m	11.0	2	-2	100
26	77 k 613 m	9.0	-2	0	50
27	80 k 120 m	9.0	0	2	50
28	81 k 627 m	12.0	2	0	50
29	87 k 980 m	12.0	0	2	50
30	89 k 098 m	13.7	2	0	50
31	93 k 215 m	13.7	0	2	50
32	95 k 034 m	17.4	2	0	50
33	101 k 043 m	17.4	0	-4	100
34	102 k 131 m	13.0	-4	0	100
35	104 k 631 m	13.0	0	5	125
36	107 k 074 m	25.2	5	-3	200
37	110 k 371 m	15.0	-3	2	125
38	115 k 505 m	25.3	2	-3	125
39	120 k 528 m	11.0	-3	0	75
40	122 k 410 m	11.0	0	2	50
41	123 k 651 m	13.5	2	-2	100
42	124 k 970 m	10.8	-2	5	175
43	127 k 400 m	23.0	5	-3	200
44	130 k 041 m	15.9	-3	2	125
45	132 k 000 m	20.0	2	-6	200
46	133 k 167 m	13.0	-6	0	150
47	135 k 347 m	13.0	0	2	50
48	138 k 499 m	19.3	2	-2	100
49	139 k 400 m	17.5	-2	0	50
50	142 k 643 m	17.5	0	2	50
51	143 k 625 m	19.5	2	-2	100
52	147 k 434 m	12.5	-2	0	50
53	150 k 452 m	12.5	0	2	50
54	152 k 701 m	17.0	2	0	50

No.	Transition Point in Gradient		Gradient (%)		V.C.L (m)
	Kilometerage	Elevation (m)	Before	After	(R = 25,000 m)
55	154 k 326 m	17.0	0	-5	125
56	155 k 226 m	12.5	-5	0	125
57	164 k 283 m	12.5	0	-2	50
58	166 k 381 m	8.3	-2	2	100
59	168 k 220 m	12.0	2	-2	100
60	169 k 211 m	10.0	-2	0	50
61	175 k 540 m	10.0	0	-4	100
62	176 k 915 m	4.5	-4	0	100
63	179 k 324 m	4.5	0	2	50
64	184 k 749 m	15.3	2	5	75
65	187 k 670 m	30.2	5	2	75
66	192 k 105 m	39.0	2	-3	125
67	202 k 445 m	7.1	-3	2	125
68	209 k 192 m	20.6	2	6	100
69	211 k 024 m	30.8	6	-10	400
70	212 k 415 m	16.9	-10	-2	200
71	214 k 600 m	12.5	-2	0	50
72	217 k 871 m	12.5	0	5	125
73	219 k 974 m	23.0	5	-10	375
74	221 k 074 m	12.0	-10	-2	200
75	224 k 763 m	4.6	-2	0	50
76	227 k 967 m	4.6	0	2	50
77	231 k 932 m	12.6	2	-2	100
78	234 k 730 m	7.0	-2	2	100
79	237 k 480 m	12.5	2	0	50
80	240 k 771 m	12.5	0	-5	125
81	242 k 281 m	5.0	-5	0	125
82	248 k 351 m	5.0	0	2	50
83	250 k 100 m	8.5	2	-2	100
84	251 k 600 m	5.5	-2	0	50
85	253 k 667 m	5.5	0	2	50
86	255 k 548 m	9.3	2	0	50
87	260 k 594 m	9.3	0	2	50
88	262 k 900 m	13.9	2	-2	100
89	265 k 194 m	9.3	-2	2	100
90	266 k 800 m	12.5	2	0	50
91	269 k 573 m	12.5	0	-2	50
92	273 k 274 m	5.1	-2	2	100
93	276 k 863 m	12.3	2	0	50
94	281 k 060 m	12.3	0	10	250
95	282 k 130 m	23.0	10	0	250
96	283 k 790 m	23.0	0		

Source: JICA Study Team

4.5 Description of Structures for Selected Routes

4.25 In general, the basal conditions for planning the allocation of civil engineering structures include the topographical conditions, geological and soil conditions, intersection/proximity conditions, land use conditions, environmental conditions, construction conditions, maintenance and management conditions along the planned construction route, and so on. The types of civil engineering structures are selected based on the results of site surveys, taking into consideration those basal conditions.

4.26 Here, the types of civil engineering structures that may be employed on the north section include embankments (including crossing box culverts) and cuts, bridges and viaducts, tunnels structures. The bridge structures have the main road-crossing bridges include the national roads and expressways (including ones under construction and contemplation), existing railway-crossing bridges, river-crossing bridges over the medium and large-sized rivers. The other elevated structures except for the bridge structures are classified into the viaduct structures. In order to minimize construction cost, earth structures were basically selected in open sections. Viaducts were applied to the areas where population density is high to avoid hitting major buildings, roads, railways, or to the areas where soft alluvia of N values less than 5 are continuous for more than 20m deep thus the expected residual settlement of embankment is large.

4.27 Table 4.5.1 shows the types of civil engineering structures and length and ratio for each structure type on Ha Noi–Vinh section, respectively.

Table 4.5.1 Specifications of Civil Engineering Structures at Ha Noi–Vinh Section

Structural type	Ngoc Hoi ~Phu Ly		Phu Ly ~Nam Dinh		Nam Dinh ~Ninh Binh		Ninh Binh ~Thanh Hoa		Thanh Hoa ~Vinh		Total	
	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)
Station	615	1.4	650	2.9	650	1.8	650	1.3	1,820	1.4	4,385	1.5
Viaduct	32,198	70.7	21,094	95.3	31,781	89.2	13,926	27.7	37,344	28.6	136,343	48.0
Bridge	930	2.0	380	1.7	1,180	3.3	1,700	3.4	1,900	1.5	6,090	2.1
Embankment	11,780	25.9	0	0.0	2,016	5.6	24,404	48.5	73,730	56.5	111,930	39.4
Cut	0	0.0	0	0.0	0	0.0	3,200	6.4	6,660	5.1	9,860	3.5
Tunnel	0	0.0	0	0.0	0	0.0	6,390	12.7	9,010	6.9	15,400	5.4
Total	45,523	100.0	22,124	100.0	35,627	100.0	50,270	100.0	130,464	100.0	284,008	100.0

Source JICA Study Team

4.28 The alignment in North section is designed with connecting the capital of the province on the plains beside coast practically. Then the following points are specified:

(i) The soil condition approximately length of 60Km near Nam Dinh to Ninh Binh area, i.e. 40 Km to 100Km point from Ngoc Hoi station is quite weak, therefore Embankment structures will not be planned by subsiding effect, hence, only viaduct structures with supporting cast-in-placed pile shall be adopted.

(ii) For a purpose of cost reduction, Embankment structure has been used around Thanh Hoa to Vinh area considerably.

(iii) Cut length is extremely short in geomorphology condition.

4.29 The types of each civil engineering structure and plans for allocation of those are described below.

1) Embankment Structure

4.30 Embankment structures are employed for suburban sections between each station as long as they are feasible, excluding areas where the surface and deeper layers are extremely soft ground, because they are more economical and easier to construct. Furthermore, at a little distance from the planned Ninh Binh Station, the expressway construction would be going on and get to cross over the national road and existing railway, therefore, the planned HSR in parallel with the existing railway also would be required consideration of adopting low embankment structures at this station and in sections before and after the station in order to meet the above conditions.

4.31 This study considers the following three ordinary embankments to be typical embankment structures.

(a) **Emb. Type 1:** Embankment with a slope of 1/1.5 and an average height of 2.0m (Typical type for a height of 3 meters or less)

(b) **Emb. Type 2:** Embankment with a slope of 1/1.5 and an average height of 4.5m (Typical type for a height of larger than 3 meters and 6 meters or less)

(c) **Emb. Type 3:** Embankment with a slope of 1/1.8 and an average height of 7.5 m (Typical type for a height of larger than 6 meters).

4.32 Abutments, with approach block structures allow for changes in the strength of the sub grade, are constructed in the connecting sections between embankments and viaducts/bridges, and in the sections where embankments cross current roads or small rivers/drainage canals, box culverts, girders with abutments or the like will be employed for grade separations. In this study, each section of embankment structures is planned to be constructed crossing box culverts at 4 locations per 1 km.

4.33 Table 4.5.2 shows the plan for the types and locations of each embankment structure employed on Ha Noi–Vinh section, respectively.

2) Earth Structure

4.34 Earth structures (embankment and cut structures) were considered to have difficulties in maintenance and management because of collapse due to land subsidence, heavy rain, earthquakes, and mud pumping on the roadbed; however, their applicability has been improved with the development and evolution of use materials and construction techniques in Japan.

Table 4.5.2 Embankment Structures at Ha Noi–Vinh Section by Type and Location

No.	Embankment Type	Kirometerage		Length (m)	Province	Remarks
		From	To			
1	Emb. Type 3	12k530m	12k940m	410	Ha Noi	
	Emb. Type 2	12k940m	14k200m	1,260	Ha Noi	
	Emb. Type 1	14k200m	19k510m	5,310	Ha Noi	
	Emb. Type 2	19k510m	20k170m	660	Ha Noi	
	Emb. Type 3	20k170m	20k330m	160	Ha Noi	
2	Emb. Type 3	32k290m	36k270m	3,980	Ha Nam	
3	Emb. Type 3	51k820m	56k870m	5,050	Ha Nam	
4	Emb. Type 3	77k370m	79k070m	1,700	Nam Dinh	
5	Emb. Type 3	79k120m	80k070m	950	Nam Dinh	
6	Emb. Type 3	101k040m	101k380m	340	Ninh Binh	

No.	Embankment Type	Kirometerage		Length (m)	Province	Remarks
		From	To			
	Emb. Type 2	101k380m	102k130m	750	Ninh Binh	
	Emb. Type 1	102k130m	103k056m	926	Ninh Binh	
7	Emb. Type 1	103k706m	104k630m	924	Ninh Binh	
	Emb. Type 2	104k630m	105k270m	640	Ninh Binh	
	Emb. Type 3	105k270m	105k580m	310	Ninh Binh	
8	Emb. Type 3	106k490m	106k670m	180	Ninh Binh	
	Emb. Type 2	106k670m	106k880m	210	Ninh Binh	
9	Emb. Type 3	106k880m	108k490m	1,610	Ninh Binh	
10	Emb. Type 1	108k920m	109k110m	190	Ninh Binh	
	Emb. Type 2	109k110m	109k220m	110	Ninh Binh	
	Emb. Type 3	109k220m	110k040m	820	Ninh Binh	
	Emb. Type 2	110k040m	110k640m	600	Ninh Binh	
	Emb. Type 1	110k640m	110k670m	30	Ninh Binh	
11	Emb. Type 1	115k050m	115k340m	290	Thanh Hoa	
	Emb. Type 2	115k340m	115k610m	270	Thanh Hoa	
12	Emb. Type 1	116k050m	116k090m	40	Thanh Hoa	
	Emb. Type 2	116k090m	116k240m	150	Thanh Hoa	
	Emb. Type 1	116k240m	116k260m	20	Thanh Hoa	
13	Emb. Type 1	116k410m	116k420m	10	Thanh Hoa	
	Emb. Type 2	116k420m	116k430m	10	Thanh Hoa	
14	Emb. Type 3	116k430m	117k500m	1,070	Thanh Hoa	
15	Emb. Type 3	120k000m	120k530m	530	Thanh Hoa	
	Emb. Type 2	120k530m	121k830m	1,300	Thanh Hoa	
	Emb. Type 1	121k830m	121k900m	70	Thanh Hoa	
16	Emb. Type 1	122k240m	122k260m	20	Thanh Hoa	
	Emb. Type 2	122k260m	122k410m	150	Thanh Hoa	
	Emb. Type 3	122k410m	123k160m	750	Thanh Hoa	
17	Emb. Type 1	124k860m	124k880m	20	Thanh Hoa	
	Emb. Type 2	124k880m	125k000m	120	Thanh Hoa	
	Emb. Type 3	125k000m	126k070m	1,070	Thanh Hoa	
	Emb. Type 2	126k070m	126k080m	10	Thanh Hoa	
	Emb. Type 1	126k080m	126k100m	20	Thanh Hoa	
18	Emb. Type 1	126k160m	126k170m	10	Thanh Hoa	
19	Emb. Type 2	126k170m	126k180m	10	Thanh Hoa	
	Emb. Type 3	126k180m	126k260m	80	Thanh Hoa	
	Emb. Type 2	126k260m	126k280m	20	Thanh Hoa	
	Emb. Type 1	126k280m	126k300m	20	Thanh Hoa	
20	Emb. Type 1	126k470m	126k480m	10	Thanh Hoa	
	Emb. Type 2	126k480m	126k500m	20	Thanh Hoa	
	Emb. Type 3	126k500m	126k530m	30	Thanh Hoa	
21	Emb. Type 3	129k450m	130k010m	560	Thanh Hoa	
	Emb. Type 2	130k010m	130k080m	70	Thanh Hoa	
	Emb. Type 3	130k080m	130k850m	770	Thanh Hoa	
22	Emb. Type 3	132k150m	132k610m	460	Thanh Hoa	
	Emb. Type 2	132k610m	133k170m	560	Thanh Hoa	
	Emb. Type 1	133k170m	133k800m	630	Thanh Hoa	
23	Emb. Type 1	134k210m	134k910m	700	Thanh Hoa	
24	Emb. Type 1	135k330m	135k350m	20	Thanh Hoa	
	Emb. Type 2	135k350m	136k190m	840	Thanh Hoa	
	Emb. Type 1	136k190m	136k310m	120	Thanh Hoa	

No.	Embankment Type	Kirometerage		Length (m)	Province	Remarks
		From	To			
25	Emb. Type 1	138k210m	138k250m	40	Thanh Hoa	
	Emb. Type 2	138k250m	138k290m	40	Thanh Hoa	
	Emb. Type 3	138k290m	139k250m	960	Thanh Hoa	
26	Emb. Type 3	139k550m	140k650m	1,100	Thanh Hoa	
27	Emb. Type 3	144k300m	144k850m	550	Thanh Hoa	
	Emb. Type 2	144k850m	147k180m	2,330	Thanh Hoa	
	Emb. Type 3	147k180m	147k290m	110	Thanh Hoa	
28	Emb. Type 3	148k090m	150k890m	2,800	Thanh Hoa	
29	Emb. Type 3	154k840m	156k340m	1,500	Thanh Hoa	
30	Emb. Type 3	168k570m	172k440m	3,870	Thanh Hoa	
31	Emb. Type 3	175k540m	175k910m	370	Thanh Hoa	
	Emb. Type 2	175k910m	176k660m	750	Thanh Hoa	
	Emb. Type 1	176k660m	179k820m	3,160	Thanh Hoa	
	Emb. Type 2	179k820m	180k310m	490	Thanh Hoa	
	Emb. Type 1	180k310m	181k050m	740	Thanh Hoa	
	Emb. Type 2	181k050m	182k970m	1,920	Thanh Hoa	
	Emb. Type 3	182k970m	184k090m	1,120	Thanh Hoa	
	Emb. Type 2	184k090m	184k120m	30	Thanh Hoa	
	Emb. Type 1	184k120m	184k160m	40	Thanh Hoa	
32	Emb. Type 1	185k130m	185k150m	20	Thanh Hoa	
	Emb. Type 2	185k150m	185k180m	30	Thanh Hoa	
	Emb. Type 3	185k180m	187k120m	1,940	Thanh Hoa	
	Emb. Type 2	187k120m	187k160m	40	Thanh Hoa	
	Emb. Type 1	187k160m	187k210m	50	Thanh Hoa	
33	Emb. Type 1	187k460m	187k520m	60	Thanh Hoa	
	Emb. Type 2	187k520m	187k560m	40	Thanh Hoa	
34	Emb. Type 1	190k550m	190k600m	50	Thanh Hoa	
	Emb. Type 2	190k600m	190k620m	20	Thanh Hoa	
	Emb. Type 3	190k620m	190k790m	170	Thanh Hoa	
	Emb. Type 2	190k790m	190k830m	40	Thanh Hoa	
	Emb. Type 1	190k830m	190k940m	110	Thanh Hoa	
	Emb. Type 2	190k940m	191k130m	190	Thanh Hoa	
	Emb. Type 1	191k130m	191k170m	40	Thanh Hoa	
35	Emb. Type 1	192k830m	192k980m	150	Thanh Hoa	
	Emb. Type 2	192k980m	193k030m	50	Thanh Hoa	
	Emb. Type 3	193k030m	193k800m	770	Thanh Hoa	
	Emb. Type 2	193k800m	194k040m	240	Thanh Hoa	
	Emb. Type 3	194k040m	194k250m	210	Thanh Hoa	
	Emb. Type 2	194k250m	194k310m	60	Thanh Hoa	
	Emb. Type 1	194k310m	194k700m	390	Thanh Hoa	
36	Emb. Type 1	197k240m	197k590m	350	Thanh Hoa	
	Emb. Type 2	197k590m	197k780m	190	Thanh Hoa	
	Emb. Type 3	197k780m	198k670m	890	Thanh Hoa	
	Emb. Type 2	198k670m	198k920m	250	Thanh Hoa	
37	Emb. Type 3	198k920m	199k040m	120	Thanh Hoa	
	Emb. Type 2	199k040m	199k210m	170	Thanh Hoa	
	Emb. Type 1	199k210m	199k280m	70	Thanh Hoa	
38	Emb. Type 1	199k490m	199k510m	20	Thanh Hoa	
	Emb. Type 2	199k510m	199k540m	30	Thanh Hoa	

No.	Embankment Type	Kirometerage		Length (m)	Province	Remarks
		From	To			
	Emb. Type 3	199k540m	199k570m	30	Thanh Hoa	
	Emb. Type 2	199k570m	199k610m	40	Thanh Hoa	
	Emb. Type 1	199k610m	199k630m	20	Thanh Hoa	
39	Emb. Type 1	199k970m	200k000m	30	Thanh Hoa	
	Emb. Type 2	200k000m	200k090m	90	Thanh Hoa	
	Emb. Type 3	200k090m	200k740m	650	Thanh Hoa	
	Emb. Type 2	200k740m	200k850m	110	Thanh Hoa	
	Emb. Type 1	200k850m	200k930m	80	Thanh Hoa	
40	Emb. Type 1	201k510m	201k570m	60	Thanh Hoa	
	Emb. Type 2	201k570m	202k160m	590	Thanh Hoa	
	Emb. Type 1	202k160m	202k880m	720	Thanh Hoa	
	Emb. Type 2	202k880m	203k990m	1,110	Thanh Hoa	
	Emb. Type 1	203k990m	204k570m	580	Thanh Hoa	
	Emb. Type 2	204k570m	204k770m	200	Thanh Hoa	
41	Emb. Type 3	204k770m	204k830m	60	Thanh Hoa	
	Emb. Type 2	204k830m	204k840m	10	Thanh Hoa	
	Emb. Type 1	204k840m	204k860m	20	Thanh Hoa	
	Emb. Type 2	204k860m	204k920m	60	Thanh Hoa	
	Emb. Type 1	204k920m	204k950m	30	Thanh Hoa	
	Emb. Type 2	204k950m	204k960m	10	Thanh Hoa	
	Emb. Type 3	204k960m	205k010m	50	Thanh Hoa	
	Emb. Type 2	205k010m	205k060m	50	Thanh Hoa	
	Emb. Type 3	205k060m	206k650m	1,590	Thanh Hoa	
	Emb. Type 2	206k650m	206k710m	60	Thanh Hoa	
	Emb. Type 1	206k710m	206k730m	20	Thanh Hoa	
42	Emb. Type 1	207k090m	207k280m	190	Thanh Hoa	
	Emb. Type 2	207k280m	207k990m	710	Thanh Hoa	
	Emb. Type 1	207k990m	208k320m	330	Thanh Hoa	
43	Emb. Type 3	218k590m	219k220m	630	Nghe An	
	Emb. Type 2	219k220m	219k580m	360	Nghe An	
	Emb. Type 3	219k580m	219k790m	210	Nghe An	
44	Emb. Type 2	219k790m	219k820m	30	Nghe An	
	Emb. Type 1	219k820m	219k850m	30	Nghe An	
45	Emb. Type 3	220k740m	221k590m	850	Nghe An	
	Emb. Type 2	221k590m	224k350m	2,760	Nghe An	
	Emb. Type 1	224k350m	228k400m	4,050	Nghe An	
	Emb. Type 2	228k400m	229k900m	1,500	Nghe An	
	Emb. Type 3	229k900m	230k650m	750	Nghe An	
46	Emb. Type 3	232k450m	233k960m	1,510	Nghe An	
	Emb. Type 2	233k960m	235k480m	1,520	Nghe An	
	Emb. Type 3	235k480m	236k930m	1,450	Nghe An	
47	Emb. Type 3	237k930m	240k780m	2,850	Nghe An	
48	Emb. Type 3	240k930m	241k470m	540	Nghe An	
	Emb. Type 2	241k470m	242k070m	600	Nghe An	
	Emb. Type 1	242k070m	248k840m	6,770	Nghe An	
	Emb. Type 2	248k840m	249k860m	1,020	Nghe An	
	Emb. Type 3	249k860m	250k000m	140	Nghe An	
49	Emb. Type 3	250k200m	250k850m	650	Nghe An	

No.	Embankment Type	Kirometerage		Length (m)	Province	Remarks
		From	To			
	Emb. Type 2	250k850m	252k820m	1,970	Nghe An	
	Emb. Type 1	252k820m	253k710m	890	Nghe An	
	Emb. Type 2	253k710m	258k990m	5,280	Nghe An	
	Emb. Type 1	258k990m	259k280m	290	Nghe An	
	Emb. Type 2	259k280m	260k220m	940	Nghe An	
50	Emb. Type 1	260k220m	260k350m	130	Nghe An	
	Emb. Type 2	260k350m	260k950m	600	Nghe An	
	Emb. Type 1	260k950m	261k000m	50	Nghe An	
51	Emb. Type 1	264k990m	265k060m	70	Nghe An	
	Emb. Type 2	265k060m	266k050m	990	Nghe An	
	Emb. Type 3	266k050m	266k800m	750	Nghe An	
52	Emb. Type 3	270k600m	271k520m	920	Nghe An	
	Emb. Type 2	271k520m	272k910m	1,390	Nghe An	
	Emb. Type 1	272k910m	273k660m	750	Nghe An	
	Emb. Type 2	273k660m	275k180m	1,520	Nghe An	
	Emb. Type 3	275k180m	275k900m	720	Nghe An	

Source JICA Study Team

3) Cut Structure

4.35 Cut structures are employed for sections with low hills in suburban areas and approaching sections of tunnel inlet and outlet.

4.36 This study considers the following three ordinary cuts to be typical cut structures.

(a) **Cut Type 1:** Cut with a slope of 1/1.2 and an average height of 2.0 m (Typical type for a height of 3 meters or less)

(b) **Cut Type 2:** Cut with a slope of 1/1.5 and an average height of 4.5 m (Typical type for a height of larger than 3 meters and 6 meters or less)

(c) **Cut Type 3:** Cut with a slope of 1/1.5 and an average height of 7.5 m (Typical type for a height of larger than 6 meters)

4.37 Cuts, with approach block structures allow for changes in the strength of the sub-grade, are constructed in the connecting sections between cuts and viaducts/bridges, and in the sections where cuts cross current roads will be employed for grade separations with road-over-bridges (ROB).

4.38 In case of increased water due to frequent concentrated heavy rain, there must be appropriate collecting and draining equipment or other necessary facilities in place.

4.39 Table 4.5.3 shows the plan for the types and locations of each cut structure employed on Ha Noi–Vinh section, respectively.

Table 4.5.3 Cut Structures at Ha Noi–Vinh Section by Type and Location

No.	Cut Type	Kilometerage		Length (m)	Province	Remarks
		From	To			
1	Cut Type 2	108k740m	108k750m	10	Ninh Binh	
	Cut Type 3	108k750m	108k850m	100	Ninh Binh	
	Cut Type 2	108k850m	108k880m	30	Ninh Binh	
	Cut Type 1	108k880m	108k920m	40	Ninh Binh	
2	Cut Type 1	110k670m	110k710m	40	Ninh Binh	
	Cut Type 2	110k710m	110k740m	30	Ninh Binh	
	Cut Type 3	110k740m	110k760m	20	Ninh Binh	
3	Cut Type 3	114k390m	114k520m	130	Thanh Hoa	
	Cut Type 2	114k520m	114k750m	230	Thanh Hoa	
	Cut Type 1	114k750m	115k050m	300	Thanh Hoa	
4	Cut Type 1	115k610m	115k630m	20	Thanh Hoa	
	Cut Type 2	115k630m	115k670m	40	Thanh Hoa	
	Cut Type 3	115k670m	115k950m	280	Thanh Hoa	
	Cut Type 2	115k950m	115k960m	10	Thanh Hoa	
	Cut Type 1	115k960m	116k050m	90	Thanh Hoa	
5	Cut Type 1	116k260m	116k270m	10	Thanh Hoa	
	Cut Type 2	116k270m	116k280m	10	Thanh Hoa	
	Cut Type 3	116k280m	116k400m	120	Thanh Hoa	
	Cut Type 2	116k400m	116k410m	10	Thanh Hoa	
6	Cut Type 1	118k260m	118k350m	90	Thanh Hoa	
	Cut Type 2	118k350m	118k370m	20	Thanh Hoa	
	Cut Type 3	118k370m	118k480m	110	Thanh Hoa	
	Cut Type 2	118k480m	118k490m	10	Thanh Hoa	
	Cut Type 1	118k490m	118k510m	20	Thanh Hoa	
7	Cut Type 1	121k900m	122k100m	200	Thanh Hoa	
	Cut Type 2	122k100m	122k210m	110	Thanh Hoa	
	Cut Type 1	122k210m	122k240m	30	Thanh Hoa	
8	Cut Type 1	123k970m	123k980m	10	Thanh Hoa	
	Cut Type 2	123k980m	124k000m	20	Thanh Hoa	
	Cut Type 3	124k000m	124k010m	10	Thanh Hoa	
9	Cut Type 3	124k810m	124k820m	10	Thanh Hoa	
	Cut Type 2	124k820m	124k840m	20	Thanh Hoa	
	Cut Type 1	124k840m	124k860m	20	Thanh Hoa	
10	Cut Type 1	126k100m	126k110m	10	Thanh Hoa	
	Cut Type 2	126k110m	126k150m	40	Thanh Hoa	
	Cut Type 1	126k150m	126k160m	10	Thanh Hoa	
11	Cut Type 1	126k300m	126k310m	10	Thanh Hoa	
	Cut Type 2	126k310m	126k320m	10	Thanh Hoa	
	Cut Type 3	126k320m	126k440m	120	Thanh Hoa	
	Cut Type 2	126k440m	126k450m	10	Thanh Hoa	
	Cut Type 1	126k450m	126k470m	20	Thanh Hoa	
12	Cut Type 1	133k800m	133k930m	130	Thanh Hoa	
	Cut Type 2	133k930m	133k960m	30	Thanh Hoa	
	Cut Type 3	133k960m	134k160m	200	Thanh Hoa	
	Cut Type 2	134k160m	134k190m	30	Thanh Hoa	
	Cut Type 1	134k190m	134k210m	20	Thanh Hoa	
13	Cut Type 1	134k910m	134k930m	20	Thanh Hoa	
	Cut Type 2	134k930m	134k950m	20	Thanh Hoa	
	Cut Type 3	134k950m	134k960m	10	Thanh Hoa	

No.	Cut Type	Kilometerage		Length (m)	Province	Remarks
		From	To			
14	Cut Type 3	135k280m	135k290m	10	Thanh Hoa	
15	Cut Type 2	135k290m	135k310m	20	Thanh Hoa	
	Cut Type 1	135k310m	135k330m	20	Thanh Hoa	
16	Cut Type 1	136k310m	136k420m	110	Thanh Hoa	
	Cut Type 2	136k420m	136k500m	80	Thanh Hoa	
	Cut Type 3	136k500m	136k510m	10	Thanh Hoa	
17	Cut Type 3	138k150m	138k160m	10	Thanh Hoa	
	Cut Type 2	138k160m	138k180m	20	Thanh Hoa	
	Cut Type 1	138k180m	138k210m	30	Thanh Hoa	
18	Cut Type 1	184k160m	184k220m	60	Thanh Hoa	
	Cut Type 2	184k220m	184k270m	50	Thanh Hoa	
	Cut Type 3	184k270m	184k600m	330	Thanh Hoa	
	Cut Type 2	184k600m	184k630m	30	Thanh Hoa	
	Cut Type 1	184k630m	184k990m	360	Thanh Hoa	
	Cut Type 2	184k990m	185k090m	100	Thanh Hoa	
	Cut Type 1	185k090m	185k130m	40	Thanh Hoa	
19	Cut Type 1	187k210m	187k250m	40	Thanh Hoa	
	Cut Type 2	187k250m	187k410m	160	Thanh Hoa	
	Cut Type 1	187k410m	187k460m	50	Thanh Hoa	
20	Cut Type 1	188k610m	188k620m	10	Thanh Hoa	
	Cut Type 2	188k620m	188k630m	10	Thanh Hoa	
	Cut Type 3	188k630m	188k640m	10	Thanh Hoa	
21	Cut Type 3	190k490m	190k510m	20	Thanh Hoa	
22	Cut Type 2	190k510m	190k520m	10	Thanh Hoa	
	Cut Type 1	190k520m	190k550m	30	Thanh Hoa	
23	Cut Type 1	191k170m	191k200m	30	Thanh Hoa	
	Cut Type 2	191k200m	191k220m	20	Thanh Hoa	
	Cut Type 3	191k220m	191k230m	10	Thanh Hoa	
24	Cut Type 3	192k670m	192k730m	60	Thanh Hoa	
	Cut Type 2	192k730m	192k790m	60	Thanh Hoa	
	Cut Type 1	192k790m	192k830m	40	Thanh Hoa	
25	Cut Type 1	194k700m	194k740m	40	Thanh Hoa	
	Cut Type 2	194k740m	194k880m	140	Thanh Hoa	
	Cut Type 1	194k880m	194k990m	110	Thanh Hoa	
	Cut Type 2	194k990m	195k070m	80	Thanh Hoa	
	Cut Type 3	195k070m	196k560m	1,490	Thanh Hoa	
	Cut Type 2	196k560m	197k060m	500	Thanh Hoa	
	Cut Type 1	197k060m	197k240m	180	Thanh Hoa	
26	Cut Type 1	199k280m	199k320m	40	Thanh Hoa	
	Cut Type 2	199k320m	199k340m	20	Thanh Hoa	
	Cut Type 3	199k340m	199k430m	90	Thanh Hoa	
	Cut Type 2	199k430m	199k470m	40	Thanh Hoa	
	Cut Type 1	199k470m	199k490m	20	Thanh Hoa	
27	Cut Type 1	199k630m	199k660m	30	Thanh Hoa	
	Cut Type 2	199k660m	199k730m	70	Thanh Hoa	
	Cut Type 3	199k730m	199k820m	90	Thanh Hoa	
	Cut Type 2	199k820m	199k900m	80	Thanh Hoa	
	Cut Type 1	199k900m	199k970m	70	Thanh Hoa	
28	Cut Type 1	200k930m	200k970m	40	Thanh Hoa	
	Cut Type 2	200k970m	201k010m	40	Thanh Hoa	

No.	Cut Type	Kilometerage		Length (m)	Province	Remarks
		From	To			
	Cut Type 3	201k010m	201k460m	450	Thanh Hoa	
	Cut Type 2	201k460m	201k490m	30	Thanh Hoa	
	Cut Type 1	201k490m	201k510m	20	Thanh Hoa	
29	Cut Type 1	206k730m	206k750m	20	Thanh Hoa	
	Cut Type 2	206k750m	206k770m	20	Thanh Hoa	
	Cut Type 3	206k770m	207k030m	260	Thanh Hoa	
	Cut Type 2	207k030m	207k060m	30	Thanh Hoa	
	Cut Type 1	207k060m	207k090m	30	Thanh Hoa	
30	Cut Type 1	208k320m	208k640m	320	Thanh Hoa	
	Cut Type 2	208k640m	208k690m	50	Thanh Hoa	
	Cut Type 3	208k690m	208k730m	40	Thanh Hoa	
31	Cut Type 3	210k860m	210k870m	10	Nghe An	
	Cut Type 2	210k870m	210k890m	20	Nghe An	
	Cut Type 1	210k890m	210k910m	20	Nghe An	
32	Cut Type 1	219k850m	219k870m	20	Nghe An	
	Cut Type 2	219k870m	219k890m	20	Nghe An	
	Cut Type 3	219k890m	220k060m	170	Nghe An	
	Cut Type 2	220k060m	220k070m	10	Nghe An	
	Cut Type 1	220k070m	220k090m	20	Nghe An	
33	Cut Type 1	261k000m	261k080m	80	Nghe An	
	Cut Type 2	261k080m	261k140m	60	Nghe An	
	Cut Type 3	261k140m	261k200m	60	Nghe An	
34	Cut Type 3	264k790m	264k950m	160	Nghe An	
	Cut Type 2	264k950m	264k970m	20	Nghe An	
	Cut Type 1	264k970m	264k990m	20	Nghe An	

Source JICA Study Team

4) Elevated Structures

4.40 At stations and in built-up areas before and after the stations, elevated structures will mostly be used due to various land use conditions, avoidance of the barriers, continuity of the urban areas, and preservation of landscape. Also elevated structures are employed in areas where the surface and deeper layers are extremely soft or in floodplain areas that are often flooded.

4.41 This study considers the following three ordinary types to be typical elevated structures.

(a) **Viaducts:** General bridges installed at the sections other than listed below. (Section length $<$ 50 m)

(b) **Bridge 1:** Bridges installed at the crossing points of medium-sized rivers and national roads/existing railways. (50 m $\leqq$ Section length $\leqq$ 200 m)

(c) **Bridge 2:** Bridges installed at the crossing points of large-sized rivers, lake and dam. (200 m $<$ Section length)

4.42 Table 4.5.4 and Table 4.5.5 show the plans for the types and Locations of each elevated structure employed on Ha Noi–Vinh section, respectively.

Table 4.5.4 Viaduct Structures at Ha Noi–Vinh Section by Type and Location

No.	Bridge Type	Structure Type	Kirometerage		Length (m)	Province		Remarks
			From	To				
1	Viaduct	PC-T Girder	0k308m	1k440m	1,133	Ha Noi		
2	Viaduct	PC-T Girder	1k520m	7k720m	6,200	Ha Noi		
3	Viaduct	PC-T Girder	7k820m	12k530m	4,710	Ha Noi		
4	Viaduct	PC-T Girder	20k330m	25k330m	5,000	Ha Noi		
5	Viaduct	PC-T Girder	25k430m	26k010m	580	Ha Noi		
6	Viaduct	PC-T Girder	26k110m	27k290m	1,180	Ha Noi		
7	Viaduct	PC-T Girder	27k390m	27k970m	580	Ha Noi		
8	Viaduct	PC-T Girder	28k070m	30k490m	2,420	Ha Nam		
9	Viaduct	PC-T Girder	30k690m	32k290m	1,600	Ha Nam		
10	Viaduct	PC-T Girder	36k270m	43k030m	6,760	Ha Nam		
11	Viaduct	PC-T Girder	43k180m	45k215m	2,035	Ha Nam		
12	Viaduct	PC-T Girder	45k865m	46k470m	605	Ha Nam		
13	Viaduct	PC-T Girder	46k570m	51k740m	5,170	Ha Nam		
14	Viaduct	PC-T Girder	56k970m	57k790m	820	Ha Nam		
15	Viaduct	PC-T Girder	57k890m	67k339m	9,449	Ha Nam	Nam Dinh	
16	Viaduct	PC-T Girder	67k989m	71k580m	3,591	Nam Dinh		
17	Viaduct	PC-T Girder	71k700m	73k100m	1,400	Nam Dinh		
18	Viaduct	PC-T Girder	73k300m	73k560m	260	Nam Dinh		
19	Viaduct	PC-T Girder	73k640m	76k570m	2,930	Nam Dinh		
20	Viaduct	PC-T Girder	76k670m	77k320m	650	Nam Dinh		
21	Viaduct	PC-T Girder	80k170m	87k800m	7,630	Nam Dinh		
22	Viaduct	PC-T Girder	87k880m	94k680m	6,800	Nam Dinh		
23	Viaduct	PC-T Girder	94k980m	100k160m	5,180	Ninh Binh		
24	Viaduct	PC-T Girder	100k260m	101k040m	780	Ninh Binh		
25	Viaduct	PC-T Girder	105k580m	106k490m	910	Ninh Binh		
26	Viaduct	PC-T Girder	117k500m	118k260m	760	Thanh Hoa		
27	Viaduct	PC-T Girder	118k510m	120k000m	1,490	Thanh Hoa		
28	Viaduct	PC-T Girder	123k160m	123k970m	810	Thanh Hoa		
29	Viaduct	PC-T Girder	126k530m	127k350m	820	Thanh Hoa		Road(TL508)
30	Viaduct	PC-T Girder	127k450m	129k450m	2,000	Thanh Hoa		
31	Viaduct	PC-T Girder	130k850m	131k850m	1,000	Thanh Hoa		
32	Viaduct	PC-T Girder	140k650m	143k250m	2,600	Thanh Hoa		
33	Viaduct	PC-T Girder	144k000m	144k300m	300	Thanh Hoa		
34	Viaduct	PC-T Girder	147k290m	148k090m	800	Thanh Hoa		
35	Viaduct	PC-T Girder	150k890m	153k326m	2,436	Thanh Hoa		
36	Viaduct	PC-T Girder	154k326m	154k840m	514	Thanh Hoa		
37	Viaduct	PC-T Girder	156k340m	168k170m	11,830	Thanh Hoa		
38	Viaduct	PC-T Girder	168k270m	168k570m	300	Thanh Hoa		
39	Viaduct	PC-T Girder	172k440m	174k320m	1,880	Thanh Hoa		
40	Viaduct	PC-T Girder	174k420m	175k540m	1,120	Thanh Hoa		
41	Viaduct	PC-T Girder	210k910m	213k300m	2,390	Nghe An		
42	Viaduct	PC-T Girder	213k400m	214k740m	1,340	Nghe An		
43	Viaduct	PC-T Girder	214k840m	218k590m	3,750	Nghe An		
44	Viaduct	PC-T Girder	220k090m	220k740m	650	Nghe An		
45	Viaduct	PC-T Girder	230k650m	232k450m	1,800	Nghe An		
46	Viaduct	PC-T Girder	236k930m	237k430m	500	Nghe An		
47	Viaduct	PC-T Girder	237k530m	237k930m	400	Nghe An		
48	Viaduct	PC-T Girder	266k800m	270k600m	3,800	Nghe An		
49	Viaduct	PC-T Girder	275k900m	282k970m	7,070	Nghe An		

Source: JICA Study Team

Table 4.5.5 Bridges along Ha Noi–Vinh Section by Type and Location

No.	Bridge Type	Structure Type	Kilometerage		Length (m)	Province		Remarks
			From	To				
1	Bridge1	PC-Box Girder	1k440m	1k520m	80	Ha Noi		River
2	Bridge1	PC-Box Girder	7k720m	7k820m	100	Ha Noi		River
3	Bridge1	PC-Box Girder	25k330m	25k430m	100	Ha Noi		River
4	Bridge1	PC-Box Girder	26k010m	26k110m	100	Ha Noi		Road(AH1) / Existing Railway
5	Bridge1	PC-Box Girder	27k290m	27k390m	100	Ha Noi		River
6	Bridge1	PC-Box Girder	27k970m	28k070m	100	Ha Noi	Ha Nam	River
7	Bridge1	PC-Box Girder	30k490m	30k690m	200	Ha Nam		Road(QL1)
8	Bridge1	PC-Box Girder	43k030m	43k180m	150	Ha Nam		River
9	Bridge1	PC-Box Girder	46k470m	46k570m	100	Ha Nam		Existing Railway / Road(QL21)
10	Bridge1	PC-Box Girder	51k740m	51k820m	80	Ha Nam		River
11	Bridge1	PC-Box Girder	56k870m	56k970m	100	Ha Nam		River
12	Bridge1	PC-Box Girder	57k790m	57k890m	100	Ha Nam		Existing Railway / Road(QL21A)
13	Bridge1	PC-Box Girder	71k580m	71k700m	120	Nam Dinh		River
14	Bridge1	PC-Box Girder	73k100m	73k300m	200	Nam Dinh		River
15	Bridge1	PC-Box Girder	73k560m	73k640m	80	Nam Dinh		River
16	Bridge1	PC-Box Girder	76k570m	76k670m	100	Nam Dinh		Road(QL10) / Existing Railway
17	Bridge1	PC-Box Girder	77k320m	77k370m	50	Nam Dinh		River
18	Bridge1	PC-Box Girder	79k070m	79k120m	50	Nam Dinh		River
19	Bridge1	PC-Box Girder	80k070m	80k170m	100	Nam Dinh		River
20	Bridge1	PC-Box Girder	87k800m	87k880m	80	Nam Dinh		River
21	Bridge2	PC-Rigid Frame	94k680m	94k980m	300	Nam Dinh	Ninh Binh	Road / River(Song Van)
22	Bridge1	PC-Box Girder	100k160m	100k260m	100	Ninh Binh		River
23	Bridge2	PC-Rigid Frame	108k490m	108k740m	250	Ninh Binh		Lake
24	Bridge1	PC-Box Girder	127k350m	127k450m	100	Thanh Hoa		Existing Railway / Road(AH1)
25	Bridge2	PC-Rigid Frame	131k850m	132k150m	300	Thanh Hoa		River(Song Len) / Road
26	Bridge2	PC-Rigid Frame	139k250m	139k550m	300	Thanh Hoa		River
27	Bridge2	PC-Rigid Frame	143k250m	144k000m	750	Thanh Hoa		Road / River(Song Ma)
28	Bridge1	PC-Box Girder	168k170m	168k270m	100	Thanh Hoa		Existing Railway / Road
29	Bridge1	PC-Box Girder	174k320m	174k420m	100	Thanh Hoa		River
30	Bridge2	PC-Rigid Frame	187k560m	188k610m	1,050	Thanh Hoa		Dam
31	Bridge1	PC-Box Girder	213k300m	213k400m	100	Nghe An		Road / Existing Railway
32	Bridge1	PC-Box Girder	214k740m	214k840m	100	Nghe An		River
33	Bridge1	PC-Box Girder	237k430m	237k530m	100	Nghe An		Road(AH1) / Existing Railway
34	Bridge1	PC-Box Girder	240k780m	240k930m	150	Nghe An		River / Road
35	Bridge1	PC-Box Girder	250k000m	250k200m	200	Nghe An		River

Source JICA Study Team

5) Tunnels

4.43 Tunnel structures are employed for sections with relatively high mountains and hills in suburban areas.

4.44 There would be a total of 8 tunnels ranged from minimal length with 320 m to maximal length with 3,590 m on this route.

4.45 This study considers a standard tunnel structure with a cross section shape as well as Japanese type, and a great reduction of the construction cost will be achieved.

4.46 Table 4.5.6 shows the plan for the types and Locations of each tunnel structure employed on Ha Noi–Vinh section.

Table 4.5.6 Plan for Tunnels along Ha Noi–Vinh Section by Type and Location

No.	Tunnel Type	Kilometerage		Length (m)	Province		Remarks
		From	To				
1	Mountain Tunnel	110k760m	114k390m	3,630	Ninh Binh	Thanh Hoa	
2	Mountain Tunnel	124k010m	124k810m	800	Thanh Hoa		
3	Mountain Tunnel	134k960m	135k280m	320	Thanh Hoa		
4	Mountain Tunnel	136k510m	138k150m	1,640	Thanh Hoa		
5	Mountain Tunnel	188k640m	190k490m	1,850	Thanh Hoa		
6	Mountain Tunnel	191k230m	192k670m	1,440	Thanh Hoa		
7	Mountain Tunnel	208k730m	210k860m	2,130	Thanh Hoa	Nghe An	
8	Mountain Tunnel	261k200m	264k790m	3,590	Nghe An		

Source JICA Study Team

6) Station Structures

4.47 This route has a total of 6 stations with Ngoc Hoi, Phu Ly, Nam Dinh, Ninh Binh, Thanh Hoa, Vinh. And Ngoc Hoi and Vinh stations are set as terminal stations of HSR.

4.48 The types of civil engineering structures in station sections are different according to their approaches/connections to existing railways, or the absence of them, but can be broadly categorized into elevated stations over existing railways, elevated and embankment stations adjacent to existing railways on the north section.

4.49 Table 4.5.7 shows the plan for the types and Locations of each station structure to be used on the HSR north section.

Table 4.5.7 Station Structures on HSR North Section by Type and Location

No.	Station Name	Station Type	Kirometerage		Length (m)	Province	Remarks
			From	To			
1	Ngoc Hoi	Elevated	-0k308m	0k308m	615	Ha Noi	Adjacent to existing railways
2	Phu Ly	Elevated	45k215m	45k865m	650	Ha Nam	Adjacent to existing railways
3	Nam Dinh	Elevated	67k339m	67k989m	650	Nam Dinh	Adjacent to existing railways
4	Ninh Binh	Embankment	103k056m	103k706m	650	Ninh Binh	Adjacent to existing railways
5	Thanh Hoa	Elevated	153k326m	154k326m	1,000	Thanh Hoa	Adjacent to existing railways
6	Vinh	Elevated	282k970m	283k790m	820	Nghe An	Over existing railway

Source JICA Study Team

5 CONCEPT PLANS FOR HSR STATIONS AND INTEGRATED DEVELOPMENT

5.1 Approach

1) Contents of Concept Plan

5.1 The concept plan proposes the overall development orientation of the stations and station areas, Concept plans are divided into: (i) development concept, (ii) land use plan, and (iii) station and related facilities plan. These are proposed for 12 stations.

(a) Development Concept

5.2 The development concept presents the proposed vision and urban structure of each station and its surrounding areas.

(b) Land Use Plan

5.3 The land use plan presents the future land use of a station and its surrounding areas. It shows the present and a future image of an area loosely defined within a 1-km radius of a station.

(c) Station and Related Facilities Plan

5.4 The station and related facilities plan presents the basic structural plan for the station building, the layout plan of related facilities such as station plaza, access roads, transfer facilities, parking, and walkway.

Table 5.1.1 Components of Integrated Urban Development in Station Areas

Category	Component	Example of Contents
Development Concept	Vision	Gate of city, new urban core, sub-center development, new town development
	Future Urban Structure	Linkage of city center and urban core, regional and inner transportation
Land Use Plan	Urban Activity Development	New business, commercial, cultural amenity node; public/administration service; tourism service; industrial area
	Commercial and Business Development	New retail shops, civic service business, new hotel and amusement facilities, office building including public services
	Housing and Residential Area Development	High-rise housing and condominium, Medium and low-rise housing area
	Natural Preservation	Natural preservation area, agricultural area, green area
	Urban Area Improvement	Urban renewal by road and infrastructure, area infrastructure and utilities improvement
Station and Related Facilities	Station Development	Station building, commercial and service use
	Access Road Development	Access road development around station (for bus, taxi, car, MC), distribution road and community road improvement (ex. pavement, lighting, signboard, etc.)
	Intermodal Transfer Facilities	Station plaza, inter-city bus terminal, tourist bus terminal, bus berth, taxi berth
	Parking Development	Car parking for kiss-and ride and park-and-ride, motorbike parking
	Walkway Network Development	Free corridor, pedestrian deck, commercial use

Source: JICA Study Team

Table 5.1.2 List of Station Area Concept Plans

Section	Station	Location	Connection to Other Transportation Mode
North	Ngoc Hoi	Urban fringe	VR, UMRT
	Phu Ly	Suburb	VR (relocated), UMRT
	Nam Dinh	Suburb	VR
	Ninh Binh	Suburb	VR
	Thanh Hoa	Suburb	VR
	Vinh	Existing urban area	VR
South	Thu Thiem	New urban area	UMRT
	Long Thanh	Suburb	UMRT, Airport
	Phan Thiet	Urban fringe	VR
	Thuy Phong	Suburb	(None)
	Thap Cham	Urban fringe	VR
	Nha Trang	Urban fringe	VR

Source: JICA Study Team

5.2 Concept Plans for HSR Stations

1) Ngoc Hoi Station

(1) Location and Existing Conditions

5.5 Ngoc Hoi Station is located in Ngoc Hoi commune in Thanh Tri district, 13 km south of Hanoi Station and 700 m west of National Road 1A. Ngoc Hoi Station is planned to connect with the future station of the UMRT and a local train. It will function as the northern terminal station for the HSR's northern route and may in the future connect to Hanoi Station in the north.

5.6 Ngoc Hoi Station will be located approximately 750 m west of NH1 and is near to Ngoc Hoi Industrial Park. Its surrounding area is agricultural at present, and small rural villages are scattered around it. Along NH1, there are few urban facilities. On the southeast of the station's location is an army barrack.

5.7 Ngoc Hoi area is a strategic point in the transport network of Hanoi City. This station is the northernmost station for the northern HSR section. It will be an interchange station with the national railway and UMRT Line 1. An expressway will also be developed near this station to connect to the Noi Bai International Airport.

Location of Proposed HSR station	Location of Proposed HSR station
	
Existing Road along Railway	Existing Industrial Area
	

Source: JICA Study Team

Figure 5.2.1 Existing Conditions in Ngoc Hoi Station Area

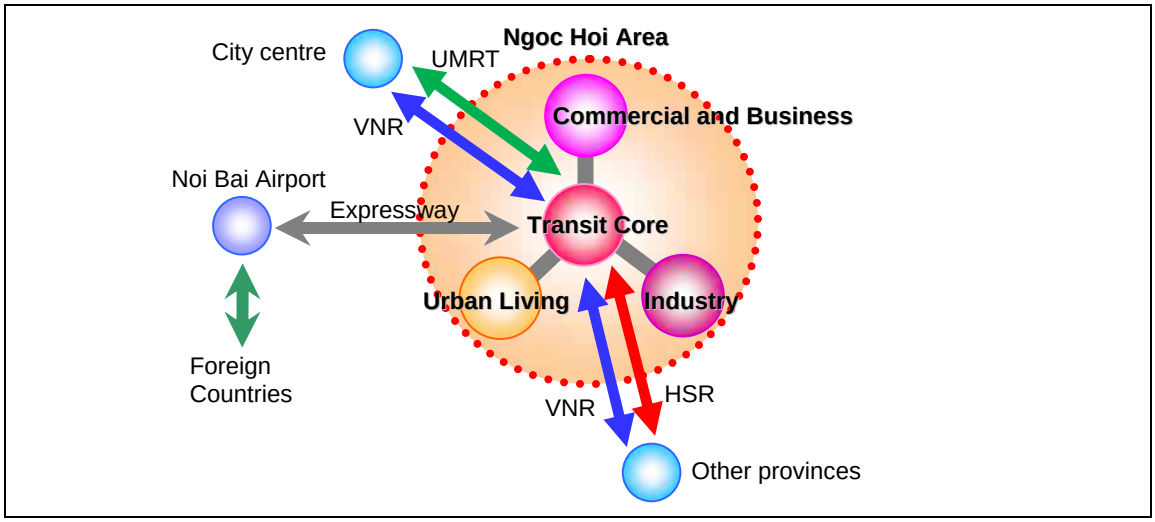
(2) Concept Plan for Station Area

5.8 As a new center south of Hanoi City, Ngoc Hoi station area will be developed in combination with industrial, commercial, and residential functions. Residents and workers from suburban areas will enjoy working and living in the same district.

5.9 The proposed vision for Ngoc Hoi Station area is as follows:

- Southern gate of Vietnam's capital;
- New sub-center south of Hanoi with commercial, business, and industrial areas; and
- Urban living with comfort and convenience based on public transport.

5.10 The proposed urban structure of Ngoc Hoi Station area is shown below (see Figure 5.2.2).



Source: JICA Study Team

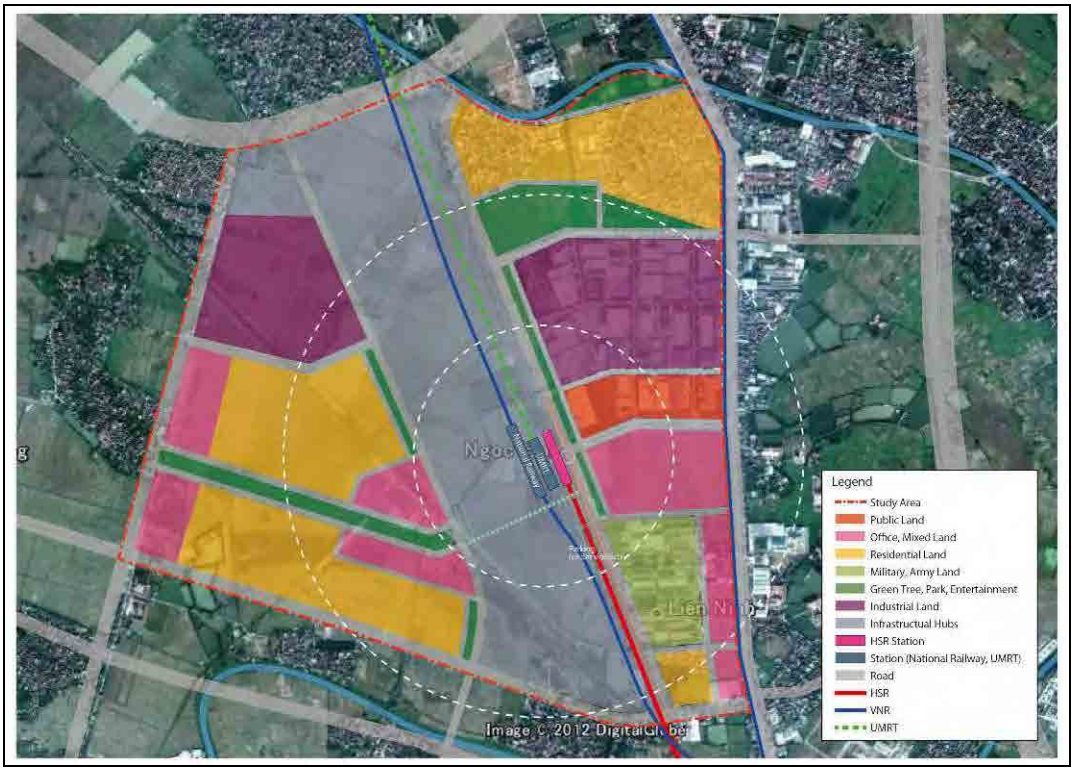
Figure 5.2.2 Future Urban Structure of Ngoc Hoi Station Area

(3) Proposed Land Use Plan for Station Area

5.11 As a southern gateway to Hanoi, public administration areas, as well as commercial and business areas, are proposed in front of the station. Part of the existing industrial land is proposed to be used for these purposes. In the northwest of the station, an environment-friendly new industrial area for logistics services is proposed to be developed near residential areas.

5.12 In the west side of the station, the existing agricultural land is proposed to be converted to mixed residential area for employees of the station area. A symbolic green road in the residential area is proposed as a commuter road to ensure mobility of the residents.

5.13 The proposed land use plan for Ngoc Hoi station area is shown in Figure 5.2.3.



Source: JICA Study Team

Figure 5.2.3 Land Use Plan for Ngoc Hoi Station Area

Commercial and Business Area	Commercial and Business Area
	
Residential Area	Symbolic Greenery Road
	

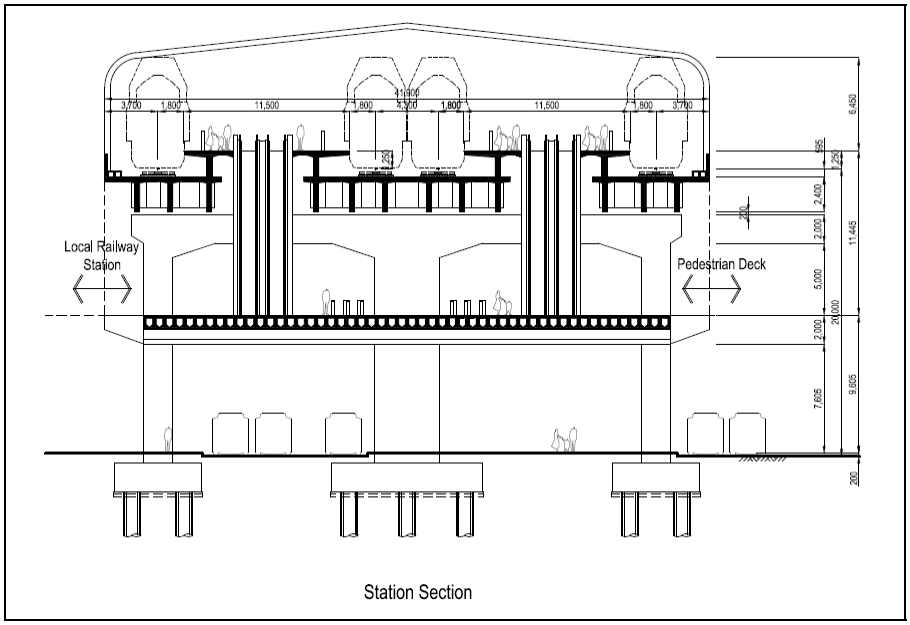
Source: JICA Study Team

Figure 5.2.4 Image of Future Ngoc Hoi Station Area

(4) Station and Related Facilities

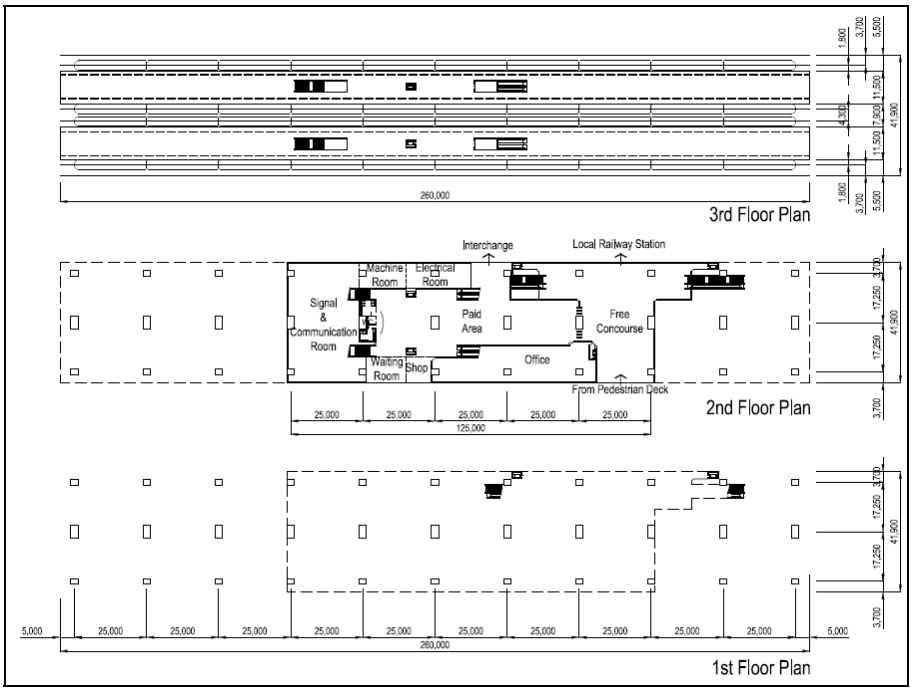
(a) Station Building

5.14 Ngoc Hoi Station is planned to comprise three elevated stories. Two (2) island platforms with four (4) lines will be on the third floor and a concourse on the second floor. Interchanges to the UMRT and the local railway will be provided on the second floor. The first floor will be used as bus and taxi berths with open space for pedestrians.



Source: JICA Study Team

Figure 5.2.5 Cross-sectional View of Ngoc Hoi Station



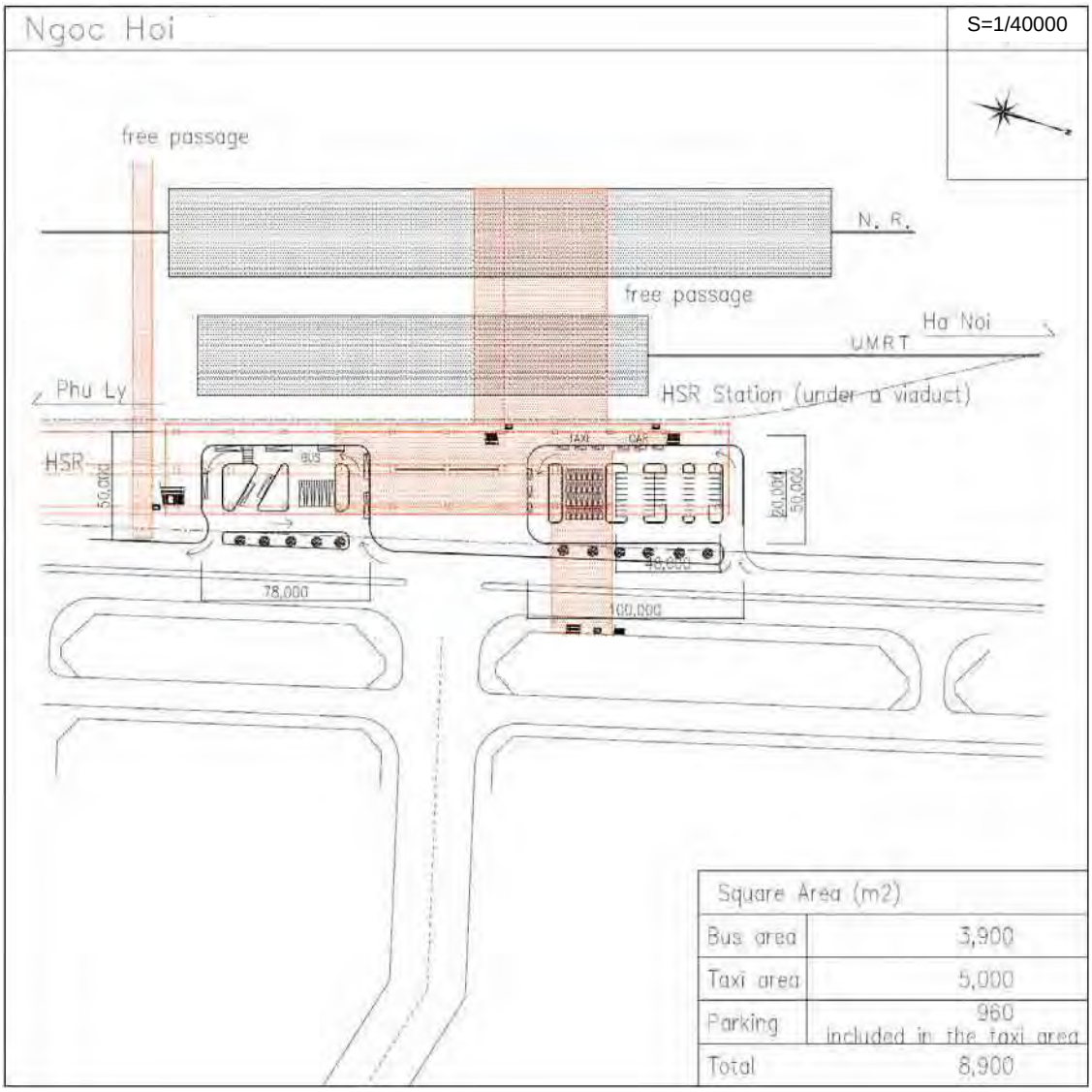
Source: JICA Study Team

Figure 5.2.6 Top View of Ngoc Hoi Station

(b) Station Square

5.15 The station square (approx. 22,000 m^2) below the station is planned to have traffic berths for five buses and 25 taxis as well as an adjacent parking space for cars and motorbikes. All facilities of the station square will be inside the station boundary and its area is estimated to cover 8,900 m^2.

5.16 A corridor for pedestrians will be provided above the road and will connect to the station concourse under the road through an elevator or escalator, and/or staircase from the walkway at ground level.



Source: JICA Study Team

Figure 5.2.7 Top View of Ngoc Hoi Station Square

2) Phu Ly Station

(1) Location and Existing Conditions

5.17 Phu Ly Station is located in the new urban planning zone located 4 km east of Phu Ly city center, while the expressway is located at 0.5 km west of the station. The local railway will shift to interchange with the HSR station, forming an integrated railway network in the future. The UMRT line is planned to connect the new urban area in the north and the southern are of Phu Ly City.

5.18 Agricultural land and small, rural villages surround the planned station area at present. In the current urban plan, industrial zones, mixed areas, and residential areas are planned in front of the station, while public works area, education zone, and hospitals are planned to be located in the surrounding area.

5.19 Phu Ly station area is a strategic point in the transport network of Phu Ly City and Ha Nam province. This station will be an interchange station for the national railway, UMRT line, and bus network.

Location of Proposed HSR Station	Existing Road North of Proposed HSR Station
	

Source: JICA Study Team

Figure 5.2.8 Existing Conditions in Phu Ly Station Area

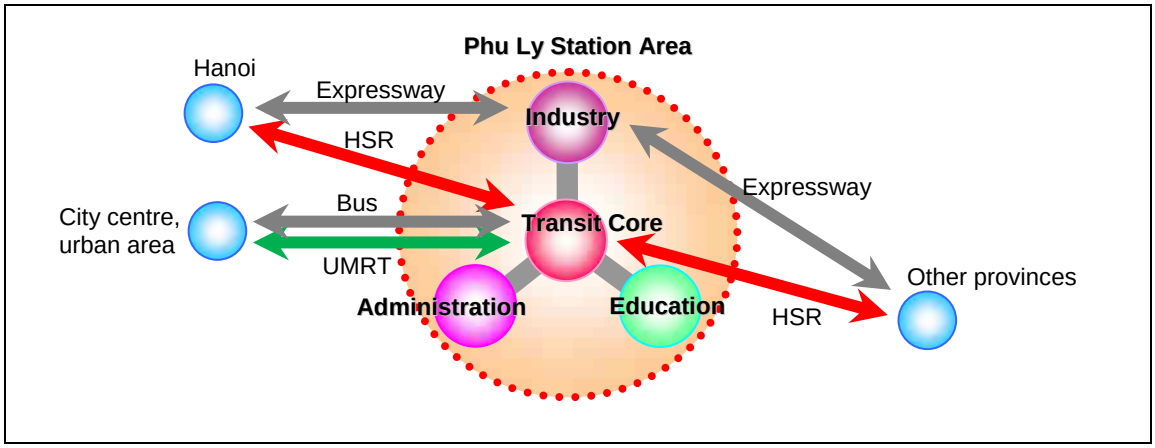
(2) Concept Plan for Station Area

5.20 As a new center east of Phu Ly City, Phu Ly station area is proposed to be urbanized with industrial, administrative, and education functions. Residents, workers, and students from the city and the rest if the province will commute to this station area and enjoy urban activities. For business persons from Hanoi City, this area is highly convenient to visit and work.

5.21 The proposed vision for Phu Ly Station area is as follows:

- Regional and inner transportation core of Ha Nam province;
- New urban core serving industry-government-academe; and
- Urban living with comfort and convenience through public transport

5.22 The proposed urban structure of Phu Ly Station Station area is shown in Figure 5.2.9.



Source: JICA Study Team

Figure 5.2.9 Future Urban Structure of Phu Ly Station Area

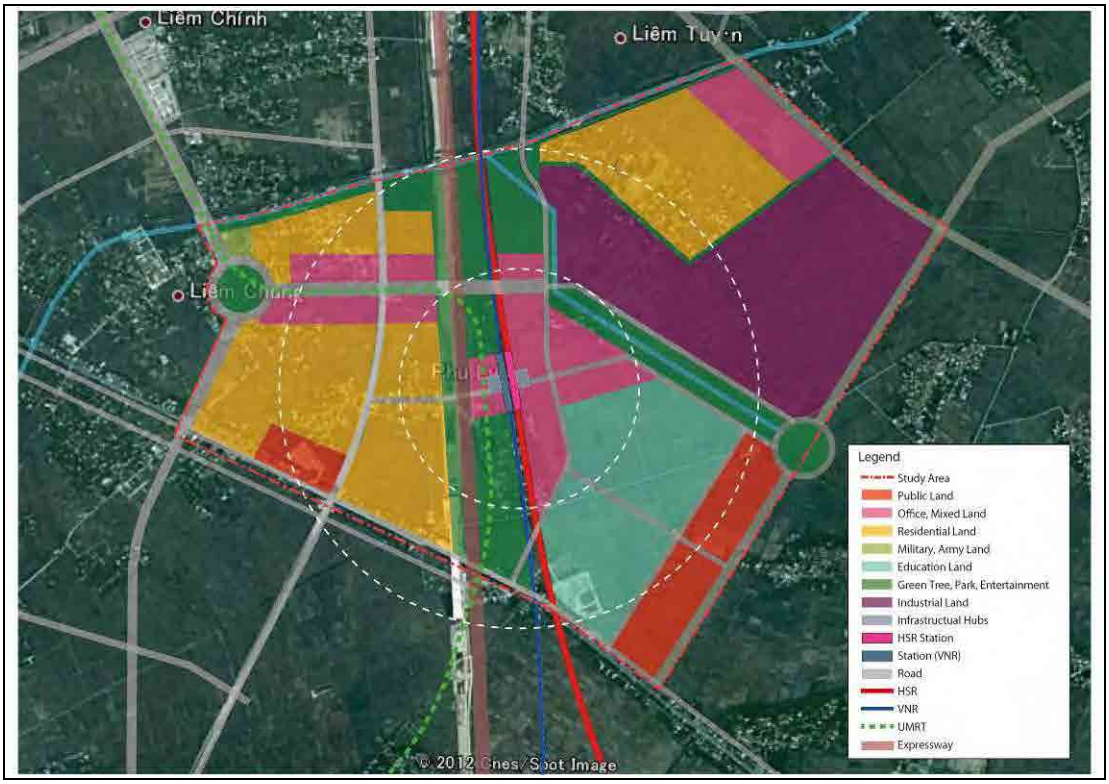
(3) Proposed Land Use Plan for Station Area

5.23 As a new urban core serving industry-government-academic research, the plan is to develop areas for public administration, education, industries, and commerce/business near the station. A section of the new industrial area proposed in the current urban plan is now being eyed to locate to the north of the planned area. But instead of that, areas for education, commerce, and business are now proposed to be developed in front of the station. For this, industrial activities and education will provide synergy in research and development.

5.24 The surroundings of the above-mentioned planned land uses are mainly agricultural land which is proposed to be converted to mixed residential area for station employees and students. One road in the residential area is proposed to become a commuter road to ease mobility of residents and workers.

5.25 The alignment of the UMRT line is proposed to shift in order to connect to the HSR and the local railway station.

5.26 The proposed land use plan for Phu Ly station area is shown in Figure 5.2.10.



Source: JICA Study Team

Figure 5.2.10 Land Use Plan for Phu Ly Station Area

Integrated Area with University and Industrial zone	Commercial and Business Area
	
Residential Area	Symbol Road
	

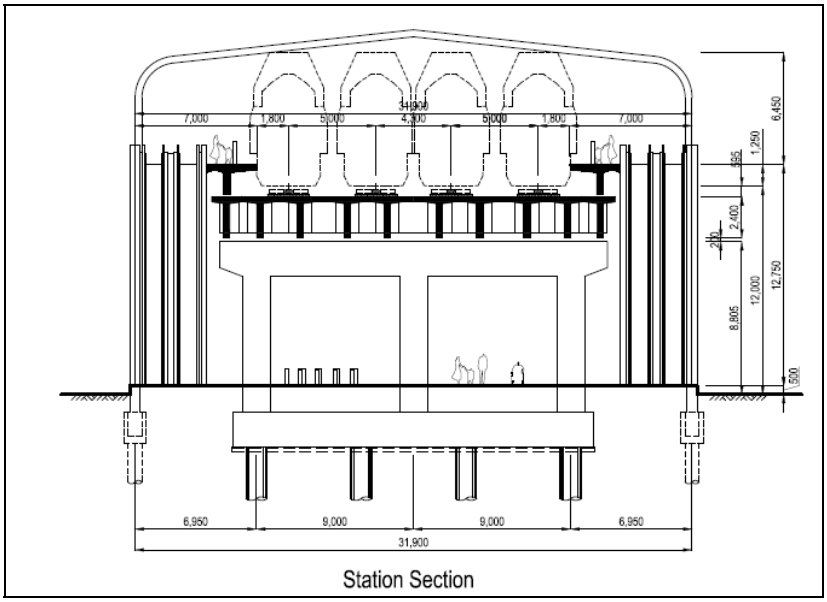
Source: JICA Study Team

Figure 5.2.11 Image of Future Phu Ly Station Area

(4) Station and Related Facilities

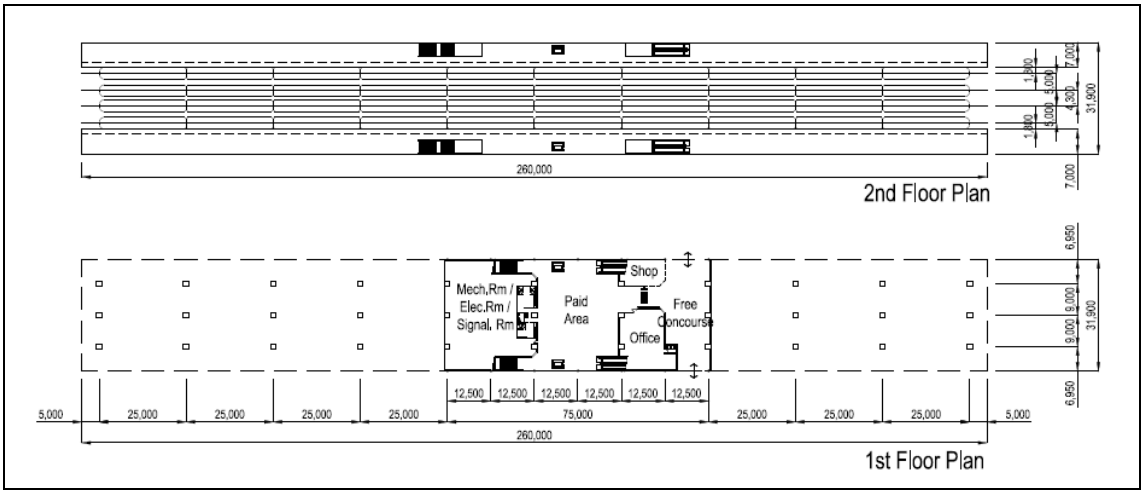
(a) Station Building

5.27 Phu Ly Station is planned to have two elevated stories. Two (2) side platforms for four (4) lines on the second floor and a concourse on the first floor are planned. Connecting the station to the local railway will be done via an interchange on the first floor. The future local railway station should therefore also have an elevated station for easy transit.



Source: JICA Study Team

Figure 5.2.12 Cross-sectional View of Phu Ly Station

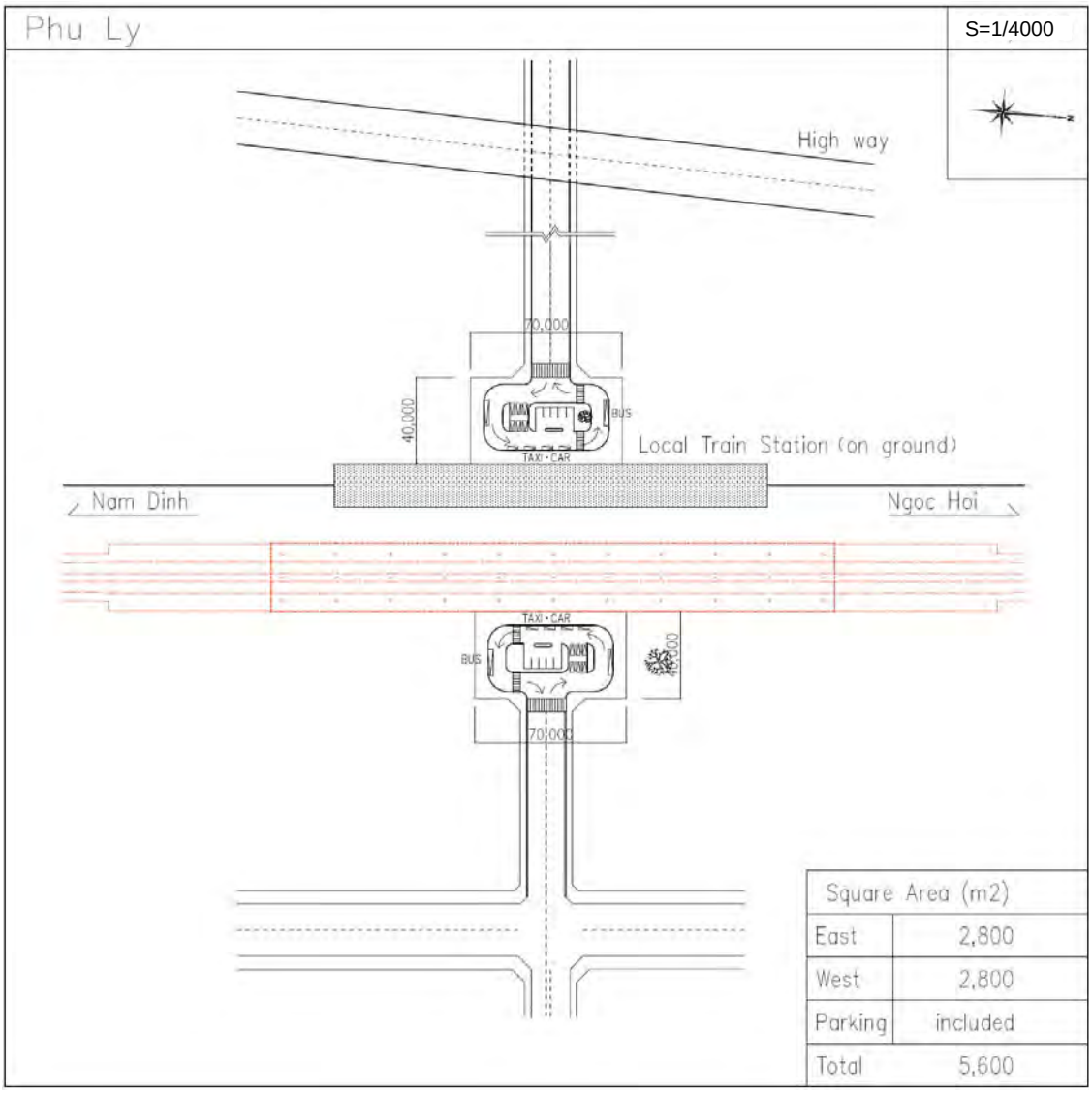


Source: JICA Study Team

Figure 5.2.13 Top View of Phu Ly Station

(b) Station Square

5.28 The station square will be located on the east and west side of the station. The eastern square will accommodate passengers from the city center and expressway, while the western square will accommodate those from the planned urban zone, Thai Binh province, and other areas. The total square will have an estimated area of 5,600 m2 for bus and taxi berths, as well as car park.



Source: JICA Study Team

Figure 5.2.14 Top View of Phu Ly Station Square

3) Nam Dinh Station

(1) Location and Existing Conditions

5.29 Nam Dinh Station will be located 6 km west of Nam Dinh city center. At about 0.3 km to its north, the planned expressway will be crossing the HSR alignment. The station will be sited between the national highway and the local railway for easy connection.

5.30 Agricultural land and small rural villages surround the station area at present. In the current urban plan, the station area is planned to remain rural and agricultural.

5.31 The Nam Dinh station area is a strategic point in the transport network of Nam

Dinh City and Nam Dinh province. This station will be an interchange station with the national railway and bus network, increasing its potential to become a new town area.

Location of Proposed HSR Station	NH1 Near Proposed HSR station
	

Source: JICA Study Team

Figure 5.2.15 Existing Conditions in Nam Dinh Station Area

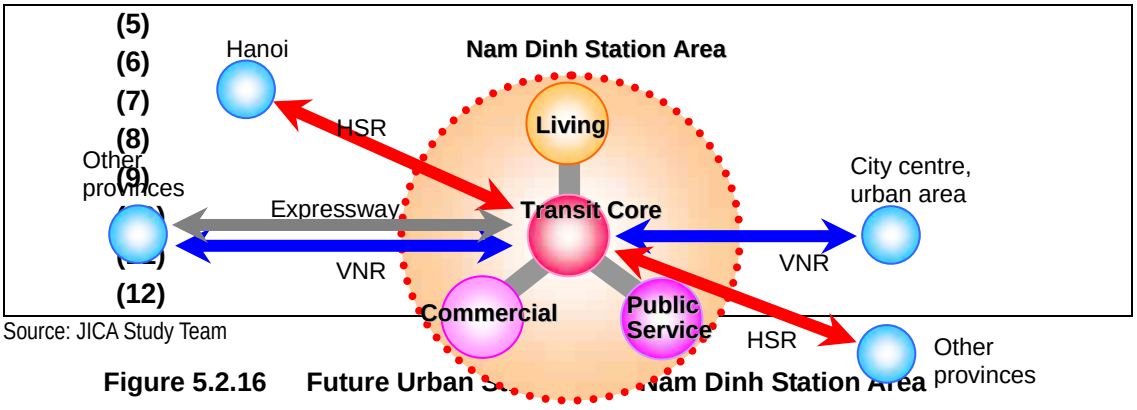
(2) Concept Plan for Station Area

5.32 As a new urban area west of Nam Dinh City, the Nam Dinh station area is proposed to be urbanized with urban living and service functions. Residents and workers in this area will commute to the city center and industrial area in Nam Dinh by public transport and enjoy comfortable living.

5.33 The proposed vision for Nam Dinh Station area is as follows:

- Regional and inner transportation core of Nam Dinh province, and
- New urban core for urban living with comfort and convenience through public transport.

5.34 The proposed urban structure of Nam Dinh Station area is shown in Figure 5.2.16.



Source: JICA Study Team

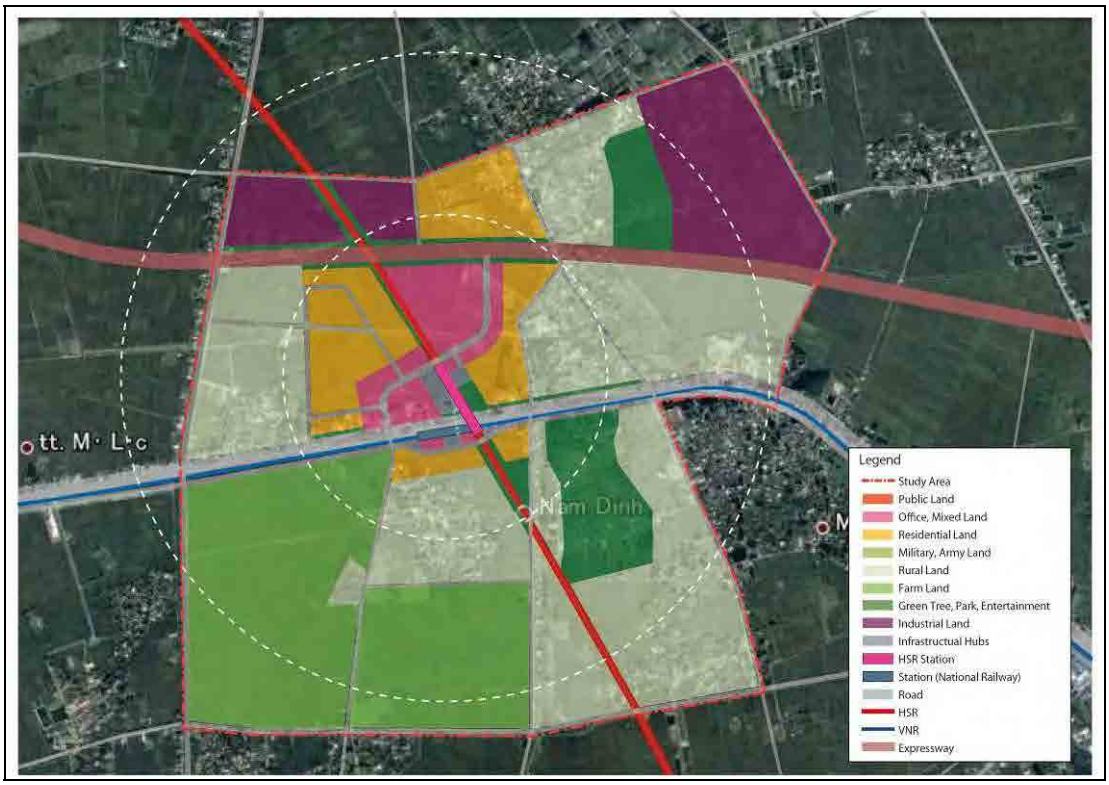
Figure 5.2.16 Future Urban S… Nam Dinh Station Area

(3) Proposed Land Use Plan for Station Area

5.35 For the formulation of a new urban core with urban living, residential areas are proposed to be developed around the station. For comfortable urban living, public service and commercial areas are also proposed to be developed in front of the station and along the access road. An industrial area is also proposed along the expressway.

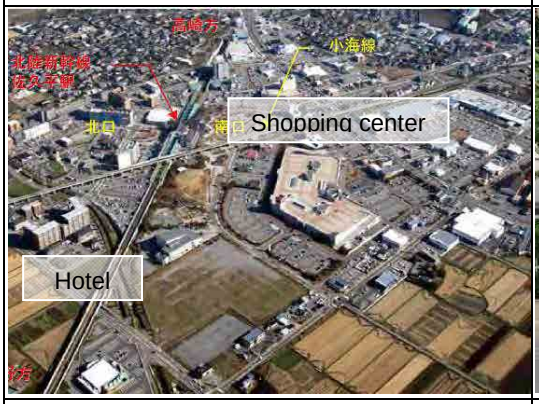
5.36 Surrounding the above-mentioned development area are agricultural land and rural villages which should be preserved to promote environmental living.

5.37 The proposed land use plan for Nam Dinh station area is shown in Figure 5.2.17.



Source: JICA Study Team

Figure 5.2.17 Land Use Plan for Nam Dinh Station Area

Commercial Area in front of Station	Residential Area
	
Residential Area (Townhouses)	**Access Road to Station**
	

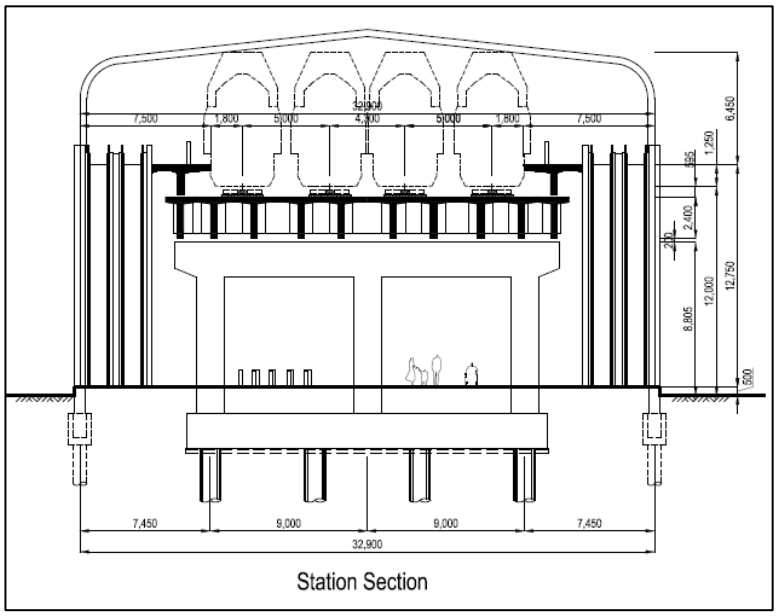
Source: JICA Study Team

Figure 5.2.18 Image of Future Nam Dinh Station Area

(4) Station and Related Facilities

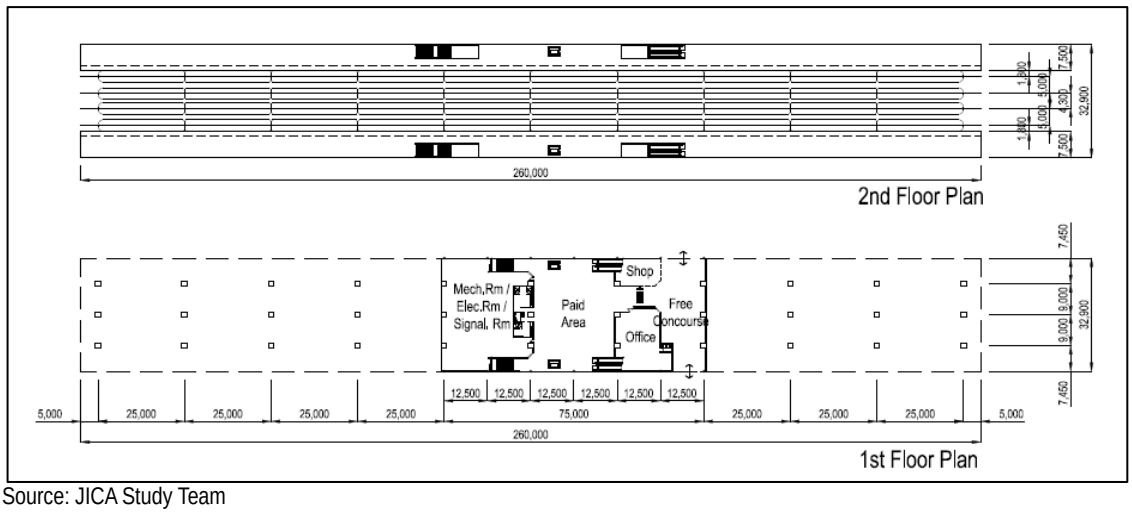
(a) Station Building

5.38 Nam Dinh Station is planned to have two elevated stories. Two (2) side platforms to serve four (4) lines will be on the second floor and concourse on the first floor. Connection to the local railway will be through the western station square and the pedestrian deck above the road. A concourse for the local station is planned on the bridge.



Source: JICA Study Team

Figure 5.2.19 Cross-sectional View of Nam Dinh Station

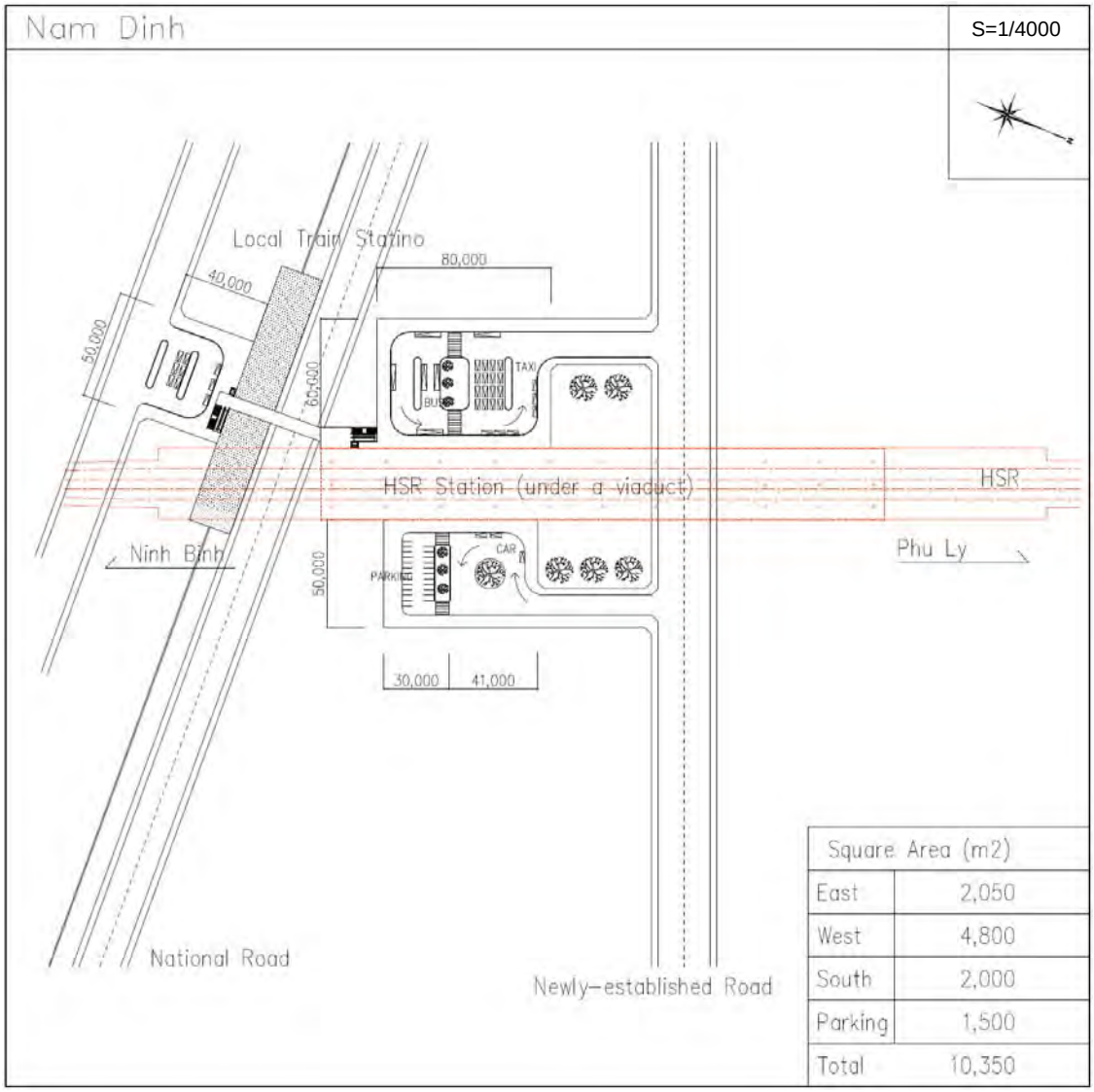


Source: JICA Study Team

Figure 5.2.20 Top View of Nam Dinh Station

(b) Station Square

5.39 The station square will be set at the east, west, and south side of the station. The eastern square will cater to passengers from the city center and expressway. The western square will cater to those from the new urban planning zone and other areas. The southern square will be for local railway passengers. The square will have an area of about 10,350 m2 for bus and taxi berths as well as car park.



Source: JICA Study Team

Figure 5.2.21 Top View of Nam Dinh Station Square

4) Ninh Binh Station

(1) Location and Existing Conditions

5.40 Ninh Binh Station is located 8 km south of Ninh Binh's city center. The HSR will run parallel to NH1A and the local railway. A flyover will be constructed on the west side of the station. Therefore, the HSR in this area is planned to be at ground level and under a flyover for through traffic.

5.41 Agricultural land and rural villages surround the planned station location at present. In the current urban plan, the station area is planned to remain rural and agricultural.

5.42 The Ninh Binh station area is in a strategic location in the middle of Ninh Binh province. This station area will become an interchange station with the national railway, and will allow buses to access Ninh Binh city center, Tam Diep town, and tourism spots in the area. It will have a high potential of developing into a new town area because of this advantage.

Location of proposed HSR station	NH1 near proposed HSR station
	

Source: JICA Study Team

Figure 5.2.22 Existing Conditions in Ninh Binh Station Area

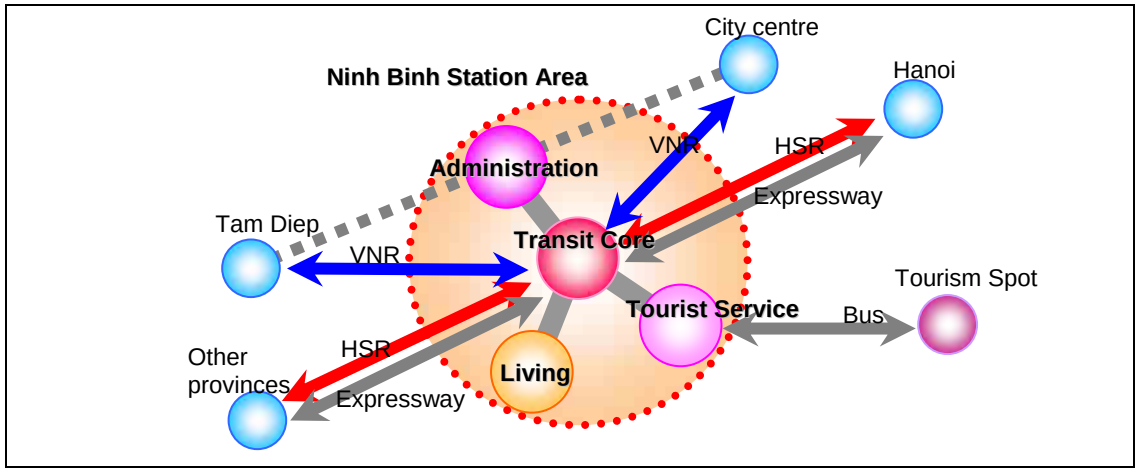
(2) Concept Plan for Station Area

5.43 As a new subcenter of Ninh Binh City, the Ninh Binh station area is proposed to be urbanized with urban residential and tourist service functions. Residents and workers in this area will be able commute to the city center and Tam Diep Town comfortably through public transport.

5.44 The proposed vision for the Ninh Binh Station area is as follows:

- Regional transportation core of Ninh Binh province;
- New urban core for administrative and urban living functions; and
- Tourism center with attractive and comfortable services.

5.45 The proposed urban structure of Ninh Binh station area is shown in Figure 5.2.23.



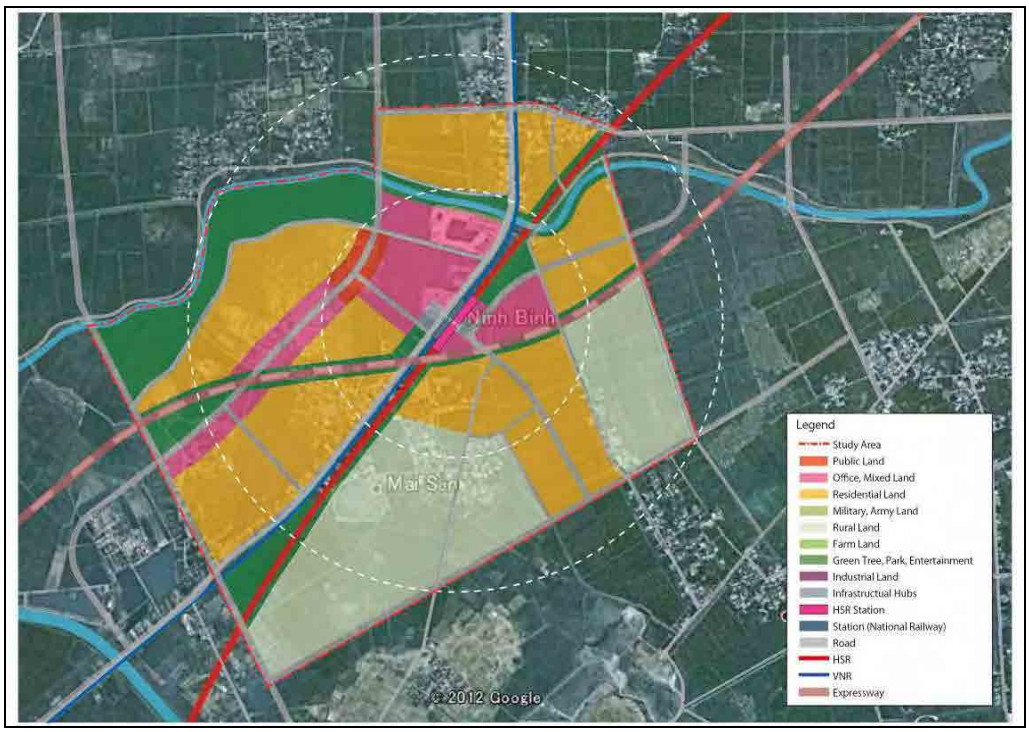
Source: JICA Study Team

Figure 5.2.23 Future Urban Structure of Ninh Binh Station Area

(3) Proposed Land Use Plan for Station Area

5.46 For the formulation of a new urban sub-center, administrative and residential areas are proposed to be developed around the station. For comfortable urban living, commercial areas are also proposed to be developed in front of the station and along the access road. Commercial areas are proposed to have tourism service areas such as tourist information centers, souvenior shops for special local products, hotel, and restaurants. In the south of the station area, existing agricultural land and rural villages should be preserved to create environmental living.

5.47 The proposed land use plan for Ninh Binh station area is shown below in Figure 5.2.24.



Source: JICA Study Team

Figure 5.2.24 Land Use Plan for Ninh Binh Station Area

Commercial Area near the Station	Tourist Information Center
	
Residential Area	Access Road to Station
	

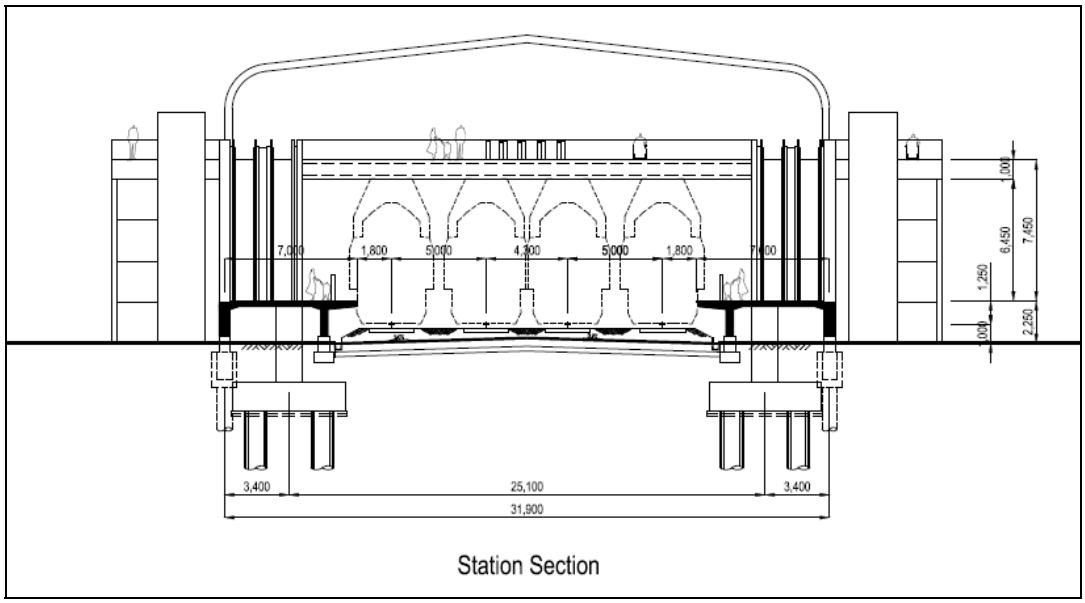
Source: JICA Study Team

Figure 5.2.25 Image of Future Ninh Binh Station Area

(4) Station and Related Facilities

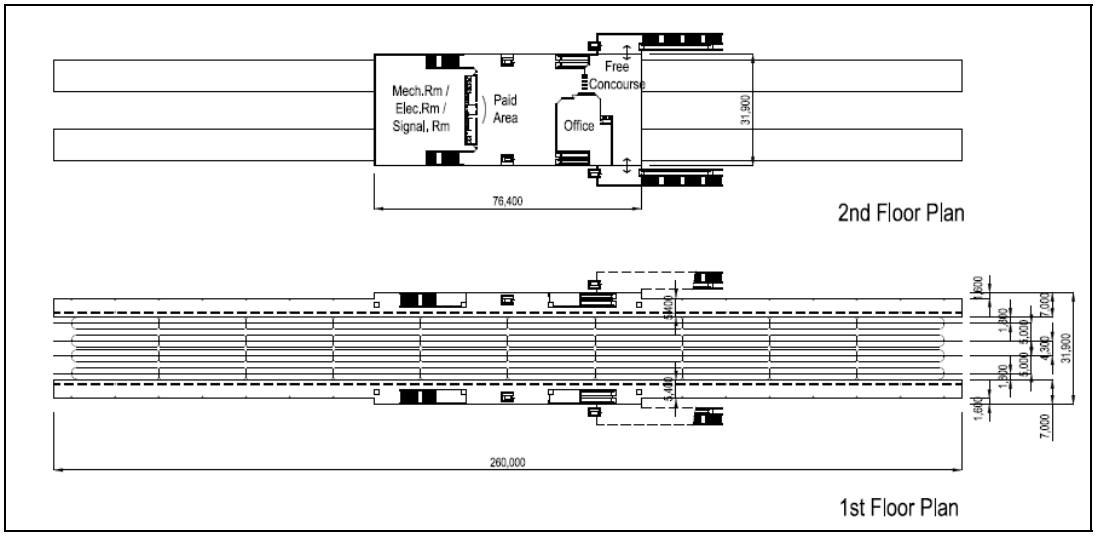
(a) Station Building

5.48 Ninh Binh Station is planned at ground level with two (2) side platforms serving four (4) lines on the first floor and a concourse on the second floor. Connection to the local railway will be provided on the second floor of the local railway station, which is recommended to be on the bridge.



Source: JICA Study Team

Figure 5.2.26 Cross-sectional View of Ninh Binh Station

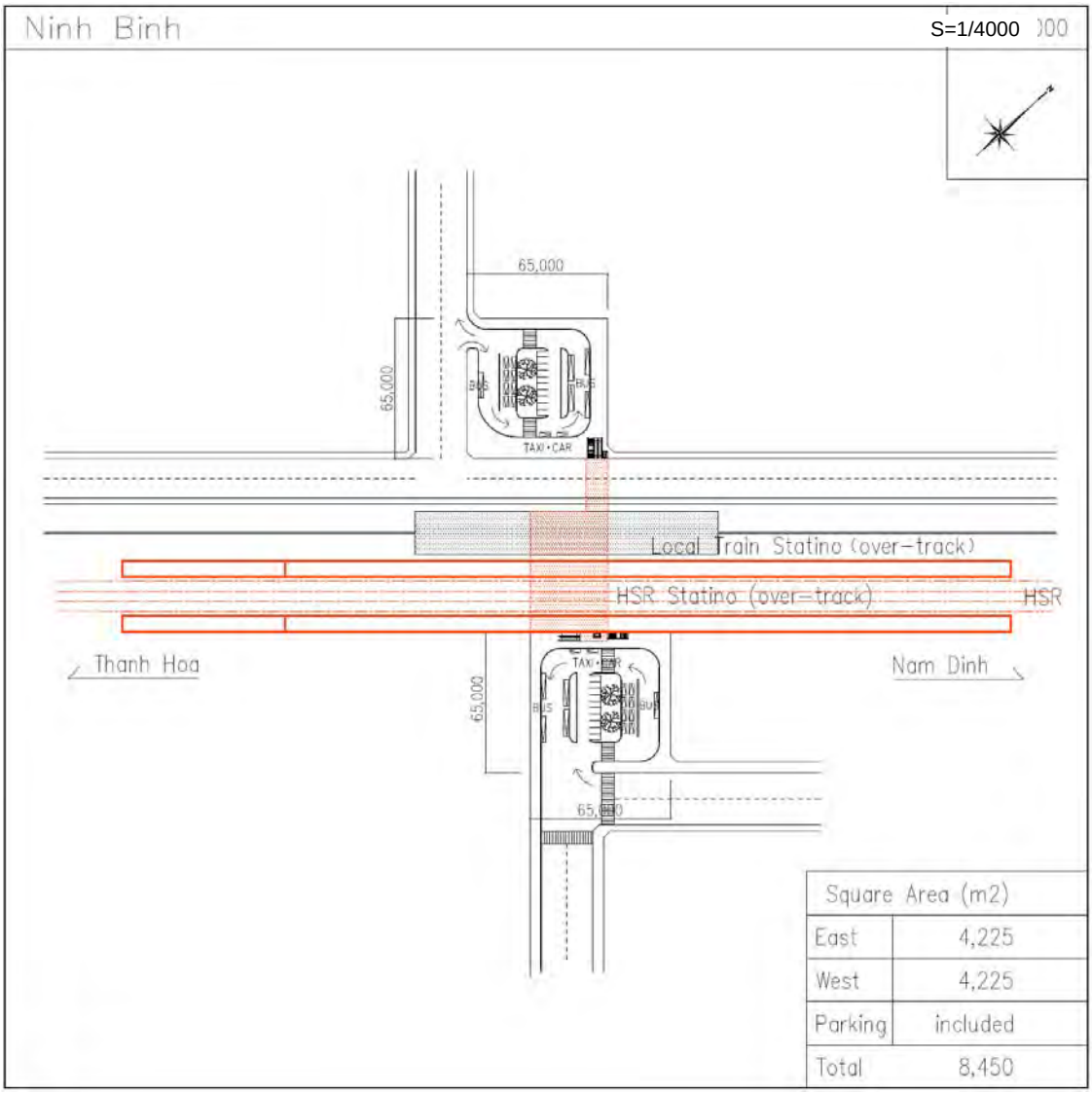


Source: JICA Study Team

Figure 5.2.27 Top View of Ninh Binh Station

(b) Station Square

5.49 The station square will be sited on the east and west side of the station. The eastern square will receive passengers from the city center, Cu Lo tourist zoo, and high way express. The western square will receive passengers from the new urban zones and other areas. The total area of the square is estimated at 8,450 m^2 for bus, taxi berth, and car park.



Source: JICA Study Team

Figure 5.2.28 Top View of the Alternative Ninh Binh Station Square

5) Thanh Hoa Station

(1) Location and Existing Conditions

5.50 Thanh Hoa Station is located 3 km south of Thanh Hoa's city center. The local railway is expected to cross the HSR alignment. In the future the local railway will provide access to the city center as an urban transport mode.

5.51 Agricultural land and rural villages surround the planned station location at present, with mountains on the north of the station. In the current urban plan, the station area is planned to become a residential area within the urbanized area.

5.52 This station area will be an interchange station with the national railway and the bus network going to Thanh Hoa's city center and other towns in Thanh Hoa province. This area will have high potential of becoming a new urban sub-center southwest of Thanh Hoa City because of its advantage in transportation and the existence of urban areas nearby.

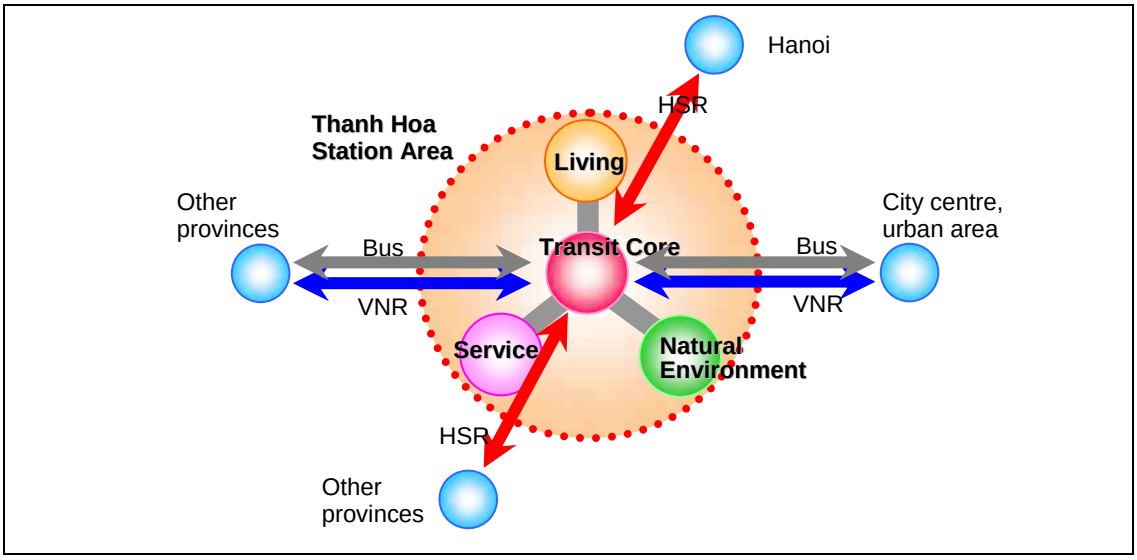
(2) Concept Plan for Station Area

5.53 As a new urban area southwest of Thanh Hoa City, the Thanh Hoa station area is proposed to become urbanized with the development of new residential areas. Residents and workers in this area will commute to/from the city center via public transport and are expected to enjoy comfortable living within a natural environment.

5.54 The proposed vision for the Thanh Hoa Station area is as follows:

- Regional transportation core of Thanh Hoa province;
- New urban sub-center with urban living functions and commercial services; and
- Natural environment with mountains and river.

5.55 The proposed urban structure of Thanh Hoa Station area is shown in Figure 5.2.29.



Source: JICA Study Team

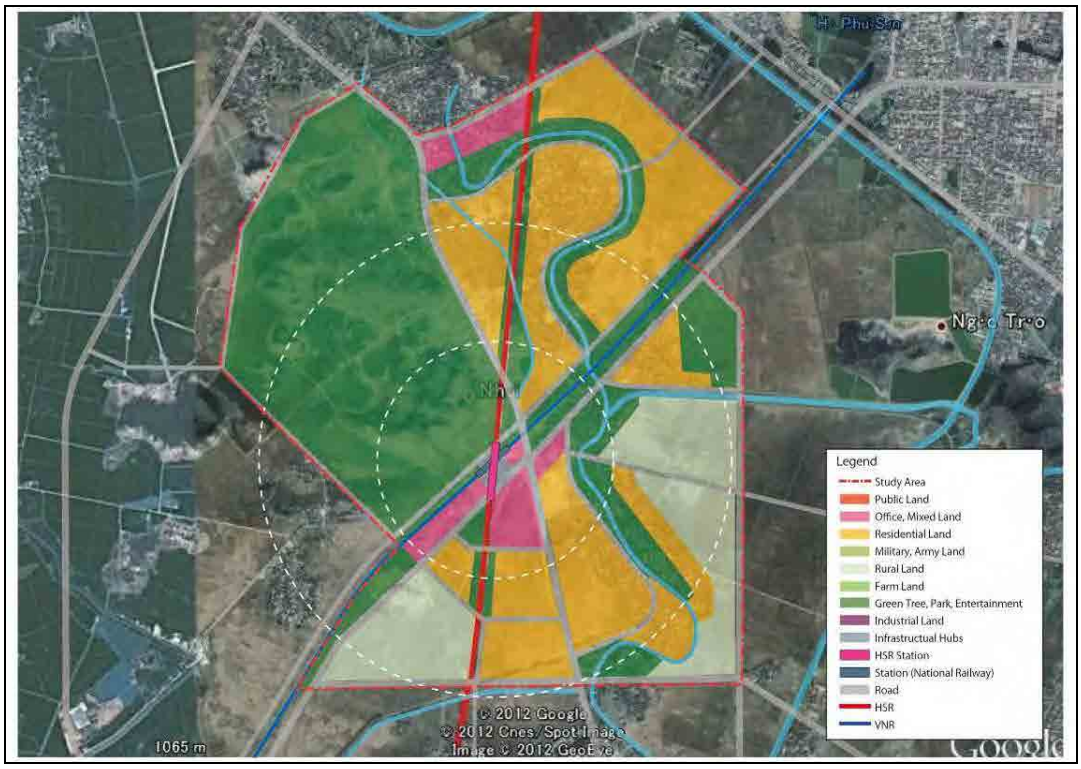
Figure 5.2.29 Future Urban Structure of Thanh Hoa Station Area

(3) Proposed Land Use Plan for Station Area

5.56 For the formulation of a new urban sub-center, residential areas are proposed to be developed around the station. For comfortable urban living, commercial and public service areas are also proposed to be located in front of the station and along the access road. The commercial area is proposed to be developed to provide daily services for the people's shopping needs.

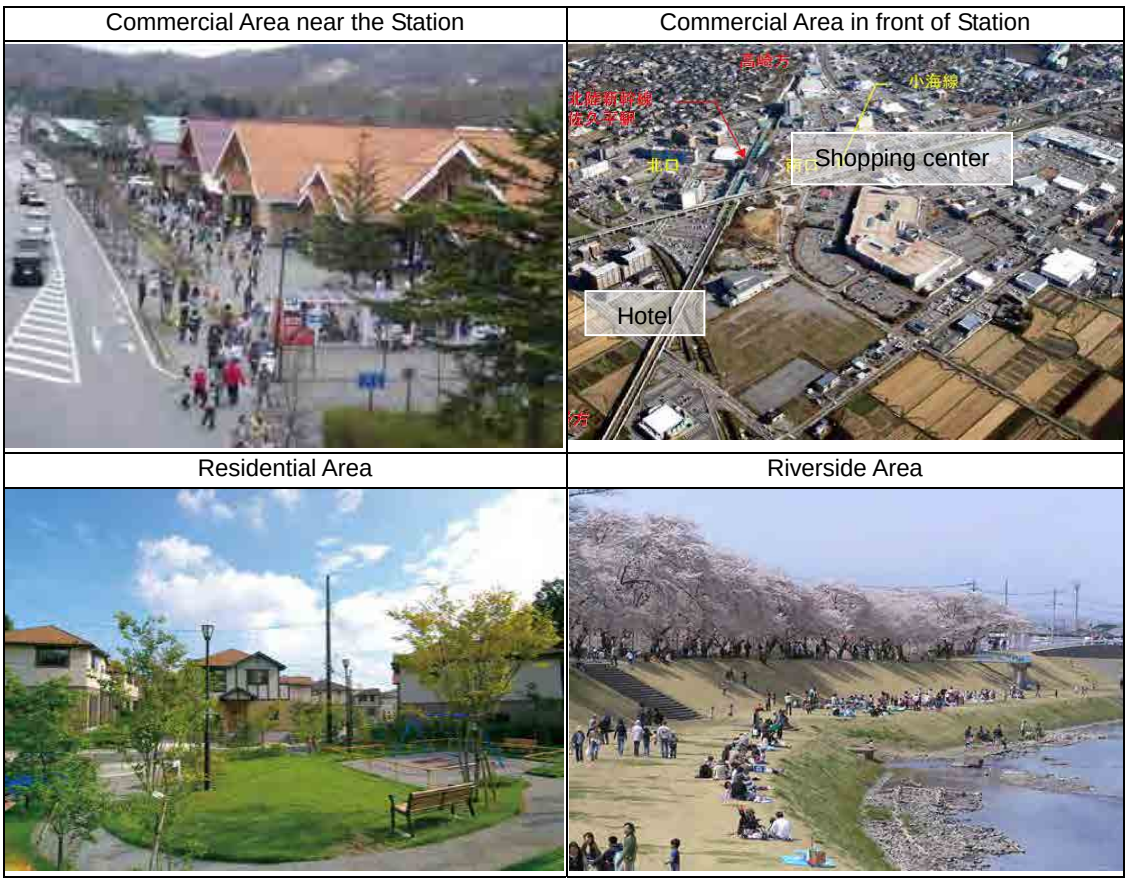
5.57 The mountainous area and riverside should be preserved as greenery to promote environmental living and urban amenity.

5.58 The proposed land use plan for Thanh Hoa station area is shown in Figure 5.2.30.



Source: JICA Study Team

Figure 5.2.30 Land Use Plan for Thanh Hoa Station Area



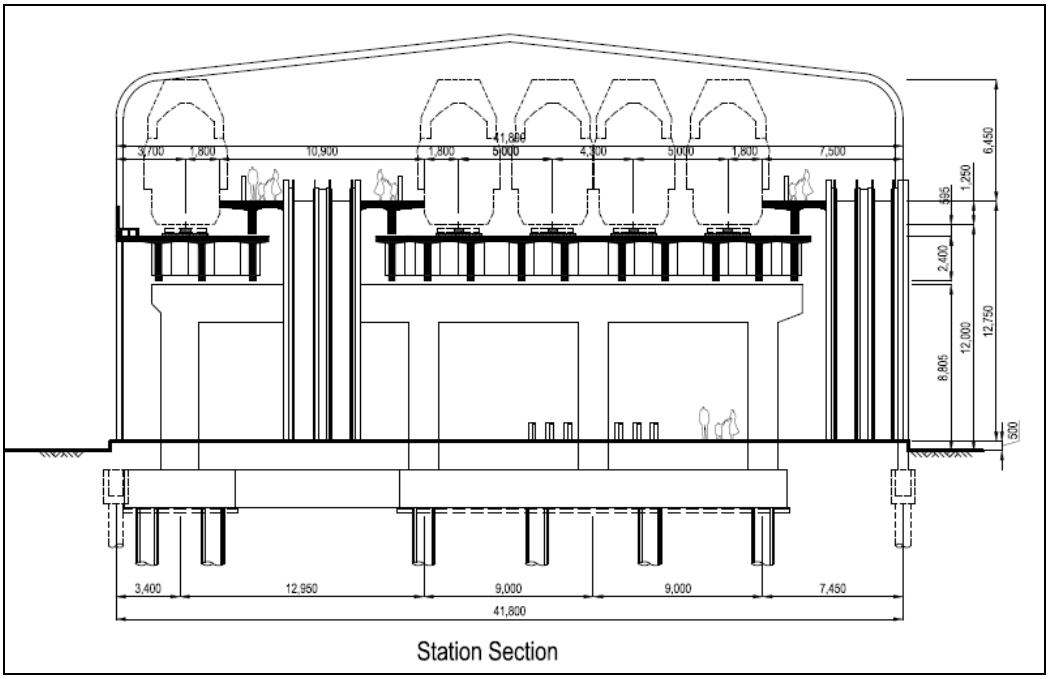
Source: JICA Study Team

Figure 5.2.31 Image of Future Thanh Hoa Station Area

(4) Station and Related Facilities

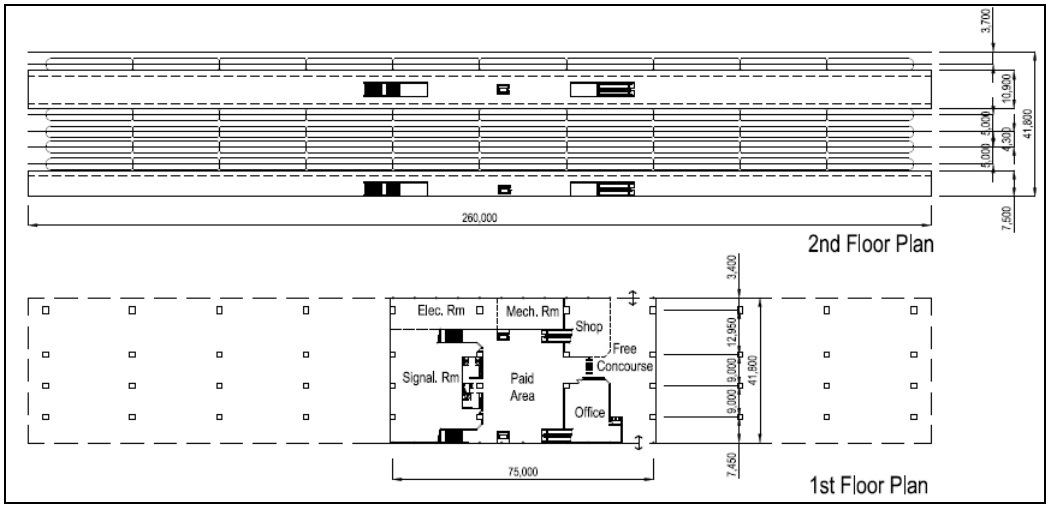
(a) Station Building

5.59 The Thanh Hoa Station is planned to have two elevated stories. One (1) side platform and one (1) island platform serving five (5) lines, including one (1) test line, will be provide on the second floor. A concourse will be set up on the first floor, with connection to the local railway to be through a concourse for the local station which is to be on the second floor as recommended.



Source: JICA Study Team

Figure 5.2.32 Cross-sectional View of Thanh Hoa Station

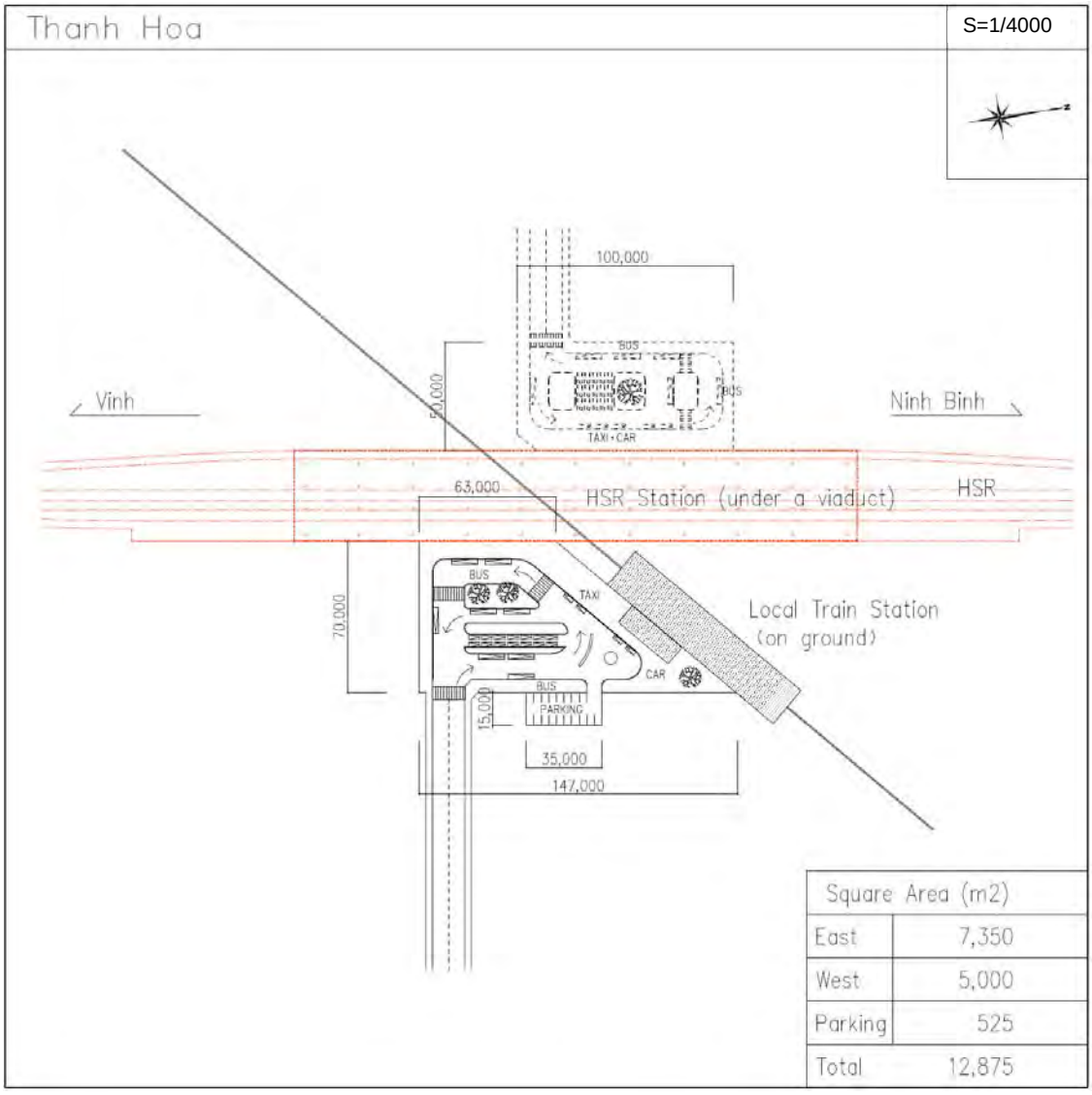


Source: JICA Study Team

Figure 5.2.33 Top View of Thanh Hoa Station

(b) Station Square

5.60 The station square will be set on the east side of the station to receive passengers from the city center, planned new urban zones, and other areas. The western square will be developed when the city expands in the future. The total area of the square will be about 12,875 m^2 including bus and taxi berths, as well as a car park.



Source: JICA Study Team

Figure 5.2.34 Top View of Thanh Hoa Station Square

6) Vinh Station

(1) Location and Existing Conditions

5.61 Vinh Station is planned to be built on an existing local railway station in the center of Vinh City and will thus serve as one of the HSR's terminal stations in the northern route and as a local railway station.

5.62 At present, land uses around the station are varied; commercial establishments proliferate on the eastern side of the station and along NH1, while residences and agricultural lands are scattered. Although there are markets, hotels, restaurants, and shops along the access road to the existing station, it is difficult to say if this current situation optimizes the land around the station.

5.63 Vinh Station is the northern terminal for the northern HSR section connecting with the national railway. For this reason, its station area will be a strategic point in the transport network of Vinh City and Nghe An province. HSR passengers are expected to comprise not only businesspeople but tourists to Cau Lo as well. This station area will also have high potential to be redeveloped as a subcenter of Vinh City for its ability to pull in more customers and users.

Existing VR Station	Existing Station Plaza
	
Existing Access Road	Market in front of Station
	

Source: JICA Study Team

Figure 5.2.35 Existing Conditions in Vinh Station Area

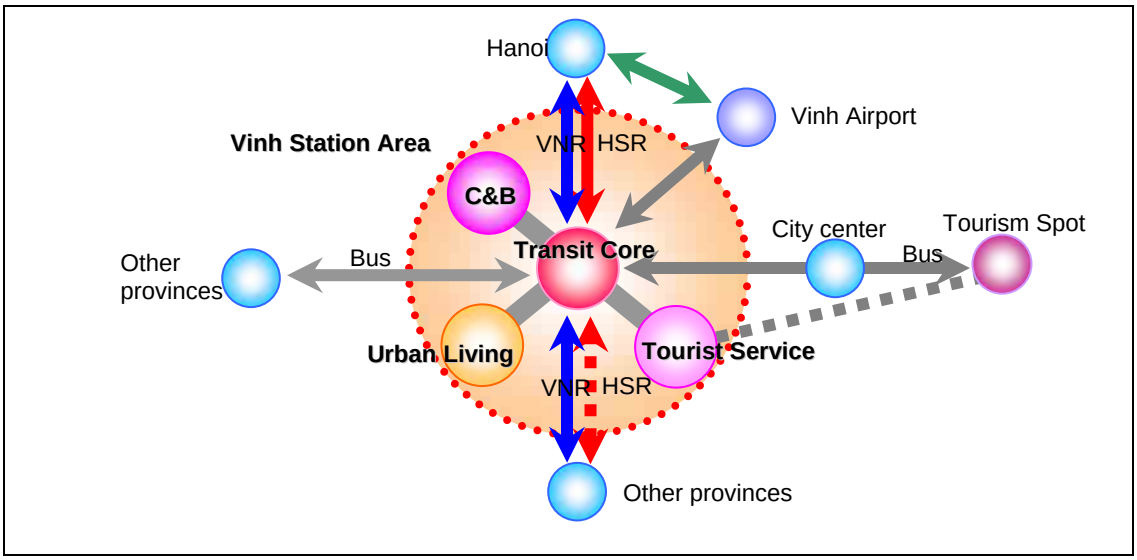
(2) Concept Plan for Station Area

5.64 As a subcenter of Vinh City, the Vinh station area is proposed to be redeveloped as an advanced commercial and business area and tourism center. Residents and workers in this area will commute to the city center by public transport and enjoy comfortable living with a natural environment.

5.65 The proposed vision for Vinh station area is proposed as follows:

- Sub-center with advanced commercial, business, and tourism services in Nghe An province, and
- Urban residential area with comfort and convenience by public transport.

5.66 The proposed urban structure of Vinh Station area is shown in Figure 5.2.36.



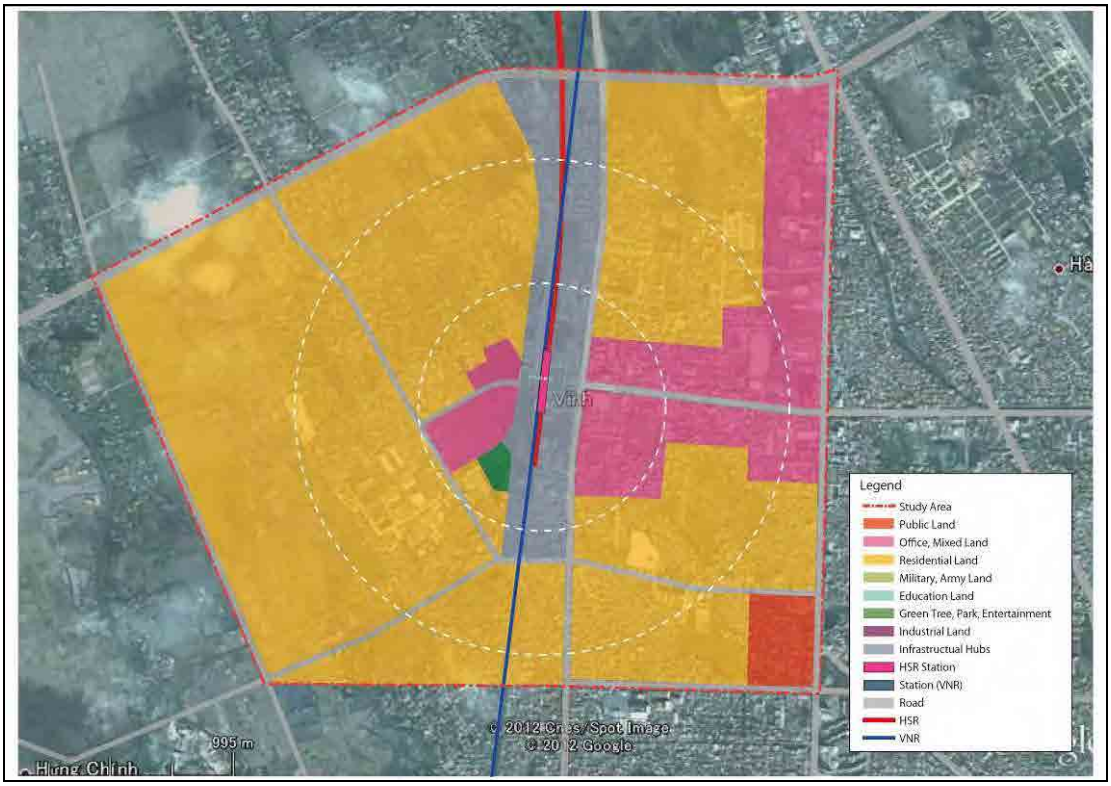
Source: JICA Study Team

Figure 5.2.36 Future Urban Structure of Vinh Station Area

(3) Proposed Land Use Plan for Station Area

5.67 For the formulation of a new sub-center, commercial and business areas are proposed to be developed west of the station which is at present an agricultural area. The existing commercial area east of the station and along NH1 will be redeveloped to accommodate high-rises. The area around the commercial area is proposed to be residential with public services and amenities.

5.68 The proposed land use plan for Vinh station area is shown in Figure 5.2.37.



Source: JICA Study Team

Figure 5.2.37 Land Use Plan for Vinh Station Area

Commercial Complex near the Station	Inside the Commercial Complex
	
Residential Area	**Commercial and Business Area**
	

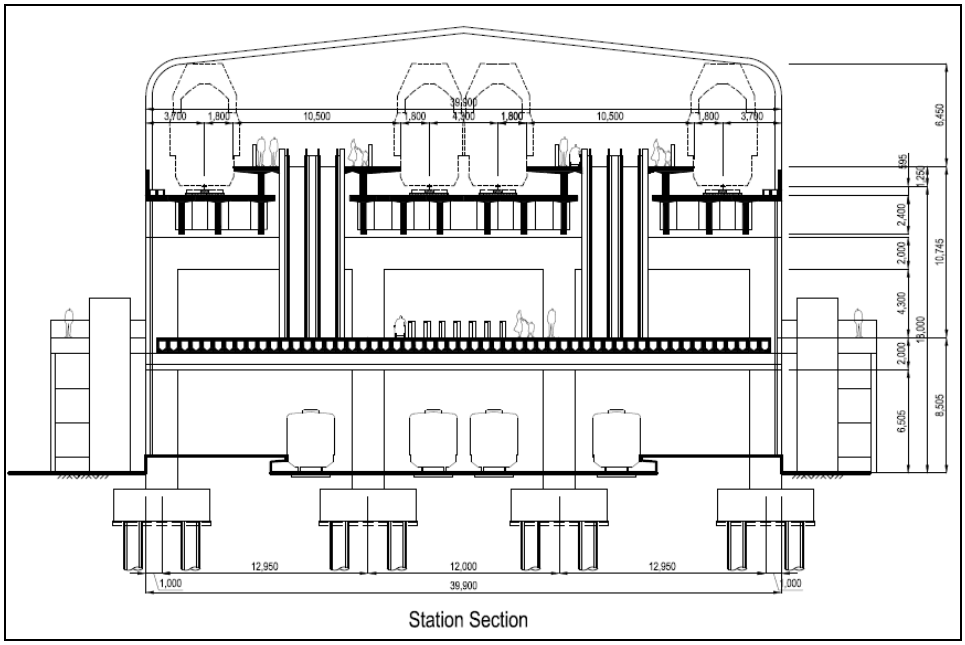
Source: JICA Study Team

Figure 5.2.38 Image of Future Thanh Hoa Station Area

(4) Station and Related Facilities

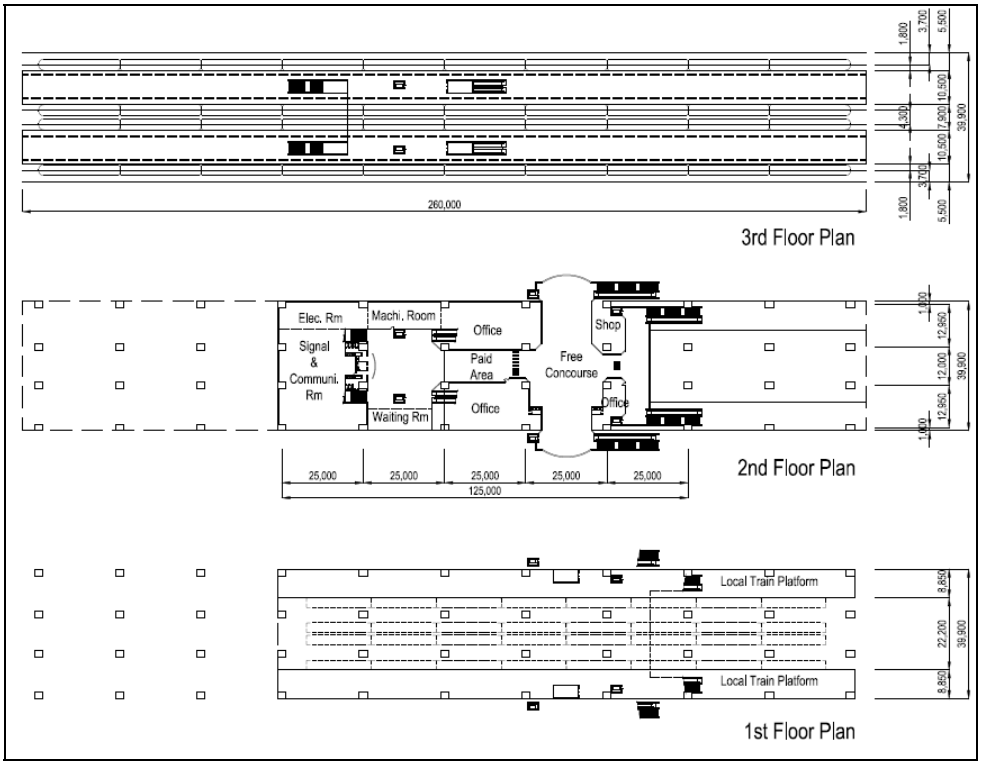
(a) Station Building

5.69 VInh Station is planned to have three elevated stories. Two (2) island platforms serving four (4) lines will be provided on the third floor, a concourse on the second floor connecting to the local railway, and a platform on the first floor for the local railway line.



Source: JICA Study Team

Figure 5.2.39 Cross-sectional View of Vinh Station

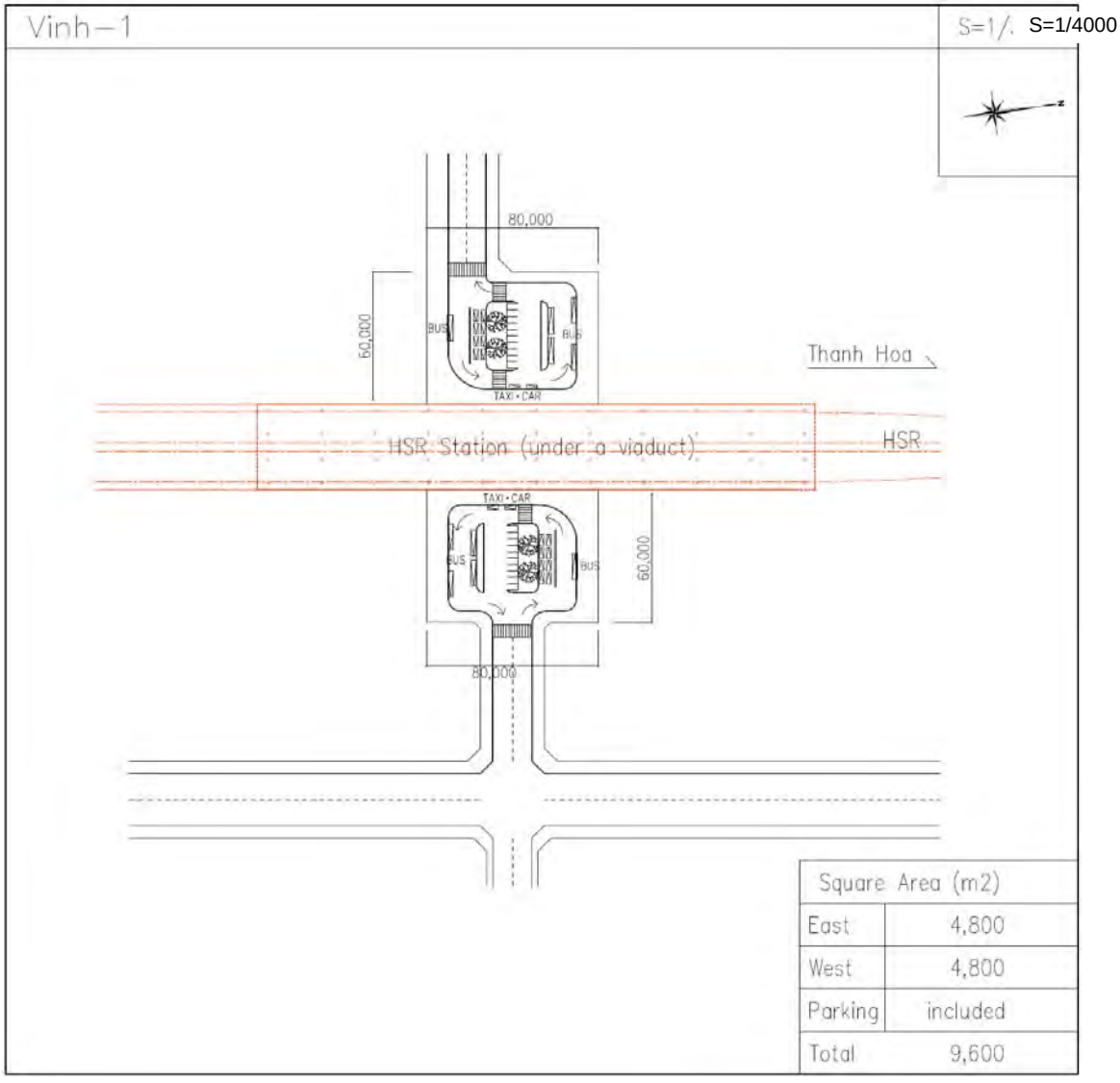


Source: JICA Study Team

Figure 5.2.40 Top View of Vinh Station Plan

(b) Station Square

5.70 The station square will be developed on the east and west sides of the station inside the station boundary. The western square will receive passengers from new urban zones and highway express. The eastern square will receive passengers from the city center and other areas. The square will have an estimated area of 9,600 m2 to include bus and taxi berths, as well as a car park.



Source: JICA Study Team

Figure 5.2.41 Top View of Vinh Station Square

7) Summary of Station Elements

(1) Platform Lengths

5.71 The size of HSR trains is standard at 25.0 m length and 3.4 m width. The estimated number of trains is 10 at the start of operation, increasing to 16 trains in the future.

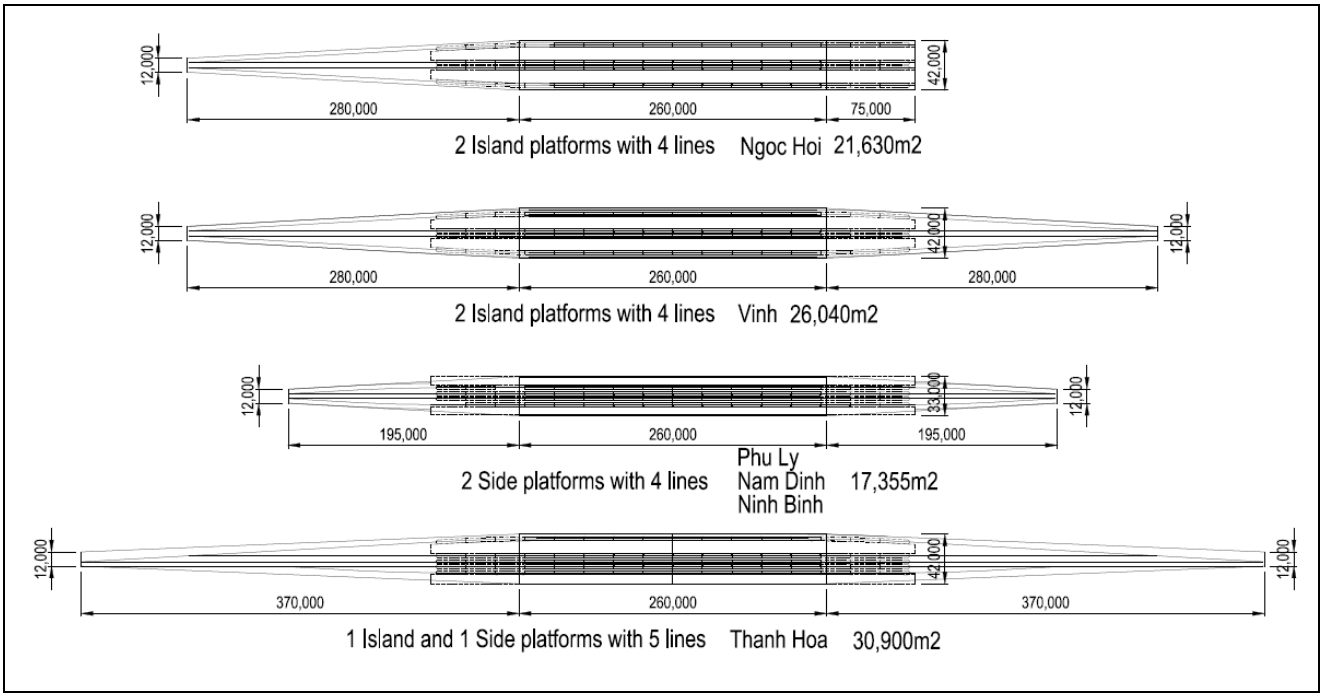
5.72 Platform length is designed to be 260 m (5 m extra + 25 m x 10 trains + 5 m extra). In the future, the platform will be expanded by 75 m at both ends, bringing the total length to 410 m (75 m + 260 m + 75 m).

(2) Safety Fence

5.73 The HSR's platform will have a safety fence to protect against strong wind pressure from a running high-speed train (over 260 km/h) and to prevent falls off the platform. Based on the high-speed train performance standard made by the Japan Railway Construction, Transport and Technology Agency (JRTT), safety fences should be kept at a distance of 2 m from the platform edge when a hi-speed train passes in full speed. In this report, safety fences should be placed at a distance of 2 m for full-speed railway and 1.4 m for regular train operation.

(3) Station Area

5.74 Considering the number of platforms and railway lines with a minimum radius in train operation which is estimated at 1200 m, station areas should be fixed. Areas of each station are shown in Figure 5.2.42.



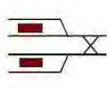
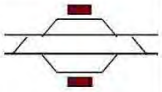
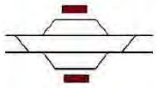
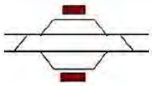
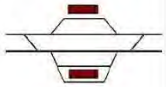
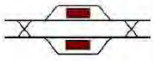
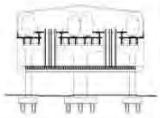
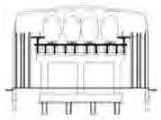
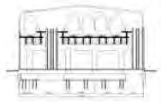
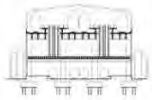
Source: JICA Study Team

Figure 5.2.42 Station Areas

(4) Summary of Station Elements

5.75 A summary of HSR station elements is shown below.

Table 5.2.1 HSR Station Elements

Station Name	Ngoc Hoi	Phu Ly	Nam Dinh	Ninh Binh	Thanh Hoa	Vinh
Location	0K000m	45K540m	67K664m	103K381m	153K826m	283K380m
Track Layout						
Station Section						
Station Type	Elevated	Elevated	Elevated	Ground	Elevated	Elevated
Platform Type	Island Platform	Side Platform	Side Platform	Side Platform	Island/Side Platform	Island Platform
Platform Length (m)	260	260	260	260	260	260
Platform Width (m)	11.5 + 11.5	7.0 + 7.0	7.5 + 7.5	7.0 + 7.0	10.9 + 7.5	10.5 +10.5
Station Area (m2)	21,700	17,400	17,400	17,400	30,900	26,100
Platform Floor Area (m2)	10,900	8,300	8,600	8,300	10,900	10,400
Concourse Floor Area (m2)	5,300	2,400	2,500	2,400	3,200	5,000
Place of Gate (Transfer)	1(0)	1(0)	1(0)	2(0)	1(0)	1(1)
Elevator (Paid Area/ Public Area)	2/2	2/0	2/2	2/2	2/0	4/2
Escalator (Paid Area/ Public Area)	4/2	4/0	4/2	4/2	4/0	8/2
Staircase (Paid Area/ Public Area)	2/2	2/0	2/2	2/2	2/0	4/2
Toilet (M/F/ Disable)	1/1/1	1/1/1	1/1/1	2/2/2	1/1/1	1/1/1
Transit to Local railway	To be Connected	To be Connected	To be Connected	To be Connected	To be Connected	To be Connected

6 TECHNICAL STUDIES

6.1 Train Operation Plan

6.1 A plan in terms of a train operation diagram in the Ngoc Hoi - Vinh section of the north to south high-speed railway includes the following services.

(a) Stoppage/ Passage Patterns

6.2 Trains of non-stop express type throughout the Ngoc Hoi - Vinh section will be set. Passage trains will stop at the Nam Din and Than Hoa stations, both having 10,000 boarding/alighting passengers or over. All stoppage trains will stop at all stations. The stoppage/passage patterns remain unchanged in 2030, 2035 and 2040.

Table 6.1.1 Stoppage/ Passage Ptterns in Ngoc Hoi – Vinh Section

	Volume of Boarding and Alighting	Phu Ly	Nam Dinh	Ninh Binh	Thanh Hoa
Express type	More than 10,000	–	–	–	–
Passage type		–	●	–	●
Stop type	More than 1,000	●	●	●	●

Source: JICA Study Team

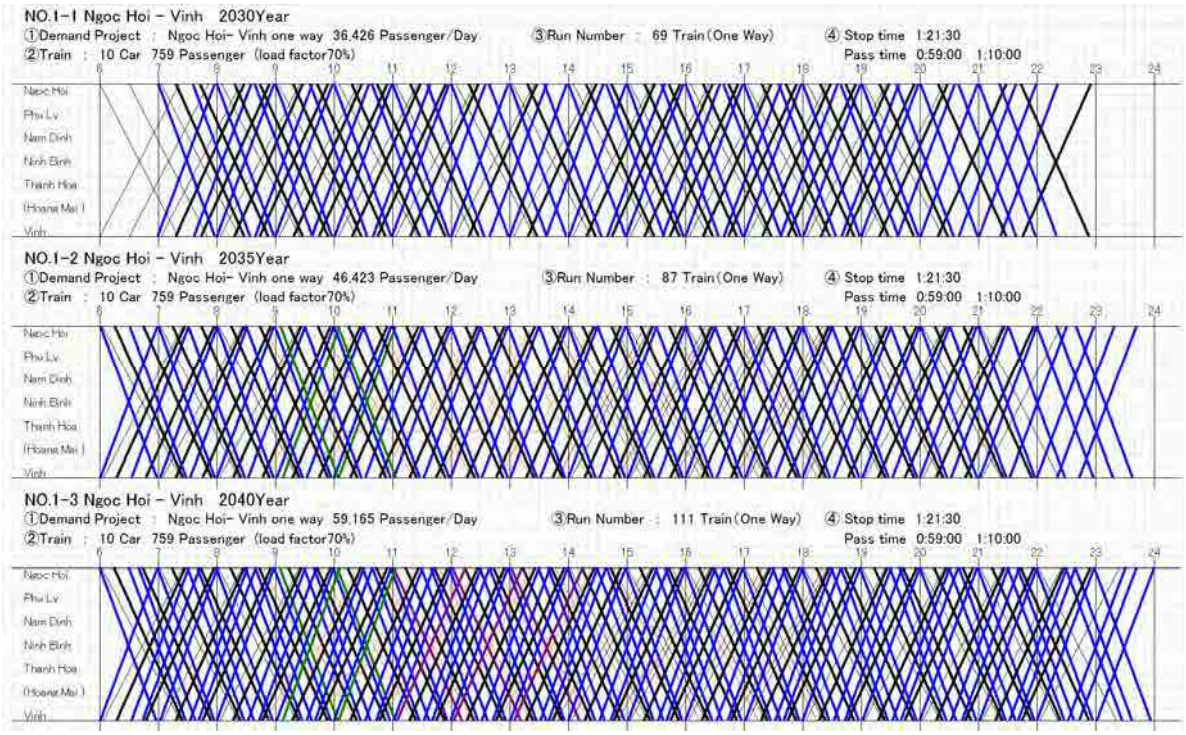
(b) Train Operation Diagram

6.3 We calculate the number of passage and stoppage trains per hour based on the number of boarding/alighting passengers in the Ngoc Hoi - Vinh section in fiscal 2030, 2035 and 2040.

Table 6.1.2 Number of Train Sets for Ngoc Hoi – Vinh Section

Year	Type	Train / hour	Train Set	Transported Volume	Passenger Load Factor 70%	Volume of Boarding & Alighting
2030	Express type	2	30	22,770	15,939	
	Passage type	2	24	18,216	12,751	
	Stop type	1	15	11,385	7,970	
	Total		69	52,371	36,660	36,426
2035	Express type	2	37	28,083	19,658	
	Passage type	2	30	22,770	15,939	
	Stop type	2	20	15,180	10,626	
	Total		87	66,033	46,223	46,423
2040	Express type	3	54	40,986	28,690	
	Passage type	2	35	26,565	18,596	
	Stop type	2	22	16,698	11,689	
	Total		111	84,249	58,974	59,165

Source: JICA Study Team



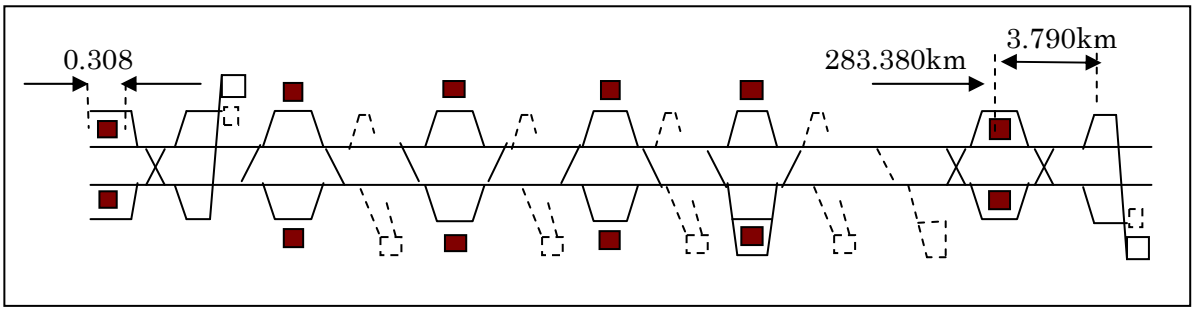
Source: JICA Study Team.

Figure 6.1.1 Stoppage/ Passage Patterns in Ngoc Hoi – Vinh Section

6.2 Tracks

(a) Track Equipment in the Section between Ngoc Hoi and Vinh

6.4 Main track length is 287.478km of double tracks. The length of the sub main line and the siding track are 45.200km. The route length of the sections from Ngoc Hoi to Vinh is 287.478km (including 308m+283.380km+3.790km) as shown in Figure 6.2.1. The chainage of each station, depot, workshop and maintenance base are shown in Table 6.2.1. The workshop and maintenance bases are located next to the main depots.



Source: JICA Study Team

Figure 6.2.1 Tracks Layout between Ngoc Hoi - Vinh

Table 6.2.1 Track Lengths of Each Station, Depot, Workshop, and Maintenance Base as well as track type

Unit: single track lenght in km

Station, Depot and Base	Chainage	Main Track	Subsidiary Main Track	Rolling stock Depot	Rolling stock Workshop	Track Maintenance Base
Starting point	-0.308					
Ngoc Hoi	0.00		1			
Rolling strock workshop	12.200				10	
Depot	12.200			8		1.6
Phu Ly	45.540		1			
Maintenance base	45.540					1.6
Nam Dinh	67.664		1.5			
Maintenance base	67.664					1.6
Ninh Binh	103.381		1			
Maintenance base	103.381					1.6
Thanh Hoa	153.826		1	1.5		
Maintenance base	153.826					1.6
Hoang Mai Maintenance Depot	230.000			8		1.6
Vinh	283.380		1			
Depot	287.170					1.6
Tracks terminal	287.170					
Total		574.956	6.5	17.5	10	11.2
Track type						
Slab	279.116	272.616	6.5			
Ballast	330.840	302.340	0	17.5		11
Special track	10.200				10	0.2
Total	620.156					

Source: JICA Study Team

(b) Track length

6.5 The track length between Ngoc Hoi and Vinh is shown in Table 6.2.2. The track structure basically consists ofballast track although slab track is used on certain sections.(see Table 6.2.3 and Table 6.2.4). Key features of the tracks are as follows:

(i) Ballast track is used on cut and embankment sections;
(ii) Slab track is used on station sections which are either elevated or at grade;
(iii) Slab track is used on elevated sections in high density housing areas and where there are clearance restrictions under the girder;
(iv) Slab track is used on bridges intersecting rivers, railways and roads in high density housing areas and where there are clearance restrictions under the girder;
(v) Slab track is used in tunnels;
(vi) The effective track length of the subsidiary main line at stations is 500m; and
(vii) The track length in rolling stock depots, rolling stock workshops and track maintenance base is based on measured lengths.

Table 6.2.2 Track Lengths According to Track Structure Between Ngoc Hoi and Vinh

Unit: Single track lengths in km

Track Structure	Main Line	Depot line	Sub Total
Slab	272.616	6.500	279.116
Ballast	302.340	28.500	330.840
Special track (in workshops, bases, pits, etc.)		10.200	10.200
Total	574.956	45.200	620.156

Source: JICA Study Team

Table 6.2.3 Length of Main Tracks in each province according to track structure

Unit: Double-tracked lenths in km

Section	City/Province	Chainage		Slab	Ballast
		from	to		
1	Hanoi	-0.308	28.020	18.618	9.710
2	Ha Nam	28.020	58.473	15.293	15.160
3	Nam Dinh	58.473	59.675	1.202	0.0
4	Ha Nam	59.675	64.495	4.820	0.0
5	Nam Dinh	64.495	94.846	17.731	12.620
6	Ninh Binh	94.846	113.975	10.059	9.070
7	Thanh Hoa	113.975	209.659	37.594	58.090
8	Nghe An	209.659	287.170	30.991	46.520
Total			287.478	136.308	151.170

Source: JICA Study Team

Table 6.2.4 Length os Main Track According to Civil Structures and Track Structure

Unit: Single track lengths in km

Civil Structures Types	Route length	Track Length	Slab	Ballast
Station	4.385	8.770	8.770	0.00
Viaduct	139.813	279.626	227.226	52.400
Bridge	6.090	12.180	5.820	6.360
Tunnel	15.400	30.800	30.800	0.00
Cutting	9.860	19.720	0.00	19.720
Embankment	111.930	223.860	0.00	223.860
Total	287.478	574.956	272.616	302.340

Source: JICA Study Team

6.3 Station and Station Facilities

(1) Platform Length

6.6 The size of HSR train is standardized with a length of 25.0m and witdh of 3.4m. Estimated number of trains will be 10 trains at the start of operation and will be increased to 16 trains in the future.

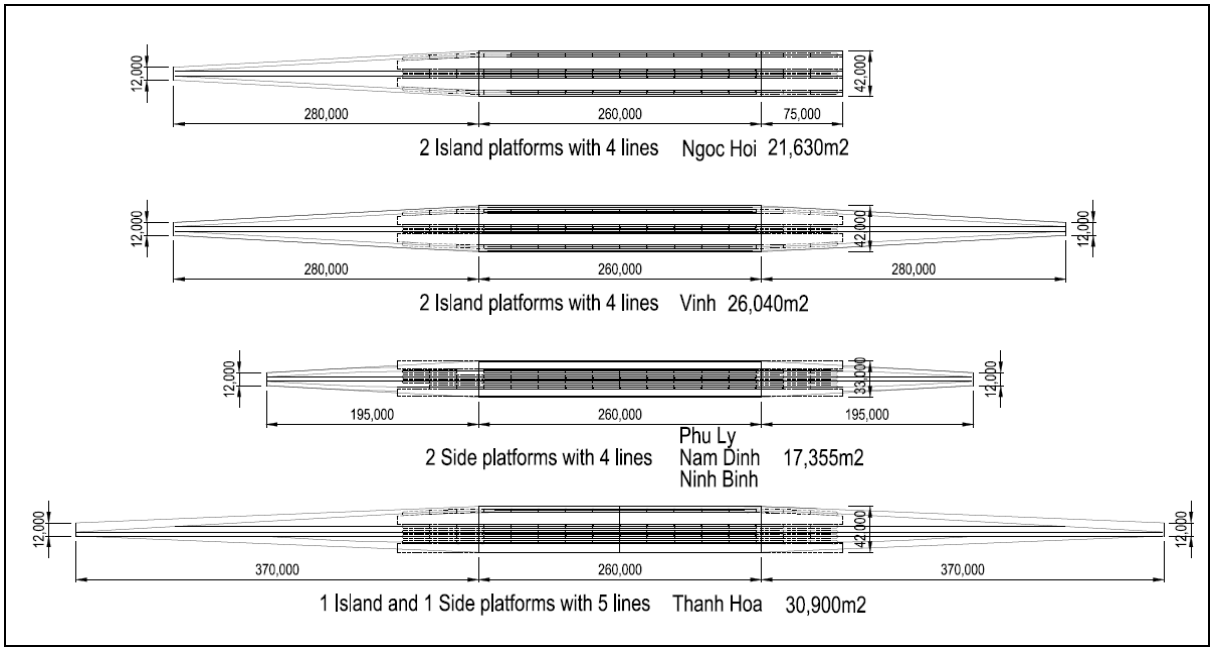
6.7 Platform length is designed at 260m (5m extra + 25m x 10 trains + 5m extra). In future, the platform will be expanded at each end 75m and total length will be 410m (75m + 260m + 75m).

(2) Safety Fence

6.8 Platform of HSR has a Safety Fence for protection against strong wind pressure from running hi-speed train (over 260h/km) and for prevention of falling from platform. According to the hi-speed train performance standard made by Japan Railway Construction, Transport and Technology Agency (JRTT), the Safety Fence shall be kept at a distance of 2m from platform edge during hi-speed train passing on full speed. As such, for the HSR, a Safety Fence is designed at 2m distance for full speed railway and 1.4m for normal operation railway.

(3) Station Area

6.9 Considering of number of platform and railway line with minimum radius on train operation that is estimated 1200m, the station area will be fixed. Areas of each station are shown in Figure 6.3.1.



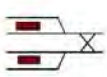
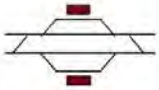
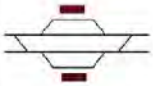
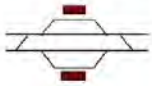
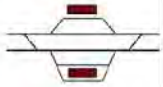
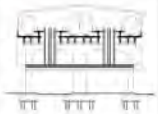
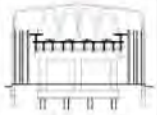
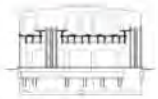
Source: JICA Study Team

Figure 6.3.1 Station Area

(4) Summary of Station Elements

6.10 Summary of HSR station elements is shown in Table 6.3.1.

Table 6.3.1 Station Elements

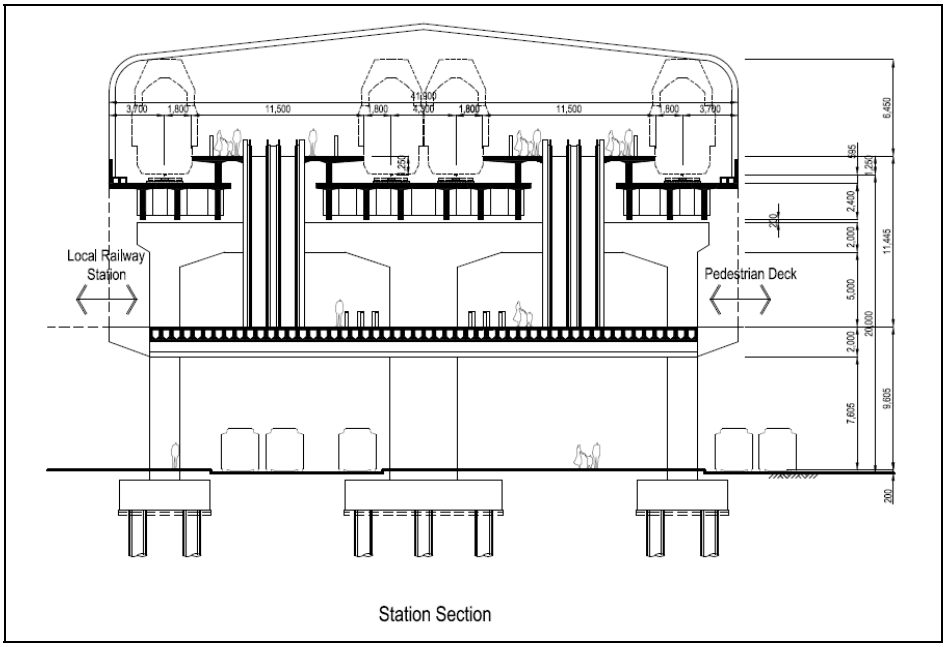
Station Name	Ngoc Hoi	Phu Ly	Nam Dinh	Ninh Binh	Thanh Hoa	Vinh
Location	0K000m	45K540m	67K664m	103K381m	153K826m	283K380m
Track Layout						
Station Section						
Station Type	Elevated	Elevated	Elevated	Ground	Elevated	Elevated
Platform Type	Island Platform	Side Platform	Side Platform	Side Platform	Island/Side Platform	Island Platform
Platform Length (m)	260	260	260	260	260	260
Platform Width (m)	11.5 + 11.5	7.0 + 7.0	7.5 + 7.5	7.0 + 7.0	10.9 + 7.5	10.5 +10.5
Station Area (m2)	21,700	17,400	17,400	17,400	30,900	26,100
Platform Floor Area (m2)	10,900	8,300	8,600	8,300	10,900	10,400
Concourse Floor Area (m2)	5,300	2,400	2,500	2,400	3,200	5,000
Place of Gate (Transfer)	1(0)	1(0)	1(0)	2(0)	1(0)	1(1)
Elevator (Paid Area/ Public Area)	2/2	2/0	2/2	2/2	2/0	4/2
Escalator (Paid Area/ Public Area)	4/2	4/0	4/2	4/2	4/0	8/2
Staircase (Paid Area/ Public Area)	2/2	2/0	2/2	2/2	2/0	4/2
Toilet (M/F/ Disable)	1/1/1	1/1/1	1/1/1	2/2/2	1/1/1	1/1/1
Transit to Local railway	To be Connected	To be Connected	To be Connected	To be Connected	To be Connected	To be Connected

Source: JICA Study Team

(5) Proposed Station

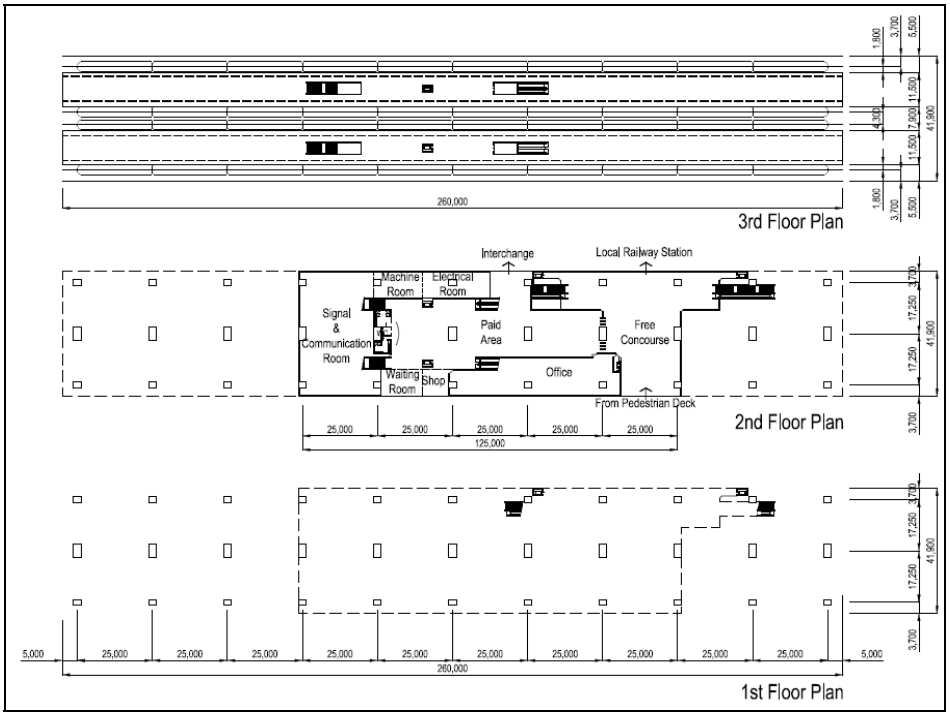
(a) Ngoc Hoi Station

6.11 Ngoc Hoi station is planned to elevated 3 stories. Two (2) island platforms with four (4) lines on 3rd floor and concourse is on 2nd floor. Interchanging to UMRT and Local railway shall be connected on 2nd floor. 1st floor is usage to bus and taxi berth with open space for pedestrian.



Source: JICA Study Team

Figure 6.3.2 Ngoc Hoi Station Plan (Cross Section)

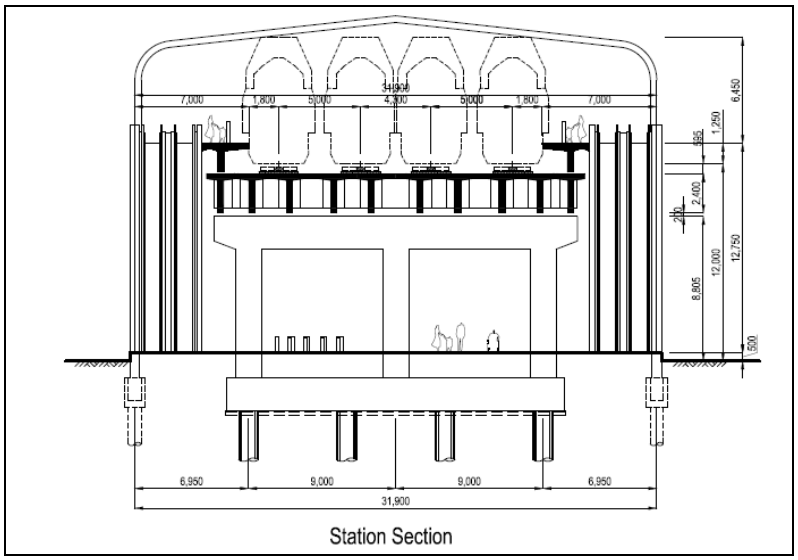


Source: JICA Study Team

Figure 6.3.3 Ngoc Hoi Station Plan

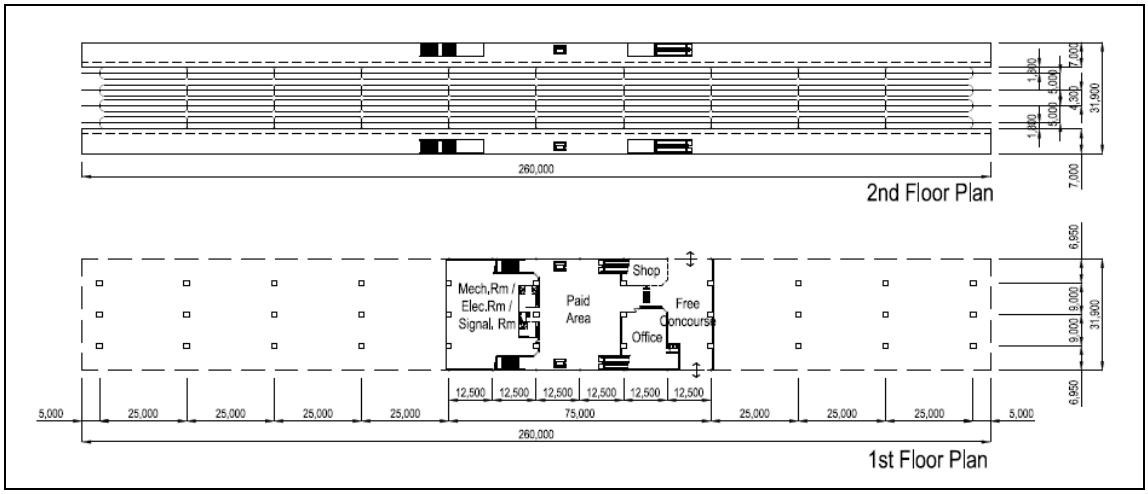
(b) Phu Ly Station

6.12 Phu Ly station is planned to elevated 2 stories. Two (2) side platforms with four (4) lines on 2nd floor and concourse is 1st floor. Connecting with local railway shall be interchange on 1st floor. Therefore, future local railway station shall be recommended to elevated station for easy transit.



Source: JICA Study Team

Figure 6.3.4 Phu Ly Station Plan (Cross Section)

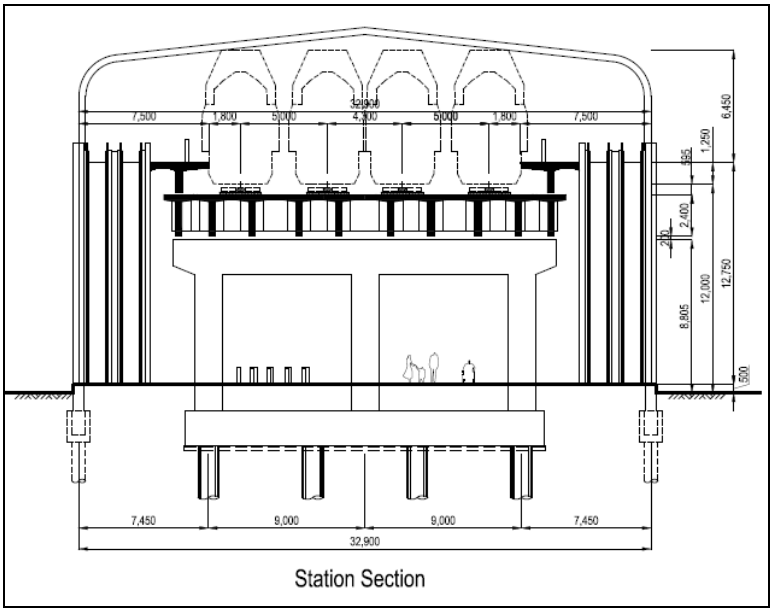


Source: JICA Study Team

Figure 6.3.5 Phu Ly Station Plan

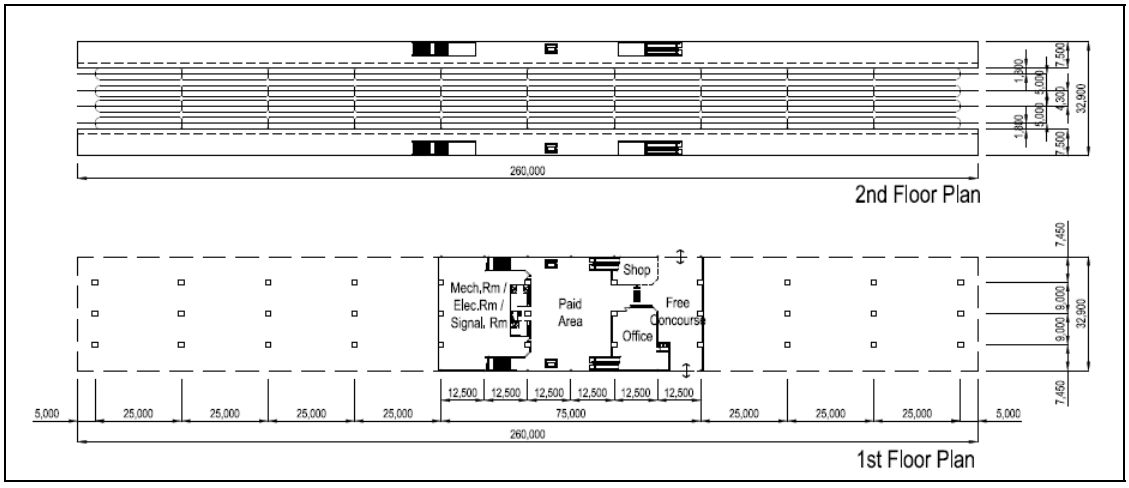
(c) Nam Dinh Station

6.13 Nam Dinh station is planned to be an elevated 2-storey structure. Two (2) side platforms with four (4) lines on 2nd floor and concourse on the 1st floor. Connection with a local railway shall be through a west station square and a pedestrian deck above the road. Concourse for the local station shall be planned on the bridge.



Source: JICA Study Team

Figure 6.3.6 Nam Dinh Station Plan (Cross Section)

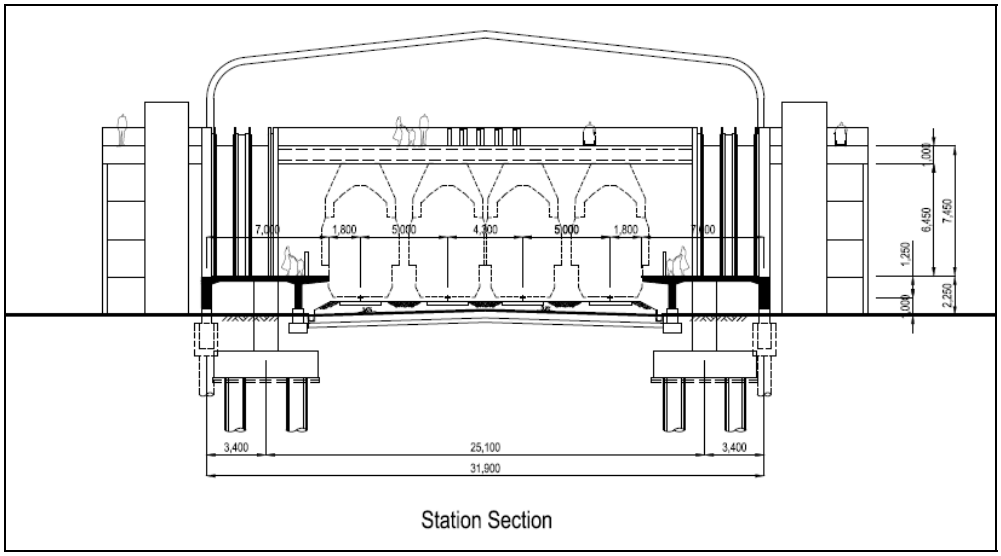


Source: JICA Study Team

Figure 6.3.7 Nam Dinh Station Plan

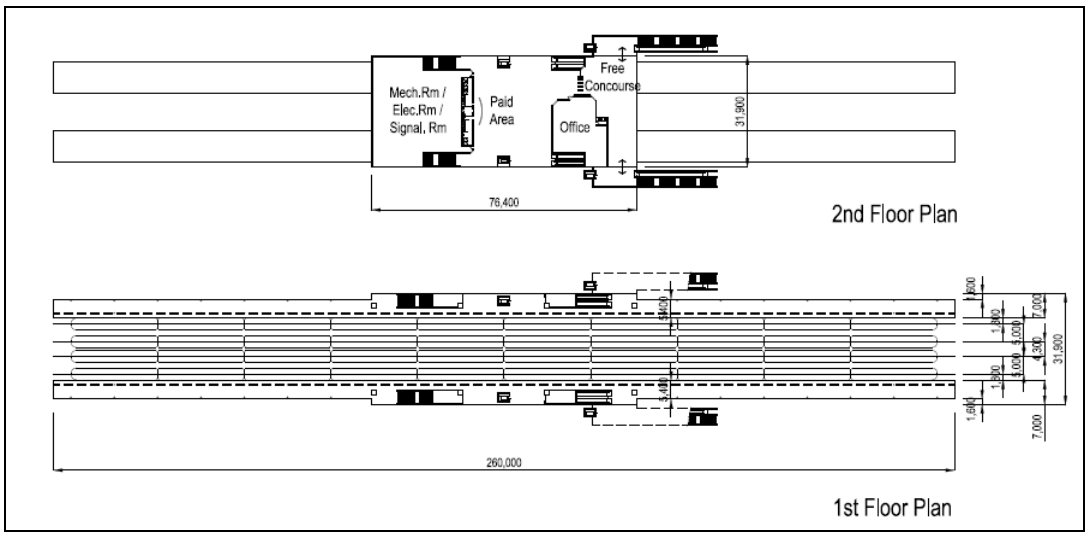
(d) Ninh Binh Station

6.14 Ninh Binh station is planned as a ground station. Two (2) side platforms with four (4) lines on 1st floor and concourse on the 2nd floor. Connection with the local railway shall be on the 2nd floor concourse of the local station which is recommended to be on bridge.



Source: JICA Study Team

Figure 6.3.8 Ninh Binh Station Plan (Cross Section)

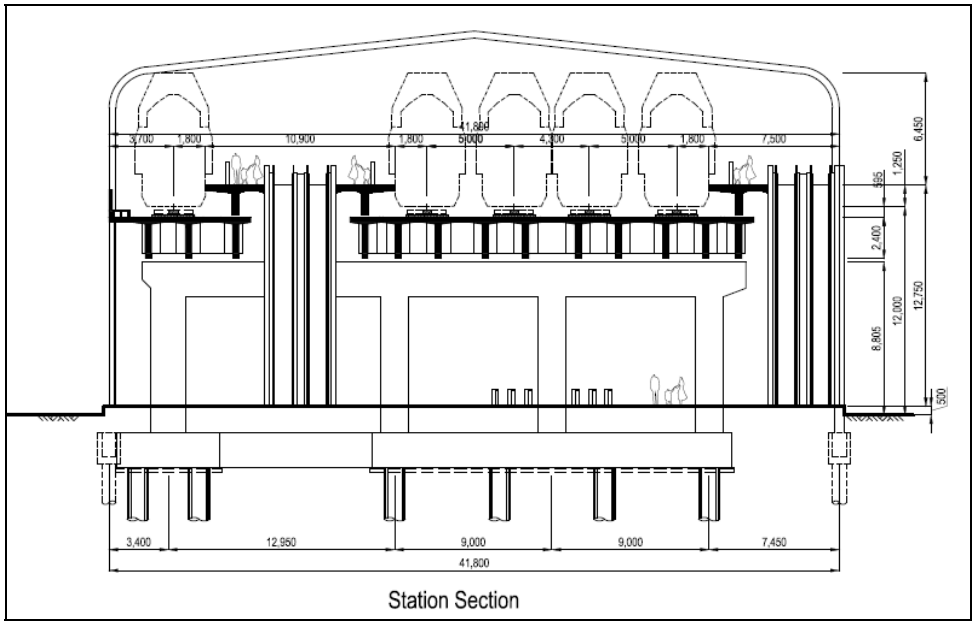


Source: JICA Study Team

Figure 6.3.9 Ninh Binh Station Plan

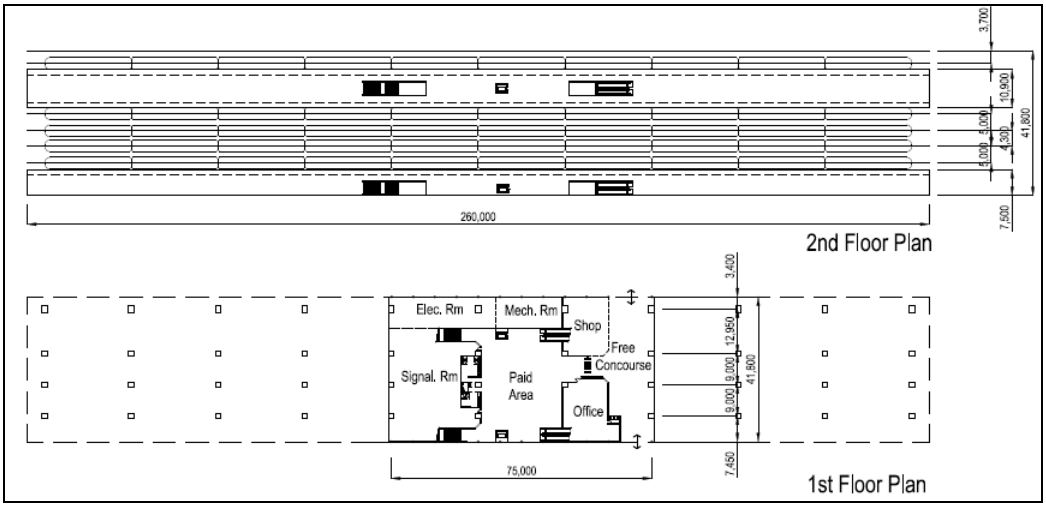
(e) Thanh Hoa Station

6.15 HSR Thanh Hoa station is planned to be an elevated 2-storey structure. One (1) side platform and One (1) island platform with 5 (5) lines including one (1) testing line on the 2nd floor. Concourse is on the 1st floor and connection with the local railway shall be through a concourse of the local station which is recommended to be on the 2nd floor.



Source: JICA Study Team

Figure 6.3.10 Thanh Hoa Station Plan (Cross Section)

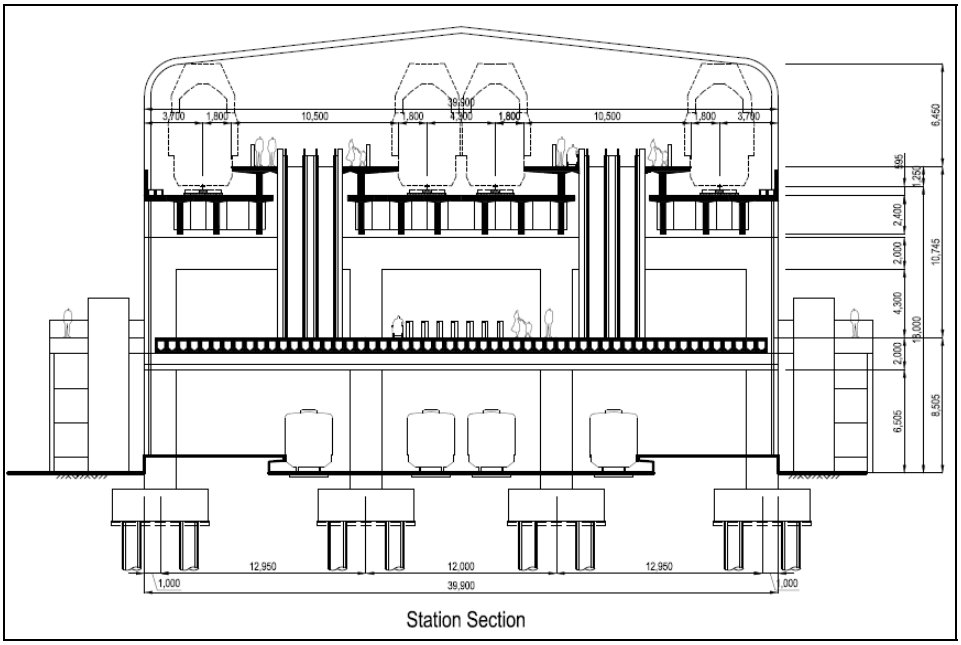


Source: JICA Study Team

Figure 6.3.11 Thanh Hoa Station Plan

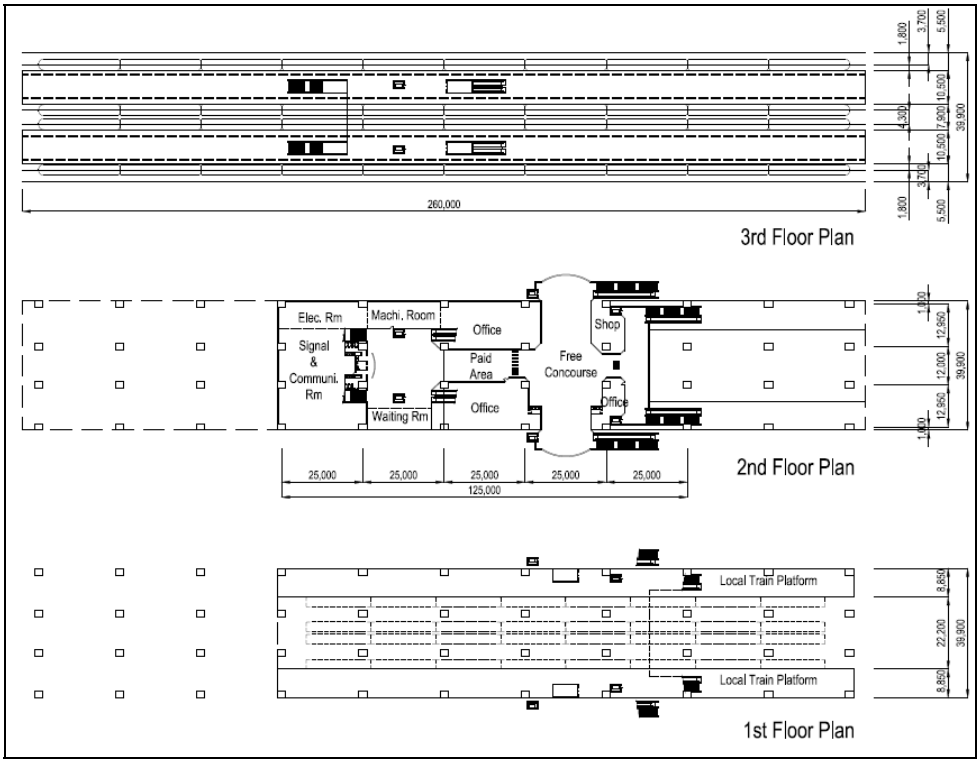
(f) Vinh Station

6.16 VInh station is planned to be an elevated 3-storey structure. Two (2) island platforms with four (4) lines on the 3rd floor and concourse on the 2nd floor. This concourse will connect with the local railway and the 1st floor will be utilized as the local railway's platform.



Source: JICA Study Team

Figure 6.3.12 Vinh Station Plan (Cross Section)



Source: JICA Study Team

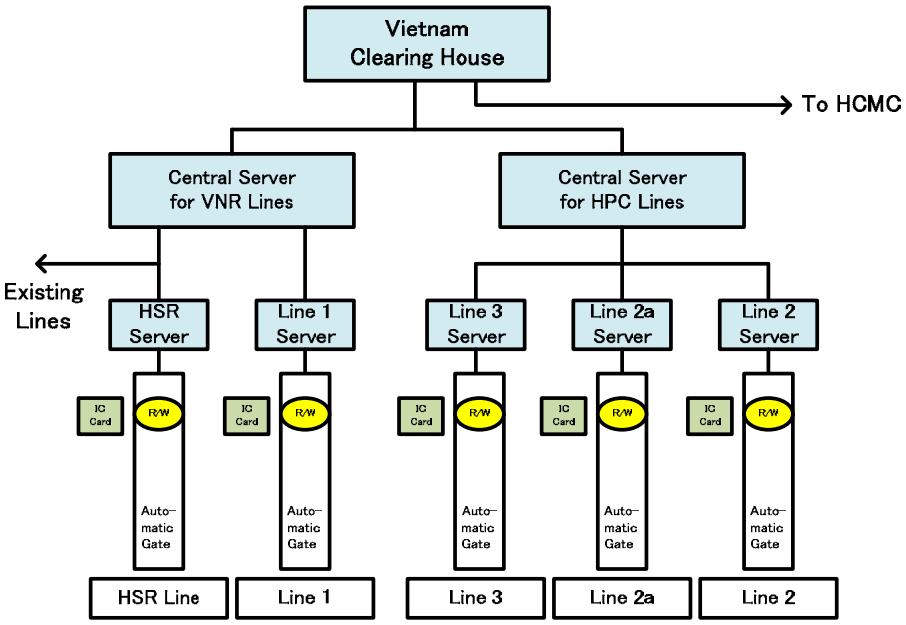
Figure 6.3.13 Vinh Station Plan

6.4 Automatic Fare Collection System (AFC)

6.17 Refer to Volume I Section 5.1 Review of World High-Speed Railway Technology, for a comparison of AFC systems to be applied to high-speed railways that are adopted in different countries and d) AFC, 2) Selection of System, 5.2 Selection of System Technology of HSR in Vietnam, for the basic system and composition of AFC to be applied to the high-speed railway in Vietnam.

6.18 There are three types A, B and Felica non-contact IC cards. The Type Felica cards have merits of high reading and writing processing speed to make passengers smoothly pass automatic passenger gates, even during rush hours crowded with passengers, and being used as electronic money cards.

6.19 To improve the convenience of users, it is desired to introduce an integrated interoperable system into the Hanoi and Ho Chi Minh areas and for all traffic facilities across the country. See Figure 6.4.1 for the composition of the AFC system to be introduced in the Hanoi area.



Source: JICA Study Team

Figure 6.4.1 Composition of the AFC System to be Introduced in the Hanoi Area

6.5 Rolling Stocks

(1) Technical specification of rolling stock

The technical specification of rolling stock is described in Part1-5.2.

(2) Preconditions for calculations of required cars

The preconditions for calculation of the number of required cars applied for train operation plan are follows.

- All VHSRS trainsets have 10 cars.
- Minimum time to turn-back with brief cleaning at the terminal station is 15 minutes.
- Daily inspection is carried out every night but regular inspection, bogie inspection, and general inspection are carried out on only weekdays (effective working days).
- Effective working days for maintenance are 250 days per one year.
- Durations for each maintenance are follows.
  - Daily inspection: 1 hour
  - Regular inspection: 1 working day
  - Bogie inspection: 4 working days
  - General inspection: 15 working days

(3) Calculation of required cars

(a) Required trainsets for operation

6.20 From the operation diagram in 2030 in the section 6.1, it can be found that at least 9 trainsets are required for each terminal in the morning before the first train from the other terminal can turn-back. Total 18 trainsets can fulfill all trains in the operation diagram in 2030. In the same way, required trainsets are estimated as in Table 6.5.1.

Table 6.5.1 Required Trainsets for Operation (Ngoc Hoi – Vinh)

Year	2030	2035	2040
Trainsets for operation	18	20	24

Source: JICA Study Team

(b) Required reserve trainsets for stand-by

6.21 From the point of transport stability, it is ideal that at least one trainset for stand-by is secured at each terminal. It can be also used for the extra trains on peak seasons. Required trainsets for stand-by are in table 6.5.2

Table 6.5.2 Required Reserve Trainsets for Stand-by (Ngoc Hoi – Vinh)

Year	2030	2035	2040
Trainsets for stand-by	2	2	2

Source: JICA Study Team

(c) Required reserve trainsets for maintenance

6.22 Required reserve trainsets for maintenance are calculated by "number of trainsets", "average rolling stock-km per day per car", "interval for each inspection", and "duration of each inspection" as follows.

$$Ave._r olling_s tock-km/day/car = \frac{Total\_train-km}{(Trainsets\_for\_operation + Trainsets\_for\_stand-by)}$$

$$Idr : Interval\_days\_for\_Regular\_inspection = \frac{30000km : Regular\_inspection\_interval\_km}{Ave.\_rolling\_stock-km/day/car}$$

$$Idbg : Interval\_days\_for\_Bogie\&General\_inspection = \frac{600000km : Bogie\&General\_inspection\_interval\_km}{Ave.\_rolling\_stock-km/day/car}$$

$$Required\_trainsets\_for\_Regular\_inspection = \frac{365 \times (Trainsets\_for\_operation + Trainsets\_for\_stand-by)}{Idr}$$

$$\times \frac{1 : Duration\_for\_Regular\_inspection}{250 : Woking\_days}$$

$$Required\_trainsets\_for\_Bogie\&General\_inspection = \frac{365 \times (Trainsets\_for\_operation + Trainsets\_for\_stand-by)}{Idbg}$$

$$\times \frac{9.5 : Ave.\_Duration\_for\_Bogie\&General\_inspection}{250 : Woking\_days}$$

6.23 Required trainsets for maintenance are estimated as shown in Table 6.5.3.

Table 6.5.3 Required Reserve Trainsets for Maintenance (Ngoc Hoi – Vinh)

Year	2030	2035	2040
No. of trains	138	174	222
Total train-km /day	39,191.7	49,415.7	63,047.6
Ave. rolling stock-km /day/car	1,959.6	2,246.2	2,424.9
Interval days for Regular Inspection	15	13	12
Interval days for Bogie & General inspection	306	267	247
Required trainsets for regular inspection	2	3	4
Required trainsets for bogie & general inspection	1	2	2
Total trainsets for maintenance	3	5	6

Source: JICA Study Team

(d) Total required number of cars

6.24 Total number of required trainsets is sum of trainsets for operation, stand-by and maintenance. Since a trainset has ten cars, total number of cars is ten times the trainsets.

Table 6.5.4 Total required number of cars (Ngoc Hoi – Vinh)

Year	2030	2035	2040
Trainsets for operation	18	20	24
Trainsets for stand-by	2	2	2
Trainsets for maintenance	3	5	6
Total required trainsets	23	27	32
Total required cars	230	270	320

Source: JICA Study Team

6.6 Signal and Telecommunications

6.25 Refer to Volume I Section 5.1 Review of World High-Speed Railway Technology, for a comparison of signal and telecommunications to be applied to high-speed railways that are adopted in different countries and f) Signaling and telecommunication, 2) Selection of System, 5.2 Selection of System Technology of HSR in Vietnam, for the basic system and composition of the signal and telecommunication systems to be applied to the high-speed railway in Vietnam.

6.26 The train control system for the Hanoi-Vinh section shall adopt an interlocking-cum-ATC system of the car-mounted device relying control type, using digital transmission along with an operation control system of the autonomous decentralized data processing type the ensure the immunity of other stations from the failure at a station.

6.27 The master plan for train operation related to the signal and telecommunication systems in the Hanoi-Vinh section is as follows

(1) Stations: Ngoc Hoi, Depot 1, Phu Ly, Nam Dinh, Ninh Binh, Thanh Hoa, Vinh, Depot 2

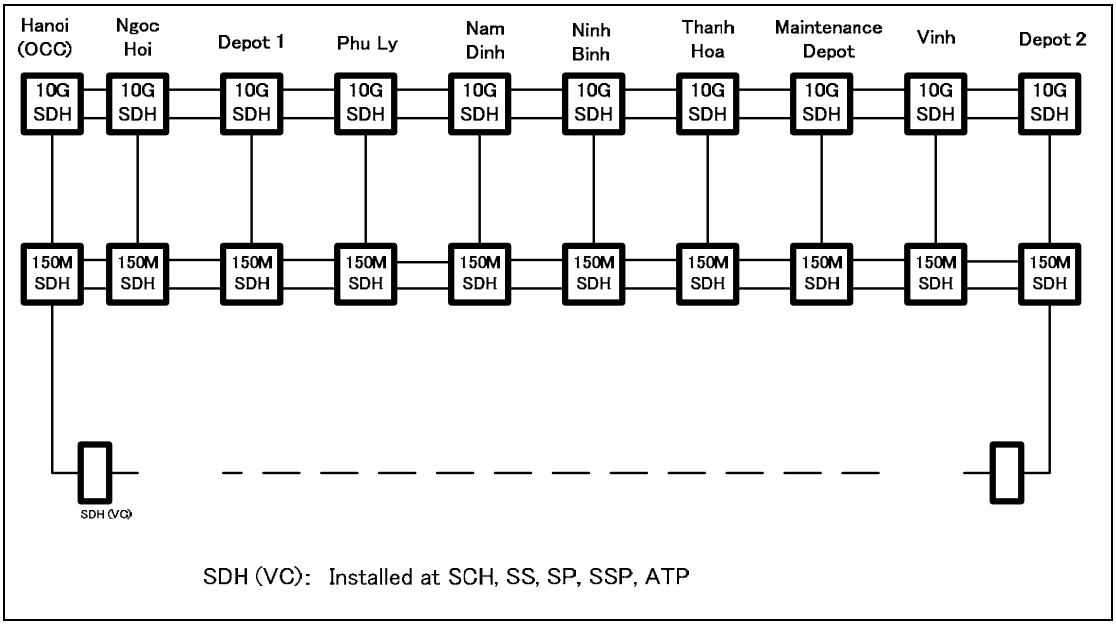
(2) Number of cars in a train set: 10

(3) Maximum speed: 320 km/h

(4) Minimum headway: 4 minutes

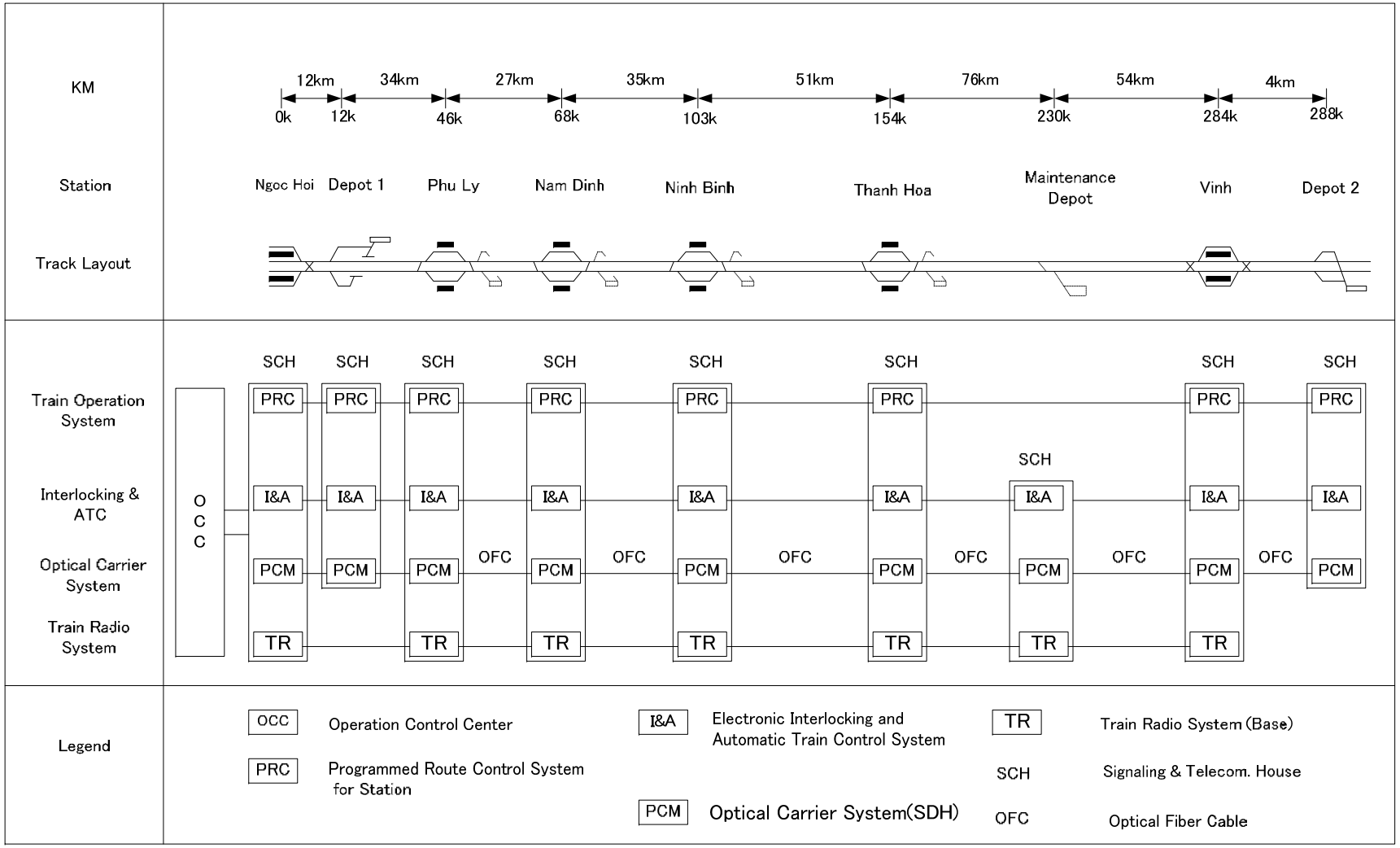
6.28 An Operation Control Cener will be installed to integrated transport and equipment dispatching offices in Hanoi City and another in Ho Chi Minh City. The train protection system will include; (i) Regular block system – the DS ATC system to ensure the clearance between trains; and (ii) Substitute block system – in case the DS-ATC system has failed. The standard length of a block section is 1.2 km in open sections and 1 km in tunnel sections. A block section corresponds to a track circuit in principle except at sectioning posts.

6.29 See Figure 6.6.1 for the composition of the optical PCM carrier system on the trunk transmission route between Hanoi and Vinh. See Figure 6.6.2 for the composition of the principal signal and telecommunications systems in the same section.



Source: JICA Study Team

Figure 6.6.1 Composition of the optical PCM carrier system on the trunk transmission route (between Hanoi and Vinh)



Source: JICA Study Team

Figure 6.6.2 Composition of the principal signal and telecommunication systems (between Hanoi and Vinh)

6.7 Electricity

(1) Power supply equipment in the section between Ngoc Hoi and Vinh

(a) Principal equipment/facilities related to substations

- Substation
- Number of substations

  Feeding substation: 7

  Feeding substation in rolling stock depots: 2

  - A feeding substation shall be installed near Ngoc Hoi (site area about 18,000 m2)

  - A substation shall separately be installed in the rolling stock depot near the Ngoc Hoi station (site area about 7,500 m2).

  - Substations, each having a similar scale, shall be installed at about 50 km-intervals from the substation at the origin (in Ngoc Hoi) into the direction of Vinh. In this section, seven substations shall be installed in total. Feeding substations shall also be installed at the two rolling stock depots (one near Ngoc Hoi and the other near Vinh).

  - Extra-high voltage transmission lines shall be drawn from the Vietnam Electric Power Company (EVN) into these nine feeding substations.

- Sectioning post (6)

  Sectioning posts shall also be installed between substations (each having a site area of about 6.000 m2).

- Sub-sectioning post (12)

  Sub-sectioning posts (each having a site area of about 1,500 m2) shall also be installed between each substations and sectioning post.

(b) Contact wire system

(i) Structure of Catenary system

6.30 The study team proposes the adoption of the simple catenary system for mainlines and the heavy catenary system in the yards of rolling stock depots in consideration of construction costs, train speed and abrasion resistance

(ii) Supports of contact wires

6.31 To realize a lightweight system, the study team proposes the adoption of steel pipe electric poles in open sections as a standard, fixed beams in rolling stock depots and at other places featuring a nest of wires and drop beam supports in tunnel sections as a standard.

6.32 Contact wires shall be supported with free brackets as a standard.

6.33 The standard interval between steel pipe poles shall be 50m as a standard.

(c) Power distribution system

(i) Substation

6.34 Power shall be supplied from substations to all electric loads other than that for feeding purposes.

6.35 As a principal unit in substations, a closed high-voltage power distribution board shall be installed, which houses transformers, vacuum circuit breakers, storage batteries and protection/control equipment.

6.36 To prepare for power shutdown, an emergency standby generator (gas turbine generator) shall be installed.

6.37 In this section, 9 substations are required in total, with seven for stations and two for rolling stock depots. As signal and telecommunication equipment rooms are placed in the buildings located at 30km intervals along the track, a small distribution station shall be attached to each of the buildings (9 stations in total).

(ii) Power distribution line

6.38 A high-voltage power distribution line (power cable) shall be laid along the entire route to supply power to the load at each basic point.

(iii) Centralized power monitor and control system

6.39 A centralized monitor and control system (power-SCADA system) shall be installed to monitor and control substations on the floor where the operation control center is located.

6.8 Maintenance and Depot

6.40 For storage and maintenance of the rolling stocks, depot and workshop will be constructed. Also maintenance base will be constructed for maintenance of the line.

Table 6.8.1 Depot and Workshop for North Section

Name	Distance from Ngoc Hoi station (junction of mainline)	Area	Facilities			
			Rolling stock storage	Rolling stock Inspection	workshop	Maintenance base
Ngoc Hoi Depot and Workshop	12.200km	380,000m2	○	○	○	○
Nam Dinh maintenance base	68.000km	32,500 m2	–	–	–	○
Ninh Binh maintenance base	104.270km	32,500 m2	–	–	–	○
Thanh Hoa maintenance base	154.570km	38,000 m2	–	–	–	○
Hoang Mai maintenance base	222.300km	28,500 m2	–	–	–	○
Vinh depot	287.770km	281,600m2	○	○		○

Source: JICA Study Team

6.41 Overall track layout of rolling stock and maintenance depot is indicated in Figure 6.8.1.

(1) Rolling Stock Depot

(a) Location of Depot

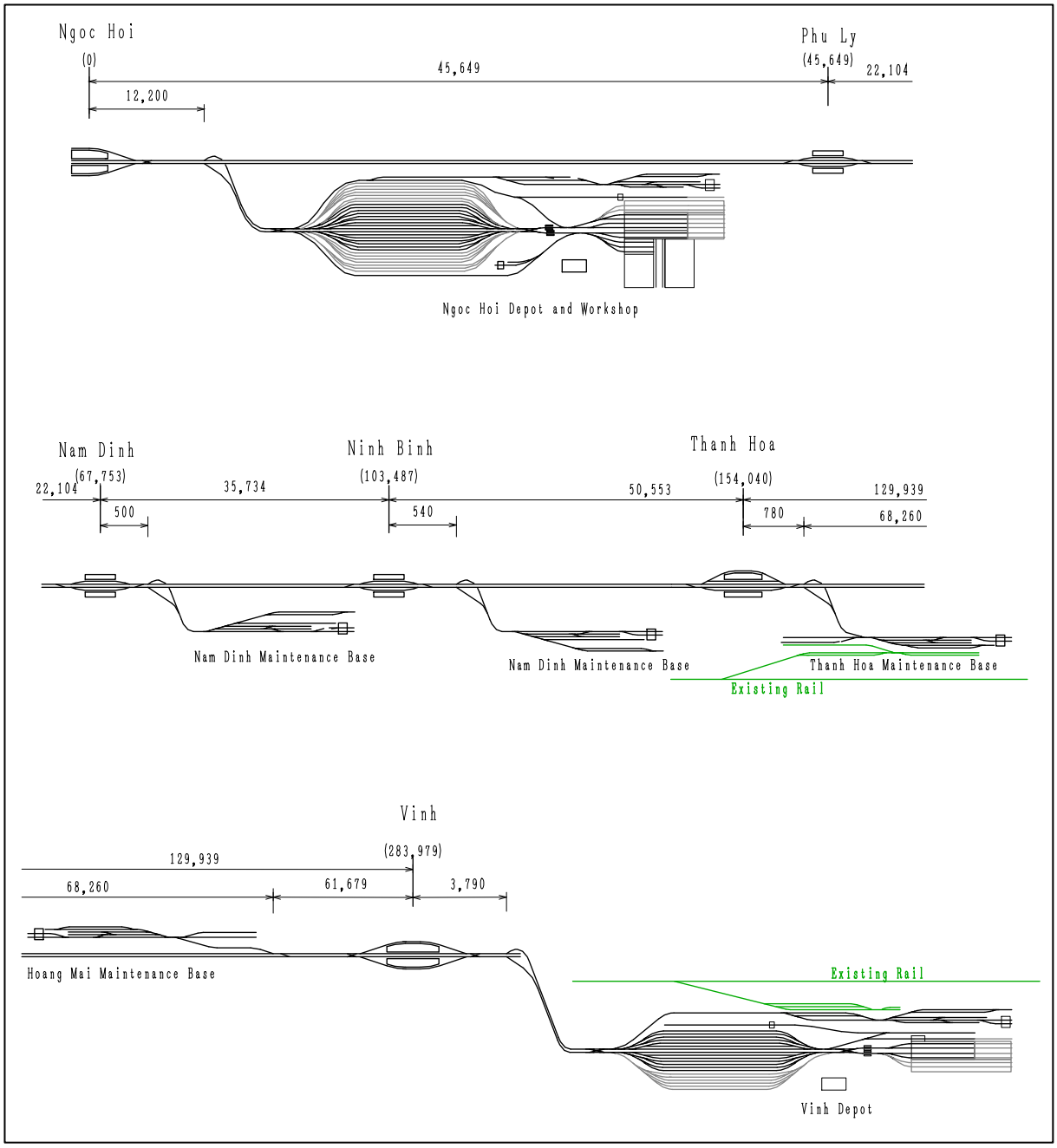
6.42 To minimize the time of running time from depot to terminal, the depot is planned to be located near the terminal station. The depots shall be planned near Ngoc Hoi and Vinh terminal. Workshop is also planned at the same complex of depot for minimizing the transporting of spare parts and efficient use of stabling tracks. Considering that Ngoc Hoi to Phu Ly will be open partially before fully opening the North section, the workshop shall be located near Ngoc Hoi because heavy maintenance or repair works will be required during the partial open of the section and workshop is necessary for those works. Therefore, depots and workshops are planned near Ngoc Hoi and near Vinh station.

(b) Capacity of Depot

6.43 The depot will be planned with enough capacity for trains for storage and inspection until 2040 without additional construction

(i) Stabling Capacity

6.44 Table 6.8.2 indicates number of trains per day and required number of train sets of each period by train operation plan and rolling stock plan.



Source: JICA Study Team

Figure 6.8.1 Outline Track Layout of Depot and Workshop

Table 6.8.2 Number of Trains

	2030	2035	2040
Number of trains per day	69	87	111
Required number of train sets	23	27	32

Source: JICA Study Team

6.45 At night time, trains will return to the depot and stored on stabling tracks. In the year 2040, there will be 32 train sets. Therefore, at least 16 stabling tracks are required for both Ngoc Hoi and Vinh depot. As trains will be put on the inspection track for regular inspection in the night time, the number of stabling tracks can be smaller than 16. But considering that down trains are brought to workshop, it is better

to provide more stabling tracks in Ngoc Hoi Depot than Vinh Depot. There are 16 stabling tracks planned for Ngoc Hoi Depot and 14 stabling tracks for Vinh Depot.

(ii) Capacity of Inspection

6.46 Table 6.8.3 indicates train mileage per day and interval of regular inspection.

Table 6.8.3 Capacity of Inspection Tracks

	2030	2035	2040
Train mileage per day	1,704	1,830	1,970
Interval of regular inspection (day)	17.6	16.4	15.2
Number of trains to be inspected per day	1.3	1.6	2.1

Source: JICA Study Team

6.47 In year 2040, assuming that 16 trains will be deployed for both Ngoc Hoi and Vinh Depot and assuming that it will take one hour for daily inspection, 2 tracks will be occupied for daily inspection. And assuming that it will take 8 hour for regular inspection, one track in each depot will be enough for regular inspection. Considering the occasional repair/inspection totally 4 tracks will be required for inspection tracks in both Ngoc Hoi and Vinh depot.

6.48 Tracks and facilities planned in Ngoc Hoi depot and workshop and Vinh depot are indicated in Table 6.8.4.

Table 6.8.4 Tracks and Facilities of Depot

	Ngoc Hoi depot and workshop	Vinh Depot
Stabling track	16	16
Inspection track	4	4
Test track for workshop	2	-
Mounting and dismounting track	3	-
Train washing plant	2	2
Wheel turning equipment	1	1
Inspection shed for shunting loco	1	-
Water supply system for train	1	1
Train sanitary water disposer	1	1

Source: JICA Study Team

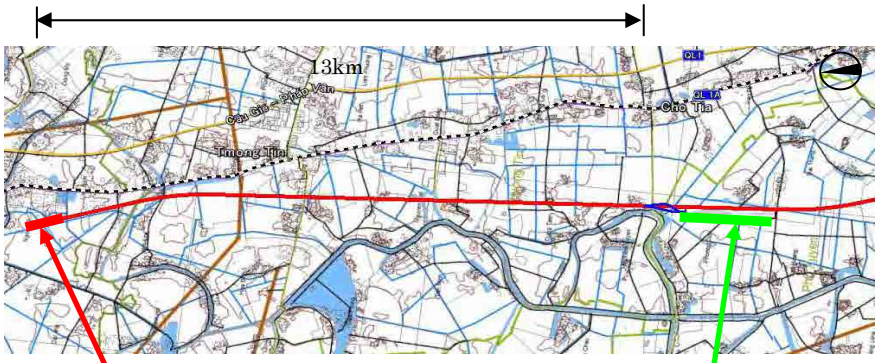
(iii) Provision for Future Expansion

6.49 When north section and south are connected more passengers are expected and 16 cars will be required in the future. For the extension of inspection shed enough space for another 6 cars is kept at backward section of the track.

6.50 For stabling track it will be difficult to extend because both end of stabling tracks are connected with switches therefore, stabling tracks are planned with enough length for 16 cars. For future expansion, space is reserved at the side of stabling tracks. Space for 14 tracks is reserved in Ngoc Hoi Depot and space for 6 tracks is reserved in Vinh Depot.

(c) Ngoc Hoi Depot and Workshop

6.51 Figure 6.8.2 indicates the location of Ngoc Hoi Depot and Workshop. It is planned at about 13km south from Ngoc Hoi station.



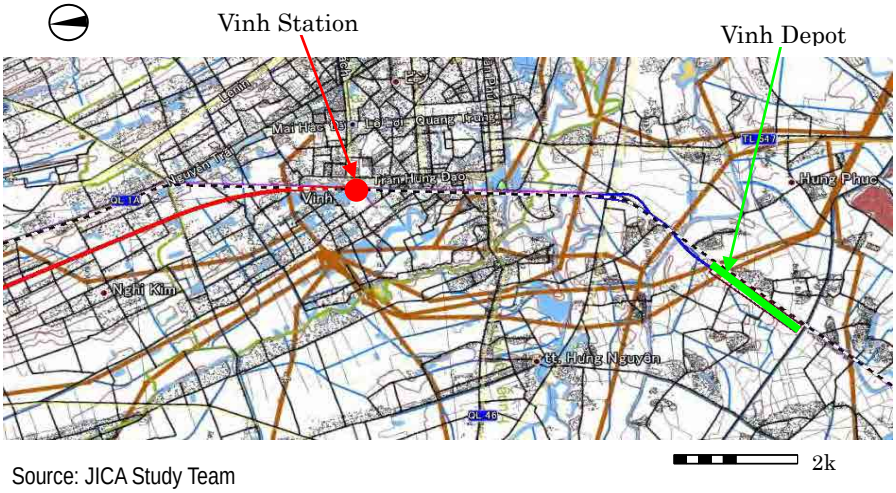
Source: JICA Study Team

Figure 6.8.2 Location of Ngoc Hoi Depot and Workshop

6.52 Figure 6.8.4 indicates its track layout of Ngoc Hoi depot and workshop and Figure 6.8.5 indicates a typical section of depot and workshop. Figure 6.8.6, on the hand, presents a floor plan and major equipments of the workshop.

(d) Vinh Depot

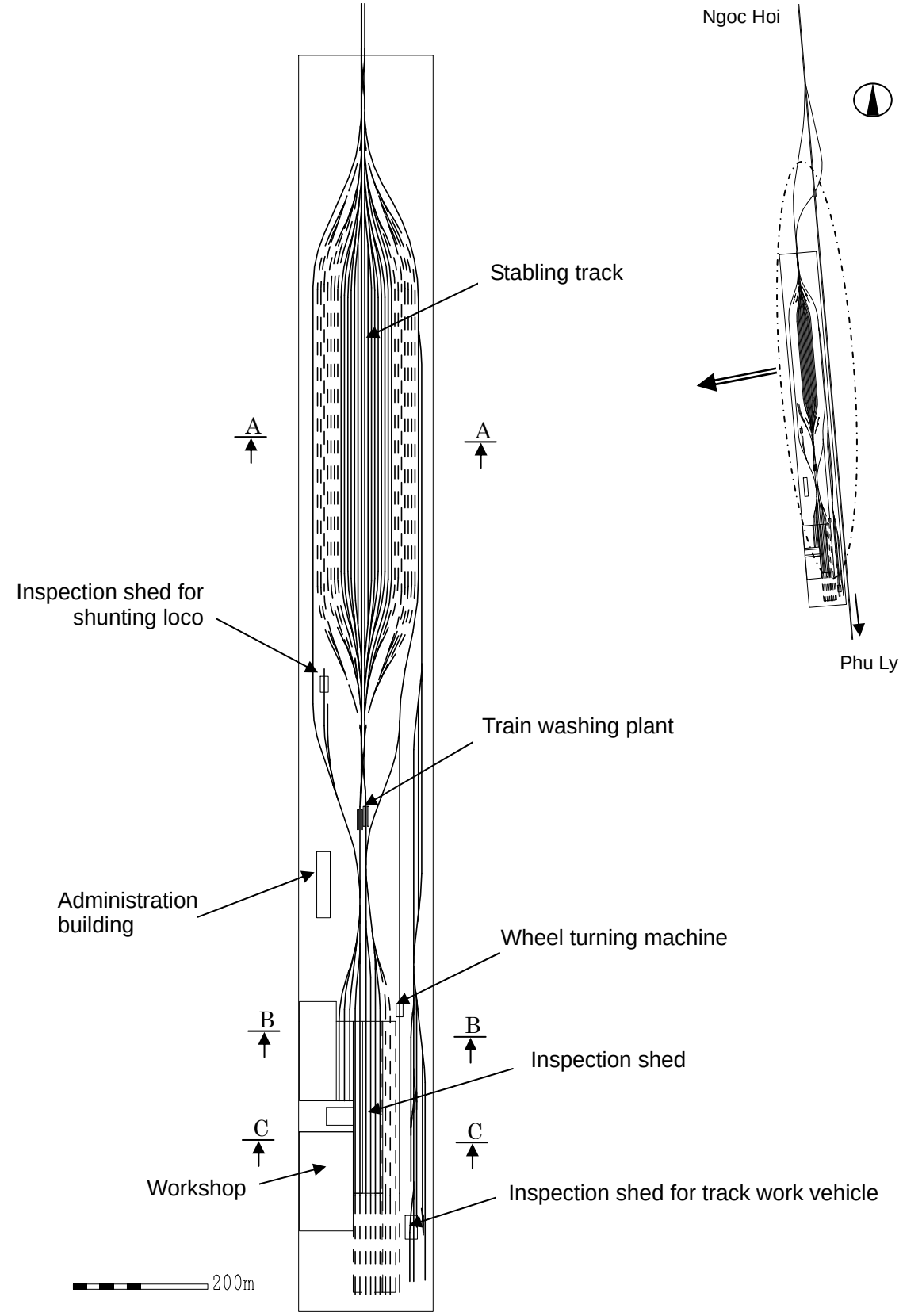
6.53 Vinh depot is planned at about 7km south of Vinh station along the existing railway track. Main line will be constructed from Vins station to south above the existing railway for future extension and access track for depot is planned to branch from there. Figure 6.8.3 indicates location of the depot.



Source: JICA Study Team

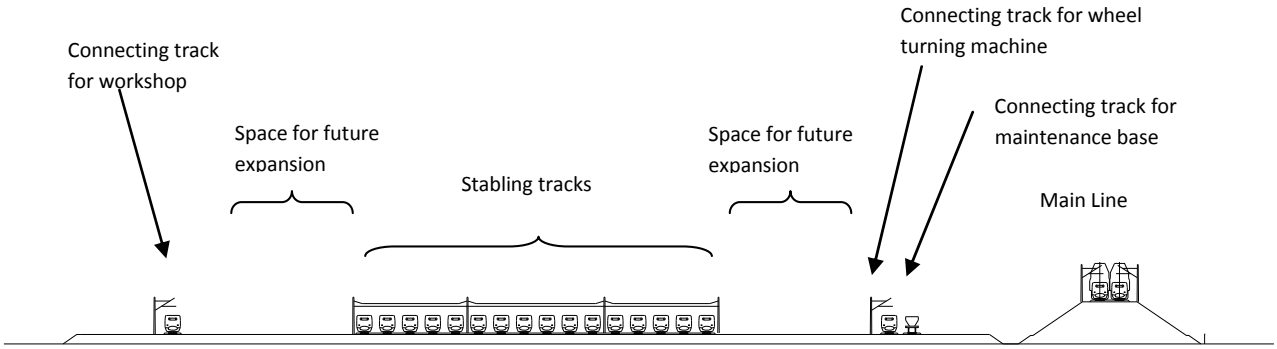
Figure 6.8.3 Location of Vinh Depot

6.54 Tracks and facilities for maintenance base will be put near the existing railway track so that materials can be brought by existing railway. Figure 6.8.7 indicates track layout of Vinh depot and Figure 6.8.8 indicates typical section of the depot.

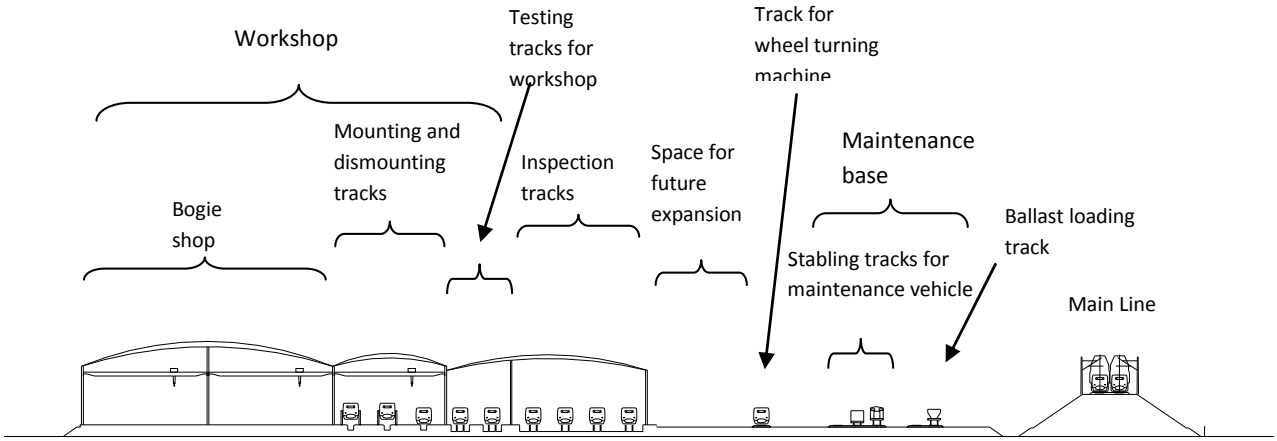


Source: JICA Study Team

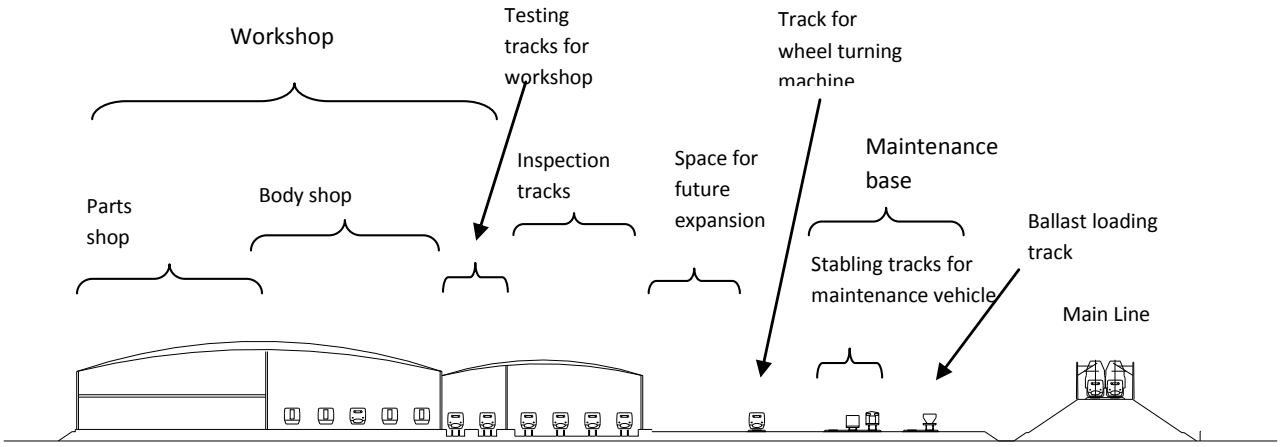
Figure 6.8.4 Track Layout of Ngoc Hoi Depot and Workshop



Section A-A



Section B-B



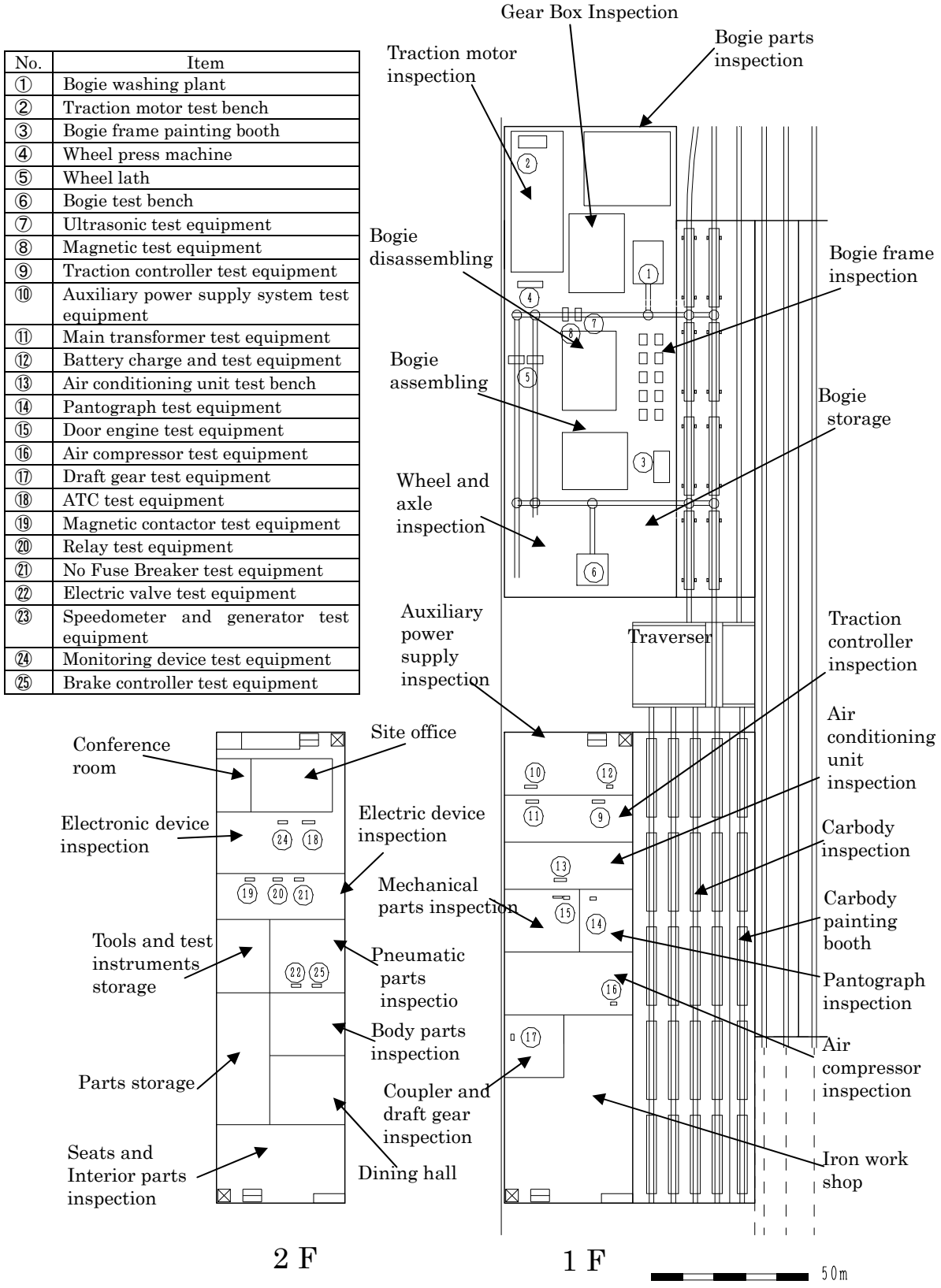
Section C-C

50m

Source: JICA Study Team

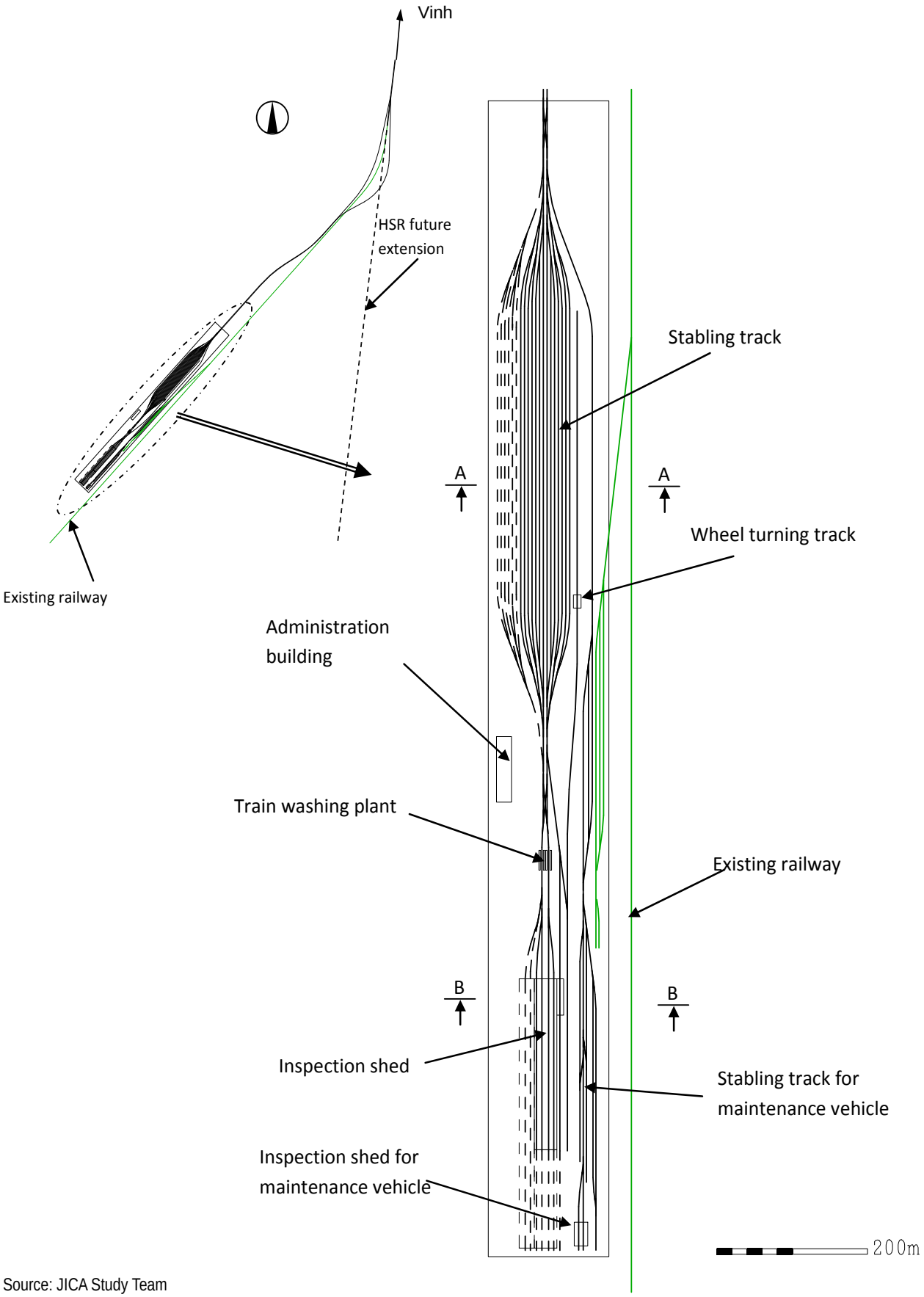
Figure 6.8.5 Section Drawing of Ngoc Hoi Depot and Workshop

No.	Item
①	Bogie washing plant
②	Traction motor test bench
③	Bogie frame painting booth
④	Wheel press machine
⑤	Wheel lath
⑥	Bogie test bench
⑦	Ultrasonic test equipment
⑧	Magnetic test equipment
⑨	Traction controller test equipment
⑩	Auxiliary power supply system test equipment
⑪	Main transformer test equipment
⑫	Battery charge and test equipment
⑬	Air conditioning unit test bench
⑭	Pantograph test equipment
⑮	Door engine test equipment
⑯	Air compressor test equipment
⑰	Draft gear test equipment
⑱	ATC test equipment
⑲	Magnetic contactor test equipment
⑳	Relay test equipment
㉑	No Fuse Breaker test equipment
㉒	Electric valve test equipment
㉓	Speedometer and generator test equipment
㉔	Monitoring device test equipment
㉕	Brake controller test equipment



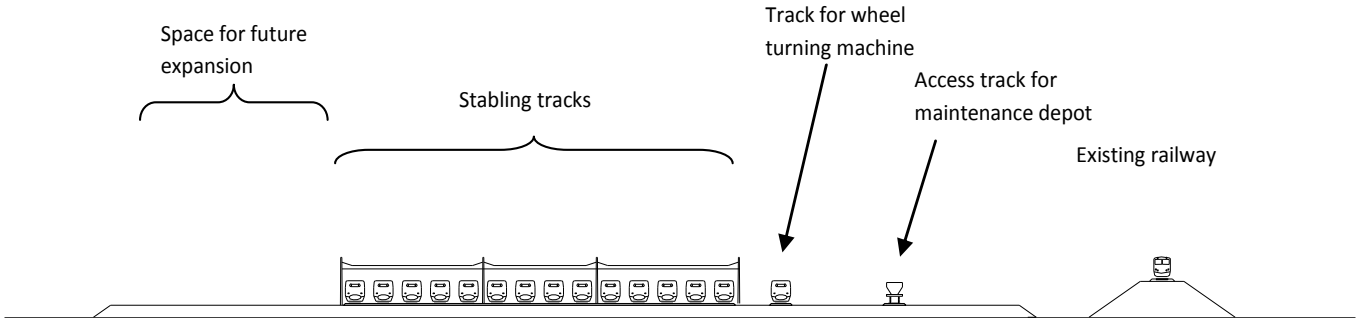
Source: JICA Study Team

Figure 6.8.6 Floor Plan of Workshop

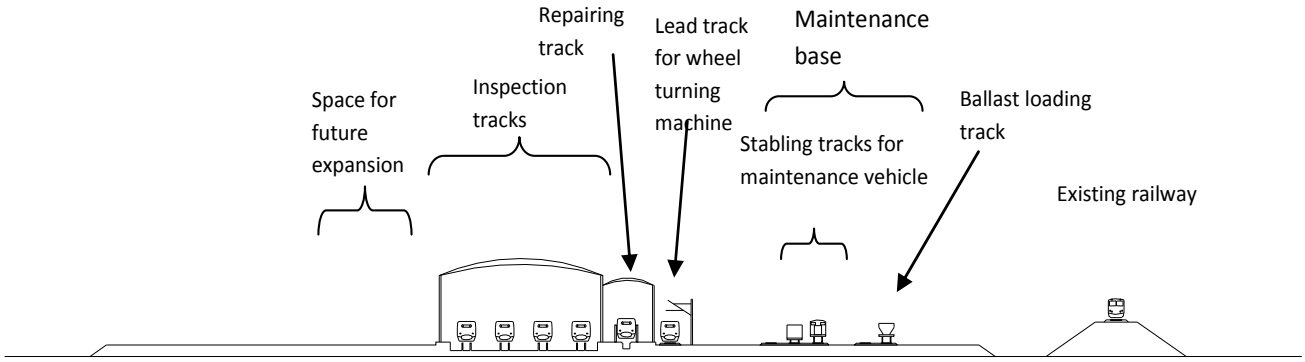


Source: JICA Study Team

Figure 6.8.7 Track Layout of Vinh Depot



Section A-A



Section B-B

50m

Source: JICA Study Team

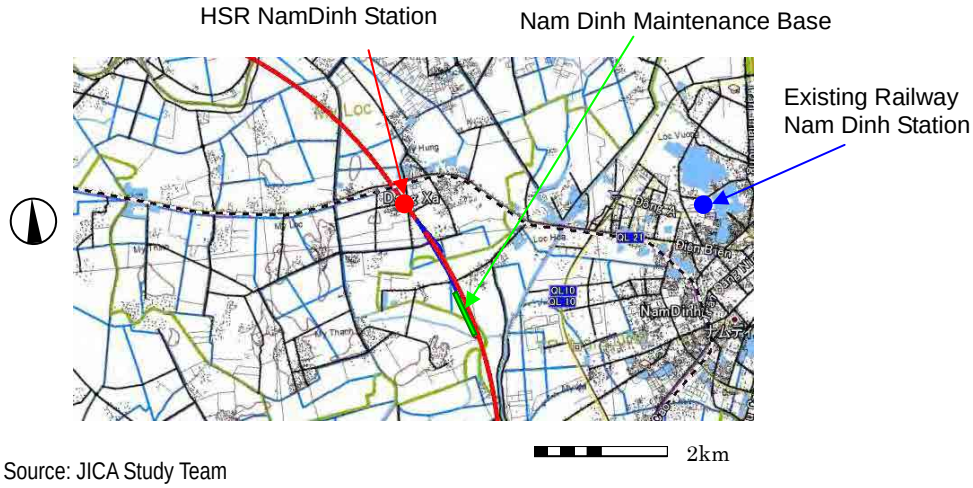
Figure 6.8.8 Section Drawing of Vinh Depot

(e) Maintenance Base

6.55 Maintenance bases are planned for stabling of maintenance vehicles. A maintenance base will be located every 50 to 80 km. Maintenance base is planned in the same location of rolling tock depot for efficient land use. Besides the bases of Ngoc Hoi and Vinh depot, 4 maintenance bases are planned; Nam Dinh maintenance base, Ninh Binh maintenance base, Thanh Hoa maintenance base and Hoang Mai maintenance base.

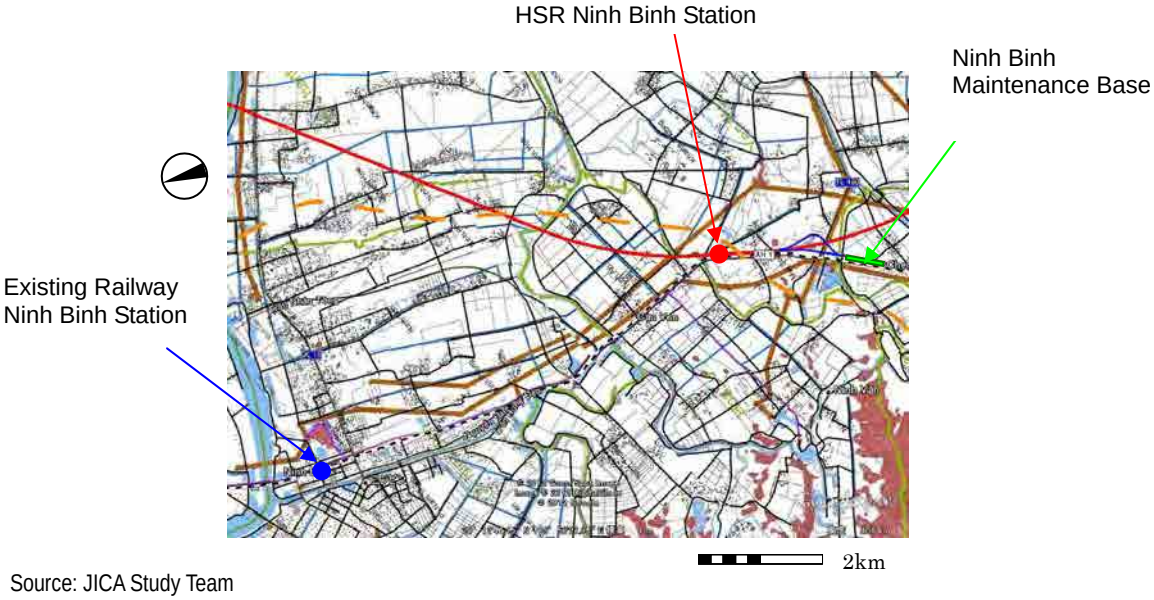
(i) Location of Maintenance Base

6.56 Location of each maintenance base is indicated in Figure 6.8.9 to Figure 6.8.12. Ngoc Hoi and Vinh is indicated in rolling stock depot.



Source: JICA Study Team

Figure 6.8.9 Location of Nam Dinh Maintenance Base

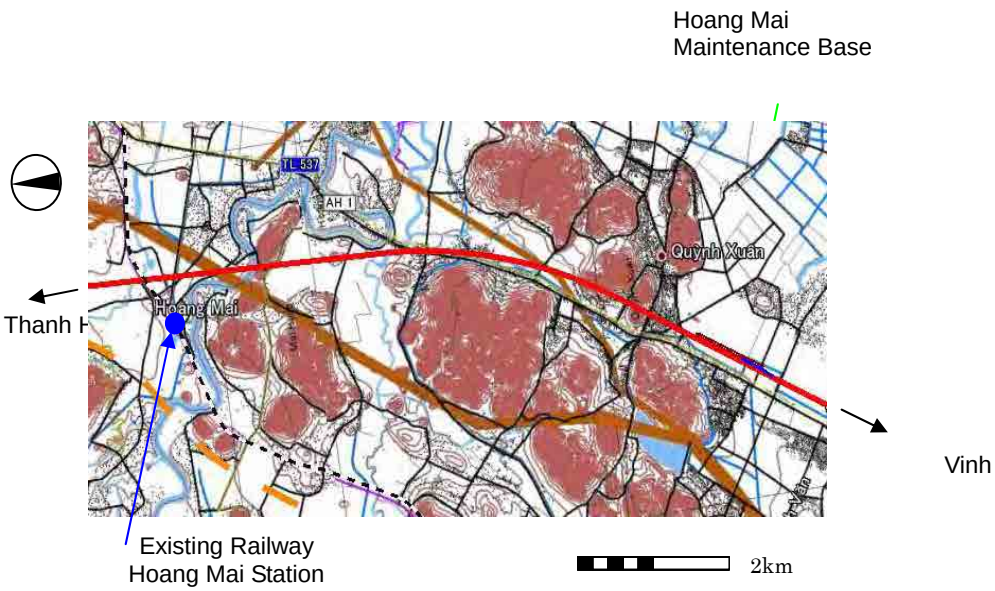


Source: JICA Study Team

Figure 6.8.10 Location of Ninh Binh Maintenance Base

Source: JICA Study Team

Figure 6.8.11 Location of Thanh Hoa Maintenance Base

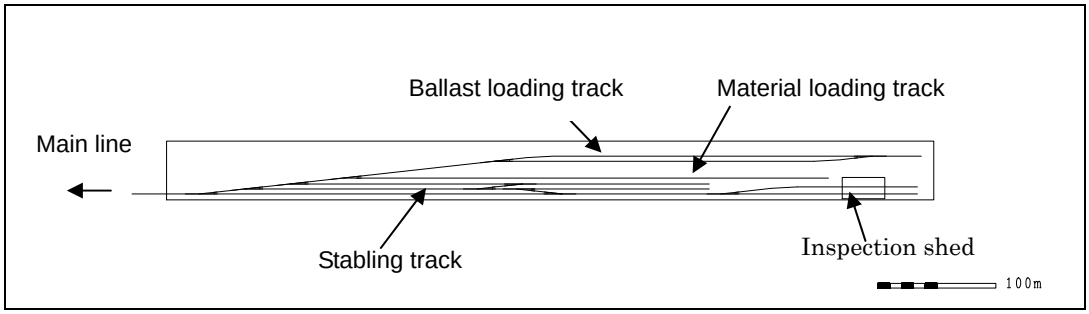


Source: JICA Study Team

Figure 6.8.12 Location of Hoang Mai Maintenance Base

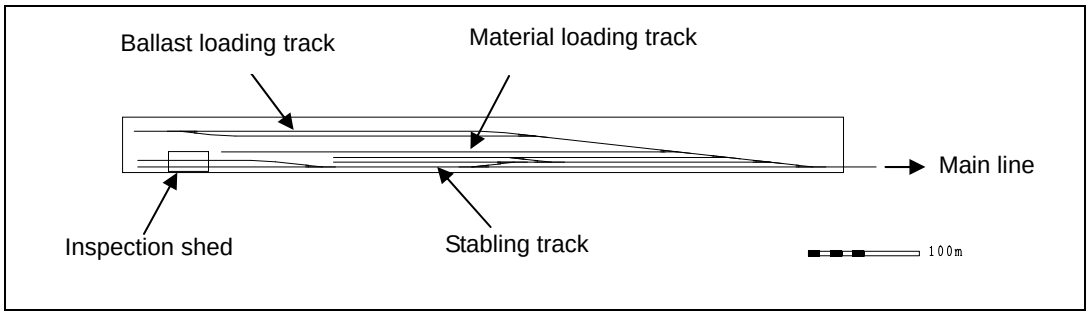
(ii) Track Layout of Maintenance Base

6.57 Track Layouts of maintenance bases are illustrated below.



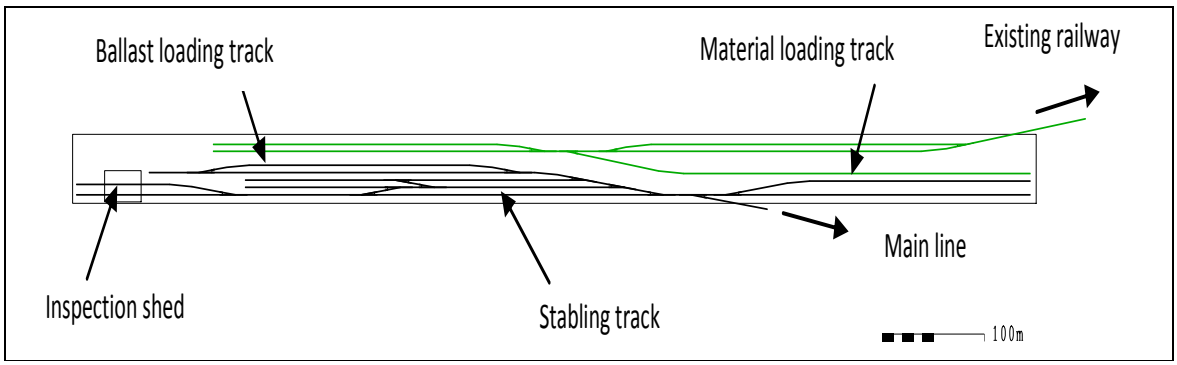
Source: JICA Study Team

Figure 6.8.13 Track Layout of Nam Dinh Maintenance Base



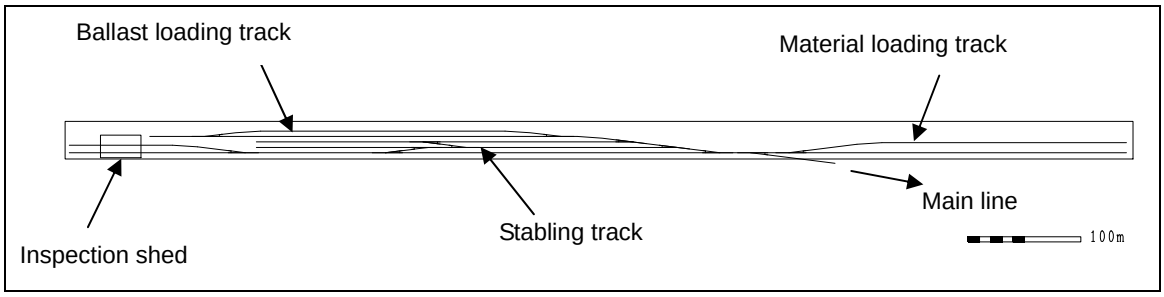
Source: JICA Study Team

Figure 6.8.14 Track Layout of Ninh Binh Maintenance Base



Source: JICA Study Team

Figure 6.8.15 Track Layout of Thanh Hoa Maintenance Base



Source: JICA Study Team

Figure 6.8.16 Track Layout of Hoang Mai Maintenance Base

(f) Maintenance Vehicle

6.58 Table 6.8.5 indicates the number of vehicles to be deployed in each maintenance base.

Table 6.8.5 Maintenance Vehicles

	Ngoc Hoi	Nam Dinh	Ninh Binh	Tanh Hoa	Hoang Mai	Vinh	**Total**
Motor car	2	1	1	1	1	1	**7**
Confirmation car	2	1	1	1	1	1	**7**
Locomotive	1	1	1	1	1	1	**6**
Hopper Wagon	4	4	4	6	6	6	**30**
Tram	4	4	4	4	4	4	**24**
Tamping machine	1	1	1	1	1	1	**6**
Lining machine	1	1	1	1	1	1	**6**
Ballast regulator	1	1	1	1	1	1	**6**
Bolt power wrench	1	1	1	1	1	1	**6**
Rail grinder	1	-	-	-	-	-	**1**
Catenary installation vehicle	1	-	-	-	-	-	**1**
Catenary inspection vehicle	1	1	1	1	1	1	**6**

Source: JICA Study Team

6.9 Operation Controlling System

(1) Controlling Center Location and Future Expansion Plan

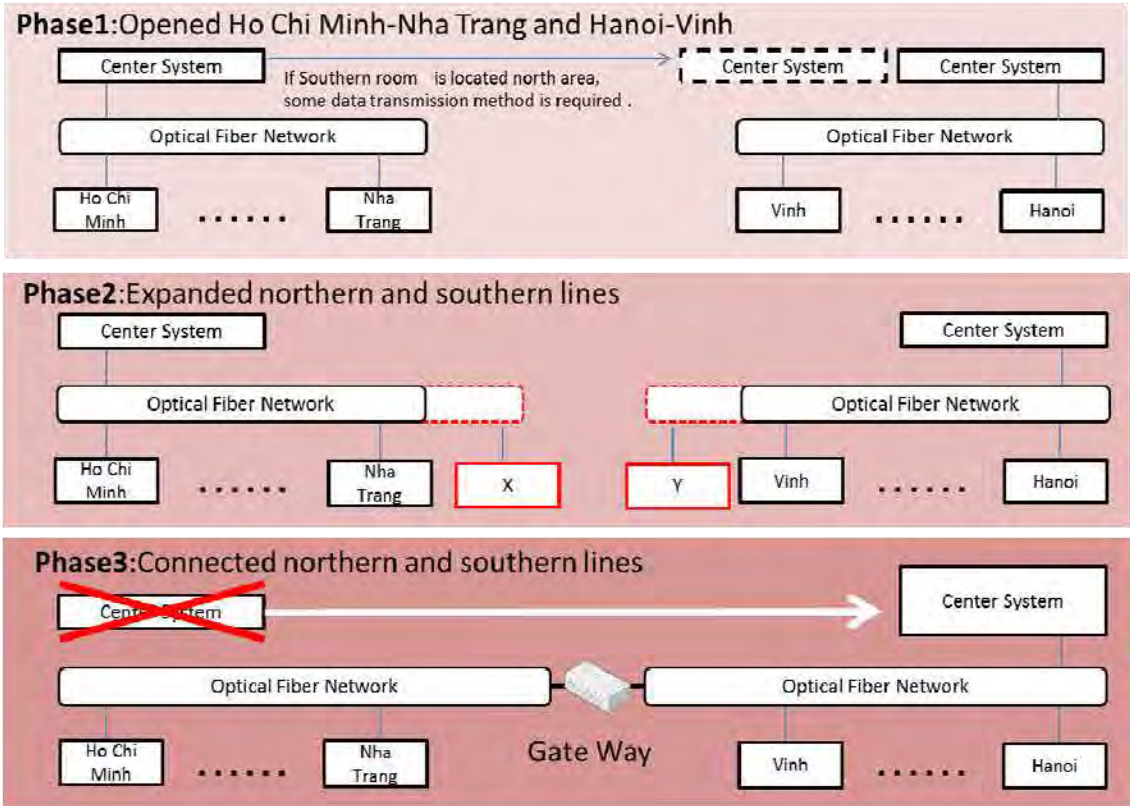
6.59 Controlling centers should be located in northern and southern lines. Phase 1 is the start of High-speed rail service. If Vietnam side requests a unique location, dedicated communication facilities shall be necessary.

6.60 Phase 2 is line extension. Both lines will be extended but Autonomous Decentralized system is available for easy construction.

6.61 Phase 3 is the complete connection between Hanoi and HCMC. In this opportunity, south OCC moved to north and the north OCC should be integrated and computer performance upgraded.

6.62 In general, computer devices' life cycle is 15 years. Due to reasons of expected difficulty in spare parts supply for the hardware and expiry guarantee of the software, system upgrading and replacement should be done.

6.63 Example of JR East, in the last fiscal year, the host computer was replaced since the cut-off life was 1997. New host computer's performance is about 500 times of the old one. System development should be considered in view of future technological advances.



Source: JICA Study Team

Figure 6.9.1 System Integration

7 COST ESTIMATION

7.1 Methodology of Cost Estimation

7.1 In determining the cost of civil engineering works, the actual and/ or calculated unit costs applied for the past, on-going and coming Vietnamese projects are used for reference. For the works with no Vietnamese experience such as electrification, high speed turn-outs, train control system, cars and other sophisticated facilities, Japanese experience in HSR construction are used as a basis for determining the unit cost.

7.2 The following sources of information on unit costs of several civil works items are used:

(i) Unit costs of actual projects procured in Vietnam for embankment、cutting, viaduct, culvert, bridge, tunnel (road tunnel), and related works;

(ii) Unit costs of earth works in bridge construction and tunnels;

(iii) Estimated unit costs based on expected orders for Vietnam's urban railways;

(iv) Standard unit costs set by Vietnam's MOC;

(v) The conversion rate used in calculating the unit cost of construction in Vietnam is based on rate recorded on 22 November 2011, as shown in Table 7.1.1.

Table 7.1.1 Currency Conversion Rate Used in Calculating Unit Construction Costs

USD	VND	JPY	Remark
1	21,000	78	1 JPY=269 VND

Source: JICA Study Team

7.2 Unit Cost on Construction Item

1) Substructure

(a) Embankment

7.3 The cost of embankment consists of (i) main body of the embankment, (ii) embankment slope protection (including drainage, sodding etc.), (iii) land clearing (10% of the unit cost of the main body of the embankment), and (iv) reinforced roadbed. The unit costs of embankment per one meter are calculated for three average heights: (i) 1.5m for 0<H≦3m; (ii) 4.5m for 3<H≦6m; and (iii) 7.5m for 6<H≦9m. The results are shown in Table 7.2.1.

7.4 Road bed of HSR embankments is reinforced with asphalt pavement. Since it is similar to motor expressway asphalt pavement, unit cost of the road bed is based on the contracted prices of Vietnamese expressway projects.

Table 7.2.1 Unit Cost of Embankment

Work Item	Unit Cost	Cost Per m		Range
		USD	VND (Mil)	
Embankment 1	m	3,215	67.52	0<H≦3 m H=1.5 m
Embankment 2	m	4,663	97.92	3<H≦6 m H=4.5 m
Embankment 3	m	7,105	149.21	6 m<H≦9 m H=7.5 m

Source: JICA Study Team

(b) Cut

7.5 The unit costs of cut per meter are calculated as proportionate to the unit costs of embankment. Conversion ratio from embankment to cut is based on the unit costs per m^3 published by MOC (unit cost of embankment 166,000VND/, unit cost of cut 131,240VND, cut/embankment ratio 1/1.265). The calculated unit costs for three average heights are shown in Table 7.2.2.

Table 7.2.2 Unit Cost of Cut

Work Item	Unit	Unit Cost Per m		Remark
		USD	VND (Mil)	
Cut1	m	2,542	53.38	0<H≦3 m H=1.5 m
Cut 2	m	3,686	77.41	3<H≦6 m H=4.5 m
Cut3	m	5,616	117.94	6 m<H≦9 m H=7.5 m

Source: JICA Study Team

(c) Box Culvert

7.6 Culverts are grouped in two types with two typical cross sections: (i) 4.5 m high and 6.0 m wide of inner space for a small country road and (ii) 2.0 m high and 2.0 wide inner space for a small creek. These two types of box culvert are assumed to be built in the embankment. This unit costs include the costs of detouring of country roads and creeks based on the unit costs of MOC. The calculated costs are shown in Table 7.2.3.

Table 7.2.3 Unit Cost of Box Culvert

Work Item	Unit	Unit Cost Per Place		Remark
		USD	VND (Mil)	
Box Culvert 1	m	9,916	208.24	H=4.5 m W=6.0 m
Box Culvert 2	m	4,447	93.38	H=2.0 m W=2.0 m

Source: JICA Study Team

(d) Tunnel

7.7 Unit cost of tunnel varies depending on soil conditions and drilling methods. However, judging from the results of the geological investigations, it is assumed that the full face drilling method can be applied for all the tunnels concerned, except for the tunnel entrance sections. Hence, a unit cost for the tunnels is assumed.

7.8 The unit cost of tunnels is calculated by referencing the unit cost of a completed road tunnel in Vietnam and the unit cost published by MOC, as shown in Table 7.2.4.

Table 7.2.4 Unit Cost of Tunnel

Work Item	Unit	Unit Cost Per m			Remark
		USD	VND (Mil)	JPY	
Tunnel	m	20,905	439.01	1,630,590	Full face tunneling method

Source: JICA Study Team

2) Superstructure

(a) Viaducts

7.9 Standard structure for HSR viaducts is assumed to be T-shaped pre-stressed concrete girders which are similar to the planned viaducts of Hanoi urban metro projects. The unit costs of HSR viaducts are, therefore, based on the estimated costs of Hanoi urban viaducts (pier, abutment, girder, and facilities) with spans of 30-40 meters. However,

considering the fact that most of the HSR works are done in the countryside, the unit costs of viaducts are reduced by 10% from those of Hanoi viaducts. The calculated values are shown in Table 7.2.5.

Table 7.2.5 Unit Cost of T-PC Girder

Work Item	Unit	Unit Cost Per m		Remark
		USD	VND (Mil)	
Viaduct	m	16,950	355.95	L=30 m–40 m

Source: JICA Study Team

(b) Bridge

7.10 Bridges fall into three categories, based on span length (L). The unit costs are set for 3 ranges of lengths: (i) 20 m<L≦40 m PCT girder, (ii) 40 m<L≦60PC box girder, and (iii) 60 m≦L. The relevant references for bridge cost are taken from urban railway projects and the unit cost of Vietnamese highway bridges. The unit cost includes the cost of constructing girder, pier or abutment, and foundation (including piles) including temporary scaffoldings. The results are shown in Table 7.2.6.

Table 7.2.6 Unit Cost of Bridge

Work Item	Unit	Unit Cost Per m		Remark
		USD	VND (Mil)	
Bridge 1	m	19,024	399.50	20 m<L≦40 m,L=30 m
Bridge 2	m	31,386	659.11	40 m<L≦60 m,L=50 m
Bridge 3	m	44,619	937.00	60 m<L

Source: JICA Study Team

(c) Track

7.11 Tracks for HSR are of two types: ballasted track and slab track. The two tracks are with high-standard components used in Japanese HSR. As such, there are no comparable cost data in Vietnam. For the both tracks (especially slab tracks), the unit costs are set by modifying Japanese ones considering the differences in labor, material, and machine cost between Japan and Vietnam. The values thus arrived at are shown in Table 7.2.7.

Table 7.2.7 Unit Cost of Track

Work Item	Unit	Unit Cost Per m of Track		Remark
		USD	VND (Mil)	
Slab Type	m	1,564	32.84	Unit cost per one rail track
Ballast Type	m	833	17.49	Unit cost per one rail track

Source: JICA Study Team

3) Environmental Mitigation

(a) Sound Proof Wall

7.12 The unit cost of sound proof wall with the height of 2.0m installed on a viaduct was calculated at about 2% of the cost of the viaduct from the Japanese experience. As the unit cost of Vietnamese HSR viaduct is assumed to be at 16,950 USD/m, the unit cost of 2.0m tall wall results in 339 USD/m (=2% of 16,950 US$/m). Standard sound proof wall height for Vietnamese HSR is set at 1.0 m from HSR rail level (RL). The unit cost of 1.0m tall wall for one side of the track is estimated at 70% of that of 2.0m tall one, i.e. 237.3

USD/m.

Table 7.2.8 Unit Cost Sound Proof Wall

Work Item	Unit	Unit Cost Per m		Remark
		USD	VND (Mil)	
Sound proof wall	M	237.3	4.98	Height per one side RL~1.0m

Source: JICA Study Team

(b) Tunnel Sound Buffering Hood

7.13 In general, the unit cost of tunnel sound buffering on the Japanese HSR lines is about 50% more than that of tunnel per meter. Consequently, the unit cost of tunnel sound buffering is set at 20,905 USD/m×1.5 = 31,400 USD/m.

Table 7.2.9 Unit Cost of Tunnel Sound Buffering Method

Work Item	Unit	Unit Cost Per m		Remark
		USD	VND (Mil)	
Tunnel sound buffering	M	31,400	659.40	RC Structure 30m~

Source: JICA Study Team

4) Station

7.14 Stations can be categorized in terms of track elevation, track layout and connection with existing lines. Regarding track elevation, there are three types of station, i.e. ground, trench and elevated. On the viewpoint of track layout, station cost varies according to the number of platforms and turn-outs. With respect to the connection with existing lines, stations are grouped in two types, stations where transfer to existing railway is possible and independent stations. Unit costs of civil work for various types of station are estimated referring mainly to the planned urban railway projects. Unit cost of civil work for the stations that intersect with or come close to the existing line is increased by 20% taking the difficulties deriving from the proximity to operating railway into account. The construction costs also take into consideration the softness of the ground in Ngoc Hoi. The unit costs of civil engineering works for various types of station are shown in Table 7.2.10.

7.15 The cost of building a station is obtained by adding up the cost of various components of a station: civil engineering + track (passing track, turn-outs) + building + equipment (elevator, escalator, automatic latch, etc.). Only the sub tracks and turn-outs are counted for station track cost. The costs of main track within the station areas are booked in the item Track.

7.16 Excluded from the cost of a station is signaling, telecommunication and power, which is treated as a separate component of the projects. The unit cost of construction for station plaza is also set separately, and indicated in the itemized cost breakdowns.

Table 7.2.10 Unit Cost of Civil Work for Various Types of Station

Type of Station	Unit	Unit Cost of Civil Work		Applied to
		USD	VND (Mil)	
Ground Station	m^2	1,216	25.54	Ninh Binh
Elevated and Railway Neighboring Station	m^2	2,432	51.07	Phu Ly, Nam Dinh, Thanh Hoa, Vinh
Elevated, Railway Neighboring and Soft Ground Station	m^2	2,513	52.77	Ngoc Hoi

Source: JICA Study Team

5) Depot & Workshop

(a) Depot & Workshop

7.17 The unit costs of building car depots or workshops take into consideration the relevant unit costs in Japan as well as their assumed unit costs for Vietnam's urban railways. In addition, the underlying costs of engineering work, buildings, tracks, equipment, and electric power (light electricity only) are shown on Table 7.2.11.

7.18 Since the two depots in the North Priority Section, one in Ngoc Hoi and one in Vinh, both locate on soft ground, the unit cost of civil engineering work for embankment is evaluated taking soil improvement cost with pre-loading and/or vertical drain into account.

Table 7.2.11 Unit Cost of Various Items for Depots and Workshops

Work Item	Unit	Cost Per Unit		Remark
		USD	VND (Mil)	
Civil engineering (embankment)	m3	26	0.55	Design height 2m, including some anti-soft ground measures
Depot line	m	3,846	80.77	Main body of the embankment, part of viaduct
Building	m^2	538	11.30	All buildings in depots and workshops
Equipment	Set	Accumulated construction cost differs in each depot and workshop		
Track	m	731	15.35	Ballasted track
Turnout 9#	no.	76,923	1615.38	For 50k rail
SC12#	no.	525,641	11,038.46	For 50k rail

Source: JICA Study Team
Depot 1 and Workshop 1: At a distance of 9.3km from Ngoc Hoi. Depot 4 and Workshop 2: At a distance of 9.5km from Thu Thiem.
Depot 2: At a distance of 4.km from Vinh. Depot 3: At a distance of 2.8km from Nha Trang.

(b) Maintenance Depot

7.19 At this stage of feasibility study, exact locations of maintenance depots cannot yet be confirmed. Hence, for the purposes of planning, it is assumed that the depots will be built on ordinary ground with no unusual foundation requirements. However, since the ground in some places along the route alignment is rather soft, the unit cost of construction is increased by about 10% being on the safe side. The unit cost for maintenance depots is added up from the costs of engineering work, buildings, tracks, equipment, and electric power (light electricity only). The unit costs are shown in Table 7.2.12.

Table 7.2.12 Unit Cost of Maintenance Depot

Work Item	Unit	Cost Per Unit		Remark
		USD	VND (Mil)	
Civil engineering (embankment)	m3	26	0.55	Design height 2m, including some anti-soft ground measures
Depot line	m	2,564	53.84	Main body of the embankment, part of viaduct
Building	m^2	385	8.09	All buildings in maintenance depot
Equipment	Set	347,436	7,296.16	Assume unit cost to be the same for all maintenance depots
Track	m	564	11.84	Ballasted track for maintenance depot
Turnout 9#	no.	76,923	1,615.38	For 50k rail

Source: JICA Study Team

6) Electro-mechanical Components

(a) Electrification

7.20 Since there are no electrified railway lines in Vietnam, the unit cost of electrification considered the unit cost of similar works in Japan with appropriate breakdowns for substations, overhead contact lines, and electric lighting. However the cost of electric lightings within stations, depots and workshops are treated as part of the construction cost of those structures. In effect, the unit cost per km shown (in Table 7.2.13 below) is the unit cost for providing tractive power to the trains while in operation.

Table 7.2.13 Unit Cost of Electric Power

Unit Cost	Unit	Unit Cost Per km		Remark
		USD mil	VND bil.	
North, electric power	km	4.49	94.29	Including various facilities, including substation, overhead contact line, electric light, electric power
Include depot	km	4.93	103.53	Ditto
South, electric power	km	4.23	88.83	Ditto
Include depot	km	4.56	95.76	Ditto

Source: JICA Study Team

(b) Signalling, Communication, and Control System

7.21 Similar to cost estimation of the power system, the unit cost of signaling, telecommunication and train operation control system is set by referencing the unit cost of such facilities in Japan, taking into account the breakdown into signaling cables, communication cables, interlocking electronic devices, communication equipment room, and train operation control system. The unit costs are indicated in Table 7.2.14.

Table 7.2.14 Unit Cost of Signalling and Telecommunication

Unit Cost	Unit	Unit Cost Per km		Remark
		USD mil	VND bil.	
North, signaling, telecommunication	km	2.24	47.04	Including signaling (signaling system, traffic control), telecommunication (transmission equipment, AFC: Automation Frequency Control)
South signaling, telecommunication	km	2.08	43.68	Including signaling (signaling system, traffic control), telecommunication (transmission equipment, AFC: Automation Frequency Control)

Source: JICA Study Team

(c) Cost of Rolling Stock

7.22 The unit cost of railcars in Japan is adopted as the Japanese train-sets are assumed in the operation plan. Insurance and shipping cost are factored in as a percentage of the car cost. The unit cost is shown in Table 7.2.15.

Table 7.2.15 Unit Car Cost

Unit Cost	Unit	Unit Cost Per Car		Remark
		USD mil	VND bil.	
Car	Car	4.75	99.75	23 train sets, 230 cars

Source: JICA Study Team

7) Land Acquisition Cost

7.23 The route alignment investigation provided the area of land required. The unit cost is generalized as to locations, as well as whether built-up or open land. The unit cost by type of land referenced road and rail projects in Vietnam. Similarly, resettlement compensation and related costs are based on past infrastructure projects. Refer to Volume II Part 1 and 2 Chapter 11 and Volume III Chapter 7 (Resettlement and Rehabilitation Policy Framework) for the detailed conditions for calculating land acquisition costs.

Table 7.2.16 Unit Cost of Land for Hanoi – Vinh Section

Unit Cost in VND (Market Price)		Unit	Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An
Compensation for Land	Agricultural Land	m^2	745,000	179,333	242,000	219,600	187,800	256,400
	Residential Land	m^2	18,422,333	4,519,667	6,247,750	6,515,000	7,064,900	7,093,200
	Vacant Land	m^2	18,422,333	4,519,667	6,247,750	6,515,000	7,064,900	7,093,200
	Commercial Land	m^2	9,211,333	2,711,667	3,436,250	4,560,600	4,945,400	3,546,600
Compensation for Assets	Structures	m^2	3,491,000	2,707,667	2,631,000	2,722,333	2,678,000	2,696,667
	Forest Trees	m^2	0	80,000	100,000	100,000	150,000	120,000
	Fruit Trees	m^2	500,000	400,000	350,000	350,000	350,000	350,000
	Crops (Rice)	m^2	8,000	6,000	6,000	5,000	4,000	3,500
	Crops (Aquaculture)	m^2	2,400	2,400	2,400	2,400	2,400	2,400
	Crops (Others)	m^2	12,000	5,100	5,500	6,000	6,000	6,000
Allowance for Relocation		HH	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Allowance for Livelihood Stabilization for HHs		HH	15,000,000	15,000,000	15,000,000	15,000,000	15,000,000	15,000,000
Allowance for Livelihood Stabilization for Business		HH	9,500,000	9,500,000	9,500,000	9,500,000	9,500,000	9,500,000
Job Trainings		HH	800,000	800,000	800,000	800,000	800,000	800,000
Assistance for Vulnerable HH		HH	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Bonus for Cooperating Resettlement		HH	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
RAP Preparation and Independent Monitoring		Lump Sum	7,809,043,921					
Administration Cost (5% of total cost)								
Contingency (10% of total cost)								

Source: JICA Study Team

7.3 Estimate of Construction Cost

1) Construction Cost by Work Package

7.24 From the unit cost of construction in the preceding sections, and the calculated quantities, volumes, or lengths for each structure, it is possible to compute the construction cost. The results for the Ngoc Hoi–Vinh section are shown in Table 7.3.1.

Table 7.3.1 Construction Cost by Work Package for Hanoi – Vinh Section

Item	Work Package	Unit	Quantity	Unit Cost		Construction Cost	
				USD mil./km	VND bil./km	USD mil.	VND bil.
Embankment	0-3m	km	29.780	3.2	67.2	95.7	2,009.7
	3-6m	km	38.190	4.7	98.7	178.1	3,740.1
	6-9m	km	51,660	7.1	149.1	367.0	7,707.0
	Subtotal	km	119.630			640.8	13,456.8
Cut	0-3m	km	2.990	2.5	52.5	7.6	159.6
	3-6m	km	2.480	3.7	77.7	9.2	193.2
	6-9m	km	4.390	5.6	117.6	24.7	518.7
	Subtotal	km	9.860			41.5	871.5
Viaduct		km	128.633	17.0	357.0	2,182.0	45,822.0
Bridge	T-PC girder	km	-	-	-	-	-
	Box-PC	km	4.19	19.0	399.0	131.5	2,761.5
	Long ridge	km	1.99	31.4	659.4	88.8	1,864.8
	Subtotal	km	6.090	44.6	936.6	220.3	4,626.3
Box Culvert	2m	km	0.900	4.4	92.4	4.1	86.1
	6m	km	1.353	9.9	207.9	13.4	281.4
	Subtotal	km	2.253			17.5	367.5
Tunnel		km	15.400	20.9		321.9	6,759.9
Civil Work Total		km				3,424.0	71,904.0
Track	Slab Type	km	307.000	1.6	32.8	480.1	10,083.1
	Ballast Type	km	261.000	0.8	17.5	217.4	4,565.7
	Subtotal	km	568.000			697.6	14,648.8
Total		km				4,121.6	86,552.9

Source: JICA Study Team

2) Station

7.25 The construction cost of each station between Ngoc Hoi and Vinh is shown in Table 7.3.2. The cost for electricity is only for lighting in the building, and is not part of the overall power system cost. Likewise, track work is excluded from the main track work cost.

3) Depot and Workshop

7.26 The construction cost of each Depot Workshop in Ngoc Hoi and Vinh are shown in Table 7.3.3. These construction cost consist of Civil, Architectural, E&M equipment, track, turnout and entrance exit line. Electricity work costs in each depot/ workshop include only lightings; the rest form part electric power and signaling & telecommunication.

Table 7.3.2 Construction Cost of Stations, in Ngoc Hoi–Vinh

Station		Ngoc Hoi (elevated)	Phu LY (elevated)	Nam Dinh (elevated)	Ninh Binh (ground)	Thanh Hoa (elevated)	Vinh (elevated)	Total
Quantity of Station Area (m2)		21,700	17,400	17,400	17,400	30,900	26,100	130,900
Civil	VNDbil	1,145.4	893.4	888.5	444.3	1,577.9	1,332.8	6,282.2
	US$mil	54.5	42.5	42.3	21.2	75.1	63.5	299.2
Artc	VNDbil	484.3	222.0	230.0	222.0	300.6	460.1	1,919.1
	US$mil	23.1	10.6	11.0	10.6	14.3	21.9	91.4
E & M	VNDbil	200.6	98.0	100.8	117.3	120.9	211.3	849.0
	US$mil	9.6	4.7	4.8	5.6	5.8	10.1	40.4
PT&	VNDbil	74.1	89.5	89.5	55.0	117.8	130.2	556.1
Turnout	US$mil	3.5	4.3	4.3	2.6	5.6	6.2	26.5
SubTotal	VNDbil	1,904.4	1,302.8	1,308.8	838.6	2,117.2	2,134.4	9,606.3
	US$mil	90.7	62.0	62.3	39.9	100.8	101.6	457.4
Station	VNDbil	66.4	37.7	69.7	56.9	86.7	64.6	381.9
Plaza	US$mil	3.2	1.8	3.3	2.7	4.1	3.1	18.2
Total	VNDbil	1,970.8	1,340.5	1,378.5	895.5	2,203.9	2,199.0	9,988.1

Source: JICA Study Team

Table 7.3.3 Construction Cost of Depot/ Workshop

	Work Item	Quantity	Unit	Construction Cost	
				USD mil.	VND bil.
Ngoc Hoi ($380,000m^2$)	Civil Work	1,565,600	m^3	40	843
	Entrance & Exit Line	1,840	m	7	149
	Architecture	44,586	m^2	24	504
	Equipment for E&M	1	set	69	1,450
	Track	18,630	m	14	287
	Turnout 9#	64	no.	5	103
	Scissors Crossover 12#	2	no.	1	22
	Total			160	3,358
Vinh ($281,600m^2$)	Civil Work	1,168,640	m^3	30	629
	Entrance & Exit Line	5,040	m	19	407
	Architecture	11,431	m^2	6	129
	Equipment for E&M	1	set	18	373
	Track	16,300	m	12	250
	Turnout 9#	44	no.	3	71
	Scissors Crossover 12#	2	no.	1	22
	Existing Line	1,460	M	1	17
	Turnout #8	6	no.	0.4	8
	Total			91	1,907

Source: JICA Study Team

4) Maintenance Depots

7.27 The construction cost of each maintenance depot between Ngoc Hoi and Vinh is shown in the tables below. There are four (4) maintenance depots to be constructed with a total cost of USD 51.8 million.

Table 7.3.4 Construction Cost of Maintenance Depot

	Work Item	Quantity	Unit	Construction Cost	
				USD mil.	VND bil.
Nam Dinh (32,500 m^2)	Civil Work	68,900	m^3	1.8	37
	Entrance & Exit Line	2,690	m	10.3	216
	Architecture	648	m^2	0.2	5
	Track	2,350	m	1.7	36
	Turnout 9#	11	no.	0.8	18
	External Equipment	1	unit	0.3	7
	Total			15.3	321
Ninh Binh (32,500 m^2)	Civil Work	68,900	m^3	1.8	37
	Entrance & Exit Line	2,410	m	9.3	195
	Architecture	648	m^2	0.2	5
	Track	2,350	m	1.7	36
	Turnout 9#	11	no.	0.8	18
	External Equipment	1	unit	0.3	7
	Total			14.2	298
Thanh Hoa (38,000m^2)	Civil Work	81,700	m^3	2.1	44
	Entrance & Exit Line	2,800	m	10.8	227
	Architecture	648	m^2	0.2	5
	Track	2,450	m	1.8	38
	Turnout 9#	11	no.	0.8	18
	Existing Line	1,710	m	1.0	20
	Turnout 8#	4	no.	0.3	5
	External Equipment	1	unit	0.3	7
	Total			17.3	363
Hoang Mai (28,500m^2)	Civil Work	62,700	m^3	1.6	34
	Entrance & Exit Line	470	m	0.2	4
	Architecture	648	m^2	0.2	5
	Track	2,450	m	1.8	38
	Turnout 9#	11	no.	0.8	18
	External Equipment	1	unit	0.3	7
	Total			5.0	105

Source: JICA Study Team

5) Electro-mechanical Components

(a) Power System

7.28 The construction cost of electric power includes all electric power equipment, except those for lightings of all stations, all depots and all maintenance depots. The construction cost for the Power System between Ngoc Hoi and Vinh is shown in Table 7.3.5. Total cost amounts to USD 1,397 million.

Table 7.3.5 Cost of Power System Ngoc Hoi to Vinh

No	Work item	Unit	Quantity	Unit Cost	Work Cost	Unit Cost	Work Cost	US$/km
				JPY100 mil	JPY100 mil	US$	US$ mil	million
1	Electric power equipment	unit			418		535.9	
2	Overhead line equipment(OH)	km	283.38	0.9	255	1.2	327.0	
3	Electric light Power(ELP)	Unit			312.7		400.9	
4	Power –SCADA	no's	1	20	20		25.6	
	Total (1~4)		283.38		1,005.7	(3.55)	1,289.4	4.55
5	Depot SS(Sub Station),OH.ELP,etc.	Unit			84		107.7	
6	Grand total (1~5)		283.38		1,089.7	(3.85)	1,397.1	4.93
Notes: Number of Station = 3 (large) and 3 (small& medium) Number of Depot = 2; Power-SCADA system = 1				( ) =100mil Yen/km Length of Section = 283.380 km				

Source: JICA Study Team

Table 7.3.6 Cost of Power System Test Line on Ngoc Hoi to Phu Ly

No	Work item	Unit	Quantity	Unit Cost	Work cost	Unit Cost	Work Cost	US$/km
				JPY100 mil	JPY100 mil	US$	US$ mil	million
1	Electric power equipment	unit			113		144.9	
2	Overhead line equipment(OH)	km	46	0.9	41	1.2	52.6	
3	Electric light Power(ELP)	Unit			66.8		85.6	
4	Power –SCADA	no's	1	20	20		25.6	
	Total (1~4)		46		240.8	(5.23)	308.7	6.71
5	Depot SS(Sub Station),OH,ELP, etc.	Unit			42		53.8	
6	Grand total (1~5)		46		282.8	(6.15)	362.6	7.82
Notes: Number of station = 2 (large) Number of Depot = 1; Power-SCADA system = 1				( ) =100mil Yen/km Length of section = 46 km				

Source: JICA Study Team

(b) Signaling &Telecommunication

7.29 The construction cost for signaling and telecommunication includes all S&T equipment. This total cost for the Ngoc Hoi to Vinh section amounts to USD 646 million as shown in Table 7.3.7.

Table 7.3.7 Signalling and Telecommunication Cost from Ngoc Hoi to Vinh

		Work Cost	Unit Cost	Work Cost	Unit Cost
		JPY100 mil	100milYen/km	US$, mil	US$/km, mil
Signalling	Equipment	219		281	
	Operation Management	60		77	
	Subtotal	279	0.97	358	1.24
Telecommunication	Equipment	211		270	
	AFC	14		18	
	Subtotal	225	0.78	288	1.00
Total		504	1.75	646	2.24
Length of section = 288 km					

Source: JICA Study Team

6) Cost of Environmental Mitigations

7.30 The environmental countermeasures for noise from the HSR trains running on the viaduct adopt the sound proof wall (SPW). Likewise, the countermeasure of micro-pressure wave at tunnel entrance adopts the tunnel entrance buffering hood (TEBH). The costs for both countermeasures are shown in Table 7.3.8.

Table 7.3.8 Cost of Environmental Mitigation

Structure	Length	Unit Cost	Construction Cost	
	m	USD/m	JPY 100 mill	US$ mil
Sound Proof Wall	92,820	237.3	17.2	22.0
Tunnel Entrance Buffering Hood	1,196	31,357	29.3	37.5

Source: JICA Study Team

7) Cost of Track Infrastructure

7.31 The construction cost of the carriageway, between the stations in the Ngoc Hoi – Vinh section is given in Table 7.3.9.

Table 7.3.9 Construction Cost of Track Infrastructure

Station	**Ngoc Hoi**		**Phu Ly**		**Nam Dinh**		**Ninh Binh**	**Thanh Hoa**			**Vinh**		**Total**
Distance (km)	**0.6**	**44.8**	**0.7**	**21.5**	**0.7**	**35.1**	**0.7**	**49.6**	**1.0**	**128.6**	**0.8**	**4.4**	**284.0**
Cut (km)		0		0		0		3.2		6.7			9.9
Cost (mil US$)		0		0		0		13		29			**42**
Embankment (km)		11.8		5.05		4.67		24.55		73.59			119.7
Cost (mil US$)		58		35.9		27.7		142.8		376.13			**641**
Viaduct(km)		32.2		16.04		29.2		13.9		37.3			128.6
Cost (mil US$)		546		272		495		236		633			**2,182**
Bridge(km)		0.9		0.4		1.2		1.7		1.9			6.1
Cost (mil US$)		41		17		51		76		85			**220**
Box Culvert(m)		0.236		0		0.093		0.49		1.47			2.3
Cost (mil US$)		1.8		0		0.7		3.8		11.4			**18**
Tunnel (km)		0		0		0		6.4		9			15.4
Cost (mil US$)		0		0		0		134		188			**322**
Track(km)	0.615	44.82	0.65	21.47	0.65	35.08	0.65	49.62	1.00	128.64	0.82		283.5
Cost (mil US$)	2.0	123.2	2.0	59.8	2.0	102.8	1.1	115.0	3.2	284.6	2.6		**698**
Station Area (m2)	21,700		17,400		17,400		17.400		30,900		26,100		130,900
*Cost (mil US$)	93.8		63.8		65.6		42.6		104.9		104.7		**476**
EP(km)		Include Depot+WS										Depot+WS	
Cost (mil US$)		363						980				54	**1,397**
S&T(km)		46.1											
Cost (mil US$)		173						473					**646**
Depot&WS(m2)		380,000										281,600	
Cost (mil US$)		114		46 *								91	**251**
MD(m2)						32,500		32,500		38000+28500(2 no's)			
Cost (mil US$)						15.3		14.2		17.3+5.0(2no's)			**52**
SPW(km)	0	18.7	0.35	11.1	0.35	18.5	0	13.2	0.7	29.4	0.52		92.8
Cost (mil US$)	0.0	4.4	0.1	2.6	0.1	4.4	0.0	3.1	0.2	7.0	0.1		**22**
THBM(km)								0.56		0.63			1.2
Cost (mil US$)								17.6		19.9			**38**
Sub Total													
Cost (mil US$)													**7,004**
Rolling Stock (No.)		12											230
Cost (mil US$)		57											**1,093**
Cost of between	357.9	735.6	51.3	1145									
stations(milUS$)	458.8	943.0	65.8	1,468									**8,097**
Right of Way (ha)	3.9	163.9	2.4	48.1	2.6	112.8	4.3	179.2	4.6	453.4	38.4		1,014
Cost (mil US$)	6.2	127.2	0.5	41.0	1.7	79	1.3	291.6	7.2	300.9	163.5		**1,020**
Total Cost (mil US$)		**1,777**						**7,340**					**9,117**

*The cost of each station consist of Civil, Architecture, E (only light electricity) &M and Track(only passing track & turnout)
**The cost of each depot consist of Civil, Architecture, E (only light electricity) &M ,Track and depot line.
EP : Electric Power, S&T: Signal & Telecommunication, MD: Maintenance Depot, SPW: Sound Proof Wall, TEBH: Tunnel Entrance Buffering Hood

Source: JICA Study Team

8) Initial Section

7.32 The initial construction section in the Ngoc Hoi – Phu Ly is estimated to cost about US$ 2.0 billion as shown in Table 7.3.10 below. It is approximately 20.0% of the cost of the north section.

Table 7.3.10 Cost for Northern HSR Initial Section

Item		Local (VND mil.)	Foreign		Total	
			US$ mil.	(VND mil.)	VND mil.	US$ mil.
1. Civil Works and Structures		12,304	65	1,367	13,671	651
2. Tracks		1,093	75	8,652	2,667	127
3. Stations		3,019	14	903	3,318	158
4. Electricity		839	323	26,103	7,623	363
5. Signal and Telecommunications		218	163	12,747	3,633	173
6. Maintenance Depots and Workshop		1,077	63	3,402	2,394	114
Subtotal (1 - 6)		18,551	703	53,174	33,306	1,586
7. Maintenance of Equipment		0	21	441	0	21
8. Training Fee		437	5	109	546	26
Subtotal (1 - 8)		18,987	729	53,724	33,852	1,633
9. Rolling Stocks		0	57	1,197	1,197	57
10. Land Acquisition and Compensation		28,140	0	0	2,814	134
Subtotal (1 - 10)		47,127	786	54,921	37,863	1,824
11. Consulting Service		759	28	2,131	1,354	64
12. Reserves (5% of 1, 2, 3, 4, 5, 6, 8, 11)		987	37	2,771	1,760	83
13. Other tax[1)]		949	0	0	949	45
Subtotal (11, 12, 13)		2,696	65	4,902	4,064	192
Total	1 – 13	49,824	851	59,823	41,927	2,016
	Excluding Rolling Stocks	49,824	794	58,626	40,730	1,959
	Excluding Land	21,684	851	59,823	39,113	1,882
	Excluding RS and Land	21,684	794	58,626	37,916	1,825
Project Cost per km	1 - 13	1,093	18.7	1,312	919	44.2
	Excluding Rolling Stocks	1,093	17.4	1,286	893	43.0
	Excluding Land	476	18.7	1,312	858	41.3
	Excluding RS and Land	476	17.4	1,286	831	40.0

Source: JICA Study Team.
1) Tax is calculated at 10% of local cost for construction material, therefore local cost * 50% (percentage of material) * 10% (tax).
2) Price escalation is not reflected to the above cost.

7.4 Support Equipment

1) Maintenance Cars

7.33 The distance between stations in Vietnam's HSR ranges from 27 km to 139 km. The plan calls for installation of maintenance bases between stations. From the beginning of operation, it is necessary to provide these bases with maintenance machines that will perform maintenance work without relying on manpower. In order to maintain the maintenance system for Vietnam's HSR, Table 7.4.1 Cost for Track Maintenance and Table 7.4.2 Cost for Electricity Maintenance will be provided in the working areas for the Ngoc Hoi – Vinh section. Most of the machines listed in the table will be used for the track construction work.

Table 7.4.1 Cost of Track Maintenance Equipment, North Section

Ngoc Hoi-Vinh Item	Quantity	Unit Cost (100milyen)	Total (100milyen)	Total (US$ mil.)
Motor car	7	0.4	3	3.6
Confirmation car	12	0.8	9.6	12.3
Locomotive	6	2.0	12	15.4
Hopper Wagon	30	0.2	6.0	7.7
Tram	24	0.05	1.20	1.5
Tamping machine	6	2.0	12.0	15.4
Lining machine	6	1.5	9.0	11.5
Ballast regulator	6	1.8	10.8	13.8
Bolt power wrench	6	0.8	4.8	6.2
Rail grinder	1	3.0	3.0	3.8
Catenary installation vehicle	1	1.2	1.2	1.5
Catenary inspection vehicle	6	1.0	6.0	7.7
total			78.4	100.5

Source: JICA Study Team

2) Education and Training Equipment

7.34 The staff will undergo education and training at least 1 year before HSR starts operation. Since this will be the first time HSR is operated in Vietnam, it is believed that that those staff members who will be engaged in O&M will need to undergo education and training from about 3 years prior to the start of operation.

7.35 As the system devices are installed at the HSR operation control center, not so many staff members are engaged in this area. Thus, the perquisite to ensuring effective use of system devices is to build compact, robust education and training facilities at car depots linked to testing tracks and turn the latter into bases for providing practical training in operating HSR trains.

7.36 Toward this end, it is necessary to build education-related facilities. These facilities will be located inside the structures built for O&M. As a consequence, only equipment used in education and training is earmarked in Table 7.4.3.

Table 7.4.2 Equipment Cost for Education and Training

Education-related Equipment and Facilities	Quantity	Unit	Cost (mil USD)	Remark
Simulator	1	unit	5.9	
Other	1	set	4.7	Track training line, electric power training line, signaling training equipment, telecommunication training machine, AFC training equipment, etc.
Training Building	1	set	15.4	
Total			26.0	

Source: JICA Study Team

7.5 Project Cost

7.37 Initial investment at the time HSR begins operation may be divided into two classes: eligible cost, which can be financed by yen-denominated government credits and the like, and local cost, which can be provided by the Vietnamese government. Total project cost including track/ electricity maintenance car and facilities related to education and training is shown in Table 7.5.1.

Table 7.5.1 Project Cost for Ngoc Hoi – Vinh Section

Item		Local (VND mil.)	Foreign		Total	
			US$ mil.	(VND mil.)	VND mil.	US$ mil.
1. Civil Works		65,848	348	7,316	73,164	3,511
2. Tracks		6,010	412	8,652	14,658	698
3. Station		9,096	43	903	9,996	476
4. Power Systems		3,227	1,243	26,103	29,337	1,397
5. Signaling and Telecommunications		814	607	12,747	13,566	646
6. Depot and Workshop		2,863	167	3,402	6,363	294
Subtotal (1 - 6)		87,858	2,820	59,123	147,084	7,022
7. Maintenance Equipment		0	101	2,121	0	101
8. Education and Training Equipment		437	26	109	546	26
Subtotal (1 - 8)		88,295	2,926	61,354	147,630	7,149
9. Rolling Stocks		0	1,093	22,953	22,953	1,045
10. Land Acquisition and Compensation		214,200	0	0	21,420	1,020
Subtotal (1 - 10)		302,495	4,019	84,307	192,003	9,214
11. Consulting Service		3,532	113	2,369	5,905	282
12. Contingency (5% of		4,591	147	3,080	7,677	475
13. Tax[1)]		4,415	0	0	4,415	266
Subtotal (11, 12, 13)		12,538	260	5,449	17,997	1,023
Total	1 - 13	315,033	4,279	89,756	210,000	10,237
	Excluding RS	315,033	3,186	66,803	187,047	9,192
	Excluding land	100,833	4,279	89,756	188,580	9,217
	Excluding RS and land	100,833	3,186	66,803	165,627	8,172
Project Cost per km	1 - 13	1,109	15.1	316	739	36.0
	Excluding RS	1,109	11.2	235	659	32.4
	Excluding land	355	15.1	316	664	32.4
	Excluding RS and land	355	11.2	235	583	28.7

Source: JICA Study Team
1) Tax is calculated at 10% of local cost for construction material, therefore local cost * 50% (percentage of material) * 10% (tax).
2) Price escalation is not reflected to the above cost.

8 OPERATION AND MANAGEMENT

8.1 Operation and Management Organization

1) The Number of Employees for HSR Operation

8.1 In Chapter 5 of Volume 1 of this report, the ideal operational organization for the Vietnamese HSR is described. Based on this, the required number of employees for operation is determined.

2) Initial Personnel at Inaugural Operation for the Priority Sections

(1) Pre-conditions for the Calculation of Employees

8.2 In discussing the number of the employees for operation, the organization "at" and "after" the inauguration of HSR will have to be planned. The factors influencing the calculation of employees are the conditions of transport and equipment/facilities as follows:

(a) Number of Train Sets in 2030, 2035 and 2040

Table 8.1.1 Number of Train Sets for 2030, 2035 and 2040

Section	Year 2030	Year 2035	Year 2040	Remarks
Northern section (Ngoc Hoi – Vinh)	69	87	111	Train operation time zone: from 6:00 to 24:00

Source: JICA Study Team

(b) Conditions of Equipment and Facilities

8.3 The general condition for the equipment and facilities for the northern section of the HSR are as follows:

(i) Number of stations: 6 for the northern section (284 km)

(ii) Railway track is composed of 50% ballast track and 50% slab track

(iii) Rolling stock: Designed on the basis of series E5

(iv) Security/signal systems: CTC and ATC

(v) Electrification of equipment/facilities: AC 25,000 V

(c) Assumptions for Staffing

8.4 In principle, the related maintenance are carried out under the direct work including the work of work-site operations.However, some works of rolling stock cleaning , visual inspection of overhead contact line and cleaning of insulators are outsourced.

8.5 The calculation of the yearly number of employees assumes that the number of employees at control divisions, head office and branch offices, remains unchanged irrespective of the increases in the number of trains. However, station staffs are calculated reflecting station size and ticket sale/ ticket gate staffs and by the increase of the station passengers. The crew numbers are calculated based on the train plan at each fiscal year.

8.6 In the worksite offices related to rolling stock, equipment/facilities, power

supply and materials, however, the number is assumed to increase 10% in 2035 and 20% in 2040 from the number in 2030.

(2) Calculation of the Number of Employees

(a) Result of Calculation of Personnel Complement

8.7 Table 8.1.2 gives the total number of employees based on the assumed pre-conditions for the control divisin and the worksite offices. At the time HSR operation commences, a personnel complement of 2,411 is anticipated.

Table 8.1.2 Personnel Complement for HSR for 2030, 2035 and 2040

Organization		2030	2035	2040
Head Office		173	173	173
Hanoi Branch Office	Control division	194	194	194
	Worksite offices	2,217	2,549	2,689
Total		2,411	2,643	2,883

Source: JICA Study Team

(b) Concept for the Calculation of Employees

(i) Head Office and Branch Office Control Divisions

8.8 In Volume 1 of this report, the concept of the organizations of the Head Office and Branch Office control divisions are explained. See Table 8.1.3 and Table 8.1.4 for the details of the organization. In calculating the number of employees of the Vietnamese HSR managing company, Head Office and Branch Offices, reference was made to the cases of Tokaido Shinkansen in Japan and Taiwan Shinkansen.

Table 8.1.3 Organization and the Number of Employees of the Head Office, Vietnamese HSR Managing Company

Name of Division/Section		Principal Assignment	Number of Employees
Management Planning Division	Planning Section	Management planning	6
	Investment Planning Section	General coordination on the investment into equipment/facilities, etc.	10
Subtotal			16
Safety and Emergency Management Office		Planning and general coordination on the safety /disaster countermeasures	8
Education/Training Office		Planning of the education of employees and training center	8
General and Personnel Affaires Division	General Affairs Section	Control of internal services and general affairs, public relations and legal affairs	10
	Personnel Affairs Section	Planning the number of employees, personal affairs and rotation, reward and punishment	15
	Welfare Section	Health and welfare of employees	6
Subtotal			31
Financial Affairs/Materials Division	Accounting Section	Budget control, cash receipts and payments	15
	Accounts Section	Accounting procedures, settlement services	20
	Materials Section	Materials services	10
Subtotal			45
Railway Operations Headquarters	Control Section	Control of internal services, general affairs	5
	Marketing Section	Planning of marketing, station services and ticket selling	6
	Transportation and Rotation Section	Train operation planning, rotation of crews and rolling stock, instructions for crews	10

Name of Division/Section		Principal Assignment	Number of Employees
	Rolling Stock Section	Planning the inspection and repair of rolling stock	6
	Equipment/Facilities Section	Maintenance of tracks and structures	10
	Electricity Section	Maintenance of power supply and signal/telecommunication equipment/facilities	10
Subtotal			47
Information System Office		Maintenance/installation of information systems and the guidance of related employees	8
Training Center		Implementation of education/training of employees indifferent fields	10
Total			173

Source: JICA Study Team

Table 8.1.4 Organization and the Number of Employees, Branch Offices, Vietnamese HSR Managing Company (Hanoi Branch Offices)

Name of division/section		Principal assignment	Number of employees	Remarks
Safety and Emergency Management Office		Planning and general coordination on the safety and disaster countermeasures	6	
Education/Training Office		Planning the education of employees and education/training at VR Vocational Colleges	6	
Control Division	General Affairs Section	Control of internal services and general affairs, public relations and legal affairs	10	
	Personnel Affairs Section	Planning the number of employees, personal affairs and rotation, reward and punishment, health and welfare of employees	15	
	Financial Affairs Section	Budget control, cash receipts and payments, accounting procedures, settlement services	20	
	Materials Section	Services on materials	10	
Subtotal			55	
Transport, Rolling Stock and Marketing Division	Control Section	Control of internal services, general affairs	5	
	Marketing Section	Planning of marketing, station services and ticket selling	5	
	Transportation and Rotation Section	Train operation planning, rotation of crews and rolling stock, instructions for crews	10	
	Rolling Stock Section	Planning the inspection and repair of rolling stock	10	
Subtotal			30	
Equipment and Facilities Division	Control Section	Control of internal services, general affairs	5	
	Track Maintenance Section	Maintenance of tracks	10	
	Equipment/Facilities Section	Maintenance of structures and architectures	10	
Subtotal			25	
Electricity Division	Control Section	Control of internal services, general affairs	5	
	Power Supply Section	Maintenance of power supply equipment/facilities	10	
	Signal/Telecommunication Section	Maintenance of signal/telecommunication equipment/facilities	10	
	Information System Section	Maintenance/installation of information systems and guidance of related employees	6	
Subtotal			31	
OCC		Dispatching services for HSR train operation control	41	See Table 8.1.5 for the details.
Total			194	

Source: JICA Study Team

(ii) Concept of the Organization and Employees for Operation Control Center (OCC)

(a) Assignment - Dispatching services for HSR train operation control

(b) Number of dispatchers

Table 8.1.5 Number of Employees at OCC

Assignment	Assigned number	Required number	Remarks
1. Chief dispatcher and Assistant Chief dispatcher	2	7	Each dispatcher is assumed to work for 24 hours under a one-shift system.
2. Transport dispatcher	3	11	
3. Passenger dispatcher	1	4	
4. Rolling stock and crew dispatcher	2	7	
5. Equipment/facilities dispatcher	1	4	
6. Power supply dispatcher	1	4	
7. Signal/telecommunication system dispatcher	1	4	
Total	11	41	

Source: JICA Study Team

(iii) Number of Employees at Worksite Offices

8.9 Table 8.1.6 summarizes the number of employees at the worksite offices in different fields while the details are provided in Appendix A8-1.

Table 8.1.6 Number of Worksite Employees at Hanoi Branch Office

Name	Number	Number of employees		
		2030	2035	2040
Station	6	367	414	456
Driver/Conductor -depot	1	228	281	345
Rolling Stock Inspection Base	1	82	90	98
Rolling Stock Workshop	1	364	400	437
Track Maintenance - depot	7	496	545	595
Power Supply Station - depot	6	340	374	408
Signal/Telecommunication - depot	6	290	290	290
Materials Center	2	50	55	60
Total		2,217	2,549	2,689

Source: JICA Study Team

3) Number of Employees at the "Partial Inauguration using the Candidate Initial Section"

8.10 If partial commercial operation is started using the candidate initial section, after finishing HSR test and training of a certain number personnel, the operational line in this case is considered the track length that does not exceed 50 km based on the test line. Therefore, the company should just have personnel and organization that meets this operational line. In this case, a small organization combining the headquarters and branch offices at the time of inaugurating the whole-line of the northern part and southern priority section is considered enough. However, work site organization shall be established according to each technical section taking into account preparations for the full-scale opening.

(1) Head Office

8.11 For the Head Office, the assumptions are: (1) approximately 1/3 to 1/2 of the number of employees should be in place at the inauguration of the northern and southern sections for non-technological divisions, (2) approximately 1/3 to 1/2 of that at the Hanoi Branch Office for technological divisions, and (3) the required number of employees for the training section and training center.

Table 8.1.7 Number of Head Office Employees at the "Partial Inauguration Using the Candidate Initial Section"

Name of Division / Section		Number of Employees
Safety and Emergency Management Office		3
Education/Training Office		6
General and Personnel Affairs Division	General Affairs Section	5
	Personnel Affairs Section	8
Subtotal		13
Financial Affairs/Materials Division	Accounting Section	5
	Accounts Section	7
	Materials Section	4
Subtotal		16
Railway Operations Headquarters	Control Section	5
	Marketing Section	3
	Transportation and Rotation Section	5
	Rolling Stock Section	5
	Equipment/Facilities Section	10
	Electricity Section	10
	Information System Office	3
Subtotal		41
OCC		28
Training Center		10
Total		117

Source: JICA Study Team
Note: Among the employees cited above, object trainees are 70 engineers.

(2) Worksite Offices

8.12 We discussed the route length (292 km) of the worksite offices, Hanoi Branch Office, and the numbers of organizations and employees at the inauguration of the northern section for reference.

(a) We assumed two small-scale (F size) stations

(b) As there were no transport plans for partial inauguration, we assumed 1/4 of the number of employees at train operation stations, conductor stations, rolling stock inspection bases and workshops in consideration of those for training into the future.

(c) We calculated the number of employees for a maintenance depot and a materials center on the assumption that there are no other organizations of these categories.

Table 8.1.8 Number of Worksite Employees at the "Partial Inauguration Using the Candidate Initial Section"

Name	Partial inauguration of HSR using the candidate initial section (assumed to be approximately 50 km)		(Reference) Worksite offices, Hanoi Branch Office, at the inauguration of the Northern section in 2030 (292 km)	
	Number of organizations	Number of employees	Number of organizations	Number of employees (2030)
Station	2	54	6	367
Train driver/Conductor - depot (Train driver)	1	20	1	90
Train driver/Conductor - depot (Conductor)	1	30	1	138
Rolling Stock Inspection Base	1	20	1	82
Rolling Stock Workshop	1	90	1	364
Track Maintenance - depot	1	80	7	496
Power Supply – depot	1	50	6	340
Signal/Telecommunication - depot	1	48	6	290
Materials Center	1	25	2	50
Total		417		2,217

Source: JICA Study Team

Note: The number of leaders and managers of the above worksite offices is approximately 80 when it accounts for 20% of the total employees.

9 ECONOMIC AND FINANCIAL EVALUATION

9.1 Methodology

1) Overview

9.1 This chapter discusses the economic analyses for HSR along the N-S corridor, with particular attention to the northern section (Hanoi–Vinh). The demand forecasts in year 2030 were extrapolated to year 2050, assuming that historical growth trends in overall transport demand on the corridor will persist. Investment costs for the project, in financial terms, were converted into economic terms via shadow pricing. This conversion was also applied on operating costs under various scenarios of demand. When completed, the project will generate economic benefits; their derivations are elaborated in the second part of this chapter. The stream of benefits are then compared against the stream of investment and operating costs, to yield a convenient value known as Economic Internal Rate of Return (EIRR) - a recognized criterion for decision making in the public sector sphere. Similarly, the Financial Internal Rate of Return (FIRR) is calculated using the same set of multi-year data but transformed into financial terms.

2) Distinguishing Economics from Financial

9.2 At the level of a firm, the basic question asked: will a proposed investment make good profits over a reasonable length of time? At a national level, the question becomes will it create net positive social welfare. The answer to the first question is arrived at through financial analyses, and the second through economic analyses.

9.3 While there are similarities in the methodology, there are also major differences between the two approaches. A major fixed cost inputs to both methods is the technically-derived Project Cost, which is converted first into economic terms by removing taxes and shadow pricing their foreign cost components. A second stream of cash-out items is operating costs, which are estimated based on technical as well as operating experiences in HSR – from Japan and Europe – but calibrated into Vietnam's conditions.

9.4 The cash-inflow streams are vastly different: the Financial Analysis hinges on rail revenues from fares charged to paying customers, while the Economic Analysis have to quantify the economic benefits of the HSR to Vietnam. Estimation of economic benefits is more complicated than the former. After estimations of the cash-inflow and cash-outflow streams, the Financial Internal Rate of Return (or FIRR)is calculated under the financial evaluation approach, while the Economic Internal Rate of Return (or EIRR)is calculated under the economic evaluation approach. These criteria (FIRR and EIRR) are the main yard sticks used in determining whether an investment in the project should be made or not.

9.5 A third evaluation method, Accounting, is not considered in this chapter, but is relevant when the project is implemented or funded via a Public-Private-Partnership approach. Table 9.1.1 illustrates the main differences in the three evaluation methods.

Table 9.1.1 Comparison of Different Approaches to Project Evaluation

	Economic	Financial	Accounting
Yardstick or Criterion	EIRR	FIRR	IRR_{equity}
Threshold value	EIRR≥12%, or the opportunity cost of capital	FIRR≥16%, or weighted average cost of capital	IRRe≥15%, or the target return of shareholders
Viewpoint	Country and public sector	The Project	Private sector investors; Lenders
Cash Inflow Streams	Economic benefits to users and the public	Rail Revenues	Rail Revenues
Cash Outflow Streams	Project costs and cash operating expenses, with shadow pricing	Project costs and cash operating expenses, without shadow pricing	Investments and (accrued) operating expenses
Depreciation	Excluded	Excluded	Included
Taxes	Excluded	Included, except tax on net income	Included
Capital Structure/Leveraging	Not relevant	Not relevant	Relevant, impacts net incomes
Impact of Inflation	Cost expressed in real terms	Cost expressed in real terms	Cost expressed in nominal terms

Source: Compiled by Study Team, from various references

3) Ridership as Determinant of Viability

9.6 Ridership on the HSR varies with line length as well as the level of fares. The base case is at fare level equal to 50% of the air fare for similar distances. Sensitivity analyses were performed for fares at 25%, 75%, and 100% of the air fare. For practical reason, only a single forecast year 2030 was produced from the Demand Forecasting Model. Since the calculations of IRRs cannot be done for a single year, the values for subsequent years – 2031 to 2050 - were extrapolated from the base year 2030, using historical growth trends in demand. Such an assumption freezes the market shares of the different modes at their 2030 levels.

9.7 The highest ridership on the northern HSR is 99 thousand a day at fare level equal to 25% of air fare. This nosedives to about 13 thousand a day (or - 87%) when the HSR fare is at parity with air fare. Gross revenue goes down by -49% to USD55 million at the highest fare, and rises to USD111m at the bargain price fare 1. Most of the passengers attracted by the HSR were at the expense of road transport (Buses and Cars) and virtually none came from air transport. At 284-km distance, the demand forecasting model found little incentive to shift from air to HSR. In contrast, under a full line N-S HSR scenario, air transport loses 36% of its passengers but existing railway only loses 7% of its traditional market.

9.8 A capsulized version of the demand forecast (discussed in Chapter 3) is summarized on Table 9.1.2 below. The figures for a shorter line, as well as the full N-S HSR, are shown only for contextual purposes. Existing railway gains more passengers with the shorter HSR projects, as passengers induced by HSR transfer at the end points to continue with their journeys.

Table 9.1.2 Demand Forecast for the North HSR

Cases	Section 1	Section 1x	Full HSR
	Hanoi–Vinh	Han–NBinh	Hanoi–HCMC
1 Number of Passengers/day, 2030			
Fare level 1 @25%	99,229	n.a.	168,560
Fare level 2 @50%	38,264	28,804	100,703
Fare level 3 @75%	17,987	n.a.	50,254
Fare level 4 @100%	12,685	n.a.	29,094
2 Passenger Kilometers, million/day			
Fare level 1	28.2	n.a.	261.6
Fare level 2	10.9	3.5	156.3
Fare level 3	5.1	n.a.	78.0
Fare level 4	3.6	n.a.	45.2
3 Modal Share of HSR			
Fare level 1	3.2%	n.a.	37.4%
Fare level 2	1.7%	0.5%	22.0%
Fare level 3	1.2%	n.a.	11.4%
Fare level 4	0.9%	n.a.	6.7%

Source: JICA Study Team

4) Project Costs

Capital Cost

9.9 The capsulized version of project cost is shown in Table 9.1.3. The local cost items needed no shadow pricing, on the premise that VAT and other taxes were already excluded. On the other hand, shadow pricing for the foreign cost items applied a factor of 1.10 to capture the scarcity of foreign exchange. No attempts were made to shadow price the cost of labor, in the absence of construction data breakdown.

Table 9.1.3 Project Cost for the Northern HSR

Breakdown	Financial Cost	Mix		Economic Cost
	Ngoc Hoi–Vinh	Foreign	Local	Ngoc Hoi–Vinh
A. Track Infrastructure	7,022			7,303
1 Civil Works	3,511	10%	90%	3,546
2 Tracks	698	59%	41%	739
3 Station	476	9%	91%	480
4 Maintenance Depot & Workshops	294	55%	45%	310
5 Power System	1,397	89%	11%	1,521
6 Signaling and Telecom	646	94%	6%	707
B. Rolling Stocks	1,093	100%	0%	1,202
C. Other Cost	1,430			
1 Engineering Services (3.5%)	284	52%	48%	299
2 Land Acquisition	1,020	0%	100%	1,020
3 Support Equipment	127	84%	16%	137
D. Contingency (5%)	477			425
E. Taxes	266			
F. Interest during construction	412			
Grand Total, in USD million	10,700			10,386
Total, excluding E and F	10,022			
Length, km	284			
Number of Trains, in item B	23			

Notes:
a/ - Item C1, Eng'g Services, is calculated at 3.5% of items A and B
b/ - Item D, Contingency, is calculated at 5% of items A, B and C
c/ - Item E, Taxes, is calculated at 10% of 50% of Local Cost Items, excluding Land Acquisition
d/ - Number of rolling stocks was calculated based on demand requirements
e/ - Interest during construction is a preliminary cost for loans at 2.5%

Source: JICA Study Team

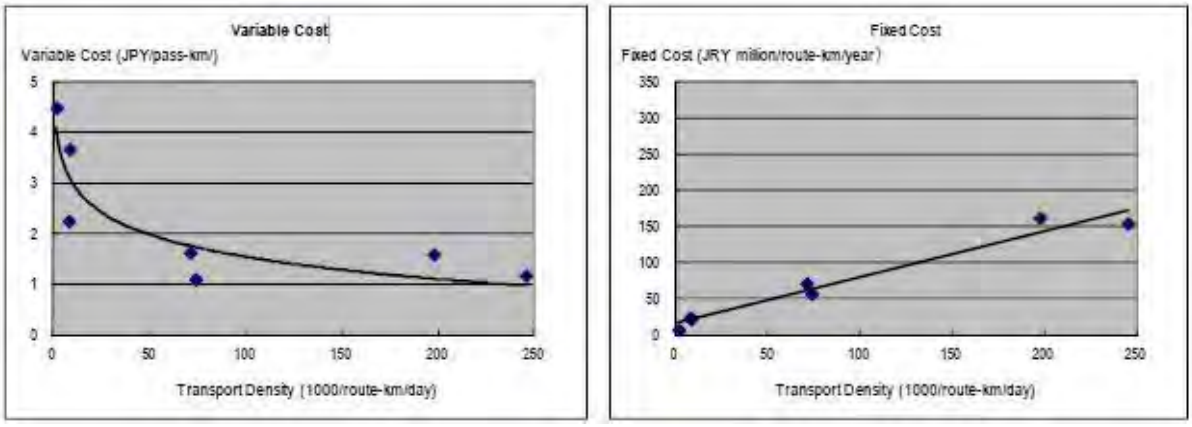
9.10 It can be inferred from the above Table that the larger the imported (i.e., foreign cost) contents, the higher is the cost in economic terms. Considering that the convertibility of VND is controlled, it is difficult to determine what the real or shadow price of foreign currency is[1]; determining this value is beyond the ambit of this study. The Study Team assumed that it is 10% more than the official exchange rate, or a shadow exchange rate factor (SERF) = 1.10. By way of comparison, past projects funded by ADB for Vietnam adopted a SERF ranging from 1.08 to 1.11. Conversely, the larger the domestic content, the lower is the equivalent economic cost. This is due to the removal of taxes, as well as its bigger multiplier impact (e.g., more jobs and local materials) in the local economy. The taxes are already netted out in the foreign cost items, before applying the shadow prices. The local cost items required no further adjustments because the taxes were already excluded.

Operating Expenses

9.11 The estimation of operating expenses took 3 complementary methodologies. One is the O&M cost experience of Shinkansen, since the basic HSR technology being contemplated in this Study is that of Shinkansen. Two, is engineering-determined cost for specific items of the system. Third, is the published cost data from Europe's HSR systems. These 3 approaches were combined to arrive at what is considered appropriate and applicable to the proposed HSR in Vietnam.

Deductive Method

9.12 The cost performance data of seven Japan railway companies were examined. Applying regression analyses for both fixed and variable O&M cost yielded good fit, shown in Figure 9.1.1. It relates transport density as explanatory variable – expressed in thousand passengers per route km per day – to variable costs (in JPY per passenger-km) and fixed cost (in JPY per route km per year).



Source: Ministry of Land Infrastructure and Transport, Japan

Figure 9.1.1 Relationship of Variable and Fixed Cost to Transport Density

[1] For a generally-accepted method, see "Shadow Exchange Rates for Project Economic Analysis", Asian Development Bank (Feb 2004).

9.13 The regression equations are: (i) Variable Cost/pax-km/day = -0.633* Loge (transport density) +4.457; and (ii) Fixed cost/route-km/year = +0.634*transport density+16.055. This may be termed as a "macro" approach to operating cost estimation.

9.14 Applying the regression equation into the project's alternative configurations leads to the results shown on Table 9.1.4. To complete the cost picture, the manpower or personnel cost have to be added in order to arrive at annual operating cost.

Table 9.1.4 Operating Expenses for Northern Section (Deductive Method)

Section / Line	Fare Level	Direct Operating Cost		Personnel	Cost, in USD m
		Variable	Fixed		Total
Section 1 (Hanoi-Vinh)	Fare50	287.2	58.8	3.9	349.9
	Fare75	146.3	58.6	3.9	208.8
	Fare100	106.8	58.6	3.9	169.3

Source: JICA Study Team

9.15 The personnel cost in the preceding Table is based on the number of staff in accordance with the organizational design (see Chapter 8) for the relevant lines, and using average payroll cost of USD8,381 per employee. The headcounts are 2,411 for the North HSR plus a share of the head Office overhead. In comparison, the estimated number for the full line is 13,508, while VNR has more than 39,000 employees on its payroll.

9.16 For initial planning purposes and for convenience, this methodology in determining operating cost would be adequate. They provide a quick-and-easy order of magnitude estimate of operating cost in relation to demand. However, they present basic dilemma: (i) the depreciation or non-cash item is bundled into the cost and is independent of project costs; and, (ii) the variable and fixed costs are based on domestic Japanese inputs, including electricity cost and wages. The power cost in Japan is at USD0.178 per kwh compared to USD0.055 per kwh in Vietnam, or more than 3 times. On the other hand, the average wage rates in Japan in the utilities sector is about 48 times that for VNR. Furthermore, considering that the rail lines of Japan were built several years ago, the depreciation charges embedded in the regression equation maybe under-valued.

Inductive or Itemized Method

9.17 To overcome the preceding analytical problem, available data from European and Japan HSR were examined. These were combined with detailed information on the project that can be provided by the Engineering study. This resulted in the following cost itemizations:

(a) For tractive power, the power consumption is set at 31.7 kwh per train-km, which is based on Shinkansen performance characteristic. An additional 10% is for the minor electricity requirements of depots and stations.

(b) Regular maintenance cost for track infrastructure is estimated at USD215 thousand per track-km. This includes USD141 thousand for tracks and USD74 thousand for power system, excluding cost of labor which is already included in the total personnel cost. The unit cost for track maintenance assumes slab track, which is the dominant form in the engineering scheme. It should be noted that ballast tracks would entail lower unit cost, based on Japanese data.

(c) The adopted cost for regular maintenance cost of rolling stock is USD3.50/train-km, excluding labor, which is already captured in Personnel Cost. By way of

comparison, the Euro HSR averaged €2.0/train-km while Shinkansen averaged $5.5 per train-km.

(d) Periodic maintenance cost at 15% of rolling stock cost every 15 years, for rolling stock to take into account major repairs and rehabilitation. No similar cost was applied to tracks.

(e) In Japan, the average operating expense per Station is US$2.05 million/year, excluding labor. This was scaled down to 75% and local labor cost added to yield USD1.60 million per station.

(f) Fixed overhead was calculated at 1.5% of the value of rolling stock and 0.75% of the value of track infrastructure, representing the cost of property insurance;

(g) Variable overhead at 12% of cash operating expenses, to account for other corporate expenses, such as office rentals, janitorial and security services, outsourced services like cleaning of trains and visual inspection of OCS, and other miscellaneous expenses (the equivalent ratio of VNR is about 32%);

(h) Depreciation expense for track infrastructure, straight line, 40 years life and 30% residual value (in Europe, the typical economic life is 50 years);

(i) Depreciation expense for rolling stock, straight line, 30 years life and zero residual value (in Europe, the typical economic life of a train set is 30 years);

(j) Operating hours of 16 hours/day and 360 days in a year, to allow for maintenance window (Shinkansen lines are operational 12 to 17 hours a day; while the London-Paris Eurostar runs 15 hours).

9.18 Table 9.1.5 shows the values for the preceding cost items, at start of operation, using the inductive method.

Table 9.1.5 Table of Operating Expenses (Inductive Method)

	COST VARIABLE	UNIT	REMARKS
1	Power Consumption	31.7 kwh/train-km	The unit cost for electricity is set at 1,160VND per kwh; increasing at 5% p.a.
2	Manpower	Headcount =2,411	Average compensation of USD8,381/year + proportionate share of the cost of 173 staff at corporate head office
3	Track Maintenance	USD215,000/km	To cover cost of materials per km of line length
4	Rolling Stock – Regular	USD3.50/train-km	To cover cost of regular maintenance of trains, per km-run, excluding labor. Step increase of 20% after 15 years to account for aging vehicles
5	Rolling Stock - Periodic	15% of Train Cost	For major repairs and rehabilitation works, every 15 years
6	Station O&M	USD1.6 million	Cost is set at ¾ the cost experience in Japan + local labor cost
7	Overhead: Fixed	1.5% and 0.75% of initial cost	Property insurance at 1.5% of the cost of rolling stock and 0.75% of the cost of track infrastructure
8	Overhead: variable	12%	12% of cash operating expenses to account for outsourced services, main office expenses, janitorial and security, sales, and other miscellaneous. The data for VNR was 32% of total operating expenses
9	Non-Cash Expenditures	Depreciation + Amortization	Track infrastructure is depreciated over 40 years, with residual value=30% of initial cost; Rolling stock is depreciated over 30 years; other assets are depreciated/amortized over 10 years
10	Power System, Signalling and Telecom	Depreciation + Add-on investment	The economic lives for Power System, Signalling & Telecommunications are set to 15 years; and replaced 100% by 16th year
11	Income tax	None	No corporate tax was applied on net income
12	Operating Hours	16 hours/day, 360 days/year	The operating period for commercial runs is 16 hours a day; daily revenues and expenses expanded to 360 days/year

Source: JICA Study Team

9.2 Economic Evaluation

1) Economic Benefits

9.19 Economic benefits of transport projects are many, but only the direct or primary benefits are quantified. The secondary benefits to the economy – such as the economic activities that it induces or enables – are excluded, because they are difficult to measure and to attribute solely to the project. The direct (or first-order) benefits of a transport project are of two types: savings in operating costs for the other transport modes (Type 1), and savings in passenger time costs (Type 2). The introduction of HSR diverts passengers away from road-based modes (e.g., cars and buses, existing railway), as well as air. The diversions to HSR reduce the operating costs of these 'losing' modes and decongest traffic in the network. Every traveller, including those not using the HSR, benefit in terms of shorter travel times. The methodology is illustrated in Figure 9.2.1

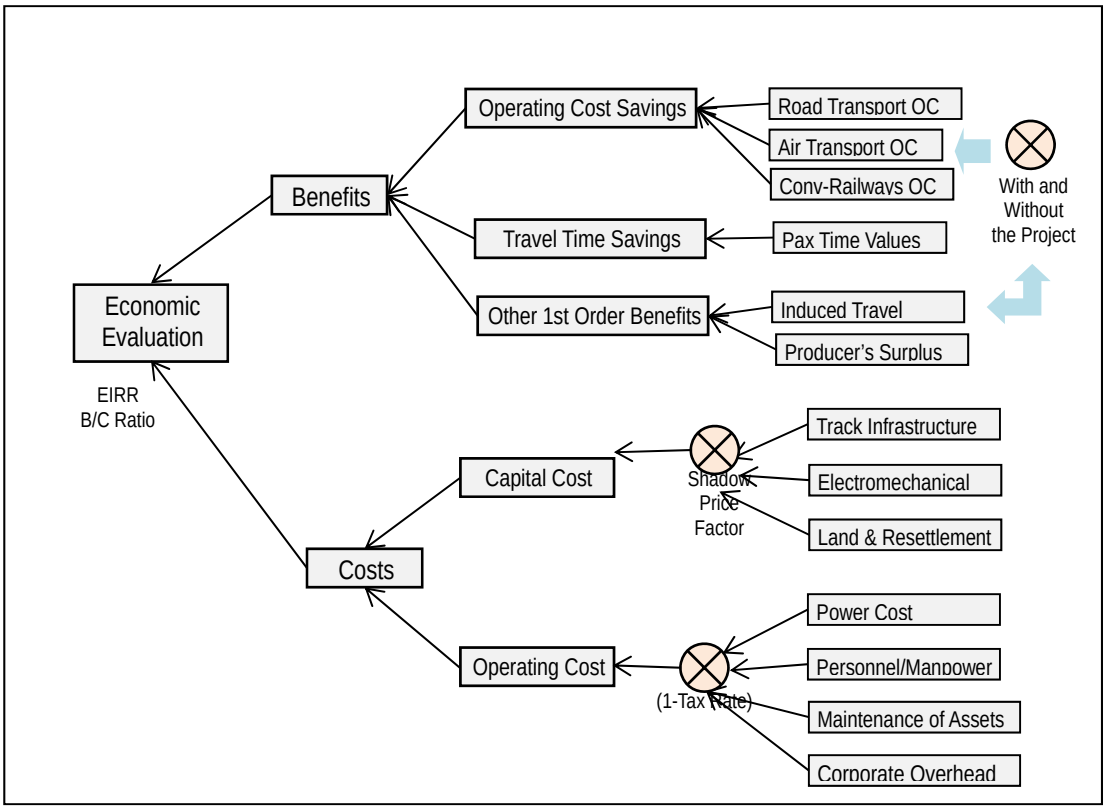


Figure 9.2.1 Methodology for Economic Evaluation

Road Transport Operating Cost

9.20 The benefit values for vehicle operating cost (roads) are the same as those applied in evaluating improvements on the existing railway system. These are shown on Table 9.2.1

Table 9.2.1 Total Road Vehicle Operating Costs (as June 2012)

(USD/1000 km)

	Speed (Km/hour)	MC	Car	Minibus (24 pax)	Standard Bus (60 pax)	Small Truck (2 ton)	Big Truck (6 ton)	Container Truck (15 ton)
Financial Cost	5	194.8	1081.7	994.2	1840.4	1836.8	1677.8	1426.0
	10	115.1	557.4	559.3	980.0	1089.0	997.2	795.3
	20	73.8	293.8	335.2	543.2	708.3	650.3	477.1

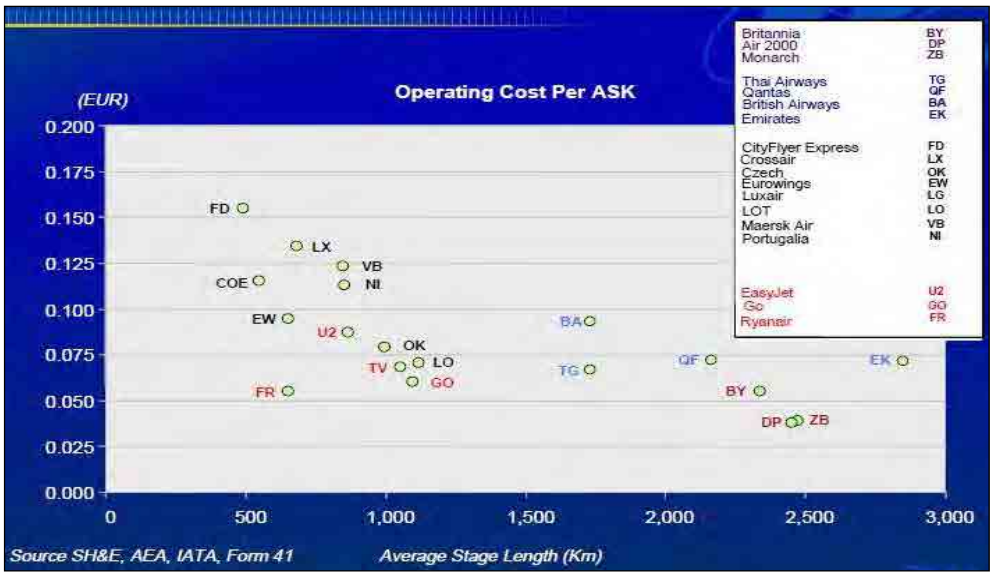
	Speed (Km/hour)	MC	Car	Minibus (24 pax)	Standard Bus (60 pax)	Small Truck (2 ton)	Big Truck (6 ton)	Container Truck (15 ton)
	30	59.7	202.7	258.8	395.3	537.4	543.3	362.6
	40	52.0	161.0	220.0	320.3	454.0	479.3	313.9
	50	48.7	135.4	197.2	276.3	416.0	484.5	287.0
	60	48.7	120.3	191.6	255.9	396.4	525.2	275.9
	70	50.0	110.9	191.9	245.6	394.4	585.8	270.2
	80	52.5	105.1	196.2	241.5	405.6	655.2	277.2
	90	56.4	102.5	205.2	243.5	437.6	714.9	290.8
Economic Cost	5	169.6	1065.3	561.9	1570.0	1668.3	1522.5	1340.8
	10	100.2	547.0	323.4	825.5	983.0	899.5	742.5
	20	64.2	286.7	200.3	449.5	634.2	582.2	440.8
	30	52.0	197.1	158.4	322.9	479.7	483.6	332.9
	40	45.3	155.6	137.2	259.0	404.1	425.2	286.3
	50	42.4	130.2	125.8	222.1	369.3	428.1	260.5
	60	42.4	115.0	124.1	203.1	351.3	462.2	249.2
	70	43.6	105.3	125.9	192.5	348.8	513.9	243.1
	80	45.7	99.2	130.6	187.5	358.1	573.6	248.4
	90	49.1	96.0	138.6	187.6	385.5	625.2	259.6

Source: JICA Study Team

Air Transport Operating Cost

9.21 The air transport operating costs in Vietnam are not readily available. Hence, this was estimated indirectly by cross-referencing available international data. ICAO data showed values equal to USD74.4 per thousand passenger-km, in financial terms, and USD64.7 in economic terms. Data from other sources suggest that this figure is understated, since the base year for the ICAO data is unknown. The cost of jet fuel, which constitutes anywhere from 20% to 50% of air transport direct operating costs, has risen 4.4 times (72.5/gallon to 319/gallon) from 2001 to 2012.

9.22 Another referent source is a detailed study of airline operating costs of several European carriers indicated a cost ranging from €0.06 to €0.15 per available seat-km (ASK), in 2001 (see Figure 9.2.1) - for the air travel range appropriate to Vietnam. Adjusting the same to the 2012 prices of jet fuel, and assuming that fuel comprised 40% of direct operating cost, yields €0.13-0.33 per ASK. Depreciation and profit margin of 15% can be deducted from this to arrive at €0.11-0.28 per ASK. Using the lower figure, the airline operating cost should be at US$0.1375/pax-km. In 2006, the domestic air in Vietnam was at US$0.365/pax-mile, which is equivalent to US$0.587/pax-km. Assuming 10% profit margin and 13% tax will result in US$0.46/pax-km. However, in both cases, the rate is higher than the assumed domestic air fare of VND1,745/pax-km. Accordingly, for consistency, the air transport cost was set at 95% of the latter, or US$0.079/pax-km.



Source: Peter Horder, "Airline Operating Costs", SH&E International Air Transport Consultancy

Figure 9.2.2 Direct Operating Cost of Selected Airlines, 2001

Existing Railway Operating Cost

9.23 The operating cost for existing railway was derived by reviewing and analyzing the 2010 performance data of VNR. The exercise yielded a unit cost of USD19.4 per 1000 passenger-km. Adjusted to 2012 and removing local taxes, the rail operating cost becomes USD19.17 per 1000 pax-km. This was trimmed down to US$16.75 to take into account improvements under Option A2 (which is the base case scenario for HSR). The demand forecasts actually produced higher traffic on existing railway - if HSR Section 1 and HSR Section 2 are built, because the passengers on HSR transfer to/from existing railway. In contrast, if the full line of HSR gets built, the existing railway would suffer a major decrease in patronage as long distance travelers would shift to HSR.

Calculating Type 1 Benefits

9.24 Based on Table 9.2.2, the Type 1 benefits from VOC of road-based transport were calculated. The results summarized in Table 9.2.2 below.

Table 9.2.2 VOC Savings from Road & Air Transport Modes

	Cases for the Northern HSR	VOC/Day (in VND million)	VOC per Year (in US$ m)	VOC Savings (in US$m)	Existing Railway Savings (in US$m)	Savings-Air (in US$m)	Total-Type 1 (in US$m)
0	Without Project	1,412,931	24,222	0		0	
	With North HSR					0	
1	CNA2SN2_050	1,388,846	23,809	454	-79	-3	372
2	CNA2SN2_075	1,399,027	23,983	262	-68	-13	181
3	CNA2SN2_100	1,405,060	24,087	148	-52	-38	59
Note: Negative savings for Existing Railway and Air were due to increased ridership on those modes, as a result of HSR-north.							

Source: JICA Study Team

Calculating Type 2 Benefits

9.25 Type 2 benefits (i.e., savings in travel times) were valued using data on household income, sample surveys, and 160 working hours a month. This is shown on Table 9.2.3. It

is assumed that income will grow in proportion to economic growth (of GDP), hence the indicated 2030 value is more than 3 times the 2011 level. For consistency with project cost, however, the value of time used is in 2012 prices with the Road Study values as base.

Table 9.2.3 Value of Time (Travel Time Cost)

Item	Mode	Minimum Value		Road Study	Adopted
		2011	2030	2009	Value, 2012
Average Income	Car/Air	314	1056		
	Bus/Rail/IWT	150	528		
Pax Time Cost (USD/hr)	Car/Air	1.96	6.60	3.36	4.00
	Bus/Rail/IWT	0.94	3.30	2.02	2.40

Source: JICA Study Team

9.26 There are theoretical issues involved in the valuation of passenger time. Cost savings derived from income is based on the theoretical argument regarding the marginal productivity of labor. Such an approach assumes no utility impact on the passenger/worker and that all travel time savings can be transferred to productive output. A more sophisticated approach allows for the fact that not all travel time is unproductive and not all savings are transferred to extra work. Willingness-to-pay surveys, based on either the revealed or stated preferences of individuals, provide a more accurate estimation. The 2009 road study mentioned in the last column of Table 9.2.3 followed the second approach. Therefore, for the passenger time costs, the value of US$4.00 and US$2.40 were adopted in the economic evaluation.

9.27 Using the above valuation, the calculated type 2 benefits from passenger time savings are shown on Table 9.2.4. These are for year 2030. They are account for about a third of total benefits. The results also suggest that the viability of shorter HSR is more sensitive to passenger's value of time, whereas the full-line HSR is more sensitive to operating costs of other modes.

Table 9.2.4 Passenger Time Savings

	Cases for the North HSR	Pax-Hours/Day (in million)		Savings in Hours/Day		Total Type 2 In USD m
		Car/Air	Bus/Rail	Car/Air	Bus/Rail	
0	Without Project	3.574	9.133			
	With North HSR					
1	CNA2SN2_050	3.335	9.158	0.238	-0.024	322
2	CNA2SN2_075	3.414	9.245	0.160	-0.112	133
3	CNA2SN2_100	3.505	9.247	0.069	-0.114	0.2

Source: JICA Study Team

9.28 What has not been captured in the preceding calculation of benefits is the economic value from induced traffic. In effect, it has unleashed pent-up demand. As a result of HSR, the aggregate number of trips – from all transport modes - went up. There was a modal shift – less people travelled by land, but more travelled by existing railway and air transport. Some experts have used the value of passenger time savings to estimate consumer surplus; others argue that this would over-estimate benefits because the additional traffic came from consumers who are "most willing to forego when their costs increase". For conservatism, this Study opted to adopt the latter position. However, there are clear benefits accruing to producers – railway and airline operators – known as producers' surplus. For existing railway, this was estimated at US$4.17 per 1000 pax-km (based on analysis of VNR data in 2010). For air carriers, no similar benefits were considered in the absence of empirical data.

2) Economic Viability

9.29 Table 9.2.5 combines Type 1 and 2 benefits, and relates them to the project's investment costs. In the absence of multi-year estimates, the ratio of first-year benefit to project cost provides an indicator of viability.

Table 9.2.5 Initial Benefits and Project Costs

	Cases for the Northern HSR	Cash Oper. Cost Yr 2030	Benefits			Net Benefits Yr2030	Investment (Economic)	Ratio of Net Benefit to Investment, (%)
			Type 1	Type 2	Induced Traffic			
1	CNA2SN2_050	154	372	322	331	852	10,386	8.2%
2	CNA2SN2_075	109	181	133	285	444	10,386	4.3%
3	CNA2SN2_100	104	59	0.2	216	126	10,386	1.2%

Source: JICA Study Team

9.30 A more valid and accurate indicator of economic viability is EIRR, but it entails multi-year estimates of benefits and cost. This was conducted for the specific case of fare level 2 (i.e., 50% of air fare), by extrapolating the 2030 results two decades farther ahead, by using growth factor assumptions shown in Table 9.2.6. Since the economic lives of the rail assets exceed 20 years (30 years for rolling stock and 40 years for civil works), it would also be necessary to assume a residual or terminal value. Such a terminal value is a surrogate for the continuing benefits beyond 2050 as the economic lives of the assets have not yet been reached, or the value of the business if sold at that time. In this particular case, the replacement value is used and is calculated as the net asset value (Acquisition cost less Accumulated Depreciation) in 2050 prices at an annual inflation factor of 5%.

Table 9.2.6 Growth Assumptions beyond 2030

Traffic Growth Rates (%)	Annual Increase in Benefit Values			Residual Value
Section 1	Value of Pax Time	Value of VOC	Value of Air OC	2050, in USD m
5.0% (2030-2040)	6.0% (Car & Air)	6.0% (Road)	6.0%	12,980
4.0% (2040-2050)	4.0% (Bus & Rail)	4.0% (Existing Railway)	n. a.	

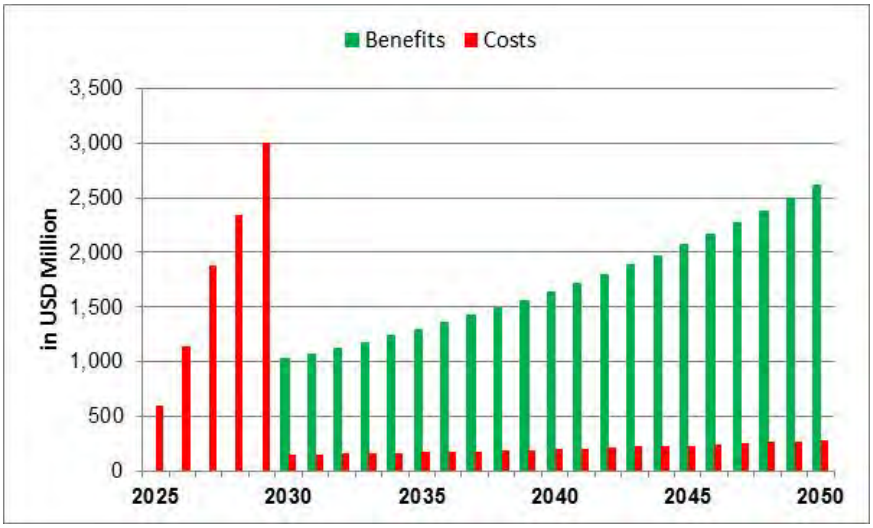
Source: JICA Study Team

9.31 From the preceding benefit and cost streams, the EIRRs for the different cases are calculated. The results are shown in Table 9.2.7. At 9.3%, the EIRR of the northern HSR is short of the minimum threshold of 12.0%. It improves to 10.4%, if the value of the land is excluded.

Table 9.2.7 EIRR for the Northern HSR

	Case	EIRR incl. Land, (%)	EIRR excl. Land, (%)
1	CNA2SN2_050 (Section 1)	9.3	10.4
	CHA2SN2_050 (Full Line)	9.1	11.3

Source: JICA Study Team.



Source: JICA HSR Study Team

Figure 9.2.3 Benefit and Cost Scenario for the Northern HSR

3) Some Issues on Economic Evaluation

9.32 In benefit-cost analysis, the value of land can also be shadow-priced – upward or downward. If the valuation represents the prevailing selling price, there is no need to increase the cost of land. When the land is idle, and would continue to be idle without the project, then a value of zero maybe used in costing land in the economic analysis. Such a situation arises in the case of forest lands, or when a landowner acquired the property for prestige and social standing without intention of using it for productive uses. A large swath of land on the HSR alignment falls under this idle category.

a) Sensitivity Analysis

9.33 The EIRR can improve, in several ways. The most obvious is reduction in project cost. A 10% reduction in capital cost pushes the EIRR up – from 9.3% to 10.3%. Of less

impact is a reduction in operating costs. If the shadow exchange rate factor goes down – from 1.10 to 1.0 – the EIRR rises slightly from 9.3% to 9.7%. It is akin to a reduction in project cost (in economic terms) by 4.0%.

9.34 High urbanization would increase travel demand for all modes. The intensive urban development scenario is set by positioning the MPI population forecast (see Technical Report No.2 for details) as the “low scenario”, and the estimation by the JICA Study Team as “high scenario”. Both figures are averaged to form the “medium scenario” which is used as input figures for this intensive urban development case. Whereas the urbanization rate in the “low scenario” is 38.6% for the northern section, this figure for the “medium scenario” is 45.3%, implying an increase of urban population of 1.3 million compared to the MPI estimates. The more passengers shift to HSR under that scenario, the higher the economic benefits will be. The predicted daily passenger kilometer on HSR will increase by 57.4%; and assuming proportionate increase in benefits, the EIRR would rise to 14.3% - which approximates the effect of a 39% reduction in project cost.

9.35 Delaying the implementation of the Northern HSR by 5 years would imply start of operation in year 2035 and higher ridership. In this case, the EIRR jumps to 12.72% as to exceed the threshold and becomes economically viable. Combined with more intensive urbanization, the EIRR rises dramatically to 17.1%.

9.36 It should be noted that the fleet size (or number of rolling stocks) in the preceding base case scenario is 23 trains, with no increment during the 20-year projection period. With more precise estimation of sectional demand, it may be possible to start with a smaller number of trains and add more in subsequent period to meet the growth in passenger traffic. The latter would have the effect of increasing the EIRR.

b) Other Benefits

9.36 Economic impacts are different from the valuation of individual user benefits of the HSR project, and they are also different from the broader social impacts. The user benefits and social impacts may include the valuation of changes in amenity or quality of life factors (such as health, safety, recreation, air or noise quality). Yet while these various types of benefits and impacts may be valued in monetary terms, through studies of individuals' or society's "willingness to pay" for improving them, they are not economic impacts (as defined above) except insofar as they also affect an area's level of economic activity. Economic impacts also lead to fiscal impacts, which are changes in government revenues and expenditures.

9.37 The HSR is also being justified in Europe on environmental terms. Diversion of traffic – from air and road transport modes – leads to a reduction in the consumption of fossil fuel and emission of greenhouse gases. For example, it was estimated that the carbon footprint of TGV is 2.2 grams per pax-km, 115 grams per pax-m for car, and 153 grams per pax-km for air travel[2]. The amount of carbon emissions saved by shifting to HSR can, theoretically, be sold in the Carbon trading market – which recently put a price tag at €15 per ton in May 2012 and where the 2020 futures price hovers at €24. However, since Vietnam’s power generation mix is heavy on coal, the net benefit is likely to be small or marginal. In the environmental portion of this study, the Northern section is estimated to save 340 k-tons of GHG per year. At a value of US$20, the economic benefit of such a reduction is no more than US$6.8 million. This will be reduced farther when one considers

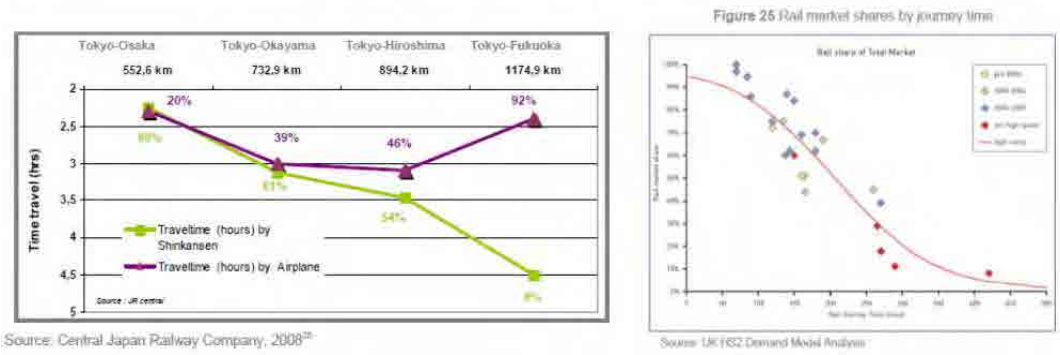
[2] Stephanie Brun-Brunet, “Applying European PPP Experience to the Development of HSR projects in USA”, Alsthom (2011).

that power generation mix is 25% coal-based. The low benefits is due to the fact that shift from air to HSR was not predicted by the demand forecasting model.

9.38 The estimation of wider economic benefits may also be included, following similar studies in Europe to justify HSR[3]. The HSR would enable growth of secondary cities – (e.g., Thanh Hoa and Vinh), relieve high price of land in Hanoi, and bring businesses and create jobs in other cities. For Vietnam, this may be the air traffic congestion relief between Hanoi and HCMC, leading to avoidance of investments in airport facilities and aircrafts. These second-order benefits, however, are prone to double-counting, difficult to quantify and attribute solely to the project; hence, have not been factored into the analysis.

c) Comparison with Selected HSR countries

9.39 The low economic impact of the Hanoi-Vinh HSR project can be appreciated when compared to selected countries with HSR. International studies have shown that HSR becomes the preferred mode for travel distance between 200km and 850km, and travel time less than 4 hours. The northern section is 284 km. On the Tokyo-Osaka route, the HSR captures 80% of the market. If Japan and Europe's experience is any gauge (see Figures 9.2.4), the project should get at least 30% of traffic from air. But the input to the economic evaluation had zero or negligible shift from air transport – which, in turn, explains the low EIRR.



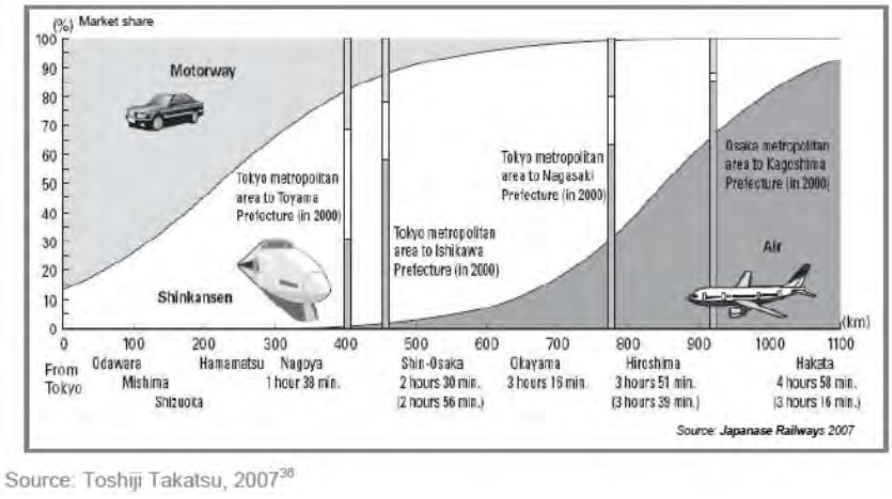


Figure 9.2.4 Multi-modal Shares of Transport in Japan

9.40 The absence of a shift from air to HSR may be attributed to differences in geography. Whereas the HSR in more developed countries connects major cities with

[3] Colin Buchanan, "Economic Impact of High Speed 1", London and Continental Railways, Jan 2009.

huge population, such is not the case for the Northern HSR. The predicted traffic density is only 14 million passengers per km of track length compared to Korea (23), Taiwan (21), Paris-Marseille TGV (25), Sanyo Shinkansen (29), and Tokaido Shinkansen (90).

9.3 Financial Evaluation

1) Revenues

9.41 Similar to, but less complicated, is the determination of revenues from the fare box. The demand forecast in Table 9.1.3 yields the following gross revenues at different fare levels (see Table 9.3.1).

Table 9.3.1 Revenues of the Northern HSR, 2030

Cases	Per Day, in VND million	Annual, in USD million
Fare level 1 @25%	12,294	210.8
Fare level 2 @50%	9,481	162.5
Fare level 3 @75%	6,685	114.6
Fare level 4 @100%	6,287	107.8

Source: JICA Study Team

2) Profit and Loss

9.42 Using the operating expenses from Table 9.1.5 and gross revenues from Table 9.3.1 yields the net operating income (before interest charges and taxes) shown in Table 9.3.2. At all fare levels, the operating income is negative. Worst, it does not generate positive cash flows.

Table 9.3.2 Net Income of the Northern HSR, 2030

Cases	Operating Income	Net Cash Generation
Fare level 1 @25%	-403	-14.2
Fare level 2 @50%	-403	-14.0.
Fare level 3 @75%	-435	-45.8
Fare level 4 @100%	-436	-47.2

Source: JICA Study Team

3) Financial Viability

9.43 An indicator of viability would be the ratio of the first year net cash income to investment (or project cost). Typically, at a ratio of 10% or higher, the ROIs or FIRRs would be extremely attractive; whereas a starting ratio of 5% or less would show poor viability even if the future prospects are high. If the demand for HSR grows at 5% growth, and the 1st year ratio is 5%, the long-term ROI (and FIRR) would still be weak at 5% or less. In contrast, the FIRR would shoot up to 12% if the 1st year ratio exceeds 10%.

9.44 It is possible to estimate FIRR as well by using the same growth assumptions (in the economic analyses) to extrapolate results beyond 2030. These are shown in Table 9.3.3. It is clear that the project is not financially viable under any plausible conditions. The FIRR becomes positive only at traffic growth rates of 10% per annum – which could be interpreted as the combined effect of an increase in fare and in traffic. Even at this favourable condition, the FIRR is marginal and way below the threshold value of 16%. It is also less than the prevailing lending rate of banks, which means that no amount of leveraging can boost return on equity above 16%.

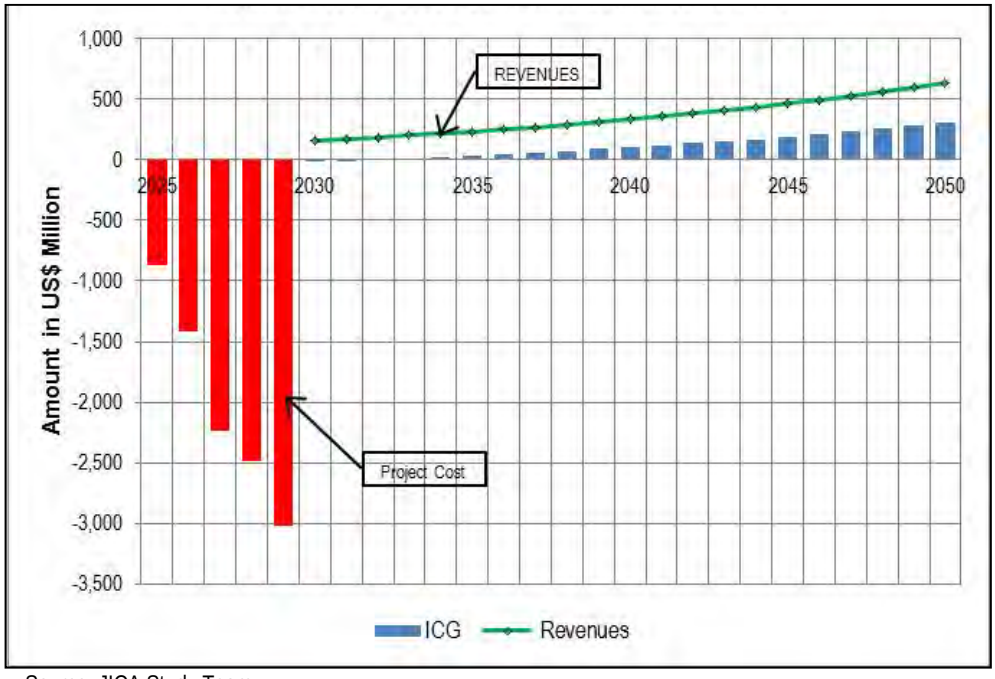
Table 9.3.3 Indicative Financial Returns, Northern HSR

Cases	1st Year Ratio	FIRR under Various Growth Rates in Demand			
		Base Scenario	AGR=5%	AGR=7%	AGR=10%
CNA2SN2_50	-0.13%	-10.52%	-9.92%	-7.18%	-3.40%
CNA2SN2_75	-0.43%	-12.97%	-12.35%	-9.75%	-5.84%
CNA2SN2_100	-0.44%	-12.14%	-12.59%	-9.99%	-6.07%

Source: JICA Study Team

9.45 In general, the poor financial results are not surprising. They are no different from other railway projects – existing railway or HSR - elsewhere where the financial returns are very low. For the northern HSR, the returns remain in the negative territory - implying fare box ratio of less than 1. After a few years of operation, the fare box ratio manages to go beyond 1, indicating positive cash generations. However, the amounts are too little compared to the huge investments. Figure 9.3.1 illustrates vividly why the FIRR is negative: huge investment upfront that dwarfs the future streams of cash incomes.

9.46 What can be done to improve financial viability? One is to undertake commercial developments at the stations. Or reduce project cost and operating expenses. Rail operators usually pursue non-rail revenues in order to generate surplus cash and cross-subsidize the rail operations. Limited data from JR East showed 20% of its income coming from non-rail activities. Taiwan HSR got 10%. If 20% more can be earned on the Hanoi-Vinh HSR, the FIRR edges up from -10.52% to -8.38%. For the northern HSR, however, it would take heroic efforts to generate surplus cash from available non-rail options that will be sufficient to overcome the financial deficits.



Source: JICA Study Team

Figure 9.3.1 Investment and Internal Cash Generation of Northern HSR

9.47 In the preceding analyses, the operating cost of the northern HSR turned out to be 35% higher than if the regression equation from Japan's rail companies were applied. This does not imply, however, that the operating cost data are on the high side. On a per passenger-km basis, the cash cost is US$ 0.045. This is even lower than the US$0.090

for Paris-East TGV and US$0.119 for TGV Atlantique in 1991, or the Taiwan HSR with US$0.074/pax-km in 2008. Because the Shinkansen are built to bigger dimensions than TGV, their cash operating cost per passenger-km is said to be 2 to 3 times more. If at all, the operating cost estimates maybe under-estimated.

9.48 What makes the financial outcome totally different is the revenue side of the equation. The revenue per passenger-km is only US$0.042, in the case of the Vietnam HSR project. The European HSR was getting US$0.23 to 0.27 (1991 data) or more than 5 times. When Taiwan HSR opened in 2007, it charges US$0.13/pax-km (more than 3x the fare assumed in the Vietnam HSR project). The average revenue per passenger in Taiwan's HSR was US$23.50 vs US$11.80 for the project. If the current tariff on Shinkansen is applied on the project, the corresponding revenue should be US$139 per passenger, or 11 times more.

9.49 In nearly all HSR countries, the end points are large urban centers and built-up industrialized areas along the corridor. If such a scenario can be made to happen in the northern coastal areas of Vietnam – with consequent de-concentration in Hanoi and spread of development to somewhere in Vinh, the FIRR improves – from -10.52% to –5.85% as a result of the increase in ridership by +46%.

9.4 Balancing Financial and Economic

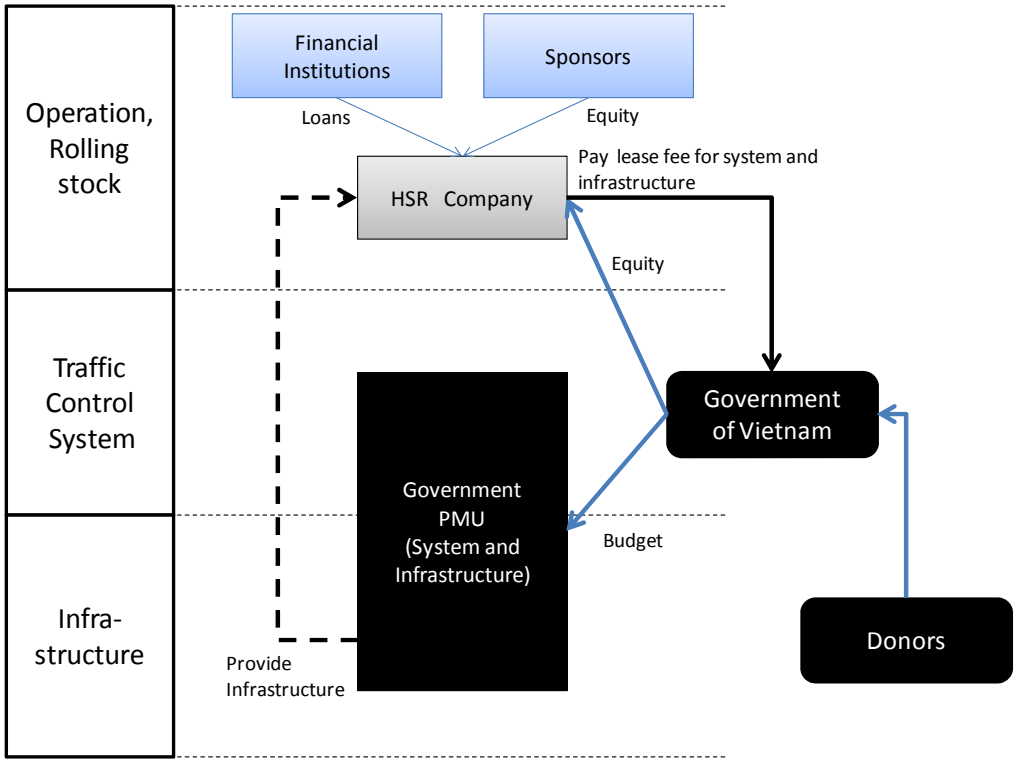
9.50 At the lower fare levels, the economic benefits to users (captured in the EIRR) get maximized. However, this means that very little benefits accrue to the producer or supplier (i.e., the HSR investor and operator). Conversely, maximizing the revenues from the HSR (reflected in FIRR) will bring down the economic benefits. At higher fares, passengers avoid the HSR and take the conventional alternatives.

9.51 The ideal situation is where the fare is high enough so the operator earns enough to be viable (FIRR>16%), but low enough to induce high economic benefits (EIRR>12%). Looking at the results of the financial and economic evaluations, one can conclude that there is no convergence point between private and public viewpoints. In all cases, the FIRR were negative.

10 FUNDING OPTIONS

1) Implementing Structure

10.1 As explained in Part I, the operator, HSR Company, owns rolling stocks and carries out the operations of high speed railways. The government owns the traffic control system and infrastructure to provide them to the operator. The implementing structure is depicted as follows;



Source: JICA Study Team.

Figure 10.1 Implementing Structure

10.2 HSR Company carries out the maintenance of rolling stocks, traffic control system and infrastructure consistently with the operation. The consistency between each layer is said to be the key to achieve safe and efficient operations of high speed railways.

10.3 The investments of the operator are mainly in rolling stocks, and they are financed both by loans and equity. When the risks in the project are considered high, the project would be mainly financed by equity of the sponsors, as financiers are not willing to provide loans due to the high risk. However, shareholders seek to increase the proportion of loans to secure the profitability of equity.

10.4 Then, sufficient profitability of HSR Company is a minimum requirement to find both financiers and sponsors. Profitability is discussed in the following section, which is followed by necessary government risk mitigation measures.

2) Estimated Profitability of HSR Company

10.5 In this section, profitability of HSR Company is examined. As mentioned above, profitability is a minimum requirement to find financiers and sponsors. However, as the profitability of the Hanoi – Vinh section is estimated to be rather low, sufficient government financial supports are required.

10.6 The preconditions to discuss profitability of HSR Company are as follows;

(i) HSR Company carries out the operation of high speed railways.

(ii) HSR Company owns rolling stocks and also carries out the maintenance of them.

(iii) The government owns traffic control system and the infrastructure, and develops them by its own funding.

(iv) HSR Company carries out the maintenance of the system and the infrastructure, and the maintenance costs are provided from state budget.

(v) The government carries out the land acquisition and resettlement.

(vi) The government provides financial support, if HSR Company cannot achieve sufficient profits.

10.7 The proportion between loans and equity, which is to be determined by the size of underlying project risk, is estimated to be 80% and 20% respectively. The loan duration and interest rate used in this estimation are 7 years and 7.0%. The interest rates or the margin are also to be determined through the credit assessments by financial institutions.

Table 10.1 Estimated Income Statement of HSR Company (Hanoi-Vinh) without Budget Allocation for the Maintenance Cost of Infrastructure

Income Statement		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
A Operating income					162.5	174.8	187.9	202.0	217.2	312.2	433.5	596.7
B Operating expenses					214.2	217.6	226.0	229.0	232.1	262.1	298.5	352.5
- Maintenance of Infrastructure					36.7	37.8	38.9	40.1	41.3	47.9	55.5	64.3
- Depreciation of rolling stock					37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
C EBITDA: Earning before Interest, Tax and Depreciation)					-14.0	-5.1	-0.4	10.7	22.9	87.8	172.7	281.9
D EBIT: Earning before Interest and tax (after depreciation)					-51.7	-42.8	-38.1	-26.9	-14.8	50.1	135.0	244.2
E Interest Expenses		13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5			
F Net profit (after interest and depreciation) before tax		-13.7	-41.0	-68.3	-110.2	-91.5	-77.1	-56.2	-34.3	50.1	135.0	244.2
G Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	40.5	73.3
H Net profit (before subsidy, after rental fee)		-13.7	-41.0	-68.3	-110.2	-91.5	-77.1	-56.2	-34.3	35.1	94.5	170.9
Corporate tax	25%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8	23.6	42.7
Financial support by the government		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K Net profit after tax (after subsidy)		-13.7	-41.0	-68.3	-110.2	-91.5	-77.1	-56.2	-34.3	26.3	70.9	128.2
L Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1

Financing		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Repayment (Years)	7				139.3	139.3	139.3	139.3	139.3	0.0	0.0	0.0
Loan Balance		195.0	585.1	975.2	835.9	696.6	557.3	417.9	278.6	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5	0.0	0.0	0.0

Dividend		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Surplus / Deficit (before dividend)		-13.7	-54.6	-122.9	-233.1	-324.6	-401.7	-457.9	-492.3	-450.1	-188.6	224.3
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1
Surplus / Defivit (after dividend)		-13.7	-54.6	-122.9	-233.1	-324.6	-401.7	-457.9	-492.3	-450.1	-188.6	160.2

Equity		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Cash outflow		48.8	97.5	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash inflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1
Net Cash Flow		-48.8	-97.5	-97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1
Equity IRR	-0.3%											

Financial support by the government	Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Budget for infrastructure maintenance				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ridership guarantee				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: JICA Study Team.

10.8 If the maintenance costs for the infrastructure are not covered by state budget, the profitability of HSR Company will be very low, as indicated in the Table 10.1.

10.9 This option is not realistic, because investors are not interested in providing equity to HSR Company, as the IRR (internal rate of return) on equity is negative. Furthermore, the deficits of HSR Company reaches at USD 492.3 million, which has to be financed either by additional equity or loans by the shareholders. Therefore, providing the state budgets for the maintenance costs for infrastructure will be essential.

10.10 When the government covers 100% of infrastructure maintenance costs, the profitability of HSR Company for this section will be better, although it is not very high (see Table 10.2).

Table 10.2 Estimated Income Statement of HSR Company (Hanoi-Vinh) after the Budget Allocation for the Maintenance Cost of Infrastructure

Income Statement		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
A Operating income					162.5	174.8	187.9	202.0	217.2	312.2	433.5	596.7
B Operating expenses					177.6	179.8	187.1	188.9	190.8	214.3	243.0	288.2
- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Depreciation of rolling stock					37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
C EBITDA: Earning before Interest, Tax and Depreciation)					22.7	32.7	38.5	50.8	64.1	135.6	228.2	346.2
D EBIT: Earning before Interest and tax (after depreciation)					-15.0	-5.0	0.8	13.1	26.5	97.9	190.5	308.5
E Interest Expenses		13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5			
F Net profit (after interest and depreciation) before tax		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	97.9	190.5	308.5
G Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.4	57.1	92.5
H Net profit (before subsidy, after rental fee)		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	68.6	133.3	215.9
Corporate tax	25%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	17.1	33.3	54.0
Financial support by the government		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K Net profit after tax (after subsidy)		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	5.2	51.4	100.0	162.0
L Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	81.0

Financing		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Repayment (Years)	7				139.3	139.3	139.3	139.3	139.3	0.0	0.0	0.0
Loan Balance		195.0	585.1	975.2	835.9	696.6	557.3	417.9	278.6	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5	0.0	0.0	0.0

Dividend		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Surplus / Deficit (before dividend)		-13.7	-54.6	-122.9	-196.4	-250.2	-288.4	-304.5	-299.3	-114.9	192.0	557.1
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	81.0
Surplus / Defivit (after dividend)		-13.7	-54.6	-122.9	-196.4	-250.2	-288.4	-304.5	-299.3	-114.9	142.0	476.1

Equity		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Cash outflow		48.8	97.5	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash inflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	81.0
Net Cash Flow		-48.8	-97.5	-97.5	0.0	0.0	0.0	0.0	0.0	0.0	50.0	81.0
Equity IRR	4.7%											

Source: JICA Study Team.

10.11 The amount allocated from state budget is set based on predetermined conditions (e.g. the budget allocation amount is increased according to the price levels or labor unit cost). HSR Company cannot request the government to increase budget allocation for maintenance, except for any unexpected cases such as natural disasters. Unlike current arrangement, HSR Company is fully responsible for the maintenance of the system and infrastructure.

10.12 Even though state budgets are provided for the maintenance of infrastructure, the IRR on equity is not high, as it is 4.7%. The deficits reaches to USD 304.9 million in the 4th year.

10.13 As the profitability of HSR Company and the sufficient level of IRR on equity are the minimum conditions to attract investors, more financial support would have to be provided by the government. One of the possible financial support measures is “revenue guarantee”, by which the government provides subsidies when the company could not achieve sufficient amount of revenue to make profits.

10.14 In this estimation, the amount of the financial support is set, so that HSR Company

can achieve 10% operating profit. On the other hand, the company pays the rental fee for the traffic control system and the infrastructure, when it achieved sufficient profitability. The estimated income statements of HSR Company are as in Table 10.3.

Table 10.3 Estimated Income Statement of HSR Company (Hanoi-Vinh) after the Financial Supports through Revenue Guarantee

Income Statement		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
A Operating income					162.5	174.8	187.9	202.0	217.2	312.2	433.5	596.7
B Operating expenses					177.6	179.8	187.1	188.9	190.8	214.3	243.0	288.2
- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Depreciation of rolling stock					37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
C EBITDA: Earning before Interest, Tax and Depreciation)					22.7	32.7	38.5	50.8	64.1	135.6	228.2	346.2
D EBIT: Earning before Interest and tax (after depreciation)					-15.0	-5.0	0.8	13.1	26.5	97.9	190.5	308.5
E Interest Expenses		13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5			
F Net profit (after interest and depreciation) before tax		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	97.9	190.5	308.5
G Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.4	57.1	92.5
H Net profit (before subsidy, after rental fee)		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	68.6	133.3	215.9
Corporate tax	25%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	17.1	33.3	54.0
Financial support by the government		0.0	0.0	0.0	89.8	71.3	57.0	36.3	14.8	0.0	0.0	0.0
K Net profit after tax (after subsidy)		-13.7	-41.0	-68.3	16.3	17.5	18.8	20.2	20.0	51.4	100.0	162.0
L Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0

Financing		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Repayment (Years)	7				139.3	139.3	139.3	139.3	139.3	0.0	0.0	0.0
Loan Balance		195.0	585.1	975.2	835.9	696.6	557.3	417.9	278.6	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5	0.0	0.0	0.0

Dividend		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Surplus / Deficit (before dividend)		-13.7	-54.6	-122.9	-106.6	-89.1	-70.4	-50.1	-30.2	102.8	326.6	691.7
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Surplus / Defivit (after dividend)		-13.7	-54.6	-122.9	-106.6	-89.1	-70.4	-50.1	-30.2	77.1	276.6	610.7

Equity		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Cash outflow		48.8	97.5	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash inflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Net Cash Flow		-48.8	-97.5	-97.5	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Equity IRR	6.6%											

Source: JICA Study Team.

10.15 By the financial supports of the government, HSR Company can achieve surplus in 7th year. Suppose HSR Company pays 50% of its net profits after tax as dividends, under the condition that it does not have any accumulated losses, investors can expect that internal rate of return (IRR) on equity is 6.6%.

3) Supports by the Government

10.16 As can be seen from the previous section, a substantial amount of subsidies is necessary for the Hanoi – Vinh section. Especially during early years after the commencement of the commercial operation, such government supports are essential, mainly due to the low demand for high speed railways.

10.17 The financial supports by the government are given in the form of revenue guarantee, by which the government guarantees to the minimum revenue, so that HSR Company can make minimum profits. The total amount necessary for the Hanoi – Vinh

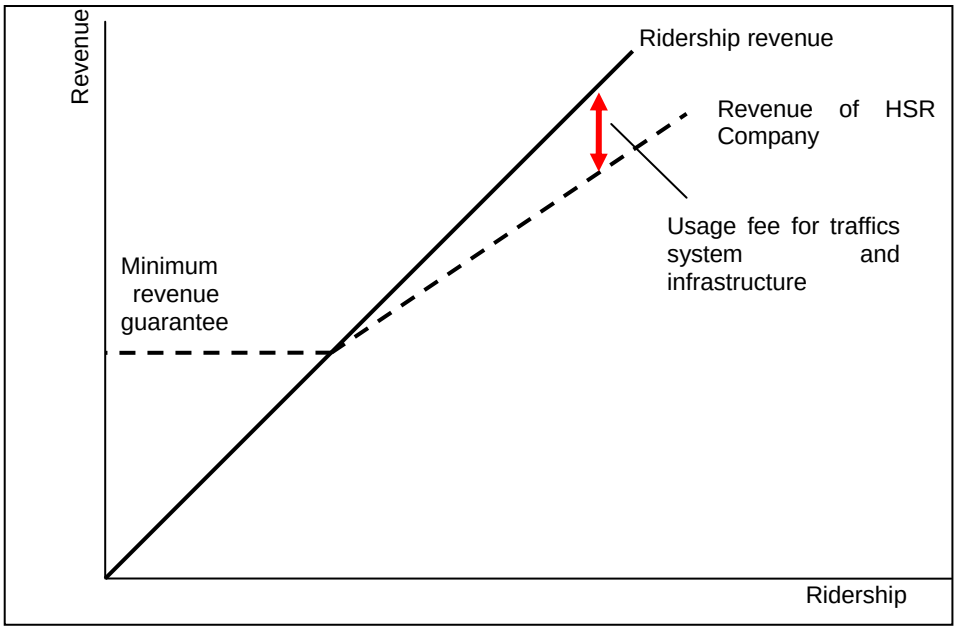
section is USD 269.1 million, excluding the budget allocation for the maintenance costs of infrastructure.

Table 10.4 Necessary Government Financial Support for HSR Company (Hanoi – Vinh)

	Year 1	Year 2	Year 3	Year 4	Year 5
Maintenance budget for infrastructure	36.7	37.8	38.9	40.1	41.3
Minimum profit	16.3	17.5	18.8	20.2	21.7
Actual Net profit (=F)	-73.5	-53.8	-38.2	-16.1	6.9
Financial support	89.8	71.3	57.0	36.3	14.8

Source: JICA Study Team.

10.18 In addition to the revenue guarantee or loss compensations, another measure to mitigate such demand risks is bargaining the system and infrastructure usage fees. HSR Company start paying usage fees when it started making sufficient profits.



Source: JICA Study Team.

Figure 10.2 Minimum Revenue Guarantee

10.19 Any other risks under the responsibilities of the government are covered by the government. For example, cost overruns in the development of infrastructures are the government responsibilities, and not transferred to HSR Company. Similarly, any losses due to the government (e.g. delays in infrastructure development, the delays in government procedures or the changes in technical specifications on rolling stocks directed by the government) caused on the company should be covered by the government.

10.20 Foreign exchange risks are also covered by the government. The foreign exchanges risks are critical, as the rolling stocks are imported and purchased in foreign currencies by the company, but the revenues of the company from passengers are in domestic currency.

4) Setting of Usage Fees for Infrastructure

10.21 HSR Company, receives financial supports when it cannot generate profits, and pays rental fee for the traffic control system and infrastructure, when it generates profits.

Usage fee levels are to be determined based on the size of profits and cash flows.

10.22 The usage fee in this simulation is calculated as follows;

[Usage fee] = [Rental fee rate (30%)] x [EBIT (Earnings before interest and tax) – Repayment for banks loans – Interest Payments]

10.23 The company starts paying the rental fee from 8th year, although the amount is marginal. This is mainly due to the fact that the profitability of the Hanoi – Vinh section is not very high.

Table 10.5 Usage Fee Paid by HSR Company (Hanoi – Vinh)

	Year 1	Year 2	Year 3	Year 4	Year 5
G Usage Fee: Profit base x Rate	0.0	0.0	0.0	0.0	0.0

Year 6	Year 7	Year 8	Year 9	Year 10
0.0	0.0	20.1	23.6	29.4

11 ENVIRONMENT AND SOCIAL CONSIDERATION STUDY

11.1 Methodology

11.1 The objectives of environmental and social considerations in the Study are:

(i) To avoid or minimize adverse impacts through a comparison exercise of alternatives and propose mitigation measures to be incorporated into the project planning;

(ii) To identify a range of significant and potentially significant environmental and social considerations items to be studied in the subsequent stage of the Environmental Impact Assessment (EIA);

(iii) To propose appropriate resettlement and rehabilitation policy framework for the further stage of land acquisition process, and;

(iv) To form a common understanding of the environmental and social issues confronting the Project among the wide range of stakeholders.

11.2 In accordance with the laws and regulations of Vietnam and JICA Environmental and Social Considerations Guidelines, 2004 and 2010, an Initial Environmental Examination (IEE) Study as environmental and social considerations for the Study was conducted as shown in Figure 11.1.1.

11.3 The flow of IEE study can be divided into five major steps as follows:

(i) **Preparation and Consultation of Plan on Environmental and Social considerations (IEE Study) of this study:** the draft plan on environmental and social considerations (IEE study) of this study was prepared and finalized through consultation with stakeholders especially on the 1st SHM.

(ii) **Conduct of Baseline Survey on Environmental and Social Considerations:** as part of the IEE study, the baseline survey on environment and social considerations were implemented. Environmental sensitivity maps were prepared for alignment planning (setting alternatives).

(iii) **Selection of Optimal Alternative on Alignment and Station Location:** in parallel with the baseline information collection, alternatives on alignment and station location were developed. On the alternatives, comparison was conducted taking into consideration comprehensive four aspects including environmental and social ones to select the optimal alternative. In the course of the comparison of alternatives, 2nd stakeholder meeting and plenary sessions were held to consult with stakeholders.

(iv) **Conduct of Provisional Scoping for EIA:** for the EIA to be conducted in the future stage of the projects, provisional scoping for the EIA was studied in order to identify a range of significant and potentially significant environmental and social impacts. Based on the result of provisional scoping, provisional mitigation measures, monitoring framework and technical requirements of the EIA were proposed, which are taken into consideration in the future stage EIA and project planning.

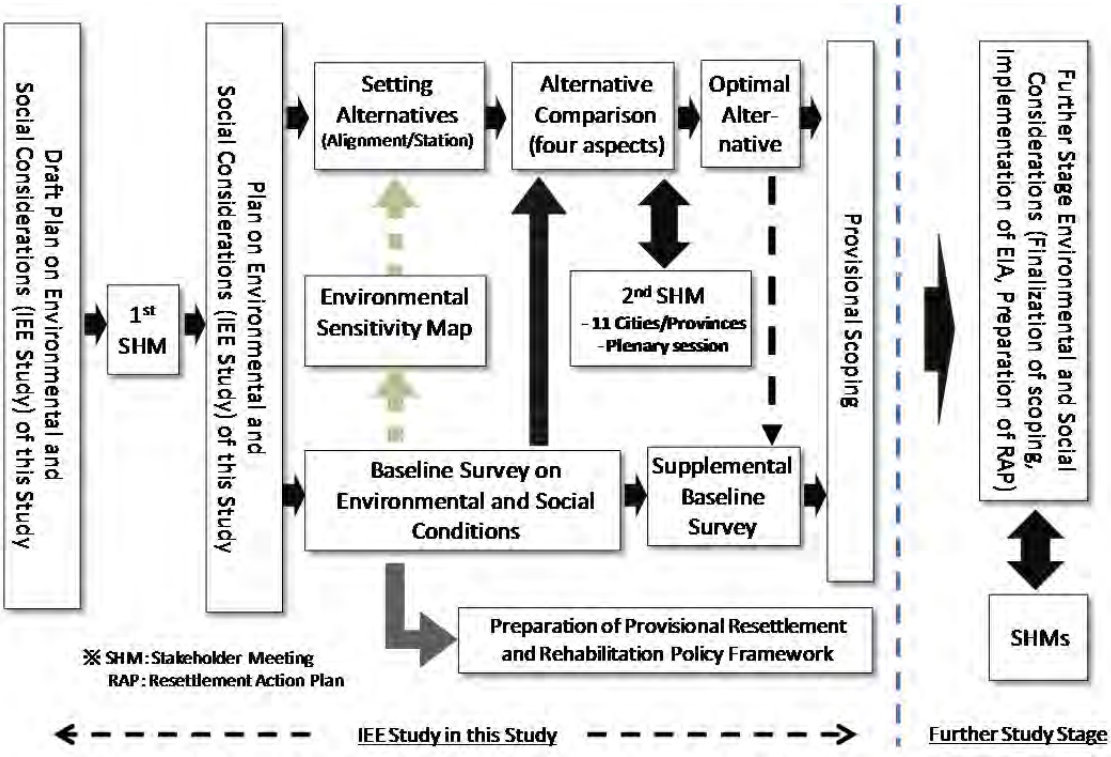
(v) **Preparation of Resettlement and Rehabilitation Policy Framework (RRPF)**: for the Resettlement Action Plan (RAP) to be prepared in the future stage of the Projects, the provisional RRPF was prepared.

11.4 It is noted that the output from this study on environmental and social considerations are 1) the selected optimal alignment and station location through IEE process, 2) the draft scoping for EIA and 3) the resettlement and rehabilitation policy

framework.

11.5 Stakeholder meetings were held in order to incorporate the idea and needs of Vietnamese side into IEE study framework and comparison of alternatives.

Figure 11.1.1 Overall Flow of Environmental and Social Considerations in the Study



Source: JICA Study Team

11.2 Result of Initial Environmental Examination (IEE)

11.6 Baseline survey on environmental and social conditions was conducted mainly by colleting secondary data through questionnaire survey to target cities and provinces, interview with the related agencies and organizations, internet and literatures review and field reconnaissance. The items surveyed covered a wide range of items of natural, living and social environment. For the alignment planning including the development of alternatives, environmentally and socially sensitive aspects which can be shown geographically on maps were chosen and then sets of Environmental Sensitivity Maps were prepared.

11.7 To avoid irreversible environmental and social impacts by the Project by selecting the optimal alignment and station location, a comparison exercise of alternatives was conducted during the alignment and station location planning phase covering comprehensive aspects including the environmental and social considerations aspect. The outline of the comparison of alternatives applied in the Study is shown in Table 11.2.1.

Table 11.2.1 Outline of Comparison of Alternatives

Item	Descriptions
Objectives	To select the optimal option from alternatives.
Target Sections	The north priority section (Hanoi – Vinh)
Alternatives	Alignment options and station location options, together with zero option.
Items Considered for Comparison of Alternatives	1) Convenience and Integrated Development 2) Environmental and Social Considerations (Natural, Living and Social Environment) 3) High Speed Serviceability 4) Economical Efficiency
Stakeholder Meeting	2nd SHM in respective city/provinces along alignment with plenary session

Source: JICA Study Team

11.8 For conducting the comparison of alternatives, the following three initial alternatives of the alignment and station locations as shown in Table 11.2.2 and also Zero option were set. These alternatives were compared from the aspects and indicators in Table 11.2.3.

Table 11.2.2 Three Initial Alternatives

Alternative	Characteristics of Alternatives
Alternative 1 (Alt1)	Station location and alignment based on this JICA study • Station Location: In urban area with integrated development in and around station area • Alignment: 1) To consider the cost efficient balance of viaduct and embankment, and 2) Minimum Curve Radius =6,000m
Alternative 2 (Alt2):	Station location and alignment based on Pre-FS in 2009 (submitted to the national assembly) • Station Location: In urban area • Alignment: 1) Free to choose alignment by application of elevated structures more, and 2) Minimum Curve Radius=6,000m
Alternative 3 (Alt3):	Station location and alignment based on KOICA study in 2007 • Station Location: In suburban area avoiding existing city area • Alignment: 1) To reduce construction cost by choosing the alignment by embankment, and 2) Minimum Curve Radius=5,000m

Note: The alignments of Alt. 1 to Alt. 3 are presented in Chapter 4.
Source: JICA Study Team

Table 11.2.3 Aspects and Items Considered in Comparison of Alternatives

Aspects	Items
• Convenience and Integrated Development	• Connectivity with other transportation modes • Accessibility of the station and potential for integrated development • Availability of land for integrated development
• Environmental and Social Considerations	• Natural environment: a) Topography, b) Geology, c) Hydrology, d) Natural hazard, and e) Protected areas and forest. • Living environment: f) Impacts by noise and vibration. (air pollution) • Social environment: g) Land use, h) Residential area and developed area, i) Cultural and historical heritages, and j) Ethnic minorities.
• High Speed Serviceability	• Ratio of the curve with less than radius=6,000m • Areas of difficulty in construction (ex. soft ground, long-span bridges, long tunnels)
• Economical Efficiency	• Construction cost • (Regional development)

Note: Air quality and regional development were considered in comparison of zero option.
Source: JICA Study Team

11.9 At the time of stakeholder meetings at each city/province, initial alternatives with initial scores of four aspects were presented and discussed among stakeholders. Based on the discussions, the initial Alternative 1 was revised reflecting comments from stakeholders and then the comparative analysis of the alternatives was conducted again. The result of comparative analysis was discussed at plenary sessions of stakeholder meeting. As a result of overall evaluation, as shown in Tables 11.2.4, Alternative 1 (revised)[1] was evaluated better than Alternatives 2 and 3 and Zero option, and then the Alternative 1 (revised) was selected the optimal one.

Table 11.2.4 Results of Comparison of Alternatives (North Section)

Aspect/Items	Alt.1 (revised)	Alt.2	Alt.3	Zero option
Overall Evaluation	A	B	C	D
1) Convenience and Integrated Development	A	B	C	D
2) Environmental and Social Considerations	A	B	C	D
2)-1 Natural Environment	(B)	(C)	(C)	(C)
2)-2 Living Environment	(A)	(B)	(A)	(D)
2)-3 Social Environment	(B)	(C)	(D)	(A)
3) High Speed Serviceability	A	B	C	D
4) Economical Efficiency	B	C	B	C

Note: A: Better, B: Good, C: Fair, D: No advantage, Alt.: Alternative
Source: JICA Study Team,

[1] This is the revised alignment after reflecting comments at stakeholder meetings.

11.3 Result of Provisional Scoping for EIA

11.10 On the selected optimal alternative, the provisional scoping was conducted together with the supplemental collection of related environmental and social information along the alignment. The rating of environmental and social considerations items in the scoping was conducted for each city/province along the alignment, and then summarized as the result for each target priority section. Regarding the scoped environmental and social consideration items, preliminary study on mitigation measures, environmental monitoring framework, and methodology for EIA study were conducted. Outline of the scoping is shown in Table 11.3.1 and the result of provisional scoping is shown in Table 11.3.2.

Table 11.3.1 Outline of Provisional Scoping for EIA

Item	Descriptions
Target Section	Selected optimal alternative for the north priority section (Hanoi – Vinh)
Studied Items	In accordance with the JICA Guidelines for Environmental and Social Considerations (2004 and 2010), wide range of various environmental and social considerations items (including natural, living and social environment) were studied at IEE level and rating of these items was conducted by assessing the scale of the impacts of them for EIA study to be conducted in the further stage of the projects. The items assessed as having the rather higher impact, and items assessed that further examinations should be required in the EIA since the impact is unknown, were scoped for the EIA, and the methodologies to collect primary information (field survey / testing etc.) and to predict and assess the impact were proposed. Additionally, preliminary study on mitigation measures (avoiding, minimization and compensation) and monitoring framework was conducted.

Source: JICA Study Team

Table 11.3.2 Result of Provisional Scoping for EIA

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
Natural Environment	Climate / Meteorological Phenomena	D	D	D	P: No impact is expected.
					C/O: Although the elevated structures such as viaduct of the HSR track and station building will be constructed, the impacts on micro-climate and micro meteorological phenomena are negligible because these structures would not disturb wind path.
	Topography	D	B-	D	P: No impact is expected.
					C: While topography between Hanoi-Ninh Binh is generally flat, there will be variations of topography between Ninh Binh - Nghe An where more mountains/hills exist along the alignment requiring about 20km of cut section. Though limited, there is some impact on topographic features.
					O: Completing construction, topography would be stable. No impact is expected
	Geology	D	D	D	P: No impact is expected.
					C: Although there are some soft soil areas and soil improvement works will be done there for the constructions, it is not a scale that changes geological features.
					O: No impact is expected.
	Soil Erosion	D	B-	B-	P: No impact is expected.
					C: By the earth work, especially when it is raining, some soil erosion is expected.
					O: Total length of the alignment is about 284 km, in which embankment or cut section is about 129.5 km, where new surface may be washed by rain water.
	Hydrology	D	D	B-	P: No impact is expected.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
					C: In the elevated structure section, construction works would cause little impacts on the hydrological cycle or regimes. In embankment or cut section, piled up soil may cause minor and temporal impact on hydrological cycle or regimes. They are not scale that change hydrological regime.
					O: In the embankment section (mostly in the section in Thanh Hoa and Nghe An), hydrological situation would be affected by the structures. The elevated section will have less and minor impact on the hydrological conditions.
	Ground water	D	B-	B-	P: No impact is expected.
					C: Ground water in Red River Delta is generally abundant due to many canal/rivers and its low altitude. In addition, ground water utilization by the construction works is not a scale that changes ground water flow. However, there may be impact on the ground water flow by construction activities of tunnels.
					O: Utilizing ground water by HSR is not a scale that can change ground water level. However, in the tunnel section, there may be impact on the ground water flow by the structure.
	Ecosystem Flora, Fauna and Biodiversity	D	B-	B-	P: No impact is expected.
					C: Besides some protection and production forest areas, most of the area along the alignment is already developed area including residential and agricultural areas. The affected flora, fauna and biodiversity along the alignment are considered to be not critical, while the construction work may interfere with the habitat of flora and fauna. - There is no Important Bird Area (IBA) affected by the alignment. -The section in Ninh Binh – Nghe An falls within the Endemic Bird Area (EBA) of Annamese lowlands.
					O: Existence of the HSR structure and HSR operation may cause negative impact on the ecosystem.
	Protected Areas/Forest	B-	B-	B-	P: There are special-use forests (protected areas) along the target city/provinces, however those areas are located far from the planned alignment (more than 10km). Besides protected areas, the alignment goes through and affect some protection forests (about 14 ha) and production forests (about 58 ha) in Ninh Binh, Thanh Hoa, Nghe An provinces. Change of forest use purpose into non-forest purpose is required in these areas.
					C: The construction machines could damage the vegetation. Activities of construction workers may also be the pressure on forest.
					O: By the structure of HSR, some of the forest area is opened, so that more sunshine will be led inside the vegetation, which would affect the edge of the forest area.
	Coastal zone	D	D	D	P/C/O: The closest distance to the alignment from the coastal line is at Nghe An (about 3.5 km) and , no mudflats or no mangrove areas are affected. Thus, no impact is expected.
	Landscape	D	D	B+/B-	P: No impact is expected.
					C: Change of landscape is temporary and limited during the construction.
					O: By the structures such as viaduct, embankment and station buildings, both positive and negative impacts on landscape are expected.
	Natural disasters	D	B-	B-	P: No impact is expected.
					C: Civil work in landslide/ erosion prone areas in Thanh Hoa may trigger landslide.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
					O:Between Ha Noi – Ninh Binh: Some regularly flooding areas are found but far from the planned alignment, the most close flooding area is at Hoang Xa commune (Ha Noi), about 4 km from the planned alignment. In Thanh Hoa, the alignment goes through landslide/erosion prone areas. In Nghe An, some flood prone areas exist along the alignment. Embankment construction in some sub-sections may result in a higher risk of flooding.
Living Environment	Air Pollution	D	B-	A+/B-	P: No impact is expected.
					C: Some negative impact is expected due to operation of many equipments and vehicles, dust incidental to earth work especially in dry season, although these impacts are temporal and limited.
					O: Overall reduction of air pollutants' emission is expected by the modal shift of passengers' transportation to the HSR (+31% of the share between Hanoi – Vinh, 2030 projection) from cars (-6%), buses (-19%), airs (-1%), and existing railway (-5%). On the other hand, increase in air pollutants from increased access of cars and buses around the station are expected.
	Offensive Odor	D	D	D	P/C/O: No impact is expected.
	Water Pollution	D	B-	B-	P: No impact is expected.
					C: Turbid water by the earth work and bridge piers' construction work, and wastewater effluents from construction works' camps/yards are expected to pollute the surrounding rivers/canals water to some extent.
					O: Wastewater effluents from passengers at the station and maintenance activities in the depot are expected. Some impacts on water quality in surrounding water bodies are expected due to discharged polluted water.
	Bottom Sediment Contamination	D	D	D	P: No impact is expected.
					C: Although some construction materials such as cement and sand are expected to be washed out mainly by the rain, the impacts on bottom sediment by them are small.
					O: Although some impact is expected on bottom sediment by deposition of pollutants from the wastewater discharged from maintenance activities in the depot in Ngoc Hoi and Vinh, the impact is small.
	Soil Contamination	D	C-	B-	P: No impact is expected.
					C: Although some impact on soil is expected by deposition of pollutants from construction materials and vehicles, the impacts are small. On the other hand, in case the soil at construction sites is already contaminated by other reasons, some impacts are expected by the construction activity. Thus, further study is necessary.
					O: Some impact may be expected on soil by deposition of pollutants from maintenance activities in the depot in Ngoc Hoi and Vinh.
	Ground Subsidence	D	D	D	P: No impact is expected.
					C: Ground water utilization by the construction works is not a scale that changes ground water flow. Thus, no ground subsidence is expected.
					O: In general, geological condition of the North priority section, especially from Hanoi – Ninh Binh is soft soil layers. As viaduct section is planned to be applied in such area, no impact is expected.
	Noise/vibration	D	B-	A-	P: No impact is expected.
					C: Noise and vibration are generated by operation of heavy equipment and vehicles, although they are temporary, and some impact is expected on the residents and facilities/places which require quietness such as schools and hospitals near the construction sites.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
					O: Noise and vibration are generated by movement of high speed trains and some impacts are expected on the residents and facilities/places which require quietness such as schools and hospitals along the HSR alignment. Maintenance of ballast track would also cause noise.
	Low frequency noise/micro-pressure wave	D	D	A-	P: No impact is expected.
					C: Construction activities will not cause low frequency noise/micro-pressure wave.
					O: Significant low frequency/micro-pressure wave at long tunnel sub-sections is expected. Long tunnels over 1km exist at 6 locations, of which two are over 3km (one in the boarder of Ninh Binh and Thanh Hoa, the other in Nghe An. Most of the tunnels are in Thanh Hoa Section, followed by Nghe An and Ninh Binh). Low frequency noise from the train passing an open section is small.
	Wave Obstruction	D	D	B-	P: No impact is expected.
					C: No wave obstruction is expected by the construction work.
					O: Radio waves would be disturbed by movement of high speed trains and some impacts such as flutter and pulse interferences on TV are expected. In addition, since the elevated structures such as viaduct (typical design: approx. 10m high) and station buildings (two stories station like Thanh Hoa: approx. 20m high, Vinh Station is three stories, approx. 27m high) will be developed, some impacts by wave disturbed by these structures are expected.
	Sunshine Obstruction	D	D	B-	P: No impact is expected.
					C: No sunshine obstruction is expected by the construction works.
					O: There will be elevated structures such as viaduct and station buildings developed; some impacts are expected by shade created by these structures.
	Wastes/Hazardous waste	D	B-	B-	P: No impact is expected.
					C: A certain amount of construction and demolition wastes which may include hazardous materials, and waste from construction workers' camps is expected to be generated.
					O: A certain amount of wastes from passengers at the station and maintenance works at the depot is expected to be generated.
Social Environment	Involuntary resettlement	A-	B-	D	P: About 1,100 ha of land would be necessary for development of the HSR structures (viaduct, station, depot, etc.) in this section. In addition, about 1,300 buildings and 4,400 households would be affected either by land acquisition or resettlement although the alignment is planned to avoid the land acquisition and resettlement as much as possible though alternative analysis.
					C: Land acquisition and resettlement activities are expected to be continued even during construction stage. Temporal relocation is also required for setting up of construction yards and workers' camps for the construction activities.
					O: No impact is expected.
	Land use	B-	B-	A+	P: The current land use needs to be changed by land acquisition and resettlement in accordance with the planned alignment and station location.
					C: Land clearance for construction yards and workers' camps is temporary. The land use around the construction site may be changed by doing business with construction workers without control.
					O: The HSR station will be developed together around the station areas as an integrated development. In addition, land use is expected to be changed gradually for further development mainly around the station in accordance with a provincial/city plan and private investments.
	Utilization of	D	B-	D	P: No impact is expected.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
	local resources				C: Using a large amount of local resources such as sand and quarry for the construction activities would obstruct its utilization by local people for other purposes.
					O: No impact is expected because the HSR would not use much local resources.
	General, regional /city plans	B+/ B-	D	B+	P: Except for Ngoc Hoi Station and Section in Ha Nam along the express way where the other further development is limited for the future HSR purpose, HSR will result in changing land use purpose in most of the provinces. The current general plan and/or regional/city plan of City/Provinces needs to be updated in accordance with the planned alignment and station location.
					C: No impact is expected (updating plans may continue).
					O: In accordance with the HSR development including development of station area, further general plan/city plans which include further development plan are expected to be prepared in all city/provinces.
	Social institutions and local decision - making institutions	C-	C-	C-	P: Some impact on social institutions local decision making institutions is expected by land acquisition and resettlement. However further examination is necessary.
					C: Some impact on social institutions and local decision making institutions is expected by inflow of many construction workers and other relating peoples from outside the area. However further examination is necessary.
					O: Some impact on social institutions and local decision making institutions is expected by disturbing movement of local people by the HSR structures. However further examination is necessary.
	Social Infrastructures and Services	B-	B-	B+/B-	P: By land acquisition and resettlement, some impacts on social infrastructure and services such as resettlement of community facility (village hall, etc.) are expected.
					C: Though temporal, impacts on social infrastructures and services by setting up of construction yards and workers' camps are expected. Especially, impacts on social infrastructures and services are expected by disturbance and interruption of their utilization by the construction activities such as relocation of public utilities and local roads.
					O: Development of the HSR station together with its surrounding areas would improve social infrastructures and services in the area and the country. On the other hand, some impacts on social infrastructures and services by the existence of the HSR structures are expected.
	Local economy and livelihood	B-	B+	A+/B-	P: Some negative impacts on the local economy and livelihood are expected because of losses of employment opportunities and income sources by land acquisition and resettlement.
					C: Some positive impact on the local economy is expected because of possible increment of business/employment opportunities generated by the construction activities.
					O: Some positive impact on the local economy is expected because of possible increment of business/employment opportunities generated by the HSR project, especially around the station and employment of the workers for track maintenance, etc. On the other hand, some negative impacts are also expected after the completion of the construction activities because of termination of temporary employment opportunities of local workers.
	Unequal Distribution of	B-	B-	B-	P: Unequal situations are expected among the project affected households/peoples and not affected households/peoples.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
	Benefit and Damage				C: Some unequal situations are expected among the local peoples between those who receive any benefit and those who receive any damage from the constriction activities, e.g. some affected households need to be relocated far away, while their neighbors not affected can do business with construction workers.
					O: Some unequal situations are expected among the local peoples between those who live near the station and those who live far from the station, especially in the latter case, they have a possibility to receive damages such as noise and vibration impacts, and some impacts on social infrastructures and services, livelihood and water usage, while in the former case, they may enjoy the benefit from the HSR service and related opportunities of businesses.
	Local conflicts of interest	C-	C-	C-	P/C/O: Local conflicts of interest are expected among local peoples, especially between beneficiaries and project affected peoples for land acquisition and inconveniences during construction and operation. Further examination would be necessary in case that unequal distribution of benefit and damage is expected to be crucial issues.
	Water Usage, Water Rights and Communal Rights	C-	C-	C-	P: Some impacts on water usage for the resettled houses/peoples are expected by land acquisition and resettlement. However, further examination would be necessary for water rights and communal rights.
					C: Impacts on water usage such as obstruction of accessibility of water sources for domestic and irrigation uses by the construction activities are small and temporal. However, further examination would be necessary for water rights and communal rights.
					O: Impacts on water usage such as obstruction of accessibility of water sources for domestic and irrigation uses are expected by the existence of the HSR structures. However, further examination would be necessary for disturbance by the structures.
	Cultural and Historical Heritages	D	B-	B-	P: Although 4 national cultural and historical heritages are found in Ninh Binh and Thanh Hoa provinces within a distance of 100m from the alignment, they are not affected directly by HSR. Thus, no impact is expected.
					C: Together with above mentioned, many heritages are found near the alignment. These may be affected by the noise and vibration, and the traffic congestions caused by vehicles for the construction. Followings are the examples of heritages near the alignment. - Ninh Binh: Tam Thanh temple as a national heritage located in distance of 68 m away the planned alignment. - Thanh Hoa: the planned alignment is located relatively close to the national heritage places i.e. Nui Nap Martyr cemetery about 60 m away from planned alignment
					O: The heritages mainly within 100m from the alignment may suffer the impact of noise and vibration to some extent.
	Religious Facilities	B-	B-	B-	P: Though the well known religious places are not directly affected, small scale village level religious facilities may be relocated (ex. Tu Thuan Village Temple, Buom Pagoda in Hanoi).
					C/O: Some pagodas and temples are found along the HSR within a distance less than 200m, So impacts such as noise and vibration are expected during the construction and operational phases.
	Sensitive facilities (ex. hospital, school,	A-	B-	B-	P: It finds some sensitive places as Nam Dinh College (Nam Dinh) and the center of war invalid health care (Ha Nam) on the alignment and those places may be relocated.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
	precision machine factory)				C: Especially the school and hospital (such as neurological hospital in distance of 38 m (Ha Nam), Yen Nhan school located in distance of 60 m (Nghe An), An Hoach school and Ha Trung hospital located in distance of about 60 m and 77 m (Thanh Hoa) away from planned alignment), the traffic congestion with heavy vehicles affect the local peoples' convenience and safety.
					O: Especially with regard to the school and hospital along the alignment, noise and vibration caused by HSR may affect the peoples' comfort.
	Poor people	C-	B+	C-	P: Poor people (who have poor household certificates issued by local authorities) stay everywhere, particularly concentrate in Thanh Hoa province. Further examination would be necessary for them because it is more difficult for them to recover their livelihood after land acquisition and resettlement than other PAPs.
					C: There is a possibility that the poor people would also have employment opportunities in construction and its associated business activities.
					O: There is a possibility that the enjoyment of the benefits of the HSR service by the poor people would be difficult. Further examination would be necessary.
	Ethnic Minorities/indigenous people	C-	C-	C-	P: In this section, there are ethnic groups such as Muong and Kho Me, particularly in Tinh Gia district, Thanh Hoa province. Some impact on their culture as well as livelihood is expected, however, further examination would be necessary.
					C: Some impact on ethnic groups is expected by the influx of a large number of construction workers and relating peoples outside the area. Further examination would be necessary.
					O: Some impact on ethnic groups is expected by disturbed movement of peoples by the existence of HSR structures. Further examination would be necessary.
	Gender	C-	C-	C-	P: Land acquisition and resettlement are an important incident to a family and some women would have a bigger burden for that. Further examination would be necessary.
					C: Equal employment opportunities for both sexes are required for the construction works. Further examination would be necessary.
					O: The HSR service will be equal to both sexes. On the other hand, equal employment opportunities for both sexes are required for the HSR operation. Further examination would be necessary.
	Children's rights	D	D	D	P: No impact is expected.
					C/O. Since employment of children for the construction works is strictly prohibited by Children Protection, Education and Care Law 2004, no impact is expected.
	Public Health (sanitation and infectious diseases)	D	B-	B-	P: No impact is expected.
					C: Some impacts on public health are expected due to unsanitary conditions caused by the influx of a large number of workers. In addition, increase of risks related to Sexually Transmitted Diseases (STD) or Sexually Transmitted Infections (STI) and HIV/AIDS is expected among the workers and local communities.
					O: Some impacts on public health are expected due to the influx of a large number of passengers (about 70,000 passengers per day at Ngoc Hoi Station, if Ngoc Hoi - Vinh section is operated in 2030) and business persons around the station area.
	Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected.
					C: Some impacts regarding OHS for the construction workers are expected.
					O: Some impacts regarding OHS for the workers for the HSR operation, especially the workers at the track for maintenance and at the depot are expected.
Other	Accidents	D	B-	C+/C-	P: No impact is expected.
					C: Increase of risks of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Basis
					O: Increase of risks of accidents associated with the HSR services is expected due to the high speed train operation. On the other hand, positive and/or negative impacts are expected by the modal sift of passengers' transportation to HSR from cars, buses, airs, and existing railways.
	Climate Change	D	D	A+/C-	P: No impact is expected.
					C: Although increase of GHGs emission is expected due to operation of heavy equipment and vehicles, the impact is temporal and small.
					O: Overall reduction of GHGs emission is expected by the modal shift of passengers' transportation to the HSR (+31% of the share between Hanoi – Vinh, 2030 projection) from cars (-6%), buses (-19%), airs (-1%), and existing railways (-5%). Low altitude area close to the coastal area may be affected by the rise of sea level by climate change, and further examination would be required.

Source: JICA Study Team

A-: Serious negative impact is expected, if any measure is not implemented to the impact.

B-: Some negative impact is expected, if any measure is not implemented to the impact.

C-: Extent of negative impact is unknown (A further examination is needed and the impact could be defined as study progresses.)

D: No impact is expected. Therefore, EIA is not required.

A+: Remarkable positive effect is expected by the project implementation itself and environmental improvement caused by the project.

B+: Some positive effect is expected by the project implementation itself and environmental improvement caused by the project.

C+: Extent of positive impact is unknown (A further examination is needed and the impact could be defined as study progresses.)

11.4 Resettlement and Rehabilitation Policy Framework

11.11 Major regulations related to land acquisition and compensation in Vietnam are Decree No. 197/2004/ND-CP, Decree No. 181/2004/ND-CP, Decree No. 84/2007/ND-CP and Decree No. 69/2009/ND-CP, and difference between these Vietnamese regulations and a donor policy such as JICA Guidelines for Environmental and Social Considerations (April, 2010, hereafter referred as JICA Guidelines) and World Bank OP4.12 for Involuntary Resettlement are identified. As for a donor funding project, such difference is necessary to be solved by establishing a realistic policy for compensation of land acquisition and resettlement and preparing appropriate Resettlement Action Plan (RAP)[2] with enhancing participation of Project Affected Persons (PAPs)[3].

11.12 Since the project (i.e. the optimum route at the North section) is not in the stage to prepare RAP due to preliminary design stage, provisional Resettlement and Rehabilitation Policy Framework (RRPF) was prepared as a guideline for preparing a Compensation, Support and Resettlement (CSR) Plan and RAP in the next study stage based on the Vietnamese regulations and donor policies or guidelines. The provisional RRPF includes policies of land acquisition and resettlement to be applied for the project in order to fulfill identified difference.

1) Eligibility for Compensation and/or Assistance

11.13 People who are living or whose assets are locating in the project area[4] at the time of cut-off date[5] are eligible for compensation and/or assistance to their loss to be caused by the project implementation. However, those who arrive after the cut-off date are not entitled. Based on the definition of cut-off date by the World Bank, cut-off date for this project is proposed to be set at; i) the day of provincial decisions on land acquisition is officially publicized, or ii) the first day of census if it is conducted prior to announcement of land acquisition decisions by Provincial People's Committee (PPC) or District People's Committee (DPC). Identified PAPs are basically classified into the following categories according to the World Bank Safeguard Policy, OP4.12 for Involuntary Resettlement, and compensation and/or assistance is entitled based on the legal status. The following criteria to define or categorize eligibility are also proposed to be applied for the project.

(i) those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country)

(ii) those who do not have formal legal rights to land at the time census begins, but have a claim to such land or assets, provided that such claims are recognized under the law

[2] According to the Handbook on Resettlement A Guide to Good Practice (ADB, 1998), RAP is " A time-bound action plan with budget setting out resettlement strategy, objectives, entitlement, actions, responsibilities, monitoring and evaluation". It generally contains; i) project description, ii) potential impact, iii) objectives, iv) socio-economic study, v) legal framework, vi) institutional framework, vii) eligibility, viii) estimation of loss, ix) resettlement measures, x) relocation sits, xi) grievance mechanism, xii) implementation schedule and xiii) budget.

[3] Project Affected Persons (PAPs) means any persons, household, firm, private or public institution that loses land, a home or business interests because of land acquisition.

[4] Project area is the target area of land acquisition. Target area of land acquisition in this project is composed of ROW and protection scope.

[5] According to the definition in the Involuntary Resettlement Sourcebook (World Bank, 2004), "cut-off date is the date of census begins. The cut-off date could also be the date the project area was delineated, prior to the census, provided that there has been an affected public dissemination of information on the area delineated, and systematic and continuous dissemination subsequent to the delineation to prevent further population influx". In the case of projects in Vietnam, cut-off date is also defined as the date when a local authority such as PPC or DPC officially announces land acquisition by a decision.

of the country (i.e. Decree No. 197/2004/ND-CP, Decree No. 181/2004/ND-CP, Decree No. 84/2007/ND-CP and Decree No. 69/2009/ND-CP in the case of this project) or become recognized through a process identified in RAP

(iii) those who have no recognizable legal right or claim to the land they are occupying

2) Entitlement

11.14 The entitlement for compensation and assistance of livelihood stabilization is defined according to Vietnamese regulations in compliance with a donor policy. An entitlement of compensation/assistance is basically categorized based on the defined eligibility to the type of loss/impact. As for the project, eligibility is proposed considering JICA Guidelines as a representative of a donor policy and past projects in the transportation sector implemented in Vietnam so far. Table 11.4.1 provides the provisional entitlement matrix as a part of the RRPF to the potential loss/impact caused by project implementation.

Table 11.4.1 Provisional Entitlement Matrix for North Section

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
1. Loss of Productive Land				
Permanent Marginal Loss	• Land on Right of Way (ROW) • Land is still economically viable for use or meets the expected personal yield	• Owners with Land Use Right Certificate (LURC), • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC, • Those who are without LURC but regarded as customary owner regardless of tenure status	• Cash compensation for acquired land at full replacement cost, OR • Land-for-land of similar attributes with secure tenure.	• Classification and measurement will be determined by District Compensation Committee (DCC) and concurred with by the affected household during Detailed Measurement Survey (DMS). • Affected households to be notified at least 4 months prior to the date that the land will actually be acquired by the project
		• People without LURC (i.e. squatters or encroachers)	• Cash compensation for structures or land improvement in a acquired land in full replacement cost	
Permanent Severe Loss	• Land on ROW • Land is no longer viable for continued use or does not meet the expected personal yield, therefore the entire property to be acquired.	• Owners with LURC, • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC • Those who are without LURC but regarded as customary owner regardless of tenure status	• Cash compensation at replacement cost (free from transaction costs) for the entire land, or land-for-land of equivalent productive value and with secure tenure, OR • Land-for-land of similar attributes with secure tenure, AND • Entitled to take part in the income restoration program	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS. • Affected households to be notified at least 4 months prior to the date that the land will actually be acquired by the project
		• People without LURC (i.e. squatters or encroachers)	• Cash compensation for structures or land improvement in a acquired land in full replacement cost	
2. Loss of Residential/Commercial Land				
Permanent Marginal Loss	• Land on ROW • Land is still viable for use and house not requiring relocation	• Owners with LURC, • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC • Those who are without LURC but regarded as customary	• Cash compensation at replacement cost (100% value- no deduction for depreciation or salvageable materials), OR • Land-for-land of similar attributes with secure tenure	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
		owner regardless of tenure status		
		• People without LURC (i.e. squatters or encroachers)	• Cash compensation for structures or land improvement in a acquired land in full replacement cost	
Permanent Severe Loss	No or insufficient remaining land for viable use	• Owners with LURC, • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC	• Cash compensation at replacement cost (free from taxes and transaction costs) for the entire land, OR • Land-for-land of similar attributes with secure tenure. • In case of cash compensation, affected households have the option to (i) purchase a land plot in resettlement sites by paying land use levies but not to pay for infrastructure fees, OR (ii) receive resettlement allowance (equals to the infrastructure fees) if they do not want to move to resettlement sites.	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS • Affected household to be notified at least 6 months prior to the date that the land will actually be acquired by the project
Permanent Marginal or Sever Loss		• Households living with relatives/friends on same land or were permitted to build houses by local officials on commune land. (Note: assumption is that these households are landless. The type of assistance will be determined during DMS.)	• For marginal loss, for the portion to be acquired permanently no compensation for land but will be allowed to use remaining land. • For severe loss, for landless households, assistance thru provision of land-for-land of similar attributes with secure tenure at no cost to landless households. The size of land will not be less than 40 m2	• Affected household to be notified at least 6 months prior to the date that the land will actually be acquired by the project
3. Loss of Structures (Residential/Commercial)				
Permanent Marginal Loss	• Affected structures on ROW • Unaffected portion of the structure is still viable for use and require no relocation	Owners of the structures with or without acceptable proof of ownership over the land; with or without building permit	• Cash compensation at replacement cost (i.e., no depreciation and no deduction for salvage materials) for the affected portion, OR • Repair allowance not less than 20% of replacement cost of the affected portion or equivalent to the actual cost of repair.	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
Permanent Severe Loss	• Affected structures on ROW • A structure is no longer viable for continued use and the entire structure is to be acquired	• Owners of the structures with or without acceptable proof of ownership over the land; with or without building permit	• Cash compensation based on current market prices of materials and labor without depreciation or deductions for salvaged building materials for the entire structure, AND • Materials transport allowance as per regulation of PPCs, AND • For relocating households, renting house allowance for 6 months will be provided.	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS
4. Loss of Secondary Structures (kitchen, latrine, etc)				
Loss of, or damage to, assets	• Affected structures on ROW	• Owners of the structures with or without acceptable proof of ownership over the land; with or without building permit	• Cash compensation based on current market prices of materials and labor without depreciation or deductions for salvaged building materials	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS
5. Loss of Cultivated Products (Crops, trees, aquaculture products, livestock)				
Loss of, or damage to, products (Crops and Trees)	• Cultivated products in ROW	• Owners regardless of tenure status and beneficiaries of the land	• Annual crops equivalent to current market value of crops at the time of compensation; • For perennial crops trees, cash compensation at replacement cost equivalent to current market value given the type, age and productive value (future production) at the time of compensation. • Timber trees based on diameter at breast height at current market value	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS
Loss of, or damage to, products (Aquaculture Projects and Livestock)		• Owner of aquaculture projects or livestock regardless of tenure status	• For aquaculture products and livestock of no commercial usage or no commercial value, cash compensation at equivalent to current market value at the time of compensation • For aquaculture projects and livestock with commercial use or commercial value, providing allowance for moving and registration fee for relocation	
6. Affected Public Properties				

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
Loss of, or damage to, properties	• Affected public structures (i.e. infrastructure, social service, etc)	• Owners of affected properties	• Cash compensation to cover the cost of restoring the facilities	• Classification and measurement will be determined by DCC and concurred with by the affected organization during DMS
7. Affected Community Properties				
Loss of, or damage to, assets	• Affected community structures (i.e. community buildings, community irrigation system, etc)	• Affected Communities	Cash compensation to cover the cost of restoring the facilities	• Classification and measurement will be determined by DCC and concurred with by the affected organization during DMS
8. Affected Religious Structures				
Loss of, or damage to, assets	• Affected graves	• Grave owners	• Substitute graves will be build in a similar location, OR • All costs of excavation, relocation and reburial will be reimbursed in cash to the affected grave owners	• Classification and measurement will be determined by DCC and concurred with by the affected commune during DMS
	• Affected pagodas	• Religious organization which manages affected pagoda	• Substitute pagodas will be build in a similar location, OR • All costs of relocation and reburial will be reimbursed in cash to the affected religious organization	
9. Loss of Livelihood[6]				
Loss of Income/ Livelihood	• Marginal impacts due to loss of 20% to 70% of their total productive land and income sources	• Owners with LURC, • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC, • Those who are without LURC but regarded as customary owner regardless of tenure status • Affected households with lease agreement over the affected land • People without LURC (i.e. squatters or encroachers) • Share croppers, agricultural labors and employees	• Transition subsistence allowance in cash equivalent to 30 kg of rice per person per month for 6 months in case of displacement within a province, for 12 months in case of displacement outside of a province and for 24 months in case of economic difficulty, AND • Affected households are eligible to take part in the income restoration program conducted by local authorities, AND • Every displaced households affected by loss of productive land, irrespective of the degree of impact, will be provided with additional assistance equivalent to 1.5 times the compensation amount.	• The eligible households will be determined by DCC

[6] Detailed livelihood restoration program shall be examined based on the prospect of PAPs which will be studied in the next study stage.

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
	• Severe impacts due to loss of 70% or more of their total productive land and income sources	• Owners with LURC, • Those who are in the process of acquiring LURC, • Those who are eligible to acquire LURC, • Those who are without LURC but regarded as customary owner regardless of tenure status • Affected households with lease agreement over the affected land • People without LURC (i.e. squatters or encroachers) • Share croppers, agricultural labors and employees	• Transition subsistence allowance in cash equivalent to 30 kg of rice per person per month for 12 months in case of displacement within a province, for 24 months in case of displacement outside of a province and for 36 months in case of economic difficulty, AND • Affected households are eligible to take part in the income restoration program conducted by local authorities, AND • Every displaced households affected by loss of productive land, irrespective of the degree of impact, will be provided with additional assistance equivalent to 1.5 times the compensation amount.	
	• Severe impacts on shops	• Relocating shop (owners) regardless of tenure status and employees	• For registered businesses, the business disruption allowances equivalent to 30% of annual net income will be applied. • For non-registered business owners, the business disruption allowances equivalent to 50% of business disruption allowances of registered businesses will be applied. • If stand-alone shops (commercial only, not house-cum-shops), materials transport allowance equivalent to the actual cost of relocation expenses (labor, transport) • Employees who are affected by residential/commercial land acquisition, public land or land of enterprises: Allowance equivalent to the minimum salary as per the provincial regulations to affected employees during the transition period for a maximum of 6 months	• The eligible households will be determined by DPC
10. Temporal Loss during the Construction[7]				

[7] The Contractor is the sole responsible party on this compensation.

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
Loss of land and structure	• Temporal Loss due to construction activities	• Owners of land and structures	• Compensation for rental fee for the area of the temporal use duration but this rental fee shall be more than net income that can be generated by this temporal use land, AND • Restoration of the land within 3 months after use. The project owner will request the contractors if they fails to restore the affected land within 3 months after end of use, AND • Affected non-land assets cause during construction will be paid at replacement cost by the Contractor, AND • The project owner will request the contractors to pay full replacement cost if contractor fails to pay affected non-land assets and does not restore the affected land within 3 months after end of use.	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS
11. Additional Support to Vulnerable Groups[8]				
Loss of Land and Non-Land Assets		• Households living or working in the project Right of Way • Affected households categorized as: (i) female headed households with dependents, (ii) households with disabled persons, (iii) households falling under the current MOLISA benchmark poverty line, (iv) children and elderly households who are with no other means of support, (v) landless households, are regarded as vulnerable groups, (vi) ethnic minority groups in case they are discriminated	• Social protection beneficiary groups defined in the Decree No. 67/2007/ND-CP of April 13, 2007 (i.e. orphans, elderly people in poor households, people aged over 85, people without pension or social insurance allowance, seriously disabled persons in poor household, mental disease patients, HIV/AIDS infected persons in poor households, families/individuals adopting orphans or abandoned children, households with serious disabled persons, women/men-headed households in the poor household raising child(ren) under 16 years old) and heroic mothers, wounded, dead soldiers: Cash allowance from 10 Million to 20 Million per household depending specific cases. • For other vulnerable households who are	

[8] Detailed additional assistance needs to be studied based on the results of census and socio-economic survey to be conducted in the next study stage

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
			identified by DPC: cash allowance of 10 million per household. • Entitled to take part the income restoration program	

Source: JICA Study Team

3) Grievance Redress Mechanism

11.15 The Vietnamese regulation establishes the systematic grievance mechanism, and the people's committee where issues the land acquisition decision is stipulated as the first contact window to appeal a grievance related to land acquisition issues in this mechanism. The overall procedure of grievance redress under Vietnamese legal scheme is summarized below:

(1) DPC issues land acquisition decisions

- Within 90 days from the date DPC issues and decision of land acquisition, a person who disagrees with the decision files a written complaint with DPC. The issue is settled within due date stipulated in Law on Complaints and Denunciations (No. 09/1998/QH10 of December 2, 1998), and settled decision is issued by DPC. The settled decision is also publicized and sent to complainants and other relevant persons.
- Within 45 days from the settled decision issues, the complaints may file a lawsuit to the People's Courte or lodge the issue to PPC in case it is not agreeable.

(2) PPC issues land acquisition decisions

- Within 30 days from the date PPC issues and decision of land acquisition, a person who disagrees with the decision files a written complaint with PPC. The issue is settled within due date stipulated in Law on Complaints and Denunciations (No. 09/1998/QH10 of December 2, 1998), and settled decision is issued by PPC. The settled decision is also publicized and sent to complainants and other relevant persons.
- Within 45 days from the settled decision issues, the complaints may file a lawsuit to the People's Courte in case it is not agreeable.

11.16 In order to secure the accessible grievance procedure for PAPs, contacting the nearest local authority might be practical rather than lodging to DPC or PPC. Thus, it is proposed that Commune People's Committee (CPC) is also the contact window throughout the project implementation, and CPC conveys lodged complaints to DPC or PPC in addition to the stipulated procedure.

4) Preliminary Estimate of Land Acquisition Impacts

11.17 Land acquisition area for the North section was calculated based on the following conditions, and Table 11.4.2 shows the definition of land acquisition area in accordance with the following conditions.

(i) Land acquisition area for the alignment (i.e. embankment, cutting, bridges, viaduct and tunnel), deport and workshop, access route to depot and workshop, stations, electric facilities, station plaza was estimated based on available data in this study level. Land acquisition for other facilities, if required, shall be examined at the next study stage when they are designed.

(ii) Embankment and cutting were designed based on three typical standards. Thus, land acquisition area was calculated to these three standards accordingly.

(iii) Land acquisition area for tunnel section was calculated on the premise that the area of the entire tunnel section will be acquired.

(iv) Protection scope is the area to secure safety of alignment, and land acquisition of this area is necessary. In the case of this project, it was defined 5m from the outer edge of embankment and cutting based on the project scope, previous railway projects in Vietnam and Japan. As for bridge, viaduct and tunnel, protection scope was also defined 5m from the utmost outer edge of a structure. Further examination of this area is necessary at the next study stage.

(v) As for station, station structure and 1m for elevated or ground station and station structure plus 3m for half-underground station were regarded as the land acquisition area.

Table 11.4.2 Definition of Land Acquisition Area/Width to be Acquired

Facility	ROW (m)	Protection Scope*1 (m)	Safety Corridor*2(m)	Total*3 (m)
Embankment, Type 1	24	5x 2sides	10x2sides	34
Embankment, Type 2	34	5 x 2sides	10x2sides	44
Embankment, Type 3	51	5 x 2sides	10x2sides	61
Cutting, Type 1	24	5 x 2sides	10x2sides	34
Cutting, Type 2	34	5 x 2sides	10x2sides	44
Cutting, Type 3	47	5 x 2sides	10x2sides	57
Bridges	12	5 x 2sides	-	22
Viaducts	12	5 x 2sides	-	22
Tunnels	12	5m at each side	-	-
Stations (Elevated)	*4	1m at each side	-	-
Station (Ground)	*4	1m at each side	-	-
Station (Half-Underground)	*4	3m at each side	-	-

Source: JICA Study Team

Note

*1: Width is defined based on the preliminary feasibility study report (Establishing Report on Construction Investment of High Speed Railway Line Hanoi – Ho Chi Minh City prepared by Vietnam Railways on February, 2009), other railway projects in Vietnam and Japanese example.

*2: This is 10m each side from the edge of the protection scope.

*3: Total means total width of land acquisition (i.e. ROW and protection scope).

*4: It defers at each tunnel and station.

(vi) Safety corridor is the area where land use is limited though land acquisition is not necessary according to the Railway Law (No. 35/2005/QH11) and practical operation of previous railway projects in Vietnam. The safety corridor was defied to be 15m from the outer edge of the embankment/cutting. Since 5m from the edge of the embankment/cutting were defined as protection scope and was included into land acquisition area, remaining 10m was regarded as safety corridor.

11.18 Potential land acquisition and resettlement impact was examined based on the available data such as topographic map produced from the satellite imagery taken between October 8, 2009 and February 16, 2011 and data of land use map collected from each city/province. The list of land use map data collected from each city/province is presented in Table 11.4.3.

Table 11.4.3 Collected Data of Land Use Map from Each City/Province

City/Province	Collected Data
Hanoi	Current Landuse Map up to 2010
Ha Nam	Landuse Plan Map up to 2010
Nam Dinh	Landuse Plan Map up to 2020
Ninh Binh	Landuse Plan Map up to 2010
Thanh Hoa	Landuse Plan Map up to 2020
Nghe An	Current Landuse Map up to 2010

Source: JICA Study Team

11.19 The information was overlaid on Arc GIS format to define the land acquisition area, as given in Table 11.4.2 as well as to calculate the physical assets within ROW for the project. Approaches to calculate affected land and physical assets are outlined below:

(i) Land use was classified into three major categories (i.e. agriculture, forest and residential area) based on the land use data and existing RAP reports of donor agency funding projects in the transportation sector such as Ben – Luc – Long Thanh Expressway Project (ADB, July 2010) and HCM – LT – DG Expressway Project Portion An Phu – Ring Road 2 and Ring Road 2 I.C (ADB, November 2010). In this study, there were additional land use categories such as commercial land, vacant land, public land, religious land, national defense security land and others according to the land use data collected from each city/province.

(ii) The type and the number of crops and trees, and category of affected houses were not able to be obtained from topographic map and city/provincial land use data. Thus, following approaches were applied.

- Crops were classified into three categories (i.e. rice, aquaculture and other crops) according to land use, and affected crops were estimated as per the affected area.
- Trees were classified into two categories (i.e. forest tree and fruit tree) according to land use, and affected trees were estimated multiplying affected land (i.e. forest land or fruit tree cultivated land) by tree density stipulated in provincial decision. If information of tree density was not available in some provinces, available tree density information at the province of similar natural condition was used.
- The number of affected structure was inventoried. Even if only a portion of the structure was found to be inside the ROW, it was counted as one regardless of the affected area in a structure.
- The number of affected structures was counted as house and shop. In addition, the number of affected structure was counted on the premise that 30% of affected structure was shop and remaining structure was house. As for house, it was classified into three types (i.e. temporary house, 1st floor house and 2nd floor house). Number of affected house at each house category was estimated from distribution rate of each house type at each province obtained from provincial statistic year books.
- Inasmuch as the total area of the grave sites was available, information on the number of graves was not available from existing data. Thus, the number of graves was estimated by referring to the estimated number in the existing RAP reports in the transportation sector.

11.20 Total land acquisition area at North section was estimated at 1,125 ha. Among them, land acquisition area at three major land use by province and section is shown in Table 11.4.4 and Table 11.4.5, .

Table 11.4.4 Preliminary Estimate of Affected Land Area by Province

Province	Land Use Category (Unit: Ha)

	Agriculture	Forest	Residence
Hanoi	108	0	7
Ha Nam	76	0	16
Nam Dinh	81	0	15
Ninh Binh	60	7	8
Thanh Hoa	218	46	83
Nghe An	239	18	52
Total	782	71	181

Source: JICA Study Team

Table 11.4.5 Preliminary Estimate of Affected Land Area by Section

Section	Land Use Category (Unit: Ha)		
	Agriculture	Forest	Residence
Ngoc Hoi Sta.	3	0	0
Km 0.308 – 45.215	148	0	14
Phu Ly Sta.	2	0	0
Km 45.865 – 67.339	35	0	14
Nam Dinh Sta.	2	0	0.4
Km 67.989 – 103.056	95	0	14
Ninh Bih Sta.	4	0	0.4
Km 103.706 – 153.326	119	29	32
Thanh Hoa Sta.	1	0	2
Km 154.326 – 282.970	359	42	83
Vinh Sta.	14	0	21
Total	782	71	181

Source: JICA Study Team

11.21 Table 11.4.6 and Table 11.4.7 show the number of affected structures at province wise and section wise respectively.

Table 11.4.6 Preliminary Estimate of Affected Structures by Province

Province	Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An	Total
Number of Affected Structures (Unit: No.)	56	57	76	64	520	518	1,291

Source: JICA Study Team

Table 11.4.7 Preliminary Estimate of Affected Structures by Section

Section	Ngoc Hoi Sta.	Km 0.308 – 45.215	Phu Ly Sta.	Km 45.865 – 67.339	Nam Dinh Sta.	Km 67.989 – 103.056
Number of Affected Structures (Unit: No.)	0	74	0	66	5	81
	Ninh Bih Sta.	Km 103.706 – 153.326	Than Hoa Sta.	Km 154.326 – 282.970	Vinh Sta.	Total
	2	340	0	517	206	1,291

Source: JICA Study Team

11.22 Table 11.4.8 and Table 11.4.9 show the number of affected trees in the forest area (excluding the affected fruit trees) by province and section, respectively.

Table 11.4.8 Preliminary Estimate of Affected Trees[1] in the Forest Area by Province

Province	Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An	Total
Number of Affected Trees	-	-	-	1,200	93,380	21,200	115,780

(Unit: No.)							

[1] Excluding fruit trees.
Source: JICA Study Team

Table 11.4.9 Preliminary Estimate of Affected Trees[1] in the Forest Area by Section

Section	Ngoc Hoi Sta.	Km 0.308 – 45.215	Phu Ly Sta.	Km 45.865 – 67.339	Nam Dinh Sta.	Km 67.989 – 103.056
Number of Affected Trees (Unit: No.)	0	0	0	0	0	0
	Ninh Bih Sta.	Km 103.706 – 153.326	Than Hoa Sta.	Km 154.326 – 282.970	Vinh Sta.	Total
	0	46,000	0	69,780	0	115,780

[1] Excluding fruit trees.
Source: JICA Study Team

11.23 Table 11.4.10 and Table 11.4.11 show the affected number of households by province and section, respectively.

Table 11.4.10 Preliminary Estimate of Affected Households by Province

Province	Hanoi	Ha Nam	Nam Dinh	Ninh Binh	Thanh Hoa	Nghe An	Total
Number of Affected Households (HHs) (Unit: No.)	493	360	400	303	1,398	1,477	4,431

Source: JICA Study Team

Table 11.4.11 Preliminary Estimate of Affected Households by Section

Section	Ngoc Hoi Sta.	Km 0.308 – 45.215	Phu Ly Sta.	Km 45.865 – 67.339	Nam Dinh Sta.	Km 67.989 – 103.056
Number of Affected Households (HHs) (Unit: No.)	13	668	10	207	15	462
	Ninh Bih Sta.	Km 103.706 – 153.326	Than Hoa Sta.	Km 154.326 – 282.970	Vinh Sta.	Total
	17	816	4	1,954	265	4,431

Source: JICA Study Team

5) Preliminary Cost Estimation for Compensation and Assistance

11.24 Based on the preliminary assessment on land acquisition and resettlement, compensation cost for land acquisition and resettlement was estimated with the following conditions.

(i) Compensation and assistance cost was estimated in full replacement cost as a premises for a donor agency funding project.

(ii) Compensation for land targeted only privately use land (i.e. agriculture land, residential land, commercial land and vacant land). In this study, land use categories such as forest land (i.e. protection forest and production forest), public land, national defense security land, religious land and other land use on land use data from city/province were regarded as public land, and compensation for these land categories was not included.

(iii) Compensation for structures and assistance for households locating or living both of private and public land use were considerd since a donor policy requested to provide necessary compensation/assitance to structures despite of tenure status.

(iv) Compensation for trees and crops were considered despite of private or public land use since an asset was necessary to be compenesated according to a donor policy.

(v) Market price of typical land use in the project area (i.e. agriculture land and residential land) at the time of July 2012 was collected from the real estate at each district in the project area. Collected data of market price is enclosed in Appendix 7A of Vol. III.

(vi) Market price was collected from three area at each land use, and average amount was used as unit cost for compensation and assistance calculation.

(vii) Administration cost and contingency were set as 5% and 10% to the total cost of compensation/assistance respectively based on the examples of donor agency funding projects in the transportation sector.

(viii) Cost for arrangement of relocation site was not included. All necessary compensation was premised to be provided in replacement cost (i.e. not providing land for land).

(ix) Necessary cost for reloction of public utilities was not included since examinig impact to public utilies is difficult at this study level. Examination of such impact and cost is necessary in the course of RAP preparation.

(x) Necessary compensation cost for domestic animal was not included since examining such impact from available data (i.e. city/provincial land use data or statistic data) was difficult. Such impact is necessary to be studied through household survey (i.e. census, inventory of loss and socio-economic survey) in the process of RAP preparation, and necessary compensastion/assistant cost shall be examined if impact is identified.

11.25 Compensation cost for the North section was estimated at province-wise and section-wise as shown each summary in Table 11.4.12 and Table 11.4.13. Breakdown of each compensation cost is enclosed in Appendix 7B of Vol. III.

Table 11.4.12 Preliminary Estimation of Compensation Cost by Province

(Unit: million VND)

	Province	Total (VND)
1	Hanoi	2,053,683
2	Ha Nam	1,377,721
3	Nam Dinh	1,443,264
4	Nin Binh	856,018
5	Thanh Hoa	9,138,512
6	Nghe An	6,553,626
Total for North Section		21,422,824

Source: JICA Study Team

Note: Cost for RAP preparation, independent monitoring, administration (5% of total cost) and contingency (10% of total cost) is included at total cost in each province.

Table 11.4.13 Preliminary Estimation of Compensation Cost by Section

(Unit: million VND)

	KM Post	Total (VND)
1	Ngoc Hoi Station	131,181
2	Km 0.308 – 45.215	2,670,278

3	Phu Ly Station	10,649
4	Km 45.865 – 67.339	861,989
5	Nam Dinh Station	35,355
6	Km 67.989 – 103.056	1,658,363
7	Ninh Binh Station	27,192
8	Km 103.706 – 153.326	6,124,306
9	Thanh Hoa Station	152,227
10	Km 154.326 – 282.970	6,318,603
11	Vinh Station	3,432,681
Total for North Section		21,422,824

Source: JICA Study Team

Note: Cost for RAP preparation, independent monitoring, administration (5% of total cost) and contingency (10% of total cost) is included at total cost in each section.

6) Provisional Implementation Schedule of Land Acquisition

11.26 The project is planned to implement the Ngoc Hoi – Phu Ly section first as the initial section following to Phu Ly – Vinh as the prioritized sections in the north section. Land acquisition schedule is explained in the following procedure. Table 11.4.14 shows provisional schedule of land acquisition in the case of donor-funded project, and is commonly usable for the both of initial and remaining sections. However, it should be reminded that necessary period for the household survey such as census, inventory of loss, socio-economic survey, replacement cost survey is depending on the length of target section to be aqcuired and local conditions.

(i) F/S is commenced when the project is approved by the Government of Vietnam. When ROW is almost delinarated at F/S level, household survey (i.e. census, inventory of loss and socio-economic survey) is started by the project implementing agency in a process to prepare RAP.

(ii) Each section at the initial section encompasses more than two province, and therefore it is preferable to arrange separate household survey team at each province since conducting household survey will need permissions from local authorties.

(iii) In parallel with household survey, replacement cost survey is necessary to be conducted by authorized valuers accroding to national regurations such as TDGVNs issued by Ministry of Finance and also according to the Involuntary Resettlement Sourcebook of the World Bank, 2004. This is to collect necessary information for estimating compensation cost in replacement cost.

(iv) Collected survey data is used for establishing compensation policy and estimating compensation cost, which is compiled as RAP. The framework of RAP is disclosed to PAPs through public consultation meeting. The RAP is then finalized by reflecting public comments. Final RAP is necessary to be approved by the concerned Vietnamese authorities and by the donor agency.

(v) RAP prepared at the time of F/S is updated in the same timing of official land acquisition procedure during D/D stage.

(vi) Household survey and replacment cost survey are implemented in collraboration with DMS when land acquisition decision is issued, if profile of PAPs is necessary to be renewed or project design is changed.

(vii) When compensation assessment is to be dislosed, the holding of a public consultation meeting is necessary in order to explain the updated RAP.

(viii) Internal and independent monitorings is started when an official procedure of land acquisition is commenced. As for internal monitoring, it is finished when land acquisiiton is complete in order to monitor livelihood stabilization of PAPs.

Table 11.4.14 Provisional Schedule of Land Acquisition

		Responsibility	Year 1				Year 2				Year 3				Year 4			
			1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
	<Project Implementation>																	
1	Project Approval																	
2	Feasibility Study																	
3	Detailed Design																	
4	Construction Work																	
	<Land Acquisition & Resettlement>																	
1	**Preparation of RAP**																	
1-1	Census	Project Implementing Agency																
1-2	Inventory of Loss	Project Implementing Agency																
1-3	Socio-Economic Survey	Project Implementing Agency																
1-4	Replacement Cost Survey	Project Implementing Agency																
1-5	Data Analysis and Report Preparation	Project Implementing Agency																
1-6	Public Consultation Meeting	Project Implementing Agency																
1-7	Finalize RAP	Project Implementing Agency																
2	**Update of RAP**																	
2-1	Supplemental/Re-Conduct Household Survey	Project Implementing Agency																
2-4	Supplemental/Re-Conduct Replacement Cost Survey	Project Implementing Agency																
2-5	Update RAP Report	Project Implementing Agency																
2-6	Public Consultation Meeting	Project Implementing Agency																
2-7	Finalize Updated RAP	Project Implementing Agency																
3	**Offical Procedure under Vietnamese Regulation (Update RAP)**																	
3-1	Issuing a Land Acquisition Decision (cut-off date)	Provincial People's Committee																
3-2	Conducting DMS	District People's Committee																
3-3	Assessment of Compensation	District People's Committee																
3-4	Prepare CSR Plan	District People's Committee																
3-5	Disclosure of CSR Plan	District People's Committee																
3-6	Compensation Payment	District People's Committee																
4	**Transferring Ownership & Evacuation**																	
	<Monitoring>																	
	Internal Monitoring	Project Implementing Agency																
	Independent Monitoring	Project Implementing Agency																

Note: Necessary period for the household survey such as census, inventory of loss, socio-economic survey, replacement cost survey is depending on the length of the target section to be acquired and local conditions.

Source: JICA Study Team