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 B

DETAILED STUDY ON HCMC-NHA TRANG 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.

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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
Japan International Cooperation Agency

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ABBREVIATIONS

AC	Alternating Current
ADB	Asian Development Bank
AFC	Automatic Fare Collection
AGR	Average Growth Rate
ALOS	Advanced Land Observing Satellite Data
(ALOS) AVNIR-2	Advanced Visible and Near-Infrared Radiometer - 2
(ALOS) PRISM	Panchromatic Remote-sensing Instrument for Stereo Mapping
ASK	Available Seat-Km
DEM	Elevation Model
ATC	Automatic Train Control system
CDG	Charles De Gaulle
CTC	Centralized Train Control
DARD	Department of Agriculture and Rural Development
DCC	District Compensation Committee
DMS	Detailed Measurement Survey
DOCST	Department of Culture, Sports and Tourism
DONRE	Department of Natural Resources and Environment
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 and Tax
EBITDA	Earning Before Interest, Tax and Depreciation
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ELP	Electric Light Power
EVN	Vietnam Electric Power Company
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GDEM	Global Digital Elevation Model
GDP	Gross Domestic Product
GHG	Greeenhouse gas
GPS	Global Positioning System
GRDP	Gross Regional Domestic Product
GSO	General Statistics Office
h	Hour
HCMC	Ho Chi Minh City
HH	Household
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
JAC	Japan Airport Consultants
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
JRTT	Japan Railway Construction, Transport and Technology Agency
Km	Kilometre
KOICA	Korean International Cooperation Agency

LTIA	Long Thanh International Airport
LURC	Land Use Right Certificate
MC	Motorcycle
MD	Maintenance Depot
MM&TE	Maintenance Machine & Trining Education equipment
MOC	Ministry Of Construction
MONRE	Ministry Of Natural Resources And Environment
mppa	Million Passengers Per Annum
NH	National Highway
NSHSR	North – South High Speed Railway
O&M	Operation And Maintenance
OC	Operation Cost
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)
PCU	Passenger Car Unit
PMU	Project Management Unit
POP	Population
PPC	Provincial People's Committee
PRC	Programmed Route Control System
PT	Passing Truck
RAP	Resettlement Action Plan
RER	Réseau Express Régional (Regional Express Network)
RL	Rail Level
ROI	Return of Investment
ROW	Right of Way
RRPF	Resettlement and Rehabilitation Policy Framework
R/W	
SAC	Southern Airport Company
SCADA	Supervisory Control and Data Acquisition System
SCH	Signaling and Telecom. House
SDH (VC)	Synchronous Digital Hierarchy
SERF	Shadow Exchange Rate Factor
SFEZ	Southern Focal Economic Zone
SHM	Stakeholder Meeting
SPW	Sound Protection Wall
TEBH	Tunnel Entrance Buffering Hood
TGV	Train a Grande Vitesse – high speed train
TR	Train Radio system
TSN	Tan Son Nhat International Airport
TTC	
UMRT	Urban Mass Rapid Transit
USD	US Dollar
UTM	Universal Transverse Mercator
V	Volt
VAT	Value Added Tax
VHSRS	Vietnam High Speed Rolling Stock
VIAP	Vietnam Institute of Architecture and Urban and Rural Planning
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 Railway
WGS	World Geodetic System

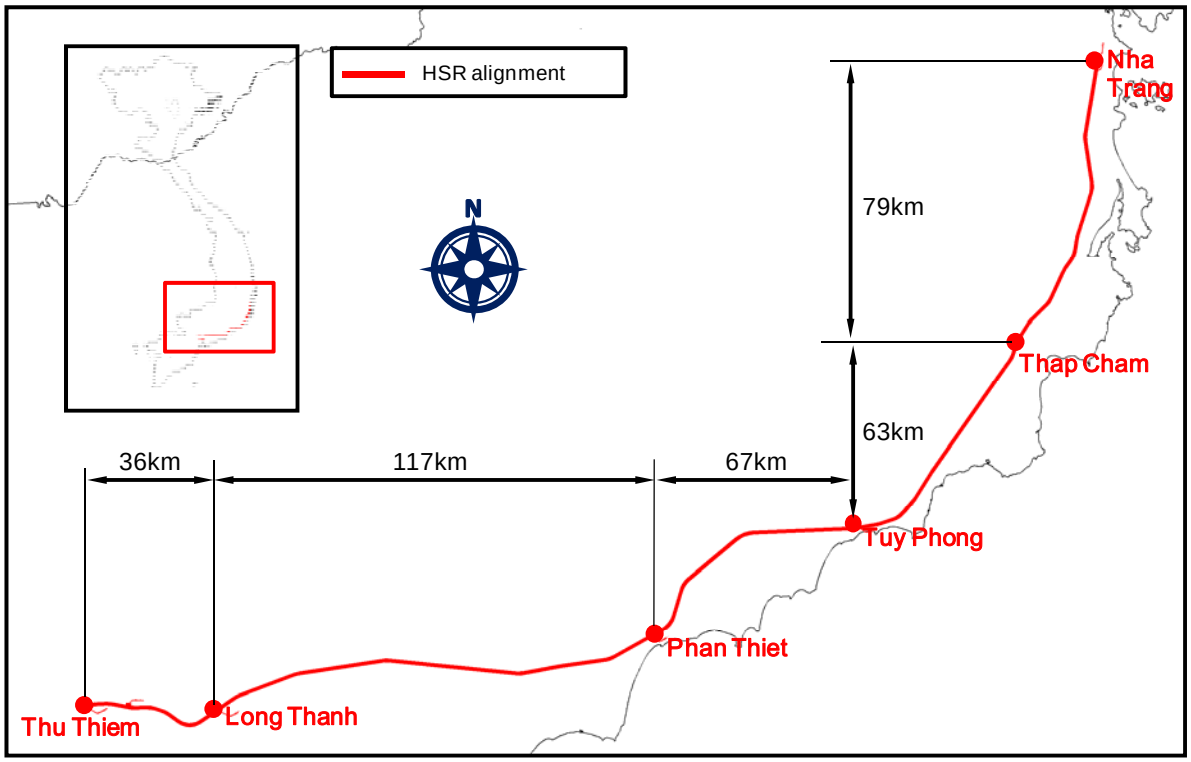
1 INTRODUCTION

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 HCMC – Nha Trang 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 Ho Chi Minh City, Dong Nai Province, Binh Thuan Province, Ninh Thuan Province, and Khanh Hoa Province, with 6 stations planned (see Figure 1.2.1). The total length of the route is 366 km.



Source: JICA Study Team.

Figure 1.2.1 Location Map of HSR South Section

2 SITUATION OF THE PROJECT INFLUENCE AREA

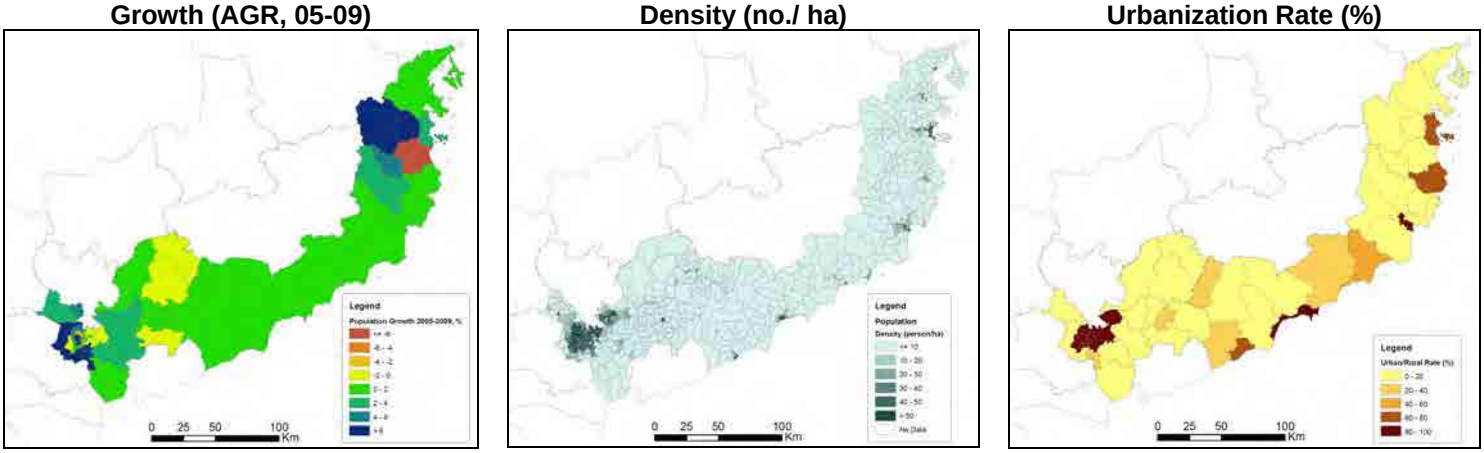
2.1 Socio-economic Development Characteristics

1) Population

2.1 The total population in the HCMC – Nha Trang Corridor is 12.5 million, equal to 15% of the national total. Currently the average population growth rate in the region is 2.7%, higher than the national average. Population growth is prominent in HCMC and Dong Nai, at an annual rate of 3.6% and 2.4%, respectively.

2.2 Population is distributed around main cities in the region, namely Nha Trang, Phan Rang - Thap Cham, Phan Thiet, Bien Hoa and HCMC. Population density is generally quite low. Urbanization is occurring around these main cities. Urbanization rate in this corridor exceeds 60% and is quite high, 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 HCMC – Nha Trang Corridor

Table 2.1.1 Demographic Indicators for HCMC – Nha Trang Corridor

		Khanh Hoa		Ninh Thuan		Binh Thuan		Dong Nai		HCMC		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
Population	Total (000)	1,160	1.0	566	0.8	1,172	0.8	2,491	2.4	7,165	3.6	12,554	2.7
	Urban (000)	461	1.9	204	5.2	462	3.5	828	3.4	5,964	3.8	7,919	3.6
	Rural (000)	699	0.4	361	-1.3	710	-0.7	1,663	2.0	1,201	2.5	4,635	1.2
	Urbanization (%)	39.7	0.9	36.1	4.4	39.4	2.6	33.2	0.9	83.2	0.2	63.1	0.9
Density (no./ha)	Total	2	0.9	2	0.8	2	0.9	4	2.4	34	3.6	5	2.7
	Urban	-	-	-	-	-	-	-	-	-	-	-	-

Source: National Census, 2009.

2) Economic Development

2.3 **GDP growth:** Although HCMC is leading the economic growth of the region, all provinces in the region register high growth rates, namely 10.5%, 10.3%, 13.4%, 13.7%, 11.0% for Khanh Hoa, Ninh Thuan, Binh Thuan ,Dong Nai, and HCMC, respectively. HCMC, Khanh Hoa, and Dong Nai provinces have relatively higher per capita GDP levels whereas this is low for especially for Ninh Thuan province.

2.4 **Sector share:** HCMC and Dong Nai which are included in the SFEZ are developed in industry, thus the secondary sector share is high, the latter exceeding half the total GDP. Ninh Thuan province is much dependent on the primary sector. While provinces around HCMC are developing in line with HCMC, Ninh Thuan and Binh Thuan are lagging behind other provinces in terms of industrialization.

2.5 **Industrial Development:** Ninh Thuan has been chosen as the site for some of Vietnam's future electricity projects that are part of EVN's diversification away from hydropower. The country's first nuclear power plant is under construction in the south of the province, and a second nuclear power project is being prepared with Japanese partners and will also be in Ninh Thuan. Although concerns for safety are being raised, the project is considered to be a pioneer for new energy sources to meet the growing demand for electricity in the country.

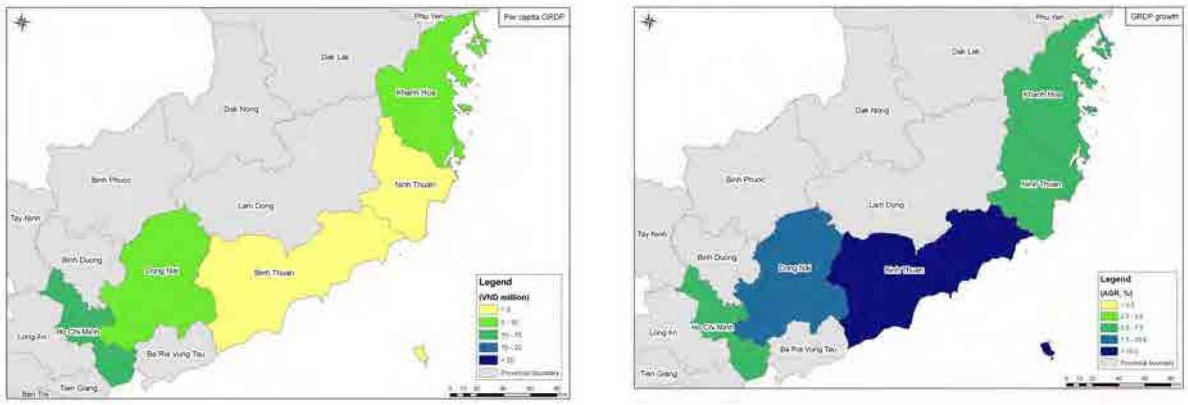
2.6 **Investment:** FDI projects are concentrated in HCMC and Dong Nai provinces. In terms of value, Ninh Thuan province is at par with these provinces. Ninh Thuan has been chosen as the site for some of Vietnam's future electricity projects that are part of EVN's diversification away from hydro-power. The country's first nuclear power plant is under construction in the south of the province. PCI ranking is relatively high for HCMC, Dong Nai, and Binh Thuan at 23rd, 25th, and 28th places, respectively.

Table 2.1.2 Economic Indicators for HCMC – Nha Trang Corridor

		Khanh Hoa		Ninh Thuan		Binh Thuan		Dong Nai		HCMC		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
GRDP (VND bil.)[1]	Primary	3,961	3.7	2,408	10.0	4,301	6.9	5,946	4.9	4,221	4.7	20,838	5.5
	Secondary	10,752	11.8	1,091	10.6	6,366	16.4	34,245	15.0	135,669	9.7	188,123	10.9
	Tertiary	11,069	12.2	1,967	10.4	7,792	15.4	19,063	15.0	172,152	12.3	212,043	12.6
	Total	25,783	10.5	5,466	10.3	18,459	13.4	59,254	13.7	312,042	11.0	421,004	11.4
GRDP share (%)[1]	Primary	15.4	-6.2	44.1	-0.3	23.3	-5.8	10.0	-7.8	1.4	-5.6	4.9	-5.3
	Secondary	41.7	1.2	20.0	0.3	34.5	2.6	57.8	1.1	43.5	-1.2	44.7	-0.5
	Tertiary	42.9	1.5	36.0	0.2	42.2	1.8	32.2	1.1	55.2	1.2	50.4	1.1
Per capita GRDP (VND mil.)		22	9.5	10	9.4	16	12.5	24	11.0	44	7.2	34	8.5
Tourists (000, annual)[2]	Domestic	1,240	17.5	555	30.5	1,544	17.5	758	32.0	2,312	12.0	6,409	16.8
	International	339	8.0	16	40.7	206	16.2	35	26.8	1,675	5.1	2,271	6.7
	Total	1,579	15.1	571	30.7	1,750	17.4	793	31.8	3,987	8.9	8,680	13.6
Turnover (VND bil., annual)		1,563	24.8	643	21.0	1,147	27.3	129	16.3	10,392	20.1	13,873	20.8
Import (USD mil.)		331	12.1	9	23.0	34	0.3	6,634	9.9	15,915	9.8	22,923	9.1
Export (USD mil.)		549	4.9	39	5.6	173	11.8	5,891	11.3	18,306	8.3	24,958	8.2
FDI (88 - 09, USD mil.)		1,345	-	10,056	-	914	-	17,838	-	30,981	-	61,134	-
PCI Index Ranking[3]		40	-	41	-	28	-	25	-	23	-	-	-

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.

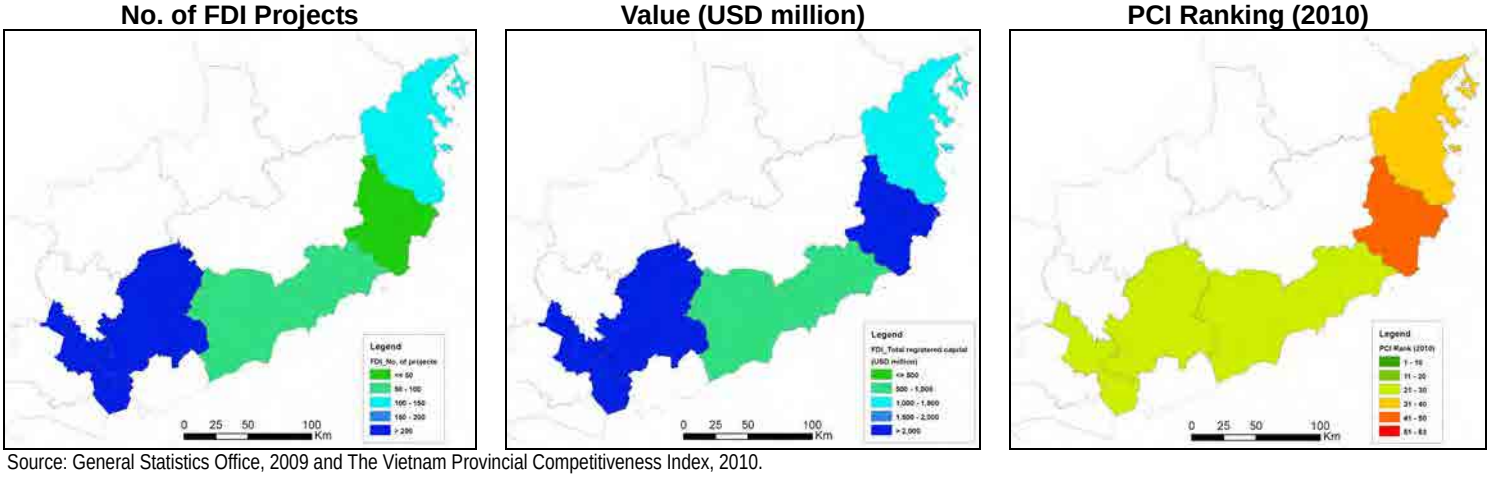
Figure 2.1.2 GDP along the HCMC – Nha Trang Corridor

Primary **Secondary** **Tertiary**

Source: General Statistics Office, 2010.

Figure 2.1.3 GDP Sector Share along the HCMC – Nha Trang 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 HCMC – Nha Trang Corridor

3) Social Aspect

2.7 **Employment:** The employment by sector in this region is composed as follows: 19%, 37%, 44% for primary, secondary, and tertiary sectors, respectively. Many districts have more than 50% of employment in the primary sector. The distribution of secondary and tertiary sector employment corresponds well with the urbanization map in Figure 3.3.5. 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).

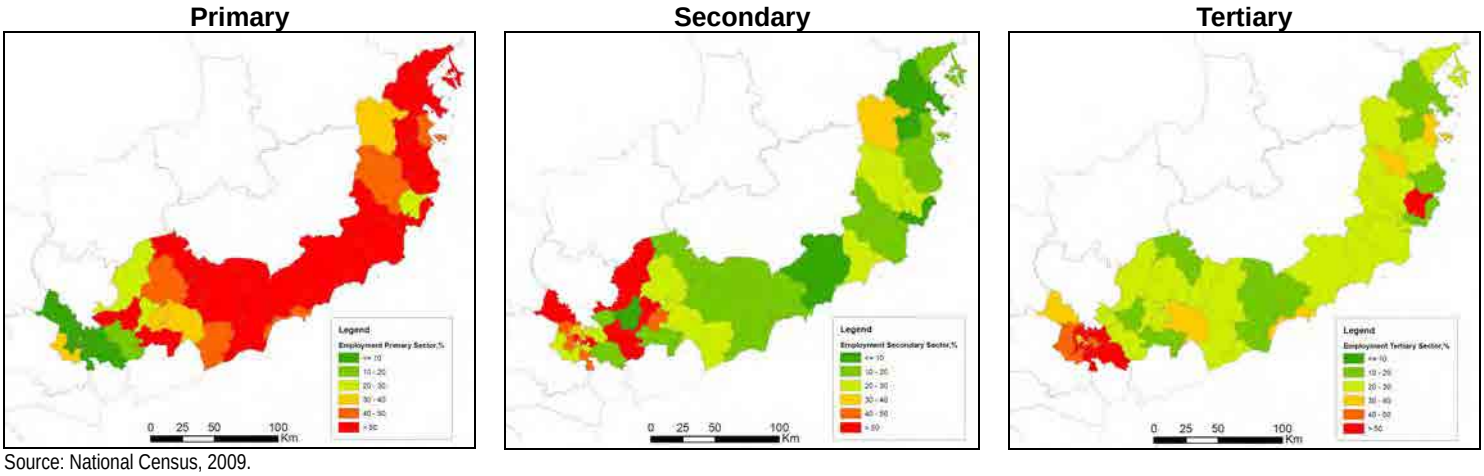
2.8 **Income and Poverty:** As explained in 3.2, economic growth effectively reduced poverty in general and helped improve people's income. This region in particular has relatively low poverty when compared with national standards. Although HCMC's poverty reduced at a high speed of annual -22.5%, nearly 5 in 1 person is still under poverty levels in Ninh Thuan Province.

2.9 While HCMC and Dong Nai provinces have an average income of 1 – 2 VND million/ month, that of Ninh Thuan provinces is as low as 0.7 VND million/ month. Inequality among different quintiles is greatest in Ninh Thuan province as well.

Table 2.1.3 Social Indicators for HCMC – Nha Trang Corridor

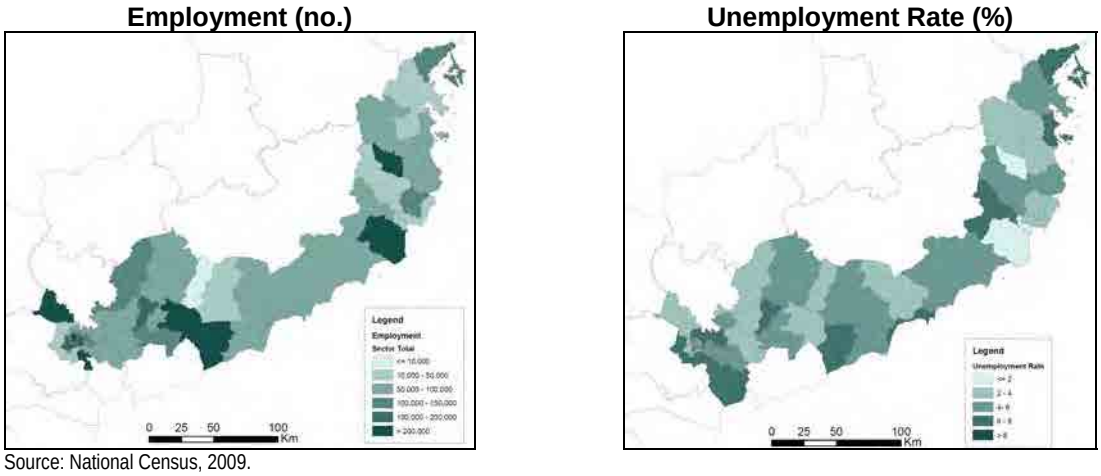
		Khanh Hoa		Ninh Thuan		Binh Thuan		Dong Nai		HCMC		Total	
		2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09	2009	AGR 05-09
Employment (000)	Primary	241	-	148	0.0	315	0.5	433	-1.1	102	-	1,239	-
	Secondary	126	-	51	6.2	98	7.5	537	10.5	1,600	-	2,412	-
	Tertiary	212	-	83	-1.9	179	5.7	363	2.7	1,974	-	2,812	-
	Total	579	-	283	0.4	592	3.0	1,333	4.1	3,676	-	6,463	-
	Unemployment (%)	5.1	-	3.9	-	3.2	-	4.3	-	4.7	-	4.2	-
Income	Per capita (000 VND/mo.)[1)]	965	-	699	-	838	-	1,318	-	2,192	-	1,202	-
Poverty	Poverty rate (%)[2)]	9.1	-9.0	19.3	-7.0	9.2	-8.5	4.3	-7.3	0.3	-22.5	8.4	-7.9
Education	Literacy rate (%)	-	-	-	-	-	-	-	-	-	-	-	-

Source: General Statistics Office.
1) Income in 2008 at current prices. 2) Poverty rates in 2006 and 2008.



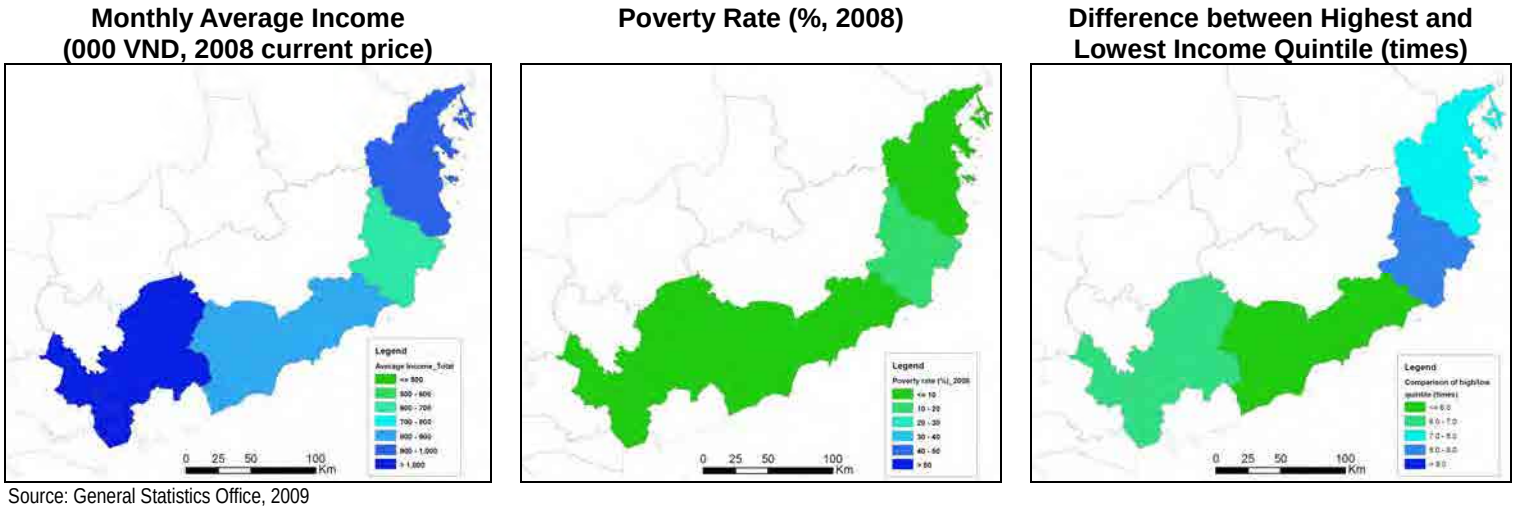
Source: National Census, 2009.

Figure 2.1.5 Employment Sector Share along the HCMC – Nha Trang Corridor



Source: National Census, 2009.

Figure 2.1.6 Employment Distribution along the HCMC – Nha Trang Corridor



Source: General Statistics Office, 2009

Figure 2.1.7 Income and Poverty along the HCMC – Nha Trang Corridor

2.2 Environmental Situation

(1) Topography

2.10 The five provinces in the HCMC – Nha Trang Corridor, namely Khanh Hoa, Ninh Thuan, Binh Thuan, Dong Nai and HCMC has a total area of 24,021km2, equal to 7.3% of the national total. While Khanh Hoa and Ninh Thuan provinces have steep highland areas in the west, the other four provinces are rather flat and low. HCMC is especially low, as the elevation of some areas are under 0 m.

(2) Geology

2.11 The geology of the southern region is characterized by Precambrian (Archean and Poterozoic) sediments and intrusive widely distributed from latitude 15°30” north to 14° north and forming “Kontun Massif”. Mesozoic sediments and intrusive rocks are predominated in the southern part of this area. Plateau Basalt of Tertiary Period and Quaternary Period are distributed at the border of Cambodia. This region is subdivided into two areas based on the petrology.

(3) Climate

2.12 The rainy season for this region is roughly from May to November, and the dry season is from December to April. 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 southern areas are relatively drier than the southern areas.

2.13 There are pockets of flood vulnerable areas in all of the provinces in the corridor, however drought does not seem to be a serious issue.

(4) Protected Area

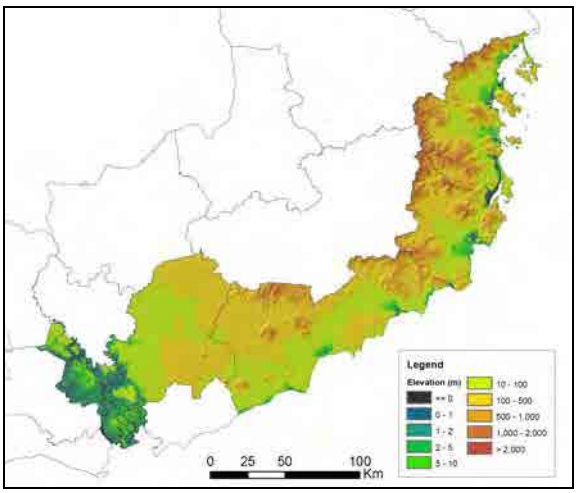
2.14 Protected areas (national parks, natural reserves, protected forests, etc.) in this region are distributed in of Ninh Thuan, Binh Thuan, and Dong Nai Provinces. Protected area totals to 2,659 km2.

(5) Hazard Area

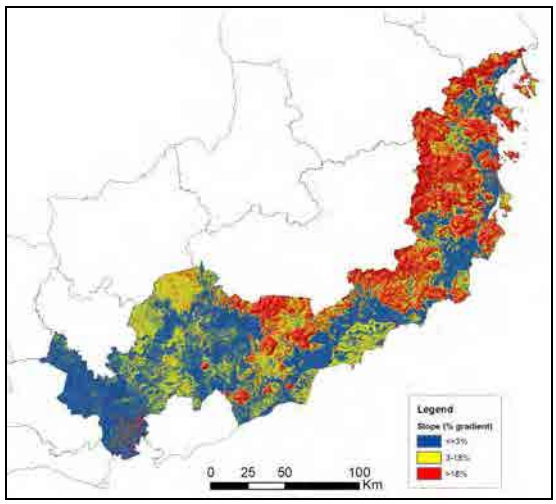
2.15 Flood is an issue in all provinces in this region, while almost no problems for landslides are observed. Flood prone areas in this corridor totals to 8,532 km2, while that of landslide prone areas are 28 km2 only.

(6) Land Use

2.16 Landuse of this corridor is especially diverse. While the northern area is mostly consisted of forests and paddy rice areas, Binh Thuan and Dong Nai provinces have rich areas of sugar cane, maize, citrus as well as temperate and semitropical fruits. This region is crisscrossed by dense rivers and canals, which are favorable for inland waterway transportation.

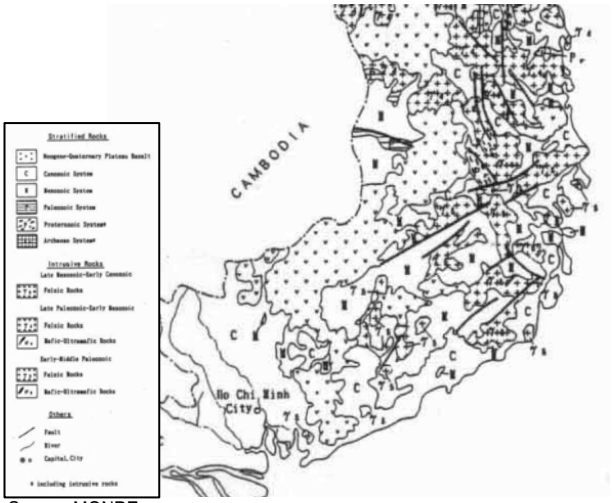


Source: MONRE, 2000.



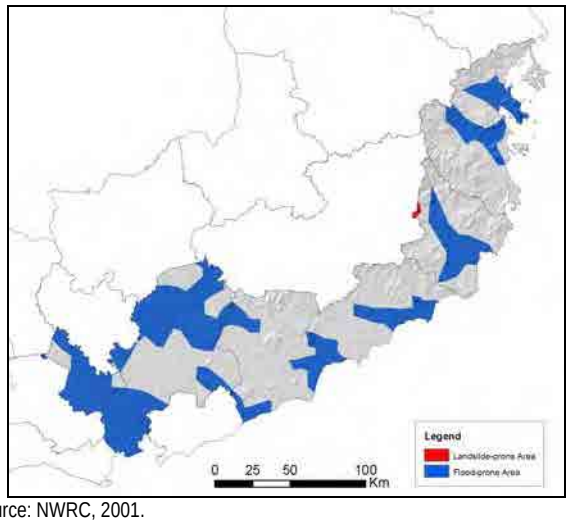
Source: MONRE, 2000.

Figure 2.2.1 Topographic Conditions of the HCMC – Nha Trang Corridor



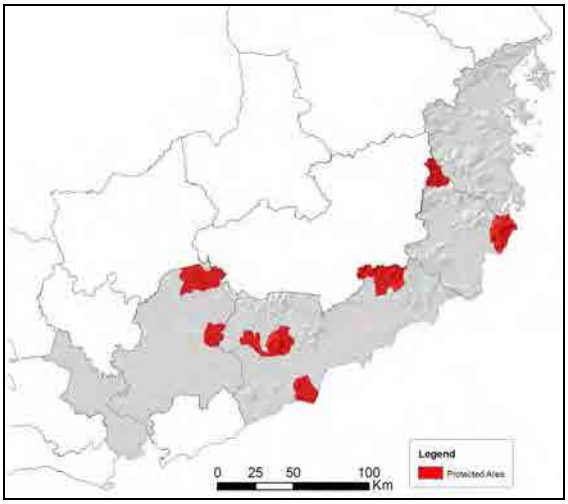
Source: MONRE

Figure 2.2.2 Geology of the HCMC – Nha Trang Corridor



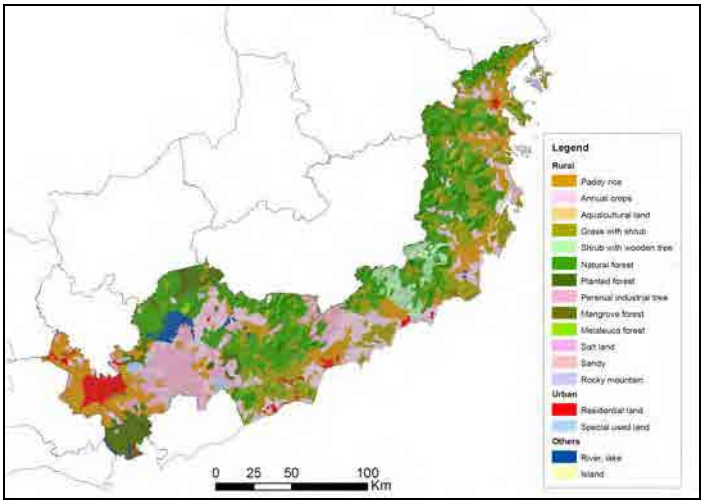
Source: NWRC, 2001.

Figure 2.2.3 Flood and Landslide-prone Areas of the HCMC – Nha Trang Corridor



Source: MONRE, 2000.

Figure 2.2.4 Protected Areas of the HCMC – Nha Trang Corridor



Source: MONRE, 2000.

Figure 2.2.5 Landuse of the HCMC – Nha Trang Corridor

2.3 Current Transport Network and Service

1) Traffic Infrastructure

2.17 The major cities on HCMC– Nha Thrang section are HCMC, Bien Hoa, Phan Thiet, and Nha Trang. HCMC, the biggest city in Vietnam, is targeting to become a 10 million city by 2025 and, thus, neighboring cities are also expected to grow in line with this development.

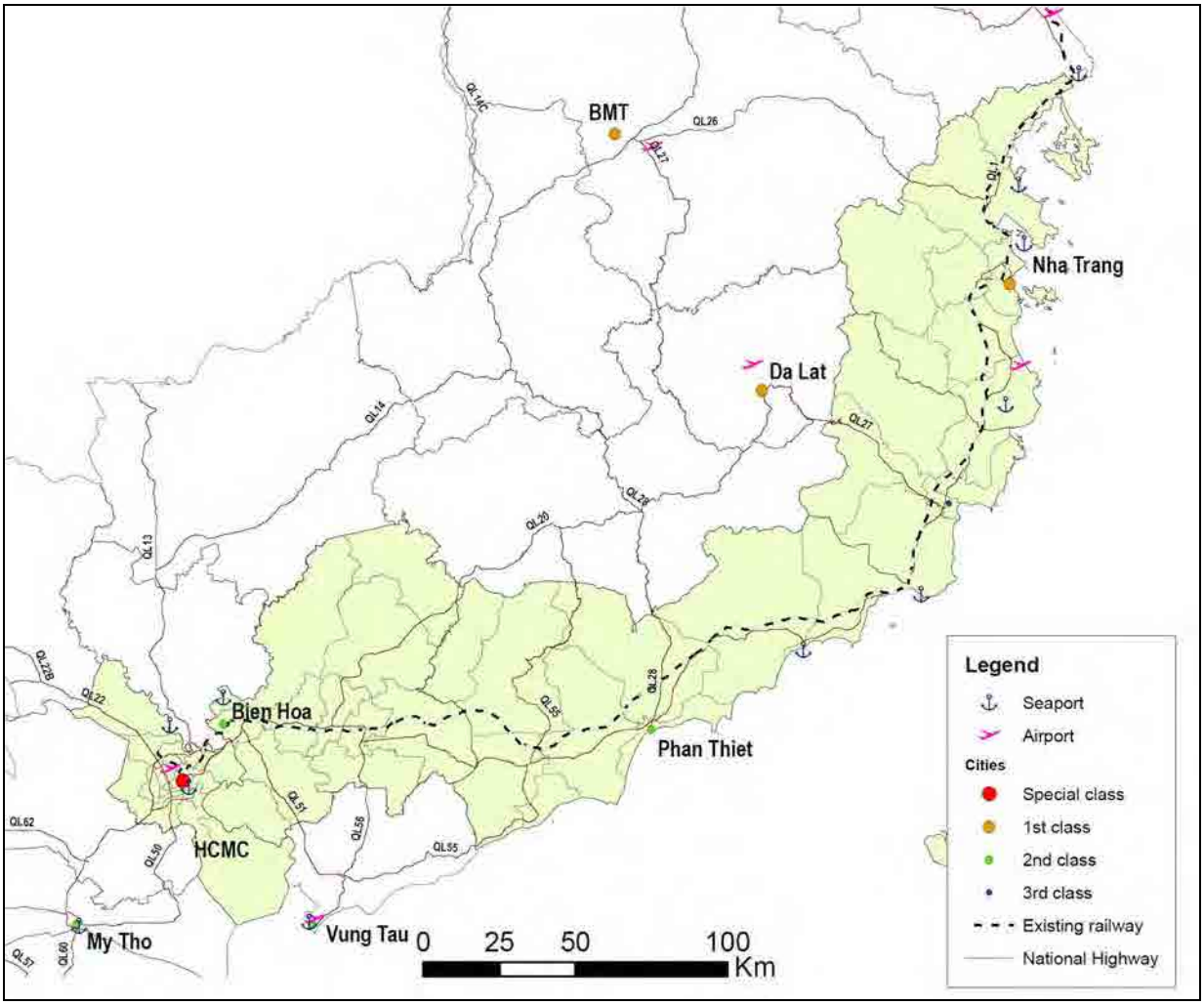
2.18 The region is connected to neighboring provinces mainly by NH1 and roads connecting coastal and inland areas (such as NH27, NH28 and NH55). Although NH1 is the main road corridor on the section, most of its section has only 2 lanes as of now, and planned to be expanded to 4 lanes in the future and, in addition, north-south expressway is planned to be developed along NH1. The north-south railway stretches from HCMC, the southern end, reaching Nha Trang and farther provinces in the north.

2.19 Tan Son Nhat International Airport (TSN) in HCMC has a passenger handling capacity of 15 million passengers per annum (mppa), which is already short to the actual volume handled of 17 mppa in 2011, and, thus, new Long Thanh International Airport (LTIA) in Dong Nai province is under planning for starting operation in 2020. Cam Ranh Airport in Khanh Hoa, on the other hand, is a small local airport with the capacity of 243 thousands passengers per annum.

Table 2.3.1 Road Condition in the Adjacent Provinces on HCMC-Nha Trang Section

		Khanh Hoa	Ninh Thuan	Binh Thuan	Dong Nai	HCMC
Road						
Total Road Length	NH (km)	223	175	228	244	1,242 (urban roads)
	PH (km)	447	272	572	410	
Road Density (NH&PH) (km/km^2)		0.13	0.13	0.10	0.11	0.59
NH1 (350 km)	Width	4 Lane:20%, 2 Lane: 80%				
	Surface Condition	Good: 14%, Fair: 68%, Bad: 18%				
	Bridges (no./length (m))	94 / 3,407				
Railway						
Track Length (km)		411 (meter gauge)				
Crossings (no.)		238				
Bridges(length (m))		5,667				
Airport						
Main airport		Cam Ranh	-	-	-	Tan Son Nhat
Destinations (cities in Vietnam)		3	-	-	-	18
Annual passenger capacity (000)		243	-	--		15,000
Seaport						
Main Seaport		Nha Trang	-	-	Dong Nai	HCMC
Max. Vessel Size (DWT)		20,000	-	-	5,000	30,000

Source: JICA Study Team, 2012



Source: MONRE, General Statistics Office, other sources.

Figure 2.3.1 Spatial Structure and Transportation along the HCMC – Nha Trang Corridor

2) Operational Conditions

2.20 **Bus Transport:** Bus is the dominant mode of transport for short to long distance trips in the section and Vietnam. In HCMC, there are 2 main inter-provincial bus terminals serving 64 routes in total. Bus transport connects both ends of HSR section; HCMC and Nha Trang, by 8-9 hour of travel time with cost of 140-200 thousand Vietnam Dong. Besides HCMC, bus service is provided for various routes with high frequency also in other cities; Nha Thang Bus Station, for example, offers services for 15 routes including every-30 minutes services for Nha Trang-HCMC route.

2.21 **Railway Transport:** Compared to bus service mentioned above, the frequency of railway transport is limited: 8 trains a day for one-direction. Railway trip for Nha Trang-HCMC takes about 7 – 11 hours and costs about 220 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:** HCMC and Nha Trang are also connected by air transport; for this route, only Vietnam Airlines offers the service, with the frequency of four flights a day. While the travel time on air is only 1 hour and the Tan Son Nhat Airport in HCMC is located in city centre, the egress time from Cam Ram airport to Nha Trang at 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: To HCMC		
Nha Trang Bus Station		15	N/A	N/A (operated every 30 mins)	9h	170
Phan Thiet Bus Station		15	171	105	5h	75-110
				Route: To Nha Trang		
Dong Nai Bus Station		29	298	28	8-9h	190-210
HCMC	East Bus Station	49	379	6	8h	140-190
	West Bus Station	15	N/A	16	9h	200

Source: Interviews with bus terminal operating companies

Table 2.3.3 Time Table of Trains at Main Stations in HCMC-Nha Trang Section

Province	Station	Departure Time								Fare from Nha Trang (SE1, Soft Seat with air conditioner) (000VND)
		SE1	SE3	SE5	SE7	TN1	SH1	SNT1	SN3	
Khanh Hoa	Nha Trang	20.28/ 20.33	22.03/ 22.08	19.40/ 19.45	7.37/ 7.42	16.46/ 16.58	19.57/ 20.12	19.00	18.30	0
Ninh Thuan	Thap Cham	22.04/ 22.07		21.17/ 21.23	9.12	18.48/ 18.51	21.48/ 21.51	20.50/ 20.53	20.16/ 20.19	122
Binh Thuan	Muong Man/Binh Thuan	0.38/ 0.41		0.12/ 0.16	11.41/ 11.44	21.57/ 22.23	1.23/ 2.21	23.52/ 23.55	23.00/ 1.02	156
Dong Nai	Bien Hoa	3.31		3.56/ 3.59	14.21	2.12 /2.15	5.21/ 5.24	3.09	5.03/ 5.06	213
HCMC	Sai Gon	4.10	5.00	4.40	15.05	3.03	6.10	3.56	5.44	220

Source: Vietnam Railways and Train Travel in Vietnam website 2012
Note: SH1: Hue – HCMC; SNT1 & SN3: Nha Trang – Sai Gon

Table 2.3.4 Profile of Air Service for Hanoi-Vinh Section

Route	Frequency/week	Travel Time	Fare (000 VND)
HCMC – Nha Trang	28 flights/week	55m-1 hour	1,100,000

Source: Vietnam Airlines (as of Oct, 2011)

2.23 **Access to terminals:** Table 2.3.5 shows average access time to transport terminals in 4 cities of HCMC-Nha Trang section. In HCMC, access time to bus terminal, railway station and airport are about 30, 35 and 45 minutes respectively. As for other cities, access time to Cam Lam Airport in Khanh Hoa is as much as 55 minutes while ones to other transport terminals are less than 30 minutes, indicating good access conditions.

Table 2.3.5 Average Access Time to Transport Terminals (HCMC-Nha Trang Section)

(Unit: minutes)

	Bus	Railway	Air	All	No. of Sample
Nha Trang	16.1	26.0	54.8	35.5	501
Phan Thiet	18.6	23.1	-1)	21.5	289
Bien Hoa	12.0	-1)	-1)	12.0	104
HCMC	29.8	35.0	43.5	34.4	780
Average	23.6	28.1	49.3	31.1	1,674

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 4 provinces and a city along HCMC-Nha Trang section is shown in the following table. HCMC generates 80% of the passenger traffic in the section and over half of freight traffic. Dong Nai, the neighboring province of HCMC follows at the second place.

Table 2.4.1 Transportation Indicators for HCMC–Nha Trang Section (Passenger & Freight)

		Khanh Hoa		Ninh Thuan		Binh Thuan		Dong Nai		HCMC		Total	
		2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11	2011	AGR 08-11
Passengers	no. (mil.)	31.0	9.4	5.6	20.2	13.5	6.4	65.4	10.7	584.9	20.9	700.4	18.9
	pax-km(mil.)	1,418	12.6	422	20.0	607	9.6	4,020	10.9	12,801	16.6	19,268.4	14.8
Freight	ton (mil)	18.7	8.8	3.5	13.9	3.3	5.3	33.7	8.4	113.3	18.5	172.5	14.7
	ton-km(mil)	1,644	-9.1	273	4.3	254	8.6	2,256	8.1	77,450	16.9	81,876.9	15.7

Source: JICA Study Team based on GSO

2) Trip distribution and Modal Share in the target section

2.25 Trip distribution among 4 provinces and a city alongside with HSR line is shown in the following table. As for trips among those 4 provinces and a city, most of the trips have origin or destination in HCMC. HCMC-Dong Nai, provinces contiguous to each other, has the highest volume, 69,000 passengers per day followed by HCMC Binh Thuan, 8,100 and HCMC-Khanh Hoa, 4,500.

Table 2.4.2 Trip Distribution (2010, both-direction)

(Unit: No. of passenger per day)

	Provinces in Central Highland	Khanh Hoa	Ninh Thuan	Binh Thuan	Dong Nai	HCMC	Other Provinces in the South
Northern Provinces	15,605	6,878	1,081	869	4,106	33,359	13,523
Provinces in Central Highland	-	5,495	32	398	62	21,941	5,168
Khanh Hoa	-	-	168	578	331	4,488	750
Ninh Thuan	-	-	-	561	12	1,447	64
Binh Thuan	-	-	-	-	576	8,147	13,559
Dong Nai	-	-	-	-	-	69,478	38,576
HCMC	-	-	-	-	-	-	167,388

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 HCMC. In the section, bus is the dominant mode of transport having the share of 40-70 %. The share of railway increases for longer distance; 34% of trips between HCMC-Khanh Hoa (411 km) uses railway. Air transport is only available for HCMC-Khanh Hoa and it covers 25% of those trips.

Table 2.4.3 Modal Share (2010, both-direction)

OD pair (both direction)	Unit	Transport Mode				Total
		Car	Bus	Railway	Air	
HCMC-Dong Nai	(000)	21,868	47,569	41	-	69,478
	(%)	31	68	0	-	100
HCMC-Binh Thuan	(000)	2,556	4,920	671	-	8,147
	(%)	31	60	8	-	100
HCMC-Ninh Thuan	(000)	272	930	245	-	1,447
	(%)	19	64	17	-	100
HCMC-Khanh Hoa	(000)	102	1,712	1,542	1,132	4,488
	(%)	2	38	34	25	100

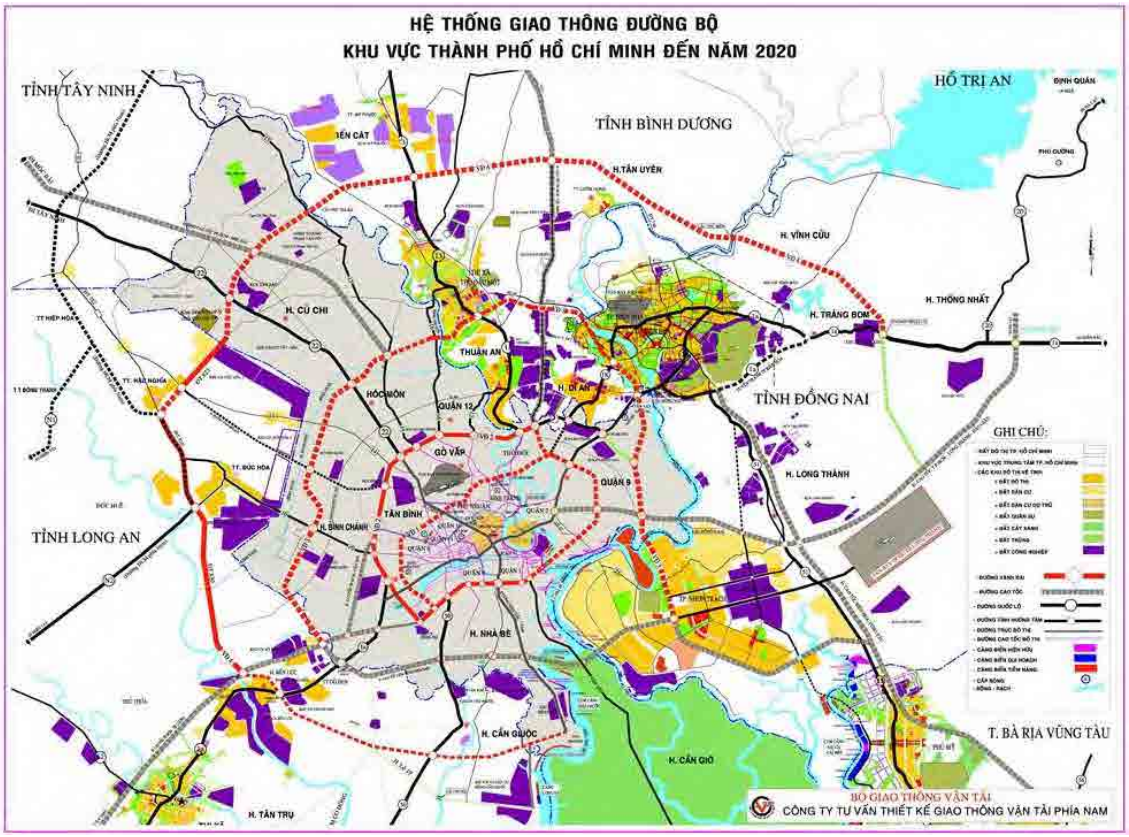
Source: JICA Study Team (OD table based on VITRANSS2 and supplemental traffic survey)

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) Ho Chi Minh City

2.28 The city's orientation for development in the transport sector is mainly based on "The Adjustment of General Construction Plan HCMC to 2025" and "HCMC Transport Development Master Plan by 2020." Being the largest urban center in the nation as well as the core of the Southern Focal Economic Zone, the city also plays a significant role as a transport node for various transport modes. The city is currently developing several ring roads to handle the mass traffic volume of the region. The plan also mentions the development of a UMRT network to promote mass transit public transport. Electrification of Trang Bom – Hoa Hung section is also under plan. The target population of the city is 10,000,000 by 2025, with an urbanization rate of 95%. With regards to station development, the city's plans notes Thu Thiem Station to become a central terminal station for the HSR. The development plan around Thu Thiem Station Area formulated by Investment and Construction Authority for Thu Thiem New Urban Area has been officially approved recently.

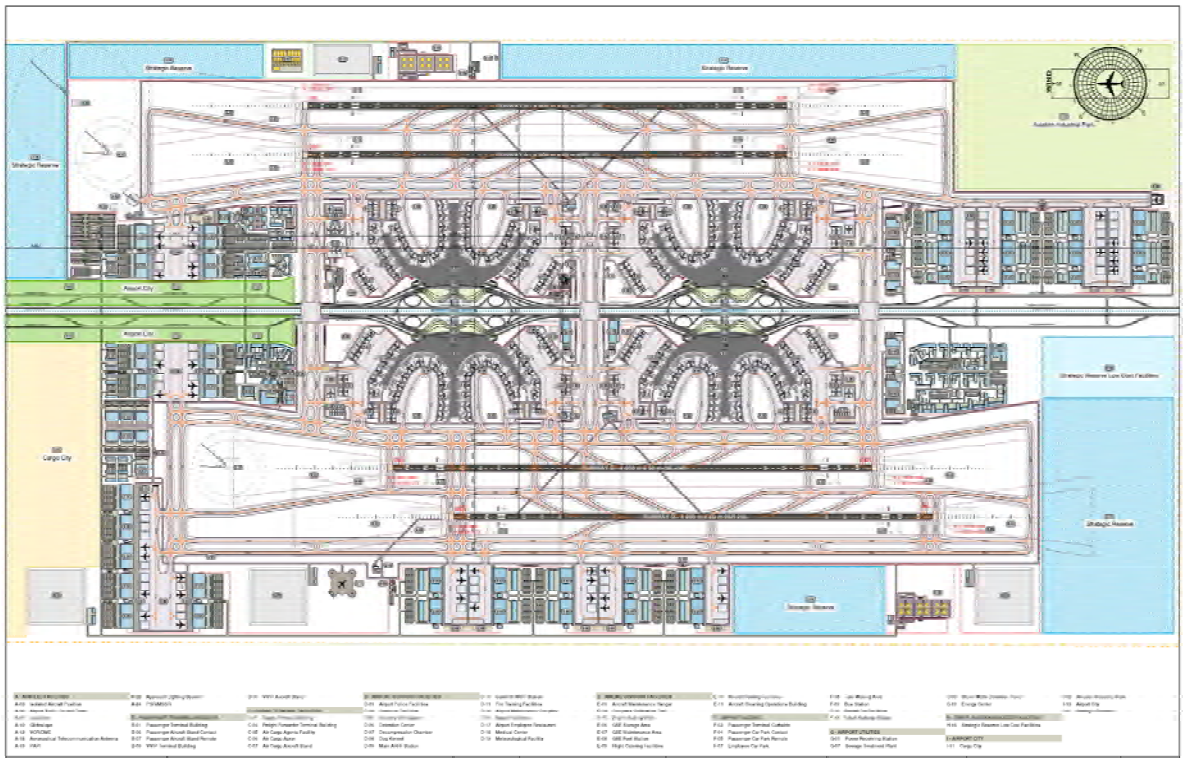


Source: Ho Chi Minh City People's Committee.

Figure 2.5.1 Ho Chi Minh City Master Plan up to 2020

2) Dong Nai Province

2.29 The Final Report of the Long Thanh International Airport was formulated between the Southern Airport Company (SAC) and Japan Airport Consultants (JAC) in February 2011. According to this plan, Long Thanh International Airport is currently planning the HSR alignment to go through the center of the airport as indicated in Figure 2.5.2. The urban development around the station is currently being formulated by VIAP and Hansen consultants.



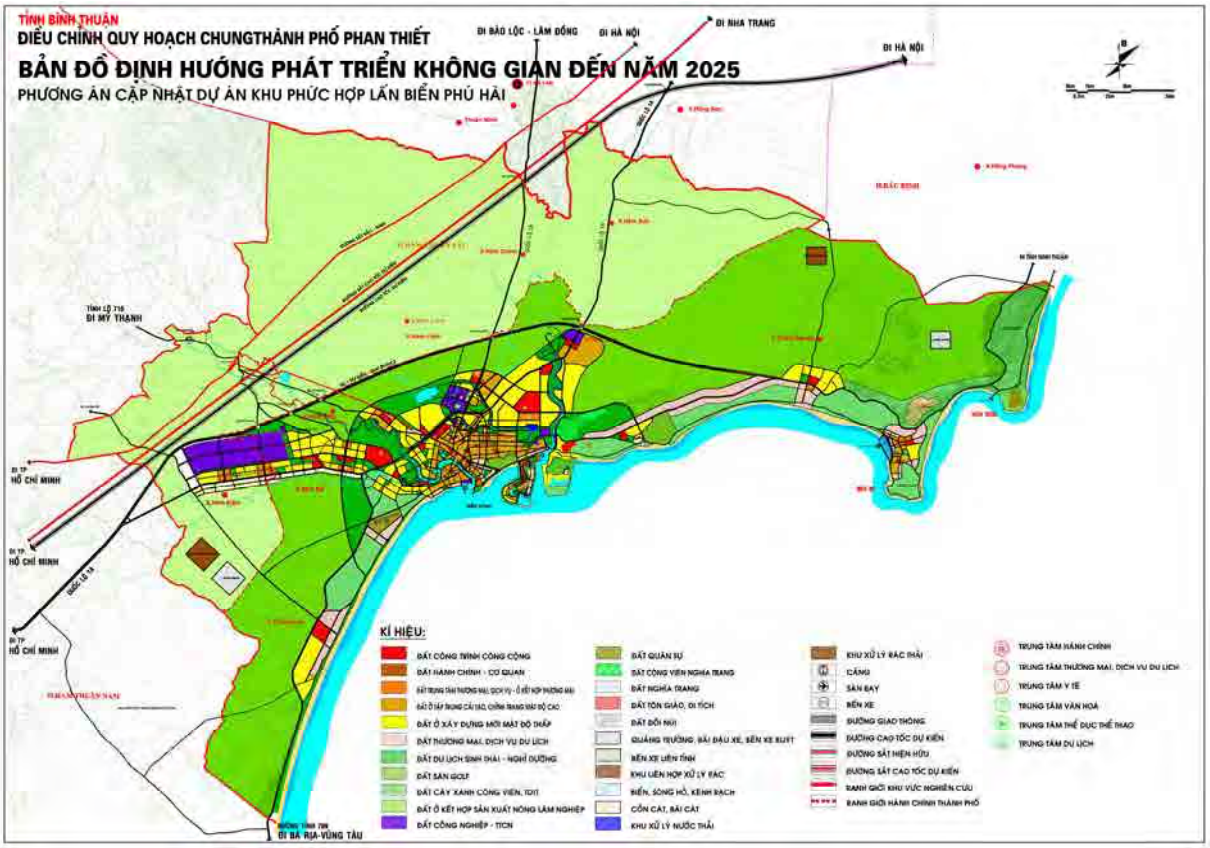
Source: Southern Airport Corporation.

Figure 2.5.2 Plan of Long Thanh International Airport

3) Binh Thuan Province

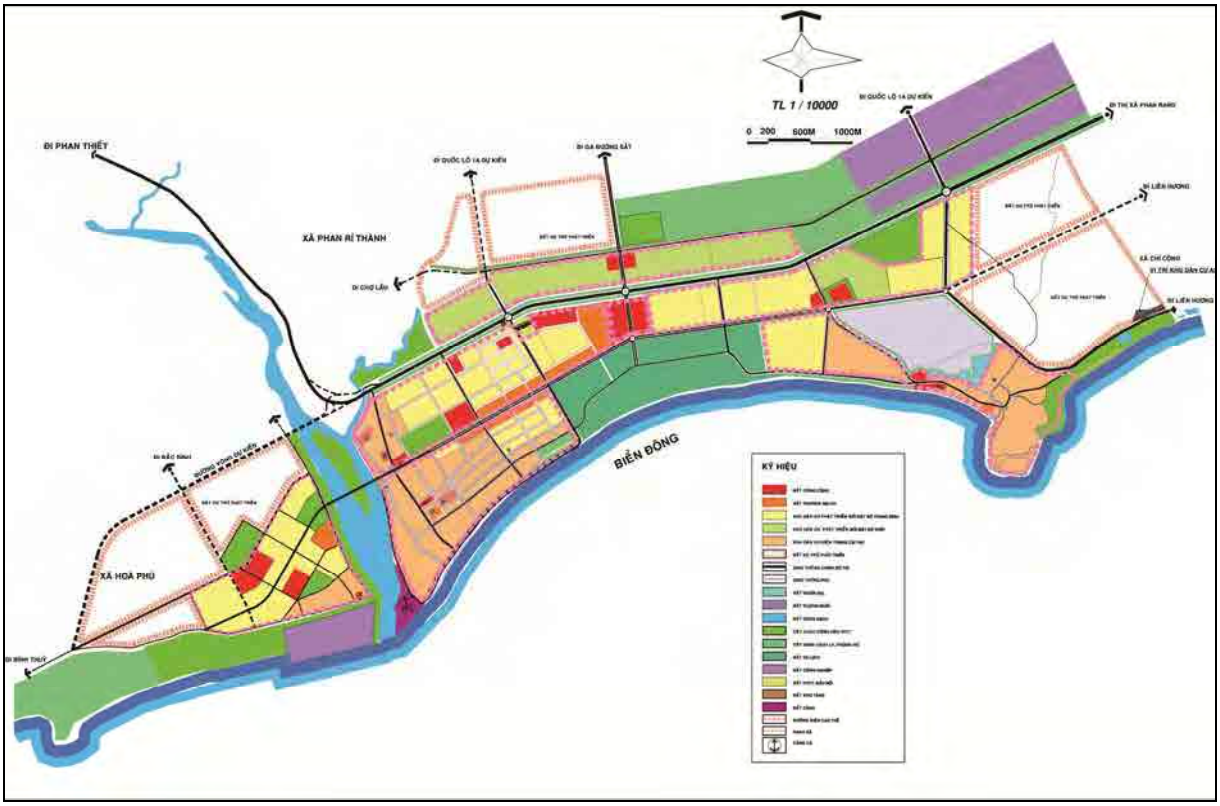
2.30 According to the regional plan of Binh Thuan Province, Phan Thiet City will be developed with the highest priority, followed by La Gi (Class II City), Phan Ri Cua (Class III City), and other urban development centers such as Lien Huong and Hoa Thang (Class IV City). With regards to consideration of the HSR alignment, Tan Nghia will also become an important urban center connecting to La Gi.

2.31 The Phan Thiet Station for the existing railway has been relocated, well connected to NH01 and about 3km near to the city center. It is in a favorable location for HSR station development. On the other hand, Tuy Phong is still a small urban area at present; however it has potential for further development in the future.



Source: Binh Thuan Provincial People's Committee.

Figure 2.5.3 Phan Thiet City Master Plan up to 2025

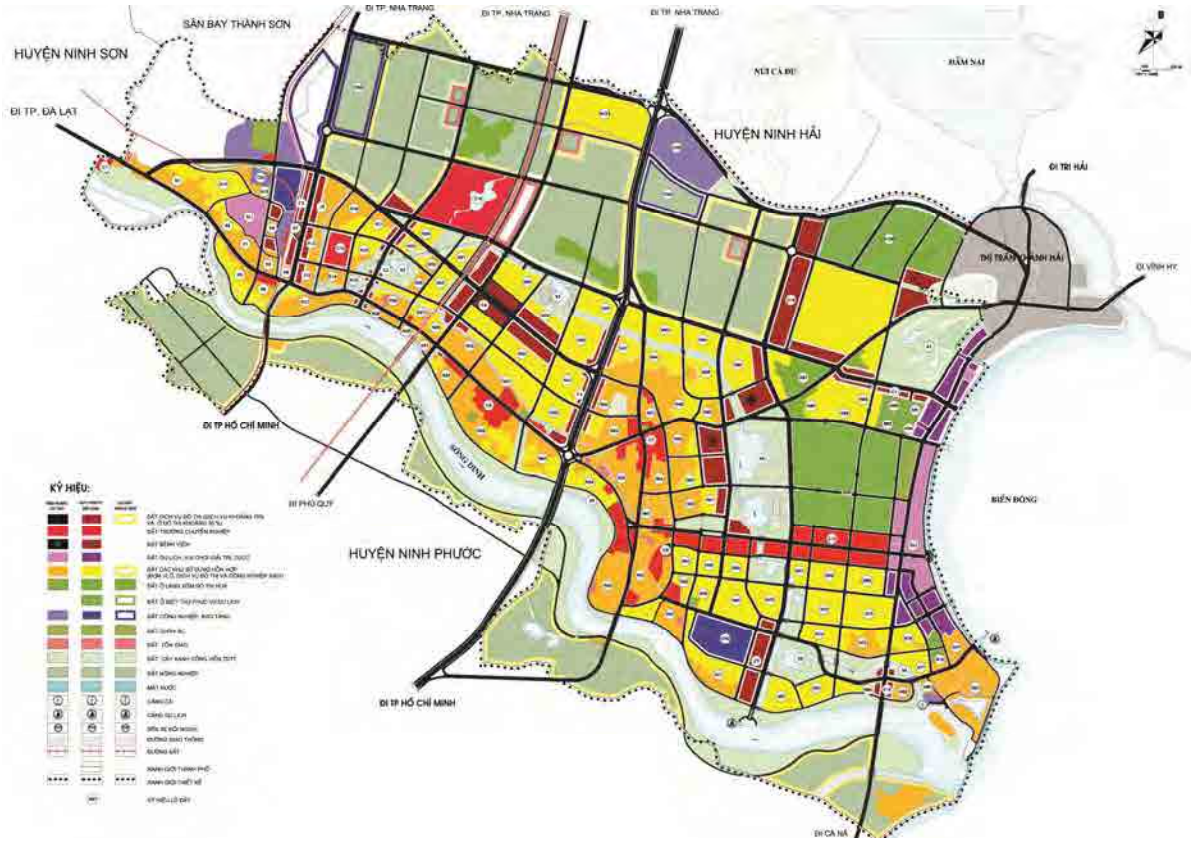


Source: Binh Thuan Provincial People's Committee.

Figure 2.5.4 Tuy Phong Town Master Plan up to up to 2025

4) Ninh Thuan Province

2.32 According to the "Adjustment on Phan Rang – Thap Cham City's General Development Plan up to 2015", the target population of Phan Rang – Thap Cham City is 197,000 by 2025. It will become the main urban center in Ninh Thuan Province. The urban development direction of the city is to become a tourism city, by exploiting the Cham relics located in the west side of the city. The city is expanding gradually to the east, and new urban centers are being planned in the east as well for further expansion of the city.



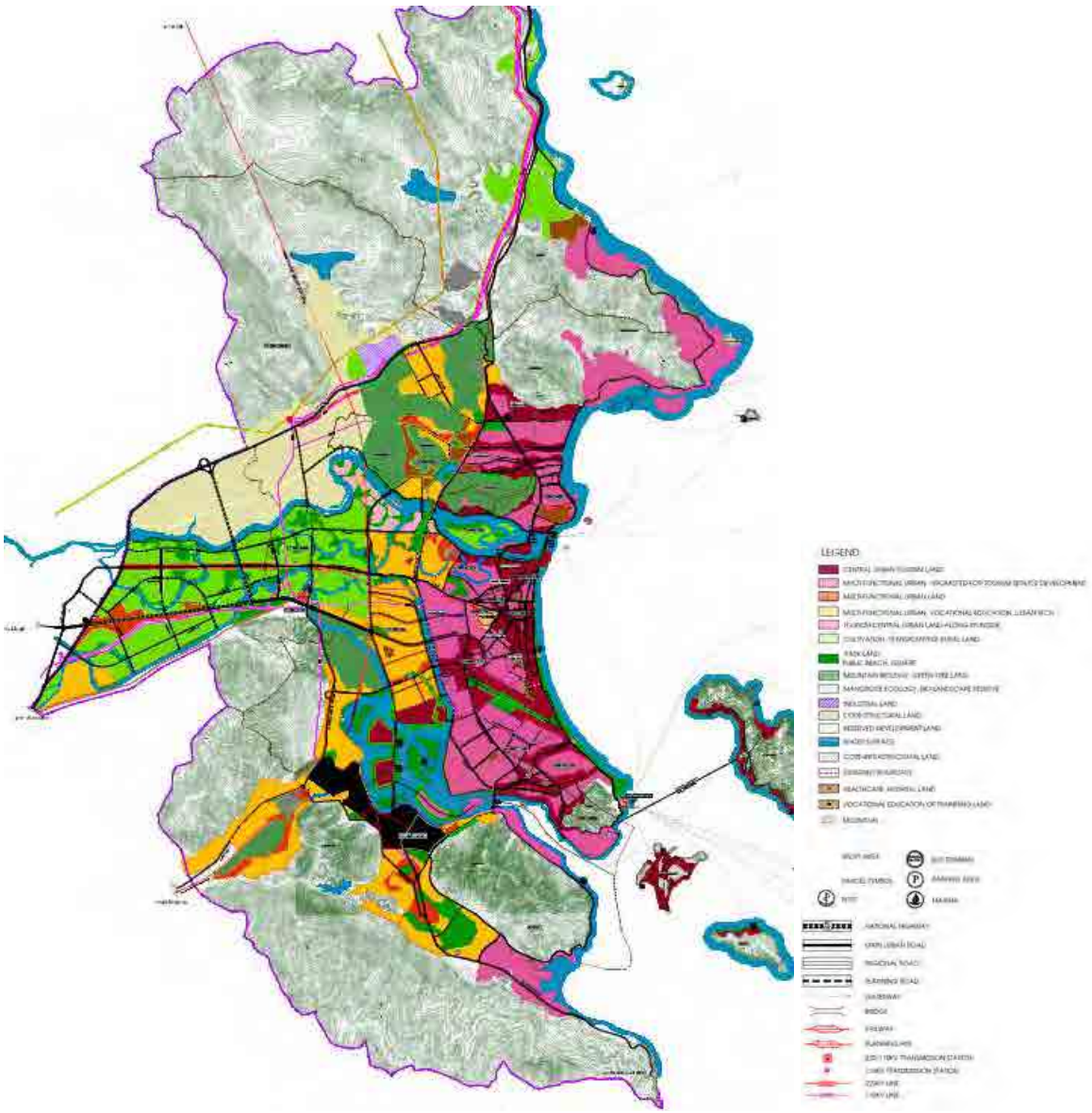
Source: Ninh Thuan Provincial People's Committee.

Figure 2.5.5 Phan Rang – Thap Cham City Master Plan up to 2025

5) Khanh Hoa Province

2.33 The "Adjustment of General Construction Plan up to the Year 2025" has been recently revised and issued by the city. According to this plan, Nha Trang City will develop to become the Class I central city in Khanh Hoa Province, with a target population of 500,000 by 2025. While the existing urban areas concentrated on the coastal side, residential development has been going on at the west side of the city, along with new waterfront tourism development along the rivers in the north. There is a plan to relocate the Nha Trang Station for the existing railway along NH1C. This will resolve the issue loss of time due to the switch-back of the current existing railway.

2.34 Cam Ranh urban area is also being developed rapidly for tourism, especially areas near the Cam Ranh International Airport which is primarily used by tourists coming to Nha Trang. The road connecting Cam Ranh International Airport and Nha Trang inner city areas have been upgraded and smooth transport between these two areas are ensured. Integrated development of both urban areas is expected to accelerate in the future.



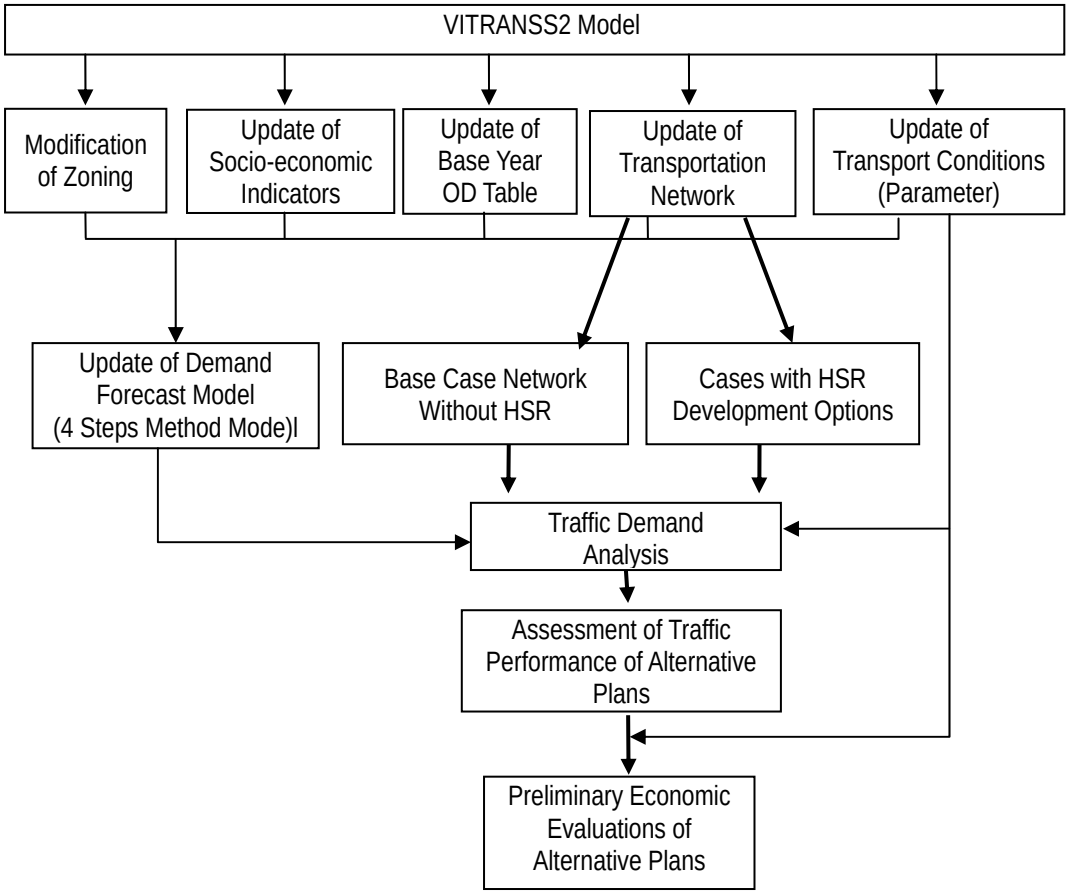
Source: Khanh Hoa Provincial People's Committee.

Figure 2.5.6 Nha Trang City Master Plan up to 2025

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 3.2.1 shows the entire flow for traffic demand analysis for HSR.



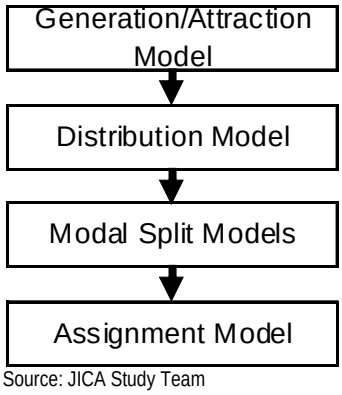
Source: JICA Study Team

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.

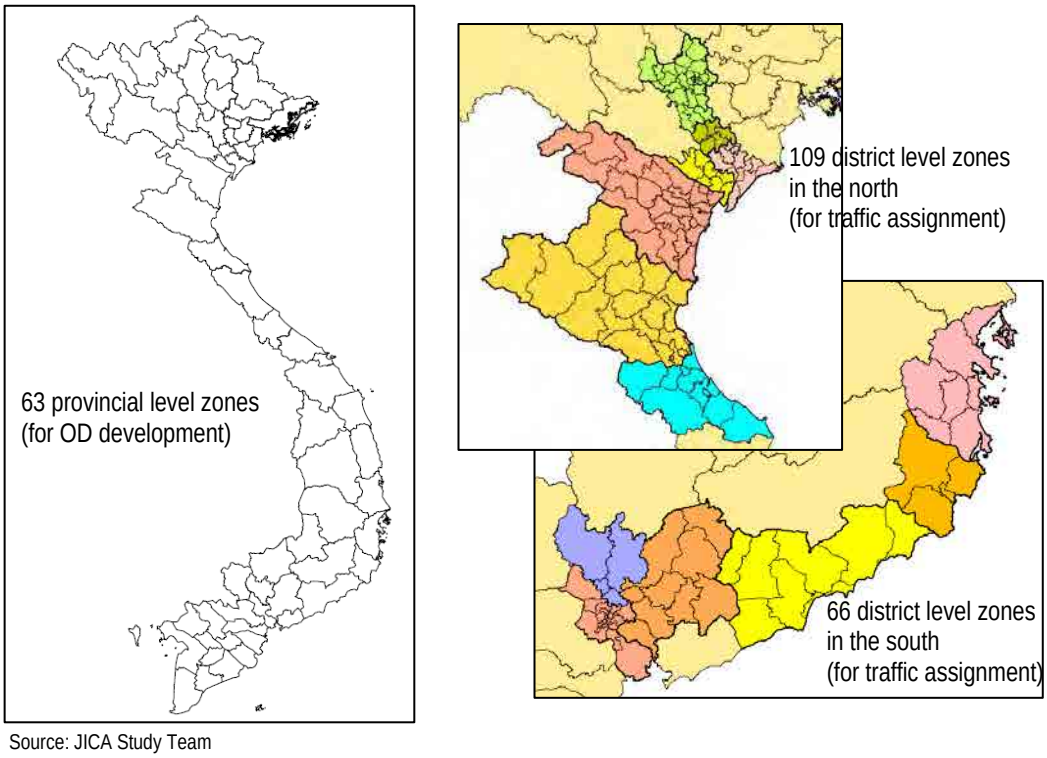


Source: JICA Study Team

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).



3)

Source: JICA Study Team

Figure 3.2.2 Applied Zoning

Socio-economic Framework

3.4 Current and future socio-economic indicators for the demand forecast are 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

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

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

3.5 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

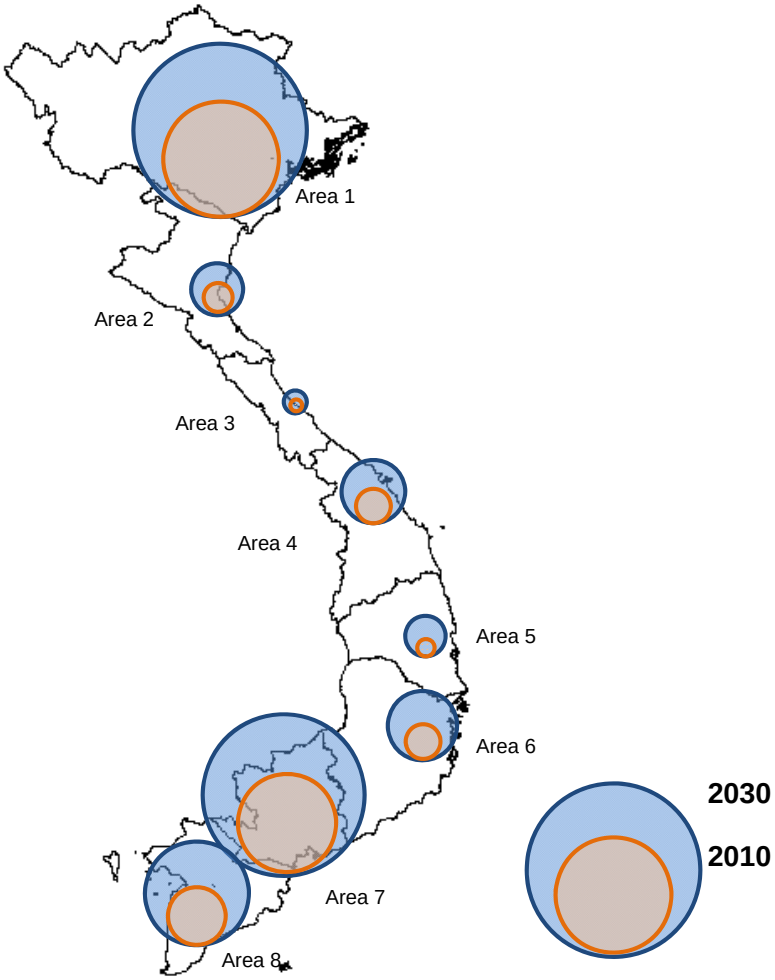
Variable	Generation Model	
	Coefficient	t Value
Constant	1.112	0.17
(GRDP/Urban population)	1.0392	5.11
Multiple correlation coefficient	0.8317	
Number of samples	63	

Source: Study Team

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

3.7 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

3.8 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

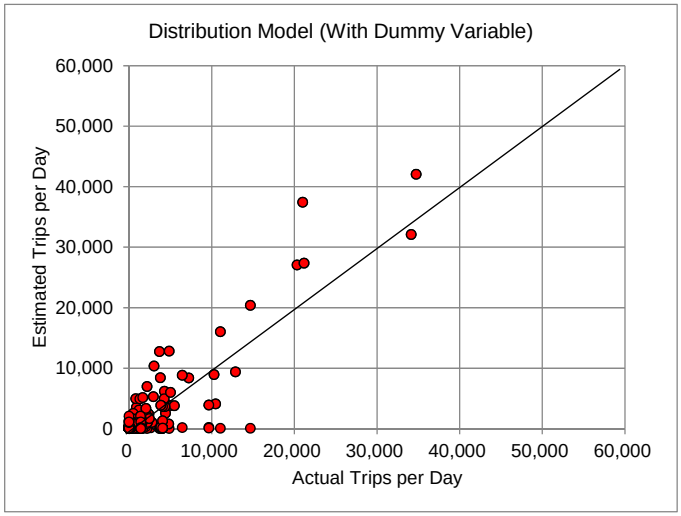
Note: Value of Time (VoT) was determined at VND 387/min and VND1096/min for 2010 and 2030 (2010 value), respectively, as a weighted average of car and bus passengers

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	

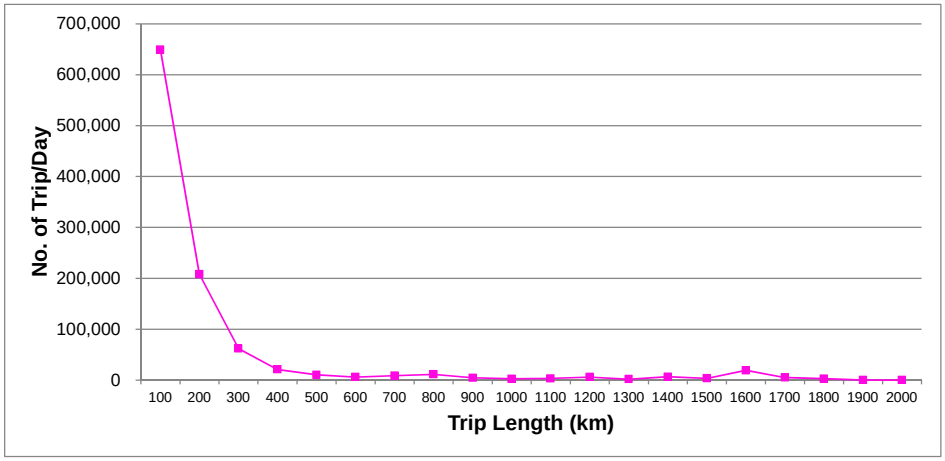
Source: JICA Study Team

3.9 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

3.10 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.

3.11 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 1,500 km distance.

Table 3.2.5 Summary of Trip Distribution (2010)

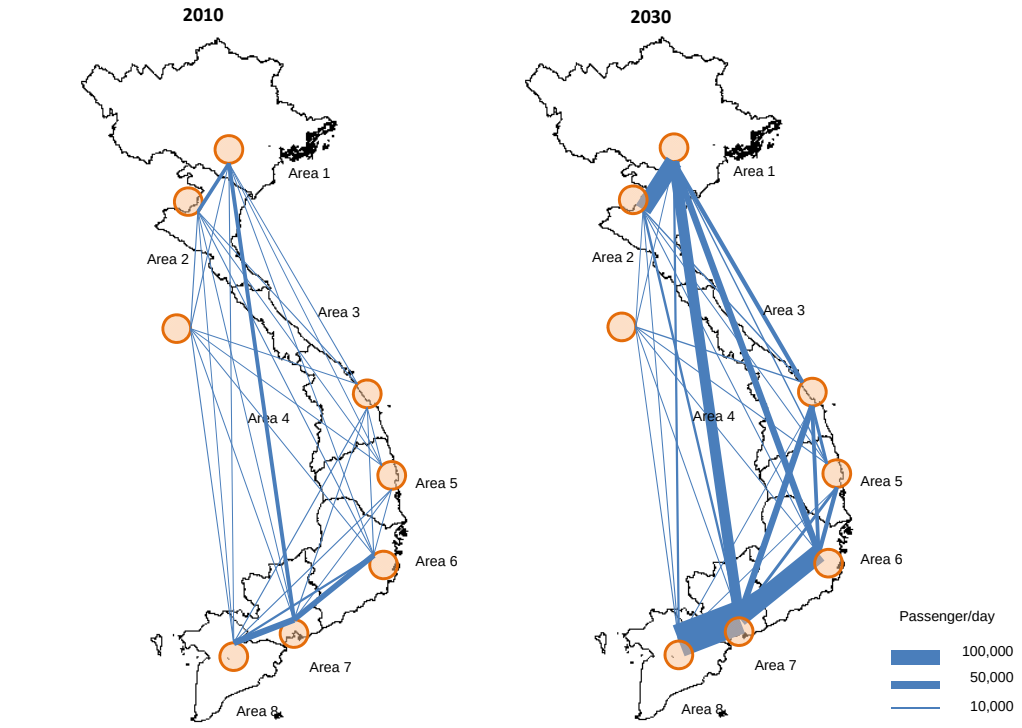
	Area 1 (Hanoi)	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7 (HCMC)	Area8
Area 1	432,634	25,326	1,300	7,698	1,712	8,332	28,023	2,817
Area 2	-	11,120	1,447	1,578	367	1,283	5,904	40
Area 3	-	-	895	5,133	87	184	1,521	308
Area 4	-	-	-	23,583	3,028	2,929	10,052	179
Area 5	-	-	-	-	809	6,095	4,639	159
Area 6	-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

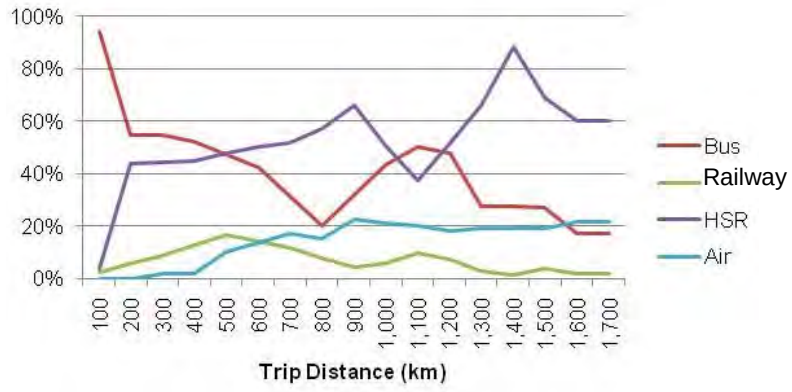


Source: JICA Study Team

Figure 3.2.6 Passenger Trip Distribution (2010 and 2030)

7) Modal Split

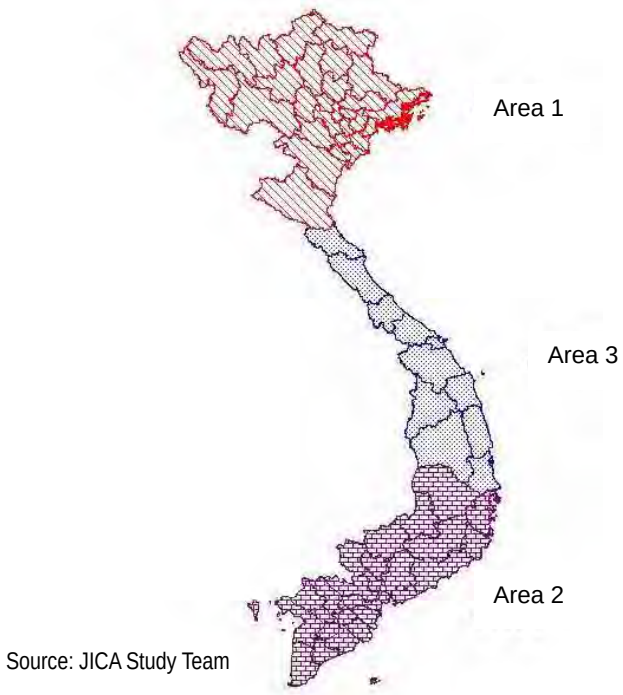
3.12 Although the main purpose of the demand analysis is the forecast of HSR Demand, the demand could not be estimated directly from demand model from present condition, since HSR does not exist at present. Therefore, virtual base year passenger OD which is including HSR demand is prepared as the base 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

3.13 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 3.2.7), type 2 for intra movement in the south (Area 2 in Figure 3.2.7) and the others.



Source: JICA Study Team

Figure 3.2.8 Distinguished Area for Modal Split Model

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: $V_5 = a \times Time_5 + b \times Cost_5 + const_5 + d_5 \times (GDP/POP)$

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

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

3.15 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)

3.16 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

3.17 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

3.18 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).

3.19 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).

3.20 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

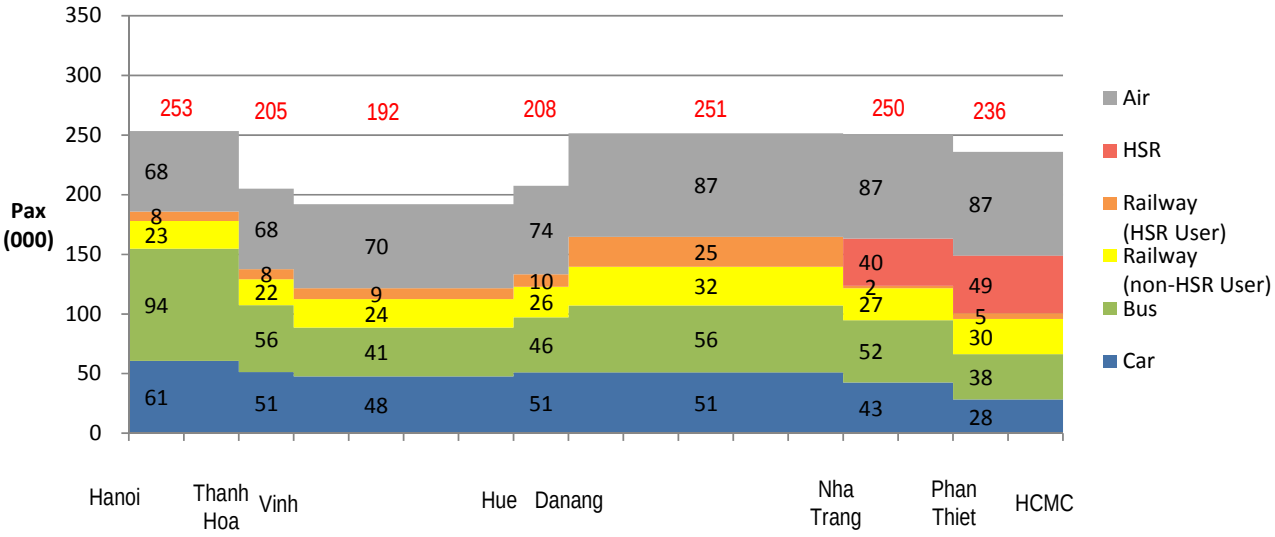
3.21 It should be noted that in case air traffic demand reaches to its capacity, the air traffic demand is fixed at its possible maximum traffic volume and modal split for other transport modes is recalculated excluding the potion for air transport (probability function for Air (P5) is not used in such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

3.3 Traffic Demand Forecast

1) Base Case Demand

3.22 HCMC-Nha Trang HSR section is approximately 362 km long with 6 stations and the major cities such as HCMC and Nha Trang are located in the section. The estimated HSR passenger demand in case HSR is operated for this section are shown as follows;

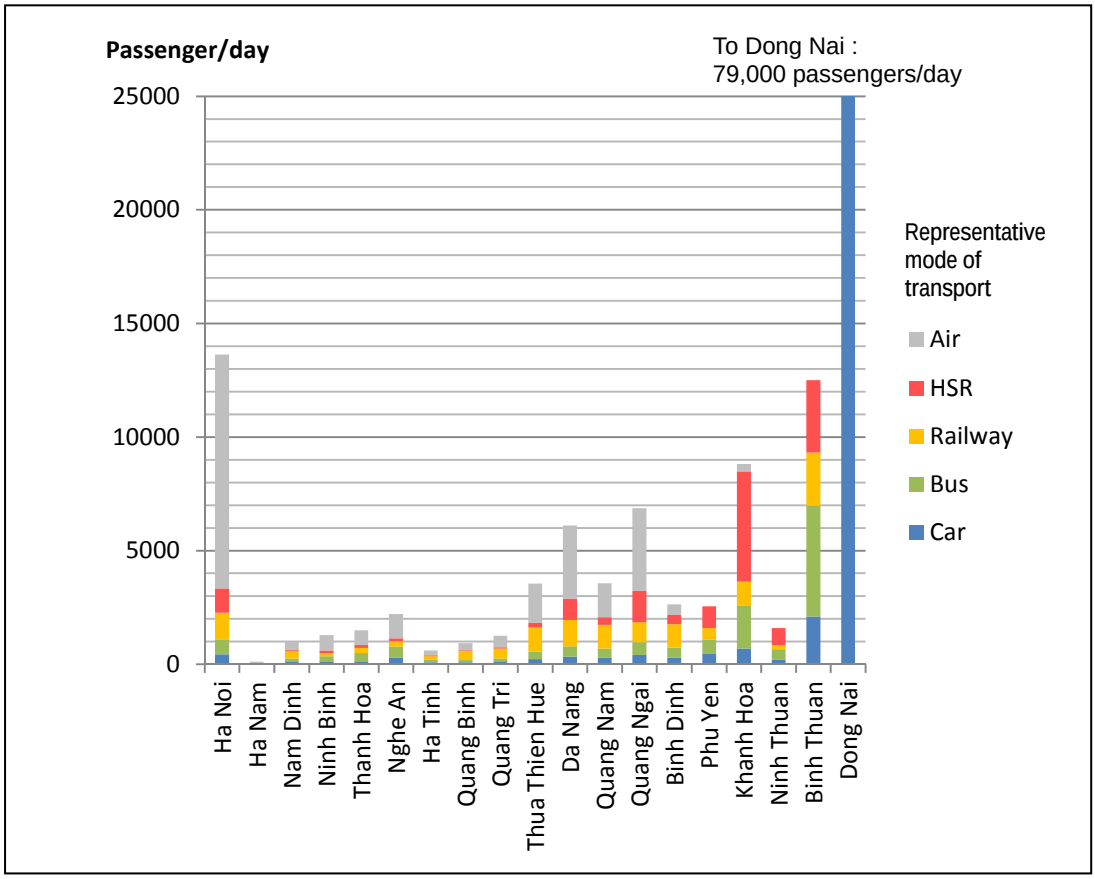
3.23 **Cross Sectional Traffic in the North-South Corridor**: Cross-sectional traffic of North-South corridor (coastal corridor) in 2030, in case HCMC-Nha Trang section is under operation, is shown in the following figure. The cross-sectional traffic demand of HSR account for approximately 20% among all modes and 49 thousands and 40 thousands on Dong Nai/ Binh Thuan and Ninh Thuan/ Khanh Hoa borders, respectively. The demand will be generated along the section where HSR exists (HCMC-Nha Trang) and South Central Coastal area (provinces between Danang and Khanh Hoa).



Source: JICA Study Team

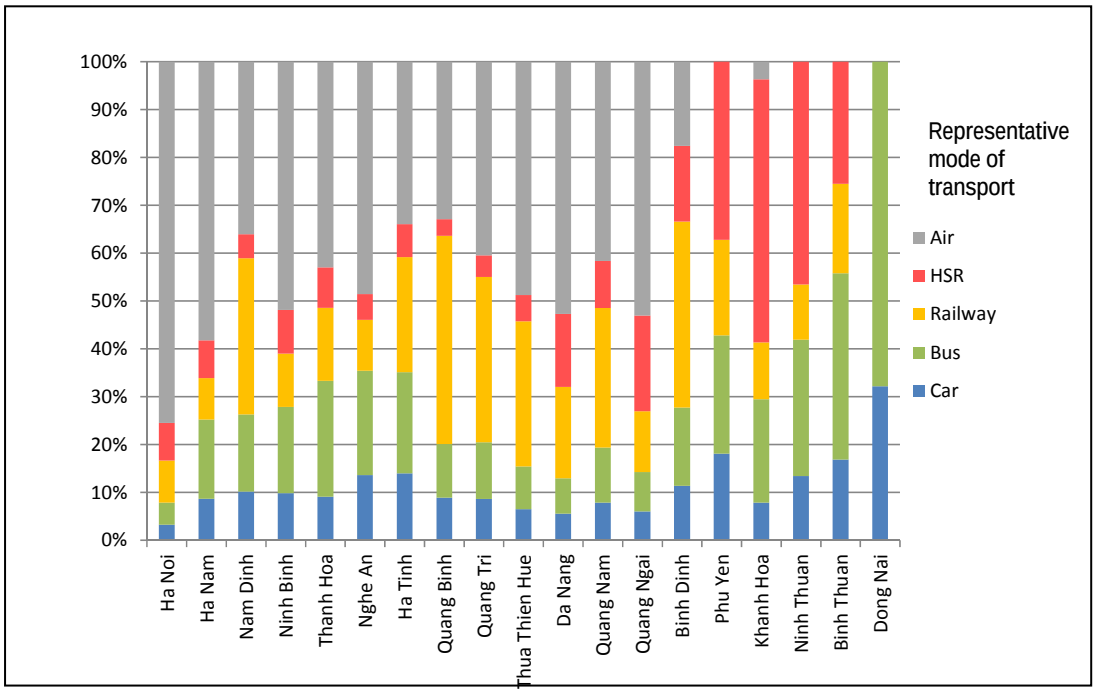
Figure 3.3.1 Cross Sectional Traffic in North-South Corridor (HSR: HCMC-Nha Trang is under operation), 2030

3.24 **Traffic Demand from HCMC:** The modal share from HCMC to the North, in case HCMC-Nha Trang section is under operation in 2030, is shown in Figure 3.3.2 and Figure 3.3.3. The share of HSR for HCMC – Nha Trang is as high as approximately 55%, while the ones for HCMC - Ninh Thuan and HCMC – Binh Thuan are 45% and 25%, respectively.



Source: JICA Study Team

Figure 3.3.2 Mode Share for Trips from HCMC to the North (HCMC-Nha Trang is under operation), 2030, No. of passenger



Source: JICA Study Team

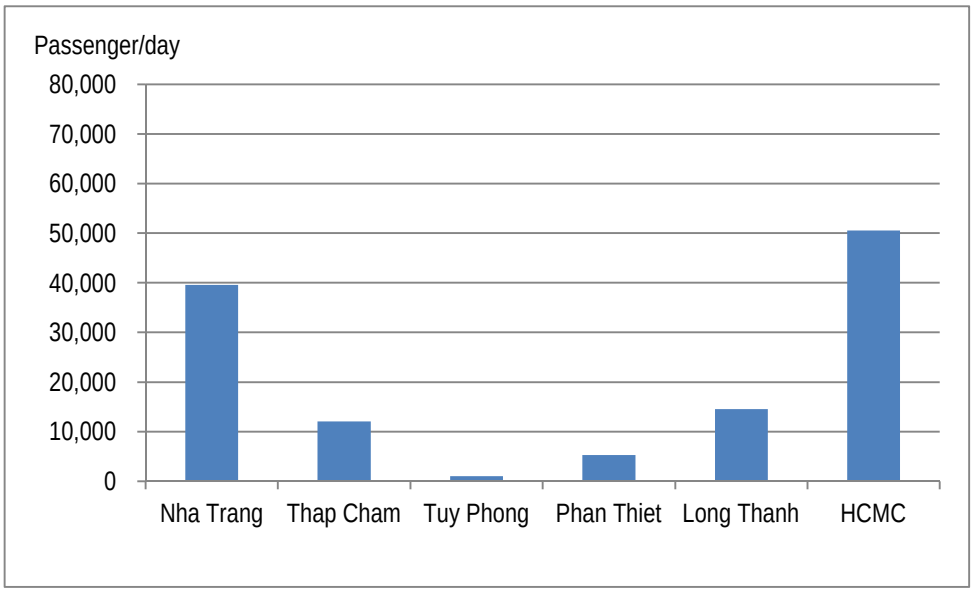
Figure 3.3.3 Mode Share for Trips from HCMC to the North (HCMC-Nha Trang is under operation), 2030, percentage

3.25 **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 HCMC-Nha Trang 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 HCMC station is the most, about 50,000 passengers per day, and, as clearly shown in Figure 3.3.6, most HSR passengers are from or to HCMC, while the passenger demand between other provinces are limited.

Table 3.3.1 Daily No. of HSR passengers between Stations (HCMC-Nha Trang is under operation)

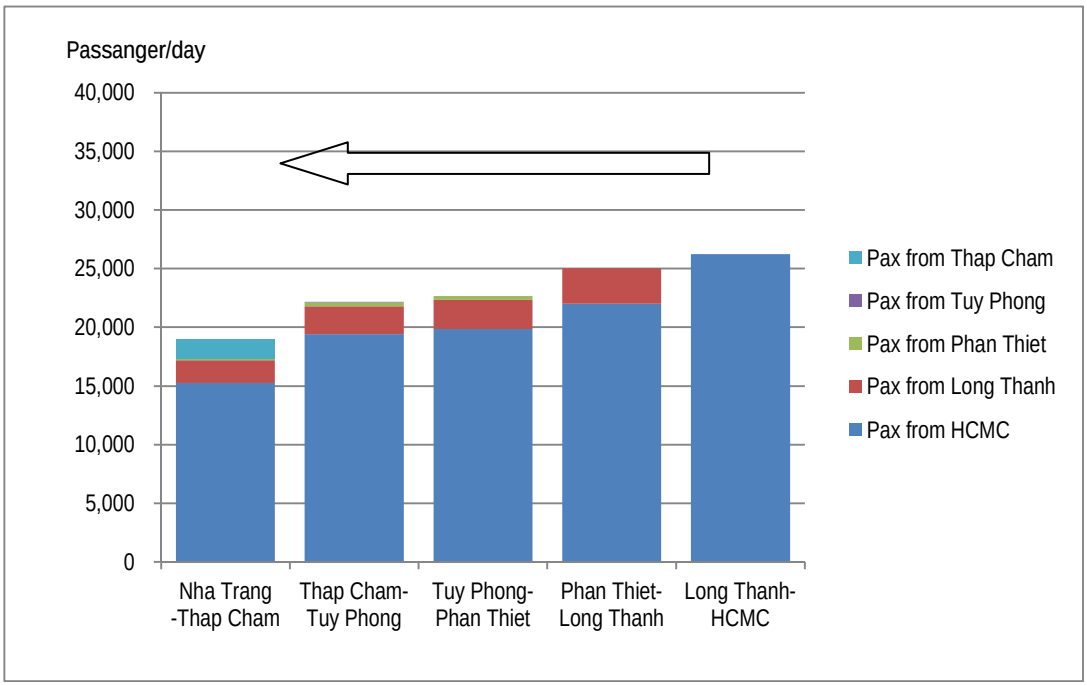
Station		1	2	3	4	5	6
		Nha Trang	Thap Cham	Tuy Phong	Phan Thiet	Long Thanh	HCMC
1	Nha Trang	--	3,988	43	221	4,473	30,845
2	Thap Cham	-		54	377	731	6,882
3	Tuy Phong	-			0	182	729
4	Phan Thiet	-				890	3,771
5	Long Thanh	-					8,298
6	HCMC	-	-	-	-	-	-

Source: JICA Study Team



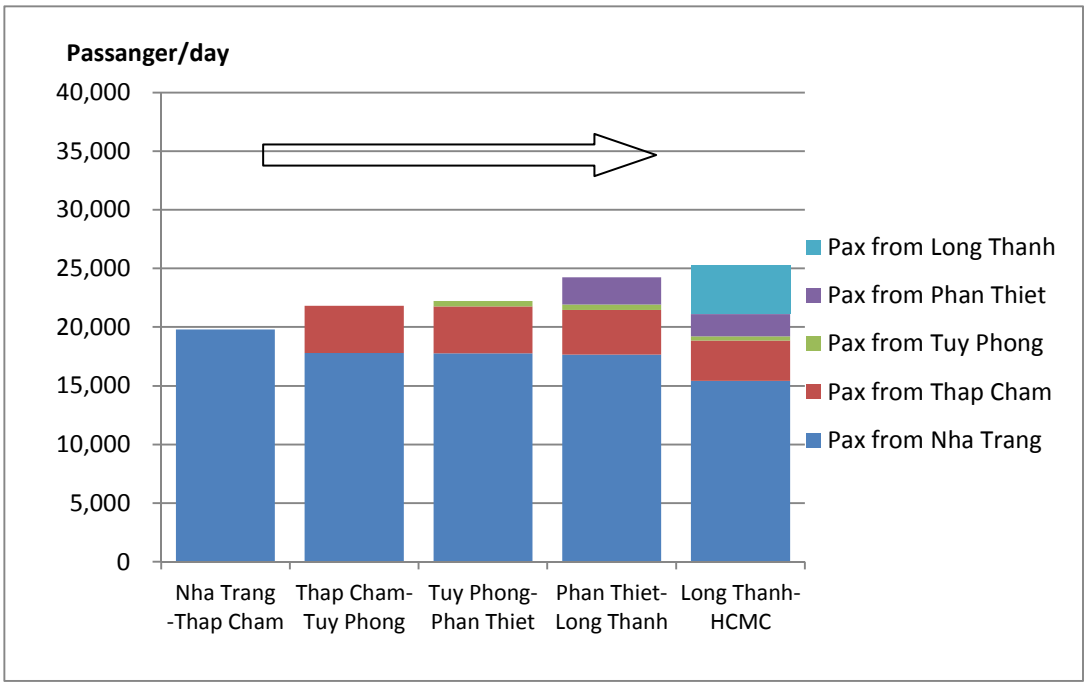
Source: JICA Study Team

Figure 3.3.4 No. of Passenger at Stations (HSR: HCMC-Nha Trang is under operation)



Source: JICA Study Team

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

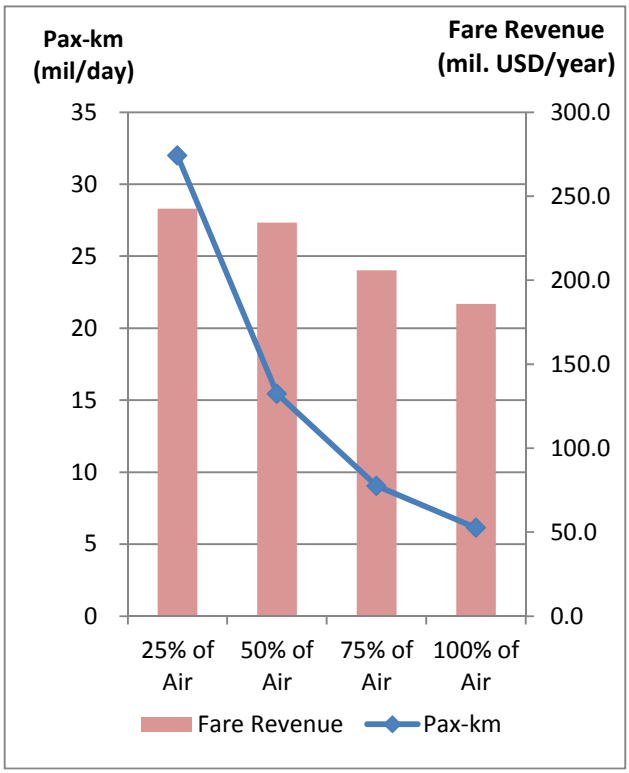


Source: JICA Study Team

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

2) Sensitivity Analysis

3.26 **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, 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). However, at 25% of air fare, the fare revenue is only slightly higher than that at 50% of air fare, which indicates, considering the difference of operating costs for passengers at cases of 25% and 50% of air fare, 50% of air fare has an advantage from financial perspective, because it requires much less number of rolling stocks than 25% case (on the other hand, 25% of air fare excels the other cases in term of economic benefit).



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)

3.27 **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.

3.28 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.

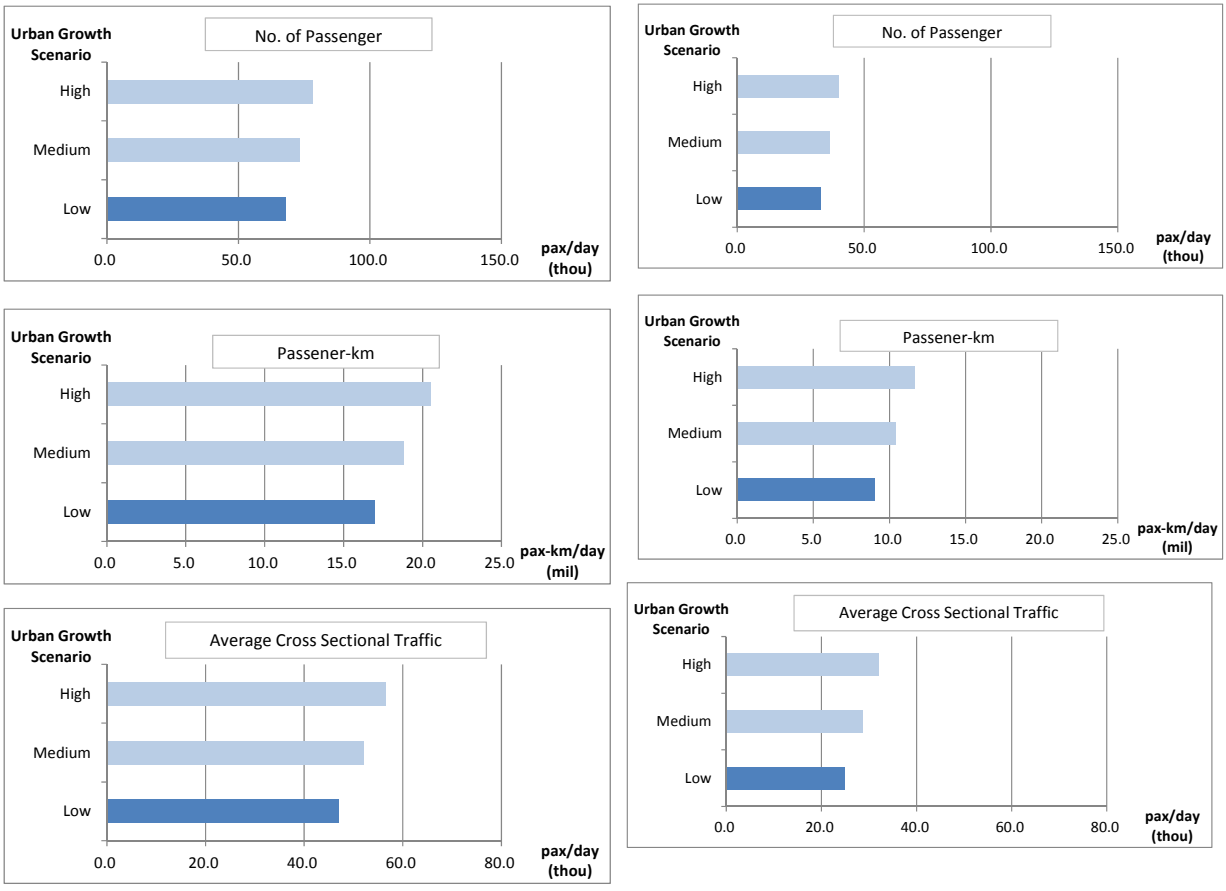
3.29 Table 3.3.2 and Figure 3.3.8 show the result of the analysis, in case HSR fare level is 50% and 75% of Air. In Medium and High case, the demand on passenger-km basis increases by 11% and 21% at 50% of air fare and 15% and 33% at 29% of air fare, respectively, compared to Low case.

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 Growth Scenario	Low (base case)	67.9	17.0	46.9	32.9	9.0	25.0
	Medium	73.3	18.8	52.0	36.6	10.4	28.8
	High	78.3	20.5	56.6	39.9	11.6	32.1

Source: JICA Study Team

50 % of Air Fare **75% of Air Fare**



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 (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 location is based on two past projects which were conducted on High-Speed Railway development, namely the KOICA Study in 2007 and the Pre F/R Study in 2009. The concept and approach for setting the alignment and station location in both of these studies, both its advantages and disadvantages, were reviewed in detail.

(b) **Collection and Review of Regional and Urban Plans:** The latest regional and urban plans were collected in order to reflect the latest plans to alignment and station location planning. These plans include the Socio-Economic Development Plan, Construction Plan, Land Use Plan, Transport Development Plan, and other plans. In addition, development plans and situation of area in vicinity of the station was carefully studied.

(c) **Site Survey:** JICA Study Team has carried out the site survey in all the city/provinces along the HSR alignment in order to get the comprehension to revise the previous study and plan the appropriate route for HSR. JICA Study Team has taken careful considerations not only about station locations in all city/provinces but also about the sensitive control points that affect the route alignment such as under-construction plan, densely populated area, nature conservation area, etc.

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

(e) **Formulation of Environmental Sensitivity Maps:** A set of environmental sensitivity maps was prepared in order to identify the potentially sensitive areas that may require environmental and social considerations, and prepare data sets in order to contribute to the alignment planning. These maps also help to clearly show that the selected alignments are drawn based on the due considerations of environmental and social aspects. After using this to considering the alternative route (including the alignment and the location of the stations), the maps are also being utilized to visualize the environmental and social considerations of this study for stakeholders. Details of these maps can be referred in Technical Report No. 4.

4.2 Preparatory Work for Route Planning

1) Site Survey

4.2 For the south section from HCMC to Nha Trang, the site survey was conducted by the team of engineers. This is part of activities aimed at selecting station and route locations, which is required during the preparation for a report on the Study on the Formation of High Speed Railway Projects for Ha Noi-Vinh and Ho Chi Minh-Nha Trang Sections.

4.3 The main purpose of the survey on the southern part of the Projects was to get necessary and useful information, which is not available in the local documents to select alignment and station alternatives.

4.4 The survey covered the area of topography, geology, land use, natural and cultural heritages and status quo of local and national development projects as well as intercity and inner-city transportation.

(1) Site Survey of Ho Chi Minh – Long Thanh Section

4.5 For the station location in HCMC, JICA Study Team has carried out the site survey several times for Hoa Hung and Thu Thiem area. The alternative station location in Hoa Hung is the existing Saigon Station while another one is in District 2 where the People's Committee of HCMC has been launching a massive urban development project. Sai Gon existing station is found with a large yard, but located in a densely populated area with the winding small access roads. On the other site, Thu Thiem area is said to have spared a place of 17ha for the future terminal station in confirmation with the Department of Planning of the City. Moreover, the proposed terminal station Thu Thiem is located near a wide road connected to the center of HCMC by Thu Thiem tunnel. JICA Study Team has suggested carrying out the borehole investigation in order to have more detail geological information in Thu Thiem station location.

4.6 Between Thu Thiem and a planned new Long Thanh International Airport (LTIA), PC of HCMC also confirmed to have allotted an area for a HSR depot/workshop. According to JICA Study Team's site observation, the area is lying inside the flood-prone zone of Dong Nai River. Geological formation of the area, therefore, must be alluvial deposits, which are very weak against the load of embankment or other structures. The express highway Long Thanh – Dau Giay along which HSR route is planned to go parallel is under construction. The area for Long Thanh International Airport is found in the middle of rubber field with the main geological formation of laterite.

	
Hoa Hung area: existing Sai Gon station with large yard but with winding small access roads.	Thu Thiem area: proposed station location of approximately 17ha connected to the city center by a wide road through Thu Thiem tunnel
	
Winding small access roads in Hoa Hung area	Wide road in Thu Thiem area connected to city center
	
Proposed land for a depot: The land is proposed on the latest master plan of HCMC.	The express highway is under construction. HSR will run parallel on the left side of the express way.
	
Bridge over Dong Nai river for Long Thanh – Dau Giay express highway under construction	Location for LTIA in the middle of rubber field.

Source: JICA Study Team

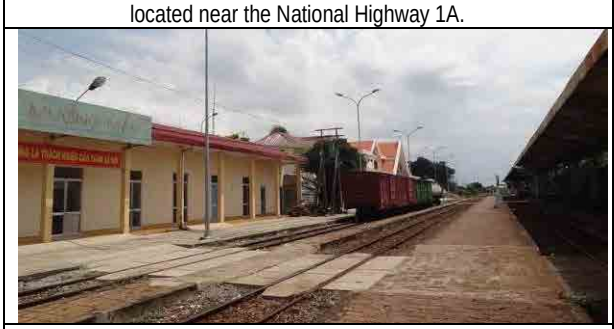
Table 4.2.1 Photos of site survey in Thu Thiem – Long Thanh Section

(2) Site Survey of Long Thanh – Phan Thiet Section

4.7 From Long Thanh to the north HSR will run up and down plateaus with rubber or dragon fruit plantations. There is a plan for Dau Giay–Phan Thiet express highway of which one alternative is suggested to run on the western side of National Highway 1A. In the 30km southwest of Phan Thiet, there is a mountain named Tra Cu designated as a nature reserve. HSR route has to be planned so that no impacts shall be made on the reserve. It should also be noted that there are cemeteries here and there on the hillsides around Phan Thiet.

4.8 Phan Thiet station of the existing north south railway is located at the end of a short line branched off the main line at Muong Man station which is lying around 10 km to the northwest of Phan Thiet city center. A new station of Phan Thiet, located on the branch line 2 km away from the existing station, was under the last stage of construction as of 3rd September 2011 and has been on used when JICA Study Team confirmed on 12nd July 2012. This new station is a strong candidate for HSR station location. The existing Phan Thiet station is located in an old urban area which seems to have no possibilities of re-development in the future. Muong Man station, on the other hand, would be too far for the HSR passengers to access to and from the town of Phan Thiet.

Table 4.2.2 Photos of site survey in Long Thanh – Phan Thiet Section

	
The location where Dau Giay-Phan Thiet Express Highway is planned to pass through. (Photo shows the view in the west direction.)	View toward National Highway 1A from Tra Cu Mountain, the nature reserve in Binh Thuan province
	
Station yard of the new Phan Thiet existing railway station located near the National Highway 1A.	Station location for Phan Thiet in KOICA Study in the middle of the paddy area far from city center without any road access
	
Station yard of Muong Man Existing Station which is around 10km far from Phan Thiet city center	Location at Ca Ty River where HSR runs across before getting to Phan Thiet Station

Source: JICA Study Team

(3) Site Survey of Phan Thiet – Tuy Phong Section

4.9 After Phan Thiet, the next station location candidate is near to Phan Ri Cua, a coastal town of Tuy Phong located 60km northeast of Phan Thiet. Between Phan Thiet and Tuy Phong, there possibly are two choices of HSR alignment. One is a route passing through the costal terrace covered with white or red sand. The other choice is one running approximately along NH1A. JICA Study Team has carefully carried out the site survey and found many sand dunes here and there. Many gardens and field were also found buried by sand in this area.

Table 4.2.3 Photos of site survey in Phan Thiet – Tuy Phong Section

	
Fields buried by sand near Gieng Trieng Village	Sand dunes between Phan Thiet and Tuy Phong
	
Bau Trang lake and sand dunes, photo taken from State Highway 716	Gullies found in the red sand area
	
Crossing Point of HSR route with National Highway 1A before Tuy Phong Station	Road bridge over Luy River. HSR route will run upstream of this location.

Source: JICA Study Team

(4) Site Survey of Tuy Phong – Thap Cham Section

4.10 After Tuy Phong, the next station candidate is Phan Rang–Thap Cham in Ninh Thuan province. Between Binh Thuan province and Ninh Thuan province, there lays a mountain area across the province border. HSR route seems to be better running through the mountain area building a tunnel of more than 10 km long because the narrow coastal corridor near the border is occupied by the existing NS line and NH1A leaving no room for HSR structures. Geology of the mountain area is composed mainly of hard granite which causes no major difficulties to bore tunnels.

4.11 Regarding overall convenience of the future HSR passengers, the connection of HSR with the existing line is the main points to consider when selecting the station location. Therefore JICA Study Team also carefully watch the surroundings of existing railway route and station considering the possibility of access route and available land. In Ninh Thuan province, Thap Cham existing railway station with a large yard is located near to the business centers and the best known tourism resources of the region, Cham Relics, Po Klong Garai Cham Towers.

Table 4.2.4 Photos of site survey in Tuy Phong – Thap Cham Section

	
The mountains near Ca Na station across Binh Thuan and Ninh Thuan province.	NH1 near Ca Na. East side of NH1 is extremely weathered mountains.
	
Existing Thap Cham station with large yard in the view toward the south	Location near Thap Cham station in the view toward the north without many buildings along the existing line
	
Existing railway bridge over Dinh Kinh river near the existing Thap Cham station (HSR route will run parallel upstream of this location)	Cham heritage, Po Klong Garai Cham Towers near Thap Cham existing station

Source: JICA Study Team

(5) Site Survey of Thap Cham – Nha TrangSection

4.12 From Thap Cham station, the existing line runs straight toward north-east without many residences along the railway. Until the terminal location in Nha Trang, most of the area is mountainous area therefore there should be several of tunnel locations for HSR alignment.

4.13 In Nha Trang city, Nha Trang station of the existing railway locates at the end of a short run back line. The existing station would not be a good candidate for HSR station location mainly because of two reasons. One is that it is in the middle of densely populated urban area. A great number of houses and buildings would have to be relocated to construct HSR structures passing through the area and to establish a HSR station at the existing station location. The other reason is that ongoing urban development is expanding westward of the city. It seems to be appropriate to set up a HSR station close to the starting point of the run back line which happens to locate at the west end of the development plans. It is also an ideal location for the connection with the existing NS line.

4.14 As a tentative terminal station of HSR, a depot /workshop must be placed near HSR Nha Trang station. It is desirable to locate it in the north of the station considering the future extension of HSR to the north. After an extensive site survey around the suburbs of Nha Trang, JICA Study Team has found a large rice field having an area of over 100 ha along the National Highway 1A, which is 4 km to northwest of the city. This place seems a good candidate for the depot/workshop.

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

4.15 Data collection and meetings with City/Provinces along the alignment were carried out properly during the study as to how to determine the route and station location. The following table shows the steps taken by JICA Study Team when planning the HSR alignment and station locations.

4.16 In each city/province JICA Study Team has not only collected the latest regional and urban plans including the Socio-Economic Development Plan, Construction Plan, Land Use Plan, Transport Development Plan, but also the development plans and situation of area in vicinity of the station. The following table shows the data JICA Study Team has collected when planning route and station locations.

Table 4.2.5 Photos of site survey in Thap Cham – Nha Trang Section

	
After Thap Cham station excluding several curve sections, existing line runs straight toward north-east without many residences along the railway.	The section between Ninh Thuan and Khanh Hoa province is located on the mountainous area. HSR will directly pass through the mountains by a tunel.
	
The rural area beyond Nha Trang city in the view of the south mountainous area direction. Almost all of the area before the mountains is cultivation areas.	Location of the branch off point on the existing NS-line in the view of Nha Trang station direction.
	
Existing Nha Trang Station with the loop line known as a bottle neck for existing line operation	The proposed location for Nha Trang HSR Station in the view toward Nha Trang existing station.
	
The proposed depot land in the north-east direction along NH1A near Vinh Phuong	Location of HSR bridge over the Cai River to access the depot location

Source: JICA Study Team

Table 4.2.6 Steps taken by JICA Study Team when planning HSR Route and Station Locations

Section	Steps taken by JICA Study Team
Common for North and South Section	• Collection and review of the latest regional and urban plans of the cities/provinces by subcontract work (July-September 2011) • Collection and review of the latest natural and social environmental regulations and information by visiting DONRE/DARD/DOCST for all cities/provinces (June-December 2011) • 1st Stakeholder meeting (SHM) on 9th December, 2011, inviting representatives from the target cities/provinces. • 2nd SHM in 11 cities/provinces along planned alignment from 9th July 2012 to 10th August 2012
South Section	• Visiting city/provincial government during the field work to collect data and explain about the project (September 2011 to May 2012) • Explanation and discussion on alignment and station in all target provinces (18th May to 8th June 2012) • 2nd SHM in Khanh Hoa, Ninh Thuan, Binh Thuan, Dong Nai from 9th to 13rd July 2012, in HCMC on 10th August 2012

Source: JICA Study Team

Table 4.2.7 Data Collection in South Section

City/ Province	Detail of collected data
All cities/ provinces	• The latest regional and urban plans of the cities/provinces • The latest natural and social environmental regulations and information from DONRE/DARD/DOCST in all cities/provinces
HCMC	• Transport Development Plan of HCMC until 2020, vision after 2020. • Development Plans, Land use plans for Thu Thiem area • Detail Plan for the railway network in HCMC • Plan for metro line 2 from and LRT from Thu Thiem to Long Thanh • Detail plan for Ho Chi Minh City – Can Tho railway • Plan for upgrade existing railway from Trang Bom to Hoa Hung • Long Thanh – Dau Giay express highway construction related documents
Dong Nai	• Construction Plan of Dong Nai province until 2030 and vision to 2050 • Master Plan of Long Thanh International Airport. • Final Report of Pre-Feasibility Study for the Project Construction of Long Thanh International Airport • Development Plan for Vicinity Area of Long Thanh International Airport • Long Thanh – Dau Giay express highway construction related documents • Plan for freight railway from Vung Tau – Bien Hoa
Binh Thuan	• Development Plan for Phan Thiet, Tuy Phong area • Plan for Dau Giay – Phan Thiet express highway
Ninh Thuan	• Development Plan for Phan Rang – Thap Cham • Development Plan for Urban and rural area until 2025
Khanh Hoa	• Latest General Construction Master Plan of Cam Ranh area and Nha Trang city • Resort Development Plans in Nha Trang and Cam Ranh area.

Source: JICA Study Team

4.17 Parallel with collecting data and planning route alignment, JICA Study Team has properly carried out the meetings with City/Provinces along the South section alignment to explain and get confirmation of route plan. The following tables show the detail of meetings held with each city/province in HCMC – Nha Trang section. For the south section, before the 2nd Stakeholder Meetings (SHM), pre-meetings to explain and confirm the route and station location with all city/provinces along the alignment were carried out.

Table 4.2.8 Date and Other Information of Pre-meetings with City/Provinces

Province	HSR Station	Date	Representative of City/Province	No. of Attendance	
				Province	JICA Study Team
Khanh Hoa	Nha Trang	31/5/2012	Chairman	10	4
Ninh Thuan	Thap Cham	1/6/2012	Vice chairman	6	4
Binh Thuan	Tuy Phong, Phan Thiet	8/6/2012	DOT Deputy Director	10	5
Dong Nai	Long Thanh	7/6/2012	DOT Deputy Director	6	5
HCMC	Thu Thiem /Hoa Hung	18/5/2012	DOT Deputy Director	3	4

Source: JICA Study Team

Table 4.2.9 Date and Other Information of 2nd SHM with City/Provinces

Province	HSR Station	Date	No. of Attendance			
			Province	MOT	VR	JICA Study Team
Khanh Hoa	Nha Trang	9/7/2012	54	1	4	6
Ninh Thuan	Thap Cham	11/7/2012	43	1	4	6
Binh Thuan	Tuy Phong, Phan Thiet	12/7/2012	23	1	4	6
Dong Nai	Long Thanh	13/7/2012	29	1	4	6
HCMC	Thu Thiem /Hoa Hung	10/8/2012	49	0	6	9

Source: JICA Study Team

3) General Geological information on Ho Chi Minh–Nha Trang Section

4.18 In the south section the main geological information along the HSR alignment could be summarized as follow:

(i) Mekong Delta area in HCMC and Dong Nai province: it is the alluvial sediment of Mekong and Dong Nai rivers.

(ii) Xuan Loc basaltic plateau in Dong Nai province: it is the developing area of fertile red soil weathered from basalt, in general, relatively smooth, weakly dissected or widely undulating with elongated and gentle slopes.

(iii) Phan Thiet coastal terrace in Binh Thuan province: with the width from 10 to over 20km, formed by marine or fluvio-marine sediments. Especially, in this area there are hands of red sand raising up to some hundred meters.

(iv) Low hills area and Phan Rang Plain in Ninh Thuan province: this is the transitory topography area between mountains and coastal terraces, comprising low mountains and hills of less than 1000 m and intermontane and coastal denuded-accumulated plains.

(v) Eastern part of Khanh Hoa province: The topography of this area is characterized by low mountain massifs, dissected by narrow plains, and stretching seaward forming twisty sections of the seashore with numerous capes, little bays and islets. Those mountains can reach more or less a height of 1,000 m. The weathered rocks and soil bed are badly developed and preserved.

4.19 Note that low areas along the coastline were avoided considering the potential impacts due to climate change and sea level rise.

4.20 The detail geological information along the HSR alignment can be referred to Technical Report No.5. The geological layer map is shown in Figure 4.2.1 with the detailed geological legends in Figure 4.2.2 and Figure 4.2.3.

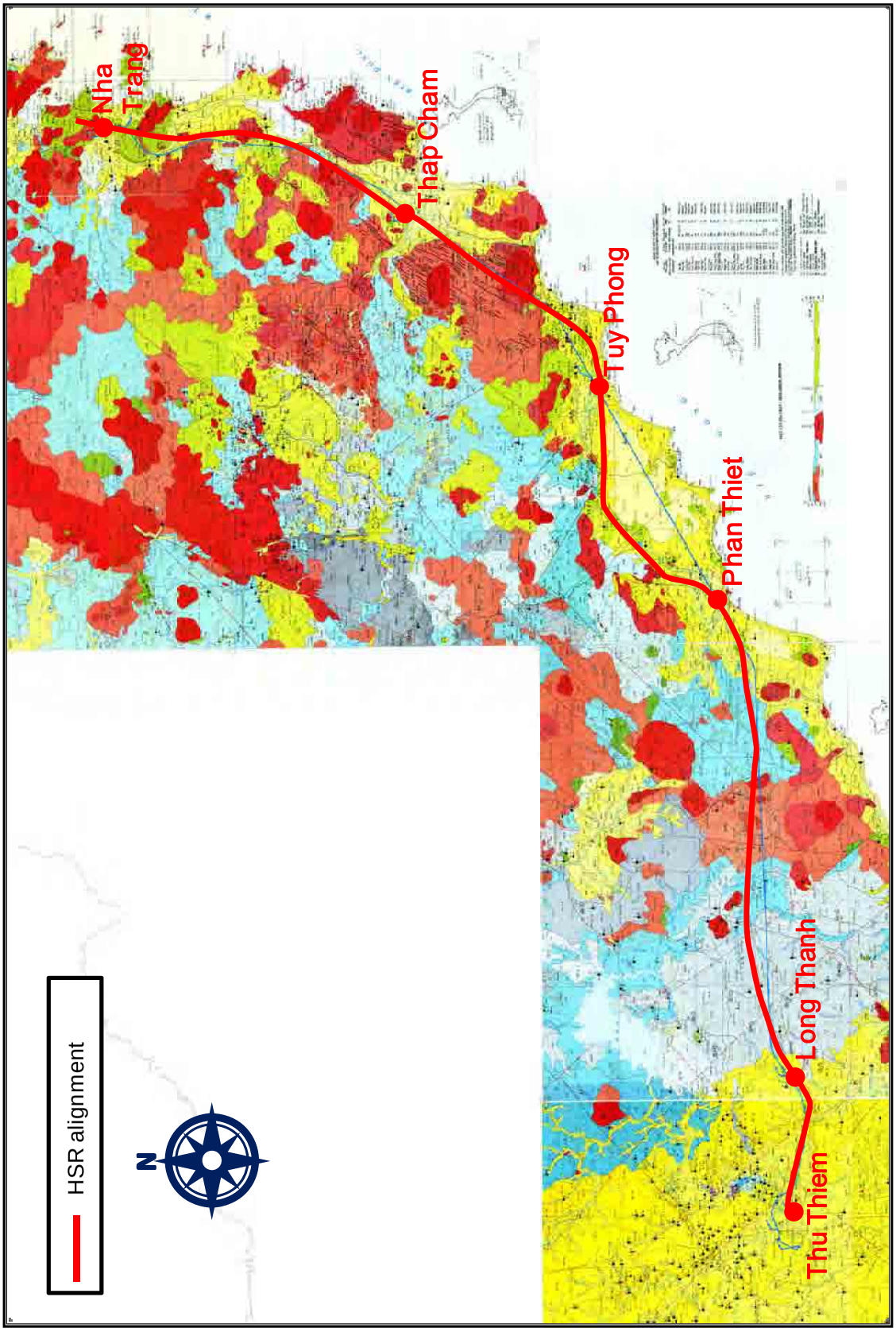
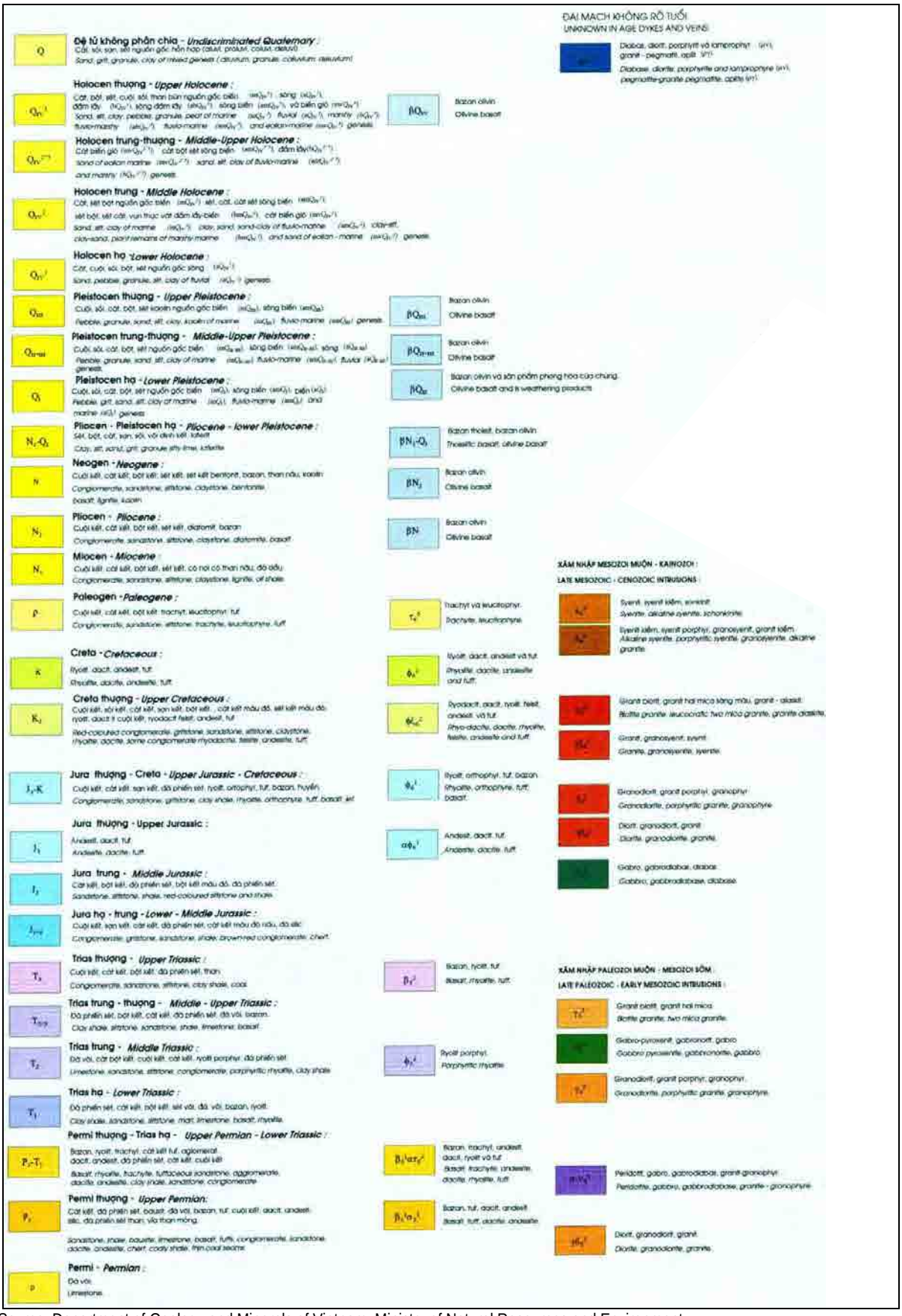
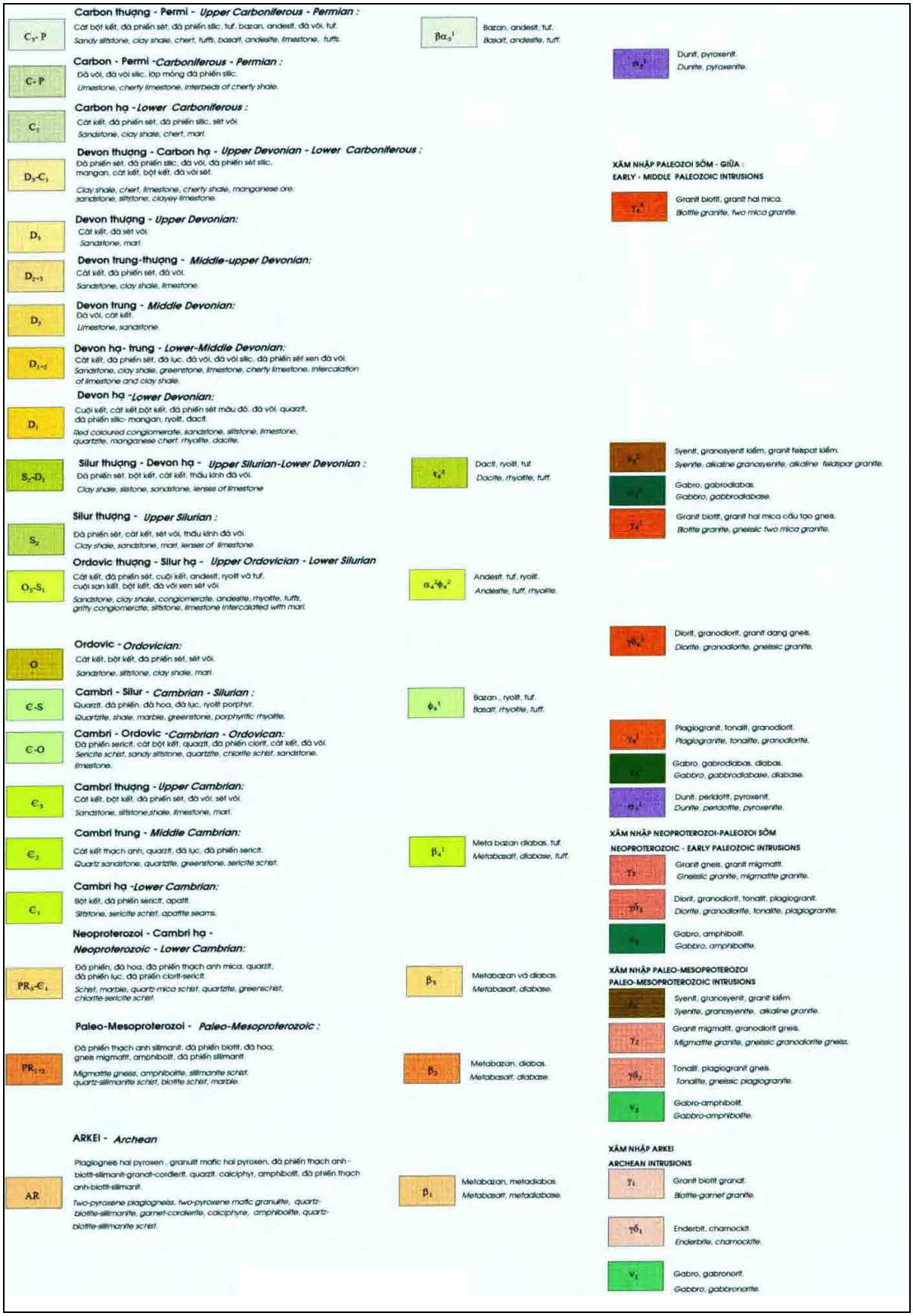


Figure 4.2.1 Geographical Features in the HSR's South Section



Source: Department of Geology and Minerals of Vietnam, Ministry of Natural Resources and Environment

Figure 4.2.2 Legend for the Geological Map (1 of 2)



Source: Department of Geology and Minerals of Vietnam, Ministry of Natural Resources and Environment

Figure 4.2.3 Legend for the Geological Map (2 of 2)

4) Preparation of Topographic Maps

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

(1) Satellite Image Processing

4.22 The following ALOS data shall be purchased and provided to the consultant by the Study Team. A sufficient number of well-distributed map and ground control points shall be used to improve geo-referencing of the ALOS PRISM imagery. The map control points shall be picked using all available topographic map data on the mapping area. Ground controls shall be established with GPS centerline surveys along the selected existing railway and roadway locations in the mapping area. Satellite image processing shall be done using ENVI software.

Table 4.2.10 List of ALOS Purchased

ALOS AVNIR-2 (70km * 70km)		ALOS PRISM (70km * 35km)	
1	ALAV2A269723380	1	ALPSMW269723385
2	ALAV2A267243380	2	ALPSMW269723380
3	ALAV2A246383370	3	ALPSMW268993380
4	ALAV2A246383360	4	ALPSMW268993375
5	ALAV2A246383350	5	ALPSMW268993370
6	ALAV2A237633220	6	ALPSMW268993365
7	ALAV2A237633210	7	ALPSMW268993360
8	ALAV2A237633200	8	ALPSMW267243385
9	ALAV2A211083380	9	ALPSMW267243380
10	ALAV2A204083190	10	ALPSMW246383370
11	ALAV2A204083180	11	ALPSMW246383365
12	ALAV2A201893380	12	ALPSMW246383360
13	ALAV2A201893370	13	ALPSMW246383355
14	ALAV2A201893360	14	ALPSMW217793375
		15	ALPSMW211083385
		16	ALPSMW211083380
		17	ALPSMW204083225
		18	ALPSMW204083220
		19	ALPSMW204083215
		20	ALPSMW204083210
		21	ALPSMW204083190
		22	ALPSMW204083185
		23	ALPSMW204083180
		24	ALPSMW204083175
		25	ALPSMW197373205
		26	ALPSMW197373200
		27	ALPSMW197373195

Source: JICA Study Team

(2) ALOS PRISM Specifications

- Scene Size: 70 km x 35 km
- Processing Level: Level 1B2 (georeferenced)
- File Format: Geotiff, 1 band (Panchromatic)
- Pixel Depth: 8-bit
- Ground Sample Distance (Resolution): 2.5 m
- Coordinate System: WGS 84, UTM Zone 48N

(3) ALOS AVNIR-2 Specifications

- Scene Size: 70 km x 70 km
- Processing Level: Level 1B2 (georeferenced)
- File Format: Geotiff, 4 bands
- Pixel Depth: 8-bit
- Ground Sample Distance (Resolution): 10 m
- Coordinate System: WGS 84, UTM Zone 48N

(4) DEM Data Acquisition

4.23 ASTER 30-m resolution DEM and 2.5m DEM (for possible area) are acquired. The entire project area is covered with approximately 12 tiles of ASTER GDEM data with the following specifications:

(5) ASTER 30-m Resolution DEM Specifications

- Tile Size: 1º x 1º (110 km x 111 km)
- File Format: Geotiff, 1 band
- Pixel Depth: 16-bit
- Ground Sample Distance (Resolution): 30 m
- Vertical Accuracy: ±20 m
- Coordinate System: WGS 84

(6) DEM Data Calibration

4.24 The ASTER GDEM is calibrated using all available topographic map data on the mapping area to improve its vertical accuracy.

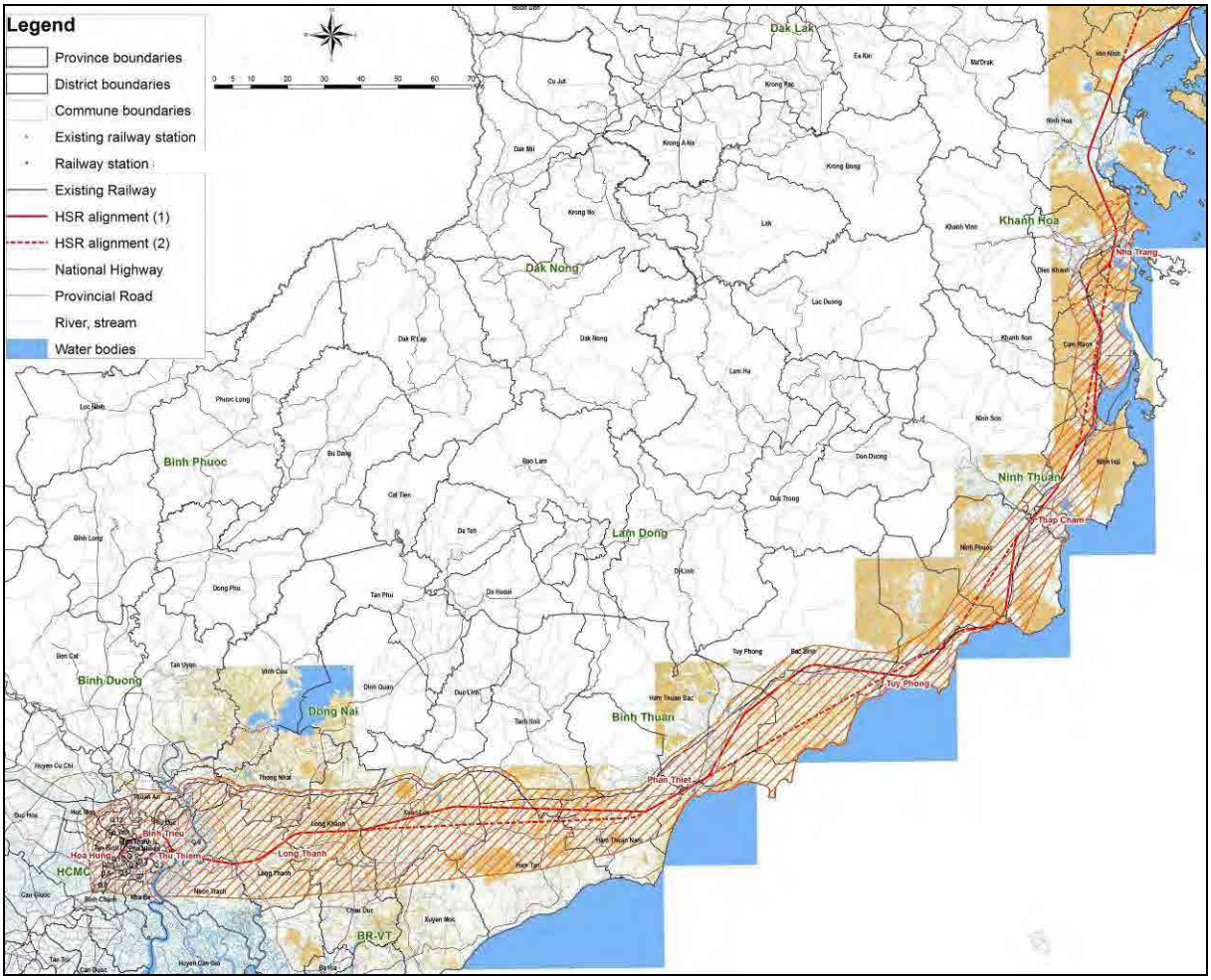
(7) Digitizing of Planimetry

4.25 Objects that are clearly identifiable on the satellite imagery are digitized and classified according to the following layers:

(i) Roads/Railways
(ii) Settlements or Built Up Areas
(iii) Lakes, Rivers, Streams, Creeks and Ponds
(iv) Irrigation Canals
(v) Vegetation/Crop Lines and other visible landcover types

(8) Mapped Area

4.26 The mapped area is shown in the figure below.



Source: JICA Study Team

Figure 4.2.4 Mapped Area along HSR's South Section

4.3 Description of Alternative Routes and Station Locations and Selection

1) Basic Considerations

(1) Review of Previous Study

4.27 There were two previous studies about the HSR Routes for HCMC - Nha Trang Section described in KOICA Report 2007 and Pre-FS Report in 2009.

4.28 In KOICA Report, the concepts for station locations and alignment determination are:

- Station Location: In suburban area avoiding existing city area and not connecting with existing line.
- Alignment: 1) To reduce construction cost by choosing the alignment by embankment, and 2) Minimum Curve Radius=5,000m

4.29 On the other hand, Pre-FS considered the following concepts:

- Station Location: In urban area, connecting with existing line in some locations.
- Alignment: 1) Free to choose alignment by application of elevated structures more, and 2) Minimum Curve Radius=6,000m

4.30 Considering the above studies, JICA Study Team made its own basic concepts to determine the station locations and alignment as follow:

- Station Location: In urban area with integrated development in and around station area, taking more considerations for connection with the existing line.
- Alignment: 1) To consider the cost efficient balance of viaduct and embankment, and 2) Minimum Curve Radius =6,000m

(2) Design Standards for HSR Alignment

4.31 JICA Study Team has considered the design standard as shown in Table 4.3.1 to design the HSR Alignment. The summary of the design standard is shown in the following table.

Table 4.3.1 Design Standard for HSR Alignment

No	Items	Unit	Proposed Value
1	Track gauge	mm	1,435
2	Number of main lines		Double track
3	Maximum design speed	Km/h	350
4	Maximum operating speed	Km/h	320
5	Minimum curve radius	m	6000
6	Maximum vertical curve radius	m	25,000
7	Maximum gradient	‰	25
8	Distance between centers	m	4.3
9	Width of road bed	m	11.3
10	Cross section of tunnel	m^2	63.4
11	Design maximum axle load	ton	P 16

Source: JICA Study Team

(3) Basic Concept for Selecting Station Locations

4.32 As basic concept for station locations 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.

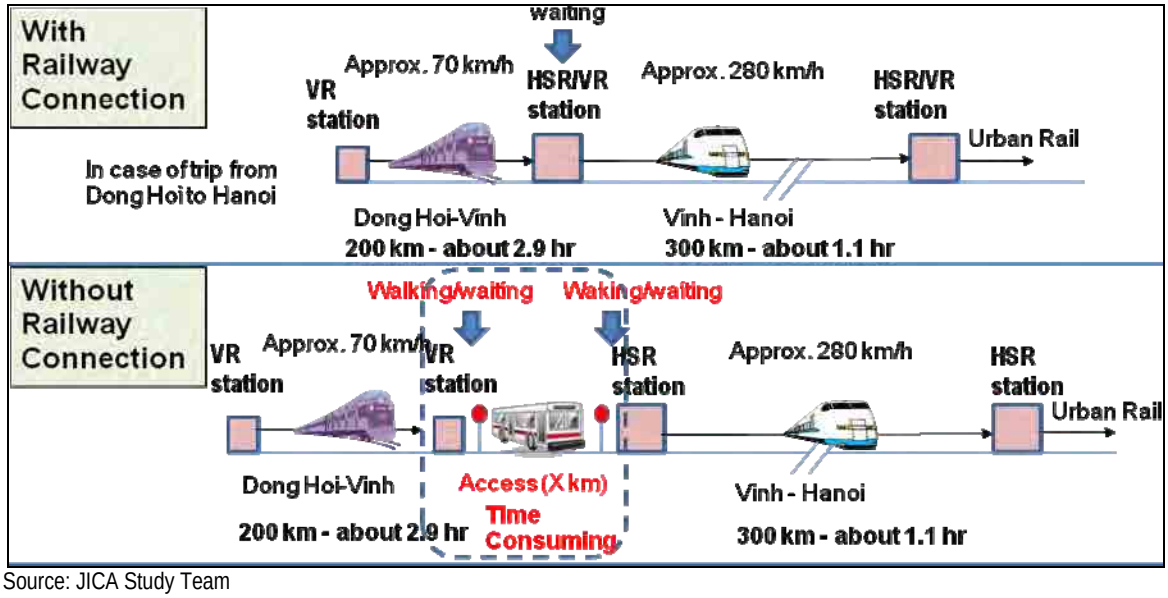
(ii) Major urban areas along the alignment.

(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.

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

4.34 After determining the areas for station locations along HSR alignment, JICA Study Team considered some detail alternative locations for each station. Upon setting these alternative locations, the connectivity of HSR with the existing railway was viewed as one of the most critical points. This is because the convenience of passengers will be the key for the success of HSR. If the HSR is connected with the existing railway, the existing railway can serve as a feeder service for the HSR. This is based on the assumption that the existing railway will also be upgraded to provide safer operation and higher speed with more frequent trains. As shown in the following figure, in case of without-railway connection, the connecting transport (such as bus) should be operated; however, the implementation of efficient operation to keep HSR/railway competitiveness is quite difficult and challenging. Due to the capacity of Railway Transport (over 1,000 passengers per time), transferring by bus/car will also be inefficient causing long waiting time.



Source: JICA Study Team

Figure 4.3.1 Importance of Connection with Existing/Local Railway

4.35 Connectivity of HSR with other transport modes is also important, as HSR will face the competition against air and road soon after its operation. Therefore, HSR should maximize the advantageous points of HSR (e.g. short access time, punctuality, high frequency of operation, etc.) by considering a strategic station location.

4.36 Successful urban development has been achieved with feeder railway network (that is to say, if there is better connectivity, the ridership will increase and thus promote economic viability). Without convenient railway connection, many cities have failed in integrated development (e.g. in Japan, Taiwan, Korea, etc.)

2) Comparison and Selection of Station Locations by Province/City

4.37 Table 4.3.2 and Table 4.3.3 show the list of HSR station location alternatives in the South Section and the basic concepts applied for each station location, respectively. The details for each city/province are further explained in the following pages.

Table 4.3.2 Station Location Alternatives

Station (Pop. in 2009, 000)	Alter-native	Characteristics
HCMC (7,163)	1	Located in Thu Thiem New Town Development Area. Conforms to the city's future spatial development plan. Connects with UMRT Line 2, and High potential for integrated urban development.
	2	Located in Hoa Hung Area. Connects with existing railway via Saigon Station. Limited available land for development, and Narrow roads near area.
	3	Same with Alternative 1
Long Thanh (288)	1	Located inside Long Thanh International Airport. Conforms to plan of Southern Airports Corporation. Possible extension of UMRT Line 2 to the airport. Potential for integrated development inside airport: transit and commercial functions.
	2	Located adjacent to the planned urban area. Land available for development adjacent to the airport.
	3	
Phan Thiet (216)	1	Located in city fringe area.
	2	Connects with existing railway via relocated Phan Thiet Station.
	3	Located in rural area. No connection (both existing and planned) to other transport modes. Administrative, business/ commercial center located more than 5km away.
Tuy Phong (141)	1	Located in planned low density residential development area. Connects via NH01. Less than 1km away from administrative, business/ commercial center.
	2	Located in rural area. No connection (both existing and planned) to other transport modes. Administrative, business/ commercial center located more than 3km away.
	3	
Thap Cham (162)	1	Located in existing urban area (west of city). Connects with existing railway via Thap Cham Station.
	2	High potential for integrated urban development, however expects some difficulties in obtaining land. Near major tourism destination.
	3	Located in new urban area. Possible division of urban areas due to the station location being located in the center.
Nha Trang (392)	1	Located along access road to existing city center. Connects with existing railway via relocated Nha Trang Station. Adjacent to planned improved village area.
	2	Located along a planning road to existing city center. Adjacent to planned improved village area.
	3	Located adjacent to water ecology tourism area.

Source: JICA Study Team

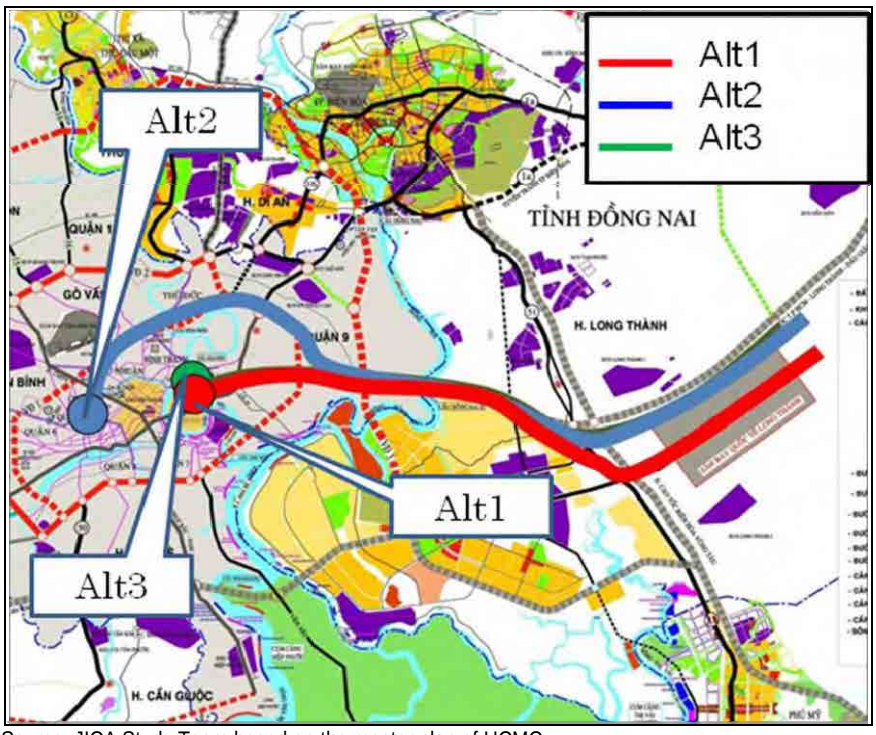
Table 4.3.3 Basic Concept applied for Station Locations in South Section

Station	Basic Concept		
	(i)	(ii)	(iii)
HCMC(Thu Thiem)	✔	✔	✔
Long Thanh			✔
Phan Thiet	✔	✔	
Tuy Phong		✔	
Thap Cham	✔	✔	
Nha Trang	✔	✔	

Source: JICA Study Team

(1) Ho Chi Minh City

4.38 As terminal station for HSR in HCMC – Nha Trang section, station location in Ho Chi Minh City plays an important role in route determination. In Ho Chi Minh City, there are 2 alternative locations for HSR, Thu Thiem (Alt1, Alt3) and Hoa Hung (Alt2). The location in Thu Thiem is located in the new development area in District 2 while one in Hoa Hung is located in the existing railway station, Sai Gon station. (see Figure 4.3.2)



Source: JICA Study Team based on the master plan of HCMC

Figure 4.3.2 Alternative Station Locations in HCMC

4.39 Upon comparison of the station locations (Thu Thiem and Hoa Hung) shown in the following table, JICA Study Team recommends situating the station in Thu Thiem for the following reasons:

(i) It conforms with the Thu Thiem New Town Development Plan approved by the city;

(ii) Smooth access to airport is ensured from Metro Line 2 and East-West Avenue;

(iii) The alignment to Hoa Hung station will require huge resettlement (estimated to be nearly 900 buildings), while Thu Thiem station will require fewer resettlement (less than 100).

(iv) The noise problem will be also significant if the alignment goes into Hoa Hung area since the alignment has to run through the highly populated districts.

(v) It is possible to have a spacious station plaza;

(vi) It is easy to extend the alignment to the south.

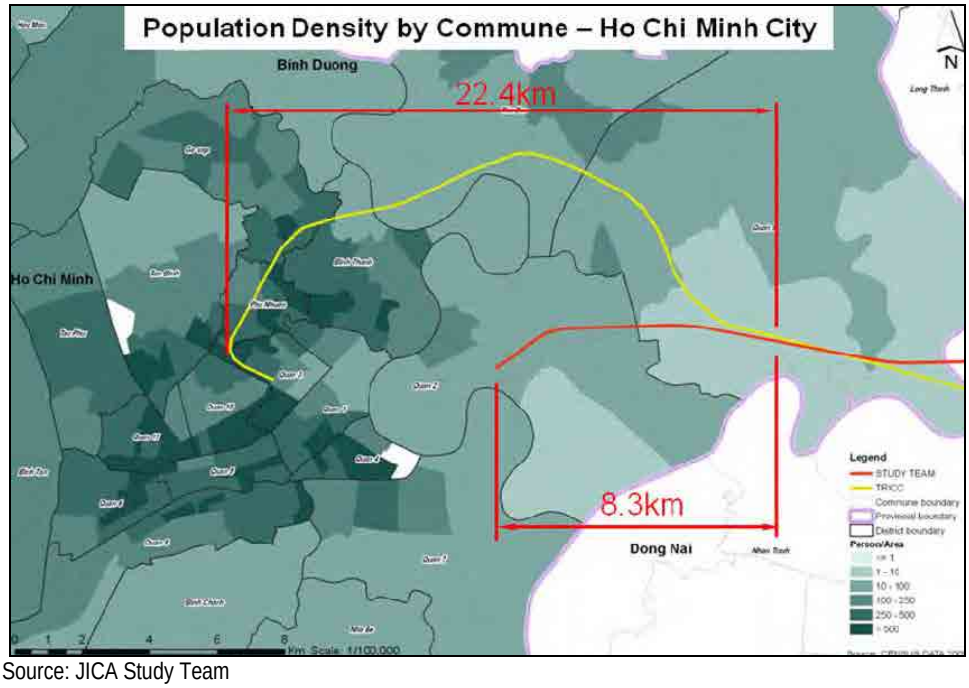
(vii) Hoa Hung alignment will cost 300 to 400 million USD more than Thu Thiem.

(viii) Winding alignment to Hoa Hung will impose around six minutes longer travel time on HSR trains than to Thu Thiem.

Table 4.3.4 Comparison of Station Locations in HCMC

	Thu Thiem (Alt1, Alt3)	Hoa Hung (Alt2)
Conformity with Urban Planning	Compatible (Thu Thiem New Town Development Plan)	Incompatible
Accessibility	Smooth (East-West Avenue, Thu Thiem Tunnel)	Difficult by Cars/Bikes (Congested narrow streets around the station area)
Station Plaza	Spacious	Narrow
Connection with Railway	Metro Line 2	Existing Railway Metro Line 2
Land acquisition	Easy (8.3km long in less populated area)	Difficult (22.4km long in densely populated area)
Resettlement	Few (64 buildings affected)	Many (866 buildings affected)
Environment Impact (Noise, estimation)	Minor (Approx 350 people affected by noise impact)	Significant (Over 7,000 people affected by noise impact)
Construction Cost	Low	High (+320 million USD)
Extension to the South	Easy	Difficult

Source: JICA Study Team



Source: JICA Study Team

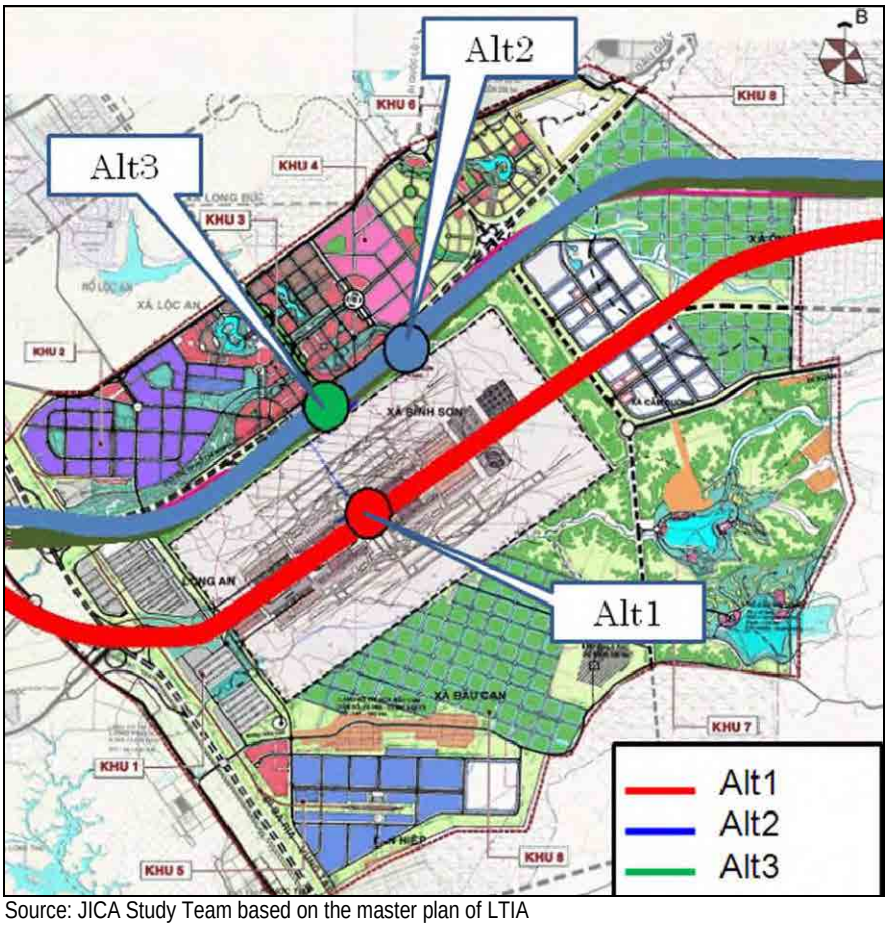
Figure 4.3.3 Population Density and Alternative Routes in HCMC

4.40 In the discussion with HCMC about the Thu Thiem Station Area, it is known that HCMC planned 17ha land for Thu Thiem Station area. As study of JICA Study Team about the HSR station yard and its square, the necessity for HSR Station area is about 5.3ha (3.8 of HSR yard plan and 1.5ha of station square). Therefore the area 17ha which HCMC planned for Thu Thiem station is found enough not only for HSR yard but also for local train yard and other business facilities.

(2) Dong Nai Province (Long Thanh Station)

4.41 In Dong Nai province, the master plan of Long Thanh international airport (LTIA) has been approved by Prime Minister. According to this master plan, access rail to the Airport is expected in addition to road access. The airport with a planned area of 5,000 ha has enough space to accommodate a HSR station as well as an urban railway station. To be located 35km east of HCMC, the airport can be reached in only ten minutes by HSR from HCMC. Considering the convenience for passengers, Long Thanh International Airport is selected to be the HSR Station Location based on the basic concept 3) Special location for passengers' convenience.

4.42 For Long Thanh HSR Station, 2 alternative locations are discussed known as one in the center of Long Thanh airport (Alt1), one in the outskirts of the airport (Alt2, Alt3).



Source: JICA Study Team based on the master plan of LTIA

Figure 4.3.4 Alternative Locations of LTIA Station

4.43 Upon comparison of the station location (center or outskirt of the airport), its characteristics are summarized in the Table 4.3.5. JICA Study Team recommends situating the station at the center of the airport for the following reasons:

(i) It conforms with the Airport Master Plan approved by the Prime Minster; (Figure 4.3.5)

(ii) Direct access to the airport terminal is ensured. Access from the outskirt HSR station to the airport terminal has to be a long detour because underpasses beneath runways will not be permitted.

(iii) The station for urban railway will be designated at the center of the airport;

(iv) As meetings held with consultants of Long Thanh Airport Plan, JICA Study Team has confirmed there is no height restriction for HSR or local train to run through the center of the airport. In the master plan, the HSR line is considered running on ground or open cut through the center of the airport (Figure 4.3.6). Therefore, there is no issue for the security and safety of the airport

(v) From the previous records, the airport accidents tend to happen along with the direction of the runway, not in the area parallel to the runway. So, the safety of HSR running parallel with the runway will be assured.

(vi) In mega airports in the world such as Charles de Gaulle (CDG) Airport in Paris and Frankfurt Airport, HSR, City Rail are directly connected to the airport terminal to enhance the convenience of passengers. Passenger can transfer smoothly between Air and HSR. Figure 4.3.7 shows the example of CDG Airport in Paris.

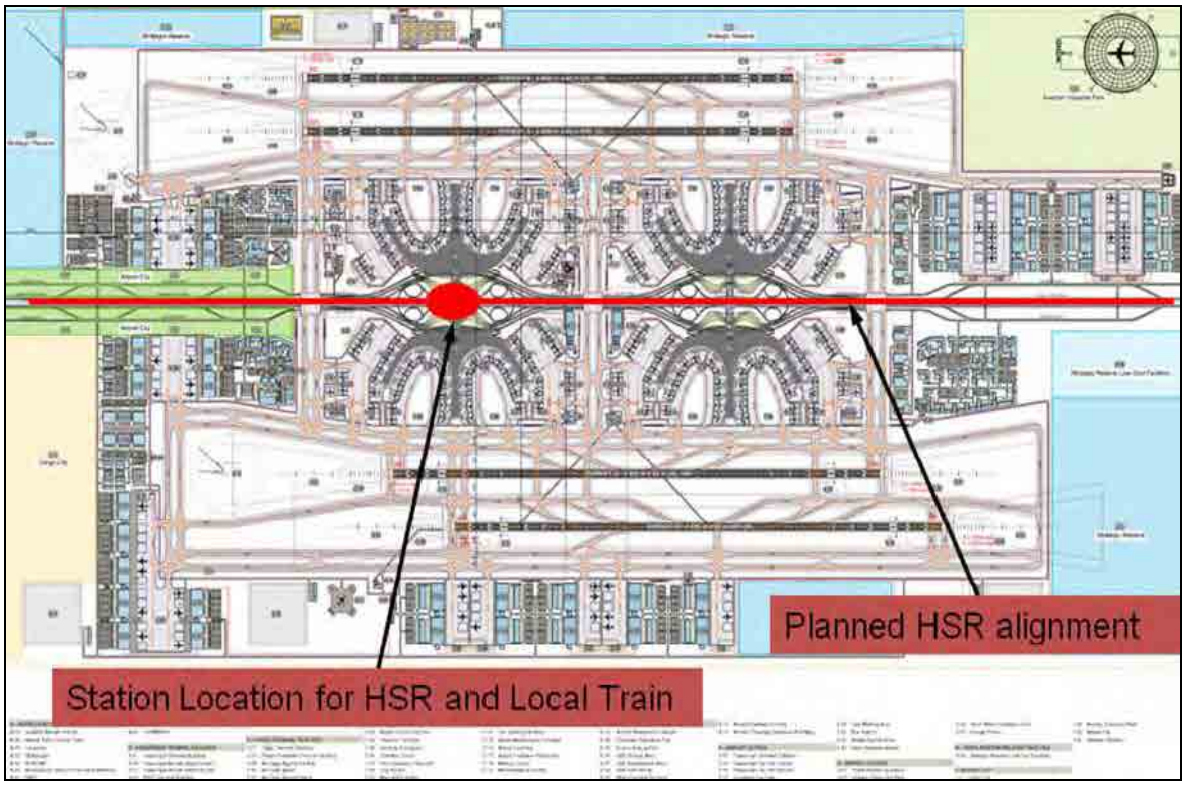
(vii) Impact to airport road access is lower as passengers moving from HSR Station to the airport center are reduced;

(viii) The estimated demand in 2030 is larger around 40,000 passengers a day using railway to and from the airport, comparing with the 13,000 passengers a day to and from the neighboring town area.

Table 4.3.5 Comparison of HSR Station Locations at LTIA

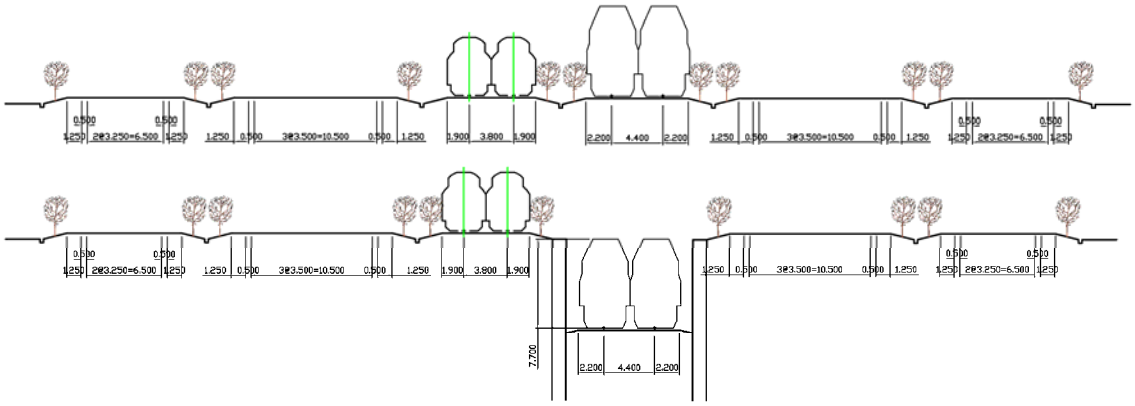
	Center of airport (Alt1)	Outskirt of airport (Alt2, Alt3)
Conformity with Airport plan	Compatible (with Airport Master Plan approved by Prime Minister)	Incompatible (with Airport Master Plan approved by Prime Minister)
Accessibility to Long Thanh Airport for HSR users	Smooth (easy to access Airport Buildings with pedestrian bridges or underground passing)	Difficult (Detour Route is needed to access to the airport. Underground access road beneath runway is not permitted)
Connection with Local Train	Same Station location with local train will be designed in the center of the airport	Different Station location with local train station which is planned in the center of the airport
Security and Safety	No issue no height restriction for HSR to run through the center of the airport	No issue HSR is running outside of the airport, parallel with the landing strip
Impact to Airport Road Access	Lower as Passengers moving from HSR St. to Airport center are reduced	Higher Due to passengers from HSR St. to Airport center, the load to Access Road will be higher
Estimated Demand	More passengers feel convenient	Less passengers feel convenient
	(Per day 40,000 passengers will use railway to access to the airport while there are only 13,000 passengers to access to the area out of the airport)	

Source: JICA Study Team



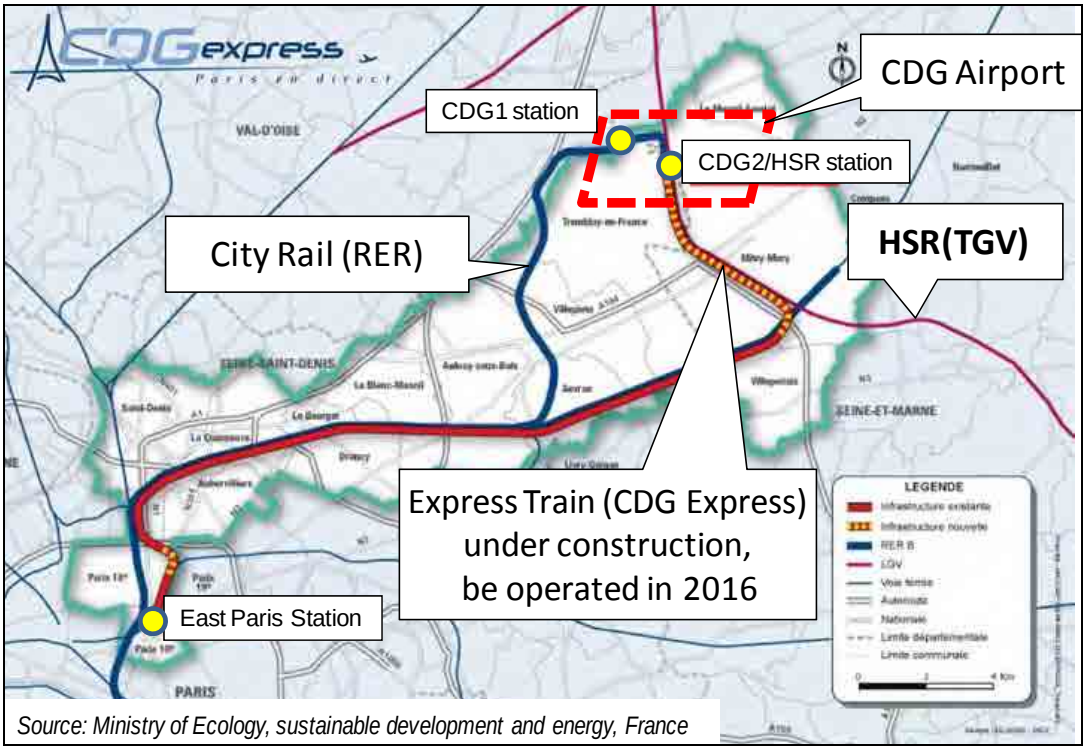
Source: JICA Study Team based on the Master Plan of LTIA of Southern Airports Corporation

Figure 4.3.5 Master Plan for LTIA and HSR Routes



Source: Southern Airports Corporation
(Pre-Feasibiliy Study for the Project, Construction of Long Thanh International Airport, Final Report)

Figure 4.3.6 Cross-section of HSR and Local Train in LTIA Master Plan



Source: Ministry of Ecology, sustainable development and energy, France

Figure 4.3.7 Example of International Airport with HSR in the Center - Charles de Gaulle (CDG) Airport

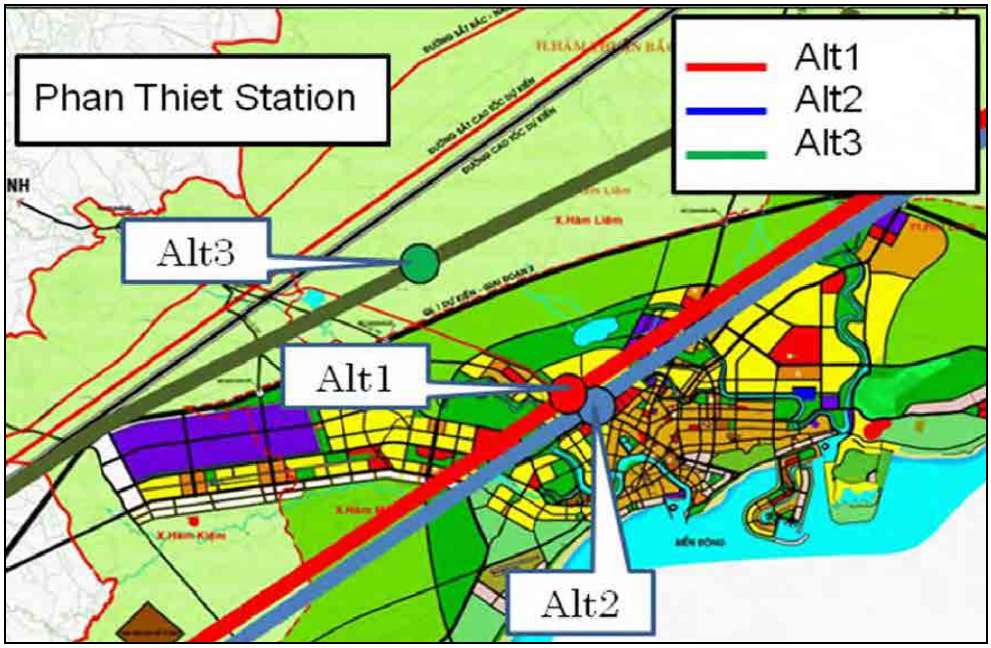
4.44 In the stakeholder meeting with Dong Nai province, there was a request to create a new station near Long Khanh area. As further study result of JICA Study Team, although it is known that Long Khanh area is being developed to be class III city in the future, the center of Long Khanh is far from the HSR alignment (around 10km). The alignment will be 7km longer if passing through the center of Long Khanh which will cost more for the whole project (about 11.5 million USD will cost per km only for civil structures construction, not yet considering the cost for the station area). Same with Tan Nghia in Binh Thuan province, the location along the HSR alignment near Long Khanh next to the NH56 is also a potential location for HSR Station in the future.

4.45 In conclusion, as basic concept no. (iv) of JICA Study Team, it is suggested that the new station should be added and developed when the demand and potential for integrated development are assured. The province's suggestion about station location of Long Khanh has been considered and the alignment is designed so that the station can be located in the future.

(3) Binh Thuan Province

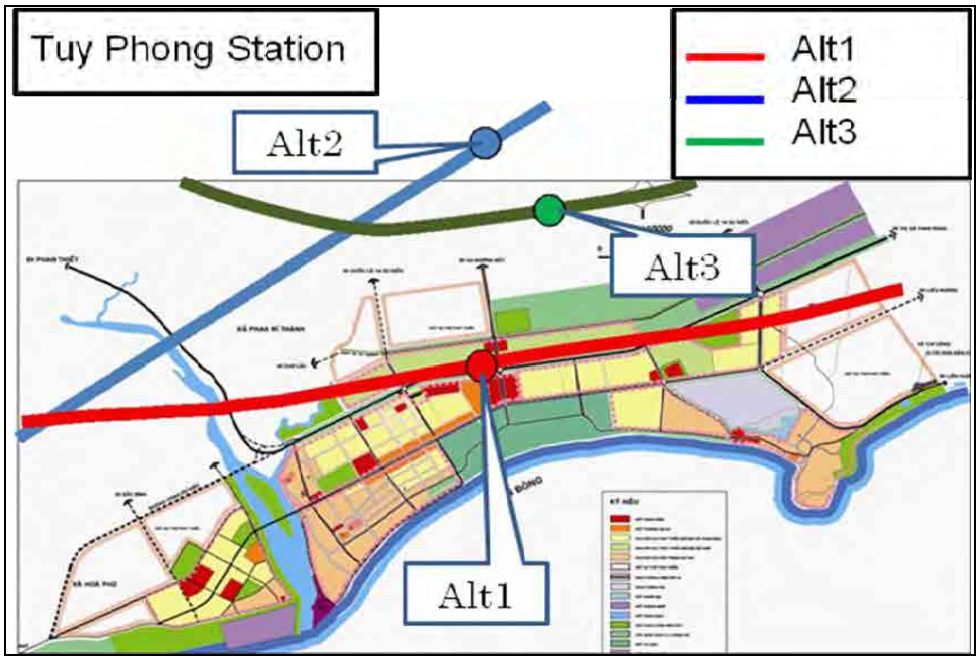
4.46 In Binh Thuan province, there are 2 areas to be considered as HSR Station known as Phan Thiet and Tuy Phong. Phan Thiet is the capital city of Binh Thuan province where the HSR alignment goes through, therefore as basic concept no. (i), Phan Thiet is chosen as HSR Station Location. For Tuy Phong, the distance from Phan Thiet to Thap Cham is about 130km and among the towns along the HSR alignment, Tuy Phong is located in the middle of the 2 cities (67km to Phan Thiet and 63km to Thap Cham). Moreover, Tuy Phong and Phan Ri Cua area is important development area of Binh Thuan province. In the master plan of province, this area is ranked as class III city and will become the main city in the east of Binh Thuan province in the future. Following the basic concept no. (ii), Tuy Phong has been suggested as one of HSR stations.

4.47 Hình 4.3.8 and Figure 4.3.9 show the alternative locations for Phan Thiet Station and Tuy Phong Station, respectively.



Source: JICA Study Team based on the master plan of Binh Thuan province

Figure 4.3.8 Alternative Locations of Phan Thiet Station



Source: JICA Study Team based on the master plan of Binh Thuan province

Figure 4.3.9 Alternative Locations of Tuy Phong Station

4.48 For Phan Thiet Station, there are 2 alternative locations of which one is at the same location with new station of existing railway (Alt1, Alt2) and one is in the rural area of the city (Alt3). The location of HSR Station is suggested at new Phan Thiet Existing Station (Alt1) for the following reasons:

- As explained in the basic concept for station location selection, considering passengers' convenience, the access to the existing line is the most important factor for HSR. In the future, the existing line can be used as a feeder line so that passengers from the nearby area can access to HSR using the existing line, or go further with local train after getting down from HSR.
- In Binh Thuan province, new Phan Thiet existing Station was already constructed and well connected to NH1 and about 3km near to the city center. The surrounding area of this new station is not populated area and therefore the issue of land acquisition is not considerable.

4.49 Regarding Phan Thiet HSR Station location, in Stakeholder meetings held with city/provinces along the alignment, there was an idea by Binh Thuan province suggesting that station location of Alt1 should be shifted to the west of the city near the planned road of 49m wide. However, it is found that shifting HSR alignment to the west will affect the new large industrial zone under construction along NH1A and Province Road 707 (shown as purple color area in Figure 4.3.9). JICA Study Team has also considered one station location as Alt3 which is suggested in the west side of the city and also does not affect this industrial zone, but it is around 10km far from the city center that will cause the inconvenience for the passengers in the future.

4.50 For Tuy Phong Station, there are 3 alternative locations; Alt2 and Alt3 are set in the rural area of the town without any road access while Alt1 is set along the NH1A near the Tuy Phong town center.

4.51 In case of Tuy Phong, the existing line is running far from the town center, therefore JICA Study Team has considered the connecting with National Road in order to provide passengers more convenient access to HSR Station.

4.52 In the meetings with Binh Thuan province, there was a request to create a new station near Tan Nghia area. This area is located in the middle of Long Thanh ~ Phan Thiet, however center of Tan Nghia is far from the alignment (around 6km) and at the moment, the scale of this area is smaller compared to the other cities. As same as Long Khanh area in Dong Nai province, based on the basic concept no. (iv), it is suggested that the new station should be added and developed when the demand and potential for integrated development are assured. JICA Study Team has considered the province's suggestion about station location of Tan Nghia and designed the alignment so that the station can be located in the future.

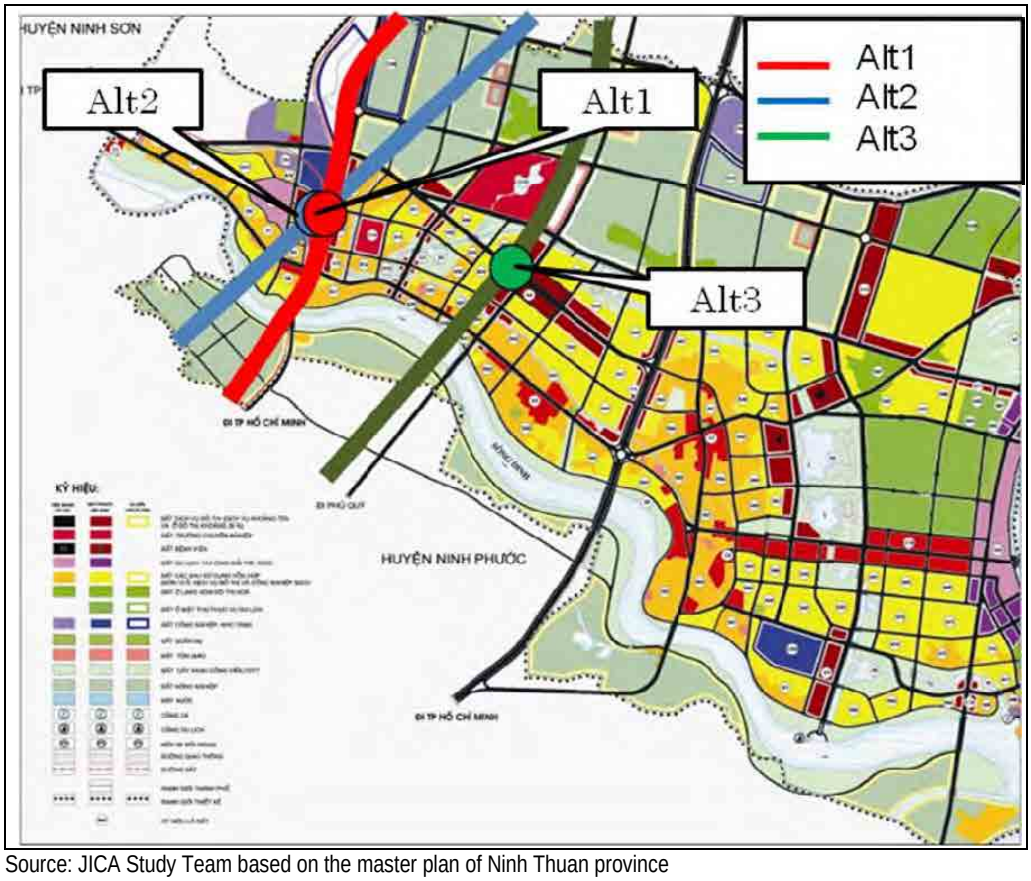
(4) Ninh Thuan Province (Thap Cham Station)

4.53 In Ninh Thuan province, Thap Cham (Phan Rang-Thap Cham) is the capital city where the HSR alignment goes through, therefore as same as Phan Thiet in Binh Thuan, Thap Cham is chosen as HSR Station Location based on the basic concept no. (i).

4.54 For Thap Cham Station, there are 2 alternative locations: one located at existing railway Thap Cham Station (Alt1, Alt2) and one located in the planned residential area (Alt3).

4.55 As same as Phan Thiet station, JICA Study Team has suggested the location of HSR Station at Thap Cham Existing Station (Alt1) for the following reasons:

- As explained in the basic concept for station location selection, considering passengers' convenience, the access to the existing line is the most important factor for HSR. In the future, the existing line can be used as a feeder line so that passengers from the nearby area can access to HSR using the existing line, or go further with local train after getting down from HSR.
- Thap Cham existing station is found with large yard plan therefore there is enough land for HSR station yard. Moreover, as existing Thap Cham Station located near the business center of the city and Cham heritage, constructing the HSR Station at the same location can induce the area to be further developed in the future.



Source: JICA Study Team based on the master plan of Ninh Thuan province

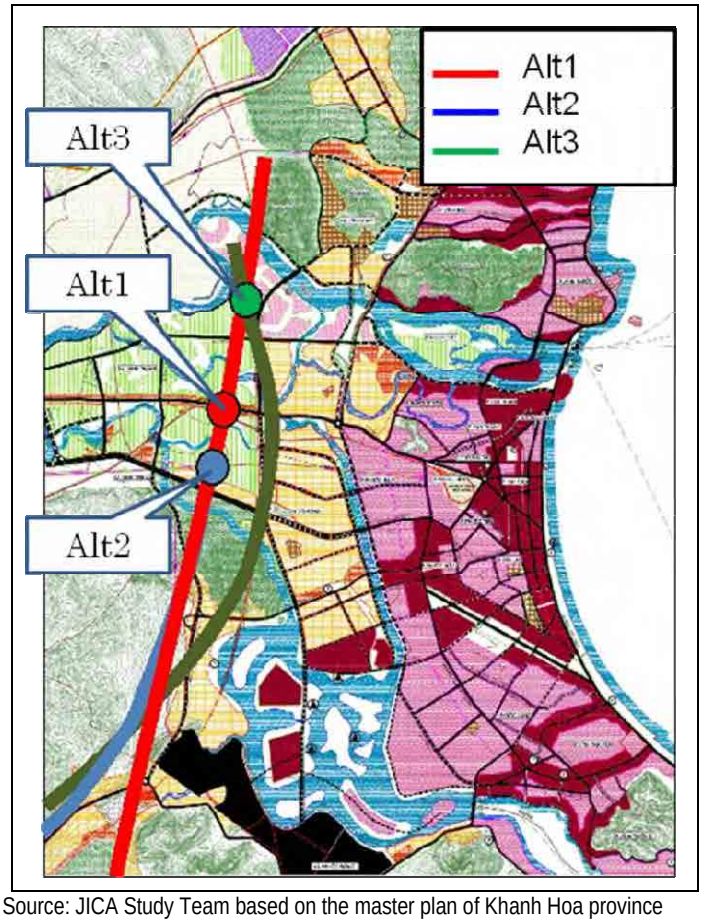
Figure 4.3.10 Alternative Locations of Thap Cham Station

(5) Khanh Hoa Province (Nha Trang Station)

4.56 Being terminal station in HCMC – Nha Trang section, Nha Trang HSR Station plays a very important role to connect with the existing line in order to provide the continuous travel for passengers. Passengers from HCMC, Phan Thiet, Thap Cham etc can go further to the North using the existing line after transferring at Nha Trang Station and vice versa. On purpose to ensure the convenience of passengers and the operation of the whole railway system in the future, Nha Trang Station location should be planned carefully considering the existing railway condition.

4.57 There are 3 alternative locations for HSR Station of which Alt2 is near the planned road to Lam Dong and Alt3 is located in rural area without any road or railway connecting. As same as the case of Phan Thiet and Thap Cham, JICA Study Team emphasized the importance of the existing railway connecting and selected the Alt1 at the crossing point with existing line near to National Highway 1C (23 thang 10 Avenue). All the alternative locations for Nha Trang are shown in Figure 4.3.11.

4.58 The existing Nha Trang station is known as a bottle neck for the operation of existing line, moreover it is located in the densely populated area. Therefore it is difficult for HSR alignment to access the existing station location without affecting the social environment of Nha Trang City. The new station for existing line is suggested at the same location with HSR (Alt1), so that the transfer between HSR and existing line will be more convenient.



Source: JICA Study Team based on the master plan of Khanh Hoa province

Figure 4.3.11 Alternative Locations of Nha Trang Station

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

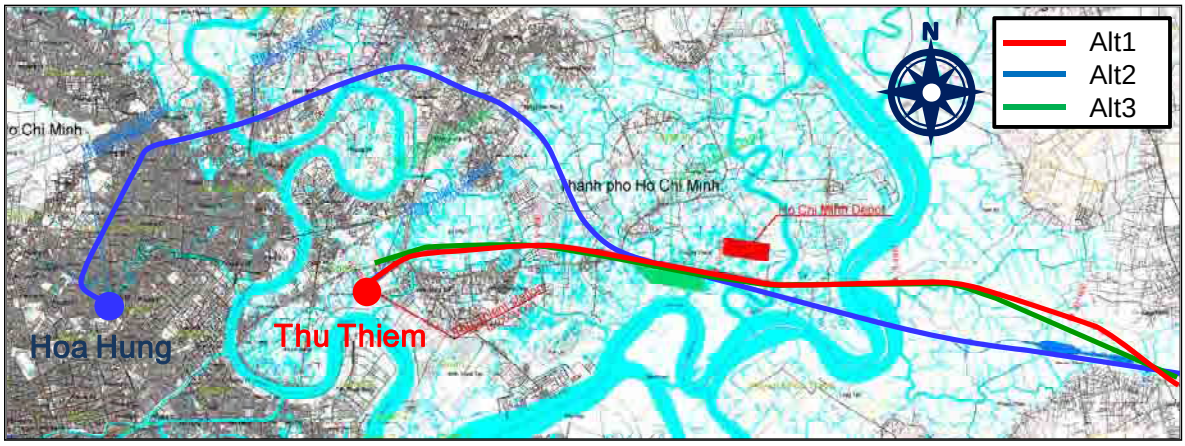
4.59 In order to select the alternative routes for HSR, JICA Study Team has reviewed the previous study (KOICA in 2007 and Pre-FS in 2009), collected the latest plan and data, then designed 2 alternative routes for the site survey. After carrying out the geological investigation and meetings with city/provinces along the alignment, JICA Study Team concluded one route as Alternative 1. Further, in order to find the optimal alignment for the HSR, JICA Study Team has carried out SEA considering 2 more alternative routes (Alternative 2 as Pre-FS Route and Alternative 3 as KOICA Route)

4.60 JICA Study Team held the Stakeholder Meetings in all the city/provinces along the alignment and explained the evaluation for the 3 Alternatives. When comparing these 3 Alternatives, the important point for alignment planning is that considering HSR as a holistic system. That is to say, the integration of optimal alignment in each section will not become the optimal alignment as a whole. Therefore, the appropriateness was judged by section (Hanoi – Vinh in North, HCMC – Nha Trang in South). Speediness shall also be ensured with a minimum curve radius of 6000m. As Station locations affect the alignment greatly, all locations were carefully considered and compared as described in 4.3 2).

4.61 The Alternative Routes (Alt-1 as JICA Study Team, Alt-2 as Pre-FS, Alt-3 as KOICA) in each city/provinces are detail explained as follow.

(1) Ho Chi Minh City

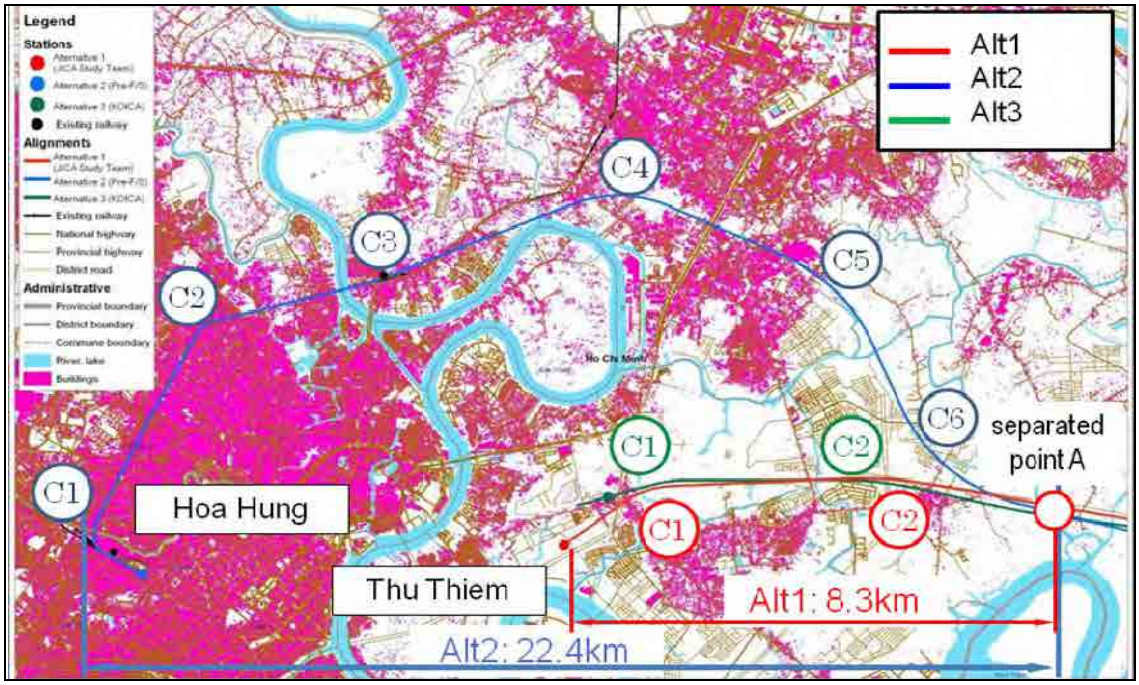
4.62 In Ho Chi Minh City, all the alternative routes are planned parallel with the Long Thanh – Dau Giay express highway which is already under construction. The whole section in HCMC is shown in the following figure.



Source: JICA Study Team

Figure 4.3.12 Alternative Routes in HCMC

4.63 The main point for comparison of these 3 alternatives is the access to Thu Thiem or Hoa Hung which will cause the differences in alignment. As shown in the following figure, compared to Alt1 and 3, as running parallel with existing railway Alt 2 needs more curves with radius less than 6000m to access to Hoa Hung area. Figure 4.3.13 and Table 4.3.6 show the list of curves with radius ≤ 6000m for each alternative from the terminal station (Thu Thiem or Hoa Hung) to the separated point A.



Source: JICA Study Team

Figure 4.3.13 Alternative Routes to Hoa Hung and Thu Thiem Stations

Table 4.3.6 Curves with Radius ≤ 6000m near the Terminal Station in HCMC

Alternative 1		Alternative 2		Alternative 3	
↓Terminal (Thu Thiem)		↓Terminal (Hoa Hung)		↓Terminal (Thu Thiem)	
↓ Curve 1	R=1500 m	↓ Curve 1	R=300 m	↓ Curve 1	R=2000m
↓ Curve 2	R=6000 m	↓ Curve 2	R=450 m	↓ Curve 2	R=5000m
-	-	↓ Curve 3	R=6,000 m	-	-
-	-	↓ Curve 4	R=2,000 m	-	-
-	-	↓ Curve 5	R=3,000 m	-	-
-	-	↓ Curve 6	R=3,000 m	-	-
↓Separated Point A		↓Separated Point A		↓Separated Point A	

Source: JICA Study Team

4.64 The curve with radius ≤ 6000m in Alt1 and Alt3 is the one at the start of Thu Thiem station so the effect to the speediness of HSR can be neglected. However the continuation of small radius curves in Alt 2 will affect directly the acceleration of HSR.

4.65 Moreover as described in the comparison of station locations in HCMC, the alignment of Alt2 to Hoa Hung station will require huge resettlement, causing more environment issues as running through the highly populated districts and especially cost more in construction.

4.66 For the Alt3, because this alignment is based on maps with scale of 1:50000, there is a small gaps in Station location and alignment with Alt1 which is based on 1:10000 maps.

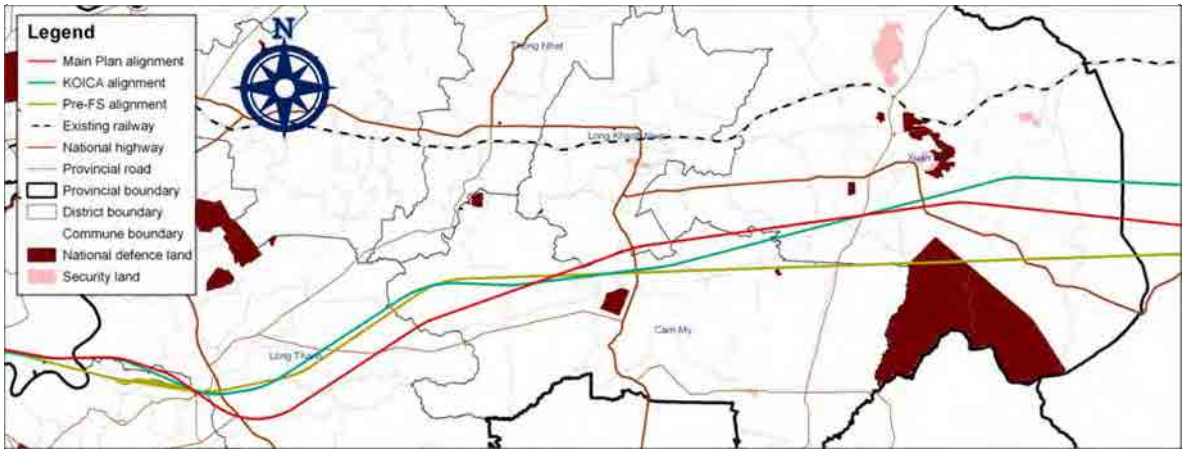
4.67 As the above reasons, the route of Alt1 is suggested for HCMC Section.

(2) Dong Nai Province

4.68 Figure 4.3.14 shows the 3 alternative routes in Dong Nai province. In Long Thanh International Airport (LTIA), Alt 2 and 3 is running parallel with Long Thanh Dau Giay express highway and the station location is on the outskirt of LTIA while Alt 1 is running through the center of the airport. In the east side of LTIA, compared to Alt 2, Alt 1 and 3 is running to the northern to avoid the military area (the dark red area) as shown in Figure 4.3.15.

Source: JICA Study Team

Figure 4.3.14 Alternative Routes in Dong Nai Province



Source: JICA Study Team based on the Planning Land use 2010 (DONRE)

Figure 4.3.15 Alternative Routes and Military Areas in Dong Nai Province

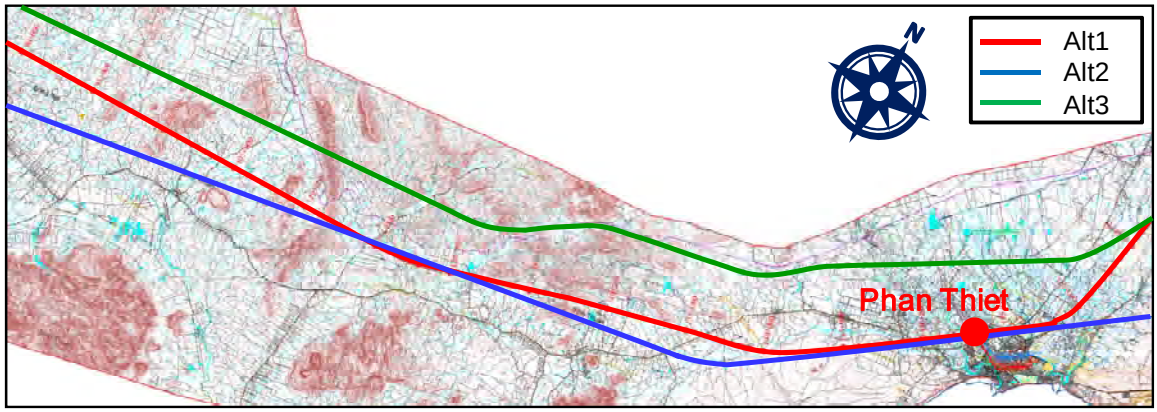
4.69 For the part of alignment around LTIA, Alt 2 and 3 run closer to the residential area while Alt 1 is considered appropriate as passengers arriving at the airport could access the HSR conveniently and vice versa. As described in Station Location comparison, it is estimated that in 2030 around 40,000 passengers a day will use railway to and from the airport, comparing with the 13,000 passengers a day to and from the neighboring town area. Therefore the sub-sections of HCMC – Long Thanh should be developed first as this would support the airport demand and activities. Alternative 1 is considered appropriate as it crosses through the center of the airport. The following issues should be taken care in the detail design state:

(i) Crossing point of HSR with the new and old National Highway 51 and

(ii) Crossing point of HSR with the planned freight railway from Ba Ria to Bien Hoa

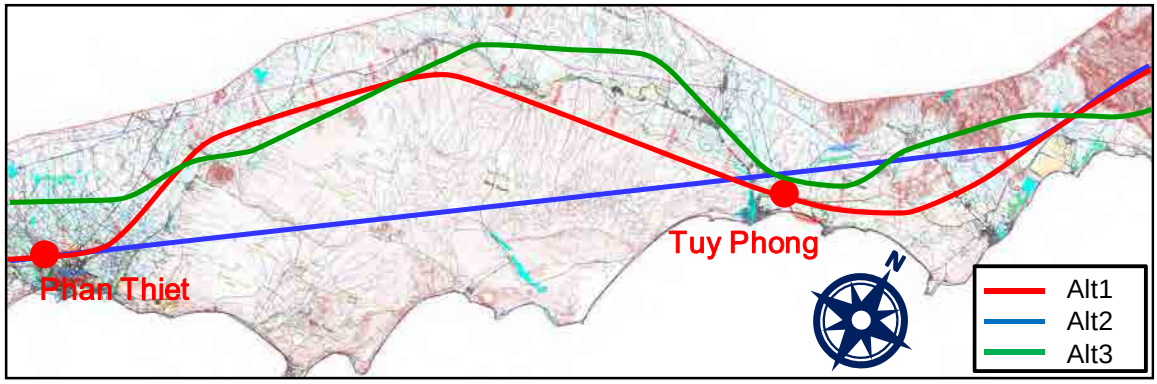
(3) Binh Thuan Province

4.70 In Binh Thuan province, Figure 4.3.16 and Figure 4.3.17 show three alternative routes for 2 Station locations of Phan Thiet and Tuy Phong.



Source: JICA Study Team

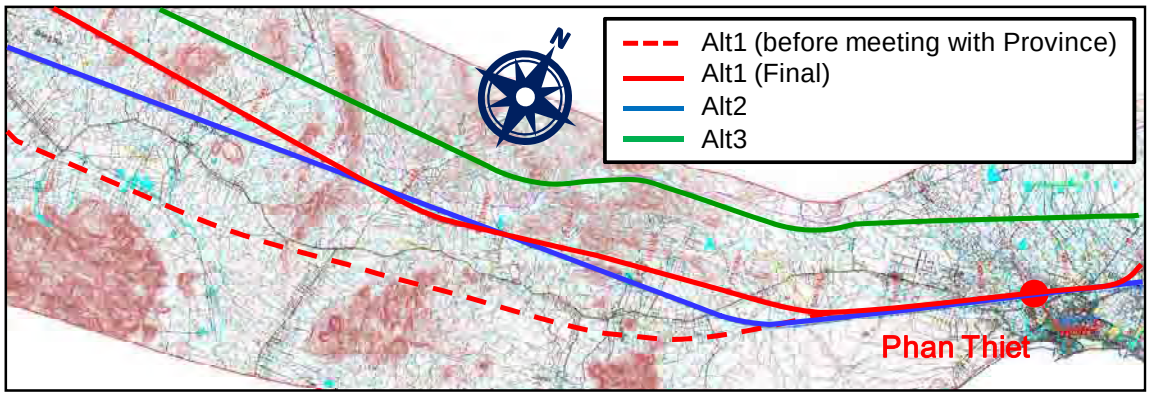
Figure 4.3.16 Alternative Routes in Binh Thuan Province (1/2)



Source: JICA Study Team

Figure 4.3.17 Alternative Routes in Binh Thuan Province (2/2)

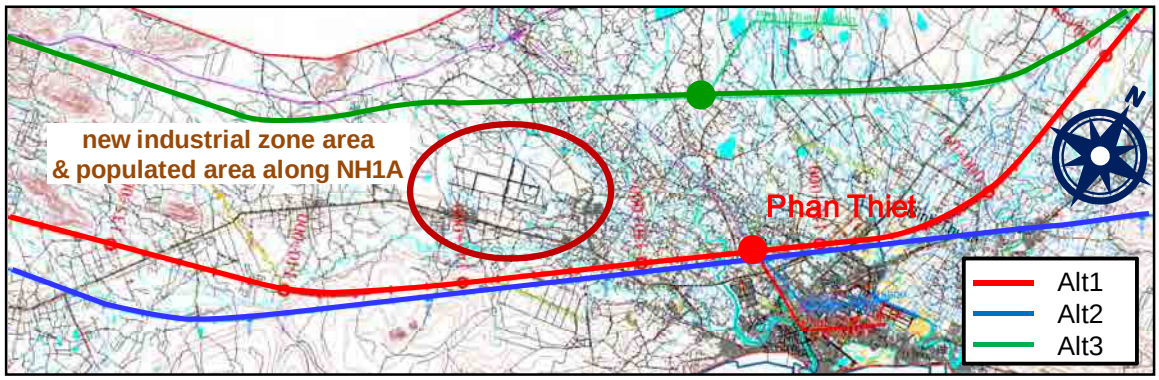
4.71 For the alignment beyond Phan Thiet, once JICA Study Team has considered one alternative route running on the east of the National Highway 1A as shown in the following figure and carrying out the meeting with Binh Thuan province. As the confirmation of province, there are plans to develop the town in the east of the NH 1A and also all the populated area is in the east of the NH 1A. Therefore JICA Study Team has modified the alignment to the western of the NH1A and considered this route as the final alternative 1.



Source: JICA Study Team

Figure 4.3.18 Initial and Final Alignment of Alternative 1 beyond Phan Thiet

4.72 In the meetings with Binh Thuan Province, there was a suggestion to move the station location to the west of the city near the 48m wide planned road. However, as explained in the station location comparison, Binh Thuan Province has a plan to develop a new industrial zone along NH1A and Province Road 707 as shown in the following figure. The surrounding area is the highly populated area while the industrial zone is already under construction. Shifting alignment to the west will affect not only the plan of the new industrial zone but also the residences along NH1A. For the selected route Alt1, JICA Study Team has planned the route with viaduct structures to minimize the social environment impacts.



Source: JICA Study Team

Figure 4.3.19 Alignment for Phan Thiet Station Location

4.73 Regarding the section between Phan Thiet and Tuy Phong, as shown in Table 4.3.7, the main point is the alignment to go straight through the sand area or the detour one near to National Highway 1A. In meeting with Binh Thuan province on 8th June 2012, many discussions have been done about the straight route from Phan Thiet to Tuy Phong, and there was a strong request from the province to seek for the possibility to construct the straight route.

4.74 For this issue, it is noted that both of the existing studies, namely KOICA study and Pre-FS study concluded the best alignment is the detour route avoiding sandy area (see Table 4.3.7). Since Pre-FS had also studied the possibility of straight alignment once (and denied it in the end), JICA Study Team has regarded the straight alignment as Alt 2 for further study and comparison.

Table 4.3.7 Comparison of HSR Alignment between Phan Thiet and Tuy Phong

Study of	Conclusion for HSR Alignment between Phan Thiet and Tuy Phong
KOICA (2007)	Detour Route to avoid sand area (crossing Existing Line twice)
Pre-FS (2009)	Giving 2 alternatives, but concluding that the most appropriate route is the Detour Route to avoid sand area (crossing Existing Line twice)
JICA Study Team	Reviewing previous studies, carrying out the geological investigation in the sand area and determining the Detour Route to avoid sand area (no crossing with Existing Line).

Source: JICA Study Team

4.75 Through the SEA process, JICA Study Team studied the geology map, conducted field survey and boring survey, then concluded that the risk of instability of the sand is not appropriate for the HSR development since it requires high standard of safety. Movement of sand dune will be unavoidable which risks the foundation of the structures.

4.76 Firstly, in the Geology and Mineral Resources (Department of Geology and Minerals of Vietnam), it is reported that:

(i) vQ sand area as light yellow area in Figure 4.3.20is formed by the wind and continues to change.

(ii) Many sand dunes move each year causing traffic jam, burying many field and garden.

Undifferentiated Quaternary
Eolian deposits (vQ)

On the surface of the red sand plateau in northeast of the Phan Thiết Town, there exist hills and hillocks >100 m high dissected by ditches 10 - 20 m deep. These topographic forms have been formed by the wind. The wind has been changing the old topographic face, and forming the present relief, which continues to change. Many sand dunes move, that can be observed each year, in some places causing the traffic jam (for example - the road to Né Cape), burying field and garden (in Bình Nhơn area). Some incelbergs have been buried by the sand, and forming sand summits about 200 m high.

Source: Geology and Mineral Resources (Department of Geology and Minerals of Vietnam)

Figure 4.3.20 Description about vQ Sand Area

4.77 Secondly, in the site survey of the sand areas are found with sand dunes easily blown up by the wind. Also in some locations, it is confirmed that the sand area is easily collapsed by the rain.

	Field buried by sand
	Sand hills
	Near Bau Trang lake with many sand dunes
	White sand area between Bau Trang lake and Phan Ri Cua

Source: JICA Study Team

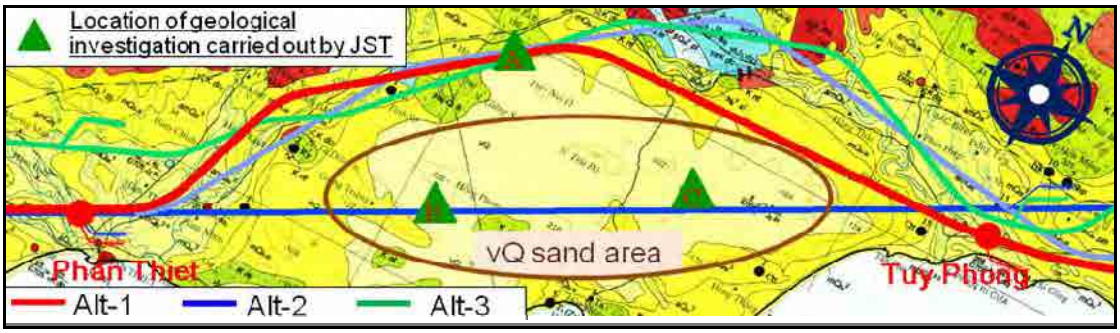
Figure 4.3.21 Site Survey in the Sand Area

4.78 Thirdly, as result of geological investigation which was carried out by JICA Study Team in this area shown in Figure 4.3.22 and Table 4.3.8 compared to location A, location B, C are found easy to collapse due to:

(i) Top layer (0~6m) is loose

(ii) Average void ratio e is larger

(iii) Average shear strength is smaller



Source: JICA Study Team

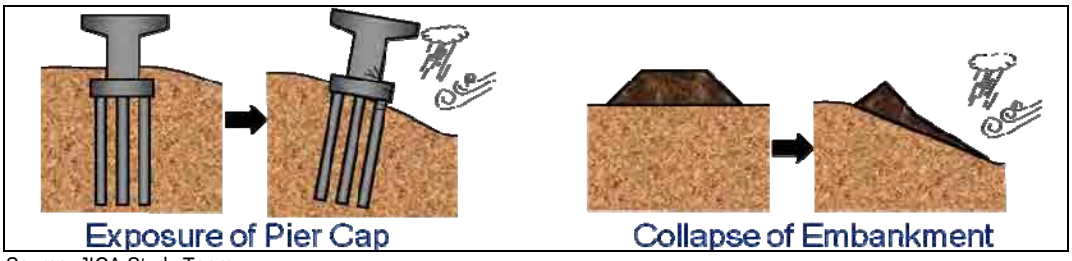
Figure 4.3.22 Location of Geological Investigations in vQ Sand Area

Table 4.3.8 Comparison of Geological Investigation Results

	Location of geological investigation		
	A	B	C
Top layer (0~6m)	dense	loose	loose
Average void ratio e	0.569	0.631	0.603
Average shear strength (kg/cm^2)	0.672	0.620	0.624

Source: JICA Study Team

4.79 For all the above reasons, the sandy area is found inappropriate for HSR alignment due to the difficulties of construction and maintenance, with high risk of land degradation and change of topography as shown in Figure 4.3.23. Since safety of the HSR is very important, JICA Study Team has tried to keep the alignment running out of the vQ sand area as much as possible. The route going straight through the vQ sand area is not suggested.



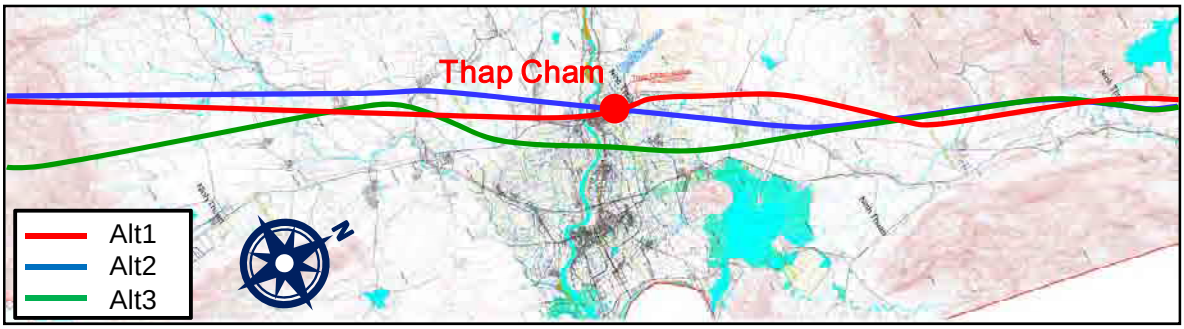
Source: JICA Study Team

Figure 4.3.23 Risk of Land Degradation and Changes in Topography

4.80 In the SHM with Binh Thuan province, there was a request to reduce the crossing points with National Highway 1A. For the selected station locations, JICA Study Team has proposed the alignment in Binh Thuan province minimizing the crossing points of the National Highway No.1. However due to the concepts of the station location and the geological condition of sand area, the alignment has to cross the National Highway at some locations. The crossing points are not the level crossings and are designed with elevated track considering the clearance for roads.

(4) Ninh Thuan Province

4.81 The following figure shows the 3 alternative routes in Ninh Thuan province with the station location in Thap Cham.



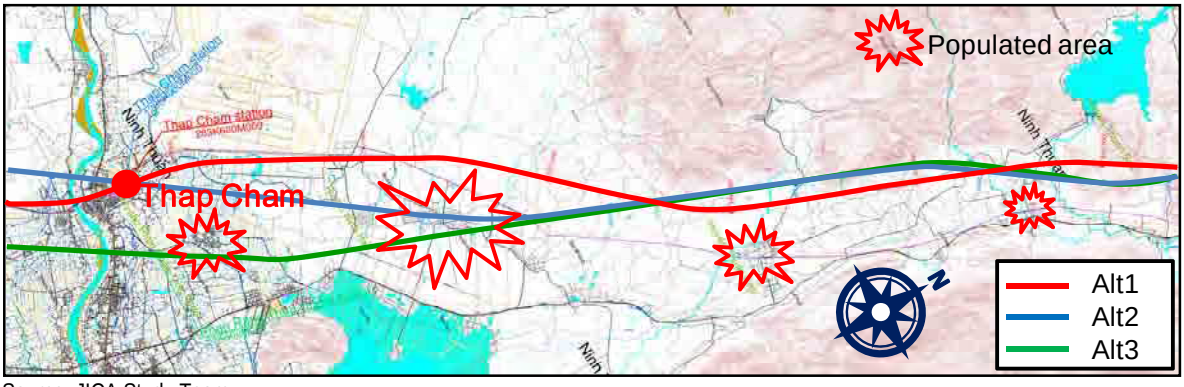
Source: JICA Study Team

Figure 4.3.24 Alternative Routes in Ninh Thuan Province

4.82 The differences for these 3 alternative routes are that Station location of Alt1 and Alt2 is set in the existing Thap Cham Station while one of Alt3 is set in the planned resident area. Around existing Thap Cham station area, Alt1 is planned almost parallel with existing line in order to achieve the minimum of land acquisition issue. Moreover in order to minimize the impact to social environment, Alt 1 has been designed to avoid as much as possible the densely populated area as shown in the following figures.

(a) from Ca Na to Thap Cham

(b) from Thap Cham to Cam Thinh Dong

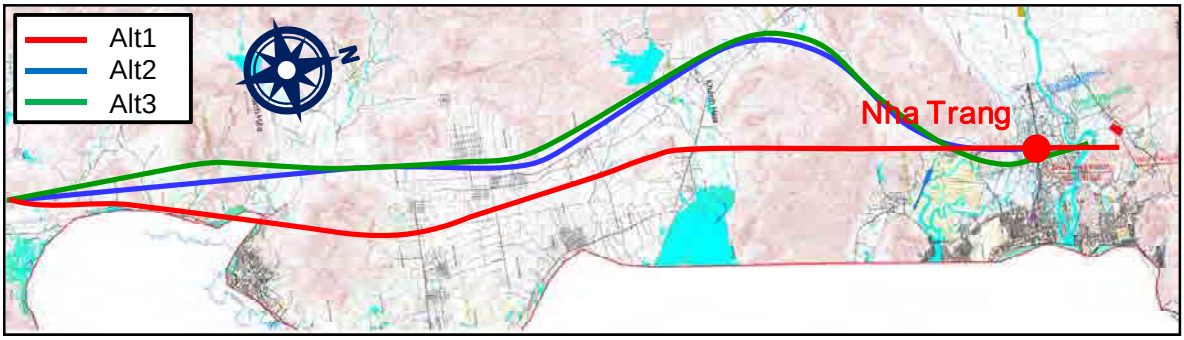


Source: JICA Study Team

Figure 4.3.25 Alternative Routes and Populated Areas in Ninh Thuan Province

(5) Khanh Hoa Province

4.83 In Khanh Hoa province, the following figures show the 3 alternative routes of which Alt 1 is planning using the tunnel to access to Nha Trang city while Alt 2 and 3 is planned with the detour route almost parallel with the Nation Highway 1A.

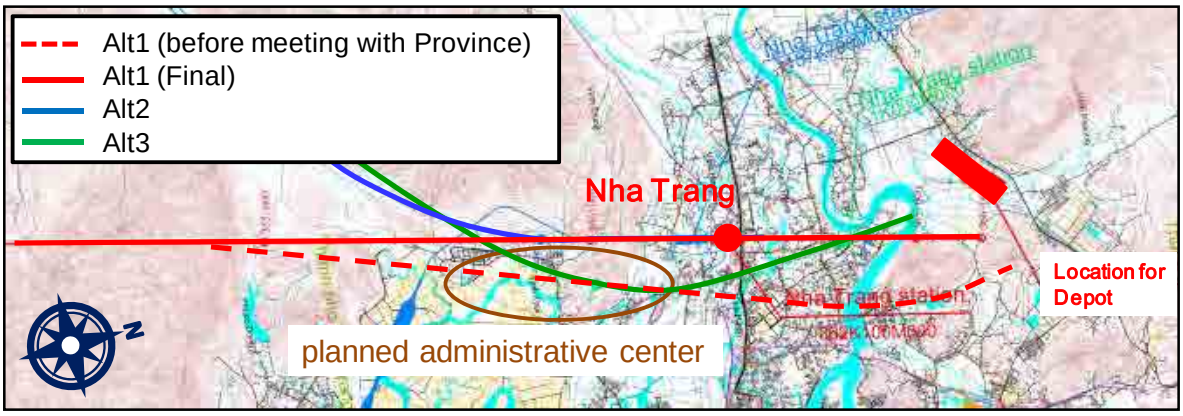


Source: JICA Study Team

Figure 4.3.26 Alternative Routes in Khanh Hoa Province

4.84 On 31st May 2012, a meeting to discuss the alignment and station location was held with a number of 10 participants represented by both the Chairman and Vice Chairman of Khanh Hoa Province People's Committee (PPC) and JICA Study Team. In this meeting, it was pointed that the route JICA Study Team planned goes through the planned administrative center (Vinh Thai) of the province which is already proposed to Prime Minister (Figure 4.3.27). Khanh Hoa PPC has agreed with JICA Study Team about Nha Trang Station location, with the condition that the HSR Station will be located at the crossing point with existing railway near to the National Highway 1C (23 thang 10 Avenue) after re-alignment to avoid the planned administrative center in Vinh Thai.

4.85 JICA Study Team took note of these comments, modified the alignment to run outside the planned administrative center and considered the modified alignment as the final Alt1. The station location for Nha Trang is set at the crossing point with existing line as explained in the station location selection.



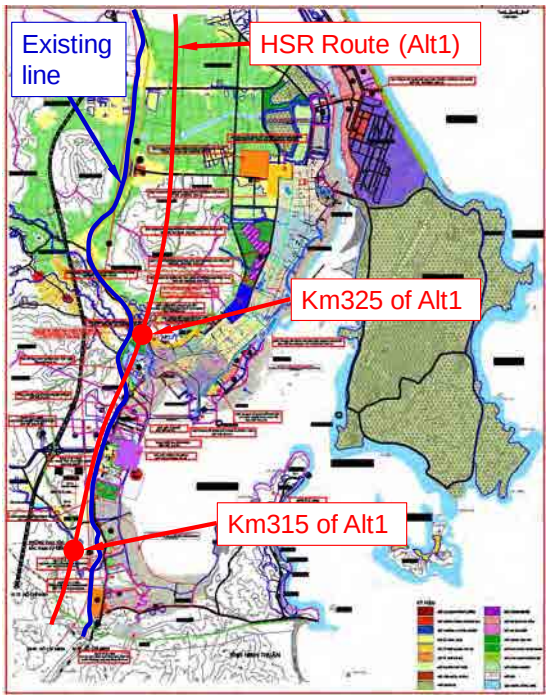
Source: JICA Study Team

Figure 4.3.27 Initial and Final Alignment of Alternative 1 in Nha Trang

4.86 In the comment letter No 5085/UBND-KT of Khanh Hoa Province sent to JICA Study Team on 12th September 2012, there was a request to further study the connection the section from Km345 in Alt1 with the section from Km1215 in Alt2 route (Fre-FS alignment). The reason is written that the combination alignment will minimize the impacts on the planned areas in Cam Ranh City (from Km315 to Km325 of Alt1).

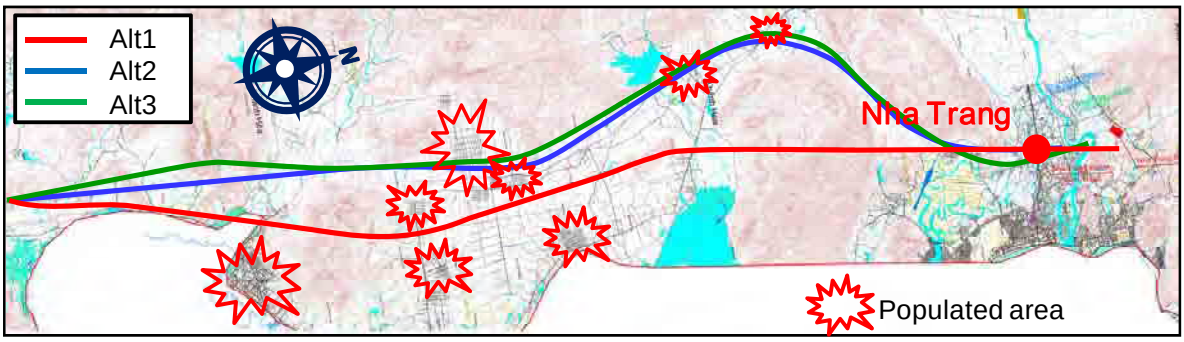
However as shown in the Figure 4.3.27 (based on the Cam Ranh land use plan received from Khanh Hoa Province on 31st May 2012), from Km315 to Km325 Alt1 is running almost parallel and on the western side of the existing line while all the land use plan of Cam Ranh City is on the east side of the existing line and along the seaside. From Km325 to the north of Cam Ranh City is the land for plantation shown as green color in Figure 4.3.28 and there is no effect for the city master plan caused by HSR.

4.87 Moreover, as shown in the Figure 4.3.29, the HSR route of Alt1 through Cam Ranh area is determined to keep out of populated resident area and to be as straight as possible. The social impact of Alt1 is less than Alt2 (Pre-FS route) and Alt3 (KOICA route) as these routes are running along the NH1A that cause much more impact for the residence. The route length in Khanh Hoa Province of Alt2 & Alt3 is around 3km longer than Alt1, which means more construction cost are needed and this may affect the feasibility and the start of the project. For all the above reasons, Alt 1 is suggested for Khanh Hoa province.



Source: JICA Study Team based on Cam Ranh Land Use Plan of Khanh Hoa Province

Figure 4.3.28 HSR Route and Cam Ranh Land Use Map



Source: JICA Study Team

Figure 4.3.29 Alternative Routes and Populated Areas in Khanh Hoa Province

4.4 Description of Alignments of Selected Routes

1) Selected Route by Province/City

4.88 As described in 4.3, there are 3 alternative routes for HSR alignment. JICA Study Team has carried out SEA to assess and compare these 3 alternatives then give out the conclusion for the optimal alignment as Alternative 1. Further assessment method and detail results should be referred to SEA report. Herein, the detail information for the optimal alignment is explained.

4.89 The total length for south section is around 366km started from Thu Thiem area to Nha Trang Depot running through 5 city/provinces. There are 6 stations planned along the alignment named as Thu Thiem (HCMC), Long Thanh, Phan Thiet, Tuy Phong, Thap Cham and Nha Trang. Table 4.4.1 shows the length of the route for each city/province along the alignment in South Section while the lengths of each station and station interval are described in Table 4.4.2.

Table 4.4.1 Route Length by Province/City

City/Province	Kilo Post		Length (km)
	from	to	
HCMC	-0.250[1)]	14.000	14.250
Dong Nai	14.000	94.250	80.250
Binh Thuan	94.250	254.220	159.970
Ninh Thuan	254.220	312.380	58.160
Khanh Hoa [2)]	312.380	366.000	53.620
Total			366.250

1) 0 km is start at the center of Thu Thiem Station
2) The length in Khanh Hoa including the main line from Nha Trang Sta. to depot location
Source: JICA Study Team

Table 4.4.2 Length of Main Line at Stations and Station Intervals

Stations and Station Interval	Kilo Post		Length[1)] (km)
	from	to	
Thu Thiem Station	-0.250[2)]	0.545	0.795
Thu Thiem – Long Thanh (TT-LT)	0.545	35.640	35.095
Long Thanh Station	35.640	36.460	0.820
Long Thanh – Phan Thiet (LT-PT)	36.460	152.875	116.415
Phan Thiet Station	152.875	153.525	0.650
Phan Thiet – Tuy Phong (PT-TP)	153.525	219.950	66.425
Tuy Phong Station	219.950	220.950	1.000
Tuy Phong – Thap Cham (TP-TC)	220.950	283.275	62.325
Thap Cham Station	283.275	283.925	0.650
Thap Cham – Nha Trang (TC- NT)	283.925	361.690	77.765
Nha Trang Station	361.690	362.510	0.820
Nha Trang – Depot (NT- Depot)	362.510	366.000	3.490
Total			366.250

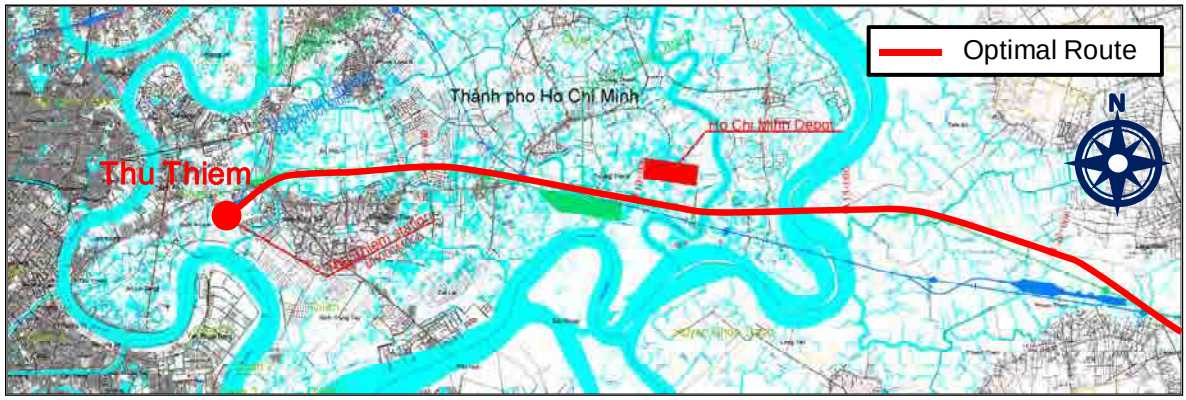
1) Station length is calculated from turnout to turnout which is different with the platform length.
2) 0 km is start at the center of Thu Thiem Station.
Source: JICA Study Team

4.90 The optimal alignment in each city/province is described as follows:

(1) Ho Chi Minh City

4.91 In Ho Chi Minh City, the optimal route is planned parallel with the Long Thanh – Dau Giay express highway which is already under construction. The terminal station is located in Thu Thiem area of District 2. The depot location is located in District 9. The detail description for the depot can be referred to Chapter 6.

4.92 The whole section in HCMC is shown in the following figures. The total length is 14.250km including the Dong Nai river bridge of 700m length.

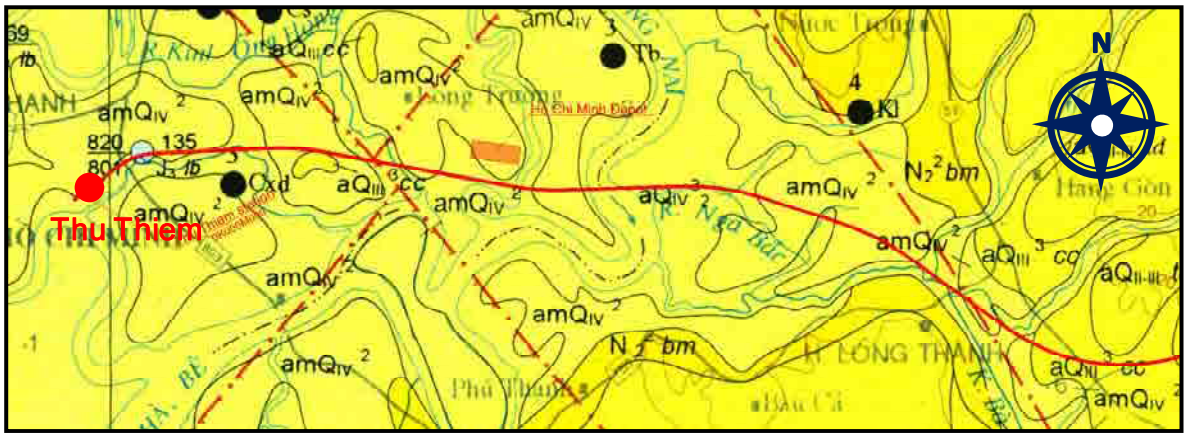


Source: JICA Study Team

Figure 4.4.1 Optimal Route in HCMC

4.93 As shown in the Figure 4.4.2, the main geology is amQIV, the fluvio marine. This area is known to be the soft ground area, therefore it should be carefully considered in the detail design stage.

4.94 For the bridge in Dong Nai River, the clearance for ship lane should be kept. The vertical clearance for HSR Bridge is designed considering the bridge under construction of Long Thanh – Dau Giay express highway.



Source: JICA Study Team

Figure 4.4.2 Optimal Route in and Geological Map of HCMC

(2) Dong Nai Province

4.95 The total length of alignment in Dong Nai province is 80.25km with one station at Long Thanh International Airport as shown in Figure 4.4.3. After Long Thanh station, the alignment runs through Cam My area, crossing with National Highway 51 near Long Khanh area. After crossing with National Highway 1A the alignment is planned to be parallel with the Dau Giay – Phan Thiet express highway.

Source: JICA Study Team

Figure 4.4.3 Optimal Route in Dong Nai Province

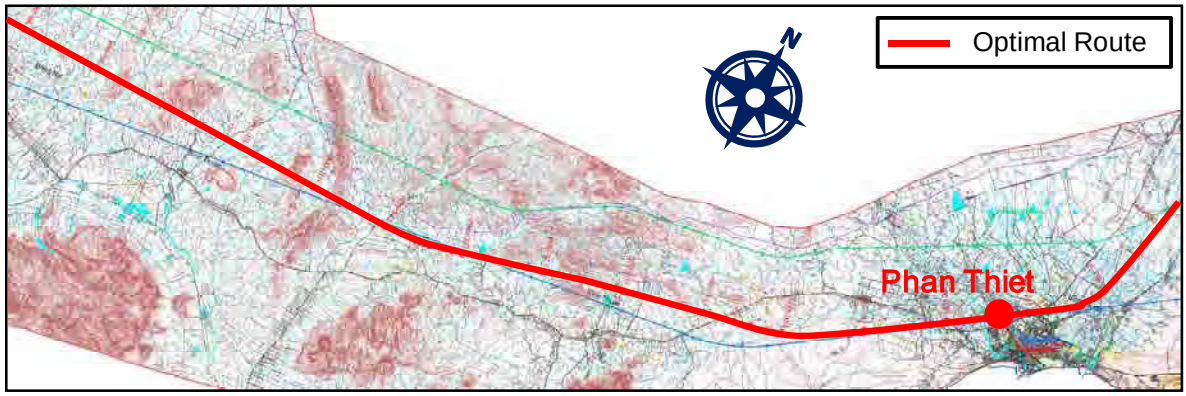
4.96 As shown in the following figure, the geology after LTIA is known as laterite and basalt of Xuan Luc Formation (βQIIxl). Usually the compaction ratio of this laterite shows high value and good for the earthwork. After crossing the National Highway 51 and the planned freight railway (Bien Hoa – Vung Tau), from the start of LTIA to the end of Dong Nai province, the main structure for HSR alignment is designed as embankment and cut.

Source: JICA Study Team

Figure 4.4.4 Optimal Route in and Geological Map of Dong Nai Province

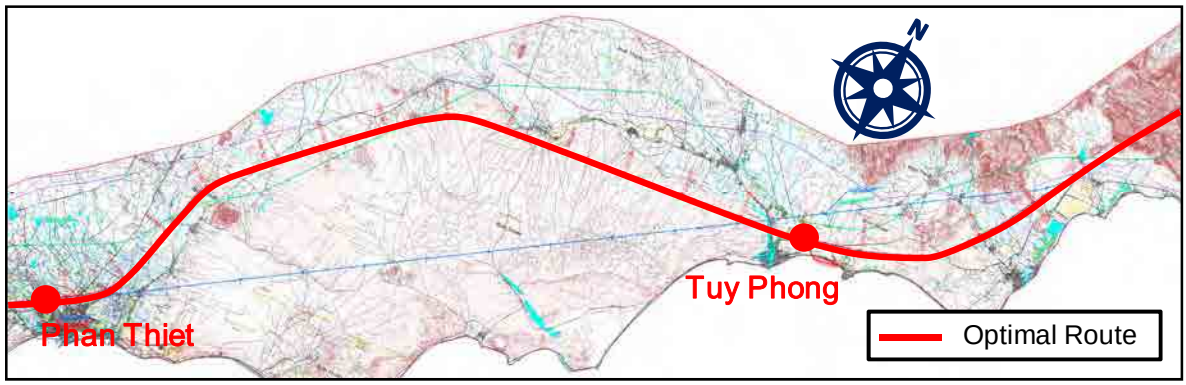
(3) Binh Thuan Province

4.97 In Binh Thuan province, Figure 4.4.5 and Figure 4.4.6 show the optimal route for HSR with 2 station locations of Phan Thiet and Tuy Phong. The total length in the province is 159.97km while the interval of Phan Thiet and Tuy Phong is 66.425 km.



Source: JICA Study Team

Figure 4.4.5 Optimal Route in Binh Thuan Province: Phan Thiet



Source: JICA Study Team

Figure 4.4.6 Optimal Route in Binh Thuan Province: Tuy Phong

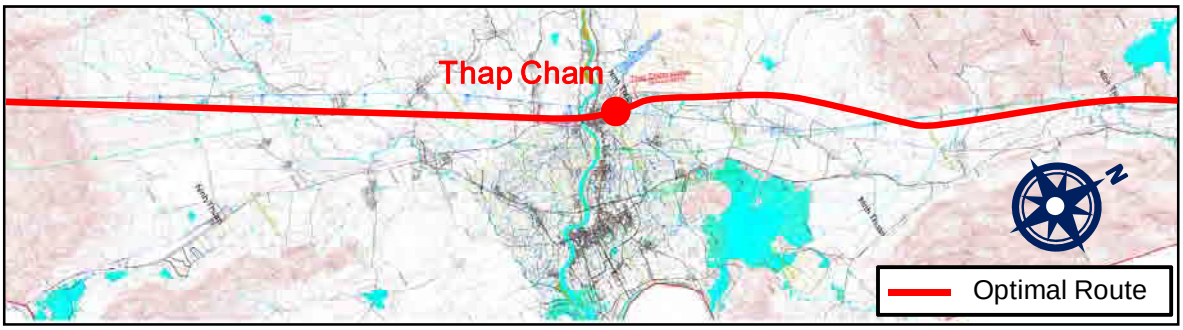
4.98 As shown in Figure 4.4.7, the caution for geology in Binh Thuan province is the sand area between Phan Thiet and Tuy Phong. This area shown as light yellow color in the following figure is known as vQ (Eolian deposits, undifferentiated quaternary). As described in 4.3, the optimal route is planned to avoid as much as possible this sand area to reduce the risk of collapse of embankment or pier cap exposure. The alignment in Binh Thuan province ends with the tunnel through Ca Na Mountain.

Source: JICA Study Team

Figure 4.4.7 Optimal Route in and Geological Map of Binh Thuan Province

(4) Ninh Thuan Province

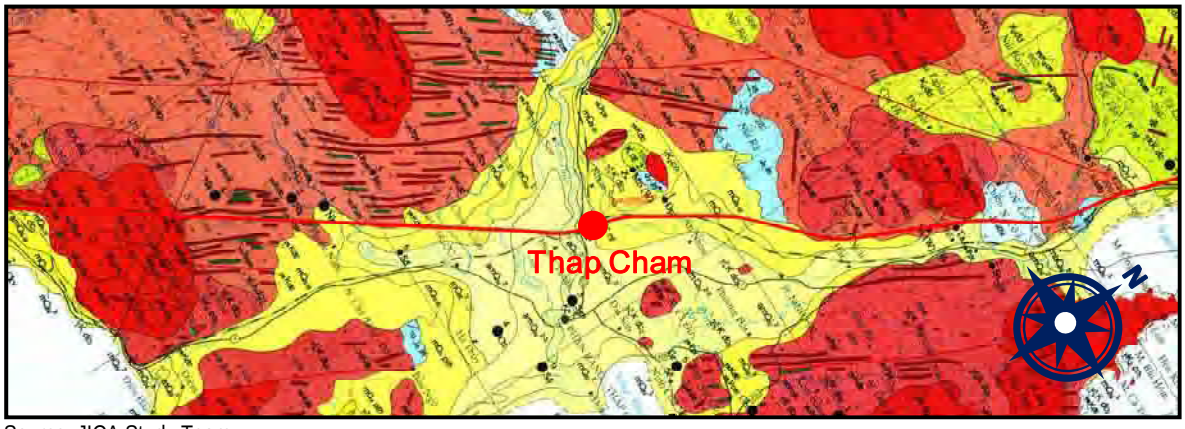
4.99 The optimal alignment in Ninh Thuan province is with one station location of Thap Cham and the total length is 58.16km. The distance from Thap Cham to Tuy Phong and Nha Trang is 62.325km and 77.765km respectively.



Source: JICA Study Team

Figure 4.4.8 Optimal Route in Ninh Thuan Province

4.100 The geology where the route is running through is shown in the following figure.

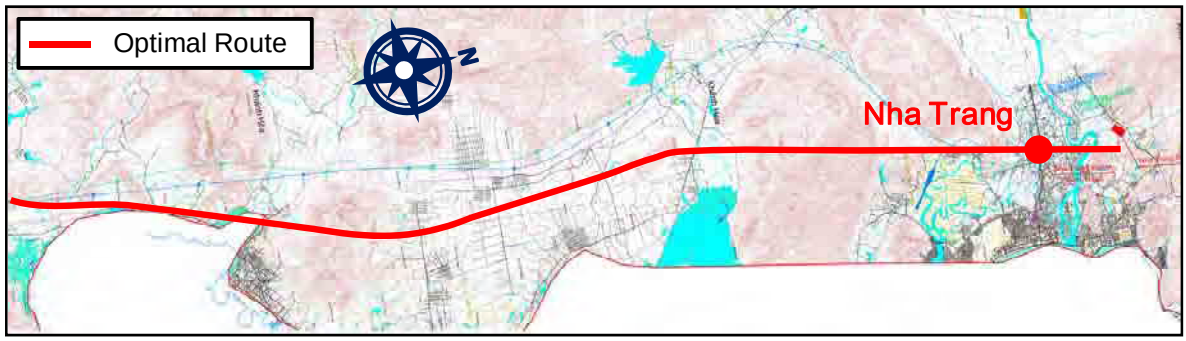


Source: JICA Study Team

Figure 4.4.9 Optimal Route in and Geological Map of Ninh Thuan Province

(5) Khanh Hoa Province

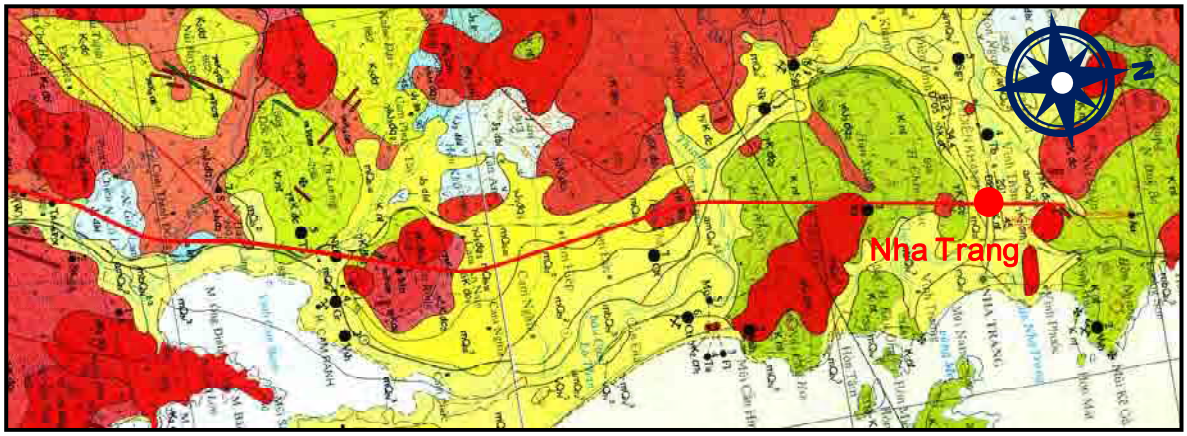
4.101 In Khanh Hoa province, the optimal alignment is running from Cam Thinh Dong on the eastern site of the National Highway 1A to Nha Trang city. Nha Trang HSR Station is planned at the crossing point with existing railway. After Nha Trang station, 3.49km of main line is designed in order that the HSR can access to depot location. The total length in Khanh Hoa province including Nha Trang station – depot part is 53.62km



Source: JICA Study Team

Figure 4.4.10 Optimal Route in Khanh Hoa Province

4.102 The geology and the optimal route in Khanh Hoa province is shown in the following figure.



Source: JICA Study Team

Figure 4.4.11 Optimal Route in and Geological Map of Khanh Hoa Province

2) Alignment Information of Selected Routes

(1) Horizontal Alignment

4.103 As described in 4.2 (1) Basic Concept of HSR Routes Determination, the horizontal alignment is designed with the minimum curve of 6000m radius and operation speed of 320 km/h (maximum design speed of 350 km) on each selected section.

4.104 The following table shows the detail information of the horizontal alignment in South Section.

Table 4.4.3 Horizontal Alignment of HSR South Section

No.	Type of Curve	Kilometerage			Curve Radius	Curve Length
		Begin of Curve	End of Curve	Center of Curve		
1	Curve R	001km246m	002km134m	001km690m	1500 m	889 m
2	Curve R	005km085m	006km424m	005km755m	6000 m	1338 m
3	Curve L	011km331m	012km603m	011km967m	6000 m	1272 m
4	Curve R	015km577m	017km641m	016km609m	6000 m	2064 m
5	Curve R	019km760m	021km605m	020km682m	6000 m	1845 m
6	Curve L	024km775m	030km872m	027km824m	5000 m	6096 m
7	Curve R	041km548m	042km999m	042km274m	6000 m	1451 m
8	Curve R	057km984m	059km231m	058km608m	6000 m	1247 m
9	Curve R	081km570m	083km074m	082km322m	6000 m	1504 m
10	Curve L	116km393m	118km088m	117km240m	6000 m	1695 m
11	Curve R	127km729m	127km966m	127km848m	6000 m	237 m
12	Curve L	139km793m	141km992m	140km893m	6000 m	2199 m
13	Curve L	156km622m	161km261m	158km941m	6000 m	4639 m
14	Curve R	168km264m	171km781m	170km022m	6000 m	3517 m
15	Curve R	187km815m	193km060m	190km438m	8000 m	5245 m
16	Curve L	218km303m	219km042m	218km673m	6000 m	739 m
17	Curve L	224km551m	225km440m	224km996m	6000 m	889 m
18	Curve L	229km307m	232km647m	230km977m	6000 m	3340 m
19	Curve L	236km625m	237km455m	237km040m	6000 m	830 m
20	Curve R	245km189m	245km475m	245km332m	6000 m	285 m

No.	Type of Curve	Kilometerage			Curve Radius	Curve Length
		Begin of Curve	End of Curve	Center of Curve		
21	Curve R	278km350m	278km491m	278km421m	6000 m	141 m
22	Curve L	280km685m	283km022m	281km854m	6000 m	2337 m
23	Curve R	284km588m	286km496m	285km542m	6000 m	1908 m
24	Curve R	291km780m	293km204m	292km492m	6000 m	1423 m
25	Curve L	298km230m	300km473m	299km351m	6000 m	2243 m
26	Curve R	308km049m	309km206m	308km627m	6000 m	1158 m
27	Curve L	311km809m	314km602m	313km205m	6000 m	2793 m
28	Curve R	317km672m	318km572m	318km122m	6000 m	900 m
29	Curve L	330km021m	332km748m	331km385m	6000 m	2727 m
30	Curve R	343km789m	345km692m	344km740m	6000 m	1903 m

Source: JICA Study Team

(2) Vertical Alignment

4.105 As described in 4.3 1) Basic Concept of HSR Routes Determination, the vertical alignment is designed with the maximum curve of 25,000m radius and maximum gradient of 25 ‰ on each selected section.

4.106 The following table shows the detailed information of the vertical alignment in South Section.

Table 4.4.4 Vertical Alignment of HSR South Section

No.	Gradient Post		Inclination (‰)		No.	Gradient Post		Inclination (‰)	
	Kilo Post	Elevation	Before	After		Kilo Post	Elevation	Before	After
1	0.000 km	16.0m	0	3	56	201.140 km	100.0m	13	-17
2	0.250 km	16.8m	3	-1	57	203.476 km	60.0m	-17	-2
3	1.575 km	16.0m	-1	0	58	210.123 km	45.0m	-2	2
4	7.333 km	16.0m	0	2	59	214.420 km	52.4m	2	-12
5	12.673 km	25.1m	2	25	60	217.413 km	18.0m	-12	-2
6	13.438 km	44.2m	25	0	61	220.200 km	12.0m	-2	0
7	14.088 km	44.2m	0	-25	62	220.700 km	12.0m	0	3
8	14.800 km	26.4m	-25	-1	63	223.121 km	18.0m	3	0
9	23.500 km	18.0m	-1	0	64	224.638 km	17.7m	0	5
10	26.667 km	18.0m	0	0	65	226.977 km	29.9m	5	-3
11	32.500 km	18.0m	0	16	66	228.760 km	24.8m	-3	22
12	34.499 km	50.0m	16	3	67	231.540 km	85.2m	22	-16
13	36.300 km	55.4m	3	10	68	235.200 km	28.0m	-16	-7
14	37.551 km	67.8m	10	-5	69	237.247 km	14.7m	-7	6
15	39.197 km	60.0m	-5	6	70	239.842 km	30.0m	6	-18
16	45.448 km	94.6m	6	14	71	240.935 km	10.0m	-18	2
17	56.798 km	255.2m	14	2	72	243.965 km	16.7m	2	6
18	58.331 km	258.0m	2	-13	73	245.800 km	28.0m	6	1
19	66.956 km	143.7m	-13	-7	74	252.773 km	34.4m	1	0
20	71.441 km	111.2m	-7	3	75	265.445 km	33.9m	0	-3
21	73.588 km	118.1m	3	1	76	270.709 km	20.0m	-3	-4
22	79.852 km	126.2m	1	-4	77	273.412 km	10.0m	-4	0
23	91.806 km	80.4m	-4	3	78	279.873 km	10.3m	0	7
24	96.301 km	93.9m	3	5	79	282.000 km	25.6m	7	1
25	100.503 km	112.8m	5	-11	80	283.350 km	27.1m	1	-1
26	104.035 km	75.5m	-11	12	81	283.850 km	26.6m	-1	-1
27	108.530 km	130.0m	12	-12	82	286.000 km	24.5m	-1	-3

No.	Gradient Post		Inclination (‰)		No.	Gradient Post		Inclination (‰)	
	Kilo Post	Elevation	Before	After		Kilo Post	Elevation	Before	After
28	114.607 km	58.0m	-12	10	83	289.483 km	14.5m	-3	7
29	115.821 km	70.0m	10	-16	84	290.900 km	24.5m	7	0
30	117.719 km	40.1m	-16	4	85	294.321 km	25.0m	0	13
31	119.482 km	47.8m	4	1	86	295.559 km	41.4m	13	-2
32	121.998 km	50.0m	1	-1	87	299.749 km	34.8m	-2	5
33	125.517 km	45.2m	-1	10	88	303.374 km	54.0m	5	-10
34	127.370 km	64.6m	10	-8	89	306.620 km	23.0m	-10	0
35	129.289 km	50.0m	-8	0	90	311.415 km	24.0m	0	-3
36	133.846 km	49.8m	0	-2	91	314.705 km	15.6m	-3	12
37	136.000 km	45.9m	-2	-4	92	315.670 km	27.2m	12	-12
38	138.000 km	38.0m	-4	4	93	316.868 km	12.9m	-12	2
39	143.044 km	56.1m	4	-8	94	319.776 km	18.0m	2	-2
40	146.009 km	33.7m	-8	-2	95	321.705 km	13.6m	-2	3
41	147.999 km	30.0m	-2	0	96	323.000 km	18.0m	3	0
42	149.500 km	30.0m	0	0	97	324.733 km	18.0m	0	2
43	150.672 km	30.0m	0	-1	98	326.060 km	20.0m	2	3
44	152.950 km	28.0m	-1	3	99	329.018 km	30.0m	3	-2
45	153.450 km	29.5m	3	-1	100	333.814 km	20.9m	-2	5
46	156.137 km	28.1m	-1	0	101	338.036 km	40.0m	5	-5
47	158.241 km	28.0m	0	-2	102	341.991 km	20.1m	-5	3
48	162.500 km	18.0m	-2	-1	103	343.722 km	24.4m	3	-3
49	165.194 km	15.9m	-1	2	104	345.933 km	18.0m	-3	0
50	170.448 km	27.4m	2	3	105	351.927 km	20.0m	0	0
51	174.734 km	38.0m	3	3	106	356.972 km	18.0m	0	1
52	180.065 km	54.9m	3	7	107	360.188 km	20.0m	1	-1
53	187.663 km	110.0m	7	2	108	361.748 km	18.0m	-1	0
54	192.375 km	120.0m	2	-14	109	365.994 km	18.0m	0	0
55	197.314 km	50.0m	-14	13					

Source: JICA Study Team

4.5 Description of Structures for Selected Routes

4.107 After determining the horizontal alignment, considering topographical conditions, geological conditions, construction and maintenance conditions, etc along the planned route, the structures are planned while designing the vertical alignment.

4.108 The structures applied to the HSR include embankments, cuts, bridges, viaducts and tunnels. 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. Table 4.5.1 shows the length and percent of each structure in Ho Chi Minh – Nha Trang section.

Table 4.5.1 Specifications of Civil Engineering Structures in HCMC-Nha Trang Section

Type	Length (m)	Percent (%)
Embankment	169,490	46.3%
Cut	102,831	28.1%
Viaduct	48,825	13.3%
Bridge	6,090	1.7%
Tunnel	34,279	9.4%
Station	4,735	1.3%
Total	366,250	100.0%

Source: JICA Study Team

4.109 Herein, the embankment length includes the box culverts for crossing road or waterway along the alignment. Details for each structure are described as follow except the structures for station which are detail explained in the Chapter 5.

1) Earthwork

4.110 Studying the suitable structures for HSR in HCMC - Nha Trang section, embankment structures are found applicable in most of locations along the selected alignment. It is generally known that embankment structures require wider ROW and more construction time in soft ground areas, however its construction cost is found much less than elevated structures. As preliminary cost estimation, viaduct/bridges for HSR will cost 20 million USD per km in average while embankment costs only 5 million USD per km. Even including the differences of the land acquisition cost and the compensation cost, the viaduct is found costly thus affecting the feasibility of the project as a whole.

4.111 Therefore, JICA Study Team has considered the balance of viaduct and embankment in order to find out the best solution for the whole project. The embankment is recommended in south section except the following areas where the viaduct will be used to minimize the impact to the social environment or to save the construction time.

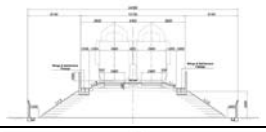
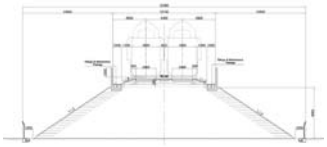
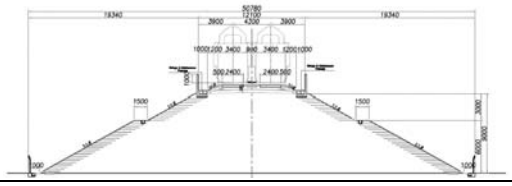
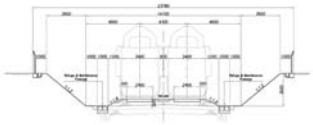
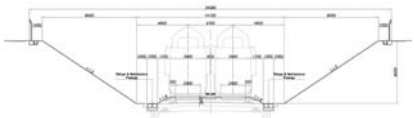
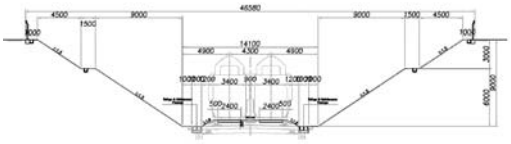
(i) Soft ground area (Mekong delta area)

(ii) City area or densely populated area

4.112 The following table shows the typical type for embankment/cut considered in this study.

4.113 The length of embankment/cut in each province is shown in Table 4.5.3 and one in each station interval is shown in Table 4.5.4.

Table 4.5.2 Typical Type of Earthwork for HSR

Earthwork type	Details for each type	Typical Section
Embankment		
Emb. Type 1	Embankment with slope of 1/1.5 and height of less than 3m (H ≤ 3m)	
Emb. Type 2	Embankment with slope of 1/1.5 and height of more than 3m and less than 6m (3m < H ≤ 6m)	
Emb. Type 3	Embankment with slope of 1/1.8 and height of more than 6m (6m < H)	
Cut		
Cut Type 1	Cut with a slope of 1/1.2 and height of less than 3m (H ≤ 3m)	
Cut Type 2	Cut with a slope of 1/1.5 and height of more than 3m and less than 6m (3m < H ≤ 6m)	
Cut Type 3	Cut with a slope of 1/1.5 and height of more than 6m (6m < H)	

Source: JICA Study Team

Table 4.5.3 Length of Earthwork by Province/City

No	City/ Province	Length (m)					
		Emb. Type 1	Emb. Type 2	Emb. Type 3	Cut Type 1	Cut Type 2	Cut Type 3
1	HCMC	0	0	0	0	0	0
2	Dong Nai	10,890	7,450	13,520	13,520	8,840	12,700
3	Binh Thuan	20,230	18,710	48,570	15,380	7,080	21,800
4	Ninh Thuan	16,070	9,010	4,300	7,490	3,100	3,200
5	Khanh Hoa	3,450	7,550	9,740	3,650	895	5,176
Total		50,640	42,720	76,130	40,040	19,915	42,876

Source: JICA Study Team

Table 4.5.4 Length of Earthwork by Station Interval

No	Station Interval	Length (m)					
		Emb. Type 1	Emb. Type 2	Emb. Type 3	Cut Type 1	Cut Type 2	Cut Type 3
1	TT-LT	1,000	400	4,150	3,690	500	400
2	LT-PT	16,820	12,240	31,940	15,530	10,870	18,310
3	PT-TP	7,150	7,310	17,300	6,680	2,900	15,150
4	TP-TC	17,420	7,010	9,200	6,390	2,800	3,590
5	TC-NT	8,200	15,660	12,690	7,750	2,845	5,426
6	Nt-depot	50	100	850	0	0	0
Total		50,640	42,720	76,130	40,040	19,915	42,876

Source: JICA Study Team

4.114 In case of embankment, JICA Study Team suggest to plan box culverts for passing road (for peoples' mobility and integrity of community) and surface water way in case of flood.

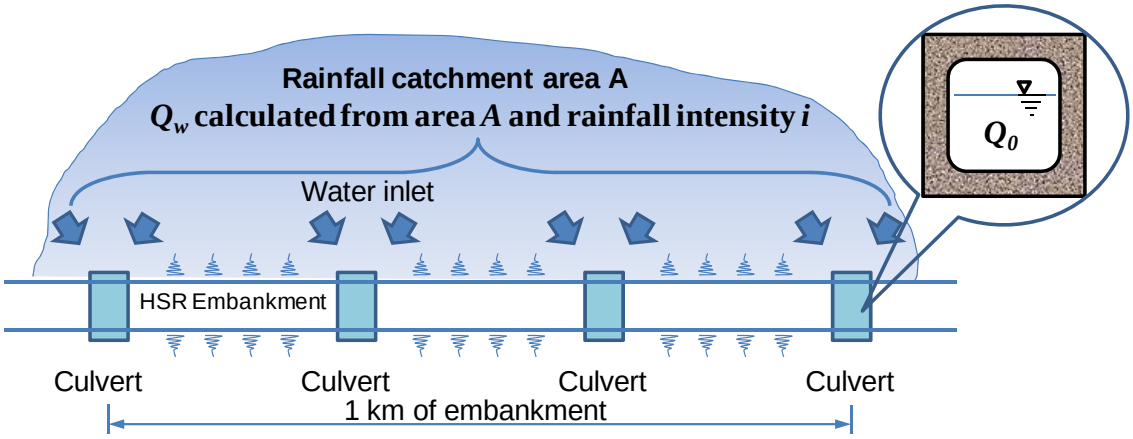
4.115 For the passing road, 2 boxes of width 6m are planned per 1 km of embankment. For the surface waterway, by carrying out the hydrological calculation based on the rainfall and topography condition along HSR alignment, inserting box culverts of 2.0m x 2.0m at 4 locations per km shall be enough for avoiding flooding situation by the embankment. The following table shows the quantity of box culverts for HSR embankment in South Section.

Table 4.5.5 Quantity of Box Culverts for HSR South Section

Box Culvert Locations n	Length n x W(m)	Remark
678	1356	4 Boxes of Width W=2m for Drainage per km of embankment
339	2034	2 Boxes of Width W= 6m for Road per km of embankment

Source: JICA Study Team

4.116 To confirm the drainage possibility of the boxes along the embankment, JICA Study Team has carried out the hydrological calculation to estimate the maximum rainfall discharge Q_w and the permissible discharge Q_0 by the drainage boxes. Q_w is calculated from the rainfall intensity i and the catchment area A while Q_0 is calculated from box culvert capacity as shown in the following figure. The rainfall intensity i is assumed as 150mm/h and the average catchment width along HSR alignment is estimated as 3km from the topography. Considering the discharge coefficients which differ by topographic and land use conditions, the maximum rainfall discharge Q_w is calculated as 69.2m^3/s. On the other hand, the permissible discharge Q_0 is calculated as 71.2 m^3/s using only 80% of the box culvert area. As the result of $Q_0 > Q_w$, it could be concluded that the planned box culverts (2m x 2m for 4 locations per km) are sufficient for the drainage along the embankment of HSR.



Source: JICA Study Team

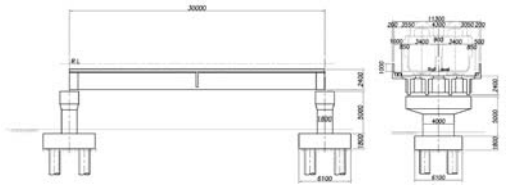
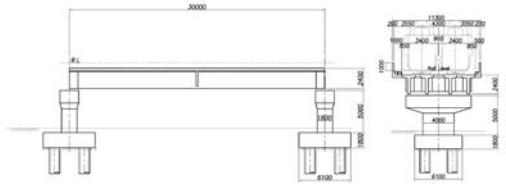
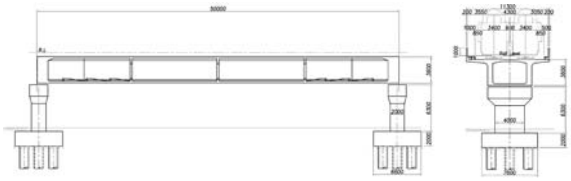
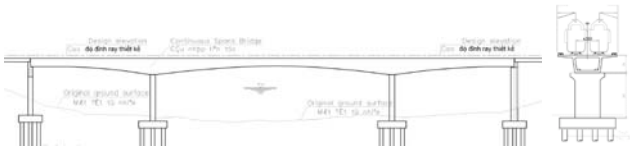
Figure 4.5.1 Calculation for drainage possibility of box culverts

2) Viaducts and Bridges

4.117 Table 4.5.6 shows the typical type for viaduct and bridges. Viaduct and Bridge type 1 is designed with PC T Girder with the span from 20m to 40m. PC Box Girder with span from 40m to 60m is used for Bridge type 2. Bridge type 3 (PC Rigid Frame) is planned for the continuous long span bridge (one span > 60m).

4.118 Bridges for crossing waterway or small road of which length less than 20m are considered as box culverts and the quantity will be calculated from embankment length.

Table 4.5.6 Types of Viaducts/Bridges for HSR

Bridge type	Details for each type	Typical Section
Viaduct		
PC T Girder	Elevated track planned for city area or populated area (20 ≤ Span ≤ 40m)	
Bridge		
Type 1 (PC T Girder)	Bridges installed at the crossing points of medium-sized rivers, national roads/existing railways, and so on. (20 ≤ Span ≤ 40m)	
Type 2 (PC Box Girder)	Bridges installed at the crossing points of medium-sized rivers, national roads/existing railways, and so on. (40 < Span ≤ 60m)	
Type 3 (PC Rigid Frame)	Bridges installed at the crossing points of large-sized rivers, lake and dam, and so on. (Span > 60m)	

Source: JICA Study Team

4.119 The length of viaducts/bridges in each province is shown in Table 4.5.7 and one in each station interval is shown in Table 4.5.8. The detail locations for each type of bridge are shown from Table 4.5.9 to Table 4.5.11.

Table 4.5.7 Length of Viaducts/Bridges by Province/City

No	City/ Province	Length (m)			
		Viaduct	PC T Girder	PC Box Girder	PC Rigid Frame
1	HCMC	12,355	0	500	700
2	Dong Nai	11,000	160	1,250	0
3	Binh Thuan	18,550	660	1,060	0
4	Ninh Thuan	3,150	360	470	0
5	Khanh Hoa	3,770	510	420	0
Total		48,825	1,690	3,700	700

Source: JICA Study Team

Table 4.5.8 Length of Viaducts/Bridges by Station Interval

No	Station Interval	Length (m)			
		Viaduct	PC T Girder	PC Box Girder	PC Rigid Frame
1	TT-LT	23,355	0	900	700
2	LT-PT	9,375	480	850	0
3	PT-TP	9,175	160	600	0
4	TP-TC	1,075	420	810	0
5	TC-NT	3,355	630	540	0
6	NT-depot	2,490	0	0	0
Total		48,825	1,690	3,700	700

Source: JICA Study Team

Table 4.5.9 List of Viaducts along the HSR South Section

No	Kilo Post		Structure Type	Length (m)	Station Interval	Province	Type of Crossing (Location)
	from	to					
1	0.545	1.100	Viaduct	555	TT-LT	HCMC	Mekong Delta Area
2	1.300	5.700	Viaduct	4,400	TT-LT	HCMC	Mekong Delta Area
3	5.800	11.600	Viaduct	5,800	TT-LT	HCMC	Mekong Delta Area
4	11.800	13.400	Viaduct	1,600	TT-LT	HCMC	Mekong Delta Area
5	14.100	23.500	Viaduct	9,400	TT-LT	Dong Nai	Mekong Delta Area
6	25.000	26.600	Viaduct	1,600	TT-LT	Dong Nai	Dong Hu river, QL51, etc
7	119.500	122.000	Viaduct	2,500	LT-PT	Binh Thuan	stream, road, residence area
8	136.000	138.000	Viaduct	2,000	LT-PT	Binh Thuan	National highway 1A
9	148.000	152.875	Viaduct	4,875	LT-PT	Binh Thuan	Ham Thuan Nam District Area
10	153.525	162.500	Viaduct	8,975	PT-TP	Binh Thuan	Ham Thuan Bac District Area
11	217.715	217.915	Viaduct	200	PT-TP	Binh Thuan	National highway 1 and resident area
12	282.200	283.275	Viaduct	1,075	TP-TC	Ninh Thuan	Thap Cham area
13	283.925	286.000	Viaduct	2,075	TC-NT	Ninh Thuan	Thap Cham area
14	319.542	319.982	Viaduct	440	TC-NT	Khanh Hoa	National highway 27B, stream, resident area
15	360.850	361.690	Viaduct	840	TC-NT	Khanh Hoa	Nha Trang area
16	362.510	365.000	Viaduct	2,490	NT-depot	Khanh Hoa	Nha Trang area

Source: JICA Study Team

Table 4.5.10 Type 1 Bridges along HCMC-Nha Trang Section by Location

No.	Kilo Post		Structure Type	Length (m)	Station Interval	Province	Type of Crossing
	from	to					
1	58.311	58.351	PC T Girder	40	LT-PT	Dong Nai	National highway 56
2	74.465	74.485	PC T Girder	20	LT-PT	Dong Nai	small road
3	75.364	75.384	PC T Girder	20	LT-PT	Dong Nai	small road
4	79.680	79.720	PC T Girder	40	LT-PT	Dong Nai	National Road
5	82.724	82.744	PC T Girder	20	LT-PT	Dong Nai	stream
6	93.110	93.130	PC T Girder	20	LT-PT	Dong Nai	Cong Hoi river
7	97.361	97.391	PC T Girder	30	LT-PT	Binh Thuan	Gieng river
8	98.390	98.410	PC T Girder	20	LT-PT	Binh Thuan	small road
9	104.016	104.056	PC T Girder	40	LT-PT	Binh Thuan	National highway 55
10	105.526	105.556	PC T Girder	30	LT-PT	Binh Thuan	stream
11	112.537	112.557	PC T Girder	20	LT-PT	Binh Thuan	small road
12	114.588	114.628	PC T Girder	40	LT-PT	Binh Thuan	Provincial road 339
13	117.490	117.530	PC T Girder	40	LT-PT	Binh Thuan	Phan river
14	144.357	144.377	PC T Girder	20	LT-PT	Binh Thuan	small road
15	145.650	145.670	PC T Girder	20	LT-PT	Binh Thuan	small road
16	145.836	145.856	PC T Girder	20	LT-PT	Binh Thuan	stream
17	146.412	146.432	PC T Girder	20	LT-PT	Binh Thuan	small road
18	146.841	146.861	PC T Girder	20	LT-PT	Binh Thuan	small road
19	166.155	166.175	PC T Girder	20	PT-TP	Binh Thuan	small road
20	172.221	172.261	PC T Girder	40	PT-TP	Binh Thuan	small road
21	176.561	176.601	PC T Girder	40	PT-TP	Binh Thuan	stream

No.	Kilo Post		Structure Type	Length (m)	Station Interval	Province	Type of Crossing
	from	to					
22	181.421	181.441	PC T Girder	20	PT-TP	Binh Thuan	small road
23	186.072	186.092	PC T Girder	20	PT-TP	Binh Thuan	small road
24	196.810	196.830	PC T Girder	20	PT-TP	Binh Thuan	small road
25	223.102	223.142	PC T Girder	40	TP-TC	Binh Thuan	National highway 1
26	224.169	224.189	PC T Girder	20	TP-TC	Binh Thuan	small road
27	231.521	231.561	PC T Girder	40	TP-TC	Binh Thuan	National highway 1
28	234.894	234.934	PC T Girder	40	TP-TC	Binh Thuan	Lien Huong-Phan Dung st.
29	245.137	245.157	PC T Girder	20	TP-TC	Binh Thuan	small road
30	245.272	245.292	PC T Girder	20	TP-TC	Binh Thuan	stream
31	267.596	267.616	PC T Girder	20	TP-TC	Ninh Thuan	stream
32	268.355	268.375	PC T Girder	20	TP-TC	Ninh Thuan	stream
33	271.409	271.449	PC T Girder	40	TP-TC	Ninh Thuan	small road
34	273.950	273.970	PC T Girder	20	TP-TC	Ninh Thuan	Mong Duc-Phuoc ha st.
35	274.148	274.188	PC T Girder	40	TP-TC	Ninh Thuan	small road
36	277.325	277.345	PC T Girder	20	TP-TC	Ninh Thuan	stream
37	277.694	277.714	PC T Girder	20	TP-TC	Ninh Thuan	stream
38	278.851	278.871	PC T Girder	20	TP-TC	Ninh Thuan	small road
39	279.887	279.927	PC T Girder	40	TP-TC	Ninh Thuan	Phuoc Huu-Phuoc Hau st.
40	300.960	301.000	PC T Girder	40	TC-NT	Ninh Thuan	stream
41	301.517	301.557	PC T Girder	40	TC-NT	Ninh Thuan	small road
42	306.942	306.982	PC T Girder	40	TC-NT	Ninh Thuan	stream
43	316.305	316.325	PC T Girder	20	TC-NT	Khanh Hoa	small road
44	320.338	320.358	PC T Girder	20	TC-NT	Khanh Hoa	stream
45	320.509	320.529	PC T Girder	20	TC-NT	Khanh Hoa	stream
46	320.733	320.753	PC T Girder	20	TC-NT	Khanh Hoa	stream
47	321.280	321.300	PC T Girder	20	TC-NT	Khanh Hoa	small road
48	322.860	322.900	PC T Girder	40	TC-NT	Khanh Hoa	small road
49	322.980	323.020	PC T Girder	40	TC-NT	Khanh Hoa	Existing line Crossing
50	324.714	324.754	PC T Girder	40	TC-NT	Khanh Hoa	Provincial road 9
51	332.286	332.326	PC T Girder	40	TC-NT	Khanh Hoa	Nguyen Cong Tru st.
52	336.190	336.210	PC T Girder	20	TC-NT	Khanh Hoa	small road
53	341.390	341.410	PC T Girder	20	TC-NT	Khanh Hoa	small road
54	345.914	345.954	PC T Girder	40	TC-NT	Khanh Hoa	National highway 1
55	346.070	346.100	PC T Girder	30	TC-NT	Khanh Hoa	stream
56	346.650	346.670	PC T Girder	20	TC-NT	Khanh Hoa	stream
57	346.731	346.751	PC T Girder	20	TC-NT	Khanh Hoa	stream
58	346.828	346.848	PC T Girder	20	TC-NT	Khanh Hoa	stream
59	347.045	347.065	PC T Girder	20	TC-NT	Khanh Hoa	stream
60	347.874	347.894	PC T Girder	20	TC-NT	Khanh Hoa	small road
61	356.953	356.993	PC T Girder	40	TC-NT	Khanh Hoa	Provincial road 3

Source: JICA Study Team

Table 4.5.11 Types 2 and 3 Bridges along HCMC-Nha Trang Section by Location

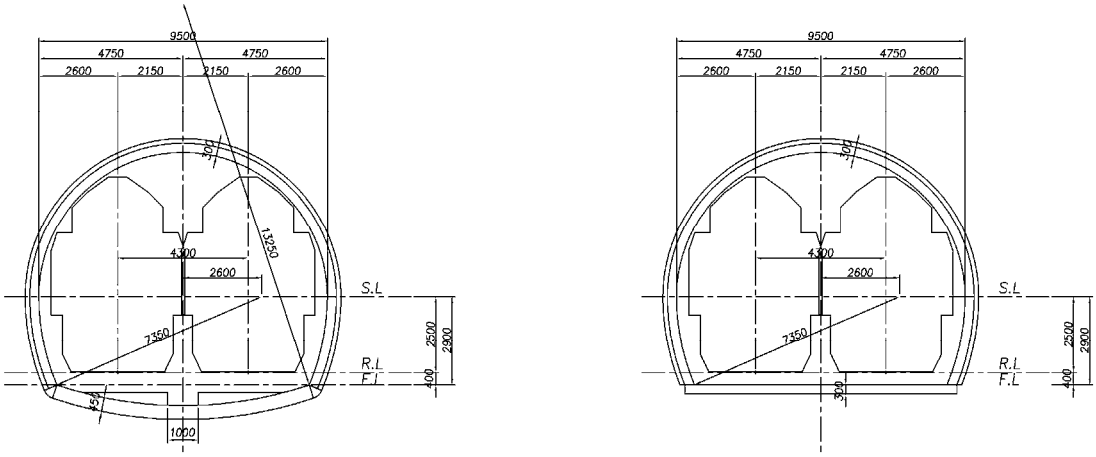
No	Kilo Post		Structure Type	Length (m)	Station Interval	Province	Type of Crossing (Location)
	from	to					
1	1.100	1.300	PC Box Girder	200	TT-LT	HCMC	East-West Avenue
2	5.700	5.800	PC Box Girder	100	TT-LT	HCMC	Ring Road
3	11.600	11.800	PC Box Girder	200	TT-LT	HCMC	Tac River
4	13.400	14.100	PC Rigid Frame	700	TT-LT	HCMC	Dong Nai River
5	26.600	27.000	PC Box Girder	400	TT-LT	Dong Nai	Provincial Road, planned freight line
6	72.950	73.800	PC Box Girder	850	LT-PT	Dong Nai	Provincial Road 765, stream
7	174.664	174.804	PC Box Girder	140	PT-TP	Binh Thuan	National highway 1
8	217.315	217.715	PC Box Girder	400	PT-TP	Binh Thuan	River
9	218.997	219.057	PC Box Girder	60	PT-TP	Binh Thuan	stream
10	235.200	235.600	PC Box Girder	400	TP-TC	Binh Thuan	stream
11	245.770	245.830	PC Box Girder	60	TP-TC	Binh Thuan	Existing line Crossing
12	268.172	268.242	PC Box Girder	70	TP-TC	Ninh Thuan	Lu river
13	275.485	275.565	PC Box Girder	80	TP-TC	Ninh Thuan	stream
14	282.000	282.200	PC Box Girder	200	TP-TC	Ninh Thuan	Dinh Kinh river
15	290.870	290.930	PC Box Girder	60	TC-NT	Ninh Thuan	Existing line Crossing

No	Kilo Post		Structure Type	Length (m)	Station Interval	Province	Type of Crossing (Location)
	from	to					
16	308.746	308.806	PC Box Girder	60	TC-NT	Ninh Thuan	Dau river
17	314.238	314.328	PC Box Girder	90	TC-NT	Khanh Hoa	stream
18	315.235	315.445	PC Box Girder	210	TC-NT	Khanh Hoa	stream
19	321.420	321.540	PC Box Girder	120	TC-NT	Khanh Hoa	stream, small road

Source: JICA Study Team

3) Tunnels

4.120 Standard cross-section of tunnel for HSR is shown in Figure 4.5.2. The detailed locations for tunnels are shown in Table 4.5.12. There are 9 tunnels in south section. The No. 1 in Ca Na and No. 2 in Co Lo is located at the province boundary of Binh Thuan - Ninh Thuan and Ninh Thuan–Khanh Hoa respectively. The others are all located in Khanh Hoa province.



Source: JICA Study Team

Figure 4.5.2 Standard Cross-section of Tunnels for HSR

Table 4.5.12 Plan for Tunnels along HCMC-Nha Trang Section by Location

No	Kilo Post		Length (m)	Station Interval	Province	Remark of Location
	from	to				
1	247.940	254.250	6,310	TP-TC	Binh Thuan	Ca Na tunnel over Binh Thuan & Ninh Thuan
	254.250	261.550	7,300		Ninh Thuan	
2	309.350	312.370	3,020	TC-NT	Ninh Thuan	Co Lo Mountain tunnel over Ninh Thuan & Khanh Hoa
	312.370	313.060	690		Khanh Hoa	
3	321.905	322.196	291	TC-NT	Khanh Hoa	Cam Ranh Bay 1 (near Cam Thinh Dong)
4	324.927	325.342	415	TC-NT	Khanh Hoa	Cam Ranh Bay 2 (near Cam Loc)
5	326.680	331.625	4,945	TC-NT	Khanh Hoa	Hon Rong Mountain
6	342.585	344.737	2,152	TC-NT	Khanh Hoa	Hon The Mountain
7	348.046	355.644	7,598	TC-NT	Khanh Hoa	Hon Nhon Mountain
8	355.945	356.395	450	TC-NT	Khanh Hoa	Before Nha Trang near Vinh Thai
9	359.650	360.758	1,108	TC-NT	Khanh Hoa	Hon Ngang Mountain

Source: JICA Study Team

4.121 Geology of HSR tunnels are roughly estimated based on the result of geology map in Viet Nam, result of geological inspection and survey borings. Geology and length of support patterns at the tunnel portal area and the inside of tunnel are assumed and detail

explained in the Technical Report No.5.

4) Station Structures

4.122 Details for the structures of station are detail explained in the Chapter 5. The following table shows the list of stations in south section with general information of locations, structure types and lengths (from turnout to turnout).

Table 4.5.13 Station Structures on HSR South Section by Type and Location

No	Station	Kilo Post		Structure Type	Length[1)] (m)
		from	to		
1	Thu Thiem	-0.250	0.545	Elevated	795
2	Long Thanh	35.640	36.460	Open Cut (shallow trench)	820
3	Phan Thiet	152.875	153.525	Elevated	650
4	Tuy Phong	219.950	220.950	Embankment	1,000
5	Thap Cham	283.275	283.925	Elevated	650
6	Nha Trang	361.690	362.510	Elevated	820

1) Station length is calculated from turnout to turnout which is different with the platform length.
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.

(1) Development Concept

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

(2) 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.

(3) 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. The list of station area concept plans is shown in Table 5.1.2.

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 buildings including public services
	Housing and Residential Area Development	High-rises and condominiums, medium- and low-rise houses
	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 the 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, intercity bus terminal, Tourist bus terminal, bus berth, taxi berth
	Parking Development	Car parking for kiss-and-ride and park-and-ride, motorbike parking area
	Walkway Network Development	Pedestrian corridors and decks, commercial use

Source: JICA Study Team

Table 5.1.2 List of Station Area Concept Plans

Section	Station	Location	Connection to Other Transportation Modes
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	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) Thu Thiem Station

(1) Location and Existing Conditions

5.5 Thu Thiem Station is located in the new urban area along East West Ring Road (w=100 m) in District 2, Ho Chi Minh City. Thu Thiem Station is planned as the southern terminal for the HSR's southern route and to connect with the future UMRT station.

5.6 The planned station area is currently used for agriculture or in some areas lying idle. The area is within a block of 40 ha bounded by the ring road and paved local roads. There are several families living in the area at present, but new residential areas are being developed around it. Based on the current urban plan, the block above-mentioned is planned for railway and commercial use, and the surrounding area is planned as a residential area.

5.7 Thu Thiem Station is the southernmost station of the HSR's southern section. This station area will be the most strategic point in the transport network of Thu Thiem New Urban Area and Ho Chi Minh City.

Location of Proposed HSR Station	Location of Proposed HSR Station (Left side)
	
East West Ring Road	New Residential Area
	

Source: JICA Study Team

Figure 5.2.1 Existing Conditions in Thu Thiem Station Area

(2) Concept Plan for Station Area

5.8 As a strategic point in the transport network of HCMC, the Thu Thiem station area is proposed to be developed by providing transit, commercial, business and urban living services. This combination is expected to pull in more passengers and customers, making this area one of the most attractive urban spaces in southern Vietnam. In addition, accessibility of and connectivity to the public transport network will provide comfortable and convenient urban living to residents and workers in Thu Thiem New Urban Area.

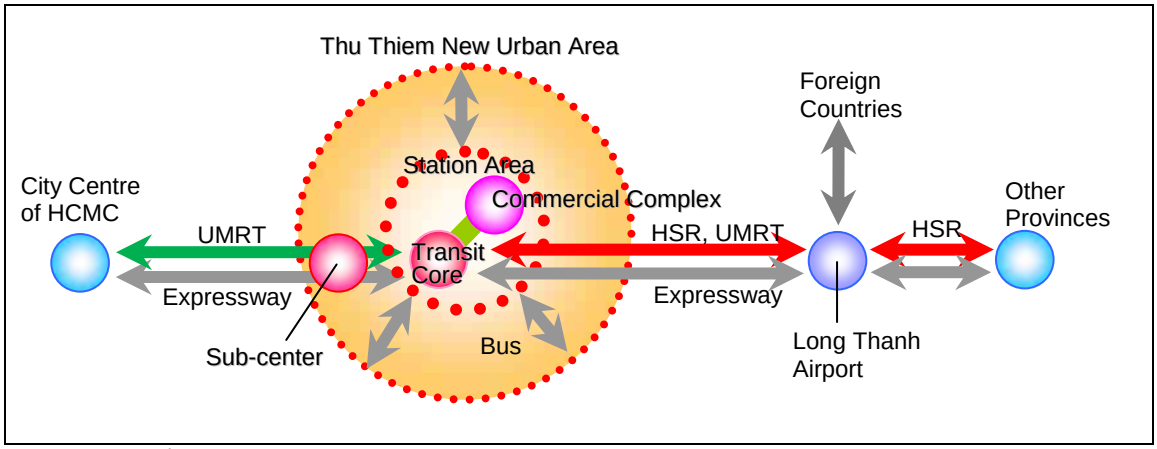
5.9 The proposed vision for Thu Thiem Station area is as follows:

(i) Eastern gate of HCMC;

(ii) Alternative commercial core linking with sub-center of Thu Thiem New Urban Area; and

(iii) Urban living with comfort and convenience by public transport.

5.10 The future urban structure of Thu Thiem station area is proposed as shown below (see Figure 5.2.2).



Source: JICA Study Team

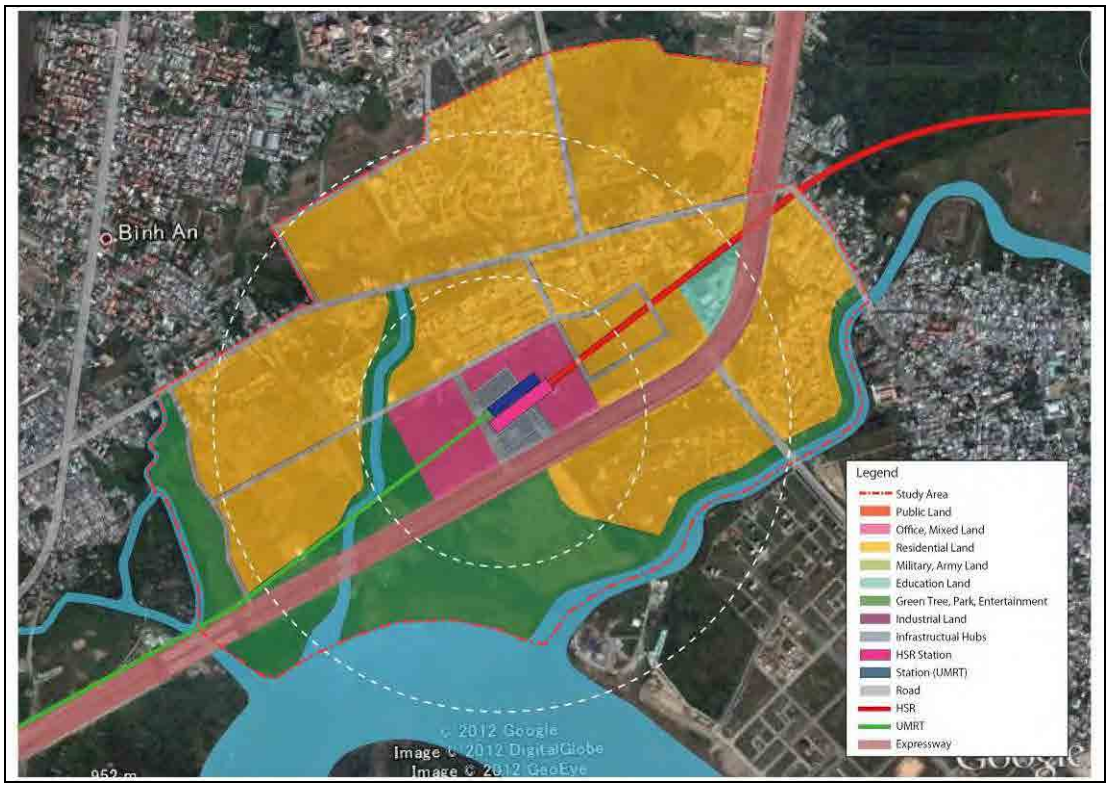
Figure 5.2.2 Future Urban Structure of Thu Thiem Station Area

(3) Proposed Land Use Plan for Station Area

5.11 As the eastern gate of HCMC, transit spaces are proposed to be located in front of the station. It consists of a bus terminal for the inner-city transport network and station plaza including bus stops, taxi berths, and parking space for private cars. An access road is also proposed to connect the station plaza to the national highway.

5.12 A commercial complex is also proposed to be developed around the station plaza. This commercial complex is proposed to consist of retail stores, restaurants, entertainment facilities, hotel and tourist information centers, etc. and will be connected to the station building by walkways such as pedestrian decks. In the surrounding area, new residential areas are proposed following the current urban plan.

5.13 The proposed land use plan for Thu Thiem station area is shown in Figure 5.2.3.



Source: JICA Study Team

Figure 5.2.3 Land Use Plan for Thu Thiem Station Area

Commercial Complex	Commercial Area in front of Station
	
Inside of Commercial Complex	**Bus Stop in Station Plaza**
	

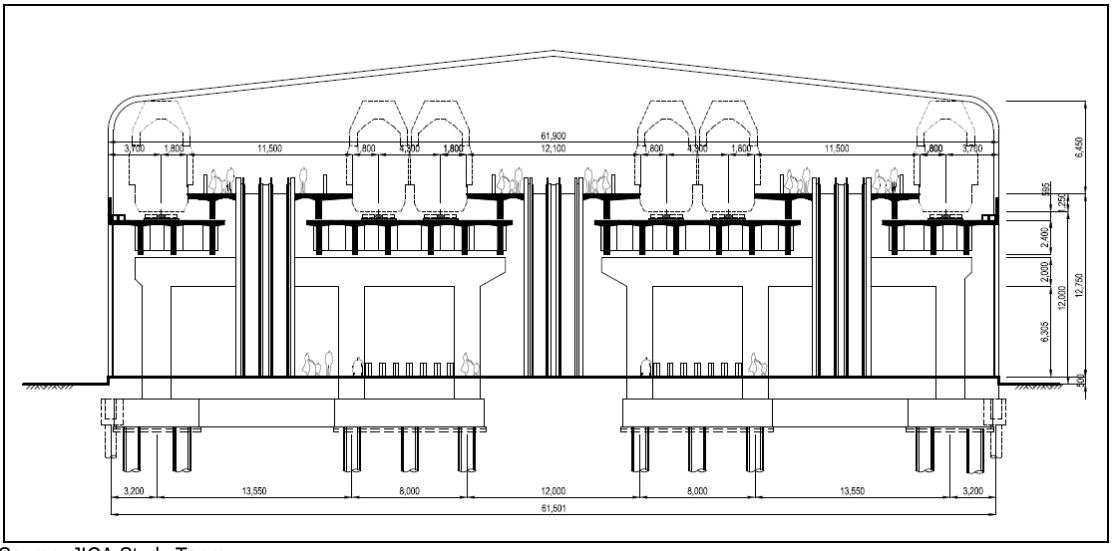
Source: JICA Study Team

Figure 5.2.4 Image of Future Thu Thiem Station Area

(4) Station and Related Facilities

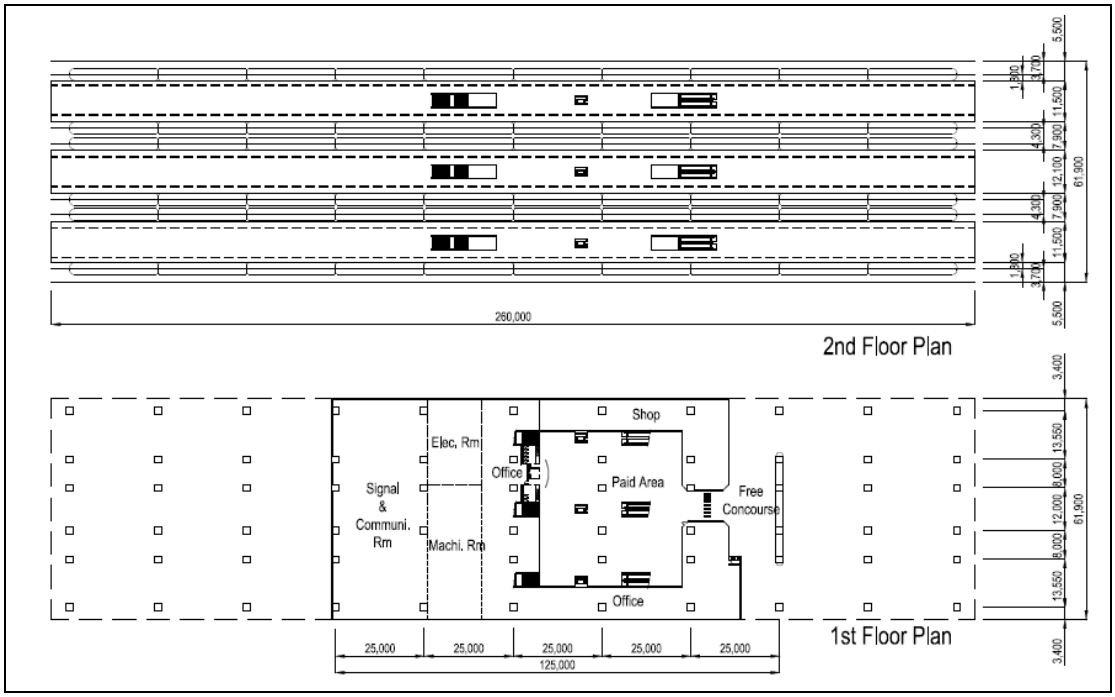
(a) Station Building

5.14 Thu Thiem Station is planned to have two stories. Three (3) island platforms will serve four (4) lines on the second floor and a concourse will be on the first floor. In the future, two additional lines will operate, bringing the total to six lines. An interchange with the UMRT will be provided on the first floor. For easier connection, the UMRT station is recommended to be elevated.



Source: JICA Study Team

Figure 5.2.5 Cross-sectional View of Thu Thiem Station

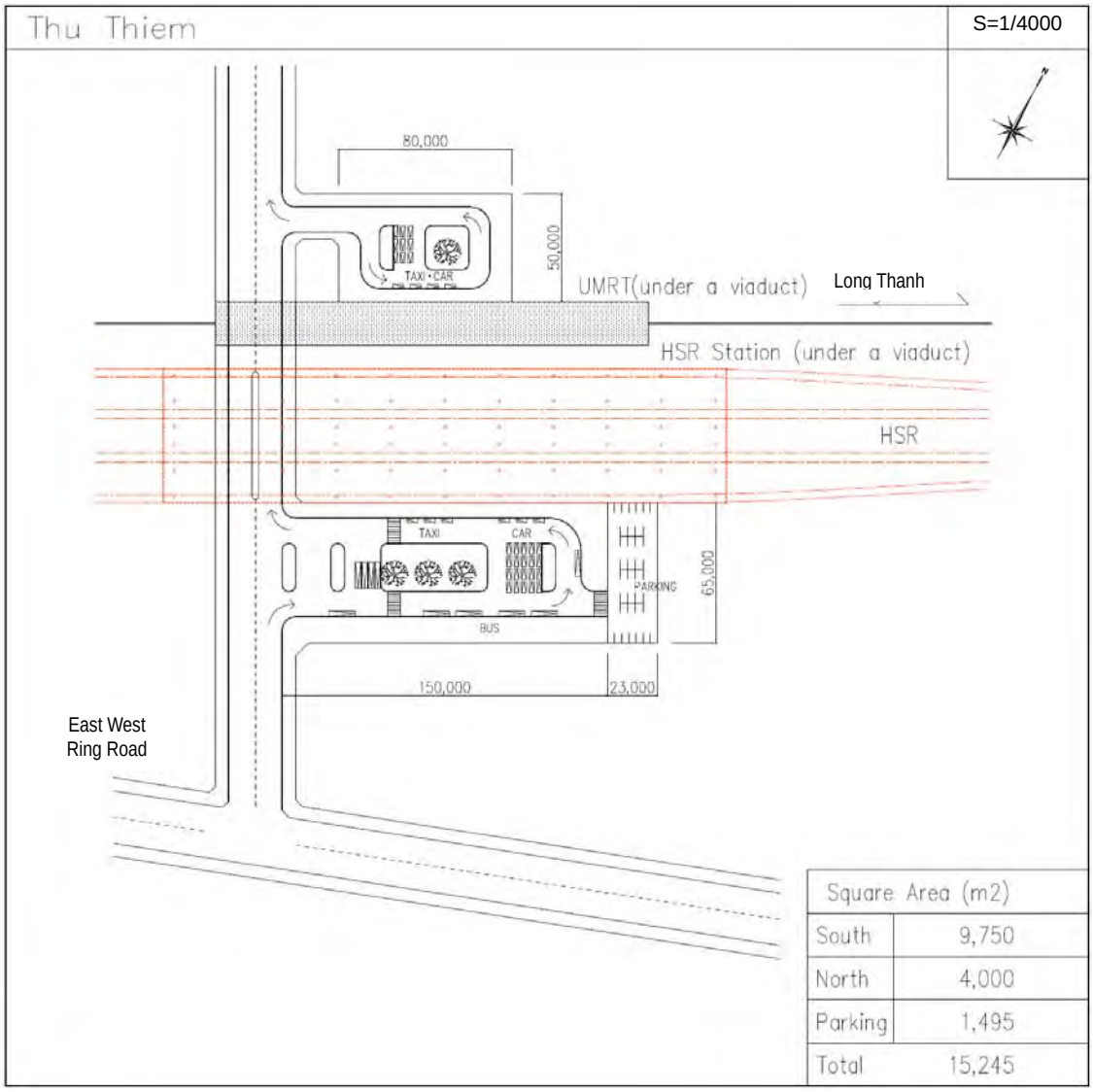


Source: JICA Study Team

Figure 5.2.6 Top View of Thu Thiem Station Plan

(b) Station Square

5.15 The plan is to provide a station square in the north and south, with a total area of 15,245 m^2. The southern square will be the main square because of easy access from Dai Lo Dong Tay road. The northern square will be the gate to this new urban area.



Source: JICA Study Team

Figure 5.2.7 Top View of Thu Thiem Station Square

2) Long Thanh Station

(1) Location and Existing Conditions

5.16 Long Thanh Station is planned to be located within the Long Thanh International Airport area which was approved in 2011. Long Thanh Station will be located at the center of the airport to allow transfers to/from the airport terminal.

5.17 The land surrounding the airport site is mostly devoted to gum plantations.

Existing Land Use (Gum Plantation)	Existing Road North of Airport Site
	

Source: JICA Study Team

Figure 5.2.8 Existing Conditions in Long Thanh Station Area

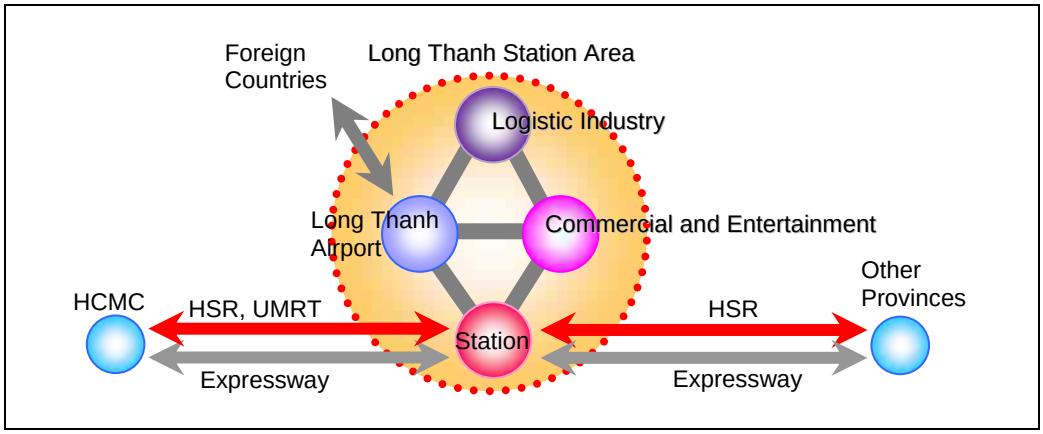
(2) Concept Plan for Station Area

5.18 As a strategic point in the transport network, Long Thanh station area is proposed to have transport and commercial function. The commercial function should be able to create a strong attraction among station users because it is expected that most passengers will only be transiting from/to the airline. Because the transit point is located inside the airport area, passengers may not wander outside the airport area anymore. On the other hand, this station area is proposed to serve the logistics industry especially in terms of air freight.

5.19 The proposed vision for Long Thanh Station area is as follows:

- New sub-center as southern international gate of Vietnam; and
- Commercial, entertainment, and logistics industry core in Dong Nai province.

5.20 The future urban structure of Long Thanh station area is proposed as shown below (see Figure 5.2.9).



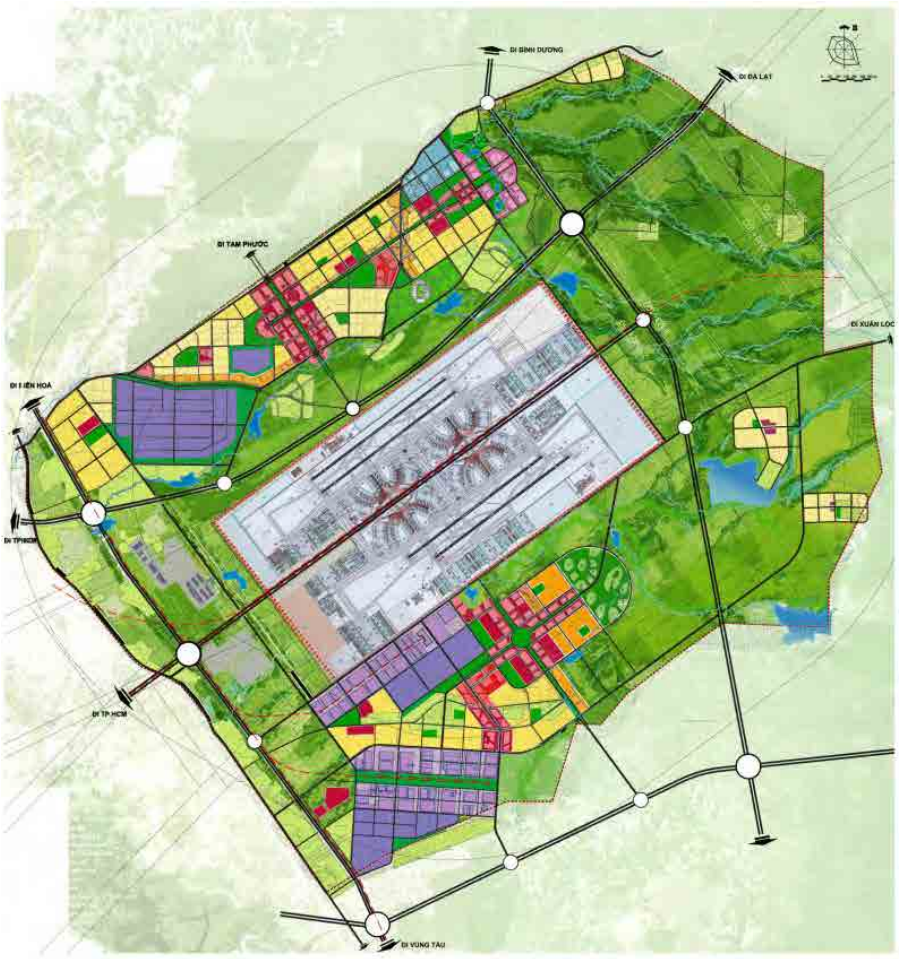
Source: JICA Study Team

Figure 5.2.9 Future Urban Structure of Long Thanh Station Area

(3) Proposed Land Use Plan for Station Area

5.21 As a new sub-center in the southern international gate, commercial and entertainment areas are proposed to be developed on the northern side of the airport facility to comprise a large-scale shopping center and entertainment area including cinemas, amusement parks, and exhibition centers.

5.22 The draft detailed plan for the Long Thanh station area is shown below (see Figure 5.2.10).



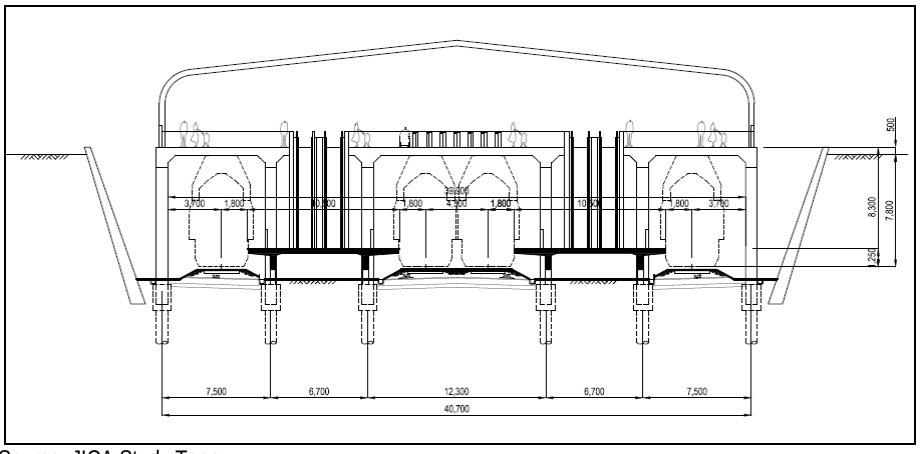
Source: Long Thanh International Airport Study Team.

Figure 5.2.10 Land Use Plan for Long Thanh Area

(4) Station and Related Facilities

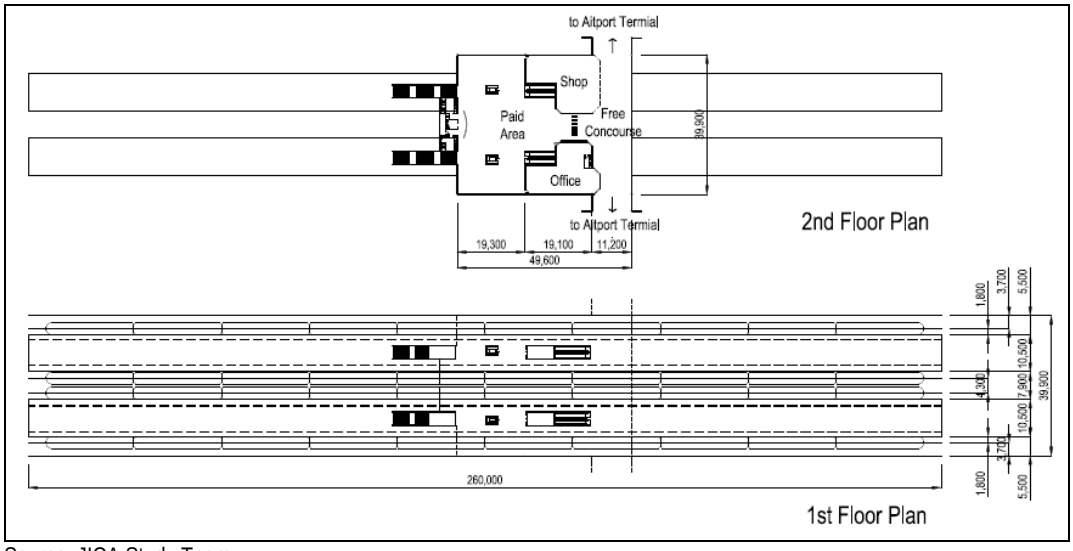
(a) Station Building

5.23 The station is planned to be constructed on a shallow trench because of a planned access road crossing above the station. Two (2) island platforms serving four (4) lines will be provided at basement level and a concourse at ground level.



Source: JICA Study Team

Figure 5.2.11 Cross-sectional View of Long Thanh Station

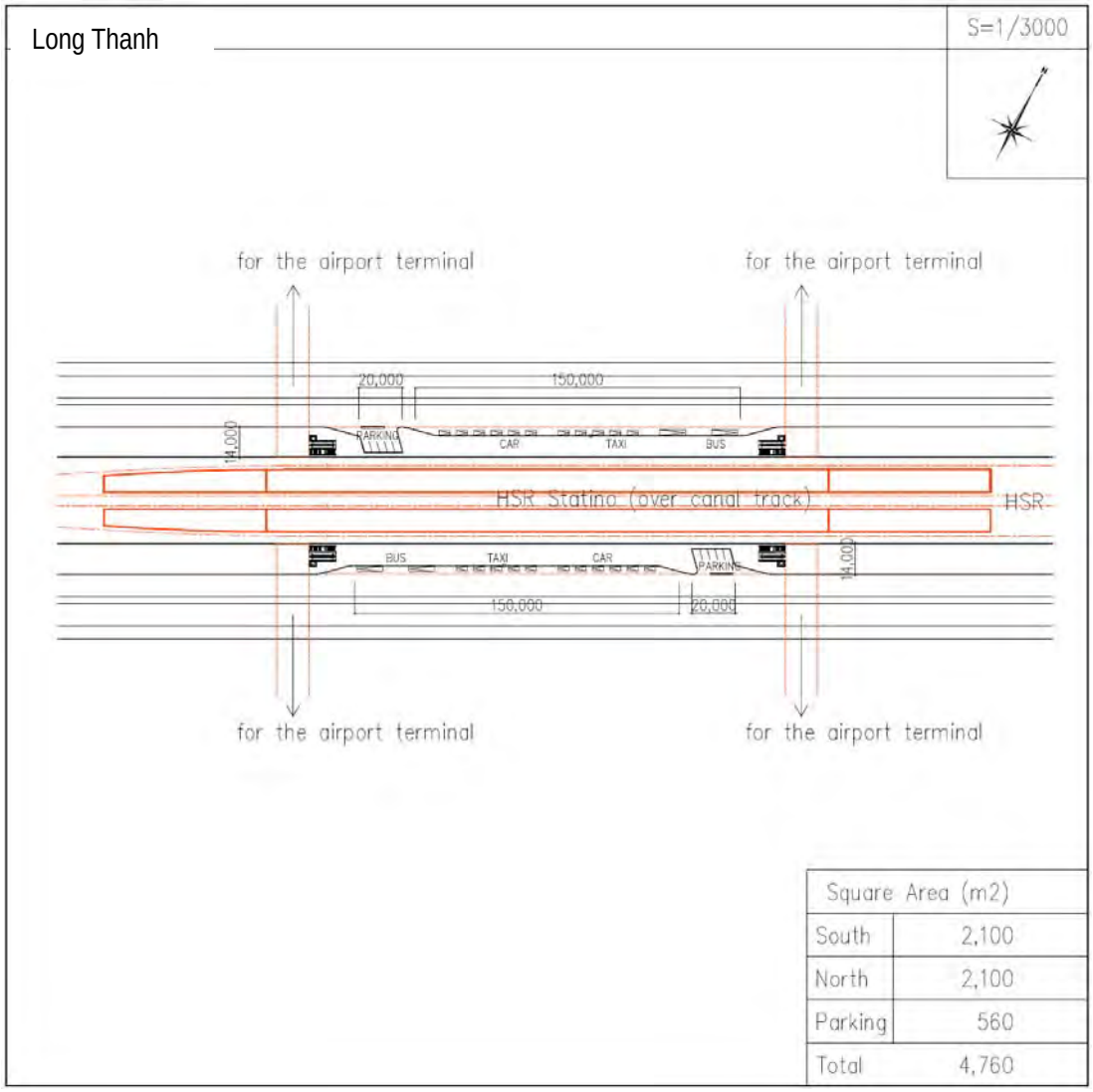


Source: JICA Study Team

Figure 5.2.12 Top View of Long Thanh Station Plan

(b) Station Square

5.24 The size of the station square will be minimized to ensure airport security, while a park-and-ride facility is recommended. This facility will have a minimum land area of 4,760 m^2.



Square Area (m2)	
South	2,100
North	2,100
Parking	560
Total	4,760

Source: JICA Study Team

Figure 5.2.13 Top View of Long Thanh Station Square

3) Phan Thiet Station

(1) Location and Existing Conditions

5.25 Phan Thiet Station is planned beside the new local railway station which is already developed 2 km west of the city center. The station plaza and access road for the local railway station are also developed and the railway track between the new station and the former station located in the city center will replace the arterial road.

5.26 The area around the planned station is currently devoted to agriculture with small, rural villages scattered throughout. In the current urban plan, administrative, commercial, and residential areas are planned to be developed around the station..

5.27 The Phan Thiet Station area is a new transit point in the transport network of Phan Thiet City, especially for tourists going to Mui Ne. For this reason, this area will have the ability to pull in more customers consisting of tourists.

Location of Proposed HSR Station	New Local Railway Station
	
Access Road	Surroundings of Local Station
	

Source: JICA Study Team

Figure 5.2.14 Existing Conditions in Phan Thiet Station Area

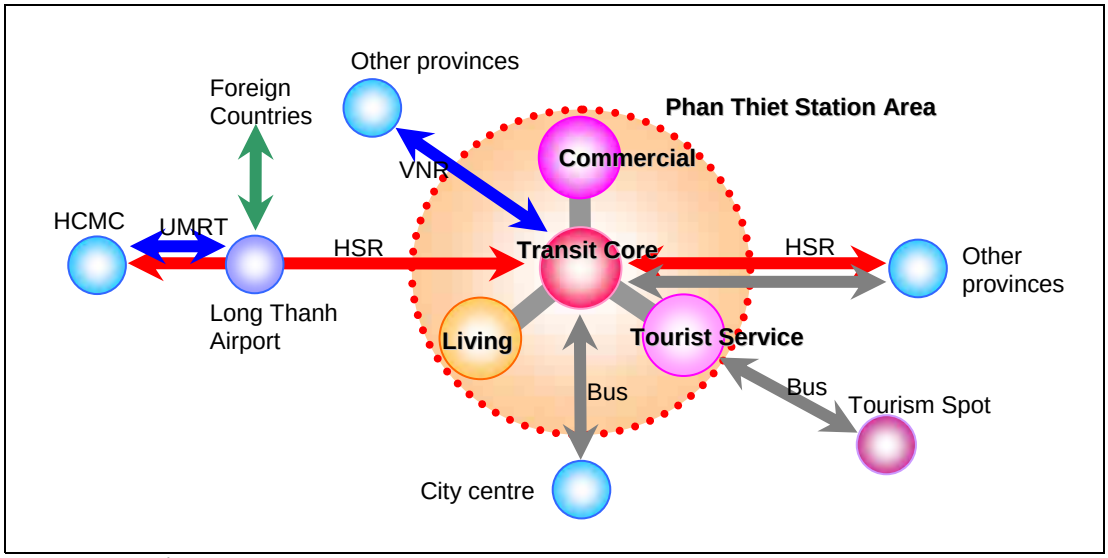
(2) Concept Plan for Station Area

5.28 As a new transit poiint in Phan Thiet City, Phan Thiet Station area is proposed to be developed in combination with tourist services, commercial spaces, and other urban amenities. This concept will promote commercial and service industries and generate employment. In addition, residents and workers will experience comfort and convenience with public transport and a natural environment.

5.29 The proposed vision for Phan Thiet Station area is as follows:

(i) New tourist service linking to tourism spots in Binh Thuan province;
(ii) Attractive commercial space for tourists and residents; and
(iii) Urban living in harmony with the natural environment.

5.30 The proposed urban structure of Phan Thiet Station area is shown in Figure 5.2.15.



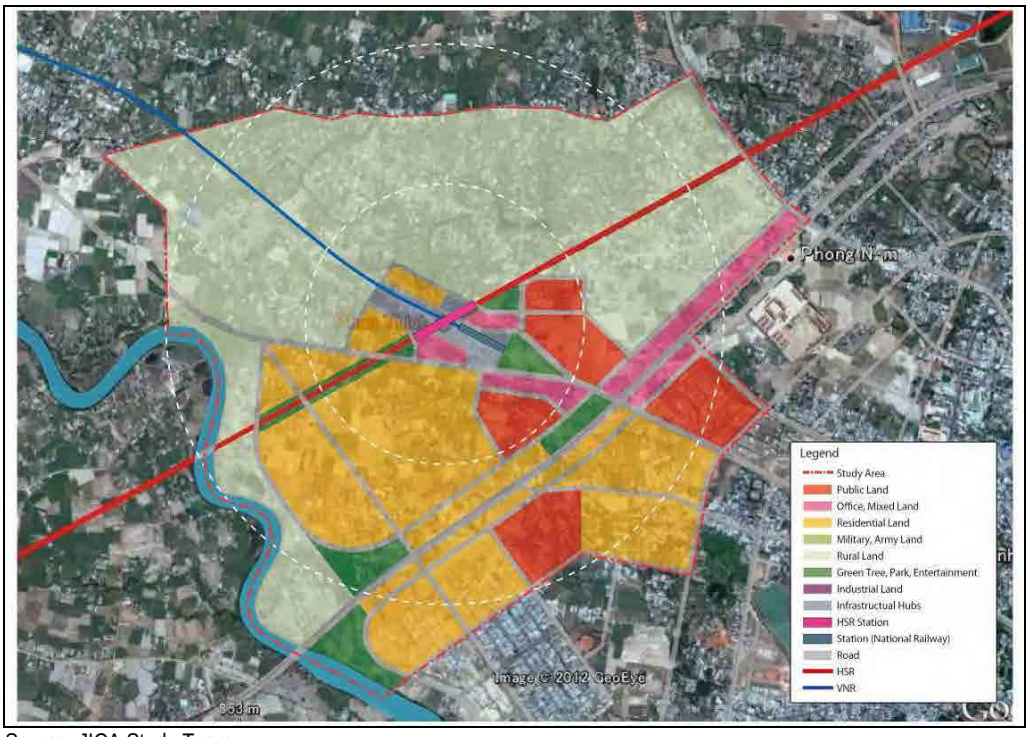
Source: JICA Study Team

Figure 5.2.15 Future Urban Structure of Phan Thiet Station Area

(3) Proposed Land Use Plan for Station Area

5.31 For the realization of the concept plan, a tourist information center, commercial areas, and green spaces are proposed to be developed in front of the station. This aims to attract users, especially tourists, and increase their convenience. New residential areas and public service areas are proposed to be developed around the commercial areas. The station's northern area is proposed to be preserved as a rural village and agricultural area

5.32 The proposed land use plan for Phan Thiet Station area is shown below (see Figure 5.2.16).



Source: JICA Study Team

Figure 5.2.16 Land Use Plan for Phan Thiet Station Area

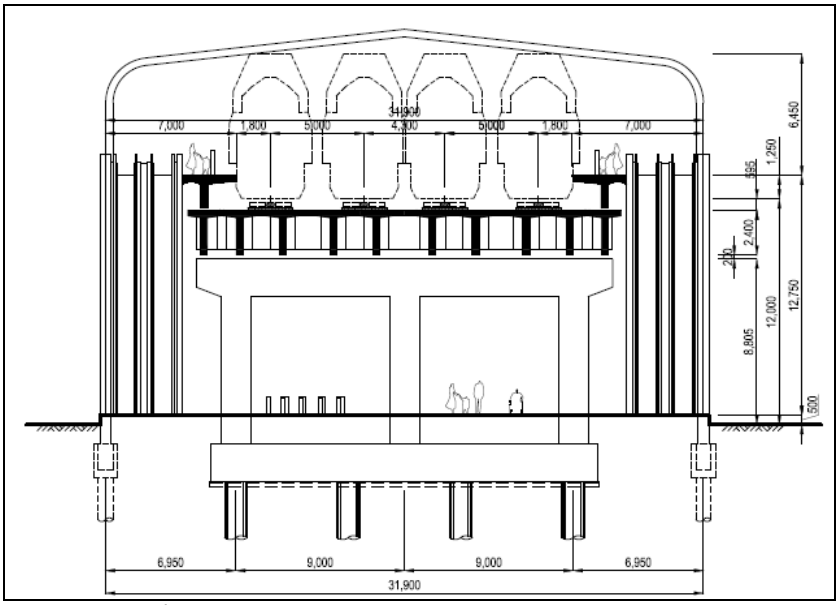
Tourist Information Center	Commercial Area near the Station
	
Residential Area	Green Space near the Station
	

Source: JICA Study Team

Figure 5.2.17 Image of Future Phan Thiet Station Area

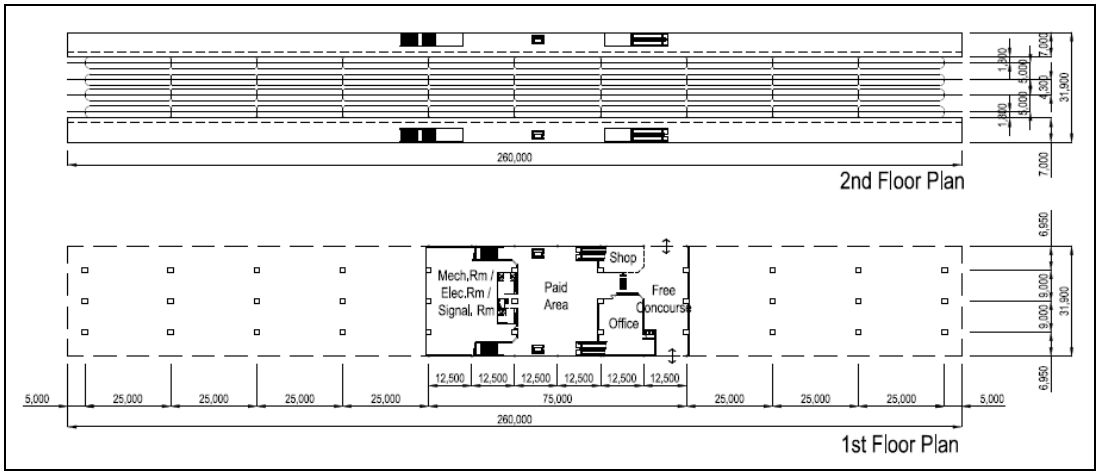
(4) Station and the Related Facilities

(a) Station Building



Source: JICA Study Team

Figure 5.2.18 Cross-sectional View of Phan Thiet Station

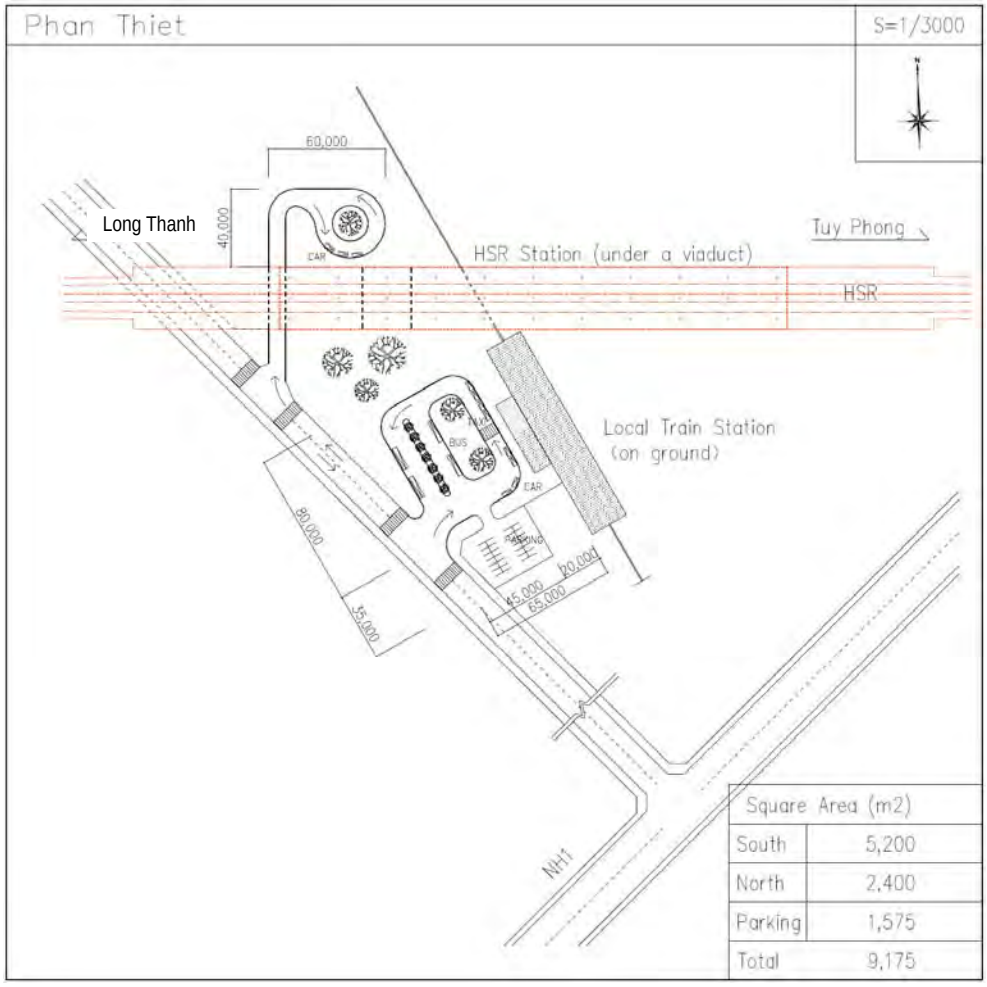


Source: JICA Study Team

Figure 5.2.19 Top View of Phan Thiet Station

(b) Station Square

5.33 The station square will be sited north and south of the station. The existing square in the south will be renovated and will receive passengers from the city center. The northern square will have a park-and-ride facility and will be the gate of the planned urban area. The squares' total land area is estimated to be over 9,000 m^2.



Source: JICA Study Team

Figure 5.2.20 Top View of Phan Thiet Station Square

4) Tuy Phong Station

(1) Location and Existing Conditions

5.34 Tuy Phong Station will be located 100 m north of NH1A in Hoa Minh commune, Tuy Phong district, Binh Thuan province.

5.35 At present, the area is devoted to agriculture with small, rural villages scattered throughout. In the current urban plan, a new administrative area, as well as commercial and residential areas, are planned to be located in this area. A new tourism area is also being planned south of the district. A development area north of the station has been secured.

5.36 The Tuy Phong Station area offers development opportunities because of its proximity to a new urban center and the availability of land.

Location of Proposed HSR Station	NH1 near the Proposed HSR Station
	

Source: JICA Study Team

Figure 5.2.21 Existing Conditions in Tuy Phong Station Area

(2) Concept Plan for Station Area

5.37 Following the current urban plan for Tuy Phong district, the Tuy Phong Station area is proposed to become the new urban center in Tuy Phong district. For this reason, this area is also proposed to offer administrative services and commercial spaces. Residents and workers are expected to enjoy comfortable urban living with public transport and a natural environment.

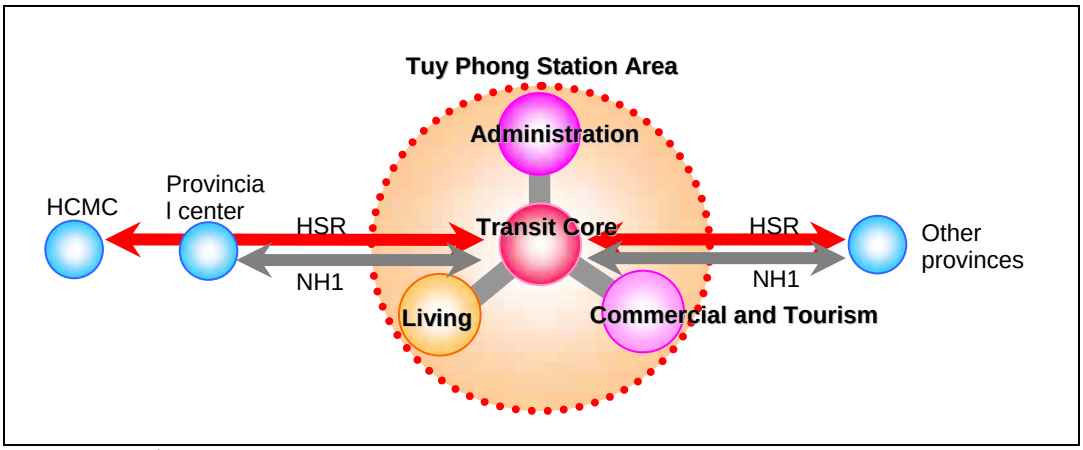
5.38 The proposed vision for Tuy Phong Station area is as follows:

(i) New urban center in Tuy Phong district;

(ii) Integrated urban space with administrative, commercial, and tourist services; and

(iii) Urban living in harmony with the natural environment.

5.39 The proposed urban structure of Tuy Phong Station area is shown below (see Figure 5.2.22).



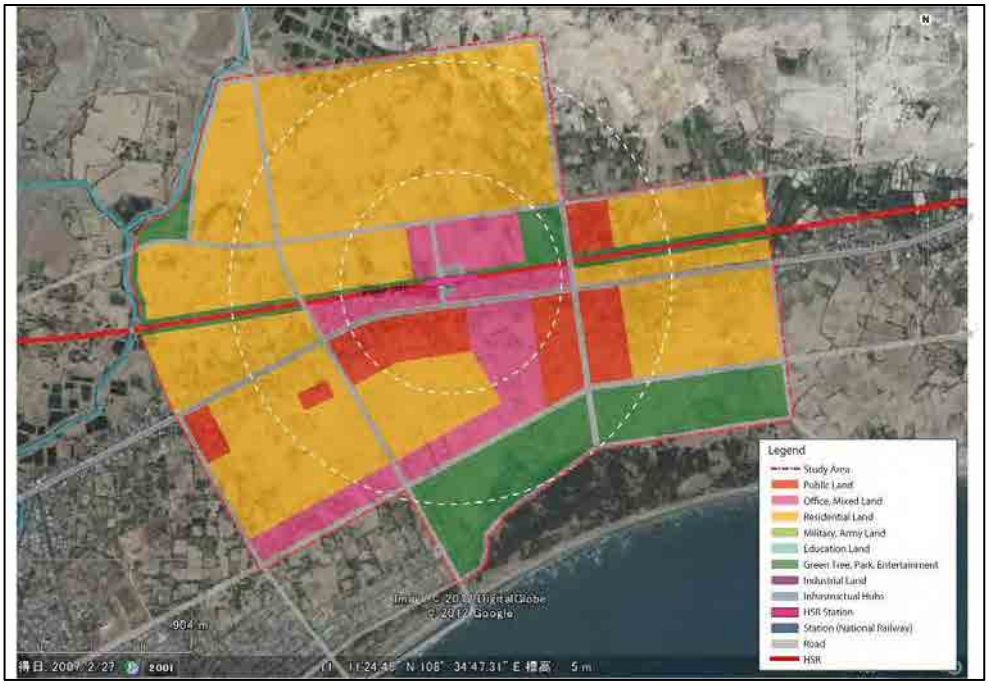
Source: JICA Study Team

Figure 5.2.22 Future Urban Structure of Tuy Phong Station Area

(3) Proposed Land Use Plan for Station Area

5.40 To realize the concept plan, commercial and business areas are proposed to be developed in front of the station. The commercial area will consist of shopping centers, tourist information centers, souvenir shops for special local products, hotels, and restaurants to increase convenience and ridership among railway passengers, tourists, and residents. The administrative and residential areas are proposed to be established along the access road and NH1, and around the commercial and administrative areas, respectively.

5.41 The proposed land use plan for Tuy Phong station area is shown below (see Figure 5.2.23).



Source: JICA Study Team

Figure 5.2.23 Land Use Plan for Tuy Phong Station Area

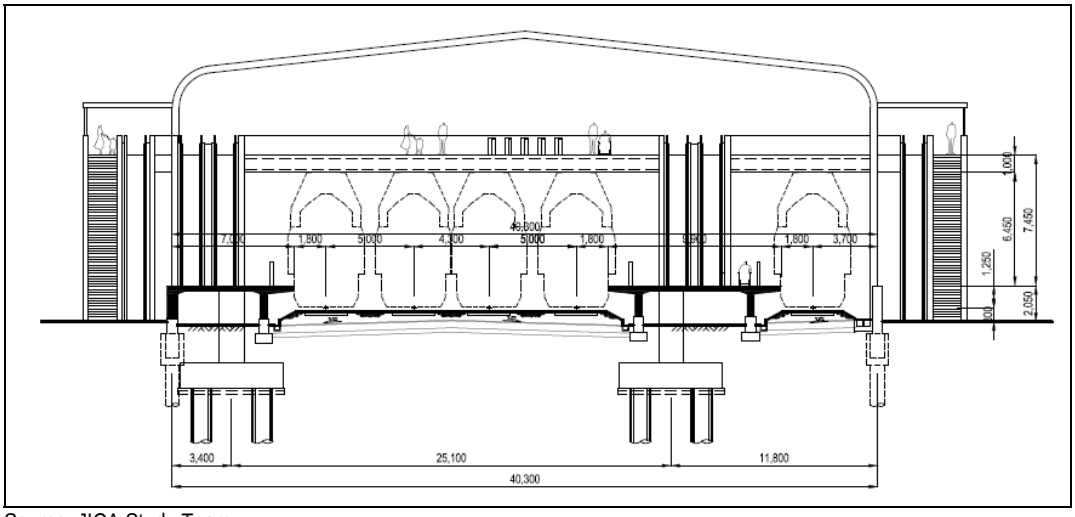
Source: JICA Study Team

Figure 5.2.24 Image of Future Tuy Phong Station Area

(4) Station and the Related Facilities

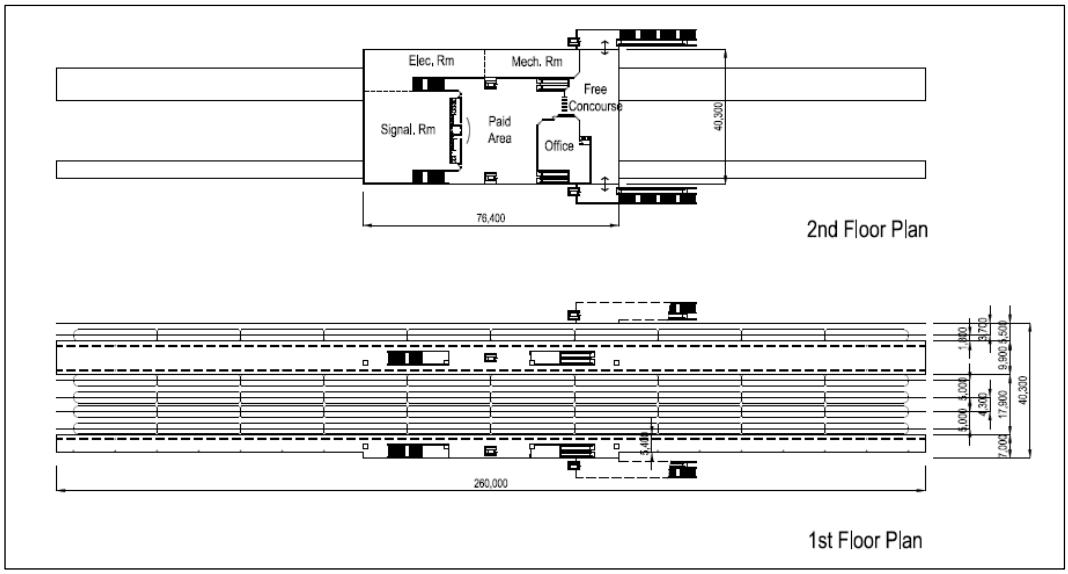
(a) Station Building

5.42 Tuy Phong Station is planned to be at grade. It will have two (2) side platforms serving four (4) lines and one test line on the first floor and a concourse on the second floor. The local railway station is more than 5 km north of the city center. Tuy Phong station will be a single station.



Source: JICA Study Team

Figure 5.2.25 Cross-sectional View of Tuy Phong Station

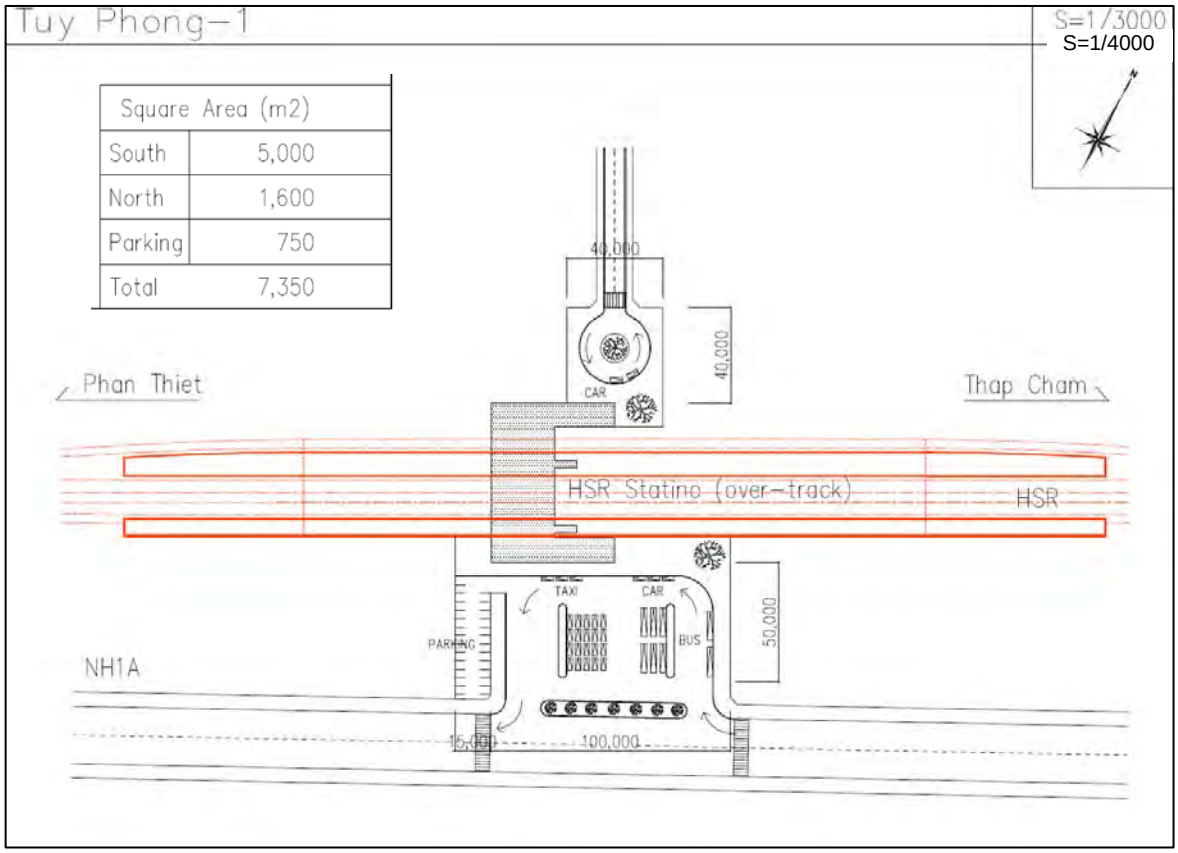


Source: JICA Study Team

Figure 5.2.26 Top View of Tuy Phong Station Plan

(b) Station Square

5.43 The station square will be sited south and north side of the station. The southern square will receive passengers coming from the city center and NH1A. The northern square will receive those coming from the planned urban zones and other areas. The square will have a total area of about 7,350 m^2 with bus and taxi berths, as well as car park.

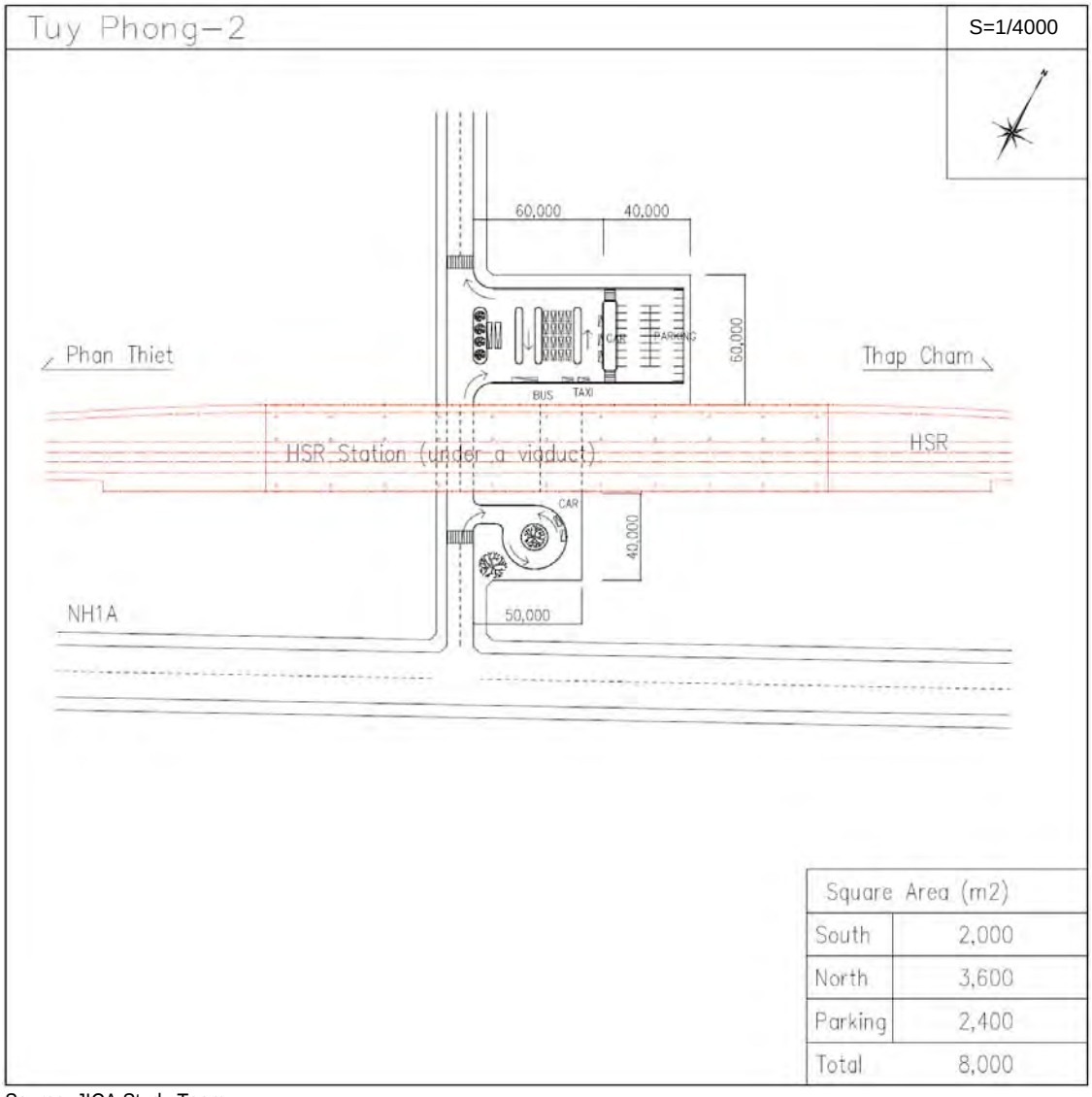


Source: JICA Study Team

Figure 5.2.27 Top View of Tuy Phong Station Square

(c) Station Square (Alternative)

5.44 Based on the Tuy Phong city master plan approved in 2010, the northern part of the station area will be a residential area. Considering the possibility of development of the area, the HSR station will be elevated to allow a local road to pass under the railway and connect to the city center and the planned development area. Under this situation, the northern part of the station will function as the main square. The station square will have an area of about 8,000 m^2.



Source: JICA Study Team

Figure 5.2.28 Top View of Tuy Phong Station Square (Alternative)

5) Thap Cham Station

(1) Location and Existing Conditions

5.45 Thap Cham Station is planned to be built beside a local railway station which is 7 km west of Thap Cham city center. The historical temple Poklong Garai is an important landmark and the HSR station will be sited in front of it.

5.46 In the area surrounding the planned station can be found a VR factory, vacant land, rural villages, and residential areas. In the current urban plan for this area, the HSR station area is planned as an improved residential area with a commercial and business area in front of the historical site. The Thap Cham Station area has a development potential as a new urban sub-center based on its historical resource and land availability.

Location of Proposed HSR Station	Surroundings of Existing Station
	
Poklong Garai View from Proposed Station Site	Access Road West of Station Area
	

Source: JICA Study Team

Figure 5.2.29 Existing Conditions in Thap Cham Station Area

(2) Concept Plan for Station Area

5.47 As a new urban sub-center of Thap Cham City, the Thap Cham Station area is proposed to functions as a transportation hub connecting the urban area of Thap Cham City and the tourist spots in the area such as Ninh Chu beeach and Da Lat. To create synergy in attracting passengers, this area is also proposed as a tourism and commercial center. Residents and workers in this area will commute to the city center using public transport and enjoy a comfortable life within a natural environment.

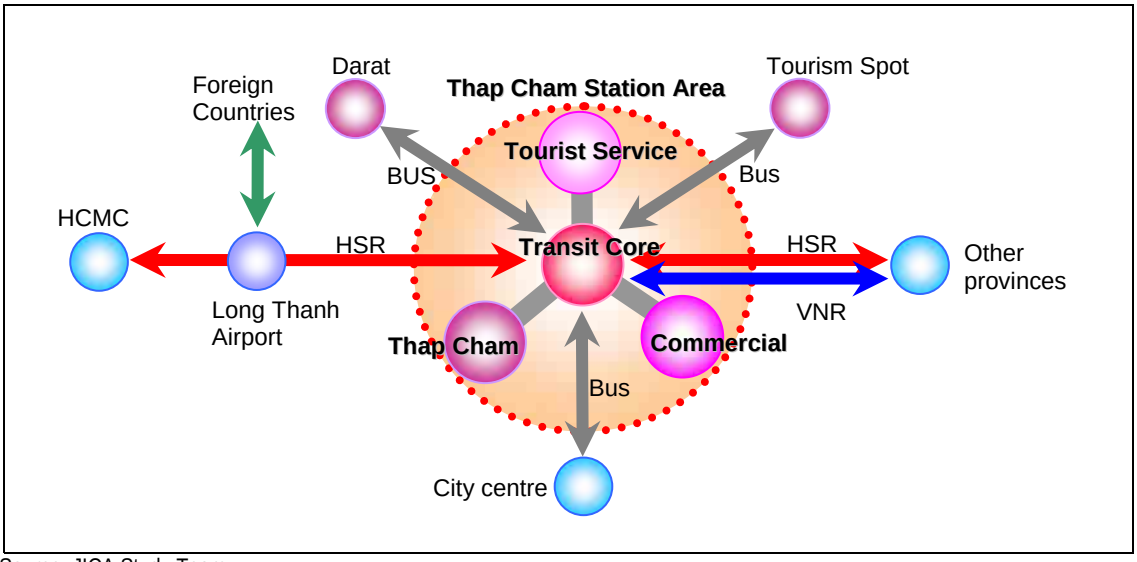
5.48 The proposed vision for Thap Cham Station area is as follows:

(i) Transport core connecting to the inner city and tourism spots;

(ii) Tourism and commercial center using Thap Cham's historical resources; and

(iii) Urban living in harmony with the natural environment.

5.49 The proposed urban structure of Thap Cham Station area is shown below (see Figure 5.2.30).



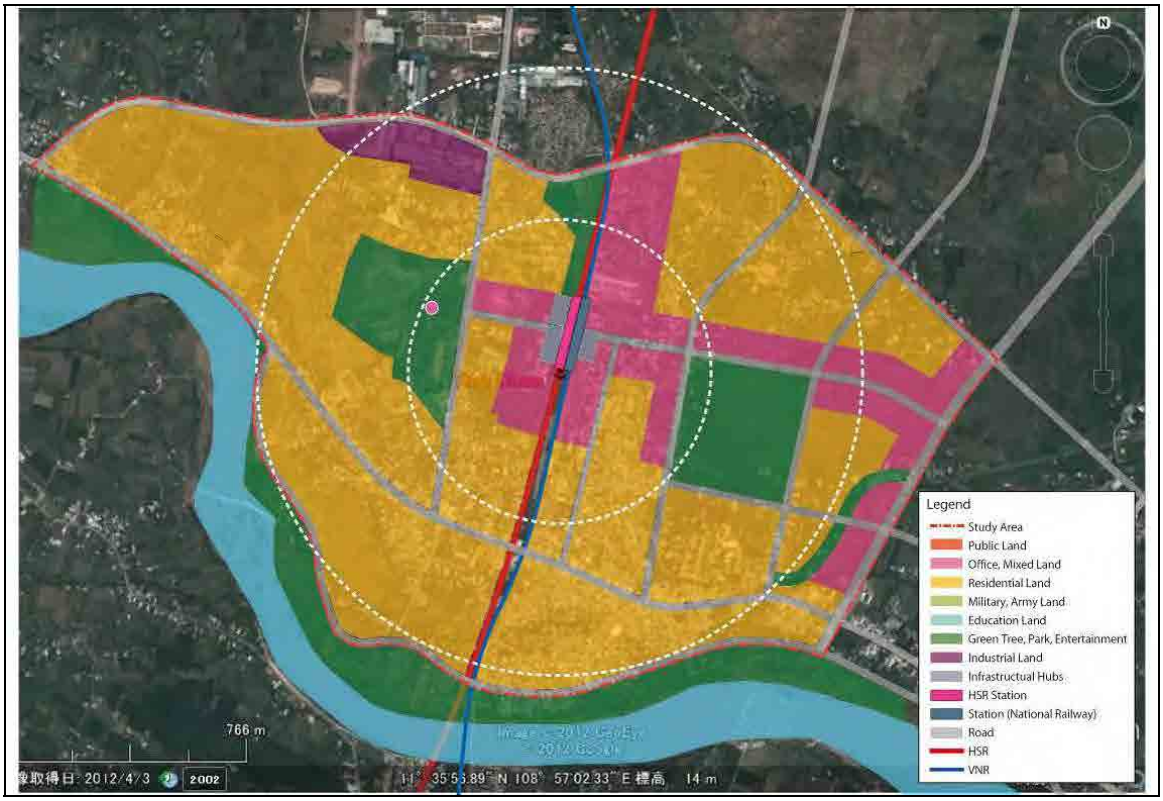
Source: JICA Study Team

Figure 5.2.30 Future Urban Structure of Thap Cham Station Area

(3) Proposed Land Use Plan for Station Area

5.50 For the realization of the concept plan, commercial and business areas are proposed to be developed around the station. The commercial area is proposed to consist of shopping centers, tourist information centers, souvenir shops for special local products, hotel, and restaurants, to increase the convenience of railway passengers and attract more users among tourists and residents. The new administrative area is proposed to be developed along the access road and NH1, while the residential area is proposed to be developed around the commercial and administrative areas.

5.51 The proposed land use plan for Thap Cham station area is shown in Figure 15.2.31.



Source: JICA Study Team

Figure 5.2.31 Land Use Plan for Thap Cham Station Area

Commercial Area nearby Station	Tourist Information Center
	
Traditional Festival at Station Plaza	Symbol Road
	

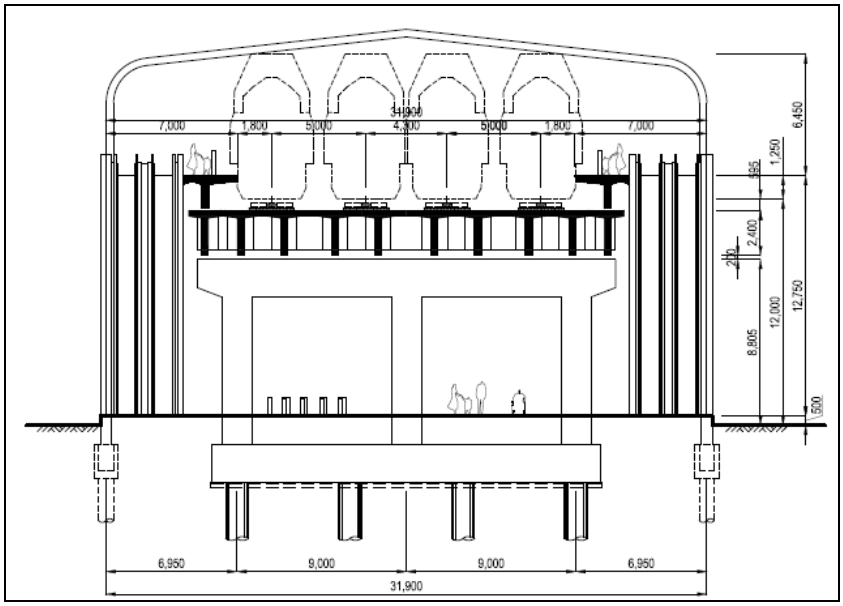
Source: JICA Study Team

Figure 5.2.32 Image of Future Thap Cham Station Area

(4) Station and Station Square

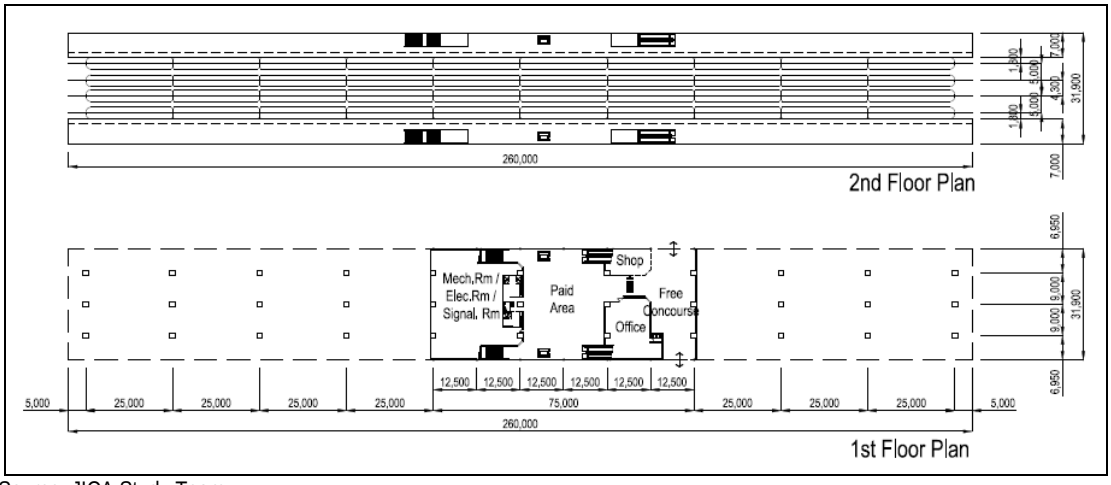
(a) Station Building

5.52 Thap Cham Station is planned to have two stories with two (2) side platforms serving four (4) lines on the second floor. The concourse will be on the first floor and will connect to the local railway via the latter's concourse which is recommended to be elevated as well.



Source: JICA Study Team

Figure 5.2.33 Cross-sectional View of Thap Cham Station

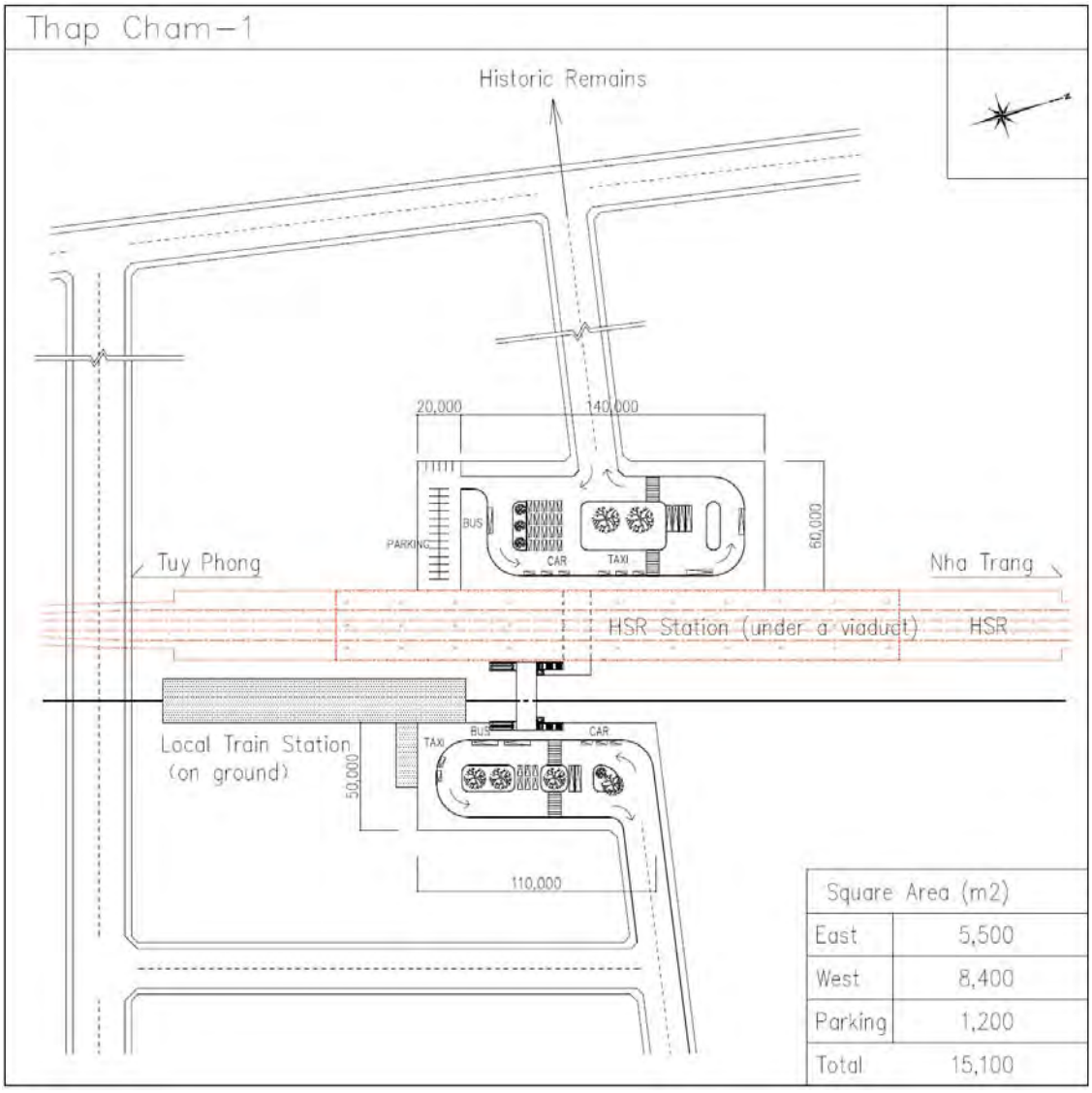


Source: JICA Study Team

Figure 5.2.34 Top View of Thap Cham Station Plan

(b) Station Square

5.53 The station square will be sited west and east of the station. The western square will be in the line of sight of the historical temple, Poklong Garai. Many tourists are expected to use this square. The eastern square will be used to transfer to the local railway and by passengers coming from the city center. The total area of the station square is estimated to be 15,100 m^2.

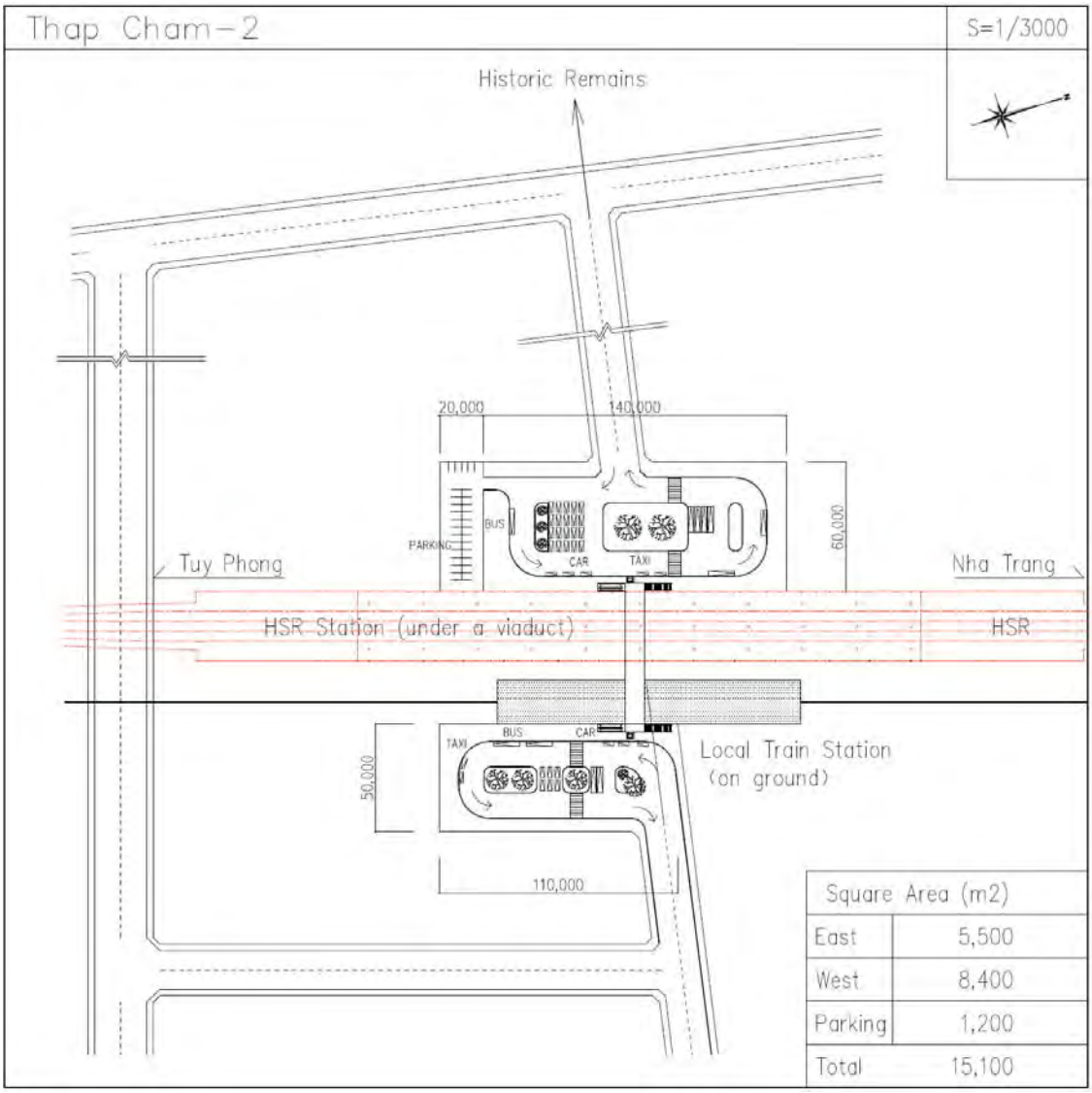


Source: JICA Study Team

Figure 5.2.35 Top View of Thap Cham Station Square

(c) Station Square (Alternative)

5.54 Considering the improvement of the local railway, the existing station will shift to the front of the HSR station for easy access. The concourse for the local railway will be on the second floor and will connect to the HSR concourse on the second floor of the HSR station. Under this situation, the HSR platforms will be on the third floor.



Source: JICA Study Team

Figure 5.2.36 Top View of the Alternative Thap Cham Station Square

6) Nha Trang Station

(1) Location and Existing Conditions

5.55 Nha Trang Station is planned to be located in Vinh Thanh commune, 4 km west of the city center. It will be the northern terminal station of the HSR's southern route. The local railway station will be moved beside this HSR station. Nha Trang station will also be one of the terminal stations of the local railway. This station will thus become a strategic point in the transport network of Nha Trang City.

5.56 In the planned station area, rural villages and agricultural land are scattered at present, while land along NH1 is urbanized. In the current urban plan, the station area is planned as an improved village area and with mixed uses along the arterial road. The Nha Trang Station area has a potential to become a new urban sub-center of Nha Trang City for its high land availability.

Location of Proposed HSR Station	Surroundings of Proposed HSR Station
	
Existing Public Office	NH1 nearby Proposed HSR Station
	

Source: JICA Study Team

Figure 5.2.37 Existing Conditions in Nha Trang Station Area

(2) Concept Plan for Station Area

5.57 As a new urban sub-center in Nha Trang City, the Nha Trang Station area is proposed to become as a transportation core, connecting the urban center and tourist spots such as Nha Trang beach and Da Lat. To create synergy in luring more passengers, this area is also proposed to be formed as a tourism and commercial core.

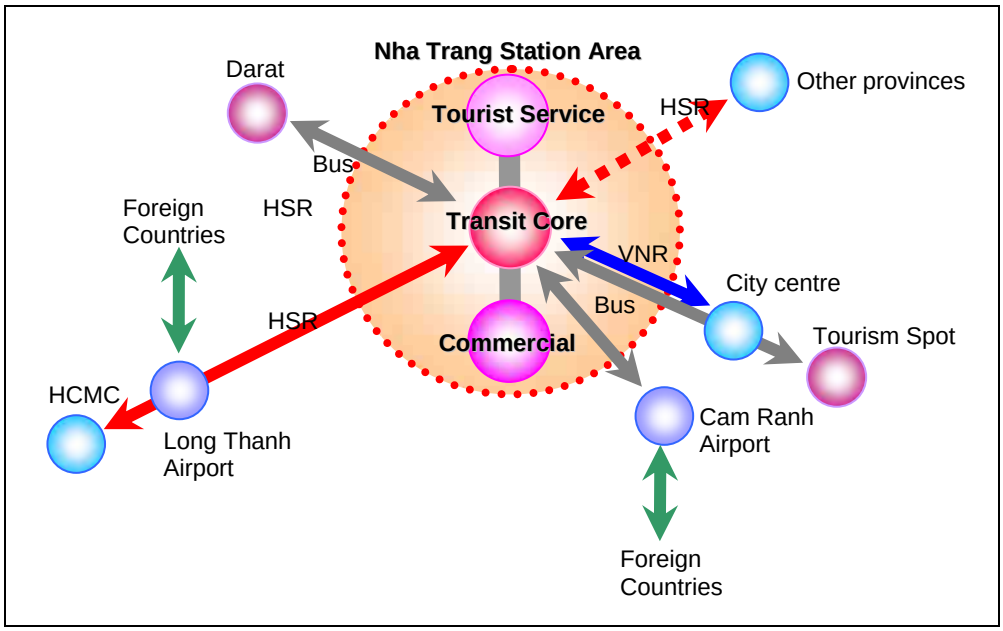
5.58 The proposed vision for Nha Trang Station area is as follows:

(i) Transport core connecting the urban center and tourism spots;

(ii) Tourism and commercial core linking tourism spots; and

(iii) Promoter of urban living in harmony with the natural environment.

5.59 The proposed urban structure of Nha Trang Station area is shown below (see Figure 5.2.38).



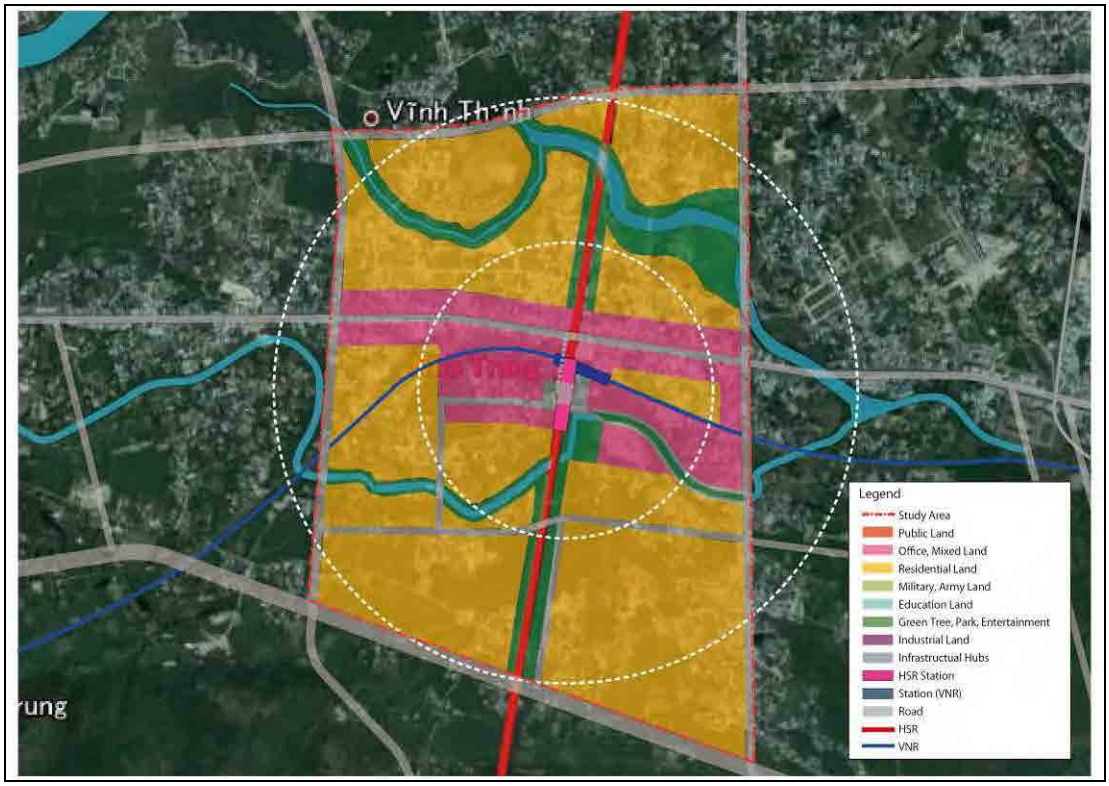
Source: JICA Study Team

Figure 5.2.38 Future Urban Structure of Nha Trang Station Area

(3) Proposed Land Use Plan for Station Area

5.60 For realization of the concept plan, commercial area is proposed to be developed in front of station and along access road. This commercial area is proposed to consist of shopping center, tourist information center, souvenir shops for special local products, hotel and restaurants. This aims to increase convenience and attractiveness for railway passenger, tourist and residents. New residential area is proposed to be developed surroundings of commercial area.

5.61 The proposed land use plan for Nha Trang Station area is shown in Figure 5.2.39.



Source: JICA Study Team

Figure 5.2.39 Land Use Plan for Nha Trang Station Area

Commercial Complex	Commercial Area nearby Station
	
Tourist Information Center	Symbol Road
	

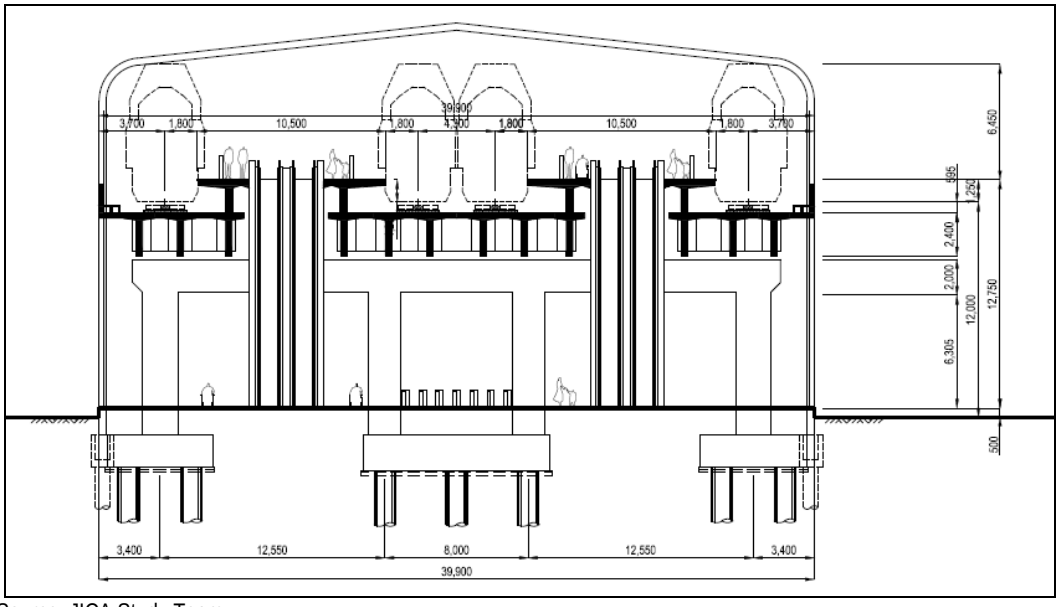
Source: JICA Study Team

Figure 5.2.40 Image of Future Nha Trang Station Area

(4) Station and the Related Facilities

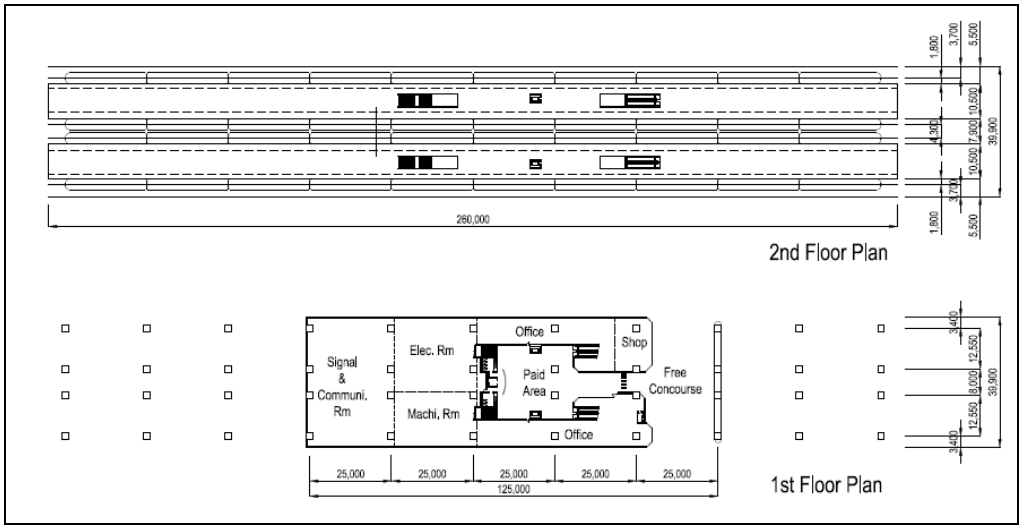
(a) Station Building

5.62 Nha Trang Station is planned to have two stories with two (2) island platforms on the second floor serving four (4) lines and a concourse on the first floor. Connection with the local railway will be through the station square which will lead to the concourse of the local station.



Source: JICA Study Team

Figure 5.2.41 Cross-sectional View of Nha Trang Station

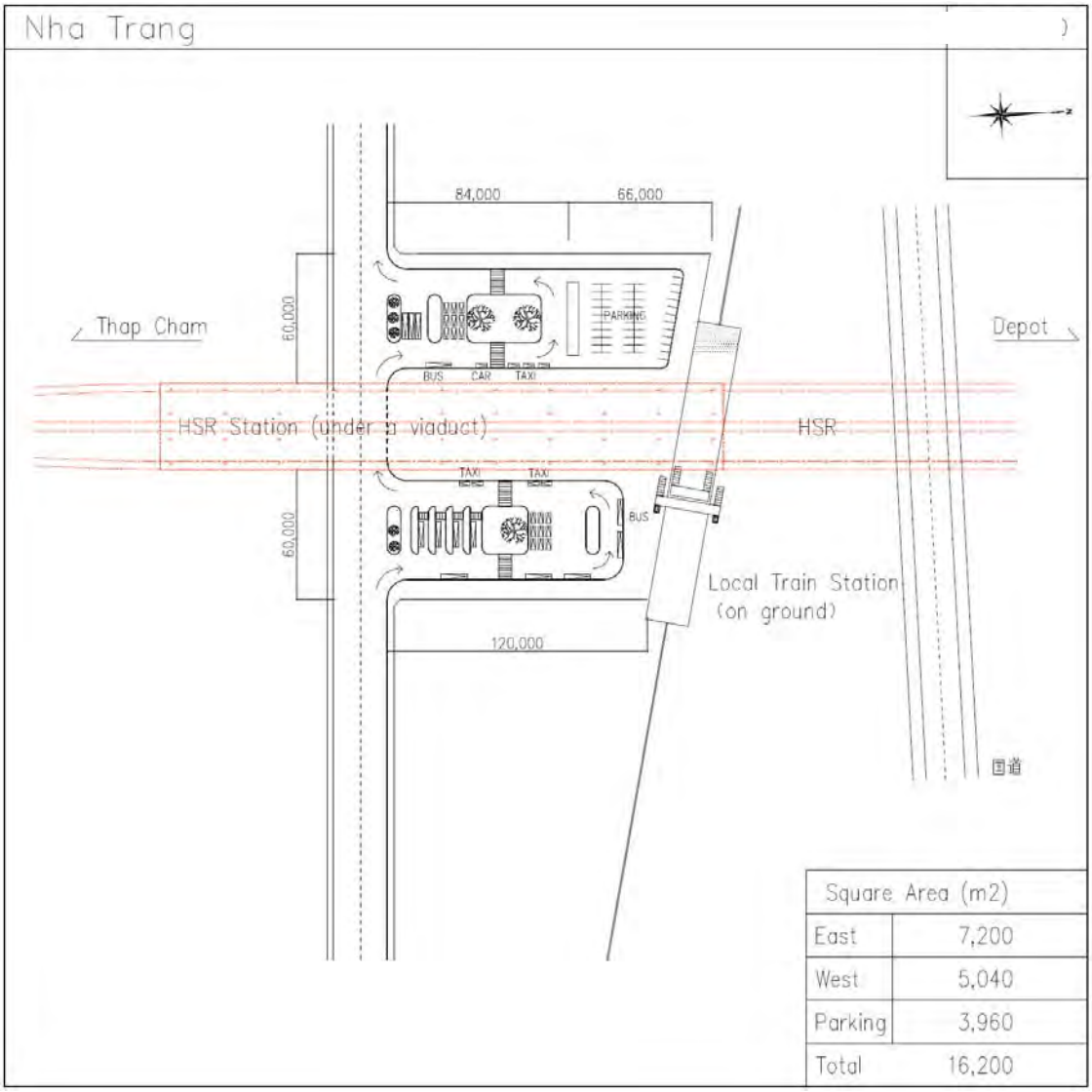


Source: JICA Study Team

Figure 5.2.42 Top View of Nha Trang Station Plan

(b) Station Square

5.63 The station square will be sited east and west of the station. The eastern square will have bus and taxi berths, while the western square will have park-and-ride with a car park. Connection to the local railway will be through the eastern square and a pedestrian deck. The total area of the station square will be about 16,200 m^2.



Source: JICA Study Team

Figure 5.2.43 Top View of Nha Trang Station Square

7) Summary of Station Elements

(1) Platform Length

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

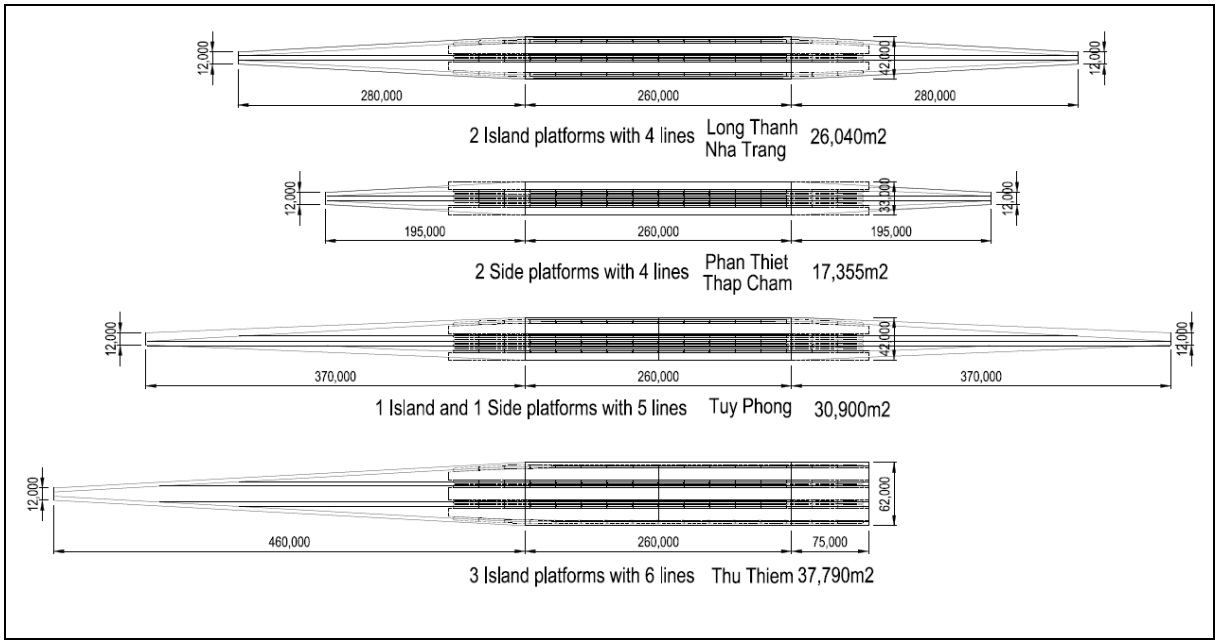
5.65 Platform length is designed to be 260 m (5 m extra + 25 m x 10 trains + 5 m extra). In the future, the platform will be expanded by 75 m at both ends, bringing the total length to 410 m (75 m + 260 m + 75 m).

(2) Safety Fence

5.66 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 high-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

5.67 Considering the number of platforms and railway lines with a minimum radius in train operation which is estimated at 1200 m, station areas will be fixed. Areas of each station are shown in Figure 5.2.44.



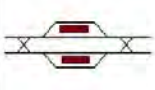
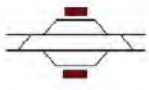
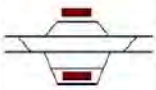
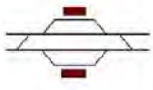
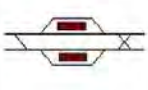
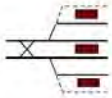
Source: JICA Study Team

Figure 5.2.44 Station Areas

(4) Summary of Station Elements

5.68 A summary of HSR station elements is shown below.

Table 5.2.1 HSR Station Elements

Station Name	Nha Trang	Thap Cham	Tuy Phong	Phan Thiet	Long Thanh	Thu Thiem
Location	362K100m	283K600m	220K450m	153K200m	36K050m	0K000m
Track layout						
Station Section						
Station Type	Elevated	Elevated	Ground	Elevated	Shallow Trench	Elevated
Platform Type	Island Platform	Side Platform	Island/Side Platform	Side Platform	Island Platform	Island Platform
Platform Length (m)	260	260	260	260	260	260
Platform Width (m)	10.5 + 10.5	7.0 + 7.0	9.9 + 7.0	7.0 + 7.0	10.5 + 10.5	11.5 + 12.1 + 11.5
Station Area (m2)	26,100	17,400	30,900	17,400	26,100	37,800
Platform Floor Area (m2)	10,400	8,300	10,500	8,300	10,400	16,100
Concourse Floor Area (m2)	5,000	2,400	3,100	2,400	3,400	7,800
Place of Gate (Transfer)	1(0)	1(0)	1(0)	1(0)	1(0)	1(0)
Elevator (Paid Area/ Public Area)	2/2	2/2	2/2	2/0	2/0	3/0
Escalator (Paid Area/ Public Area)	4/2	4/2	4/2	4/0	4/0	6/0
Staircase (Paid Area/ Public Area)	2/2	2/2	2/2	2/0	2/0	3/0
Toilet (M/F/ Disable)	1/1/1	1/1/1	1/1/1	1/1/1	1/1/1	1/1/1
Connection with other railway	To be Connected	To be Connected	None	To be Connected	To be Connected	To be Connected

Source: JICA Study Team

6 TECHNICAL STUDIES

6.1 Train Operation Plan

1) Train Operation

6.1 A plan in terms of a train operation diagram in the Thu Thiem - NhaTrang section of the north to south high-speed railway includes the following:

(a) Passage Pattern

6.2 Trains of the non-stop express type throughout the NhaTrang - Thu Thiem section will be set. The passage type trains will stop at Thap Cham stations in and after 2035. At the Long Thanh station, the number of boarding/alighting passenger exceeds 10,000 in 2040. Despite that, the passage type trains will not stop at the station, with the boarding/alighting passengers required to use the stoppage trains coming from the adjacent Thu Thiem station.

(b) Stoppage Pattern

6.3 A train per two hour will be set for the type B Tuy Phong station having 1,000 boarding/alighting passengers or less per day until 2040.All stoppage trains will stop at all other stations, as they are all classified as type A to have 1,000 boarding/alighting passengers or over every day.

(c) Train Operation Diagram

6.4 We calculate the number of passage and stoppage trains per hour based on the number of boarding/alighting passengers in the NhaTrang - Thu Thiem section in fiscal 2030, 2035 and 2040.

Table 6.1.1 Stoppage/ Passage Patterns in the NhaTrang – Thu Thiem Section

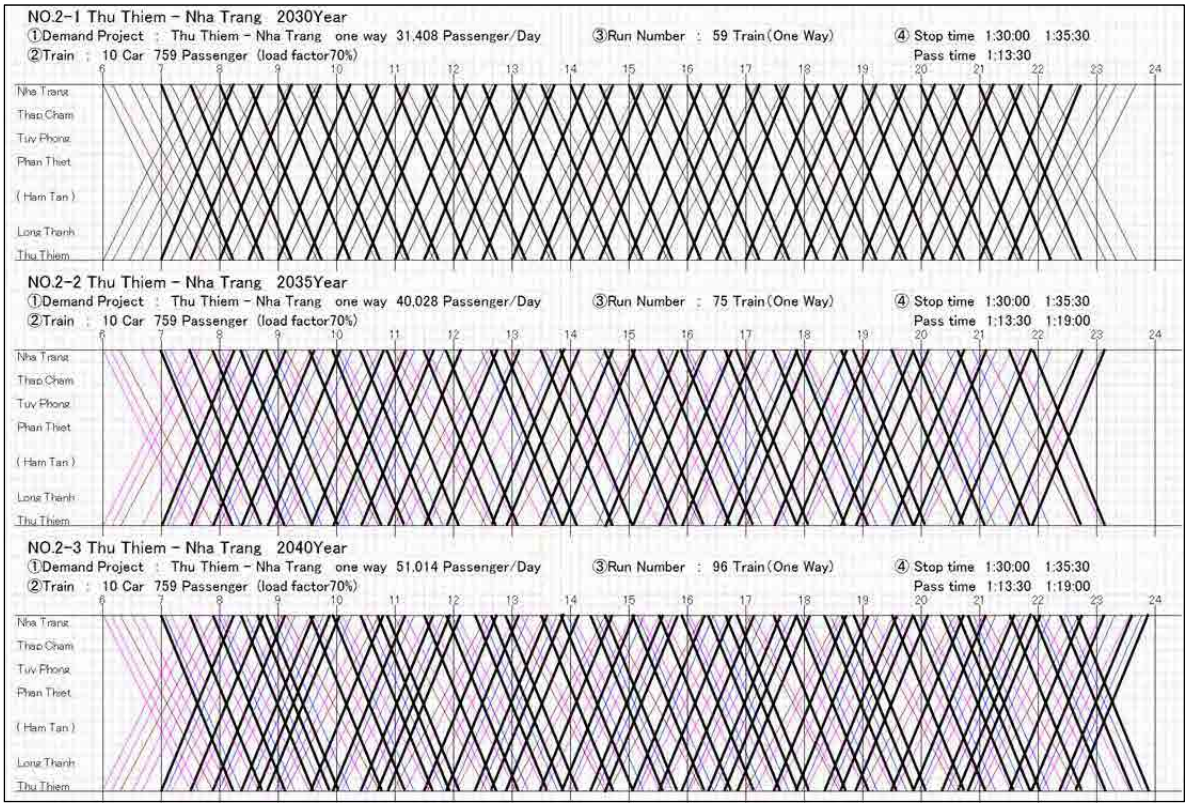
Year		Volume of Boarding and Alighting	Thap Cham	Tuy Phong	Phan THiet	Long Thanh
2030	Express type	More than 10,000	–	–	–	–
	Stop A type	More than 1,000	●	–	●	●
	Stop B type	Not more than 1,000	●	●	●	●
2035	Express type	More than 10,000	–	–	–	–
	Passage type		●	–	–	–
	Stop A type	More than 1,000	●	–	●	●
	Stop B Type	Not more than 1,000	●	●	●	●
2040	Express type	More than 10,000	–	–	–	–
	Passage type		●	–	–	–
	Stop A type	More than 1,000	●	–	●	●
	Stop B type	Not more than 1,000	●	●	●	●

Source: JICA Study Team

Table 6.1.2 Number of Trains Set for NhaTrang– ThuThiem 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	
	Stop type A	2	21	15,939	11,157	
	Stop type B	0.5	8	6,072	4,250	
	Total		59	44,781	31,347	31,408
2035	Express type	2	30	22,770	15,939	
	Passage type	1	15	11,385	7,970	
	Stop type A	2	22	16,698	11,689	
	Stop type B	0.5	8	6,072	4,250	
	Total		75	56,925	39,848	40,028
2040	Express type	3	40	30,360	21,252	
	Passage type	2	20	15,180	10,626	
	Stop type A	2	28	21,252	14,876	
	Stop type B	0.5	8	6,072	4,250	
	Total		96	72,864	51,005	51,014

Source: JICA Study Team.



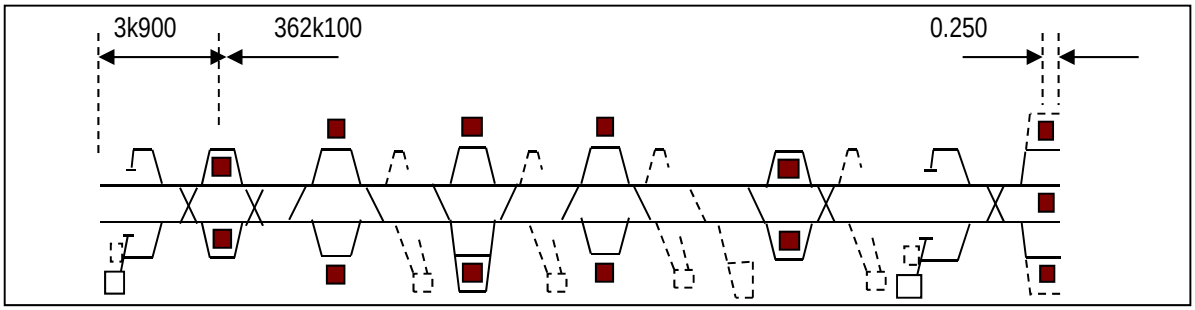
Source: JICA Study Team.

Figure 6.1.1 Train Operation Diagram

6.2 Tracks

(a) Track Equipment in the Section between Thu Thiem – Nha Trang

6.5 The main track is doubled-tracked and 366.250km long. The length of the subsidiary main track and siding tracks is 51.4km. The route length of the sections from Thu Thiem to Nha Trang 366.250km (250m+362.100km+3.900km) as shown in Figure 6.2.1. The chainage of each station, depot, and workshop and maintenance base is 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 Thu Thiem – Nha Trang

Table 6.2.1 Chainage of Each Station, Depot, Workshop, and Maintenance Base as well as track type length

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
Terminal Point	366.0					
Depot	364.9			9.6		1.8
Nha Trang	362.10		1			
Thap Cham	283.60		1			
Maintenance Base	283.60					1.8
Tuy Phong	220.45		1.5	1.5		
Maintenance Base	220.45					1.8
Phan Thiet	152.20		1			
Signal Station Maintenance Base	153.20					1.8
Maintenance Base	103.00					1.8
Long Thanh	36.05		1			
Maintenance Base	36.05					1.8
Depot	9.50			9.6		1.8
Rolling stock Workshop	9.50				11.6	
Thu Thiem	0.00		1			
Starting Point	-0.25					
Total	783.90	732.500	6.5	20.7	11.6	12.6
Track Type						
Slab	183.916	177.416	6.5			
Ballast	588.184	555.084		20.7		12.4
Special Track	11.8	0.0			11.6	0.2
Total	783.900					

Source: JICA Study Team

(b) Track length

6.6 The track length between Thu Thiem and Nha Trang is shown in Table 6.2.2. The track structure basically consists of ballast track although slab track is used on certain sections. 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 restriction 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.The tunnel located at chainage 321.905km is 291m long and uses ballast track;

(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 bases is based on measured lengths.

Table 6.2.2 Lengths according to Track Structure between Thu Thiem and Nha Trang

Unit: Single track length in km

Track Structure	Main Line	Depot Line	Sub Total
Slab	177.416	6.5	183.916
Ballast	555.084	33.1	588.184
Special track (in workshops, bases, pits, etc.)		11.8	11.8
Total	732.500	51.400	783.90

Source: JICA Study Team

Table 6.2.3 Length of Main Track in Each Province According to Track Structure

Unit: Double-tracked lengths in km

Section	City/Province	Chainage		Slab	Ballast
		from	to		
1	HCMC	-0.25	14.00	14.25	0.00
2	Dong Nai	14.00	94.25	12.32	67.93
3	Binh Thuan	94.25	254.22	26.31	133.69
4	Ninh Thuan	254.22	312.38	14.32	43.80
5	Khanh Hoa	312.38	366.00	21.508	32.122
Total			366.25	88.708	277.542

Source: JICA Study Team

Table 6.2.4 Length of Main Track According to Civil Structure and Track Structure

Unit: Single track lengths in km

Civil Structure	Route length	Track Length	Slab	Ballast
Station	4.735	9.47	9.47	0.0
Viaduct	48.825	97.650	96.37	1.28
Bridge	6.090	12.180	3.60	8.58
Tunnel	34.279	68.558	67.976	0.582
Cutting	102.831	205.662	0.0	205.662
Embankment	169.490	338.980	0.0	338.980
Total	366.250	732.500	177.416	555.084

Source: JICA Study Team

6.3 Station and Station Facilities

(1) Platform Length

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

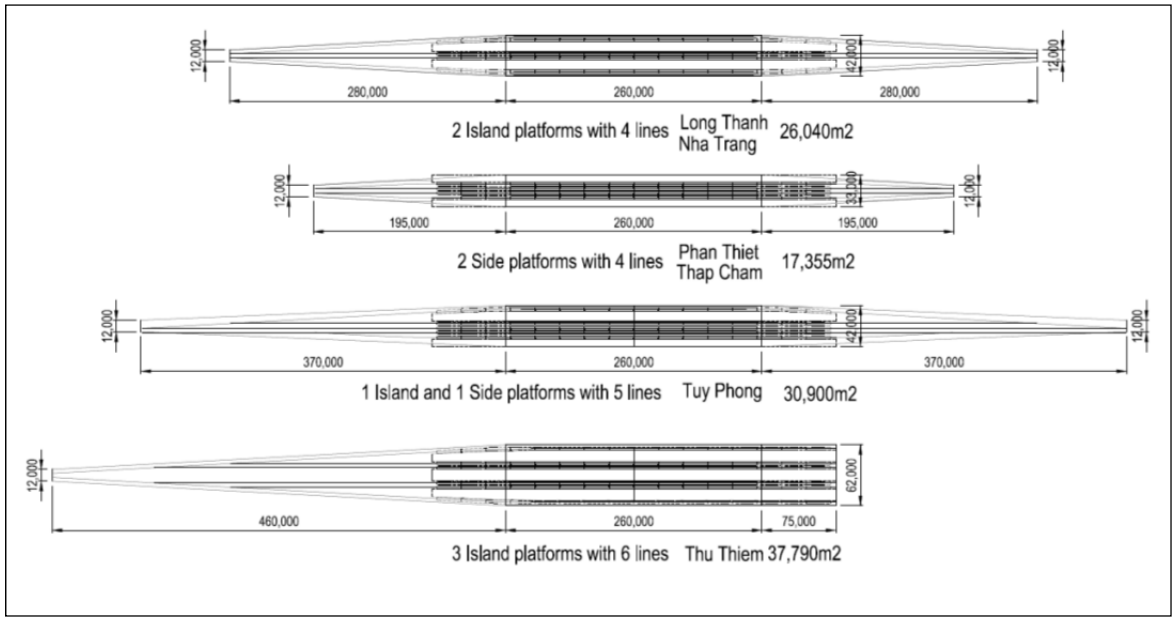
6.8 Platform length is designed at 260m (5m extra + 25m x 10 trains + 5m extra). In future, the platform will be expanded at each end 75m and total length will be 410m (75m + 260m + 75m).

(2) Safety Fence

6.9 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. Accordingto hi-speed train performance standard made by Japan Railway Construction, Transport and Technology Agency (JRTT), 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

6.10 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.



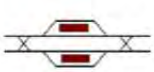
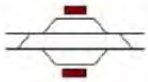
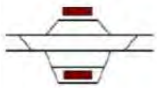
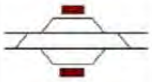
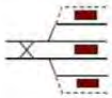
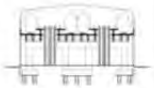
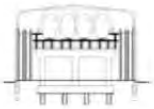
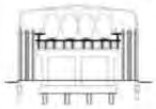
Source: JICA Study Team

Figure 6.3.1 Station Area

(4) Summary of Station Elements

Summary of HSR station elements is shown in Table 6.3.1

Table 6.3.1 Station Elements

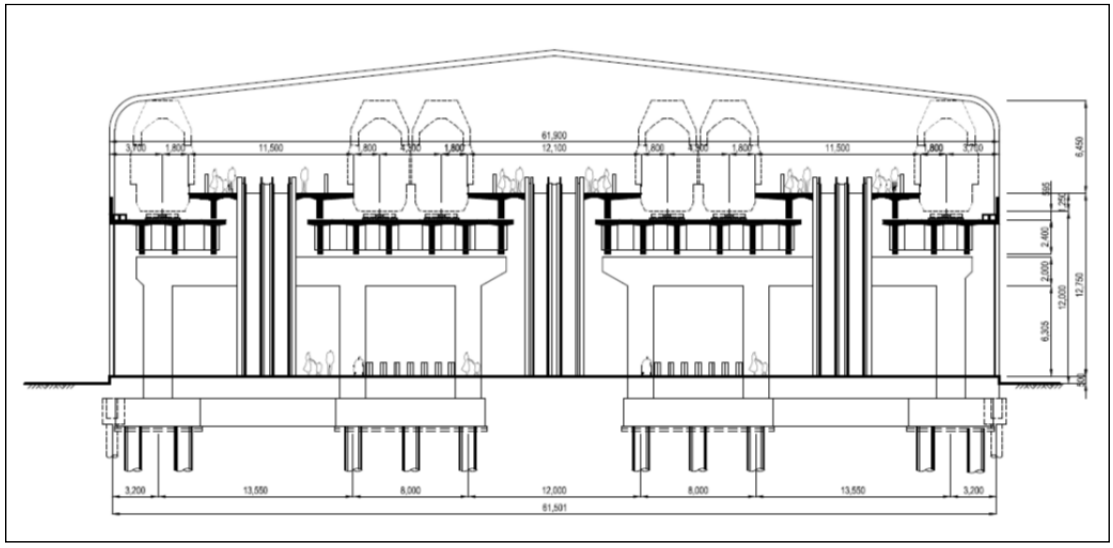
Station Name	Nha Trang	Thap Cham	Tuy Phong	Phan Thiet	Long Thanh	Thu Thiem
Location	362K100m	283K600m	220K450m	153K200m	36K050m	0K000m
Track layout						
Station Section						
Station Type	Elevated	Elevated	Ground	Elevated	Shallow Trench	Elevated
Platform Type	Island Platform	Side Platform	Island/Side Platform	Side Platform	Island/Side Platform	Island Platform
Platform Length (m)	260	260	260	260	260	260
Platform Width (m)	10.5 + 10.5	7.0 + 7.0	9.9 + 7.0	7.0 + 7.0	10.5 + 10.5	11.5 + 12.1 + 11.5
Station Area (m2)	26,100	17,400	30,900	17,400	26,100	37,800
Platform Floor Area (m2)	10,400	8,300	10,500	8,300	10,400	16,100
Concourse Floor Area (m2)	5,000	2,400	3,100	2,400	3,400	7,800
Place of Gate (Transfer)	1(0)	1(0)	1(0)	1(0)	1(0)	1(0)
Elevator (Paid Area/ Public Area)	2/2	2/2	2/2	2/0	2/0	3/0
Escalator (Paid Area/ Public Area)	4/2	4/2	4/2	4/0	4/0	6/0
Staircase (Paid Area/ Public Area)	2/2	2/2	2/2	2/0	2/0	3/0
Toilet (M/F/ Disable)	1/1/1	1/1/1	1/1/1	1/1/1	1/1/1	1/1/1
Connection with other railway	To be Connected	To be Connected	None	To be Connected	To be Connected	To be Connected

Source: JICA Study Team.

(5) Proposed Stations

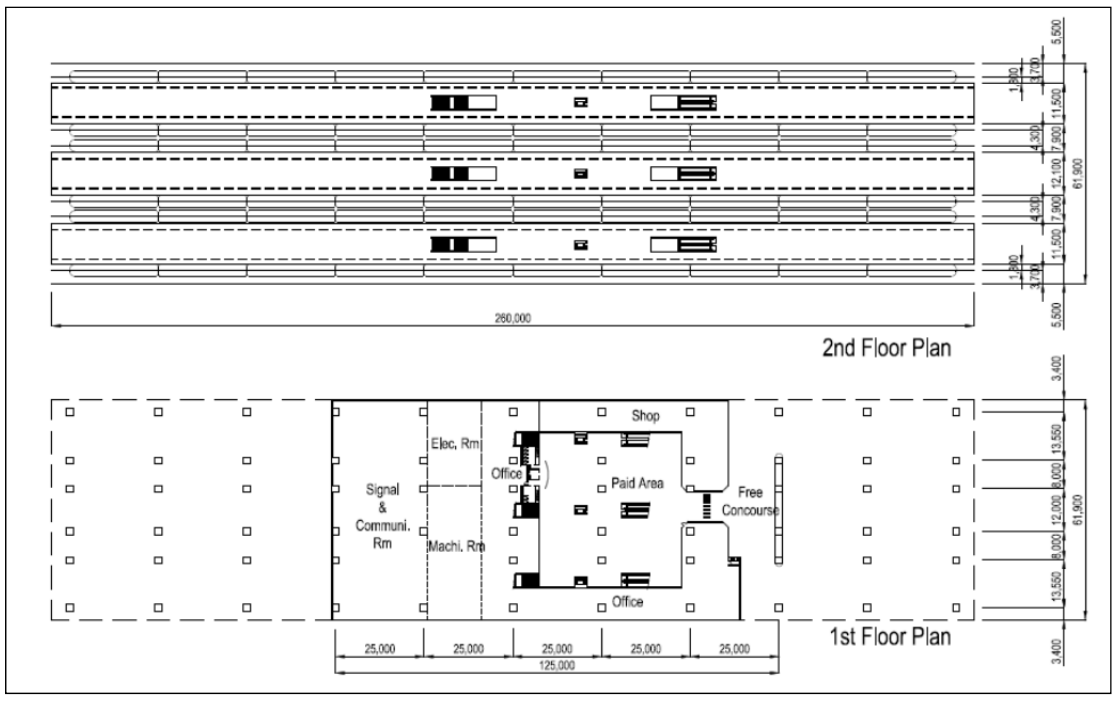
(a) Thu Thiem Station

6.11 Thu Thiem station is planned to elevated 2 stories. Three (3) island platforms with four (4) lines on 2nd floor and Concourse is 1st floor. Additional 2 lines will be operate and totally 6 lines in future. Interchanging to UMRT will be on 1st floor. For considering connection with UMRT, UMRT station shall be recommended to elevated station.



Source: JICA Study Team

Figure 6.3.2 Thu Thiem Station Plan (Cross Section)

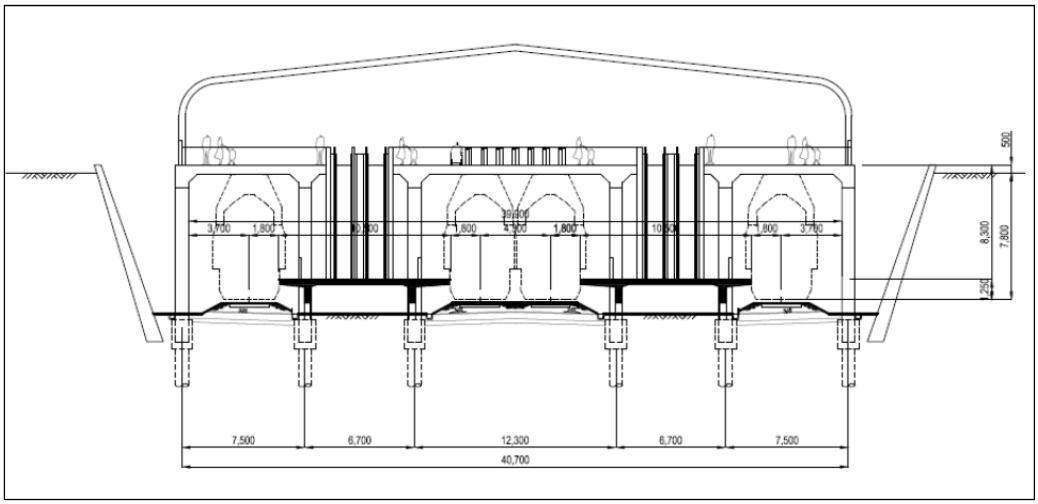


Source: JICA Study Team

Figure 6.3.3 Thu Thiem Station Plan

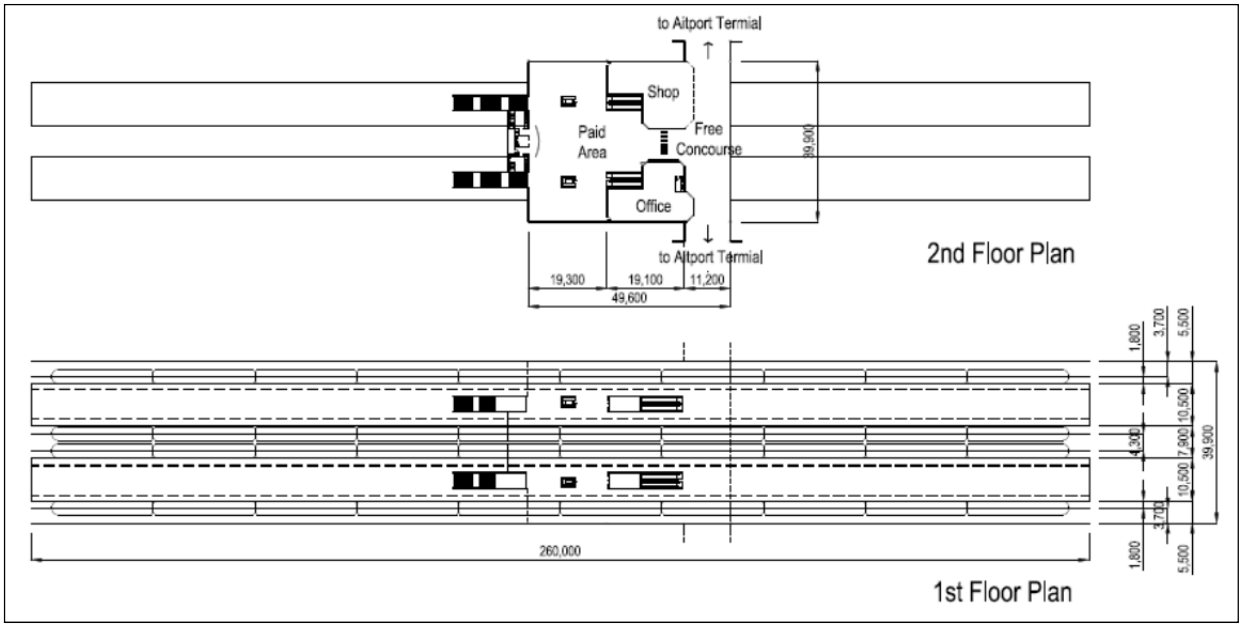
(b) Long Thanh Station

6.12 The station is planned to Shallow Trench because of access road crossing above. Two (2) island platforms with four (4) lines on basement and concourse is ground floor.



Source: JICA Study Team

Figure 6.3.4 Long Thanh Station Plan (Cross Section)

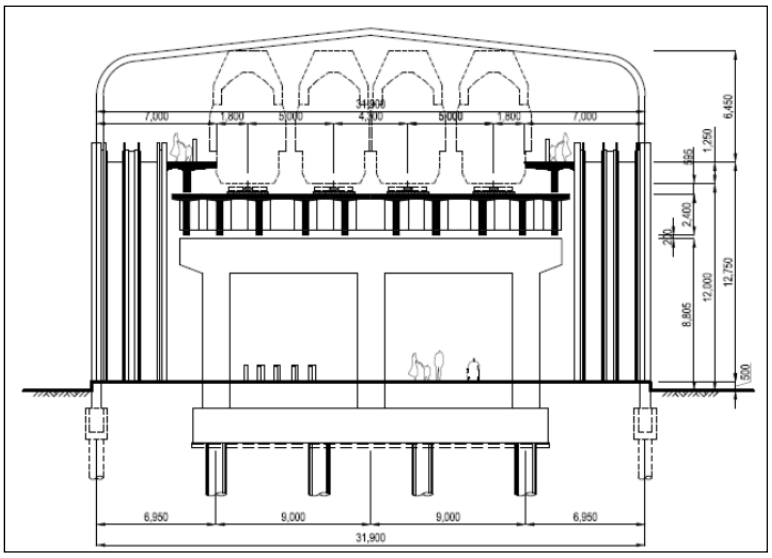


Source: JICA Study Team.

Figure 6.3.5 Long Thanh Station Plan

(c) Phan Thiet Station

6.13 HSR PhanThiet 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 pass station square and connect to concourse of local station.



Source: JICA Study Team

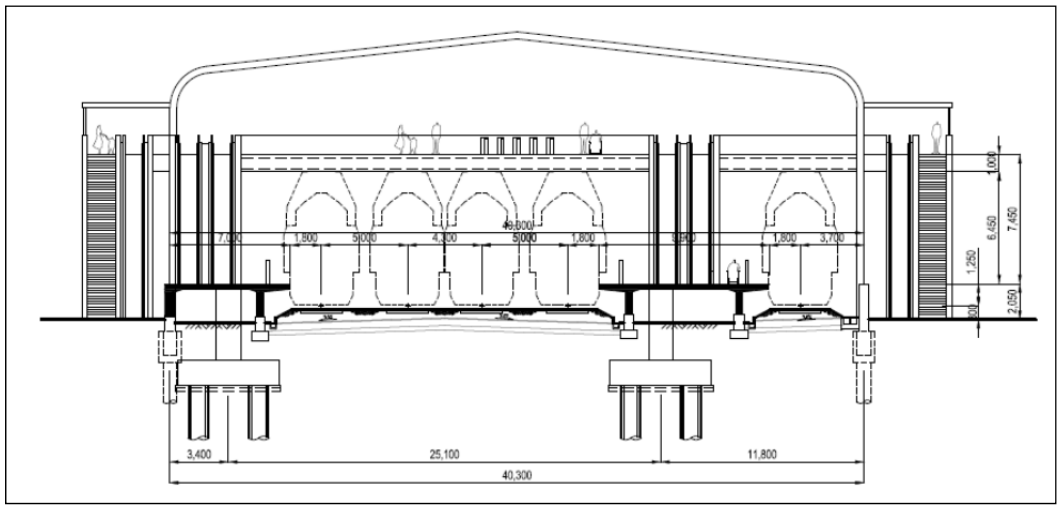
Figure 6.3.6 Phan Thiet Station Plan (Cross Section)

Source: JICA Study Team

Figure 6.3.7 Phan Thiet Station Plan

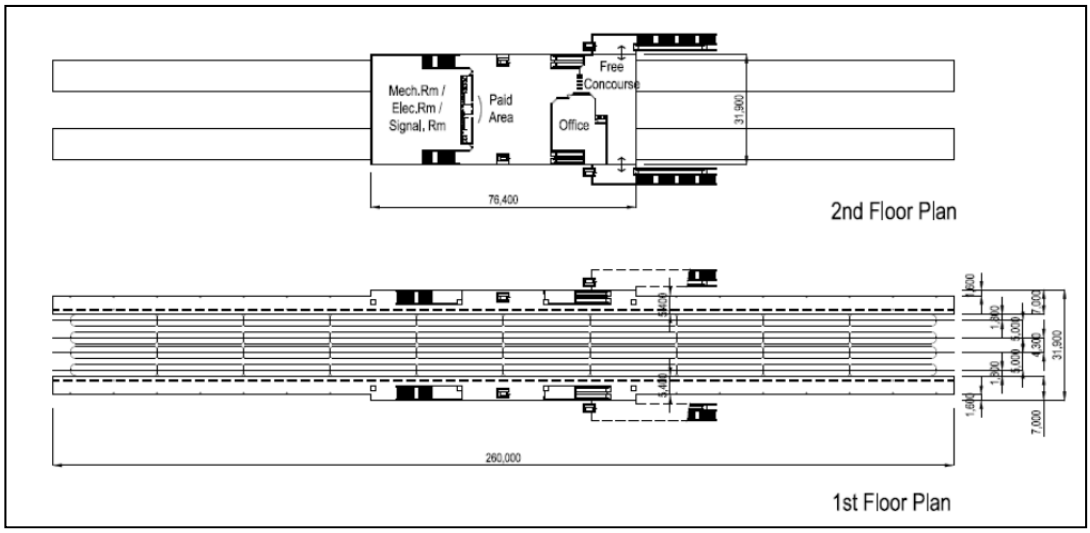
(d) Tuy Phong Station

6.14 Tuy Phong station is planned ground station. Two (2) side platforms with four (5) lines on 1st floor including one (1) testing line and concourse is 2nd floor. Local railway station is more than 5km north from city center and Tuy Phong station is single station.



Source: JICA Study Team.

Figure 6.3.8 Tuy Phong Station Plan (Cross Section)

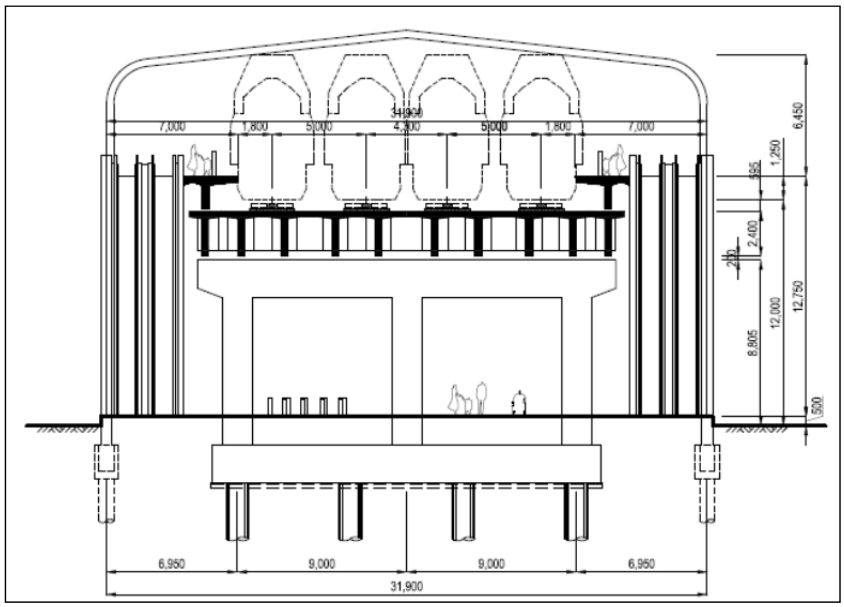


Source: JICA Study Team

Figure 6.3.9 Tuy Phong Station Plan

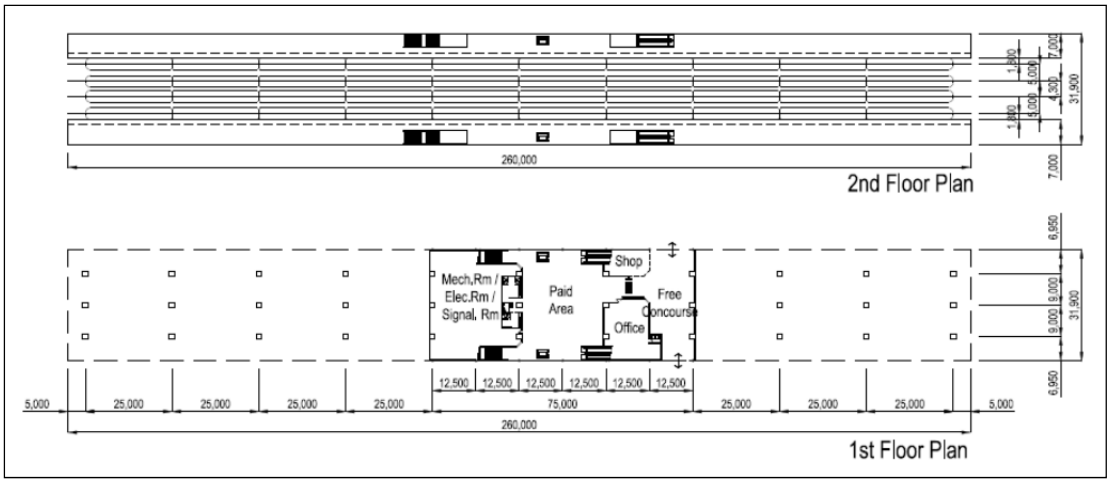
(e) Thap Cham Station

6.15 HSR Thap Cham station is planned to elevated 2 stories. Two (2) side platforms with four (4) lines are on 2nd floor. Concourse is 1st floor and connecting with local railway shall be connecting to concourse of local station which is recommended to elevate.



Source: JICA Study Team.

Figure 6.3.10 Thap Cham Station Plan (Cross Section)

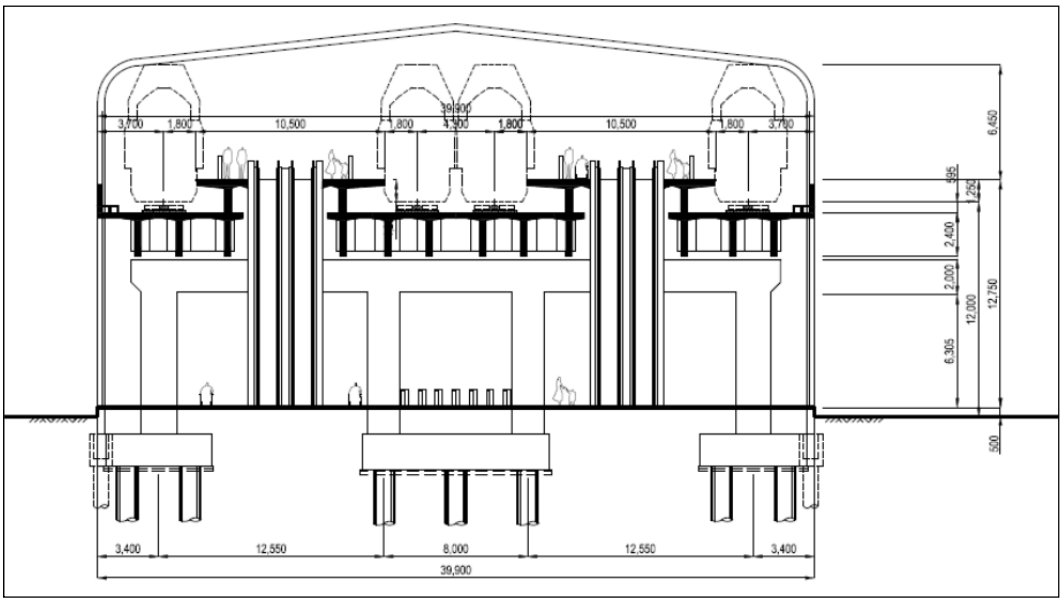


Source: JICA Study Team

Figure 6.3.11 Thap Cham Station Plan

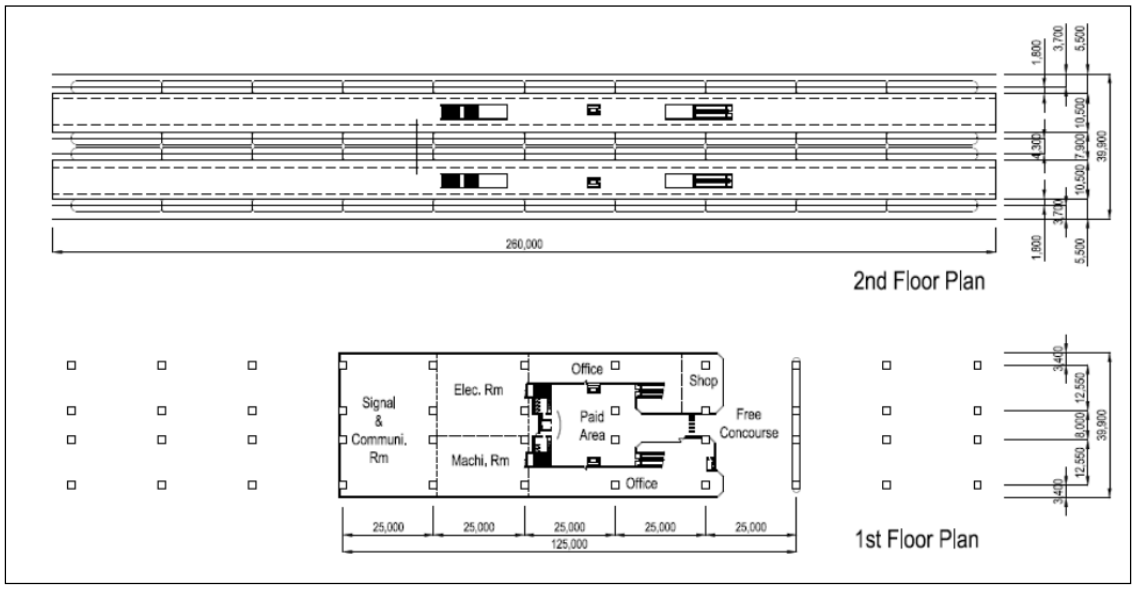
(f) NhaTrang Station

6.16 HSR NhaTrang station is planned to elevated 2 stories. Two (2) island platforms with four (4) lines on 2nd floor and concourse is 1st floor. Connecting with local railway shall be pass station square and connect to concourse of local station.



Source: JICA Study Team.

Figure 6.3.12 Nha Trang Station Plan (Cross Section)



Source: JICA Study Team.

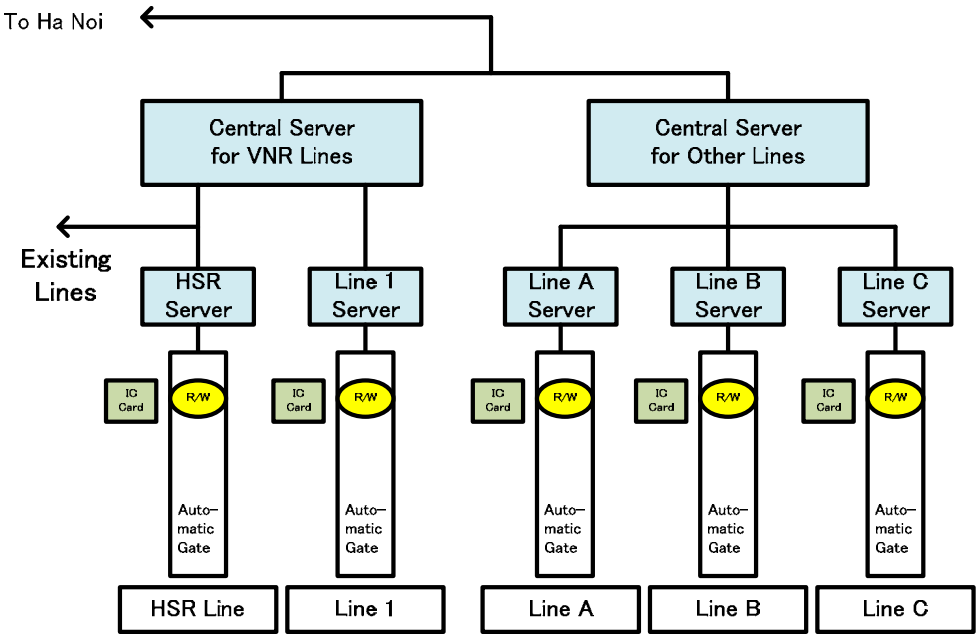
Figure 6.3.13 Nha Trang Station Plan

6.4 Automatic Fare Collection System

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 railways that are adopted in different countries and Section 5.2 Selection of System Technology of HSR in Vietnam d) AFC, 2) Selection of System 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 Fig. 6.4.1 for the composition of the AFC system to be introduced in the Ho Chi Minh area.



Source: JICA Study Team

Figure 6.4.1 Composition of the AFC System to be introduced in the Ho Chi Minh Area

6.5 Rolling Stocks

(1) Technical specification of rolling stock

The technical specification of rolling stock is described in Volume I Chapter 5.3.

(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

(d) Required trainsets for operation

6.20 From the operation diagram in 2030 in the section 6.1, it can be found that at least 8 trainsets are required for each terminal in the morning before the first train from the other terminal can turn-back. Total 16 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 (Thu Thiem – Nha Trang)

Year	2030	2035	2040
Trainsets for operation	16	20	24

Source: JICA Study Team

(e) 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 (Thu Thiem – Nhatrang)

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

Source: JICA Study Team

(f) 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.

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

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

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

$$Required\_trainsets\_for\_Regular\_inspection = \frac{365 \times (Trainsets\_for\_operation + Trainsets\_for\_stand-by)}{Idr} \times \frac{1 : Duration\_for\_Regular\_inspection}{250 : Woking\_days}$$

$$Required\_trainsets\_for\_Bogie\&General\_inspection = \frac{365 \times (Trainsets\_for\_operation + Trainsets\_for\_stand-by)}{Idbg} \times \frac{9.5 : Ave.\_Duration\_for\_Bogie\&General\_inspection}{250 : Woking\_days}$$

6.23 Required trainsets for maintenance are estimated as in Table 6.5.3

Table 6.5.3 Required Reserve Trainsets for Maintenance (Thu Thiem – Nhatrang)

Year	2030	2035	2040
No. of trains	118	150	192
Total train-km /day	42,727.8	54,315.0	69,523.2
Ave. rolling stock-km /day/car	2,373.8	2,468.9	2,674.0
Interval days for Regular Inspection	12	12	11
Interval days for Bogie & General inspection	252	243	224
Required trainsets for regular inspection	3	3	4
Required trainsets for bogie & general inspection	1	2	2
Total trainsets for maintenance	118	150	192

Source: JICA Study Team

(g) 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 (Thu Thiem–Nha Trang)

Year	2030	2035	2040
Trainsets for operation	16	20	24
Trainsets for stand-by	2	2	2
Trainsets for maintenance	4	5	6
Total required trainsets	22	27	32
Total required cars	220	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 telecommunication systems 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 signal and telecommunication systems to be applied to the high-speed railway in Vietnam.

6.26 The master plan for train operation related to the signal and telecommunication systems in the HCMC - NhaTrang section is as follows

(1) Stations: Thu Thiem, Depot 4, Long Thanh, Phan Thiet, Tuy Phong, Thap Cham, Nha Trang, Depot 3

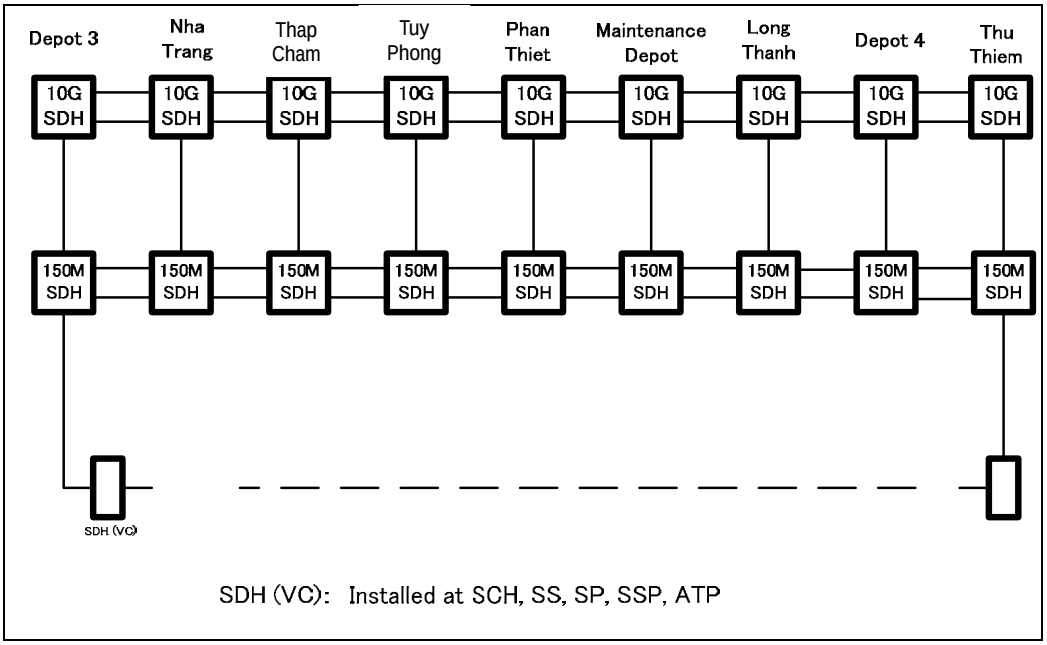
(2) Number of cars in a train set: 10

(3) Maximum operating speed: 320 km/h

(4) Minimum headway: 4 minutes

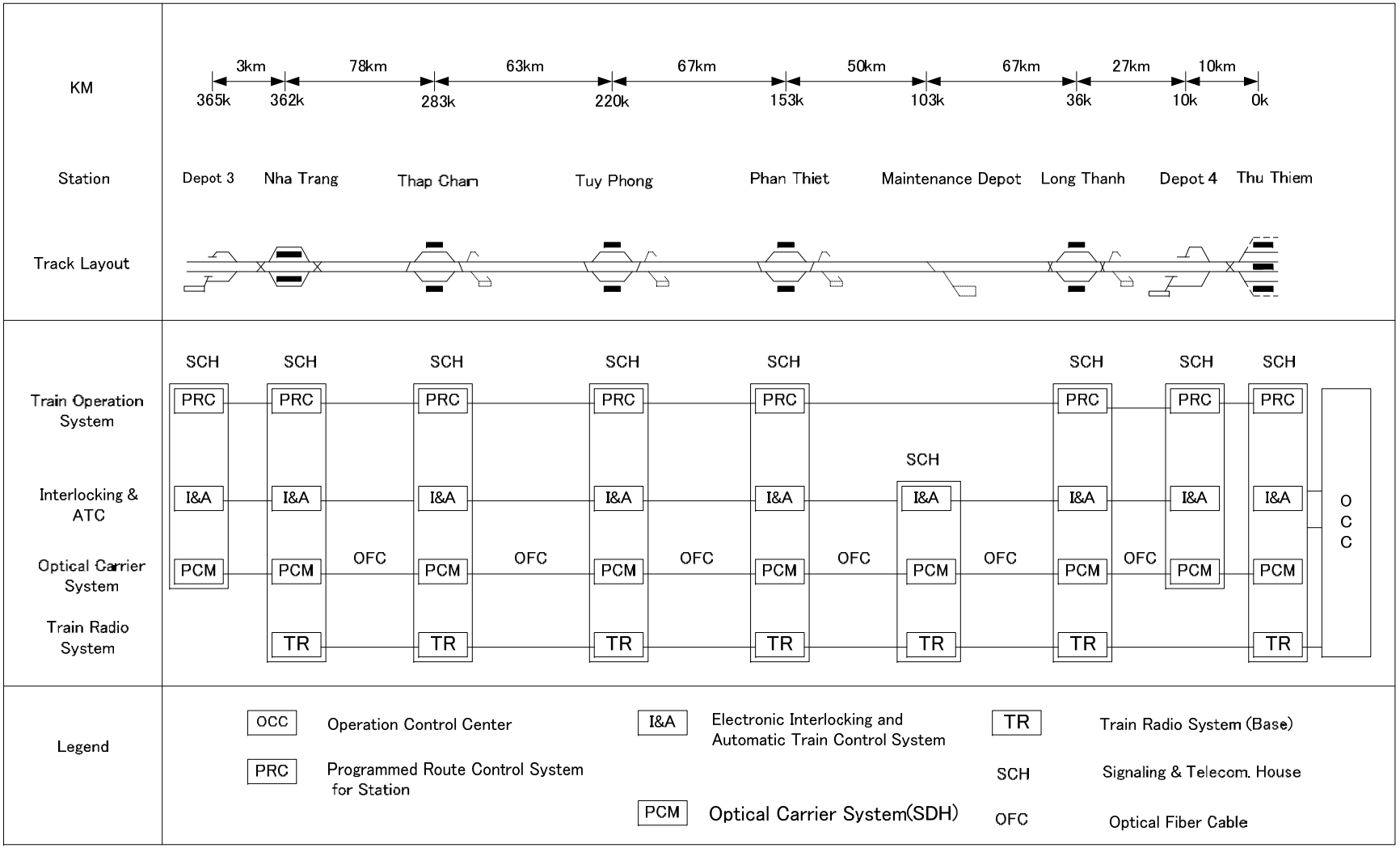
6.27 An Operation Control Center will be installed to integrate transport and equipment dispatching offices in Hanoi City and another in Ho Chi Minh City. The train protection system will include; (i) Regular block system – the DS ATC system to ensure the clearance between trains; and (ii) Substitute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

6.28 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 HCMC and NhaTrang)



Source: JICA Study Team

Figure 6.6.2 Composition of the Principal Signal and Telecommunication Systems (between HCMC and Nha Trang)

6.7 Electricity

(1) Power supply equipment in the section between Ho Chi Minh and NhaTrang

(a) Principal equipment/facilities related to substations

- Substation
- Number of substations

  Feeding substation: 8

  Feeding substation in rolling stock depots: 2

  (i) A feeding substation shall be installed near Thu Thiem (site area about 18,000 m^2) Also a substation shall separately be installed in the rolling stock depot near the Thu Thiem station (site area about 7,500 m^2).

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

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

- Sectioning post (7)

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

- Sub-sectioning post (14)

  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

6.29 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

6.30 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.

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

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

(c) Power Distribution System

(i) Substation

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

6.34 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.

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

6.36 In this section, 10 substations are required in total, with 8 for stations and 2 for rolling stock depots.

6.37 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 (12 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 Thu Thiem station (junction of mainline)	Area	Facilities			
			Rolling Stock Storage	Rolling Stock Inspection	Workshop	Maintenance Base
Thu Thiem Depot and Workshop	9,550km	384,250m^2	○	○	○	○
Long Thanh Maintenance Base	42,500km	28,500 m^2	—	—	—	○
Maintenance Base	103.000km	28,500 m^2	—	—	—	○
PhanThiet Maintenance Base	151.750km	28,500 m^2	—	—	—	○
Tuy Phong Maintenance Base	223.550km	28,500 m^2	—	—	—	○
Thap Cham Maintenance Base	284,600km	38,000 m^2				○
NhaTrang Depot	365.200km	316,827m^2	○	○		○

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

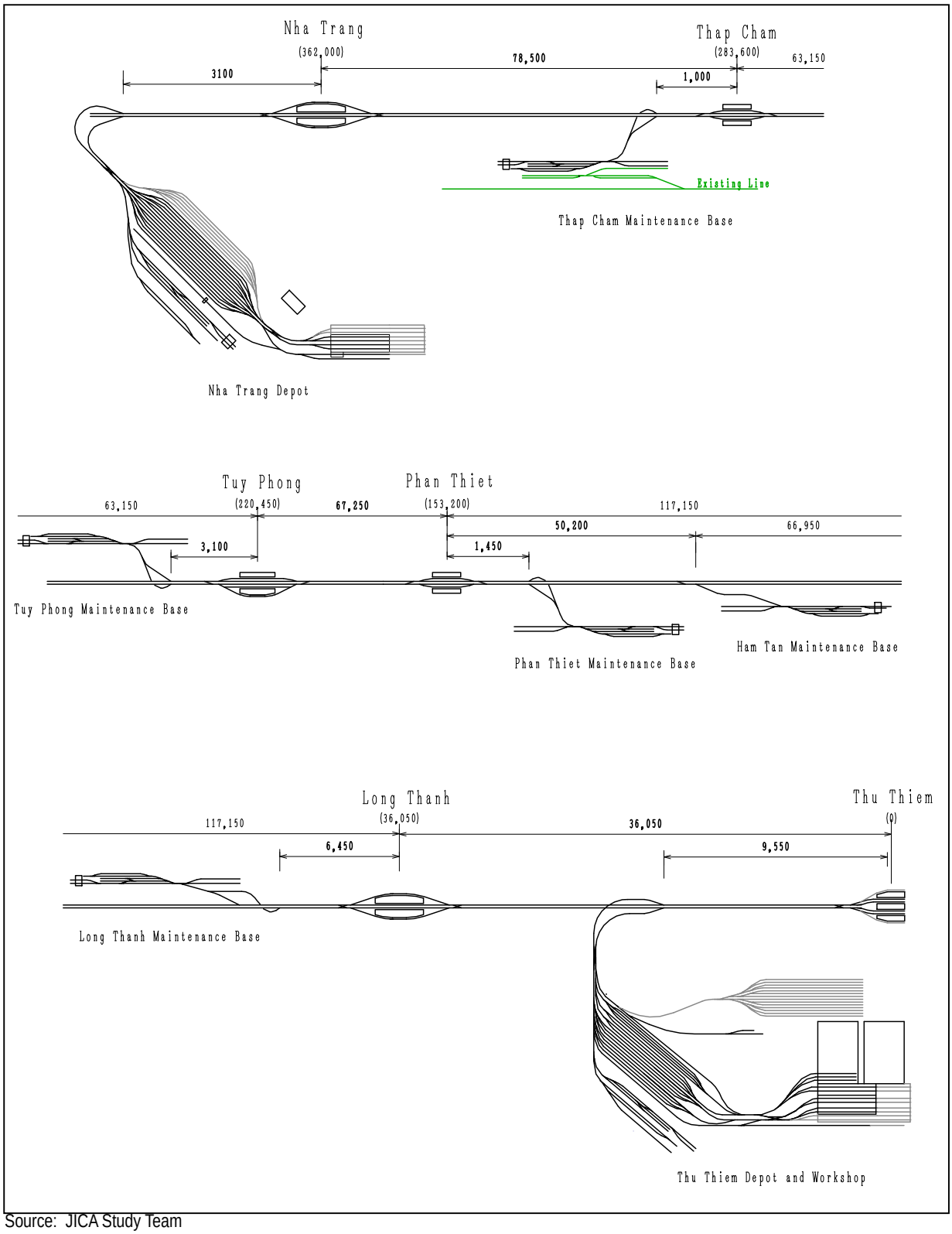
6.42 To minimize the time of running time from depot to terminal depot is planned near the terminal station. Depot shall be planned near Thu Thiem and NhaTrang terminal. Workshop is also planned at the same complex of depot for minimizing the transporting of spare parts and efficient use of stabling tracks. Considering that Thu Thiem to Long Thanh will be open partially before fully opening of South section Workshop shall be located near Thu Thiem because heavy maintenance or repair works will be required while partial open and workshop is necessary for those works. Therefore Depot and Workshop is planned near Thu Thiem and Depot is planned near NhaTrang station.

(b) Capacity of Depot

6.43 Depot will be planned with enough capacity of the 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	59	75	96
Required number of train sets	22	27	32

Source: JICA Study Team

6.45 In the night time trains will be back to depot and stored in stabling tracks. In the year 2040 there will be 32 train sets therefore at least 16 stabling tracks are required both Thu Thiem and NhaTrang depot. As trains will be put on the inspection track for regular inspection in the night time 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 Thu Thiem than NhaTrang Depot. 16 stabling tracks are planned in Thu Them Depot and 14 stabling tracks are planned in NhaTrang Depot.

(ii) Capacity of Inspection

6.46 Table 6.8.3 indicates train mileage per day and train occupation of inspection tracks.

Table 6.8.3 Capacity of Inspection Tracks

	2030	2035	2040
Train mileage per day	1,942	2,011	2,072
Interval of regular inspection (day)	15.5	14.9	13.8
Number of trains to be inspected per day	1.4	1.8	2.3

Source: JICA Study Team

6.47 In year 2040 assuming that 16 trains will be deployed both Thu Thiem and NhaTrang 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 Thu Thiem and NhaTrang depot.

6.48 Tracks and facilities planned in Thu Thiem depot and workshop and NhaTrang depot are indicated in Table 6.8.4.

(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 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.

6.51 For future expansion space is reserved at the side of stabling tracks. Space for 14 tracks is reserved in Thu Thiem Depot and space for 6 tracks is reserved in NhaTrang Depot.

Table 6.8.4 Tracks and Facilities of Depot

	Thu Thiem depot and workshop	NhaTrang Depot
Stabling track	16	14
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

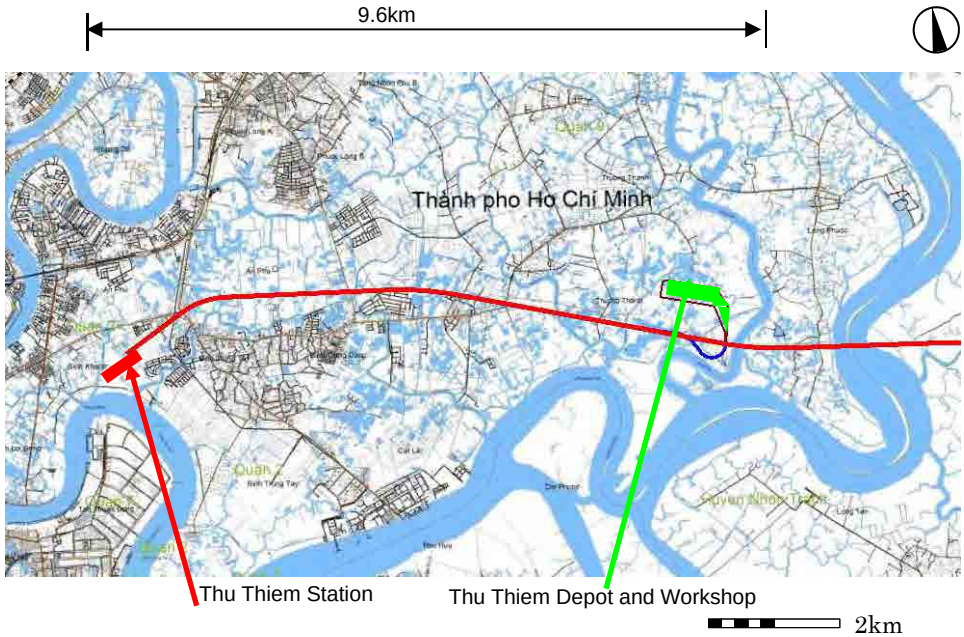
Source: JICA Study Team

(c) Thu Thiem Depot and Workshop

6.52 Figure 6.8.2 indicates location of Thu Thiem Depot and Workshop. Thu Thiem depot and workshop is planned about 9.6km east from Thu Thiem station.

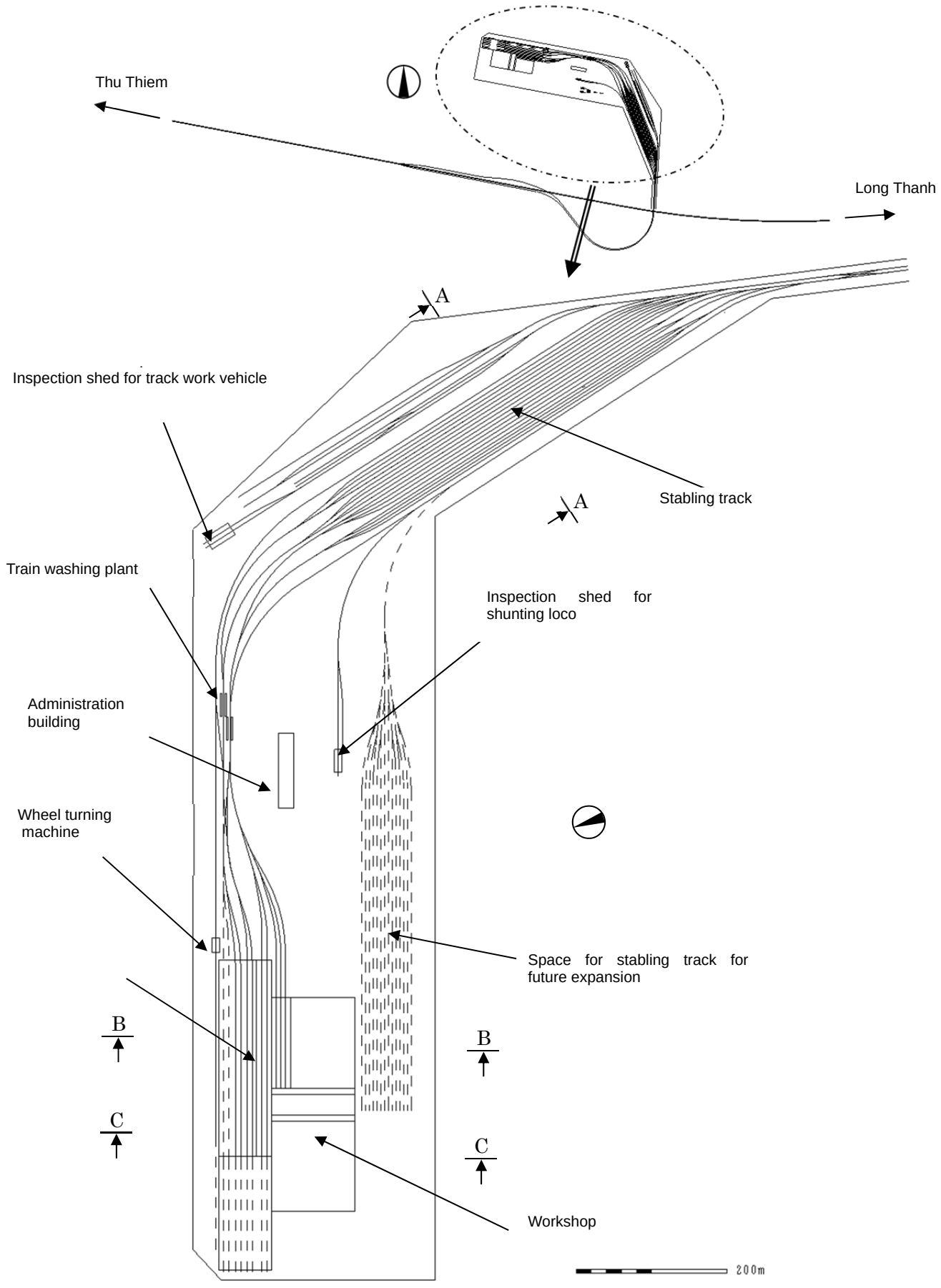
6.53 Currently the land is wetland but there is development plan and long area is not available. It is preferable to put stabling tracks and inspection tracks in series but there is not enough length to put them straightly. Stabling tracks are put diagonally and connected with inspection tracks with curved tracks.

6.54 Figure 6.8.3 indicates the track layout of Thu Thiem depot and workshop and Figure 6.8.4 indicates typical section of the depot and workshop. Figure 6.8.5, on the other hand, shows the floor plan and major equipments of the workshop.



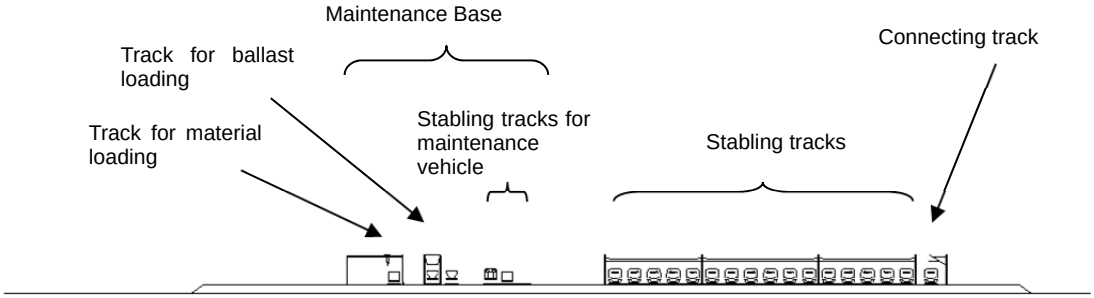
Source: JICA Study Team

Figure 6.8.2 Location of Thu Thiem Depot and Workshop

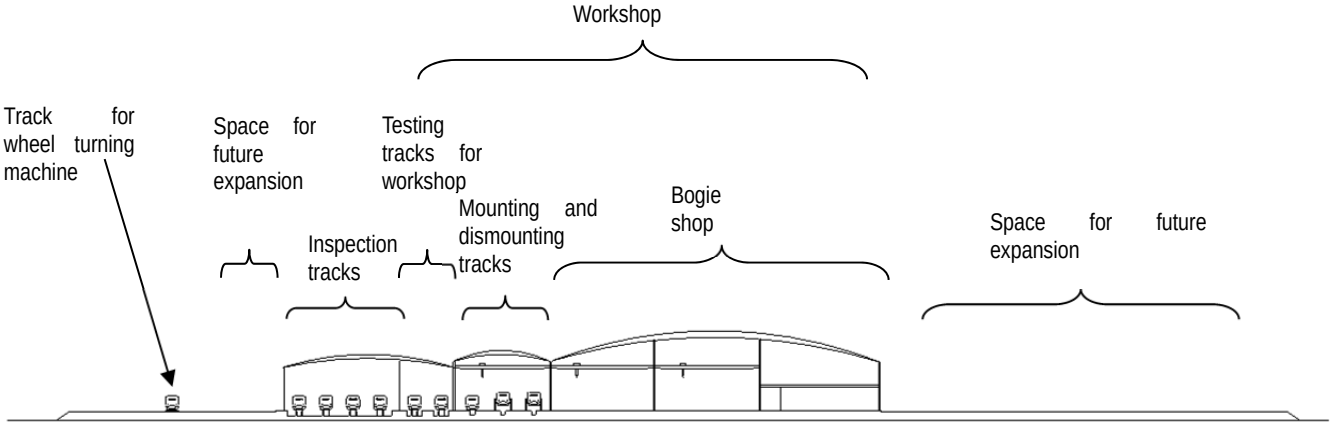


Source: JICA Study Team

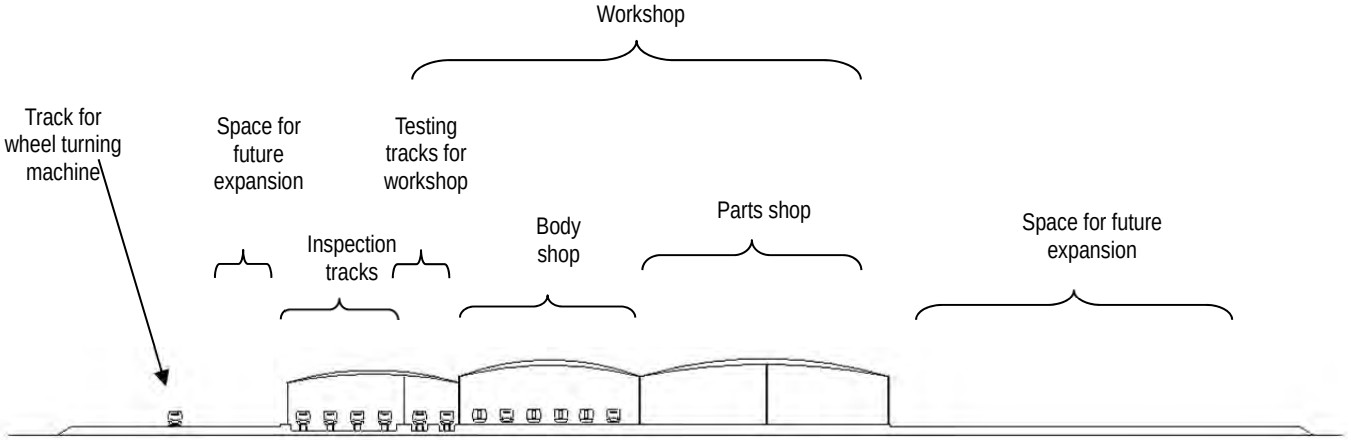
Figure 6.8.3 Track Layout of Thu Thiem Depot and Workshop



Section A-A



Section B-B

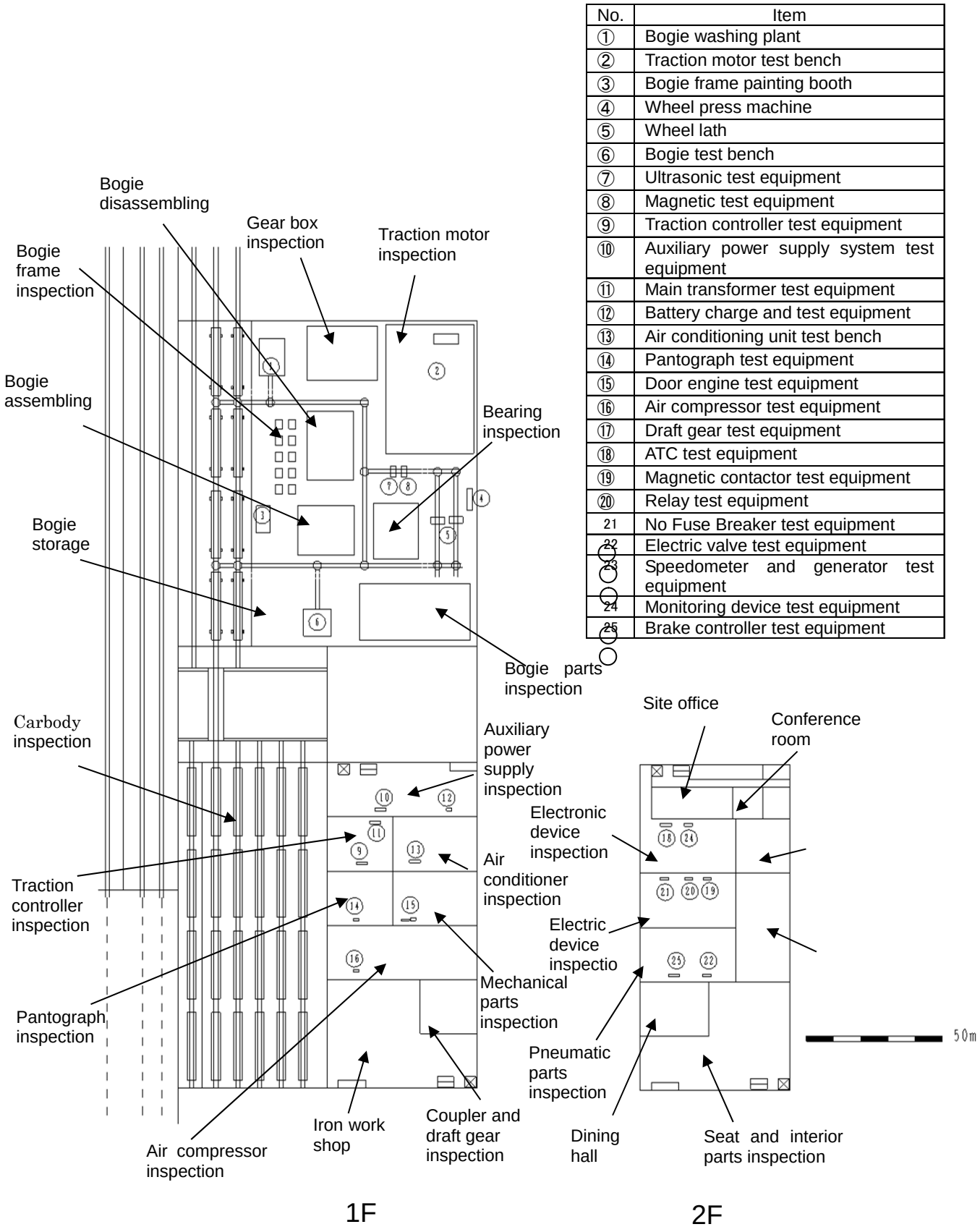


Section C-C

Source: JICA Study Team

50m

Figure 6.8.4 Section Drawing of Thu Thiem Depot and Workshop



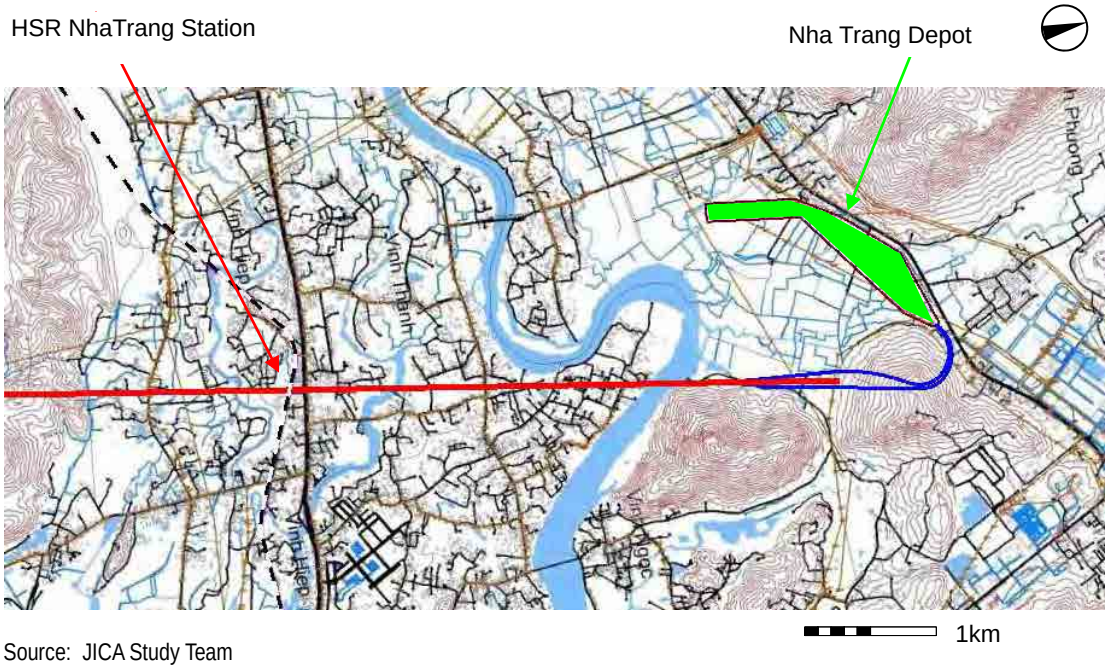
No.	Item
①	Bogie washing plant
②	Traction motor test bench
③	Bogie frame painting booth
④	Wheel press machine
⑤	Wheel lath
⑥	Bogie test bench
⑦	Ultrasonic test equipment
⑧	Magnetic test equipment
⑨	Traction controller test equipment
⑩	Auxiliary power supply system test equipment
⑪	Main transformer test 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 6.8.5 Floor Plan of Workshop

(d) NhaTrang Depot

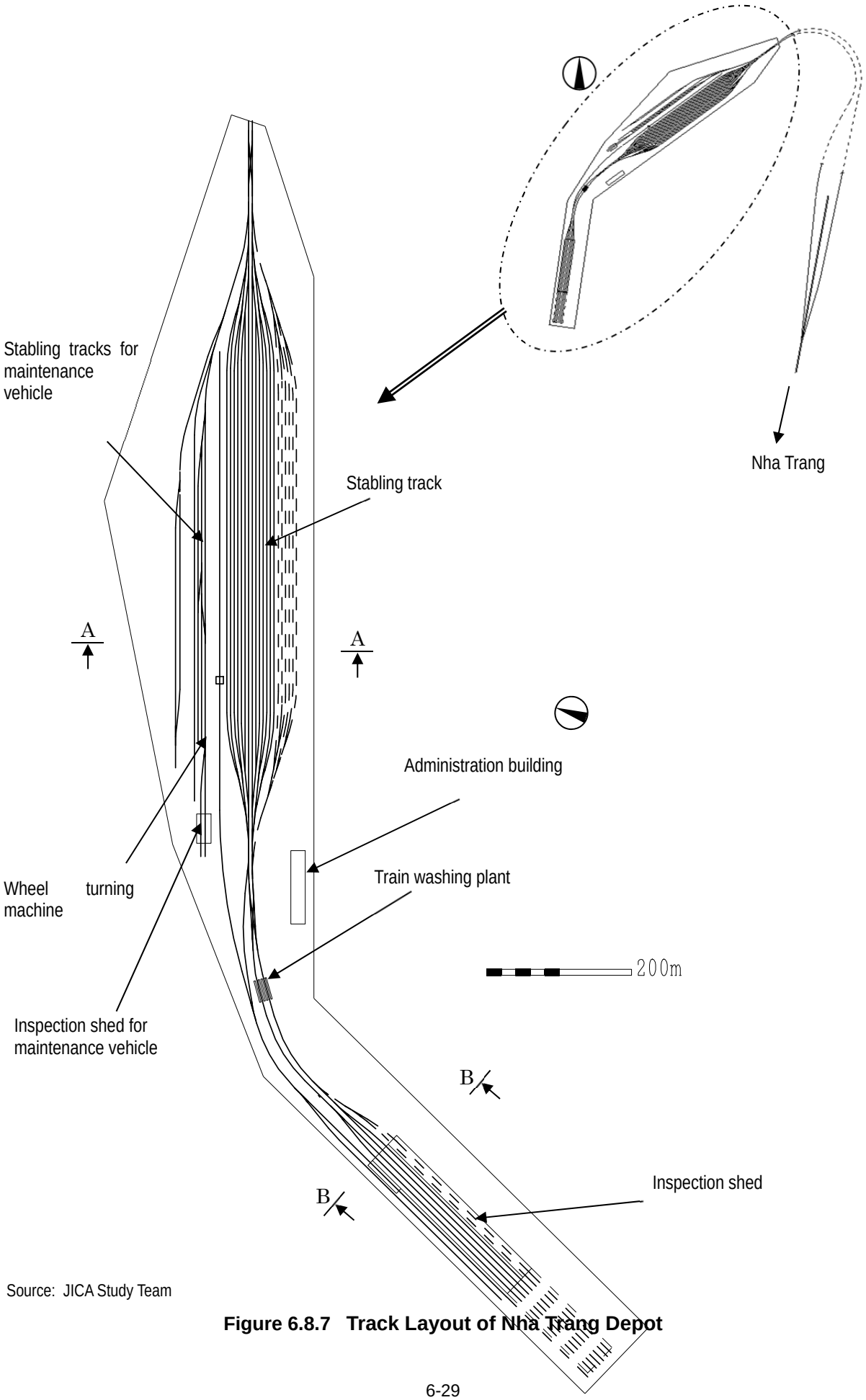
6.55 Nha Trang depot is planned to be about 4km north of NhaTrang station. Main line will be constructed from NhaTrang station to north future extension and access track for depot is planned to branch from extension track. Figure 6.8.6 indicates location of the depot.



Source: JICA Study Team

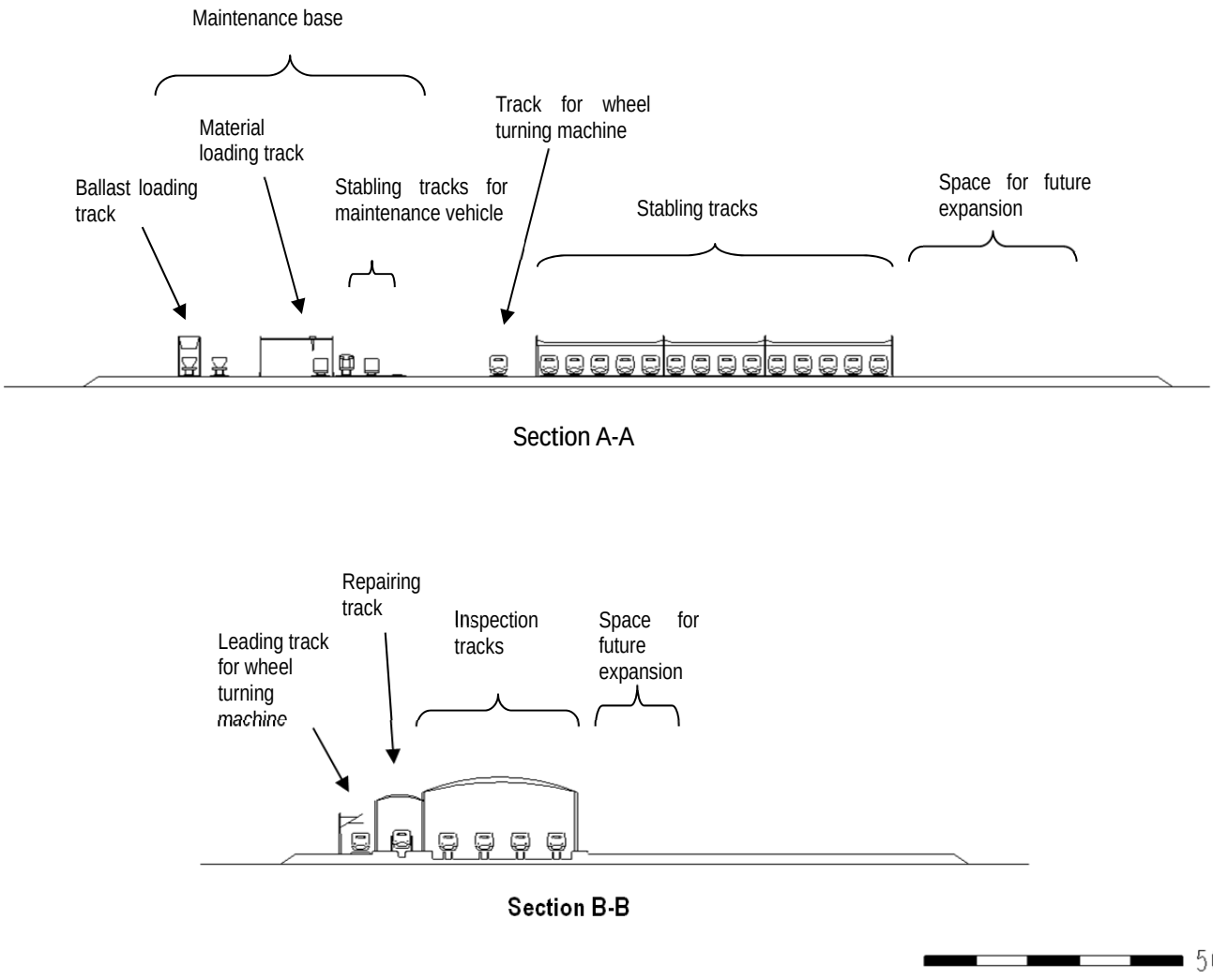
Figure 6.8.6 Location of NhaTrang Depot

6.56 Figure 6.8.7 shows the track layout of NhaTrang depot while Figure 6.8.8 indicates typical section of the depot.



Source: JICA Study Team

Figure 6.8.7 Track Layout of Nha Trang Depot



Source: JICA Study Team

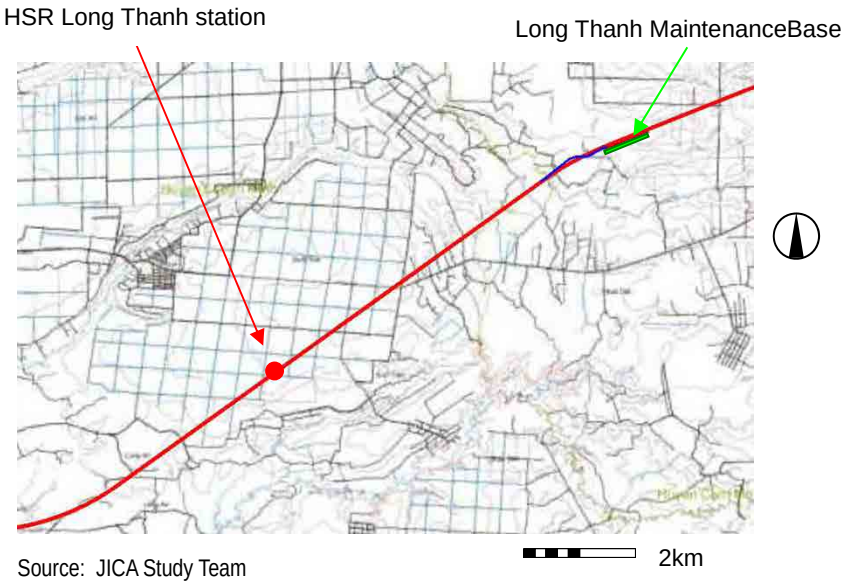
Figure 6.8.8 Section Drawing of NhaTrang Depot

(e) Maintenance Base

6.57 Maintenance bases are planned for stabling of maintenance vehicles. A maintenance base will be located every 50 to 80km. It is planned to be in the same location as the rolling stock depot for efficient land use. Basides the bases of Thu Thiem and Nha Trang depot, 5 maintenance bases are planned.

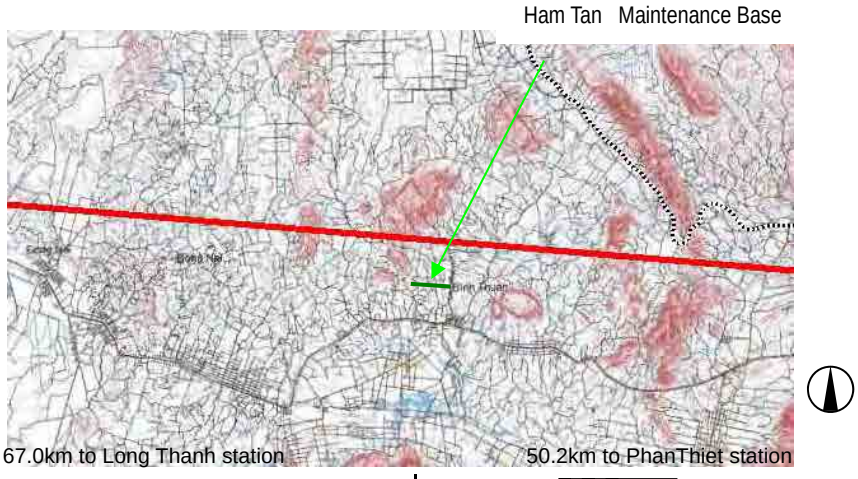
(i) Location of Maintenance Base

Location of maintenance bases are indicated in Figure 6.8.9 to Figure 6.8.13.



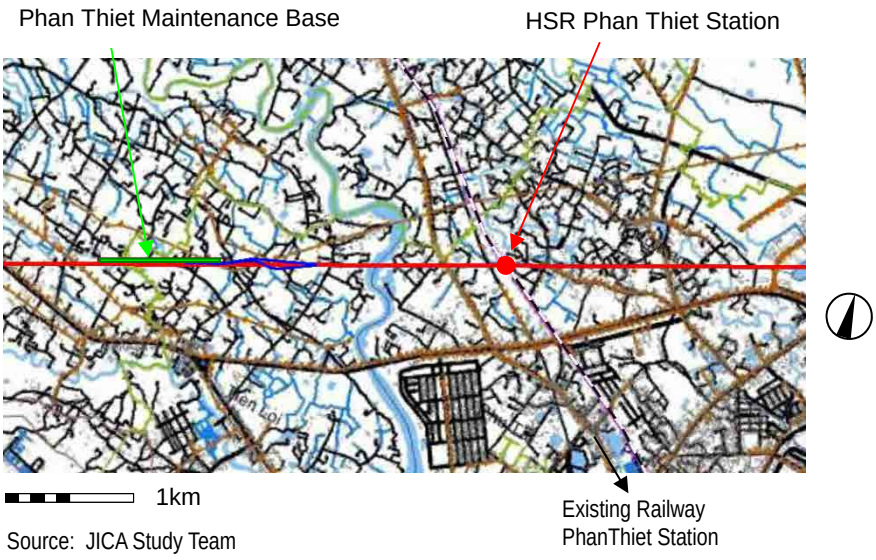
Source: JICA Study Team

Figure 6.8.9 Location of Long Thanh Maintenance Base



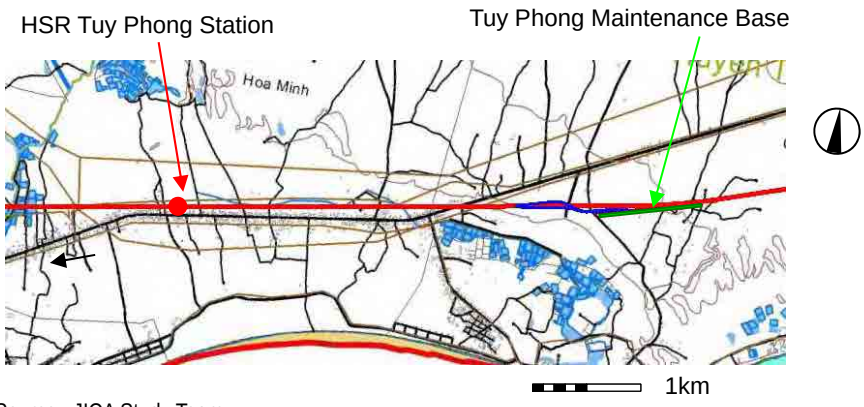
Source: JICA Study Team

Figure 6.8.10 Location of Nam Dinh Maintenance Base



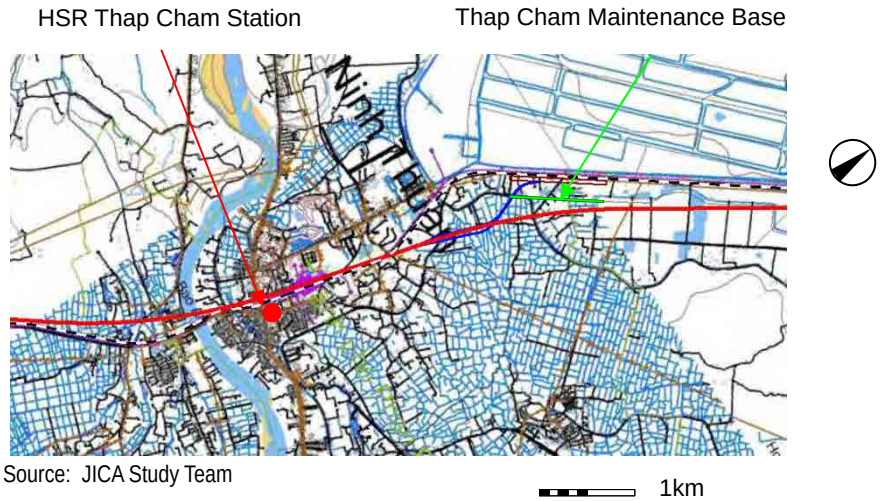
Source: JICA Study Team

Figure 6.8.11 Location of PhanThiet Maintenance Base



Source: JICA Study Team

Figure 6.8.12 Location of Tuy Phong Maintenance Base

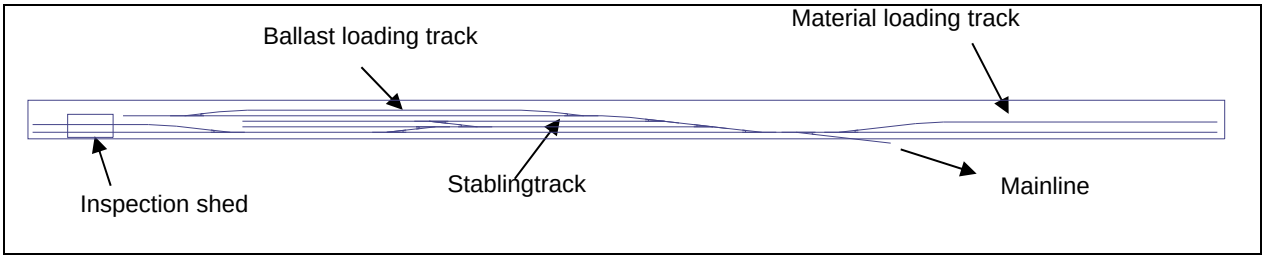


Source: JICA Study Team

Figure 6.8.13 Location of Thap Cham Maintenance Base

(ii) Track Layout of Maintenance Base

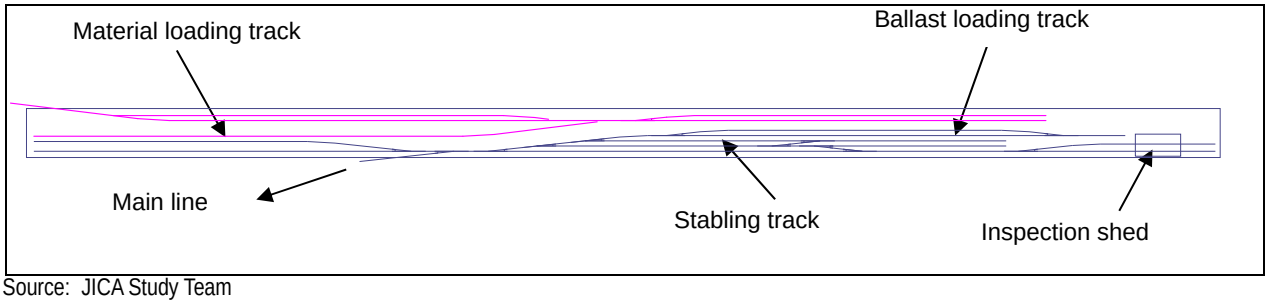
6.58 Track Layouts of maintenance bases are indicated in Figure 6.8.14 and Figure 6.8.15.



Source: JICA Study Team

Figure 6.8.14 Track Layout of Maintenance Base

(Long Thanh, Ham Tan, Phan Thiet, Tuy Phong maintenance bases)



Source: JICA Study Team

Figure 6.8.15 Track Layout of Thap Cham Maintenance Base

(iii) Maintenance Vehicle

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

Table 6.8.5 Maintenance Vehicles

6.9

	Thu Thiem	Long Thanh	Ham Tan	Phan Thiet	Tuy Phong	Thap Cham	Nha Trang	Total
Motor car	2	1	1	1	1	1	1	8
Confirmation car	2	1	1	1	1	1	1	8
Locomotive	1	1	1	1	1	1	1	7
Hopper Wagon	6	6	6	6	6	6	6	42
Tram	4	4	4	4	4	4	4	28
Tamping machine	1	1	1	1	1	1	1	7
Lining machine	1	1	1	1	1	1	1	7
Ballast regulator	1	1	1	1	1	1	1	7
Bolt power wrench	1	1	1	1	1	1	1	7
Rail grinder	1	-	-	-	-	-	-	1
Catenary installation vehicle	1	-	-	-	-	-	-	1
Catenary inspection vehicle	1	1	1	1	1	1	1	7

Source: JICA Study Team

Operation Controlling System

(1) Controlling Center Location and Future Expansion Plan

6.60 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.

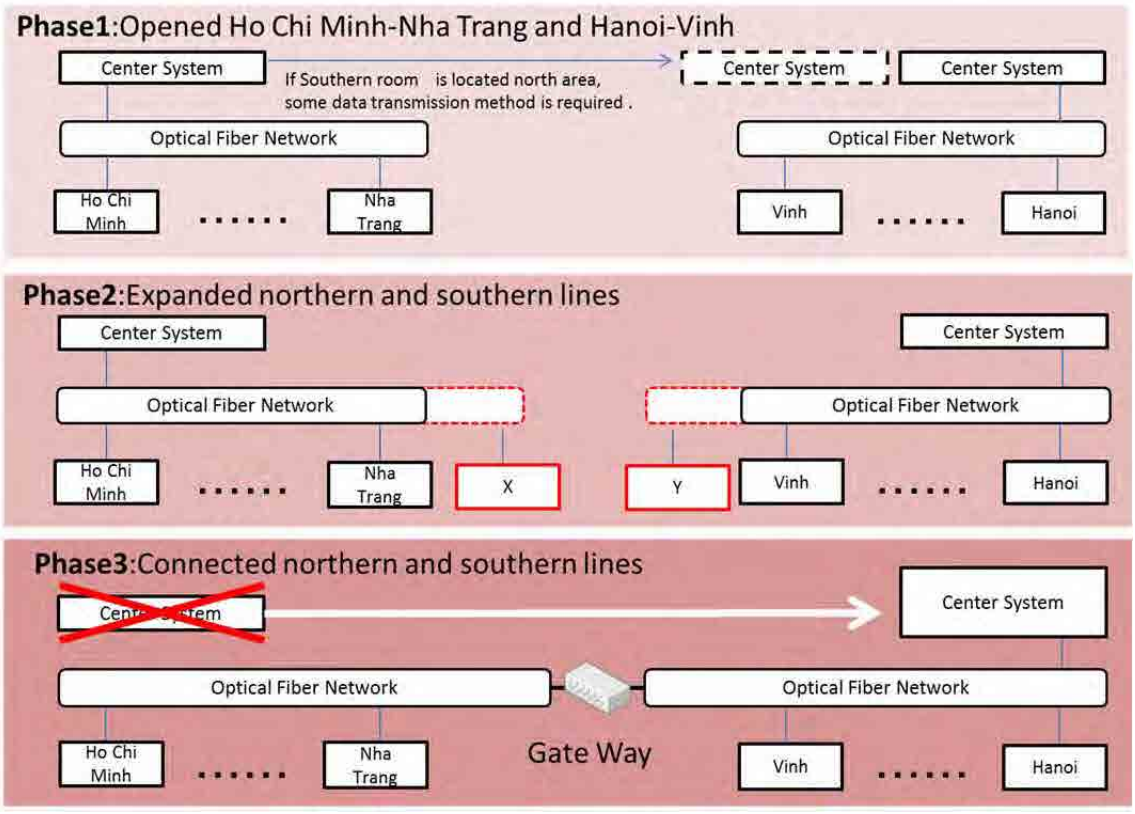
6.61 Phase 2 is line extension. Both lines will be extended but Autonomous Decentralized system is available for easy construction.

6.62 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.

6.63 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.

6.64 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.

6.65 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, 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 are used for several civil work items:

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

(ii) Estimated unit costs for Vietnamese urban railway projects;

(iii) Standard unit costs published by Vietnamese MOC;

(iv) The conversion rate used in calculating the unit cost in Vietnam is based on the 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

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 Costs of Embankment

Work Item	Unit Cost	Cost Per m		Remark
		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 Costs 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
Cut2	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 Costs of Box Culvert

Work Item	Unit	Unit Cost Per piece		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)	
Tunnel	m	20,905	439.01	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 Tracks

Work Item	Unit	Unit Cost Per m		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~1.0 m

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	VTD (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 Thu Thiem. 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 work + track (passing tracks, 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 itemiz^{e}d 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	Tuy Phong
Shallow Trench Station	m^2	1,676	35.20	Long Thanh
Elevated and Railway Neighboring Station	m^2	2,432	51.07	Phan Thiet, Thap Cham, Nha Trag
Elevated, Railway Neighboring and Soft Ground Station	m^2	2,513	52.77	Thu Thiem

Source: JICA Study Team

5) Depot and Workshop

a) Depot and 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~~ in Table 7.2.11.

7.18 Since the two depots in the South Priority Section, one in Thu Thiem and one in Nha Trang, both locate on soft ground; the unit cost of civil engineering work for embankment is set 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	Unit Cost Per Each Unit Cost		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	Unit Cost Per Each Unit Cost		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	7296.16	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 referred to 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 traction 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 to 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) Car

7.22 The 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	22 train sets, 220 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 HCMC – Nha Trang Section

Unit Cost in VND (Market Price)		Unit	HCMC	Dong Nai	Binh Thuan	Ninh Thuan	Khanh Hoa
Compensation for Land	Agricultural Land	m^2	190,500	83,400	91,667	121,500	301,000
	Residential Land	m^2	29,650,000	1,063,200	1,872,667	739,500	7,851,333
	Vacant Land	m^2	29,650,000	1,063,200	1,872,667	739,500	7,851,333
	Commercial Land	m^2	17,790,000	531,600	1,311,000	591,500	3,926,000
Compensation for Assets	Structures	m^2	2,320,333	2,302,333	2,234,667	2,274,667	2,257,333
	Forest Trees	m^2	4,499	4,499	40,500	12,000	3,780
	Fruit Trees	m^2	429,000	306,800	303,000	300,000	300,000
	Crops (Rice)	m^2	4,000	3,000	4,350	2,800	4,000
	Crops (Aquaculture)	m^2	2,400	2,400	2,400	2,400	2,400
	Crops (Others)	m^2	4,000	3,000	4,350	2,800	4,000
Allowance for Relocation		HH	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
Allowance for Livelihood Stabilization for Business		HH	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
Assistance for Vulnerable HH		HH	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
RAP Preparation and Independent Monitoring		Lump Sum					9,745,699,508
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 Thu Thiem–Nha Trang section are shown in Table 7.3.1.

Table 7.3.1 Construction Cost by Work Package for HCMC – Nha Trang Section

Item	Work Package	Unit	Quantity	Unit Cost		Construction Cost	
				USD mil./km	VND bil./km	USD mil.	VND bil.
Embankment	0-3m	km	50.640	3.2	67.2	162.8	3,418.8
	3-6m	km	42.720	4.7	98.7	199.2	4,183.2
	6-9m	km	76.130	7.1	149.1	540.9	11,358.9
	Subtotal	km	169.490			902.9	18,960.9
Cut	0-3m	km	40.040	2.5	52.5	101.8	2,137.8
	3-6m	km	19.915	3.7	77.7	73.4	1,541.4
	6-9m	km	42.876	5.6	117.6	240.8	5,056.8
	Subtotal	km	102.831			416.0	8,736.0
Viaduct		km	48.825	17.0	357.0	827.6	17,379.6
Bridge	T-PC girder	km	1.690	19.0	399.0	32.2	676.2
	Box-PC	km	3.700	31.4	659.4	116.1	2,438.1
	Long ridge	km	0.700	44.6	936.6	31.2	655.2
	Subtotal	km	6.090			179.5	3,769.5
Box Culvert	2m	km	1.356	0.4	8.4	6.0	126.0
	6m	km	2.034	1.0	21.0	20.2	424.2
	Subtotal	km	3.390			26.2	550.2
Tunnel		km	34.279	20.9	438.9	716.6	15,048.6
Civil Work Total		km				3,069.0	64,448.0
Track	Slab Type	km	189.6	1.6	32.8	296.5	6,227.2
	Ballast Type	km	546.6	0.8	17.5	455.3	9561.7
	Subtotal	km	736.2			751.9	15,788.9
Total		km				3820.7	80,233.7

Source: JICA Study Team

2) Station

7.25 The construction cost of each station between Nha Trang and Thu Thiem is shown in Table7.3.2. 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 Nha Trang and Thu Thiem 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 of electric power and signaling & telecommunication.

Table 7.3.2 Construction of Each Station in Southern HSR

Station		Nha Trang (elevated)	Thap Cham (elevated)	Tuy Phong (ground)	Phan Thiet (elevated)	Long Thanh (trench)	Thu Thiem (elevated)	Total
Quantity of Station Area (m2)		26,100	17,400	30.900	17,400	26,100	37,800	155,700
Civil	VND bil.	1,333.5	888.3	789.6	888.3	917.7	1,995.0	6,812.4
	US$ mil	63.5	42.3	37.6	42.3	43.7	95.0	324.4
Architecture	VND bil.	459.9	222.6	291.9	222.6	235.2	714.0	2,146.2
	US$ mil	21.9	10.6	13.9	10.6	11.2	34.0	102.2
E &M	VND bil.	191.1	117.6	136.5	98.7	98.7	266.7	909.3
	US$ mil	9.1	5.6	6.5	4.7	4.7	12.7	43.3
PT & turnout	VND bil.	102.9	90.3	71.4	90.3	94.5	73.5	520.8
	US$ mil	4.9	4.3	3.4	4.3	4.5	3.5	24.8
Subtotal	VND bil.	2,087.4	1,316.7	1,291.5	1,297.8	1,346.1	3,051.3	10,390.8
	US$ mil	99.4	62.7	61.5	61.8	64.1	145.3	494.8
Station Plaza	VND bil.	109.2	100.8	50.4	56.7	86.1	102.9	455.7
	US$ mil	5.2	4.8	2.4	2.7	4.1	4.9	21.7
Total	VND bil.	2,196.6	1,419.6	1,339.8	1,354.5	1,434.3	3,154.2	10,846.5
	US$ mil	104.6	67.6	63.8	64.5	68.3	150.2	516.5

Source: JICA Study Team

Table 7.3.3 Construction Cost of Depot/ Workshop

	Work Item	Quantity	Unit	Construction Cost	
				USD mil.	VND bil.
Nha Trang ($316,827m^2$)	Civil Work	1,174,760	m^3	30	630
	Entrance & Exit Line	3,764	m	14	294
	Architecture	11,431	m^2	6	126
	Equipment for E&M	1	set	18	378
	Track	15,010	m	11	231
	Turnout 9#	40	no.	3	63
	Scissors Crossover 12#	2	no.	1	21
	Total			84	1,743
Thu Thiem ($384,250m^2$)	Civil Work	1,310,736	m^3	34	714
	Entrance & Exit Line	4,080	m	16	336
	Architecture	47,736	m^2	26	546
	Equipment for E&M	1	set	69	1,449
	Track	19,170	m	14	294
	Turnout 9#	57	no.	4	84
	Scissors Crossover 12#	2	no.	1	21
	Total			164	3,444

Source: JICA Study Team

4) Maintenance Depots

7.27 The construction cost of each maintenance depot between Nha Trang and Thu Thiem is shown in the tables below. There are five (5) maintenance depots to be constructed with a total cost of USD 62.6 million.

Table 7.3.4 Construction Cost of Maintenance Depot

	Work Item	Quantity	Unit	Construction Cost	
				USD mil.	VND bil.
Thap Cham ($38,000m^2$)	Civil Work	81,700	m^3	2.1	44
	Entrance & Exit Line	2,880	m	11.1	233
	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	no.	1.0	20
	Turnout 8#	4	no.	0.3	5
	External Equipment	1	unit	0.3	7
	Total			17.6	370
Tuy Phong ($28,500m^2$)	Civil Work	62,700	m^3	1.6	34
	Entrance & Exit Line	2,080	m	8.0	168
	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			12.8	269
Phan Thiet ($28,500m^2$)	Civil Work	62,700	m^3	1.6	34
	Entrance & Exit Line	2,030	m	7.8	164
	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			12.6	265
103km ($28,500m^2$)	Civil Work	62,700	m^3	1.6	34
	Entrance & Exit Line	570	m	2.2	46
	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			7.0	147
Long Thanh ($28,500m^2$)	Civil Work	62,700	m^3	1.6	34
	Entrance & Exit Line	2,020	m	7.8	164
	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			12.6	265

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 electric lightings of all the stations, depots, workshop, and maintenance depots. The construction cost for the power system between Nha Trang and Thu Thiem is shown in Table 7.3.5. Total cost amounts to USD 1,652 million.

Table 7.3.5 Construction Cost for Electric Power System from Nha Trang to Thu Thiem

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			479		614.1	
2	Overhead line equipment(OH)	km	362.1	0.9	325.9	1.2	417/8	
3	Electric light Power(ELP)	Unit			379.7		486.8	
4	Power –SCADA	no's	1	20	20.0		25.6	
	Total (1~4)				1,204.6	(3.33)	1,544.3	4.26
5	Depot SS(Sub Station),OH.ELP,etc.	Unit			84		107.7	
6	Grand total (1~5)				1,288.6	(3.56)	1,652.0	4.56
	Notes: Number of Station = 3 (large) and 3 (small& medium) Number of Depot = 2; Power-SCADA system = 1				( ) =100mil Yen/km Length of Section = 362.1 km			

Source: JICA Study Team

Table 7.3.6 Construction Cost for Electric Power System for the Test Line on Thu Thiem to Long Thanh

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			113.0		144.9	
2	Overhead line equipment(OH)	km	36	0.9	32.4	1.2	41.5	
3	Electric light Power(ELP)	Unit			58.8		75.4	
4	Power –SCADA	no's	1	28.6	28.6		25.6	
	Total (1~4)				232.8	(6.46)	287.4	7.98
5	Depot SS (Sub Station),OH.ELP,etc.	Unit			42		53.8	
6	Grand total (1~5)		36		274.8	(7.63)	341.3	9.48
	Notes: Number of Station = 2 (large) and 0 (small& medium) Number of Depot = 1; Power-SCADA system = 1				( ) =100mil Yen/km Length of Section = 36.0 km			

Source: JICA Study Team

b) Signalling &Telecommunication (S&T)

7.29 The construction cost for signaling and telecommunication includes all S&T equipment. The total cost for the Nha Trang to Thu Thiem section amounts to USD 756 million, as shown in Table 7.3.7.

Table 7.3.7 Signalling and Telecommunication Cost - Nha Trang to Thu Thiem

		Work Cost	Unit Cost	Work Cost	Unit Cost
		JPY100 mil	100milYen/km	US$, mil	US$/km, mil
Signalling	Equipment	263			
	Operation Management	60			
	Subtotal	323	0.89	414	1.14
Telecommunication	Equipment	253			
	AFC	14			
	Subtotal	267	0.73	342	0.94
Total		590	1.62	756	2.08
Length of section = 365 km					

6) Cost of Environmental Mitigations

7.30 The environmental countermeasure for noise from the HSR trains running on the viaduct adopts the sound proof wall (SPW). Likewise, the countermeasure of micro-pressure wave at tunnel entrances 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 Thu Thiem – Nha Trang Section

Structure	Length	Unit Cost	Construction Cost	
	m	USD/m	JPY 100 mill	US$ mil
Sound Proof Wall	44,415	237.3	8.2	10.5
Tunnel Entrance Buffering Hood	1,396	31,357	34.1	43.8

Source: JICA Study Team

7) Cost of Track Infrastructure

7.31 The construction cost of the main carriageway, between the stations in the Thu Thiem -Nha Trang section is given in Table 7.3.9.

Table 7.3.9 Construction Cost of Infrastructure

Station	Thu Thiem		Long Thanh	Phan Thiet			Tuy Phong	Thap Cham		Nha Trang			Total
Distance (km)	**0.8**	**35.1**	**1.2**	**116.4**	**1.2**	**66.4**	**1.0**	**62.3**	**1.2**	**77.8**	**1.2**	**3.5**	**368.1**
Cut (km)		4.59		44.7		24.73		12.78		16		0	103
Cost (mil US$)		13.5		182.4		112.8		46.7		61		0	**416**
Embankment (km)		5.55		61.00		31.76		33.63		37		1	169
Cost (mil US$)		34.6		338.1		180.0		154.1		190		7	**903**
Viaduct(km)		23.36		9.38		9.18		10.8		3.4		2	49
Cost (mil US$)		395.9		158.9		155.5		18.2		56.9		42	**828**
Bridge(km)		1.60		1.33		0.76		1.23		1.17		0	6
Cost (mil US$)		59.5		35.8		21.9		33.4		29		0	**180**
Box Culvert(km)		0.11		1.22		0.64		0.67		0.73		0.02	3
Cost (mil US$)		0.9		9.4		4.9		5.2		6		0	**26**
Tunnel (km)		0		0		0		13.60		21		0	34
Cost (mil US$)		0		0		0		284.5		432		0	**717**
Track(km)	0.8	35.1	1.2	116.4	1.2	66.4	1.0	62.3	1.2	77.8	1.2	3.5	368.1
Cost (mil US$)	2.6	95.0	3.8	209.6	3.8	125.2	1.6	127.0	3.8	166.4	3.8	9.4	**752**
Station Area (m2)	37,800		26,100		17,400		30,900		17,400		26,100		155,700
*Cost (mil US$)	150.2		68.3		64.5		63.8		67.6		104.2		**517**
EP(km)		Include Depot+WS										Depot+WS	
Cost (mil US$)		352						1,246				54	**1,652**
S&T(km)													
Cost (mil US$)		150						606					**756**
Depot&WS(m2)		384,250										316,827	
Cost (mil US$)		117		47	*							84	**248**
MD(m2)		38,000		28,500		28,500		28,500		28,500			152,000
Cost (mil US$)		17.6		12.8		12.6		7		12.6			**63**
SPW(km)	0	16	0	10.1	0.35	9.0	0	2.0	0.35	3.7	0.52	2.5	44.5
Cost (mil US$)	0.0	3.8	0.0	2.4	0.1	2.1	0.0	0.5	0.1	0.9	0.1	0.6	**10.5**
THBM(km)	0	0	0					0.21		1.18			1.4
Cost (mil US$)	0	0	0					6.7		37.1			**44**
Sub Total													
Cost (mil US$)													**7,111**
Rolling Stock(No)		12											220
Cost (mil US$)		57											**1,045**
Cost of between stations(milUS$)	107.200	749.4	71.4	928									**8,156**
Right of Way (ha)	7.3	120.3	0.00	474.5	4.3	274.8	4.0	180.3	2.4	252.7	45.9		1,367
Cost (mil US$)	152.0	127.8	0.1	57.8	4.1	62.1	1.5	38.0	2.0	192.8	47.0		**685**
Total Cost (mil US$)		**1,742**						**7,100**					**8,842**

*The cost of each station consists of Civil, Architecture, E (only light electricity) &M and Track(only passing track & turnout)
**The cost of each depot consists 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 South Priority section is estimated to cost about US$ 2.0 billion as shown in Table 7.3.10 below. It is approximately 20.1% of the cost of the south section.

Table 7.3.10 Cost of Southern HSR Initial Section

Item		Local (VND mil.)	Foreign		Total	
			US$ mil.	(VND mil.)	VND mil.	US$ mil.
1. Civil Works and Structures		9,601	51	1,067	10,668	508
2. Tracks		870	60	1,251	2,121	101
3. Stations		4,185	20	414	4,599	219
4. Electricity		813	313	6,579	7,392	352
5. Signal and Telecommunications		189	141	2,961	3,150	150
6. Maintenance Depots and Workshops		1,276	74	1,559	2,835	135
Subtotal (1 - 6)		16,934	659	13,831	30,765	1,465
7. Maintenance of Equipment		0	21	441	0	21
8. Training Fee		437	5	109	546	26
Subtotal (1 - 8)		17,371	685	14,381	31,311	1,512
9. Rolling Stocks		0	57	1,197	1,197	57
10. Land Acquisition and Compensation		5,880	0	0	5,880	280
Subtotal (1 - 10)		23,251	742	15,578	38,388	1,849
11. Consulting Service		695	26	553	1,231	59
12. Reserves (5% of 1, 2, 3, 4, 5, 6, 8, 11)		869	33	697	1,566	75
13. Other tax[1)]		869	0	0	869	41
Subtotal (11, 12, 13)		2,432	60	1,250	3,665	175
Total	1 – 13	25,682	801	16,829	42,053	2,024
	Excluding Rolling Stocks	25,682	744	15,632	40,856	1,967
	Excluding Land	19,802	801	16,829	36,173	1,744
	Excluding RS and Land	19,802	744	15,632	34,976	1,687
Project Cost per km	1 - 13	711	22.2	466	1,165	56.1
	Excluding Rolling Stocks	711	20.6	433	1,132	54.5
	Excluding Land	549	22.2	466	1002	48.3
	Excluding RS and Land	549	20.6	433	969	46.7

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.

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 Thu Thiem–Nha Trang 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, South HSR

Item	Quantity	Unit Cost (100milyen)	Total (100milyen)	Total (US$ mil.)
Motor car	8		0.00	0.00
Confirmation car	14	0.80	11.20	14.36
Locomotive	7	2.00	14.00	17.95
Hopper Wagon	42	0.20	8.40	10.77
Tram	28	0.05	1.40	1.79
Tamping machine	7	2.00	14.00	17.95
Lining machine	7	1.50	10.50	13.46
Ballast regulator	7	1.80	12.60	16.15
Bolt power wrench	7	0.80	5.60	7.18
Rail grinder	1	3.00	3.00	3.85
Catenary installation vehicle	1	1.20	1.20	1.54
Catenary inspection vehicle	7	1.00	7.00	8.97
Total			88.90	113.97

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 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 prerequisite 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 (USD mil)	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 Thu Thiem – Nha Trang Section

Item		Local (VND mil.)	Foreign		Total	
			US$ mil.	(VND mil.)	VND mil.	US$ mil.
1. Civil Works		59,111	317	6,567	65,679	3,128
2. Tracks		6,357	436	9,148	15,506	738
3. Station		9,916	47	981	10,897	519
4. Power System		3,816	1,470	30,876	34,692	1,652
5. Signal and Telecommunications		953	711	14,923	15,876	756
6. Depot and Workshop		2,780	162	3,398	6,178	294
Subtotal (1 - 6)		82,933	3,143	65,913	148,828	7,087
7. Maintenance Equipment		0	114	2,394	0	114
8. Education and Training Equipment		437	5	109	546	26
Subtotal (1 - 8)		83,370	3,262	68,749	149,374	7,227
9. Rolling Stocks		0	1,045	21,945	21,945	1,045
10. Land Acquisition and Compensation		14,385	0	0	14,385	685
Subtotal (1 - 10)		97,755	4,307	90,694	185,704	8,957
11. Consulting Service (3.5% of 1-10)		2,600	161	3,377	5,977	285
12. Contingency (5% of 1-11)		4,584	244	5,120	9,704	462
13. Tax[1)]		4,813	0	0	4,813	229
Subtotal (11, 12, 13)		11,997	405	8,497	20.494	976
Total	1 - 13	109,752	4,712	99,191	206,198	9,933
	Excluding RS	109,752	3,667	77,246	184,253	8,888
	Excluding land	95,367	4,712	99,101	191,813	9,248
	Excluding RS and land	95,367	3,667	77,246	169,868	8,203
Project Cost per km	1 - 13	300	12.9	271	563	27.1
	Excluding RS	300	10.0	211	503	24.3
	Excluding land	261	12.9	271	524	25.3
	Excluding RS and land	261	10.0	211	464	22.4

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 in 2030, 2035 and 2040

Section	Year 2030	Year 2035	Year 2040	Remarks
Southern Section (Nha Trang–Thu Thiem)	59	75	96	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 southern section (362 km)
(ii) Railway track is composed of 700% ballast track and 30% 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 2,735 is anticipated.

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

Organization		2030	2035	2040
Head Office		173	173	173
HCMC Branch Office	Control division	194	194	194
	Worksite offices	2,541	2,797	3,068
Total		2,735	2,991	3,262

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
	Rolling Stock Section	Planning the inspection and repair of rolling stock	6
	Equipment/Facilities Section	Maintenance of tracks and structures	10

Name of Division/Section		Principal Assignment	Number of Employees
	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 Ho Chi Minh Branch Office

Name	Number	Number of employees		
		2030	2035	2040
Station	6	334	370	404
Driver/Conductor -depot	1	256	318	397
Rolling Stock Inspection Base	1	82	90	98
Rolling Stock Workshop	1	364	400	437
Track Maintenance - depot	7	650	715	780
Power Supply Station - depot	6	435	479	522
Signal/Telecommunication - depot	6	370	370	370
Materials Center	2	50	55	60
Total		2,541	2,797	3,068

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 southern 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 Introduction

1) Overview

9.1 This chapter discusses the economic analyses for HSR along the N-S corridor, with particular attention to the southern HSR (HCMC - Nha Trang). 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 yardsticks 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 southern HSR is 78 thousand a day, at fare level equal to 25% of air transport. This nosedives to 17 thousand a day (or -78%) when the fare is set equal to air fare. The reduced traffic translates to -15% drops in daily revenues. Most of the passengers attracted by the HSR were at the expense of road transport (Buses and Cars) and almost none came from air transport for the 362-km southern line. 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 for contextual purposes.

Table 9.1.2 Demand Forecast for the South HSR

Cases	Section 2	Section 2x	Full HSR
	HCMC-Nha Trang	HCMC-Phan Thiet	Hanoi-HCMC
1 Number of Passengers/day, 2030			
Fare level 1 @25%	77,583	*n.a.*	168,560
Fare level 2 @50%	43,321	23,123	100,703
Fare level 3 @75%	24,002	*n.a.*	50,254
Fare level 4 @100%	16,508	*n.a.*	29,094
2 Passenger Kilometers, million/day			
Fare level 1	28.085	*n.a.*	261.6
Fare level 2	15.682	3.3	156.3
Fare level 3	8.689	*n.a.*	78.0
Fare level 4	5.976	*n.a.*	45.2
3 Modal Share of HSR			
Fare level 1	4.6%	*n.a.*	37.0%
Fare level 2	2.4%	0.6%	22.0%
Fare level 3	1.3%	*n.a.*	11.4%
Fare level 4	0.9%	*n.a.*	6.2%

Source: The Study Team

4) Project Costs of Southern HSR

(1) Capital Cost

9.9 The capsulized version of project cost is shown in Table 9.1.3. The local cost items were converted into economic costs by a shadow factor of 0.87, to exclude VAT and other taxes. 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 priced the cost of labor, in the absence of construction data breakdown.

Table 9.1.3 Project Cost for the Southern HSR

Breakdown	Financial Cost	Mix		Economic Cost
	Thu Thiem-Nha Trang	Foreign	Local	Thu Thiem – Nha Trang
Track Infrastructure	7,087			7,401
Civil Works	3,128	10%	90%	3,159
2 Tracks	738	59%	41%	782
3 Station	519	19%	91%	524
4 Maintenance Depot & Workshops	294	62%	38%	310
5 Power System	1,652	89%	11%	1,799
6 Signaling and Telecom	756	94%	6%	827
B. Rolling Stocks	1,045	100%	0%	1,150
C. Other Cost	1,110			
1 Engineering Services	285	47%	53%	299
2 Land Acquisition	685	0%	100%	685
3 Support Equipment	140	84%	16%	152
D. Contingency	462	42%	58%	428
E. Taxes	229	0%	100%	
F. Interest during construction	397			
Grand Total, in USD million	10,330			10,114
Total, excluding E and F	9,704			
Length, km	366			
Number of Trains, in item B	22			

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 Costs, 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: The Study Team

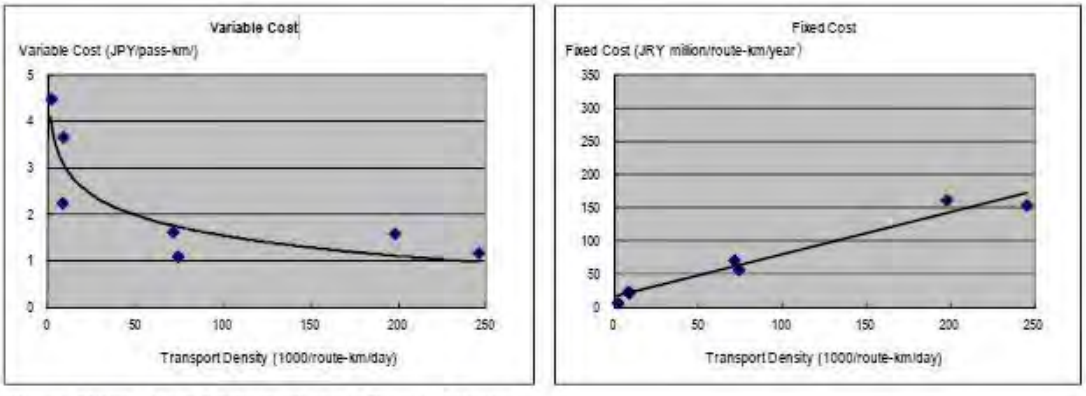
9.10 It can be inferred from the above Table that the larger the imported (i.e., foreign cost) contents, the higher is the cost in economic terms. Considering that the convertibility of VND is controlled, it is difficult to determine what the real or shadow price of foreign currency is1, and is beyond 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.

(2) 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. Three, is the published cost data from Europe 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

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

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

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 Southern Line (Deductive Method)

Section/Line	Fare Level	Direct Operating Cost		Personnel	Cost, in US$ m
		Variable	Fixed		Total
Section 2 (HCMC-Nha Trang)	Fare50	419.9	. 74.9	4.4	499.2
	Fare75	247.6	74.7	4.4	326.7
	Fare100	176.8	74.7	4.4	255.9

Source: The Study Team

9.15 The personnel cost in the above Table is based on the number of staff in accordance with the organizational design for the relevant lines, and using average payroll cost of US$8,381 per employee (this rate is 1.5x the 2010 values of VNR, to account for the higher level of competence demanded by HSR over ordinary railways). The headcounts are 2,735 for the Southern HSR. 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, these operating cost data would be adequate. They provide a quick-and-easy order of magnitude estimate of project cost in relation to demand. However, they present basic dilemma: (a) the depreciation or non-cash item is bundled into the cost and is independent of project costs; and, (b) the variable and fixed costs are based on domestic Japanese inputs, including electricity cost. The power cost in Japan is at US$0.178 per kwh compared to US$0.055 per kwh in Vietnam, or more than 3 times. Considering that the rail lines 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. These 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 of rolling stock is US$3.50/train-km, excluding labor which is already captured in the Personnel Cost. By way of comparison, the Euro HSR averaged €2.0/train-km, while Shinkansen averaged $5.50 per train-km.;

(d) Periodic maintenance cost at 15% of rolling stock cost every 15 years, 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 added to USD1.60 million per station.

(f) Fixed overhead was calulated 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 of the preceding cost items, at start of operation, using the inductive method.

Table 9.1.5 Table of Operating Expenses (Inductive Method)

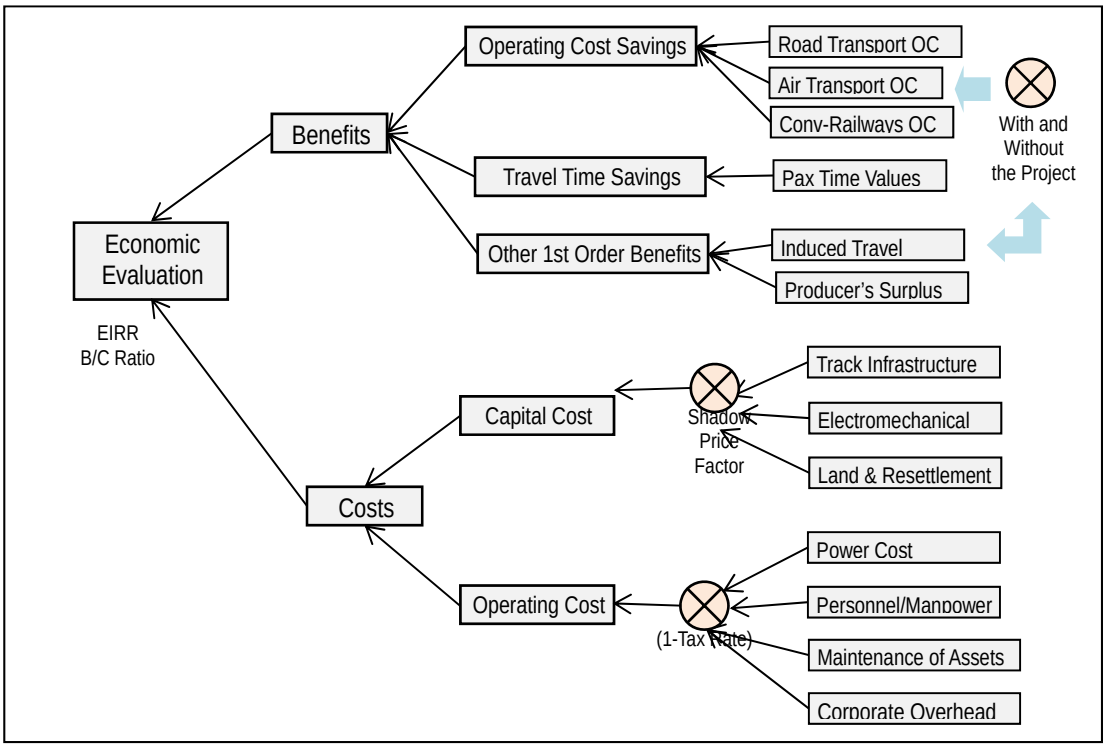
	COST VARIABLE	UNIT	REMARKS
1	Power Consumption	31.7 kwh/train-km	The unit cost for electricity is set at 1,160VND per kwh; increasing at 5% p.a.
2	Manpower	Headcount =2,735	Average compensation of USD8,381/year + proportionate share of the cost of 173 staff at corporate head office
3	Track Maintenance	USD124,000/km	To cover cost of materials per km of line length, inclusive of maintenance of power system (or electric circuits). Based on engineering evaluation of Shinkansen data, recalibrated to Vietnam's wage rates.
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+ S&T	Depreciation + Replacement	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 Analysis

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.



Source: JICA Study Team

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 Vehicle Operating Costs (as June 2012)

(US$/1000km)

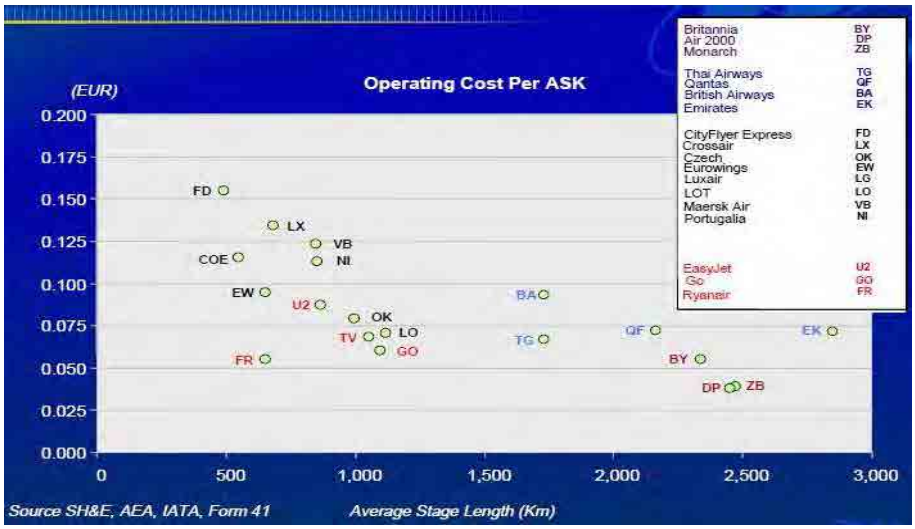
	Speed	MC	Car	Minibus	Standard Bus	Small Truck	Big Truck	Container Truck
	(Km/hour)			*(24 pax)*	*(60pax)*	*(2ton)*	*(6ton)*	*(15ton)*
Financial Cost	5	194.8	1081.7	994.2	1840.4	1836.8	1677.8	1426.0
	10	115.1	557.4	559.3	980.0	1089.0	997.2	795.3
	20	73.8	293.8	335.2	543.2	708.3	650.3	477.1
	30	59.7	202.7	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 US$74.4 per thousand passenger-km, in financial terms, and US$64.7 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 that indicated a cost ranging from €0.06 to €0.15 per available seat-km (ASK), in 2001 (see figure 9.2-2) - 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 analysing the 2010 performance data of VNR. The exercise yielded a unit cost of US$21.1 per 1000 passenger-km. Adjusted to 2012 and removing local taxes, the rail operating cost becomes US$19.17 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 CSR. 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 9.2.1, 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 Southern 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 Southern HSR						
1	CSA2SN2_050	1,380,035	23,658	564	- 102	-40	422
2	CSA2SN2_075	1,386,977	23,777	445	- 108	-50	287
3	CSA2SN2_100	1,388,404	23,801	420	-90	- 55	275
	Note: Negative savings for Existing Railway and Air were due to increased ridership on those modes, as a result of HSR-south.						

Source: JICA Study Team

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 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.

Table 9.2.3 Value of Time (Travel Time Cost)

Item		Minimum Value		Road Study 2009	Adopted Value, 2012
	Mode	2011	2030		
Average Income	Car/Air	314	1056		
	Bus/Rail/IWT	150	528		
Pax Time Cost (US$/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 labour. 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 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, Southern HSR

	Cases for the Southern HSR	Pax-Hours/Day (in million)		Savings in Hours/Day		Total TTC
		Car/Air	Bus/Rail	Car/Air	Bus/Rail	In US$ m
0	Without Project	3.574	9.133			
	With Southen HSR					
1	CSA2SN2_050	3.263	9.142	0.311	-0.01	440
2	CSA2SN2_075	3.367	9.154	0.207	-0.02	280
3	CSA2SN2_100	3.385	9.110	0.189	+0.02	292

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". The extent of 'induced traffic', however, cannot be accurately measured. Hence, in this Study no valuation was made for it. However, there are clear benefits accruing to producers – railway and airline operators – known as producers' surplus. If the incremental costs to these two modes are included in the equation, consistency dictates that their gains should also be included. 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 investment costs. In the absence of multi-year estimates, the ratio of first-year benefit to project cost provides an indicator of viability. The higher ratio for the shorter segments would suggest that smaller project configuration, i.e., shorter lines, is justifiable.

Table 9.2.5 Initial Benefits and Project Costs

	Cases for the Northern HSR	ash Oper. Cost Yr 2030	Benefits			Net Benefits	Investment (Economic)	Ratio of Net Benefit to Investment, (%)
			Type 1	Type 2	Others			
	CSA2SN2_050	178	422	440	424	1,116	10,114	11.0%
2	CSA2SN2_075	132	287	280	450	869	10,114	8.6%
3	CSA2SN2_100	121	275	292	376	802	10,114	7.9%

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 3%.

Table 9.2.6 Growth Assumptions beyond 2030

Traffic Growth Rates (%)	Annual Increase in Benefit Values			Residual Value
Section 2	Value of Pax Time	Value of VOC	Value of Air OC	2050, in USD m
5.0% (2030-2040)	6.0% (Car & Air)	4.0% (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 13.6%, the EIRR of the southern HSR exceeds the desirable threshold of 12%. It rises up to 14.6%, if the value of the land is excluded. This jump is due to the high cost of land between ThuTiem and Nha Trang, particularly in the HCMC area.

Table 9.2.7 EIRR for the Southern HSR

	CASE	EIRR incl. Land	EIRR excl. Land
1	CSA2SN2_050 (Section 2)	12.0%	12.9%
2	A2SN2_050 (Full Line)	9.1%	11.3%

Source: JICA Study Team

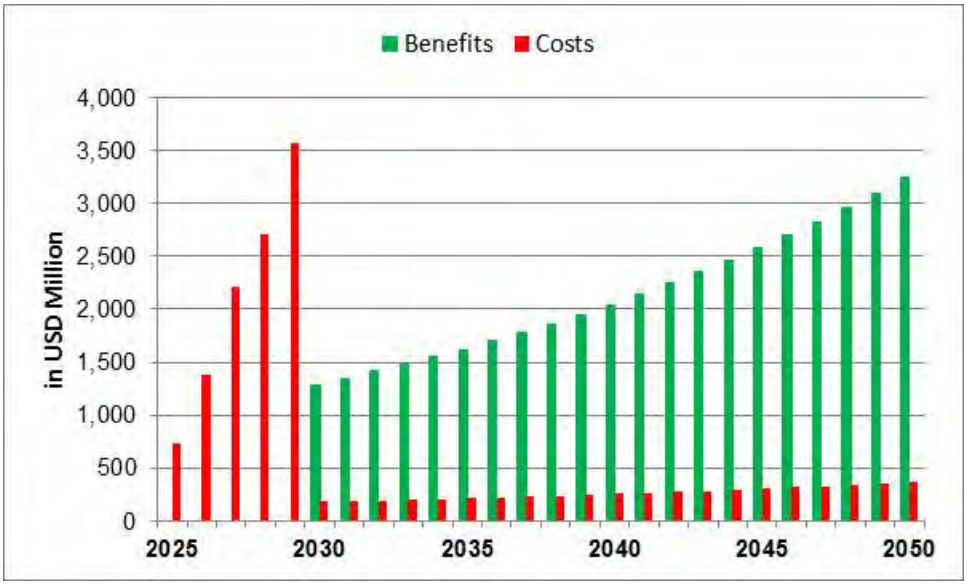


Figure 9.2.3 Benefit and Cost Scenario for the Southern HSR

3) Some Issues in Economic Evaluation

9.32 In benefit-cost analysis, the value of land can be adjusted – 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.

Sensitivity Analysis

9.33 The EIRR can improve, in several ways. The most obvious is reduction in project cost. A 10% reduction pushes the EIRR up – from 12.0% to 13.2%. Of less impact is a reduction in operating costs. On the other hand, if the shadow exchange rate factor goes down – from 1.10 to 1.0 – the EIRR rises from 12.0% to 12.5%. 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 76.0% for the southern section, this figure for the “medium scenario” is 82.6%, implying an increase of urban population of 1.1 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 ridership in pax-km on HSR will increase by 21.9%; and assuming proportionate increase in benefits, the EIRR would

rise to 14.5% - which approximates the effect of a 20% reduction in project cost. The EIRR is more sensitive to the shift from air to HSR, particularly within the distance of the south HSR length (366-km) because of the high differentials in operating cost. Thus, a 10% shift would push the EIRR higher by at least 2 percentage points to 14.6%.

9.35 Delaying the implementation of the southern HSR by 5 years would imply start of operation in year 2035 and higher ridership. In this case, the EIRR jumps – from 12.0% to 14.5% and becomes more economically viable. Combined with more intensive urbanization, the EIRR rises dramatically to 21.2%.

9.36 It should be noted that the fleet size (or number of rolling stocks) in the preceding base case scenario is 22 trains, as determined in the Technical Chapter. No incremental increase was assumed throughout the 20-year projection period. It is possible that when more precise estimation of sectional demand is made, a lower number of trains can be deployed at the start of operation and additional train acquired as demand grows.

Other Benefits

9.37 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.

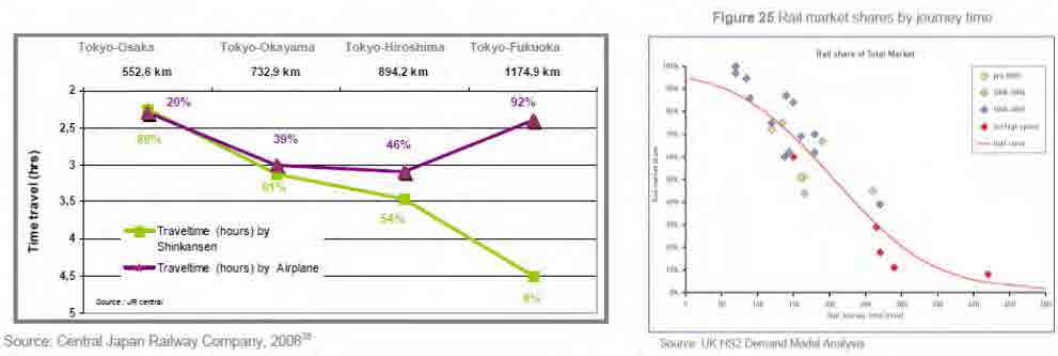
9.38 The HSR is also being justified in Europe on environmental terms. Diversion of traffic – from air and road transport modes – leads to a reduction in the consumption of fossil fuel and emission of greenhouse gases. For example, it was estimated that the carbon footprint of TGV is 2.2 grams per pax-km, 115 grams per pax-m for car, and 153 grams per pax-km for air travel2. 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 southern 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 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.

9.39 The estimation of wider economic benefits may also be included, following similar studies in Europe to justify HSR3. The HSR would enable growth of secondary cities (such as Nha Trang, Bien Hoa and Phan Thiet), 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 benefits, however, are prone to double-counting, difficult to quantify and attribute solely to the project; hence, have not been factored into the analysis.

[2] Stephanie Brun-Brunet, “Applying European PPP Experience to the Development of HSR projects in USA”, Alsthom (2011).
[3] Colin Buchanan, “Economic Impact of High Speed 1”, London and Continental Railways, Jan 2009.

Comparison with Selected HSR countries

9.40 The low economic impact of the HCMC-Nha Trang 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 southern section is 366 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.



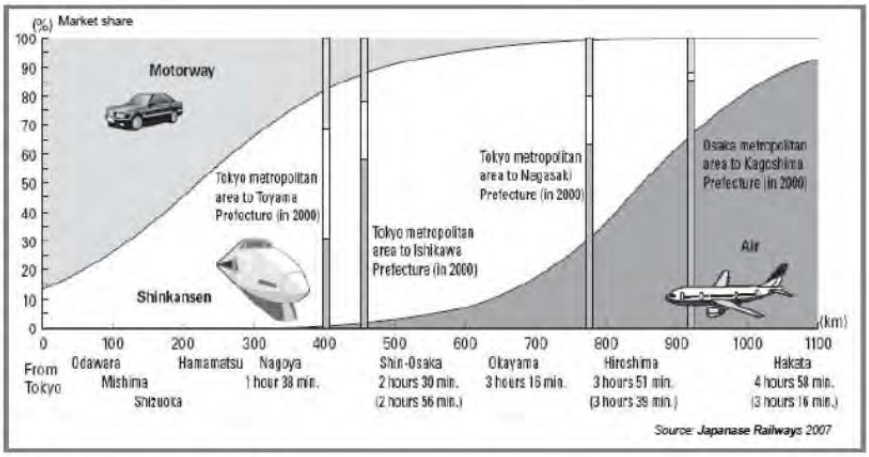


Figure 9.2.4 Multi-modal Shares of Transport in Japan

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 huge population, such is not the case for the southern HSR. The predicted traffic density is only 15.6 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 Analyses

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 Southern HSR, 2030

Cases	Per Day, in VND million	Annual, in USD million
	HCMC-Nha Trang	HCMC-N.Trang
Fare level 1 @25%	12,252	210.0
Fare level 2 @50%	13,683	234.6
Fare level 3 @75%	11,371	194.9
Fare level 4 @100%	10,428	178.8

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. At fare levels 2, 3 and 4, the operation generates positive cash flows.

Table 9.3.2 Net Income of the Southern HSR, 2030

Cases	Operating Income (in US$ m)	Net Cash Generation
Fare level 1 @25%	-426	-26
Fare level 2 @50%	-368	+33
Fare level 3 @75%	-391	+10
Fare level 4 @100%	-396	+5

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 data beyond 2030. The results are shown in Table 9.3.3. It is clear from this Table that the southern HSR project is not financially viable under any conceivable conditions. The FIRR becomes positive only by assuming a very optimistic traffic growth of 10%. Given the prevailing lending rate of banks, it means that no amount of leveraging can boost return on equity above 16% - unless the government provides substantial subsidy to the HSR company.

Table 9.3.3 Indicative Financial Returns, Southern HSR

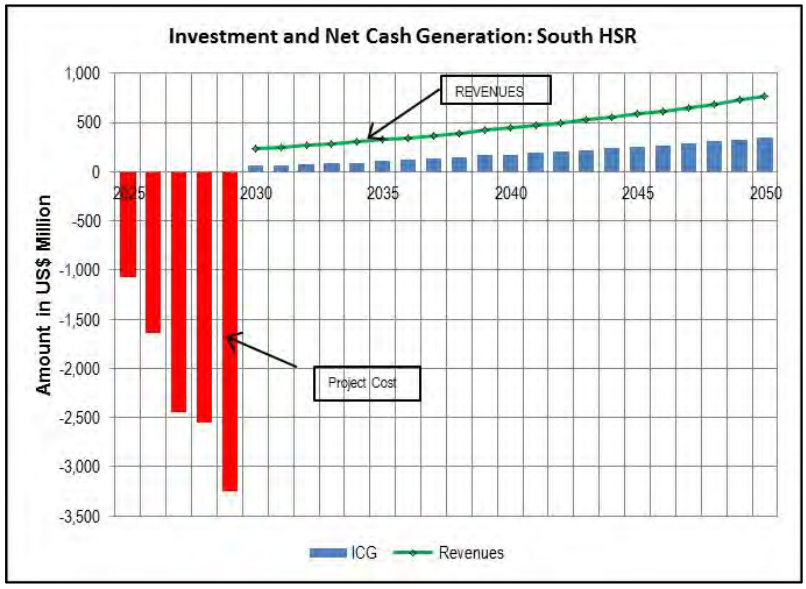
	CASES for the southern HSR	1st Year Ratio	FIRR under Various Growth Rates in Demand			
			Base Scenario	AGR=5%	AGR=7%	AGR=10%
	CSA2SN2_50	+0.3%	-9.83%	-8.94%	-5.29%	-1.26%
2	CSA2SN2_75	+0.1%	-11.42%	-10.47%	-6.68%	-2.20%
3	CSA2SN2_100	+0.0%	-12.14%	-11.19%	-7.33%	-2.69%

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 and HSR - elsewhere where the financial returns are very low. For the Southern HSR, the internal cash generations are mostly positive - implying fare box ratio greater than 1. It suggests potentials for public-private-partnership, provided government is willing to provide subsidies. Figure 9.3-1 shows the cost expenditure profile and future internal cash generations.

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 HCMC-Nha Trang HSR, the FIRR edges up by nearly 3%, from -9.83% to -6.78%. With positive cash flows and heavy subsidy from the government, it may be able to attract private investors in some segments of the business. For example, if the government pays for the cost of track infrastructure, the railway operating company can expect FIRR = -4.8%.

9.47 The fare level is too low, since this was based on 50% of air fare which in turn appears too low even by international standards. If this can be doubled without affecting demand – which can reasonably happen if household incomes would continue to rise as fast as the country's economic growth, then the FIRR can jump from -9.83% to +0.30%. At 3x the fare level assumed in the Base Case of the financial forecast, the FIRR jumps to +5.1%.



Source: JICA Study Team.

Figure 9.3.1 Investment and Internal Cash Generation of Southern HSR

9.48 In the preceding analyses, the operating cost of the southern HSR turned out to be 15.5% 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$ 0.036. 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 has been analyzed by researchers to be 2 to 3 times more in power and maintenance cost. If at all, the operating cost estimates adopted in the financial and economic evaluation are under-estimated, i.e., over optimistic.

9.49 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 charged US$0.13/pax-km (more than 3x the starting fare assumed in the Vietnam HSR project). The average revenue per passenger in Taiwan's HSR was US$23.50 vs US$15.00 for the project. If the current tariff on Shinkansen is applied on the project, the corresponding revenue should be US$177 per passenger, or 11 times more.

9.50 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 southern coastal areas of Vietnam – with consequent de-concentration in HCMC and spread of development to somewhere in Nha Trang, the FIRR improves – from -9.83% to -7.46% as a result of the increase in ridership by +15%.

9.4 Balancing Financial and Economic

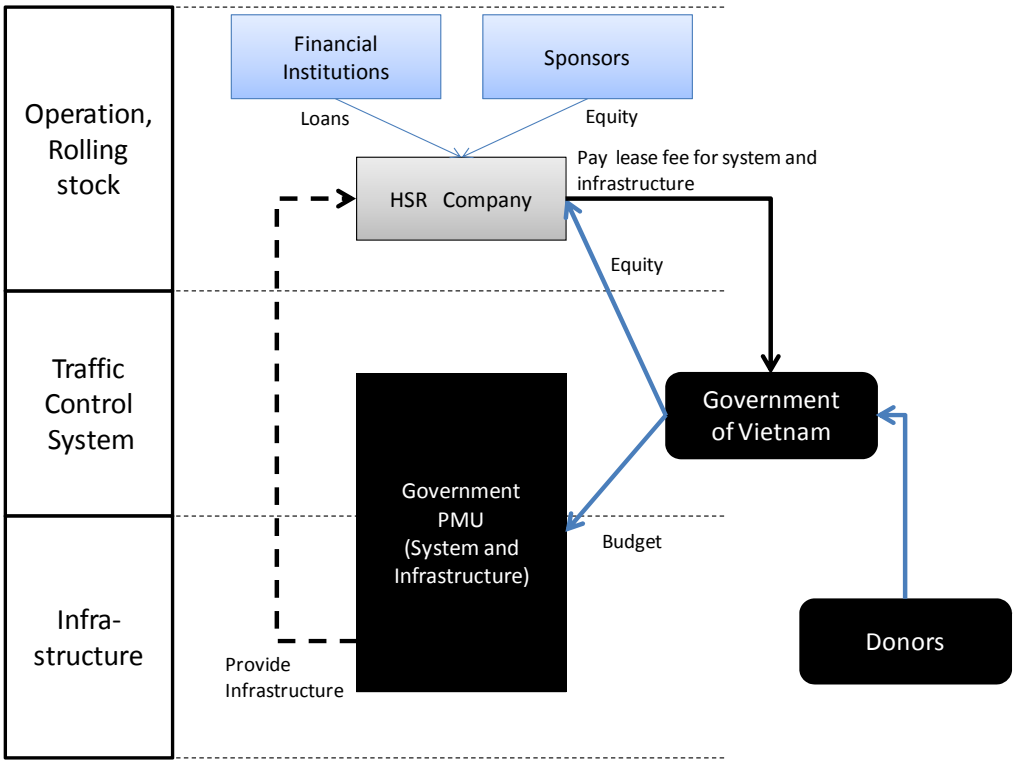
9.51 At the lower fare levels, the economic benefits to users (captured in the EIRR) get maximized. However, this means that very little benefits accrue to the producer or supplier (i.e., the HSR investor and operator). Conversely, maximizing the revenues from the HSR (reflected in FIRR) will bring down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

9.52 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 below 2%, if not outright negative.

10 FUNDING OPTIONS

1) Implementing Structure

10.1 The implementing structure is as explained in Part I and Part II. 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 The operator, HSR Company carries out the maintenance of rolling stocks, traffic control system and infrastructure consistently with the operation. The investments of the operator are mainly in rolling stocks, and they are financed both by loans and equity.

2) Estimated Profitability of HSR Company

10.3 In this section, profitability of HSR Company is examined. 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 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.

10.4 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 rate or the margin is also to be determined through the credit assessments by financial institutions.

10.5 When HSR Company cannot achieve sufficient level of profits from operations, the government will provide financial supports as a form of revenue guarantee. In this estimation, the government is supposed to provide such financial supports, so that HSR Company can achieve 10% operation profits.

10.6 As mentioned above, the maintenance costs for the infrastructure are provided by the government to HSR Company, based on the current arrangement. The profitability of HSR Company for this section will be rather higher than Hanoi – Vinh section, and the the shareholders can achieve 12.5% of IRR on equity. (See Table 10.1).

Table 10.1 Estimated Income Statement of HSR Company (HCMC-Nha Trang) 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					237.2	255.0	274.2	294.8	317.0	455.5	632.5	870.6
B	Operating expenses					193.2	201.9	204.0	206.2	214.7	241.8	282.7	347.7
	- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	- Depreciation of rolling stock					36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1
C	EBITDA: Earning before Interest, Tax and Depreciation)					80.0	89.1	106.2	124.6	138.3	249.8	385.9	559.0
D	EBIT: Earning before Interest and tax (after depreciation)					43.9	53.1	70.1	88.6	102.3	213.8	349.8	523.0
E	Interest Expenses		13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0			
F	Net profit (after interest and depreciation) before tax		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	213.8	349.8	523.0
G	Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1	104.9	156.9
	- Profit base = Profit before subsidy - repayment		-13.3	-39.8	-66.4	-148.4	-129.8	-103.2	-75.3	-52.1	213.8	349.8	523.0
H	Net profit (before subsidy, after rental fee)		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	149.6	244.9	366.1
	Corporate tax	25%	0.0	0.0	0.0	0.0	1.4	8.1	15.0	20.8	37.4	61.2	91.5
	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 profixt after tax (after subsidy)		-13.3	-39.8	-66.4	-12.9	4.3	24.2	45.1	62.5	112.2	183.7	274.6
L	Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	56.1	91.8	137.3

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				135.4	135.4	135.4	135.4	135.4	0.0	0.0	0.0
Loan Balance		189.6	568.8	948.0	812.6	677.1	541.7	406.3	270.9	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0	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)		-13.3	-53.1	-119.4	-132.4	-128.1	-104.0	-58.9	3.6	300.8	721.5	1,347.3
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	56.1	91.8	137.3
Surplus / Deficit (after dividend)		-13.3	-53.1	-119.4	-132.4	-128.1	-104.0	-58.9	1.8	244.7	629.7	1,210.0

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		47.4	94.8	94.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash iniflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	56.1	91.8	137.3
Net Cash Flow		-47.4	-94.8	-94.8	0.0	0.0	0.0	0.0	1.8	56.1	91.8	137.3
Equity IRR	12.5%											

Source: JICA Study Team.

10.7 As the profitability of HSR Company and the sufficient level of IRR on equity are

the minimum conditions to attract investors, "revenue guarantee", by which the government provides subsidies when the company could not achieve sufficient revenue to make profits is considered.

10.8 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 10.2.

Table 10.2 Estimated Income Statement of HSR Company (HCMC-Nha Trang) 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					237.2	255.0	274.2	294.8	317.0	455.5	632.5	870.6
B	Operating expenses					193.2	201.9	204.0	206.2	214.7	241.8	282.7	347.7
	- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	- Depreciation of rolling stock					36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1
C	EBITDA: Earning before Interest, Tax and Depreciation)					80.0	89.1	106.2	124.6	138.3	249.8	385.9	559.0
D	EBIT: Earning before Interest and tax (after depreciation)					43.9	53.1	70.1	88.6	102.3	213.8	349.8	523.0
E	Interest Expenses		13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0			
F	Net profit (after interest and depreciation) before tax		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	213.8	349.8	523.0
G	Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1	104.9	156.9
	- Profit base = Profit before subsidy - repayment		-13.3	-39.8	-66.4	-148.4	-129.8	-103.2	-75.3	-52.1	213.8	349.8	523.0
H	Net profit (before subsidy, after rental fee)		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	149.6	244.9	366.1
	Corporate tax	25%	0.0	0.0	0.0	0.0	1.4	8.1	15.0	20.8	37.4	61.2	91.5
	Financial support by the government		0.0	0.0	0.0	36.6	19.8	0.0	0.0	0.0	0.0	0.0	0.0
K	Net profixt after tax (after subsidy)		-13.3	-39.8	-66.4	23.7	24.1	24.2	45.1	62.5	112.2	183.7	274.6
L	Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3

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				135.4	135.4	135.4	135.4	135.4	0.0	0.0	0.0
Loan Balance		189.6	568.8	948.0	812.6	677.1	541.7	406.3	270.9	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0	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)		-13.3	-53.1	-119.4	-95.7	-71.7	-47.5	-2.4	60.1	329.1	749.7	1,375.5
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Surplus / Deficit (after dividend)		-13.3	-53.1	-119.4	-95.7	-71.7	-47.5	-2.4	30.1	272.9	657.9	1,238.2

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		47.4	94.8	94.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash iniflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Net Cash Flow		-47.4	-94.8	-94.8	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Equity IRR	13.0%											

Source: JICA Study Team.

10.9 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 13.0%, which is slightly higher than the case without financial supports through revenue guarantee.

3) Supports by the Government

10.10 The profitability of the Ho Chi Minh– Nha Trang section is higher than the Hanoi –

Vinh section, but a certain amount of subsidies is necessary to secure the profitability of HSR company, especially during early years after the commencement of the commercial operation.

10.11 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 Ho Chi Minh–Nha Trang section is USD 56.5 million, excluding the budget allocation for the maintenance costs of infrastructure.

Table 10.3 Necessary Government Financial Support for HSR Company (HCMC– Nha Trang)

	Year 1	Year 2	Year 3	Year 4	Year 5
Maintenance budget for infrastructure	47.3	48.7	50.1	51.6	53.2
Minimum profit	23.7	25.5	27.4	29.5	31.7
Actual Net profit (=F)	-12.9	5.7	32.2	60.1	83.3
Financial support for ridership	36.6	19.8	0.0	0.0	0.0

Source: JICA Study Team.

10.12 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 the operator. 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 operator should be covered by the government.

10.13 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 operator, but the revenues of the operators from passengers are in domestic currency.

4) Setting of Usage Fee for Infrastructure

10.14 HSR Company receives financial supports from the government when it cannot generate profits, and pays rental fee for the traffic control system and infrastructure, when it generates profits. Rental fee levels are to be determined based on the size of profits and cash flows.

10.15 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]

10.16 HSR Company starts paying the usage fee from 7th year, when it starts making sufficient profit base.

Table 10.4 Usage Fee Paid by HSR Company (HCMC-Nha Trang)

		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	1.5	49.5	55.5	64.1

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 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 IEE study, the baseline survey on environmental and social considerations was implemented. Environmental sensitivity maps were prepared for alignment planning (setting alternatives).

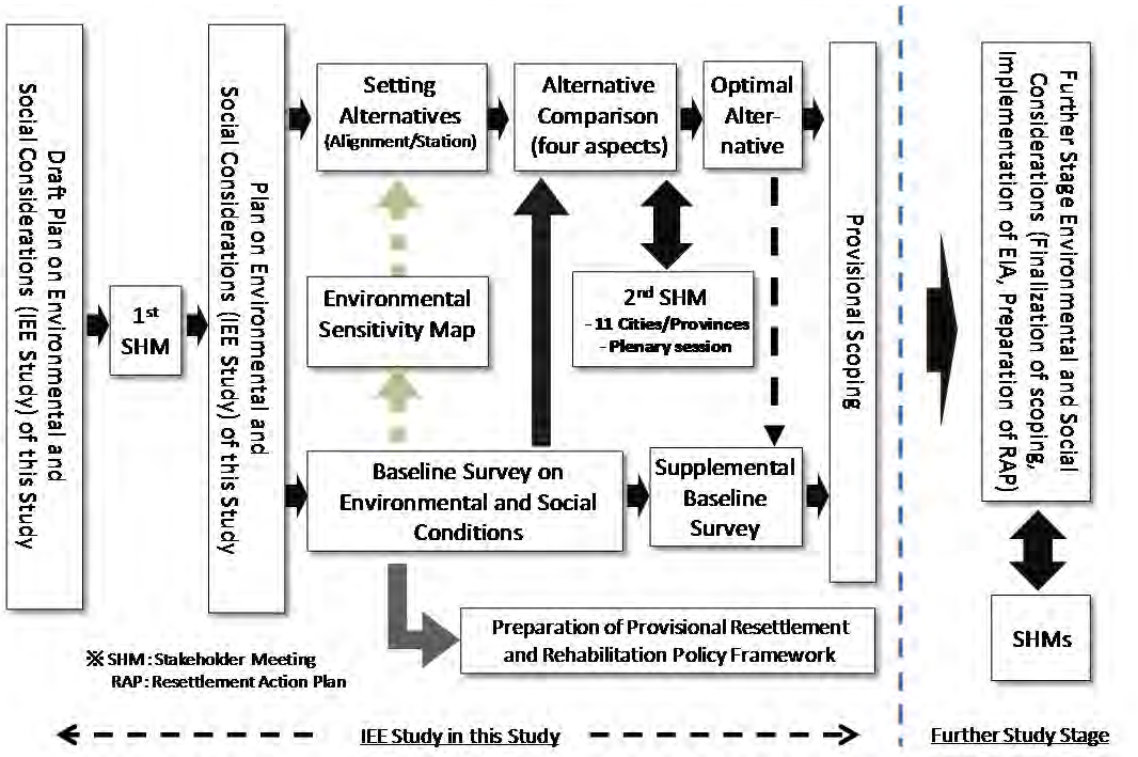
(iii) **Selection of Optimal Alternative on Alignment and Station Location:** in parallel with the baseline information collection, alternatives on alignment and station location were developed. On the alternatives, comparison was conducted taking into consideration comprehensive four aspects including 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.



Source: JICA Study Team

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

11.2 Result of Initial Environmental Examination (IEE)

11.6 Baseline survey on environmental and social conditions was conducted mainly by collecting 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 chose 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 south priority section (HCMC – Nha Trang).
Alternatives	Alignment options and station location options, together with zero option.
Items to be Considered for Alternative Comparison	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 three 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 Indicators Compared in Comparison of Alternatives

Aspects	Indicators
• 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)
• Economic 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 (South Section)

Aspect/Items	Alt1.(revised)	Alt2	Alt3	Zero option
Overall Evaluation	A	B	D	D
1) Convenience and Integrated Development	A	B	C	D
2) Environmental and Social Considerations	A	B	C	D
2)-1 Natural Environment	(A)	(A)	(D)	(C)
2)-2 Living Environment	(A)	(B)	(A)	(D)
2)-3 Social Environment	(A)	(D)	(C)	(C)
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 consideration 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 Sections	Selected optimal alternative for the south priority section (HCMC – Nha Trang)
Studied Items	In accordance with the JICA Guidelines for Environmental and Social Considerations (2004 and 2010), wide range of various environmental and social consideration 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 Base
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 HCMC-Binh Thuan is generally flat, there will be variations of topography between Binh Thuan – Khanh Hoa where more mountains/hills exist along the alignment requiring about 67km of cut section and 34km of tunnel section. It is noted that about 35km of cut section is also required in Dong Nai Section even though it is rather flat area. 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 366 km, in which embankment or cut section is about 275 km, where new surface may be washed by rain water.
	Hydrology	D	D	B-	P: No impact is expected.
					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: Since the HSR track will be developed mostly as embankment, the HSR structures may disturb the hydrological cycle or regimes in this section to some extent.
	Ground water	D	B-	B-	P: No impact is expected.
					C: Ground water in Mekong 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. Especially, in Ninh Thuan Province, the average rainfall of major towns is 650-800mm/year, and ground water resources are limited. Thus, even small impact may cause more serious issues in such area.
	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. - All section in Binh Thuan - Khanh Hoa falls within the boundary of Endemic Bird Area (EBA) of South Vietnamese lowlands.
					O: Existence of the HSR structure and HSR operation may cause negative impact on the ecosystem.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
	Protected Areas/Forest	B-	B-	B-	P: The closest special-use forests along the alignment are: Nui Chua National Park in Ninh Thuan (about 2km from the alignment) and Ta Kou Nature Reserve in Binh Thuan (about 3km from the alignment). No impact is expected to these precious areas. Besides protected areas, the alignment goes through protection forests (about 92 ha) and production forests (about 64 ha) in Dong Nai, Binh Thuan, Ninh Thuan and Khanh Hoa provinces. Change of forest use purpose into non-forest purpose is required in these areas.
					C: The construction machine 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 would 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 Binh Thuan (about 1.1 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 building, both positive and negative impacts on landscape are expected. - There are recreational areas such as Suoi Thien in HCMC and Mui Ne in Binh Thuan, they are far from the alignment and no impact is expected in such areas.
	Natural disasters	D	B-	B-	P: No impact is expected.
					C: Civil work in landslide/erosion prone areas in all of the City/Province along the alignment may trigger landslide.
					O: Some regularly flooding/land slide areas are found in the south priority section in all of the city/provinces. Typhoon damage is reported as well. Embankment construction will change topography in some sub-sections that may result in a higher risk of flooding. - It is reported that the soil erosion in the major rivers in Khanh Hoa is serious in these years.
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 (+55%) from cars (-13%), buses (-38%), airs (-3%), and existing railway (-1%) (Example of HCMC-Nha Trang Section, 2030). 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 Thu Thiem and Nha Trang, the impact is small.
	Soil	D	C-	B-	P: No impact is expected.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
	Contamination				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 Thu Thiem and Nha Trang.
	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 Mekong Delta in HCMC section 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.
					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 7 locations, of which 4 are over 3km (the longest one, approx. 14km in the boarder of Binh Thuan and Ninh Thuan, one in the boarder of Ninh Thuan and Khanh Hoa, and the other 2 in Khanh Hoa. Including the shorter ones, most of the tunnels are in Khanh Hoa Section, followed by Ninh Thuan and Binh Thuan. 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 Phan Thiet, Nha Trang: approx. 20m 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.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
Social Environment	Involuntary resettlement	A-	B-	D	P: About 1,700 ha of land would be necessary for development of the HSR structures (viaduct, station, depot, etc.) in this section. In addition, about 1,250 buildings and about 6,100 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 local resources	D	B-	D	P: No impact is expected.
					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 Thu Thiem Station and Section in HCMC - Dong Nai along the express way where 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, 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 would be 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.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
	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 Benefit and Damage	B-	B-	B-	P: Unequal situations are expected among the project affected households/peoples and not affected households/peoples.
					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 by the existence of the HSR structures are small, however, there may be some impact in the province like Ninh Thuan because the domestic water sources and irrigation facility is limited and further examination would be necessary for disturbance by the structures.
	Cultural and Historical Heritages	C-	C-	C-	P: There are no registered cultural and historical heritages found within a distance of 100m from the alignment. However, in Dong Nai Section, potential existence of undiscovered underground heritages was indicated by DOCST of Dong Nai.
					C: Registered heritages are not found within 100m from the alignment. Unknown heritages or heritages at distance may be affected by the traffic congestions caused by vehicles for the construction.
					O: Besides the undiscovered heritages, the registered heritages are located far from the alignment and they may not suffer from the impact of noise and vibration.
	Religious Facilities	A-	B-	B-	P: Though the well-known religious places are not directly affected, small scale village level religious facilities may be relocated (ex. Pho Quang Pagoda in Binh Thuan and several cemeteries).

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
					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, precision machine factory)	A-	B-	B-	P: It finds some sensitive places as elementary school in Dong Nai on the planned alignment and others near the alignment, which may be relocated.
					C: Especially the school and hospital, 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, the noise and vibration caused by HSR may affect the peoples' comfort.
	Poor people	B-	B+	C-	P: Poor people (who have poor household certificates issued by local authorities) stay everywhere, particularly concentrate in Ninh Thuan and Binh Thuan 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 and special considerations are necessary.
	Ethnic Minorities/indigenous people	A-	B-	B-	P: In this section, there are many ethnic groups, particularly in Ninh Thuan province with about 30 ethnic groups (such as Ra Glai and Cham). Though the planned HSR runs through the plain area, where the ethnic groups are less, land acquisition and resettlement may affect their livelihood and culture.
					C: Some impact on ethnic groups is expected by the influx of a large number of construction workers and relating peoples outside the area. Since the HSR runs through the plain area where the ethnic minorities are comparatively less, the impact would not be significant.
					O: Some impact on ethnic groups is expected by disturbed movement of peoples by the existence of HSR structures. Since the HSR runs through the plain area where the ethnic minorities are comparatively less, the impact would not be significant.
	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.

Category	Items	Result of Rating			
		Pre-construction	Construction	Operation	Rating Base
					O: Some impacts on public health are expected Increase of risks on spread of infectious diseases is expected due to the influx of a large number of passengers (about 50,000 passengers per day at Thu Thiem Station, if Thu Thiem – Nha Trang 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 on 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.
					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 the HSR from cars, buses, airs, and existing railway.
	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 GHG emission is expected by the modal shift of passengers' transportation to the HSR (+55% of the share between HCMC – Nha Trang, 2030 projection) from cars (-13%), buses (-38%), airs (-3%), and existing railway (-1%). 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 donor policies such as JICA Guidelines for Environmental and Social Considerations (April, 2010, hereafter referred to 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 south 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 will be 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 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

[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 in this project 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.

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 South 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 the 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 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

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
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
	• Severe impacts due to loss of 70% or more of their total productive land and income	• Owners with LURC, • Those who are in the process of acquiring LURC,	• 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	

[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
	sources	• 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	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]				
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	• Classification and measurement will be determined by DCC and concurred with by the affected household during DMS

[7] The Contractor is the sole responsible party on this compensation.

Loss Type	Application	Entitled Person	Compensation Policy	Implementation Issues
			• 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.	
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 identified by DPC: cash allowance of 10 million per household. • Entitled to take part the income restoration program	

Source: JICA Study Team

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

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 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 South 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), depot 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 for the entire tunnel section will be acquired.

(iv) Protection scope is the area to secure safety of the alignment, and land acquisition of this area is necessary. In the case of this project, the protection area was defined to be 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 to be 5m from the 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 was defined as protection scope and was included in land acquisition area, the remaining 10m was regarded as the 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
HCMC	Landuse Plan Map up to 2020
Dong Nai	Landuse Plan Map up to 2010
Binh Thuan	Landuse Plan Map up to 2020
Ninh Thuan	Landuse Plan Map up to 2010
Khanh Hoa	Landuse Plan Map up to 2020

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 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 South section was estimated at 1,681 ha. Among them, land acquisiiton area at three major land use is shown in Table 11.4.4 and Table 11.4.5 shows the affected land area and land use at province wise and section wise respectively.

Table 11.4.4 Preliminary Estimate of Affected Land Area by Province

Province	Land Use Category (Unit: Ha)		
	Agriculture	Forest	Residence
HCMC	64	0	17
Dong Nai	265	26	17
Binh Thuan	558	56	36
Ninh Thuan	178	20	5
Khan Hoa	154	53	32
Total	1,219	155	107

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
Thu Thiem Sta	0	0	7
Km 0.250 – 35.8	105	8	14
Long Thanh Sta	0	0	0
Km 36.3 - 152.95	455	30	17
Phan Thiet Sta	2	0	1
Km 153.45 – 220.20	240	13	18
Tuy Phong Sta	2	0	2
Km 220.70 – 283.35	158	42	12
Thap Cham Sta	0	0	1
Km 283.85 – 361.85	215	57	31
Nha Trang Sta	42	5	4
Total	1,219	155	107

Source: JICA Study Team

11.21 Table 11.4.6 and Table 11.4.7 show the number of affected structure by province and section, respectively.

Table 11.4.6 Preliminary Estimate of Affected Structure by Province

Province	HCMC	Dong Nai	Binh Thuan	Ninh Thuan	Khan Hoa	Total
Number of Affected Structures (Unit: No.)	90	102	483	214	360	1,249

Source: JICA Study Team

Table 11.4.7 Preliminary Estimate of Affected Structure by Section

Section	Thu Thiem Sta	Km 0.250 – 35.8	Long Thanh Sta	Km 36.3 - 152.95	Phan Thiet Sta	Km 153.45 – 220.20
Number of Affected Structures (Unit: No.)	4	108	0	260	52	222
	Tuy Phong Sta	Km 220.70 – 283.35	Thap Cham Sta	Km 283.85 – 361.85	Nha Trang Sta	Total
	17	193	13	222	158	1,249

Source: JICA Study Team

11.22 Table 11.4.8 and Table 11.4.9 show the number of affected tree 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	HCMC	Dong Nai	Binh Thuan	Ninh Thuan	Khan Hoa	Total
Number of Affected Trees (Unit: No.)	-	47,340	10,980	8,820	47,340	114,480

[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	Thu Thiem Sta	Km 0.250 – 35.8	Long Thanh Sta	Km 36.3 - 152.95	Phan Thiet Sta	Km 153.45 – 220.20
Number of Affected Trees (Unit: No.)	0	14,940	0	34,920	0	8,460
	Tuy Phong Sta	Km 220.70 – 283.35	Thap Cham Sta	Km 283.85 – 361.85	Nha Trang Sta	Total
	0	0	0	47,340	8,820	114,480

[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 Household by Province

Province	HCMC	Dong Nai	Binh Thuan	Ninh Thuan	Khan Hoa	Total
Number of Affected HHs (Unit: No.)	348	1,167	2,715	928	973	6,125

Source: JICA Study Team

Table 11.4.11 Preliminary Estimate of Affected Household by Section

Section	Thu Thiem Sta	Km 0.250 – 35.8	Long Thanh Sta	Km 36.3 - 152.95	Phan Thiet Sta	Km 153.45 – 220.20
Number of Affected HHs (Unit: No.)	4	528	0	2,080	61	1,183
	Tuy Phong Sta	Km 220.70 – 283.35	Thap Cham Sta	Km 283.85 – 361.85	Nha Trang Sta	Total
	25	824	13	1,083	324	6,125

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 South section was estimated at province-wise and section-wise as shown each summary in Table 11.4.12 and Table 11.4.13. Breakdown at each compensation cost is enclosed in Appendix 7B in Vol. III.

Table 11.4.12 Preliminary Estimation of Compensation Cost by Province

(Unit: million VND)

	Province	Total (VND)
1	HCMC	5,664,363
2	Dong Nai	806,855
3	Binh Thuan	2,461,435
4	Ninh Thuan	719,592
5	Khan Hoa	4,738,381
Total for South Section		14,390,626

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	Thu Thiem Station	3,192,214
2	Km 0.250 – 35.8	2,683,538
3	Long Thanh Station	2,574
4	Km 36.3 - 152.95	1,213,701
5	Phan Thiet Station	87,095
6	Km 153.45 – 220.20	1,304,402
7	Tuy Phong Station	32,014
8	Km 220.70 – 283.35	797,495
9	Thap Cham Station	41,067
10	Km 283.85 – 361.85	4,049,819
11	Nha Trang Station	986,707
Total for South Section		14,390,626

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

The project is planned to implement Thu Thiem – Long Thanh section first as the initial section following to Long Thanh to Nha Trang section as the prioritized section in the south section. Land acquisition schedule is explained in the following procedure.

11.26 Table 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 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 a donor agency and concerned Vietnamese authorities.

(v) RAP prepared at the time of F/S is updated in the same timing of official land acquisition procedure during D/D phase.

(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 to be organize 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 acquisition is completed, while independent monitoring, it is continued even after the 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