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No. 52

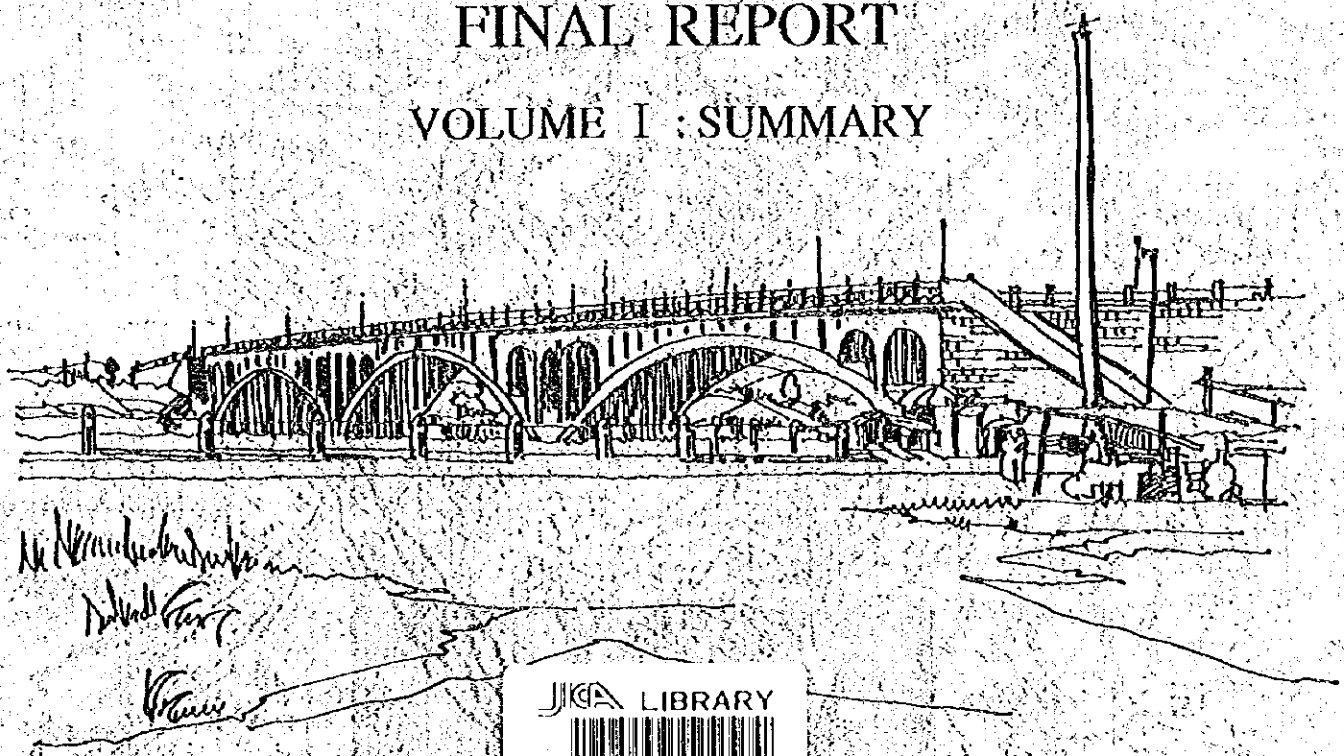
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF TRANSPORT
THE SOCIALIST REPUBLIC OF VIETNAM

FEASIBILITY STUDY
ON
THE HIGHWAY NO.18 IMPROVEMENT IN VIETNAM

FINAL REPORT

VOLUME I : SUMMARY



MARCH 1996

PACIFIC CONSULTANTS INTERNATIONAL

ORIENTAL CONSULTANTS CO.,LTD

JICA FEASIBILITY STUDY ON THE HIGHWAY NO.18 IMPROVEMENT IN VIETNAM FINAL REPORT MARCH 1996

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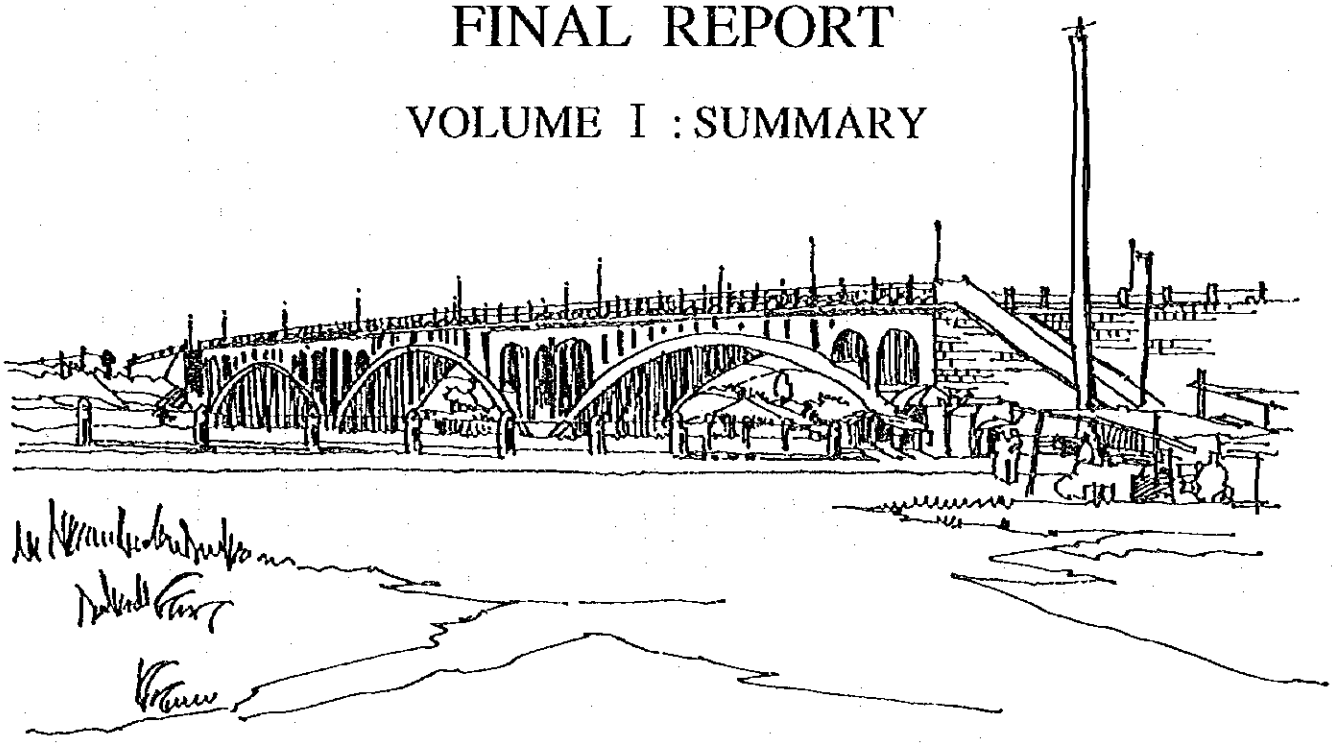

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The following foreign exchange rate is applied in the study:

US$ 1.00 = 10,950 Dong (as of January 1996)

PREFACE

In response to a request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct a feasibility study on the highway No. 18 improvement in the Socialist Republic of Vietnam and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Vietnam a study team headed by Mr. Akira Shikichi, Pacific Consultants International, between July 1995 to February 1996.

The team held discussions with the officials concerned of the Government of Vietnam, further studies were made and the present report was prepared.

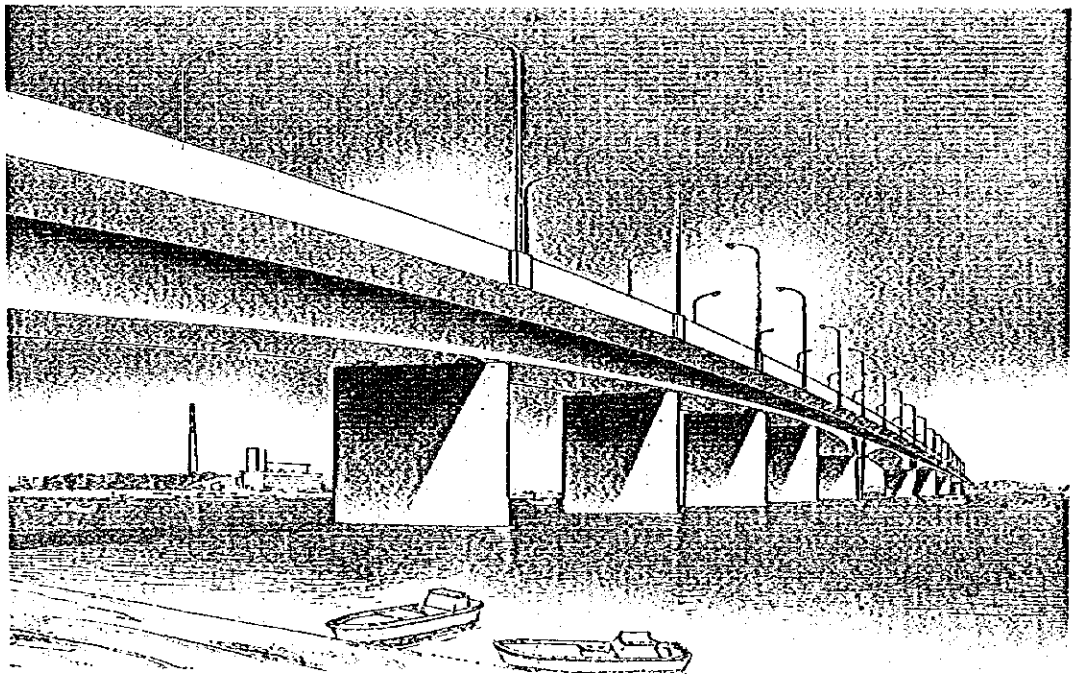
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

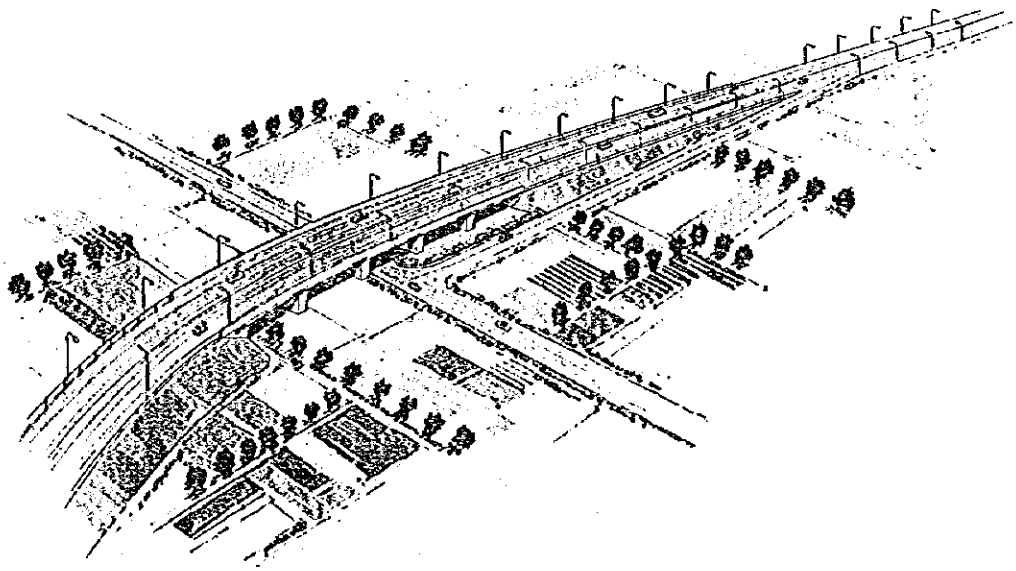
March 1996

Kimio Fujita
President
Japan International Cooperation Agency

PERSPECTIVE VIEWS
OF
HIGHWAY NO. 18 IMPROVEMENT

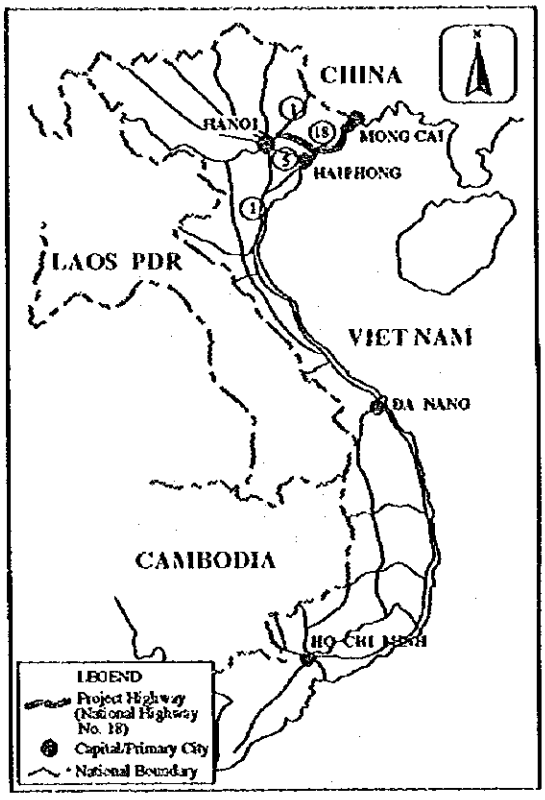


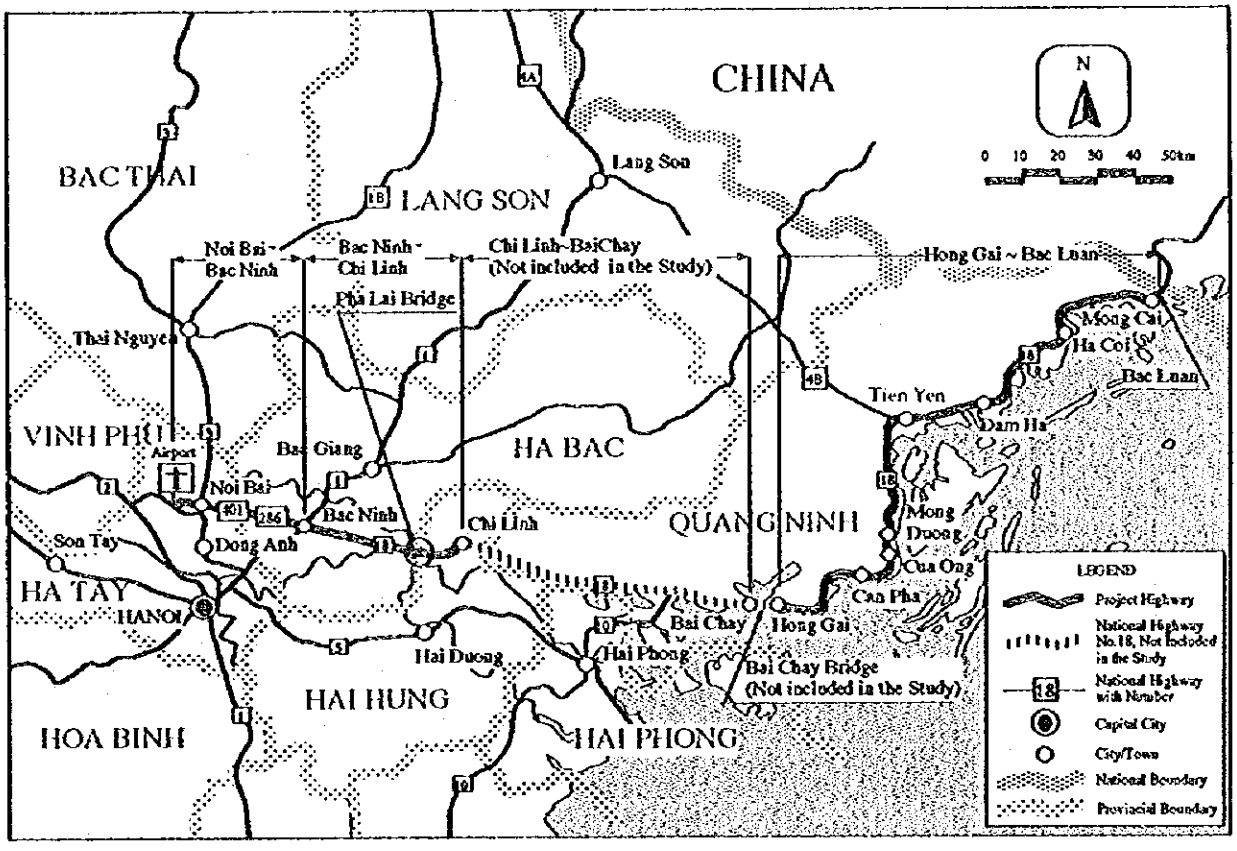
PHA LAI BRIDGE (PROPOSED)



PHU LO INTERCHANGE (PROPOSED)

PROJECT LOCATION MAP





DEFINITIONS AND ABBREVIATIONS

(1) Agencies

ADB	Asian Development Bank
CEETIA	Centre for Environmental Engineering of Towns and Industrial Areas
HPC	Hanoi People's Committee
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Association
JICA	Japan International Cooperation Agency
MOE	Ministry of Energy
MOT	Ministry of Transport
OECF	Overseas Economic Cooperation Fund, Japan
PMU No. 18	No. 18 Projects Management Unit
SPC	State Planning Committee
TEDI	Transport Engineering Design Inc.
TESI	Transport Economic Scientific Institute
UNDP	United Nations Development Program

(2) Technical, Traffic and Economic Terms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ADT	Average Daily Traffic
B/C	Benefit Cost Ratio
CLEPZ	Cai Lan Export Processing Zone
DID	Densely Inhabited District
DWT	Dead Weight Tonnage
EIRR	Economic Internal Rate of Return
EPZ	Export Processing Zone
ESAL	Equivalent 8.2 Ton Single Axle Load
GDP	Gross Domestic Product
GNP	Gross National Product
GPP	Gross Provincial Product
Highway No. 18	National Highway No. 18
NBIA	Noi Bai International Airport
NFEA	Northern Focal Economic Area
NMV	Non-Motorized Vehicles
NPV	Net Present Value
NTSR	National Transport Sector Review
NVMP	Northern Vietnam Master Plan Study (1994, by JICA)
OD	Origin and Destination

PC	Prestressed Concrete
PCU	Passenger Car Unit
RC	Reinforced Concrete
ROW	Right-Of-Way
SPT	Standard Penetration Test
Sta.	Station
USD/US $	US Dollar
V/C	Volume to Capacity Ratio

PROJECT SUMMARY

1. COUNTRY	The Socialist Republic of Vietnam
2. NAME OF STYDY	Feasibility Study on The Highway No.18 Improvement in Vietnam
3. COUNTERPART AGENCY	Project Management Unit 18(PMU18), Ministry of Transport
4. OBJECTIVE OF STUDY	To carry out the feasibility study on the highway No.18 improvement

1. SITE OF AREA : Area between Noi Bai ~ Bac Luan on route of Highway No.18 and surrounding area (except Chi Linh ~ Bai Chay)

2. FUTURE TRAFFIC VOLUME

Section No.		1	2	Chi Linh ~ Bai Chay	Bai Chay Bridge	3	4	5
Road Length		31.3km	36.4km	82.0km	0.8km	38.7km	43.5km	86.9km
Traffic Volume (PCU/day)	Year 1995	1,800	2,800	5,500	3,800	4,900	600	700
	Year 2005	7,600	14,800	26,500	17,200	21,300	3,200	3,400
	Year 2015	22,700	37,100	58,200	39,100	49,800	9,700	9,900

3. NUMBER OF LANE AND TYPICAL CROSS SECTIONS

Section No.	Section	Design Speed	Number of Lane	Typical Cross Section*
1	Noi Bai ~ Bac Ninh	120km/hr	4	Type D
2	Bac Ninh ~ Chi Linh	80km/hr	2	Type A-1
3	Hong gai ~ Cua Ong	60(80)km/hr	4	Type C-2
4	Cua Ong ~ Tien Yen	60km/hr	2	Type A-1 or B
5	Tien Yen ~ Bac Luan	60km/hr	2	Type B

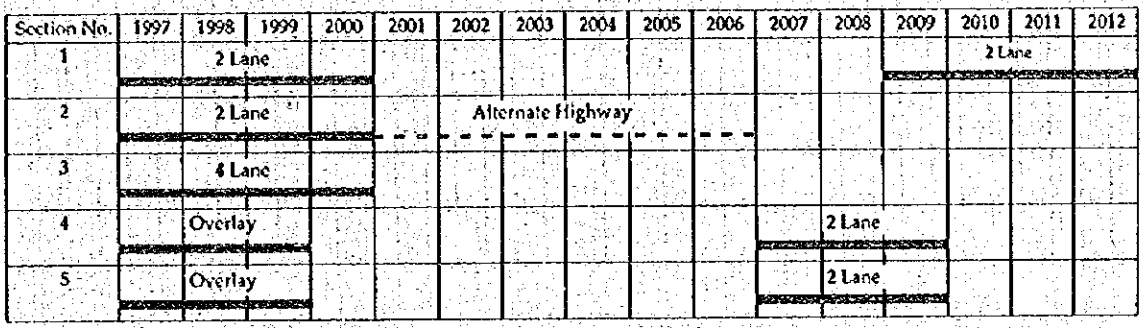
Note : *See Figure 2

4. PROJECT COST

-Unit : Million Dong
-1996 January Prices
-1US$=10,950 Dong

Section No.	Section	Length	Initial Stage	Final Stage	Total
1	Noi Bai ~ Bac Ninh	31.3km	664,379	591,105	1,255,484
2	Bac Ninh ~ Chi Linh	36.4km	531,438	-	531,438
3	Hong gai ~ Cua Ong	38.7km	536,030	-	536,030
4	Cua Ong ~ Tien Yen	43.5km	61,966	219,589	281,555
5	Tien Yen ~ Bac Luan	86.9km	150,942	452,825	603,767
Total		236.8km	2,244,755	1,263,519	3,508,274

5. IMPLEMENTATION SCHEDULE



6. FEASIBILITY AND ECONOMIC INDICATOR

	Section 1	Section 2	Section 3	Section 4	Section 5
EIRR(%)	15.1%	15.4%	20.6%	19.7%	18.3%
NPV(Million Dong)	387,194	274,826	720,926	183,501	339,567
B/C	1.70	2.00	2.28	2.67	2.47

Note : NPV and B/C were calculated based on a discount rate of 10% p.a.

7. RECOMMENDATION

1. Noi Bai ~ Bac Ninh Section is to be constructed as four (4) lane road (two lane opened at 2001 and additional two lane opened at 2013).
2. Bac Ninh ~ Chi Linh Section is to be widened to two lane road opened at 2001, and the realization of Alternate Highway is expected to be opened at 2007.
3. Hong Gai ~ Cua Ong Section is to be widened to four (4) lane road opened at 2001.
4. Cua Ong ~ Bac Luan Section is first to be overlaid to the existing pavement and to be opened at 2000 together with bridges and by-passes, and secondly to be widened to two (2) lane road opened at 2010 together with bridges and by-passes.
5. It is recommended that a road management unit for the maintenance of Highway 18 is set up in RMU No.2
6. Intermediate to major repair work should be switched from force account system to contract basis, and RMU No.2 should change its organization to respond chiefly to routine maintenance and emergency repairs.
7. Noise buffers are to be provided for public facilities along the highway between Hong Gai and Cua Ong.
8. Care is to be taken in selecting locations for dumping of excess cut soil, also for erosion prevention and drainage facilities in these locations in section 4.

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5	Tien Yen ~ Bac Luan	86.9km	150,942	452,825	603,767
Total		236.8km	2,244,755	1,263,519	3,508,274

5. IMPLEMENTATION SCHEDULE

Section No.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1		2 Lane												2 Lane		
2		2 Lane			Alternate Highway											
3		4 Lane														
4		Overlay										2 Lane				
5		Overlay										2 Lane				

6. FEASIBILITY AND ECONOMIC INDICATOR

	Section 1	Section 2	Section 3	Section 4	Section 5
EIRR(%)	15.1%	15.4%	20.6%	19.7%	18.3%
NPV(Million Dong)	387,194	274,826	720,926	183,501	339,567
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5. It is recommended that a road management unit for the maintenance of Highway 18 is set up in RMU No.2
6. Intermediate to major repair work should be switched from force account system to contract basis, and RMU No.2 should change its organization to respond chiefly to routine maintenance and emergency repairs.
7. Noise buffers are to be provided for public facilities along the highway between Hong Gai and Cua Ong.
8. Care is to be taken in selecting locations for dumping of excess cut soil, also for erosion prevention and drainage facilities in these locations in section 4.

OUTLINE OF THE STUDY

The Socialist Republic of Vietnam, Feasibility Study on the Highway No. 18 Improvement

- Study period: July, 1995 - March, 1996
- Counterpart Agency: Ministry of Transport, PMU 18

1. Background

National Highway No. 18 as currently conceived, starts at the Noi Bai International Airport and terminates at Bac Luan border gate. It constitutes an important trunk highway network in the Northern Part of Vietnam which connects Noi Bai International airport and major industrial zones such as Ha Noi, Hai Phong, Quang Ninh; sea ports (Hai Phong and Cai Lan), tourism centers (Ha Noi, Ha Long) which are being developed in the Northern Focal Economic Area.

However, the present condition of National Highway No. 18 suffers from a number of constraints and is not fulfilling the required functions of a national highway or trunk road; lack of direct connecting roads (Noi Bai - Bac Ninh), shortage of carriageway width, existence of ferry crossing (Pha Lai) and lack of all-weather connected river crossings (Tien Yen - Bac Luan), bridges with insufficient bearing capacity are the major problems.

2. Objective

The objective of the Study is to carry out the feasibility study on the Highway No. 18 improvement, targeting year 2015.

3. Study Area

The study covers the area between Noi Bai and Bac Luan and its environs.

- Noi Bai International Airport - Bac Ninh (31 km);
- Bac Ninh - Chi Linh (including Pha Lai Bridge (36 km));
- Hong Gai - Cua Ong (39 km);
- Cua Ong - Tien Yen (44 km);
- Tien Yen - Bac Luan (87 km).

4. Project Outline

4.1 Basic Policy

As stated in 1. Background, planning has been made to resolve all major issues of the improvement project by the target year 2015. However, considering the enormous amount of investment required for the project, the most appropriate initial investment, and road structure which meets traffic demand must be

selected to ensure the greatest possible investment efficiency. Furthermore, in planning the improvement of National Highway No. 18, involvement and interaction with road planning of related areas must be taken into account. In particular, relation to planned alternate highway (expressway) must be made clear.

4.2 Content

Plans for the improvement of National Highway No. 18 were made in reference to the basic policy stated above.

The order followed and results of study are stated below.

(1) Forecast Future Traffic Volume

A forecast of future traffic volume based on present volume and the future socio-economic framework of the study area is shown in the table below.

Table 1 Future Traffic Volume

Section No.		1	2	Chi Linh ~ Bai Chay	Bai Chay Bridge	3	4	5
Road Length		31.3km	36.4km	82.0km	0.8km	38.7km	43.5km	86.9km
Traffic Volume (PCU/day)	Year 1995	1,800	2,800	5,500	3,800	4,900	600	700
	Year 2005	7,600	14,800	26,500	17,200	21,300	3,200	3,400
	Year 2015	22,700	37,100	58,200	39,100	49,800	9,700	9,900

(2) Number of Lanes and Standard Cross Section

Judging from future traffic volume and traffic capacity, the number of required lanes was considered. Road geometric standard, which includes design speed and cross-section structure, was determined in consideration of the characteristics of each section.

Table 2 Number of Lane and Typical Cross Sections

Section No.	Section	Design Speed	Number of Lane	Typical Cross Section*
1	Noi Bai ~ Bac Ninh	120km/hr	4	Type D
2	Bac Ninh ~ Chi Linh	80km/hr	2	Type A-1
3	Heng gai ~ Cua Ong	60(80)km/hr	4	Type C-2
4	Cua Ong ~ Tien Yen	60km/hr	2	Type A-1 or B
5	Tien Yen ~ Bac Luan	60km/hr	2	Type B

Note: See Figure 2 for typical cross sections in page 6.

(3) Preliminary Design, Construction Planning, and Accumulate Project Cost

Based upon the road's geometric standard, route selection was made with efforts to keep influences on the human and natural environments to a minimum. At the same time, improvement plans of bridges, preliminary design and construction planning were conducted. The project cost estimation was made in consideration of these aspects. (see Table 3)

(4) Outline of Project

As mentioned in 4.1, a phased construction system is adopted to raise investment efficiency, and improvements were planned in conjunction with the plans for the new alternate highway. (see Figure 1)

- Noi Bai to Bac Ninh section is to be constructed as a four (4) lane road, of which only two lanes are to be completed in initial stage construction, to minimalize front investment.
- Considering that plans are made for an alternate highway, upgrading of the existing Highway No. 18 route between Bac Ninh and Chi Linh beyond enhanced two-lane status is neither justifiable in terms of traffic demand nor in terms of road network.
- The Hong Gai - Cam Pha - Cua Ong section of Highway No. 18 requires four traffic lanes.
- Considering the relatively slow growth of traffic volume section No. 4 from Cua Ong to Bac Luan is to be widened to the two lane road in the final stage, after pavement overlay in the initial stage.

5. Project Costs

The estimated project costs by stage in exchange rates effective in January 1996 (1US$ = 10,950 D) for each section are shown in the following in local and foreign currencies;

Table 3 Estimated Proejct Cost in 1996 Prices

(Unit : Million Dong)

Section	Stage	Financial Cost			
		Total	Foreign Currency	Local Currency	
Section 1 : Noi Bai - Bac Ninh	Initial Stage	664,379	382,629	281,750	(75,338)
	Final Stage	591,105	360,037	231,068	(70,993)
Section 2 : Bac Ninh - Chi Linh	Initial Stage	531,438	318,664	212,774	(62,776)
Section 3 : Hong Gai - Cua Ong	Initial Stage	836,030	452,768	383,262	(89,135)
Section 4 : Cua Ong - Tien Yen	Initial Stage	61,966	37,743	24,223	(7,436)
	Final Stage	219,589	128,213	91,376	(25,253)
Section 5 : Tien Yen - Bac Luan	Initial Stage	150,942	90,105	60,837	(17,750)
	Final Stage	452,825	268,145	184,680	(52,820)

Note: Values in ( ) shows tax amount

6. Project Evaluation

6.1 Economic Analysis

The economic indicators for the project are shown in Table 4. All sections' construction is deemed feasible.

Table 4 Results of Economic Analysis

(Unit : Million Dong)

Section No.	Section	Present Worth of Benefit at i = 10%	B/C Ratio at i = 10%	IRR (%)
1.	Noi Bai - Bac Ninh	387,194	1.70	15.1
2.	Bac Ninh - Chi Linh	274,826	2.00	15.4
3.	Hong Gai - Cua Ong	720,926	2.28	20.6
4.	Cua Ong - Tien Yen	183,501	2.67	19.7
5.	Tien Yen - Bac Luan	339,567	2.47	18.3

Note: Figures for "Present Worth of Benefit" and "B/C Ratio" were attained by a discounting rate of 10 % p.a.

6.2 Environmental Aspects

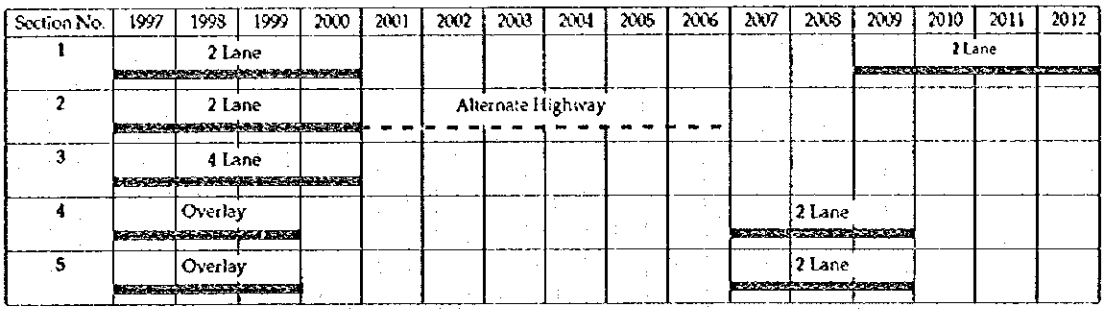
The improvement of Highway No. 18 will entail a great amount of favorable impacts on society and the economy of the people along the highway as well as the state, but not without adverse effects. Therefore the following points are to be considered;

- Appropriate compensation should be made for land and structures affected by the project;
- The forest system along the route is secondary growth, with almost no species of exceptional ecological rarity. A valuable mangrove forest which would have been affected was previously destroyed by local residents. Therefore, adverse ecological effects are not anticipated.;
- The section No. 4 from Cua Ong to Tien Yen will produce excavated excess material of about one (1) million m^3 for which disposal sites should be carefully selected and protected to avoid environmental problems;
- In Section No. 3 from Hong Gai to Cua Ong, noise barriers of 220 m long are needed to mitigate the noise level; these buffer structures are to be installed as parts of the wall for each affected facility, varying from 2 m to 3 m.

7. Implementation Schedule

In order to minimalize initial investment and maximize investment efficiency, construction has been planned in stages. (see Figure 1)

Figure 1 Project Implementation Schedule



(Note) The project plans for Section 2 are based upon the assumption that the alternate highway is completed by the year 2006.

8. Recommendations

(1) Noi Bai - Bac Ninh section is to be constructed as four (4) lane road (two lanes opened in 2001 and two additional lanes opened in 2013).

(2) Bac Ninh - Chi Linh section is to be widened to two-lane road opened in 2001, and the alternate highway is expected to be opened in 2007.

(3) Hong Gai - Cua Ong section is to be widened to four (4) lanes and opened in 2001.

(4) Cua Ong - Bac Luan section is initially to be overlaid and opened in the year 2000, and afterwards to be widened to two (2) lanes opened in 2010 together with bridges and by-passes.

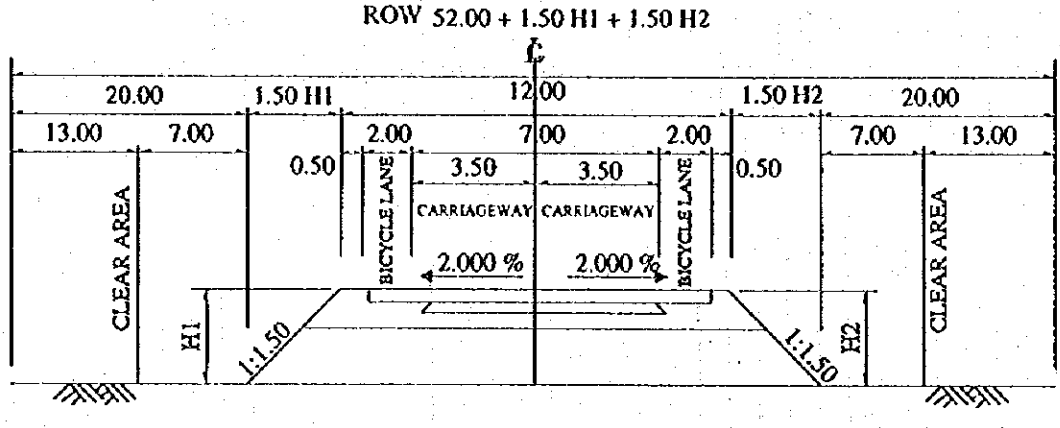
(5) Since at present there is no authority responsible for the maintenance of Highway No. 18, it is recommended that a road management unit should be set up (RMU No. 2).

(6) In light of the present changeover to a market system, intermediate to major repair work should be switched from direct administration to contract basis, and RMU No. 2 should change its organization to respond chiefly to routine maintenance and emergency repairs.

(7) Noise buffers are to be provided for certain structures (religious structures, schools, hospitals) along the highway, between Hong Gai and Cua Ong.

(8) Care is to be taken in selecting locations for dumping of excess cut soil to prevent adverse environmental affects (e.g., water contamination, filling, muddiness, etc.) downstream from the locations, also for erosion prevention and drainage facilities in these locations.

Type A-1



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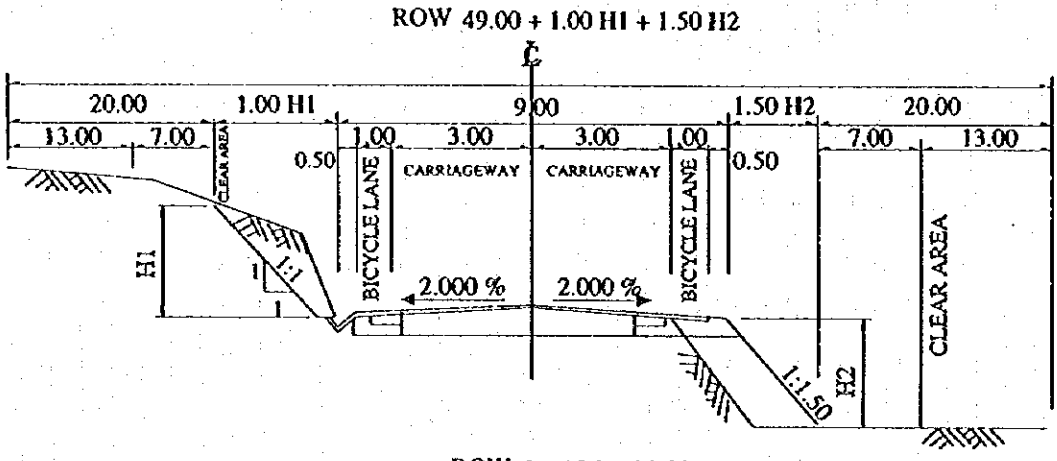

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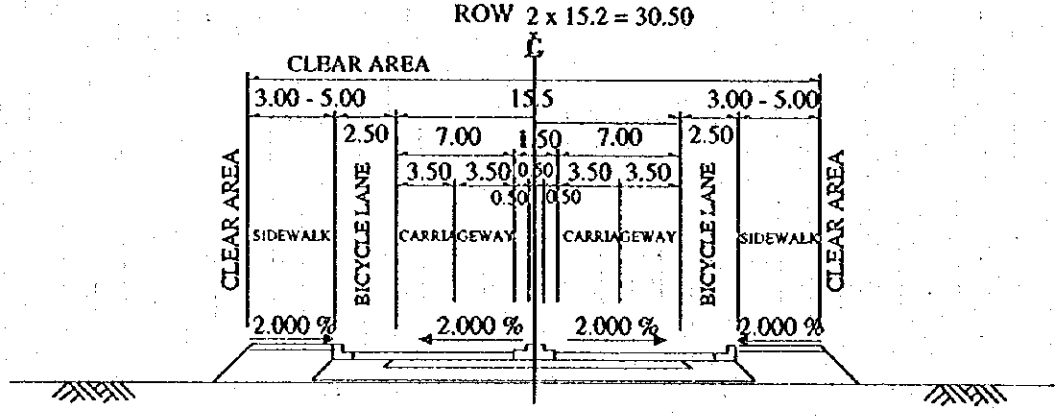

Type D

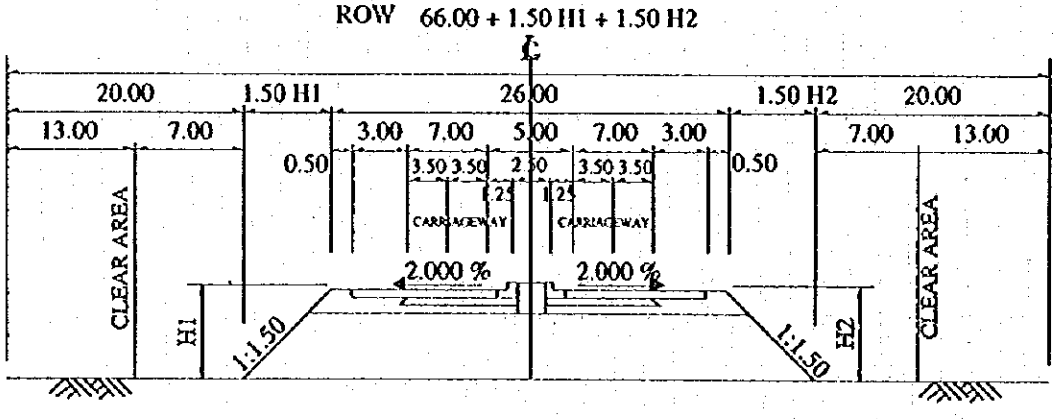

Figure 2 Typical Cross Sections

FEASIBILITY STUDY
ON
THE HIGHWAY NO. 18 IMPROVEMENT
IN VIETNAM

FINAL REPORT

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VOLUME I: SUMMARY

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1. INTRODUCTION

1.1 Project Background

The Government of the Socialist Republic of Vietnam has embarked on a profound remodeling of the country under the "Doi Moi" policy. A new vision for its future socio-economic development targeted for the year 2000 and the direction for further economic development were confirmed at the National Conference of the Communist Party held in 1991. An efficient transport system is a vital element to achieve the future socio-economic development and further economic development.

To cope with this situation, the government decided to improve National Highway Nos. 1, 5 and 18 which directly influence the development of Northern Focal Economic Area and the enhancement of the international trade through sea ports and border gate.

National Highway No. 18 as currently conceived, starts at the Noi Bai International airport and terminates at Bac Luan border gate. Constituting an important trunk highway network in the Northern Part of Vietnam which connects Noi Bai International Airport and planned major industrial zones (Ha Noi, Hai Phong, Quang Ninh), sea ports such as Hai Phong and Cai Lan, and tourism areas in the Northern Focal Economic Area.

However, National Highway No. 18 has been suffering from a number of constraints and not fulfilling the required functions of a national highway or trunk road. Lack of a direct connecting road (Noi Bai - Bac Ninh), shortage of carriageway width, existence of ferry crossing (Pha Lai) and lack of all-weather connected river crossings (Tien Yen - Bac Luan) are the major problems.

Under such circumstances, the basic policy of Highway No. 18 improvement had been established by MOT and JICA Preparatory Study Team in January 1995 and focused to the early implementation of urgently needed construction.

1.2 Study Objectives

The objective of the study is to carry out the feasibility study on Highway No. 18 improvement. The study sections are comprised of:

(1) Bac Ninh - Noi Bai Airport (approximately 31 kilometers)
(2) Bac Ninh - Chi Linh (approximately 36 kilometers, including Pha Lai Bridge)
(3) Hon Gai - Cua Ong (approximately 39 kilometers)
(4) Cua Ong - Tien Yen (approximately 44 kilometers)
(5) Tien Yen - Bac Luan (approximately 87 kilometers)

1.3 Study Area

The study area is defined as the direct-influence area of the Highway No. 18 Improvement Project (see Figure 1.1). This includes such administrative districts as the cities of Ha Noi, Hai Phong; provinces of Hai Hung, Ha Bac and Quang Ninh. The 81 km stretch of highway between Chi Linh (37 km from Bac Ninh) and Bai Chai (118 km from Bac Ninh) is not included in the study area as it is already in the final detailed design stage by others. Thus, the 36.4 km segment between Bac Ninh and Chi Linh and 169 km segment between Hong Gai and Bac Luan along Highway No. 18 and the Bac Ninh - Noi Bai International Airport route which will link up achieve Highway No. 18 status upon completion, are together considered as the study area.

1.4 Influence Area

The influence area is defined as the twenty province/city the northern part of Vietnam which as depicted in Figure 1.1. This area can be divided into two district sub-regions when described in terms of geographical and socio-economic characteristics. These are:

- The North Mountain and Midland Region; and
- The Red River Delta.

1.5 Basic Study Approach and General Work Flow

In principle, the study was carried out based on the scope of work which was agreed upon between PMU No. 18 and JICA Preparatory Study Team in January 1995. The study was carried out in two steps, Step-1 and Step-2. The major works in Step-1 are:

- Socio-economic study and formulation of socio-economic framework;
- Supplementary traffic survey and future traffic demand forecast; and
- Selection of optimum solution for Highway No. 18 improvement.

The major works in Step-2 were:

- Preliminary engineering design and cost estimation;
- Economic and financial analysis;
- Environmental impact assessment; and
- Recommendations.

A general work flow chart of the study has been prepared as shown in Figure 1.2.

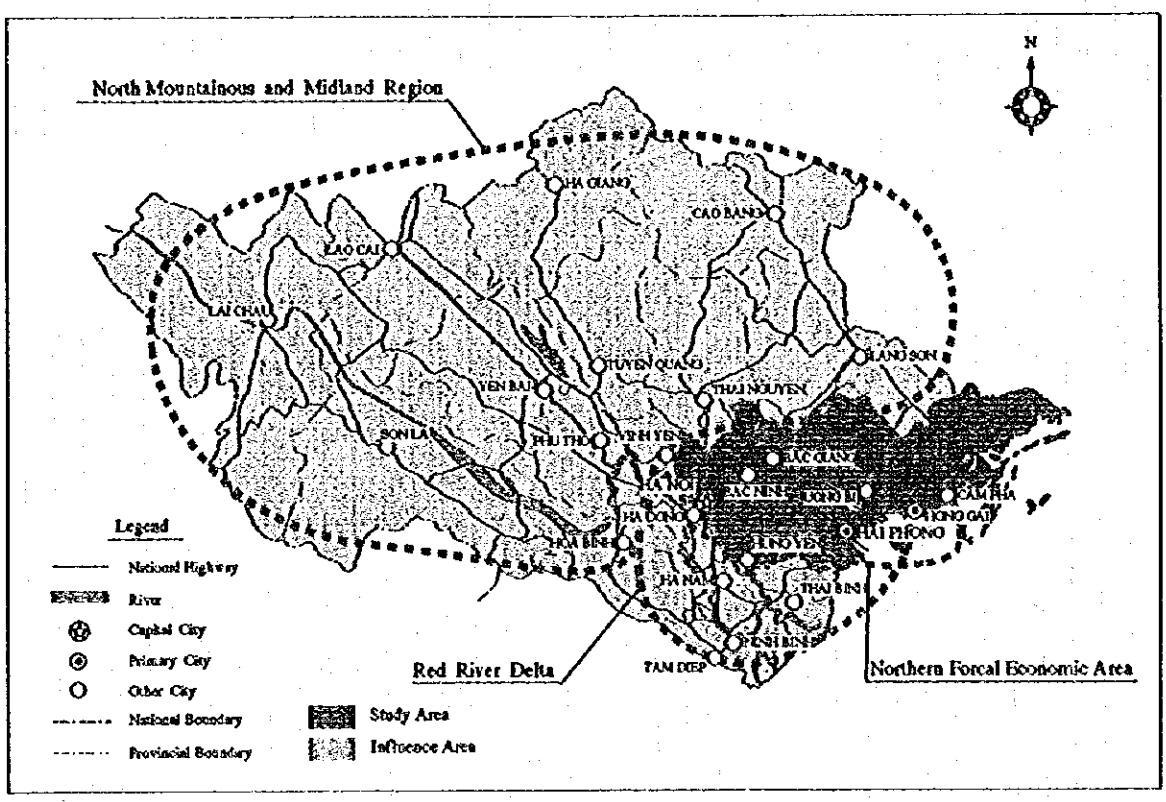
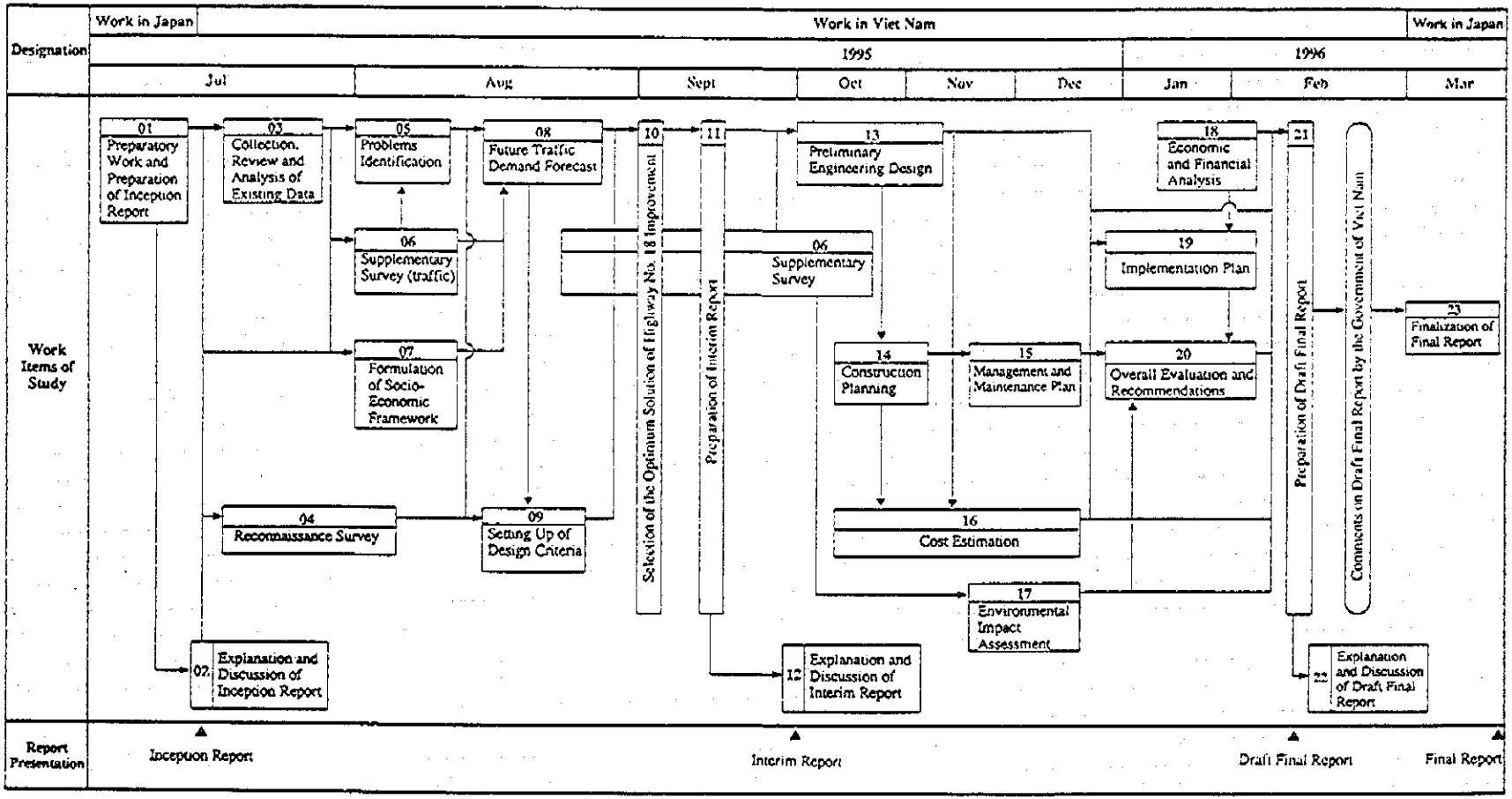


Figure 1.1 Study Area and Influence Area



HIGHWAY NO. 18 IMPROVEMENT

Figure 1.2 General Work Flow Chart

2. SOCIO-ECONOMIC CONDITIONS OF THE STUDY AREA

2.1 Population

The influence area has registered a population of 25.9 million with 15 % living in urban areas. The average population in 1993 density was 224 persons per km^2. The Red River Delta accounts for 13.8 million people with an average density of 1,104 persons per km^2 and 17 % in urban areas. The North Mountain and Midland Region accounts for 12.1 million people with an average density of 118 persons per km^2 and an urban population of 13 %. Population density in the Red River Delta is almost 10 times higher than that in the North Mountain and Midland Region. Urban population ratios in both the Red River Delta and North Mountain and Midland Region are below the national average of 20 %. Population of the influenced area increased at an average annual growth rate of 2.39 % over the period between 1979 and 1989.

The population distribution in the study area is shown in Table 2.1. Hai Hung province holds the largest population of 2.66 million in 1993 followed by the provinces of Ha Bac (2.26 million), city of Ha Noi, (2.15 million), city of Hai Phong (1.58 million) and province of Quang Ninh (0.89 million) respectively.

Table 2.1 Population by Province in Study Area (1990 - 1993)

Unit: 1000 person

Province	1990	1991	1992	1993	Growth Rate
Ha Noi	2,052.3	2,070.0	2,099.6	2,154.9	1.64
Hai Phong	1,483.0	1,512.2	1,556.6	1,583.9	2.22
Hai Hung	2,503.3	2,559.0	2,613.6	2,658.0	2.02
Ha Bac	2,122.3	2,172.8	2,218.4	2,262.8	2.16
Quang Ninh	830.9	857.5	878.8	889.6	2.30
Entire Nation	66,233.3	67,774.1	69,405.2	70,982.5	2.36

Source: Statistical Data on Labour and Social Affairs
Statistical Publishing House, 1994

2.2 Landuse in Study Area

More than 30 % of the area of each province except Quang Ninh is developed for agricultural land. Hai Hung province discloses the highest percentage of agricultural land (62.23 %) and Ha Noi (48.00 %), Hai Phong (45.27 %) and Ha Bac (31.78 %) follow. Quang Ninh province shows very low percentage of agricultural land of 9.66 % since about 40 % of total area is covered by unimplemented hilly and mountainous areas. It is noted that more than 10 % of the city of Ha Noi is residential land. About 5 - 6 % of the respective total areas of the provinces of Hai Hung, Ha Bac, and the city of Hai Phong are occupied by residential land and about 2 % of Quang Ninh province.

2.3 Economic Situation

Although the influenced area accounts for 37 % of the country's population, its GDP share is 25 % and per capita GDP is estimated at US$162. Figure 2.1 shows GPP (Gross Provincial Product) distribution of each province of the influence area.

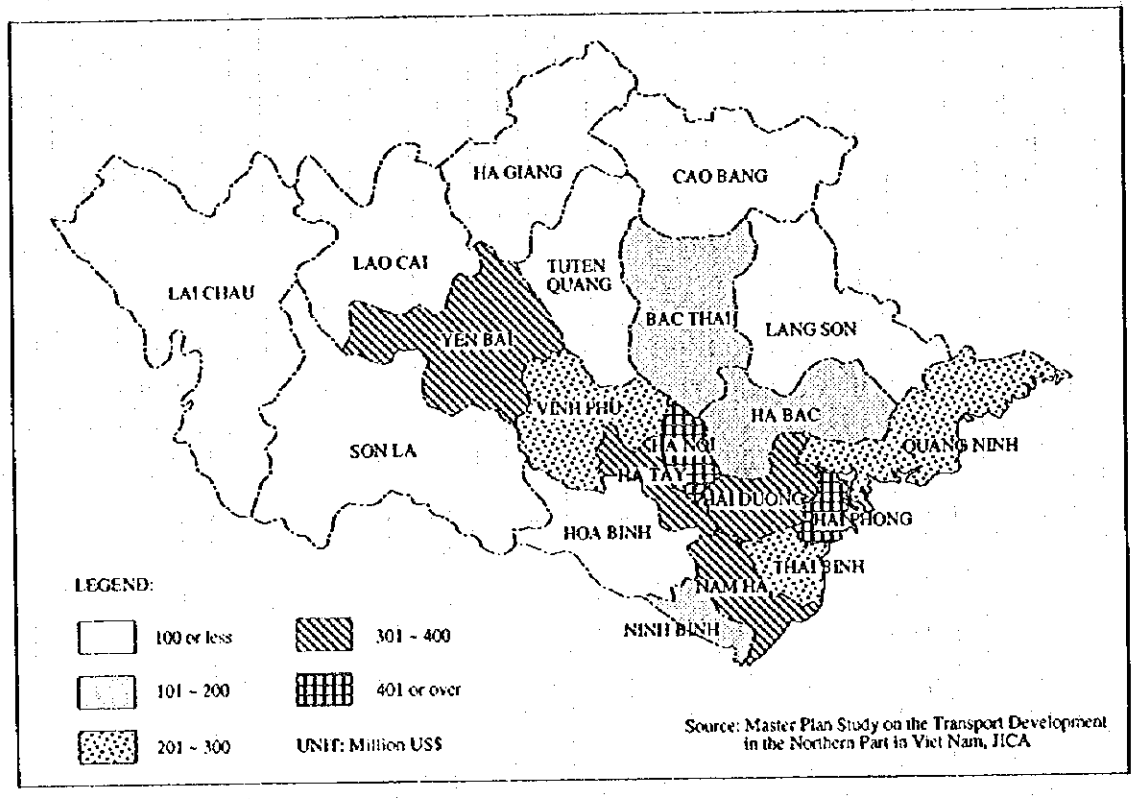


Figure 2.1 GPP of Each Province in the Influence Area

The increase of index of gross domestic product (GDP) by type of economic activity is shown in Table 2.2. Finance, banking and insurance show the highest figures, followed by the construction industry.

Table 2.2 Increase of GDP Index by Kind of Economic Activity at Constant Prices of 1989: Previous Year = 100

Category	1992	1993	1994
Industry	114.6	112.1	112.9
Construction	111.0	118.3	119.4
Agriculture & Forestry	107.1	103.8	103.9
Transport, Post and Communication	106.3	106.5	107.0
Finance, Banking & Insurance	110.7	116.5	122.8

Source: Statistical Yearbook, 1994

3. SOCIO-ECONOMIC FRAMEWORK

3.1 Growth of GDP

Recent economic development in Vietnam is remarkable. The real economic growth in 1992, 1993 and 1994 has been, respectively, 8.6 %, 8.1 % and 8.3 % per annum. The growth rate in GDP in 1995 is estimated at 9.5 %; 13 % in industrial production, 4 % for agriculture and forestry in spite of heavy natural disasters, 20.8 % in export value which is estimated at 3.6 billion USD.

3.2 Social and Economic Development Strategy

(1) Focal Economic Areas in Vietnam

The government has set forth Social and Economic Development Strategies up to the year 2000 for which three Focal Economic Areas are planned. The first one covers Ha Noi, Hai Phong and Quang Ninh in the Northern Part of Vietnam, the second area includes Da Nang and the surrounding area and the third area is the core of the Southern Part of Vietnam including Ho Chi Minh City.

(2) Northern Focal Economic Area and Red River Delta Region

It is the intention of the government to establish the Northern Focal Economic Area (NFEA) mainly comprising Ha Noi, Hai Phong and Quang Ninh. Hence, integration of different transport modes within this area as well as integration of the NFEA with the whole influenced area are important to ensure smooth transport of cargo and people. The NFEA falls within the same administrative boundaries of five provinces which are included in the study area.

3.3 Regional Structure in Red River Delta

A number of development centers are recognized as sub-regional growth poles endowed with different economic potentials for industrial, commercial and tourism development in the Red River Delta Region, all of which need to be integrated into the entire regional economy with adequate road transport network.

Furthermore, in order to encourage foreign direct investment in the industrial sector a number of new industrial zones to accommodate industrial estate projects, including Estate Planning Zone (EPZ) have been planned in the region.

3.4 Future Socio-Economic Framework

(1) GDP Growth Rate

A framework of long-term national economic growth in Vietnam is presented in Table 3.1. Three scenarios are assumed: (1) high case; (2) medium case: and (3) low case.

In regards to the future national economic growth framework, the SPC set as a minimum framework yearly average economic growth rates at 9.8 % for 1996 ~ 2000 and 10.0 % for 2001 ~ 2010. Vietnam's GDP growth rate over previous year for 1995 is certain to reach 9.5 %. It is not likely that case (3), that is, a pessimistic projection in Table 3.1 for 1995, will occur.

On the other hand, an overly optimistic case such as (1) in the same table would not be considered realistic, judging from survey results. Therefore, future economic framework should be judged on the most realistic case (2).

Table 3.1 Framework of Long-Term National Economic Growth

Year	(1) High Case		(2) Medium Case		(3) Low Case	
	GDP (VND Bill)	Annual Growth Rate	GDP (VND Bill)	Annual Growth Rate	GDP (VND Bill)	Annual Growth Rate
Actual						
1991	31,286	6.0 %	31,286	6.0 %	31,286	6.0 %
1992	33,991	8.6 %	33,991	8.6 %	33,991	8.6 %
1993	36,735	8.1 %	36,735	8.1 %	36,735	8.1 %
1994	39,975	8.8 %	39,975	8.8 %	39,975	8.8 %
Estimated						
1995	43,778	9.5 %	43,778	9.5 %	43,778	9.5 %
Projected						
2000	73,768	11.0 %	68,917	9.5 %	65,827	8.5 %
2005	118,804	10.0 %	106,037	9.0 %	96,721	8.0 %
2010	182,795	9.0 %	155,803	8.0 %	135,656	7.0 %
2015	268,586	8.0 %	218,522	7.0 %	185,861	6.5 %

Notes : GDP at 1989 prices
Source : 1) "Statistical Yearbook, 1993"
2) Ministry of Finance
3) JICA Study Team

(2) Regional Economic Growth

The "Regional Master Plan 2010" which was recently presented by SPC has been selected as a basic framework for future regional economic development. This master plan explains the national policy of long-term development in the three strategic regions which are given higher priorities in industrialization.

In the study, the above basic medium-case framework (2) has been slightly modified and extended until the year 2015, as shown in Table 3.2.

Table 3.2 **Regional Contribution of GDP in Three Focal Economic Areas (Growth Rate)**

Year	Northern Focal Economic Area	Middle Corridor	Southern Focal Economic Area	Total of the Three Economic Growth Area
1994 (Actual)	13.00 %	1.80 %	28.00 %	42.80 %
1995	13.17 %	1.89 %	28.54 %	43.60 %
2000	14.05 %	2.43 %	31.40 %	47.88 %
2005	14.99 %	3.12 %	34.54 %	52.65 %
2010	16.00 %	4.00 %	38.00 %	58.00 %
2015	16.53 %	4.54 %	39.87 %	60.94 %

Source: "Development Orientation for Regional Master Plan in 2010". Institute of Development Strategy, SPC 1995.

Based on the regional contribution of Northern Focal Economic Area shown in Table 3.2 framework of GRDP in the study area is set up as shown in Table 3.3.

Table 3.3 **Framework of GRDP in Study Area**

Year	Whole Country	Study Area	
	(VND Billion)	VND Billion	Growth Rate (% p.a.)
1994	39,975	5,197	10.93
2000	68,917	9,683	9.92
2010	155,803	24,928	7.70
2015	218,522	36,122	

Source: 1) "Development Orientation for Regional Master Plan in 2010". Institute of Development Strategy, SPC 1995.
2) JICA Study Team

(3) Future Population

Two types of future projections for the population of Vietnam are available. Scenario-1 shows the population forecast figured by General Statistics Development, and Scenario-2 shows the projected figures based on "The Population of Vietnam, by General Statistical Office, 1992".

The study adopts Scenario-3 which applies moderate population growth rates compared with the other two. This is because the up-to-date projection by province has been given by SPC and the said projection assumes that the growth rate of population will be brought down to 1.4 % in the year 2010. Population projection is thus totally dependent on performance of population control policy and family planning. Compared with the natural growth rate (2.1 %) in the period between two census years (1979 - 1989), it is said that each population projection sets an assumption on growth rate, ranging from 1.34 % to 1.53 % during the period from 2000 to 2010.

Future population in the study area is estimated under the following assumptions:

- Population growth rate of each province is set at the same level of the national population growth rate;
- No migration from the northern region to the central or southern regions is considered;
- Average growth rate of urban population is considered to be 5 % per annum;
- Maximum urbanization level is set at 80 %; and
- Rural population will be stable after year 2005 (saturation level).

4. CURRENT ROAD TRANSPORT PROFILE AND RESULTS OF TRAFFIC SURVEY

4.1 Road Network

(1) Road Network in Vietnam

The ratio of road density within the entire nation of Vietnam is 0.32 km/km², which is by no means inferior to other Asian nations. Surface conditions of the nationwide road network are shown in Table 4.1.

Table 4.1 Road Conditions in Vietnam

	Total Length	Asphalt Concrete	Macadam Penetr.	Gravel	Earth/ Gravel
National Roads	10,805 km 100.0 %	3,305 km 30.5 %	3,600 km 33.3 %	1,400 km 13.0 %	2,500 km 23.2 %
Provincial Roads	15,295 km 100.0 %	115 km 0.8 %	2,650 km 17.3 %	2,330 km 15.2 %	10,200 km 66.7 %
District Roads	25,290 km 100.0 %	60 km 0.2 %	1,200 km 4.8 %	4,430 km 17.5 %	19,600 km 77.5 %
Total	51,390 km 100.0 %	3,480 km 6.7 %	7,450 km 14.5 %	8,160 km 15.9 %	32,300 km 62.9 %

Source: Ministry of Transport, 1994

Most of roads have narrow width and gravel or earth surfaces in Vietnam. National roads, which have comparatively fine surface conditions, have asphalt (or cement) concrete pavement of 30 % of the total length. Including provincial and district roads, paved roads are less than 7 % of the total.

Due to these facts, the current main focus is on upgrading of road quality, which means rehabilitation of road facilities comprised of road widening, pavement and alignment improvement.

(2) Road Network in the Study Area

Total road length in each province varies depending on the area of each province. Ha Noi, as a matter of course, shows particularly high road density, however, the figures of the other provinces are more or less the same as the national average (see Table 4.2).

The pavement ratio (percentage of asphalt and macadam penetration pavement) of the study area is even higher than the national average. However, much of pavement in the study area is penetration macadam and the percentage of asphalt (or cement) concrete pavement is rather low. This causes deterioration of pavement and inferior surface conditions of roads in the study area in general. Therefore, the policy of road improvement is how sifts from macadam penetration to asphalt concrete.

Table 4.2 Classified Road Length and Surface Conditions in the Study Area

Province	National Roads (km)					Provincial Roads (km)					District Roads (km)					Grand Total	Length per Area
	Total Length	Asphalt Conc.	Macadam Penetr.	Gravel	Earth / Gravel	Total Length	Asphalt Conc.	Macadam Penetr.	Gravel	Earth / Gravel	Total Length	Asphalt Conc.	Macadam Penetr.	Gravel	Earth / Gravel	km	km/km2
Ha Noi (921 km2)	121.0 100.0%	100.0 82.6%	21.0 17.4%	0.0 0.0%	0.0 0.0%	436.0 * 100.0%	0.0 0.0%	332.0 * 76.1%	104.0 23.9%	0.0 0.0%	1,382.0 100.0%	0.0 0.0%	0.0 0.0%	500.0 36.2%	882.0 63.8%	1,939.0	2.11
Ha Bac (4,614 km2)	316.8 100.0%	0.0 0.0%	106.1 33.5%	46.2 14.6%	164.5 51.9%	278.8 100.0%	0.0 0.0%	54.8 19.7%	0.0 0.0%	224.0 80.3%	561.0 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	561.0 100.0%	1,156.6	0.25
Hai Hung (2,551 km2)	125.0 100.0%	47.0 37.6%	40.0 32.0%	25.0 20.0%	13.0 10.4%	370.0 100.0%	0.0 0.0%	74.0 20.0%	296.0 80.0%	0.0 0.0%	430.0 100.0%	0.0 0.0%	22.0 5.1%	300.0 69.8%	108.0 25.1%	925.0	0.36
Hai Phong (1,504 km2)	88.0 100.0%	20.0 22.7%	68.0 77.3%	0.0 0.0%	0.0 0.0%	125.0 * 100.0%	0.0 0.0%	125.0 * 100.0%	0.0 0.0%	0.0 0.0%	345.0 100.0%	0.0 0.0%	0.0 0.0%	145.0 42.0%	200.0 58.0%	558.0	0.37
Quang Ninh (5,939 km2)	330.0 100.0%	0.0 0.0%	289.0 87.6%	0.0 0.0%	41.0 12.4%	193.0 100.0%	0.0 0.0%	37.0 19.2%	38.0 19.7%	118.0 61.1%	997.0 100.0%	0.0 0.0%	22.0 2.2%	0.0 0.0%	975.0 97.8%	1,520.0	0.26
Study Area Total	980.8 100.0%	167.0 17.0%	524.1 53.4%	71.2 7.3%	218.5 22.3%	1,402.8 100.0%	0.0 0.0%	622.8 44.4%	438.0 31.2%	342.0 24.4%	3,715.0 100.0%	0.0 0.0%	44.0 1.2%	945.0 25.4%	2,726.0 73.4%	6,098.6	0.39
National Total	10,805.0 100.0%	3,305.0 30.6%	3,600.0 33.3%	1,400.0 13.0%	2,500.0 23.1%	15,295.0 100.0%	115.0 0.8%	2,650.0 17.3%	2,330.0 15.2%	10,200.0 66.7%	25,290.0 100.0%	60.0 0.2%	1,200.0 4.7%	4,430.0 17.5%	19,600.0 77.5%	51,390.0	0.32

Source: Ministry of Transport

Note: Figure with * includes unban roads

4.2 Modal Distribution

According to NTSR (National Transportation Sector Review, UNDP, 1992), the nationwide total of interprovincial freight movement is 40 million tons. The number of passenger movements nationwide is assumed to total at 106 million. Table 4.3 summarizes the modal distribution of freight and passenger transport.

Table 4.3 Modal Distribution of Freight and Passenger Transport

Category	Road	Rail	River	Coastal	Air	Total
Freight (ton)	40.7 %	5.4 %	29.1 %	24.8 %	-	100.0 %
Freight (ton-km)	32.0 %	18.0 %	37.0 %	13.0 %	-	100.0 %
Passenger	89.5 %	2.3 %	8.0 %	0.1 %	0.1 %	100.0 %
Passenger-km	78.0 %	12.0 %	7.0 %	-	3.0 %	100.0 %

Source: NSTR, 1992

Table 4.3 shows that both freight and passenger transport highly depends on road transport. These figures have been changing year by year, however, and the road share of transport will by no means decrease in the future.

4.3 Road Transport

Privately-owned truck transport companies were 16 % of the total in 1991; however, they are presumed to have increased dramatically since. The major freight transported by trucks is construction materials, which account for 22 % of the total amount. (61 % of river transport is coal, 61 % of rail transport is coal and other industrial products.)

Passenger transport entities have had difficulty replacing buses. About half of all buses are more than 10 years old. 80 % of bus enterprises had privatized by 1993. Bus fares are going down as the competition heats up. As a result of decreasing bus fares, bus enterprises have had difficulty to keeping business in unprofitable rural areas.

Frequent traffic accidents are becoming a major social issue. More than 3,500 people died in traffic accidents in the northern part in 1989, which is considerably a high figure compared with the number of vehicles on roads.

4.4 Vehicle Ownership

Table 4.4 shows 1991 vehicle registration data in the study area. Some 38,000 vehicles (19 % of the national total) were registered within the study area during 1991. The highest amount of all categories of vehicles by far was registered in Ha Noi (64.3 % of the whole study area), which is about 24,800 cars, buses and trucks. The data for other provinces show more or less the same level of numbers from 2,700 to 4,100 vehicles.

Table 4.4 1991 Vehicle Registration Data in the Study Area

Province	Registered Vehicles				Registration Percentages				Modal Percentages			
	Cars	Buses	Trucks	Total	Cars	Buses	Trucks	Total	Cars	Buses	Trucks	Total
Ha Noi	7,678	1,627	15,450	24,755	68.2	45.9	65.2	64.3	31.0	6.6	62.4	100.0
Ha Bac	917	454	1421	2792	8.2	12.8	6.0	7.3	32.8	16.3	50.9	100.0
Hai Hung	835	325	1551	2711	7.4	9.2	6.6	7.0	30.8	12.0	57.2	100.0
Hai Phong	935	750	2455	4140	8.3	21.1	10.4	10.8	22.6	18.1	59.3	100.0
Quang Ninh	892	391	2798	4081	7.9	11.0	11.8	10.6	21.8	9.6	68.6	100.0
Study Area Total	11,257	3,547	23,675	38,479	100.0	100.0	100.0	100.0	29.3	9.2	61.5	100.0
National Total	62,400	45,760	96,940	205,100					30.4	22.3	47.3	100.0

Source: Transport Modeling and Demand Forecasts, Technical Report from Master Plan Study on the Transport Development in the Northern Part of Vietnam, JICA 1994

A comparison of modal percentages between the study area and the national total shows a tendency of more trucks and less buses. 61.5 % of the registration is by trucks in the study area, which is much higher than the national percentage of 47.3 %. Buses are only 9.2 % of the total, compared with the national figure of 22.3 %. This tendency is particularly observed in Ha Noi and Quang Ninh, where industrial activities are more flourishing.

The composite average ownership aggregated to 2.8 vehicles per 1,000 persons. Ha Noi province exhibited the highest rate (12 vehicles per 1,000 people) followed by Quang Ninh province (4.8 vehicles per 1,000 people) and Hai Phong province (2.7 vehicles per 1,000 people). In contrast, the lowest ownership rate was found in Hai Hung province; 1.1 vehicles per 1,000 people.

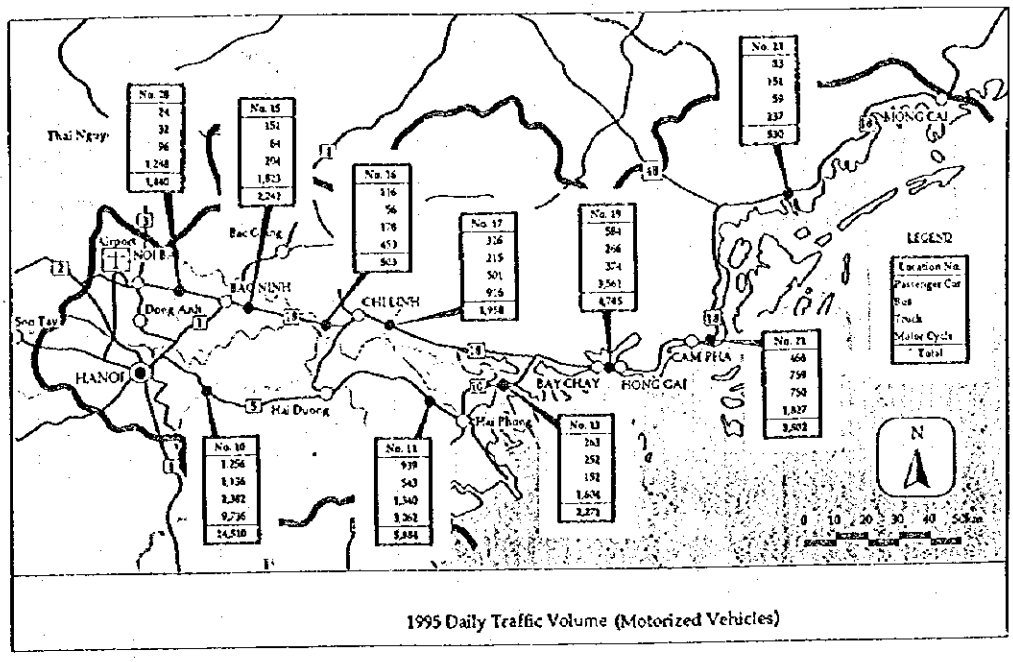
4.5 Traffic Survey

(1) Execution of Traffic Survey

A traffic count and roadside interviews were carried out to ascertain up-to-date vehicle trip patterns in the study area. Twenty-one locations were designated for collecting two-day traffic counts, of which five locations were also designated for an origin-destination interview survey.

(2) Traffic Volumes on Roads in the Study Area

The overall results of the traffic count survey are shown in Figure 4.1 for major stations on Highway Nos. 18, 5 and 10. The data at 12-hour survey locations and 16-hour survey locations are all converted into 24-hour traffic volume equivalents.



Source: JICA Study Team

Figure 4.1 1995 Daily Traffic Volume (Motorized Vehicles)

(3) Hourly Fluctuations of Traffic Volume

Figure 4.2 shows hourly fluctuations of the traffic flows at major stations on Highways Nos. 18, 5 and 10. At many of the stations the peak hours are around 7:00 and 16:00.

Peak-hour ratio calculated by the actual number of vehicles (excluding non-motorized vehicles) varies from 8.0 % to 11.3 %. Peak-hour ratio is rather high at sites No. 19 (10.7 %), No. 23 (11.3 %) and No. 28 (11.2 %).

(4) Vehicle Composition

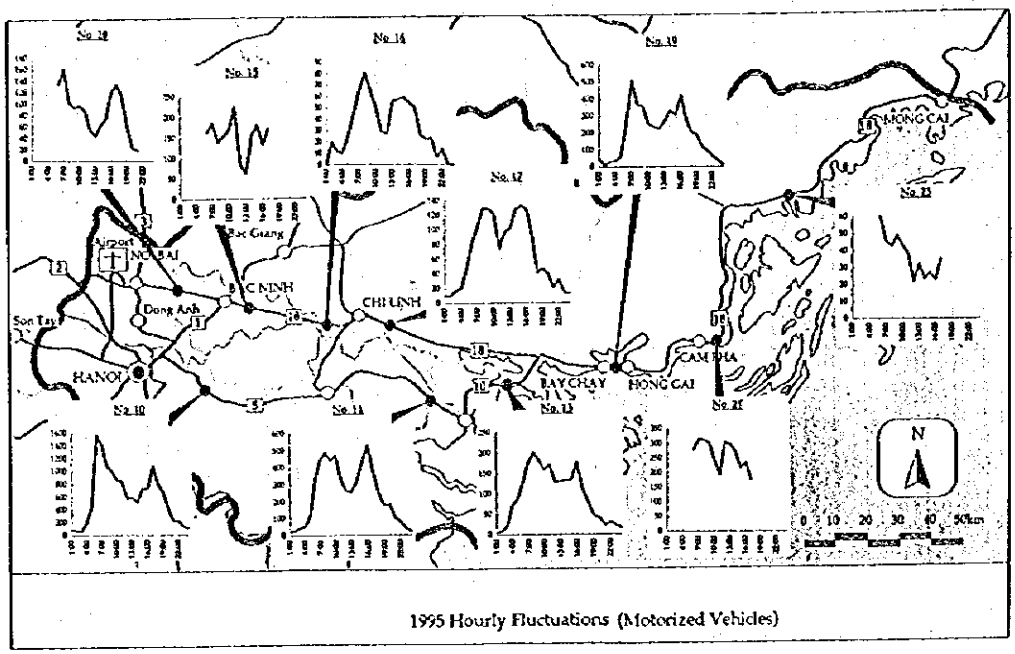
Vehicle type characteristics based on the survey results are as follows:

Motorcycles are particularly dominant around Ha Noi area site No. 10 (67 %), No. 15 (81 %) and No. 28 (89 %), as well as at Bai Chay and Quang Yen ferry points, site No. 13 (70 %),and No. 19 (74 %).

Cars shows a high share of mode around Chi Linh area, site No. 16 (14 %) and No. 17 (17 %) and on highway No. 5, site No. 11 (16 %). Also, their share is high at Tien Yen-Mong Cai section (16 %).

Buses show a rather high share at all of locations between Hong Gai and Mong Cai (20 % - 28 %).

Trucks show a high share particularly on Highway No. 5 (16 % - 23 %) and Chi Linh area (26 %) and Cam Pha area (20 %) of Highway No. 18.



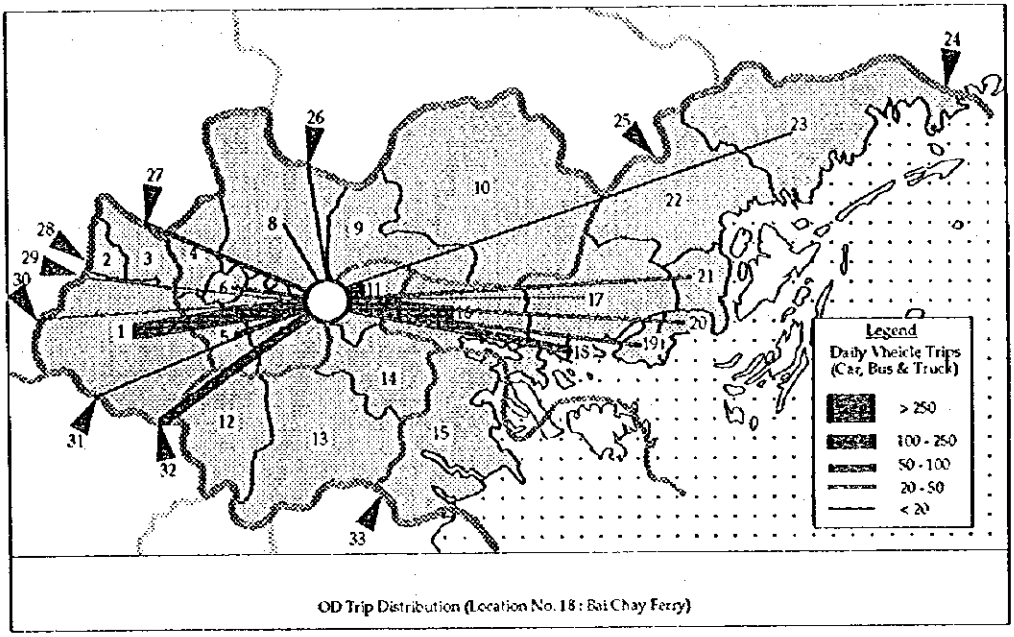
Source: JICA Study Team

Figure 4.2 1995 Hourly Fluctuations (Motorized Vehicles)

(5) Trip Distribution

The distribution pattern of traffic in the study area was analyzed based on the results of the traffic count survey and the roadside OD survey. Trip distribution patterns of three roadside OD survey locations on Highway No. 18 (No. 16 [Pha Lai Ferry], No. 17 [East of Chi Linh] and No. 19 [Bai Chay Ferry]), were selected from 5 survey locations.

Figure 4.3 shows the OD distribution at location No. 16 (Pha Lai ferry). The counted number of traffic as a whole is rather small at present compared with other Highway No. 18 locations. However, the figure shows a strong linkage from Ha Noi to Chi Linh, Dong Trieu and Uong Bi.



Note: Zone numbers indicate the following zone names:

Province	Zone No.	Zone Name	Province	Zone No.	Zone Name
Ha Noi	1	Ha Noi	Hai Hung	10	Luc Ngan
	2	Hien Ninh		11	Chi linh
	3	Tan		12	Ban Yen Nanh
Ha Bac	4	Hiep Hoa		13	Hai Duong
	5	Tien Son		14	Kim Mon
	6	Bac Ninh	Hai Phong	15	Hai Phong
	7	Que Vo	Quang Ninh	16	Dong Trieu
	8	Bac Giang		17	Hoanh Bo
	9	Luc Nam		18	Bai Chay
				19	Hong Gai
				20	Cam Pha
				21	Mong Duong
				22	Tien Yen
				23	Quang Ha

Source: JICA Study Team

Figure 4.3 OD Trip Distribution (Location No. 16: Pha Lai Ferry)

5. TRANSPORT MODELING AND DEMAND FORECASTS

5.1 Overview

The transport modeling process can, in its most basic sense, be summarized as consisting of four essential steps (Figure 5.1).

1) Network Development

Road inventory data, assembled in simulated network format by the "Master Plan Study on the Transport Development in the Northern Part in the Socialist Republic of Viet Nam, by JICA, 1994" (NVMP), are updated to 1995 status. Inclusion of anticipated improvements such as upgrading of existing sections or construction of new segments leads to development of future years (2005 and 2015) networks.

2) Demand Model Calibration

Vehicle trip matrixes developed by the NVMP are expanded and calibrated to 1995 conditions via information derived from the data collection program. Transport demand is correlated with socio-economic data.

3) Transport Demand Projections

Future traffic activity is correlated with landuse activity, regional development and traffic impacts of major new projects such as Cai Lan port.

4) Trip Assignments

Trip demand is loaded onto the base and future years networks, thus providing the basis for sufficiently analyses and projection of Highway 18 utilization.

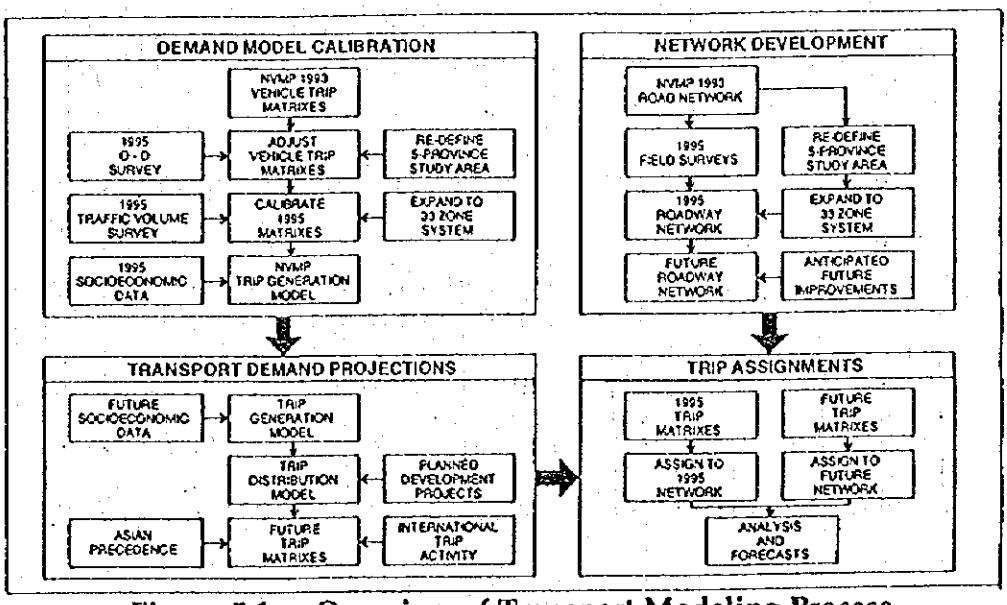


Figure 5.1 Overview of Transport Modeling Process

5.2 Trip Matrix Content

Results of the trip matrix analysis confirm that significant growth in trip activity can be expected within the Study Area in coming years. The combined number of car, bus and truck trips is shown as increasing from 31,700 in year 1995 to 86,500 in year 2005 and 195,800 in year 2015. While trips by all three vehicle types will increase on an absolute basis, relative changes will also occur. During 1995, for example, truck vehicle trips (12,730 per day) represent some 40 percent of the car/bus/truck grouping. While truck vehicle trips grow to some 69,000 by year 2015, the relative share is shown as dropping to about 35 percent. On a PCU basis, however, truck trips represent a very significant continuing component of near 50 percent of daily trips.

Motorcycle trips exhibit very rapid growth expanding from 132,300 in 1995 to 670,000 in 2005 and some 1.4 million in year 2015. Non-motorized vehicles (NMV) vehicle trips, after continued modest growth over the next several years, are likely to gradually decline as personal wealth increases and motorcycles continue to emerge as a preferred mode of travel relative to the bicycle.
Vehicle trip growth for five provinces and external zones between years 1995 and 2015 is shown in Table 5.1.

Table 5.1 Vehicle Trip Growth Rates

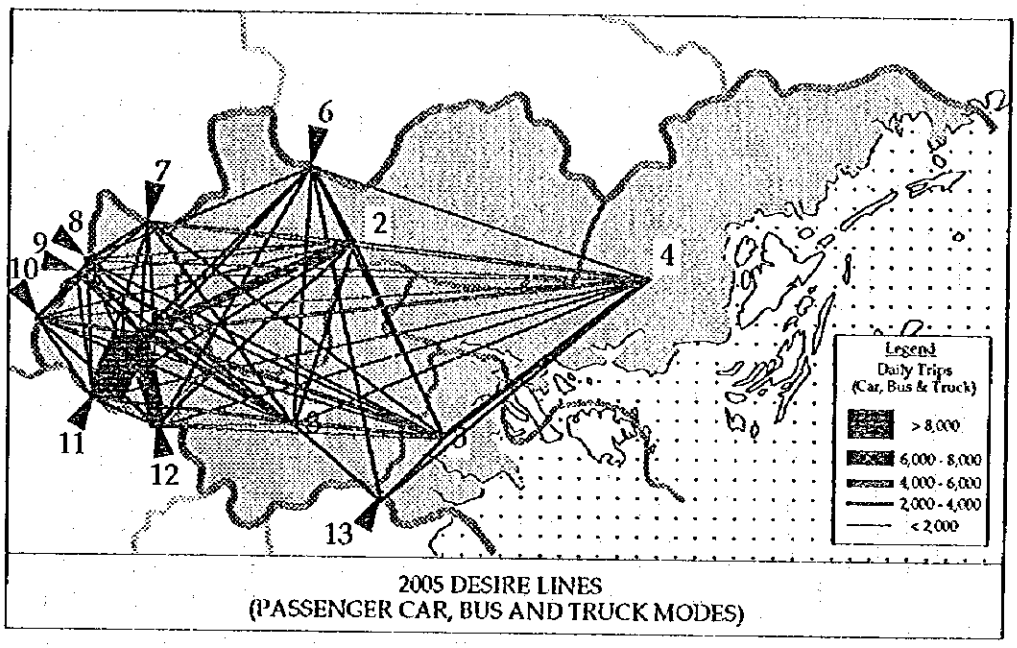
Province/ External Zone	Percentage Growth Per Annum, 1995-2005				
	Cars	Bus	Truck	Motorcycle	NMV
Ha Noi	9.1	9.2	5.5	11.4	-4.1
Ha Bac	13.7	12.5	6.0	14.2	-4.1
Hai Hung	12.4	12.0	5.3	13.1	-4.2
Quang Ninh	8.8	8.4	14.7	14.5	-4.2
Hai Phong	11.2	11.0	9.9	14.1	-4.1
External Zones	10.5	9.8	8.5	12.1	-4.2

Years "2005 and 2015 desire lines for the passengers car, bus and truck combined modes (Figure 5.2) confirms:

1) Ha Noi province is the dominant province in terms of trip activity, although this role noticeably decreases over time.

2) Strong trip linkages continue to exist between Ha Noi province and other parts of the nation via Highways 1,2,3 and 6.

3) The Quang Ninh - Ha Noi axis is shown as experiencing very strong growth, to be exceeded only by the Quang Ninh - Hai Phong axis in year 2015.



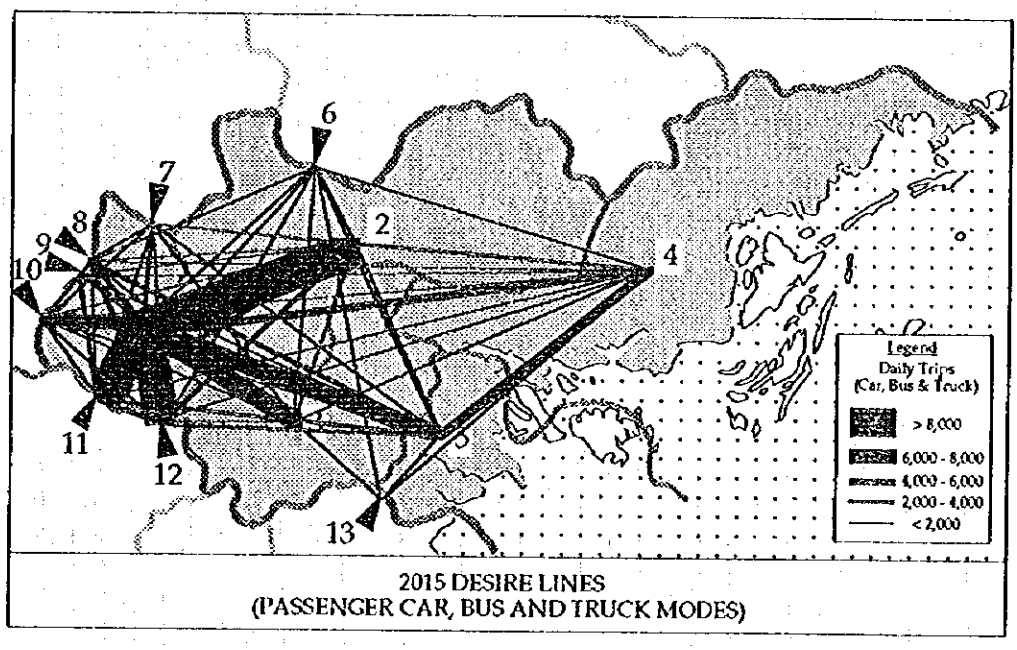


Figure 5.2 Years 2005 and 2015 Desire Lines Inter-Province Vehicle Trips

5.3 Forecast Traffic Demand

Future years (2005, 2015) trip matrixes were assigned to future networks which reflect both "with" and "without" JICA Highway 18 improvement scenarios. Findings were, for presentation purposes, grouped over 10 discrete modeling sections.

The strong growth in vehicle trip activity intimated by the trip matrixes is confirmed by results of the assignment process. Several conditions may be drawn in terms of the total daily unconstrained PCU demand calculated on principal road links throughout the study area (Figure 5.3).

(1) Highest volume segments are encountered on Highway No. 5 with daily activity ranging between 66,000 and 83,000 PCUs' depending on status of Highway No. 18. These data suggest that, in the longer term future, the four-lane Highway No. 5 cross-section (currently under construction) may prove inadequate to meet demand along the Ha Noi - Hai Phong axis.

(2) The status of Highway No. 18 catalyzes a considerable "swing" in traffic demand between the Highway Nos. 5 and 18 Axes. In 2005, for example, the volume on Highway No. 5 east of Ha Noi Province is shown as almost 40,000 PCU if Highway No. 18 is not improved, but only 30,000 PCU if Highway No. 18 is improved.

(3) Two sections of the Highway No. 18 corridor experience, at present, considerable capacity constraints. These are Highway No. 286 between Highway No. 3 and Highway No. 1, as well as the Pha Lai ferry segment. These constraints are clearly mirrored in the forecasts, as is the urgent need for improving these segments. At Pha Lai ferry (modeling section 5), for example, the assignment process suggests that less than 5,000 PCU per day can be accommodated under the "without" improvement scenario under year 2015 condition. However, demand will increase dramatically to over 24,000 PCU per day if the ferry is replaced by a bridge and the section road upgraded to a reasonable standard. The Highway No. 286 segment (modeling sections 2 and 3) exhibits similar results.

(4) Demand along several sections will, by year 2015, approach 40,000 daily PCU's. These include section 1 (Highway No. 2), section 4 (Highway No. 18 near Bac Ninh) and section 6 (Highway No. 18 between Hong Gai and Cam Pha). The considerable truck content of the Cam Pha - Cua Ong traffic stream (section 7) catalyzes a daily loading which is shown as approaching 50,000 PCU's by year 2015.

(5) Demand forecasts along Highway No. 18 north of Cua Ong (sections 8, 9 and 10) is modest relative to other parts of the corridor totaling some 4,000 and 10,000 daily PCU's by year 2005 and year 2015, respectively. However, even the year 2015 total still represents a roughly 15-fold increase over current levels of traffic activity.

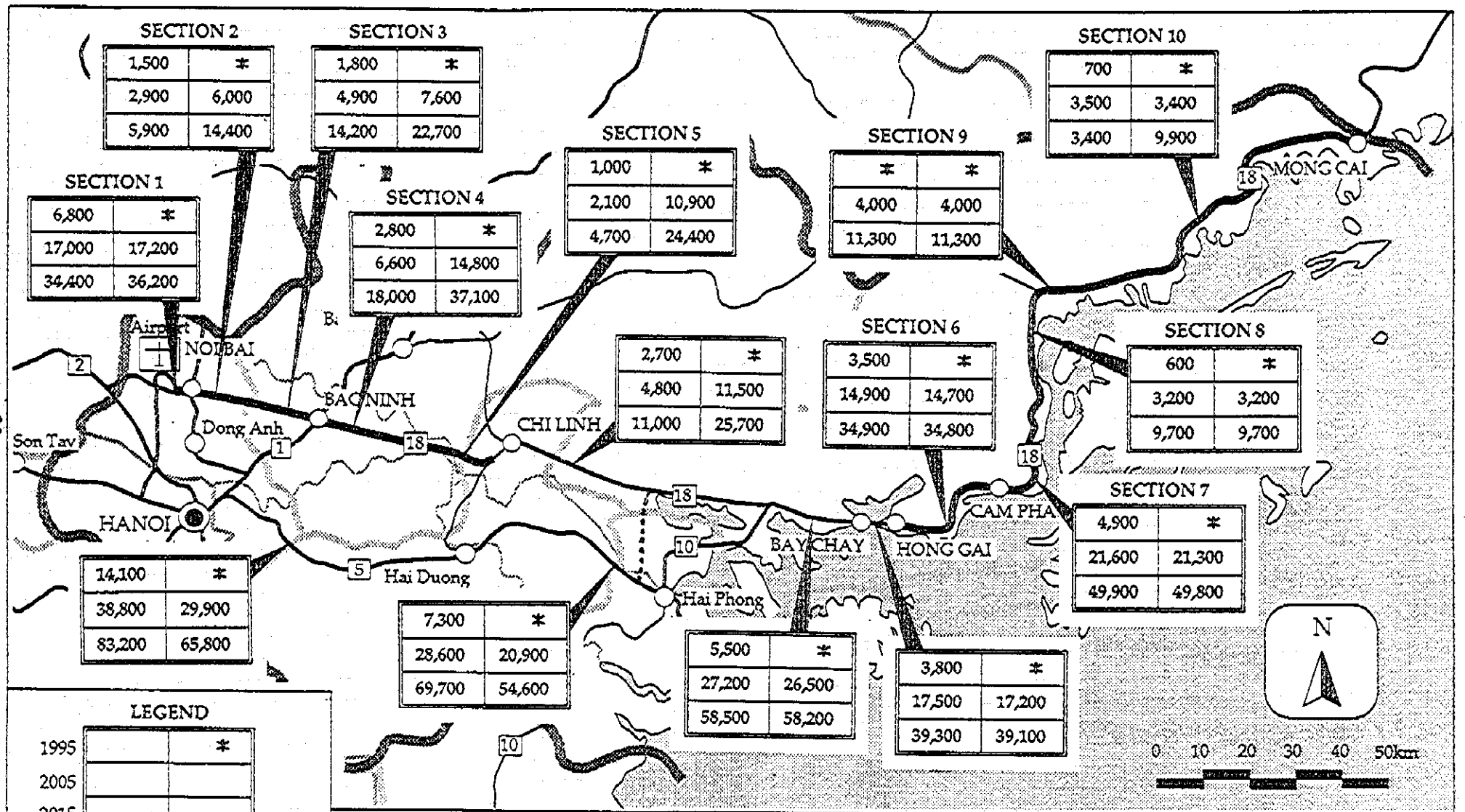


Figure 5.3

EXISTING AND FORECAST DAILY UNCONSTRAINED DEMAND (PCU)

5.4 Conclusions

The forecasting process and allied sufficiency analysis leads to several conclusions regarding treatments appropriate to Highway No. 18 improvement.

- Given the important role of Noi Bai - Hong Gai vis-a-vis Highway No. 18, it is urged that the improvement of Noi Bai - Bac Ninh Section (i.e. constructions) should be completed at the earliest possible instance.

- Assuming realization of the alternate highway, it is reasonable to conclude that justification for upgrading the existing Highway No. 18 corridor between Bac Ninh and Chi Linh to beyond enhanced two-lane status is dubious from a view point of traffic. Indeed, recent actions by the Government in the Chi Linh - Hong Gai segment of Highway No. 18 support and confirm this conclusion.

- The Hong Gai - Cam Pha - Cua Ong segment of Highway No. 18 requires capacity equivalent to four traffic lanes.

- Improvement of Highway No. 18 north of Cua Ong to Class III standard (mountainous terrain) seems appropriate in the light of modest levels of forecast traffic demand.

6. PHYSICAL CONDITIONS OF STUDY AREA AND ENGINEERING SURVEY

6.1 Physical Conditions of Study Area

(1) Topography and River System

1) Noi Bai - Chi Linh

The topography is favorable throughout the entire section. Flat land is spread out in the Red River delta with elevations at less than 10 m. The area is mainly used for rice cultivation. The existing Highway No. 18 crosses Thai Binh river by Pha Lai ferry (200 - 250 m) which is a major road transport bottleneck in this section.

2) Hong Gai - Cua Ong

Highway No. 18 runs through flat or hilly coastal area but topography is generally favorable. Unfavorable road alignment due to rugged terrain is observed at Ha Tu. The terminus of this section is Cua Ong, a coal mining-oriented town.

3) Cua Ong - Mong Cai

Highway No. 18 mainly runs through the outer edges of mountainous area, however irrigated rice paddies exist in several river basins. The highway crosses a number of rivers, among these the major rivers (those exceeding 50 meters in width) are: Ha Chanh, Tien Yen, Dam Ha, Duong Hoa, Ha Coi, Nga Bat and Ka Long.

(2) Geology

Geological sequence in the flat terrain is rather simple but complicated in the rolling/mountainous areas.

1) Noi Bai - Chi Linh

Geologically, the flat terrain in Red River delta area is of alluvium or diluvium formation of Holocene or Pleistocene Ages, composed of alluvial or diluvial soils of gravel, sand, loam, silt and clay. According to the data obtained in the past studies, the bearing strata for the construction of pile foundation for bridge structures are situated at 20-30 meters depth from the existing ground level.

2) Hong Gai - Cua Ong

The rolling terrain in Hong Gai-Cua Ong is mainly of limestone formation from the Carboniferous-Permian Age and of conglomerated sandstone or siltstone or coal formation of Triassic Age. The coastal plain in Cam Pha is of diluvial formation of Pleistocene Age and the soils are composed of silty clay.

3) Cua Ong - Mong Cai

Geological sequence is a rather simple rolling terrain mainly composed of sandstone, siltstone or limestone formation from the Jurassic Age and the coastal plain is of alluvial or dilluvial formation of Holocene or Pleistocene Age and composed of variety of soils including gravel, sand, loam, silt and clay.

(3) Climate

The seasons are influenced by the monsoons which blow from the southwest between May and October and from the northeast between November and April. The southwest monsoons bring heavy rainfalls, often storms and typhoons. During the northeast monsoon season, (dry season), cold gusts and drizzles are common.

Annual average rainfall in Ha Noi is about 1,700 mm of which 80 - 85 % falls in the rainy season. The annual average number of rainy days is 140. Annual average temperature in Ha Noi is 23.6 °C with its minimum of 4 °C and maximum 39.4 °C; mean humidity is 82 %. In Quang Ninh province, the annual average rainfalls is 2,000 - 2,500 mm which is much higher than in Ha Noi.

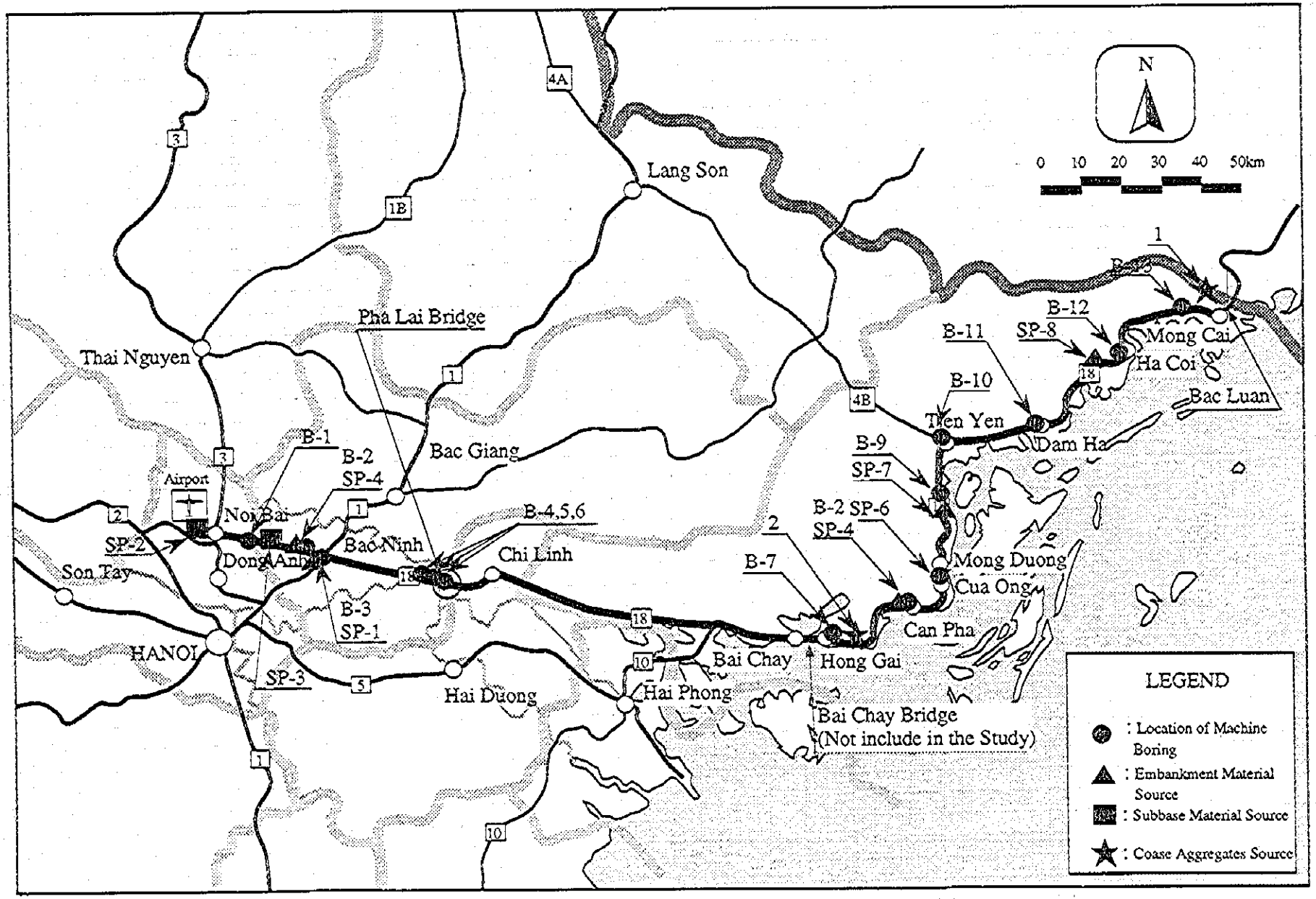
6.2 Soil and Material Investigation

(1) Field Work and Laboratory Testing

Machine boring (390 m) with standard penetration tests (2 m intervals) was conducted at 13 locations. Thin-wall tube samplings were also carried out for soft soils. Test pit samplings (10 locations) were made at possible sources of embankment materials, pavement materials and concrete aggregates (Figure 6.1). Furthermore, laboratory tests were conducted to learn the geological characteristics of the soils and materials obtained by the above samplings.

(2) Bearing Strata of Foundation Piles

Summary of bearing strata for piled foundations are shown in Table 6.1.



Figre 6.1 Location Map for Soil Investigation

Table 6.1 Summary of the Bearing Strata for Piled Foundations (N ≥ 50)

Borehole No.	Description	Position of Bearing Strata (m)	Nomenclature
B - 1	Ca Lo Bridge	34.0	Gravelly sand
B - 2	Ngu Huyen Khe Bridge	37.5	Claystone
B - 3	NH No. 1	48.0	Gravelly sand
B - 4	Pha Lai Bridge	10.0	Sandstone
B - 5	Pha Lai Bridge	3.5	Sandstone
B - 6	Pha Lai Bridge	13.5	Sandstone
B - 7	Hong Gai Bridge	15.0	Sandstone
B - 8	Cam Pha Bridge	19.0	Limestone
B - 9	Ba Che Bridge	10.2	Weathered claystone
B - 10	Tien Yen Bridge	6.3	Gravelly sand
B - 11	Dam Ha Bridge	11.2	Weathered siltstone
B - 12	Ha Coi Bridge	4.0	Gravelly sand
B - 13	Kinh Koong Bridge	7.0	Weathered claystone

(3) Embankment Materials

Locations of embankment material sources are shown in Table 6.2.

Table 6.2 Locations of Embankment Material Source

Sampling Pit No.	Station (km)	Place	Remarks
SP - 1	33.0	Bac Ninh	Along exist. road
SP - 4	28.8	Ton Loc	Along exist. road
SP - 5	143.2	Cam Pha	Near exist. borrow pit
SP - 6	162.0	Dan Cu Cach	Along exist. road
SP - 7	185.0	Cai Tan	Along exist. road
SP - 8	253.3	Cha Lin Thin	Along exist. road

Table 6.3 shows the result of laboratory test of samples obtained at each sampling pit.

Table 6.3 Result of Laboratory Test of Embankment Materials

Test Pit No.	Moisture Content W (%)	Dry Density gd (t/m³)	CBR (%)	Remarks
SP - 1	15.37	2.02	9.0	Silt
SP - 4	8.75	2.00	10.0	Sandy clay w/ gravel
SP - 5	16.50	1.74	5.0	Clay w/ gravel
SP - 6	18.16	1.62	4.2	Clay w/ gravel
SP - 7	16.38	1.80	5.0	Clay w/ gravel
SP - 8	20.45	1.78	4.0	Clay w/ gravel

(4) Subbase Materials and Coarse Aggregates

Subbase materials of clay with gravel or fine sand, with CBR of approximately 15 % were identified as shown in Table 6.4. Cement stabilization of these materials are recommended.

Table 6.4 Result of Laboratory Test, Subbase Materials

Test Pit No.	Station (km)	Place	CBR (%)	Remarks
SP - 2	6.0	Son Dong	15.0	Clay w/ gravel
SP - 3	24.0	Van Doan	15.0	Fine sand

Sampling and testing of currently available course aggregates were carried out; the quality of these materials was judged satisfactory. Table 6.5 shows the summary of laboratory test of presently available coarse aggregates.

Table 6.5 Laboratory Test Result of Coarse Aggregates

Sample No.	Place	Specific Gravity (g/cm³)	Absorption (%)	Los Angeles Abrasion (%)	Type of Rock
1	Thai Van (km 296)	2.72	4.2	18.0	Granite
2	Yen Cu (km 128)	2.69	6.4	20.6	Limestone

6.3 Existing Surface Conditions of Highway No. 18

The existing surface conditions of the pavement were surveyed and evaluated during a period from September 18, 1995. The evaluation was conducted based on the cracks, rutting and riding conditions.

The pavement evaluation results of Highway No. 18 are shown in Table 6.6.

Table 6.6 Pavement Evaluation Results of Highway No. 18

Unit : km

Section	Location	Length (km)	Evaluation of Pavement Surface			
			Good	Fair	Poor	Very poor
2	Bac Ninh - Chi Linh	34.9	3.0	21.0	5.0	5.9
3	Hong Gai - Cua Ong	39.5	0	18.5	10.0	11.0
4	Cua Ong - Tien Yen	45.5	0	29.5	7.5	8.5
5	Tien Yen - Bac Luan	93.5	0	56.0	23.0	14.5
	Total	213.4	3.0	125.0	45.5	39.9

7. DESIGN STANDARD

7.1 Geometric Design Standard

(1) Geometric Design Standard

National Highway No. 18 is considered a major arterial route in its region. However, due to the lack of a substitute route between Bac Ninh and Chi Linh, and between Hong Gai and Cua Ong, it is also closely involved with local areas, and can therefore also be characterized as a local road.

In determining the geometrical design standards for the project, the standards of the MOT are implemented as a base while Japanese and AASHTO standards are referred to when necessary.

1) Recommended Highway Classes and Number of Lanes

The highway class, design speed, and number of lanes required in the final stage (Table 7.1) for each section of the Highway No. 18 improvement have been selected based on the nature of terrain, the traffic demand and the following background.

- In the Noi Bai - Bac Ninh section, the safe and efficient movement of high volumes of traffic at the specified design speed (i.e. 120 km/hr) should be attained by the provision of good roadway alignment, since the section is a part of high standard road network system, consisting of Noi Bai Airport Highway (Design Speed 120 km/hr), Ring Road No 3 (Design Speed 120 km/hr), new separate Highway No. 1 (Design Speed 120 km/hr) and Highway No. 5 (Design Speed 100 km/hr). Judging from traffic volume, a four-lane highway is deemed necessary for the final stage.

- In the Bach Ninh - Chi Linh section, in regards to the flat terrain and below-mentioned traffic volume, design speed was set at 80 km/hr. With plans for the alternate highway from Bac Ninh to Ha Long, it is reasonable to conclude that justification for upgrading the existing Highway No. 18 between Bac Ninh and Chi Linh to more than two-lane status is unnecessary from the result of forecast traffic demand before 2006, difficulty of resettlement and uniformity with the section of 2-lane road from Chi Linh to Bai Chay.

- In Hong Gai and Cam Pha towns the Highway No. 18 must pass highly developed areas in certain stretches, if the high geometric design standard was applied for the entire sections, the land acquisition, compensation for inhabitants resettlement will become major social issues. Therefore, in application of substandard for mitigating adverse environmental impacts, design speed of 60 km/hr was selected. Future traffic volume dictates the need for 4 lanes.

- Design speed of 60 km/hr will be appropriate for the segment of Highway No. 18 north of Cua Ong to Class III standard (mountainous terrain) in light of the modest levels of forecast traffic demand and its mountainous conditions.

Table 7.1 Recommended Highway Classes and Number of Lanes

Section	Highway Class	Design Speed (km/hr)	Number of Lane (2015)
Noi Bai - Bac Ninh	Class-I, TCVN 4054-85 (Flat Terrain)	120	4
Bac Ninh - Chi Linh	Class-III, TCVN 4054-85 (Flat Terrain)	80	2
Hong Gai - Cua Ong	Class-Ib, TCVN 4054-85 (Flat Terrain)	80 - 60	4
Mong Duong	Class-III, TCVN 4054-85 (Flat Terrain)	60	2
Mong Duong - Bac Luan	Class-III, TCVN 4054-85 (Mountainous)	60	2

2) Lane Width

In general, lane width is decided based on empirical data on vehicle speed, traffic volume, ratio of heavy trucks and traffic safety. In addition to the above, the Vietnamese government's road structure decrees, Japanese design standards, traffic capacity and future traffic volume considerations were made in calculation of lane width which was conducted in consideration of the above design speed as well as the following data shown in "a" and "b".

a. Traffic volume and heavy truck ratios are shown in Table 7.2. The heavy truck ratio is extremely high. Sections 1 - 3 have high volumes (approximately 23,000 ~ 50,000 pcu/day), therefore lane width under 3.0 m should be avoided.

Table 7.2 Heavy Truck Ratio of Each Section

Section	Traffic Volume (pcu/day)	Heavy Truck Ratio
1	22,700	33.5 % (54.3 %)
2	37,100	59.2 % (70.3 %)
3	49,800	76.2 % (85.5 %)
4	9,700	88.4 % (83.5 %)
5	9,900	81.3 % (82.7 %)

Note : Because of the high number of motorcycles, these are converted into automobile equivalents as part of the heavy truck ratio. Figure inside ( ) indicates this ratio when motorcycles are not figured.

b. According to Japanese design standards, lanes under 3 meters are apt to cause a high rate of accidents, and are to be avoided. In the case of a two-lane road with a design speed of 100 km/hr, lane width 3.5 - 3.75 m, 80 km/hr; 3.5 m is recommended.

c. Judging from the above, two types of lane width (3.5 m and 3.0 m) are applied as follows.

- Sections 1 - 3 : 3.5 m
- Sections 4 - 5 : 3.0 m

(2) Recommended Geometric Design Standard

The Noi Bai - Bac Ninh section of the Highway No. 18 is considered as a multilane suburban arterial without access control (i.e., principal arterials) and other sections are considered as arterials in rural areas.

The geometric design standard for classes-Ib and III are established based on the Vietnamese, Japanese and AASHTO design standards.

The geometric design standards mentioned above are summarized in Table 7.3.

Table 7.3 Geometric Design Standards for Each Section of Highway No. 18

Item	Unit	Noi Bai - Bac Ninh	Bac Ninh - Chi Linh	HongGai - Cua Ong	Mong Duong - Bac Luan
Class of Road	-	I	III	Ib	III
Terrain	-	Flat	Flat	Flat	Mountainous
Design Speed	km/hr	120	80	60 (80)	60
Cross Section Elements					
Lane Width	m	3.5	3.5	3.5	3.0
Outer Shoulder Width	m	3.0	2.0	2.5	1.0
Bicycle Lane	m	-	2.0	2.5	1.0
Median Width (Raised)	m	2.5	-	0.50	-
Inner Shoulder Width	m	1.25	-	0.50	-
Crossfall of Carriageway	%	2	2	2	2
Crossfall of Shoulder	%	2	2	2	2
Vertical Clearance	m	4.75	4.75	4.75	4.75
Min. Stopping Sight Distance	m	210	100	75	75
Horizontal Alignment					
Min. Radius	m	710 (600)	250	150	150 (120)
Vertical Alignment					
Max. Grade	%	3	6	5	7
Min. Vertical Curve Radius					
Crest	m	11,000	5,000	1,400	2,500
Sag.	m	4,000	2,000	1,000	1,500

7.2 Bridge Design Standard

Basically Vietnamese Bridge Design Code (Specifications 2057/QD-KT4-1979) follows AASHTO specifications. Due to the reasons explained below, AASHTO load HS 20 - 44 x 125 % is adopted for design load. In light of the immense problems resulting from bridge failure and the high cost of replacement, it goes without saying that their structural design should be treated with great importance. With proper design, construction, and maintenance, a bridge can last for more than 50 years. Furthermore, once a bridge is built, due to the complicated nature of its structure, even relatively simple strengthening work can cause economic repercussions, not to mention the problems caused by traffic slowdown.

Therefore, when designing a bridge, it is necessary to consider not only the present conditions, but 30 to 50 years in the future as well. As a worldwide trend, vehicles are being made on larger scales to accommodate greater loads. In Japan as well, design load has recently been raised from 20 t to 25 t.

Vietnam's design load at present subscribes to this reality as well. The bridge rehabilitation project on National Highway No. 1 has adopted AASHTO HS20-44 x 1.25. This load is in response to Vietnam's standard H30. With the present and projected heavy truck ratio in mind, this is an appropriate design load for Highway No. 18 when considering its importance as a route: linking Cai Lan's port with Ha Noi, and carrying coal from Cua Ong, etc.

7.3 Flood Clearances

Article 1.27 of Vietnam Bridge Design Code 2057/QD-KT4-1979 was followed to determine the clearances for the design of bridges in case the river is not utilized for navigation.

7.4 Navigation Clearances

Classification of waterways (i.e. rivers and canals) and navigation clearances are determined in accordance with TCVN-5664-1992. In the case of Pha Lai bridge, horizontal clerance is set at 50 m; vertical clearance 7 m. This is considered as a reasonable clearance.

7.5 Road and Railway Clearances

The clearances for the design of bridges crossing over any classes of roads were determined in accordance with the Design Criteria of Highway TCVN-4054-85. Accordingly a minimum vertical clearance of 4.75 m was kept in the design considering future overlay allowance of 0.25 m. This is standard is considered reasonable when compared with Japanese standards.

The clearances for the design of bridges crossing over railways were determined depending on the railway gauges in accordance with Decision of the Railway Authority No. 288/CDKT.

8. OPTIMUM SOLUTION OF HIGHWAY NO. 18 IMPROVEMENT

8.1 Improvement Policy for Highway No. 18

The improvement of the Highway No. 18 will require an enormous investment. A method which will ensure optimum investment efficiency needs to be selected in consideration of initial investments and road structure which satisfies traffic demand; therefore it is necessary to adopt the stage construction approach. In conjunction with the project, sufficient consideration must be taken for the highway's involvement with the road network plan of the surrounding area. In particular, it is necessary to clarify the planning policies for the proposed Alternate Highway and for National Highway No. 18.

8.2 Forecast Traffic Volume and Capacity

Forecast traffic volume in each section is shown in Table 8.1.

To decide the daily design traffic capacity, a review of the "Highway Capacity Manual of Highway Research Board (U.S.A.)", "Highway Research Board Standards (Japan)" was conducted, keeping in mind special characteristics of the survey area. The results are shown in Table 8.2.

Table 8.1 Forecast Traffic Volume

Section		Noi Bai - Bac Ninh	Bac Ninh - Chi Linh	Hong Gai - Cua Ong	Cua Ong - Tien Yen	Tien Yen - Bac Luan
Road Length (km)		31.3	36.4	38.7	43.5	86.9
(pcu/day)	1995	1,800	2,800	4,900	600	700
	2005	7,600	14,800	21,300	3,200	3,400
	2015	22,700	37,100	49,800	9,700	9,900

Note : pcu : Passenger/car unit

Table 8.2 Road Traffic Capacity

	Design speed (km/hour)	Road width (m)	Peak factor (%)	Design daily capacity per lane (pcu/day)
Two-lane road	60	6.0	10.0	15,000*
Two-lane road	80	7.0	9.0	15,000*
Four-lane road	80	3.5	9.0	13,500
Four-lane road	120	3.5	9.0	18,900

Note : pcu: passenger/car unit
* indicates traffic capacity per two lanes

8.3 Determination of Required Number of Traffic Lanes by Stage

The number of required traffic lanes was calculated for Highway No. 18 based on the future traffic capacity forecast for the year 2015.

The number of lanes of the respective highway section by stage was determined as shown in Table 8.3.

Table 8.3 Number of Required Lanes by Section

Section		Required No. of Lanes	
		Initial Stage	Final Stage
1)	Nai Bai - Bac Ninh	2	4
2)	Bac Ninh - Chi Linh	2	-
3)	Hong Gai - Cua Ong	4	-
4)	Cua Ong - Bac Luan	1 - 2	2

8.4 Improvement Policy by Section

(1) Noi Bai - Bac Ninh Section

Completion of two lanes will be carried out in initial stage (2001); the additional lanes will be constructed in the final stage to make a total of four lanes.

(2) Bac Ninh - Chi Linh Section

Alternative proposals for a four-lane improved highway and a two-lane improved highway with four-lane alternate highway were compared. It was found that the adoption of a 2-lane improved highway together with the construction of the Alternate Highway is a superior plan when considering the number of residences that would be spared from demolition and/or relocation, and its integration with the government plan for widening Highway No. 18 east of Chi Linh. Therefore, preliminary designs were made for a two-lane two-direction highway.

(3) Hong Gai - Cua Ong Section

This section is to be treated as an urban thorough fare, with side lanes for bicycles and oxcarts and a medium divider or median walkyway. Due to rapid increase of traffic volume, a four-lane highway will be completed within the initial construction stage (scheduled completion 2001).

(4) Cua Ong - Bac Luan Sectin

In the initial stage, traffic volume dictates the need for overlay work and bridge replacement in locations of insufficient load-bearing capacity; to keep initial investment at a minimum.

8.5 Consideration for the Development of Alternate Highway

(1) Necessity of Alternate Highway

The need for improving the road network in the Red River delta through provision of a new highway system (i.e., alternate highway) is primarily a product of the recent rapid economic development and forecasted drastic rise in future vehicle traffic demand. To cope with this situation, the government recently decided to develop an alternate highway in the Ha Noi - Ha Long corridor, since even the upgrading of Highway No. 18 and four-lane widening of Highway No. 5 together will not be sufficient to meet this demand, which includes greater shipping and speed capacities as well. It will take approximately ten years from planning stage to completion. Experience of other Asian countries has shown that Vietnam is at an economic stage appropriate for the development of expressway, based on the GDP per capita of the nation.

(2) Alternate Highway Development Policy of the Government

The development policy of the alternate highway (expressway) which was recommended in the "Master Plan Study on the Transport Development in the Northern Part in Vietnam (1994, by JICA)" was accepted, although the adoption of the original route directly connecting Ha Noi and Hai Phong has been modified to run the northern area generally parallel to the Highway No. 18 between Noi Bai - Ha Long. The improvement project proposed for Highway No. 18 will be directly effected where the alternate highway passes through its vicinity. This influence is reflected in the policies of this survey, as concluded in 8.2.

(3) Planning of Alternate Highway (Expressway)

The alternate highway (expressway) network should be developed with a basic understanding that the services of arterials and expressways differ. Vehicles on shorter trips use arterials and expressways are generally utilized by vehicles bound for further destinations. Expressways such as the proposed alternate highway are required to maintain higher standards of traffic capacity and driving speed.

9. SELECTION OF THE ROUTE LOCATION

9.1 Route Components

The Highway No. 18 Improvement as treated in the feasibility study is comprised of the following five (5) sections:

- Noi Bai - Bac Ninh;
- Bac Ninh - Chi Linh;
- Hong Gai - Cua Ong;
- Cua Ong - Tien Yen;
- Tien Yen - Bac Luan.

9.2 Comparison of Alternate Routes

When reviewing alternate routes, data gathering and analysis of land acquisition, resettlement issues, main control points, land-use, topography, route alignment, and road length is required. In the case of this survey, the number of encumberments proved to be an issue.

The partial or complete demolition of 7,129 residences and 225 facilities (temples, factories, schools, etc.) is required in the event that the project solely consists of the widening of existing routes 18, 286, and 401. Therefore, it is very important that optimum routes be studied and selected to minimize the number of residences and facilities affected by realignments and new bypasses. As the result of further study, the number of structures affected was reduced to 3,871 in total. Location of alternative routes are shown in Figure 9.1.

(1) Corridor from Noi Bai to Bac Ninh

The comparison of alternative routes in this corridor was conducted by counting the number of residences lying within the 46 m clear area of the standard cross section being applied.
According to the site survey, if existing provincial roads Nos. 401 and 286 are to be widened, more than 1,242 houses must be demolished. The alternative routes were established to reduce the number of demolitions.
Upon review of four alternative routes, a route which passes along the north of routes 286 and 401 before detouring south of the town of Bac Ninh was selected.

(2) Corridor from Bac Ninh to Chi Linh

More than 1,153 residences are required to be demolished to make way for the widening of the existing Highway No. 18, which requires a clear area of 30.5 meters in width in the case of type A-1 typical cross sections. Three case locations were selected to find the route requiring the least amount of problematic structures. The results are stated below:

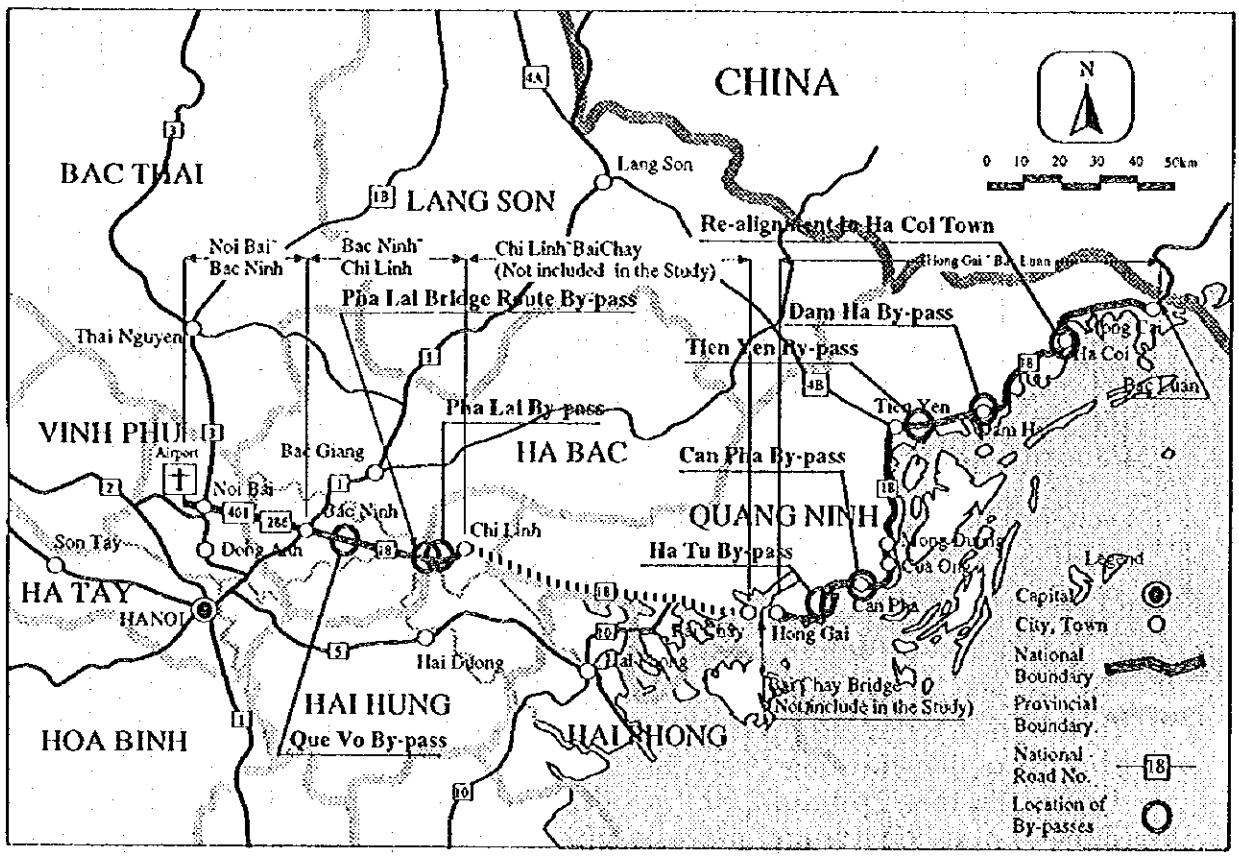


Figure 9.1 Location of Alternative Routes

- The new route which includes the proposed Pha Lai bridge (2.25 km) and Pha Lai bypass were recommended;
- Que Vo proposed bypass was rejected, as explained below:

  Proposed Que Vo bypass requires the demolition of only 7 houses, while the widening of the existing Highway No.18 requires the demolition of 69 houses and 3 public facilities. In the case that Highway No. 18 requires four lanes, the proposed bypass particularly becomes a more attractive alternative. Therefore, the new route will be selected only if the widening of Highway No. 18 is deemed necessary, due to the fact that construction cost of a new route is much higher than widening an existing one. The widening of existing road to two lanes is the recommended alternative.

(3) Corridor from Hong Gai to Cua Ong

In this section, due to urban conditions, type C-2 cross-section (including walkways) would be applied, bringing the width of the clear area to 30.5 m and consequentially require the removal of 2,232 residences. To avoid this situation, two bypasses are proposed; one at Ha Tu (3.5 km) and the other at Cam Pha (5.34 km). (See Figure 9.1)

(4) Corridor from Tien Yen to Bac Luan

In this section, type B cross-section would be applied, bringing the width of the clear area to 27.5 m; requiring the removal of more than 1,400 residences. (See Figure 10.1).

To alleviate this situation, a comparison was made among four locations, and the three following new routes were selected:

- Tien Yen bypass (5.60 km)
- Dam Ha bypass (4.54 km)
- Route change through Ha Coi city area (3.36 km)

Upon further consideration, under the circumstances that the Ha Coi bypass route has lower priority than the Ha Coi city route, and that it would entail double investment; it was concluded that construction of the Ha Coi bypass should be forestalled until after the year 2015.

10. PRELIMINARY ENGINEERING DESIGN

10.1 Preliminary Geometric Design

(1) Design Speed and Typical Cross Sections

The recommended design speed, typical cross sections and number of lanes for each section are shown as follows (Table 10.1 and Figure 10.1).

Table 10.1 Design Speed, Typical Cross Sections and Number of Lane

Section	Length (km)	Design Speed	Typical Cross Section	Number of Lane
1. Noi Bai - Bac Ninh	31.3	120 km/hr	Type D	4 (Final Stage)
2. Bac Ninh - Chi Linh	36.4	80 km/hr	Type A-1	2
3. Hong Gai - Cua Ong	38.7	80 - 60 km/hr	Type C-2	4
4. Cua Ong - Tien Yen	43.5	60 km/hr	Type A-1 or B	2 (Final Stage)
5. Tien Yen - Bac Luan	86.9	60 km/hr	Type B	2 (Final Stage)

(2) Preliminary Alignment Design

The horizontal alignment of the optimum route obtained through the route selection process was refined based on a study of 1 : 5,000 scale topographical maps of Sections 1 to 3, and on 1:10,000 scale maps of Sections 4 and 5.

1) Alignment Design in Noi Bai - Bac Ninh Section

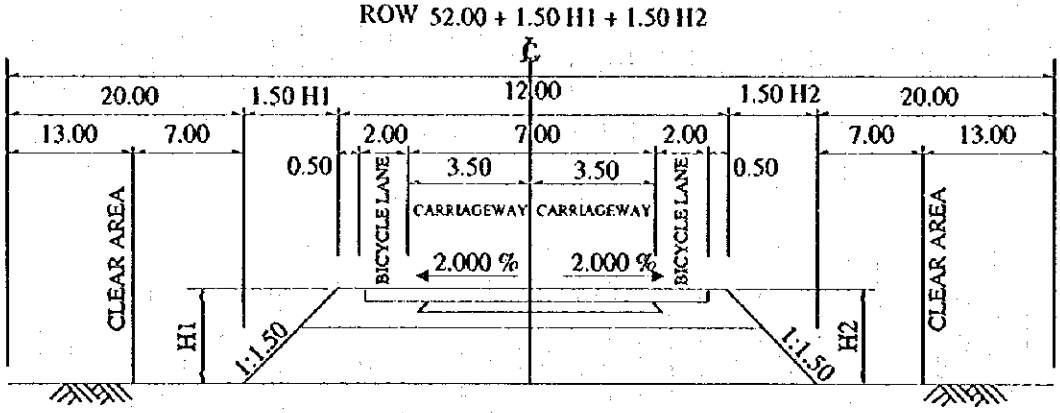
In regards to horizontal alignment planning, study was conducted based on results of field survey while keeping the following points in mind:

- Densely populated residential areas, schools, hospitals and other public facilities are to be avoided;
- To shorten bridge lengths over Ca Lo and Ngu Huyen Khe rivers, alignment will be at a right angle to the river course.
- Considerations are made for any future plans for enlargement of Noi Bai Airport facilities.

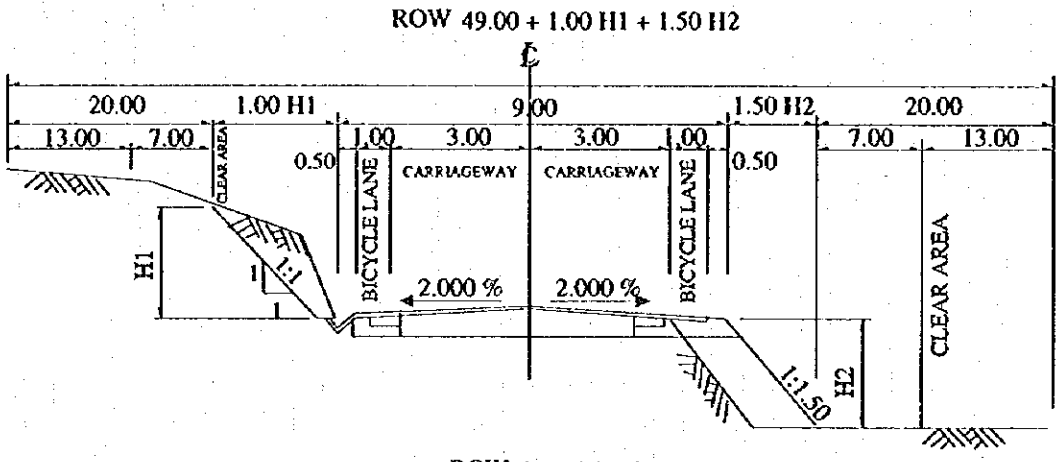
In the vertical alignment design, crossings with the existing lines (i.e., highways, railway lines and rivers) are principal controls for vertical alignment design and careful studies were carried out based on specific on-site field surveys. The following basic rules were established for the vertical alignment design of Highway No. 18:

- Existing national roads and railway lines are to be overcrossed (i.e., to run below above Highway No. 18);

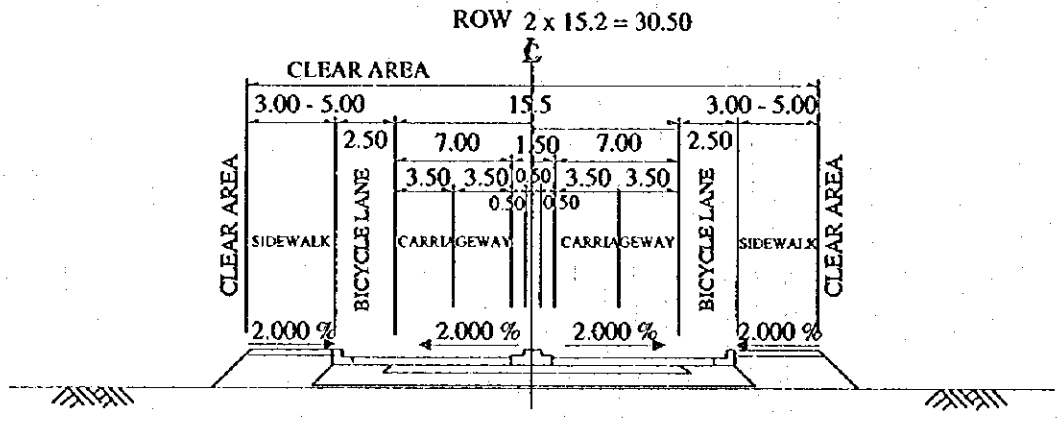
Type A-1



Type B



Type C-2



Type D

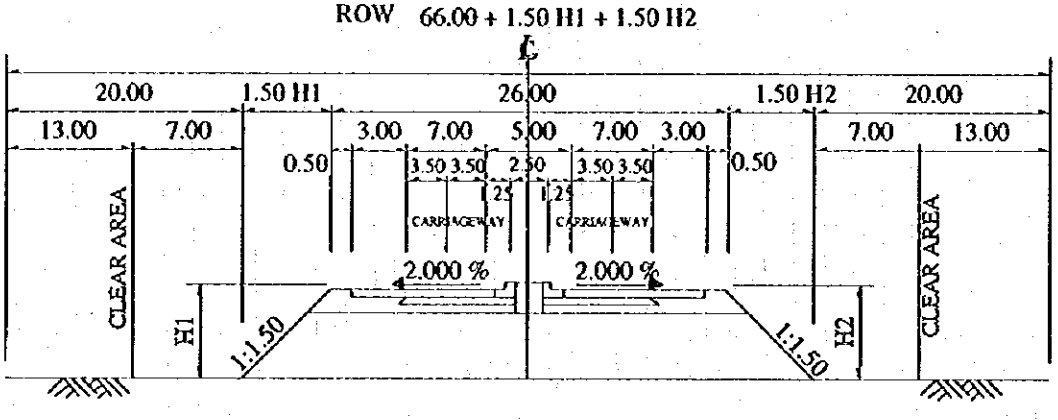


Figure 10.1 Typical Cross Sections

- The Ca Lo and Ngu Huyen Khe rivers are to be provided with inspection roads;
- At crosspoints with provincial Highway No. 286 and Alternate Highway No. 1, Highway No. 18 will become an underpass to lessen the construction cost;
- Severance of local communities is to be avoided by the provision of box culverts underneath Highway No. 18;
- A minimum embankment height of 2 m above the existing ground line is provided in irrigated rice paddy area to ensure the preservation of irrigation systems;
- The embankment height is kept low as possible to reduce soft ground treatment efforts as well as to shorten the construction period.

2) Alignment Design in Bac Ninh - Chi Linh Section

Designed horizontal alignment generally follows the centerline of existing Highway No. 18. The route crosses the Thai Binh River where the construction of Pha Lai Bridge is planned. The centerline of planned Pha Lai Bridge has been shifted about 500 m downstream to avoid a temple and old factory complex. As a result of the preliminary horizontal alignment design, the length of Bac Ninh - Chi Linh section is measured to be 36.4 km (distance between Bac Ninh Interchange and Chi Linh terminus).

Designed vertical alignment generally follows the existing grade of Highway No. 18. Pha Lai Bridge is planned at Sta. 25 + 860 (center of main span). The vertical alignment design has been carried out based on the following conditions (Table 10.2).

Table 10.2 Design Conditions of Pha Lai Bridge

Descriptions	Unit	Design Conditions
Class of river	-	III
Flood water level (H 1 %)	m	7.94
Flood water level (H 5 %)	m	7.05
Navigation clearance		
Horizontal	m	50
Vertical (above H 5 %)	m	7.0
Finished grade of approach road	m	9.6

3) Alignment Design in Hong Gai - Cua Ong Section

Since Highway No. 18 passes through existing urbanized or soon-to be-urbanized areas, urban highway design approach was adopted in the preliminary design.

Highway No. 18 in Hong Gai - Cua Ong Section is comprised of several segments of differing construction type (i.e., new construction of Bai Chay Bridge approach road, upgrading of existing streets, and provision of bypass highway) and applicable typical highway cross sections.

Basically the horizontal and vertical alignment design follow TEDI's working drawings; however minor changes were made as follows:

- TEDI's horizontal alignment in Bai Chay Bridge approach was slightly shifted uphill to avoid an existing beer factory;
- A smaller longitudinal gradient of four (4) percent was adopted to consider the use of bicycles; and
- The maximum gradient of Ha Tu bypass was limited to six (6) percent to meet the recommended design standard (60 km design speed).

4) Alignment Design in Cua Ong - Tien Yen Section

Highway No. 18 in this section is divided into two (2) segments as follows:

- Cua Ong - Mong Duong (Class-III, flat terrain); and
- Mong Duong - Tien Yen (Class-III, mountainous terrain).

The terrain condition along the existing highway is mountainous over certain stretches, but cross section elements of Class-III for flat terrain have been provided for the Mong Duong segment.

Class-III for mountainous terrain has also been applied only for alignment design to cope with extremely rugged terrain and to avoid resettlement. Since the terrain condition is unfavorable, extremely deep cut (h = 15 m ~ 20 m) is required in several locations. The preliminary horizontal alignment design length of Cua Ong - Mong Duong segment is 8.0 km.

Horizontal and vertical alignment generally followed the TEDI's working drawings between Tien Yen and Ha Coi. The study team carried out repeated site investigations to ascertain problems of resettlement; in particular, in Dam Ha and Ha Coi bypasses. Considerations were given to the new construction and replacement of bridges, and horizontal and vertical alignments are determined based on the terrain conditions and hydrological data at the bridge sites.

10.2 Preliminary Design of Bridges

(1) Summary of Existing and New Construction Bridges

The summary of the number of existing and new construction bridges is shown in Table 10.3.

Table 10.3 The Number of Existing and New Construction Bridges by Section

Bridges	Sec. 1	Sec. 2	Sec. 3	Sec. 4	Sec. 5	Total
New Construct Bridges	14	8	8	1	12	43
Existing Bridges	0	3	17	19	32	71
Total	14	11	25	20	44	114

Note : Number of newly constructed bridges includes the Pha Lai bridge.

(2) Bridge Improvement Policies

Existing bridges were evaluated in the following categories according to their effective width, loading capacity, clearance against flood water level as well as degree of deterioration of superstructure.

- Replacement;
- Widening;
- Retainment.

(3) Determination of Bridge Improvement Framework

Based on the above-mentioned improvement policies, the results of investigations, as well as the highway alignment design results, the study team determined bridge improvement framework as carried out on existing bridges. The results are shown in Table 10.4. As regards to existing bridges requiring replacement, almost none of them meet demands of present design load standards and were judged as lacking supporting strength.

Table 10.4 Number and Length of Bridges by Type of Improvement

Section	New Construction		Replacement		Widening		Retainment		Total	
	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)
1	14	1,950.0	0	0	0	0	0	0	14	1,950.0
2	8	1,477.0	3	74	0	0	0	0	11	1,551.0
3	8	490.0	5	78	12	134.7	0	0	25	702.7
4	1	15.0	11	264	0	0	8	167.2	20	446.2
5	12	1,193.0	26	333.5	0	0	6	258.5	44	1,785.0
Total	43	5,125.0	45	749.5	12	134.7	14	425.7	114	6,434.9

(4) Preliminary Design

A total of 114 bridges are to be involved in the improvement. Among the 114 bridges, 88 bridges need to be newly constructed or replaced.

1) Design of Short-Span and Medium-Span Bridges

Basic policy for the determination of total bridge length and span arrangement are:

River Bridges

- Abutments of bridges which cross rivers must be located away from the dikes to prevent weakening of dike body/foundation in accordance the government's regulation;
- Bridge length of river crossings not at dikes should be determined to take the river width in flooding condition into account;
- The minimum span length of river bridges should be determined to limit obstruction by piers during flooding to approximately 5 % of the sectional area of the river. Also from an aesthetic point of view, all span lengths should be as constant as possible.

Flyovers

- The ends of flyover should be determined considering the limitation of maximum embankment height;
- The span arrangement for flyovers should be determined taking into account the existing and future width of the road or railway.

According to the policies of the determination of total bridge length and span arrangement, maximum span length of 33 m was determined. The Study Team selected the following superstructure types for various span length (Table 10.5).

Table 10.5 Superstructure Types by Span Length

Span Length (m)	Superstructure Type	Remarks
L < 10	RC Slab	
10 ≦ L < 20	RC Hollow Slab	Supporting required
10 ≦ L < 20	RC T - Girder *	Supporting not required
20 ≦ L < 33	PC I - Girder	

* Note : RC T - girder indicates the "Precast Reinforced Concrete T-girder" which is mainly utilized in unfavorable subsoil areas such as Noi Bai - Bac Ninh section, to avoid excess cost for temporary construction (e.g., supporting of forms and temporary road) and to minimize construction period.

A simple beam type has been adopted for all bridges for ease of construction, construction economy and minimalization of construction period.

2) Design of Thai Binh River (Pha Lai) Bridge

Thai Binh river bridge consists of eleven (11) spans. This bridge can be divided into two distinct portions when viewed in terms of structural characteristics:

- One (1) prestressed concrete continuous box girder bridge (65 m + 105m + 65 m) for main spans with effective width of 11.0 meters;
- Two (2) prestressed concrete simple box girder bridges (4 x 43.0 m + 4 x 43.0 m) for approaches each with an effective width of 11.0 meters.

It should be noted that the above-mentioned Thai Binh river (Pha Lai) bridge will constitute an integral part of Pha Lai Bridge. The Pha Lai Bridge consists of the special Thai Binh bridge and two types of viaducts to avoid flooding. The overall length will be 1,433 m (575 m + 858 m).

Thai Binh River bridge has been designed as summarized in the following:

- Bridge Length : 579 m
- Span Allocation : 43 m x 4 + 65 m + 105 m + 65 m + 43 m x 4
- Deck Width : 11.0 m (= 2.0 + 3.5 x 2 + 2.0)
- Design Live Load : 125 % of HS 20 - 44

10.3 Preliminary Pavement Design

(1) Design Conditions

The truck factor per vehicle computed from the equivalent single axle is assumed to be 1.0 up to the year 2000. The truck factor will also be increased to 3.0 by the year 2015. A value of 2.5 for truck factor has been applied for the computation of cumulative equivalent single axle loads.
The strength of subgrade will govern the thickness design of pavement. A CBR value of 4.0 to 6.0 % is adopted in the computation of pavement thickness.

(2) Design Features

AASHTO (1972 and 1986) and Japan Road Association standards have been used to design the thickness of the pavement layers.

The result of thickness design is as shown in the following:

- Asphalt Concrete Surface Course : t = 10 cm
- Asphalt Treated Base Course : t = 20 cm
- Crushed Stone Sub-base Course : t = 30 cm

11. CONSTRUCTION PLANNING

11.1 General

The construction planning study is mainly comprised of i) establishment of construction method and ii) preparation of construction time schedule. The result of the study will be utilized in the construction cost estimates and further reflected in the establishment of a project implementation schedule.

11.2 Construction Planning

The following construction planning is recommended which is considered appropriate in regards to initial investment cost and traffic demand.

- Two lanes will be constructed in the initial stage for the section from Noi Bai to Bac Ninh, which is ultimately to be a four-lane highway.
- In consideration of the fact that the four-lane alternative highway will be implemented by the year 2007, Highway No. 18 will only be widened to two lanes.
- Sections 4 and 5 from Cua Ong to Bac Luan will be overlaid with pavement for the initial stage to reduce front investment and obtain economic viability.
- The maximum construction period of 30 months is recommended based on the actual working days per year and quantities of earth work, pavement and structures.

11.3 Construction Method

(1) To attain construction economy and to realize the improvement within a shorter construction period, the equipment-intensive construction method will be adopted.

(2) Earthwork

Table 11.1 shows the sources of embankment materials for the improvement. The hauling distance is generally not more than 7km.

Table 11.1 Borrow Materials Source

Section No.	Segment	Source
1	Noi Bai - Bac Ninh	Ca Lo river, Ngu Huyen Khe river and their tributaries (river sand).
2	Bac Ninh - Chi Linh (bypasses)	Neighboring hills, Thai Binh river and Duong river (river sand).
3	Hong Gai - Cua Ong (bypasses)	Neighboring hills and excavated materials from roadway improvement.
4 & 5	Cua Ong - Bac Luan	Neighboring hills, existing rivers (sandy gravel) and excavated materials from roadway improvement.

(3) Pavement

- Sub-base Course Materials

Sub-base course materials from the existing rivers will require processing for gradation control considering amount of fine-grain deposit included.

- Base Course Materials; Coarse and Fine Aggregates

A number of aggregate producers are in operation in the Noi Bai - Bac Ninh corridor. The contractor will be able to establish his own quarries and gravel pits and to operate his own crushing/screening plant.

- Asphalt Mixture

Procurement of hot-mix asphaltic concrete is possible for the construction of asphalt treated base course and surface course.

(4) Thai Binh River (Pha Lai) Bridge

Cofferdams with steel sheet piling in the water will be required for the substructure construction. Cast-in-place concrete piling will be executed by a reverse-circulation-drill method. The adoption of cantilever erection is recommended for continuous main spans. Erection truss method with precast segments will be applied for the erection of simple PC box girders.

(5) Other Bridges and Viaducts

No major problems are anticipated in the construction of bridge foundations and substructures. PC I-girders will be erected by means of conventional crane erection method or erection girder method.

11.4 Implementation Schedule

The project implementation schedule has been prepared for both initial and final stages of the Highway No. 18 improvement. The detailed design for the initial stage improvement will commence by the beginning of 1997 for a 1.0 - 1.5 year period, and construction will be conducted within 2.0 - 2.5 year from the outset, or mid-1998. The beginning of the final stage construction is dependent on traffic requirement and the optimization policy of project costs investment (refer to Figure 11.1).

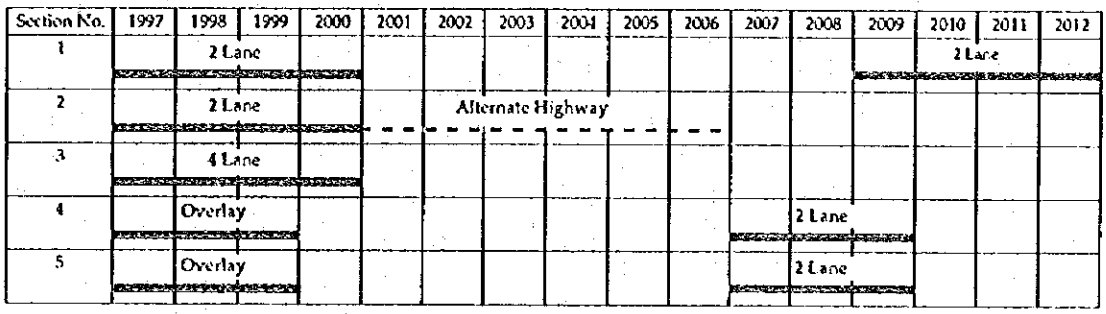


Figure 11.1 Implementation Schedule

12. MANAGEMENT AND MAINTENANCE PLAN

12.1 Present Situation of Highway Maintenance and Management

(1) Present Organization

Road administration exists within the jurisdiction of the Ministry of Transportation (MOT). MOT consists of 5 Vice Ministers, 8 Departments, 4 Bureaus, 4 Institutions, 9 enterprises, and other offices, including the Vietnam Road Administration Bureau. Under the Government Decree No.07, the Road Administration Bureau (RAB) was formed on 30 January 1993 and commenced operation on 26 May 1993.

The comprehensive organization of the VRAB is shown in Figure 12.1 together with the number of employees for each group.

Regional Management Unit No.2 (RMU No.2) is responsible for road management and maintenance of national highways in the northern part of Vietnam.

(2) Highway Maintenance Management

RMU No.2 is located in Ha Noi and is mainly responsible for the maintenance of the National Highways Nos. 1, 2, 3, 4E, 5, 6, 15, 70, 183 and 279; a total of 1,476.5 km.

RMU No. 2 presently is comprised of the 10 Road Management Divisions and 4 autonomous enterprises mentioned above. Road Management Divisions (RMD) are responsible for the routine maintenance of various lengths of national highway and receives an annual budget allocation from the MOT.

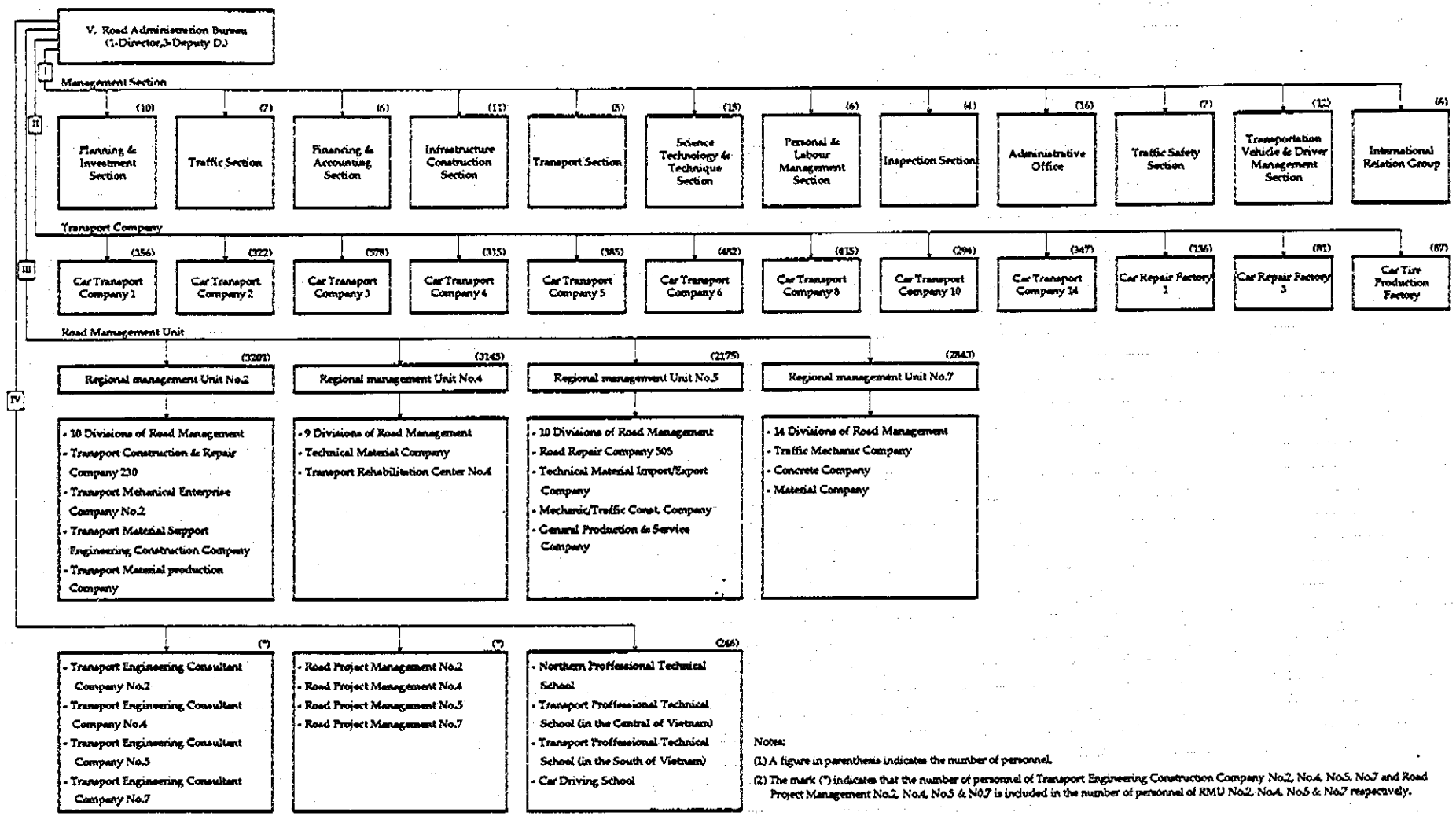


Figure 12.1 Organization Chart of Vietnam Road Administration Bureau (VRAB)

(3) Budget Allocations

In the case of RMU No.2, only routine maintenance budget has been allocated to RMD on a force account basis and the other budgets for medium- and large-scale maintenance/repair have been allocated mostly to the Transport Construction and Repair Company on a contract basis. (Refer to Table 12.1)

Table 12.1 Allocated Budget for Maintenance and Repair

Category of Maintenance/Repair	Allocated Budget (million Dong)	
	1994	1995
Routine Maintenance	12,886	16,136
Medium Repair	23,712	24,484
Large Scale Repair	14,912	17,327

Notes 1) Routine Maintenance: Pavement, potholes, drainage, signs, lane markings, weeds
2) Medium Repair: Pavement overlay (2 cm ~ 4 cm), 163 km/year
3) Large Scale Repair: Pavement overlay (15 cm ~ 20 cm), 29 km/year

(4) Vehicles and Equipment Presently Possessed

RMDs suffer from a lack of routine maintenance equipment.

In most cases, available equipment consists only of a grader, pick up truck, and roller.

12.2 Maintenance Plan

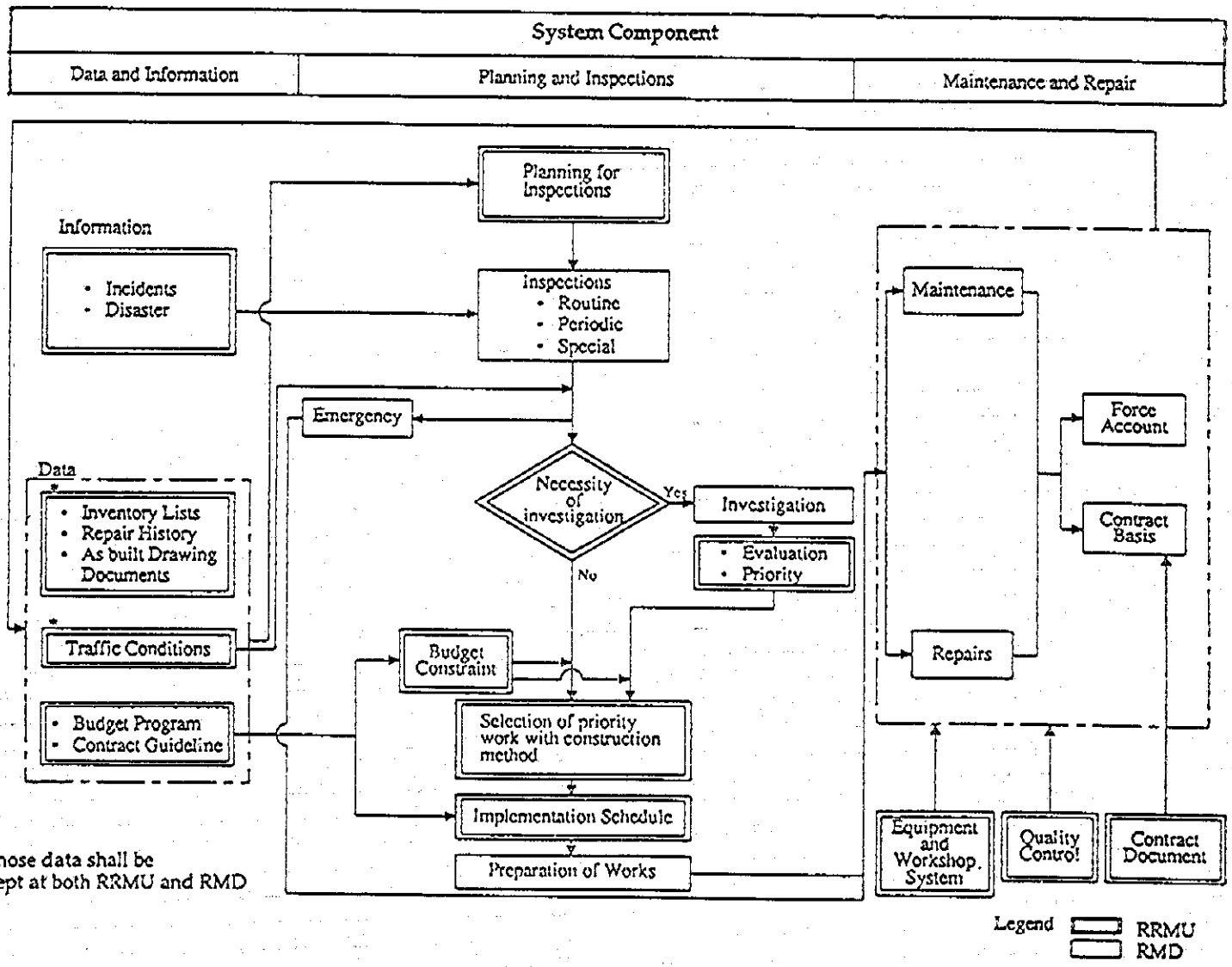
(1) System to Operate Highway Maintenance

In order to attain proper highway maintenance, all systems of highway maintenance must be carried out in a proper manner, and established organization must be consistent with the requirement of work components and needed capacities. Figure 12.2 shows the general flow chart of the recommended overall highway maintenance works.

1) Maintenance Operating System

Highway maintenance covers various activities related to inspections, maintenance and repairs, which require quick response and are appropriate to keep the highway open to traffic.

RMU should be responsible for the following activities of highway maintenance by force account or on contract basis, depending on the nature of the work :



HIGHWAY NO. 18 IMPROVEMENT

Figure 12.2 Flow Chart of Highway Maintenance Works

- Inspections by maintenance patrol unit;
- Road surface cleaning ;
- Vegetation control;
- Repairs of traffic safety and management facilities;
- Pavement maintenance and repairs;
- Maintenance and repair of bridges;
- Maintenance and repair of other structures;
- Disaster prevention and restoration;
- Miscellaneous activities.

2) Equipment and Workshops

The types and number of maintenance equipment required at each RMU and maintenance divisions (RMUs) are closely related to the intended service levels of the highway, weather conditions, the types of major road structures (bridge, pavement type, etc.) and the traffic volume. Consideration whether the work will be done by force account or on a contract basis is also necessary for such determination.

Workshops and depots will be located at each RMD. However, they may be of small scale since major maintenance and repair work will be done by contractors under the supervision of RMU.

3) Data Base and Management System

Data base and management system is indispensable for highway maintenance. One of the most important activities is to collect reliable data, in particular, to collect and keep as-built drawings and documents including design reports and specifications, construction record, and historical repair records. These records must include inspector's observation of a non-routine incident, the work carried out, and the interference to traffic, particularly in relation to vehicular accidents and the causes of their occurrence.

(2) Activities and Tasks of Highway Maintenance

The activities and tasks of highway maintenance are categorized as shown in Figure 12.3.

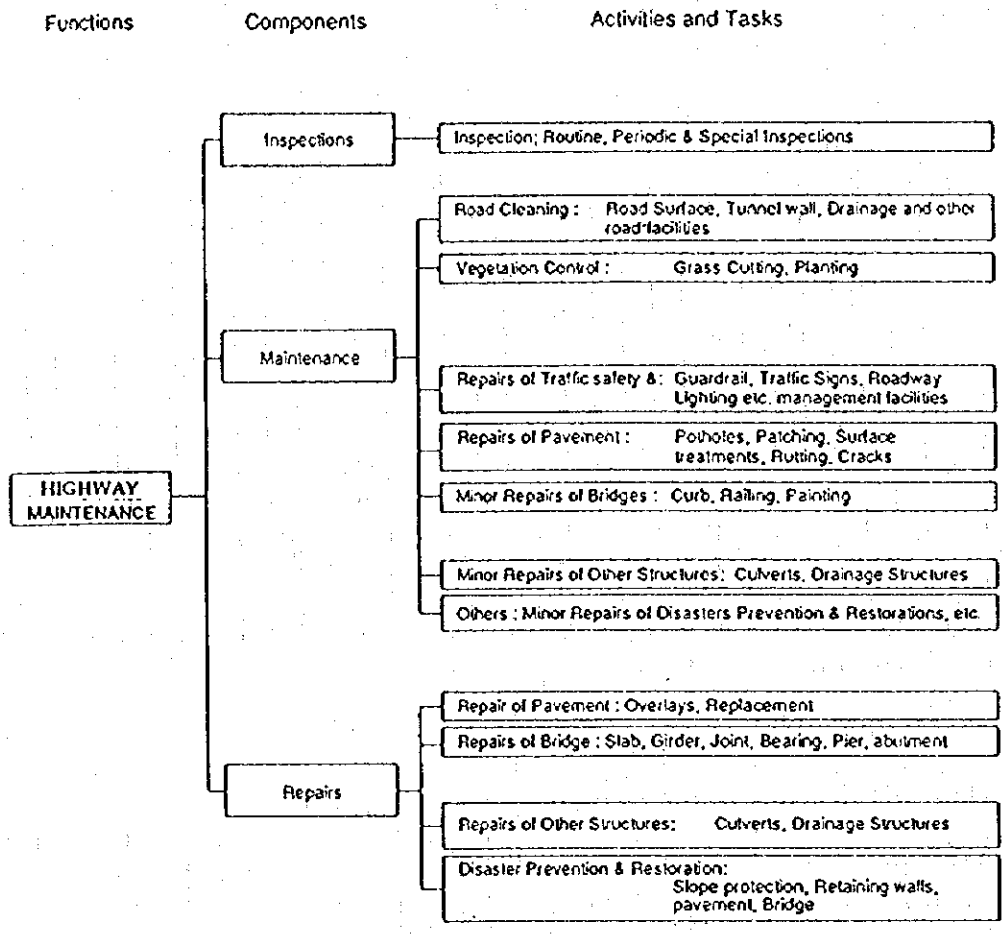


Figure 12.3 Activities and Tasks of Highway Maintenance

(3) Implementation of Highway Maintenance

Attention should be paid to the following items during maintenance and repairs :

- Personnel in charge of traffic control will be assigned on-site for the safety of workers and motorway users ;
- Guide signs and traffic markings will be installed to clearly mark lanes restricted to highway users.
- Lighting facilities will be provided during night maintenance and repairs.
- Equipment, facilities and materials will be neatly located in the work area for efficient and safe work operations.

- Excavated and excess materials will be disposed of immediately so that the highway surface is always free from obstacles during work activities.
- Personnel in charge of traffic control will be assigned during the maintenance and repairs. They shall ensure smooth and safe traffic flow and worker's safety.

(4) Traffic Control Measures

The date, time-frame, construction methods and proposed traffic control measures will be analyzed for the highway maintenance activities based on traffic volumes, number of traffic lanes, and detours.

12.3 Recommendations

(1) It is recommended that a new RMD appropriate to the maintenance of Highway No.18 be set up at an early date to enable the technical transfer and on-the-job training concerning highway maintenance through the execution of the Highway No.18 improvement.

(2) Table 12.2 shows the recommended type and number of vehicles and equipment for the routine maintenance and minor repairs of RMU No.2 which has ten (10) road maintenance divisions.

Table 12.2 Vehicles and Equipment for RMU No.2

Vehicles and Equipment	Amount
1. Sedan	22
2. Inspection Vehicles (Land Cruiser Type)	12
3. Pick up Truck	10
4. Truck	20
5. Sprinkler Truck	5
6. Asphalt Distributor	5
7. Steel Wheel Roller	10
8. Loader	10
9. Tamper	20
10. Generator	2
11. Bulldozer	5

(3) The force account activities of highway maintenance (medium and large repair) will be reduced in scope and volume, in consideration of the technical capability of contractors. However, RMU must undertake information collection & dissemination, and activities requiring a quick response.

(4) A data-base and management system is the major component for planning any maintenance work as it is the record of all past experience concerning all road structures and facilities. It is also important to collect as-built drawings and documents including engineering design documents.

(5) Training of inspectors and engineers for the maintenance is important to keep optimum highway maintenance levels. The inspectors and engineers should be trained to be responsible for inspections, recording observations, preparing inspection reports planning maintenance works and managing operations in an efficient manner.

(6) To upgrade management capability of PMU No. 18, efforts are required to develop expertise in budget planning and management, as well as in project planning and realization. To alleviate the present conditions, hiring of professionals and staff training will be necessary.