CHAPTER 7
DESIGN STANDARD

Appendix A - 7.1 Materials and Basic Strength

(1) General

The strength of materials to be used for the structural design are shown as follows reference to AASHTO, ASTAM and JIS which refer to the latest revisions of the specifications or method test.

(2) Concrete

The use of each class of concrete and required strengths are shown in Tables A - 7.1.1 and A - 7.1.2 respectively.

Table A - 7.1.1 Concrete Classes and Their Use

Class of Concrete	Use of Each Class of Concrete
A - 1	Precast prestressed concrete box girders
A - 2	Prestressed concrete box girders
A - 3	Precast prestressed concrete I - girders
A - 4	Precast prestressed concrete U - girders
A - 5	Prestressed concrete hollow slabs
A - 6	Precast prestressed concrete hollow core slab units
B - 1	Reinforced concrete slabs and cross beams of prestressed concrete bridges
B - 2	Reinforced concrete for pier columns and cantilevered pier heads except for pedestrian bridges, abutment
B - 3	Cast - in - place reinforced concrete piles
B - 4	Precast reinforced concrete pile
C - 1	Piers (except for columns) approach slabs, retaining walls, on Stair embankment and foundation of street lighting poles
C - 2	Box culverts (including wing walls) and encasement of pile
C - 3	Curbs reinforced
C - 4	Stair of pedestrian bridges
C - 5	Piers for pedestrian bridges
D	Gravity - type retaining wall, concrete footpaths, head walls curbs (non - reinforced) and cradles of pile culverts
E	Leveling concrete, backfield concrete in masonry structure and as specified drawings
AA	Prestressed concrete piles

Table A - 7.1.2 Strength of Concrete (UNIT : kg/cm2)

Class of Concrete	Minimum Compressive Strength at 28 Days by Cylinder Test
A1 to A4	400
A5 to A6	346
B1 to B4	290
C1 to C5	210
D	130
E	80
AA	500

(3) Reinforcing Steel

Type, desgnation and yield strengths of reinforceing steel for concrete structures are specified in Table A - 7.1.3.

Table A - 7.1.3 Reinforcing Steel Strength (UNIT : kg/cm2)

Type	JISG 3112		ASTMA - 615		Distance Standard
	Designation	Yield Strength	Designation	Yield Strength	
Road bar	SR 235	24	Grade 40	28	Applicable
Deformed bar	SD 295	30	Grade 60	42	Applicable

(4) Prestressing Steel

Notation, nominal diameter and yield and breaking Strengths of prestressing steel are as shown in Table A - 7.1.4.

Notation	Utilization	Nonational Diameter (mm)	Yield Strength (kg/cm2)	Breaking Strength (kg/cm2)	Applicable Standard ASTM
PC Wire SWPR1	PC I - girder	Dia.7	13.500	15.500	A 421
PC Wire SWPR1	Diaphragm for PC box girder	Dia.8	13.000	15.000	A 421
PC 7 - Wire Strand SWPR 7A	PC I girder and hollow slab	T 12.4	15.000	175.000	A 416
PC 7 - Wire Strand SWPR 7B	PC box girder and PC hollow core slab unit	T 12.7	16.000	19.000	A 416
PC 19 - Wire Strand SWPR 19	Diaphragm for PC I - girder	T 19.3	16.200	189.000	A 416
PC 19 - Wire Strand SWPR 19	Slab for PC box girder	T 21.8	16.100	187.000	A 416
PC bar SBPR 80/95	Diaphragm for box girder PC I - girder	Dia. 23	8.000	9.500	A 722

CHAPTER 8

OPTIMUM SOLUTION OF HIGHWAY NO.18 IMPROVEMENT

Appendix A - 8.1

WORKING PAPER ON ALTERNATE HIGHWAY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF TRANSPORT
THE SOCIALIST REPUBLIC OF VIET NAM

FEASIBILITY STUDY
ON
THE HIGHWAY NO. 18 IMPROVEMENT IN VIET NAM

WORKING PAPER
ON
ALTERNATE HIGHWAY
BETWEEN
NOI BAI AND CHI LINH

JANUARY 1996

PACIFIC CONSULTANTS INTERNATIONAL
ORIENTAL CONSULTANTS CO., LTD.

FEASIBILITY STUDY

ON

THE HIGHWAY NO. 18 IMPROVEMENT

IN VIET NAM

WORKING PAPER

ON

ALTERNATE HIGHWAY

BETWEEN

NOI BAI AND CHI LINH

TABLE OF CONTENTS

FEASIBILITY STUDY
ON
THE HIGHWAY NO. 18 IMPROVEMENT
IN VIETNAM

WORKING PAPER
ON
ALTERNATE HIGHWAY
BETWEEN
NOI BAI AND CHI LINH

1. Introduction

1.1 Background

In response to the request of No. 18 Projects Management Unit, Ministry of Transport of the Government, the JICA Study Team has conducted the further study concerning the alternate highway between Noi Bai and Chi Linh.

The main purposes of the further study have been aimed at :

- Comparison of the alternate highway routes which were selected by JICA Study team and Transport Engineering Design Inc., Ministry of Transport (hereinafter referred to as "TEDI") between Noi Bai and Bac Ninh; and
- Inception study of the alternate highway between Bac Ninh and Chi Linh.

1.2 Necessity of the Alternate Highway and the Government's Highway Development Policy

The necessity of improving the road network in the Red River Delta by providing new highway system (i.e. alternate highway) is primarily due to the recent rapid economic development and forecast drastic increase 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.

The following future development had been envisaged by the Government in the Ha Noi - Ha Long corridor:

- Major urban development (Ha Noi, Hai Phong and Ha Long);
- Areas of mineral extraction (Uong Bi, Bai Chay, Cua Ong);
- Industrial concentrations (Ha Noi, Pha Lai and Ha Long); and
- Tourism development area (Ha Noi and Ha Long).

2. Basic Concept of Ha Noi - Ha Long Alternate Highway

2.1 Planning of Alternate Highway

The alternate highway network will be developed with a basic understanding that the service of rural collector roads and alternate highways are differ from each other. Vehicles with shorter trips would use rural collector roads and the service by alternate highways would be for the vehicles with relatively longer trips.

2.2 Network of Alternate Highway

Presently the Government is intending to provide the alternate highways in the corridors of the following national highways :

- National Highway No.1 in Ha Noi and its vicinity areas;
- National Highway No. 286 (i.e. Noi Bai - Bac Ninh Section of Highway No.18) and;
- National Highway No. 18 between Bac Ninh - Ha Long.

2.3 Service Level

High capacity and high speed as on the regional expressway will be maintained for the alternate highways.

2.4 Contribution to Development Projects

The alternate highways will render the services to the new airport, urban and industrial development areas and their vicinities as well as to the projects arising from Ha Long seaboard.

3. Basic Policies of Further Study

3.1 Objective Alternate Highway Section

The study sections comprise :

- Noi Bai - Bac Ninh (approximately 33 kilometers); and

- Bac Ninh - Chi Linh (approximately 35 kilometers).

3.2 Execution of Further Study

The initial phase of the further study essentially consists of the clarification of the following conditions which were studied in the framework of "Feasibility Study on the Highway No.18 Improvement" :

- Socio-economic characteristics;
- Forecast traffic demand; and
- Various design standard.

Two routes, namely Noi Bai - Bac Ninh route (hereinafter referred to as "the West Route") and Bac Ninh - Chi Linh route (hereinafter referred to as "the East Route") will be selected and further the East Route (Bac Ninh - Chi Linh Alternate Highway) will be analyzed comprising the following works :

- Inception engineering study;
- Magnitude project cost estimates; and
- Inception economic analysis.

4. Socio-Economic Characteristics

4.1 Influence Area and Direct Influence Zone

The influence area and direct influence zone of Ha Noi - Ha Long Alternate Highway coincides with the same regions which were established in the " Feasibility Study on the Highway No.18 Improvement".

(1) Influence Area

The influence area is defined as the northern part of Viet Nam which covers twenty provinces. This area can be divided into two distinct sub-regions when described in terms of geographical and socio-economic characteristics. There are:

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

The major characteristics of the North Mountain and Midland Region are a low population density coupled with a relatively low per capita income level, while the Red River Delta has relatively high levels of both population density and per capita income. A third important feature of the influence area is the existence of urban and industrial agglomeration centers in the triangle bounded by Ha Noi, Hai Phong and Quang Ninh.

This triangle, which geographically forms part of the Red River Delta, has been designated for development purposes as " The Northern Focal Economic Area" in view of its high potential for industrial development, its outstanding urbanization rate and existing level of agricultural diversification.

(2) Direct Influence Zone

The Direct Influence Zone (Study Area) is defined as the direct influence area of the alternate highway project which includes such administrative districts as provinces of Ha Noi, Hai Phong, Hai Hung, Ha Bac and Quang Ninh through which the alternate highway passes and its environs. Ha Noi city functions as a primary center of regional activities in the administrative, social, economic, cultural and educational field.

4.2 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 NEFA with the whole Influence Area are important to ensure a smooth transport of cargo and people. The NEFA falls within the same administrative boundaries of five provinces which are included in the Direct Influence Zone.

4.3 Development Plans

(1) 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.

Still more, 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.

(2) Development Plans in Ha Noi Area

Hanoi People's Committee has a Ha Noi City Master Plan, 2010. Some projects in this master plan have been approved by the Government for the implementation and some developments are ongoing. The most vital issues in the master plan are the road transport network development and new land development in order to meet the demand of recent urbanization and industrialization.

1) A new Urban Structure (2010)

A new urban structure had been formulated together with a planned Ha Noi Ring Road which is expected :

- To provide better access for new urban development areas and industrial zones; and
- To provide land access to Noi Bai international airport.

2) New Industrial Development Areas

New industrial development are planned mainly in the north of Red River, in Thang Long, Soc Son, Sai Dong, Xuan Mai and Hoa Lac (Refer to subsection 7.4 for development projects of industrial areas).

5. Traffic Demand

5.1 Forecast Traffic Demand in Noi Bai - Chi Linh Section

The forecast traffic volumes for the target years of 2005 and 2015 were calculated as described in the Interim Report of the "Feasibility Study on the Highway No.18 Improvement" and are summarized in Table 2 together existing traffic volumes at the year 1995.

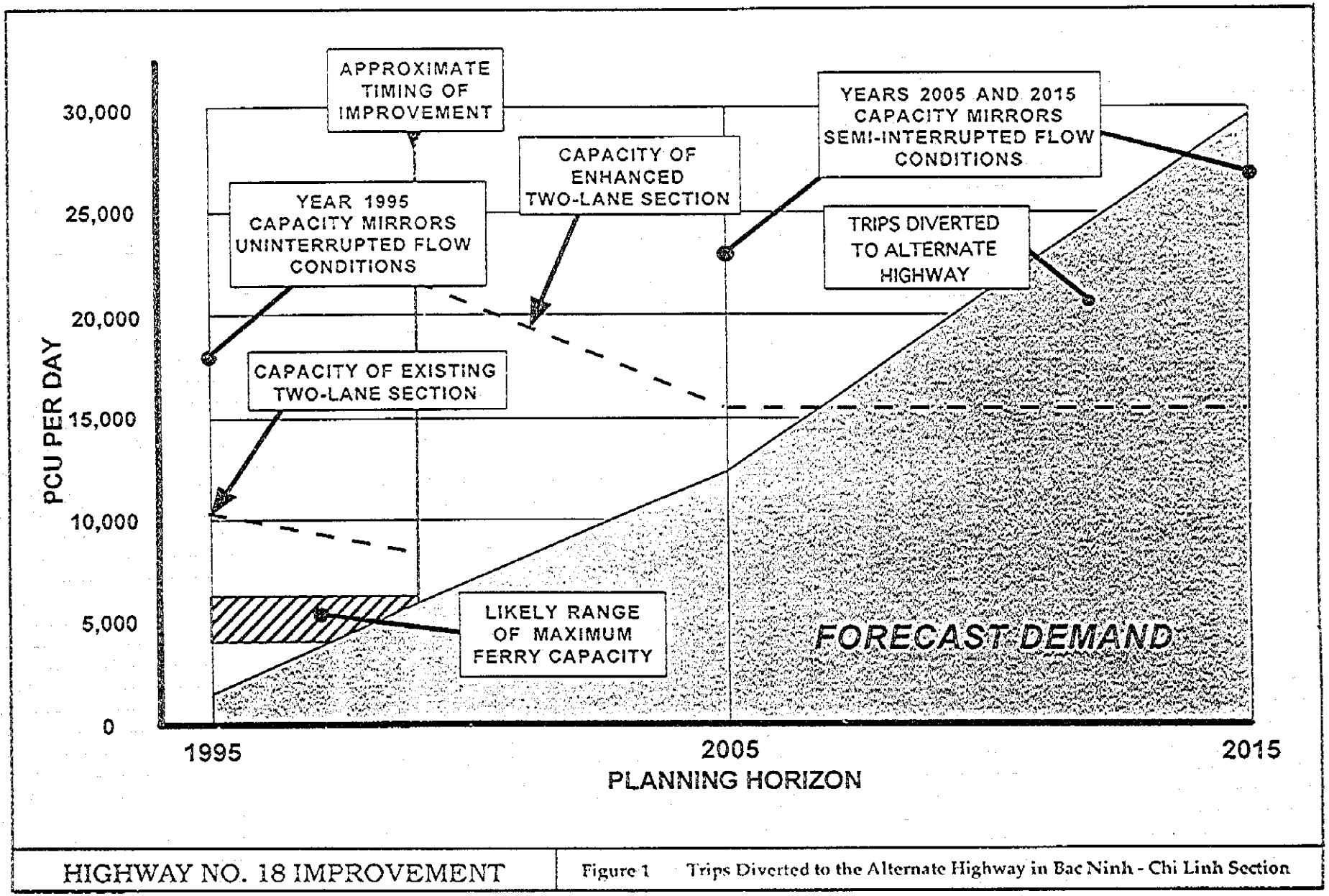
Table 1 Summary of Traffic Volume

Highway Section		Noi Bai	(1)	Bac Ninh	(2)	Chi Linh	Bai Chay
Traffic Volume (PCU/day)	Year 1995	1,800		2,800		5,500	
	2005	7,600		14,800		26,500	
	2015	22,700		37,100		58,200	

Notes:
(1) Traffic volume at the West of Bac Ninh
(2) Traffic volume at the East of Bac Ninh

5.2 Trips Diverted to the Alternate Highway in Bac Ninh-Chi Linh Section

The improvement of Highway No.18 in Bac Ninh - Chi Linh (Section 2) will be improved by adopting 2 - lane 2 - way highway. Once the said section was improved, it is likely that additional capacity by providing alternate highway will not be required until near year 2007 (refer to Figure 1, the diagram shows a concept only).



HIGHWAY NO. 18 IMPROVEMENT

Figure 1 Trips Diverted to the Alternate Highway in Bac Ninh - Chi Linh Section

5.3 Further Descriptions on Traffic Demand

(1) Noi Bai - Bac Ninh Section

The existing capacity of section 1 (Noi Bai - Bac Ninh) is very low due to the poor state of Highway 286. Following implementation of an enhanced two-lane section, capacity will increase to in excess of 20,000 pcu per day. This should be sufficient for approximately ten years after completion of construction, at which time the limits of semi-interrupted capacity will likely be reached. At that point vehicle trips would be forced to divert to additional highway facilities if levels of service implied by semi-interrupted capacity are to be maintained. The growth rate of demand suggests that additional road capacity (i.e. highway widening) must be in-place near year 2008. In view of conservative future traffic volumes, staged construction approach should be employed in the development to ensure the viability of the project.

(2) Bac Ninh - Chi Linh Section

The 2-lane 2-way improved Highway No.18 will reach to its capacity near year 2007 and will require an alternate highway. The forecast traffic growth suggests the construction of 4-lane divided highway at the initial stage, rather than the adoption of staged construction approach (2-lane 2-way in the initial stage construction and 4-lane divided highway at the final stage), to enhance high speed and to attract more traffic.

6. Outline Design Standard

6.1 General

The Government's standards are to be used to a maximum extent where available. The American and Japanese standards can be referred to the items not covered in the Government's standard.

6.2 Geometric Design Standard

There exist the Government's standard related to the design of new construction, improvement and rehabilitation of public highways, namely "Viet Nam Highway Design Standards, TCVN 4054-85". This standard will be followed for the maximum extent.

An adoption of 120 Km/hr design speed is recommended for the design of Noi Bai - Chi Linh alternate highway (hereinafter referred to as " the Alternative Highway"), taking into account the role of alternate highway system which should have high-speed and high-capacity services. Favorable terrain conditions in the project area will permit high-speed design.

Design speed is the maximum safe speed that can be maintained over a specified section of the Alternate Highway. The design speed will directly affect

many geometric elements i.e. horizontal and vertical alignments, sight distance, provision of super elevation, etc. Other features such as lane width and roadside clearance are influenced by design speed but to a lesser degree.

Further discussions will be made in the Section 8 in this paper.

6.3 Bridge Design Standard

Following is an outline specifications of the bridge design, please refer to the Interim Report of the " Feasibility Study on the Highway No.18 Improvement" for further details.

(1) Loading Specifications

Vietnamese Bridge Design Code (Specifications 2057/QD-KT4-1979) will be followed together with AASHTO specifications.

Design load to be applied is 125% of HS 20-44 (Truck loading) or 125% of HS 20-44 (Lane Loading) whichever produces the maximum stress.

(2) Seismic Design

The Direct Influence Zone is covered by Region 6 or Region 7 in accordance with the Seismic Map of Viet Nam and the adoption of the following acceleration coefficients are suggested.

Seismic Intensity				
Scale (region)	:	6	7	8
Acceleration Coefficient	:	0.04	0.07	0.17

The following table shows the relation among seismic intensity scale, acceleration coefficient and seismic performance category.

Seismic Intensity Scale shown in the Map	6	7	8
Acceleration Coefficient	0.04	0.07	0.17
Seismic Performance Cetegory	A	A	B

In the region which falls in the Seismic Performance Category A, no detailed analysis will be required for any bridge structures, except the longitudinal connections of girders must be designed for specified forces.

6.4 Flood and Navigation Clearances

(1) Frequency of Design Flood

The frequencies of design flood will be determined in accordance with Article 1.29 of Vietnam Bridge Design Code 2057/QD - KT4 - 1979 and Article 4.6 of Design Criteria of Highway TCVN - 4054-85. Following table gives the frequencies of design flood by size of bridge.

Size of Bridge	Design Frequency
All sizes of Bridges $L \geq 25m$	1%
Small Bridges $L < 25m$	2%

(2) Flood Clearance

The clearances for the design of bridges are given as shown in the following table in case the river is not utilized for navigation (Article 1.27 of Vietnam Bridge Design Code 2075/QD-KT4-1979).

Structure			Minimum clearance above Design flood level (m) for Highway Bridges
Girder	Water level rising by influence of piers	Less than 1m	0.50
		over 1m	0.50
	Flooded Material	Wooden logs and debris	1.00
		Roll stone	1.00
Bearing plate			0.25

(3) Navigation Clearances

Classification of waterways (i.e. rivers and canals) shall be determined in accordance with TCVN-5664-1992. The classification of waterways and navigation clearances are to be given in accordance with the following table.

Class	Waterway size					Navigation Clearance		
	Natural River		Canal		Curvature	Horizontal		Vertical
	Water Depth	Width of Water Surface	Water Depth	Width of Water Surface		River	Canal	
I	> 3.0	> 90	> 4.0	> 50	> 700	80	50	10
II	2.0 - 3.0	70 - 90	3.0 - 4.0	40 - 50	500 - 700	60	40	9
III	1.5 - 2.0	50 - 70	2.5 - 3.0	30 - 50	300 - 500	50	30	7
IV	1.2 - 1.5	30 - 50	2.0 - 2.5	20 - 30	200 - 300	40	25	6 (5)
V	1.0 - 1.2	20 - 30	1.2 - 2.0	10 - 20	100 - 200	25	20	3.5
VI	< 1.0	10 - 20	< 1.2	10	60 - 150	15	10	2.5

Notes:

1. Figure in ( ) may be applied with approval of official agencies.
2. Horizontal clearance : span length
   Vertical clearance : height between water level and bottom of girder.
3. Water depth and width of water surface shown on the above table are based on low water level of waterway with a frequency of 95% in dry season.

6.5 Pavement Design Standard

Presently production of portland cement in Viet Nam is limited therefore the adoption of flexible design will be recommended to attain economical and rapid construction.

The thickness design of the pavement will be carried out based on the "AASHTO Interim Guide for Design of Pavement Structures, 1972". The "AASHTO Guide for Design of Pavement Structures, 1986" will also be used to determine percent of 18-kip ESAL in design lane.

7. Route Study

7.1 Bases of Route Study

(1) Studies of TEDI Concerning Route Location

Pre-feasibility Study for the Ha Noi - Ha Long Alternate Highway (Nghien Cuu Tien Kha Thi, Duong Cao Toc Ha Noi - Ha Long, sponsored by PMU No.18) is ongoing by TEDI.

TEDI's preliminary report on the above study was provided by PMU No.18 and the JICA Study Team interviewed TEDI for their opinions about the route selection of the Alternate Highway.

(2) Socio-Economic Condition

Comprehensive Socio-Economic study had been carried out in the influence and direct influence zone (Study Area) of the Highway No.18 improvement

project, in the framework of JICA Study. Since the influence and direct influence zone of the above Ha Noi- Ha Long Alternate Highway coincides with the JICA Study, the findings of the said study have been reflected to the selection of the optimum route.

(3) Traffic Condition

Traffic demand projected by JICA Study Team was used for the maximum intent (refer to Section 5. Traffic Demand in this paper for further details).

(4) Design Speed

A 120 Km/hr design speed was applied taking into account the role of the Alternate Highway (refer to Subsection 6.2 for further descriptions).

7.2 Basic Data for Route Study

(1) Topographical Maps

Current topographical maps to a scale of 1:50,000 were used to proceed with the route location in the context of the total road network in the project area, to check the topographic conditions along the corridor.

Topographical maps to a scale of 1: 5,000 were available between Noi Bai and about 2 Km West of Pha Lai river and these maps were made use of. The crossings with Song Cau (Cau river) and Song Thuong (Thuong river) were checked and confirmed with 1 : 25,000 topographical maps and on-the-ground field investigations.

(2) Information on the Geological Conditions

The findings of JICA Study together with soils survey (i.e. borings and laboratory testing) data are utilized. Geologically, the flat terrain in Noi Bai - Chi Linh area is of alluvium or diluvium formation of Holocence Age or Pleistocene Age composed of alluvial or diluvial soils of gravel, sand, loam, silt and clay.

(3) Hydrological Study

The findings of JICA Study was made use of. To obtain the hydrological information on Cau and Thuong rivers an additional data collection had been conducted.

7.3 Consideration for Environmental Impact

Environmental survey data is available only for the following subcorridors :

- Noi Bai - Bac Ninh (Highway No.18 improvement route); and
- Bac Ninh - Chi Linh (Highway No.18 improvement route).

Environmental study for Bac Ninh - Chi Linh alternate highway would involve numerous variables which require through and lengthy works. No specific survey or study was carried out in the Further Study, however, the experience gained through the study on the Highway No.18 improvement has been applied as necessary for the comparison of alternative routes.

7.4 Development Projects of Industrial Areas

Information on the size and location of future industrial area will influence the utilization of Alternate Highway. Table 2 shows the summary of future industrial development areas together with possible route to connect Ha Noi with future Cai Lan port or Hai Phong port.

Table 2 Summary of Future Industrial Areas and Possible Route Utilization

Industrial Zones	Major Types of Industries	Area	Possible Route
North Thang Long	Electric and electronic appliances; High-quality construction materials; Optical products.	300 ha	AH (Noi Bai - Bac Ninh - Chi Linh)
Soc Son Industrial Zone	Electric and electronic appliances/ parts; Computer-related industries; Optical products; Precision machinery; Toys.	300 - 400 ha	AH (Noi Bai - Bac Ninh - Chi Linh)
Sai Dong - Gia Lam	Electric products/ appliances; Packaging industries; Machinery/ parts; Food processing; Bevarages.	500 ha	NH No.1. AH (Bac Ninh - Chi Linh)
Xuan Mai	Construction materials; Sanitary fixtures; Ceramics.	300 ha	NH No.21, NH No.1, AH (Bac Ninh - Chi Linh)
Hoa Lac	Electronic appliances; Precision machinery; Automobile parts.	1,600 ha	NH No.32, NH No.1, AH (Bac Ninh - Chi Linh)

Note : NH and AH denote National Highway and Alternate Highway respectively.

7.5 Selection of the Optimum Alternate Highway Route (Noi Bai - Bac Ninh)

(1) Topographic Condition

Topographic condition is favorable but there are several locations of low laying areas.

(2) Geological and Soils Conditions

The corridor is covered by the alluvium formation of Holocene Age. According to the results of the soils survey carried out by the JICA Study Team, the soil condition is not favorable and bearing strata for bridge foundation piling are situated in the following depths from the existing ground level :

Name of Bridge or Viaduct	Depth of Bearing Strata
Ca Lo Bridge	35m
Ngu Huyen Khe Bridge	38m
Highway No.1 Viaduct	49m

However, the soft ground layer (N-value less than 4) was not identified in the JICA route.

(3) Hydrological Condition

The corridor develops along the Ca Lo and Ngu Huyen Khe rivers. No flood is recorded in recent years, but there was observed retained water areas in limited locations.

(4) Existing Highway Network

The pattern of the highway network in the corridor is not complicated as far as the route location of the Alternate Road is concerned. The connections with the existing national roads are given full consideration to enhance regional development as well as to obtain the long-term and short-term viability of the Alternate Highway.

The highway links which are important in the route selection are as shown in

the following table:

Name of Highway	Highway Link
National Highway No.1	Ha Nam - Ha Noi - Bac Giang
National Highway No. 2	Phu Lo - Viet Tri
National Highway No.3	Yen Vien - Da Phuc
National Highway No.286	Noi Bai - Bac Ninh
Provincial Highway No. 295	Tien Son - Yen Phong - Mai Dinh
Thang Long - Airport Highway	Thang Long - Noi Bai Airport

(5) Railway Line

There are two existing railway lines, Ha Noi - Thai Nguyen Line which runs in the north-south direction in Phu Lo and Ha Noi - Bac Giang - Dong Dang which runs parallel with Highway No.1.

(6) Noi Bai International Airport

Various forecasts suggested that the demand at NBIA would reach at 4 to 6 million passengers per annum level by 2005. Thus a necessity arose to apply world class standard for Noi Bai International Airport to meet the requirement compatible to the national gateway airport in the capital. Provision of land access from the east region was took into account in the route selection.

(7) Industrial Development Areas

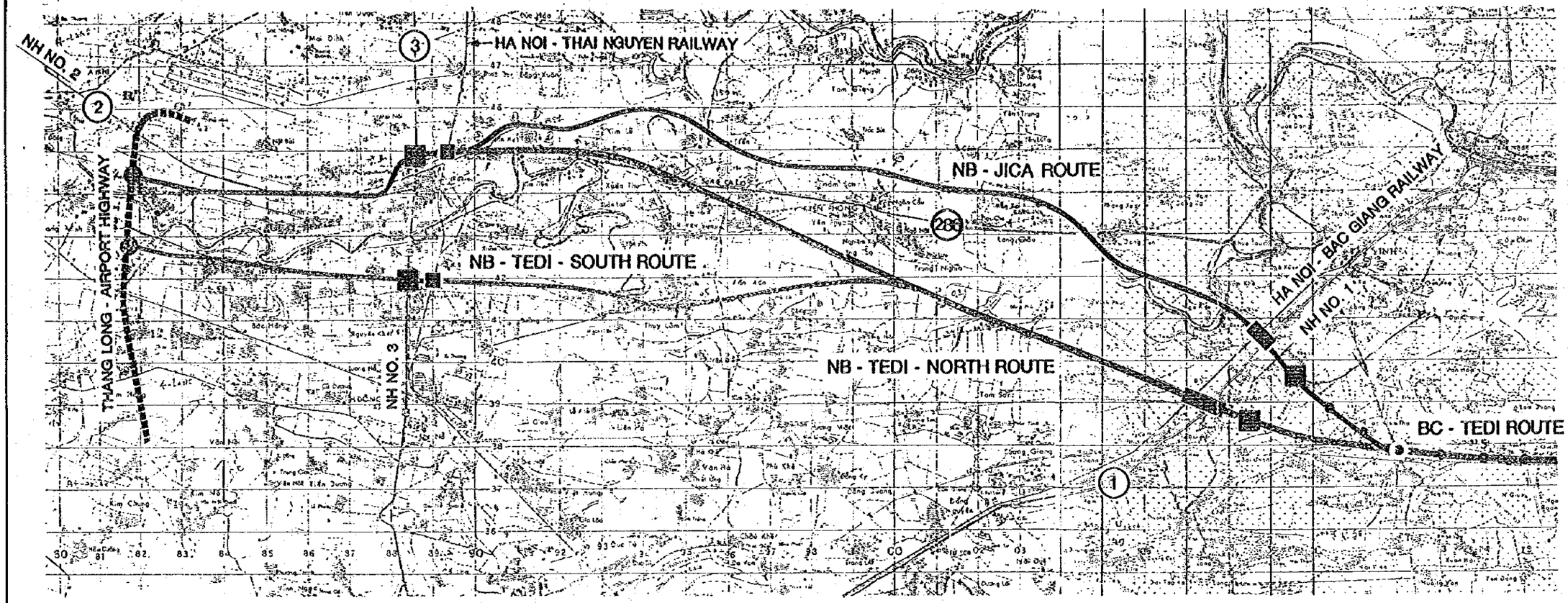
Industrial areas are planned in Ha Noi city and its surrounded areas as discussed in Subsection 7.4. The enhancement of accessibilities to these industrial areas has been considered in the study.

(8) Interchanges

Selection of the locations of interchanges is one of the major governing factors in the route selection of the Alternate Highway. Along the corridor, the connection with Thang Long - Airport highway, national highway No.3 (NH No.3) and national highway No.1 (NH No.1) are the major interchanges to be considered in the route selection. Once the locations of interchanges are determined, the general route alignment of the Alternate Highway is almost fixed.

(9) Description of Alternative Routes

A total of three (3) route alternatives are compared. These alternatives are designated Alternative NB - JICA Route, NB - TEDI North Route and NB - TEDI South Route (Figure 2). The following is brief description of each route alternative.



HIGHWAY NO.18 IMPROVEMENT

Figure 2 Alternative Routes of the Alternate Highway, Noi Bai - Bac Ninh Section

1) Alternative NB - JICA Route

This alternative is basically identical to the JICA route shown in the Interim Report of the "Feasibility Study on the Highway No.18 Improvement". It aims at less adverse impact on the existing socio-economic environment and passes through undeveloped areas. The route starts from the existing Thang Long - Airport Highway at the nearest point to connect with Noi Bai International Airport.

Starting at the Noi Bai terminus on Thang Long - Airport Highway, about 0.5 kilometer south of planned airport gate, the route runs to the east and meets the existing NH No. 2 and runs on the NH No.2 for about 3 km. Thereafter the route turns to the northeast, runs in an undeveloped area for one (1) kilometer and then gradually turns the direction to the east. After running about one (1) kilometer to the east again gradually turns the direction to the north east and passes the north of Xuan Ky village for about 1.5 km. In the east of Xuan Ky village there is Kim Lu low laying area. The route avoids this area and passes through the northern edge of the wet land. Thereafter the route runs toward the general direction of southeast by east (SEE) and reaches NH No. 286 near Dong Yen village. After crossing NH No. 286 the route turns the direction to the southeast and crosses Ngu Huyen Khe river, Ha Noi - Bac Giang - Dong Dang railway line/ existing NH No.1 and reaches the planned alternative highway of NH No.1 (Km Post 144).

2) Alternative NB - TEDI - North Route

This alternative route has been established by TEDI together with TEDI - South Route in the framework of " Pre-Feasibility Study on the Ha Noi - Ha Long Alternate Highway Project". According to the preliminary report on the said pre-feasibility study, TEDI subdivided Noi Bai - Bac Ninh section into the following two (2) stretches :

- Noi Bai - Dong Mai; and
- Dong Mai - Bac Ninh.

In Noi Bai - Dong Mai stretch TEDI assumed that there are two choices of route location namely the north route and the south route (Figure 2).

Noi Bai terminous of Alternative NB - TEDI - North Route is identical with before mentioned Alternative NB - JICA Route and follows to the JICA Route up to Phu Tho village. From Phu Tho village, TEDI's route continues to run eastward up to Xuan Duong (approximately 3 km east of Phu To) and then gradually turns the direction southeasterly to pass through the south of Yen Phong and reaches Dong Mai.

TEDI Selected the location of the overcrossing with NH No.1 at about 5 km southwest of Bac Ninh (Kilometer Post 146) and the above mentioned Dong Mai and the location of the said overcrossing with a straight line

and determined the location of Bac Ninh Interchange (Bac Ninh terminus) on the extension of this straight line.

3) Alternative NB - TEDI - South Route

This alternative aims at the selection of a more straight connection between Thang Long - Airport Highway and Bac Ninh terminus.

Starting at the Noi Bai terminus on Thang Long - Airport Highway, about 2 km south of planned airport entrance, the route runs to the general direction of east for about 18 km and reaches Dong Mai which is the meeting point with TEDI - North Route. The other characteristics of this route alternative are identical to TEDI - North Route.

(10) Selection of the Optimum Route

1) General

Formation of a consensus amongst the government agencies concerned on the development policies of the alternate highway, in particular, to fix an optimum route of the alternate highway and interchange locations, is indispensable. This paragraph contains the comparison of route alternatives on the following bases :

- Technical aspects;
- Environmental impact; and
- Transportation aspects.

2) Technical Aspects

Technical aspects of each alternative are compared in the form of various aspects of i. Length of the Alternate Route; ii. Connection with NH No. 2; iii. Disturbance of existing social settings at the crossing with existing NH No.1; iv. River crossings; and v. Interference to the operation of existing highway system.

i. Length of route

When future widening of NH No.2 to 4-lane was considered, the length of route can be compared with the distance between future Noi Bai Interchange and the crossing location with Provincial Highway No. 288 which is the meeting point of three alternative routes. The route length in the pre-feasibility study generally offers rather shorter distances, since the avoidance of difficult places are not considered seriously. The following is the distances measured on the preliminary design drawings (JICA Route) and on the 1: 50,000 maps (TEDI Route).

Alternative	Route Length (km)
JICA Route	33
TEDI North Route	31.5
TEDI South Route	32.5

ii. Connection with NH No.2

JICA Route and TEDI - North Routes would provide direct connection with NH No.2 when future interchange will be realized on Thang Long - Airport Highway. In case of TEDI-South route, the widening of Thang Long-Airport Highway to 6-lane for about 1.5 km including the widening of an existing bridge crossing Ca Lo river.

iii. Crossing with NH No.1

The location of existing NH No.1 crossing point was determined based on careful site surveys in case of JICA Route. Roadsides are already developed along the existing NH No.1 at the crossing area of TEDI's Route, therefore the change of route selection may be necessary to avoid adverse social impacts associated with land acquisition and resettlement.

vi. River Crossings

Three (3) alternative routes cross the following two (2) rivers and the situations are considered almost equal to all alternatives :

- Ca Lo river (Bridge widening in case of TEDI-South Route); and
- Ngu Huyen Khe.

v. Interference to the Operation of Existing Highway System

It is noted that Alternative NB - TEDI-North Route will disturb and damage the function of existing NH No. 286 between Phu Tho and Kim Lu Thuong. This problem is serious in case that the Alternate Highway will come to the full operation and charge toll levy, since the Alternate Highway operator must provide frontage road(s) for about 4km stretch to provide other choice to use toll-free road.

3) Environmental Impact

Since there found no preserved area, important vegetation and wildlife in the direct influence zone, comparison of natural surroundings is omitted and land acquisition and resettlement matters are focused in the comparison.

The loss of agricultural land is assumed the same for all alternatives. The following table shows the comparison of alternatives from the viewpoint of adverse social impact.

Description	JICA Route	TEDI-North Route	TEDI-South Route
Densely/ sparsely inhabited villages	0.3	1.3	2.3

Note: The table shows the villages crossed by each alternative route, in km, measured on the 1:50,000 scale maps.

The comparison of route alternatives from the viewpoint of environmental impact revealed that JICA Route is superior to the other alternatives.

4) Transportation Aspects

i. Road Network

As discussed before JICA Route and TEDI-North Route enable a direct connection with NH No.2 and the entrance of planned Noi Bai International Airport. The terminous of TEDI-South Route is located a little remotely from these points.

TEDI-North Route will disturb the local transportation on the existing NH No. 286 in Xuang Duon area as mentioned in the above.

Consequently, from the road network point of view, JICA Route is preferable to the other alternatives.

ii. Impact on Regional Development

As discussed in Subsection 7.4, North Thang Long industrial area and Soc Son industrial area are major future development projects. Both industrial area will have a similar scale of 300 ha and utilize NH No.3 and Noi Bai - Bac Ninh Alternate Highway to go and come from Future Cai Lan Port.

Since Thang Long industrial area is located in the south of TEDI-South Route and Soc Son industrial area is located in the north of JICA Route the accessibility to these industrial areas will be considered equal in both routes.

iii. Conclusion

Overview of the issues discussed above will conclude that JICA Route is recommendable from the viewpoint of transportation aspects.

5) The Optimum Route

Order of priority to be taken up in technical, environmental impact and transportation aspects among the route alternatives is summarized in Table 3.

Table 3 Preferable Priority in Three Major Aspects for Each Alternative Route

Major Aspects for Comparison	Order of Priority to Adopt		
	JICA Route	TEDI-North Route	TEDI-South Route
Technical Aspects	1	3	2
Environmental Impact	1	2	3
Transportation Aspects	1	2	3

The JICA Study Team and TEDI strived to satisfy optimally the needs of road users while maintaining the integrity of the environment of each route alternative. However the preferable priority in three major aspects differentiated as seen in Table 3 in the above.

The priority, as a total evaluation for JICA Route, will not be changed even if different weighting factors are adopted for these three elements of technical, environment and transportation, thus the Study Team recommends JICA Route as the optimum route in Noi Bai - Bac Ninh section of the Alternate Highway.

7.6 Selection of the Optimum Alternate Highway Route (Bac Ninh - Chi Linh)

(1) Topographic Condition

There are three (3) kinds of topographic conditions in Bac Ninh - Chi Linh section :

- Favorable flat area between Bac Ninh and Dong Du;
- Low lying wet area in Thai Binh and its tributaries basins; and
- Hilly areas in Pha Lai and east of Pha Lai.

There are several hills between Bac Ninh and Dong Du but these areas can be easily avoided in the route selection and could be utilized as the embankment material sources for the Alternative Highway construction.

(2) Geological and soils Conditions

The corridor is basically of alluvium formation of Holocene Age or Pleistocene Age composed of alluvium or diluvial soils of clay, silt, loam, sand, gravel and sandstone.

As a result of the soils survey conducted by JICA Study Team, the following soils condition was revealed along proposed Pha Lai bridge which was studied for the Highway No.18 improvement.

Boring Location	Depth of Bearing Strata
West bank of Thai Binh river	10m
East bank of Thai Binh river	14m

The bearing strata consists of conglomerated silty sand/gravel or weathered sandstone. No soils data is available at the crossings of Cau and Thuong rivers.

(3) Hydrological Condition

No difficult hydrological condition exists between Bac Ninh and Dong Du. However, in the east of Dong Du, the Alternate Highway must pass flooding areas of the Thai Binh, Cau and Thuong rivers for about 5 km. The Cau and Thuong rivers are the tributaries of the Thai Binh river which diverge to the northwest and northeast respectively at one (1) kilometer north of existing ferry crossing. All these rivers are provided with flood protection dikes but the occurrence of flood in the west of the Cau and Pha Lai rivers is common.

(4) Existing Highway Network

The pattern of the highway network in the corridor is rather simple. The connections with national highways are given full consideration to obtain the long-term and short-term viability of the Alternate Highway. Following highways are considered in the route selection :

Name of Highway	Highway Link
National Highway No.18	Bac Ninh - Ha Long
Provincial Highway No.288	Bac Ninh - Cam Binh
Local Road	Dai Lien - Vu Duong
Local Road	Pha Lai - Vuon Dao
Provincial Highway No.376	Binh Giang - Vuon Dao
National Highway No.183	Hai Duong - Chi Linh
National Highway No.379	Chi Linh - Thai Nguyen

(5) Railway Line

Chi Linh - Pha Lai railway line (spur of Kep - Bai Chay railway line) is the only railway line which affects the route selection of the Alternate Highway.

(6) Interchanges

Interchanges may be provided at Bac Ninh, Chi Linh and near the middle point of Bac Ninh - Chi Linh section. Normally the following standard range is adopted in Japan for the spacing of interchanges :

- Urban areas, major industrial areas	5 - 10km
- Flat area with scatterd small towns	15 - 25 km
- Rural areas, mountainous area	25 - 30 km

(7) Description of Alternative Routes

According to the preliminary report on the Pre-Feasibility Study, TEDI divided the Bac Ninh - Chi Linh section into two (2) sections, Bac Ninh - Dong Du and Dong Du - Chi Linh, and established South Route and North Route in the said Dong Du - Chi Linh section. As the result of a site investigation these alternative routes are well selected and the JICA Study Team felt that the set up of additional alternative route is unlikely.

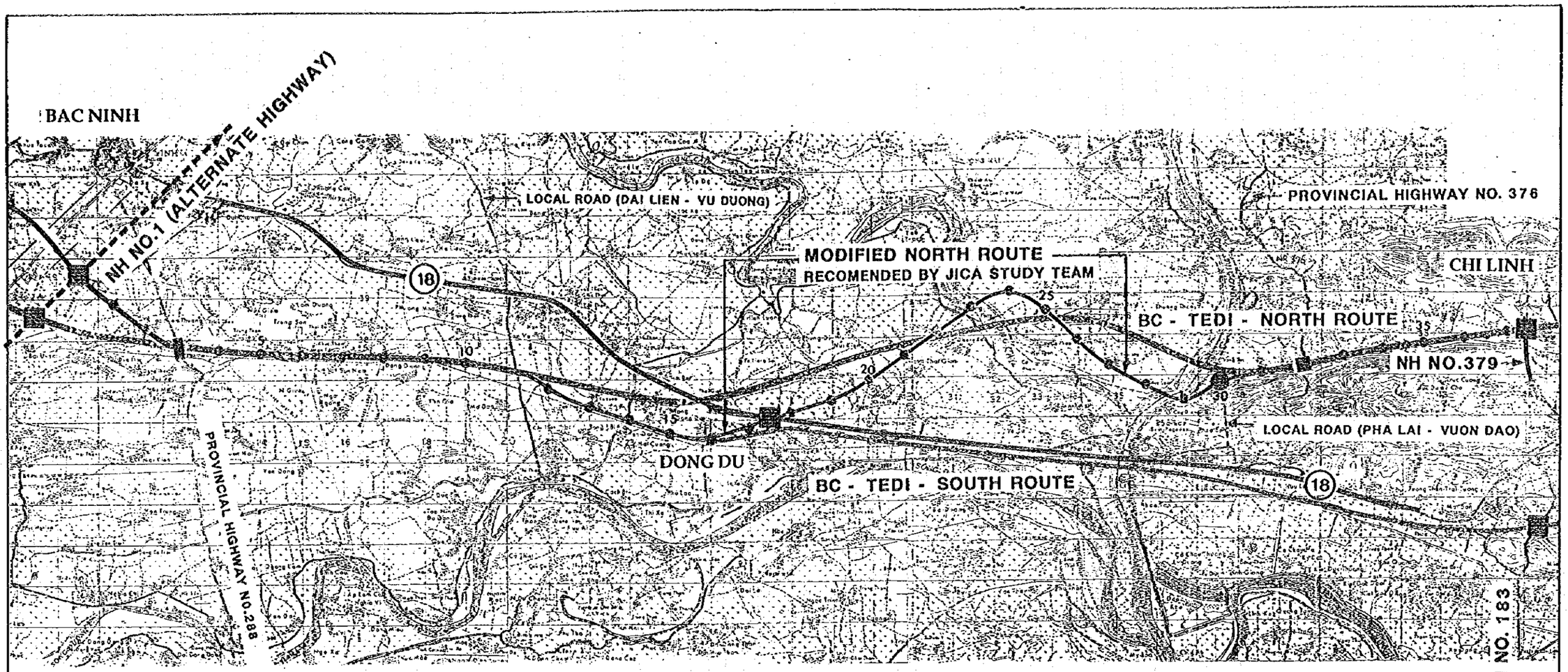
1) Alternative BC - TEDI - South Route

As a highway alignment the South Route offers ideal features. Starting at Bac Ninh Interchange the Route runs straight to the east and directly reaches Chi Linh Interchange which is the terminous of the Bac Ninh - Chi Linh section. Pha Lai Bridge is planned at about 500m down stream of existing ferry crossing.

2) Alternative BC - TEDI - North Route

This alternative route is identical with the South Route between Bac Ninh and Dong Du. From Dong Du, the North Route veers to the east-northeast (ENE) and runs straight for about 7.5 km. Thereafter the route crosses the Cau river and gradually turns the direction to the east-southeast in the Cao Thai area and soon crosses the Thuong river (Figure 3).

After crossed the Thuong river, the route turns the direction to the east-northeast to pass through the northern foot of N. Duong Tau, Nui Doc Nung and Dong Sanh hills and runs about 7 km with fairly straight line and then reaches Chi Linh Terminous where Chi Linh Interchange is located to connect with National Highway No. 379.



HIGHWAY NO.18 IMPROVEMENT	Figure 3 Alternative Routes of the Alternate Highway, Bac Ninh - Chi Linh Section

(8) Selection of the Optimum Route

1) General

Formation of a consensus amongst the Government agencies concerned on the development policies of the Alternate Highway is important as mentioned before in Paragraph 7.5 (10).

However, the real comparison and finalisation of the route will require more studies on the various aspects in the similar depth for both alternative routes because of the presence of the Thai Binh, Cau and Thuong rivers and a number of villages and towns in the corridor.

Since the development plan of the Alternate Highway is still in the pre-feasibility study phase, many important data for comparison such as soils, hydrological, social environment and detailed traffic data are not in hand at this moment.

A full scale comparison of the South Route and North Route would involve numerous variables which require through and lengthy studies, which is considered to be beyond the control of the Study Team and to be considered beyond the scope of work which was agreed upon between the Government and the JICA Preliminary Study Team in January 1995.

Under such circumstances, the conclusion which are derived from this route study would still be of a tentative nature. The Study Team is leaving room for the discussion of future investigations in the establishment of the optimum route of the Alternative Highway between Bac Ninh and Chi Linh. It is hoped that the appropriate agencies will pick up and continue this endeavor. This paragraph contains the inception comparison which is carried out based on the TEDI's Study, on the following aspects :

- Technical;
- Environmental impact; and
- Transportation.

2) Technical Aspects

Technical aspects of each alternative are compared in the from of various aspects of i. Length of Alternative Route; ii. Interrelation with existing highways; iii. River crossings; and iv. Embankment construction.

i) Length of Route

The Western terminous is Bac Ninh Interchange and the eastern terminous is planned Chi Linh Interchange.

Alternative	Route Length (km)
TEDI - South Route	36.9 km
TEDI - North Route	37.5 km

ii) Interrelation with existing Highways

TEDI Proposed three (3) interchanges for the South Route and four (4) interchanges for the North Route. However, the Study Team considers that an interchange is neccessary also in case of the South Route near Dong Du to enhance the use of the Alternate Highway.

An addition of one (1) overcrossing by provision of box culvert may be considered at about 5 km west of Dong Du (presently a local road for dry season is provided between Dai Lien and Vu Duong).

iii) River Crossings (Bridges)

Table 4 shows the general information concerning Thai Binh (Pha Lai), Cau and Thuong rivers:

Table 4 General Information Thai Binh, Cau and Thuong Rivers

Descriptions	Unit	Thai Binh R.	Cau R.	Thuong R.
Class of River	-	III	III	III
Water Depth	m	> 4.0	> 4.0	> 4.0
Flood Discharge (Q 1 %)	m^3/sec	4,380	3,120	3,450
Flood W. L (H 1 %)	m	7.94	8.49	7.55
Flood W. L (H 5 %)	m	7.05	7.56	7.35
Navigation Clearance				
Horizontal	m	50	50	50
Vertical (above H 5%)	m	7.0	7.0	7.0
High of Dike				
East Bank	m	7.7 - 8.0	6.8	N.1
West Bank	m	6.3	N.1	6.2 - 6.7
Subsurface soils at Bridge Site		Fair	N.1	N.1

Notes : 1. N.1 denotes no information.
2. R. denotes the river.

TEDI proposed the bridge lengths for the above river crossings in his preliminary report on the Pre-Feasibility Study. The Study Team checked these proposed bridge lengths based on 1: 25,000 scale map and site investigation. Since the maximum embankment height is preferable less than 7m the bridge length can not be determined by the distance between two dikes (east and west) only, but should have about 100m of allowance (50m for each approach behind the dike to keep 7m embankment height) for each river crossing, in case of the North Route.

Considering this situation for the North Route, as well as based on the study result obtained through Highway No.18 Improvement, the Study Team checked the TEDI's preliminary findings (Table 5). As seen in Table 5, it may be said that TEDI assumes considerably shorter bridge lengths compared with the realistic bridge lengths.

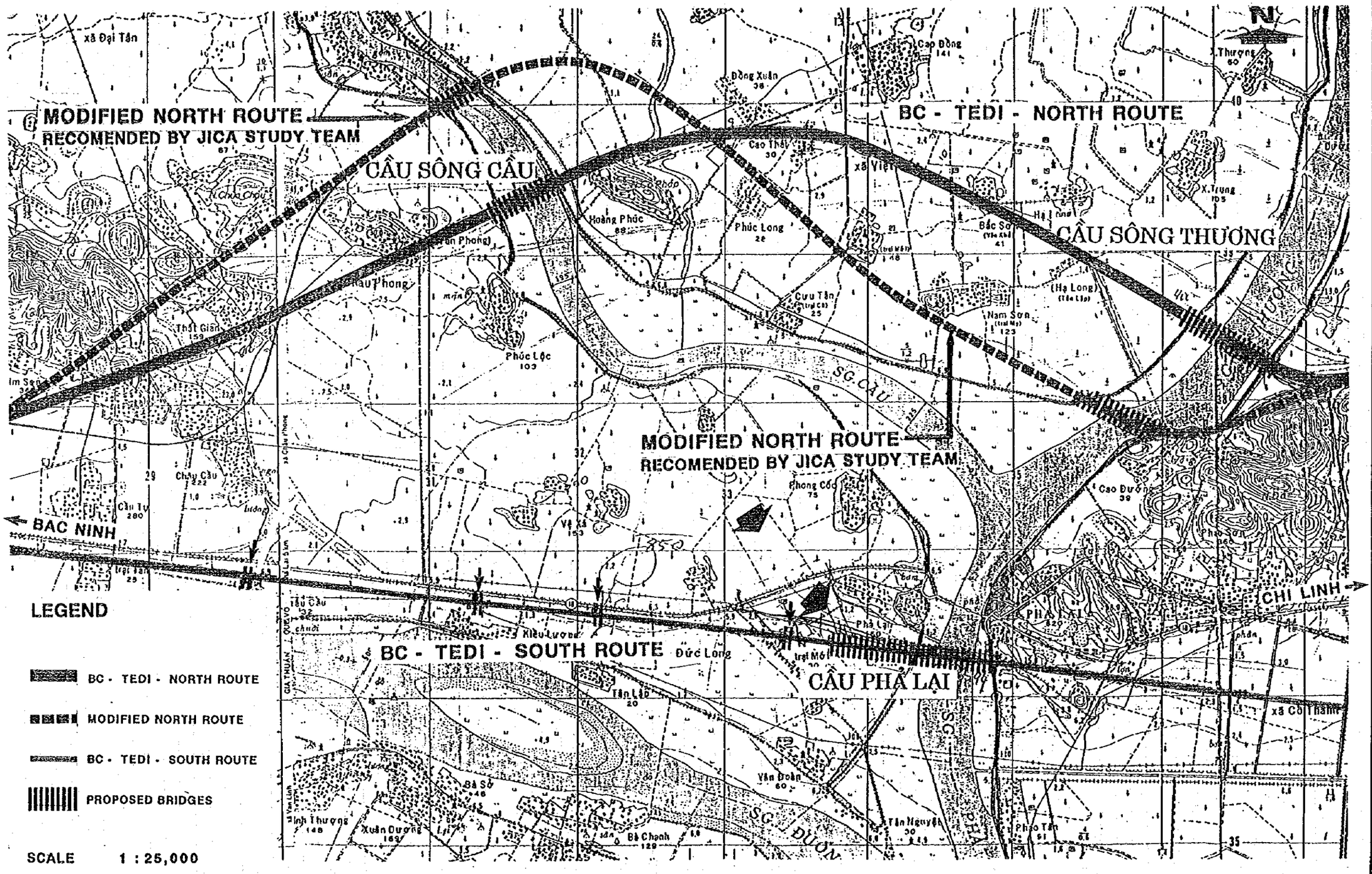
Table 5 Bridge Length by Alternative Route

Unit : in meter

Bridge Name	South Route		North Route	
	TEDI's Study	Checked by JICA Study Team	TEDI's Study	Checked by JICA Study Team
Pha Lai Bridge (main)	550	580		
Pha Lai Bridge (approach)	300	860		
Cau Bridge			350	500+100=600*
Thuong Bridge			450	600+100=700*
Total Length	850	1,440	800	1,300

* Note : TEDI's bridge lengths have been checked with 1:25,000 scale map and site investigation.

Finalization of TEDI's alignment of North Route was carried out by the Study Team with a site investigation by using an engine boat, to try the reduction of the bridge lengths. Narrower possible river crossings were found at about 1 km upstream of TEDI's Cau Bridge site and at about 1 km downstream of TEDI's Thuong Bridge site (Figure 3). When the bridge lengths were measured on the 1:25,000 scale map the required bridge lengths at new sites would become as shown in Table 6.



HIGHWAY NO.18 IMPROVEMENT

Figure 4 Selected Locations of Cau Bridge and Thuong Bridge

Table 6 Bridge Length by Alternative Route (JICA Study Team)

Unit : in meter

Bridge Name	South Route	North Route
Pha Lai Bridge (main)	580	
Pha Lai Bridge (approach)	860	
Cau Bridge		350+100=450
Thuong Bridge		500+70*=570
Total Length	1,440	1,020

Note : * The length of an east approach has been reduced to 20m due to the existence of rock outcrops in the area.

The Study Team recommends the subsurface soils investigations and on-the-ground topographical survey together with environmental survey (resettlement and existence of historic structures such as temples especially in the east bank of the Thuong river, the northeast of Cao Duong) along the TEDI and JICA Study Team routes to confirm the actual site conditions.

Overview of the issues discussed above will conclude that the North Route is recommended from the view point of river crossings aspects.

iv) Embankment Construction

In the west area of the Cau-Thai Binh rivers axis, the North Route is advantageous compared with the South Route in the following points:

- Avoidance of low-lying area;
- Reduction of hauling distance of embankment materials;
- Contribution to the flood fighting policy (future dike construction plan) of the region; and
- Embankment construction in dry conditions.

Since the Study Team shifted the Cau river crossing to the north, the TEDI's route section between Dong Du and the Cau bridge can be modified as shown in Figure 4.

The North Route will path the Duong Mai - Trai Ma - Bac Luong triangle area which is blocked by the Cau river and the Thuong river. The general ground elevation of this triangle is about 2.0m along the Route and no sustained water in dry season.

The hauling of embankment materials across the Cau river or Thuong river will result expensive disposition, the utilization of pump dredge would result adverse environmental impact by mud flow and this dredging sometimes changes the alignment of river course.

Therefore, the embankment materials should be obtained in the said triangle area. Topographical map shows high spot areas near Ban Tuong, but topographical survey, soils and materials survey and environmental investigations will be necessary during the further steps of the Alternate Highway development. The triangle area is well protected by higher dikes and the embankment work will be possible in dry conditions.

The result of above study suggests an adoption of the North Route from the view point of embankment construction.

3) Environmental Aspects

The most significant environmental condition which affects the planning and design of the Alternate Highway is the social settings especially resettlement of residents and loss of agricultural land. Ha Bac province holds the second large population of 2.26 million in 1993 followed by the province of Ha Noi (2.15 million, 1993) in the direct influence zone of the Alternate Highway. However, when Ha Bac province is viewed from the development of agricultural land, the percentage of agricultural land is low compared with other provinces as shown in the following table :

Province	Agricultural Land (ha)	Percentage of Agricultural Land
Hai Hung	158,702	62.23%
Ha Noi	44,188	48.00%
Hai Phong	68,061	45.27%
Ha Bac	146,691	31.78%
Quang Ninh	57,364	9.66%

The environmental aspects are viewed from i. Land acquisition and resettlement; and ii. favorable impact on socio-economic development.

i. Land Acquisition and Resettlement

The South Route passes the low-lying wet land between Dong Du and Pha Lai which is sparsely inhabited. While the North Route passes hilly area where many houses are scatterd for about 2 km stretch, therefore, a careful alignment selection is still needed, but the number of affected houses may not exceed around 100.

The North Route passes through rice paddy area between Dong Du and Thuong Bridge. Since the Alternate Highway will adopt high embankment, the loss of agricultural land will be considerably large since the bottom width of the embankment would become of about 100m.

In the eastern area, the South Route passes through the technical irrigated area between Hou Loc and Chi Linh, therefore, the loss of agricultural land in valuable area should be in mind in the case of the South Route.

ii. Favorable Impact on Socio-Economic Development

The South Route will give a favorable impact to the southern flat area of Pha Lai/Hou Loc, and the landuse potential in the area will be greatly enhanced. Higher landuse potential will cause an increase in development demand and thus increase land values.

The major advantages of the North Route from a view point of socio-economic development can be described as follows :

- The construction of the elevated Alternate Highway on high embankment will contribute to the establishment of strengthened flood control system in the region; and

- Development of Duong Mai-Tri Ma-Bang Luong triangle area which is presently isolated from Highway No.18 will be enhanced by the provision of the connections (frontage road) between west dike and east dike for the Cau river and the Thuong river.

4) Transportation Aspects

i) Road Network Pattern and Impact on Regional Development

The western region of Ha Bac province has been suffered from the low density of road network. The reasons are mainly due to the existence of major rivers which cross the region. The Duong river, the Cau river and the Thuong river are flowing in the west-east direction. When the Alternate Highway between Noi Bai - Bac Ninh - Chi Linh was developed, this new highway will greatly contribute to the strengthening of the highway network in the western region of Ha Bac.

In the other hand, when viewed the development of the Alternate Highway from the situation of road network pattern, it is preferable that the subcorridors of the Alternate Highway and Highway No.18 should not be overlapped in the similar subcorridors to cover more larger area to obtain larger impact on the regional development.

Since the South Route follows the alignment of Highway No.18 the adoption of this alternative is doubtful from the stand point of road network pattern.

ii) Traffic Demand

The calculation of detailed average cross sectional traffic volumes and average number of the Alternate Highway users are impossible at this moment but it can be said that there is no significant change in two alternatives from the traffic demand point of view.

iii) Conclusion

Overview of the issues discussed above will conclude that the North Route is recommended from the transportation aspects.

5) The Optimum Route

Order of priority to be taken up in technical, environmental and transportation aspects in the two (2) route alternatives is summarized in Table 7. The basic premises to the comparison is that the Highway No.18 Improvement (including the rehabilitation approach, but with the construction of Pha Lai Bridge) will be executed before the development of the Alternate Highway, since the expected traffic volume on the Alternate Highway will never reach to the presumed level which satisfies the economic viability without abovementioned improvement.

Table 7 Preferable Priority in Three Major Aspects for Each Alternative Route

Major Aspects for Comparison	Order of Priority to Adopt	
	North Route	South Route
Technical Aspects	1	2
Environmental Impact	1	2
Transportation Aspects	1	1

Both alternative routes are technically feasible and no serious difficulties will be encountered in the construction of the Alternate Highway, but modified North Route showed shorter bridge length of about 1,020m compared with the South Route (total estimated total bridge length = 1,440m).

Land acquisition and resettlement is advantageous in the South Route. However, the North Route will create enormous flood protected area by the construction of high embankment highway in the north-east axis and contributes to the implementation of further regional flood control scheme.

Projected future traffic demand will be similar in both alternative routes but the North Route will provide better road network pattern and larger favorable impact on regional development.

The Study Team recommends the adoption of North Route in the Bac Ninh - Chi Linh section of the Alternate Highway based on the above conclusions of the route study.

8. Inception Engineering Study of Bac Ninh - Chi Linh Alternate Highway

8.1 Geometric Design Standard

(1) Geometric Standard for Throughway

1) Highway Type

Full access controlled inter-city or inter-region high type highway through sparsely inhabited area.

2) Design Speed

The design speed has a direct effect on the minimum standards of such features as sight distance, horizontal curvature, super-elevation, ect. The higher design speed of 120 Km/hr was adopted for the entire section. Adoption of higher design speed will not seriously affect to the construction cost since the terrain condition is very flat and landuse pattern is simple.

3) Lane Width

A lane width of 3.5m is recommended in lieu of 3.75 which is specified in the Government standard.

4) Shoulder Width

A 3.0m outer shoulder and a 1.25m in inner shoulder are to be adopted considering design policies of the Government and Japanese design practice and AASHTO's design policy.

5) Median Width

The median width id expressed as the dimension between the through-lane edges and includes inner shoulders.

It is recommended to provide a 5.0m median including 1.25m inner shoulders and with 2.5 m width raised. A 2.5m width is generally

sufficient for the construction of pier columns of grade separation structure including space for protection with guardrail.

6) Summary of Geometric Design Standard for Throughway.

The summary of geometric deign standard for throughway is shown in Table 8.

Table 8 Geometric Design for Throughway

Item	Unit	Throughway Geometric Design Standards			
Standard	-	Government's Standard	Japanese Standard	AASHTO Standard	Recommended Standard
Terrain	-	Flat	Flat	Flat	Flat
Design Speed	km/h	120	120	112	120
Stopping Sight Distance	m	175	210	190	210
Lane Width	m	3.75	3.5	3.66	3.5
Median Width	m	-	4.5 (3)	4.3 (1)	5.0 (1)
Inner Shoulder Width	m	-	1.25	1.2 (2)	1.25
Outer Shoulder Width	m	3.0	2.5 (3)	3.0 (3)	3.0
Minimum Radii	m	600	710	500	710
Minimum Radius not Requiring Transition Curve	m	-	4,000	-	4,000
Minimum Redius not Requiring Super elevation	m	-	7,500	-	7,500
Maximum Gradient	%	4.0	2.0	3.0	3.0 - 4.0
Crossfall Carriageway	%	2.0	2.0	1.5 - 2.0	2.0
Crossfall of outer Shoulder	%	3.0 (4)	4.0 (4)	4.0 - 6.0 (4)	2.0 - 4.0
Maximum Superelevation	%	-	6.0	4.0 - 6.0	6.0

Note : (1) Total of raised median and inner shoulders
(2) Paved shoulder for 4-lane divided highway
(3) Usable shoulder
(4) Gravel or crushed rock shoulder

High type highway requires junctions (alternate highway to alternate highway interchange) and interchanges (alternate highway to national highway or access road) in many cases.

Refer to interim report of the "Feasibility Study on the Highway No.18 Improvement" (hereinafter referred to as the "Interim Report") for the design standard for throughway in the vicinity of junction or interchange ramp terminal.

(2) Geometric Design Standard for Junction or Interchange Ramps

The recommended geometric design standard for junction or Interchange ramps of the Alternate Highway is shown in Table 9.

Table 9 Geometric Design Standard for Interchange Ramps

Item	Unit	Junction or Interchange Ramps	
Design Speed	km/h	40	50
Sight Distance	m	40	55
Lane Width	m	3.5	3.5
Median Width, Raised	m	2.5	2.5
Inner Shoulder Width	m	0.75	0.75
Outer Shoulder Width	m	3.0	3.0
Minimum Radii	m	50	90
Minimum Radius for Curve not Requiring Transition Curve	m	140	220
Minimum Radius for Curve not Requiring Superelevation	m	800	1,300
Maximum Gradient	%	6 (8)	5.5 (7.5)
Minimum Vertical Curve Length	m	40	50
Crossfall of Pavement	%	2	2
Crossfall of Shoulder	%	4	4
Maximum Superelavation	%	10	10

Note : ( ) shows absolute minimum values.

8.2 Typical Cross Sections

(1) Number of Traffic Lanes

4-lane divided highway will be adopted for the Alternate Highway.

(2) Cross Section Elements

The major cross sectional elements are:

- Number of lanes;
- Lane width;

- Widths of shoulders;
- Median;
- Side slopes; and
- Drainage channels.

(3) Side slopes, Drainage Channels and Erosion Control

1) Side Slopes in Embankment

Site conditions do not permit the use of flat or gentle slopes. A side slope of 1:1.5 will be generally adopted in the design.

2) Side slope in cut section

A back slope of 1:1.0 will be adopted based on evaluation regarding the slope stability (i.e. silty sand), and normal highway construction practices in the region.

3) Drainage Channels

The design incorporates safety, and economy of maintenance. Provision of intercepting ditches is considered in the design where long distance overland flow is anticipated.

4) Erosion Control

Rainwater which falls on the traveledway flows away laterally under the influence of the cross slope or superelevation. A common rule for drainage where the traveledway are situated on earth embankment is to let the flow continue off the shoulders and down the side slopes to the side ditches. Protection with sodding (i.e. strip sodding in the construction) will be also adopted in the design. Cut slopes are designed in similar manner.

(4) Typical Cross section and Right-of-Way Width

1) Clear Area and Right-of-Way

The Decree 203-HDBT dated 21-12-1982 indicates a right-of-way (ROW) of 20 meters for highway from the lower edge of fill or from the outer edge of longitudinal ditches.

The Circular, MOTAC 704/GTTB dated 16-06-199 stipulates that the edge of clear area shall be 7 meters from the toe of embankment or the end of cut slope to consider traffic safety and future upgrading and pavement widening.

Any kind of houses and buildings within clear area shall be demolished and compensated. Farmers will, however, be able to continue to cultivate in the clear area.

The existing houses and buildings in the area between clear area and right-of-way edge lines will be maintained as they are, but new houses or buildings will not be allowed to be constructed.

2) Typical Cross Sections

The typical cross section of the Alternate Highway has been proposed as shown in the Interim Report (Figure 8.2(1), Type D).

(5) Special Considerations

1) Cut Area at That Phong

As before-mentioned (7.6. (8).2).iv.), the Alternate Highway will path Van Phong, Xa Chau Phong and Xa Ngoc Xa low-lying area with high embankment, and borrow materials are intended to obtain in That Giang hilly area (Figure 4). Since a large volume of borrow materials is necessary for the embankment construction, it is beneficial to select the route which passes the hilly areas which will create enormous cut volume. It is recommended to adopt ultimate 6-lane Alternate Highway (Figure 5) in that hilly areas based on the following reasons :

- To provide enough volume of borrow materials; and
- To avoid the future difficulty in the highway widening.

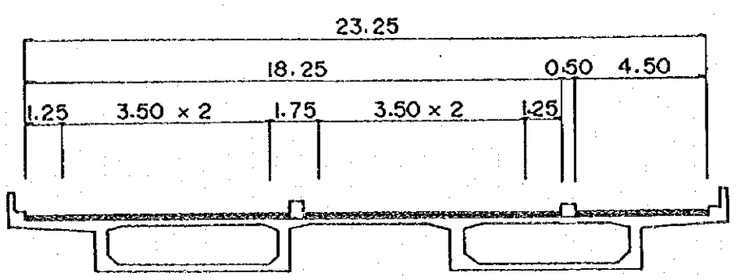
2) Cau and Thuong Bridges

The Alternate Highway is envisaged 6-lane in the ultimate stage. Once 4-lane bridges were constructed for the Cau river and Thuong river, the major difficulties would occur in the future in the widening of these bridges.

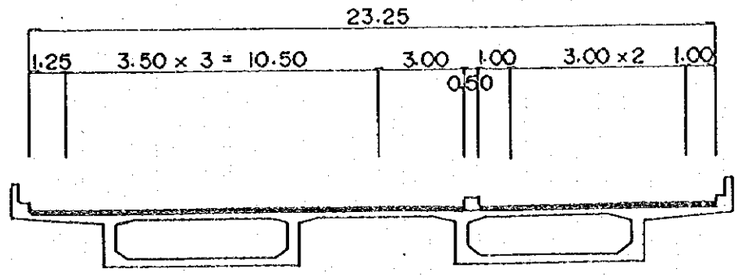
The ideal Alternate Highway development is to provide 6-lane bridges and 4-lane paved road in the embankment sections in the initial stage but the economic viability situation will not justify this method. In the other hand the PMU No.18 suggested the provision of an additional 4.5m wide carriageway (i.e. side lane) to the Cau and Thuong bridges for the utilization by local traffic.

To cope with the above situations the Study Team decided to recommend the following countermeasures :

- Planned bridges in the ultimate stage status will be constructed for Ha Noi bound only (3-lane carriageway) in the initial stage;

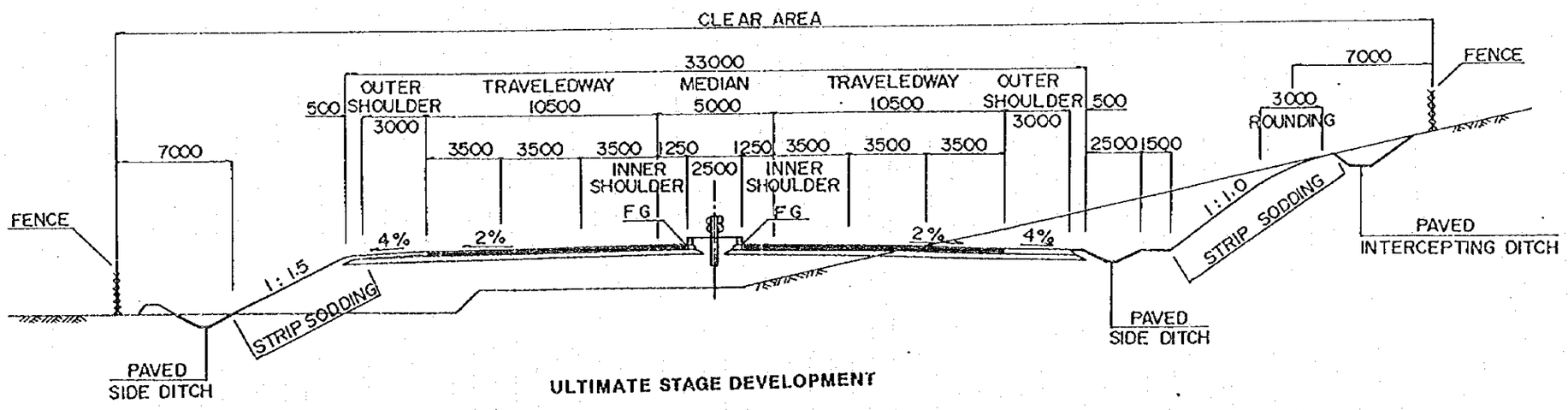


INITIAL STAGE DEVELOPMENT



ULTIMATE STAGE DEVELOPMENT

TYPICAL CROSS SECTION (CAU BRIDGE AND THUONG BRIDGE)



ULTIMATE STAGE DEVELOPMENT

TYPICAL CROSS SECTION (EARTH WORK SECTION)

HIGHWAY NO.18 IMPROVEMENT	Figure 5 Typical Cross Section of the Alternate Highway and Provision of Auxiliary Lane(s) for Cau and Thuong Bridge

- A 4.5m wide side lane will be provided at the outside of the Alternate Highway carriageway in the initial stage;

- Constructed Ha Noi bound bridges will be operated as a 4-lane divided highway applying slightly lower design speed of 100 km/hr in lieu of 120 km/hr until the ultimate bridges (additional 3-lane carriageway) will be realised;

- The total width of 3-lane carriageway including shoulders in normal design is 14.75m and this carriageway width is not sufficient for 4-lane operation which is able to keep 100 km/hr and traffic safety, therefore, the initial stage Alternate Highway carriageway shall have 18.25m of width (Figure 5);

- Since an extra width of 3.5m (18.25m - 14.75m = 3.5m) will be provided for the Alternate Highway carriageway in the initial stage, these extra width can be transferred to the 4.5m side lane after the realization of ultimate stage development of bridges, the total width of the side lane will become 8.0m and 2-lane 2-way operation will become possible.

The recommended Alternate Highway typical cross section for ultimate stage in the embankment or cut section is shown in Figure 5.

8.3 Interchanges

(1) General

Interchanges at the ultimate status are tentatively planned at the crossings with National Highway Nos.1 (alternate highway), 18 and 379 and Provincial Highway No.376 which connects Binh- Giang - Vuon Dao to collect/distribute the Alternate Highway traffic from/to the highway network in the corridor, normally with the consideration given to the provision of possible toll gate.

(2) Toll Levy System

TEDI's study suggests the toll levy for the Alternate Highway. Therefore the Study Team will follow this basic policy. It can be understood that basically the Alternate Highway will be operated under a distance-proportional toll levy system.

(3) Location of Interchanges

Four (4) interchanges (Table 10) were planned as mentioned in the above, however really needed and important interchanges in the initial stage are Bac Ninh Interchange and Chi Linh Interchange.

Table 10 List of Interchange

No.	Name of Interchange	Distance (km)	Connection
1.	Bac Ninh		Alternate NH No.1
		16.0	
2.	Dong Du		Highway No.18
		14.5	
3.	Vuon Dao		Provincial Highway No.376
		7.0	
4.	Chi Linh		National Highway No.379

Justification of Vuon Dao interchange is doubtful since the normal intervals of interchange in toll levy highways under a distance-proportional toll levy system in Japan suggests the following :

Standard Interval of Interchange

- Urban areas, major industrial areas..... 5 - 10km; and
- Flat area with scattered small towns ..... 15 - 25km.

Dong Du interchange requires a considerable amount of initial investment, therefore only the at-grade intersection with toll gate may be provided in the initial stage.

(4) Selection of Type of Interchange

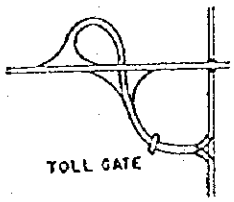
There are several basic types of interchange and patterns of ramps for vehicle maneuvering at a grade separation, and each type of interchange has inherent advantages and disadvantages. The Study Team selects a trumpet type of interchange considering volume of traffic, topography, availability of land, location of tollgate and construction cost.

In consideration of the toll levy system for the connection between a toll road and a toll free road, trumpet interchange has a definite advantage as compared with other types of interchange.

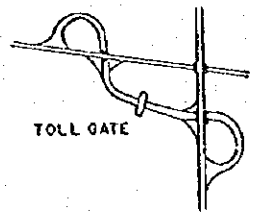
This advantage is to be able to gather all toll plazas into one place, and thus, the toll levy administration is to be easy and economical. Therefore, trumpet type interchange has been adopted for all interchanges in consideration of the inherent advantages to a trumpet mentioned above.

(5) Layout of Interchange

To manage larger on/off ramp traffic, a double trumpet type may be selected for Bac Ninh interchange. But for Chi Linh interchange the construction of second trumpet will not be necessary in the initial stage development but the securing of right-of-way should consider the ultimate stage development.



Double Trumpet Type
(Initial Stage)



Single Trumpet Type
(Ultimate Stage)

(6) Toll Collection Facilities

Under the distance-proportional toll levy system, it is necessary to provide toll gates, on-ramp gates for issuing cards and off-ramp gates for collecting toll. The type of interchange which provides integrated on/off ramp gates at one locations is advantageous as it is economical and efficient for toll levy highway operation and management. The type which allows such arrangement is normally a trumpet type, single or double trumpet depending on the volume of on/off traffic which has been applied for all the interchanges.

The major roles of toll collection facilities are collection of the distance-proportional tariff and recording the number of vehicles by class. The functions of each tollgate and toll office are as follows:

Tollgate

- Toll collection and issue of receipts;
- Vehicle counting by loop detectors, where required; and
- Registration of the number and types of vehicles.

Toll Office

- Total and check the toll account daily;
- Total the number and types of vehicles daily;
- Check for mis-registration and discrepancies; and
- Real time audit.

(7) Tollgate

Since the forecast on/off traffic are not available at this phase of the study, the further discussions on number of toll booth are omitted.

8.4 Major Bridges

(1) Design Standard

Vietnamese Bridge Design Code (Specifications 2057/QD-KT4-1979) will be followed together with AASHTO specifications. Refer to subsections 6.3 and 6.4 for further descriptions on bridge design standard.

(2) General Information on the Cau River and Thuong River

Refer to subparagraph 7.6 (8).2).

(3) Design Features of Major Bridges

Design features of highway crossing and river crossing are summarized in Table 11.

Table 11 Design Features of Highway and River Crossing Bridges

No.	Approximate Station (km)	Name of Bridge	Total Length (m)	Bridge Width (m)
1.	0.5	Bac Ninh Interchange	40	14
2.	3	PH No.288 Under crossing	80	12
3.	14	Drainage Channel No.3	30	11.25x2=22.5
4.	15.5	Dong Du Interchange	40	12
5.	17.5	NH No.18 Under crossing	250	12
6.	23	Cau River	450	23.25
7.	28	Thuong River	570	23.25
8.	30	Vuon Dao Interchange	40	12
9.	32	PH No.376 Crossing	30	11.25x2=22.5
10.	37.5	Chi Linh Interchange	20	11.25x2=22.5
Total Area of Bridges				30,996m2

8.5 Pavement

Adoption of an uniform layer thickness for the Alternate Highway will be recommended, although traffic characteristics varies by each subsection.

(1) Design Conditions

- Pavement design — Flexible pavement design
- Pavement design Strategy — Two stages
- Service life of the first stage — 10 years

- Service life of second stage — 10 years
- Soil support value — 3.7 (=CBR 4)
- Number of lanes — 4
- ESAL in the first stage — 7.4×10^6
- Regional factor — 2.5
- Terminal serviceability — 2.5

(2) Design Thickness

Table 12 shows the results of flexible pavement design for the first stage.

Table 12 Result of Flexible Pavement Design of the Alternate Highway

Item	Design Features
Service Life (years)	10
Surface Course Thickness (cm)	10
Asphalt Treated Base Course Thickness (cm)	20
Aggregate Subbase Course Thickness (cm)	30

An overlay of pavement (10cm thickness) will be required after 10 years of the opening of the Alternate Highway (2016).

9. Magnitude Project Cost

9.1 General

The estimates of the project cost were based on the result of the inception engineering study. The project cost which dealt in this Section consists of the following items:

- Construction;
- Land acquisition and resettlement;
- Engineering services;
- Supervision services; and
- Physical contingency.

The unit price of each cost component was determined based on the economic conditions prevailing in January 1996. The project cost was estimated in financial and economic prices.

9.2 Construction Cost

(1) Initial Investment Cost

The estimated construction cost at January 1996 prices is shown in Table 13. 13.

(2) Overlay Cost

For overlay of asphalt concrete pavement, it is assumed that the overlay will be executed, once life span of the project, in 2016. The cost was estimated for the purpose of economic project evaluations. The estimated construction cost is Dong 84,869 million.

9.3 Land Acquisition and Resettlement Cost

No tax component is included in the land acquisition and resettlement cost. The cost was estimated based on the data of the "Feasibility Study on Noi Bai - Bac Ninh Highway, by TEDI, in 1994". To consider the ultimate stage status of the Alternate Highway, TEDI's cost was doubled and estimated at Dong 55,270 million.

9.4 Estimated Project Cost

(1) Initial Investment Cost

The estimated initial investment cost is Dong 1,295,500 million in financial cost as summarized in Table 14.

(2) Additional Investment Cost

Only an overlay cost above mentioned was considered in the estimates.

Table 14 Summary of Project Costs in 1996 Prices

Description	Financial Cost (Million Dong)
(1) Construction	1,018,406
(2) Land Acquisition and Resettlement	55,270
(3) Engineering Services	42,947
(4) Supervision Services	61,104
(5) Physical Contingency (10%)	117,773
Total	1,295,500

Table 13 Estimated Construction Cost, In January 1996 Prices

Alternate Highway between Bac Ninh and Chi Linh

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	LS			29,662,317
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	1,760,000	3,520,000
Soil Excavation	cu.m	18,000	0	0
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	45,000	1,645,103	74,029,635
Embankment (Borrow Material)	cu.m	40,000	3,829,126	153,165,040
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				230,714,675
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	882,156	5,292,936
Aggregate Subbase Course	cu.m	100,000	317,625	31,762,500
Asphalt Treated Base Course	cu.m	750,000	118,180	88,635,000
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	801,456	4,007,280
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	1,266,708	4,180,136
Asphalt Concrete Surface (t=5cm)	sq.m	55,000	0	0
- ditto - (t=10cm)	sq.m	110,000	733,536	80,688,960
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				214,566,812
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	83	99,600
Pipe Culvert (D=1.0m)	l.m	1,700,000	935	1,589,500
Pipe Culvert (D=1.5m)	l.m	2,700,000	327	882,900
Box Culvert (1.5 x 1.5)	l.m	3,400,000	277	941,800
- ditto - (4.0x 2.5)	l.m	30,000,000	277	8,310,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				11,823,800
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	24,020	312,260,000
Long Span Bridge	sq.m	26,000,000	6,975	181,350,000
Sub Total				493,610,000
(6) Miscellaneous Works	L.S			38,028,611
Total				1,018,406,215

10. Implementation Schedule

Assuming realization of Highway No.18 improvement, it is recommended that the construction of the Alternate Highway be completed by the end of 2006 before the capacity of Highway No.18 will be saturated.

Taking into account the scale of the construction and the urgency of the Alternate Highway development, the maximum possible construction period was set at 2.5 years (Figure 6).

The Alternate Highway project implementation schedule has been prepared as shown in Figure 3, assuming the following implementation schedule :

Feasibility Study and Detail Design	2001 - 2003 (2.5 years)
Land Acquisition/ Resettlement	2003 - 2004 (1.5years)
Construction	2004 - 2006 (2.5 years)

11. Inception Economic Analysis

The Alternate Highway development will have to alternative cases :

Scheme - 1 : Alternate Highway development with the improvement of Highway No.18.

Scheme - 2 : Alternate Highway with the rehabilitation (only overlay of asphalt pavement) of Highway No.18.

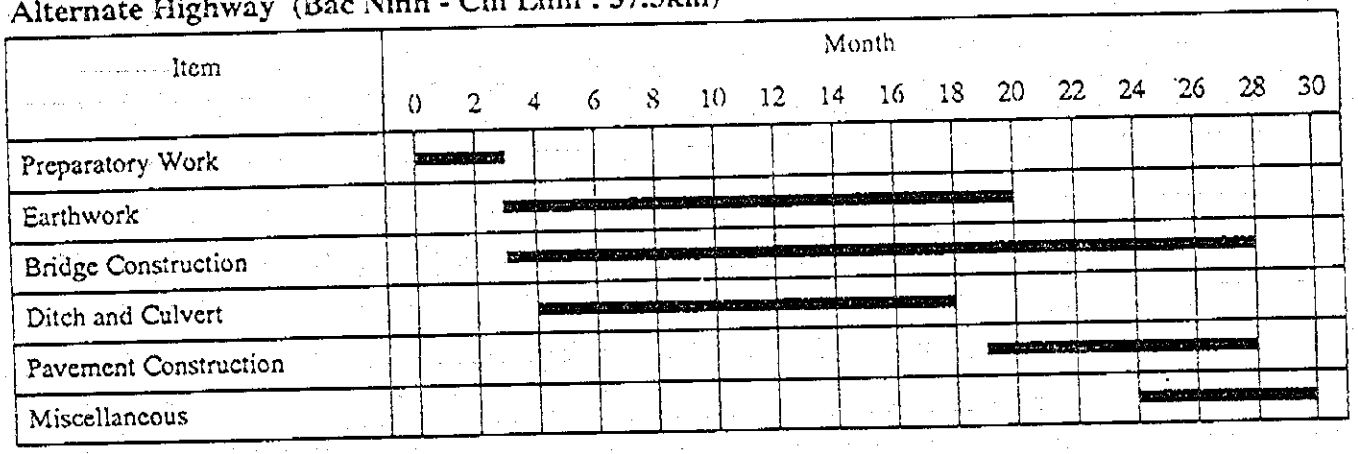
The economic indicators for the Alternate Highway development alternatives are shown in Table 15.

Table 15 Economic Indicators

Scheme No.	Development Alternative	Present Worth of Benefit at i = 10 % (in million Dong)	B/C Ratio at i = 10 %	IRR (%)
S-1	With Improvement of Highway No.18	489,616	2.00	15.04
S-2	With Rehabilitation of Highway No.18	351,639	1.40	13.23

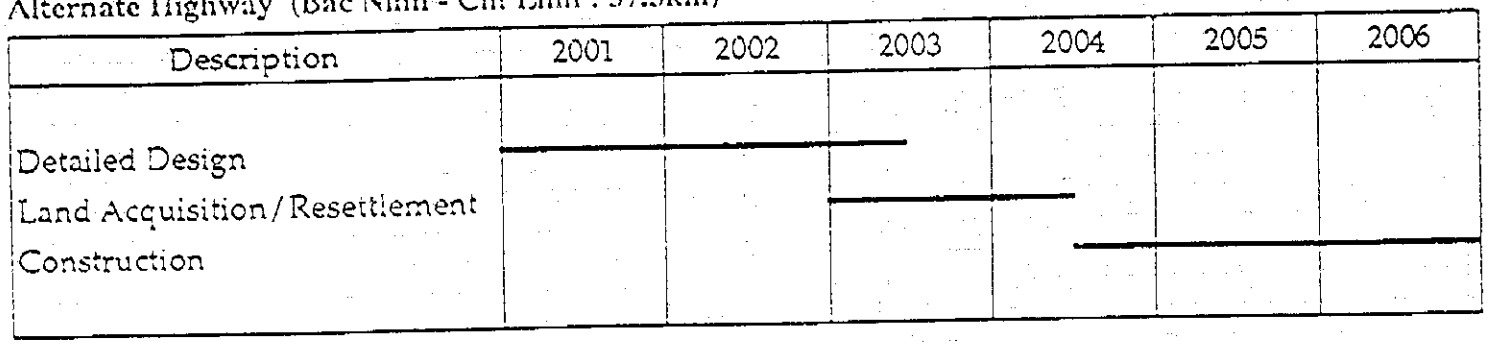
It is found that the Alternate Highway development with improvement of Highway No.18 (S - 1) indicates higher return. The difference compared with rehabilitation scheme (S - 2) is quite small since the construction of Pha Lai bridge is included in both schemes of S - 1 and S - 2. The adoption of S - 1 is

Alternate Highway (Bac Ninh - Chi Linh : 37.5km) Initial Stage



Construction Time Schedule

Alternate Highway (Bac Ninh - Chi Linh : 37.5km) Initial Stage



Implementation Schedule

HIGHWAY NO. 18 IMPROVEMENT | **Figure 6 Construction Time Schedule and Implementation Schedule**

recommended for conceivable Alternate Highway development. Refer to Tables 16 and 17 for the cost benefit analysis of schemes S - 1 and S - 2.

Further, the economic indicators for only the Alternate Highway portion has been analyzed for reference (Table 18). The result of analysis showed the following economic indicators :

IRR	=	13.72 %	
Present worth of benefit	=	193,334	at i = 10 % (in million Dong)
B/C ratio	=	1.40	

12. Annual Fund Requirement

A tentative disbursement schedule for the implementation of the Alternate Highway development is prepared as shown in Table 19.

For the calculation of annual fund required, the escalation allowances of 1 percent per annum and 10 percent per annum for the foreign currency component and the local currency component are applied respectively.

Table 19 Annual Fund Requirement

Alternate Highway Development

Bac Ninh - Chi Linh Alternate Highway (Unit : Million Dong)

		Cost in 1996 Price	Current Price						Total
			2001	2002	2003	2004	2005	2006	
1. Detailed Design	F/C	33,069	13,902	14,041	7,091	0	0	0	35,034
	L/C	14,172	9,130	10,043	5,523	0	0	0	24,696
2. Land Acquisition	F/C	0	0	0	0	0	0	0	0
and Resettlement	L/C	60,797	0	0	59,238	65,162	0	0	124,400
3. Construction	F/C	672,148	0	0	0	72,784	367,559	296,988	737,331
	L/C	448,098	0	0	0	96,054	528,296	464,900	1,089,250
4. Supervision	F/C	47,050	0	0	0	5,095	25,729	20,789	51,613
Services	L/C	20,164	0	0	0	4,322	23773	20,920	49,015
Sub Total	F/C	752,267	13,902	14,041	7,091	77,879	393,288	317,777	823,978
	L/C	543,231	9,130	10,043	64,761	165,538	552,069	485,820	1,287,361
Total		1,295,498	23,032	24,084	71,852	243,417	945,357	803,597	2,111,339

13. Conclusions

The results of the study suggest that the project will be technically sound and economically feasible. Taking into account the direct and indirect benefits towards regional development other than the quantified savings in travel costs, the project should be initiated at earlier opportunity.

Table 16 Cost Benefit Analysis of Alternate Highway with Improvement of Highway No.18

Case : 2 Lane + Alernate Highway
Design length : 36.4 km

IRR : 15.04%
Unit : Million Dong

	Year	Cost			Benefit						B/C Analysis		
					V.O.C Saving		Time Saving		Ferry Cost Saving	Total	Discout Factor	Cost Present Value	Benefit Present Value
		Capital	Mainte-nance	Total	Normal Traffic	Diverted Traffic	Normal Traffic	Diverted Traffic					
1	1997	19.450	0	19.450	0	0	0	0	0	0	0.8693	16.907	0
2	1998	47.275	0	47.275	0	0	0	0	0	0	0.7556	35.722	0
3	1999	207.103	0	207.103	0	0	0	0	0	0	0.6568	136.032	0
4	2000	165.682	0	165.682	0	0	0	0	0	0	0.5710	94.598	0
5	2001	16.602	425	17.027	12.300	17.439	1.757	630	15.184	47.311	0.4963	8.451	23.481
6	2002	16.602	425	17.027	14.636	25.029	2.295	916	5.470	48.345	0.4314	7.346	20.858
7	2003	38.700	425	39.125	14.370	34.951	2.621	1.285	5.836	59.064	0.3750	14.673	22.150
8	2004	128.030	425	128.455	15.122	46.353	3.354	1.711	11.402	78.443	0.3260	41.876	25.572
9	2005	483.156	425	488.581	17.208	60.618	4.150	2.158	10.214	94.347	0.2834	138.451	26.736
10	2006	423.647	425	424.072	20.247	67.379	5.109	2.452	14.826	110.012	0.2463	104.460	27.099
11	2007	0	1.425	1.425	33.493	90.904	7.194	3.538	16.232	151.366	0.2141	305	32.411
12	2008	0	1.425	1.425	38.597	100.510	8.782	3.861	11.598	163.347	0.1861	265	30.404
13	2009	0	1.425	1.425	44.454	117.928	10.744	4.675	12.684	190.486	0.1618	231	30.820
14	2010	0	1.425	1.425	51.205	138.112	13.180	5.677	18.296	226.471	0.1406	200	31.851
15	2011	0	1.425	1.425	58.929	155.215	16.212	6.486	16.982	253.824	0.1223	174	31.031
16	2012	18.217	1.425	19.642	67.804	167.657	20.017	7.008	16.788	279.274	0.1063	2.087	29.679
17	2013	0	1.425	1.425	81.180	181.021	27.577	7.546	26.000	323.324	0.0924	132	29.868
18	2014	0	1.425	1.425	93.306	195.443	34.600	8.147	21.732	353.229	0.0803	114	28.365
19	2015	0	1.425	1.425	103.168	210.915	38.834	8.764	22.824	384.504	0.0698	99	26.839
20	2016	90.368	1.425	91.793	110.858	222.352	42.173	9.237	27.716	412.336	0.0607	5.570	25.019
21	2017	0	1.425	1.425	123.349	234.314	51.598	9.700	25.328	444.790	0.0527	75	23.460
22	2018	18.217	1.425	19.642	133.156	246.940	56.038	10.217	28.260	474.611	0.0458	901	21.760
23	2019	0	1.425	1.425	143.199	260.131	60.861	10.721	35.712	510.623	0.0399	57	20.351
24	2020	0	1.425	1.425	154.040	273.974	66.100	11.243	31.084	536.441	0.0346	49	18.584
25	2021	0	1.425	1.425	165.744	288.496	71.792	11.785	31.550	569.366	0.0301	43	17.146
26	2022	0	1.425	1.425	178.383	303.723	77.975	12.347	32.024	604.451	0.0262	37	15.823
27	2023	0	1.425	1.425	192.035	319.683	84.694	12.928	32.504	641.843	0.0223	32	14.605
28	2024	18.217	1.425	19.642	206.732	336.405	91.993	13.528	32.991	681.700	0.0198	389	13.484
29	2025	0	1.425	1.425	222.718	353.917	99.924	14.147	33.486	724.192	0.0172	25	12.452
30	2026	90.368	1.425	91.793	222.705	372.247	99.922	14.785	33.989	743.648	0.0149	1.372	11.115
	Total	1.786.634	31.050	1.817.684	2.519.492	4.822.156	999.497	195.492	570.712	9.107.350		610.672	610.963

Table 17 Cost Benefit Analysis of Alternate Highway with Rehabilitation of Highway No.18

Case : Overley + Highway
Design length : 36.4 km

IRR : 13.23%
Unit : Million Dong

	Year	Cost			Benefit						B/C Analysis		
					V.O.C Saving		Time Saving		Ferry Cost		Discout	Cost	Benefit
		Capital	Maintenance	Total	Normal Traffic	Diverted Traffic	Normal Traffic	Diverted Traffic	Saving	Total	Factor	Present Value	Present Value
1	1997	0	0	0	0	0	0	0	0	0	0.8832	0	0
2	1998	154.572	0	154.572	0	0	0	0	0	0	0.7800	120.561	0
3	1999	154.572	0	154.572	0	0	0	0	0	0	0.6888	106.475	0
4	2000	38.700	283	38.983	0	0	0	0	0	0	0.6084	23.715	0
5	2001	128.030	283	128.313	7.004	13.101	1.363	338	15.184	36.990	0.5373	68.939	19.874
6	2002	488.156	283	488.439	8.769	18.898	1.862	513	5.470	35.512	0.4745	231.761	16.850
7	2003	390.524	283	390.807	9.983	27.054	2.301	769	5.836	45.942	0.4191	163.769	19.252
8	2004	0	1.283	1.283	21.350	51.988	3.869	1.987	11.402	90.597	0.3701	475	33.529
9	2005	30.192	1.283	31.475	24.523	72.499	4.753	2.795	10.214	114.784	0.3268	10.283	37.517
10	2006	0	1.283	1.283	28.285	81.916	5.785	3.201	14.826	134.013	0.2887	370	38.684
11	2007	0	1.283	1.283	32.663	90.773	7.060	3.532	16.232	150.259	0.2549	327	38.306
12	2008	0	1.283	1.283	37.687	100.377	8.630	3.884	11.598	162.175	0.2251	289	36.513
13	2009	0	1.283	1.283	43.462	117.794	10.573	4.746	12.684	189.259	0.1988	255	37.632
14	2010	0	1.283	1.283	50.122	137.978	12.987	5.810	18.296	225.193	0.1756	225	39.545
15	2011	30.192	1.283	31.475	57.747	155.076	15.994	6.662	16.982	252.462	0.1551	4.881	39.154
16	2012	0	1.283	1.283	63.758	167.508	17.949	7.198	16.788	273.201	0.1370	176	37.420
17	2013	90.368	1.283	91.651	70.481	180.861	20.143	7.750	26.000	305.185	0.1210	11.086	36.916
18	2014	0	1.283	1.283	77.841	195.271	22.606	8.366	21.732	325.817	0.1068	137	34.807
19	2015	0	1.283	1.283	86.074	210.714	25.371	9.013	22.824	353.996	0.0943	121	33.399
20	2016	0	1.283	1.283	92.493	222.122	27.553	9.513	27.716	379.397	0.0833	107	31.613
21	2017	30.192	1.283	31.475	99.278	234.049	29.895	10.003	25.328	398.554	0.0736	2.316	29.329
22	2018	0	1.283	1.283	106.568	246.631	32.437	10.550	28.260	424.446	0.0650	83	27.585
23	2019	0	1.283	1.283	115.574	259.770	35.195	11.084	35.712	457.336	0.0574	74	26.249
24	2020	0	1.283	1.283	122.815	273.551	38.188	11.639	31.084	477.277	0.0507	65	24.193
25	2021	0	1.283	1.283	131.393	287.891	41.376	12.218	31.550	504.429	0.0448	57	22.582
26	2022	0	1.283	1.283	140.524	302.869	44.826	12.817	32.024	533.059	0.0395	51	21.075
27	2023	120.560	1.283	121.843	150.237	318.491	48.559	13.434	32.504	563.225	0.0349	4.254	19.666
28	2024	0	1.283	1.283	160.564	334.772	52.598	14.068	32.991	594.994	0.0308	40	18.348
29	2025	0	1.283	1.283	171.538	351.725	56.967	14.719	33.486	628.435	0.0272	35	17.115
30	2026	0	1.283	1.283	111.583	369.360	56.796	15.386	33.989	587.114	0.0241	31	14.121
	Total	1,656,058	30,641	1,686,699	2,022,267	4,823,042	625,687	201,994	570,712	8,243,652		750,964	751,275

Table 18 Cost Benefit Analysis of Alternate Highway based on Scheme S - 2

IRR : 13.72%
Unit : Million Dong

	Year	Cost			Benefit						B/C Analysis		
					V.O.C Saving		Time Saving		Ferry Cost		Discout	Cost	Benefit
		Capital	Maintenance	Total	Normal Traffic	Diverted Traffic	Normal Traffic	Diverted Traffic	Saving	Total	Factor	Present Value	Present Value
1	1997	0	0	0	0	0	0	0	0	0	0.8794	0	0
2	1998	0	0	0	0	0	0	0	0	0	0.7733	0	0
3	1999	0	0	0	0	0	0	0	0	0	0.6800	0	0
4	2000	0	0	0	0	0	0	0	0	0	0.5979	0	0
5	2001	16.602	0	16.602	0	0	0	0	0	0	0.5258	8.729	0
6	2002	16.602	0	16.602	0	0	0	0	0	0	0.4624	7.676	0
7	2003	38.700	0	38.700	0	0	0	0	0	0	0.4066	15.735	0
8	2004	128.030	0	128.030	0	0	0	0	0	0	0.3575	45.774	0
9	2005	488.156	0	488.156	0	0	0	0	0	0	0.3144	153.471	0
10	2006	390.524	0	390.524	0	0	0	0	0	0	0.2765	107.964	0
11	2007	0	1.532	1.532	20.706	54.542	4.447	2.123	9.739	91.557	0.2431	372	22.258
12	2008	0	1.532	1.532	23.858	60.306	5.428	2.316	6.959	98.867	0.2138	328	21.135
13	2009	0	1.532	1.532	27.479	70.757	6.641	2.805	7.610	115.292	0.1880	288	21.673
14	2010	0	1.532	1.532	31.651	82.867	8.147	3.406	10.978	137.049	0.1653	253	22.655
15	2011	0	1.532	1.532	36.426	93.129	10.021	3.892	10.189	153.657	0.1454	223	22.336
16	2012	0	1.532	1.532	41.912	100.594	12.373	4.205	10.073	169.157	0.1278	196	21.622
17	2013	0	1.532	1.532	50.180	108.613	17.046	4.528	15.600	195.967	0.1124	172	22.027
18	2014	0	1.532	1.532	57.675	117.266	21.388	4.888	13.039	214.256	0.0988	151	21.177
19	2015	0	1.532	1.532	63.772	126.549	24.004	5.258	13.694	233.277	0.0869	133	20.276
20	2016	90.368	1.532	91.900	68.525	133.411	26.069	5.542	16.630	250.177	0.0764	7.024	19.121
21	2017	0	1.532	1.532	76.555	140.539	31.895	5.820	15.197	270.055	0.0672	103	18.150
22	2018	0	1.532	1.532	82.308	148.164	34.639	6.130	16.956	288.197	0.0591	91	17.033
23	2019	0	1.532	1.532	88.516	156.079	37.620	6.432	21.427	310.074	0.0520	80	16.115
24	2020	0	1.532	1.532	95.217	164.385	40.858	6.746	18.650	325.856	0.0457	70	14.892
25	2021	0	1.532	1.532	102.452	173.097	44.377	7.071	18.930	345.928	0.0402	62	13.902
26	2022	0	1.532	1.532	110.262	182.234	48.199	7.408	19.214	367.317	0.0353	54	12.980
27	2023	0	1.532	1.532	118.703	191.810	52.352	7.757	19.502	390.124	0.0311	48	12.123
28	2024	0	1.532	1.532	127.819	201.843	56.864	8.117	19.795	414.438	0.0273	42	11.325
29	2025	0	1.532	1.532	137.669	212.350	61.766	8.488	20.092	440.365	0.0240	37	10.581
30	2026	90.368	1.532	91.900	137.661	223.348	61.766	8.871	20.393	452.039	0.0211	1.942	9.551
Total		1.259.350	30.640	1.289.990	1,499.346	2.741.932	605.900	111.303	304.668	5.263.650		351.016	350.931

CHAPTER 13
PROJECT COST ESTIMATE

Appendix 13.1 Estimated Construction Cost (1)

Section 1 : Noi Bai - Bac Ninh (Initial Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			15,081,222
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	702,031	1,404,062
Soil Excavation	cu.m	18,000	0	0
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	1,465,737	87,944,220
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				89,348,282
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	440,537	2,643,222
Aggregate Subbase Course	cu.m	100,000	158,018	15,801,800
Asphalt Treated Base Course	cu.m	750,000	53,631	40,223,250
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	370,307	1,851,535
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	616,114	2,033,176
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	354,345	38,977,950
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,600	0	0
Sub Total				101,530,933
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	0	0
- ditto - (D=1.0m)	l.m	1,700,000	799	1,358,300
- ditto - (D=1.5m)	l.m	2,700,000	238	642,600
Box Culvert (1.5 x 1.5)	l.m	3,400,000	26	88,400
- ditto - (3.0 x 3.0)	l.m	10,300,000	720	7,416,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				9,505,300
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	731	7,310,000
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	21,206	275,678,000
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				282,988,000
(6) Miscellaneous Works	L.S			19,334,901
Total				517,788,638

Appendix 13.1 Estimated Construction Cost (2)

Section 1 : Noi Bai - Bac Ninh (Final Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			14,228,636
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	468,020	936,040
Soil Excavation	cu.m	18,000	0	0
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	1,159,340	69,560,400
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				70,496,440
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	411,807	2,470,842
Aggregate Subbase Course	cu.m	100,000	148,442	14,844,200
Asphalt Treated Base Course	cu.m	750,000	55,546	41,659,500
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	376,691	1,883,455
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	595,364	1,964,701
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	344,768	37,924,480
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				100,747,178
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	0	0
- ditto - (D=1.0m)	l.m	1,700,000	728	1,237,600
- ditto - (D=1.5m)	l.m	2,700,000	196	529,200
Box Culvert (1.5 x 1.5)	l.m	3,400,000	14	47,600
- ditto - (2.5 x 2.5)	l.m	6,000,000	0	0
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				1,814,400
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	731	7,310,000
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	21,206	275,678,000
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				282,988,000
(6) Miscellaneous Works	L.S			18,241,841
Total				488,516,495

Appendix 13.1 Estimated Construction Cost (3)

Section 2 : Bac Ninh - Chi Linh (Initial Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			12,584,360
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	74,822	149,644
Soil Excavation	cu.m	18,000	0	0
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	569,205	34,152,300
Sand Mat (t=50cm)	sq.m	45,000	49,500	2,227,500
Sub Total				36,529,444
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	453,827	2,722,962
Aggregate Subbase Course	cu.m	100,000	162,787	16,278,700
Asphalt Treated Base Course	cu.m	750,000	55,248	41,436,000
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	381,478	1,907,390
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	634,700	2,094,510
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	365,035	40,153,850
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				104,593,412
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	35	42,000
- ditto - (D=1.0m)	l.m	1,700,000	603	1,025,100
- ditto - (D=1.5m)	l.m	2,700,000	208	561,600
Box Culvert (1.5 x 1.5)	l.m	3,400,000	132	448,800
- ditto - (2.5 x 2.5)	l.m	6,000,000	9	54,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				2,131,500
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	573	286,500
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	121	1,210,000
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	14,388	187,044,000
Long Span Bridge	sq.m	30,000,000	2,385	71,550,000
Sub Total				260,090,500
(6) Miscellaneous Works	L.S			16,133,794
Total				432,063,010

Appendix 13.1 Estimated Construction Cost (4)

Section 2 : Bac Ninh - Chi Linh (Final Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			12,114,255
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	279,531	559,062
Soil Excavation	cu.m	18,000	15,456	278,208
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	307,190	18,431,400
Sand Mat (t=50cm)	sq.m	45,000	12,750	573,750
Sub Total				19,842,420
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	6,742	606,780
Subgrade Preparation	sq.m	6,000	279,531	1,677,186
Aggregate Subbase Course	cu.m	100,000	155,468	15,546,800
Asphalt Treated Base Course	cu.m	750,000	52,289	39,216,750
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	330,504	1,652,520
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	531,109	1,752,660
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	297,618	32,737,980
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				93,190,676
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	48	57,600
Pipe Culvert (D=1.0m)	l.m	1,700,000	332	564,400
Pipe Culvert (D=1.5m)		2,700,000	119	321,300
Box Culvert (1.5 x 1.5)	l.m	3,400,000	145	493,000
- ditto - (2.5 x 2.5)	l.m	6,000,000	9	54,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				1,490,300
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	121	1,210,000
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	14,388	187,044,000
Long Span Bridge	sq.m	30,000,000	2,850	85,500,000
Sub Total				273,754,000
(6) Miscellaneous Works	L.S			15,531,096
Total				415,922,747

Appendix 13.1 Estimated Construction Cost (5)

Section 3: Hong Gai - Cua Ong (Initial Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			17,790,204
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	390,211	780,422
Soil Excavation	cu.m	18,000	716,316	12,893,688
Rock Excavation	cu.m	120,000	32,432	3,891,840
Embankment (Borrow Material)	cu.m	60,000	945,876	56,752,560
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				74,318,510
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	5,849	526,410
Subgrade Preparation	sq.m	6,000	728,382	4,370,292
Aggregate Subbase Course	cu.m	100,000	252,716	25,271,600
Asphalt Treated Base Course	cu.m	750,000	117,870	88,402,500
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	745,027	3,725,135
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	1,193,525	3,938,633
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	667,188	73,390,680
Concrete Sidewalks	sq.m	140,000	280,920	39,328,800
Overlay (t=10cm)	sq.m	130,000	38,000	4,940,000
Sub Total				243,894,050
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	415	498,000
- ditto - (D=1.0m)	l.m	1,700,000	384	652,800
- ditto - (D=1.5m)	l.m	2,700,000	0	0
Box Culvert (1.5 x 1.5)	l.m	3,400,000	420	1,428,000
- ditto - (2.5 x 2.5)	l.m	6,000,000	71	426,000
Street Pipe Drain	l.m	1,500,000	23,000	34,500,000
Street U-Ditch	l.m	500,000	46,320	23,160,000
Sub Total				60,664,800
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	451	225,500
RC Slab Bridge (L<10m)	sq.m	6,000,000	892	5,352,000
- ditto - (with Piling)	sq.m	8,000,000	1,144	9,152,000
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	901	9,010,000
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	1,673	16,730,000
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	7,137	78,507,000
- ditto - (with Piling)	sq.m	13,000,000	5,565	72,345,000
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				191,321,500
(6) Miscellaneous Works	L.S			22,807,954
Total				610,797,018

Appendix 13.1 Estimated Construction Cost (6)

Section 4 : Cua Ong - Tien Yen (Initial Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			1,491,608
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	0	0
Soil Excavation	cu.m	18,000	0	0
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	0	0
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				0
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	0	0
Aggregate Subbase Course	cu.m	100,000	0	0
Asphalt Treated Base Course	cu.m	750,000	0	0
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	0	0
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	0	0
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	0	0
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	185,915	24,168,950
Sub Total				24,168,950
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	0	0
- ditto - (D=1.0m)	l.m	1,700,000	0	0
- ditto - (D=1.5m)	l.m	2,700,000	0	0
Box Culvert (1.5 x 1.5)	l.m	3,400,000	0	0
- ditto - (2.5 x 2.5)	l.m	6,000,000	0	0
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	0	0
Sub Total				0
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	1,274	637,000
RC Slab Bridge (L<10m)	sq.m	6,000,000	356	2,136,000
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	120	960,000
- ditto - (with Piling)	sq.m	10,000,000	407	4,070,000
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	104	832,000
- ditto - (with Piling)	sq.m	10,000,000	0	0
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	1,364	15,004,000
- ditto - (with Piling)	sq.m	13,000,000	0	0
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				23,639,000
(6) Miscellaneous Works	L.S			1,912,318
Total				51,211,876

Appendix 13.1 Estimated Construction Cost (7)

Section 4 : Cua Ong - Tien Yen (Final Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			5,056,851
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	216,528	433,056
Soil Excavation	cu.m	18,000	1,233,706	22,206,708
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	203,862	12,231,720
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				34,871,484
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	2,408	216,720
Subgrade Preparation	sq.m	6,000	443,935	2,663,610
Aggregate Subbase Course	cu.m	100,000	161,523	16,152,300
Asphalt Treated Base Course	cu.m	750,000	58,271	43,703,250
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	393,976	1,969,880
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	655,192	2,162,134
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	372,449	40,969,390
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				107,837,284
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	302	362,400
- ditto - (D=1.0m)	l.m	1,700,000	159	270,300
- ditto - (D=1.5m)	l.m	2,700,000	13	35,100
Box Culvert (1.5 x 1.5)	l.m	3,400,000	180	612,000
- ditto - (2.5 x 2.5)	l.m	6,000,000	0	0
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	36,180	18,090,000
Sub Total				19,369,800
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	0	0
- ditto - (with Piling)	sq.m	13,000,000	0	0
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				0
(6) Miscellaneous Works	L.S			6,483,143
Total				173,618,562

Appendix 13.1 Estimated Construction Cost (8)

Section 5 : Tien Yen - Bac Luan (Initial Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			3,557,582
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	110,376	220,752
Soil Excavation	cu.m	18,000	31,020	558,360
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	158,722	9,523,320
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				10,302,432
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	0	0
Subgrade Preparation	sq.m	6,000	87,480	524,880
Aggregate Subbase Course	cu.m	100,000	30,942	3,094,200
Asphalt Treated Base Course	cu.m	750,000	10,368	7,776,000
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	69,660	348,300
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	115,830	382,239
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	68,040	7,484,400
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	297,987	38,738,310
Sub Total				58,348,329
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	251	301,200
- ditto - (D=1.0m)	l.m	1,700,000	24	40,800
- ditto - (D=1.5m)	l.m	2,700,000	0	0
Box Culvert (1.5 x 1.5)	l.m	3,400,000	67	227,800
- ditto - (2.5 x 2.5)	l.m	6,000,000	12	72,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	2,820	1,410,000
Sub Total				2,051,800
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	1,893	946,500
RC Slab Bridge (L<10m)	sq.m	6,000,000	688	4,128,000
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	816	6,528,000
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	104	832,000
- ditto - (with Piling)	sq.m	10,000,000	0	0
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	1,872	20,592,000
- ditto - (with Piling)	sq.m	13,000,000	792	10,296,000
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				43,322,500
(6) Miscellaneous Works	L.S			4,561,002
Total				122,143,645

Appendix 13.1 Estimated Construction Cost (9)

Section 5 : Tien Yen - Bac Luan (Final Stage Construction)

Item	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) General	L.S			10,583,064
(2) Earthwork				
Clearing & Grubbing	sq.m	2,000	503,456	1,006,912
Soil Excavation	cu.m	18,000	581,502	10,467,036
Rock Excavation	cu.m	120,000	0	0
Embankment (Borrow Material)	cu.m	60,000	561,618	33,697,080
Sand Mat (t=50cm)	sq.m	45,000	0	0
Sub Total				45,171,028
(3) Pavement				
Removal of Existing Asphalt Pavement	cu.m	90,000	9,594	863,460
Subgrade Preparation	sq.m	6,000	771,120	4,626,720
Aggregate Subbase Course	cu.m	100,000	278,764	27,876,400
Asphalt Treated Base Course	cu.m	750,000	98,048	73,536,000
Prime Coat (1.0 liter/sq.m)	sq.m	5,000	658,760	3,293,800
Tack Coat (0.5 liter/sq.m)	sq.m	3,300	1,095,380	3,614,754
Asphalt Concrete Surface (t=10cm)	sq.m	110,000	620,460	68,250,600
Concrete Sidewalks	sq.m	140,000	0	0
Overlay (t=10cm)	sq.m	130,000	0	0
Sub Total				182,061,734
(4) Drainage Structures				
Pipe Culvert (D=0.8m)	l.m	1,200,000	596	715,200
- ditto - (D=1.0m)	l.m	1,700,000	778	1,322,600
- ditto - (D=1.5m)	l.m	2,700,000	261	0
Box Culvert (1.5 x 1.5)	l.m	3,400,000	953	3,240,200
- ditto - (2.5 x 2.5)	l.m	6,000,000	65	390,000
Street Pipe Drain	l.m	1,500,000	0	0
Street U-Ditch	l.m	500,000	37,480	18,740,000
Sub Total				24,408,000
(5) Bridges				
Removal of Existing Bridge	sq.m	500,000	0	0
RC Slab Bridge (L<10m)	sq.m	6,000,000	0	0
- ditto - (with Piling)	sq.m	8,000,000	0	0
RC Hollow Slab Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
RC T-Beam Bridge (10m<L<20m)	sq.m	8,000,000	0	0
- ditto - (with Piling)	sq.m	10,000,000	0	0
PC I-Beam Bridge (20m<L)	sq.m	11,000,000	7,960	87,560,000
- ditto - (with Piling)	sq.m	13,000,000	0	0
Long Span Bridge	sq.m	30,000,000	0	0
Sub Total				87,560,000
(6) Miscellaneous Works	L.S			13,568,030
Total				363,351,856

Appendix 13.2 Estimated Land Acquisition and Resettlement Cost (1)

Section 1 : Noi Bai - Bac Ninh (Initial Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	400,000	2834	1,133,600
Inhabited Land in Rural Area	sq.m	38,600	11,337	437,608
Rice Field/Cultivated Area	sq.m	19,300	1,155,880	22,308,484
Forest Area	sq.m	14,000	0	0
Subtotal				23,879,692
(2) Crop Compensation				
Rice	sq.m	7,200	1,155,880	8,322,336
Subtotal				8,322,336
(3) Resettlement/Compensation				
Permanent House	sq.m	1,500,000	580	870,000
Semi-Permanent House	sq.m	1,200,000	0	0
Temporary House	sq.m	500,000	0	0
Subtotal				870,000
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	3	18,000
Subtotal				18,000
Total				33,090,028

Section 2 : Bac Ninh - Chi Linh (Initial Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	400,000	4604	1,841,600
Inhabited Land in Rural Area	sq.m	38,600	0	0
Rice Field/Cultivated Area	sq.m	19,300	44,557	859,950
Forest Area	sq.m	14,000	25661	359,254
Subtotal				3,060,804
(2) Crop Compensation				
Rice	sq.m	7,200	44,557	320,810
Subtotal				320,810
(3) Resettlement/Compensation				
Permanent House	sq.m	1,500,000	2653	3,979,500
Semi-Permanent House	sq.m	1,200,000	0	0
Temporary House	sq.m	500,000	0	0
Subtotal				3,979,500
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	32	192,000
Subtotal				192,000
Total				7,553,114

Appendix 13.2 Estimated Land Acquisition and Resettlement Cost (2)

Section 2 : Bac Ninh - Chi Linh (Final Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	400,000	39,134	15,653,600
Inhabited Land in Rural Area	sq.m	38,600	0	0
Rice Field/Cultivated Area	sq.m	19,300	240,397	4,639,662
Forest Area	sq.m	14,000	0	0
Subtotal				20,293,262
(2) Crop Compensation				
Rice	sq.m	7,200	240,397	1,730,858
Subtotal				1,730,858
(3) Resettlement/Compensation				
Permanent House	sq.m	1,500,000	2,486	3,729,000
Semi-Permanent House	sq.m	1,200,000	0	0
Temporary House	sq.m	500,000	0	0
Subtotal				3,729,000
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	40	240,000
Subtotal				240,000
Total				25,993,120

Section 3 : Hong Gai - Cua Ong (Final Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	245,000	126,691	31,039,295
Inhabited Land in Rural Area	sq.m	24,200	173,240	4,192,408
Rice Field/Cultivated Area	sq.m	12,100	45,140	546,194
Forest Area	sq.m	8,900	45,140	401,746
Subtotal				36,179,643
(2) Crop Compensation				
Rice	sq.m	7,200	45,140	325,008
Subtotal				325,008
(3) Resettlement/Compensation				
Permanent House	sq.m	1,500,000	22,646	33,969,000
Semi-Permanent House	sq.m	900,000	11,323	10,190,700
Temporary House	sq.m	500,000	3,774	1,887,000
Subtotal				46,046,700
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	368	2,208,000
Subtotal				2,208,000
Total				84,759,351

Appendix 13.2 Estimated Land Acquisition and Resettlement Cost (3)

Section 4 : Cua Ong - Tien yen (Final Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	150,000	2,519	377,850
Inhabited Land in Rural Area	sq.m	19,400	0	0
Rice Field/Cultivated Area	sq.m	12,100	30,538	369,510
Forest Area	sq.m	8,920	183,471	1,636,561
Subtotal				2,383,921
(2) Crop Compensation				
Rice	sq.m	7,200	30,538	219,874
Subtotal				219,874
(3) Resettlement/Compensation				
Permanent House	sq.m	1,300,000	3,143	4,085,900
Semi-Permanent House	sq.m	900,000	1,571	1,413,900
Temporary House	sq.m	400,000	524	209,600
Subtotal				5,709,400
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	0	0
Subtotal				0
Total				8,313,195

Section 5 : Tien Yen - Bac Luan (Initial Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	150,000	0	0
Inhabited Land in Rural Area	sq.m	19,400	0	0
Rice Field/Cultivated Area	sq.m	12,100	55,188	667,775
Forest Area	sq.m	8,920	55,188	492,277
Subtotal				1,160,052
(2) Crop Compensation				
Rice	sq.m	7,200	55,188	397,354
Subtotal				397,354
(3) Resettlement/Compensation				
Permanent House	sq.m	1,300,000	607	789,100
Semi-Permanent House	sq.m	900,000	304	273,600
Temporary House	sq.m	400,000	101	40,400
Subtotal				1,103,100
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	15	90,000
Subtotal				90,000
Total				2,750,506

Appendix 13.2 Estimated Land Acquisition and Resettlement Cost (4)

Section 5 : Tien Yen - Bac Luan (Final Stage)

Description	Unit	Unit Cost (Dong)	Quantity	Total (1000 Dong)
(1) Land Acquisition/Compensation				
Inhabited Land along Existing Road	sq.m	150,000	4,345	651,750
Inhabited Land in Rural Area	sq.m	19,400	75,184	1,458,570
Rice Field/Cultivated Area	sq.m	12,100	200,344	2,424,162
Forest Area	sq.m	8,920	223,583	1,994,360
Subtotal				6,528,842
(2) Crop Compensation				
Rice	sq.m	7,200	200,344	1,442,477
Subtotal				1,442,477
(3) Resettlement/Compensation				
Permanent House	sq.m	1,300,000	1,803	2,343,900
Semi-Permanent House	sq.m	900,000	902	811,800
Temporary House	sq.m	400,000	300	120,000
Subtotal				3,275,700
(4) Other Compensation				
Cost Relevant to Relocating house	nos.	6,000,000	44	264,000
Subtotal				264,000
Total				11,511,019

CHAPTER 14
ECONOMIC PROJECT ANALYSIS

Appendix A - 14.1 Income Structure in Study Area/Month

Income Class	Average	Percentage of Total
Upper class	445,690 Dong	2%
Lower upper class	173,750 Dong	15%
Middle class	94,540 Dong	37%
Lower middle class	62,050 Dong	25%
Lower class	38,980 Dong	21%
Total	815,010 Dong	100%

Source : Statistical data on labor and social affairs 1994

Appendix A - 14.2 Vehicle Price for Vehicle Operating Cost Calculation (Financial price in Table - 1)

Unit : Million dong

Passenger Car	Component	Average Value	Weighed Price	Registration Fee	Financial Price
Import	40%	270	108 204	5%	214
Knock-down	60%	160	96		

Bus	Registered Amount	%	Average Value	Weighed Price	Financial Cost Registration Fee 5%
less than 12 seats	941	60%	370	222	
12 - 36 seats	644	40%	100	40	265
more than 36 seats	2,259		900		945
Truck					
less than 1 ton	1,048	11%	240	26	
1 - 3 tons	680	7%	240	17	
3 - 5 tons	7,728	82%	270	221	
	9,456	100%		246	277
5 - 7 tons	16,875	90%	560		
7 - 10 tons	1,556	8%	560		
more than 10 tons	230	2%	560		
	18,661	100%		560	588
Van			225	225	236
Motorcycle					
Honda "Dream"		20%	22.5	6	
70cc		50%	18.0	9	
50cc		30%	17.5	4	
				19	19.8

Authorized Value of Vehicle : Vehicle value to levy for registration tax by Ha Noi Vehicle Taxation Department, Vietnam State Treasury.
Averaged class 1 and class 2
Value revised every 2 years

Appendix A - 14.3 Procedure and Equation for Unit Vehicle Operating Cost Calculation

B - 1 Fuel Cost

Financial Fuel Cost = Financial Fuel Price x Fuel Consumption (l/km) Economic Fuel Cost = Economic Fuel Price x Fuel Consumption (l/km)

B - 2 Lubricant Oil Cost

Financial Lubricant Oil Cost = Financial Lubricant Oil Price (liter) x Lubricant Oil Consumption (l/100km) Economic Lubricant oil Cost = Economic Lubricant Oil Price (liter) x Lubricant Oil Consumption (l/100km)

B - 3 Tyre Cost

Financial Tyre Cost = Financial Tyre Unit Price x Number of Tyre ÷ Tyre Life km Economic Tyre Cost = Economic Tyre Unit Price x Number of Tyre ÷ Tyre Life km

B - 4 Maintenance Cost

- Parts Financial Maintenance Parts Costs = Financial Vehicle Price ÷ Vehicle Life Km x Maintenance Spare Parts per year (%) Economic Maintenance Parts Costs = Economic Vehicle Price ÷ Vehicle Life Km x Maintenance Spare Parts per Year (%)

- Labor Financial Maintenance Labor Costs = Financial Maintenance Labor Cost (per hour) x Maintenance Labor Working Hour (per year) ÷ Vehicle Annual Km Economic Maintenance Labor Costs = Economic Maintenance Labor Cost (per hour) x Maintenance Labor Working Hour (per year) ÷ Vehicle Annual Km

B -5 Depreciation Cost (A part of Capital Cost) - distance related portion

Financial Depreciation cost = Financial vehicle price ÷ Vehicle life Km x depreciation distance related (60%)
Economic Depreciation cost = Economic vehicle price ÷ Vehicle life Km x depreciation distance related (60%)

Capital Cost

Capital cost consists of depreciation cost and interest cost. The depreciation cost is composed of two parts : distance-related portion and time-related portion. For the estimation of capital cost : price of vehicle cost has to estimate in advance both its financial and economic cost.

Capital Cost	Depreciation - distance related	Running cost
	Depreciation - time related	Fixed cost
	Interest	Fixed cost

B- 6 Depreciation - time related

Financial Depreciation Cost = Financial vehicle price ÷ Vehicle life Km x depreciation distance related (60%)
Economic Depreciation Cost = Economic vehicle price ÷ Vehicle life Km x depreciation distance related (60%)

B - 8 Crew Costs

Crew number (1) x Financial crew cost per hour = Financial crew cost
Crew number (1) x Economic crew cost per hour = Financial crew cost

B - 9 Overhead Cost

This component is the most difficult to estimate; often a certain percentage (between 10 and 20%) of total annual cost is applied.

B - 10 Registration Cost (License and Insurance)

Registration tax per year ÷ Vehicle annual operating hours = Financial registration costs
0 = Economic costs

B - 11 Factor

Fleet reduction factor = Productivity of Saving hour (%)

B - 12 Equation of Vehicle Operating Costs

Passenger car	$y = 0.514 x^2 - 79.84 x + 4828$
Bus	$y = 0.745 x^2 - 93.19 x + 6186$
Truck	$y = 0.972 x^2 - 126.88 + 6952$
Motor Cycle	$y = 0.0083 x^2 - 7.53 x + 462$

Where : y = Vehicle Operating Cost
x = Running Speed (km/h)

Appendix A - 14.4 Explanation and Calculation of Benefits Resulting from Ferry Saving Cost

(1) Methodology

1. First, the total present value of the total waiting time of ferry traffic will be calculated, discounted at 12% of the capital.

2. The total present value of ferry's additional investment cost discounted at capital opportunity cost (12%) is then calculated.

3. When both totals are equal to each other, investment is feasible. The investment scale of ferry boat, proven economically feasible, will be calculated as a benefit of the bridge (As ferry boat will not be used if bridge is constructed).

(2) Amount of Ferry Traffic in the Case Without Bridge

1. All traffic on route 18 uses the ferry. For example in year 2000, the passenger car unit (PCU) will be 3,830 per day.

2. Traffic volume at peak hour will be 383 per hour; 10% of the total traffic volume.

3. Minimum number of ferries required:

- Ferry capacity of 20 PCU per boat
- Ferry trips twice in one hour : so that it carries 40 PCU per hour.
- During the peak hour; number of ferry vessels required will be 10: 383 ÷ 40 = 10.
- The average ferry traffic volume per hour is 4 vessels ; 383 vehicles ÷ 24 hours = 160 vessels ÷ 40 = 4 vessels.

4. Thus, minimum number of ferry vessels required is four (4), and at peak hours ten (10). For the present calculation, the average figure of 7 was used. By the year 2019 the daily ferry traffic would require 67 vessels.

5. Number of Ferry Boats Needed and the Cost.

The life span of a ferry is 6 years. The average yearly amount of purchase is 3 vessels. A ferry costs 12 million dong, and it is traded in for a new one at 20% six year later.

There are other costs; (1) harbor, (2) ticket sales office and waiting facilities, (3) operational costs such as personnel expenses, and fuel expenses, (4) management costs. Ferry costs by the year 2019 will be 374.168 million dong.

Table A - 14.4.1 Section 2 Pha Lai Ferry Projection
(for Comparison with Bridge Substitution)

Traffic = Passenger Car Unit

	Total	Peak	Max.	Hour	Min.	Ave.
	a	b = a x 10%	c = b/40	d = a/24	e = d/40	f =(d+f)/2
	Vehicle	Vehicle	Ship	Vehicle	Ship	Ship
2000	3,830	383	10	160	4	7
2001	4,839	484	12	202	2	9
2002	6,118	612	15	255	6	11
2003	7742	774	19	323	8	14
2004	9805	981	25	409	10	17
2005	12427	1243	31	518	13	22
2006	13530	1353	34	564	14	24
2007	14736	1474	37	614	15	26
2008	16050	1605	40	669	17	28
2009	17485	1749	44	729	18	31
2010	19049	1905	48	794	20	34
2011	20575	2058	51	857	21	36
2012	22621	2262	57	943	24	40
2013	24656	2466	62	1027	26	44
2014	26878	2688	67	1120	28	48
2015	29306	2931	73	1221	31	52
2016	31211	3121	78	1300	33	55
2017	33240	3324	83	1385	35	59
2018	35400	3540	89	1475	37	63
2019	37701	3770	94	1571	39	67
2020	40152	4015	100	1673	42	71
2021	42762	4276	107	1782	45	76
2022	45541	4554	114	1898	47	81
2023	48501	4850	121	2021	51	86
2024	51654	5165	129	2152	54	91
2025	55011	5501	138	2292	57	97
2026	58587	5859	146	2441	61	104

(3) Benefits of Waiting Time Saved

Large ferry cost should be analyzed feasible for investment. Benefits of ferry investment : (1) saving of waiting time, (2) year-round river crossing made possible (including flood periods).

For the calculation of waiting time saving, normal traffic and generated traffic is included. Diverted traffic is not counted.

About 12% of the normal and generated traffic have to wait in line for 2.5 hours during the peak hours.

For instance, in year 2000 normal traffic volume of passenger car per day will be 219.

- Cars waiting in line is 26 vehicles; 12%
- Time value per hour is 11,048 dong a vehicle and 7,730 dong per passenger = 18778 dong.
- Therefore, when 219 vehicles wait in line for one hour, the cost will be 493,486 dong.

Waiting time value of the generated traffic is a half.

(4) Flood Benefit

Flood occurs 2 - 3 times every year. Once in 8 years, water level reaches to P = 12%, and it becomes impossible to cross for 5 - 7 days. Users of the ferry make a detour of 25km to National Highway No.1, and of 80.8 km to Highways Nos.5 and 183.

Driving cost and time benefit is calculated for the case of ferry stop for 3.5 day a year. The analysis includes only the normal traffic.

(5) Investment feasibility analysis

Table 14.28 is the analysis of cost and benefit comparison for the case of ferry investment. Discounted at 12% of the capital opportunity cost. Benefit shows more than cost.

Thus the ferry investment is feasible from a national viewpoint. Lastly, this investment amount is regarded as a benefit of bridge construction, because ferry investment will be saved by the bridge.