Chapter 9

SELECTION OF THE ROUTE LOCATION

CHAPTER 9 SELECTION OF THE ROUTE LOCATION

9.1 General

This section describes the results of the initial route study which aimed i) to pick up the possible route alternatives taking into account the socio-economic, environmental and physical conditions in the project area and ii) to narrow them down through comparative study to short-listed alternatives (see Figure 9.1).

Such short-listed alternatives were then compared in more detail based on the study results of traffic demand forecast, inhabitants resettlement, topographic conditions and soil conditions to select an optimum route.

The Highway No. 18 for the feasibility study consists of the following five (5) sections:

- Noi Bai to Bac Ninh, along Provincial Highway Nos. 401 and 286;
- Bac Ninh to Chi Linh, National Highway No. 18;
- Hong Gai to Cua Ong, National Highway No. 18;
- Cua Ong to Tien Yen, National Highway No. 18; and
- Tien Yen to Bac Luan, National Highway No. 18.

9.2 Methodology of the Study

Based on the information gathered through the site investigations and the examination of the different scale of maps, possible alternative subcorridors (route) are studied for the above five sections, paying special attention to the social, environmental, economic and technical points of view. Among others, the study has focused to the main check items described below:

- Land acquisition and compensation/ inhabitants resettlement;
- Primary control points;
- Landuse;
- Topography;
- Horizontal and vertical alignments; and
- Length of route.

(1) Land Acquisition and Compensation/Inhabitants Resettlement

The optimum route in regards to land acquisition and compensation/ inhabitants resettlement was chosen, avoiding existing commercial centers (i.e. Hong Gai and Cam Pha), towns and villages and with the least intervention to existing roads and railways.

(2) Control Points

The following were considered as the primary control points in the route selection:

- Commercial centers, congested towns and villages;
- Temples, churches, pagodas;
- Public facilities and buildings (i.e. school, hospitals, markets);
- Military facilities;
- Sufficient spaces for interchanges and functions;
- Major roads and railways crossings; and
- River crossings.

(3) Landuse

To select each alternative route, due attention was paid to present and future landuse of the area and possible environmental impacts.

(4) Topography

In setting alternative subcorridors attention was paid to the following:

- Effective use of waterways; and

- Avoidance of river, major highway, or railway crossing at an acute angle.

(5) Horizontal and Vertical Alignments

Horizontal and vertical alignments were determined so as to satisfy the established geometric design standard for the safety and comfort of users. Highway aesthetics was also considered.

(6) Length of Route

The shortest possible route was considered preferable.

9.3 Salient Features of Alternative Routes

(1) Corridor from Noi Bai to Bac Ninh

The Noi Bai - Bac Ninh corridor follows an east-west axis. The corridor diverts from Hanoi/Noi Bai Airport Highway in front of Noi Bai Airport, goes east and traverses National Highway Nos. 2 and 3. The corridor continues to run eastward parallel with the provincial highway Nos. 401 and 286, crossing the Ca Lo river at approximately 12 km, the Ngu Huyen Khe river at approximately 27 km, and then connects with National Highway No. 18 at approximately 33 km and further connects with National Highway No. 1 at Bac Ninh.

The following four alternative routes were established in the corridor to select an optimum route:

Alternative A : Most of the route stretch runs along provincial highway Nos. 401 and 286, except the first 2 km section and the last 7 km section which runs in the northern part of Bac Ninh town and connects with National Highway No. 18 east of Bac Ninh Town.

Alternative B-1 : This route traverses on the northern part of the subcorridor, about 100 to 1,000 meters north of provincial highway Nos. 401 and 286, to avoid settled areas.

Alternative B-2 : This route is a modification of Alternative B-1. It diverts from Alternative B-1 at 22 km, turns to the southeast and accesses to the southern part of Bac Ninh Town, connecting with existing National Highway No. 18 after crossing National Highway No. 1.

Alternative B-3 : This route is the same as Alternative B-1 up to 18 km and then turns southeast to connect with Alternative A. The route diverts from Alternative A at Sta. 25 + 300 and merges into Alternative B-1 at Sta. 27 + 150 .

(2) Corridor from Bac Ninh to Chi Linh

It has been proposed that existing roadway of National Highway No. 18 be widened from 7 m to 12 meters. The following four alternatives were studied to compare bypass construction and widening of the existing road.

Alternative A-1 : Widening of the existing National Highway No. 18 (Existing Route)

Alternative A-2 : Bypass from 24 km + 500 to 26 km + 750 to select an optimum location of new Pha Lai bridge and to avoid settled areas.

Alternative A-3 : Bypass from 29 km + 00 to 31 km + 00 to avoid small radius of horizontal curves and settled areas.

Alternative A-4 : Bypass from 9 km + 00 to 12 km + 750 to avoid settled areas. In case that a four-lane road with shoulders is planned due to traffic demand or in the event that it is decided not to introduce an alternate highway, this alternative will be more advantageous, compared with widened the existing route into a four-lane road which adversely affects a large number of houses in the towns of H.Que Vo district.

(3) Corridor from Hong Gai to Cua Ong

This corridor requires four lane divided road with shoulders due to the large traffic demand.

Types C-2, C-3 and B of typical cross sections (refer to Section 10.3 in Chapter 10) were applied to study the right-of-way width from the viewpoint of inhabitants resettlement occurring in case of widening of existing road.

The existing National Highway No. 18 will be widened to four lanes. The following three alternatives have been studied :

Alternative A : This route consists of access road to Bai Chay bridge and of widening of the existing National Highway No. 18.

Alternative B-1 : Ha Tu Bypass from 132 km + 00 to 135 km + 300, to avoid small radius horizontal curves and to reduce the number of inhabitants to be resettled.

Alternative B-2 : Cam Pha Bypass from 143 km + 800 to 149 km + 140 (= 150 km + 00), to reduce the number of inhabitants to be resettled due to roadway widening.

(4) Corridor from Cua Ong to Tien Yen

Based on the traffic demand forecast for 2015, this corridor from the end point of Cua Ong to the beginning point of Tien Yen requires a two-lane road with shoulders.

Type A-1 and B of typical cross sections (refer to section 10.3 in Chapter 10) were applied to study the right-of-way width from the viewpoint of inhabitants resettlement due to widening of existing road. Type A-1 was applied to the Mong Duong section from the end point of Cua Ong to the end point of Mong Duong Town. Type B was applied to the other section from the end point of Mong Duong to the beginning point of Tien Yen.

Except for minor improvement of horizontal alignments, this corridor does not have an alternative but to widen existing road section.

(5) Corridor from Tien Yen to Bac Luan

This corridor requires a 2-lane 2-way road with shoulders to accommodate the traffic demand for 2015. Types A-2, A-3 and B of typical Cross Sections (refer to Section 10.3 in Chapter 10) were applied. Type B was adopted for the section from Tien Yen to the western point of Mong Cai and types A-2 and A-3 for the sections in Mong Cai. The existing National Highway No. 18 will be widened to a 2-lane road. The five following alternatives have been studied:

Alternative A : This route requires the widening of the existing National Highway No. 18.

Alternative B-1 : Tien Yen Bypass from Sta.206 + 00 to Sta.212 + 00 to avoid small radius horizontal curves and settled areas.

Alternative B-2 : Dam Ha Bypass from Sta.235 + 00 to Sta.239 + 00 to reduce the number of inhabitants of Dam Ha Town to be resettled in.

Alternative B-3 : Ha Coi Bypass from Sta.258 + 00 to Sta.269 + 00 to shorten the route and to avoid settled areas.

Alternative C : Realignment of street in Ha Coi Town from Sta.263 + 00 to Sta.266 + 00 to avoid the existing National Highway No. 18 where it becomes a narrow street in Ha Coi Town.

9.4 Comparison of Alternative Routes and Recommendation

The locations of route alternatives in the four (4) corridors are shown in Table 9.1 to Table 9.10.

9.4.1 Corridor from Noi Bai to Bac Ninh

The comparison of alternative routes was conducted applying the cleared area of 46.00 meters in width for type D of typical cross sections. In case of widening the existing provincial roads Nos. 401 and 286, more than 1242 houses must be demolished, according to the site survey. The alternative routes were established to reduce that number, and to employ technical modification.

The comparison of each route is shown in Table 9.1 from technical and environmental points of view.

(1) Comparison of Alternative Routes

Alternative A : This route can not be recommended, considering the required demolition of approximately 450 houses, 1 school, 2 industrial factories, 2 temples, 1 hospital, 2 cemeteries, 3 public facilities and 1 shop.

Alternative B-1 : This route is better than Alternative A with less need for demolition and fewer adverse environmental effects.

Alternative B-2 : This route is recommended for the following reasons:

- The number houses demolished is the least; equal to Alternative B-1;
- Future extension of this route from Bac Ninh to Bai Chay is planned for construction south of Highway No. 18.

Alternative B-3 : This route is a combination of Alternatives A and B-1 and is not superior to Alternative B-2 regarding demolition, environmental effects, future extension, and interchange with Highway No. 1

9.4.2 Corridor from Bac Ninh to Chi Linh

More than 1,153 houses will need to be demolished for the widening of the existing Highway No. 18 with the clear area of 30.5 meters in width for type A-1 of typical cross sections. Three locations were selected for a comparative study.

(1) Alternative A-2 (Pha Lai Bridge Route)

Alternative A-2 is superior to the widening of the existing No. 18 in the following regards:

- Horizontal alignment;
- Number of inhabitants resettled;
- Impact during the construction; and
- Right-of-way cost.

The comparison of the alternatives is indicated in Table 9.2 and Alternative A-2 has been recommended.

(2) Alternative A-3 (Pha Lai Bypass)

Alternative A-3 has been compared with the widening of the existing Highway No. 18 and recommended for the reasons stated in the above paragraph (1). The comparison of the alternatives is described in Table 9.3.

(3) Alternative A-4 (Phuong Mao Bypass)

Alternative A-4 requires the demolition of only 7 houses while the widening of the existing Highway No. 18 requires the demolition of 69 houses and 3 public facilities. This Alternative A-4 is advantageous considering the possibility of its future widening to four lanes, which if undertaken on the existing National Highway No. 18, would require the demolition of more than 200 houses. Therefore, Alternative A-4 will be selected in the event that a 4-lane road is adopted. Construction cost of Alternative A-4 is much higher than the widening since it would be a newly constructed road. As the results of the comparison shown in Table 9.4, Alternative A-1 is recommended due to the required number of two lanes.

9.4.3 Corridor from Hong Gai to Cua Ong

More than 2,232 houses must be demolished for the widening of the existing Highway No. 18 for type C-2 (clear area is 30.50 m wide/urban type). An alternative route study was undertaken for two locations (Ha Tu and Cam Pha) applying type C-2 (30.5 m wide/urban type) of typical cross sections.

(1) Alternative B-1 (Ha Tu Bypass)

Alternative B-1 has been recommended compared with Alternative A-1 due to its superiority in the following regards as shown in Table 9.5;

- Length of road;
- Number of houses to be demolished; and
- Impact during the construction.

(2) Alternative B-2 (Cam Pha Bypass)

Alternative B-2 has been recommended since there would be less property demolition and adverse environmental effects during the construction, those of which are compared in Table 9.6.

9.4.4 Corridor from Cua Ong to Tien Yen

There is no alternative route in this corridor, as mentioned in paragraph 9.3 (4).

9.4.5 Corridor from Tien Yen to Bac Luan

Type B with a clear area of 27.5 meters in width of typical cross sections will require the demolition of more than 1,400 houses. Four locations were selected to minimize the number of houses demolished.

(1) Alternative B-1 (Tien Yen Bypass)

Alternative B-1 has been recommended compared with Alternative A-1 of widening the existing road as the results of the comparison Table 9.7.

(2) Alternative B-2 (Dam Ha Bypass)

Alternative B-2 of Dam Ha Bypass is recommended. Reference will be made to Table 9.8.

(3) Alternative B-3 (Ha Coi Bypass)

Alternatives A and B-3 are compared in Table 9.9 for the selection of the more advantageous route. This bypass is costly but shortens the existing highway by 3.48 km. This route is recommendable, but will be constructed after the completion of Alternative C and after 2015 to avoid double investment, since Alternative C has a priority due to the nature of local and industrial road.

(4) Alternative C (Realignment in Ha Coi Town)

Alternative C is recommendable in comparison with Alternative A (widening of the existing road) considering the amount of demolition, number of bridges needed, and construction cost.

The comparison is shown in Table 9.10.

SECTION 1 (NOI BAI ~ BAC NINH)

CROSS SECTION TYPE D

STA.2-000

STA.29+500

Airport

PHU LO

Ca Lo River

Alternative B-1, B-2, B-3

Alternative B-3

NOI BAI

Alternative A

Ngu Huyen Khe River

Red River

HA NOI

HA DONG

SOC SON

SECTION 2 (BAC NINH ~ CHI LINH)

CROSS SECTION TYPE A-1

STA.2-010

STA.34+380

BAC GIANG

Alternative B-1

Alternative A

Cau River

BAC NINH

Alternative A-1

Alternative B-2

Alternative A-4

Alternative A-2

Duong River

Alternative A 3

PHA LAI

CHI LINH

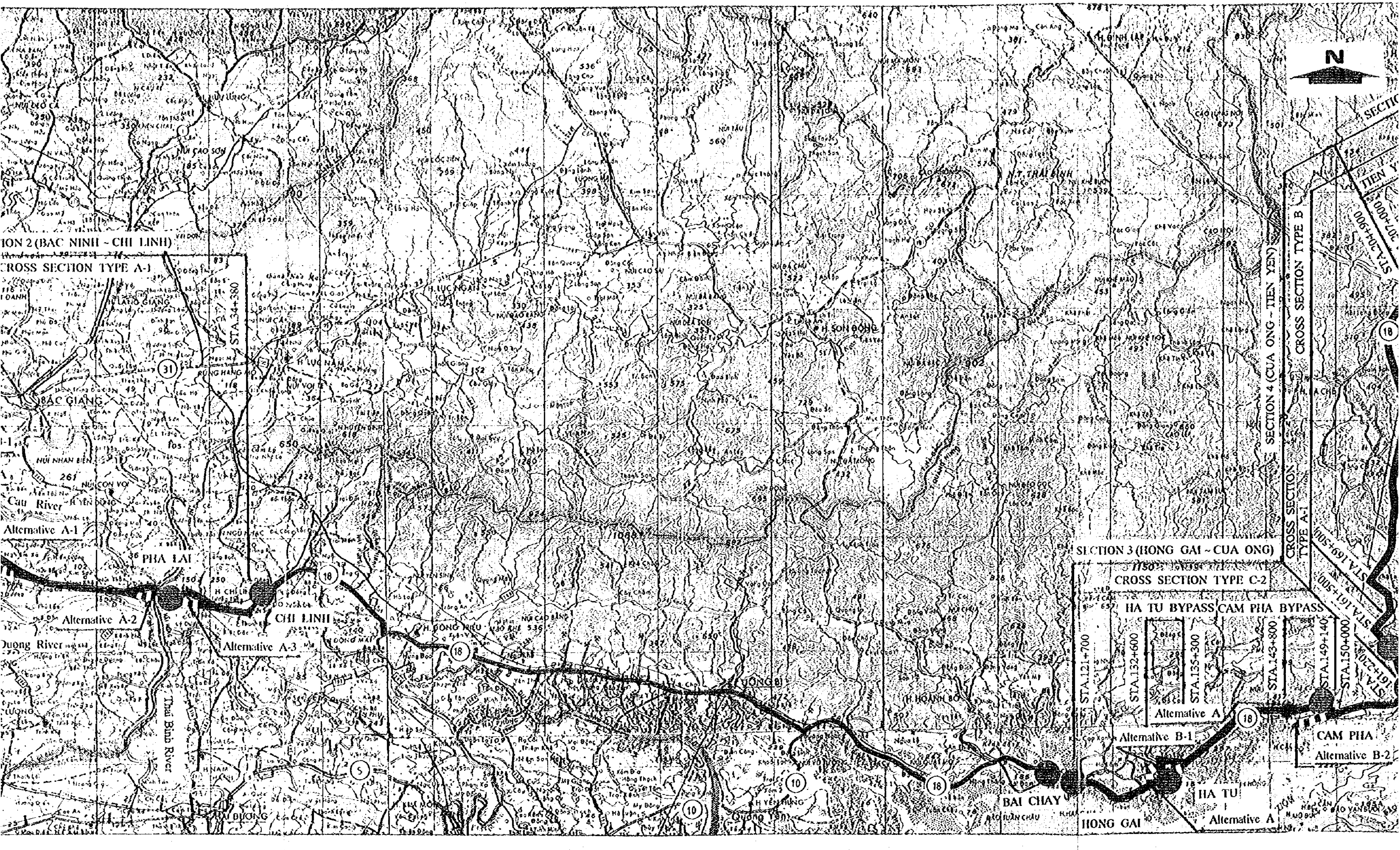
Thai Binh River

HAI DUONG

LUC NGAN

LUC NAM

SUOI VOI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ION 2 (BAC NINH ~ CHI LINH)
CROSS SECTION TYPE A-1
STA.34+380
BAC GIANG
Cau River
Alternative A-1
PHA LAI
Alternative A-2
CHI LINH
Alternative A-3
Duong River
Thai Binh River
SECTION 3 (HONG GAI ~ CUA ONG)
CROSS SECTION TYPE C-2
HA TU BYPASS
CAM PHA BYPASS
STA.121+700
STA.132+600
STA.135+300
STA.143+800
STA.149+140
STA.150+000
Alternative A
Alternative B-1
CAM PHA
Alternative B-2
BAI CHAY
HONG GAI
HA TU
Alternative A
SECTION 4 (CUA ONG ~ TIEN YEN)
CROSS SECTION TYPE B
CROSS SECTION TYPE A-1
STA.169+500
STA.161+500
STA.161+200
STA.204+900
STA.207+000
SECTIO
TIEN Y
18
31
5
10

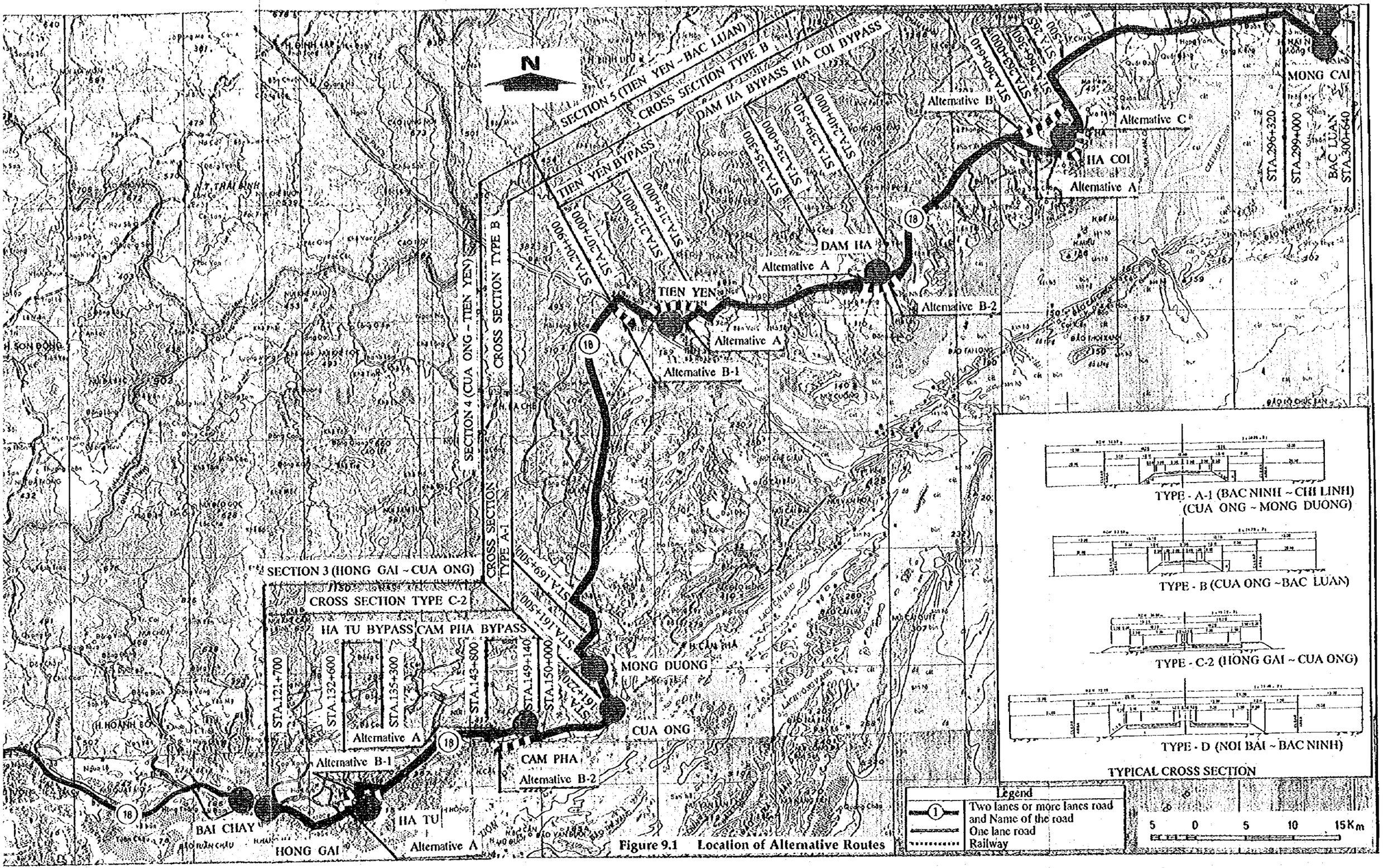
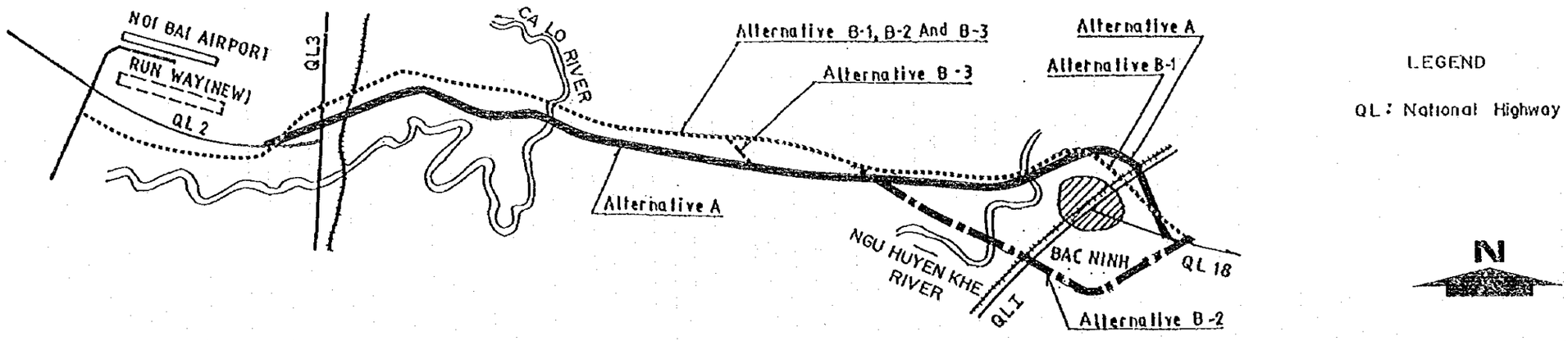


Figure 9.1 Location of Alternative Routes

Item / Alternative	A	B - 1	B - 2	B - 3
Road Length (Km)	30.9	30.9	31.3	30.9
Horizontal Alignment	Min. Radius = 600m	Min. Radius = 1000m	Min. Radius = 1000m	Min. Radius = 1000m
Control Points to be Demolished (1) Public Properties (2) Residential Houses	school - 1 shop - 1 temple - 1 hospital - 1 cemetery - 2 public facilities - 3 houses - 242	school - 1 public facility - 1 houses - 3	school - 1 public facility - 1 houses - 3	school - 1 public facility - 1 houses - 3
Environmental Adverse Effect (Area on both sides of road within 100m from road center)	temples (pagodas) - 3 school - 1 hospital - 1	temples (pagodas) - 0 school - 0 hospital - 0	temples (pagodas) - 0 school - 0 hospital - 0	temples (pagodas) - 0 school - 0 hospital - 0
Landuse	Arable Land & Residential Area	Arable Land & Residential Area	Arable Land & Residential Area	Arable Land & Residential Area
Impact During the Construction (Traffic Diversion)	Only diversing and marging points with the existing roads will be affected during the construction. (small)	Same as Alt.A (small)	Same as Alt.A (small)	Same as Alt.A (small)
Construction and R.O.W cost	Construction cost is lower, but R.O.W cost is higher than other alternatives. (moderate)	Construction cost is higher, but R.O.W cost is lower than Alt.A (high)	Construction cost is a little bit higher than Alt.B-1 & B-3, but negligible. R.O.W cost is lower than Alt.A (high)	Same as Alt.B-1 (high)
Recommendation	This route can not be recommendable from a view point of the requirement of demolition of 1242 houses.	This route is better than Alternative A from view points of the demolition and environmental adverse effect.	This route is recommended due to the following : * The number of demolition of houses is smallest as well as Alternative B-1; * Future extension of this route from Bac Ninh to Bai Chay is expected to be constructed in the southern area to Highway No.18	This route is a combination of Alternatives A and B-1 and is not superior to Alternative B-2 from a view point of demolition, environmental effects, future extension and interchange with Highway No.1
Evaluation (priority)	4	3	1	2

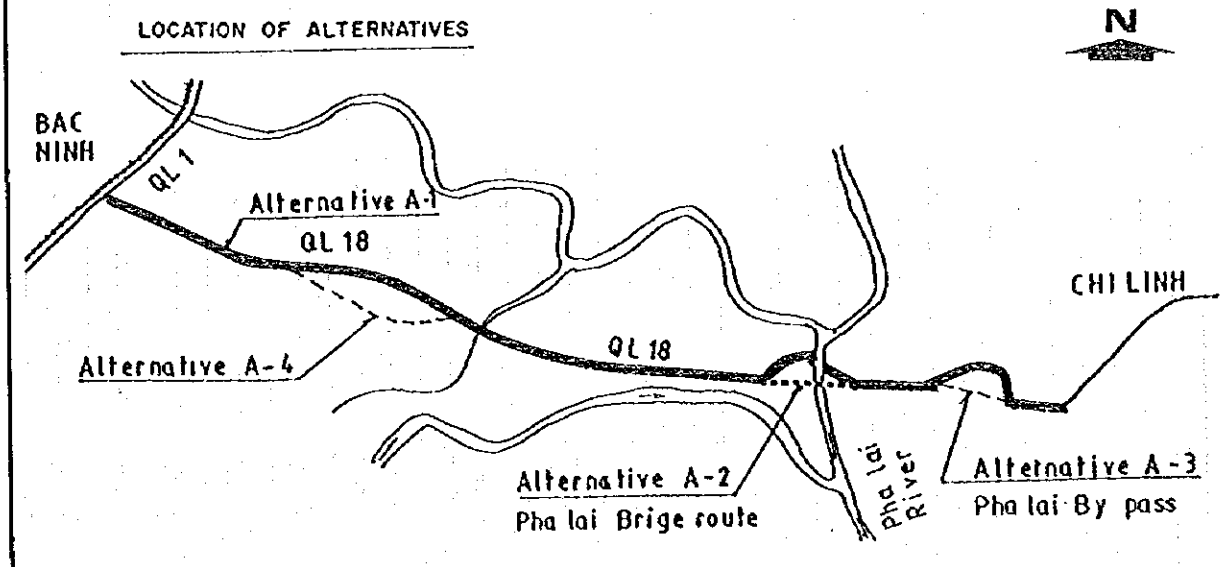
LOCATION OF ALTERNATIVES



HIGHWAY NO.18 IMPROVEMENT

Table 9. 1 Comparison of Alternative Routes for the Section of Noi Bai to Bac Ninh from Sta.-2-00 to Sta.31+310

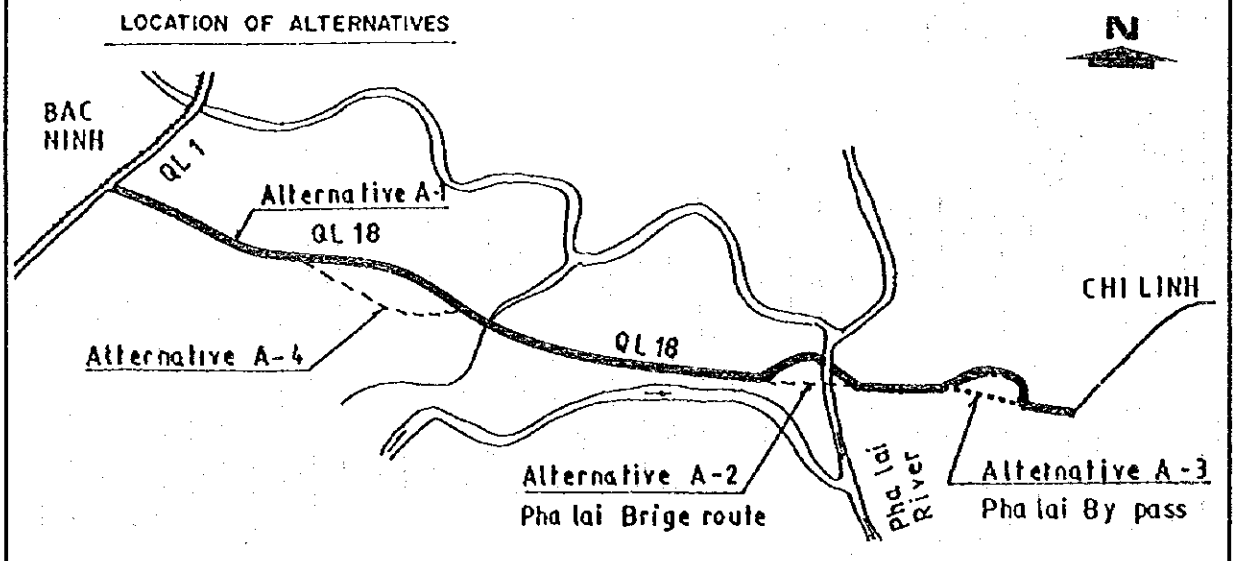
Item / Alternative	A - 1 (Existing Road)	A-2 (Pha Lai Bridge Route)
Road Length (Km)	2.43	2.25
Horizontal Alignment	Min. Redius = 150m	Min. Radius = 1,000m
Control point s to be demolished (1) Public Properties (2) Residential Houses	(1) 0 (2) 23 houses	(1) 3 industrial factories (2) 22 houses
Environmental Adverse Effect (Area on both sides of road within 100m from road center)		
Landuse	Arable Land & Residential Area	Arable Land & Residential Area
Impact During the Construction (Traffic Diversion)	Replacement of ferry ports is required during the construction (big)	(small)
Construction and R.O.W cost	(high)	Construction and R.O.W cost is almost same as A - 1 and the number of demolition of houses is less than A - 1 (high)
Recommendation		This route is recommended due to the following : ' Horizontal Alignment is better; ' Number of demolition is smaller; and ' Right of way cost is lower.
Evaluation (priority)	2	1



HIGHWAY NO. 18 IMPROVEMENT

Table 9.2 Comparison of Alternative Routes for Pha Lai Bridge route from Sta.24+500 to Sta.26+750

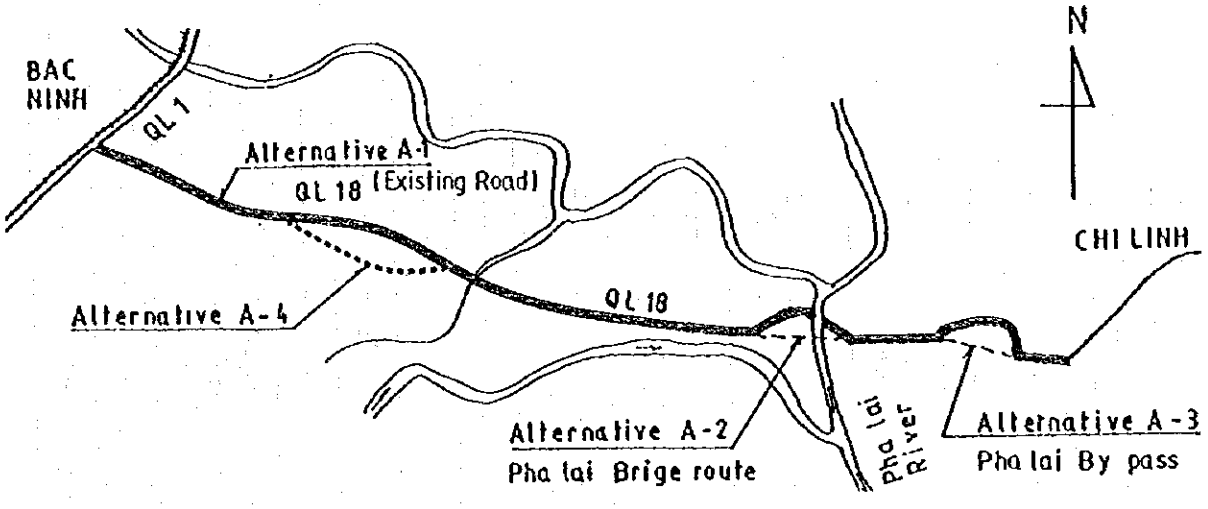
Item / Alternative	A - 1 (Existing Road)	A-3 (Pha Lai By-pass)
Road Length (Km)	2.36	2.00
Horizontal Alignment	Min. Redius = 100m	Min. Radius = 500m
Control point s to be demolished (1) Public Properties (2) Residential Houses	(1) 1 hospital (2) 192 houses	(1) 1 cemetery (2) 10 houses
Environmental Adverse Effect (Area on both sides of road within 100m from road center)	-	-
Landuse	Residential Area	Arable Land & Residential Area
Impact During the construction (Traffic Diversion)	One lane out of two traffic lanes will be closed during the construction. (big)	- (small)
Construction and R.O.W cost	Construction cost is lower, but R.O.W cost is higher than A - 3. (low)	(moderate)
Recommendation		This route is recommendable due to the following points: • Min. Radius = 500; • Lesser number of demolition; and • Lesser impact during construction.
Evaluation (priority)	2	1



HIGHWAY NO. 18 IMPROVEMENT	Table 9. 3 Comparison of Alternative Routes for Pha Lai By-pass from Sta.29+00 to Sta.31+00

Item / Alternative	A - 1 (Existing Road)	A-4 (Que Vo By-pass)
Length (Km)	4.00	3.95
Horizontal Alignment	Min. Redius = 1200m	Min. Radius = 600m
Control point s to be demolished (1) Public Properties (2) Residential Houses	(1) 3 public facilities (2) 69 houses	(1) 0 (2) 7 houses
Environmental Adverse Effect (Area on both sides of road within 100m from road center)	1 school	
Landuse	Residential Area & Arable Land	Residential Area & Arable Land
Impact During the construction (Traffic Diversion)	One lane out of two traffic lanes shall be closed. (big)	Only diversing and merging points of By-pass will be affected. (small)
Construction and R.O.W cost	Construction cost is much lower, but R.O.W cost is higher than A - 4. (low)	(moderate)
Recommendation	This route is recommendable due to the following : * Construction cost is much lower; * The number of demolished houses is not so many in case of 2 lane road adopted.	
Evaluation (priority)	1	2

LOCATION OF ALTERNATIVES

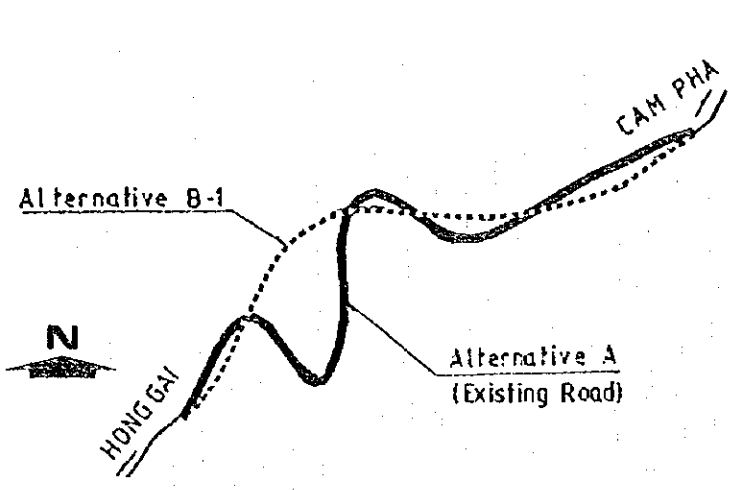


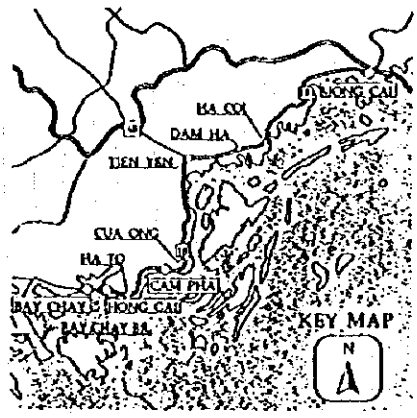
HIGHWAYNO. 18 IMPROVEMENT

Table 9 4 Comparison of Alternative Routes for Que Vo By-pass from Sta.9+00 to Sta.13+00

Item / Alternative	A - 1 (Existing Road)	B - 1 (Ha Tu By-pass)
Road Length (Km)	3.76	3.30
Horizontal Alignment	Min. Redius = 36m	Min. Radius = 240m
Control point s to be demolished Public Properties Residential Houses	1 school 3 public facilities 260 houses	0 public properties 151 houses
Environmental Adverse Effect (Area on both sides of road within 100m from road center)	1 temple 1 hospital	
Landuse	Residential Area	Residential Area
Impact During the construction (Traffic Diversion)	One lane out of two traffic lanes will be closed during construction. (big)	(small)
Construction and R.O.W cost	Construction cost will be slightly lower than B - 1, but R.O.W cost is higher than B - 1. (moderate)	(moderate)
Recommendation		This route is recommendable due to the following : * Length of road is shorter; * Number of demolition is smaller; and * Impact during the construction is smaller
Evaluation (priority)	2	1

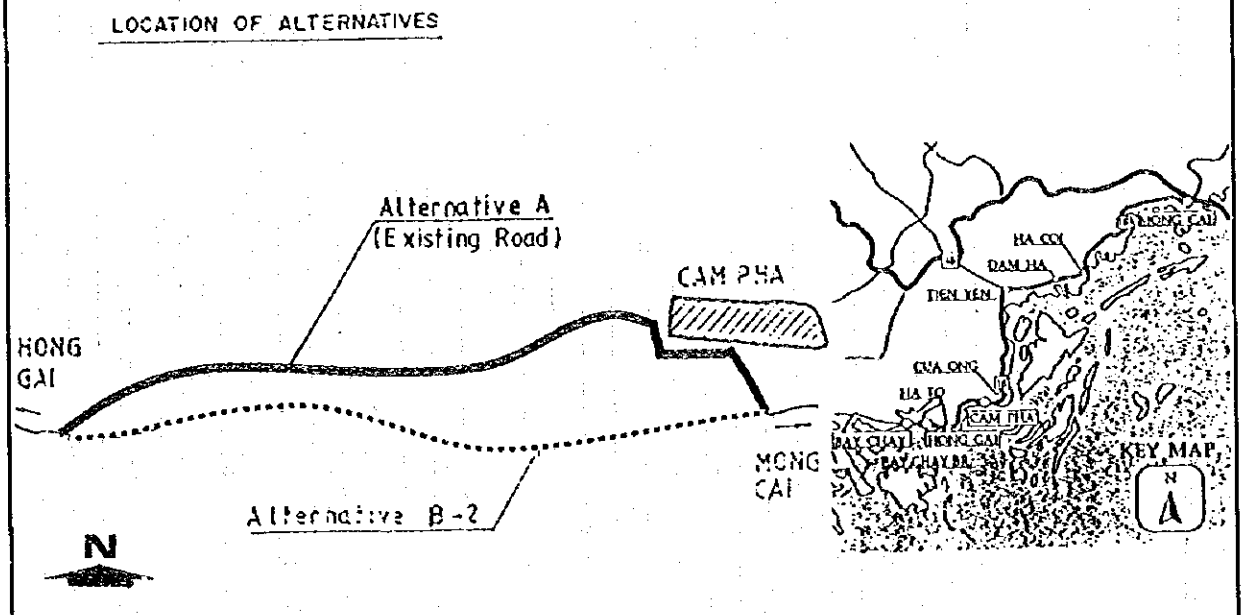
LOCATION OF ALTERNATIVES





HIGHWAY NO. 18 IMPROVEMENT	Table 9. 5 Comparison of Alternative Routes for Ha Tu By-pass from Sta.132+00 to Sta.135+300

Item / Alternative	A - 1 (Existing Road)	B - 2 (Cam Pha By-pass)
Road Length (Km)	6.20	5.34
Horizontal Alignment	Min. Redius = 80m	Min. Radius = 300m
Control point s to be demolished Public Properties Residential Houses	0 public property 182 houses	0 public property 162 houses
Environmental Adverse Effect (Area on both sides of road within 100m from road center)	1 hospital 7 school	
Landuse	Residential Area	Residential Area
Impact During the construction (Traffic Diversion)		Only the diversing and merging points of By - pass will be affected during construction
Construction and R.O.W cost	(low)	(moderate)
Recommendation		Alternative B - 2 is recommended due to the demolition, impact during the construction and policy of city planning.
Evaluation (priority)	2	1

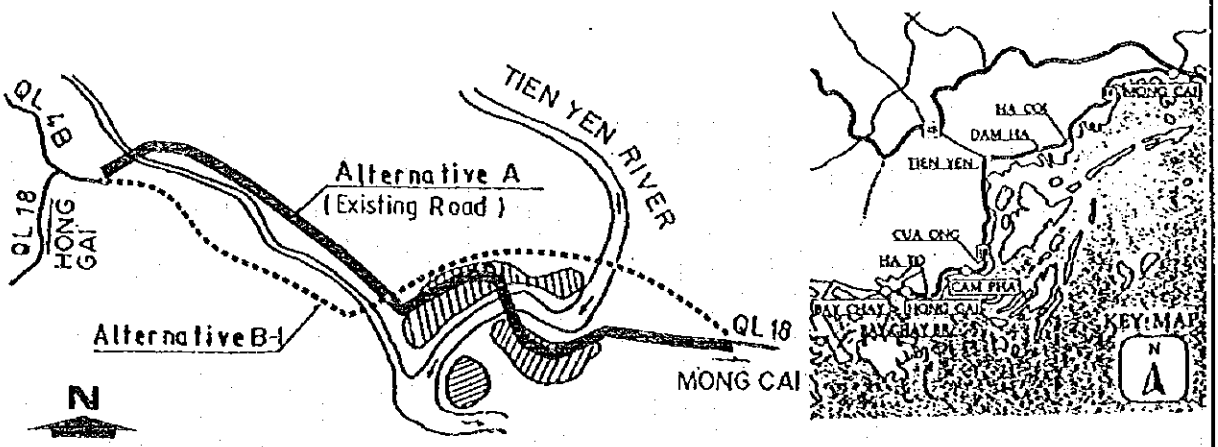


HIGHWAY NO. 18 IMPROVEMENT

Table 9. 6 Comparison of Alternative Routes for Cam Pha By-pass from Sta.143+800 to Sta.149+140

Item / Alternative	A (Existing Road)	B - 1 (Tien Yen By-pass)
Road Length (Km)	6.30	5.60
Horizontal Alignment	Min. Redius = 120m	Min. Radius = 140m
Control point s to be demolished Public Properties Residential Houses	1 temple 2 hospitals 1 cemetery 15 public facilities 448 houses	1 temple 1 school 1 cemetery 1 public facility 78 houses
Environmental Adverse Effect (Area on both sides within 100m from road center)	1 school 1 church	2 temples 2 schools 2 hospitals
Landuse	Residential Area & Arable Lane	Residential Area & Arable Lane
Impact During the construction (Traffic Diversion)	A half width of road shall be closed during the construction.	The impact during the construction is small since the existing highway is always open to traffic.
Construction and R.O.W cost	(moderate)	The construction cost is higher than B - 1 due to new bridges and new alignment, but the R.O.W cost is smaller. (high)
Recommendation	This route has a big problem of demolition since the road is very narrow (width : 10m~ 14m) in Tien Yen Town.	This route is recommended due to the following points : ' Better horizontal alignment; ' Lesser number of demolition; ' Small impact during construction
Evaluation (priority)	2	1

LOCATION OF ALTERNATIVES

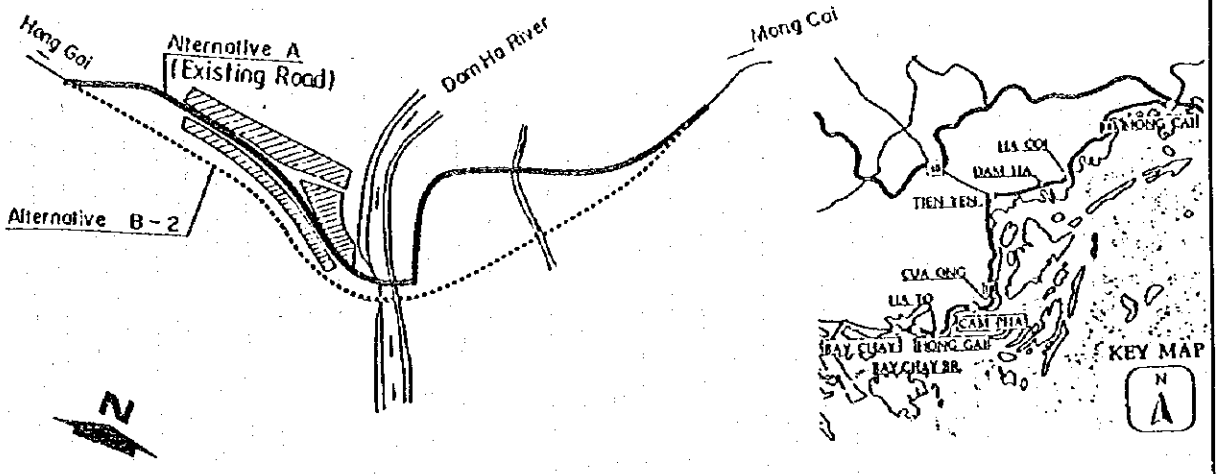


HIGHWAY NO. 18 IMPROVEMENT

Table 9. 7 Comparison of Alternative Routes for Tien Yen By-pass from Sta.207+00 to Sta.212+600

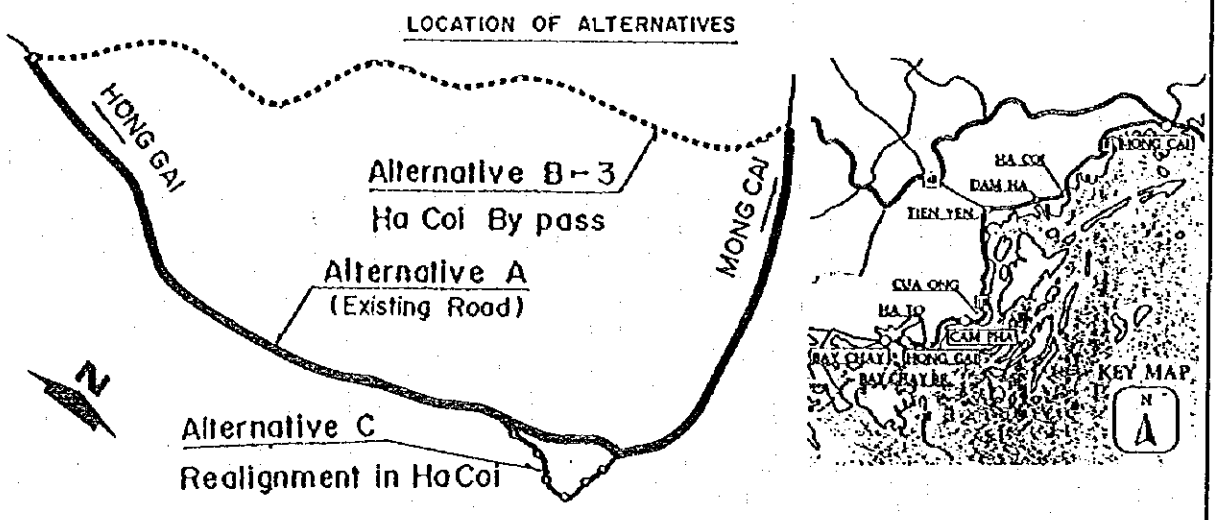
Item / Alternative	A (Existing Road)	B - 2 (Dam Ha By-pass)
Road Length (Km)	4.82	4.54
Horizontal Alignment	Min. Redius = 30m	Min. Radius = 150m
Control point s to be demolished Public Properties Residential Houses	4 public facilities 266 houses	0 public property 16 houses
Environmental Adverse Effect (Area on both sides within 100m from road center)	1 school	
Landuse	Residential Area	Residential Area
Impact During the construction (Traffic Diversion)	One lane out of two traffic lanes is to be closed during construction. (big)	Only the diversing and merging points of By-pass will be affected during construction. (small)
Construction and R.O.W cost	(moderate)	The construction cost is slightly higher, but R.W.O cost is lower than A. (moderate)
Recommendation		This route is recommended due to the following points : * Lesser number of demolition; * Better horizontal alignment; * Traffic diversion is easily attained.
Evaluation (priority)	2	1

LOCATION OF ALTERNATIVES



HIGHWAY NO. 18 IMPROVEMENT	Table 9. 8 Comparison of Alternative Routes for Dam Ha By-pass from Sta.235+00 to Sta.239+540

Item / Alternative	A (Existing Road)	B - 1 (Ha Coi By-pass)
Road Length (Km)	10.49	7.01
Horizontal and Vertical Alignment	Min. Redius = 200m Too steep gradient of access roads to two bridges	Min. Radius = 260m
Control point s to be demolished Public Properties Residential Houses	0 public property 348 houses	0 public property 7 houses
Environmental Adverse Effect (Area on both sides within 100m from road center)	1 school	
Landuse	Residential Area	Residential Area
Impact During the construction (Traffic Diversion)	One lane out of two traffic lanes is to be closed during construction. (big)	Only the diversing and merging points of By-pass will be affected during construction. (small)
Construction and R.O.W cost	Construction cost is lower than B - 3, but R.O.W cost is higher than B - 3. (low)	(moderate)
Recommendation	This route can not be recommended due to a large number of houses to be demolished.	This route is recommendable. It is costly, but shorten the existing highway by 3.48km. However, this route shall be constructed after the completion of Alt. C and after 2015 to avoid double investment.
Evaluation (priority)	2	2

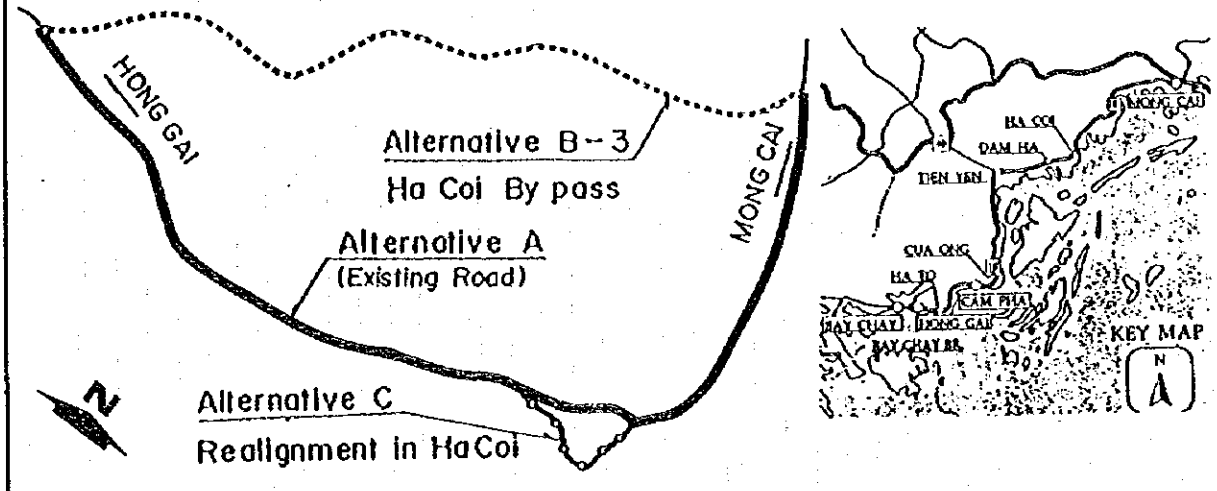


HIGHWAY NO. 18 IMPROVEMENT

Table 9. 9 Comparison of Alternative Routes for Ha Coi By-pass from Sta.258+00 to Sta.265+010

Item / Alternative	A (Existing Road)	C (Realignment in Ha Coi Town)
Road Length (Km)	2.50	3.36
Horizontal and Vertical Alignment	Min. Redius = 200m Too steep gradient of access roads to the two bridges	Min. Radius = 200m
Control point s to be demolished Public Properties Residential Houses	3 industrial companies 2 school 1 hotel 1 public facility	0 public property 144 houses
Environmental Adverse Effect	-	-
Landuse	Residential Area	Residential Area
Impact During the Construction (Traffic Diversion)	It is difficult to provide a space for temporary spillway during construction of two bridge accesses where many houses are located.	
Construction and R.O.W cost	The construction cost is almost the same as Alt. C because the road length is shorter than C but it has two bridges to be constructed.	The R.O.W cost is higher than Alt.A, but construction cost is almost the same as Alt.A. It has one bridge to be constructed.
Recommendation	This route can not be recommended due to the steep access roads to the two bridges, which require design speed of less than 50 km/h.	This route is better than Alt.A and recommendable.
Evaluation (priority)	2	2

LOCATION OF ALTERNATIVES



HIGHWAY NO. 18 IMPROVEMENT	Table 9. 10 Comparison of Alternative Routes for Ha Coi Realignment from Sta.263+00 to Sta.266+360

Chapter 10

PRELIMINARY ENGINEERING DESIGN

CHAPTER 10 PRELIMINARY ENGINEERING DESIGN

10.1 General

This chapter describes the results of preliminary engineering design prepared for the selected optimum route and covers the followings:

- Geometric design policies;
- Cross section design;
- Preliminary geometric design;
- Preliminary design of interchanges;
- Preliminary design of flyovers;
- Overview of bridge improvement;
- Preliminary design of bridges and culvert;
- Preliminary design of pavement; and
- Road supporting facilities.

10.2 Geometric Design Policies

Basic design policies to be applied to the Highway No. 18 improvement are established based on the result of study of surrounding conditions. Horizontal and vertical alignment design will be achieved by carrying out integral studies on geometric, structural, hydrological/drainage and geological aspects.

The outline of design policies and controls for the determination of horizontal and vertical alignment are described as follows :

- In the Noi Bai - Bac Ninh section, the safe and efficient movement of large volumes of traffic at the specified design speed (i.e. 120 km/hr) will be attained by the provision of good roadway alignment;

- More specifically, where vertical and horizontal curves occur in combination or in close proximity to each other, consideration should be given to designing a flowing alignment by providing good coordination of curves;

- Countermeasures will be provided to maintain the functions of the existing rivers, waterways, irrigation channels and public facilities (i.e. roads, railways and high voltage power transmission lines);

- The existing towns and villages will be avoided as much as possible to mitigate adverse environmental impact associated with the inhabitants resettlement;

- In Hong Gai and Cam Pha towns the Highway No. 18 must pass highly developed areas in certain stretches. If the standard geometric design standard were applied for the entire sections the land acquisition/ compensation/inhabitants resettlement would become a major social

issue, therefore application of substandard should be considered to mitigate adverse environmental impacts in difficult areas.

10.3 Cross Section Design

10.3.1 Cross Section Elements

(1) Number of Traffic Lanes

The number of traffic lanes of the respective highway section is summarized in Table 10.1.

Table 10.1 Number of Adopted Traffic Lanes

Highway Section	Number of Adopted Traffic Lanes	
	Initial Stage	Final Stage
1) Noi Bai - Bac Ninh	2	4
2) Bac Ninh - Chi Linh	2	4
3) Hong Gai - Cua Ong	4	4
4) Cua Ong - Bac Luan	1-2	2

(2) Cross Section Elements

The cross sectional elements are as discussed in Subsections 7.2.4 - 7.2.7 in Chapter 7 which are briefly described as follows:

- Number of lanes;
- Lane width;
- Widths of shoulders;
- Median;
- Side slopes; and
- Drainage channels.

10.3.2 Side Slopes

(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 an evaluation regarding the slope stability, cutting depth and normal highway construction practices in the region.

10.3.3 Drainage Channels and Erosion Control

(1) 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.

(2) Erosion Control

Rainwater which falls on the road surface flows away laterally under the influence of the cross slope or superelevation. A common rule for drainage where the traveledway is 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) is also adopted in the design. Cut slopes are designed in a similar manner.

10.3.4 Clear Area and Right-Of-Way Width

The Decree 203 - HDBT dated 21 - 12 - 1982 indicates a right-of-way (ROW) of 20 meters for highway from the toe of embankment or the end of cut slope.

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

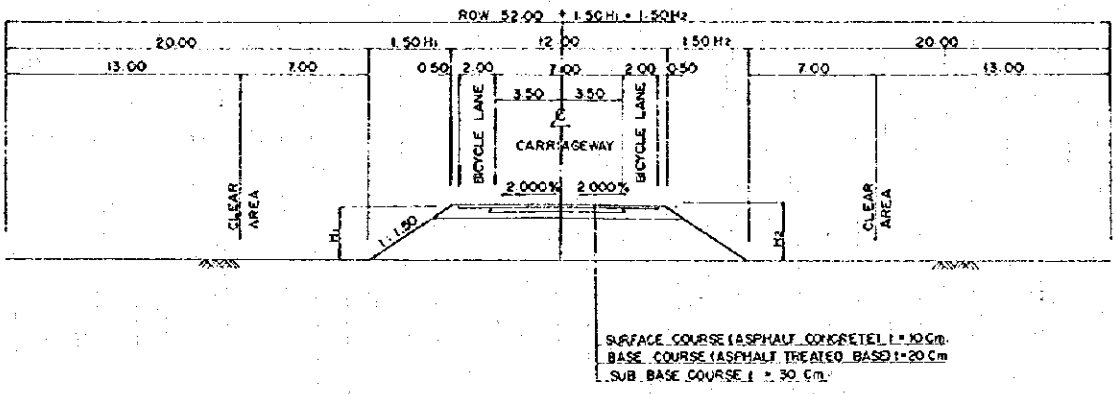
The existing houses and buildings in the area between clear area and right-of-way edge lines will be maintained as they are, but construction of new houses or buildings will not be allowed.

The clear area can be minimized or eliminated in the urbanized areas.

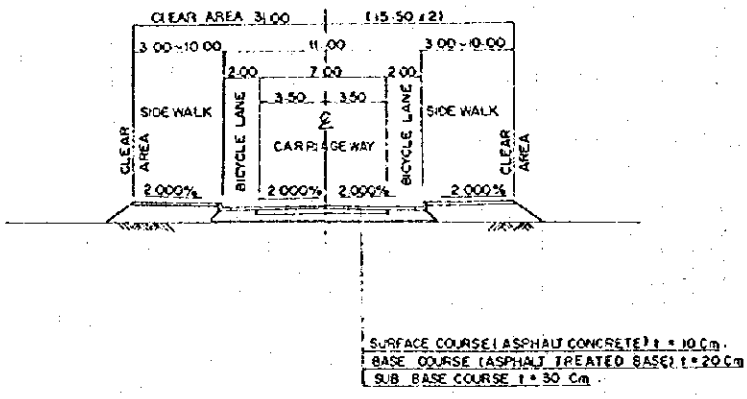
10.3.5 Typical Cross Sections

Typical cross sections have been determined as shown in Table 10.2 and in Figure 10.1. Refer to sheet numbers 10.2 in volume II : Drawings for Detailed Typical Cross Sections.

TYPE A-1
BAC NINH ~ CHI LINH SECTION
(STA.-2 - 010 ~ STA.34 + 380)
CUA ONG ~ MONG DUONG
(STA.161 + 500 ~ STA.169 + 500)

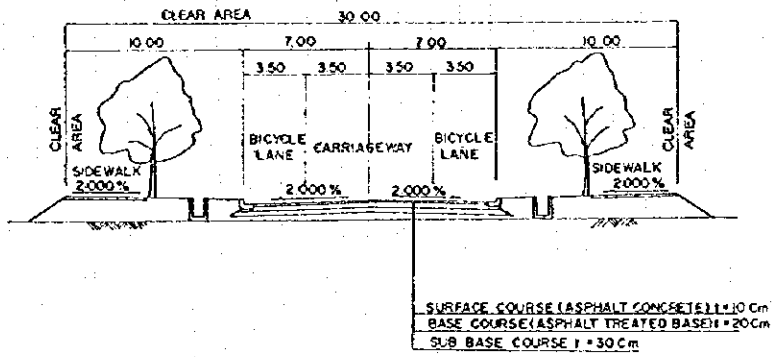


TYPE A - 2
MONG CAI
(STA.300 + 000 ~ STA.300 + 640)

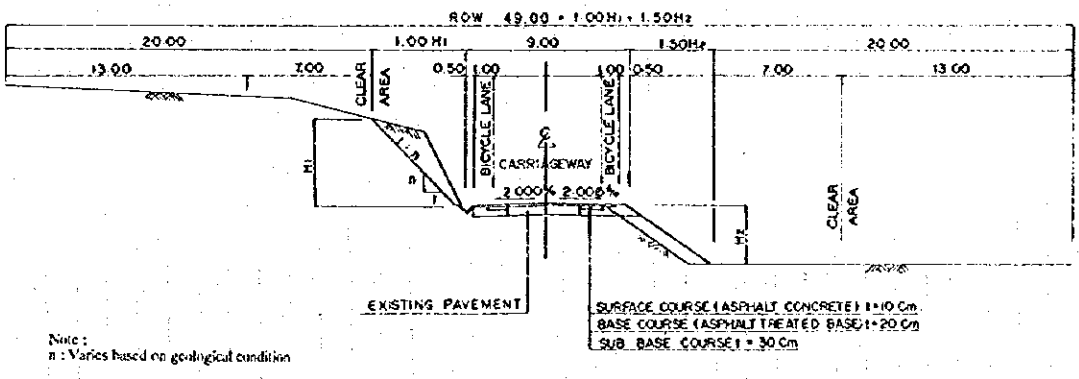


HIGHWAY No.18 IMPROVMENT	Figure 10.1 (1) Typical Cross Sections TYPE A - 1, A - 2

TYPE A- 3
MONG CAI
(STA.299 + 000 ~ STA.300 + 000)



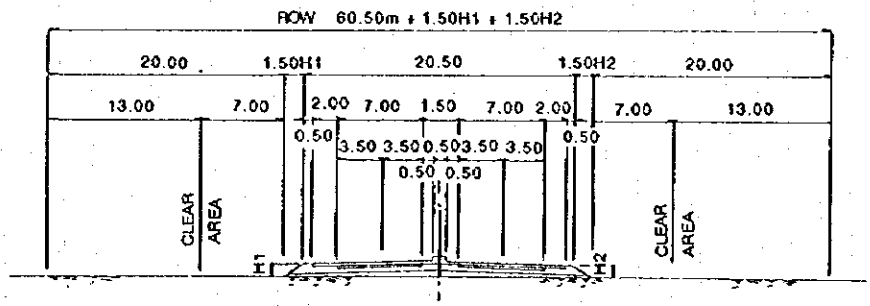
TYPE B
CUA ONG ~ BAC LUAN SECTION
(STA.169 + 500 ~ STA.299 + 000)



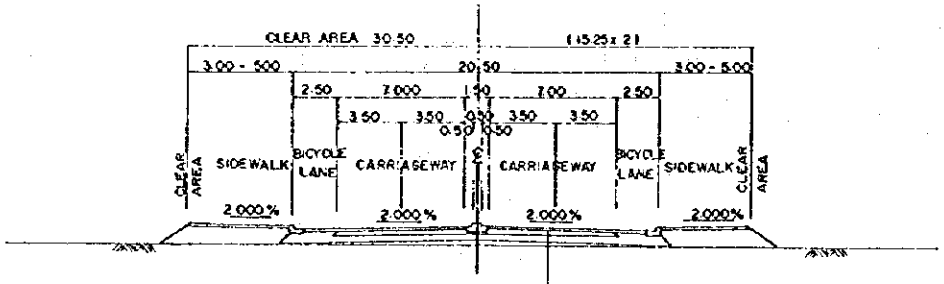
Note :
n : Varies based on geological condition

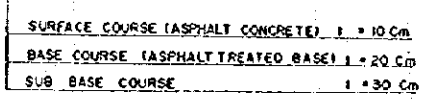
HIGHWAY No.18 IMPROVMENT	Figure 10.1 (2) Typical Cross Sections TYPE A -3, B

TYPE C - 1
(Reference for TYPE C - 2)
(See TYPE C - 2 for Right - of - Way Concept)



TYPE C - 2
HONG GAI ~ CUA ONG SECTION
(STA.121 + 700 ~ STA.161 + 500)

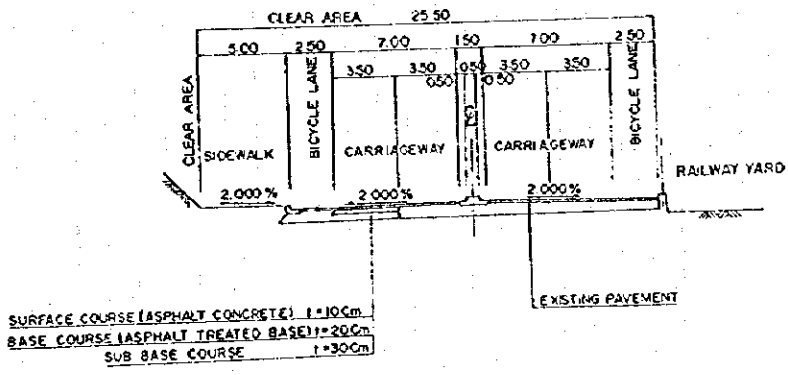




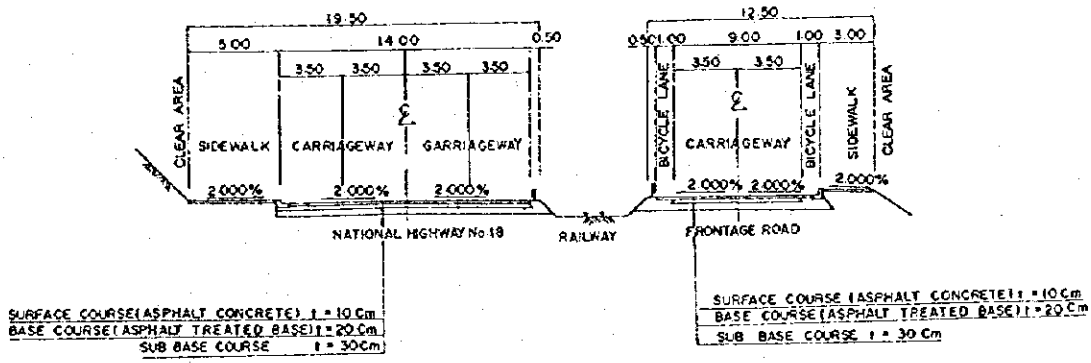
Note:
1. Section from STA.123+600 to STA.124+500 maintains the existing cross section with overlay (10cm).
2. Section from STA.124+500 to STA.128+500 and STA.156+300 to STA.159+300 have the other types (See Figure 10.1 (4)).
3. Side walk width of 4.00m is applied to the Bai Chay Bridge Access (STA.121+700 to STA>123+600).

HIGHWAY No.18 IMPROVMENT	Figure 10.1 (3) Typical Cross Sections TYPE C - 1, C - 2

TYPE C - 2
CAM PHA ~ CUA ONG
(STA.156 + 300 ~ STA.159 + 300)

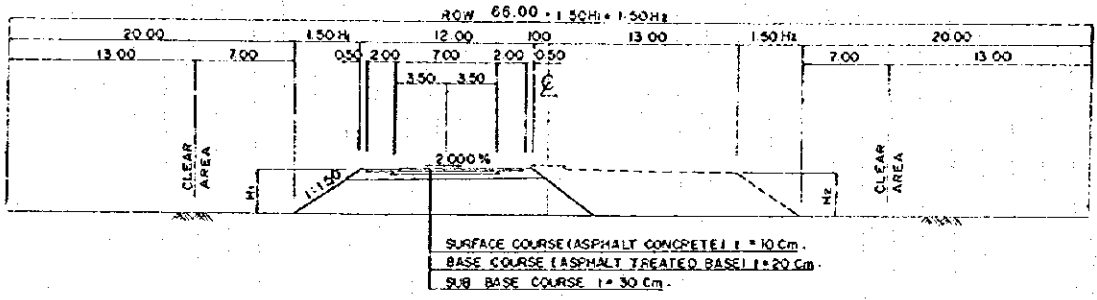


TYPE C - 3
HONG GAI
(STA.124 + 500 ~ STA.128 + 500)

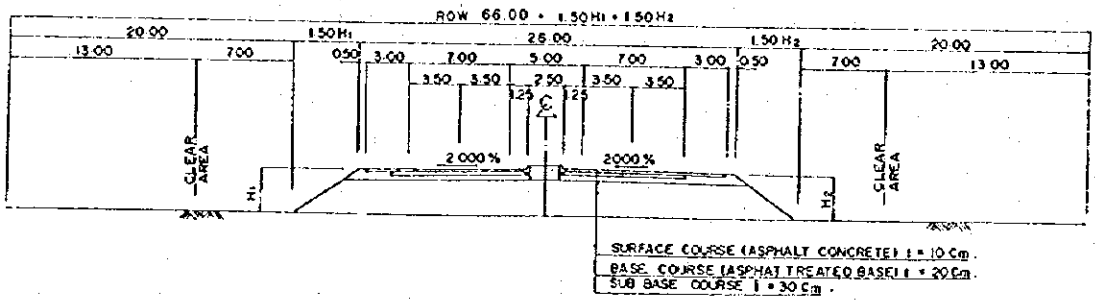


HIGHWAY No.18 IMPROVMENT	Figure 10.1 (4) Typical Cross Sections TYPE C - 2, C - 3

TYPE D (INITIAL STAGE)
NOI BAI ~ BAC NINH SECTION
(STA.-2 - 000 ~ STA.29 + 300)



TYPE D (FINAL STAGE)
NOI BAI ~ BAC NINH STAGE
(STA.-2 - 000 ~ STA.29 + 300)



HIGHWAY No.18 IMPROVMENT	Figure 10.1 (5) Typical Cross Sections TYPE D

Table 10.2 Highway Section and Type of Typical Cross Section

Section	Type of Typical Cross Section	
	Initial Stage	Final Stage
1. Noi Bai - Bac Ninh	D	D
2. Bac Ninh - Chi Linh	A-1	A-1
3. Hong Gai - Cua Ong	C-2 & C-3	-
4. Cua Ong - Mong Duong	- *	A-1
5. Mong Duong - Bac Luan	- *	A-2, A-3 &B

* Note : Asphalt concrete overlay will be conducted in the initial stage, keeping the existing general carriageway widths of 4m - 7m in Cua Ong - Mong Duong and 3m - 4m in Mong Duong - Bac Luan.

10.4 Preliminary Geometric Design

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

10.4.1 Geometric Design in Noi Bai - Bac Ninh Section

(1) Horizontal Alignment Design

1) Major Controls

The following major factors are considered in the refinement of the horizontal alignment.

- To avoid congested village areas;
- To avoid as much as possible the existing public facilities such as schools, hospitals, temples, cemeteries and government offices;
- To avoid possible future approach surface of Noi Bai International Airport;
- To minimize the effect of bridge construction at the crossing of the Ca Lo river and Ngu Huyen Khe river; and
- To minimize the demolition of existing house/building which is located along existing NH No.1.

2) Summary of Design Features

As a result of the preliminary horizontal alignment design, the length of Noi Bai - Bac Ninh section is measured at 31.3 km (distance between Noi

Bai Interchange and Bac Ninh Interchange). A summary of design features of horizontal alignment of the highway is shown in Table 10.3.

Table 10.3 Summary of Design Features of Horizontal Alignment of Noi Bai - Bac Ninh Section

Item	Unit	Design
Design speed	kph	120
Road length	km	31.3
Minimum radii	m	600 *
Maximum superelevation	%	6

Note : Two locations of 600m radii to avoid congested village by S - curve.

(2) Vertical Alignment Design

1) Major Elements Affecting the Design

Intersections with existing transport lines (i.e., highways, railway lines and rivers) are principal controls for vertical alignment design and careful studies were carried out based on specific on-site field surveys. A summary of the existing facilities is shown in Table 10.4.

Table 10.4 Summary of Transport Lines to be Crossed by the Planned Highway No.18 Noi Bai - Bac Ninh Section

Category	Designation	Number of Locations
		Bridge
Roads and railway lines	National highway	2
	Provincial highway	-
	Local road	-
	Pedestrian path	-
	Railway	2
Rivers/waterway	River	2

2) Basic Design Rules

The following basic rules were established for the vertical alignment design of Highway No.18:

- Existing national roads and railway lines are to be overcrossed (i.e., to run below Highway No. 18);
- The Ca Lo and Ngu Huyen Khe rivers are to be provided with inspection roads;

- At crosspoints with Alternate Highway No. 1, Highway No. 18 will become an underpass to lessen the construction cost;
- Severance of local communities will be avoided by the provision of box culverts underneath Highway No. 18;
- A minimum embankment height of 2 m above the existing ground line will be provided in irrigated rice paddy areas to ensure the preservation of the irrigation systems; and
- The embankment height will be retained where possible to reduce treatment efforts as well as to shorten the construction period.

3) Summary of Design Features

A summary of design features of vertical alignment is presented in Table 10.5.

Table 10.5 Summary of Design Features of Vertical Alignment Noi Bai - Bac Ninh Section

Item	Unit	Design
Design Speed	kph	120
Toll Road Length	km	31.3
Maximum Gradient	%	2
Minimum Vertical Curve Length (crest)	m	200
Minimum Vertical Curve Radii (crest)	m	15,000
Minimum Vertical Curve Length (sag)	m	200
Minimum Vertical Curve Radii (sag)	m	5,000

10.4.2 Geometric Design in Bac Ninh - Chi Linh Section

(1) Horizontal Alignment Design

Designed horizontal alignment generally follows the centerline of existing Highway No. 18. Where a bypass route is provided (28 km + 000 - 30 km + 750) TEDI's design was followed. The route crosses the Thai Binh River where the construction of Pha Lai Bridge is planned. The centerline of planned Pha Lai Bridge has been shifted about 500 m to the downstream side to avoid a temple and old factory complex. A summary of design features of horizontal alignment of the highway is shown in Table 10.6.

Table 10.6 Summary of Design Features of Horizontal Alignment Bac Ninh - Chi Linh Section

Item	Unit	Design
Design Speed	kph	80
Road length	km	36.4
Minimum radii	m	250
maximum superelevation	%	6.0

As a result of the preliminary horizontal alignment design, the length of Bac Ninh - Chi Linh section is measured at 36.4 Km (distance between Bac Ninh Interchange and Chi Linh terminus).

(2) Vertical Alignment Design

Designed vertical alignment generally following the existing grade of Highway No.18. Pha Lai Bridge is planned at 25 km + 860 (center of main span). The vertical alignment design has been conducted based on the following conditions (Table 10.7).

Table 10.7 Design Conditions of Pha Lai Bridge

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

A summary of design features of vertical alignment is presented in Table 10.8.

Table 10.8 Summary of Design Features of Vertical Alignment Bac Ninh - Chi Linh Section

Item	Unit	Design
Design Speed	kph	80
Toll Road Length	km	36.4
Maximum Gradient	%	3.2
Minimum Vertical Curve Length (crest)	m	100
Minimum Vertical Curve Radii (crest)	m	5,000
Minimum Vertical Curve Length (sag)	m	100
Minimum Vertical Curve Radii (sag)	m	6,300

10.4.3 Alignment Design in Hong Gai - Cua Ong Section

(1) Design Approach

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

(2) Design Segments

Highway No. 18 in Hong Gai - Cua Ong Section is comprised of several segments of differing construction type (e.g., new construction of Bai Chay Bridge approach road, upgrading of existing streets and provision of bypass highway) and applicable typical highway cross sections as shown in Table 10.9.

Table 10.9 Design Segments of Hong Gai - Cua Ong Section

No.	Segment	Length (km)	Stations	Applicable Typical Cross Section
1.	Bai Chay Bridge Approach	1.9	Sta.121 + 700 ~ Sta.123 + 600	Modified C-2 (Reduced sidewalk)
2.	Hong Gai, Detour Streets	0.9	Sta.123 + 600 ~ Sta.124 + 500	Overlay of Asphalt Pavement
3.	Hong Gai (1)	4.0	Sta.124 + 500 ~ Sta.128 + 500	C - 3
4.	Hong Gai (2)	3.5	Sta.128 + 500 ~ Sta.132 + 000	C - 2
5.	Ha Tu Bypass	3.3	Sta.132 + 000 ~ Sta.135 + 300	C - 2
6.	Cam Pha (1)	8.2	Sta.135 + 300 ~ Sta.143 + 500	C - 2
7.	Cam Pha Bypass	5.64	Sta.143 + 500 ~ Sta.149 + 140 (= Sta.150 + 000 Ahead)	C - 2
8.	Cam Pha (2)	6.3	Sta. 150 + 000 ~ Sta. 156 + 300	C - 2
9.	Cua Ong (1)	3.0	Sta.156 + 300 ~ Sta.159 + 300	Modified C - 2 (sidewalk one side)
10.	Cua Ong (2)	1.92	Sta.159 + 300 ~ Sta.161 + 220	C - 2
Total		38.66		

(3) Horizontal and Vertical Alignment Design

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

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

A summary of design features of horizontal and vertical alignment is presented in Table 10.10.

Table 10.10 Summary of Design Features of Horizontal and Vertical Alignments Hong Gai - Cua Ong Section

Item	Unit	Design
Design Speed	kph	60
Road Length	km	38.7
Minimum radii	m	150
Maximum Superelevation	%	6.0
Maximum Gradient	%	6.0
Minimum Vertical Curve Length (crest)	m	100
Minimum Vertical Curve Radii (crest)	m	2,700
Minimum Vertical Curve Length (sag)	m	100
Minimum Vertical Curve Radii (sag)	m	1,700

10.4.4 Alignment Design in Cua Ong - Tien Yen Section

(1) Design Segments

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

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

(2) Alignment Design in Cua Ong - Mong Duong Segment

The study team carried out its own preliminary alignment (horizontal and vertical) design in this highway segment, since no previous design data was available. The terrain condition along the existing highway is mountainous for the certain stretches, but cross section elements of Class - III for flat terrain have already been provided for the entire segment.

In accordance with the request of PMU No. 18, Class-III for flat terrain is adopted, however Class - III for mountainous terrain had been also applied for only horizontal alignment design to cope with extremely rugged terrain and to avoid adverse environmental effects associated with resettlement of inhabitants. The vertical alignment design was conducted based on Class - III for flat terrain. Since the terrain condition is unfavorable, extremely deep cuts (h = 15 m - 20 m) were made in several locations even though substandard of 130 - 200 m curve radii were applied. As a result of the preliminary horizontal alignment design, the length of Cua Ong - Mong Duong subsection is measured at 8.0 km.

(3) Geometric Design in Mong Duong - Tien Yen Segment

The study team carried out new preliminary alignment designed up to Ba Che bridge. In the stretch between Ba Che and Tien Yen, TEDI's design data were available and these were made use of for the preliminary design.

A summary of design features of horizontal and vertical alignments is presented in Table 10.11.

Table 10.11 Summary of Design Features of Horizontal and Vertical Alignments Mong Duong - Tien Yen Subsection

Item	Unit	Design
Design Speed	kph	60
Road length	km	35.5
Minimum radii	m	130
Maximum Superelevation	%	6.0
Maximum Gradient	%	6.0
Minimum Vertical Curve Length (crest)	m	200
Minimum Vertical Curve Radii (crest)	m	5,000
Minimum Vertical Curve Length (sag)	m	100
Minimum Vertical Curve Radii (sag)	m	1,700

10.4.5 Alignment Design in Tien Yen - Bac Luan Section

(1) Design Segments

Highway No. 18 in this section is divided into seven (7) segments as shown in Table 10.12.

Table 10.12 Design Segment of Tien Yen - Bac Luan Section

No.	Segment	Length (km)	Stations	Applicable Typical Cross Sections
1.	Tien Yen Bypass	5.60	Sta.207 + 000 ~ Sta.212 + 600 (=Sta.215 + 000 Ahead)	B
2.	Highway No.18 (1)	20.30	Sta.215 + 000 ~ Sta.235 + 300 (=Sta.235 + 000 Ahead)	B
3.	Dam Ha Bypass	4.54	Sta.235 + 000 ~ Sta.239 + 540 (=Sta.240 + 000 Ahead)	B
4.	Highway No.18 (2)	20.64	Sta.240 + 000 ~ Sta.260 + 640 (=Sta.263 + 000 Ahead)	B
5.	Ha Coi Bypass	3.36	Sta.263 + 000 ~ Sta.266 + 360 (=Sta.265 + 500 Ahead)	B
6.	Highway No.18 (3)	30.82	Sta.265 + 500 ~ Sta.296 + 320 (=Sta.299 + 000 Ahead)	B
7.	Highway No.18 (4)	1.00	Sta.299 + 000 ~ Sta.300 + 000	A-3
		0.64	Sta.300+000 ~ Sta.300 + 640	A-2
Total		86.9		

(2) Horizontal and Vertical Alignments Design

Horizontal and vertical alignment generally followed the TEDI's working drawings between Tien Yen and Ha Coi. The study team carried out repeated site investigations to ascertain problems associated with resettlement; in particular, in Dam Ha and Ha Coi bypasses. Considerations were given to the new construction and replacement of bridges, and horizontal and vertical alignments are determined based on the terrain conditions and hydrological data in the bridge sites. New horizontal and vertical alignment design was carried out by the study team between Ha Coi and Bac Luan since no previous design data were available.

A summary of design features of horizontal and vertical alignments is presented in Table 10.13. A sharp curvature of 70m radius was adopted in Ha Coi bypass to avoid demolition of existing houses. This is only the place where a substandard curve has been applied.

Table 10.13 Summary of Design Features of Horizontal and Vertical Alignments, Tien Yen - Bac Luan Section

Item	Unit	Design
Design Speed	kph	60
Road length	km	86.9
Minimum radii	m	70
Maximum superelevation	%	6.0
Maximum Gradient	%	7.0
Minimum Vertical Curve Length (crest)	m	100
Minimum Vertical Curve Radii (crest)	m	2,600
Minimum Vertical Curve Length (sag)	m	100
Minimum Vertical Curve radii (sag)	m	1,800

10.5 Preliminary Design of Interchanges

10.5.1 General

Design interchange is applicable only for Noi Bai - Bac Ninh Section. There are two (2) categories of interchanges; i) high-type highway to high-type highway (junction : JC) and ii) high-type highway to artery (interchange : IC). Two (2) future junctions are considered at the connection between Noi Bai - Bac Ninh highway and the Thang Long - Airport Highway and future alternate highway of NH No.1 and two (2) interchanges are planned at crossings with NH No.2 and NH No. 1 to collect/ distribute the Noi Bai - Bac Ninh highway traffic.

10.5.2 Location of Interchanges

Four (4) interchanges including those junctions on both ends were studied in the stage of route selection, focusing on the availability of land. The shortest interval is 1.3 km between NH No.1 IC and Bac Ninh IC and the longest is 21.5 km between NH No.3 IC (Table 10.14).

Table 10.14 List of Interchanges

No.	Name of Interchange	Station (Distance, km)	Connecting Road
1.	Noi Bai Junction	- 2 + 000	Thang Long - Airport Highway
		[8.5]	
2.	Phu Lo Interchange	6 + 500	Existing NH No.3
		[21.5]	
3.	NH No.1 Interchange	28 + 000	Existing NH No.1
		[1.3]	
4.	Bac Ninh Junction	29 + 300	Alternate highway of NH No.1

There is no major point of trip generation or attraction in the 21.5 km stretch between Phu Lo Interchange and NH No.1 Interchange and no interchange is planned in the present plan.

10.5.3 Layout of Interchanges

(1) Noi Bai and Bac Ninh Junctions

There is a possibility that the government will charge a toll with the distance-proportional toll levy system in Noi Bai - Bac Ninh highway in future. 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 location is advantageous as it is economical and efficient for highway operation and management especially where the on/off ramp traffic volumes are large. The type which allows such arrangement is normally a trumpet type, which has been envisaged for Noi Bai and Bac Ninh Junctions.

(2) Phu Lo Interchange

Diamond interchange is particularly adaptable to major (high type highway) - minor (low type highway) crossings and has the following advantages over a partial cloverleaf :

- All traffic can enter and leave the major road at relatively high sped;
- Left-turning maneuvers entail little extra travel; and
- Relatively narrow band of right-of-way is required.

Considering the existence of NH No.2/NH No.3 at-grade intersection in the vicinity, the adoption of a half-diamond type has been recommended.

(3) NH No.1 Interchange

NH No.1 and Ha Noi - Bac Giang railway line run parallel in a north-south direction. Since the distance between NH No.1 and railway line is only 300m the adoption of full diamond or full cloverleaf is impossible. Based on the

above site condition a partial cloverleaf with two loops and two ramps in the eastern quadrants.

10.6 Design of At-Grade Intersections

10.6.1 General

While the improved highway has the function of providing more capacity, faster and more freely flowing routes for traffic movement, full benefit will not be realized unless good connections are provided between the highway and the existing road/street system where most trips will originate and end. In view of the larger traffic volumes involved and the restricted right-of-way, the use of free-flowing rotary intersections is impractical. This design aimed at the finalization of design concept of typical at-grade intersections with traffic signal.

10.6.2 Design features

Result of intersection design is compiled in Volume II : Drawings as shown in Table 10.15.

Table 10.15 Design Features of Typical At-Grade Intersections

No.	Name of Intersection	Connecting Road	Sheet Number in Volume II
1.	Noi Bai (Sta.4 + 850)	NH No.2	141
2.	Phu Lo IC (Sta.6 + 500)	NH No.3	142
3.	Bac Ninh (Sta.2 + 500)	Existing NH No.18	144
4.	Hong Gai-1 (Sta.123 + 600)	Detour Road	145
5.	Hong Gai - 2 (Sta.124 + 500)	Detour Road	146
6.	Hong Gai - 3 (Sta.128 + 500)	Frontage Road	147
7.	Cam Pha (Sta.150 + 000)	Existing Road	148
8.	Mong Cai (Sta.300 + 000)	Planned Streets	149

10.7 Overview of Bridge Improvement

10.7.1 Design Standard

Refer to Section 7.3 of Chapter 7 for loading specification and seismic design together with Section 7.4 of the same chapter for flood and navigation clearances.

10.7.2 Adoption of Concrete Bridges

Concrete bridges will be adopted for the Highway No. 18 improvement for the following reasons :

- Durability of concrete structure;
- Lower initial and maintenance costs;
- Utilization of local labourers and materials such as Portland cement, reinforcing steel and aggregates; and
- Bridge aesthetics.

10.7.3 General Description of Bridge Types

(1) Superstructure

The superstructures of the new bridges in the Highway No. 18 improvement should be designed to meet the following general requirements.

1) Structural Requirements

The general relationship between span length and bridge type is shown in Figure 10.2. The minimum span length of a bridge is generally determined by the nature of the rivers, roads or railway lines over which the bridge is required to pass: the soil condition, and factors relating to the surroundings. For a bridge over an unimproved river, a careful study should be made of the river course and flow characteristics. The span length is one of the most important factors in determining the bridge type. Once the span length is fixed then the choice of bridge type is limited.

A beam or girder has a desirable ratio of depth to the length of span which will result in minimum construction cost, and this depth ratio is generally adopted.

However, for the main span of a bridge where the depth is critical for determining the vertical alignment of the road which will affect the total cost of the structure, the minimum depth is adopted.

2) Environmental Requirements

Careful considerations are necessary to preserve the existing environment of man-made facilities (e.g., irrigation canals, public facilities such as road network and railway lines) and to avoid adverse effect to existing rivers.

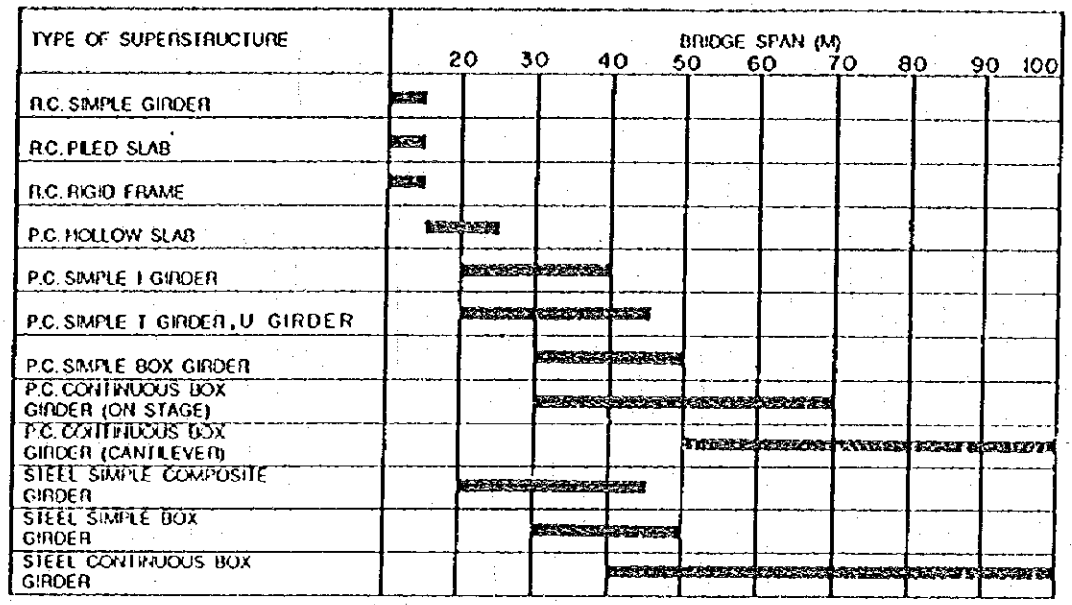


Figure 10.2 Standard Spans for Various Types of Bridge

From the aesthetic point of view, a bridge type which harmonizes with the surrounding environment should be adopted. For flyover bridges, the structural appearance from the underside will be also considered.

3) Construction Requirement

The cantilever method is considered for Pha Lai Bridge. The precast method is an effective way to shorten the construction period. If the construction period is limited, the type of bridges is determined by taking into account the speed of construction.

4) Construction Economy

The most economical type of bridge will ultimately be selected from the alternatives which satisfy the conditions mentioned above. To compare the costs of various bridge types, the total construction costs of the superstructure, substructure and approaches will be considered.

(2) Substructure

The substructure of new bridges should be designed to meet the following general requirements.

1) Abutment

Reinforced concrete will be used for abutments. In general the type of abutment is determined based on the relationship between height and the suitability of abutment type as shown in Figure 10.3.

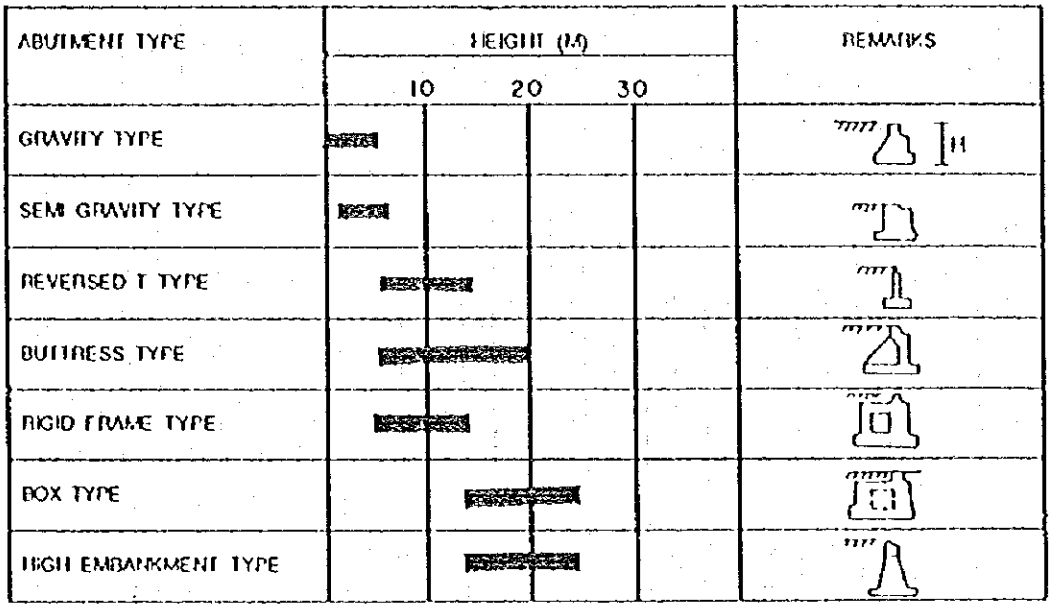


Figure 10.3 Range of Heights for Various Type of Abutment

2) Pier

Reinforced concrete piers will generally be used unless special conditions must be met. The appearance of the piers is an important factor in determining which type should be used, especially for flyovers in urbanized areas.

Wall-type pier is recommended for river/canal piers to provide smooth flow of water at the piers.

3) Types of Foundation

The foundation type is determined mainly by subsoil conditions, the loading to be supported, and economic criteria. Generally, a direct foundation is used where the depth of the supporting strata is less than 5m, whereas a piled foundation is employed for depths more than 5m.

10.7.4 Investigation of Existing Bridges and New Construction Bridge Sites

(1) Data Collection and Site Investigations

The study team reviewed TEDI's feasibility study and carried out data collection and site investigations for the following items :

a. Existing bridges

- Adaptability to planned highway alignment;
- Loading capacity;
- Bridge length, span arrangement and effective width;
- Type of superstructure and girder depth;
- Type of substructure and pier and abutment height;
- Type of foundation;
- Flood water level of rivers near the existing bridge locations;
- Future improvement plan of the rivers.

b. New construction bridges

- Adaptability to planned highway alignment;
- Width of rivers and facilities such as, channels, roads and railways to be crossed;
- Flood water level of the rivers;
- Class of rivers and required navigation clearances; and
- Future improvement plan of rivers.

(2) Results of the Investigation

The summary of number of existing and new construction bridges is shown in Table 10.16.

Table 10.16 The Number of Existing and New Construction Bridges by Section

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

* Note : Number of new construction bridges includes the one Pha Lai special bridge.

10.7.5 Criteria for the Evaluation of Existing Bridges and Bridge Improvement Framework

(1) Bridge Improvement Policies

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

- Replacement;
- Widening; or
- Retainment.

The criteria for the evaluation of existing bridges are recommended as follows :

1) Replacement

- Bridges designed with substandard loading specifications such as H8, H10 and H13 (the current Vietnamese loading specification designates H30);
- Bridges which do not satisfy the requirement of vertical clearance against the specified flood water level;
- Seriously damaged or deteriorated bridges; and
- Bridges with narrow width whose widening is judged impracticable.

H18 and H30 loading will result in similar maximum bending moment in the simple span girders in cases the span length is less than 30 m. Therefore the short span bridges ($L \leq 30m$) designed with H18 will be remained as it is if all other requirements are satisfied.

2) Widening

Selected bridges which are designed with H18 or H30, only with insufficient width and is possible to widen structurally (RC T-girder, RC slab and PC I-girder).

3) Retainment

Bridges designed with H18 or H30 and sufficient for all other requirements.

(2) Determination of Bridge Improvement Framework

1) General

Based on the above-mentioned improvement policies, the results of investigations, as well as the highway alignment design results, the study team determined bridge improvement framework as carried out on existing bridges. The results are shown in Table 10.17. As regards to

existing bridges requiring replacement, almost none of them meet demands of present design load standards and more judged as lacking loading capacity.

Table 10.17 Number and Length of Bridges by Type of Improvement

Section	New Construction		Replacement		Widening		Retainment		Total	
	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)	No.	Total Length (m)
1	14	1950.0	0	0	0	0	0	0	14	1950.0
2	8	1477.0	3	74	0	0	0	0	11	1551.0
3	8	490.0	5	78	12	134.7	0	0	25	702.7
4	1	15.0	11	264	0	0	8	167.2	20	446.2
5	12	1193.0	26	333.5	0	0	6	258.5	44	1785.0
Total	43	5125.0	45	749.5	12	134.7	14	425.7	114	6434.9

The results of screening existing bridges and determination of newly constructed bridges in each section are described briefly in the following.

2) Noi Bai - Bac Ninh Section

The selected horizontal alignment of the Highway No.18 in this section is separated from the existing provincial highways (Nos.286 and 401). Therefore, a total of 14 bridges, which have a total bridge length of 1,950m, are planned in this section. Major bridges in this section are as follows:

Flyovers
- National Highway No.3 (L = 150m);
- Dong Anh - Thai Nguyen Railway (L = 390m);
- Hanoi - Lang Son Railway + National Highway No.1 (L = 950m).

River Bridges
- Ca Lo River (L =180m);
- Ngu Huyen Khe River (L =150m).

3) Bac Ninh - Chi Linh Section

a. Evaluation of Existing Bridges

There are three existing bridges and all of them have lower loading capacities (H10 and H13) and are in poor condition. Therefore, it has been judged that all existing bridges are to be replaced.

b. New Construction Bridges

There is planned a major bridge at the Thai Binh river crossing (Pha Lai Bridge, L = 579m) whose route passes through a low-lying area between sta. 21 + 00 and sta. 25 + 500. To cope with the complex flow patterns and the adverse hydrological conditions in the area, a total of five (5) bridges which total 858m in length are planned in the said low-lying area aiming to:

- Avoid flooding in the upstream area;
- Maintain existing short cut flood course of the Cau river (Bridge L= 660m); and
- Maintain four (4) existing drainage water courses (Bridge L= 198 m).

4) Hong Gai - Cua Ong Section

a. Evaluation of Existing Bridges

The results of the investigation of existing bridges is shown in Table 10.18 together with the study team's judgment on bridge replacement or widening.

All existing bridges are of a permanent type. The majority of existing bridges were constructed between 1975 - 1990 to meet the loading standard of H18 or H30 and their present condition is fair. However, some bridges built in an earlier period had been designed with H13 loading standard.

In view of the above situation, it is recommended that:

- H18 and H30 loading-standard bridges will be utilized for Highway No. 18 improvement providing the necessary widening; and
- H13 loading-standard bridges will be replaced or retained for the use of local traffic where the existing national highway No. 18 will be bypassed and no further improvement will be conducted within the framework of the project.

b. New Construction Bridges in the Bypass Sections

This section is comprised of three (3) bypasses. Several new bridges are required in these bypasses.

- Bai Chay Bridge Access (Km 121 + 700 - Km 123 + 600)

The Bai Chay bridge which connects Bai Chay with Hong Gai, approximate bridge length of 800m, is in the planning stage and a pre-feasibility study (pre - F/S) of the bridge has been carried out by TEDI. Access road of the Bai Chay bridge is planned based on the said pre - feasibility report and it was found that three new bridges which have a total length of 430m are required.

- Ha Tu Bypass (Km 132 + 000 - Km 135 + 300)

There are 3 bridges to be improved, but no newly constructed bridges are required.

Table 10.18 List of Existing Bridges and Current Conditions, Hong Gai - Cua Ong

No.	Name	Station	Crossing Structure	Total Length (m)	Span (m)	Effective Width (m)	Superstructure				Substructure				Founda-tion Type	H.W.L. (m)	Clearance against H.W.L.	Adopted Category	Remarks
							Structure Type	Girder Depth (m)	No. of Girder	Design Load	Abut. Type	Hight (m)	Pier Type	Hight (m)					
3-1	Bai Chai Bridge Aproach	121 + 880	Valley	(90)														New Construction	
3-2	Bai Chai Bridge Aproach	122 + 380	Valley	(110)														New Construction	
3-3	Bai Chai Bridge Aproach	122 + 840	Local Road	(210)														New Construction	
3-4	Cau Trang	130 + 260	Local Road	31.0	31.0	7.0 +1.5x2	PC-T Girder	1.0	5	H13	Masonry Gravity	8.0	-	-	Spread			Replace	Substandard Design Load
3-5	Ha Tu	132 + 470	River	6.0	6.0	12.5	RC Slab	0.4	1	H18	Masonry Gravity	2.0	-	-	Spread	10.58 (H2%)	OK	Replace	Improvement of Vertical alignment
3-6	Lo Phong	133 + 540	River	29.2	28+1.2	7.0 +1.5x2	PC-T Girder	1.0	8	H18	RC Gravity	6.0	RC Multi-Column	5.0	Spread	6.50 (H2%)	OK	Widenning	Shortage of the Width
3-7		137 + 600	River	9.0	9.0	10.0	RC Slab	0.6	1	H18	Masonry Gravity	3.5	-	-	Spread	5.00 (H2%)	OK	Widenning	Shortage of the Width
3-8		141 + 580	River	4.5	4.5	6.7	RC Slab	0.4	1	H13	Masonry Gravity	2.0	-	-	Spread	5.84 (Hmax)	NO	Replace	Substandard Design Load
3-9		142 + 440	River	3.6	3.6	10.0	RC Slab	0.35	1	H13	Masonry Gravity	2.0	-	-	Spread	9.72 (Hmax)	NO	Replace	Substandard Design Load
3-10		143 + 150	River	5.5	5.5	10.0	RC Slab	0.45	1	H18	Masonry Gravity	2.5	-	-	Spread	9.70 (Hmax)	OK	Widenning	Shortage of the Width
3-11		144 + 860	River	(17.0)												4.42 H2%+Ha		New Construction	
3-12		145 + 750	River	(8.5)												4.42 H2%+Ha		New Construction	
3-13		146 + 460	River	(8.5)												4.42 H2%+Ha		New Construction	
3-14		147 + 710	River	(17.0)												4.42 H2%+Ha		New Construction	
3-15		149 + 010	River	(8.5)												4.42 H2%+Ha		New Construction	
3-16		150 + 040	River	17.0	8.5x2	7.0 +0.75x2	RC T-Gider	0.7	7	H18	Concrete Gravity	4.0	RC Wall	3.0	Pile	4.42 H2%+Ha	OK	Widenning	Shortage of the Width
3-17		150 + 610	River	17.0	8.5x2	7.0 +0.75x2	RC T-Gider	0.7	7	H18	Concrete Gravity	5.0	RC Wall	4.0	Pile	4.42 H2%+Ha	OK	Widenning	Shortage of the Width
3-18		151 + 585	River	8.5	8.5	7.0	RC T-Girder	0.7	7	H18	Concrete Gravity	4.5	-	-	Pile	4.42 H2%+Ha	OK	Widenning	Shortage of the Width
3-19		152 + 815	River	8.5	8.5	7.0	RC T-Girder	0.7	7	H18	Concrete Gravity	4.5	-	-	Pile	4.42 H2%+Ha	OK	Widenning	Shortage of the Width
3-20		153 + 360	River	25.5	8.5x3	7.0 +1.0x2	RC T-Girder	0.7	7	H18	Concrete Gravity	6.0	RC Wall	5.0	Pile	4.42 H2%+Ha	OK	Widenning	Shortage of the Width
3-21	-	154 + 215	River	6.7	6.7	9.0	RC Slab	0.3	1	H18	Masonry Gravity	3.0	-	-	Pile	3.40 (Hmax)	OK	Widenning	Shortage of the Width
3-22	-	154 + 550	River	8.5	8.5	7.0 +0.75x2	RC T-Girder	0.7	7	H18	Concrete Gravity	3.5	-	-	Pile	3.42 (Hmax)	OK	Widenning	Shortage of the Width
3-23	-	157 + 490	River	12.6	12.6	8.1 +1.0x2	RC T-Girder	0.8		H18	Concrete Gravity	3.5	-	-	Pile	4.72 (Hmax)	OK	Widenning	Shortage of the Width
3-24	Cau Trang	160 + 210	River	4.7	4.7	8.8	RC Slab	0.5	1	H30?	Masonry Gravity	1.5	-	-	Spread	3.57 (Hmax)	OK	Widenning	Shortage of the Width
3-25	Cau 10	160 + 930	River	11.2	11.2	7.0 +1.0x2	RC T-Girder	0.8		H30	Masonry u-shaped	2.5	-	-	Pile	2.80 (H92)	OK	Widenning	Shortage of the Width

* The value in the ( ) shows the width of crossing structure.
* H1% : Flooding High Water Level at 100 years frequency

- Cam Pha Bypass (Km 143 + 500 - Km 149 + 140)

There are several small river crossings on the bypass alignment. Therefore, five new bridges which have a total length of 59 m are planned.

5) Cua Ong - Tien Yen Section (Km 161 + 500 - Km 204 + 900)

a. Evaluation of Existing Bridges

The results of the investigation of existing bridges is shown in Table 10.19 together with the Study Team's judgment concerning the bridge improvement categories.

There are 19 medium and short span existing bridges in the section and their total bridge length is 431 m.

The existing bridges are classified into the three following groups based on loading standards and year of construction:

	Loading Standard	Construction
1.	H8/H10	before 1945
2.	H13	recent years
3.	H30	recent years

These existing bridges are evaluated according to the following criteria:

- All H10 and H13 bridges will be replaced because of their shortage of loading capacity and degree of deterioration (replacement of 11 existing bridges);

- All H30 bridges are in good or fair conditions. Therefore, they will be fully utilized for the improvement. Ba Che bridge (steel truss) has a narrow carriageway width of only 4.5 m. Therefore, it is proposed that another 2-lane 2-way bridge will be constructed at the nearby site and the existing truss should be reused in another project.

- The existing Mong Duong Bridge has a loading capacity of H30. However, the bridge deck level is lower than floodwater level and sometimes becomes unpassable for several days. Therefore, this bridge will be reconstructed to provide sufficient vertical clearance against floodwater level.

b. New Construction Bridge

There is one new construction bridge which is necessitated due to the realigning of Highway No. 18.

Table 10.19 List of Existing Bridges and Current Conditions, Cua Ong - Tien Yen

No.	Name	Station	Crossing Structure	Total Length (m)	Span (m)	Effective Width (m)	Superstructure				Substructure				Pounda-tion Type	H.W.L. (m)	Clearance against H.W.L.	Adopted Category	Remarks
							Structure Type	Gider Depth (m)	No. of Girder	Design Load	Abut. Type	Hight (m)	Pier Type	Hight (m)					
4-1	Cau Vuot 1	165 + 170	Railway	17.3	17.3	13.0	RC T-Girder	0.6	9	H30	Concrete ushaped	8	-	-	Spread			Use as it is	
4-2	Cau San	166 + 860	River	8.4	8.4	11.0	RC T-Girder	0.6		H30	Masonry u-shaped	7	-	-	Pile	5.00 (H86)	OK	Use as it is	
4-3	Cau Vuot 2	167 + 830	River	33.6	16.6x2	7.0 +0.7x2	RC T-Girder	1.0		H30	RC ReverseT	5.5	RC Wall	4.5	Pile	5.10 (H86)	OK	Use as it is	
4-4	Cau Mong Duong	168 + 130	River	36.2	12.1x3	7.0	RC I-Girder	0.5		H30	Masonry Gravity	4.0	Masonry Wall	5.0	Pile 9m-12m	6.80 (H86)	NO	Replace	Shortage of clearance agaist H.W.L.
4-5	Cau Den	170 + 530	River	4.8	4.8	6.9	RC Slab	0.4	1	H30	Concrete U-Shape	4.0	-	-	Spread	6.69 (H86)	OK	Use as it is	
4-6		171 + 650	River	(15)														New Construction	
4-7	Cau Cam Y	172 + 220	River	5.0	5.0	7.0	RC Slab	0.25	1	H30	Concrete U-Shape	4.0	-	-	Spread	5.80 (H86)	OK	Replace	Improvement of Vertical Alignment
4-8	Cau Trang 1	172 + 935	River	9.0	9.0	2.8 +0.7x2	RC T-Girder	0.7	2	H10	Concrete U-Shape	6.0	-	-	Spread	15.88 (H86)	OK	Replace	Substandard Design Load
4-9	Cau Trang 2	173 + 320	River	14.8	7.4x2	7.0	RC Slab	0.4	1	H18or30	Concrete Gravity	5.5	RC T-shape	4.5	Spread	14.00 (H86)	OK	Use as it is	
4-10	Cau Goc Thong	178 + 035	River	69.0	23.0x3	7.0	Steel I-beam	1.2	5	H18	Concrete Gravity	5.0	Masonry Wall	6.0	Spread	4.44 (H92)	OK	Use as it is	
4-11	Goc Thong Con	178 + 460	River	12.9	12.9	2.8 +0.7x2	RC T-Slab	1.1	2	H10	Concrete Gravity	8.0	-	-	Spread	4.62 (H92)	OK	Replace	Substandard Design Load
4-12	Ba Chan	180 + 705	River	20.5	5.75x2 +8.85	2.8 +0.7x2	RC T-Slab	0.6	2	H10	Concrete Gravity	7.0	RC Wall	7.0	Spread	6.34 (H92)	OK	Replace	Substandard Design Load
4-13	Cai Tun	183 + 510	River	8.8	8.8	2.8 +0.7x2	RC T-Slab	0.7	2	H10	Concrete Gravity	6.0	-	-	Spread	4.57 (H92)	OK	Replace	Substandard Design Load
4-14	Cai Tanh 1	185 + 405	River	13.1	6.5x2	8.1	RC Slab	0.6	1	H18 or 30	Concrete Gravity	4.5	RC Wall	4.0	Spread	3.63 (H92)	OK	Use as it is	
4-15	Cau 89	188 + 165	River	6.2	6.2	7.0	RC Slab	0.3		H30	Concrete Gravity	4.0	-	-	Spread	3.90 (H92)	OK	Use as it is	
4-16	Ba Che	190 + 330	Ba Che River	128.0	64.0x2	4.5	Steel Truss			H30	RC ReverseT	15.0	RC	14.0	Spread	3.30 (Hmax)	OK	Replace	Shortage of Width
4-17	-	195 + 570	River	5.5	5.5	7.5	RC	0.3	1	H13	Concrete Gravity	3.0	-	-	Spread	10.8	OK	Replace	Substandard Design Load
4-18	-	196 + 730	River	4.2	5.2	7.6	RC	0.3	1	H13	Concrete U-shape	3.5	-	-	Spread	7.4	OK	Replace	Substandard Design Load
4-19	-	201 + 285	River	21.0	10.5x2	4.0	Steel I-beam	0.3	10	H13	Masonry Gravity	6.0	RC Wall	6.0	Spread	7.3	OK	Replace	Substandard Design Load
4-20	-	202 + 740	River	9.3	9.3	4.0	Steel I-beam	0.3	10	H13	Concrete Gravity	6.5	-	-	Spread	6.2	OK	Replace	Substandard Design Load

* The value in the ( ) shows the width of crossing structure.

6) Tien Yen - Bac Luan Section (Km 207 + 000 - Km 300 + 640)

a. Evaluation of Existing Bridges

The results of the investigation of existing bridges is shown in Table 10.20 together with the study team's judgment concerning bridge improvement.

There are 12 spillways (submerged weir-type crossings) and 32 medium and short span bridges.

- Spillway (Submerged weir-type crossings) : 12 locations/1,193 m ; and
- Medium and short span bridges : 32 bridges/592 m.

The existing bridges are classified into the following three groups based on the loading standards and the year of construction:

	Loading Standard	Construction
1.	H8/H10	before 1945
2.	H13	recent years
3.	H18 (Ka Long Bridge)	1963
4.	H30	recent years

The above existing bridges were evaluated as follows:

- All H10 and H13 bridges will be replaced because of their lack of loading capacity and degree of deterioration;
- Ka Long Bridge (H18), a historic monument, should be preserved as it is; and
- All H30 bridges are in good or fair condition. Therefore, they can be fully utilized for the improvement.

b. New Construction Bridges

- Replacement of Existing Spillways with New Construction Bridges.

The existence of a number of spillways causes serious roadblocks for road traffic in the region, since heavy rains bring on frequent flood waters and often results in making Highway No. 18 unpassable for 3 to 5 days in many locations. In view of this situation, the improvement of Highway No. 18 will include replacement of all existing spillways with newly constructed bridges. The aim is to attain an all-weather connected road through bridge improvement;

Table 10.20 (1) List of Existing Bridges and Current Conditions, Tien Yen - Bac Luan

No.	Name	Station	Crossing Structure	Total Length (m)	Span (m)	Effective Width (m)	Superstructure				Substructure				Founda-tion Type	H.W.L. (m)	Clearance against H.W.L.	Adopted Category	Remarks
							Structure Type	Gider Depth (m)	No. of Girder	Design Load	Abut. Type	Hight (m)	Pier Type	Hight (m)					
S-1	Khe Tien	209 + 515	Pho Cu River	(120)						-						8.58 (H71)		New Construction	Spillway
S-2		211 + 300	Tien Yen River	(100)						-		(10.0)				8.38 (H71)		New Construction	Spillway
S-3	-	216 + 765	River	4.3	4.4	6.1	RC Slab	0.6	1	H13	Concrete u-shape	4.5	-	-	Spread			Replace	Substandard Design Load
S-4		217 + 690	River	5.2	5.2	6.9	RC Slab	0.4	1	H13	Concrete u-shape	4.0	-	-	Spread			Replace	Substandard Design Load
S-5	Tran Ha Gian	221 + 050	River	(46)			-			-		(4.0)		(6.0)		14.06 (H71)		New Construction	Spillway
S-6	Tran Ha Trang	226 + 345	River	(80)						-						11.68 (H65)		New Construction	Spillway
S-7	-	227 + 800	River	12.2	12.2	6.0	Steel I-beam	0.4		H13	Masonry Gravity	3.5	-	-	Spread			Replace	Substandard Design Load
S-8	-	228 + 330	River	8.8	8.8	6.0	Steel I-beam	0.4		H13	Masonry Gravity	3.0	-	-	Spread			Replace	Substandard Design Load
S-9	Tran Dong Loc	231 + 170	River	3.7	3.7	7.0	RC Slab +Arch			Unknown	Masonry Gravity	5.0	-	-	Spread			Replace	Substandard Design Load
S-10		231 + 745	River	5.0	5.0	6.0	RC Slab	0.55		Unknown	Masonry Gravity	3.5	-	-	Spread			Replace	Substandard Design Load
S-11	-	232 + 080	Dong Loc River	(80)						-						10.98 (H93)		New Construction	Spillway
S-12	-	232 + 750	River	4.3	4.3	6.4	RC Slab	0.4		Unknown	Masonry Gravity	3.0	-	-	Spread			Replace	Substandard Design Load
S-13	-	234 + 660	River	9.0	9.0	6.5	Steel I-beam	0.4	8	H13	Concrete Gravity	5.0			Spread			Replace	Substandard Design Load
S-14	Dam Ha	237 + 320	Dam Ha River	36.0	29.5+10.5	4.0	Steel Truss			H13	RC 2column	5.0	RC 2column	8.0	Spread	12.95 (Hmax)	OK	Replace	Substandard Design Load
S-15	Ngam Tan Binh	238 + 870	River	(26)						-						7.74 (Hmax)		New Construction	Spillway

* The value in the ( ) shows the width of crossing structure.
* H71 : Flooding Highest Water Level occured at 1971

Table 10.20 (2) List of Existing Bridges and Current Conditions, Tien Yen - Bac Luan

No.	Name	Station	Crossing Structure	Total Length (m)	Span (m)	Effective Width (m)	Superstructure				Substructure				Foundation Type	H.W.L. (m)	Clearance against H.W.L.	Adopted Category	Remarks
							Structure Type	Gider Depth (m)	No. of Girder	Design Load	Abut. Type	Hight (m)	Pier Type	Hight (m)					
5-16	Cau Chu 5	244 + 550	River	19.5	19.5	7.3	Stone Masonry Arch			-					Spread	3.26 (Hmax)		Replace	Substandard Design Load
5-17	Ngam D. Hoa	245 + 835	River	(73)			-								Spread	3.81 (Hmax)		New Construction	Spillway
5-18	Ngam	248 + 650	River	(50)		-	-			-						6.10 (H93)		New Construction	Spillway
5-19	Khe Heo	251 + 690	River	28.0	28.0	7.0	PC T-shape	0.7	4	H30	Masonry Gravity	5.0	-	-	Spread	7.00 (Hmax)		Replace	Improvement of Virtical Alignment
5-20	-	253 + 450	River	18.1		8.5	Stone Masonry Arch			Unknown					Spread	48.93 (H93)		Replace	Substandard Design Load
5-21		253 + 970		7.3	7.3	6.2	Stone Masonry Arch			Unknown					Spread	48.93 (H93)		Replace	Substandard Design Load
5-22	-	254 + 840	River	5.8	5.8	6.7	RC Slab	0.4	1	Unknown	Concrete U-shape	2.0	-	-	Spread			Replace	Substandard Design Load
5-23	-	256 + 000	Cannel	5.0	2.5x2	6.7	RC Slab	0.2	1	Unknown	Masonry Gravity	2.0	Masonry Wall	2.0	Spread	23.69 (H93)		Replace	Substandard Design Load
5-24	Ha Coi	264 + 920	Ha Coi River	(130+ 50)												3.75 (H1%)		New Construction	Spillway Q1%=1382m3/s
5-25		266 + 400	River	13.0	4.3x3	3.2	RC Slab	0.4	1	Unknown	Masonry Gravity	2.0	Masonry Wall	2.0	Spread	4.07 (Hmax)		Replace	Substandard Design Load
5-26	Cau L.157	269 +750	Stream	5.5	5.5	6.0	RC Slab	0.3	1	Unknown	Concrete U-shape	5.0	-	-	Spread	5.20 (Hmax)		Replace	Substandard Design Load
5-27	Cau 58 A	270 +800	River	12.0	12.0	6.5	Steel I-beam	0.5	11	H30	Masonry Gravity	6.5	-	-	Spread	5.20 (Hmax)		Replace	Improvement of Horizontal Alignment
5-28	Cau 158 B	271+000	River	13.5	6.8x2	7.5	RC Slab	0.5	1	H30	Concrete Gravity	2.5	Concrete Wall	2.5	Spread	4.50 (Hmax)	OK	Use as it is	
5-29	-	272 +875	River	5.3	5.3	6.5	RC Slab	0.6	1	H30	Concrete U-shape	4.5	-	-	Spread	3.00 (Hmax)	OK	Use as it is	
5-30	Dam Nau	273 +700	River	11.3	5.7x2	7.3	RC Slab	0.35	1	H18or30	Concrete Gravity	3.0	Concrete wall	2.5	Spread	9.00 (Hmax)	OK	Use as it is	

* The value in the ( ) shows the width of crossing structure.
* Hmax : Histrical Flooding High Water Level

Table 10.20 (3) List of Existing Bridges and Current Conditions, Tien Yen - Bac Luan

No.	Name	Station	Crossing Structure	Total Length (m)	Span (m)	Effective Width (m)	Superstructure				Substructure				Founda-tion Type	H.W.L. (m)	Clearance against H.W.L.	Adopted Category	Remarks
							Structure Type	Gider Depth (m)	No. of Girder	Design Load	Abut. Type	Hight (m)	Pier Type	Hight (m)					
5-31		274+980	River	(14)												4.72 (Hmax)		New Construction	Spillway
5-32	Coc4	275+935	River	4.0	4.0	6.25	RC Slab	0.3	1	H10	Concrete U-shape	2.5	-	-	Spread	4.72 (Hmax)	OK	Replace	Substandard Design Load
5-33	Tran Bat Cap	278+150	River	(90)												6.15 (Hmax)		New Construction	Spillway
5-34	Banh Du	279+740	River	9.6	9.6	4.0	RC Slab	0.3		H10	Masonry Gravity	5.0	Masonry Wall	4.5	Spread	10.10 (Hmax)	OK	Replace	Substandard Design Load
5-35	Ba Tuc	280+645	River	10.2	5.1x2	7.0	RC Slab	0.4	1	H30	Concrete Gravity	3.5	Concrete Wall	3.0	Spread	2.21 (Hmax)	OK	Use as it is	
5-36	Coc1	281+645	River	5.3	5.3	7.0	RC Slab	0.4	1	H30	Concrete U-shape	3.5	-	-	Spread	2.00 (Hmax)	OK	Use as it is	
5-37	Tran Thinh Cong	282+885	River	(209)												3.88 (Hmax)		New Construction	Spillway Q=1130m3/s
5-38	Coc4	284+100	River	4.5	4.5	7.0	RC Slab	0.4	1	H13	RC Gravity	2.0	-	-	Spread	2.82 (Hmax)	OK	Replace	Substandard Design Load
5-39	Khe Giat	285+410	River	27.0	8.7x2+9.3	5.90	RC Slab	0.5	1	H10	Masonry Gravity	5.5	Masonry Wall	5.0	Spread	4.18 (Hmax)	OK	Replace	Substandard Design Load
5-40	Ban Mai 3	289+575	River	12.4	6.2x2	6.6	RC Slab	0.3	1	H30	Masonry Gravity	3.0	Masonry Gravity	3.0	Spread	4.60 (Hmax)	OK	Replace	Substandard Design Load
5-41	Ban Mai 2	289+690	River	18.4	6span	5.8	Stone Masonry Arch			H10				2.5	Spread	4.60 (Hmax)	OK	Replace	Substandard Design Load
5-42	Ban Mai 1	290+120	River	16.6		5.5	Stone Masonry Arch			H10				2.5	Spread	4.60 (Hmax)	OK	Replace	Substandard Design Load
5-43	Chang On	292+300	River	18.8	6.2x3	6.5	RC Slab	0.4	1	H10	Masonry Gravity	5.0	Masonry Gravity	5.0	Spread	7.55 (Hmax)	OK	Replace	Substandard Design Load
5-44	Ka Long	299+850	River	212.9	3span	7.0	Stone Masonry Arch			H18					Spread		OK	Use as it is	

* The value in the ( ) shows the width of crossing structure.
* Hmax : Histrical Flooding High Water Level

- Newly Constructed Bridges in the Bypass Sections

Tien Yen - Bac Luan section is comprised of the following bypass sections :

Tien Yen Bypass	:	km 207 - km 212 + 600
Dam Ha Bypass	:	km 235 - km 239 + 540
Ha Coi Bypass	:	km 263 - km 266 + 360

In Tien Yen Bypass two rivers are crossed; the Pho Cu River (river width = 120 m) and the Tien Yen River (river width = 100 m). Two newly constructed bridges are planned in this section.

In Dam Ha Bypass one new bridge is planned.

In Ha Coi Bypass, the Ha Coi River (130 m river width) is crossed.

10.8 Preliminary Design of Bridges

This subsection describes the results of preliminary design of bridges covering the followings:

- Design of short-span and medium-span bridges;
- Widening of existing bridges; and
- Design of special bridge.

10.8.1 Design of Short-Span and Medium-Span Bridges

(1) General

As a result of overview of bridge improvement in the previous subsection, it was found that a total of 113 bridges are to be involved in the improvement. Among 113 bridges, 87 bridges need to be newly constructed or replaced.

The widths of existing structures to be crossed are no more than 30 m, and no rivers require navigation clearance. Therefore, the maximum span length for medium bridges will fall within approximately 30 m. To cope with the large number of bridges, the study team decided to consider a standardisation in design and construction for both superstructures and substructures.

(2) Basic Policy for the Determination of Total Bridge Length and Span Arrangement

1) River Bridges

- Abutments of bridges which cross rivers must be located away from the dikes to prevent weakening of dike body/foundation in accordance the government's regulation;

- Bridge length of river crossings with no dikes should be determined to take the river width in flooding condition into account; and

- The minimum span length of river bridges should be determined to limit obstruction by piers during flooding to approximately 5% of the sectional area of the river. Also from an aesthetic point of view, all span lengths should be as constant as possible.

2) Flyovers

- The ends of flyover should be determined considering the limitation of maximum embankment height;

- The span arrangement for flyovers should be determined taking into account the existing and future width of the road or railway.

(3) Superstructure Design

According to the policies of the determination of total bridge length and span arrangement, a maximum span length of 33 m was determined. Based on the relationship between span length and standard type of bridge the study team selected the following superstructure types for various span lengths. (Table 10.21)

Table 10.21 Superstructure Types by Span Length

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

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

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

(4) Substructure Design

1) Abutments

The height of abutments generally ranges from 4m to 12m. Based on this fact and considering the current construction practices in Vietnam, the adoption of the following types of abutment is recommended (Table 10.22)

Table 10.22 Abutment Type by Its Height

Abutment Height (m)	Abutment Type
H ≦ 6	Concrete Gravity Type
6 < H ≦ 12	RC Reversed T - Type

Wing walls and approach slabs are required in many cases. It is assumed that the wing wall length is limited to about 8m and the approach slabs are provided where the embankment height is more than 5m.

2) Piers

a. Piers in Rivers

The wall type is adopted for piers in rivers to provide smooth flow of water.

b. Piers for flyovers

The rigid frame type is adopted for flyover piers for economic reasons.

(5) Foundation Design

1) General

According to the results of soil investigations carried out by the study team and the information of TEDI's Feasibility Study, pile foundations are required in the following sections :

Highway Section	Pile Length
Noi Bai - Bac Ninh	20m - 40m
Bac Ninh - Chi Linh	15m - 30m
Hong Gai - Cua Ong (only in coastal area)	around 10m

In the mountainous areas in the Hong Gai - Cua Ong section, Cua Ong - Tien Yen section and Tien Yen - Bac Luan section, spread foundations are adopted because the bearing strata (consisting of sandstone and claystone) are found at a depth of less than 5m.

2) Types of Pile

Precast RC square piles (40cm x 40cm) are generally adopted for economic reasons and in light of current construction practice in Vietnam.

3) Minimum Cover Depth of Footings

Pier and abutment footings will be provided with appropriate soil covers depending on their situations. In the case of piers in rivers, a minimum cover depth of two (2) meters is considered to be sufficient to take account of possible scouring. In the case of piers for flyovers, a minimum cover depth of one (1) meter is considered adequate to take the construction of drainage facilities into account.

(6) Summary of Design Features of Short-Span and Medium Span Bridges

Design features of river bridges (excluding Pha Lai main bridge) and flyovers are summarized in Table 10.23.

10.8.2 Widening of Existing Bridges

(1) General

In the Hong Gai - Cua Ong section, there are 12 existing bridges which were designed with sufficient loading standard and still in fair condition, but all of these bridges have insufficient effective width. As these bridges are built in the same period, they have the same nature of design as follows:

Bridge Length and span arrangement	:	8.5m, 8.5m x 2 and 8.5m x 3
Type of Superstructure	:	RC T- Girder
Type of Substructure		
Abutment	:	Concrete Gravity Type
Pier	:	Wall Type
Type of Foundation	:	Pile Foundation

Therefore, the same widening measures will be applied to all of these bridges.

(2) Widening and Construction Procedures

Bridge widening of 9.15m will place at both sides of existing bridges as shown in Figure 10.4.

Table 10.23 (1) List of Short-Span and Medium-Span Bridges

Section 1 (From Noi Bai To Bac Ninh)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Length (m)	Superstructure			**	Abutment						Pier							***
					Span (m)	Nos. of Span	Effective Width (m)	Type	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Construction Stage
1-1	1 + 480	Channel	N	15.0	15.0	1	11.25 *	RC-T	Gravity	2	3.0	Pile	0.4	20.0	24 * 4							I, F
1-2	6 + 500	QL3	N	150.0	30.0	5	11.25 *	PC-I	Reversed-T	2	7.0	Pile	0.4	20.0	45 * 4	Rigid Frame	6	6-8	Pile	0.4	25.0	23 * #	I, F
1-3	7 + 370	Railway	N	390.0	30.0	13	11.25 *	PC-I	Reversed-T	2	7.0	Pile	0.4	25.0	40 * 4	Rigid Frame	13	6-11	Pile	0.4	25.0	19 * #	I, F
1-4	8 + 300	Channel	N	10.0	10.0	1	11.25 *	RC-T	Reversed-T	2	7.0	Pile	0.4	20.0	34 * 4								I, F
1-5	8 + 410	Pond	N	10.0	10.0	1	11.25 *	RC-T	Reversed-T	2	7.0	Pile	0.4	20.0	34 * 4								I, F
1-6	10 + 290	Channel	N	10.0	10.0	1	11.25 *	RC-T	Gravity	2	3.0	Pile	0.4	20.0	* 4								I, F
1-7	12 + 170	Pond	N	10.0	10.0	1	11.25 *	RC-T	Gravity	2	3.0	Pile	0.4	20.0	24 * 4								I, F
1-8	13 + 410	Ca Lo riv.	N	180.0	30.0	6	11.25 *	PC-I	REversed-T	2	7.0	Pile	0.4	27.0	45 * 4	Wall	5	12.0	Pile	-	20.0	33 * 6	I, F
1-9	14 + 650	Channel	N	25.0	25.0	1	11.25 *	PC-I	Gravity	2	3.0	Pile	0.4	20.0	29 * 4								I, F
1-10	15 + 960	Channel	N	20.0	20.0	1	11.25 *	RC-T	Gravity	2	5.0	Pile	0.4	20.0	24 * 4								I, F
1-11	19 + 260	Channel	N	20.0	20.0	1	11.25 *	PC-I	Gravity	2	3.0	Pile	0.4	20.0	24 * 4								I, F
1-12	23 + 000	Channel	N	10.0	10.0	1	11.25 *	RC-T	Gravity	2	5.0	Pile	0.4	20.0	21 * 4								I, F
1-13	26 + 750	Khe riv.	N	150.0	30.0	5	11.25 *	PC-I	Reversed-T	2	7.0	Pile	0.4	22.0	45 * 4	Wall	4	11.0	Pile	0.4	20.0	33 * 6	I, F
1-14	27 + 790	Rail.+QL1	N	950.0	25-30	34	11.25 *	PC-I	Reversed-T	2	7.0	Pile	0.4	37.0	45 * 4	Rigid Frame	20	6-15	Pile	0.4	37.0	24 * #	I, F

Section 2 (From Bac Ninh To Chi Linh)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Length (m)	Superstructure			**	Abutment						Pier							***
					Span (m)	Nos. of Span	Effective Width (m)	Type	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Construction Stage
2-1	-1-785	Channel	N	20.0	20.0	1	11.00	PC-I	Gravety	2	3.0	Pile	0.4	20.0	24 * 4								I, F
2-2	0 -020	Channel	N	20.0	20.0	1	11.00	PC-I	Gravity	2	5.0	Pile	0.4	20.0	24 * 4								I, F
2-3	3 +790	River	R	11.0	11.0	1	11.00	RC-T	Gravity	2	4.0	Pile	0.4	12.0	27 * 2								I, F
2-4	13+680	River	R	30.0	30.0	1	11.00	PC-I	Reversed-T	2	7.0	Pile	0.4	7.0	56 * 2								I, F
2-5	20+850	Raddy	N	46.0	23.0	2	11.00	PC-I	Reversed-T	2	7.5	Pile	0.4	20.0	56 * 2	Wall	1	6.0	Pile	0.4	20.0	19 * 1	I, F
2-6	22+670	Raddy	N	46.0	23.0	2	11.00	PC-I	Reversed-T	2	7.5	Pile	0.4	15.0	40 * 2	Wall	1	6.0	Pile	0.4	15.0	19 * 1	I, F
2-7	23+300	Raddy	N	46.0	23.0	2	11.00	PC-I	Reversed-T	2	8.5	Pile	0.4	30.0	40 * 2	Wall	1	6.5	Pile	0.4	30.0	19 * 1	I, F
2-8	24+300	Raddy	N	60.0	20.0	3	11.00	PC-I	Reversed-T	2	10.0	Pile	0.4	25.0	53 * 2	Wall	2	8.0	Pile	0.4	25.0	19 * 2	I, F
2-9	25+300	Swamp	N	660.0	30.0	22	11.00	PC-I	Reversed-T	1	10.0	Pile	0.4	20.0	53 * 1	Rigid Frame	22	9.0	Pile	0.4	20.0	22 * #	I, F
2-10	25+860	Thai Binh River	N	579.0	43-105	10	11.00	PC-Box	Reversed-T	1	7.0	Pile	0.4	15.0		Wall	10		Pile	0.4-1.5	9-35		I, F
2-11	26+990	Canal	R	36.0	36.0	1	11.00	PC-I	Reversed-T	2	10.0	Pile	0.4	20.0	59 * 2								I, F

* Type of Improvement; N : New Construction, R : Replacement, W : Widennig, U : Use as it is

** Superstructure Type ; PC-I:PC I-Girder, RC-T:RC T-Girder, RC-H:RC Hollow Slab, RC-S:RC Slab

*** Construction Stage; I : Initial Stage, F : Final Stage

Table 10.23 (2) List of Short-Span and Medium-Span Bridges

Section 3 (From Hong Gai To Cua Ong)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Length (m)	Superstructure				Abutment							Pier							**** Construction Stage
					Span (m)	Nos. of Span	Effective Width (m)	** Type	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	
3-1	121 + 880	Valley	N	99.0	33.0	3	26.50	PC-I	Gravity	2	4.0	Spread				Wall	1	20.0	Spread	-	-		I
3-2	122 + 380	Valley	N	120.0	30.0	4	26.50	PC-I	Gravity	2	4.0	Spread				Wall	1	17.0	Spread	-	-		I
3-3	122 + 840	Valley	N	210.0	30.0	7	26.50	PC-I	Reversed-T	2	10.0	Pile	0.4	9.0	164 * 1	Rigid Frame	6	12.0	Pile	0.4	9.0	73 * 6	I
3-4	130 + 260	Road	R	31.0	31.0	1	26.50	PC-I	Reversed-T	2	10.0	Spread											I
3-5	132 + 470	River	R	6.0	6.0	1	26.50	RC-S	Reversed-T	2	7.0	Spread											I
3-6	540	River	R	29.0	29.0	1	26.50	PC-I	Reversed-T	2	12.0	Spread											I
3-7	137 + 600	Stream	W	9.0	9.0	1	0 (17.3)	RC-S	Reversed-T	2	6.5	Spread											I
3-8	141 + 580	Stream	R	6.0	6.0	1	26.50	RC-S	Gravity	2	3.0	Spread											I
3-9	142 + 440	Stream	R	6.0	6.0	1	26.50	RC-S	Gravity	2	3.0	Spread											I
3-10	143 + 150	Stream	W	5.5	5.5	1	26.50 (16.5)	RC-S	Gravity	2	3.0	Spread											I
3-11	144 + 860	River	N	17.0	17.0	1	26.50	RC-H	Gravity	2	6.0	Pile	0.4	9.0	110 * 2								I
3-12	145 + 750	River	N	9.0	9.0	1	26.50	RC-S	Reversed-T	2	7.0	Pile	0.4	6.0	95 * 2								I
3-13	146 + 480	River	N	9.0	9.0	1	26.50	RC-S	Gravity	2	6.0	Pile	0.4	12.0	95 * 2								I
3-14	147 + 710	River	N	17.0	17.0	1	26.50	RC-H	Gravity	2	6.0	Pile	0.4	15.0	110 * 2								I
3-15	149 + 010	River	N	9.0	9.0	1	26.50	RC-S	Reversed-T	2	7.0	Pile	0.4	6.0	95 * 2								I
3-16	150 + 040	River	W	17.0	8.5	1	26.50 (18.3)	RC-T	Reversed-T	2	7.0	Pile	0.4	7.0	64 * 2	Wall	1	6.0	Pile	0.4	7.0	36 * 1	I
3-17	150 + 610	River	W	17.0	8.5	1	26.50 (18.3)	RC-T	Reversed-T	2	7.0	Pile	0.4	7.0	64 * 2	Wall	1	6.0	Pile	0.4	7.0	36 * 1	I
3-18	151 + 585	River	W	8.5	8.5	1	26.50 (18.3)	RC-S	Reversed-T	2	7.0	Pile	0.4	7.0	64 * 2								I
3-19	152 + 815	River	W	8.5	8.5	1	26.50 (18.3)	RC-S	Reversed-T	2	7.0	Pile	0.4	7.0	64 * 2								I
3-20	153 + 360	River	W	25.5	8.5	3	26.50 (18.3)	RC-T	Reversed-T	2	7.0	Pile	0.4	7.0	64 * 2	Wall	2	6.0	Pile	0.4	7.0	36 * 2	I
3-21	154 + 215	River	W	6.7	6.7	1	26.50 (17.5)	RC-S	Gravity	2	4.0	Pile	0.4	7.0	38 * 2								I
3-22	154 + 550	River	W	8.5	8.5	1	26.50 (18.3)	RC-T	Gravity	2	4.0	Pile	0.4	7.0	40 * 2								I
3-23	157 + 490	River	W	12.6	12.6	1	26.50 (16.8)	RC-T	Gravity	2	5.0	Pile	0.4	7.0	68 * 2								I
3-24	160 + 210	River	W	4.7	4.7	1	26.50 (18.3)	RC-S	Gravity	2	3.5	Spread											I
3-25	160 + 930	River	W	11.2	11.2	1	26.50 (18.3)	RC-T	Gravity	2	4.0	Pile	0.4	6.0	40 * 2								I

* Type of Improvement; N : New Construction, R : Replacement, W : Widennig, U : Use as it is

** Superstructure Type ; PC-I:PC I-Girder, RC-T:RC T-Girder, RC-H:RC Hollow Slab, RC-S:RC Slab

*** Construction Stage; I : Initial Stage, F : Final Stage

**** The value into ( ) shows the necessary Effective Width for widenning.

Table 10.23 (3) List of Short-Span and Medium-Span Bridges

Section 4 (From Hong Gai to Cua Ong)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Total Length (m)	Superstructure Span (m)	Nos. of Span	Effective Width (m)	** Type	Abutment Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Pier Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	*** Construction Stage
4-1	165 + 170	Railway	U	-	-	-	-	-	-	-	-	-											-
4-2	166 + 840	River	U	-	-	-	-	-	-	-	-	-											-
4-3	167 + 830	River	U	-	-	-	-	-	-	-	-	-											-
4-4	168 + 130	River	R	37.0	18.5	2	11.00	RC-H	Reversed-T	2	9.0	Pile	0.4	8.0	67 * 2	Wall	1	6.0	Pile	0.4	9.0	24 * 1	I
4-5	170 + 530	River	U	-	-	-	-	-	-	-	-	-											-
4-6	171 + 650	River	N	15.0	15.0	1	8.00	RC-H	Gravity	2	6.0	Spread											I
4-7	172 + 220	River	R	5.0	5.0	1	8.00	RC-S	Reversed-T	2	10.0	Spread											I
4-8	172 + 935	River	R	9.0	9.0	1	8.00	RC-S	Gravity	2	6.0	Spread											I
4-9	173 + 320	River	U	-	-	-	-	-	-	-	-	-											-
4-10	178 + 035	River	U	-	-	-	-	-	-	-	-	-											-
4-11	178 + 460	River	R	13.0	13.0	1	8.00	RC-T	Reversed-T	2	7.5	Spread											I
4-12	180 + 705	River	R	20.5	20.5	1	8.00	PC-I	Reversed-T	2	10.0	Spread											I
4-13	183 + 510	River	R	9.0	9.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
4-14	185 + 405	River	U	-	-	-	-	-	-	-	-	-											-
4-15	188 + 465	River	U	-	-	-	-	-	-	-	-	-											-
4-16	190 + 330	River	R	129.0	33.0	4	8.00	PC-I	Reversed-T	2	12.0	Spread				Wall	3	14.0	Spread				I
4-17	195 + 570	River	R	6.0	6.0	1	8.00	RC-S	Gravity	2	6.0	Spread											I
4-18	196 + 730	River	R	6.0	6.0	1	8.00	RC-S	Gravity	2	4.0	Spread											I
4-19	201 + 285	River	R	21.0	21.0	1	8.00	PC-I	Reversed-T	2	10.0	Spread											I
4-20	202 + 740	River	R	9.5	9.5	1	8.00	RC-S	Reversed-T	2	10.0	Spread											I

* Type of Improvement; N : New Construction, R : Replacement, W : Widennig, U : Use as it is

** Superstructure Type ; PC-I:PC I-Girder, RC-T:RC T-Girder, RC-H:RC Hollow Slab, RC-S:RC Slab

*** Construction Stage; I : Initial Stage, F : Final Stage

Table 10.23 (4) List of Short-Span and Medium-Span Bridges

Section 5 (From Tien Yen To Bac Luan) (1/2)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Length (m)	Superstructure			** Type	Abutment						Pier						*** Construction Stage
					Span (m)	Nos. of Span	Effective Width (m)		Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	
S-1	209 + 515	River	N	99.0	33.0	3	8.00	PC-I	Reversed-T	2	8.0	Pile	0.4	12.0	42 * 2	Wall	2	15.0	Pile	0.4	12.0	31 * 2	I
S-2	211 + 300	River	N	150.0	30.0	5	8.00	PC-I	Reversed-T	2	8.0	Spread				Wall	4	12.0	Spread				F
S-3	216 + 765	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	7.0	Spread											I
S-4	217 + 690	River	R	6.0	6.0	1	8.00	RC-S	Gravity	2	6.0	Spread											I
S-5	221 + 050	River	N	50.0	25.0	2	8.00	PC-I	Reversed-T	2	7.0	Spread				Wall	1	5.5	Spread				F
S-6	226 + 345	River	N	50.0	25.0	2	8.00	PC-I	Reversed-T	2	12.0	Spread				Wall	1	12.0	Spread				F
S-7	227 + 800	River	R	13.0	13.0	1	8.00	RC-T	Reversed-T	2	10.0	Spread											I
S-8	228 + 330	River	R	9.0	9.0	1	8.00	RC-S	Reversed-T	2	8.0	Spread											I
S-9	231 + 170	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
S-10	231 + 745	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
S-11	232 + 080	River	N	50.0	25.0	2	8.00	PC-I	Reversed-T	2	9.0	Spread				Wall	1	11.0	Spread				F
S-12	232 + 750	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
S-13	234 + 660	River	R	9.0	9.0	1	8.00	RC-S	Reversed-T	2	7.0	Spread											I
S-14	237 + 320	River	R	40.0	20.0	2	8.00	PC-I	Gravity	2	5.0	Spread				Wall	1	8.0	Spread				I
S-15	238 + 870	River	N	40.0	20.0	2	8.00	PC-I	Gravity	2	4.0	Spread				Wall	1	5.0	Spread				F
S-16	244 + 550	River	R	20.0	20.0	1	8.00	PC-I	Reversed-T	2	8.0	Spread											I
S-17	245 + 835	River	N	50.0	25.0	2	8.00	PC-I	Reversed-T	2	6.5	Spread				Wall	1	7.5	Spread				F
S-18	248 + 650	River	N	75.0	25.0	3	8.00	PC-I	Gravity	2	6.0	Spread				Wall	2	7.0	Spread				F
S-19	251 + 690	River	R	28.0	28.0	1	8.00	PC-I	Reversed-T	2	10.0	Spread											I
S-20	253 + 450	River	R	18.0	18.0	1	8.00	RC-H	Reversed-T	2	12.0	Spread											I
S-21	253 + 970	River	R	8.0	8.0	1	8.00	RC-S	Gravity	2	6.0	Spread											I
S-22	254 + 840	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
S-23	256 + 000	Cannel	R	6.0	6.0	1	8.00	RC-S	Gravity	2	6.0	Spread											I
S-24	264 + 920	Ha Coi River	N	300.0	30.0	10	8.00	PC-I	Reversed-T	2	12.0	Spread				Wall	9	11.0	Spread				F
S-25	266 + 400	River	R	13.0	13.0	1	8.00	RC-H	Gravity	2	3.0	Spread											I
S-26	269 + 750	River	R	6.0	6.0	1	8.00	RC-S	Reversed-T	2	6.5	Spread											I
S-27	270 + 800	River	R	12.0	12.0	1	8.00	RC-H	Reversed-T	2	7.0	Spread											I
S-28	271 + 000	River	U	-	-	-	-	-	-	-	-	-											-
S-29	272 + 875	River	U	-	-	-	-	-	-	-	-	-											-
S-30	273 + 700	River	U	-	-	-	-	-	-	-	-	-											-

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** Superstructure Type ; PC-I:PC I-Girder, RC-T:RC T-Girder, RC-H:RC Hollow Slab, RC-S:RC Slab

*** Construction Stage; I : Initial Stage, F : Final Stage

Table 10.23 (5) List of Short-Span and Medium-Span Bridges

Section 5 (From Tien Yen To Bac Luan) (2/2)

Bridge No.	Station	Crossing Structure	* Type of Improve.	Total Length (m)	Superstructure				Abutment							Pier							*** Construction Stage
					Span (m)	Nos. of Span	Effective Width (m)	** Type	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	Type	Nos.	Hight (m)	Founda. Type	Pile Dia. (m)	Pile L (m)	Nos. of Pile	
S-31	274 + 980	River	N	20.0	20.0	1	8.00	PC-I	Gravity	2	4.0	Spread											F
S-32	275 + 935	River	R	6.0	6.0	1	8.00	RC-S	Gravity	2	4.0	Spread											I
S-33	278 + 150	River	N	99.0	33.0	3.0	8.00	PC-I	Gravity	2	4.0	Spread				Wall	2	6.0	Spread				I
S-34	279 + 740	River	R	10.0	10.0	1	8.00	RC-H	Gravity	2	4.0	Spread											I
S-35	280 + 645	River	U	-	-	-	-	-	-	-	-	-											-
S-36	281 + 645	River	U	-	-	-	-	-	-	-	-	-											-
S-37	282 + 885	River	N	210.0	30.0	7	8.00	PC-I	Reverse-T	2	8.0	Spread				Wall	6	6.5	Spread				F
S-38	284 + 100	River	R	6.0	6.0	1	8.00	RC-S	Gravity	2	5.0	Spread											I
S-39	285 + 410	River	R	27.0	27.0	1	8.00	PC-I	Gravity	2	5.5	Spread											I
S-40	289 + 575	River	R	13.0	13.0	1	8.00	RC-H	Reverse-T	2	6.5	Spread											I
S-41	289 + 690	River	R	19.0	19.0	1	8.00	RC-H	Reverse-T	2	6.5	Spread											I
S-42	290 + 120	River	R	17.0	17.0	1	8.00	RC-H	Gravity	2	6.0	Spread											I
S-43	292 + 300	River	R	20.0	20.0	1	8.00	PC-I	Gravity	2	5.0	Spread											I
S-44	299 + 850	River	U	-	-	-	-	-	-	-	-	-											-

* Type of Improvement; N : New Construction, R : Replacement, W : Widennig, U : Use as it is

** Superstructure Type ; PC-I:PC I-Girder, RC-T:RC T-Girder, RC-H:RC Hollow Slab, RC-S:RC Slab

*** Construction Stage; I : Initial Stage, F : Final Stage

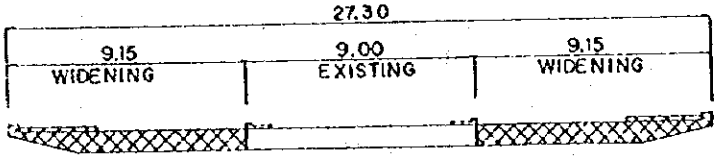

Figure 10.4 Widening of Existing Bridge Deck

The widening procedure may be as follows (Figure 10.5):

1. Fabrication of new RC-T girders.
2. Chipping of existing substructures and widening of structures.
3. Removal of handrail and sidewalk; chipping of side edge of existing girders.
4. Setting of new girders and connecting with existing superstructure.
5. Work on bridge accessories.

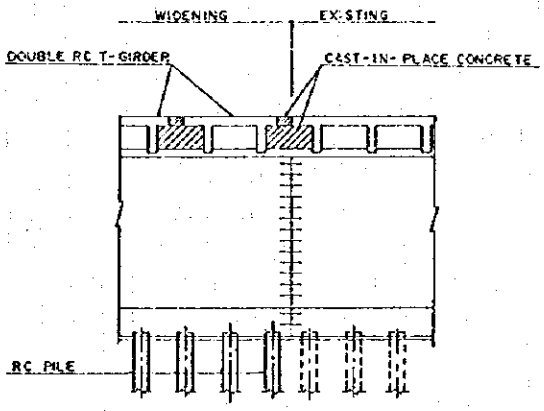

Figure 10.5 Bridge Widening Concept