SOCIALIST REPUBLIC OF VIET NAM
PROJECTS MANAGEMENT UNIT NO.2

FINAL REPORT

FOR ROAD & BRIDGE PORTION ON LACH HUYEN PORT INFRASTRUCTURE CONSTRUCTION PROJET IN VIET NAM

(Vol. 1 of 2)

MARCH 2013

Japan International Cooperation Agency (JICA)

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CHAPTER 1 GENERAL

1.1 Introduction

1.1.1 Background

Owing to the Government's policy "Doi Moi", Vietnam economy has remarkably expanded and, sea-borne trade through the ports in the north of Vietnam has experienced a significant increase both in quantities and kinds of commodities.

Along the area connecting Hai Phong in the northern coastal region of Vietnam and Hanoi, there exist various enterprises that contribute to the development of the region. Major ports supporting commercial activities of these enterprises include Hai Phong and Cai Lan Port, which received JICA's loan assistance in the past for rehabilitation and expansion works. While the capacity of these ports and other ports in the region is planned to cope with total 40.2 million tons of containerized cargo in 2015, the demand is expected to surpass this figure in 2015 and expand to 58.9 million in 2020, making it necessary to build a new port with enough capacity to cover the demand that would overflow. Against this backdrop, the Government of The Socialist Republic of Vietnam (hereinafter referred to as "GOV") carried out a feasibility study on the Lach Huyen Port Infrastructure Construction Project, based on which GOV requested the government of Japan (hereinafter called as "GOJ) to provide a Japanese ODA Yen loan in order to enforce the development plan proposed in its feasibility study.

In response to the request of GOV, the Japan International Cooperation Agency (hereafter referred to as "JICA") conducted the Preparatory Survey for Lach Huyen Port Infrastructure Construction in Vietnam from October 2009 to June 2010. The survey team recommended the development of Lach Huyen Port Infrastructure Construction Project as a priority project under the finance by Japanese Government ODA Loan Project (hereinafter referred to as "the Project")

Responding to the recommendation of the JICA study, GOV requested GOJ to provide an ODA loan for the Project by JICA, and to conduct the Detailed Design Study for Lach Huyen Port Infrastructure Construction Project (hereafter referred to as "the Design Study") by the technical cooperation program of GOJ in June 2010.

GOJ decided to extend Design Study, and JICA and the Ministry of Transport of GOV (hereinafter referred to as "MOT"), a responsible organization for the Design Study in GOV, have agreed that both sides shall sincerely cooperate with each other in implementing the Design Study and confirmed the implementation details of the Design Study.

This report was prepared to show the Detailed Design result as a part of Design Study. The contents of this report has been discussed and confirmed at the initial stage & second stage by the both sides of the Design Study Team and GOV to ensure successful implementation of the Design Study for the Project.

1.1.2 Outline of Design Study

1.1.2.1 Objectives of Design Study

The Design Study is intended to assist the implementing agencies for the Project, Maritime Project Management Unit No.2 (MPMU II) under Vietnam Maritime Administration for the port portion and Project Management Unit No.2 (PMU2) under Directorate of Roads for Vietnam for the road and bridge portion to implement smoothly and successfully Lach Huyen Port Infrastructure Project. The objectives of the Design Study are to prepare the tendering documents and detailed design for the Project. It is confirmed by MOT that the drawing and documents formulated by the Design Study (hereinafter referred to as "the Design Documents") shall be fully utilized for the procurement procedure of the Project.

1.1.2.2 Project Profile

1) Name of the Project: Lach Huyen Port Infrastructure Construction Project
2) Signing L/A: Under processing
3) Proposed Facilities of the Project:

The Project (under the finance by Japanese Government ODA Loan) consists of the construction of land reclamation for two (2) berths of international container terminal and the related port and access road/bridge infrastructures. The following highway facilities and relative equipment are to be provided for the Project.

(Road and Bridge Portion)

Construction of Access Road and Bridges from Tan Vu to Lach Huyen for 15.63 km long, consisting of:

a) Road of about 10.19 km long,
b) Bridges of totally 5.44 km long,
c) 4 lanes of 3.5 m lane width

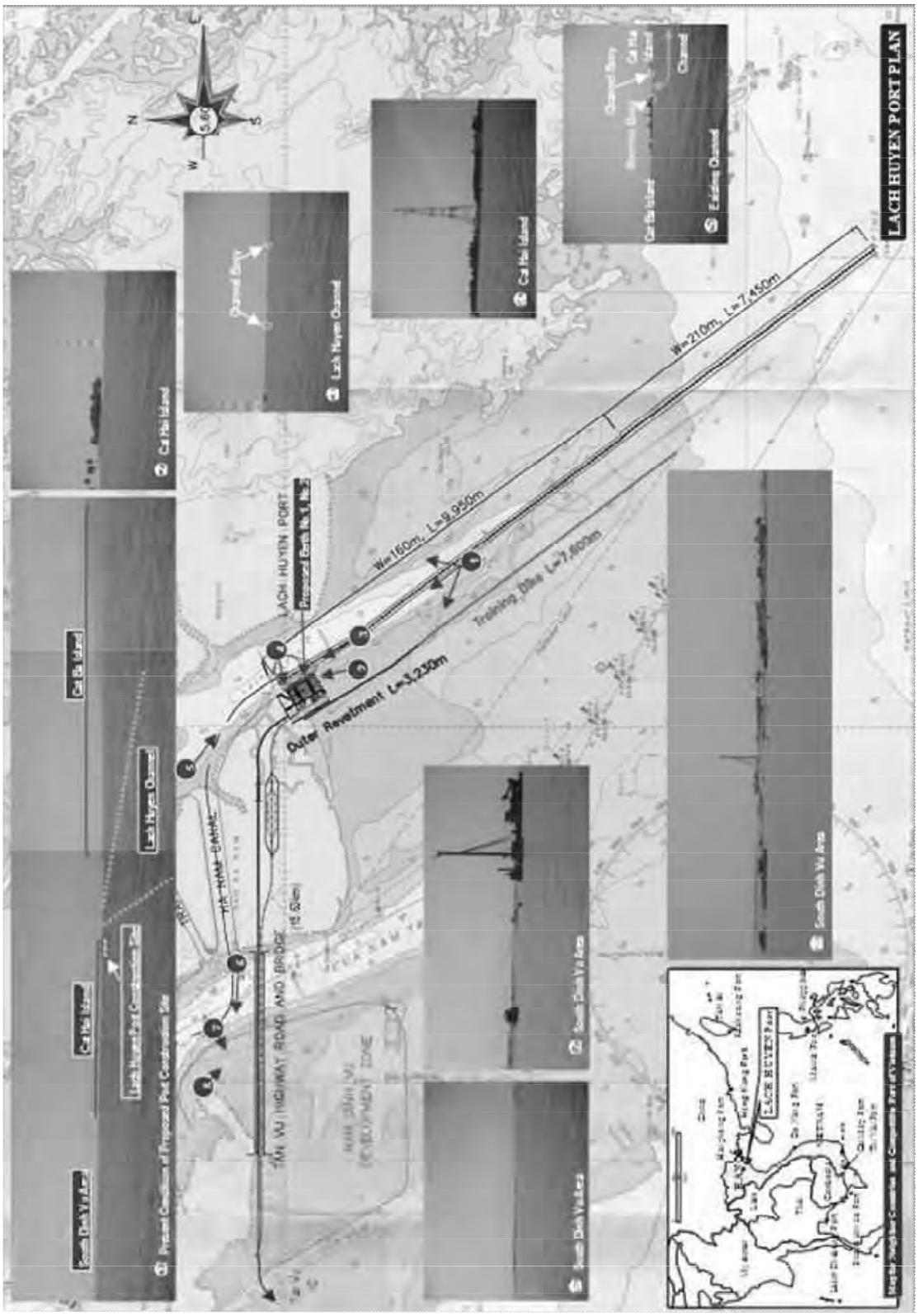
4) Implementing Agencies

Ministry of Transport (MOT) of GOV

(Road and Bridge): PMU2 under Directorate of Roads for Vietnam (DRVN)

1.1.3 Study Area

Hai An District & Cat Hai Island and their surrounding area in Hai Phong City, Vietnam



Source : Study Team

Figure 1.1.3-1 Study Area

1.2 Scope of Design Study

1.2.1 Scope of Design Study

In order to achieve the objectives mentioned above, the Design Study shall cover, but not limited to, the following study works.

(1) Review of previous studies

(2) Establishment of framework for the detailed design

(3) Implementation of Design Study (detailed design including cost estimation and preparation of tender documents)

1.2.1.1Review of Previous Studies and Plans

(1) Review previous master plans, feasibility studies, Environmental Impact Assessment (EIA), Resettlement Action Plan (RAP), and other records and data related to the Project based on the latest information on traffic data, social and economic conditions, traffic forecast of the target year of 2015 in short term and 2020 in medium term among others, and

(2) Review plans, scope, scale, location or layout, if necessary and appropriate, and operation and maintenance system for the Project.

In the basic design stage, the above said items were completed.

1.2.1.2 Establishment of Design Study Framework

(1) Establish design criteria and design/technical standards to be applied for the Project.

(2) Recommend and agree with PMU2 the format and content for the Bills of Quantities and cost estimate for construction of each contract package of the Project.

(3) Recommend and agree with PMU2 the division of each categorized package for construction,

(4) Recommend and agree with PMU2 the format and content for prequalification and tender documents for each package of construction,

(5) Recommend and agree with PMU2 the time schedule for implementation of the detailed design, the Bills of Quantities, cost estimate, prequalification documents and bidding documents to allow the tendering of works and construction for each contract package to commence immediately after the completion of necessary design and documentation work and the gaining of necessary approvals, and,

(6) Agree with the Technical Advisory Committee of GOV the schedule, item and content of technical aspect for authorization of Design Study and Design Documents

In the basic design, the above said items have been being discussed with Vietnamese relative agencies due to delayed schedule for establishment of Technical Advisory Committee. The results are reflected in this final report.

1.2.1.3 Design Study

The Design Study Team has used the reference documents of previous studies approved by GOV as the basis for the Design Study. The Design Study Team has carried out surveys and investigation, basic design of road and bridge/structures, study of operation and maintenance system, preparation of construction method and schedule, cost estimate, preparation of prequalification documents and tender documents, preparation of implementation program, etc. as listed below:

(1) Conduct the following survey and investigations required for the Design Study (basic and detailed design):

(Field Survey and Investigation)

- Soil investigation at the area along the construction of road and bridges,
- Topographic survey at the area along the construction of road and bridges,
- Evaluation survey on availability and suitability of material sources for road and bridge construction,
- Hydro- and meteoro-logical (Data Collection) Survey
- Environmental survey around the Project site

(2) Prepare detailed design for roads, bridges and other structures,

(3) Establish an operation and maintenance system for the Project,

(4) Prepare the detailed environmental management and monitoring program,

(5) Monitor the progress of land acquisition and resettlement,

(6) Recommend appropriate construction methods and prepare a construction schedule,

(7) Prepare a cost estimate for the Project and study the effectiveness of the Project,

(8) Prepare prequalification and tender documents

(9) Prepare and implementation program, and

(10) Prepare HIV/AIDS prevention program together with the People's Committee of Hai Phong City.

1.2.2 Work Schedule

The Design Study has been commenced immediately after the agreement on the Contract for Design Study in March 2011. The Design Study is scheduled to carry out within 10-month period subject to obtaining comments in time from Technical Advisory Committee to be established by GOV.

The overall Design Study schedule is shown in Figure 1.2.2-1 as the original schedule, and in Figure 1.2.2-2 as the actual design schedule. The detailed study schedules for each portion are indicated in Figure 1.2.2-3.

Year / Month	2011										2012
	3	4	5	6	7	8	9	10	11	12	1
Work in Vietnam											
Work in Japan											
Report		△ IC/R			△ CD/R		△ PQ/R EIA/R	△ DF/R			△ F/R

IC/R : Inception Report
CD/R : Basic Design Report
PQ/R : Draft Prequalification Documents
EIA/R : Draft Supplemental EIA Report
DF/R : Draft Final Report
F/R : Final Report

Figure 1.2.2-1 Overall Study Schedule (Original)

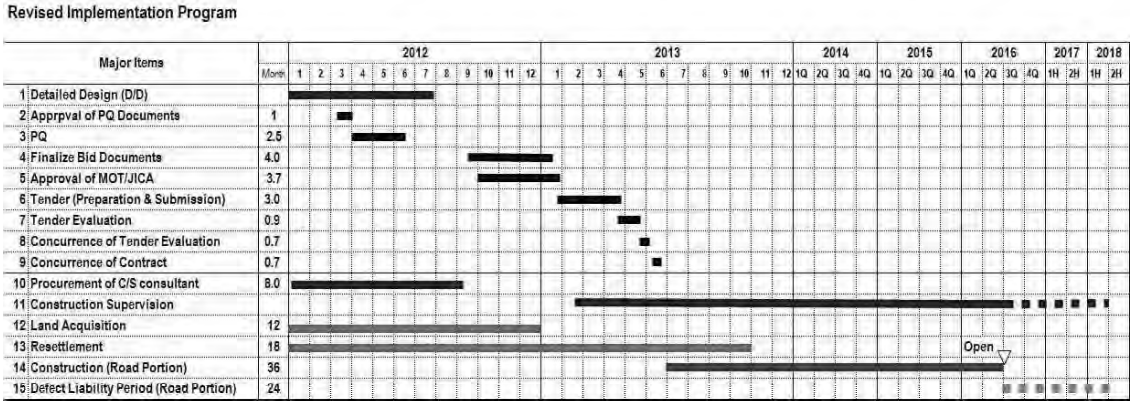


Figure 1.2.2-2 Overall Study Schedule (Actual)

TIME	TASK	REPORTS
March 2011	**Preparatory Work in Japan** ★Collection & analysis of existing data / information ★Preparation of Inception Report (IC/R) & Questionnaires	
April 2011	**1st Work in Viet Nam** ★Presentation / Discussion of Inception Report (IC/R) ★Existing Data Collection and Review of Previous Studies and Plans ★Review of EIA and monitor land aquisition, etc. ★Establishment of Framework for Design Study ★Field Surveys for Natural & Environmental Conditions ★Basic Design: Establishment of Design Criteria, Road and Bridge Facilities ★Preliminary Construction Planning & Time Schedule ★Preliminary Cost Estimate of Construction and Procurement Package for Construction	**Inception Report (IC/R)**
July 2011	**1st Work in Japan** ★Preparation/Finalization of Basic Design Report (CD/R)	**Basic Design Report (CD/R)**
August 2011	**2nd Work in Viet Nam** ★Presentation / Discussion of Basic Design Report (CD/R) ★Preparation of Confirmation of Details on Design Contents ★Preparation of Prequalification Documents (PQ) ★Detaild Design ★Detailed Construction Planning ★Detailed Project Cost Estimates ★Procurement Program of Construction Materials and Equipment ★Overall Project Evaluation by Economic Analysis and Financial Analysis ★Formulation of Construction Work Safety Program ★Preparaion of Tender Documents ★Preparation of Draft Supplemental EIA report (EIA) and Environmental Management/Monitoring Plan ★Preparation of HIV/AIDS Prevention Program ★Operation and Management Plan ★Preparation of Draft Final Report and Draft Tender Documents (DF/R)	**Prequalification Documents (PQ)** **Draft Supplemental EIA Report (EIA)** **Draft Final Report (DF/R)**
October 2011		
December 2011	**2nd Work in Japan** ★Follow-up GOV Comments on DF/R	
January 2012	**3rd Work in Viet Nam** ★Finalization of Final Report and Revised Tender Documents (F/R)	**Final Report (F/R)**

Figure 1.2.2-3 Work Schedule of Design Study of Road/Bridge Portion for Lach Huyen Port Infrastructure Construction (Original)

1.2.3 Main History of the Study

The Design Study Team has executed the kick off meeting at MOT on 23rd March 2011 together with JICA and continuously at PMU-2 on 29th March 2011. The site visit was carried out on 25th March 2011. All previous study data were handed over to the Study Team on 31st March 2011 from PMU-2. The pre-bid meeting for site investigations was held on 30th March 2011 and bid opening was on 6th April 2011. The topographic survey was completed in July 2011 and geotechnical survey was completed in September 2011 including the final reports. Although the all technical issues were studied carefully and the results were submitted as discussion papers to Vietnamese sides and there were numbers of technical meetings held, in order to implement the study work in time, JICA requested MOT to hold the official meeting so that the outstanding matters in the basic design can be settled. The meeting at MOT was held on 7th June and 12th August 2011. After the first meeting at MOT, the TAC was established and main points of design subjects were discussed at TAC meeting

and the both sides (JICA Study Team and Vietnamese sides) shared understanding in the all technical issues. The major items which have been discussed and agreed by the both sides are as follows:

(1) Main bridge's foundation (SPSP) was designed under the assumption of stage construction. It deferred from the Preparatory Study of JICA in 2010. The span component (95m + 2@150m + 95m) and the superstructure construction method (cantilever erection with cast-in-situ) was not changed.

(2) The span component in the approach bridges was concluded that 60m span length & single wall pier. This plan can be applied to all approach bridges including two (2) flyovers at Hai An side. Construction method for approach bridges was decided that SBS method is for Hai An side and cantilever erection method with cast-in-situ is for Cat Hai side.

(3) The pile foundation for approach bridges consists of steel pipe piles and bored piles after considering technical issues and economical aspects.

(4) Based on the discussion results between the Study Team and the local authorities, there are some changes in numbers of box culverts. Major change was that the box culvert at Cam River was changed into three (3) continuous PC girder bridge.

(5) Tan Vu-IC was designed as at grade intersection with traffic signal control after considering some technical request from VIDIFI.

(6) Pavement structure was designed based on the Vietnamese Standards that is different from AASHTO which has been adopted in Hanoi – Hai Phong Expressway. The pavement structure is bigger than the above expressway.

(7) Typical cross section of highway was basically not changed, but it was modified a little after considering the environmental impact to the local resident's assets and requests from the local authorities in some areas.

(8) Retaining wall behind abutments was omitted, and embankment was designed instead of that from economical and technical view points.

(9) EIA supplementary report was planned at the initial stage of this study. And social & natural EIA works were completed in October 2011. However, new EIA report was required in accordance with the new regulation since the temporary access for construction by dredging was designed in some areas. That supplementary EIA has been carried out in 2012 and the appraisal conference at MOT was held on 15th August 2012 for the approval procedure.

(10) Operation & maintenance plan was prepared for future O & M organization after opening highway. Due to unknown factors in future plan of the Vietnamese Government (MOT), it was concluded that the Study Team shall propose practical plan as much as possible based on the current conditions.

(11) HIV/AIDS Prevention was prepared based on technical researches and a numbers of hearings from each authority (not only central government but also local authorities). As the results, the HIV/AIDS prevention program was established in this report and it complies with the national and local framework. Regarding the application of the program to the tender documents including BOQ, the discussion is still under conducting.

(12) The Project cost increased by some reasons like temporary facilities, temporary road structure, and pavement structure from the Preparatory Study in 2010. As the results, Vietnamese Government requested JICA Study Team to review the all items and the JICA Study Team has re-submitted his cost estimation report in March 2012 for getting the concurrence of total investment decision for implementation of tender stage. However, the study results on effectiveness of the project shows still high level.

CHAPTER 2 TOPOGRAPHIC AND HYDROLOGICAL SURVEY

2.1 Topographic Survey

2.1.1 Scope and Purpose of Survey

The expected length of the whole project area is approximately 15.63km. The start point (station km0+000) is in Tan Vu Hamlet, Trang Cat Street, Hai An District, Hai Phong City. The end point (station km15+629.937) is in Dong Bai Commune, Cat Hai Island District, Hai Phong City. This project includes a large-scale bridge across the Nam Trieu River.

Location: The route runs through Tan Vu Hamlet (Trang Cat Street, Hai An District, Hai Phong City), Ninh Tiep Hamlet, Minh Hong Hamlet and Trung Lam Hamlet (Nghia Lo and Dong Bai Communes, Cat Hai Island District, Hai Phong City).

The aim is to obtain a full set of data on terrain for the calculation and design of the project, providing survey data in a form compatible with the formatting style requested of the designers. The results of the topographic survey in this stage are used in design, estimate of the volume of site clearance and estimate of the general cost of the project.

2.1.2 Applied Standards

Coordinate system of Vietnam used: VN2000 system, central meridian 105 degree 45 minutes with 3 degree projection zone and the following parameters;

1) Reference ellipsoid: WGS – 84
   - Major semi-axis: a = 6,378.137km
   - Flatness: f = 1/298.257223563
2) Projection: Transverse Mercator
   - Scale factor k = 0.9999

Elevation system used: National elevation system (data from Hon Dau Island - Hai Phong province)

The Standards to be applied in this project are as follows;

Table 2.1.2-1 Standards System

No.	Code	Title	Issued by
1	22TCN 263 - 2000	Standards for Motorway Survey	Ministry of Communications and Transport
2	22TCN 262 - 2000	Standards for Highway Survey and Design on weak ground	Ministry of Communications and Transport
3	TCXDVN364:2006	Standards for Engineering Survey GPS Monitoring and Processing	Ministry of Construction
4	96TCN 43 - 90	Standards for Topography Map Survey	Department of Survey and Mapping
5	QCVN 11:2008 BTNMT	Standards for establishment of leveling network	Ministry of Natural Resources and Environment

Source : Study Team

All technical requirements by the main Consultant to be used for the project have been applied in accordance with the above standards and approved by the competent organizations

2.1.3 Work Volume

The contracted and actual work volume of the topographic survey is as follows;

Table 2.1.3-1 Contracted and Actual Work Volume

Work Items	Contract	Progress	Remarks
1. Control Point Survey			
1-1 Grade IV control points (GPS)	15 points	15 points	
1-2 Secondary control points (TS)	88 points	88 points	
1-3 IV-class leveling network	25.0 km	34.9 km	
1-4 Technical leveling network	25.0 km	16.4 km	
2. Route Survey for Road Portion			
2-1 Center Line Survey (20m intervals)	13.2 km	10.2 km	
2-2 Longitudinal Survey	13.2 km	10.2 km	
2-3 Cross-section Survey (50m on each side)	660 sections	510 sections	
2-4 Plan metric survey (50m on each side)	120 ha	102 ha	
3. Route Survey for Bridge Portion			
3-1 Longitudinal Survey	5.44 km	5.44 km	
3-2 Cross-section Survey (50m on each side)	109 sections	109 sections	
3-3 Plan metric Survey (50m on each side)	55 ha	55 ha	
4. Positioning of Boring Pits			
4-1 Positioning of Boring Pits	155 points	155 points	
5. Additional Survey			
5-1 Km1+500 – Km2+000	4.9532 ha	4.9532 ha	plan
5-2 Km12+100 – Km13+300	1.2 ha	1.2 ha	plan
5-3 Km14+920 – Km15+340	4.0243 ha	4.0243 ha	plan
5-4 Km3+400 – Km4+000			
5-4-1 Plan-metric survey	12 ha	12 ha	
5-4-2 Cross-section survey	13 sections	13 sections	200m width

Source : Study Team

2.1.4 Equipment for Survey

The equipment for the survey was as follows;

Table 2.1.4-1 Equipment for Survey

No	Equipment	Unit	Qnty.	Remarks
1	GPS receiver	set	4	Topcon HiPer Ga
2	Total station	set	4	Topcon, Sokkia
3	Level	set	4	SDL30,B21,Ni025,Leica
4	Echo sounding instrument	set	1	Bruttour International PTY
5	Hand-held GPS receiver	set	4	Topcon
6	Prism	set	4	Topcon, Sokkia
7	Leveling staff	set	4	
8	Walkie-talkie	set	8	
9	Laptop PC	set	10	

Source : Study Team

2.1.5 Control Point Survey

2.1.5.1 Survey of Grade IV Control Points

(1) Implementation of Grade IV control point survey

The Grade IV control point survey was performed by the Contractor (Transport Engineering Design Inc.) in April 2011.

- The Grade IV control networks were checked in F/S stage, and after that compared with the requirements of the JICA Consultant regarding quantity / density of Grade IV control points to position new points on the plan at a scale of 1/25,000

- The control points were set at the following important areas;

  - Area of start point;
  - Area of end point;
  - Both ends area of bridge portion;

- The Grade IV control points with the exception of those in the above areas were positioned in accordance with the requirements of the JICA Consultant at equal distances (approximate interval of between 1km and 1.5km) along the route.

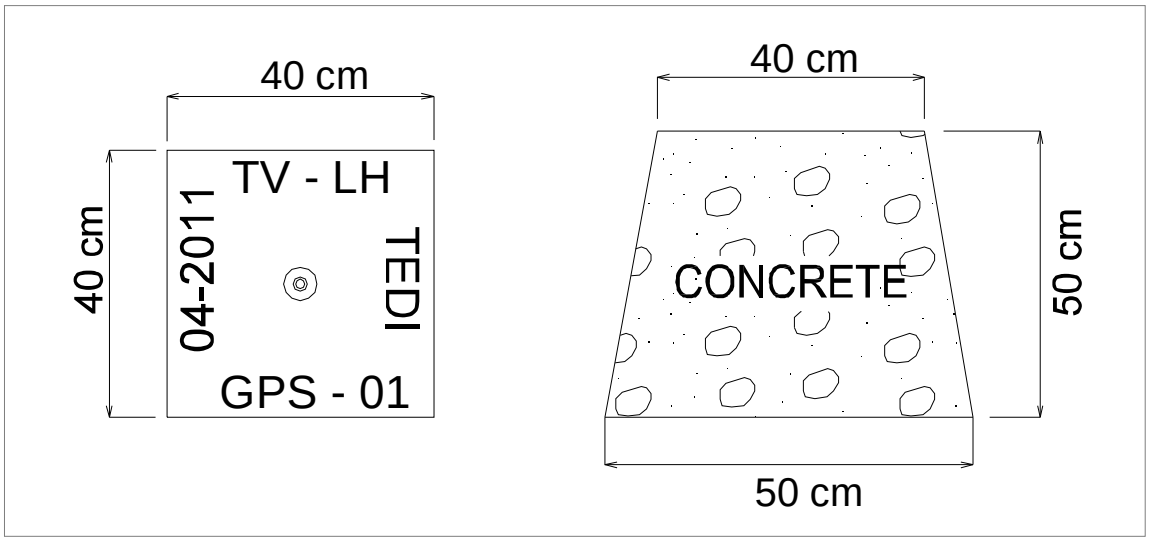
- The Grade IV control points were positioned so as to be connected to the original azimuths for secondary traverse networks later.

- The control points in the field were positioned reasonably with regard to distribution and the structure of the survey network, installed on solid foundations as well as sites suitable for the lower control networks in the future.

- The Grade Ⅳ control points were established along the centreline within 500m widthwise.

- The Grade IV control points network was connected to two (2) upper national control points.

- The material specifications for Grade IV control points;
  - Top: 40cm x 40cm
  - Bottom: 50cm x 50cm
  - Height : 50cm
  - Foundation: 60cm x 60cm x 10cm
  - Material: Concrete
  - Core : Porcelain
- Point names assigned were GPS01, GPS02, ….. GPS15 (see Figure 1 below)
- The short name of the project and the Consultant, the point name and date of erection were marked on the top.



Source : Study Team

Figure 2.1.5-1 Specifications for a Grade IV control point

(2) Rules for GPS observation

- The minimum measurement time at a station (called measurement shift) was between 60 and 90 minutes depending on the number of satellites and quality of received signals.

Table 2.1.5-1 Parameters in 364:2006 standards

Length of Baseline (km)	Measurement Shift (minutes)
0 -:- 1	20' -:- 30'
1 -:- 5	30' -:- 60'
5 -:- 10	60' -:- 90'
10 -:- 20	90' -:- 120'

Source : Study Team

- Information on a receiving-station is written in the field, for example: date, point name, weather, height of antenna, start time, finish time (of a measurement shift) etc.

- Measurement data were transferred to a computer for processing every day.

- Measurement data were processed and calculated on a computer using GP survey 2.35 software. The output was edited / displayed in 7 tables in accordance with the TCXDVN 364:2006 standards.

- Observation errors must comply with the TCXDVN 364:2006 standards.

Table 2.1.5-2 Observation error tolerance in TCXDVN 364:2006 standards

D / n	0.10 km	0.15 km	0.20 km	0.50 km	1.00 Km	2.00 km	3.00 km	4.00 km
3	1:8160	1:12200	1:16300	1:40600	1:80000	1:151600	1:210000	1:255000
4	1:9430	1:14100	1:18800	1:46900	1:92400	1:175000	1:242500	1:294500
5	1:10500	1:15800	1:21000	1:52400	1:103400	1:195700	1:271200	1:329200
	1:11500	1:17300	1:23000	1:57400	1:113200	1:214400	1:297000	1:360700

Source : Study Team

(3) Comparison for base line vector of duplication and conclusion

Table 2.1.5-3 Comparison for D/D stage

Station name		Δ x	Δ y	Δ z
118510	GPS02	2011.473	-85.214	1740.634
		2011.470	-85.221	1740.653
Difference		0.003	0.007	-0.019
118510	GPS03	-4342.352	-708.881	-1509.251
		-4342.342	-708.865	-1509.261
Difference		-0.010	-0.016	0.010
GPS04	GPS13	28.111	-152.790	406.798
		28.114	-152.793	406.796
Difference		-0.003	0.003	0.002
GPS06	GPS14	34.995	-111.853	307.216
		35.000	-111.850	307.212
Difference		-0.005	-0.003	0.004
GPS15	118528	2674.162	454.240	899.710
		2674.149	454.255	899.696
Difference		0.013	-0.015	0.014
118528	GPS16	377.787	-328.613	117.585
		377.779	328.606	1117.577
Difference		0.008	-0.007	0.008
118528	GPS18	-1709.034	-688.862	425.801
		-1709.037	-688.874	425.800
Difference		0.003	0.012	0.001

Source : Study Team

Table 2.1.5-4 Comparison for F/S stage

Station name		Δ x	Δ y	Δ z
GPS02	GPS03	2330.910	794.010	-231.346
		2330.897	794.024	-231.353
Difference		0.013	-0.014	0.007
GPS04	GPS05	751.157	438.676	-531.233
		751.215	438.507	-531.304
Difference		-0.058	0.169	0.071

Source : Study Team

Table 2.1.5-5 Comparison for D/D and F/S stages

Station name			Δ x	Δ y	Δ z
GPS01	GPS02	FS	1659.443	646.039	-371.202
		DD	1659.430	646.033	-371.152
Difference			0.013	0.006	-0.050
GPS02	GPS03	FS	-2330.910	-794.010	231.346
		DD	-2330.879	-794.095	231.382
Difference			-0.031	0.085	-0.036
GPS06	118528	FS	3595.059	766.345	815.634
		DD	3595.101	766.316	815.676
Difference			-0.042	0.029	-0.042
118528	GPS10	FS	-1924.614	-686.101	256.630
		DD	-1924.611	-686.150	256.683
Difference			-0.003	-0.049	-0.053

Source : Study Team

In the comparison table for duplicated baselines in the D/D stage above, the correct results were obtained from the GPS observation data by GPS data processing.

However, in the comparison table for the F/S stage, the following fact has been proved; the data to be compared were from only two (2) baselines, in addition to which the duplicated baseline to be compared between GPS04 and GPS05 was outside the specified limit; and as a result of the comparison of D/D and F/S data, the closing error was too large and outside the specified limit, with the exception of control point GPS01.

Hence, it was decided that only GPS01 would be used as the coordinate for the GPS control point at the F/S stage .

2.1.5.2 IV-class Leveling Network

The IV-class leveling network survey was performed by the Contractor (TEDI) in April 2011 in accordance with the basic specifications of the QCVN 11:2008/BTNMT standards.

(1) Work volume

- Leveling line of the riverside in the direction of Hai An District: ~21.2 km
- Leveling line of the Trieu River between Dinh Vo and Cai Hai Island District: ~5.7 km
- Leveling line of the riverside in the direction of Cai Hai Island District: ~8.0 km

(2) Rules for leveling observation

- The network was measured by the geometric levelling method. The observer took readings on the leveling staff above, below and in the centre of the crosshairs.
- Height closure error $f_h < \pm 20\ mm\sqrt{L}$ (where L = distance between each pair of GPS points, in km).
- The leveling network was adjusted on the computer using professional software (see results in Grade IV control networks report)
- Cross-leveling at the Trieu River (GPS04A-GPS06A) was performed using the hydrostatic method and the RTK (Real-time kinematic) method because of the very wide (approx. 5 km) river mouth.

(3) Comparison of elevation of F/S and D/D stages

Table 2.1.5-6 Comparison of Elevation of F/S and D/D stages

Station	D/D	F/S	Difference	Distance
(HN-HP)20A	Height diff.(m)	Height diff.(m)	(m)	(km)
GPS01	-0.654	-0.677	0.023	14.6
GPS02A	0.778	0.793	-0.015	2.7
GPS03A	0.413	0.382	0.031	2.8
GPS04A	-0.455	-0.468	0.013	1.1
GPS06A	-0.509	-0.680	0.171	5.7
GPS10A	-0.102	-0.115	0.013	8.0

Source : Study Team

As a result of the comparison in height difference between GPS04A and GPS06A in the above table, there was found to be a discrepancy of 0.171 m. This discrepancy has been reconfirmed by the following inspection and check survey;

a) The mean value (-0.517 m) of the leveling result of GPS observation and tidal observation results on 21 April 2011.

b) The mean values (-0.517 m and -0.530 m respectively) of check surveys carried out two (2) times by tidal observation on 26 April and 27 May 2011.

In accordance with the above results, the height difference between the Dinh Vo side and Cat Hai Island has been adapted to the elevation value of D/D which was approx. 0.170 m higher than the elevation value of the F/S stage.

(4) Quality control in IV-class leveling

The results of quality control in IV-class leveling are as follows;

Table 2.1.5-7 Result of quality control of IV class leveling

Station	Dis.(km)	Go(m)	Back (m)	Diff. (mm)	Tolerance
(HN-HP)20A/GPS01	14.6	-0.648	0.660	12	76
GPS01 / GPS11	0.5	2.571	-2.576	-5	14
GPS11 / GPS02A	2.2	-1.794	1.806	-12	29
GPS02A / GPS12	1.2	-0.116	0.108	-8	21
GPS12 / GPS03A	1.6	0.523	-0.519	4	25
GPS03A / GPS04A	1.1	0.454	-0.451	3	20
GPS04A / GPS13	0.4	0.213	-0.210	3	12
GPS04A / GPS06A	5.3	-0.530	-0.518	-12	46
GPS06A / GPS14	0.4	-0.405	0.403	-2	12
GPS14 / GPS15	1.1	0.629	-0.627	2	20
GPS15 / GPS08A	1.3	0.122	-0.118	4	22
GPS08A / GPS16	1.1	-0.202	0.201	-1	20
GPS16 / GPS17	1.5	-0.068	0.073	5	24
GPS17 / GPS18	2.3	-1.140	1.143	-3	20
GPS18 / GPS10A	0.3	0.953	-0.954	-1	10

Note: Tolerance of closure error of Elevation is $20\text{mm}\sqrt{L}$.

Source : Study Team

2.1.5.3 Secondary Control Points and Technical Leveling Network

(1) Secondary control points:

Secondary control points were established along the center line and each point was observed using Total Station (Topcon GTS510 or Sokkia SET5 30R3 type, with equivalent accuracy), conforming to the 22 TCN 263-2000 standards.

The average distance between two consecutive control points was approx. 150m. Secondary control points were positioned stable ground and were optimally suited for topographic survey work.

Form of Secondary control points: Class 200 concrete was used in the construction of the Secondary control points. The top surface was marked with porcelain. Then, implementing group, date of construction, etc was carved clearly. The dimensions are as follows:

Table 2.1.5-8 Dimensions of secondary control point

Top	20cm x 20cm
Bottom	30cm x 30cm
Height	40cm
Benchmark base	40cm x 40cm x 10cm

Source : F/S

(2) Technical leveling network:

This conformed to Standard 22 TCN 263-2000.

The technical leveling network coincides with the Secondary control points.

The geometric method was used for observation of the Secondary control points.

The leveling machines used were Leca NA720, Sokkia B21 and other machines of equivalent accuracy. The allowable error was $fh < 30mm\sqrt{L}$ (L is measured in km).

(3) Quantity

The number of Secondary control points is as follows;

Trang Cat and Dong Hai 2 areas: 45 points covering 7.5 km.

Cat Hai Island Area: 50 points covering 8.4 km

(4) Results of quality control for Secondary control points are as follows;

Table 2.1.5-9 Results of quality control for Secondary control points

Station	Distance (km)	Number of Sides (N)	Closure error of Coor.		Closure error of Elev.	
			Error (m)	Tolerance (m)	Error (mm)	Tolerance (mm)
GPS01_GPS02A	2.767	21	0.060	0.353	2	41
GPS11_GPS02A	2.176	16	0.013	0.274	-4	36
GPS02A_GPS12	1.169	6	0.016	0.157	4	27
GPS12_GPS03A	1.621	10	0.018	0.202	0	31
GPS03A_GPS04A	1.111	8	0.018	0.162	4	26
GPS06A_GPS15	1.443	12	0.063	0.199	0	30
GPS15_GPS08A	1.327	7	0.007	0.170	4	28
GPS08A_GPS16	1.146	6	0.012	0.156	-1	26
GPS16_GPS17	2.153	13	0.007	0.255	5	36
GPS17_GPS10A	2.791	18	0.020	0.336	2	41

Note: Tolerance of closure error of coordinates is 10cm+2cmΣD√N, Elevation is 25mm√L.

Source : Study Team

2.1.6 Route Survey for Road Portion

2.1.6.1 Center Line Survey

The center-line was marked using wooden pegs or long bamboo sticks along the center-line except where there was more than 2m depth of water in a river or fish-pond, or in vegetated areas of a fish pond (km0+60 to km0+500).

The alignment staked out was as follows;

- Start and end point
- 20m interval station
- SC: point of change from spiral to circular curve
- CS: point of change from circular curve to spiral
- TS: point of change from tangent to spiral
- ST: point of change from spiral to tangent

2.1.6.2 Longitudinal Survey

A longitudinal survey was performed along the center-line using Total Station except for several parts of the survey area that are covered by water. The points which were surveyed are station markers, changed terrain, ground objects and culverts, etc.

Distances covered by the longitudinal survey are as follows;

- Trang Cat and Dong Hai 2 areas: approx. 4.50km
- Cat Hai Island area: approx. 5.69km

The drawing scale of the profile chart is as follows;

- Horizontal scale: 1: 1,000
- Vertical scale: 1: 100

2.1.6.3 Cross-section Survey

A cross-section survey was performed along the center-line. A RTK system survey by GPS (Topcon Hiper Ga) was carried out between km0+000 and km0+500. The other areas (km0+520 to km4+700, km9+945 to km15+630) were surveyed using Total Station. The width of each cross-section was 50m on each side of the center-line.

The volume of the cross-section survey is as follows;

- Trang Cat and Dong Hai 2 areas : 226 sections
- Cat Hai Island area : 284 sections

The drawing scale of the cross-section chart is as follows;

- Horizontal scale: 1: 200
- Vertical scale: 1: 200

2.1.6.4 Plan-metric Survey

The plan-metric survey was performed along the center-line to a width of 50m on each side. The residential area of Cat Hai Island was surveyed in particular detail. The main specifications for the plan are as follows;

- Plan scale : 1: 1,000
- Surveyed objects: irrigation ditch, sluice gate, high- and low-voltage lines, communication lines, historical sites, temples, pagodas, cemeteries, control points, etc.
- Interval of intermediate contour: 0.5m
- Interval of index contour: per 2.5m

The area covered by the Plan-metric survey is as follows;

- Trang Cat and Dong Hai 2 areas : approx. 45 ha
- Cat Hai Island area : approx. 57 ha

2.1.6.5 Comparison of Feasibility Study (F/S) and Detailed Design(D/D)

The results of the F/S and D/D had the following differences;

- Horizontal position: Some areas on Cat Hai Island were found to have a difference of more than 5m.
- Differences in elevation: The elevations of F/S and D/D do not match each other. Some positions in Trang Cat and Dong Hai 2 area were found to have a significant difference of more than 1m .

2.1.7 Route Survey for Bridge Portion

2.1.7.1 Longitudinal Survey

A longitudinal survey was performed along the center-line.

The length of the longitudinal survey is approx. 5.44km.

The drawing scale of the profile chart is as follows;

- Horizontal scale : 1: 1,000
- Vertical scale : 1: 100

2.1.7.2 Cross-section Survey

A cross-section survey was performed along the center-line at 50m intervals. The width of each cross-section was 50m on each side of the center-line.

The volume of the cross-section survey is 109 sections.

The drawing scale of the cross-section chart is as follows;

- Horizontal scale : 1: 200
- Vertical scale : 1: 200

2.1.7.3 Plan-metric Survey

The plan-metric survey was performed along the center-line to a width of 50m on each side. The main specifications for the plan are as follows;

- Plan scale : 1: 1,000
- Interval of intermediate contour: 0.5m
- Interval of index contour: per 2.5m

The area covered by the plan-metric survey is approx. 55ha.

2.1.7.4 Check Survey

The check survey was performed about 22 cross-section lines using GPS RTK system and Echo sounding instrument on 29 June. As the survey result, the each point difference was approximately within 10cm to 30cm.

2.1.7.5 Additional Survey

The additional survey was performed about 4 areas, 1) Km1+500 - Km2+000, 2) Km3+400 - Km4+000, 3) Km12+100 - Km13+300 and 4) approximately Km14+920 - Km15+340. The plan-metric survey was performed about all of the additional area and the cross-section survey was performed about only Km3+400 to Km4+000.

The main specifications for the plan are as follows;

- Plan scale : 1: 1,000
- Interval of intermediate contour: 0.5m
- Interval of index contour: per 2.5m

The drawing scale of the cross-section chart is as follows;

- Horizontal scale : 1: 200
- Vertical scale : 1: 200

2.1.8 Positioning of Boring Pits

The boring pit positioning survey was performed along the center-line.

The coordinates of the boring pits for the Road section are shown in Table 2.1.8-1 below, and the coordinates of the boring pits for the Bridge portion are shown in Table 2.1.8-2 following:

Table 2.1.8-1 Coordinates of Boring Pits for Road portion

Station	North	East		Station	North	East
BC-1	2301992.317	614119.668		BA-3	2301395.704	604297.562
BC-2	2301997.263	614269.587		BA-4	2301416.136	604446.164
BC-3	2302000.56	614369.532		BA-5	2301429.758	604545.232
BC-4	2302005.506	614519.451		BA-6	2301457.002	604743.367
BC-5	2302010.452	614669.369		BA-7	2301477.435	604891.969
BC-6	2302020.343	614969.206		BA-8	2301497.867	605040.571
BC-7	2302025.289	615119.124		BA-9	2301525.111	605238.707
BC-8	2302030.235	615269.043		BA-10	2301538.733	605337.775
BC-9	2302035.180	615418.961		BA-11	2301559.166	605486.377
BC-10	2302038.477	615518.907		BA-12	2301593.220	605734.046
BC-11	2302045.072	615718.798		BA-13	2301606.842	605833.114
BC-12	2302050.017	615868.717		BA-14	2301620.464	605932.182
BC-13	2302054.963	616018.635		BA-15	2301647.707	606130.318
BC-14	2302061.557	616218.526		BA-16	2301661.329	606229.386
BC-15	2302064.855	616318.472		BA-17	2301681.762	606377.988
BC-16	2302069.800	616468.390		BA-18	2301702.195	606526.589
BC-17	2302079.692	616768.227		BA-19	2301727.939	606724.921
BC-18	2302084.637	616918.146		BA-20	2301738.608	606824.349
BC-19	2302087.935	617018.091		BA-21	2301751.500	606973.790
BC-20	2302094.529	617217.983		BA-22	2301766.462	607273.393
BC-21	2302099.475	617367.901		BA-23	2301771.408	607423.311
BC-22	2302104.420	617517.820		BA-24	2301774.706	607523.257
BC-23	2302111.015	617717.711		BA-25	2301781.300	607723.148

BC-24	2302114.312	617817.656		BA-26	2301786.246	607873.066
BC-25	2302119.258	617967.575		BA-27	2301791.191	608022.985
BC-26	2302124.203	618117.493		BA-28	2301797.786	608222.876
BC-27	2302129.130	618267.412		BA-29	2301801.083	608322.822
BC-28	2302110.997	618566.216		BA-30	2301806.028	608472.740
BC-29	2302074.887	618711.703				
BC-30	2302020.919	618851.554				
BC-31	2301949.936	618983.585				
BC-32	2301830.776	619143.923				
BC-33	2301761.606	619216.102				
BC-34	2301647.197	619312.959				
BC-35	2301410.172	619461.618				

Source : Study Team

Table 2.1.8-2 Coordinates of Boring Pits for Bridge portion

No.	Station	Offset	North	East
1	Km 4+504.10	+0m	2301810.944	608621.759
2	Km 4+561.30	+8m	2301805.000	608684.189
3	Km 4+621.30	+8m	2301806.978	608744.156
4	Km 4+681.30	+8m	2301808.956	608804.124
5	Km 4+741.30	+8m	2301810.934	608864.091
6	Km 4+801.30	+8m	2301812.913	608924.059
7	Km 4+861.30	+8m	2301814.891	608984.026
8	Km 4+921.30	+8m	2301816.869	609043.993
9	Km 4+981.30	+8m	2301818.848	609103.961
10	Km 5+041.30	+8m	2301820.826	609163.928
11	Km 5+101.30	+8m	2301822.804	609223.895
12	Km 5+152.80	+8m	2301824.502	609275.367
13	Km 5+212.80	+8m	2301826.480	609335.335
14	Km 5+272.80	+8m	2301828.459	609395.302
15	Km 5+332.80	+8m	2301830.437	609455.270
16	Km 5+392.80	+8m	2301832.415	609515.237
17	Km 5+452.80	+8m	2301834.394	609575.204
18	Km 5+512.80	+8m	2301836.372	609635.172
19	Km 5+572.80	+8m	2301838.350	609695.139
20	Km 5+632.80	+8m	2301840.329	609755.107
21	Km 5+692.80	+8m	2301842.307	609815.074
22	Km 5+752.80	+8m	2301844.285	609875.041
23	Km 5+812.80	+8m	2301846.263	609935.009
24	Km 5+872.80	+8m	2301848.242	609994.976
25	Km 5+932.80	+8m	2301850.220	610054.943
26	Km 5+992.80	+8m	2301852.198	610114.911
27	Km 6+052.80	+8m	2301854.177	610174.878
28	Km 6+112.80	+8m	2301856.155	610234.846
29	Km 6+172.80	+8m	2301858.133	610294.813
30	Km 6+232.80	+8m	2301860.111	610354.780
31	Km 6+292.80	+8m	2301862.090	610414.748
32	Km 6+352.80	+8m	2301864.068	610474.715
33	Km 6+412.80	+8m	2301866.046	610534.682
34	Km 6+472.80	+8m	2301868.025	610594.650
35	Km 6+532.80	+8m	2301870.003	610654.617
36	Km 6+592.80	+8m	2301871.981	610714.585

37	Km 6+652.80	+8m	2301873.959	610774.552
38	Km 6+712.80	+8m	2301875.938	610834.519
39	Km 6+772.80	+8m	2301877.916	610894.487
40	Km 6+832.80	+8m	2301879.894	610954.454
41	Km 6+892.80	+8m	2301881.873	611014.421
42	Km 6+952.80	+8m	2301883.851	611074.389
43	Km 7+012.80	+8m	2301885.829	611134.356
44	Km 7+072.80	+8m	2301887.808	611194.324
45	Km 7+132.80	+8m	2301889.786	611254.291
46	Km 7+192.80	+8m	2301891.764	611314.258
47	Km 7+252.80	+8m	2301893.742	611374.226
48	Km 7+312.80	+8m	2301895.721	611434.193
49	Km 7+372.80	+8m	2301897.699	611494.160
50	Km 7+432.80	+8m	2301899.677	611554.128
51	Km 7+491.16	+8m	2301901.601	611612.456
52	Km 7+551.16	+8m	2301903.580	611672.423
53	Km 7+611.16	+8m	2301905.558	611732.391
54	Km 7+671.16	+8m	2301907.536	611792.358
55	Km 7+731.16	+8m	2301909.515	611852.326
56	Km 7+791.16	+8m	2301911.493	611912.293
57	Km 7+844.14	+8m	2301913.240	611965.244
58	Km 7+904.14	+8m	2301915.218	612025.212
59	Km 7+964.14	+8m	2301917.196	612085.179
60	Km 8+024.14	+8m	2301919.175	612145.146
61	Km 8+077.12	+8m	2301920.921	612198.098
62	Km 8+130.10	+8m	2301922.668	612251.049
63	Km 8+190.10	+8m	2301924.647	612311.016
64	Km 8+250.10	+8m	2301926.625	612370.983
65	Km 8+310.10	+8m	2301928.603	612430.951
66	Km 8+363.08	+8m	2301930.350	612483.902
67	Km 8+416.06	+8m	2301932.097	612536.853
68	Km 8+476.06	+8m	2301934.075	612596.821
69	Km 8+536.06	+8m	2301936.053	612656.788
70	Km 8+596.06	+8m	2301938.032	612716.755
71	Km 8+649.04	+8m	2301939.779	612769.707
72	Km 8+702.02	+8m	2301941.525	612822.658
73	Km 8+762.02	+8m	2301943.504	612882.625
74	Km 8+822.02	+8m	2301945.482	612942.593

75	Km 8+882.02	+8m	2301947.460	613002.560
76	Km 8+935.00	+8m	2301949.207	613055.511
77	Km 9+030.00	+8m	2301952.339	613150.459
78	Km 9+030.00	-6.25m	2301966.566	613149.990
79	Km 9+180.00	+8m	2301957.285	613300.378
80	Km 9+180.00	-6.25m	2301971.512	613299.908
81	Km 9+330.00	+8m	2301962.231	613450.296
82	Km 9+330.00	-6.25m	2301976.458	613449.826
83	Km 9+425.00	+8m	2301965.363	613545.245
84	Km 9+479.80	+8m	2301967.170	613600.015
85	Km 9+539.80	+8m	2301969.148	613659.982
86	Km 9+599.80	+8m	2301971.127	613719.950
87	Km 9+659.80	+8m	2301973.105	613779.917
88	Km 9+714.60	+8m	2301974.912	613834.687
89	Km 9+769.40	+8m	2301976.719	613889.457
90	Km 9+829.40	+8m	2301978.697	613949.425
91	Km 9+889.40	+8m	2301980.675	614009.392
92	Km 9+944.50	+0m	2301990.479	614063.998

Notes: The above coordinates are the original data for the boring pits.

Source : Study Team

2.1.9 Survey Results

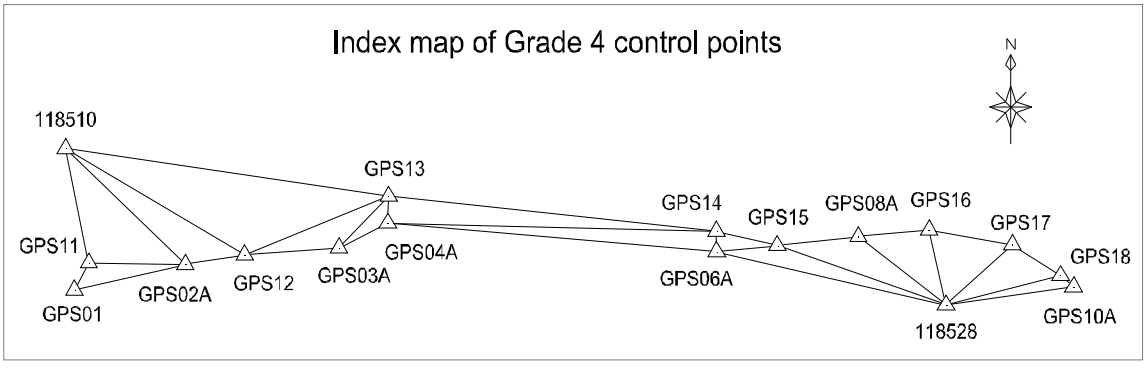
2.1.9.1 Final Results and Index Map of Grade IV Control Points

The final results and index map of the Grade IV control points are as follows;

Table 2.1.9-1 Final Results of Grade IV control points

No	Station	Coordinates – VN2000		Elevation H (m)	Remarks
		North X(m)	East Y(m)		
1	GPSS01	2301233.267	603823.657	1.629	Reference point
2	GPS02A	2301641.111	605596.459	2.407	GPS point
3	GPS03A	2301904.158	608055.811	2.820	GPS point
4	GPS04A	2302299.210	608836.246	3.275	GPS point
5	GPS06A	2301845.710	614097.683	2.766	GPS point
6	GPS08A	2302088.194	616362.090	3.116	GPS point
7	GPS10A	2301287.501	619805.750	2.664	GPS point
8	GPS11	2301663.910	604054.983	4.204	GPS point
9	GPS12	2301795.417	606546.509	2.297	GPS point
10	GPS13	2302734.445	608850.662	3.487	GPS point
11	GPS14	2302174.524	614094.368	2.364	GPS point
12	GPS15	2301942.167	615068.968	2.994	GPS point
13	GPS16	2302192.082	617492.184	2.916	GPS point
14	GPS17	2301958.035	618827.998	2.849	GPS point
15	GPS18	2301467.317	619598.980	1.709	GPS point
16	118510	2303491.361	603683.311		Reference point
17	118528	2300998.527	617766.663		Reference point

Source : Study Team



Source : Study Team

Figure 3.1.9-1 Index map of Grade IV control points

2.1.9.2 Final Result of Secondary Control Points

The final result of the Secondary control points are as follows;

Table 2.1.9-2 Final Result of Secondary control points

No	Station	Coordinates – VN2000		Elevation H (m)	Remarks
		North X(m)	East Y(m)		
1	DC01	2301172.996	603802.907	4.377	SCP point
2	DC02	2301068.822	603987.956	3.136	SCP point
3	DC03	2300995.028	604112.913	2.566	SCP point
4	DC04	2301067.657	604247.731	2.565	SCP point
5	DC05	2301169.465	604299.662	2.465	SCP point
6	DC06	2301273.598	604349.066	2.370	SCP point
7	DC07	2301579.600	604433.597	2.238	SCP point
8	DC07A	2301465.947	604399.860	2.080	SCP point
9	DC08	2301686.634	604459.964	2.362	SCP point
10	DC09	2301794.549	604508.567	2.291	SCP point
11	DC10	2301856.261	604592.008	2.009	SCP point
12	DC11	2301796.152	604668.408	1.901	SCP point
13	DC12	2301760.064	604776.651	2.174	SCP point
14	DC13	2301678.403	604874.577	2.008	SCP point
15	DC14	2301628.624	604973.485	2.533	SCP point
16	DC15	2301524.858	605110.962	2.794	SCP point
17	DC16	2301455.151	605231.932	2.812	SCP point
18	DC17	2301410.845	605344.585	2.779	SCP point
19	DC18	2301387.647	605473.089	2.725	SCP point
20	DC19	2301501.171	605585.916	2.788	SCP point
21	DC21	2301529.370	605777.864	2.990	SCP point
22	DC22	2301818.279	604141.431	4.331	SCP point
23	DC23	2301931.399	604204.096	4.354	SCP point
24	DC24	2302042.894	604264.680	4.230	SCP point
25	DC25	2302067.968	604407.868	2.913	SCP point
26	DC26	2301966.344	604526.424	2.545	SCP point
27	DC27	2301683.430	605973.696	3.204	SCP point
28	DC28	2301835.484	606047.811	2.609	SCP point
29	DC29	2301900.011	606234.444	2.331	SCP point
30	DC30	2301807.788	606374.363	2.281	SCP point
31	DC31	2301898.232	606690.150	1.697	SCP point

32	DC32	2301891.109	606890.860	1.827	SCP point
33	DC33	2301783.858	607062.366	3.087	SCP point
34	DC34	2301785.315	607202.696	3.390	SCP point
35	DC35	2301785.784	607344.320	3.382	SCP point
36	DC36	2301790.613	607511.326	3.452	SCP point
37	DC37	2301801.729	607703.221	3.341	SCP point
38	DC38	2301809.356	607874.430	3.288	SCP point
39	DC39	2301816.973	607999.075	3.346	SCP point
40	DC40	2301820.153	608137.351	3.590	SCP point
41	DC41	2301817.349	608376.795	2.901	SCP point
42	DC42	2301854.266	608529.498	2.881	SCP point
43	DC43	2301953.771	608631.442	2.887	SCP point
44	DC44	2302070.265	608646.965	3.097	SCP point
45	DC45	2302211.120	608660.917	3.441	SCP point
46	DC46	2301864.315	614000.415	2.735	SCP point
47	DC47	2301952.079	614070.818	2.399	SCP point
48	DC48	2301985.997	614175.691	3.436	SCP point
49	DC49	2302107.217	614203.381	1.814	SCP point
50	DC50	2302180.333	614279.145	2.013	SCP point
51	DC51	2302041.741	614415.078	1.815	SCP point
52	DC52	2302049.872	614564.691	1.571	SCP point
53	DC53	2302076.525	614751.633	1.840	SCP point
54	DC54	2301974.781	614888.051	2.001	SCP point
55	DC54A	2301981.520	614978.389	1.831	SCP point
56	DC55	2301945.165	615246.585	3.104	SCP point
57	DC56	2302013.914	615420.687	3.232	SCP point
58	DC57	2302049.297	615592.397	3.388	SCP point
59	DC58	2302021.265	615812.163	1.466	SCP point
60	DC59	2302072.438	616054.505	3.295	SCP point
61	DC60	2302041.009	616228.435	1.587	SCP point
62	DC61	2302056.003	616514.829	1.658	SCP point
63	DC62	2302105.301	616742.975	3.442	SCP point
64	DC63	2302116.134	616912.382	3.435	SCP point
65	DC64	2302125.485	617088.222	3.482	SCP point
66	DC65	2302134.596	617267.882	3.323	SCP point
67	DC66	2302055.721	617584.998	1.613	SCP point
68	DC67	2302099.064	617768.682	1.893	SCP point

69	DC68	2302236.539	617908.828	1.330	SCP point
70	DC69	2302233.422	618056.954	1.967	SCP point
71	DC70	2302144.370	618063.866	2.407	SCP point
72	DC70A	2302115.803	617986.876	2.425	SCP point
73	DC70B	2302100.060	617894.723	2.207	SCP point
74	DC70C	2301953.119	617911.789	1.364	SCP point
75	DC70D	2302037.216	618084.184	1.363	SCP point
76	DC71	2302121.428	618186.994	1.367	SCP point
77	DC72	2301985.618	618441.708	1.480	SCP point
78	DC73	2301882.074	618606.512	1.387	SCP point
79	DC86	2301987.950	618979.138	2.236	SCP point
80	DC74	2301842.691	619056.029	2.824	SCP point
81	DC87	2301652.003	618992.362	3.800	SCP point
82	DC88	2301560.747	618937.093	3.894	SCP point
83	DC89	2301496.409	618763.415	2.944	SCP point
84	DC90	2301352.171	618674.182	2.600	SCP point
85	DC91	2301185.425	618801.569	2.760	SCP point
86	DC92	2301231.200	618946.427	2.725	SCP point
87	DC93	2301416.622	619050.598	3.933	SCP point
88	DC94	2301517.597	619130.996	3.951	SCP point
89	DC95	2301608.635	619229.799	4.017	SCP point
90	DC75	2301687.517	619324.144	4.062	SCP point
91	DC76	2301537.158	619441.577	1.483	SCP point
92	DC77	2301379.894	619505.425	2.398	SCP point
93	DC78	2301278.141	619621.783	2.180	SCP point
94	DC79	2301167.755	619619.739	2.879	SCP point
95	DC80	2301222.036	619735.674	2.866	SCP point

Source : Study Team

2.1.9.3 Route Survey for Road Potion

(1) Drawings of Longitudinal

As the survey result, the station, changed terrain, ground objects, river, culverts, etc. are summarized in the drawings (H: 1/1000, V: 1/100). Detailed quantity is shown in the table bellow;

Table 2.1.9-3 Detail of Drawings of Longitudinal

Station	Area	Units	Quantities	Remarks
Km0+000 - Km4+501	Hai An District	Km	4.501	
Km9+944 - Km15+630	Cat Hai Island	Km	5.686	
Total		Km	10.187	

Source : Study Team

(2) Drawings of Cross-section

As the survey result, the station, changed terrain, ground objects, river, culverts, house, drainage, etc. are summarized in the drawings (H: 1/200, V: 1/200). Detailed quantity is shown in the table bellow;

Table 2.1.9-4 Detail of Drawings of Cross-section

Station	Area	Units	Quantities	Remarks
Km0+000 - Km4+501	Hai An District	section	226	20m interval
Km9+944 - Km15+630	Cat Hai Island	section	284	20m interval
Total		section	510	

Source : Study Team

(3) Drawings of Plan-metric

As the survey result, the content which are mentioned in 3.1.6.4 Plan-metric Survey, coordinates, annotation, symbols, etc. are summarized in the drawings (Scale: 1/1000). Detailed quantity is shown in the table bellow;

Table 2.1.9-5 Detail of Drawings of Plan-metric

Station	Area	Units	Quantities	Remarks
Km0+000 - Km4+501	Hai An District	ha	45.01	100m width
Km9+944 - Km15+630	Cat Hai Island	ha	56.86	100m width
Total		ha	101.87	

Source : Study Team

2.1.9.4 Route Survey for Bridge Portion

(1) Drawings of Longitudinal

As the survey result, the station, changed terrain, etc. are summarized in the drawings (H: 1/1000, V: 1/100). Detailed quantity is shown in the table bellow;

Table 2.1.9-6 Detail of Drawings of Longitudinal

Station	Area	Units	Quantities	Remarks
Km4+501 - Km9+944	Estuary of Trieu River	Km	5.443	
Total		Km	5.443	

Source : Study Team

(2) Drawings of Cross-section

As the survey result, the station, changed terrain, etc. are summarized in the drawings (H: 1/200, V: 1/200). Detailed quantity is shown in the table bellow;

Table 2.1.9-7 Detail of Drawings of Cross-section

Station	Area	Units	Quantities	Remarks
Km4+501 - Km9+944	Estuary of Trieu River	section	109	50m interval
Total		section	109	

Source : Study Team

(3) Drawings of Plan-metric

As the survey result, the content which are mentioned in 3.1.7.3 Plan-metric Survey, coordinates, annotation, symbols, etc. are summarized in the drawings (Scale: 1/1000). Detailed quantity is shown in the table bellow;

Table 2.1.9-8 Detail of Drawings of Plan-metric

Station	Area	Units	Quantities	Remarks
Km4+501 - Km9+944	Estuary of Trieu River	ha	54.43	100m width
Total		ha	54.43	

Source : Study Team

2.1.9.5 Additional Survey

(1) Drawings of Plan-metric

As the survey result, the content which are mentioned in 3.1.7.3 Plan-metric Survey, coordinates, annotation, symbols, etc. are summarized in the drawings (Scale: 1/1000). Detailed quantity is shown in the table bellow;

Table 2.1.9-9 Detail of Drawings of Plan-metric

Station	Area	Units	Quantities	Remarks
Km1+500 - Km2+000	Hai An District	ha	4.9532	Cua Cam river
Km3+400 - Km4+000	Hai An District	ha	12.000	Temporary yard
Km12+100 - Km13+300	Cat Hai Island	ha	1.200	10m width
Km14+920 - Km15+340	Cat Hai Island	ha	4.0243	
Total		ha	22.1775	

Source : Study Team

(2) Drawings of Cross-section

As the survey result, the station, changed terrain, etc. are summarized in the drawings (H: 1/200, V: 1/200). Detailed quantity is shown in the table bellow;

Table 2.1.9-10 Detail of Drawings of Cross-section

Station	Area	Units	Quantities	Remarks
Km3+400 - Km4+000	Hai An District	section	13	200m width
Total		section	13	

Source : Study Team

2.1.10 Points to be Noted for Drawings

The points to be noted for the drawings are as follows.

- The data of drawing (Km0+000 to approx. Km15+680) of the plan-metric, longitudinal and cross-section were prepared by the Auto CAD software, and the whole data was saved by the Auto CAD data.
- The points of elevation are position of the decimal point, but these points can not move because of these elevation and points are included macro data.
- The data of additional area was combined into main drawings of digital data.

2.2 Hydrological Survey

2.2.1 General

In order to grasp the hydrological conditions in TAN VU – LACH HUYEN HIGHWAY PROJECT, a hydrological survey was carried out by JBSI-HYDER-HECO Joint Venture in 2008 for Feasibility Study (FS). The investigation consists of both site survey and investigation into flooding at the locations of the highway approaches and bridges. The site survey involves surveying the River bed and flood plain cross sections for both upstream and downstream of the planned river crossing.

In this section, the existing hydrological survey results of FS stage were reviewed and the outline of supplemental survey conducted in this detailed design study is described.

2.2.2 Review of Hydrological Survey Report in FS Stage

2.2.2.1 Conditions of Hydrological Survey in FS Stage

Based on the survey results of the investigation shown in the table blow, the design water level, wave height, requirement of drainage, impact of scouring were obtained in the condition with,.

- Design frequency of large bridge: P=1%,

- Design road according to design standard TCVN4054-2005 with design speed V=80Km/h, design frequency P=4%.

Table 2.2.2-1 Scope and Quantities of Hydrological Survey in FS Stage

No.	Description	Unit	Quantity
1	Collecting the drainage data on the Plans on the left and right ‘is Route;	Working day	10
2	Collecting and buying data of hydrometeorology*	Station	03
3	Cross-sections	Km	5+5.5+0.5
4	Flood Investigation of Bridges	Point	75

* The items for data collection is as follows,

-Sea-Hydro meteorology data at Hon Dau Station (from 1974 to 2004).
-The largest flow, water level data at Cua Cam Station (1961-1980, 1986-2006).
-Hydro meteorology monitoring document.
-General statement of Lach Huyen – Hai Phong Gateway Port Project.
-Report on sea and hydro meteorology data collection of Lach Huyen – Hai Phong Gateway Port Project.
-Report on Study on Wave and Flow Regime Based on Mathematic Model Infrastructure which Port-Water Construction Consulting Company made plan project step for Construction Investment Project of Nam Dinh Vu Industrial Zone, Hai Phong City implemented in May 2008.

According to the Decision 3139/QĐ-BGTVT dated 29/10/2010 issued by MOT, the frequency of high water level for road design is P=1% and it is to be applied to road design in detailed design stage.

2.2.2.2 Review on Water Level and Wave Height

(1) Water Level in Bridge Section

The strong points of the F/S report are as follows,

- The marine data at the Hon Dau station and the difference between measured water level (WL) at the Hon Dau station and investigated WL at the bridge were used to calculate the design high water level. It is an acceptable method in the condition of having no any monitoring station at the bridge location and the lack of hydrological data on the upstream river.
- The values of historical high WL up to the year of 2005 which contains the measured and investigated data in the bridge section were considered.
- The design HWL in the case of the Dinh Vu Industrial Zone completed was obtained.
- It was recommended that the historical WLs collected at the left and right banks of river should be used as the design HWLs for the bridge.

However, follows are to be updated,

- The meteorological, hydrological data were not updated up to the calculation time, especially the values of 2005.
- The effect of flow coming from the upstream river was not considered.
- The elevation difference between the National Chart and Sea Chart should be 1.86m (more accurate than 1.90m (FS value)).

(2) Wave Height in Bridge Section

The followings are to be noted,

- The results of wave calculation in the FS stage are not correct possibly due to the wrong computation of the design wind speed and initial wave height.
- It was recommended that the wave height calculated in the project "Nam Dinh Vu Industrial Zone Infrastructure Construction Project" by TEDI Port in 2008 should be used.

(3) Water Level in Road Section

The followings are to be noted,

- The design HWL of road was calculated in the same way as the bridge.
- The project goes through the areas that have different hydrological systems. In the FS stage, however, the effects of topographic and hydrological conditions were not considered in detail for each section. For example, the section from Km10+050 to Km14+660 is protected in the dike so that it is flooded by storm events, not affected by sea water.

Therefore, in the detailed design, the alignment should be divided into some specified sections based on the difference conditions of topographic and hydrological systems to detail the design WLs for each section.

2.2.2.3 Review on Culverts and Drainage System

The locations and sizes of culverts along the alignment were defined based on the topographic data, the project area map, the aquaculture demand and the calculation of drainage system.

However, it is the preliminary results in the FS stage. In basic design stage, more detailed study was executed (e.g.: surveying the site combine with discussing with local people and authorities to determine the location and the size of culvert; study project area to define the sphere of flood influence based on which we can calculate the suitable size of drainage culvert...)

2.2.2.4 Impact of Scouring

The methods used to calculate the depth of scour at the abutments and piers of bridge are reasonable. These methods are given in "Manual for hydrology and hydraulic computations for roads and bridges" approved by Ministry of Transportation and Communication in 2006 and have being applied widely for many bridge projects in Vietnam. The results given in the report are correct and acceptable

2.2.3 Supplemental Hydrological Survey

2.2.3.1Purpose of Survey

In order to update the results of the hydrological survey in FS stage, supplemental survey and analysis are planned. The items of the survey are base line survey, water level investigations and data collection.

2.2.3.2Scope of survey

(1) Water Level Investigation for Bridge Section

The clusters of maximum flood water level within the scope of bridge's plan (10 clusters) were investigated. Water level groups were allocated in the surveyed area and on 2 river banks. Investigation data in each water level group include:

- Historically highest water level in 3 years
- Average annual flood water level
- Lowest water level
- Peak flood-tide water level, lowest tide
- Water level in survey time.

(2) Water Level Investigation for Road Sections

The clusters of water level along the route were investigated (18 clusters: In Hai An side 8 clusters and in Cat Hai side 10 clusters). On the route on average each km there are 2 groups of water level and calculating at frequencies of 1%, 2%, 4%, and 10% to design elevation of the profile along the route. Each group of water level includes:

- Highest water level of 3 historical flood years caused by rain.
- Regular flood water level
- Lowest water level
- Effect of tide, tidal amplitude.
- Determination of flow, clearance, and elevation of the expected culvert slabs (working with local hydraulic agency and reaching agreement in writing).

(3) Collection of Data of gauging station, marine station and meteorological station

- Collection of data of 01 gauging station, 01 marine station for calculation of water level, current, design speed. In the FS stage, the marine data at the Hon Dau station used for the calculation was only up to the year 2004. Data from the year 2005 to 2010 has been added in basic design calculation.
- Updating, collection of data on meteorology of Phù Lien station up to the year of 2010.

2.2.3.3Update of Water Level

In this section, update of water level is discussed based on supplemental data collected in this survey. As stated in the review, the alignment is divided into 4 sections based on the different topographic and hydrological conditions of project area, as follows:

- Section 1: Km0 to Km4+200 (Hai An side);
- Section 2: Bridge section;
- Section 3: Km10+060 to Km14+670;
- Section 4: Km14+670 to the End.

(1) Bridge Section

This section is affected not only by tide from the sea but also the flow coming from the upstream of the Bach Dang River.

The high water level in this section is calculated based on the measured data at Hon Dau (marine station) and Do Nghi station (on Bach Dang River). It is also considered in 2 cases of current status (without Dinh Vu Industrial Zone) and Dinh Vu IZ completed.

The progress of calculating high water level is shown in the tables below.

Table 2.2.3-1 Highest Water Levels equivalent to frequencies at Hon Dau Station

Frequency	**1%**	**2%**	**4%**	**5%**	**10%**	**20%**	**50%**
$WL_{Sea\ Chart}$	4.36	4.28	4.21	4.18	4.09	3.99	3.81
$WL_{National\ Chart}$	**2.50**	2.42	**2.35**	2.32	2.23	2.13	1.95

Table 2.2.3-2 Highest Water Levels equivalent to frequencies in Bridge Section (Current Status)

P%	**1%**	**2%**	**4%**	**5%**	**10%**	**20%**	**50%**
$WL_{HON\ DAU}$	2.50	2.42	2.35	2.32	2.23	2.13	1.95
$WL_{DO\ NGHI}$	2.63	2.57	2.51	2.48	2.40	2.31	2.15
WL_{BRIDGE}	**2.57**	2.50	**2.43**	2.40	2.32	2.22	2.05

Table 2.2.3-3 Highest Water Levels equivalent to frequencies in Bridge Section
(After Dinh Vu Industrial Zone completed)

Frequency	**1%**	**2%**	**4%**	**5%**	**10%**	**20%**	**50%**
WL_{BRIDGE}	**2.72**	2.65	**2.58**	2.55	2.47	2.37	2.20

The major design values are summarized as follows,

Design High Water Level (P = 1%)=2.72 m

High Water Level (P = 5%)=2.55 m

Mean High Water Level=1.97 m

Mean Water Level=0.15 m

Mean Low Water Level=-1.67 m.

* Note: - All above elevation is in the National Chart.

- EL National Chart = EL Sea Chart - 1.86 (m)

(2) Road Sections

Section 1 (Km0 to Km4+200) and Section 4 (Km14+670 to the End):

These sections are located in low elevation area. The hydrology regime of the sections is generally affected by tidal wave. During storm events and typhoons, the tidal water level raised which results in inundation.

The high water levels equivalent to frequencies is calculated based on measured data at Hon Dau marine station and shown in the top table on the previous page.

Table 2.2.3-4 Highest Water Levels equivalent to frequencies in Road Section Km0 – Km4+200

Frequency	**1%**	**2%**	**4%**	**5%**	**10%**	**20%**	**50%**
WL Sea Chart	4.36	4.28	4.21	4.18	4.09	3.99	3.81
WL National Chart	**2.50**	2.42	**2.35**	2.32	2.23	2.13	1.95

Section 3: Km10+060 to Km14+670:

The section is located in a protected low land. In the event of a storm or a typhoon, the combination of rising sea water level outside and great volume of rainfall in the region results in inundation.

The high water level in this section is calculated based on the meteorological data at Phu Lien station.

Table 2.2.3-5 Difference of water level between investigated data and high WLs equivalent to frequencies

No		Total volume of rainfall at Phu Lien (mm)						K	Δ1% (m)	Δ % (m)	Δ4% (m)	Δ5% (m)	Δ10% (m)
		X_{2005}	$X_{1\%}$	$X_{2\%}$	$X_{4\%}$	$X_{5\%}$	$X_{10\%}$						
1	$X_{1ngày\,max}$	141	369	330	293	279	239	1.24	0.28	0.23	0.19	0.17	0.12
2	$X_{3ngày\,max}$	146	500	455	411	393	344	1.24	0.44	0.38	0.33	0.31	0.25
3	$X_{5ngày\,max}$	150	626	559	495	470	401	1.24	**0.59**	0.51	**0.43**	0.40	0.31
4	$X_{7ngày\,max}$	213	690	617	547	519	443	1.24	0.59	0.50	0.41	0.38	0.29

Table 2.2.3-6 Design high water levels along the section

Station			Design WL (m)		
Km	+	.....	$H_{max2005}$	$H_{1\%}$	$H_{4\%}$
10	+	820.00	1.50	2.09	1.93
14	+	620.00	1.40	1.99	1.83
14	+	650.00	1.40	1.99	1.83

The result of calculating high WL along the alignment is summarized in the table below.

Table 2.2.3-7 Summary of Design Water Levels at Locations of Drainage Structures

No	Station			Stick	Flow	Stage: FS				Stage: DD						Note
	Km	+	.....		direction	Type	No	F (B)	H	Type	No	F (B)	H	$H_{max2005}$	$H_{1\%}$	$H_{4\%}$	
	Hai An District																
1	0	+	780.00		R - L					Box		2.00 x	2.00	2.82	2.50	2.35	Shrimp pond
2	0	+	940.00		L - R	Box		3.00 x	3.00	Box		3.00 x	3.00	2.82	2.50	2.35	Drainage culvert
3	1	+	700.00		L - R	Box	8 x	4.00 x	4.00	Box	8 x	4.00 x	4.00	2.79	2.50	2.35	Cua Cam River
4	2	+	390.00		L - R	Pipe		2.00		Box		2.00 x	2.00	2.84	2.50	2.35	Shrimp pond
5	2	+	650.00		L - R					Box		2.00 x	2.00		2.50	2.35	Shrimp pond
6	4	+	160.00		L - R	Box	3 x	4.00 x	4.00	Box	3 x	3.00 x	3.00	2.83	2.50	2.35	Drainage culvert
	Cat Hai District																
7	9	+	906.2											2.75	2.72	2.58	At the end point of bridge
8	10	+	90.00		L - R	Pipe		1.25		Pipe		1.25					Ditch
9	10	+	659.00		L - R	Pipe		1.25		Pipe		1.25					Ditch
10	10	+	820.00		L - R	Box	2 x	4.00 x	3.00	Box		3.00 x	3.00	1.50	2.09	1.93	Ditch
11	13	+	980.00		L - R	Pipe		1.25									
12	14	+	620.00		L - R	Pipe				Box		4.00 x	4.00	1.40	1.99	1.83	Pond
13	14	+	650.00			Box		1.50 x	3.00	Box	2 x	2.00 x	4.00	1.40	1.99	1.83	On the dyke (on the left of alignment)
14	14	+	880.00		L - R	Box		3.00 x	3.00	Box		2.00 x	2.00	2.87	2.50	2.35	Ditch
15	15	+	100.00		R - L	Box	3 x	4.00 x	4.00	Box	3 x	4.00 x	6.00	2.87	2.50	2.35	River
16	15	+	520.00		R - L	Pipe		1.25		Pipe		1.25			2.50	2.35	Ditch