CHAPTER 2 PRELIMINARY STUDY

2.1 Traffic Characteristics and Facilities

The total length of road network in the Mekong Delta is approximately 30,000 km. These roads are classified into national roads, provincial roads, and rural or feeder roads. Provincial and rural or feeder roads connect provincial capitals with district centers, or link the district centers to the national roads. Judging from the current road network density of 0.77 km per sq. km, the road network is widely spread over the delta.

Generally, however, the road conditions are poor with the exception of the national roads. Most of the rural or feeder roads in the flood prone areas are inundated during the wet season, resulting in vast areas which are not accessible by vehicle. Out of the 30,000 km of roads in the Mekong Delta (compiled from 1994 statistics), only 1,600 km or 5% were asphalted.

The total number of bridges in the Mekong Delta is about 20,000 due to the network of flowing and tidal waterways around the tributaries of the Mekong River. The gradients of the approach roads to bridges are generally steep for maintaining vertical clearances for the passage of boats and barges.

Thirty ferry sites are currently located in the delta, of which Can Tho, Vam Cong, An Hoa, and Chau Doc are along the Hau (Bassac) River.

There are many canals, waterways, and rivers in the delta. According to the Transport Infrastructure Survey in 1994, the navigable length is about 2,700 km out of some 5,000 km of waterways. The navigable channels extend to the Port of Phnom Penh in Cambodia. The density of the waterway network in the Delta is 0.68 km per sq. km. This figure is almost comparable to that of road. Waterways are still functioning as a major transport means for economic and the inhabitants' daily activities, due to the flooding in the rainy season. Waterway transport on the main Mekong and Saigon river channels to the South China Sea in the South East are supplemented by a network of canals from Ho Chi Minh City South West to Ca Mau (320km) and to Kien Luong (330.3km) near the Cambodian border at the Gulf of Thailand.

2.2 Related Organization

The organization of the Ministry of Transport (MOT) consist of Bureau, Department, Institute, Corporation, Union, Enterprise, and Project Unit. The My Thuan Projects Management Unit is acting as the counterpart agency to the Study Team of JICA (Figure 2.1)

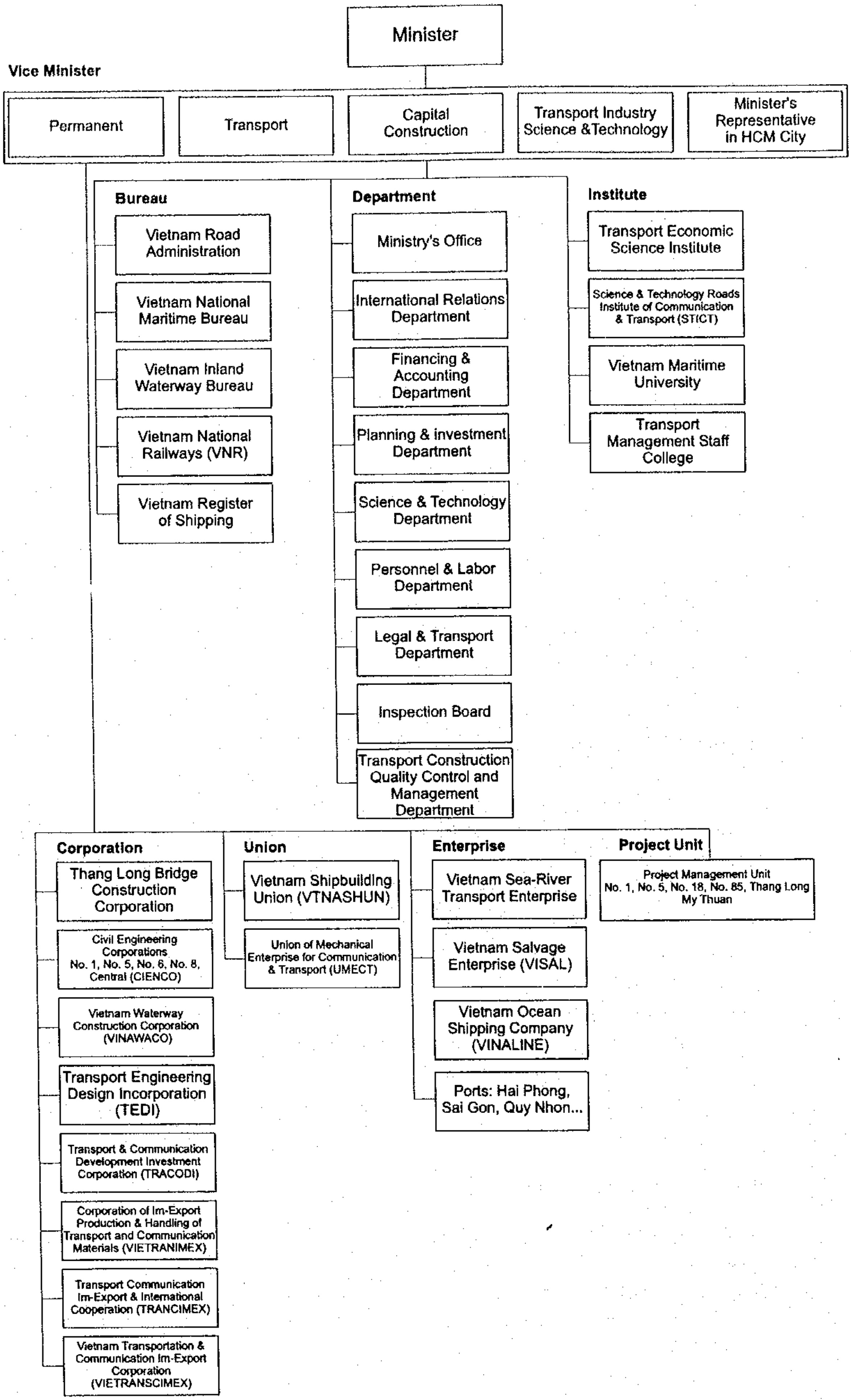


Figure 2.1 Organization Chart of Ministry of Transport

CHAPTER 3 NATURAL CONDITION

3.1 Surveys of Natural Condition

Geotechnical investigations were carried out using machine boring with Standard Penetration Test (SPT), Pressure Meter Test in the field and soil test in a laboratory.

A topographical survey was conducted covering the area along the final centerline for the detailed design (shifted 220m to the downstream side from the centerline of the F/S) and also the interchange, and service, resettlement areas.

The investigation for construction materials for road embankment, road surface pavement and concrete mixture was conducted. The investigation works covered the material source surveys for sand, aggregates, and cement, and the laboratory tests of the engineering properties of each material.

3.2 Hydrological and Hydraulic Surveys and Analysis

(1) Hydrological and Hydraulic Surveys

The following surveys were carried out in the areas surrounding the Can Tho Bridge site.

- Hydrographic and hydrological data collections
- Hydrographic and hydrological surveys
- Hydrological and morphological studies
- Riverbed material sampling and analysis

(2) Design Flood

Based on the data of two gauging stations (Can Tho and Dai Ngai) in the downstream reach of the Hau River from the Can Tho Bridge site, the design flood discharge and higher water surface level were calculated by comparing several methods in conjunction with the results of the F/S.

Since the Can Tho Bridge site is located between the Can Tho and Dai Ngai gauging stations, and is about 3km downstream from the Can Tho station, the analyzed results of the Can Tho Station were applied directly to the Can Tho Bridge site.

Table 3.1 Design Flood at Can Tho Bridge Site of the Hau River

Recurrence Interval (year)	100	50	20	10	5	2	Max-Actual Record at the Can Tho Station (year)
P%	1%	2%	5%	10%	20%	50%	
Final Value							
Higher Water Level (cm) This Analysis	184.97	181.91	177.59	173.99	169.91	162.90	184 (1997)
Preliminary Value							
F/S (C Route)	155.46	153.93	151.66	149.66	147.26	142.75	
(Value in the F/S report)	(195.46)	(193.93)	(191.66)	(189.66)	(187.26)	(182.75)	
Discharge (m^3/s) This Analysis	30,529	29,436	27,855	26,504	24,931	22,109	27,900 (1991)
F/S	30,999	29,849	28,204	26,819	25,232	22,453	

Remark: The State Datum was employed in this analysis.

The result of higher water level in F/S was referred to a different datum that is 40 cm lower than the State Datum. The water surface slope in the Can Tho reach of the Hau River was assumed to be equal to 0.000055 in the F/S. In the tidal river, however, water surface slope cannot be used to deduce required water surface level from another location.

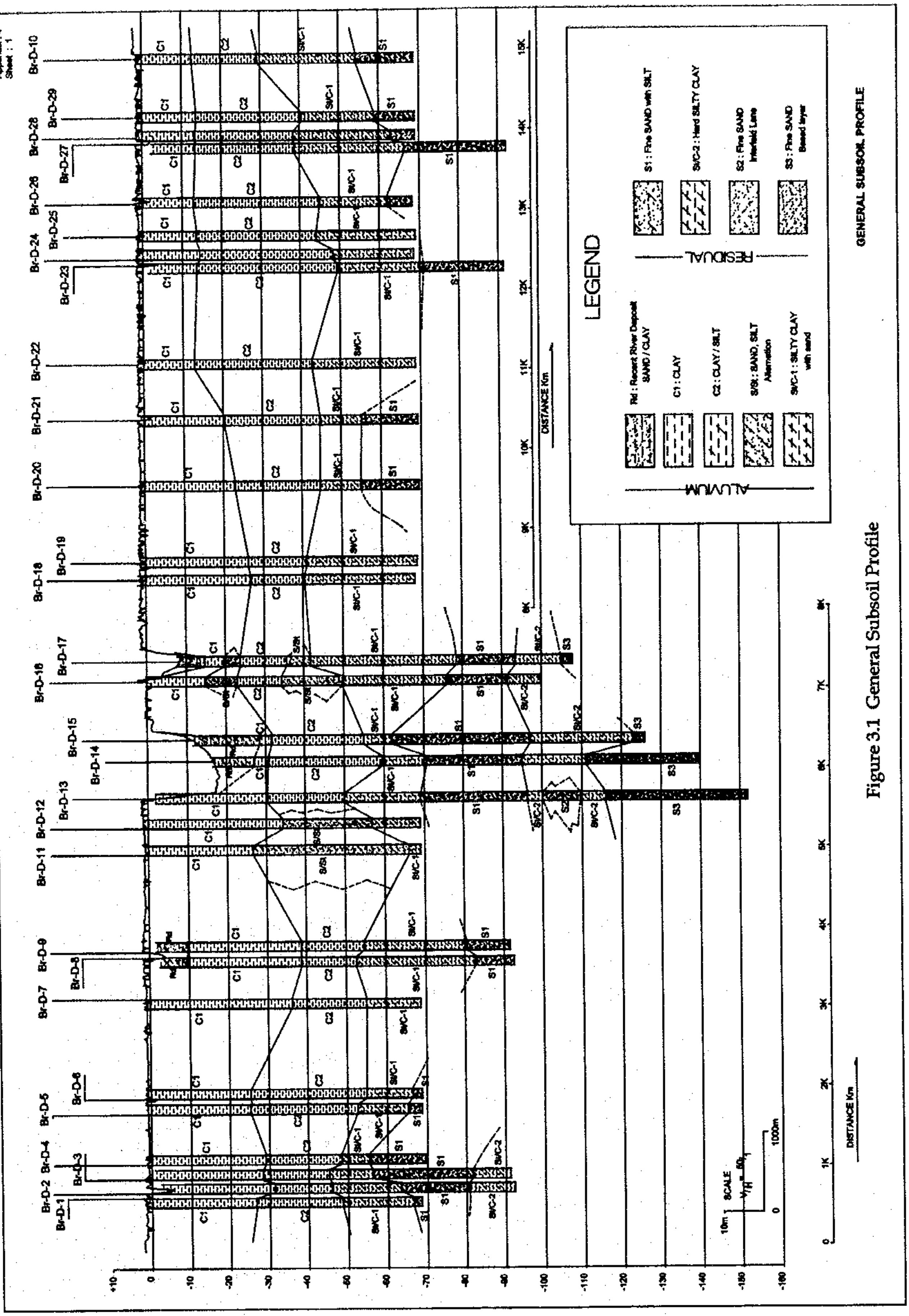


Figure 3.1 General Subsoil Profile

(3) Estimating of Maximum Scouring Depth around the South Tower

The erodible bed deforms until it reaches an equilibrium scour configuration for which the rate of sediment supplied to the scour area is balanced by the rate of transport out of the area. Therefore, the equilibrium depth of scour is reached gradually. By the numerical modeling, the equilibrium maximum depth of local scour could be obtained if the simulation was executed continuously for a longer periods of flooding, for example, over several weeks or months. However, by using an ordinary computer, the computation would take too long time to obtain the maximum depth of local scour directly by this simulation.

The treatments of the scour problem usually end with an empirical formula. More than 10 different formulas have been developed for predicting local scour around bridge piers, based essentially on laboratory and field data. Despite the large number, such formulas contain a limited number of variables, namely, approach flow depth, effective pier width, Froude number, dimensionless shear stress and critical one. The sediment rate is an inverse function of the particle size. Because sediment rates flowing into and out of a scour area change with the size, at nearly the same proportion, the scour depth is not significantly affected by the sediment size which is therefore missing in most formulas for local scour.

For the design purpose, the general scouring of the riverbed and the local scouring around the pier were combined. The scouring depth of the case that the south tower will be composed of 40 cylindrical piles was also calculated. In accordance with the formulas of Shen et al and Colorado State University (CSU), the comparative figures calculated between the two types of the foundations are as follows:

Table 3.2 Comparison of Scouring Depth by Foundations

Description	a) Multi Column with Open Caisson		b) Pile Foundation
• Specific condition	Dia = 10m, n = 6		Dia = 3m, n = 40
• Local scouring			
by Shen's formula	15.63 x 1.3 = 20.32m		7.14 x 1.3 = 9.28m
by CSU'A formula	13.18 x 1.3 = 17.13m		6.16 x 1.3 = 8.01m
on Average	18.73m	*	8.65m 12.98m (1.5 x 8.65)
• Riverbed will be changed	11.50m		11.50m
• Total riverbed change (on average)	30.23m	*	20.15m~24.48m

*: In the case of pile (dia = 3m) foundation, more safety factor should be considered because narrow spaces between foundations may influence to fill the spaces by such as drift woods.

CHAPTER 4 ENVIRONMENTAL SURVEY AND STUDY

4.1 Procedures for Approval of the EIA

The Can Tho Bridge Construction Project is considered to be a highway construction project, and is classified as a Third Category Project, according to provisions of Circular No.490/1998/TT-BKHCNMT issued by MOSTE (Ministry of Science, Technology and Environment) on 29 April 1998. Consequently, the procedures required for approving the environment impact assessment (EIA) of this Project are stipulated as follows.

Table 4.1 Procedures Required for Approving the EIA

Project stage	Application or Action needed to be done by the project owner	Documents issued by competent agency
1. Pre-Feasibility Study	Submit the (1) Preliminary Report on EIA, together with the Pre-Feasibility Study Report to MOSTE.	Issuance of the (1) Investment License [Note 1] by MOT (Ministry of Transport, the project-supervising agency), after ratified by MOSTE.
2. F/S	Submit the (2) Detailed Report on EIA, together with the F/S Report to MOSTE.	Issuance of (2) Approval Document [Note 2] by MOSTE, with the comments made by the EIA Appraising Committee.
3. Detailed Design	(3) Setting up and carrying out the environmental measures proposed in the EIA Report and in response to the comments made by the EIA Appraising Committee.	Issuance of the (3) Construction Permit by MOT.
4. Completion and before operation	Admission of inspection carried out by the competent environmental agencies [Note 3].	Issuance of the (4) Environmental Qualification Certificate by MOSTE, and then the (5) Operation Permit by MOT.

Note 1: The Pre-Feasibility Study Report related to the Can Tho Bridge Construction Project had been approved by Prime Minister as described in the Decision No. 5302 on 21st October 1997.

Note 2: The Detailed Report on EIA relating to the Can Tho Bridge Construction Project had been approved by MOSTE as described in Decision No.1003/QD-BKHCNMT on 13th July 1998.

Note 3: The "competent environmental agencies" are considered to be the Vinh Long Province's Department of Science, Technology and Environment (DOSTE), and the Can Tho Province's DOSTE.

4.2 Measures for Mitigating Impacts

(1) The surveys on natural environment were conducted in order to observe supplementary data on air quality, noise, and aquatic ecosystem at the site. The measures for mitigating impacts on natural environment, based on the recommendations of the F/S, includes: erosion and sediment control, water pollution and air pollution.

(2) The interview survey on project-affected peoples (PAPs) had been prepared carefully in June and July 1999. Several seminars for training the persons in charge of carrying out the interview survey had been held in advance to the survey, which was planned to be conducted during the third and fourth weeks of July 1999.

The assessment on impacts on socio-economic environment, as well as the setting up of impact-mitigatory measures (including the Compensation Program, the Resettlement Action Plan), and the environmental monitoring programs were planned to be completed up to the end of December 1999.

To avoid undesirable disputes on compensation issue, it is recommended that the compensation policy should be prepared carefully and take into account matters such as:

- Compensation should be adequate for dislocated families to re-establish and survive financially until acquired new land becomes fully productive.

- Compensation should be given for all affected structures or lands of all families registered in the census of a fixed day (such as the project approval day). No differentiation should be made according to the legal status of the families registered.

- Compensation should include all additional works carried out by PAPs, such as household electrification, compound walls, and all additional items such as trees, graves, wells, etc.

- For families losing part of their land and their house, where the remaining land is inadequate for building a new house, compensation should be paid for the loss of their house and the total land, even if not all acreage is required for project purposes. These families are entitled to receive a lot of $100m^2$ at least in a resettlement zone prepared by the authorities.

- For families wanting to acquire lots and houses in a location other than the resettlement zone prepared by the authorities, compensation can be paid in cash at replacement cost.

- All families, whose house is affected by the Project, are entitled to have a subsistence allowance for a fixed period needed to rebuild the new house or relocate to other place.
- All dislocated families should be provided a transport allowance for the move from the original homestead to the new settlement area.

To mitigate the impacts on residents who lost their dwellings for the Project, a resettlement plan was prepared carefully at the detailed design study. To ensure that the Project is acceptable to all PAPs and avoid any undesirable disputes during the project implementation, adequate preparations such as the following were done in the process of making the resettlement plan:

- Conducting the detailed surveys on PAPs' intentions, to collect necessary detailed information for the setting up of compensation policy, resettlement plan, etc.
- Setting up the policy on compensation, land acquisition, and resettlement which is preferable to a majority of PAPs.
- Setting up the principles on the formulation and the activities of the Committee of Compensation for Land Acquisition responsible for the implementation of the resettlement plan, taking into account the participation of PAPs in this organization,
- Setting up the principles on the providing of subsistence allowances, and other subsidiary policies.
- Setting up the appeal mechanism, to allow any aggrieved resident to express his/her opinions to the Committee of Compensation for Land Acquisition, and ensure that these appeals are appropriately considered.

CHAPTER 5 BASIC DESIGN

5.1 Basic Design Conditions

(1) Specifications and Standards

The design is to be based on the Vietnamese Standards and the AASHTO Specification for Bridge Design with reference to Japanese Standards, especially for the proof check.

The major references are:

- Highway Design Standards (TCVN-4054-1998), Viet Nam Specifications for Bridge Structures (2057/QD-KT-1979-Viet Nam) Highways Bridge Specification
- AASHTO LRFD Bridge Design Specification, Second Edition 1998 published by AASHTO (American Association of State Highway and Transportation Officials).
- Reference will also be made to the AASHTO Standard Specification for Highway Bridge, Sixteenth Edition 1996.
- AASHTO Guide for Design of Pavement Structures 1993
- Japanese Highway and Bridge Standards
- Other related standards and specifications

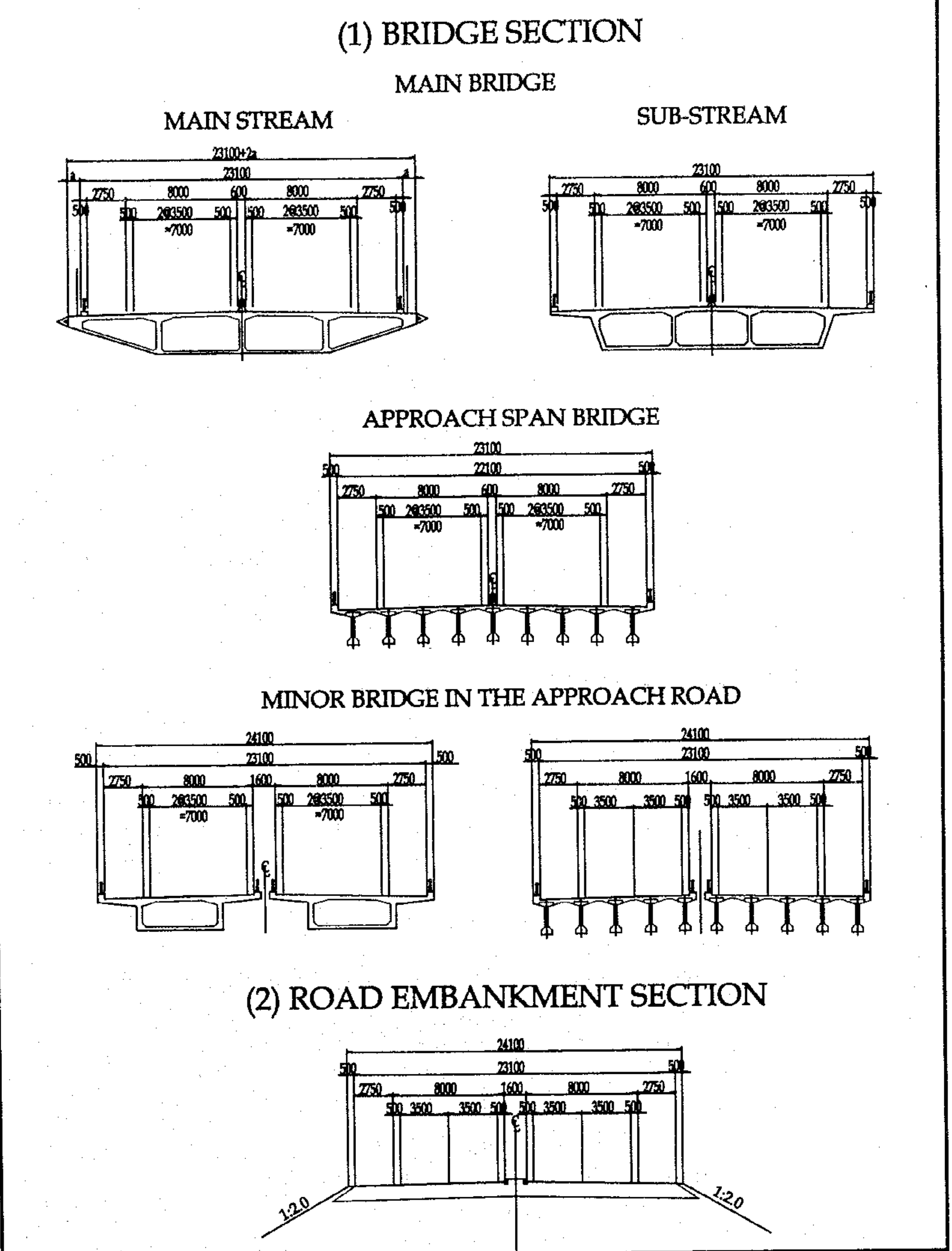
(2) Typical Transverse Cross-section

The typical transverse cross sections for the bridge deck and road embankment are recommended as the following illustration. The cross sections were determined based on the conditions discussed with the Vietnamese side.

(3) Navigational Clearance

Through the series of discussions during the F/S stage, the vertical navigational clearance for the main bridge was determined as 39.0m (37.5m for 10,000DWT vessel plus 1.5m for safety surplus). The detailed navigational and hydrological conditions required for the main bridge of the Can Tho Bridge were as below:

a) The space for the existing and proposed navigation should not be disturbed by the new bridge structures. The space for navigation should be the maximum of 39.0m (vertical) x 110m (horizontal) central in the main span and 30m x 300m overall for the full width of navigable space.



THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure 5.1 Typical Cross Sections JAPAN INTERNATIONAL COOPERATION AGENCY

b) The navigational clearance should be confirmed with Cambodia and accepted by the Mekong River Commission of Viet Nam and its secretariat offices.

c) The basic water level for the vertical navigation clearance should be high water level of 5% frequency, i.e. a 20-year return period.

As for the navigational clearances for the bridges crossing the river branch of the Hau River, and the streams and canals in the areas of the approach roads, the proposed classification were prepared in accordance with Technical Classification of Inland Waterway (TCVN-5664-1992).

(4) Possible Bearing Stratum for the Main Bridge

The upper part (0 to 30m) is very soft, the middle part (30 to 70m) is clay with N-blow 10 to 50, and from 95m to 120m deep, there is silty clay at the Bore Hole 13, 14. The possible bearing stratum for the foundations of the main bridge could be the sand layer (more than 95m deep at boring point 13) below the silty clay layer. As for the approach span bridge, the possible bearing stratum could be silty sand (more than 70m deep).

5.2 Basic Design for Highway

(1) Horizontal Alignment

To determine the final centerline for the detailed design, the following conditions were investigated and discussed with the related officers and people.

- Connecting point with the National Highway (NH) No.1
- Area and location of temples and tombs
- Public facilities such as hospital, school and disposal sites
- Density of residential areas including markets
- Consistency with the master plans for industrial zones and city development
- Future plans of roads and interchanges
- Dockyard Facilities and fuel stations for ships
- Confluence point of the stream and/or canal
- Influence to ecosystem

Mainly due to the locations of temples and cemeteries, the centerline was finally shifted 220m to the downstream side from the centerline of the F/S.

(2) Vertical Alignment (Maximum Gradient)

The gradient should not be greater than 6%, which is specified as the maximum gradient at the design speed of 80km/hr in accordance with the Highway Design Standards (TCVN-4054-1998, Viet Nam).

In comparing gradients between 4.0% and 4.5% for the main bridge and its approach spans, the 4.0% case means a shorter distance at the reduced average vehicle speed of 45km/hr and it can also provide a better solution for moving of launching girder during construction. Thus, a 4.0% gradient for the approach portion of the main bridge is recommended in terms of shorter critical length of gradient, while the maximum gradient for the approach road sections can be designed in accordance with the Highway Design Standards (TCVN-4054-1998, Viet Nam).

(3) Type of Interchange

Three interchanges and one at-grade intersection were decided after consideration of future full control of access, connection with heavily traveled routes such as the NH No.1, avoiding serious accidents, and reducing the road-user costs such items as fuel, tires, oil, repair, etc., and traffic volumes in excess of the capacity of alternative at-grade intersection. In addition to these considerations, the site investigation and discussions with People's Committee of both Vinh Long and Can Tho Provinces were conducted. The following four interchanges were concluded.

- Project Route and NHNo.1, Vinh Long
  Type: Semi-Y type with half interchange system
- Project Route and NH No.54
  Type: Diamond type with full interchange system
- Project Route and NH No.91&91B
  Type: Diamond type with full interchange system
- Project Route and NH No.1, Can Tho
  Type: Intersection system

5.3 Basic Design for Bridge Structures

(1) Central Span Length of the Main Bridge.

The required central span length of the main bridge was determined by the horizontal navigational clearance, the size of structure, and from assessing the requirements that the bridge structure specifically foundations be stable and safe from hydrodynamic issues such as riverbed change and local scouring around the piers.

At the river section of the bridge route, the variation in water velocity was observed from the left riverbank to the middle of the river, with the peak velocity located approximately 350m from the left riverbank. The velocity peak observed in June 1999 will considerably affect the hydrodynamic issues around the pier foundations. Consequently, to avoid the hydrodynamic issues around the pier foundations and to maintain clearance to maneuvering lane from the left riverbank for large size vessels, the final central span length should be 550m from the tower at the left riverbank, while the central span length of the F/S was 500m.

(2) Location of Tower on the Left Riverbank for the Main Bridge

The location and the foundation depth of the tower on the left riverbank were decided from the following reasons: to maintain the maneuvering safety for large size vessels by locating the tower on the land, which is also able to economize construction costs compared with constructing the tower in the main stream of the river, to support the foundation stability to the riverbank erosion by extreme floods in the future, and to avoid hydrodynamic problems such as local scouring which may occur around the pier foundations in the case where the pier was constructed in the deep part of main stream of the Hau River.

(3) Bridge type for the Main Bridge

A Hybrid Cable-stayed bridge for the main span was concluded for the following reasons:

- A hybrid (steel and concrete) bridge type can maximize the use of locally procured construction materials, which can make the bridge construction cost more economical compared with an all steel bridge type.

- The longer span of the Hybrid Cable-stayed bridge type can minimize the number of piers where the foundations have to penetrate into the bearing stratum approx. 100m deep.

- The longer span of the Hybrid Cable-stayed bridge type enables the hydrological and hydraulic problem such as river bank erosion, and local scouring around piers to be minimized, maintaining the required horizontal navigational clearance. It also minimizes the girder depth for the central vertical navigational clearance of 39.0m.

- The cable-stayed bridge with a partial concrete structure (hybrid system) can be advantageous in the case of aerodynamic stability compared with all steel structure.

- The towers and cables can provide symbolic and landmark views, which is excellent from the aesthetic aspect.

(4) Optimum Steel Girder Length in the Central Span

To optimize the steel girder length in the central span of the main bridge, the following items were compared:

a) Maximum and minimum bending moment
b) Forces acting at the junction of the steel and concrete girders
c) Magnitude of deflection at the mid-span caused by live loads
d) Reaction forces at the tower foundations
e) Number of supplement any piers for the side spans
f) Construction cost ratio

Consequently, the 210m steel girder length with two supplementary piers for the side spans was optimized with the reasons below:

a) Bending moment, deflection, etc. are minimal
b) Construction cost is comparatively cheap
c) Providing supplementary piers for the side spans improves the total stability of the structure.

(5) Shape of Girder Section

The best solution on the main girder shape was selected among the three possible shapes, i.e. edge girder, triangle edge and trapezoidal box type. The trapezoidal box type was recommended by the reasons that it has advantages for aerodynamic stability, segmental construction, and the hybrid girder system.

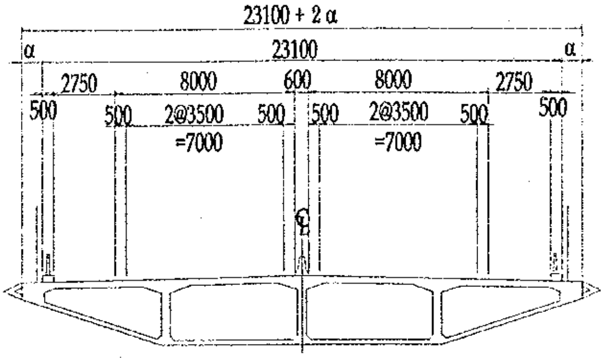


Figure 5.2 Shape of Girder

(6) Shape of Tower and Supporting System

An A-shaped tower was concluded for the main bridge (Cable-stayed type bridge) from the reasons of structural stability, i.e., smallest deformation and bending moment at the bottom due to lateral loads like wind or earthquake forces, and least influence to the foundations. For the supporting system, the bearing shoe system was selected since it is suitable for the three span cable-stayed bridge and for the comparatively longer span bridge.

(7) Cable Arrangement

There are, normally, three layouts of the cable arrangement for the cable-stayed bridge, i.e., radial, Fan, and Harp layouts. The Fan arrangement of cable layout was recommended because the cables are regularly spaced along the top part of the tower. The cable angles are more effective for vertical lifting forces. In addition to this, the separated anchorages requires a less complex anchoring system.

(8) Anchorage System of Cables and Tower

Anchorage of cables inside the tower was the recommended solution, for the following reasons:

- The inner anchorages can minimize the corrosion by reduced exposure to the atmosphere,
- It does not require heavy and costly steel structure, and
- The different forces are not occurred by different active-axis.

(9) Connection of PC and Steel Girders

The rigidity between the PC and steel girders is quite different. Therefore, at the connecting point between them, a buffer or transition zone will be provided to avoid the abrupt change of stress flow and to control structural fatigue. The partial area connection can solve these problems and is recommended.

(10) Type of Approach Span Bridge

To determine the type of approach span bridge, the optimum span length was concluded to be 40m after optimizing the cost of superstructure and substructure including foundations. The most suitable bridge type for the approach span was I-shaped girder.

(11) Bridge Type for the River Branch

In order to economize the bridge cost, the types of bridge crossing the river branch of the Hau River on the route were studied. The costs of the three applicable bridge types, a Hybrid extra-dosed type with a central span length of 180.0m, a 120.0m span PC Extra-dose type, and a 80.0m span PC Box girder type were compared. The 9m vertical clearance and multiplies of 60m horizontal clearances (referring to the Technical Classification of Inland Waterways (TCVN-5664-1992), were considered for this comparison study as well as the deep soft subsoil conditions. Since the 80m span PC Box-girder type has less technical problems and is more economically viable, it was recommended for the bridge crossing the river branch of the Hau River.

(12) Bridge Types for the Approach Roads

The bridge types to be designed for the approach road section should cover the conditions: to reduce the construction time and cost, to minimize procedures quality control, and to minimize variation in concrete behaviors. The following relationship between bridge type and applicable span length was considered for the preparation of design concept of the bridges.

Table 5.1 Type of Girder

Type of Girder	Span Length (m)
- RC Hollow Slab *	10 ~ 15
- PC – T (Pre-Tension)	10 ~ 15
- PC – T (Post-Tension)	15 ~ 30
- PC-I (Post-Tension)	20 ~ 40
- PRC Hollow Slab *	20 ~ 35
- PC-Box girder	35 ~ 60
- PC-Box (Balanced Cantilever)	50 ~ 150

*: For road embankment and interchange

(13) The Type of Foundation for the Main Bridge

The three types of foundation for the main bridge were compared, i.e. Cast in Place Pile, Multi-column with Open Caisson, and 2-Cylindrical Open Caisson.

Based on the technical and economical comparison, the Cast in Place Pile and Multi Columns with Open Caisson were selected for further comparison in the detail design.

CHAPTER 6 WIND TUNNEL TEST

6.1 Wind Tunnel Test

The experimental conditions of wind tunnel test are as follows:

(1) The scale ratio of the actual bridge and section model girders is one to 60.

(2) The length of section model girder is 1.25m.

(3) The cases for test by changing attack angle are as below:

Table 6.1 Attack Angle

Description	Attack Angle (degree)
	0
Section Model Test	+3
	-3

(4) Basic wind velocity (V10) is 10m above the river surface.

(5) Design basic wind velocity (at the height of girder) is:

$$U_D = 40 \times \left(\frac{40}{10}\right)^{0.16} = 50 m/\sec.$$

(6) Required wind velocity of flutter in the tunnel is:

$$U_{rf} = 1.2 \times E_{rl} \times U_D = 1.2 \times 1.15 \times 50 = 69 m/\sec.$$

6.2 Results of Test

(1) On the attack angle of zero (0) degree, vortex - excited vibration induced at the wind velocity of 15m/sec (full- scale velocity) with the maximum torsional vibration of 0.08 degree. This vortex - excited vibration in case of change of the damping from 0.02 to 0.03, no vibration such as vortex - excited appeared. Flutter vibration did not induce up to the wind velocity of 100m/sec., but appeared at 311m/sec.

(2) On the attack angle of plus three (+3) degree, vortex - excited vibration induced at the wind velocity of 15m/sec, (full-scale velocity) with the maximum torsional vibration of 0.04 degree and it is small. If the damping is 0.03, this vortex-excited vibration disappeared. No flutter vibration appeared up to 320m/sec.

(3) On the attack angle of minus three (-3) degrees, vortex - excited

vibration is 0.04 degree which is same as the case of the attack angle of plus three (+3) degree. The vertical vibration is 2.9cm at the maximum wind velocity of 9m/sec. If the damping increased to 0.03, torsional vibration disappeared, but the vertical vibration reduced to 2.5cm only. Flutter vibration appeared at the wind velocity of 281m/sec.

Thus, it is clear that in accordance with the sectional model test, aerodynamic behavior of girder is stable. However, general aerodynamic behavior is affected by many kinds of natural conditions, and in the next stage, the review of this test with the newest data is required.

CHAPTER 7 DETAILED DESIGN

7.1 Drainage System and Opening of Bridge

(1) Estimate of Discharge

All box culverts and bridge crossings of the Project area are located on the relatively straight reaches of channel with uniform geometry upstream and downstream of the bridge site. So the Manning Equation to determine the discharge is available.

Based on the Manning Equation with design water levels, cross section of the streams, hydraulic slope, and the roughness coefficients, the discharges of all streams at bridge sites and box culverts were calculated.

(2) Opening of Bridge and Box Culvert

The required openings are determined by the discharge of the rivers or canals. This is based on an empirical regime formula for stable alluvial channels.

The main Can Tho bridge conveys the discharge of 31,000m^3/s occupied of 93.45% of the total flood discharge of the Hau River (31,000 + 2,174.36 = 33,174.36m^3/s). The bridges and box culverts on floodplain convey the discharge of 2,174.36m^3/s occupied of 6.55% of the total discharge.

The discharges for the designed bridges and box culverts were estimated in accordance with the Manning Equation, $Q=\frac{1}{n} A\ R^{2/3}\ S^{1/2}$.

The openings were also estimated through the Lacey's formula for alluvial channels. The cross section areas were calculated based on the opening of bridges and box culverts and flood water level.

The design opening by the bridges and culverts in accordance with discharge and opening area are summarized in Table 7.1.

Table 7.1 Summary of Design Discharge and Design Opening

Location	Estimated Discharge (m^3/sec)	Design Discharge (m^3/sec)	Required Opening (m)	Design Opening (m)
(a) Vinh Long side	1,275 (100%)	1,423 (111%)	403 (100%)	520 (129%)
(b) Main Bridge	31,000 (100%)	31,367 (101%)	1,824 (100%)	2,615 (143%)
(c) Can Tho Side	899 (100%)	1,214 (135%)	391 (100%)	835 (213%)
(d) Total	33,174 (100%)	34,004 (102%)	2,618 (100%)	3,970 (151%)

As shown in the table, the design total discharge is 2% greater than the estimated one, and the design total opening is 51% greater than the total required opening.

7.2 Design of Interchange

The types of interchange for both connections with NH No.54 and NH No.91B were studied. Two types of interchange for both of NH No.54 and NH No.91B were compared, namely, Case-1 (the type of interchange with that the project road passing over the crossing roads) and Case-2 (the type of interchange with that the project road passing under the crossing roads).

Consequently, Case-2 was recommended for the connection with both of NH No.54 and NH No.91B, with the following advantages:

- Smaller influence for the drainage for the inundated area around the whole road embankment because of the lower embankment height of Project road
- Economizing of the construction cost due to the smaller bridge area
- Smooth traffic due to sufficient interval of the intersections

7.3 Design of Main Bridge

(1) Major Design Loads

- As the design live load, Japanese B-Live Load was adopted after comparison study on the relationship between span length and bending moment, which dominated other loadings such as specified by Vietnamese and AASHTO standards.
- For the deck slabs and floor structures, T-loads of B-Live Load

considered, and for the main girders, L-loads of B-Live Loads was considered.

- Other applied major design loads are wind loads, braking force, seismic force, vessel collision forces.

(2) Structural Analysis

- 2-Dimensional frame analysis was used to calculate sectional forces, displacement, stress of concrete structure, with considering the erection steps and the effects of creep & shrinkage. The results of frame analysis were used for the design of main girder, stay cables and pylon (longitudinal).
- 3-Dimensinal frame analysis was used for the design in transverse direction of the main girder for the proof of the structural safety, including pylon structure.
- Pile foundations were designed through the frame analysis in relation with the soil data.

(3) Selection of Foundation Type for the Tower

Steel Pile Sheet Pile, Cast-in-situ Wall, Multi Columns Open Caisson Foundation and Cast-in-situ Pile are the possible types of foundation for the main tower in consideration of severe natural conditions such as hydrodynamic (local scouring around the pier), deep bearing stratum, construction method and construction cost.

Based on the technical and economical comparisons done in the Basic Design, the Cast in Place Pile and Multi Columns with Open Caisson were selected for further comparison. The following table shows further comparison of them.

Table 7.2 Comparison of Foundation for the Tower of the Main Bridge

Description	Multi Column with Open Caisson (ϕ10.0m)	Cast in Place Pile (ϕ3.0m)
- Construction Cost	O	O
- Construction of Extremely Deep Foundation (100m)	Δ	O
- Influence to Superstructure (Rigidity: Moment of Inertia)	O	Δ*
- Duration of Construction Period	Δ	O
- Quality Control (Concrete)	O	Δ
- Quality Control(Drilling/ Excavation)	Δ	Δ
- Hydrodynamic Problem	Δ**	Δ
- Confirmation of Bearing Capacity	Δ	O

Note: O : Fair
Δ : Comparatively Problem
* : To consider steel casing of pile
** : Simulation analysis was conducted

The cast in place pile foundation was recommended for the following reasons:

- Special equipment and operations for forcing down the open caisson will require more sophisticated technology and higher cost.
- To maintain the rigidity of the pile foundation, the steel casing for cast in place pile will be used.
- For the open caisson foundation, the duration of sinking caisson stein down in the fine sand layer below approximately 70m is rather long.
- The direct observation of bearing capacity of the foundation is possible for the cast in place pile foundation.

7.4 Bridge Design for the Approach Road Sections

To control the design of the bridges for the approach road sections, the location of abutment, span length, span arrangement, location of riverbank, and type of bridge structures were carefully studied and designed.

(1) Location of Abutment

To determine the location of the abutment of bridges, the following conditions were considered:

a) The maximum height of the abutment above the ground is 7.0m from the viewpoint of soft ground treatment and construction costs.

b) The following distance from the riverbank to the abutment should be maintained.

- L =25m, 6.0m< Abutment Height (H) ≤ 7.0m
- L=20m, 5.0m < Abutment Height (H) ≤ 6.0m
- L=15m, Abutment Height (H) ≤ 5.0m

(2) Span Length and Arrangement

The span length and its arrangement between piers or pier and abutment of the bridge were determined based on the following conditions:

a) The requirements from the navigational clearance of tributaries (canal and river) and the clearance for the people's passing across the road.

b) The pier's location in the tributary should be as near as possible to the riverbank.

c) To standardize the design and economize the construction cost, the girder lengths for PC-I girder are max 37m and 25, 28 and 31m, and the ratio of span length for the balanced cantilever PC-BOX varies from 1:1.5:1 to 1:1.6:1.

(3) Location of the Riverbank

The location of the riverbank is not clear at the site and there are no exact rules or future plan at the place of bridge crossing. For the design of bridge the condition of natural riverbank was considered.

(4) Type of Bridge Structures

- In case that the design penetration depth is shallower than 40m, Precast Reinforced Concrete (RC) pile with 450mm x 450mm was designed.

- In case that the design penetration depth is deeper than 40m, Bored Hole Pile with diameter 1.5m and 2.0m were designed. Because of the difficulty to install the pile vertically as designed, Bored Hole Piles with diameter less than 1.2m were rejected.

- In case of the required height above the ground is to be 7m, Inverted-T type of abutment was designed.

- For the PC-BOX and PRC-Hollow-Slab, the wall type of pier was designed.

- In case that the required span length is less than 37m, PC-I girder type was designed, while greater than 37m, PC-BOX girder was designed.

7.5 Design of Infrastructure and Facilities

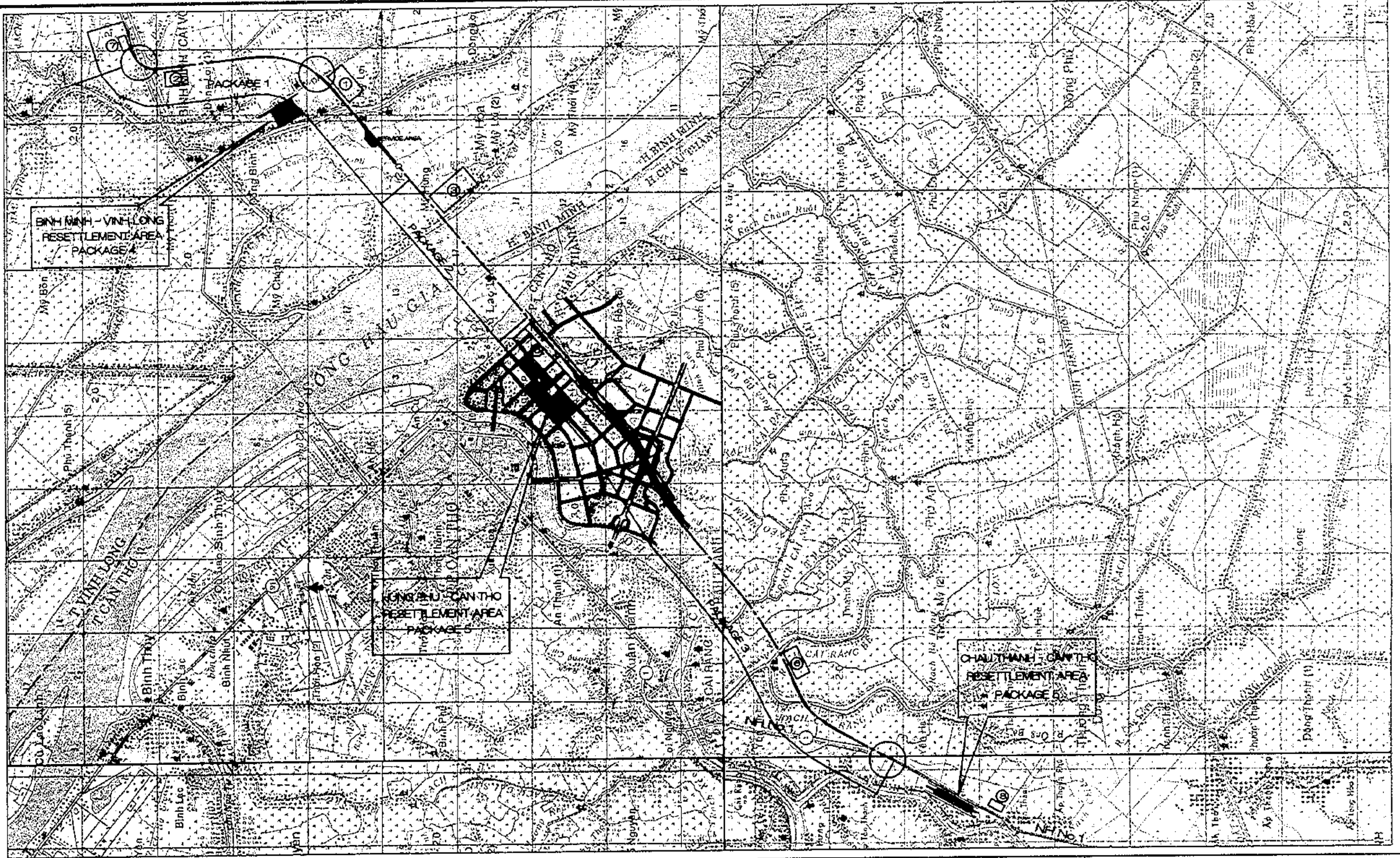
The detailed design of infrastructure and facilities was conducted based mainly on the discussion with People's Committee of Can Tho Province and People's Committee of Vinh Long Province, and other related authorities and organizations.

In addition to these conditions, the results of the interview survey from the residents in the Project areas, conducted in November 1999, were considered. The number of households willing to move to the Resettlement Areas (R.A.) is the basis of design conditions for each R.A., as shown in Table 7.3 and Figure 7.1.

Table 7.3 Design Condition for Resettlement Areas (R.A.)

Description	Binh Minh R.A.	Hung Phu R.A	Chau Thanh R.A
Number of Households	149	22	57
Number of land lots	149	22	57
Average Area of each lot	250m^2	126m^2	200m^2
Total Area	60,645m^2	10,815m^2	21,250m^2
Public Const. Toilet and W.T.P*	Toilet - 3W.T.P	W.T.P	Toilet - 2W.T.P
Access Road	1 x 3.5	1 x 3.5	1 x 3.5
Bicycle lane	2 x 1.75	2 x 1.75	2 x 1.75
Inner Road	1 x 3.5		1 x 3.5
	2 x 1.25		2 x 1.25
Sidewalk and Shoulder	2.00 or 2.75	5.00	2.00 or 2.75

*W.T.P: Water Treatment Plant



THE DETAILED DESIGN OF
THE CAN THO BRIDGE CONSTRUCTION
IN SOCIALIST REPUBLIC OF VIET NAM

Figure 7.1 Resettlement Area

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CHAPTER 8 CONSTRUCTION PLANNING

8.1 Procurement of Construction Materials

(1) Cement

Cement is one of the major construction materials restricted for importing into Viet Nam. Three local cements are available for the Can Tho Bridge construction, namely, Chinfon, Morning Star, and Nghi Son. The trial mixing tests were conducted using Chinfon and Morning Star cements. Moreover through the laboratory tests, the results reached to the target concrete strength of 600kgf/cm^2.

(2) Rock Products (Aggregate) and Sand

Three locations of quarries, varying from 120 to 290km from the Project site, were investigated for the construction materials of base course, subbase course, and concrete aggregate. The aggregate from the three quarries, Co To, Phuoc Hoa, and Hoa An, was judged suitable for use.

Four locations of potential sources for road embankment, structural backfill, and fine aggregate for asphalt concrete mixture were investigated and judged suitable for use, namely Can Tho, Dai Ngai, Dong Nai, and Tan Chau. Distances from the Project site varied from 5 to 250km.

(3) Water

Water for the construction works will be taken from the well at each construction yard subject to quality and quantity tests.

(4) Reinforcement Steel

Reinforcement steel is one of the restricted items for importing into Viet Nam. However, Vietnamese – Foreign Joint factories are able to supply except for large size diameter.

(5) PC Strand

There are some foreign suppliers of PC strand, anchorage, stay cable for the main bridge, approach span bridges, and bridges in the approach roads.

(6) Construction Steel

In Viet Nam, structural steel is not available except for small size of shaped-steel. Therefore, the procurement of structural steel from a foreign country is necessary. However, it is possible to assemble the steel structures at factories or at the site with establishment of equipment.

8.2 Construction Yard and Temporary Works

Two construction yards were planned for Package-1, three for Package-2, and one for Package-3 for the main route construction. Two site offices were also planned for infrastructure construction, namely, Package-4 & 5. The major temporary works consist of temporary access roads, temporary bridges in the access roads, and temporary jetties beside the river or canal.

8.3 Construction Methods

(1) Outline of the Construction Sequence of Main Bridge

a) Construction of Pylon

Construction method of pylon is categorized into 3 stages.

The lower portion, from the top of pilecap to the cross beam is cast by the prefabricated staging method.

After the cross beam is constructed, the self climbing form (travelling formwork) is used for the casting of double columns of pylon.

At the final stage, namely, after the double columns of A shape pylon are connected, all staging method is applied for the casting of the top of pylon.

The casting works are done at the high and narrow places, so the carefully scheduled safety plan is required.

b) Prefabrication of Precast Segment of PC Girder

PC box girders are prefabricated and match-cast in the yard against each other, i.e., using the steam-cured casting system and stock piled. The weight of girder elements is limited to maximum 250 tons due to transportation restrictions and lifting machine capacity.

The construction yard has to have space to provide for form work, a short line and bed, stockyard, reinforcement-fabricating yard, concrete mixing plant, and space for stockpiling all materials. Pretensioning method is applied for the transverse prestressing.

c) Cantilever Erection from Pylons using Temporary Stay and Inner Prestressing Steel

Barges or heavy vehicles are used for the transportation of the fabricated segments from the casting yard to the place where the segments are to be lifted up.

The free cantilever erection method is used for construction of the superstructure. Fabricated elements are then assembled using the stay cable and inner cables. Two types of prestressing steel, namely, PC Bar and PC Strand are applied for the inner cables.

d) Production and Erection of Steel Girder Segments

Members of the steel girder segments are transported from the steel fabrication plant, and the transported members are assembled in the fabrication yard at the site.

Fabricated steel girder segments are transported and erected with the same method, equipment, and sequence with the PC segments.

e) Installation and Stressing of Prefabricated Stay Cables

A fan layout of stay cables is used. Anchorages are provided with anti-fatigue devices. The tensioning jack has the capacity to transfer a 1,000tf ~ 2,000tf tensioning force to the cables which are composed of multi-strands. Several cables can be stressed at the same time.

f) Closure of Center Span

The final steel girder segment is fabricated at site with considering the adjustment to the installation into the closing portion of the center span.

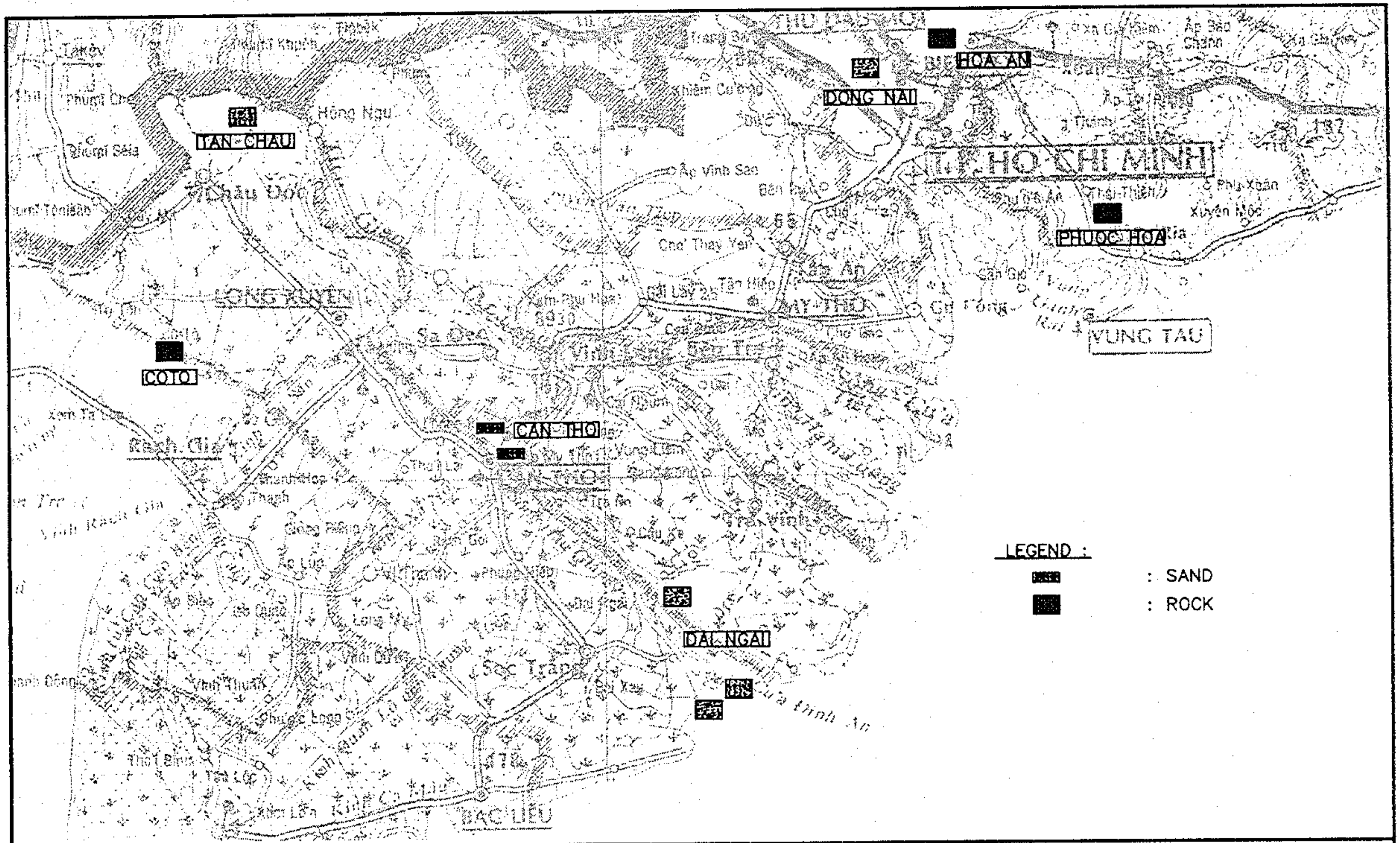
(2) Production and Erection of Concrete Girder Segment

The concrete girder of main bridge will be produced and erected with precast segmental method for the following reasons:

- Better uniform quality by quality control in the casting yard
- Shorter construction time for simultaneous construction with substructure and foundations
- Economizing costs by reuse of formworks and easier transportation and erection

(3) Construction of Cast-in-situ Pile

Cast-in-situ pile foundations are constructed in the drilled hole. A steel casing is used in the free water zone as a standpipe to prevent entry of water into the drilled hole and to protect from collapse. With reverse circulation drilling, the steel casing is lowered to the predetermined depth and the caged reinforcement bars are set inside the steel casing and the drilled hole. After pouring concrete to form cast-in-situ, the steel casing is removed.



THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Figure 8.1 Location of the Investigated Sources
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CHAPTER 9 MAINTENANCE PROGRAMMING

9.1 Organization for Maintenance

A maintenance organization is to be set up to create the conditions and logistical support for the effective implementation of all maintenance activities. The organization should be simple and meet with the specific requirements and resources of Viet Nam, and accommodate the existing Vietnamese organizations and budgetary systems for the maintenance of highways.

9.2 Organization and Expenditure

(1) Viet Nam Roads Administration (VRA)

The Planning Department of the VRA under the Ministry of Transport (MOT) has responsibility for both annual and long-term plans. The long-term plan is a strategic document, which provides the framework for the more formal five-year expenditure plan. The five-year plan provides the basis of the capital component of the annual plans, but subject to modification as the five-year period proceeds. The approval mechanism for long-term plans is for VRA to pass proposals to MOT for incorporation in the overall transport plan, which is submitted to the Government for approval. The VRA long-term plan for the roads sector deals principally with the national roads but also includes aggregate targets for the provincial roads summarizing the provincial plans drawn up by the Provincial Transport Authorities (PTAs).

(2) Expenditure and the Annual Plan

For the national roads, proposals or current expenditure originate with the maintenance authorities, i.e. the Regional Road Management Unit (RRMUs) and PTAs. These proposals are reviewed by the Planning Department of Viet Nam Road Administration (VRA) and assembled into the form of a budget request, which is passed up from the VRA to the MOT and then to the Ministry of Planning & Investment (MPI).

The MPI determines the allocation of funds for VRA - the total VRA budget. The VRA translates this back into allocations for the various departments, enterprises and authorities involved, and specifically in regard to road maintenance this implies the RRMUs and the PTAs. The annual maintenance budget for roads covers both small and medium repairs (corresponding to routine and recurring maintenance), but not big repairs (approximating to periodic maintenance), which are classed as capital expenditure.

(3) Capital Expenditure

Road works are considered to be either small, medium or large. Procedures differ accordingly. Proposals for small and medium works originate with the RRMUs and the PTAs and are reviewed by the Planning Department of the VRA. Small works may be approved by the chief of the VRA; medium works proposals must go up to the MOT. Proposals for large projects are prepared by the VRA and must be submitted through MOT to the Government. Certain large projects, notably those for which foreign finance is sought, come directly under MOT. Execution is the responsibility of the Project Management Units (PMUs).

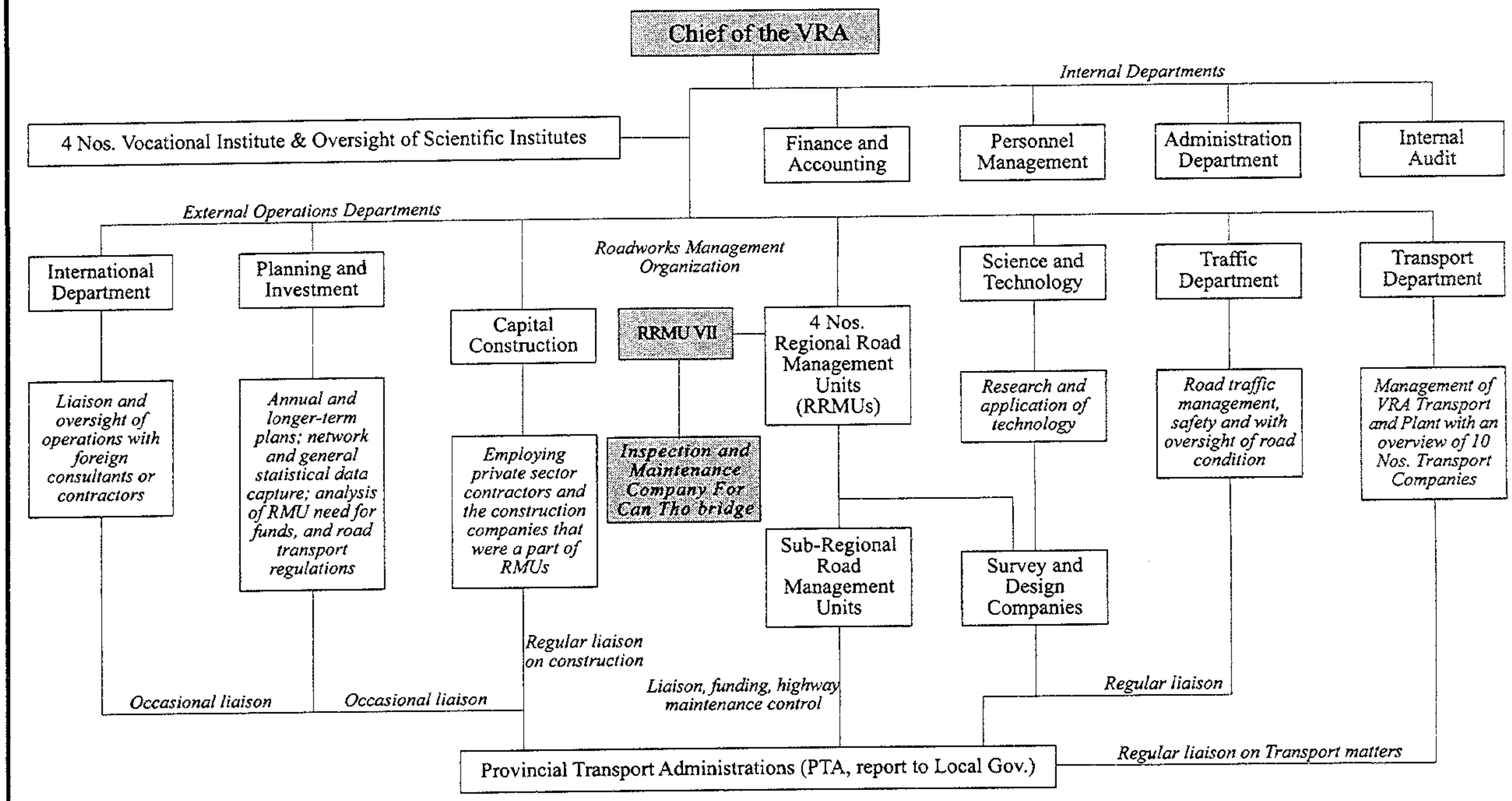


Figure 9.1 Organization of the Viet Nam Roads Administration (VRA) and the Interface with Provincial Transport Administrations

THE DETAILED DESIGN OF
THE CAN THO BRIDGE CONSTRUCTION STUDY
IN SOCIALIST REPUBLIC OF VIET NAM

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 10 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

10.1 Natural Environmental Impacts

Regarding the natural environmental aspect, the surveys on aquatic organisms did not identify any valuable or rare species. However, caution should be paid to prevent the disturbance of the riverine ecosystem that may be caused by the soils, mud, and contaminated water generated during the construction of the bridge foundation, and other earthworks. Soils, and mud excavated from the riverbed should be collected and disposed of at the sites specified previously by the Province Peoples' Committees. In addition, contaminated water should be carefully treated by the appropriate method before discharging into the river.

On the aspect of terrestrial ecosystem, the surveys found that almost all of primitive vegetation in the Project area had been exterminated and replaced by rice paddy fields, tree-croplands, and other agricultural ecological systems. However, appropriate measures should be implemented for mitigating adverse impacts on air environment at the concrete batching sites, construction areas, and other places where there is a generation of dust, contaminant gas, etc.

10.2 Socio-Economic Environmental Impacts

Regarding the socio-economic environment aspect, it is anticipated that a number of residents, and communities would suffer many direct adverse impacts caused by the Project. The most affected people may be: (1) the residents who lose their dwellings and cultivated lands for the project, (2) the shopkeepers, the peddlers, the local transporters, etc., who lose main sources of income due to the reduction of the existing ferry service. About 265.8 ha of land was estimated to be acquired for the Project, and about 550 houses, several public facilities including an elementary school, a solid waste disposal site, and a number of electric power poles would be directly affected by the Project. In addition, about 90 shopkeepers, 150 peddlers and local transporters, etc. would lose their means of livelihood or main sources of income due to the reduction of the Can Tho Ferry's services after the construction of the Can Tho Bridge. The issues which are concerned the most among these PAPs are likely: (1) relocation of dwellings and croplands, (2) insufficient compensation for loss of dwellings and lands, and other issues such as: (3) decrease in income, (4) relocation of ancestor tombs, etc.

10.3 Resettlement Action Plan

To prevent any delay of the project implementation caused by the local residents' opposition, it is recommended that the Resettlement Action Plan

(RAP) and other mitigatory measures should be carefully prepared and duly implemented. The main objective of the RAP is to improve or at least to restore the former living standards, as well as the income earning capacity and the production ability of the residents whose cultivated lands or dwellings or properties are affected by the Project.

The principles set up for the RAP including the following:

- The PAPs should be all entitled to receive compensation and allowances, including: (1) compensation for all parts of acquired land; (2) compensation for all properties, assets, structures, and other additional works which are built on, or installed in the acquired lands; (3) allowances for relocation, subsistence allowances, compensation for lost business, incomes, and wages; (4) rehabilitation assistance including vocational training, employment assistance, for those who have to seek new means of livelihood.

- The rates of compensation and other allowances, should be determined in a fair, impartial, and reasonable manner, so as it is proportionate the losses that the PAPs have to suffer in actuality. The subsistence allowance, the compensation for lost business, incomes and wages provided to the PAPs should be extended during the whole of the time span required for the PAPs to build their new houses and rehabilitate their production facilities.

- The impacts of the Project on the socio-economic environment of the Project area, as well as the progress of the implementation of the RAP should be monitored by PMU My Thuan (as a internal monitoring agency), and by an independent agency (as an external monitoring agency). Specified monitoring reports should be prepared and submitted to MOT and JBIC at a certain time interval, during the pre-construction phase, the construction phase, and the operation phase.

In addition, there are three Resettlement Sites (RSs) being designed for the PAPs who would lose their dwellings, and have no other appropriate land for relocation. Also, two service areas are designed for the PAPs whose livelihoods are depending on the business activities at the existing ferry.

10.4 Other Recommended Measures for Mitigating Adverse Impacts

Other measures such as the following were also proposed to mitigate the adverse impacts caused by the Project on the socio-economic environment of the project area.

- Carrying out the training programs oriented to the residents whose livelihoods are depending on the existing ferry, on some viable forms of food processing which could be undertaken at the households level.

- Establishment of some forms of soft loans, to help affected residents, especially the peddlers, who intend to carry out new business plan, but do not have sufficient finance.

- Pushing forward the plans to establish the gardening-tourism areas in the southern part of the Binh Minh District and in the Con Au Island, to create new jobs for local residents, especially for the peddlers, the local transporters who would lose main source of income due to the reduction of the Can Tho Ferry. Such tourism areas may also serve as places to absorb unemployed workers after the completion of the bridge.

- Carefully examining the relocation plans of the elementary schools in the Binh Minh District, and the solid waste disposal site in the Chau Thanh District which are affected by the Project.

10.5 Estimated Environmental Cost

Total estimated environmental cost is US$ 10,324,773, including US$ 10,114,773 for land acquisition and mitigation measures for adverse impacts on socio-economic environment, and US$ 210,000 for environmental monitoring programs.

CHAPTER 11 ESTIMATE OF PROJECT COST

The Project Cost consists of the following components.

- Construction cost
- Engineering cost
- Administration cost
- Land acquisition and compensation cost
- Environmental monitoring cost
- Price escalation
- Physical contingency
- UXO cost
- Interest during construction
- Duty tax

Construction cost is the sum of the cost for various items of work required in the construction.

These individual costs are the product of a calculated quantity of an item of work multiplied by the estimated unit cost of the item.

The unit cost of each item was obtained by totaling the labor cost, material cost, equipment operation cost, etc. It is expressly acknowledged that the pricing method and data for construction cost estimation were based on the internationally accepted competitive bidding practice that is virtually non-existent in Viet Nam at present moment.

The Study Team tried to use the estimate method based on a similar project in Japan. Accordingly, the estimate method is based on the Estimate Standard for Civil Work of Ministry of Construction in Japan 1999. The data was adjusted considering the respective socio-economic realities in the two countries.

Other indirect cost is estimated referred to other international tendering project and official letter issued by Viet Nam.

The following Diagram of Cost Estimate (Figure 11.1) shows the individual components of the cost estimation.

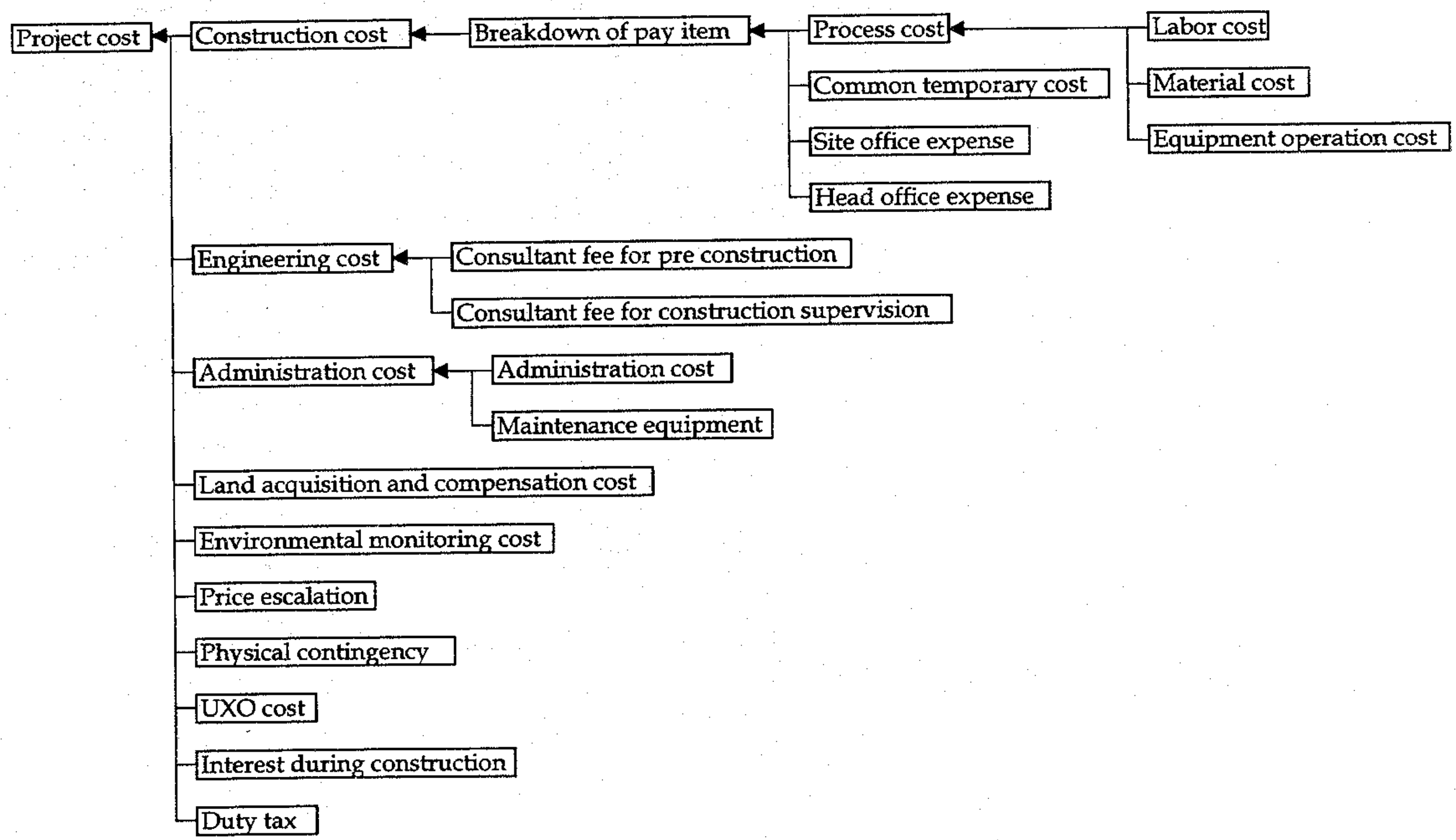


Figure 11.1 Diagram of Cost Estimate

Package 4 and 5 for the resettlement was estimated based on Viet Nam standard. These construction packages will be tendered in local bidding. Calculation method, labor cost, material cost and equipment cost are based on the regulations for cost estimate in Can Tho province and Vinh Long province.

The construction cost for the resettlement (Package- 4 and 5) was estimated based on Viet Nam standard. These construction packages will be tendered in local bidding, and should be completed prior to the main route project. Accordingly, the calculation method, labor cost, material cost, and equipment cost were based on the regulations for cost estimate in Can Tho province and Vinh Long province.

The estimated project cost and breakdown are summarized as shown in the following:

(1) Project cost (Package 1, 2 & 3)

1)	Construction cost	:	28,726,000,000	JP Yen
	1-1) Package-1	:	(2,800,000,000	JP Yen)
	1-2) Package-2	:	(22,394,000,000	JP Yen)
	1-3) Package-3	:	(3,532,000,000	JP Yen)
2)	Engineering cost (consultant)	:	1,721,000,000	JP Yen
3)	Administration cost			
	3.1) Administration cost	:	621,000,000	JP Yen
	3.2) Maintenance equipment	:	216,000,000	JP Yen
4)	Land acquisition and compensation cost	:	1,158,000,000	JP Yen
5)	Environmental monitoring	:	22,000,000	JP Yen
6)	Price escalation	:	587,000,000	JP Yen
7)	Physical contingency	:	1,466,000,000	JP Yen
8)	UXO cost	:	86,000,000	JP Yen
9)	Interest during construction	:	1,155,000,000	JP Yen
10)	Duty Tax	:	2,873,000,000	JP Yen
Total (Project cost)		:	38,631,000,000	JP Yen

(2) Project cost (Package 4 & 5)

1)	Construction cost	:	230,000,000	JP Yen
2)	Environmental monitoring	:	4,000,000	JP Yen
3)	Contingency (Physical contingency)	:	23,000,000	JP Yen
4)	UXO cost	:	2,000,000	JP Yen
Total (Project cost)		:	259,000,000	JP Yen

(1US$=108JP Yen=14,100VND)

CHAPTER 12 PREPARATION OF PREQUALIFICATION AND TENDER DOCUMENTS

12.1 Prequalification Documents and Evaluation

The documents of prequalification cover general information about the contractor, legal and financial information and technical information, which is to include previous experience on similar projects. The detailed contents prepared are as follows:

- Invitation to apply for prequalification
- General instructions to applicants for prequalification
- Particular instructions to applicants for prequalification
- Appendix-A: Preliminary project details for package
- Appendix-B: Schedule for all 5 packages
- Application letter and forms

The detailed method of evaluation is included in the appendices of the main report. The results of the prequalification evaluation will be summarized in a report recommending contractors for short-listing. The report will also include a list of disqualified contractors specifying the reasons for their disqualification. Short-listed contractors will be notified on the availability of the bidding documents.

12.2 Tender Documents and Evaluation

The tender documents will be issued by the PMU My Thuan and will consist of:

- Invitation to Tender and Forms of Acknowledgment
- Project Definition
- Conditions of Tendering
- Appendix A to Conditions of Tendering, Information provided by PMU My Thuan.
- Appendix B to Conditions of Tendering, Major Points of Conformance
- Form of Tender
- Appendix to Form of Tender
- Schedules to Form of Tender, Information to be completed by Tenderer
- Form of Agreement
- Conditions of Contract Part I (FIDIC IV, 1992)
- Conditions of Contract Part II (Special Condition)
- Forms of Bank Guarantees

The objective in evaluating tenders is to obtain the best value for money and not necessarily the lowest price. In addition to the consideration of price and compliance with the tender documents, the following factors will be taken into consideration in the assessment of tenders. The detailed method of evaluation is included in appendices of the main report.

- Technical management, physical and financial resources
- Subcontract, labour and material supply proposals
- Extent of local contractor participation
- Current commitments
- Record of previous performance on projects both in Japan and overseas
- Reputation within the industry
- Extent of construction experience on similar projects
- Ability to perform within contract time
- Financial capacity
- Quality system proposals and quality assurance record
- Industrial relations, safety performance and contract claims record
- Pricing structure of tender schedules
- Extent of minimisation of risk to the government of Viet Nam

CHAPTER 13 IMPLEMENTATION PROGRAMME

13.1 Packaging of the Project

The appropriate size of contract of the Project were recommended for implementation under the JBIC Guideline, taking into consideration the following items:

- Proper size in consideration of cost requirements
- Proper size from the point of view of technical content for the selection of the civil works contractor
- Proper size and location from the point of view of handling by municipality, in case of domestic tender
- Minimizing the number of construction yards and offices
- Minimizing the organization and staff to be required
- Unified control for the construction quality and progress
- Maintaining the effective communication system

The project packaging can be tentatively scheduled in accordance with the meeting held on 13 October 1999 in Hanoi as below:

- Package - 1: Approach Road Section for Vinh Long side (ICB)
- Package - 2: Main Span and Approach Span Bridges (ICB)
- Package - 3: Approach Road Section for Can Tho side (ICB)
- Package - 4: Infrastructure and Facility for Vinh Long side (LCB)
- Package - 5: Infrastructure and Facility for Can Tho side (LCB)

Package-4&5 will be funded by the domestic resource with considering the early commencement of other packages, and scheduled to be tendered in local bidding. For facilitating the Project, PMU My Thuan submitted the application of the "Implementation Schedule and Cost Estimate of the Land Acquisition and the Resettlement Areas of Can Tho Bridge Project" including the design of Package-4&5 to Ministry of Transport by on 6th March 2000. The Minister of MOT approved this application on 28th April 2000 with the official letter, No.1042/QD-GTVT.

13.2 Tentative Implementation Schedule

- The Detailed Design will be accomplished by October 2000

- Land acquisition including resettlement for people to be removed should be started from April 2000.

- Selection of Consultant will be from January 2001 to June 2001

- Pre-qualification will be from July 2001 to September 2001
- Tendering is from October 2001 to June 2002
- Commencement of Construction will be June 2002

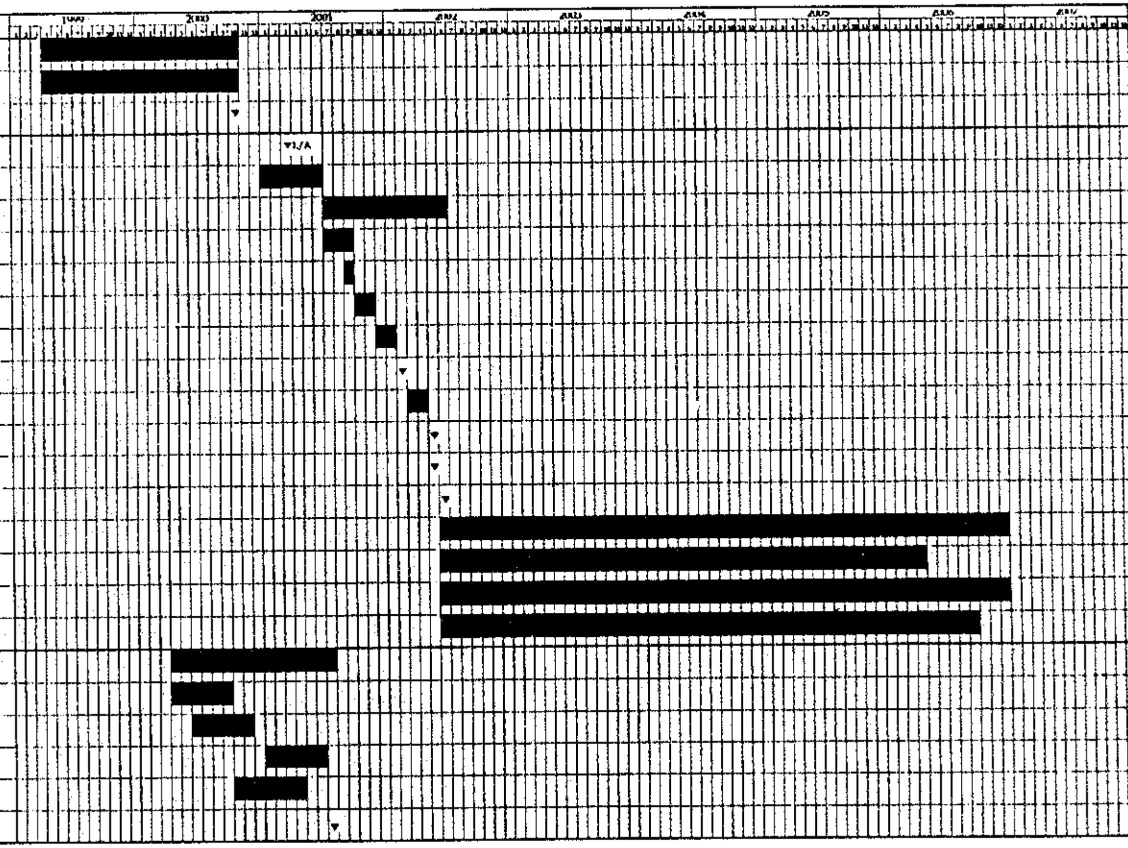
	Period		Months
<1> Detailed Design	Apr. 1999 ~ Oct. 2000		19
Detailed Design	Apr. 1999 ~ Oct. 2000		19
Submission of Final Report	Oct. 2000		
<2> Loan Agreement	Mar.2001		
<3> Selection of Consultant	Jan. 2001 ~ June 2001		6
<4> Selection of Contractor	July 2001 ~ June 2002		12
Pre-Qualification	July 2001 ~ Sep. 2001		3
Preparation of Tender Documents	Sep. 2001		1
Tender Period	Oct. 2001 ~ Nov. 2001		2
Tender Evaluation	Dec. 2001 ~ Jan. 2002		2
Concurrence of Tender Evaluation by JBIC	Feb. 2002		
Negotiation of Contract	Mar. 2002 ~ Apr. 2002		2
Concurrence of Contract by JBIC, Approval by MOT	May 2002		
Signing on Construction Contract	May 2002		
L/C Opening	June 2002		
<5> Construction Works	June 2002 ~ Dec. 2006		55
Package-1	June 2002 ~ Apr. 2006		47
Package-2	June 2002 ~ Dec. 2006		55
Package-3	June 2002 ~ Sep. 2006		52
<6> Land Acquisition, Compensation, and Resettlement	Apr. 2000 ~ July 2001		16
Cadastral Mapping	Apr. 2000 ~ Sep. 2000		6
Determination of Affected Lands, Houses, and Assets	June 2000 ~ Nov. 2000		6
Construction of Resettlement Area	Jan. 2001 ~ June 2001		6
Land Acquisition and Compensation	Oct. 2000 ~ Apr. 2001		7
Handover of Land to Contractor	July 2001		

Figure 13.1 Tentative Implementation Schedule of Can Tho Bridge Construction

CHAPTER 14 FINANCIAL ANALYSIS

14.1 Cost Disbursement and Revenue

(1) Analytical Aspects

It was assumed that the Can Tho Bridge will be operated as a toll bridge similar to the My Thuan Bridge. Namely it is supposed that collected charges from users o the bridge will be allocated to the repayment of the loan and pay back to capital or project investment and to cover the costs for operation and maintenance of the bridge.

Financial analysis was made to acquire the clear prospects to following basic primary questions.

1) Viability of the Project under favorable ODA loaning condition;
2) Viability of the Project under the financing condition of long and short term loan without subsidy;
3) Possibility of covering operation and maintenance costs the Bridge by the revenue as an autonomous project; and
4) Possible measures to enhance the financial soundness of the Project.

(2) Cost Disbursement

In addition to the construction costs, costs related to the toll collection system are necessary for the financial analysis in the case of a toll bridge. Costs related to toll collection system comprises administration and operation costs and taxes.

The costs for operation system mainly comprise personnel expenditure and maintenance costs for toll system. Personnel expenditure was estimated at 12 million JPY per year based on the survey results of current salary level and cost for equipment at Can Tho ferry Company.

Cost disbursement schedule is shown in Table 14.1.

Table 14.1 Disbursement Schedule

1. Packages 1, 2 & 3

(unit: 1,000 JP\)

		2000	2001	2002	2003	2004	2005	2006	2007	-	2026	Total
1	Land Acquisition & Compensation	1,257,950	103,490	0	0	0	0	0	0	-	0	1,361,440
2	UXO Cost	93,877	7,723	0	0	0	0	0	0	-	0	101,600
3	Administration Cost	0	0	42,917	260,603	355,744	220,013	105,482	0	-	0	984,759
4	Consultant Fee	34,931	25,616	72,191	439,666	600,116	370,852	178,032	0	-	0	1,721,404
5	Environmental Monitoring	0	0	1,079.5	6,731	9,207.5	5,651.5	2,730.5	0	-	0	25,400
6	Construction Work	0	0	1,320,666	8,118,883	10,987,512	7,359,530	3,865,408	0	-	0	31,651,999
	- Pckage 1 (App. Road Vinh Long)	0	0	294,645	1,258,941	1,411,230	243,184	0	0	-	0	3,208,000
	- Pckage 2 (Main and App. Span bridge)	0	0	898,318	5,766,573	7,699,855	6,218,033	3,795,221	0	-	0	24,378,000
	- Pckage 3 (App. Road Can Tho)	0	0	127,703	1,093,369	1,876,427	898,313	70,187	0	-	0	4,065,999
7	Price Escalation	0	0	12,917	121,201	217,796	198,174	78,737	0	-	0	628,825
8	Physical Contingency	0	0	66,679	412,004	560,265	377,885	197,207	0	-	0	1,614,040
9	Tax Duty	0	0	132,067	811,888	1,098,751	735,953	386,541	0	-	0	3,165,200
10	Maintenance	0	0	0	0	0	0	0	31,700	-	31,700	634,000
11	Operation	0	0	0	0	0	0	0	12,009	-	12,009	240,180
	Total	1,386,758	136,829	1,648,517	10,170,976	13,829,392	9,268,059	4,814,138	43,709	-	43,709	42,128,847

2. Package 4 & 5

(unit: 1,000 JP\)

		2000	2001	2002	2003	2004	2005	2006	2007	-	2026	Total
1	Land Acquisition & Compensation	0	0	0	0	0	0	0	0	-	0	0
2	Pre-Construction Work	3,000	0	0	0	0	0	0	0	-	0	3,000
3	Construction Supervision	0	0	0	0	0	0	0	0	-	0	0
4	Administration	0	0	0	0	0	0	0	0	-	0	0
5	Environmental Monitoring & Countermeasures	2,000	2,000	0	0	0	0	0	0	-	0	4,000
6	Construction Work (Package 4, 5)	68,280	204,839	0	0	0	0	0	0	-	0	273,118
7	Contingency	27,312	0	0	0	0	0	0	0	-	0	27,312
8	Maintenance	0	0	0	0	0	0	0	0	-	0	0
9	Operation	0	0	0	0	0	0	0	0	-	0	0
	Total	100,591	206,839	0	0	0	0	0	0	-	0	307,430

Note: As of 15.Sep.2000

Source: JICA Study Team

(3) Revenue

In the case of same charge level as the Can Tho Ferry, forecast revenues are 1,141 million JPY, 2,071 million JPY and 3,001 million JPY for 2010, 2015, and 2020, respectively. It was estimated that the revenue would increase by 70% when the charge is doubled.

14.2 Financial Analysis

Profitability of the Project highly depends on the construction costs, charges, and funding condition. Therefore, study cases are established by assuming the possible variations of those factors to meet the scope of the financial analysis.

For the financial analysis the following loans were assumed available.

a) long term loan
   - interest rate 1.8% a year
   - grace period 10 years
   - repayment period 30 years

b) short term loan
   - interest rate 8 % a year
   - repayment period 1 year

A long term loan is expected to cover up to 85% of the Project costs in combination with government subsidy or other resources to cover the remaining Project costs. The conditions are same as those of JBIC ODA Loan.

Through the financial analysis, following prospects are acquired.

(1) Viability of the Project under the favorable ODA loaning condition

This is a case of financing the Project by long term loan with limitation of 85% of the Project cost and governmental subsidy. The cash flow analysis proved that the Project is viable in this financial case with the same charge level as Can Tho Ferry. DCF investment pay back period was estimated at 25 years.

In the same financing case with the charge level 1.5 times higher than Can Tho ferry, DCF investment pay back period be came 20 years.

It was proved that DCF investment pay back period would exceed 30 years in the case where the traffic demand is 60% of the forecast one in the F/S under the same financial condition, the combination of long term loan with 1.8% interest rate and subsidy. Furthermore, in this case revenue from toll charge could not cover the interest and repayment of the long term loan at initial stage after the opening, and an additional resource would become necessary after the opening.

(2) Viability of the Project under the financing condition of long and short term loan without subsidy

The financial situation becomes more severe in this case.

The cash flow analysis proved that pay back period would be prolonged over 30 years in the financial case of long term loan (1.8%) with the same charge level as Can Tho Ferry. However, in this case short term loan would be necessary to cover the deficit after opening. The viability of the Project highly depends on he loan condition and traffic demand.

In conclusion financing by the combination of long and short term loans worsen the financial situation and should be avoided.

Sensitivity test to the cost increase (10% and 20%) and revenue decrease (-20%, -30% and -40%) was made for the case of the charge level, 1.5 times higher than existing Can Tho Ferry charge level, with governmental subsidy. The result showed that the DCF investment pay back periods were considerably sensitive to the cost increase and revenue decrease. In the case of 40% decrease of the revenue, the DCF investment pay back period was extended to 23 years.

CHAPTER 15 CONCLUSIONS AND RECOMMENDATIONS

(1) The geomorphology of this region is a vast alluvial marsh and plain. Around two major rivers, the Tien River and the Hau River (divided from the Mekong), numerous tributaries, lakes and/or marshes join, to form a great water network. On the river sides, low and flat land spread extensively.

(2) River sand is found available for road embankment around the Project site. The locations are Hau Giang, Doi Ngai, Tra Ech, Long Xuyen, and Tan Chau.

(3) Rocks and sands are widely used for road construction in Viet Nam. The following locations are used for subbase and base course, namely, Bien Hoa, Vung Tau, Coto, Dong Nai, Long Xuyen and Tan Chau.

(4) The cements available in Viet Nam are Chin Fong, Morning Star, and Nghi Son. Coto granite is fairly good quality for concrete aggregate of which alkali reaction factor is judged to be harmless. Than Chau river sand is good as a fine aggregate for concrete.

(5) For the flood analysis at the Can Tho Bridge site, the Log-normal Distribution Iwai's Method was adopted after comparison with other methods. The high water levels (flood water level) were 177.59 cm for 20-year reoccurrence (5%) and 184.97 cm for 100-year reoccurrence (1%).

(6) The local scouring depths around the tower (South Tower) were 24.48 m in case of pile foundation in consideration that the riverbed around the tower might be degraded 11.50 m from the present riverbed.

(7) Standards and Specifications for the design of the Can Tho Bridge were based mainly on the Vietnamese standards, otherwise AASHTO specifications and Japanese Standards were used from the reasons of reliability and proof check of safety.

(8) Due to the locations of temples and cemeteries, the project centerline was shifted 220 m downward from that of the Feasibility Study.

(9) It was concluded that the typical transverse cross section consist of four-lane carriageways and two non-motorized lanes as trafficable function, which was able to allow approx. 60,000 pcu/day.

(10) On the project route, three interchanges and one intersection were concluded. Those were the connections to NH No. 1, NH No. 54, and NH No. 91B. The types of interchange were selected mainly from the reasons for minimizing the land acquisition and geometrical conditions.

(11) The central span length of 550m for the main bridge was recommended by the Study Team and concluded by the Vietnamese side to clear the navigable width of 300m, to construct the North Pier on the land without hydrodynamic issues, and to construct the South Pier to avoid the high velocity area of the river flow for minimizing local scouring of the riverbed.

(12) The location and the foundation depth of the tower (North Pier) on the left riverbank were decided from the following reasons: to maintain the maneuvering safety for large size vessels and to avoid hydrodynamic problems by locating the tower pier on the land, which is also able to economize construction costs compared with constructing the tower pier in the river.

(13) The possible types of the main bridge to span the length of 550 m are Hybrid Cable-stayed, Steel Cable-stayed and Steel Suspension Bridge. Among these bridge types, Hybrid Cable-stayed type is recommended for mainly economical reasons.

(14) Vertical and torsional responses versus wind speed were tested with the three cases of attack angle (0, +3, -3 degree) and 0.03 of the damping coefficient, in the wind tunnel. Flutter vibrations were not occurred until the wind velocity reached to 100 m/sec, 320 m/sec, and 281 m/sec in the cases of attach angle of 0, +3, -3 degree respectively.

(15) Vortex-induced vibration may occur on the stay cables during rain (rain-induced-wind-vibration). Countermeasure such as damping devices to reduce quite large vibration should be considered.

(16) Opening by the designed bridges and box culverts were examined to avoid the disturbance of the water flow by road embankment. The designed discharge by opening was greater than the required one by 2%. The designed opening by bridges and box culverts was greater than the required one by 51%.

(17) The detailed design of infrastructures and facilities was carried out based mainly on the discussions with People's Committee of Can Tho Province and People's Committee of Vinh Long province, and other related authorities and organizations.

The total areas for Bin Minh Resettlement Area (R.A), Hung Phu R.A and Chau Thanh R.A. are 60,645 m^2, 10,815 m^2 and 21,250 m^2 respectively.

(18) Project Outline

a) Project Length : 15,850 m

b) Bridge Features

- Total Bridge Length	:	2,750 m
- Main Bridge	:	1,090 m
- Vinh Long side approach span bridge	:	480 m
- Can Tho side approach span bridge (Including 180 m of the sub stream bridge)	:	1,180 m
- Bridge Width (4-lane carriageway)	:	23.1 m

c) Approach Roads

i) Road Length

- Total Length	:	13,100 m
- Vinh Long Side	:	5,410 m
- Can Tho Side	:	7,690 m

ii) Service Area

- Vinh Long Side	:	21,000 m^2
- Can Tho Side	:	21,000 m^2

iii) Toll Gate and Management Office : 1 location

(19) The organizations related to budget procedures and allocations for the Can Tho Bridge will be Viet Nam Roads Administration (VRA), Regional Management Unit (RRMU VII), and Inspection and Maintenance Company for Can Tho Bridge will be involved for maintenance actions.

(20) Total estimated environmental cost is US$10,324,773, including US$10,114,773 for land acquisition and mitigation measures for adverse impacts on socio-economic environment, and US$210,000 for environmental monitoring programs.

(21) The Project Cost was estimated including the following items.

- Construction Cost
- Resettlement Area Cost
- Engineering and Administration Cost
- Land Acquisition and Compensation Cost
- Environmental Monitoring
- Physical Contingency
- Price Escalation
- Duty Tax
- UXO Cost
- Interest during Construction
- O&M Cost

(22) The appropriate size of contract of the Project was recommended for the implementation under the JBIC Guideline. It is recommended that the main route should be three packages, namely, Package-I covering the Approach Road of Vinh Long side, Package-II covering Main Bridge across the Hau River, and Package-III covering the Approach Road of Can Tho side, as international tenders, with considering the following matters.

- Concentration of the management for the whole project at one head office
- Minimizing the number of construction yards and offices
- Minimizing the organization and staff to be required
- Unified control for the construction quality and progress
- Maintaining the effective communication system

(23) The implementation of the Project will be scheduled tentatively as below:

- The Detailed Design will be accomplished by October 2000
- Land acquisition including resettlement for people to be removed should be started from April 2000.
- Selection of Consultant will be from January 2001 to June 2001
- Pre-qualification will be from July 2001 to September 2001
- Tendering is from October 2001 to June 2002
- Commencement of Construction will be June 2002

(24) The financial analysis proved that the Project is feasible under the long term loan and governmental subsidy. It was assumed that the long term loan covers 85% of the project costs of packages 1,2, and 3 with an interest rate of 1.8% per annum and 30 year repayment period including 10 year grace period. The subsidy was assumed to apply to the costs of package 4 and 5 and the remnant costs of packages 1,2, and 3. The calculated pay back periods are as following.

- 20 years (1.5 times higher charge level than Can Tho Ferry)
- 23 years (60% of the forecast traffic volume, 1.5 times higher charge level than Can Tho Ferry)

(25) At the end of the Detailed Design Stage (September and October 2000), a flood occurred at the Mekong Delta, and large areas including the Project site were affected. The review of this flood data at the beginning of the next stage is strongly suggested. Moreover, if necessary, the design works will be amended after considering this flood data before the pre-construction procedures.

(26) After the construction is completed, one large pylon is established permanently near the navigational route. Securing of the navigation is necessary to be considered and noticed, not only during construction, but also in the operation stage.

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