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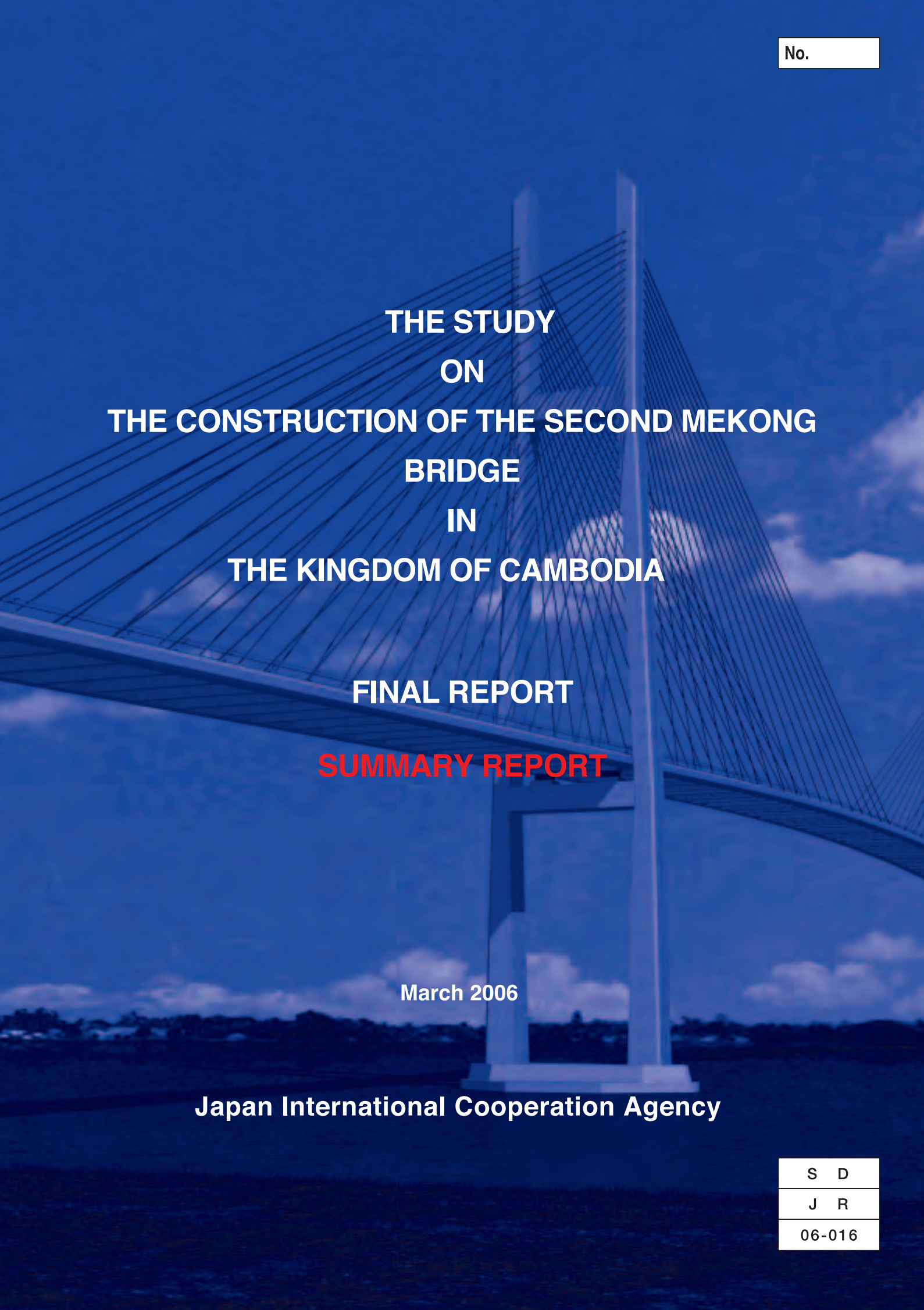

THE STUDY
ON
THE CONSTRUCTION OF THE SECOND MEKONG BRIDGE
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT

SUMMARY REPORT

March 2006

Japan International Cooperation Agency

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Exchange rates applied in this Study are:

US$1 = 4,067 Riel
US$1 = 108.03 Yen
(as of September 2005)

PREFACE

In response to the request from the Royal Government of Cambodia, the Government of Japan decided to conduct the Study on the Construction of the Second Mekong Bridge in the Kingdom of Cambodia and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched the Study Team which consists of Pacific Consultants International and Chodai Co, Ltd. to the Kingdom of Cambodia between April 2004 and February 2006. The Study Team is headed by Mr. Isamu Gunji of Pacific Consultants International. In addition, JICA set up an Advisory Committee headed by Professor Akira Kaneko of Toyo University between April 2004 and February 2006, which examined the Study from the specialist and technical point of view.

The Study Team held discussions with the officials concerned of the Royal Government of Cambodia and conducted field surveys at the study area. Upon returning to Japan, the Study Team conducted further studies and prepared this final report.

It is my hope that this report will contribute to development in the Kingdom of Cambodia, and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to all the officials concerned of the Royal Government of Cambodia for their generous cooperation to the Study Team.

March 2006

Kazuhisa Matsuoka
Vice-President
Japan International Cooperation Agency

March 2006

Mr. Kazuhisa Matsuoka
Vice-President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit herewith the Final Report of "the Study on the Construction of the Second Mekong Bridge in the Kingdom of Cambodia".

The Study was undertaken in the Kingdom of Cambodia from April 2004 through February 2006 by the Study Team organized by Pacific Consultants International and Chodai Co, Ltd. under the contract with JICA.

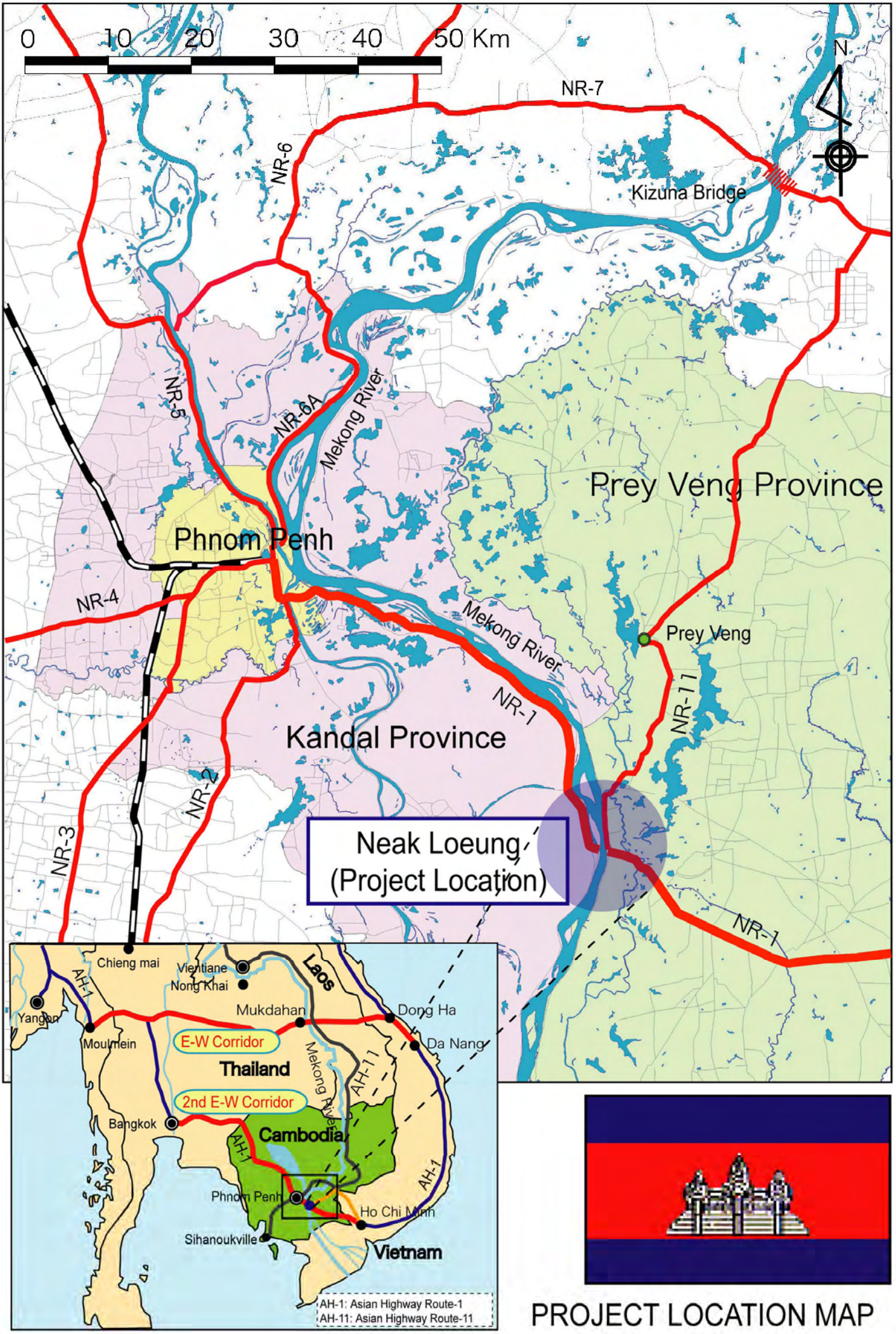
This report consists of four volumes: Summary, Main Report, Appendix and Drawings. It explores both the master plan and feasibility study of the Second Mekong Bridge from socio-economic, engineering and environmental viewpoints, fully applying the JICA New Guideline for Environmental and Social Consideration.

We would like to express our sincere gratitude and appreciation to all the officials of your agency and the JICA Advisory Committee, the Ministry of Foreign Affairs, the Embassy of Japan in Cambodia, the Ministry of Public Works and Transport as the counterpart agency, and to counterpart personnel.

We hope that the report will be able to contribute significantly to development in the Kingdom of Cambodia.

Very truly yours,

Isamu Gunji
Team Leader
The Study on the Construction of the Second Mekong Bridge in the Kingdom of Cambodia



PROJECT LOCATION MAP

FINAL REPORT

SUMMARY REPORT

TABLE OF CONTENTS

SEPARATE VOLUMES

MAIN TEXT
APPENDIX
DRAWINGS

List of Figures

List of Tables

Abbreviations

AADT	-	Annual Average Daily Traffic
AASHTO	-	American Association of State Highway and Transportation Officials
AC	-	Alluvial Clay
AC	-	Asphalt Concrete
ADB	-	Asian Development Bank
ADHOC	-	Cambodian Human Rights and Development Association
AG	-	Alluvial Gravel
AH	-	Asian Highway
AHC	-	Alluvial Hard Clay
AHP	-	Analytic Hierarchy Process
AIPC	-	Statuts de l'Association Internationale des Ponts et Charpentes
AO	-	Organic Clay
AP	-	Appendix
AS	-	Alluvial Sand
ASEAN	-	Association of South East Asian Nations
ASTM	-	American Society for Testing and Material
B/D	-	Basic Design
BKK	-	Bangkok
BOD	-	Biochemical (Biological) Oxygen Demand
BS	-	Banking Soil
BST	-	Bituminous Surface Treatment
C	-	Cohesion
C/S or CS	-	Commune/Sangkat
CBR	-	California Bearing Ratio
Cc	-	Compression Index
CCC	-	Cambodia Cooperation Committee
CDC	-	Cambodia Development Council
CDP	-	Cambodia Development Plan
CH	-	Predominary clay, High plasticity (Soil Classification ASTM D2487)
CITES	-	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	-	Predominary clay, Low plasticity (Soil Classification ASTM D2487)
CNMC	-	Cambodia National Mekong Committee
CO	-	Carbon Monoxide
CO2	-	Carbon Dioxide
COD	-	Chemical Oxygen Demand

COI	-	Corridor of Impact
CPCP	-	Cast-in-Place Concrete Pile
CRE	-	Chief Resident Engineer
CSF	-	Commune/Sangkat Fund
CUP	-	Condom Use Program
Cv	-	Coefficient of Consolidation
D/S	-	Downstream
dBA	-	decibel
DBST	-	Double Bituminous Surface Treatment
DC	-	Diluvial Clay
DFW	-	Department of Forestry and Wildlife
DG	-	Diluvial Gravel
DHI	-	Danish Hydraulic Institute
DI	-	Department of Inspections
DMS	-	Detailed Measurement Survey
DoHR	-	Department of Hydrology and River Works
DPWT	-	Department of Public Works and Transport
DS	-	Diluvial Sand
DWT	-	Dead Weight Tone
EIA	-	Environmental Impact Assessment
EL	-	Elevation
EM	-	Environmental Monitor
EMP	-	Environmental Management Plan
EU	-	European Union
FCMRP	-	Forest Crimes Monitoring and Reporting Project
FCMU	-	Forest Crime Monitoring and Reporting Unit
FHWA	-	Federal Highway Administration
FRMR	-	Fund for Road Maintenance and Repair
GC	-	Grievance Committee
GDP	-	Gross Domestic Product
GM	-	Predominantly gravel, Silty (Soil Classification ASTM D2487)
GMS	-	Greater Mekong Sub-region
GPS	-	Global Positioning System
GRS	-	Geodesic Referecy System
GW	-	Groundwater
HCMC	-	Ho Chi Minh City
HDPE	-	High Density Polyethylene
HV	-	Heavy Vehicle

HWL	-	High Water Level
IABSE	-	International Association for Bridge and Structural Engineering
IBA	-	Important Bird Area
IEE	-	Initial Environmental Examination
IMF	-	International Monetary Fund
Ip	-	Plastic Index
IRC	-	Inter-ministerial Resettlement Committee
IUCN	-	International Union for the Conservation and Nature Resources
IVBH	-	Statuten der Internationalen Vereinigung für Brückenbau und Hochbau
JICA	-	Japan International Cooperation Agency
JRO	-	Japan Road Association
Lao PDR	-	Lao People's Democratic Republic
LEPNRM	-	Law on Environmental Protection and Natural Resources Management
LL	-	Liquid limit
LMB	-	Lower Mekong Bassin
LRFD	-	Load and Resistance Factor Design
LV	-	Light Vehicle
LWL	-	Low Water Level
MAFF	-	Ministry of Agriculture, Forestry and Fishery
MC	-	Motorcycle
MEF	-	Ministry of Economic and Finance
ML	-	Predominary silt, Low plasticity (Soil Classification ASTM D2487)
MOE	-	Ministry of Environment
MOH	-	Ministry of Health
MOWRM	-	Ministry of Water Resource and Metrology
MPWT	-	Ministry of Public Work and Transport
MRC	-	Mekong River Commission
MS	-	Multi Strand
MSL	-	Mean Sea Level
mv	-	Coefficient of Volume
NGO	-	Non-governmental Organization
NIS	-	National Institute of Statistics
NL	-	Neak Loeung
NO2	-	Nitrogen Dioxide
NPRD	-	National Program to Rehabilitate and Develop Cambodia
NPRS	-	National Poverty Reduction Strategy
NR	-	National Road
NRP	-	National Resettlement Policy

OD	-	Origin and Destination
OH	-	Organic, High plasticity (Soil Classification ASTM D2487)
OL	-	Organic , Low plasticity (Soil Classification ASTM D2487)
ORRSJ	-	Ordinance for River Related Structures of Japan
PAHs	-	Project Affected Households
PAIs	-	Project Affected Individuals
PAPs	-	Project Affected Persons
PC	-	Pre-stressed Concrete
PCUs	-	Passenger Car Units
PL	-	Plastic Limit
PM	-	Project Manager
PMU	-	Project Management Unit
PO	-	Project Owner
PUA	-	Provincial Urban Authority
PUED	-	Provincial Urban Environmental Department
PWS	-	Parallel Wired Strand
qu	-	Unconfined Compressive Strength
RAN	-	Resettlement Action Network
RAP	-	Resettlement Action Plan
RCC	-	Road Construction Center
RE	-	Resident Engineer
REO	-	Resident Engineer's Organization
RGC	-	Royal Government of Cambodia
ROW	-	Right of Way
S/W	-	Scope of Work
SEA	-	Strategic Environmental Assessment
SEDP	-	Socio-Economic Development Plan
SGS	-	Socite Generale de Surveillance
SHM	-	Stakeholder Meeting
SM	-	Predominantly sand, Silty (Soil Classification ASTM D2487)
SO2	-	Sulfur Dioxide
SPP	-	Steel-Pipe-Pile
Sta.	-	Station
TEU	-	Twenty-feet Equivalent Unit
TOR	-	Terms of Reference
TSP	-	Total Suspended Particles
TSS	-	Total Suspended Sediment
TWSC	-	Tow-Way Stop-Controlled

U/S	-	Upstream
UNDP	-	United Nations Development Program
USBR	-	Bureau of Reclamation in United States
UTM	-	Universal Transverse Mercator
UXOs	-	Unexploded Ordnances
VDCs	-	Village Department Committee
WGS	-	World Geodesic System
WTO	-	World Trade Organization

SUMMARY REPORT

1. INTRODUCTION

1.1 Background of the Study

National Road No. 1 is currently being improved under the support by ADB (between Neak Loeung and the Vietnam border) and by Japanese Grant Aid (between Neak Loeung and Phnom Penh). The crossing point of the Mekong River at Neak Loeung has become a bottleneck to the transportation of both goods and people, and consequently it hinders the development of Cambodia and neighboring countries (refer to Figure 1.1.1). The Project is, accordingly, expected to accelerate the mobility of goods and passengers and generate substantial benefits to the region and Cambodia.

Figure 1.1.1 Asian Highway Network in Indochina Region

1.2 Study Objectives

The ultimate aim of the Project is to enhance the economic development at local, regional and national levels by improving a road network in Cambodia. In order to achieve this aim, the objectives of the Study are threefold: 1) to formulate a regional development plan of Neak Loeung Area to fully realize regional potentials, 2) to examine feasibility of the Second Mekong Bridge, and 3) to realize capacity building through technical transfer to Cambodian counterparts and other relevant personnel.

2. CURRENT SOCIAL, ECONOMIC AND NATURAL CONDITIONS

2.1 Current Social and Economic Conditions

(1) Greater Mekong Sub-region and Cambodia

The GMS comprises five countries (Cambodia, Laos, Myanmar, Thailand, Vietnam) and one province (Yunnan, China) and covers the area of 2.34 million sq.km with its population of 257.5 million in 2002 (see Table 2.1.1). The nominal GDP of the sub-region in 2002 is estimated at about $200 billion. The average GDP per capita, measured in purchasing power parity (PPP) terms, is $3,288 in 2002 (see Table 2.1.2 and Table 2.1.3).

The population in Cambodia is 13.5 million and it accounts for about 5.2 % of the total GMS population in 2002. Cambodia's GDP per capita is $1,649 (PPP) in 2002 and its growth ranges between 4% and 7% during 1992/2002, though 10.8% is recorded in 1999. Compared to other GMS countries, Cambodia's GDP per capita is almost the same as Laos and Myanmar. Thai GDP per capita is about four times Cambodia's, and Yunnan Province and Vietnam follow after Thailand.

Table 2.1.1 1992-2002 Population

(Unit: Million Persons)

Country/Province	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cambodia	9.0	9.5	10.0	10.5	11.0	11.6	12.2	12.5	12.8	13.2	13.5
Laos	4.4	4.5	4.6	4.6	4.7	4.8	5.0	5.1	5.2	5.4	5.5
Myanmar	42.3	43.1	43.9	44.7	45.6	46.4	48.2	49.1	50.1	51.1	52.2
Thailand	57.3	58.0	58.7	59.4	60.0	60.6	61.2	61.8	62.4	62.9	63.4
Vietnam	68.5	69.7	70.8	72.0	73.2	74.3	75.5	76.6	77.6	78.7	79.7
Yunnan Province, China	38.3	38.9	39.4	39.9	40.4	40.9	41.4	41.9	42.9	42.9	43.1
TOTAL	219.8	223.6	227.4	231.1	234.9	238.7	243.4	247.1	251.1	254.1	257.5

Source: Asian Development Bank. 2003. Key Indicators. Manila: ADB; and National Bureau of Statistics of China. 2003. China Statistical Yearbook.

Table 2.1.2 1992-2002 GDP Growth Rate

(Unit: % p.a.)

Country/Province	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cambodia	7.0	4.1	4.0	6.9	4.6	6.8	3.7	10.8	7.0	5.7	5.5
Laos	7.0	5.9	8.1	7.0	7.0	6.9	4.0	7.3	5.8	5.8	5.9
Myanmar	9.7	6.0	7.5	6.9	6.4	5.7	5.8	10.9	13.7	13.0	9.7
Thailand	8.1	8.3	9.0	9.2	5.9	-1.4	-10.5	4.4	4.6	1.9	5.2
Vietnam	8.7	8.1	8.8	9.5	9.3	8.2	5.8	4.8	6.8	6.9	7.0
Yunnan Province, China	10.9	10.6	11.6	11.2	10.4	9.4	8.0	7.2	7.1	6.5	n.a.
Average [a]	8.6	8.2	9.0	9.2	7.0	2.5	-2.7	5.6	6.3	4.8	6.2[b]

Note : [a] Weighted average based on purchasing power parity gross national income shares.
[b] Weighted average does not include Yunnan Province in 2002.

Source: Asian Development Bank. 2003. Key Indicators. Manila: ADB; and National Bureau of Statistics of China. 2003. China Statistical Yearbook.

Table 2.1.3 1992-2002 GDP per Capita

(Unit: PPP: purchasing power parity US$)

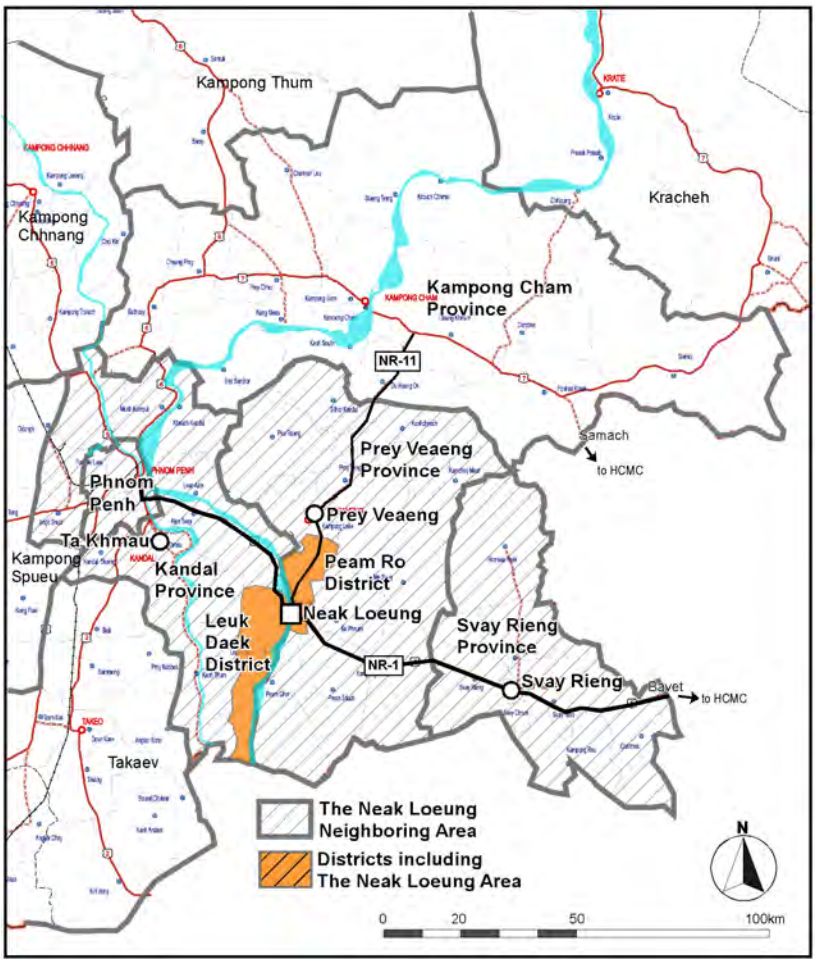
Country/Province	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cambodia	1,100	1,129	1,163	1,260	1,328	1,313	1,361	1,486	1,498	1,591	1,649
Laos	971	1,020	1,097	1,185	1,248	1,328	1,344	1,428	1,534	1,641	1,678
Myanmar [a]	853	888	937	983	1,027	1,066	1,087	1,181	1,316	1,458	1,568
Thailand	4,530	4,898	5,395	6,054	6,477	6,352	5,652	5,943	6,316	6,452	6,788
Vietnam	1,141	1,235	1,326	1,451	1,582	1,684	1,744	1,834	1,997	2,103	2,240
Yunnan Province, China	1,218	1,347	1,410	1,597	1,856	2,002	2,204	2,355	2,479	2,662	2,881
Average [b]	1,977	2,129	2,304	2,555	2,554	2,778	2,647	2,795	2,982	3,108	3,288

Note : [a] Calculated by applying the growth rate of real GDP per capita.
[b] Weighted by population

Source: World Bank. 2003. World Development Indicators; Asian Development Bank. 2003. Key Indicators. Manila: ADB; and National Bureau of Statistics of China. 2003. China Statistical Yearbook.

(2) Neak Loeung and Neighboring Area

Neak Loeung and its neighboring area as shown in Figure 2.1.1 is defined in this Study to include four provinces: namely, Phnom Penh, Kandal, Prey Veaeng and Svay Rieng. Neak Loeung itself is defined to consist of two districts: Leuk Daek in Kandal province and Peam Ro in Prey Veaeng province.



Source: Prepared by JICA Study Team

Figure 2.1.1 Location of Neak Loeung and Neighboring Area

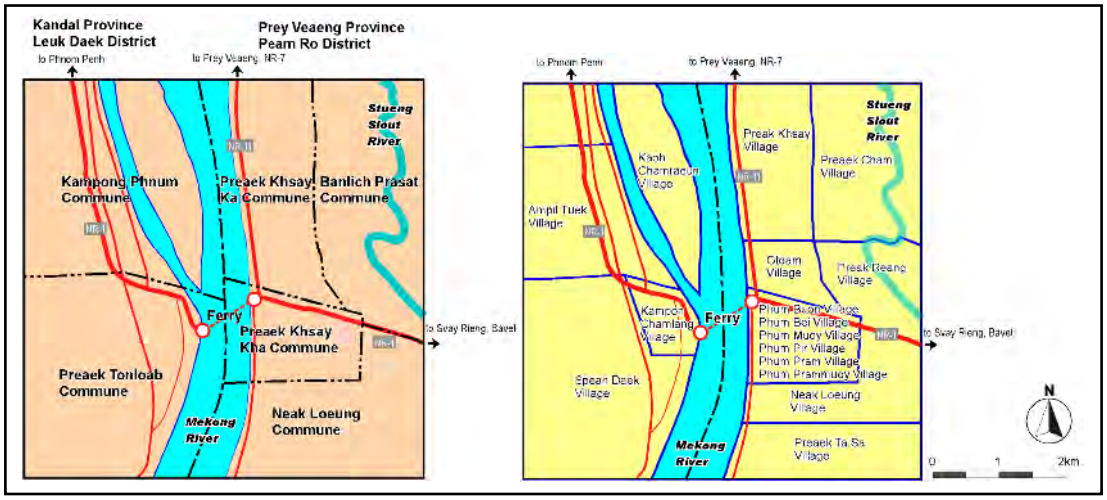
Neak Loeung and its neighboring area have population of 3.75 million, which accounts for 30% of the country. This area covers 11,707 km^2, which accounts for only 6.5% of the country's area. Population growth of Prey Veaeng and that of Svay Rieng has slightly higher annual rates of around 2% than the national average of 1.8% as shown in Table 2.1.4.

Table 2.1.4 Population Density in Neak Loeung Neighboring Area

	Land area[1] (km^2)	Population[1] 1998 (Thousands)	Population[2] 2003 (Thousands)	Density 2003 (person/ km^2)	Annual Growth ('98-'03)
Phnom Penh	267	1,000	1,007	3,771	0.1%
Kandal	3,591	1,075	1,161	323	1.6%
Prey Veaeng	4,883	946	1,051	215	2.1%
Svay Rieng	2,966	478	527	178	2.0%
Neighboring area	11,707	3,499	3,746	320	1.4%
(%)	(6.5%)	(30.6%)	(30.0%)		
Cambodia total	181,035[1]	11,438	12,503	63	1.8%

Source: [1] Population Census 1998,
[2] Ministry of Planning prepared by JICA Study Team

Neak Loeung covers 6 communes and 16 villages as shown in Figure 2.1.2. The current number of households in Neak Loeung is around 7,500 and that of population is 39,000. The land of Preaek Khsay Kha commune is mostly built up but population has decreased (-2.8% per annum). Meanwhile, the areas where population increases include Kampong Phnom (Westside) and Neak Loeung (Eastside) communes.

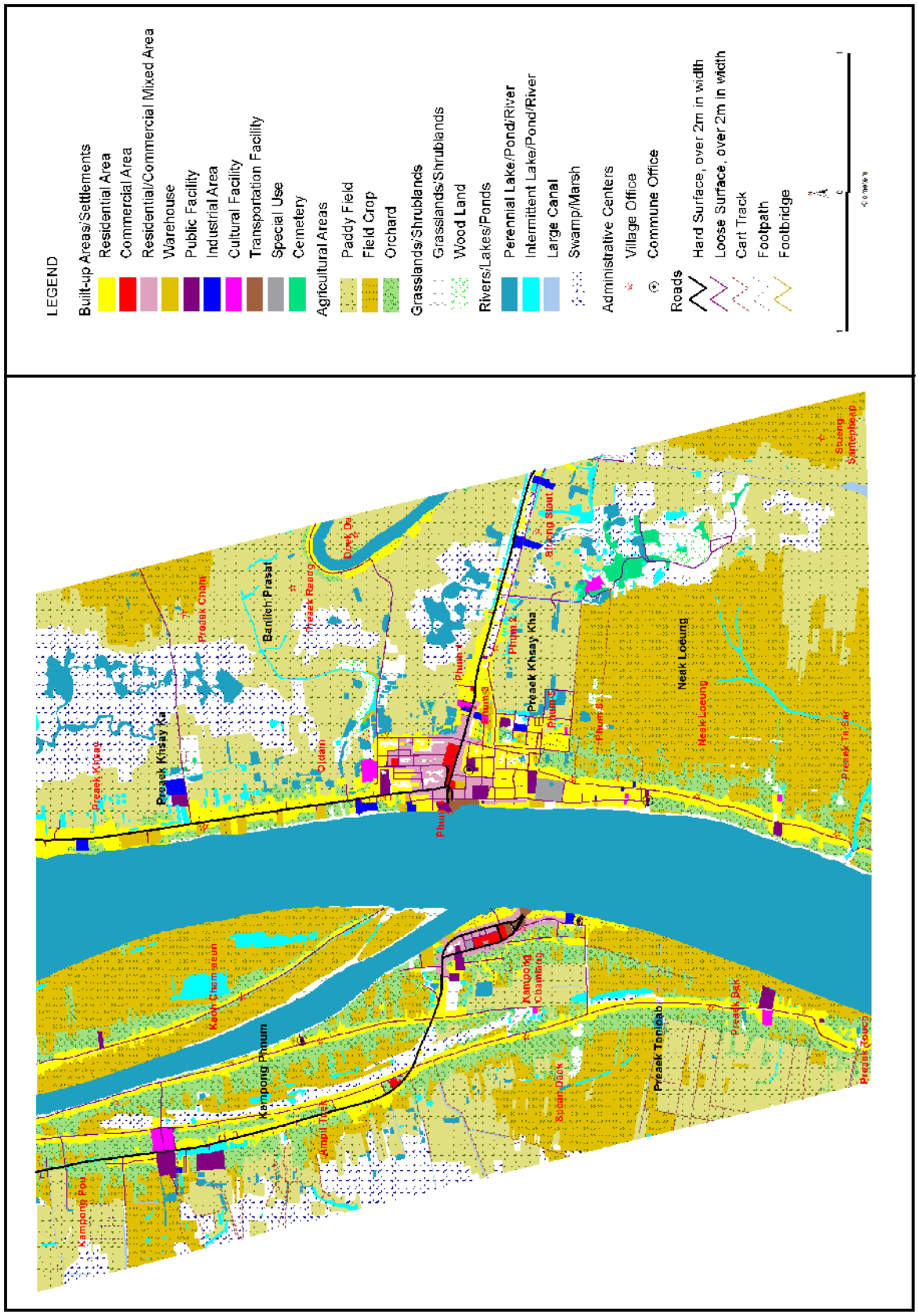


Source: Prepared by JICA Study Team

Figure 2.1.2 Communes and Villages in Neak Loeung

The major land use in Neak Loeung is agriculture; Half of land is used for agriculture including the paddy field, field cropland and orchard. Built-up area, which is mostly residential and commercial complexes, has only 10% of the total area. Other land uses are grassland/shrub land and water related lands, rivers and canals

[1] Including 3,000 km^2 of Tonlesap area, Statistical Yearbook 2003



Source: Land use survey by JICA Study Team

Figure 2.1.3 Land Use in Neak Loeung

2.2 Physical Conditions and Engineering Survey

(1) Topography of the Study Area

General Features of the Study Area

The valley between Kratie and the mouth of the Mekong River, with a length of about 520 km, is called the Lower Mekong Basin or the Mekong Delta. Phnom Penh and its surroundings, located at some 300 km from the mouth of the Mekong River, is the area called the Four Faces where the Mekong River meets the Tonle Sap River and separates to the Tonle Bassak River. In the rainy season, the water level of the Mekong River rises to approximately 10 m in height. As a result, the water of the Mekong River pours into the Tonle Sap Lake through the Tonle Sap River. In the dry season, the water of the Tonle Sap Lake drains into the Mekong River through the Tonle Sap River. The floodwater, accordingly, shows complex movements in Phnom Penh and its surrounding area.

Along the channels of the Mekong River and the Tonle Bassak River, natural levees are distributed on both banks of those rivers. These natural levees, of which the height ranges from 6 to 8 m above sea level, are not flooded during the rainy season. A vast buck marsh, at its height of 2 to 4 m, expands east and west outside of the natural levees. And in these buck marshes, there are various permanent lakes along the old river channels. In parallel with the buck marshes, there are wide flood plains at a height of 4 to 6m. Most of plains are flooded in the rainy season and are not flooded in the dry season.

Lands near study area are dominantly use for agriculture and residential area expand along the national road No.1 and No.11. Elevation of the national road No.1 is around 8.5 m above MSL on the west bank and approximately 8.8 m above MSL on the east bank. Elevation of residential area where reclaimed from flood field is 6 to7 m approximately.

Topographic Survey

The topographic survey was carried out in two survey stages comprised of five work items. The survey quantity and the scale of drawings being produced for each work item are shown in Table 2.2.1.

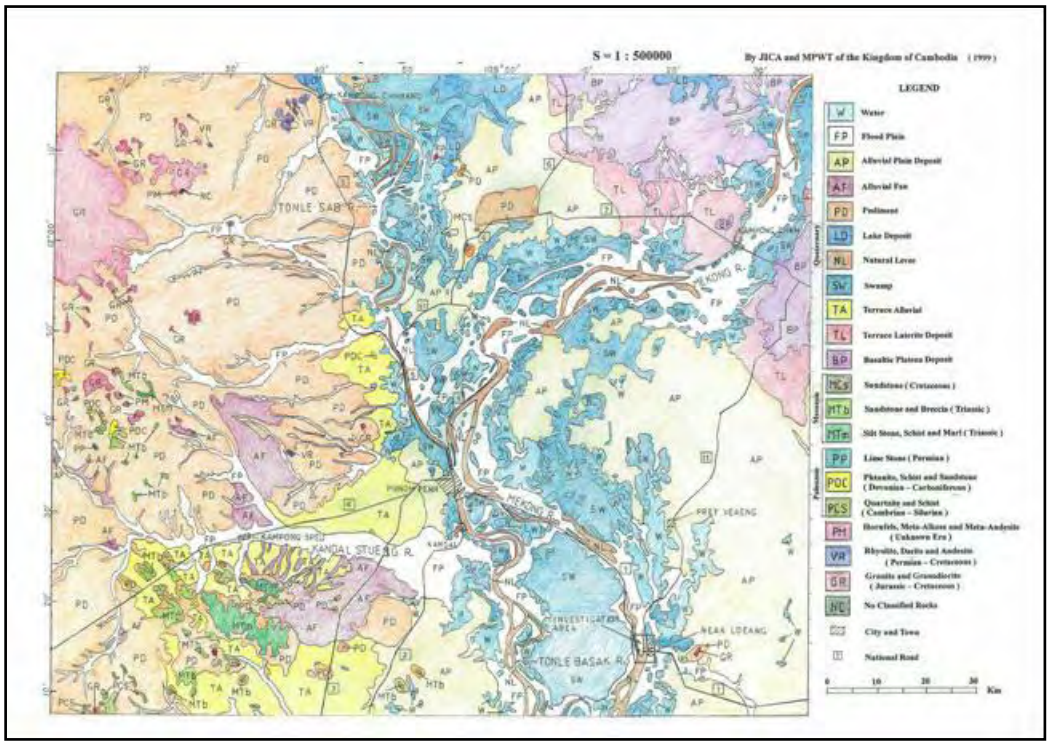
Table 2.2.1 Survey Quantity and Scale of Drawings

Work Items		Survey Quantity	Scale of Drawings
Topographic Survey			
	Centerline Survey	5.529 km	Included in Plan Survey
	Profile Survey	5.529 km	Horizontal; 1/2000, Vertical; 1/200
	Cross Section Survey	10.7 km	1/200
	Plan Survey	0.823 sq.km	1/2,000
Bathymetric Survey			
	River Cross Section Survey	11 cross sections	1/200

(2) Soil and Geotechnical Conditions

Geomorphological and Geological Conditions

Geomorphological and geological map of Phnom Penh is illustrated in Figure 2.2.1.



Source: MPWT

Figure 2.2.1 Geomorphological and Geological Map of Phnom Penh

In the study areas, alluvial and diluvial deposits of the Quaternary are widely distributed. The Quaternary deposits consist of unconsolidated sandy soil and clayey soil and are founded on natural levees, flood plains and marsh areas. Thickness of Quaternary deposit in down stream of Lower Mekong Basin of Mekong Delta is estimated about 200 meters. According to soil investigation in Phnom Penh City, the thicknesses of alluvial and diluvial deposit are from 40to 50 meters and from 150 to 160 meters respectively.

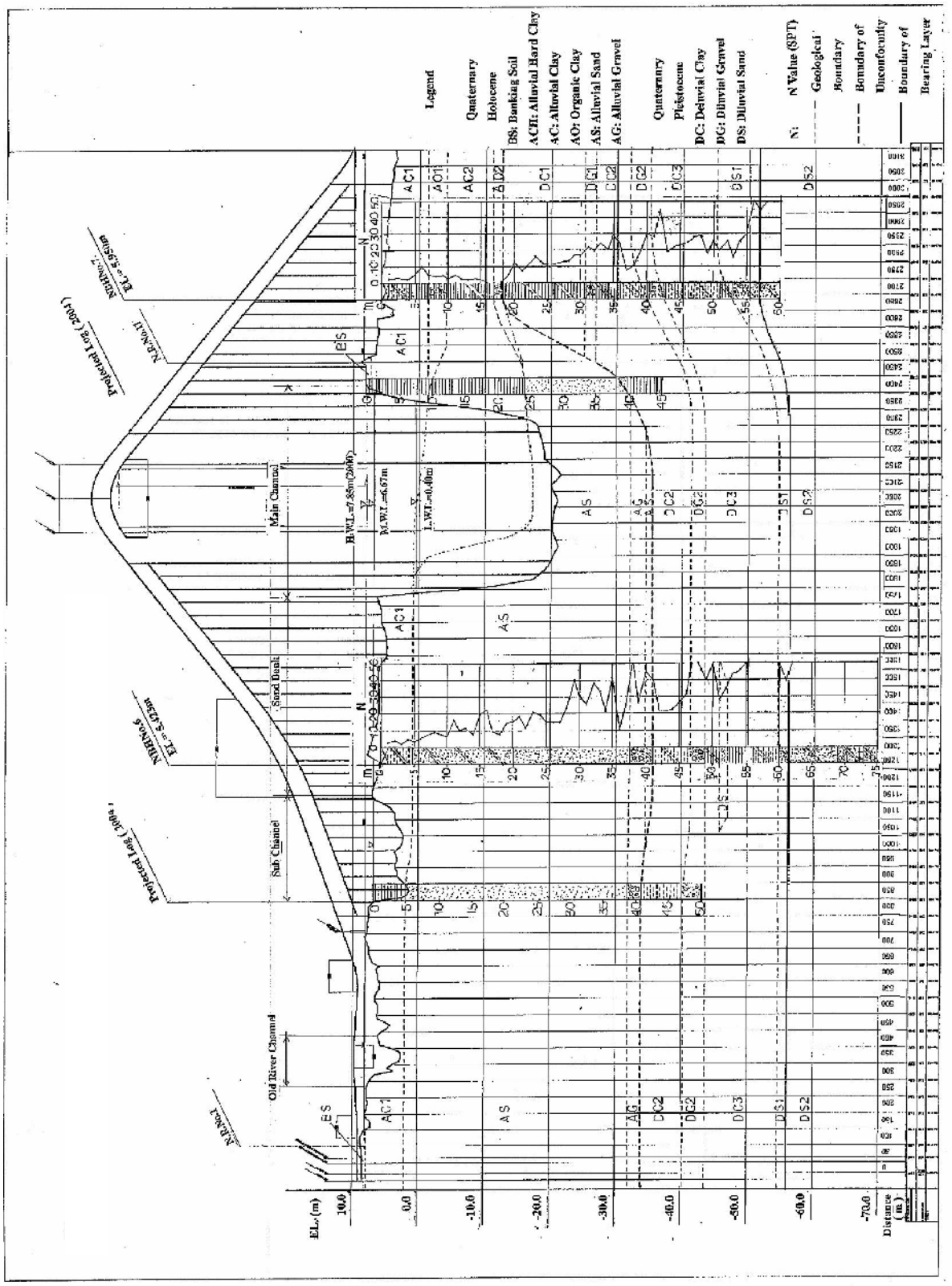
Geological Survey

Geological Survey including soil boring and laboratory test were carried out in the study area. Survey item and quantity of soil boring are shown in Table 2.2.2.

Table 2.2.2 Summary of Drilling Work

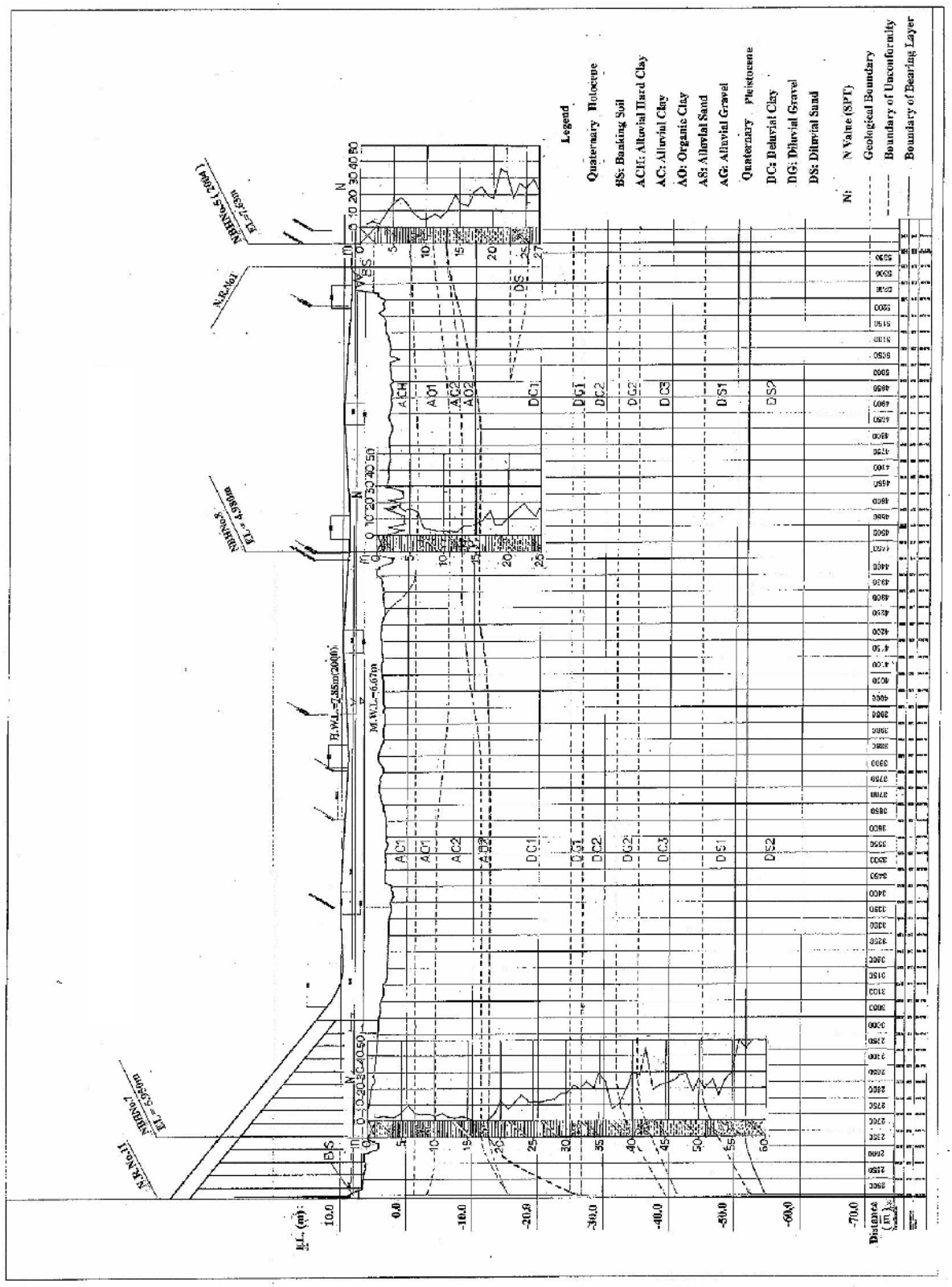
Item	First Stage (2004)	Second Stage (2005)	Total
Number of boreholes (location)	5	3	8
Total of drilling length (m)	212	160	372
Standard Penetration Test (time)	212	160	372
Un-disturbed sample (sample)	10	4	14

Geological profile along the optimum route is described in Figure 2.2.2.



Source: JICA Study Team

Figure 2.2.2 (1) Geological Profile along the Optimum Route



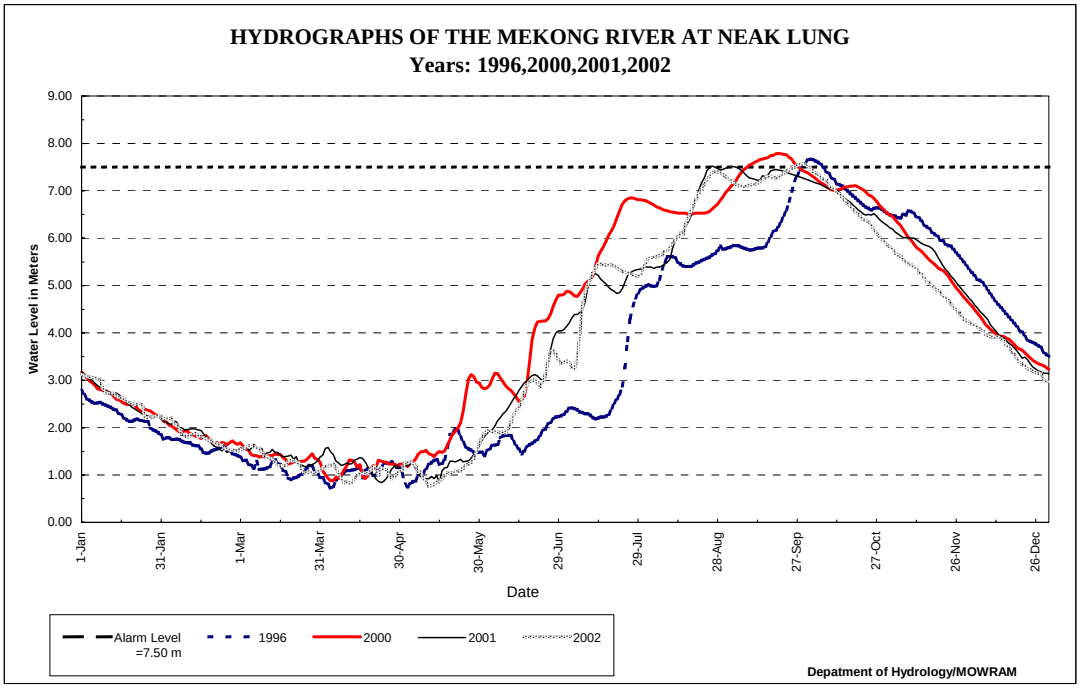
Source: JICA Study Team

Figure 2.2.2 (2) Geological Profile along the Optimum Route

(3) Hydraulic Conditions

Monthly Variation of Water Level

At Neak Loeung Station, range of the highest water level is 6m to 8m above the MSL. The high water level more than 7 m continues for about two months from middle of August to middle of October, while the lowest water level less than 1m over the MSL continues for three months from March to May. The Hydrograph of Mekong River at Neak Loeung from 1996 to 2006 is shown in Figure 2.2.3.

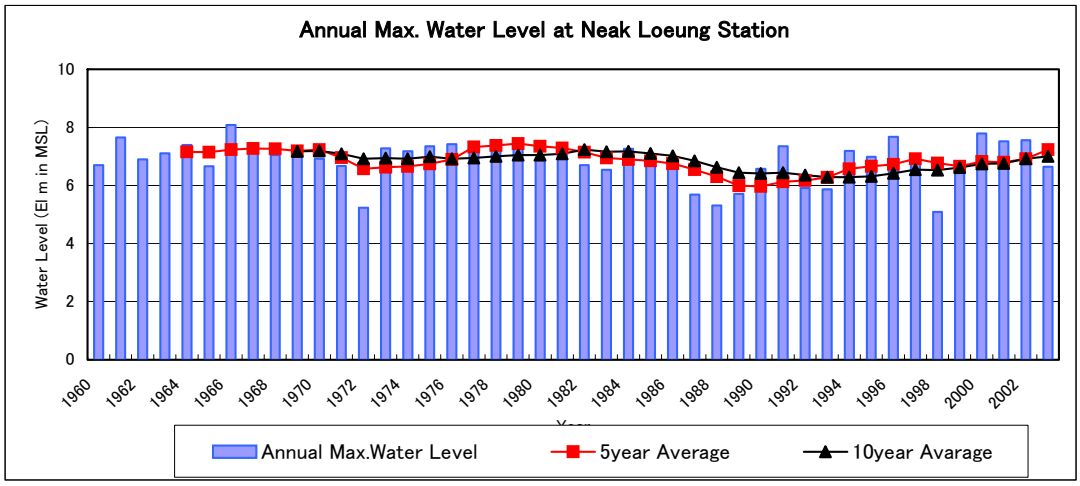


Source: Department of Hydrology, MOWRAM

Figure 2.2.3 Hydrographs of Mekong River at Neak Loeung (1996 to 2003)

Long Term Tendency of Water Level

Based on the annual maximum water level data at Neak Loeung Gauge Station from 1960 to 2003, the historical annual maximum water levels in these 43 years are plotted as shown in Figure 2.2.4.

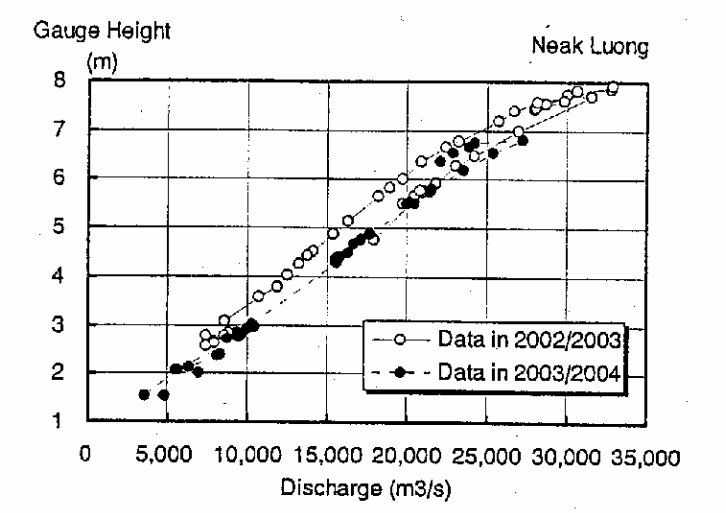


Source: Prepared by JICA Study Team

Figure 2.2.4 Annual Maximum Water Level at Neak Loeung (1960 to 2001)

Discharge

Discharges at Neak Loeung gauge station are shown Figure 2.2.5. Maximum discharge at the flood time is 33,000m^3/sec with about 8m above the MSL and minimum discharge in the dry season is 3000m^3/sec.

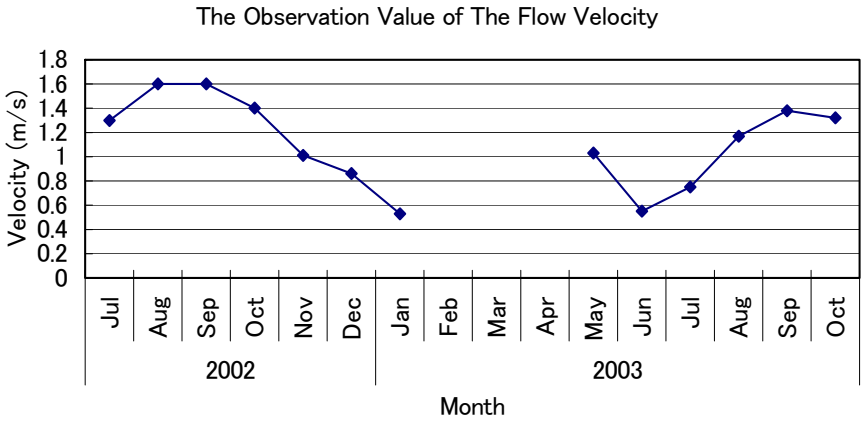


Source: The Study on Hydro-meteorological Monitoring for Water Quantity Rules in Mekong River Basin

Figure 2.2.5 Discharge at Neak Loeung Station

Flow Velocity

Average flow velocity in Mekong River is shown in Figure 2.2.6. Maximum flow velocity at the flood time is 1.6m/sec and minimum flow velocity is 0.5m/sec.



Source: The Study on Hydro-meteorological Monitoring for Water Quantity Rules in Mekong River Basin

Figure 2.2.6 Flow Velocity at Neak Loeung Station

3. TRAFFIC DEMAND ANALYSIS

3.1 Current Ferry Traffic at Neak Loeung

(1) Current Vehicle Traffic on Ferry

Average daily ferry traffic, obtained by the traffic survey, at Neak Loeung is shown in Table 3.1.1.

Table 3.1.1 16-hour Traffic Volume on Ferry

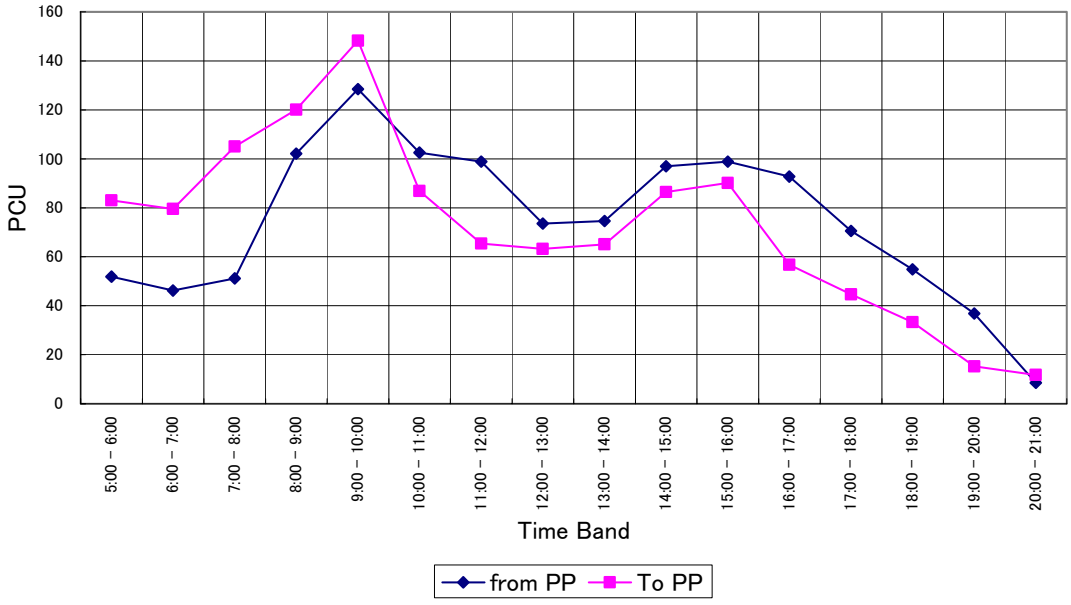
(Unit: Number/16 hours)

Direction	Classification	MC	LV	HV	Total	Total	Pedal Cycle	Pede-strian
		(Vehicles)				(PCU)	(Veh.)	(Persons)
	PCU Conv. Rate	0.128	1.165	2.241	-	-	-	-
From Phnom Penh	Weekday	841	399	280	1520	1,201	295	3,749
To Phnom Penh		822	405	267	1494	1,175	285	2,234
From Phnom Penh	Non weekday	927	380	278	1585	1,184	290	4,136
To Phnom Penh		879	481	263	1623	1,263	303	2,225
Both Directions	Weekday	1,663	804	547	3,014	2,376	580	5,983
	Non weekday	1,806	861	541	3,208	2,447	593	6,361

Source : Traffic survey by JICA Study Team in 2004

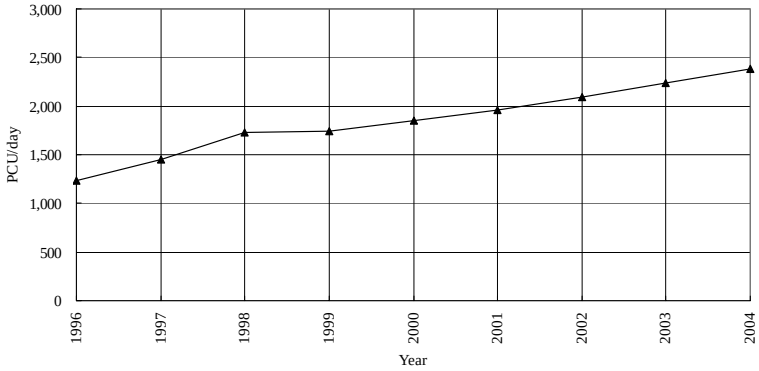
Note : MC : Motorbike, Motor Tricycle / Motorbike Trailer,
LV : Sedan, Wagon, Light Van / Pickup, Jeep Light Truck,
HV : Short & Long Body Bus / Short & Long Body Truck / Semi and Full Trailer Truck,
PCU: Passenger car unit

Figure 3.1.1 shows the hourly fluctuation of vehicle traffic on board on average weekday and the Figure 3.1.2 shows the historical annual growth in average daily traffic volume on board.



Source: Traffic Survey by JICA Study Team

Figure 3.1.1 Hourly Traffic (Average Weekday)



Source: MPWT

Figure 3.1.2 Average Daily Traffic (Annual Growth)

(2) Ferry Capacity

Operation time varies from dry to rainy season due to the height of water level of the Mekong River. Based on the observation survey, the average operation time was obtained as shown in Table 3.1.2.

Table 3.1.2 Operation Time of Ferry to Cross the Mekong River

(Unit: Minutes)

Season	Operation Time	
	(One way)	(Round trip)
Rainy	14	28
Dry	10	20
Annual Average	12	24

Note: Including embarkation and disembarkation time

The full daily capacity in PCU for both directions by three ferryboats is calculated as follows:

15.5 hours x 60minutes / 8 minutes x 24 PCU x 2 (directions) = 5,580 PCU

This capacity indicates a possible full capacity in one day but it does not indicate the practical one to discuss a facility limitation. In other words, such a level of service as a congestion ratio/waiting time needs to define the upper limit of ferry capacity for planning purpose. In this study, it is assumed that the average waiting time of 36 minutes should be the maximum in all the day, which corresponds to 81.5% occupancy on average of the ferry capacity and results in the planning capacity of 4,548 PCU of the current three-ferry operation per day.

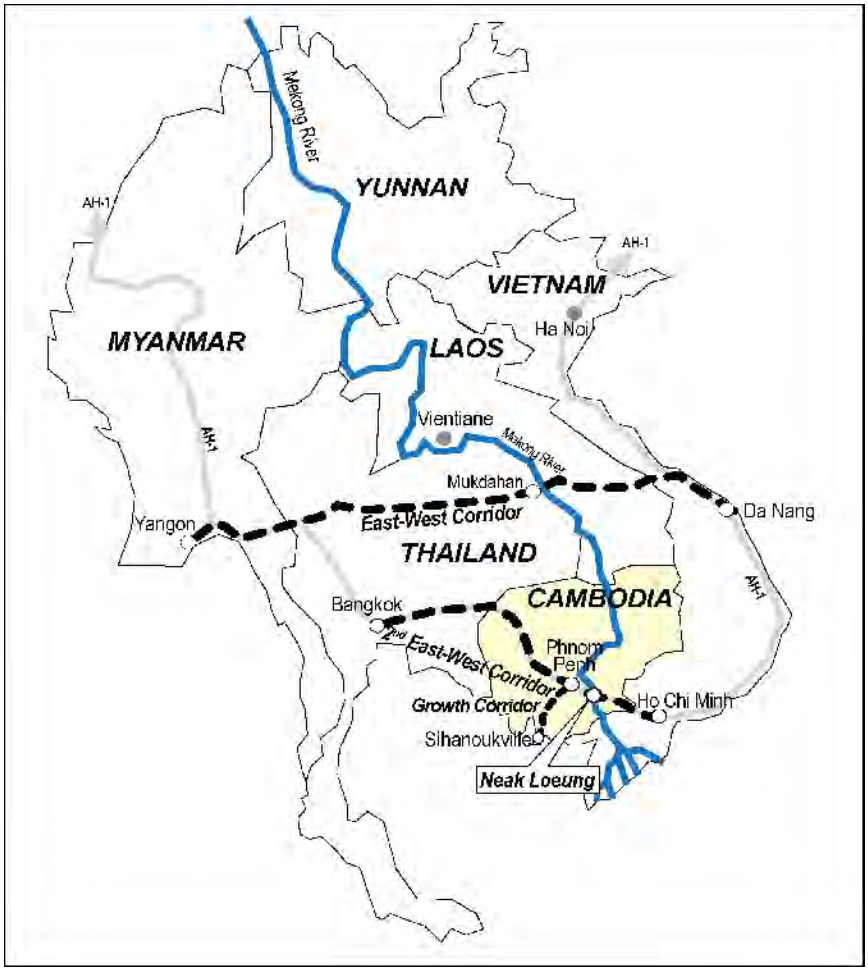
3.2 Development Plans and Strategies

(1) Regional Development Plans and Strategies

The GMS development policies and strategies intend to lead to the following directions (refer to Figure 3.2.1):

- East West Economic Corridor running from Savannakhet in Laos to Da Nang Port in Vietnam and the construction of a bridge over the Mekong River between Savannakhet and Mukdahan.

- The Southern Corridor or so-called "the 2nd East-West Economic Corridor" links Ho Chi Minh and Bangkok through Phnom Penh.
- Asian Highway AH1, part of which is "the 2nd East-West Economic Corridor", will link Cambodia, China, Laos, Myanmar, Thailand and Vietnam.
- The 2nd corridor is also connected to so called "North South Phnom Penh - Sihanoukville Growth Corridor" at Phnom Penh which leads to Sihanoukville Port, Cambodia's principal international port.

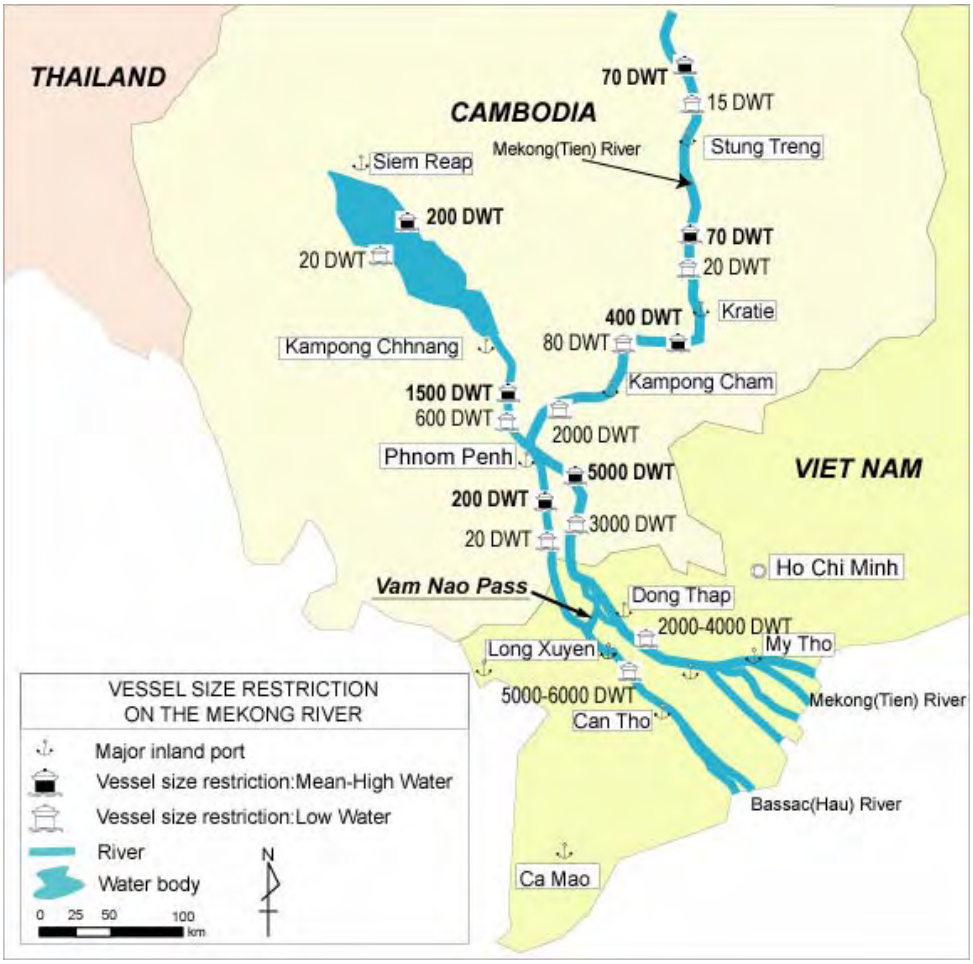


Source: Study Team

Figure 3.2.1 GMS and East West Corridor

(2) Navigation Program (MRC)

Between Phnom Penh and the Vam Nao Pass, the Mekong River is navigable by sea-going vessels with sizes of up to 3,000 - 5,000 DWT as shown in Figure 3.2.2. The Bassac (Hau) River is also navigable by such vessels between the Vam Nao Pass in Vietnam and the South China Sea, although it is subject to a tidal variation to enable a 5.000 DWT vessel to enter the estuary.



Source: State of the Basin Report 2003, Mekong River Commission

Figure 3.2.2 Vessel Size Restrictions on the Mekong River (Cambodia and Viet Nam)

The objective for MRC navigation development is:

- To promote freedom of navigation in the Lower Mekong River system
- To assist in co-ordination and co-operation in developing effective and safe waterborne transport in a sustainable and protective manner for the waterway environment
- To increase international trade opportunities for the mutual benefit of the Member Countries of the MRC

(3) Development Policies and Plans on Port and Waterway

The Royal Government of Cambodia recognizes the importance of maintaining both Sihanoukville and Phnom Penh as the two major international ports, and it is committed to complying with international conventions and WTO principles within the framework of the ASEAN Action Plan.

Inland river waterway transport is a crucial means of communication in Cambodia, and therefore a regular dredging program should be assured to maintain safe navigation on the Mekong River in particular. The Port of Phnom Penh has a role to play in the future of Cambodia, especially as a gateway as well as a distribution center to support the urban and

industrial development of the Phnom Penh Metropolitan Area.

The bridge construction over the Mekong and Bassac Rivers in the Southern Vietnam are as follows:

- Vertical navigation clearance of the My Thuan Bridge was determined at 37.5 meters by the request of the Government of Cambodia, and the Bridge was completed in May 2000.
- Vertical navigation clearance of Can Tho Bridge was finally determined at 39.0 meters to enable 15,000 DWT vessels to enter the Can Tho Port and which is now under the construction in 2004.

(4) Government Policies and Strategies for National Development

"Socioeconomic Development Plan 1996-2000 (SEDP-1)" is a five-year national plan developed in conjunction with the NPRD, and which stresses the development of rural infrastructure, especially roads. Table 3.2.1 compares the targets and realizations of SEDP-1.

Table 3.2.1 Target and Performance of Key Indicators of SEDP-1

		1996	1997	1998	1999	2000
Real GDP Growth (%)	Planed [1)]	7.5	7.5	7.5	7.5	7.5
	Performed [2)]	4.6	4.3	2.1	6.9	7.7
Agriculture (%)	Planed	5.2	5.2	5.2	5.2	5.2
	Performed	2.3	5.5	3	0	-0.3
Industry (%)	Planed	11.8	9.8	9.8	9.8	9.8
	Performed	9.9	21.3	7.3	13.2	34.6
Services (%)	Planed	8.2	9	9	9	9
	Performed	3.6	-2.6	0.7	7.1	5.8

Sources: [1)] SEDP-1,
[2)] National Accounts of Cambodia 1993-2000

Based on number of lessons during SEDP-1 period, the Second Five Socio-Economic Development Plan (SEDP-II) was formulated in 2001 and approved by the National Assembly in June 2002 as shown in Table 3.2.2.

Table 3.2.2 Target of Key Indicators of SEDP-2

	2001	2002	2003	2004	2005
Real GDP Growth (%)	6.0	6.0	6.0	6.5	6.5
Per Capita GDP (US $)	275	295	317	341	359
Growth of Agriculture (%)	3.5	3.5	3.5	3.5	3.5
Growth of Industry (%)	7.0	7.0	7.0	7.0	7.0
Growth of Services (%)	8.0	8.0	8.0	8.0	8.0

Source: SEDP-2

The National Poverty Reduction Strategy (NPRS) was publicly launched in March 2003 to improve the accessibility of road network, ensure effectiveness, enhance road safety, and improve rural transport. The focus is placed on:

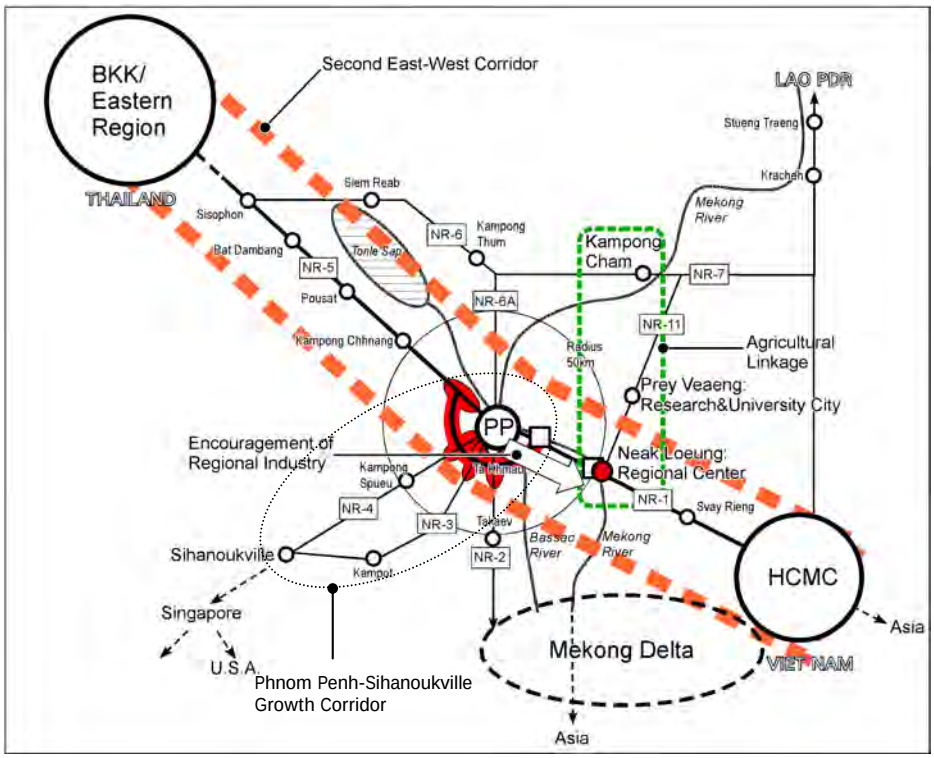
- continuing rehabilitating and reconstructing the primary national roads;
- building road links to neighboring countries; and
- developing a sustainable road maintenance program.

3.3 Proposed Regional and Local Development Strategies

(1) Regional Development Perspectives for the Metropolitan and Neak Loeung Areas

Development issues in the area cover the following subjects and are illustrated in Figure 3.3.1.

- Developing the 2nd East-West Corridor and strengthening the linkage between Phnom Penh Metropolitan area and Neak Loeung area
- Developing a Post-Garment Leading Industries and Import-Substituting Industries
- Increasing Demand of Urban Growth in the Neak Loeung Area as a Regional Center
- Encouragement of Regional Industrial Development and Shifting Administration function of Prey Veaeng
- Need to develop Flood-free Land for the Regional Center[2] (Provincial Town)



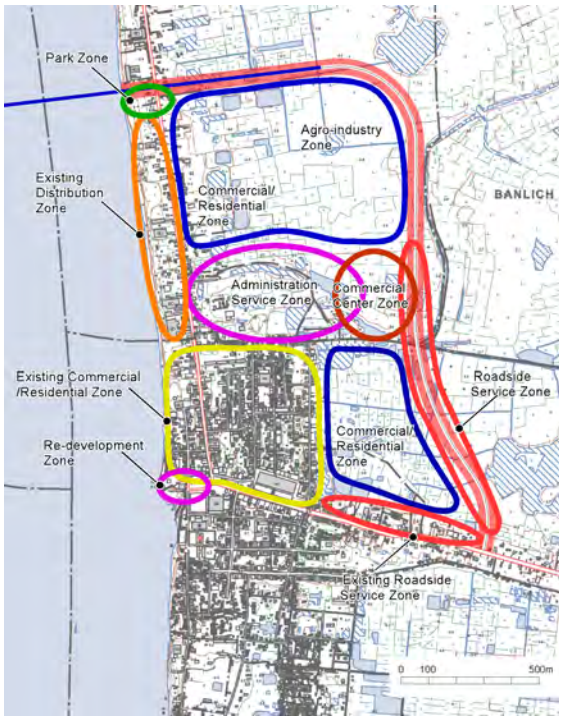
Source: JICA Study Team

Figure 3.3.1 Target Perspective for Future Regional Development

(2) Local Development through Generation and Utilization of Flood-free Land

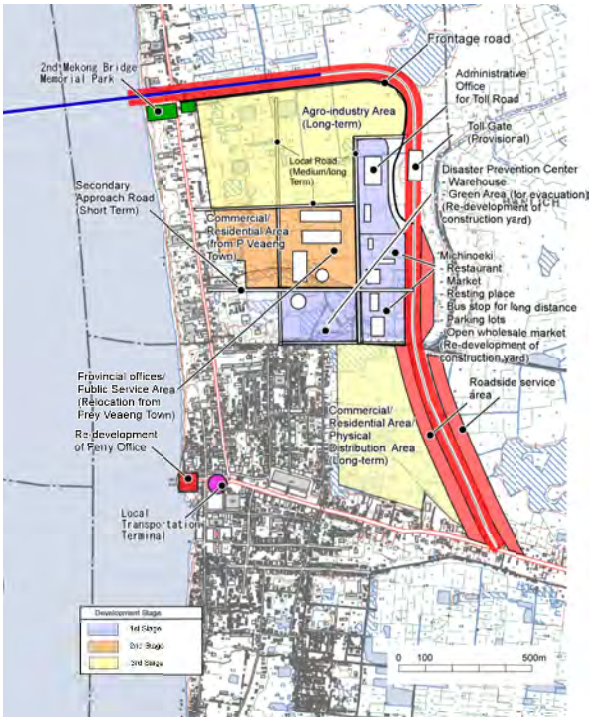
Generation and utilization of the flood-free land is a key strategy to the development of "Neak Loeung Regional Center" and its preliminary zoning and the land use plan are proposed in Figures 3.3.2 and 3.3.3.

[2] City with sphere of influence equivalent to provincial area. Provincial capital is a typical one.



Source: Prepared by JICA Study Team

Figure 3.3.2 Preliminary Zoning Plan



Source: Prepared by JICA Study Team

Figure 3.3.3 Preliminary Land Use Plan

The flood-free land development is the potential accruing from the construction of the Bridge and its approach road. The land development cost, therefore, should be borne separately from the 2nd Mekong Bridge Project.

3.4 Traffic Demand Forecast

(1) Future Socio-economic Framework

Three indices, i.e. population, GDP and jobs, mainly used for the traffic demand forecast are shown in Tables 3.4.1 through 3.4.3.

Table 3.4.1 Population

(Unit: 1,000 Persons)

Province	2005	2010	2015	2020
Phnom Penh	1,314	1,529	1,754	1,983
Kandal	1,243	1,343	1,459	1,583
Prey Veaeng	1,095	1,126	1,158	1,223
Svay Rieng	538	571	610	651
Total	4,190	4,570	4,982	5,440

Source: NIS

Table 3.4.2 GDP Growth

(Unit: %)

Scenario	2005 - 2020
High	8
Medium	6
Low	4

Table 3.4.3 Number of Jobs (Unit: 1,000 Employees)

Province	2005	2010	2015	2020
Phnom Penh	621	731	934	969
Kandal	536	609	694	734
Prey Veaeng	519	533	548	564
Svay Rieng	252	270	292	306
Total	1,927	2,144	2,468	2,573

Source: JICA Study Team

(2) Future Traffic Demand Forecast by GDP Growth Scenario

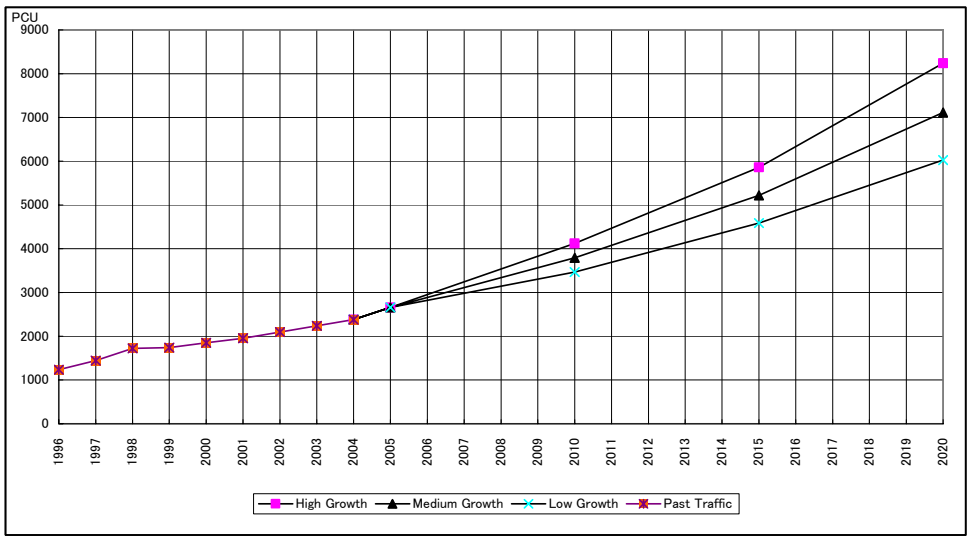
Based on the above future socio-economic framework, the future traffic demand is forecast by the GDP growth scenario as shown in Table 3.4.4 and Figure 3.4.1.

(3) Development Scenarios with Project

Estimated future traffic demand will increase due to a series of development programs and projects, including improvement of NR 1 and the implementation of cross border facilitation agreement. In addition, the Second Mekong Bridge Project itself will contribute to an increase of traffic demand by generating transferred demand from pedestrians to vehicles and demand from the area development of flood-free land. The selected series of development program and projects are as follows:

(A) Base case under the same ferry operation.
(B) Traffic generated by improvement of NR 1 (to be completed by 2011).
(C) Cross-border truck traffic generated by implementation of cross border facilitation agreement at the border with Vietnam (to be executed by 2007).
(D) Traffic generated from modal change by the transfer from pedestrians and pedal-cycles currently using the ferry to mini-buses (when the bridge is completed).
(E) Cross-border passenger traffic between Cambodia and Vietnam after the implementation of cross border facilitation agreement (to be executed by 2005).
(F) Traffic generated by bridge construction.
(G) Traffic increase generated from the flood-free land development.

Based on the above development scenarios, future traffic demand is forecast as shown in Figure 3.4.2 and Table 3.4.4.



Source : JICA Study Team
Note : Forecasted traffic is plotted every five years.

Figure 3.4.1 Traffic Demand Forecast by Economic Growth Scenarios

Table 3.4.4 Summary of Estimated Future Traffic Volume by Improvement Scenario

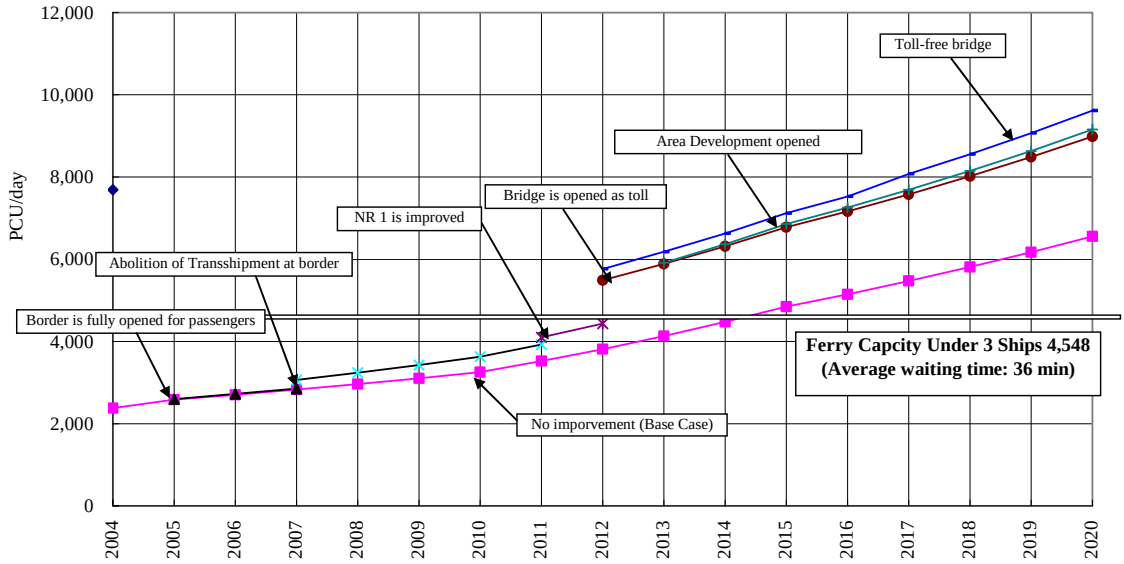
(Unit: Vehicles or PCU/day)

Improvement Scenarios				Growth Case	2004	2005	2010	2015	2020	Remarks
A	Base Case (without Project) (PCU)			High	2,376	2,583	3,526	5,383	7,490	
				Medium		2,583	3,253	4,848	6,557	
				Low		2,583	2,983	4,313	5,625	
B	Traffic Generated by Improvement of NR1 (PCU)		Impact Coefficiency					0.05	0.05	NR1 will be improved in 2011
			Base Case	High				269	374	
				Medium				242	328	
				Low				216	281	
C1	Cross-border Traffic (Truck)	(Vehicle)	No Improvement	High		16	39	56	77	
				Medium			34	46	59	
				Low			30	37	45	
C2			Without Transshipment	High			64	91	126	Transshipment at the border will be abolished in 2007
				Medium			56	75	97	
				Low			50	61	74	
C3			Bridge Open After No Transshipment	High				16	22	
				Medium				13	17	
				Low				11	13	
C1		(PCU) (3+4.5)/2= 3.75	No Improvement	High		59	146	209	289	
				Medium			129	171	221	
				Low			114	140	170	
C2			Without Transshipment	High			240	342	474	Transshipment at the border will be abolished in 2007
				Medium			212	281	363	
				Low			187	230	278	
C3			Bridge Open After No Transshipment	High				61	84	
				Medium				50	64	
				Low				41	49	
D	Traffic Generated from Modal Change (PCU)			PCU				818	890	Pedal-cycles & pedestrians will change to mini-buses after the bridge opens in
E	Cross-border Traffic (Passenger) (PCU)			PCU		15	34	76	170	The border is fully opened for passengers in 2005
F	Traffic Generated by Bridge Construction (PCU)			High				323	449	The bridge will be open in 2012 (6% increment to Base Case)
				Medium				291	393	
				Low				259	338	
G	Traffic Generated from Area Development (PCU)							81	170	Area development will be completed in 2020
Ferry Only (excluding C3,D,F,G)			Without Transshipment	High	2,376	2,657	3,946	6,279	8,797	Under the Assumption of Ferry
				Medium			3,629	5,619	7,640	
				Low			3,318	4,975	6,524	
Toll Bridge (PCU)			Without Transshipment	High	2,376	2,657	3,946	7,562	10,390	Bridge (Toll)
				Medium			3,629	6,859	9,157	
				Low			3,318	6,174	7,971	
Toll-free Bridge (PCU)			Without Transshipment	High	2,376	2,657	3,946	7,941	10,910	Bridge(Toll-free)
				Medium			3,629	7,202	9,615	
				Low			3,318	6,483	8,369	

Source: JICA Study Team

(4) Timing to Require the Bridge Opening

The total daily maximum load of three ferries is estimated at 4,548 PCUs as discussed in the previous section. Under the assumption that all the facility development is completed as scheduled, the daily traffic volume to cross the river will exceeds the loading capacity of three ferries in 2013 as shown in Figure 3.4.2. Accordingly, it is desirable for the bridge to open to traffic in 2012 before the existing ferry capacity is saturated. This timing is compatible with the completion of the NR 1 improvement in 2011. Along with the bridge opening, area development is supposed to start at the flood-free land.



Source: JICA Study Team

Figure 3.4.2 Ferry Capacity and Traffic Demand by Development Scenarios (Medium Case)

The time schedule therefore is set up as follows:

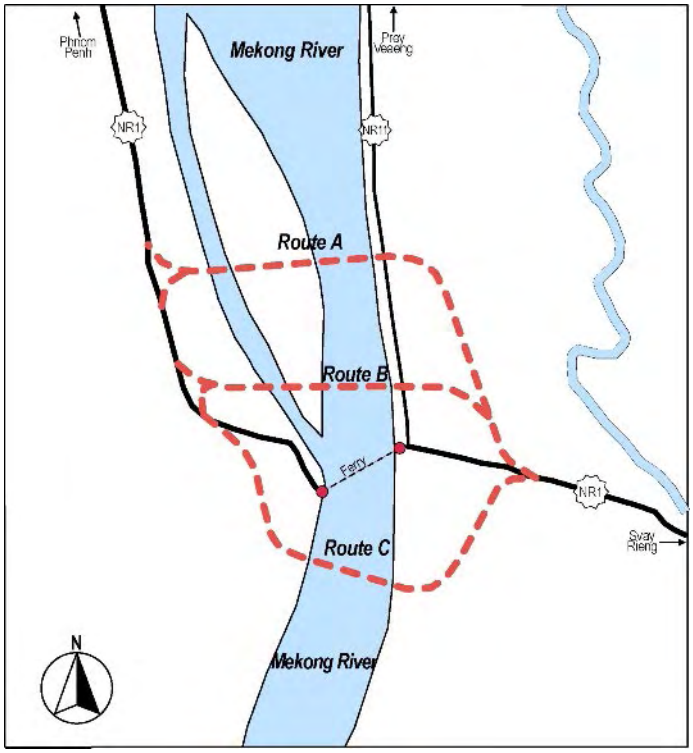
- 2012: The project bridge is open to traffic in 2012[3] and the area development starts at the flood-free land
- 2020: Area development at the flood-free land is completed

[3] For economic and financial analysis, September 2012 is employed as the opening time of the bridge.

4. SELECTION OF OPTIMUM ROUTE AND METHOD TO CROSS THE RIVER

4.1 Methodology

In order to select the optimum solution to cross the Mekong River at Neak Loeung, the study applied the AHP (Analytic Hierarchy Process) to a multi-criteria decision making requirement in two steps: the first step (AHP (1)) was to select an optimum bridge route from the alternatives shown in Figure 4.1.1, and the second step (AHP (2)) was to select the optimum method to cross the Mekong River at Neak Loeung.



Source: Study Team

Figure 4.1.1 Locations of Alternative Routes for the Bridge Option

Four alternative crossing methods compared in this analysis were as follows:

(1) Zero Option: No additional improvement but only maintenance of the existing crossing facility (ferry)

(2) Ferry Improvement: Improvement of the existing ferry facility to accommodate the traffic demand by replacing the ferryboat with a larger capacity or providing additional ferryboats with additional pier

(3) Bridge Option: Bridge construction but the existing ferry should be only maintained until the bridge is completed

(4) Ferry Improvement + Bridge Option: Before the bridge is completed the capacity improvement of the existing ferry facility as the demand requires. This is the combination of the "Bridge" Option and "Ferry Improvement" Option. This option, however, does not imply

that the project consists of two components, i.e. the Bridge Project and the Ferry Improvement Project. The ferry improvement is considered as the prerequisite.

The evaluation criteria covered three levels as shown below.

Table 4.1.1 Structured Evaluation Criteria Common in AHP (1) and AHP (2)

Primary Level Criteria	Secondary Level Sub-criteria	Tertiary Level Sub-criteria
Engineering Criteria	n.a.	Stability of Crossing Service
		Safety of Crossing Service
		Sustainability of Crossing Service
Economic Criteria	n.a.	Appropriateness to Traffic Demand
		Investment Efficiency
		Impacts on Regional Economy
Environmental Criteria	Natural Environment	Noise and Vibration
		Traffic Accidents
		Other Impacts on Natural Environment
	Social Environment	Involuntary Resettlement
		Impacts on Land Use
		Impacts on Local Livelihood
		Other Impacts on Social Environment

4.2 Selected Optimum Crossing Route and Method

Based on the derived weights of alternative routes/methods by the evaluation criteria and weights of the evaluation criteria by the stakeholders, the overall evaluation of the alternatives was made for the route and method as shown below.

Table 4.2.1 Overall Evaluation of Alternative Routes

Stakeholder Groups	Route A	Route B	Route C
Government	0.417	0.353	0.230
Private Sector	0.442	0.328	0.230
NGO	0.447	0.328	0.225
Donor	0.461	0.323	0.216
Research Institute	0.451	0.335	0.214
NL Ferry	0.409	0.354	0.237
Villager	0.423	0.348	0.229
Average of S.H	**0.430**	**0.343**	**0.227**
MPWT	**0.414**	**0.338**	**0.248**
Study Team	**0.460**	**0.327**	**0.213**

Table 4.2.2 Overall Evaluation of Alternative Crossing Methods

Stakeholder Groups	Bridge	Zero Option	Ferry Imp.	Ferry Imp. + Bridge
Government	0.228	0.065	0.202	0.505
Private Sector	0.241	0.076	0.191	0.492
NGO	0.225	0.070	0.206	0.499
Donor	0.246	0.110	0.191	0.453
Research Institute	0.232	0.073	0.198	0.497
NL Ferry	0.244	0.062	0.191	0.503
Villager	0.243	0.064	0.189	0.504
Average of S.H	**0.235**	**0.069**	**0.196**	**0.500**
MPWT	**0.240**	**0.066**	**0.191**	**0.503**
Study Team	**0.234**	**0.095**	**0.191**	**0.480**

Source: JICA Study Team

Consequently, it was confirmed that all the stakeholder groups as well as MPWT and the Study Team are agreeable to the “Ferry Improvement + Bridge” option on Route A as the optimum

method to cross the Mekong River at Neak Loeung.

4.3 Achieving Stakeholder Consensus

Stakeholder Meeting 2-3, which was the last stakeholder meeting of the Phase-1 Study, was held on March 10-11, 2005 in an attempt to explain that the "Ferry Improvement + Bridge (Route A)" option was selected as the optimum solution to cross the Mekong River at Neak Loeung.

In order to further guarantee the far-reaching transparency and information disclosure to all the stakeholders, one-and-half month public comment period was set up after Stakeholder Meeting 2-3, and, during this public comment period, MPWT received a wide range of comments and questions from 22 various stakeholders. After this public comments and response process, MPWT officially announced that "Ferry Improvement + Bridge (Route A)" option was agreed among all the stakeholders, and it could be regarded as the final consensus on the optimum solution to cross the Mekong River at Neak Loeung.

5. PRELIMINARY ENGINEEERING DESIGN OF THE PROJECT

5.1 Highway Design

The following factors determine the design criteria for the study road.

- The study road forms part of the Asian Highway Route AH-1 and 2nd East-West Economic Corridor, connecting Thailand – Phnom Penh – Ho Chi Minh.
- The study road is located between ADB Section and JICA B/D Section of National Road No.1, and both sections apply AASHTO for the highway design.
- A sufficient level of service needs to be provided and maintained with the full understanding of local characteristics in Cambodia.

Accordingly, the design criteria for the study road were developed based on AASHTO. For the local contexts, the design parameters such as the friction between tires and pavement, driver's eye height adopt relevant Japanese Standard or Cambodian Standard.

Major elements of the geometric design are based on the following considerations:

(1) Number of Lanes

The current daily traffic volume loaded on the ferry is 2,995 vehicles (2,376 PCU) and the future traffic demand in the study section is estimated at 9,157 PCU in 2020. Therefore, the recommended number of lanes to the project road is 2-lane, which is affordable for the future traffic demand. The number of lanes for the adjoining JICA Section (western side of the river) B/D and ADB Section (eastern side of the river) are also designed 2-lane.

(2) Cross Section Elements

1) Lane Width

AASHTO (U.S.A.) adopts the widest lane width of 12 feet (3.60m), while other countries adopt 3.50m, for instance, for Rural Arterial Road as well as Class II of Aisin Highway. Eventually, the recommended lane width to the project road is 3.50m.

It should be noted that JICA B/D Section as well as the Study adopts 3.5 m lane width, while ADB Section adopts 3.75 m lane width. The gap of 0.25m between the two sections is adjusted at a taper section of the intersection.

2) Motorbike Lane Width

The project road should accommodate the motorbike lane. One of the salient features of the traffic characteristics in the study area is a large number of slow-moving vehicles such as bicycles, motorbikes, tractor and animal carts. Among them, motorbikes account for the majority. A mixture of motorbikes and ordinary 4-wheeled vehicles may reduce the traffic capacity as well as traffic safety. Therefore, the study Study recommends separating them by the provision of the motorbike lane.

The motorbike lane should be reserved for such reasons as a stuck or out-of-order motorbike and the space for inspection. The recommended motorbike lane width on the 2nd Mekong Bridge is 1.5 m from the following reasons.

- Kizuna Bridge on NR-7 adopts the same width from an economical viewpoint.
- A typical cross section of the ADB Section does not accommodate the motorbike-lane, instead ADB Section accommodates a hard shoulder of 1.5m wide and which functions as a motorbike lane.
- The motorbike lane width of 1.5m is considered capable of accommodating the 2020 future traffic demand of the 2nd Mekong Bridge.

In Cambodia, motorbikes are often observed to overflow into the car lane for overtaking slow motorbikes. Therefore, it is recommended that such facilities incidental to traffic management as thick road marking and a traffic safety device like a delineator, which does not occupy a large space in the cross section, should be considered as the facility incidental to traffic management.

3) Shoulder Width

Shoulder widths of 0.5-3.6 m are generally adopted in the highway. The recommended shoulder width for the project is 1.0 m, considering an economic constraint, land acquisition condition and service level.

The shoulder width of 3.0 m is stipulated for the Rural Highway (R5) in Cambodian Standard. This requirement meets when the motorbike lane is considered as part of the shoulder, so that the actual total shoulder width on the embankment section will be become more than 3.0m.

4) Marginal Strip Width

The recommended marginal strip width is 0.25 m, which is located between the outer edge of the 4-wheel vehicle lane and that of the motorbike lane in a whole stretch excluding the bridge section. In Cambodia, the marginal strip along the outer edge of the bike lane is generally omitted in the bridge section from the economical viewpoint. However, a lot of traffic accidents of the motorbike were are observed on the bridge, especially some motorbikes have collided with the lighting pole on Chruoy Changvar Bridge.

Therefore, the marginal strip is considered essential necessary in a minimum width of 0.25 m along the outer edge of the motorbike lane on the bridge section.

5) Space for Installation of Utilities and Inspection

Following the design standard and road improvement practices in Cambodia, a width for utilities is recommended at 0.5m on the embankment section. This space accommodates road signs, guard posts, road lighting, electric wire poles and telegraph poles.

In the bridge section, the recommended width is 0.75 m. This space is utilized not only for installation of public utilities but also for inspection and maintenance works, evacuation route and side clearance.

It is assumed that the sidewalk on the project bridge is not necessary from such considerations that there are few pedestrians to pass through the bridge, because the bridge length exceeds 2km, and the total length is more than 5 km, including the approach roads on the east and west banks.

Based on the study of the geometric design elements, the typical cross section of the project is recommended as shown below.

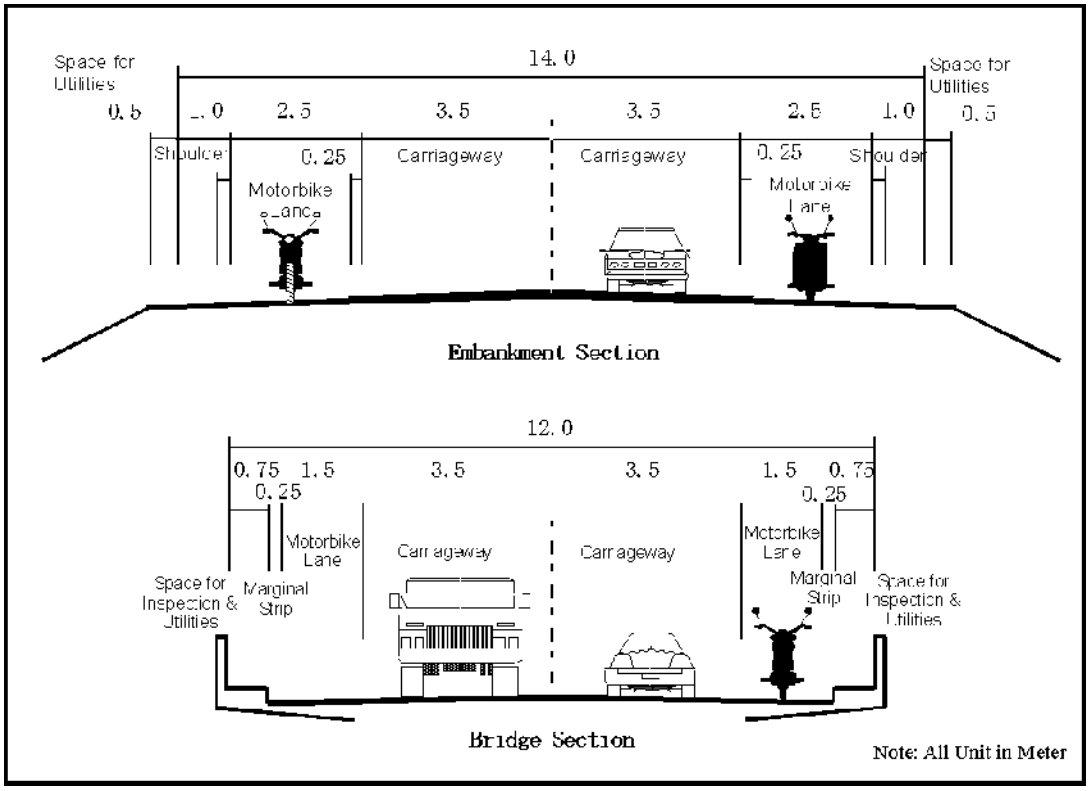


Figure 5.1.1 Typical Cross Section of the Project Road

(3) Alignment of the Proposed Route

The alignment of the proposed route was carried out, considering the following aspects: 1) Design Controls, 2) Physical Constrains, 3) Toll Levy System, and 4) Road Network.

The physical constraints considered included an orphanage and a steel telecommunication tower and cemetery as primary controlling points, residential area solid buildings, graves and irrigation channels as secondary controlling points along the route of the project road.

Following the study on physical conditions, a proposed alignment was determined by such design controls as the design speed of 80 km/h and minimum horizontal curve of 280 m in radius determined by the function of the project road. Further, the alignment was drawn to cross the river at right angles and at a point of the river width to be as short as possible. Figure 5.1.2 shows the proposed alignment of the project road.

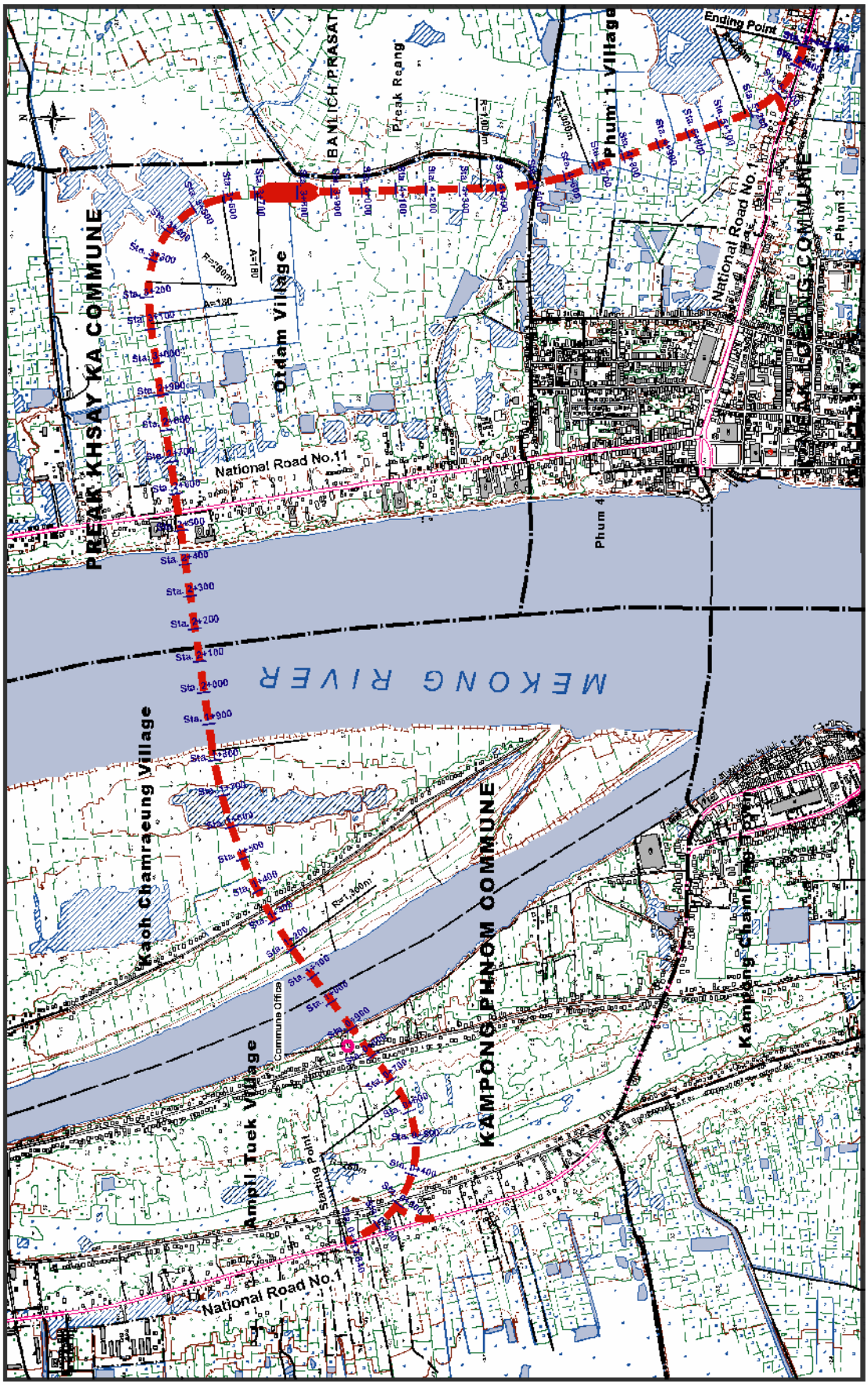


Figure 5.1.2 Proposed Alignment of the Project

5.2 Bridge Design

(1) Width of Bridge

The roadway width on the bridge defers to that of the KIZUNA Bridge in general but is different on the outside of the traveled way. It is understood that the KIZUNA Bridge was planned to accommodate pedestrians with a sidewalk for such traffic characteristics as commuting and going school on foot and the relatively short distance of the bridge.

In case of the Project Bridge, it is unlikely that people would cross the river over the 2.2 km long bridge. Therefore, the bridge is planned to provide pedestrian facility only for the bridge inspection purpose.

However, such additional facility as the observation platform that enables people to enjoy a fine perspective opened out over the Mekong River can be provided at selected bridge sections. Since the bridge length is too long to cross on foot people would use motorized vehicles to get up to the platform. 4-wheeled vehicles, however, should not be allowed to park along the roadside on the bridge in order to save the construction cost of the bridge and to properly manage the traffic flow on the bridge.

Consequently, the width of the bridge is recommended as show in Figure 5.2.1.

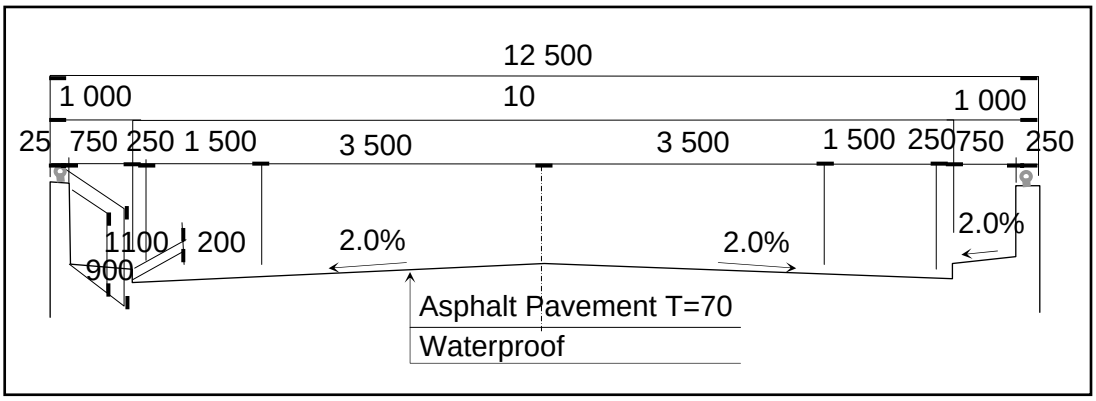


Figure 5.2.1 Roadway Width on the Bridge

(2) Navigation Channel Layout

Horizontal and vertical clearance of the navigation channel is the fundamental condition that affects the safety of navigation and consequently the size of a navigable vessel, overall bridge layout, optimal bridge type and construction costs.

a. Vertical Clearance

The vertical clearance of the navigation channel was based upon the following conditions:

External conditions:

- My Thuan Bridge crosses the Mekong River in Vietnam; it was completed in May 2000.
- The vertical clearance of My Thua Bridge was determined at 37.5 m by the request of the Cambodian government to the Vietnamese government.

- Can Tho Bridge in Vietnam is planned to cross the Hau River with the vertical clearance of 39.0 m to enable a 15,000 DWT vessel to enter Can Tho Port.
- Generally, 5000 DWT vessels and 3000 DWT vessels are navigable up to Phnom Penh through the Hau River in Vietnam and the Mekong River in Cambodia at Mean-High water and Low water, respectively (see Figure 3.2.2).

Development Policies and Plans:

- Containerization is making rapid progress at Phnom Penh Port, and the Autonomous Phnom Penh Port plans to construct an Inland Container Depot near the Port to accommodate a maximum 5000 DWT container ship at Phnom Penh Port
- An MRC official stated formally that the navigation clearance of the Bridge at Neak Loeung should be 37.5 m at the Stakeholder Meeting held on 7th of October 2004 to ensure "Freedom of Navigation" for the Mekong River as agreed by the member countries in the article 9 of the agreement.
- The World Bank is studying access to the Hau River and the Mekong River for entry from the sea into the Mekong river system; it stated that 5000 DWT container ship should be able to use the Mekong river system and navigate up to Phnom Penh Port.
- Based on the data from the Technical Note No. 714 of the Port and Harbor Research Institute of Ministry of Transport, Japan, the mast height of 5000 DWT container ship could be determined as 36.0 m. Considering the allowance to be 1.5 m for the safety over the mast height, the vertical clearance of the navigation span of the bridge is planned to be **37.5 m.**

b. Horizontal Clearance.

Based on the "Technical Standard for the Port Facilities", Ministry of Transport, Japan, April 1999 and the "Ship Domain" theory in the report of "SHIP COLLISION WITH BRIDGES, IABSE, AIPC, IVBH 1993", the required horizontal clearance guidance is shown in Tables 5.2.1 and 5.2.2.

Table 5.2.1 Vessel Profiles

Type of Vessel		Ship Length (m)	Breadth (m)	Draught(m)
5000 DWT	Cargo Ship	109	16.8	
	Oil Carrier	102	16.8	
	Container Ship	103	15.4	
700 DWT	Cargo Ship	57	9.5	3.4

Source: Technical Standard for the Port Facilities, Ministry of Transport, Japan, April 1999.

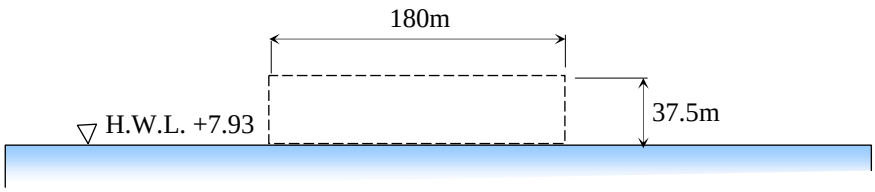
Table 5.2.2 Technical Criteria for the Horizontal Clearance of Navigation Span of the Bridge

Source	One Way	Two Way	Note
Technical Standard for the Port Facilities, Ministry of Transport, Japan	Waters with low traffic density : H.C.＞0.5L	Waters with high traffic density : H.C.＞1L	In case H.C.＜1L, safety measure such as navigation aid system shall be settled.
	a) In case long navigation route: 1.5L		
	b) Open sea situation with high traffic density : 1.5L		
	c) Long navigation route with high traffic density: 2.0L		
	In case of navigation route with special condition such as high traffic density include crossing vessel, super large vessel or severe natural conditions, horizontal clearance shall be wider than the standard.		
Ship Collision with Bridges (IABSE)	3.2L	6.7L to 8.2L	Free Navigation (at service speed)
	1.6L	3.5L to 5.0L	Restricted Waters (With pilots or Vessel Traffic Service System)

Note: H.C. : Horizontal Clearance, L: Ship length
IABSE : International Association for Bridge and Structural Engineering
AIPC : Association of Intenationale des Ponts et Charpentes
IVBH : Internationale Vereinigung für Brückenbau und Hochbau

Consequently, the minimum clearance of the navigation channel layout for the Second Mekong Bridge is recommended as shown in Table 5.2.3.

Table 5.2.3 Recommended Navigation Channel Layout

	One way traffic	Two Way traffic
Vessel Size	5,000DWT Container Ship	500DWT Coaster
Horizontal Clearance*	B=1.6 x L =175 < 180m Where, L : Ship Length = 109m	B= 3.5 x L =179 < 180m Where, L : Ship length = 51m
Vertical Clearance	37.5m	37.5m
Minimum Clearance of Navigation Channel		

*Note: Horizontal Clearance is calculated by the Ship Domain analysis in the Ship Collision with Bridges issued by IABSE, AIPC and IVBH

(3) Design Criteria and Standard

Japanese Design Standard is applied to the Project and major design standard for the Bridge are as follows:

Item	Standard
Live Load	B-Load (TL25)
Water Velocity	V=2.0m/s
Vessel Collision and velocity	5,000 DWT, V= 2.25m/sec
Temperature Variation	15℃～40℃
Seismic Coefficient	K_h=0.05 , K_v=0.00

(4) Selection of Bridge Type

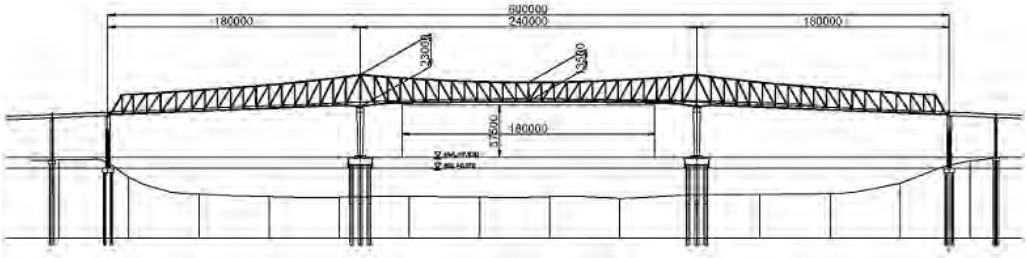
a. Approach Bridge

PC Continuous Composite I Girder, Steel Continuous I Girder and PC Continuous Box Girder are examined for comparison and consequently, PC Continuous Composite I Girder is selected for Approach Bridge.

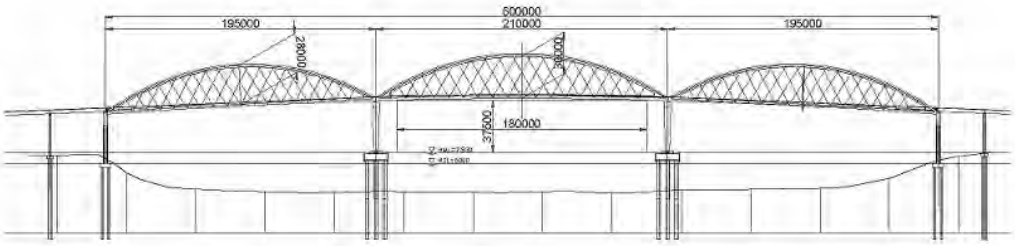
b. Main Bridge

Six alternative bridge types are initially compared and narrowed down to three bridge types for the final selection of Main Bridge Type. Three alternatives were selected taking into account the minimum requirement of vertical and horizontal navigation clearance and minimizing the number of piers in the river and the safety navigation of local ships. These alternatives are Steel Truss bridge, Through Arch bridge and Concrete Cable Stay bridge as shown in Figure 5.2.2. The construction cost and features of each bridge type was compared and as a result, Pre-stressed Concrete Cable Stay Bridge was selected and its main span length is 320 m.

Steel Truss Bridge



Through Arch Bridge



Concrete Cable Stay Bridge

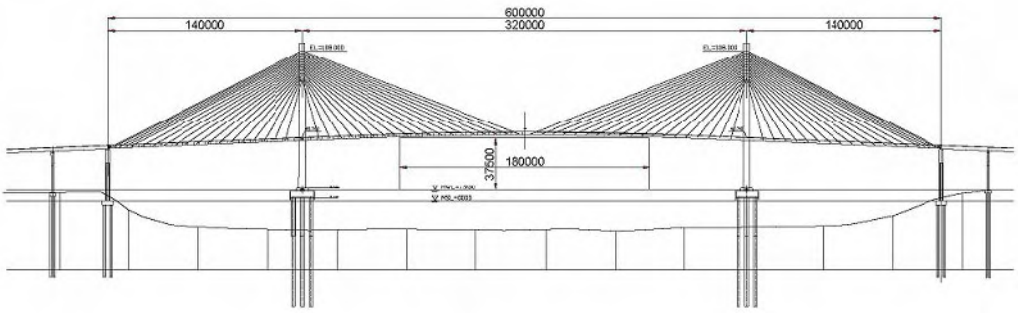


Figure 5.2.2 Alternative Bridge Types

The summary of Project decisions in this section are as follows:

- The total length of the Project is 5,420 m.
- Bridge length is 2,220 m (600 m-long main bridge, approach bridges with length of 960 m on the west side and 660 m on the east side).
- Approach road length is 3,200 m (800 m on the west side and 2,400 m on the east side).

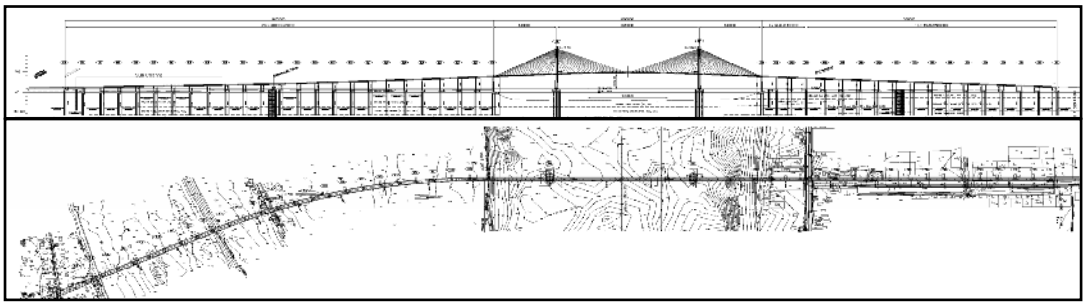


Figure 5.2.3 General View of the Project Bridge

6. CONSTRUCTION, OPERATION AND MAINTENANCE OF THE PROJECT

6.1 Estimated Project Costs

(1) Base Year and Exchange Rate

Cost Estimation was carried out based on the material, labor and equipment at the price level in September 2005. The foreign currency exchange rate is US$1.0 = ¥108.03 which is the average exchange rate of consecutive 6 months descending from August 2005.

(2) Construction Cost

Construction cost was estimated by the method mentioned in the previous section. Total construction cost is estimated at US$ 73.17 million which is summarized in Table 6.1.1.

Table 6.1.1 Summery of the Overall Construction Cost

(Unit US$ Million)

Cost Item	Local	Foreign	Total
Direct Cost			
Temporary Work	0.31	1.61	1.92
Road Construction	6.66	1.65	8.31
Bridge Construction	7.67	29.09	36.76
River Protection	0.19	0.02	0.21
Miscellaneous work	0.00	2.08	2.08
(1)Direct Cost	**14.82**	**34.45**	**49.27**
Indirect Cost			
Common temporary Work	0.45	0.37	0.82
Site Expenses	0.27	2.69	2.96
Overhead	0.00	3.37	3.37
(2)Indirect Cost Total	**0.72**	**6.43**	**7.15**
(3)Tax (10%) = ((1)+(2))x 0.1	1.55	4.09	5.64
(4)Contingency (10%)=((1)+(2)+(3))x0.1	1.71	4.50	6.21
(5)Construction Cost =(1)+(2)+(3)+(4)	**18.81**	**49.46**	**68.27**
Engineering Service			
Detailed Design	0.01	1.54	1.55
Construction Super Vision	0.35	2.15	2.50
(6)Engineering Service Total	**0.36**	**3.69**	**4.05**
(7)Tax (10%) =(6)x0.1	0.04	0.37	0.40
(8)Contingency (10%) =((6)+(7))x0.1	0.04	0.41	0.45
(9)Engineering Cost=(6)+(7)+(8)	**0.43**	**4.47**	**4.90**
(10)Overall Construction Cost =(5)+(9)	**19.24**	**53.93**	**73.17**

(3) Land Acquisition and Compensation Costs

Land acquisition and compensation costs are estimated based on the compensation table, that IRC currently adopts for the Project of Improvement of National Road No.1 (as shown in Table 6.1.2).

Table 6.1.2 Land Acquisition and Compensation Costs

(Unit US$ Million)

Item	Cost	Remarks
Land Acquisition	0.448	Total area that needs for acquisition is 528,000m^2 excluding the river, and roads, and including the construction yard. Administration cost (15% of the total land price) and contingency (10% of the total land cost plus administration costs) are inclusive.
Compensation Cost	0.226	Compensation includes that for houses, wells, fences and trees. It also includes such allowances as resettlement allowance, widow allowance, disabled allowance, poor-household (less than 10 US$) allowance. Administration cost (15%) and contingency (10% of the sub-total) are also inclusive.
Total	0.673	

(4) De-mining ad UXO Clearance Costs

De-mining and UXO clearance costs are estimated and summarized in Table 6.1.3.

Table 6.1.3 De-mining and UXO Clearance Costs

Location	Usage	Area (m^2)	Unit Cost (US$/ m^2)	Cost (US$ Million)
Phnom Penh Side	Road	100,000	0.25	0.025
	Construction yard	43,000	0.25	0.011
Neak Loeung Side	Road	280,000	0.35	0.098
	Construction yard	120,000	0.35	0.042
Total		543,000		0.176

(5) Total Project Costs

Total project costs are estimated at US$ 74.0 million at the price level in September 2005 as shown in Table 6.1.4.

Table 6.1.4 Summery of the Total Project Cost

(Unit US$ Million)

Item	Cost	Remarks
Construction Cost	**73.17**	Construction cost includes engineering service and contingency.
Land Acquisition and Compensation	0.673	
De-mining and UXO Clearance Costs	0.176	
Total	74.02	

6.2 Application of Toll System to the Project

Imposition of a toll, aside from its level, will be acceptable to bridge users if the government budget excludes the project operation and maintenance costs. Meanwhile, the project bridge replaces the existing ferry service in an improved manner to cross the River. This will underlie a rationale, whatever the project fund source is, to collect a toll from bridge users within the level of the existing ferry tariff.

The acceptance of toll imposition is important especially when newly introducing a toll system at a new location. The river crossing service at Neak Loeung, however, has been long undertaken by a toll ferry and its toll level has been accepted by the general public. In this sense, the existing ferry tariff will be a threshold to determine the level of the bridge toll. Further, since the "beneficiaries-pay" principle provides a rationale to limit the

maximum level of the toll, either this beneficiary level or the existing ferry tariff, whichever is lower, should define the maximum level of the bridge toll.

As a result of the project economic analysis in Chapter 9, it was found that the existing ferry tariff exceeds the bridge user benefit, in terms of financial costs, when the bridge is open to traffic. Therefore, the bridge toll should fall between the level of covering the project operation/maintenance costs and the bridge user's benefit, which corresponds to 55% of the current ferry tariff.

The discussion with MPWT on the toll level revealed that it should be lower than the present ferry tariff but higher than the project operation/maintenance costs. Since the surplus (about US$ 500,000/year) from the current ferry operation has been utilized for expenses to maintain other roads, it is assumed to keep this budgetary source in the bridge toll revenue.

Based on this assumed policy for the toll system of the project bridge, it is proposed, though depending upon the requirement of fund raising policy, that the bridge toll should be set at the level between 25% and 55% of the current ferry tariff.

6.3 Annual Operation and Maintenance Costs

(1) Maintenance Cost

The periodic maintenance costs were converted into annual cost based on the time span of the required works. Necessary funds for periodic maintenance works were reserved for the future expenditure. As the consequence, the annual maintenance costs for the bridge and approach road are estimated at US$190,800 as shown below.

Table 6.3.1 Annual Maintenance Costs

Unit: $1000/year

Type	Routine	Periodic	Total
Approach Road	7.1	55.7	62.8
Bridge	26.0	102.0	128.0
Total	33.1	157.7	190.8

Source: JICA Study Team

(2) Estimated Operation Costs

Only collecting tolls is a prerequisite condition for estimating operation costs. Under the condition that the project maintenance body also undertakes whole management including the toll collection and the maintenance works, the costs of toll collection and management are estimated at US$77,569 per year.

6.4 Construction Plan and Implementation Schedule

(1) Construction Schedule

The construction schedule of the selected bridge was developed considering the following conditions:

- Commencement of the foundation work in the river should be November or December when the water level of the Mekong River will start to fall.
- Embankment of the approach road is utilized as the construction road and dike against floods. Therefore, earthwork for the embankment shall start in the early stage of the schedule.

- Foundation work of the approach bridge should commence after completing the embankment of the approach road.
- The super-structure of the main bridge is to be constructed by balanced cantilever erection method and constructed in the year after completing the Pylons.
- PCT girders for the approach bridge should start fabrication in the construction yard in parallel with the construction of substructure of the approach road, and girders should be erected stage by stage after accomplishment of substructures.

The total construction period is estimated at 45 months. Figure 6.4.1 shows the construction schedule of the Second Mekong Bridge in Cambodia under ideal hydraulic conditions to commence the construction of foundation for the main bridge pylons.

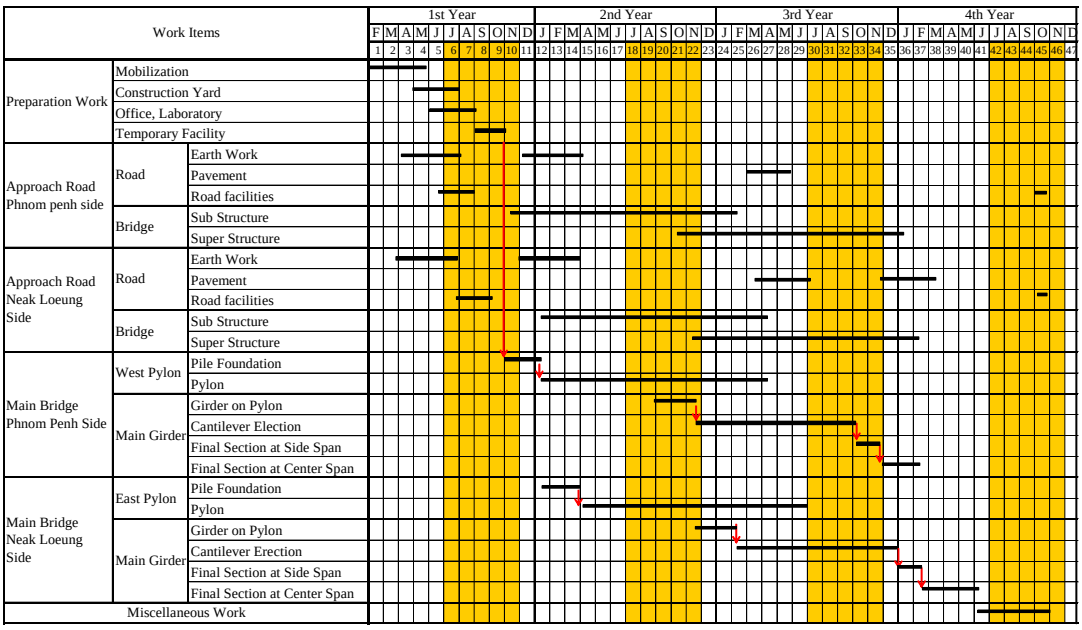


Figure 6.4.1 Construction Schedule of the Second Mekong Bridge

(2) Implementation Schedule

After completion of the feasibility study of the project, the subsequent implementation phase should cover the engineering studies and actions:

- Basic Engineering Study
- Procurement of fund for the Project.
- Detailed design for construction and selection of the construction contractor.
- Construction of the Structure for the Projects.

A 45-month construction period including the mobilization period is expected for the project bridge construction. The critical works of the construction of the main bridge will be as follows:

1) Preparation work that includes site clearance, construction of construction road and yard.
2) Construction of the site office, construction of facilities that include concrete batching plants and casting yard for the approach bridge.

3) Construction of temporary facilities including temporary piers.

4) Construction of the foundation of pylons. Timing of the construction shall be examined in detail considering the hydraulic condition of the river.

5) Construction of Pylon

6) Erection of the main girder.

7) Completion of road furnishing and miscellaneous works.

8) Completion of default liability period.

The target timetable for the Project is proposed below.

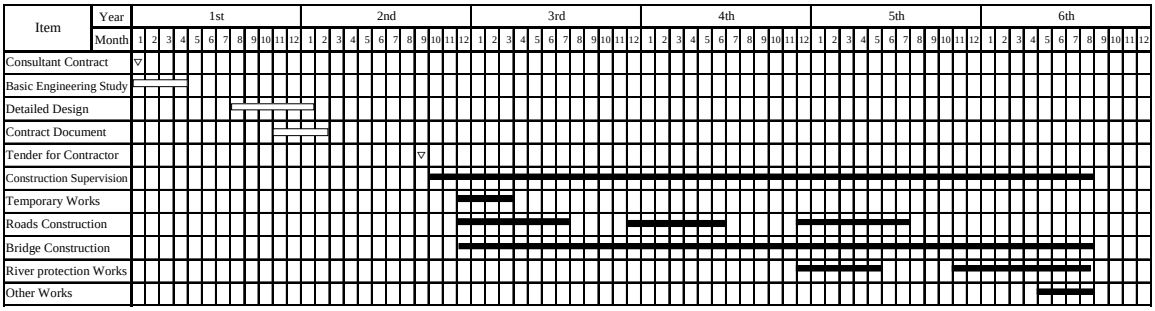


Figure 6.4.2 Time Schedule of the Project

7. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

7.1 Initial Environmental Examination (IEE)

(1) Scoping for IEE Study

The JICA guidelines refer to a wide range of 13 natural environmental impacts, including impacts on human health and safety, and 12 social environmental impacts. Tables 7.1.1 and 7.1.2 compare three cases of scope range: i) the full-coverage by the requirement of the JICA guidelines, ii) the preliminary scope at the time of S/W mission in December 2003, and iii) the proposed scope agreed among stakeholders in May 2004. Although some impacts to be assessed are deleted from the list in December 2003, the full-coverage of the impacts to be assessed stipulated by the guideline was proposed, taking into account whatever possible impacts might be provoked by the alternative crossing routes and methods at Neak Loeung.

Table 7.1.1 Scope for IEE-level Study on Natural Environment*

No.	Impacts to be Assessed	JICA Guidelines Requirement	Scope at S/W Mission (December 2003)	Agreed Scope at Kick-off Stakeholder Meeting (May 2004)
1	Air Quality	X	X	X
2	Water Quality (Surface/Subsurface Water and Groundwater)	X	X	X
3	Soil and Sedimentation Quality	X		X
4	Waste Disposal	X	X	X
5	Noise and Vibration	X	X	X
6	Subsidence	X		X
7	Bad Smells	X	X	X
8	Topography and Geology	X		X
9	River Bed Materials	X	X	X
10	Fauna and Flora	X	X	X
11	Use of Water Resources	X		X
12	Accidents	X	X	X
13	Greenhouse Effect Gas	X	X	X

Note: X means “applicable”. *: Natural environment includes such elements as item No. 1, 2, 5, 12 and 13 that affect human health and safety.

Table 7.1.2 Scoping for IEE-level Study on Social Environment

No.	Impacts to be Assessed	JICA Guideline Requirement	Scope at S/W Mission (December 2003)	Agreed Scope at Kick-off Stakeholder Meeting (May 2004)
1	Migration of Populations Involuntary Resettlement	X	X	X
2	Impact on Local Economy (Employment, Livelihood, etc.)	X	X	X
3	Utilization of Land and Local Resources	X	X	X
4	Social Institutions (Social Capital and Local Decision-making institution)	X	X	X
5	Existing Social Infrastructure and Services	X	X	X
6	Vulnerable Social Groups	X		X
7	Equality of Benefits and Losses and Equality in Development process	X		X
8	Local Conflicts of Interests	X	X	X
9	Gender	X		X
10	Children's Rights	X		X
11	Cultural Heritage	X	X	X
12	Infectious Diseases (HIV/AIDS)	X	X	X

Note: X means "applicable".

(2) Summary of Impacts on Natural Environment

During the construction period, it is expected to have several disturbances to the riverbed condition including benthos due to the bridge pier construction activities to be carried out inside of the Mekong River. So, environmental impacts on the water quality of the Mekong River, local aquatic fauna and fishery around both Neak Loeung deep pool and riffle areas would be critical discussion points throughout the bio-physical environmental information-based IEE process (Note: According to current Cambodian fishery law, the project owner of any development project that would contain construction activities adjacent to/or inside of the major tributaries, navigational channel and floodplain area that are important for spawning/or breeding for migrating fishes must obtain the permission from the MAFF).

Also, inundation and subsidence issues related with the approach road construction would become the critical discussion points. Well-planned regional drainage program during the rain season shall be established before the construction will start. It is expected that large amounts of construction waste will be generated, so that it would be quite essential to prepare enough waste disposal sites with proper treatment methods. The roadside air quality and noise may be somewhat deteriorated due to the temporally increase of the local traffic volume (mainly, construction-related heavy vehicles).

After the bridge operation will start, most of critical environmental issues to arise during the construction period will be subdued/or disappear, but the following environmental impacts such as the subsidence around the approach roads on both sides and inundation issues would still be critical discussion points. Also, the erosion of the road bank to be caused by the wind-induced waves would not be negligible during the flood period. It is essential to prepare an appropriate road bank protection measures such as the implementation of proper roadside vegetation.

Similar environmental impacts identified within the IEE evaluation of the bridge option (except impacts to be caused by inside-river-related construction activities) would be caused at both construction/operation phases of the improved ferry option. Besides, impacts on the water quality in the operation phase of both ferry options would become critical discussion points to some extents.

(3) Summary of Impacts on Social Environment

As a result of the IEE study on the social environment, it was revealed that there might have potential impacts on a wide range of the social environment during the construction phase as well as the operation phase of the bridge option (including the combined option) or the ferry improvement option with an additional pier.

The most significant social impact would be a considerable level of resettlements required for the construction of a bridge or an additional pier before and during the construction phase. The estimated number of PAPs (Project Affected Persons) which is defined as the number of heads of the affected households at the time of the IEE-level study ranges from 51 to 70, while that of PAIs (Project Affected Individuals) which is defined as the number of all the family members of PAPs ranges from 263 to 364. Other significant impacts would be loss of income and job opportunities of vendors, retailers and restaurants at the ferry terminals due to abolishment of ferry services.

In addition to these major impacts, other significant impacts would be:

- That the prevalence rate of HIV/AIDS might increase due to the massive inflow of construction workers during the construction phase and the improved mobility of the epidemic through various mobile groups of people during the operation phase, being closely related to serious social threats to women and children.
- That the flood-free land will be created by spaces surrounded by National Road No.1, National Road No.11, and an approach road associated with the construction of a bridge or an additional pier and the flood-free land might bring about the economic disparity as well as land disputes in the project affected area during the operation phase.

7.2 Environmental Impact Assessment (EIA)

Based on the comprehensive literature reviews and the collection of the up-to-date baseline information/data, the natural and social environmental conditions around the study area of Neak Loeung were profiled, and potential natural and social impacts were qualitatively and quantitatively identified. In addition, more in-depth field surveys covering a wide range of natural and socio-economic information were conducted in order to obtain the full-scale data and information to identify those impacts.

Regarding the time range in which potential impacts were assessed, the Study covered the pre-construction period, the construction period, and the post-construction period under the proposed *"Ferry+Bridge Option (Route A)"*.

More concretely, the EIA study on natural and social environment was based on more in-depth qualitative and quantitative data analysis resulting from a series of field surveys, thereby assessing the potential natural and social impacts shown in Tables 7.2.1 and 7.2.2.

(1) Impact Assessment of Natural Environment

Table 7.2.1 Summary of Possible Impacts (Natural Environment)

	Environmental Factors	Remarks of Possible Impacts
1	Air Quality	1. Dust during the construction period 2. Future roadside air quality condition after the construction
2	Water Quality	1. Risk of water pollution to the Mekong River during the construction. 2. Potential of water quality degradation due to the erosion during/and after the construction
3	Soil and Sedimentation	1. Potential for soil erosion during/and after the construction. 2. Potential of sedimentation due to the erosion during/and after the construction. 3. Potential of cross-sectional seepage of the approach roads after the construction.
4	Waste Disposal	1. Preparation of excavated soil dump site. 2. Household wastes discharged from construction yard during the construction period.
5	Noise/Vibration	1. Noise and vibration during the construction period. 2. Future roadside noise and vibration after the construction.
6	Subsidence	1. Potential of Subsidence during/and after the construction.
7	Bad Smell	1. Bad smell due to the compost smell originated from the decayed plants under inundated water.
8	Topography and Geology	1. Worsened local flood/or inundation after the construction. 2. Risk of malaria, dengue and waterborne disease outbreak from newly created long-term inundated area. 3. Potential of the regional seepage/or recharge from the Mekong River to the regional drainage system of the flood-free land during/and after the construction. 4. Potential of the erosion of the riverbank of the Mekong River.
9	River Bed (e.g., benthos)	1. Disturbance to the river bed condition (e.g., benthos)
10	Flora/Fauna	1. Destruction of natural floodplain vegetation. 2. Disturbance to birds and wildlife during the construction period. 3. Illegal fishing/or hunting activities by bridge construction workers. 4. Habitat change due to the physical change/or damage on the Mekong River. 5. Risk of pollution to aquatic species during the construction period. 6. Disturbance to animal path after the construction.
11	Water Resources	1. Demolition of shallow wells. 2. Risk of pollution to the aquifer during the construction period.
12	Accidents	1. Potential of increased traffic accidents during the construction period. 2. Potential increase in traffic accidents after bridge operation starts. 3. Undiscovered UXOs or landmines during the construction period. 4. Increased risk of vessel collisions.
13	Global Warming	1. Possible CO_2 emission reduction after bridge operation starts.

Throughout this EIA study on the natural environment, it was found that potential impacts on the water quality, inundation, and subsidence would not be negligible. Also, it was found that several important reptile species with IUCN "Vulnerable" status occur on the east side of the Mekong River, so the conservation of those species is one of important and critical discussion points. The key components of the local fauna/flora conservation of the

Mekong floodplain area is to establish well-coordinated link with a basin-wide LMB management program while undertaking education and extension for the general community concerning biodiversity conservation. It is quite essential to establish comprehensive and effective environmental mitigation/management programs during the planning phase of this project.

(2) Impact Assessment of Social Environment

Table 7.2.2 Summary of Possible Impacts (Social Environment)

No.	Environmental Factors	Remarks of Possible Impacts
1	Migration of Populations and Involuntary Resettlement	1) Involuntary resettlement of houses and land due to the acquisition of land needed before the construction period
2	Impact on Local Economy (Employment, Livelihood, etc.)	1) Possibility of increase in unemployment of vendors at the ferry terminals due to decrease in the demand stemming from the abolishment of the ferry services after the construction period 2) Possibility of decrease in sales of local restaurants and retail shops due to decrease in the demand stemming from the abolishment of the ferry services after the construction period 3) Possibility of unemployment of local workers and staff of the Neak Loeung Ferry after the construction period
3	Utilization of Land and Local Resources	1) Slight possibility of reducing the production of agriculture and fishing in the flood-free area due to the change of the land use pattern during and after the construction period. 2) Almost no possibility of increasing forest crimes due to the opening of the bridge after the construction period
4	Social Institutions (Social Capital and Local Decision-making institution)	1) Slight possibility of hampering communes' and villages' official decision-making process after the construction period
5	Existing Social Infrastructure and Services	1) No adverse impacts on various social capitals such as norms, network and social bond of the local communities after the construction period 2) Improvement in accessibility to various social services such as educational and medical services after the construction period
6	Vulnerable Social Groups	1) Possibility of adverse economic impacts on vulnerable households who will be resettled before the construction period 2) Possibility of decreasing vulnerable households' income due to the abolishment of the ferry services after the construction period
7	Equality of Benefits and Losses and Equality in Development process	1) Possibility of unequal distribution of economic benefits between the rich and the poor after the construction period 2) Possibility of incurring the disparity in geographical advantages between well-located households and badly-located households after the construction period
8	Local Conflicts	1) Slight possibility of incurring economic conflicts such as land disputes between flooded area and flood-free area due to the creation of the flood-free area after the construction period
9	Gender	1) Possibility of decreasing women's cash income or unemployment due to the abolishment of the ferry services after the construction period 2) Possibility of increasing the risk of occurrence of sexual exploitation such as trafficking of women due to the increase in traffic after the construction period 3) Possibility of increasing prevalence of women's HIV/AIDS due to the massive inflow of construction workers during the construction period

No.	Environmental Factors	Remarks of Possible Impacts
10	Children's Rights	1) Possibility of decreasing children's cash income due to the the abolishment of ferry services after the construction period 2) Possibility of increasing the risk of occurrence of sexual exploitation such as trafficking of children due to the increase in traffic after the construction period
11	Cultural Heritage	1) No resettlement of archeological heritage sites and religious monuments before and during the construction period
12	Infectious Diseases (HIV/AIDS)	1) Possibility of increasing prevalence of HIV/AIDS due to the massive inflow of construction workers during the construction period 2) Possibility of increasing prevalence of HIV/AIDS due to the improvement of mobility of the people to and from urban areas after the construction period

Involuntary resettlement, one of the largest social impacts, is separately discussed in section 7.3.

The construction of the Bridge will be associated with the abolishment of ferry services, which might have significant economic impacts on the economic situations of local stakeholders such as whole sellers, retailers, vendors, etc., unless necessary mitigation measures are taken. Since the portion of sales to drivers and passengers is estimated as relatively small in the business communities such as large markets and relatively large in small-scale business communities such as restaurants and retail shops around the both ferry terminals, the economic impacts might be trivial in large markets and serious in small-scale business communities.

The massive inflow of construction workers for the construction of the Bridge might have significant economic impacts on the local economy. The business communities could benefit also if the contractor is encouraged to buy local materials where appropriate.

Although it is likely that some dozens of locally-employed workers of the Neak Loeung Ferry might lose their job opportunities, it might be solved by shifting these workers and their families to other ferry-crossing points.

The massive inflow of construction workers as well as the mobility effect by the construction of the Bridge might aggravate the situation on the spread of HIV/AIDS which has various negative socio-economic impacts, unless sufficient countermeasures are taken. More specifically, the improvement in mobility accrued from the construction of the Bridge might bring about a risk of increasing the prevalence ratio of HIV/AIDS through activating various mobile groups of people. What is worse, massive construction workers needed for the construction of the Bridge have a considerable risk of increasing the prevalence ratio of the epidemic through their sexual activities.

In addition to these direct social impacts, a wide range of secondary and cumulative negative impacts were identified in order to obtain the clear understanding of the complicated socio-economic interrelationship in Neak Loeung.

Major secondary impacts on the social environment which might be triggered by the direct impacts are: i) that the involuntary resettlement might have a risk to transform ordinary households to households in economically and socially vulnerable group, ii) that the lower social and economic status of women and children might be accelerated by HIV/AIDS, further worsening lower income, high mobility and other social problems such as orphanage, trafficking, and etc., and iii) that the local economy might be aggravated by the spread of HIV/AIDS through the decrease in productivity.

On the other hand, cumulative impacts would be generated from a wide range of accumulated factors which are individually minor but collectively significant taking place over the considerable period of time. Although each direct impact derived form the construction of the Bridge is not so serious, there might be accelerated by cumulative impacts which are collectively significant. Those cumulative impacts are that the unemployment, spread of HIV/AIDS and other social problems against women, children and other vulnerable groups who are socially and economically in weak positions might be accelerated by the construction of the Bride over the considerable period of time.

(3) Mitigation and Monitoring (Natural Environment)

Mitigation measures must be incorporated into tender documents prepared under the engineering component of this project in order to ensure that the contractor is obliged to comply with measures in the environmental management plan (EMP). The major mitigation measures are listed below.

a) Maintenance of comfortable roadside environment throughout the project.

b) Alleviation of disturbance of regional hydrological balance, in particular, drainage system, and to lessen related secondary impacts such as inundation.

c) Alleviation of secondary impacts of a large-scale subsidence around the approach roads on both sides of the Mekong River.

d) Minimize the risk of the erosion of road bank of approach roads, that may lead to new local inundation or water quality degradation, and the erosion of the riverbank of the Mekong River.

e) Alleviation of disturbance of natural fauna/flora condition over the Mekong floodplain and inside of the Mekong River throughout the project.

f) Harmonization of new transport facilities with surrounding communities.

In addition, the major monitoring activities for the impacts are listed below.

a) Noise and Vibration

The purpose of the noise and vibration monitoring is to limit nuisance to local residents and to the workforce, and the noise should be measured frequently during the construction. Potential sources of the noise include a heavy construction plant and vehicles. An ad-hoc approach should be taken, depending on the type of activities in progress and their location on site in relation to sensitive receivers. Background noise and vibration level must be measured before the project commencement. Parameters to be monitored for the noise and vibration are Leq (dBA) and L10 (dB), respectively. Remedial measures will be taken when Leq value exceeds the Cambodian environmental standard. In Cambodia, no environmental standards for vibration is established yet, but there would be likelihood to have property damage due to the roadside vibration to some extents when the traffic volume will be increased during both construction and operation periods. So, it is wise to use other ISO-based vibration standards such as the one implemented in Japan for the vibration monitoring.

b) Dust

The objective of the dust monitoring is to control nuisance to both local residents and the workforce on site. Monitoring site should be located in areas where there are sensitive receivers. Generally, dust generation is the most severe along unpaved access roads and at

areas where loose materials are handled (e.g., industrial wastes site, stockpiles, and so on). Based on those facts, the monitoring station sites should be determined. Parameters to be monitored are PM-10 and/or the weight of the dust accumulated within a specific time period (e.g., 1 week – 1 month). Background dust level must be measured before the project commencement, and remedial measures will be taken where more than 50% increase of the background dust level occurs or when PM-10 value exceeds the Cambodian environmental standard.

c) Groundwater Level

The objective of groundwater monitoring is to observe a change in the regional water balance during the construction. Several monitoring wells should be installed in order to establish a proper monitoring network, and the monitoring will determine whether there is a severe drawdown/or uprising, that will lead to regional aquifer consolidation/or vegetation change.

d) Groundwater Quality

Parameters to be monitored include: organoleptic conditions such as color and odor; physico-chemical characteristic such as turbidity, conductivity, sulfate and aluminum content; undesirable substances such as nitrates and hydrocarbons; toxic substances such as chromium, lead and pesticide. Polluted discharge from road surfaces can be assessed either by heavy metal content, oil or suspended matter. Also, spillage of untreated household effluents can be detected by BOD, COD, Coliform, grease and other common parameters.

e) Surface Water Quality

It is essential to have periodical water quality tests during the construction phase of the project in order to check the water quality pumped from excavations and discharges from construction sites, and to monitor the effects of any localized pollution due to human activities and spills. In particular, intense water quality monitoring program should be implemented around the project site of the Mekong River. Monitoring of the ambient water quality will determine whether there are likely to be problems for downstream users, whereas monitoring of the effluents will help to identify the source of the problem and the remedial action. Parameters to be monitored should reflect the type of contaminants likely to be detected. For example, contamination caused by concrete may be detected through increased pH levels.

f) Conservation Pond

It is essential to prepare a proper field surveillance/or monitoring program in order to establish a well-managed conservation pond and to avoid/or lessen the occurrence of illegal hunting therein. As described in previous section, the alternative site for the conservation pond is ex-old river and several ponds and natural vegetation already exist. So, construction itself (e.g., setting up of fence and signboard) would not take relatively long time nor huge manpower, and it is expected to this newly created conservation pond would become a full-fledged sanctuary within relatively short time period (Walston, personal communication, 2005). However, it is recommendable to assign a special trained-personnel/or field officer in the regional office for periodic on-site check of the conservation pond status (e.g., direct observation of pond, water quality, number of turtles recognized within this pond, occurrence of any damages to the fence, and so on).

g) Fish

As mentioned in the early section, there is little information on the ecology and distribution of most of these species, especially their local status around Neak Loeung. It is,

accordingly, essential to monitor the impacts on fish, especially such critically endangered species as Mekong Giant Catfish, during/after the construction of the project bridge, using fisheries catch data and local ecological surveys, in order to mitigate these adverse impacts on them.

(4) Mitigation and Monitoring (Social Environment)

Apart from the measures to mitigate the impacts on natural environment which are incorporated into tender documents prepared under the engineering component of the Project in order to ensure that the contractor is obliged to comply with measures in the environmental management plan (EMP), the impacts on the social environment should be mitigated with the assistance of the line ministries and agencies. While the mitigation measures for involuntary resettlement are separately discussed in the RAP, the mitigation measures for major social impacts are proposed below.

a) Comprehensive Michi-no-eki Development Programme

As one of the major mitigation measures to create economic opportunities for the local economy, a comprehensive "Michi-no-eki (Roadside Station)" programme is proposed in order to provide opportunities to sell local products to drivers and passengers who will stop over at Neak Loeung. Michi-no-eki is a multi-functional space for rest and exchange along a highway whose functions are linked to rural roads, creating connections between highway network and local communities. The main functions of Michi-no-eki are:

- Rest: Providing highway users with a clean and comfortable rest area.
- Market: Providing a place for direct sales of products and possibly for processing those products to generate high value added.
- Terminal: Providing terminal functions for public transport.
- Public Services: Providing a wide range of public services for highway users as well as local residents.
- Sightseeing: Providing a new recreational site for visitors.

The concrete blueprint for the roadside station should be proposed as one of the mitigation measures.

b) Smooth Transfer and Training Programme Neak Loeung Ferry Staff

After the Bridge is open to traffic, it is projected that the ferry system at Neak Loeung will be abolished and 3 ferry boats (TA PHROM, VISHNU and PEACE-2) will be deployed to other ferry terminals. In any event, a potential demand for the ferry transport in Cambodia is evident along such large rivers as the Mekong River, the Tonle Sap River and Bassac River. MPWT will be able to transfer the Neak Loeung Ferry staff to other crossing points.

MPWT is strongly recommended to take into account the following actions in case of transferring its Neak Loeung ferry contracted-based staff and workers.

(i) Staff and workers who will wish to work at new crossing points should be given priorities in their work contracts.

(ii) Even if staff and workers do not prefer working at newly assigned remote crossing points, they should be transferred to other appropriate sections of MPWT, or should be assisted in their job seeking activities to the maximum extent, after carefully hearing their requests.

c) Participatory Maintenance of Roads near the Bridge for Creation of Economic Opportunities

Providing immediate and direct income from labor-based construction and maintenance of approach roads, improving critical small-scale civil works, and developing the local small-scale contracting industry, are important in terms of the rural development and the provision of economic opportunities. Gravel or laterite surfacing is widely adopted for low cost rural and access roads in many developing countries. Low Cost Surfacing (LCS) approach providing local people with opportunities for the community participation of rural roads to connect to the approach roads is recommended, and periodic re-gravelling is an effective way.

d) Credit and Saving Program for Small-scale Business for Local Traders and Farmers

In order to stimulate the local economy, the credit and savings programmes for small-scale businesses for local traders and farmers are proposed as one of the mitigation measures.

e) Comprehensive HIV/AIDS Prevention Package for Construction Workers and Local Communities

The mitigation measures of HIV/AIDS during and after the construction period of the Bridge are critical to provide a wide range of prevention and supporting programmes targeting construction workers and local people. Large infrastructure construction sites offer job opportunities that attract a large number of young people who migrate from poor rural areas nearby regions. Construction workers comprise the key mobile groups. The Project must promote HIV/AIDS awareness and implement prevention programmes, and the programme should be an obligation of the contractors. Therefore, the obligation should be included into the EMP in addition to the mitigation measures for the impacts on the natural environment during the construction phase. The program will consist of 4 components:

i) Advocacy actions on HIV/AIDS to be organized through workshops targeting local resident communities in the Project area, bridge contractors, and transportation companies.

ii) Information and education campaign on HIV/AIDS through posters, pamphlets, launch events, and focus group discussions at the construction worksites and resident community level in the project area.

iii) Surveillance and monitoring activities of HIV/AIDS prevalence.

iv) The 100% condom use program (CUP): The 100% condom use program (CUP) was pilot tested in Sihanoukville in 1998. After the pilot phase of CUP was evaluated in late 1999, the National Policy on 100% Condom Use was approved. The Government prepared the National Strategic Plan for a Comprehensive and Multi-sectoral Response to HIV/AIDS 2001-2005 (NSP). Several Ministries are undertaking major HIV/AIDS activities, including National Defense; Social Affairs, Labor, Vocational Training and Youth Rehabilitation; Women's and Veteran's Affairs; Education, Youth and Sports; and Culture and Religion. CUP should be implemented before starting the construction of the Bridge.

On the other hand, the major monitoring activities for the social impacts focus on a wide range of the monitoring indicators to measure the effectiveness of mitigation measures apart from the EMP and the monitoring of the RAP. Monitoring for the implementation of the RAP is of critical importance. External monitoring on the full-scale RAP is required to provide an independent periodic assessment of resettlement implementation and impacts, to verify internal reporting and monitoring, and to suggest adjustment of delivery mechanisms

and procedures as required to function effectively. Project promoters are responsible to contract a suitable and experienced external monitoring agency which is required to keep its neutrality, and the budget for the said external monitoring should be provided in the RAP. The results of the external monitoring should be properly reported to PAPs and relevant stakeholders in appropriate timings.

i) Entitlement policies as well as basic policies of the full-scale RAP are in line with the planned framework of RAP.

ii) Agreements to resettlement to PAPs are properly obtained.

iii) Entitlements of PAPs are in accordance with the approved entitlement policies.

iv) Assessment of compensation is carried out in accordance with agreed procedures.

v) Payment of compensation to the affected people in the various categories according to the level of compensation as described in the RAP.

vi) Public information and public consultation and Grievance procedures are followed as described in the RAP.

vii) Relocation and payment of subsistence and shifting allowances are made in timely manner.

viii) Smooth linkage of resettlement and commencement of civil works.

7.3 Framework for Resettlement Action Plan (RAP)

(1) Background and Necessity for Formulating Full-scale RAP

A Resettlement Action Plan (RAP) is a document required for any project which results in the physical resettlement of people, and it must specify the procedures and actions that should be taken in order to properly resettle and compensate the affected people and communities. It is required as a minimum condition that a RAP must ensure that the incomes and living standards of the affected people are restored to pre-project levels and are not worse off than they would have been without the project. More specifically, a full-scale RAP should be prepared as a detailed plan for mitigating the land acquisition impacts, the largest social impact, by *the ferry plus bridge option (Route A)* of the 2nd Mekong Bridge Project.

In summary, since there are no systematic, consistent and comprehensive resettlement policies in Cambodia, donors are extending cooperation on ad-hoc basis, depending on the particular donors' specific requirements. However, the Government of Cambodia is in a transitional position, trying to fill the gap between international best practices and the existing policy with the assistance of donor agencies and drafted National Resettlement Policy (NRP).

Since the socio-economic survey is not an official census before the feasibility study is completed, full-scale RAP should be formulated based on the DMS together with the full-scale census.

(2) Number of PAPs

The number of PAPs at the stage of the "Simple Survey" is 260 house owners and landowners with 270 assets as shown below.

Table 7.3.1 Number of PAPs

No.	Province	District	Commune	Number of PAPs	Number of Asset Records (House and Land)
1	Prey Veng	Peam Ror	Prek Ksay Ka	69	71
2	Prey Veng	Peam Ror	Prek Ksay Kha	81	88
3	Kandal	Leuk Dek	Kampong Phnom	110	113
Total				260	270

(3) Resettlement Policy Framework

1) Eligibility and Entitlement Policy (Compensation Measures)

The eligibility and entitlement policy consists of a set of guidelines and criteria that define the compensation measures for each category of PAPs who are eligible to receive compensation. The compensation package includes a wide range of measures like cash compensation and institutional support provided to eligible PAPs. A Detailed Measurement Survey (DMS) will be carried out covering 100% PAPs to quantify and categorize the affected households and structures. The compensation/mitigation measures cover:

- Loss of land
- Loss of structures
- Loss of productive trees
- Loss of commune and public assets
- Allowances for disruption/resettlement and for vulnerable households

Consequently, the tentative cost for the RAP is summarized in Table 7.3.2. It should be noted that the detailed breakdown of the compensation is not specified in the cost summary due to the fact that the quantity is not based on the official census.

Table 7.3.2 Tentative Cost Estimate for RAP

Content	Items	Quantity	Compensation (USD)
1. Compensation	House Structure (sq.m)	5,773	103,497
	Wells (no.)	32	2,520
	Fences (m)	2016	10,449
	Trees (no.)	6624	52,576
	Allowances (no.)	227	8,460
Subtotal		-	177,502
2. Land Acquisition	Construction Yard (Paddy Field) (sq.m)	161,038	90,181
	Residential Land (sq.m)	70,807	158,608
	Paddy Field (sq.m)	188,359	105,481
Subtotal		420,204	354,270
3.Management Cost			79,766
4.Contingency			61,154
Total			672,692

Source: Prepared by JICA Study Team

2) Taxes and Government Fees

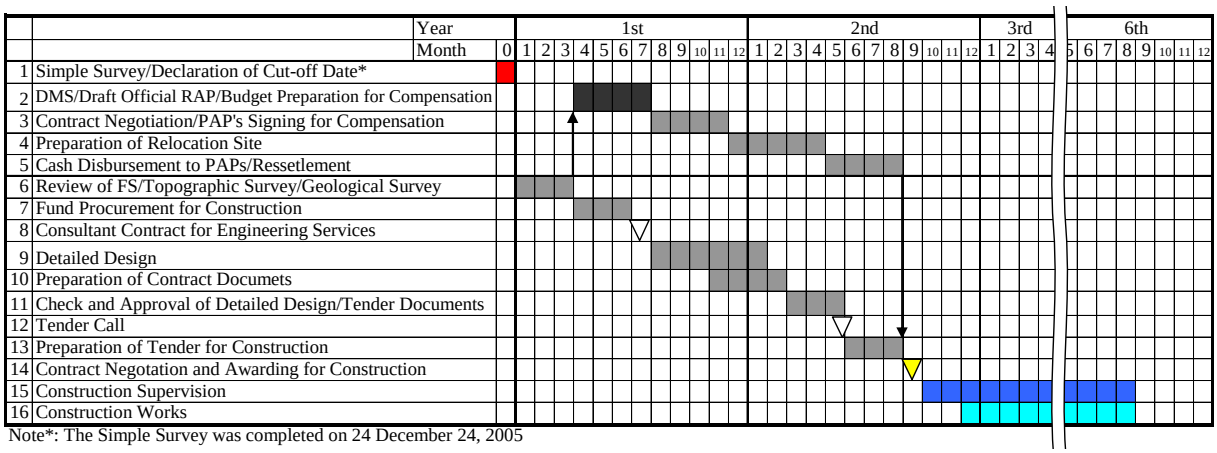
The government is responsible for all fees and taxes PAPs have to pay as a result of any transaction associated with their relocation or compensation assistance.

3) Detailed Measurement Survey (DMS)

Detailed Measurement Survey (DMS) is the survey to identify extent and effects of assets loss after the detailed design of the project.

(4) Implementation Schedule

The detailed implementation schedule for RAP should be specified in the full-scale RAP, taking into account the availability of the funds and the timing of the construction of the Bridge. Figure 7.3.1 shows tentative implementation schedule for compensation and resettlement. The implementation schedule will be divided into the preparation stage, the implementation stage, and the supervision/monitoring stage.



Note*: The Simple Survey was completed on 24 December 24, 2005

Figure 7.3.1 Tentative Implementation Schedule for Compensation and Resettlement

7.4 Results of Simple Survey

"Simple Survey" was conducted as a milestone to confirm the PAPs' basic agreement to the Project. The result of "Simple Survey" was that out of 260 PAPs identified as of December 24, 2005, 98.8% (257 PAPs) were in agreement to the Project. Two PAPs expressed their objections to the Project, and one PAP had no comments. The reasons for the objections are that they are generally concerned about the livelihood after the resettlement. Most of those who agreed are conditional to compensation.

8. PUBLIC CONSULTATIONS

8.1 JICA Guidelines for Environmental and Social Considerations and Its Applications for the Project

In the JICA guidelines for environmental and social considerations, JICA emphasizes that democratic decision-making is essential, and in order to achieve an appropriate decision-making process, it is critical to ensure stakeholder participation, information transparency, accountability and efficiency as well as the respect for human rights.

JICA classifies projects into 3 categories in accordance with the extent of environmental and social impacts, taking into account an outline of the project, the scale, the site condition, and the environmental impact assessment scheme. This Project is classified as Category A which is regarded as a project which might have significant negative impacts on the environment and society.

8.2 Procedures for Public Consultations

The Study was divided into 2 stages: the master plan stage (IEE-level study stage) and feasibility study stage (EIA-level study stage) with main tasks as follows:

- Master plan stage: main task is to study the optimum method to cross the Mekong river at Neak Loeung.
- Feasibility study stage: main task is to examine the feasibility of the selected crossing method and route from engineering, environmental and economic/financial aspects.

Table 8.2.1 shows the procedures for the overall stakeholder meetings which were in compliance with the guidelines. Eight stakeholder meetings (SHM 1-1～3-3) have been held in both Phnom Penh and Neak Loeung, and the last stakeholder meeting (SHM 3-3) was held at the end of January 2006, when the Draft Final Report was submitted to the government

Table 8.2.1 Procedures for Overall Stakeholder Meetings

No.	Meeting	Level	Objective	Timing
1	SHM 1-1	Kick-off	Introduction of the Project, explanation on procedures for public consultations, and preliminary scoping of environmental and social considerations study	May 2004
2	SHM 1-2	Kick-off	Same as above (Special Session at Neak Loeung)	June 2004
3	SHM 2-1	IEE	Consultation at the time of scoping of environmental and social considerations	October 2004
4	SHM 2-2	IEE	Consultation at the time of preparing a rough outline of environmental and social considerations	December 2004
5	SHM 2-3	IEE	Consultation at the time of preparing a draft of the final report (Consensus was made among the stakeholders on the selected optimum method)	March 2005
6	SHM 3-1	EIA	Consultation at the time of scoping of environmental and social considerations	June 2005
7	SHM 3-2	EIA	Consultation at the time of preparing a rough outline of environmental and social considerations	September 2005
8	SHM 3-3	EIA	Consultation at the time of preparing a draft of the final report	January, 2006

Remarks: SHM means Stakeholder Meeting

In addition to the overall stakeholder meetings, the following 3 special stakeholder meetings for the minority groups were held during the master plan stage as shown below.

Table 8.2.2 Procedures for Stakeholder Meetings with Minority People

No.	Meeting	Level	Objectives	Date
1	2-1-a	IEE	Consultation at the time of scoping of environmental and social considerations	October, 2004
2	2-2-a	IEE	Consultation at the time of preparing a rough outline of environmental and social considerations	December, 2004
3	2-3-a	IEE	Consultation at the time of preparing a draft of the final report	March, 2005

At the early stage of the public consultation, a wide range of possible participants who are interested in the project was enumerated, and the following 94 stakeholders shown below were eventually invited for overall meetings at Phnom Penh.

Table 8.2.3 Selected Stakeholders for the Overall Meetings at Phnom Penh

No.	Category	Number of Stakeholders
1	Ministries and Agencies	25
2	Representative from People in Neak Loueng	12
3	Management and Staff of Neak Loueng Ferry	5
4	International Organizations and Donor Agencies	20
5	Local Governments	5
6	NGOs	15
7	Private Sector	7
8	Universities and Research Institutions	5
Total		94

8.3 Results of Public Consultations

Stakeholder Meeting 2-3, the last stakeholder meeting of the master plan stage of the Study, was held on March 2005 in an attempt to demonstrate and achieve consensus among stakeholders that the “Ferry Improvement + Bridge (Route A)” option was selected as the optimum solution to cross the Mekong River at Neak Loeung.

In order to further guarantee the far-reaching transparency and information disclosure to all the stakeholders, one-and-half month public comment period was set up after the Stakeholder Meeting 2-3, and, during this public comment period, the Ministry of Public Works and Transport properly answered to a wide range of comments and questions from various stakeholders.

As the final stakeholder meeting of the whole study, the Stakeholder Meeting 3-3 was held at the end of January 2006. One-month public comment period was set up after Stakeholder Meeting 3-3, and during this public comment period, the Ministry of Public Works and Transport received a wide range of comments and questions from all the stakeholders and is to answer to those comments and questions to make the final consensus among all the stakeholders.

9. ECONOMIC AND FINANCIAL ANALYSIS

9.1 Economic Evaluation of the Project

(1) Basic Assumptions

1) Project life

The evaluation period is assumed to be 25 years after the completion of the Project in 2012.

2) Prices

The base year for prices is September 2005 and exchange rates are set up as follows:

US$ 1.0 = Yen 108.03 = 4067 Riel (average rates of the six months between March 2005 and August 2005)

(2) Estimation of the benefits

The benefits that could be expected by the implementation of the project are identified as follows:

Savings to those road users that would have crossed the river by the Neak Loeung Ferry and to those road users that would take alternative route via Kampong Cham and Kizuna Bridge because of the lack of the ferry capacity. Those savings are composed of:

- Vehicle operating costs
- Travelers time costs
  (Savings of passenger travel time and savings in the opportunity cost of capital caused by the delayed freight by trucks)

(3) Estimation of Economic Project Costs

For the economic analysis, financial costs were converted to economic costs by deducting the tax portions and applying a standard conversion factor (SCF) to the portion of non-trade goods. According to the statistical data regarding foreign trade and governmental revenues in Cambodia, Standard Conversion Factor (SCF) is estimated to be 0.855.

As a result, the project costs in terms of economic prices for the proposed bridge are estimated at US$64.51 million.

(4) Operation and Maintenance Cost

1) Operating & Maintenance Costs of Ferry and Project Bridge

Annual operating and maintenance costs for Neak Loeung Ferry are based on data from the Ministry of Public Works and Transport to be US$ 892,000, and its economic price is estimated at US$615.900 by deducting tax payment from the cost of fuel and lubricant and applying the SCF for the rests.

2) Operation & Maintenance Costs of Bridge

The operation and maintenance costs for the proposed bridge in terms of financial prices are estimated at US$ 268,370/year and in terms of economic prices at US$ 229,550/year.

(5) Cost and Benefit Analysis

For the Economic Analysis of the project, costs and benefits are identified below.

Table 9.1.1 Costs and Benefits Items of the Project for Economic Analysis

for Supplyer		for User		Net Cash Flow for the cases
Cash-Out	Cash-In	Cash-Out	Cash-In	
Case: [Without] Project				
Ferry Operation & Maintenanc (future replacement costs are annualized)	*Revenue by Ferry Tariff*	*Payment for Ferry Tariff* VOC Travel Time Cost		・Ferry Operation & Maintenance ・VOC ・Travel Time Cost
Case: [With] Project				
Investment (Bridge) Operation & Manitenance of the bridge	*(Revenue from the bridge, if toll is applied)*	*(Payment for the bridge, if toll is applied)* VOC Travel Time Cost		・Investment (Bridge) ・O & M of the bridge ・VOC ・Travel Time Cost
[With - Without] Project				
				Cash-In items **・Ferry O & M** **・User's savings in VOC & TTC** Cash-Out items **・Investment (Bridge)** **・Bridge O & M**

Source: JICA Study Team

Based on the above table, the cost and benefit flows are estimated as shown in Table 9.1.2 and the economic evaluation indicators are derived as shown in Table 9.1.3.

(6) Sensitive Analysis

A sensitivity analysis was undertaken to assess the cost benefit analysis under worse scenarios as shown in Table 9.1.4.

Table 9.1.2 Cost Saving by Bridge Development

Unit; 000US$(Economic Price)

Unit; 000US$ (Economic Price)

Year	Cash - Out			Cash - In						Net Cash Flow
	Bridge		Total	User's Cost Savings				Ferry	Total	
	Investment	O&M		VOC	Time Cost	Freight Time	Total	O&M		
2007	2,045	0	2,045	0	0	0	0	0	0	-2,045
2008	2,057	0	2,057	0	0	0	0	0	0	-2,057
2009	16,919	0	16,919	0	0	0	0	0	0	-16,919
2010	16,035	0	16,035	0	0	0	0	0	0	-16,035
2011	16,105	0	16,105	0	0	0	0	0	0	-16,105
2012	11,356	77	11,433	-264	1,760	149	1,645	308	1,953	-9,480
2013	0	230	230	-288	2,461	205	2,378	924	3,302	3,073
2014	0	230	230	-312	3,774	310	3,773	924	4,696	4,467
2015	0	230	230	1,279	7,317	598	9,194	924	10,118	9,889
2016	0	230	230	3,883	11,863	958	16,705	924	17,629	17,399
2017	0	230	230	6,587	13,032	1,050	20,670	924	21,594	21,364
2018	0	230	230	9,395	14,245	1,146	24,786	924	25,710	25,481
2019	0	230	230	12,310	15,503	1,245	29,059	924	29,983	29,753
2020	0	230	230	15,336	16,808	1,349	33,492	924	34,416	34,187
2021	0	230	230	18,475	18,160	1,415	38,050	924	38,974	38,744
2022	0	230	230	21,732	19,562	1,481	42,775	924	43,698	43,469
2023	0	230	230	25,109	21,015	1,547	47,671	924	48,595	48,365
2024	0	230	230	28,611	22,520	1,614	52,744	924	53,668	53,439
2025	0	230	230	32,241	24,079	1,680	58,000	924	58,924	58,694
2026	0	230	230	36,004	25,693	1,746	63,444	924	64,368	64,138
2027	0	230	230	39,904	27,365	1,812	69,081	924	70,005	69,776
2028	0	230	230	43,944	29,096	1,878	74,918	924	75,842	75,613
2029	0	230	230	48,129	30,887	1,945	80,961	924	81,885	81,655
2030	0	230	230	52,463	32,741	2,011	87,215	924	88,139	87,909
2031	0	230	230	56,951	34,659	2,077	93,687	924	94,611	94,382
2032	0	230	230	61,598	36,643	2,143	100,384	924	101,308	101,078
2033	0	230	230	66,359	38,358	4,845	109,563	924	110,487	110,257
2034	0	230	230	71,386	40,152	7,683	119,221	924	120,145	119,915
2035	0	230	230	76,692	42,028	10,660	129,380	924	130,304	130,075
2036	0	230	230	82,292	43,990	13,782	140,065	924	140,988	140,759
2037	-399	230	-170	88,201	46,043	17,054	151,298	924	152,222	152,392
Total	64,117	5,815	69,933	898,021	619,755	82,383	1,600,159	23,405	1,623,564	1,553,632
NPV	40,579	951	41,529	68,621	63,568	6,035	138,225	3,827	142,052	100,522
B/C	discount rate 12%									3.43
EIRR										23.0%

Source; JICA Study Team

Source: JICA Study Team

Table 9.1.3 Summary of Cost Benefit Analysis

Indicator	Result
EIRR	23.0%
B/C (at discount rate of 12%)	3.43
NPV (US$000, at discount rate of 12%)	100,522

Source: JICA Study Team

Table 9.1.4 Summary of Economic IRRs by Varying Traffic Demand

		Project Cost		
		Base Case	10% Increase	20% Increase
Traffic Demand	Base Case	23.0%	22.0%	21.1%
	10% Decrease	20.5%	19.6%	18.9%
	20% Decrease	18.4%	17.6%	16.8%

Source: JICA Study Team

9.2 Financial Evaluation of the Project

(1) Revenue Estimation

Toll rate

As described in the section 6.3, Application of Toll System to the Project, base case is set to the level to collect the maintenance costs required for the proposed bridge. In this financial analysis, the following additional cases are examined to know the financial viability of the project. It should be noted in revenue calculation that from the traffic survey and practical consideration, collection rate[4] of toll is set to be 80%. The cases examined are summarized below.

Table 9.2.1 Toll Rates for Cases

Toll Case / Category of vehicle	Base Case: Level to operate and maintain the project		Case 1: Level to cover $0.5 mil. surplus + Base Case		Case 2: Level at 80% of user's benefit		Case 3: Level at 100% of user's benefit		Case 4: Level at current ferry rate	
	Riel	USD	Riel	USD	Riel	USD	Riel	USD	Riel	USD
Motorbike	100	0.02	200	0.05	200	0.05	250	0.06	500	0.12
Sedan	400	0.10	1,400	0.34	2,600	0.64	3,200	0.79	5,800	1.43
Pickup	400	0.10	1,400	0.34	2,600	0.64	3,200	0.79	5,800	1.43
Short Body Bus	600	0.15	2,100	0.52	3,700	0.91	4,600	1.13	8,500	2.09
Long Body Bus	1,700	0.42	6,000	1.48	11,000	2.70	13,700	3.37	25,000	6.15
Short Body Truck	1,700	0.42	6,000	1.48	11,000	2.70	13,700	3.37	25,000	6.15
Long Body Truck	1,700	0.42	6,000	1.48	11,000	2.70	13,700	3.37	25,000	6.15
Semi/Full Trailer	3,400	0.84	11,800	2.90	21,000	5.16	27,000	6.64	49,000	12.05
Ratio to Ferry Tarrif	7%		24%		45%		55%		100%	

Note: Excahnge rate 1$=Riel 4067, Toll level for Case3 is set at 44% of Case1, Toll level for Case4 is set at 55% of Case1
Source: JICA Study Team

(2) Cash Flow Analysis

Project Costs

The project costs in terms of financial prices are estimated in the process of the cost estimates and summarized in Table 6.1.4. For the financial analysis it is assumed that the implementation body covers Land Acquisition and Compensation Cost, Site Expenses, and Tax.

Estimated FIRR (ROI)

Based on the estimated revenues and project costs, FIRR regardless of fund raising condition is calculated for the case of without repayment of the initial investment cost and interest cost . The project life is 30 years after the completion.

Table 9.2.2 shows the summary of the estimated FIRR.

[4] To exclude the traffic, which are exempted from paying toll, such as emergency vehicles and some public purpose vehicles, collection rate are conducted in the traffic survey by the study team

Table 9.2.2 Estimated FIRRs of Alternative Toll Cases

Case		FIRR
Base Case	Level to cover maintenance cost of the proposed project	Unsolved
Case 1	Level to cover $0.5 million surplus + Base Case	Unsolved
Case 2	Level at 80% of user's benefit	Unsolved
Case 3	Level at 100% of user's benefit	2.9%
Case 4	Level at current ferry rate	6.6%

Source: Study Team

As discussed in Section 6.3 "Application of Toll System to the Project", it is desirable that the toll level should fall between the Case1 and Case2. However, the result shows that the project is financially not feasible in both these cases.

Even at the toll level equivalent to the current ferry tariff, the project will not be able to attract private sector for the investment, considering the fund raising cost of 16% p.a. in Cambodia and the risk in foreign exchange rates.

Cash Flow Analysis

Alternative case analysis was executed to evaluate the possible cash flows that reflect the fund procurement method and repayment conditions. The purpose of cash flow analysis is to show, if the necessary investment cost is funded by loan, how much subsidy the government of Cambodia needs to prepare to compensate annual deficit of the project under the different alternative toll rates. Other basic conditions of the alternative analysis are:

- Interest during construction is assumed to be covered by the subsidy.
- Subsidy (annual short-term loan required to cover the shortage of balance) is calculated to show the necessary amount that the implementation body (government) needs to prepare to compensate the annual deficit, and the analysis result exhibits the first year of annual surplus and also the first year of the accumulated surplus.

The cash flow analysis was conducted under different conditions, such as alternative toll levels, loan/equity ratios and repayment conditions. The loan/equity ratio is assumed to be 100/0 or 85/15. The latter is more realistic in the practice of ODA lending agencies and the 15% equity nearly corresponds to the required cost for the estimated "Land Acquisition and Compensation", "Site Clearance" and "Tax" portion (13.1%) of the project cost.

The summary of the results of alternative analysis is shown in Table 9.2.3 and cash flow table in Case 3-b is presented in Table 9.2.4.

Table 9.2.3 Summary of Result of Alternative Cases

	Toll Level		Loan Condition				Results		
			Interest Rate	Repayment Period (year)	Grace Period (year)	Loan/Equity Ratio	Max Annual Subsidy (Year)	First Year of Annual Surplus	First Year of Accumulated Surplus
Base Case	Level to cover maintenance and operation cost of the project	a	1%	30	10	100/0	$mil 4.25 (12th)	31st	do not show in the project life
		b		30	10	85/15	$mil 3.59 (12th)	31st	
		c	5%	30	10	100/0	$mil 7.40 (12th)	n.a.	do not show in the project life
		d		30	10	85/15	$mil 6.27 (12th)	n.a.	
Case 1	Level to cover $0.5 mil. surplus + Base Case	a	1%	30	10	100/0	$mil 3.17 (12th)	29th	do not show in the project life
		b		30	10	85/15	$mil 2.51 (12th)	28th (5th)*3	
		c	5%	30	10	100/0	$mil 6.32 (12th)	29th	do not show in the project life
		d		30	10	85/15	$mil 5.18 (12th)	29th	
Case 2	Level at 80% of user's benefit	a	1%	30	10	100/0	$mil 1.97 (12th)	21st (2nd)*4	28th (4th)*8
		b		30	10	85/15	$mil 1.31 (12th)	19th (2nd)*5	22nd (3rd)*9
		c	5%	30	10	100/0	$mil 5.12 (12th)	26th	do not show in the project life
		d		30	10	85/15	$mil 3.98 (12th)	24th	
Case 3	Level at 100% of user's benefit	a	1%	30	10	100/0	$mil 1.30 (12th)	18th (2nd)*6	3rd
		b		30	10	85/15	$mil 0.64 (12th)	15th (2nd)*7	2nd
		c	5%	30	10	100/0	$mil 4.44 (12th)	23rd	do not show in the project life
		d		30	10	85/15	$mil 3.31 (12th)	21st	
Case 4	Level at Current Ferry Tariff	a	1%	30	10	100/0	n.a.	1st	2nd
		b		30	10	85/15	n.a.	1st	2nd
		c	5%	30	10	100/0	$mil 1.63 (12th)	15th (7th) *1	22nd
		d		30	10	85/15	$mil 0.50 (12th)	13th (5th) *2	18th

Note: Repayment period includes grace period, Loan amount ratio is the percentage of loan amount to total investment amount

*Note: Annual surplus initially shows between 7th and 8th year (*1), 5th and 9th (*2), 5th and 8th (*3), 2nd and 9th (*4), 2nd and 9th (*5), 2nd and 9th (*6), 2nd and 10th (*7).*
*Accumulated surplus initially shows between 4th and 11th (+8), 3rd and 14th (*9). Refer detail to the Table AP9.2.1 in Appendix.*

Source: JICA Study Team

The results show:

1) As the toll rate becomes higher the cash flow shows better results in order as Case 4, Case 3, Case 2, Case1 and Base Case
2) When the interest rate is 1%, Case 4 (4-a, 4-b) does not require subsidy and make annual surplus from the 1st year of operation. All other cases require subsidy and even in the next best condition, Case 3-b, actual first year of annual surplus appears only in the 15th year.
3) When the interest rate is 5%, all the cases require subsidy. The least subsidy appears in Case 4-d with the maximum annual subsidy of $0.50 million and the first year of annual surplus is found in the 13th year.
4) Both Loan/Equity Ratio of 85/15 and 100/0 require subsidy except for Case 4 (4-a & 4-b) of the interest rate at 1%. Although the cash flow of Case 4 under the Loan/Equity ratio of 85/15 is better and the amount of subsidy is smaller than the case under the Loan/Equity ratio of 100/0, the implementing body has to be prepared for equity portion amounting to 15% of the total project cost.

Table 9.2.4 Alternative Cash Flow Analysis (Case 3-b)

Case3−b: Level at 100% of User's Benefit Loan/Equity: 85/15 Interest Rate: 1%

Year	Equity	Loan	Revenue	Initial Inflow	Investment Cost	O&M Cost	Loan Repayment	Loan Interest	Initial Outflow	Initial Balance	Outstanding Loan amount	Required Subsidy	Accumulated Surplus	Annual Loan Repayment
2007	0.36	2.01		2.37	2.37	0.00	0.00		2.25	0.00	2.01	0.00	0.00	0.000
2008	0.39	2.21		2.60	2.60	0.00	0.00	0.02	2.59	-0.02	4.22	0.02	-0.02	0.000
2009	2.90	16.45		19.36	19.36	0.00	0.00	0.04	19.40	-0.04	20.68	0.04	-0.06	0.000
2010	2.76	15.66		18.42	18.42	0.00	0.00	0.21	18.63	-0.21	36.34	0.21	-0.27	0.000
2011	2.78	15.73		18.50	18.50	0.00	0.00	0.36	18.87	-0.36	52.07	0.36	-0.63	0.000
2012	1.91	10.85	0.51	13.28	12.77	0.08	0.00	0.53	13.37	-0.09	62.92	0.09	-0.72	0.000
2013			1.66	1.66		0.25	0.00	0.64	0.89	0.77	62.92	0.00	0.05	0.000
2014			1.78	1.78		0.25	0.00	0.64	0.89	0.89	62.92	0.00	0.94	0.000
2015			1.92	1.92		0.26	0.00	0.64	0.90	1.02	62.92	0.00	1.96	0.000
2016			2.08	2.08		0.26	0.00	0.64	0.90	1.18	62.92	0.00	3.14	0.000
2017			2.25	2.25		0.27	0.00	0.64	0.91	1.35	62.92	0.00	4.49	0.000
2018			2.43	2.43		0.27	0.10	0.64	1.01	1.42	62.82	0.00	5.91	0.096
2019			2.62	2.62		0.28	0.20	0.64	1.12	1.49	62.62	0.00	7.41	0.205
2020			2.81	2.81		0.29	1.03	0.64	1.95	0.86	61.59	0.00	8.26	1.028
2021			3.00	3.00		0.29	1.81	0.64	2.74	0.26	59.78	0.00	8.53	1.811
2022			3.20	3.20		0.30	2.60	0.63	3.52	-0.32	57.18	0.32	8.21	2.597
2023			3.41	3.41		0.30	3.14	0.61	4.05	-0.64	54.04	0.64	7.58	3.140
2024			3.63	3.63		0.31	3.14	0.58	4.03	-0.40	50.90	0.40	7.17	3.140
2025			3.85	3.85		0.32	3.14	0.55	4.01	-0.15	47.76	0.15	7.02	3.140
2026			4.08	4.08		0.32	3.14	0.52	3.98	0.10	44.62	0.00	7.12	3.140
2027			4.32	4.32		0.33	3.14	0.49	3.96	0.37	41.48	0.00	7.49	3.140
2028			4.57	4.57		0.34	3.14	0.46	3.93	0.64	38.34	0.00	8.13	3.140
2029			4.83	4.83		0.34	3.14	0.43	3.91	0.92	35.20	0.00	9.05	3.140
2030			5.09	5.09		0.35	3.14	0.39	3.88	1.21	32.06	0.00	10.25	3.140
2031			5.37	5.37		0.36	3.14	0.36	3.86	1.51	28.92	0.00	11.76	3.140
2032			5.65	5.65		0.37	3.14	0.33	3.84	1.81	25.78	0.00	13.57	3.140
2033			5.95	5.95		0.37	3.14	0.30	3.81	2.14	22.65	0.00	15.71	3.140
2034			6.26	6.26		0.38	3.14	0.27	3.79	2.48	19.51	0.00	18.19	3.140
2035			6.59	6.59		0.39	3.14	0.24	3.77	2.82	16.37	0.00	21.01	3.140
2036			6.92	6.92		0.40	3.14	0.21	3.74	3.18	13.23	0.00	24.19	3.140
2037			7.27	7.27		0.41	3.14	0.17	3.72	3.55	10.09	0.00	27.74	3.140
2038			7.62	7.62		0.41	3.04	0.14	3.60	4.02	7.04	0.00	31.76	3.044
2039			7.99	7.99		0.42	2.93	0.11	3.47	4.52	4.11	0.00	36.28	2.935
2040			8.37	8.37		0.43	2.11	0.08	2.62	5.75	2.00	0.00	42.02	2.112
2041			8.76	8.76		0.44	1.33	0.05	1.82	6.94	0.67	0.00	48.96	1.329
2042			9.17	9.17		0.45	0.54	0.03	1.02	8.14	0.13	0.00	57.11	0.543
Total	11.1	62.9	144.0		74.0	10.2	62.8	13.9	158.5			2.24		62.9

Source: Study Team

5) The amount of subsidy: The minimum subsidy amount is nil in Case 4-a and 4-b, while the maximum single year subsidy of the Base Case-c amounts to $7.40 million in the 12th year and the maximum cumulative subsidy reaches $154.97 million by the year 2042.

6) First year of annual surplus: As to Cases 1-b, 2-a, 2-b, 3-a, 3-b, 4-c and 4-d the annual surplus appears before the loan repayment starts, but when the repayment of the principal begins subsidies are required again.

7) First year of accumulated surplus: Similar to item 6) above, the accumulated surplus of Case 2-a and 2-b initially appear before the loan repayment starts, however, once the repayment starts the accumulated deficit appears again.

8) In Case 3-a and 3-b, though the subsidy is required in several years between the 10th (11th) year and the 16th (14th) year for Case 3-a (Case 3-b), the first year of accumulated surplus appears continuously from the relatively early stages, i.e. the 3rd year (Case 3-a) and the 2nd year (Case 3-b), which are considered acceptable for the implementing body, only if they can afford to manage the annual deficit during the construction period and in the early few years of the project operation.

Further investigation shows the minimum toll levels required for the project to be financially positive in the annual account (no subsidy is required) as presented in Table 9.2.5.

Table 9.2.5 Toll Rate Level for Nil Subsidy

	Interest Rate	Loan/Equity Ratio	Minimum Toll Rate Required (Percentage to Current Ferry Level)
a	1%	100/0	75%
b	1%	85/15	64%
c	5%	100/0	n.a.
d	5%	85/15	n.a.

Source: Study Team

9.3 Overall Evaluation of the Project

(1) Economic Evaluation

Major quantifiable economic benefits derived from the proposed project are mainly comprised of savings in vehicle operating cost and travelers time cost. The project EIRR for the base case results in 23%, and the sensitivity analysis, which reduces the traffic demand by 20% and increases the project cost by 20%, results in 16.8% of EIRR that assures the economic feasibility of the project.

In addition to these quantitative benefits, unquantifiable benefits also suggest the importance of improving the infrastructure network, especially a trunk road such as NR-1 that connects capital cities of the neighboring countries.

From these results it is considered that high priority should be given to the implementation of the project to promote economic and social development of the country and the GMS region as well.

(2) Financial Evaluation

The analysis of the financial IRR (ROI) shows that the FIRR is positive but small so that it cannot attract private sector for the project investment. The positive FIRR, however, is only realized when the toll rate is set at or more than 100% of bridge user's benefit (6.60% in case the toll rate is equivalent to the current ferry tariff and 2.93% in case the toll rate is set at 100% of user's benefit).

When the project cost is funded by loan at 1% interest rate, the financial cash flow analysis reveals that the toll rate needs to be set to the level of 75% (in case loan/equity ratio is 100/0) or 64% (in case loan/equity ratio is 85/15) of the current ferry tariff in order to maintain the positive balance of annual account continuously.

In case the toll rate is set at the maximum bridge user's benefit (55% of the current ferry tariff level), the deficit emerges only several years of the early stage of the project construction, but the cumulative surplus remain positive thereafter (2^{nd} or 3^{rd} year from the Bridge opening). This is, however, only possible when the loan interest is as low as 1% and the repayment period is as long as 30 years with the grace period of 10years. If the loan interest is 5%, the annual deficit continues by the 22^{nd} year (in case the loan/equity ratio is 100/0) or by the 20^{th} year (in case the loan/equity ratio is 85/15).

Consequently, if the implementing body is to raise the required funds by loan, the toll rate will have to be set at minimum to cover the maximum benefit of the project users (about 55% of the current ferry tariff level) to attain sound financial condition, and the loan interest should be as low as possible, preferably less than 1%, and the repayment schedule should be as soft as possible, such as 30 years repayment with 10 years grace period.

10. CONCLUSIONS AND RECOMMENDATIONS

Based on the thorough examination of the project on both master plan stage and feasibility study stage, the Study results in the following conclusions and recommendations:

10.1 Conclusions

(1) Selection of Optimum Crossing Route and Method:

- Applying the Analytic Hierarchy Process for the selection of an optimum alternative to cross the river, the "Ferry Improvement + Bridge" option on Route A is estimated as the optimum method to cross the Mekong River at Neak Loeung.
- "Ferry Improvement + Bridge (Route A)" option was agreed among all the stakeholders, and which could be regarded as the final consensus on the optimum solution to cross the river, through public comments and response process between MPWT and the stakeholders.
- "Ferry Improvement + Bridge (Route A)" option, however, should not be identified as one project that consists of the "Ferry Improvement" and the "Bridge" components. The "Ferry Improvement" should be considered as prerequisite for the "Bridge" development.

(2) Economic and Financial Analysis:

- The EIRR of the project is 23.0% and the sensitivity analysis results in 16.8 %, when the traffic demand decreases by 20% and the project cost increases by 20%. It is, therefore, concluded that a high priority should be given to implementation of the project to promote economic and social development in Cambodia and GMS region as well.
- The results of financial analysis show low FIRR of 6.6% (at the toll level equivalent to the current ferry tariff) or 2.9% (at the toll level to cover 100% of the bride user benefit). Therefore, the project will not be attractive for private sector to invest without significant financial support by the government.
- In order to operate as a financially sound toll bridge, the toll rate will have to reach the full level of the bridge user benefit, which is about 55% of the current ferry tariff. Further, conditions of the fund procurement should be as soft as possible, that is, less than 1% interest rate and 30 years repayment period with 10 years grace period.
- If the consensus is made among concerned stakeholders, it is desirable to adopt the toll level equivalent to the current ferry tariff, so that the project will not require any subsidy but it attains the first year annual surplus and the first year accumulated surplus in the first and the second year from the bridge opening, respectively

10.2 Recommendations

(1) Traffic Demand and Timing of Bridge Opening

- It is recommended that the bridge should be open to traffic in the Year 2012 before the existing ferry capacity (4,548 PUC/day) is saturated.
- Given the margin of error in the traffic demand forecast, it is advised to monitor the actual traffic volume for the next few years by the proponents. It is also suggested that, based on the results of traffic demand monitoring during this period, further consideration be given to appropriate timing of preparation for the construction. This

is in accordance with the recommendations by the JICA Appraisal Committee on the Environmental and Social Considerations with respect to the importance of the traffic demand forecast for the project implementation.

- The traffic demand monitoring should be executed using an indirect method such as the data on monthly revenue from the ferry operation and a direct method such as counting traffic volume on board during the fixed one week period in May, so that the counting result can be compared with the traffic survey conducted in May 2004 by the current Study Team. In addition, the queuing survey should be carried out in parallel with the traffic counts for evaluating the congestion level at the ferry terminal.

(2) Proper Maintenance and Improvement of the Neak Loeung Ferry

- The ferry improvement is not regarded as part of the 2nd Mekong Bridge construction project but it is prerequisite for the bridge project. Therefore, the government should extend the full support to the proper maintenance and improvement of the existing ferry service at Neak Loeung before the bridge is open to traffic.
- In order to meet the estimated traffic demand until 2012, at least three (3) existing ferryboats, "TA PHROM", "VISHNU" and "PEACE-2" should be operated and properly maintained at Neak Loeung.
- If the project bridge is not constructed by 2012 or not allowed to lower the ferry service, for instance much longer queuing time over 36 minutes, the ferrying capacity can be enhanced for example by replacing one (1) ferryboat of 24 PCU with a new ferry boat of 30 PCU.
- Acquisition of new ferry boats to replace the existing ferry boats shall be seriously planned, since the existing ferryboats are so old that degradation of the boats will accelerate year by year.
- In order to enhance the ferrying service over the existing and prospective routes to cross the Mekong River or to meet the increasing traffic demand in future, further recommendations are made as follows:

1) To plan a whole repair and maintenance schedule for the existing ferry boats.
2) To reserve a budget for maintenance and repair.
3) To carry out repair and maintenance of ferry boats on schedule.
4) To reinforce the workshop for improvement of quality in repair and maintenance including training and education of staff.
5) To contrive a long term deployment plan including acquisition plan of ferry boats crossing rivers in Cambodia.
6) To expand the activity of the work at the Neak Loeung Dockyard.

(3) Environmental Impact Assessment and Resettlement Action Plan

- As the result of IEE and EIA, sensitive natural and social environmental elements were identified and impacts of the project against these elements as well as a wide range of secondary, interactive and cumulative impacts were assessed to prepare effective countermeasures to alleviate the negative impacts as discussed and recommended in Chapter 7 of Main Text. Special attention should be paid on vulnerability groups such as economically vulnerable PAPs, female-headed households, vendors, women, children, physically-handicapped persons, and other economically and socially vulnerable households by providing proper recommended mitigation measures.

- Environmental Management Plan should be prepared to pursue the conservation of natural and social environment.
- The number of PAPs to be affected by the land acquisition of the Project at the stage of "Simple Survey" is 260 house owners and landowners with 270 cases of assets, although the figure will be updated at the stage of DMS.
- Since the socio-economic survey, which was conducted in the feasibility stage, is not an official census, the full-scale RAP should be formulated based on the DMS together with the full-scale census.
- The full-scale RAP should include proper mechanizms for information disclosure, grievance resolution, and monitoring activities to guarantee the appropriate planning and implementation of the resettlement and compensation activities.
- Referring to the EIA study explored in this Study, EIA report should be prepared and submitted by MPWT and need to be approved by MOE at appropriate timing for implementation of the Project.

(4) Development of Newly Created Flood-free Land:

- Through studying national and regional development plans and strategies, generation and utilization of the flood-free land is proposed as a key strategy for the development of "Neak Loeung Regional Center" and its preliminary zoning and the land use plan are consequently proposed.
- Although the newly created flood-free land development is not incorporated into the Bridge project, the land development should be promoted by government initiative and private sector funds and by entrepreneurship.

(5) Design Conditions and Criteria for the Project:

- Through applying AASHTO and comparing with the design standards adopted in the past projects in Cambodia, the Highway Design Standard adopted in this Project recommends to accommodate 2-lanes on the carriage way and two motorbike lanes with design speed of 80 km/h.
- Horizontal and vertical clearance of the project bridge is proposed in minimum 180 m and 37.5 m respectively, considering external conditions and development policies and plans, and which allows a 5,000 DWT container ship for one-way traffic and 500 DWT coasters for two-way traffic.
- Taking into account the safety navigation of local ships and therefore minimization of the number of piers in the river, construction costs and features of alternative bridge types, Pre-stressed concrete Cable Stay Bridge were selected eventually with center span length of 320 m.

(6) Project Costs and Implementation Plan:

- Total project cost is estimated at US$ 74 million, including the construction cost, land acquisition and compensation costs, de-mining and UXO clearance costs, using the price level in September 2005. The total construction period, including the mobilization period, is estimated at 45 months, and the overall project implementation period is to be about 6 years.
- Since the financial viability (FIRR) of the project is as low as 6.6% even at the toll level equivalent to the current ferry tariff, the government should take the initiative for the project investment. If the government can successfully procure the funds for the project implementation, the private sector will be able to participate in the operation and maintenance business of the project toll bridge.

- However, before the private sector is invited to participate in project operation and maintenance, the government will have to prepare the legal and institutional environment to attract private sector.
- Since the subject project is a large-scale bridge project, the government should fully utilize this opportunity to train government staff and enhance their technology and management quality.

(7) Public Consultations:

- Following the JICA guidelines for environmental and social considerations, eight stakeholder meetings (SHM 1-1～3-3) were held to discuss the Study results and achieve consensus among stakeholders. The last stakeholder meeting (SHM 3-3) was held at the end of January 2006.
- To have the project implemented smoothly, the government should maintain transparency, accountability of the decision-making process and information disclosure to concerned stakeholders through the procedure of public consultation.