

Ministry of Public Works and Transport  
The Kingdom of Cambodia

**IMPLEMENTATION REVIEW STUDY REPORT  
ON  
THE PROJECT FOR IMPROVEMENT OF  
NATIONAL ROAD NO.1  
(PHNOM PENH-NEAK LOEUNG SECTION)  
IN  
KINGDOM OF CAMBODIA**

November 2007

**JAPAN INTERNATIONAL COOPERATION AGENCY**  

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**KATAHIRA & ENGINEERS INTERNATIONAL**

<b>GM</b>
<b>CR(1)</b>
<b>07-219</b>

## **PREFACE**

The Government of Japan decided to conduct a implementation review study on the Project for Improvement of National Road No.1 (Phnom Penh - Neak Loeung Section) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from August 28 to September 10, 2007.

The team held discussions with the officials concerned of the Government of Cambodia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. As this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Cambodia for their close cooperation extended to the teams.

November, 2007

Masahumi Kuroki  
Voice-President  
Japan International Cooperation Agency

November, 2007

## **Letter of Transmittal**

We are pleased to submit to you the implementation review study report on the Project for Improvement of National Road No.1 (Phnom Penh - Neak Loeung Section) in the Kingdom of Cambodia.

This study was conducted by Katahira & Engineers International, under a contract to JICA, during the period from August 2007 to November 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Cambodia and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kazuyuki Hiraoka  
Project manager,  
Implementation review study team on  
the Project for Improvement of National  
Road No.1 (Phnom Penh - Neak  
Loeung Section) in Kingdom of  
Cambodia  
Katahira & Engineers International

## SUMMARY

National Road No.1 connects the Cambodian Capital “Phnom Penh” and “Ho Chi Minh City” the primary commercial city in Vietnam. Furthermore, this national road forms a part of the Asian Highway (A1) as a well-known international arterial road. The section with about 105 km from Neak Loueng up to the border of Vietnam has been improved in 2003 by ADB. However, the section about 56 km from Phnom Penh to Neak Loueng was excluded from their improvement. The traveling speed is restricted with an average of about 30 k/hr due to severe damages of the section. Therefore the improvement of the section is an urgent problem by which the Government of Cambodia (GOC) is confronted.

To cope with the problem, the Government of Cambodia requested a grant aid from Japan to improve the section from Phnom Penh to Neak Loueng (hereinafter referred to the project). In response to the request, the Government of Japan decided to study on the implementation of the project.

On the other side, in accordance with JICA Guidelines for Environmental and Social Considerations April 2004 (hereinafter referred to as JICA Guidelines), the Project was classified as “Category A” and the Project activities of GOC have been required to comply with JICA Guidelines as close as possible. The discussions with GOC were held mainly on the measures for “Involuntary Resettlements” which caused the Project to classify “Category A”. Through the Preliminary Studies (Environmental and Social Consideration) in twice, JICA proposed GOC to reach appropriate consensus with the Project Affected Persons (PAPs) on the compensations for resettlement, set-back and etc. Then JICA provided the necessary assistance and monitoring conducted by the third party.

Upon fulfillment of necessary conditions for conducting Basic Design Study (B/D) with above stated activities, B/D was commenced in March 2004. The Grant Aid Project (itself) has been implementing, by stage by stage, according to the progress of reaching consensus with PAPs, based on the advices given by the Advisory Council of Environmental and Social Considerations. The Project is composed of 3 stages, and “Stage-1” has been already completed and “Stage-2” has been constructing.

As of now, Regular Meeting on the agenda of “Involuntary Resettlements Progress” is hold twice a month by Inter-ministerial Resettlement Committee (IRC : Cambodian side’s counter agency) and Japanese sides (JICA Cambodia Office, JICA Expert, the Consultant and Embassy of Japan attends at need). Information sharing and follow-up on the important issues such as “to reach appropriate consensus”, “compensation payments”, “resettlement sites arrangement” and etc. have been performed by and between both sides.

At B/D stage, it was agreed that IRC would inform Japanese side about the progress and situation of reaching consensus with PAPs of Stage-3 by the end of October 2007. Remarkable change has been observed around Monivong Bridge located at the Project Starting Point on Phnom Penh, and at the Regular Meeting, it was confirmed that the construction of Second Monivong Bridge in addition to the existing 2 lanes bridge has been materialized by Phnom Penh Municipality with their own financing furnished by Canadian Bank since 2006.

Due to the circumstances as the above, Design of the area at Starting Point of Existing Monivong Bridge East side including the approach to New Bridge have to be changed. Accordingly, the area affected by road improvement is subject to design change and re-fixation of PAPs with topographic survey and confirmation of under-ground utilities are required. Furthermore, it has passed more than 2 years after the completion of B/D. In the meanwhile, costs in materials as well as crude oil have risen, and large gap between the present and the past (B/D) has been observed. So the Project Cost is considered to be re-estimated properly.

Taking account of background and circumstances as mentioned above, the Government of Japan entrusted the Implementation Review Study of Stage-3 of the Project to Japan International Corporation Agency, the official agency implementing Japanese Government’s technical assistance and expediting proper execution of the Japan’s Grant Aid.

Hence, JICA decided to conduct Implementation Review Study and sent the study team, headed by Dr. INABA Makoto, Deputy Director General, Grant Aid Management Department, JICA.

As the result of the study, it was confirmed that there is no significant problem for the project implementation of the section from Sta. 1+900 to Sta. 13+100 of the Stage-3 section. However, of the section from Sta. 0+000 to Sta. 1+900 of the Stage 3 section, reaching consensus with the PAPS before its time limit was judged difficult since the issues regarding the land compensation could not be settled between the concerned parties. Finally, the section from Sta. 0+000 to Sta. 1+900 was excluded from Stage-3 section.

Major Contents of the Project are as follows:

Item		Outline	Major Works	
			Whole Project (Stage-1 to 3)	Stage-3
Road Improvement	Widening	Existing carriageway average width 6.5m is too small against the traffic which is mixed with 4-wheel and 2-wheel vehicles, and causing traffic accidents.	Road Length 55.98km (Sta. 0+000~55+980)  (4-Lane: 1.800km, 2-Lane: 54.180km)	Road Length 11.2km (Sta. 1+900~13+100)  2-Lane: 11.2km
	Grade Rise	Existing road average grade is only 30cm above the flood in 2000. The flood overflowed at 3 sections totally 1.100m.	Almost all sections will be grade raised.	Almost all sections will be up-graded.
	Pavement	6.5m wide carriageway was paved. Pavement was damaged by floods.	Pavement on carriageway, sidewalk and shoulder for 55.98 km.	Pavement on carriageway, sidewalk and shoulder for 11.2 km.
Widening of Road Shoulder	Market Area	Lack of parking lane along markets is causing traffic jams.	3 nos.	1 nos.
	Bus Stop / Evacuation Space	Bus stop space and evacuation space for livestock during floods.	20 nos.	5 nos.
	School / Hospital	Groups of student pedestrians are causing traffic jams.	School : 31 nos. Hospital: 9 nos.	School : 5 nos. Hospital : 2 nos.
Bridge Construction		Bailey bridges are narrow and causing traffic jams.	3 bridges, 240.6m (68.8+103.0+68.8m)  (2 replacement, 1 new)	—  —
Culvert		Existing 4 culverts are clogged with mud. Inadequate opening is causing flood level high and disturbing water fertilizes farms.	9 nos.  Pipe culvert: 2 nos.  Box culvert: 7 nos.  (Total Length: Pipe culvert= 50.1m, Box culvert= 107.1m)	—  —  —
Road Drainage Facility		Lack of road drainage facility is causing traffic jams and traffic accidents.	Side Ditch: 2,230m Criss Pipe: 5,045m	Side Ditch: 220m  —
Revetment/Riverbed Protection	Revetment	Slope erosions are occurring at inlet/outlet of openings.	—	—
	Riverbed Protection	Riverbed scouring is occurring at inlet/outlet of openings.	Bridge: 3 nos. Culvert: 9 nos.	—
Measures for Slope Erosion	Greenbelt	Slope erosion is occurring where current hits, road bends and bridge exists and wave is strong.	Length: 2,800m	—
	Wet Masonry	Slope around culverts are being eroded.	Length: 1,060m	—
Measures for Soft Ground	Replacement by Qualified Soil	Embankment for road widening on soft ground will cause unequal settlement.	Mekong side: 16.52km, Colmatage side: 44.96km	Mekong side: 10.15km, Colmatage side: 9.86km
	Replacement by Sand	Underwater soft soil will be replaced by sand	Mekong side: 0.80km, Colmatage: 1.72km	Mekong side: 1.05km, Colmatage: 1.34km
Intersection Improvement		Traffic jams and traffic accidents are occurring frequent at Chbar Ampov Intersection. Traffic jams are occurring at Tiger Beer Intersection.	2 locations Chbar Ampov Intersection and Tiger Beer Intersection	1 location Tiger Beer Intersection
Ancillary Facilities	Retaining Wall	Instead of embankment slope, retaining wall will be installed to minimize resettlement. (Sta. 0+300~1+166m)	masonry wall: 1,635m, RCL Retaining Wall: 1,166m	—
	Road Marking & Traffic Sign	Road marking and traffic signs will be installed for the traffic safety.	Centerline, lane line & edge line and 39 crosswalks  Regulatory sign: 20 nos., Warnig sign: 112 nos., Guide sign: 21 nos.	Centerline, lane line & edge line and 14 Crosswalks  Warnig sign: 22 nos.
	Median Strip	Median strip will be installed for traffic safety.	Total length: 1,688m	—
	Curb	Curb will be installed for traffic safety.	Total length: 16,800m	Total length: 8,304m
	Guardrail	Guardrail will be installed at approach of bridges and culverts.	Mekong side: 180m, Colmatage side: 180m	—
	Guide Post	Guide posts will be installed at curbs, culverts and at embankments are higher than 5m.	1,010 nos.	190 nos.

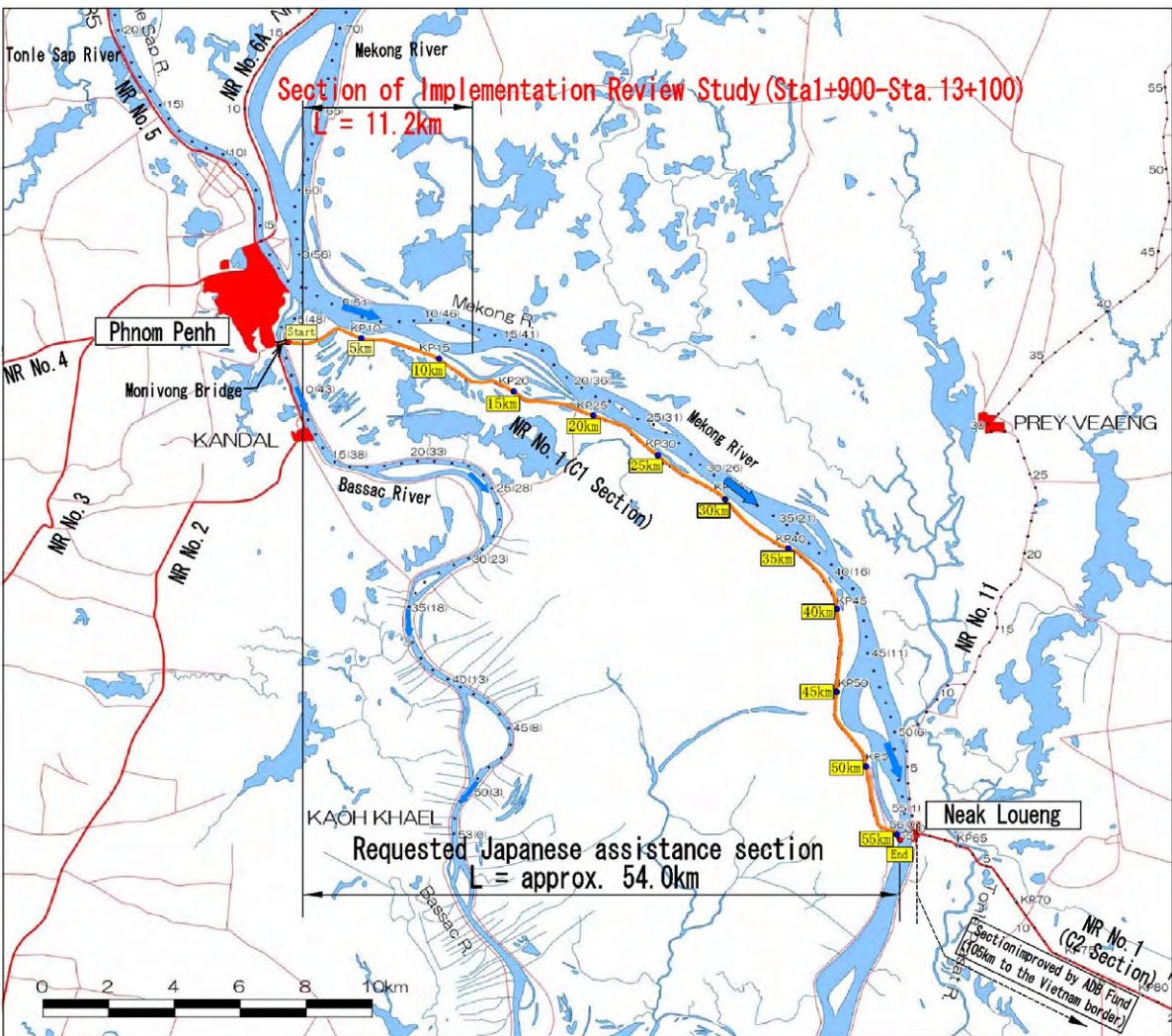
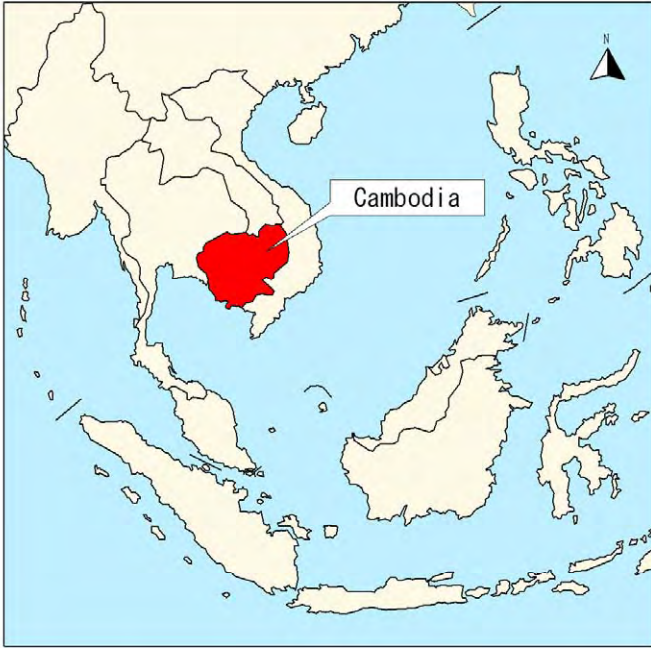
The direct beneficiaries by the Project are those residents with the populations of 2.42 million (2003) live in Phnom Penh (populations of 1.23 million) and Kandal Province (populations of 1.19 million), and indirect beneficiaries are 13.29 million populations (expectancy in 2003) of the whole nation. The advantageous effects resulted from the implementation of the Project are summarized as below.

- Function as an arterial road will improve because the existing road is narrow and congested with mixed vehicles and motorcycles traffic. This is causing the lower efficiency of traffic flow and significantly disturbing the function as an arterial road.
- Not enough traffic service facilities are provided, existing vehicle parking space and side walk are narrow or none. These make the residents inconvenient. Along the market area, school and hospital area new traffic service facilities are considered in the Study to improve the road function as life line.
- As a result of increased traffic capacity and improved mobility, trip time between Phnom Penh and Neak Loueng can be shortened as 45 - 50 minutes by upgrading the traveling speed from about 30 k/hr now up to 80kph for most sections.
- Traffic accidents, caused by mixed traffic, are expected to be reduced by the implementation of traffic separation between four and two wheels drivings. In addition, the provision of traffic sign board, guardrail, and hamper is also expected to increase traffic safety for vehicles and residents.
- At present, the load limits are 15 tons for the existing one-lane temporary Bailey bridges. Transport of large-scale goods can be made more efficient by applying the design loads of 20 tons together with the widening of bridge's width.
- To improve the soundness of road surface and safe traveling at the time of flood by improving the road elevation as flood control measures. Moreover, the flood control effects on the Mekong River can be strengthened by the construction/installation of more waterway openings (3 bridges, 2 pipe culverts and 7 box culverts). In addition, the agricultural promotion in the Colmatage side can be expected by the scaling up of farmlands to be irrigated by the inflow of overflow floodwater.
- The rainwater discharged into the road during raining will cause the lowering of traffic function and the inhibition of traffic safety because no rainwater drainage facilities exist within the urbanized area. Such situation can be resolved by installing the road surface drainage facilities.
- Socio-economic activities become active through the promoted people and physical exchanges due to the improved function of National Road No.1. Moreover, living standards will be upgraded together with the improvement of user-friendliness along the road because of the enhanced function of living road.

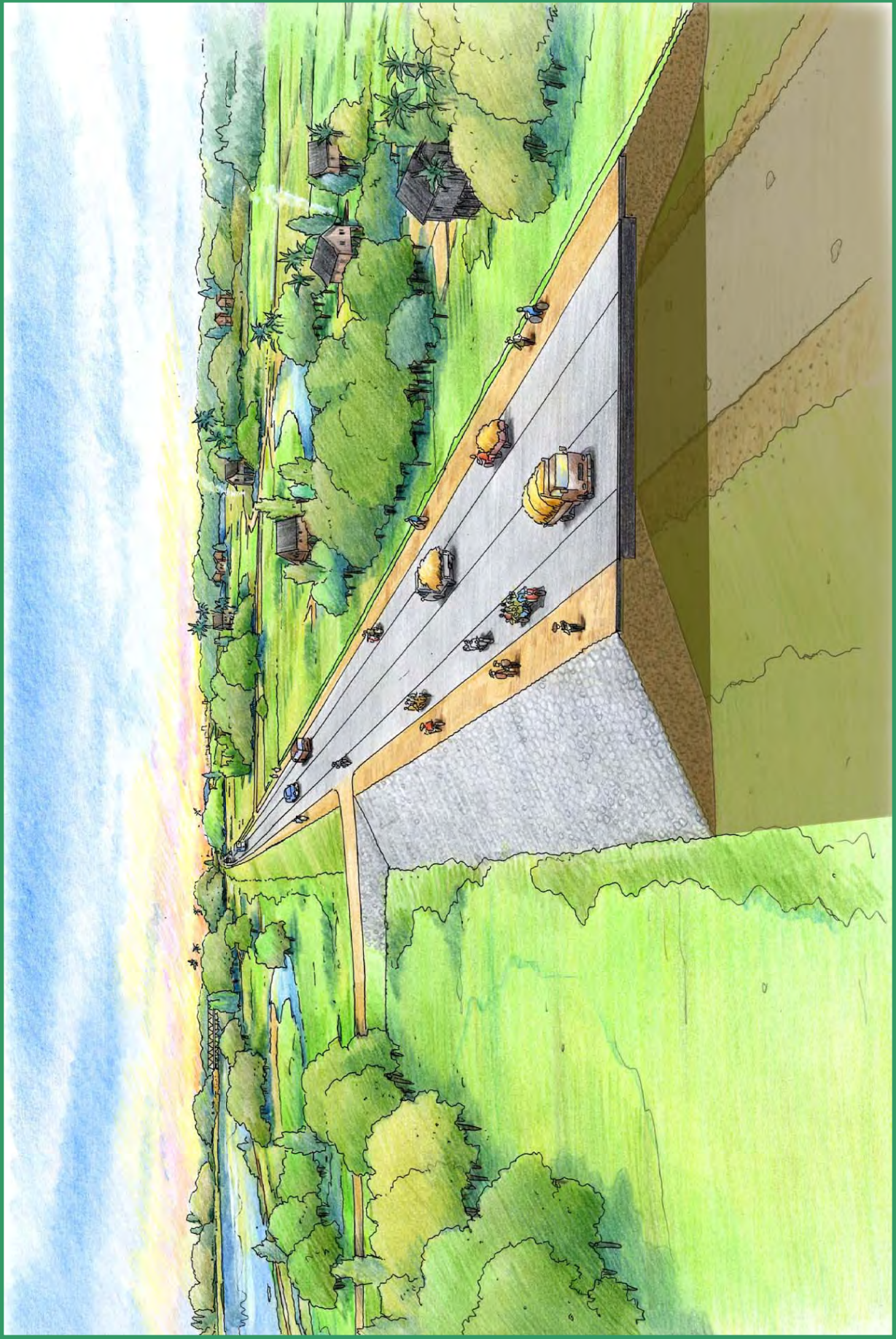
As mentioned above, significant advantageous effects will be expected from the Project. In addition, the regional gaps between the Capital Phnom Penh and local region can be eliminated by facilitation of human and physical migration. It can be judged that the Project to be undertaken by the Grant Aid of Japan is appropriate from the viewpoint of contributing the Cambodian nationwide socio-economic vitalization. However, it is considered that both of personnel and funds are unsatisfactory in management and maintenance for the Project.

Therefore, maintenance shall be adequately done by the Government of Cambodia to manifest/sustain the Project's significant advantageous effects. Especially, the cleanup activities for the road and bridge drainage facilities are most important. Moreover, it is considered that the significant advantageous effects of the Project can be enlarged through the improvement on the sections other than the tie-up target section to be carried out by self-help efforts.

Moreover, the Government of Cambodia is required to make valid the provided facilities through the restriction of driving speed and traffic safety education to the residents etc. after completion of the Project.



Location Map



PERSPECTIVE



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## ABBREVIATIONS

AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
ADB	:	Asian Development Bank
AH	:	Asian Highway
BC	:	Box Culvert
BCU	:	Bridge Construction Unit
BOD	:	Biological Oxygen Demand
CBR	:	California Bearing Ratio
C.C.P	:	Cast-in-place Concrete Pile
CO	:	Carbon Monoxide
DMS	:	Detailed Measurement Survey
DO	:	Dissolved Oxygen
EL	:	Elevation
E/N	:	Exchange of Note
ESAL	:	Equivalent Single Axle Load
F/S	:	Feasibility Study
GDP	:	Gross Domestic Product
GOJ	:	Government of Japan
HCM	:	Highway Capacity Manual
HV	:	Heavy Vehicles
H.W.L	:	High Water Level
IRC	:	Inter-Ministerial Resettlement Committee
JICA	:	Japan International Cooperation Agency
LV	:	Light Vehicles
MC	:	Motor Cycles, Motorbike
MPWT	:	Ministry of Public Works and Transport
MRC	:	Mekong River Commission
NO <sub>2</sub>	:	Nitrogen Dioxide
PAPs	:	Project Affected Persons
PC	:	Pre-stressed Concrete
PC	:	Pedal Cycles
PCU	:	Passenger Car Unit
PH	:	Ionized Hydrogen Concentration Index
PRW	:	Provisional Road Width
RAP	:	Resettlement Action Plan
RCC	:	Road Construction Center
ROW	:	Right of Way
SN	:	Structure Number
SO <sub>2</sub>	:	Sulfate Dioxide
SS	:	Suspended Solid
T/N	:	Tender Notice
TSP	:	Total Suspended Particulated
UNDP	:	United Nations Development Program
V/C	:	Traffic Volume/Traffic Capacity
V/C	:	Verification of Contract

## **Chapter 1 Background and Objectives of the Implementation Review Study**

National Road No.1 connects the Cambodian Capital “Phnom Penh” and “Ho Chi Minh City” the primary commercial city in Vietnam. Furthermore, this national road forms a part of the Asian Highway (A-1) as a well-known international arterial road. The section with about 105 km from Neak Loueng up to the border of Vietnam has been improved in 2003 by ADB. However, the section about 56 km from Phnom Penh to Neak Loueng was excluded from their improvement. The traveling speed is restricted with an average of about 30 kph due to severe damages of the section. Therefore the improvement of the section is an urgent problem by which the Government of Cambodia (GOC) is confronted.

To cope with the problem, the Government of Cambodia requested a grant aid from Japan to improve the section from Phnom Penh to Neak Loueng (hereinafter referred to the project). In response to the request, the Government of Japan decided to study on the implementation of the project.

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Due to the circumstances as the above, Design of the area at Starting Point of Existing Monivong Bridge East side including the approach to New Bridge have to be changed. Accordingly, the area affected by road improvement is subject to design change and re-fixation of PAPs with topographic survey and confirmation of under-ground utilities are required.

Furthermore, it has passed more than 2 years after the completion of B/D. In the meanwhile, costs in materials as well as crude oil have risen, and large gap between the present and the past (B/D) has been observed. So the Project Cost is considered to be re-estimated properly.

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## **Chapter 2 Contents of the Project**

### **2.1 Basic Concept of the Project**

#### **(1) Overall Goal and Project Purpose**

The Government of Cambodia, formulates three (3) national development objectives. In the Second Five-year Socio-economic Development Plan (year 2001-2005). The three objectives are:

- Economic growth that is broad enough to include sectors where the poor derive their livelihood;
- Social and cultural development; and
- Sustainable use of natural resources and sound environmental management.

Development of the basic infrastructure in the transport sector is essential in achieving an economic growth with equity and social development. The policy objective of developing the transport infrastructure is to be attained by giving first priority to road rehabilitation with an associated improvement in operations and maintenance capability. The plan has three main aims:

- To rehabilitate and reconstruct the main national roads, thereby improving land transport throughout the nation;
- To build road links to neighboring countries, thereby opening up some of the more remote areas of the country to international trade and tourism; and
- To develop a sustainable road maintenance program, thereby assuring that investment in road rehabilitation and reconstruction generates sustainable benefits.

The road network in Cambodia consists of 4,165 km of national roads (1,988 km of 1-digit national roads and 2,177 km of 2-digit national roads), 3,615 km of 3-digit provincial roads and 31,000 km of rural and strategic roads. National Road No.1, which is the project road, extends from Phnom Penh Municipality to Ho Chi Minh City the primary commercial city in Vietnam. The National Road No.1 is also the Asian Highway No. A-1 and serves as the Second East-West Corridor, which is given a high priority in this plan.

The overall goal and project purpose are as follows:

- Overall Goal : To stimulate socioeconomic activities in Cambodia.
- Project Purpose : To improve the movement of people and goods between Phnom Penh Municipality and Ho Chi Minh City.

#### **(2) Basic Concept of the Project**

This project aims to improve National Road No.1 (Phnom Penh - Neak Loueng Section),

approximately 56 km long including opening sections and revetments, to achieve the above over all goal.

However, approximately 105 km section of from Neak Loueng to the border of Vietnam has improved as a part of the Asian Highway No. A-1 in 2003 by ADB fund.

This section, approximately 56 km long, and located at the floodplain paralleling the Mekong River, is difficult to be designed and constructed. Moreover, the flood in 2000 has caused extensive damage to this section. Before this survey, the Feasibility Study in 2002 and Preparatory Study on the confirmation of Environmental and Social Consideration for the Project in 2003 was implemented.

The project is expected to smoothen the traffic and shorter the travel time as a result of the improvement of the road function.



## **2.2 Basic Design of the Requested Japanese Assistance**

### **2.2.1 Review (Design) Policy**

The project facility designs which were proposed in the basic design study are generally adopted without change in this implementation review study. However, the project site conditions have been changed since the basic design study. Therefore, based on the change of site conditions, the contents of project are reviewed as hereafter. As the appropriate consensus has not yet reached for the section (Sta.0+000 – Sta.1+900), the section (from Sta.1+900 to Sta.13+100) shall be subject of the review (design) policy.

#### **2.2.1.1 Review Policy on Environmental and Social Considerations**

The progress status of reaching consensus with PAPs in Stage-3 section is as follows as of August 31, 2007.

##### Sta. 1+900 – Sta. 13+100 Section

The Inter-Ministrial Resettlement Committee (IRC) has completed the compensation negotiation with PAPs in Stage-3 section based on the Detailed Measurement Survey (DMS) (Please refer to Appendix 4). There are 1,329 items to be compensated in Stage-3 section including 711 of houses. All PAPs in the section understand and agree to the project implementation. As of the time, the consensus has not reached on 8 items and owner of 7 items are not yet identified.

#### **2.2.1.2 Review Policy on Related to the 2<sup>nd</sup> Monivong Bridge Construction**

Since the 2<sup>nd</sup> Monivong Bridge is located at Sta.0+000. As aforesaid, the consent for the Project has not yet reached at the section (Sta.0+000 – Sta.1+900), the starting point of Stage-3 shall be Sta.1+900. Then Stage-3 is not subject to change the road alignment due to new access construction to the 2<sup>nd</sup> Monivong Bridge.

#### **2.2.1.3 Review Policy on Undertakings of Cambodian Side**

The Undertaking of Cambodian Side for the implementation Stage-3 (STA.1+900~STA.13+100) are as follows;

- Compensation to the involuntary resettlement (1,329 items including 711 houses)
- Relocation of Electric Poles (575 ea.)
- Relocation & installation of Optical Fiber Cable (22,400m.)
- Installation of new Waterline (11,200m)

As aforesaid, the numbers of PAPs who has not yet agreed for the resettlement is few, it is expected the Resettlement Action Plan to be carried-out smoothly taking lesson from the past achievement of Stage-1 and Stage-2. And many related organizations involved in Relocation of Utilities and the procedures of relocation are complex and take a lot of time. Early taking of procedures are required for Relocation of Utilities not to be obstacle to Stage-3 construction works.

Moreover, the construction of purification plant is planned and intake pipe (1.2m Dia.) may be installed along NR-1. It is requested to install the pipe on the slope of the Road not so as to be dug up the embankment and/or paving constructed for Stage-3.

The positions of the Utilities' Relocation and intake-pipe installation are shown on the Annex 7.

#### **2.2.1.4 Review Policy on Increasing Traffic**

As stated at 2.4, according to the analyzed result of traffic volume survey, the average traffic volume increment rate is approx 9% at the section of Stage-3. At B/D stage, the traffic increment rate set-up 7.6% on the average. The surveyed traffic volume increment rate is a little bigger than the rate set-up at B/D stage. As the difference is not significant, numbers of traffic lanes and pavement structure are unchanged (not re-analyzed).

## 2.2.2 Basic Plan

### 2.2.2.1 Design Standards

As for the grade of the Project, Asian Highway Standard and Cambodian Standard are used as standards of this design and other criteria such as AASHTO, Japan Road Association are used as subsidiaries.

#### Design Criteria for Road Design :

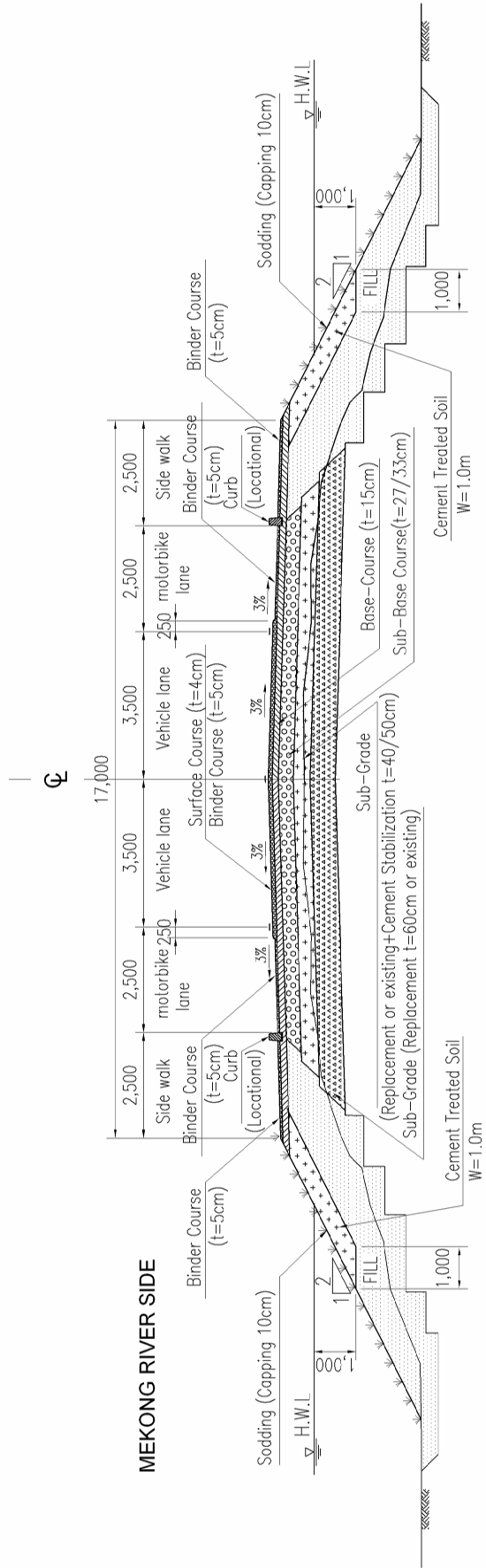
- AASHTO : Highway Capacity Manual, 1965
- AASHTO : Guide for Design of Pavement Structure, 1993
- United Nations, Economic and Social Commission for Asia and the Pacific :  
Asian Highway (AH) Classification and Design Standards
- Kingdom of Cambodia, Ministry of Public Works and Transport :  
Road Design Standard (Part1, 2 and 3)

#### Design Criteria for Bridge and Culvert :

- AASHTO : Standard Specification for Highway Bridges
- Japan Road Association : Specification for Highway Bridges
- Japan River Association : Cabinet Order Concerning Structural Standards for River Management Facilities, etc.
- Kingdom of Cambodia, Ministry of Public Works and Transport ;  
Road Design Standard (Part1, 2 and 3)  
Bridge Design Standard
- United Nations, Economic and Social Commission for Asia and the Pacific :  
Asian Highway (AH) Classification and Design Standards

#### Live Load :

- AASHTO HS-20-44



**Type 3 2-LANES SECTION  
(STA. 1+900 ~ 13+100)**

PAVEMENT STRUCTURE COMPOSITION

TYPE	STATION	SURFACE COURSE	BINDER COURSE	BASE COURSE	SUB-BASE COURSE	SUB GRADE
3-1	1+900 to 3+000	40	50	150	330	500
3-2	3+000 to 4+000	40	50	150	330	600
3-1	4+000 to 5+000	40	50	150	330	500
3-3	5+000 to 13+100	40	50	150	270	400

Figure 2.2.2.1-1 Typical Cross Section (Type3)

### 2.2.2.2 Design of Countermeasures against Soft Ground to Embankment

The new road embankment ground is floodplain. There are places at which soft silty cohesive soil and/or humus soil is deposited. Countermeasure against the places at which harmful consolidation settlement and/or slope slip may occur due to the embankment is designed based on the conditions below.

- Definition of the ground applied the countermeasure design  
Cohesive soil of N value  $\leq 4$  and Unconfined compressive strength :  $q_u \leq 60\text{kN/m}^2$
- Analyses  
One dimension consolidation settlement analysis  
Slip slope analysis
- Required Conditions for the stability of road embankment  
Residual settlement at the time of surface course work  $S_r \leq 5\text{ cm}$   
Slip safety factor  $F_{s_{\min}} \geq 1.2$

Cross section of replacement method is shown in Figure 2.2.2.2-1.

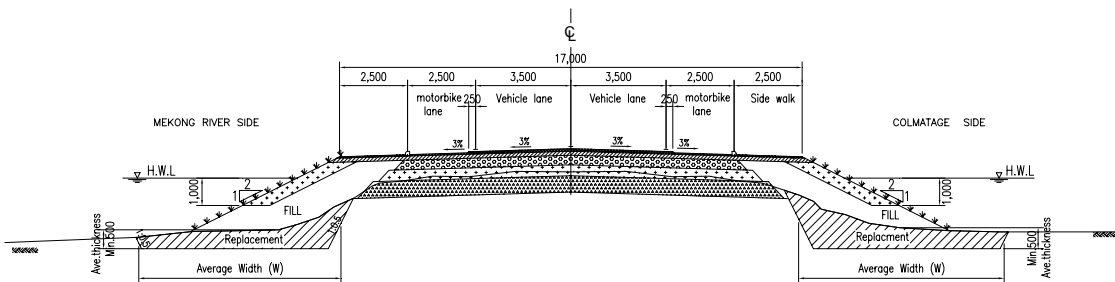


Figure 2.2.2.2-1 Cross Section of Replacement Method

Replacement thickness (t) and width (w) depend on the height and the soft layer thickness. Dimension of replacement method every section is shown in the Table 2.2.2.2-1. With regard to the classification of replacement materials, sands will be adopted for the sections where cannot be compacted due to under the water full-time, however, high-quality soils will be applied for the remaining sections.

Table 2.2.2.2-1 Dimension and Quantity of Replacement Method

(Replacement with Soil)

Station	Mekong side				Colmatage side			
	Sec. length	Ave. thk.	Ave. width	Sec. area	Sec. length	Ave. thk.	Ave. width	Sec. area
	m	m	m	m <sup>2</sup>	m	m	m	m <sup>2</sup>
1.9km - 2.0km	100m	0.50	6.60	3.30	100m	1.40	7.82	10.95
2.0km - 3.0km	1,000m	0.68	6.96	4.70	963m	0.50	5.48	2.74
3.0km - 4.0km	1,000m	0.75	5.50	4.13	100m	1.22	6.49	7.92
4.0km - 5.0km	1,000m	1.02	4.22	4.30	900m	0.65	4.32	2.81
5.0km - 6.0km	1,000m	0.50	5.60	2.80	1,000m	0.50	5.42	2.71
6.0km - 7.0km	1,000m	0.81	4.42	3.60	1,000m	0.50	4.38	2.19
7.0km - 8.0km	1,000m	0.83	5.06	4.20	1,000m	0.50	4.92	2.46
8.0km - 9.0km	850m	0.50	4.40	2.20	1,000m	0.50	6.64	3.32
9.0km - 10.0km	900m	0.50	4.82	2.41	1,000m	0.50	6.37	3.19
10.0km - 11.0km	1,000m	0.72	5.80	4.20	1,000m	0.57	4.58	2.61
11.0km - 12.0km	400m	0.70	4.57	3.20	700m	0.96	5.03	4.83
12.0km - 13.0km	800m	1.39	4.63	6.42	1,000m	1.91	7.54	14.41
13.0km - 13.1km	100m	0.54	4.63	2.50	100m	1.07	4.28	4.58

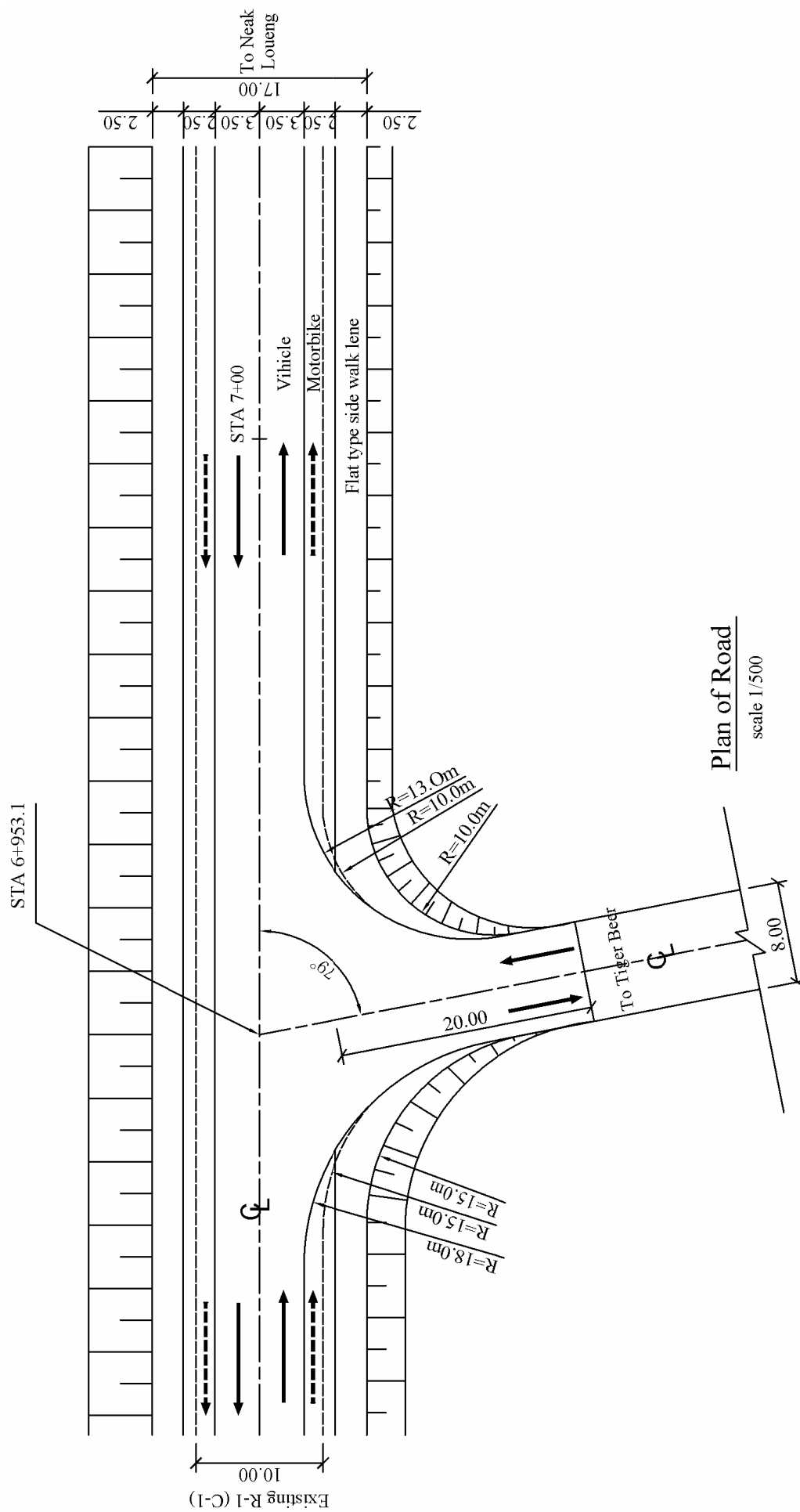
Replacement by Sand

Station	Mekong Side				Colmatage Side			
	Length	Ave. Thickness	Ave. Width	Section Area	Length	Ave. Thickness	Ave. Width	Section Area
	m	m	m	m <sup>2</sup>	m	m	m	m <sup>2</sup>
2.0 km - 3.0 km					37	1.00	7.80	7.24
3.0 km - 4.0 km					900	1.40	4.54	6.71
4.0 km - 5.0 km					100	1.50	6.63	7.86
8.0 km - 9.0 km	150	1.00	5.58	5.58				
9.0 km - 10.0 km	100	1.00	5.27	5.27				
11.0 km - 12.0 km	600	1.90	5.46	10.12	300	1.50	6.68	10.02
12.0 km - 13.0 km	200	1.50	8.91	13.37				
Total	1,050				1,337			

### **2.2.2.3 Intersection Design**

#### **(1) Tiger Beer Road Intersection (Sta.6+953.1)**

The service level is above C judging from the present traffic volume and from the future traffic volume 10 years later, therefore, the improvement of this intersection is ordinary T-type intersection, refer to Figure 2.2.2.3-1.



Plan of Road  
scale 1/500

Figure 2.2.2.3-1 Tiger Beer Road Intersection



### 2.2.2.4 Ancillary Facilities Design

#### (1) Pavement Marking and Traffic Sign

Centerline, lane line, borderline and crosswalk are set up as pavement marking. Cat's-eye is set up every 25 m on the centerline. Center line, lane line and border line are set up at all sections of the road, and crosswalk is set up at school and hospital zone.

Traffic signs for traffic safety are set up. Speed limit sign as regulatory sign, chevron board and school zone as warning sign and informatory sign are set up.

#### (2) Guardrail and Guidepost

Guideposts are set up at the curved alignment sections where radius is under 500 m, culvert approaches and the road with embankment height of over 5 m. In addition, guardrails are set up at bridge approaches, bridges and culverts.

The guardrail and guidepost locations are shown in the Table 2.2.2.4-1. Total numbers of guidepost is 1,010, and total length of guardrail is 360 m.

#### (3) Truck Scale (Vehicle Weighing Machine)

Within the Cambodia, the damages of the roads and bridges caused by overloading vehicles is remarkable, and become the severe problems from the viewpoints of road maintenance and traffic safety control. Therefore, two (2) truck scales were installed at Sta. 7+000 (right side) and Sta. 52+000 (left side) to regulatory the overloading vehicles

Table 2.2.2.4-1 Location of Guidepost and Guardrail

(Guideposts)

No.	Left Side					Right Side					
	Station		Length (m)	Nos. Pitch =5m	Remarks	No. Start	Station		Length (m)	Nos. Pitch =5m	Remarks
	Start	End					Start	End			
1	1+955	1+965	10.0	3	Embankment	1	2+955	2+985	30.0	7	Embankment
2	2+050	2+070	20.0	5	Embankment	2	12+340	12+616	276.0	1	Acute Curve
3	2+125	2+160	35.0	8	Embankment	3	12+720	12+755	35.0	8	Embankment
4	2+320	2+330	10.0	3	Embankment	4	12+800	12+825	25.0	6	Embankment
5	2+950	2+985	35.0	8	Embankment	5	12+875	12+885	10.0	3	Embankment
6	3+182	3+713	531.0	107	Acute Curve						
7	12+715	12+750	35.0	8	Embankment						
8	12+870	12+890	20.0	5	Embankment						
9	13+015	13+145	130.0	27	Embankment						
TOTAL			781.0	165		TOTAL			376.0	25	