

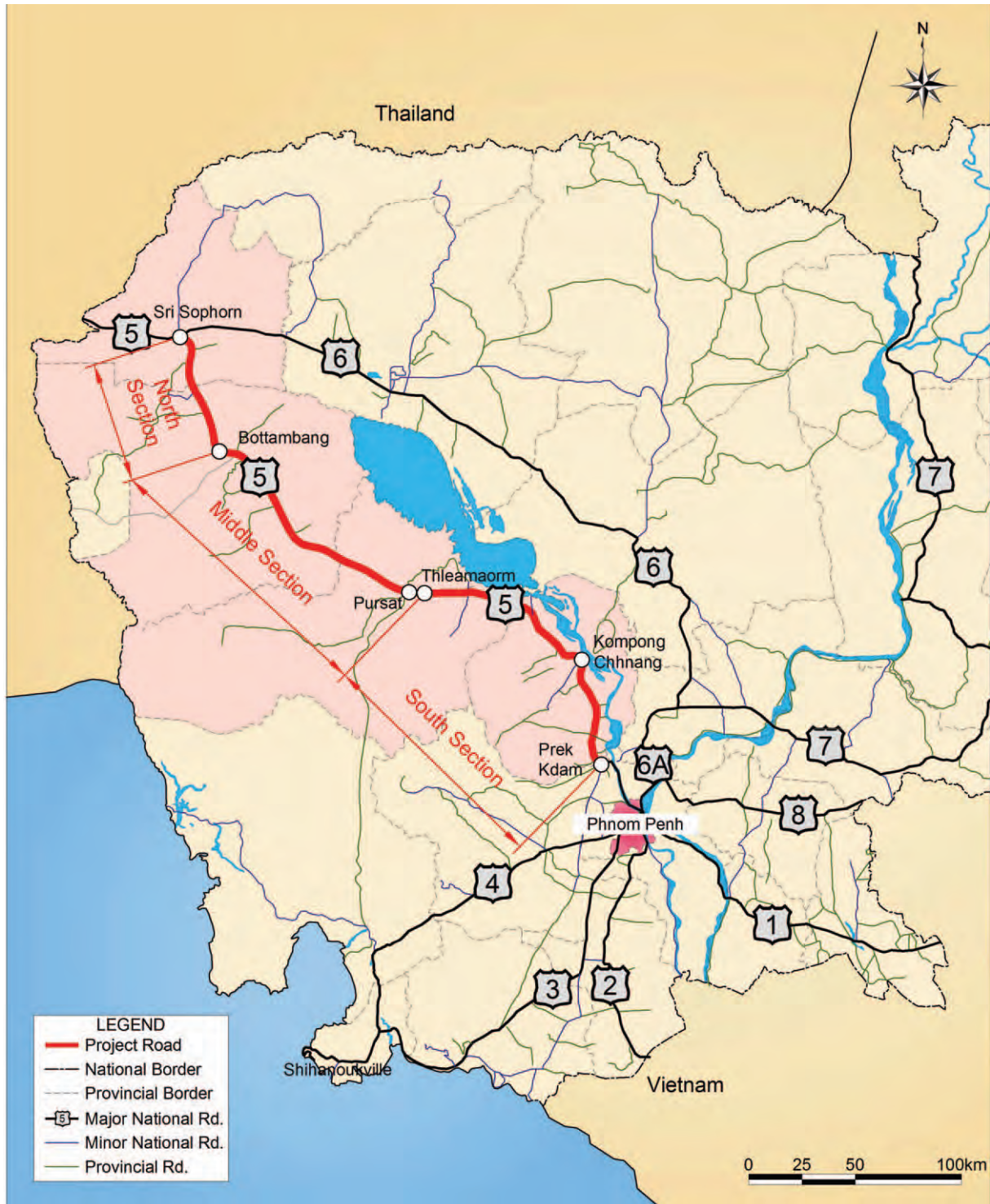
**PREPARATORY SURVEY FOR
NATIONAL ROAD NO. 5
REHABILITATION PROJECT
IN THE KINGDOM OF CAMBODIA**

**FINAL REPORT
EXECUTIVE SUMMARY**

OCTOBER 2012

**JAPAN INTERNATIONAL COOPERATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL**

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Location Map

** The name of the city of ‘Sisophon’ was officially changed to ‘Serei Saophoan’ after this Survey had started, and finally to ‘Sri Soporn’ during the loan processing. In preparing the Final Report, the Survey Team corrected from ‘Sisophon’ to ‘Sri Sophorn’ as much as possible. However, there may still remain the word ‘Sisophon’ and ‘Serei Saophoan’. The readers are kindly requested to interpret that ‘Sisophon’, ‘Serei Saophoan’ and ‘Sri Sophorn’ refer the same city.*

Table of Contents

LOCATION MAP

1. INTRODUCTION	1
2. PROFILE OF THE SURVEY AREA	2
3. NATIONAL ROAD NETWORK OF CAMBODIA AND ROLE OF NR 5	4
4. PRESENT CONDITION OF NATIONAL ROAD 5	6
5. TRAFFIC SURVEYS AND TRAFFIC DEMAND FORECAST	10
6. SELECTION OF PRIORITY SECTION	12
7. PLANNING OF BYPASS ROUTE	14
8. HIGHWAY DESIGN	15
9. BRIDGE PLANNING	16
10. COST ESTIMATION.....	17
11. IMPLEMENTATION PLAN	19
12. MAINTENANCE AND OPERATION PLAN	21
13. PROJECT EVALUATION.....	23
14. NOTE FOR IMPLEMENTATION OF JAPANESE YEN LOAN PROJECT.....	24
15. ENVIRONMENTAL AND SOCIAL CONSIDERATION	25
16. RESETTLEMENT ACTION PLAN	27
17. CONCLUSION AND RECOMMENDATION.....	30

1. INTRODUCTION

1.1 Background

- The road network had severely deteriorated during the Civil War which officially ended in 1992.
- Up to early 2000s, there were many unpassable sections even on the arterial (single-digit) national highways.
- Since then, condition of national road network in Cambodia have been substantially improved owing to the great effort of the Royal Government of Cambodia (RGC), the particularly Ministry of Public Works and Transport (MPWT), as well as assistances of the development partners including Japan (JICA), ADB and World Bank.
- Nowadays, most of the sections of single-digit national roads are passable. Also many of double-digit national roads have been, or are now being paved.
- However, width is narrow and pavement is DBST at many places of single-digit national roads, hampering smooth and safe traffic and imposing heavy financial burden of maintenance cost to RGC.

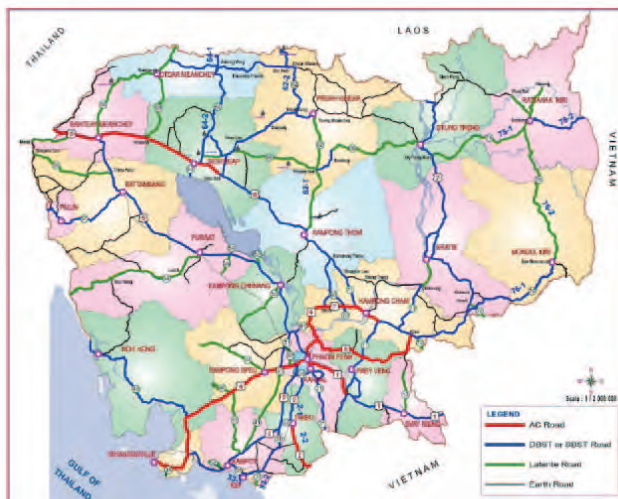


Figure 1-1 Pavement Type of National Roads
(As of 2010)

- Due to rapid economic growth in recent years, Cambodia is now eligible for Yen

Loan.

- RGC requested the first Yen Loan for rehabilitation of Prek Kdam – Thlea ma’Aam and Battambang – Sri Sophorn Sections of National Road No. 5 (NR 5), as well as construction of bypasses around the cities of Kampong Chhnang and Battambang.
- Upon this request, Japan International Cooperation Agency (JICA), the sole national agency exclusively for technical and financial assistance of Japan decided to conduct the Preparatory Survey for National Road No. 5 Rehabilitation Project.
- The Scope of the Survey was as follows:
 - Evaluation of the current conditions of Prek Kdam – Thlea ma’Aam, Thlea ma’Aam – Battambang and Battambang – Sri Sophorn Sections and prioritize the urgency/necessity for rehabilitation these sections and construction of bypasses.
 - Carry out feasibility study on the section selected to have the highest priority.
 - Carry out necessary surveys and design in the course of carrying out the above tasks.
- In the course of the Survey, significance of construction of Sri Sophorn Bypass was recognized both by RGC and JICA, and survey on construction of Sri Sophorn Bypass was added to the Scope of the Survey.

1.2 Objectives

- Objectives of the Rehabilitation Project are as follows:
 - To ensure safe and smooth means of transport
 - To promote socio-economic activity in the area along the Project Road.
- Objectives of this Survey are as follows:
 - To confirm the justification of the Project
 - To obtain data and information required for appraisal of a loan project.

2. PROFILE OF THE SURVEY AREA

2.1 Topography

- NR 5 starts from Phnom Penh and traverses the southwest side of Tonle Sap River and Tonle Sap Lake until it reaches the city of Sri Sophorn in Banteay Meanchey Province.
- The terrain is generally flat, except the sections between Kampong Chhnang and Pursat where the terrain is lightly hilly.

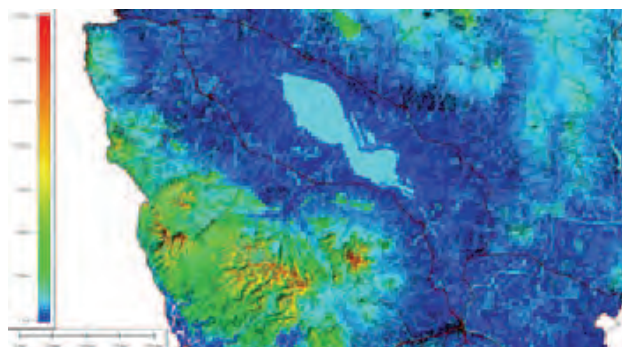


Figure 2-1 Topography of Survey Area

2.2 Climate

- Climate of Cambodia is categorized as ‘Asian Monsoon’, and is hot and humid in general.
- Annual rainfall ranges 1,200 to 1,600 mm.

- Rainy season is May – September and dry season is November – April.
- Monthly average temperature ranges 25 – 34 degrees Celsius.

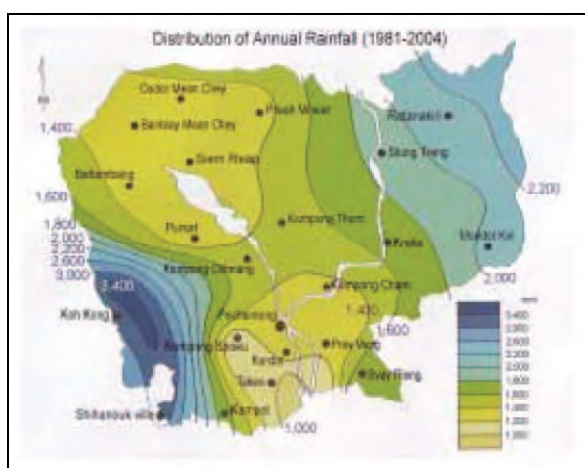


Figure 2-2 Distribution of Annual Rainfall

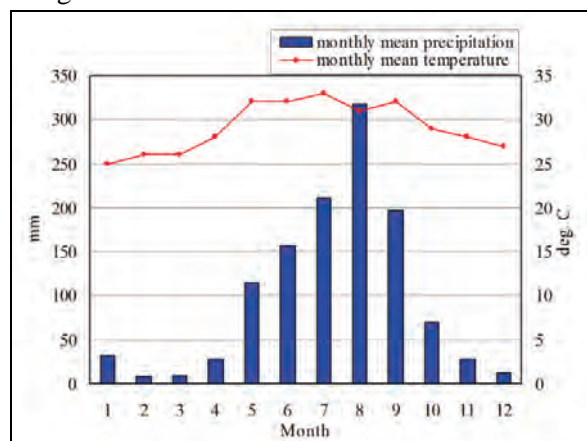


Figure 2-3 Monthly Rainfall and Temperature in Phnom Penh

- Tables 2-1 and 2-2 shows monthly average rainfall, monthly average of maximum and minimum temperature recorded in Battambang.

Table 2-1 Monthly Average Rainfall in Battambang

(mm)

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2010	8.3	12.0	25.2	69.9	77.3	121.2	241.9	216.6	193.3	325.2	40.5	8.3	1339.7
2011	0.0	50.8	35.1	152.7	151.5	108.0	186.8	253.2					-

Table 2-2 Monthly Average of Maximum and Minimum Temperature in Battambang (oC)

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	2010	33.2	35.3	36.1	37.1	36.6	34.6	33.4	32.3	32.1	30.5	30.6	31.1
	2011	30.8	33.6	32.5	33.8	34.0	33.4	33.5					
Min	2010	22.4	24.9	25.2	26.0	27.2	26.3	25.6	25.4	25.5	24.5	23.7	21.7
	2011	20.1	23.2	23.3	25.3	25.8	26.0	25.6					

2.3 Socio-Economic Profile

(1) Population

- The table below summarizes the socio-economic data of the Survey Area.
- The total population of the 4 provinces against that of the whole country is approximately 28% while the percentage of land area is only 20%.
- This means that the population density of the Survey area is higher than the national average, implying that the Survey Area is the developed area in Cambodia.

Table 2-3 Socio-Economic Data of Survey Area

	Kampong Chhnang	Pursat	Battambang	Banteay Meanchey	Whole Country	Proportion to Whole Country (%)
Population	472,000	397,000	1,025,000	678,000	13,389,000	28.3
Land Area (ha)	552,100	1,269,200	1,170,200	6,67,900	18,103,500	20.2
Rice Field Area (ha)	127,700	95,300	234,100	210,800	2,566,800	17.8
Proportion of Rice Field Area (%)	23.1	7.5	20.0	31.6	14.2	N.A.
Rice Production (ton)	311,500	239,700	567,200	447,200	6,727,100	23.3

(2) Agriculture

- The area along NR 5 is developed with agriculture as the main industry.
- Provinces of Battmabang and Banteay Meanchey are known by their rice production.

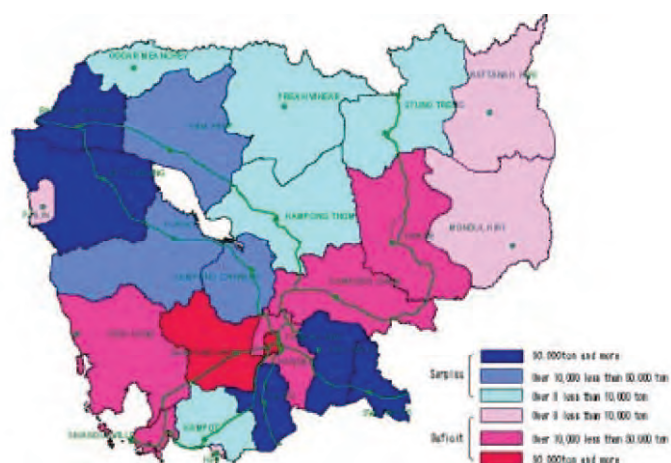


Figure 2-4 Rice Production by Province

(Source: Quoted from the final report of 'the Study on the Road Network Development in the Kingdom of Cambodia, October 2006, JICA)

3. NATIONAL ROAD NETWORK OF CAMBODIA AND ROLE OF NR 5

3.1 National Road Network of Cambodia

- National Road Network of Cambodia consists of arterial national roads with single digit numbers (1 to 8) and minor arterial roads with double digit numbers. The total lengths of single-digit and double-digit national roads are 2,096 km and 4,848 km, respectively (as of end of year 2008).
- Most of the arterial national roads of Cambodia is extend in radial directions centered at Phnom Penh and reach to the border points with neighboring countries of Vietnam and Thailand.
- Total length of NR 5 from Phnom Penh to Poipet is 407.5 km.

3.2 Surface Condition of National Road Network

- Road network of Cambodia had deteriorated during the period of the civil war and road projects up to early 2000's mainly focused urgent rehabilitation.
- The pavement type adopted in the past road projects was DBST which cannot support heavy traffic.
- Most of the sections of national roads are 2 lanes
- Widening and improvement of pavement into AC is becoming important issue.

3.3 Road Network Development Plan

- National Strategic Development Plan 2009 –13 states that the Government wishes to widen NR 5 as well as NR 1 and NR 4.

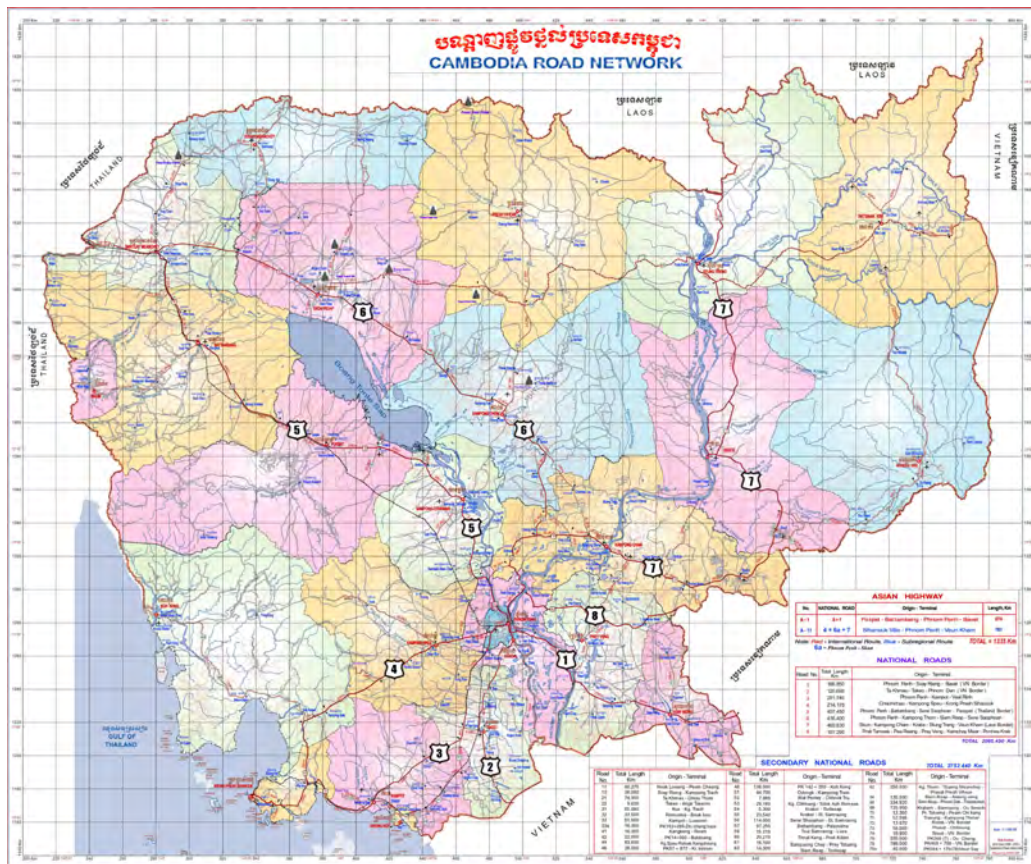


Figure 3-1 National Road Network of Cambodia

3.4 Role of NR 5

- NR 5 is an arterial national road connecting Phnom Penh and the border point with Thailand.
- It traverses provinces of Battambang and Banteay Meanchey whose populations are 3rd and 4th largest in the country.
- Thus, NR 5 accommodates the traffic needed for the day-to-day activities of the citizens, including access to the public services such as hospital and school, along the highway.
- NR 5 also accommodates the traffic transporting goods and passengers between the major cities along the highway, such as Sri Sophorn, Battambang, Pursat, Kampong Chhinang and Phnom Penh.
- Further it is connected, via Phnom Penh, to National Road No. 1 (NR 1) which reaches to Ho Chi Min City in Vietnam and National Road No. 3 (NR 3) and National Road No. 4 (NR 4) which reach to Sihanoukville, the largest international seaport of Cambodia.
- NR 5 is an important highway not only for domestic transport in Cambodia but also for international transport in ASEAN and the Greater Mekong Subregion (GMS).
- NR 5, together with National Road No. 1 (NR 1), forms a route connecting Bangkok, Phnom Penh and Ho Chi Minh City. Thus, NR 5 has been designated as ASEAN Highway No. 1 and Asian Highway No. 1.
- With rapid growth in the regional cooperation in GMS in the recent years, the importance of NR 5 is also rapidly growing.
- The distance between the city of Sri Sophorn (the north end of the Survey Section) and Poipet (the border point with Thailand) is approximately 50 km and distance between Poipet and Bangkok in Thailand is approximately 250 km.

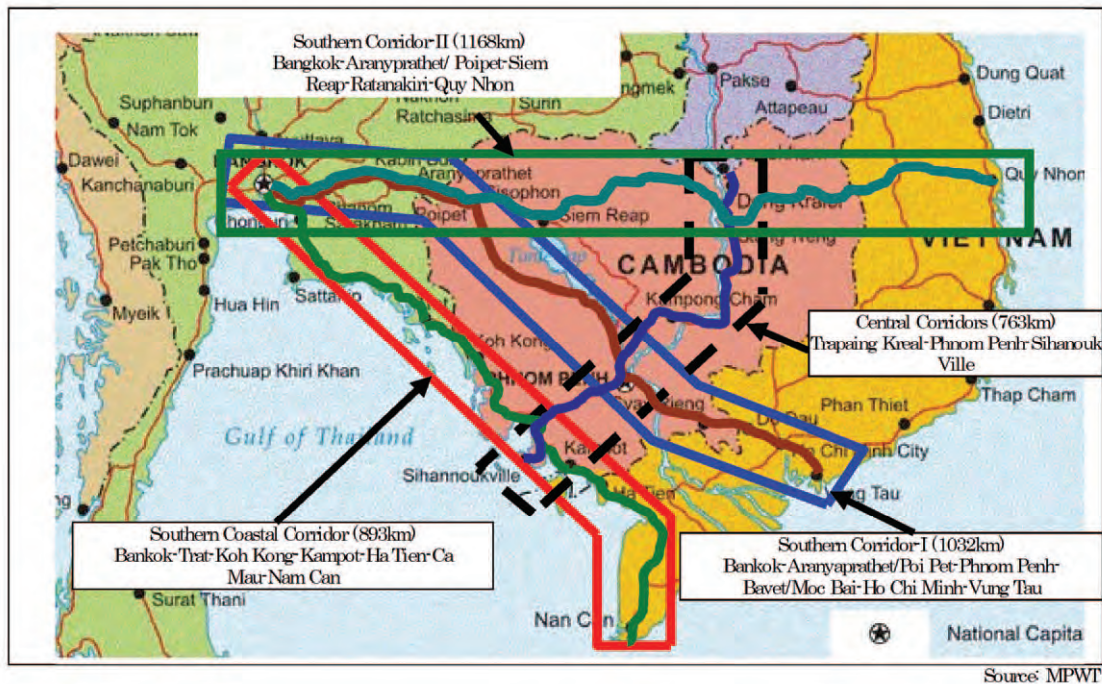


Figure 3-2 Economic Corridors of GMS

(Source: Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia, Infrastructure and Regional Integration Technical Working Group, 2010)

4. PRESENT CONDITION OF NATINAL ROAD 5

4.1 Overall Condition

- The Survey on the existing condition of NR 5 was conducted on the 3 sections.
 - South Section: KP32 ~ KP171, 139 km
 - Middle Section: KP171 ~ KP301, 130 km
 - North Section: KP301 ~ KP361, 60 km
- * KP32 Prek Kdam Bridge; KP171 Thlea Ma'Am; KP301 Battambang; KP361 Sri Sophorn
- The existing condition was observed during the Survey focusing on the points as listed below:
 - Inundation: experience of overflow or high water level near the road surface,
 - Drainage: the flow of rain water,
 - Pavement: present condition and defects,
 - Resettlement/PAPs: present condition of houses/buildings within ROW and along the road.

4.2 Geometric Structure

Horizontal Alignment

- Horizontal Alignment is generally generous.
- Some sharp curves need to be improved.

Vertical Alignment

- NR 5 traverses generally flat terrain.
- Rolling terrain is found only near Kampong Chhnang.
- Some sections with steep grade are found near the bridges.
- Embankment hight are as summarized below.

Table 4-1 Embankment Height

Section	Embankment Height	Inundation
South Section	-0.3 ~ 5.0 m	Some sections in 2002&04
Middle Section	-0.3 ~ 2.5 m	Inside town by heavy rain
North Section	0.0 ~ 2.5 m	Few sections in 2010

* Minus (-) embankment height indicates that the height of the road surface is lower than the ground surface adjacent to the road.

Cross Section

- Cross section of NR 5 is composed of 2-lane carriageway and shoulders.
- Divided 4-lane section is found in the cities of Battambang and Sri Sophorn.
- There are two types cross section on the

South Section; (i) 9.8 m pavement & 1.5 m shoulder (Prek Kdam ~ Kampong Chhnang), and (ii) 7.7 m pavement & 1.5 m shoulder (Kampong Chhnang ~ Thlea Ma'Am)

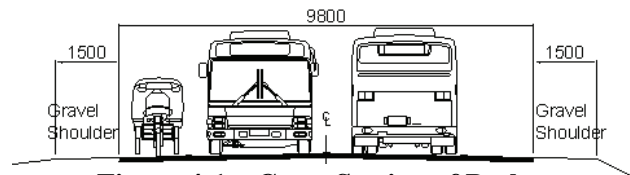


Figure 4-1 Cross Section of Prek Kdam – Kampong Chhnang

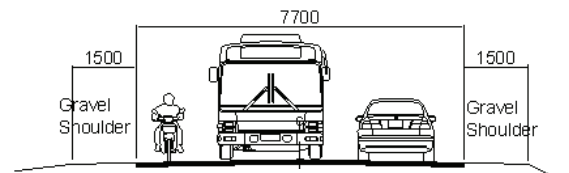


Figure 4-2 Cross Section of Kampong Chhnang – Thlea Ma'am

- The pavement width on the Middle Section is wider than the other sections.
- The paved shoulder with SBST provides the space for motorcycle & cart.

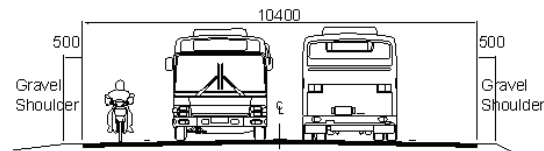


Figure 4-3 Cross Section of Middle Section

- The typical cross section of North Section is similar with that of South Section.
- The average pavement width is 7.8 m and average width of shoulder is 1.5 m.

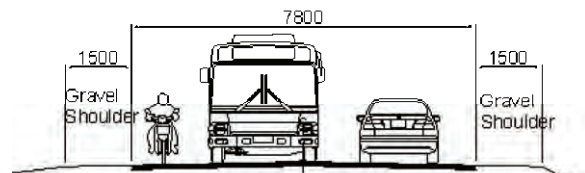


Figure 4-4 Cross Section of North Section

4.3 Pavement Condition

- The several kinds of repair works under RAMP have been carried out.
- The typical failures of pavement are crack, pothole, depression, flush, rutting, aggregate loss, edge damage and shoving.

Table 4-2 Damage on South Section

Failure	Location
Crack	KP32~KP54, KP136~KP167
Depression	KP32~KP77, KP102~KP170
Aggregate Loss	KP93~KP98
Edge Damage	KP92~KP131

Table 4-3 Damage on Middle Section

Failure	Location
Crack	KP232~KP248, KP259~KP284
Depression	KP217~KP243, KP262~KP266
Rutting	KP187~KP268
Edge Damage	KP216~KP220

Table 4-4 Damage on North Section

Failure	Location
Crack	KP311~KP322, KP338~KP357
Depression	KP302~KP306, KP311~KP324, KP341~KP348, KP353~KP360
Rutting	KP325~KP335, KP347~355
Aggregate Loss	KP350~KP351, KP360~KP361

4.4 Bridge

- The number of bridges located on the Project Road is 87 in total.
- Most of the bridges have been recently constructed.
- Some bridges do not have enough width to match 'to-be-widened' road.
- Twelve bridges in total are evaluated to be in necessity for replacement.

Table 4-5 Bridges to be Replaced

KP	Code	Length	Carriageway Width	Bridge Type
South Section				
38.5	Br5	9.15m	10.75m	2 span Rigid Frame RC Girder
40.1	Br6	24.0m	8.1m	2 span Simple Steel Plate Girder
46.8	Br11	16.7m	10.4m	4 span Rigid Frame RC Slab
88.3	Br20	6.0m	13.6m	1 span RC Slab
106.3	Br22	91.0m	7.3m	4 span Simple Steel Plate Girder
116.6	Br26	71.0m	7.25m	3 span Simple Steel Plate Girder
Middle Section				
182.0	Br42	19.4m	9.7m	4 span Simple RC Girder
186.0	Br47	120.0m	7.3m	6 span Simple PC Girder
187.5	Br48	38.9m	8.8m	2 span Simple RC Girder
245.9	Br66	9.7m	9.3m	2 span Simple RC Girder
North Section				
341.1	Br84	4.9m	10.2m	2 span Rigid Frame RC Arch
357.2	Br91	14.4m	8.6m	3 span Simple RC Girder

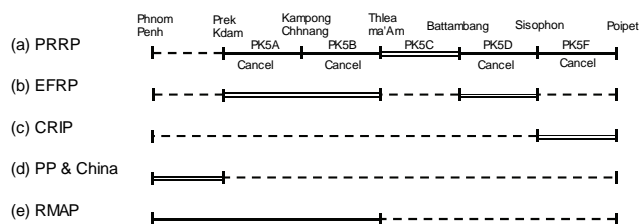
4.5 Planned, On-going and Past Project for NR 5

- After the flood in year 2000, restoration and rehabilitation works have been implemented.
- Maintenance project by ADB is on-going up to the end of South Section

- Widening project of existing road is also scheduled.

Table 4-6 Project List on National Road No. 5

Section	Project	Year
Phnom Penh ~ Prek Kdam Br.	Restored by Army	~2003
	RAMP funded by ADB 4-lane widening by China fund	~2011 2012~
Prek Kdam Br. ~ Kampong Chhnang (South Section)	Restored by Army	~2003
	RAMP funded by ADB	~2011
Kampong Chhnang ~ Thlea Ma'Am (South Section)	EFRP funded by ADB	~2004
	RAMP funded by ADB	~2011
Thlea Ma'Am ~ Battambang (Middle Section)	PRRP funded by ADB	~2003
Battambang ~ Sri Sophom (North Section)	EFRP funded by ADB	~2004
Sri Sophom ~ Poipet	CRIP funded by ADB	~2008



- * PRRP: Primary Roads Restoration Project by ADB
- EFRP: Emergency Flood Rehabilitation Project by ADB
- CRIP: Cambodia Road Improvement Project by ADB
- PP: Project by Phnom Penh Municipality
- RAMP: Road Asset Management Project by ADB

4.6 Hydrological Condition and Record of Flood

- Several locations along National Road No.5 experiences flood every year. Information of the flood condition was collected through hearing on Provincial DPWTs, and local residents as well as interpretation of topographic maps.
- Highest water level of Tonle Sap River in recent year is almost 10m.
- Flood prone areas coincide with the areas where land elevation is lower than 10 m on the topographic map.
- Hearing from local residents indicated flood of conditions such as water level above road, duration and frequency of flood.
- Based on the flood condition survey, following locations have been identified as the sections which need countermeasure of flood in Detailed Design.
 - KP 40 km ~ 59 km
 - KP 90 km ~ 91 km
 - KP 105 km ~ 109 km
 - KP 155 km ~ 160 km
 - KP 340 km ~ 359 km

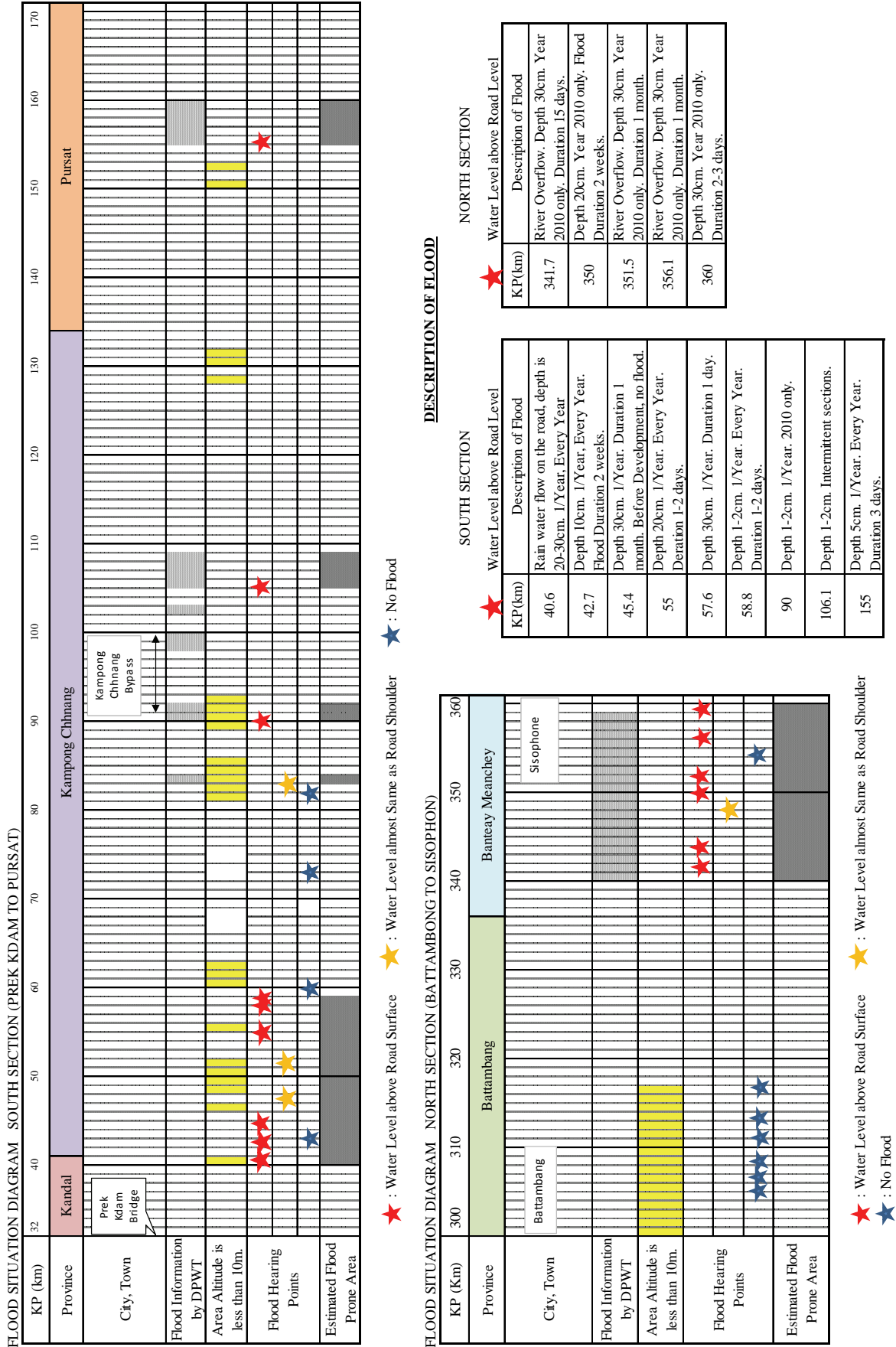


Figure 4-5 Summary of Information on Flood

4.7 Topographic Survey

- Air photos were taken on the North Section and South Section of existing NR 5.
- Altitudes of road surface and ground level adjacent to the road were surveyed using GPS apparatus.
- Para-glider was used for taking air photo.
- Surveys were conducted on Battambang Bypass and Sri Sophon Bypass for the following items:
 - Road centerline survey
 - Cross section and profile
 - Topography adjacent to bypass

- Topography of the planned bridge locations

4.8 Geotechnical Survey

- The following surveys were conducted:
 - Test pitting at shoulder to see the layers of pavement and embankment, as well as to take samples for the CBR tests
 - Boring at locations of bridges to be newly constructed or replaced.
- Table 4-7 shows the results of laboratory CBR tests

Table 4-7 Results of Laboratory CBR Tests on Existing Subgrade Soils

Section	No. of Data	CBR (%)		
		Min.	Max.	Ave.
South (Prek Kdam – Kampong Chhnang)	26	14	50	26.4
South (Kampong Chhnang – Pursat)	39	3.5	42	24.5
North (Battambang – Sri Sophorn)	39	5.5	40	19.0

5. TRAFFIC SURVEYS AND TRAFFIC DEMAND FORECAST

5.1 Survey Background

- Traffic surveys were carried out on the National Road No. 5. The objectives of the surveys were to have better understanding on the characteristic of the Survey Area, as well as the present traffic pattern.
- The following three (3) types of the survey were conducted, namely; traffic count survey (12hr and 24hr), origin destination (OD) interview survey and travel speed survey.

5.2 Outline

- The traffic counts were conducted at eight (9) stations with three (3) vehicle groups and eight (8) vehicle classifications.
- The traffic counts were conducted at eight (9) stations with three (3) vehicle groups and eight (8) vehicle classifications.
- These traffic counts were carried out on weekdays, excluding Saturday, Sunday and national holidays. The groups and classifications of vehicle were classified as follows.

Table 5-1 Vehicle Category

Group		Classification	
I	Motor Cycle (MC)	1	Motorcycle and Motor Tricycle
		2	Motorbike Trailer
II	Light Vehicle (LV)	3	Sedan, Wagon, Light Van and Pick-up(for passenger)
		4	Pick-up(for commodity), Jeep and Light Truck (>3.5t)
		5	Mini Bus (Van type and Pick-up Type)
III	Heavy Vehicle (HV)	6	Short and Long Body Bus
		7	Short and Long Body Truck (<3.5t)
		8	Semi and Full Trailer Truck

5.3 Survey Locations

- The survey locations were selected at the provincial boundary and city boundary (Kompong Chhnang City and Battambang City) and they are shown in Figure below.

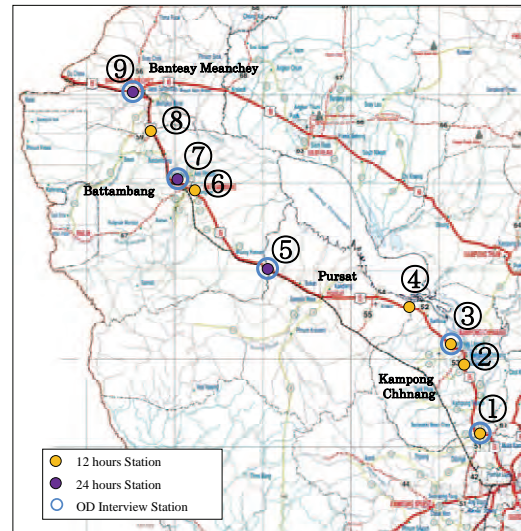


Figure 5-1 Location of Traffic Count Survey

5.4 Survey Result

- The 24 hours (daily) traffic volumes were calculated using the conversion factor of 24 hours / 12 hours ratio of rural area and city boundary.
- The conversion factor for rural area is applied to traffic volume at station No.1, 4 and 8 and that for city boundary is applied to those at station No. 2, and 6 respectively.
- The results of 24 hours traffic volume are shown in the table below.

Table 5-2 Daily (24 Hour) Traffic Volume

Unit: Vehicles

Station No.	Motorcycle			Light Vehicle				Heavy Vehicle				Grand Total
	Motorcycle and Tricycle	Motorbike Trailer	Total	Sedan, Wagon and Light Van	Pick-up, Jeep and Light Truck	Mini Bus	Total	Short & Long Body Bus	Short & Long Body Truck	Semi & Full Trailer Truck	Total	
1	4,708	331	5,039	2,004	676	892	3,572	204	871	437	1,512	10,122
2	5,504	119	5,622	1,990	687	607	3,284	228	457	51	735	9,641
3	4,063	60	4,123	1,505	452	599	2,556	217	461	94	772	7,451
4	760	40	800	1,038	334	399	1,771	196	445	139	780	3,351
5	1,674	50	1,724	970	357	391	1,718	195	567	194	956	4,398
6	13,143	497	13,640	1,922	769	580	3,271	205	1,003	83	1,291	18,202
7	8,238	484	8,722	2,205	651	516	3,372	157	382	193	732	12,836
8	4,103	209	4,312	1,664	394	314	2,372	109	999	303	1,411	8,094
9	3,476	92	3,568	2,816	545	312	3,673	113	385	314	812	8,053

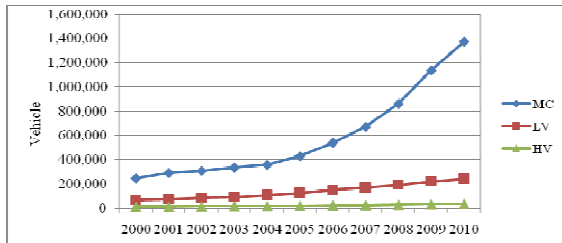
5.5 Traffic Demand Forecast

- Forecast of the future traffic demand is the basis of highway planning and economic analysis. This chapter describes the methodology and data used in the traffic demand forecast, as well as the result of the forecast.

- In the estimation of future traffic demand, target years are set at 2016, 2021 and 2030. Years 2016 and 2021 correspond to 5 and 10 years from 2011, and year 2030 is chosen since it will be 10 years after the long-term target year of the JICA M/P Study, 2006.

5.6 Vehicle Registration

- The salient feature of vehicle registration in Cambodia is that the share of motorcycles (MC) is predominantly larger than those of the other vehicles. In 2010, the total number of vehicles in Cambodia accounts for 1.65 million, of which 1.37 million are MC and the remaining 0.28 million are Light vehicle (LV) and Heavy Vehicle (HV).
- Average growth rates of MC, LV and HV over the period from 2000 to 2010, obtained by discarding the maximum and minimum annual growth rates, are 33%, 18% and 10%, respectively. Vehicle ownership of MC and LV per 1000 population is 96.0 and 17.0, or 1 vehicle per 10 people for MC and 1 vehicle per 59 people for LV, respectively.



Source: Ministry of Public Works

Figure 5-2 Vehicle Registration in Cambodia

5.7 Future Vehicle Registration

- Future growth rates of vehicle registration in Cambodia for the ‘Medium Growth Scenario’ are estimated as shown in Figure
- Table below shows the future growth of vehicle registration, as well as growth of past 10 years.

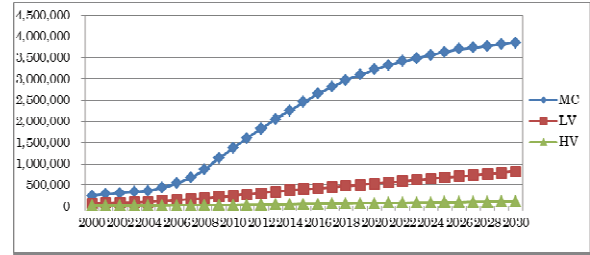


Figure 5-3 Projection of Number of Vehicles

- Figure below shows the projected growth of vehicle registration for the three scenarios of GDP growth. In case of the ‘High Growth Scenario’, the total number of registered vehicle is projected to reach 6,547,000, or 2.8 person/veh, in 2030. Compared to the figures of Vietnam and Japan, this figure is considered to be too large. Thus, the figure of the ‘Medium Growth Scenario’ is adopted.

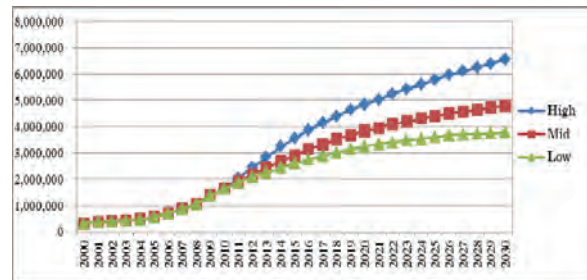


Figure 5-4 Projection of Number of Vehicles for Three Scenarios of GDP Growth

5.8 Traffic Assignment Result

- Table below lists the forecasted traffic volumes for years 2011, 2016, 2021 and 2030 at the traffic counting stations

Table 5-3 Result of Traffic Assignment

Unit: PCU

Section	Station No.	Year			
		2011	2016	2021	2030
South	1	10,612	14,720	20,641	28,637
	2	8,644	11,519	15,735	21,164
	3	7,426	10,001	13,775	18,947
	4	5,616	7,453	10,092	13,888
Middle (Boundary)	5	6,071	8,232	11,368	15,899
	6	12,052	17,556	25,625	36,834
North	7	9,065	13,545	20,090	29,464
	8	8,453	12,356	17,812	25,540
	9	8,983	12,734	17,794	23,861

6. SELECTION OF PRIORITY SECTION

6.1 Evaluation of Existing Road Condition

- Existing width of road is narrow in North Section and Kampong Chhnang – Thlea Ma’Am Section of South Section (7.7 m and 7.8 m respectively) compared with other sections.
- These narrow road widths are causing hazardous traffic conditions.
- Pavement conditions are generally acceptable, although many defects such as depression and cracks are actually observed.
- However, this does not necessarily mean that the strength of the existing pavement is sufficient. Rather, the strength of existing pavement, in general, is not sufficient to support the increasing traffic volume, especially that of heavy vehicles.
- Although the pavement is maintained in a acceptable condition, such maintenance will become heavy burden in budget requirements, workload of contacting, supervision of maintenance works and traffic management during the maintenance works.
- Forecasted traffic volumes are interpreted as summarized in Table 6-1.

- Also, frequent inundation and subsequent reduction in bearing capacities of the pavement/subgrade is accelerating the deterioration of the pavement.
- Twelve (12) bridges need to be replaced for various reasons. Table 6-2 shows the number of bridges which need to be replaced.

Table 6-2 Number of Bridges to be Replaced

Section	South	Middle	North
No. of Bridges	6	4	2

- The information on inundation collected from various sources, including the local residents and DPWT of respective province, is summarized in Table 6-3:

Table 6-3 Summary of Information on Inundation

Section	South		Middle	North	
Location (KP)	40.6, 42.7, 57.6	45.7	55, 58.8, 90, 106.1	155	341.7 - 360
Water Depth	10 – 30cm	30cm	1 -5 cm	5cm	20 – 30cm
Frequency	1/ Yr.	1/ Yr.	1/ Yr.	1/ Yr.	2010 only
Duration	1 day – 2 weeks	1 month	1 – 2 days	3 days	2 days – 1 month

Table 6-1 Forecasted Traffic Volume and Degree of Congestion for Three Sections

Year	Location	Sta. No.	Description of Congestion (If no measure is taken)
By 2021	South Section (Prek Kdam)	1	<ul style="list-style-type: none"> VCR in peak hour approaches 0.8 and congestion is anticipated in peak hour. Daily traffic volume exceeds 20,000 PCU and congestion is anticipated substantial periods of day time.
	Middle Section (South end of Battambang City)	6	<ul style="list-style-type: none"> Daily traffic volume exceeds 25,000 PCU and congestion is anticipated substantial periods of day time.
	North Section	7, 8	<ul style="list-style-type: none"> VCR in peak hour exceeds 0.85 and congestion is anticipated in peak hour.
By 2030	South Section	1	<ul style="list-style-type: none"> Daily traffic volume exceeds 28,000 PCU and severe congestion is anticipated substantial periods of day time.
		2	<ul style="list-style-type: none"> Daily traffic volume exceeds 21,000 PCU and congestion is anticipated substantial periods of day time.
	Middle Section (South end of Battambang City)	6	<ul style="list-style-type: none"> Daily traffic volume exceeds 36,000 PCU and traffic is paralyzed.
	North Section	7, 8	<ul style="list-style-type: none"> Daily traffic volume approaches 25,000 PCU and congestion is anticipated substantial periods of day time.

6.2 Priority of Three Sections for Rehabilitation

- Considering the above aspects (narrow road width, forecasted traffic volume, inundation), as well as planned (pledged) and on-going projects for the three sections, such as RAMP assisted by ADB, the priorities of the three sections are evaluated as follows:

- North Section (Battambang – Sri Sophorn)
 - South Section (Prek Kdam – Thlea Ma’ Am)
 - Middle Section (Thlea Ma’ Am – Battambang)
- It should be noted that the priority of the South Section is also very high, although lower than that of the North Section. Thus the rehabilitation of South Section needs to be planned as soon as possible.

Table 6-4 Priority of Three Sections of Existing NR 5

Criteria	Evaluation and Reason		
	North Section	Middle Section	South Section
Traffic Demand/ Traffic Congestion	◎ • Congestion by 2021	△ • Some congestion is anticipated by 2030	○ • Congestion on the south end (Prek Kdam) by 2021
Existing Road Condition	○ • Narrow width • Insufficient pavement strength • Some sharp curves • Inundation	△ • Insufficient pavement strength	○ • Narrow width on Pursat – Thlea Ma’ Am section • Insufficient pavement strength • Inundation
Influence of Other Project	○ Nothing particular	○ Nothing particular	× • Existing serious pavement defects are to be repaired in RAMP: Large-scale rehabilitation in the next few years becomes ‘double investment’. • There is a possibility that Chinese government improves/ widens the section near Prek Kdam.
Overall Evaluation of Urgency	Very High	Medium	Very High: Considering that various repair/maintenance works are being implemented, the priority is evaluated next to North Section.

6.3 Priority of Bypass

- Priority of Battambang Bypass is evaluated to be higher than that of Kampong Chhnang Bypass for the reasons as listed below:
 - Traffic volume flowing into the urbanized area of Battambang City is larger than that into Kampong Chhnang City. Thus traffic congestion in Battambang City is more severe than in Kampong Chhnang.
 - Especially the traffic volume in the southern suburbs of Battambang City is the largest among those forecasted at 8 locations, and is anticipated to greatly exceed the capacity of the road by 2021. If the North Section is rehabilitated, supervision of construction of Battambang Bypass is easier than that of Kampong Chhnang Bypass because it is adjacent to the North Section.

Table 6-5 Traffic Volume on Bypass and in City

Area	Route	2021	2030
Kampong Chhnang	Bypass	11,432	15,395
	City Center	3,533	4,859
Battambang	Bypass	7,840	11,799
	City Center	15,495	22,136

6.4 Necessity of Sri Sophorn Bypass

- Study on Siophon Bypass was added after this Survey had started.
- Construction of Sri Sophorn Bypass is justified because it can greatly reduce the number of houses or buildings to be relocated if the existing NR 5 is to be widened.

7. PLANNING OF BYPASS ROUTE

7.1 Alternative Routes of Battambang Bypass

- Three alternative routes were proposed by DPWT, Battambang.
- Another three alternatives were proposed by the JICA Team.
- These alternative routes were evaluated considering the following aspects:
 - Number of houses/buildings which need to be relocated
 - Future development/expansion of the urban area of Battambang City
 - Adverse impact to Tonle Sap Lake and its surrounding protected area
 - Easiness/difficulty for access from the urbanized area of Battambang City
- As a result, JICA-1 route was proposed as the best alternative and was accepted by the Cambodian side.

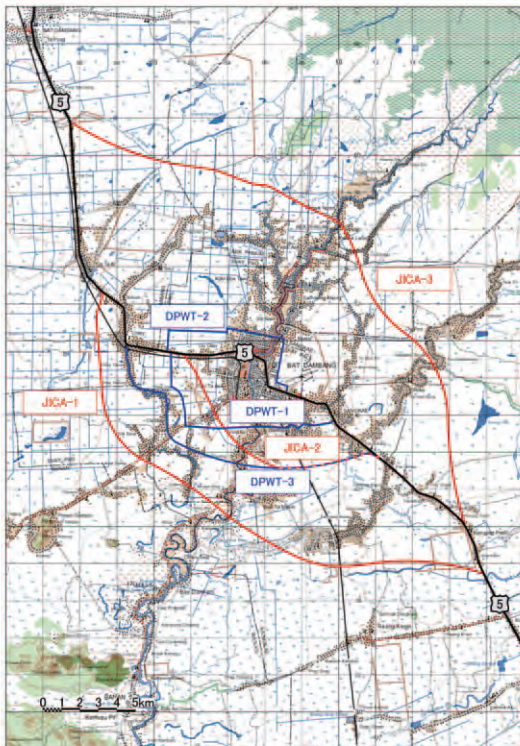


Figure 7-1 Alternative Routes of Battambang Bypass

7.2 Adjustment of Route of Battambang Bypass

- After JICA-1 route was agreed, the Battambang Governor's wish that the route of the bypass be as close as possible, but not to the extent to reduce the function of bypass, was conveyed to JICA Team.

- Upon receipt of the above Governor's opinion and based on further survey on the site conditions, the southern section of the bypass route was adjusted to make the connecting point with NR 5 closer to the City. This modified route was proposed to the Cambodian side (MPWT and Battambang Province) and was agreed.

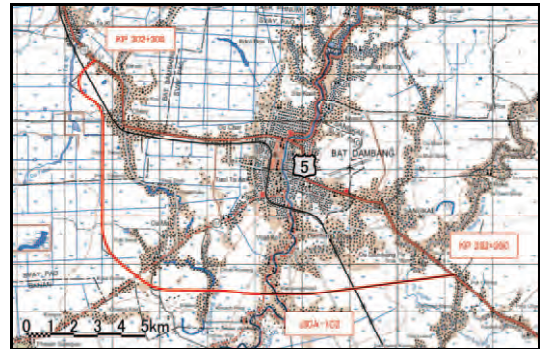


Figure 7-2 Adjusted Route of Battambang Bypass

7.3 Alternative Routes of Sri Sophorn Bypass

- One alternative and three alternatives were proposed by DPWT, Banteay Meanchey and JICA Team, respectively.

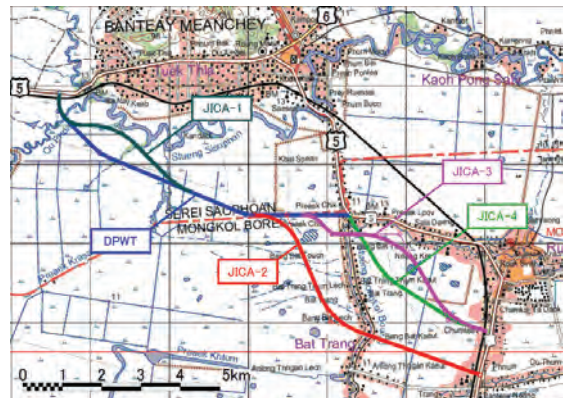


Figure 7-3 Alternative Routes of Sri Sophorn Bypass

- JICA-2 was proposed as the best option considering the following aspects:
 - To avoid resettlement in the town of Mongkol Borei
 - Connection to the existing NR 5 at the middle of Siophon City and Mongkol Borei Town
- Eventually this route was agreed by the Cambodian side (MPWT and Banteay Meanchey Province).

8. HIGHWAY DESIGN

8.1 Basic Design Policy

- The following facts were taken into account:
 - NR 5 is designated as Class I Road of Asian Highway Network.
 - It is a primary arterial national road of Cambodia.
 - Design criteria of Asian Highway and Cambodian Road Design Standard are compared in the table on the right.

Table 8-1 Comparison of Design Criteria

Items	Asian Highway	Cambodian Standard		Recommend (Rural, Urban)
		R5 (Rural)	U5 (Urban)	
Road Class	Class I	R5 (Rural)	U5 (Urban)	(Rural, Urban)
Design Speed	100km/h(flat)	100km/h(flat)	50km/h(type3)	100, 50km/h
Min. Curve Radius (Superelevation)	350m (10%)	415m (6%)	90m (6%)	350m, 80m (10%)
Lane Width	3.50m	3.50m		3.50m
Shoulder Width	3.00m (Flat)	3.00m (Flat)	2.50m (Type3)	3.00m
Median Strip	3.00m (Flat)	4.0~12.0m (Flat)	2.0~4.0m (Type3)	0.5~3.0m
Cross Slope	2.0% (AC)	2.5~3.0% (AC)		2.0%
Shoulder Slope	3.0~6.0%	3~4% (sealed)	3%	
Vertical Clearance	4.5m			4.5m

8.2 Alternatives of Cross Section

- Three alternatives as shown below were proposed for the rural section where the types roadside land use are either agricultural, waste or residential:

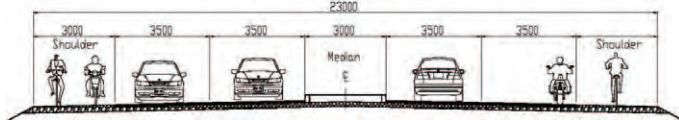


Figure 8-1 Alternative R-1: Cross Section of Asian Highway

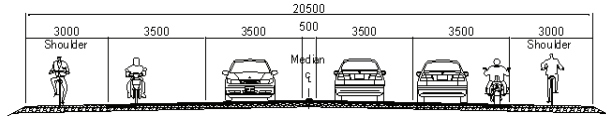


Figure 8-2 Alternative R-2: 4-Lane with Narrow Median and 3-Meter Shoulder

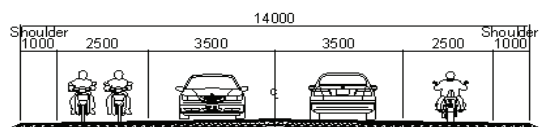


Figure 8-3 Alternative R-3: Opposed 2-Lane + MC Lane

- Road width or number of lane was studied the following aspects:
 - Future traffic volume
 - Role of NR 5 as Asian Highway No. 1 and a primary arterial national road
 - Improvement of traffic safety condition by separating slow traffic and high-speed traffic.

Alternative R-2 is recommended as the result of discussion between MPWT and JICA Team.

- Two alternatives of cross section of urban or commercial area were studied.

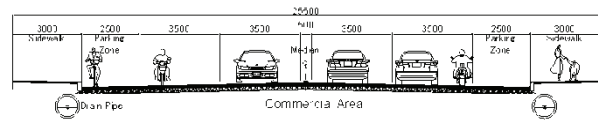


Figure 8-4 Alternative U-1: 4-Lane with Parking Space and Sidewalk

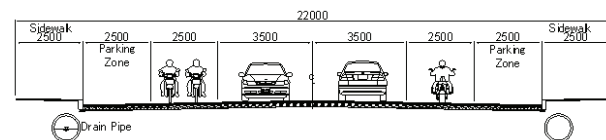


Figure 8-5 Alternative U-2: 2-Lane + MC with Parking Space and Sidewalk on Both Sides

- In studying the cross section of urbanized area, the following aspects were considered:
 - Speed limit of 40 km/h is imposed in the urban section
 - There are commercial activities on the both sides of the road and vehicles often cross the road to go to right side of the road
 - Space for road side parking should be provided to prevent block the traffic
 - As the conclusion, Alternative U-1 is recommended.

8.3 Preliminary Design of Bypass

- Two-lane road is capable to provide smooth traffic until year 2030
- Two-lane is proposed as the initial construction of the stage construction to reduce the initial investment

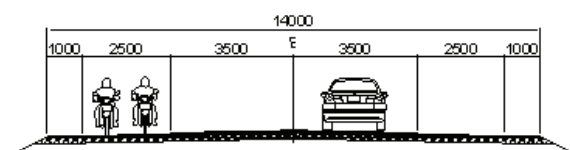


Figure 8-6 Cross Section of Bypass

9. BRIDGE PLANNING

9.1 Inventory of Existing Bridges on the North Section

- An inventory of the existing bridges on the North Section, Battambang to Sri Sophorn, is presented in the main report. The inventory is based on site inspections made by the Study Team, supplemented with drawings included in the document “Bridge Location on National Road No. 5 & 6”, MPWT, 2009.
- There are a total of fifteen (15) existing bridges on the North Section, of which nine (9) are included in the proposed scope of work.

9.2 Bridge Rehabilitation Plan on the North Section

- The bridge rehabilitation plan comprises of:
 - Bridge widening – 6 locations (Br. 80, 81, 83, 85, 86 and 87)
 - Additional bridge – 2 locations (Br. 79 & Br. 82).
 - Bridge reconstruction - 1 location (Br. 84)

9.3 Details of Bridge Widening for 4-Lane Road

- All the bridges that are proposed to be widened feature PSC decks. The deck widening concept will make use of similar section PSC units placed on extended substructure and transversely pre-stressed to the existing units of the deck.

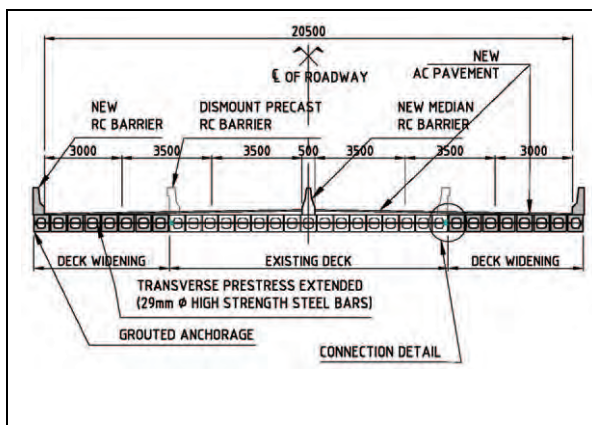


Figure 9-1 Bridge Deck Widening Concept

- It is proposed to replace the existing structure at Br. 84 with a new 4-Lane box culvert structure.
- Bridge substructure layout has been selected to be consistent with the existing bridge construction and adopting standard arrangements wherever possible.
- For all bridges, standard driven precast concrete driven piles are typically proposed, adopting the standard 40 cm x 40 cm section for abutments and pier pile caps, and 50 cm x 50 cm section for pier pile bents.
- The proposed additional bridges (Br. 79 & Br. 82) are proposed to feature pre-stressed concrete deck girder (PCDG) bridges. The girder selected for these bridges is the AASHTO standard girder type. Six (6) girders are proposed for each 10 m wide deck to be consistent with the standard set under the ongoing Strengthening of Construction Quality Project.

9.4 Planning of Bridges on Battambang Bypass

- Two (2) bridges are proposed to be constructed at km 2+020 and km 7+550 (Sangkae River) respectively.
- The bridge at km 2+020 is proposed to be PSC type, 20 m long single span.
- The proposed bridge at km 7+550 will cross the Sangkae River. A 105 m long bridge is considered sufficient to span the river. This bridge is proposed to be 3 span PCDG type.

9.5 Planning of Bridges on Sri Sophorn Bypass

- Two (2) bridges are proposed to be constructed at km 4+620 (Mongkol Borei) and km 12+700 (Steung Touch) respectively. The bypass traverses rivers at both locations that require bridge crossings.
- The Mongkol Borei bridge at km 4+620 is proposed to be a 3 span PSC bridge of total length 50 m.
- The Steung Touch bridge at km 12+700 is proposed to be a 3 span PSC bridge of total length 60 m.

10. COST ESTIMATION

10.1 Scope of Work

- As described in the previous chapters, National Road No. 5 (NR 5) Rehabilitation Project between Battambang – Sri Sophorn Section is divided into the sections, as shown in Figure 10-1. North Section from the intersection of NR 5 with Battambang Bypass in the north of Battambang City to the intersection of NR 5 with Sri Sophorn Bypass in the south of Sri Sophorn City is named Section I, Battambang Bypass is named Section II and Sri Sophorn Bypass is named Section III.

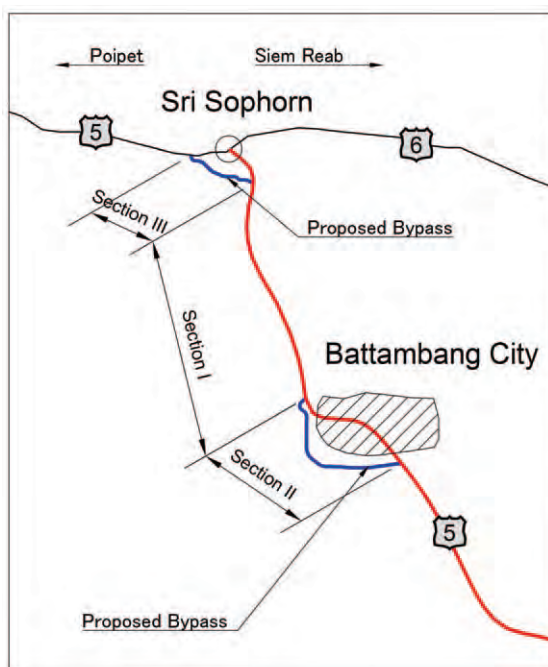


Figure 10-1 Map of Sections

- The scope of work and quantities of major works in each section are shown in Table 10-1.

Table 10-1 Work Scope in Each Section

Major works	Section I	Section II	Section III
Road length	47.0 km	23.1 km	13.4 km
Road width	20.5 m & 25.5 m	14.0 m	14.0 m
Pipe culvert	15 no.	92 no.	52 no.
Box culvert	28 no.	18 no.	18 no.
Bridge	9 no. to be rehabilitated	2 no. to be constructed	2 no. to be constructed

10.2 Project Cost

- The summary of project cost computed is shown below. It is to note that JICA will loan for items 1-1 to 1-4 in the Table 10-2 and the Royal Government of Cambodia (RGC) shall prepare budget for items 2-1 to 2-7 in the same table.

Table 10-2 Summary of Project Cost

Items		Amount (million USD)	Remarks
JICA Portion			
1-1	Construction cost		
	Section I (North Section of NR 5)	42.3	
	Section II (Battambang Bypass)	23.8	
	Section III (Sri Sophorn Bypass)	15.1	
	Total of Construction Cost	81.2	
1-2	Consulting Services	8.1	
1-3	Price Escalation	13.1	
1-4	Contingency	9.7	
	Total of Project Cost (JICA Portion)	112.1	
RGC Portion			
2-1	Land Acquisition and Resettlement Cost	6.3	
2-2	Utilities Relocation / Removal / Protection Cost	4.1	
2-3	Detection and Removal Cost of Mines and UXOs	0.3	
2-4	Price Escalation	0.7	
2-5	Contingency	0.5	
2-6	Employer's Administration Cost	2.0	
2-7	Taxes	11.8	
	Total of Project Cost (RGC Portion)	25.7	
	Grand Total	137.8	

10.3 Annual Progress

- Annual progress is calculated by expanding project cost to each year in accordance with the implementation schedule discussed in Chapter 10.
- Annual progress after applying escalation factor are shown below.
- As per the implementation schedule shown in Chapter 10, the loan will be commenced in the year 2013 and the total cumulative amount including interest at the end of grace period is USD 112.2 million.
- After the grace period, repayment shall be started with equal amount with interest and the amount per year is calculated approximately USD 3.7 million per year in thirty years from 2023 till 2052.

10.4 Repayment Schedule

- JICA loan conditions applying to Cambodia are as follows.
 - Interest rate: 0.01 %
 - Repayment period: 40 years
 - Grace period: 10 years

Table 10-3 Annual Progress

(Unit: million USD)

Items	Year	2013	2014	2015	2016	2017	2018	2019	Total
	Annual Progress with Escalation	JICA portion	1.4	1.2	31.0	35.8	27.2	12.5	3.0
RGC portion		1.2	7.8	7.7	4.1	3.2	1.4	0.3	25.7
Total		2.6	9.0	38.7	39.9	30.4	13.9	3.3	137.8

11. IMPLEMENTATION PLAN

11.1 Execution Plan

(1) Road works

- In this Project, there are two types of road works, which are widening of the existing road (Section I) and construction of bypasses around the cities of Battambang and Sri Sophorn (Section II and III).
- Section I is to widen the existing NR 5 on both sides or either side to accommodate two lanes on both directions from one lane on both direction, by mainly filling road body. Since NR 5 is a part of major road network in Cambodia, hindrance to the traffic needs to be minimal during construction. Therefore, construction works should be carried out half by half to maintain traffic capacity similar to that of the existing road during construction.
- Process of road works for Section I allowing the smooth flow of traffic is described below.

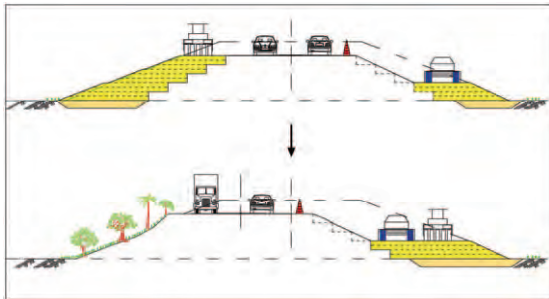


Figure 11-1 Embankment Works

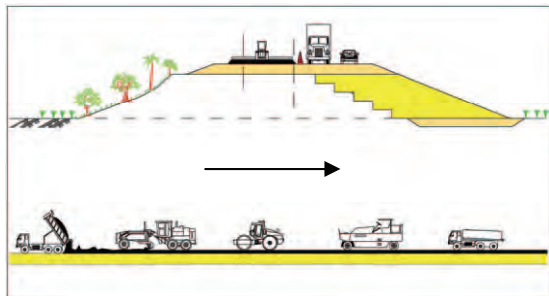


Figure 11-2 Sub-Base Works

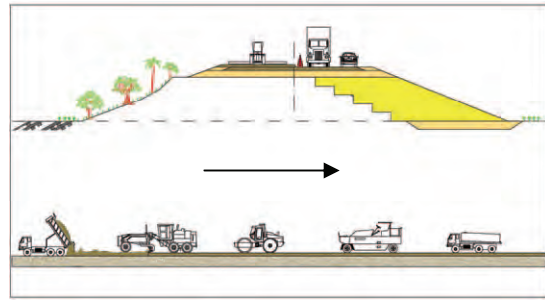


Figure 11-3 Base Course Works

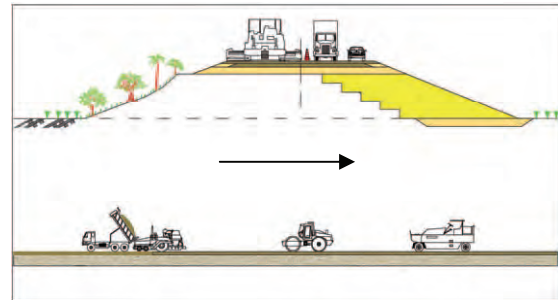


Figure 11-4 Asphalt Concrete Works

- On the other hand, works of Section II and III are construction of new roads mainly in paddy field or vacant land, and construction of road is relatively straight-forward.
- As for Battambang Bypass and Sri Sophorn Bypass, the works can be executed without consideration for traffic except at intersections with existing roads, where certain measures are necessary to maintain traffics on the existing roads.

(2) Bridge works

- There are also two types of bridge works, which are rehabilitation to existing bridges (on the existing NR 5) and new bridge construction (on the bypasses).
- Three kinds of bridge works are planned as the rehabilitation of the nine bridges on the existing NR 5; construction additional bridges, widening of existing bridges and construction of a new bridge after demolishing the existing bridges.
- In summary, 9 bridges in Section I are to be rehabilitated as listed below:

Table 11-1 Summary of Bridges in Section I

Way of rehabilitation		Bridge nos.
a	Additional bridge	2 nos. (Br. 79, 82)
b	Existing bridge widened	6 nos. (Br. 80, 81, 83, 85, 86, 87)
c	Replace with new box culvert	1 no. (Br. 84)
d	Re-construction of existing bridge slab	2 nos. (Br. 79, 82)

- In Section II and III, there are two bridges each to be newly constructed.

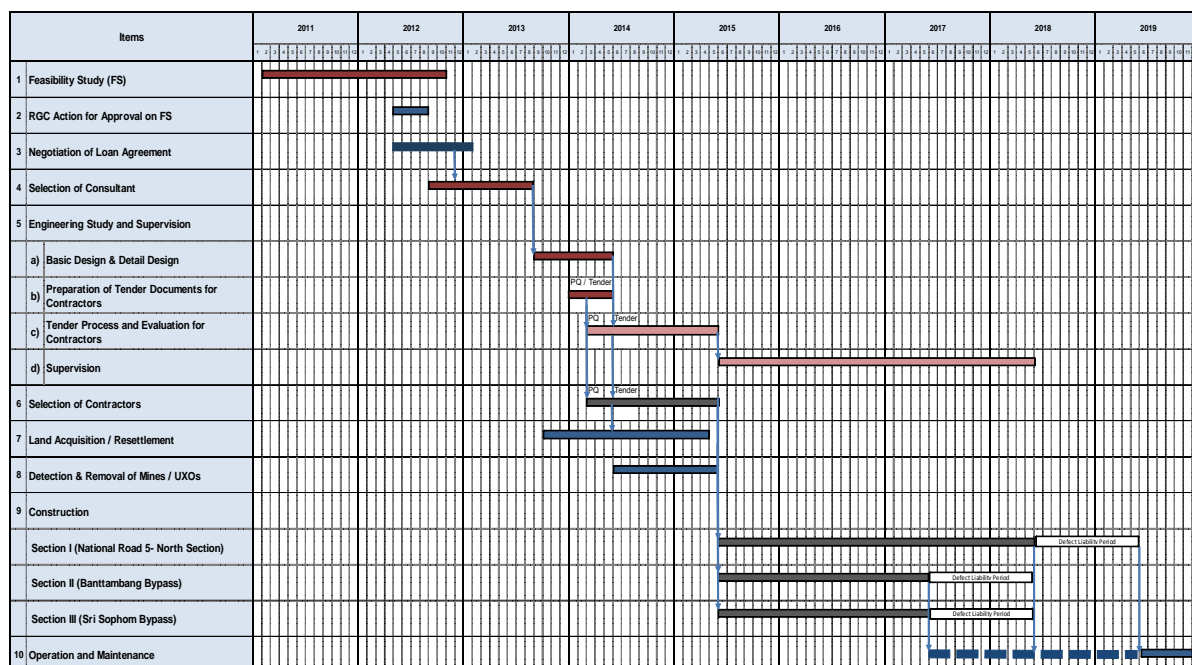
11.2 Implementation Schedule

- The followings are most probable schedule in each task.
 1. Feasibility study (FS): The final report is submitted in October 2012.
 2. Royal Government of Cambodia (RGC) Action for Approval on FS: The RGC will take a few months for approval.

3. Negotiation of Loan Agreement: Loan agreement will be planned to make in January 2013.
4. Selection of Consultant: Selection will take 12 months.
5. Engineering Study: This task will be complete in 9 months.
6. Selection of Contractors: Selection will take 15 months, including PQ process.
7. Land Acquisition / Resettlement: This task will take 19 months after basic design.
8. Detection and Removal of Mines / UXOs: This task will take 4 months after detail design and be carried out during dry season only.
9. Construction: Section I will be complete in three years and Section II/III in two years.

- The schedule is shown in Table 11-2 Implementation Schedule.

Table 11-2 Implementation Schedule



12. MAINTENANCE AND OPERATION PLAN

12.1 Maintenance and Operation Cost

- There are two kinds of maintenance, which are routine maintenance and periodic maintenance.
- Routine maintenance needs to be implemented every year after completion.
- As described in Highway Design, the design period of the pavement for this Project is 10-years. Thus, overlay of 5 cm thickness becomes necessary every 10-year after completion as the periodic maintenance.
- Unit rate of future routine maintenance cost of the Project road is estimated at USD 5,000/km, based on the experience in the past and routine maintenance cost in Section I to III is shown in Table 12-1.
- Periodic maintenance cost in each 10-year is computed as follows based on unit price of USD 14/m² of overlay (5 cm thick asphalt concrete). Table 12-2 shows cost of periodic maintenance.
- In summary, road maintenance and operation cost after completion is estimated in the price of 2011 as shown below.
 - Routine maintenance: USD 418,000/year
 - Periodic maintenance: USD 16,163,000/10-year

Table 12-1 Routine Maintenance in Section I, II and III

Section	Unit Rate (USD1,000/km)	Length (km)	Amount (USD1,000)
Section. I	5	47.0	235
Section. II	5	23.1	116
Section. III	5	13.4	67
Total			418

Table 12-2 Periodic Maintenance in Section I, II and III

Items	Unit Rate (USD)	Length (km)	Amount (1,000USD)
Section I			
Rural Area	USD 14/m ² x 15.0 m x 1,000 = USD 210,000/km	44.7	9,387
Urban Area	USD 14/m ² x 20.0 m x 1,000 = USD 280,000/km	2.3	644
Total of Section I			10,031
Section II	USD 14/m ² x 12.0 m x 1,000 = USD 168,000/km	23.1	3,881
Section III	USD 14/m ² x 12.0 m x 1,000 = USD 168,000/km	13.4	2,251
Total of Section I - III			16,163

12.2 Annual Road Maintenance and Operation Cost

- Annual road maintenance and operation cost with 2011 price and including escalation in each year is as shown in Table 12-3.

Table 12-3 Annual Road Maintenance and Operation Cost

unit: 1,000USD

Year	Costs with 2011 price			Costs with escalation applied		
	Routine maintenance	Periodic maintenance	Total	Routine maintenance	Periodic maintenance	total
2019	418	-	418	544	-	544
2020	418	-	418	564	-	564
2021	418	-	418	584	-	584
2022	418	-	418	605	-	605
2023	418	-	418	627	-	627
2024	418	-	418	636	-	636
2025	418	-	418	644	-	644
2026	418	-	418	653	-	653
2027	418	16,163	16,581	662	25,605	26,267
2028	418	-	418	671	-	671
2029	418	-	418	680	-	680
2030	418	-	418	690	-	690
2031	418	-	418	699	-	699
2032	418	-	418	709	-	709
2033	418	-	418	719	-	719
2034	418	-	418	729	-	729
2035	418	-	418	739	-	739
2036	418	-	418	749	-	749
2037	418	16,163	16,581	759	29,361	30,121
2038	418	-	418	770	-	770
2039	418	-	418	781	-	781
2040	418	-	418	792	-	792
2041	418	-	418	803	-	803
2042	418	-	418	814	-	814
2043	418	-	418	825	-	825
2044	418	-	418	837	-	837
2045	418	-	418	849	-	849
2046	418	-	418	861	-	861
2047	418	16,163	16,581	873	33,746	34,619
2048	418	-	418	885	-	885
2049	418	-	418	898	-	898
2050	418	-	418	910	-	910

13. PROJECT EVALUATION

13.1 Project Evaluation

- The section between Battambang and Sri Sophorn, Battambang Bypass and Sri Sophorn Bypass have the overall goals of facilitating transportation of goods and passengers. As a national and regional level goal, the Project will contribute to socio-economic development of Cambodia as well as to promote regional development.
 - To facilitate transportation of goods and passengers
 - To mitigate traffic congestion of roads in Battambang and Sri Sophorn City.
 - To promote regional development along National Road No. 5.
 - To maintain environmental conditions

Evaluation Index

- The operation of the section of between Battambang and Sri Sophorn, Battambang Bypass and Sri Sophorn Bypass are assessed based on a comparative analysis of indices of traffic volume in two cases of “without the Project road” and “with the Project road”.

Operation and Effect Monitoring Plan

- Operation and effect of the Project will be monitored by measuring impact indicators. The targets of the indicators are estimated as of the planned monitoring timing.

Operation and Effectiveness Indicators:

- Traffic Volume
- Travel Time

13.2 Economic Analysis

- Economic analysis is carried out through economic cash flow analysis based on ‘benefit-cost’ analysis. Benefits accruing from the Projects are (i) time saving benefit and (ii) vehicle operation cost saving benefit, while the Project cost consists of (i) construction cost, (ii) land acquisition cost and (iii) operation/maintenance cost.

(i) Economic Indicators

- In order to evaluate the road projects from an economic view point, the following economic indicators were estimated:
 - Economic internal rate of return (EIRR)
 - Benefit-cost ratio (B/C Ratio)
 - Net Present Value (NPV)

(ii) Cost Benefit Analysis

- The project is evaluated in terms of EIRR, BCR and NPV with assumed operation period of 30 years. Evaluation of the economic viability is done through three approaches and using social discount rate of 12.0%. Comparing with such discount rate, it can be said that economic viability is secured at a feasible level.

Indicator	Result
EIRR	22.6
B/C	3.18
NPV (Milion USD)	150.02

(iii) Sensitive Analysis

- The sensitivity analysis of the economic analysis is conducted for the respective fluctuation of benefit and construction cost at 10%.

Case	EIRR
Base Case	22.6
Investment Cost +10%	21.5
Benefit -10%	21.4
Investment Cost +10%, Benefit -10%	20.4

14. NOTE FOR IMPLEMENTATION OF JAPANESE YEN LOAN PROJECT

14.1 General

- Through the long experiences of implementation of Japanese ODA loan projects, JICA has found many important points which need attention from the view point of smooth implementation of projects as well as to fully achieve the objectives of projects.

14.2 Pre-Construction Stage

- The issue “Land Acquisition, Relocation and Mitigation Plan for Affected Families” is one of the most important points in the pre-construction stage.
- MPWT is expected to utilize the past experiences.
- Sometime, the time spent for approval procedures of key actions, such as approval of selection of consultant for detailed design and construction supervision take longer than expected, and delay in such approval often becomes the main cause of the delay in implementation of the project.
- Thus, MPWT, as ‘the Executing Agency’ of the project, should pay sufficient attention to this aspect.

14.3 Procurement Stage

- JICA sometimes extends technical assistance to the Executing Agency for smooth procurement. MPWT is recommended to request to JICA for this assistance.
- In the procurement stage, most important thing is to employ competent consultant and good contractors. Competent consultants and good contractors, in many cases, can prevent many risks, such as poor work quality, delay in progress and cost overrun, from occurring.
- To recruit a good consultant, weight of financial proposal in the evaluation of proposal with QCBS needs to be as small as possible. In case of consultant services, low price becomes possible only with low-priced experts who often do not have required

skill/knowledge/ experience.

- Offering large-size contract packages is one of practical measures for employing good contractors. In addition to this, diligent prequalification and bid evaluation are also important.
- However, there have been cases in the past where contractors with poor ability were employed. Employment of a competent consultant can prevent to a certain extent the problem caused by a contractor with poor capacity.

14.4 Construction Stage

- Quality control is utmost importance in road construction/rehabilitation.
- Employment of competent consultant and good contractors is the key to successful quality management.
- In order to achieve good quality of civil works, PQ condition is important. It would be necessary to incorporate the following conditions, in addition to the fundamental conditions; experience in large scale civil work contract of road project, experience in the project financed by Japanese ODA loan, experience of the contract which is based on the sample document of JICA, experience of the FIDIC contract.

14.5 Operation and Maintenance Stage

- AC pavement needs rehabilitation every 10 years and MPWT needs to prepare relatively large fund for this pavement rehabilitation.
- Overloaded trucks severely damage pavement. Enforcement against overloaded trucks is indispensable to secure expected life period of pavement
- There is a possibility that some pedestrians cannot respond to the increased speed of vehicles. It is recommended that traffic safety campaign be implemented.

15. ENVIRONMENTAL AND SOCIAL CONSIDERATION

15.1 Institutional Setup

- The Department of Environmental Impact Assessment (DEIA) is a structure of the Ministry of Environment (MOE) which is responsible for reviewing the EIA/IEIA report and monitoring the environmental management plan of both public and private development projects.
- Provincial and Municipal Environment Department (PMED) is in charge of projects on regional level.

15.2 Legal Framework

- Law on Environmental Protection and Natural Resource Management (1996) is the fundamental law of environment in Cambodia in which Chapter III stipulates Environmental Impact Assessment (EIA).
- If a project owner should conduct EIA and submit the report to get approval depends on type of projects and their size and capacity in Cambodia.
- According to this sub-decree the project of national road construction needs EIA when construction length is 100 km and more.

15.3 Categorization of the Project by JICA Guideline

- Category A projects defined by JICA New Guidelines generally include;
 - (i) vital sectors, such as transportation,
 - (ii) projects having sensitive characteristics, such as large-scale involuntary resettlement, or
 - (iii) projects located in/around sensitive areas.
- Under this circumstance, this project is classified as a Category A project, since it belongs to the transportation sector and also expected large-scale involuntary resettlement in the target area, despite the length of the target area is less than 100km as stipulated in Sub-Decree on Environmental Impact Assessment Process (1999).

- Accordingly, the project will not need to proceed into the official procedure for EIA approval prescribed in Cambodian legislation.
- However it is recommended that MPWT, as the project proponent, follow the procedures in line with what are required for EIA in the JICA's Guideline.

15.4 Examination of Potential Environmental Impact and Scoping

- To identify potential impacts on the environment during the pre-construction, construction and operation stages of the project, the environmental scoping list and matrixes has been prepared for the target section of NR 5 and selected Bypass plan.

15.5 Alternative Analysis

(1) North Section of NR 5

- Since the main content of the project is widening of the existing NR 5 and no major alteration of the alignment is anticipated, except at hazardous curve sections, alternatives of cross section (road width) are studied.
- Three alternatives of cross sections, as shown in Figures 8-1 to 8-3 in Section 8, are compared.
- Factors considered in the alternative study are; magnitude of land acquisition, separation of community, project cost, traffic safety, smoothness of traffic flow.
- Degree of advantage and disadvantage of alternatives with regard to the above factors were comparatively compared.
- With regard to the factors of social impact, ie magnitude of land acquisition and separation of community, degrees of negative impact were in the order of R-1 → R-2 → R-3 with R-1 with largest negative social impact.
- On the other hand, R-1 is most preferable from viewpoint of safe and smooth traffic.

(2) Battambang Bypass

- In the study of alternative routes, the following factors were considered:
 - Number of houses which need to be relocated
 - Traffic function as a bypass
 - Willingness of roadside residents for road improvement
 - Formation of future expansion of urbanized area
 - Loss of agricultural land
 - Impact to Tonle Sap Lake
- With regard to the number of houses to be relocated, impacts of the alternatives proposed by DPWT were much larger than those of the alternative proposed by the JICA Team. Difference of number of houses to be relocated among the three alternatives proposed by JICA was relatively small.
- The JICA Team recommended Alternative JICA-1C, and this proposal was agreed by MPWT and DPWT Battambang, in principle. This alternative has been agreed by MPWT, DPWT Battambang and JICA Team.

(3) Sri Sophorn Bypass

- Although construction of Sri Sophorn Bypass was proposed by the Provincial government of Banteay Meanchey to avoid relocation of large number of houses which becomes necessary to widen the existing NR 5, the alternative proposed by DPWT was to bypass only the city of Sri Sophorn and relocation of houses in the town of Mongkol Borei located about 3 km south of Sri Sophorn was still necessary.
- Thus, the main objective of the alternatives proposed by JICA Team was to bypass the town of Mongkol Borei and further decrease the number of houses to be relocated. After discussions among MPWT, DPWT Banteay Meanchey and JICA Team,

Alternative JICA-2 was adopted.

15.6 Present Condition Air Quality, Water Quality, Noise and Vibration

- Air quality, noise and vibration were surveyed at three locations.
- The surveyed data of air quality, and water quality, except Total Suspended Solid (TSS), were below standard of Cambodia.
- Noise levels during daytime were below Cambodian standard, but exceeded the standard in the night.

15.7 Environmental Management Plan

- Environmental Management Plan is essential to ensure that impacts identified are prevented and mitigated.
- Environmental Management Plan consists of Environmental Mitigation Plan and Environmental Monitoring Plan.
- Environmental Mitigation Plan shows the mitigation measures against negative environmental impacts during construction and after completion of the project, but mainly focus those to be done during construction.
- Environmental Monitoring Plan shows the monitoring during pre-construction stage, construction stage, and operation stage (after completion of the Project).
- Items of Environmental Monitoring in operation stage include survey on noise and air quality.
- To ensure the competence of project personnel in undertaking the environmental procedures and plans, training shall be conducted for the concerned personnel.

16. RESETTLEMENT ACTION PLAN

16.1 Institutional Setup

- Inter-Ministerial Resettlement Committee (IRC) is a collegial body for resettlement.
- IRC is headed by the representative from MEF and composed of representatives from concerned line ministries.
- The Resettlement Department (RD) under the Ministry of Economy and Finance (MEF) is a secretariat of IRC.
- The owner of the Project is the Executing Agency (EA) which is MPWT; therefore, it has overall responsibility for the successful implementation of the RAP.
- The Environmental Section of PMU (PMU-ES) will be established to work closely with the RD and IRC for the preparation, updating, and implementation of the RAP.

16.2 Legal Framework

- Article 44 of 1993 Constitution established governing principles pertaining to land acquisition.
- Land Law of 2001 governs land and property rights in Cambodia based on the provisions of 1993 Constitution.
- The Land Law defines the scope of ownership of immovable properties such as land, trees and fixed structures.
- Expropriation Law February 2010 prescribes procedures for acquiring private properties for national or public interest.
- There are several relevant Sub-Decrees and Praks.

16.3 Project Resettlement Policy

- The objective of the project resettlement policy is to ensure that AHs are not worse off because of the project. The project should provide an opportunity for the local people to derive benefits from it, and it should likewise serve as an occasion for the local people to participate in its planning and implementation, thereby engendering a

sense of ownership over the same.

16.4 Project Impacts

- Table 16-1 shows Affected Households (AHs) by Project.

Table 16-1 Number of Affected Households

Province	No. of AHs by Section			Total (AHs)
	National Road 5	BTB Bypass	BMCH Bypass	
Banteay Meanchey Province	644	0	150	794
Mongkol Borei District	644	0	108	752
Krong Sri Sophorn	0	0	42	42
Battambang (BTB) Province	964	507	0	1,471
Thma Koul District	964	107	0	1071
Krong Bat Dambang	0	235	0	235
Sangkae District	0	165	0	165
Total (the Project)	1,608	507	150	2,265

16.5 Inventory of Affected Assets

- The inventory of affected land or PRW (20 m from the centerline of the road on bothsides) in the ROW (30 m - 30 m) of NR 5 was not considered because the ROW is a public state land.
- The affected area (20 m - 20 m) will be not compensated by the project. Even so, the survey team has also determined the identities of the land occupants or users if the affected land is accompanied by immovable assets such as trees, houses, shops and/or other structures.
- A total of 1,556,605.71 m² of land will be required for the construction of the two bypasses (BTB and BMCH).
- It is comprised of 1,456,493 m² of private land and 100,112 m² of flooded forest land (state land). Of these, 86.32% (1,343,597 m²) is used for growing rice.
- Table 16-2 shows the number of households who will lose their private land due to construction of the two bypasses and areas of such lands.

- A total of 704 AHs along NR 5 and the bypasses have main structures (house, house-shop and/or shop/restaurant) that will be affected by the project, comprising of 681 AHs along NR 5 and 23 AHs along the two bypasses.

Table 16-2 Number of Households Who Lose Private Land and Their Areas due to Construction of Bypasses

District/ Krong	Rice Field		Orchard		House Plot/ Home Garden		Commercial		Flooded Forest	
	AH	m ²	AH	m ²	AH	m ²	AH	m ²	AH	m ²
Mongkol Borei	93	303,296.75	3	5,799.04	17	9,169.90	0	0.00	1	268.25
Krong Sri Sophorn	40	171,394.68	1	5,911.34	0	0.00	0	0.00	1	99,844.20
Banteay Meanchey	133	474,691.43	4	11,710.38	17	9,169.90	0	0.00	2	100,112.45
Thma Koul	95	182,728.96	0	0.00	9	5,731.90	1	3,347.33	0	0.00
Krong Bat Dambang	196	425,005.36	14	24,865.94	26	24,273.91	0	0.00	0	0.00
Sangkae	133	261,171.79	8	14,880.06	20	18,916.30	0	0.00	0	0.00
Battambang	424	868,906.11	22	39,746.00	55	48,922.11	1	3,347.33	0	0.00
Total	557	1,343,597.54	26	51,456.38	72	58,092.01	1	3,347.33	2	100,112.45

16.6 Public Participation and Consultation

- During RAP preparation stage, the following public consultations were held at different stages.
 - (i) Provincial stakeholder meeting: Participated by governors of Districts, DPWT staff, MPWT staff and consultant employed by JICA Team.
 - (ii) Public Consultation Meeting (before cut-off date): Participated by the people of Communes traversed by the Project Road and Bypass and other concerned parties.
 - (iii) Public Consultation Meeting (after cut-off date): Participated by the people of Communes traversed by the Project Road and Bypass and other concerned parties.
- In the Provincial stakeholder meeting, alternative routes of bypasses were discussed and the route recommended by the JICA Team was supported. In the 2nd and 3rd meetings, there were not strong opposition to the proposed Project, and many questions raised were on the

procedures of resettlement including compensation.

16.7 Grievance Redress

- Grievances of AHs in connection with the implementation of the RP will be handled through negotiation with the aim of achieving consensus.
- Complaints will pass through three stages before they may be elevated to a court of law as a last resort. MPWT will shoulder all administrative and legal fees that will be incurred in the resolution of grievances and complaints.

16.8 Relocation Strategy

- IRC-WG in collaboration with PRSC will acquire a piece of land for preparing a resettlement site based on consultation with entitled AHs or their representatives.
- The location of the land will be as close as possible to their original land and will have access to nearby or on-site primary and secondary schools, health facilities and market facilities.

16.9 Income Restoration Strategy

- Restoring the incomes of AHs whose means of livelihood have been disturbed or removed is a high priority for RGC and JICA. This is of particular concern with respect to households whose livelihoods as well as property are lost.
- Therefore, an Income Restoration Program (IRP) will be developed during resettlement implementation stage, after DMS is conducted. IRC will contract out to implement IRP.
- Possible measures to restore livelihood depend on sort of income sources.
- The report of monitoring results will be prepared by MPWT and submitted to IRC and JICA on quarterly basis.
- External monitor has the specific responsibility of studying and reporting on measures for income restoration and on social and economic situations of AHs particularly disrupted by the road works, including all households whose houses or shops and stalls are relocated.
- The external monitor also has the responsibility of reviewing potentials for job opportunities and training for AHs, including women and youth, which would be assisted by provincial authorities, and for which the Commune Resettlement Committees and local NGOs may provide additional support.
- IRC will hire an External Monitoring Agency (EMA) to carry out external monitoring and post-implementation evaluation.

16.10 Monitoring and Evaluation

- PMU-ES in close coordination with IRC will conduct an **internal monitoring** on resettlement implementation.
- The monitoring will include progress reports, the status of the RAP implementation, information on location and numbers of people affected, compensation amounts paid by item, and assistance provided to AHs.

17. CONCLUSION AND RECOMMENDATION

17.1 Conclusion

- Improvement of Battambang – Sri Sophorn Section of National road No. 5 and construction of Battambang Bypass and Sri Sophorn Bypass is justified considering the following aspects:
 - There is no strong opposition to the Project among the stakeholders, including the people who are anticipated to be relocated.
 - The Project is expected to yield economic benefit such as EIRR of 22%
 - No significant adverse impact on natural and living environment of the Project Area is anticipated.
- The Project cost for widening of Battambang – Sri Sophorn Section of NR 5 into 4 lanes and construction of Battambang Bypass and Sri Sophorn Bypass is estimated at approximately USD137.8 million, including cost for land acquisition and resettlement, UXO detection and demining, administration and price escalation.
- Implementation period is estimated to be 5 years and a half starting from ‘Selection of Consultants for Detailed Design, Assistance in Procurement of Civil Works and Construction Supervision’ until ‘Opening of the Road to Traffic’.

17.2 Recommendation

- Improvement of Battambang – Sri Sophorn Section of NR 5 and construction of Battambang Bypass and Sri Sophorn Bypass is recommended to be implemented.
- MPWT is recommended to employ competent consultants for the consultant services of detailed design/assistance for procurement of civil works/construction supervision to minimize risks possible to occur during construction.
- MPWT is recommended to request to JICA for technical assistance for implementation of Yen loan project.
- Survey on improvement of Prek Kdam – Thlea Ma’am Section and construction of Kampong Chhnang Bypass need to be urgently studied.