MINISTRY OF PUBLIC WORKS AND TRANSPORT
THE KINGDOM OF CAMBODIA

THE PROJECT

FOR

STUDY ON THE IMPROVEMENT OF EXISTING BRIDGES

IN

THE KINGDOM OF CAMBODIA

FINAL REPORT

VOLUME II
MAIN REPORT

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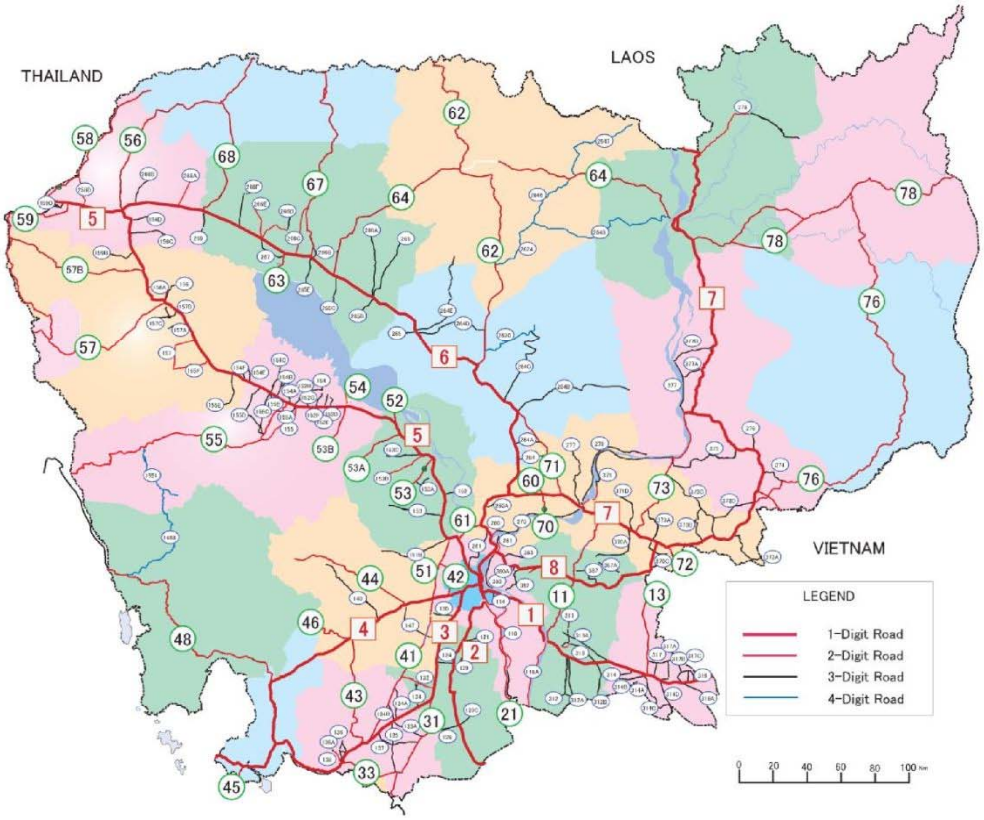
The following foreign exchange rates are applied in the Study:

USD 1.00 = 80.41 JPY (as of 2012)

USD 1.00 = 4,127.27 KHR (as of 2012) *KHR: (Cambodian Riel)

LOCATION MAP OF THE STUDY



NUMBER OF ROADS AND BRIDGES FOR THE STUDY

	ROAD	BRIDGE
2-DIGIT NATIONAL ROAD	37	668
3-DIGIT PROVINCIAL ROAD	124	505
4-DIGIT PROVINCIAL ROAD	7	32
TOTAL	168	1205

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AHP	Analytic Hierarchy Process
ASEAN	Accociation of Southeast Asian Nations
CDC	Council for Development of Cambodia
B/C	Benefit Cost Ratio
BMS	Bridge Management System
DBST	Double Bituminous Surface Treatment
DPWT	Department of Public Works and Transport
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
GPS	Global Positioning System
GMS	Great Mekong Sub-Region
GIS	Geographic Information System
HEC	Heavy Equipment Center
HWL	High Water Level
HV	Heavy Vehicle
IEE	Initial Environmental Examination
IEIA	Initial Environmental Impact Assessment
ICD	International Cooperation Department
IMC	Inter-Ministerial Committee
IRC	Inter-ministerial Resettlement Committee
JICA	Japan International Cooperation Agency
MPWT	Ministry of Public Works and Transport
MEF	Ministry of Economy and Finance
MOE	Ministry of Environment
MRD	Ministry of Rural Development
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOJ	Ministry of Justice
MLMUPC	Ministry of Land Management Urban Planning and Construction
MINE	Ministry of Industry, Mines and Energy
MC	Motorcycle
NR	National Road
NPV	Net Present Value
LV	Light Vehicle
IMF	International Monetary Fund
PR	Provincial Road
PWRC	Public Works Research Center
PK	Kilometer Post of on the road
RAMP	Road Asset Management Project
RID	Road Infrastructure Department
RGC	Royal Government of Cambodia
ROW	Right of Way
SPIED	Sub-National Public Infrastructure and Engineering Department
SEZ	Special Economic Zones
TTC	Travel Time Cost
VOC	Vehicle Operation Cost
WB	World Bank

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CHAPTER 1

OUTLINE OF THE PROJECT

1. OUTLINE OF THE PROJECT

1.1 Background of the Project

In the report of "THE STUDY ON ROAD NETWORK DEVELOPMENT IN THE KINGDOM OF CAMBODIA, October 2006", improvement of the road network and improvement of the road maintenance work was recommended for the short term, the middle term and the long term periods including the pre-feasibility study of the bridge improvement program as the priority project. Following the recommendation of the above study, the Royal Government of the Kingdom of Cambodia (hereinafter referred to as the Cambodia) has been trying to rehabilitate the roads and bridges by its own funds and the funds from foreign donors. There are many temporary bridges still remain on national and provincial roads and they are not inspected nor maintained well. Damaged temporary bridges are often left unrepaired for a long time and they sometimes collapsed accidentally or are damaged due to heavy truck loading or natural disaster including the flooding of 2011.

With this background, the Cambodia requested Japanese Government to carried out The Study on the Improvement of Existing Bridges (hereinafter referred to as the Study) for the replacement of the existing temporary bridges on 2-, 3- and some 4-digit roads (hereinafter referred to as the target roads) to permanent bridges and preparation for capacity development project for bridge maintenance. According to the request from the Cambodia, JICA dispatched the Study Team.

1.2 Objective of the Project

The project content two packages including plan for bridge replacement (Package A) and capacity development of bridge maintenance (Package B). Objective of the project with each package are as follows and describe in Chapter 2 to 11 for Package A and Chapter 12 for Package B.

(1) Plan for bridge replacement (Package A)

1) Investigate the inventory of bridges on the target roads and determine the target bridges such as a temporary bridges which should be replaced with permanent bridges.
2) Carry out site survey and inspect bridge conditions including the effects of the flooding of 2011.
3) Establish a database for the target bridges
4) Investigate environmental and social conditions around the bridges.
5) Survey the traffic volume on the target roads.
6) Study the priority of the target roads.
7) Propose the standard of bridge and structure for the replacement of target bridges and estimate their costs.
8) Recommend the priority of bridges to be replaced on the target roads.

(2) Capacity development of bridge maintenance (Package B)

1) Review the past programs / projects for bridge maintenance assisted by donor agencies including JICA, ADB, WB, New Zealand, and analyze the present issues and problems to improve the capacity for bridge maintenance in the MPWT.
2) Analyze the present system /database for bridge maintenance in the Cambodia
3) Recommend the programs/ projects to enhance the capacity for bridge maintenance in the MPWT.

(3) Study Area

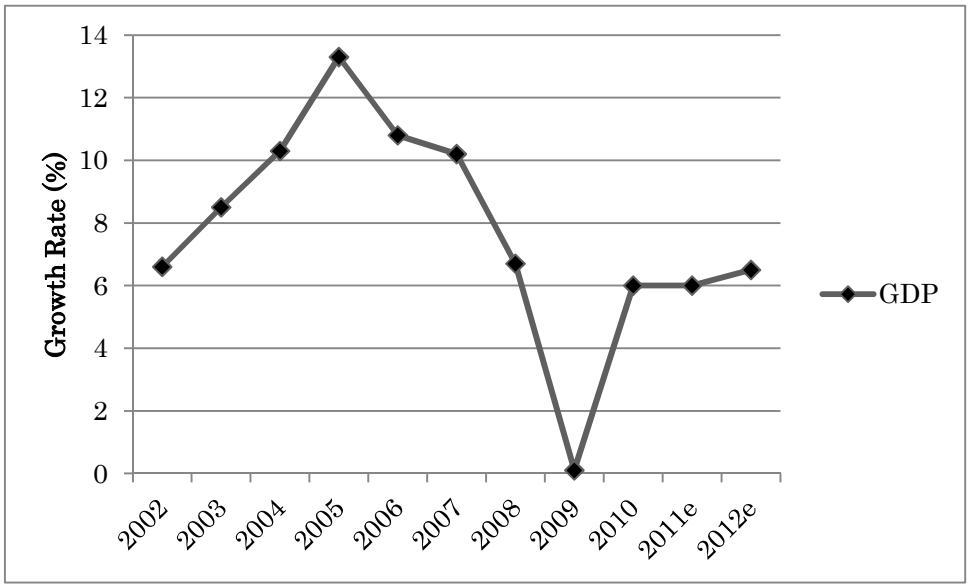
The study area is shown in the "Location Map"

1.3 Socio-Economic Conditions

(1) Economic Growth

The economy of Cambodia maintained high growth of more than 10% per annum for four consecutive years between 2004 and 2007 as shown in Figure 1-1. While growth of the Gross Domestic Product (GDP) of Cambodia dropped to 0.1% in 2009 due to the effects of the world economic recession started in the latter half of 2008, the GDP growth rate in 2010 recovered to 6.0%. According to the forecast by the Ministry of Economy and Finance (hereinafter referred to as the MEF), the growth rates are estimated to be sustained between 6.0% and 6.5% in 2011 and 2012.

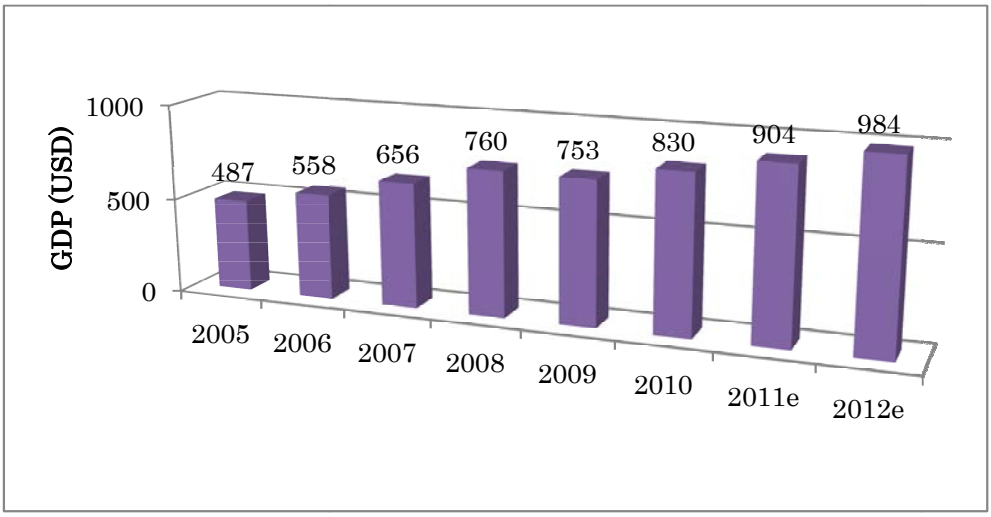
The GDP amount has steadily grown with 43,057 billion Riel in 2009 and 47,048 billion Riel in 2010, and is projected to be 52,141 billion Riel in 2011and 57,363 billion Riel in 2012.



Source: Ministry of Economy and Finance

Figure 1-1 GDP Annual Growth Rate

The GDP per capita has also steadily increased since 1998 when the Riel greatly depreciated against the US dollar. The GDP per capita in 2010 reached 830 US dollars, increasing approximately 70% from 487 US dollars in 2005. It is projected to reach 904 US dollars in 2011 and 984 US dollars in 2012 respectively as shown in Figure 1-2.

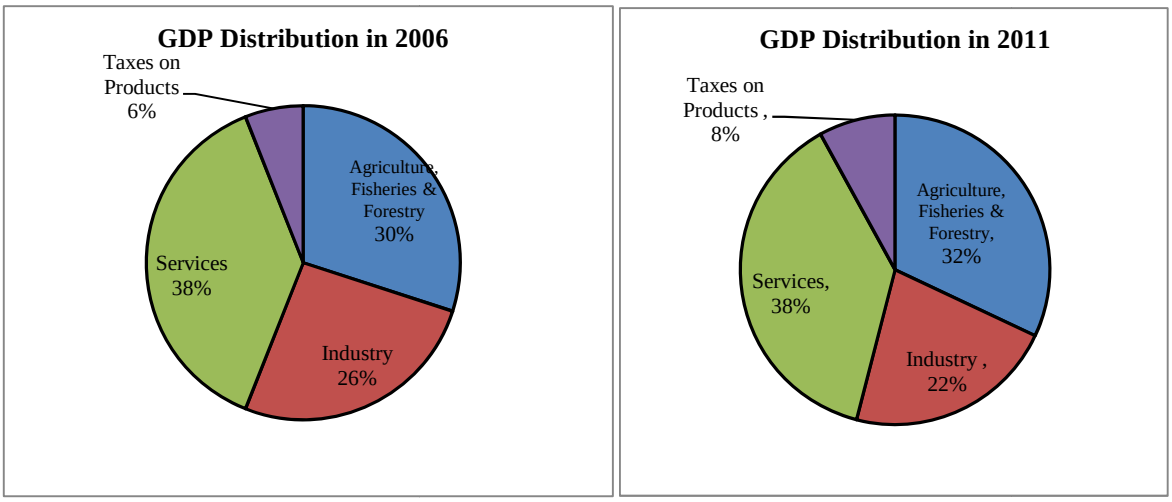


Source: Ministry of Economy and Finance

Figure 1-2 GDP Per Capita

(2) Composition of Industrial Sectors

Industrial sectors that make up the GDP are composed of agriculture, industry and services. The GDP distributions in 2006 and 2011 are shown in Figure 1-3. The ratio of industry dropped from 26 % to 22% while the ratio of agriculture, forestry and fisheries increased from 30% to 32%.

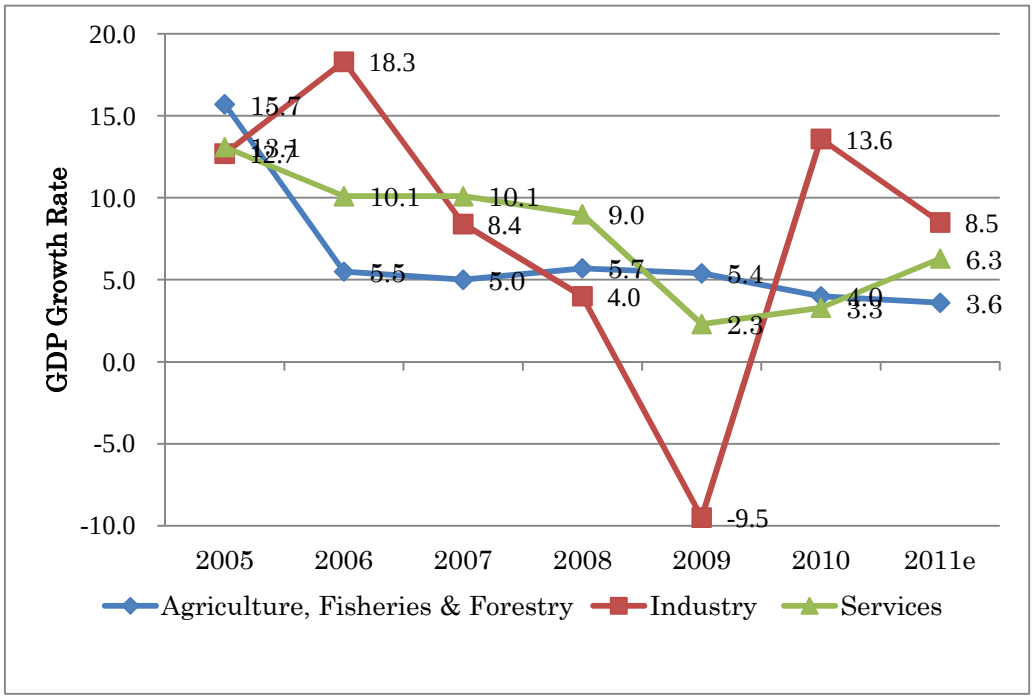


Source: Ministry of Economy and Finance

Figure 1-3 GDP Distribution by Economic Activity

The sector of agriculture which includes crops, livestock, fisheries and forestry has been steadily growing after reaching a peak in 2005 to 2006. Industry including manufacturing,

textile and construction grew unstably between 2007 and 2010. The services include trade, hotel, transport, real estate and others have continued to grow upward since 2005 as shown in Figure 1-4.



Source: Ministry of Economy and Finance

Figure 1-4 GDP Growth Rate by Economic Activity

1) Agriculture, Fisheries & Forestry

The growth rate of crops dropped to 3.7% in 2011, although it grew at the highest record of 27.6% in 2005. Livestock & poultry recorded growth of 5% or more in 2009 and 2010 but the growth ratio was lower in 2011. The growth rate of fisheries and forestry & logging sharply dropped in 2010, but recovered in 2011 to 3.8% and 1.1% respectively as shown in Table 1-1.

Table 1-1 Growth rate of Agriculture Sector (%)

Item	2005	2006	2007	2008	2009	2010	2011e
Agriculture Sector (Total)	15.7	5.5	5.0	5.7	5.4	4.0	3.6
Crops	27.6	5.3	8.2	6.6	5.8	5.7	3.7
Livestock & Poultry	5.6	8.2	3.7	3.8	5.0	5.6	3.9
Fisheries	5.6	3.8	0.8	6.5	6.0	0.4	3.8
Forestry & Logging	5.1	7.0	1.1	0.9	1.1	0.2	1.1

Source: Ministry of Economy and Finance

2) Industry

Textile, apparel, footwear and, construction were the major players for fast growth of industry sector occupying 76% share in 2007. These subsectors were seriously suffered in

the world economic recession. While the growth rate of industry decreased to 4% in 2008 and -9.5% in 2009, it recovered to 13.6% in 2010. According to the economic forecast by the MEF, the growth rate of industry will remained at 8% to 9% in 2011 and 2012.

Table 1-2 Growth rate of Industry Sector (%)

Item	2005	2006	2007	2008	2009	2010	2011e
Industry (Total)	12.7	18.3	8.4	4.0	-9.5	13.6	8.5
Manufacturing	9.7	17.4	8.9	3.1	-15.5	29.6	9.0
Textile, Apparel & Footwear	9.2	20.4	10.0	2.2	-9.0	18.5	10.4
Construction	22.1	20.0	6.7	5.8	5.0	-25.5	6.4

Source: Ministry of Economy and Finance

3) Services

Services occupied 38% share in the GDP in 2011 with heavy dependency on the trade, transport and communication. Hotel and restaurant which benefited from tourism and infrastructure development have been kept high growth rate constantly until 2011. While the growth rate of real estate and business sharply dropped to -2.5% in 2009 and -15.8 % in 2010 owing to world economic recession, the rate recovered to 5.1% in 2011.

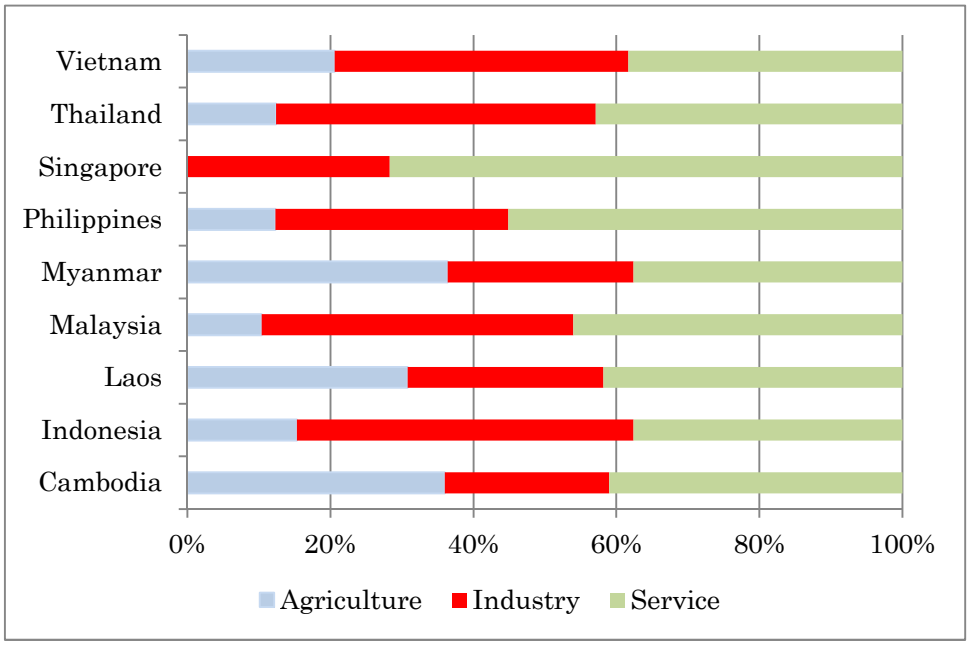
Table 1-3 Growth rate of Service Sector (%)

Item	2005	2006	2007	2008	2009	2010	2011e
Service (Total)	13.1	10.1	10.1	9.0	2.3	3.3	6.3
Trade	8.5	7.1	9.5	9.4	4.2	7.5	6.0
Hotel & Restaurant	22.3	13.7	10.2	9.8	1.8	11.2	10.7
Transport & Communication	14.5	2.1	7.2	7.1	3.9	8.0	6.8
Real Estate & Business	7.8	10.9	10.7	5.0	-2.5	-15.8	5.1
Other Services	18.3	17.2	12.1	12.0	2.9	4.2	4.6

Source: Ministry of Economy and Finance

(3) Composition of Industrial Sectors in South Asia

The comparison of industrial structure with other Southeast Asian nations is shown in Figure 1-5. Cambodia is still at the initial stage of industrialization together with Laos and Myanmar owing to the small ratio of industry.



Source: Asian Development Bank, Key Indicators

Figure 1-5 GDP Composition of Southeast Asian Countries in 2010

(4) Government Finance

According to the data of national revenue and expenditure as shown in Table 1-4, domestic revenue increased by 7% per year on average rate between 2008 and 2011. The total of domestic revenue in 2011 was 6,444.82 billion Riel. General tax on goods and value added tax (VAT) contributed to 64% of the domestic tax revenue.

Budget expenditure also has been increased parallel to domestic revenue by 15%. Non-wage of current expenditure is the largest component according for around 34% of budget expenditure in 2011. Non-wage includes purchases, external services, financial charges, subsidies and social assistance.

Table 1-4 National Revenue and Expenditure (Billion Riel)

State Budget	2008	2009	2010	2011	2012e
Domestic Revenue					
Current Revenue	5,213.08	4,855.98	5,738.77	6,368.28	7,300.66
Tax Revenue	4,429.97	4,155.19	4,691.96	5,304.92	6,280.38
Domestic Tax Revenue	3,249.93	3,090.91	3,533.64	**4,098.71**	4,919.28
Taxes on international Trade	1,180.04	1,064.28	1,158.32	1,206.21	1,361.10
Non Tax Revenue	783.11	700.79	1,046.81	1,063.36	1,020.27
Property Income	67.16	64.54	181.93	63.87	111.75
Sale of Goods and Services	427.32	407.95	452.97	596.14	585.72
Other Non Tax	288.63	228.30	411.91	403.35	322.81
Capital Revenue	79.21	29.28	129.92	76.54	80.00
Total	**5,292.29**	**4,885.26**	**5,868.69**	**6,444.82**	**7,380.66**
Budget Expenditure					
Current Expenditure	3,774.12	4,439.69	4,792.33	5,784.31	6,330.66
Wage	1,437.67	2,011.62	2,065.88	2,232.97	2,672.75
Non Wage	2,336.45	2,428.07	2,726.45	**3,551.34**	3,657.91
Capital	2,654.48	2,896.46	4,436.59	4,746.37	4,187.33
Domestic Financing	711.31	1,019.16	990.49	1,343.68	1,327.33
External Assistance (Project)	1,943.17	1,877.30	3,446.10	3,402.69	2,860.00
Total	**6,428.60**	**7,336.15**	**9,228.92**	**10,530.68**	**10,517.98**

Source: Ministry of Economy and Finance, Monthly Bulletin Statistics

The budget financing by the difference of revenue and expenditure has increased by 55% as an average annual growth rate as shown in Table 1-5. The financing from by the foreign and domestic financing in 2011 reached 3,937.16 billion Riel.

The Japanese Government, World Bank, and Asian Development Bank contributed to the budget support as grant basis. The budget support decreased from 324.87 billion Riel in 2008 to 222.02 billion Riel in 2011.

The project aid financed by international borrowing and foreign assistance was 3,398.38 billion Riel accounting for 86 % of the financing in 2011.

The 54% share of debt and related liabilities is a larger amount than the grant in project aid.

Table 1-5 Deficit Financing (Billion Riel)

Financing	2008	2009	2010	2011	2012e
Foreign Financing	2,424.40	1,926.34	3,356.33	3,456.70	2,630.00
Budget Support	**324.87**	272.71	166.28	**222.02**	20.00
Project Aid	2,200.64	1,766.17	3,330.50	**3,398.38**	2,860.00
Grant	1,167.82	900.00	2,219.93	1,580.96	1,600.00
Debt and related liabilities	775.36	977.30	1,226.17	**1,821.73**	1,260.00
Pending	257.46	-111.13	-115.60	-4.31	
Amortization on External Debts	-101.11	-112.54	-140.45	-163.70	-250.00
Domestic Financing	-1377.52	686.59	1131.81	480.46	1063.69
Outstanding Operations	173.08	86.68	-840.32		
Total	**1,219.96**	**2,699.61**	**3,647.82**	**3,937.16**	**3,137.32**

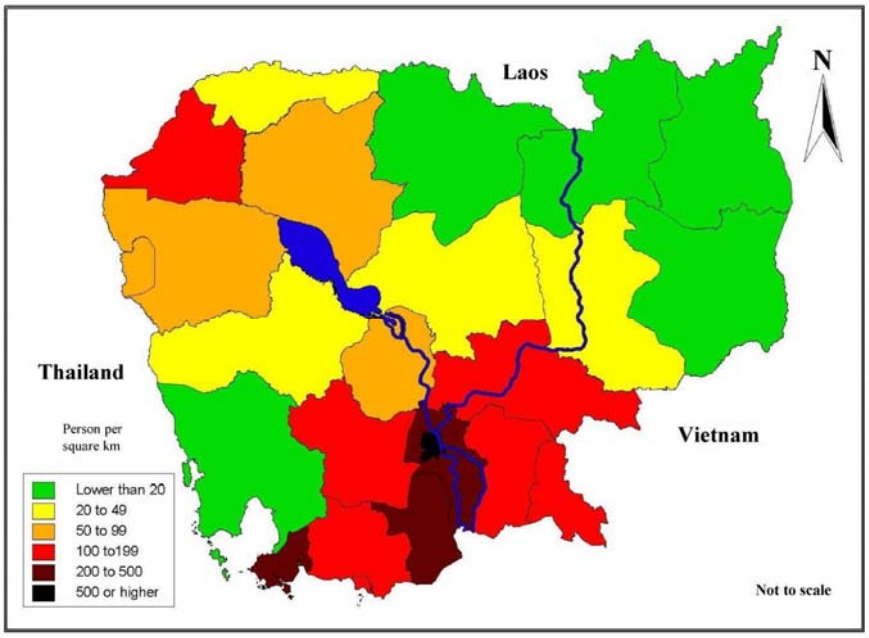
Source: Ministry of Economy and Finance, Monthly Bulletin Statistics

(5) Population

The general population census was conducted in March 1998 and March 2008. Population projection was examined based on the results of both census data.

Cambodia's population was 13.4 million in 2008 and its annual population growth rate of 1.54 % was higher than that of Southeast Asia as a whole. The rates vary from province to province depending on the interaction of fertility, mortality and migration factors. Kampong Cham continues to be the biggest province in terms of population, although it registered a very low growth rate. The population density as a whole increased from 64 to 75 persons/ square kilometre between1998 and 2008. The population density by each province is shown in Figure 1-6.

The average size of a normal or regular household as a whole came down from 5.2 persons/household in 1998 to 4.7 in 2008. Urbanization has increased over the last decade. The percentage of urban population according to the new definition of urban areas increased from 17.4% in 1998 to 19.5% in 2008. The annual population growth rates for urban and rural areas are 2.55% and 1.30% respectively.



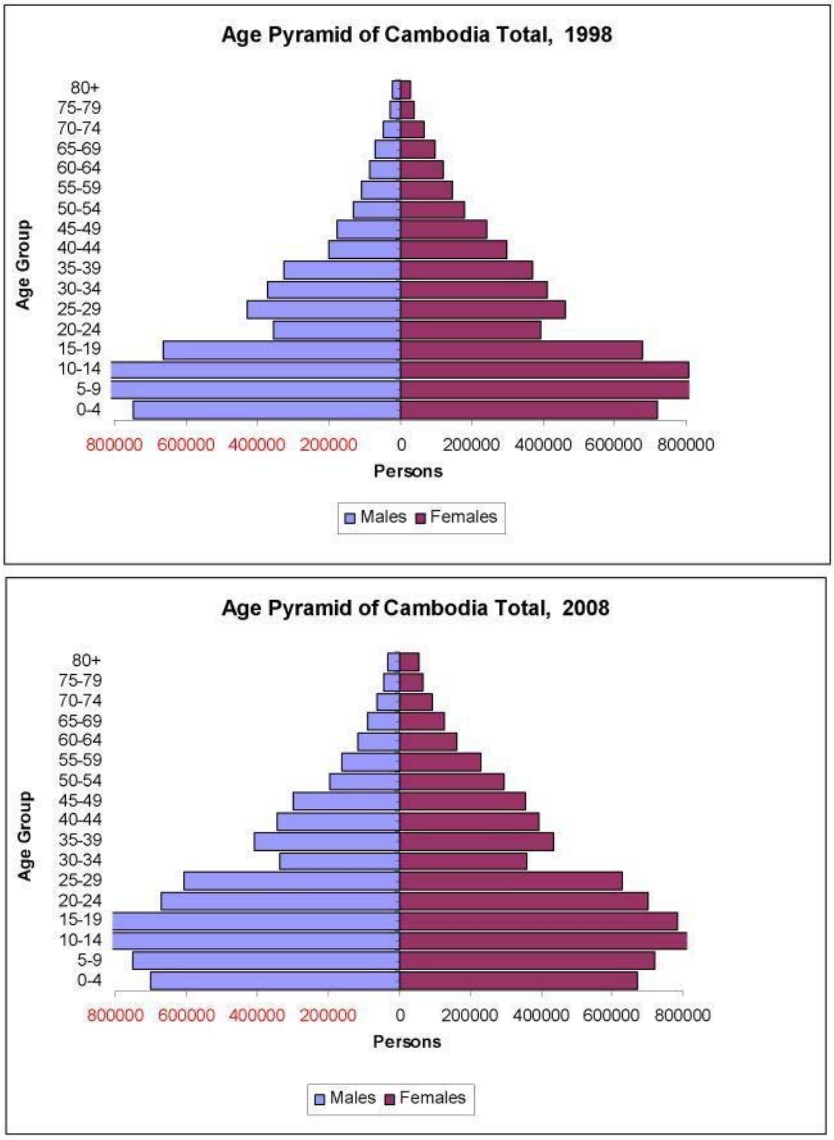
Source: Ministry of Planning, NIS, General Population Census 2008

Figure 1-6 Population Density by Province

The overall shape of the age-sex pyramid in 2008 is typical of a developing country which has been experiencing a decline in fertility over the past two or three decades. The triangular pyramid shape in 1998 has been replaced by a notable "pinching in" of the size of the age cohorts at the base and a bulge passing upwards through the age structure as shown in Figure

1-7. Even though the total population grew by 17.1% during 1998-2008, the 0-4 age group enumerated in 2008 was in absolute numbers (1,372,615) smaller than the 0-4 enumerated in 1998 (1,466,792). The decline of annual births had already begun by 1998.

The population ratio by broad age group is 33.7% of child ages (0-14 years), 62.0% of working ages (15-64 years) and 4.3% of old ages (over 65 years).



Source: NIS, Population Projection , 2010

Figure 1-7 Age pyramids in 1998 and 2008

Population projection from 2008 to 2030 was estimated by Ministry of Internal Affairs and Communications in Japan. Total fertility rate (TFR) was estimated as 3.1 children per woman based on the fertility level provided by the 2008 census. The total population will increase from 13,868,227 in 2008 to 18,390,683 in 2030. The annual growth rate will decrease from 1.57% in 2008 to 0.90% in 2030.

Table 1-6 Population Projection from 2008 to 2030

Year	Total (Persons)	Male	Female	Annual Growth Rate (%)	Median Age
2008	13,868,227	6,745,592	7,122,635		21.9
2009	14,085,324	6,859,756	7,225,568	1.57	22.3
2010	14,302,779	6,973,994	7,328,785	1.54	22.6
2011	14,521,275	7,088,691	7,432,584	1.53	23.0
2012	14,741,414	7,204,166	7,537,248	1.52	23.4
2013	14,962,591	7,320,112	7,642,479	1.50	23.8
2014	15,184,116	7,436,178	7,747,938	1.48	24.2
2015	15,405,157	7,551,944	7,853,213	1.46	24.6
2016	15,626,444	7,667,790	7,958,654	1.44	25.0
2017	15,848,495	7,783,987	8,064,508	1.42	25.4
2018	16,069,921	7,899,824	8,170,097	1.40	25.8
2019	16,289,270	8,014,562	8,274,708	1.36	26.2
2020	16,505,156	8,127,496	8,377,660	1.33	26.6
2021	16,717,422	8,238,593	8,478,829	1.29	27.1
2022	16,925,995	8,347,859	8,578,136	1.25	27.5
2023	17,129,834	8,454,760	8,675,074	1.2	27.9
2024	17,327,917	8,558,773	8,769,144	1.16	28.3
2025	17,519,272	8,659,399	8,859,873	1.1	28.7
2026	17,704,090	8,756,659	8,947,431	1.05	29.1
2027	17,883,061	8,850,832	9,032,229	1.01	29.5
2028	18,056,858	8,942,266	9,114,592	0.97	29.9
2029	18,226,073	9,031,264	9,194,809	0.94	30.3
2030	18,390,683	9,117,812	9,272,871	0.9	30.7

Source: Ministry of Internal Affairs and Communications in Japan,
Population Projection for Cambodian 2008-2030

(6) National Development Plans

The Cambodia has prepared the policies for the further rehabilitation and construction of transport infrastructure in the National Strategic Development Plan 2009-2013(NSDP).

The plan stated that “Transport network is a prime mover of economic growth. The transport network linking all parts of the country makes it a cohesive economic body, and helps to integrate the Cambodian economy into the region and the world. The Cambodia has so far almost completed the rehabilitation and reconstruction of important national roads. The Cambodia will continue to give high priority to the rehabilitation and reconstruction of multimodal transport network connecting all parts of the country, and with neighbouring countries. This will enable provision of convenient, stable, safe, economically efficient, lower cost transportation and logistics services network, aiming at trade facilitation, tourism promotion, rural development, regional and global economic integration as well as national defence.” The road sector of the MPWT has committed to carry out the following main activities for the implementation of prioritized policies.

1) Continued strengthening management of road network
2) Continued the construction of the main national roads for the integration of all locations in the country and the region
3) Collaboration with the Ministry of Rural Development (MRD) and city authorities to ensure that the road network is consistently organized.

(7) Road Development Strategies

The MPWT published the sector plan with the Infrastructure and Regional Integration Technical Working Group (IRITWG) by a prioritized policies of the NSDP. The plan stated the six strategies and described the detailed activities of planning.

Strategy I: Strengthen and improve the multi growth poles development

Future project:

1) Upgrade road and try to enlarge them to 4 lanes to connect to potential development poles
2) Improve the road network in development pole
3) Construct bypass and viaduct to solve traffic congestion at development poles
4) Construct express way Phnom Penh-Sihanouk Ville
5) Construct high way Phnom Penh – Chrey Thom
6) Construct express way Phnom Penh – Siem Reap – Poi pet
7) Construct bypass at Siem Reap, Battambang and Kampong Chhnang
8) Construct ring road of Phnom Penh

Strategy II: Strengthen and improve road network to serve important social economic development region

1) Road way width of NR 4 and NR 1is enlarged to 4 lanes
2) Construct second Neak Loeung Bridge
3) Prepare plan and develop road network connecting NR 4 and NR 1
4) Improve quality and traffic safety of road at economic development corridor.

Strategy III: Push the development of tourism

Enhance road in tourist area in order to offer convenient, good environment, create opportunity to public Establish administrative office at international gates and enhance the connecting road to offer convenience to tourists,

Strategy IV: National and regional integration

1) Construct and upgrade 1-, 2-, 3-digit and in province roads
2) Construct and upgrade district and rural roads

Strategy V: Develop international corridor

1) Develop international corridor at Greater Mekong Sub-Region (GMS) International Highway
2) Strengthen the function of 1-digit roads and enhance 2-digit roads that defined to 3) be the GMS highway
3) Construct nation-wide road connecting to all international gates:
   Vietnam: NR 33, NR 2, NR 21, NR 1, NR 8, NR72, NR74, PR3762 and NR78
   Lao: NR7
   Thailand: NR62, NR 64, NR 66, NR 5, NR 59, NR 57, NR 55 and NR 58
   Others: NR 4 (through Sihanouk Ville seaport)

Strategy VI: Praise the development of social economy at rural and along border in order to reduce poverty

1) Strengthen 2-, 3-digit, province and district roads connecting to rural area and road along border that have high potential for agriculture, industry, and tourism
2) Construct road at triangle development (Cambodia, Lao, Vietnam)
3) Construct road at emerald triangle development (Cambodia, Lao, Thai)

(8) Road Network Condition

The road network in Cambodia consists of 2,117km of 1-digit, 3,146km of 2-digit, 6,441km of provincial road and 33,005km of rural road. The National Road is mostly primary road network linking Phnom Penh to provincial capitals and important centres of population and economic activity. About 2,400km of the national road network was paved with asphalt, but over the years, through no maintenance due to civil war and the effect of flooding, much of this pavement has disappeared. After the civil war, main national high ways in Cambodia have been improved rapidly, however the provincial roads are still remain undeveloped.

Condition of 1-digit roads is almost maintained by concrete or bituminous pavement including Double Bituminous Surface Treatment (DBST) which has low durability.

Ratio of paved road by the DBST status in 2-digit roads is 30.2%. Ratio of paved road in provincial roads is only 1.7% so that the drivers cannot pass the provincial roads safely during the rainy season. Road network and pavement status are shown in Table1-7.

Table 1-7 Road network and Pavement Status

Road classification	Length (km)	Percentage	Pavement ratio	Pavement status (km)			
				Earth	Laterite	DBST	Concrete or Asphalt
1-digit roads	2,117	18.1%	99.1%	20	0	1381	716
2-digit roads	3,146	26.9%	30.2%	273	1923	949	0
3- and 4-digit roads	6,441	55.0%	1.7%	2437	3895	101	9
Total	11,704	100%					

Source: Overview on Transport Infrastructure Sectors, 2010

(9) Road Development by Donors and Cambodia

Road and road structure in Cambodia are developed by the Cambodia and donor countries. The main donors are Japan, WB, ADB, China, Korea, Thailand and Vietnam. China has contributed the fund for road development which is 52.2% in the total budget of land transport infrastructure.

Funds from each donor for land transport infrastructure are shown in Table 1-8 and the items of the table show completed projects, on-going projects, committed projects and proposed projects.

Table 1-8 Internal/ External funding for land transport Infrastructure (Million US$)

Item	Japan	China	Korea	Thailand	Vietnam	ADB/WB	Cambodia	Total
Complete	85.77	425.17	53.95	64.45	25.00	108.30	374.59	1137.23
Ongoing	95.00	687.79	55.00			122.63	124.15	1084.57
Project in Pipeline		200.00	204.00			72.10		476.10
Proposed Project	140.96	536.50	170.00					847.46
Total	321.73	1849.46	482.95	64.45	25.00	303.03	498.74	3545.36
%	9.1	52.2	13.6	1.8	0.7	8.5	14.1	

Source: Project profile & progress of June 2012 land transport infrastructure (Cambodia)

1.4 Natural Conditions

(1) Geography

Cambodia is located in Southeast Asia in the southern part of Indochina and covers an area of 181,035 square kilometres. Geographical coordinates are between the 10th and 15th parallels north latitude and the 102nd and 108th parallels east latitude. The shape of the country is an almost-square polygon.

Cambodia is neighboured to the northeast by the people's Democratic Republic of Laos, to the east and southeast by the Socialist Republic of Vietnam, and to the west and northwest by the Kingdom of Thailand. Its 2,572 kilometre border is split among Laos (541kilometres), Vietnam (1228kilometres), and Thailand (803kilometres), as well as 443 kilometres of coastline.

The land surface comprises deep and plains in the middle surrounded by mountains and plateaus.

About 75% of the country consists of the Tonle Sap Basin and the Mekong Lowlands. The southeast of the basin is the Mekong Delta which extends through Vietnam to the South China Sea. The basin and delta are rimmed with mountain ranges with the Cardamom Mountains (about 1,500 m) to the southwest, and the Elephant Range and Dangrek Mountains to the north.

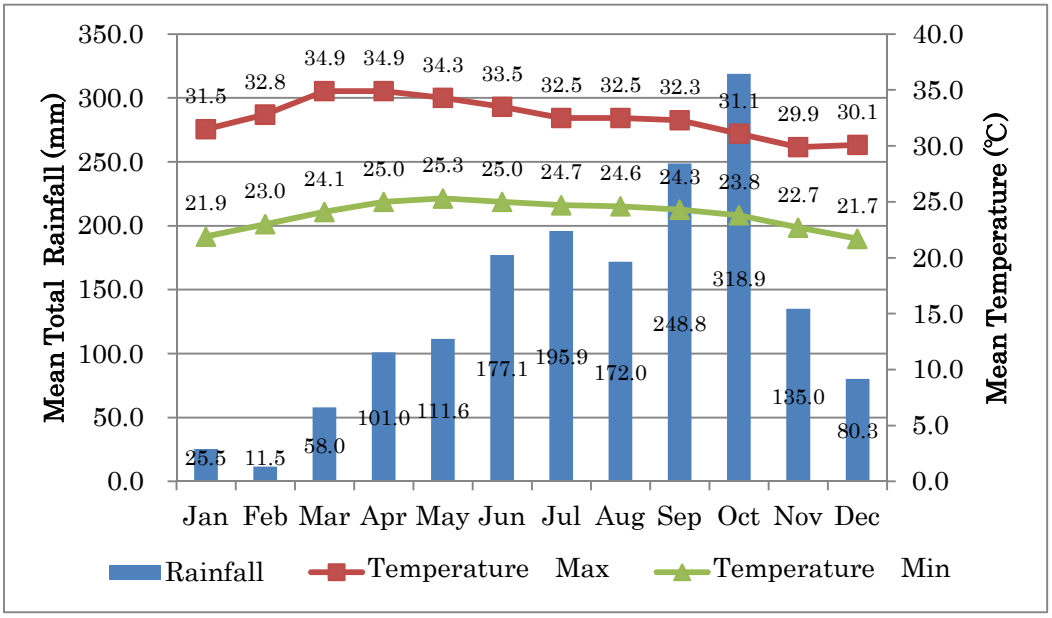
Cambodia is classified by four topographic areas, namely plain the area around Tonle Sap Basin, coastal, and plateau areas.

1) Plain area covers 25,069 square kilometres. The capital city of Phnom Penh, as well as Kandal, Kampong Cham, Svay Riend, Prey Veng, and Takeo provinces are located in this area.
2) Tonle Sap Basin area covers 67,668 square kilometres. It consists of the alluvial ground made by Tonle Sap and Mekong River with elevations generally of less than 100 meters. The area includes Kampong Thom, Siem Reap, Banteay Meanchey, Battambang, Pursat, Kampong Chhnang, Oddar Meanchey, and Pailin provinces.
3) Coastal area covers 17,237 square kilometres. The area includes Sihanoukville, Kampot, KohKong, and Kep provinces. Sihanoukville is the midpoint of the coastal area. It is 232 kilometres from Phnom Penh. There are 60 islands in Cambodia's coastal waters. They include 23 in Koh Kong province, 2 in Kampot province, 22 in Sihanoukville, and 13 in Kep.
4) Plateau and Mountainous area covers 68,061 square kilometres. The area includes Kampong Speu, Kratie, Stung Treng, Preah Vihear, Rattanakiri, and Mondulkiri provinces.

(2) Climate

Cambodia's climate is dominated by tropical monsoons with rainy and dry seasons. The south west monsoon brings the rainy season from May to October. The annual rainfall average is between 1,000 to 1,500 mm and the heaviest amounts fall in the southeast.

Monthly mean maximum temperature in Phnom Penh varies between 34.9ºC in the hottest months of March and April to 29.9ºC. Minimum temperature varies between 21.7ºC in December to 25.3ºC as shown in Figure 1-8.



Source: World Weather Information Service

Figure 1-8 Mean Total Rainfall and Mean Temperature at Phnom Penh

The stations with reliable rainfall record from 1985 to 2011 are at Batam Bang, Pursat, Kompong Chhang, Siem Reap, Kratie, Kompong Thom, Kompong Cham and Prey Veng. Table 1-9 shows the data of average yearly rainfall, and this indicates that maximum rainfall is at Kratie.

Table 1-9 Average Yearly Rainfall

Station Name	Yearly Average (mm)
Battanm Bang	1,327.8
Pursat	1,394.9
Kompong Chhang	1,676.7
Kompong Thom	1,522.8
Siem Reap	1,407.3
Kratie	**1,717.1**
Kompong Cham	1,412.6
Prey Veng	1,185.0

Source: Flood Damage Assessment, 2011 by the MPWT

(3) Review of Past Flood and Damages

Flood are occurred during the monsoon period from August to November. The origin of flood is heavy and prolonged rainfall during the period in north part of Cambodia. The water level rises and its vicinities of river is covered by widespread flooding in the lowland area as southwest part of Cambodia where many suffered the worst flood in last decades. Large-scale of flood can be expected on October to occur more frequently due to climate change predictions.

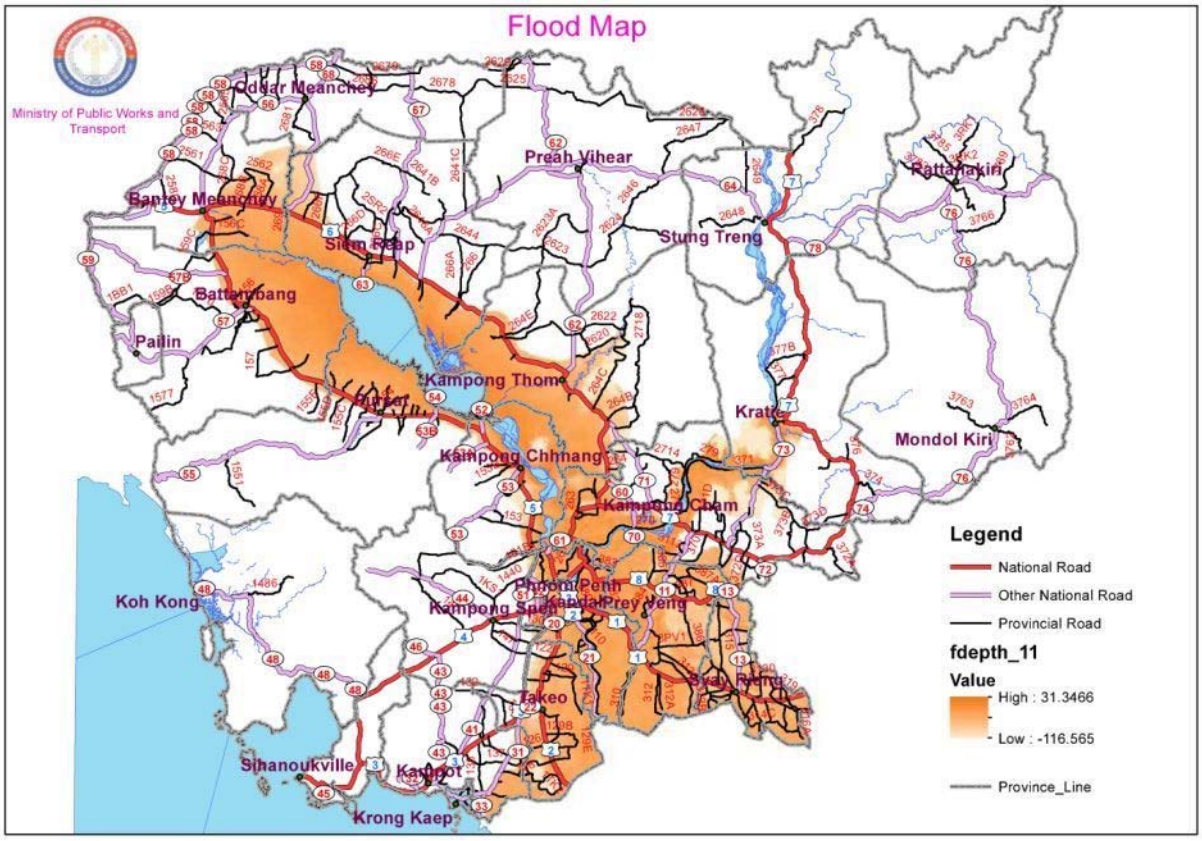
Mekong Delta is very flat and flood develops along the main river systems. When flood occurs, it often covers large areas of Kompong Cham and Prey Veng provinces. The division of the Bassac River at Phnom Penh is an indication of the flatness of the delta and of the complexity of the river system in the Mekong Delta. The flood is attributable to water flow from the Mekong river and also partly to the backwater effect from the Tonle Sap River.

Cambodia is severely affected by the flood between August and October 2011. Transportation assets such as roadway, bridges, culverts, drainage system and agricultural land have been damaged by the flood. The magnitude of the damages extends to 18 provinces as well as Phnom Penh municipality. Damaged infrastructure was surveyed and recorded by the MPWT. The data was used as a primary data to verify the flood area to measure the actual damages. Estimated number of people living in affected areas is 14.8 million and of these an estimated 50 to 60% people are in need of urgent humanitarian assistance.

Large parts of the district of 4 provinces including Kampong Cham and Prey Veng provinces are underwater during the month of October. In Seam Reap, flood waters in upstream accumulated in Seam Reap City and other districts located in lowland areas as well as Kampong Cham, Kampong Thom and Prey Veng provinces which were amongst the worst areas affected from October to December 2011. The Cambodia needs are particularly acute in 4 major provinces such as Seam Reap, Kampong Thom, Kampong Cham, Prey Veng including 14 neighbouring provinces and other remote areas, and all of these urgent needs for humanitarian support as stated will be fulfilled by means of urgent emergency repair of road and bridge infrastructure for temporary ease of access.

18 provinces and their districts were severely damaged by the flood from continuous heavy rainfall and that merged with the flood water flowing down from the upstream. Other rivers and streams are swollen and incapable of containing the huge volume of water causing overflow and swelling that leads to damage of road infrastructures. There is a lack of structures along the roadway to prevent the flood waters from the upstream crossing over to the road pavement. Some sections of the road pavement have been washed out due to the strong current of the flood water.

Areas of high damage by the flooding of 2011 are shown in Figure 1-9.



Source: Flood Damage Assessment, 2011 by the MPWT

Figure 1-9 Flood Map in 2011

The MPWT carried out the assessment of 2011 flood damage. Total of flood length was 943,882km and 61 % of the length was damaged in according to the assessment. Total number of damaged bridges was 53 as shown in Table1-11. The situations of bridge damage were collapse of approach road and slope protection, deformation of girder and abutment, and collapse of temporary bridges. Hence, the temporary bridges which are located in the 18 provinces should be replaced with permanent bridges to prevent the damage by the flood.

Table 1-10 Damaged Road length

Road Category	Flood length (km)	Damaged length (km)
National Road	333,999	46,788
Provincial Road	552,475	470,710
Urban Road	57,408	55,710
Total	943,882	573,208

Table 1-11 List of Damaged Bridge

Province	Number of Bridges	Condition
Siem reap	5	Collapse Approach Slab
Kampong Thom	2	Collapse Wooden Bridges
Stung Treng	1	Wooden bridge deformed
Banteay Meanchey	12	Wooden and concrete bridges has been damaged
Kratie	3	Deformation of abutment, Collapse the approach slab
Kampong Cham	2	Collapse abutment
Battanbang	1	Collapse slop protection
Prey Veng	1	Collapse Approach Slab
Takeo	1	Collapse Wooden Bridges
Kandal	12	Wash out slope protection
Kampot	1	Collapse Approach Slab
Kampong Chhnang	6	Wash out bridge
Svay Rieng	1	Collapse Approach Slab
Pursat	5	Wooden bridge deformed
Total	53	

Source: Flood Damage Assessment, 2011 by the MPWT

CHAPTER 2

PRIORITIZATION OF THE TARGET ROADS

2. PRIORITIZATION OF THE TARGET ROADS

Total number of the target roads for the Study is 168 and list of road and roads committed to be developed are shown in Table2-1. Majority of 2-digit and some 3-digit road have been completed or committed to be improved by donors and the Cambodia and funds for improvement of other 3-digit and 4-digit roads are expected as next development. The roads already improved or committed by donor countries and roads which has no bridges are excluded from target roads because the objective of this project is to improvement of existing bridges on the target roads.

Table 2-1 List of Target Roads

No.	Road Number	Length (Km)	The name of commtted donor	No.	Road Number	Length (Km)	The name of commtted donor	No.	Road Number	Length (Km)	The name of commtted donor
1	11	90.28	Japan, remain 2 Br.	57	140	49.50	Cambodia	113	266F	24.23	
2	13	45.60	ADB	58	147	34.61		114	267	20.51	
3	21	65.56	China	59	151B	63.68		115	268A	15.92	
4	31	54.81	Korea	60	152	5.27		116	268B	44.68	
5	33	52.27	Korea	61	152D	6.82		117	269	12.76	
6	41	96.45	China	62	152E	7.07		118	270	59.34	ADB
7	42	24.26		63	152F	9.00		119	277	39.84	
8	43	78.88	China	64	152G	3.94		120	279	33.92	
9	44	84.84	China	65	152H	11.34		121	311	8.45	Cambodia
10	45	9.30		66	153	40.83		122	312	28.66	Cambodia
11	46	26.99		67	153A	14.49		123	312A	21.17	
12	48	161.27	Korea	68	153B	24.71		124	312B	22.09	
13	51	38.01	Cambodia	69	153C	14.30		125	313	41.22	
14	52	8.01		70	154	26.82		126	313A	28.67	
15	53	49.15	ADB	71	154A	15.58		127	314	11.01	
16	53A	29.75		72	154B	15.58		128	314A	9.60	
17	53B	22.30		73	154C	10.44		129	314B	14.85	Cambodia
18	54	4.87		74	154E	12.00		130	314C	45.88	
19	55	185.20	China	75	154F	11.25		131	314D	25.67	
20	56	113.62	ADB	76	155	38.89		132	315	61.76	
21	57	103.34	China	77	155A	13.96		133	316A	14.33	
22	57B	176.35	China	78	155B	10.75		134	317	8.55	
23	58	104.00	China	79	155C	26.07		135	317A	22.41	Cambodia
24	59	144.27	China	80	155D	19.47		136	317B	15.80	
25	60	19.94		81	155E	22.47		137	317C	6.92	
26	61	16.00	China	82	155F	23.40		138	319	13.19	
27	62	242.66	China	83	156	19.35		139	370A	17.18	
28	63	14.31		84	156A	15.80		140	370C	25.87	
29	64	236.68	China	85	156C	22.29		141	371	89.51	China
30	67	133.87	Cambodia	86	156D	11.23		142	371D	46.71	
31	68	117.68	ADB	87	157	26.78		143	372A	29.07	
32	70	13.53		88	157A	8.80		144	373A	23.05	
33	71	57.83	Cambodia	89	157B	7.99		145	373B	25.39	
34	72	13.50	Cambodia	90	157C	24.57		146	373C	53.72	Cambodia
35	73	92.40	Request to Japan	91	159B	62.10		147	373D	27.28	
36	76	306.18	China	92	159D	20.63	Cambodia	148	374	18.06	
37	78	193.96	China	93	258D	18.05	China	149	375	45.96	
38	110	85.75	Cambodia	94	260	4.24	Cambodia	150	376	9.96	
39	114	3.39		95	260A	6.40		151	377	40.61	
40	118A	42.53	Cambodia	96	261	24.14	Cambodia	152	377A	29.93	
41	121	8.85		97	264	10.85		153	377B	13.44	
42	124	10.21		98	264A	15.48		154	378	79.01	Cambodia
43	126	16.39		99	264B	119.26		155	380	25.80	Cambodia
44	129	22.48		100	264C	70.72		156	380A	4.16	
45	129C	2.21		101	264D	48.43	Cambodia	157	381	10.53	Cambodia
46	130	30.82		102	264E	57.32	Cambodia	158	382	13.19	Cambodia
47	132	20.81		103	265	7.56		159	383	13.68	Cambodia
48	133A	20.39		104	265B	8.01		160	387	28.46	
49	134	16.31		105	265C	12.74		161	387A	16.49	
50	134A	20.12		106	265E	11.81		162	1488	75.00	China
51	134B	10.46		107	266	39.39		163	1551	41.17	China
52	135	30.88		108	266A	38.38		164	2620	29.68	
53	136	16.57		109	266B	21.46		165	2624	78.95	
54	136A	3.71		110	266C	31.00		166	2646	41.26	
55	137	27.58		111	266D	29.08		167	2647	65.54	
56	138	10.01	Cambodia	112	266E	87.29		168	2648	63.31	

Source: Study Team

The replacement of temporary bridges has high priority for improvement of the road network. However, the budget for the bridge replacements is limited due to the budget constraint so that prioritization to determine the order for bridge replacement is essential. As a bridge is a part of roads, a group of bridges on each road among the target roads shall be prioritized. The priority of the bridge replacement will be analysed by Analytic Hierarchy Process (AHP).

The prioritization of bridge replacement will be implemented by the following steps;

1) Set up attributes for the evaluation and intensity of each attribute
2) Prioritization of the target roads and nomination of roads for bridge replacement
3) Prioritization of bridges on the nominated roads

2.1 Selection of the Target Roads for Bridge Replacements

(1) Attribute for Evaluation of Priority of the Target Roads

1. Priority of roads selected through the follow up study on the road network development master plan, 2009 (short-, Medium and long-term)
2. Population along roadside area of the target roads.
3. Traffic volume of the target roads
4. Character of the road i.e. road to the border, road composed of the road network, road to dead end
5. Economic status of the roadside area i.e. agricultural area, industrial area and others.
6. Number of buildings in vicinity of the bridges

(2) Attribute for Selection of the Target Bridges

1. Maximum high water level
2. Deterioration rate of the bridge
3. Bridge width
4. Type of bridge i.e. wooden, bailey, concrete and steel bridge

2.2 Evaluation Method

(1) The Analytic Hierarchy Process (AHP)

The roads and bridges are prioritized by using the AHP. The weights for the evaluation factors are examined by the pair wise comparison matrix of each attribute.

Example matrix to weigh each attribute for the evaluation of priority roads is shown in Table 2-3 and the method to set the weight of attributes is described as follows.

1) Introduction

The AHP is a priority ordering method for use as a factor in decision making. It is a systematic procedure which uses a matrix of pair wise comparisons to derive relative priority. The steps for setting weight by the AHP are as follows:

Step 1. Determine the attributes used for route priority setting.
Step 2. Compare and evaluate the attributes for relative importance.
Step 3. Set the priorities of the routes by using the weight of attribute and intensity of attributes for the route.

The user must select or establish attributes and determine the scale of relative importance for each attribute. The scale of relative importance is shown in Table 2-2.

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Table 2-2 Scale of Relative Importance

Intensity of Relative Importance	**Definition**	**Explanation**
1	Equal importance	Two activities contribute equally to the objective.
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another.
5	Essential or strong Importance	Experience and judgment slightly favor one activity over another.
7	Demonstrated Importance	An activity is strongly favored and its dominance is demonstrated in practice.
9	Extreme importance	The evidence favoring one activity over Another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed.
Reciprocal of above Non-zero numbers	If an activity has one of the above numbers (e.g.3) compared with A second activity, then the second activity has the reciprocal value (i.e.1/3) when compared to the first.	

2) Steps to Obtain the Weight of the Attribute

a) Define the problem and determine what the decision maker wants to know.

b) Structure the hierarchy from the top (the objectives from a managerial viewpoint) through the intermediate levels (criteria on which subsequent levels depend) to the lower level (which usually a list of candidate bridges being selected by deficiency point method or sufficiency method).

c) Construct a set of pair wise comparison matrices for each of the lower levels- one matrix for each element in the level immediately above. Compare to each other, the elements in the lower level based on their effects on the governing elements above.

d) There are n(n-1)/2 judgments required to develop the matrix.

e) Weight of each attribute is obtained by normalization of the Eigen value.

(2) Setting Weight

Table 2-3 Example of matrix to set weight for each attribute

Attribute	A	B	C	D	E	F	Eigen Vector	Weight
A	1.000	7.000	3.000	5.000	7.000	7.000	4.155	0.454
B	0.143	1.000	0.167	0.250	1.000	1.000	0.426	0.046
C	0.333	6.000	1.000	3.000	6.000	6.000	2.449	0.268
D	0.200	4.000	0.333	1.000	4.000	4.000	1.274	0.139
E	0.143	1.000	0.167	0.250	1.000	1.000	0.426	0.046
F	0.143	1.000	0.167	0.250	1.000	1.000	0.426	0.046
Total							9.155	1.000

A: Priority road determined by the master plan (Short, Medium, Long term)
B: Population along the road
C: Traffic volume of the road
D: Character of the road (Road to border, road for network, road to dead end)
E: Economy of the road side area
F: Number of buildings in vicinity of the bridges

(3) Intensity of Each Attribute

Table 2-4 Priority road determined by the master plan (Short, Midterm, Long term)

Intensity of Attribute	National plan
9	Short Term
7	Mid Term
5	Long Term
3	Not planned
Neglect from the List	Completed or committed

Table 2-5 Population along the road

Intensity of Attribute	Population(P)
9	P over 100,000
7	100,000.> P > 50,000
5	50,000> P .> 10,000
3	P less than 10,000

Table 2-6 Traffic volume of the road

Intensity of Attribute	Traffic volume/day (TV)
9	TV over 5,000
7	5,000 > TV> 2,000
5	2,000>TV>500
3	500>TV>100
1	TV less than 100

Table 2-7 Character of road

Intensity of Attribute	Character of road
9	Road to border
7	Road for network
2	Road to dead end

Table 2-8 Economy of the road side area

Intensity of Attribute	Road side circumstance
9	City area
7	Industrialized area
5	Agricultural area
3	Forest or grassy plain
1	Area for protection of nature

Table 2-9 Number of buildings in vicinity of the bridges

Intensity of Attribute	Number of building(NB)
9	50>NB
7	100>NB>50
5	300>NB>100
3	500>NB>300
1	NB> 500

2.3 Results of the Analysis

(1) Weight of each attribute

Weights for setting the priority of the target roads are examined by the six Cambodian counterparts with same method mentioned above and the weights for each attribute are evaluated as shown in Table 2-10.

Table 2-10 Weight evaluated by the Cambodian Counterparts

Attribute for prioritization	Weight
A: Priority road determined by the master plan (Short, Medium, Long term)	0.352
B: Population along the road	0.062
C: Traffic volume of the road	0.220
D: Character of the road (Road to border, road for network, road to dead end)	0.109
F: Economy of the road side area	0.131
F: Number of buildings in vicinity of the bridges	0.127

(2) Priority of the Target Roads

Result of the prioritization of the target roads for the Study is shown in Table 2-11.

Improvement of the existing bridge is the main objective of this study so that the road which has no bridge necessary to be improved shall be neglected from the target bridges. There are many temporary bridges including wooden bridge, Bailey bridge and other type of temporary bridge in Cambodia and they have high priority for replacement with a permanent bridge. Besides, there are lot of concrete bridge with one carriageway being constructed by the Cambodia in recent years. They have some durability for the existing traffic load compared with the temporary bridges. They need to be replaced in the near future, however the urgency for the replacement is rather low compared with the temporary bridges. The road with temporary bridge and concrete bridge with one lane carriageway are picked up as target bridges. The target roads shall be prioritized to determine the strategy to improve the target bridges. The roads with concrete bridge with one lane carriageway are given half weight for priority to distinguish the roads with temporary bridges because they do not have high urgency to be replaced. The revised priorities of the target roads are shown in Table 2-12.

Table 2-11Priority of the Target Roads of the Study

Priority No.	Road No.	Evaluation Attribute						Priority	Priority No.	Road No.	Evaluation Attribute						Priority	Priority No.	Road No.	Evaluation Attribute						Priority
		A	B	C	D	E	F				A	B	C	D	E	F				A	B	C	D	E	F	
1	57	9	9	9	9	9	9	9.009	57	140	9	7	5	2	1	9	6.194	113	155D	3	7	5	7	5	9	5.151
2	57B	9	9	9	9	9	9	9.009	58	1551	9	5	3	7	1	9	6.175	114	155F	3	7	5	7	5	9	5.151
3	59	9	9	9	9	9	9	9.009	59	126	5	5	7	7	5	9	6.171	115	157	3	7	5	7	5	9	5.151
4	78	9	7	9	9	9	9	8.885	60	279	3	9	9	7	9	5	6.171	116	260A	3	7	5	7	5	9	5.151
5	31	9	9	9	7	9	9	8.791	61	63	3	9	9	2	9	9	6.134	117	264B	3	7	5	7	5	9	5.151
6	51	9	9	9	7	9	9	8.791	62	114	3	7	7	7	9	9	6.115	118	266F	3	7	5	7	5	9	5.151
7	56	9	9	9	7	9	9	8.791	63	151B	3	7	7	7	9	9	6.115	119	314	3	7	5	7	5	9	5.151
8	62	9	9	7	9	9	9	8.569	64	155	3	7	7	7	9	9	6.115	120	371D	3	7	5	7	5	9	5.151
9	11	9	9	9	7	9	7	8.537	65	2620	7	7	5	7	1	9	6.035	121	380A	3	7	5	7	5	9	5.151
10	68	9	7	7	9	9	9	8.445	66	132	3	7	9	7	5	9	6.031	122	387A	3	7	5	7	5	9	5.151
11	76	9	7	9	7	9	7	8.413	67	314C	3	5	7	7	9	9	5.991	123	152H	3	7	5	2	9	9	5.130
12	72	9	7	9	9	5	9	8.361	68	130	3	9	7	7	9	7	5.985	124	156D	3	7	7	2	9	5	5.062
13	61	9	9	7	7	9	9	8.351	69	44	5	9	5	2	9	9	5.958	125	153C	3	5	5	7	5	9	5.027
14	41	9	9	9	7	5	9	8.267	70	377	3	7	7	7	9	7	5.861	126	317	3	5	5	7	5	9	5.027
15	33	9	7	7	9	9	7	8.191	71	264C	7	7	3	7	3	9	5.857	127	377A	3	5	5	7	5	9	5.027
16	48	9	7	7	9	9	7	8.191	72	135	3	9	5	7	9	9	5.799	128	155A	3	5	5	2	9	9	5.006
17	138	9	7	9	2	9	9	8.122	73	154A	3	9	5	7	9	9	5.799	129	269	3	5	5	2	9	9	5.006
18	260	9	5	9	7	7	7	8.027	74	157C	3	9	5	7	9	9	5.799	130	314A	3	7	3	9	5	9	4.929
19	159D	9	7	7	7	7	9	7.965	75	277	3	9	5	7	9	9	5.799	131	266A	3	7	5	7	3	9	4.889
20	73	9	9	7	7	9	5	7.843	76	315	3	9	5	7	9	9	5.799	132	317C	3	5	3	7	7	9	4.849
21	71	9	9	7	7	5	9	7.827	77	129C	5	5	5	7	5	9	5.731	133	46	5	7	5	2	1	9	4.786
22	373C	9	9	7	7	5	9	7.827	78	270	3	9	7	7	9	5	5.731	134	159B	3	9	5	7	5	5	4.767
23	314B	9	7	5	7	9	9	7.787	79	316A	3	5	7	7	7	9	5.729	135	2646	3	5	5	7	3	9	4.765
24	311	9	7	7	7	5	9	7.703	80	129	3	9	7	7	5	9	5.715	136	264	3	9	5	2	5	9	4.730
25	312B	9	7	7	7	5	9	7.703	81	264A	3	9	7	7	5	9	5.715	137	137	3	7	3	7	5	9	4.711
26	313	9	7	7	7	5	9	7.703	82	136A	3	7	5	7	9	9	5.675	138	313A	3	7	3	7	5	9	4.711
27	53	7	7	7	7	9	9	7.523	83	157B	3	7	5	7	9	9	5.675	139	387	3	7	3	7	5	9	4.711
28	110	9	9	9	7	7	1	7.513	84	375	3	7	5	7	9	9	5.675	140	152G	3	7	3	2	9	9	4.690
29	67	9	7	7	9	1	9	7.397	85	134B	3	7	7	7	5	9	5.591	141	266	3	7	5	7	1	9	4.627
30	258D	9	5	5	9	5	9	7.357	86	266D	3	7	7	7	5	9	5.591	142	53A	3	7	5	2	5	9	4.606
31	314D	9	5	5	9	5	9	7.357	87	266E	3	7	7	7	5	9	5.591	143	121	3	7	5	2	5	9	4.606
32	13	7	7	7	7	9	7	7.269	88	45	3	5	5	9	7	9	5.507	144	153B	3	7	5	2	5	9	4.606
33	264D	9	7	5	7	5	9	7.263	89	371	5	9	5	7	5	5	5.471	145	154C	3	7	5	2	5	9	4.606
34	1488	9	5	3	7	9	9	7.223	90	266B	3	5	7	7	5	9	5.467	146	154E	3	7	5	2	5	9	4.606
35	380	9	7	7	7	5	5	7.195	91	373B	3	7	5	7	7	9	5.413	147	154F	3	7	5	2	5	9	4.606
36	261	9	5	5	7	7	7	7.147	92	372A	3	7	5	9	5	9	5.369	148	155E	3	7	5	2	5	9	4.606
37	378	9	5	5	7	5	9	7.139	93	52	5	7	5	2	5	9	5.310	149	157A	3	7	5	2	5	9	4.606
38	312	9	7	5	7	5	7	7.009	94	317B	3	5	5	7	7	9	5.289	150	265	3	7	5	2	5	9	4.606
39	147	5	9	7	7	9	9	6.943	95	319	3	5	5	7	7	9	5.289	151	370C	3	7	5	2	5	9	4.606
40	55	7	9	5	9	9	5	6.917	96	153	3	9	5	7	5	9	5.275	152	383	3	7	5	2	5	9	4.606
41	317A	9	5	3	9	5	9	6.917	97	268B	3	9	5	7	5	9	5.275	153	377B	3	5	3	7	5	9	4.587
42	381	9	7	7	2	5	7	6.904	98	370A	3	9	5	7	5	9	5.275	154	374	3	5	5	7	1	9	4.503
43	58	3	9	9	9	9	9	6.897	99	373A	3	9	5	7	5	9	5.275	155	53B	3	5	5	2	5	9	4.482
44	382	9	9	5	2	5	9	6.842	100	373D	3	9	5	7	5	9	5.275	156	152	3	5	5	2	5	9	4.482
45	42	5	7	7	7	9	9	6.819	101	156	3	9	5	2	9	9	5.254	157	376	3	5	5	2	5	9	4.482
46	118A	9	5	7	9	5	1	6.781	102	154	3	7	9	2	5	7	5.232	158	265C	3	5	7	2	5	5	4.414
47	264E	9	7	5	7	1	9	6.739	103	266C	3	9	7	7	1	9	5.191	159	265E	3	5	7	2	1	9	4.398
48	156A	3	9	9	7	9	9	6.679	104	124	3	7	5	7	5	9	5.151	160	265B	3	7	5	2	5	7	4.352
49	267	3	9	9	7	9	9	6.679	105	133A	3	7	5	7	5	9	5.151	161	312A	3	7	1	7	5	9	4.271
50	2624	9	5	5	7	1	9	6.615	106	134	3	7	5	7	5	9	5.151	162	268A	3	7	3	2	5	9	4.166
51	21	5	9	9	9	9	1	6.585	107	134A	3	7	5	7	5	9	5.151	163	156C	3	7	5	2	5	5	4.098
52	60	5	9	5	7	9	9	6.503	108	136	3	7	5	7	5	9	5.151	164	2647	3	5	3	7	1	9	4.063
53	64	3	9	9	7	9	7	6.425	109	153A	3	7	5	7	5	9	5.151	165	152D	3	5	3	2	5	9	4.042
54	43	7	9	5	7	3	9	6.421	110	154B	3	7	5	7	5	9	5.151	166	152E	3	5	3	2	5	9	4.042
55	2648	9	5	1	7	5	9	6.259	111	155B	3	7	5	7	5	9	5.151	167	152F	3	5	3	2	5	9	4.042
56	70	3	9	7	7	9	9	6.239	112	155C	3	7	5	7	5	9	5.151	168	54	3	5	5	2	1	9	3.958

Table 2-12 Revised Priority of the Target Roads

Priority No.	Road No.	Evaluation Attribute						Priority	Annulation of Completed, On-going, & Committed Projects	Priority (Final)	Priority No.	Road No.	Evaluation Attribute						Priority	Annulation of Completed, On-going, & Committed Projects	Priority (Final)
		A	B	C	D	E	F						A	B	C	D	E	F			
1	11	9	9	9	7	9	7	8.537	1	8.537	**44**	383	3	7	5	2	5	9	4.606	1	4.606
2	73	9	9	7	7	9	5	7.843	1	7.843	**45**	374	3	5	5	7	1	9	4.503	1	4.503
3	314D	9	5	5	9	5	9	7.357	1	7.357	**46**	53B	3	5	5	2	5	9	4.482	1	4.482
4	42	5	7	7	7	9	9	6.819	1	6.819	**47**	265C	3	5	7	2	5	5	4.414	1	4.414
5	267	3	9	9	7	9	9	6.679	1	6.679	**48**	265E	3	5	7	2	1	9	4.398	1	4.398
6	2624	9	5	5	7	1	9	6.615	1	6.615	**49**	62	9	9	7	9	9	9	8.569	0.5	4.285
7	70	3	9	7	7	9	9	6.239	1	6.239	**50**	68	9	7	7	9	9	9	8.445	0.5	4.223
8	279	3	9	9	7	9	5	6.171	1	6.171	**51**	152D	3	5	3	2	5	9	4.042	1	4.042
9	151B	3	7	7	7	9	9	6.115	1	6.115	**52**	152F	3	5	3	2	5	9	4.042	1	4.042
10	155	3	7	7	7	9	9	6.115	1	6.115	**53**	260	9	5	9	7	7	7	8.027	0.5	4.014
11	2620	7	7	5	7	1	9	6.035	1	6.035	**54**	159D	9	7	7	7	7	9	7.965	0.5	3.983
12	314C	3	5	7	7	9	9	5.991	1	5.991	**55**	313	9	7	7	7	5	9	7.703	0.5	3.852
13	377	3	7	7	7	9	7	5.861	1	5.861	**56**	67	9	7	7	9	1	9	7.397	0.5	3.699
14	264C	7	7	3	7	3	9	5.857	1	5.857	**57**	261	9	5	5	7	7	7	7.147	0.5	3.574
15	277	3	9	5	7	9	9	5.799	1	5.799	**58**	147	5	9	7	7	9	9	6.943	0.5	3.472
16	316A	3	5	7	7	7	9	5.729	1	5.729	**59**	156A	3	9	9	7	9	9	6.679	0.5	3.340
17	375	3	7	5	7	9	9	5.675	1	5.675	**60**	114	3	7	7	7	9	9	6.115	0.5	3.058
18	373B	3	7	5	7	7	9	5.413	1	5.413	**61**	130	3	9	7	7	9	7	5.985	0.5	2.993
19	372A	3	7	5	9	5	9	5.369	1	5.369	**62**	154A	3	9	5	7	9	9	5.799	0.5	2.900
20	373D	3	9	5	7	5	9	5.275	1	5.275	**63**	135	3	9	5	7	9	9	5.799	0.5	2.900
21	156	3	9	5	2	9	9	5.254	1	5.254	**64**	157C	3	9	5	7	9	9	5.799	0.5	2.900
22	154	3	7	9	2	5	7	5.232	1	5.232	**65**	129C	5	5	5	7	5	9	5.731	0.5	2.866
23	266C	3	9	7	7	1	9	5.191	1	5.191	**66**	129	3	9	7	7	5	9	5.715	0.5	2.858
24	136	3	7	5	7	5	9	5.151	1	5.151	**67**	136A	3	7	5	7	9	9	5.675	0.5	2.838
25	154B	3	7	5	7	5	9	5.151	1	5.151	**68**	157B	3	7	5	7	9	9	5.675	0.5	2.838
26	155B	3	7	5	7	5	9	5.151	1	5.151	**69**	134B	3	7	7	7	5	9	5.591	0.5	2.796
27	371D	3	7	5	7	5	9	5.151	1	5.151	**70**	266E	3	7	7	7	5	9	5.591	0.5	2.796
28	380A	3	7	5	7	5	9	5.151	1	5.151	**71**	317B	3	5	5	7	7	9	5.289	0.5	2.645
29	152H	3	7	5	2	9	9	5.130	1	5.13	**72**	153	3	9	5	7	5	9	5.275	0.5	2.638
30	156D	3	7	7	2	9	5	5.062	1	5.062	**73**	268B	3	9	5	7	5	9	5.275	0.5	2.638
31	155A	3	5	5	2	9	9	5.006	1	5.006	**74**	133A	3	7	5	7	5	9	5.151	0.5	2.576
32	317C	3	5	3	7	7	9	4.849	1	4.849	**75**	314	3	7	5	7	5	9	5.151	0.5	2.576
33	46	5	7	5	2	1	9	4.786	1	4.786	**76**	387A	3	7	5	7	5	9	5.151	0.5	2.576
34	159B	3	9	5	7	5	5	4.767	1	4.767	**77**	153C	3	5	5	7	5	9	5.027	0.5	2.514
35	2646	3	5	5	7	3	9	4.765	1	4.765	**78**	313A	3	7	3	7	5	9	4.711	0.5	2.356
36	137	3	7	3	7	5	9	4.711	1	4.711	**79**	387	3	7	3	7	5	9	4.711	0.5	2.356
37	266	3	7	5	7	1	9	4.627	1	4.627	**80**	152G	3	7	3	2	9	9	4.690	0.5	2.345
38	53A	3	7	5	2	5	9	4.606	1	4.606	**81**	121	3	7	5	2	5	9	4.606	0.5	2.303
39	154C	3	7	5	2	5	9	4.606	1	4.606	**82**	153B	3	7	5	2	5	9	4.606	0.5	2.303
40	154E	3	7	5	2	5	9	4.606	1	4.606	**83**	152	3	5	5	2	5	9	4.482	0.5	2.241
41	154F	3	7	5	2	5	9	4.606	1	4.606	**84**	265B	3	7	5	2	5	7	4.352	0.5	2.176
42	155E	3	7	5	2	5	9	4.606	1	4.606	**85**	268A	3	7	3	2	5	9	4.166	0.5	2.083
43	265	3	7	5	2	5	9	4.606	1	4.606	**86**	156C	3	7	5	2	5	5	4.098	0.5	2.049

Remarks: Red shows temporary bridge and Yellow shows overflow or one lane bridge

(3) Focus on the Group of High Priority Roads

The road sector will improve 2- and 3-digit roads to integrate national and regional areas. Bridges are a part of roads and the roads are one of important infrastructure to sustain the development of the region. Hence the roads shall be selected as a part of road network in a region and road development plan shall be established as a group for a region. Short-term plan should be selected taking into considered priority of the target roads together with project cost. The step to select the target roads is as follows.

1) Focus on the high priority roads

2) Grouping the roads considering the regional development

3) Prioritization of the target roads.

High priority roads are distinguished into 5 groups as shown in Table 2-13. Those groups are located along NR7, NR1 (Vietnam border), NR5, NR6 and NR3 as shown in Table 2-12. Total demand for bridge replacement can be obtained by multiplication of weight for the target roads and the number of bridges on the road. Average weight for bridge in each group is calculated by total weight divided by the total number of bridges on the road. Group1 and 2 are recommended for improvement as first priority groups in short-term plan for the following reasons.

1) The Group1 includes the NR11and NR73, which is one of the highest priority roads among the target roads
2) Average weight of bridge importance in Group2 is the highest compared to other alternative groups.

Table 2-13 Group of the Target Roads

Group1 (NR7)	Road No.	11	70	73	277	279	372A	373B	373D	375	377	Total	Average
	Priority	8.54	6.24	7.84	5.80	6.17	5.37	5.41	5.28	5.68	5.86		
	Br. No	2	2	6	2	1	5	1	10	3	12	44	
	Weight	16.71	12.48	47.06	13.36	6.17	26.85	5.41	52.75	17.025	70.33	268.15	**6.09**
Group2 (NR1)	Road No.	314C	314D	316A									
	Priority	5.99	7.36	5.73									
	Br. No	1	1	1								3	
	Weight	5.991	7.36	5.73								19.08	**6.36**
Group3 (NR5)	Road No.	151B	154	155	156	154B	42						
	Priority	6.12	5.23	6.12	5.25	5.15	6.82						
	Br. No	4	3	6	2	1	1					17	
	Weight	24.4	15.6	36.7	10.5	5.1	6.8					99.1	5.83
Group4 (NR6)	Road No.	264C	266C	267	2624	2620							
	Priority	5.86	5.19	6.68	6.62	6.04							
	Br. No	2	1	1	1	1						6	
	Weight	11.71	5.19	6.68	6.62	6.04						36.24	6.04
Group5 (NR3)	Road No.	136											
	Priority	5.151											
	Br. No	1										1	
	Weight	5.15										5.15	5.15

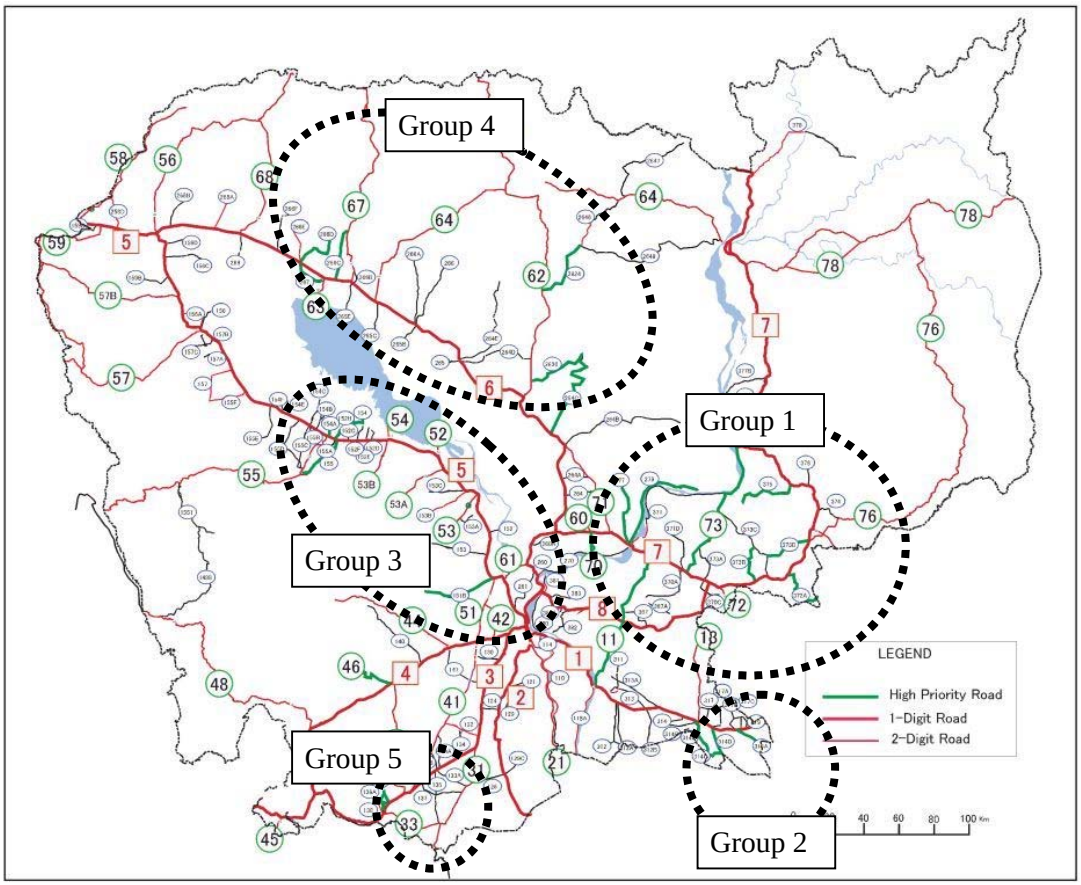


Figure 2-1 Location Map of Priority Roads

CHAPTER 3

BRIDGE SURVEY

3. BRIDGE SURVEY

Survey team confirmed conditions of the target roads including development plan for the roads by the Cambodia and the donor countries based on the bridge inventory data prepared by the Heavy Equipment Center (HEC) in 2006. The survey team confirmed that the majority of the 2-digit roads are completed or committed to be improved by the donor countries and agencies including China, Korea and Thailand Asian Development Bank. Many one lane concrete bridges that were constructed from the year 1993 to 2005 by the Cambodia were confirmed on 3-digit roads.

With confirmation on the inventory and inspection data, six roads could not be confirmed because of the duplication or wrong entries to the data. The roads already improved or committed by the donor countries, and roads that could not be identified on the database or site survey will not be included as the target bridges.

Number of bridges and types of bridges listed in the inventory data from the HEC and results of the site survey are not consistent. Some bridges confirmed through the site survey are not listed in the inventory data. Many bridges are already replaced, however, data in the bridge inventory from the HEC is not updated therefore the inventory data collected through site survey by the Study Team will be treated as the latest data for selection of the prioritized road in the study.

3.1 Bridge Inventory Survey

(1) Outline of Bridge Inventory Survey

The bridge inventory survey was carried out by the local survey company in Cambodia from April to September 2012. The purposes of the survey were as follows.

1) To identify the target roads
2) To identify the temporary bridges
3) To inspect degree of bridge deficiency
4) To prioritize the target bridges
5) To design and estimate cost for bridge replacement

The target roads were selected based on the bridge list which was made in 2006 by the HEC. Some box culverts, water gates and causeways were also investigated to evaluate whether the structure should be replaced with a bridge. Number of surveyed roads is 168 and numbers of surveyed structures are shown in Table 3-1.

Table 3-1 Structures investigated through the survey

Road	Structure			
	Bridge	**Box culvert**	**Water gate**	**Causeway**
168	1205	44	26	3

Source: Study Team

(2) Contents of Bridge Inspection Manual

The bridge inspection manual including the methods of measuring bridge dimensions and evaluation for degree of bridge deficiencies is prepared for the site survey. The contents of inspection sheet are considered to evaluate the scale of new bridges which will replace temporary bridges and to collect information for bridge design. Items of the information to be collected are as follows.

1) General Information
2) Environment and social consideration
3) Dimensions of Super Structure
4) Dimensions of Sub-Structure
5) Photos of Bridge
6) Condition rating of bridge deficiency
7) Photos of Bridge Deficiency

The items of the bridge inspection for each type of bridge are shown in Table 3-2.

Table 3-2 Items of the Bridge Inspection

Survey Item	Temporary bridge				Permanent bridge	
	Wood	Bailey	Concrete	Steel	Concrete	Steel
Inventory Survey						
1. General Information	○	○	○	○	○	○
2. Dimensions of Super Structure	○	○	○	○	○	○
3. Dimensions of Sub-structure	○	○	○	○	○	○
4. Photos of the Bridge	○	○	○	○	○	○
Inspection Survey						
5. Condition Rating of Bridge deficiency					○	○
6. Photos of Bridge deficiency					○	○

(3) General Information

1) General information

Inspection date, road number, bridge name, province and river name should be recorded.

2) Coordinates

Coordinates should be measured at the centre of bridge by Global Positioning System (GPS).

3) Construction year

Construction year of the bridge if any should be recorded.

4) Width of river

The width of river should be measured by the following steps.

a) Confirm the location of bridge by flood area or river area.

b) If the bridge is located in river area, measure the width of river at upstream of the bridge. The width is shown in Figure 3-1.

c) If the bridge is located in flood area, record "flood area'' in the form.

d) "Flood area" means surrounding area of bridge is covered by the flood water during the rainy season.

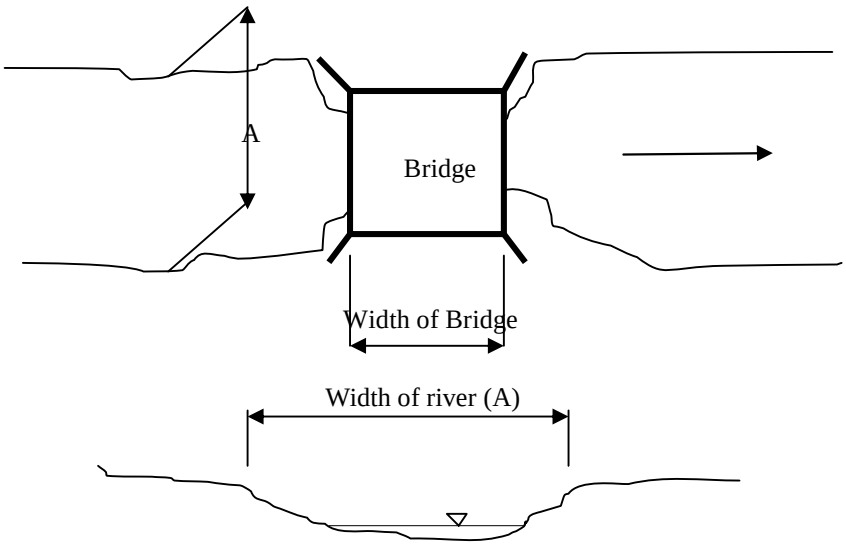


Figure 3-1 Width of river

5) Geological features at the river bed or near the river

The geological features should be coded as designated in Table 3-3.

Table 3-3 Type of the stone or sand

Code No	Item
1	Fine aggregate (0.35mm or less)
2	Coarse aggregate (0.35-2mm)
3	Gravel (2-75mm)
4	Boulder (75-300mm)
5	Rock (More than 300mm)

6) Geographical features

The geographical features near the target bridge should be coded as designated in Table 3-4. The types of geographical features are shown in Figure 3-2.

Table 3-4 Geographical features

Code No	Item
1	Flat plain
2	Gentle hill
3	Steep mountain

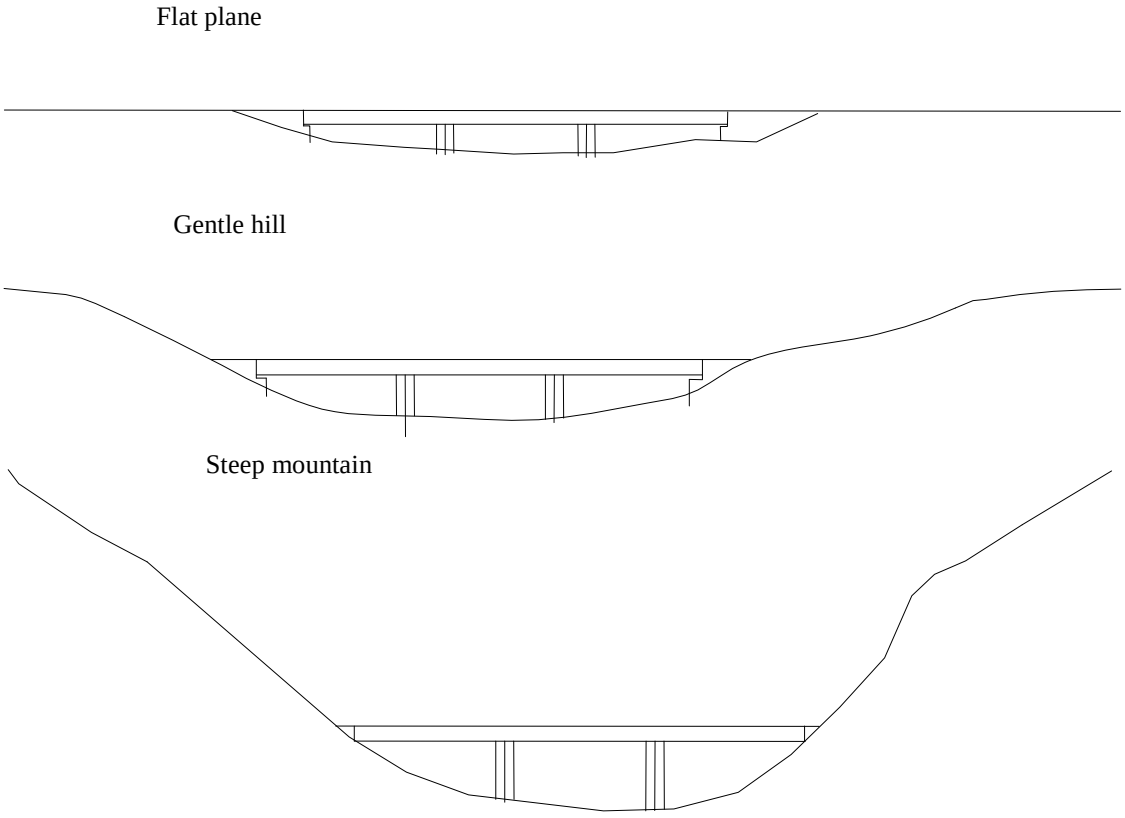


Figure 3-2 Geographical features

7) Clearance

The clearance of the bridge should be measured from river bed to bridge surface. Measuring point of elevation is shown in Figure 3-3.

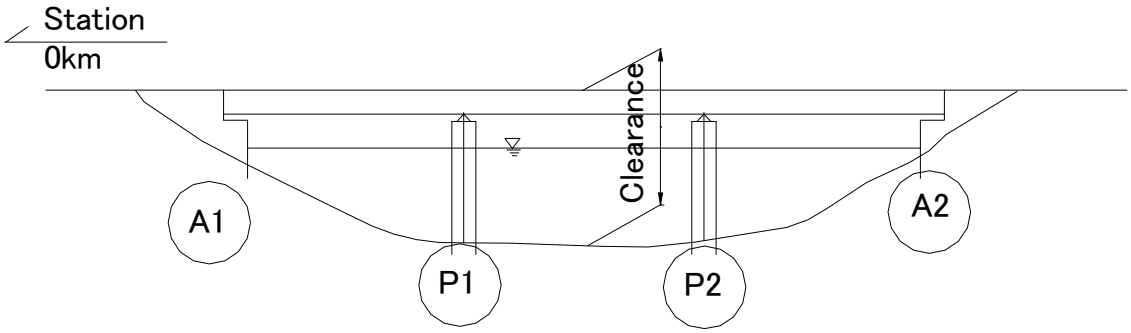


Figure 3-3 Clearance of the bridge

8) Maximum high water level

The maximum high water level (HWL) in the past should be confirmed from local residents or the trace of the high water level of the flood. The height should be measured as indicated in the following cases.

Case 1: If maximum high water level is higher than road surface, measure the height from road surface to the level (Example 1.5m).

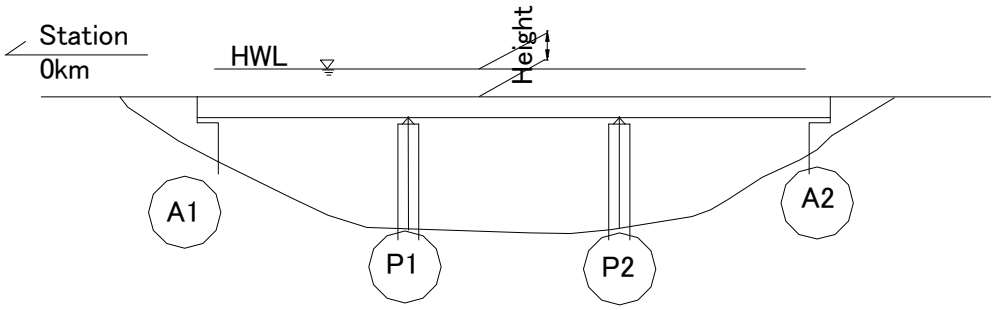


Figure 3-4 Maximum high water level (Case 1)

Case 2: If maximum high water level is lower than road surface, measure the height from road surface to the level as minus (Example -1.5m).

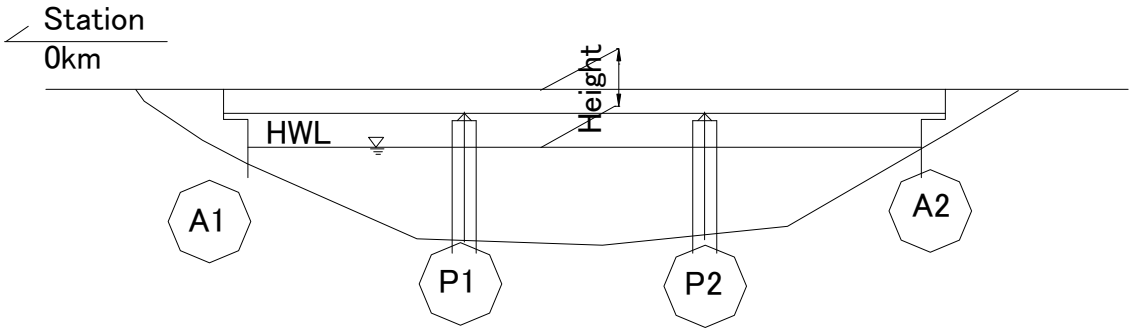


Figure 3-5 Maximum high water level (Case 2)

9) Traffic regulation

The traffic regulation including width limit, loading capacity and limit for vertical clearance should be recorded.

10) Types of lifelines

The types of the lifelines on a bridge should be coded as designated in Table 3-5.

Table 3-5 Type of life line

Code No	Item
1	Telephone wire
2	Water pipe
3	Electric cable
4	Fiber-optic cable
9	Others

11) Material of wearing surface on deck

The materials of wearing surface on deck should be coded as designated in Table 3-6.

Table 3-6 Material of wearing surface

Code No	Item
1	Asphalt
2	Concrete
9	Others

12) Materials of deck

The materials of deck should be coded as designated in Table 3-7.

Table 3-7 Type of deck

Code No	Item
1	Concrete
2	Steel
3	Wood
9	Others

13) Materials of guardrail or handrail

The materials of guardrail or handrail should be coded as designated in Table 3-8.

Table 3-8 Material of guardrail or handrail

Code No	Item
1	Concrete
2	Steel
3	Wood
9	Others

14) Embankment protection

The types of embankment protection for the abutment should be coded as designated in Table 3-9.

Table 3-9 Type of embankment protection

Code No	Item
1	Masonry
2	Gabion basket
3	Concrete block
4	Natural soil
9	Others

15) Environmental and social consideration

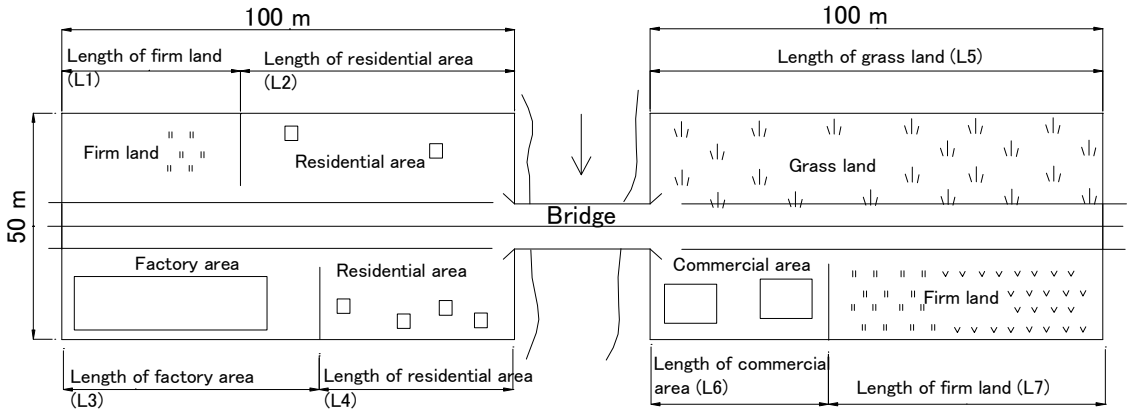
Number of the structure and land use along the approach road of the bridge should be measured. Items to be measured are listed in Table 3-10 and Table 3-11. The survey area is 100m from behind of the bridge on both side and 25m width from centreline of road as shown in Figure 3-6.

Table 3-10 Type of structure

No	Item
1	Residence
2	Commercial Building (Shop, Restaurant, Kiosk)
3	Workshop (for food, commodity, artifact, vehicle)
4	Factory
5	Stall
6	Other Business office
7	Public Building
9	Others

Table 3-11 Type of land use

No	Item
1	Residential area
2	Commercial/Business area
3	Factory area
4	Firm Land
5	Forest
6	Wetland
7	Grass Land
9	Others



Total length of firm land = L1 + L7

Total length of residential area = L2 + L4

Figure 3-6 Environmental and social survey area (Sample)

(4) Dimensions of Super Structure

1) Span and girder height

The span and height of girder should be recorded in ascending order from a point of origin of the road as shown in the Figure 3-7. The unit should be centimetre.

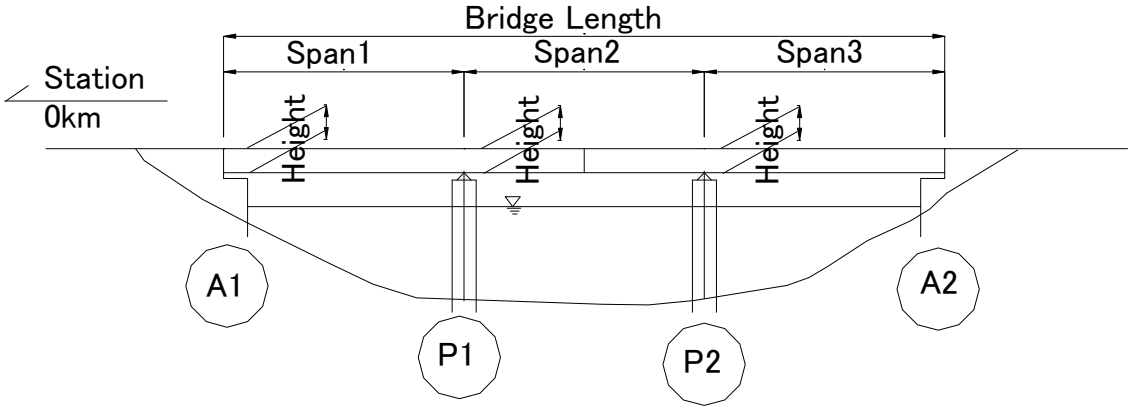


Figure 3-7 Span and Height of Girder

2) Bridge width

The bridge width including traffic lane, side walk, median, and curb on the bridge are shown in Figure 3-8 . The unit should be centimetre.

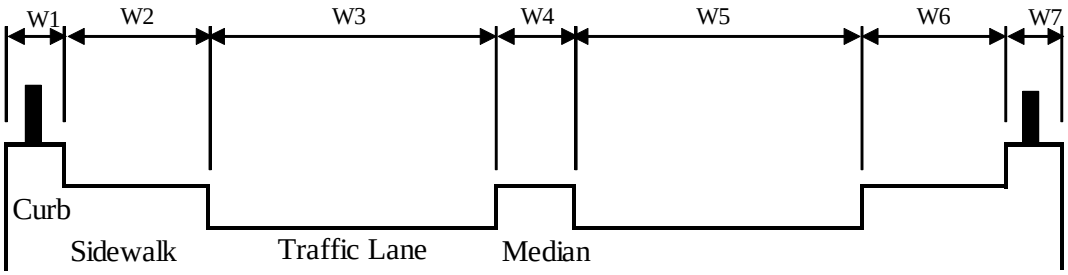


Figure 3-8 Bridge width

3) Types of bridge and girder

Types of bridge and girder should be coded as designated in Table3-12 and 3-13.The sample photos of each type are shown in Photo 3-1 to Photo 3-6.

Table 3-12 Type of bridge

Code No	Item
1	Bailey
2	Wood
3	Steel
4	Concrete
9	Others

Table 3-13 Type of girder

Code No	Item
1	Slab
2	Girder
3	Box
4	Truss

Photo 3-1 Bailey bridge

Photo 3-2 Wooden bridge

Photo 3-3 Steel bridge (Temporary type)

Photo 3-4Wooden deck on steel bridge

Photo 3-5 Steel Bridge (I girder)

Photo 3-6 Concrete Bridge (T girder)

(5) Dimensions of Sub-Structure

1) Height of substructure

The height of abutment and pier should be measured at the point as shown in Figure 3-9.

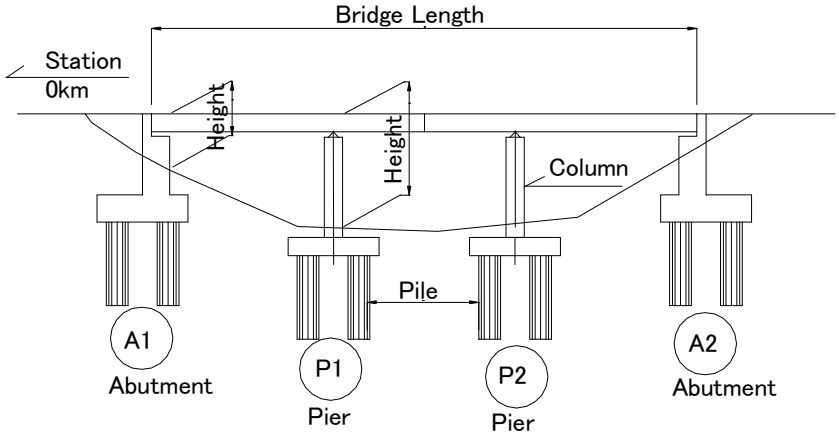


Figure 3-9 Height of substructure

2) Type of abutment

The type of abutment should be coded as designated in Table 3-14. The sample photos of each type of abutment are shown in Photo 3-7 to Photo 3-10.

Table 3-14 Type of abutment

Code No	Item
1	Concrete
2	Gabion
3	Masonry
4	Steel
5	Wood
6	No abutment
9	Others

Photo 3-7 Concrete abutment

Photo 3-8 Gabion abutment

Photo 3-9 Masonry abutment

Photo 3-10 No abutment

3) Type of pier

The types of pier should be coded as designated in Table 3-15. The sample photos for each type of pier are shown in Photo 3-11 to Photo 3-16

Table 3-15 Type of pier

Code No	Item
1	Wall
2	Single column
3	Multi column
4	Steel
5	Wood
6	Masonry
9	Others

Photo 3-11 Wall type

Photo 3-12 Single column type

Photo 3-13 Multi column type

Photo 3-14 Steel type

Photo 3-15 Wood type

Photo 3-16 Masonry type

4) Type of pile

If the pile is observed, code as designated in Table 3-16.

Table 3-16 Type of pile

Code No	Item
1	Concrete pile
2	Steel pipe pile
3	H section steel pile
4	Wooden pile
9	Others

(6) Photos of Bridge

The indispensable photos of the bridge in the inventory should be formulated as follows in Table 3-17.

Table 3-17 Photos of bridge

1. Elevation	2. Overall view of bridge	3. Upstream from the bridge
		
4. Downstream from the bridge	5. Abutment	6. Pier
		
7.Bridge plate		
		

3.2 Bridge Inspection Survey

(1) Condition Rating for Bridge Deficiency

1) Holes on the concrete deck slab

Holes including scaling, pop out and peeling of the concrete are the clear evidence of the deterioration of the concrete deck slab. The damage degrees on the concrete deck slab are defined in Table 3-18.

Table 3-18 Degree of holes on the concrete deck

Damage Degree	Description
1	No hole is observed
2	Small spalls along the rebar on the deck slab are observed.
3	There are clear evidences that the hole extends to pierce through the deck slab.

2) Deformation of the steel main girder

Main causes of deformation of the steel main girder include overload, collision of vehicles and settlement of substructures. The inspector should check the horizontal alignment of the main girder to detect the deformation by the settlement of the substructure and any girder that may have been damaged due to the collision. The damage degrees for the deformation of the steel main girder are defined in Table 3-19.

Table 3-19 Deformation of the main girder

Damage Degree	Description
1	No damage can be observed on the main girder
2	Deformed 5 to 10cm from the original
3	Deformed over 20 cm from the original

3) Collapse of the slope protection in front of the abutment

The damage degrees for the collapse of the slope protection in front of the abutment are defined in Table 3-20

Table 3-20 Protection of slope infront of abutment

Damage Degree	Description
1	There is no damage on the slope
2	The slope in front of the abutment is deformed.
3	The slope in front of the abutment is missing.

4) Inclination of abutment and pier

The definition of the inclination includes vertical, lateral and rotational movement.

The damage degrees for the inclination of abutment and pier are defined in Table 3-21.

Table 3-21 Inclination of abutment and pier

Damage Degree	Description
1	No movement is observed
2	Slight movement is confirmed visually
3	Inclination is obviously confirmed

5) Scour at foundation of abutment

Scour is the removal of material from a streambed as the result of the erosive action of running water. Scour can cause undermining of an abutment by the streams or rivers flowing adjacent to them. The damage degrees for the score at foundation of abutment are defined in Table 3-22.

Table 3-22 Scour at foundation

Damage Degree	Description
1	No Scour is observed
2	Scour is observed but it has not extended to the foundation
3	Foundation is showing because of the scour

6) Scour at foundation of pier

The foundations must be buried by earth and cannot be inspected basically. However, piles may happen to be exposed due to soil erosion, scour or other factors. To evaluate the score at a foundation refer to Table 3-23.

Table 3-23 Scour at foundation of pier

Damage Degree	Description
1	No Scour is observed
2	Some scour is observed but it has not extended to the foundation
3	Foundation is showing because of the scour

(2) Photo of Bridge Deficiency

The photos of bridge deficiency should be taken and the condition of deficiency noted as follows in Table 3-24.

Table 3-24 Example of photos of bridge deficiency

No.1	**Holes on the concrete deck slab**	**No.2**	**Deformation of steel main girder**
Note: Hole could be observed on deck slab and covered by soil		Note: Girder slightly deformed horizontally	
			
No.3	**Slope protection at abutment**	**No.4**	**Inclination of abutment or pier**
Note: Collapse the stone mason		Note: Inclination at abutment	
			
No.5	**Scour at foundation of abutment**	**No.6**	**Scour at foundation of pier**
Note: Scour at foundation		Pile of pier (about 2m)can be observed	
			

(3) Bridge Inspection Sheet

Results of bridge inspection were recorded in the following sheets for each bridge and the form of inventory and inspection sheets are shown in Table 3-25 and Table 3-26.

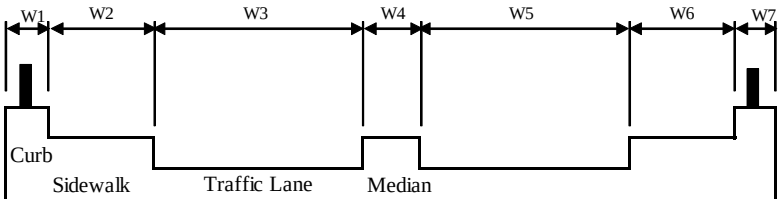
1) General Information of the Bridge Inventory
2) Environment and social consideration
3) Dimensions of structure and condition rating of bridge deficiency
4) Photo of bridge
5) Photo of bridge deficiency

Table 3-25 General Information of the Bridge Inventory

1. General Information of the Bridge Inventory

Inspector :	Date	Month	Year	1.2 Coordinate	°	'	''
1.1 Inspection date			2012	North latitude			
1.1 Bridge Name				East longitude			
1.1 Province				1.1 Road Number			
1.1 River Name				1.4 Width of River (m)			
	Date	Month	Year	1.6 Geographical features			
1.3 Construction Year				1.7 Clearance (m)			
1.9 Loading capacity (t)				1.8 Maximum high watar level (m)			
1.9 Width limit (m)				1.9 Vertical clearance(m)			
1.5 Particle size							
1.10 Type of the life line							
1.11 Material of surface layer							
1.12 Material of Deck							
1.13 Material of Guardrail							
1.14 Embankment protection							

2.3 Cross sections	1	2	3	4	5	6	7	Total width
W (cm)								-



1.15 Type of structure	Number of Structure	1.15 Land Use along Route	Length (m)
1) Residence		1) Residential area	
2) Commercial Building (Shop, Restaurant, Kiosk)		2) Commercial/ Business area	
3) Workshop (for food, commodity, artifact, vehicle)		3) Factory area	
4) Factory		4) Firm land	
5) Stall		5) Forest	
7) Other Business office		6) Wetland	
8) Public Building		7) Grass Land	
9) Others		8) Others	

Table 3-26 Dimensions of Surer Structure

2. Dimensions of Super Structure

Bridge Length (m)	0.00

2.1 Span No.	2.4 Type of bridge		2.4 Type of girder		2.1 Hight of girder (cm)	2.2 Length of span (m)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

3. Dimensions of Sub Structure

2.1 Item	3.2 Type of abutment and pier		3.1 Height (m)	Material of Pile	
A1					
A2					
P1					
P2					
P3					
P4					
P5					
P6					
P7					
P8					
P9					

5. Condition rating of bridge deficiency

Item	Rating
5.1 Holes on the concrete deck slab	
5.2 Deformation of steel main girder	
5.3 Collapse of the slope protection at abutment	
5.4 Inclination of abutment	
5.4 Inclination of pier	
5.5 Scour at foundation of abutment	
5.6 Scour at foundation of pier	

3.3 Result of the Bridge Survey

(1) Target roads for the Survey

As shown in Table 3-27, the target roads for the inventory survey are classified into four categories.

1) Roads that have already been improved or are committed to be improved by donor countries.(Green in the Table)
2) There is no temporary bridge on the road. (Light blue)
3) One lane bridge and bridge over flow by flood water constructed by the Cambodia on the road.(Yellow)
4) Temporary bridges including Bailey bridges, wooden bridges are remaining on the roads. (Red)

Each group of roads is distinguished by green for No 1) roads, light blue for No 2) roads, yellow is for No3) roads and red for No 4) roads in Figure 3-10 and Table 3-27 respectively. The objective of the project is to plan the replacement of temporary bridges on the roads, thus the prioritized roads for the bridge replacements will be selected from the road category No 3) and No.4).

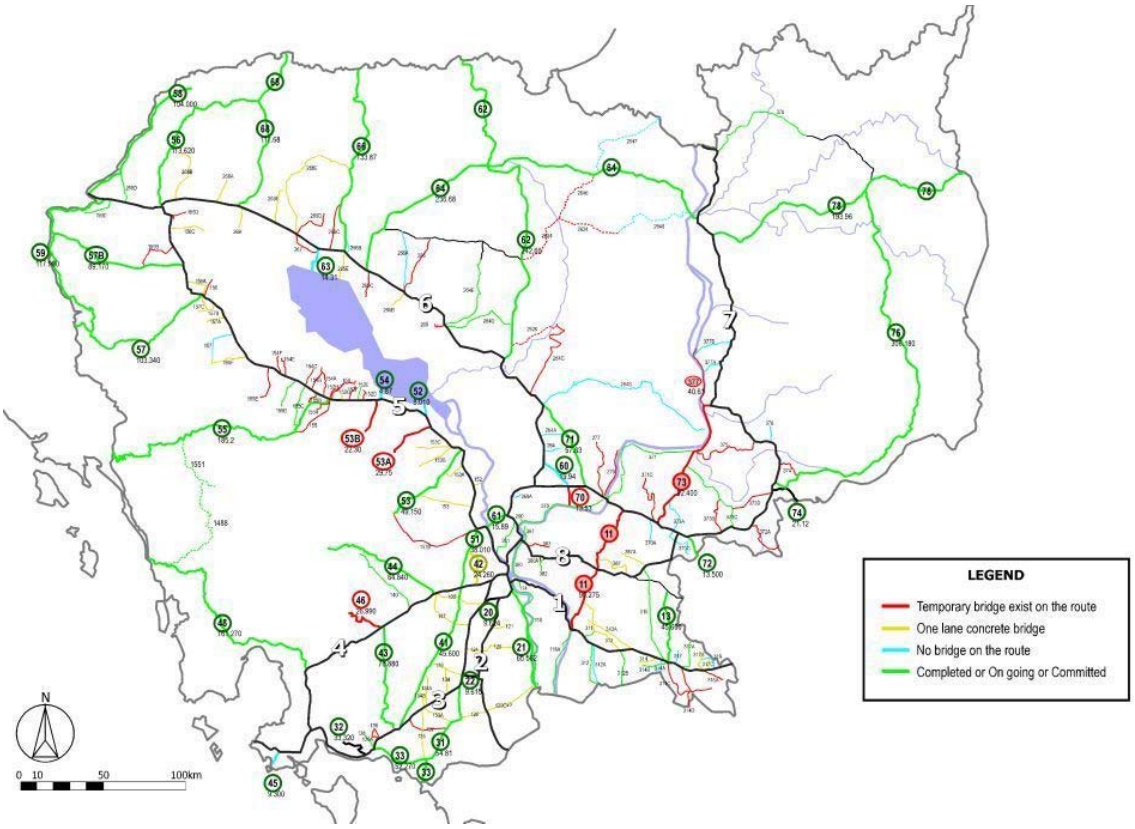


Figure 3-10 Road Network and the Target Roads

Table 3-27 List of the target roads for inventory survey

No.	Road No.	Number of Bridge	Type of Bridge					No.	Road No.	Number of Bridge	Type of Bridge				
			Bailey	Wood	Steel	Concrete	Other				Bailey	Wood	Steel	Concrete	Other
1	11	18	4		8	6		43	126	1				1	
2	13	8	3		1	4		44	129	1				1	
3	21	66	37		17	12		45	129C	1				1	
4	31	6	1			5		46	130	9			1	8	
5	33	12	3			9		47	132	1				1	
6	41	16				16		48	133A	4				4	
7	42	6				6		49	134	1				1	
8	43	35	31			4		50	134A	1				1	
9	44	13	11	1		1		51	134B	3				3	
10	45	0						52	135	2				2	
11	46	4	3		1			53	136	2		1		1	
12	48	39				39		54	136A	3				3	
13	51	3				3		55	137	6	1			5	
14	52	0						56	138	3				3	
15	53	11		1		10		57	140	6		1	1	4	
16	53A	1	1					58	147	4				4	
17	53B	3			2	1		59	151B	4	4				
18	54	0						60	152	1				1	
19	55	116	93	17	1	5		61	152D	3		2		1	
20	56	19				19		62	152E	2		1		1	
21	57	19				19		63	152F	1		1			
22	57B	24				21	3	64	152G	1				1	
23	58	3		2		1		65	152H	2		1		1	
24	59	12				12		66	153	1				1	
25	60	0						67	153A	3				3	
26	61	0						68	153B	4				4	
27	62	28				28		69	153C	1				1	
28	63	0						70	154	6		2	3	1	
29	64	54	18			30	6	71	154A	7		1		6	
30	67	39				39		72	154B	1		1			
31	68	31				31		73	154C	3		2		1	
32	70	3	2			1		74	154E	2		2			
33	71	2				2		75	154F	4		3		1	
34	72	1				1		76	155	14	1	5	2	6	
35	73	16	6		1	9		77	155A	1	1				
36	76	47	19	14		14		78	155B	6		6			
37	78	13				13		79	155C	2		1		1	
38	110	69		2		67		80	155D	2			1	1	
39	114	1			1			81	155E	5		1		4	
40	118A	42	1			41		82	155F	4				3	1
41	121	1				1		83	156	9	2			7	
42	124	1				1		84	156A	5				5	

No.	Road No.	Number of	Type of Bridge					No.	Road No.	Number of Bridge	Type of Bridge				
			Bailey	Wood	Steel	Concrete	Other				Bailey	Wood	Steel	Concrete	Other
85	156C	13				12	1	127	314	1				1	
86	156D	9	1	3		5		128	314A	0					
87	157	0						129	314B	1				1	
88	157A	1				1		130	314C	2	1			1	
89	157B	2				2		131	314D	1	1				
90	157C	3				3		132	315	6				5	1
91	159B	13	1			12		133	316A	1	1				
92	159D	6				6		134	317	0					
93	258D	1					1	135	317A	1				1	
94	260	1				1		136	317B	1				1	
95	260A	0						137	317C	2				2	
96	261	7				7		138	319	0					
97	264	0						139	370A	0					
98	264A	0						140	370C	0					
99	264B	0						141	371	10	4			6	
100	264C	3		2		1		142	371D	1	1				
101	264D	2				2		143	372A	5	5				
102	264E	9				8	1	144	373A	0					
103	265	1		1				145	373B	1				1	
104	265B	2				2		146	373C	5				5	
105	265C	4		1		3		147	373D	12		11			1
106	265E	1				1		148	374	2	2				
107	266	4	1			3		149	375	5		3		2	
108	266A	0						150	376	0					
109	266B	0						151	377	12	5	1	6		
110	266C	3	1			2		152	377A	0					
111	266D	1				1		153	377B	0					
112	266E	5				5		154	378	7				7	
113	266F	1				1		155	380	10				7	3
114	267	2			1	1		156	380A	2	1			1	
115	268A	5				5		157	381	4				3	1
116	268B	2				2		158	382	1				1	
117	269	1				1		159	383	9	5			1	3
118	270	19	4		3	12		160	387	2				2	
119	277	4	2			2		161	387A	2				2	
120	279	9	1			8		162	1488	5	1			3	1
121	311	1				1		163	1551	13	1	12			
122	312	1					1	164	2620	6	1			5	
123	312A	0						165	2624	4	1			3	
124	312B	1				1		166	2646	4	2				2
125	313	5				5		167	2647	0					
126	313A	1				1		168	2648	0					
								Total		1205	285	102	50	742	26

(2) Bridge Condition

1) Outline of Bridges

The 168 roads including 25 roads which have no bridge on the roads are investigated in this study. 1,205 bridges are investigated through the survey. Bailey bridge type , wooden bridge type, steel bridge type, concrete bridge type including pre-stressed concrete bridge are identified in the Study.

2) Number of bridges and traffic lanes

Many wooden bridges and Bailey bridges have been replaced to concrete bridge or box culvert compared with bridge inventory of 2006. Total number of bridges in 2012 is reduced to 1,205 compared to 1,337 in 2006 because large numbers of wooden bridges have been replaced with box culverts and box culverts were not counted in this survey. Many bridges are improved from one lane to two lanes. Summary of the data for each type of bridge and traffic lane are shown in Table 3-28.

Table 3-28 Summary of Bridge Type

Road Classification	Surveyed Year	Bridge type						Total	Number of Traffic Lane	
		Bailey	Wood	Steel	Concrete	Stone	Other		Single	Double
2-digit	2006	204	244	43	100	8	0	599	512	87
	2012	232	35	31	360	0	10	668	295	364
3-digit	2006	185	214	42	281			722	680	42
	2012	47	56	19	368		15	505	310	180
4-digit	2006	2	4		10			16	12	4
	2012	6	12		11		3	32	19	10
Sub total	2006	391	462	85	391	8	0	1337	1204	133
	2012	285	103	50	739	0	28	1205	624	554

Note: Other means under construction

3) Relevant data in the bridge inventory

Based on the data collected through the bridge inspection, relevant information of each bridge could be extracted as data list from the data base. Those are coordinates of the location of bridge, bridge type, bridge length, girder type, number of spans, bridge width. The list of bridge information is shown in Table 3-29 and Appendix.

Table 3-29 Bridge Information (Sample)

Road		North latitude			East longitude			Bridge type	Bridge Length (m)	Girder type	Number of span	Number of Lane	Width of Cross Sections (cm)
Number	No	°	'	''	°	'	''						
11	1	11	19	18.8	105	17	15.1	Concrete	144	Girder	6	2	1106
11	2	11	23	23.3	105	19	58.6	Steel	80	Truss	3	1	630
11	3	11	23	58.1	105	20	25.1	Steel	80	Truss	3	1	630
11	4	11	26	16.4	105	21	6.6	Concrete	42	Girder	3	2	1000
11	5	11	26	48.9	105	21	15.3	Steel	42	Girder	3	1	543
11	6	11	28	26.0	105	20	40.5	Steel	84	Girder	6	1	540
11	7	11	28	51.7	105	20	25.7	Steel	54	Girder	5	1	495
11	8	11	29	54.7	105	20	18.5	Bailey	18	Truss	1	1	505
11	9	11	30	17.5	105	20	36.9	Concrete	16	Girder	1	2	948
11	10	11	32	17.3	105	22	47.4	Bailey	42	Truss	2	2	862
11	11	11	32	56.9	105	23	38.3	Concrete	30	Girder	5	2	800
11	12	11	33	9.4	105	23	55.8	Bailey	43	Truss	2	2	510
11	13	11	33	32.4	105	24	27.8	Steel	48	Girder	4	1	479
11	14	11	43	51.5	105	27	53.1	Bailey	28	Truss	1	2	990
11	15	11	44	11.6	105	28	0.8	Concrete	19	Girder	4	2	650
11	16	11	44	33.5	105	28	9.2	Concrete	47	Girder	3	2	974
11	17	11	44	49.4	105	28	15.6	Steel	24	Girder	2	1	485
11	18	11	45	52.0	105	28	41.3	Steel	27	Girder	2	1	542
13	1	11	5	34.4	105	49	9.0	Concrete	5	Girder	2	2	768
13	2	11	6	10.3	105	49	10.1	Concrete	7	Slab	1	1	500
13	3	11	9	10.5	105	49	27.5	Concrete	7	Slab	1	1	390
13	4	11	9	30.7	105	49	22.5	Bailey	27	Truss	2	1	510
13	5	11	11	15.4	105	49	3.2	Bailey	12	Truss	1	1	460
13	6	11	17	46.6	105	49	41.6	Steel	36	Girder	3	1	480
13	7	11	23	12.1	105	48	8.7	Concrete	9	Slab	3	2	800
13	8	11	25	25.0	105	47	52.6	Bailey	84	Truss	4	1	524

4) Condition of the target bridges

The Study Team investigated bridge deficiencies and damage of bridges suffered by the flooding of 2011. The concrete deck on some of bridges has been badly deteriorated as shown in Photo 3-17. The foundation is scored and the cracks appeared on the wing wall of abutment of the bridge located on NR64 as shown in Photo 3-18

Photo 3-17 Bridge on NR21

Photo 3-18 Bridge on NR64

Approach road has been washed away at the back of the abutment by the flooding of 2011. The traffic could not pass on the bridge on PR312B as shown Photo 3-19. The water level over the bridge reaches about 6m from the elevation on the deck during the rainy season. The bridge is located on PR265C along the Tonle Sap as shown in Photo 3-20

Photo 3-19 Bridge on PR312B

Photo 3-20Bridge on PR265C

5) Structure on the target roads

Structures other than the bridge are out of scope of the study however the Study Team investigated some box culverts, water gates and causeways as those structures may be replaced with bridges. Box culvert on PR264D is shown in Photo 3-21, water gate on PR154A is shown in Photo 3-22, and causeway on PR266E is shown in Photo 3-23.

Photo 3-21 Box Culvert

Photo 3-22 Water Gate

Photo 3-23 Causeway

(3) Selection of Bridge Replacement

The bridges are classified into following types of bridge according to the bridge inspection survey. Those types of bridge shall be classified into a group of permanent, temporally, over flow and one lane bridge for bridge replacement plan as shown in Table 3-30. The groups of bridge which should be replaced with permanent bridge are temporary, over flow and one lane bridge excluding the bridge length less than 7m.

1) Permanent bridge including steel bridge, concrete bridge, and bridge under construction and committed
2) Temporary bridge including wooden bridge bailey bridge, steel bridge concrete bridge and bridge condition of grade 3
3) Bridges over flow by flood water
4) One lane bridge of steel and concrete bridge
5) Bridges which length less than 7m

Table 3-30 Classification of bridge

Group of Classification	Num. of Bridge	Type of Bridge				
Permanent Bridge	903	Steel	Concrete	Under construction		
Temporally Bridge	116	Wooden	Bailey	Temporary steel	Temporary concrete	Bridge of grade 3
Bridge over flow by a flood	25	Overflow on deck	HWL reach to girder			
One Lane Bridge	78	Concrete				
Bridge length less than 7m	83	Temporally Bridge	Over flow Bridge	One Lane Bridge		
Total	1205					

CHAPTER 4

TRAFFIC COUNT SURVEY

4. TRAFFIC COUNT SURVEY

4.1 Outline of Traffic Count Survey

The traffic count survey was carried out for determining the characteristics of the road traffic on the target roads and the survey results are used for the evaluation for the priority of the target roads. The MPWT issued the permission for the traffic survey in the Study area. The traffic survey was carried out by the local company.

(1) Type and Location of Traffic Survey

Traffic count surveys was carried out from April 2012 to July 2012. Scope of the traffic survey is as follows.

(2) Survey Hours

The survey periods were 12 hours from 6:00 in the morning to 18:00 in the evening (184 sites) and 24 hours from 6:00 in the morning to 6:00 in the morning of the following day (9 Sites).

(3) Survey Days

The traffic count survey was performed on weekdays excluding public holidays.

(4) Vehicle classifications

The types of vehicles for the counting are classified into the following eleven (11) categories.

1) Motorcycle
2) Motor Cycle + Trailer
3) Car and Taxi
4) 4 WD/Pick Up
5) Passenger Van and Mini Bus
6) Bus
7) Light Commercial and 2 axle Truck
8) 3 axle Truck
9) 4 and 5 axle Truck
10) 4,5,6&7 axle Trailer
11) Ox Cart & Etan

(5) Survey Method

The numbers of vehicles running on the roads were counted in each direction of traffic.

Basic survey methods of the traffic count were as follows.

1) The survey group led by the supervisor, sets up a survey point at each location.

2) Surveyors continuously count the number of vehicles by direction and by vehicle type at roadsides.
3) Surveyors count the number of vehicles at roadsides manually or using traffic counters.
4) Surveyors record the number of vehicles by direction and by vehicle type from traffic counters on a survey sheet every one hour.

   The survey sheet includes count station, date, time, weather, PK, GPS (E, N), direction, surveyor name and 11 types of vehicles and 4 rows for recording traffic volume at every 15-minute interval. The survey sheet is shown in the Appendix.

(6) Location of Traffic Count Survey

The number of survey roads and sites are shown below. A site on PR2648 had no traffic during the survey period due to the rainy season. Traffic count survey was carried out based on previous traffic count survey locations chosen by the HEC. However, according to the results of survey site checking, a few roads were duplicated and/or missing

Table 4-1 The Number of Survey Roads and Sites

Category	The number of roads	The number of survey sites
2- digit Roads	29	63
3- digit Roads	122	124
4- digit Roads	7	7
Total	158	194

Source: Study team
Note: The number includes PR2648 survey site, but there is no traffic in rainy season

Survey site list is shown in Table 4-2.

Table 4-2 Survey Site Number, Location and Period

Survey Site No.	Survey Location		Survey Period
	Longitude	Latitude	
11-1	105d16'53"	11d17'18"	12 hours
11-2	105d25'32"	11d36'01"	12 hours
11-3	105d28'53"	11d46'20"	12 hours
11-4	105d32'55"	11d53'13"	12 hours
13	105d49'09"	11d06'22"	**24 hours**
21-1	105d00'16"	11d23'42"	12 hours
21-2	105d03'22"	11d05'42"	12 hours
31-1	104d39'13"	10d56'19"	12 hours
31-2	104d39'34"	10d47'43"	12 hours
31-3	104d34'21"	10d41'52"	12 hours
33	104d21'45"	10d31'38"	12 hours
41	104d39'44"	11d28'55"	**24 hours**
42	104d45'04"	11d31'39"	12 hours
43-1	104d13'35"	11d16'31"	12 hours
43-2	104d17'04"	10d43'37"	12 hours
44	104d28'13"	11d29'52"	12 hours
46	104d10'24"	11d17'11"	12 hours
48-1	103d48'00"	11d05'00"	12 hours
48-2	103d26'34"	11d10'27"	**24 hours**
48-3	102d56'50"	11d38'09"	12 hours
51-1	104d45'01"	11d48'21"	12 hours
51-2	104d39'54"	11d30'16"	12 hours
53	104d38'29"	12d13'43"	12 hours
55	103d47'35"	12d28'25"	12 hours
56-1	102d58'13"	13d35'56"	12 hours
56-2	103d03'03"	13d56'05"	12 hours
56-3	103d29'36"	14d10'17"	12 hours
57-1	103d08'53"	13d03'27"	12 hours
57-2	102d54'25"	12d49'56"	12 hours
57-3	102d48'44"	12d51'08"	12 hours
57-4	102d39'34"	12d48'44"	12 hours
59-1	102d39'08"	13d37'17"	12 hours
59-2	102d21'42"	13d26'47"	12 hours
59-3	102d21'04"	13d21'50"	12 hours
59-4	102d27'47"	13d05'07"	12 hours
60	105d09'11"	12d09'50"	12 hours
62-1	104d55'18"	12d46'15"	12 hours
62-2	105d01'44"	13d30'17"	12 hours
62-3	104d58'37"	13d45'52"	12 hours
62-4	104d47'09"	14d06'09"	12 hours
63	103d51'12"	13d20'32"	12 hours
64-1	104d07'35"	13d15'22"	12 hours
64-2	104d44'00"	13d49'07"	12 hours
66-1	104d00'16"	13d21'37"	12 hours
66-2	103d59'09"	13d37'05"	12 hours
66-3	104d04'40"	14d14'58"	12 hours
68-1	103d28'22"	13d38'36"	12 hours
68-2	103d31'16"	13d51'05"	12 hours
68-3	103d30'57"	14d10'08"	12 hours
68-4	103d32'03"	14d12'18"	12 hours
70	105d15'31"	12d02'54"	12 hours
71-1	105d21'16"	12d04'14"	12 hours
71-2	105d15'26"	12d20'02"	12 hours
71-3	105d09'49"	12d27'36"	12 hours
72	105d56'42"	11d45'35"	12 hours
73-1	105d45'47"	11d51'24"	12 hours
73-2	105d57'52"	12d14'37"	12 hours
76-1	106d28'34"	12d02'58"	12 hours
76-2	106d52'51"	12d06'44"	12 hours
76-3	107d11'14"	12d27'15"	12 hours
78-1	106d05'19"	13d26'27"	12 hours
78-2	106d55'42"	13d40'22"	12 hours
78-3	107d00'29"	13d44'35"	12 hours
110	104d57'42"	11d28'18"	12 hours
114	104d59'38"	11d31'43"	12 hours
118A	105d16'12"	11d15'13"	**24 hours**
121	104d49'52"	11d15'58"	12 hours
124	104d45'30"	11d08'49"	12 hours
126	104d40'13"	10d46'39"	12 hours
129	104d46'44"	11d08'41"	12 hours
129C	104d47'31"	10d51'48"	12 hours
130-1	104d46'16"	11d24'17"	12 hours
130-2	104d32'52"	11d26'45"	12 hours
132	104d39'59"	11d00'48"	12 hours
133A	104d29'17"	10d48'20"	12 hours
134	104d35'08"	10d55'10"	12 hours
134A	104d28'01"	10d50'43"	12 hours
134B	104d27'06"	10d50'52"	12 hours
135	104d26'44"	10d49'11"	12 hours
136	104d12'05"	10d39'51"	12 hours
137	104d22'24"	10d46'03"	12 hours
138	104d09'50"	10d37'36"	12 hours
140	104d21'45"	11d24'20"	12 hours
147	104d30'38"	11d23'04"	12 hours
151B	104d42'58"	11d48'13"	12 hours
152	104d44'39"	12d03'47"	12 hours
152D	104d06'32"	12d31'58"	12 hours
152E	104d04'59"	12d32'55"	12 hours
152F	104d02'13"	12d33'13"	12 hours
152G	103d59'23"	12d32'04"	12 hours
152H	103d55'29"	12d32'00"	12 hours
153	104d41'44"	11d56'48"	12 hours
153A	104d38'09"	12d08'34"	12 hours
153B	104d35'20"	12d15'23"	12 hours
153C	104d33'44"	12d16'18"	12 hours
154	103d55'46"	12d33'21"	12 hours
154A	103d53'14"	12d33'01"	12 hours
154B	103d49'11"	12d35'19"	12 hours
154C	103d47'03"	12d36'20"	12 hours
154E	103d40'20"	12d40'28"	12 hours
154F	103d38'36"	12d40'44"	12 hours
155	103d48'45"	12d24'23"	12 hours
155A	103d53'32"	12d30'05"	12 hours
155B	103d50'26"	12d33'28"	12 hours
155C	103d46'24"	12d35'18"	12 hours
155D	103d40'59"	12d34'58"	12 hours
155E	103d34'35"	12d41'59"	12 hours
155F	103d25'06"	12d45'30"	12 hours
156	103d13'15"	13d08'17"	12 hours
156A	103d12'52"	13d07'51"	12 hours
156C	103d02'13"	13d28'06"	12 hours
156D	103d03'09"	13d32'30"	12 hours
157	103d21'07"	12d52'56"	12 hours
157A	103d18'45"	12d58'34"	12 hours
157B	103d15'59"	13d02'05"	12 hours
157C	103d13'01"	13d03'03"	12 hours
159B	103d01'34"	13d21'26"	12 hours
159D	102d40'40"	13d37'10"	12 hours
258D	102d45'53"	13d37'04"	12 hours
260	104d59'22"	11d50'39"	12 hours
260A	104d57'13"	11d59'42"	12 hours
261	104d57'18"	11d50'06"	12 hours
264	105d12'21"	12d15'42"	12 hours
264A	105d07'35"	12d20'18"	12 hours
264B-1	105d09'05"	12d32'14"	**24 hours**
264B-2	105d58'55"	12d21'32"	12 hours
264C	105d03'16"	12d34'37"	12 hours
264D	104d36'06"	12d56'11"	12 hours
264E	104d34'45"	12d57'06"	**24 hours**
265	104d33'28"	12d56'19"	12 hours
265B	104d19'20"	13d06'40"	12 hours
265C	104d08'15"	13d12'59"	12 hours
265E	103d59'46"	13d18'51"	12 hours
266	104d20'36"	13d08'46"	12 hours
266A	104d20'05"	13d08'24"	12 hours
266B	104d01'08"	13d20'44"	12 hours
266C	103d55'47"	13d24'13"	12 hours
266D	103d44'19"	13d27'07"	12 hours
266E	103d43'45"	13d27'18"	12 hours
266F	103d36'40"	13d31'40"	12 hours
267	103d50'14"	13d20'35"	12 hours
268A	103d16'56"	13d37'35"	12 hours
268B	103d02'44"	13d38'39"	12 hours
269	103d25'03"	13d34'34"	12 hours
270	105d25'25"	11d57'30"	12 hours
277	105d27'22"	12d00'08"	12 hours
279	105d27'57"	12d00'15"	12 hours
311	105d21'25"	11d13'58"	12 hours
312	105d23'21"	11d10'09"	12 hours
312A	105d23'55"	11d10'26"	12 hours
312B	105d33'33"	11d07'11"	12 hours
313	105d31'33"	11d10'06"	12 hours
313A	105d36'22"	11d09'33"	12 hours
314	105d44'02"	11d05'55"	12 hours
314A	105d46'24"	11d04'08"	12 hours
314B	105d45'19"	11d04'03"	12 hours
314C	105d48'56"	11d03'41"	12 hours
314D	105d53'48"	11d01'29"	12 hours
316A	106d01'19"	11d01'51"	12 hours
317	105d51'23"	11d04'45"	12 hours
317A	105d56'08"	11d04'08"	12 hours
317B	106d00'16"	11d02'37"	12 hours
317C	106d02'20"	11d03'12"	12 hours
319	106d04'08"	11d03'47"	12 hours
370A	105d43'23"	11d50'59"	12 hours
370C	105d49'13"	11d46'07"	12 hours
371	105d28'30"	11d59'15"	12 hours
371D	105d44'22"	11d52'06"	12 hours
372A	106d17'44"	11d49'51"	12 hours
373A	105d51'43"	11d49'41"	12 hours
373B	106d05'14"	11d51'33"	12 hours
373C	106d10'48"	11d50'42"	12 hours
373D	106d23'34"	12d00'40"	12 hours
374	106d28'15"	12d10'38"	12 hours
375	106d17'58"	12d17'02"	12 hours
376	106d23'57"	12d18'37"	12 hours
377	106d01'16"	12d37'17"	12 hours
377A	106d06'05"	12d43'34"	12 hours
377B	106d10'23"	12d50'37"	12 hours
378	106d07'20"	13d54'15"	12 hours
380	104d59'45"	11d44'05"	12 hours
380A	105d06'15"	11d40'06"	12 hours
381	105d01'25"	11d46'50"	12 hours
382	105d06'41"	11d38'15"	12 hours
383	105d02'48"	11d43'30"	12 hours
387	105d35'06"	11d35'15"	12 hours
387A	105d41'05"	11d37'23"	12 hours
1488	103d00'59"	11d37'08"	**24 hours**
1551	103d06'44"	12d13'54"	12 hours
2620	104d57'22"	12d50'12"	**24 hours**
2624	105d02'36"	13d18'42"	12 hours
2646	105d24'17"	13d45'51"	12 hours
2647	105d26'18"	13d47'09"	**24 hours**
2648	105d56'08"	13d33'33"	-

Source: Study team

Locations of traffic count surveys are shown in Figure 4-1.

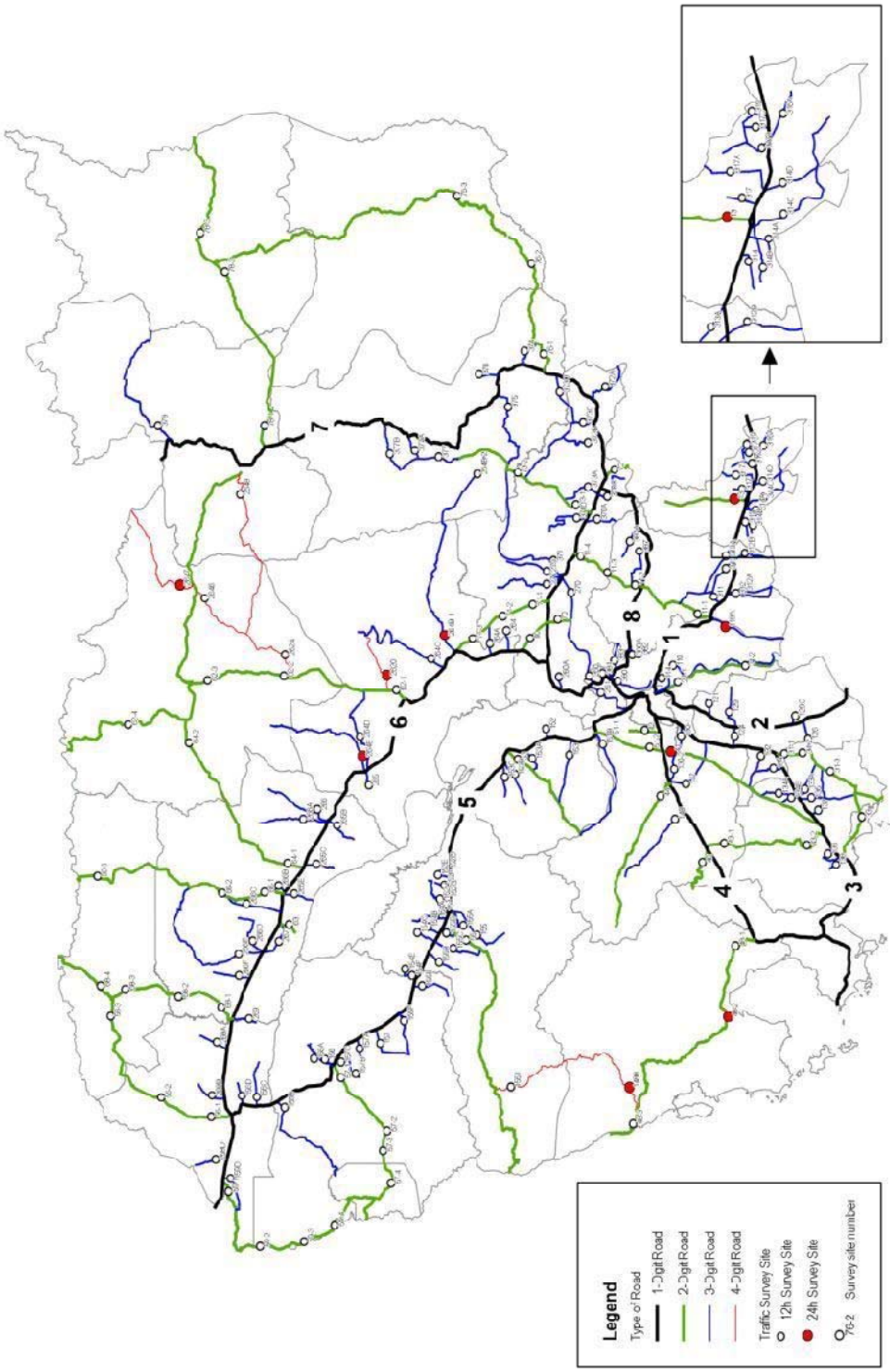


Figure 4-1 Survey Site Locations

4.2 Characteristics of Road Traffic at Traffic Count Survey Sites

(1) Result of Survey

1) 12-hour traffic volume by Vehicle Type

12-hour traffic volume by vehicle type is shown in Table 4-3.

Table 4-3 12 hour Traffic Volume (Unit: Vehicle)

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
11-1	5390	4093	236	218	183	107	50	203	172	71	33	24
11-2	4106	2397	153	233	388	474	18	224	95	54	26	44
11-3	3678	1959	122	226	382	440	9	239	195	54	23	29
11-4	5199	2874	239	374	531	531	32	333	179	49	36	21
13	2725	2246	63	95	114	76	1	62	12	0	2	54
21-1	13041	9928	742	528	362	683	12	664	57	16	6	43
21-2	6779	5324	153	166	131	483	0	406	39	12	1	64
31-1	2801	1546	90	188	257	373	25	193	24	21	69	15
31-2	4287	3146	103	167	150	343	24	202	28	26	71	27
31-3	2322	1398	43	172	158	228	21	162	23	20	88	9
33	3648	2605	73	261	237	219	15	180	7	16	24	11
41	6967	5546	230	166	141	150	14	525	97	31	63	4
42	1680	1479	83	12	17	9	0	77	0	0	0	3
43-1	1291	1101	24	14	46	21	0	42	11	6	1	25
43-2	816	580	56	15	43	16	0	48	24	6	9	19
44	1544	1009	161	70	65	101	2	68	21	8	12	27
46	1059	856	37	55	40	16	1	38	3	0	0	13
48-1	2081	1014	23	294	204	230	33	97	32	46	106	2
48-2	1097	486	4	176	137	132	21	48	47	18	22	6
48-3	2980	2114	56	229	272	133	11	80	50	10	25	0
51-1	4981	3607	339	237	107	154	1	344	16	112	49	15
51-2	7558	5428	529	317	225	254	10	594	35	46	103	17
53	2684	2031	110	100	27	47	1	340	0	2	2	24
55	1122	917	26	39	22	21	0	45	8	16	1	27
56-1	10733	7398	233	1458	958	100	12	264	80	88	20	122
56-2	2460	1594	11	307	141	14	0	68	30	51	6	238
56-3	1303	808	15	98	98	11	0	14	8	1	0	250
57-1	6479	4041	274	804	550	114	19	218	282	41	4	132
57-2	3375	2052	51	493	356	83	17	125	48	15	0	135
57-3	2297	1065	25	399	266	56	15	80	290	24	1	76
57-4	2836	1826	29	420	302	37	15	71	43	26	21	46
59-1	182	181	0	0	0	0	0	0	0	0	0	1
59-2	3,711	2,803	150	339	166	19	2	69	88	8	0	67
59-3	1,570	1,151	43	145	122	21	0	39	19	7	3	20
59-4	5,501	4,321	77	426	312	55	9	90	72	28	2	109
60	821	462	82	45	48	54	2	53	51	12	3	9
62-1	3,139	2,053	110	180	284	154	27	165	47	27	33	59
62-2	895	453	6	84	194	73	8	35	18	6	5	13
62-3	2,381	1,773	84	118	213	75	8	33	40	5	8	24
62-4	492	211	7	64	93	49	11	20	15	3	4	15
63	10,957	8,811	770	526	383	156	64	161	63	5	0	18
64-1	4,718	3,825	287	138	168	89	41	62	15	3	0	90

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
64-2	781	490	24	55	77	31	0	28	10	4	4	58
66-1	1,617	1,061	75	86	130	34	15	55	109	23	1	28
66-2	2,573	1,443	152	323	262	135	13	111	40	15	1	78
66-3	2,506	1,747	34	301	280	33	0	43	7	0	0	61
68-1	1,501	919	6	198	191	16	2	33	8	7	5	116
68-2	1,345	827	7	205	131	28	3	44	9	5	0	86
68-3	2,723	1,949	32	258	183	24	3	33	25	6	1	209
68-4	2,148	1,540	48	236	157	8	1	36	7	1	0	114
70	4,084	3,478	163	86	63	107	5	137	26	3	6	10
71-1	3,281	1,845	125	259	274	303	91	157	102	42	65	18
71-2	3,410	2,392	125	182	178	147	12	92	80	38	42	122
71-3	2,042	1,161	109	141	133	134	8	66	80	24	41	145
72	5,457	4,283	196	247	279	93	4	132	94	39	34	56
73-1	2,450	951	65	188	337	444	13	306	40	43	17	46
73-2	3,952	2,563	84	243	221	405	14	134	109	32	4	143
76-1	2,044	1,249	24	176	226	247	6	68	16	2	6	24
76-2	2,977	2,218	30	210	205	202	9	41	18	13	2	29
76-3	4,818	3,862	17	275	481	108	5	47	18	4	0	1
78-1	1,194	649	9	69	191	150	8	58	21	22	8	9
78-2	1,336	850	16	77	173	129	7	54	13	2	2	13
78-3	4,461	3,366	50	179	504	166	3	96	42	8	5	42
110	6826	5366	537	199	198	122	0	381	16	7	0	0
114	2621	1991	95	151	158	45	5	158	15	3	0	0
118A	3259	2719	163	117	59	75	3	74	18	3	1	27
121	1145	1078	15	5	8	3	1	27	1	0	0	7
124	1172	1028	52	8	12	22	0	39	0	2	0	9
126	1698	1413	62	27	20	26	0	62	14	35	11	28
129	3123	2589	92	78	104	79	0	158	4	3	9	7
129C	761	714	13	6	3	19	0	3	0	0	0	3
130-1	1758	1343	43	24	33	12	0	111	30	135	27	0
130-2	1414	1242	69	19	11	7	0	24	5	0	0	37
132	4622	4026	147	114	87	107	0	122	6	1	4	8
133A	1198	1081	35	12	13	22	0	27	0	0	0	8
134	1368	1266	36	20	10	10	0	19	0	0	0	7
134A	1252	1180	23	4	1	8	0	34	1	0	0	1
134B	2233	1930	81	35	37	34	0	96	2	3	0	15
135	999	809	51	21	21	25	1	68	1	0	0	2
136	1103	947	52	6	8	4	0	70	3	0	1	12
137	364	337	12	0	1	2	0	0	0	0	0	12
138	5421	4587	92	164	183	58	0	325	3	2	4	3
140	1334	1184	39	12	6	9	0	29	0	0	0	55
147	1880	1568	57	46	53	36	0	81	31	3	0	5
151B	2466	2118	126	27	43	50	1	65	13	10	2	11
152	1216	981	46	10	23	33	0	63	27	0	0	33
152D	311	281	16	2	0	1	0	0	0	0	0	11
152E	372	334	16	2	3	5	0	2	0	0	0	10
152F	376	334	13	4	3	4	0	6	1	0	0	11
152G	212	196	4	2	0	4	0	2	0	0	0	4
152H	599	568	13	7	3	0	0	4	0	0	0	4
153	1241	1005	63	19	27	23	0	75	3	0	0	26
153A	1351	1102	84	34	15	13	1	81	1	1	0	19

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
153B	1265	1007	43	37	11	7	4	76	0	0	0	80
153C	1239	983	44	21	11	5	0	53	2	0	0	120
154	4336	3712	158	109	142	29	0	174	3	5	0	4
154A	1161	1032	40	29	15	8	0	9	0	0	0	28
154B	571	511	21	2	13	0	0	4	3	0	0	17
154C	1300	1182	38	5	6	4	0	23	2	0	0	40
154E	1431	1189	56	33	7	9	2	40	1	2	0	92
154F	812	715	27	5	5	2	0	7	0	0	0	51
155	1734	1241	43	198	150	30	0	52	2	4	0	14
155A	842	720	27	11	8	3	0	44	0	0	0	29
155B	641	579	21	5	5	0	0	2	0	0	0	29
155C	1468	1298	29	9	28	3	0	28	3	0	0	70
155D	1454	1226	17	28	27	13	0	41	30	3	0	69
155E	447	423	9	1	2	0	0	2	0	0	0	10
155F	856	722	14	0	0	0	0	9	0	0	0	111
156	1628	1441	64	33	31	9	0	32	6	0	0	12
156A	9070	7875	437	368	213	38	0	53	22	3	3	58
156C	1551	1320	28	37	45	9	0	28	19	1	0	64
156D	1799	1576	53	52	16	8	0	26	6	0	0	62
157	927	689	18	42	74	13	0	38	11	1	3	38
157A	481	403	14	11	1	5	0	32	4	1	1	9
157B	1405	1267	43	17	18	5	0	22	4	0	1	28
157C	955	900	11	5	10	4	0	5	6	0	0	14
159B	926	754	23	39	24	4	0	15	8	2	1	56
159D	1777	995	29	281	205	17	0	51	96	11	4	88
258D	1307	868	31	135	85	5	0	28	23	24	15	93
260	5270	4240	153	182	132	142	6	195	149	7	1	63
260A	899	851	5	4	3	9	0	20	0	0	0	7
261	820	733	11	2	9	9	0	19	23	10	0	4
264	1282	1073	42	17	11	21	0	21	12	5	0	80
264A	2761	2366	149	32	34	49	0	55	18	0	1	57
264B-1	1615	1055	102	37	80	69	2	86	14	5	3	162
264B-2	1345	1174	15	8	31	3	0	39	29	7	0	39
264C	357	305	15	6	0	2	0	3	0	0	0	26
264D	1639	1510	24	12	12	6	0	37	0	0	0	38
264E	884	813	6	15	11	11	0	13	5	0	0	10
265	1332	1202	35	10	15	8	0	15	1	2	0	44
265B	1465	1240	71	41	31	10	0	19	8	2	0	43
265C	2829	2139	168	51	72	19	9	59	216	11	0	85
265E	2145	1874	120	55	40	7	3	25	2	0	0	19
266	1094	942	35	12	47	2	0	15	1	0	0	40
266A	1418	1218	68	11	41	3	0	13	33	0	0	31
266B	1961	1677	112	52	40	36	0	23	10	0	0	11
266C	3491	1907	351	383	325	258	97	92	34	5	0	39
266D	1838	1377	33	8	21	2	0	23	59	0	0	315
266E	2117	1942	34	9	26	2	6	35	1	0	0	62
266F	1216	920	29	52	73	14	0	48	11	4	1	64
267	7287	6055	436	233	218	71	19	168	27	4	0	56
268A	254	182	0	21	11	2	0	17	4	5	0	12
268B	813	681	11	16	17	0	0	10	2	0	0	76
269	1692	1536	20	25	29	6	1	22	2	0	0	51

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
270	3928	3498	121	37	54	52	0	149	2	0	0	15
277	8076	7343	233	146	108	88	1	120	15	10	0	12
277-2	907	859	21	1	2	2	0	20	2	0	0	0
279	5935	5117	233	129	138	169	6	99	14	2	0	28
311	2281	1671	82	43	70	91	2	160	91	66	0	5
312	1689	1358	59	45	50	47	0	52	61	3	4	10
312A	81	72	0	0	0	0	0	4	0	0	0	5
312B	1911	1788	13	15	32	27	0	18	4	1	0	13
313	2015	1860	45	8	19	42	0	29	7	1	0	4
313A	243	235	3	1	0	1	0	1	0	0	0	2
314	889	855	5	0	1	14	0	4	0	0	0	10
314A	405	380	11	0	5	0	0	2	0	0	0	7
314B	1615	1483	28	13	33	11	0	22	4	0	0	21
314C	1717	1579	37	29	10	10	0	18	5	1	0	28
314D	1078	870	26	44	23	23	0	35	18	8	16	15
316A	1891	1625	54	40	37	18	0	72	10	1	2	32
317	823	674	25	32	15	26	0	32	0	0	0	19
317A	334	320	3	7	1	0	0	2	0	0	0	1
317B	1138	1057	9	6	5	6	0	18	1	0	0	36
317C	356	300	4	3	7	3	0	20	0	0	0	19
319	576	538	16	1	1	0	0	8	0	0	0	12
370A	1008	926	21	13	13	10	0	19	0	0	0	6
370C	973	855	14	0	29	5	0	38	6	1	0	25
371	1692	1615	44	4	9	6	0	8	0	0	0	6
371D	1141	1029	27	10	17	20	0	19	0	0	0	19
372A	1150	896	15	44	114	26	1	27	15	7	1	4
373A	988	910	7	6	13	3	0	27	1	0	0	21
373B	1028	809	21	15	112	8	0	41	12	2	0	8
373C	3495	3062	52	65	116	31	0	60	12	0	0	97
373D	844	781	10	10	17	3	0	5	5	0	0	13
374	850	793	3	6	12	16	0	7	0	0	0	13
375	1093	930	12	22	41	36	0	30	3	0	0	19
376	871	691	9	26	23	100	0	8	1	4	0	9
377	1762	1340	32	123	106	86	0	50	4	1	0	20
377A	904	751	25	25	36	27	1	23	3	0	0	13
377B	110	103	0	0	0	0	0	0	0	0	0	7
378	460	359	8	29	19	26	0	6	3	0	0	10
380	2035	1759	53	39	58	12	0	104	0	3	4	3
380A	1105	938	29	15	44	11	0	42	0	2	0	24
381	2841	2448	113	38	118	25	0	85	1	0	0	13
382	1449	1294	54	14	24	16	0	34	5	0	0	8
383	1226	912	54	5	41	13	0	58	72	53	14	4
387	214	211	1	0	0	0	0	0	0	0	0	2
387A	646	625	0	0	0	2	0	5	1	0	0	13
1488	228	120	0	44	49	3	0	7	1	1	3	0
1551	333	254	6	50	14	1	0	2	4	0	0	2
2620	740	449	10	54	72	82	9	38	4	7	1	14
2624	628	462	8	19	83	27	1	14	6	1	1	6
2646	644	611	1	0	5	0	0	4	0	0	0	23
2647	248	197	2	0	10	1	0	1	2	0	0	35
2648	-	-	-	-	-	-	-	-	-	-	-	-

Source: Study Team
Note: PR2648 is a cart road. There is no motorized vehicle traffic in the rainy season.

2) Expansion Factor

Twenty four hour traffic count survey were conducted at 9 locations (2-digit roads: 3 sites, 3-digit roads: 3 sites, 4-digit roads: 3 sites). The expansion factors for expanding 12-hour traffic volume to 24-traffic volume were calculated using the results of the 24 hour surveys. The 12/24-hour traffic volume at 9 locations are shown in Table 4-4.

Table 4-4 12/24 hour Traffic Volume at 24 hour Traffic Count Survey Sites

	24H Survey Station		Motorcycle	Motorcycle +Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial& 2axles truck	3 axle Truck	4&5 axle Truck	4,5,6&7 axle Trailer	Ox Cart & Etan	Total
2 digit Road	13	24H	2627	76	118	129	101	1	77	14	2	2	68	3215
		12H	2246	63	95	114	76	1	62	12	0	2	54	2725
		24/12H	1.17	1.21	1.24	1.13	1.33	1.00	1.24	1.17	-	1.00	1.26	1.18
	41	24H	6658	281	245	168	183	18	668	139	36	85	7	8488
		12H	5546	230	166	141	150	14	525	97	31	63	4	6967
		24/12H	1.20	1.22	1.48	1.19	1.22	1.29	1.27	1.43	1.16	1.35	1.75	1.22
	48-2	24H	598	8	208	180	183	21	70	100	32	39	6	1445
		12H	486	4	176	137	132	21	48	47	18	22	6	1097
		24/12H	1.23	2.00	1.18	1.31	1.39	1.00	1.46	2.13	1.78	1.77	1.00	1.32
3 digit Road	118A	24H	3186	213	145	69	84	3	96	20	7	1	29	3853
		12H	2719	163	117	59	75	3	74	18	3	1	27	3259
		24/12H	1.17	1.31	1.24	1.17	1.12	1.00	1.30	1.11	2.33	1.00	1.07	1.18
	264B-1	24H	1191	136	41	88	76	2	93	23	8	5	294	1957
		12H	1055	102	37	80	69	2	86	14	5	3	162	1615
		24/12H	1.13	1.33	1.11	1.10	1.10	1.00	1.08	1.64	1.60	1.67	1.81	1.21
	264E	24H	939	10	16	14	20	0	17	5	0	0	22	1043
		12H	813	6	15	11	11	0	13	5	0	0	10	884
		24/12H	1.15	1.67	1.07	1.27	1.82	-	1.31	1.00	-	-	2.20	1.18
4 digit Road	1488	24H	148	0	56	71	7	0	10	6	6	3	0	307
		12H	120	0	44	49	3	0	7	1	1	3	0	228
		24/12H	1.23	-	1.27	1.45	2.33	-	1.43	6.00	6.00	1.00	-	1.35
	2620	24H	542	11	65	78	84	9	46	6	7	1	18	867
		12H	449	10	54	72	82	9	38	4	7	1	14	740
		24/12H	1.21	1.10	1.20	1.08	1.02	1.00	1.21	1.50	1.00	1.00	1.29	1.17
	2647	24H	227	3	0	14	1	0	1	2	0	0	39	287
		12H	197	2	0	10	1	0	1	2	0	0	35	248
		24/12H	1.15	1.50	-	1.40	1.00	-	1.00	1.00	-	-	1.11	1.16

Source: Study Team
Note: Expansion Factor for "3 axle Truck" and "4&5 axle Truck" of PR1488 is too large, so it was not used for setting the average factor 4&5 axle Truck traffic volume at NR13 survey site of 12 hours and 24 hours are "0" and "2" respectively, so it was not used for setting the average factor

Average expansion factors of 3 categories of road class were calculated and adopted as expansion factors for same class of road. This is shown in Table 4-5.

The 12-hour traffic volume multiplied by the expansion factor is the 24-hour traffic volume.

Table 4-5 Traffic Volume Expansion Factors

Road Type	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axle truck	3 axle Truck	4&5 axle Truck	4,5, 6& 7 axle Trailer	Ox Cart & Etan	Total
2 digit	1.20	1.48	1.30	1.21	1.31	1.10	1.32	1.58	1.47	1.37	1.34	1.24
3 digit	1.15	1.44	1.14	1.18	1.35	1.00	1.23	1.25	1.97	1.33	1.70	1.19
4 digit	1.20	1.30	1.24	1.31	1.45	1.00	1.21	1.25	1.00	1.00	1.20	1.23

Source: Study Team

3) 24-hour traffic volume by Vehicle Type

The 24-hour traffic volumes using expansion factors are shown in Table 4-6. The table reveals that the NR21 is the busiest road with the daily traffic volume of 16,103 vehicles per day. The road with the smallest traffic volume is PR312A where the traffic volume is only 96 vehicles per day.

Table 4-6 24 hour Traffic Volume

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
11-1	6681	4912	348	283	222	140	55	269	271	104	45	32
11-2	5139	2877	226	303	470	622	20	297	150	79	36	59
11-3	4648	2351	180	294	463	577	10	316	307	79	32	39
11-4	6536	3449	353	486	644	697	35	441	282	72	49	28
13	3215	2627	76	118	129	101	1	77	14	2	2	68
21-1	16103	11916	1095	686	439	896	13	879	90	24	8	57
21-2	8329	6390	226	216	159	634	0	538	61	18	1	86
31-1	3501	1856	133	244	312	489	27	256	38	31	95	20
31-2	5286	3776	152	217	182	450	26	267	44	38	98	36
31-3	2892	1678	63	224	192	299	23	215	36	29	121	12
33	4485	3127	108	339	287	287	16	238	11	24	33	15
41	8488	6658	281	245	168	183	18	668	139	36	85	7
42	2053	1775	123	16	21	12	0	102	0	0	0	4
43-1	1574	1321	35	18	56	28	0	56	17	9	1	33
43-2	1019	696	83	19	52	21	0	64	38	9	12	25
44	1940	1211	238	91	79	132	2	90	33	12	16	36
46	1295	1027	55	71	48	21	1	50	5	0	0	17
48-1	2613	1217	34	382	247	302	36	128	50	68	146	3
48-2	1445	598	8	208	180	183	21	70	100	32	39	6
48-3	3668	2537	83	298	330	174	12	106	79	15	34	0
51-1	6203	4329	500	308	130	202	1	456	25	165	67	20
51-2	9400	6515	781	412	273	333	11	787	55	68	142	23
53	3314	2438	162	130	33	62	1	450	0	3	3	32
55	1379	1101	38	51	27	28	0	60	13	24	1	36
56-1	13218	8879	344	1895	1161	131	13	350	126	129	27	163
56-2	3055	1913	16	399	171	18	0	90	47	75	8	318
56-3	1619	970	22	127	119	14	0	19	13	1	0	334
57-1	8111	4850	404	1045	667	150	21	289	444	60	5	176
57-2	4183	2463	75	641	432	109	19	166	76	22	0	180
57-3	2946	1278	37	519	322	73	16	106	457	35	1	102
57-4	3502	2192	43	546	366	49	16	94	68	38	29	61
59-1	218	217	0	0	0	0	0	0	0	0	0	1

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
110	8078	6181	771	226	234	164	0	468	20	14	0	0
114	3073	2293	136	172	187	61	5	194	19	6	0	0
118A	3853	3186	213	145	69	84	3	96	20	7	1	29
121	1330	1242	22	6	9	4	1	33	1	0	0	12
124	1379	1184	75	9	14	30	0	48	0	4	0	15
126	2032	1628	89	31	24	35	0	76	18	69	15	47
129	3661	2982	132	89	123	106	0	194	5	6	12	12
129C	887	822	19	7	4	26	0	4	0	0	0	5
130-1	2167	1547	62	27	39	16	0	136	38	266	36	0
130-2	1672	1431	99	22	13	9	0	29	6	0	0	63
132	5404	4637	211	130	103	144	0	150	8	2	5	14
133A	1401	1245	50	14	15	30	0	33	0	0	0	14
134	1593	1458	52	23	12	13	0	23	0	0	0	12
134A	1454	1359	33	5	1	11	0	42	1	0	0	2
134B	2621	2223	116	40	44	46	0	118	3	6	0	25
135	1177	932	73	24	25	34	1	84	1	0	0	3
136	1298	1091	75	7	9	5	0	86	4	0	1	20
137	429	388	17	0	1	3	0	0	0	0	0	20
138	6314	5284	132	187	216	78	0	399	4	4	5	5
140	1582	1364	56	14	7	12	0	36	0	0	0	93
147	2204	1806	82	52	63	48	0	100	39	6	0	8
151B	2909	2440	181	31	51	67	1	80	16	20	3	19
152	1445	1130	66	11	27	44	0	77	34	0	0	56
152D	369	324	23	2	0	1	0	0	0	0	0	19
152E	440	385	23	2	4	7	0	2	0	0	0	17
152F	445	385	19	5	4	5	0	7	1	0	0	19
152G	248	226	6	2	0	5	0	2	0	0	0	7
152H	697	654	19	8	4	0	0	5	0	0	0	7
153	1473	1158	90	22	32	31	0	92	4	0	0	44
153A	1601	1269	121	39	18	18	1	100	1	2	0	32
153B	1519	1160	62	42	13	9	4	93	0	0	0	136
153C	1511	1132	63	24	13	7	0	65	3	0	0	204
154	5069	4276	227	124	168	39	0	214	4	10	0	7
154A	1366	1189	57	33	18	11	0	11	0	0	0	47
154B	674	589	30	2	15	0	0	5	4	0	0	29
154C	1534	1362	55	6	7	5	0	28	3	0	0	68
154E	1720	1370	80	38	8	12	2	49	1	4	0	156
154F	974	824	39	6	6	3	0	9	0	0	0	87
155	2032	1429	62	225	177	40	0	64	3	8	0	24
155A	997	829	39	13	9	4	0	54	0	0	0	49
155B	760	667	30	6	6	0	0	2	0	0	0	49
155C	1741	1495	42	10	33	4	0	34	4	0	0	119
155D	1729	1412	24	32	32	18	0	50	38	6	0	117
155E	522	487	13	1	2	0	0	2	0	0	0	17
155F	1051	832	20	0	0	0	0	11	0	0	0	188
156	1906	1660	92	38	37	12	0	39	8	0	0	20
156A	10620	9071	627	419	251	51	0	65	28	6	4	98
156C	1836	1520	40	42	53	12	0	34	24	2	0	109
156D	2125	1815	76	59	19	11	0	32	8	0	0	105
157	1104	794	26	48	87	18	0	47	14	2	4	64
157A	567	464	20	13	1	7	0	39	5	2	1	15
157B	1648	1459	62	19	21	7	0	27	5	0	1	47

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
157C	1114	1037	16	6	12	5	0	6	8	0	0	24
159B	1107	869	33	44	28	5	0	18	10	4	1	95
159D	2132	1146	42	320	242	23	0	63	120	22	5	149
258D	1594	1000	45	154	100	7	0	34	29	47	20	158
260	6212	4884	220	207	156	191	6	240	186	14	1	107
260A	1045	980	7	5	4	12	0	25	0	0	0	12
261	964	844	16	2	11	12	0	23	29	20	0	7
264	1543	1236	60	19	13	28	0	26	15	10	0	136
264A	3270	2725	214	36	40	66	0	68	23	0	1	97
264B-1	1957	1191	136	41	88	76	2	93	23	8	5	294
264B-2	1588	1352	22	9	37	4	0	48	36	14	0	66
264C	431	351	22	7	0	3	0	4	0	0	0	44
264D	1918	1739	34	14	14	8	0	45	0	0	0	64
264E	1043	939	10	16	14	20	0	17	5	0	0	22
265	1573	1385	50	11	18	11	0	18	1	4	0	75
265B	1737	1428	102	47	37	13	0	23	10	4	0	73
265C	3391	2464	241	58	85	26	9	72	270	22	0	144
265E	2519	2159	172	63	47	9	3	31	3	0	0	32
266	1294	1085	50	14	55	3	0	18	1	0	0	68
266A	1676	1403	98	13	48	4	0	16	41	0	0	53
266B	2307	1932	161	59	47	48	0	28	13	0	0	19
266C	4197	2197	504	436	384	347	97	113	43	10	0	66
266D	2306	1586	47	9	25	3	0	28	74	0	0	534
266E	2485	2237	49	10	31	3	6	43	1	0	0	105
266F	1457	1060	42	59	86	19	0	59	14	8	1	109
267	8581	6975	626	265	257	96	19	206	34	8	0	95
268A	306	210	0	24	13	3	0	21	5	10	0	20
268B	982	784	16	18	20	0	0	12	3	0	0	129
269	1986	1769	29	28	34	8	1	27	3	0	0	87
270	4590	4029	174	42	64	70	0	183	3	0	0	25
277	9411	8458	334	166	128	118	1	147	19	20	0	20
277-2	1052	988	30	1	2	3	0	25	3	0	0	0
279	6963	5894	334	147	163	228	6	122	18	4	0	47
311	2749	1925	118	49	83	123	2	197	114	130	0	8
312	1990	1564	85	51	59	63	0	64	76	6	5	17
312A	96	83	0	0	0	0	0	5	0	0	0	8
312B	2221	2060	19	17	38	36	0	22	5	2	0	22
313	2350	2143	65	9	22	57	0	36	9	2	0	7
313A	281	271	4	1	0	1	0	1	0	0	0	3
314	1034	985	7	0	1	19	0	5	0	0	0	17
314A	474	438	16	0	6	0	0	2	0	0	0	12
314B	1885	1708	40	15	39	15	0	27	5	0	0	36
314C	2007	1819	53	33	12	13	0	22	6	2	0	47
314D	1275	1002	37	50	27	31	0	43	23	16	21	25
316A	2224	1872	78	46	44	24	0	88	13	2	3	54
317	972	776	36	36	18	35	0	39	0	0	0	32
317A	386	369	4	8	1	0	0	2	0	0	0	2
317B	1336	1218	13	7	6	8	0	22	1	0	0	61
317C	424	346	6	3	8	4	0	25	0	0	0	32
319	675	620	23	1	1	0	0	10	0	0	0	20
370A	1173	1067	30	15	15	13	0	23	0	0	0	10
370C	1145	985	20	0	34	7	0	47	8	2	0	42

Survey Site No.	Total (Both Directions)	Motorcycle	Motorcycle + Trailer	Car & Taxi	4WD/ Pick Up	Passenger Van & Minibus	Bus	Light Commercial & 2axles truck	3 axles Truck	4&5 axles Truck	4,5,6&7 axles Trailer	Ox Cart & Etan
371	1967	1860	63	5	11	8	0	10	0	0	0	10
371D	1337	1185	39	11	20	27	0	23	0	0	0	32
372A	1349	1032	22	50	135	35	1	33	19	14	1	7
373A	1154	1048	10	7	15	4	0	33	1	0	0	36
373B	1205	932	30	17	132	11	0	50	15	4	0	14
373C	4109	3527	75	74	137	42	0	74	15	0	0	165
373D	983	900	14	11	20	4	0	6	6	0	0	22
374	991	913	4	7	14	22	0	9	0	0	0	22
375	1282	1071	17	25	48	48	0	37	4	0	0	32
376	1035	796	13	30	27	135	0	10	1	8	0	15
377	2073	1544	46	140	125	116	0	61	5	2	0	34
377A	1063	865	36	28	43	36	1	28	4	0	0	22
377B	131	119	0	0	0	0	0	0	0	0	0	12
378	543	414	11	33	22	35	0	7	4	0	0	17
380	2374	2026	76	44	68	16	0	128	0	6	5	5
380A	1303	1080	42	17	52	15	0	52	0	4	0	41
381	3325	2820	162	43	139	34	0	104	1	0	0	22
382	1697	1491	78	16	28	22	0	42	6	0	0	14
383	1492	1051	78	6	48	18	0	71	90	104	19	7
387	247	243	1	0	0	0	0	0	0	0	0	3
387A	752	720	0	0	0	3	0	6	1	0	0	22
387A	752	720	0	0	0	3	0	6	1	0	0	22
1488	307	148	0	56	71	7	0	10	6	6	3	0
1551	402	304	8	62	18	1	0	2	5	0	0	2
2620	867	542	11	65	78	84	9	46	6	7	1	18
2624	770	553	10	24	109	39	1	17	8	1	1	7
2646	773	732	1	0	7	0	0	5	0	0	0	28
2647	287	227	3	0	14	1	0	1	2	0	0	39

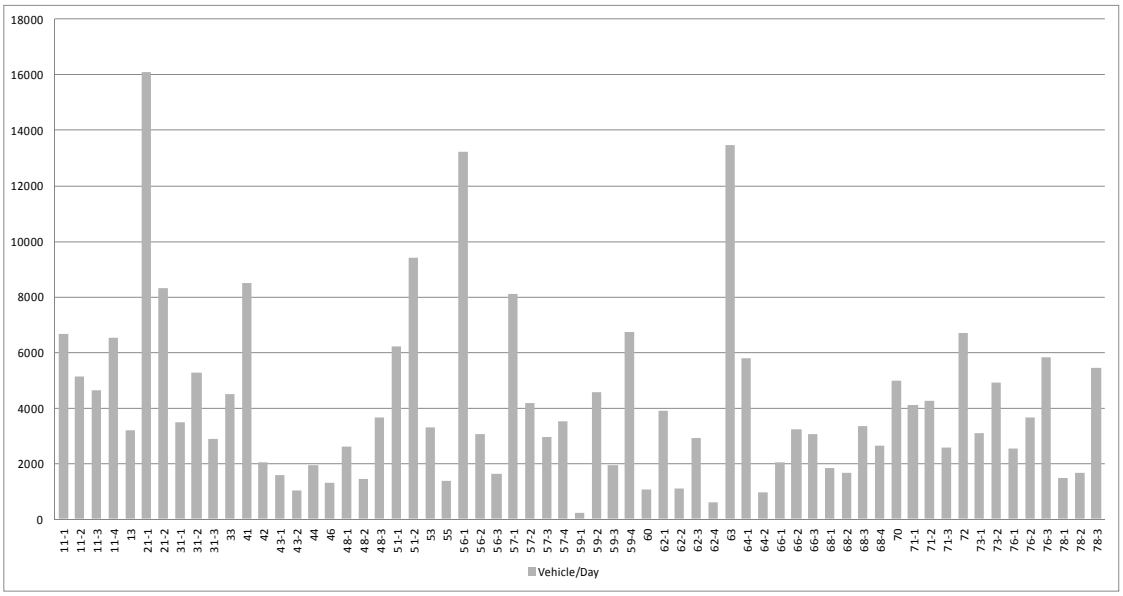
Source: Study Team

(2) Characteristics of Road Traffic at Traffic Count Survey Sites

1) Traffic Volume

Daily traffic volumes are shown in Figure 4-2 to Figure 4-4. Percentages of the number of roads with daily traffic volume less than 2000 vehicle/day in 2-, 3- and 4-digit roads are 27%, 70% and 100% respectively.

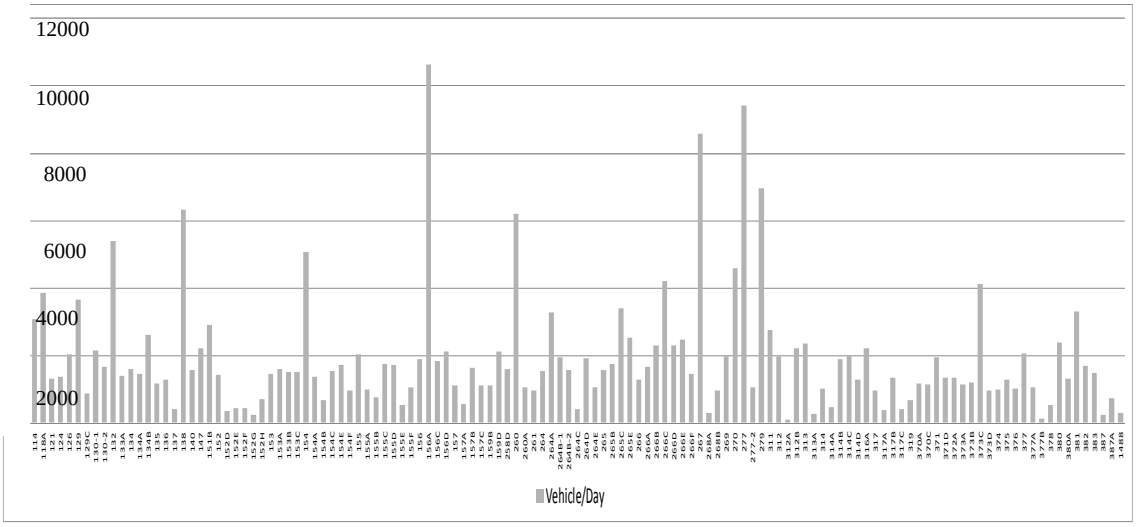
Unit: Vehicle/Day



Source: Study Team

Figure 4-2 Daily Traffic Volume on 2-Digit Roads

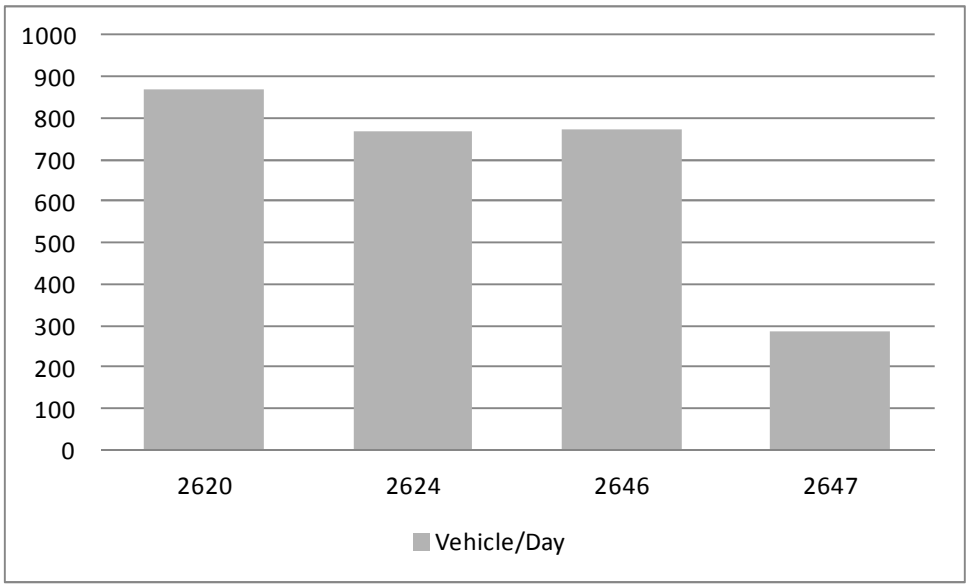
Unit: Vehicle/Day



Source: Study Team

Figure 4-3 Daily Traffic Volume on 3-Digit Roads

Unit: Vehicle/Day



Source: Study Team

Figure 4-4 Daily Traffic Volume on 4-Digit Roads

2) Traffic Composition at each Survey Station

The 11 vehicle types are put together into 4 groups.

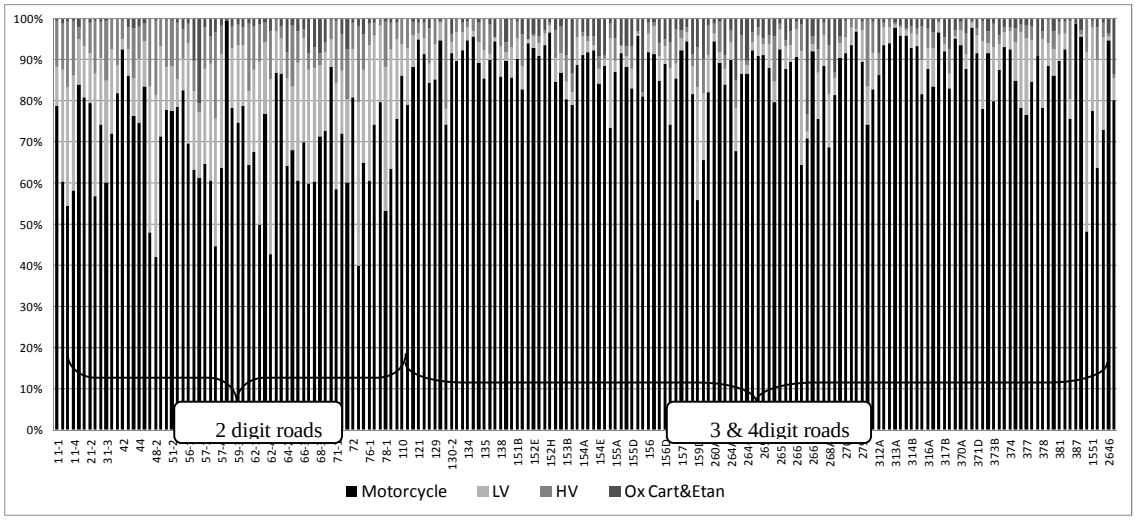
a) Motorcycle: Motorcycle, Motorcycle + Trailer

b) Light Vehicle (LV): Car + Taxi, 4WD/Pick Up, Passenger Van & Minibus

c) Heavy Vehicle (HV): Bus, Light Commercial & 2 axle truck

d) Other: Ox Cart & Etan

Percentages of motorcycles in the traffic are the highest at all sites. It seems that percentages of motorcycles on 2-digit roads are generally lower than on 3-and 4-digit roads.



Source: Study Team

Figure 4-5 Traffic Composition at each Survey Station

3) Comparison between Daytime Traffic and Daily Traffic

According to the expansion factors from 12-hour to 24-hour, heavy vehicle factors are higher than motorcycles and light vehicles. It seems that heavy vehicle activity in the night time is higher than the others.

Table 4-7 Expansion Factors from 12 Hour to 24 Hour Traffic Volume

Item	Motorcycle	Light Vehicle	Heavy Vehicle	Others
2-digit roads	1.20	1.27	1.41	1.34
3-digit roads	1.16	1.21	1.23	1.70
4-digit roads	1.20	1.28	1.42	1.20

Source: Study Team

4.3 Comparison between 2012 Survey Results and 2006 Survey Results

To understand the change of traffic flow on the road network, the traffic volume obtained through the study and that obtained through the "Study on Road Network Development in the Kingdom of Cambodia, 2006 by JICA (hereinafter referred to as the road network development plan) are compared in this section.

To enable an accurate comparison, it is necessary to classify the counted vehicles into common groups of similar vehicles in Cambodia. This is because vehicle categories are classified different in the Study compared to the road network development plan. The vehicle classifications are shown in Table 4-8

Table 4-8 Vehicle Classifications

Vehicle Classification		Vehicle Categories in Traffic Survey Count 2006		Vehicle Categories in Traffic Count Survey 2012	
I	Motorcycle	1	Motorcycle, M.Tricycle	1	Motorcycle
		2	Motorbike Trailer	2	Motorcycle + Trailer
II	Light Vehicle	3	Sedan, Wagon, Light Van	3	Car and Taxi
		4	Pick-up, Jeep, Light Truck (>3.5t)	4	4WD/Pick Up
		5	Mini Bus (Van type and Pick-up Type)	5	Passenger Van and Mini Bus
III	Heavy Vehicle	6	Short and Long Body Bus	6	Bus
		7	Short and Long Body Truck (<3.5t)	7	Light Commercial and 2-axle Truck
		8	Semi and Full Trailer Truck	8	3-axle Truck
		--	--	9	4 and 5-axle Truck
		--	--	10	4,5,6&7-axle Trailer
IV	Other	--	--	11	Ox Cart & Etan

Source: Study Team

After classifying vehicle categories into motorcycle, light vehicle, and heavy vehicle, location of survey stations was carefully selected i.e. the same locations, or, at least, at the same road sections to ensure the traffic volume of 2012 is consistent with that of 2006.

There are 21 (twenty one) survey stations in total where traffic volume comparison can be made. The comparison is shown in Table 4-9.

The comparison reveals that total traffic volume increased at all survey stations. The largest increase of traffic volume is observed at survey station number 66-3 of the NR66 where the ratio indicates a 12-fold increase compared to the 2006 survey with that of the 2012 survey. The traffic increase is mainly contributed to by the growth of motorcycle traffic which constitutes the majority of road traffic in Cambodia. Only two survey stations present a decrease of motorcycle traffic, i.e. survey station 48-1 of NR48 and survey station 68-2 of NR 68, yet the reductions are relatively small with the ratio of 0.92 and 0.75 respectively. Other stations indicated more than 1.25.

Aside from motorcycles, traffic volume of light vehicles and heavy vehicles also increased at all survey stations. The increase ratios range from 1.21 to 26.55 and from 1.28 to 43.00 for light vehicles and heavy vehicles respectively.

It seems that the large traffic growth of the all vehicle types was affected by the improvement of the road network and the increasing number of vehicle owners due to the active economy in Cambodia in recent years.

Table 4-9 Daily Traffic Volume by Vehicle Classification in 2006 and 2012

(Unit: Vehicle/Day)

Seq. No.	Road No.	Station No.	Motorcycle			Light Vehicle			Heavy Vehicle			Total(*)		
			2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)
1	11	11-3	2,018	2,531	1.25	352	1,334	3.79	263	744	2.83	2,633	4,609	1.75
2	31	31-1	607	1,989	3.28	551	1,045	1.90	49	447	9.12	1,207	3,481	2.88
3	33	33	1,770	3,235	1.83	107	913	8.53	14	322	23.0	1,891	4,470	2.36
4	48	48-1	1,353	1,251	0.92	544	931	1.71	159	428	2.69	2,056	2,610	1.27
5	48	48-3	1,562	2,620	1.68	350	802	2.29	26	246	9.46	1,938	3,668	1.89
6	51	51-1	1,417	4,829	3.41	264	640	2.42	181	714	3.94	1,862	6,183	3.32
7	56	56-2	379	1,929	5.09	74	588	7.95	55	220	4.00	508	2,737	5.39
8	57	57-1	2,550	5,254	2.06	679	1,862	2.74	124	819	6.60	3,353	7,935	2.37
9	57	57-3	453	1,315	2.90	256	914	3.57	28	615	21.96	737	2,844	3.86
10	57	57-4	1,076	2,235	2.08	247	961	3.89	11	245	22.27	1,334	3,441	2.58
11	62	62-2	189	553	2.93	108	440	4.07	24	99	4.13	321	1,092	3.40
12	66	66-2	1,513	1,956	1.29	758	915	1.21	157	247	1.57	2,428	3,118	1.28
13	66	66-3	113	2,147	19.0	126	773	6.13	11	68	6.18	250	2,988	11.95
14	68	68-2	1,329	1,003	0.75	210	462	2.20	14	82	5.86	1,553	1,547	1.00

(Unit: Vehicle/Day)

Seq. No.	Road No.	Station No.	Motorcycle			Light Vehicle			Heavy Vehicle			Total(*)		
			2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)	2006	2012	Ratio (2012/2006)
15	68	68-4	831	1,919	2.31	208	507	2.44	24	61	2.54	1,063	2,487	2.34
16	71	71-3	457	1,554	3.40	120	520	4.33	245	313	1.28	822	2,387	2.90
17	72	72	1,005	5,429	5.40	193	781	4.05	286	431	1.51	1,484	6,641	4.48
18	73	73-2	1,183	3,200	2.70	386	1,115	2.89	54	416	7.70	1,623	4,731	2.91
19	76	76-2	1,003	2,706	2.70	169	787	4.66	62	114	1.84	1,234	3,607	2.92
20	78	78-2	433	1,044	2.41	104	479	4.61	24	106	4.42	561	1,629	2.90
21	78	78-3	775	4,114	5.31	40	1,062	26.6	5	215	43.00	820	5,391	6.57

(*) Total traffic volume of 2012 survey excludes “Ox Cart & Etan” for the purpose of comparison

Source: Study Team

The road improvement statuses on 2-digit roads are indicated in Table 4-10. Most of the 2-digit roads have completed the improvement or are under construction or committed to be improved by the donor countries.

Table 4-10 Improvement Status of 2 digit Roads in 2012

Road No.	Status of the road
11	Committed by ADB and Japan except two brides.
31	Under construction
33	Commited by ADB,
44	Commited by China
48	Completed
51	Completed.
56	Commited by ADB
57	Completed.
62	Completed.
66	Completed
68	Completed
71	Completed
72	Completed
73	Completed
76	Under construction
78	Under construction

Source: MPWT

The number of new registered vehicles by year is shown in Table 4-11. According to the interview with the MPWT, vehicle owners have to register their vehicles while they own vehicles, but owners don’t delete the registration when they scrap their vehicles. Therefore, the number of actual active vehicles is not available. We estimated the number of registered vehicle using the registration records from 1990 when the MPWT started the registration system. For the estimation, we assume the following.

・The number of registered vehicles in 1990 includes all vehicles owned in Cambodia.

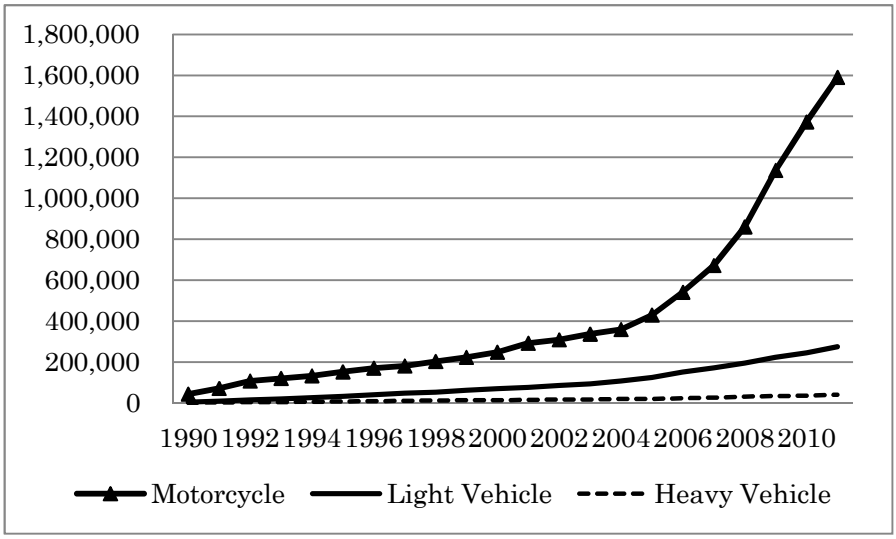
・Estimation does not consider scrapped vehicles

The estimation results are shown in Figure 4-6.The number of registered vehicles increased rapidly from 2006 to 2011, especially motorcycles.

Table 4-11 The Number of New Registered Vehicles (Unit: Vehicle)

Year	Motorcycle	Light Vehicle	Heavy Vehicle	Total	Year	Motorcycle	Light Vehicle	Heavy Vehicle	Total
1990	43,733	4,181	1,536	49,450	2001	43,690	6,710	720	51,120
1991	27,432	5,107	1,288	33,827	2002	16,956	8,667	1,487	27,110
1992	36,443	5,580	693	42,716	2003	27,891	8,167	1,282	37,340
1993	12,544	5,222	1,357	19,123	2004	22,664	13,856	1,664	38,184
1994	12,818	5,843	973	19,634	2005	70,523	17,319	1,375	89,217
1995	19,080	6,268	1,384	26,732	2006	111,457	25,544	2,633	139,634
1996	18,422	7,233	1,753	27,408	2007	130,106	20,934	3,544	154,584
1997	10,794	8,029	2,058	20,881	2008	188,915	23,048	3,519	215,482
1998	21,756	5,000	951	27,707	2009	275,471	28,014	3,565	307,050
1999	20,147	9,005	999	30,151	2010	236,614	21,888	2,467	260,969
2000	24,796	8,539	894	34,229	2011	218,217	30,220	3,292	251,729
Total						1,590,469	274,374	39,434	1,904,277

Source: Study Team



Source: Study Team estimated using the MPWT vehicle registration data

Figure 4-6 The Number of Registered Vehicles

CHAPTER 5

INDICATOR FOR SELECTION OF PRIORITY ROAD

5. INDICATOR FOR SELECTION OF PRIORITY ROAD

The Study Team collected the data below and information as indicators for the priority of the target roads.

5.1 Road development plan

The road development plan is a core indicator for the priority of the target roads as it is generally understood that the development of a road network follows the plan. The road network development plan and the "Follow up Study on the Road Network Development Master Plan, 2009 by the MPWT (hereinafter referred to as the master plan).

However, there are some differences between the actual implementation and the master plan in recent years where the actual road improvements by the Cambodia together with various development partners are ahead of the master plan.

In this respect, the Study Team collected the information on the road development plan based on three sources before deciding the priority of the target roads. These sources of information are:

1) The master plan
2) The MPWT road development list
3) Site survey to confirm the actual condition of the road

The information on the road development plan from the 3 sources is summarized in Table 5-1 to Table 5-4. The table shows the classification of the road development plan for the survey roads:

1) Short term
2) Medium term
3) Long term
4) Not planned

Table 5-1 Road Development Plan (1/4)

Seq. No.	Road No.	Road Planning and Actual Condition			Conclusion on the Road Planning
		Follow-up M/P Study in 2009	MPWT List	Survey by Study Team	
1	11	Short-Mid Term	Japan (Proposing)	-	Short Term
2	13	Mid Term	-	-	Mid Term
3	21	Long Term	Korea Loan Requested	-	Long Term
4	31	Short Term	On-going by Korea	-	Short Term
5	33	Short Term	ADB Bidding Preparation	-	Short Term
6	41	Mid Term	On-going by China	On-going	Short Term
7	42	Long Term	-	-	Long Term
8	43	Mid Term	-	-	Mid Term
9	44	Long Term	China F/S under nego.	-	Long Term
10	45	-	-	-	Not Planned
11	46	Long Term	-	-	Long Term
12	48	-	Thai	Completed	Short Term
13	51	-	WB	Conpleted	Short Term
14	53	Mid-Long Term	-	-	Mid Term
15	53A	-	-	-	Not Planned
16	53B	-	-	-	Not Planned
17	54	-	-	-	Not Planned
18	55	Mid-Long Term	China loan under nego.	-	Mid Term
19	56	Short-Mid Term	ADB /Korea Bid prepa.	On-going	Short Term
20	57	Short Term	On-going by China	Completed	Short Term
21	57B	-	-	On-going	Short Term
22	58	-	-	-	Not Planned
23	59	Mid-Long Term	On-going by China	On-going	Short Term
24	60	Long Term	On-going by ADB?	-	Long Term
25	62	Short Term	Completed /On-going by China	Completed	Short Term
26	63	-	-	-	Not Planned
27	64	-	-	-	Not Planned
28	66	Long Term	-	Completed	Short Term
29	68	Short-Mid Term	On-going by Cambodia	Completed	Short Term
30	70	-	-	-	Not Planned
31	71	-	-	Completed	Short Term
32	72	Short Term	-	Completed	Short Term
33	73	Short Term	-	-	Short Term
34	76	Short-Mid Term	-	-	Short Term
35	78	Short Term	Completed by Vietnam and China.	Completed	Short Term
36	110	-	-	On-going	Short Term
37	114	-	-	-	Not Planned
38	118A	-	-	Completed	Short Term
39	121	-	-	-	Not Planned
40	124	-	-	-	Not Planned
41	126	Long Term	-	-	Long Term

Source: Study Team

Table 5-2 Road Development Plan (2/4)

Seq. No.	Road No.	Road Planning and Actual Condition			Conclusion on the Road Planning
		Follow-up M/P Study in 2009	MPWT List	Survey by Study Team	
42	129	-	-	-	Not Planned
43	129C	Long Term	-	-	Long Term
44	130	-	-	-	Not Planned
45	132	-	-	-	Not Planned
46	133A	-	-	-	Not Planned
47	134	-	-	-	Not Planned
48	134A	-	-	-	Not Planned
49	134B	-	-	-	Not Planned
50	135	-	-	-	Not Planned
51	136	-	-	-	Not Planned
52	136A	-	-	-	Not Planned
53	137	-	-	-	Not Planned
54	138	-	-	Complete	Short Term
55	140	-	-	On-going	Short Term
56	147	Long Term	-	-	Long Term
57	151B	-	-	-	Not Planned
58	152	-	-	-	Not Planned
59	152D	-	-	-	Not Planned
60	152E	-	-	-	Not Planned
61	152F	-	-	-	Not Planned
62	152G	-	-	-	Not Planned
63	152H	-	-	-	Not Planned
64	153	-	-	-	Not Planned
65	153A	-	-	-	Not Planned
66	153B	-	-	-	Not Planned
67	153C	-	-	-	Not Planned
68	154	-	-	-	Not Planned
69	154A	-	-	-	Not Planned
70	154B	-	-	-	Not Planned
71	154C	-	-	-	Not Planned
72	154E	-	-	-	Not Planned
73	154F	-	-	-	Not Planned
74	155	-	-	-	Not Planned
75	155A	-	-	-	Not Planned
76	155B	-	-	-	Not Planned
77	155C	-	-	-	Not Planned
78	155D	-	-	-	Not Planned
79	155E	-	-	-	Not Planned
80	155F	-	-	-	Not Planned
81	156	-	-	-	Not Planned
82	156A	-	-	-	Not Planned
83	156C	-	-	-	Not Planned
84	156D	-	-	-	Not Planned
85	157	-	-	-	Not Planned
86	157A	-	-	-	Not Planned
87	157B	-	-	-	Not Planned
88	157C	-	-	-	Not Planned
89	159B	-	-	-	Not Planned
90	159D	Short Term	-	Completed	Short Term

Source: Study Team

Table 5-3 Road Development Plan (3/4)

Seq. No.	Road No.	Road Planning and Actual Condition			Conclusion on the Road Planning
		Follow-up M/P Study in 2009	MPWT List	Survey by Study Team	
91	258D	-	-	On-going	Short Term
92	260	-	-	Completed	Short Term
93	260A	-	-	-	Not Planned
94	261	-	-	Completed	Short Term
95	264	-	-	-	Not Planned
96	264A	-	-	-	Not Planned
97	264B	-	-	-	Not Planned
98	264C	Mid Term (with PB2620)	-	-	Mid Term
99	264D	-	-	Completed	Short Term
100	264E	Mid Term (2 sections)	-	On-going	Short Term
101	265	-	-	-	Not Planned
102	265B	-	-	-	Not Planned
103	265C	-	-	-	Not Planned
104	265E	-	-	-	Not Planned
105	266	-	-	-	Not Planned
106	266B	-	-	-	Not Planned
107	266A	-	-	-	Not Planned
108	266C	-	-	-	Not Planned
109	266D	-	-	-	Not Planned
110	266E	-	-	-	Not Planned
111	266F	-	-	-	Not Planned
112	267	-	-	-	Not Planned
113	268A	-	-	-	Not Planned
114	268B	-	-	-	Not Planned
115	269	-	-	-	Not Planned
116	270	-	-	-	Not Planned
117	277	-	-	-	Not Planned
118	279	-	-	-	Not Planned
119	311	-	-	Completed	Short Term
120	312	Short Term	-	Completed	Short Term
121	312A	-	-	-	Not Planned
122	312B	Short Term	-	Completed	Short Term
123	313	-	-	Completed	Short Term
124	313A	-	-	-	Not Planned
125	314	-	-	-	Not Planned
126	314A	-	-	-	Not Planned
127	314B	-	-	On-going	Short Term
128	314C	-	-	-	Not Planned
129	314D	Short Term	-	-	Short Term
130	315	-	-	-	Not Planned
131	316A	-	-	-	Not Planned
132	317	-	-	-	Not Planned
133	317A	-	-	Completed	Short Term
134	317B	-	-	-	Not Planned
135	317C	-	-	-	Not Planned
136	319	-	-	-	Not Planned
137	370A	-	-	-	Not Planned

Source: Study Team

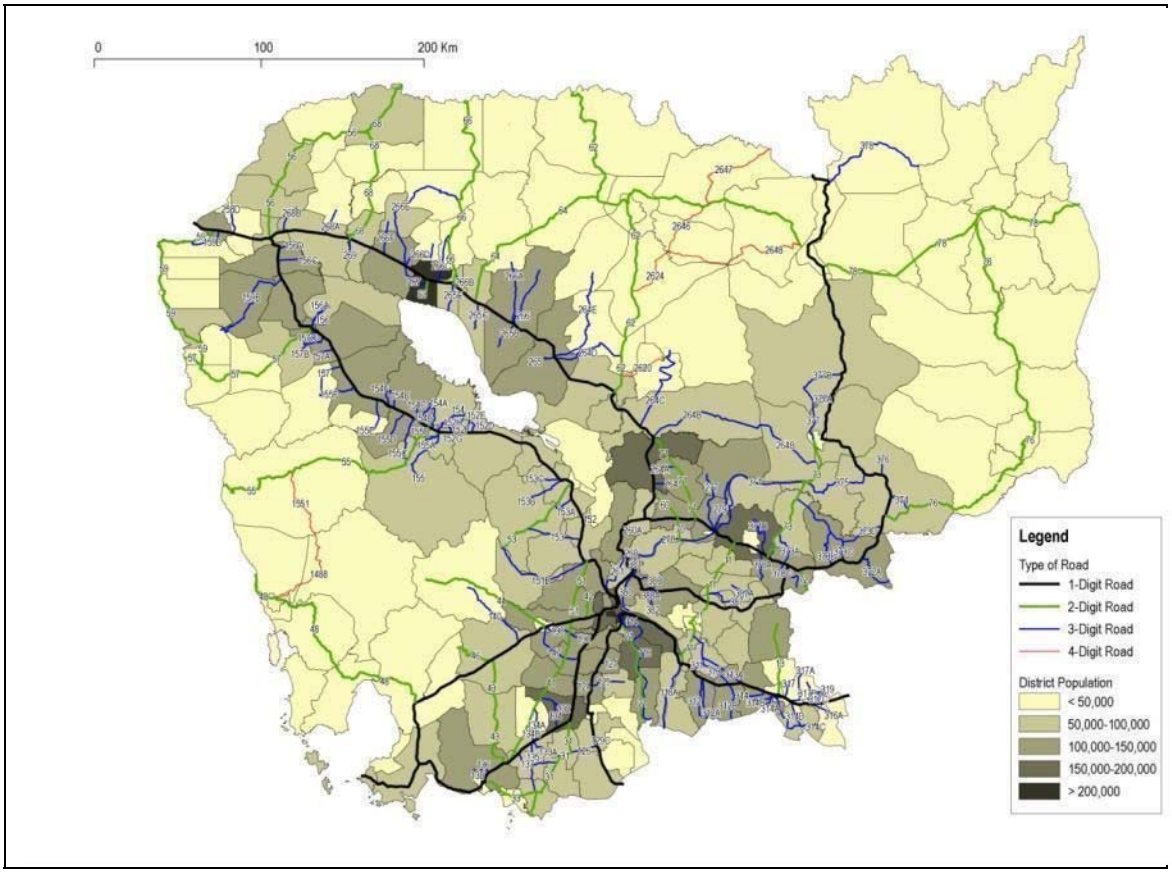
Table 5-4 Road Development Plan (4/4)

Seq. No.	Road No.	Road Planning and Actual Condition			Conclusion on the Road Planning
		Follow-up M/P Study in 2009	MPWT List	Survey by Study Team	
138	370C	-	-	-	Not Planned
139	371	Long Term	-	-	Long Term
140	371D	-	-	-	Not Planned
141	372A	-	-	-	Not Planned
142	373A	-	-	-	Not Planned
143	373B	-	-	-	Not Planned
144	373C	-	-	Completed	Short Term
145	373D	-	-	-	Not Planned
146	374	-	-	-	Not Planned
147	375	-	-	-	Not Planned
148	376	-	-	-	Not Planned
149	377	-	-	-	Not Planned
150	377A	-	-	-	Not Planned
151	377B	-	-	-	Not Planned
152	378	Short/Mid Term	-	Completed	Short Term
153	380	-	-	On-going	Short Term
154	380A	-	-	-	Not Planned
155	381	-	-	On-going	Short Term
156	382	-	-	Completed	Short Term
157	383	-	-	-	Not Planned
158	387	-	-	-	Not Planned
159	387A	-	-	-	Not Planned
160	1488	Short/Mid Term	-	-	Short Term
161	1551	Short/Mid Term	-	-	Short Term
162	2620	Mid Term	-	-	Mid Term
163	2624	Short/Mid Term (GMS Fund)	-	-	Short Term
164	2646	-	-	-	Not Planned
165	2647	-	-	-	Not Planned
166	2648	Short Term (On-going)	-	-	Short Term

Source: Study Team

5.2 Population along the road

Population along the target roads is the sum of population by districts where the subject roads passes through. The population of districts used in the Study is obtained from the General Population Census on 2008 (hereinafter referred to as the Census). The population by district and the location of surveyed roads, as well as the number of population along the roads are shown in Figure 5-1 and Table 5-5 respectively.



Source: Study Team

Figure 5-1 District Population and Survey Roads

Table 5-5 Population along the Roads

Seq. No.	Road No.	No. of Districts Crossed	Population along the Road
1	11	8	577,013
2	13	3	196,548
3	21	3	417,056
4	31	4	393,652
5	33	4	157,896
6	41	8	858,056
7	42	1	129,865
8	43	3	301,791
9	44	3	219,278
10	45	1	93,141
11	46	2	111,921
12	48	5	105,498
13	51	4	507,518
14	53	3	192,778
15	53A	2	113,339
16	53B	1	82,902
17	54	1	82,902
18	55	4	256,193
19	56	5	299,483
20	57	5	348,117
21	57B	4	298,413
22	58	5	312,975
23	59	6	320,428
24	60	2	209,123
25	62	7	252,798
26	63	1	230,714
27	64	7	226,795
28	66	4	175,269
29	68	4	162,212
30	70	2	215,079
31	71	4	503,947
32	72	1	135,318
33	73	5	403,125
34	76	8	157,190
35	78	8	162,516
36	110	4	776,730
37	114	1	172,950
38	118A	1	54,250
39	121	1	131,031
40	124	1	107,807
41	126	1	99,033
42	129	2	203,223
43	129C	1	72,684
44	130	3	302,316
45	132	1	152,170
46	133A	2	172,271
47	134	1	152,170
48	134A	2	146,763
49	134B	2	146,763
50	135	3	239,624
51	136	1	106,977
52	136A	2	143,344
53	137	2	137,283
54	138	2	143,344
55	140	2	125,110
56	147	3	302,316
57	151B	2	169,987
58	152	1	80,835
59	152D	1	82,902
60	152E	1	82,902
61	152F	1	82,902
62	152G	2	116,912
63	152H	2	116,912
64	153	3	203,522
65	153A	2	149,648
66	153B	2	149,648
67	153C	1	92,715
68	154	2	116,912
69	154A	3	241,741
70	154B	1	124,829
71	154C	1	124,829
72	154E	1	124,829
73	154F	1	124,829
74	155	2	118,312
75	155A	1	58,846
76	155B	2	183,675
77	155C	2	184,295
78	155D	1	124,829
79	155E	2	152,671
80	155F	2	138,470
81	156	2	212,599
82	156A	2	212,599
83	156C	1	139,315
84	156D	1	139,315
85	157	2	138,470
86	157A	1	111,663
87	157B	1	111,663
88	157C	2	203,801
89	159B	4	288,745
90	159D	2	150,273
91	258D	1	47,196
92	260	1	90,748
93	260A	2	186,695
94	261	1	90,748
95	264	2	278,548
96	264A	2	278,548
97	264B	2	139,553
98	264C	3	169,320
99	264D	2	151,269
100	264E	3	168,548
101	265	1	104,076
102	265B	1	125,367
103	265C	1	98,378
104	265E	1	61,425
105	266	1	125,367
106	266B	1	61,425
107	266A	2	151,093
108	266C	2	273,487
109	266D	2	137,217
110	266E	3	198,676
111	266F	2	166,650
112	267	2	343,596
113	268A	2	134,024
114	268B	3	232,964
115	269	1	57,690
116	270	3	237,074
117	277	3	266,254
118	279	3	266,254
119	311	2	183,147
120	312	1	110,571
121	312A	1	110,571
122	312B	1	109,291
123	313	2	181,867
124	313A	2	181,867
125	314	1	120,318
126	314A	2	160,854
127	314B	2	160,854
128	314C	2	98,268
129	314D	1	57,732
130	315	5	391,273
131	316A	2	62,027
132	317	1	46,163
133	317A	1	46,163
134	317B	2	83,286
135	317C	2	83,286
136	319	2	83,286
137	370A	2	315,359
138	370C	1	135,318
139	371	3	325,775
140	371D	1	180,041
141	372A	1	148,463
142	373A	2	215,808
143	373B	1	148,463
144	373C	2	228,953
145	373D	2	210,066
146	374	1	61,603
147	375	2	114,492
148	376	1	61,603
149	377	3	145,401
150	377A	1	55,696
151	377B	1	55,696
152	378	2	49,282
153	380	2	184,056
154	380A	1	117,322
155	381	1	117,322
156	382	2	224,408
157	383	1	117,322
158	387	2	165,215
159	387A	2	129,198
160	1488	3	45,572
161	1551	1	13,052
162	2620	2	128,608
163	2624	2	56,363
164	2646	2	37,461
165	2647	1	16,731
166	2648	1	30,439

Source: Study Team

5.3 Traffic volume on the roads

As was already described in an earlier section of this chapter, the number of survey stations was 194 over 158 surveyed. The expanded daily traffic volumes are shown in Table 5-6.

Moreover, while the number of roads for the traffic survey was 158, the table below shows 166 roads in total. The 8 roads were added during the bridge inspection survey because there are some differences between the results of the site survey and the inventory data from HEC. Therefore, the 8 additional roads do not have counted traffic data. To solve this issue, the Study Team estimated the traffic volume for these additional roads assuming by the similarity in characteristics of road and locations with other roads on which the traffic volume was already counted.

Table 5-6 Daily Traffic Volume

Seq. No.	Road No.	Traffic Volume (veh/day)
1	11	6,681
2	13	3,215
3	21	16,103
4	31	5,286
5	33	4,485
6	41	8,488
7	42	2,053
8	43	1,574
9	44	1,940
10	45	1,500
11	46	1,295
12	48	3,668
13	51	9,400
14	53	3,314
15	53A	1,473
16	53B	1,473
17	54	1,473
18	55	1,379
19	56	13,218
20	57	8,111
21	57B	8,111
22	58	6,736
23	59	6,736
24	60	1,048
25	62	3,892
26	63	13,478
27	64	5,790
28	66	3,222
29	68	3,349
30	70	4,995
31	71	4,240
32	72	6,716
33	73	4,922
34	76	5,844
35	78	5,447
36	110	8,078
37	114	3,073
38	118A	3,853
39	121	1,330
40	124	1,379
41	126	2,032
42	129	3,661
43	129C	887
44	130	2,167
45	132	5,404
46	133A	1,401
47	134	1,593
48	134A	1,454
49	134B	2,621
50	135	1,177
51	136	1,298
52	136A	1,298
53	137	429
54	138	6,314
55	140	1,582
56	147	2,204
57	151B	2,909
58	152	1,445
59	152D	369
60	152E	440
61	152F	445
62	152G	248
63	152H	697
64	153	1,473
65	153A	1,601
66	153B	1,519
67	153C	1,511
68	154	5,069
69	154A	1,366
70	154B	674
71	154C	1,534
72	154E	1,720
73	154F	974
74	155	2,032
75	155A	997
76	155B	760
77	155C	1,741
78	155D	1,729
79	155E	522
80	155F	1,051
81	156	1,906
82	156A	10,620
83	156C	1,836
84	156D	2,125
85	157	1,104
86	157A	567
87	157B	1,648
88	157C	1,114
89	159B	1,107
90	159D	2,132
91	258D	1,594
92	260	6,212
93	260A	1,045
94	261	964
95	264	1,543
96	264A	3,270
97	264B	1,957
98	264C	431
99	264D	1,918
100	264E	1,043
101	265	1,573
102	265B	1,737
103	265C	3,391
104	265E	2,519
105	266	1,294
106	266B	2,307
107	266A	1,676
108	266C	4,197
109	266D	2,306
110	266E	2,485
111	266F	1,457
112	267	8,581
113	268A	306
114	268B	982
115	269	1,986
116	270	4,590
117	277	9,411
118	279	6,963
119	311	2,749
120	312	1,990
121	312A	96
122	312B	2,221
123	313	2,350
124	313A	281
125	314	1,034
126	314A	474
127	314B	1,885
128	314C	2,007
129	314D	1,275
130	315	2,474
131	316A	2,224
132	317	972
133	317A	386
134	317B	1,336
135	317C	424
136	319	675
137	370A	1,173
138	370C	1,145
139	371	1,967
140	371D	1,337
141	372A	1,349
142	373A	1,154
143	373B	1,205
144	373C	4,109
145	373D	983
146	374	991
147	375	1,282
148	376	1,035
149	377	2,073
150	377A	1,063
151	377B	131
152	378	543
153	380	2,374
154	380A	1,303
155	381	3,325
156	382	1,697
157	383	1,492
158	387	247
159	387A	752
160	1488	307
161	1551	402
162	2620	867
163	2624	770
164	2646	773
165	2647	287
166	2648	0

Note: Hightlighted cells are the estimated traffic volume

Source: Study Team

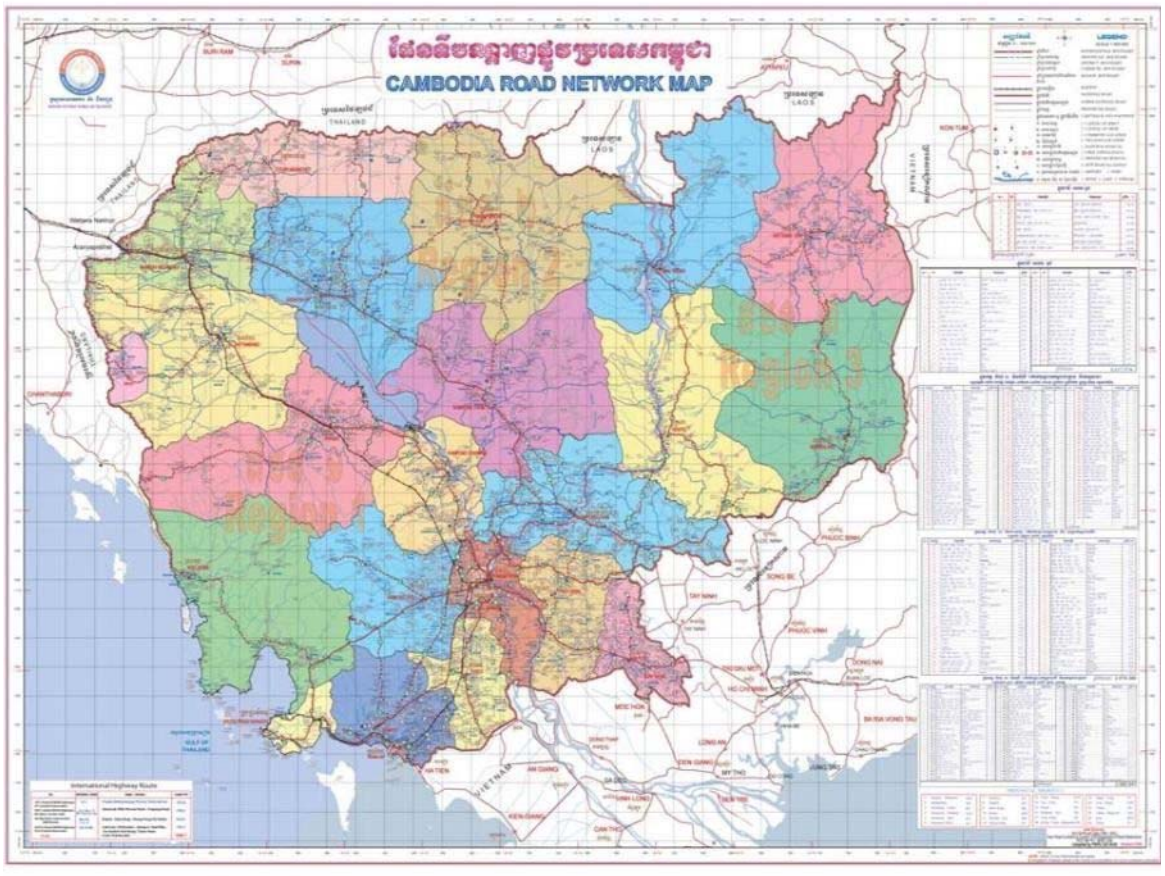
5.4 Characteristics of the roads

The characteristics of the target roads were identified based on the Cambodia Road Network Map compiled by the MPWT in 2009 shown in Figure 5-2.

The characteristics of the survey roads are categorized into three groups and the numbers of roads in each corresponding group are as follows.

1) Road to the border – 20 roads;
2) Road for the network – 108 roads;
3) Road to dead-end – 38 roads.

The information on the characteristics of the survey roads is summarized in Table 5-7.



Source: MPWT

Figure 5-2 Cambodia Road Network Map 2009

Table 5-7 Characteristics of the Survey Roads

Seq. No.	Road No.	Character of the Road
1	11	For network
2	13	For network
3	21	To border
4	31	For network
5	33	To border
6	41	For network
7	42	For network
8	43	For network
9	44	To dead end
10	45	To border
11	46	To dead end
12	48	To border
13	51	For network
14	53	For network
15	53A	To dead end
16	53B	To dead end
17	54	To dead end
18	55	To border
19	56	For network
20	57	To border
21	57B	To border
22	58	To border
23	59	To border
24	60	For network
25	62	To border
26	63	To dead end
27	64	For network
28	66	To border
29	68	To border
30	70	For network
31	71	For network
32	72	To border
33	73	For network
34	76	For network
35	78	To border
36	110	For network
37	114	For network
38	118A	To border
39	121	To dead end
40	124	For network
41	126	For network
42	129	For network
43	129C	For network
44	130	For network
45	132	For network
46	133A	For network
47	134	For network
48	134A	For network
49	134B	For network
50	135	For network
51	136	For network
52	136A	For network
53	137	For network
54	138	To dead end
55	140	To dead end
56	147	For network
57	151B	For network
58	152	To dead end
59	152D	To dead end
60	152E	To dead end
61	152F	To dead end
62	152G	To dead end
63	152H	To dead end
64	153	For network
65	153A	For network
66	153B	To dead end
67	153C	For network
68	154	To dead end
69	154A	For network
70	154B	For network
71	154C	To dead end
72	154E	To dead end
73	154F	To dead end
74	155	For network
75	155A	To dead end
76	155B	For network
77	155C	For network
78	155D	For network
79	155E	To dead end
80	155F	For network
81	156	To dead end
82	156A	For network
83	156C	To dead end
84	156D	To dead end
85	157	For network
86	157A	To dead end
87	157B	For network
88	157C	For network
89	159B	For network
90	159D	For network
91	258D	To border
92	260	For network
93	260A	For network
94	261	For network
95	264	To dead end
96	264A	For network
97	264B	For network
98	264C	For network
99	264D	For network
100	264E	For network
101	265	To dead end
102	265B	To dead end
103	265C	To dead end
104	265E	To dead end
105	266	For network
106	266B	For network
107	266A	For network
108	266C	For network
109	266D	For network
110	266E	For network
111	266F	For network
112	267	For network
113	268A	To dead end
114	268B	For network
115	269	To dead end
116	270	For network
117	277	For network
118	279	For network
119	311	For network
120	312	For network
121	312A	For network
122	312B	For network
123	313	For network
124	313A	For network
125	314	For network
126	314A	To border
127	314B	For network
128	314C	For network
129	314D	To border
130	315	For network
131	316A	For network
132	317	For network
133	317A	To border
134	317B	For network
135	317C	For network
136	319	For network
137	370A	For network
138	370C	To dead end
139	371	For network
140	371D	For network
141	372A	To border
142	373A	For network
143	373B	For network
144	373C	For network
145	373D	For network
146	374	For network
147	375	For network
148	376	To dead end
149	377	For network
150	377A	For network
151	377B	For network
152	378	For network
153	380	For network
154	380A	For network
155	381	To dead end
156	382	To dead end
157	383	To dead end
158	387	For network
159	387A	For network
160	1488	For network
161	1551	For network
162	2620	For network
163	2624	For network
164	2646	For network
165	2647	For network
166	2648	For network

Source: Study Team

5.5 Economy of the roadside areas

To evaluate the road priority, the economy of the roadside areas is one of the important indicators. The economy of the roadside areas is classified according to the character of the roadside vicinity which was divided into 5 categories and economy of the roadside is shown in Table 5-8.

1) City area
2) Industrialized area
3) Agricultural area
4) Forest or grassy plain
5) Area for natural protection

(1) Setting of Predefined Priority Level for Category of Roadside Economy

It is common that one road, especially a longer one, matches with more than one category listed above, e.g. one part is connected to a city while another part is connected to an agricultural area. To overcome this problem, the study pre-defines the priority level for each category of the economy of roadside area. By doing so, one road has only one category, i.e. the one with the highest priority among others. “City area” was given the highest priority, and “Agricultural area” the lowest one.

The reason for giving the lowest priority to agricultural area is explained as follows. Cambodia is agricultural country; therefore, the roadside economy of all the roads is agricultural area by default. If a survey road does not match with any of the other four categories, it automatically falls in the category of agricultural area.

Table 5-8 Predefined Priority Level for Classifying the Roadside Economy

Category of Economy of the Roadside Area	Priority for Classifying Roadside Economy	Note
City area	1	Highest priority
Industrialized area	2	
Area for natural protection	3	
Forest or grassy plain	4	
Agricultural area	5	Lowest priority

Source: Study Team

(2) Data Collection

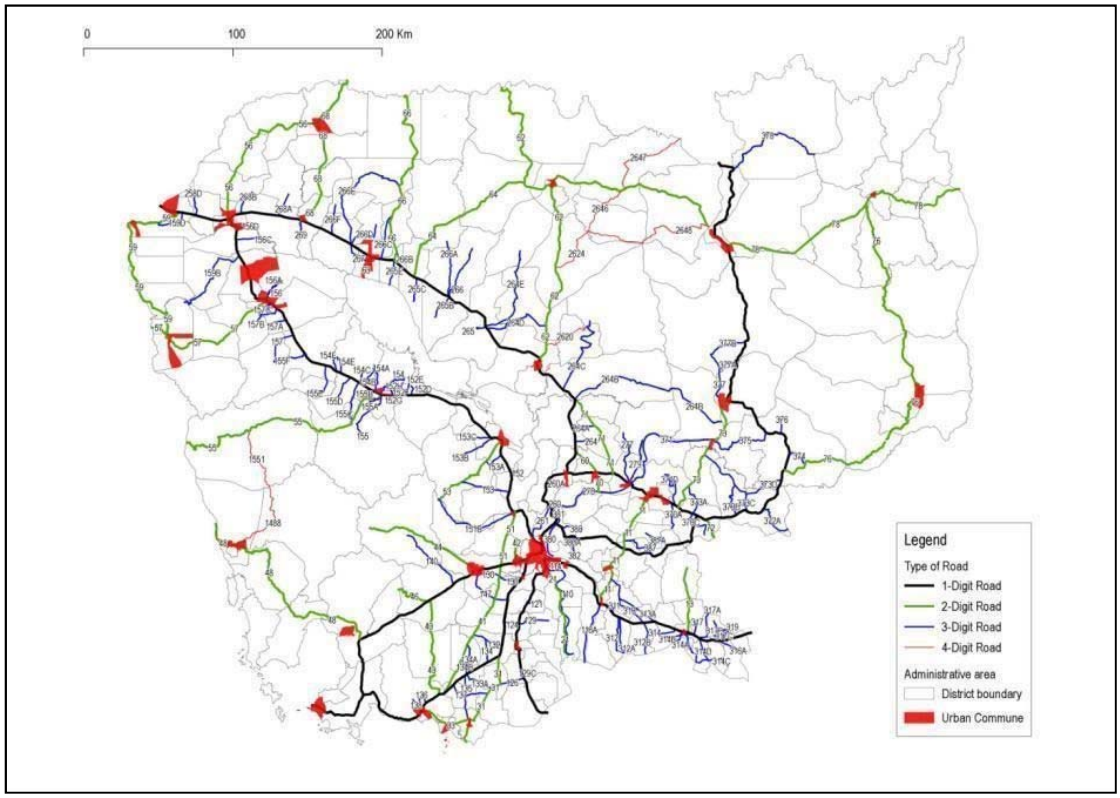
The information required for identifying the economy of the roadside area was collected from various sources as follows:

1) City Area

According to the Census, all communes in Cambodia are classified into two groups:

Urban – 162 communes
Rural – 1458 communes

Any roads connected to the urbanized communes defined in the Census are categorized as city area for the economy of the roadside. The locations of the urbanized communes are illustrated in Figure 5-3.



Source: Study Team

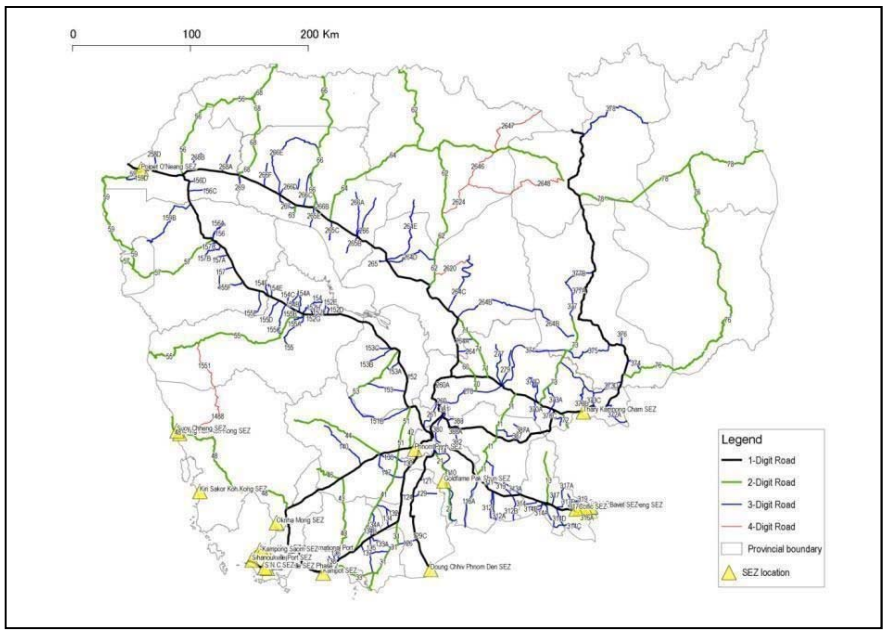
Figure 5-3 Urbanized Communes and Survey Roads

2) Industrialized areas

The Study imposes two criteria to define a roadside economy as an industrialized area: i) either the survey roads connects to the vicinity of a special economic zone (SEZ); or ii) the percentage of employed population in industrial economic activities of the survey roads is more than that of NR4[1].

According to a report called "Invest in Cambodia, Q1, 2012", the Council for the Development of Cambodia (CDC) has approved 21 special economic zones (SEZs) across the country, out of which, seven of these have occupants – Sihanoukville SEZ, Phnom Penh SEZ, Manhattan SEZ, Tai Seng Bavet SEZ, Poipet SEZ, Goldfame Pak Shun SEZ, and Koh Kong SEZ. Meanwhile, others are at various stages of development. Based on the locations provided in the profile of the SEZs, the Study Team prepared Figure 5-4 to illustrate the locations of SEZs and the survey roads as shown in the locations.

At the same time, the percentage of employed population in industrial economic activities was calculated based on the Census and is shown Table 5-9. The table shows the percentage of employed population in industrial economic activities out of total employed population (%Employed) and over total population (%Population)



Source: JICA study team

Figure 5-4 Locations of Special Economic Zones

[1] Roadside economy of NR4 is assumed to be an industrialized area; therefore, population in industrial economic activities of this road is used as the threshold.

Table 5-9 Percentage of Population Employed in Industrial Economic Activities

Seq. No.	Road No.	Employed Population in the Industrial Sector	
		%Employed	%Population
1	11	3.8%	2.0%
2	13	2.5%	1.4%
3	21	16.6%	8.9%
4	31	1.5%	0.8%
5	33	4.8%	2.5%
6	41	11.5%	6.3%
7	42	36.9%	21.8%
8	43	3.6%	1.8%
9	44	15.0%	7.9%
10	45	4.7%	2.2%
11	46	3.8%	1.8%
12	48	7.3%	3.3%
13	51	21.0%	11.5%
14	53	8.0%	4.3%
15	53A	1.9%	1.0%
16	53B	1.9%	1.1%
17	54	1.9%	1.1%
18	55	2.8%	1.4%
19	56	5.7%	3.1%
20	57	8.1%	3.9%
21	57B	3.0%	1.6%
22	58	7.1%	3.9%
23	59	7.2%	3.9%
24	60	2.8%	1.5%
25	62	1.9%	1.0%
26	63	16.3%	7.3%
27	64	3.0%	1.6%
28	66	6.3%	3.2%
29	68	2.4%	1.3%
30	70	2.9%	1.6%
31	71	4.1%	2.2%
32	72	2.5%	1.3%
33	73	3.4%	1.7%
34	76	3.4%	1.8%
35	78	4.4%	2.2%
36	110	24.9%	13.1%
37	114	18.7%	9.3%
38	118A	3.5%	1.8%
39	121	7.6%	4.2%
40	124	3.5%	1.8%
41	126	1.6%	0.8%
42	129	6.1%	3.2%
43	129C	0.9%	0.5%
44	130	15.5%	8.4%
45	132	1.8%	0.9%
46	133A	0.9%	0.5%
47	134	1.8%	0.9%
48	134A	0.8%	0.4%
49	134B	0.8%	0.4%
50	135	1.2%	0.7%
51	136	6.2%	3.1%
52	136A	8.2%	3.9%
53	137	1.3%	0.7%
54	138	8.2%	3.9%
55	140	2.9%	1.4%
56	147	15.5%	8.4%
57	151B	6.4%	3.3%
58	152	4.7%	2.5%
59	152D	1.9%	1.1%
60	152E	1.9%	1.1%
61	152F	1.9%	1.1%
62	152G	5.2%	2.6%
63	152H	5.2%	2.6%
64	153	3.2%	1.7%
65	153A	5.8%	3.2%
66	153B	5.8%	3.2%
67	153C	8.1%	4.5%
68	154	5.2%	2.6%
69	154A	3.1%	1.6%
70	154B	1.3%	0.6%
71	154C	1.3%	0.6%
72	154E	1.3%	0.6%
73	154F	1.3%	0.6%
74	155	4.6%	2.3%
75	155A	8.2%	3.9%
76	155B	3.4%	1.7%
77	155C	1.2%	0.6%
78	155D	1.3%	0.6%
79	155E	2.2%	1.1%
80	155F	2.5%	1.3%
81	156	14.1%	6.1%
82	156A	14.1%	6.1%
83	156C	6.7%	3.5%
84	156D	6.7%	3.5%
85	157	2.5%	1.3%
86	157A	6.6%	3.3%
87	157B	6.6%	3.3%
88	157C	4.7%	2.4%
89	159B	3.4%	1.7%
90	159D	13.4%	7.0%
91	258D	2.7%	1.4%
92	260	23.7%	11.9%
93	260A	2.3%	1.3%
94	261	23.7%	11.9%
95	264	2.9%	1.5%
96	264A	2.9%	1.5%
97	264B	2.8%	1.4%
98	264C	2.5%	1.3%
99	264D	1.6%	0.9%
100	264E	1.5%	0.8%
101	265	1.9%	1.0%
102	265B	1.3%	0.7%
103	265C	3.8%	2.1%
104	265E	9.7%	5.0%
105	266	1.3%	0.7%
106	266B	9.7%	5.0%
107	266A	1.4%	0.8%
108	266C	14.5%	6.6%
109	266D	4.4%	2.3%
110	266E	3.0%	1.6%
111	266F	3.3%	1.7%
112	267	12.0%	5.7%
113	268A	2.7%	1.4%
114	268B	7.1%	3.7%
115	269	2.2%	1.2%
116	270	7.5%	3.8%
117	277	6.8%	3.5%
118	279	6.8%	3.5%
119	311	1.6%	0.8%
120	312	1.3%	0.7%
121	312A	1.3%	0.7%
122	312B	1.0%	0.6%
123	313	1.4%	0.8%
124	313A	1.4%	0.8%
125	314	1.4%	0.8%
126	314A	3.0%	1.6%
127	314B	3.0%	1.6%
128	314C	5.3%	2.8%
129	314D	3.3%	1.8%
130	315	1.8%	1.0%
131	316A	11.2%	6.4%
132	317	6.1%	3.4%
133	317A	6.1%	3.4%
134	317B	9.9%	5.6%
135	317C	9.9%	5.6%
136	319	9.9%	5.6%
137	370A	2.9%	1.6%
138	370C	2.5%	1.3%
139	371	3.3%	1.7%
140	371D	3.3%	1.7%
141	372A	1.8%	1.0%
142	373A	1.9%	1.0%
143	373B	1.8%	1.0%
144	373C	1.5%	0.8%
145	373D	2.2%	1.2%
146	374	3.2%	1.7%
147	375	4.0%	2.0%
148	376	3.2%	1.7%
149	377	4.2%	2.0%
150	377A	2.4%	1.2%
151	377B	2.4%	1.2%
152	378	7.1%	3.4%
153	380	11.3%	5.7%
154	380A	14.2%	7.2%
155	381	14.2%	7.2%
156	382	8.6%	4.5%
157	383	14.2%	7.2%
158	387	1.2%	0.7%
159	387A	1.4%	0.8%
160	1488	10.9%	4.5%
161	1551	1.4%	0.8%
162	2620	1.3%	0.6%
163	2624	1.1%	0.5%
164	2646	0.4%	0.2%
165	2647	0.5%	0.2%
166	2648	0.8%	0.4%

NOTE:
1). %Employed: % out of total employed population
2). %Population: % out of total populattion
3). % of population employed in industrial economic activities along NR4:
- %Employed = 19.2%
- %Population = 9.9%

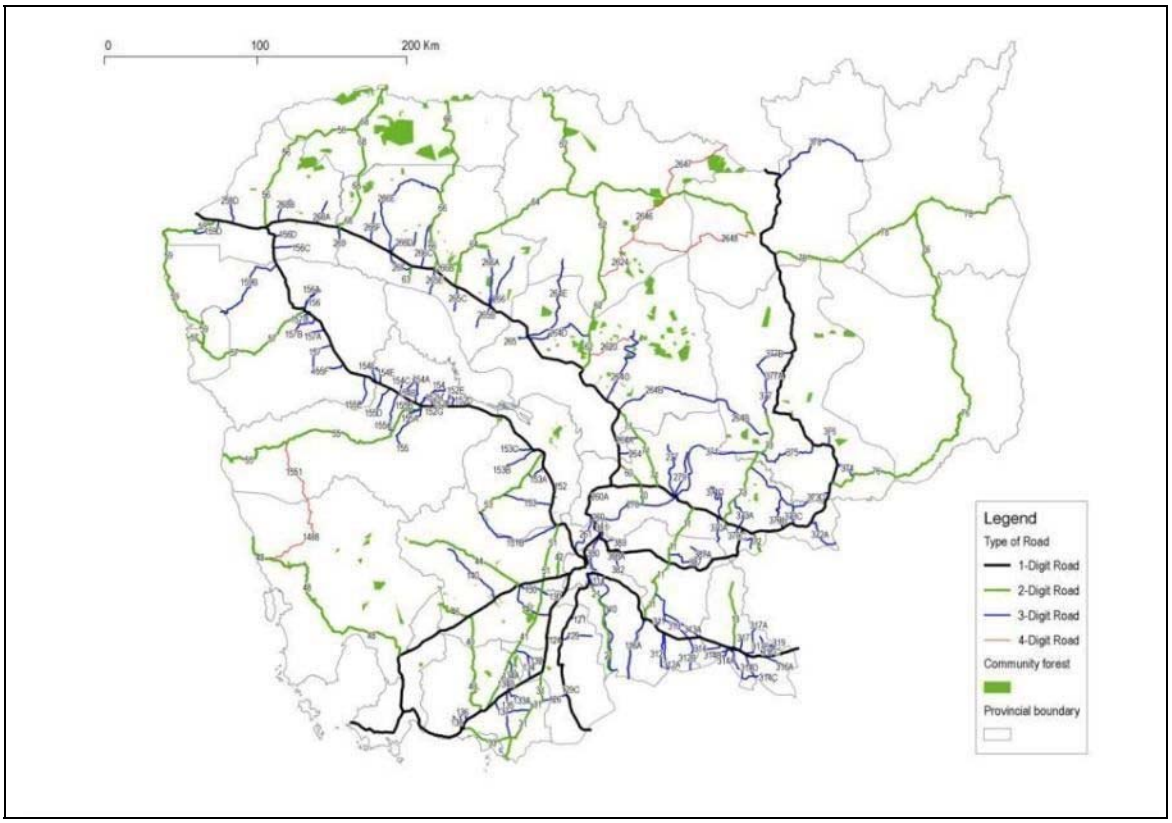
Sorce: Study Team

3) Agricultural areas

As explained earlier, if a survey road does not match with any of the other four categories, it automatically falls into the category of an agricultural area because the majority of employees are in agricultural economic activities.

4) Forest and grassy plain

The forest and grassy plain data are available from the community forest data. The community forest data were collected from a website called "Open Development Cambodia" where officially approved community forest is available in shape file format. Before utilizing this data, the Study Team checks to verify the contents of the sub-degree and Prakas issued by the government on each of the community forests and this information is illustrated in Figure 5-5.

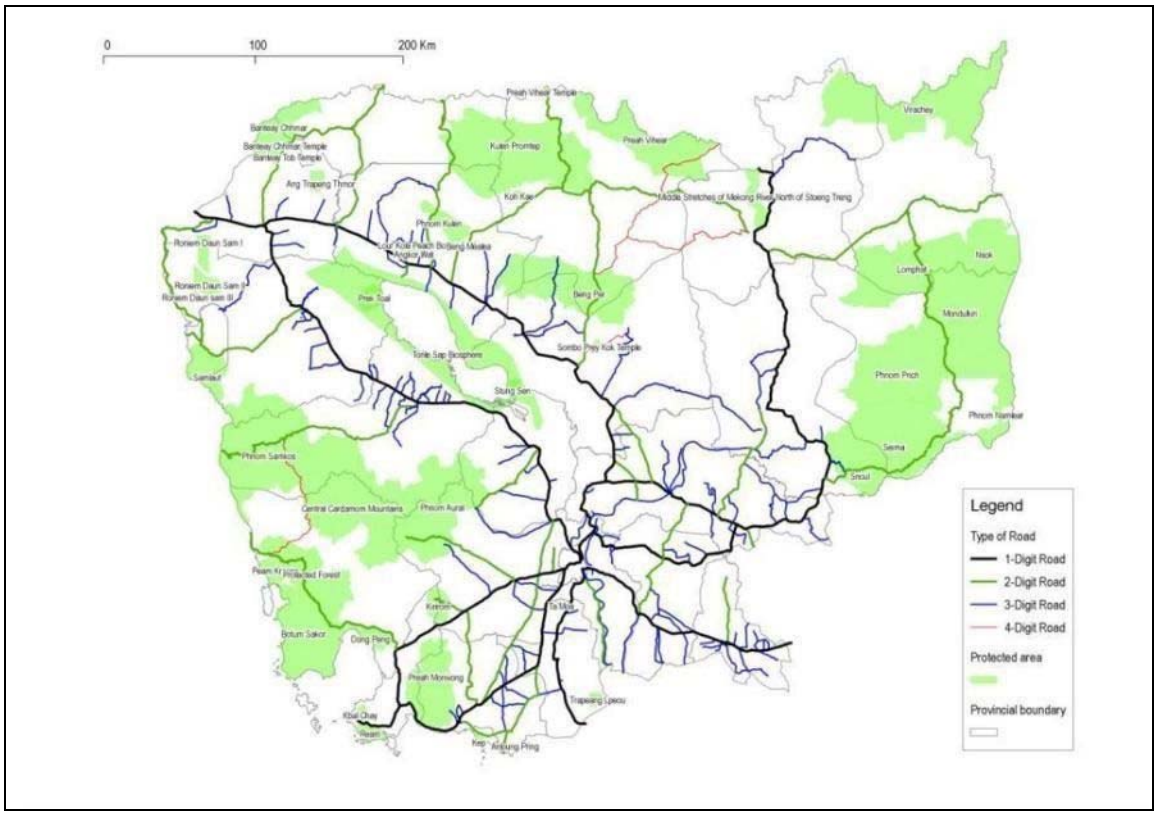


Source: Study Team analysis of the data from Open Development Cambodia

Figure 5-5 Community Forests

5) Area for Natural Protection

Similar to the forest and grassy plain data, the area for natural protection was also obtained from the website called "Open Development Cambodia" where officially approved protected areas are available in shape file format. Before utilizing this data, the Study Team checks to verify the contents of the Decree and Sub-decree which defines each of the protected areas and this information is illustrated in Figure 5-6.



Source: Study Team analysis of data from Open Development Cambodia

Figure 5-6 Protected Areas

(3) Conclusions regarding the Economy of the roadside areas

After the analysis of the collected data, the economy of the roadside areas was determined for the survey roads. Table 5-10 shows the economy of the roadside areas for each of the survey roads.

Table 5-10 Economy of the Roadside Areas

Seq. No.	Road No.	Economy of Roadside Area
1	11	City Area
2	13	City Area
3	21	City Area
4	31	City Area
5	33	City Area
6	41	Agricultural Area
7	42	City Area
8	43	Forest or Grassy Plain
9	44	City Area
10	45	Industrialized Area
11	46	Protected Area
12	48	City Area
13	51	City Area
14	53	City Area
15	53A	Agricultural Area
16	53B	Agricultural Area
17	54	Protected Area
18	55	City Area
19	56	City Area
20	57	City Area
21	57B	City Area
22	58	City Area
23	59	City Area
24	60	City Area
25	62	City Area
26	63	City Area
27	64	City Area
28	66	Protected Area
29	68	City Area
30	70	City Area
31	71	Agricultural Area
32	72	Agricultural Area
33	73	City Area
34	76	City Area
35	78	City Area
36	110	Industrialized Area
37	114	City Area
38	118A	Agricultural Area
39	121	Agricultural Area
40	124	Agricultural Area
41	126	Agricultural Area
42	129	Agricultural Area
43	129C	Agricultural Area
44	130	City Area
45	132	Agricultural Area
46	133A	Agricultural Area
47	134	Agricultural Area
48	134A	Agricultural Area
49	134B	Agricultural Area
50	135	City Area
51	136	Agricultural Area
52	136A	City Area
53	137	Agricultural Area
54	138	City Area
55	140	Protected Area
56	147	City Area
57	151B	City Area
58	152	Agricultural Area
59	152D	Agricultural Area
60	152E	Agricultural Area
61	152F	Agricultural Area
62	152G	City Area
63	152H	City Area
64	153	Agricultural Area
65	153A	Agricultural Area
66	153B	Agricultural Area
67	153C	Agricultural Area
68	154	Agricultural Area
69	154A	City Area
70	154B	Agricultural Area
71	154C	Agricultural Area
72	154E	Agricultural Area
73	154F	Agricultural Area
74	155	City Area
75	155A	City Area
76	155B	Agricultural Area
77	155C	Agricultural Area
78	155D	Agricultural Area
79	155E	Agricultural Area
80	155F	Agricultural Area
81	156	City Area
82	156A	City Area
83	156C	Agricultural Area
84	156D	City Area
85	157	Agricultural Area
86	157A	Agricultural Area
87	157B	City Area
88	157C	City Area
89	159B	Agricultural Area
90	159D	Industrialized Area
91	258D	Agricultural Area
92	260	Industrialized Area
93	260A	Agricultural Area
94	261	Industrialized Area
95	264	Agricultural Area
96	264A	Agricultural Area
97	264B	Agricultural Area
98	264C	Forest or Grassy Plain
99	264D	Agricultural Area
100	264E	Protected Area
101	265	Agricultural Area
102	265B	Agricultural Area
103	265C	Agricultural Area
104	265E	Protected Area
105	266	Protected Area
106	266B	Agricultural Area
107	266A	Forest or Grassy Plain
108	266C	Protected Area
109	266D	Agricultural Area
110	266E	Agricultural Area
111	266F	Agricultural Area
112	267	City Area
113	268A	Agricultural Area
114	268B	Agricultural Area
115	269	City Area
116	270	City Area
117	277	City Area
118	279	City Area
119	311	Agricultural Area
120	312	Agricultural Area
121	312A	Agricultural Area
122	312B	Agricultural Area
123	313	Agricultural Area
124	313A	Agricultural Area
125	314	Agricultural Area
126	314A	Agricultural Area
127	314B	City Area
128	314C	City Area
129	314D	Agricultural Area
130	315	City Area
131	316A	Industrialized Area
132	317	Agricultural Area
133	317A	Agricultural Area
134	317B	Industrialized Area
135	317C	Industrialized Area
136	319	Industrialized Area
137	370A	Agricultural Area
138	370C	Agricultural Area
139	371	Agricultural Area
140	371D	Agricultural Area
141	372A	Agricultural Area
142	373A	Agricultural Area
143	373B	Industrialized Area
144	373C	Agricultural Area
145	373D	Agricultural Area
146	374	Protected Area
147	375	City Area
148	376	Agricultural Area
149	377	City Area
150	377A	Agricultural Area
151	377B	Agricultural Area
152	378	Agricultural Area
153	380	Agricultural Area
154	380A	Agricultural Area
155	381	Agricultural Area
156	382	Agricultural Area
157	383	Agricultural Area
158	387	Agricultural Area
159	387A	Agricultural Area
160	1488	City Area
161	1551	Protected Area
162	2620	Protected Area
163	2624	Protected Area
164	2646	Forest or Grassy Plain
165	2647	Protected Area
166	2648	Agricultural Area

Source: Study Team

5.6 Number of buildings in vicinity of the bridges along the survey roads

The number of the buildings in the vicinity of the bridges along the survey roads was collected in the bridge inspection survey for more than 1,200 bridges as an indicator for environmental and social considerations. However, the Study of Package A aims at prioritization of the bridges to be replaced and the Study does not include construction method. Consequently the locations of temporary bridges and diversions were still unclear, and it was not sure how many buildings were affected. Therefore, the number of residential building units was tentatively counted within approximately 100 meters of the temporary approach road on both sides of the bridges to assume potentially affected buildings as an indicator. Total numbers of buildings counted in the bridge vicinity on the survey roads are shown in Table 5-11. In total bridge vicinity on each road, residences would be assumed at less than 200 people in the site reconnaissance.

Table 5-11 Number of buildings in vicinity of the bridges along the survey roads

Seq. No.	Road No.	Buildings	Seq. No.	Road No.	Buildings	Seq. No.	Road No.	Buildings	Seq. No.	Road No.	Buildings
1	11	53	43	129C	-	85	157	-	127	314B	-
2	13	55	44	130	62	86	157A	15	128	314C	4
3	21	1,607	45	132	-	87	157B	17	129	314D	6
4	31	47	46	133A	14	88	157C	32	130	315	15
5	33	54	47	134	-	89	159B	176	131	316A	6
6	41	9	48	134A	-	90	159D	3	132	317	-
7	42	5	49	134B	2	91	258D	-	133	317A	3
8	43	31	50	135	3	92	260	53	134	317B	7
9	44	18	51	136	12	93	260A	-	135	317C	-
10	45	-	52	136A	4	94	261	77	136	319	-
11	46	3	53	137	31	95	264	-	137	370A	-
12	48	79	54	138	9	96	264A	-	138	370C	-
13	51	-	55	140	4	97	264B	-	139	371	176
14	53	15	56	147	11	98	264C	-	140	371D	-
15	53A	6	57	151B	4	99	264D	-	141	372A	13
16	53B	-	58	152	3	100	264E	1	142	373A	-
17	54	-	59	152D	13	101	265	10	143	373B	-
18	55	210	60	152E	-	102	265B	65	144	373C	18
19	56	18	61	152F	35	103	265C	104	145	373D	16
20	57	47	62	152G	-	104	265E	-	146	374	8
21	57B	-	63	152H	7	105	266	22	147	375	21
22	58	1	64	153	2	106	266B	-	148	376	-
23	59	26	65	153A	-	107	266A	-	149	377	100
24	60	-	66	153B	13	108	266C	13	150	377A	-
25	62	11	67	153C	-	109	266D	-	151	377B	-
26	63	-	68	154	75	110	266E	13	152	378	3
27	64	59	69	154A	45	111	266F	-	153	380	122
28	66	33	70	154B	-	112	267	32	154	380A	3
29	68	13	71	154C	7	113	268A	-	155	381	78
30	70	48	72	154E	14	114	268B	-	156	382	18
31	71	-	73	154F	24	115	269	10	157	383	-
32	72	-	74	155	48	116	270	248	158	387	-
33	73	124	75	155A	-	117	277	-	159	387A	1
34	76	52	76	155B	11	118	279	112	160	1488	-
35	78	1	77	155C	12	119	311	21	161	1551	15
36	110	1,597	78	155D	26	120	312	60	162	2620	17
37	114	22	79	155E	4	121	312A	-	163	2624	7
38	118A	882	80	155F	35	122	312B	-	164	2646	11
39	121	-	81	156	-	123	313	10	165	2647	-
40	124	1	82	156A	-	124	313A	-	166	2648	-
41	126	-	83	156C	146	125	314	14			
42	129	-	84	156D	116	126	314A	-			

Source: Study Team