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For the Ministry of Public Works and Transport and the Asian Development Bank

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Asian Development Bank



**Ministry of Public Works
and Transport**



Asian Development bank

**MINISTRY OF PUBLIC WORKS AND TRANSPORT
KINGDOM OF CAMBODIA
ADB LoanNo.2839-CAM (SF) / ADB Loan No.8254-CAM**

FINAL REPORT

**FEASIBILITY STUDY
ON
SECOND PROVINCIAL ROADS IMPROVEMENT PROJECT**

December 2016

KCI KOREA CONSULTANTS INTERNATIONAL

**in association with
Dainichi, Sambo and
Hankuk Engineering Consultants**

**in sub-consultancy with
MECC, SBK, KACE and SAWAC**

SECOND PROVINCIAL ROADS IMPROVEMENT PROJECT

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CURRENCY EQUIVALENTS

(As of 8 Nov 2016)

Currency unit – riel/s (KR)

KR1.00 = \$0.00025

\$1.00 = KR4,025

Note: Cambodia Riel (RI) also has the acronym KHR

ABBREVIATIONS

AADT	Annual Average Daily Traffic
ADT	Average daily traffic
ADB	Asian Development Bank
BEC	Board of Engineers Cambodia
CBR	California Bearing Ration
DBST	Double Bituminous Surface Treatment
DDIS	Detailed design and Implementation Supervision
EA	Executing Agency
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ESA	Equivalent Standard Axle (identical to ESAL)
GDP	Gross Domestic Product
GPS	Global Positioning Satellite (receiver)
GVW	Gross Vehicle Weight
HDM4	Highway Development and Management Model 4
HGV	Heavy Goods Vehicle
HH	Household
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examinations
IMF	International Monetary Fund
IRC	Inter-Ministerial Resettlement Committee
IRI	International Roughness Index
JICA	Japanese International Cooperation Agency
IDC	Interest during Construction
ILO	International Labour Organisation
KEXIM	Korea Export and Import Bank
MEF	Ministry of Economy and Finance
MMS	Maintenance Management System
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
MOWRAM	Ministry of water Resources and Meteorology
MUV	Manufactures Unit Value Index
NMT	Non-motorized transport
NPV	Net Present Value
NR	National Road
ODA	Oveseas Development Assistance
PBC	Performance -Based Contract
PCU	Passenger Car Unit
PDRD	Provincial Department of Rural Development

PMU	Project Management Unit
PPTA	Project Preparation TA
PSA	Poverty and Social Assessment
PSC	Pre-stressed Concrete
RGC	Royal Government of Cambodia
RID	Road Infrastructure Department
RI	Riel
RNDS	Road Network Development Study (JICA)
RoW	Right of Way
RP	Resettlement Plan
RSAP	Road Safety Action Plan
RTAVIS	Road Traffic Accident and Victim Information system
SBST	Single Bituminous Surface Treatment
SEU	Social and environment Unit
TA	Technical Assistance
TOR	Terms of Reference
US\$	United States Dollar
UCS	Unconfined Compressive Strength
UXO	Unexploded Ordnance
VOC	Vehicle Operating Costs
WB	World Bank

NOTES

- I. The fiscal year (FY) of the Government of kingdom of Cambodia end in December
- II. In this report, "\$" refers to US dollars unless otherwise specified.

FEASIBILITY STUDY ON PROVINCIAL ROADS IMPROVEMENT PROJECT

EXECUTIVE SUMMARY

1. The Government of Cambodia has prepared the Second Provincial Roads Improvement Project. This project is a priority project in the Government's key infrastructure development agenda as it provides all-year access to provincial and rural agricultural communities of Prey Veng and Kandal provinces of Cambodia. The project aims to rehabilitate 48.3 kilometers (km) of provincial roads in Veng and Kandal provinces to paved condition to provide a safer, cost-effective provincial road network with all-year access to markets and other social services for provincial centers of mid-west and southeastern Cambodia for Inter-modal Transport to enable trade facilitation and development of Cambodian Regional Integration. The project will support a sustainable road maintenance regime in MPWT, HIV/AIDS and human trafficking prevention program.

2. In 2011 ADB approved Loan 2839-CAM: Provincial Roads Improvement Project which intended to remedy aforementioned issues systematically by providing reliable all-year road access from provincial towns and rural areas to markets, employment centers, and social services in four provinces. These provinces are Kampong Chhnang, Kampong Speu, Svay Rieng and Prey Veng. These roads are unpaved with no all-year accessibility. The proposed project aims at continuing the initiatives of Loan 2839 further to ensure achieving the development objectives, impact and outcome through an extended scale of wider coverage.

3. The project roads have been selected based on the following selection criteria: (i) connectivity to GMS corridors, (ii) government national road improvement program, (iii) vulnerability to climate change effects, (iv) lower resettlement impact, and (v) closer geographical location.

4. PR312 that links NR1 with the CBF Banteay Chakrey is a provincial road that is vital for transport within Prey Veng province and for cross-border transport and trade. PR23 located at Kandal province is a provincial road for trade facilitation and development of the remote rural economy. During the inception phase the improvement of PR1534 which traverse Kampong Chhnang and Pursat provinces was included in the project scope. These roads do not provide all-year accessibility. The output for these roads is civil works. This output has associated detailed design and implementation supervision consulting services, and land acquisition and resettlement studies required for the project roads.

5. Three provincial roads – PR23 and PR312 that both connect to NR1 and PR1534 have been selected for further study, and the feasibility studies are substantially completed. However, due to funding constraint, PR1534 has been excluded from the project scope by the government during Fact-finding Mission. Therefore, project scope has been adjusted as implementation of PR312 and PR23 with the length of 48.3 km.

6. The impact of the project is improved access to markets, jobs, and social services, and cross border transport and trade in project provinces. The expected outcome of the project is the safe, cost effective, all-year access provided in the road network of

provincial agricultural areas of Prey Veng and Kandal provinces, which encompass a large proportion of Cambodia's rural poor population.

7. The outputs of the project are: (i) safe and climate resilient provincial roads completed civil works to improve PR312 and PR23, length 48.3 km approximately; and (ii) to Increased road safety enforcement in project communes.

8. The overall objective of the Feasibility Study (FS) is to prepare the ensuing project that will achieve these outputs. The FS has undertaken: (i) Preparation of the engineering design for the upgrading of PR312 and PR23 to paved road standard with a DBST; (ii) Economic analysis for the project roads and the preparation of the benefit monitoring framework and the establishment; (iii) Preparation of the IEE for the project roads; (iv) Preparation of Resettlement Plans and Resettlement Policy Framework; (v) Preparation of the Poverty and Social Analysis including the preparation of and HIV/AIDS and Human Trafficking awareness prevention program, and a labor and gender action plan for the project; (vi) Preparation of a community based road safety plan; (vii) Preparation of the procurement plan.

9. Engineering surveys have been carried out on each of the roads proposed for improvement. These have included road inventory including bridges, box and pipe culverts, geological survey measuring existing subgrade strengths, and hydrological survey through interview and measures of existing pavement strengths. Traffic count and environmental studies have also been carried out. The detail of the survey is consistent with a feasibility study level. More detailed studies must be carried out during the project implementation stage to provide the detailed design for civil works contracts.

10. PR312 connecting NR1 and Banteay Chakrey Border is paved with DBST wearing course with 4.2~4.6m carriageway width in fair condition. It is possible to maintain 50-60kph speed for existing road, but considering the traffic volume of the harvesting season, the width of carriageway is not enough for two-way traffic. Two sections have been paved newly in 1.3km with 6.2m width by DPWT financing in 2015. The road maintenance by patching was observed along lengths of the existing road on multiple occasions. Existing road cannot be simply overlaid with the macadam base left in place in its present condition due to unsuitable materials for CBR strength.

11. PR23 plays an important role as a connecting road between Bassac River and Mekong River neighborhood. There is one realignment section in the beginning point in order to connect with Koh Thom Bridge which is under construction in Bassac River. This road is with natural soil surface and has narrow width in severe condition. It is not possible to pass by vehicles during the wet season. Especially from PK 16.2, existing road is a winding path with 1m~2m width through to the swamp blocking up the road. Even in the dry season, this section is impassible. Minor adjustment is recommended and it is required raising the road level in this section.

12. Road design features are generally in accordance with the Cambodia road design standards. For PR312 and PR23, the road cross-section provides a 6.5m carriageway in both directions with DBST and 1.5m shoulder on each side. The total road

width of PR312 and PR23 will be 9.5m. For town areas (market areas), the project road will be paved with DBST in whole width including shoulders and the sidewalks with 2.5m width will be installed with raised curbs.

13. The Pavement design for the project roads is based on the Cambodian Road Design Standard Part 2: Pavement (MPWT 2003), which for flexible pavement is itself founded on TRL Overseas Road Note 31 (1993). To decide project oriented effective pavement design, obligatory information such as the strength of the existing subgrade and the cumulative traffic axle loading over the design life for each road section was studied. The CBR values of existing subgrade were classified from S2 to S4 and the cumulative traffic loading for the design life of 20 years varies from T3 to T5 for individual roads. A double bituminous surface treatment (DBST) will be used for the project roads. The thickness of each layers have been decided from design chart-1 under Section 2.7 of the Road Design Standard.

14. The materials to be used for aggregate base course shall meet the material specifications set forth in the technical specifications of the design manual. The CBR strength of aggregate base material shall not be less than 80% and the CBR strength of granular subbase material shall not be less than 30%. For selected subgrade, minimum 10% of CBR strength is required in consideration of the site condition. The existing embankment that also formed the part of the subgrade is required to have a CBR of not less than 4%. All CBR tests on materials for design purposes shall be compacted to specified density and be tested in the laboratory after 4days soaking following the AASHTO T193 designation.

15. The foremost speculation is to use the prevailing material sources, particularly the stone quarries, for the project roads. However there are no viable operating quarries within short hauling distance from the project roads. Materials has to be produced by self installing crushing plants or material to be procured from existing commercial producers from quarries having hauling distance between 30km and 150km.

16. The project will construct 1 new bridge. As drainage structures, there are 9 existing box culverts, and the project will replace 12 box culverts including newly construct 1 new box culverts. There are 21 existing pipe culverts, and project will replace existing pipe culverts. 10 new pipe culverts will be constructed.

17. The locations of PR312 and PR23 situate in the areas where aerial bombing and land armed conflict took place at some point of time in a Cambodian long civil war (1970-98). To ensure the safety of the project, first, Mine/UXO clearance operation must be carried out. Second, Mine/UXO awareness must be provided to contractor and local people so that they would be able to ID, to help report the contaminated objects, if any, and they would be able to stay and work safe for years to come

18. Manual, classified traffic counts identifying different vehicle types were carried out on project roads. The standard procedure was to carry out the count over a 12-hour period, from 6 am to 6 pm. The count commenced during the day, to enable close supervision of the initial counting. The locations of the sites were chosen as points where traffic levels were believed to be typical of the whole road. A number of adjustments were

made to survey data to estimate the 2016 traffic flows on the project roads in terms of annual average daily traffic (AADT) to serve as the base year traffic figures. Normal traffic growth forecasts were based on GDP growth and the estimated elasticity of demand for transport with respect to GDP. A GDP growth rate of 5.99% are used for the period from 2017-2020, with 6.80% from 2020 to 2025, with 7.58% from 2025-2030, with 7.86% after 2030.

19. The terms of reference require the Consultants to prepare the Initial Environmental Examination (IEE) for the project roads and in accordance with both the Asian Development Bank's (ADB) Social Safeguards Policy (SPS, 2009) and to confirm if the project should be categorized as B or re- categorized, and recommend on mitigation measures for the Environmental Management Plan (EMP) including its implementation and monitoring.

20. Consultations were conducted with all stakeholders, including the Ministry of Public Works and Transport (MPWT) and its Social and Environment Unit (SEU), Ministry of the Environment (MOE), Ministry of Agriculture, Forests, and Fisheries (MOAFF), the Ministry of Culture and Fine Arts, their Provincial Departments in the project area, and relevant non- government organizations (NGOs).

21. Detailed maps were obtained and field studies undertaken to identify the proximity of places of religious, cultural, and traditional value, and Sites of Special Ecological Interest such as protected areas, natural reserves, and national parks.

22. The roads PR23 in Kandal and PR312 in Prey Veng are not in close proximity to any protected areas of ecological significance.

23. The Sub-decree No. 72 ANRK.BK dated 11 August 1999 contains an annex "List of the projects that require an Initial Environmental Impact Assessment (EIA)". This stipulates that an IEE is required for "National Road Construction \geq 100 km. As this project is rehabilitation of existing roads, of which the longest is 82km, according to MOE Legislation, an IEE will not be required by MOE.

24. To avoid or mitigate negative impacts arising from the project, an EMP detailing mitigation measures and monitoring activities has been prepared as part of the IEE.

25. Public consultations involving affected people and local officials have been conducted during the preparation of the IEE through focus group and individual discussions in all project affected provinces. Impacts were not seen as a major issue by those discussions.

26. Climate change adaptation was included in the project. Roads in Kandal have moderate risk of flooding. Roads in Prey Veng have moderate risk of flooding.

27. Only minor environmental impacts are anticipated. Such impacts will be experienced during site works mainly due to dust and noise emissions as well as potential

occupational, community health, and safety risks, but can be mitigated. Temporary impacts caused by the civil works have been identified and mitigation measures are given in the EMP.

28. Social and Environmental Office (SEO), is operational but needs capacity building. The detailed design and implementation supervision (DDIS) consultant will provide on- the-job training to the field staffs.

29. All potential environmental impacts have been identified. The project is confirmed as Category B according to ADB guidelines. No environmental impacts were identified that would warrant the conduct of an environmental due diligence study.

30. A Resettlement Plan (RP) was prepared for the two roads, PR23 and PR312. The RP addresses the potential concerns for the affected households. The plan includes an Inventory of Loss (IOL) and Socio-economic Study. A Replacement Cost Study (RCS) was carried out in parallel with the former studies. The total resettlement Cost is approximately \$ 2,046,959.61.

31. The poverty and social analysis (PSA) describes the socio-economic conditions including poverty, demographic profiles of the project areas; presents and analyze the data gathered from the households' baseline socio-economic survey; assess the perception of the affected local people and communities on project impacts and how they will be benefited by the proposed project, and suggestions raised by concerned stakeholders relevant to the project. The PRIP-II will benefit about 36,066 households and 178,588 populations in 14 communes within 6 districts and 4 provinces of Cambodia.¹ About 80.5% of the total population and households in the country resides in rural areas. The proportion of the population living in rural areas is about 80.5% and 19.5% in urban areas.² The total population in the 3 provincial roads project areas is 178,588 (90,617 female or 50.7%) with 36,066 households and 40,668 families as of September 2016.

32. Stakeholders' consultations were conducted in the project areas, as well as a baseline household social survey with 360 (50% women) respondents. The respondents were randomly selected in all of the 14 communes within 6 districts in 4 provinces covered by PRIP-II. Each respondent represents one household in the project areas, who was randomly selected in 14 communes within the 6 districts and 4 provinces. Gender and ethnic assessment was also conducted. For gender, the proposed project is effective gender mainstreaming (EGM) based on ADB gender mainstreaming category, and Category C for IPs who will be adversely affected by the project. There are Cham living in the project areas but they will not be adversely affected. A Gender Action Plan (GAP) has been prepared to ensure this project is socially inclusive for women, poor and other vulnerable persons. A TOR for HIV/AIDS and Human Trafficking Awareness and Prevention Program was also prepared.

33. The PSA concluded that the project will provide positive benefits to the local people and the communities within the project area. It will also benefit the women, low

¹ Data from the Commune Councils in 14 communes affected by PRIP-II, as of September 2016.

² Ibid.

income households, and other vulnerable persons in the project areas. All (100%) of the people who participated in the public consultations are in favor of the proposed project. Likewise, over 85% of the social survey respondents are in favor of the project and perceived that the project is essential.

34. Each year nearly 1.3 million people die as the result of road crashes and more other got injured or disable worldwide. In Cambodia, more than 6 persons died and many others injured of road crash in roads network per day, most of them are the youth age from 15 to 29 years old, road fatalities became a leading cause of death among any other communication and non-communication disease such as HIV-AIDs and UXO.

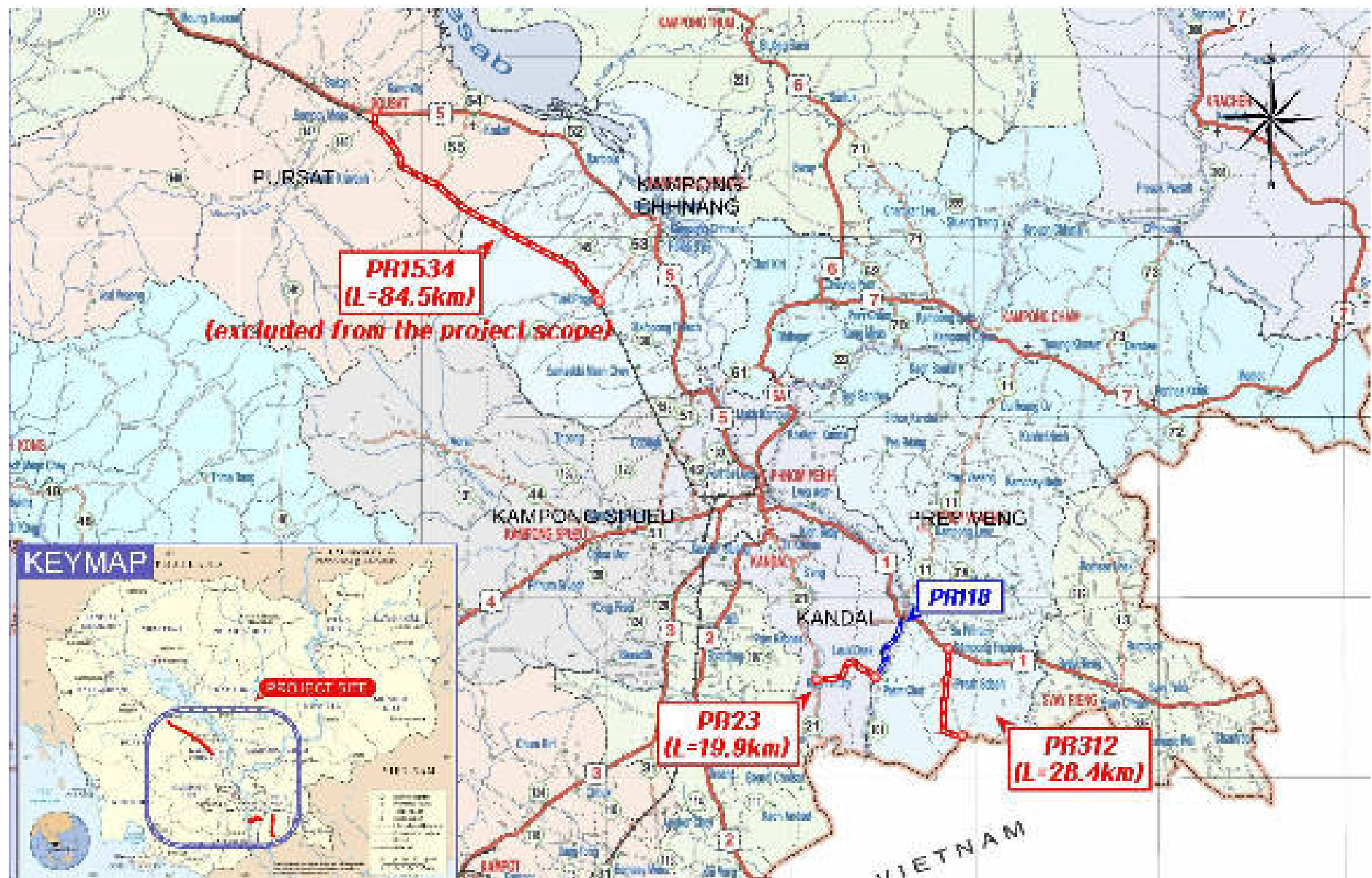
35. The road safety component of this Feasibility study is aimed at formulating a sustainable Community Based Road Safety (CBRS) program throughout the (i) the information gathered from road safety stakeholders, existing documents, geographic, population and latest road crashes data, (ii) road safety policy and action plan, (iii) national framework which align with UN action Plan or sustainable Development Goals, (iv) build the road safety management (v) Monitor and evaluation (road safety auditing) which help to measure the road safety since the beginning of the roads improvement project.(vi) the combination of 5Es of Road Safety Action Plan (2011-2020) is the key concept to promote road safety and change the behavior of road users in the communities in Cambodia,. A detailed Community Based Road Safety Program has been designed for the project areas.

36. The main purpose of economical analysis for this study is to show the effects of the implementation of the proposed provincial roads improvements from viewpoint of national economy and it aims at evaluating the economic viability of the project implementation. In total 2 road sections were identified for evaluation purposes, and each of these has been appraised individually, with specific characteristics and conditions for each used as inputs to the evaluation. The evaluation for each road has been done in terms of the EIRR and NPV expressed in 2016 values discounted at 12%.

37. The annual cost and benefit streams are calculated from year 2016 up to 25 years and discounted to 2016 values using a discount rate of 12%. Road improvements were assumed to be completed by year 2021 taking into account the review and budget preparation, the detail design and tendering (2017), and construction periods (2018-2021); hence, the project life is considered for 20 years after the completion. No benefits have been included for any savings which may occur before the opening year as a result of some sections of the networks being completed before the end of the overall construction period. Similarly, no costs to road users caused by disruptions to traffic during the construction period have been included. The overall economic costs uses for the evaluation are assumed 90% of financial cost to allow for taxes included in the financial costs and shadow pricing of unskilled labour.

38. Economic analysis covers 2016~2041 periods. The appraisal has been carried out for two road sections. The two sections evaluated are viable. The EIRR of PR312 is 22.1% and PR23 is 18.5%. The proposed whole sections have an economic feasibility with EIRR of 20.4%. Therefore, the implementation of the project is economically feasible from view point of national and regional economy.

PROJECT LOCATION MAP



PROJECT LOCATION MAP

SECOND PROVINCIAL ROADS IMPROVEMENT PROJECT

1 INTRODUCTION

1. The Government of Cambodia has prepared the second Provincial Roads Improvement Project. This project is a priority project in the Government's key infrastructure development agenda as it provides all-year access to provincial and rural agricultural communities of Prey Veng and Kandal provinces of Cambodia. The project aims to rehabilitate 48.3 kilometers (km) of provincial roads in Prey Veng and Kandal provinces to paved condition to provide a safer, cost-effective provincial road network with all-year access to markets and other social services for provincial centers of southeastern Cambodia for Inter-modal Transport to enable trade facilitation and development of Cambodian Regional Integration. The project will support a sustainable road maintenance regime in MPWT, HIV/AIDS and human trafficking prevention program.

2. Roads are the principal mode for transport in Cambodia. This road network of 55,242 km includes: (i) national roads (primary national highways) with a total length of about 11,107 km; (ii) provincial roads (secondary national highways) with a total length of about 4,407 km; and (iii) about 39,728 km of rural roads. Management of national and provincial roads is the responsibility of the Ministry of Public Works and Transport (MPWT), whereas management of rural roads is the responsibility of the Ministry of Rural Development (MRD).

3. The remote rural economy is becoming increasingly dependent on the improved national road network, yet the provincial road network, with a paved ratio of 11%, continues to deteriorate because of the rapid growth in traffic, combined with a lack of maintenance financing, and poor road maintenance standards, inadequate institutional capacity in road maintenance and management.

4. In 2011 ADB approved Loan 2839-CAM: Provincial Roads Improvement Project which intended to remedy aforementioned issues systematically by providing reliable all-year road access from provincial towns and rural areas to markets, employment centers, and social services in four provinces. These provinces are Kampong Chhnang, Kampong Speu, Svay Rieng and Prey Veng. These roads are unpaved with no all-year accessibility. The proposed project aims at continuing the initiatives of Loan 2839 further to ensure achieving the development objectives, impact and outcome through an extended scale of wider coverage.

5. PR312 that links NR1 with the CBF Banteay Chakrey is a provincial road that is vital for transport within Prey Veng province and for cross-border transport and trade. PR23 located at Kandal province is a provincial road for trade facilitation and development of the remote rural economy. During the inception phase the improvement of PR1534 which traverse Kampong Chhnang and Pursat provinces was included in the project scope. These roads do not provide all-year accessibility. The output for these roads is civil works. This output has associated detailed design and implementation supervision consulting services, and land acquisition and resettlement studies required for the project roads.

6. The project roads have been selected based on the following selection criteria: (i) connectivity to GMS corridors, (ii) government national road improvement program, (iii)

vulnerability to climate change effects, (iv) lower resettlement impact, and (v) closer geographical location.

7. Three provincial roads – PR23 and PR312 that both connect to NR1 and PR1534 have been selected for further study, and the feasibility studies are substantially completed. However, due to funding constraint, PR1534 has been excluded from the project scope by the government.

8. The impact of the Project is improved access to markets, jobs, and social services, and cross border transport and trade in project provinces.

9. The expected outcome of the project is the safe, cost effective, all-year access provided in the road network of provincial agricultural areas of Prey Veng and Kandal provinces, which encompass a large proportion of Cambodia's rural poor population.

10. There are two outputs of the Project that address the aforementioned issues pertaining to provincial roads, continuing from the efforts initiated in Loan 2839. Incidentally, Loan 2839 has been ongoing since 2011 which aims to rehabilitate 159 km of rural roads. The outputs are:

- i. Safe and climate resilient provincial roads completed civil works to improve roads PR312 and PR23, length 48.3 km approximately. This output has associated Detailed Design consulting services, Construction Supervision consulting services, land acquisition and resettlement required for roads.
- ii. The second output is increased road safety enforcement in project communes:
(a) a community-based road safety awareness program including education program for schools, drivers, road users, and the community, in-line with the national program that also incorporates road safety provisions in project design;
(b) analyzed road crash data at commune level for formulating road safety activities effective for communes, these data along with school characteristics are gathered to design the safety school zone under this output.

11. The overall objective of the Feasibility Study (FS) is to prepare the ensuing project that will achieve these outputs. The FS has undertaken the following studies.

- i. Preparation of the engineering design for the upgrading of PR312 and PR23 to a paved road standard with a DBST to provide safe, cost effective all year (all weather) access including preliminary pavement design. The overall length of these roads is 48.3 km.
- ii. The economic analysis for the project roads and the preparation of the benefit monitoring framework and the establishment of the sex-disaggregated baseline data for the design and monitoring framework for the ensuing project. All have been prepared according to ADB guidelines and Government guidelines, as applicable.
- iii. Preparation of the IEE for the project roads to comply with both ADB and the Government guidelines, and confirmation that the project is category B. Recommendations on mitigation measures for the Environmental Management Plan including its implementation and monitoring have been prepared.
- iv. Preparation of Resettlement Plans for the project roads and the preparation of the Resettlement Policy Framework.

- v. Preparation of the Poverty and Social Analysis for the project including the preparation of an HIV/AIDS and Human Trafficking awareness prevention program, and a labor and gender action plan for the project, for effective mainstreaming in all project outputs.
- vi. Preparation of a community based road safety plan for the project area and safety school zone, in-line and consistent with the national road safety plans.
- vii. Preparation of the procurement plan and a draft the Project Administration manual for the ensuing project, including suggestions for a remedial action plan for the MPWT's procurement capacity to reduce financial risks, and preparation of the good governance framework for the ensuing project and provide assistance in loan processing as required.

12. This final report for the FS describes the studies that have been carried out leading to the definition of the second provincial roads improvement project. Each study is described in detail and the results and recommendations used to develop a viable and effective project are presented. Separate reports have been prepared where required to meet the needs of the ensuing project. These include an Initial Environmental Examination, a Poverty and Social Analysis and the Resettlement Plan.

2 ROAD DESIGN

2.1 DESCRIPTION OF PROJECT ROADS

13. The project roads of PRIP-II are located in the 4 provinces. one of these is located in middle part, namely Pursat and Kampong Chhnang provinces, and the others are Prey Veng and Kandal provinces located in southeast of Cambodia. These provinces are mostly highly populated and predominantly agricultural area.

14. The total length of the project roads is approximately 132.8km. The individual roads vary in length from 19.9km to 84.5km. The project roads will provide better access to essential services, reduce remoteness and increase economic opportunities. All of the project roads link to a national road or provincial road and provide access to the road network at large. Currently all of national roads connecting the project roads are paved with either asphalt concrete pavement or Double Bituminous Surface Treatment (DBST).

15. PR312 that links NR1 with the CBF Banteay Chakrey is a provincial road that is vital for transport within Prey Veng province and for cross-border transport and trade. PR23 located at Kandal province is a provincial road for trade facilitation and development of the remote rural economy. During the inception phase the improvement of PR1534 which traverse Kampong Chhnang and Pursat provinces was included in the project scope. These roads do not provide all-year accessibility.

16. The project roads have varying widths depending on each project road. The drainage structures are often narrower than the width of the road and the carriageway is restricted at these locations. The widths of the existing roads are between 4m to 7m and some road sections which are like winding paths are less than 3m in width. The project will improve the existing roads to DBST paved roads for PR1534, RP312 and PR23 and upgrade more stable pavement structure.

17. Road numbering follows the national system prepared for national and provincial roads by MPWT in June 2009. The list of project roads in the four provinces is shown in Table 2.1.

Table 2.1 List of Proposed Project Roads

Code No.	Road No	Province	From	To	Length (km)
1	PR1534	Kampong Cham & Pursat	NR53, Tuek Phos, Kampong Chhnang	NR5, Pursat, New roundabout	84.5
10	PR312	Prey Veng	NR1, PK77+100 Samroung, Lvear, Pras sdach district	Banteay Chakrey Border	28.4
15	PR23	Kandal	PR110, Koh Thom Bridge	PR118 Peam Reang commune	19.9
	3				Total
					132.8

Source: Provided by MPWT, 2016

2.2 SITE VISIT AND FINDINGS

18. Numerous site visits have been undertaken to the project areas and engineering surveys also have been carried out on each of the roads proposed for improvement. These have included road inventory including bridges and drainage structures, geological survey measuring existing subgrade strengths, and hydrological survey through interview and measures of existing pavement strengths. Traffic count, environmental and resettlement studies have also been carried out. The detail of the surveys is consistent with a feasibility study level. More detailed studies must be carried out during the project implementation stage to provide the detailed design for civil works contracts.

19. The widths of the existing roads were measured frequently including the widths at structures where the road often narrowed. The surface material and conditions were also surveyed. All existing bridges were checked for length, widths, types and current condition etc. Drainage structures such as box and pipe culverts were surveyed for location, widths, lengths, sizes and current conditions.

2.2.1 PR1534 in Kampong Chhnang and Pursat Province, 84.5km

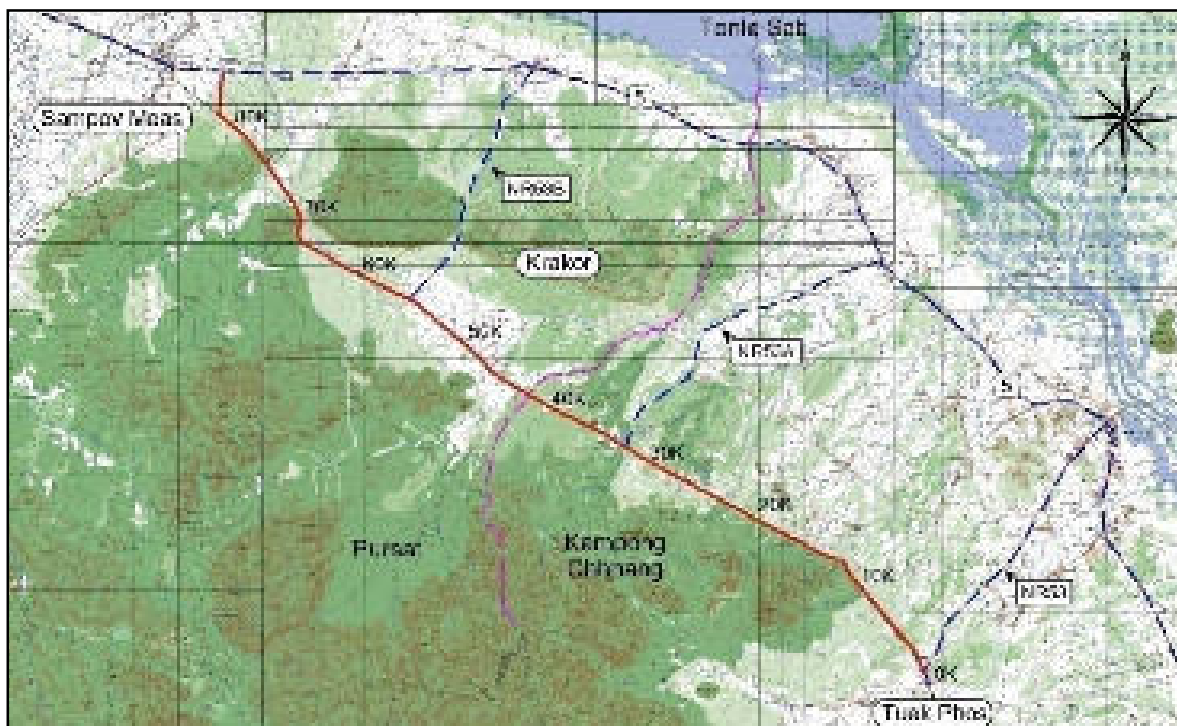


Figure 2.1 Location Map of PR1534

20. PR1534 with total length 84.5km is located in two provinces, Kampong Chhnang and Pursat provinces. Also this road passes 3 districts and 6 communes. Tang Krasang and Krang Skear commune are in Tuek Phos district of Kampong Chhnang province and Chheu Tom, Svay Sa, Tnaot Chum are in Krakor District, and Roleab is in Pursat city of Pursat province. It starts from NR53 junction (PK27.5) at Tang Krasang commune in Kampong Chhnang province and ends at new round about at PK180.6 of NR5 in Pursat province. The road traverses open fields, such as rice field and agricultural land, and light rolling terrain.

21. Most of the road is paved with laterite wearing course except for some section (about PK62.3~PK75.1) where is impassable by vehicles during the wet season. Paved section with laterite wearing course is well shaped in normal condition because it is maintained by DPWT and MPWT every year. Except two main town area at PK34 and PK47 on this road, houses and villages are rarely distributed along the road.

22. From the beginning point connecting with NR53 to about PK15.8, the road has been maintained about 5km length each year from 2013 to 2015 by DPWT. From PK15.8 of this road, MPWT has been maintaining this road since 2015. The section which has been maintained is 7.0m width with laterite wearing course in fair condition normally. But in some section, especially near structure sections (bridges, box/pipe culvert), laterite wearing course is rough and potholed and the continuing deterioration of pavement is in progress.



Figure 2.2 Typical Section and Potholed Section of PR1534

23. After travelling northwest about 30km along the road passing the cultivated land, the road meets NR53A which connects with NR5 paved with laterite wearing course at PK33.4. One of the main towns (markets) is located in this area from PK33.8 to PK34.2. After passing the first market area through to PK62.3, the road runs rice field and agriculture land. The other main market is located in Bamnak village from PK46.9 to PK47.5. These town areas are required to provide a more suitable solution for these built up areas. Within town areas a suitable drainage plan shall be considered on the both side of the road.

24. From PK50.7 to PK56.1, a wide channel flows alongside the right side of project road. This channel is from Bamnak River and irrigates the cultivated land along the road. Since this channel is wide and high-speed, this section shall be considered one side extension of the road to minimize effects of the construction and maintain the capacity of the channel..



Figure 2.3 Town Area at PK 34 and Main Channel at PK 50.7

25. The project road meets NR53B connecting NR5 and PR1534 at PK56.1 forming 5-way intersection. Thus, this section should be planed carefully for road safety and traffic flow during the detail design period. From PK 56.1 to PK62.3, existing road is in good condition with 7m width and has good side drain being used for the channel on both side of the road because this section has been constructed in 2016.

26. From PK62.3 to PK75.1, existing road is unpaved with soil surfacing and it is impassible by vehicles during the wet season. Especially the section from PK67 to PK70 is more serious. The road in this section passes the rolling terrain and forest area. Drainage facility, such as box/pipe culvert and side drain, is insufficient and it has caused a road washout.



Figure 2.4 5-way Intersection and Existing Road (Washout)

27. The railway runs alongside PR1534 with about 50m spacing from beginning point to PK80.7. Especially at PK70.2, since the distance of C.T.C between railway and existing road is only 19m, this section shall be considered one side extension of the road to minimize effects of the construction and keep the RoW of between the project road and the railway.



Figure 2.5 The section passing close to the railway

28. There is a mobile phone tower at PK 71.3 in Tnaot Chum commune. Existing road passes through this mobile phone tower and trees with narrow width as shown Figure 2.6. This section has 3 curves with small radii continuously about 80m long and it is very close to the fence of the mobile phone tower. Thus, this section shall be considered realignment in order to avoid the conflict with this tower. Even if there are no any obstacles, this section shall be straitened.



Figure 2.6 Location and View of Mobile Phone Tower Section

29. From PK 71.4 to PK74.3, the project road passes open fields with rice field and agricultural land. In this section, the existing road is just a farm road which is not formed in the shape of the road and has same elevation with surrounding area. Therefore, Final road level shall be raised up in consideration of flooding level and cross drainage structures.

30. From PK 74.3 to PK 75.1, this section is also impossible to pass due to Oh Veng River. Currently, there is some trace of the timber bridge. This river flows to the northeast and its width is about 80m. New structures, such as bridge and new box culverts, are necessary to pass this section. It is very important to raise the level of the existing road and to plan drainages.



Figure 2.7 Oh Veng River

31. From PK 75.1 to ending point which connects with NR5, the road passes the rice fields and agricultural land again. The existing road is 7m width with laterite wearing course in normal condition. Near structure section, such as bridge and box/pipe culvert, existing wearing course is rough and potholed, continuing deterioration of pavement is in progress.

32. The existing structures are 18 bridges (8 concrete bridges, 3 bailey bridges and 7 timber bridges) and 33 box culverts and 60 pipe culverts. Even though these box/pipe culverts have enough lengths and fair conditions, except few culverts, it will be considered to replace in consideration of some reasons such as new irrigation channels, capacities of culverts and integrated drainage plans. Along the project road, there are 10 schools and 2 hospitals.



Figure 2.8 Existing Timber Bridge and Pipe Culvert

2.2.2 PR312 in Prey Veng Province, 28.4km



Figure 2.9 Location Map of PR312

33. PR312 is located in Prey Veng province, and traverses one district (Preah Sdach) and 4 communes, Lvea, Chey Kampok, Angkor Reach and Banteay Chakrey. It starts from the intersection with NR1 about 16km southeast of Neak Loeung Bridge and ends at Banteay Chakrey Border. The road traverses open fields with rice field and agricultural land. Houses and villages are distributed along the road.

34. PR312 with total length of 28.4km connecting NR1 and Banteay Chakrey Border is paved with DBST with 4.2~4.6m width. The condition of existing DBST is not severe except some section. It is possible to maintain 50-60km speed, but considering the traffic volume of the harvesting season, the carriageway is not enough for two-way traffic.

35. Two sections with a total length of 1.3km have been paved newly with 6.2m width by DPWT financing in 2015. But existing road cannot be simply overlaid with the macadam base left in place in its present condition due to unsuitable materials for CBR value. The road maintenance by patching was observed along lengths of the existing road on multiple occasions.



Figure 2.10 Existing Road (DBST) and Damaged Pavement

36. It was noted that there are three widening section at the curves of PK7.2, PK14.3 and PK23.1 with 10m~11m widths on this road. But it needs to consider that more sections will be needed to wide for the road safety. In most of sections along the road, there are

channels on one or both side of the road except town areas. It is understood that these channels have been formed by cutting soil and filling it for materials of road embankment. The major town of PR312 is located in Angkor Reach commune from 9.8km to 10.5km and substantial town is from 28.0km to the Banteay Chakrey Border with a length of about 400m. These town areas is required a suitable cross section for drainage plans on both side of the road.



Figure 2.11 Town Area at PK 7.2 and Widening Section at PK 23.1

37. There is a small port along the Krorm River toward south from the Banteay Chakrey Border. It is used for a means of alternative transportation for the import and the export. Generally, unhulled rice and mango are exported to Vietnam and rice is imported from Vietnam. Actually this access road has a function of connection to the project road, but it doesn't serve as a provincial road. Further, it is not a public road but just private land. Thus, it is not necessary to include in the project.



Figure 2.12 The Port near the Border

38. The existing structures are 2 box culverts and 20 pipe culverts. Even though these box/pipe culverts have enough lengths and fair conditions, except few culverts, it will be considered to replace in consideration of some reasons such as integrated drainage plans, new irrigation channels and climate changes. Along the project road, there are 11 schools and 1 hospital.



Figure 2.13 Existing Box and Pipe Culvert and New Irrigation Channel (Pipe, PK18.1)

2.2.3 PR23 in Kandal Province, 19.9km

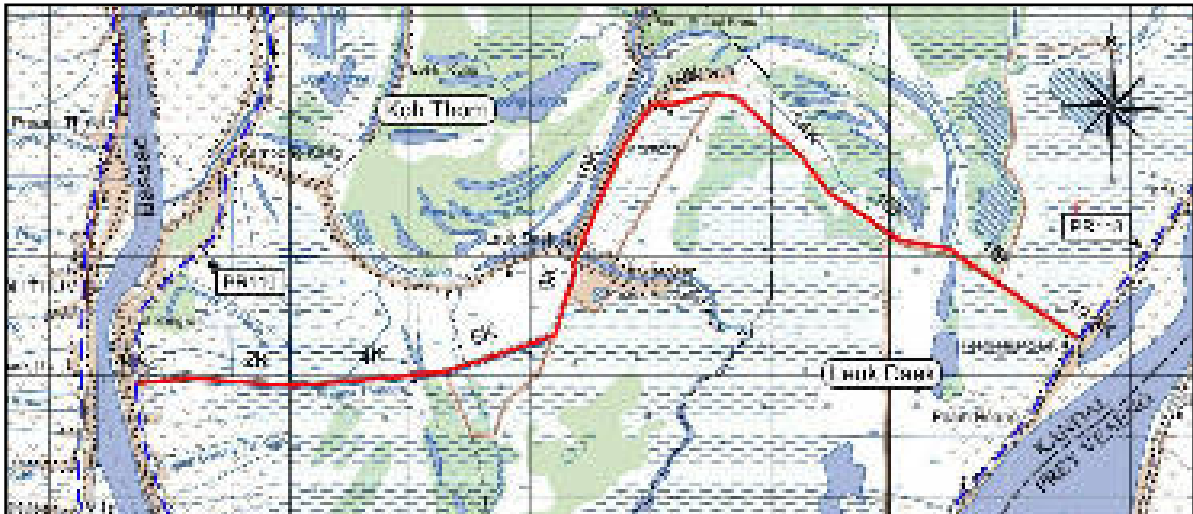


Figure 2.14 Location Map of PR23

39. Kandal province covering PR23 completely surrounds the capital Phnom Penh and features two of the biggest rivers in the country, the Bassac River and Mekong River. PR23 is located in two districts, Koh Thom and Leuk Daek, of Kandal province, and it covers 4 communes; Chrouy Takaev, Kampong Kong, Leuk Daek and Peam Reang. The road traverses typical plain wet area, covering rice fields and other agricultural land. Houses and villages are distributed along the road.

40. The road length including realignment section and minor adjustment sections is about 19.9km. PR23 starts from the intersection with PR110 connecting to Koh Thom Bridge which is under construction at the Bassac River in Chrouy Takaev commune and ends at the intersection with PR118 in Peam Reang commune around Mekong River. Most of existing road is with natural soil surface in very poor condition. It is rough and potholed severely and is not possible to pass during wet season.

41. From beginning point to about PK0.9, realignment will be set in order to connect with Koh Thom Bridge. After that, the road traverses open fields with rice fields and corn crops land through to PK 11.4. In this section, existing road is with natural soil surface and has narrow width sometimes. It is impossible to pass by vehicles during the rainy season due to severe road condition. Except beginning section and around Wat Chroy at PK 8.4, houses and villages are rarely distributed along the road.

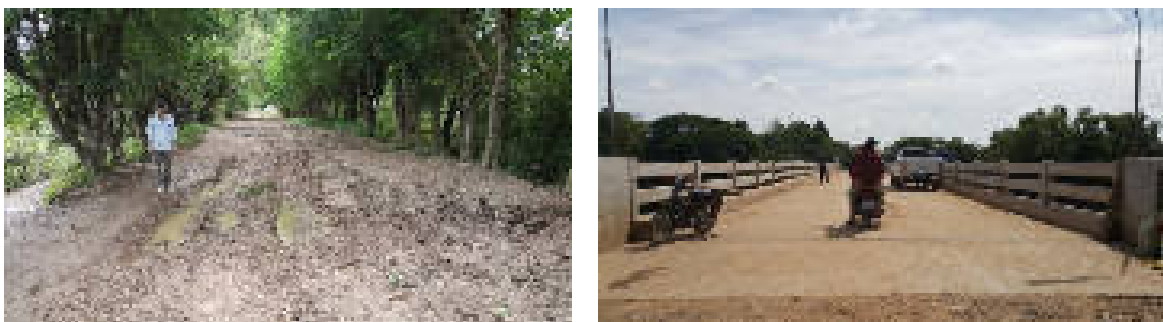


Figure 2.15 Existing Road and Wat Chroy Bridge.4

42. From PK11.4 through to PK19.3, this section has more severe conditions. The winding road has too narrow width in very poor condition. This section is required minor adjustment to straighten the existing road. Especially from PK16.2, existing road is a winding path with 1m~2m width through to the swamp. Even in the dry season, this section is not possible to pass by vehicles. This section is required raising the road level and a suitable drainage plans.



Figure 2.16 Existing Road Condition at PK 11.4 and PK 16.5

43. In PK18, there is a swamp blocking up the road with over 100m width. The original ground is particularly low and existing road have been washed out by the water. It was understood that the road have been flooded up to about 60cm to 120cm over the road in 2000. This section is required to be raised up to over 3.0m from original ground to reduce the risk of flooding and the bridge or box culvert will be planned to allow the water in both side of the road to pass.

44. The existing structures are 1 bridge, 8 box culverts and 3 pipe culverts. The concrete bridge built in 2011 by government financing is with 8m width and 90m long. The consultants judged to use it without replacement by the current condition and its width. Existing box culverts are generally with short lengths in poor conditions. All of the existing box culverts are needed to be replaced in consideration of the project road. One pipe culvert will be replaced with box culvert to connect the new irrigation channel.



Figure 2.17 Existing Box Culvert and he Swamp Area

45. The major town/market area on PR23 is located around Wat Chroy Bridge (PK 8.6) in Leuk Daek commune, Koh Thom District. Since it is located along the Leuk Daek River, not on the project road, this town section is not necessary to consider any drainage plans on the both side of the road. There are 3 schools along the project road.

2.3 ROAD DESIGN

2.3.1 Road Cross Section

46. For each of the project roads, cross section surveys have been carried out with 500m intervals and some section where the road is seen to be significantly different to the preceding section. The cross section surveys are principally to assist with ensuring the road heights are suitable for the surrounding terrain and with respect to climate resilience, and to assist with estimating quantities for civil works. The design approach for road height and finished road levels is described in section 2.3.4. The cross section drawings for existing roads are in Appendix D.

47. A typical road section for improvement was studied in consideration of function of project roads, resettlement impact and construction costs. The typical cross section of project roads are decided two types in areas as rural road and urban road. Total road width also will be divided two types, 9.5m and 8.0m widths for both rural road and urban road. The road with total width of 9.5m includes 6.5m carriageway with 1.5m shoulders on each side. It will be applied to PR312 and PR23. PR1534 will be applied 8.0m road cross section with 6m carriageway and 1m shoulders on each side. Elements of cross sections for each road are summary in the table 2.2.

Table 2.2 Summary of Road Cross Section

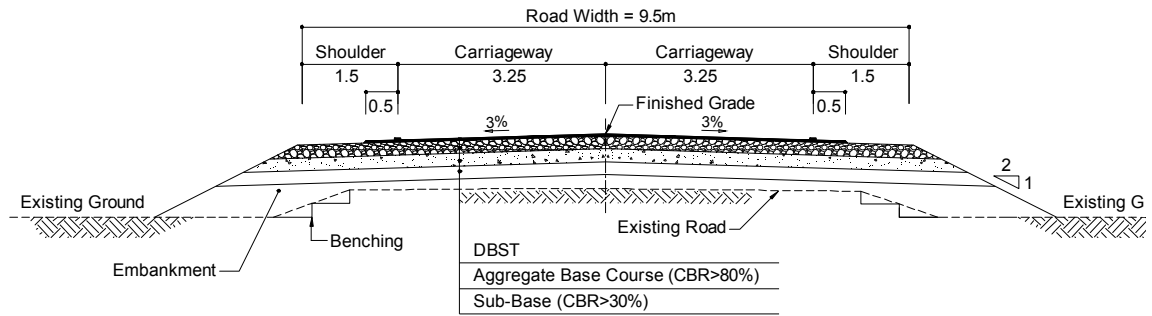
Road No.	Project Road Width			Existing Road Width
	Carriageway	Shoulder	Total	
PR1534	2@3.00=6.0m	2@1.0=2.0m	8.0m	2.0~7.5m
PR312	2@3.25=6.5m	2@1.5=3.0m	9.5m	5.5~8.0m
PR23	2@3.25=6.5m	2@1.5=3.0m	9.5m	2.0~7.2m

48. Although some existing road sections are not homogeneous in width and many structures are narrower than the project road width, they will be upgraded to provide safer roads. The surfacing of the carriageway will be a Double Bituminous Surface Treatment (DBST) and some part of shoulder also will be paved with DBST in order to maintain the function of carriage way and provide the safety and comfort of driving for bicycles and motorcycles for the rural roads.

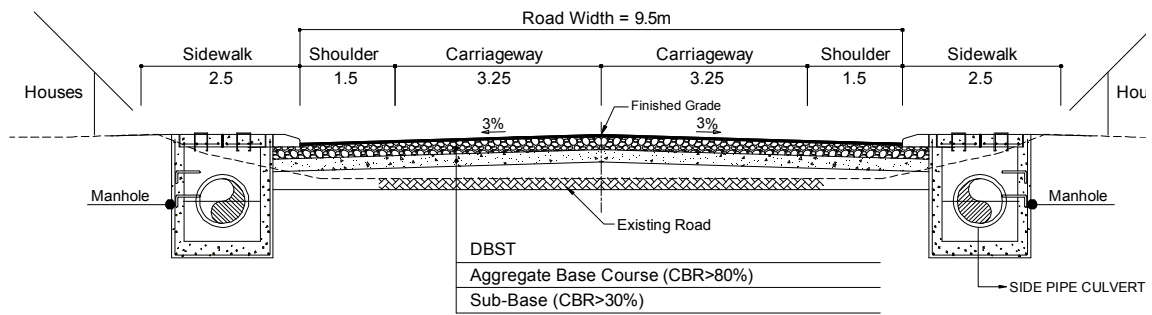
49. The carriageway and shoulders will have the same cross-fall to maintain an even grade across the surface so that vulnerable road users can easily travel on the shoulders. Where side drains are to be provided, these will be trapezoidal in shape with shallow slope. Side slope of the road will be grassed with topsoil for the slope protection. Widening will be considered in some curve sections where have small radius and the width of widening will be decided according to Road Design Standard – Geometry (MPWT, 2003)

50. For the town areas (market areas), the cross section will be more suitable for these built up areas. These town areas have shop on both sides of the road and will limit resettlement and the effects on main structures and provide a safer environment for road side vendors and pedestrians. The carriageway will be same as rural road but whole shoulders will be paved with DBST and the sidewalk with 2.5m width will be installed with raised curbs. The curbs will have a vertical face to prevent vehicles using the sidewalk and side walk will be provided for pedestrian use only. Longitudinal side pipe culvert will be installed under the sidewalk for the side drainage.

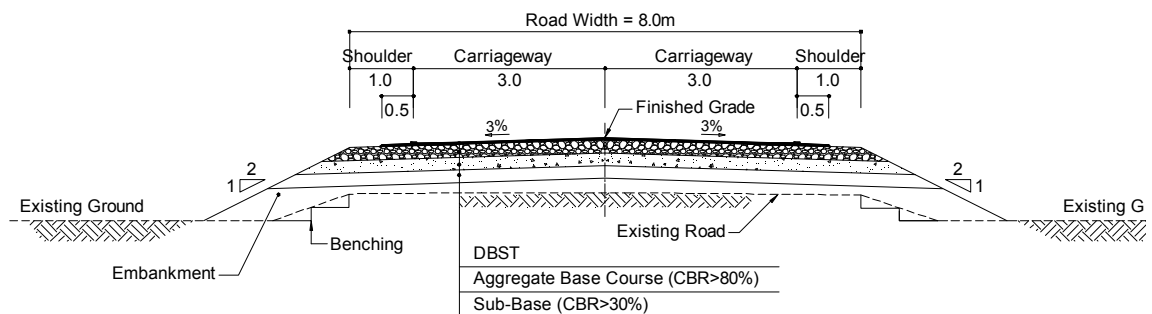
51. Typical cross-sections for the improvement of project road are proposed as shown in Figure 2.18.



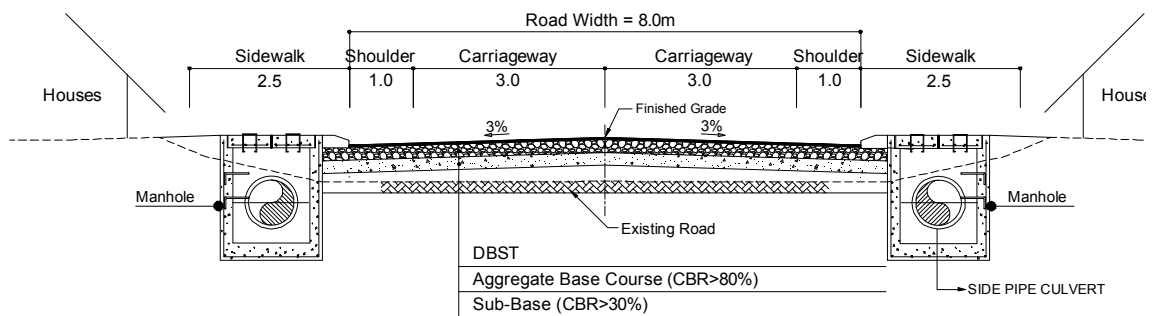
(a) Type-A, Rural Area (W=9.5m)



(b) Type-B, Town Area (W=9.5m)



(c) Type-A, Rural Area (W=8.0m)



(d) Type-B, Town Area (W=8.0m)

Figure 2.18 Typical Cross Sections for Project Roads

2.3.2 Road Realignments

52. In principle, the project roads will follow their existing alignment. However two realignment sections are proposed on PR1534 and PR23. On PR1534, there is a mobile phone tower beside the road at about PK71.3 and the existing road passes through this mobile phone tower and trees with narrow width as show in Figure 2-19. Existing road has 3 curves with very low radii about 80m long and it is very close to the fence of the mobile phone tower. This section shall be considered realignment in order to avoid the conflict with this tower. Even if there is no any obstacle, this section shall be straitened.

53. Second realignment section is on PR23. PR23 plays an important role as a connecting road between Bassac River and Mekong River neighborhood. It is provincial road for trade facilitation and developoment of the remote rural economy. Thus, PR23 will be realigned at beginning section about 940m long in order to connect with Koh Thom Bridge which is under construction at Bassac River. Finished road level also will be raised up in consideration of flooding level and cross drainage structures in this section.

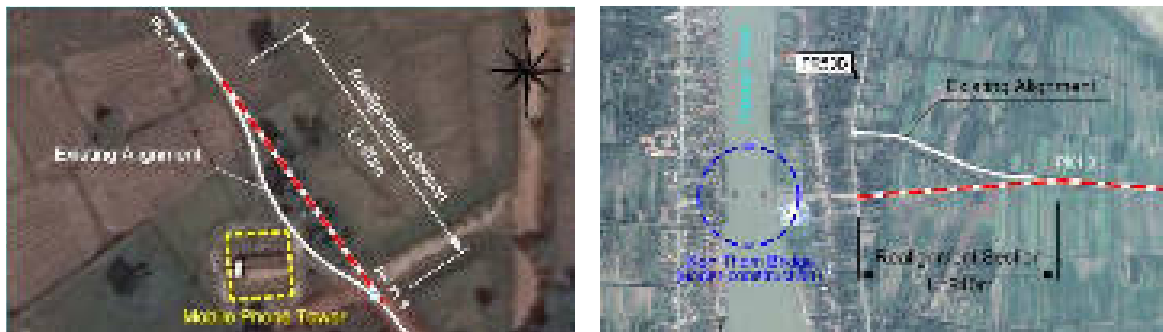


Figure 2.19 Realignment Sections of PR1534 and PR23

2.3.3 Minor Adjustments within the ROW

54. Three minor adjustments of the road centerline are recommended. The first minor adjustment is on PR1534. There are two sections to be adjusted the alignment on PR1534. First section is from PK 67.0 to PK 70.7 where road passes rolling terrain beside Totoeng Thngai mountain. Second section on the PR1534 is from PK73.4 to PK75.2. Two-thirds of this section traverses open field in slight windings and the other section passes through the forest with some stream and river. These two sections shall be improved by minor adjustment within the RoW.

55. The second minor adjustment is from PK11.8 to PK19.3 on PR23. In this section, existing road is winding very often. Especially from PK 16.2, existing road is a winding path with 1m~2m width through to the swamp blocking up the road. This section will be improved by being straightened and increasing the radius of the curve.

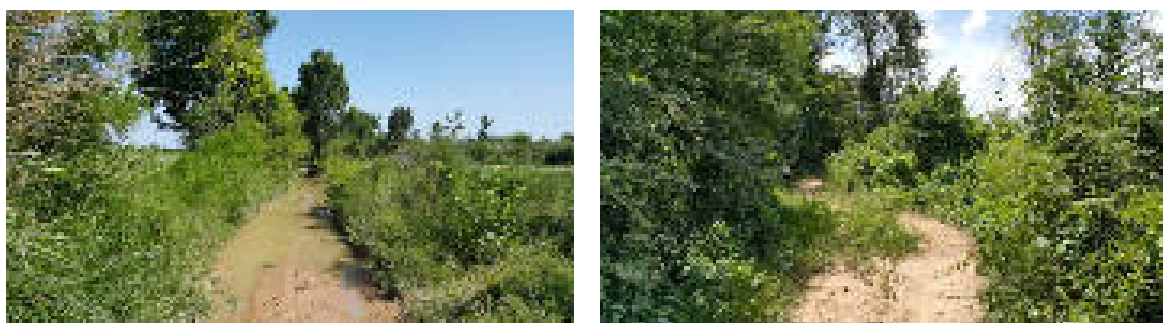


Figure 2.20 View of Minor Adjustment Section for PR1534 and PR23

2.3.4 Finished Road Levels

56. There is a balance between raising road heights because of the risk of climate change causing flooding and preserving the current heights to maintain access to roadside properties and intersections. Unnecessary raising of the road level is not aesthetic and also presents a greater hazard to road users, in the event that they have an accident. Care and attention must also be paid to the provision of side drains to ensure run-off water does not concentrate in roadside properties.

57. For the PR1534, the existing road is not generally at risk from increased rain fall and flooding. According to the interview with DPWT staffs and residents, there was no flooding for latest few years after upgrading the road by DPWT and MPWT from beginning point to PK62.3 and PK75.1 to ending point. Most of this section will be raised by the height of the pavement, approximately 50cm. But some sections which are likely to be flooded are required more raising the road level at PK15.8, PK 18.4 and PK53.1. Localized height adjustments will be attended to during detailed design. A section from PK62.3 to PK75.1 will be raised the road level between 60cm to 90cm for the risk of climate change causing flooding and suitable drainage plans.

58. PR312 is at an adequate height and there was no flooding area according to the interview with DPWT and residents. This road will be raised by only the height of the pavement thickness, approximately 45cm.

59. For PR23, finished level of the realignment section will be raised up 1.3m height which is the same elevation of existing road. The vertical slop of the PR23 is not mostly smooth. It was noted that there are some flooding areas through to PK11.4 in 10cm~25cm depth by interview with residents. Basically, this section will be raised approximately 60cm height including the pavement and subgrade thickness. From PK11.4 to 19.3, the project road will be raised 80cm height in consideration of the low lying area which is same level with nearby topography. Especially a section at PK18.4 which is blocked by the swamp is required more than 3.0m embankment height. The ending section also will be raised about 60cm height.

60. Basically, finished road level for project roads will be 60cm higher than High Water Level (HWL) in order to prevent possible damage to the pavement structure during the wet season as shown in Figure 2.21.

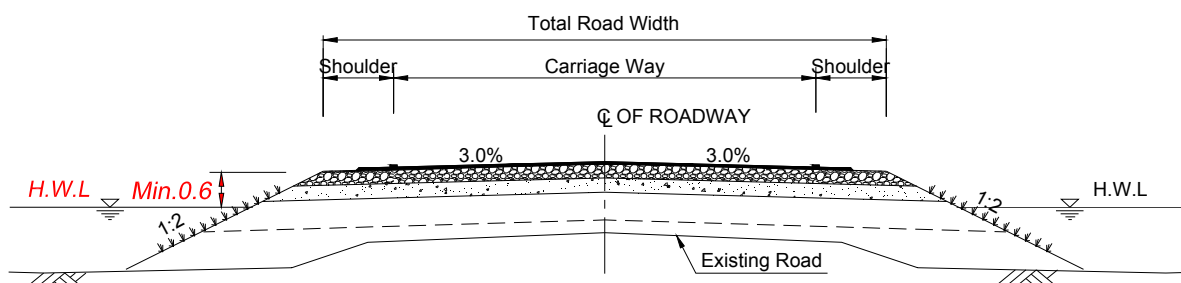


Figure 2.21 Road Cross Section at the Inundation Section

2.4 PAVEMENT DESIGN

61. The Pavement design for the project roads is based on the Cambodian Road Design Standard Part 2: Pavement (MPWT 2003), which for flexible pavement is itself founded on TRL Overseas Road Note 31 (1993).

62. To decide project oriented effective pavement design, obligatory information is required on the existing subgrade of each individual selected road sections and the cumulative traffic axle loading over the design life for each road sections. Supplementary details are needed about the availability and location of construction materials for intended pavement type. Getting together and using this information an appropriate pavement design can be chosen from one of the charts given in section 2.7 of the Cambodian Road Design Standard.

63. At this stage of project development which is before the detail design period, the pavement selection is only an analytic in many respects but allows the estimation of material quantities and hence cost to be determined with sufficient accuracy for the project to move ahead. The objective is to select an appropriate design that minimizes the cost and produces a durable pavement. At the same time the road designs are required to be resilient towards climate changes. Minimum cost and durable pavement in the past has meant durable with respect to accepted engineering standards, durable now means resilient to changes in the future. This approach has been taken in the design process.

64. Roads are threatened mostly by increase in water within the structure and consequential early failure because of the loss of strength. Decrease in water within the pavement structure generally mean increase in strength and therefore greater durability, although shrinkage cracking can occur and these must be sealed promptly to prevent an easy path for water to enter the structure when it rains. Increase in water are often gradual changes caused by water movement in the liquid or gaseous phase as the road moves into equilibrium with the environment, which itself is changing with the effect of climate change. The conditions on the road are likely to change seasonally, particularly in Cambodia where a five month dry season is followed by a long, seven month wet season, and precipitation and runoff water levels are high.

2.4.1 Subgrade

65. The existing subgrade have been constructed comprising the material alongside the road or from nearby local borrow areas. Therefore the soils in the road are indicative or those will be used for widening or raising the height of the road embankment. The strength of the existing subgrade and pavements, gravel or paved component of the project roads has been tested by the consultant to determine their in-situ strength and physical properties of material in place.

66. Existing subgrade soil investigated in the months of June and August, 2016. In-Situ California Bearing Ratio (CBR) by TRL Dynamic Cone Penetrometer (DCP) method and other relevant physical properties have been tested on samples collected from the project road sections. Test results have been analyzed and considered for design purposes. DCP penetration test done up to the depth of 1000mm below the existing subgrade surface. Test pits were selected staggered at both side edges and wheel tracks of graveled, paved road and unpaved road sections at an interval of 5 kilometers. Same test pit used for DCP tests

and other samples to test in the laboratory. Summary of the DCP and laboratory tests results are presented in Appendix F of the final report.

67. Because of plenty of rainfall in a year, the expected ground water table to be within one meter of the ground surface or above within the neighborhood of the project roads, it alerts that the road pavement has to be located on an embankment of a suitable height to avoid saturation of pavement from below and of course inundation from the sides.

68. To decide on a suitable design CBR for the subgrade strength the 10 percentile level value of the measured strength is used to ensure effectively the entire road will be strong enough to endure the cumulative loads imposed by the traffic during the design life. The existing pavement with DBST surfacing for PR312 is strong enough to use as subgrade considering subgrade strength class S4. Road PR1534 stretching over Kampong Chhnang and Pursat Provinces has existing lateritic surfacing from Ch.0+000 to Ch.62+200 and Ch.75+000 to Ch.84+500 which can be used as subgrade considering subgrade strength class S3.

69. The road section of PR1534 between Ch.62+200 and Ch.75+000 is earth surface public traffic not passable during wet season particularly during rainfall, needs lifting up of height and widening by new embankment material of 4 days soaked CBR not less than 4 percent (AASHTO T193) at 90 percent of MDD (AASHTO 180) and selected subgrade material of CBR strength not less than 10 percent (AASHTO T 193) when compacted to 95 percent of MDD (AASHTO T180). For road number PR23, the existing embankment will require increase in height and widening. Materials of 4 days soaked CBR strength not less than 4 percent for embankment (subgrade strength class S2) and 4 days soaked CBR not less than 10 percent for top 20 to 30 cm selected subgrade has been considered to be used in the design.

70. Usual practice to use of 4 days soaked CBR strength is appropriate to suit the weather condition in Cambodia as the project roads are located in the central plains where annual flooding is natural phenomenon and because this ground water table remains close to the ground surface for much of the year. Therefore the tested data can be used as reference to find a representative strength of soils available nearby the project roads and can be used for road embankment widening and elevating heights. To check the material strengths for embankment, selected subgrade, subbase and base course a CBR after 4 days soaking be tested in the laboratory following the AASHTO T 193 designation when compacted to specified degree of MDD following AASHTO T 180 in each and individual case as specified in the particular project technical specifications.

2.4.2 Traffic Loading

71. Traffic axle loading over the design life has been estimated from classified traffic counting by the consultant in 2016. For the purpose of the pavement design, only the heavier vehicles contribute significantly to structural deterioration of the road. To accumulate the loading, information is required on the current daily numbers of heavy vehicles, an equivalency factor (EF) for each vehicle type, which will allow for those that are loaded and those that are unloaded, a day to night factor if night has not been recorded for 24 hours periods, and a seasonal factor to allow for variations such as more traffic in harvesting time. Prominently, estimations must be made for the growth of traffic using axle load survey data available weigh stations near by the project roads. For computation of Cumulative Equivalent Standard Axles (ESAs), representative Traffic Axle Load data recorded in January and

February 2016 at weigh stations located at Ch.48+000 of NR-5 at Long Vek in Kampong Chhnang Province, Ch.191+00 of NR 5 at Klaing Meuong village in Pursat Province and Ch.149+100 at Bavet in Svay Reing Province were used as standard reference for all project roads.

72. The Annual Average Daily Traffic (AADT) base traffic levels have been determined for each project roads. These are summarized in Table 4.5 of Chapter 4 Traffic, with traffic grouped into four categories; non-motorized, motorcycles, light vehicles, heavy Vehicles. A table showing all vehicle types is given in Appendix 1.

73. The equivalency factor for each vehicle type is shown in Table 2.3. These were estimated from an analysis of the WIM data obtained from NR5 and NR-1 in 2016. These are regarded as being typical for the heavy vehicle fleet in Cambodia.

Table 2.3 Equivalency Factor for Each Vehicle Type

Vehicle Type	PR1534 & PR23	PR312	Vehicle Type	PR1534 & PR23	PR312
Car	0.004	0.004	Light Truck	0.324	0.324
Jeep/4-WD	1.010	1.010	Medium Truck	2.527	4.787
Pick-up	0.050	0.050	Heavy Truck (3 axle)	3.886	6.834
Minibus	0.040	0.040	Heavy Truck (4/5 axle)	3.216	4.325
Bus	1.024	1.024	Semi Trailer (4/5 axle)	4.645	5.498
Small Koyun	0.050	0.050	Semi Trailer (6 axle)	5.940	7.167
Large Koyun	0.200	0.200	-	-	-

74. The traffic growth rate is shown in Table 4.9 of Chapter 4 Traffic. The Resulting calculations of the cumulative equivalent standard axles in million in one direction over a 20 year design period are shown in Table 2.4. Where the cumulative equivalent standard axles are close to the traffic classes, the class assigned is the highest class in accordance with the design manual.

Table 2.4 Traffic Class for Pavement Design

Road ID	ESA (millions)	Traffic class
PR1534-1 (Pk. 0+000 to 62+200)	1.54	T4
PR1534-2(Pk.62+200 to Pk.84+500)	1.52	T4
PR312 DBST	5.66	T5
PR23 earth surface	0.83	T3
- Source of data: Consultant's Traffic Survey and Computations - PR1534-1 Traffic count at Pk.33+800 (Kg Chhnang Province area of road) and PR1534-2 Traffic count at Pk.47+000 (Pursat province area of road)		

2.4.3 Pavement Design Options

75. The deliberations made towards selecting an appropriate design chart for the project roads are the availability of construction materials that shall meet the technical specifications required in the pavement design manual of MPWT and additional requirements that the road should be climate resilient. The source of specified quality hard rock quarries to get aggregate for base course and surfacing are not available within short hauling distance from the project roads. There is also scarcity of specified quality subbase materials within the neighborhood of the project roads. However, within 20 to 150 km hauling distance stone quarries for hard rock aggregates for base course and surfacing are available. Subbase materials can be procured from nearby mountainous area and highlands. In some cases the natural laterite required to be mixed with base course aggregates to meet the specified grading and inclusive material quality.

76. The overall priority is to make best possible use of the local materials wherever is practical. The traffic loading and subgrade classification as shown in Tables 2.4 and Table 2.4 respectively indicates that Chart-1 of the Cambodian Road Pavement Design Standards is suitable for pavement design of the project. The selected subgrade material 4 days soaked CBR (AASHTO T 193) considered to be 10 percent when compacted to 95 percent of MDD (AASHTO T 180) in place of 15 percent specified in the technical specifications of PMU3 for PRIP-I.

77. The reason to reduce the CBR from 15 percent to 10 percent is the unavailability of material with CBR value 15 percent for subgrade within reasonable hauling distance, both sides of the project roads are farming flat land and natural borrow pit soil alone cannot produce 15 percent CBR. The other reason is 10 percent soaked CBR for subgrade material is quite satisfactory to support the designed pavement load for provincial roads. It is citable here that "GMS Cambodia Road Improvement Project, ADB Loan No.1945-CAM(SF) and GMS Northwest Provincial Road Improvement Project ADB Loan No. 2539-CAM (SF) both used 4 days soaked CBR not less than 10 percent for new and selected subgrade material strength.

78. Aggregate base course and granular subbase, in addition to bearing the traffic loads, also considered to drain out the excess moisture from the pavement if penetrated because of rainfall or flooding. Subbase materials once soaked take longer time to drain out excess water might cause pavement damage while flood water submerged the surrounding. To get rid of such natural problem, in the pavement design free board allowance has been considered to keep the formation level or lower most layer of the pavement structure above the Highest Flood Level (HFL) recorded for the project roads.

79. Design Chart-1 under Section 2.7 of the Road Design Standard (Part-2 Pavement MPWT 2003) considered suitable for the project roads because it includes the options of granular subbase and selected subgrade. Selected subgrade material is available at locations not frequently like embankment but will be available within 3 to 5 km hauling distance from the project roads. Naturally occurring granular subbase material will save the project cost and will provide opportunity to make faster progress of the project works. In some cases well graded subbase material may be difficult to find. If such condition encountered, base course aggregates of suitable percentage can be mixed with the natural gravel or lateritic materials to improve grading and strength. The thickness of each component part of a flexible pavement has been determined evaluating the computed value of cumulative equivalent standard axles in millions and soil class strength of a particular road sections and are entered in Table 2.5.

Table 2.5 Pavement Design Thickness

Road sections		Sub-grade strength class	Traffic Class	Surfacing	Thickness of pavement layer (mm)		Thickness of selected subgrade (mm)
					Aggregate Base	Granular Subbase	
PR1534	PK 0 to PK 62.3	S3	T4	DBST	200	275	200
	PK 62.3 to PK 75.1	S2	T4	DBST	200	225	200
	PK 75.1 to PK 84.5	S3	T4	DBST	200	275	200
PR312	PK 0 to PK 28.4	S4	T5	DBST	200	250	200
PR23	PK 0 to PK 19.9	S2	T3	DBST	200	175	200
For PR1534 existing lateritic wearing course and for PR312 existing pavement can be used as selected subgrade. New subbase can be constructed on the existing pavement or wearing course. However shoulder areas to be widened and old portion excavated to a depth of not less than 200mm and backfill with material having 4 days soaked CBR value not less than 10 percent (AASHTO T 193) when compacted to 95 percent of MDD (AASHTO T180).							

80. The existing surface of PR1534 stretching over Kampong Chhnang and Pursat Province Ch.0+000 to 62+300 and Ch.75+300 to 84+500 have lateritic wearing course and all season passable by public traffic but the road section between Ch.62+300 and Ch.75+300 is narrow earth surface and about 60 cm low from the level of lateritic surface, not passable during wet season. Existing subgrade soil investigation of this road indicates subgrade below lateritic wearing course has strength class is S3 according to IN-Situ CBR test by DCP. However when sample taken from existing subgrade and tested in laboratory, 4 days soaked CBR (AASHTO T193) found average 13.67 percent when compacted to 95 percent of MDD (AASHTO T 180).

81. The existing lateritic wearing course have average thickness of 18cm and test shows 4 days soaked CBR for this layer is average 52 percent (Appendix F, Table D-1) which is much higher than selected subgrade CBR of not less than 10 percent. However this lateritic wearing course cannot be used as subbase because it needs widening and raising embankment to overcome flooding problem. The existing lateritic wearing course therefore has been considered to be retained as selected subgrade for future follow up construction.

82. Material required to widen the subgrade width can be added in the estimate. Both side shoulders of lateritic wearing course required to be widen to the design standard and 200mm depth of shoulder top to be filled with material having 4 days soaked CBR not less than 10 percent to bring it to the level of exiting lateritic wearing course. Road section Ch.62+300 to Ch. 75+300 is narrow earth embankment and needs widening and lifting up height by earth filling and constructing all item including embankment, selected subgrade, subbase and aggregate base course.

83. PR312 has existing old, several time repaired irregular pavement surface with bituminous surfacing (some part AC and some part DBST). Aggregate base course and subbase thickness is variable, different quality material used and some location has no base course, surfacing placed directly on granular wearing course with first few kilometers of the

road. Existing subgrade soil In-Situ CBR test by TRL DCP and its analysis indicates that it meets the subgrade strength class S4 of Road Design Standard, Part-2 Pavement.

84. Laboratory tests on existing base course and subbase materials sampled from road shows that 4 days soaked CBR is average 119 percent (AASHTO T 193) when compacted to 95 percent of MDD (AASHTO T180) for base material and the layer below it is subbase used quarry by product and sandy soil mixed with quarry waste and has 4 days soaked CBR average 101 percent(Appendix F, Table D-1) which means they are strong enough to use as base and subbase respectively for new construction but they cannot be because the pavement layers are with variable thickness and uneven surface and needs widening and increase height of embankment to meet design parameters.

85. Some location for example at Ch. 25+000 LHS 1.5m the base course material below thin layer of asphalt concrete has been found very poorly compacted. 4 days soaked laboratory CBR for this location is high because of good material but on the road the base course layer is loose, not well compact. Considering all those facts and high traffic impact on the road (Traffic Class T5), the existing pavement after recycling and spreading the salvaged material uniformly overfull design width and re-compact to form the subgrade of CBR not less than 10 percent (AASHTO T193) when compacted to 95 percent of MDD (AASHTO T 180). Thus construction of new subbase and base course on reconstructed subgrade have been considered in the design of pavement layers following design Chart-1 in the Road Design Standard, Part-2 Pavement (MPWT 2003).

86. The material from the existing pavement of this road therefore can be scarified to a depth of 100mm from surface, spread over the full width and re-compact. Alternatively both side earth shoulder can be widened first to design width, fill top 200mm of shoulder width by use of subgrade material having 4 days soaked CBR not less than 10 percent and compact to the specified degree of compaction and bring the compacted surface to the level of existing pavement surface true to the level and crossfall specified. Additional quantity of material required to backfill the widening part of subgrade to be estimated and quantity be added in the BOQ.

87. For PR23 in Kandal Province, the existing earth road embankment needs raising height to avoid flood inundation and widening to meet the design standard. The existing embankment soil falls under subgrade strength class S2 that means it has provision for adding selected subgrade as per design chart-1 of design manual. As the embankment height to be raised to keep the road passable by public traffic round the year and place the lower level of pavement above top of ground water table and safe from flood water inundation, therefore top 200mm of the embankment is suggested to be constructed using material having 4 days soaked CBR not less than 10 percent (AASHTO T193) when compacted to 95 percent of MDD (AASHTO T 180).

2.4.4 Surfacing

88. The surfacing for design chart 1 is Double Bituminous Surface Treatment (DBST). This surfacing will protect the pavement below by waterproof seal. It will also provide sufficient skid resistance properties. However this surfacing do not contributes countable structural strength to the pavement layer. DBST surfacing has been considered in the design for each project road sections because it lowers the overall project cost, easy to construct and maintain compared to Asphalt Concrete Surfacing.

2.5 CONSTRUCTION MATERIALS

89. The materials to be used for aggregate base course shall meet the material specifications set forth in the technical specifications of the design manual. The CBR strength of the combined mix material shall not be less than 80 percent (AASHTO T193) after 4 days soaking, on samples compacted to 95 percent of the maximum dry density (AASHTO T 180) over a moisture range of 4 percent. CBR strength for granular subbase material shall not be less than 30 percent and that for selected subgrade shall not be less than 10 percent when determined using the same test standards as mentioned above. The existing embankment that also formed the part of the subgrade is required to have a CBR of not less than 4 percent. All CBR tests on materials for design purposes shall be compacted to specified density and be tested in the laboratory after 4 days soaking following the AASHTO T 193 designation.

2.5.1 Embankment

90. The pavement has been designed considering the maximum possible use of embankment materials which are close to the road alignment so that the haulage of large quantity of better quality costly material minimized. As the road side lands are farming land therefore materials adjacent to the roads are weak but there is no sign to swell or deformation of old road embankment under present traffic use and weather pattern for PR312 and PR1534. However on PR23 there are several locations having surface upheaval and traffic not passable. For construction of embankment materials shall not be taken from the formation of ditches and within road reserve. A situation of creating greater potential for standing water directly alongside the embankment by creating side ditches that do not drain should be avoided. Materials are likely to be taken from borrow areas outside the road reserve. Following this approach, also, potentially, provides frequent borrow pits which are valued by local land owners if safely left open, because they provide dry season water reserves for live stocks, fish culture and other purposes.

91. The surface of the embankment should be shaped to crossfall at least equal to that of the pavement layers to induce better drainage should water enter the pavement. Even during construction stage it is important to maintain cross-fall of the surface, especially, in the wet season so that rain water cannot be stagnant on surface. Following this practice the embankment surface can be maintained passable by traffic longer than uneven surface and undulated surface.

2.5.2 Selected Subgrade

92. It is considered that the existing Asphalt Concrete and DBST sealed surface pavement on PR312 and Laterite /Gravel wearing course on PR1534 will provide much of the materials for the selected subgrade. However the roads are being widened and in some cases increasing embankment height will require considerable quantities of additional material and it should be included in the estimate.

93. The strength requirement for the selected subgrade, CBR not less than 10 percent (AASHTO T-193) after 4 days soaking, determined at 95 percent of maximum dry density (AASHTO T-180). Subgrade materials may be produced from the borrow areas close to the road although at less frequently than the embankment materials. Subgrade material can also be obtained from nearby crushing plants as overburden and as quarry by products.

94. When the existing gravel or pavement surface confirms the design level and quality of material for subgrade, the old pavement and or laterite / gravel wearing course material can be scarified to a suitable depth and spread over full design width and compact to the required density. If the existing surface material not enough to form the design level for full width subgrade, approved additional subgrade material can be mixed homogeneously with old material and compact true to the level and crossfall as indicated in the design and drawings.

2.5.3 Sub-base

95. The pavement design requires construction of subbase using naturally occurring granular gravel or lateritic materials to make easy procurement and faster construction process. In some instances it has been perceived that the naturally occurring gravel / laterite alone cannot meet the grading and strength requirements specified. In such consequences suitable percent of base course aggregates, as determined by laboratory tests, may be added and uniformly mixed with naturally occurring gravel / lateritic material for subbase construction. Mixing of two different source materials can be done by use of portable or stationary mixing plants. One of the PRIP-I project using locally made indigenous subbase mixing plant of sufficient capacity and it is serving satisfactorily.

96. Construction of new subbase is required for all the project roads. The material in existing road pavement for PR312 is gravel wearing course and aggregates base course with partly damaged and uneven surface are not strong enough to recycle as subbase and hence considered to be scarified to desired depth, re-compact and use as subgrade. PR1534 has lateritic / gravel wearing course of 15 to 18 cm thick. This existing old wearing course has been considered to be used as subgrade.

2.5.4 Use of Stabilization

97. This is an important issue to confer with. Many countries in the world are successfully constructing stabilized subgrade, subbase and base course for last several years and at present. However the present and recent past experience in Cambodia bring to light that it is still not the appropriate time to successfully handle stabilized subbase and base construction. The main hindrance behind it is lack of experienced contractors, skilled supervising personnel and unavailability of purpose made equipment, particularly mixing plants. Stabilization of subbase and base need much more care during material production, mixing stabilizer with host material, hauling, spreading, compacting and finally curing. Any one of those tasks if not time bound, the anticipated quality of stabilization cannot be achieved in an expectation it designed for.

98. At present most of the contractors working in Cambodia, local or foreign, do not have minimum experience to construct the stabilized subbase or base course and not well equipped to successfully accomplish stabilized pavement construction. It is therefore advisable that contractors and supervisors be motivated and trained through implementation of small scale projects having activities of stabilized subbase and base under close supervision by relevant specialist. Purpose made equipment, skilled equipment operators, foreman and supervising personnel to be engaged to attentively learn the whole process and shall keep the detail records for future guide.

99. Once the engineer is satisfied with the performance of the trained contractors, staffs, equipment and working techniques then will be the suitable time to think about implementation of large scale project consisting of stabilized subbase and base course. This

is well known that in Cambodia rainy season is longer, six to seven months in a year. During the rainy season it becomes almost impossible to properly mix stabilizer with host material because of wet materials thus the work cannot progress on time. Compaction on a limited time and curing of the placed stabilized subbase or base course are two very important factors that influenced the quality of end products. Mixing of stabilizer with host materials directly on road bed has not been found satisfactory and not recommended to employ this method for stabilization.

100. At present there is one project in progress, having cement stabilized subbase, under PRIP-I, is suffering with material processing, progress and quality due to contractor's ignorance about the work procedure, mismanagement to control quality of host material, interruption with availability of mixing plant, want of experienced personnel and the weather problem. Thus for future construction of pavement consisting of stabilized subbase or base course it is the time to plan and execute small scale experimental projects to train and get the contractors and supervising staffs familiar with the materials, mixing process, work procedure and curing of compacted job so that costly pavement construction becomes durable to achieve its design service life. When the trial sections proved to be successful and sustainable that will be the time to plan, design and implement pavement with stabilized subbase or base course.

2.5.5 Aggregate Base Course

101. Aggregate base course layer is the major load bearing component within the flexible pavement layers and it needs use of sound, hard, durable stone or gravel crushed aggregates combined with adequate fines of approved quality. There are some hard stone quarries within 50 to 150 km distance from the project roads. Private owned quarries normally produce aggregates for concrete works and supply materials for road pavement and surfacing works when ordered by the road constructing agency or contractors. Depending on hauling distance unit price of the processed aggregates are fixed by the quarry owners.

2.5.6 Aggregate for Surfacing

102. The design table reflects that DBST will be the finished surface for the pavement. This will give much more durability than SBST. A DBST confers on appropriate surfacing with a longer initial service life extending the period of resealing need and predominantly suitable for roads with higher traffic volume or those with high cumulative traffic loading. It will also provide a dense textured and skid resistance surface for the traffic. A DBST surface where hard stone crushed chips are used and specified quality duly maintained can serve safely for ten to fifteen years before resealing under heavy traffic whereas a SBST need resealing only after 3 to 4 years or in less time span. Therefore a DBST surfacing is recommended for the project roads.

2.5.7 Surfacing Materials

103. A bituminous prime coat, material conforming to the requirements of AASHTO M82 for MC-30 and MC-70 or AASHTO M 208 for cationic emulsified bitumen CSS-1, required to be sprayed on the approved base course surface prior to application of bituminous chips sealing. Prime coat shall penetrate top 6 to 10mm depth of road surface, binds it and provides a key for the bituminous surfacing. In good weather condition curing period (time to penetrate and fully dries up) of prime coat materials normally takes 24 hours.

After 24 hours blotting material of specified quality and quantity shall be spread on excess and un-dried surface. Penetration and curing time also depends on the surface treated and material used for priming. Generally emulsion dries faster than cutback bitumen. Open graded surface dried up faster than dense graded surface. Because of unavoidable circumstances if the primed surface to be opened public traffic immediately after its application, a thin layer of approved blotting material (e.g. dry clean sand or stone screenings of approved size) can be applied on primed surface and control traffic speed within 16 to 20 km per hour.

104. For this project bituminous surfacing has been proposed to be a Double Bituminous Surface Treatment (DBST). Bituminous material or binder shall be straight run bitumen of penetration grade 60/70 or 80/100 or Cationic Emulsified Bitumen CRS-2, CRS-3 (Cationic Rapid Setting Emulsified Bitumen-2 or 3) or other as specified in the bidding documents. This will be used as binder between primed surface and sealing chips. In Cambodia 60/70 penetration grade straight run bitumen and CRS-2 are familiar and well accepted as binder for SBST and DBST surfacing and their performance is satisfactory. The Emulsion is made by bitumen blended with water at specialist facility of the manufacturer or supplier and delivered and laid cold or at specified temperature. However for easy and effective application, reference spraying temperature for CSS-1 is between 25-55°C, CRS-2 and CRS-3 is 75-85°C and that for 60/70 or 80/100 penetration grade straight run bitumen is 160-170°C or as specified in particular project technical specifications.

105. Crushed rock aggregates to be used as sealing chips shall be obtained from high quality and uniform color of quarry extracted rocks. Cubical and angular shape chips maintaining specified grading, flakiness and elongation Index, hardness and average least dimension (ALD) are more suitable than round or other shapes. Presence of contaminated chips like discolored and soft particles in the stockpile is not allowable. When straight run bitumen or cutback bitumen is used as binder, sealing chips shall be cleaned by blowing and be pre-coated by approved material. When emulsified bitumen is used as binder, sealing chips shall be washed to make them free from dust and other deleterious materials.

106. Public traffic shall not be allowed to use the sealed surface within 6 to 12 hours of its application or until the binder is completely cool down and chips are firmly sticks to the binder. Depending on ambient temperature this process might take 6 to 12 hours from the time of chips application. Time gap between application of binder and chips preferably shall be 3 to 4 minutes from application of binder. When traffic control is not possible due to unavoidable circumstances, sealed surface can be permitted to ply traffic provided speed not exceeds 16 km to 20 km per hour.

107. After curing period is over the quality of a surface treatment will be greatly enhanced if traffic is allowed to run on the first sealing for a minimum of 2 to 3 weeks before the second sealing is applied. If the trafficking results in contamination of the first sealing with mud, cow drops or foreign materials, this should be thoroughly cleaned off before the application of second sealing. Nominal size of sealing chips for first and second layer may be 19 mm and 12.5mm respectively or as specified.

2.6 ROAD MAINTENANCE

108. The project roads have been designed considering expected structural service life 20 years from its completion. However after that period, the road pavement structure still will be there and will need rehabilitation either by fortifying base course layer of 150mm thick and a new surfacing or structural surfacing or both depending upon the requirements and economics prevails at that time.

109. For the duration of the structural design life of pavement, a resealing by SBST will require as a maintenance approach after about 5 to 7 years of its service. It will then provide good service for further 6 to 7 years. Maintenance of roads should be a continuous process and be started immediate after maintenance period expired by the original construct contractor or agency. The design service life will robustly dependent on the quality control at the time of construction.

110. During original construction if the quality control exercise is satisfactory then post construction maintenance activity will be limited and minimal tasks such as grass cutting, minor edge repair and cleaning of structure openings. Any defects on the road base, which should be isolated and infrequent, may be potholes or loss of sealing chips, can be repaired by patching using similar materials as in the existing pavement layers.

111. Routine and periodic maintenance on a regular basis is a prerequisite to get expected performance during design life of project roads. Maintenance program, even negligible quantity, shall be initiated immediate after the expiry of original contractor's security maintenance period. Any delays caused by technical support or lack of funds would be detrimental to the process. For this reason, the technical requirements for maintenance by resealing and the funding for civil works should be identified and quantified through the preparation for a future project component of this project.

112. Minor surfacing defects can be maintained by the in house maintenance team of MPWT / DPWT or by contracting using of small scale equipment like a small bitumen distributor tank fitted with hand lance for spraying bituminous material and supply of sealing chips and spreading by local made chips spreader.

2.7 GEOLOGY IN THE PROJECT AREAS

113. The initial geological surveys have identified that there are difficulties to procure hard rock for base course, surfacing and concrete aggregates. There are limited source of viable hard stone quarry nearby the project roads. Mountain strips visible along both sides of PR1534 do not have any known operating crushing plant and some of the mountains are within the environmentally protected areas. However, within 30 to 50 km hauling distance there are some other sources of commercial hard rock quarries from the starting point of PR1534 and within 60 to 150 km hauling distance from end point of PR1534.

114. Contractors for construction of NR 5 ADB Loan No. 1697-CAM (SF) used aggregate for base course and DBST by installing crushing plant at Thepaday Mountain in 2003. Later MRD contractors used aggregates from Thepaday mountain installing crushing plant by themselves for project under ADB Loan 2670-CAM (SF). Color of the extracted rocks from this quarry is redish brown. Thus aggregates produced are not same like other

quarries in Cambodia, after production plenty of stone dust adhered to the surface of each particle and need careful washing or clean by blowing and then pre-coating before using for SBST/DBST surfacing works. Aggregate from this quarry is of variable quality depending on selection of locations within the mountain. Conscientious selection of location can produce hard and sound quality aggregate suitable for all purpose use.

115. There is no permanent crushing plant at Thepaday Mountain site and hence if any agency wants to produce aggregate from that mountain will need to install crushing plant by the party concerned. The section of the geological maps in Figure 2.22 and Figure 2.23 shows the locations of the project roads marked by red line. In Figure 2.22 the purple color areas are mountain strips but as of now there is no crushing plant to collect stone crushed aggregates. However local information indicates subbase material will be available from those areas for PR1534. As seen in Figure 2.23 there is no mountain near PR23 and PR312. However there is one small mountains identified at near north from the project roads for procuring hard stone crushed aggregate and subbase materials.

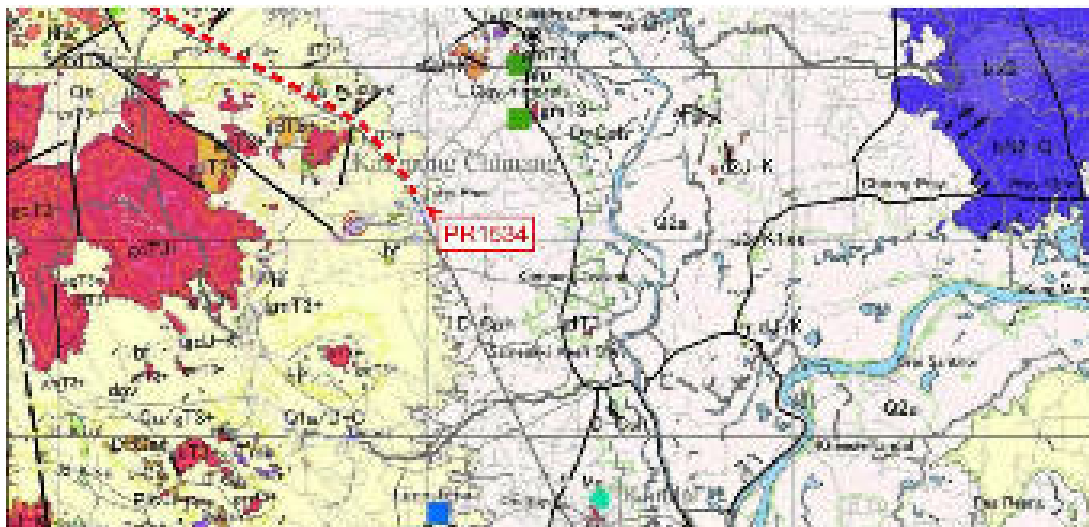


Figure 2.22 Section of the Geological Map of Cambodia (Midwest)

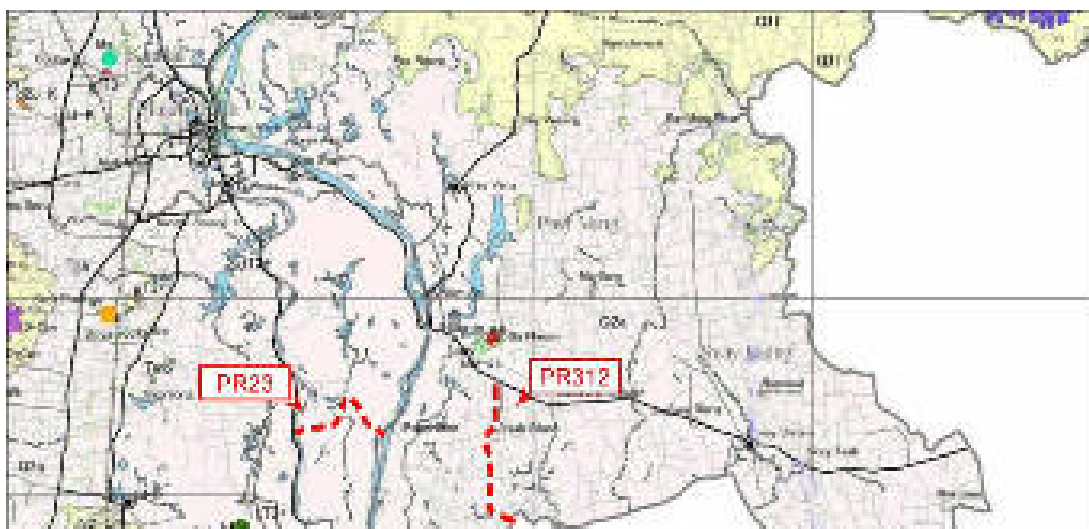
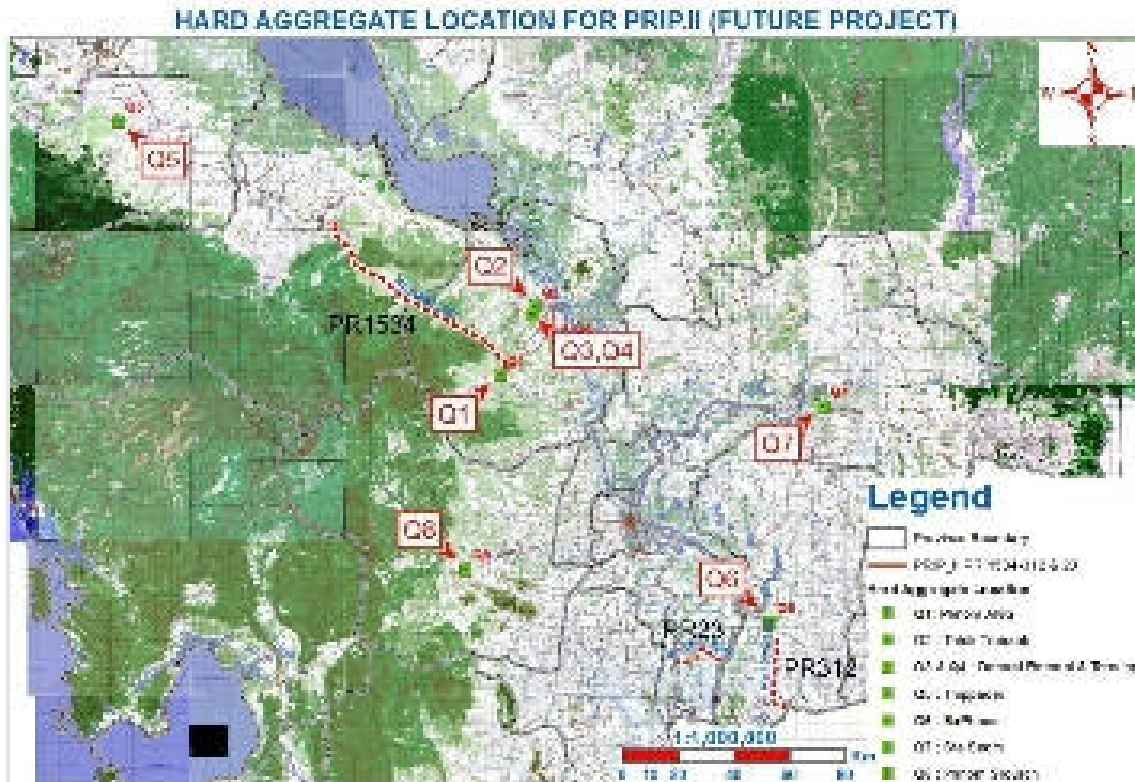


Figure 2.23 Section of the Geological Map of Cambodia (South)

2.8 MATERIAL SOURCES FOR CONSTRUCTION OF ROADS

116. The foremost speculation is to use the prevailing material sources, particularly the stone quarries, for the project roads. However there are no viable operating quarries within short hauling distance from the project roads. Materials has to be produced by self installing crushing plants or material to be procured from existing commercial producers from quarries having hauling distance between 30 km and 150 km.



2.8.1 Hard Aggregate

117. For PR1534 (Kampong Chhnang portion up to Ch. 50+000): Hard aggregates for base course, and subbase can be collected from mountain ANG located at Ch. 31+500 LHS 700m beside NR 53. Phnom Thlok Trobaek located at Ch.98+020 LHS 500m from NR 5. Phnom Domrei Romeal located at Ch.6+300 RHS 3.7 km from RN-53 and Phnom Toteung located at Ch.6+300 RHS 3.3 km beside NR53. All are in Kampong Chhnang Province.

118. For PR1534(Pursat portion of the road from Ch.56+000 to Ch.84+500 new roundabout at NR 5 in Pursat): Hard aggregate is obtainable only from Thepaday Mountain located at CH.261+500 RHS 15km beside NR5 and alternative quarry may be in Battambang Province or Kampong Chhnang Province prevailing stone quarries. There are several functional stone quarries in Battambang but they will be far from the project road.

119. For PR312: Phnom Chheu Kach located at Ch. 71+000 LHS 5km from NR 1 within Ba Phnom in Prey Veng Province and Phnom Srouch Kathan Kan Thomo Lim Bunna quarry at Ch. 131+500 LHS 300m beside NR-7 in Kampong Cham province can also provide good quality stone crushed aggregates for all purpose use.

120. For PR23 : Phnom Chheu Kach located at Ch. 71+000 LHS 5km from NR 1 within Ba Phnom located in Prey Veng Province, Quarry at Peatmony Mountain in Kampong Speu and Phnom Srouch Quarry located at Pk. 64+000 RHS 1.5 km also in Kampong Speu Province beside NR 4. Owner of Srouch quarry is SWEE. All types of hard aggregates are produced here by the manufacturer. In kampong Speu there are 3 to 4 more crushing plants beside NR-4 that can be traced in the future.

2.8.2 Materials for Subgrade and Sub-base

121. Material for subgrade including embankment is presumed to be procured from individual road side borrow areas. Both sides of all the project roads have farming land mostly paddy field. Borrow pit for embankment and subgrade material to be obtained by investigating and selecting suitable locations with the help of local people. Quarry by product and overburden from nearby mountains having crushing plants also can be alternative source of subgrade and subbase materials.

122. For PR1534 stretching over Kampong Chhnang and Pursat Provinces, existing road surface have lateritic wearing course from Ch.0+000 to Ch. 62+300 and from Ch.75+300 to Ch. 84+500. The remaining 12.0 km is earth road, narrow and not passable during wet season. For the starting portion of road number PR subbase material could be produced from Phnom ANG beside NR 53 at Ch. 31+500 LHS 700m. Thereafter material from Phnom Sentai near Domna Village at Ch. 22+000 RHS 2.0 km, and CH. 38+100 O Lapaw and Dongee Mountain and at CH 52+000 all beside PR1534.

123. Above source materials might supply the required quantity of subbase material for the road falls within Kampong Chhnang Province. Information from an ongoing project in that region indicates that the naturally occurring gravel/laterite sometimes have problem with gradation and CBR strength. To overcome this problem certain percentage of crushed aggregates may need to mix with naturally occurring borrow pit materials. One of the projects under PRIP-I has permitted contractor's proposal to mix 25 percent crushed stone aggregates with locally available laterite material. Laboratory test and field tests have confirmed that the suitability of mix material for subbase construction and the contractor successfully using it for NR 53. Contractor hired indigenous mixing plant to mix borrow pit material and crushed aggregate at a central place adjacent to the road and it is working well. This option is also recommended for PRIP-II.

124. For PR-312 the existing surfacing is AC and DBST but the pavement layer underneath is not uniform. Some locations have only laterite subbase for example Ch. 0+000 to 12+250 only 18 to 25cm thick laterite layer placed on subgrade, Ch.12+250 to 17+250 have 18 cm aggregate base course with thin layer of subbase, at Ch. 21+000 have 20 cm aggregate base course on 20cm thick laterite layer, at Ch. 25+000 have 70 cm thick aggregate base course.

125. The existing uneven and rough surface pavement is required to be scarified and spread over full width to use as selected subgrade material, additional material when required to maintain design formation level of subgrade in the shoulder part, new material having 4 days soaked CBR not less than 10 percent (AASHTO T 193) at 95 percent of MDD (AASHTO T180) be added and uniformly mixed and compacted to required degree of compaction specified. Thus scarifying and recycling the old pavement material for subgrade construction can save considerable amount of material cost and enhance the progress of work.

126. For PR23 there is less possibility to find naturally occurring laterite or gravel with close vicinity of the project road PR23. Some of the land owners might allow the contractors to procure soil from their land by receiving some royalty to make pond for fish culture or reserving water for livestock so that they can use it during dry season for embankment and subgrade borrow pits. However, Subbase materials to be transported from Chheu Kach mountain in Prey Veng, Phnom Totea in Kandal Province or Peatmony Mountain in Kampong Speu Province.

2.9 BRIDGES

127. A list of the bridges is Table 2.6, and further details are given in Appendix E. The PR312 road route is passing through the farmland and village area to Viet Nam border, and there are no bridges. In PR23 road section, there is one new concrete bridge which was constructed in 2011, and its conditions are good and there is no problem to cross the traffic. All of the bailey and timber type bridges which have shorten of width shall be replaces to Two Lane Concrete Bridges. Moreover, Single Lane Concrete Bridges which conditions are poor shall be replaced to the Two Lane Concrete Bridges. However, the concrete bridges which conditions are good and be available to two-lane traffic shall keep using from an economical perspective. Furthermore, it is required to newly construct a bridge across the swamp area and river stream in the end part of PR1534 Sta. 74+650. The 4-span Bailly Bridge which located between Damnak Ampil Village in Sta. 33+480 and Kdol Senchey Village has injured link-element in the truss of superstructure and deterioration, thus traffic vehicle has limited weight, and to be required to repair urgently.

128. During the implementation stage of the project, the Contractor will be required to undertake detailed topographic surveys and foundation investigations at each bridge location before the commencement of construction and prepare detailed design drawings for the approval of the Engineer.

2.9.1 Design Criteria

129. The Design Standards for bridges are as follows:

- AASHTO Standard Specification for Highway Bridges, Seventeenth Edition, supplemented as necessary by
- Cambodian Bridge Design Standard, CAM PW 04-102-99

130. The adopted design criteria as follows:

- AASHTO HS 20-44 highway loading plus 25% overload.
- 8.0(9.5)m wide roadway between railings, comprising 6.0(6.5) m carriageway and 1.5mwalk ways for the long bridges and 2.0(3.0)m shoulders for the short bridges (less than 30 m)
- A vertical clearance between maximum flood water level and underside of bridge deck of 600mm for structures providing a drainage function, or crossing secondary waterways.

2.9.2 General

131. The most bridges are typically of relatively short span occupying similar site conditions which allows their arrangement to be standardized. Field construction activity is limited to the dry season, a period of six months from November to April. Considering these conditions, precast construction methods are the most appropriate. These are widely used in Cambodia for ADB road improvement projects and have been adopted for this project.

2.9.3 Superstructure

132. The standard bridge deck form adopted for this project comprises; pre-tensioned deck units (PSC) transversely post-tensioned to form a contiguous slab. This form of construction is covered explicitly in the Cambodian General Specification for Road Construction with pay items already established. The form is well suited for small to medium span structures ranging from 10 m up to 25 m span. The method also allows the use of integral construction at piers and abutments with units set on mortar beds and located with anchor bars negating the need for bearings or expansion joints.

133. The form of side protection railing adopted in the bridge design is reinforced concrete post and rail barriers. This is widely used elsewhere in Cambodia and maintains a consistent appearance of structures along the project roads

Table 2.6 List of Bridges

Road	No.	Type	Length, m	Width, m
NR23	1	Concrete	90.0	8.0
PR312	None	-	-	-
PR1534	1	Concrete	24.0	7.0
	2	Bailey	30.0	4.9
	3	Bailey	72.0	5.2
	4	Bailey	30.0	5.2
	5	Concrete	49.3	9.0
	6	Concrete	15.0	7.0
	7	Concrete	15.0	7.1
	8	Timber	23.8	3.0
	9	Timber	4.2	3.3
	10	Timber	7.2	3.1
	11	Timber	18.2	3.2
	12	Timber	3.5	3.5
	13	Timber	28.0	3.3
	14	Timber	15.5	3.2
STA. 74+650	15(new)	Concrete	75.0	10.5

Road	No.	Type	Length, m	Width, m
PR1534	16	Concrete	9.4	3.7
	17	Concrete	11.5	3.7
	18	Concrete	12.0	3.6
	19	Concrete	16.8	3.7

Source: Consultant's surveys

2.10 DRAINAGE

134. Cross drainage structures are very important to solve local water flooding and stagnation during the wet season. Damaged box and pipe culverts have been designated for replacement if the existing structures were not able to be functioned properly. As a lesson learned during the implementation of the previous project, narrow pipe culverts and box culverts need to be extended to the design road widths for road safety, if they are in good condition. Thus, it is necessary to survey the condition of each structure in details during the detailed design period.

135. . Some pipe culverts and box culverts were planned to be newly constructed in consideration of future climate change. In particular, new drainage structures are to be provided where actual flooding had occurred based on interviews and observations and where it was reported that the flood waters were significantly higher on one side of the road than the other, such that the road was acting as a dam. Some sections, where is expected flooding after construction due to insufficient drainage plan, also need to be installed new drainage structures.

136. The improvement of drainage structures has been carefully studied in consideration of road safety, resettlement and construction costs. The improvement of drainage structures are given in Table 2.7 and more details with locations and conditions are given in Appendix E.

Table 2.7 Summary of Improvement for Drainage

Road No.	Box Culvert				Pipe Culvert			
	Existing	Use	Replace	New	Existing	Use	Replace	New
PR1534	33	29	10	1	60	-	58	8
PR312	2	-	3	-	20	-	19	5
PR23	8	-	8	1	3	-	2	5
Total	43	29	21	2	83	-	79	18

Source: Consultants, 2016

137. The typical cross sections of concrete pipe culvert and box culvert to be replaced are given in Figure 2.25 and Figure 2.26.

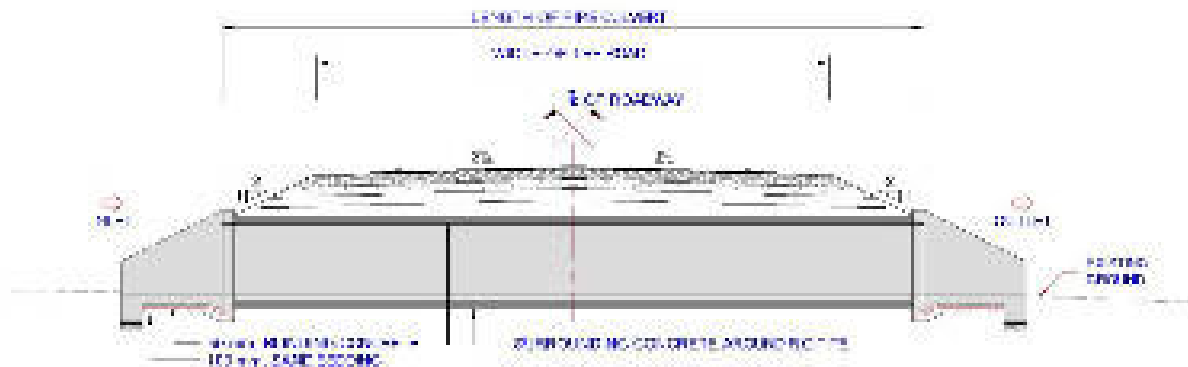


Figure 2.25 Typical Cross Section of Concrete Pipe Culvert

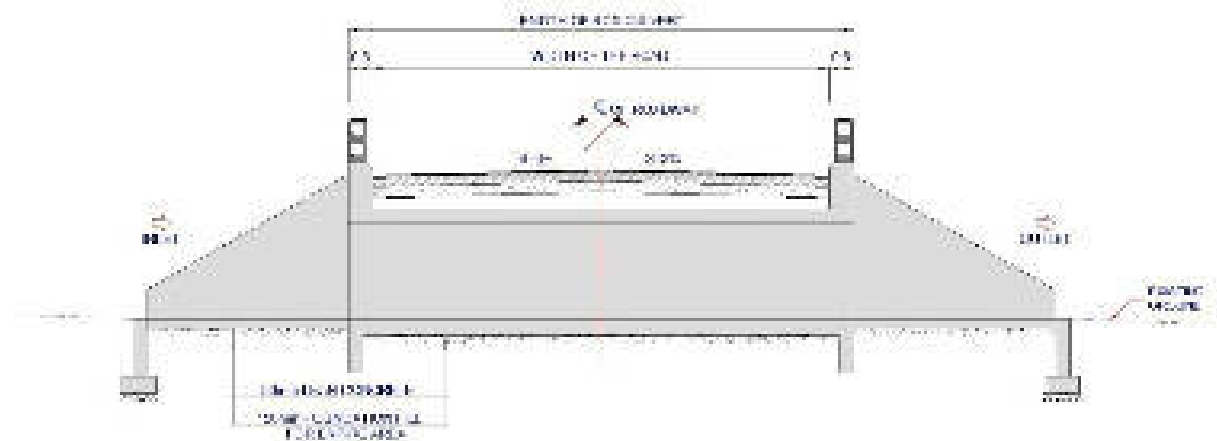


Figure 2.26 Typical Cross Section of Concrete Box Culvert

2.11 ROAD SAFETY

138. Road crashes claim more than 1.2 million lives each year on global roads and have a huge impact on health and development. They are the leading cause of death among young people aged between 15 and 29 years, and cost governments approximately 3-5% of GDP. Despite this massive and largely preventable human and economic toll, action to combat this global challenge has been insufficient. Low and middle-income countries are hardest hit, with double the fatality rates of high-income countries and 90% of global road traffic deaths. Vulnerable road users (pedestrians, cyclists and motorcyclists) make up half of these fatalities.

139. CBRS is one of the leading value programs to deduct the number of road crashes, fatalities, and disabilities in Cambodia. In the face of rapidly increasing motorization, this stabilization of an otherwise projected increase in deaths is an indication of the progress that has been made. However, efforts to reduce road traffic deaths are clearly insufficient if the national road safety targets set for the Sustainable Development Goals, a halving of deaths by 2020 are to be met due National Road Safety Action Plan.

140. Changing road user's behavior is a key component of the Safe Systems Approach. Setting and enforcing good laws relating to key behavioral risk factors can be effective at realizing such change. Although some progress has been made over the past few years with all provinces and cities, improving legislation on key risk factors, making sure the laws are in line with best practice and equipped.

141. Lack of law enforcement frequently undermines the potential of road safety to reduce injuries and deaths. More work is needed to explore the best ways to optimize enforcement of existing road safety. Social marketing campaigns need to be conducted to support and maximize the effects of enforcement.

142. Insufficient attention has been paid to the needs of pedestrians, cyclists and motorcyclists, who together make up 86% of all fatalities by mode of transport. Making the roads safer will not be possible unless the needs of these road users are considered in all approaches to road safety, including the way roads are constructed. Making walking and cycling safer will also have other positive for young generation in the community level.

143. Road safety has been considered comprehensively through all aspects of the roads improvement project. The safety features are given to all road users. Road safety was divided into two parts, hard road safety component and soft road safety component.

144. **Hard component:** the engineering requirements for safer road infrastructure thus are focus on:

- Inclusion of a separate pedestrian, bike cycle, motorbike, car and heavy truck lane, namely the sealed road shoulder for the all project roads.
- Improved horizontal geometry by providing curves, super elevation and widening on identified black spots and curves with small radii.
- Installing road signs such as road signs plates, signs posts, traffic light and road markings.
- Road stud and reflectorized road and lane markings consisting of central line, edge line and pedestrian crossing.
- Rumble strips at the entrance to populated areas, buildup area and school zone.
- Landmarks, monuments, and physical road design constraints such as road narrowing identified and marked to reduce speeds to the desired level especially where they pass through communities. Curbed sidewalks for town areas.
- Guardrails on bridge approaches, box culverts and high embankments.
- Chevron on sharp curve area, it provided additional emphasis and guidance for drivers.
- Set up Safe school zone and parking for vulnerable area
- Provision of adequate sight distances.

145. **Soft component:** Road construction and road furniture called hard road safety component, but hard component is not enough for safer road users, road safety education program is called soft road safety component that could change the road user's behavior, attitude and law integration. All road signs also interpret for local communities to make sure

they are easy to understand and know about its value. Soft road safety component are focus on:

- i. Road safety education program for school students, teachers and villagers
- ii. Road safety campaign for all road users,
- iii. Road safety training for specifics vulnerable road users
- iv. Road safety event for promote road safety during special event which rapidly increase of road crashes,
- v. Road safety auditing and monitor and evaluation.

2.12 ROAD SIGNS AND INSTALLATION

146. There are five types of road signs: road signs plates, signs posts, traffic lights, road markings and traffic police signals. In the road sign posts have ten sub traffic sign plates that will be used for the provincial road improvement project which cover a part of four provinces;

147. The installation of each road signs will be based on realistic geometry on the road and speed by type of road, The Cambodia road signs structure standard part I and part II will provide more guidance on installation and use of traffic signs plate standard;

148. Based on the law on road, article 13, road asset management or private sector who authorized to constructed or develop new road must equip the road furniture completely and align with technical regulation before approval to use. In the same law, on article 14, the new road construction in the city/town, housing and new development zone must construct the paths road, road for people with disability, and other important road infrastructure to ensure the road safety.

149. At all intersections especially those with the primary national roads, NR1, NR5, head of Koh Thom Bridge will be widened appropriately to ensure a good line of sight and traffic calming and extensive signage that be used to control road users within special design for safer junction. All intersection along the road should be installed the stop sign on access road.

150. .The Road Safety Program is design and commented on in Section 8, on road safety section.

3 MINE/UXO CLEARANCE

3.1 HISTORICAL BACKGROUND

151. Between 1965 – 1998, Cambodia experienced military incursion, armed conflict and civil war where millions of tons of munitions including air dropped, ground-to-ground and landmine types were used indiscriminately. These explosive devices (landmine and Unexploded Ordnance or literally known as UXO) continue to maim and kill hundreds of Cambodian annually even long after the end of the civil war. Great effort had been made by Cambodian government to eradicate this problem through extensive mine/UXO clearance program. However, the priority of this humanitarian program mainly focusing on saving lives and supporting agriculture development. Mine/UXO contamination locates along infrastructure is left to the developer or related ministries to handle.

152. Project Management Unit 3 (PMU3), which is under the Ministry of Public Works and Transport (MPWT), is tasked to carry out feasibility study on PR1534, PR312 and PR23 under PROVINCIAL ROAD IMPROVEMENT PROJECT II or PRIP II. The threat of Mine/UXO contamination has been taken into account and this is how this report is all about.

153. The objective of this report is trying to figure out:

- i. The extent of Mine/UXO contamination: air-dropped, ground to ground and landmine
- ii. Mine/UXO Impact on community: Mine/UXO victims
- iii. Respond: Mine/UXO clearance and Mine/UXO awareness
- iv. Cost estimated

3.2 WORK METHODOLOGY

154. The consultant has a total less than a person-month to carry out the above objectives started from 01st September 2016. The work will be carried out in two assignments: 1) Existing record review and analyze information obtained from database; 2) Field trip survey and interview. The use of metal detector on site to identify suspected contamination objects and check ground metallic disturbance signature could not be carried out due to time constraint of this assignment.

3.2.1 Existing Record Review

155. In collaboration with Cambodian Mine Action Centre (CMAC) and Cambodian Mine Action and Victim Assistance Authority (CMAA), an American-bombing data is reviewed to obtained US-bombing data at project sites (commune level).

156. In collaboration with Cambodian Mine Victims and Information System (CMVIS), review mine/UXO victims by year and by commune level.

3.2.2 Field Trip Survey and Interview

157. The following is the field trip schedule activities:

Table 3.1 Field Trip Schedule Activities

Date	Day	Field	Activity
6	Tue.	1	Depart for PR1534 (No.1): Interview with local people, local authority and police (PK: 0+000 to PK: 30+000)
7	Wed.	1	Interview with local people, local authority and police (PK: 30+000 to PK: 60+000)
8	Thu.	1	Interview with local people, local authority and police (60+000 to PK: 84+500)
9	Fri.	1	Visual check (PK: 0+000 to PK: 45+000)
10	Sat.	1	Visual check (PK: 45+000 to PK: 84+500)
11	Sun.	1	Depart to PR312 (N10) (Weekend)
12	Mon.	1	PR312 (No.10): Meeting with local people, local authority and police & Visual check
13	Tue.	1	PR23 (No.15): Meeting with local people, local authority and police & Visual check and return to Phnom Penh
Total		8	

158. Taking into consideration imminent rainfall which hinders car mobility at project sites, the availability of the interview person who has local knowledge particularly during armed conflict and time constraint, the field trip intent to collect name, position and mobile contact number so that vital information could be taken through distant interview survey later, if appropriate.

A. Road: PR1534:

- From: NR.53, Teuk Phos, Kampong Chhnang
- To: NR5, Pursat, New round about

Table 3.2 Local authority's contacts at PR1534

No.	Name	Position	Org./village	Mobile
1		Village Chief	Phnum kasam	097 950 1282
2		Village Chief	KrangSkear	089 835 111
3		Village Chief	Chombork Prasaat	089 217 833
4		Village Chief	Domnak Ompel	017 918 581
5		Village Chief	Kdol	012 648 037
6		Village Chief	O Lpov	071 357 467
7		Village Chief	Domnak Klong	092 532 507
8	Pakk Phorn	Commune Chief	Chherkom	089 250 056
9	Chann Sai	Commune Chief	Svay Sar	092 749 814
10	Chhab Khoeun	Commune Chief	Thnaot Chhum	092 923 943
11	Kung Sam Im	Commune Chief	Krang Skear	012 875 930

B. Provincial road: PR312

- From: NR1 (PK: 77+100) Samroung, Lvear, Prassdach district
- To: Banteay Chakrey, Cambodia-Vietnam Border

Table 3.3 Local authority's contacts at PR312

No.	Name	Age	Sex	Position	Org./village	Mobile
1	Yim Nhak	61	Male	Village Chief	KrosangTorng	071 988 1230
2	Sor Sarin	59	Male	Village Chief	Kroch	010 444 721
3	Long Heng	57	Male	Village Chief	Prey Meas	011 220 769
4	Kuy Yon	75	Male	Village Chief	Prey Asteang	096 842 4525
5	Touch Seam	56	Male	Village Chief	Oknha Em	010 444 728
6	Horm Sambath	65	Male	Commune Council	Angkor Reach	010 444 706
7	Chhim Sidoeun	39	Female	Commune Council	Angkor Reach	096 397 1948
8	ToekSothea	47	Female	Dep. Village Chief	Boeung Ed	010 444 733
9	Triev Bou	46	Male	Village Chief	Pea Ni	087 669 275
10	Sin Teng	66	Male	Commune Chief	Lvear	010 444 779
11	Tim Soeun	72	Male	Village Chief	Loeung	010 444 722
12	Khim Phan	59	Male	Village Chief	Boeung Kampot	010 444 754

C. Provincial road: PR23

- From: Koh Thom Bridge, Kandal Province
- To: Peam Raing commune, Leuk Daek district, Kandal province

Table 3.4 Local authority's contacts at PR23

No.	Name	Age	Sex	Position	Org./village	Mobile
1	Chhrehhak	67	Male	Commune Chief	LoeukDek	012 569 998
2	Suan son	53	Male	Village Chief	Toul Sleng	011 379 757
3	Chhin Vanny	43	Male	Village Chief	Por nimeth	012 330 601
4	NuanChhun Heang	63	Male	Village Chief	Samroung	092 764 063
5	Phornveth		Male	Village Chief		092 664 801
6	SannYoeung	49	Male	Village Chief	Anlung Slat	089 844 104
7	Hoy Chamroeun		Male	Commune Council	Chhroy Takeo	012 680 178
8	TithChhamroeun		Male	Commune Council	Chhroy Takeo	012 615 027
9	Srun Nov		Male	1st Deputy	Chhroy Takeo	097 494 5977
10	PhornSongorn		Male	Village Chief	Toul Svay	
11	Se Ly		Male	Village Chief	Toul Sangker	
12	Si Bunthoeun		Male	Village Chief	PrekRuseei	
13	ChheangPheng		Male	Village Chief	Toul Ngoun tam	

3.3 Survey Result

3.3.1 PR1534

3.3.1.1 Air-Dropped Munitions Finding at PR1534

159. The following is a list of Districts and Communes locate along PR1534:

Table 3.5 List of Districts and Communes

Province	District	No.	Commune/ Sangkat
Kampong Chhnang	Tuek Phos	1	Tang Krasang
		2	Krang Skear
Pursat	Krakor	3	Chheu Tom
		4	Svay Sa
		5	Tnoat Chum
	Krong Pursat	6	Roleab

160. According to data provided by American embassy, project area is found to be affected by air-war where a total of about 5,000 tons had been dropped by 13 types of aircraft. According to CMAC expert, about 20% of those munitions fail to exploded according to their design and they became Unexploded Ordnance (UXO).

Table 3.6 Geographical Information from 01-Oct-65 to 31-May-75

Gazetteer			Effected To		
Tuek Phos		No. Commune	Tuek Phos		No. Commune
Kampong Chhnang Province		8	Kampong Chhnang Province		8
Total Ammunition Expended					
Quantity : 16,543			Weight (T) : 16,345.92		
Ammunition Expended by Province					
Commune Name	Ordnance		Cluster Bomb		
	Quantity	Weight(T)	Quantity	Weight(T)	Sub Munition (Qty)
Akphivoadth	3964	3,246.23	44	121.07	3,311
ChaongMaong	3439	1,653.92	28	71.85	2,897
Chieb	1369	972.07			
Kbal Tuek	2603	4,218.53			
Khlong Popok	857	872.26	20	59.58	2,010
KrangSkear	1010	1,655.46	3	9.19	217
Tang Krasang	2826	2,920.08	4	12.26	217
TuolKhpos	376	533.44			
Total :	16,444	16,071.98	99	273.95	8,652

Table 3.7 Ammunition Expended Classified by Aircraft

Ammunition Drop by	Quantity	Weight (T)
A37	175	257.72
A4	64	95.01
A7	291	590.14
AC119	242	6.59
AC130	4,724	174.84
AC47	1,620	0.01
B52	7,401	11,576.02
B57	6	22.34
F100	16	45.6
F111	1,279	2,377.28
F4	467	810.75
OV10	34	10.78
T28	224	378.86
Total :	16,543	16,345.94

Table 3.8 Ammunition Expended Classified by Category

Category	Quantity	Weight (T)
Ammunition	6,515	161.85
Cannon_Artillery	149	27.06
Cluster_Bomb	99	273.95
Flare	32	0.00
General_Purpose	9,614	15,709.37
Incendiary	32	70.55
Rocket	102	103.14
Total :	16,543	16,345.92

Table 3.9 Geographical Information from 01-Oct-65 to 31-May-75

Gazetteer			Effected To		
Krakor		No. Commune	Krakor		No. Commune
Pursat Province		11	Pursat Province		8
Total Ammunition Expended					
Quantity : 1,858			Weight (T) : 1,371.68		
Ammunition Expended by Province					
Commune Name	Ordnance		Cluster Bomb		
	Quantity	Weight(T)	Quantity	Weight(T)	Sub Munition (Qty)
Anlong Tnaot	10	21.20	2	2.40	132
Ansa Chambak	1011	798.28			
Chheu Tom	313	97.32			
Kampong Pou	24	32.64			
OuSandan	80	144.06			
Sna Ansa	44	115.69			
Svay Sa	12	28.93			
Tnaot Chum	362	131.16			
Total :	1,856	1,369.28	2	2.40	132

Table 3.10 Ammunition Expended Classified by Aircraft

Ammunition Drop by	Quantity	Weight (T)
A1	24	32.64
A37	44	70.97
AC119	585	15.94
AC130	535	33.47
B52	450	669.96
F111	64	169.56
F4	84	205.58
T28	72	173.57
Total :	1,858	1,371.69

Table 3.11 Ammunition Expended Classified by Category

Category	Quantity	Weight (T)
Ammunition	876	20.43
Cannon_Artillery	250	30.52
Cluster_Bomb	2	2.40

Category	Quantity	Weight (T)
General Purpose	720	1,296.78
Incendiary	4	15.80
Rocket	6	5.75
Total :	1,858	1,371.68

3.3.1.2 Ground-to-Ground Munitions at PR1534

161. According to interview during site survey, the project site (both in Kampong Chhnang and Pursat) is affected by civil war which waged between 1970-1975 and again between 1979-1998. Ground to ground munitions were reported to be heavily used during that period of time but there is no record to be found related to this issue. According to CMAC expert, about 20% of those munitions fail to work according to their design and they became Unexploded Ordnance (UXO).

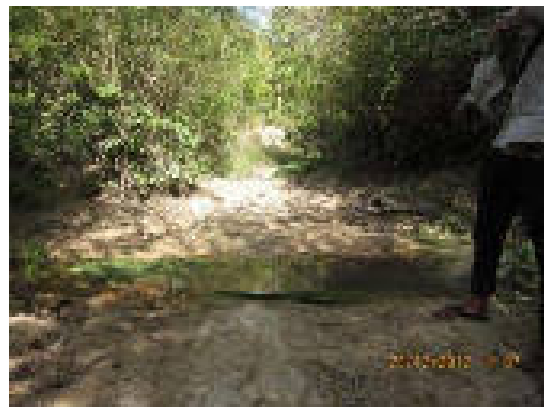


Figure 3.1 PR1534 road condition in 2012



Figure 3.2 UXO found along PR1534 in 2012

3.3.1.3 Landmine Warfare at PR1534

162. The subjected road is running northern railway line where it was heavily attacked by Khmer Rouge during civil war (1979 – 1998). In addition to ground to ground munitions used to attack this vital transport system, both sides (government and Khmer Rouge) used landmine to protect and attack railway line particularly at structure sites. With proximity to railway line, PR1534 serve as logistics for railway line defense. Due to this role, this road was targeted by the guerilla force through mine laying and ambush.

163. The nature of mine laying during civil war does not keep a record, there is concrete document that could identify the location of this explosive objective. According to the interview with railway officer, during railway line rehabilitation, there are approximately 10 landmines were found every 1 km of railway line length. In this reason, it is assumed that the similar contamination is expected to be found at project site which locates less than 100m from railway line. According to local people, Mine/UXO could be found located along project site.

3.3.1.4 Mine/UXO Victims at PR1534

164. Since the establishment of the national mine/UXO incident and casualty report, there are 6 reported accidents related to mine and UXO.

Table 3.12 Summary MINE/UXO Incident and Casualty Report by Commune from 2000 to 2012

Commune	Incident			Number Casualty caused by				Victim Gender					Type of accident			
	Mine	ERW	Total	Mine	ERW	IED	Total	Men	Women	Children		Total	Killed	Injured	Amputation	Total
										Boy	Girl					
Akphivoadth								1	0	0	1	2	1	0	1	2
Chaong Maong	0	1	1	0	2	0	2	2	0	0	0	2	1	1	0	2
Chieb	1	0	1	1	0	0	1	1	0	0	0	1	0	0	1	1
Kbal Tuek	1	1	2	1	4	0	5	4	0	1	0	5	1	2	2	5
Khlong Popok	0	2	2	0	6	0	6	0	0	5	1	6	1	5	0	6
Krang Skear	1	3	4	1	6	0	7	3	0	4	0	7	1	5	1	7
Tang Krasang	0	1	1				0					0				0
Anlong Tnaot								3	0	0	0	3	2	1	0	3
Chheu Tom	0	1	1	0	1	0	1	0	0	1	0	1	0	1	0	1
Sna Ansa	1	0	1	3	0	0	3	3	0	0	0	3	2	1	0	3
Svay Sa	0	2	2	0	3	0	3	3	0	0	0	3	0	2	1	3
Total	1	4	5	3	7	0	10	9	0	1	0	10	4	5	1	10

3.3.2 PR312

3.3.2.1 Air-Dropped Munitions Finding at PR312

165. The following is a list of Districts and Communes locate along PR312:

Table 3.13 List of Districts and Communes

Province	District	No.	Commune/ Sangkat
Prey Veng	Preah Sdach	1	Lvea
		2	Chey Kampok
		3	Angkor Reach
		4	Banteay Chakrei

166. According to data provided by American embassy, project area is found to be affected by air-war where a total of about 2,000 tons had been dropped by 13 types of aircraft. According to CMAC expert, about 20% of those munitions fail to exploded according to their design and they became Unexploded Ordnance (UXO).

Table 3.14 Geographical Information from 01-Oct-65 to 31-May-75

Gazetteer			Effected To		
Preah Sdach Prey Veng Province		No. Commune 0	Preah Sdach Prey Veng Province		No. Commune 11
Total Ammunition Expended					
Quantity : 18,223			Weight (T) : 19,353.58		
Ammunition Expended by Province					
Commune Name	Ordnance		Cluster Bomb		
	Quantity	Weight(T)	Quantity	Weight(T)	Sub Munition (Qty)
Angkor Reach	24	28.33			
BanteayChakrei	299	436.20	18	34.71	1,001
BoengDaol	231	229.19	14	37.24	1,340
Chey Kampok	451	472.72	16	60.29	600
Kampong Soeng	5665	3,672.21	127	371.73	10,280
KrangSvay	1867	1,739.86	24	38.92	2,144
Lvea	1118	981.42	18	26.71	1,432
Preah Sdach	881	477.56	5000	8,920.73	247
Reathor	100	196.44	12	20.06	782
Rumchek	1740	1,090.31	12	14.38	792
Sena Reach Otd am	606	504.57			
Total :	12,982	9,828.81	5,241	9,524.77	18,618

Table 3.15Ammunition Expended Classified by Aircraft

Ammunition Drop by	Quantity	Weight (T)
A1	73	61.55
A37	6,843	12,151.72
A4	857	1,213.36
A7	328	779.46
AC119	679	38.18
AC130	5,511	336.42
AC47	1,384	27.28
B52	777	1,316.74
F100	4	0.36
F111	280	567.25
F4	1,471	2,822.69
F5	12	28.93
T28	4	9.64
Total :	18,223	19,353.58

Table 3.16Ammunition Expended Classified by Category

Category	Quantity	Weight (T)
Ammunition	7,688	247.14
Cannon_Artillery	100	18.16
Cluster_Bomb	5,241	9,524.77
General_Purpose	4,805	8,984.91
Grenade	60	16.72
Incendiary	161	359.46
Mine	23	29.87
Rocket	145	172.55
Total :	18,223	19,353.58

3.3.2.2 Ground-to-Ground Munitions at PR312

167. Ground-to-ground munitions contamination along this road took place during the following armed conflict:

- Between 1970-1975: The war between the government supported by America and South Vietnam against guerilla forces of Khmer Rouge supported by North Vietnamese and Chinese. At the initial stage of this civil war, an offensive launched from South Vietnam supported by US were taking place along this road to attacked north Vietnamese sanctuary within this region.
- Between 1975-1979: There were several border wars between Khmer Rouge and Vietnamese. Khmer Rouge forces were pushed back several kilometers

inside Cambodia by Vietnamese force. PR312 locates well within the offensive zone.

- 1979: A salvation army of Kampuchear (former name of Cambodia) was established on 2nd December 1978. With the support from Vietnam, armed struggle to topple the Khmer Rouge ensured particular in the region where PR312 is located.

3.3.2.3 Landmine Warfare at PR312

168. To strengthening its weak force, Khmer Rouge relied on mine laying along Khmer Vietnam border, including the area where PR312 locates. After the collapse of the Khmer Rouge, then government of Cambodia established all-female military demining unit to work to remove landmine. The tool to remove landmine were very primitive: prodding by using sharp object such as knife or bayonet. The use of mine detector had not been reported as occasionally this heroic act was reported by local newspaper. The quality of work, the number of mine/UXO found/destroyed were considered military affair and were kept out of public at that time. This all-female-demining team was dissolved/reorganized after the general election in Cambodia in 1993.

169. As a result, the demining data was also disappeared and could not be located. However, taking into consideration the large Mine/UXO contaminated size (along Cambodia Vietnam border) with limited deminer, limited budget and primitive technology and limited timeframe to work on, mine/UXO remained a threat in the region. This statement could be proven by the finding of several anti-tank mine near Bavet in early 2004 and recent Anti-tank explosion on 19th September 2016 at Andong Krosang village, Pongtek Commune, Rumdual district, Svay Rieng province.



Figure 3.3 Anti-Tank mine explosion on 19th September 2016 during earth work excavation to support canal construction at Svay Rieng province

3.3.2.4 Mine/UXO Victims at PR312

170. Mine/UXO casualty was reported in this region however, this information could not be found in CMVIS report due to the fact that it took place before the creation of CMVIS.

3.3.3 PR23

3.3.3.1 Air-Dropped Munitions Finding at PR23

171. The following is a list of Districts and Communes locate along PR23:

Table 3.17 List of Districts and Communes

Province	District	No.	Commune/ Sangkat
Kandal	KoahThum	1	ChouyTakaev
		2	Kampong Kong
		3	LeukDaek
	LeukDaek	4	PeamRaeng

172. According to data provided by American embassy, project area is found to be affected by air-war where a total of about 4,000 tons had been dropped by 13 types of aircraft. According to CMAC expert, about 20% of those munitions fail to exploded according to their design and they became Unexploded Ordnance (UXO).

Table 3.18 Geographical Information from 01-Oct-65 to 31-May-75

Gazetteer			Effected To		
Kaoh Thum		No. Commune	Kaoh Thum		No. Commune
Kandal Province		11	Kandal Province		11
Total Ammunition Expended					
Quantity : 5,032			Weight (T) : 7,752.36		
Ammunition Expended by Province					
Commune Name	Ordnance		Cluster Bomb		
	Quantity	Weight(T)	Quantity	Weight(T)	Sub Munition (Qty)
Chheu Khmau	473	953.71	16	25.93	511
Chrouy Ta Kaev	205	70.10			
Kampong Kong	347	384.20			
Kaoh Thum Ka	124	186.41			
Kaoh Thum Kha	187	163.03			
Leuk Daek	350	507.95			
Pouthi Ban	2325	3,715.21	60	151.71	3,250
Preaek Chrey	341	580.51			
Preaek Sdei	406	761.57			

Preaek Thmei	90	117.00			
Sampov Pun	108	135.03			
Total :	4,956	7,574.72	76	177.64	3,761

Table 3.19 Ammunition Expended Classified by Category

Category	Quantity	Weight (T)
Ammunition	511	11.74
Cluster_Bomb	76	177.64
General_Purpose	4,289	7,302.92
Incendiary	60	146.59
Rocket	96	113.46
Total :	5,032	7,752.35

Table 3.20 Ammunition Expended Classified by Aircraft

Ammunition Drop by	Quantity	Weight (T)
A1	397	367.1
A37	470	904.72
A4	16	23.7
A7	24	42.98
AC119	30	0.82
AC130	280	10.64
AC47	131	0
B52	2,988	4,988.25
F100	34	105.2
F111	366	768.96
F4	92	159.34
F5	24	57.86
T28	180	322.79
Total :	5,032	7,752.36

Table 3.21 Geographical Information from 01-Oct-65 to 31-May-75

Gazetteer		Effected To	
Leuk Daek	No. Commune	Leuk Daek	No. Commune
Kandal Province	7	Kandal Province	7
Total Ammunition Expended			

Quantity : 22,224			Weight (T) : 26,146.46		
Ammunition Expended by Province					
Commune Name	Ordnance		Cluster Bomb		
	Quantity	Weight(T)	Quantity	Weight(T)	Sub Munition (Qty)
K'am Samnar	735	1,119.52			
Kampong Phnum	11563	9,383.68	114	262.27	6,266
Khpob Ateav	3153	5,461.49	61	183.32	4,120
Peam Reang	2665	3,282.49	41	125.64	1,953
Preaek Dach	2014	3,562.44	49	115.27	3,282
Preaek Tonloab	1129	1,685.75	12	27.53	867
Sandar	687	934.00	1	3.06	217
Total :	21,946	25,429.37	278	717.10	16,705

Table 3.22 Ammunition Expended Classified by Category

Category	Quantity	Weight (T)
Ammunition	7,749	268.90
Cannon Artillery	459	83.35
Cluster Bomb	278	717.10
General Purpose	13,654	24,880.63
Incendiary	64	158.48
Rocket	20	38.01
Total :	22,224	26,146.47

Table 3.23 Ammunition Expended Classified by Aircraft

Ammunition Drop by	Quantity	Weight (T)
A1	77	90.75
A37	184	346.17
A4	192	288.05
A7	1,825	3,638.40
AC119	521	19.05
AC130	7,378	292.67
AC47	145	0
B52	5,655	9,801.48
F100	47	112.39
F111	2,815	5,206.47

Ammunition Drop by	Quantity	Weight (T)
F4	3,341	6,259.83
F5	28	52.62
T28	16	38.57
Total :	22,224	26,146.45

3.3.3.2 Ground-to-Ground Munitions at PR23

173. Similar to PR312, ground-to-ground munition contamination along this road took place during the following armed conflict which last from 1970 to 1979. Please see ground-to-ground munitions at PR312 for detail.

3.3.3.3 Landmine Warfare at PR23

174. Similar to PR312, landmine warfare along this road took place during the following armed conflict which last from 1970 to 1979. Please see landmine warfare at PR312 for detail.

3.3.3.4 Mine/UXO Victims at PR23

175. Mine/UXO casualty was reported in this region however, this information could not be found in CMVIS report due to the fact that it took place before the creation of CMVIS.

3.4 Mine/UXO Clearance Work & Methodology

176. It is obvious that the project sites locate within in the bombing zones carried out by US planes during American War half a century ago. According to interview with local people, the area experienced ground to ground fighting which surely indicates to be polluted by ground to ground munitions. From our survey the entire length of the road is potentially contaminated. Mine/UXO clearance must be carried out. To maximize the safety and minimize the cost, 15m either side of the road is to be cleared. At structure sites, enough space should be cleared to provide accommodation for the construction of detour road.

3.4.1 Mine/UXO Clearance

177. To ensure the safety of the civil work, mine/UXO must be carried out before the start of any civil work activity. Taking mine/UXO threat, depth, time and budget into consideration, the clearance is divided into two categories: Mine/UXO detection, excavation and removal - Normal and Mine/UXO detection, excavation and removal - Intense. Found mine/UXO on site is not recommended to be destroyed on site per recommendation from Cambodia Mine Action and Victim Assistance Authority (CMAA). It must be handled carefully, neutralized if possible and removed and handed over to the authority.

178. Due to the possibility of Chinese made anti-personnel landmine type-72A/B within project site at PR1534

- For PR1534: If metallic signature is detected at flood prone area, prodding is not recommended due to the fact that face-up position of the mine is disturbed by

flood from mountain. Other method than prodding such as 20cm-away-from-object excavation to the depth of the suspected objected is recommended. Mine/UXO clearance guideline for this road section is to be produced during detailed design stage.

- For road PR312, existing asphalt is to be removed prior to the rehabilitation in preparation for thus deep search is commenced.

The total size of mine/UXO clearance for all three roads is approximately 410 ha.

3.4.2 Community-Based Mine/UXO Awareness

179. After mine/UXO clearance operation is taking place, community-based mine/UXO awareness shall be provided to all parties involved in this project: contractor, engineer, local people who are going to work and live and to get benefit from this infrastructure rehabilitation.

3.4.3 Cost

180. The following is an estimated cost related to Mine/UXO:

Table 3.24 Estimated Cost for Mine/UXO

No.	Description	Cost in USD
1	Mine/UXO detection, excavation and removal (Normal and Intense)	\$1.4 million
2	Community-Based Mine/UXO awareness	\$0.1 million

4 TRAFFIC

4.1 INTRODUCTION

181. Two among three proposed provincial roads included in the study are open to traffic and the majorities have unrestricted access for the whole year; except PR23 in Kandal province was passable on small portion of the section during wet season. Benefits from upgrading will therefore be predominantly from road user cost savings. The accuracy of an appraisal of such roads is very dependent on the accuracy of the estimates of the base year traffic level and the future growth in traffic. Considerable effort was therefore made to determine traffic levels accurately for each road. Although a number of the roads have been improved under MPWT project and other donor assisted projects, and therefore subject to some form of appraisal, no previous traffic count data for the roads could be available. Two methods are available for conducting traffic volume counts: (1) manual and (2) automatic. Manual counts are typically used to gather data for determination of vehicle classification, turning movements, direction of travel. Automatic counts are typically used to gather data for determination of vehicle hourly patterns, daily or seasonal variations and growth trends, or annual traffic estimates. For this study, manual classified counts were carried out on all roads to provide the main source of traffic information.

182. Following the usual conventions, traffic levels are expressed in terms of daily traffic flows. When expressed as total traffic over 24 hours the term Average Daily Traffic (ADT) is used. When seasonal variations are taken into account the term Annual Average Daily Traffic (AADT) is used. Estimates of AADT were used as the basis of the economic appraisals.

4.2 STATISTICS OF VEHICLE REGISTRATION

183. According to data of registered vehicles, the total number of registered vehicles has reached almost 3,200,320 in 2015. Since 2010, the average annual increasing rate is 14.1%. The number of motorcycles dominates the biggest share of registered vehicle (accounted about 84.8% of all registrations).

Table 4.1 The number of Registered vehicles

Year	Registered Vehicles (cumulative)							Only Auto (exclude Motorcycl e)
	Motor cycle	Light vehicle	Bus		Truck		Total	
			Small	Big	Small	Big		
2000	247,965	49,559	5,888	971	14,560	12,915	331,858	83,893
2001	291,655	54,052	6,481	1,042	16,184	13,564	382,978	91,323
2002	308,611	59,470	7,384	1,224	18,530	14,869	410,088	101,477
2003	336,502	64,805	8,412	1,331	20,334	16,044	447,428	110,926
2004	359,166	75,080	9,617	1,533	22,710	17,506	485,612	126,446
2005	429,689	87,887	11,366	1,711	25,473	18,703	574,829	145,140

Year	Registered Vehicles (cumulative)							Only Auto (exclude Motorcycl e)
	Motor cycle	Light vehicle	Bus		Truck		Total	
			Small	Big	Small	Big		
2006	541,146	106,581	13,852	2,060	29,837	20,987	714,463	173,317
2007	671,252	121,034	16,136	2,461	34,034	24,130	869,047	197,795
2008	860,167	136,936	18,474	2,692	38,842	27,418	1,084,529	224,362
2009	1,135,638	157,371	20,988	3,016	43,907	30,659	1,391,579	255,941
2010	1,372,252	172,934	23,498	3,240	47,722	32,902	1,652,548	280,296
2011	1,590,469	194,747	26,392	3,644	53,235	35,790	1,904,277	313,808
2012	1,823,966	216,956	29,748	4,146	60,117	40,499	2,175,432	351,466
2013	2,068,937	238,109	32,780	4,473	67,645	45,625	2,457,569	388,632
2014	2,372,117	261,902	36,107	4,864	75,718	51,110	2,801,818	429,701
2015	2,714,193	296,788	40,717	5,399	85,902	57,321	3,200,320	486,127
Portion	84.8%	9.3%	1.3%	0.2%	2.7%	1.8%	100.0%	15.2%

Source: Department of Land Transport, 2016.

Table 4.2 The average annual increasing rate

Period	Motor cycle	Light vehicle	Bus		Truck		Total	Only Auto
			Small	Big	Small	Big		
'00~'05	11.6%	12.1%	14.1%	12.0%	11.8%	7.7%	11.6%	11.6%
'05~'10	26.1%	14.5%	15.6%	13.6%	13.4%	12.0%	23.5%	14.1%
'10~'15	14.6%	11.4%	11.6%	10.8%	12.5%	11.7%	14.1%	11.6%

Source: Consultants, 2016.

4.3 TRAFFIC SURVEY

4.3.1 Classified Counts

184. Manual, classified traffic counts identifying different vehicle types were carried out on all project roads for two days. The standard procedure was to carry out the count over a 12-hour period, from 6AM to 6PM. The count commenced during the day, to enable close supervision of the initial counting. A minimum of one site was used on each road. Additional sites were used where there was believed to be a difference in traffic flow along the roads of more than 30km; for example on either side of a large village or other major road junction. The locations of the sites were chosen as points where traffic levels were believed to be typical of the whole road, or section of road, being covered by the count. Care was taken to avoid locations near markets, schools or any other site where there may be large numbers of

motorcycles and bicycles making very short distance journeys not typical of the whole length of the section. However, for practical reasons sites needed to be in villages or immediately adjacent to them, and often the amount of non-motorized traffic recorded was clearly above general levels along the road. This was particularly the case for bicycles, which are used by large number of children going to/from school; and on few road sections where located between other road construction or other development project sites which are also used by larger number of dump trucks or transport trucks going to/from borrow pits or warehouse. The results were adjusted to compensate for these, and produce an estimate of average non-motorized traffic and heavy traffic levels along the whole section length. Traffic was recorded separately for each hour.

4.3.2 Vehicle Types

185. Extensive vehicle classification systems that were used for PRIPI, was classified to enable the characteristics of vehicle types used in the economic evaluation to be specified more accurately. As shown in Table 4-3 the vehicle classifications identified in the counts were:

Non-motorized traffic (NMT):











- 1. Bicycle - All two and three-wheeled non-motorised vehicles, including carried carts and those used for carrying freight.




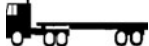


Motorized Traffic (MT)

- 2. Motorcycle - Motorcycles, scooters and any other 2-wheeled motorized vehicles, but not those with trailers. Motorcycle traffic dominates vehicle movements on virtually all roads.
- 3. Motorcycle with Trailer - Motorcycles with a trailer (remorque), or any 3-wheeled motorised vehicle, used for freight or passenger transport.
- 4. Car - This type includes sedan cars and (but not 4-wheel drive vehicles) with a maximum of 5 seats.
- 5. 4-wheel Drive Vehicles - All four-wheel drive (4WD) vehicles and station wagons, such as Toyota Land Cruiser or Mitsubishi Pajero, with a maximum of 7 seats.
- 6. Pick-up - Vehicles such as the Toyota VIGO or Mitsubishi Triton 2.5 GLX and other types of pick-up designed for use as light freight vehicles, but are also used for private transport as an alternative to sedan cars. They are also known as utilities. Very small trucks are also included in this category, being distinguished from the Light Truck category in having only single wheels on the rear axle. If it appeared that a pick-up was being used for private passenger transport, especially a twin-cab model, it was counted as a Car or a 4-wheel Drive Vehicle as appropriate. If converted for public transport use, with seats and a canopy or roof over the rear section, it was counted as a Minibus.
- 7. Minibus - The minibus type is typically an 8-12 seat vehicle, such as the Mercedes MB 140D-Ssang Yong Motor (now replaced by the Sprinter), sometimes referred to as a microbus or van.

- 8. Bus - All buses with more than 16 passenger seats. They are distinguished from the Minibus type by having dual-wheel on the rear axle. (Very few buses operate on rural roads in Cambodia, except on some rural roads where its serves as access road or bypass road to tourist or religious sites.
- 9. Small Koyun/Etan - Small tractors made into a road vehicle by attaching a single-axle trailer, or small, slow moving, locally-made trucks.
- 10. Large Koyun/Etan - Locally-made trucks that typically have low capacity engines not always designed for motor vehicles. These are much slower than conventional vehicles and are normally only used for short distance freight movements.
- 11. Light Truck - These are trucks with a payload of up to 4 tonnes. They have two axles and dual-wheels on the rear axle. If converted for passenger transport and carrying passengers they were counted as buses.
- 12. Medium Truck - These are larger trucks than the light truck, but also have two axles and dual-wheels on the rear axle. They have a carrying capacity up to 10 tonnes. Although sometimes difficult to distinguish from the Light Truck in traffic counts most are much larger. There are significant differences between these two types, especially in terms of axle loads, and it is considered desirable to obtain information on the numbers of each for use in feasibility and pavement design studies.
- 13. Heavy Truck - All 3-axle rigid trucks and articulated trucks.
- 14. Heavy Truck - All 4 or 5-axle rigid trucks and articulated trucks. A large range of such vehicles operates in Cambodia but most have a similar ESA, and numbers are very low on most of the study roads.
- 15. Heavy Truck - 4 or 5-axle semi-trailers.
- 16. Heavy Truck – 6 or more axle of semi-trailer and full trailer.

Table 4.3 Vehicle Classification Description

Veh. Class	Image	Description	Veh. Class	Image	Description
1		Bicycle	9		Koyun/Etan (Small)
2		Motorcycle	10		Koyun/Etan (Large)
3		Motorcycle Trailer (Including 3-wheel motorised)	11		Truck Small (2~4 tonnes)-2 Axle
4		Car (Max 5 Seats)	12		Truck Medium (+4 tonnes) -2 axle
5		Jeep/ 4WD (Max 7 Seats)	13		Truck Heavy (Rigid 3 Axle)

Veh. Class	Image	Description	Veh. Class	Image	Description
6		Pick-up (Freight Use)	14		4 or 5-axle rigid trucks and articulated trucks
7		Minibus (8 - 16 Seats)	15		4 or 5-axle Semi-trailers
8		Bus (16+ Seats)	16		Semi & Full Trailer (6 Axle or more)

186. If any vehicle did not meet one of the above descriptions, it was recorded as the vehicle type it was closest to in appearance and size (for example an ambulance would be recorded as a Minibus). The only exceptions were graders, rollers and other equipment used in road construction or maintenance. These were excluded, but all other vehicles were included even if they did not match exactly one of the types shown on the form. Pedestrian movements can be included in an HDM-4 analysis, with benefits related to higher walking speeds on improved roads. However, it is difficult to determine appropriate levels of traffic and the benefits are minor for provincial roads, so pedestrian traffic was not included.

4.3.3 Moving Observer Counts

187. Moving observer counts were made during the initial field surveys and traffic count survey, recording the levels of motorcycle traffic and the total of all other motorised traffic traveling in the opposite direction at approximately 2-5km intervals along the roads. Traffic levels were too low for these to be used as an indicator of the overall level of traffic, but they could be used as a guide to levels of motorcycle traffic, and of the variation of traffic flow along each road. Their main use was in planning the manual classified counts, in particular identifying where more than one count site was required and in providing information on the vehicle types in use on the study roads.

4.4 ESTIMATES OF BASE YEAR TRAFFIC

188. A number of adjustments were made to survey data to estimate the 2016 traffic flows on the study roads in terms of annual average daily traffic (AADT) to serve as the base year traffic figures.

4.4.1 24 Hour Adjustment

189. The counts were for 12 hours and estimates of night-time traffic were required to adjust the results to a 24 hour basis. The ratio to adjust a count of less than 24 hours to an average daily traffic (ADT) basis is normally higher for inter-urban roads than on provincial roads, and on high traffic roads compared with low traffic roads. When the 12-hour count results are for the period between 6AM and 6PM the 24/12 adjustment factor for provincial roads is normally in the range 1.1 to 1.3. It is rarely above this, but can be as low as 1 in some cases. The Road Asset Management Project II (RAMP2) carried out some 24-hour counts and from these assumed a factor of 1.1 was applied. Also the 24-hour count results of some remote provincial, district and rural roads indicated that a factor of 1.1 to 1.2 was

consistent over a period of seven days. Therefore, a factor of 1.11 has been applied, which is consistent with an assumption that 90 percent of traffic occurs in the 12 hours between 6AM and 6PM.

4.4.2 Daily Traffic Variation

190. Traffic counts are often carried out over a continuous period of seven days. The reason for this is that daily traffic levels often vary in a regular pattern, reflecting the distribution of activities relating to work, trading and recreation over a week. When this occurs, extending traffic counting periods progressively towards seven days results in increasing levels of accuracy of an estimate of ADT as more of the daily peaks and lows are included in the count period. Increasing the count period beyond seven days continues to improve the accuracy, but the rate of improvement is less. In this study the traffic patterns were referenced to the study of PRIP I and RRIP I rather than on long counts at every location. The results were shown that the daily variation is random and there is no reason to adjust for the days of the week on which counting took place, even if these were Saturdays and Sundays. So, the conversion factor of 1 is applied.

4.4.3 Seasonal Variation

191. Seasonal patterns to traffic need to be considered in producing an estimate of AADT. The major seasonal influences are usually crop harvesting, causing peaks in traffic flows, and rainfall, disrupting traffic on unsealed roads and reducing traffic levels over much of the road network. The peaks of traffic in harvest seasons may be predominantly caused by passenger vehicles rather than those transporting crops; the increased traffic reflecting more movement of labour and generally increased activity at that time.

192. Continuous automatic counting carried out on National roads does show a seasonal pattern; with peak traffic in January/February and low traffic in June/September. Some of this is likely to be caused by rainfall, with the impact of rainfall on road condition, and hence on traffic level, probably higher on unsealed and flood-prone roads directly affected. However, there is no direct evidence of the amount of seasonal variation in traffic levels on the project roads.

193. These factors show that traffic levels are usually below the AADT during the period June to November, with lowest traffic levels in August when traffic is on average 80 per cent of the AADT. The traffic counts for this study were carried out in June, so a seasonal adjustment factor of 1.2 was applied to derive an estimate of the AADT from the traffic count results.

4.4.4 Derivation of Base Traffic Levels

194. From the information referred to above base year traffic levels were estimated for each section of road. The PCU values for each vehicle type are sourced from the ADB-TA8784-CAM as shown in Table 4.4 . A summary of the traffic data is shown in Table 4.5 with more detailed information showing traffic by vehicle type shown in Appendix I-A. In all cases the traffic level is an estimate of the traffic over the designated section for the year 2016.

Table 4.4 Passenger Car Unit (PCU) Value

Group	Vehicle Class		Specification	PCU Value
I. Non-Motorized	1	BC	Bicycle	0.3
II. Motorcycle (MC)	2	MC	Motorcycle	0.4
	3	MCT	Motorcycle trailer	0.4
III. Light Vehicle (LV)	4	PC	Passenger car, Taxi	1
	5	J/4WD	Jeep/4WD, Van	1
	6	PU	Pick-up/Freight Only	1.1
	7	Mini-Bus	Mini bus (8-16 seats)	1.1
	9	KE/AE-S	Koyun & Etan (Small)	1.5
	10	KE/AE-L	Koyun & Etan (Large)	1.5
	11	LGV	Light Truck (4- tons)	1.5
IV. Heavy Vehicle (HV)	12	MV	Medium Vehicle/Truck (4+ tons)	2
	8	Bus	Bus (16+ seats)	2.3
	13	HV1	Heavy Vehicle/ Truck 1 (Rigid 3 axles)	2.5
	14	HV2	Heavy Vehicle/Truck 2 (Rigid 4&5 axles)	3
	15	HVT1 (Trailer 4&5)	Semi-trailer (4&5 axles)	3
	16	HVT2 (Trailer 6+)	Semi and Full Trailer (6+ axles)	3

Source: ADB TA8784-CAM, the Second Road Asset Management Project (RAMP2). MPWT, March 2016.

Table 4.5 Base Year Traffic Summary (AADT)

Classification				AADT (by Vehicle Group)					TOTAL (PCU)
				I.	II.	III.	IV.	Total	
Project Road Number	Count Location	Province	Length (km)	Non-motorised (N-MTR)	Motor-cycle (MC)	Light Vehicle (LV)	Heavy Vehicle (HV)		
PR1534	PK 33.5km (from NR53)	Kampong Chhnang (KCH)	84.5km	169	1,030	462	13	1,674	1,131
	PK46.8km (from NR53)	Pursat (PST)		530	2,398	456	15	3,398	1,756
PR312	PK 4km (from NR1)	Prey Veng (PVG)	28.4km	342	2,669	673	49	3,734	2,073
PR23	PK 7km (from Junction NR21B via concrete road)	Kandal (KDL)	19.9km	2,286	3,658	80	5	6,029	2,267

Source: Consultants, 2016.

4.4.5 Traffic Growth

195. To assess the benefits of road improvements it is necessary to establish future traffic levels on the project roads. The existing traffic volumes on road are expected to change in the future. In this study traffic levels need to be projected from the current year of 2016 for a period of 25 years to provide the data for a 20-year benefit period. Theoretically, the following future traffic growth on road must be considered:

- Normal traffic: the traffic that would use the road if no improvement were made.
- Generated traffic: The traffic that would not have existed but is expected because of reduced travel times or diversion from other modes.
- Diverted traffic: The traffic that can be expected to divert to the road because of the improvement.
- Induced traffic: Traffic expected because of the new development created by better access (example, building a road into a new area will open it up for development).

4.4.5.1 Normal Growth

196. Normal traffic flows are likely to increase over time as a result of growth in population and economic activity. Previous growth is commonly used as a basic indicator of normal growth.

197. Naturally, the main factor leading to increased traffic volume is economic growth, because increasing disposable incomes enable people to travel more and because increasing economic activity generates increasing freight traffic. The relationship between economic growth and transport growth is known as elasticity, defined by:

$$\frac{\Delta T}{T} = e \frac{\Delta G}{G}$$

Where:

$$\frac{\Delta T}{T} = \text{percentage increase in demand for transport}$$

$$\frac{\Delta G}{G} = \text{percentage increase in real GDP}$$

E = elasticity of demand for transport

198. The elasticity is defined as the proportional change in demand per unit change in real GDP, so an elasticity of 1 implies a 10% growth in travel demand in response to a 10% increase in real GDP. Typically, the elasticity in developing countries range from 1 to 2, with the higher rate applying to personal passenger traffic. In provincial area of Cambodia, the demands for motorcycle are highly rated rather than car or four wheel drives; it depends not only the income level but as well as the road pavement condition and width. So the motorcycle demand elasticity is expected to be higher than other passenger vehicle.

199. It is noted that there is no historical data done on provincial roads, so that the above analysis shall be made with the available historical data on national 1-digit and 2-digit roads. The traffic volume in 2012 and future traffic volume in 2020 on some 1-digit and 2-digit roads were estimated through the traffic data from the Study of Data Collection Survey of Trunk Road Network Study in Cambodia in 2013 under JICA-Cambodia.

200. Elasticities in developing countries typically range from 1 to 2, with the higher rate applying to personal passenger traffic. Higher rates sometimes occur during periods of increasing personal vehicle ownership which, in the case of motorcycle traffic, is currently happening in provincial areas of Cambodia. Elasticities tend to fall as economies develop, but this is unlikely to be a significant effect over the period in question. The elasticity values used other road improvement project were shown in Table 4.7, and these could be used for provincial road cases in this study.

Table 4.6 Elasticity by Modes of Traffic

Mode of Traffic	Elasticity of the demand
Motorcycle	1.7
Passenger	1.2
Freight	1.1

Source: Feasibility Study Report on Rural Roads Improvement Project II, 2013

201. In this study, real GDP growth rates was calculated by using GDP data of Denver University's the international Futures(IFS, version 7.15), which provided forecasts of economic indicator for 186 countries. The base year of traffic count surveys were carried out in 2016. Hence, the growth rate of real GDP as given in Table 4.8 was also considered from 2016 base year. An average annual growth rate of 5.99% are used for the period from 2017-2020 (International Futures), with 6.80% from 2020 to 2025, with 7.58% from 2025-2030, with 7.86% after 2030.

Table 4.7 Real GDP Growth Rates (base year 2016)

Year	2017-2020	2020-2025	2025-2030	2030 onwards
Growth Rate (Base year : 2016)	5.99%	6.80%	7.58%	7.58%

Source: Consultants, 2016, based on: Frederick S. Pardee Center for International Futures of University of Denver (IFS Version 7.15)

202. Therefore, using the above growth rate of GDP and elasticity of demand for vehicles, the normal traffic growth rates can be calculated as given in Table 4.9.

Table 4.8 Normal Traffic Growth Rates

Mode of Traffic	2017-2020	2020-2025	2025-2030	2030 onwards
Motorcycle	10.19	11.55	12.89	12.89
Passenger	7.19	8.16	9.10	9.10
Freight	6.59	7.48	8.34	8.34

Source Consultants, 2016

203. The traffic growth can be affected by a change in the vehicle types used or the loading patterns following significant improvements to the road. Such changes cannot be incorporated in a standard HDM-4 analysis and no allowance for such changes has been made in the growth rates. In addition, NMT(non-motorized transport) traffic has been assumed not to growth above the present levels, reflecting that the growth in motorized traffic includes an element of changing travel modes from non-motorized vehicles.

4.4.5.2 Generated Traffic

166. The main casual factors of generated traffic are reductions in travel costs or time, or the increased development brought about by a road investment. This can be explained as shown in Figure 4.1.

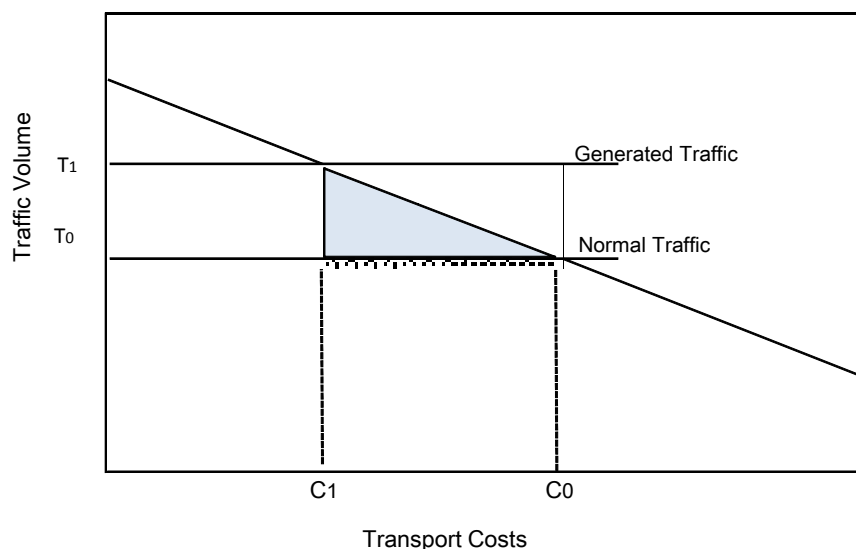


Figure 4.1 Basic Concept of Generated Traffic

204. Referring to Figure 4.1, generated traffic is resulted from traffic volume (T_1) subtracting traffic volume (T_0); it is due to reduction of transport cost from C_0 to C_1 . Normally it is assumed that there must be a reduction in VOC of approximately 25 percent before there is measurable generated traffic. In the case of upgrading unpaved roads to sealed standard there are normally sufficient reductions for generation to occur. The standard approach to estimating generated traffic is to use demand relationships. The price elasticity of demand for transport is the responsiveness of traffic to a decline in transport costs. It has been measured in road appraisal studies in developing countries and found to fall in the range -0.6 to -2.0, with an average of about -1.0. This means that a one per cent decrease in transport costs leads, on average, to a one per cent increase in traffic. Evidence suggests that the elasticity of demand for passenger transport is above one, with that for freight transport usually much lower.

205. The economic benefit from this traffic is calculated as half the benefit to an equal amount of normal traffic. In theory, generation should be determined from costs expressed in financial rather than in the economic terms used for the calculation of project benefits, but the different in percentage terms is small. For the Project roads the cost reduction following improvement depends largely on the condition of the existing road, measured by roughness.

Given the normal maintenance procedures in Cambodia, this is expected to vary greatly over time; from low roughness immediately after periodic maintenance, increasing to high roughness over a period of 3-4 years before the next periodic intervention. This would suggest that generated traffic could be up to 50% of normal traffic levels referring to VOC reduction of more than 50% in case of road roughness variations. However, it is important to note that it depends not on the VOC but on the perceived cost reduction. This mainly the cost of fuel, plus the time value in the case of private vehicles. In the case of public transport it is the fare reduction, again plus the value of time. The impact of cost reduction on travel demand will therefore be less than the theoretical response.

206. It is also important to note that any calculation of increased traffic due to road improvement should be based on total journey costs, and not just that part of the cost incurred on the road under study. This will vary according to the origin and destination of each trip, but where travel on the roads is part of a longer journey there will be a reduction in the overall journey cost saving, and in the amount of traffic generation.

207. In addition to generated traffic of the type discussed above there are also additional trips made if any road closure during the rainy season is eliminated or reduced following upgrading. The benefits to such additional trips are valued in the same way as generated trips, and so are best included as generated traffic. Most of the study roads have already been upgraded to all-weather condition in terms of surface condition, drainage and structures, but some wet season closures can be expected. The average number of days during for which roads will be closed is difficult to determine, and some closures may still occur after sealing as a result of flooding. Also the number of additional trips will vary according to the degree to which temporary road closure, or difficult road conditions, can be anticipated. In some cases additional trips will be made before the rainy season to avoid the difficult conditions, so that all-year access will not necessarily lead to more traffic on an annual basis. In order words, road improvement will lead to a change in the timing of some trips, and only a limited increase in the total number of trips.

208. In order to allow for the significant increase in traffic occurred following road improvement to sealed standard in some cases, a general traffic increase of 20% has been assumed in the case of cars and other light vehicles, and 15% in the case of motorcycles. Generation in freight traffic theoretically occurs only if the reduction in transport costs has sufficient impact on prices of goods to induce consumers to buy more goods. Given the low proportion of transport cost to the value of goods normally carried by a truck it is unlikely that the impact will be more than one or two per cent of retail prices of goods, even if the full transport saving is passed on to consumers. However, freight traffic is normally observed to increase following sealing of roads and it has been assumed that there will be an additional 10% freight traffic. The effect of generation is sometimes assumed not to occur in full for a number of years, as road users adjust to the new situation following road improvement. For simplicity all generation has been assumed to occur in the first year after improvement. Generated traffic has been assumed to grow at the same rate as normal traffic.

4.4.5.3 Induced Traffic

209. Induce traffic can occur when road improvement leads to new or expanded activities that produce additional traffic being established in the area served by road. Often induced traffic is considered to be a component of generated traffic, and there is overlap between when the reduction in transport costs associated with road improvements is large

enough to induce an increase in agricultural production in the zone of influence of the road. It can also be related to the opening up of new tourist facilities or industries. No specific schemes were identified in the area served by the roads, and because the projects are involved in upgrading from unsealed roads to sealed roads rather than new roads providing for accessing to areas for the first time, so the reduction in transport costs in such cases is not considered to be large enough to change agricultural production transport patterns and to produce additional traffic. Therefore, no additional induced traffic has been considered in the analysis

4.4.5.4 Diverted Traffic

210. As being aware in transport economic, traffic will normally travel on the quickest or cheapest route available, which may not necessarily be the shortest. Improvements to the road system may cause existing traffic to divert to another route if it becomes quicker or cheaper than the route currently being used. With most roads included in this study being provincial roads, there is almost no possibility of traffic diversion, but in some cases it needs to be considered.

211. However, the potential for diversion is very limited in the present study or due to the provincial roads width and the distance saving are expected to be small and speeds will be lower, so no diversion is expected. Therefore, for simplicity, the diversions to the study roads in this study were assumed not to incur.

5 ENVIRONMENT

5.1 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK.

5.1.1 Policy Framework

212. In 1993, the Royal Government of Cambodia confirmed a new Constitution in which environmental considerations were included for the first time. Specifically Article 59 states: The State shall protect the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind, geology, ecological system, mines, energy, petrol and gas, rock and sand, gems, forests and forestry products, wildlife, fish and aquatic resources and it was within this constitutional context that the MOE was established.

213. The hierarchy of legislation in Cambodia is:

- Royal Decree signed by the King
- Sub-decree signed by the Prime Minister
- Ministerial Decision signed by a Minister
- Regulation issued by a Ministry

214. The major legislation in Cambodia is the Royal Decree which ratifies laws passed by parliament. These can be supplemented by "PRAKAS" or ministerial decisions. These laws allow sub-decrees and regulations to be passed which can stipulate procedures and standards to be met in order to ensure compliance with the law. Many of these sub-decrees and standards have been drafted but have not yet been ratified by parliament. However, contractors are still expected to make sure their operations comply with the draft regulations.

5.1.2 Legal Framework

5.1.2.1 Laws on Environment

215. In 1996, the Law on Environmental Protection and Natural Resource Management (NS/RKM/1296/36) came into force and it requires the government to prepare national and regional environmental plans and sub-decrees concerning a wide range of environmental issues, including EIAs, pollution prevention and control, public participation and access to information.

216. Other ministries explicitly mentioned at the time were Ministry of Water Resources, Hydrology, and Meteorology (MOWRAM), and the Ministry of Land Use Management, Urbanization, and Construction. The list was later expanded to include MPWT, MOAFF, the Ministry of Rural Development (MRD), the Ministry of Health, and the Ministry of Tourism.

5.1.2.2 Laws on Historical Monuments

217. There is a general law in Cambodia which covers all national monuments. This is the "Law on Protection of Cultural and National Heritage" (1996). This is supplemented by the "Decision on the Definition of 3 Zones to Protect Temple Surrounding Areas in All Provinces and Municipalities except Angkor Wat", 1996. These laws protect small temples or ancient structures.

5.1.2.3 Laws on Nature Reserves

218. Royal Decree "Protected Natural Areas" issued in November 1993 gives protection to environment, land, forests, wetlands, and coastal zones. This decree covers 23 locations representing 18% of Cambodia's total area and is under the jurisdiction of MOE.

5.1.2.4 Laws on Wildlife

219. The "Joint PRAKAS of MOE and MOAFF on Prohibition of Hunting and Catching of Wildlife Animals" (1996) specifically bans hunting of animals and birds for food. A contractor's workers must observe this law.

5.1.2.5 Subsidiary Laws on Environmental Protection

a) Sub-decrees and Regulations

220. The "Law on Environmental Protection and Natural Resource Management" (1996) is "enabling legislation", in that it enables MOE to pass sub-decrees and regulations to protect the environment. This subsidiary legislation lays down quantitative standards which must be met by contractors in their operation.

221. Several sub-decrees are already laws. Others have been drafted and are expected to become law in the near future. These standards give parameters and values which must be measured to check compliance with the regulations. Even if the regulations are in draft form, the contractors are expected to comply with them.

5.1.2.6 Sub-Decree on Air and Noise Pollution Control (Draft)

Air Quality (Draft)

222. The air pollution regulations are contained in Draft Sub-Decree on Air and Noise Pollution. For dust control, there should no visible emissions from stockpiles of materials, crushers or batching plants. At sensitive receptors, a standard of total suspended particulates (TSP) < 0.33 milligrams/cubic meter at 24-hour average should be met. All vehicles should be well maintained and comply with the air quality regulations.

Noise (Draft)

223. The noise regulations are contained in Draft Sub-Decree on Air and Noise Pollution. The regulations do not stipulate a level for noise from construction sites but refer to mixed commercial and/or industrial and residential property. Neither do they give the measurement method. Therefore the following standards are recommended. Noise levels at the perimeter of any site should not exceed:

- Continuous Equivalent Level (Leq) = 75dB(A) 12 hours daytime (0700–1900)
- Continuous Equivalent Level (Leq) = 65dB(A) 12 hours nighttime (1900–0700)

224. The descriptor "Continuous Equivalent Level (Leq)" is a commonplace measurement and most noise monitoring equipment measures it directly. The measurement is made at the construction site perimeter which makes monitoring easier as it does not require one gaining access to a private residence. The level of 75dB(A) daytime/65 dB(A) nighttime is a "good" standard and commonly used in countries such as Singapore and Malaysia.

Vibration

225. There is no standard for vibration in Cambodia, therefore the following standard is recommended: the vibration levels at any vibration sensitive property or location should be less than 1 millimeter/second (mm/s) peak particle velocity (PPV). The level of 1 mm/s PPV is a good “standard” and is derived from the United States Bureau of Mines publications for avoidance of damage and the United Kingdom Greater London Council standard for avoidance of nuisance.

b) Sub-Decree on Water Pollution Control (No. 27 ANRK.BK 1999) (Draft)

226. As a minimum, all discharges of liquid wastes from construction camps, work sites or operations, to streams or water courses should be: biological oxygen demand <50 milligrams (mg)/liter (l); turbidity < 5 NTU; suspended solids < 50 mg/l; temperature < 45°C; pH = 6–9; oil and grease < 5 mg/l and dissolved oxygen > 4mg/l.

227. There is no legal standard for performance of septic tanks but they should be checked for correct operation: that is absence of smell; no overflowing; and no surface water logging.

c) Sub-Decree on Solid Waste Management (No. 36 ANRK.BK 1999) (Draft)

228. Under the Draft Sub-Decree on Solid Waste Management (No. 36 ANRK.BK 1999), Article 7 “the disposal of waste in public sites or anywhere that is not allowed by authorities shall be strictly prohibited”. There are no quantitative parameters given but good sensible practice is expected. Such practices would include:

- (i) All general waste and food waste should be removed to a government approved landfill.
- (ii) All demolition waste must be removed to a government approved location.
- (iii) All waste oils and greases should be removed by a registered subcontractor. The final destination should be established.

229. Failure to employ sensible precautions may cause sanitation problems to workers living in camps and also may result in prosecution.

d) Hazardous Substances

230. There is no specific regulation for hazardous substances in Cambodia. This aspect is covered in the Sub-Decree on Water Pollution Control Annex 1 and Sub-Decree on Solid Waste Management, which give details of classifications of what are defined as hazardous substances. Any hazardous substances must be stored correctly and only disposed in a manner approved by the MOE.

5.1.3 Administrative Framework

231. There are two particular types of areas of special ecological interest in relation to this project. These are:

5.1.3.1 Protected Areas

232. Cambodia has a network of 23 natural protected areas managed through the MOE. These areas cover 2.2 million hectares (ha) or 18% of Cambodia’s land area and include most of its important habitats. The Forest Administration has also designated

protected forests (from cancelled logging concessions) bringing the total area under protection to around 25% which is more than twice the global average. Protected Areas are sites which are protected by Royal Decrees, Laws and Regulations. Such mandatory stipulations are promulgated in Khmer language. These have been obtained and if necessary, translated. The Khmer version takes precedence over the translated version.

233. In 2008 Cambodia introduced the Protected Area Law (No. NS/RKM/0208/007), which defines:

- (i) national parks
- (ii) wildlife sanctuaries
- (iii) protected landscapes
- (iv) multiple use areas
- (v) Ramsar sites
- (vi) biosphere reserves
- (vii) natural heritage sites and
- (viii) marine parks

234. These have been referenced to the International Union for Conservation of Nature (IUCN) Categorization list :

- National Parks (IUCN category II) - Natural and scenic area of significance for their scientific, educational and recreational values.
- Wildlife Sanctuaries (IUCN category IV) Natural area where nationally significant species of flora or fauna, natural communities, or physical features require specific intervention for their perpetuation.
- Protected Landscapes (IUCN category V) – Nationally significant natural and semi-natural landscapes that must be maintained to provide opportunities for recreation.
- Multiple-Use Areas (IUCN category VIII) – Areas that provide for the sustainable use of water resources, timber, wildlife, fish, pasture, and recreation with the conservation of nature primarily oriented to support these economic activities.
- Ramsar Sites – There are two sites in the IUCN categories IV and VIII above and one site in the middle stretches of the Mekong River between Stung Treng and the border with Laos.
- Biosphere Reserve - The Tonle Sap Multiple-Use Area was nominated as Cambodia's first Biosphere Reserve in 1997. The Boeung Chmar portion of Tonle Sap Multiple-Use Area (28,000 ha) is designated as a Ramsar site.

235. The Law on Forestry Management prohibits the hunting of wildlife within such protected areas. As well as maintaining check points and providing rangers, MOE has an active community education program to promote environmental awareness especially within the rural communities.

236. This law is relatively recent (2008) and many of the protected areas predate this by many years. Both the original legislation and the most current have been reviewed during this project.

5.1.3.2 Important Bird Area

237. An Important Bird Area (IBA) is an area recognized as being a globally important habitat for the conservation of bird populations. Currently there are about 10,000 IBAs worldwide. The program was developed and sites are identified by Bird Life International. These sites are small enough to be entirely conserved and differ in their character, habitat or ornithological importance from the surrounding habitat.

238. Bird Life International is an international organization working to protect the world's birds and their habitats. It is a global conservation federation with a worldwide network of over 100 partner organizations. Bird Life International was founded in 1922 and was originally known as the International Council for Bird Preservation, acting as a lobbying group. It changed its name in 1993 to Bird Life International and is the official IUCN Authority for the Red List for birds.

239. Often IBAs form part of a country's existing protected area network, and so are protected under national legislation. Both the Cambodia's PAWS and the Phnom Samkos Wildlife Sanctuary contain designated IBAs.

5.1.4 Cambodian IEE Requirements

240. On 11 August 1999, a Sub-decree (72 ANRK.BK) on EIA processes was promulgated requiring an initial EIA or EIA for selected projects listed in the sub-decree annex to be submitted by public or private project owners to the MOE for review. Projects that require an Initial Environmental Impact Assessment are given below in table 5.1.

Table 5. 1 List of Projects that require an Initial Environmental Impact Assessment

No	Type and activities of the projects	Size / Capacity
A.	Industrial	
	a) Foods, Drinks, Tobacco	
1	Food processing and caned	≥ 500 tons/year
2	All fruit drinks manufacturing	≥ 1,500 liters / day
3	Fruit manufacturing	≥ 500 ones/year
4	Orange Juice manufacturing	All sizes
5	Wine manufacturing	All sizes
6	Alcohol and Beer brewery	All sizes
7	Water supply	≥ 10,000 users
8	Tobacco manufacturing	≥ 10,000 boxes/day
9	Tobacco leave processing	≥ 350 tons/ year
10	Sugar refinery	≥ 3,000 tons / year
11	Rice mill and cereal grains	≥ 3,000 tons / year
12	Fish, soy bean, chili, tomato sources	≥ 500,000 liters/ year
	b) Leather tanning, Garment and Textile	
13	Textile and dyeing factory	All sizes
14	Garments, washing, printing, dyeing	All sizes
15	Leather tanning, and glue	All sizes

No	Type and activities of the projects	Size / Capacity
16	Sponge- rubber factory	All sizes
	c) Wooden production	
17	Plywood	≥100,000m3/year(log)
18	Artificial wood	≥ 1,000 m3/year (log)
19	Saw mill	≥ 50,000m3/year (log)
	d) Paper	
20	Paper factory	All sizes
21	Pulp and paper processing	All sizes
	e) Plastic, Rubber and Chemical	
22	Plastic factory	All sizes
23	Tire factory	≥ 500 tons /year
24	Rubber factory	≥ 1,000 tons /year
25	Battery industry	All sizes
26	Chemical production industries	All sizes
No.	Type and activities of the projects	Size / Capacity
27	Chemical fertilizer plants	≥ 10,000 tons /year
28	Pesticide industry	All sizes
29	Painting manufacturing	All sizes
30	Fuel chemical	All sizes
31	Liquid, powder, solid soaps manufacturing	All sizes
	f) Mining production other than metal	
32	Cement industry	All sizes
33	Oil refinery	All sizes
34	Gas factory	All sizes
35	Construction of oil and gas pipeline	≥ 2 kilometers
36	Oil and gas separation and storage facilities	≥ 1,000,000 liters
37	Fuel stations	≥ 20,000 liters
38	Mining	All sizes
39	Glass and bottle factory	All sizes
40	Bricks, roofing tile manufacturing	150,000 piece /month
41	Flooring tile manufacturing	90,000 piece /month
42	Calcium carbide plants	All sizes
43	Producing of construction materials(Cement)	900 tons/month
44	Cow oil and motor oil manufacturing	All sizes
45	Petroleum study research	All sizes
	g) Metal industries	
46	Mechanical industries	All sizes
47	Mechanical storage factory	All sizes
48	Mechanical and shipyard enterprise	All sizes

No	Type and activities of the projects	Size / Capacity
	h) Metal Processing Industrials	
49	Manufacturing of harms, barbed wires, nets	≥ 300 tons/month
50	Steel mill, Irons, Aluminum	All sizes
51	All kind of smelting	All sizes
	i) Other Industries	
52	Waste processing, burning	All sizes
53	Waste water treatment plants	All sizes
54	Power plants	≥ 5 megawatt
55	Hydropower	≥ 1 megawatt
56	Cotton manufacturing	≥ 15 tons/month
57	Animal's food processing	≥ 10,000 tons/year
B.	AGRICULTURE	
58	Concession forest	≥ 10,000 hectares
59	Logging	≥ 500 hectares
60	Land covered by forest	≥ 500 hectares
61	Agriculture and agro-industrial land	≥ 10,000 hectares
62	Flooded and coastal forests	All sizes
63	Irrigation systems	≥ 5,000 hectares
64	Drainage systems	≥ 5,000 hectares
65	Fishing ports	All sizes
C.	TOURISM	
66	Tourism areas	≥ 50 hectares
67	Golf Course	≥ 18 holes
D.	INFRASTRUCTURE	
68	Urbanization development	All sizes
69	Industrial zones	All sizes
70	Construction of bridge-roads	≥ 30 tons weight
71	Buildings	Height ≥ 12 m or floor ≥ 8,000 m ²
72	Restaurants	≥ 500 seats
73	Hotels	≥ 60 rooms
74	Hotel adjacent to coastal area	≥ 40 rooms
75	Nationalroadconstruction	> 100 kilometers
76	Railwayconstruction	All sizes
77	Portconstruction	All sizes
78	Airportconstruction	All sizes
79	Dredging	≥ 50,000 m ³
80	Dumpingsite	≥ 200,000 people

m = meter, m² = square meter, m³ = cubic meter.

241. The Sub-decree No. 72 ANRK.BK dated 11 August 1999 Annex “List of the projects that require an Initial Environmental Impact Assessment” refers to “National Road Construction ≥ 100 km and bridges ≥ 30 tons”. As this project is rehabilitation of existing roads, and bridges are 25-ton capacity, an IEE will not be required. This has been confirmed in discussions with MOE.

5.1.5 Project Environmental Classification

242. The Project is classified as environment category B and an IEE has been conducted as part of project preparation in accordance with ADB SPS.

5.2 DESCRIPTION OF THE PROJECT

5.2.1 Description of Project Roads

243. The project roads of PRIP-II are located in four provinces. One road is located in central Cambodia, and runs across the two provinces of Pursat and Kampong Chhnang. The other two roads are in Kandal and Prey Veng provinces, located in southeast Cambodia. These provinces are mostly highly populated and predominantly agricultural areas.

244. The total length of the future project roads is approximately 132.8km. The individual roads are from 19.9km, 28.4km and 84.5km in length. The project roads will provide better access to essential services, reduce remoteness and increase economic opportunities. Most of the project roads link to a national road or provincial road and provide access to the road network at large. Currently all of national roads connecting the project roads are paved with either asphalt concrete pavement or Double Bituminous Surface Treatment (DBST). Road numbering follows the national system prepared for national and provincial roads by MPWT in June 2009. The list of project provincial roads in the four provinces is shown below in table 5.2.

Table 5. 2 List of Proposed Project Roads

Code No.	Road No	Province	From	To	Length (km)
1	PR1534	Kampong Chhnang & Pursat	NR53, Teuk Phos, Kampong Chhnang	NR5, Pursat, Newroundabout	84.5
10	PR312	PreyVeng	NR1, PK77+100 Samroung, Lvear, Pras Sdach district	Banteay Chakrey Border	28.4
15	PR23	Kandal	PR110, Koh Thom Bridge	PR118 Peam Raing district	19.9
	3	Total			132.8

Source: Provided by MPWT, 2016

245. Most of the project roads carry predominantly motorcycle traffic and light 4-wheeled vehicles. The project roads have varying widths both within their length and

between projects. The drainage structures are often narrower than the remainder of the road and the carriageway is restricted at these locations. This constricts traffic flow but is tolerable given the types and volumes of traffic. Existing widths are between 5m to 6m and some road sections are over 6m in width the project will improve the existing earth/laterite roads to DBST paved roads for PR1534 and PR23 and upgrade more stable pavement structure.

246. Numerous site visits have been undertaken to the project areas and engineering surveys have also been carried out on each of the roads proposed for improvement. An inventory was made of bridges and drainage structures, a geological survey measuring existing subgrade strengths, and existing pavement strengths.

247. The widths of the existing roads were measured frequently including the widths at structures where the road often narrowed. The surface material and conditions were also surveyed. All existing bridges were checked for length, widths, types and current condition etc. Drainage structures such as box culverts and pipe culverts were surveyed for location, widths, lengths, sizes, and current conditions. (Figure 5.1)

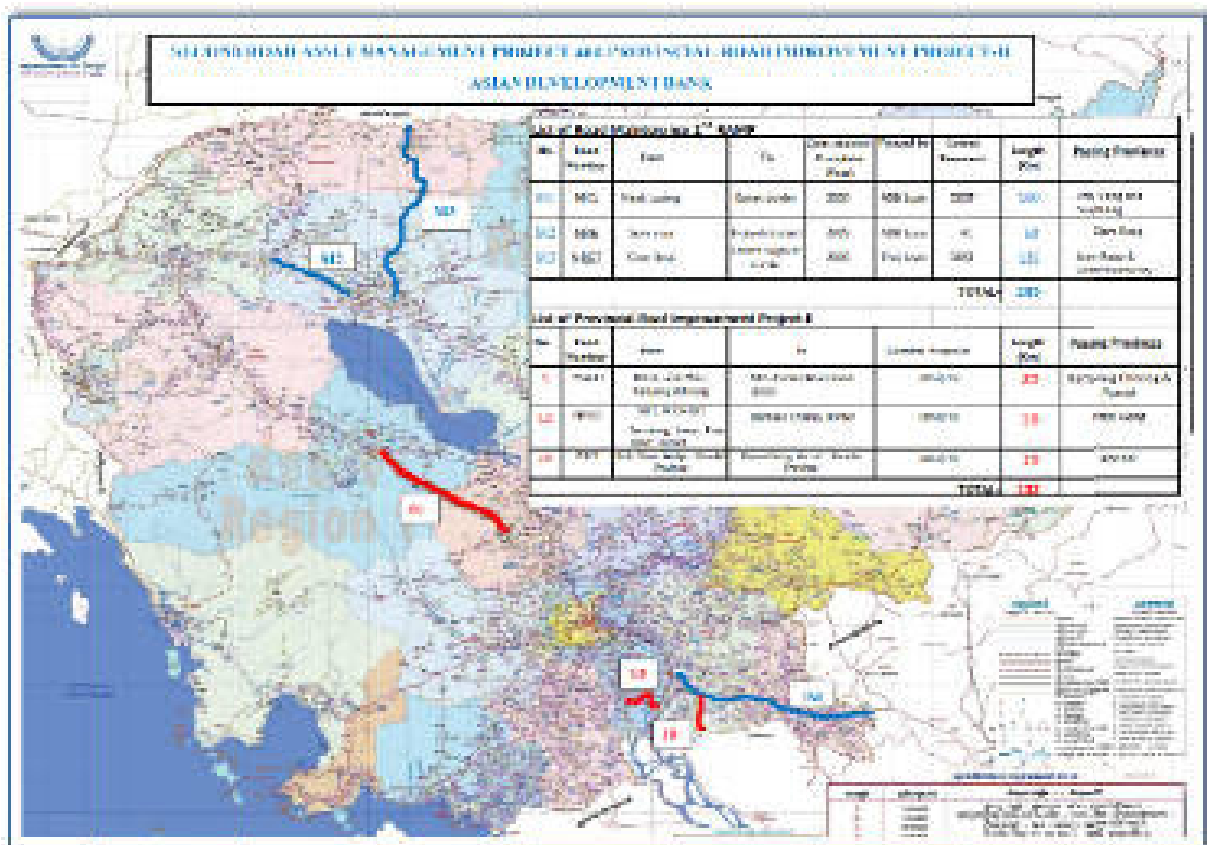


Figure 5.1 Details of the project roads and their locations

5.2.2 Current Environmental Conditions of Project Roads

5.2.2.1 Kampong Chhnang and Pursat

248. The road commences in Tuek Phos and runs for 84.5 km until it joins NR5 at the new roundabout before Pursat. (Figure 5.2) The road is currently well used laterite road of about 15m width although this varies along the length and is not clearly defined. The road has a large number of old wooden bridges and new concrete bridges. There is one major river crossing.

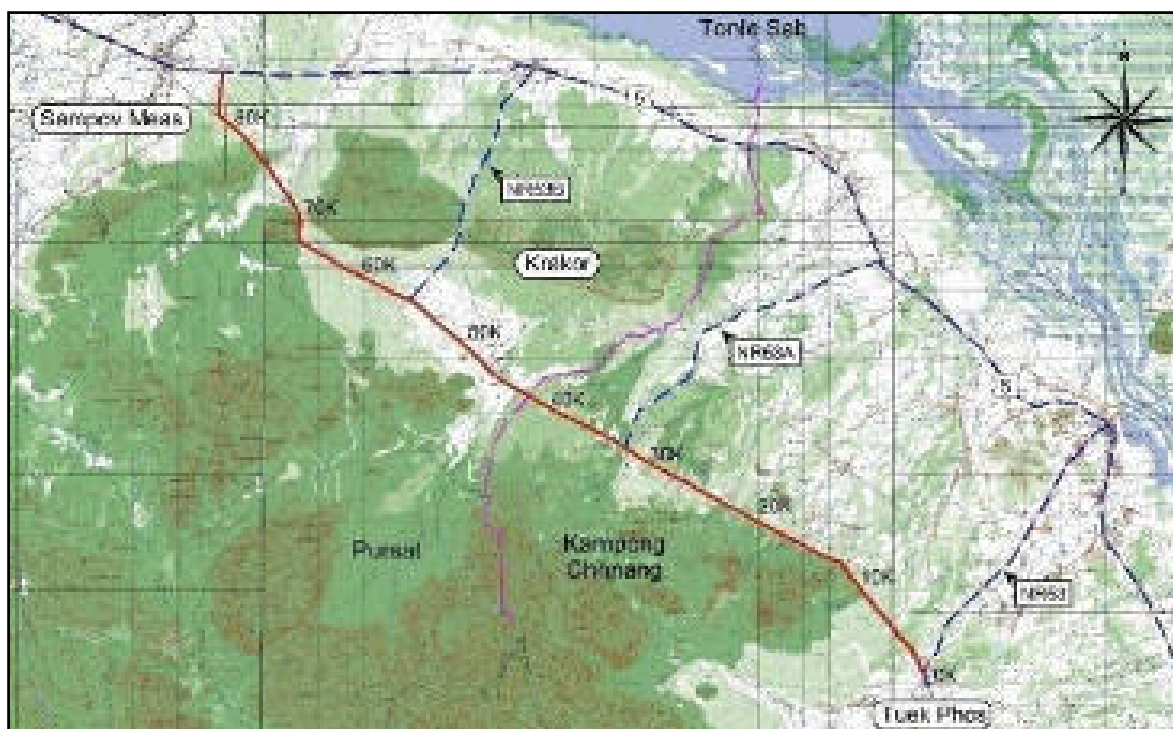


Figure 5.2 Details of the project roads and their locations

249. A condition survey was carried out to establish sensitive points which must be taken into consideration during construction. Details are given in the IEE (Annex A).

5.2.2.2 Kandal

250. The road commences at the new Koh Thom Bassac River crossing and runs for 19.9km until it reaches Peam Raing district. The road is currently a narrow muddy track which can only be accessed by motor cycle. It is extremely difficult to pass by a vehicle. There is one major river crossing at the midpoint where the road crosses a tributary of the Bassac River over the established Wat Chroy Bridge. For most of its length it passes through rice padis and agricultural land. (Figure 5.3)

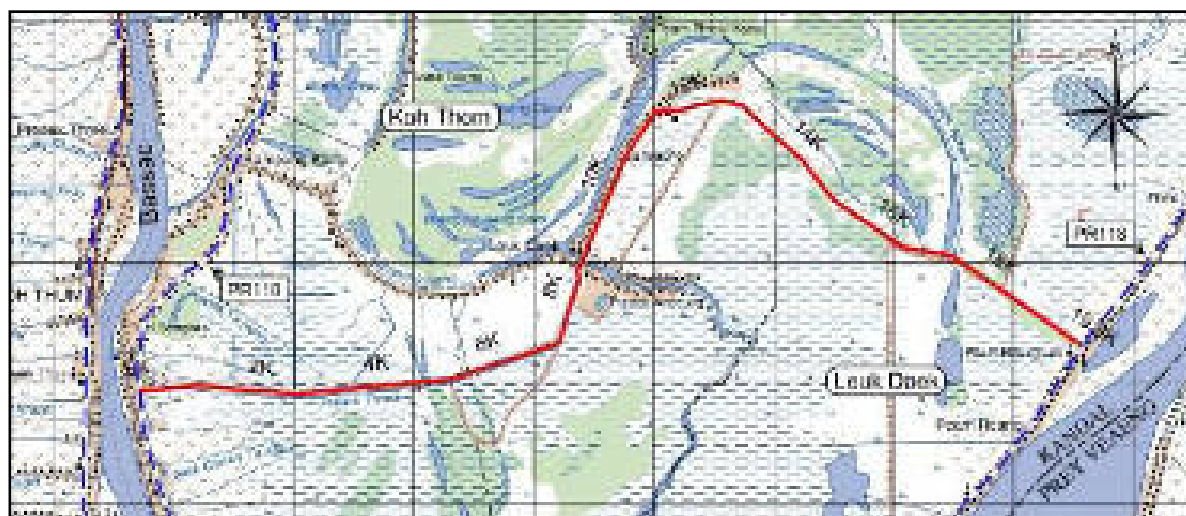


Figure 5.3 Details of the project roads and their locations

251. A condition survey was carried out to establish sensitive points which must be taken into consideration during construction. The condition survey is given in the IEE.(Annex A).

5.2.2.3 Prey Veng

252. The road commences on NR1 at PK77+100 and runs for 28.4 km until it reaches the Cambodia - Vietnam border at Banteay Chakrey border crossing. The road is currently a well trafficked sealed road, unlike the other two roads under this project which are laterite. It passes mainly through agricultural lands. The one major river crossing is at the border beyond the extent of the road scheme. (Figure 5.4)



Figure 5.4 Details of the project roads and their locations

253. A condition survey was carried out to establish sensitive points which must be taken into consideration during construction. The condition survey is given in the IEE.(Annex A).

5.3 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

5.3.1 Physical Environment

5.3.1.1 Geography

254. Cambodia lies in the southwestern part of the Southeast Asian peninsula and has a land area of 181,035 km². International borders are shared with Thailand to the west, the Lao People's Democratic Republic to the north, and the Socialist Republic of Vietnam on the east and southeast. The country is bounded on the southwest by the Gulf of Thailand and has a coastline of 440 km.

5.3.1.2 Climate

255. Cambodia's climate is dominated by the monsoon which causes distinct wet and dry seasons. The southwest monsoon typically brings the rainy season from May to October. The northeast monsoon brings drier and cooler air from early November to March, then hotter air prevails in April and early May. The southern part of the country typically has a two-month dry season whereas the northern areas have a four-month dry season although weather patterns have been changing and to say what is typical is now increasingly problematic.

5.3.1.3 Temperatures

256. Temperatures are fairly uniform throughout the country, with only small variations from the average annual temperature of around 28°C. January is the coldest month where temperatures as low as 12°C have been recorded and April is the warmest where temperatures reach 42°C.

5.3.1.4 Wind

257. Most of Cambodia's regions have an average wind velocity of less than 3 m/s. Maximum wind speeds can reach in excess of 20 m/s during the wet season. During the dry season the maximum wind velocities are lower and are commonly in the range of 6 - 8 m/s.

5.3.1.5 Rainfall

258. The total annual rainfall average is between 1,000 and 1,500 millimeters and the heaviest amounts fall in the southeast. Rainfall from April to September in the Tonle Sap and Mekong Lowlands area averages 1,300 to 1,500 millimeters annually, but the amount varies considerably from year to year.

259. Rainfall around the basin increases with elevation. It is heaviest in the mountains along the coast in the southwest, which receive from 2,500 millimeters to more than 5,000 millimeters of precipitation annually as the southwest monsoon reaches the coast. This area of greatest rainfall, however, drains mostly to the sea; only a small quantity goes into the rivers flowing into the basin.

260. There are really no reliable rainfall databases for the Project zones and rainfall can vary from a low of less than 1,000 mm to a high of 2,000 mm.

5.3.1.6 Humidity

261. The relative humidity is high throughout the year, usually exceeding 90%, and even in the dry season rarely falls below 50%.

5.3.1.7 Minerals

262. Cambodia's natural mineral resources include gem stones such as sapphires, ruby and zircon; coal, offshore gas and oil; basalt, granite, limestone, dolomite, quartzite; and phosphate deposits. There are no major mineral resources in the vicinity of the project roads.

5.3.1.8 Air and Noise Quality Condition

263. The Royal Government of Cambodia (RGC) established Ministry of Environment (MoE) following the Sub-decree on Air Pollution Control and Noise Disturbance. The MoE is responsible for protecting environmental quality and public health from air pollutants and noise pollution through monitoring and mitigation activities.

264. The project roads traverse primarily agricultural areas and villages/residential areas in rural settings with no industrial development. The main sources of air pollution are dust emissions due to entrainment of dust by passage of vehicles along the two unpaved project roads. Sources of noise are community activities (especially near markets) and the existing traffic largely composed of motorcycles.

265. In Cambodia there is growing concern regarding increasingly poor air quality. Increased air pollution may be linked to increase in the number of vehicles and industry. But PR1534, PR312, and PR23 are located in rural areas, so the air quality is still good.

There is very limited data on air quality but it is evident that very little air pollution occurs in this area.

5.3.1.9 Water Quality

266. In Cambodia water quality control and management is regulated by the Sub-decree on Water Pollution Control (Ministry of Environment 1999). MOWRAM and MRC conduct on-going water quality monitoring programs based on water samples from designated sampling points in the Mekong River, Tonle Sap River and Bassac River. According to their results, the quality of these water bodies is generally good in comparison with the other riparian countries.

5.3.1.10 Topography

267. Cambodia's topography is bowl shaped covering an area of about 181,035 km². The country is rimmed by mountains consisting of the Dangrek Mountains plateau to the north along the Thai boundary; by the Annamite Range to the northeast; the Cardamom Mountains to the south west; and to the south by the Elephant Mountains. This means that the whole of northwest Cambodia acts as a catchment area draining ultimately into Tonle Sap.

268. There are three distinct topographic regions: the central plains, the flat coastal areas, and the mountain ranges with high plateaus. The central plains form 75% of the country and consist of the alluvial plains of the Mekong River and the Tonle Sap basin.

5.3.1.11 Hydrology

269. The hydrologic setting of Cambodia is dominated by the Mekong River and Tonle Sap Lake system. Mekong River is among the world's largest rivers in terms of length and average discharge, while Tonle Sap Lake is the largest fresh water lake in Southeast Asia. It enters Cambodia in the north at the border with Laos and flows out to the south to Vietnam.

270. Tonle Sap, or Great Lake, is situated in the center of the Cambodian central plain, with an elevation of 10–30 meters above sea level covering about 6% of the country. The Cambodia stretch of the Mekong River is 486 km long and starts from upstream of the Cambodia-Laos border passing through the country to end downstream at the Cambodia-Vietnam border.

271. In Phnom Penh the Mekong separates into four branches: upstream-Mekong, downstream-Mekong, Bassac, and Tonle Sap. The Tonle Sap River is the most important water flow in Cambodia because of it has two different water regimes. During the wet season it acts as a downstream reservoir, fish spawning ground and flood control, and during the dry season when the Mekong river water levels drop, water flows back from Tonle Sap Lake when the flow is reversed.

272. Evaporative losses account for 20-30% of the rainfall occurring in Cambodia.

5.3.1.12 Flooding

273. Rain fall raw data from all the provinces shows that because of the rapid runoff in the catchment areas the provinces with highest rainfall are not provinces most vulnerable to flooding.

274. PR1534, PR312, and PR23 are located in Kampong Chhnang, Pursat, Kandal, and Prey Veng provinces. The hydrology of these areas is dependent on Mekong River flow

or the Mekong water regime and interaction with Tonle Sap Lake. The rain water runoff from uplands flows directly into lowland floodplains through rivers (Preks), streams, and existing canals.

275. Kampong Chhnang and Pursat province are located in the catchment area dominated by Mount Aural and Tonle Sap. Kandal is in the zone of influence of the Bassac River a downstream branch of the Mekong. Prey Veng is located in a very flat area with almost zero gradient. Flooding is common in this area due to the lack of natural drainage.

5.3.2 Biological Environments

5.3.2.1 Forest Cover and Forest Resources

276. Cambodia has one of the highest levels of forest cover in the region as the interdependence of Cambodia's geography and hydrology makes it rich in natural resources and biological diversity. Cambodia contains approximately 10.36 million hectares of forest cover, representing approximately 57% of Cambodia's land area (2011).

277. About 69,000 ha (1%) of forest cover is planted forest. Overall Cambodia's forests contain an estimated 464 million metric tonnes of carbon stock in living forest biomass. Approximately 40% of Cambodia's Forests have some level of protection, while one of the Cambodia Millennium Development Goals targets was to achieve a 60% forest cover by 2015.

278. According to the Forestry Administration Statistics, a total of 380,000 hectares of forest were cleared between 2002 and 2005/2006 which is a deforestation rate of 0.5% per year. The main cause of deforestation has been determined to be large-scale agricultural expansions.

a) Kampong Chhnang and Pursat Province

279. There are no protected areas, protected forests, or any sensitive forest areas located close or near to PR1534 in Kampong Chhnang and Pursat province.

280. During the field investigation in Kampong Chhnang and Pursat province, it was noted that there are no forest or vegetation cover located near the road line of PR1534. Both sides of the road are covered by rice fields, farm crops, fruit trees farm and vegetable farm, economic concession farms, residential areas, and village gardens.

281. There are some public trees and fruit trees located on the road side and within the RoW of RP1534 such as: Degraded National Forest Resource, Acacias, Eucalyptus, Rain Trees, and Mango Trees and Sugar Palm Trees.



Figure 5. 5 Forestry resources support villagers livelihoods

b) Kandal and Prey Veng Province

282. PR23 is located in Koh Thom and Leu Dei district, Kandal province and PR312 is located on Preah Sdach district, Prey Veng province. Both project locations (PR23 and PR312) are located in the flood plain downstream of the Mekong Basin. There are no any protected or conservation areas located near the project roads in Kandal and Prey Veng province.

283. Due to the low lying flat land and tendency to flood there are no extensive stands of trees or forest cover in Kandal and Prey Veng Province.

284. The some areas are flooded during wet season by Mekong Flood and Flash Flood, especially in project area in Kandal province. Most of areas are setting by rice field, agricultural farms, vegetable farms and fruit trees farms, residential areas, grass land, lakes, rivers, flooded areas.

285. On both sides of the roads it was noted that there are rice fields, fruit trees and vegetable farms as well as village gardens. Some stretches of road were shaded on both sides by mature stands of trees. These are discussed in the resettlement inventory of losses (IOL)

286. There are some public and private trees or fruit trees are along the road side and RoW such as: Acacias, Eucalyptus, Rain Trees, Thorm Trees and Mango Trees, Sugar Palm Trees, Banana Trees.

287. Due to lack of forest resources which act as a habitat in these areas (PR23 and PR312) of Kandal and Prey Veng province, the wildlife resources and any sensitive wild animals are not found in the projects areas.



Figure 5. 6 Forest condition of Kandal and Prey Veng Province

5.3.2.2 Biodiversity

288. Cambodia has a rich biodiversity. The forests, wetlands and other habitats support many species of flora and fauna, including 212 species of mammals, 536 species of birds, 240 reptile species, 850 freshwater and 436 marine fish species and more than 2,300 plants and 800 of these plants are used in for the local manufacture of traditional Khmer medicine. The Cardamom Mountains are known to contain almost all the country's known mammals, birds, reptiles and amphibians.

a) Main Animal Species

289. The Kulen Promtep Wildlife Sanctuary is a rich source of water bird and mammals. Mammals in the sanctuary include: Tiger, Leopard, Eld's Deer, Banteng, Dhole, Asiatic Jackal, Sambar, Sun Bear, Red Muntjac, Oriental Small-Clawed Otter, Wild Pig, East Asian Porcupine, Sunda Pangolin, Spotted Civet, and Rabbit. Of those species, some are classed as "Endangered" and some "Rare".

290. Base on a Biodiversity Survey of Northwest Cambodia (April, 2016) a total of 26 mammal species were recorded including ten species classed as threatened by the IUCN Red List (IUCN, 2014). In addition three species are listed on CITES Appendix II, being the Long-tailed macaque, Leopard cat (*Prionailurus bengalensis*) and Northern tree shrew (*Tupaia belangeri*).

b) Bird Species

291. The Tonle Sap Lake is one of the most important areas for bird conservation in the region and has long been understood to be extremely important for gregarious large water birds, particularly storks, pelicans, ibises and cormorants. Seventeen globally threatened or near threatened species are known to occur regularly around the Tonle Sap Lake. These are divided between two key habitat types - swamp forest and inundated grassland, both only seasonally flooded. The swamp forest, particularly of the Prek Toal Core Area is home to large breeding colonies of colonial water birds, while the inundated grassland has its own unique suite of threatened breeding birds, and during the early flood season hosts many feeding birds from the swamp forest, (PGS-IEM, 2008).

292. Birds include Golden-Crested Myna, White-Vented Myna, Hill Myna, Peaceful Dove, Red Collared Dove, Spotted Dove, Emerald Dove, Cattle Egret, Little Egret, Red-Wattled Lapwing, Great Slaty Woodpecker, Dollar bird, Asian Fairy Bluebird, Black Drongo, Black-Collared Starling, Black-Crowned Night Heron, Brahminy Kite.

293. Reptiles include Asian Box Turtle, Elongated Tortoise, Water Monitor, Burmese Python, King Cobra, Monocled Cobra, Indochinese Spitting Cobra.

5.3.3 Fishery

a) Fish Production

294. Fish is the most important source of animal protein in the diet of all Cambodians, constituting upwards of 75% of total animal protein input. Fish are also an important source of calcium and Vitamin A, especially for the rural poor. On average the countrywide consumption rate is 65.5 kg/capita/year. Each year, Cambodia's combination of subsistence, middle-scale and large-scale commercial fishing harvests produce 300,000 to 430,000 tons of freshwater fish. This production ranks fourth in the world and is worth approximately US\$300 million. However, there have been incremental declines in fish catches and it is now estimated that less than 250,000 tons of fish is being caught, consisting of approximately 105,000 tons of household fisheries, 75,000 tons of rice field fisheries and 68,000 tons of middle and large-scale fisheries (marine fisheries production account for an additional estimated 55,000 tons).

b) Importance of Tonle Sap Lake

295. The Tonle Sap Lake is the most productive inland fisheries in the world and reportedly has a potential fish production of 65 kg/ha/year, based on the dry season area

(FAO 1994). Cambodia's inland fisheries are totally depended on the seasonal increase in the water flow of the Mekong and other rivers that cause inundation of floodplains, forest and shrub-land. The increase of the area and depth of the Tonle Sap Lake during the wet season from 2,500-3,000 km² to 10,000-15,000 km² (NEDECO 1998, MoE 2004) and from 1-2 meters to 8-10 meters has an immense effect on the fish production.

5.3.4 Protected Areas

5.3.4.1 PR1534: Kampong Chhnang and Pursat Province

296. PR1534 is located in Kampong Chhnang and Pursat province. The road runs from the start point in Tuek Phos district, Kampong Chhnang province to the endpoint in Pursat town, Pursat province where it connects to National Road No.5, with total length 84.5km.

297. There are several protected areas located around the project area:

- Tonle Sap Biosphere Reserve
- Phnom Aural Wildlife Sanctuary
- Phnom Samkos Wildlife Sanctuary.

298. Both Phnom Aural and Phnom Samkos wildlife sanctuaries are located in the protected forest of the Cardamon Mountain.

299. None of the project roads are located within the core, buffer zones and transition zones of TSBP.

5.3.4.2 PR23 and PR312: Kandal and Prey Veng Province

300. PR23 is located in Koh Thom and Leuk Dei district, Kandal province and the project area is in the downstream Mekong River Basin or flood plain of Mekong River (Tonle Bassac River and Mekong River).

301. There are no protected areas and forest areas located near and around PR23 and PR312.

5.3.5 Archaeological and Cultural Heritage

302. Following discussion with commune authorities and relevant departments there are no sensitive archaeological and cultural resources located near the project roads.

5.4 CLIMATE CHANGE

5.4.1 Climate Change Projections

303. Recent climate change studies use RCPs of 8.5 for extreme CO₂ future concentrations and values of 3.5 or 4.5 to represent low CO₂ future concentrations. In the projections for MPWT the RCP 8.5 is used. Therefore this is a pessimistic scenario and will give worst case conditions. It is designated the “extreme scenario”.

5.4.1.1 Projected Rainfall Change

304. Climate in Cambodia is traditionally described with reference to two seasons, the wet season, when rain bearing monsoon winds from the southwest predominate and the dry season, when dry northeast monsoon occur. Climate change could result in changes in the total amount of rain in each season and a change in the onset or end of the wet season. Climate change studies project a shorter wet season in the future with a later start and a longer drier dry season. The results for rainfall change are much more varied than those for temperature.

305. The model projects an overall decrease in rainfall during the wet season, an increase at the start of the wet season and an increase in the amount of rain that falls in extreme events. The first points are significant to farmers. This latter point is significant for drainage design.

5.4.1.2 Rainfall Intensity

306. Climate change studies have projected an increase in rainfall intensity during rainy days by 2055. A decrease in the total yearly rainfall that is projected for some locations is a result of a decrease in the number of rainy days not a reduction in intensity.

307. While climate models are run at intervals of 1 hour or less the outputs that are generated are at the scale of 1 day. Predictions of rainfall intensity in terms of mm per hour may under estimate maximum rainfall intensity. As a guide, in tropical conditions, hourly rain fall can be assumed to be 20-40% of daily rainfall.

5.4.1.3 Changes to 1-day Precipitation

308. The increases in 1 day rainfall are modest for the 2030 projection (6 to 8%) and the 2050 projection (9 to 10%) but larger for the 2070 projection (28 to 34%).

5.4.1.4 Changes to 5-day Precipitation

309. The increases in 5 day rainfall are from 9% to 14% for the 2030 projection, from 16% to 20% for the 2050 projection and 29% to 38% for the 2090 projection. The 5-day duration is likely to correspond to the critical flood duration for some of the larger river basins.

5.4.1.5 Floods in Cambodia

310. Flooding in Cambodia is a natural occurrence and lifestyles are adapted to seasonal floods. There are two major flood types in Cambodia: (i) flashfloods, resulting from heavy downpour upstream on the Mekong River, which affect provinces along the Mekong and the southeastern areas of the country; and (ii) central area large scale floods, resulting from a combination of runoff from the Mekong River and heavy rains around the Tonle Sap Lake, which affect the provinces around the lake and the southern provinces.

311. In rural areas flooding is a major problem for roads. In some upland areas with significant slopes and a water course, the type of flooding is flash flooding which occurs over several hours. In low-lying areas with no natural gradient flooding can last for months. Banteay Meanchey had the longest period of flooding at 68 days.

312. The main conclusions from the above as they relate to precipitation are:

- Annual rainfall may remain unchanged but rainfall will increase more in the wettest months by being of stronger duration. This will lead to longer dry periods. There may be “mini-droughts” during the wet season.
- Precipitation will increase most in the south-west and decrease in the north-east.
- Both the maximum 5-day and 1-day storms are expected to increase. The projected increases are 10% for 2030, 20% for 2050 and 30% or more for 2090.
- The relative increase in rainfall is heavier for short durations.
- An increase of 20% on existing IDF curves will allow for a global temperature increase of 2oC. This factor is conservative and is recommended as a design factor.

5.4.1.6 Flood Risk Management Interface - FRMI

313. MPWT has developed a knowledge management tool called Flood risk management interface (FRMI). (Figure 5.7) This software provides easy access to information about floods and roads, as well as flood risk maps developed under the CR-PRIP. This is used to assess the vulnerability of roads to flooding.



Figure 5.7 MPWT Flood Risk Management Interface

5.4.2 Risk Information from FRMI

5.4.2.1 Tuek Phos, Kampong Chhnang to Pursat PR1534

314. The section of road on PR1534 from Tuek Phos to Pursat at NR5 is shown at a province level below. The road segment is not actually included in the FRMI database as it is currently a minor road. However adjacent roads are rated at “Moderate” to “Low” level of flood risk in 2055 under RCP 8.5.

315. As this road segment is bounded on one side by the Cardamom Mountains and has several small river crossings it may face flash floods in the watercourses crossing under the road. Drainage design must be selected to accommodate this under future climate

conditions. However due to the gradients associated with the nearby mountains flooding, on both sides leading to total inundation of the road is unlikely.

316. Existing lateral drains are used to control the irrigation supply for farmer's fields. These may need enlarging to handle extreme weather events. Sections of the road which are currently impassable can be corrected by minor vertical realignments.

5.4.2.2 Kandal PR23

317. The section of road on PR23 is shown at province level below. The road segment is rated at "Moderate" level of flood risk under RCP 8.5.

318. This is mainly due to the proximity to the Bassac River. Raising of the road elevation on embankment above the 1 in 100 year flood level will be necessary. Due to the flat nature of the terrain flood levels may occur on both sides of the road. Strengthening of the material underlying the pavement may be necessary due to the long period of expected inundation. Additional cross drains are needed to avoid a differential head between the two sides of the road.

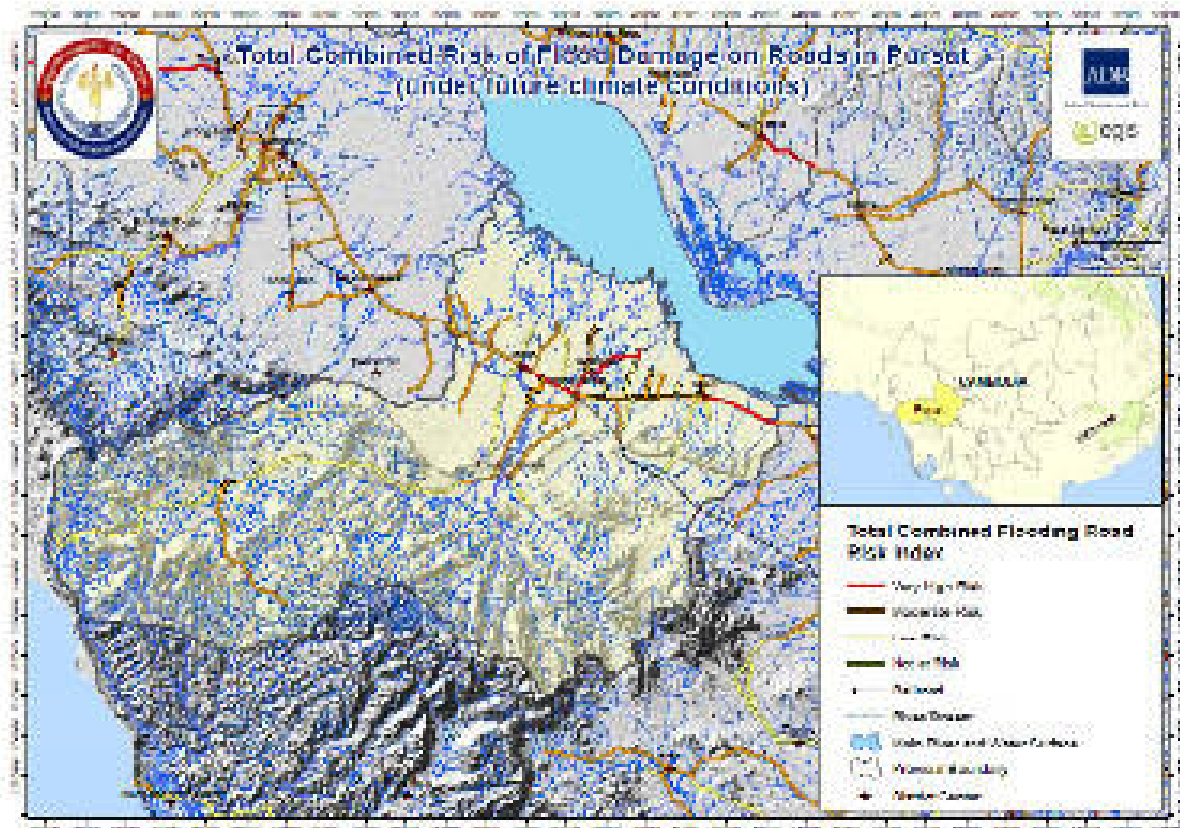


Figure 5.8 MPWT Flood Risk Pursat

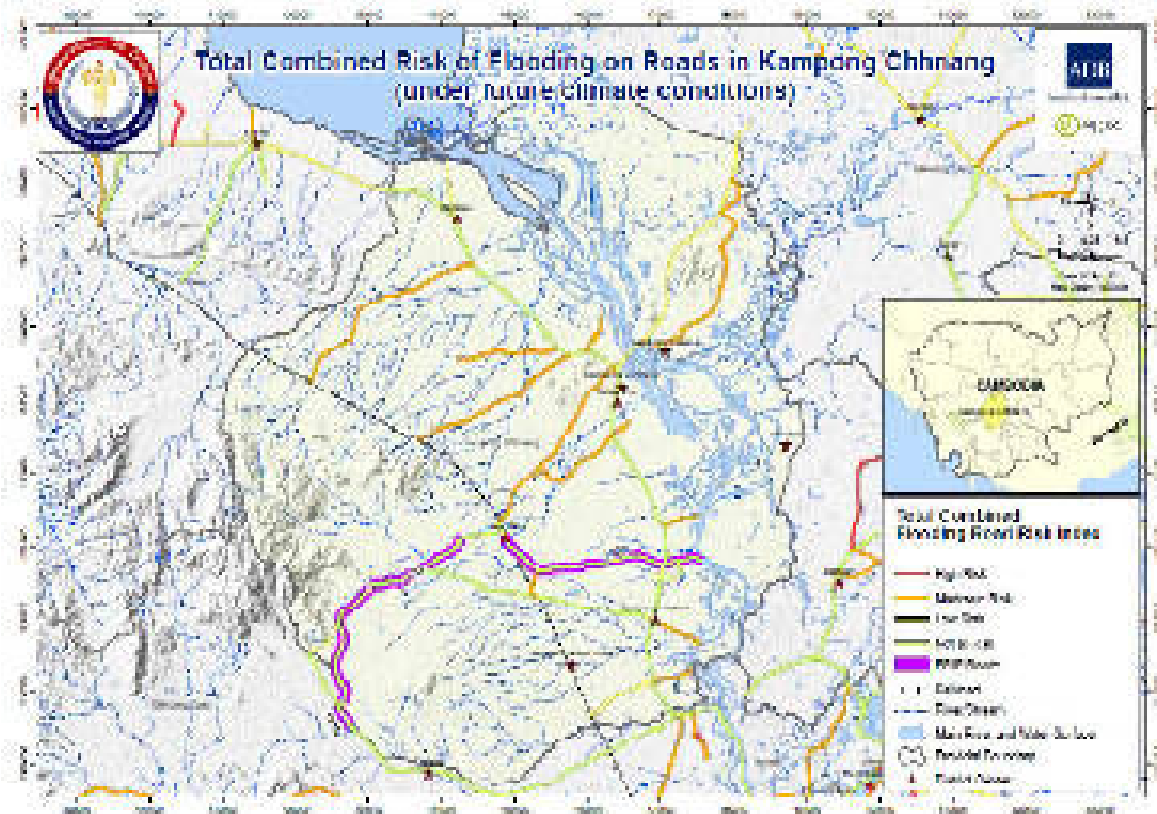


Figure 5.9 MPWT Flood Risk Kampong Chhnang

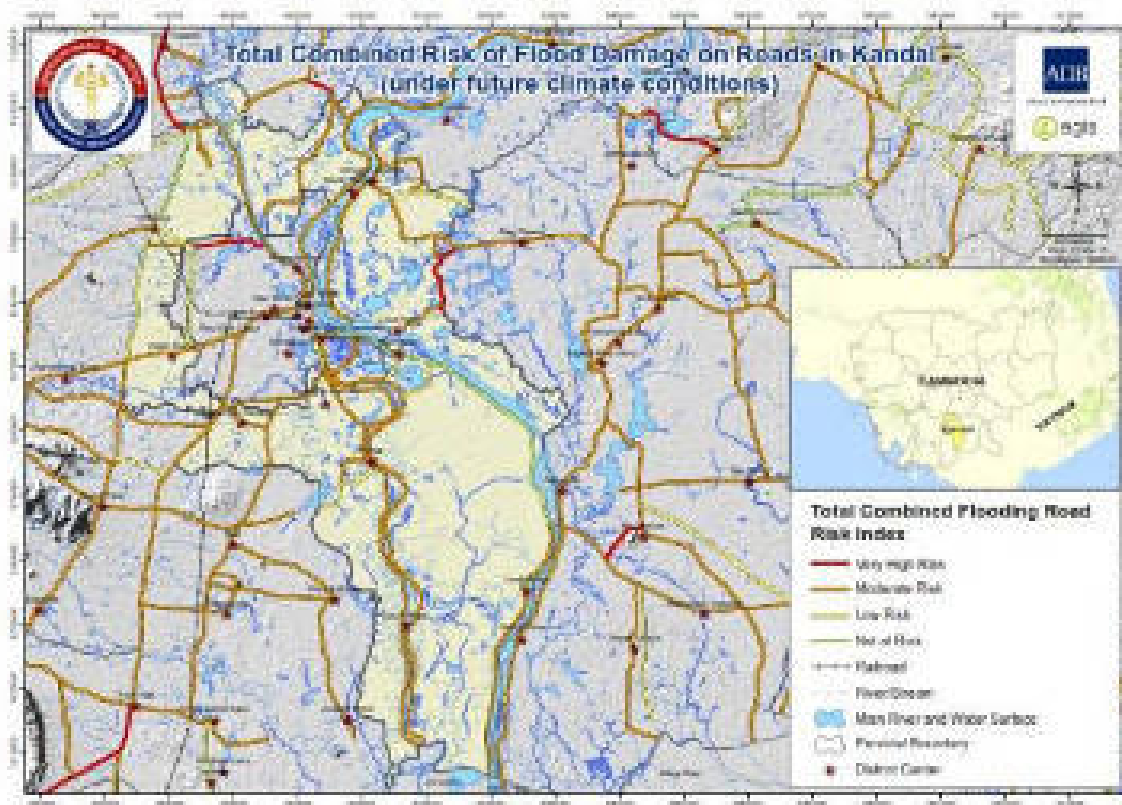


Figure 5.10 MPWT Flood Risk Kandal

323. Adaptation measures include : (a) applying a safety factor; (b) considering a longer return period for exceptional events when designing hydraulic structures; (c) considering storm water volumes over a longer period; (d) reducing the gradients of slopes and taking into account the materials used; (e) protecting the base of fills and discharge structures; (f) enclosing the materials; (g) using waterproof materials or treating them to make them so; (h) checking the condition of slopes regularly; (i) regularly checking the condition and function of the drainage system and hydraulic structures; and, (j) improving the implementation of alternative routes in the event of a road closure.

5.4.3.2 Adaptation Measures

324. Adaptation to climate change in highway design may require intervention at several stages. Some modifications can be introduced at preliminary design, other items will be required at detailed design phase.(Table 5.3)

Table 5.3 Climate Change Adaptation Measures

Highway Design Component
Roadways <ul style="list-style-type: none"> Increased height of embankment above HWL Modification of side slope ratios Use all-weather wearing course / running surfaces e.g. DBST, surface seals.
Hydrological Studies <ul style="list-style-type: none"> Coordination of data collection/recording systems e.g. rainfall, stream gauges Adjustment of design criteria to account for increased flows Allowances for effects of future dam and irrigation schemes.
Drainage Design <ul style="list-style-type: none"> Additional waterway opening at bridge sites Additional cross-culvert capacity Debris deflectors and energy dissipaters Install Debris Deflectors Sub-drainage systems. Turf surfaces on side slopes.
Erosion Controls <ul style="list-style-type: none"> Anti-scour provisions at bridge sites Channel training / riprap bank protection Side ditch linings in areas of high flow velocity Retaining walls and gabions to stabilize slopes
Operations and Maintenance <ul style="list-style-type: none"> Regular inspection and repair of road, shoulders, drainage systems Regular cleaning of culverts and side ditches Regular cleaning of box and pipe culvert systems Cleaning of culverts before known storms or typhoons Quick restoration of items following major flood events.

5.4.4 Specific Recommendations from MPWT

325. MPWT have produced a series of Design Guide Recommendations that incorporate climate resilience. For full details reference should be made to the MPWT Guidance Notes.

5.4.4.1 Field Work and Ground Truth

326. Engineers must visit the site areas and enquire for local characteristics of floods and update flood information from the relevant authorities before deciding on a design elevation. Historical extreme flood elevation maps and 100 Year flood depth maps should be used for general guidance only.

5.4.4.2 Elevation

327. The recommended crest level for National roads and Provincial roads should be a minimum height of the water level of floods with a recurrence interval of 1 in 100 years, plus an additional 0.5 meters for wave overtopping due to wind. For district and local roads the crest level should be a minimum height of the water level of floods with a recurrence interval of 1 in 10 years plus 0.25 meters.

5.4.4.3 Flood Calculations

328. Flood calculations are based on flow in one direction only. Where area-wide flooding is possible, other methods will be applicable. The commonly used Rational Method can only be applied to catchment areas less than 10km². For larger areas the Generalized Tropical Flood Model (GTFM) developed by Fidler and Watkins (1984) should be used.

5.4.4.4 Pavement and Embankments

329. Pavements are normally designed solely on the basis of traffic levels. Theoretically, a “perfect” road, with an adequate level for clearing floods, with proper embankment materials, with adequate drainage structures, with fully compliant compaction and structural materials and which is perfectly maintained does not require pavements standards higher than those given in current design codes.

330. In reality in Cambodia special measures have to be taken for additional protection from floods. One flood proofing improvement is the use of better sealed pavements such as asphalt / concrete or concrete. It has been recommended by CR-PRIP as a new road policy statement for MPWT that national and provincial roads should be covered with asphalt concrete, or concrete.

331. Where a road lies on a soft subgrade, is to carry heavy traffic, and is expected to be regularly submerged for appreciable periods, the pavement is recommended to be of asphalt concrete or preferably concrete.

332. If the cost of raising a road on embankment plus extra drainage costs is excessive then a climate resilient road that can withstand occasional inundation maybe more cost effective if the occasional loss of connectivity is acceptable.

333. When determining CBR values test samples shall be soaked for a period not less than 7 days. Materials with a CBR value less than 3 shall be considered unsuitable. Lime stabilization and additional compaction may be employed to increase structural strength under inundation.

334. In areas where gradients are minimal, even a small flood depth can extend sideways over a very large area. Where that is the case the only option is to raise embankment levels.

335. For new roads the side slopes of embankments shall not be steeper than 1 vertical on 2 horizontal for embankment covered with rip rap and 1 vertical on 2.5 horizontal for those without rip rap cover. For existing roads increasing road embankment heights after a road has been built is costly. Agricultural land and properties both tend to get as close to roads possible, so any future increase in elevation and width of an embankment could lead to resettlement issues which must be considered. If a slope of 1:3 is considered it must be investigated from economic and policy points of view. A 5 meter high embankment of 1:3, as compared to a 1:2 embankment needs 10 m more road corridor and 50 % additional earth works. This could require substantial resettlement or compensation actions.

336. The sub-base on embankments shall be constructed to the full width of the subgrade surface. The shoulders shall be constructed same as the pavement structure. The shoulders shall be sealed with an approved bituminous treatment up to the edges of the embankment or, where guard rail is constructed, up to the line of guard rail. Each part of the bituminous shoulder treatment which is the same as for the pavement shall be applied simultaneously with the pavement treatment.

337. Rip Rap protection is recommended to cover the full surface of embankments of roads at high risks of flash floods and of low land floods. For full coverage of embankments of roads at high risk of flash floods and of low land floods, a minimum thickness of 200 mm shall be used.

338. A layer of soil shall be constructed over the completed and trimmed side slopes of embankments. A complete dense cover of growing grass shall be established on the soil covering the side slopes. Where the side of an embankment is subject to wave action, a hedge of shrubs shall be established growing on a line 1.2 m in elevation below the top edge of the roadway.

5.4.4.5 Drainage Design

339. Raising the road elevation must always be conducted in parallel to increases in drainage capacity. Otherwise, the hazard of a road on a high embankment, intended to be flood-free can be much worse than for a low level road, if a flood overtops the road. The risk of this happening needs to be reduced by a combination of higher embankment level and increased drainage capacity in the culverts and under the bridges, all of which add to costs.

340. Inadequate cross drainage can not only pose a hazard to the road itself but can also cause localized flooding to nearby property.

341. In places where there are clearly defined water channels and sufficient gradients for water to flow at all times of the year, then the capacity of the cross drainage should be increased by around 25% - 30%.

342. All cross drains be they pipe or box culvert should be of minimum diameter 1200mm to make for easy cleaning and removal of blockages.

343. Drainage calculations require knowledge of rainfall intensities over different time periods at different Annual Return Intervals. These can be in the form of tables or IDF curves.

5.4.4.6 Bridge Standards

344. The most important change to bridge design will be a slight increase in spans to allow for larger storm flows from more extreme rainfalls. The ideal bridge design is a single span. The soffit of bridges must be 0.5m clear of the 1 in 100 Year flood level to clear floating debris such as logs and branches which could damage the bridge.

345. Minor changes due to wind loads and temperature changes may be needed. For bridge design the historical maximum shade air temperatures for bridge design should be increased by 3oC.

346. Average wind speed will increase in winter, spring and autumn months, but decrease in the summer months (MONRE 2011). The projected changes in metre per second are very small.

5.4.4.7 Geometry

347. Crossfall on sealed roads should be 2% minimum to avoid ponding. It is reported that Super-elevation seems to be inadequate for curves for 80 km/h operating speed. In road sections with super-elevation lateral drains can be constructed on one side only. This gives a cost saving but the drains must be sized to carry twice the normally expected road surface runoff.

5.4.4.8 Maintenance

348. The importance of maintenance cannot be over emphasized. No matter how good the design a lack of maintenance will render it ineffective. As indicated above cross drains should be increased in diameter to be a minimum of 1200mm to make for ease of clearing debris.

349. Many drains are reported to be choked due to silt and rubbish. Bar screens should be installed on upstream inlets to pipes to catch floating debris. Vertical screens are easier to clean by manual labor.

350. Local communities can be hired for drain cleaning and grass cutting. This only needs unskilled labor and providing of some simple tools. The community sense of ownership can improve the efficiency of maintenance.

5.4.4.9 Detailed Costs

351. The FRMI software considers risk in general terms where road sections are possibly 1km in length. In reality only a smaller section of road may require additional climate resilience measures. A FRMI subroutine will carry out these calculations but it is very site specific. This needs to be addressed at the detailed design stage.

5.5 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.5.1 Impacts and Mitigation due to Location

5.5.1.1 TLSBR

352. NR5 is the boundary of TLSBR. The core, buffer zones and transition zones of TSBR are located to the east of NR5. The project roads are all located to the west of TLSBR as shown in Figure 5.12. There will be no impacts from road PR1534 on TSBR.

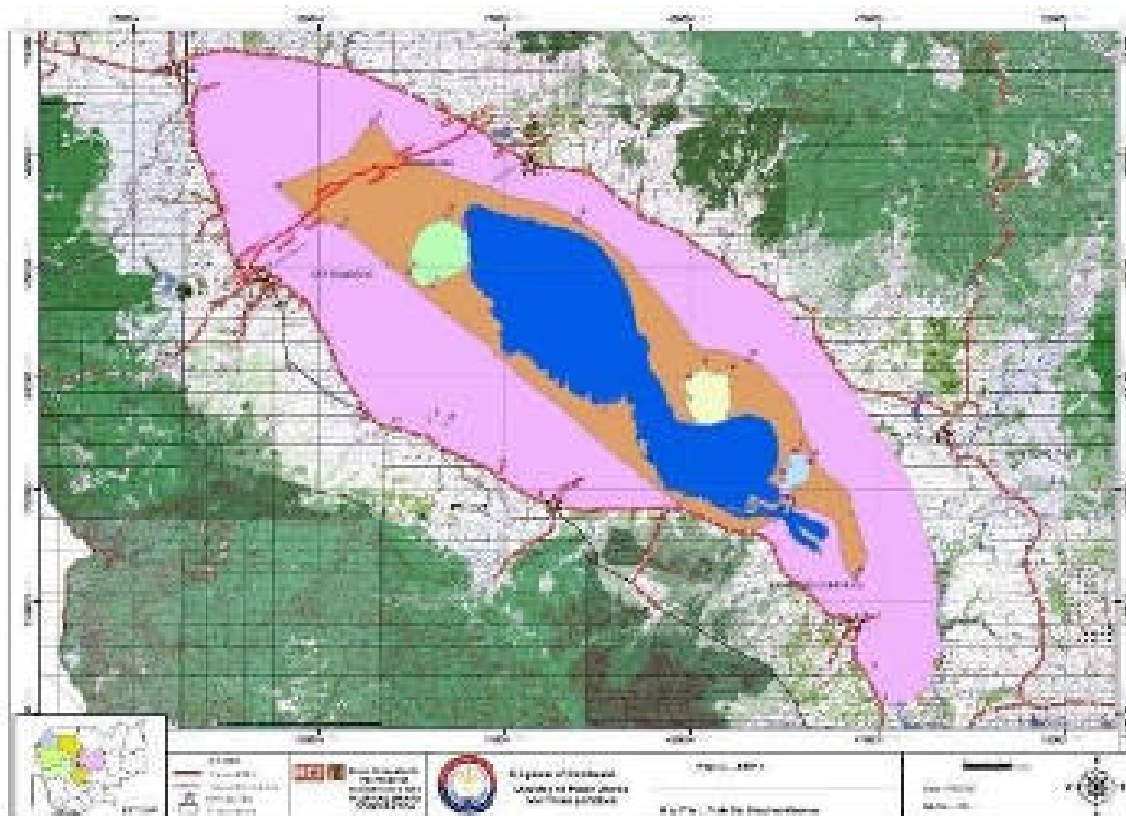


Figure 5.12 PR1534 in relation to TLSBR

5.5.1.2 Phnom Aural Wildlife Sanctuary

353. The boundary of PAWS was given in the Royal Decree of 1993 which showed a boundary line drawn on a map and gave coordinates. Concrete posts have been erected to mark the boundary and UTM coordinates are written on these posts. Site surveys were carried out and the road alignment checked with a GPS unit. The alignment is shown below.

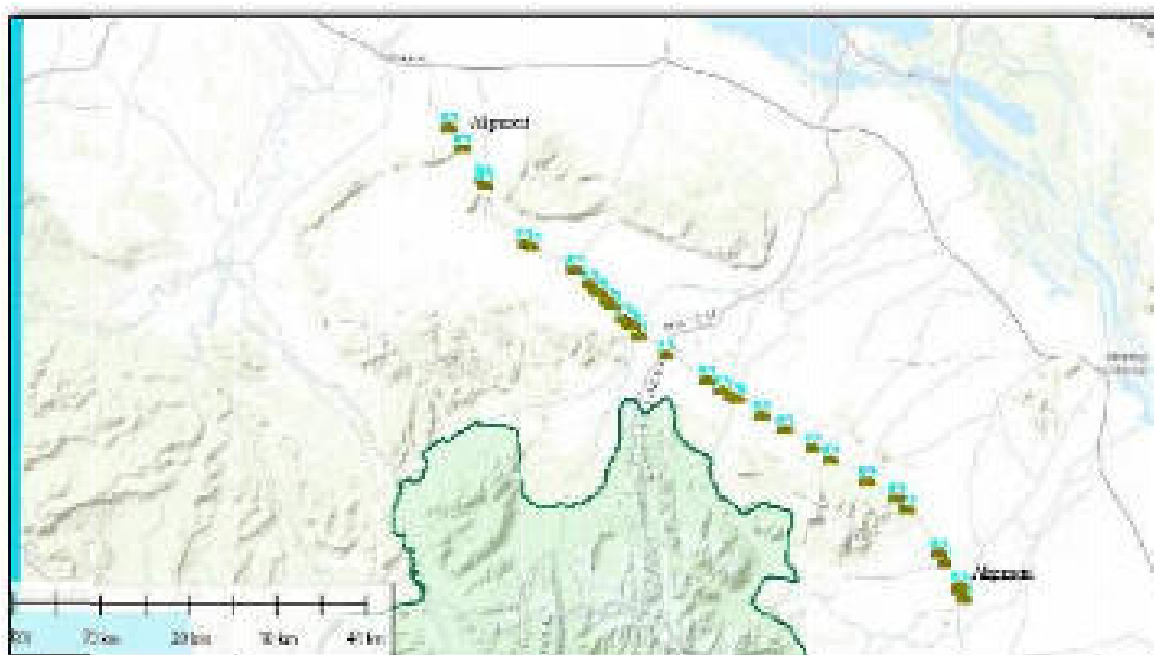


Figure 5.13 Alignment of PR1534 relative to PAWS Boundary as in Royal Decree

354. As can be seen (Figure 5.14) the alignment of PR1534 is 3.5kms from the boundary of PAWS at its closest point and at other places if further away.

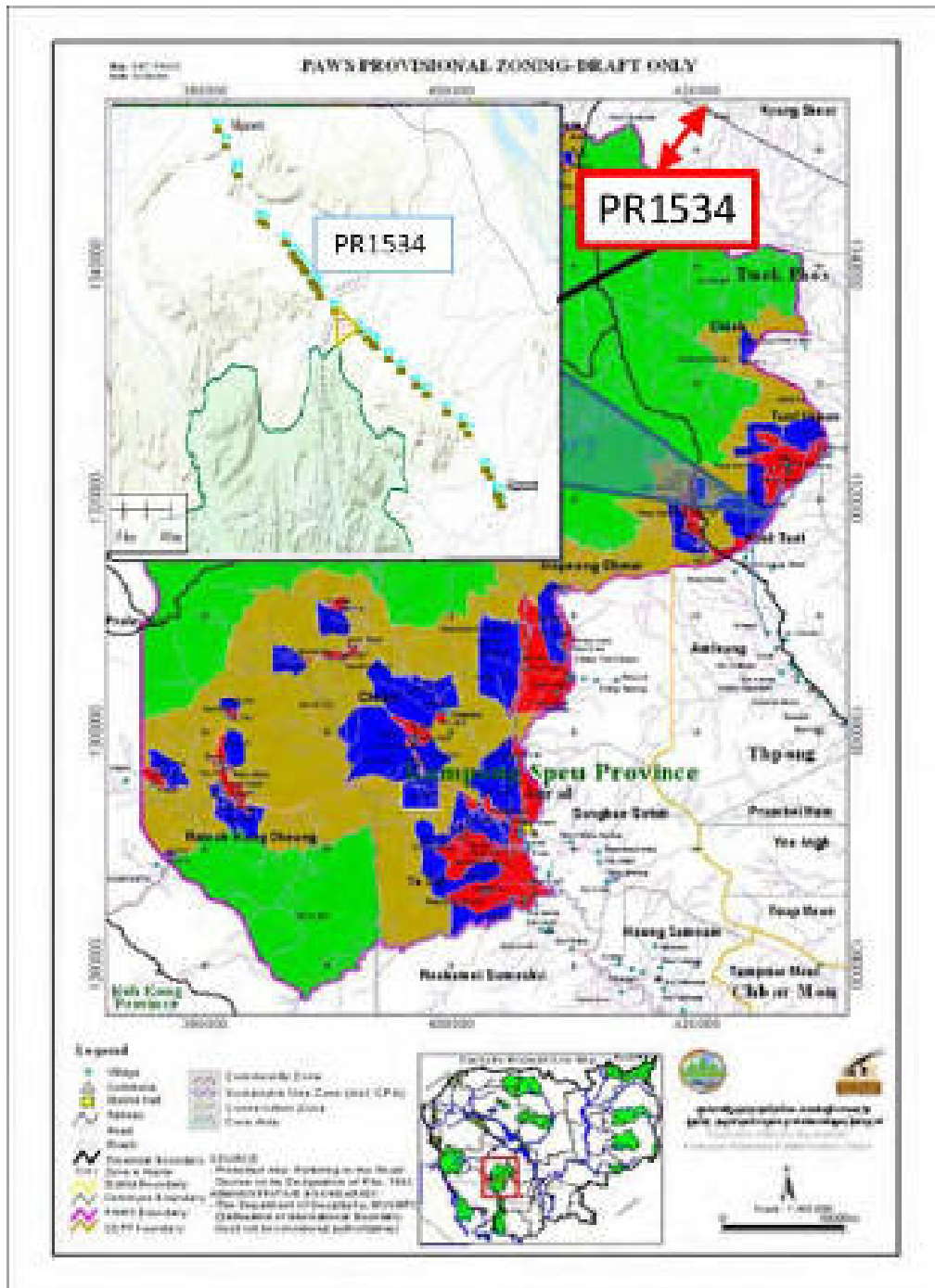


Figure 5.14 Alignment of PR1534 is 3.5kms from Boundary of PAWS

355. No impacts from the project roads are anticipated on PAWS.

356. As PAWS is the closest Protected Area no impacts are anticipated on any other protected areas in Kampong Chhnang or Pursat provinces. There are no protected areas in

Kandal or Prey Veng provinces. There will be no impacts from roads PR23 or PR312 on protected areas.

5.5.1.3 Resettlement Issues

357. The resettlement issues are dealt with in a separate report. The main impact on the environment is the loss of some trees which must be cut down for road widening. The details are given below.

Total # of TREES	21,886	Replacement Cost US\$	239,900
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5.5.1.4 Bridge Crossing

358. A bridge crossing will be required at PK74.7 on PR1534. It will consist of 5 spans with a total length 80m. However this length is needed to raise the approach roads above the flood plain of the river. The actual stream crossing over the main flow is quite small estimated at approximately 15m.

359. At this time no details are available from the engineers. If a bridge pillar is constructed in the middle of the stream there may be temporary impacts downstream of increased silt loads but no fishing is taking place in this location.

360. A single span is preferable to having support pillars located in the river itself. This will give added protection to climate change induced flood levels.

5.5.2 Impacts and Mitigation during Pre-construction Phase

5.5.2.1 Setting up of Construction Camp

a) Predicted Impacts

361. The setting up and operations of construction camp will have direct but short term impacts on land use, pollution, encroachment of ecologically sensitive areas and public health and safety.

362. The occupation of a land will have an indirect impact of temporary change in land use. This impact will have low magnitude since it will be of short duration and will affect a limited land area. Impacts are reversible as the land can be rehabilitated at the end of the Contractor's lease.

363. The impacts of pollution from workers' accommodation will be due to effluents from waste water from toilets, bathrooms and kitchen. Solid waste from the camp is another source of pollution and health hazard.

364. The adverse impacts on ecologically sensitive area scan occur if construction camp is located within or near ecologically sensitive areas. The adverse indirect impacts will be encroachment, intrusion into protected areas by workers for collection of wildlife, hunting, etc. The indirect impacts of which are loss of vegetation, disturbance of wildlife among others.

365. Threats to health and safety of workers may include malaria and dengue, unsanitary camp conditions, lack of clean water and sanitary facilities.

b) Mitigation Measures

366. Site selection is a key mitigating measure, like developed or cleared private land should be preferred for construction camp. This will eliminate the need for clearing. Camps should not be located on productive lands, at or near sensitive habitats (e.g. forest).

367. Additionally, construction owner should be done. The Contractor should remove all structures, waste materials, etc.

368. Pollution prevention in construction camps will require the proper management of wastes by the Contractor. This should include provision of septic tanks for waste water from the toilets, bathroom and kitchen. The grey water from septic tank should be disposed in a leaching field. Discharge of waste water into the sewer or water body conforms with the standards set by the Sub- Decree on Water Pollution Control No 27 ANRK.BK. The standards for the physical parameters of effluents discharged into public water areas or sewer are given below. (Extracted from Annex2 of the sub-decree No 27 ANRK.BK.

Table 5.4 Standards of effluents discharged into public water or sewer

No	Parameters	Unit	Allowable limits for discharging pollutant into	
			Protected public Water	Public Water Area & Sewer
1	Temperature	C	<45	<45
2	pH		6 to9	5 to9
3	BOD5(5daysat200oC)	mg/l	<30	<80
4	COD	mg/l	<50	<100
5	Total Suspended Solids	mg/l	<50	<80
6	Total Dissolved Solids	mg/l	<1000	<2000
7	Grease and Oil	mg/l	<5.0	<15

369. Solid waste management should likewise be implemented. Waste bins for segregating waste should be provided within the camp with regular collection schedule. Waste should be segregated with recyclables sold to recyclers; organic wastes composted and non-recyclable wastes disposed in authorized disposal facility.

370. Health and safety protection of workers in the camp is part of the Contractors obligation. For health and safety of workers, the contractor should provide: safe, suitable and comfortable accommodations, kitchen, dining and sanitary facilities (toilet and bath); ample supply of clean water; and first aid supplies and equipment. Camp surroundings should be kept clean to prevent breeding of insect vectors.

371. For security and to maintain order in the camp and to avoid social problems with the community, Camp rules have to be established and imposed by the Contractors and effectively disseminated to workers. These camp rules should address health, safety and security of workers; compliance with environmental management plan. Among the house rules and prohibition are:

- Entry to camp is limited only to workers residing in the camp

- Curfew time should be imposed
- No consumption of alcoholic drinks and illegal drugs in camp and worksite
- No gambling in the camp and work site
- Workers are prohibited from collecting firewood and / or wildlife, i.e. no hunting
- Workers are prohibited from keeping wildlife pets
- Weapons, guns and bladed weapons are not allowed in camp and worksite

372. Contractor should conduct a training and orientation on environmental protection, hygiene, health, safety and security. The training program should be presented in the CEMP.

373. The Contractor should secure permits from the landowner, local government and other relevant agencies.

374. The CEMP to be prepared by the Contractor should present a detailed plan of the construction camp showing the layout, the sanitary facilities, septic tank, drainage, access road, fuel storage, equipment yard, among others. All permits should be submitted with the CEMP.

5.5.2.2 Hiring of Workers

a) Predicted Impacts

375. The hiring of workers from outside can create social conflicts with the local communities. The locals may: (i) feel aggrieved for not having been employed in the construction; (ii) resent having outsiders within the community; (iii) view the workers as competitors for local resources like food and water; and (iv) Outsiders disregard for local traditions and practices.

376. The use of child labor and trafficked workers in the construction may occur specially on sub-contracted works.

b) Mitigation Measures

377. To minimize adverse impacts with operating construction camp, hiring of workers from host communities should be given preference for hiring. This will minimize the number of workers to be housed in the camp and will help avoid social conflicts between workers and local communities.

378. The contractor should maintain communication and good relationship with the community so complaints or grievance are immediately brought to the Contractor's attention and attended to within the shortest time possible through the grievance redress mechanism.

5.5.2.3 Identification of Materials Sources, Borrow Pits and Quarries

c) Predicted Impacts

Quarry

379. Quarrying can have long term and permanent adverse impacts such as visual impairment (scarring), change in topography, consumption of resources, change in land use, increased susceptibility to erosion and siltation, alteration of natural drainage patterns, etc.

Borrow Pits

380. Direct impact of borrow pits is change in land form with indirect impacts of visual impairment, increased siltation and erosion, threats to public safety, health hazards as accumulated water can serve as breeding ground for insect vectors.

381. Chance discovery of culturally significant items or sites might occur during excavation of quarry or borrow pit.

d) Mitigating Measures

Quarry

382. Commercial quarry operators are present in some of the provinces traversed by the roads. The selection of the aggregate material supplier should also consider the legitimacy of the operations, i.e. licensed operator. For new areas, Contractor should avoid sites near water bodies and ecologically sensitive areas and aggregate plant should be located at least 500 m from settlements.

383. The contractor should include in the CEMP a material balance estimate for cut and fill material requirements and identify possible sources for fill materials and disposal sites for spoils. Additionally, the Contractor should submit a quarry development plan to the Project Implementation Consultant together with the CEMP. It is also the responsibility of the contractor to secure mining/ quarry permits and comply with applicable government regulations on waste (solid, liquid and hazardous) management. The English translation of all permits should be incorporated in the CEMP and submitted no later than one month before cut and fill operations start.

Borrow Pits

384. Borrow materials may be obtained by widening cuts, widening ditches or by excavating from other sources outside the planned cross section within the right-of-way or slope easements and within the limits of the project, with the expressed approval by the Engineer.

385. All areas being worked shall be drained and kept drained. The Contractor shall confine his operations solely to the areas provided or acquired by the Contractor and shall demarcate the boundary of the area and erect temporary or permanent fencing; Where the height of any face exceeds 1 meter, the Contractor shall provide, erect and maintain at its own expense fencing and gates to prevent unauthorized access to the top of the working face. On completion of work all faces shall be neatly trimmed to a slope flatter than 1 in 4. Where this is impracticable or where the working face is to be left exposed, the edge shall be permanently fenced.

386. The access roads to borrow areas must be maintained in good condition by the contractor and restored to its original state after completion. Additionally, upon completion of work temporary fences and all temporary structures shall be demolished and removed, and the site cleaned and top soiled.

387. If borrow site will be used as dam, water reservoir, fish pond for use by local area, ensure that this complies with local requirements and with the Engineers approval.

388. Contractor should comply with the prescribed procedure for chance discovery of culturally important sites or items.

5.5.3 Impacts and Mitigation during Construction Stage

389. MPWT (2008) listed the priority environmental management concerns during the construction stage of RAMP roads. Among these are:

- Resurfacing of pavements and associated pavement works and repair and surfacing of shoulders
- Transport of materials
- Materials stockpiling on shoulders
- Borrow areas
- Worksite installation (if needed)
- Road safety and traffic management

390. These concerns, the corresponding impacts and mitigating measures are subsumed in the following discussion of impacts and mitigations as well as incorporated in the EMP.

5.5.3.1 Earthworks

391. As listed in the BOQ, earthworks will consist of (1) clearing and removal of top soil and vegetation for widening; (2) excavation of roadway to remove unsuitable materials; (3) channel excavation for drainage; (4) construction of embankment; and (4) placement of sub-grade materials. The earthworks activities will involve the use of heavy equipment as well as dump trucks for the transport and delivery of materials.

a) Predicted Impacts

392. Its direct impacts will include generation of noise and emissions from heavy equipment, dust from excavation and bare areas and transport of materials.

b) Mitigating measures

393. To mitigate noise impacts and emissions, the construction equipment are to be fitted with noise mufflers and maintained regularly; timing of earthworks in populated sections should be limited during daytime hours, i.e. 0600H to 1800H.

394. Dust suppression should be carried out in populated areas by watering the road. Control of dust during transport of spoils and aggregate materials should include fitting of all dump trucks with tailboard and load should be covered for trips that will go through populated areas; speed limits to be imposed for project vehicles travelling over unpaved roads in populated areas.

395. Traffic management during construction work especially with lane closure, warning signs, directional signs and barriers should be installed and the assignment of signal men at both ends of the work sites. Alternate routes should be provided if possible.

396. The contractor shall also minimize the need for permanent disposal sites by using the spoils as fill materials, as topsoil or the sodding of the embankment slopes, filling up of abandoned borrow pits. If disposal is unavoidable, non-productive lands away from water bodies should be preferred with the permission from the landowner, local community and local government.

5.6 ENVIRONMENTAL MANAGEMENT PLAN

5.6.1 The Environmental Management Plan(EMP)

397. The Environmental Management Plan (EMP) gives guidance on how to mitigate the environmental concerns identified in connection with this project. The EMP deals with mitigation and management measures to be taken during implementation to avoid, reduce, and mitigate adverse environmental impacts.

398. MPWTD will ensure that the EMP is included in the tender documents for civil works. It will form part of the contract between MPWT and the selected contractor and the requirements of the EMP will be contractually binding on the contractor. The conformity of contractors with environmental contract procedures and specifications shall be regularly monitored by the project management unit (PMU) through the Social and Environmental Office (SEO) during implementation. PMU/SEO will be assisted by the detailed design and implementation supervision consultant (DDIS) to undertake EMP monitoring and to prepare corresponding semi-annual reports for submission to ADB.

5.6.2 Contractors Environmental Management Plan (CEMP)

399. After appointment and mobilization the contractor must prepare his own version of the EMP known as the Contractors EMP (CEMP). This must give specific details of locations of borrow areas borrow roads, workers camps and other facilities. This must be submitted to the DDIS Consultant for their approval before works commence.

5.6.3 Environmental Management and Monitoring Plan (EMMP)

400. The Environmental Monitoring Program is included in the Environmental Management Plan and so the EMP can be considered as an EMMP - Environmental Management and Monitoring Plan. Response to Complaints

401. Villagers and APs are encouraged to voice complaints and these are to be duly investigated and reported through the contractor to SEO and so to MPWT.

402. Response to complaints will be based on the following schedule:

- Complaint made to contractor or others
- Response by contractor or construction supervision consultants' inspectors.
- Weekly compiling of checklists by inspectors. Copies of checklists to be given to contractors as official notification of action being required, confirmation of receipt obtained by contractor signing copy, and joint inspection carried out if necessary.
- Monthly progress reports by inspectors by consolidating weekly reports.
- Corrective Action Reports (CARs) from contractors, as soon as action taken.
- Monthly progress meetings with contractors at which CARs from previous month examined and checked.
- Three monthly progress reports to ADB detailing problems and Corrective Actions taken.
- Regular checks by the Local Environmental Specialist (SEO) and regular oversight checks by International Environmental Specialist.
- Checks with complainants that they are satisfied

403. Review of progress must be checked on a daily basis by the inspectors. Any urgent issues must be drawn to the contractors' attention immediately. Failure by the contractor to respond in a timely or adequate manner must be raised with them at the monthly progress meetings.

5.6.4 Costs for EMP

404. The estimated costs for implementing the EMP are provided in the table below.

Table 5. 5 Estimated Costs for EMP Implementation (1year)

Item	Estimated Total Cost (US\$)
1.Environmental monitoring to be undertaken by DDIS environment specialists	
a. International (1 person for 1 monthUS\$20,000/month)	20,000
b. National (1 person for 1 month@ US\$5,000/month)	5,000
2. Environmental management capacity building program/training to be undertaken by DDIS for SEO staff (estimates only, to be determined during Project implementation)	20,000
3. Transportation for environmental monitoring(@ US\$5,000 year for 1 year)	5,000
4. Construction phase mitigation measures (included in project costs)	\$50,000
Total	\$100,000

5.7 INFORMATION DISCLOSURE, PUBLIC CONSULTATION AND PARTICIPATION

5.7.1 Introduction

405. The ADB's Environment Policy mandates the procedural requirements for effective public consultation and information disclosure in the EA process. The CEMP should include a plan for public consultation activities during the finalization and implementation of the EMP.

5.7.2 Consultation Stakeholders

406. The stakeholders in these meetings were identified by commune chiefs/ commune authorities and national consultants during conducting field visit and discussion with commune chiefs or commune authorities. There were 4 consultation meetings of PR1534 in Pursat and Kampong Chhnang province, 2 consultation meetings of PR23 in Kandal province, and 2 consultation meetings of PR312 in Prey Veng province, the meeting locations and number of participants are presented in the tables below. The stakeholders involved in the design of the project included :

- Village and commune authorities along the road project sites
- Communities living near the roads who will benefit from the project, and who have an interest in identifying measures to enhance or maximize the benefits
- Communities living near the roads who may be directly and indirectly affect/impact or adverse impacts
- Vulnerable and/or marginalized groups who have an interest in the identification and implementation of measures that support and promote their involvement and participation in the projects.

Table 5. 6 Public Consultation Meetings for PR1534, Kampong Chhnang and Pursat

Date	Activities and Locations	Attended Participants
15 Sept, 2016		
	(i) Consultation meeting at Krang S kear commune, Teuk Phos district, Kampong Chhnang province	26 participants came from Kran g Krear commune and Tang K rasang commune
16 Sept, 2016		
	(ii) Consultation meeting at Chheu T om commune, Krakor district, Pursat province.	29 participants came from Chh eu Tom commune and Svay S ar commune
	(iii) Consultation meeting at Thnot C hum commune, Krakor district, Purs at province.	24 participants came from Tho t Chum commune
17 Sept, 2016		
	(iv) Consultation meeting at Roleap commune, Pursat town, Pursat provi nce.	35 participants came from Rol eap commune.

Table 5. 7 Public Consultation Meetings for PR23, Kandal Province

Date	Activities and Locations	Attended Participants
21 Sept, 2016		
	(i) Consultation meeting at Kampon g Kong commune, Koah Thum distr ict, Kandal province	48 participants came from Ka mpong Kong, Chrouy Takaev, and Leuk Daek commune
22 Sept, 2016		
	(ii) Consultation meeting at Peam R angcommune, Leuk Daek district, K andal province.	27 participants came fromPea m Rang commune

Table 5. 8 Public Consultation Meetings for PR312

Date	Activities and Locations	Attended Participants
22 Sept, 2016		
	(i) Consultation meeting at Angkor Reach commune, Preah Sdach district, Prey Veng province	30 participants came from Angkor Reach, Lvear, and Chey Kampok commune
23 Sept, 2016		
	(ii) Consultation meeting at Banteay Chakrei commune, Preah Sdach district, Prey Veng province.	31 participants came from Banteay Chakrei commune.

5.7.3 Attendance List of Participants

407. The participants were invited from some villages are located along the provincial road projects such as: commune chiefs, commune councils, village chiefs, and representative of communities (male and female). The participant's name and number are given in the IEE (Annex A) as are the comments and responses.

5.8 GRIEVANCE REDRESS MECHANISM

408. According to MPWT (2008) (Environment and Social Safeguards Policies for Cambodia Road Asset Management Project) grievances related to any aspect of a project will be handled through negotiations and are aimed at achieving consensus. All complaints received in writing (or written when received verbally) from the PAPs will be documented by each level grievance committee, established by the project authorities at varying governance levels, i.e. Commune, district and/or provincial levels. The project affected persons will be exempted from all administrative and legal fees incurred in pursuant to the grievance redress procedures. Grievance committees would comprise of representatives of project affected persons, community leaders and independent assigned NGOs, in addition to the representatives of commune and district officials, and project authorities.

409. In consonance with this guideline, the Project Management Unit (PMU) of Ministry of Public Works and Transport (MPWT) will undertake implementation of the GRM. Details are given in the IEE.

5.9 RECOMMENDATIONS

410. To avoid or mitigate negative impacts arising from the project, an EMP detailing mitigation measures and monitoring activities has been prepared as part of the IEE.

411. Public consultations involving affected people and local officials have been conducted during the preparation of the IEE in compliance with ADB information disclosure and consultation requirements through focus group discussions and individual interviews in all project affected provinces. Environment was not seen as a major issue by those persons interviewed.

412. Climate change adaptation was included in the project. The MPWT software Flood Risk Management Interface has been used to identify the flood risk associated with the project roads. Roads in Pursat are not classified as being at risk of flooding under future climate change scenarios. Roads in Kandal have moderate risk of flooding. Roads in Prey Veng have moderate risk of flooding under future climate change scenarios. Suggestions on adaptation measures to the design standards have been made.

413. Only minor environmental impacts are anticipated. Such impacts will be experienced during site works mainly due to dust and noise emissions as well as potential occupational, community health, and safety risks, but can be mitigated. Some minor mitigation measures will be specified but no major impacts have been identified.

414. Temporary environmental impacts caused by the civil works have been identified and mitigation measures are given in the EMP. The EMP (and EMMP) will be included in the IEE and will form part of the tender documents which becomes legally binding on the selected contractor.

415. To ensure that the project is carried out in accordance with the EMP requirements, MPWT will specify details of the implementation of the EMP in the tender documents and civil works contracts.

416. Social and Environment Office (SEO), previously SEU, is operational but needs capacity building. The detailed design and implementation supervision (DDIS) consultant will provide on- the-job training to the field personnel of the SEO of MPWT to build their capacity in environmental management and monitoring.

417. All potential environmental impacts have been identified. The project is confirmed as Category B according to ADB guidelines. No environmental impacts were identified that would warrant the conduct of an environmental due diligence study

6 RESETTLEMENT

6.1 INTRODUCTION

418. The Second Provincial Roads Improvement Project (PRIP-II) in Cambodia intends to rehabilitate approximately 132 kms. of roads under the Ministry of Public Works and Transport (MPWT). The roads targeted for improvements are: (1) PR 312 to connect with NR1 up to Banteay Chakrey Border, Prey Veng Province; and (2) PR 23 from Koh Thom Bridge to Peam Raing district in Kandal Province.

419. The project aims to provide better access to essential services, reduce remoteness and improve economic opportunities. Most of the project roads link to a national road and provide access to the road network at large. Currently all of national roads connecting the project roads are paved with either asphalt concrete pavement or Double Bituminous Surface Treatment (DBST).

6.2 SCOPE OF LAND ACQUISITION AND RESETTLEMENT

420. The major impacts caused by the Project include demolition of structures used for residence and business, and acquisition of privately owned lands. Based from the results of IOL conducted on July to September 2016, 100 houses, 57 stores, 5 shops, 21 House cum shops and 19 Houses cum Store are partially affected by the proposed Project roads and owners will move back from their remaining land outside the ROW. About 1.65 has must be acquired for the proposed road project of which 13,210 m² are farmlands and 3,330m² are residential lands.

421. Other fixed structures affected include fences, stalls and other secondary structures. Approximately 21,886 of perennial trees and timber trees need to be removed from the COI of the Project roads.

6.3 MEASURES TO MINIMIZE IMPACTS AND RESETTLEMENT

422. In order to avoid or minimize displacement of people from assets and livelihoods, the existing road alignment will be confined within a corridor of impact (COI) of 8 meters measured either side from the road centerline. Several alignment options were considered in order to avoid affecting existing settlements. In addition, as part of the Project's resettlement strategy, project affected households (AH) will be provided sufficient time to rebuild their homes and shops prior to the commencement of civil works and that they are able to continue with their present livelihood activities even during Project implementation. Also, all standing annual crops, including privately-owned trees, will be allowed to be harvested before the start of civil works in a particular section of the Project roads. The MPWT, through its Project Management Unit 3 (PMU3) and the Inter-ministerial Resettlement Committee (IRC), through the General Department of Resettlement at the Ministry of Economy and Finance (GDR-MEF), will ensure that this resettlement strategy is followed diligently.

6.4 LEGAL AND POLICY FRAMEWORK

423. This RP has been prepared to address land acquisition and resettlement in the rehabilitation of PR312 to connect with NR1 up to Banteay Chakrey in Prey Veng Province; and PR23 from Koh Thom Bridge to Peam Raing district in Kadal province consistent with ADB's Safeguard Policy Statement(June 2009) and relevant laws and regulations of the

Royal Government of Cambodia, notably the 1993 Constitution, the 2001 Land Law, 2010 Expropriation Law, and Prakas (Government Order) No. 6, dated 27 September 1999. The RP includes the resettlement policy and specific time-bound and budgeted measures for mitigating the adverse social impacts of the Project and for rehabilitating all physically and economically affected AHs.

424. The basic compensation and rehabilitation principles adopted in this RP are (a) land acquisition is minimized if avoidance is not possible; (b) compensation and cash and non-cash assistance will be provided to help ensure that AHs are able to maintain, if not improve, their pre-Project living standards; (c) AHs are fully informed and consulted on compensation and relocation options; (d) existing socio-cultural institutions of AHs are supported and used; (e) the Project resettlement policy will equally apply to women and men; (f) lack of formal title will not be a bar to compensation and rehabilitation; (g) particular attention will be extended to vulnerable groups, such as households headed by women and the elderly with no other social support; (h) resettlement is planned and implemented as an integral part of the project and that the budget for resettlement is part of Project costs; and (i) AHs are not displaced from assets until they are fully compensated for the same.

6.5 PARTICIPATION AND GRIEVANCE REDRESS

425. The IOL identified 119 women-headed households, 200 AHs that are headed by persons within the retirement age bracket of the Government (i.e., 60 years and older), 10 AH that are headed by persons with disabilities, 13 as landless AHs and 8 poor AHs whose monthly income are less than 20\$. Additional measures are incorporated in the RP to help ensure that these AHs, who are considered particularly vulnerable, are not further disadvantaged and that, along with the other AHs, they will equally benefit from the Project.

6.6 VULNERABILITY AND GENDER ISSUES

426. The IOL identified 119 women-headed households, 200 AHs that are headed by persons within the retirement age bracket of the Government (i.e., 60 years and older), 10 AH that are headed by persons with disabilities, 13 as landless AHs and 8 poor AHs whose monthly income are less than 20\$. Additional measures are incorporated in the RP to help ensure that these AHs, who are considered particularly vulnerable, are not further disadvantaged and that, along with the other AHs, they will equally benefit from the Project.

6.7 IMPLEMENTATION ARRANGEMENTS

427. The MPWT, through the Project Management Unit 3 (PMU3) and the Environmental and Social Office (ESO), and the Inter-ministerial Resettlement Committee (IRC), through the General Department of Resettlement of the Ministry of Economy and Finance (GRD-MEF), are overall responsible for preparing, updating, implementing and financing the RP. At the local government level, the MPWT and IRC are assisted by the Resettlement Subcommittee in the provinces and districts through the Resettlement Subcommittee Working Groups (RSWGs).

6.8 MONITORING

428. The ESO is the Project's internal monitor, while an external monitoring organization will be hired by IRC to do external monitoring and evaluation (M&E). During RP

implementation, which is reckoned to begin at the time of the detailed measurement survey (DMS), quarterly progress report of internal monitoring and semi-annual external M&E report will be submitted to ADB. Within one year after the completion of RP implementation, a resettlement completion report will be submitted to ADB that includes lessons learned to improve resettlement work in future projects.

6.9 RESETTLEMENT BUDGET AND INDICATIVE SCHEDULE OF RP IMPLEMENTATION

429. The total cost of resettlement for the project is estimated at \$ 2,046,959.61. The indicative schedule of RP preparation and implementation is given below.

Table 6.1 Indicative schedules of RP preparation and Implementation

Activities	Schedule
RP Preparation	September – December 2016
ADB Approval of Draft RP	December 2016
RP Updating	September 2017
Detailed Measurement Survey	April –March 2017
Replacement Cost Survey	April –March 2017
Submission and ADB approval of URP	September 2017
Public Disclosure of Approved URP	October 2017
Implementation of approved URP	
Disbursement of Compensation to APs	
Relocation of AHs	
Internal Monitoring (Submission of Quarterly Report)	
External Monitoring Report (Intermittent)	
Civil Works Construction	

7 POVERTY AND SOCIAL ASSESSMENT

7.1 INTRODUCTION

430. The proposed Second Provincial Roads Improvement Project (PRIP-II) is an ADB financed project, under the Ministry of Public Works and Transport (MPWT) as the Executing Agency (EA). It is a priority project of the Government of Cambodia under the key infrastructure development agenda. The project aims to rehabilitate about 132.8 kilometers (km) provincial roads to paved condition in 4 provinces (Kampong Chhnang, Pursat, Prey Veng and Kandal). It will provide a safer, cost-effective provincial road network access to markets and other social services for provincial centers in the mid-west and southeastern part of the country for trade facilitation and development of Cambodia Regional Integration. The project will also support a sustainable road maintenance regime in MPWT, HIV/AIDS and human trafficking awareness and prevention program.

431. The PRIP-II will benefit an additional number of about 36,066 households and 178,588 population in 14 communes within 6 districts and 4 provinces of Cambodia.³ About 80.5% of the total population and households in the country resides in rural areas. ADB supports the promotion of inclusive growth through improved roads support, the country's agricultural production, economic condition will be improved as well as promote social development. It is aligned with the ADB's Country Partnership Strategy (CPS), 2015 - 2018 and the Country Operations Business Plan (CBOP), 2015 - 2017. Expanding rural-urban-regional connectivity is an integrated approach to developing the areas where most poor people live which supports higher agricultural productivity and commercialization.⁴

7.2 DEMOGRAPHIC AND ECONOMIC PROFILE OF THE PROJECT AREAS

432. Cambodia has a total population of about 15.41 million in 2015, with a population growth rate of 1.79%.⁵ The country's population has grown over 0.73 million in just over 2 year, compared to its population in 2013 with 14.68 and 3.16 million households. The rural population of Cambodia accounts for about 80.5% (over 2.5 million households) and 19.50% urban.⁶ Average household size in Cambodia is 4.7.⁷ The country's annual population growth rate declined to 1.5% from 2010 to 2012. It has an average family size ranges from 4.7 to 5.2 persons. The women population in Cambodia was estimated at 51.3% compared to the male population from 1998 to 2010.

433. The proportion of the population living in rural areas is about 80.5% and 19.5% in urban areas.⁸ The total population in the project areas is 178,588 (90,617 female or 50.7%) with 36,066 households and 40,668 families as of September 2016. The majority of the population is Khmer by ethnicity and less than 1% is Cham (Khmer Islam). There are 14.5% of the total households who are headed by females.

³ Data from the Commune Councils in 14 communes affected by PRIP-II, as of September 2016.

⁴ Ibid.

⁵ World Economic Forum (WEF). Global Gender Gap Index Report 2015.

⁶ Cambodia Demographic and Health Survey. 2014. Ministry of Planning, National Institute of Statistics, and Ministry of Health. Phnom Penh, Cambodia.

⁷ Cambodia Demographic and Health Survey (CDHS). Cambodia. 2014.

⁸ Ibid.

434. Cambodia is considered as one of the countries with fast economic growth, globally. Since 2011 Cambodia's economy has grown by 7.1% per cent, and increased to 7.3% in 2012 and 7.4% in 2013, respectively. In 2015, its GDP rate declined to 7.0% and ADB has projected that it will continue through 2017. Cambodia Industrial Sector Grew 11.7% in 2015.⁹ In 2013, the industrial sector's share of GDP rebounded to around 24%. The average annual growth rate spread over the past 15 years (1998-2013) was estimated at 12.4% compared to 4.7% and 8.5% for the agriculture and the service sector, respectively. In that light the industrial sector is the best performer in term of achieving the highest growth. In 1993, about 72% of the total labor force was in the agriculture sector as compared only to about 5% in the industrial sector.

7.3 POVERTY AND SOCIAL ANALYSIS

435. The poverty and social analysis (PSA) describes the socio-economic conditions including poverty, demographic profiles of the project areas; presents and analyze the data gathered from the households' baseline socio-economic survey; assess the perception of the affected local people and communities on project impacts and how they will be benefited by the proposed project, and suggestions raised by concerned stakeholders relevant to the project. The PSA also presents social and gender assessment, and proposed safeguards and social mitigation to address potential risks associated with the road project.

436. Various community participation approaches and methods were used in data gathering such as consultation meetings with the concerned agencies/ organizations, in-depth interview with key informants or key informant interview (KII), and focus group discussions (FGDs) with various groups such as women, farmers, community leaders, and other residents in the communes/villages. Households' social survey was also conducted to gather baseline socio-economic data of the project beneficiaries and communities. Information gathered include both quantitative and qualitative data, primary and secondary data. growth drive by solid performance in garment manufacture, tourism, paddy and milled rice, and construction.

437. In 2015, the country's total GDP was reported at US\$11.48 and the GDP (PPP) per capita (constant 2011, international in US\$) was \$3,093.¹⁰ Between 2007 and 2012, the poverty rate in the country fell dramatically from about 50% to 20%.¹¹ The poverty rate in Cambodia in 2012 was 17.7%, with almost 3 million poor people and over 8.1 million near-poor, and mostly live in the countryside. Although the country achieved the MDG of halving poverty in 2009 but the vast majority of families who escaped poverty were able to do so by a small margin. The areas of health and sanitation, and education are still considered as development priorities in the country.

438. Urban poverty rate in Phnom Penh was 16.3% in 2012 and 14.5% in other urban areas. On the other hand, rural poverty incidence fell from 24.6% in 2009 to 20% in 2012.

⁹ ADB. Asian Development Outlook 2016. ADB.Manila.

¹⁰ WEF. Global Gender Gap Index Report. 2015

¹¹ Ibid.

The international poverty line of US\$1.25 per person per day (in 2005 purchasing power parity or PPP dollars, shows a sharp reduction in extreme poverty.¹²

439. The poverty rate in the rural areas is higher (almost 25%) compared to urban areas (19.3%), and Phnom Penh has the lowest poverty rate with close to 13%. Overall the country's poverty rate in 2009 was 22.9%. The daily per capita poverty line in Cambodia in 2009 was KR3, 871 and the monthly per capita poverty line in USD was \$28.39.¹³

440. The latest poverty data available in the commune and in the government agency (Ministry of Planning) was in 2012. In the same year, the poverty rate in Kandal province was 14.6% compared to Phnom Penh with 12.8% (2009 data). Kandal is located adjacent to the country's capital city and is considered as one of the provinces with higher income. Prey Veng province has a poverty rate of 21.9%, and the two remaining provinces (Kampong Chhnang and Pursat) in PRIP-II have higher poverty rates registered at 27.7% and 27.8%, respectively.

7.4 PRESENTATION AND ANALYSIS OF THE BASELINE SOCIAL SURVEY CONDUCTED IN THE PROJECT AREAS

441. A baseline household social survey was conducted in the project areas for PRIP-II, using survey questionnaire as the main instrument of the study. The study was conducted by an independent social survey team engaged by the PMU through KCI. The social survey was conducted on the last week of September and completed on the 1st week of October 2016. A total of 360 (50% women) were utilized as respondents of the baseline household social survey. The respondents were randomly selected in all of the 14 communes within 6 districts in 4 provinces covered by PRIP-II. Each respondent represents one household in the project areas, who was randomly selected in 14 communes within the 6 districts and 4 provinces.

442. Of the 360 respondents, about 35% of the 996 household members in the 4 provinces with PRIP-II are students and 14% have no jobs. The primary occupation of the household members is agriculture/farming and self-employed, which account for about 35%. Of the 360 respondents, 34% mentioned that the total monthly income of their households ranges from Riel 400,000 to 800,000.00 (or \$100 -200); 28% have a monthly household income over 1,200,000.00 (\$300.00 and over); 21% have a monthly household income ranging from Riel 800,000 to 1,200,000.00 (\$200.00 to \$300.00). The remaining 9% of the respondents have a monthly household income of 200,000 and below (\$50.00 or lower), and 8% have a monthly household income of Riel 200,000 to 400,000.00 (\$50.00 to \$100.00). The data implies that about 17% of the 360 respondents/ households are considered poor.

443. The respondents were asked about their perception on how important is the proposed road project (PRIP-II). About 53% of the respondents perceived that the project is "very important" and 44% considered the roads as "important. Only 2% of the 360 respondents perceived that the proposed project is "less important", and 1% thought that it is "not needed". The top five reasons cited by the respondents why the proposed improvement of the roads is important are: (i) difficult to travel or commute for the road users if the road is

¹² Cambodia DHS. 2015. Ministry of Planning. National Institute of Statistics.

¹³ ADB. Cambodia Country Poverty Analysis. 2014. ADB. Cambodia.

bad (1st rank); (ii) the government could help in planning road widening, to help in reducing traffic jam in some road sections that are narrow (2nd rank); (iii) need to repair/ improve already the roads in some section/ areas as they are already in bad condition (3rd rank); (iv) wider road is much better than narrow road (4th rank); and (v) road accidents may be reduced as there will be road safety awareness and road signs and lighting facilities that will be installed, and included in the design.

444. The respondents were also asked about their perception of project benefits or positive that they and/or their household members could get from the proposed project. The following are the top five positive impacts identified by the respondents once the PRIP-II propose roads have been completed: (i) reduce traffic accidents, as road safety awareness and other safety measures will be implemented, and the road will be widened (1st rank); (ii) having improved roads could boost business and economic growth, and attract business investors; could also help the local people in their business (2nd rank); (iii) value of land will increase along road sides after the project has been completed (3rd rank); (iv) improved roads will be of good quality and could provide longer-term benefit to the people and road users (4th rank); and could help improve the income of the people in the project areas, district and province as a whole (5th rank).

445. As regards potential negative impacts, about 56% of the respondents perceived that the number of road accidents will increase after the completion of the project; 12.5% stated that there will be more drivers who will drive fast; and the rest are worried of the potential effects related to land acquisition and resettlement (i.e. farmland, trees, houses and shops along the right-of way and along road sides will be affected by the proposed project).

446. Overall, the respondents are happy of the road project, and they want it to be implemented as soon as possible. There were no environmental related problems (i.e. dust, noise, etc.) that were identified as potential negative impacts of the proposed project. They thought that these are only temporary and the contractors could implement necessary mitigation measures to control these problems. However, for land acquisition and resettlement related impacts, they perceived that these may be permanent impacts and might have long-term impacts to their livelihoods and households incomes. They suggested that necessary compensation and assistance be provided to the affected persons/ households.

7.5 SOCIAL IMPACT ASSESSMENT

447. The total number of beneficiaries in the project areas, consisting of 14 communes, 6 districts within 4 provinces, is 178,588 (50.5% women) as of September 2016. The total number of households that will be benefited by the improved road project is 36,066, and of which 5,402 (15%) are female-headed households, and more than 19% are considered poor.

448. In terms of ethnicity, less than 1% of the total project beneficiaries (178,588 people) belong to the Khmer Cham ethnic group. They are residing in the provinces of Tuek Phos, Pursat and Kandal. The Cham people do not consider themselves different from the Khmer in terms of language and lifestyle. The only difference is their religion as they profess Islam as their religion and Buddhism for the majority of the population who belong to Khmer ethnicity, and the food because the Cham do not eat pork. The children of the Cham go to the same school, where the majority of the Khmer children also attend school. The medium

of communication used in school is Khmer, and both the Cham and the Khmer children use the same language. There are no problems in integration in school and in the communities for the Cham and Khmer people.

449. The houses of the Cham people are located in the commune proper, and far from the provincial roads. They will not be adversely affected by the proposed project (PRIP-II). Thus, the project is Category C as regards Indigenous Peoples (IPs), as per ADB Safeguard Policy Statement (2009). There are no Vietnamese nor Chinese in the project areas. The local people including the Cham population will be benefited by the proposed PRIP-II, as it will provide them access to basic social services and facilities, including going to markets, schools, church, commune office, work place and other places.

7.6 STAKEHOLDERS' CONSULTATIONS AND ANALYSIS

450. The purpose of the stakeholders consultations are as follows: (i) To inform the stakeholders about the proposed Project, project outputs/components, requirements and reports that need to be prepared by the Team and PMO for submission to ADB as part of requirements for loan processing; (ii) To gather data needed for the preparation of the PSA/gender reports (including the stakeholders' level of awareness about the proposed project, perception on project impacts and suggestions); (iii) To assess the positive and potential social risks that may be associated during project implementation; views on project impacts or benefits which they and/or their household members and/or the village/ town will get once the project is implemented; (iv) To identify issues and concerns raised by the stakeholders and proposed mitigation measures; and (v) To consult the women and women organization/ agency on how they would like to be involved during Project implementation.

451. Field visits in the project areas were conducted by the Consultants on the last week of August 2016. Public consultations in the project areas were conducted by province and road section by the Project's Social Team consisting of the consultants for social development and gender, road safety, and environment). The consultations were participated by the people in the villages/ communes within the PRIP-II areas. Consultations were conducted in Kampong Chhnang and Pursat provinces on September 15-17 and participated by 117 people (33% women). Separate consultations were conducted in PR23 (Kandal province) on September 21-22, 2016 and participated by 75 people (37% women); and consultation in PR312 (Prey Veng province) was conducted on September 22-23, 2016 was 61 and of which 28% are women.

7.7 GENDER ANALYSIS

452. The proposed project is effective gender mainstreaming (EGM) based on ADB gender mainstreaming category. The project outputs could provide benefits and opportunities for women to work and earn income, increase level of awareness on road safety, HIV/AIDS and Human Trafficking Prevention, and safeguard measures. A gender action plan (GAP) have been prepared to serve as blue-print during project implementation.

453. Gender relations in Cambodia are complex. Women could exercise considerable autonomy, own assets, manage financial transactions, and contribute to household making. Both men and women can inherit property. The gender division of labor can be complementary and flexible, with men and women performing a range of productive and

household tasks. However, the low levels of educational and literacy rate in the country is one of the factors identified that could limit girls and women's choices and options.¹⁴

454. Cambodian society is generally patriarchal and hierarchical, with strong traditional norms where men have higher status than women. There are few women elected in political positions, promoted to higher positions in the government, and in the justice system. In educational institutions, there are more men than women teachers, and has few women in technical line. Participation of women in economic activities is high. The number of women working in garment factories, entertainment industries, and social services jobs (i.e., doing laundry, working as house helpers, in restaurants, etc.) is higher compared to men. Likewise, the number of women migrant workers in Cambodia is increasing, although the statistics show that the number of male migrant workers still exceeds that of women.

455. In the project area, the majority of rural women work in agriculture; assist their spouse in farming and other economic activities (i.e., raising livestock, poultry, and engage in selling). The number of men working in fishing, rubber plantation and agriculture, and construction work is higher than women. Results of the stakeholder consultations with the commune leaders also show the most common social problems existing in the project areas, as follows: (i) high cases of school drop-outs especially in high school level (ii) lack of job opportunities and low income in the rural areas is a key determinant for high migration rate, and this push the local people to migrate to urban center and/or abroad to look for jobs; (iii) women and girls work in agricultural / forestry areas, garment factories especially in Kampong Chhnang, Pursat and Kandal due to presence of garment factories in the project areas and adjacent places. Kandal is located very close to Phnom Penh and Kampong Speu, where there are many garment factories. Other women are engaged in selling goods and agricultural products, and in fishing to augment households' income.

456. A Gender Action Plan (GAP) has been prepared to ensure this project is socially inclusive for women and measures are taken to proactively support gender mainstreaming. Gender equity, gender performance targets, indicators and benchmarks were included in the GAP. The key gender actions include: (i) involving women in public awareness campaigns; (ii) provision of project employment for local women during construction and operations; (iii) consultation with women for community participation and in water tariff (including affordability for any tariff that will be set for the provision of improved services in the future); (v) gender awareness for Project implementation staff; and (v) collection of sex disaggregated data to monitor achievement of targets.

457. Appendix 2 is the draft Gender Action Plan (GAP) for the proposed project.

7.8 SOCIAL SAFEGUARDS (RESETTLEMENT RELATED IMPACTS)

458. The Project is Category B for resettlement as per ADB SPS 2009. The resettlement Team has conducted an Inventory of Loss (IOL) and Socio-economic survey (SES) for the affected people/households in the project areas for PRIP-II. The total number of households who will be affected by land acquisition in the project areas for PRIP-II is 1,919. A total of 149,497.54 sq.m of affected land are residential; 130,806.70 sq. m are farmland; and 550 sq. m are forest land. The total number of Affected Persons (APs) is

¹⁴ ADB. Cambodia Gender Analysis Report 2012.

2,151 (32.5% women). There are 207 household heads who are widowed, 23 disabled and 369 elderly (60 years old and above).

7.9 IMPLEMENTATION ARRANGEMENT

459. The Project's executing agency (EA) is the Ministry of Public Works and Transport (MPWT) through the Project Management Unit (PMU). The PMU will hire the services of a DDIS Team (Consultants) including 1 international and 1 national social development and gender specialist to assist the PMU in the implementation and monitoring of the GAP conducting safeguards and gender mainstreaming training to project implementers including the contractors; and in preparing GAP Quarterly progress report.

7.10 CONCLUSIONS AND RECOMMENDATIONS

460. The PSA concluded that the project will provide positive benefits to the local people and the communities within the project area. It will also benefit the women, low income households, and other vulnerable persons in the project areas. All (100%) of the people who participated in the public consultations are in favor of the proposed project. Likewise, over 85% of the social survey respondents are in favor of the project and perceived that the project is essential.

461. The project will provide benefits to the local people including the poor households, and local people by participating in jobs during civil works during project implementation/construction, operation and maintenance. About 20% of women will have job opportunities during the construction stage and maintenance. The local people's level of knowledge and skills will be enhanced through training and capacity building included in the design/project activities; awareness campaign on road safety, HIV/AIDS, gender, climate change, safeguards and other related topics.

462. Potential negative impacts of the project such as resettlement, environment i.e. dust, noise, disruption of business during construction stage, etc.), gender related risks related to employment. To address the problems and/or concerns raised by the stakeholders, the following mitigation measures are recommended: (i) conduct regular consultations with the concerned stakeholders during project implementation stage; (ii) implement the necessary and appropriate safeguard measures related to environment (refer to EMP prepared by the environment consultant); (iii) implement the activities and target indicators as stated in the GAP to ensure effective gender mainstreaming, taking into consideration the target indicators and activities; (iv) implement HIV/AIDS and human trafficking awareness/prevention program; community-based road safety program, and other safeguard measures. Overall, the proposed project is feasible and is expected to provide more benefits and positive impacts to the local people and in the project area.

463. The detailed Poverty and Social Assessment (PSA) is in Appendix B.

8 ROAD SAFETY STUDY

8.1 INTRODUCTION

464. In 2014, there were 4,645 road crash cases that caused 15,315 casualties. Among them, there were 2,226 fatalities and 6,005 were serious injured. On average there were about 6 fatalities and 17 serious injuries per day. The number of fatalities doubled. At the same time, the population increased by 15% and the number of registered motorized vehicles increased by 385%. There were 7.9 fatalities per 10,000 registered vehicles, a number higher than in Lao PDR (6.7) and Vietnam (2.0).

465. The National Road Safety Action Plan (2011-2020) is a crucial potential and key concept to ensuring road safety, order and safety for all road users in the Kingdom of Cambodia. The Royal Government of Cambodia has encouraged all sectors to pay more attention to road safety with all costs on activities being considered as an investment for human development to be free from road crash grave disaster.

466. A road crash can result from many causal factors, it is very important to identify the contributing factors in a crash in order to be able to develop measures and actions to prevent and reduce the number of fatalities and injuries. Human errors is very highest and contributed about more than 90%, it is included speeding, drunk driving, not respecting the right of way, dangerous overtaking, change direction without due care, etc. Road infrastructure is also contributed to reduce road crash if the road improvement, bridge construction, road maintenance is consider for road safety as the key pillar.

467. Cambodia has sustained high growth at an average 7.9% from 2000 to 2015, this growth make Cambodian have a chance for buy new vehicles and travel long distances on the roads network. This is a power of push of the good economic condition in Cambodia. At the same time, it is reported that in the villages where road crash rarely happened, their number are on the rise with vehicles passing through at high speed on the newly improved rural roads. Considering these circumstances, the aim of this study is to reduce the anticipated road crashes along the rural roads due to the drastic change in circumstance by introducing the community based road safety scheme and road safety engineering. The cooperation between consultant team with local authorities and stakeholders it make more sustainable development.

468. In 2014, there were 38 persons died on the road network in project area due the road condition still limit, the number of fatalities, casualties, case of crash and disability may increase if the road infrastructure not apply to road safety engineering and road safety soft component. Road safety is a key crucial tips to save road users' live through behavior and attitude's change.

469. Based on above information, Community Based Road Safety (CBRS) program proceeded in the manner shown in Figure 8.1 bellow.

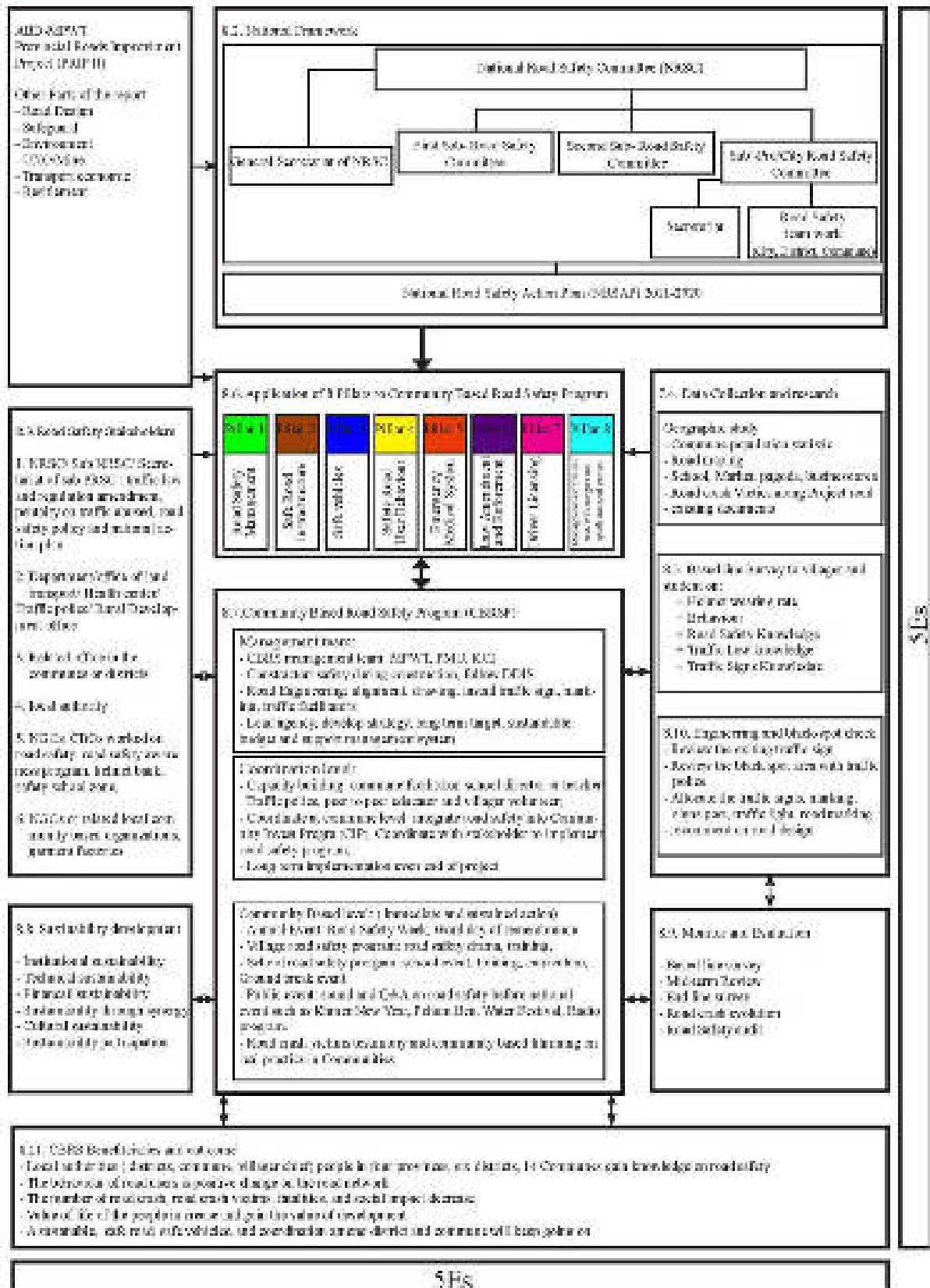


Figure 8.1 CBRs structure and workflow

8.2 NATIONAL FRAMEWORK

8.2.1 National Road Safety Committee

470. To counteract the growing road crash trend and fatalities, The Royal Government of Cambodia has highlighted road crash as a key national issue impacted to a sustainable development goal.

471. In 2005, the National Road Safety Committee (NRSC) was officially established by the Royal Government of Cambodia by Sub-degree number 77. The NRSC is an inter-ministerial body and is chaired by ministry of Public Works and Transport, in August 2015 the NRSC was restructured and chaired by Minister of Ministry of Interior with in two Sub-National Road Safety Committees, and General Secretariat of NRSC and Pro/city Road Safety Committees by Sub-degree number 84, The NRSC has high level representative from all government ministries, most led by ministries of Interior, Public Works and Transport, Justice, Education and ministry of Health and all related ministries.

472. NRSC is tasked with overall coordination among stakeholders, develop policy, action plan, strategy, law and regulation and implement the law enforcement aim to reduce road crashes, fatalities, injuries and its impact into minimum. It is also responsible for overseeing the effective implementation of the traffic law nationally, ensuring that the public are educated on road safety, and for developing road safety related regulations and directive such as national policy, National Action Plan, and high risk of vulnerable road users.

473. NRSC and General Secretariat work closely with a variety of international organizations, local and international non-government organization and private sectors to conduct road safety education activities most notable both national level, provincial and district level to educate all road users on new traffic law, new regulation, risky behavior especial before the main national holidays.

474. National Road Safety Committee was assigned as bellow structure:

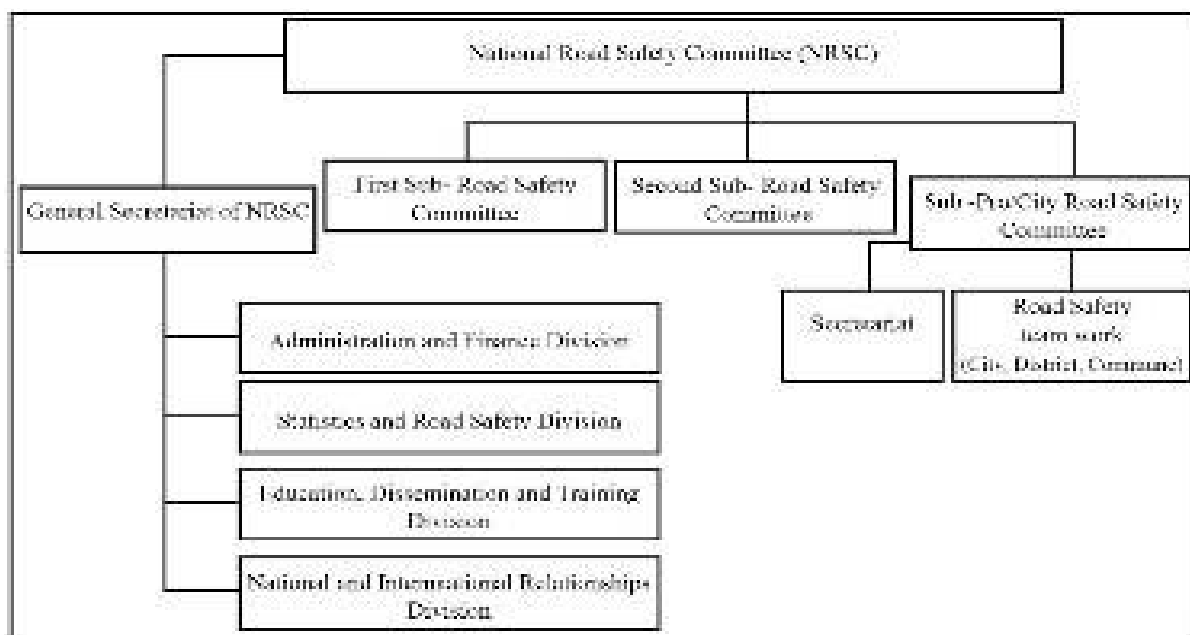


Figure 8.2 Organization Chart of NRSC and GSNRSC

8.2.2 National Road Safety Action Plan (2011 – 2020)

475. In 2004, National Road Safety Action Plan (2006 – 2010), was approved by the government covering 15 key road safety components including education, enforcement, engineering, emergency services, vehicle safety and management mechanisms. This is the first National Road Safety Action Plan in Cambodia to cope with the revision of the Road Traffic Law in 2007.

476. Following the appeal of Mr. Ban Ki Moon, UN Secretary General, on 11 May 2011, many countries across the globe kicked off the first global Decade of Action for Road Safety 2011-2020 meeting. This initiative seeks to prevent road crashes which are projected to take the lives of 1.9 million people annually by 2020. To mark the occasion, the governments in these countries, including Cambodia, hosted a high-profile launch and expressed their commitment to the Decade of Action for Road Safety, aiming to improve road safety through 5 pillars such as Road Safety Management, Safer Roads and Mobility, Safer Vehicles, Safer Road Users and Post-Crash Response

477. To align with International Decade of Action for Road Safety, The Royal Government of Cambodia has developed a National Road Safety Action Plan (2011- 2020) with focused on:

Pillar 1: Road Safety Management

Pillar 2: Safe Road Infrastructure

Pillar 3: Safe Vehicles

Pillar 4: Safe Road Users Behavior

Pillar 5: Emergency Medical System

Pillar 6: Law Amendment and Enforcement

Pillar 7: Driving License

Pillar 8: Management and Evaluation on Passengers and Goods Transport Services

478. The Royal Government of Cambodia (RGC) has committed to reach a national target of reducing road crash fatalities by 50% in 2020, it means that can save 7,350 people's lives for 10 years. To reach that goal, the country's interventions will focus on the main risk factors of helmet wearing, speeding and drink-driving over the coming decade. This is a historical milestone, demonstrating the RGC's commitment to road safety and its contribution towards the United Nations 'Decade of Action'.

8.3 ROAD SAFETY STAKEHOLDERS

479. National Road Safety Committee, Sub-Road Safety Committees, General Secretariat of NRSC and Sub- Pro/city Road Safety Committee: to enhance the cooperation, coordination with stakeholders to implement the road safety and law enforcement aim to reduce road crash in minimum and develop road safety policy, strategy, action plan, monitor and evaluation and amendment on traffic law or any regulation.

480. Related departments/ districts and commune office: Integrate the related officer to attend the training program to promote road safety at their communities and share responsibilities to save their people's life by input road safety issue into the Community Investment Program (CIP).

481. Local authorities: Involved all related local authorities to participation at activities in communities based road safety program, keep remind their willing to protect their local people that most are their relative and their community, it an sustainable resource even the road safety community based program is end but the still go on and on to prevent and protect their communities.

482. NGOs, CBOs, and any related institutions who worked in commune level: invite them to participant communities based road safety program to initiative their mind to develop road safety program for implementation at community level. Some existing NGOs who worked on road safety: Cambodia Red Cross, Handicap International, Asia Injury Prevention Foundation,

8.4 DATA COLLECTION

483. Before starting the Community Based Road Safety Program, the basic and related data collection is conducted. These are maps (topographical, road network and administrative boundary), population, school, number of students, health care center, and religion building, number of students, market, provincial data and road crash data. Road crash data is described in the next section in detail.

8.4.1 Population and geographic

484. The project road cover in four Province, six Districts and 14 Communes which there are 175, 963 people, 89, 941 are female, about 70 to 85 % are the farmers, factory workers and seasonal workers. The road is connect from place to place which link from rural area to urban area, the city or to other country, recently some roads could not access or difficult to transport the goods or travel during the raining season and the traffic volume still in low level.

Table 8.1 The province, District, Commune and number population

Province		District		Road length	Commune		Population	
Code	Name	Code	Name	Km	Code	Name	Total	F
N° 01, PR1534, 84.5km, From Tuek Phos to Pursat's roundabout (NR5)								
04	Kg. Chhnang	0408	Tuek phos	84.5	040807	Tang krasang	9,589	5,026
					040806	Krang Skear	15,015	7,626
15	Pursat	1503	Krakor		150304	Chheu Tom	15,805	8,054
					150310	Svay Sar	9,345	4,669
		1505	Pursat		150311	Thnoat Chum	14,250	7,139
					150506	Roleab	16,635	8,375
N° 10, PR312 , 28.4km, From NR01 to VN border								
14	Prey Veng	1419	Preeh	28.4	140907	Lvea	8,676	4,503

Province		District		Road length	Commune		Population	
			Sdach		140904	Chhey Kampok	11,831	6,158
					140901	Angkor Reach	12,613	6,472
					140902	Banteay Chakrei	15,347	8,013
N°15, PR23, 19.9km, St koh Thom Bridge to Peam Reang District								
08	Kandal	0804	Koh Thom	19.9	080402	Chhroy Takeo	9,543	4,984
					080403	Kampong Kong	13,991	6,965
					080407	Leuk Deak	15,755	8,209
		0805	Leuk Deak		080504	Peam Reang	7,568	3,748
	4	6		132.8	14		175,963	89,941

8.4.2 Type of transport

485. 97% are the two wheel vehicles, thus vehicle is called vulnerable vehicle among other type of transport and two wheel vehicles' fatalities represent about 76% of any vehicles in country data. Notice that the number of agricultural machine rapidly increase if compare to last few year, this type machine is used in field to plowing, harvesting and threshing in the field of agriculture but this type of machine are also used on the roads. Based on the road crash information these type of transportation are much involved with road crash due most machine is not equipped with safety equipment and the drivers mostly not appropriate with age and physical development.

Table 8.2 Number of vehicles along project rods

Type of transport	Kandal		Kampong Chhnang	Pursat		Prey Veng	Total	%
	Koh Thom	Leuk Deak	Tuek Phos	Krakor	Pursat	Preah Sdach		
Motorbike	20,391	5,514	11,270	9,869	8,656	11,823	67,523	42.65%
Motorbike-Trailer	52	71	15	58	53	100	349	0.22%
Small Trucks	250	67	74	91	87	54	623	0.39%
Heavy Trucks	118	73	28	67	135	86	507	0.32%
Mini Van	222	43	40	90	47	48	490	0.31%
Van	23	10	2	4	7	16	62	0.04%
Family Car	209	105	152	161	494	107	1,228	0.78%
Bike cycle	26,196	11,023	11,270	12,902	9,955	16,013	87,359	55.17%
Other vehicle	106	4	2	23	48	8	191	0.12%
Total	47,567	16,910	22,853	23,265	19,482	28,255	158,332	100.0%

8.4.3 School

486. Road safety knowledge should provide for school students since they are not yet a driver on the roads, or targeted for high school students which is the vulnerable road users, youth from 15 to 29 years old is high proportion of road crash. CBRS program need to integrate into the state school timetable to have a sustainable road safety for the school and hold communities, road safety also consider for safe school zone and parking area for the school along the road too.

Table 8.3 List of school along the project roads

No	Name of School	Kilometer post	Side	School categories
PR1534 (TeukPhos- Pursat)				
1	Kneang Primary School	27+100	R	Primary School
2	Kdol Primary School	33+860	R	Primary School
3	Damnakhlong Primary School	42+555	R	Primary School
4	Chheu Tom High School	45+790	L	High school
5	Chheu Tom Primary School	46+860	R	Primary School
6	Svay Sa Secondary School	52+975	R	Secondary school
7	Svay Sa Primary School	55+760	L	Primary School
8	O Chan Primary School	60+140	R	Primary School
9	Dambouk 100 Primary School	64+545	L	Primary School
10	Moly Thnal Bat Primary School	77+725	R	Primary School
Total	10			
PR23 (Koh Thom-LeukDaek (Kandal))				
1	WatChroy Primary School	8+760	L	Primary School
2	WatChroy Secondary School	8+760	L	Secondary school
3	ToulSleng Primary School	11+370	L	Primary School
Total	3			
PR312 (NR1 to BanteayChakrei (Prey Veng))				
1	Takok High School	00+125	R	High school
2	SeilaOdumPrimay School	2+680	L	Primary School
3	Chang Nang Primary school	5+185	L	Primary School
4	WatKandal Primary School	7+720	R	Primary School
5	Khmer - Japan friendship High school	9+000	L	High school
6	BramolPrum High School	10+665	L	High school
7	PurthiTatan Primary School	12+470	R	Primary School
8	BrabosRoluoy Primary School	17+700	L	Primary School
9	BanteayChakrei Secondary School	19+370	R	Secondary School
10	Sampoung Primary School	23+045	R	Primary School
11	BrahSva Primary School	25+900	L	Primary School
Total	11			
Sub	24			

8.4.4 Road Crash Data (RCVIS Annual Report 2014)

487. In 2014, 4,645 crashes and 15,315 casualties were reported. Among them, 2,226 were fatalities and 6,005 were serious injured. On average, more than 6 people died and 17 were injured every day. In Cambodia, there were 7.9 fatalities per 10,000 registered vehicles, a number higher than in Lao PDR (6.7) and Vietnam (2.0). Farmers represented the largest group of fatalities (42%), followed by workers (19%) and students (12%).

488. National roads accounted for the largest percentage of fatalities (66%), followed by local roads (16%). 70% of the total number of fatalities on national roads occurred on one digit national roads (National Road 1 to National Road 9). National Road 5 accounted for the highest number of fatalities (23%), followed by National Road 6 (15%). Compared to 2013, the highest increases in number of fatalities in 2014 were on National Road 8 (33%) and National Road 5 (29%). Remark: PR1534 is parallel with NR5, so after the improvement of this road the number of traffic is automatically increase and the road crashes will also increase in trend.

489. Children less than 15 years of age accounted for 8% of the fatalities, a number that increased by 16% compared to 2013. The following statistics are related to fatalities of children less than 15 years old:

- 61% of them were male;
- 42% of them were pedestrians, followed by motorbike riders (34%) and bicycle riders (11%);
- 49% of them were caused by speeding or not respecting the right of way (9%).

490. Road crashes affected the most economically active part of the population, mostly farmers, workers and students. In 2014, farmers represented the largest proportion of fatalities (42%), followed by workers (19%) and students (12%). The number of farmer fatalities has increased from year to year, from 703 in 2011 to 932 in 2014. Among student fatalities, university students accounted for 40% followed by primary school students (30%), high school students (18%), and secondary school students (12%).

491. Motorbikes play a very important role in day to day lives of the community in transportation. Motorbikes accounted for around 85% of the overall vehicle fleet in 2014. At the same time, motorbike riders were the most vulnerable road user group, which accounted for 73% of total fatalities, followed by pedestrians (10%) and those traveling by family cars (6%). Only 12% of motorbike drivers and passenger casualties wore a helmet while involved in a crash. 69% of the fatalities within motorbike drivers and passengers suffered from a head injury in the crash.

492. Over the last 4 years (2011-2014), regarding human error factors, speeding was the leading cause of fatalities in Cambodia. Unappropriated road improvement, lack for road safety education, engineering and low road safety knowledge could be contribute for road crashes.

493. The leading cause of fatalities could be attributed to the road improvements that took place throughout the country that allowed drivers to drive much faster and speeding. Limited law enforcement and public knowledge about road safety are other contributing factors. Compared to 2013, the number of fatalities due to speeding increased by 5%.

494. At the same year, in four improvement project roads which cover 132.8km there are 38 fatalities and more than 100 persons were injuries, most of them are farmer and two wheel motorbike users.

Table 8.4 The major road crashes statistics by provinces and city year, 2014

Province	Population	Fatalities	Fatalities rate per 100,000 pop	Fatalities rate age category (15-29)	motorbike fatality rate	Fatalities rate (2013-2014)	Remarks
Phnom Penh	1,770,131	249	14.07	57.83 %	86.30%	-12%	
Kampong Cham	1,743,280	217	12.45	41.47%	71.40%	16%	
Kampong Chhnang	535,439	109	20.36	42.20%	69.70%	24%	rapidly increase
Pursat	441,768	69	15.62	40.58%	55.10%	11%	
Prey Veng	981,943	136	13.85	43.38%	70.60%	27%	rapidly increase
Kandal	1,422,940	150	10.54	48.67%	78.00%	21%	rapidly increase

8.4.5 Road Crash Data in Project Area (customize report 2014)

495. Road crash is the leading cause of death in Cambodia, in 2014, about 464 persons died in project provinces, and 38 person died in project area, most of them are the motorbike users, famers, speeding is the main cause of death.

496. Below are the road crash statistics along the project roads year 2014:

Table 8.5 Consequence of injury on project roads, 2014

Provinces	N°	District	Road length	N°	Commune	Consequence of injury				
						Fatalities	Serious Injury	Slight Injuries	No injury	Unknowe
PR1534, 84.5km, St. Kampong Chhnang to Pursat's roundabout (NR5)										
Kg. Chhnang	1	Tuek phos	84.5km	1	Tang Krasang	3	5	5	0	0
				3	Krang Skear	6	12	1	0	1
Pursat	2	Krakor		4	Chheu Tom	6	3	1	0	0
				5	Svay Sar	1	4	1	0	0
				6	Thnoat Chum	4	5	11	0	0
				3	Pursat	7	Roleab	2	8	5
PR312 , 28.4km, st.NR01 to Vietnam border										
Prey Veng	1	Preah Sdach	28.4km	1	Lvea	2	8	8	0	0
				2	Chhey Kampok	0	4	1	0	0
				3	Angkor Reach	3	12	7	0	0
				4	Banteay Chakrei	4	8	1	0	0
PR23, 19.9km, St koah Thum Bridge to Peam Raing district										
Kandal	1	Koh Thom	19.9km	1	Chrouy Takeo	1	0	0	0	0
				2	Kampong Kong	2	1	1	0	1
				3	Leuk Deak	1	1	0	0	0
	2	Leuk Deak		4	Peam Reang	3	3	0	0	0
4	6	132.8	14	38	74	42	0	2		

Table 8.6 Number casualties by mode of transport on project road, 2014

Provinces	N°	District	Road length	N°	Commune	Number of casaulty by mode of transport						
						Motorbike	Pesestrian	Family car	Passenger vehicle	Goods vehicle	Agriculture vehicle	Other
PR1534, 84.5km, St. Kampong Chhnang to Pursat's roundabout (NR5)												
Kg. Chhnang	1	Tuek phos	84.5km	1	Tang Krasang	11	1	1	0	0	0	0
				3	Krang Skear	18	0	0	0	0	1	1
Pursat	2	Krakor		4	Chheu Tom	6	3	0	0	0	0	1
				5	Svay Sar	6	0	0	0	0	0	0
				6	Thnoat Chum	11	0	1	0	0	4	4
				7	Roleab	10	3	0	0	0	1	1
PR312 , 28.4km, st.NR01 to Vietnam border												
Prey Veng	1	Preah Sdach	28.4km	1	Lvea	10	1	1	1	4	0	1
				2	Chhey Kampok	1	1	0	0	0	0	0
				3	Angkor Reach	22	0	0	0	0	0	0
				4	Banteay Chakrei	10	1	0	0	1	1	0
PR23, 19.9km, St koah Thum Bridge to Peam Raing district												
Kandal	1	Koh Thom	19.9km	1	Chrouy Takeo	1	0	0	0	0	0	0
				2	Kampong Kong	5	0	0	0	0	0	0
				3	Leuk Deak	1	0	0	0	0	0	1
	2	Leuk Deak		4	Peam Reang	6	0	0	0	0	0	0
4	6	132.8	14	118	10	3	1	5	7	9		

Table 8.7 Number of casualties by occupation on project road, 2014

Provinces	N°	District	Road length	N°	Commune	Number of casualty by mode of transport										
						Farmer	Worker	Student	Child	House keeper/servant	Vendor/busines sman	Motor taxi driver	Car/Truck driver	Tourist/Expatriate	Government employee	Other
PR1534, 84.5km, St. Kampong Chhnang to Pursat's roundabout (NR5)																
Kg. Chhnang	1	Tuek phos	84.5km	1	Tang Krasang	6	1	6	0	0	0	0	0	0	0	0
				3	Krang Skear	17	1	0	0	0	0	0	0	1	1	1
Pursat	2	Krakor		4	Chheu Tom	7	0	2	1	0	0	0	0	0	0	0
				5	Svay Sar	3	1	2	0	0	0	0	0	0	0	0
				6	Thnoat Chum	12	0	4	2	0	0	1	0	0	0	1
				7	Roleab	9	1	1	1	0	1	0	0	0	0	2
3				Pursat												
PR312 , 28.4km, st.NR01 to Vietnam border																
Prey Veng	1	Preah Sdach	28.4km	1	Lvea	11	4	0	0	0	0	0	1	0	0	1
				2	Chhey Kampok	3	2	0	0	0	0	0	0	0	0	0
				3	Angkor Reach	18	1	0	1	0	0	0	1	0	1	1
				4	Banteay Chakrei	6	0	4	0	0	1	0	0	1	0	0
PR23, 19.9km, St koah Thum Bridge to Peam Raing district																
Kandal	1	Koh Thom	19.9km	1	Chrouy Takeo	1	0	0	0	0	0	0	0	0	0	0
				2	Kampong Kong	5	0	0	0	0	0	0	0	0	0	0
				3	Leuk Deak	2	0	0	0	0	0	0	0	0	0	0
	2	Leuk Deak		4	Peam Reang	6	0	0	0	0	0	0	0	0	0	
4	6	132.8	14	106	11	19	5	0	2	1	2	2	2	6		

Table 8.8 Number of casualties by human error on project road, 2014

Provinces	N°	District	Road length	N°	Commune	Number of Casaulty by Human Error							
						Over speedin g	Drink and drive	Not respect right of way	Dangerous overtaking	Change lane without due care	Change direction without due care	Other	
PR1534, 84.5km, St. Kampong Chhnang to Pursat's roundabout (NR5)													
Kg. Chhnang	1	Tuek phos	84.5km	1	Tang Krasang	7	0	0	0	0	0	6	
				3	Krang Skear	15	0	1	0	0	0	4	
Pursat	2	Krakor		4	Chheu Tom	8	1	0	0	0	0	1	
				5	Svay Sar	3	0	0	0	0	0	3	
				6	Thnoat Chum	20	0	0	0	0	0	0	
				7	Roleab	4	4	3	0	0	0	4	
PR312 , 28.4km, st.NR01 to Vietnam border													
Prey Veng	1	Preah Sdach	28.4km	1	Lvea	12	2	0	3	0	0	1	
				2	Chhey Kampok	1	0	0	0	0	0	0	
				3	Angkor Reach	8	11	0	0	2	0	1	
				4	Banteay Chakrei	5	7	0	0	1	0	0	
PR23, 19.9km, St koah Thum Bridge to Peam Raing district													
Kandal	1	Koh Thom	19.9km	1	Chrouy Takeo	0	1	0	0	0	0	0	
				2	Kampong Kong	0	3	0	0	0	0	0	2
				3	Leuk Deak	0	1	0	0	0	0	0	1
	2	Leuk Deak		4	Peam Reang	0	0	0	0	0	0	6	
4	6	132.8	14	83	30	4	3	3	0	29			

8.5 BASELINE SURVEYS

8.5.1 Purpose of Surveys

497. For more understanding of road safety issue, road safety program must conduct a finding to measure the knowledge, behaviors, attitude and understanding about what road safety program could provide as much as possible to fit the need in the communities. The findings of the initial assessment of the project area suggest a number of research or survey to be conducted to obtain reliable information relevant for designing Community Based Road Safety Program and evolution of the sustainable project. The same methodology should be keep for mid-term review or final assessment to make a comparison each stage, what road safety program should keep in touch with the issue need to adjustment for future project or better solutions.

8.5.2 Outline of Research/Surveys

498. Following surveys have been prepared and conduct with in future project that the data could be used for DDIS:

- **Villagers/ High school student's knowledge:** Helmet use, Speeding, Drink and drive, pedestrian safety, visibilities, and road crash along the roads.
- **Student knowledge:** pedestrian safety, cyclist safety and visibilities
- **Helmet survey:** the helmet wearing rate should be conduct to measure the wearing rate among the motorbike users among general people and student, helmet observation really useful if this observation could continuously measure such as every 6 months during the project implementation.
- **Pedestrian/ visibility survey:** the pedestrian safety and visibility observation could provide some information of their daily activities that the road safety program need to understand and make a positive change. Understanding their activities help to understand how the road users perceive dangers while walk/cyclist on the roads and give them some tips to be safe on the road.
- **School Observation:** the school survey provide clear information around the school, location information, behavior of road user in front the school, these information is very crucial for set up safety school zone and accurate information to produce the road safety curriculum for school students.
- **Black Spot Audit:** the black spot audit is the part of road safety and safety engineering it is a part of 5Es that contribute to reduce road crash and provide some information to design better road to have a safer road for road users.
- **Helmet Survey (roadside survey):** the helmet survey should be take place in following location:
 1. PR1534: Tang Krasang Commune, Tuek Phos District, Kampong Chhnang Province (PK 00+000 or NR 53), Chheu Tom Commune, Krakor District, Pursat Province(PK47+000), and Roleap Khan, Pursat Province (PK 84+500)
 2. PR23: Chhroy Takeo Commune, Kandal Province (PK00+000), Wat Chhroy (PK8+700) and Peam Raeng (PK 19+900)

3. PR312: Lvea Commune (PK 00+000), Trea Market (PK10+000)

8.5.3 Outcome of Surveys

499. Due the mobilization within short time the road safety based line survey will be delay to the next step early of DDIS.

8.6 APPLICATION OF 8 PILLARS OF NATIONAL ROAD SAFETY ACTION PLAN 2011 – 2020 TO CBRS ACTIVITIES

500. Road crashes had an enormous impact on the social economic and welfare of Cambodian with an estimated annual cost of millions USD, to reduce the road crashes and social economic lost the Government of Cambodia have produced the National Road Safety Action (2011- 2020) which aligned with the UN's Global Decade of Action for Road Safety, this action aim to save 7,350 lives on the roads about 50% of fatalities in year 2020.

501. The National Road Safety Action Plan 2011-2020 had eight pillars as following:

8.6.1 Pillar 1: Road Safety Management

502. Road safety is a multi-sector issue, and therefore requires a multi-dimensional management system that allows the responsible agencies to develop and implement appropriate strategies, policies and action plans and to coordinate the various actors involved in road safety at all levels. The lead agency for road safety management is NRSC, which was established in 2005. NRSC shall improve and ensure coordination and collaboration among road safety stakeholders and partners.

503. The Community Based Road Safety (CBRS) scheme also needs this management. The important of establishing CBRS is not only vertical relations but also horizontal relations between communes or villages, because CBRS cannot be conducted in all communes and villages in the project roads at for a long time, so the CBRS management should be established for a sustainable communities based road safety.

504. 5Es approach In the “five E” system, the five Es stand for Engineering (road engineering and vehicle engineering), Education (training, traffic education), Enforcement, Encouragement/ Enhancement and Emergency services, another E is sometimes added to the project system is Evaluation. In developed country, 3Es is the most common, Engineering, Education and Enforcement.

8.6.2 Pillar 2: Safe Infrastructure

505. Infrastructure plays a crucial role in road safety sector. Quality and forgive safe roads help road users travel safely and reduce potential risks to the lowest level by providing equipment and road furniture to ensure road safety is accordance with Internationally accepted standards and needs. Road infrastructure focuses mainly on vulnerable road users (motorbike riders, Motorized tricycle riders, pedestrian, cyclist, children and disable people).

506. Road infrastructure is the central element of a road transport system. It can be defined as the basic facilities, services and installations needed for the functioning of

transport on National Road, Provincial Road, Roads, and Streets. Road infrastructure is a wide area and covers land use and network planning, (re)construction and design of road sections and intersections, signing and marking, maintenance, and, last but not least, quality assurance procedures like safety audits, safety impact assessments and safety inspections. In general, the road infrastructure would need to be designed and operated in such a way that road users understand what they can expect and what is expected from them, taking into account the limited human information processing capacity and resulting mistakes human beings are capable of;

507. The engineering must focus on road lanes for heavy trucks and general vehicles, speed management especially in school area, buildup area, markets and public service center. Curb between main roads and connecting roads should be balance. Long distance road travelling, the road should have the road port for parking to relax;

508. Another essential element in safer road is the appropriate installation of road furniture such as road signs, signs posts, traffic light, road markings, road stud and special design at hazardous locations. Installation is not enough to reduce road crashes, good understanding of them by the people is the concern. CBRS can include activities to make the meaning of the road furniture easily understandable to the people along the project roads;

509. Approximately 25 schools located nearby or along the project roads, the engineering need to follow safe school zone standards by install the safe school zone furniture as much as possible. School area is a part of busy place when the school student leave the school at the same time, so the engineering better design a parking space for them and their parent, make sure that the people will not use the road surface where is so generous specially young students;

510. CBRS program must integrate the road furniture into the training program to let the people know about the meaning of road markings, signboard, traffic signs, guideposts, especially speed limit signage;

511. Stop signage on the connecting road must install to let the road users in loss of give ways rule have a space and stop before they come on the main roads;

512. Particular intersection and vulnerable area concern are:

- PR1534: PK 01+000 (three junctions), PK 84.5 (connected with NR 5)
- PR23: PK 00+000(head of Koh Thom Bridge), PK 8+570(head of Wat Chhroy Bridge) and End PK 19+900
- PR312:PK00 (junction of NR1), PK 8+600 to 10+700 (District center) PK 23+160 (sharp curve)horizontal grade at curve and PK 27+600 to 27+900 (heavy trucks parking area)

513. CBRS must involve with contractors to make sure during the construction, the traffic still accessible within safety both road users and workers who work on the roads; do the temporary sign are used and proper installation.

514. After the installation of typical road safety furniture, it is necessary to monitor the road and traffic conditions and to evaluate them with the participation of community members along the project roads and to improve continuously, if necessary.

8.6.3 Pillar 3: Safe Vehicles

515. Road crash prevention improvement and safety devices equipped within the vehicle can be minimize severe injuries and fatalities. Therefore, improvement quality vehicle inspections and prevention of the import of non-standards vehicles and illegally modified vehicles are the major concerns;

516. Fleet safety should be introduce to all institutions, companies, or NGOs to take the used motor vehicle to inspect every year as mention in the traffic law. Fleet safety team for each sectors should establish and train on road safety;

517. A simple daily vehicle check should introduce to all vehicle users, some parts are daily check or weekly check by him/herself that no need advance technology or expert. The daily check can help users to know the broken part or intent to break of vehicle before they use that can prevent them from road crash;

518. Most of used bike cycle, motor trailers and farm tractor are less visibility (reflective materials) at the night time, based on the road crash and victims information system (RCVIS) showed that the road crashed rapidly increate at the low light time (20% of fatalities occurred between 6pm to 8 pm);

519. Based on RCVIS in year 2014 the number of fatalities used bike cycle increased 47% compare to 2013. This number most occur in the community, at the primary school and secondary school about 80% of student used bike cycle mode for traveling;

520. CBRS program will led in safe vehicle in road safety program to let the school students and villagers to know about how to check the vehicles and promote to take their motor vehicle to take the inspection as well.

8.6.4 Pillar 4: Safe Road User Behavior

521. All road users are responsible for using the road safely as well as paying attention to other road users. To change some road users' behavior, attitude and to protect others vulnerable road users, education and Awareness should be taken place to minimized and changed accordingly. Road crash related risks and victims can be reduced to the low level by safe behavior education;

522. Some human error will be focus such as not wearing helmet, speeding, drink and drive, not wearing seatbelt, overloading, drive without driving license, walking along or crossing road for school children, villagers;

523. CBRS will be a key program which contribute road safety behavior changing for sustainable communities, A road safety education program will be design to fit the need of the community and align with risky behavior of road users. Peer to peer education, school based, communities based, mass media, campaigns program will be made by engaging with law enforcement for effective implementation;

524. Safe school zone program will be established for school children and pedestrian crossing mark will be install in area of buildup areas, markets for safe crossing. The tips for safety will introduced such as how to wear helmet correctly, how to walk along the road, where should be across the road, how to check the bike cycle, how to drive safety for bike cycle and motorbike and what should not be done on the roads. The parent of the school children will be promote to help their children when leave school, waiting space in frond school is the best place for children that not allow the standby on the road; selected school list and Safety School Zone (SSZ) show in Appendix G.

525. A training manual of road safety will be develop with target client and to fit the CBRS Program. How to develop and design road safety user behavior is presented in the detail below.

8.6.5 Pillar 5: Emergency Medical System

526. Emergency Medical System covers the major context such as trauma related emergency medical system. The ministry of Heath will improve the basis emergency medical service across the nation wide in order to provide the pre-hospital medical service on time and bring the road crash victims safely to appropriate hospital or health care center. The in hospital emergency section is a significant component of the emergency medical system;

527. 15% of the casualties were fatalities and 39% were severe injuries. Among fatalities, 69% of them died immediately at the scene of crashes, 24% died at a health facility, and 7% died during the transfer from the crash scene to a health facility, year 2014;

- Only 24% of the casualties were transferred to a health facility by ambulance; 58% were transferred by the private transportation,
- Only 8% of casualties could reach the first health facility in less than 30 minutes in Phnom Penh municipality, while this statistic was 10% in other provinces,
- In Phnom Penh, and other provinces, most of the casualties spent about 1-2 hours to reach health facilities,

528. The key principle is to provide initial stabilization of the injured party during the golden hour (i.e., the first hour after injury). Thus, a key priority in Cambodia is first aid trainings to first responders such as traffic police or community/village volunteers who live along the road or first person who reach the road crash victim;

529. Simple first aid treatment at the crash site helps many victims with serious injuries, especially on the local roads located far from the fully-equipped large hospitals. Many people die needlessly because of the insufficient first aid at the scene, slow transport to a hospital, and not enough medical help at the hospital.

8.6.6 Pillar 6: Law Amendment and Enforcement

530. The Road Traffic Law contribute frameworks for traffic police and other institutions responsible for enforcing the law to improve efficiency in compliance with traffic ruler and regulation. The law is enforced at a vigorous and sustainable manner to prevent major risk factors. One this is achieved, a change in road users, behavior can be observed, and a reduction in road crashes and victims can be achieved;

531. The CBRS program, in collaborate with local traffic police will conduct a training on new traffic law to local people, school students, teachers, commune councils to understand about new law or regulation for obeying and respecting. Respecting the traffic law is a main part of reduce the road crashes, severity of injuries or property damage, loss of outcome;

532. The enforcement could be implement successfully when the traffic police have some equipment and skill for supporting their activities, so the enforcement capability building and enforcement equipment such as alcohol analyzer, speed gun, con and strobe light are will provide due such things are limited in remote provinces and districts. Therefore, the collaboration between 3-Es (E1: Engineering, E2: Education and E3: Enforcement) and the participation of CBRS are more important in these local roads;

533. A sustained traffic law enforcement, together, effective legislation and enforcement will change road user attitudes and behaviors and reduce road crashes and casualties.

8.6.7 Pillar 7: Driver License

534. A driving license is a basic requirement for drivers and assurance for riders that the persons behind the wheel are fit to drive. Traffic law, road signs, guide posts, road marking, First aid respond, rights of ways, driving schools, competency of instructors must improve including driving test in the field. The driving practical test should be in accordance with international standard;

535. Driver licensing is a fundamental aspect of safe driving. Implementing a comprehensive training and testing system will ensure that there is a basic level of safety training before a driver gets on the road. In Cambodia, about 80% of the motorcycle fleet does not have driver's licenses;

536. Obtaining a driver's license is the only chance to get a road safety education, especially in the case of adults, in other countries. In Cambodia, most of the motorcycle drivers drive without driving license. This means that the non-licensed motorcycle drivers did not get a road safety education which could lead to risky driving behavior and ultimately cause a road crash. Therefore, the key to reduce road crashes is how to efficiently issue the motorcycle driving license to non-licensed drivers; recently the led of government announce no need for the driver below 126cc but above 125 cc must official got. And the driver below 126cc must set clear age and possibility to drive due road crash data showed that about 70% of motorbike riders fatalities are the below 126cc.

537. CBRS program will be coordinate with Land Transport Department to promote and find a better solutions how to provide a driving license for community motor drivers and car drivers who live in rural area which far from Land Transport Department.

8.6.8 Pillar 8: Management and evaluation on passengers and goods transport services

538. Management and Evaluation on transport safety is an ongoing measure for improve the safety of passengers and goods vehicles so as safety is ensured and trusted.

539. CBRS program will design a training for the driver of garment factory's worker, which recently the worker is the second leading fatalities by occupation.

8.7 COMMUNITY BASED ROAD SAFETY PROGRAM

8.7.1 Rationale

540. The participatory CBRS program will provide assistance to the local people to mitigate any adverse effects arising from the improvement of provincial road improvement project and to improve road safety (RS) in the project areas. Local communities located along the road project will become more vulnerable road users as the traffic volume dramatically increases after road was improved. The program will enable them to protect themselves and mobilize them to become road safety ambassador.

541. In particular road users aged 15 to 29 will be encouraged to participate and become volunteers, adding to long term sustainability and a peer education effect. Women will also best rongly encouraged to engage themselves. Farmers, workers and students are a further target group.

542. The CBRS program is divided in bellow segments:

- i. Preparation Phrase: Review of the road safety issues in Cambodia including the past and current programs (including planned future programs) that are in place, and address them; list of communes, schools, setup the road safety structure and identification of core working group, produce training manual/presentation, produce IECs materials and budgeting;
- ii. Capacity Building for core working group, Trainee of trainer, Peer to Peer education (see the framework);
- iii. Community Based Road Safety Education and Awareness activities;
- iv. School Based Road Safety Education and Awareness activities.

543. The production of appropriate IEC materials will be part of the program with samples provided in the DDIS. Training programs for teachers, trainers and other target groups will be drafted with the necessary space for adaptation. The focus will be on long term use to be cost effective. Information gathered during site visits is that there is a strong need for material. Materials chosen will be durable and suitable for multi users in different settings.

544. The CBRS program is aligned with National Road Safety Action Plan and Policy and the UN Decade of Action for Road Safety 2011- 2020 (World Health Organization)

8.7.2 Project Area

545. The Provincial Road Improvement Project area will consist of all communes along the project roads. It will be checked if further districts or communes are to be included as they have direct access to the project roads, thus the residents in these areas should be added as they qualify as regular users. The communes currently included are show in Table 8.9 to 8.12. A communes list is given below each of these geography detailing the population in each commune:

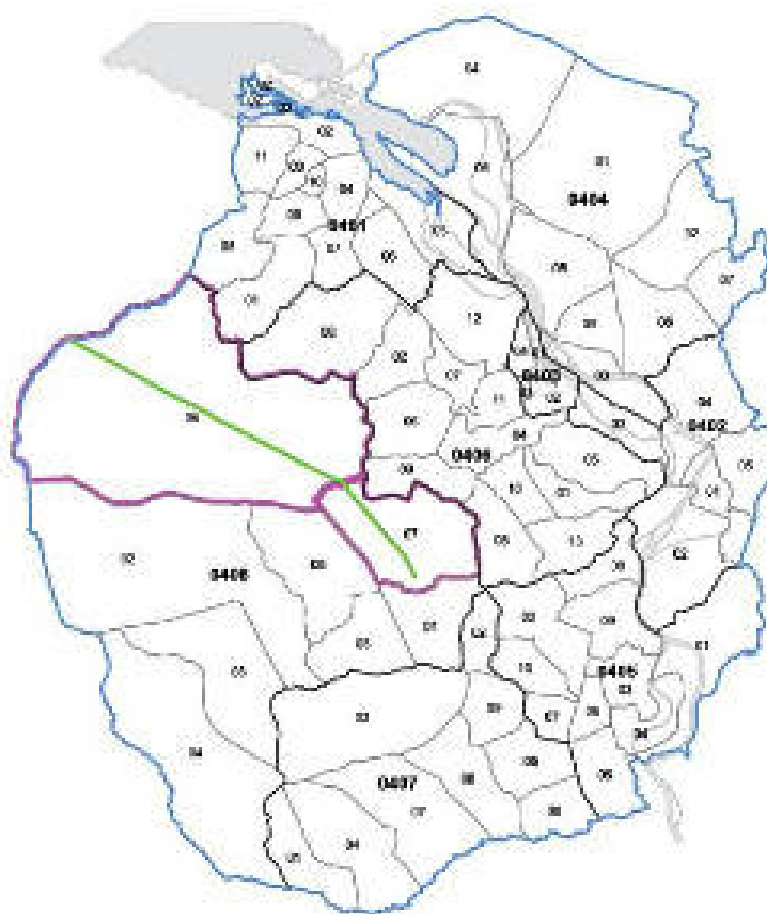


Figure 8.3 The road map along the communes in Kampong Chhnang Province

Table 8.9 Number of Population by Communes in Kampong Chhnang Province

Province		District		Road length	Commune		Population	
Code	Name	Code	Name	Km	Code	Name	Total	F
04	Kampong Chhnang	0408	Tuek phos	42+800	040807	Tang krasang	9,589	5,026
					040806	Krang Skear	15,015	7,626
Total Population							24,604	12,652

Source: Provincial department of planning, Ministry of Planning, 2014

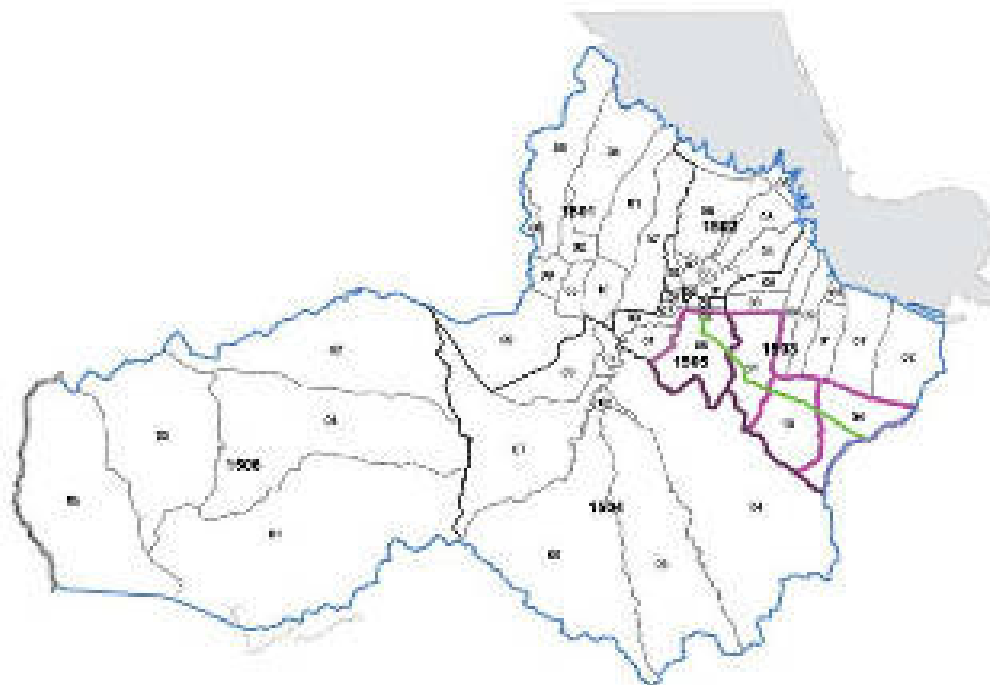


Figure 8.4 The road map along the Communes in Pursat province

Table 8.10 Number of Population by Communes in Pursat Province

Province		District		Road length	Commune		Population	
Code	Name	Code	Name	Km	Code	Name	Total	F
15	Pursat	1503	Krakor	41+700	150304	Chheu Tom	15,805	8,054
					150310	Svay Sar	9,345	4,669
					150311	Thnoat Chum	14,250	7,139
		1505	Pursat		150506	Roleab	16,635	8,375
Total Population							56,035	28,237

Source: Provincial department of planning, Ministry of Planning, 2014

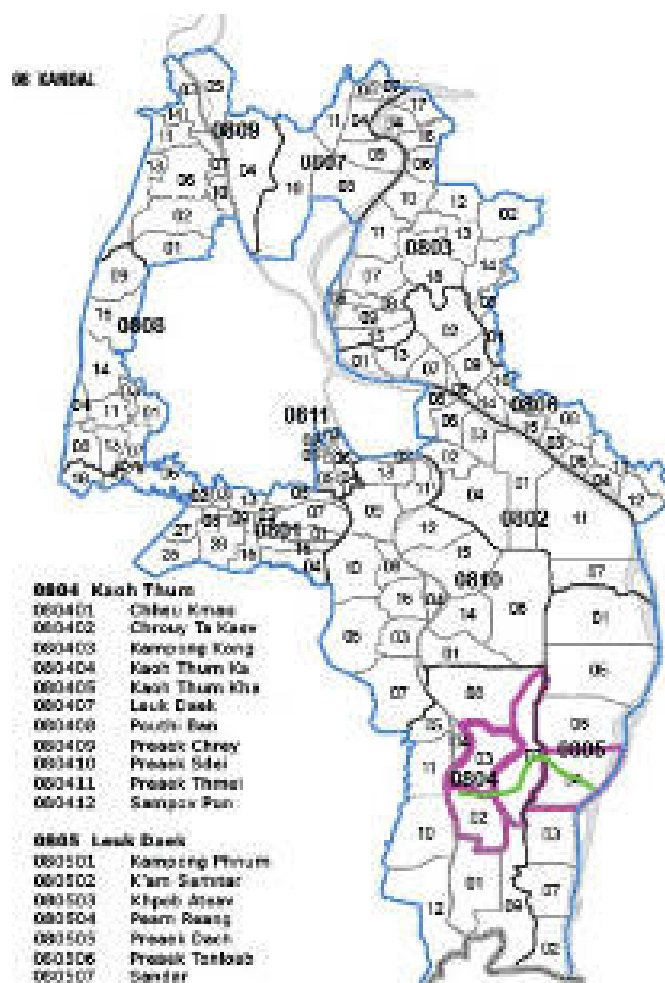


Figure 8.5 The road map along the Communes in Kandal Province

Table 8.11 Number of Population by Communes in Kandal Province

Province		District		Road length	Commune		Population	
Code	Name	Code	Name	Km	Code	Name	Total	F
08	Kandal	0804	Koh Thom	19+900	080402	Chrouy Takeo	9,543	4,984
					080403	Kampong Kong	13,991	6,965
					080407	Leuk Deak	15,755	8,209
		0805	Leuk Deak		080504	Peam Reag	7,568	3,748
Total Population							46,857	23,906

Source: Provincial department of planning, Ministry of Planning, 2014

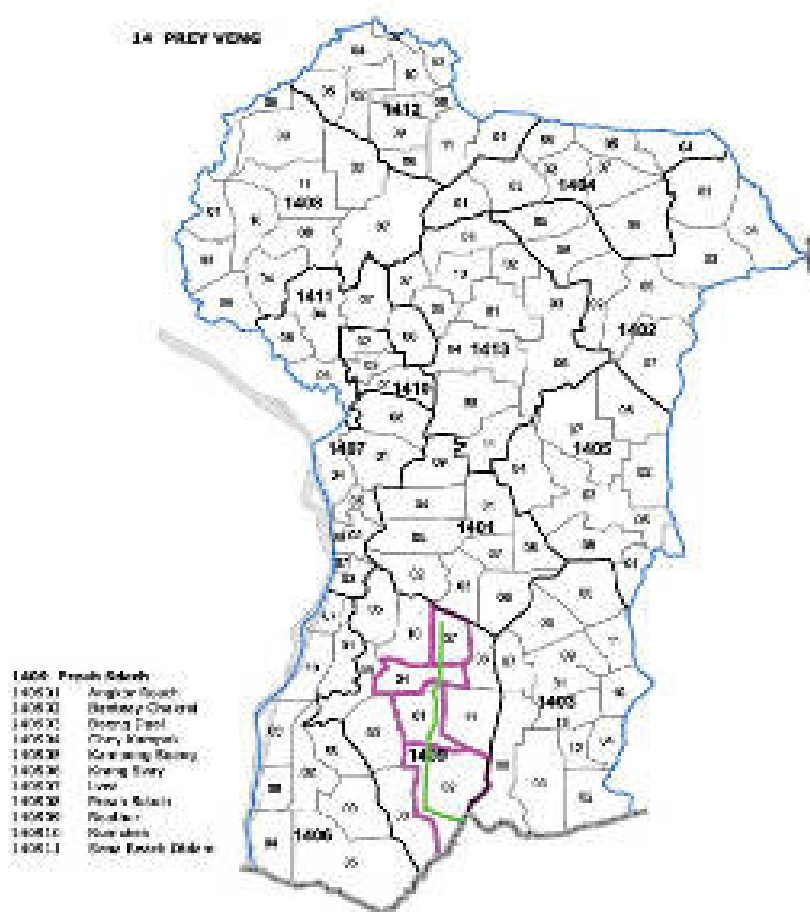


Figure 8.6 The road map along the Communes in Prey Veng Province

Table 8.12 Number of Population by Communes in Prey Veng Province

Province		District		Road length	Commune		Population	
Code	Name	Code	Name	Km	Code	Name	Total	F
14	Prey Veng	1419	Preeh Sdach	28+400	140907	Lvea	8,676	4,503
					140910	Chhey Kampot	13,991	6,965
					140901	Angkor Reach	12,613	6,472
					140902	Banteay Chakrei	15,347	8,013
Total Population							48,467	25,146

Source: Provincial department of planning, Ministry of Planning, 2014

8.7.3 Objectives

546. The CBRs Program aims to:

- i. Raise the awareness of road safety for all road users in targeted area
- ii. Work with local communities, local authorities and their members, in particular youth and women to become agents for promote road safety, and
- iii. Support the commune council in developing appropriate road safety plan and coordination system based on accurate and relevant information.

8.7.4 Preparation Phase

547. The finding some exiting information from the communities and related stakeholders is the core value to develop a sustainable communities based road safety program in Cambodia, the National Road Safety Committee was established since 2005 which was structured from national level to provincial level, in 2015 the Royal Government of Cambodia just restructured the National Road Safety Committee (NRSC) by a Sub-degree number 84. The current NRSC has three sub committees, one General Secretariat of NRSC and one Provincial Secretariat. Currently the Ministry of Interior also integrate one road safety component of nine issue into the Villages and Communes Safety Policy, National Road Safety Policy, National Road Safety Action Plan, all these elements could fruitful as sustainable road safety program to save life on the roads network in Cambodia;

548. The target communes, schools, market, health centers, and buildup area are listed to make sure who will be get the benefit and affect from road crash after the road infrastructure was improved, they are the vulnerable road users if they not get any information to change their behavior due the lack of road safety information,

549. Based on this background the CBRs institutional team would be set up in the initial phase of project implementation will consist of two targeted advised and supervised by the CBRs coordinating team and will be gender-focused. The districts, communes and villages are either on or adjacent to project roads.

- i. CBRs coordinator team: the team will be led by one project manager and two facilitators who have experiences in road safety education and awareness in the communities. This team will be work closely with communes chief and school director to promote road safety in place, and coordinate with districts, communes/commune council officer;
- ii. Commune facilitator: who are responsible for planning and coordinate of CBRs activities and link to the CBRs coordinator team. Thirty per cent (30%) of the facilitators are female. Two members are to be assigned to participate in meetings of and report to road safety facilitator;
- iii. Village volunteer: who will undertake various tasks including giving regular advice to road users or roadside communities and conducting observation in villages. Forty per cent (40%) are females and majority of them are youth. Two members are to participate at the commune level meetings, training or event both in village and schools.

- iv. School facilitator: who are responsible for planning and coordinate of CBRS activities in school with support from road safety facilitators. Thirty percent (30%) of the facilitators are female.
- v. Peer to Peer educator: who will undertake various tasks including giving regular advice to other school children, families, communities and conducting observation in villages. Forty percent (40%) are females. Two members are to participate at the commune level meetings, School training program and event both in villages and schools.

550. Effective Information, Education and Communication (IECs) materials are an important component of the comprehensive Road Safety Education program which will implement with the help of the Road safety to sustainable project. The most effective IECs materials are relevant and tap into interests of the local population. In addition, effective materials are clear, communicate specific messages, and are easily remembered. There are some materials such as printing materials and mass media.

551. Financial resource is a crucial for the effectiveness of CBRS. Therefore, the resource allocation process always needs to be part of a road safety program. Conversely, resource allocation processes should be linked to specific goals for road safety in order to achieve a maximum benefit of the funds which are allocated in the process. Preconditions for resource processes are a long enough timeframe and sufficient budgets.

552. The decision on the institutions to be involved is not finalized yet. The institution selected will have previous experience with community-based programs, a strong presence in the provinces of the project areas and be able to mobilize and train volunteers accordingly. Education and health sectors will be included long-term and sustainable project are targeted.

8.7.4.1 CBRS institutional Structure

553. Cambodia developed the national road safety structure (NRSC, national road safety action plan, policy, strategy, Traffic law) aim to reduce road crash and save live on the road aligned with UN Decade of Action. The decentralization of the structure is a fundamental step to ensure long-term sustainability at grassroots level.

554. Road safety will become a task of local authorities and be included in the annual commune action plans, Commune Investment Program (CIP), reflecting the local situation. The local action plans are part of the decentralization strategy of the Cambodian government and can be submitted to the higher level for approval and funding, although financial constraints are responsible that plans are not fully implemented.

555. The road safety training provided to district, commune authorities and village chief will be a catalyst to enable local communities to draft and implement their own road safety interventions with the help of the activities offered in the CBRS program.

556. Please confirmed that the director of Land Transport Department is the director of Provincial Road Safety Secretariat, so CBRS program is also a part of Secretariat's responsibility too, the provincial RS secretariat meeting would be arranged to integrate CBRS program in road safety action.

8.7.4.2 CBRS Coordinating Team

557. The CBRS coordination team at the central level should be targeted, this team will help to provide support and coordination to all levels below.

558. An overarching team at central level is essential as the project roads are in different areas / provinces and are also recipients of some shared interventions (capacity development, campaigns, RS show...). With a high likelihood of extending the CBRS program further and as there are already CBRS activities ongoing by the experiences NGOs, Non NGOs or any institution, it will also be necessary to have a central CBRS team for overall coordination. Ideally, the CBRS management team should be based with Secretariat of Provincial Sub Road Safety Committee (SPSRSC)

559. There is a possibility of outsourcing a sizeable section of CBRS to an implementing partner (CRC, HI, SPSRSC and UYFC) or assign this to trains and surveys.

560. This team will also have a strong advisory function. It will consist of 2-3 people (government staff from GNRSC and Education or Health Department). This team will receive initial training on road safety, CBRS and monitoring & evaluation). It will be responsible for:

- i. Facilitating capacity development for Commune / village levels conducted by outside trainers where applicable;
- ii. Assisting with commune road safety action plans (which are to be integrated into the annual overall action plan of the commune);
- iii. Providing advice to the teams in the field; and
- iv. Monitoring and evaluation activities.

8.7.4.3 CBRS Facilitators by Communes

561. Commune level CBRS facilitators will be responsible for coordinating road safety interventions of all villages, in particular campaigns and enforcement. Basic road safety training will be organized for commune level authorities to increase their understanding of the issue. This may comprise:

- i. Coordinate the meeting or training with commune council, related office in the commune, media, also;
- ii. Coordinate the training within the villagers;
- iii. Assigned village staff (see below), one person per village;
- iv. Traffic police are also to be involved.

8.7.4.4 CBRS Facilitators by School

562. School CBRS facilitators will be responsible for coordinating road safety interventions of all school in the communes, in particular training, campaigns and enforcement. Basic road safety training will be organized for school director, school teachers and student to increase their understanding of the issue. This may comprise:

- i. Coordinate the meeting or training with school program, media, also;

- ii. Coordinate the campaign within the school;
- iii. Assigned Peer to Peer educator (see below), or manage student club for road safety;
- iv. Traffic police are also to be involved.

8.7.4.5 CBRS Volunteers

563. The volunteers are from two sources: villager, village authorities and schools. The school pillar will be particularly important as students will be lifelong road users. A strong involvement in schools will pay off in the long-term, as these students will be the first generation growing up with awareness road safety. The number of volunteers will depend on size of village and number of student each school. They will comprise:

- i. Village chief or deputy must be part of volunteer team as a facilitator and represents his village at commune level,
- ii. Villager volunteers,
 - number will depend on village size
 - He/she could be village chief or villager who have the house nearby the road and willing to contribute his/her time on road safety
 - will organize all RS activities at his/her village
 - will be responsible for contribute IECs materials to any other villagers
- iii. School director or deputy, one teacher of each school on village grounds. They will organize all RS activities at the school and will be responsible for student volunteers
- iv. Student volunteers
 - number will depend on the total number of students (approx. one volunteer per 100 students to keep workload reasonable)
 - He/she will involve over one school term to organize event and training program
 - Manage peer to peer education in class or outdoor within student club
 - Student volunteers can also be active as community volunteer

8.7.5 Activities

564. The activities suggested for the CBRS program are listed and described in Table 8.13 below. The table only includes activities taking place after the preparation phase with the exception of the CBRS;

565. There are further important safety issues which cannot be covered within this CBRS structure. The 'toolbox' approach of the program allows flexibility to develop additional training modules or design activities with the help of the templates.

Table 8.13 CBRS activities proposed

N°	CRBS by Pillar	Activities	Remarks
1	Road Safety Management	<ul style="list-style-type: none"> - Identify and build up road safety core working group in National, districts and communes level, - Allocate financial resource through action plan - Strengthening core working group through training, meeting, events, exchange program - Make sure the CBRS program are aligned with National Road Safety Action Plan - Build up the collaboration with local and international resource, NGOs, CBOs, Government sector and private sectors - Provide information and analysis risk factors to develop sustainable project, plans and out come - Provide road crash evolution to counterparts and related projects - Conduct regularly research on road safety issue, behaviors change, and risks - Organize road safety events follow the National and international calendar 	
2	Safe Road Infrastructure	<ul style="list-style-type: none"> - Road Safety audit all provincial road improvement project - Work with road engineering to design safe school zone and parking zone around school area - Review the black spot and road risk in junction road, markets, schools, buildup area, or public service center - Integrate slowdown area to reduce speed in select area - Make sure all road sign plates , road markings, guideposts, guiderails and other necessary road furniture are properly install - Integrate the transport safety system approach into the project especially parking system in school, market area - Audit road safety in accordance with sustainable safety approaches in the period of geographical study, road planning, and construction period and post construction. 	

N°	CRBS by Pillar	Activities	Remarks
3	Safe vehicles	<ul style="list-style-type: none"> - Develop simple vehicle technique checklist for bike cycle and motorbike users - Raise awareness to vehicles users to inspect their vehicle regularly - Real practice on checking vehicle check list 	
4	Safe road users behavior	<ul style="list-style-type: none"> - Develop road safety education and awareness tools and materials - Develop action plan and integrate the action plan into activities - Organize road safety seminars, events(road safety week and World Day of remembrance) and campaigns (main holidays) - Training CBRS core working group, CBRS commune level, CBRS School level, volunteers on high risk factors - Develop safe school zone and speed enforcement around school including parking space for parent who come to take their children - Organize road safety show by commune during mean holiday - Organize training for farm tractors, garment factory car drivers - Enhancing the pedestrian safety for villagers and students 	arking space is a new model it should be one or two school with primary or secondary school which have more than 300 student that the gate allocate along the project road as the pilot.
5	Emergency medical System	<ul style="list-style-type: none"> - Build up the capacity of the traffic polices, school teachers, school students and villagers on First Aid skills - Strengthening the local resource on how to protect road crash victims at the crash site - Integrate the contact number of appropriate referral or health care centers into the training materials 	
6	Law amendment and enforcement	<ul style="list-style-type: none"> - Integrate the amendment traffic law into the training manual - Integrate the traffic police as the core working group and capacity building - Provide the law enforcement equipment to the traffic police - Support and encourage the traffic police enforce the traffic law in the commune based on risky factors such as drink driving, helmet wearing and speeding 	

N°	CRBS by Pillar	Activities	Remarks
7	Driving License	<ul style="list-style-type: none"> - Promote the car drivers to get the driving license through training and testing - Promote the driving license conditions, age of drivers, capacity of motor vehicle (cc) - Engage the land transport department to issue the driving license for local commune car drivers 	
8	Management and evaluation on passengers and goods transport service	<ul style="list-style-type: none"> - Working with each land transport department to promote safety passengers transportation especially garment factory car drivers 	

8.7.6 CBRS Program

566. Table 8.14 shows the CBRS program based on the road safety experiences, data collection, interviews with stakeholders and the CBRS activities described in Table 8.13. In coming up with the CBRS program, a selection is made from among the programs that had already been conducted in Cambodia by road safety specialist, NGOs and stakeholders, to try to maximum the use of existing resources aim to promote roads safety through nation wades. Following is the outline of the program:

8.7.6.1 Public Event program:

- **Road Safety Week:** road safety week is an international event which most country celebrate during April each year by government, NGOs in collaboration in local resource; in Cambodia this event is organize on Sunday, first week of April before Khmer New Year which the government take this event to promote, alert and aware the road users to respect the traffic law, drive carefully due road crash rapidly increase during Khmer New Year.
- **The World Day of Remembrance for Road Crash Victims (WDR):** is commemorated on the third Sunday of November each year to remember the many millions killed and injured on the world's roads, together with their families, friends and many others who are also affected. In Cambodia the Royal Government of Cambodia also assigned Sunday, third week of November to organize such event aim to alert all road users to prevent themselves from road crash which was the intention of United Nation and Royal Government of Cambodia to save life on the road networks.
- **Road Safety Campaigns and Events:** Based on Road Crash and Victims Information System, the road fatalities, number of road crash rapidly increase during publish holiday such as Chinese New Year, Khmer New Year, Pchum Ben and Water Festival, so during this event, the Royal Government of Cambodia always concern about safety of the people who will be travel on the roads, during this time many people move from one place to another place for their purpose

some go to homeland, some go for country visit which make the traffic flow very busy on the roads. During this time, especially the General Secretariat of NRSC always conduct a road safety campaign to promote road safety through many types mass media and direct distribution the IECs material and road safety key messages to all road users.

8.7.6.2 Communes and schools program

567. Follow the International and national action plan, the CBRS will design a best practice of road safety education and awareness fit to the need and local resource for the communes along the roads;

▪ **Commune activates:**

- High risk factors on road crashes will be train for commune councils and villagers,
- Drama show for villagers
- Filming on road crash victims and road safety behavior will be produce and display
- Road safety campaign at the market will be arrange during the main event of the years
- Farm tractor/car drivers will be train on high risk factors
- Reflective material are also provide to the farm tractors

▪ **School activities:**

- High risk factors on road crash for student will be train to school teachers and students
- The drama show for students
- Peer to peer education activities will be introduce and guide the student club to take action
- Road safety play ground is also integrated
- Parking space in front of school will be integrate into annual school action plan and DDIS
- Installation of road safety information board in the school for contribute the road safety information of posters or leaflets

568. The IECs materials will be contribute during each event and activities to encourage the participant such as helmets, T-shirt, bag, posters, leaflet, reflective tape... all this material will be printed in ADB, MPWT logo.

Table 8.14 CBRS program proposed

Pillars	N°	Activities	Activity type(6Es)	Calendar	Responder	Involved	Venue	Target	Topic	tools and materials	Remarks
1	1	Road Safety Week (RSW)	Education	April	GSNRSC	NGOs, PWTD, CBRS team, Private sectors	National	All road users	Follow National title	Agenda, IECs material, Helmet, T-shirt, social media	
	2	World Day of Remembrance(WDR)	Education	November	GSNRSC	NGO, PWTD, CBRS, Private sector	National	All road users	Follow National title	Agenda, IECs material, Helmet, T-shirt, social media	
	3	Identify project geography and commune characteristics	Enhancement	Early of Project	RS expert	Commune chiefs and school directors	Project roads	All road users	Communes, schools, markets, population and road crashes	list of communes, schools, and population	
	4	CBRS monitor and evaluation	Evaluation	Scheduling	Research team	RS expert/communes/villager/student	Project roads	Villagers and students	Risk factors and behaviors	questionnaire, support resource	
	5	Coordination among stakeholders	Enhancement	hold project	CBRS team	stakeholders	Project roads	Stakeholders	Good communication	communication	
2	1	Road safety audit of road improvement project area	Engineering	Early of Project	RS expert	Engineering	Project roads	All road users	Black spot and risky area	checklist and maps	
	2	Set up Safe school zone and park space for schools and markets ...	Engineering	Early of Project	Engineering	RS expert/ commune/ school director/market	Project roads	Students and villagers	safe school zone	road furniture and training program	Newly Proposed
	3	Proposed road signs	Engineering	Early of Project	RS expert	Engineering	Project roads	All road users	road signs	traffic signs manual	
	4	Review and audit road safety during planning, construction, and post construction period	Engineering	Scheduling	RS expert	Constructors	Project roads	All road users	Risks factors and safety	transportation, and checklist form	
3	1	Develop Simple vehicle check list for bike cycle and motorbike	Education	Scheduling	RS expert	PWTD, PMU, Villagers and student	Project roads	cyclist and motor riders	vehicle part checklist	checklist form	
	2	Training and practice on how to check the safety part on vehicles	Education	Scheduling	CBRS team	Vehicles users	Project roads	Vehicles user	Check parts of vehicles	Vehicles and checklist form	Newly Proposed
	3	Encourage the motor vehicles users to take inspection	Education	Scheduling	CBRS team	PWTD, Motor vehicles users	Project roads	Motor vehicles users	Inspect the motor vehicles	Communication	
	4	Stick the reflective sticker on vehicles	Education	Scheduling	CBRS team	communes, vehicle users	Project roads	Vehicles users	visibility	Reflective stickers	
4	1	Develop road safety education and awareness tools and materials	Education	Scheduling	RS expert	PMU3, ADB, stakeholders	Project roads	Communes	High risk factors	Presentation, IECs materials, Laptop, Projector, speaker	
	2	Organize road safety seminars, events and campaigns	Education	Scheduling	CBRS team	Commune chiefs and school directors	Project roads	Villagers and students	High risk factors	Sound system, IECs materials, Prize	
	3	Training Road Safety Program	Education	Scheduling	CBRS team	Commune council, school director and teachers	Project roads	Villagers and students	High risk factors	Presentation, IECs materials, Laptop, Projector, speaker	
	4	Develop safety school zone and enforcement around schools	Education	Scheduling	CBRS team	School directors and police	Project roads	All road users	Slow down area	Training manual, and safety school zone standard	
	5	Organize road safety show	Education	Scheduling	CBRS team	Commune chiefs and school directors	Project roads	Villagers and students	High risk factors	Sound system, IECs materials, Prize, show team	Newly Proposed
	6	Install road safety information banners and boards	Education	Scheduling	CBRS team	Communes and schools	Project roads	All road users	High risk factors and penalty price	Print PVCs and boards	
	7	Organize road safety training for farm tractor users and factories car drivers	Education	Scheduling	CBRS team	Commune chiefs and car driver association	Project roads	farm tractor users and car drivers	High risk factors	Sound system, IECs materials, Prize, show team	
5	1	First Aid Training Program	EMS	Scheduling	EMS team	CBRS team, commune and schools	Project roads	Police, villagers and students	secure the road crashes victims	First Aid Kits, FA specialist	Newly Proposed
	2	Training the village and student on how to protect the road crash victims on crashsite	Education	Scheduling	CBRS team	Commune and school directors	Project roads	Villagers and students	secure the road crashes victims	Presentation, IECs materials, Laptop, Projector, speaker	
6	1	Training on amendment traffic law	Education	Scheduling	CBRS team	Commune and school directors	Project roads	Villagers and students	related traffic law and penalty	Presentation, IECs materials, Laptop, Projector, speaker	
	2	Provide law enforcement equipment	Enforcement	Scheduling	CBRS team	PMU3, Communes	Project roads	Traffic Police	Materials	Equipment	
	3	Support the traffic police to enforce the traffic law in commune level	Enforcement	Scheduling	traffic police	Commune, road users	Project roads	All road users	Helmet, speeding and drink and drive	Equipments, traffic polices	
7	1	Training on driving license conditions and penalty	Education	Scheduling	CBRS team	communes and schools	Project roads	Villagers and students	Driving license conditions	IECs materials	
	2	Encourage the PWTD to issue the driving license for commune level	Enhancement	Scheduling	PWTD	CBRS team and commune and school directors	Project roads	Motor vehicles users	have a legal license	Testing field, Motorvehicles	
8	1	Promote transport safety for passenger and goods transportation	Education	Scheduling	CBRS team	PWTD, passengers and goods transport drivers	Project roads	passengers and goods transport drivers	High risk factors	IECs materials,	

Table 8.15 Road safety feasibility and implementation schedule

N°	Description	Road	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	Feasibility study	PR1534, 23, 312	x								
2	Loan signing	PR1534, 23, 312		x	x						
3	DDIS	PR1534, 23, 312			x						
4	Procurement	PR1534, 23, 312				x					
5	Construction	PR1534				x	x	x	x	x	x
		PR23				x	x	x	x		
		PR312				x	x	x	x	x	
6	CBRS Program										
	Feasibility study	PR1534, 23, 312	x								
	CBRS Program design				x						
	Produce and print material								x		
	Implementation CBRS					x	x	x	x	x	x

Notice that the road safety education program may extend depending on the extension of construction period too.

8.8 SUSTAINABILITY

569. The goal of inherently or sustainably road safety is to prevent road crashes and, where this is not possible, to reduce the chance of severe injury to zero. We can achieve this by means of a proactive approach with human as the measure of all things' as a starting point. This approach recognizes people's physical vulnerability, but also what they are capable of (people make errors, after all) and what they are willing to do (people do not always abide by the rules). In the first place, the surroundings, such as the road and the vehicle, must be modified to meet these human characteristics. In addition, education should optimally prepare people for the traffic task and their final behavior must be checked.

570. The sustainability of the road safety interventions through and around the CBRS program will be achieved as follows:

- **Institutional sustainability:** will be achieved using existing structures and anchoring road safety into the district and commune action plans. Government stakeholders will be included at all levels. In particular, schools will be involved through the RS focal point, usually a teacher, and students becoming volunteers. Civil society organizations are a support for the funded period and will assist in creating the localized structure.
- **Policy sustainability:** The program is in line with Cambodia's National RS Action Plan 2011-2020, supporting its long-term goals. It will be replicable as a whole or in sections, providing a blueprint that can be adjusted. The toolbox approach will ensure the quality of materials and activities. The activities will be impact-driven. Training and capacity development for all levels are included. In particular, the competencies in road safety of relevant government staff in the project area will be built.

- **Principle Sustainability:** Road crash is the main concern of The Royal Government of Cambodia, it is a tragedy of welfare which impacts the development goal, so for a sustainable road safety for road users, the government should integrate road crash into the Millennium Development Goals (MDGs) which is a long-term sustainable development goal.
- **Financial sustainability:** will be achieved with the involvement of a strong non-governmental partner with the ability to receive further funding and with a long-term vision. Cost-effective activities will be designed. The involvement of sponsors will be considered. The long-term benefit will be a reduction of the costs of road crashes to society.
- **Sustainability through synergy:** will be achieved with different stakeholders bringing in their strengths and information sharing. This will be through new or existing networks like the road safety committees at provincial and district levels. Road Safety training can be outsourced to a specialized organization.
- **Cultural sustainability:** The program will be culturally sensitive as a Cambodian team designs detail and pretests all components in the field. A logo will lead to strong identification of the target population with the CBRs program.

8.9 MONITORING AND EVALUATION

571. Road safety education seeks to bring about change in knowledge, attitude or skills related to being safe and making sure others are safe on the road. It can be delivered in many ways. A key role of road safety education is to raise awareness of road safety as a personally relevant issue to make sure the how frequency of change we need to make a series monitoring and evaluation to measure the extent to which a program has met its goals and objectives.

572. Monitoring and evaluation of the CBRs program will be done in different ways. Regular repeated surveys or questionnaires before, during and after activities would verify change or the effect of activities. Road crash data of the project areas will also be used for monitoring. Reports and work plans give information on progress.

573. There are some steps in the monitor and evaluation process:

Step 1: Identify the program goals and objectives

Step 2: Choose the best method of evaluation

- Define the objective of the monitor and evaluation
- Plan your monitor and evaluation
- Key questions for your monitor and evaluation

Step 3: Choose how will collect the information

- Possible data collection methods,
- Ethical considerations

Step 4: Carry out the monitor and evaluation

- Collect data/information
- Analysis the data/information
- Interpret the results

Step 5: Report on your findings

574. Road safety monitoring and evaluation must process since the beginning of the project, Based line survey, mid –term review and final evaluation. In each term the questionnaire should be the same, that we can measure the evolution and impact of road safety program. The monitor and evaluation should addressing as following:

- i. Assessment of the impact of the CBRs program;
- ii. Assessment of whether adjustments are necessary;
- iii. Review if the institutional setup and trainings are appropriate;
- iv. Assessment of whether activities and tools are relevant to context, culturally appropriate and cost-effective; and
- v. Assessment of whether further RS features are to be addressed.

575. Note only road safety education need to monitor and evaluation but road infrastructure and construction site also not need to monitor and evaluation regularly to make sure a life cycle of project road improvement is sustainable and the people who travel and live along the road are safety and benefit.

8.10 ROAD SAFETY FACILITIES ON THE PROPOSED ROAD

8.10.1 Introduction

576. Recently, More than 1.2 million people die each year on the world's roads, making road traffic injuries a leading cause of death globally. Most of these deaths are in low- and middle-income countries where rapid economic growth has been accompanied by increased motorization and road traffic injuries. As well as being a public health problem, road traffic injuries are a development issue: low- and middle income countries lose approximately 3% of GDP as a result of road traffic crashes.

577. In Cambodia, about 6 persons died every day on the road networks, road crash resulted from many factors, road infrastructure is one of main caused after the human error. The development of infrastructure in rural area make a change for people who live along here, many such areas have had a large traffic growth. Neither the road infrastructure nor the buildings and surroundings are however prepared for handling the problems increasing traffic is bringing about. Those zones aim at improving the environment for residents, pedestrians, cyclists, motor rider and the cityscape as a whole. Road safety may be improved as well to protect and save their vulnerable road users' live.

8.10.2 Road Safety Audit

578. Road safety audit is proactive road safety management. An audit deals with the design of new or reconstructed roads. The purpose is to make new, reconstructed and existing roads as safe as possible before construction is started and/or road crashes rapidly occur. Road safety audit focus solely on road safety without regard for other possibly conflicting objectives.

579. Road characteristic inspected: a sustainable road safety for community, the understanding of road characteristic is the key concept. The geography of road, people, schools, markets, build up area are the elementary to road safety, number of road crash was clarify by local authorities or villagers, where, when, why, how and who much involved with road crashed at place. The numerous of road fatalities called black spot, road safety expert and designer need to make a change after road was constructed or reconstructed.

580. Black Spot Audit: Black spot treatment aims at identifying, analyzing and improving roads at places with a concentration of road crashed by improving road design or traffic regulation at such spots in order to reduce the expected number of crashes.

581. In rural areas, road crashes often cluster at specific places. These are often junctions or straight road, but may also be private access roads, curves, railway, highway level crossings, narrow road stretches or bridges, the clustering of road crashes may be avoided or reduced by improving road design or installing road furnisher properly.

8.10.3 Road Signs

8.10.3.1 Road Signs Plates

i. Prohibitory signs (Speed Limit Signs)

Prohibitory signs are used to prohibit the drivers must or must not be made. If the drivers saw these signs must follow,

Speed limit: A driver usually wants to get from place to place using as little time as possible and with a reasonable feeling of comfort and safety while travelling. The majority of drivers trade off travel time against safety for themselves and for other road users. Many drivers have an expectation of being able to control their motor vehicle at much higher speeds than the posted speed limits. This is particularly true of young and inexperienced drivers, who have a tendency to overestimate their own ability and to underestimate traffic hazards.

The speed limit must define by type for road, geography and special area such as school and market.

ii. Mandatory signs

The mandatory signs are used to instruction the drivers about what they must do follow each mandatory signs such as keep right, turn right ahead etc.

iii. Priority signs (Stop sign on assess Roads)

One of the most common factors associated with road crashes is the human error of road users involved to see each other in time, or at all. The design of a junction, visibility, traffic volume and road user behavior are some of the factors that influence the probability that road users will see each other in time to avoid the road crash. Doubts as to who should give way at a junction may also lead to the crashes.

iv. Warning signs

Warning signs are used to alert drivers to potential danger ahead. They indicate a need for special caution by road users and may require a reduction in speed

and follow the sign a must.

Appropriate warning signs can greatly assist road safety. To be most effective, however, they should be used sparingly. Their frequent use to warn of conditions which are readily apparent tends to bring them into disrepute and detracts from their effectiveness. Unjustified signing should not be used at individual locations simply in response to complaints from the public.

v. Temporary signs

Temporary signs are used in the construction road works to protect the workers who being work on the road works or any other road users. Road users must increase the carefully driving and follow the traffic sign and signal of traffic controller.

vi. Direction signs

The direction signs normally are used to tell the road users information about the route and about places and facilities of particular value or interest such as tour venue, important area, districts, and communes. Most informatory signs are rectangular but direction signs usually have one end pointed.

vii. Buildup area and boundary signs (Market /village area)

The buildup area signs are rectangular and used to tell the road users about the starting point and end of buildup area. It also tell the road users about the village, commune, and district boundary.

viii. Street name signs

The street name signs are used to tell the road users about the street name, it is rectangular with white text and blue background.

ix. Information signs

The information sing are used to tell the road users about the information or other place such as parking area, pedestrian crossing area, hospital, compulsory lanes and others.

x. Supplementary signs

The supplementary signs are used as additional assistance under traffic sings to express the clear meaning such as type vehicles, distance, direction, time, mark and important text.

8.10.3.2 Signs posts (Guidepost, Guard Rails and Chevrons at Curves)

582. The signs posts are used in different purpose such as guidepost to straighten the road at the night time, post on the steep ascent/descent curve roads and kilometer posts.

583. Guideposts are used to let the drivers know about the curved road of surface or straighten the road near by the danger area especially at the night time,

584. Chevrons at Curve: is a tool provide additional emphasis and guidance for drivers, chevrons can delineate the curve or roundabouts so drivers can interpret the sharpness of the curve. Almost all road crashes in curves are driving off the road crashes or head

on collisions between vehicles. It is not always possible to improve sharp curves by rebuilding the road. Horizontal curves are designed to reduce the crash rate in curves by giving good prior warning sign of these curves, indicating the path of the curve as clearly as possible and possibly providing road users with information about safe speeds in the curve,

585. Guard rails is a system designed to keep people or vehicles from danger driving off road, it is a strong bar or fence that prevents people from falling off a high embankment, bridge, etc.

8.10.3.3 Traffic lights

586. The traffic lights are used to mandatory and process of traffic stream by direction, timing to reduce traffic jam, road crash and alert the road users about danger area.

8.10.3.4 Road markings (Rumble Strips)

587. Road Marking was establish if purpose of safely and comfortably drive, drivers depend on reference points in the proximity of the vehicle and further ahead in the direction they are driving. In the dark, in particular, but also in other poor visibility conditions, such reference points are essential when it is hard to identify the road from its surroundings. At complicated junctions, it is important for road users to be able to find the right place on the carriageway using reference points. Road markings are intended, among other things, to give drivers such reference points.

588. Road markings include several measures. Longitudinal lines on the road surface include centre lines, lane lines and edge lines. The central line separates opposite traffic streams. It can either be a prohibitory line (solid line), which it is not allowed to cross, a warning line or a traffic lane line. Lane marking lines separate traffic lanes for traffic in the same direction. Edge lines mark the outer edge of the carriageway. Other types of road markings and related measures is rumble strips,

589. Rumble strips are installed along center or edge lines. They may be milled into the road surface, or the lane markings may contain transverse elevated elements. Rumble strips produce vibrations and noise when a vehicle drives over them it is alert the driver to slowdown or manage driving speed.

8.10.3.5 Special Design of Some Junctions or zone

590. Most of the road system carries mixed traffic, that is, all or most categories of road users use the same area for traveling. Rural roads may have no separate facilities for pedestrians, motorcycles and/or cyclists, at junctions, pedestrians and cyclists normally mix with cars or trucks. Stop sign is introduce for access road.

591. As the consultation meeting and field visit along the project road, some junction should be well design due these area is black spot and connecting with main road or national road. The designer need to consider to make the speed in low level and separate lane with mode of transport. The number of junctions and access points has a major impact on road crashes rate. At junctions, the road crash rate increases if a junction has more legs and if a higher proportion of traffic enters the junction from the minor road or poor design. Detail recommendation will be encode in the DDIS.

592. On the PR312 which connect from NR1 to Vietnam border is a cross border investment road, the traffic so busy during the people some provinces take their products especially rice to sell in Vietnam. Many trucks park along the road freely and make the road smaller and sometime cause to road crash, the road port on one side of the road should be constructed for thus trucks (PK 27+600 -27+900).

8.11 CBRS BENEFICIARIES AND OUTCOME

593. The people who live along the road will get a not only the new road for daily transport but they also got the safer road for all road users, it mean the number of road crashes automatically decline or not increase if compare to other roads which not consider for road safety.

594. Apply to the Decade of Action for road safety, the Royal Government of Cambodia contributed the National Road Safety Action Plan to save live on the roads, to reduce the number of fatalities, number crashes, injuries and disability by 2020. The deduct for number of road crashes at communes will make a change for fatalities rate in national level and contribute to worldwide road crashes data.

595. The villagers and students who live along the project roads will have a positive change of the attitude, behavior and norm on road safety throughout the trainings, campaigns, workshops and any events at the communities. The combination of 5Es really appreciated to drive the community based road safety program for a sustainable project.

596. Community Based Road Safety Program really a value for contribute a Sustainable Development Goal and improving the quality of life and well-being of the people, long distance travelling is not a mater to sustainable education, business, gender equality, climate action, health and poverty.

9 PROJECT COST ESTIMATES

9.1 GENERAL

597. A cost estimate has been prepared based on an estimation of the quantities required for the project elements and an estimation of the financial unit costs for each major item in the quantities. The estimates are broken down into those for PR1534, PR312 and PR23. In the final project cost estimate other items such as resettlement costs and consultancy costs and provisions for contingency and as well as price increases are included to provide a total cost of the project.

598. The feasibility studies are substantially completed. However, due to funding constraint, PR1534 has been excluded from the project scope by the government.

9.2 FINANCIAL UNIT RATES

599. The unit rates used in the analysis are given in Table 9.1 below. These have been obtained from tenders submitted for PRIP and other MPWT projects, and a review of recently contracted prices. The costs of the individual items have been adjusted to reflect recent cost changes. Adjustments have been made to allow for price escalation and the basis for the unit rates in terms of materials, equipment and labour have also been considered. Based on these costs, the expected cost for the civil works will be approximately \$311,460 to \$398,164 per kilometer including contingencies as shown in Table 9.2.

600. The lowest cost is for the PR312 where existing pavement will be used for sub-grade layer and necessary width of pavement will be widened. The highest costs are for the PR23 where the roads are to be wide and backfilled, and the box culverts are to be replaced.

Table 9. 1 Financial Unit Costs for Civil Works

Item	Description	Unit	Rate (US\$)
1	Grubbing	sq.m	0.41
2	Embankment	cu.m	5.45
3	Subgrade	cu.m	6.00
4	Sub-Base Course	cu.m	13.80
5	Aggregate Base Course	cu.m	39.38
6	Double Bituminous Surface Treatment (DBST)	sq.m	7.60
7	Bridge (PSC Deck)	sq.m	1,864.00
8	Pipe culverts	l.m	598.00
9	Box culverts	each	140,516.00
10	Ancillary works	km	8,133.00
11	Mine/UXO detection, removal and demolition - normal	ha	3,300.00
12	Mine/UXO detection, removal and demolition - intense	ha	3,500.00

Note: using local raw material (usually laterite)

Source: MPWT data and Consultant's estimates

Table 9. 2 Financial Unit Costs for Civil Works

Road No.	Province	Length (km)	Cost (US\$)	Per km (US\$)
PR312	Prey Veng	28.4	8,845,469	311,460
PR23	Kandal	19.9	7,923,469	398,164
	Total	48.3	16,768,938	347,182

Source: Consultant's estimates

9.3 CIVIL WORKS PACKAGES

601. Although the roads of four provinces are to be upgraded, it is not the intention to locate one civil works package for each province. The case against that approach is that it creates too many packages (contracts) each of a smaller value which would be more difficult to manage and administer. The advantage of grouping packages is to attract larger firms with greater capacity and equipment, such as large efficient machines for example. It also creates other efficiencies such as fewer laboratory and office facilities. The packages are geographically grouped with two: (i) PR312 in Prey Veng province; and (ii) PR23 in Kandal province. The cost of each package including taxes and contingencies is given in Table 9.3.

Table 9. 3 Cost of the Civil Works Packages (US\$ million)

Civil Works Packages	Cost	Province
CW1, Improvement of PR312	10.57	Prey Veng
CW2, Improvement of PR23	9.47	Kandal

Note: including taxes and contingencies
Source: Consultant's estimates

9.4 RESETTLEMENT COST

602. The detailed base cost estimate for land and resettlement costs for PR312 and PR23 combined is \$2.05 million. This amount comprises land acquisition costs and resettlement costs, including the administrative costs.

9.5 CONSULTING SERVICES

603. The project will be implemented by two separated international consulting firm in association with a local consulting firm for implementation of detailed design, and for implementation of construction supervision respectively.

a. DETAILED DESIGN CONSULTING SERVICES

604. The Detailed Design Consultant (DDc) will be responsible for all aspects of the project detailed design for civil works and other contract preparation and bidding and award of the civil works. Where specialists are to be engaged from outside the DDc firm, the DDc will provide a coordinating role. The DDc will report to the Director of PMU3. The main

offices of the consultant will be at MPWT. Detailed design cost will be financed by PRI Fund. Therefore, cost of the DD consulting services has not been considered.

b. CONSTRUCTION SUPERVISION CONSULTING SERVICES

605. The Implementation of Construction Supervision Consultant (CSc) will be responsible for all aspects of the supervision of the civil works for the project. They will also support the capacity building programmes, the resettlement plans and environmental monitoring and mitigation actions. Where specialists are to be engaged from outside the CSc firm, the CSc will provide a coordinating role. The CSc will report to the Director of PMU3. The main offices of the consultant will be at MPWT and field offices will be established at the location of the civil works contractors' office and maintained by the civil works contractor. Construction supervision cost has been estimated at 12% of the civil works cost. The cost of the CSc consulting services has been estimated at US\$ 2.37 million including taxes, and contingencies.

c. ROAD SAFETY PROGRAM

606. Section 8 describes a community based road safety program for the project areas. The program will be carried out under the DDc and CSc services through the appointment of one international and one national road safety expert.

607. Minor civil works for safety school zone has been estimated at US\$ 0.5 million including taxes, and contingencies as CW3.

d. HIV/AIDS AWARENESS AND HUMAN TRAFFICKING PREVENTION PROGRAM

608. The project will undertake a HIV awareness and human trafficking awareness program. Using the requirement prescribed and guidelines described in Section 7 and in the PSA separate report and with a full awareness of the national program for prevention, consulting services specialists will be engaged to implement the program. The cost of the package for the program is financed by Government fund. Therefore, cost of HIV/AIDS Awareness has not been considered.

9.6 MINES AND UXO AWARENESS

609. The potential risk to the project workers and to the local communities has been mentioned in this report. The project provides for the DDs and CSc to appoint an expert to assess the risks in detail as part of the consulting services respectively. The expert will also advise the local communities of the increase in risk caused by civil works activities, and hold meetings and deliver awareness documents/pamphlets to the local communities, as appropriate in areas of risk. The funding for demining and UXO removal is listed under the civil works activities. Specialist contractors will be engaged by the civil works contractor to undertake this work. The cost of mine/UXO clearance is US\$ 1.5 million includes US\$ 0.1 million for the cost of community-based Mine/UXO awareness.

9.7 PROJECT COSTS

610. A summary of the project costs is given in Table 9.5. The costs include taxes and duties of \$4.19 million to be financed from government resources. The base cost is from mid 2016 prices. Physical contingencies have been computed at 10% for the civil works, field research, training, surveys and studies. Price contingencies computed for foreign exchange

costs and local currency costs are based on the annual rates given in Table 9.4 below. They include provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate. Project management cost has been estimated at 1% of the civil works and consulting services cost.

9.8 INTEREST DURING CONSTRUCTION

611. Interest during construction (IDC) has been calculated at 1% per annum for ADB of the cumulative amount drawn down from the loan during the implementation period.

Table 9. 4 Annual Rates for Price Increases (percent)

Year	2016	2017	2018	2019	2020	2021	2022	2023
Foreign Currency	0.7	1.4	1.4	1.5	1.5	1.5	1.6	1.6
Local Currency	2.5	3.4	3.5	3.5	3.5	3.5	3.5	3.5

Source: Foreign: Manufactures Unit Value (MUV) Index rates from WB, Local: ADB estimates

Table 9. 5 Summary Project Costs (US\$ million)

		Local	Foreign	Total ^a	% Local	% Foreign	% Base Costs
A	Base Costs ^b						
1A	Civil Works - Roads Improvement						
	CW1: Improve PR312, 28.4 km	5.09	3.75	8.85	57.58	42.42	40.53
	CW2: Improve PR23, 19.9 km	4.54	3.38	7.92	57.31	42.69	36.31
	CW3: Safety school zone, 24 places	0.24	0.16	0.41	60.00	40.00	1.87
	Land Acquisition	2.05	-	2.05	100.00	-	9.38
1B	Consulting Services for Design and Supervision						
	- Consulting Services for the Detailed Design	-	-	-	-	-	-
	- Consulting Services for the Construction Supervision	0.80	1.21	2.01	40.00	60.00	9.22
2	Increased Road Safety and Safeguards						
	- Community based Road Safety Program	0.18	0.02	0.20	90.00	10.00	0.92
	- HIV/AIDS & Human Trafficking Prevention Program	-	-	-	-	-	-
3	Efficient Project Management	0.35	0.04	0.39	90.00	10.00	1.78
	SUB TOTAL (A)	13.26	8.56	21.82	60.76	39.24	100.00
B	Contingency ^c						
1	Physical	1.10	0.84	1.94	56.63	43.37	8.88
2	Price	1.40	0.42	1.81	77.05	22.95	8.30
	SUB TOTAL (B)	2.49	1.26	3.75	66.49	33.51	17.17
C	Financial Charge During Implementation						
1	Interest During Construction ^d	-	0.42	0.42	-	100.00	1.92
	SUB TOTAL (C)	-	0.42	0.42	-	100.00	1.92
TOTAL PROJECT COST (A+B+C)		15.75	10.24	25.99	60.61	39.39	119.09

^a Includes taxes and duties of \$4.19 million to be financed from Government resources.

^b In mid 2016 prices.

^c Physical contingencies have been computed at 10% for base costs. Price contingencies computed for foreign exchange costs and local currency costs based on the annual rates given in Table 9.4; includes provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.

^d Interest during construction computed at 1%.

10 ECONOMIC EVALUATION

10.1 INTRODUCTION

612. The main purpose of economic analysis for this study is to show the effects of the implementation of the proposed provincial roads improvements from viewpoint of national economy and it aims at evaluating the economic viability of the project implementation. Economic analysis estimates whether it is the project which benefits to national economy by analyzing the expenses consumption of the resources which national economy holds. The approach used for this follows the standard evaluation methodology for road improvement schemes. That is situation forecast to occur with improvements to the roads, referred to as the "with project case" has been compared with the situation expected if the roads are maintained at their present standard, the "without project case". It takes into account factors which can be quantified, such as the road construction and maintenance costs, traffic volume in the future, and the potential level of benefit of each traffic vehicles. These items are considered over an evaluation period, with costs and benefits discounted and expressed in present value items. It provides measures of the overall return obtainable from the project, which can be compared to returns from expenditure on other types of road works and other types of investment, so that capital resources can be distributed throughout the economy as efficiently as possible.

613. In total 2 road sections were identified for evaluation purposes, and each of these has been appraised individually, with specific characteristics and conditions for each used as inputs to the evaluation. Minor changes in terrain and in existing road width were not considered significant enough to require further division. A key road characteristic used in determining benefits is the estimate of surface roughness. The current roughness of existing surfaces was estimated from visual inspections and from travel speeds, but it is apparent that the condition of the existing roads is highly variable over time. Developing appropriate scenarios for road condition in the base case is an important part of the analysis. The viability of the whole project was estimated as well as the sensitivity analyses along with switching value were also estimated as well.

10.2 CRITERIA OF ECONOMIC ANALYSIS

614. As being said, comparison of the benefit and cost of cases with and without the project is carried out for the analysis of this project. The benefit is regarded as various desirable effects given to the national economy when the project is implemented, and the cost is regarded as all national economical expenditure required for the project implementation concerned.

615. In order to evaluate the road projects from an economic view point, the following economic indicator were considered:

- The Net Present Value (NPV) of a given instrument is obtained by subtracting the present value of the costs from the present value of the future benefits. The benefits as well as the costs are discounted at the OCC (Opportunity of Cost and Capital) discount rate. The investment is viable if the NPV is positive.
- The Economic Internal Rate of Return (EIRR) of a given project is defined as the discount rate at which the present value of benefits and the present value of

costs are equal. It is a measure of the marginal efficiency of capital. For a project to be viable, the EIRR has to be greater than the OCC rate. Normally the NPV and EIRR will give the same indications of viability and priority ranking between projects.

10.3 PRESUMPTION OF THE ANALYSIS

616. The following assumptions are made: "With Project" or "Without Project". While "With Project" means the situation of implementation of the improvement from existing unsealed or sealed surfaces taking DBST pavement into account. "Without Project" stands for the situation of no such improvements.

617. The annual cost and benefit streams are calculated from year 2016 up to 25 years and discounted to 2016 values using a discount rate of 12%. Road improvements were assumed to be completed by year 2021 taking into account the review and budget preparation, the detail design and tendering (2017), and construction periods (2018-2021); hence, the project life is considered for 20 years after the completion. No benefits have been included for any savings which may occur before the opening year as a result of some sections of the networks being completed before the end of the overall construction period. Similarly, no costs to road users caused by disruptions to traffic during the construction period have been included. The exchange rate is set up with reference to the market rate as in June 2016. According to the survey of exchange rate, the US\$1.00 was set to equal to 4,085 riels. Since it is presumed to receive exemption for the tariff portion of foreign currency expense, tariff has not added to the cost. Moreover, about economic analysis, it also deducts a domestic tax portion, and change into economic project cost by applying a standard conversion factor to a non-trading article portion.

10.4 Benefits

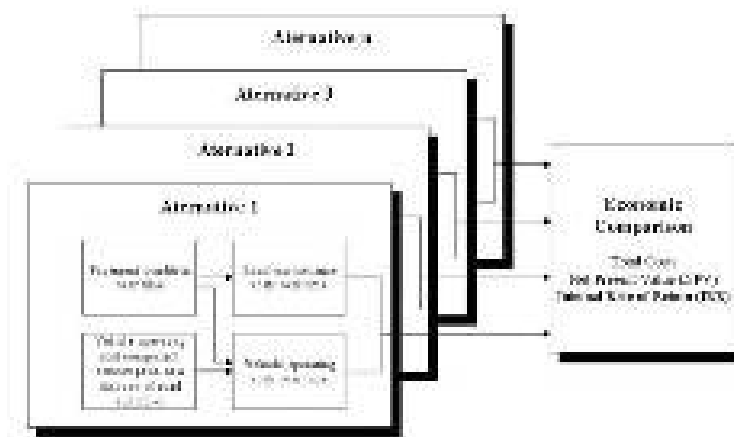
618. Of the various benefits derived from the provincial road network in Cambodia, Benefits are considered to be mainly (i) savings in travel time and (ii) savings of Vehicle Operating Cost (VOC). Travel time savings are obtained when road improvements lead to an increase in vehicle speeds, thus reducing the journey times of passengers. A value of time per hour for each vehicle type is applied as a unit cost to journey times to produce passenger time costs. Vehicle Operating Cost (VOC) savings will be estimated using HDM-4. VOCs are a basic item in road project evaluations and the main source of benefits. Using a computer model such as HDM-4 they can be calculated in detail. The HDM-4 model predicts the consumption of resources for each component of vehicle operating cost per kilometer. The model takes into account a wide range of factors, including the surface condition and geometry of each road section, and the characteristics of representative vehicles. If it is found that the traffic volumes are too low to be calculated by the above conventional measures, other factors as social benefits will be carefully considered as an alternative or complementary form of analysis.

619. Residual values of the works is also considered as a benefit from road improvement representing the remaining asset value of the works were included at the end of the evaluation period, although the impact of the result is small when an evaluation period of more than 20-year is used, because of the impact of discounting. The residual value in this study is assumed to be zero.

10.4.1 Evaluation Model

620. The Highway Development and Management Tool so called HDM-4 has been used to prepare road investment programmes and to analyze road network strategies. The broad concept of HDM for this study is illustrated in Figure 11.1. The user defined a series of alternatives that describe different investment and preservation options for the road. The investments influence the condition of pavement over time and road maintenance costs. The pavement and traffic conditions have an influence on Road User Effects (RUE). The model predicts traffic speeds and the consumption of the RUE components, such as fuel, tyre etc. Multiplying these by the unit costs of the individual components gives the RUE over time. Comparing the cost outputs from various investment alternatives allows assessment of the relative merits, cost savings and benefits of the different alternatives using economic principles.

Figure 10.1 Overview of the HDM approach for the Study



Source: HDM-4 Manual, Volume 5

621. The HDM-4 model consists of a series of sub-models that address different aspect of the analysis.

- Road Deterioration-which predicts pavement deterioration and surface
- Works Effects-which simulate the effects of road works on pavement condition and determines the corresponding costs.
- Road User Effects- which determine costs of vehicle operation and travel time.

622. These entail predicting the deterioration of the pavement under time and traffic, the road user effects, and the effects of maintenance on the pavement condition and rate of deterioration. As with any model, HDM is a representative of reality. How well the model predictions reflect reality is dependent upon a combination of the

- Validity of the underlying HDM relationships
- Accuracy and adequacy of the input data
- Calibration factors used in the analysis

623. Calibration of HDM-4 is necessary for reflecting local conditions. Calibration of the HDM model focuses on the two primary components that determine the physical quantities, costs and benefits predicted for the analysis, namely:

- Road User Effects (RUE) - comprised of vehicle operating costs (VOC), travel time etc.
- Road deterioration and works effects (RDWE)- comprised of the deterioration of the pavement and the impact of maintenance activities on pavement condition and the future rate of pavement deterioration.

624. The most comprehensive calibration of the model and listing of input values seem to have been carried out for the Location Referencing and Condition Survey (LRCS) undertaken as part of the Road Rehabilitation Project carried out for the ministry of Public Works and Transport. Most of the input data were taken from LRCS, with updating of prices to 2016 levels. Reference was also made to other studies involving the use of HDM-4, in particular the Preparing Provincial Road Improvement Project taken under MPWT in 2011.

10.4.2 Road User Effects Calibration

625. The Road User Effects (RUE) model calibration focuses on ensuring that the key RUE model parameters and calibration factors are appropriate for the conditions under which the model is to be applied.

626. Road user cost consists of the following two (2) major components: Vehicle operating costs(VOC) and Travel time costs(TTC). In RUC component, accident cost (ACC), that is the physical costs of an accident and the value of injuries and fatalities, is sometimes taken into accounts; However, ACC is not taken into accounts in this study. This is reasons why saving in ACC is comparatively small in amount compared with the saving in VOC and TTC for provincial roads. The economic prices have been calculated in each case from first principles involving the buildup of the different price elements from the public. Information on import duties and value added tax (VAT) has been referred to the source of General Department of Customs and Excise of Cambodia and Cambodia Pocket Tax Booklet in 2012.

627. As stated above, economic appraisals of a road project should always be undertaken in economic terms. This required that both construction and maintenance costs, and vehicle operating costs are quoted net of all taxes, duties, effects of shortages of skilled labor and foreign exchange. Where a good is traded internationally, this can be undertaken easily by identifying tax and duty (or subsidy) elements of retail prices and removing these tax and duty. The residue is economic prices, including an element of profit for traders where markets are competitive. However, many goods are not traded internationally, either because they cannot be transported or they have no value outside the country such as vehicle crew cost and passenger time saving. In these cases different methods of estimating economic prices are required. Two (2) typical methods are by estimating the shadow wage factor (SWF) for unskilled labor and a standard conversion factor (SCF).

628. When the market price of any good or service is changed to make it more closely represent the opportunity cost (the value of a good or service in its next best alternative use) to the society, the new value assigned becomes the "shadow price" (sometimes referred to as an "accounting price"). In the strictest sense, a shadow price is any price that is not a

market price, but the term usually also carries the connotation that it is an estimate of the economic value of the good or service in question, perhaps weighted to reflect income distribution and savings objectives.

629. An alternative way to allow for the foreign exchange premium on traded items that is increasingly coming into use is to reduce the domestic currency values for non-traded items by an amount sufficient to reflect the premium. This is sometimes called the "conversion factor" approach. In its simplest form, based on straightforward efficiency prices, a single conversion factor-the "standard conversion factor" of Squire and van der Tak-is derived by taking the ratio of the value of all exports and imports at border prices to their value at domestic prices (Squire and Van Der Tak 1975, p. 93). A standard conversion factor for non-traded goods of 0.89 and 0.92 was used in JICA study Team on Master Plan Study in 2005 and in ADB TA 7665-Cam (Preparing the Provincial Road Improvement Project, Cambodia), respectively. A shadow price of 0.75 of the market rate applied for unskilled labour was used from previous report of TA-7199 and TA-7665-Cam as well.

10.4.3 Vehicle Characteristics

630. Traffic volume (manual counts) survey was undertaken for all road sections in this study. During this survey, a detailed investigation was carried out on the type of vehicles prevailing in the country and classified into logical groups considering the type, utility and axle group. All of vehicle types identified in the traffics surveys have been adopted for use in the evaluation. These are: (The following should be same type in previous Traffic Part)

- 1. Bicycle - All two and three-wheeled non-motorised vehicles, including cyclos and those used for carrying freight.
- 2. Motorcycle - Motorcycles, scooters and any other 2-wheeled motorized vehicles, but not those with trailers. Motorcycle traffic dominates vehicle movements on virtually all roads.
- 3. Motorcycle with Trailer - Motorcycles with a trailer (remoque), or any 3-wheeled motorised vehicle, used for freight or passenger transport.
- 4. Car - This type includes sedan cars and station wagons (but not 4-wheel drive vehicles) with a maximum of 7 seats.
- 5. 4-wheel Drive Vehicles - All four-wheel drive (FWD) vehicles, such as Toyota Landcruiser or Mitsubishi Pajero, with a maximum of 7 seats.
- 6. Pick-up - Vehicles such as the Toyota VIGO or Mitsubishi Triton 2.5 GLX and other types of pick-up designed for use as light freight vehicles, but are also used for private transport as an alternative to sedan cars. They are also known as utilities. Very small trucks are also included in this category, being distinguished from the Light Truck category in having only single wheels on the rear axle. If it appeared that a pick-up was being used for private passenger transport, especially a twin-cab model, it was counted as a Car or a 4-wheel Drive Vehicle as appropriate. If converted for public transport use, with seats and a canopy or roof over the rear section, it was counted as a Minibus.
- 7. Minibus - The minibus type is typically an 8-12 seat vehicle, such as the Mercedes MB 140D-Ssang Yong Motor (now replaced by the Sprinter), sometimes referred to as a microbus or van.

- 8. Bus - All buses with more than 16 passenger seats. They are distinguished from the Minibus type by having dual-wheel on the rear axle. (Very few buses operate on province roads in Cambodia, except on some province roads where its serves as access road or bypass road to tourist or religious sites.
- 9. Small Koyun/Etan - Small tractors made into a road vehicle by attaching a single-axle trailer, or small, slow moving, locally-made trucks.
- 10. Large Koyun/Etan - Locally-made trucks that typically have low capacity engines not always designed for motor vehicles. These are much slower than conventional vehicles and are normally only used for short distance freight movements.
- 11. Light Truck - These are trucks with a payload of up to 4 tonnes. They have two axles and dual-wheels on the rear axle. If converted for passenger transport and carrying passengers they were counted as buses.
- 12. Medium Truck - These are larger trucks than the light truck, but also have two axles and dual-wheels on the rear axle. They have a carrying capacity up to 10 tonnes. Although sometimes difficult to distinguish from the Light Truck in traffic counts most are much larger. There are significant differences between these two types, especially in terms of axle loads, and it is considered desirable to obtain information on the numbers of each for use in feasibility and pavement design studies.
- 13. Heavy Truck - All 3, 4 or 5-axle rigid trucks, articulated trucks and truck trailers. A large range of such vehicles operates in Cambodia but most have a similar ESA, and numbers are very low on most of the study roads, thus a single category was considered to be appropriate.

631. Pedestrian traffic is not considered in this study because it is not clear that higher walking speeds would be achieved after road improvement.

632. The key characteristic of the vehicles are based on the specified default values in the HDM-4 model, with some adjustment for Cambodian conditions. HDM-4 requires a number of input values relating to vehicle age and annual utilization that are used to calculate the capital cost component of VOCs. Vehicle age, expressed as average life, is also used in the calculation of vehicle maintenance costs. These inputs are difficult to determine. Estimates have been made from the information used in other studies in Cambodia. Vehicle registration and imported statistics have been considered, although these are not detailed enough to give more than a general impression of the age structure of the vehicle fleet. Many vehicles used in Cambodia are imported second-hand although this is becoming less common for motorcycle. This means that the defined service life in Cambodia is much less than the total service life, and that average age of vehicles in Cambodia is greater than in most other countries. This has implications for the calculation of vehicle maintenance costs, which are assumed in HDM-4 to be much higher for older vehicles.

633. The average service life used as input to the model is less than the estimated average age of all vehicles, to reflect that the majority of annual vehicle-km are operated by the newer vehicles in the fleet. For practical reasons the vehicle prices used in the analysis are based on an assumption that only new vehicles and vehicle age and utilization values were based on an assumption that only new vehicles enter the fleet.

634. The main characteristics of the vehicle types used in the analysis including estimated average utilization and Passenger Car Space Equivalent (PCSE) are shown in the Table 10.1.

Table 10. 1 Vehicle Characteristics

Vehicle Type	No of Tires	Fuel Type	Annual working hours	Annual km	Average Life (years)	Crew No.	Equivalent Standard Axle (ESA)	PCSE	Economic Price (\$)
Bicycle	2	-	150	2,500	10	-	0	0	40
Motorcycle	2	P	600	8,000	8	0.4	0	0.3	700
MC +Trailer	4	P	600	8,000	10	1	0	0.5	850
Car	4	P	750	15,000	12	0.4	0.004	1	22,000
Jeep/4WD	4	D	750	25,000	10	0.8	0.010	1	48,500
Pick-up	4	P	1,250	25,000	10	1	0.050	1	12,000
Mini bus	4	P	1,600	35,000	10	1	0.040	1	14,500
Bus	6	D	1,750	35,000	10	2	0.700	1.6	22,000
Koyun Small	4	D	400	6,000	10	1	0.050	0.8	1,500
Koyun Large	4	D	400	6,000	10	1	0.200	1	3,000
Light Truck	6	D	1,600	30,000	8	1	0.200	1.3	15,000
Medium Truck	6	D	2,000	40,000	12	1.5	0.800	1.4	22,000
Heavy Truck	10-16	D	2,400	45,000	12	2	3.500	1.6	45,000

Source: Second Road Asset Management Project, 2016

10.4.4 Replacement Tires

635. The replacement tire cost is the average cost of the new tire. This should not include the cost of the whole wheel. The weighted average cost of the tires should be used in HDM-4 analysis as different vehicles may use different tires. The economic costs of tires have been assessed in the same way as vehicle prices. New tires are subject to import duty, special tax and VAT which is incurred around 32.825% according to the data from General Department of Customs and Excise. For the purpose of calculating the economic price of each vehicle tires, these taxes and import duty have been subtracted from retail price. The tire prices were assumed based on Second Road Asset Management Project as given in Table 10.2.

Table 10. 2 Tire prices

Vehicle type	Size	Price (USD)
Motorcycle	2.50x17/6 PR	9.0
Car	6.00 x13/12PR	45.0
4 Wheel Drive	205/55 R 16	68.0
Minibus	7.00x16/14PR	117.0
Bus	9x20/16PR	197.0

Vehicle type	Size	Price (USD)
Pick-up	6.5x16/12PR	91.0
Light Truck	8.25x16/16PR	144.0
Med. Truck	9x20/16PR	197.0
Heavy Truck Rigid	10x20/16PR	220.0

Source: Second Road Asset Management Project, 2016

10.4.5 Fuel and Lubricants Costs

636. In HDM analysis the fuel type is determined for each representative vehicle. It is recommended to model separately the petrol and diesel engine vehicles within a vehicle class if they are significant.

637. Fuel and lubricants prices have estimated based on a survey of prices in Phnom Penh. There are a number of suppliers in here operating competitively. Three (3) types of fuel are available, gasoline which can subdivide into two (2); super and regular and diesel. Fuel is subject to import duty, special tax, and VAT which is range from 18.53% to 18.75% based on tax and levy rates of the General Department of Customs and Excise. In this study, the surveys of gasoline and lubricant retail price were carried out from various suppliers. The financial and economic prices are shown in Table 10.3.

Table 10.3 Fuel and Lubricant Prices

Type	Financial Price (USD)/litre	Economic Price (USD)/litre	Import Duty
Gasoline Super	0.82	0.66	18.75%
Gasoline Regular	0.78	0.64	18.75%
Diesel	0.69	0.56	18.70%
Lubricant (motorcycle)	3.27	2.66	18.61%
Lubricant (4 wheels or more)	6.26	5.10	18.53%

Source: DDIS Consultants, 2016

638. Given the uncertainty about future oil prices, these fuel prices are only indicative. However, it should be noted that although fuel is an important component of VOCs, it does not dominant the total, even with the relatively high fuel prices assumed.

10.4.6 Maintenance Labor and Crew Wages

639. The maintenance labor cost should include labor cost, tools and workshop overheads. Wages paid for vehicle maintenance labor are in the range USD0.6 per hour for unskilled works to USD2.0 per hour for senior mechanics. A workshop labor rate of USD3.0 per hour has been used to allow for overheads.

640. The wages of vehicle drivers vary in the range USD 1.1 to 1.6 per hour, with the higher rates applying to larger vehicles. Not all vehicles have a paid driver and average crew costs have derived from the estimated number of crew for each vehicle.

10.4.7 Road Deterioration Calibration

641. It describes the types of pavement modeled in HDM-4, and the possible combinations of pavement surface types and base types. It discussed the key variables that affect deterioration, which include climate and environmental effects, traffic volume on road, and pavement history.

642. In this section, the road network definition(roughness, length, type of pavement, width,...etc), geometry based on the road inventory survey for 2nd PRIP, and annual average daily traffic volume (AADT) produced by each vehicle types on roads mentioned in the previous section of traffic count survey, are specified on the current stage by year 2016. Calibration of the speed flow type, traffic flow pattern, climate zone and road class were followed by the case of Cambodia. Asset valuation of road was not included in this study.

10.4.8 Vehicle Operation Cost Saving

643. The level of VOCs is determined by many factors but the two main determinants are surface roughness and speed. Speed is partially determined by roughness, and so a simple indication of VOCs can be given in terms of roughness alone. In Table 10.4, VOCs are shown for the vehicle types used in the study for a range of roughness levels. They are for a typical road section in flat terrain. An IRI of 3 represents the expected level of a DBST surface in the project; the other IRI levels shown cover the range of typical roughness levels of the existing surfaces of most of the project roads. The VOCs are lower than those used in some other recent studies in Cambodia, mainly as a result of the adjustments made to the calculation of vehicle capital costs, or standing costs, in the analysis.

Table 10.4 Vehicle Operating Cost (US\$/km)

Vehicle Types	IRI 3	IRI 10	IRI 15
Bicycle	0.00	0.00	0.01
Animal Cart	0.11	0.15	0.17
Motorcycle	0.03	0.04	0.05
3-Wheeler	0.04	0.05	0.06
Car	0.25	0.31	0.37
Jeep/4WD	0.36	0.54	0.68
Pick-up	0.18	0.24	0.28
Mini bus	0.20	0.26	0.32
Heavy Bus	0.38	0.51	0.64
Small Koyun	0.08	0.09	0.10
Large Koyun	0.19	0.32	0.36
Light Truck	0.26	0.37	0.44
Medium Truck	0.36	0.51	0.61
Heavy Truck	0.66	0.93	1.13

Source: DDIS Consultants, 2016

10.4.9 Travel Time Cost Saving

644. Travel time savings are obtained when road improvements lead to an increase in vehicle speeds, thus reducing the journey times of passengers. A value of time per hour for each vehicle type is applied as a unit cost to journey time to produce passenger time costs. A time cost per vehicle can be included in HDM-4 to value time savings, and the costs per km are calculated directly from the speeds predicted in the VOC sub-model. These savings are in addition to the time value of the vehicle itself and crew costs for commercially operated vehicles.

645. Reducing cargo delay costs can also be considered as a potential source of benefit. Freight in transit is capital and a reduction in travel times can therefore be translated into savings in inventory costs. Thus the saving in time can be valued by the price of capital that is the rate of interest. In addition reduced travel time can produce benefits in the form of reduced spoilage of perishable goods, or reduced disruption to production resulting from delays in the supply of materials or components. However the savings are normally small and are not normally included in province road studies of this type. Accordingly freight time costs have not been included.

646. Travel time costs also referred to as Value of Time are important components of road user costs. The concept of travel time costs is based on a premise that the time spent in traveling has an opportunity cost and could be used in an alternative activity which also produce or may produce some significant utility (benefit). If the alternative activity can have monetary value assigned to it, this can be used as a part of RUC in the economic appraisal of the projects, particularly road improvement project. TTC may vary from country to country to country even from project to project in the same country. Value of time will be much higher in the developed countries than that in a developing country.

647. To estimate the travel time costs, the average wage approach method is taken into consideration. The wage rates of vehicle occupants are assessed and then their average rates are estimated to reflect the value of time of occupants in different vehicles. An assessment of number of travelers in working time and non-working time is made for each vehicle types. HDM-4 allows values for work and non-work time per hour per person of each vehicle type to be specified, which are combined with an average passenger load per vehicle and an estimate of the percentage of passenger trips that are work related, to produce a passenger time cost per vehicle hour.

648. The estimate of valuing travel time is commonly based on GDP per head of the working population. A GDP per capita is around \$1,200 in 2016 based on estimated through International Monetary Fund (World Economic Outlook Database 2016). According to Key Indicators for Asia and the Pacific 2015 from ADB, 54% of the population was employed. In case of assuming on average work 2,000 hours per year, the average hourly income in 2016 becomes around \$1.14.

649. Taking province area of person incomes in Cambodia into account, such value is much higher. Followed by TA7199 in 2009 and TA7665-Cam in 2011, a value of \$0.5 per hour has therefore been used for the working time of motorcycle users and \$1.0 was used for other motorized vehicle users except those in cars and 4-wheel drive vehicles. An average working time income of \$2.0 per hour has been assumed for car and 4 wheel drive because passengers in these two vehicle types have incomes above national average. Generally in Cambodia, proportions of working and non working time are not clear. Non-work travel time is valued at \$0.3 per hour for car and 4-wheel drive passengers and \$0.15 for

other passengers. Freight time cost savings have not been considered because the effect are normally small and are not normally included in province road studies of this type.

10.5 Project Costs

650. It describes the types of road works and their effects on road pavements, including the calculation of physical quantities of road works as civil construction and the corresponding costs with including the maintenance works.

10.5.1 Improvement Costs

651. The major capital costs are the costs of the civil construction works proposed for each road section to upgrade it to a DBST standard. Based on engineering point of view, specific cost estimates have been produced based on the inventories. The costs estimated include earthwork and allied activities, sub-base and base courses, bituminous works, structures, drainage and protection work, ancillary work, unexploded ordnance, miscellaneous, day-works schedule and contingency.

652. The current bridges are adequate in most cases, with many newly constructed. Where bridges are inadequate, the cost of replacing them has been included in the project cost. No land acquisition or resettlement costs are expected. Only minor environmental mitigation measures are expected to be required, and an allowance for any costs is included in the contingency.

653. It is assumed that civil works will be implemented started 2018 but the cost estimates are based on 2016 costs and do not include any allowance for price escalation over the design and construction period. In some cases the road improvements might not be implemented until later, depending on the size of the contract packages. However, it was decided that it was preferable at the evaluation stage to consider all subprojects assuming the same timing, so that they could be compared directly to determine relative rankings in the economic evaluation. The pavement design has been made according to the strength of the materials and the predicted cumulative equivalent standard axle load (ESA) on each road.

654. The overall economic costs uses for the evaluation are assumed 90% of financial cost to allow for taxes included in the financial costs and shadow pricing of unskilled labour. The variation of cost of improvement per kilometers depends on the road width and location of material available as well as labor works. The cost used for each road is shown in Table 10.5.

Table 10.5 Road Improvement Costs (US\$/km)

Contract No.	Road No	Road Name	Province	Length (km)	Cost of Improvement (USD/km)	
					Financial	Economic
CW1	PR312	NR1 Samroung – Banteay Chakrey Border	Prey Veng	28.4	449,759	412,547
CW2	PR23	Koh Thom Bridge – Peam Raing	Kandal	19.9	597,120	549,336
Total			-	48.3	-	-

Source: DDIS Consultants, 2016

10.5.2 Maintenance Costs

655. Maintenances of roads are assumed to take into account for both with and without road upgrading projects to DBST. The cost of maintaining a sealed road with low traffic is normally low compared with the cost of maintaining an unsealed road to a good standard. This maintenance cost reduction is considered as a benefit in the evaluation.

656. Routine and periodic maintenances were considered for both cases. The maintenance operations applied each are determined within HDM-4 according to road condition and assumed intervention standards or specified time interval.

657. For the "without project", the laterite gravel road maintenance standard is applied to all road sections with regravelling for every 3 years, grading for every 365days. For the upgrading alternatives, the upgrading improvement standard is applied from 2018, with the maintenance before upgrading standard applied for the years prior to the start of the upgrading, followed by the Maintenance after upgrading standard applied once the upgrading has been completed.

658. Purely routine maintenance procedures, such as drain clearance, grass cutting and traffic sign repair, would be similar in both the "without" and "with" project cases. As such it does not affect the evaluation result and a nominal estimate of annual costs per km of road has been applied.

659. The maintenance criteria with cost of maintenance for with and without project which are based on previous studies or actual works are summarized is shown in Table 10.6.

Table 10.6 Road Maintenance and Improvement Criteria

Items	Standard	Work Items	Criteria
Maintenance	Laterite Road Maintenance Maintenance before upgrading	Literite Regravelling	Interval ≥ 3 years
		Literite Grading	Interval ≥ 365 days
		Routine Maintenance (Miscellaneous)	Interval ≥ 1 year
	Maintenance after upgrading to DBST	Overlay of AC	Year $\geq 2029, \leq 2029$
		Resealing with SBST	Interval ≥ 5 years
		Pothole Patching, 100% Annually	Interval ≥ 1 year
		Routine Maintenance (Miscellaneous)	Interval ≥ 1 year
Improvement	Upgrading to DBST	30mm surface dressing	year ≥ 2019

Source: DDIS Consultants, 2016

660. In the case of the improved roads maintenance items such crack sealing and pothole patching were assumed to be carried out as required according to the predicted surface condition.

661. The unit costs of the maintenance operation shown in Table 10.7 are based on costs estimated in previous studies following TA7665-Cam.

Table 10.7 Unit Cost of Road Maintenance

Work Items		Unit	Economic Cost (\$US)
Laterite Road			
1	Regravelling	cu.m	10.0
2	Grading	km	120.0
3	Annual Routine Maintenance	km	350.0
DBST Road			
1	Crack Sealing	sq.m	2.0
2	Pothole Patching	sq.m	9.5
3	Edge Repair	sq.m	7.5
4	SBST Reseal	sq.m	3.0
5	Annual Routine Maintenance	km	350.0

Source: TA7665-CAM

10.6 Economic Analysis

10.6.1 Results of cost benefit analysis

662. Economic analysis covers 2016~2041 periods. The appraisal has been carried out for two road sections. The results of the evaluation for each road are summarized in Table 10.8 through Table 10.10 for each province in terms of the EIRR and the NPV expressed in 2016 values discounted at 12%. The two sections evaluated are viable. The EIRR of PR312 is 22.1% and the PR23 is 18.5%.

Table 10.8 Summary of Evaluation Results

Contract No.	Road No	Road Name	Length (km)	Economic Indicators	
				EIRR (%)	NPV (US\$ Mill)
CW1	PR312	NR1 Samroung – Banteay Chakrey Border	28.4	22.1	14.97
CW2	PR23	Koh Thom Bridge – Peam Raing	19.9	18.5	7.93

663. As a result of the whole projects, the proposed whole projects has a economic feasibility with EIRR of 20.4%. The economic indicators of the whole projects for all roads are shown in Table 10.9.

Table 10.9 Cost Benefit Analysis for the all road projects

All Road Sections	Indicators
EIRR (Economic Rate of Return) (%)	20.4
Net Present Value (US \$ million)	22.90

10.6.2 Sensitivity Analysis

664. In this study, the conducts of risk and sensitivity analyses are followed from the ADB's Guidelines for Economic Analysis of Projects (1997). Quantitative risk analysis provides a means of estimating the probability that the project NPV will fall below zero, or that the project EIRR will fall below the opportunity cost of capital.

665. The impact of adjusting some of the key input values has been tested to show the sensitivity of the overall project EIRR to the changes. The EIRR was analyzed with respect to changes in the benefit and cost streams. Because of the high level of viability of the Project, the parameters were varied over a wider range than is usual in sensitivity tests. The tests applied were applies as referred to TA7199 as the following manners:

666. Construction costs increased by 20%

- Vehicle operating costs (VOC) reduced by 20%
- Construction costs increased by 20% and VOC reduced by 20%
- Base year traffic reduced by 20%
- Traffic growth rates reduced by 20%
- Value of time benefits excluded
- Generated traffic excluded

667. A switching valued identifies the percentage change in a variable for the NPV to become zero that is the EIRR to be 12%. The sensitivity indicator and switching value is calculated as:

$$SI = \frac{NPV_b - NPV_1}{NPV_b} \div \frac{V_b - V_1}{V_b} \quad (1)$$

$$SV = 100 * (NPV_b / (NPV_b - NPV_1)) * ((V_b - V_1) / V_b) \% \quad (2)$$

Where;	V_b is the value of the variable in the base case NPV_b is the value of the NPV in the base case V_1 is the value of the variable in the sensitivity test NPV_1 is the value of the NPV with the sensitivity test SI is the sensitivity indicator SV is the switching value
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668. A sensitivity indicator compares the percentage change in a variable with the percentage change in the NPV. It is in effect the elasticity of the EIRR against the input variable. For example an SI of 1 shows that with a 1% change in the value of the input the EIRR will also change by 1%.

669. Based on the above formula (1) and (2), the results for the switching value and sensitivity indicator are shown in Table 10.10 that the results are most sensitivity to traffic data, either base year traffic or traffic growth.

Table 10.10 Sensitivity Analysis Results

Scenario	EIRR (%)	NPV	Switching Value(%)	Sensitivity Indicator
		(US\$ million)		
Base Case	20.4	22.90	-	-
Costs +20%	18.5	19.89	-152.16	-0.66
VOC -20%	19.0	18.24	98.28	1.02
Base traffic - 20%	16.5	9.57	34.36	2.91
Traffic Growth Rate -20%	15.1	5.44	26.23	3.81
No time benefits	15.8	8.33	-	-
No generate traffic	20.4	22.90	-	-
Costs +20% & VOC-20%	17.3	15.23	-	-

670. As the results of sensitivity analysis, even if the worst case which traffic growth rate is decreased by 20%, the overall project EIRR is 15.1%. This is greater than 12%, the discount rate of Royal Government of Cambodia. Therefore, the implementation of the project is economically feasible from view point of national and regional economy.

11 PROCUREMENT

671. Correct, efficient and corruption-free procurement is critical to the effective implementation of the project. The approach is to study current practice and seek better efficiency within the Government procurement policy and processes. The Government has existing financial management documentation prepared by ADB and the World Bank in recent years which will provide a good insight to current policy and procedures. Thus public and financial management, procurement processes, MPWT's capacity and their weaknesses will be identified and reported and a good governance framework has been prepared for the improvement of the procurement system.

11.1 Good Governance Frameworks

672. In all instances, the Loan Agreement shall be the overriding legal document. Asian Development Bank (ADB) Procurement Guidelines (2010, as amended from time to time [Procurement Guidelines]) and ADB Guidelines on the Use of Consultants by the Asian Development Bank and its Borrowers (2010, as amended from time to time [Consulting Guidelines]), shall be applied pursuant to the Loan Agreement as they may be modified by the Loan Agreement. The Government of Cambodia's policies and procedures shall be applicable to the extent there is no discrepancy with the Loan Agreement or ADB's Procurement Guidelines and Consulting Guidelines. In the event there is a discrepancy, then the Loan Agreement, the Procurement Guidelines and the Consulting Guidelines shall apply.

Table 11.1 Good Governance Framework with Assessment

No.	Risks	Action to Mitigate Risk	Responsibility	Target/ Monitoring
Element 1: Procurement				
1.a	Risks of corruption and fraud in the procurement process: <ul style="list-style-type: none"> • Collusion during bidding process; • Biased bid evaluation • Suppliers/ contractors offering incentives for favourable treatment. 	<p>The executing agency and implementing agency to establish procurement committee under the Project, in accordance with the Government's SOP/Procurement Manual, mandated on 22 May 2012, both of which are in line with ADB guidelines.</p> <p>The adoption of the new Criminal Code in late 2009 paved the way for the promulgation of the Anti-Corruption Law in 2010. The Anti-Corruption Unit (ACU) has been established under the Anti-Corruption Law and is gradually operational. Using the current ACU mechanism in filing the complaints (if any) is an option to mitigate such risks.</p>	The executing agency is the MPWT and the implementing agency is the PMU3 in MPWT.	Before loan negotiation
1.b	Insufficient compliance with procedures	<p>The executing agency and implementing agency are to adhere strictly to the procedures and guidelines set forth in the Loan Agreement, ADB's Procurement Guidelines, and SOP/procurement manual that also cover international competitive bidding, and national competitive bidding and shopping.</p> <p>PMU3 has accumulated comprehensive experiences of ADB funded projects; Loan 1945: Cambodia Road Improvement Project, and Loan 2539: Cambodia Northwest Provincial Road Improvement Project.</p>	<p>Executing agency/ implementing agency</p> <p>MEF to monitor for compliance with the Loan Agreement, ADB's Procurement Guidelines and the SOP/procurement manual.</p>	Throughout Project duration

No.	Risks	Action to Mitigate Risk	Responsibility	Target/ Monitoring
1.c	Weak procurement capacity.	<p>A procurement capacity assessment was undertaken as part of the project preparatory technical assistance for preparation of the Project. The assessment found that the procurement capacity is adequate.</p> <p>The executing agency and implementing agency will receive continued hands-on training and technical assistance from consultants recruited under the Project. The Government SOP/procurement manual will be used under the Project.</p> <p>Recruitment of well-experienced Procurement Officer and Website Officer in PMU3 is the key to avoid delays in procurement process which will definitely lead to the overall delay of the project.</p> <p>Project to closely monitor and review procurement conduct (both pre & post review), and where necessary, take measures to improve procurement procedures based on lessons learnt from each successive procurement activity.</p> <p>Weakness is derived from insufficient staff members for procurement. The implementing agency/executing agency have noted this issue and will recruit additional staff members in accordance with progress of the Project (if needed and budget available).</p>	<p>Executing agency and implementing agency</p> <p>Implementing agency</p> <p>Executing agency, MEF and ADB</p> <p>Executing agency and implementing agency</p>	<p>Throughout Project duration</p> <p>Prior to signing of Loan Agreement</p> <p>Throughout Project duration</p> <p>Prior to signing of Loan Agreement</p>
1.d	Procurement Plans	Preparation of realistic annual Procurement Plan as guided by the Procurement Guidelines, tied to annual work plan and budget and revise from time to time if needed.	Executing agency, implementing agency	<p>First Year Plan complete by appraisal and attached to the Minutes of Loan Negotiations</p> <p>Annually thereafter in July</p>
1.e	Informal payments by contractors, suppliers and consultants	All contractors, suppliers and consultants – firms or individuals, national and international – bidding for contracts under the Project shall sign the Declaration on Ethical Conduct and Fraud and Corruption in the SOP/ procurement manual.	Executing agency, implementing agency and MEF	Throughout project duration
Element 2: Financial Management				
2.a	Weak internal controls.	<p>Strengthen financial management system and internal controls function by ensuring that the Project uses SOP including procedures in the FMM, which cover:</p> <ul style="list-style-type: none"> (i) financial policies and standards; (ii) elements of internal control; (iii) financial accounting system, ledgers, journals; (iv) bank accounts and credit/grant withdrawals; (v) Project expenditure, payroll, petty cash, advances; and (vi) financial management reports, audit, counterpart funds withdrawals. 	MEF to monitor for compliance with SOP/FMM, as well as Loan Agreement and ADB's Anticorruption Policy	Throughout Project duration

No.	Risks	Action to Mitigate Risk	Responsibility	Target/ Monitoring
2.b	Weak financial management capacity	<p>The executing agency and implementing agency to receive continued hands-on training and technical assistance from consultants recruited under the Project. The Government's FMM and Financial Management Activities, which was issued in May 2012. The SOP will be used under the Project, as well as relevant provisions of the Loan Agreement and ADB's Procurement Guidelines and Consulting Guidelines.</p> <p>Project to closely monitor and review financial management conduct and make necessary improvements as required.</p>	<p>Executing agency, implementing agency and ADB</p> <p>Executing agency and implementing agency and ADB</p>	Throughout Project duration
2.c	Minimize cash transactions	Where not applicable for petty cash procedures stated in PAM, Project to make all progress payments to contractors, suppliers and consultants – firms, individuals, national and international – by check or transfer to bank accounts, and retain evidence for audit and donor supervision missions.	Executing agency and implementing agency	Throughout Project duration
2.d	Delayed or non-existent reconciliation of advances for operating costs and expenses	<p>Project to reconcile operating expenses to staff or field offices within one week of the end of each month.</p> <p>No further advances to be paid until previous advance reconciled and cleared against documentary evidence.</p>	Executing agency and implementing agency	Throughout Project duration
Element 3: Disclosure				
3.a	Conflict of interest among Project staff	All staff to disclose private and public affiliations or personal interest before becoming involved in any Project-related transaction, such as contract award. EA to prepare a declaration statement for staff's signature and keep it posted in the project website.	EA and IA to ensure all PRC staff sign the disclosures	Throughout Project duration
3.b	Inadequate transparency and disclosure	<p>For all contracts subject to prior review, within two weeks of receiving ADB's no-objection letter to the recommendation of contract award, executing agency will publish on its website the results of the bid evaluation, identifying the bid and lot numbers, and providing information on:</p> <ul style="list-style-type: none"> (vii) name of each bidder who submitted a bid; (viii) bid prices as read out at bid opening; (ix) name and evaluated prices of each bid that was evaluated; (x) name of bidders whose bids were rejected and the reasons for their rejection; and (xi) name of the winning bidder, and the price it offered, as well as the duration and summary scope of the contract awarded. <p>For contracts subject to post review, MPWT will publish the bid evaluation results no later than the date of contract award.</p> <p>At a minimum, the Project will disclose the information required by the Loan Agreement.</p>	Executing agency and implementing agency to arrange disclosure once the information is available	Throughout Project duration
Element 4: Complaints and Remedies Mechanism				

No.	Risks	Action to Mitigate Risk	Responsibility	Target/ Monitoring
4.a	Inadequate complaints and remedies mechanisms	Project to build well-defined complaints and remedies mechanism into Project documents.	Executing agency and implementing agency in consultation with ADB	At effectiveness
		Complaints procedures regarding procurement to follow process set out in Loan Agreement and SOP/PM.	Executing agency and implementing agency	At effectiveness
		Following established publication of evaluation and awards, debriefing mechanism is also necessary not only to enhance transparency but also for the losing bidders to know their weak points.	Executing agency and implementing agency in consultation with ADB	At effectiveness
Element 5: Code of Ethical Conduct				
5.a	Poor enforcement of the Code of Conduct for civil servants	Project to provide copies of the relevant laws and articles on Code of Conducts for civil servants to all Project staff, including contracted staff. Project will maintain signed declaration of receipt of these documents by all Project staff, including contracted staff.	Executing agency and implementing agency	Throughout Project duration
		Similarly, all members of the procurement committee undertaking the evaluation shall sign the Declaration on Ethical Conduct.	Executing agency, implementing agency, and MEF	Throughout Project duration
		If necessary, Project to design the code for all project implementation staff (including contract staff and consultant), distribute to all staff, obtain acknowledgement of staff receipt and post the list in project website.	EA in consultation with ADB	Effectiveness
Element 6: Sanctions				
6.a	Inadequate sanctions for fraudulent and corrupt activity by Project staff, contractors, suppliers and consultants	The Project to identify and apply sanctions available under current law and regulations of Cambodia, ADB's Loan Regulations, the Loan Agreement, and ADB's Procurement Guidelines and Consulting Guidelines. Sanctions for individuals may include transfer of duties, retraining, suspension, dismissal, re-grading, and prosecution under Cambodian Law. Sanctions for firms may include: termination of contract, debarment or blacklisting under ADB's Procurement Guidelines and Consulting Guidelines, or prosecution under Cambodian Law.	Executing agency and implementing agency, and in consultation with ADB	Effectiveness
Element 7: Project Specific Risks				
7.a	Poor enforcement of contract terms and needing to conduct contractors performance evaluation	Executing agency to ensure that contract terms are strictly enforced and the loan consultant will be a party to ensuring quality control of contract outputs, include acceptance of completion of works and services.	Executing agency and implementing agency	Throughout Project duration
		The executing agency to conduct performance evaluation of all contractors providing all types of services under the Project. (also see 7c).	MEF to oversight and monitor the progress and constraints	
7.b	Poor quality of design and works construction	Executing agency and implementing agency to ensure that approved infrastructure's design standards and specification developed by the respective agencies are utilized for the design of structures under the Project.	Executing agency and implementing agency, and with ADB NOL	Throughout Project duration
		Project to recruit experienced design		Contract

No.	Risks	Action to Mitigate Risk	Responsibility	Target/ Monitoring
		consultant on a timely basis to assist the Project. Site supervision by project engineering consultants shall be conducted regularly (also see 7c).		signed immediately after effectiveness
7.c	Risk of low quality construction and supervision	<p>Project to recruit experienced site supervision consultants to assist executing agency and implementing agency.</p> <p>Regular technical audit is to be undertaken with any adverse findings to be acted upon immediately.</p> <p>Project to evaluate contractors' performance with poor performing contractors declared ineligible to bid for at least one year.</p>	<p>Executing agency and implementing agency, and with ADB NOL</p> <p>Executing agency and implementing agency</p> <p>Executing agency and implementing agency, and with ADB NOL</p>	<p>Prior to award of first works contract.</p> <p>Throughout Project duration.</p> <p>Annually in July</p>

ADB = Asian Development Bank, FMM = Financial Management Manual, MEF = Ministry of Economy and Finance, MPWT = Ministry of Public Works and Transport, NOL = no-objection letter, PMU = project management unit, SOP = standard operating procedures.

12 PROJECT IMPLEMENTATION

12.1 EXECUTING AGENCY

673. The EA will be the MPWT, and the project will be implemented by PMU3.

12.2 PROJECT MANAGEMENT

674. The costs of managing the project by PMU3 will be met by the project. The cost of project management has been estimated to include support for all project components throughout the period of the project.

12.3 IMPLEMENTATION PLAN

675. It is estimated that the implementation period for the project will be four years as shown in Figure 12.1. The implementation plan anticipates that advanced action will be undertaken to engage the DD consultants and Supervision consultant during the loan processing period. This greatly advances the progress towards the commencement of civil works contracts and therefore the overall implementation of the project. The schedule under consideration for the Loan is:

Loan signing:	31 September 2017
Loan Effectiveness:	31 December 2017
Earliest starting date:	30 April 2017

Table 12.1 Project Investment Plan

Item		Amount ^a (US\$ million)
A.	Base Cost ^b	
	1. Civil Works for road rehabilitation	21.27
	CW1 package, Improve PR312	8.85
	CW2 package, Improve PR23	7.92
	CW3 package, Safety school zone	0.41
	Land Acquisition	2.08
	Consulting Services	
	- Detailed Design	-
	- Implementation Construction Supervision	2.01
	2. Increased Road Safety and Safeguards	0.20
	- Community based Road Safety Program	0.20
	- HIV/AIDS and Human Trafficking Prevention Program	-
	3. Project Management	0.39
	Subtotal (A)	21.85
B.	Contingencies ^c	
	1. Physical Contingency	1.94
	2. Price Contingency	1.81
	Subtotal (B)	3.75
C.	Financial Charges During Implementation	
	1. Interest during Construction ^d	0.42
	Subtotal (C)	0.42
	Total (A+B+C)	26.02

^a Includes taxes and duties of US\$ 4.21 million

^b In mid 2016 prices.

^c Physical contingencies computed at 10% for base cost. Price contingencies computed for foreign exchange costs and local currency costs based on the annual rates includes provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.

^d Interest during construction has been computed at 1%.

Source: Asian Development Bank estimates.

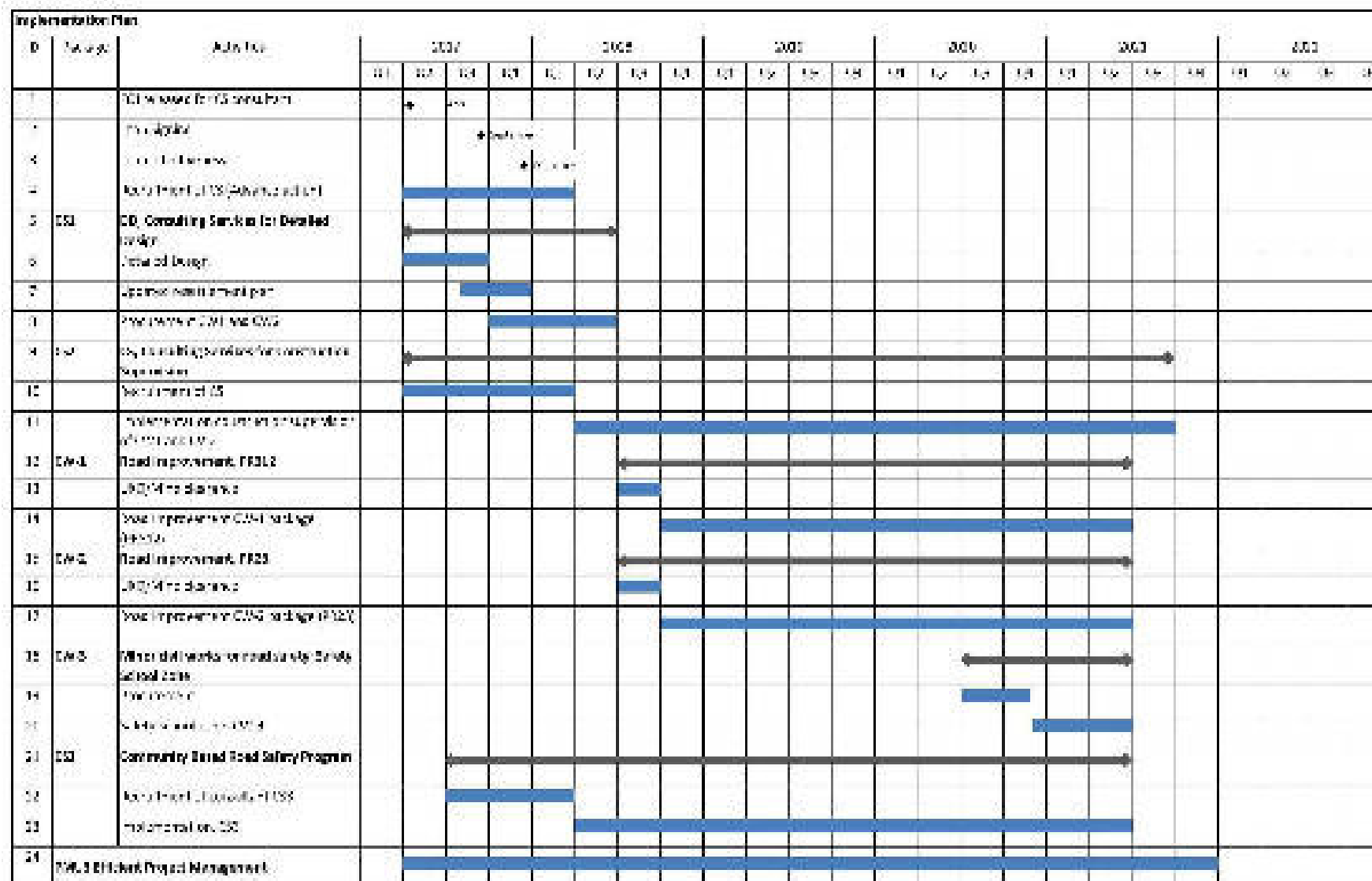


Figure 12.1 Project Implementation Plan

13 CONCLUSION AND RECOMMENDATIONS

676. The preliminary designs for approximately 132.8 km of provincial roads in four provinces, Kampong Chhnang, Pursat, Prey Veng and Kandal have been completed. The roads are designed to the full Cambodian engineering standard with sealed shoulders and the designs are consistent with the motorized traffic they will carry and safe for vulnerable road users.

677. The roads have been widened within the construction limits to provide a safer road profile consistent with the volume of traffic expected in the future. For PR1534 the road width has been increased from 2~7.5m to 8m to provide a safe travelling way for two lane traffic. Provincial roads with a width of less than 8 m are inadequate for the needs of MPWT's service provision and this is an essential step towards providing suitable transport infrastructure to support Cambodia's development. One realignment section has been designed to ensure the route is consistent with the movement of local and through traffic and avoid the conflict with mobile phone tower at PK 71.3.

678. For PR312, the road width has been increased from paved 5.5~8.0m to 9.5 m with 1.5 m shoulders on each side to provide a safe travelling way for two lane traffic. For PR23, the road width has been increased from 2~7.2m to 9.5m. One realignment section has been designed to connect with Koh Thom Bridge for trade facilitation and development of the remote rural economy.

679. The roads have been raised generally to reduce the risk of flooding. For PR1534, some sections of road level will be raised between 60cm to 90cm for the risk of climate change causing flooding with suitable drainage plans. For PR312, road will be raised by the height of the pavement thickness, approximately 45cm. for PR23, road will be raised minimum 60cm up to 1.3m, especially a section at PK 18.4 is required more than 3.0m embankment height due to swamp area.

680. For PR1534 existing lateritic wearing course and for PR312 existing pavement can be used as selected subgrade. New subbase can be constructed on the existing pavement or wearing course. The material from the existing pavement of this road therefore can be scarified to a depth of 100mm from surface, spread over the full width and re-compact.

681. To meet the prescribed requirement to use an aggregate road base for the project roads, the alternative of using stabilization of the local materials has not been considered in depth. From previous experience MPWT have concerns about the construction quality that can be achieved and the cost of poor performance of this critical layer in the road pavement. Materials has to be produced by self installing crushing plants or material to be procured from existing commercial producers from quarries having hauling distance between 30km and 150km. The cost of aggregates is expensive not only for the project roads but also to the wider road network travelled by heavily loaded trucks.

682. This surfacing will protect the pavement below by waterproof seal. It will also provide sufficient skid resistance properties. However this surfacing do not contributes countable structural strength to the pavement layer. DBST surfacing has been considered in the design for each project road sections because it lowers the overall project cost, easy to construct and maintain compared to Asphalt Concrete Surfacing.

683. The project will replace 11 bridges into concrete bridge and construct 1 new bridge. As drainage structures, there are 43 existing box culverts, and the project will replace 21 box culverts including replacing timber bridge with box culvert and newly construct 2 new box culverts. There are 83 pipe culverts, among them the project will replace 79 pipe culverts and 4 pipe culverts will be replaced with box culverts. 18 new pipe culverts will be constructed.

684. To meet the requirements for climate resilience in the road design firstly the roads are to be paved with a bituminous surface treatment as mentioned. The roads will be raised and drainage structures will be increased.

685. The conclusion from the engineering perspective is that the roads have been designed according to the accepted standards and will provide durable service. There are no significant adverse technical issues present that could increase risks sufficiently to prevent or delay the implementation of the project.

686. The locations of PR1534, PR312 and PR23 situate in the areas where aerial bombing and land armed conflict took place at some point of time in a Cambodian long civil war (1970-98). To ensure the safety of the project, first, Mine/UXO clearance operation must be carried out. Second, Mine/UXO awareness must be provided to contractor and local people so that they would be able to ID, to help report the contaminated objects, if any, and they would be able to stay and work safe for years to come.

687. The road PR1534 in Kampong Chhnang and Pursat does not traverses the transition, buffer or core zones of Tonle Sap Biosphere Reserve. Road PR1534 never approaches closer than 3.5kms to the boundary of Phnom Aural Wildlife Sanctuary (PAWS). There will be no impacts on PAWS or any other protected areas. Public consultations have been conducted and the participants voiced favorable response to the project.

688. The requirements for social safeguards have been assessed. Overall, the people consulted, during the baseline survey are in favor of the project. The benefits or positive impacts range from increased incomes to better access to services. However they voiced the concern that road accidents may increase. The project is perceived by the people as an intervention that could help reduce poverty especially in the rural areas, where majority of the households are poor. The recommendation is that it is imperative to implement the mitigation measures that will address the social risks. These are the HIV/AIDS, and human trafficking program to prevent, minimize or mitigate negative impacts of the project, and address the key gender issues that may arise due to the project by implementing the Labor and Gender Action Plan. HIV/AIDS and anti-human trafficking program will be carried out by government fund.

689. However, due to funding constraint, PR1534 has been excluded from the project scope by the government during Fact-finding Mission on November 2016. Therefore, project scope has been adjusted as implementation of PR312 and PR23 with the length of 48.3 km.

690. A consolidated Resettlement Plan had been prepared for PR312 and PR23. Losses and land requirements for the project have been minimized by careful attention to limit the COI and to reduce it through town areas. Public consultations have been conducted and the affected persons are in favor of the project. The resettlement costs are considered to be reasonable.

691. For gender, the proposed project is effective gender mainstreaming (EGM) based on ADB gender mainstreaming category, and Category C for IPs who will be adversely affected by the project. A Gender Action Plan (GAP) has been prepared to ensure this project is socially inclusive for women, poor and other vulnerable persons.

692. The PSA concluded that the project will provide positive benefits to the local people and the communities within the project area. It will also benefit the women, low income households, and other vulnerable persons in the project areas. All (100%) of the people who participated in the public consultations are in favor of the proposed project. Likewise, over 85% of the social survey respondents are in favor of the project and perceived that the project is essential.

693. Road accident rates in Cambodia are severe and road improvements tend to increase traffic speeds. A community base road safety program has been devised for the project areas that are consistent with the National Road Safety Action. The program focuses on creating a sustainable approach to road safety and engendering high levels of responsibility within the local communities. The program should be implemented throughout the period of the project.

694. The economic viability of the project has been determined through proven analysis techniques. The appraisal has been carried out for two road sections. The lowest is 18.5% and the highest is 22.1%. The proposed whole sections have an economic feasibility with EIRR of 20.4%. Each of the individual project roads is also above the threshold of 12%. Therefore, the implementation of the project is economically feasible from view point of national and regional economy.

APPENDICES

Appendix 1 : 2016 Base Year Traffic Data by Vehicle Type (AADT)

Appendix 2 : Cost and Benefit Flows for the Project (Undiscounted)

Appendix 3 : Gender Action Plan (GAP)

Appendix 4 : Summary Poverty Reduction and Social Strategy (SPRSS)

Appendix 1 :

2016 Base Year Traffic Data by Vehicle Type (AADT)

Vehicle Class			I. NMTR	II. MC		III. Light Vehicle (LV)						IV. Heavy Vehicle (HV)						
			Bicycle	Motor-cycle	Motorcycle Trailer	Car	Jeep/4WD	Pick- up	Mini bus	Koyun/Etan		Truck	Truck	M&L	Heavy Truck			
										Small	Large	Light	Medium	Bus	Heavy 1	Heavy 2	Trailer 1	Trailer 2
			1	2	3	4	5	6	7	9	10	11	12	8	13	14	15	16
Road Number	Count Location	Province			Incl. 3 wheel	Max 7 Seats	Max 7 Seats	Freight Use only	8-16 Seats	Small tractors	Locally-made trucks	Light truck (<4 tons)	(>4 tons)	16+ Seats	Rigid (3 Axle)	Rigid (4&5 Axle)	Semi Trailer 4&5 Axle	Semi & FullTrailer with 6+ Axle
PR1534	PK 33.5km (from NR53)	Kampong Chhnang (KCH)	169	994	36	28	35	27	39	304	20	11	-	3	11	-	-	-
	PK46.8km (from NR53)	Pursat (PST)	530	2,344	53	61	33	17	72	228	28	16	3	-	7	3	3	-
PR312	PK 4km (from NR1)	Prey Veng (PVG)	342	2,543	127	125	152	29	189	21	112	44	27	3	-	9	3	8
PR 23	PK 7km (from Junction NR21B via concrete road)	Kandal (KDL)	2,286	3,603	55	1	5	1	21	21	23	7	4	1	-	-	-	-

Source: Consultants traffic count, 2016

Appendix 2 :

Cost and Benefit Flows for the Project (Undiscounted)

(US\$ million)

Year	Costs		Benefits			Net Benefits
	Capital Works	Road Maintenance	VOC Savings	Time Savings	Non-MT	
2017	0.000	0.000	0.000	0.000	0.000	0.000
2018	4.993	0.000	0.000	0.000	0.000	-4.993
2019	5.901	-0.002	0.137	0.026	0.010	-5.726
2020	6.070	-0.002	0.429	0.105	0.034	-5.500
2021	5.355	-0.064	0.128	0.016	0.011	-5.136
2022	0.000	-0.002	1.514	0.812	0.077	2.405
2023	-0.059	-0.002	2.048	1.008	0.113	3.230
2024	-0.869	-0.064	1.816	0.984	0.088	3.822
2025	0.000	-0.002	2.142	1.233	0.101	3.479
2026	-0.059	-0.002	2.518	1.418	0.118	4.113
2027	1.430	-0.064	2.187	1.392	0.080	2.293
2028	0.000	-0.002	2.914	1.812	0.133	4.861
2029	-0.059	-0.002	3.448	2.094	0.152	5.754
2030	0.000	-0.002	3.056	2.106	0.102	5.267
2031	0.000	-0.002	4.694	2.777	0.181	7.654
2032	-0.059	-0.002	5.619	3.271	0.204	9.156
2033	0.000	-0.002	5.421	3.498	0.141	9.062
2034	0.000	-0.002	8.225	4.775	0.243	13.245
2035	-0.059	-0.002	10.650	6.216	0.272	17.198
2036	0.000	-0.002	11.855	7.528	0.192	19.577
2037	0.000	-0.002	15.448	9.075	0.324	24.851
2038	-0.059	-0.002	18.991	11.184	0.360	30.596
2039	0.947	0.014	24.071	15.728	0.199	39.037
2040	0.000	-0.002	39.743	25.298	0.341	65.384
2041	-0.928	-0.064	43.862	27.736	0.377	72.966
Total:	22.549	-0.277	210.917	130.093	3.853	322.592
					NPV	22.90
					EIRR(%)	20.4

EIRR = economic internal rate of return, NPV = net present value (discounted at 12%)
Source : DDIS Consultants, 2016

Appendix 3 :

Gender Action Plan (GAP)

1. Background.

The Second Provincial Roads Improvement Project (PRIP-II) is an ADB financed project, under Ministry of Public Works and Transport (MPWT) as the Executing Agency (EA). The project aims rehabilitate about 132 km) provincial roads to paved condition in 14 communes, 6 districts within 4 provinces (Kampong Chhnang, Pursat, Prey Veng and Kandal) of Cambodia. It will provide a cost-effective provincial road network access to markets and other social services. The project will support a sustainable road maintenance regime in MPWT, HIV/AIDS and human trafficking awareness and prevention program. A total of over 178,588 population (50.7% women) and 36,066 households and 40,668 families, and of which 4.5% are female-headed households will be benefited by the project. This GAP ensures that women will be given equal benefits and opportunities for participation during project implementation by addressing gender concerns and ensuring efficient gender mainstreaming in all project outputs as shown in DMF and matrix below.

2. Gender and Infrastructure. Based on the GAP monitoring report on labour force employed by contractors under the ADB Loan 2839 CAM (SF)8254-CARM: Provincial Roads Improvement Project, under MPWT, which includes data from October 2014 to March 2016, “women have been responsible for an average of 21% of all civil works person days. The data on the share of women in civil works is broken by area as well as skilled and unskilled jobs, as follows:

Area	Skilled Labour	Unskilled Labour	Total
CW-A Southeast	24%	16%	23%
CW-B1-Southeast	27%	16%	24%
CW-C Midwest	11%	26%	17%
Total	20%	22%	21%

The project will provide significant benefits to the project beneficiaries by facilitating faster and more convenient transport, and better access to basic social services and facilities. Local producers will have greater access to markets, which will increase households' income. Farmers could easily transport products, and road construction could generate jobs and provide income for the local people including women and poor people. Potential risks or unintended negative impacts that may arise during project implementation include (i) road accidents, (ii) land acquisition and resettlement impacts; (iii) spread of HIV/AIDS and increase in human trafficking cases due to improved road connectivity; and (iv) environmental impact such as dust and noise during road construction. These could be mitigated by implementing safeguard measures, including road safety awareness, HIV/AIDS and Human Trafficking Prevention Program (HAHTAPP).

3. Gender Mainstreaming. Greater gender equality in labor-based road construction and maintenance will provide significant social benefits to local communities and households. Women can participate in jobs, i.e. repairing potholes, cleaning pavement, clearing ditches and culverts, etc. They could also work in maintaining embankments, plant and care for trees to protect erosion. The project will also organize capacity building and awareness raising activities on gender, LBAT, core labor standards, HIV/AIDS and human trafficking awareness and prevention, and road safety. The project will support the Gender Mainstreaming Action Group (GMAG) to implement relevant sections of the Gender Mainstreaming Action Plan (GMAG) 2016-2020.

4. Implementation Arrangements. The GAP will be implemented by the MPWT through the PMU and social and environment office (SEO). MPWT will be assisted by one international social development specialist and one national labor and gender specialist to ensure effective implementation of the GAP indicators. Detailed plans and activities for the implementation of the GAP, monitoring and evaluation tools will be prepared, including monthly and quarterly progress report, mid-term and final report that will be submitted to ADB.

Project Output	Proposed Activities and Targets	Agency / Person Responsible
Output 1: Improved road Maintenance	<ul style="list-style-type: none"> Civil works will utilize the labor-based appropriate technology (LBAT); contractors will prioritize use of local unskilled labor. Contractors cumulative skilled and unskilled labor days will be at least 20% women by 2022. Skilled and unskilled men and women will receive equal pay for equal work. Capacity development focused on LBAT with topics on gender awareness, core labor standards, and safeguards in local people including women and poor people. 	<ul style="list-style-type: none"> - MPWT/ PMU3/ SEO -Consulting Services (DDIS)/ Social & gender Specialists (2) - Contractors
Output 2: Increased road safety and awareness of potential social Problems	<ul style="list-style-type: none"> All project roads will have road safety signage and speed bumps to slow down traffic in local communities, especially in front of schools, hospitals, markets, mosques, pagodas, etc. At least 40% of project beneficiaries (50% women) in project areas participate in HIV/AIDS and human trafficking awareness and prevention program, before and during civil works, by 2022. 100% of contractors' personnel participate in HIV/AIDS and human trafficking awareness and prevention program before and during civil works construction, by 2021. Sex-disaggregated baseline socioeconomic data established, by 2019. Mothers will have a share of at least 30% of the participants in community-based road safety awareness activities by 2021. 	<ul style="list-style-type: none"> -MPWT/ PMU3/ SEU -MPWT Gender Technical Working Group -Consulting Services/ DDIS Social/gender specialists (2) -Consultants -Contractors -Other agencies
Output 3: Reduced vulnerability to climate change.	<ul style="list-style-type: none"> Women participants in meetings, training and awareness campaign on climate change related training and activities including livelihoods capacity building relevant to the output (at least 30% women) by 2022. Participation of women in civil works (i.e. planting and taking care of trees, and other activities during project implementation shall be at least 20%. 	<ul style="list-style-type: none"> MPWT/ PMU3/ SEU -MPWT Gender Technical Working Group -Consulting Services/ DDIS Social/gender specialists (2) -Consultants -Contractors
Output 4: Efficient project Management	<ul style="list-style-type: none"> PMU3 personnel increased from 15 (10 male, 5 female) in 2014 to 22 (14 male, 8 female) in 2021. All PMU3 staff (current 10 male, 5 female) participate in training on social safeguard and gender awareness/analysis, by 2021 (likely 22 with 14 14 male and 8 female). 	<ul style="list-style-type: none"> -MPWT/ PMU3/ SEO -Consulting Services//DDIS Social/gender specialists (2)

HAHTAPP = HIV/AIDS and human trafficking prevention program; GAP = gender action plan;
MOE = Ministry of Environment, MPWT = Ministry of Public Works and Transport;
NGO = non-government organization, PMU = project management unit.

Appendix 4 :

SUMMARY POVERTY REDUCTION AND SOCIAL STRATEGY

Country:	Cambodia	Project Title:	Second Provincial Roads Improvement Project
Lending/Financing Modality:	Project Loan	Department/ Division:	Southeast Asia Department Transport and Communications Division

I. POVERTY AND SOCIAL ANALYSIS AND STRATEGY

Targeting classification: General Intervention. The project will improve access to basic social services in 4 provinces in Cambodia covered by the proposed project. It will improve the lives of rural and urban communities, which constitute over 80% of Cambodia's population.

A. Links to the National Poverty Reduction and Inclusive Growth Strategy and Country Partnership Strategy

ADB supports the promotion of inclusive growth through improved roads support, agricultural production, economic and social development in Cambodia. Expanding rural-urban-regional connectivity is an integrated approach to developing the areas where most poor people live which supports higher agricultural productivity and commercialization.¹ The proposed project is included in the ADB's Country Operations Business Plan (CBOP) 2015 - 2017 and in ADB and Cambodia's Partnership Strategy (CPS) 2015-2018, and further supports the implementation of the country's poverty reduction goal. The CPS is also aligned with the government's Rectangular Strategy for Growth, Employment, Equity, and Efficiency, Phase III, with the NSDP (2014-2018). The CPS builds on two strategic pillars of rural-urban-regional links, and human and social development.

The project supports the country's commitment to sustainable development and poverty reduction goals as stated in Cambodia's Rectangular Strategy for Growth, Employment, Equity, and Efficiency, Phase III, and the National Strategic Development Plan (NSDP), 2014-2018. The "Rectangular Strategy-Phase III" reaffirms the RGC's mission and its strong commitment to sustainable development and poverty reduction that respond to the people's will and emerging contexts of national and international developments. RGC's goal is to graduate from a low-income country to a lower-middle income status in the near future, and become an upper-middle income country by 2030. The project also supports the Cambodia Industrial Development Policy (IDP), 2015-2025 approved by the Council of Ministers on 06 March 2015, to help maintain sustainable and inclusive high economic growth, through economic diversification, strengthening competitiveness and productivity.

B. Results from the Poverty and Social Analysis during PPTA or Due Diligence

1. Key poverty and social issues.

Cambodia has a total population of about 15.41 million in 2015, with a population growth rate of 1.79%.² The country's rural population accounts for about 80.5% (over 2.5 million households) and 19.50% urban.³ About 25.6% of the total households in Cambodia, and 14.5% in the project areas are headed by women. The average household size in Cambodia is 4.7.⁴ The total population in the project areas is 178,588 (90,617 or 50.7% female) with 36,066 households and 40,668 families as of September 2016. The majority of the population is Khmer by ethnicity and less than 1% is Cham (Khmer Islam). Between 2007 to 2012, the poverty rate in the country fell dramatically from about 50% to 20%.⁵ The poverty rate in Cambodia in 2012 was 17.7%, with almost 3 million poor people and over 8.1 million near-poor, and mostly live in the countryside. Although the country achieved the MDG of halving poverty in 2009 but the vast majority of families who escaped poverty were able to do so by a small margin. The areas of health and sanitation, and education are still considered as development priorities in the country.

Access to basic facilities and services is difficult in the rural areas. Access to health centers/hospitals and schools is a major problem of the people especially when roads are in bad condition. Farming is

¹ Ibid.

² World Economic Forum (WEF). Global Gender Gap Index Report 2015.

³ Cambodia Demographic and Health Survey. 2014. Ministry of Planning. National Institute of Statistics, and Ministry of Health. Phnom Penh, Cambodia.

⁴ Cambodia Demographic and Health Survey (CDHS). Cambodia. 2014.

⁵ Ibid.

the primary livelihood of more than 60% of the households in the project area. There is high cases of school drop-outs among children in the lower secondary and high school levels, for employment reason. Migration rate, both within the country from rural to urban centers and overseas, among the households in the provinces in order to look for jobs and higher salary is also high. Of the 4 provinces within the PRIP-II areas, Pursat province has the highest multidimensional poverty index (MPI) registered at 32%, followed by Kampong Chhnang (23%). The poverty rate in Kandal province was 14.6% compared to Phnom Penh with 12.8% in 2012. Prey Veng province has a poverty rate of 21.9%, and the two remaining provinces (Kampong Chhnang and Pursat) in PRIP-II have higher poverty rates registered at 27.7% and 27.8%, respectively.

2. Beneficiaries.

The project will benefit over 178,588 (90,617 or 50.7% female) with 36,066 households and 40,668 families as of September 2016. The majority of the population is Khmer by ethnicity and less than 1% is Cham (Khmer Islam). Improved mobility and transport is expected to contribute to long-term economic development and livelihoods in the project areas. The project road construction will provide job opportunities for the poor local households including women and marginalized individuals who have no jobs, especially during off-farming season. Access to basic facilities and services will be significantly improved after project completion.

3. Impact channels.

Having improved roads is essential for providing better access to public services and facilities, generate employment and economic growth. Local households for both skilled and unskilled labour including women and unemployed female-headed households will have the opportunity to participate in capacity building (such as LBAT), awareness of HIV/AIDS and human trafficking prevention, gender, and community-based safety. Travel time will also be reduced thus, the people could utilize their time wisely for productive activities. Reduced travel time will indirectly contribute to lower freight costs thus contributing to lower input costs and higher ex-farm prices for farm products in the project areas.

4. Other social and poverty issues.

Enhanced connectivity can also have potential and unintended social risks (e.g., increased risk of HIV/AIDS transmission, land acquisition and resettlement, human trafficking, road accidents and environmental impacts). Appropriate social mitigation measures will be implemented to address these social risks/negative impacts such as GAP, HIV/AIDS and Human Trafficking Awareness and Prevention Program, RP, EMP, and Road safety program. Collaboration with concerned agencies, local government units including the commune councils, and the committee of women and children, and other community-based organizations/NGOs will be undertaken during project implementation phase.

5. Design features.

The project will (i) assist the MPWT through the PMU during project implementation. The project has four (4) key outputs: (i) Improved roads (civil works); (ii) Increased road safety and awareness of potential social problems; (iii) Reduced vulnerability to climate change; and (iv) Efficient project management. It will also support a community-based road safety program, an HIV/AIDS and human trafficking awareness and prevention program, with sufficient gender considerations. The project is effective gender mainstreaming according to ADB gender category, and is expected to provide gender benefits during civil works.

II. PARTICIPATION AND EMPOWERING THE POOR

1. Summarize the participatory approaches and the proposed project activities that strengthen inclusiveness and empowerment of the poor and vulnerable in project implementation. Stakeholder consultations in the project area (provincial/district officials, commune/village leaders, contractors, women as well as men, local households, etc.) were conducted for the period August September 2015. Follow-up consultations will be conducted during the detailed design stage and prior to the start of civil works.

2. If civil society has a specific role in the project, summarize the actions taken to ensure their participation. Consultations with the district officials, commune councils/village leaders, women's organizations, health agencies, schools and stakeholders were conducted through FGDs, meetings, baseline survey and public consultations. These consultations will continue in the implementation

phase especially in public awareness campaign on road safety, HATAPP, climate change, and in civil works in relevant key outputs/activities.

3. Explain how the project ensures adequate participation of civil society organizations in project implementation. Collaboration with relevant NGOs, women's organizations, schools, local communities and other sectors will be undertaken during the implementation of the HHTAPP, gender action plan, community-based safety, capacity building such as LBAT. Public consultations involving commune/village councils, and other sectors will be conducted prior to start and during project implementation.

4. What forms of civil society organization participation is envisaged during project implementation? (H) Information gathering and sharing (H) Consultation (M) Collaboration (M) Partnership

5. Will a project level participation plan be prepared to strengthen participation of civil society as interest holders for affected persons particularly the poor and vulnerable? Yes A service provider/NGO will be hired to implement the HIV/AIDS and Human Trafficking Awareness and Prevention Program, community-based road safety, etc. Consultants will be hired to assist the PMU in implementation and monitoring, including preparation of reports.

III. GENDER AND DEVELOPMENT

Gender mainstreaming category: Effective Gender Mainstreaming

A. Key issues. The female population represents 50.5% of the country's total population. At the macro level, gender relations in Cambodia are complex. Women can exercise considerable autonomy, own assets, manage financial transactions, and contribute to household making. Both men and women can inherit property. The gender division of labor can be complementary and flexible, with men and women performing a range of productive and household tasks. However, the low levels of educational and literacy in the country is one of the factors identified that could limit girls and women's choices and options. Participation of women in economic activities is high. The number of women working in garment factories, and social services jobs (i.e., doing laundry, working as house helpers, in restaurants, etc.) is higher compared to men. Likewise, the number of women migrant workers in Cambodia is increasing, although the statistics show that the number of male migrant workers still exceeds that of women. In the project area, the majority of rural women work in agriculture; assist their spouse in farming and other economic activities (i.e., raising livestock, poultry, and engage in selling). In family managed livelihoods such as farming, the women and other household members are not paid compared to paid agricultural laborers working in cassava plantation, forestry and other agricultural work. The project will provide opportunity for the local people including women and marginalized sectors to work and earn income during civil works/maintenance. It will also increase the level of awareness of women on HHTAPP, road safety, LBAT, gender awareness and safeguard measures.

B. Key actions.

[X] Gender action plan [X] Other actions or measures (HIV/AIDS and Human Trafficking Awareness/Prevention Plan (HAHTAPP), Gender Action Plan (GAP) have been prepared. Key activities and indicators in the GAP include: (i) contractors cumulative skilled and unskilled labor days will be at least 20% women by 2022; local women participates in capacity building on LBAT/gender awareness, HHTPP, and at least 20% hired in civil works; (ii) core labor standard (equal pay for equal work); (iii) At least 40% of project beneficiaries (50% women) in project areas participate in HIV/AIDS and human trafficking awareness and prevention program, before and during civil works; (v) women including mothers have a 30% share in community participants in road safety awareness activities by 2020

IV. ADDRESSING SOCIAL SAFEGUARDS ISSUES

A. Involuntary Resettlement Safeguard Category: ☐A ☒B C ☐F1

1. Key impacts. The total number of households who will be affected by land acquisition in the project areas for PRIP-II is 1,919. A total of 149,497.54 sq.m of affected land are residential; 130,806.70 sq. m are farmland; and 550 sq. m are forest land. The total number of Affected Persons (APs) is 2,151 (32.5% women). There are 207 household heads who are widowed, 23 disabled and 369 elderly (60 years old and above). Details on entitlement package and other assistance to APs/ AHs are included in the Project's RP.

2. Strategy to address the impacts. None. Plan or other Actions ☒Resettlement plan ☐No action

B. Indigenous Peoples Safeguard Category:	<input type="checkbox"/> A	<input type="checkbox"/> B	<input checked="" type="checkbox"/> C	<input type="checkbox"/> F1
<p>1. Key impacts. No indigenous peoples will be adversely affected by the proposed project. The IPs live in villages far from the road sides but they will be indirectly benefited by the improved roads. IPs interested to work will have opportunity to be hired by the contractors and participate in awareness campaign during project implementation.</p> <p><input type="checkbox"/>Yes <input checked="" type="checkbox"/>No</p>				
<p>2. Strategy to address the impact. No Indigenous Peoples Development Framework is required.</p>				
<p>3. Plan or other actions. No action</p>				
V. ADDRESSING OTHER SOCIAL RISKS				
A. Risks in the Labor Market				
<p>1. Relevance of the project for the country's or region's or sector's labor market.</p> <p><input type="checkbox"/>unemployment <input type="checkbox"/>underemployment <input type="checkbox"/>retrenchment H <input checked="" type="checkbox"/>core labor standards</p>				
<p>2. Labor market impact. Core Labor Standards (CLS) requirements will be included in the civil works bidding documents and contracts. Orientation on ADB Safeguard Policy Statement (SPS 2009) and strict adherence of the contractors to the CLS (no child labor, equal pay for equal work regardless of sex, safe working conditions, etc.) will be provided to the contractors for civil works; the construction workers including women during LBAT training; and monitoring will be conducted on a quarterly basis. The DDIS consultant with the PMU/ SEO and PPWT will participate in project monitoring.</p>				
B. Communicable Diseases and Other Social Risks				
<p>1. Indicate the respective risks, if any, and rate the impacts as high (H), medium (M), Low (L), or not applicable (NA): H Communicable diseases M Human trafficking</p>				
<p>2. Describe the related risks of the project on people in project area. Increased risk of road accidents is associated with improved roads will lead to increased traffic speeds and traffic. Community-based road safety awareness activities are included in the project. The project improves existing roads rather than build new roads. As such the risk of increased HIV transmission is considered highest during the construction phase due to the presence of construction workers and the risk of increased human trafficking is considered medium. HHTAPP has been prepared.</p>				
VI. MONITORING AND EVALUATION				
<p>1. Targets and indicators: The target activities and indicators include the following: (i) women to comprise at least 20% of civil works labor participation; women are to comprise 40% of the participants in community-based road safety awareness; and HHTPP; and at least 20% of participants in LBAT shall be held by women.</p>				
<p>2. Required human resources: 1 international social safeguards/development specialist; 1 national labor and gender specialists will assist the PMU/SEU in implementing and monitoring the GAP, HHTAPP, etc. An NGO/service provider (consulting services) will be engaged to implement the road safety awareness, HIV/AIDS and human trafficking prevention and awareness program. The SEO will be provided additional capacity building activities by the DDIS consultants.</p>				
<p>3. Information in PAM: The PAM specifies that monthly and quarterly project progress reports, including internal monitoring of the social dimensions covered in the SPRSS, will be submitted to ADB during project implementation. A project completion report covering the same facets will also be prepared one year following completion of the project.</p>				
<p>4. Monitoring tools: GAP quarterly progress monitoring report will be prepared to monitor implementation of the GAP, baseline sex-disaggregated data will be collected to serve as basis for monitoring of the project.</p>				