MINISTRY OF PUBLIC WORKS AND TRANSPORT(MPWT)
THE ROYAL GOVERNMENT OF THE KINGDOM OF CAMBODIA

PREPARATORY SURVEY FOR NATIONAL ROAD NO. 5 IMPROVEMENT PROJECT (MIDDLE SECTION: THLEA MA'AM – BATTAMBANG, AND SRI SOPHORN – POIPET) IN THE KINGDOM OF CAMBODIA

FINAL REPORT

(VOLUME I MAIN REPORT)

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Location Map of Survey Area

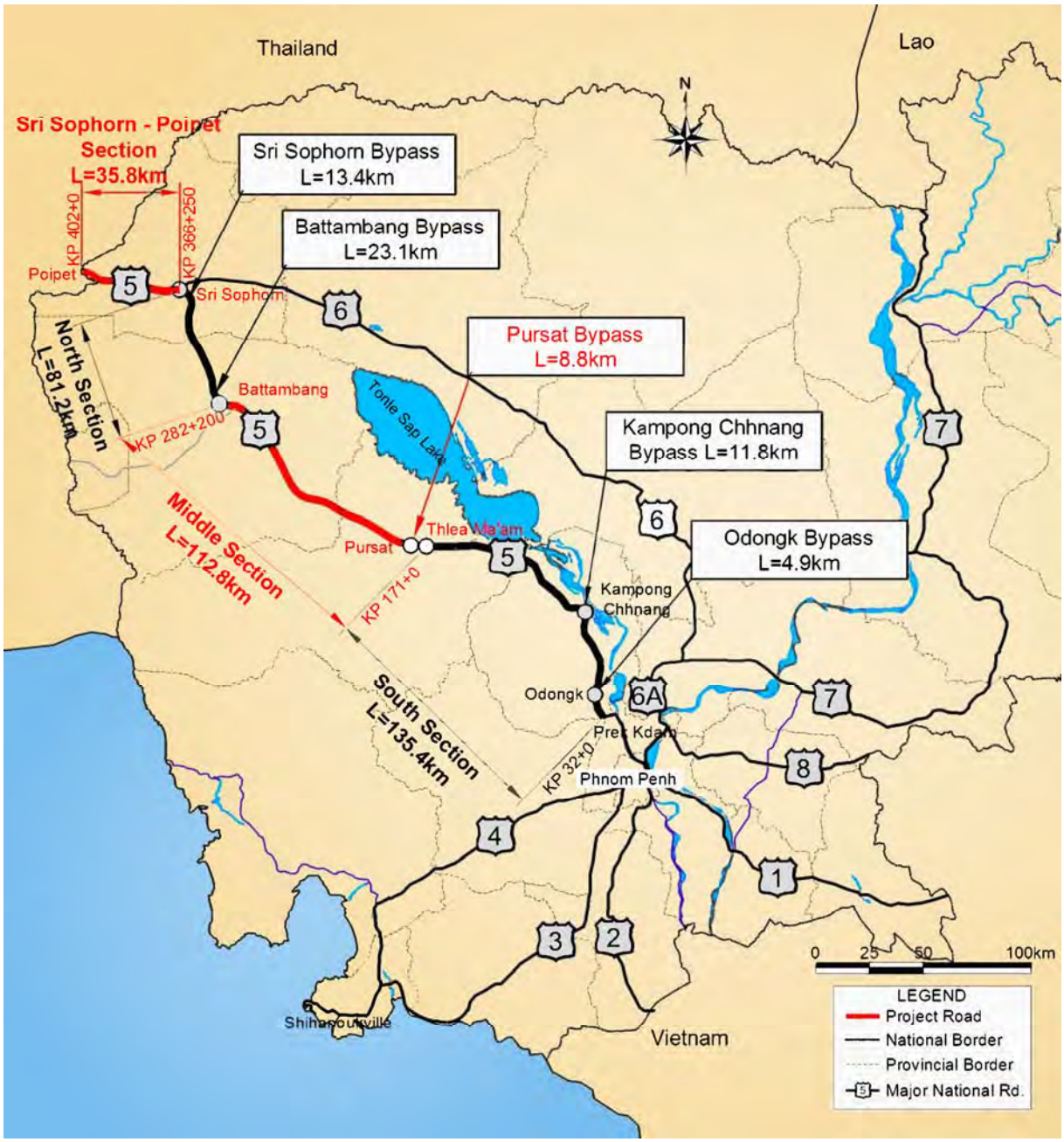


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LIST OF ABBREVIATIONS (1/4)

AASHTO	: American Association of State Highway and Transportation Officials
AC	: Asphalt Concrete
ADB	: Asia Development Bank
AH	: Affected Household / Asian Highway
AIDS	: Acquired Immune Deficiency Syndrome
ALEF	: Axle Load Equivalent Factor
APs	: Affected People
ASEAN	: Association of South East Asian Nations
ASTM	: America Society for Testing and Materials
Bc	: Box Culvert
B/C	: Benefit Cost ratio
BM	: Bench Marks
BP	: Bypass
BQ	: Bill of Quantities
Br	: Bridge
CBR	: California Bearing Ratio
CBTA	: Cross - Border Transport Agreement
CDC	: Council for the Development of Cambodia
CF	: Community Fishery
CMAC	: Cambodian Action Mine Centre
COI	: Corridor of Impact
CRIP	: Cambodia Road Improvement Project
DBST	: Double Bituminous Surface Treatment
DE	: Department of Environment
DEIA	: Department of Environmental Impact Assessment
D/D	: Detailed Design
DMS	: Detailed Measurement Survey
DPs	: Development Partners
DPWT	: Department of Public Works and Transport
EA	: Executing Agency
EIA	: Environmental Impact Assessment
EIRR	: Economic Internal Rate of Return
EFRP	: Emergency Flood Rehabilitation Project
ESAL	: Equivalent Single Axle Load
ESC	: Environmental and Social Considerations
FAO	: Food and Agriculture Organization
FDRMP	: Flood Disaster Rehabilitation and Mitigation Project

LIST OF ABBREVIATIONS (2/4)

GDP	: Gross Domestic Product
GDI	: Gender-related Development Index
GEM	: Gender Empowerment Measure
GII	: Gender Inequality Index
GL	: Ground Level
GMS	: Grater Mekong Sub region
GOC	: Government of Cambodia
GPS	: Global Positioning System
GRDP	: Gross Regional Domestic Product
HIV	: Human Immunodeficiency Virus
HV	: Heavy Vehicle
ICD	: International Cooperation Department (of MPWT)
ICT	: Information and Communication Technology
IEIA	: Initial Environmental Impact Assessment
IOL	: Inventory of Loss
IP	: Intersection Point
IRC	: Inter-Ministerial Resettlement Committee
IRC-WG	: IRC-Working Group
IRITWG	: Infrastructure and Regional Integration Technical working Committee
JICA	: Japan International Cooperation Agency
kN	: kilo Newton
KP	: Kilometer Post
LA (L/A)	: Loan Agreement
LV	: Light Vehicle
MC	: Motorcycle
MEF	: Ministry of Economic and Finance
MOE	: Ministry of Environment
M/P	: Master Plan
MPWT	: Ministry of Public Works and Transport
MSL	: Mean Sea Level
N.A.	: Not Applicable
NCDM	: National Committee for Disaster Management
NPV	: Net Present Value
NR	: National Road No.
NSDP	: National Strategic Development Plan
OD	: Origin Destination
ODA	: Official Development Assistance

LIST OF ABBREVIATIONS (3/4)

PAPs	: Project Affected Person(s)
Pc	: Pipe Culvert
PC	: Pre-stressed Concrete
PCDG	: Pre-tensioned Precast Concrete Deck Girder
PCU	: Passenger Car Unit
PDEF	: Provincial Department of Economy and Finance
PDPWT	: Provincial Department of Public Works and Transport
PMED	: Provincial / Municipal Environmental Department
PMU	: Project Management Unit
PMU-ES	: Environmental Section of PMU
PPP	: Public Private Partnership
PPUTMP	: Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City
PQ	: Pre-Qualification
PRC	: People's Republic of China
PRRP	: Primary Roads Restoration Project
PRSC	: Provincial Resettlement Sub Committee
PRSC-WG	: PRSC Working Group
PRW	: Provisional Road Width
PSC	: Pre-tensioned Precast Plank hollow slab
PWRC	: Public Work Research Center
RAMP	: Road Assets Management Project
RAP	: Resettlement Action Plan
RC	: Reinforced Concrete
RD	: Resettlement Department (of MEF)
RCDG	: Reinforced Concrete Deck Girder
RCS	: Reinforced Concrete Flat Slab, also Replacement Cost Survey
	: Replacement Cost Survey
RGC	: Royal Government of Cambodia
ROW	: Right of Way
SC	: Steering Committee
SEZ	: Special Economic Zone
SHM	: Stakeholder Meeting
SN	: Structure Number
SPT	: Standard Penetration Test
STRADA	: System for Traffic Demand Analysis
TSBR	: Tonle Sap Biosphere Reserve
UNDP	: United Nations Development Plan

LIST OF ABBREVIATIONS (4/4)

UNESCO	: United Nations Educational, Scientific and Cultural Organization
UXO	: Unexploded Ordnance
VAT	: Value Added Tax
VCR	: Traffic Volume per Capacity Ratio

CHAPTER 1 INTRODUCTION

1.1 Background of the Survey

In the Kingdom of Cambodia ("Cambodia"), the road transport accounts for around 65% of the passenger transport, for 70% of the freight transport, and plays the most important role in the domestic transport. During the civil war in the 70's to 80's, most of the roads were deteriorated due to poor (practically non - existent) maintenance. Since 1993, the rehabilitation has progressed with the assistance of Japan, the United State, Australia, Asian Development Bank (ADB), World Bank and other development partners.

National Road No.5 (NR 5) is the trunk national road connecting the capital city of Phnom Penh to a major city of Battambang and then to Bangkok through Thai border city of Poipet. It is also designated as Asian Highway No.1 or the Southern Economic Corridor of Grater Mekong Sub-region (GMS). However, all the road surface type is double-layered bituminous surface treatment (DBST) and the surface condition is being deteriorated due to rapidly increasing heavy vehicles, as well as inundation / flood except the surface of the sections of 12.6 km from Phnom Penh and between Sri Sophorn and Poipet where asphalt concrete (AC) is adopted to their surfaces.

Under such situation, Japan International Cooperation Agency (JICA) dispatched a survey team to Cambodia in November 2010 and reached agreement to conduct the Preparatory Survey on improvement of North Section (between Battambang and Sri Sophorn) and South Section (between Prek Kdam Bridge and Thlea Ma'am) of NR 5. The survey named as "Preparatory Survey for National Road No.5 Rehabilitation Project" started in February 2011. As the result of this survey, the North Section (Approx. 68 km) was selected as the high priority section. Loan agreement for improvement of the North Section was signed by the Royal Government of Cambodia (RGC) and Japan on 16th of May, 2013.

After that, severe flood occurred in September 2011, and many parts of the South Section were damaged. Thus RGC and JICA agreed to conduct Survey on the South Section (approx. 139 km). The survey named as "Preparatory Survey for National Road No.5 (South Section) Improvement Project" was completed in December 2013.

From a viewpoint of consistency in road improvement, RGC requested that remaining section of NR 5 (between Thlea Ma'am and Battambang) be surveyed and this survey was started in May 2013. After the commencement of this survey, the Sri Sophorn - Poipet Section was added to the components of the survey in July 2013 in response to its request from RGC.

1.2 Objective of the Survey

This Preparatory Survey is implemented for the Improvement project of NR 5 (between Thlea Ma'am and Battambang, and between Sri Sophorn and Poipet) to obtain data and information required for appraisal of loan project of Japanese ODA (official development assistance), such as

the objectives, outline, project cost, implementation schedule, implementation organization, maintenance system and natural and social impacts.

1.3 Survey Area

The Survey Area is provinces of Pursat, Battambang and Banteay Meanchey.

1.4 Scope of Work

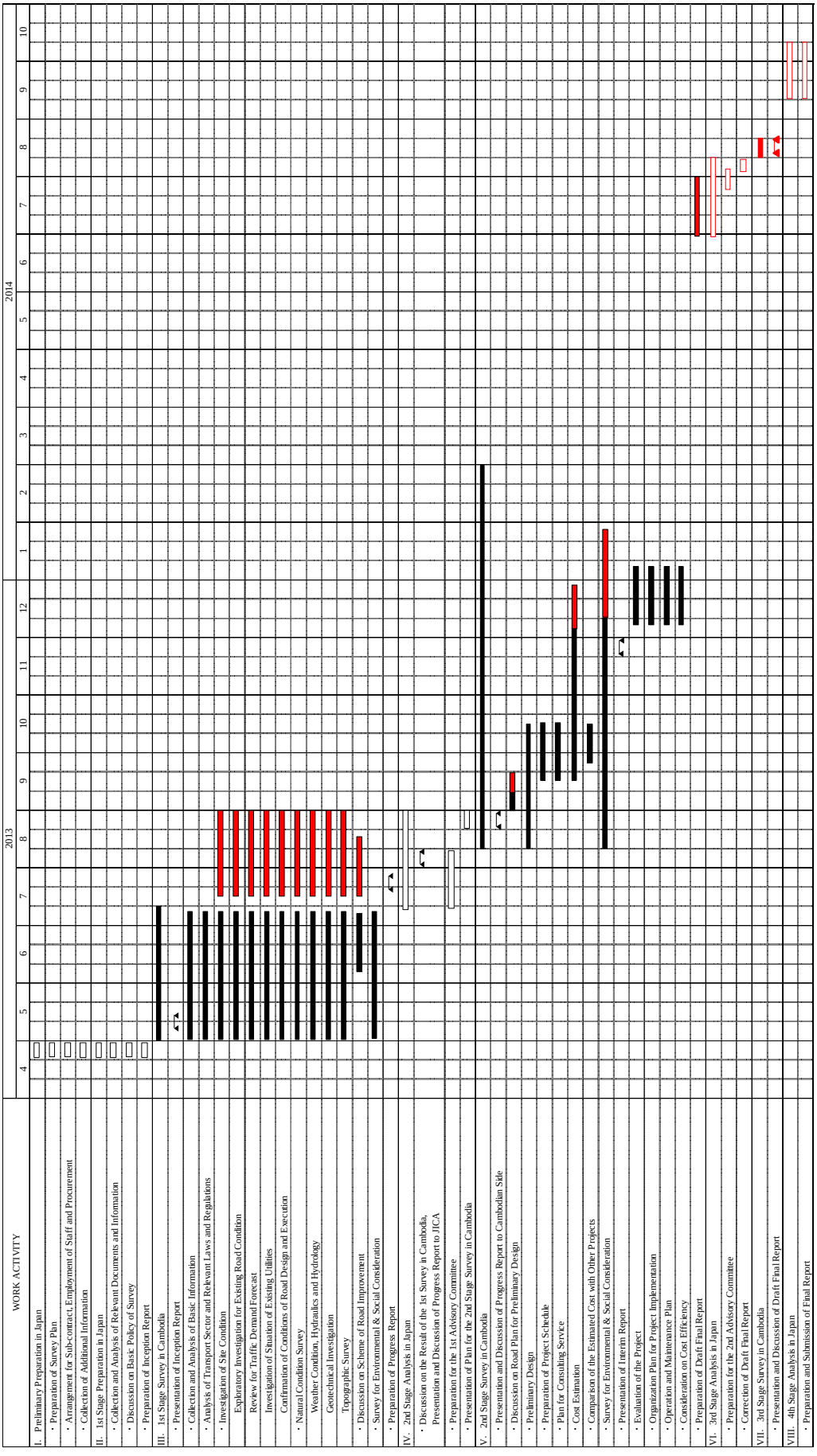
To achieve the above objectives, the following tasks were carried out:

1. Confirmation of the Scope of the Work
2. Collection of Basic Information Regarding the Project
3. Comparison of Law, Regulation, Standard on Transport Sector
4. Investigation of Site Condition
5. Review of Traffic Demand Forecast
6. Natural Condition Survey
7. Weather Condition, Hydraulics and Hydrology
8. Study on the Scheme of Road Improvement
9. Proposal and Discussion on Road Improvement
10. Preliminary Design
11. Study of Measures for Traffic Safety
12. Implementation Schedule of the Project
13. Preparation of Working Plan of Consulting Services
14. Cost Estimation of Project Summary Cost
15. Comparison of Summary Project Cost with Similar Project
16. Evaluation of the Project
17. Organization Plan for Project Implementation
18. Operation & Maintenance System
19. Investigation for Environmental and Social Consideration
    (i) Assistance to MPWT in Preparation of EIA report
    (ii) Assistance to MPWT in Preparation of Resettlement Action Plan (RAP)

1.5 Survey Schedule

The survey on the Middle Section was started in April 2013. The First Steering Committee was held on 8 May 2013 and the Inception Report was explained and discussed. Then, the Sri Sophorn - Poipet Section was added to the Survey Area and the survey schedule was additionally changed. Table 1.5-1 in the next page shows the general schedule of the Survey. In this schedule red bars show the additional tasks or change due to addition of Sri Sophorn – Poipet Section.

Table 1.5-1 Schedule of the Survey



1.6 Organization of the Survey

(1) Steering Committee

Steering Committee (SC) has been established for smooth and effective implementation of the Survey. The SC coordinates with MPWT and advise JICA and the Survey Team through MPWT. Table 1.6-1 lists the members of the SC.

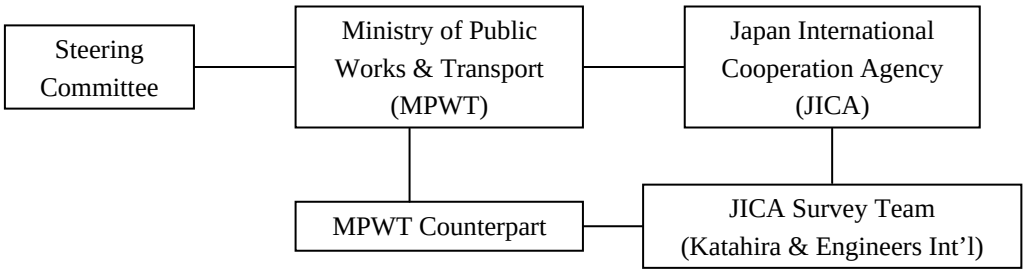


Table 1.6-1 Member List of Steering Committee

Institution	Name	Position
Ministry of Economy & Finance (MEF)	HE Chan Sothy	Deputy Secretary General, Investment and Cooperation
	Mr. Por Yutha	Deputy Director, Investment and Cooperation
	Mr. Sim Samnang	Deputy Director, Resettlement Department
Ministry of Environment (MOE)	Mr. Oung Vuthy	Deputy Director,
Pursat Province	Mr. Hun An	Director, General Affairs
	Mr. Ting Kuong	Deputy Director, DPWT
Battambang Province	Mr. Neang Chanthara	Chief Cross Sectorial Office
	Mr. Sal Satat	Chief Office
Banteay Meanchey Province	Mr. Sok Chantha	Deputy Director
Ministry of Public Works & Transport (MPWT)	H.E. Tauch Chankosal	Secretary of State
	H.E. Kem Borey	Director General of Public Works
	Mr. Chhim Phalla	Director of International Cooperation Department (ICD)
	Mr. Kong Sophal	Deputy Director, ICD
	Mr. Ket Shandararith	Deputy Director, ICD
	Mr. Heng Salpiseth	Officer, ICD
	Mr. SHIMADA Takashi	JICA Experts for MPWT
JICA Headquarter	Mr. TSUCHIHASHI Toru	Deputy Director, Transport & ICT Division 2, Economic Infrastructure Department
JICA Cambodia Office	Mr. ITO Takashi	Senior Representative
	Mr. EGAMI Masahiko	Representative
	Mr. SAY Bora	Program Officer
JICA Survey Team	Mr. SAKURAI Tatsuyuki	Team Leader,
	Mr. NAKAMURA Tomohiko	Deputy Team Leader

(2) JICA Officials in Charge of the Survey

Table 1.6-2 lists the main JICA officials in charge of this Survey.

Table 1.6-2 Main JICA Officials in Charge of Survey and Project

Name	Position	Remarks
JICA Headquarter (in Tokyo)		
MIYAKE Shigeki	Director, Transport & ICT Division 2, Economic Infrastructure Department	
TSUCHIHASHI Toru	Deputy Director, Transport & ICT Division 2,	
KANEKO Yutaro	Transport & ICT Division 2,	
FUKAWA Kensuke	Director, Southeast Asia Division 4, Southeast Asia & Pacific Department	
NAKANO Akihiko	Southeast Asia Division 4, Southeast Asia & Pacific Department	Up to May 2014
NO Daichi		
YOSHIDA Risa	Deputy Assistant Director, Southeast Asia Division 4	From May 2014
TSUBOTA Yumiko	Southeast Asia Division 4	
KAWANO Takaaki	Director, Environmental & Social Consideration Division, Credit Risk & Environmental Review Department	
SUZUKI Eri	Senior Safeguard Officer, Environmental and Social Considerations Review Division	From May 2014
HANAI Akane	Environmental and Social Considerations Review Division	
JICA Cambodia Office		
ITO Takashi	Senior Representative, JICA Cambodia Office	
EGAMI Masahiko	Representative, JICA Cambodia Office	

(3) Survey Team Member

Table 1.6-3 lists the member of the Survey Team.

Table 1.6-3 Survey Team Member List

Name	Position	Company
SAKURAI Tatsuyuki	Team Leader / Road Traffic Planer	KEI
NAKAMURA Tomohiko	Deputy Team Leader	KEI
MURAKAMI Keiichi	Road Engineer	KEI
OHASHI Keiichi	Bridge / Structure Planer	KEI
YASHIRO Syuuichi	Economic Analysis Specialist	KEI
WATANABE Kanji	Environmental Consideration Specialist	KEI
YAMASHITA Akira	Social Consideration / Resettlement Plan Specialist	KEI
KAWAMURA Yoshinori	Natural Condition Survey Specialist	KEI
AOKI Hiromasa	Hydrological & Hydraulic Survey Specialist	KEI
WATANABE Hiroshi	Construction Plan / Cost Estimation Specialist	KEI
TOCHINAKA Masateru	Project Coordination / Assistant Road Engineer	KEI

** KEI: Katahira & Engineers International*

CHAPTER 2 PROFILE OF THE SURVEY AREA

2.1 Physical Profile

(1) Geography

National Road No. 5 (NR 5) starts from Phnom Penh and traverses the southwestern side of Tonle Sap River and Tonle Sap Lake up to Battambang. Between Battambang and Sri Sophorn, it passes through the upstream area of Tonle Sap Lake and finally reaches the border with Thailand. The distance between the city of Sri Sophorn (the northern end of the Survey Section) and Poipet (the border point with Thailand) is approximately 50 km and the distance between Poipet and Bangkok in Thailand is approximately 250 km. Thus, NR 5 forms the main transport route between Phnom Penh and Bangkok.



Figure 2.1-1 Location of NR 5

(2) Topology

Figure 2.1-2 explains the hypsometric conditions of Cambodia.

Cambodia is situated in the northwest of the Gulf of Thailand. The area of the land is

approximately 171,000 km^2, The capital is Phnom Penh, situated on the right bank of the Mekong River at the confluence of its principal tributary in this area, the Tonle Sap.

The country is dominated by the Mekong River, which crosses the country from the north to the south. Its heartland is the basin of the Great Lake, fed by rivers draining the hills in the north, west, and south, but above all by the Mekong itself. Every year, between May and October, the Great Lake is replenished by flow up the Tonle Sap River from the Mekong in flood; when the flood waters recede, it is drained by reverse flow down the Tonle Sap into the Mekong.

A low threshold formed by ridges of bedrock near Kampong Chhnang prevents the complete draining of the Great Lake. At its lowest level, the lake has depths of around 1 meter and an area of about 3,000 km^2, while at its maximum it expands its area to 16,000 km^2 and up to 9 meters deep.

In the southwest, the country is mountainous, with the highest summits rising to more than 1,500 meters. This range is known as the Caradamome or Kravanh Mountains. In the north, the land rises gradually from the shores of the Great Lake to the foot of the Dangrek escarpment, the crest of which is the southern edge of the Khorat Plateau and marks the boundary between Cambodia and Thailand.

The east part of the country consists of plains, low hill ranges and plateaus of up to a few hundred meters elevation. In the southeast locates the head of the Mekong Delta, the greater part and mouths of which lie in Vietnam.



Source: Indochina Atlas (1970), U.S. Central Intelligence Agency

Figure 2.1-2 Hypsometric Map of Cambodia (Cropped from Map of Indochina)

(3) Topography

Figure 2.1-3 shows the topography of Cambodia. The ground height along the Middle Section of NR 5 is, in general, around 11 ~ 21 m above sea level, and the one along the section of Sri Sophorn – Poipet is 14 m ~ 41 m. The terrain along the Middle Section of NR 5 is generally flat.

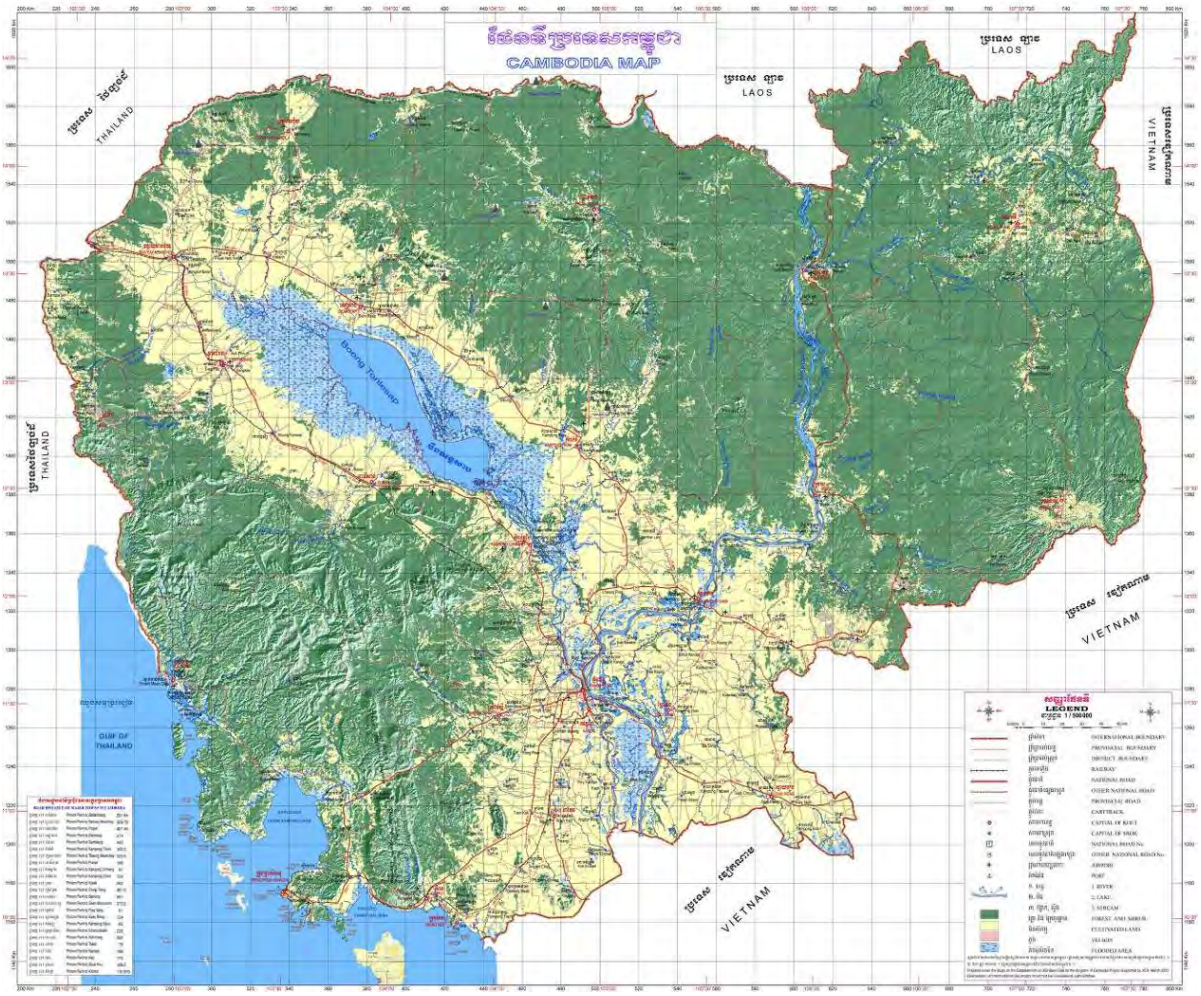


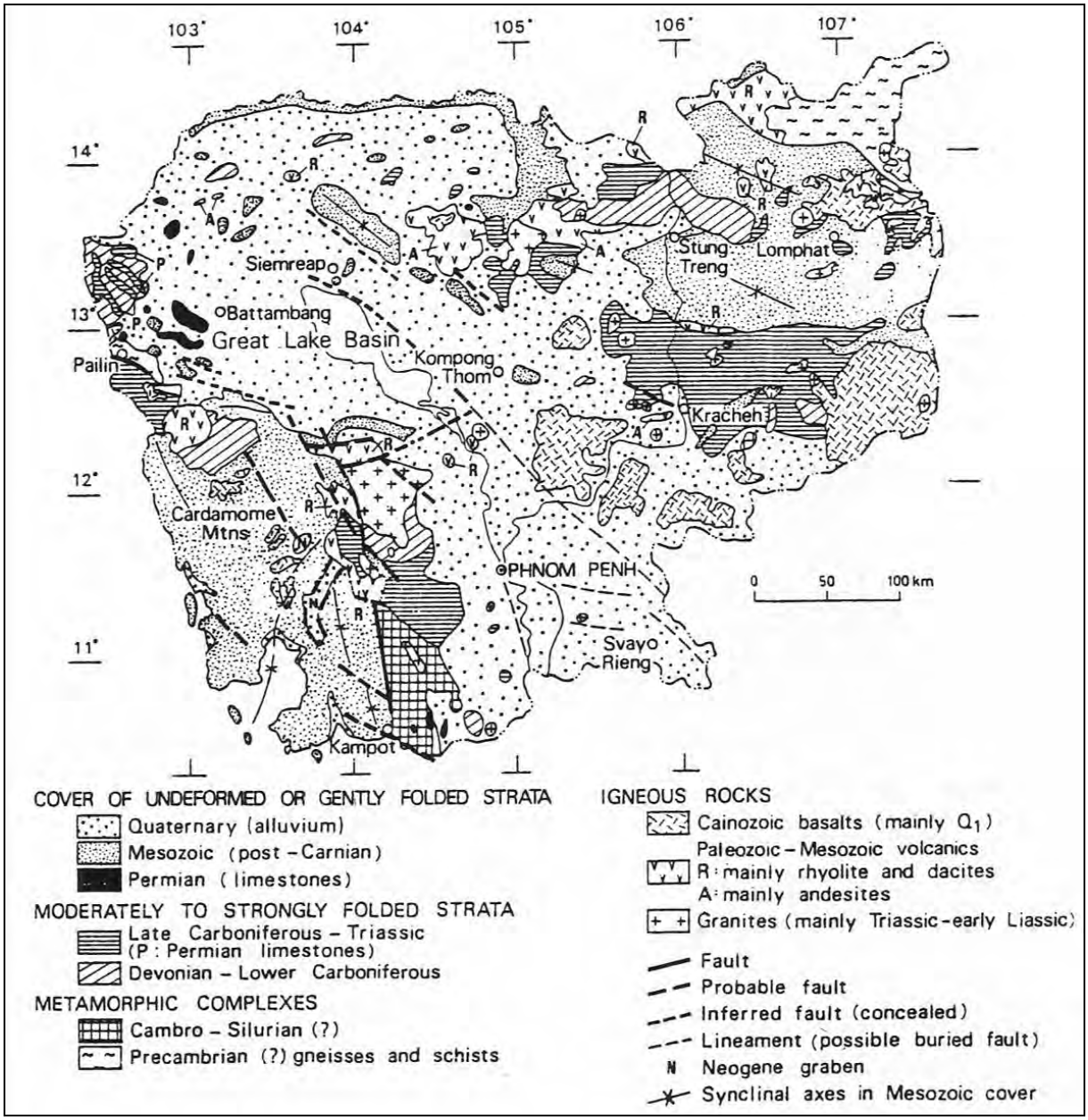
Figure 2.1-3 Topography of Survey Area

The country of Cambodia is often divided into the following five zones related to their relative location and topography as shown in the table below.

Zone	Province / Municipality
Phnom Penh	**Phnom Penh**
Plains	Kampong Cham, Kandal, Prey Veng, Svay Rieng and Takeo
Tonle Sap	Banteay Meanchey, Battambang, Kampong Thom, Siem Reap, Kampong Chhnang and Pursat
Coast	Kampot, Sihanouk Ville, Kep and Koh Kong
Plateau / Mountain	Kampong Speu, Kratie, Mondul Kiri, Prea Vehea, Ratanak Kiri, Stung Treng, Odtar Meanchey and Pailin

According to this zoning, survey areas; Pursat, Battambang and Banteay Meanchey belong to the Tonle Sap Zone which extends from Tonle Sap Lake.

(4) Geology



Source: Encyclopedia of European and Asian Regional Geology

Figure 2.1-4 Geological Framework of Cambodia

Figure 2.1-4 summarizes geological condition in Cambodia. The latest geological map prepared by the General Department of Mineral Resources in corporation with JICA in 2010 is attached to Appendix 2.

(a) Stratigraphy

Precambrian

The gneisses and schist of the Proterozoic Kontum Massif in Vietnam extended in the north east of the country. High - grade metamorphic rocks that may be at least partly Precambrian are also found at Pailin in the west.

Paleozoic

Paleozoic rock in Cambodia consists of three major parts: Cambro - Silurian, Devono - Carboniferous, and Permian.

The Cambro - Silurian occurs in the south and shows metamorphic complex; the dominant rock types are quartzite with interbedded rhyolites, quarts - tourmaline schist, sericite schist, and chlorite schist.

The Devono - Carboniferous is widely distributed in Cambodia, especially in the south. The rocks are strongly folded and fractured. The most distinctive units are varicolored chert or jasper, often brecciated. Other rock types in the Devono - Carboniferous sequence include black shale, sandstone, conglomerate and breccia, and some beds of limestone towards the top.

The Permian is distinctive for the wide distribution of limestone. The main occurrences are in the west and in the south, but small limestone lenses in a dominantly clastic succession are seen elsewhere.

Mesozoic: Triassic

Rocks mapped as Triassic occur widely in Cambodia. They are for the most part clastic and only sparsely fossiliferous. Some sequences are continental (with coal in places). Others are marine or alternating marine - continental.

Towards the end of Triassic, there were important earth movements throughout the region, comprising the main phase of the Indosinian Orogeny. In Cambodia, there was moderate to strong folding and general emergence.

The Upper Triassic stages are represented almost entirely by continental and lagoonal facies, and red beds are dominant. These comprise the greater part of the so - called "Terrain Rouge", a thick succession of conglomerate, sandstone and mudstone which extend into the Lower Jurassic and form the basal member of a great thickness of late Mesozoic continental deposit. In Cambodia, the Terrain Rouge covers large areas, especially in the north and east.

Mesozoic: Jurassic - Cretaceous

Following the general Late Triassic emergence, in the Early Jurassic, marine conditions persisted or returned in certain areas. The Early Jurassic is present in the east and around Rovieng in the north in the form of a littoral facies: sandstone and limestone with bivalves and brachiopods. Elsewhere in the east, there are deeper - water marine sediments of the

Early Jurassic age, extending towards the Vietnamese border in the Sre Pok Valley. These beds have yielded many ammonites.

From the Middle Jurassic onwards, deposition was purely continental or paralic. A thick succession of sandstone and conglomerate was laid down, spanning the Middle Jurassic to Lower Cretaceous time interval. The main area where these rocks are found is the Cardamome Mountains in the southwest with the succession of the order of 1,000 ~ 2,000 meters thick. Another prominent occurrence is in the Dangrek escarpment in the north. Elsewhere, these rocks form numerous isolated hill ranges and mesas with flat - lying or only very gently folded strata.

Cenozoic

Pliocene and Peistocene form terraces and plains at elevations of between 25 and 150 meters. They used to be considered as "the Old Alluvium", such as in 1:200,000 geological map prepared under French technical assistance to Cambodia.

Quaternary is very widespread and found at elevations of between 0 and 40 meters. Middle Quaternary forms terraces of reddish sandy deposit around an elevation of 15 meters. Late Quaternary spreads in the north, southeast, and northwest and form undulating terrains surrounding the central plain. Gravel, pebble, sand and clay compose the strata and, in Battambang, the thickness reaches around 200 meters.

The Holocene is found in the beds and floodplains of the present day rivers, coastal plains, and the Great Lake Basin. In many areas, these Alluvium deposits, although extensive, are thin and frequent small exposures of the underlying bedrock are observed.

(b) Igneous Activity

Volcanism

Eruptive rocks, both lavas and tuffs, and their associated subjacent intrusive phases, are common and widely distributed at many levels in the stratigraphic column, notably the late Paleozoic - early Mesozoic (mainly acidic - intermediate types) and the late Cenozoic (basalts). The Cenozoic basalts are clearly related to a phase of extensional tectonics with the development of deep - seated normal faults. These rocks cover some 10,000 km^2 in the east of Cambodia, where they form vast plateaus at elevation of up to a few hundred meters.

Plutonic Rocks

The basement complexes of the Kontum Massif and Pailin are made up in large part of more or less metamorphosed plutonic rocks which may be Paleozoic or older. These are predominantly granodioritic but include both more acidic and more basic types.

Most of the plutonic rocks of Cambodia, which are dominantly granitoids, intrude late Paleozoic and early Mesozoic formations and are likely to have a Triassic - early Jurassic age of emplacement.

(c) Tectonic Evolution

Important unconformities, separating major tectonic stages, occur at the base of the late Paleozoic (Upper Carboniferous - Permian) succession in the west and south and at the base of essentially late Triassic Terrain Rouge throughout the country. The former indicates a post early Carboniferous episode of folding.

The unconformity at the base of the Terrain Rouge marks the main episode of folding of the regional Indosinian Orogeny. It is thought to lie more or less at the Carnian - Norian boundary.

The period from the Norian to the present day constitutes the post - Indosinian tectonic stage. A small - scale angular unconformity in some places between the Terrain Rouge (low dips) and the overlying Middle Jurassic sandstone (very low to zero dips) marks a last, minor pulse of the Indosinian Orogeny. At some point in the late Cretaceous or Tertiary, the post - Indosinian platform cover of continental deposits was epeirogenically raised and warped across the region, forming a series of broad, open anticlines and synclines. The eroded axis of one of the anticlines crosses NW Cambodia from northwest to southeast along the line of the Great Lake. In this area, the Mesozoic sandstones are horizontal, and thus form flat - topped mesas. To the north, dips increase slightly towards the Dangrek escarpment, which is the south face of a cuesta. Similarly, to the south the Cardamome Mountains are formed of Mesozoic sandstone dipping at very low angles to the southwest. There was also important block faulting during this period, including the formation of several graben in the Cardamomes. There were vast outpourings of basalt, indicative of tensional tectonic environment in the late Cenozoic.

In very recent times, the Great Lake Basin was formed by subsidence along NW trending fault lines (Carbonnel, Duplaix and Selo, 1972). The lake itself, and the form of its outlet to the Mekong, are due to the existence of several small NE-trending swells in the surface of the sub - Quaternary bedrock underlying the upper part of the Tonlé Sap River. The subsidence involved in the formation of the Great Lake was in fact very slight, and may have taken place mainly in the Holocene. The lake is believed to be only about 5,000 years old (Carbonnel, 1965).

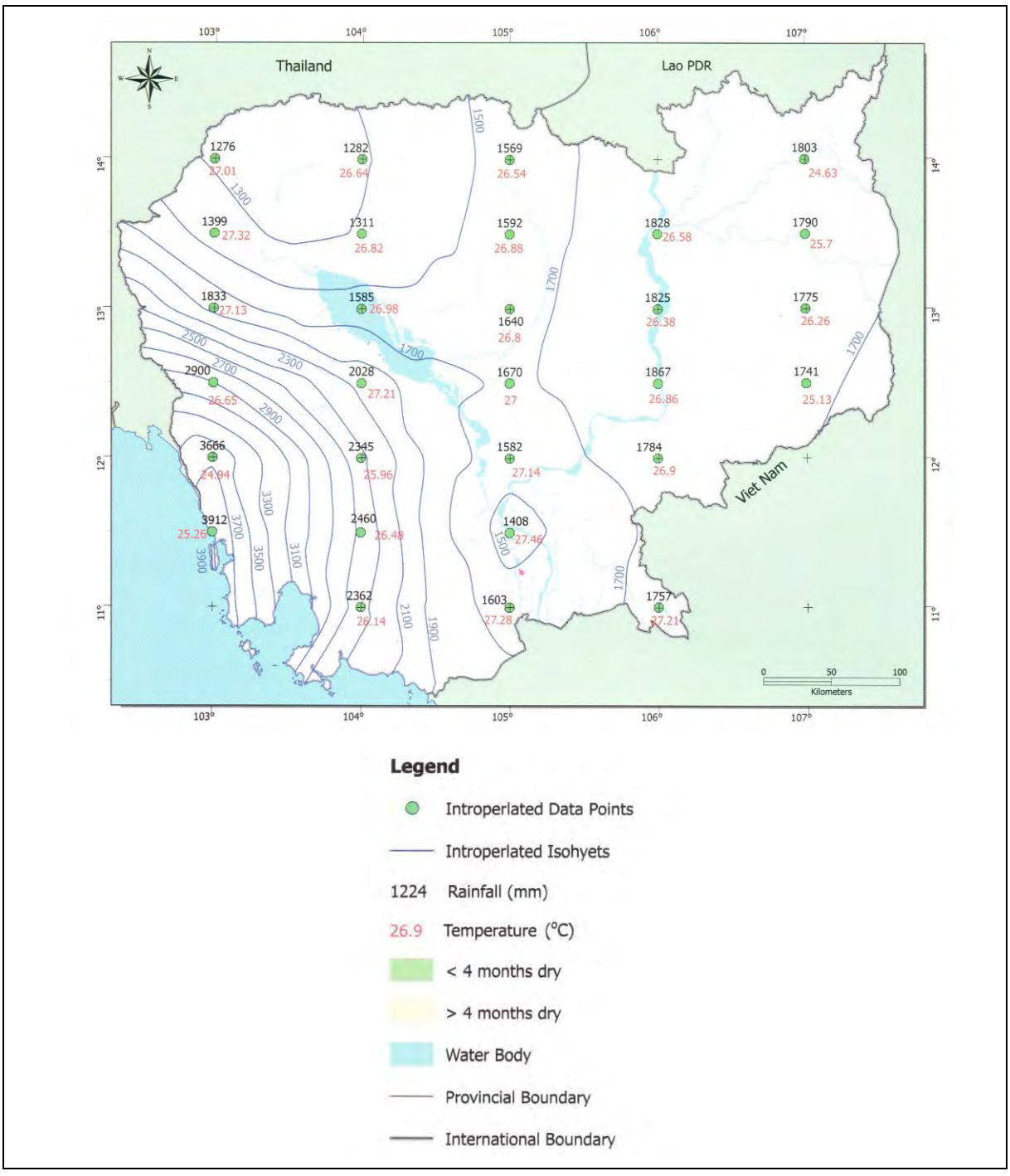
Note:

Carnian: The Carnian lasted from about 235 to 228 million years ago (Ma).

Norian: The Norian lasted from about 228 to 208.5 Ma.

(5) Meteorology

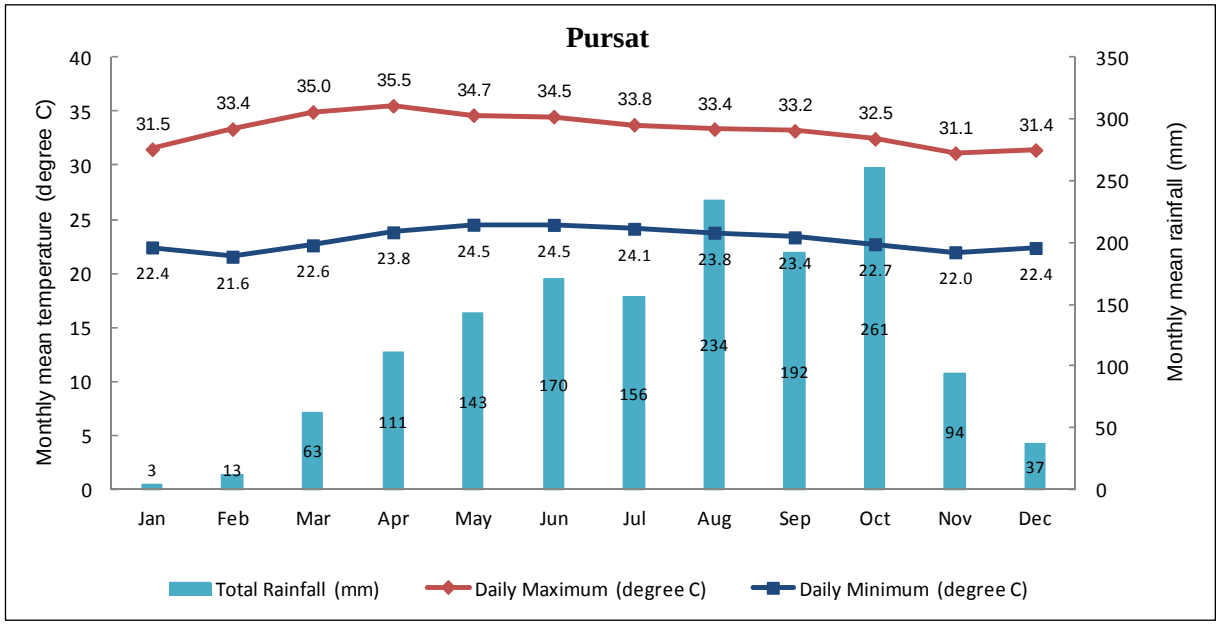
The climate of Cambodia is influenced by the Asian monsoon and the climate can be described as 'hot and humid' in general. Figure 2.1-5 shows annual rainfall in Cambodia. It shows that the annual rainfall of the Survey Area is in the range of 1,400 ~ 1,900 mm/yr.

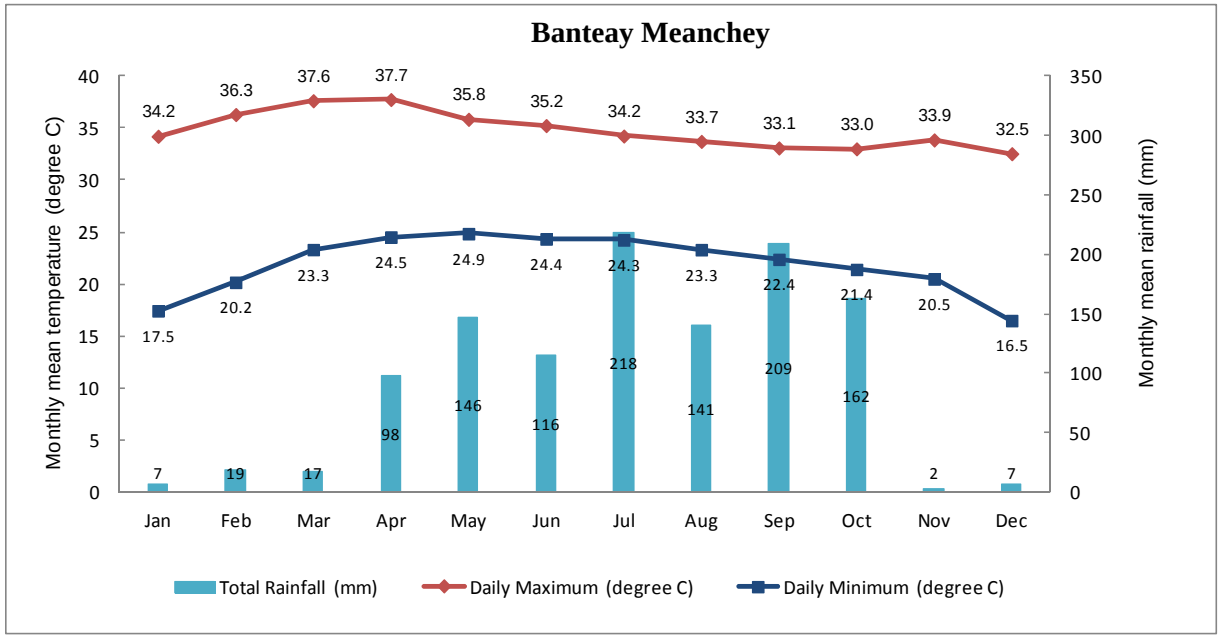


Source: The Atlas of Cambodia - National Poverty and Environment Maps

Figure 2.1-5 Rainfall and Temperature

Figure 2.1-6 shows the monthly average rainfall and temperature measured at Pursat and Banteay Meanchey. It shows that the rainy season is from May to October and the dry season is from November to April. It also shows that the monthly average temperature ranges between 16 and 38 degrees Celsius.





Source: Department of Meteorology (Information is based on monthly averages for the 5 - year period 2007 - 2011)

Figure 2.1-6 Average Monthly Rainfall and Temperature

2.2 Socio - Economic Profile

(1) Demography

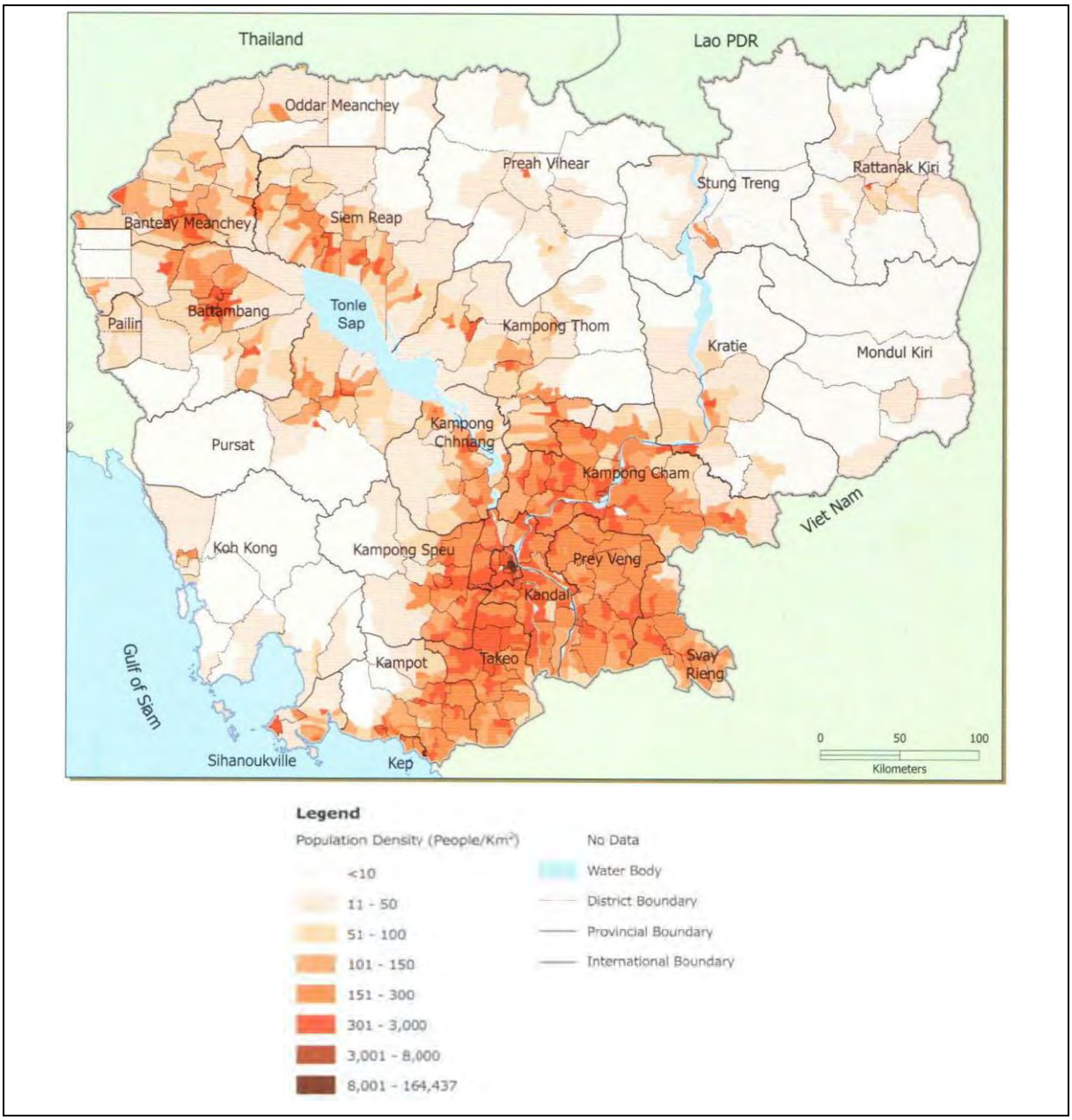
Table 2.2-1 summarizes the socio - economic data of the Survey Area, focusing on the three provinces substantially influenced by the Project.

Table 2.2-1 Socio - Economic Data of Survey Area in 2008 (3 provinces only)

	Pursat	Battambang	Banteay Meanchey	Whole Country	Proportion to Whole Country (%)
Population (1,000)	397	1,025	678	13,396	16
Land Area (km^2)	12,692	11,702	6,679	181,035	17
Population Density	36	88	101	75	-

Source: Statistical Yearbook of Cambodia 2011

The population densities of the provinces in the Survey Area, except Pursat, are higher than the national average, implying that the Survey Area is a developed area in Cambodia. Among the three provinces, Pursat is less populated than the national average.

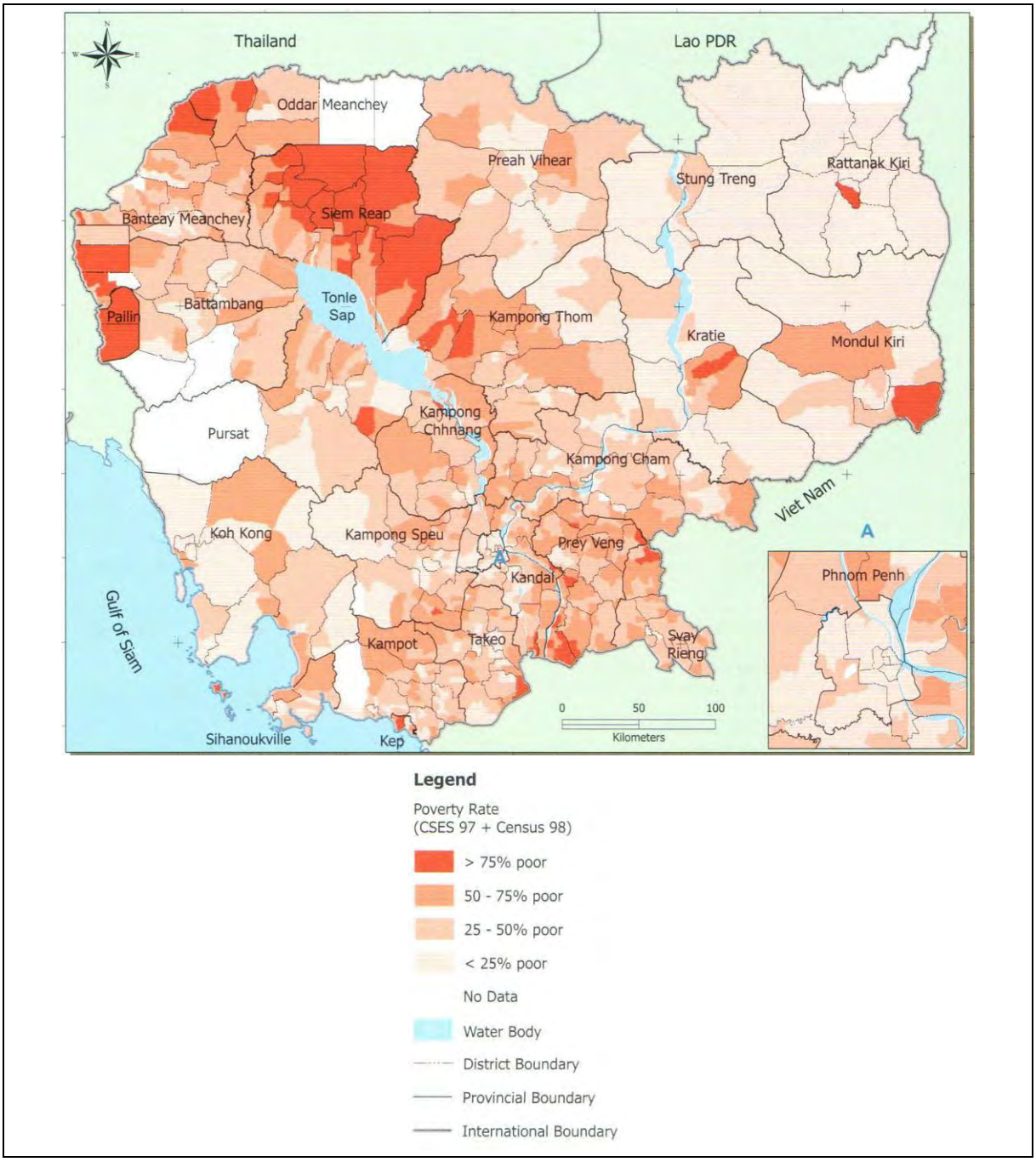


Source: The Atlas of Cambodia; National Poverty and Environmental Maps

Figure 2.2-1 Population Density by Districts

(2) Economy

Figure 2.2-2 shows the poverty level by District. As can be seen in the figure, the income level of Pursat city, Battambang city and Poipet city is relatively high.



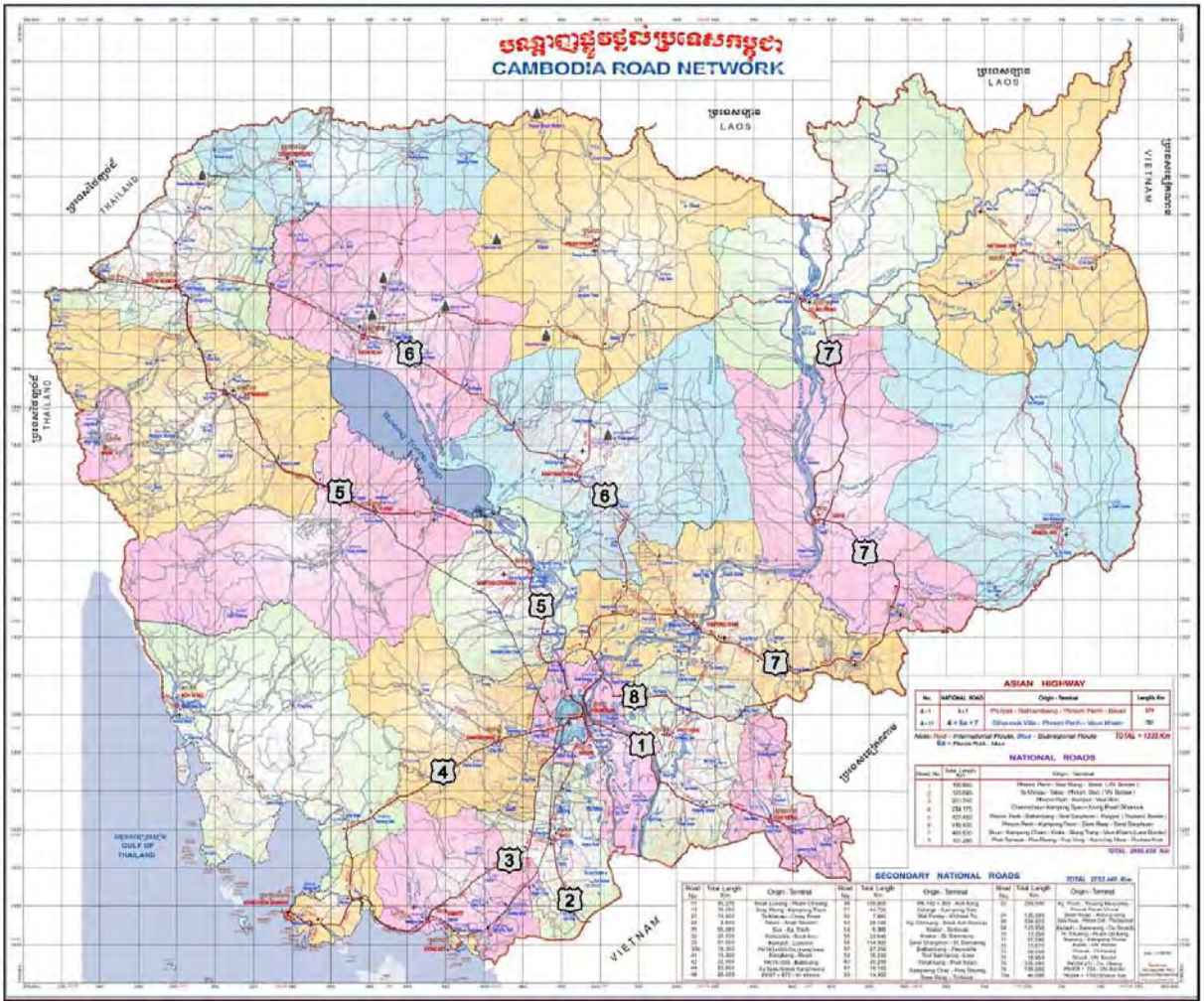
Source: The Atlas of Cambodia; National Poverty and Environmental Maps

Figure 2.2-2 Poverty Level of Districts

CHAPTER 3 NATIONAL ROAD NETWORK OF CAMBODIA AND ROLE OF NATIONAL ROAD NO. 5

3.1 National Road Network of Cambodia

National Road Network of Cambodia consists of arterial national roads with single digit numbers (1 to 9) and minor arterial roads with double digit numbers. The total length of national road network is 5,604 km (as of July 2014). Out of this 5,604 km, 2,244 km are single digit national roads and 3,360 km are double digit national roads. Figure 3.1-1 show the map of National Road Network of Cambodia. As can be seen in the figure, most of the arterial national roads of Cambodia extend in radial directions centered at Phnom Penh and reach to the border points with neighboring countries of Vietnam and Thailand. They are numbered, in principle, in crock - wise direction starting from No. 1.



Source: MPWT

Figure 3.1-1 National Road Network of Cambodia

Table 3.1-1 shows the lengths and routes of arterial (single - digit) national roads.

Table 3.1-1 Length and Route of Arterial National Road (As of 2008)

Road No.	Length (km)	Route
1	166.9	Phnom Penh - Bavet (Vietnam border)
2	120.7	Ta Kmau - Takeo - Phnom Den (Vietnam border)
3	201.6	Phnom Penh - Kampot - Veal Rinh
4	214.2	Chaom Chau - Kampong Speu - Krong Prea Sihanouk
5	407.5	Phnom Penh - Battambang - Sri Sophorn - Poipet (Thailand border)
6	415.5	Phnom Penh - Kampong Thom - Siem Reap - Sri Sophorn
7	460.8	Skun - Kamopong Cham - Kratie - Steung Treng - Veum Kham (Vietnam border)
8	132.4	Prek Kdam - Pea Reang - Prey Veng - Kamchay Mear - Ponhhea Krek
9	143.3	Stung Treng - Prea Vehear
Total	2,262.9	

3.2 Development Plan

A road improvement project needs to planned in accordance with the master plan for road network development. The road network development master plan should be in conformity with the national development plan. Followings are the status of these plans.

(1) National Strategic Development Plan

National Strategic Development Plan (NSDP) 2006 ~ 2010 adopted 'Rectangular Strategy' as the very basic strategy / policy for national development. 'Further Rehabilitation of Physical Infrastructure' was designated as one of the four components of 'Rectangular Strategy'. The NSDP was updated in 2008 and issued as 'NSDP Update 2009 ~ 2013', which was valid when this survey was started. NSDP Update 2009 ~ 2013 prescribes 'Further Rehabilitation and Construction of Transport Infrastructure' as one of the four sub - components of 'Further Rehabilitation of Physical Infrastructure'. Then, NSDP Update 2009 ~ 2013 states 'Continuing to seek funding for …… (omitted) … the widening of NR 1, NR 4, NR 5 and NR 6'. It is clear that widening of NR 5 is designated as one of the projects for national development.

Since NSDP 2009 -2013 had expired, NSDP 2014 – 2018 was newly prepared and approved by the Council of Ministers on 30 May 2014. **"Widen 1-Digit NRs from 2 lanes to 4 lanes in and around major cities"** and "**Install drainage facilities in 1-Digit National Roads, for flood control"** are listed among the "prioritized policies" in Chapter 4 of NSDP 2014 - 2018. NSDP 2014 – 2018 also lists "Introduce bus public transportation system in the Capital Area" as another activity of "the prioritized policies" showing the Government's recognition of importance of mass transit.

(2) Comprehensive Development Plan for All Transport Sector

Cambodian Government (MPWT) is aware of importance of transport modes other than road and exerting effort to improve / develop, railroad, shipping and aviation, as well as mass transit.

Comprehensive development plan of transport sector was prepared in 2002 through 'Transport Strategy Study' with an assistance of ADB. After this study, master plans of subsectors were prepared and some projects have been, or are being, implemented.

Major projects and studies of these transport modes are as summarized below:

Table 3.2-1 Plans and Projects of Transport Modes Other than Road

Transport Mode	Description of Major Project / Plan
Railroad	・ Railroad master plan is being prepared with assistance of Korean government. ・ Railroad rehabilitation project is has been implemented with financial assistance of ADB. ・ Phnom Penh - Kampot Section (Approx. 150 km) of the South Line (Phnom Penh - Sihanoukille: 266 km) completed in 2012 and operation started. ・ Rehabilitation of the remaining section of the South Line is currently being implemented. ・ Rehabilitation of the North Line has been haltered due to shortage of fund ・ There are some other plans of railroad development proposed by Chinese and Korean governments.
Mass Transit	・ City bus service was proposed in JICA's 'Urban Transport Master Plan Study' 2001 and experimental bus operation was successfully implemented. However, bus service did not materialize. ・ Study on introduction of monorail between Phnom Penh Airport and the city center Phnom Penh was implemented in 2008 with technical assistance of Japanese Government (Ministry of Economy, Industry and Trade) ・ Introduction of city tram system in Phnom Penh was studied in 2010 with technical assistance of French Government. ・ Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City (PPUTMP) was implemented by JICA and completed in 2014. Experimental bus operation was successfully implemented. Concession for bus operation is being offered to possible private operators.
Ship (Sea port and inland water port)	・ There are 8 major seaports in Cambodia which are in operation. ・ Sihanoukville Port is the largest and the main export / import port. Expansion of capacity of Sihanoukville Port is being planned. ・ There are many inland water ports along Mekong River and its tributaries (Tonle Sap River etc). ・ Phnom Penh Port is the largest inland water port. ・ A new Phnom Penh Port has been constructed approx. 25 km downstream along Tonle Sap / Mekong River (along NR 1) where Special Economic Zone (SEZ) is being planned.
Aviation	・ Currently there is no master plan. ・ Two international airports (Phnom Penh and Siem Reap) are under operation. ・ New airports are being planned (New Phnom Penh Airport and New Siem Reap Airport). ・ Improvement of five local airports is being discussed.

While improvement of road network needs to be continued, improvement of other transport modes is indispensable for efficient and comprehensive transport system. Accordingly, it is recommended that the RGC continue the effort to improve these transport facilities.

(3) Road Network Master Plan

Road network development in Cambodia is planned and implemented basically based on the master plan proposed by 'the Study on the Road Network Development in the Kingdom of Cambodia' conducted in 2006 by JICA (M/P Study). In this M/P Study, NR 5 was proposed to be improved to support 'Multi Growth Pole Development' and 'Development of International Corridor', as well as 'Rural Economic Development and 'Poverty Reduction'. M/P Study proposed widening of NR 5 to full 4-lanes between Phnom Penh and Kampong Chhnang and remaining sections were proposed to be 2-lanes. It should be noted that this M/P was prepared when the economic level of Cambodia was still low and it was rather difficult to expect the rapid economic growth which occurred in the last few years, and the proposed road network development plan is sometimes insufficient to support the growth of traffic demand which is expected today.

Infrastructure and Regional Integration Technical Working Group (IRITWG) is a meeting of the development partners and MPWT on implementation of transport infrastructure development. The latest meeting of IRITWG was held in September 2012 and 4th edition[1] of "Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia (OTIS)" was published. This publication lists the past, on - going and planned road improvement projects, as shown in Table 3.2-2.

The 2014 version (5th edition) of OTIS is currently being prepared and is expected to be published in late 2014. The contents of the 5th edition is not confirmed yet.

[1] Version for year 2014 is being prepared, but not completed, as of August 2014.

Table 3.2-2 (1) Past, Ongoing and Planned Road Improvement Projects (1/2)

No.	Org.	Cost (Mill$)	length (km)	Section	Year Start	Fund End	Status	Pavement status
1	Japan	$36.14	43.0	PK: 13+000 – Neak Loeung (2nd phase)	2006	2009	Grant	AC
	Japan	$11.168	11.0	PK: 4+000 – PK: 13+000 (3rd phase)	2010	2011	Grant	AC
	Japan	$19.46	4.0	Monivong Brige – PK: 4+000 (4th Phase)	2010	-	Grant	AC
	Japan	$80.00	57.0	Phnom Penh - Neak Loeung	2005	-	Grant	AC (2010: Korki to Neak Loeung)
	ADB	$50.00	107.0	Neak Loeung - Bavet	1999	2004	Loan	DBST
	WB	$3.00	107.0	Neak Loeung - Bavet	2009	2013	Loan	Road Maintenance (Upgrading)
2	ADB	-	63.0	Kbal Thnal - Takeo	2001		Loan	DBST
	Korea	-	63.0	Kbal Thnal - Takeo	-	-	-	-
	Korea	-	-	Takeo - Ang Tasaom (NR3)	-	-	-	DBST
	Japan	$12.45	51.7	Takeo - Phnum Den	2003	2007	Grant	AC
3	Korea	$36.90	137.5	Chom Chao - Kampot	2008	2010	Loan	DBST
	Korea	$17.05	32.7	Kampot - Trapang Ropaou	2004	2008	Loan	DBST
	WB	$47.60	32.5	Trapang Ropaou - Veal Renh	1999	2006	Loan	DBST
4	USA	$50.50	217.0	Chaom Chao - Sihanoukville		1996		AC
	AZ		217.0	Chaom Chao - Sihanoukville	2001	2035	OT	OT (periodic maintenance)
5	Cambodia		91.0	Phnom Penh - Kampong Chhnang		2003	Trea-sury	DBST
	ADB	>$1	85.0	PK:6+00 - Kampong Chhnang	2010	2011	Loan	Maintenance
	ADB	$68.00	261.0	Kampong Chhnang - Sisophon	2000	2004	Loan	DBST
	ADB	$77.50	48.0	Sisophon - Poipet	2006	2008	Loan	AC
	China	$56.5	30.0	Phnom Penh – Prek Kdam	2011	2014	Loan	AC (4 lanes) – 2%
	Japan	$103.50	139.0 + 68.0	Prek Kdam – Thlea Maorm and Battambang – Banteay Meanchey	2010	-	F/S	AC
6	Japan	$28.00	44.0	Phnom Penh - Chealea	1993	1995	Grant	AC
	Japan			Chealea - Cheung Prey	1996	1999	Grant	AC (deteriorated condition)
	ADB		112.0	Cheung Prey -	2000	2004	Loan	DBST
	WB	$16.10	73.0	Kampong Thom - Ro Lous	1999	2006	Loan	DBST
	Japan	$12.00	15.0	Siem Reap - Bakong temple	2000	2001	Grant	AC
	ADB		100.0	Sisophon - Siem Reap	2006	2008	Loan	AC
	China	$248.8	248.525	Thnal Kaeng – Skun (4 lanes) Skun – Angkrong (2 lanes)	2012	-	Loan	AC (Contracted)
	China	$70.250	40.0	PK: 4+000 to Thnal Keng	2011	2014	Loan	AC (4 lanes) – 32.3%
7	Japan			Cheung Prey - Kompong Cham	1996	1999	Grant	AC
	Japan	$19.00		Kompong Cham - Chob	2001	2003	Grant	AC
	ADB		205.0	Chob - Kratie	2000	2004	Loan	DBST
	China	$67.5	196.8	Kratie - Trapeang Kriel (Lao border)	2003	2007	Loan	DBST
8	China	$71.513	109.0	Preak Ta Mak - Anlong Chrey	2008	2011	Loan	AC
8-1	China	$14.80	5.6	Krabao - Moeun Chey	2010	2012	Loan	AC (96.06%)
8-2	China		18.56	Anlong Chrey - Krek	2010	2012	Loan	
9	China	$116.499	141.68	Tbaeng Meanchey – Thealaborivat	2012	2015	Loan	DBST (Incl. bridge) – 29.84%
11	ADB	-	90.4		2001	2004	Loan	DBST
	Japan			Bridges				
	China	$63	90.4	NR1: Neak Loeung – NR7: Thnal Tortoeung	2015		Loan	AC
13	ADB	-	-	Svay Rieng - Anlong Chey	-	-	-	-
21	ADB	-	77.5		2002	2004	Loan	DBST
	VN		0.4	Chhrey Thom			Loan	Bridge (50%-50% share with RGC)
	Korea	$57.00	25.0		2010			
23	China	$33.00	53.00	Pea Reang Leu – Chombork (border)	2013	-	Loan	DBST
31	WB	$12.90	51.7		2003	2005	Loan	DBST
33	WB		39.8	Takeo - Kampong Trach - Kampot	2002	2005	Loan	
	ADB	$13.00	17.0	Kompong Trach - Lork (Vietnam border)	2007	2010	Loan	DBST
41	WB			National Road 4 - Prek Thnout River	-	-	Loan	DBST
	China	$95.28	46.25	Thal Tortoeng – Chum kiri - Kampot	2011	2014	Loan	DBST (31%)
43	China	$42	77	NR4: Treng Troyeng – NR3: Thvear Thmey	2015	-	Loan	DBST (Under negotiation)
44	China	$80.30	139.607	Chbamorn – Oral – Amleang – Udong	2012	-	Loan	DBST (Under negotiation)
44 + 151	ADB	-	124.0	Kg. Speu town - Oral - U dong	-	-	Loan	DBST
48	Thai	$21.69	151.3	Koh Kong - Sre Ambel	2004	2007	Loan	DBST
	Thai	$7.20	1.6				Grant	4 Bridges

Source: Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia (4th Edition), 2012, IRITWG

Table 3.2-2 (2) Past, Ongoing and Planned Road Improvement Projects (2/2)

No.	Org.	Cost (Mill$)	length (km)	Section	Year Start	Fund End	Status	Pavement status
50C	China	$35+$98	58+3.5	Kg. Thom – Kg. Leng (Kg. Chhnang) + Bridge	2014	-	Loan	DBST (Under negotiation)
51	WB	$5.80	38.9	Udong - Thnal Torteng	2003	2006	Loan	DBST
	China	$27	38.9	Udong - Thnal Torteng	204	-	Loan	AC
55	China	$140	189.70	Pursat – Thmar Da, Thai – Cambodia border	2013	-	Loan	DBST (next 5-year plan)
56	Seeking	-	115.0	Sisophon - Samrong	-	-	-	(Excluding structure)
	Korea	$29.90	84.0	29km from Sisophon to Samrong	-	2009	-	Road improvement
56-68	ADB	$12.50	185.0	Sisophon - Smarong - Kralanh	2005	2007	Loan	Structure only
57	China	$41.88	103.14	Batambang – Pailin - Thai Border	2008	2012	Loan	DBST
57B	China	$176.35	89.98	1) Tmor Kol - Bovel - Sampov Luun 2) Bovel-Samseb-Phnom Prek 3) Samseb - Kamrieng	2011	2013	Loan	DBST (56.53%)
58	China	$77.00	132.0	Banteaychey – Banteay Meanrit – Thmar Daun - Phaong	2014	-	Loan	DBST (Under negotiation)
59	China	$72.89	144.27	NR 59 (Koun Damrey - Malay - Sampov Luun – Phnom Prek – Kamrieng - Pailin)	2011	2013	Loan	DBST (69.47%)
5x	Private	$5.50	13.0	National Road 5 - Thai border (through Chay Chay investment)	2004	-	-	DBST (not yet started)
60B	China	$130	140+1.67	Kg. Thmor – Kratie + Bridge	2015	-	Loan	DBST (+ bridge cost)
61	WB		16.0	Prek Kdam - Thnal Keng (NR6)	2002	2005	Loan	Maintenance
	China	$9.76	16.0	Prek Kdam - Thnal Keng (NR6)	2010	2012	Loan	DBST (52.96%)
62	WB	-	-	Kg.. Thom - Provincial border	2005	-	Loan	Laterite
	Seeking	-	-	Provincial border - Meanchey	-	-	-	-
	China	$57.80	157.0	Koh Ke – Tbeng Meanchey - Preah Vihear temple	2008	2011	Loan	DBST
	China	$52.00	128.0	Kampong thom - Tbaeng Meanchey	2008	2011	Loan	DBST
64C	China	$100	132	Tbaeng Meanchey - Thearaborivat	2011	2014	Loan	DBST
65	WB	-	-	Dam Dek -	2005	-	Loan	DBST
66	WB	$1.40	18.5	Phnom Dek - Rovieng	2004	2006	Loan	DBST
	WB	$3.20	18	Rovieng - River Stung Sen			Loan	DBST (not yet started)
67	Thai	$3.06	18.0	Choam Sa Ngam - Anlong Veng	2006	2007	Grant	DBST
	Thai	$32.50	131.0	Anlong Veng - Siem Reap	2006	2009	Loan	DBST
68	Thai	$35.00	113.0	O Smach - Kralanh	2007	2009	Loan	DBST
70B	China	$90	150	Tonlebet – Srey Santhor – Prek Tamak – Lvear Em – Peam Ro	2015	-	-	DBST
71	Cambodia	-	-	Chomkarleu – Kg. Cham	-	-	-	-
	WB	$1.50	15.5	Traueng (NR7) - Kampong Thmar (NR6)	2004	2006	Loan	DBST
71C	China	$66	110	Tbong Khum – Kroch chmar - Chamkarleu	2015	-	-	DBST (+ Kroch Chmar Bridge)
72	ADB		14.0	Memot – Tropeang Plong	2007	2009	Loan	
71+7+72	China	$112	145	Tropeang Plong – Krek – Troeung – Kg. Thmar	2015	-	-	AC
76	China	$51.90	127.0	Snoul - Sen Monorom	2008	2011	Loan	DBST
	China	$100	171.78	Monorom – Koh Nhek – Lumphat – Taang	2012	2015	Loan	DBST (5%)
78	VN	$25.80	70.0	Bang Lung - O Yadav	2007	2008	Loan	AC
	China	$73.30	123.1	O Pong Moan - Ban Lung	2009	2013	Loan	DBST (92.78%)
78x	Private	$6.00	36.0	Ban Lung - Bou Sra (waterfall)	2008	-	-	DBST (not yet started)
92	China	$75	137	Sam An (NR9) – Kg. Sralaor 2 – Kg. Sralaor 1 – Mom 3	2015	-	-	DBST
134B +135	China	$24	43	Chumkiri – Chhuk – Dorng Tung – Kg. Trach	2015	-	-	DBST
181	WB	$2.00	28	Samraong - Chong Kal	2004	2006	Loan	DBST
207	WB	$1.00	1	Sautr Nikom - Beong Tonle Sap	2004	2006	Loan	DBST
210	Private	$21.50	-	Siem Reap - Koh Ke	2003	-	BOT	DBST
258D	China	$50.00	20.0	Kob (NR5, PK: 383) – O Beychoann	2011	2013	Grant	DBST (48.3%)
378	China	$85	141	NR7: Dong Krolor – NR78: Banlung	2015	-	-	DBST
1551	China	$72	135	NR4: Smach Meanchey – NR55: Promoy	2016	-	-	DBST
1554	China	$41	70	Veal Veng (NR55) – Samlot (PR1577)	2015	-	Loan	DBST
1577	China	$25.00	55.16	Sek Sork – Samlot – Border Pass 400	2015	-	Loan	DBST
3762	China	$14.89	26.45	Sen Monorom - Dakdam	2010	2012	Loan	DBST
3787	China	$98	180	Banlung – Kantuyneak	2015	-	-	DBST
Prek Phnov	Private	$42.00	8.17	Phnom Penh (Prek Phnov) - NR6		2010	BOT	DBST (+ bridge cost)
2nd Ring Road	-	$52	38	NR5, PK: 9+000 – NR2, Prek Ho	2014	-	-	AC

Source: Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia (4th Edition), 2012, IRITWG

3.3 Role of National Road No. 5

3.3.1 Role in the National Road Network and Role as an International Arterial Road

NR 5 is an arterial national road connecting Phnom Penh and Poipet, the border point with Thailand. It traverses provinces of Kandal, Kampong Speu, Kampong Chhnang, Pursat, Banteay Meanchey and Battambang. Thus, NR 5 accommodates the traffic needed for the day - to - day activities of the citizens, including access to the public services such as hospital and school, along the highway.

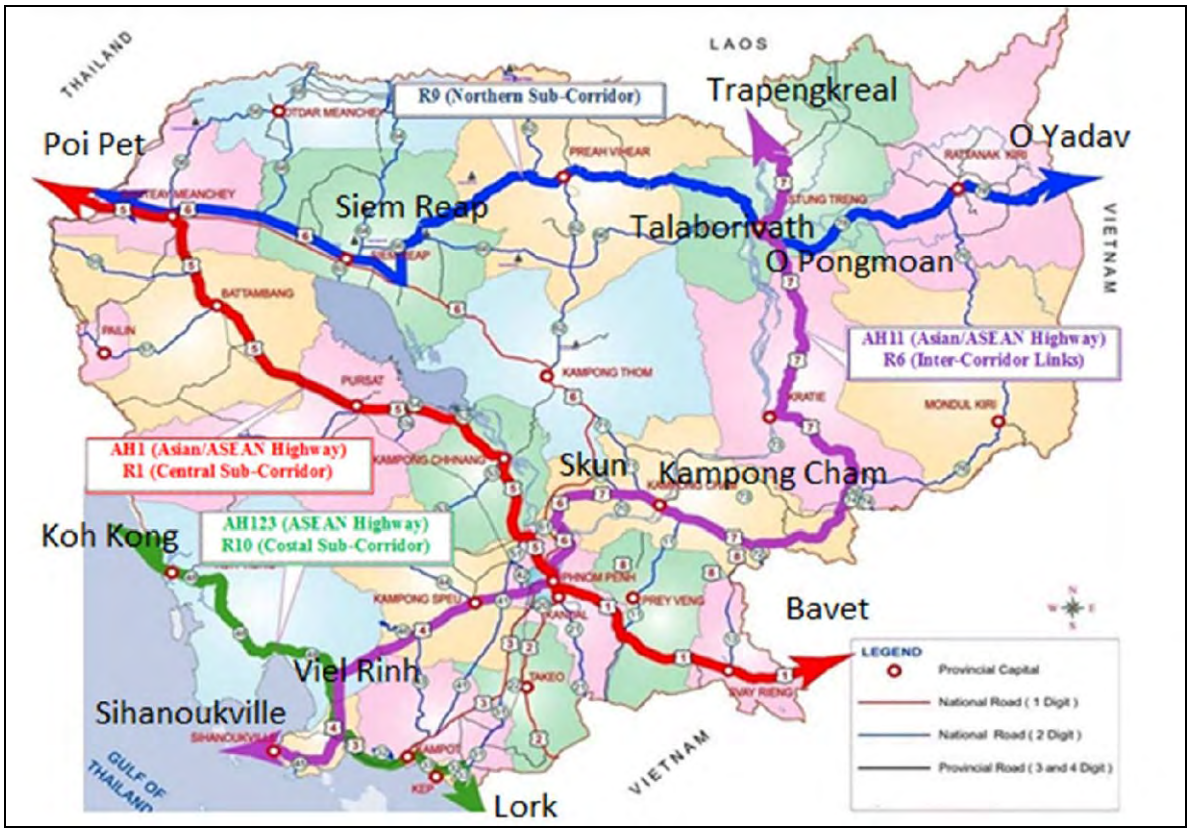
NR 5 also accommodates the traffic transporting goods and passengers between the major cities along the highway, such as Sri Sophorn, Battambang, Pursat, Kampong Chhnang and Phnom Penh. Near to the starting point of the South Section (Prek Kdam Bridge), Odongk, the old capital of Cambodia is located. Odongk is about 40 km away from Phnom Penh and is one of the tourist spots in and near Phnom Penh.

NR 5 is connected, via Phnom Penh, to NR 1 which reaches to Ho Chi Min City in Vietnam and NR 3 and NR 4 which reach to Sihanoukville, the largest international seaport of Cambodia. Thus, NR 5 is an important highway not only for domestic transport in Cambodia but also for international transport in ASEAN and the Greater Mekong Subregion (GMS). NR 5, together with NR 1, forms a route connecting Bangkok, Phnom Penh and Ho Chi Minh City. Thus, NR 5 has been designated as ASEAN Highway No. 1 and Asian Highway No. 1 (see Figure 3.3-2 and Table 3.3-1). With rapid growth in the regional cooperation in GMS in the recent years, the importance of NR 5 is also rapidly growing.



Source: ASEAN Economic Community

Figure 3.3-1 ASEAN Highway



Source: Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia (4th Edition), Infrastructure and Regional Integration Technical Working Group, 2012

Figure 3.3-2 Economic Corridors of GMS

Table 3.3-1 International Road Network in Cambodia

Name of international road			Transit Cities/provinces	Length in Cambodia (km)	International Road Classification				
GMS roads	Asian Highway	ASEAN Highway			Primary	Class I	Class II	Class III	Below Class III
Central Sub-Corridor (R1)	AH1	AH1	Poipet-Sisophon (NR5)	47.5			47.45		
			Sisophon - Phnom Penh (NR5)	360.0				360	
			Phnom Penh - Bavet (NR1)	164.0			57	107	
			Sub-total Length (km)	571.5			104.45	467	
Inter-Corridor Link (R6)	AH11	AH11	Phnom Penh - Sihanoukville (NR4)	226.4			226.4		
			Phnom Penh - Skun (NR6)	75.0			75		
			Skun-Kampong Cham (NR7)	49.0			49		
			Kampong Cham - Trapengkreal (NR7)	411.8				411.83	
			Sub-total Length (km)	762.2			350.4	411.83	
Coastal Sub-Corridor (R1)	-	AH123	Cham Yeam - Koh Kong (NR48)	13.0			13		
			Koh Kong - Sre Ambel (NR48)	138.0				138	
			Sre Ambel - Viel Rinh (NR4)	42.0			42	0	
			Viel Rinh - Kampot (NR3)	36.0				36	
			Kampot - Lork (NR33)	51.8				51.8	
			Sub-total Length (km)	280.8			55	225.8	
Northern Sub-Corridor (R9)	-	-	Siem Reap - Talaborivath (NR66+NR210+NR62+NR9)	305.2				38.8	266.38
			Talaborivath - O Pongmoan (NR7)	19.0				19	
			O Pongmoan - O Yadav border (NR78)	187.7			68.2		119.5
			Sub-total Length (km)	511.9			68.2	57.8	385.9
Grand total length (km)				2,129.4			581.1	1,162.4	385.9

Regional Cooperation in GMS and Cross - Border Transport Agreement

Importance of NR 5 as an international transport corridor has been recently increasing due to the development of regional cooperation in GMS, as seen in the signing and ratification of Cross - Border Transport Agreement (CBTA) in 2008. Further ASEAN countries are actively negotiating to form ASEAN Economic Community, which is similar to EU in nature, to be realized by 2015. If this will be realized, it is expected to accelerate the regional cooperation in ASEAN and GMS and further increase the importance of NR 5.

CBTA is an agreement among 6 countries of GMS; Cambodia, China, Laos, Myanmar, Thailand and Vietnam. Table 3.3-2 shows the contents of Annexes attached to the Agreement. They show the subjects discussed and agreed. Annex 11 is on the road and bridge design standards.

Table 3.3-2 CBTA Status

Item	Description / Title	Countries						
		Cam	PRC	Lao	Mya	Thai	VN	
Annex 1	Carriage of Dangerous Goods	R	R	R	S	S	R	TQ
Annex 2	Registration of Vehicles in International Goods	R	R	R	S	R	R	TI
Annex 3	Carriage of Perishable Goods	R	R	R	S	R	R	TQ
Annex 4	Facilitation of Frontier - Crossing Formalities	R	R	R	S	S	R	C
Annex 5	Cross - Border Movement of People	R	R	R	S	R*	R	I
Annex 6	Transit and Inland Clearance Customs Regime	R	R	R	S	S	S	C
Annex 7	Road Traffic Regulation and Signage	R	R	R	S	R	R	T
Annex 8	Temporary Importation of Motor Vehicles	R	R	R	S	S	R	C
Annex 9	Criteria for Licensing of Transport Operator for Cross - Border	R	R	R	S	R	R	T
Annex 10	Conditions of Transport	R	R	R	S	S	R	T
Annex 11	Road and Bridge Design and Construction Standards & Specifications	R	R	R	S	R	R	T
Annex 12	Border Crossing and Transit Facilities and Services	R	R	R	S	R	R	T
Annex 13a	Multimodal Carrier Liability Regime	R	R	R	S	R	R	T
Annex 13b	Criteria for Licensing of Multimodal Transport Operators for Cross - Border Transport Operations	R	R	R	S	R	R	T
Annex 14	Container Customs Regime	R	R	R	S	S	S	C
Annex 15	Commodity Classifications Systems	R	R	R	S	R	R	C
Annex 16	Criteria for Driving Licenses	R	R	R	S	R	R	TI
Protocol 1	Designation of Corridors, Routes and Points of Entry & Exit Border Crossing	R	R	R	S	R	R	TI
Protocol 2	Charges Concerning Transit Traffic	R	R	R	S	R	R	T
Protocol 3	Frequency and Capacity of Services and Issuance of Quotas and Permits	R	R	R	S	R	R	TI

*Note: * Ratified part 1 - 4*
Legend:
R: Ratification has completed and finished T: Transport, C: Customs, I: Immigration, Q: Quarantine
S: Signed but Ratification still pending
Source JICA Survey Team based on data from ADB website

As implementation of CBTA is difficult as a whole (six countries together), bilateral and tripartite agreements have been sought, like between Cambodia, Laos and Vietnam, and Cambodia and Thailand. Bilateral or tripartite agreements are shown in the table below.

Table 3.3-3 Bilateral / Tripartite Agreement

(unit per day)

Agreement	Contents	Remarks
With Vietnam	・ Quota of vehicles for cross border transport: 40 units in year 2006 ・ Quota of vehicles: increased to 150 units in year 2009 ・ Quota of vehicles: increased to 300 units in year 2010 ・ Quota of vehicles: increased to 500 units (trucks, scheduled & non - scheduled buses) in year 2012 ・ Seven border crossing points: confirmed in year 2012 1) Oyadav (Ratanakiri) - Le Thanh (Gia Lai) 2) Dak Dam (Mundulkiri) - Bu Prang (Dac Nong): pending due to border demarcation 3) Tranpeang Sre (Kratie) - Hoa Lu (Binh Phuoc) 4) Trapeang Phlong (Kampong Cham) - Xa Mat (Tay Ninh) 5) Bavet (Svay Rieng) - Moc Bai (Tay Ninh) 6) Phnom Den (Takeo) - Tinh Bien (An Giang) 7) Prek Chak (Kam Pot) - Ha Tien (Kien Giang)	
With Laos	・ Quota of vehicles for cross border transport: 40 units (trucks) ・ Scheduled buses for cross border transport: 4 units ・ Non - scheduled buses for cross border transport: 20 units under discussion ・ One border crossing point 1) Trapeang Kriel (Stung Treng) - Nong Nokkhien (Chanpasak)	
With Thailand	・ Quota of vehicles for cross border transport: 40 units (trucks & non - schedule buses) (MPWT is currently negotiation with Thai Government to increase this to 500 units.) ・ Scheduled buses for cross border transport: each 3 units ・ One border crossing point 1) Poipet (Banteay Meanchey) - Aranyaprathet (Thailand)	Separate MOU is needed for other cross border point

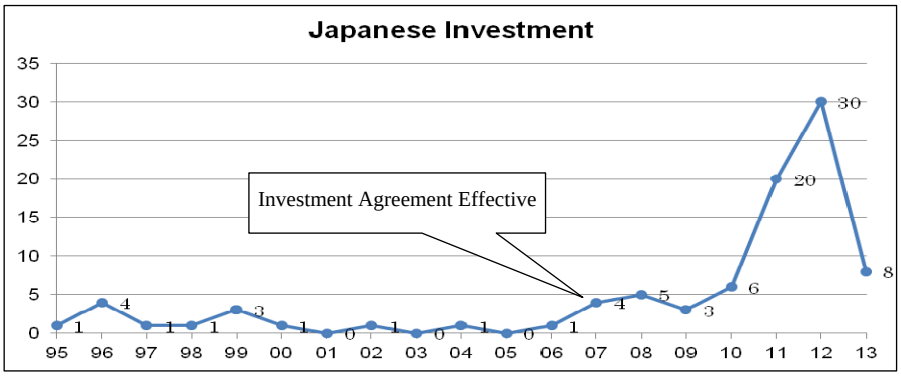
Source MPWT information

As can be seen in the above table, the number of vehicles which are allowed to cross the border with Thailand is limited. MPWT is planning to negotiate with Thai Government to increase the quota of trucks for crossing the border to 500 units/day in the future. When this increase of quota will materialize, the volume of international traffic between Cambodia and Thailand through NR 5 will substantially increase. However, the time schedule for this increase of quota is not clearly drawn.

3.3.2 Benefit to Japanese Businesses

Since the signing of the 'Agreement between Japan and the Kingdom of Cambodia for the Liberalization, Promotion and Protection of Investment' in June 2006 (the Agreement became effective in July 2007), investment in Cambodia by Japanese businesses have been, and are, accelerating. According to the information provided by the Japan Desk of Council for the Development of Cambodia (CDC), the total number of licenses given for Japanese investment in

Cambodia up to the end of year 2012 is 84. Among these 84 investment license, the total of those issued in the 15 - year period of 1995 ~ 2009 was only 28 while those issued during the last 3 years (2010 ~ 2012) was 56. Therefore, the number of investment license issued in the last 3 years is 2 times of that of 16 years of 1995 ~ 2009. Further, additional 8 investment plans have been submitted for license as of January 2013 alone.



Source: Japan Desk, CDC (Original data were in tabular form)

Figure 3.3-3 Japanese Investment in Cambodia

Out of 74 factories of Japanese investment which started, and applied for license, between 2008 and 2013, 34 are located in Phnom Penh SEZ which is located near KP 14 of NR 4. Some of them, for example MINEBEA and DENSO, are operating world - wide, including in Thailand and Vietnam. It is supposed that the products of these factories are transported to Thailand via NR 5. Thus, the improvement of NR 5 is expected to benefit such industries by shortening the transportation time and, as a result, contribute to promote Japanese investment in Cambodia.

3.4 Planned, Ongoing and Past Project for Rehabilitation / Improvement of NR 5 and Other Relevant Project

This subsection summarizes the past projects which contributed to the current condition of NR 5, as well as the on - going and planned project which are expected to improve the current condition of NR 5.

(1) ADB: Emergency Flood Rehabilitation Project (EFRP)

EFRP aims urgently restore the damaged section of NR 5 to their conditions before the flood and contribute to recovery of economic and social activities. The damaged sections of the South Section and North Section, were repaired. Reconstruction of bridges was covered by Package 5E of Primary Roads Restoration Project (PRRP) funded by ADB, which had been removed from PRRP and transferred to EFRP.

(2) Project Funded by Phnom Penh Municipality

The approximately 8 km - long section between Phnom Penh (Chruoy Changvar Bridge) and the boundary between Phnom Penh Municipality and Kandal Province (outs of scope of this Survey), was overlaid with asphalt concrete (AC) recently by the fund of Phnom Penh Municipality. Pavement works had been completed by the end of year 2012.

(3) Widening of Phnom Penh - Prek Kdam Section by Financial Assistance of Chinese Government

This project is to widen the approximately 31 km - long section from Chruoy Changvar Bridge Kandal to Prek Kdam into full 4-lane with AC pavement by Chinese fund. Thus, this project has close relation with the Project of the Survey of the South Section is conducted by JICA Study Team.

The project started in October 2012 and is scheduled to be completed in June 2014. The commencement ceremony was held on 9 October 2012. Figure 3.4-1 shows the typical cross sections (urban section and rural section) of the widening project.

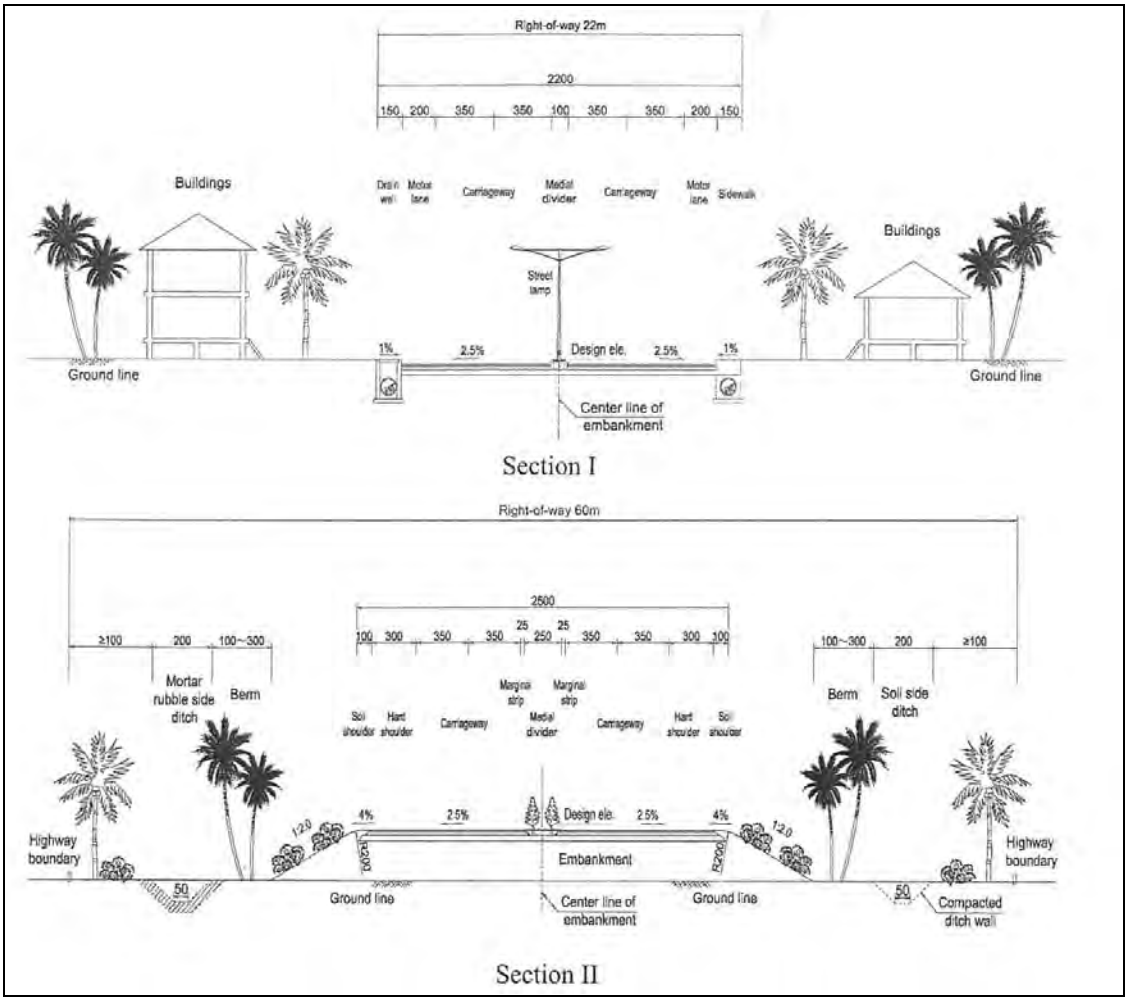


Figure 3.4-1 Typical Cross Section of Widening Under Chinese Fund

(4) ADB: Road Asset Management Project (RAMP)

Road Asset Management Project (RAMP) funded by ADB implemented the maintenance work between Phnom Penh (KP 3.9) and Thlea Ma'am (KP 170.9) in 2010, 2011 and 2012. The contents of the works are the installation of road signs, guide posts, lane marking and kilometer posts. Repairs of pavement such as cracks, potholes, depression, rutting, shoving, corrugation, base course failure, edge break damage, as well as full depth reconstruction of pavement were also carried out. However, no improvement or upgrading works were carried out in this project.

Figure 3.4-2 shows examples of repair works carried out in RAMP.



Vicinity of KP 120



Vicinity of KP 111

Figure 3.4-2 Pavement Repair by RAMP Project

(5) JICA: Flood Disaster Rehabilitation and Mitigation Project (FDRMP)

During the rainy season in 2011, the water level of Mekong River reached almost the same level as that of the serious flooding occurred in 2000. This unusually high rise of the water level in the Mekong River was attributed to the unusually heavy rainfall at the upstream of the Mekong River. Many sections of NR 5 were severely damaged by the flood of 2011. FDRMP aims to rehabilitate and improve the selected roads and drainages in Kampong Chhnang City and bridges along National Road No. 11 under Japanese grant aid. The component of road improvement in Kampong Chhnang City includes improvement of pavement, drainages and sidewalks of the city center section of National Road No. 5 (2.2 km) and the related major streets (2.4 km). It also includes extension of drainage (by 2.6 km) to outlet the rain water to the nearest river.

The recent projects on NR 5 as described above are listed in Table 3.4-1.

Table 3.4-1 Project List on NR 5

Section	Project	Year
Phnom Penh ~ Prek Kdam Br.	・ Restored by Army	2000 - 2002
	・ RAMP funded by ADB	2010 - 2011
	・ Full 4-lane widening & AC pavement by Phnom Penh Municipality (Chrouy Changvar Br. – P. P./ Kandal Border)	2012
	・ Widening to full 4-lane by Chinese fund	2012 -
Prek Kdam Br. ~ Kampong Chhnang (South Section)	・ Restored by Army	2000 - 2002
	・ RAMP funded by ADB	2010 - 2011
Kampong Chhnang ~ Thlea Ma'am (South Section)	・ EFRP funded by ADB	2000 - 2004
	・ RAMP funded by ADB	2011 - 2012
Kampong Chhnang City	・ FDRMP funded by JICA	2012 -

(6) ADB: GMS: Railroad Rehabilitation Project

As listed in Table 3.2-1, the railroad is being rehabilitated under the financial assistance of ADB. Most significant component of this project in relation to NR 5 is rehabilitation of the Northern Line. This component was scheduled to be completed in March 2012. The civil works started in March 2008. There had been delay in progress due to various problems, such as resettlement, and the contractor abandoned the project in July 2012. Currently, the project is

haltered for time being. After completion of rehabilitation of railroad facility, the process of selecting the to whom the concession of operation will be awarded will take place. It is unknown at present how long this process will take.

(7) Plan for Construction of Expressway

As the fundamental improvement of long - distance road transport, construction of expressway network is currently being discussed. A master plan of the national expressway network was prepared by the assistance of the government of Henan Province, China and was presented in April 2014. This master plan proposed an expressway network with a total length of 2,200 km. The expressway along NR 5 is proposed as one of the main lines of the national expressway network, and is planned a few to ten kilometer away from the existing national road on the west side of NR 5 (opposite from Tonle Sap) to avoid the densely populated areas along the existing national roads. This route is also suitable for avoiding inundation/flood. The master plan proposes this expressway along NR 5 be listed among the "medium term projects" but does not mention the time of construction.

After these expressways will be constructed and will be open to traffic, existing NR 5 will be used mainly for the daily activities of the people living along NR 5.

3.5 Necessity of Improvement of the Middle Section and the Sri Sophorn - Poipet Section

Improvement of the Middle Section and the Sri Sophorn - Poipet Section of NR 5 is necessary in view of the facts summarized below:

(1) Designation in the National Development Plan and Road Network Master Plan

Widening of NR 5 has been designated as one of major projects in both of national development plan (NSDP) and road network master plan.

(2) Halter of the railroad rehabilitation project

In view of the uncertainties in railroad rehabilitation, improvement of NR 5 is the only foreseeable improvement of transport infrastructure between Phnom Penh and Sri Sophorn/Poipet.

(3) Improvement of the South Section and the North Section

The North Section and the South Section are to be widened to full 4-lane by the assistance of Japanese Government. From a viewpoint of consistency of road standard, it is necessary to widen from Thlea Ma'am to Battambang and the Sri Sophorn – Poipet Section to the same standard.

(4) Promotion of regional economic cooperation

ASEAN community is scheduled to be agreed in 2015 as described Subsection 3.3.1. Also many foreign companies, including Japanese enterprises, are constructing factories in Cambodia. Thus international transportation between Thailand and Cambodia needs to be improved.

CHAPTER 4 PRESENT CONDITION OF MIDDLE SECTION AND SRI SOPHORN – POIPET SECTION

4.1 Overall Conditions

(1) Overall Road Condition of the Middle Section

An inventory survey of the Middle Section was conducted in the middle of May 2013 utilizing the same survey method used in the Survey of the North Section conducted in February – March 2011. In the inventory survey conducted in the Survey for the North Section intended to evaluate the existing conditions of the entire length of Prek Kdam – Sri Sophorn, and thus, covered all of South, Middle and North Sections.

In the inventory survey conducted in May 2013, it was observed that the road condition had become worse than those observed in the survey in 2011. Figure 4.1-1 shows examples of the damages observed in May 2013. One of the main causes for the worsened road condition is the rain water which accumulated at the roadside and consequently penetrated into the pavement structure and subgrade. Pavement is quickly damaged once the base course and subgrade are weakened by the penetrated water. Once cracks occur, the water seep into the base course and subgrade through cracks and potholes further developing these damages.



Longitudinal Crack (KP 224)



Mesh Crack (KP 236)



Pothole (KP 229)



Depression (KP 265)

Figure 4.1-1 Condition of Middle Section

The road condition of Middle Section is summarized in the straight diagram attached as Appendix 4-1.

Discrepancy in Kilometer Posts

During the period of the Survey of the North Section, MPWT installed kilometer posts (KP) along NR 5. However, there seemed to be some discrepancies between the distances of the installed KPs and those observed by the Survey Team using a GPS apparatus. The distances between KPs measured by the Survey Team are shown in Table 4.1-1. The locations used in this report are those measured from the existing KPs.

Table 4.1-1 Distance between KPs Measured by Survey Team

Unit: km

KP	Distance	KP	Distance	KP	Distance
171		215	1.02	259	1.02
172	1.01	216	1.01	260	1.03
173	0.98	217	1.04	261	1.01
174	1.01	218	1.01	262	1.03
175	1.00	219	1.00	263	1.00
176	0.96	220	1.00	264	1.03
177	1.00	221	1.03	265	0.99
178	1.05	222	1.00	266	1.03
179	1.01	223	1.01	267	1.00
180	1.01	224	1.00	268	1.00
181	0.97	225	1.02	269	1.02
182	0.94	226	1.01	270	1.02
183	0.99	227	1.04	271	1.04
184	0.95	228	1.00	272	1.05
185	0.97	229	1.03	273	1.04
186	1.00	230	1.02	274	1.04
187	0.98	231	1.03	275	1.01
188	0.98	232	1.01	276	1.06
189	0.97	233	1.01	277	1.05
190	1.35	234	1.00	278	1.00
191	0.69	235	1.02	279	1.02
192	1.02	236	1.01	280	1.02
193	1.05	237	1.01	281	0.99
194	1.02	238	0.99	282	1.02
195	1.07	239	0.99	283	Shift to
196	1.03	240	1.00	284	Bypass
197	1.04	241	1.00	285	
198	0.99	242	0.99	286	
199	1.07	243	1.06	287	
200	1.03	244	1.01	288	
201	0.97	245	1.02	289	
202	1.03	246	1.00	290	
203	1.01	247	1.02	291	
204	0.99	248	1.00	292	
205	1.03	249	1.01	293	
206	0.98	250	1.00	294	
207	1.00	251	1.00	295	
208	1.00	252	0.99	296	
209	1.03	253	1.01	297	
210	1.00	254	1.00	298	
211	1.04	255	1.01	299	
212	0.99	256	1.01	300	
213	1.03	257	1.02	301	
214	1.04	258	1.04		

(2) Overall Road Condition of Sri Sophorn - Poipet Section

Sri Sophorn - Poipet Section of NR 5 was improved in 2008 under Cambodia Road Improvement Project (CRIP), Package 5F financed by ADB. The AC pavement was adopted in this section. Therefore, the road surface condition is better than the other sections of NR 5. Problems are found at limited number of locations and most part of the road surface is still in good condition. Flushing and rutting are the main observed problems. Figure 4.1-2 shows examples of the main observed damages.



Flushing (KP 370)



Rutting (KP 386)

Figure 4.1-2 Condition of Sri Sophorn - Poipet Section

The distances between KPs in Sri Sophorn - Poipet Section also measured by GPS apparatus are shown in Table 4.1-2.

Table 4.1-2 Distance between KPs along Sri Sophorn - Poipet Section

(Unit: km)

KP	Distance	KP	Distance	KP	Distance	KP	Distance
366	0.00	377	1.01	388	1.00	399	1.01
367	1.00	378	1.02	389	0.99	400	1.02
368	1.00	379	0.99	390	1.03	401	1.03
369	1.03	380	1.00	391	1.00	402	0.93
370	0.97	381	1.00	392	0.99	403	1.10
371	1.00	382	1.01	393	1.02	404	0.99
372	1.01	383	1.00	394	1.01	405	1.03
373	1.01	384	1.01	395	0.99	406	1.00
374	1.00	385	1.02	396	1.00	407	0.91
375	1.00	386	1.03	397	1.02		
376	1.01	387	0.99	398	1.00		

4.2 Geometric Structure

4.2.1 Cross Section

A space of a road is used not only for passage of motorized vehicles but also for other purpose. A road provides space for various facilities including drainage, telecommunication cables and electric power line. Parts of road are also used as the space for passage of non - motorized vehicles and pedestrians. Thus, it is necessary to consider these functions.

(1) Cross Section of Middle Section

The existing cross section of the Middle Section comprises two undivided opposing lanes and shoulders. All of road surface along Middle Section is Double-Layered Bituminous Surface Treatment (DBST) with a gravel shoulder.

The average width of pavement of Middle Section is 10.4 m. The typical cross section of Middle Section is shown in Figure 4.2-1.

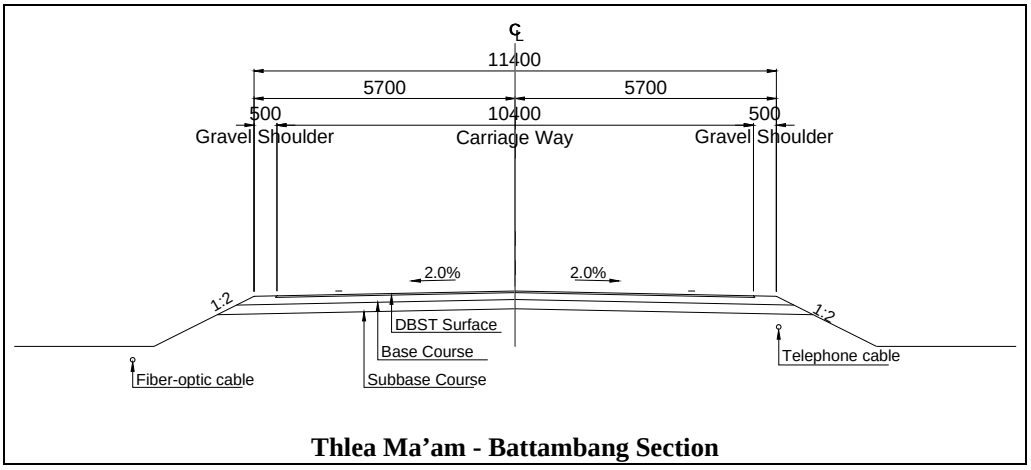
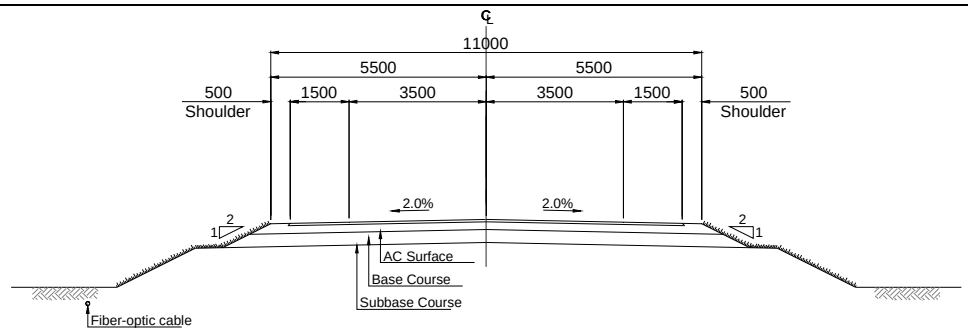


Figure 4.2-1 Typical Cross Section of Middle Section

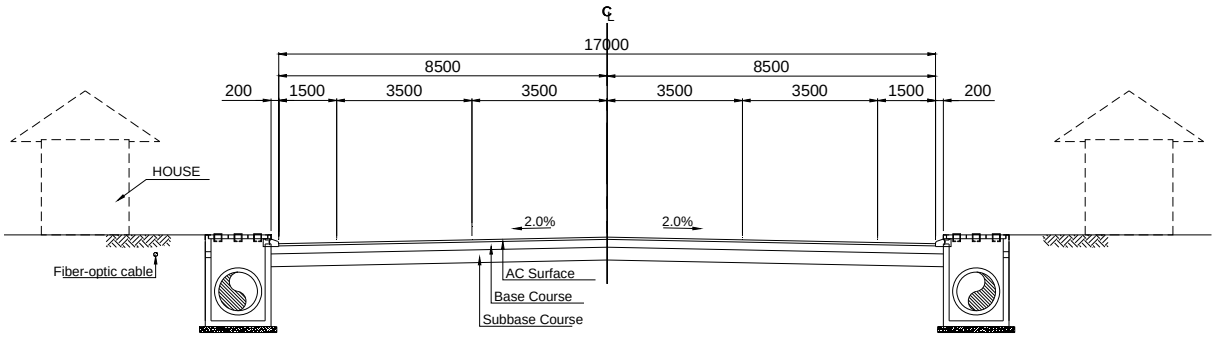
(2) Cross Section of Sri Sophorn - Poipet Section

The cross section of Sri Sophorn - Poipet Section in rural areas comprises two undivided opposed lanes with 1.5 m-wide shoulders on the both sides which can be used by motorcycles and other slows vehicles. All of road surface of this section is AC and the surface of shoulder is covered by gravel. On the other hand, the cross section in urban areas is undivided 4-lane with 1.5 m-wide shoulder. The cross section for urban area starts from KP 403 and ends at KP 407.

The cross sections in rural and urban of the Sri Sophorn - Poipet Section are shown in Figure 4.2-2.



Cross Section between Sri Sophorn - Poipet Section for Rural Area
(KP 366 – KP 402)



Cross Section between Sri Sophorn - Poipet Section for Urban Area
(KP 403 – KP 407)

Figure 4.2-2 Cross Sections of Sri Sophorn - Poipet Section

4.2.2 Horizontal Alignment

Horizontal alignment is one of the most important factors influencing the efficiency and safety of an arterial road such as NR 5. A curve with a small radius results in lower speeds, which in turn, results in reduction in the performance of NR 5 as an arterial road in terms of safety and comfort. Horizontal alignment of NR 5 is generally generous. Where there is a curve, the radius is usually large enough to satisfy the criteria of geometric design of Cambodia.

(1) Horizontal Alignment of Middle Section

In the Middle Section, there are six curves with radii smaller than 350 m which is the minimum value for the design speed of 100 km/h. The curve lengths at 25 locations, including one location in urban area, are shorter than the minimum value. Table 4.2-1 shows the locations and elements of curves including those whose radii are smaller than the criterion.

Table 4.2-1 Elements of Substandard Curves on Middle Section

No.	KP	Radius (m)	Length (m)	Problem *	No.	KP	Radius (m)	Length (m)	Problem *
1	175 + 496	1,817	167	L	14	264 + 875	541	128	L
2	179 + 549	24,538	102	L	15	273 + 962	546	105	L
3	192 + 437	1,024	119	L	16	275 + 942	519	100	L
4	192 + 573	1,475	125	L	17	276 + 259	155	69	R/L
5	199 + 030	135,302	89	L	18	277 + 110	1945	128	L

No.	KP	Radius (m)	Length (m)	Problem *	No.	KP	Radius (m)	Length (m)	Problem *
6	213 + 759	2,239	116	L	19	277 + 450	608	101	L
7	239 + 357	668	137	L	20	277 + 750	121	40	R/L
8	240 + 911	3,329	83	L	21	277 + 889	1098	143	L
9	242 + 424	442	85	L	22	278 + 015	312	111	R/L
10	242 + 693	322	56	R/L	23	278 + 479	248	43	R/L
11	244 + 015	271	73	R/L	24	279 + 264	270	147	R
12	253 + 553	625	41	L	25	279 + 478	1059	114	L
13	255 + 327	1,139	133	L					

**L: Insufficient curve length R: Radius of curve smaller than standard*

There are 10 sections in the Middle Section where the maximum speed is regulated at 40 km/h. Table 4.2-2 shows the location of speed reduction on the Middle Section.

Table 4.2-2 Section of Speed Reduction on Middle Section

No.	KP		Length (km)	Name
	Beginning	End		
1	184 + 100	188 + 200	4.09	Pursat
2	197 + 500	198 + 300	0.83	Andoung Krasang
3	200 + 800	202 + 500	1.75	Bakan
4	208 + 800	212 + 700	4.64	Boeung Khnar
5	215 + 100	217 + 000	1.97	Ou Ta Paong
6	218 + 800	220 + 000	1.12	Svay Daun Keo
7	222 + 400	224 + 900	2.45	Prek Svay
8	230 + 600	231 + 600	0.96	Kalaom Phluk
9	235 + 900	237 + 000	1.17	Prey Svay
10	243 + 700	245 + 600	1.85	Moung Russei

(2) Horizontal Alignment of Sri Sophorn - Poipet Section

In the Sri Sophorn - Poipet Section, the smallest radius of curve is 1,500 m. Thus, there is no serious problem in the present horizontal alignment. There are 5 sections in the urbanized areas where the maximum speed is regulated at 40 km/h. Table 4.2-3 shows the location of speed reduction on the Sri Sophorn - Poipet Section.

Table 4.2-3 Section of Speed Reduction on the Sri Sophorn - Poipet Section

No.	KP		Length (km)	Name
	Beginning	End		
1	372 + 600	373 + 200	0.62	Soryathmi
2	376 + 900	377 + 400	0.50	Soryathmi
3	380 + 000	389 + 200	9.12	Nimit
4	392 + 300	394 + 100	1.79	Koun Damrei
5	401 + 900	407 + 300	5.40	Poipet

4.2.3 Vertical Alignment

Vertical alignment often constitutes the governing factor in design in case of a road traversing mountainous terrain. In case of NR 5, the vertical alignment is generally flat since NR 5 generally traverses flat terrain.

(1) Middle Section

The steepest grade on the Middle Section is observed on the approach sections of the bridges. Even on the sections approaching bridges, the gradients are less than 4 percent, the maximum grade stipulated in the Cambodian Standard for Geometric Design. Thus, the gradient itself is not imposing serious problems. Rather, the height of the road surface near the bridges needs to be examined in relation to flood/inundation. The profile of the Middle Section, drawn based on the cross section survey data, is shown in Figure 4.2-4 to 4.2-5.

The common embankment height is 1 to 2 m and the maximum embankment height is 4 m according to the result of inventory survey. Embankment height of zero means that the elevation of land on both sides of NR 5 is same with the road surface. Where the elevation of the land adjacent to the road is higher than road surface, rain water flows into the road and causes inundation. Figure 4.2-3 shows examples of road surface lower than the adjacent land and inundated road surface.



Figure 4.2-3 Road Surface Lower than Adjacent Land; Inundation Occurred due to Rain Water Flowing into Road from Adjacent Land

The problem of flood / inundation is discussed in Chapter 6.

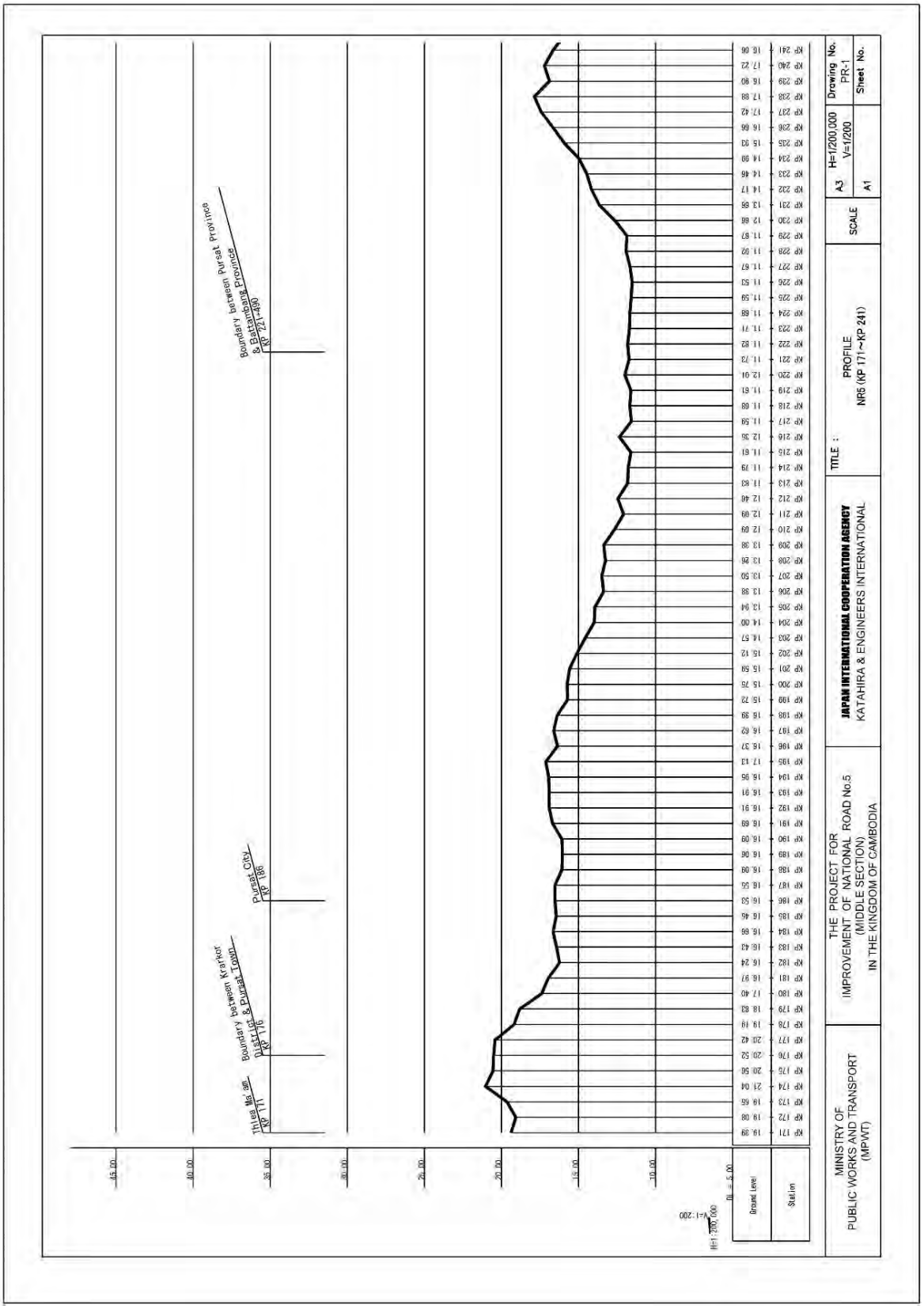


Figure 4.2-4 Road Elevation of Middle Section: from KP 171 to KP 241

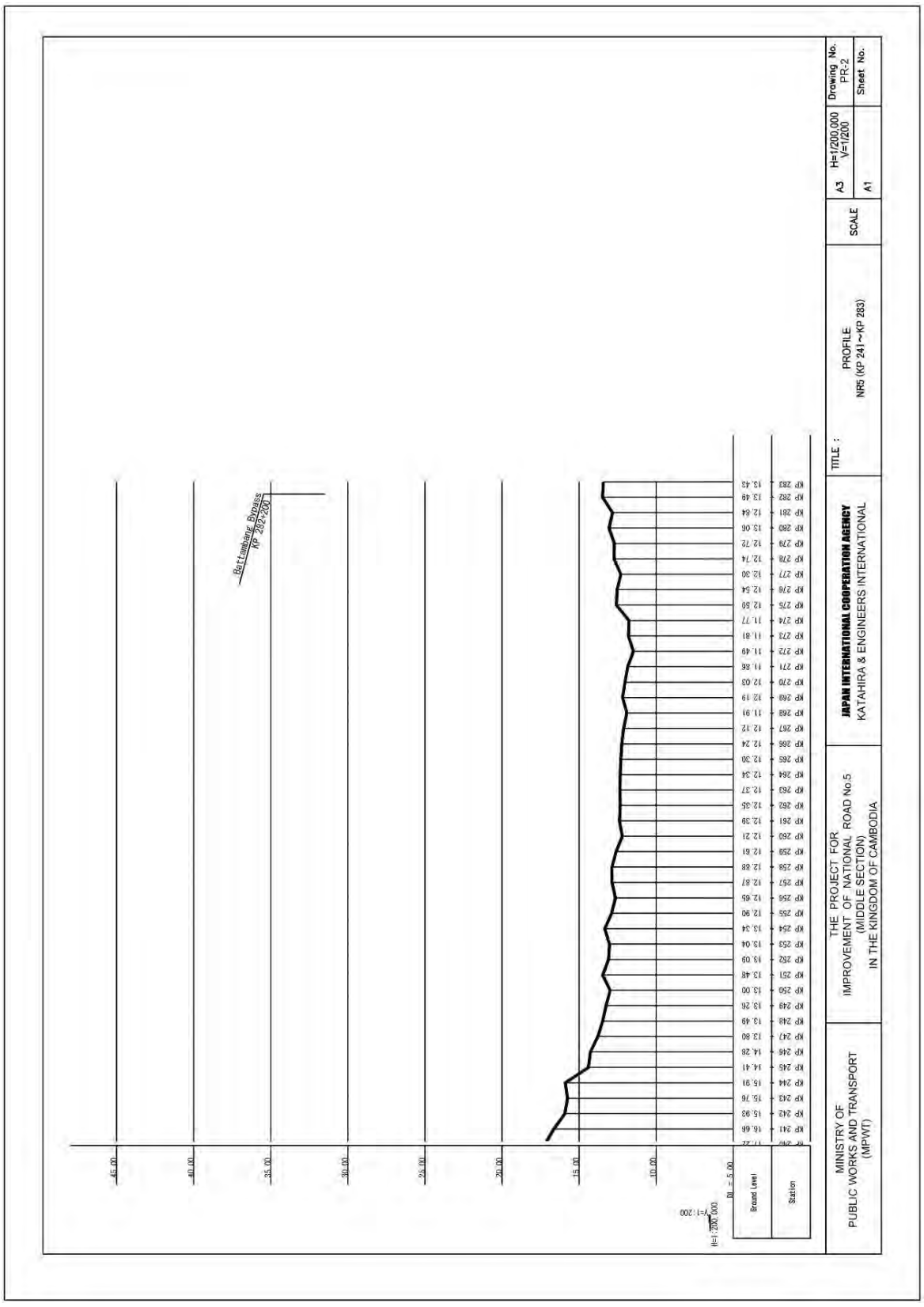


Figure 4.2-5 Road Elevation of Middle Section: from KP 241 to KP 283

(2) Sri Sophorn - Poipet Section

The vertical alignment of Sri Sophorn to Poipet Section is slightly climbing in the direction of from Sri Sophorn to Poipet. The maximum grade is 0.36 percent and gradients of most of the sections are less than 0.10 percent as observed in the as-built drawings prepared in the CRIP financed by ADB. Thus, the gradient itself is not imposing serious problems. Rather, the height of road surface is an important subject in view of the flood/inundation. The embankment height was raised in CRIP by around 60 cm or more from the original embankment height. In the urbanized areas, the road surface level is either equal to, or less than, the level of adjacent land. Drainage pipes for the rain water were installed in CRIP.

Figure 4.2-6 shows examples of road surface lower than the adjacent land where inundation of road surface has occurred (left) and inlet of drainage installed under the sidewalk.



Figure 4.2-6 Road Surface Lower than Adjacent Land in the Commercial Area (Left) and Inlet of Drainage Installed under CRIP

The problem of flood / inundation is discussed more in detail in Chapter 6.

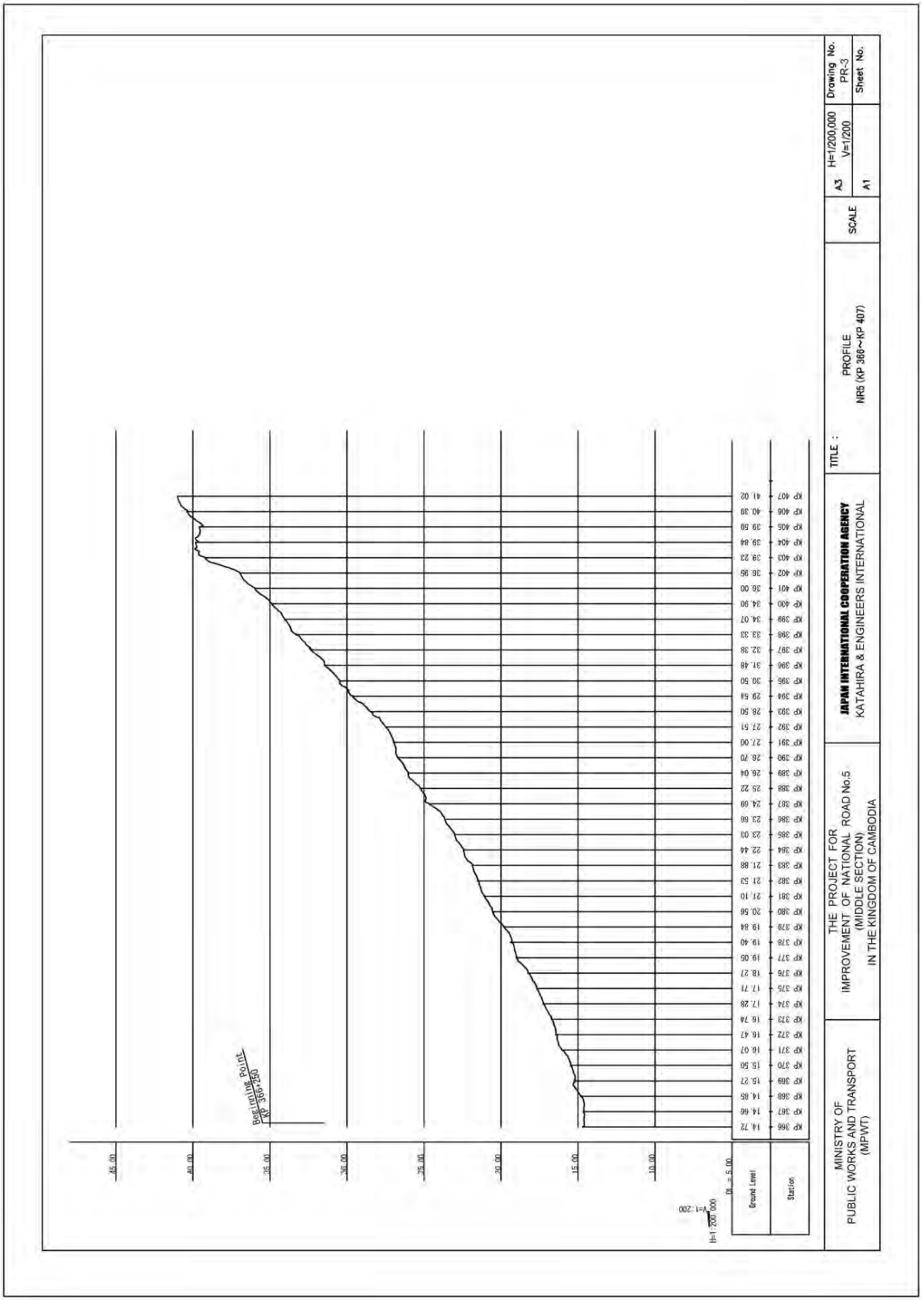
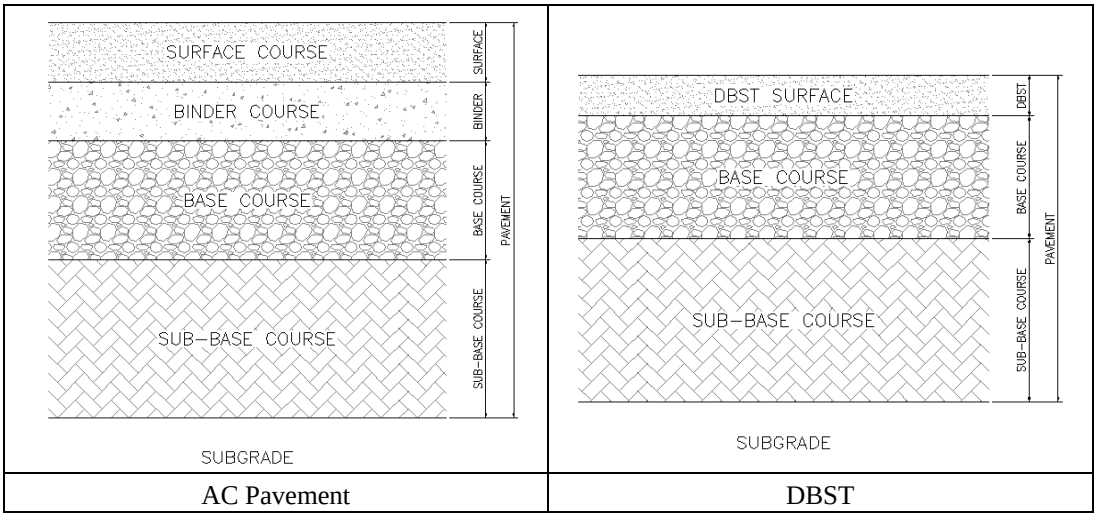


Figure 4.2-7 Road Elevation of Sri Sophorn – Poipet Section: from KP 366 to KP 407

4.3 Pavement

Adequate pavement design is one of the most important aspects of road design. The condition and adequacy of the highway is often judged by the smoothness or roughness of the pavement. Deficient pavement conditions can result in increased user costs, travel delays, excessive braking, increased fuel consumption, vehicle maintenance cost and higher risk of traffic accidents.

The existing pavement structures of the Middle Section is double-layered bituminous surface treatment (DBST) and that of Sri Sophorn - Poipet Section is asphalt concrete (AC). The typical pavement structures of "AC Pavement" and "DBST" are shown in Figure 4.3-1. DBST is used in the road with minimal traffic volume of heavy vehicles.



AC Pavement	DBST

Figure 4.3-1 Standard Pavement Condition

(1) Middle Section

The condition of the existing pavement was observed at the points of failure and at 1 km intervals at the fixed kilometer post in the Survey of the North Section in 2011. These inventory data are updated on May 2013 in this Survey.

The maintenance of the pavement was in general carried out during dry season of 2012 and 2013. The inventory survey was carried out at the end of the dry season of 2013 (May 2013). The maintenance works under DPWTs have been carried out to repair major damages in the Middle Section but many minor failures were left unrepaired.

The typical pavement defects observed on the Middle Section and Sri Sophorn - Poipet Section are shown in Table 4.3-1.

(2) Sri Sophorn - Poipet Section

The condition of existing pavement was closely observed by the same method with the Middle Section. Only the cracks and potholes have been observed in some parts. Generally pavement condition is still kept better than the other parts of NR 5.

Table 4.3-1 Typical Pavement Defects

Type of Failures	Description	Photo
Crack KP 207 ~ KP 214, KP 220 ~ KP 253, KP 260 ~ KP 282, KP 387, KP 390, KP 396 ~ KP 397,	There are two types of crack; longitudinal line crack on the shoulder and mesh crack on the depressed area. The longitudinal line cracks are assumed to be caused by the settlement of embanked surface.	
Pothole KP 192 ~ KP 193, KP 229 ~ KP 243, KP 265 ~ KP 271, KP 274 ~ KP 281 KP 375	There are numerous small holes. These small halls usually develop further during the rainy season.	
Depression KP 235 ~ KP 237, KP 265 ~ KP 271, KP 275 ~ KP 281 KP 393	Usually observed in the right wheel tracks of vehicles. It is caused by insufficient strength of the pavement and / or penetration of water into the pavement structure.	
Flush (Bleeding) KP 200, KP 367 ~ KP 374, KP 380 ~ KP 382, KP 395 ~ KP 398,	Bituminous material seeping out to the pavement surface. Caused by excess use of bitumen.	
Rutting KP 177 ~ KP 182, KP 191 ~ KP 201, KP 226 ~ KP 230, KP 246 ~ KP 251, KP 259 ~ KP 263, KP 366, KP 374, KP 380, KP 382, KP 386 ~ KP 387, KP 391 ~ KP 394,	Observed on the wheel tracks of vehicles: Caused by insufficient strength of the pavement compared to the traffic load.	
Aggregate loss KP 205, KP 248, KP 279	Breakaway of surface aggregate is observed on the old surface: Caused by the poor adhesion of deteriorated bitumen or insufficient binder.	
Edge Damage KP 184 ~ KP 188, KP 239 ~ KP 246	Wear of shoulder caused by action of water and / or vehicle entering to the road.	

4.4 Bridge Condition

4.4.1 Inventory of Bridges

The conditions of existing bridges were visually inspected. The location of each bridge was measured from the existing kilometer post along the NR 5 and the distances from the existing KPs to the bridge were measured by GPS apparatus in the field survey. Accordingly, KP of bridge locations is expressed with 50 meters as the effective number.

A bridge inventory provided by MPWT lists 38 bridges. The field survey conducted by the Team indicated some discrepancies between records in the inventory and the results of the field survey as compared in Table 4.4-1 shown below.

Table 4.4-1 Differences between Inventory of MPWT and Result of Survey

Br. No	Inventory of MPWT		Result of Survey	
	KP	Bridge type	KP	Bridge type
40	177 + 007	RC Steel Bridge	177 + 200	Steel Girder
41	178 + 326	PC Bridge	178 + 500	PC Hollow
42	181 + 584	RC Bridge	181 + 800	RC Girder
43	182 + 525	PC Bridge	182 + 800	PC Hollow
44	182 + 945	RC Steel Bridge	183 + 300	Steel Girder
45	183 + 527	PC Bridge	183 + 900	PC Hollow
46	183 + 720	PC Bridge	184 + 100	PC Hollow
47	185 + 192	PC Bridge	185 + 700	PC Girder
48	186 + 961	PC Bridge	187 + 400	PC Girder
49	187 + 268	PC Bridge	187 + 700	PC Hollow
50	187 + 541	PC Bridge	188 + 100	PC Hollow
51	187 + 725	PC Bridge	188 + 250	PC Hollow
52	188 + 703	PC Bridge	189 + 250	PC Hollow
53	189 + 371	PC Bridge	189 + 900	PC Hollow
54	189 + 931	PC Bridge	190 + 150	PC Hollow
55	190 + 544	PC Bridge	191 + 100	PC Hollow
56	201 + 514	PC Bridge	201 + 800	PC Hollow
57	208 + 237	RC Bridge / PC Bridge	208 + 500	PC Hollow
58	215 + 428	RC Steel Bridge	215 + 750	Steel Girder
59	219 + 274	RC Steel Bridge	219 + 600	Steel Girder
60	220 + 465	PC Bridge	220 + 800	PC Hollow
61	222 + 345	PC Bridge	222 + 650	PC Hollow
62	223 + 291	PC Bridge	223 + 650	PC Hollow
63	242 + 379	PC Bridge	242 + 850	PC Hollow
64	243 + 189	PC Bridge	243 + 600	PC Hollow
65	243 + 938	PC Bridge	244 + 400	PC Hollow
66	245 + 491	RC Bridge	245 + 900	RC Girder
67	254 + 191	PC Bridge	255 + 250	PC Hollow
68	254 + 741	PC Bridge	255 + 600	PC Hollow
69	256 + 043	PC Bridge	256 + 550	PC Hollow
70	257 + 401	PC Bridge	257 + 900	PC Hollow
71	265 + 348	PC Bridge	265 + 900	PC Hollow

Br. No	Inventory of MPWT		Result of Survey	
	KP	Bridge type	KP	Bridge type
72	270 + 378	PC Bridge	270 + 900	PC Hollow
73	271 + 124	PC Bridge	271 + 700	PC Hollow
74	272 + 082	PC Bridge	272 + 650	PC Hollow
75	272 + 775	PC Bridge	273 + 300	PC Hollow
76	275 + 164	PC Bridge	275 + 650	PC Hollow
77	276 + 024	PC Bridge	276 + 550	PC Hollow

Table 4.4-2 shows the details of bridges observed through the field survey.

Table 4.4-2 Details of Existing Bridges on Middle Section

Ref.	Code	KP (Km)	Bridge Type	Length (m)	No. Of Span	Width (m)			Year Built	Note
						Total	Carriage	Side		
1	Br. 40	177 + 200	Steel Girder	23.0	1	9.6	7.0	1.3	1996	・ Steel Girder is galvanized. ・ Slope protections stone mason at A1 abutment and A2 abutment are destroyed partially caused by flood. ・ Widening at left side has advantages due to the surrounding site condition.
2	Br. 41	178 + 500	PC Hollow	15.1	1	10.1	10.1	No	2003	
3	Br. 42	181 + 800	RC Girder	18.6	4	9.15	9.15	No		
4	Br. 43	182 + 800	PC Hollow	36.0	2	10.1	10.1	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
5	Br. 44	183 + 300	Steel Girder	45.6	3	9.05	9.05	No	1996	・ Steel Girder is painted. ・ Each pier table of the bridge is supported by RC piles (10 each). ・ Widening at left side has advantages due to the surrounding site condition
6	Br. 45	183 + 900	PC Hollow	36.0	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
7	Br. 46	184 + 100	PC Hollow	20.0	1	10.0	10.0	No	2003	
8	Br. 47	185 + 700	PC Girder	120.0	6	9.6	7.0	1.3	1995	・ All pier tables of the bridge are supported by RC piles (10 each). ・ Widening at left side has advantages due to the surrounding site condition
9	Br. 48	187 + 400	PC Girder	28.0	2	8.5	8.5	No		
10	Br. 49	187 + 700	PC Hollow	24.0	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
11	Br. 50	188 + 100	PC Hollow	54.0	3	10.0	10.0	No	2003	・ All pier tables of the bridge are supported by RC piles (6 in total).
12	Br. 51	188 + 250	PC Hollow	45.0	3	10.0	10.0	No	2003	・ All pier tables of the bridge are supported by RC piles (6 in total).
13	Br. 52	189 + 250	PC Hollow	30.0	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
14	Br. 53	189 + 900	PC Hollow	18.0	1	10.0	10.0	No	2003	
15	Br. 54	190 + 150	PC Hollow	18.0	1	10.0	10.0	No	2003	
16	Br. 55	191 + 100	PC Hollow	30.0	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
17	Br. 56	201 + 800	PC Hollow	12.0	1	10.0	10.0	No	2003	
18	Br. 57	208 + 500	PC Hollow	28.0	2	10.0	10.0	No	2003	
19	Br. 58	215 + 750	Steel Girder	45.6	3	10.0	7.0	1.5	1996	・ Steel Girder is painted. ・ All pier tables of the bridge are supported by RC piles (10 each).

Ref.	Code	KP (Km)	Bridge Type	Length (m)	No. Of Span	Width (m)			Built Year	Note
						Total	Carriage	Side		
20	Br. 59	219 + 600	Steel Girder	91.0	3	9.6	7.0	1.3	1996	・ Steel Girder is galvanized. ・ Slope protection stone mason at A1 abutment is destroyed partially caused by flood. ・ All pier table of the bridge is supported by Steel piles (12 each). ・ One part of steel handrail of the bridge is damaged. ・ Widening at right side has advantages due to the surrounding site condition
21	Br. 60	220 + 800	PC Hollow	24.1	2	10.0	10.0	No	2003	・ Slope protections stone mason at A1 abutment and A2 abutment are destroyed partially caused by flood. ・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
22	Br. 61	222 + 650	PC Hollow	12.1	1	10.0	10.0	No	2003	・ Slope protections stone mason at A1 abutment and A2 abutment are destroyed partially caused by flood
23	Br. 62	223 + 650	PC Hollow	12.1	1	10.0	10.0	No	2003	
24	Br. 63	242 + 850	PC Hollow	18.0	1	10.1	10.1	No	2003	
25	Br. 64	243 + 600	PC Hollow	30.1	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
26	Br. 65	244 + 400	PC Hollow	24.2	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
27	Br. 66	245 + 900	RC Girder	9.0	2	9.15	9.15	No		
28	Br. 67	255 + 250	PC Hollow	15.1	1	10.1	10.1	No	2003	
29	Br. 68	255 + 600	PC Hollow	24.0	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
30	Br. 69	256 + 550	PC Hollow	15.0	1	10.0	10.0	No	2003	
31	Br. 70	257 + 900	PC Hollow	12.1	1	10.0	10.0	No	2003	
32	Br. 71	265 + 900	PC Hollow	12.1	1	10.0	10.0	No	2003	
33	Br. 72	270 + 900	PC Hollow	12.1	1	10.0	10.0	No	2003	
34	Br. 73	271 + 700	PC Hollow	18.5	1	10.0	10.0	No	2003	
35	Br. 74	272 + 650	PC Hollow	12.1	1	10.0	10.0	No	2003	
36	Br. 75	273 + 300	PC Hollow	24.1	2	10.0	10.0	No	2003	・ Pier table of the bridge is supported by RC piles (6 in total) at the center.
37	Br. 76	275 + 650	PC Hollow	12.1	1	10.1	10.1	No	2003	
38	Br. 77	276 + 550	PC Hollow	12.1	1	10.0	10.0	No	2003	

There are four steel bridges and 34 concrete bridges on the Middle Section.

The bridge type of all four steel bridges is girder and the maximum girder length is 30 m. The number of girders in cross section is five to six depending on the girder size. A typical cross section of a steel bridge with six girders is shown in Figure 4.4-1.

Steel main girders are painted or galvanized.

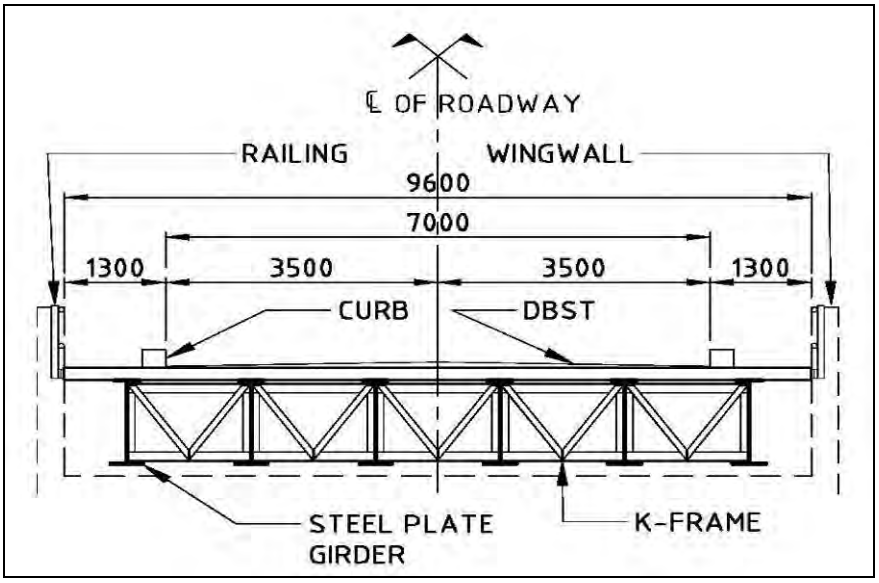


Figure 4.4-1 Typical Cross Section of Steel Bridge

Among the 34 concrete bridges, there are two RC girder bridges, two PC girder bridges and 30 PC hollow slab bridges. The girder length of PC hollow slab is 12 m to 20 m. A typical cross section of a PC hollow slab bridge is shown in Figure 4.4-2.

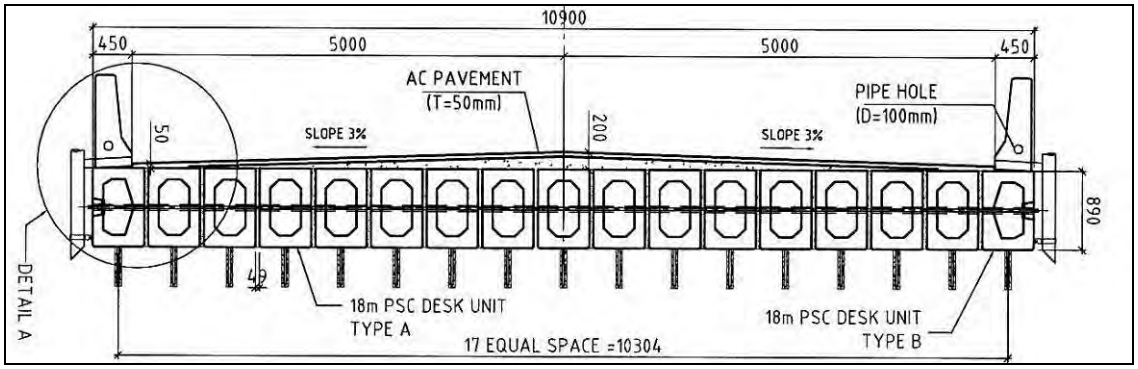


Figure 4.4-2 Typical Cross Section of PC Hollow Bride

4.4.2 Condition of Bridges

The bridges on the Middle Section from KP 171 to KP 282.3 are generally in good condition as shown in Figure 4.4-3 (1) to 4.4-3 (5).



Br. 40 (KP 177 + 200)



Br. 41 (KP 178 + 500)



Br. 42 (KP 181 + 800)



Br. 43 (KP 182 + 800)



Br. 44 (KP 183 + 300)



Br. 45 (KP 183 + 900)

Figure 4.4-3 (1) Bridge Condition (1/5)



Br. 46 (KP 184 + 100)



Br. 47 (KP 185 + 700)



Br. 48 (KP 187 + 400)



Br. 49 (KP 187 + 700)



Br. 50 (KP 188 + 100)



Br. 51 (KP 188 + 250)



Br. 52 (KP 189 + 250)



Br. 53 (KP 189 + 900)

Figure 4.4-3 (2) Bridge Condition (2/5)



Br. 54 (KP 190 + 150)



Br. 55 (KP 191 + 100)



Br. 56 (KP 201 + 800)



Br. 57 (KP 208 + 500)



Br. 58 (KP 215 + 750)



Br. 59 (KP 219 + 600)



Br. 60 (KP 220 + 800)



Br. 61 (KP 222 + 650)

Figure 4.4-3 (3) Bridge Condition (3/5)



Br. 62 (KP 223 + 650)



Br. 63 (KP 242 + 850)



Br. 64 (KP 243 + 600)



Br. 65 (KP 244 + 400)



Br. 66 (KP 245 + 900)



Br. 67 (KP 255 + 250)



Br. 68 (KP 255 + 600)



Br. 69 (KP 256 + 550)

Figure 4.4-3 (4) Bridge Condition (4/5)



Br. 70 (KP 257 + 900)



Br. 71 (KP 265 + 900)



Br. 72 (KP 270 + 900)



Br. 73 (KP 271 + 700)



Br. 74 (KP 272 + 650)



Br. 75 (KP 273 + 300)



Br. 76 (KP 275 + 650)



Br. 77 (KP 276 + 550)

Figure 4.4-3 (5) Bridge Condition (5/5)

4.4.3 Condition of Bridge Members

The field survey of bridges was conducted on the beginning of the rainy season. The following is the result of the observation in the survey.

- Table 4.4-3 shows the condition of each bridge members. Most of the conditions of the existing bridge members are good in general.
- All bridges have a simple support system. There is no expansion joint but the gap spaces of less than 40 mm between girders and between a parapet and a girder. The pavement type on every bridge is DBST and the pavement has been repaired at some patches.
- The road width on the bridge is 8.5 m to 10.1 m and some bridges have side walk for pedestrian.
- 32 PC bridges include 30 PC hollow slab bridges and two I-girder type bridges. PC hollow slab bridges consist of 17 hollow girders. The width of girders of PC hollow slab is 600 mm, the girder height is 430 mm to 700 mm. The width of I - girder is 500 mm to 550 mm, and the height of I-girder is 1,000 mm to 1,150 mm.
- All PC hollow slab bridges are still in good condition.
- All the steel girder bridges are of I-girder type, one of which consists of five to six girders. Every steel girder is painted or galvanized in for anti - corrosion. The girder height is 900 mm to 1,400 mm.
- Two RC bridges are of RC girder type, every one of which consists of nine (9) girders. The girder height is 350 mm to 500 mm.
- While twenty one bridges have bearing shoes of rubber type, almost a half of the whole bridges are not provided with bearing shoes.
- The bridge handrails are steel rail type or PC parapet type. Some of the bridge hand rails were damaged by car accidents. But most of them were repaired except Br. 59 which was damaged recently.



Figure 4.4-4 Damaged Handrail of Br. 59

Table 4.4-3 Condition of Member of Bridge

Ref	Bridge No.	Bridge Type	GH (mm)	GW (mm)	Gt (mm)	Girder No	Structural Condition			Shoe Type	Handrail Type	Pav.
							A1	Pier	A2			
1	Br. 40	Steel Girder	900	330	20	6	OK	OK	OK	Rubber	Steel Rail	OK
2	Br. 41	PC Hollow	550	650	N.A.	17	OK	NA	OK	NO	RC Parapet	OK
3	Br. 42	RC Girder	500	200	N.A.	9	OK	OK	OK	NO	Steel Rail	OK
4	Br. 43	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
5	Br. 44	Steel Girder	1,000	340	30	5	OK	OK	OK	Rubber	Steel Rail	OK
6	Br. 45	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
7	Br. 46	PC Hollow	700	630	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
8	Br. 47	PC Girder	1,150	550	200	5	OK	OK	OK	Rubber	Steel Rail	OK
9	Br. 48	PC Girder	1,000	500	200	4	OK	OK	OK	NO	Steel Rail	OK
10	Br. 49	PC Hollow	450	630	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
11	Br. 50	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
12	Br. 51	PC Hollow	530	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
13	Br. 52	PC Hollow	530	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
14	Br. 53	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
15	Br. 54	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
16	Br. 55	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
17	Br. 56	PC Hollow	430	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
18	Br. 57	PC Hollow	600	600	N.A.	17	OK	OK	OK	NO	RC Parapet	OK
19	Br. 58	Steel Girder	1,000	320	25	5	OK	OK	OK	Rubber	Steel Rail	OK
20	Br. 59	Steel Girder	1,400	420	25	6	OK	OK	OK	Rubber	Steel Rail	OK
21	Br. 60	PC Hollow	450	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
22	Br. 61	PC Hollow	450	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
23	Br. 62	PC Hollow	450	600	N.A.	17	OK	OK	OK	Rubber	RC Parapet	OK
24	Br. 63	PC Hollow	600	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
25	Br. 64	PC Hollow	600	600	N.A.	17	OK	OK	OK	Rubber	RC Parapet	OK
26	Br. 65	PC Hollow	430	600	N.A.	17	OK	OK	OK	Rubber	RC Parapet	OK
27	Br. 66	RC Girder	350	600	N.A.	9	OK	OK	OK	NO	Steel Rail	OK
28	Br. 67	PC Hollow	530	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
29	Br. 68	PC Hollow	430	600	N.A.	17	OK	OK	OK	Rubber	RC Parapet	OK
30	Br. 69	PC Hollow	530	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
31	Br. 70	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
32	Br. 71	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
33	Br. 72	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	NO	RC Parapet	OK
34	Br. 73	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
35	Br. 74	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
36	Br. 75	PC Hollow	430	600	N.A.	17	OK	OK	OK	Rubber	RC Parapet	OK
37	Br. 76	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK
38	Br. 77	PC Hollow	430	600	N.A.	17	OK	N.A.	OK	Rubber	RC Parapet	OK

Denotation: Denotation in Table 4.4-3 are as follows:

GH: Height of girder
GW: Width of lower flange member
Gt: Thickness of lower flange member
G no.: Girder number
Clearance: Distance from the water surface to the soffit of the girder.

OK: Good condition
N/M: Cannot be measured
N.A.: Not applicable
NO: Not exist

4.5 Roadside Land Use

4.5.1 Land Use along NR 5

(1) Middle Section

The roadside of NR 5 has been rapidly developed with factories, commercial facilities and residential buildings. There are also many rice mill factories and warehouses which are functioning as the base stations for transportation of rice in the Middle Section. Also, around 25 villages are located along the Middle Section. The basic form of land use outside urbanized areas is agriculture; predominantly rice paddies. Examples of roadside land use are shown in the Figure 4.5-1.



Pursat City (KP 186)



Land Fill for Factory (KP 193)



Rice Paddy (KP 224)



Rice Mill Factory (KP 242)

Figure 4.5-1 Roadside Land Use (Middle Section)

Salient features of the roadside land use along the Middle Section are summarized below:

(i) The roadside from KP 186 to KP 189 in Pursat City is very densely populated.

(ii) In addition to the above, the roadsides of Bakan (KP 201 ~ KP 203), Boeng Khnar (KP 209 ~ KP 211), Ou Ta Paong (KP 216 ~ KP 217), Svay Doun Kaev (KP 219 ~ KP 220) and Kalaom Phluk (KP 231 ~ KP 232) are urbanized.

(iii) There are many small villages in addition to the urbanized areas as listed above.

(iv) A "road station" (Michi-no-eki) is located at KP 180.

(v) A weigh station is located near KP 191.

(2) Sri Sophorn - Poipet Section

The basic form of land use outside urbanized areas along this section is also cultivation, predominantly rice paddies. Most of the houses and small shops are located about 20 meter away from road centerline. These buildings might have relocated for Cambodia Road Improvement Project (CRIP).

In Poipet City, there are many truck yards. Many semi and full trailer trucks coming from Thailand go back to Thailand after transshipping containers and/or cargos to Cambodian trucks in the truck yards in Poipet.

The examples of roadside land use are shown in the Figure 4.5-2.



Rice Mill Factory (KP 374)



Rice Paddy (KP 391)



Commercial Area (KP 393)



Cargo Terminal for Transshipment (KP 404)

Figure 4.5-2 Roadside Land Use (Sri Sophorn - Poipet Section)

Salient features of the roadside land use along the Sri Sophorn - Poipet Section are summarized below:

(i) The roadsides in Nimit (KP 383 + 300 – KP 384 + 100), Koun Damrei (KP 392 + 800 – KP 393 + 300) and Poipet City (KP 402 – KP 407 + 300) are very densely populated.

(ii) On the other sections, there are small villages.

(iii) A weigh station is located at KP 391 + 350.

(iv) The Poipet Tourist Passenger International Terminal is located at KP 396 + 500.

(v) A container scan station is located at KP 399 + 700.

4.5.2 Occupancy of ROW by Roadside Shops and Utilities

In the urbanized areas, private shops occupy the road shoulder and sidewalk in the designated Right of Way (ROW) to display their merchandise. Outside of the urbanized areas, most of the residential houses are built outside of the ROW

Notice boards announcing that 30 m from the centerline of road is designated as ROW have been installed along NR 5 at an interval of 10 km through an ADB project. Although, these notice board stipulates that electric poles should be installed at least 28 m away from the road center, new electric poles are actually installed approximately 17 m from the road center. This will cause confusion among residents. It is strongly recommend that MPWT issue an instruction to SKL Group who has been installing electric poles to observe the rule.

4.6 Utilities

Various kinds of utilities exist along the NR 5 in the areas adjacent to the road. Some of them are crossing NR 5. The types of utilities exiting in the area adjacent to NR 5 are electric power lines and poles, optic fiber cables, water supply pipes, drainage facilities and street lights.

(1) Middle Section

Test - pitting for confirmation of utilities was carried out at 10 locations in the following towns and villages. It turned out that the electric power lines and poles and optic fiber cables exist along the whole length of NR 5.

Electricity Power Line

Electric poles are located along whole stretch of NR 5. There are around 16 poles per 1 km. The total number of electric poles in the Middle Section is estimated to be around 2,900 poles. Most of electric poles will not need be to be relocated for the widening of the road.



Figure 4.6-1 Electric Poles near KP 214

Telecommunication Cables

There are 2 types of telecommunication cable along NR 5. One is conventional (metal) telephone line and the other is fiber - optic cable. Telephone line is located on the left side (mountain side) and fiber - optic cable is located on the right side (Tonle Sap side). The cables buried on both road sides should be relocated before the widening of the road.



Figure 4.6-2 Telephone Cable on Br. 56 (KP 201 + 800)

Water Supply Pipes

The water supply systems in Bakan, Boeng Khnar and Moung Ruessei are managed by private companies. In Pursat City, the pipes were replaced by the "Project for Replacement and Expansion of Water Distribution System in Provincial Capitals" and it is operated by Ministry of Industry Mines and Energy.

The water supply pipes located on both road sides should be relocated before the construction works start.



Figure 4.6-3 Water Supply Pipes on Br. 48 (KP 187 + 500)

Drainage

There are rain water drainage pipes under the ground on both road sides only in Pursat City. The total length of the pipe is 2.6 km for both roadside. Diameter of the pipe is 600 mm. Drainage pipes are clogged in many places with litter and/or soils.



Figure 4.6-4 Clogged Drainage Pipe near KP 186 + 500

Street Light

There are street lights from KP 183 to KP 187 in Pursat City. The street lights are installed from KP 183 to Br. 47 (KP 185+700) on both sides and from Br. 47 to KP 187 on right side only. Most of street light poles would need to be relocated if the existing road in Pursat City would be widened. However, construction of a bypass around Pursat City is propped and the existing road will not be widened. Thus, relocation of the street light will not be necessary.



Figure 4.6-5 Street Light near KP 367

Figure 4.6-6 shows the plan of existing water supply pipe system in Pursat city.

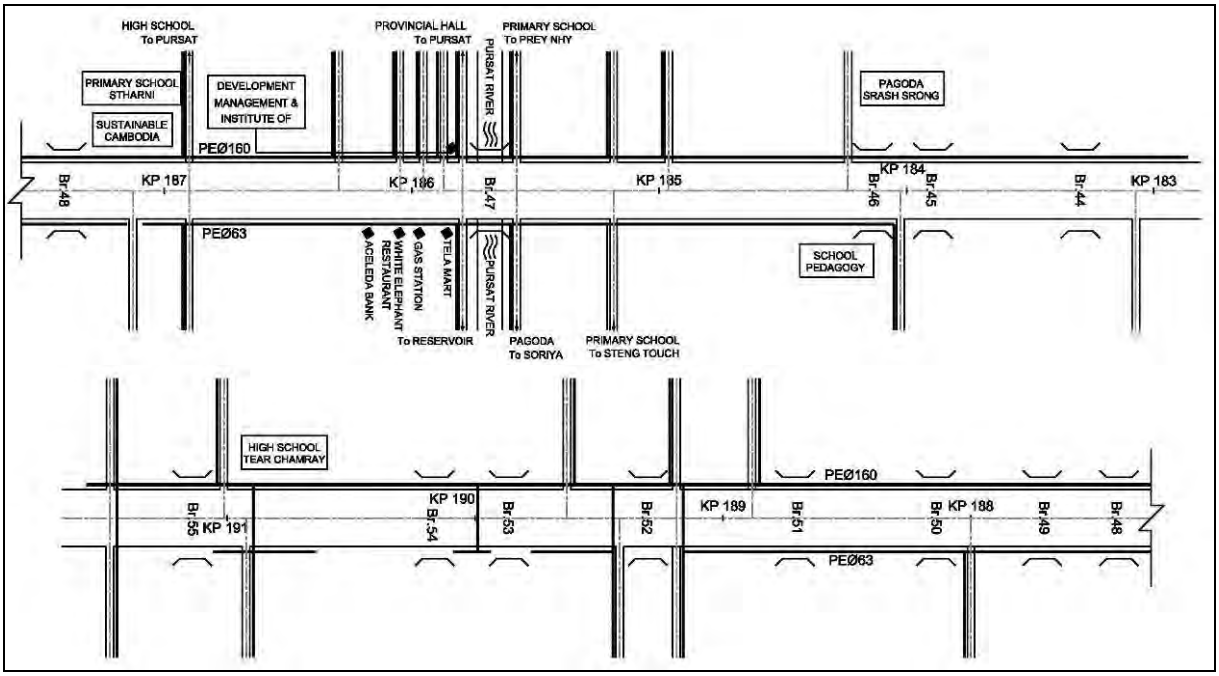


Figure 4.6-6 Plan of Water Supply Pipes in Pursat

Table 4.6-1 shows the summary of the major utilities along the Middle Section.

Table 4.6-1 Major Utility along Middle Section

Type of Utility	Location	Side	Distance from Centerline	Quantity	Owner / Operator
1.Electricity Power Line					
Electric pole (concrete); 230 kV	KP 171 ~ 283	L	15 ~ 20 m	112 km (About 16 no. /km)	[1)]EDC
Electric pole (concrete); 230 kV	KP 178 ~ 248	R	15 ~ 20 m	70 km (About 16 no. /km)	EDC
2.Telecommunication Cables					
Electric pole (concrete)	KP 171 ~ 283	L or R	15 m	112 km (About 8 no. /km)	Metfone
Optic fiber cable	KP 171 ~ 283	R	5 ~ 10 m	112 km	[2)]Telecom
Optic fiber cable	KP 171 ~ 283	L	7 ~ 30 m	112 km	[3)]CFO
3.Water Supply Pipes					
HDPE pipe, D160	KP 183 ~ 191	L	7 ~ 10 m	8 km	[4)]MIME
HDPE pipe, D60	KP 187 ~ 191	R	7 ~ 10 m	4 km	MIME
HDPE pipe, D40 - 200	KP 201 ~ 213	L, R	7 ~ 10 m	20 km	Private
PVC pipe, D60 - 120	KP 243.7 ~ 246	L, R	7 ~ 10 m	4.6 km	Private
4.Drainage					
Concrete pipe D600	KP 185.7 ~ 186.3	L, R	8 ~ 9 m	2.6 km	MPWT
5.Street Light					
Street light and Cable	KP 183 ~ 185.7	L, R	9 ~ 12 m	2.2 km (65 no.)	Government of Pursat
	KP 185.7 ~ 187	R		1.8 km (26 no.)	

[1)] EDC: Electricite Du Cambodge
[2)] Telecom: Telecom Cambodia
[3)] CFO: Cambodia Fiber Optic Communication Network
[4)] MIME: Ministry of Industry Mines and Energy

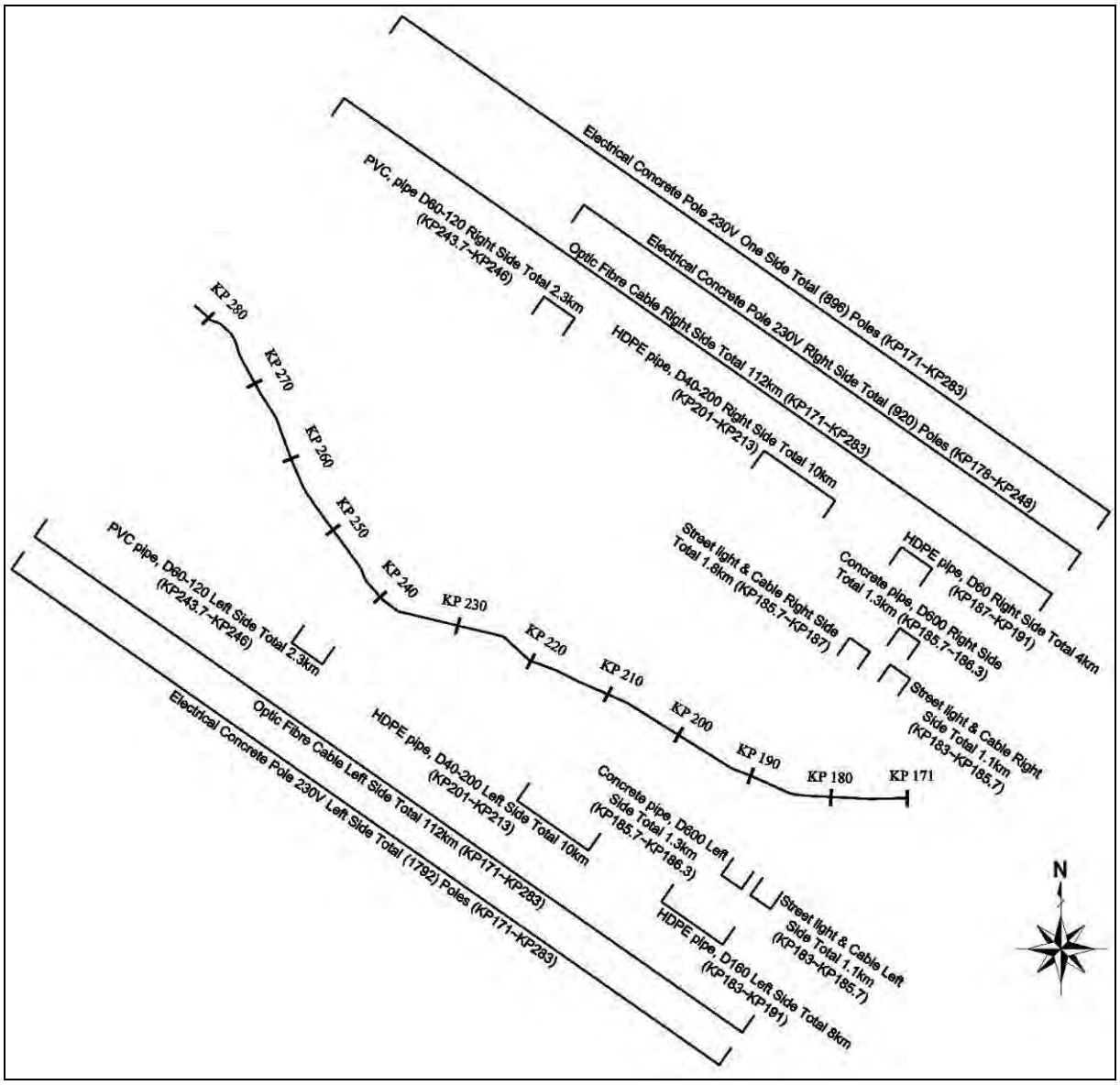


Figure 4.6-7 Major Utility along Middle Section

(2) Sri Sophorn - Poipet Section

Test - pitting for confirmation of utilities was carried out at the 4 points in the following town and village.

(a) KP 383 + 000 (Both Side) in Nimit

(b) KP 403 + 000 (Both Side) in Poipet

Electricity Power Line

Electric power lines are located along NR 5 along Sri Sophorn - Poipet Section as well. There are approximately 14 poles per 1 km. The total number of electric poles in Sri Sophorn - Poipet Section is estimated at approximately 1,000. Most of the electric poles will not need to be relocated for the widening of the road.



Figure 4.6-8 Electric Power Line in the Vicinity of KP 186

Telecommunication Cables

There are 2 types of telecommunication cable (conventional telephone line and optic – fiber cable) in Sri Sophorn – Poipet Section as well. The cables located on both sides should be relocated before the widening of the road.

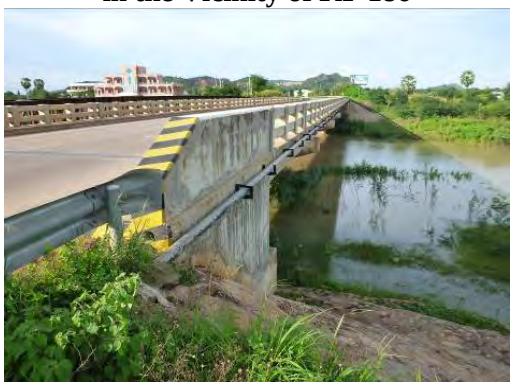


Figure 4.6-9 Telecommunication Cable at KP 365 + 800

Water Supply Pipes

The water supply system in Poipet City is operated by a private company. The water supply pipes located on the both sides of road should be relocated before the widening of the road.



Figure 4.6-10 Water Supply Map in Poipet City

Drainage

There are rain water drainage pipes under the ground on both sides in Nimit, Koun Damrei and Poipet City



Figure 4.6-11 Inlet of Drainage at KP 393

Figure 4.6-12 shows the plan of existing water supply pipe system in Poipet city.

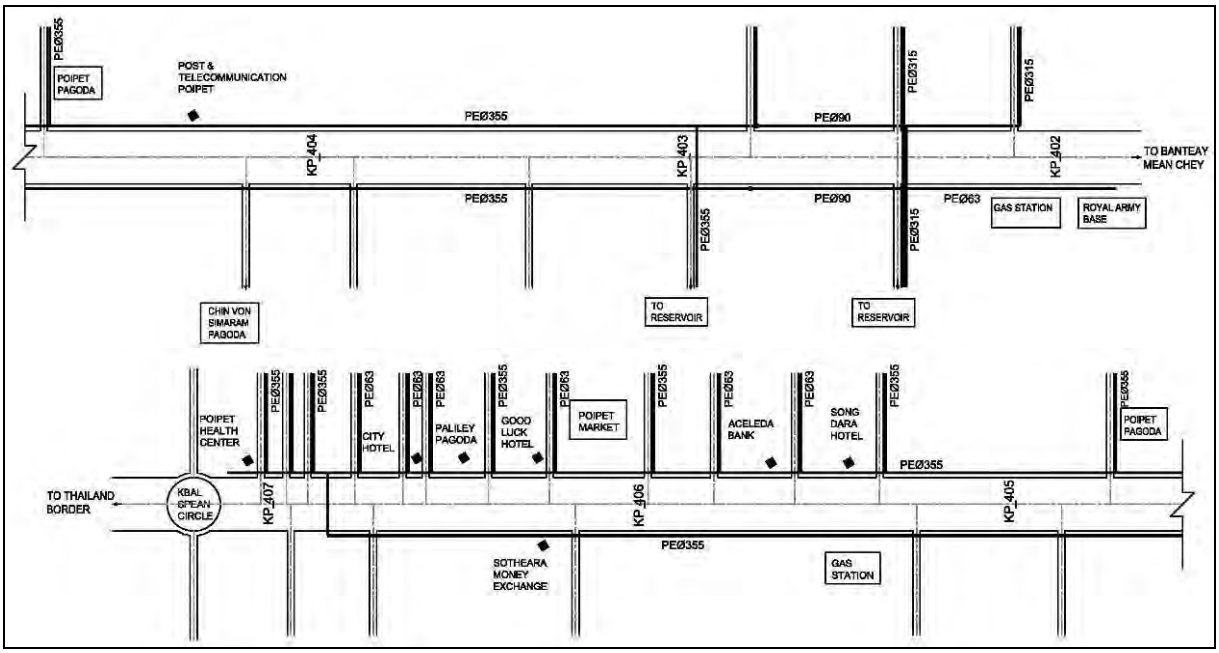


Figure 4.6-12 Plan of Water Supply Pipes in Poipet

Table 4.6-2 shows the utilities of Sri Sophorn – Poipet Section.

Table 4.6-2 Major Utility along Sri Sophorn – Poipet Section

Type of Utility	Location	Side	Distance from Centerline	Quantity	Owner / Operator
1.Electricity Power Line					
Electric pole (concrete); kV	KP 367.2 ~ 395.4	L	15 ~ 20 m	28 km (About 14 no. /km)	[1)]PSTC
Electric pole (concrete); 230 kV	KP 366 ~ 407	R	15 ~ 20 m	41 km (About 16 no. /km)	EDC
2.Telecommunication Cables					
Electric pole (concrete)	KP 366 ~ 407	L	15 m	41 km (About 8 no. /km)	Metfone
Optic fiber cable	KP 366 ~ 407	R	4.5~5.0 m	41 km	Cambodian Post
Optic fiber cable	KP 366 ~ 407	L	7 ~ 30 m	41 km	[3)]CFO
3.Water Supply Pipes					
HDPE pipe, D160	KP 183 ~ 191	L	7 ~ 10 m	8 km	[4)]MIME
HDPE pipe, D60	KP 187 ~ 191	R	7 ~ 10 m	4 km	MIME
HDPE pipe, D40 - 200	KP 201 ~ 213	L, R	7 ~ 10 m	20 km	Private
PVC pipe, D60 - 120	KP 243.7 ~ 246	L, R	7 ~ 10 m	4.6 km	Private
4.Drainage					
Concrete pipe D600	KP 383.2 ~383.6	L, R	8 ~ 9 m	0.4 km	MPWT
Concrete pipe D400	KP 392.7 ~393.1	L, R	8 ~ 9 m	0.4 km	MPWT
Concrete pipe D800	KP 402.9 ~407	L, R	8 ~ 9 m	4.1 km	MPWT

[1)] *EDC: Electricite Du Cambodge*
[2)] *Telecom: Telecom Cambodia*
[3)] *CFO: Cambodia Fiber Optic Communication Network*
[4)] *MIME: Ministry of Industry Mines and Energy*

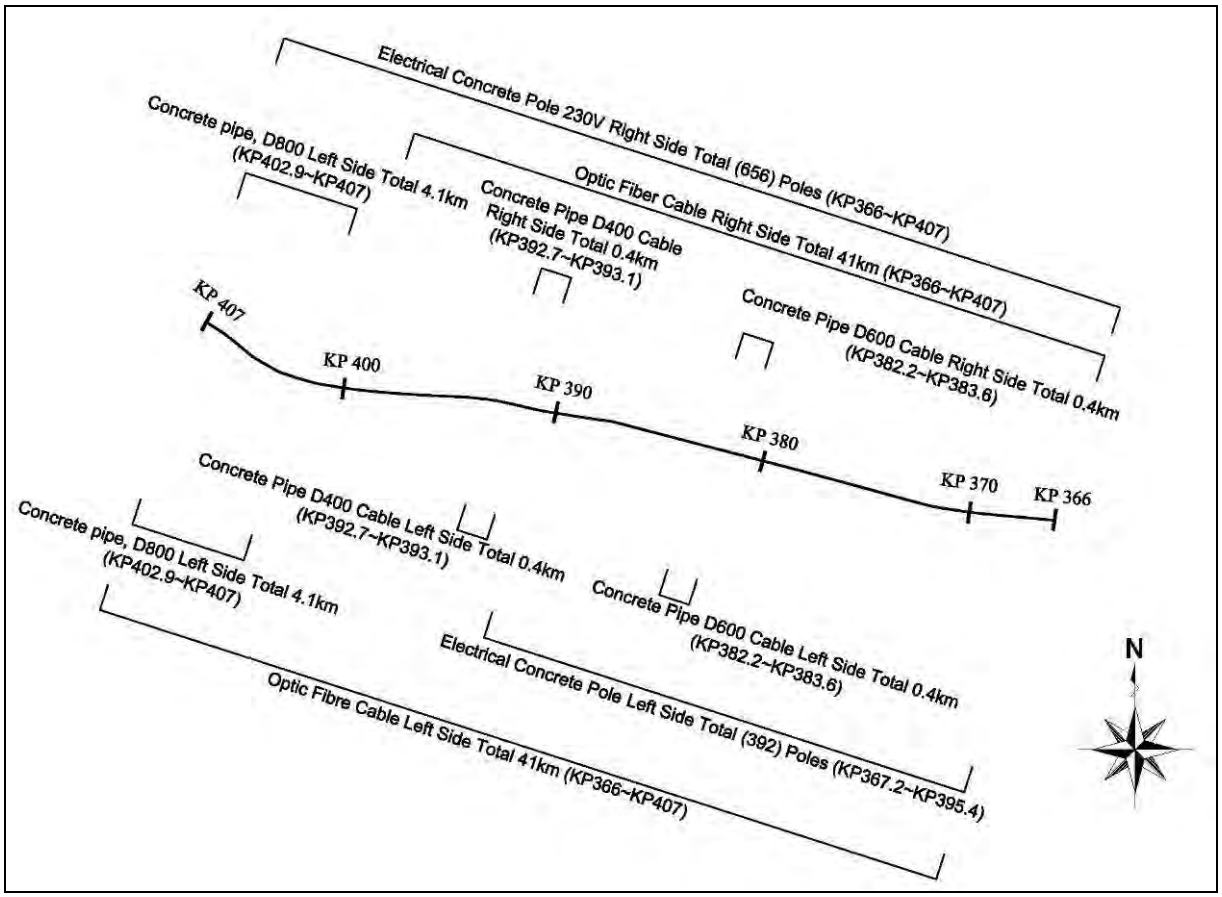


Figure 4.6-13 Major Utility within the Study Area in the Sri Sophorn – Poipet Section

CHAPTER 5 FUTURE TRAFFIC DEMAND FORECAST

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

Future traffic demand was estimated for the target years of 2018, 2023, 2028 and 2033. Years 2018, 2023, 2028 and 2033 correspond to 5 years, 10 years, 15 years and 20 years from the present time.

5.1 Methodology

Figure 5.1−1 shows the flow future traffic forecast. In this survey, traffic volume is estimated based on traffic demand forecast model used in the Survey of the South Section and revised socio-economic data.

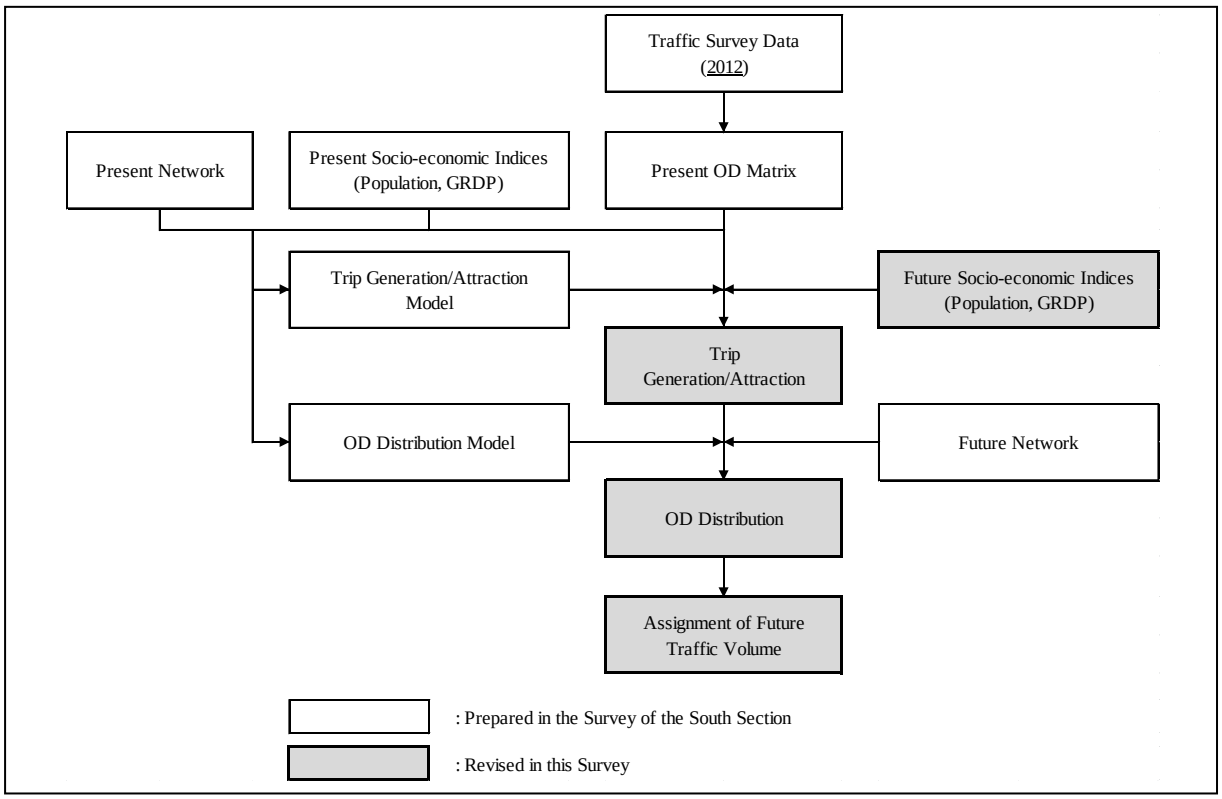


Figure 5.1-1 Traffic Demand Forecast Flowchart

5.2 Traffic Survey Data

Traffic data (counted traffic volume and OD data) surveyed in the Survey for the South Section are used in this traffic forecast.

In the Survey for the South Section, the traffic counts were conducted 2 times to verify the daily fluctuation of traffic volume. The First Survey was conducted on 24th – 25th of October 2012 and the Second Survey was conducted on 7th of November 2012. Traffic volumes were counted for 24 hours (from 6:00 a.m. to 6:00 a.m. next day) at five (5) stations and for 16 hours (from 5:00 a.m. to 9:00 p.m.) at three (3) stations in the First Survey. The Second Survey for traffic counts were conducted at five (5) stations from 5:00 a.m. to 9:00 p.m.

The survey locations were selected at the provincial boundary, city boundary and city center and they are shown in Table 5.2-1 and Figure 5.2-1, respectively. All the survey locations except Station No. 3a and NR6-1 were planned so that they coincide with the survey locations used in the Survey on the North Section and "the Study on the Road Network Development" implemented by JICA in year 2006. Station No. 3a was selected to know traffic volume within the city of Kampong Chhnang, and Station NR6-1 was selected to understand the present traffic pattern of National Road No. 6 which is an alternative route of NR 5.

Traffic volumes were counted for at Stations No. 1. 3a, 4, 5 and 6 while they were counted for 16 hours at Stations No. 2, 5 and 8. 16-hour traffic counts were converted to 24-hour traffic counts using the 24-hour/16-hour ratios of the similar traffic characteristics (urban, suburban or rural). Table 5.2-2 shows 24-hour traffic volume actually counted (Stations No. 1. 3a, 4, 5 and 6) and converted from 16-hour traffic count (Stations No. 2, 5 and 8).

Table 5.2-1 Location of Traffic Count Survey (Conducted in the Survey for the South Section)

No	Survey Station		Period	
	Road No	City	The first survey	The confirmation survey
1	5	Provincial Boundary (between Kampong Speu and Kampong Chhnang)	24 hrs	16 hrs
2	5	Kampong Chhnang city (Southern suburbs)	16 hrs	16 hrs
3a	5	Kampong Chhnang (City center)	24 hrs	16 hrs
3	5	Kampong Chhnang city (Northern suburbs)	16 hrs	16 hrs
4	5	Provincial Boundary (between Kampong Chhnang and Pursat)	24 hrs	16 hrs
5	5	Provincial Boundary (between Prusat and Battambang)	24 hrs	–
8	5	Provincial Boundary (between Battambang and Banteay Meanchey)	16 hrs	–
NR6-1	6	Intersection of NR 6 & NR 71	24 hrs	–
	Note: 24 hrs: 6:00 AM - 6:00 AM (Next day) *16 hrs: 5:00 AM - 21:00 PM* *The first day survey was conducted from 24th to 25th October 2012 (Wed and Thu).* *The second day survey was conducted 7th November 2012 (Wed).*			

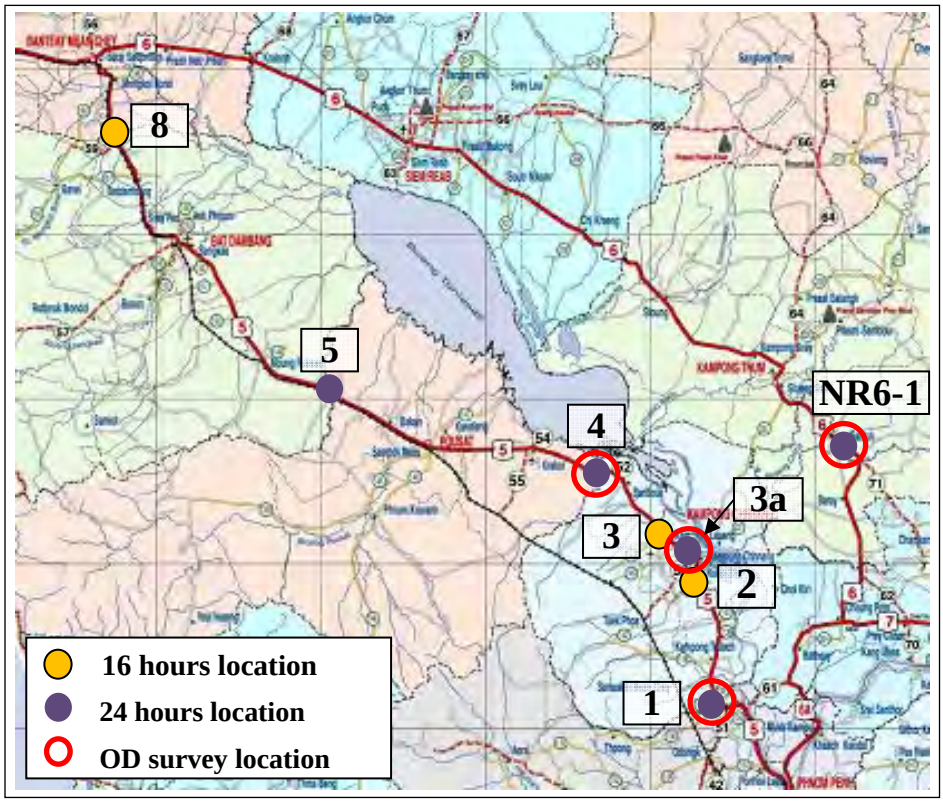


Figure 5.2-1 Location of Traffic Count Survey (Conducted in the Survey for the South Section)

Table 5.2-2 Daily (24 Hours) Traffic Volume

(Unit: Vehicle/day)

Sta.	Motorcycle (MC)			Light Vehicle (LV)				Heavy Vehicle (HV)				Grand Total
	Motorcycle & Tricycle	Motorcycle Trailer	Total	Sedan, Wagon &Light Van	Pick-up, Jeep & Light Truck	Mini Bus	Total	Short & Long Body Bus	Short & Long Body Truck	Semi & Full Trailer Truck	Total	
1	5,174	499	5,673	2,037	1,171	669	3,877	229	866	173	1,268	10,818
2	6,041	289	6,330	1,733	900	402	3,034	226	829	82	1,137	10,501
3a	15,495	452	15,947	2,171	966	432	3,569	227	832	145	1,204	20,720
3	3,353	190	3,543	1,102	931	388	2,421	212	500	124	836	6,800
4	943	49	992	876	565	244	1,685	209	609	146	964	3,641
5	1,769	44	1,813	884	552	217	1,653	228	793	167	1,188	4,654
8	3,972	104	4,076	1,589	572	180	2,341	195	290	289	774	7,191
NR6-1	3,619	225	3,844	1,130	714	689	2,533	211	577	144	932	7,309

5.3 Socio-Economic Framework

5.3.1 Future Socio-Economic Framework

Since transportation supports the social activities of the citizens and the economic activities of the industries and commerce, traffic demand is governed by socio-economic factors. Future trip generation/attraction estimated in the Survey of the South Section is used after being updated based on the updated population and Gross Regional Domestic Product (GRDP).

(1) Population Projection

The "General Population Census of Cambodia 2008", published in January 2011 by the National Institute of Statistics; Ministry of Planning is the latest population projection for Cambodia.

The survey team estimate population projection in 2033 based on the "General Population Census of Cambodia 2008". The population projection by province up to 2033 is shown in Table 5.3-1. The predicted growth rate of the whole of Cambodia (nationally) between 2012 and 2033 is 1.28.

Table 5.3-1 Population and Predicted by Province

(Unit: Person)

Provinces	2012	2018	2023	2028	2033	2033 / 2012 Growth
Banteay Meanchey	**760,770**	**853,065**	**927,392**	**993,625**	**1,052,624**	**1.38**
Battambang	**1,148,444**	**1,283,223**	**1,391,110**	**1,485,232**	**1,567,294**	**1.36**
Kampong Cham	1,745,184	1,733,442	1,711,003	1,670,485	1,611,142	0.92
Kampong Chhnang	**520,398**	**563,997**	**595,744**	**620,555**	**639,103**	**1.23**
Kampong Speu	**775,704**	**818,486**	**849,778**	**874,611**	**891,289**	**1.15**
Kampong Thom	673,247	695,256	710,988	722,060	726,036	1.08
Kampot	615,944	638,360	666,893	701,685	739,242	1.20
Kandal	**1,383,298**	**1,504,195**	**1,601,111**	**1,685,123**	**1,759,963**	**1.27**
Koh Kong	137,033	162,771	185,915	209,381	233,132	1.70
Kratie	357,249	396,156	426,789	455,158	481,435	1.35
Mondul Kiri	73,080	88,907	103,725	119,931	137,260	1.88
Phnom Penh	**1,637,473**	**2,018,312**	**2,262,593**	**2,413,511**	**2,497,710**	**1.53**
Preah Vihear	188,297	205,430	220,916	237,155	253,175	1.34
Prey Veng	980,811	991,128	1,020,035	1,066,655	1,122,529	1.14
Pursat	**430,837**	**466,168**	**500,675**	**537,494**	**576,133**	**1.34**
Ratanak Kiri	169,609	189,558	207,423	225,854	243,849	1.44
Siem Reap	1,023,990	1,167,456	1,278,650	1,377,823	1,467,987	1.43
Preah Sihanouk	253,654	292,404	323,420	350,703	375,147	1.48
Stung Treng	125,166	141,813	159,038	178,857	200,638	1.60
Svay Rieng	500,745	508,949	524,863	548,318	576,438	1.15
Takeo	879,328	898,226	931,305	976,431	1,027,010	1.17
Otdar Meanchey	227,353	277,792	317,402	352,538	383,163	1.69
Kep	41,420	52,097	65,027	81,351	101,000	2.44
Pailin	92,379	122,730	148,036	172,321	196,398	2.13
Cambodia	14,741,414	16,069,921	17,129,834	18,056,858	18,859,697	1.28

Source: "General Population Census of Cambodia 2008, Population Projections of Cambodia", National Institute of Statistics, Ministry of Planning Population in 2033 is estimated by Survey Team.

(2) Future Growth of GDP

➢ GDP Growth Rate Predictions by Different Institutions

Cambodia's long term growth of GDP to 2030, has been predicted by The United States Department of Agriculture and International Futures at the University of Denver and the short term GDP growth rate has been predicted by The International Monetary Fund and The Ministry of Economic and Finance. According to this prediction, the short term GDP growth rate is around 7%. Actual GDP growth rate in 2012 was upper than the prediction in last year, and the GDP growth rate prediction by each organizations were revised to high side compared with the prediction used in the Survey for the South Section.

Table 5.3-2 Predicted Annual Growth Rate of GDP by Agency

Year	2012	2013	2014	2015	2016	2017	2018	2023	2028	2030
USDA	6.8	8.2	8.4	8.3	8.2	8.1	8.0	7.7	7.2	6.8
International Futures	6.2	6.4	6.5	6.7	6.7	7.0	7.3	7.9	8.2	8.0
IMF	6.5	6.7	7.2	7.4	7.4	7.5	7.5			
MEF	7.3	7.6	7.0							

Source: Economic Research Service, United states Department of Agriculture (USDA)
International Futures, University of Denver (International Futures)
World Economic Outlook, International Monetary Fund (IMF)
Cambodia Macroeconomic Framework 2010-2011, Ministry of Economic and Finance (MEF)

➢ Scenario of Future GDP Growth and GDP Per Capita

Considering the above-stated predictions, as well as the economic growth that actually happened in Cambodia in the past, three scenarios of the GDP growth have been assumed.

Table 5.3-3 Scenarios of Future GDP Growth

(Unit: %/Yr)

Scenario	2012 - 2018	2018 - 2023	2023 - 2028	2028 - 2033
High Growth	8.5	7.8	7.1	6.3
Medium Growth	7.4	6.8	6.2	5.4
Low Growth	6.5	6.0	5.4	4.8

Table 5.3-4 Scenarios of GDP Per Capita

(Unit: USD, Constant 2012 rice)

Scenario	2018	2023	2028	2033
High Growth	1,428	1,953	2,610	3,388
Medium Growth	1,338	1,734	2,203	2,730
Low Growth	1,277	1,602	1,979	2,396

(3) GRDP

After the future GDP of the whole of Cambodia has been estimated, the GRDP of each Province is then estimated. The procedure of estimating GRDP is shown in Figure 5.3-1. Table 5.3-5 shows the result of the GRDP estimation by province.

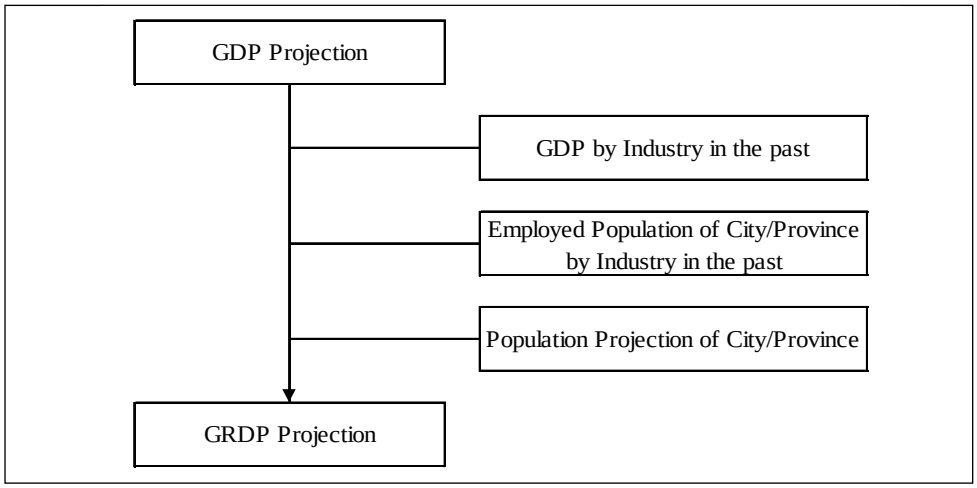


Figure 5.3-1 Procedure for GRDP Estimation

Table 5.3-5 GRDP Projection (at Constant 2005 Prices)

(Unit: $million)

Province	Year				
	2012	2018	2023	2028	2033
Banteay Meanchey	**439**	**668**	**915**	**1,225**	**1,580**
Battambang	**575**	**883**	**1,215**	**1,625**	**2,100**
Kampong Cham	757	1,046	1,322	1,613	1,897
Kampong Chhnang	**226**	**336**	**454**	**592**	**753**
Kampong Speu	**353**	**527**	**719**	**935**	**1,176**
Kampong Thom	257	383	516	664	820
Kampot	235	351	486	640	831
Kandal	**997**	**1451**	**1,938**	**2,562**	**3,280**
Koh Kong	87	143	208	293	397
Kratie	150	228	320	434	563
Mondul Kiri	33	58	91	136	190
Phnom Penh	**3,429**	**5,192**	**7,033**	**9,213**	**11,618**
Preah Vihear	69	113	166	231	304
Prey Veaeng	367	530	718	944	1,221
Pursat	**176**	**270**	**375**	**510**	**677**
Ratanak Kiri	67	111	167	236	314
Siemreap	510	797	1,119	1,526	1,995
Preah Sihanouk	227	354	491	663	865
Stung Treng	52	85	128	186	255
Svay Rieng	206	297	398	522	674
Takeo	338	500	685	901	1,167
Otdar Meanchey	100	173	258	361	478
Kep	17	32	53	84	126
Pailin	53	96	144	211	292

5.4 Future OD Table

5.4.1 Zoning System

The OD zoning system that used the JICA M/P Study has been revised and used in this Survey. The revision of the OD zoning system is mainly to take account of the change of Districts promulgated after 2006. The total number of zones is 206 (194 zones within Cambodia and 12 zones outside of Cambodia). Table 5.4-1 shows the list of OD zones.

Table 5.4-1 OD Zones

Province Name	Zone No.	District Name	Traffic Zone
Banteay MeanChey	1	Mongkol Borei	1
		Phnum Srok	2
		Preah Netr Preah	3
		Ou Chrov	4
		Serei Saophoan	5
		Thma uok	6
		Svay Chek	7
		Malai	8
		Paoy Paet	9
Battambang	2	Banan	10
		Thma Koul	11
		Battambang	12
		Bavel	13
		Aek Phnum	14
		Moung Ruessei	15
		Rotonak Mondol	16
		Sangkae	17
		Samlout	18
		Sampov Lun	19
		Phnum Proek	20
		Kamrieng	21
		Koas Krala	22
		Rukh Kiri	23
Kampong Cham	3	Batheay	24
		Chamkar Leu	25
		Cheung Prey	26
		Dambae	27
		Kampong Cham	28
		Kampong Siem	29
		Kang Meas	30
		Kaoh Soutin	31
		Krouch Chhmar	32
		Memot	33
		Ou Reang Ov	34
		Ponhea Kraek	35
		Prey Chhor	36
		Srei Santhor	37
		Steung Trang	38
		Tboung Khmun	39
		Suong	40
Kampong Chhnang	4	Baribour	41
		Chol Kiri	42
		Kampong Chhnang	43
		Kampong Leaeng	44
		Kampong Tralach	45
		Rolea Bier	46
		Sameakki Mean Chey	47
		Tuek Phos	48
Kampong Speu	5	Basedth	49
		Chbar Mon	50
		Kong Pisei	51
		Aoral	52
		Odongk	53
		Phnum Sruoch	54
		Samraong Tong	55
		Thpong	56
Kampong Thom	6	Baray	57
		Kampong Svay	58
		Stueng Saen	59
		Prasat Baliangk	60
		Prasat Sambour	61
		Sandan	62
		Santuk	63
		Stoung	64
Kampot	7	Angkor Chey	65
		banteay Meas	66
		Chhuk	67
		Chum Kiri	68
		Dang Tong	69
		Kampong Trach	70
		Tuek Chhou	71
		Kampot	72
Kadal	8	Kandal Stueng	73
		Kien Svay	74
		Khsach Kandal	75
		Kaoh Thum	76
		Leuk Daek	77
		Lvea Aem	78
		Mukh Kampul	79
		Angk Snuol	80
		Ponhea Lueu	81
		S'ang	82
		Ta Khmau	83
Koh Kong	9	Botum Sakor	84
		Kiri Sakor	85
		Kaoh Kong	86
		Khemara Phoumin	87
		Mondol Seima	88
		Srae Ambel	89
		Thma Bang	90
Kratie	10	Chhloung	91
		Kracheh	92
		Preaek Prasab	93
		Sambour	94
		Snuol	95
		Chetr Borei	96
Mondul Kiri	11	Kaev Seima	97
		Kaoh Nheaek	98
		Ou Reang	99
		Pech Chreada	100
		Saen Monourom	101

Province Name	Zone No.	District Name	Traffic Zone
Phnom Penh	12	Russey Keo	102
		Toulkok	103
		Daun Penh	104
		7 Makara	105
		Chamkarmorn	106
		Meanchey	107
		Dang Kor	108
		SenSok	109
		PoSenChey	110
Preah Vihear	13	Chey Saen	111
		Chhaeb	112
		Choam Ksant	113
		Kuleanen	114
		Rovieng	115
		Sangkum Thmei	116
		Tbaeng Mean Chey	117
		Preah Vihear	118
Prey Veng	14	Ba Phnum	119
		Kamchay Mear	120
		Kampong Trabaek	121
		Kanhchriech	122
		Me Sang	123
		Peam Chor	124
		Peam Ro	125
		Pea Reang	126
		Preash Sdach	127
		Prey Veng	128
		Kampong Leav	129
		Sithor Kandal	130
		Svay Antor	131
Pursat	15	Bakan	132
		Kandieng	133
		Krakor	134
		Phnum Kravanh	135
		Pursat	136
		Veal Veaeng	137
Ratanak Kiri	16	Andoung Meas	138
		Ban Lung	139
		Bar Kaev	140
		Koun Mom	141
		Lumphat	142
		Ou Chum	143
		Ou Ya Dav	144
		Ta Veaeng	145
		Veun Sai	146
Siem Reap	17	Angkor Chum	147
		Angkor Thum	148
		Banteay Srei	149
		Chi Kraeng	150
		Kralanh	151
		Puok	152
		Prasat Bakong	153
		Siem Reap	154
		Soutr Nikom	155
		Srei Snam	156
		Svay Leu	157
		Varin	158
Preah Sihanouk	18	Preah Sihanouk	159
		Prey Nob	160
		Stueng Hav	161
		Kampong Seila	162
Stung Treng	19	Sesan	163
		Siem Bouk	164
		Siem Pang	165
		Stueng Traeng	166
		Thala Barivat	167
Svay Reang	20	Chantrea	168
		Kampong Rou	169
		Rumduol	170
		Romeas Haek	171
		Svay Chrum	172
		Svay Rieng	173
		Svay Teab	174
		Bavet	175
Takeo	21	Angkor Borei	176
		Bati	177
		Borei Cholsar	178
		Kiri Vong	179
		Kaoh Andaet	180
		Prey Kabbas	181
		Samraong	182
		Doun Kaev	183
		Tram Kak	184
		Treang	185
Oddar Meanchey	22	Anlong Veang	186
		Banteay Ampil	187
		Chong Kal	188
		Samraong	189
		Trapeang Prasat	190
Kep	23	Damnak Chang'aeur	191
		Kaeb	192
Paillin	24	Pailin	193
		Sala Krau	194
Laos	25	NR7	195
Thailand	26	NR5	196
	27	NR48	197
	28	NR57	198
	29	NR67	199
	30	NR68	200
Vietnam	31	NR1	201
	32	NR2	202
	33	NR21	203
	34	NR33	204
	35	NR72	205
	36	NR76	206

5.4.2 Preparation of Present OD Table

The OD table of year 2012 used in the Survey of the South Section is used in this survey also.

5.4.3 Trip Generation and Attraction

(1) Trip Generation and Attraction Model

A future trip generation and attraction model formulated in the Survey of the South Section is used in this survey. The model parameters are calibrated as shown in Table 5.4-2.

$G_i = a_i \times X1_i + b_i \times X2_i$

$A_j = a_j \times X1_j + b_j \times X2_j$

G_i: Generation from Zone i

A_j: Attraction to Zone j

$X1$, $X2$: Attributes in Zone i, j

a_i, a_j, b_i *and* b_j: Coefficient

Table 5.4-2 Trip Distribution Model Parameters

Model Type	Vehicle Category	Population (a_i, a_j)	GRDP (b_i, b_j)	Multiple Correlation Coefficient (R^2)
Trip Generation	MC	0.00576	13.53175	0.919
	LV	0.00046	6.74668	0.927
	HV	0.00024	1.24503	0.978
Trip Attraction	MC	0.00594	13.25812	0.915
	LV	0.00070	6.48985	0.928
	HV	0.00023	1.25918	0.974

(2) Trip Production (Total of Generation and Attraction)

The number of the total trips by vehicle type for the years 2012, 2018, 2023 and 2033 are shown in Table 5.4-3.

Table 5.4-3 Future Trip Production

(Unit: Vehicle/day)

Year	2012	2018	2023	2028	2033	(2033/2012)
MC	216,283	296,666	379,173	473,612	579,652	2.68
LV	68712	107,247	144,117	188,169	238,225	3.47
HV	15,357	22,446	29,606	38,033	47,563	3.10
Total	300,352	426,359	552,896	699,814	865,440	2.88

(3) Generation and Attraction

The predicted trip generation and attraction by vehicle type for 2012, 2018, 2023, 2028 and 2033 are shown in Tables 5.4-4 to 5.4-8.

Table 5.4-4 Trip Generation and Attraction by Vehicle Type in 2012

Zone No.	Province	Trip Generation in 2012			Trip Attraction in 2012		
		MC	LV	HV	MC	LV	HV
2	Battambang	14,398	4,408	986	14,451	4,531	985
15	Pursat	4,865	1,386	320	4,895	1,442	320
4	Kampong Chhnang	6,051	1,761	403	6,084	1,826	402
5	Kampong Speu	9,248	2,739	622	9,293	2,832	621
8	Kandal	21,454	7,359	1,566	21,435	7,430	1,569
12	Phnom Penh	55,828	23,884	4,654	55,190	23,390	4,689

Table 5.4-5 Trip Generation and Attraction by Vehicle Type in 2018

Zone No.	Province	Trip Generation in 2018			Trip Attraction in 2018		
		MC	LV	HV	MC	LV	HV
2	Battambang	19,088	6,530	1,391	19,072	6,595	1,394
15	Pursat	6,263	2,029	443	6,272	2,066	443
4	Kampong Chhnang	7,711	2,518	547	7,720	2,561	548
5	Kampong Speu	11,774	3,929	846	11,777	3,983	847
8	Kandal	28,067	10,463	2,151	27,938	10,435	2,160
12	Phnom Penh	81,198	35,904	6,911	80,125	35,018	6,970

Table 5.4-6 Trip Generation and Attraction by Vehicle Type in 2023

Zone No.	Province	Trip Generation in 2023			Trip Attraction in 2023		
		MC	LV	HV	MC	LV	HV
2	Battambang	24,445	8,831	1,839	24,367	8,848	1,845
15	Pursat	7,931	2,746	582	7,920	2,769	583
4	Kampong Chhnang	9,560	3,329	704	9,545	3,353	706
5	Kampong Speu	14,580	5,219	1,091	14,540	5,236	1,094
8	Kandal	35,492	13,833	2,793	35,254	13,712	2,808
12	Phnom Penh	108,676	48,725	9,332	107,156	47,443	9,414

Table 5.4-7 Trip Generation and Attraction by Vehicle Type in 2028

Zone No.	Province	Trip Generation in 2028			Trip Attraction in 2028		
		MC	LV	HV	MC	LV	HV
2	Battambang	30,546	11,646	2,372	30,374	11,579	2,384
15	Pursat	10,000	3,689	761	9,958	3,685	765
4	Kampong Chhnang	11,583	4,278	883	11,534	4,272	886
5	Kampong Speu	17,686	6,708	1,369	17,590	6,674	1,376
8	Kandal	44,374	18,058	3,586	43,981	17,798	3,609
12	Phnom Penh	138,568	63,264	12,037	136,489	61,468	12,149

Table 5.4-8 Trip Generation and Attraction by Vehicle Type in 2033

Zone No.	Province	Trip Generation in 2033			Trip Attraction in 2033		
		MC	LV	HV	MC	LV	HV
2	Battambang	37,483	14,902	2,986	37,195	14,732	3,003
15	Pursat	12,504	4,843	980	12,424	4,805	985
4	Kampong Chhnang	13,901	5,386	1,090	13,812	5,343	1,096
5	Kampong Speu	21,116	8,374	1,679	20,957	8,281	1,689
8	Kandal	54,538	22,939	4,498	53,963	22,512	4,531
12	Phnom Penh	171,193	79,317	15,013	168,481	76,931	15,158

Figure 5.4-1 to Figure 5.4-5 show the total trip production (the total of generation and attraction) by zone in 2012, 2018, 2023, 2028 and 2033.

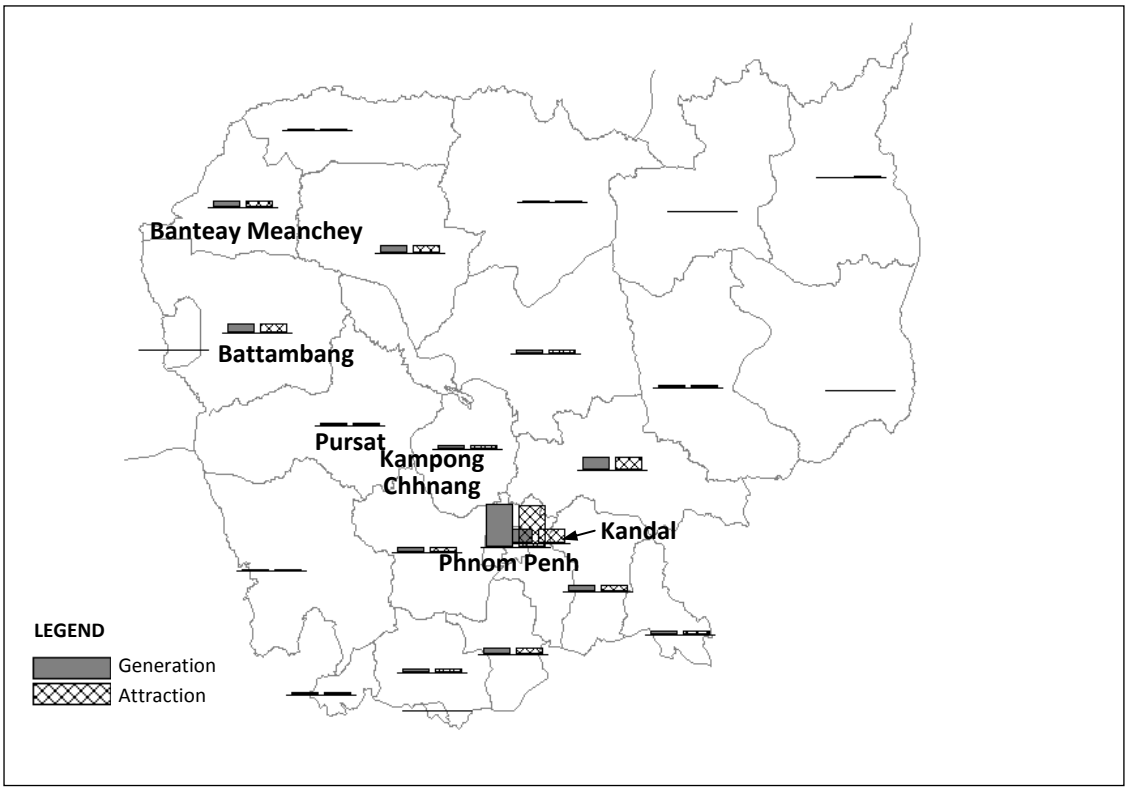


Figure 5.4-1 Trip Generation and Attraction in 2012 (Total Vehicle)

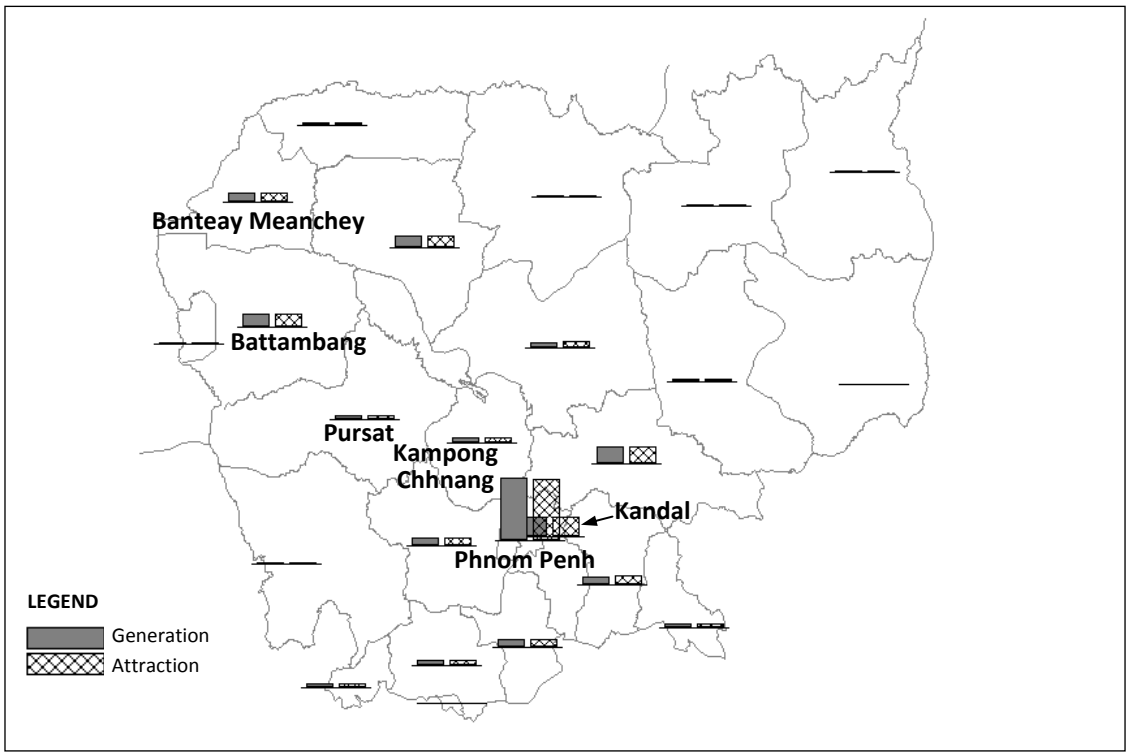


Figure 5.4-2 Trip Generation and Attraction in 2018 (Total Vehicle)

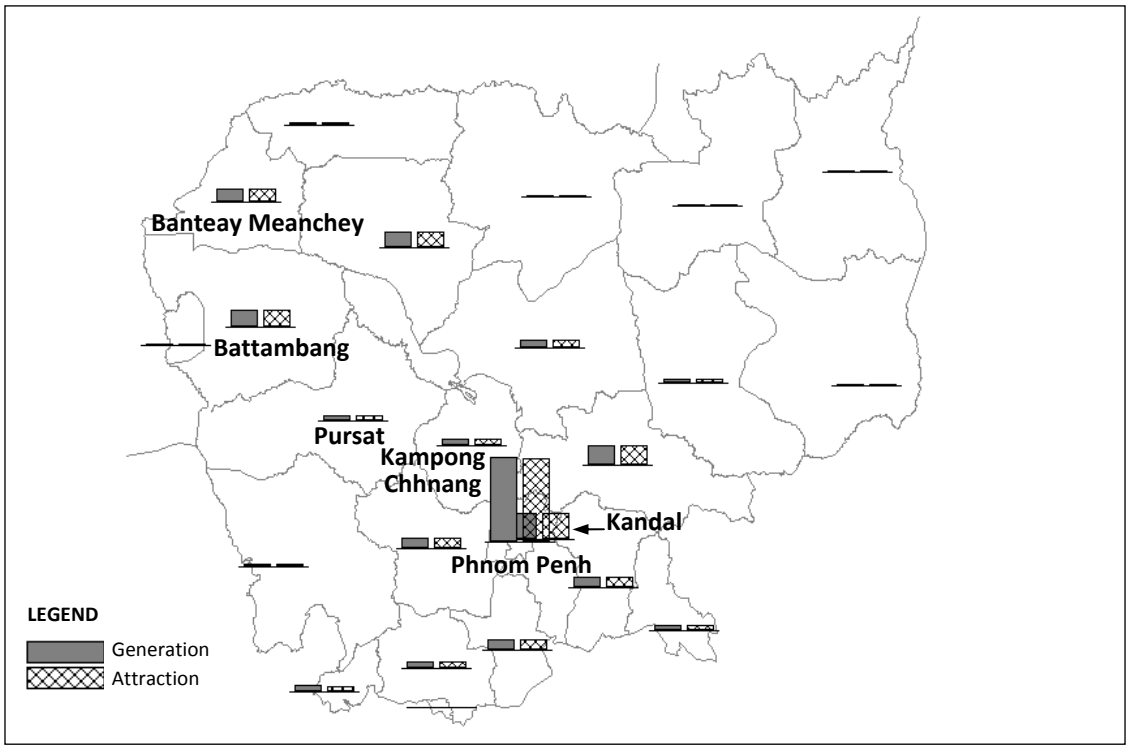


Figure 5.4-3 Trip Generation and Attraction in 2023 (Total Vehicle)

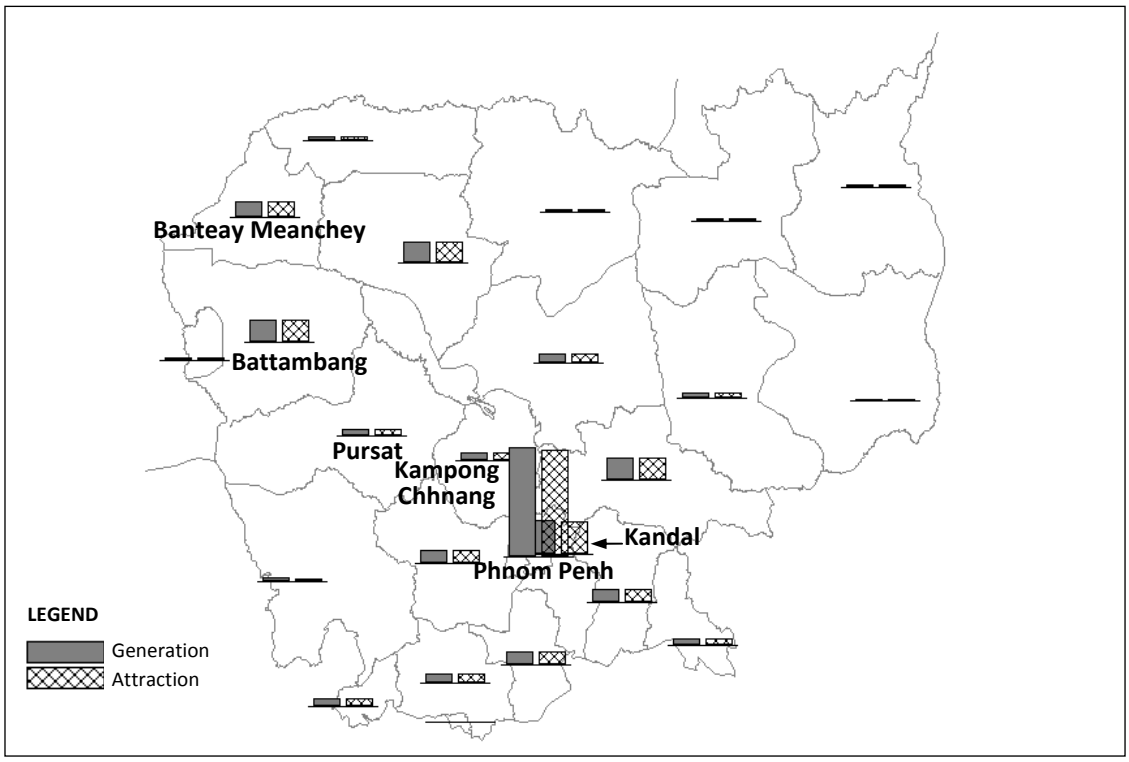


Figure 5.4-4 Trip Generation and Attraction in 2028 (Total Vehicle)

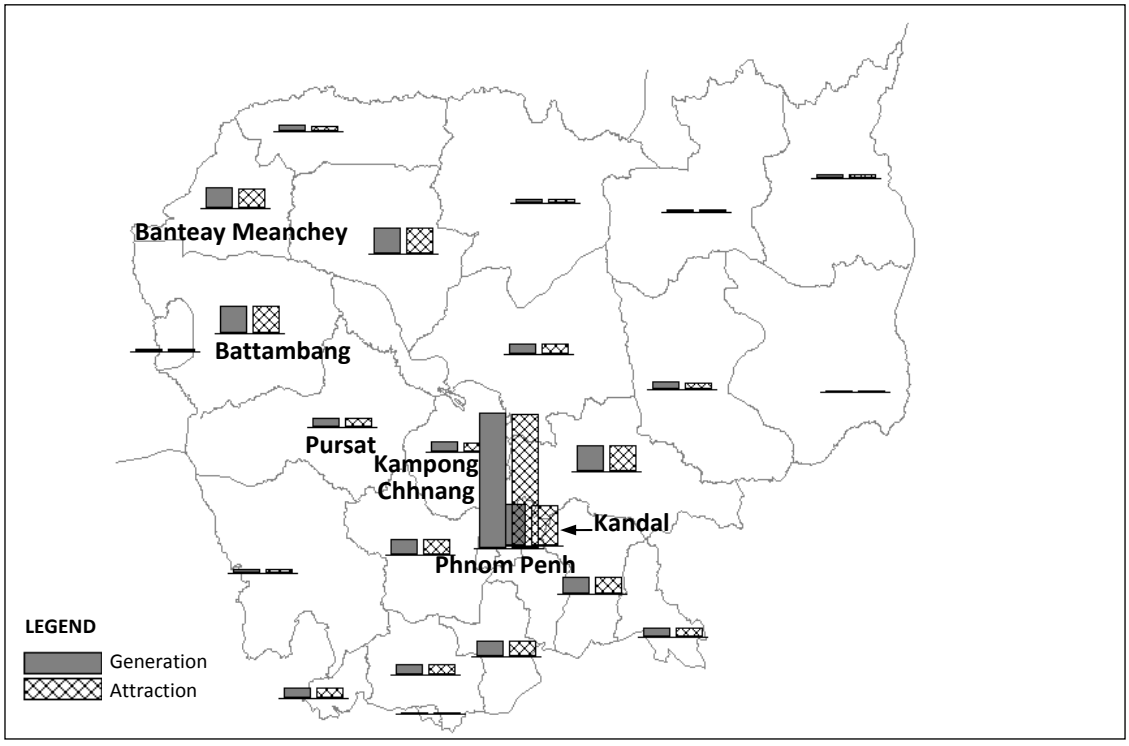


Figure 5.4-5 Trip Generation and Attraction in 2033 (Total Vehicle)

5.4.4 Future OD Matrix (Future Traffic Demand)

The future OD matrixes are estimated by the Frator Method using the present OD matrix and the estimated trip generation and attraction. The future OD matrices expressing the future traffic

demand between the traffic zones were prepared in a form of tables. Then, this traffic demand data is converted into a form of 'desire line' as shown in Figure 5.4-6.

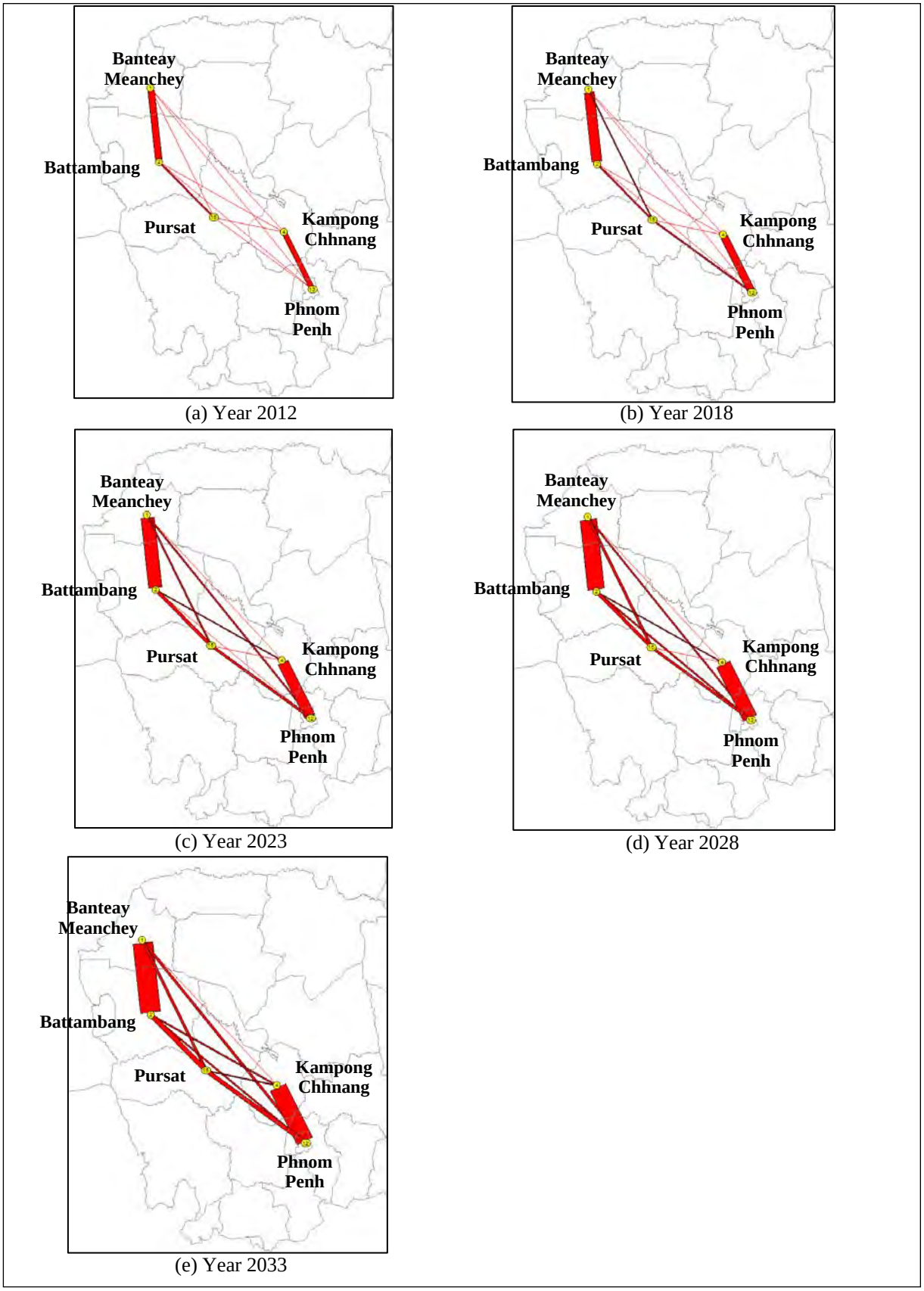


Figure 5.4-6 Desire Line for 2012, 2018, 2023, 2028 and 2033

5.4.5 Modal Split

(1) Railroad

A railroad line (North Line) between Poipet and Phnom Penh, is running in parallel to NR 5. This railroad is currently being rehabilitated with a financial assistance of ADB. The 30-years concession to manage and upgrade Royal Cambodian Railways has been awarded to Toll Holding, an joint venture of Australian investor and Royal Group. The Master Plan for the Development of the Railway Network in Cambodia has been prepared by Korea and MPWT. However, the operation plan is not publically available. Therefore, the diversion of cargo and/ or passengers from automobile to railroad is not considered in this traffic forecast, but the overall examination of forecasted traffic volume is presented in Item (5) of Subsection 5.4.1 below.

(2) Bus Service

Many long-distance bus services are available on NR 5. It is not conceivable that the share of transport by such long-distance buses greatly increase in the future as the income level of the people will be upgraded. Therefore, diversion to long-distance bus service is not taken into account in this future traffic demand forecast.

(3) Inland Water Transport

There are four (4) inland water ports (Phnom Penh, Kampong Chhnang, Battambang and Siem Riap) along NR 5. "The master plan on Waterborne Transport in the Mekong River System in Cambodia" was established under the assistance of Belgian Technical Cooperation. An agreement to promote inland water transport was signed between the RGC and the government of Vietnam in December 2009. This will encourage the inland water transport along Mekong River, Tonle Sap River, Tonle Sap Lake and Bassac River. However the diversion of cargo or passenger from NR 5 to such inland water transport is considered to be limited. Thus, such diversion is not considered in this traffic forecast.

5.5 Traffic Demand Forecast

5.5.1 Traffic Assignment

The prediction of future traffic volume by road link is estimated by traffic assignment program of JICA STRADA. JICA STRADA adopt the "minimum paths" method, in which the vehicles are assumed to take the path with the minimum cost (sum of travel time cost and vehicle operation cost) among the road links of the network connecting the pair of OD zones.

(1) Passenger Car Unit

In the traffic assignment, traffic volume is expressed in the form 'Passenger Car Unit' (PCU). The PCU equivalents used in this Survey are shown in Table 5.5-1.

Table 5.5-1 Passenger Car Unit

Categories	MC	LV	HV
PCU Equivalents	0.30	1.25	3.00

Normally, the PCU of sedan and pick-up truck is set at 1.0. In this Survey, the PCU of Light Vehicle (LV) has been set at 1.25 for the reason that this category includes light trucks and pick-up trucks. Their speeds light trucks and pick-up tracks are slower than that of passenger cars because of cargo and therefore their contribution to traffic congestion is larger than ordinary passenger cars.

(2) Road Network

The future road network used for traffic assignment needs to incorporate the planned improvements. The 4th edition of publication of the Infrastructure and Regional Integration Technical Working Group (IRITWG), which was published in September 2012 lists the past and future improvement of National Roads. Among these improvement plans, the following projects are incorporated in the future road network used in this traffic forecast.

Table 5.5-2 Future Improvements to Road Network

Year	Road No	Section	Content
2018	NR 5	Phnom Penh – Prek Kdam	Widening (4 lanes)
	NR 5 (North Section)	Battabang – Sisophon	Widening (4 lanes)
		Battambang Bypass	New Construction
		Sri Soporn Bypass	New Construction
	NR 6	Phnom Penh - Thnal Keng	Widening (4 lanes)
2023	NR 5 (South Section)	Prek Kdam - Thlea Ma'am	Widening (4 lanes)
		Odongk Bypass	New Construction
		Kampong Chhnang Bypass	New Construction
	NR 6	Siem Reap Bypass	New Construction
		Thnal Keng - Skun	Widening (4 lanes)

Other improvement plans are not incorporated in the future road network, but their influences are individually examined in "(5) Overall Examination of Forecasted Traffic Volume".

(3) Traffic Assignment Result

Figure 5.5-1 to Figure 5.5-5 shows the result of the traffic assignment for year 2012, 2018, 2023 and 2033.

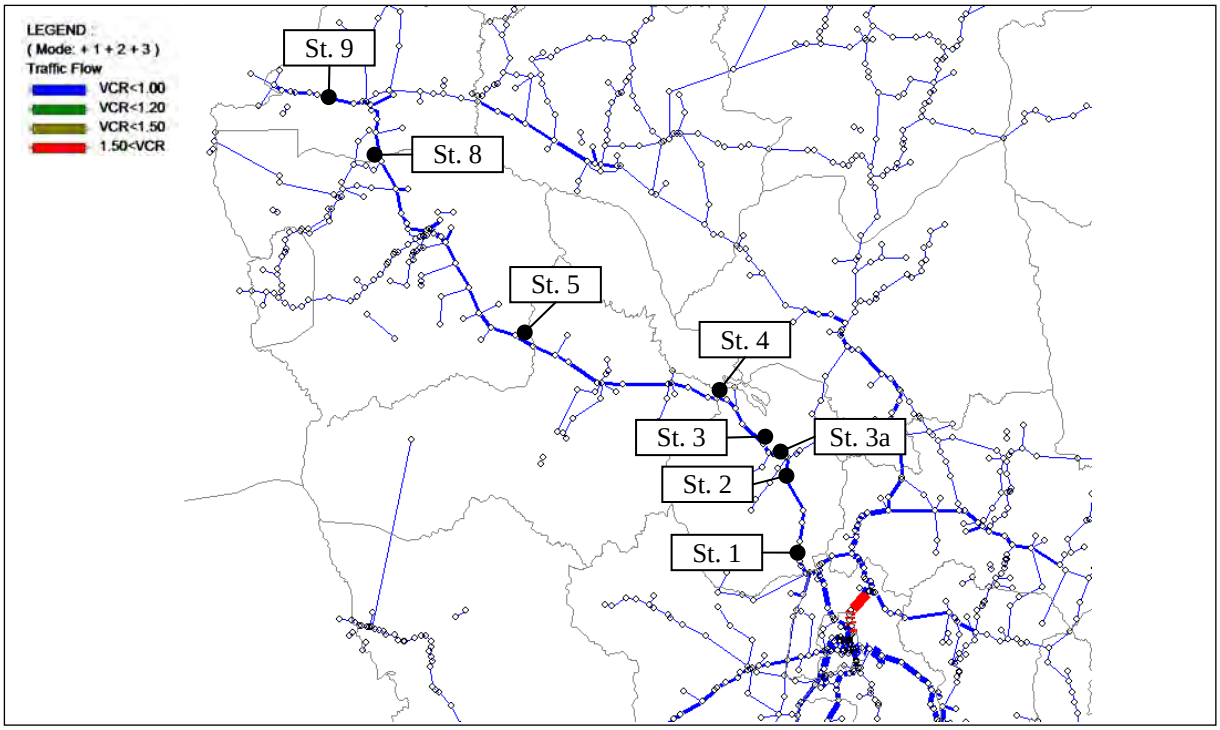


Figure 5.5-1 Results of Traffic Assignment for Year 2012

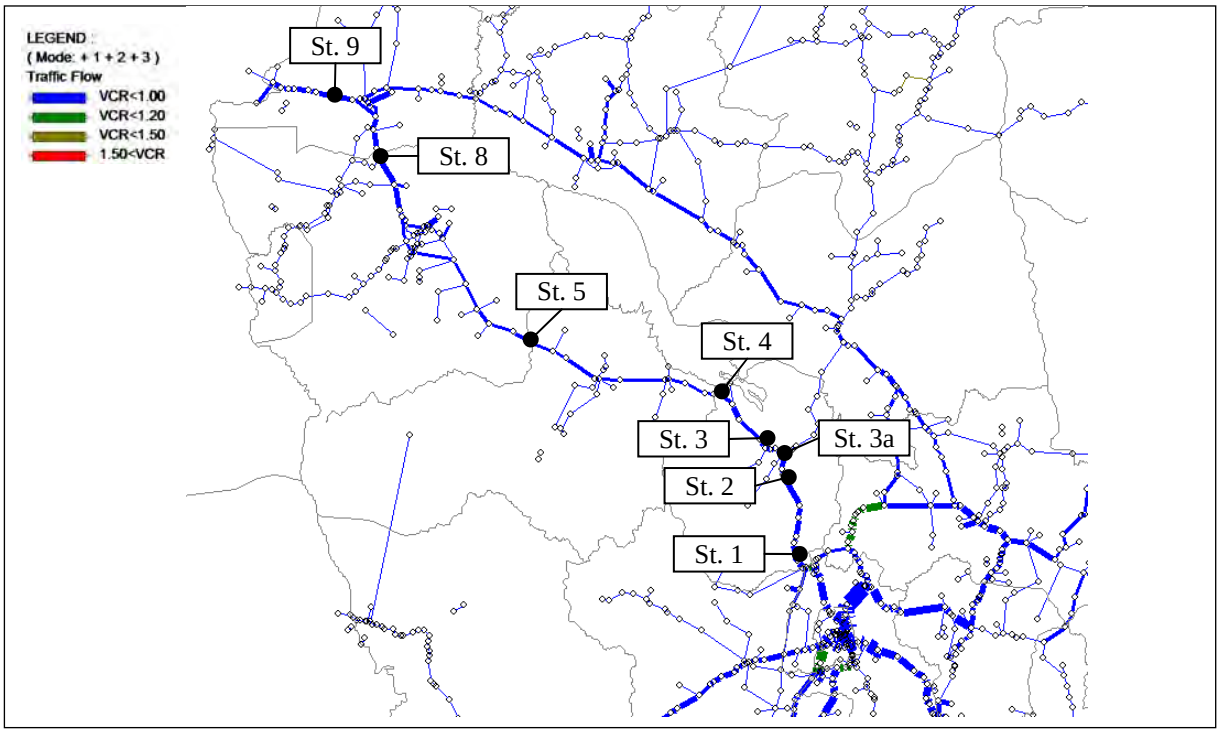


Figure 5.5-2 Results of Traffic Assignment for Year 2018

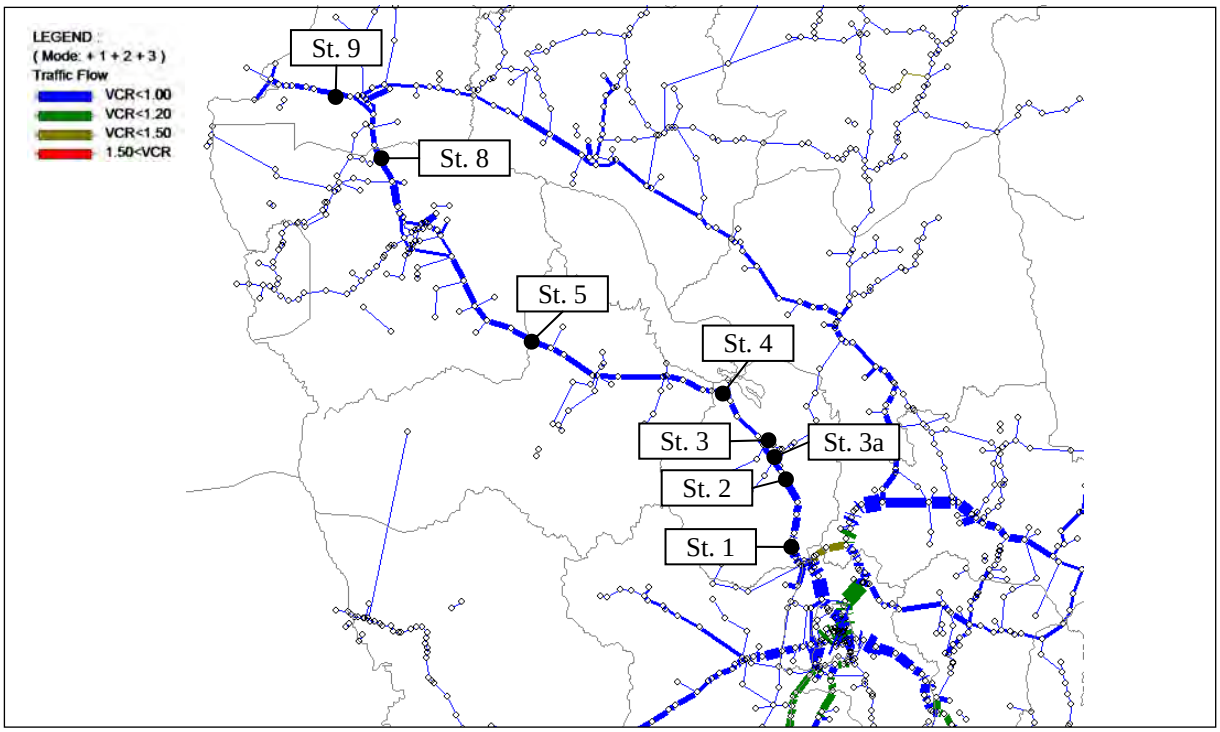


Figure 5.5-3 Results of Traffic Assignment for Year 2023

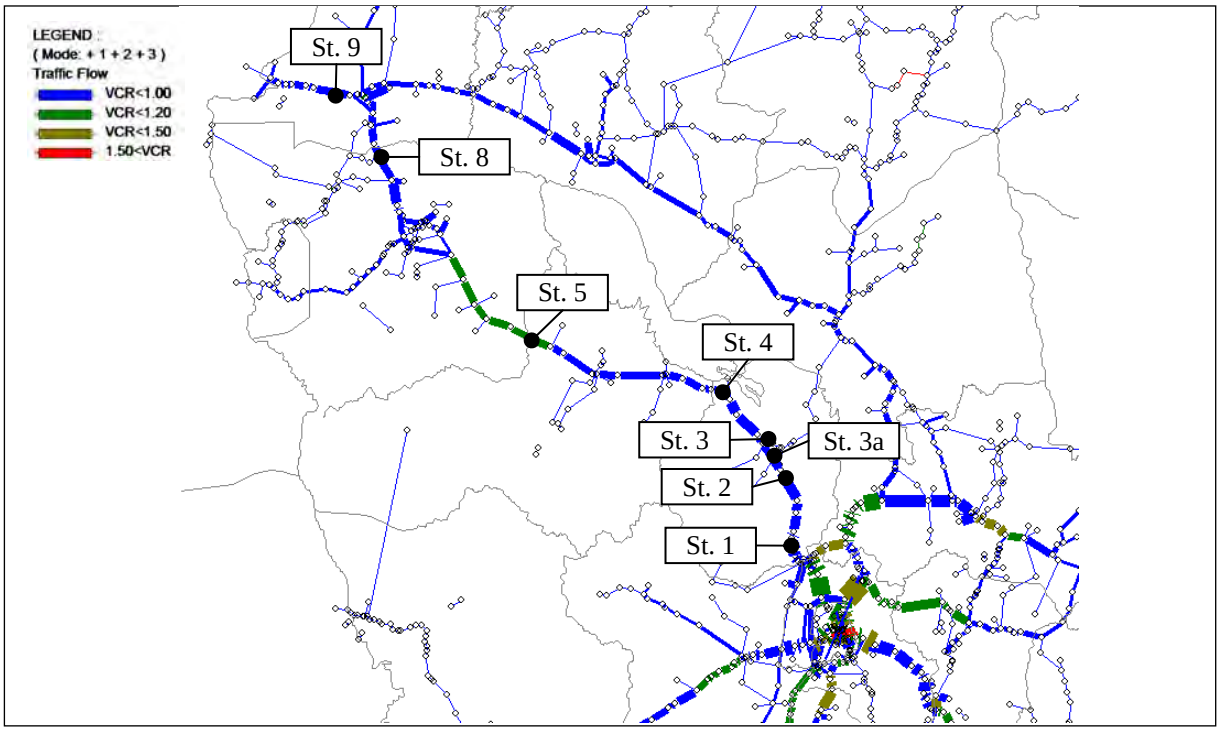


Figure 5.5-4 Results of Traffic Assignment for Year 2028

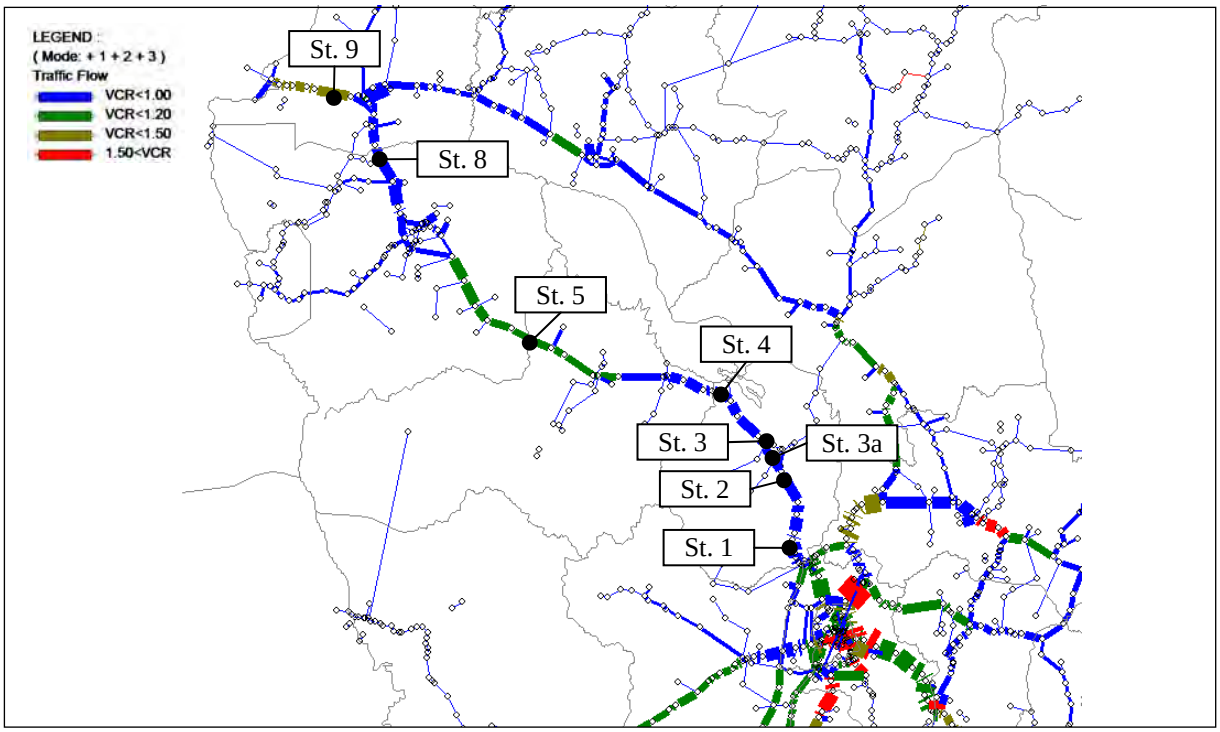


Figure 5.5-5 Results of Traffic Assignment for Year 2030

(4) Future Traffic Volume at Traffic Counting Stations

Table 5.5-3 and Table 5.5-4 lists the forecasted traffic volumes at the traffic counting stations for the years 2012, 2018, 2023 and 2033. Figure 5.5-6 shows the forecasted traffic volume between Prek Kdam and Sri Sophorn on NR 5.

Table 5.5-3 Result of Traffic Assignment by Counting Stations

(Unit: PCU/day)

Section	Station No.	Year					
		2012		2018	2023	2028	2033
		Observed	Assignment Result				
South Section	1	10,352	10,308	17,679	24,176	32,734	42,438
	2	9,103	8,684	15,523	21,365	29,289	38,218
	3a	12,857	-	21,769	22,998	31,245	40,434
	3	6,596	6,474	12,324	17,156	24,332	31,974
Middle Section	4	5,296	5,162	10,650	15,014	21,673	28,714
	5	6,174	6,117	10,138	14,229	20,777	27,484
North Section	8	6,470	6,350	11,822	15,650	22,736	30,410
Sri Sophorn – Poipet	9	-	7,454	11,746	15,566	20,238	25,514

Note: Assignment result at Station No.3a in 2012 is not shown in this table. The Result of the traffic volume count survey at Station No.3a included the short trips within the city, because Station No.3a was located at the city center of Kampong Chhnang. However the future traffic volume forecast in this Survey does not estimate the short trips within the city. The Assignment results at Station No.3a in 2018, 2023, 2028 and 2033 are estimated based on assignment result and result of traffic count survey in the Survey of the South Section .

Table 5.5-4 Traffic Volume by Vehicle Type, Actual and Predicted

Station	2012 (Actual)					2018 (Predicted)				
	MC	LV	HV	Total (Veh.)	PCU	MC	LV	HV	Total (Veh.)	PCU
1	5,727	3,788	1,285	10,800	10,308	8,633	6,820	2,188	17,641	17,679
2	5,637	2,964	1,096	9,697	8,684	8,550	6,044	1,801	16,395	15,523
3a	15,947	3,569	1,204	20,720	12,857	21,067	7,660	1,958	30,685	21,769
3	3,303	2,123	943	6,370	6,474	4,677	5,002	1,556	11,235	12,324
4	867	1,738	910	3,514	5,162	2,130	4,415	1,497	8,043	10,650
5	1,583	1,660	1,189	4,432	6,117	2,260	3,525	1,685	7,469	10,138
8	3,897	2,282	776	6,955	6,350	6,733	4,654	1,328	12,715	11,822
9	4,027	3,432	652	8,111	7,454	8,753	4,236	1,275	14,264	11,746

Station	2023 (Predicted)					2028 (Predicted)				
	MC	LV	HV	Total (Veh.)	PCU	MC	LV	HV	Total (Veh.)	PCU
1	12,487	9,350	2,914	24,751	24,176	15,700	12,695	4,052	32,447	32,734
2	12,390	8,324	2,414	23,128	21,365	15,590	11,442	3,437	30,468	29,289
3a	21,857	7,821	2,221	31,900	22,998	27,065	10,851	3,188	41,103	31,245
3	7,217	6,950	2,101	16,268	17,156	9,053	9,939	3,064	22,057	24,332
4	4,057	6,174	2,026	12,257	15,013	5,230	8,953	2,971	17,154	21,673
5	4,140	4,967	2,259	11,367	14,228	5,260	7,507	3,272	16,039	20,778
8	8,003	6,346	1,772	16,121	15,650	10,443	9,390	2,622	22,455	22,736
9	11,210	5,723	1,683	18,616	15,566	14,130	7,567	2,180	23,877	20,238

Station	2033 (Predicted)				
	MC	LV	HV	Total (Veh.)	PCU
1	19,013	16,302	5,452	40,768	42,438
2	18,880	14,727	4,715	38,322	38,218
3a	32,604	13,961	4,400	50,966	40,434
3	10,830	12,718	4,276	27,824	31,974
4	6,253	11,484	4,161	21,898	28,714
5	6,163	9,686	4,509	20,358	27,483
8	13,107	12,352	3,679	29,138	30,410
9	17,417	9,660	2,738	29,815	25,514

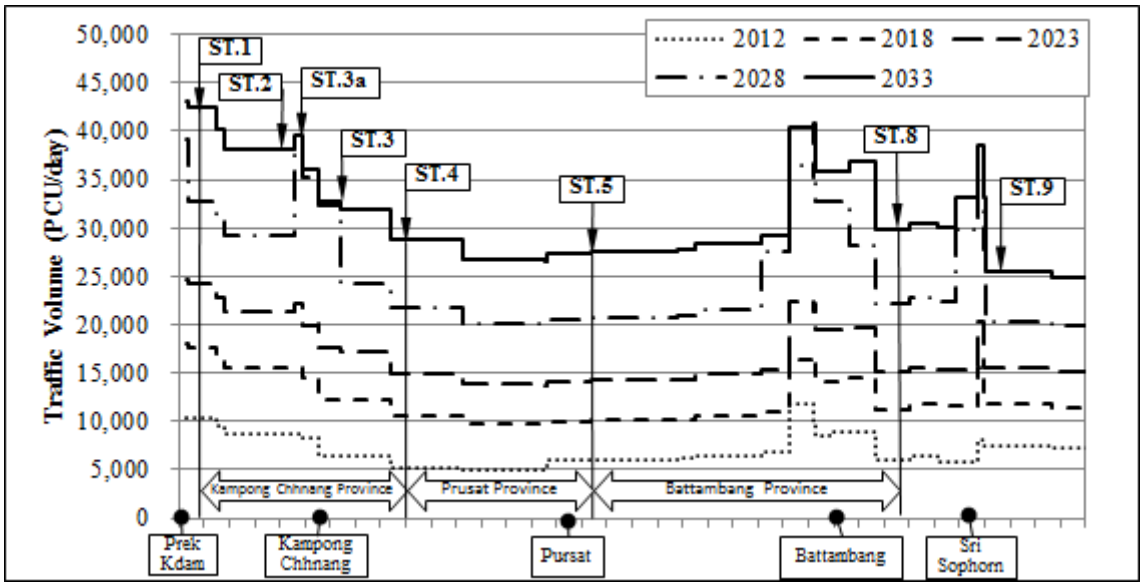


Figure 5.5-6 Result of Traffic Assignment

(5) Overall Examination of Forecast Traffic Volume

➢ Influence of Rail Road

Rehabilitation of the North Line of the railroad along NR 5 is being implemented. However the diversion of trips from automobile to railroad is not considered in the traffic assignment (Table 5.5-3), because the operation plan of the railroad and the route of the new road are not fixed yet. Based on the experience of Japan and USA, as well as considering the routes and other conditions of rail transport and NR 5, it is assumed that traffic of heavy vehicles is may be subject to diversion to rail transport. Railroad carry mainly heavy cargo like construction material. Result of OD interview survey in the survey of the South Section, 10% of heavy vehicles carried cargo of construction. If 10% of traffic of heavy vehicles divert to rail transport, future total traffic volume on NR 5 will be reduced by 4 % from Table 5.5-3 in year 2033.

➢ Influence of Expressway

Expressway routes in the Kingdom of Cambodia is under consideration now. It is assumed that the expressway will be planned along NR 1, NR 4 and NR 5, since these routes are selected as Asian highway. If 50% of Light Vehicle and Heavy Vehicle will divert to expressway, future total traffic volume on NR 5 will be reduce by 45% from Table 5.5-3 in year 2033.

5.5.2 Peak Hour Traffic Volume and Congestion

Table 5.5-5 shows the traffic volumes in peak hour at the traffic counting stations. The degree of congestion expressed in the form of the ratio of traffic volume against traffic capacity of the road (v/c ratio or VCR). VCR of 0.85 is usually considered to be the allowable limit of congestion in road planning.

By the year 2033, at all the traffic counting stations , the VCR is predicted to exceed 0.85. Thus these sections require widening by that time.

Table 5.5-5 Peak Hour Traffic Volume and Congestion Degree

Station No.	Peak Hour Volume (PCU)					Congestion Degree VCR					Link Capacity	No. of Lane
	2012	2018	2023	2028	2033	2012	2018	2023	2028	2033		
1	927	1,582	2,177	2,927	3,763	0.34	0.59	0.81	1.08	1.39	2,700	1.5×2
2	754	1,330	1,843	2,498	3,226	0.28	0.49	0.68	0.93	1.19	2,700	1.5×2
3a	1,147	3,226	1,978	2,648	3,382	0.42	1.19	0.73	0.98	1.25	2,700	1.5×2
3	517	983	1,380	1,940	2,522	0.26	0.49	0.69	0.97	1.26	2,000	2
4	408	868	1,235	1,777	2,335	0.20	0.43	0.62	0.89	1.17	2,000	2
5	656	1,081	1,527	2,222	2,932	0.24	0.40	0.57	0.82	1.09	2,700	1.5×2
8	584	1,092	1,440	2,082	2,770	0.29	0.55	0.72	1.04	1.38	2,000	2
9	698	1,099	1,455	1,890	2,228	0.35	0.55	0.73	0.94	1.11	2,000	2

It should be noted that daily traffic volumes at all Stations exceed 20,000 PCU by year 2033 (see Table 5.5-3). 20,000 PCU is generally considered to be, or close to be, the capacity of an opposed 2-lane road. Thus, the traffic at these locations is anticipated to be congested. By year 2033, the daily traffic volume at Station No. 4 and No. 5 is predicted to exceed, 20,000 PCU and widening of the Middle Section will become an absolutely necessary.

5.5.3 Traffic Volume on Bypass

One of the tasks included in the Scope of this Survey is to study the possibility of construction of bypasses around Pursat. Table 5.5-6 shows the forecasted traffic volume on these bypasses.

Table 5.5-6 Future Traffic Volume on Bypass

Section	2023					2028				
	MC	LV	HV	Total (Veh.)	PCU	MC	LV	HV	Total (Veh.)	PCU
Bypass	2,878	4,150	1,953	8,981	11,911	3,698	6,330	2,873	12,900	17,639
City Center	723	972	246	1,941	2,170	940	1,266	321	2,526	2,826

Station	2033				
	MC	LV	HV	Total (Veh.)	PCU
Bypass	4,017	7,059	3,154	14,230	19,203
City Center	1,033	1,435	366	2,835	3,203

Note: The future traffic volume forecast in this Survey is not estimated the short trips within the city.

CHAPTER 6 NATURAL CONDITION OF SURVEY AREA/SURVEY ROAD

In this chapter, the natural conditions in the Survey Area which will affect planning and designing of NR 5 and its bypass are discussed in (i) the hydrological conditions/ potential for flood, (ii) the topography of the existing road, and (iii) the geotechnical conditions.

6.1 Hydrological Condition and Flood Records

The climate of Cambodia is classified as tropical monsoonal and dominated by annual monsoon cycle with its alternating wet and dry season. In wet season, May to October, inundations occur frequently on the NR 5, disrupting traffic and economic and social activities. Thus inundations cause considerable loss to the economy and social activities. With regard to the road structure, inundation also reduces the bearing capacity of the pavement structure and then cause premature deterioration of pavement. Inundation on the Middle Section of NR 5 is caused by two possible reasons. One is influence of flooding in the Tonle Sap Lake system, and the other is discharge of rainwater from mountains and paddy field located in the west of NR 5.

Sri Sophorn – Poipet Section is located far from the Tonle Sap Lake. Thus flooding in Tole Sap is unlikely to be the cause of inundation on Sri Sophorn – Poipet Section. Possible causes of inundation on Sri Sophorn - Poipet Section are supposed to be discharge of rain water from mountains because of heavy rain, and flood water from Thailand.

6.1.1 River System and Existing Drainage Facilities

NR 5 runs southwest side of Tonle Sap River and Tonle Sap Lake. The Tonle Sap River and Lake play an important role not only as a buffer (a natural flood retention basin) for the floods of the Mekong River System but also as a source of water for agriculture and other purposes during the dry season. During the dry season, Tonle Sap River flows downstream as a normal tributary draining into the Mekong. During wet season, however, the level of the Mekong rises higher than the Tonle Sap River. Consequently, the Tonle Sap River flows upstream as water from the Mekong flows into Tonle Sap Lake. Table 6.1-1 shows the hydrological features of the Mekong River and Tonle Sap River.

Table 6.1-1 Hydrological Features of Mekong River and Tonle Sap River

River Name	Catchment Area (km^2)	River Length (Km)	Average Discharge (m^3/s)
Mekong River	660,000* (795,000 in total)	4,500* (4,880 in total)	11,830** (15,060 in total)
Tonle Sap River	84,400*	120* (400 in total)	1,570**

*Note: * Upstream of Phnom Penh ** At Phnom Penh*

The drainage area along the Middle Section of NR 5 is divided into 16 areas taking the watershed and boundary into consideration based on the prevailing topographic terrain, embankments, and canals on the topographic map of the scale of 1/100,000. There are 14 rivers, streams, and channels crossing NR 5 in the Middle Section (see Table 6.1-2). Some of them flow only during the period of deluge, and thus lack clear shape of river. Figure 6.1-1 illustrates the major river network in Cambodia. It shows there are two major river system (Pursat and Doun Tri) in the Survey Area.

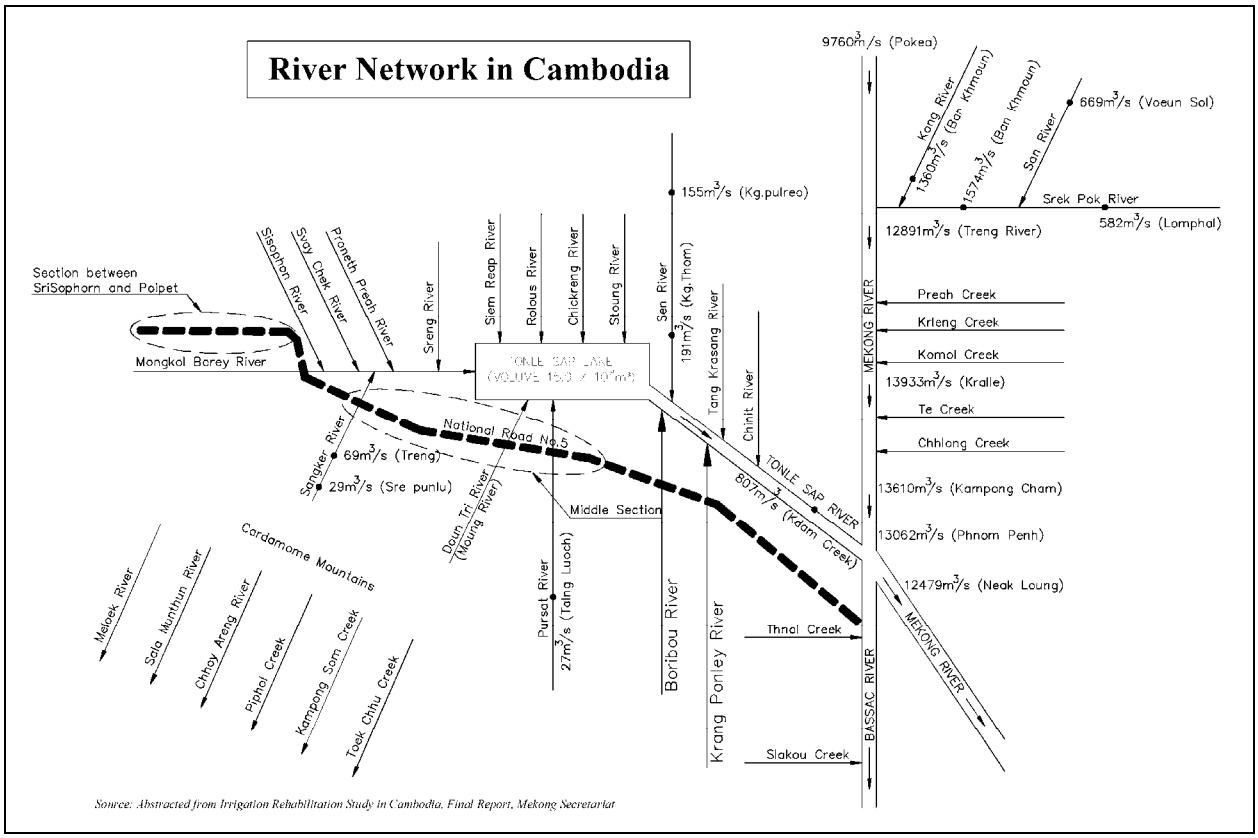


Figure 6.1-1 River Network in Cambodia

Table 6.1-2 shows the river and stream basins and water courses along NR 5. Several streams finally discharge themselves into paddy field or floodplains of the Tonle Sap Lake after crossing NR 5. This means the riverbed gradients of downstream reaches are extremely gentle. Most of the streams, however, directly flow into the Tonle Sap Lake.

As shown in Figure 6.1-1 above, a number of rivers and streams originate from the Cardamome Mountains, located in the southwestern of the Tonle Sap Lake, and cross NR 5 flowing into the Tonle Sap Lake. Thus, drainage system of the NR 5 governs the flow into the Tonle Sap Lake from the southwestern side. Table 6.1-3 summarizes the existing bridges functioning as opening or channel for water flow across NR 5.

Table 6.1-4 to Table 6.1-5 shows the inventory of the existing box culverts and pipe culverts. Appendix 6-1 provides details. In the survey, at some culverts, silting-up at both of inlet and outlet and a couple of pipe culverts are completely covered or demolished are observed.

In the Sri Sophorn - Poipet Section, flood water from Thailand flow into Cambodia and goes to the east along NR 5, and finally, flows into the Tonle Sap Lake through the Sri Sophorn River. There is no rivers/creek across NR 5 between Sri Sophorn and Poipet.

While there are many pipe culverts on Sri Sophorn – Poipet Section, as shown Table 6.1-6, there are no bridges/box culverts which have much larger drainage capacity than pipe culverts. Thus, drainage pipe culverts installed under NR 5 are supposed to be not for drainage flood water but for irrigation.

Table 6.1-2 River Systems along Middle Section

No.	KP (Km)	River System														
1	177+200 ~ 178+400	montane	⇒	Srang Creek	⇒	Daek Creek	⇒	Srang Thum Creek	⇒	*Br40*	⇒	Pousat River	⇒		⇒	Tonle Sap Lake
							⇒	Srang Creek	⇒	*Br41*	⇒	Srang Touch Creek	⇒	Pousat River	⇒	Tonle Sap Lake
2	181+800	montane	⇒	Creek	⇒				⇒	*Br42*	⇒	irrigation canal	⇒	paddy field		
													⇒	flood plain		
3	185+700 ~ 191+100	montane	⇒	Pousat River	⇒				⇒	*Br47*	⇒	Pousat River	⇒	flood plain	⇒	Tonle Sap Lake
					⇒	irrigation canal	⇒		⇒	*Br48~ Br51*	⇒	irrigation canal	⇒	paddy field	⇒	Tonle Sap Lake
													⇒	Pousat River		
					⇒	Svay At Creek	⇒		⇒	*Br55*	⇒	Toch River	⇒	paddy field	⇒	Tonle Sap Lake
							⇒	Sdau Creek	⇒	*Br52*			⇒	flood plain		
4	201+900	paddy field	⇒	Bakan Creek	⇒	Creek			⇒	*Br56*	⇒	Bat Kardaol Pond	⇒	Kandieng Brook	⇒	Tonle Sap Lake
5	208+500	reservoir	⇒	Chambot River	⇒	Kambot River			⇒	*Br57*	⇒	Kambot River	⇒	paddy field	⇒	Tonle Sap Lake
													⇒	flood plain		
6	215+700	paddy field	⇒	Ta Paong Creek	⇒				⇒	*Br58*	⇒	Srah Mokak Creek	⇒	paddy field	⇒	Tonle Sap Lake
7	218+800 ~ 219+700	montane	⇒	Svay Doun Kaev River	⇒				⇒	*Bc62, Bc63*	⇒	Svay Doun Kaev River	⇒	Kbal Toul River	⇒	Tonle Sap Lake
									⇒	*Br59*			⇒	Khnay Tol Creek		
8	221+400	paddy field	⇒	Boeng Prey Creek	⇒	S'at Creek			⇒	*Bc64*	⇒	irrigation canal			⇒	Tonle Sap Lake
			⇒	irrigation canal												
9	240+000 ~ 244+400	montane	⇒	Moung River	⇒				⇒	*Br65*	⇒	Donn Tri River	⇒	flood plain	⇒	Tonle Sap Lake
					⇒	Creek			⇒	*Bc70*	⇒	Creek	⇒	paddy field		
10	251+000 ~ 253+600	paddy field	⇒	Ta Muk River	⇒	Char River	⇒	paddy field								
					⇒	+ Krabuav Creek	⇒		⇒	*Bc74, Pc201*	⇒	Ta Muk River	⇒	paddy field		
11	255+600	paddy field	⇒	Svay Creek	⇒	Chak River	⇒		⇒	*Br68*	⇒	Chak River	⇒	paddy field		
12	265+900 ~ 267+000	paddy field	⇒	irrigation canal					⇒	*Br71, Bc82*	⇒	irrigation canal	⇒	paddy field		
13	273+400	paddy field	⇒	Krieng Creek	⇒	Sanda Creek			⇒	*Br75*	⇒	Sanda Creek	⇒	paddy field		
14	278+000 ~ 285+100	paddy field	⇒	Sralau Creek	⇒				⇒	Bc89	⇒	Chas Sa River	⇒	flood plain	⇒	Tonle Sap Lake
									⇒	Bc90	⇒	Moni Ceek	⇒	paddy field		
					⇒	Rumchek Creek	⇒		⇒	Pc208	⇒	Rumchek Creek	⇒	paddy field		
					⇒	Creek	⇒		⇒	Bc87, Bc88	⇒	Creek	⇒	paddy field		

Source: Topograpic Maps (Scale: 1/100,000)

Note: Br, Bc and Pc mean bridge, box culvert and pipe culvert respectively. Number means their grouping number.

Table 6.1-3 Existing Bridges (Middle Section)

Province	Bridge No.		KP(km)		JICA*					Bridge Type	Remarks
	PWRC	JICA*	PWRC	JICA*	Width (m)	No. of Span	Span (m)	Length (m)	Hight (m)		
Pursat	Br40	Br40	177+007	177+200	9.6	1	23.1	23.1	5.5	RC Steel Bridge	across Srang Thum Creek
	Br41	Br41	178+326	178+400	10.0	1	19.8	19.8	4.4	PC Bridge	across Srang Touch Creek
	Br42	Br42	181+584	181+800	9.1	4	4.8*4	19.2	2.2	RC Bridge	
	Br43	Br43	182+525	182+800	10.0	2	21.3*2	42.6	3.5	PC Bridge	
	Br44	Br44	182+945	183+300	9.0	3	15.1*3	45.3	4.9	RC Steel Bridge	
	Br45	Br45	183+527	183+850	10.0	2	21.25*2	42.5	5.0	PC Bridge	
	Br46	Br46	183+720	184+100	10.1	1	26.45	26.5	3.9	PC Bridge	
	Br47	Br47	185+192	185+700	10.0	6	20.0*6	120.0	8.4	RC Bridge	across Pursat River
	Br48	Br48	186+961	187+300	8.8	2	19.55*2	39.1	6.1	RC Bridge	
	Br49	Br49	187+268	187+600	10.0	2	15.25*2	30.5	3.4	PC Bridge	
	Br50	Br50	187+541	188+000	10.0	3	18.0*1 21.5*2	61.0	2.5	PC Bridge	
	Br51	Br51	187+725	188+200	10.0	3	15.0*1 18.25*2	51.5	2.9	PC Bridge	
	Br52	Br52	188+703	189+300	10.0	2	18.25*2	36.5	3.6	PC Bridge	across Sdau Creek
	Br53	Br53	189+371	189+900	10.0	1	24.5	24.5	2.1	PC Bridge	
	Br54	Br54	189+931	190+100	10.0	1	24.5	24.5	1.9	PC Bridge	
	Br55	Br55	190+544	191+100	10.0	2	18.2*2	36.4	4.9	PC Bridge	across Toch River
	Br56	Br56	201+514	201+900	10.0	1	18.5	18.5	2.4	PC Bridge	
	Br57	Br57	208+237	208+500	10.0	2	17.2*2	34.4	4.4	PC Bridge/RC Bridge	across Kambot River
	Br58	Br58	215+428	215+700	10.0	3	15.2*1 15.1*2	45.4	3.0	RC Steel Bridge	across Srah Mokak Creek
	Br59	Br59	219+274	219+700	9.0	3	30.15 30.20 30.40	90.8	6.8	RC Steel Bridge	across Svay Doun Kaev River
	Br60	Br60	220+465	220+800	10.0	2	15.2*2	30.4	4.2	PC Bridge	
Battdam bang	Br61	Br61	222+345	222+700	10.0	1	18.5	18.5	2.9	PC Bridge	
	Br62	Br62	223+291	223+500	10.0	1	18.5	18.5	3.0	PC Bridge	
	Br63	Br63	242+379	242+800	10.0	1	24.5	24.5	3.0	PC Bridge	
	Br64	Br64	243+189	243+600	10.0	2	18.5*2	37.0	3.1	PC Bridge	
	Br65	Br65	243+938	244+400	10.0	2	15.25*2	30.5	6.3	PC Bridge	across Donn Tri River
	Br66	Br66	245+491	245+900	9.1	2	7.9*2	15.8	2.4	RC Bridge	
	Br67	Br67	254+191	255+300	10.0	1	21.5	21.5	2.4	PC Bridge	
	Br68	Br68	254+741	255+600	10.0	2	15.25*2	30.5	2.3	PC Bridge	across Chak River
	Br69	Br69	256+043	256+600	10.0	1	21.5	21.5	2.5	PC Bridge	
	Br70	Br70	257+401	257+900	10.0	1	18.5	18.5	3.0	PC Bridge	
	Br71	Br71	265+348	265+900	10.0	1	18.5	18.5	2.9	PC Bridge	
	Br72	Br72	270+378	270+900	10.0	1	18.5	18.5	2.8	PC Bridge	
	Br73	Br73	271+124	271+600	10.0	1	18.5	18.5	2.4	PC Bridge	
	Br74	Br74	272+082	272+600	10.0	1	18.5	18.5	2.3	PC Bridge	
	Br75	Br75	272+775	273+400	10.0	2	15.25*2	30.5	3.4	PC Bridge	across Sanda Creek
	Br76	Br76	275+164	275+700	10.0	1	18.5	18.5	2.5	PC Bridge	
	Br77	Br77	276+024	276+500	10.0	1	18.5	18.5	2.4	PC Bridge	

Source: Public Works Research Center(PWRC). General Directorate of Public Works, Ministry of Public Works and Transport, Kingdom of Cambodia
**JICA Survey Team carried out the inventory on May 2013*

Table 6.1-4 Existing Box Culverts (Middle Section)

Province	No.		KP(km)		Dimension No. of Box×W×H					Remarks
	PWRC	JICA	PWRC	JICA	Total Width(m)	No. of Span	Width (m)	Hight (m)	Length (m)	
Pursat	Bc54	Bc54	171+628	171+800	2.90	1	2.80	1.70	13.6	
	Bc55	Bc55	178+851	179+100	6.40	2	2.80	1.90	13.7	
							2.80	1.90		
	Bc56	Bc56	179+275	179+500	6.25	2	2.85	1.90	13.6	
							2.85	1.90		
	Bc57	Bc57	179+578	179+800	9.60	3	2.85	1.65	12.2	
							3.00	1.80		
							2.85	1.65		
	Bc58	Bc58	181+818	182+200	2.90	1	2.80	1.75	13.6	
	Bc59	Bc59	196+150	196+500	3.10	1	3.00	1.60	14.0	
	Bc60	Bc60	199+008	199+300	3.10	1	3.00	1.45	13.8	
	Bc61	Bc61	213+724	214+100	9.45	3	2.80	1.75	13.7	
							2.95	2.00		
							2.80	1.75		
	Bc62	Bc62	218+402	218+800	3.10	1	3.00	2.55	15.2	
	Bc63	Bc63	218+532	218+900	3.10	1	3.00	1.95	15.3	
	Bc64	Bc64	221+109	221+400	4.10	2	1.80	2.00	13.7	
							1.80	2.00		
	Bc65	Bc65	221+373	221+700	6.30	2	3.00	1.80	16.2	
							3.00	1.80		
Battdambang	Bc66	Bc66	230+014	230+400	6.30	2	3.00	1.80	13.7	
							3.00	1.80		
	Bc67	Bc67	232+448	232+800	3.20	1	3.10	1.45	13.7	
	Bc68	Bc68	237+087	237+400	3.10	1	3.00	1.55	13.7	
	Bc69	Bc69	237+745	238+200	3.10	1	3.00	1.90	13.7	
	Bc70	Bc70	239+613	240+000	9.65	3	2.80	1.85	13.7	
							3.00	2.10		
							2.80	1.85		
	Bc71	Bc71	244+876	245+400	9.50	3	2.80	1.80	13.8	
							3.00	2.05		
							2.80	1.80		
	Bc72	Bc72	248+025	248+500	6.35	2	2.85	2.00	13.7	
							2.85	2.00		
	Bc73	Bc73	248+579	249+000	3.10	1	3.00	2.05	13.8	
	Bc74	Bc74	250+516	251+000	9.70	3	2.85	2.00	13.7	
							3.00	2.20		
							2.85	2.00		
	Bc75	Bc75	251+949	252+400	9.50	3	2.85	0.75	13.7	
							3.00	1.00		
							2.85	0.75		
	Bc76	Bc76	254+182	254+700	8.80	2	4.30	1.45	13.5	
							4.30	1.45		
	Bc77	Bc77	255+396	255+900	6.20	2	2.80	1.60	13.8	
							2.85	1.60		
	Bc78	Bc78	258+795	259+100	6.20	2	2.75	1.90	13.7	
							2.85	1.90		
	Bc79	Bc79	260+801	261+400	8.60	2	4.15	1.90	13.7	
							4.15	1.90		
	Bc80	Bc80	261+868	262+300	6.30	2	2.85	2.00	13.7	
							2.85	2.00		
	Bc81	Bc81	263+620	264+100	6.20	2	2.85	1.80	13.7	
							2.85	1.80		
	Bc82	Bc82	266+492	267+000	9.60	3	2.85	1.95	13.7	
							3.00	2.20		
							2.85	1.95		
	Bc83	Bc83	269+194	269+700	6.30	2	3.00	2.00	13.0	
							3.00	2.00		
	Bc84	Bc84	269+898	270+400	6.30	2	3.00	1.90	13.1	
							3.00	1.90		
	Bc85	Bc85	273+781	274+200	2.90	1	2.85	1.65	13.7	
	Bc86	Bc86	275+608	276+100	2.90	1	2.85	1.95	13.7	
	Bc87	Bc87	280+156	280+700	3.10	1	3.00	1.80	13.7	
	Bc88	Bc88	281+215	281+700	9.50	3	2.85	1.95	13.7	
							3.00	2.20		
							2.85	1.95		

Source: Public Works Research Center (PWRC), General Directorate of Public Works and Transport, Kingdom of Cambo
JICA Survey Team carried out the inventory on May 2013

Table 6.1-5 Existing Pipe Culverts (Middle Section)

Province	No.		KP(km)		Dimension No. of Pipe×D				Remarks
	PWRC	JICA	PWRC	JICA	Total Width(m)	No. of Pipe	φ (cm)	Length (m)	
Pursat	Pc148	Pc148	171+677	171+800	4.55	3	100 100 100	15.6	
	Pc149	Pc149	172+048	172+200	1.20	1	100	13.3	
	Pc150	Pc150	173+802	174+100	1.23	1	95	13.5	
	Pc151	Pc151	174+484	174+700	4.70	3	100 100 100	13.3	
	Pc152	Pc152	174+773	175+000	2.90	2	95 95	12.8	
	Pc153	Pc153	175+336	175+600	1.25	1	100	13.3	
	Pc154	Pc154	175+877	176+100	1.20	1	100	13.2	
	Pc155	Pc155	175+943	176+200	1.30	1	100	13.4	
	Pc156	Pc156	176+121	176+400	4.70	3	100 100 100	15.5	
	Pc157	Pc157	176+197	176+500	1.30	1	100	14.8	
	Pc158	Pc158	176+400	176+700	0.95	1	80	14.5	
	Pc159	Pc159	177+735	177+900	1.00	1	70	14.5	
	Pc160	Pc160	180+354	180+500		-	-	-	demorished
	Pc161	Pc161	182+250	182+600	10.50	8	80 80 80 80 100 100 80 80	13.7	
	Pc162	Pc162	191+504	192+100	0.95	1	80	13.5	
	Pc163	Pc163	192+077	192+700	1.50	1	120	17.3	
	Pc164	Pc164	193+145	193+600	1.25	1	100	13.6	
	Pc165	Pc165	193.579	194+100	1.50	1	120	16.0	
	Pc166	Pc166	193+877	194+400	5.25	3	120 120 120	14.8	
	Pc167	Pc167	197+044	197+300	1.25	1	100	13.5	
	Pc168	Pc168	198+538	198+800	1.20	1	100	13.4	
	Pc169	Pc169	200+544	200+300	3.00	2	100 100	13.5	
	Pc170	Pc170	203+395	203+400	3.00	2	100 100	13.7	
	Pc171	Pc171	203+687	204+000	1.05	1	80	13.5	
	Pc172	Pc172	204+423	204+700	1.20	1	100	13.6	
	Pc173	Pc173	205+854	206+600	1.20	1	100	14.8	
	Pc174	Pc174	205+951	206+300	1.20	1	100	14.7	
	Pc175	Pc175	206+825	207+200	3.00	2	100 100	16.1	
	Pc176	Pc176	207+096	207+400	1.20	1	100	16.0	
	Pc177	Pc177	209+987	210+300	1.40	1	120	14.9	
	Pc178	Pc178	210+820	211+100	1.20	1	100	13.5	
	Pc179	Pc179	211+109	211+400	1.20	1	100	13.6	
	Pc180	Pc180	211+222	211+500	1.05	1	80	13.6	
	Pc181	Pc181	212+557	212+800	1.20	1	100	13.6	
	Pc182	Pc182	212+915	213+200	2.50	2	80 80	14.8	
	Pc183	Pc183	213+219	213+500	3.20	2	100 100	13.6	
	Pc184	Pc184	213+337	213+600	2.60	2	80 80	13.5	
	Pc185	Pc185	214+181	214+500	3.10	2	100 100	16.1	
	Pc186	Pc186	214+602	214+900	1.15	1	100	13.6	
	Pc187	Pc187	216+489	216+800	3.10	2	100 100	15.9	
	Pc188	Pc188	217+476	217+800	3.10	2	100 100	14.9	
	Pc189	Pc189	217+950	218+300	3.10	2	100 100	16.0	
Battdambang	Pc190	Pc190	224+362	224+700	5.30	4	100 100 100 100	11.1	
	Pc191	Pc191	226+319	226+700	4.20	3	100 100 100	10.9	
	Pc192	Pc192	227+382	227+700	-	1	-	-	inlet is covered
	Pc193	Pc193	227+649	228+000	5.20	3	120 120 120	13.6	
	Pc194	Pc194	228+227	228+600	1.15	1	100	11.7	
	Pc195	Pc195	230+308	230+700	2.75	2	100 100	9.9	
	Pc196	Pc196	231+359	231+700	4.00	3	100 100 100	10.9	
	Pc197	Pc197	231+859	232+200	2.45	2	100 100	11.2	
	Pc198	Pc198	238+875	239+200	1.20	1	100	16.0	
	Pc199	Pc199	249+728	250+100	3.30	2	120 120	13.8	
	Pc200	Pc200	252+664	253+100	3.30	2	120 120	16.1	
	Pc201	Pc201	253+221	253+600	3.00	2	120 120	15.3	
	Pc202	Pc202	256+612	257+000	3.00	2	100 100	13.6	
	Pc203	Pc203	260+287	260+800	3.00	2	100 100	16.0	
	Pc204	Pc204	267+944	268+500	2.80	2	100 100	17.2	
	Pc205	Pc205	269+127	269+600	1.30	1	100	18.3	
	Pc206	Pc206	271+645	272+200	1.40	1	120	16.1	
	Pc207	Pc207	274+497	275+000	1.75	1	150	16.1	
	Pc208	Pc208	277+579	278+000	3.30	2	120 120	14.5	
	Pc209	Pc209	278+633	279+200	3.85	2	100 100	13.8	
	Pc210	Pc210	281+810	282+300	3.75	3	80 80 80	13.7	
	Pc211	Pc211	282+553	283+100	5.35	3	120 120 120	13.8	

Source: Public Works Research Center (PWRC), General Directorate of Public Works and Transport, Kingdom of Cambod
JICA Survey Team carried out the inventory on May 2013

Table 6.1-6 Existing Pipe Culverts (Sri Sophorn - Poipet Section)

No.	X	Y	Category	Type	Code	Length	When Construction	PK
459	273850	1501947	Pipe Culvert	Concrete	Pc242	ø1.20	2008	365 + 704
460	273355	1501995	Pipe Culvert	Concrete	Pc243	ø1.20	2008	366 + 206
461	272727	1502053	Pipe Culvert	Concrete	Pc244	ø1.20	2008	366 + 835
462	272158	1502106	Pipe Culvert	Concrete	Pc245	ø1.20	2008	367 + 412
463	271564	1502173	Pipe Culvert	Concrete	Pc246	ø1.20	2008	367 + 999
464	270967	1502260	Pipe Culvert	Concrete	Pc247	ø1.20	2008	368 + 610
465	270238	1502369	Pipe Culvert	Concrete	Pc248	2ø1.20	2008	369 + 352
466	269925	1502423	Pipe Culvert	Concrete	Pc249	2ø1.20	2008	369 + 663
467	269341	1502555	Pipe Culvert	Concrete	Pc250	2ø1.20	2008	370 + 263
468	268583	1502761	Pipe Culvert	Concrete	Pc251	2ø1.20	2008	371 + 041
469	267630	1503024	Pipe Culvert	Concrete	Pc252	ø1.20	2008	372 + 030
470	267208	1503139	Pipe Culvert	Concrete	Pc253	ø1.20	2008	372 + 466
471	266611	1503301	Pipe Culvert	Concrete	Pc254	ø1.20	2008	373 + 087
472	266016	1503465	Pipe Culvert	Concrete	Pc255	ø1.20	2008	373 + 709
473	265341	1503650	Pipe Culvert	Concrete	Pc256	ø1.20	2008	374 + 406
474	264769	1503803	Pipe Culvert	Concrete	Pc257	2ø1.20	2008	375 + 005
475	264198	1503955	Pipe Culvert	Concrete	Pc258	ø1.20	2008	375 + 588
476	263721	1504083	Pipe Culvert	Concrete	Pc259	ø1.20	2008	376 + 094
477	262936	1504293	Pipe Culvert	Concrete	Pc260	ø1.20	2008	376 + 899
478	262655	1504370	Pipe Culvert	Concrete	Pc261	ø1.20	2008	377 + 195
479	261949	1504552	Pipe Culvert	Concrete	Pc262	ø1.20	2008	377 + 916
480	261101	1504773	Pipe Culvert	Concrete	Pc263	2ø1.20	2008	378 + 803
481	260501	1504926	Pipe Culvert	Concrete	Pc264	ø1.20	2008	379 + 418
482	259836	1505102	Pipe Culvert	Concrete	Pc265	ø1.20	2008	380 + 109
483	259402	1505214	Pipe Culvert	Concrete	Pc266	ø1.20	2008	380 + 555
484	259276	1505248	Pipe Culvert	Concrete	Pc267	ø1.20	2008	380 + 692
485	258087	1505557	Pipe Culvert	Concrete	Pc268	ø1.20	2008	381 + 905
486	257335	1505754	Pipe Culvert	Concrete	Pc269	ø1.20	2008	382 + 686
487	257023	1505838	Pipe Culvert	Concrete	Pc270	ø1.20	2008	383 + 014
488	256179	1506060	Pipe Culvert	Concrete	Pc271	2ø1.20	2008	383 + 885
489	255727	1506175	Pipe Culvert	Concrete	Pc272	ø1.20	2008	384 + 341
490	255061	1506352	Pipe Culvert	Concrete	Pc273	ø1.20	2008	385 + 038
491	254124	1506517	Pipe Culvert	Concrete	Pc274	2ø1.20	2008	385 + 990
492	253626	1506586	Pipe Culvert	Concrete	Pc275	2ø1.20	2008	386 + 498
493	253124	1506667	Pipe Culvert	Concrete	Pc276	ø1.20	2008	387 + 001
494	252589	1506750	Pipe Culvert	Concrete	Pc277	ø1.20	2008	387 + 549
495	252094	1506829	Pipe Culvert	Concrete	Pc278	ø1.20	2008	388 + 048
496	251584	1506910	Pipe Culvert	Concrete	Pc279	ø1.20	2008	388 + 563
497	250954	1507043	Pipe Culvert	Concrete	Pc280	ø1.20	2008	389 + 217
498	250493	1507150	Pipe Culvert	Concrete	Pc281	ø1.00	2008	389 + 685
499	250022	1507258	Pipe Culvert	Concrete	Pc282	ø1.00	2008	390 + 173
500	248475	1507520	Pipe Culvert	Concrete	Pc283	ø1.00	2008	391 + 738
501	247897	1507568	Pipe Culvert	Concrete	Pc284	ø1.00	2008	392 + 318
502	247524	1507593	Pipe Culvert	Concrete	Pc285	ø1.00	2008	392 + 689
503	246956	1507615	Pipe Culvert	Concrete	Pc286	4ø1.00	2008	393 + 250
504	246525	1507633	Pipe Culvert	Concrete	Pc287	2ø1.00	2008	393 + 689
505	245710	1507677	Pipe Culvert	Concrete	Pc288	2ø1.20	2008	394 + 509
506	245112	1507717	Pipe Culvert	Concrete	Pc289	2ø1.20	2008	395 + 108
507	244554	1507754	Pipe Culvert	Concrete	Pc290	ø1.20	2008	395 + 669
508	243903	1507807	Pipe Culvert	Concrete	Pc291	ø1.20	2008	396 + 324
509	243305	1507858	Pipe Culvert	Concrete	Pc292	ø1.00	2008	396 + 926
510	242752	1507919	Pipe Culvert	Concrete	Pc293	ø1.00	2008	397 + 476
511	242115	1508010	Pipe Culvert	Concrete	Pc294	ø1.00	2008	398 + 118
512	241512	1508105	Pipe Culvert	Concrete	Pc295	2ø1.20	2008	398 + 724
513	240980	1508199	Pipe Culvert	Concrete	Pc296	ø1.00	2008	399 + 272
514	240396	1508343	Pipe Culvert	Concrete	Pc297	ø1.00	2008	399 + 867
515	239238	1508720	Pipe Culvert	Concrete	Pc298	ø1.00	2008	401 + 087
516	238946	1508846	Pipe Culvert	Concrete	Pc299	ø1.00	2008	401 + 410
517	238593	1509056	Pipe Culvert	Concrete	Pc300	ø1.00	2008	401 + 821
518	238246	1509256	Pipe Culvert	Concrete	Pc301	ø1.00	2008	402 + 214
519	237989	1509399	Pipe Culvert	Concrete	Pc302	ø1.00	2008	402 + 524
520	237770	1509573	Pipe Culvert	Concrete	Pc303	2ø1.00	2008	402 + 798
521	237301	1509955	Pipe Culvert	Concrete	Pc304	3ø1.00	2008	403 + 412
522	237082	1510141	Pipe Culvert	Concrete	Pc305	ø1.00	2008	403 + 701
523	236757	1510406	Pipe Culvert	Concrete	Pc306	ø1.00	2008	404 + 127
524	236122	1510833	Pipe Culvert	Concrete	Pc307	ø1.00	2008	404 + 881
525	235927	1510957	Pipe Culvert	Concrete	Pc308	ø1.00	2008	405 + 118
526	235768	1511057	Pipe Culvert	Concrete	Pc309	ø1.00	2008	405 + 306

Source: Public Works Research Center (PWRC), General Direcorate of Public Works and Transport, Kingdom of Cambodia

Table 6.1-7 to Table 6.1-9 summarizes drainage capacity of the existing bridges, box culverts and pipe culverts, respectively. In estimation of drainage capacity, following conditions are employed:

- Drainage capacity is evaluated by steady flow analysis with HEC-RAS model.
- Water level of the inlet (mountain side) is 1.00 m lower than road surface.
- Water level of the outlet (Lake side) is 11.13 m (MSL), the water level of the Tonle Sap Lake with return period of 10-yr by statistical analysis. For details, refer to 6.1.2 "Water Level of Mekong River and Tonle Sap River/Lake". If downstream normal depth is higher than 11.13 m (MSL), it is taken as the water level of the outlet.
- If water level of inlet is lower than its outlet, drainage capacity is evaluated as zero (0 m^3/s).

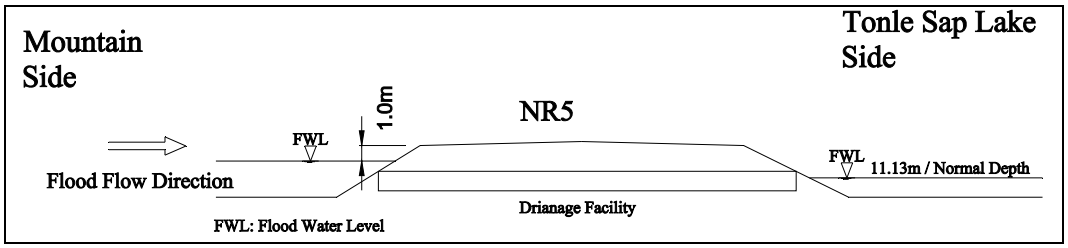


Figure 6.1-2 Assumed Water Level for Evaluating Drainage Capacity

Water surface are computed from one cross section to the next by solving the Energy Equation iterative procedure. The Energy Equation is written as follows:

$$Z_2+Y_2+\frac{a_2V_2^{\,2}}{2g}=Z_1+Y_1+\frac{a_1V_1^{\,2}}{2g}+he$$

Where,

Z_1, Z_2 : Elevation of the main channel inverts (m)
Y_1, Y_2 : Depth of water at cross section (m)
V_1, V_2 : Average velocities (m/s)
a_1, a_2 : Velocity weighting coefficients
g : Gravitational acceleration (m/s^2)
he : Energy head loss (m)

The energy head loss (he) between two cross sections is comprised of friction losses and contraction or expansion losses. The equation for the energy head loss is as follows:

$$he=L\bar{S}_f+C\left|\frac{a_2V_2^{\,2}}{2g}-\frac{a_1V_1^{\,2}}{2g}\right|$$

Where,

L : Reach length (m)
$\bar{S}_f$: Representative friction slope between two sections
C : expansion or contraction loss coefficient

Table 6.1-7 Drainage Capacity of Existing Bridges

Province	No.	Location KP(km)	Bridge Type	Dimension					Drainage Capacity (m^3/s)	Remarks
				No. of Span	Span (m)	Length (m)	Hight (m)	Water level of upstream (MSLm)		
Pursat	Br40	177+200	RC Steel Bridge	1	23.1	23.1	5.5	18.98	94.4	across Srang Thum Creek
	Br41	178+400	PC Bridge	1	19.8	19.8	4.4	17.45	95.3	across Srang Touch Creek
	Br42	181+800	RC Bridge	4	4.8*4	19.2	2.2	15.32	27.4	
	Br43	182+800	PC Bridge	2	21.3*2	42.6	3.5	15.39	195.5	
	Br44	183+300	RC Steel Bridge	3	15.1*3	45.3	4.9	15.26	349.1	
	Br45	183+850	PC Bridge	2	21.25*2	42.5	5.0	15.64	465.7	
	Br46	184+100	PC Bridge	1	26.45	26.5	3.9	15.63	182.1	
	Br47	185+700	RC Bridge	6	20.0*6	120.0	8.4	15.06	1461.2	across Pursat River
	Br48	187+300	RC Bridge	2	19.55*2	39.1	6.1	14.78	262.1	
	Br49	187+600	PC Bridge	2	15.25*2	30.5	3.4	15.21	123.8	
	Br50	188+000	PC Bridge	3	18.0*1 21.5*2	61.0	2.5	15.09	85.5	
	Br51	188+200	PC Bridge	3	15.0*1 18.25*2	51.5	2.9	15.09	81.1	
	Br52	189+300	PC Bridge	2	18.25*2	36.5	3.6	15.07	200.2	across Sdau Creek
	Br53	189+900	PC Bridge	1	24.5	24.5	2.1	15.09	18.7	
	Br54	190+100	PC Bridge	1	24.5	24.5	1.9	15.15	11.3	
	Br55	191+100	PC Bridge	2	18.2*2	36.4	4.9	15.71	384.5	across Toch River
	Br56	201+900	PC Bridge	1	18.5	18.5	2.4	14.17	29.1	
	Br57	208+500	PC Bridge/RC Bridge	2	17.2*2	34.4	4.4	12.32	136.2	across Kambot River
	Br58	215+700	RC Steel Bridge	3	15.2*1 15.1*2	45.4	3.0	11.13	*N/A*	across Srah Mokak Creek
	Br59	219+700	RC Steel Bridge	3	30.15 30.20 30.40	90.8	6.8	10.49	*N/A*	across Svay Doun Kaev River
	Br60	220+800	PC Bridge	2	15.2*2	30.4	4.2	10.79	*N/A*	
Battdambang	Br61	222+700	PC Bridge	1	18.5	18.5	2.9	10.74	*N/A*	
	Br62	223+500	PC Bridge	1	18.5	18.5	3.0	10.69	*N/A*	
	Br63	242+800	PC Bridge	1	24.5	24.5	3.0	14.79	92.9	
	Br64	243+600	PC Bridge	2	18.5*2	37.0	3.1	14.85	63.6	
	Br65	244+400	PC Bridge	2	15.25*2	30.5	6.3	14.24	230.4	across Donn Tri River
	Br66	245+900	RC Bridge	2	7.9*2	15.8	2.4	13.29	27.3	
	Br67	255+300	PC Bridge	1	21.5	21.5	2.4	11.82	55.6	
	Br68	255+600	PC Bridge	2	15.25*2	30.5	2.3	11.75	45.7	across Chak River
	Br69	256+600	PC Bridge	1	21.5	21.5	2.5	11.78	52.7	
	Br70	257+900	PC Bridge	1	18.5	18.5	3.0	11.88	74.8	
	Br71	265+900	PC Bridge	1	18.5	18.5	2.9	11.25	53.6	
	Br72	270+900	PC Bridge	1	18.5	18.5	2.8	10.87	*N/A*	
	Br73	271+600	PC Bridge	1	18.5	18.5	2.4	10.61	*N/A*	
	Br74	272+600	PC Bridge	1	18.5	18.5	2.3	10.68	*N/A*	
	Br75	273+400	PC Bridge	2	15.25*2	30.5	3.4	10.79	*N/A*	across Sanda Creek
	Br76	275+700	PC Bridge	1	18.5	18.5	2.5	11.56	46.4	
	Br77	276+500	PC Bridge	1	18.5	18.5	2.4	11.42	38.2	

Table 6.1-8 Drainage Capacity of Existing Box Culverts

Province	No.	Location KP(km)	Dimension							Drainage Capacity (m^3/s)
			Total Width(m)	No. of Span	Width (m)	Hight (m)	Water level of upstream (MSLm)	t (m)	Length (m)	
Pursat	Bc54	171+800	2.90	1	2.80	1.70	18.11	0.85	13.6	10.8
	Bc55	179+100	6.40	2	2.80	1.90	17.68	0.53	13.7	18.9
					2.80	1.90				
	Bc56	179+500	6.25	2	2.85	1.90	17.11	0.62	13.6	20.8
					2.85	1.90				
	Bc57	179+800	9.60	3	2.85	1.65	16.68	0.73	12.2	33.8
					3.00	1.80		0.48		
					2.85	1.65		0.73		
	Bc58	182+200	2.90	1	2.80	1.75	15.28	0.65	13.6	9.5
	Bc59	196+500	3.10	1	3.00	1.60	15.48	0.80	14.0	12.0
	Bc60	199+300	3.10	1	3.00	1.45	14.73	0.75	13.8	8.9
	Bc61	214+100	9.45	3	2.80	1.75	10.77	0.97	13.7	*N/A*
					2.95	2.00		0.72		
					2.80	1.75		0.97		
	Bc62	218+800	3.10	1	3.00	2.55	10.62	0.75	15.2	*N/A*
	Bc63	218+900	3.10	1	3.00	1.95	10.61	1.05	15.3	*N/A*
	Bc64	221+400	4.10	2	1.80	2.00	10.77	0.80	13.7	*N/A*
					1.80	2.00				
	Bc65	221+700	6.30	2	3.00	1.80	10.80	1.25	16.2	*N/A*
					3.00	1.80				
Battdambang	Bc66	230+400	6.30	2	3.00	1.80	12.06	0.65	13.7	21.5
					3.00	1.80				
	Bc67	232+800	3.20	1	3.10	1.45	13.43	0.75	13.7	8.8
	Bc68	237+400	3.10	1	3.00	1.55	16.63	0.80	13.7	9.8
	Bc69	238+200	3.10	1	3.00	1.90	16.70	0.62	13.7	11.3
	Bc70	240+000	9.65	3	2.80	1.85	16.22	0.75	13.7	42.0
					3.00	2.10		0.50		
					2.80	1.85		0.75		
	Bc71	245+400	9.50	3	2.80	1.80	13.36	1.30	13.8	52.0
					3.00	2.05		1.05		
					2.80	1.80		1.30		
	Bc72	248+500	6.35	2	2.85	2.00	12.37	0.45	13.7	21.4
					2.85	2.00				
	Bc73	249+000	3.10	1	3.00	2.05	12.26	0.65	13.8	13.0
	Bc74	251+000	9.70	3	2.85	2.00	12.48	0.72	13.7	44.2
					3.00	2.20		0.52		
					2.85	2.00		0.72		
	Bc75	252+400	9.50	3	2.85	0.75	12.07	1.20	13.7	18.9
					3.00	1.00		0.95		
					2.85	0.75		1.20		
	Bc76	254+700	8.80	2	4.30	1.45	12.03	1.10	13.5	34.8
					4.30	1.45				
	Bc77	255+900	6.20	2	2.80	1.60	11.68	0.70	13.8	16.9
					2.85	1.60				
	Bc78	259+100	6.20	2	2.75	1.90	11.57	0.75	13.7	21.3
					2.85	1.90				
	Bc79	261+400	8.60	2	4.15	1.90	11.37	1.05	13.7	28.2
					4.15	1.90				
	Bc80	262+300	6.30	2	2.85	2.00	11.35	0.45	13.7	15.7
					2.85	2.00				
	Bc81	264+100	6.20	2	2.85	1.80	11.34	0.55	13.7	14.3
					2.85	1.80				
	Bc82	267+000	9.60	3	2.85	1.95	11.12	0.75	13.7	*N/A*
					3.00	2.20		0.50		
					2.85	1.95		0.75		
	Bc83	269+700	6.30	2	3.00	2.00	11.08	0.55	13.0	*N/A*
					3.00	2.00				
	Bc84	270+400	6.30	2	3.00	1.90	10.96	0.60	13.1	*N/A*
					3.00	1.90				
	Bc85	274+200	2.90	1	2.85	1.65	10.93	0.55	13.7	*N/A*
	Bc86	276+100	2.90	1	2.85	1.95	11.52	0.55	13.7	9.6
	Bc87	280+700	3.10	1	3.00	1.80	11.91	0.65	13.7	10.7
	Bc88	281+700	9.50	3	2.85	1.95	12.29	1.05	13.7	52.5
					3.00	2.20		0.80		
					2.85	1.95		1.05		

Note: " t " means hight from top of culvert to road surface.

Table 6.1-9 (1) Drainage Capacity of Existing Pipe Culvert

Province	No.	Location KP(km)	Dimension						Drainage Capacity (m^3/s)
			No. of Pipe	φ (cm)	Water level of upstream (MSLm)	s (m)	t (m)	Length (m)	
Pursat	Pc148	171+800	3	100	18.11	0.10	1.45	15.6	5.09
				100		0.10	1.45		
				100		0.10	1.45		
	Pc149	172+200	1	100	18.21	0.35	0.65	13.3	0.19
	Pc150	174+100	1	95	19.99	0.05	0.80	13.5	0.63
	Pc151	174+700	3	100	19.70	0.20	0.75	13.3	1.49
				100		0.20	0.75		
				100		0.20	0.75		
	Pc152	175+000	2	95	19.56	0.10	0.90	12.8	1.47
				95		0.10	0.90		
	Pc153	175+600	1	100	19.53	0.00	0.98	13.3	1.11
	Pc154	176+100	1	100	19.51	0.00	1.08	13.2	1.28
	Pc155	176+200	1	100	19.50	0.00	0.90	13.4	0.96
	Pc156	176+400	3	100	19.48	0.00	1.55	15.5	6.09
				100		0.00	1.55		
				100		0.00	1.55		
	Pc157	176+500	1	100	19.47	0.00	1.22	14.8	1.53
	Pc158	176+700	1	80	19.45	0.00	1.15	14.5	0.82
	Pc159	177+900	1	70	18.31	0.00	1.15	14.5	0.59
	Pc160	180+500	-	-	16.16	-	-	-	demorished
	Pc161	182+600	8	80	15.36	0.00	1.65	13.7	11.95
				80		0.00	1.65		
				80		0.00	1.65		
				80		0.00	1.65		
				100		0.00	1.45		
				100		0.00	1.45		
				80		0.00	1.65		
				80		0.00	1.65		
	Pc162	192+100	1	80	15.91	0.00	0.95	13.5	0.57
	Pc163	192+700	1	120	15.91	0.00	1.60	17.3	3.12
	Pc164	193+600	1	100	15.93	0.10	1.05	13.6	1.10
	Pc165	194+100	1	120	15.96	0.05	1.55	16.0	2.93
	Pc166	194+400	3	120	16.01	0.00	1.00	14.8	5.46
				120		0.00	1.00		
				120		0.00	1.00		
	Pc167	197+300	1	100	15.54	0.00	0.90	13.5	0.97
	Pc168	198+800	1	100	14.85	0.00	0.65	13.4	0.56
	Pc169	200+300	2	100	14.70	0.00	0.90	13.5	1.92
				100		0.00	0.90		
	Pc170	203+400	2	100	13.32	0.20	0.85	13.7	1.26
				100		0.20	0.85		
	Pc171	204+000	1	80	13.00	0.00	0.80	13.5	0.41
	Pc172	204+700	1	100	12.96	0.20	1.00	13.6	0.86
	Pc173	206+600	1	100	12.45	0.00	0.98	14.8	1.11
	Pc174	206+300	1	100	12.42	0.00	1.10	14.7	1.32
	Pc175	207+200	2	100	12.45	0.10	1.45	16.1	3.36
				100		0.10	1.45		
	Pc176	207+400	1	100	12.41	0.10	1.68	16.0	1.96
	Pc177	210+300	1	120	11.51	0.15	1.45	14.9	2.05
	Pc178	211+100	1	100	11.12	0.20	0.90	13.5	*N/A*
	Pc179	211+400	1	100	11.24	0.40	0.95	13.6	0.34
	Pc180	211+500	1	80	11.27	0.30	0.65	13.6	0.02
	Pc181	212+800	1	100	10.90	0.30	0.35	13.6	*N/A*
	Pc182	213+200	2	80	10.82	0.40	0.43	14.8	*N/A*
				80		0.40	0.43		
	Pc183	213+500	2	100	10.81	0.20	1.00	13.6	*N/A*
				100		0.20	1.00		
	Pc184	213+600	2	80	10.81	0.30	1.00	13.5	*N/A*
				80		0.30	1.00		
	Pc185	214+500	2	100	10.70	0.00	1.15	16.1	*N/A*
				100		0.00	1.15		
	Pc186	214+900	1	100	10.63	0.00	0.75	13.6	*N/A*
	Pc187	216+800	2	100	10.74	0.20	1.45	15.9	*N/A*
				100		0.20	1.45		
	Pc188	217+800	2	100	10.67	0.00	1.05	14.9	*N/A*
				100		0.00	1.05		
	Pc189	218+300	2	100	10.66	0.20	1.35	16.0	*N/A*
				100		0.20	1.35		

Note: " t " means hight from top of culvert to road surface.
" s " means blocked depth of culvert.

Table 6.1-9 (2) Drainage Capacity of Existing Pipe Culvert

Province	No.	Location KP(km)	Dimension						Drainage Capacity (m^3/s)
			No. of Pipe	φ (cm)	Water level of upstream (MSLm)	s (m)	t (m)	Length (m)	
Battdambang	Pc190	224+700	4	100	10.62	0.00	1.20	11.1	*N/A*
				100		0.00	1.20		
				100		0.00	1.20		
				100		0.00	1.20		
	Pc191	226+700	3	100	10.63	0.00	1.22	10.9	*N/A*
				100		0.00	1.22		
				100		0.00	1.22		
	Pc192	227+700	1	-	10.85	-	-	-	inlet is covered
	Pc193	228+000	3	120	10.92	0.00	1.00	13.6	*N/A*
				120		0.00	1.00		
				120		0.00	1.00		
	Pc194	228+600	1	100	10.89	0.10	1.03	11.7	*N/A*
	Pc195	230+700	2	100	12.36	0.40	1.20	9.9	1.53
				100		0.40	1.20		
	Pc196	231+700	3	100	13.02	0.25	1.40	10.9	4.06
				100		0.25	1.40		
				100		0.25	1.40		
	Pc197	232+200	2	100	13.24	0.60	1.25	11.2	0.83
				100		0.60	1.25		
	Pc198	239+200	1	100	15.97	0.20	1.20	16.0	1.15
	Pc199	250+100	2	120	12.05	0.00	0.93	13.8	3.28
				120		0.00	0.93		
	Pc200	253+100	2	120	12.07	0.00	1.25	16.1	4.83
				120		0.00	1.25		
	Pc201	253+600	2	120	12.24	0.10	1.55	15.3	5.63
				120		0.10	1.55		
	Pc202	257+000	2	100	11.87	0.00	0.95	13.6	2.12
				100		0.00	0.95		
	Pc203	260+800	2	100	11.35	0.20	1.00	16.0	1.56
				100		0.20	1.00		
	Pc204	268+500	2	100	11.05	0.10	1.20	17.2	*N/A*
				100		0.10	1.20		
	Pc205	269+600	1	100	11.09	0.30	1.85	18.3	*N/A*
	Pc206	272+200	1	120	10.55	0.00	0.89	16.1	*N/A*
	Pc207	275+000	1	150	11.59	0.20	1.30	16.1	1.34
	Pc208	278+000	2	120	11.74	0.40	0.72	14.5	1.08
				120		0.40	0.72		
	Pc209	279+200	2	100	11.78	0.00	0.70	13.8	1.23
				100		0.00	0.70		
	Pc210	282+300	3	80	12.47	0.15	0.74	13.7	0.64
				80		0.15	0.74		
				80		0.15	0.74		
	Pc211	283+100	3	120	12.42	0.30	0.88	13.8	3.09
				120		0.30	0.88		
				120		0.30	0.88		

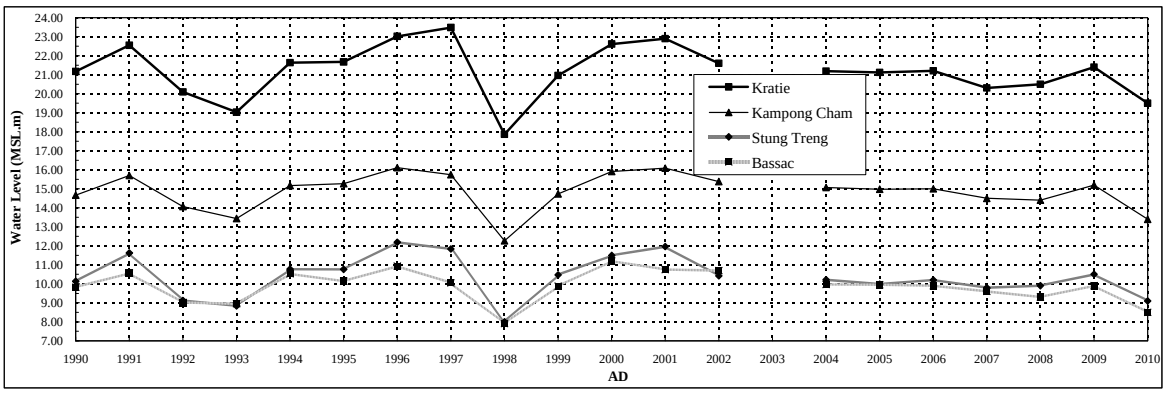
Note: " t " means hight from top of culvert to road surface.
" s " means blocked depth of culvert.

6.1.2 Water Level of The Mekong River and The Tonle Sap River and Lake

Figure 6.1-3 illustrates annual maximum water level records at four gauging stations along the Mekong River in Cambodia. Throughout the last decade, no obvious trend of rising or lowering in flood water level is recognized.

Figure 6.1-4 compares daily water levels of the Tonle Sap Lake at Kampong Luong Gauging Station from June up to November, i.e., rainy season, for several years from 1996. In 2011, the high water level exceeded the flood water-level (10 m) for more than one month (26th Sep ~ 11th Nov). Figure 6.1-5 shows the hyetograph updated at Pursat and Svay Donkeo, while Figure 6.1-6 depicts daily water level of three gauging stations, Pursat River, Svay Doun Kaev River and Tonle Sap Lake (Kampong Luong). In the period of deluge, the water level of the Svay Kaev River, which flows lower place in the Survey Area, rises because of backwater effects of the Tonle Sap Lake. On the other hand, the water level of the Pursat River, whose river bed is higher than the water level of the Tonle Sap Lake, is dominated by rainfall.

Table 6.1-10 summarizes the estimated maximum water level of the Tonle Sap Lake (1924 -1959, 1995 - 2008). As a result, water level of 11.13 m (MSL) with return period of 10-yr by Log-Pearson III method, is widely used in the Mekong basin, can be applied to the Project.



(Unit: MSL.m)

Station	Warning WL	Item	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Kratie	22.00	WL	21.17	22.55	20.09	19.03	21.63	21.67	23.02	23.48	17.86	20.96	22.61	22.90	21.60		21.19	21.12	21.20	20.30	20.50	21.40	19.50
		Date	6-Sep	8-Sep	23-Aug	16-Sep	6-Aug	8-Sep	28-Sep	5-Aug	24-Aug	5-Aug	17-Sep	22-Aug	25-Sep		17-Sep	12-Sep	8-Aug	8-Oct	9-Aug	5-Oct	5-Sep
Kampong Cham	15.20	WL	14.66	15.70	14.07	13.44	15.17	15.27	16.11	15.74	12.26	14.73	15.91	16.09	15.38		15.07	14.98	15.00	14.50	14.40	15.20	13.40
		Date	7-Sep	9-Sep	1-Sep	17-Sep	12-Sep	10-Sep	29-Sep	7-Aug	24-Sep	8-Aug	18-Sep	22-Aug	26-Sep		18-Sep	16-Sep	18-Aug	10-Oct	13-Aug	6-Oct	6-Sep
Stung Treng	10.70	WL	10.13	11.62	9.12	8.84	10.77	10.76	12.19	11.83	8.00	10.47	11.49	11.96	10.42		10.22	9.98	10.20	9.80	9.90	10.50	9.10
		Date	5-Sep	30-Aug	29-Aug	22-Aug	5-Aug	7-Sep	24-Sep	5-Aug	23-Sep	1-Aug	16-Sep	20-Aug	12-Sep		15-Sep	11-Sep	19-Aug	14-Oct	15-Aug	7-Oct	6-Sep
Bassac	10.50	WL	9.82	10.56	9.02	8.95	10.53	10.14	10.93	10.05	7.92	9.88	11.20	10.75	10.70		9.97	9.95	9.90	9.60	9.30	9.90	8.50
		Date	8-Oct	11-Sep	3-Sep	19-Sep	29-Sep	18-Sep	2-Oct	1-Oct	1-Oct	6-Oct	20-Sep	19-Sep	30-Sep		25-Sep	1-Oct	14-Oct	19-Oct	29-Sep	10-Oct	23-Oct

Source: Statistical Yearbook 2006 & 2011

Figure 6.1-3 Annual Maximum Water Levels of Mekong River in Cambodia

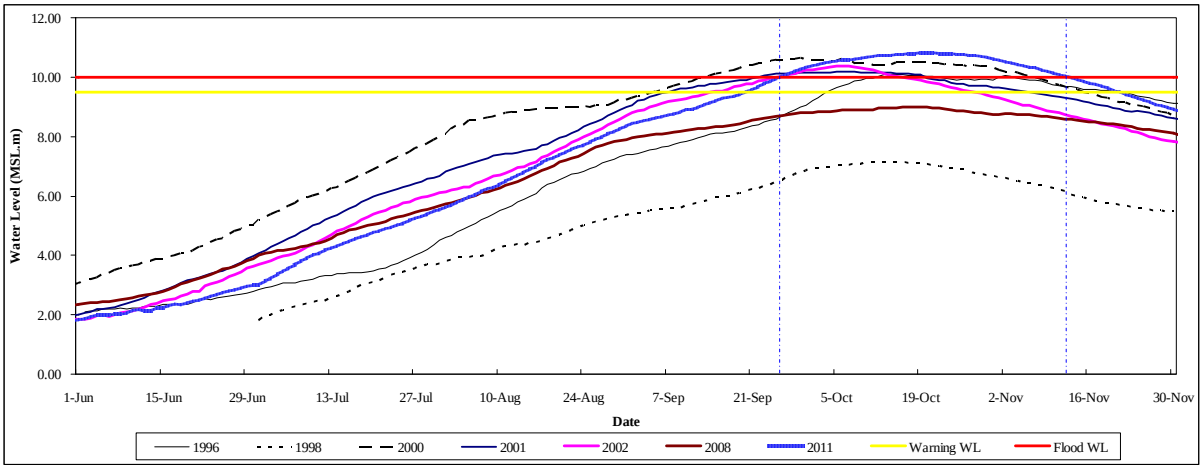


Figure 6.1-4 Water Levels at Kampong Luong Gauging Station (June ~ November)

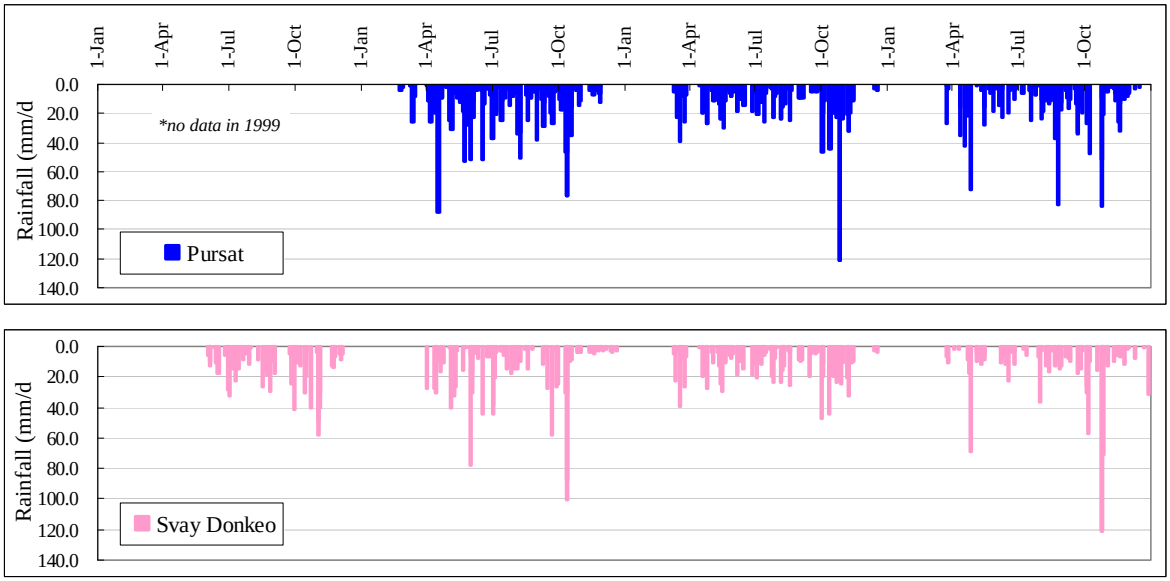


Figure 6.1-5 Hyetograph at Pursat (above) and Svay Donkeo (below) Station (1999 ~ 2002)

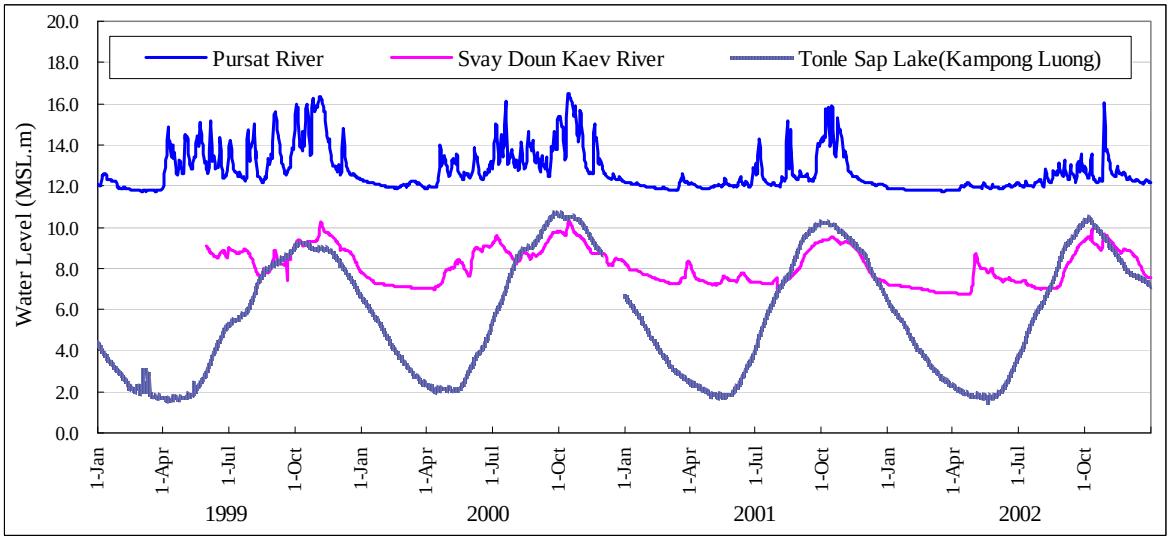


Figure 6.1-6 Hydrograph at Rivers along NR 5 and Tonle Sap Lake (1999 ~ 2002)

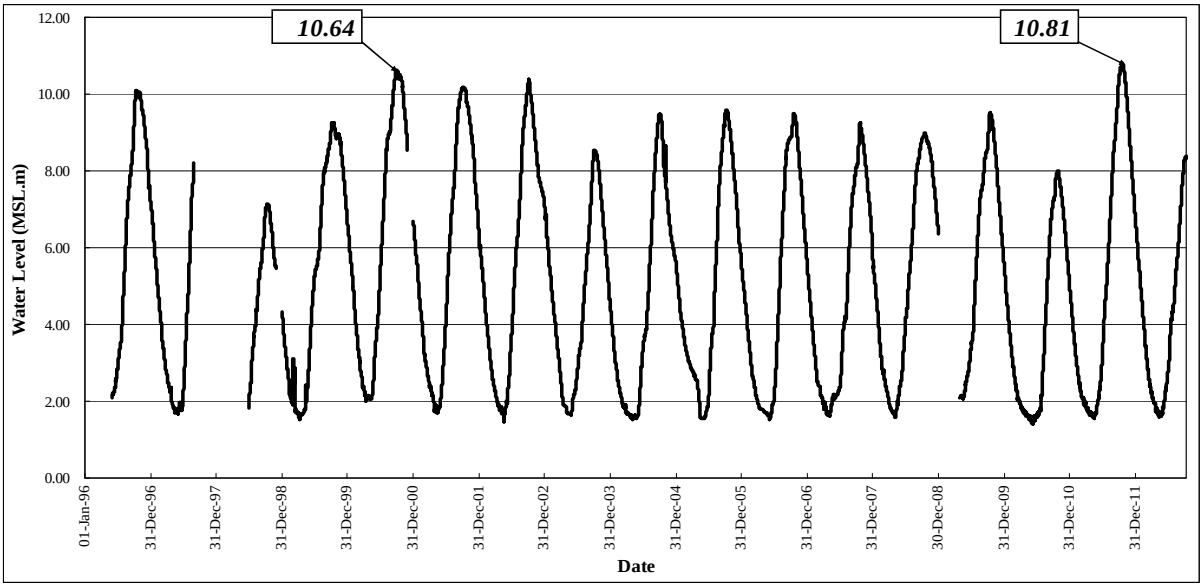


Figure 6.1-7 Hyetograph at Kampong Luong Gauging Station, Tonle Sap Lake (1996 ~ 2011)

Table 6.1-10 Flood Water Level Estimated by Statistic Analysis

Return Period	Estimated Design Magnitude (Design Hydrologic Data)							
	Normal	Log-Normal (Lg-N)	Pearson III (P III)	Log-Pearson III (Lg-P III)	Gumbel & Chow (EV I)	Gumbel (EV II)	Weibull	Hazen
2 -yr	9.75	9.72	9.78	9.56	9.64	9.65	9.72	9.72
5 -yr	10.59	10.09	10.29	10.60	10.20	10.27	10.32	10.29
10 -yr	11.03	10.30	10.54	11.13	10.57	10.68	10.65	10.60
20 -yr	11.40	10.48	10.74	11.67 (25-yr)	10.93	11.07	10.93	10.86
50 -yr	11.80	10.68	10.95	12.01	11.39	11.58	11.25	11.16

As for Sri Sophorn - Poipet Section, hydrological records in a time series imply the mechanism of flood/inundation. Figure 6.1-8 shows water level of the Sri Sophorn River and the Tonle Sap Lake (Kg. Loung), and rainfall observed at Sri Sophorn station, respectively (2010 - 2012). It is seen that the water level of the Sri Sophorn River rose quickly in August and October 2010 while that of Tonle Sap Lake rose almost at constant rate in the same period. In addition, rainfall intensity prior to the time when level of the Sri Sophorn River rose sharply was not high. Thus, it can be said that the rainfall did not substantially influence the rise of water level of Sri Sophorn River in August and October 2010. Therefore, it may be reasonable to assume that the flood of Tonle Sap or rainfall. According to the local residents the flood in August/October was caused by the water coming from Thailand (see Subsection 6.1.3 below).

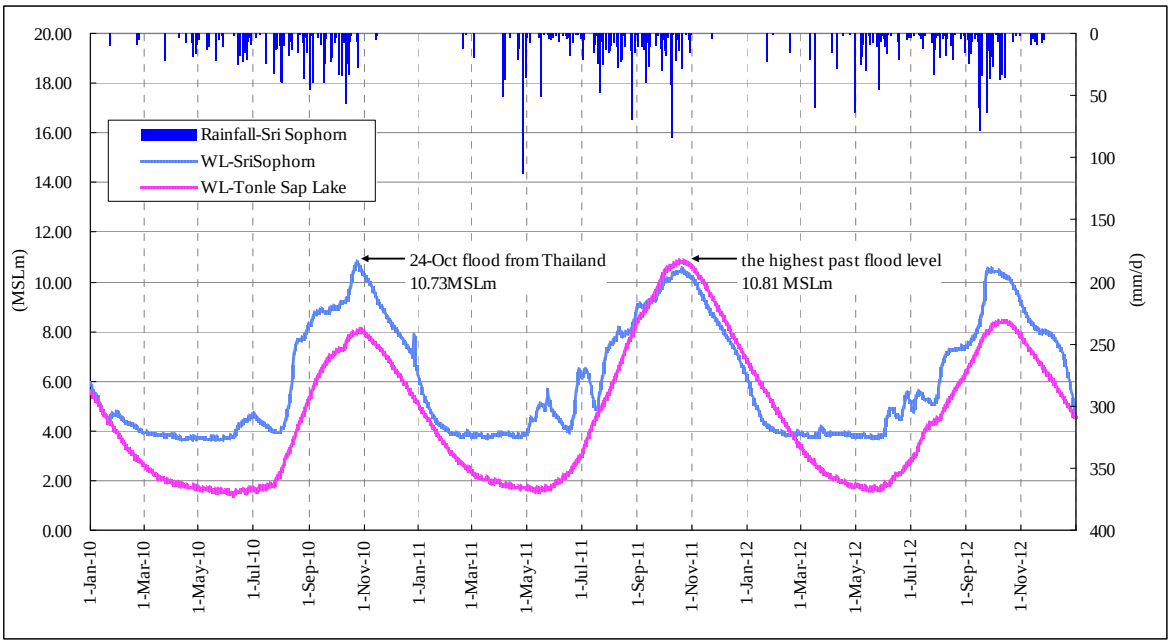


Figure 6.1-8 Hydrograph & Hyetograph of Sri Sophorn and Water Level of Tonle Sap Lake

6.1.3 Information of Road Inundation/Flood

(1) Interviews Survey for Gather Information on Inundation/ Flood

The Team carried out an interview survey to the residents living along or close to NR 5. Appendix 6-2 provides its details. In addition, the Team visited DPWT offices in Pursat and Battambang to collect additional information on damaged and flood-prone sections.

The result of the interview survey showed that the highest past flood levels at most of the surveyed locations along the Middle Section are at least 1.0 m from the ground height. After the road rehabilitation of NR 5 (2004 - 2006), the flood water has never reached the surface of the road. Table 6.1-11 summarizes the information/records on flood/inundation along NR 5 obtained through the interview and those provided by DPWTs. It is noteworthy that the direction of the flood flow in 2011 on the section between KP 269 and KP 272 (Tonle Sap => Mountain) is reverse to other sections (Mountain => Tonle Sap Lake). The highest past flood level of each interviewee spotted are shown in Figure 6.1-9.

Table 6.1-11 Information/Records on Road Flood/Inundation Conditions (Middle Section)

KP	Flood					Source
(Km)	Period	Level	Duration	Flow Direction	Frequency	
172+800	Oct ~ Nov-01	-100cm	2-3 days	⇒Tonle Sap Lake	Seldom	Survey Team
176+200	Rainy season	-20cm	2-3 days	⇒Tonle Sap Lake	Every year	Survey Team
179+100	Rainy season	-100cm	1 week	⇒Tonle Sap Lake	Every year	Survey Team
185+700	Sep ~ Oct-08	-3cm	3~4 days	⇒Tonle Sap Lake	Seldom	DPWT*
188+200	Never flooded					Survey Team
204+000	Sep ~ Nov-07	-50cm	2-3 days	⇒Tonle Sap Lake	Seldom	Survey Team
215+700	Rainy season	-150cm	3-4 days	⇒Tonle Sap Lake	Every year	Survey Team
227+700	Never flooded					Survey Team
245+400	Rainy season	-100cm	2-3 days	⇒Tonle Sap Lake	Every year	Survey Team
265+900	Oct-11	-100cm	2-3 days	⇒Tonle Sap Lake	Seldom	Survey Team
269+700	Oct ~ Nov-11	-125cm	4~5 days	⇒Mountain Side	Seldom	Survey Team
272+600	Oct ~ Nov-11	-125cm	4~5 days	⇒Mountain Side	Seldom	Survey Team
286+400	Rainy season	-200cm	2-4 days	⇒Tonle Sap Lake	Every year	Survey Team

*Note: * Pursat, DPWT, MPWT ** Battambang, DPWT, MPWT JICA means JICA Survey Team*

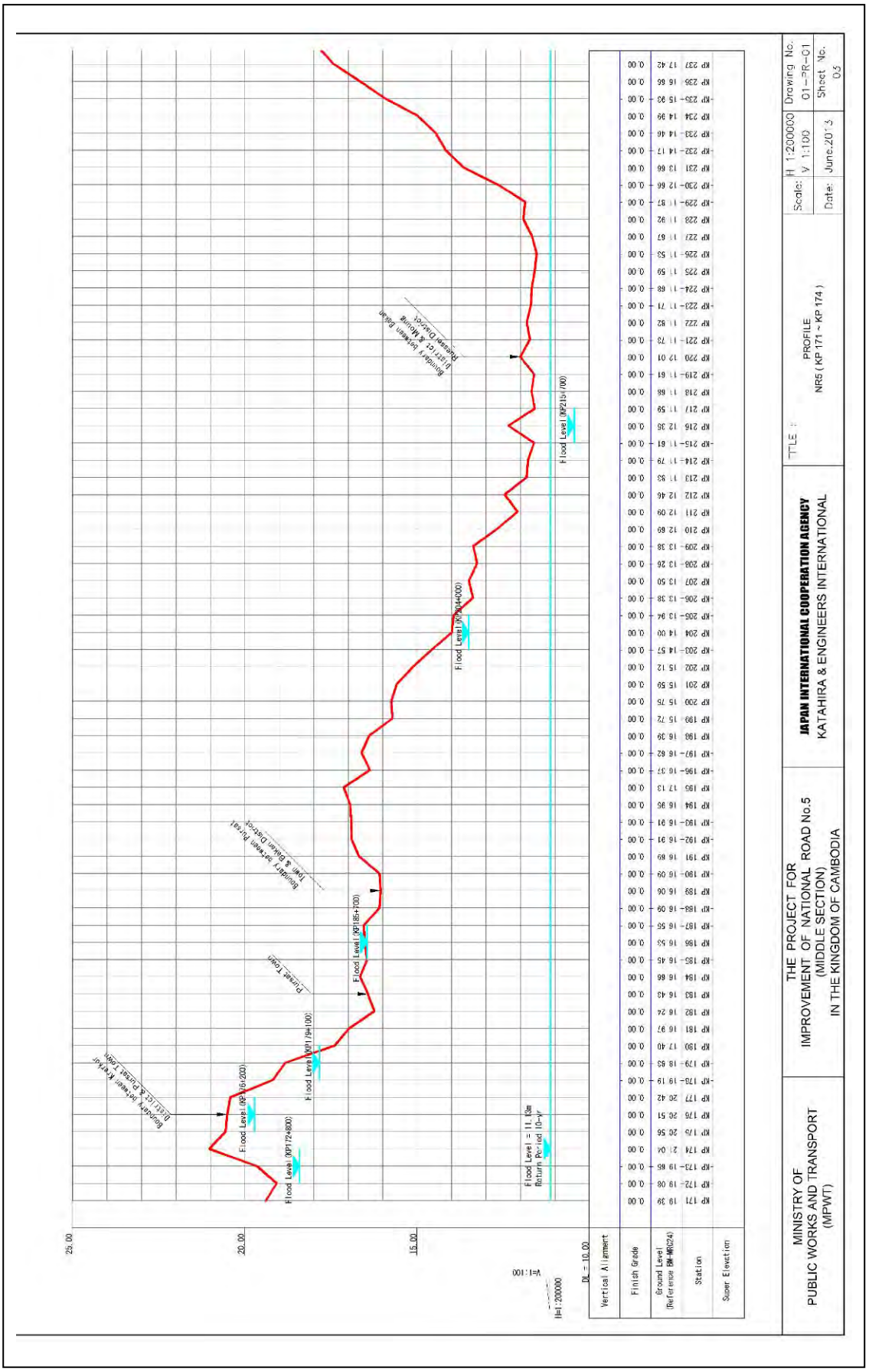


Figure 6.1-9 (1) Estimated Flood Level along the Middle Section

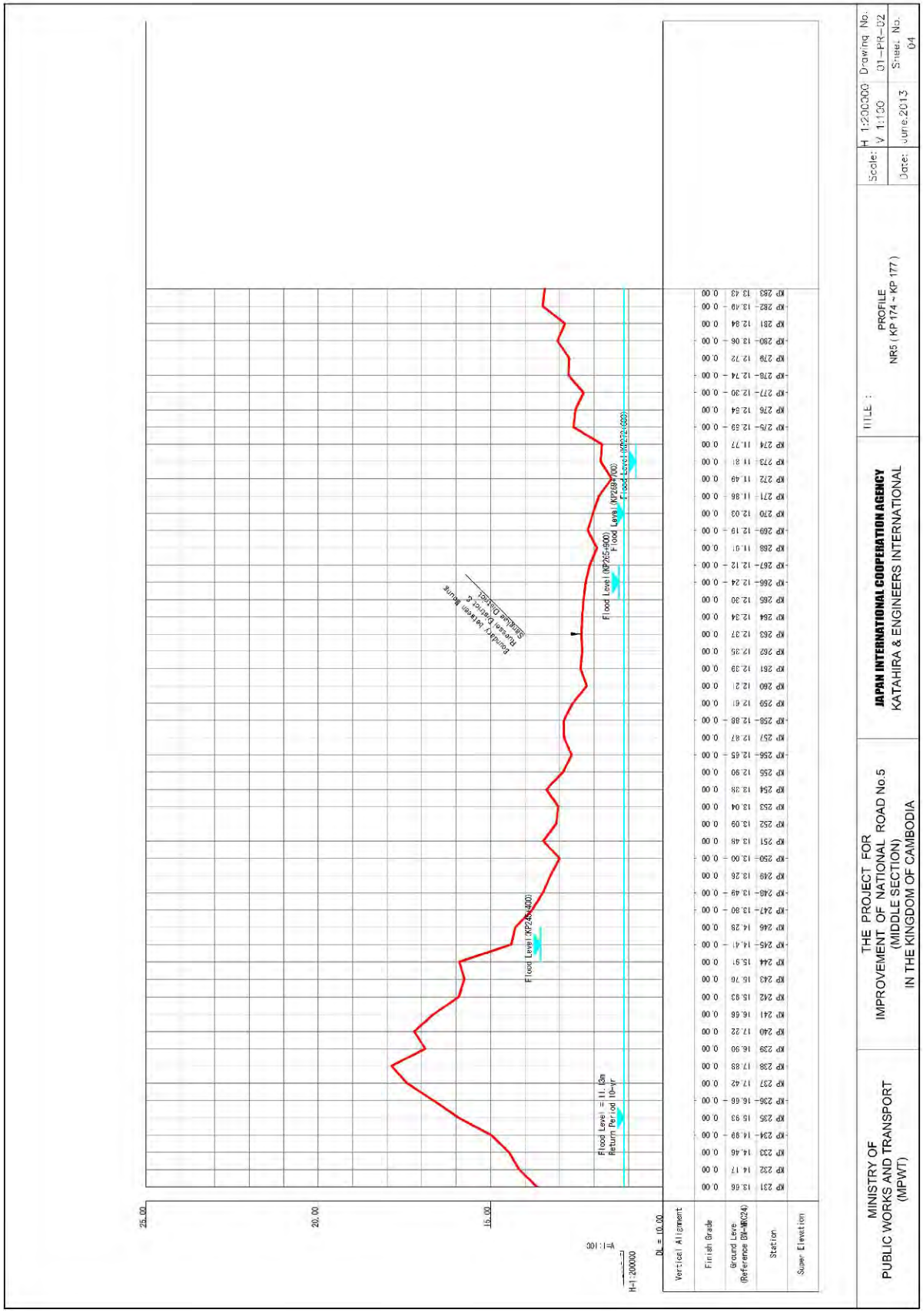


Figure 6.1-9 (2) Estimated Flood Level along the Middle Section

As for Sri Sophorn – Poipet Section, the flood which occurred in Sep – Oct 2013 recoded the highest water level in the past. The flood water, however, did not reach the surface of the road. Table 6.1-12 summarizes the information/records on flood condition obtained through the survey. According to the survey results, flood water, mainly flows from the west to the east, flows from the north side to the south side between Sri Sophorn and Ou Chrov, while flood water flows in opposite direction between Ou Chrov and Poipet. As a result, Sri Sophorn – Poipet Section of NR 5 hardly influences the flood flow because the flood water flows along NR 5.

Figure 6.1-10 shows profile of the road surface and estimated flood level of this section.

Table 6.1-12 Information/Records of Influence of Road Floods
(Sri Sophorn – Poipet Section)

KP (Km)	Flood						Source
	Period	Level (North side)	Level (South side)	Duration	Flow Direction	Frequency	
366+000	Sep ~ Oct-13	-50cm	-50cm	1 month	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
368+000	Sep ~ Oct-13	-65cm	-83cm	2 weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
372+000	Sep ~ Oct-13	-105cm	-110cm	2 weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
374+000	Sep ~ Oct-13	-116cm	-104cm	-	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
376+000	Sep ~ Oct-13	-105cm	-123cm	2 weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
378+000	Sep ~ Oct-13	-97cm	-100cm	10 days	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
380+000	Sep ~ Oct-13	-94cm	-126cm	2 ~ 3weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
382+000	Sep ~ Oct-13	-66cm	-80cm	10 days	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
384+000	Sep ~ Oct-13	-15cm	-55cm	10 ~ 15 days	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
386+000	Sep ~ Oct-13	-56cm	0cm (ground*)	2 weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
388+000	Sep ~ Oct-13	-52cm	-45cm	10 days	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
390+000	Sep ~ Oct-13	-123cm	-100cm	1 week	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
392+000	Oct-12 (Sep ~ Oct-2013)	-5 ~ -10 cm (-90cm)	-5 ~ -10 cm (-98cm)	1 week	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
394+000	Sep ~ Oct-13	-143cm	0cm (ground*)	10 days	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
396+000	Sep ~ Oct-13	-132cm	-102cm	-	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA
400+000	Sep ~ Oct-13	-127cm	-127cm	2 weeks	Popet(Thailand) ⇒ Sri Sophorn	Seldom	JICA

*Note: *ground level is same as road surface. JICA means JICA Survey Team*

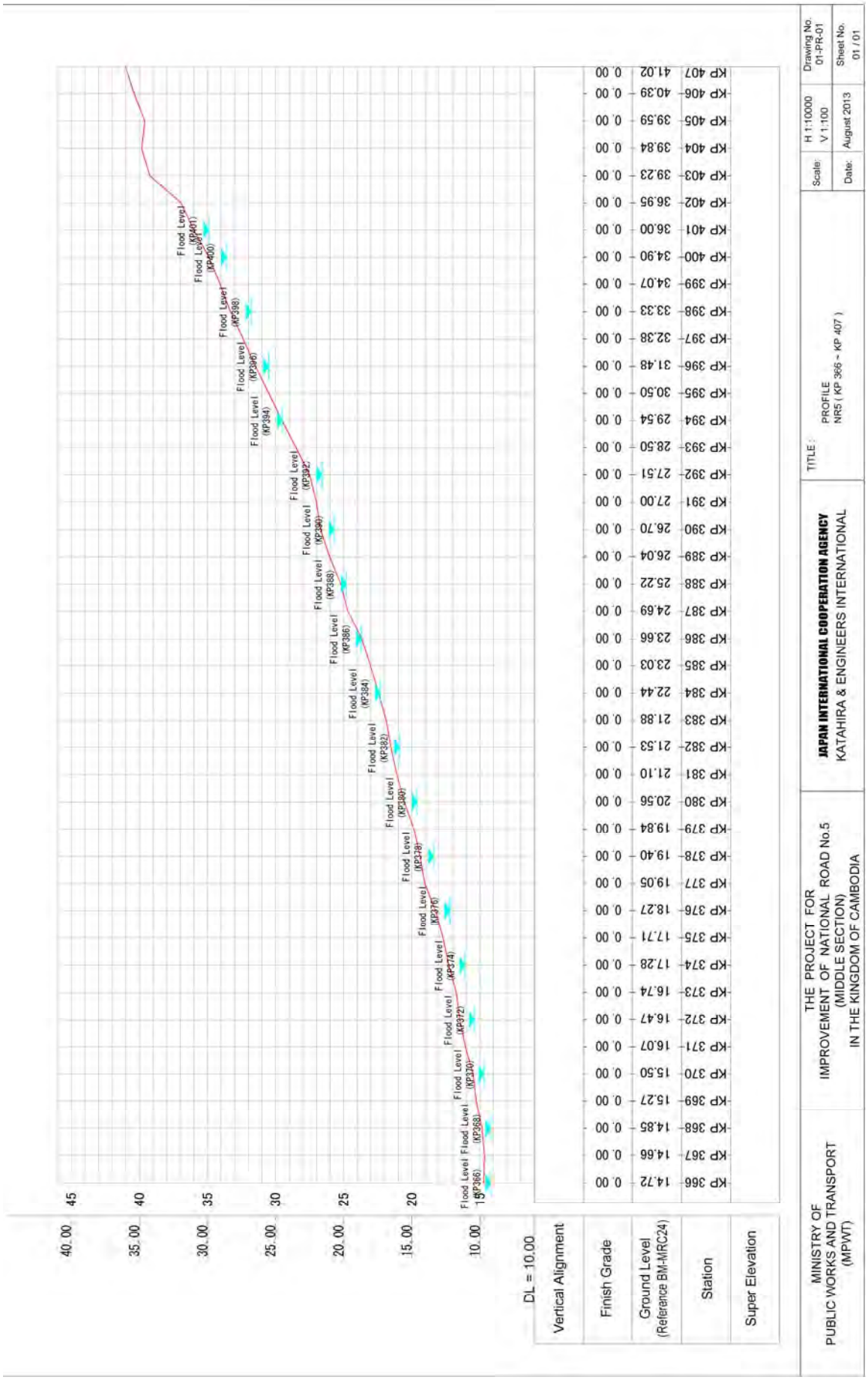


Figure 6.1-10 Estimated Flood Level along the Sri Sophorn - Poipet Section

In the survey for Sri Sophorn - Poipet Section, most of the interviewees answered that the flood along this section was caused by (i) the flood water coming from Thailand and (ii) heavy rain. The flood water coming from Thailand passed two routes; one from Ou Bei Choan (northern side) and the other from Malai (southern side) (see Figure 6.1-11). The gradient of the ground surface along this section of NR 5 (west to east) is approximately 1/1,500 and it is much steeper than in the direction of north to south.

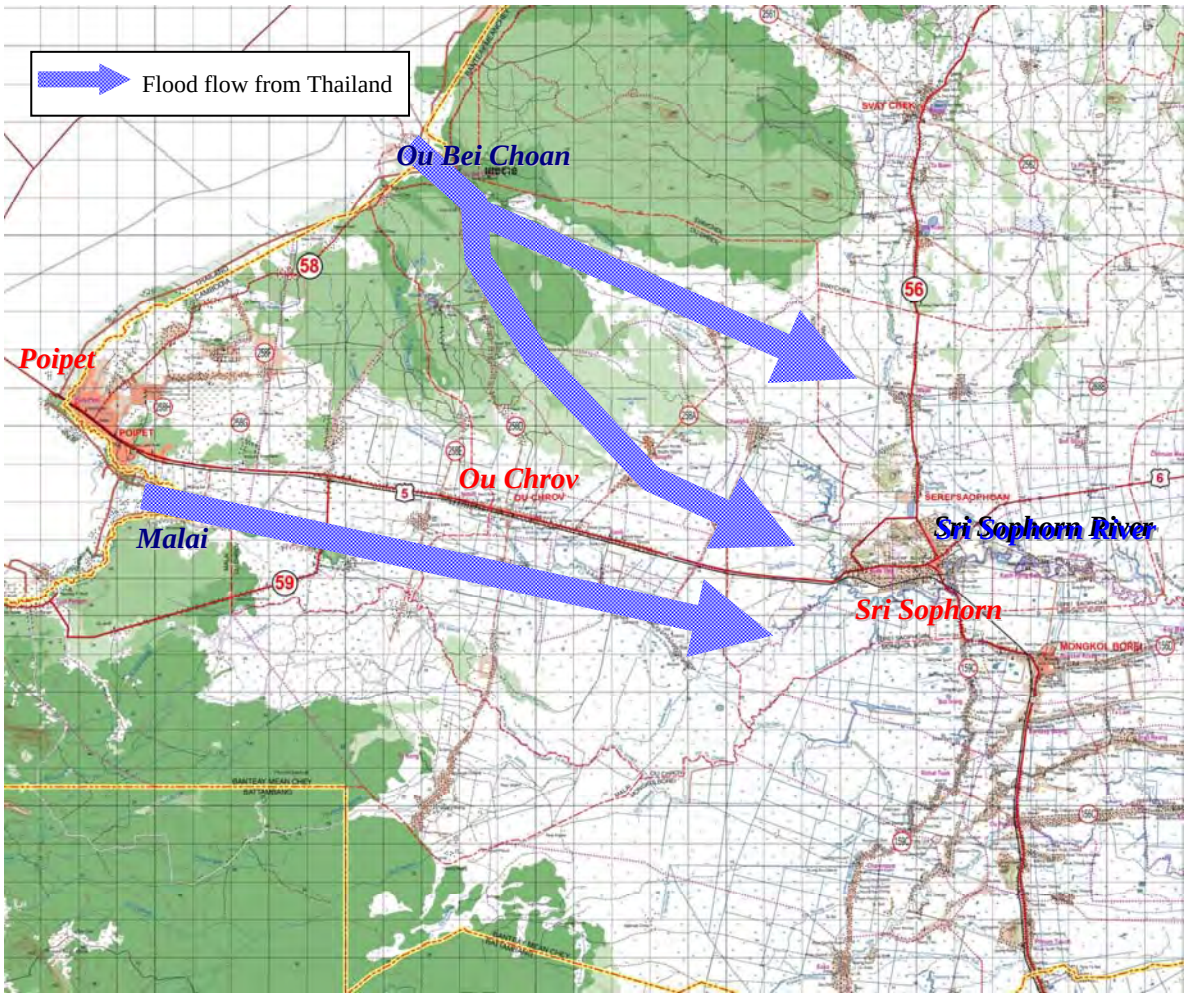
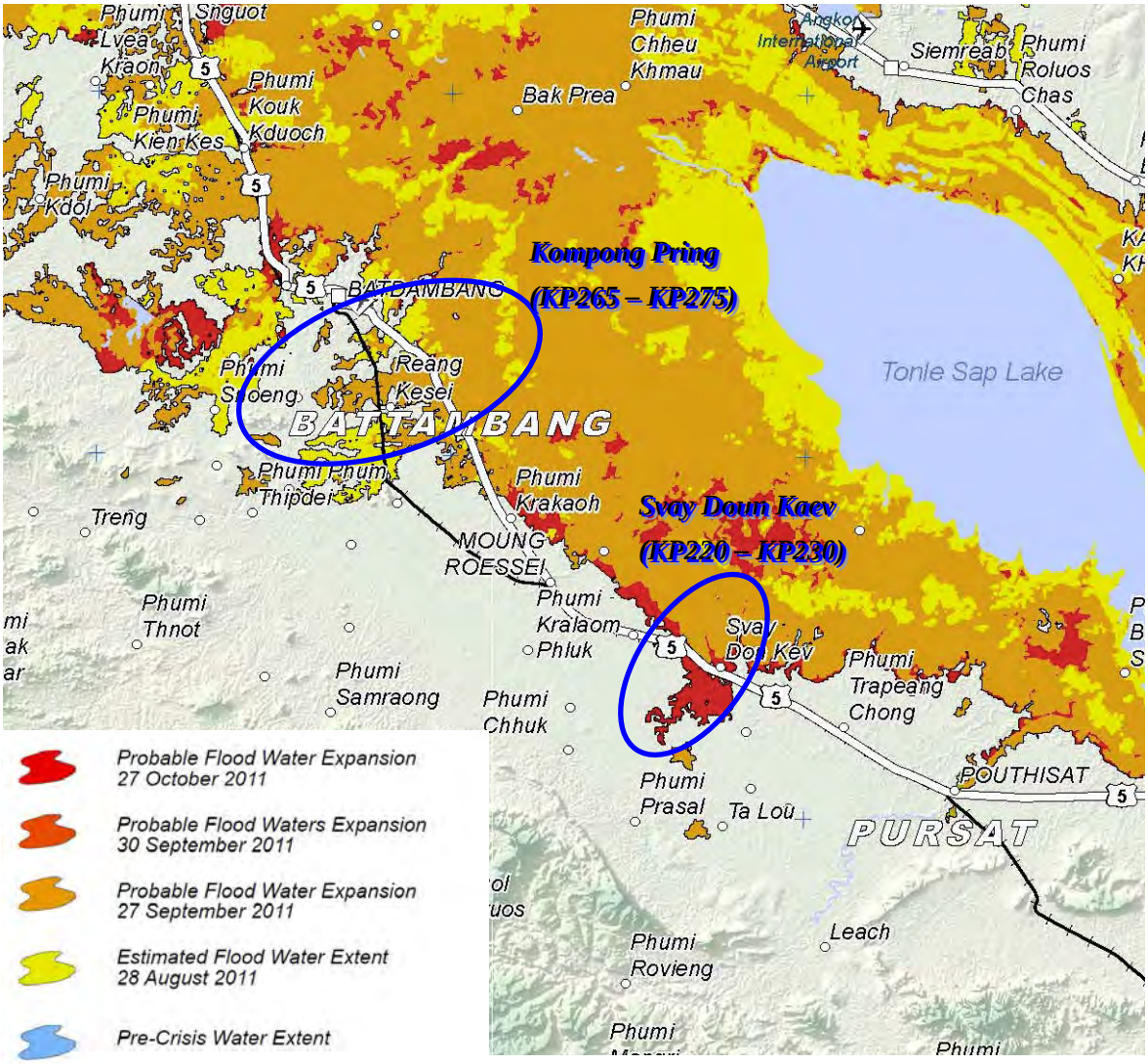


Figure 6.1-11 Flood Flow along the Sri Sophorn - Poipet Section

(2) Road Flood Effects seen in Satellite Image

In addition to the information obtained through the interview survey, a study with satellite images were carried out to understand flood condition. Figure 6.1-12 presents potential standing flood waters/flood land over the affected area surrounding the Tonle Sap Lake. The satellite image indicates that flood water expanded over the lake area between 28 August and 27 October 2011. The satellite image indicates two flood-prone areas in the Middle Section; Svay Doun Kaev (KP 220 – KP 230) and Kampong Pring (KP 265 – KP 275), as shown in Figure 6.1-12 with blue circles. According to the information available to JICA Survey Team, it is highly likely that the flood in the Tonle Sap Lake in 2011 reached these two sections.



Source: Map produced 10-11-2011 by UNOSAT

Figure 6.1-12 Overview of Flood Water along Tonle Sap Lake

6.1.4 Estimated Flood Discharge from Mountains

Three factors affect runoff and flood discharge from a catchment area, namely; (i) rainfall and weather characteristics; (ii) terrain characteristics; and (iii) stream characteristics. Rainfall and weather characteristics are obtained from statistical analysis of rainfall record. This method is applicable for a watershed which has the annual maximum floods records for 25 years or more. Probability for 50 to 200 years is used depending on damageable value of flood-prone area or design life period for a targeted structure.

Basically, hydrological component of a road design is concerned with estimation of probable flood discharges. Several models or formulae have been proposed and used for estimating probable flood discharges in drainage basins. Among these model/formulae, "rainfall-runoff model" is one of the most commonly used methods. This model evaluates the drainage area considering the various factors employed in the model. One of the factors is hydraulic characteristics of river or drainage canal such as cross sectional area, and slope of stream allowing velocity of flow. Another factor is the available records of discharges observed on in river or drainage canal at the site or at any other site in its vicinity.

The "Rational Method" is an empirical formula, and is one of the most widely used methods of rainfall-runoff models due to its simplicity and easy application. The formula is as shown below:

$$Q = \frac{CIA}{3.6}$$

Where,

Q : Peak design discharge for a given return period (m^3/s)

C : Coefficient of runoff

I : Rainfall intensity for a given return period (mm/hr)

A : Catchment (Drainage) area (km^2)

Catchment area, A, of each particular site is obtained by defining drainage boundaries such as the ridges, terrain, and artificial structures like embankments and canals, read in the 1:100,000 scale topographic maps provided by MPWT. In this study, the area of rainfall which causes inundation is assumed be substantially smaller than the catchment area defined by the topographic boundaries. Thus the area defined with "squall lines" is adopted instead of catchment area. The area of squall lines is assumed according to classification of the climate of the area. Extent of "squall line" in tropical monsoon region like Cambodia is said to be meso-beta scale (20 ~ 200 km^2). Thus, discharge computed by "Rational method" could be overestimated if catchment area is larger than Meso-beta scale. Each catchment area using for rational method, therefore, was adjusted to approximately 200 km^2 or less. Consequently, the drainage area along NR 5(Middle Section) was divided into 16 areas.

To obtain a value of I, the time of concentration, referred to as t, was initially computed using the formula developed by Kirpich. According to hourly rainfall records, duration of rainfall was less

than six hours. Thus, if time of flood concentration is over six hours, rainfall intensity was converted into it of six hours for an estimate by rational method.

$$t = \frac{L^{1.15}}{51.408\, H^{0.385}}$$

Where,

t = Time of flood concentration (min)

H = Difference in elevation between the point of interest and the most remote point (m)

L = Maximum flow length (m)

Coefficient of runoff, referred to as C, is a function of the soil type and gradient of watershed.

Type of drainage area was classified as Lawns: Sandy soil, flat, 2% (C=0.10) in the Survey Area.

Table 6.1-13 Coefficients of Runoff

Type of Drainage Area	Max Runoff Coefficient
Downtown areas	0.95
Neighborhood areas	0.70
Single-family areas	0.50
Multi-units, detached	0.60
Multi-units, attached	0.75
Suburban	0.40
Apartment dwelling areas	0.70
Industrial: Light areas	0.80
Industrial: Heavy areas	0.90
Parks, cemeteries	0.25
Playgrounds	0.40
Railroad yard areas	0.40
Unimproved areas	0.30
Lawns: Sandy soil, flat, 2%	0.10
Lawns: Sandy soil, average, 2 - 7%	0.15
Lawns: Sandy soil, steep, 7%	0.20
Lawns: Heavy soil, flat, 2%	0.17
Lawns: Heavy soil, average, 2 - 7%	0.22
Lawns: Heavy soil, steep, 7%	0.35
Streets: Asphaltic	0.95
Streets: Concrete	0.95
Streets: Brick	0.85
Streets: Drives and walks	0.85
Roofs	0.95

Applying the above-mentioned factors for the Project area, Table 6.1-14 summarizes the estimated flood discharge for the grouping facilities mentioned above.

Table 6.1-14 summarizes estimated flood discharge with various rain intensity by rational method and drainage capacity of grouping facilities. It compares each volume and shows that grouping drainage facilities have insufficient drainage capacity against estimated flood discharge with hatching of blue. At grouping No.8, No.9,and No.15, drainage capacity is evaluated as zero, in addition, all drainage facilities of grouping No.7 is also evaluated their drainage capacity as zero

except Br. 58. The reason is that water level of upstream for computation is lower than 11.13 m(MSL) which is the flood water level of the Tonle Sap Lake, as it was mentioned in 6.1.1 River System and Existing Drainage Facilities. Consequently, grouping No.5, No.7 ~ No.11, No.14, and No.15 are needed to increase drainage capacity for maintaining bearing capacity of pavement from reducing in the case of rainfall with return period of 10-yr.

Table 6.1-14 Estimated Flood Discharge and Drainage Capacity of Grouping Facilities

grouping No.	Existing facilities			Drainage capacity of existing facilities (m^3/s)	drainage area (km^2)	coefficient of runoff	inflow reach		T (min)	estimated flow discharge(m^3/s) rainfall intensity				
	Bridge	Box_C	Pipe_C				waterway length(km)	Gradient (‰)		20 mm/hr	40 mm/hr	60* mm/hr	80 mm/hr	100 mm/hr
1	Br40 - Br41	Bc54 - Bc56	Pc148 - Pc159	552.64	85.7	0.10	20.2	0.7	612	28	56	84	112	140
2	Br42 - Br43	Bc57 - Bc58	Pc160 - Pc161	275.73	41.9	0.10	11.2	2.2	255	23	47	70	93	117
3	Br44 - Br46	-	-	998.16	33.6	0.10	10.0	3.3	202	19	37	56	75	93
4	Br47 - Br55	-	-	2346.08	251.5	0.10	34.3	0.2	1433	35	70	105	140	175
5	Br56	Bc59 - Bc60	Pc162 - Pc169	63.57	116.2	0.10	31.2	0.6	904	26	51	77	103	129
6	Br57	-	Pc170 - Pc180	184.49	182.8	0.10	29.2	0.6	891	41	82	123	164	205
7	Br58	Bc61	Pc181 - Pc186	75.43	121.4	0.10	31.2	1.0	773	31	63	94	126	157
8	Br59	Bc62 - Bc63	Pc187 - Pc189	0.00	225.7	0.10	30.1	0.9	786	57	115	172	230	287
9	Br60 - Br62	Bc64 - Bc65	Pc190 - Pc192	0.00	187.2	0.10	23.1	1.1	580	65	129	194	258	323
10	-	Bc66 - Bc67	Pc193 - Pc197	36.77	115.9	0.10	17.4	0.9	516	45	90	135	180	225
11	-	Bc68 - Bc69	Pc198	22.25	119.9	0.10	24.7	1.4	557	43	86	129	172	215
12	Br63 - Br66	Bc70 - Bc75	Pc199 - Pc201	620.34	244.8	0.10	34.2	1.1	781	63	125	188	251	314
13	Br67 - Br70	Bc76 - Bc78	Pc202	326.31	259.0	0.10	25.6	1.1	642	81	161	242	323	404
14	Br71	Bc79 - Bc82	Pc203	116.25	143.5	0.10	20.3	0.5	693	41	83	124	166	207
15	Br72	Bc83 - Bc84	Pc204 - Pc205	0.00	81.2	0.10	23.7	0.4	897	18	36	54	72	90
16	Br73 - Br77	Bc85 - Bc90	Pc206 - Pc213	188.30	141.7	0.10	22.8	0.4	859	33	66	99	132	165

Note: T means time of flood concentration by Kirpich
** Flood discharges estimated by 60mm of rainfall intensity adopted for the North and South Section will be thus aplied to the Project.*

The drainage capacities of each group increases with raising road surface. Table 6.1-15 shows grouping No.7 ~ No.9 and No.14 ~ No.16 are able to gain enough drainage capacity with raising road surface more than 0.4 m. However, drainage capacities of grouping No.10 and No.11 are still insufficient even if raising road surface more than 1.0 m. Thus, considering number of box culvert for gaining enough capacity is shown next.

Actually, the surface of NR 5 will be above at least 0.8 m because of rehabilitation. So insufficient discharge of No,10 and No.11 are 66 m^3/s and 94 m^3/s respectively. Drainage capacity of one additional box culvert is estimated 24.3 m^3/s. Consequently, grouping No.10 is required 3 additional box culverts, and No.11 is required 4 as well. Dimension of assumed additional box culvert is shown by Figure 6.1-13.

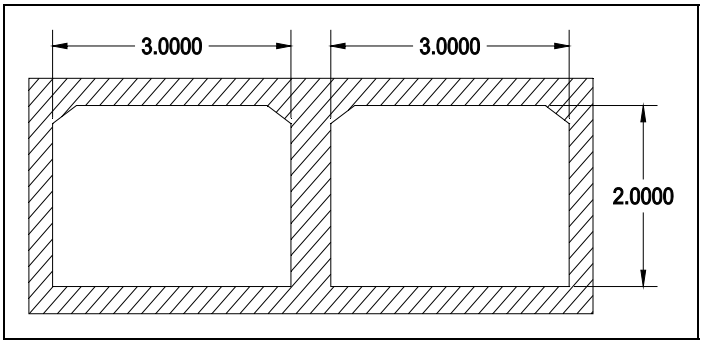


Figure 6.1-13 Typical Box-Culvert

Table 6.1-15 Increase of Drainage Capacity with Raising Surface of NR 5

Group No.	KP	Existing Drainage facilities			Estimated flood discharge(m3/s)	Drainage capacity of existing facilities (m3/s) with Raising height of Road Surface									
		Bridge	Box_C	Pipe_C	(r=60*mm/h)	+0.0m (current)	+0.1m	+0.2m	+0.3m	+0.4m	+0.5m	+0.6m	+0.7m	+0.8m	+0.9m	+1.0m
1	171 ~ 179+700	Br40 - Br41	Bc54 - Bc56	Pc148 - Pc159	84	553	-	-	-	-	-	-	-	-	-	-
2	179+700 ~ 183+200	Br42 - Br43	Bc57 - Bc58	Pc160 - Pc161	70	276	-	-	-	-	-	-	-	-	-	-
3	183+200 ~ 185+400	Br44 - Br46	-	-	56	1001	-	-	-	-	-	-	-	-	-	-
4	185+400 ~ 191+100	Br47 - Br55	-	-	105	2359	-	-	-	-	-	-	-	-	-	-
5	191+100 ~ 202	Br56	Bc59 - Bc60	Pc162 - Pc169	77	78	-	-	-	-	-	-	-	-	-	-
6	202 ~ 211+600	Br57	-	Pc170 - Pc180	123	184	-	-	-	-	-	-	-	-	-	-
7	211+600 ~ 216	Br58	Bc61	Pc181 - Pc186	94	75	89	103	117	143	168	190	212	232	251	271
8	216 ~ 220+700	Br59	Bc62 - Bc63	Pc187 - Pc189	172	0	254	385	488	573	653	743	825	898	970	1041
9	220+700 ~ 227+700	Br60 - Br62	Bc64 - Bc65	Pc190 - Pc192	194	0	0	0	56	210	332	441	525	596	659	719
10	227+700 ~ 235+800	-	Bc66 - Bc67	Pc193 - Pc197	135	37	40	43	50	55	59	63	66	69	72	75
11	235+800 ~ 239+900	-	Bc68 - Bc69	Pc198	129	22	24	26	28	29	31	32	34	35	36	38
12	239+900 ~ 254+600	Br63 - Br66	Bc70 - Bc75	Pc199 - Pc201	188	584	-	-	-	-	-	-	-	-	-	-
13	254+600 ~ 259+500	Br67 - Br70	Bc76 - Bc78	Pc202	242	348	-	-	-	-	-	-	-	-	-	-
14	259+500 ~ 267+700	Br71	Bc79 - Bc82	Pc203	124	116	163	194	218	240	259	277	294	311	328	345
15	267+700 ~ 271	Br72	Bc83 - Bc84	Pc204 - Pc205	54	0	10	26	39	84	141	168	188	201	213	225
16	271 ~ 285+600	Br73 - Br77	Bc85 - Bc90	Pc206 - Pc213	99	76	191	404	488	597	671	738	790	843	900	952

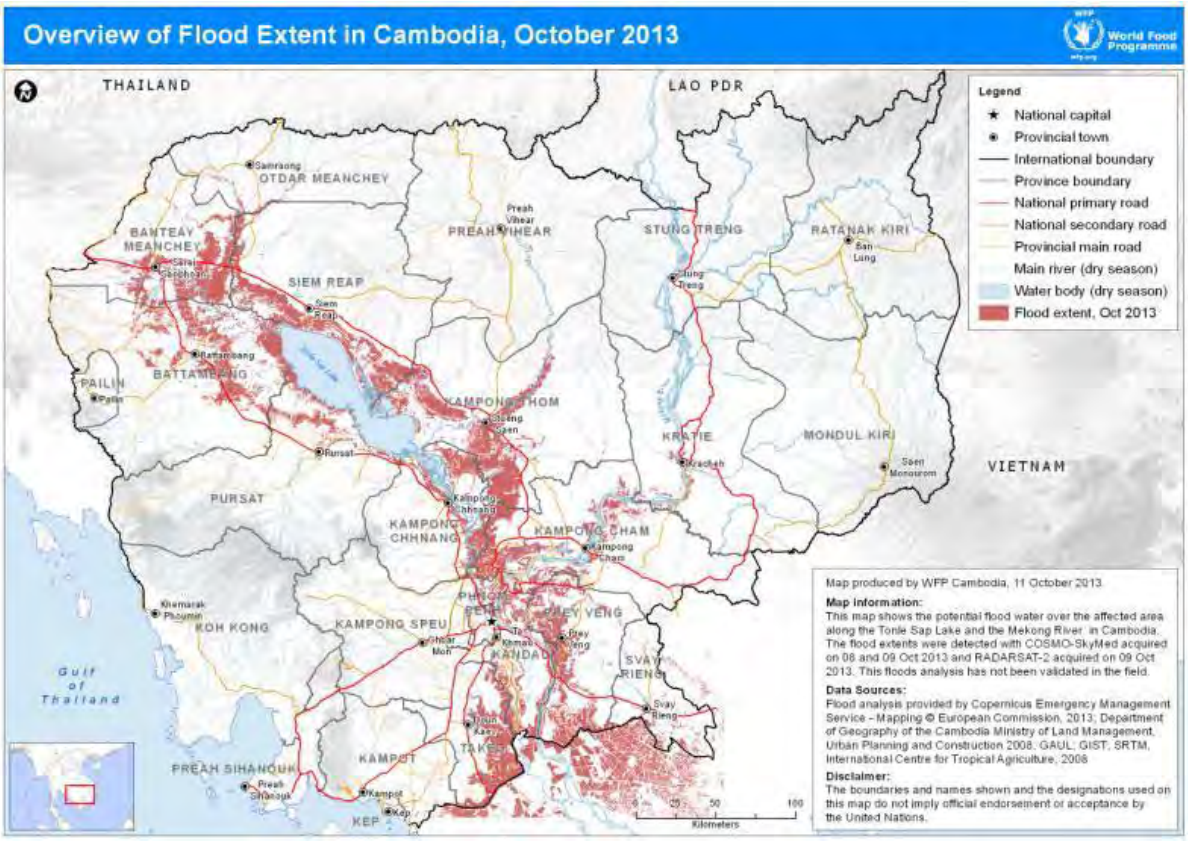
6.1.5 Study of the Flood of 2013

(1) Flood Condition of 2013

Heavy rain since the third week of September resulted in floods in at least 17 provinces through the north-west and along the Mekong River in central Cambodia. The continuous rains in neighboring countries caused repeated flash floods in some provinces, including Banteay Meanchey. In addition, the north-western provinces of Banteay Meancheay, Battambang and Siem Reap affected by flash floods caused by a combination of heavy rains and increase in water levels, as well as overflow from Thailand.

According to latest National Committee for Disaster Management (NCDM) figures published on 12 October, there were 134 confirmed deaths, with approximately 377,695 households (or approximately 1,737,397 people) affected, and more than 26,619 households (approximately 122,447 people) evacuated.

The Team observed flood condition of the Middle section, and summarized it in Table 6.1-16 and Figure 6.1-14. And also, flood condition of the Sri Sophorn - Poipet Section was observed. From KP 366 to KP 376, the flood water level was about 20 cm below the road surface elevation.



Source: Cambodia: Floods Humanitarian Response Forum (HRF) Situation Report No. 03

Figure 6.1-14 Flood Area of Oct. 2013

Table 6.1-16 Overflow Water Level of the Flood of 2013

KP	Depth of Flood	Elevation of Road Surface	Flood Elevation
241+000		16.659	16.659
241+500		16.287	16.287
242+000		15.929	15.929
242+500		15.659	15.659
243+000		15.759	15.759
243+500		15.784	15.784
244+000		15.908	15.908
244+500		15.773	15.773
245+000		14.406	14.406
245+500		14.202	14.202
246+000		14.280	14.28
246+500		13.776	13.776
247+000		13.799	13.799
247+500		13.486	13.486
248+000		13.486	13.486
248+500		13.485	13.485
249+000		13.263	13.263
249+500		13.087	13.087
250+000		12.996	12.996
250+500		12.942	12.942
251+000		13.476	13.476
251+500		12.858	12.858
252+000		13.094	13.094
252+500		13.041	13.041
253+000		13.04	13.04
253+500		13.428	13.428
254+000		13.342	13.342
254+500		12.983	12.983
255+000	0.00	12.898	12.898
255+500	0.00	13.037	13.037
256+000	0.05	12.651	12.701
256+500	0.05	12.911	12.961
257+000	0.00	12.873	12.873
257+500	0.05	12.712	12.762
258+000	0.00	12.877	12.877
258+500	0.05	12.564	12.614
259+000	0.05	12.612	12.662
259+500	0.05	12.668	12.718
260+000	0.05	12.208	12.258
260+500	0.00	12.184	12.184
261+000		12.391	12.391
261+500		12.338	12.338
262+000		12.345	12.345
262+500		12.309	12.309
263+000		12.366	12.366
263+500		12.227	12.227

KP	Depth of Flood	Elevation of Road Surface	Flood Elevation
264+000		12.344	12.344
264+500		12.178	12.178
265+000		12.300	12.300
265+500		12.237	12.237
266+000		12.242	12.242
266+500		12.035	12.035
267+000		12.124	12.124
267+500		11.946	11.946
268+000		11.907	11.907
268+500		12.000	12.000
269+000	0.00	12.186	12.186
269+500		12.266	12.266
270+000	0.00	12.032	12.032
270+500	0.20	11.902	12.102
271+000	0.25	11.856	12.106
271+500	0.30	11.612	11.912
272+000	0.15	11.490	11.640
272+500	0.10	11.626	11.726
273+000	0.10	11.805	11.905
273+500	0.15	11.679	11.829
274+000	0.20	11.768	11.968
274+500	0.00	12.205	12.205
275+000	0.00	12.593	12.593
275+500		12.484	12.484
276+000		12.541	12.541
276+500	0.10	12.512	12.612
277+000	0.00	12.303	12.303
277+500		12.537	12.537
278+000		12.742	12.742
278+500		13.025	13.025
279+000		12.715	12.715
279+500		13.191	13.191
280+000		13.064	13.064
280+500	0.10	13.087	13.187
281+000	0.20	12.844	13.044
281+500	0.05	13.392	13.442
282+000		13.486	13.486
282+500		13.303	13.303
283+000		13.431	13.431

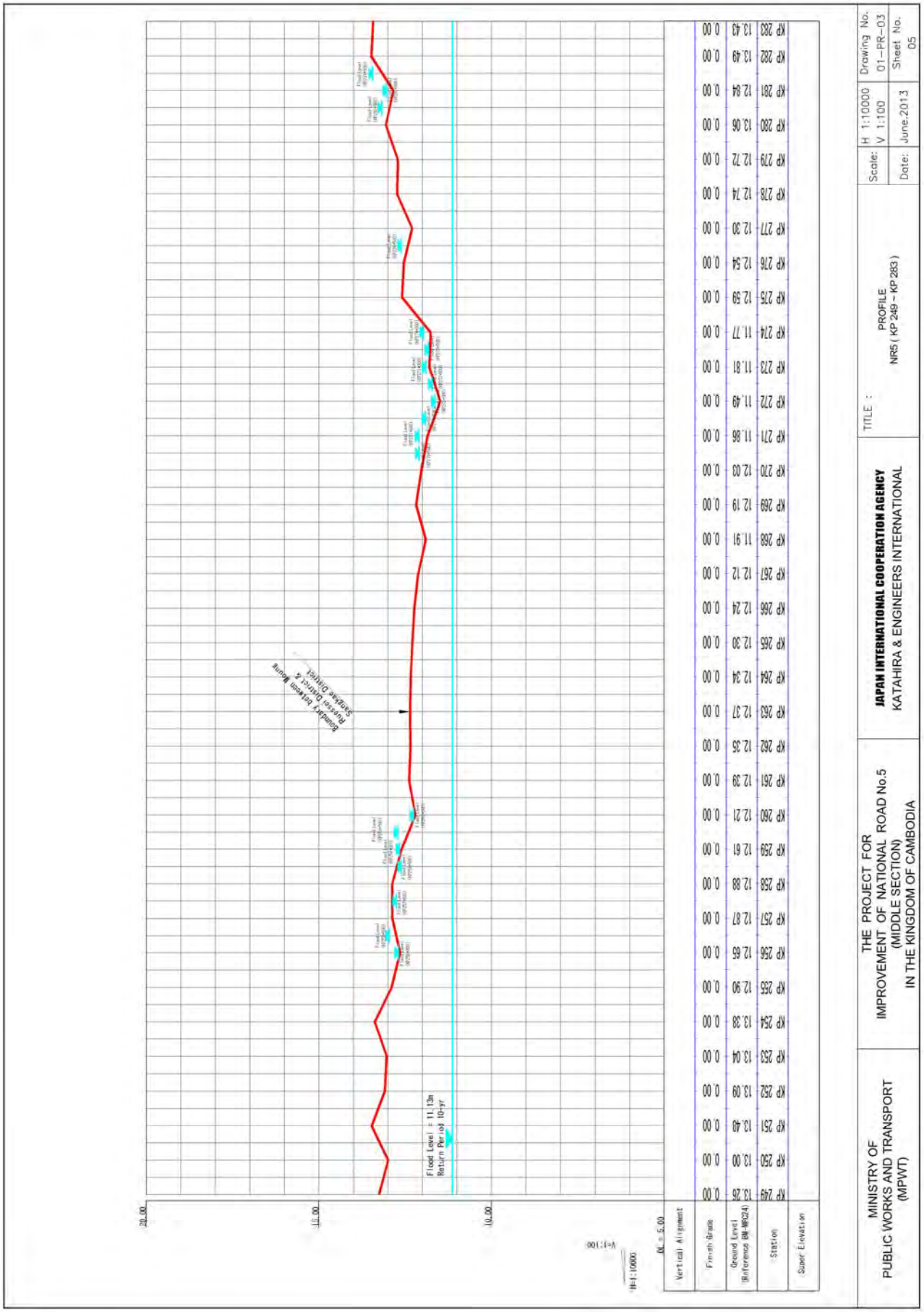


Figure 6.1-15 Flood Water Level at Oct. 2013

Figure 6.1-16 graphs the Hyetograph updated at Pursat, Battambang and Sri Sophorn and it shows heavy rain occurred from 3 until 5 October especially at Battambang.

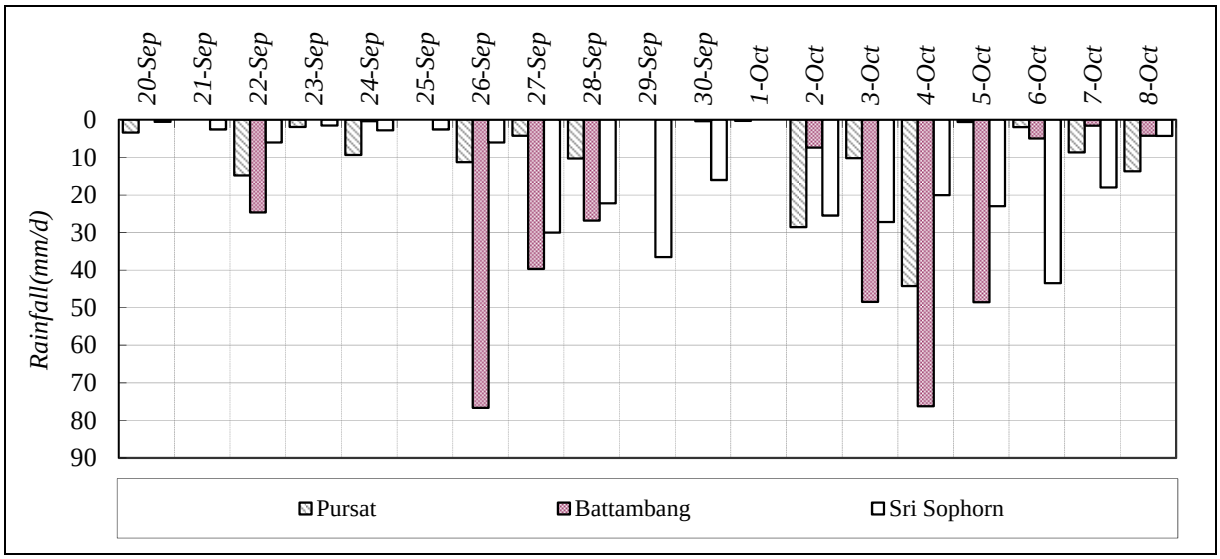


Figure 6.1-16 Hyetograph at Pursat, Battambang and Sri Sophorn (20 Sep. ~ 8 Oct. 2013)

Comparing this flood and average about monthly total and daily maximum, rain condition was not so furious except on September at Battambang.

Table 6.1-17 Rain Condition of 2013

Station	Rainfall		Jun	Jul	Aug	Sep	Oct*
Pursat	Total (mm)	average	154.6	167.2	209.4	220.5	246.6
		2013	281.8	225.6	239.3	172.1	108.4
	Max(mm/d)	average	34.8	43.9	41.2	47.4	57.3
		2013	76.4	32.1	49.8	34.8	44.3
Battambang	Total (mm)	average	153.3	146.1	177.5	194.7	252.5
		2013	278.6	147.4	86.4	334.8	191.6
	Max(mm/d)	average	30.7	40.3	41.2	53.7	77.3
		2013	50.9	29.5	24.0	76.7	76.3
Sri Sophorn	Total (mm)	average	96.2	120.7	152.2	309.4	199.0
		2013	247.2	222.3	245.0	247.3	161.5
	Max(mm/d)	average	22.9	35.1	38.5	72.0	51.3
		2013	41.5	42.0	156.6	62.0	43.5

Note: Total Rainfall of Oct. 2013 is total amount of rainfall from 1 Oct. to 8 Oct.

(2) Estimated Flood Discharge at the Flood of 2013

Flood discharge of the flood of 2013 is able to be estimated by depth of flood water on NR 5. As a result of consideration, because the maximum flood water depth was 0.30 m, flood discharge is estimated at most 230 m^3/s/km.

Figure 6.1-18 summarize estimated flood discharge of each depth of flood water. In consideration of flood discharge, following condition is assumed for computation:

- Flood discharge is evaluated by steady flow analysis with HEC-RAS model.
- Water level of downstream is normal depth (I=1/10,000) calculated each discharge case.
- Model channel width is 1 km.
- Depth of flood water above NR 5 is computed with model channel by each discharge cases respectively.

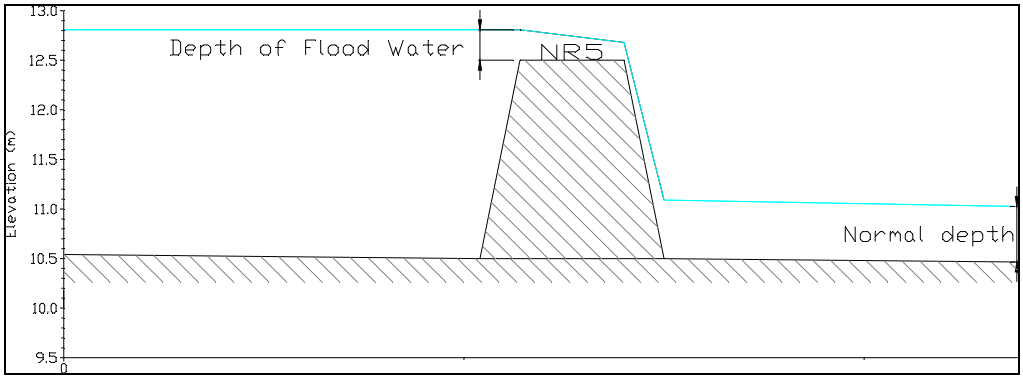
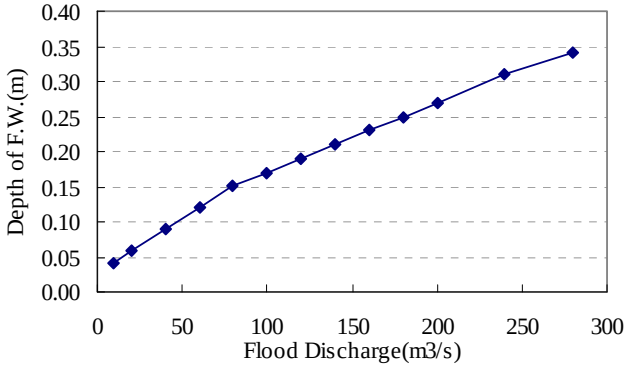


Figure 6.1-17 Model Channel for Evaluating Flood Discharge (Profile View)



Depth (m)	Q Total
0.00	0.0
0.05	15.0
0.10	46.7
0.15	80.0
0.20	130.0
0.25	180.0
0.30	230.0

Figure 6.1-18 Estimated Flood Discharge

(3) Measures for the Flood

As shown in Table 6.1-16 and Figure 6.1-14, the flood water gathered lower land (around KP 270 ~ KP 280). Thus, the section which was inundated by this flood is required much more drainage capacity than the others. There are two factors to increase drainage capacity of inundated section: raising road surface and establishing drainage facilities.

Consideration to measures for flood like 2013 uses these two factors, specifically, upstream water level which does not reduce bearing capacity of pavement (at least 1.3 m below road surface) is computed under several case of number of opening width of embankment. Table 6.1-18 and Figure 6.1-20 summarizes result of computation.

In consideration of upstream water level and opening width, following condition is assumed for computation:

- Water level of upstream is evaluated by steady flow analysis with HEC-RAS model.
- Water level of downstream is 11.13 m (MSL), the water level of the Tole Sap Lake with return period 10-yr by statistical analysis.
- Model channel width is 1 km.
- Flow discharge is 230 m^3/s/km which is maximum estimated flood discharge.
- Opening width of embankment (NR 5) is simulated as number of box culvert. For example, 2 box culverts means 24 m of opening.
- Box culvert has same dimension as Figure 6.1-13.

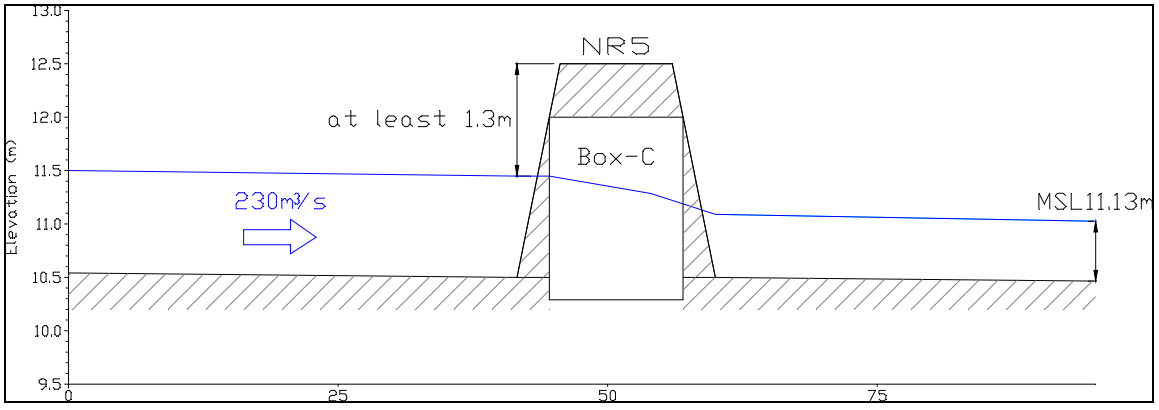


Figure 6.1-19 Model Channel for Estimating Flood Water Level (Profile View)

Table 6.1-18 Elevation of Road Surface with Box Culverts

4*Box-C (Open ≒ 25m/1km)		8*Box-C (Open ≒ 50m/1km)		16*Box-C (Open ≒100m/1km)		26*Box-C (Open ≒150m/1km)	
Elevation of Road Surface (MSL.m)	Drainage capacity (m3/s)	Elevation of Road Surface (MSL.m)	Drainage capacity (m3/s)	Elevation of Road Surface (MSL.m)	Drainage capacity (m3/s)	Elevation of Road Surface (MSL.m)	Drainage capacity (m3/s)
12.43	0.0	12.43	0.0	12.43	0.0	12.43	0.0
12.53	25.6	12.53	57.8	12.53	105.0	12.53	155.0
12.73	51.7	12.73	102.2	12.73	195.4	12.73	301.4
12.93	68.3	12.93	137.6	12.93	272.3	12.93	444.3
13.23	92.1	13.23	183.0	13.23	387.7	13.23	658.6
13.43	107.3	13.43	213.3	13.43	464.6	13.43	801.4
13.63	122.4	13.63	243.6	13.63	541.5	13.63	944.3
13.93	141.2	13.93	289.1	13.93	656.9	13.93	1158.6

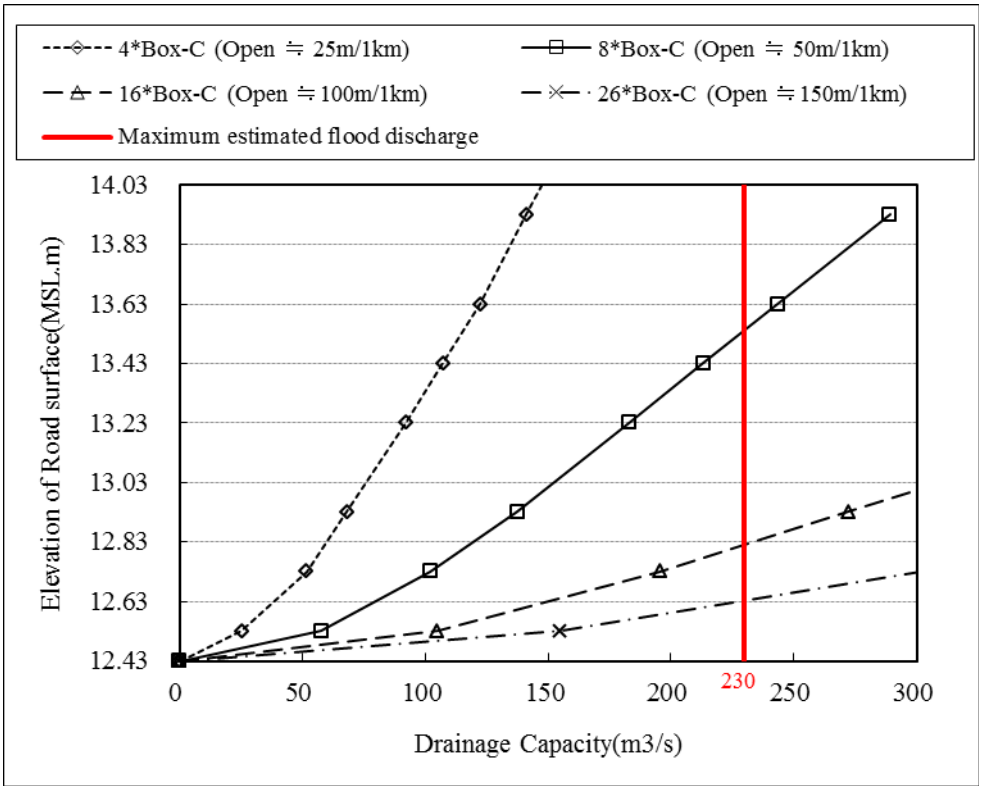


Figure 6.1-20 Elevation of Road Surface with Box Culverts

6.2 Topographical Survey

6.2.1 Objective

Topographical surveys were carried out along NR 5 in the Middle Section and the Sri Sophorn - Poipet Section, and at the selected bridges of NR 5 (Middle Section) for the preliminary road design and the cost estimation.

(1) Middle Section

Existing Road (NR 5)

- Longitudinal survey of the road surface: Necessary for planning of measures against flood
- Cross section survey of every 1 km of the road: Necessary for the preliminary design and the cost estimation of the earthwork of the road construction

Selected Bridges

- Longitudinal survey of bridges to be replaced: Necessary for the preliminary design and the cost estimation of the bridge construction
- Longitudinal survey and cross section survey of river bridges: Necessary for a hydrological condition survey

(2) The Sri Sophorn - Poipet Section

Existing Road (NR 5)

- Longitudinal survey of the road surface: Necessary for planning of measures against flood
- Cross section survey of every 1 km of the road: Necessary for the preliminary design, the cost estimation of the earthwork of the road construction and a hydrological condition survey.

(3) Pursat Bypass

- Cross section survey of every 20 m of the road: Necessary for the preliminary design and the cost estimation of the earthwork of the road construction
- To prepare a topographical map: Used in the design of Pursat bypass

6.2.2 Contents

The topographical survey consists of the following parts.

Table 6.2-1 Summary of Contents

Section	Survey Type	Description	Quantities
NR 5 in the Middle Section	Longitudinal and Cross Section Survey	Elevation of road surface at road center, shoulder and toe of embankment at intervals of 1 km	L = 112 km
NR 5 in the Sri Sophorn - Poipet	Longitudinal and Cross Section Survey	Elevation of road surface at road center , shoulder and toe of embankment at intervals of 1 km	L = 41 km

Section	Survey Type	Description	Quantities
Section	Cross Section Survey for hydrological condition survey	Elevation of and distance from the center line of the points which are shoulder of slope, toe of slope on both sides shall be surveyed within 30 m from the center line.	8 sections
Selected Bridges to be replaced	Longitudinal survey	Longitudinal survey at bridge location at intervals of 10 m and changing points	3 no.
Selected Bridges for hydrological condition survey	Longitudinal survey	Longitudinal survey at bridge location at intervals of 10 m and changing points	5 no.
	Cross section survey	Cross section survey at A1 abutment and A2 abutment of bridge, and center of bridge	
Pursat Bypass	Road centerline, Longitudinal section Cross section Topographical survey	Road centerline, longitudinal, cross section and topographical survey shall be surveyed at intervals of 20 m	L=8.8 km (Bypass)
	Longitudinal section Cross section	Longitudinal and cross section survey at bridge location at intervals of 10 m and changing points	1 no. (Bypass)

6.2.3 Detail and Output

(1) Middle Section

Details and output of the topographical survey are shown in Table 6.2-2 to 6.2-7.

Altitude of road surface survey for existing road (NR 5)

Table 6.2-2 Survey Item for NR 5

Survey Item	Description
Control Point Setting	Control Points were installed at approximately 5 km intervals. Their XY coordinates surveyed by hand GPS and elevations were recorded. The control points made of concrete were installed on the firm ground. The size of the concrete is W × L × H = 20 cm × 20 cm × 80 cm (embedded; 60 cm).
Longitudinal Survey	Longitudinal survey along center line was performed by leveling. Points at every 1 km of the center line and changing points were surveyed. Each Control Point was confirmed by longitudinal survey.
Cross Section Survey	The elevation of and the distance from the center line to the following points were surveyed; ・ The shoulder of the slope on both sides ・ The toe of the slope on both sides ・ Any points within 30 m from the center line on both sides if the elevation changes at a height of more than 10 cm.

Table 6.2-3 Output of the Survey for NR 5

Item	Description
Longitudinal Section Drawing	Scale: Horizontal 1:10,000, Vertical 1:100. The water level of the river and canal are indicated.
Cross Section Drawing	Scale: 1:200. Fences, houses, canals, etc. are shown.

Topographical survey for selected bridges to be replaced

Table 6.2-4 Survey Item for Bridges to be Replaced Section

Survey Item	Description
Longitudinal Survey	Longitudinal survey along the center line was performed at intervals of 10 m and changing points. Land altitude within 50 m from center of bridge on both sides including the river bed was surveyed.

Table 6.2-5 Output for Bridges to be Replaced Section

Item	Description
Longitudinal Section Drawing	Scale: 1:250. High water levels are indicated.

Topographical survey for selected bridges over rivers

Table 6.2-6 Survey Item for River Bridges Section

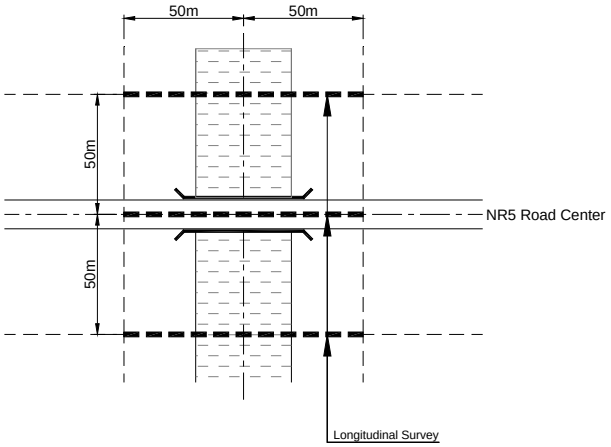
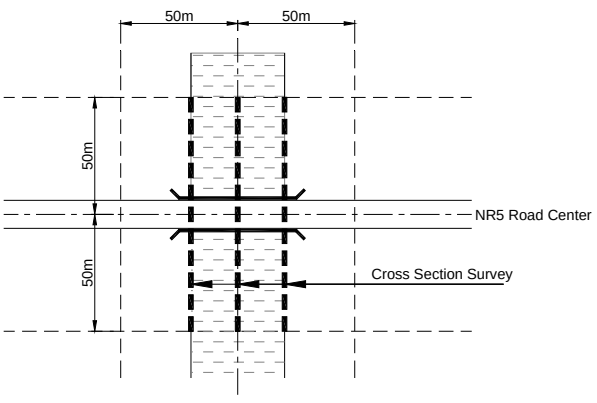
Survey Item	Description
Longitudinal Survey	Longitudinal survey along the 3 lines including center line, upstream and downstream part of a river 50 m apart from bridge was performed at intervals of 10 m and changing points. Land altitude within 50 m from center of bridge both sides including the river bed was surveyed.
	
Cross Section Survey	Cross section survey along the 3 lines passing A1 abutment and A2 abutment of the bridge, and the center of the bridge within 50 m both sides from the center line of the bridge were surveyed at intervals of 10 m and changing points.
	

Table 6.2-7 Output of the Survey for River Bridges Section

Item	Description
Longitudinal Section Drawing	Scale: 1:250. High water level is indicated.
Cross Section Drawing	Scale: 1:200. Fence, house, canal etc. are drawn.

(2) The Sri Sophorn - Poipet Section

Details and output of the topographical survey are shown in Table 6.2-8 to 6.2-10.

Altitude of road surface survey for existing road (NR 5)

Table 6.2-8 Survey Item for NR 5

Item	Description
Leveling	Leveling from KP 283 to KP 366 to connect the BM elevation
Control Point Setting	Control Points were set at approximately 5 km intervals. Their XY coordinates surveyed by hand GPS and Elevations were recorded. The control points made of concrete were installed on the hard ground. The size of the concrete is W × L × H = 20 cm × 20 cm × 80 cm (embedded; 60 cm).
Longitudinal Survey	Longitudinal survey along center line was performed by leveling. Points at every 1 km of the center line and changing points were surveyed. Each Control Point shall be confirmed by longitudinal survey.
Cross Section Survey	The elevation of and the distance from the center line to the following points were surveyed; ・ The shoulder of the slope on both sides ・ The toe of the slope on both sides ・ Any points within 30 m from the center line on both sides if the elevation changes at a height of more than 10 cm.

Table 6.2-9 Survey Item for Hydrological Condition

Item	Description
Cross Section Survey	The elevation of and the distance from the center line to the following points were surveyed; ・ The shoulder of the slope on both sides ・ The toe of the slope on both sides ・ Any points within 30 m from the center line on both sides if the elevation changes at a height of more than 10 cm.

The detail of the cross section survey for hydrological condition is shown in the figure below.

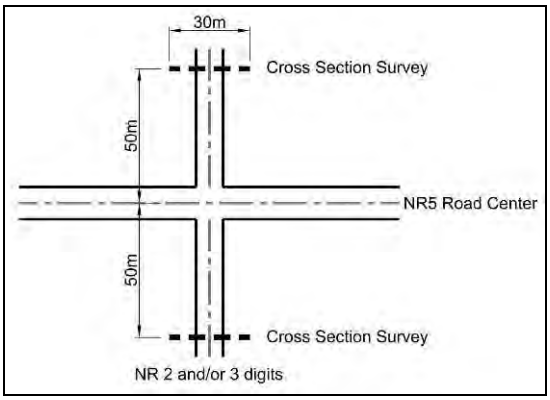


Figure 6.2-1 Detail of Cross Section Survey

Table 6.2-10 Output of the Survey for NR 5 and for Hydrological Condition

Item	Description
Longitudinal Section	Scale: Horizontal 1:10,000, Vertical 1:100. Water level of river and canal are indicated.
Cross Section	Scale: 1:200. Fence, house, canal and etc. are shown.

(3) Pursat Bypass

Details and output of the topographical survey are shown in Table 6.2-11 to 6.2-14.

Table 6.2-11 Survey Item and Output for Road Section

Survey Item	Description
Control Point Setting	Control Points were set at approximately 2 km intervals. Coordination and elevation were recorded. Control point shall be installed on the hard ground by concrete (20 cm x 20 cm x 80 cm (Depth; 60 cm)).
Road Center Line Survey	Setting center line at 20 m intervals, IP, BC, EC shall be set out.
Longitudinal Survey	Longitudinal survey along center line, 20 m interval and changing points were be surveyed.
Cross Section Survey	Cross section survey interval 20 m, changing points within 30 m on both sides of the road were surveyed
Peg Installations	Peg installations at bypass route, intervals 20 m on the centerline, and 20 m on both sides from center line peg Peg installations along NR 5, interval 20 m, and 20 m both side from new centerline Peg (diameter 60 mm, length 1,000 mm) shall be made of wood.
Mapping	Survey houses, culverts, trees, objects and terrain within 30 m on both sides of the road

Table 6.2-12 Output of the Survey for Road Section

Item	Description
Road Plan	Scale: 1:1,000. Contour Line 1 m increments. Road elements and coordinates are indicated.
Longitudinal Section	Scale: Horizontal 1:1,000, Vertical 1:100. Water level of river/canal are indicated.
Cross Section	Scale: 1:200. Fence, house, canal etc. are shown.
BM List	Coordination and elevation

Table 6.2-13 Survey Item for Bridge Section

Survey Item	Description
Longitudinal Survey	Longitudinal survey along center line, 10 m intervals and changing points was surveyed. Within 120 m from center of bridge on both sides were surveyed
Cross Section Survey	Cross section survey intervals 10 m within 120 m on both sides from center of bridge along the road, changing points within 50 m on both sides of centerline were surveyed
Mapping	Survey houses, culverts, trees, objects and terrain within 50 m on both sides of road. Elevation of bore hole for soil investigation were surveyed.

Table 6.2-14 Output of the Survey for Bridge Section

Item	Description
Road Plan	Scale: 1:250. Contour Line 1 m increments.
Longitudinal Section	Scale: 1:250. High Water level shall be indicated.
Cross Section	Scale: 1:200. Fence, house, canal are shown.

6.2.4 Landmine Clearance

The landmine clearance was carried out by RGC under Minutes of Discussion dated 19 November, 2010. The Study Team discussed and explained the landmine clearance for the topographical survey at bypass route in Pursat with MPWT. After the discussion, MPWT coordinated it with relevant organization and Local consultant has gone with Cambodian Action Mine Centre (CMAC) on the site. The topographical survey on Pursat Bypass was started from December, 2013 and was completed in January 2014.

6.2.5 Result of Survey

The results of the topographical survey are summarized below:

Survey of road surface levels for exiting road (NR 5)

(1) Middle Section

In this survey, bench marks (BM) were installed utilizing BMs which were installed by the South Section Survey to be consistent.

The sections where the attitude of road surface is less than 12 m might be concerned about flood according to the South Section Survey.

The sections which are less than ground height 12 m are below:

Beginning Point	Ending Point	Elevation
KP 212 + 600	KP 215 + 800	11.306 ~ 11.971
KP 216 + 150	KP 219 + 500	11.374 ~ 11.900
KP 220 + 100	KP 229 + 300	11.372 ~ 11.978
KP 267 + 200	KP 267 + 500	11.852 ~ 11.946
KP 268 + 000	KP 268 + 400	11.907 ~ 11.964
KP 270 + 400	KP 274 + 400	11.490 ~ 11.952

(2) The Sri Sophorn - Poipet Section

BMs were set correlating with the BMs which had been installed in the Middle section from a viewpoint of consistency.

According to the result of topographical survey, the elevation below 12 m was not observed. The existing road surface gradually goes up from KP 366 (14.72 m) to KP 407 (41.02 m).

In this section, the water flow from Thailand to Sri Sophorn and some parts of this section, there are no difference between the road surface and toe of the embankment. Therefore, the base course and sub-base course in the some parts of this section are lower than water level .

6.3 Aerial Photo Survey

Aerial photos using motored paraglider were taken for the following purpose.

- To prepare digital map to be used in the road design in the later stage
- To check the situation of houses/facilities along NR 5

This survey started in early June 2013 on the Middle Section. In this survey, a propeller equipped paraglider is used in place of an airplane as well as the others sections of NR 5. Use of paraglider makes the entire schedule of the survey more flexible than an ordinary airplane since the flight schedule of a paraglider can be adjusted to weather and other conditions more easily than a ordinary airplane.

(1) Middle Section

Digital Map for the Preliminary Road Design was produced at the end of July 2013. Table 6.3-1 shows the work schedule for the aerial photo survey.

Table 6.3-1 Aerial Photo Survey Schedule (Middle Section)

Item	June				July			
	1st week	2nd week	3rd week	4th week	1st week	2nd week	3rd week	4th week
Mobilization and Digital Database Preparation								
Aerial Ortho-Photo Survey								
Aerial Photography								
Ground Control Point with DGPDS (GCP:X,Y,Z)								
Ortho-Photo Processing								
Final Report and Contact Printing								
Digital Mapping								
Road Alignment Survey with DGPS (XYZ) every 50 m interval								
Data Processing (generate 1 m contour line of the road Alignment)								

Table 6.3-2 summarizes the outline of the activities of aerial photo survey.

Table 6.3-2 Description of Activities of Aero Photo Survey

Item	Description
Aerial Photo	Length of Road : 130 km
	Scale: 1:5,000 (Overlap 60%, Side lap 30%)
	No of Photos : 400 pcs
Ground Survey Control Point	35 points
	Scale : 1:2,000
Digital Mapping	Mapping Area 13,000,000 m^2 (130,000 m × 100 m)

(2) The Sri Sophorn - Poipet Section

Digital Map for the Preliminary Road Design was produced in the middle of August 2013. Table 6.3-3 shows the work schedule for the aerial photo survey.

Table 6.3-3 Aerial Photo Survey Schedule (the Sri Sophorn - Poipet Section)

Item	July				August			
	1st week	2nd week	3rd week	4th week	1st week	2nd week	3rd week	4th week
Mobilization and Digital Database Preparation								
Aerial Ortho-Photo Survey								
Aerial Photography (Flying)								
Ground Control Point with DGPDS (GCP:X,Y,Z)								
Ortho-Photo Processing								
Final Report and Contact Printing								
Digital Mapping								
Road Alignment Survey with DGPS (X,Y,Z) every 50 m Interval								
Data Processing (Generate 1 m contour line of the road Alignment)								

Table 6.3-4 summarizes the outline of the activities of aerial photo survey.

Table 6.3-4 Description of Activities of Aero Photo Survey

Item	Description
Aerial Photo	Length of Road : 48 km
	Scale: 1:5,000 (Overlap 60%, Side lap 30%)
	No of Photos : 150 pcs
Ground Survey Control Point	15 points
Digital Mapping	Scale : 1:2,000
	Mapping Area 4,800,000 m^2 (48,000 m × 100 m)

6.4 Geotechnical Investigation

6.4.1 CBR Tests of Existing Subgrade

To understand the existing condition of the subgrade under the existing NR 5, CBR tests were carried out with the samples collected from the unpaved shoulder of the road.

Locations of Sampling

The samples were collected from the unpaved shoulder adjacent to the paved shoulder at the intervals of 2 kilometers between the beginning and the ending of the Middle Section, i.e., KP 171 to KP 283, by manual digging of test pits down to 1.5 meters deep from the surface.

(1) Middle Section

Schematic illustrations of the test pits of the Middle Section are attached to Appendix 6-3.

(2) The Sri Sophorn - Poipet Section

Schematic illustration of the test pits of the Sri Sophorn - Poipet Section are attached to Appendix 6-4.

Laboratory Tests

Laboratory tests were carried out following the standards listed below:

・ CBR tests	ASTM D 1883 or equivalent
・ Moisture - density relation	ASTM D 698 or equivalent
・ Specific Gravity	ASTM D 854 or equivalent
・ Moisture Content	ASTM D 2216 or equivalent
・ Atterberg Limits	ASTM D 4318 or equivalent
・ Sieve Analysis	ASTM D 422 or equivalent
・ Soil Classification	ASTM D 2487 or equivalent

(1) Middle Section

The results of the laboratory tests are attached to Appendix 6-5 and the Table 6.4-1 summarizes the test results.

Table 6.4-1 Summary of CBR Tests in the Middle Section

CBR -No.	Km	Thickness (mm)				CBR / MDD				Soil Classification	Particle Size Distribution			Specific Gravity	Atterberg Limit			Moisture Content (%)
		DBST	Base Course	Sub Base	Subgrade	CBR at 95%MDD (%)	OMC (%)	MDD (g/cm3)	95% MDD		Fine Content (%)	Sand (%)	Gravel (%)		LL (%)	PL (%)	PI (%)	
1	171	25			800	6.20	7.30	2.162	2.054	A6	42.86	40.63	16.51	2.685	24.20	12.19	12.01	5.78
2	173	20			650	9.90	6.10	2.182	2.073	A4	40.49	45.08	14.43	2.662	32.60	16.90	15.70	3.45
3	175	20			650	8.40	8.30	2.125	2.019	A6	66.65	31.16	2.19	2.569	30.20	12.18	18.02	11.51
4	177	15			700	5.00	7.70	2.148	2.041	A7	35.71	44.87	19.42	2.818	27.30	12.15	15.15	9.64
5	179	15			700	9.70	8.30	2.140	2.033	A6	39.58	40.17	20.25	2.690	32.30	13.63	18.67	8.99
6	181	20			700	4.00	8.30	2.158	2.050	A6	38.16	51.31	10.53	2.637	34.40	11.39	23.01	9.66
7	183	20			700	3.80	8.60	2.108	2.003	A7	49.09	47.54	3.37	2.618	18.70	10.03	8.67	8.32
8	185	20			700	9.00	7.40	2.140	2.033	A4	33.07	48.72	18.21	2.687	25.40	12.30	13.10	4.90
9	187	20			600	2.20	7.40	2.135	2.028	A7	38.61	50.03	11.36	2.644	25.60	12.71	12.89	7.97
10	189	20			700	7.70	9.40	2.095	1.990	A6	35.53	35.92	28.55	2.784	33.70	17.90	15.80	8.13
11	191	20			600	9.40	9.20	2.135	2.028	A4	50.25	33.15	16.60	2.644	30.60	12.61	17.99	9.81
12	193	20		180	500	0.60	6.75	2.184	2.075	A7	34.99	43.31	21.70	2.741	18.70	11.55	7.15	3.91
13	195	20		230	400	2.01	8.56	2.114	2.008	A7	28.85	30.47	40.68	2.829	36.40	16.77	19.63	10.51
14	197	20		330	600	6.10	8.50	2.057	1.954	A6	45.56	32.49	21.95	2.753	34.60	13.32	21.28	12.20
15	199	20		300	400	3.35	9.25	2.020	1.919	A7	51.43	28.93	19.64	2.708	32.60	12.91	19.69	12.46
16	201	20		250	500	3.25	9.50	2.180	2.071	A7	31.99	34.75	33.26	2.846	32.00	12.96	19.04	8.29
17	203	20		300	400	2.30	8.90	2.057	1.954	A7	56.37	23.62	20.01	2.675	35.80	17.23	18.57	10.64
18	205	20		200	400	2.70	7.90	2.160	2.052	A7	43.87	28.46	27.67	2.816	33.00	13.94	19.06	10.95
19	207	20		250	500	7.10	8.20	2.145	2.038	A7	44.32	33.21	22.47	2.781	34.60	13.49	21.11	10.89
20	209	20		200	400	5.90	8.20	2.110	2.005	A7	51.97	30.68	17.35	2.722	30.80	18.17	12.63	11.45
21	211	20		200	500	1.65	8.20	2.100	1.995	A7	46.52	34.08	19.40	2.715	19.80	13.44	6.36	12.85
22	213	15		300	500	5.00	5.00	2.049	1.947	A7	34.59	27.40	38.01	2.684	27.90	13.42	14.48	8.09
23	215	20		180	400	2.05	8.30	2.117	2.011	A7	43.70	29.87	26.43	2.734	32.60	16.53	16.07	11.07
24	217	20			500	3.50	9.40	2.098	1.993	A7	45.65	25.98	28.37	2.760	39.20	15.99	23.21	9.89
25	219	20		300	400	1.00	8.60	2.049	1.947	A7	72.65	19.08	8.27	2.680	32.40	12.77	19.63	8.39
26	221	10		180	600	4.20	8.60	2.114	2.008	A7	38.80	38.19	23.01	2.708	27.00	11.91	15.09	9.95
27	223	25		200	400	2.76	8.20	2.175	2.066	A7	33.48	32.74	33.78	2.800	31.00	11.73	19.27	10.99
28	225	20	250		700	11.20	7.80	2.165	2.057	A6	27.07	29.10	43.83	2.773	27.10	13.85	13.25	7.43
29	227	20		250	600	2.80	9.00	2.132	2.025	A7	40.21	35.31	24.48	2.679	21.20	13.67	7.53	6.51
30	229	20			700	6.80	7.90	2.180	2.071	A7	44.48	34.49	21.03	2.707	27.30	12.39	14.91	4.40
31	231	20		150	500	2.58	9.20	2.010	1.910	A7	40.25	39.89	19.86	2.576	29.10	12.62	16.48	10.71
32	233	20			600	1.65	9.78	2.045	1.943	A7	41.75	32.28	25.97	2.717	38.00	14.66	23.34	11.46
33	235	20			800	7.50	8.00	2.115	2.009	A6	40.50	31.72	27.78	2.788	26.20	12.69	13.51	5.50
34	237	25			600	6.35	8.20	2.100	1.995	A7	39.83	33.06	27.11	2.742	23.20	13.29	9.91	7.01
35	239	25			700	3.55	8.65	2.051	1.948	A7	42.24	37.99	19.77	2.656	34.30	17.67	16.63	7.72
36	241	20			1200	6.60	7.76	2.082	1.978	A7	35.76	33.94	30.30	2.654	27.40	12.55	14.85	5.40
37	243	20		200	500	5.03	9.40	2.022	1.921	A6	38.30	33.02	28.68	2.754	61.00	12.65	48.35	8.33
38	245	20		200	500	13.20	7.90	2.060	1.957	A6	48.01	37.09	14.90	2.621	30.80	12.77	18.03	12.38
39	247	20			850	0.47	7.25	2.113	2.007	A7	35.83	27.28	36.89	2.691	33.00	11.91	21.09	11.48
40	249	20			800	4.30	8.80	2.087	1.983	A7	41.00	36.01	22.99	2.649	27.40	15.75	11.65	13.20
41	251	20			700	1.60	8.50	2.157	2.049	A7	45.15	26.23	28.62	2.741	27.80	18.12	9.68	4.83
42	253	25		200	500	2.80	9.90	1.995	1.895	A7	47.55	27.11	25.34	2.657	30.60	10.56	20.04	12.38
43	255	20		200	600	4.50	7.70	2.160	2.052	A7	36.85	26.31	36.84	2.662	30.60	12.47	18.13	10.67
44	257	20		250	450	5.95	6.77	2.135	2.028	A6	42.15	40.84	17.01	2.699	24.80	14.35	10.45	8.78
45	259	20			850	7.30	6.70	2.150	2.043	A6	43.25	36.65	20.10	2.750	25.10	14.84	10.26	6.87
46	261	20		200	400	6.10	10.75	2.009	1.909	A7	58.63	27.84	13.53	2.563	33.00	13.23	19.77	11.32
47	263	30		200	600	11.90	8.50	2.081	1.977	A4	53.85	31.67	14.48	2.605	32.50	15.37	17.13	11.44
48	265	20		200	450	7.20	10.55	1.991	1.891	A7	53.18	25.49	21.33	2.593	37.30	23.99	13.31	13.02
49	267	20		200	300	5.00	8.10	2.170	2.062	A7	19.16	57.44	23.40	2.702	33.00	15.80	17.20	11.29
50	269	20		200	600	6.40	11.40	1.983	1.884	A7	60.93	26.59	12.48	2.607	41.00	14.40	26.60	13.90
51	271	25		200	400	2.56	8.30	2.158	2.050	A7	54.04	29.33	16.63	2.576	35.00	13.62	21.38	15.73
52	273	20		180	400	0.80	8.55	1.891	1.796	A7	39.54	29.10	31.36	2.556	36.00	12.77	23.23	19.50
53	275	20			1000	3.10	8.50	1.937	1.840	A7	33.80	31.10	35.10	2.608	33.20	11.85	21.35	15.76
54	277	25			600	7.65	8.00	2.048	1.946	A7	46.35	30.80	22.85	2.632	32.00	12.97	19.03	7.44
55	279	20			600	2.51	11.75	1.875	1.781	A7	40.42	32.89	26.69	2.582	29.10	16.11	12.99	10.68
56	281	20			700	1.30	9.10	2.014	1.913	A7	34.43	32.59	32.98	2.611	34.20	13.08	21.12	11.06
57	283	20		200	500	1.40	9.90	1.927	1.831	A7	45.32	29.05	25.63	2.621	44.20	15.72	28.48	14.04

(2) The Sri Sophorn - Poipet Section

The results of the laboratory tests are attached to Appendix 6-6 and the Table 6.4-2 summarizes the test results.

Table 6.4-2 Summary of CBR Tests in the Sri Sophorn - Poipet Section

CBR -No.	Km	Thickness (mm)				CBR / MDD				Soil Classification	Particle Size Distribution			Specific Gravity	Atterberg Limit			Moisture Content (%)
		DBST	Base Course	Sub Base	Subgrade	CBR at 95%MDD (%)	OMC (%)	MDD (g/cm3)	95% MDD		Fine Content (%)	Sand (%)	Gravel (%)		LL (%)	PL (%)	PI (%)	
1	367	40	0	300	300	4.25	10.75	1.910	1.815	A6	39.01	48.2	12.78	2.686	14.49	36.30	21.81	18.16
2	369	35	400	0	400	1.98	10.45	1.975	1.876	A6	49.43	43.73	6.83	2.639	16.59	38.20	21.61	15.71
3	371	40	300	0	300	1.80	10.60	1.952	1.854	A6	34.91	44.26	20.83	2.637	16.97	43.90	26.93	9.01
4	373	30	300	0	300	0.95	11.60	1.920	1.824	A6	43.29	46.01	10.69	2.554	16.26	43.00	26.74	12.87
5	375	30	300	0	250	1.92	10.50	1.925	1.829	A6	58.86	38.81	2.33	2.573	15.31	36.10	20.79	15.29
6	377	50	320	0	250	1.45	11.25	1.910	1.815	A6	43.5	41.63	14.87	2.662	12.71	60.20	47.49	13.04
7	379	40	300	0	250	3.44	9.75	1.975	1.876	A5	39.17	42.02	18.81	2.567	17.35	57.90	40.55	15.93
8	381	40	300	0	250	3.40	11.70	1.915	1.819	A6	40.05	42.19	17.76	2.688	14.10	40.60	26.50	13.28
9	385	40	400	0	180	1.55	7.75	2.120	2.014	A6	55.05	33.01	11.94	2.65	11.98	37.40	25.42	13.38
10	387	40	360	0	250	0.52	8.90	2.035	1.933	A7	44.52	30.93	24.55	2.676	12.05	29.10	17.05	12.5
11	389	30	440	0	300	1.92	9.25	2.060	1.957	A6	34.11	30.83	35.06	2.682	15.16	42.00	26.84	12.03
12	391	30	430	0	400	1.18	9.40	2.040	1.938	A6	64.43	21.51	14.06	2.693	15.16	42.00	26.84	10.79
13	393	40	250	0	400	0.88	10.50	1.955	1.857	A5	54.12	26.17	19.71	2.735	13.47	46.80	33.33	15.15
14	401	35	430	0	150	2.98	7.75	2.105	2.000	A6	44.94	35.37	19.69	2.681	12.05	38.80	26.75	12.46
15	399	40	300	0	250	2.18	7.90	2.090	1.986	A6	32.12	28.68	39.19	2.803	17.01	34.20	17.19	12.4
16	397	30	300	0	280	5.26	7.75	2.100	1.995	A6	45.25	42.26	12.49	2.679	16.50	39.20	22.70	10.82
17	395	35	300	0	250	1.70	7.70	2.090	1.986	A6	52.18	25.47	22.35	2.686	13.39	38.00	24.61	15.94
18	403	0	0	0	400	1.50	11.40	2.000	1.900	A6	36.69	32.86	30.46	2.724	15.71	46.80	31.09	17.21
19	405	0	0	200	200	1.10	11.50	1.930	1.834	A6	44.8	50.03	5.89	2.755	17.00	38.40	21.40	23.57
20	407	10	0	0	0	1.32	11.90	1.894	1.799	A6	53.07	34.74	12.19	2.661	12.41	58.40	45.99	27.42

6.4.2 Geotechnical Investigation for Bridges

(1) Middle Section

As a preliminary investigation for foundations of the bridges along the Middle Section of National Road No.5, 12 boreholes were drilled and Standard Penetration Tests (hereinafter referred to as SPT) were conducted. Laboratory tests were carried out with disturbed and undisturbed samples obtained from the boreholes.

Location of Boreholes

Borehole investigation was done at the following 12 bridge sites:

(a) KP 181 + 900 (Br. 42)

(b) KP 183 + 200 (Br. 44)

(c) KP 185 + 700 (Br. 47)

(d) KP 187 + 500 (Br. 48)

(e) KP 188 + 100(Br. 50)

(f) KP 191 + 100 (Br. 55)

(g) KP 208 + 500 (Br. 57)

(h) KP 215 + 800 (Br. 58)

(i) KP 219 + 700 (Br. 59)

(j) KP 245 + 900 (Br. 66)

(k) KP 255 + 500 (Br. 68)

(l) KP 273 + 300 (Br. 75)

Figure 6.4-1 to 6.4-3 and Appendix 6-7 show the locations of the boreholes.

(2) The Sri Sophorn - Poipet Section

There is no bridge in the section of Sri Sophorn - Poipet. Therefore, geotechnical investigation for bridge is not carried out.

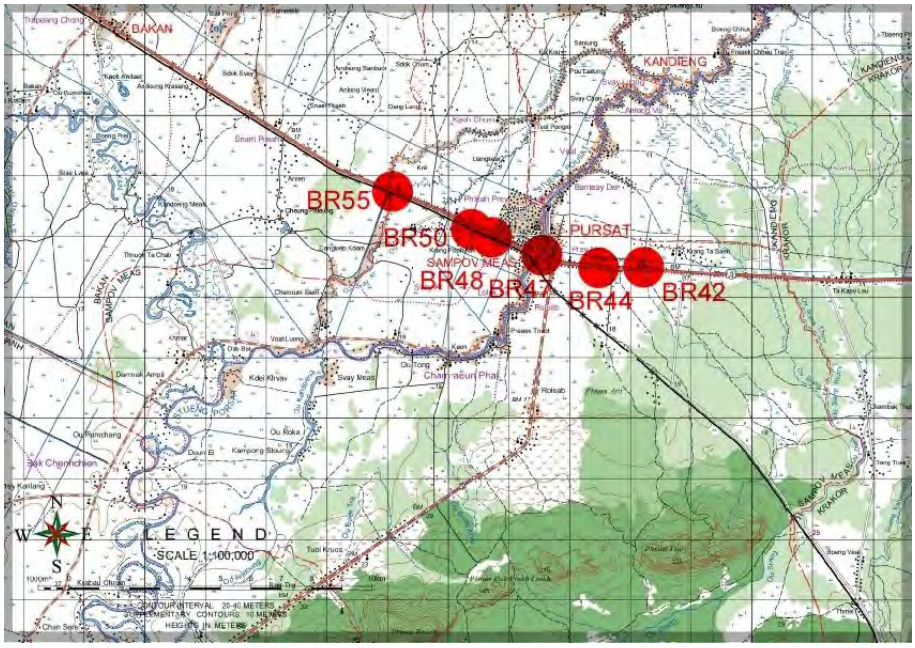


Figure 6.4-1 Location of Boreholes (1)

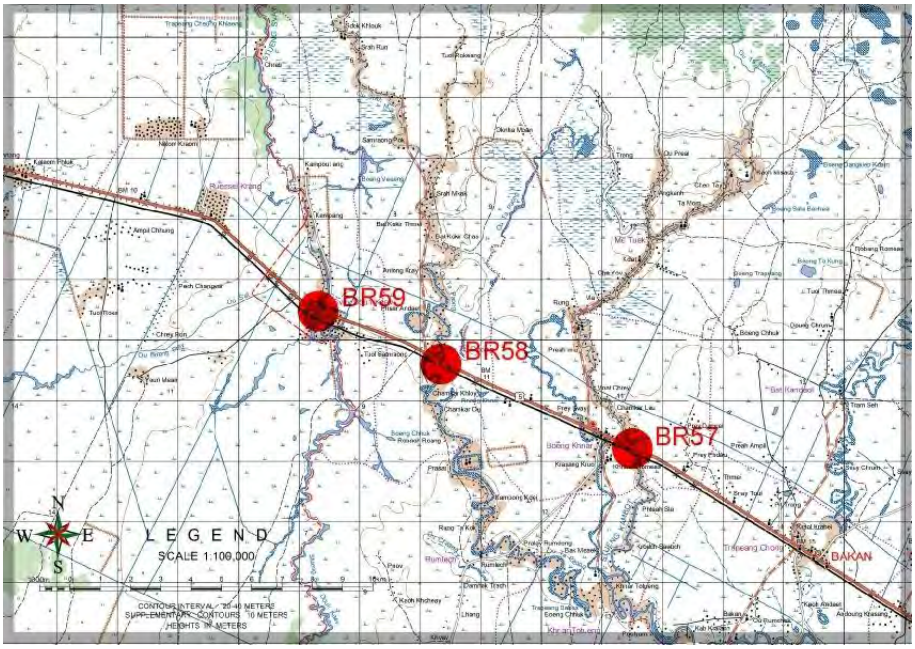


Figure 6.4-2 Location of Boreholes (2)

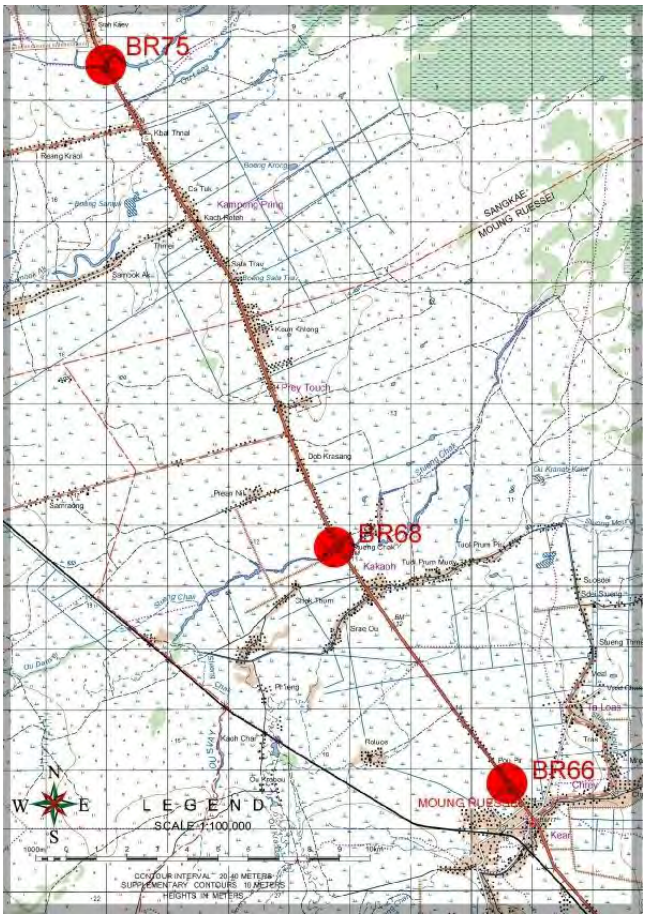


Figure 6.4-3 Location of Boreholes (3)

Geological Condition

This section summarizes stratification, groundwater condition, and distribution of SPT N-values at each borehole. Drilling logs are attached as Appendix 6-8. The borehole investigation was executed with a truck-mounted rotary auger equipped with an apparatus for SPT, shown in Figure 6.4-4.



Figure 6.4-4 Truck-Mounted Rotary Auger, with SPT Apparatus

(1) Br. 42

Figure 6.4-5 shows stratification and distribution of SPT N-values at Br. 42. N-values increase downwards. Recorded groundwater table was GL-2.35 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
3.00	*3.00*	QS1	Loose - Medium Dense	Yellowish Clayey SAND
4.00	*1.00*	QC1	Very Stiff	Yellowish, light gray Sandy CLAY
7.00	*3.00*	QC2	Firm - Stiff	Yellowish, grayish Sandy CLAY
16.00	*9.00*	QC3	Stiff - Very Stiff	Yellowish, graysh, reddish-gray Sandy CLAY
19.00	*3.00*	QC4	Very Stiff - Hard	Yellowish, grayish, reddish-gray CLAY with Sand
20.00	*1.00*	QS2	Dense	Reddish-gray Clayey SAND
22.00	*2.00*	QC5	Very Stiff - Hard	Yellowish, grayish, light gray Sandy CLAY
25.45	*3.45*	QS3	Dense - Very Dense	Grayish, light gray Clayey SAND

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

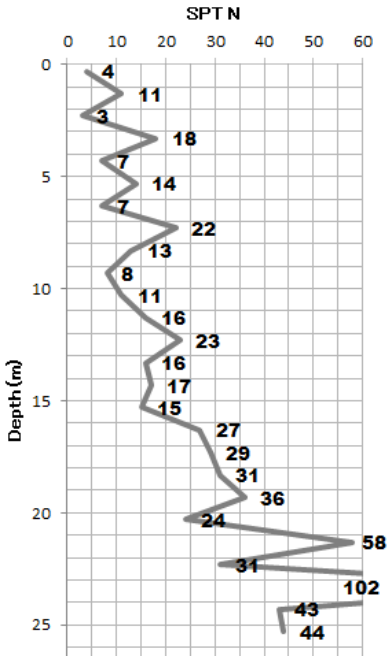


Figure 6.4-5 Br. 42

(2) Br. 44

Figure 6.4-6 shows stratification and distribution of SPT N-values at Br. 44. N-values increase with the depth gradually. Recorded groundwater table was GL-6.00 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
3.00	*3.00*	QS1	Very Loose - Loose	Yellowish-red, yellowish Silty fine Sand with Gravel At the bottom, loose Clayey Sand
7.00	*4.00*	QC1	Soft - Stiff	Grayish Sandy CLAY
8.00	*1.00*	QS2	Medium Dense	Yellowish, grayish Clayey coarse SAND
15.00	*7.00*	QC2	Firm - Very Stiff	Grayish, yellowish CLAY with Sand (upper and bottom) or Sandy CLAY (lower)
21.00	*6.00*	QS3	Medium Dense - Dense	Yellowish, grayish, light gray Clayey coarse SAND
25.00	*4.00*	QC3	Very Stiff	Reddish-gray, reddish-yellow, light gray Sandy CLAY
25.45	*0.45*	QC4	Hard	White Sandy CLAY

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

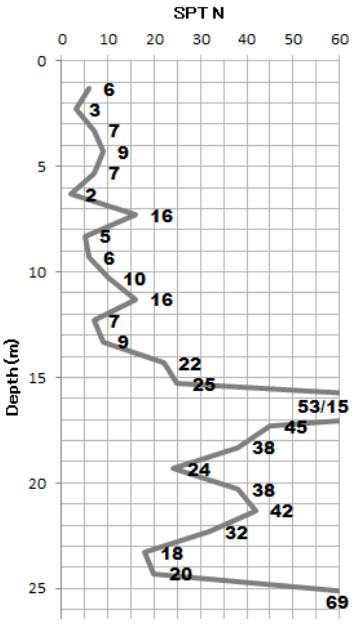


Figure 6.4-6 Br. 44

(3) Br. 47

Figure 6.4-7 shows stratification and distribution of SPT N-values at Br. 47. Clay is dominant in this borehole. N-values show sudden increase at the depth of 12 meters. Recorded groundwater table was GL-5.10 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
4.00	*4.00*	QC1	Soft - Firm	Yellowish, grayish Sandy CLAY At the top, Sandy CLAY with Gravel
9.00	*5.00*	QS1	Loose - Medium Dense	Yellowish, grayish, dark gray fine to medium SAND. Coarsening-downward. At the top and 6~7m, Clayey SAND.
12.00	*3.00*	QC2	Stiff - Very Stiff	Reddish -gray, light gray, yellowish Sandy CLAY. At the top CLAY with Sand.
15.00	*3.00*	QC3	Hard	Reddish -gray, light gray, yellowish CLAY with Sand. At the top Sandy CLAY.
16.00	*1.00*	QS2	Very Dense	Grayish Silty coarse SAND
19.00	*3.00*	QC4	Hard	Yellowish, light gray CLAY with Sand. At the bottom, Sandy CLAY
21.00	*2.00*	QS3	Very Dense	Yellowish, light gray Clayey coarse SAND with Gravel
25.45	*4.45*	QC5	Hard	Yellowish, reddish-gray, light gray Sandy CLAY

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

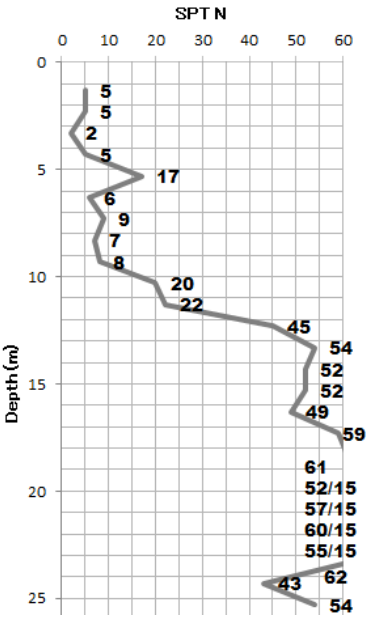


Figure 6.4-7 Br. 47

(4) Br. 48

Figure 6.4-8 shows stratification and distribution of SPT N-values at Br. 48. N-values show downward -increasing profile. Recorded groundwater table was GL-9.70 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
2.00	*2.00*	QC1	Firm - Very Stiff	Yellowish, grayish Sandy CLAY with Gravel
3.00	*1.00*	QS1	Loose	Grayish, yellowish Silty fine SAND
11.00	*8.00*	QC2	Firm - Stiff	Yellowish, brownish, grayish CLAY with Sand, overlain and underlain by and interbedded with Sandy CLAY in the middle.
14.00	*3.00*	QS2	Medium Dense	Yellowish, yellowish-gray Clayey SAND, coarsening upward.
16.00	*2.00*	QC3	Stiff - Very Stiff	Light gray, yellowish, grayish-yellow Sandy CLAY
25.45	*9.45*	QC4	Hard	Yellow,white Sandy CLAY. At the top, CLAY with Sand.

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

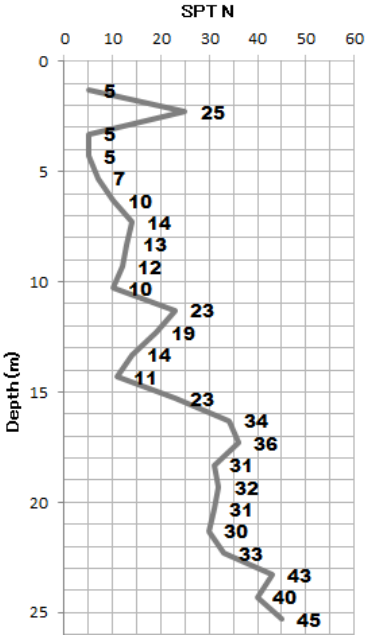


Figure 6.4-8 Br. 48

(5) Br. 50

Figure 6.4-9 shows stratification and distribution of SPT N-values at Br. 50. N-values increase downwards, except between GL-13 and 20 meters. Recorded groundwater table was GL-8.40 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
2.00	*2.00*	QS1	Loose - Medium Dense	Reddish-bronw Clayey SAND with Gravel
9.00	*7.00*	QC1	Stiff - Very Stiff	Brownish, dark brown, light gray CLAY (upper) or Sandy CLAY (middle ~ lower)
12.00	*3.00*	QS2	Medium Dense - Dense	Grayish, light gray Clayey coarse SAND
13.00	*1.00*	QC2	Hard	Grayish Sandy CLAY
18.00	*5.00*	QC3	Stiff - Very Stiff	Grayish, yellowish, light gray CLAY with Sand 15~16m, Sandy CLAY
19.00	*1.00*	QS3	Medium Dense	Light gray, yellow Clayey SAND
20.00	*1.00*	QC4	Very Stiff	Light gray, yellow Sandy CLAY
25.45	*5.45*	QC5	Hard	Yellowish, light gray Sandy CLAY

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

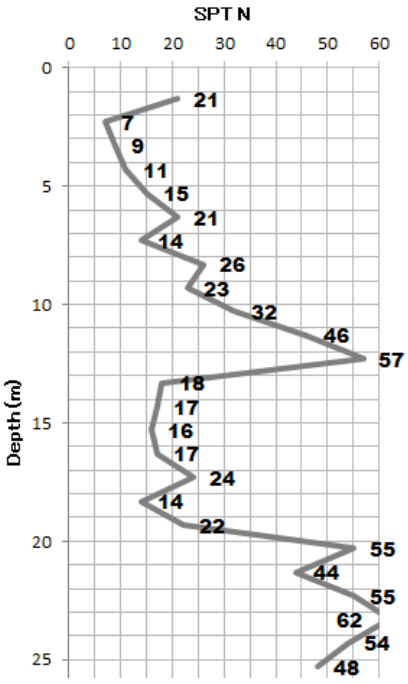


Figure 6.4-9 Br. 50

(6) Br. 55

Figure 6.4-10 explains stratification and distribution of SPT N - values at Br. 55. N - values increase slightly with the depth. Recorded groundwater table was GL-5.85 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
5.00	*5.00*	QC1	Soft - Stiff	Reddish-brown, yellowish-gray CLAY with Sand or CLAY
8.00	*3.00*	QS1	Loose - Medium Dense	Yellow fine to medium SAND
11.00	*3.00*	QC2	Firm - Very Stiff	Yellow, gray Sandy CLAY
15.00	*4.00*	QS2	Medium Dense	Grayish, yellowish,light gray Cleyey fine to coarse SAND
20.00	*5.00*	QC3	Very Stiff - Hard	Yellowish, reddish-gray, light gray Sandy CLAY or CLAY with Sand
24.00	*4.00*	QCS1	Medium Dense - Dense / Very Stiff	Alternation of Clayey Sand and CLAY with Sand or Sandy CLAY, colored in gray and yellow.
25.50	*1.50*	QCS2	Dense / Hard	Alternation of Clayey Sand and CLAY, colored in gray, yellow, and brown.

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

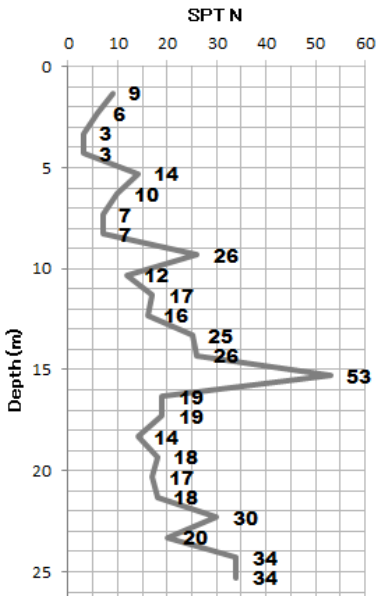


Figure 6.4-10 Br. 55

(7) Br. 57

Figure 6.4-11 shows stratification and distribution of SPT N-values at Br. 57. N-values increase downwards. Groundwater was not confirmed during the drilling.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
4.00	*4.00*	QC1	Firm - Stiff	Brown, gray CLAY with Sand (upper) or CLAY (lower)
11.00	*7.00*	QC2	Very Stiff	Gray, brown, yellowish-brown CLAY with Sand
18.00	*7.00*	QS1	Medium Dense - Dense	Dark gray, yellowish-gray, yellow Clayey fine to coarse SAND
25.45	*7.45*	QC3	Hard	Grayish-brown, reddish gray CLAY with Sand

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

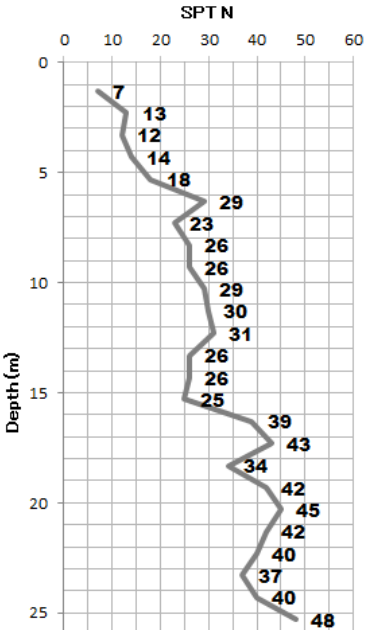


Figure 6.4-11 Br. 57

(8) Br. 58

Figure 6.4-12 shows stratification and distribution of SPT N-values at Br. 58. N-values increase with the depth gradually, except between GL-20 and 22 meters. Recorded groundwater table was GL-2.60 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
2.00	*2.00*	QC1	Firm - Stiff	Brown, gray CLAY with Sand
7.00	*5.00*	QS1	Loose	Gray Clayey fine SAND, interbedded with in the middle and underlain by fine sand.
12.00	*5.00*	QC2	Firm - Stiff	Brown, gray CLAY with Sand
15.00	*3.00*	QC3	Stiff - Very Stiff	Yellow, brown CLAY with Sand
20.00	*5.00*	QC4	Very Stiff - Hard	Yellow, grayish-brown, reddish-yellow CLAY with Sand, 18~19m, Clayey SAND with Gravel, 19m~, Sandy CLAY
25.45	*5.45*	QS2	Medium Dense	Yellow, light gray, yellowish gray Clayey fine SAND

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

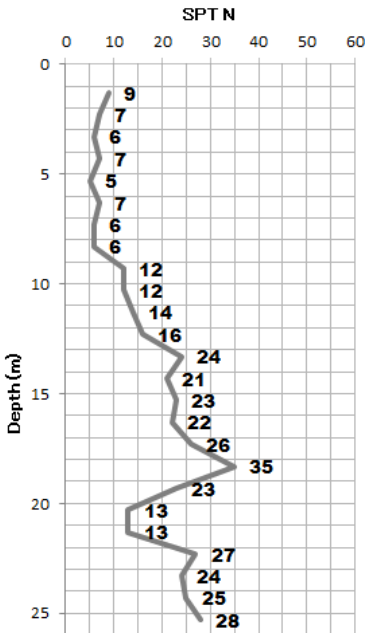


Figure 6.4-12 Br. 58

(9) Br. 59

Figure 6.4-13 shows stratification and distribution of SPT N-values at Br. 59. N-values show downward-increasing profile. The drilling encountered groundwater at GL-15.15 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
3.00	*3.00*	QC1	Firm - Stiff	Upper: blown CLAY with Sand, lower: reddish-gray CLAY with Sand.
6.00	*3.00*	QS1	Medium Dense	Yellow Clayey fine SAND
15.00	*9.00*	QC2	Stiff - Very Stiff	Brown, gray, yellow CLAY with Sand (upper, middle) or Sandy CLAY (lower)
18.00	*3.00*	QS2	Medium Dense	Yellow, gray, light gray Clayey coarse SAND
25.45	*7.45*	QC3	Very Stiff - Hard	Gray, light gray, brown Sandy CLAY

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

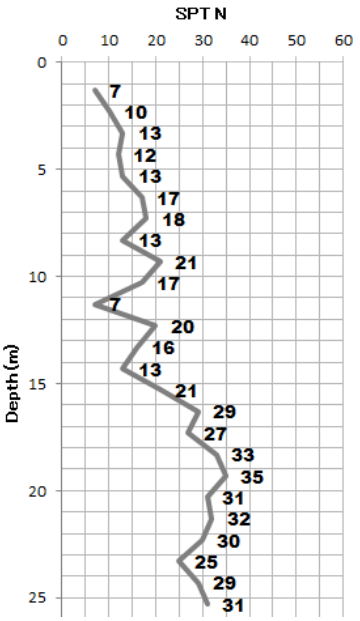


Figure 6.4-13 Br. 59

(10) Br. 66

Figure 6.4-14 shows stratification and distribution of SPT N-values at Br. 66. N-values increase with the depth gradually. Groundwater was not confirmed.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
4.00	*4.00*	QC1	Stiff	Brown, dark brown, yellow CLAY with Sand 2~3m, Sandy CLAY
14.00	*10.00*	QC2	Stiff - Very Stiff	Brown, Yellow CLAY or CLAY with Sand
18.00	*4.00*	QS1	Medium Dense	Brown, yellow, light gray Clayey fine to medium SAND, coarsening-downward
20.00	*2.00*	QC3	Very Stiff	Brown, yellow, gray CLAY (upper) or CLAY with Sand (lower)
21.00	*1.00*	QS2	Very Dense	Reddish-gray Clayey SAND with Gravel
25.45	*4.45*	QC4	Very Stiff - Hard	Brown, yellow, gray CLAY with Sand or Sandy CLAY 24~25m, contains some gravel, 25~25.5m, CLAY

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

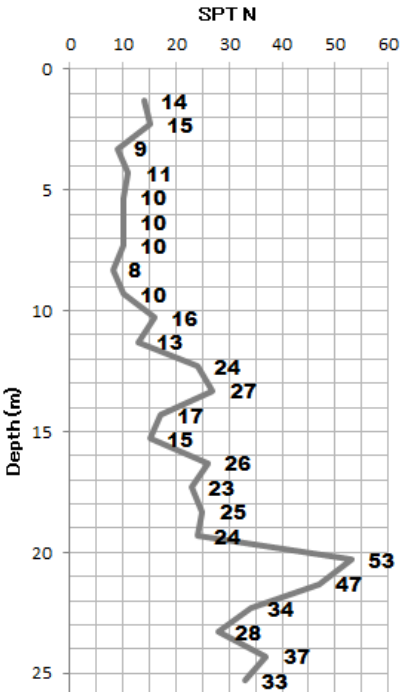


Figure 6.4-14 Br. 66

(11) Br. 68

Figure 6.4-15 shows stratification and distribution of SPT N-values at Br. 68. N-values increase gradually with the depth. The drilling encountered groundwater at GL-5.10 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
3.00	*3.00*	QC1	Firm	Reddish-gray, gray Sandy CLAY
4.00	*1.00*	QG1	Medium Dense	Gray Clayey GRAVEL with Sand
7.00	*3.00*	QC2	Firm - Stiff	Gray, light brown CLAY with Sand or Sandy CLAY
8.00	*1.00*	QS1	Loose	Gray Clayey fine SAND
10.00	*2.00*	QC3	Stiff	Light brown, brown CLAY (upper) or Sandy CLAY (lower)
20.00	*10.00*	QC4	Stiff - Very Stiff	Brown, Yellowish-brown, gray CLAY (upper, lower) or CLAY with Sand (middle)
22.00	*2.00*	QC5	Very Stiff	Gray, yellow, brown CLAY with Sand
25.45	*3.45*	QC6	Hard	Gray, yellow, brown CLAY with Sand (upper) or CLAY (lower)

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

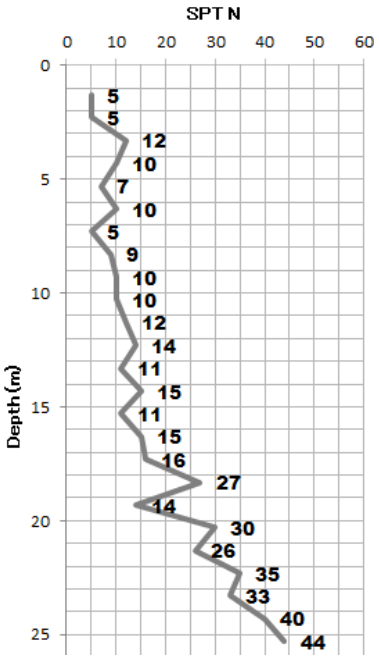


Figure 6.4-15 Br. 68

(12) Br. 75

Figure 6.4-16 shows stratification and distribution of SPT N-values at Br. 75. N-values increase gradually with the depth. Recorded groundwater table was GL-5.20 m.

Depth(m)	Thickness (m)	Strata	Apparent Density / Consistency	Description
3.00	*3.00*	QC1	Soft - Stiff	Dark gray organic CLAY with Sand (upper) or Sandy CLAY (lower)
11.00	*8.00*	QC2	Firm - Very Stiff	Reddish-gray, yellowish-red, dark brown CLAY with Sand or CLAY
19.00	*8.00*	QS1	Medium Dense	Gray, brownish-gray, light gray Clayey fine to coarse SAND 16~17m, Sandy CLAY
22.00	*3.00*	QC3	Very Stiff	Gray, brownish-gray, CLAY with Sand or CLAY 21~22m, Sandy CLAY
25.45	*3.45*	QC4	Hard	Gray, brownish-gray, CLAY with Sand (upper, lower) or CLAY (middle)

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

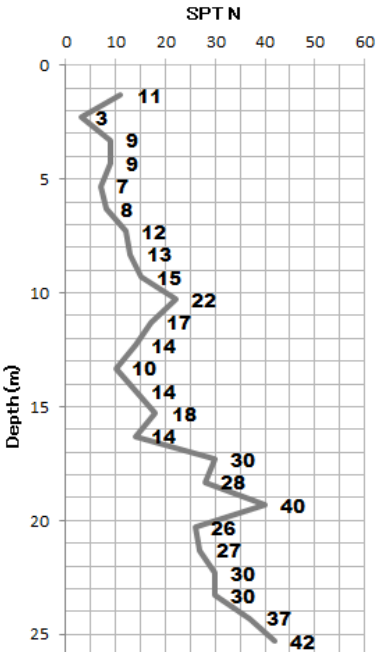


Figure 6.4-16 Br. 75

Laboratory Test

Laboratory tests were implemented utilizing disturbed and undisturbed samples obtained from the boreholes by SPT and undisturbed sampling, for the following test items:

· Specific Gravity	ASTM D 854 or equivalent
· Natural Moisture Content	ASTM D 2216 or equivalent
· Atterberg Limits	ASTM D 4318 or equivalent
· Sieve Analysis	ASTM D 422 or equivalent
· Unconfined Compression Test	ASTM D 2166 or equivalent

The results of the laboratory tests are attached to Appendix 6-9.

6.4.3 Geotechnical Characteristics of the Survey Area

(1) General

Throughout the Middle Section, NR 5 traverses the flat terrain at elevations of between 10 and 18 meters, except around KP 220 and between KP 270 and 280 near Battambang where elevations of the ground are lower than 10 meters. On the other hand, the flood plains surrounding the Great Lake mark elevations a little higher than 4 meters at the southern perimeter of the lake. Thus the flat terrain of NR 5 has distinct difference in elevation with the flood plain. Clear difference is also seen in the hardness of the soil observed at site between the flat terrain and the flood plains. These differences strongly support that the geological condition in the flat terrain of NR 5 is different from that of the flood plain.

Topographic information and site condition described above suggest the sediments of the flat terrain of NR 5 correspond to Middle Quaternary or Late Quaternary, whereas the flood plains, which was formed by the subsidence of the Great Lake Basin in recent several thousand years, is overlain by Holocene Alluvium. Along the NR 5, the sediments of Middle to Late Quaternary may be underlain by Pliocene - Pleistocene or Jurassic - Cretaceous sedimentary rocks.

Another point which may attract attentions is the distance from the marginal parts of the Caradamome Mountains, which stretch its ridges generally in NW - SE trend in the south of NR 5. Around Pursat, the distances between the road and the Caradamomes are 10 km or less, whereas in other sections such as around Battambang or Moung Ruessei, the distances reach around 30 km or more. In and around Pursat, therefore, Pliocene - Pleistocene or Jurassic - Cretaceous are expected to underlie Quaternary in shallower depths than in other sections of the road.

(2) Geotechnical Characteristics

As explained in the previous section, except shallower depths of the boreholes, the strata

confirmed in the investigation show stiff or dense conditions which cannot be seen in Holocene Alluvium. In general, the strata show yellow, gray, and brown colors in SPT samples. White and whitish colors are also observed.

The strata often contain both clayey and sandy contents, the proportion of which varies by depths and locations. Thus, even though clay is predominant, alternation of clay and sand is dominant stratification in the area.

The strata occasionally include a small amount of gravels. In some parts, weathered gravels, which is often seen in the strata of Pleistocene or older, were confirmed in SPT samples.

From a geotechnical point of view, the strata of the sites provide favorable condition to be used as bearing layers for pile foundations, rather than unfavorable. Although desirable bearing layers for pile foundations such as layers with SPT N-values of N=50 or more are expected only in the very limited sites, layers with N-values of N=30 or more are confirmed in many locations.

Table 6.4-3 suggests candidates of bearing layers at each site, selected under the following conditions for bearing layers for pile foundations:

- SPT N-value of N=30 or more
- More than 5 meters thick
- No underlying soft layers

Table 6.4-3 Candidates of Bearing Layers

Bridge Site	Bearing Layer		
	Emerging Depth (GL-m)	Strata	Description
Br 42	22.00	QS3	Clayey sand, N>=30, Thickness shall be confirmed in DD.
Br 44	25.00	QC4	Clay, N>=50, *Thickness shall be confirmed in DD*.
Br 47	12.00	QC3 ~	Clay with sand, clayey sand, N>=40
Br 48	16.00	QC4	Sandy clay, N>=30
Br 50	20.00	QC5	Sandy clay, N>=40
Br 55	24.00	QCS2	Alternatio of clay and sand, N>=30, *Thickness shall be confirmed in DD*.
Br 57	18.00	QC3	Clay with sand, N>=30
Br 58	No layers with N-values of N>=30 within the drilled depths.		
Br 59	18.00	QC3	Sandy clay, N>=30, except GL-23~24m where SPT N-values were N=25 and 29.
Br 66	20.00	QS2 / QC4	Clayey sand with gravel, N>=50, Clay with sand, sandy clay, N>=30, except GL-23m where N=28.
Br 68	22.00	QC6	Clay with sand, clay, N>=40 *Thickness shall be confirmed in DD.*
Br 75	22.00	QC4	Clay with sand, clay, N>=30 *Thickness shall be confirmed in DD.*

* Name of strata is unique for each borehole;
same name of strata does not mean the same strata between boreholes.

(3) Groundwater

Through the drilling on site, groundwater was carefully investigated. Drilling by a rotary auger used in the Study does not require circulation water for cooling drilling bits and evacuating slime and sludge from boreholes. Thus groundwater encountered in the bore holes can be easily detected by checking inner rods of auger pipes and drilling bits equipped at the tip of the inner rods. In addition, at each bore hole, groundwater table was checked one day after the completion of the drilling.

Table 6.4-4 summarizes groundwater condition at the sites.

At Br. 42, Br. 48, Br. 58, and Br. 75, the depths of water table were much shallower than the depths of emergence of groundwater. The strata where groundwater emerged were sandy

layers or clayey layers with rich sandy contents and overlain by clayey layers. It is likely, therefore, that the groundwater at these sites is artesian water confined by the overlain clayey layers. Since the works were done in the rainy season, however, there was some possibility that rain water might flow into the boreholes during the period between the completion and the measurement of the water table and then raise the level of water table. Thus confirmation in D/D period is important.

At Br. 57, Br. 59, Br. 66, and Br. 68, water table was not confirmed.

At Br. 59, where drilling was done on the river bed, the depth of water table was unable to be checked, due to the river water flowing into the bore hole and filling it up to the ground level.

Table 6.4-4 Groundwater Condition

Bridge Site	Groundwater			Remark
	Encountered in Drilling (GL-m)	Strata	Watertable 1 Day After Drilling (GL-m)	
Br42	6.15	QC2	2.35	Artesian Water?
Br44	6.40	QC1	6.00	
Br47	5.00	QS1	5.10	
Br48	14.25	QC3	9.70	Artesian Water?
Br50	6.00	QC1	8.40	
Br55	6.00	QS1	5.85	
Br57	None		None	
Br58	4.40	QS1	2.60	Artesian Water?
Br59	15.15	QS2	None	River water flowed into the borehole.
Br66	None		None	
Br68	5.10	QC2	None	
Br75	13.00	QS1	5.20	Artesian Water?

6.4.4 Soil Parameter

Based on the SPT N-value measured at site and the results of laboratory tests, soil parameters of the sites were preliminary calculated. Calculated soil parameter was organized into Appendix 6-10.

(1) Specific Gravity, γt

Specific Gravity, γt , of soil was assumed from the commonly accepted table organized by Ministry of Land, Infrastructure, Transport and Tourism of Japan, shown in Table 6.4-5.

(2) Angle of Shear Resistance, φ

The angle of shear resistance of sandy soil was calculated from the SPT N-value. Figure 6.4-17 shows the way to estimate the angle of shear resistance with SPT N-value and effective overburden pressure.

According to the behavior of clay, angle of shear resistance is assumed to be null.

(3) Undrained Cohesion, c

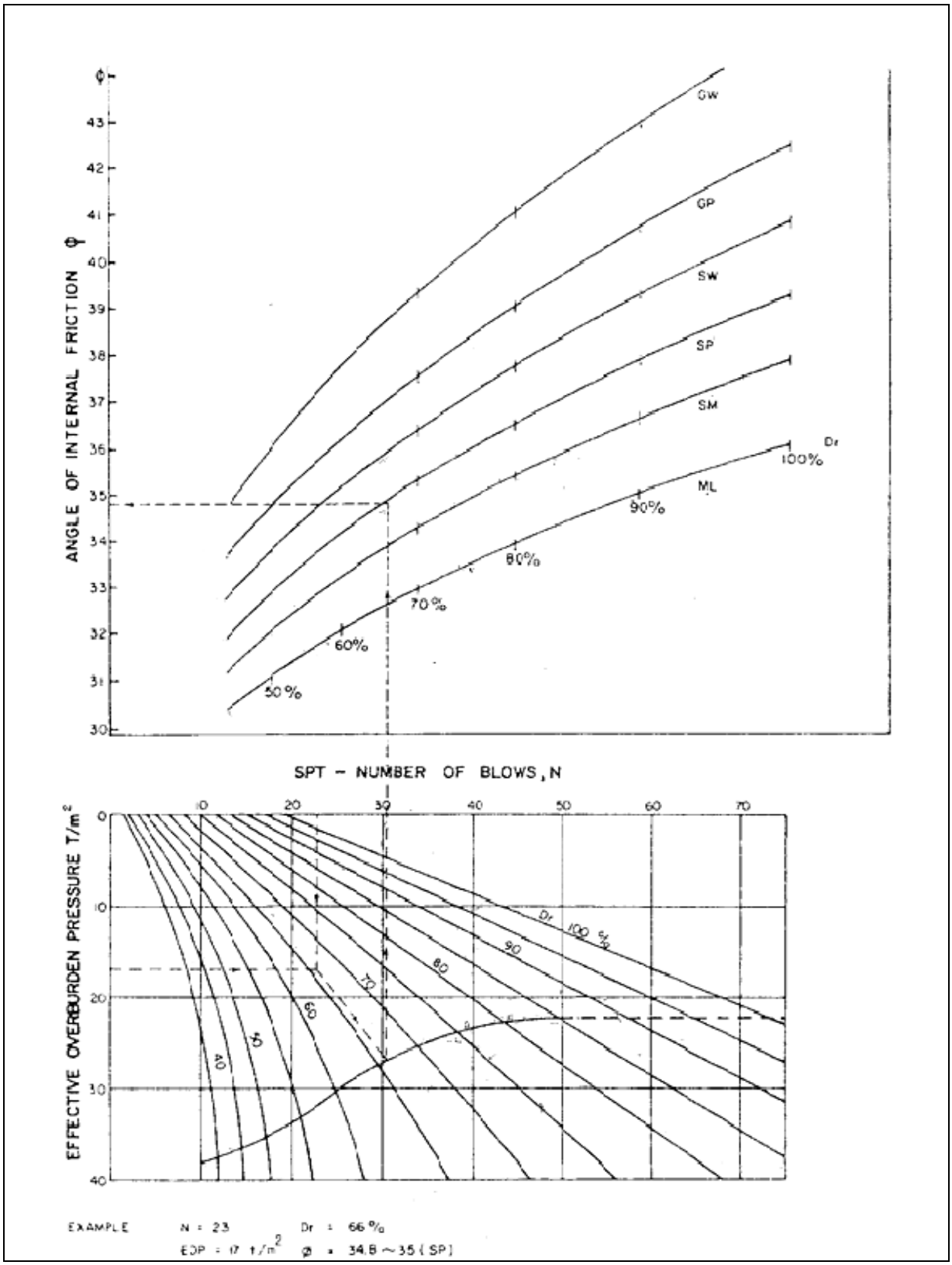
Undrained cohesion was estimated from the SPT N-value of clayey soil. Figure 6.4-18 shows the commonly accepted correlation between undrained cohesion and SPT N-value.

According to the behavior of free-draining materials, cohesion of sandy soil is assumed to be null.

Table 6.4-5 Soil Parameters by Ministry of Land, Infrastructure, Transport and Tourism of Japan

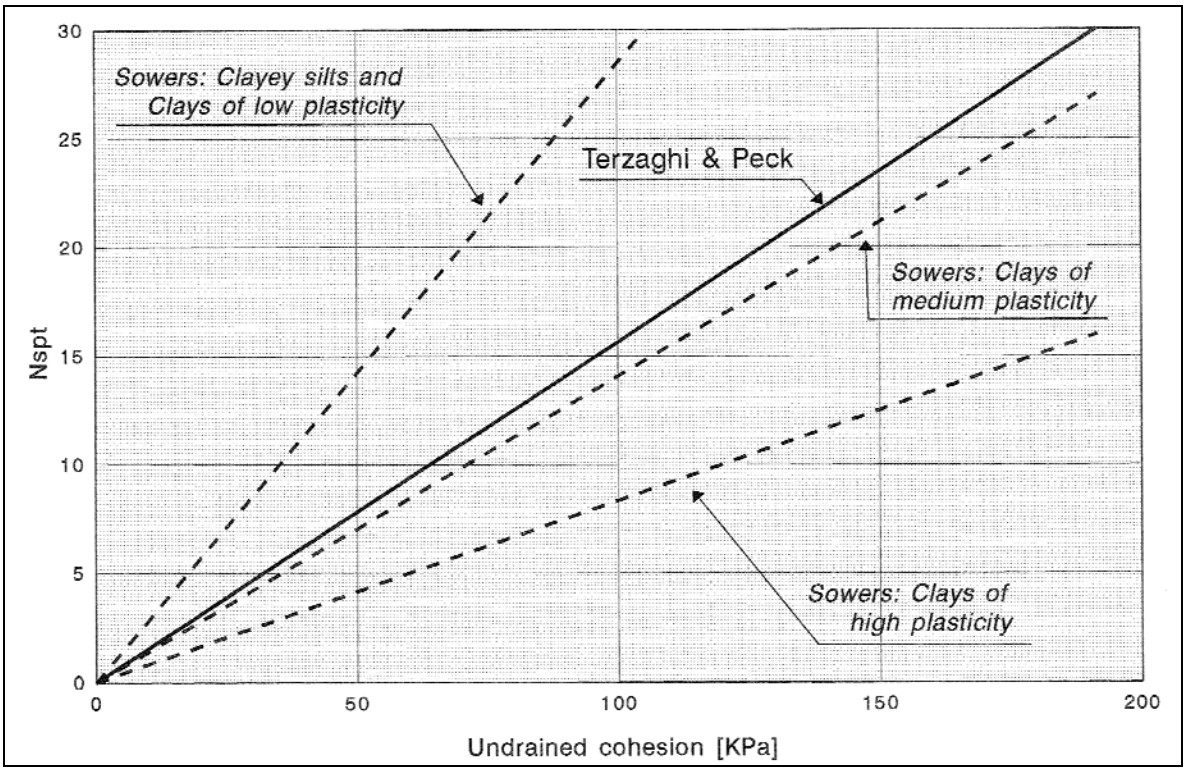
Soil Type		Status		Unit Weight (t/m3)	Angle of Internal Friction (°)	Cohesion (kN/m2)	Unified Soil Classification System
Artificial Ground	Gravel or Sand with Gravel	Well Compacted		2.0	40	0	GW, GP
	Sand	Well Compacted	Well-graded	2.0	35	0	SW
			Poorly-graded	1.9	30	0	SP
	Sandy Soil	Well Compacted		1.9	25	<30	SM, SC
	Clayey Soil	Well Compacted		1.8	15	<50	MH, ML, CH, CL
Natural Ground	Gravel	Well Compacted or Well-graded		2.0	40	0	GW
		Poorly Compacted or Poorly-graded		1.8	35	0	GP
	Sand with Gravel	Well Compacted		2.1	40	0	GW
		Poorly Compacted		1.9	35	0	GP
	Sand	Well Compacted or Well-graded		2.0	35	0	SW
		Poorly Compacted or Poorly-graded		1.8	30	0	SP
	Sandy Soil	Well Compacted		1.9	30	<30	SM, SC
		Poorly Compacted		1.7	25	0	
	Clayey Soil	Stiff (N = 8-15)		1.8	25	<50	ML, CL
		Medium Stiff (N = 4-8)		1.7	20	<30	
		Soft (N = 2-4)		1.6	15	<15	
	Clay or Silt	Stiff (N = 8-15)		1.7	20	<50	CH, MH, ML
		Medium Stiff (N = 4-8)		1.6	15	<30	
		Soft (N = 2-4)		1.4	10	<15	

Translated from: Road Design Manual, Kinki Regional Bureau, Ministry of Land, Infrastructure, Transport and Tourism of Japan



Source: Soil Mechanics Design Manual 7.01, Naval Facilities Engineering Command (Modified from: H.J.Gibbs & W.G.Holtz, 1957)

Figure 6.4-17 Determinations of Dr and φ, Based on SPT N Values



Source: Soil Mechanics Design Manual 7.01, Naval Facilities Engineering Command 7.01

Figure 6.4-18 Determination of Cohesion with SPT N Values

CHAPTER 7 PROBLEMS OF EXISTING ROAD CONDITION AND GENERAL SHCEME OF IMPROVEMENT

7.1 Problems of Existing Road Condition of NR 5

Based on the results of various surveys as cited above, the problems of current Middle Section and the Sri Sophorn – Poipet Section of NR 5 can be summarized as below:

7.1.1 Problems of Existing Road Condition of Middle Section

(1) Insufficient Road Width

- The average width of existing carriageway is 10.4 m. Because of the large volume of slow-speed traffic, such as motorumocks, agricultural tractors and motorcycles, high-speed traffic are forced to slow down. As a result, the efficiency of transport is reduced.
- This mixture of slow-speed traffic and high-speed traffic on a narrow carriageway is creating hazardous traffic situation. In view of the fact that widening of the adjacent sections on the both sides of the Middle Section (South Section and North Section) into full 4 lanes is being planned, it is preferable to widen the Middle Section into 4 lanes to maintain the same level of traffic safety.
- Forecasted traffic demand in 2033 on the section between Thlea Ma'am and Battambang is approximately 27,500 pcu/day. With this traffic volume on 10.4 m-wide carriageway, substantial traffic congestion is anticipated in the peak hours.
- Thus, widening to full 4-lanes will become necessary before year 2033.

(2) Weak Pavement Structure

- Existing pavement is DBST. Because of small bearing capacity of DBST, damages occur every year, especially after rainy season.
- Because of potholes and other defects, vehicles are forced to slowdown. This is causing great economic loss.
- MPWT is spending considerable amount of fund in repair of damaged pavement every year. This is imposing financial burden to the Royal Government of Cambodia (RGC) which can be reduced if the pavement is improved to asphalt concrete (AC).
- Thus, improvement of pavement to AC is needed.

(3) Insufficient Road Height

- Flood water flew over the road surface at some places of the Middle Section in October 2013, severely hampering the traffic. Such slow down and/or interruption resulted in substantial economic loss.

- Thus, raising the height of the road surface at the inundated sections is needed.

(4) Passing Through Urbanized Areas

- The existing NR 5 is passing through cities and towns, such as Pursat.
- This is undesirable not only from the viewpoint of traffic congestion but also from the viewpoint of traffic accident and air pollution.

7.1.2 Problems of Existing Road Condition of the Sri Sophorn - Poipet Section

(1) Insufficient Road Width

- The average width of existing carriage way is 11.0 m composed of 2-lane + MC lane in the rural areas. A carriage way with this width cannot provide with sufficient space for full 4-lanes.
- Forecasted traffic demand in 2033 on the Sri Sophorn - Poipet Section is approximately 25,500 pcu/day as it is forecasted in this Survey. A full 4-lane road is necessary to accommodate this traffic volume.
- Thus, widening to full 4-lane will become necessary before year 2033.

(2) Deteriorating Pavement Condition

- This section was improved and the surface was changed to AC pavement in 2008. The general condition of pavement is still good. However, six years has passed since the construction of the existing pavement and some defects such as cracks and ruts are observed on the surface of the road. (Please see in Chapter 4) It is supposed that rehabilitation of the pavement, such as re-paving or overlay, will become necessary in some years.
- Traffic volume on this section is increasing more rapidly than forecasted for the planning of the rehabilitation in 2008.
- Thus, it is recommended that reconstruction of pavement structure be delivered at the same time as its widening.

Considering these problems, general scheme of the improvement of the Middle Section and the Sri Sophorn - Poipet Section of NR 5 is proposed as presented in the following section:

7.2 General Scheme of Improvement of Middle Section and the Sri Sophorn - Poipet Section

The scheme of improvement of the Middle Section and the Sri Sophorn - Poipet Section is to be discussed and agreed upon between the RGC and JICA at the time of Loan Fact - Finding and Loan Appraisal. The followings are the proposals by the Survey Team to be used as the basis for discussion between RGC and JICA:

7.2.1 Section to be Improved

The surveyed roads are divided into four sections; Section I, II, III and IV as shown in Figure 7.2-1.

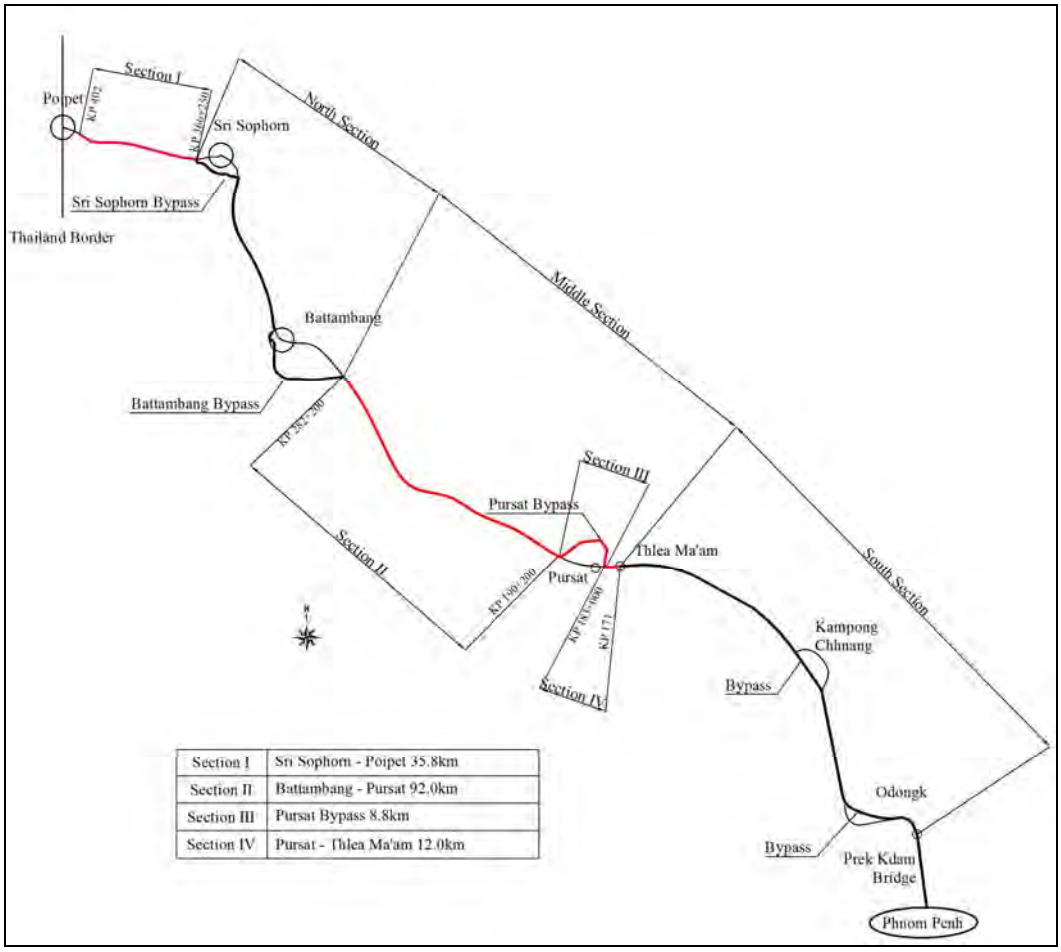


Figure 7.2-1 Section to be Improved

Section I (Sri Sophorn – Poipet Section):

The main scope of work of this section is widening into 4-lane and re-construction of pavement.

This section starts from KP 366+250 at the northern end of Sri Sophorn Bypass which is included in the project of the North Section and end at around KP 402 where the road has already been widened to 4-lane. This section covers planned connection point with the access road to/from the future border facilities between Thailand and Cambodia. The access road to/from the future border facilities is currently being studied by the government of Thailand and is expected to be constructed by the government of Thailand. Therefore, this project is planned not to include this access road.

Figure 7.2-2 shows the end point of this section. And, Figure 7.2-3 shows the detailed drawing of the end point.

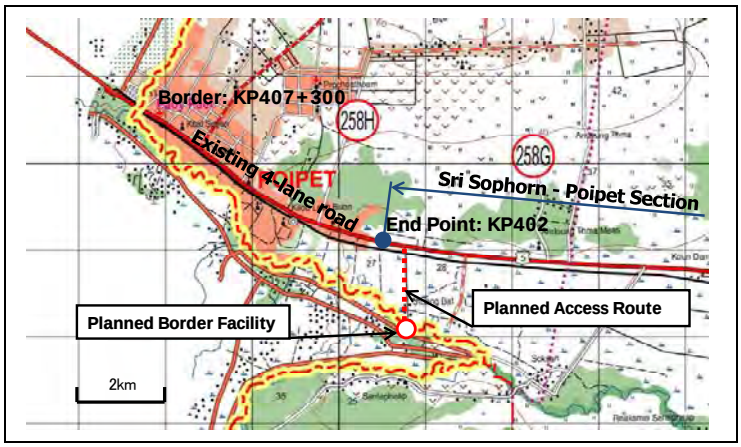


Figure 7.2-2 End Point of Sri Sophorn – Poipet Section

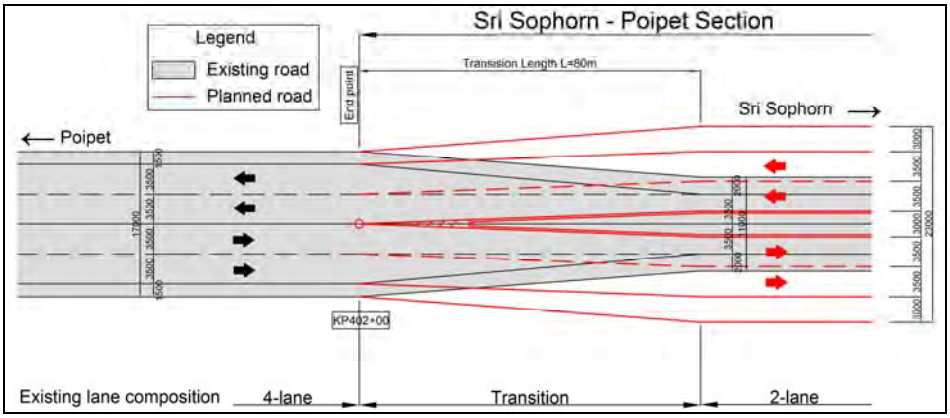


Figure 7.2-3 Plan Drawing of the End Point of Sri Sophorn – Poipet Section

Section II and IV:

The main scope of work of these sections is widening into 4-lane And improvement of pavement from DBST to AC.

Section IV starts from KP 171+000 in Thlea Ma'am at the end of the South Section and end at KP 183+000 which is the starting point of Pursat Bypass (Section III). Section II starts from KP 190+200 (the end point of Pursat Bypass) and end at KP 282+200 which is the starting point of Battambang Bypass, included in the project of the South Section.

Section III:

The main scope of work of this section is construction of Pursat Bypass.

This section is proposed as a bypass to avoid large scale relocation of households/buildings in the urbanized area of Pursat City which is required if this section of the existing NR 5 is to be widened.

7.2.2 Widening

It is proposed that the Middle Section and the Sri Sophorn – Poipet Section of NR 5 be widened

into full 4-lane considering the following facts:

(1) Role of NR 5 and Modern Logistics

As discussed in Chapter 3, NR 5 as well as NR 1 and NR 4 is given a very important role in the road network of both Cambodia and GMS. Therefore, such national road needs to be widened into full 4-lane in order to lead to activation of logistics system of Cambodia. Modern logistics require reliable transportation infrastructure which can transport goods in the planned time. Carriage way of 10.4 m in width can accommodate only an opposed '2-lane with MC lanes' road and has little safety margin with regard to the capacity compared to a full 4-lane road. For example, a '2-lane with MC lanes' road is easily jammed if a severe traffic accident occurs and one lane is blocked. On the other hand, traffic in full 4-lane road can be operated even if one lane is blocked, by effectively utilizing remaining 3-lanes and shoulder. Thus, it is recommended that the whole section of NR 5 be widened into full 4-lane.

(2) Consistency of Design Standard

In most countries, uniform design standard is applied on the entire section of a road. Change in design standard often causes confusion on the side of drivers. Of course, design standard is adjusted depending of the planned/estimated traffic volume, terrain and other factors. In the case of the Middle Section and the Sri Sophorn – Poipet Section, estimated traffic volumes (approx. 27,500 pcu/day and approx. 25,500 pcu/day, respectively) are similar to those on the North Section and South Section which are being planned to be widened into full 4-lane road. In addition, the section between Phnom Penh and Prek Kdam is being widened into full 4-lanes. From viewpoint of consistency of road design standard, 4-lane cross section is recommended.

(3) Traffic Situation and Traffic Accident of NR 5

Accident rate of NR 5 is the highest among the single-digit national highways. The statistics of road crashes and casualties in Cambodia in 2011 are summarized in Table 7.2-1. These data/information are not of NR 5 but of the whole road network of Cambodia. However, the general features can be applied to NR 5. Thus, these statistics are considered to show the causes of traffic accidents of NR 5.

The principal causes of traffic accident in Cambodia are over-speeding, drunken driving, hazardous overtaking and not observing traffic rule. They account for approximately 80% of causes of motorbike or pedestrian fatalities. Fatalities of motorbike riders/passengers and pedestrians account for 79% of total fatalities. Human errors are often the main cause of these accidents. Traffic safety education and traffic regulation are deemed to be priority to reduce road crushes and casualties. While the education and regulation are expected to be developed, improvement of road structures should also contribute to reducing road crushes and casualties. Widening to full 4-lane is to separate slow traffic and fast traffic, and thus, reduces the necessity of overtaking.

Table 7.2-1 Summary of Statics of Road Crushes and Casualties in Cambodia in 2011

Percentage of Fatalities by Mode of Transport	Motorbike riders accounted for 66% of total fatalities, followed by pedestrians (13%) and drivers/passengers of passenger cars (8%).
Cause of Motorbike Fatalities	Over speeding accounted for 48%, followed by drunk driving (18%), dangerous overtaking (9%) and not observing priorities between vehicles/traffic flow (9%).
Cause of Pedestrian Fatalities	Over speeding accounted for 65%, followed by drunken driving (6%) and not observing priorities between vehicles/traffic flow (5%).
Percentage of Fatalities by Characteristic of Roads	80% of fatalities happened on straight roads, followed by curve roads (9%). 26% of fatalities on straight road occurred at urban.
Percentage of fatalities by type of collisions	Head-on collision accounted for 36% of the total fatalities, followed by rear-end collisions (16%), right - angle collisions (15%) and overturned/fell alone (12%).
Contribution Factors of Crashes and Fatalities	Human errors contributed to 95% of crashes and fatalities, while vehicle defects accounts for 3.2% and road environment for 1.7%.
Black spots on NR 5	- Nak Tahang and Takol village, Peani and Kampong Tralach commune, Kampong Tralach district, Kampong Chhnang province - Tram village, Tnaot Chum commune, Krakor district, Pursat province - Kbal Khmouch village, Chrey commune, Thmor Koul district, Battambang province - Kbal spean village, Poy Pet municipality, Ou Chrov district, Banteay Meanchey province

Source: "Road Crush and Victim Information System, 2011 Annual Report" issued by National Road Safety Committee.

The road improvement should include traffic control facilities that guide drivers observe the traffic rule. The following facts need to be addressed in planning the scale of improvement of the Middle section and the Sri Sophorn – Poipet Section.

- In rural areas, high speed vehicles tend to go into the opposite lane when they take over slow speed vehicles. Travelling in the opposite lane leads to high risk of serious crush. Physically blocking vehicles' travelling on the opposite lane is expected to substantially reduce serious crushes even if there are vehicles of over speeding and/or drunken driving on the road,. Thus, median division with adequate structure and width needs to be installed.
- There are few pedestrian crossings despite the fact that farmers with domestic animals such as cows or water buffalos cross the road. When the road improvement is completed, road crossing will become more dangerous for those farmers and cattle because vehicles' travelling speed will become higher and the road width will be wider. Thus, pedestrian crossings with traffic signs need to be provided at strategic locations.
- In urban areas, many pedestrians walk along the road and vehicles are parked on the road. In addition, pedestrians cross the road and vehicles turn to go in to the streets connected to NR 5. Considering these, the cross section in urban areas should be as follows:
  - Side walk needs to be provided
  - Parking space should be provided
  - Raised median should not be adopted to allow turning of vehicles.

(4) Structure of Median Division

Design of the structure of a median division is one of the most important design items to reduce traffic accidents. Raised median physically prohibits travelling on the opposite lanes and eliminates the risk of head-on collision. Type of median division is selected considering the following points.

- Smooth traffic must be assured as the function of both national and international trunk road.
- Cross section and other aspects of geometric design should be distinguished between urban area and rural area because the traffic characteristics are different.
- In rural area, the prime consideration is safe and smooth traffic with high speed (high mobility).
- In urban area, the prime consideration is accessibility to the connected roads and roadside houses/shops, as well as safety of pedestrians.

The following table shows the comparison of two types of median division. As a result, the type of "raised structure with curb stone" is selected provided that the following measures are adopted in order to improve the week points to the type of "double line with road stud/chatter bar".

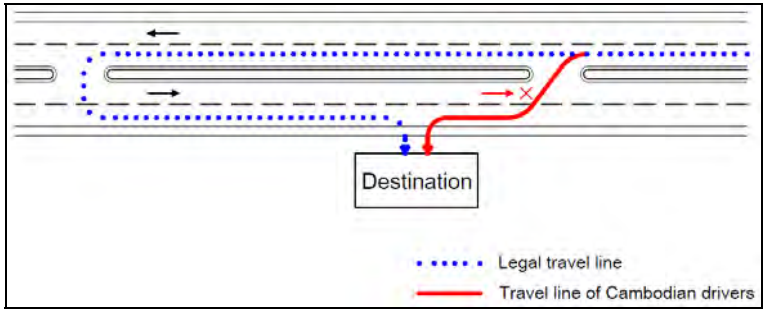
- U-turn lane shall be installed at a regular interval and at strategic locations.
- Opening in median should be provided at strategic locations.

Table 7.2-2 Comparison of Median Type

Median Type	Double Line only	Double Line with Road Stud/Chatter Bar	Raised with Curb Stone
Sample Picture			
Traffic Safety	**Poor:** Vehicles can easily go beyond the center line and cause head-on collision.	**Fair:** Drivers are discouraged to cross the median by shock when the wheel of the vehicle treads on the stud/chatter bar. Drivers are also warned if crossing the median unintentionally.	**Good (in general):** ・Vehicles are physically prohibited to go into the opposite traffic lane due by the curve. The function of visual guidance also. ・See the bottom box for negative influence.
Pedestrian Safety	**Poor:** Pedestrians are forced to cross the road in a hurry because of large width of full 4-lane.	**Poor:** Same as the left box.	**Good:** Openings of the median can be used as areas for pedestrians and ox carts to evacuate when they cross the road.
Emergency Traffic Operation	**Good:** Even if the carriageway in one direction is closed due to severe accident etc., minimum trafficability is secured by using remaining carriageway.	**Good:** Same as the left box.	**Poor:** If the carriageway in one direction is closed due to severe accident etc., traffic in that direction is stopped.
Travelling Performance	**Fair:** No structure is located at the median and that is normal road.	**Good:** Drivers think that oncoming vehicles of high speed do not come into their traffic lane but slow speed vehicles turning left or road crossing vehicles may disturb their driving.	**Excellent:** Drivers think that no oncoming vehicle or road crossing vehicle disturbs their driving, so driving speed can be kept high.

Median Type	Double Line only	Double Line with Road Stud / Chatter Bar	Mount up with Curb Stone
Access to Road Side Houses/Facilities	**Excellent:** Vehicles can turn left anywhere and there is no limitation for access to road side houses / facilities. Agricultural tractors or ox carts can cross the road easily anywhere.	**Excellent:** Same as the left box.	**Poor:** Access to road side houses/facilities are limited to openings of median.
Landscape	**Fair:** Normal road looking	**Fair:** Normal road looking	**Good:** Planting on the median is possible.
Cost Ratio to "Double Line with Road Stud/ Chatter Bar"	-----	**1.00**	**1.028**
Expected Ratio of Reduced Traffic Accident	-----	**68.7%** (Example rate of Rumble Strips applied in Japan) 	**91.7%** (Example rate of Mount Up Median with Fence applied in Japan) 

Negative influence: Cambodian drivers tend to turn to left and travel on the opposite lane before the location where they want to turn if tuning there is prohibited for some reason such as existence of median.



(5) Traffic Volume against Capacity

In the survey on South Section, the capacity of existing NR 5 was estimated at 19,000 pcu/day as the practical capacity of '2-lane with MC lanes' cross section which allows smooth traffic.

The estimated traffic volume on the Middle Section and the Sri Sophorn – Poipet Section in year 2033 are about 27,500 pcu/day and 25,500 pcu/day, respectively. These figures exceed the practical capacity of '2-lane with MC lanes' cross section as explained above.

(6) Proposed Road Cross Section

In addition to the considerations cited above, natural and social impacts and cost of the project are considered to select the cross section. Three alternatives of cross section are proposed including zero option as shown in the Table 7.2-3 and the comparison table for proposed road cross sections is shown in the Table 7.2-4.

Table 7.2-3 Alternatives of Cross Section

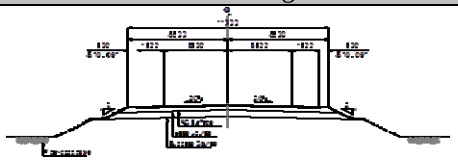
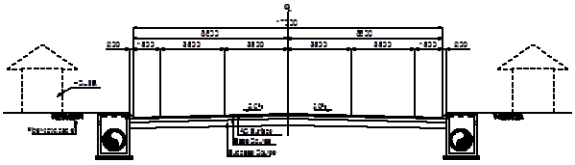
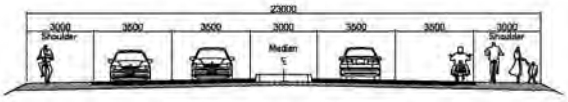
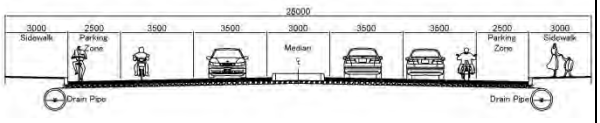
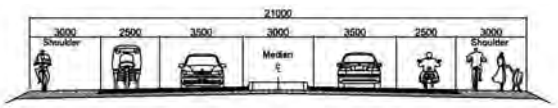
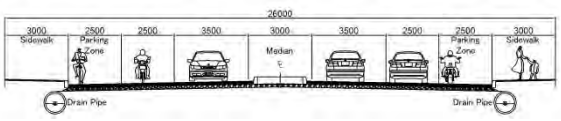
Alternative	Description	Schematic Diagram
ALT-0: Zero Option	No improvement of the road will be made.	 Rural Section  Urban Section
ALT-1: Widening road to full 4-lane and pavement improvement	Smooth traffic will be ensured against the future traffic volume. Slow speed vehicles such as motorcycles and bicycles will be separated from high speed vehicles such as passenger cars, resulting in improvement of traffic safety.	 Rural Section  Urban Section
ALT-2: Widening road to 2-lane with MC lanes and pavement improvement	Likewise ALT-1, smooth traffic will be ensured against the future traffic volume. Slow speed vehicles such as motorcycles and bicycles will be separated from high speed vehicles such as passenger cars resulting in improvement of traffic safety. However, the width of MC lane for slow speed vehicles is narrower than the lane width of ALT-1 (3.5 m) to reduce the impact to social and natural environment and the project cost.	 Rural Section  Urban Section

Table 7.2-4 Comparison of Alternatives of Improvement of Existing NR 5

Evaluation Rank 1st: ◎、2nd: ○、3rd: △、Improper: ×

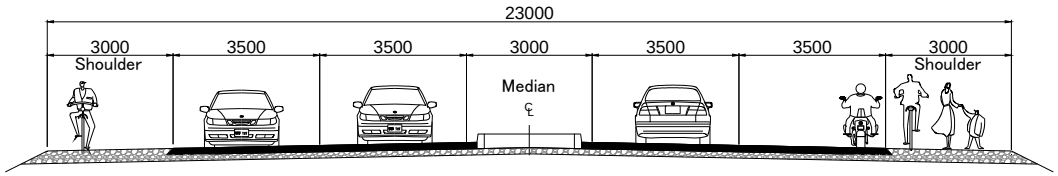
Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
Traffic Characteristic			
Predicted Traffic Volume	Middle Section : 14,200 pcu/day in 2023 : 20,800 pcu/day in 2028 : 27,500 pcu/day in 2033	Sri Sophorn – Poipet :15,600 pcu/day in 2023 :20,200 pcu/day in 2028 :25,500 pcu/day in 2033	
Capacity of Traffic Volume (pcu)	× 19,000	◎ 40,000	× 19,000
Natural Environmental Impact			
Natural Environmental Impact	◎ There is no impact.	○ No great impact is anticipated since this project is widening of the existing road and project site is considerably distant from Tonle Sap Lake and its important natural reserves. However, minor negative impact may occur and diligent consideration to minimize the impacts is required.	○ Same as ALT-1.
Social Impact			
Resettlement, Loss of Agricultural Land	◎ No resettlement will be required. And, no loss of agricultural land is anticipated.	△ Large-scale resettlement is required. And, agricultural land along the road will be lost for by the road.	○ Although they will be less than ALT-1, resettlement of a great number and replacement of agricultural land will arise.
Impact on Living Environment/Pollution	× As traffic volume increases in the future, traffic congestion is likely to occur. In that case, average driving speed will be slower and the increased stop and go will result in increase in the fuel consumption. This will cause increase in emission of air-pollutants.	◎ It is not likely that traffic congestion will arise if traffic volume increased in the near future. Therefore increase of car exhaust will be prevented.	○ It is same as ALT-1 basically but the capacity of traffic is smaller than ALT-1. Therefore, traffic congestion will arise earlier than ALT-1 and emission of air-pollutants will increase.

Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
Access to Public Service Facilities	△ Traffic will be not smooth and it will take more time to access schools, hospitals, etc.	◎ Access to public services, such as schools and hospitals, will become easier as a result of smooth traffic.	○ Easiness of access to public services is basically same as ALT-1, but will be deteriorated earlier than that in ALT-1.
Impact on Socio-Economic Activity	× Hindered smooth traffic will hinder socio-economic activities. Then, it will hamper the regional and national development.	◎ Smooth traffic will enhance socio-economic activities and regional development. The income level of the roadside areas will be upgraded due to improvement of employment opportunity and consumption of local goods during the construction work.	○ Basically same with ALT-1 but the traffic capacity is smaller than that in ALT-1. Therefore, traffic congestion will occur earlier than ALT-1 and affect the socio-economic activities.
Traffic Safety			
Vehicle to Vehicle	× Narrow carriageway width may result in accidents when vehicles overtake.	◎ Slow speed traffic, such as agricultural tractors, and high speed traffic, such as passenger cars, will be separated and traffic safety will be improved. Possibility of serious accidents such as head-on collision will be decreased by elimination of necessity of overtaking using the lane in opposite direction.	○ Traffic safety will be improved, to less extent than that of ALT-1, because slow speed traffic and high speed traffic will be separated (but to less extent than in ALT-1). Possibility of serious accidents such as head-on collision will be decreased by decrease of necessity for overtaking by using the opposite lane. Possibility of accidents for pedestrians when crossing the road is smaller than that of ALT-1 because the carriageway width is narrower than that of ALT-1.
Dangerousness of Crossing Road by Pedestrians/Farm a Animals	◎ Possibility of accidents when pedestrians/farm animals crossing road is the lowest among all of the alternatives because the carriageway	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of sufficiently wide median where pedestrians	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of sufficiently wide median.

Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
	width is the narrowest.	and animals can stand and wait passage of vehicles. However, traffic accidents of pedestrians crossing the road hit by high-speed vehicles may increase because of increased speed of vehicles.	
Road and Traffic Function	× As traffic volume increases, traffic congestion will occur and smooth traffic will not be achieved.	◎ Sufficient traffic capacity and smooth traffic will be achieved.	○ Traffic capacity of this alternative is smaller than that of ALT-1, therefore, traffic congestion of this alternative will occur earlier than that of Alt-1 and road widening will be needed again.
Economy			
Construction Cost	◎ No project cost is required.	△ Project including cost for resettlement, cost for road widening and cost for improvement of pavement. is necessary.	○ Cost for this alternative is smaller than that of ALT-1 since the work volume is smaller than that of ALT-1, resulting in reduced cost for resettlement and construction works.
Maintenance Cost	△ Middle Section: Fragile exiting pavement (DBST) is maintained resulting in high maintenance cost. Sri Sophorn – Poipet Section: The existing road was rehabilitated in 2008. Sin the design life period of AC pavement is usually 10 years, rehabilitation with overlay or reconstruction will be necessary in a few years.	◎ Maintenance cost will be decreased because the pavement is improved to durable AC.	◎ Maintenance cost will be decreased because the pavement is improved to durable AC.

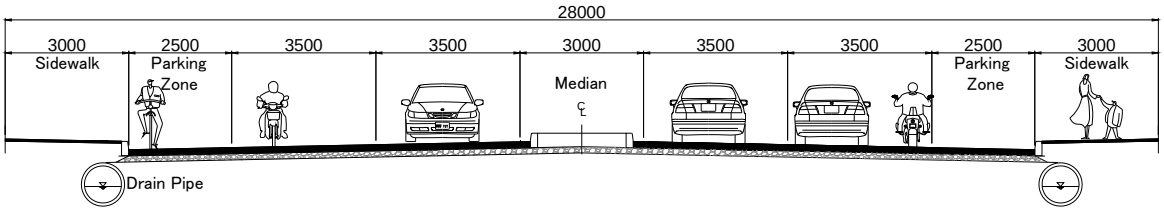
Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
Total Evaluation	×	◎ (Recommended)	○
	ALT-1 is the highest in the total evaluation, and is recommended. Views on the evaluation items of ALT-1 that are evaluated lower compared to other alternatives are as follows. ・"Construction Cost" of ALT-1 is the largest, however ALT=1 yields largest socio-economic benefits. ・Negative social impacts (resettlement and loss of agricultural land) and negative natural environmental impact of ALT-1 is larger than those of other alternatives. However these impacts are considered to be the minimum for achieving the objectives of the Project (achieving socio-economic development of Cambodia and enhancing integration of regional economy through enhancing transport capacity, improving transport efficiency, and improving traffic safety).		

With the considerations as cited above, it is proposed to widen the existing NR 5 into full 4-lanes with raised median division. Figure 7.2-4 and 7.2-5 show the proposed typical cross sections.



Raised Median (w=3.0 m) + full 4-lane Carriageway (w=3.5 m)
+ Shoulder (w=3.0 m)

Figure 7.2-4 Proposed Cross Section (Rural Area)



Raised Median (w=3.0 m) + full 4-lane Carriageway (w=3.5 m)
+ Parking Zone (w=2.5 m) + Sidewalk (w=3.0 m)

Figure 7.2-5 Proposed Cross Section (Urban Area)

7.2.3 Horizontal Alignment of Road

The Middle Section and the Sri Sophorn – Poipet Section of NR 5 will be improved basically maintaining the present road centerline. However, horizontal alignment of some sections of the road not satisfying the minimum radius of curve will be improved.

7.2.4 Elevation of Road Surface

The elevation of most parts of the existing road surface of the Middle Section is more than 1.0 m higher than flood water level of Tonle Sap. Nevertheless, it was observed in October 2013 that water flew over the road at some sections. The elevation of the flood water is discussed in Chapter 6 "6.1.5 Study of the Flood in 2013". Elevation of the road surface and installation of new drainage facilities are planned based on the study on the flood water level.

7.2.5 Improvement of Pavement Structure

The pavement of the Middle Section is DBST. DBST does not possess sufficient bearing capacity against the heavy traffic which is rapidly increasing in recent years. Also, in the smoothness of surface, DBST is inferior to AC. For these reasons, it is proposed that pavement structure be improved to AC.

On the other hand, the pavement of the Sri Sophorn – Poipet Section is AC. Five years have passed since the pavement of this section was constructed, and some defects such as cracks, potholes and flushes are observed. The design period of this section is supposed to be over within five years. It is proposed that the pavement structure of this section be reconstructed considering the strength of subgrade of the road and the future traffic volume.

7.2.6 Route of Pursat Bypass

The section between KP 184 and KP 188 is passing through the urbanized area of Pursat City. Widening of this section requires resettlement of large number of houses/households. Thus, construction of a bypass was studied.

The existing alignment of this section is almost straight. If a bypass is constructed to detour the city, the travel distance unavoidably becomes longer than that in the existing alignment. However, construction of a bypass is the practical solution to avoid the large scale resettlement needed for widening of the existing NR 5.

Five alternative routes were planned and compared. Figure 7.2-6 shows alternative routes.

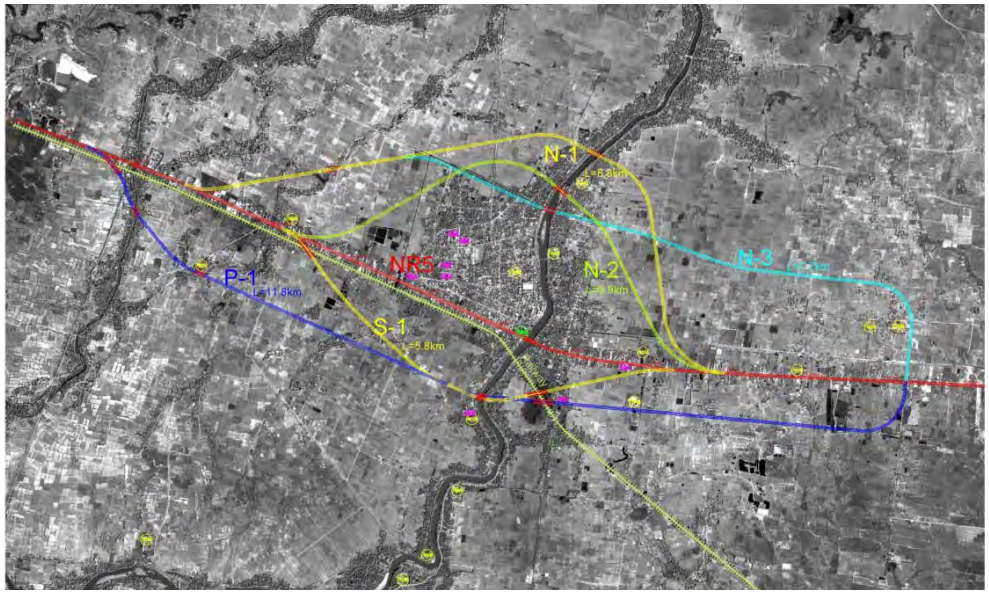


Figure 7.2-6 Alternative Routes of Pursat Bypass

One of the important points in evaluating the alternative routes is that the railroad is passing on the southern periphery of the city which is somewhat hindering the development of urban area

towards south. If the bypass is to pass the southern side of the city, two flyovers need to be constructed to avoid at-grade railroad crossing which is not preferable from the viewpoint of traffic safety. Construction of flyover requires considerable amount of cost.

On the other hand, if the bypass is to traverse the northern outskirt of the city, the route becomes longer than the routes passing the southern outskirt of the city. Also, the northern routes are closer to Tonle Sap Lake than southern routes.

Table 7.2-5 compares the advantage and disadvantage of the alternatives. Alternative N-2 was evaluated by the JICA Survey Team as the most practical route. On the other hand, the local government (Pursat Province) preferred to allow future expansion of the urbanized area.

After the discussion between the JICA Survey Team and RGC counterparts, ie MPWT and DPWT of Pursat, "N-1" route was selected. MOWRAM was consulted on the route of N-1 and replied that N-1 route is acceptable since it traverses the transition zone of Tonle Sap Biosphere Reserve where residential houses already exist and agriculture is being done. Figure 7.2-7 shows the selected route of Pursat Bypass.

It is proposed that the section of existing NR 5 which runs parallel to the bypass be excluded from the scope of "the Middle Section Improvement Project".

Table 7.2-5 Comparison of Alternative Routes of Pursat Bypass

Evaluation Rank 1st: ◎、2nd: ○、3rd: △、Improper: ×

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
Description	Widen existing NR 5.	Long detour route on the north side of the city.	Short detour on the north side of the city.	Plan intersections of BP with NR 5 at the roundabouts with monument which are located 5 km or more distant from the urbanized area.	Short detour on the south side of the city. Flyovers are constructed for railroad crossings at 2 locations.	Plan intersections of BP with NR 5 at the roundabouts with monuments which are located 5 km or more distant from the urbanized area. Flyovers are constructed for railroad crossing at 2 locations.
Natural Environmental Impact						
Impact on Natural Environment	◎ There is no big impact.	○ The biosphere might be split because new road will be constructed in the outskirt. Construction of a new road in the suburbs of the existing town area may accelerate expansion of urbanized area.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.
Social Impact						
Resettlement, Loss of Agricultural Land	× Widening of existing road passing town area still cause much resettlement. Resettlement is the largest among all the alternatives. Loss of agricultural	◎ Magnitude of resettlement is the smallest because this route is the farthest from the town. Loss of agricultural land is the 3rd smallest because the length of the route is the 3rd shortest.	× Magnitude of resettlement is the second largest. Loss of agricultural land is the second smallest because the length of the route is the second	× Resettlement is the third largest. Loss of agricultural land is relatively large because the length of the route is the second longest.	△ Resettlement is the third smallest. Loss of agricultural land is the smallest because the length of the route is the shortest.	○ Resettlement is the second smallest. Loss of agricultural land is the largest because the length of the route is the longest.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	land is minimum.		shortest.			
Impact on Living Environment / Pollution	○ Traffic passing the town will make more noise, vibration and air pollution.	◎ Traffic passing through the town will decrease and noise, vibration and pollution in the town will decrease. Noise, vibration and air pollution will be newly created on the bypass but times of stopping and starting will be decreased. Total impact on the living environment will be smaller compared to that in "Widen Existing NR 5".	◎ Mostly same as N-1.	◎ Mostly same as N-1.	◎ Mostly same as N-1.	◎ Mostly same as N-1.
Impact on Socio-Economic Activity	○ Efficiency of transport is lower than those of other alternatives because vehicles passing the town need to stop at traffic signals.	◎ Smoother traffic than that of "Widen Existing NR 5" will enhance socio-economic activities and promote development of the region.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.
Traffic Safety						
Traffic Safety	× Increased number of vehicles passing the town will worsen the situation of traffic accidents.	◎ Number of traffic accidents in the town will decrease because of decreased number of vehicle passing the town. Meanwhile, traffic accidents in the bypass will occur newly but the total number of traffic accidents will decrease	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
		because the bypass does not pass the urbanized area.				
Traffic Function						
	○	○	○	△	○	△
Advantage	・Shortest travel distance	・ Smooth connection with existing NR 5 ・ The function of bypass can be maintained for long time in the future even if the urbanized area will expand.	・ Smooth connection with existing NR 5	・ Intersections are sufficiently remote from the urbanized area and remain outside of the urbanized area.	・ Increase in travel distance is the smallest. ・ No serious influence to future expansion of the urbanized area.	・ Intersections are sufficiently remote from the urbanized area and remain outside of the urbanized area.
Disadvantage	・ Vehicles passing the town will stop at traffic signals. ・ Time required for pedestrians to cross the road will become longer resulting in increase in stopping time of vehicles while waiting the pedestrians crossing the road.	・ Travel distance will be the longest.	・ The function of the bypass may be reduced as the urbanized area will expand and be close to the bypass in the near future. ・ Travel distance is the second longest.	・ Vehicles are forced to slow down at the intersection on the east which is T-shaped with roundabout.	・ Steep longitudinal grade on the both sides of the flyovers for railroad crossing.	・ Vehicles are forced to slow down at the intersection on the east which is T-shaped with roundabout. ・ Steep longitudinal grade on the both sides of the flyovers for railroad crossing.
Acceptance by PAPs						
Acceptance by PAPs	◎ People along the road generally welcome the road improvement because:	○ People having land along bypass generally welcome because: ・ The land price becomes	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	・ The land price becomes higher, ・ Smooth traffic will be ensured and access to school, hospital, etc. becomes easier, ・ Dust from road is mitigated.	higher, ・ Smooth traffic is ensured and access to schools hospital, etc. becomes easier.				
Economy						
Construction Cost	◎	△	○	×	×	×
Numeric Data						
Length (km) of construction (BP) + improvement (NR 5)	10.8	12.5	11.9	11.8	11.6	11.8
Length (km) of Bypass	---	8.8	7.7	10.4	5.8	11.8
No. of Houses to be Relocated	240	17	78	55	25	18
Total Cost (US$ Million)	22.6	35.3	31.1	37.7	49.4	60.9
BP. Construction	0	29.4	24.3	33.8	41.9	58.1
Widen NR 5	20.2	3.3	4.5	1.2	5.2	0
Resettlement	2.4	1.3	1.4	1.1	1.4	1.1
Land Acquisition	0	1.3	1.0	1.6	0.9	1.8
Total Evaluation		◎ (Recommended)	○	△		
	"Widen Existing NR 5" is not recommended because; the number of houses to be relocated is very large (around 240), although the impact on natural environment of this alternative is minimal,. Alternatives "S-1" and "P-1" are not recommended because; these alternatives pass the southern side of the city crossing the railroad at two location. This result in very high construction costs compared to other alternatives passing the northern side of the city.					

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	Thus, N-1, N-2 and N-3 are compared. N-1 has the following advantages to N-2 and N-3: ・N-1 can allow future expansion of the city with maintaining the function of the bypass for a long time because its route is located distant from the exiting urbanized area. ・Number of houses to be relocated is the minimum Considering the above, N-1 is recommended.					

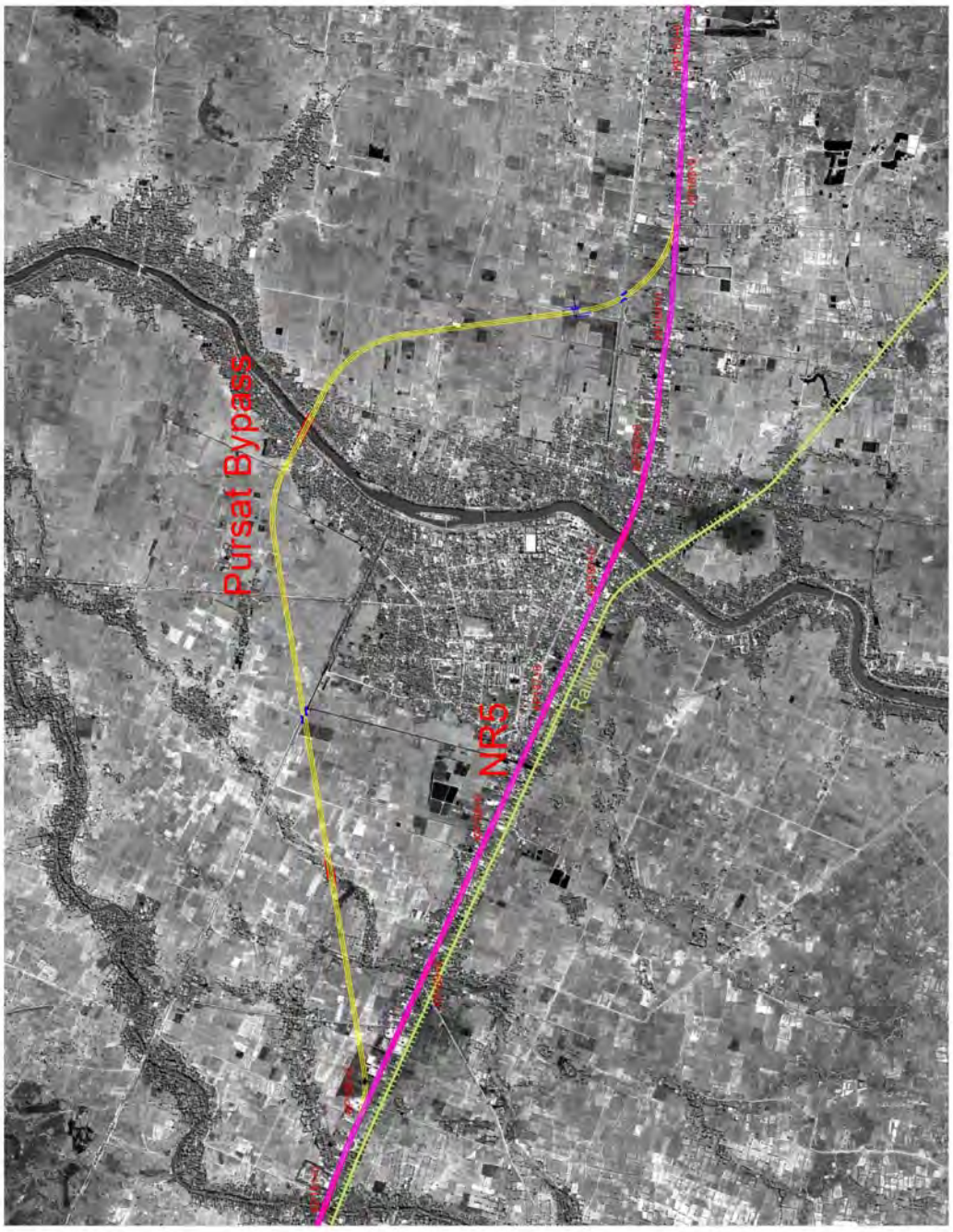


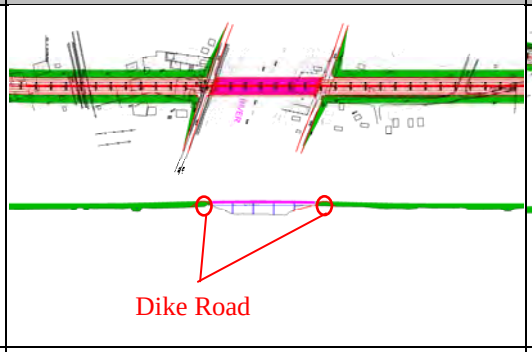
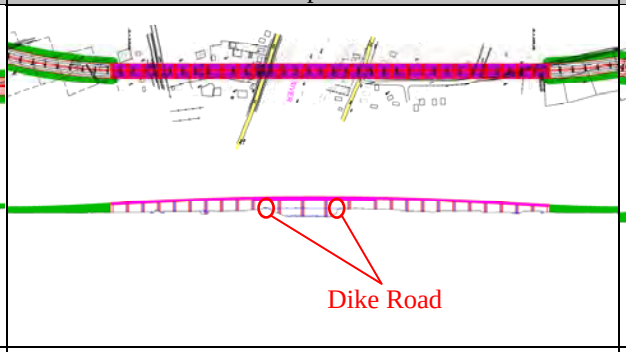
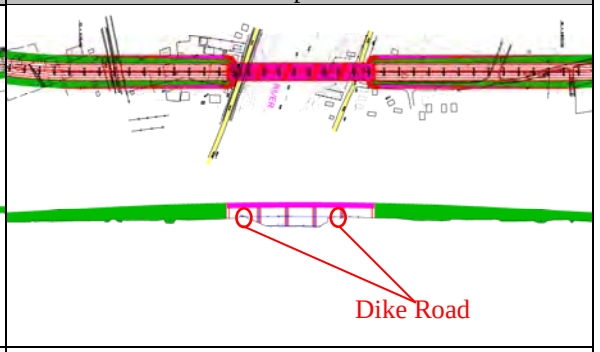
Figure 7.2-7 Selected Route of Pursat Bypass

7.2.7 Bridge over the Pursat River in Bypass

Pursat Bypass needs to cross Pursat River. There are roads on the both banks of the river. Whether or not the bypass be connected to these roads needs careful examination. If these roads on the banks of Pursat River are connected to the bypass with at grade intersection, traffic speed on both the bypass and roads on the river banks will unavoidably reduced due to stop at the intersection. On the other hand, grade separation of these roads need raising of the height of the bridge of the bypass and lead to increase in the construction cost.

Three alternatives for crossing of Pursat River were evaluated as follows and Grade Separation -1 was selected.

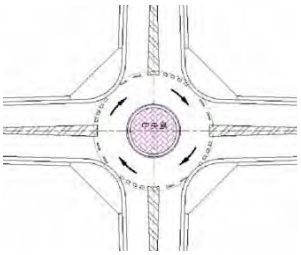
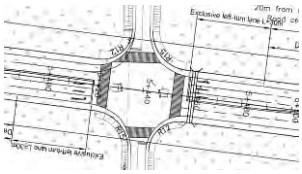
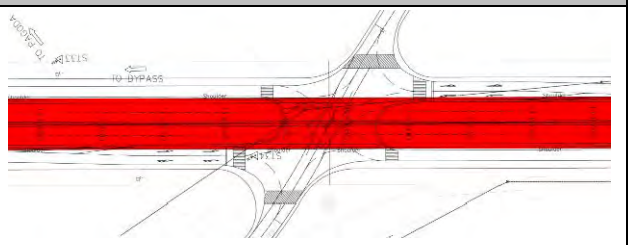
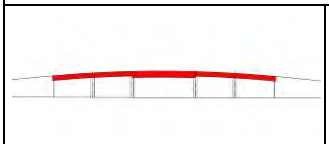
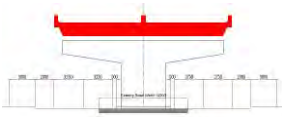
Table 7.2-6 Comparison of Alternatives for Crossing of Pursat River

	At Grade	Grade Separation-1	Grade Separation-2
Plan Longitudinal Cross Section			
Length	Embankment Road: L=8,410 m Bridge: L= 137.5 m (5@27.5)	Embankment Road：L=7,910 m Bridge: L= 695 m (9@25+42+3@27+42+11@25)	Embankment Road：L=8,468 m Bridge: L= 195 m (42+3@27+42)
Characteristics (Community Separation, Flood, Ventilation, etc.)	・Embankment of road will split the community. Box culverts to be installed will have little effect for preventing community separation. ・Area near the road will not be well-ventilated. ・Unexpected flood may break the road embankment.	・Viaduct constructed in place of embankment road will mitigate the community split. ・Area near the road will be well-ventilated. ・Unexpected flood will not affect the road structure.	・Embankment of road will split the community. Box culverts to be installed will have little effect for preventing community separation. ・Area near the road will not be well-ventilated. ・Unexpected flood may break the road embankment.
Traffic Condition	・Traffic flow from the dyke roads will affect the smooth traffic of the bypass. Traffic volume of the dyke roads is approximately 7,000 veh./day.	・The bypass will function well without disturbance of traffic from the dyke roads.	
Construction Cost	USD 36 million	USD 49 million	USD 39 million
Recommendation		○	

7.2.8 Improvement of Intersection

Traffic management at the intersection is studied in order to enable smooth traffic and traffic safety for NR 5 and access road to NR 5. Common types of intersections and their characteristics are shown in Table 7.2-7.

Table 7.2-7 Typical Intersection

	Intersection without traffic signal (Roundabout etc.)	Normal Intersection with/without traffic signal	Grade-Separated Intersection
Image figure	 **Plan**	 **Plan**	 **Plan**  **Profile**  **Cross section**
Characteristic	・ Delay at intersection is small. ・ Capacity of traffic volume is about 1,000 vehicles / hour. ・ Necessary land space is bigger than normal intersection.	・ Delay at intersection is large. ・ Capacity of traffic volume of normal intersection with traffic signal is bigger than that without traffic signal, including roundabout. ・ Necessary land space is smaller than that of roundabout.	・ Capacity of traffic volume is the largest. ・ The traffic flow (straight-going) can be separated from the traffic entering the at-grade intersection. ・ Traffic signal is required at the ground level

In this survey, normal intersection without traffic signal is adopted in the highway design, considering the forecasted traffic volume which can be accommodated by signalized intersections. However, grade-separated intersection may become necessary in the long future.

7.2.9 Manner of Widening of Road to Minimize Resettlement

The land within 30m from the centerline of the road on the both sides has been designated as the right of way (ROW) of the road. However, there are some houses within this boundary of the ROW. The density of houses increases as the distance from the road centerline increases. Contrarily, the density of houses is relatively low near the road (see Figure 7.2-8). Actually, many houses are located near the boundary of ROW (30 m from the road centreline).

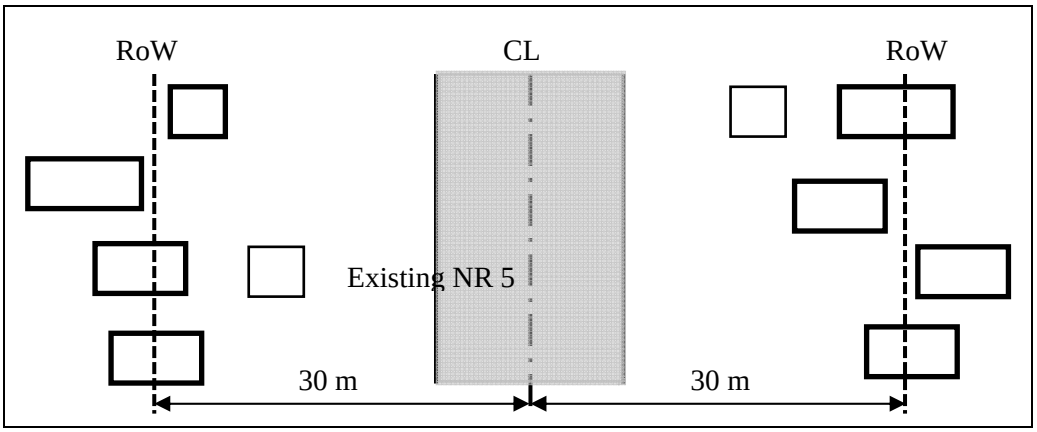


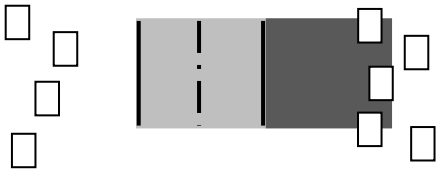
Figure 7.2-8 Schematic Illustration of Density of Houses with Regard to Distance from Centerline of Road

The total width of land required for widening to 4-lane on one side, including embankment slopes is calculated to be approximately 20 m, as shown below:

Carriageway (travel lane + median) + Shoulder: 11.5 m (23 m rural section; see Figure 7.2-4) /2
Embankment Slopes (1 side): 6 m (= H 3 m x Slope 1:2.0)
Margin for construction works: 2 m
Total: 19.5 m

If the road is widened equally on the both sides, the density of houses located in the land to be acquired for widening is generally low. Contrarily, if the road is widened on one side, the land to be acquired needs to extend to the area with relatively high house density. Table 7.2-8 schematically illustrates this situation.

Table 7.2-8 Comparison of Widening Methods on the Road

	Widening on both Sides			Widening on One Side		
Schematic Illustration	 Widened Part	Existing NR 5	Widened Part		Existing NR 5	Widened Part
Number of Houses to be Relocated		Small			Large	

Considering such situation of houses to be relocated, widening is basically planed on the both sides.

CHAPTER 8 HIGHWAY DESIGN

8.1 Sections for Highway Design

Many locations between Thlea M'am and Battambang as well as between Sri Sophorn and Poitet were inundated during the flood which occurred in 2013 and the pavements of these sections were severely damaged. To prevent inundation due to flood and subsequent failure of pavement, height of road surface needs to be set sufficiently higher than the flood water level (see Subsection 8.2.5 for explanation on height of road surface and flood water level). Thus, Thlea Ma'am – Battambang Section and Sri Sophorn – Poipet Section are divided into following 6 sections for the purpose of highway design with regard to flood:

Thlea Ma'am – Battambang Section

Design Section 1 (KP 171 – KP 138): Flood water level is lower than the existing road surface by 50 cm or more. Thus, the new pavement is constructed on top of the existing pavement.

Design Section 2 (KP 183 – KP 190: Pursat Bypass): The bypass is newly constructed traversing mainly agricultural land. The level of flood water is not high.

Design Section 3 (KP 190 – KP 255): Flood water level is low and basic concept of design is same to that of Design Section 1

Design Section 4 (KP 255 – KP 283): Flood water level exceeded road surface during the flood in 2013. Height of the new road surface is planned so that the bottom of the pavement structure becomes 50 cm above the recorded flood water level.

Sri Sophorn – Poipet Section

Design Section 5 (KP 366 – KP 371): Flood water level exceeded road surface during the flood in 2013. The design policy same as that of Design Section 4 is adopted.

Design Section 6 (KP 371 – KP 402): Flood water level is low. The new pavement is constructed on top of the existing pavement utilizing the existing pavement as the subgrade.

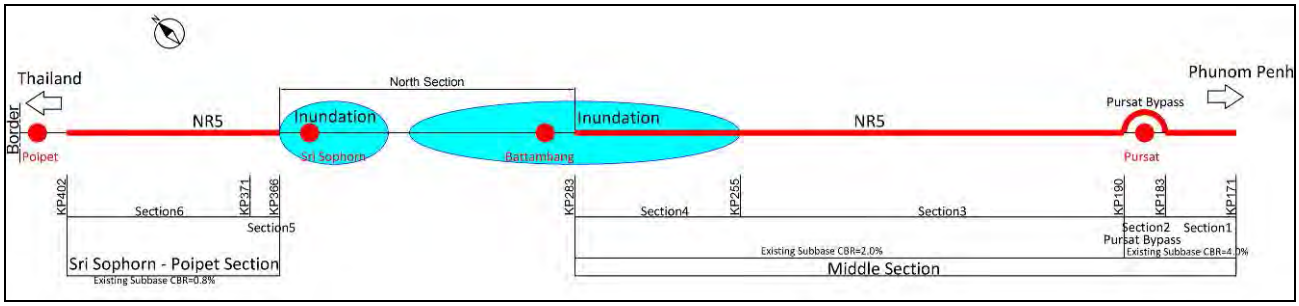
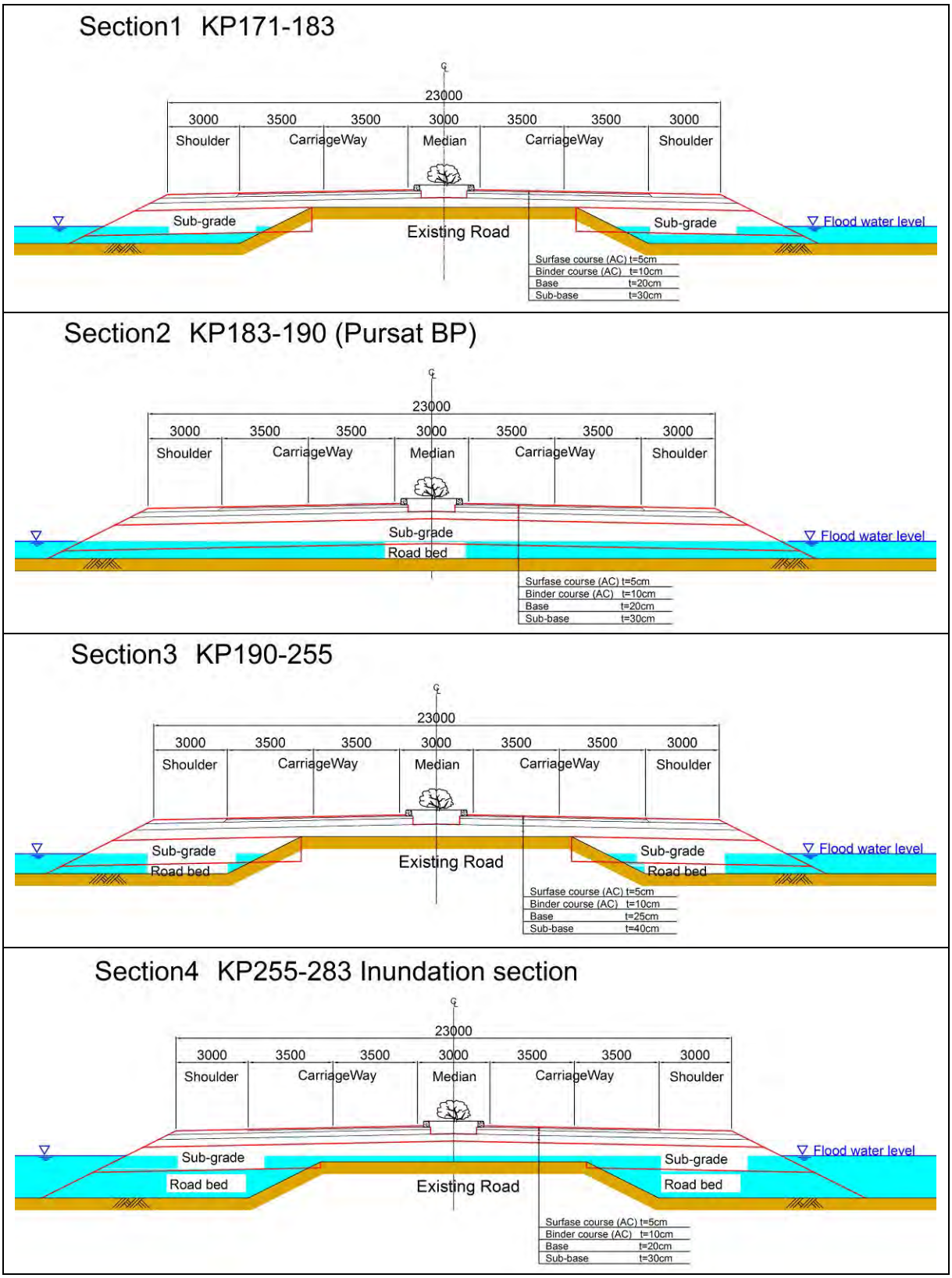


Figure 8.1-1 Design Sections


Section1 KP171-183
23000
3000 3500 3500 3000 3500 3500 3000
Shoulder CarriageWay Median CarriageWay Shoulder
Sub-grade
Existing Road
Sub-grade
Flood water level
Surfase course (AC) t=5cm
Binder course (AC) t=10cm
Base t=20cm
Sub-base t=30cm
Section2 KP183-190 (Pursat BP)
23000
3000 3500 3500 3000 3500 3500 3000
Shoulder CarriageWay Median CarriageWay Shoulder
Sub-grade
Road bed
Flood water level
Surfase course (AC) t=5cm
Binder course (AC) t=10cm
Base t=20cm
Sub-base t=30cm
Section3 KP190-255
23000
3000 3500 3500 3000 3500 3500 3000
Shoulder CarriageWay Median CarriageWay Shoulder
Sub-grade
Road bed
Existing Road
Sub-grade
Road bed
Flood water level
Surfase course (AC) t=5cm
Binder course (AC) t=10cm
Base t=25cm
Sub-base t=40cm
Section4 KP255-283 Inundation section
23000
3000 3500 3500 3000 3500 3500 3000
Shoulder CarriageWay Median CarriageWay Shoulder
Sub-grade
Road bed
Existing Road
Sub-grade
Road bed
Flood water level
Surfase course (AC) t=5cm
Binder course (AC) t=10cm
Base t=20cm
Sub-base t=30cm

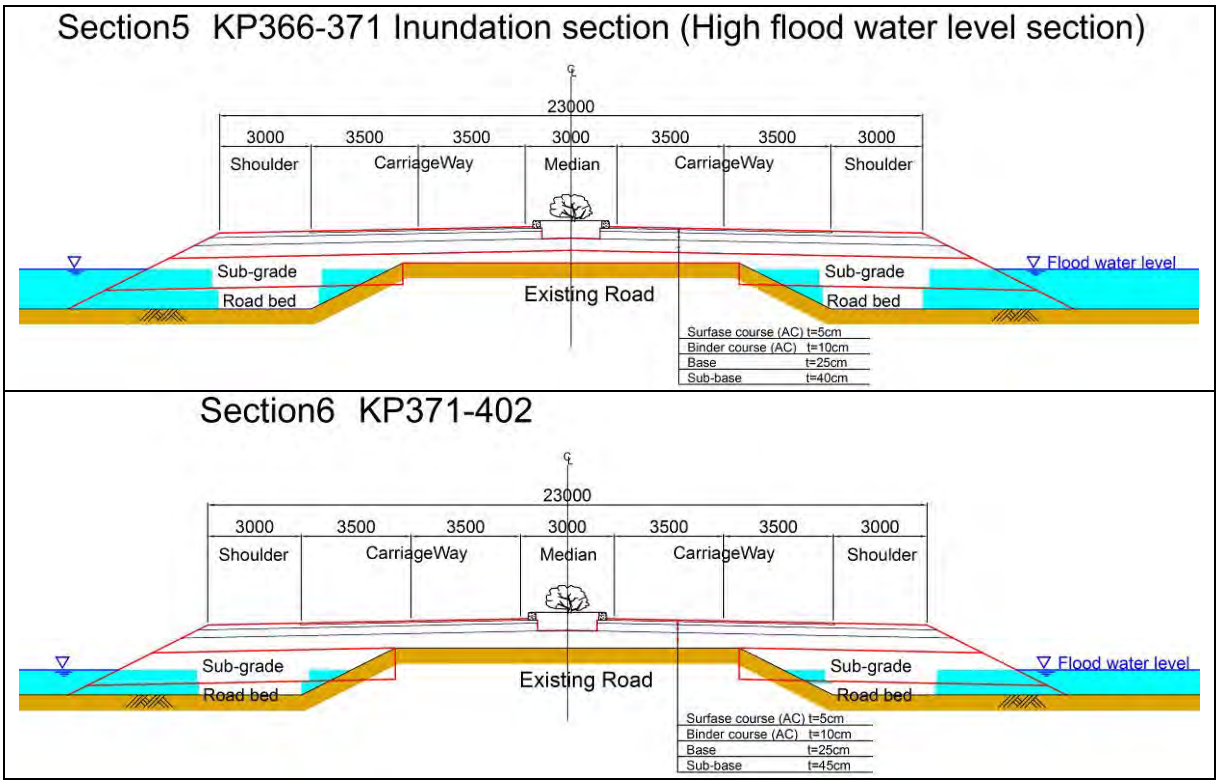


Figure 8.1-2 Typical Cross Sections on the Middle Section and Sri Sophorn – Poipet Section

8.2 Middle Section

8.2.1 Basic Design Policy and Design Criteria

The design of the North Section (Battambang – Sri Sophorn) and the South Section (Prek Kdam – Thlea Ma'am) of NR 5 were studied in the reports of previous preparatory surveys for these sections. Such design includes the preliminary design for the improvement of NR 5 and construction of four bypasses (Odongk, Kampong Chhnang, Battambang, and Sri Sophorn). Since the Middle Section and Sri Sophorn - Poipet Section are the remaining parts of NR 5, the design policy for the these sections should be consistent with those of other sections.

NR 5 is designated as a Class I Road in the hierarchy of the Asian Highway Network. Thus, it is desirable to satisfy the design criteria of Asian Highway Class I Road. At the same time, NR 5 is an arterial national road of Cambodia and it needs to satisfy the Road Design Standard of Cambodia. Table 8.2-1 compares the design criteria of Asian Highway Class I and Road Design Standard of Cambodia. The table also shows the criteria recommended for the Project. These recommended criteria have been discussed and agreed between MPWT and the JICA Team during the Survey of North section.

Table 8.2-1 Comparison of Design Speed and Criteria

Standard	Asian Highway	Cambodian Standard		Recommended	
Road Class	Class I	R5 (Rural)	U5 (Urban)	Rural	Urban
Design Speed	100 km/h (Flat)	100 km/h (flat)	50 km/h (Type3)	100 km/h	50 km/h
Min. Curve Radius (Super elevation)	350 m (10%)	415 m (6%)	90 m (6%)	350 m (10%)	80 m (10%)

8.2.2 Urban Sections

At present, the maximum speed on the urban section of NR 5 is regulated to be 40 km/h. Nevertheless, the design speed of 50 km/h is proposed for the urban section, considering the fact that many vehicles travel at 50 km/h or higher.

Table 8.2-2 lists the urban sections where the speed is currently regulated at 40 km/h. Design speed of 50 km/h is applied to these sections.

Table 8.2-2 List of Urban Sections with Design Speed of 50 km/h is Applied

KP	Length	Name of Location
KP 184+100 ~ KP 188+200	4,100 m	Pursat
KP 197+500 ~ KP 198+300	800 m	Andoung Krasang
KP 200+800 ~ KP 202+500	1,700 m	Bakan
KP 208+100 ~ KP 212+700	4,600 m	Boeung Khnar
KP 215+100 ~ KP 217+000	1,900 m	Ou Ta Paong
KP 218+800 ~ KP 220+000	1,200 m	Svay Daun Keo
KP 222+400 ~ KP 224+900	2,500 m	Pray Svay
KP 230+600 ~ KP 231+600	1,000 m	Kalaom Phluk
KP 235+900 ~ KP 237+000	1,100 m	Pray Svay
KP 243+700 ~ KP 245+600	1,900 m	Moung Russei

8.2.3 Cross Section

Table 8.2-3 compares the design criteria of cross-sectional composition of Asian Highway and the design standard of Cambodia.

Table 8.2-3 Comparison of Design Criteria of Cross-Sectional Composition

Items	Asian Highway	Cambodian Standard		Recommend
Road Class	Class I	R5 (Rural)	U5 (Urban)	
Lane Width	3.50 m	3.50 m		3.50 m
Shoulder Width	3.00 m (Flat)	3.00 m (Flat)	2.50 m (Type3)	3.00 m
Median Strip	3.00 m (Flat)	4.0 ~ 12.0 m (Flat)	2.0 ~ 4.0 m (Type3)	3.0 m
Cross Slope	2.0% (AC)	2.5 ~ 3.0% (AC)		2.0%
Shoulder Slope	3.0 ~ 6.0%	3 ~ 4% (sealed)	3%	
Vertical Clearance	4.5 m			4.5 m

As discussed in Chapter 7, it is proposed that the existing NR 5 to be widened to 4 lanes. From viewpoint of consistency of design standard, it is recommended that the cross section adopted in the North and South Sections be adopted also in the Middle Section. In the North and South Sections, two types of cross section were adopted depending on the roadside land use; rural area

and urbanized area. With regard to the structure of median strip, raised type median is recommended from the view point of traffic safety. Considerations as mentioned below shall be given for convenience of road user in the detail design stage:

- Opening of median division for left-turn and u-turn should be provided at regular interval and at necessary place.
- U-turn lane shall be provided at a regular interval and at necessary locations.

Figure 8.2-1 shows the proposed typical cross sections for rural area and urbanized area. For the sections passing through urbanized areas where many vehicles are anticipated to park on the street, a 2.5 m-wide parking spaces is proposed on both sides.

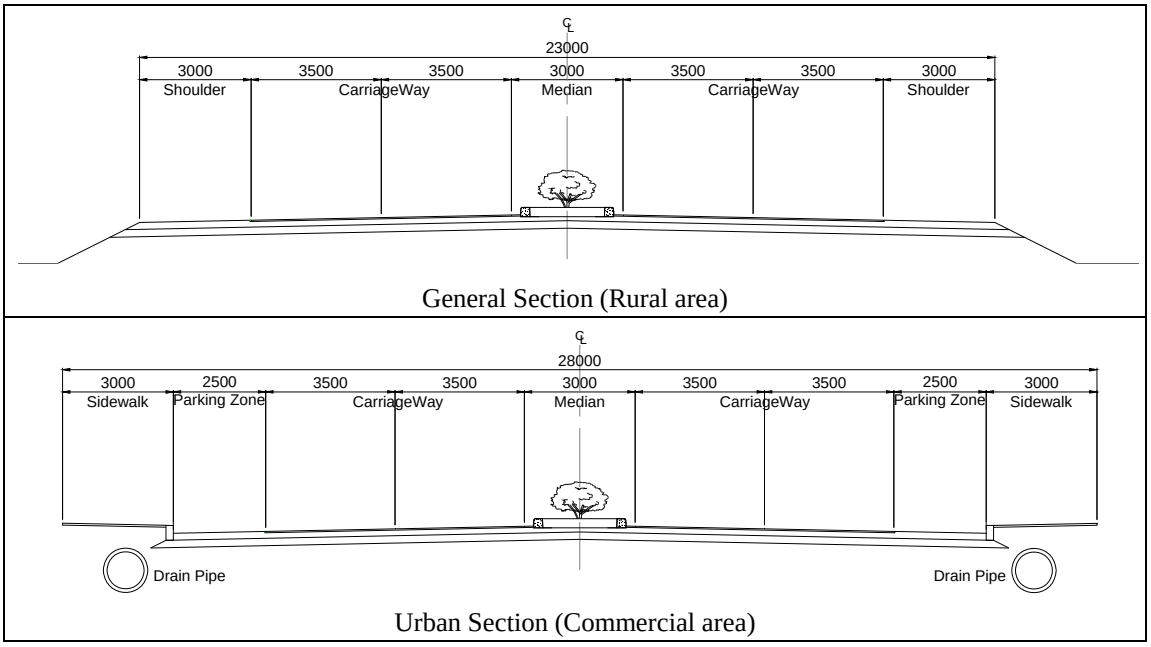


Figure 8.2-1 Typical Cross Section

8.2.4 Horizontal Alignment

The horizontal alignment of the Middle Section of NR 5 is mostly composed of long straight sections connected each other by relatively short curve sections. These curves sections need to be improved if the existing configurations do not satisfy the requirements of design criteria.

(1) Existing Horizontal Alignment

There are 41 curve sections and 125 bending points with small intersecting angles without curve between the straight lines along the Middle Section.

The radii of many curves are generally small and some of them do not satisfy the requirement of design criteria. In addition, there are some curve sections where the lengths of curve are too short to meet the design criteria. In such short curves, the drivers are confused and, are forced quick steering operation. These short curve sections and many bending points need to be improved by introducing proper lengths of curves.

(2) Improvement of Horizontal Alignment

(a) Small radius of curve

There are 6 curve sections where the existing curve radii are smaller than the minimum value defined in the design criteria. Table 8.2-4 shows the curve sections with substandard curve radii and proposed curve radii after improvement. The table also shows the distances of centerline shift due to the improvement. Examples of the improvements of curve sections are shown in Figures 8.2-2 and 8.2-3.

(b) Section with short curve length

There are 25 curve sections where the existing curve length is insufficient. The lengths of these curve sections are planned to be extended by introducing road sections with larger curve radii. Minimum curve lengths of 170 m and 80 m are achieved for design speed of 100 km/h (general section) and 50 km/h (urban section), respectively.

Table 8.2-4 Curves with Small Radii

IP	KP of IP	Land	Radii of Curve		Center Shift
			Existing	Proposed	
93	242+693	Rural	322	1,000	2.6
149	276+259	Rural	155	400	6.2
153	277+750	Rural	121	550	5.8
156	278+015	Rural	312	Move IP	
158	278+479	Rural	248	1,000	2.9
160	279+264	Rural	270	350	3.1



Figure 8.2-2 Proposed Alignment at KP 276 + 498 – KP 276 + 676 (IP149)
(Radius of the existing curve is 155 m: Proposed to improve to radius of 400 m)



Figure 8.2-3 Proposed Alignment at KP 277 + 996 – KP 278 + 179 (IP153)

(Radius of existing curve is 121 m: Proposed to improve to radius of 550 m)

(c) Bending alignment without curve

As stated above, there are 125 bending points with small intersecting angles without curves between the straight lines. Curves with sufficient lengths and relatively large radii are inserted between the two straight lines in order to secure smooth and comfortable travel of vehicles.

8.2.5 Vertical Alignment and Height of Road Surface

The Middle Section experienced inundation due to the flood which occurred in 2013 and the pavement was severely damaged on many sections. The rain water overflowed the road from mountain side to the Tonle Sap side. Installation of additional cross drainage to lower the flood water level was studied. The details of cross drainage is discussed in Chapter 6.

Road embankment is planned to be raised enough considering the past flood level. Table 8.2-5 shows the depth of flood on the road surface and the embankment level to be raised.

Table 8.2-5 Countermeasures for Flood and Inundation

Location	Flood Water Level (Below Road Surface)	Countermeasure
KP 256+000 ~ KP 257+000	0.05 m	Raise embankment by 0.55 meters
KP 258+500 ~ KP 260+000	0.05 m	Raise embankment by 0.55 meters
KP 270+500 ~ KP 271+500	0.25 m	Raise embankment by 0.75 meters
KP 272+000 ~ KP 274+000	0.15 m	Raise embankment by 0.65 meters
KP 276+500 ~ KP 277+000	0.10 m	Raise embankment by 0.60 meters
KP 280+500 ~ KP 281+500	0.20 m, low surface	Raise embankment by 0.70 meters

In principle, the height of road surface is designed to be raised so that the top of embankment (subgrade) be 50 cm higher than flood water level to seepage of flood water into subgrade and reduction in bearing capacity of subgrade. Also, the height of road surface needs to be high enough to prevent the inundation and/or overflow during flood. Figure 8.2-4 shows the conceptual illustration of the minimum height of embankment above flood water level.

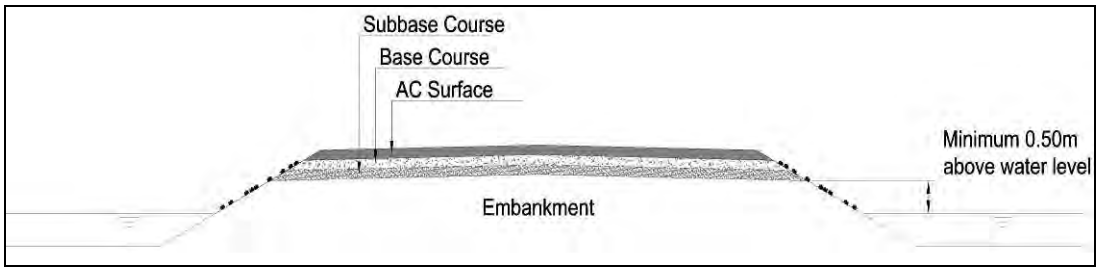


Figure 8.2-4 Conceptual Illustration of Minimum Height of Embankment

8.2.6 Pavement Design

Pavement structure is usually designed based on forecasted traffic load and CBR. AASHTO's Pavement Design Manual is one of the most widely used text books of pavement design. In the design method presented in this manual, the traffic load is converted from estimated traffic volume to cumulative 18-Kip Equivalent Single Axle Load (ESAL), using a parameter called 'Axle Load Equivalent Factor (ALEF)'. The required strength of the pavement structure is expressed in terms of Structural Number (SN).

(1) Structural Number (SN)

Structural number (SN) is an abstract number that expresses the structural strength of a pavement required for given combinations of soil support, total traffic loading expressed in terms of ESALs, terminal serviceability and environment such as climate.

The following equation can be used to relate individual material types and thicknesses to the structural number:

SN = a1D1 + a2D2M2 + a3D3M3

where:

a1, a2, a3 = structural-layer coefficients of the wearing surface, base, and subbase layers, respectively,

D1, D2, D3 = thickness of the wearing surface, base, and subbase layers in inches, respectively, and

M2, M3 = drainage coefficients for the base and subbase, respectively

(2) ALEF and ESAL

In the design method presented in the AASHTO's manual, traffic load is converted from

estimated traffic volume to ESAL, using a parameter of ALEF. As a part of the traffic survey in South Section, the actual axle loads of heavy vehicles were surveyed utilizing the facility of the weighing station at KP 48 of NR 5. The axle loads of 219 heavy vehicles travelling on both directions were measured. As the result of analysis, the average ALEF of heavy vehicle travelling on NR 5 was calculated to be 2.48/veh.

ESAL is obtained by multiplying ALEF with number of heavy vehicles passing the design section during the design period (usually 10 years). Thus,

ESAL = 2.48 x [Traffic Volume of Heavy Vehicle per Day] x 365 days/year x 10 years.

(3) Minimum Thickness of AC Layer

'Road Design Standard of Cambodia; Part 2: Pavement' designates standard pavement structures taking into account traffic volume and type of subgrade. According to this standard, a pavement structure with 150 mm-thick AC layer is adopted for highways with a large traffic volume of heavy vehicles, while 100 mm-thick AC surface course is adopted for highways with less traffic volume of heavy vehicles. Also, a 150 mm-thick AC surface course is commonly adopted in many countries for highways where large volumes of heavy vehicles are anticipated. Thus, it is recommended to adopt 150 mm-thick AC layer.

(4) Design of Pavement Structure

(a) Ratio of Heavy Vehicle

The ratio of heavy vehicles is approximately 43% and 49% at Station 4 and Station 5, respectively in pcu units in 2033 in Existing NR 5 as shown in Table 8.2-6.

Table 8.2-6 Predicted Traffic Volume and Ratio of Heavy Vehicle (the Middle Section)

(Unit: pcu/day)

		MC	LV	HV	Total	Ratio of Heavy Vehicles
Station 4 (KP 171 ~ 186)	Year 2023	1,217	7,718	6,078	15,013	40.49%
	Year 2028	1,569	11,191	8,913	21,673	41.12%
	Year 2033	1,876	14,355	12,483	28,714	43.47%
Station 5 (KP 187 ~ 283)	Year 2023	1,242	6,209	6,777	14,228	47.63%
	Year 2028	1,578	9,384	9,816	20,778	47.24%
	Year 2033	1,849	12,108	13,527	27,483	49.22%

(b) CBR Value of Subgrade

Figure 8.2-5 shows the CBR values of existing subgrade obtained through the laboratory tests. Design CBR values of 4% is adopted for the section between KP 171 and KP 183 and that of 2% is adopted for the section between KP 190 and KP 283.

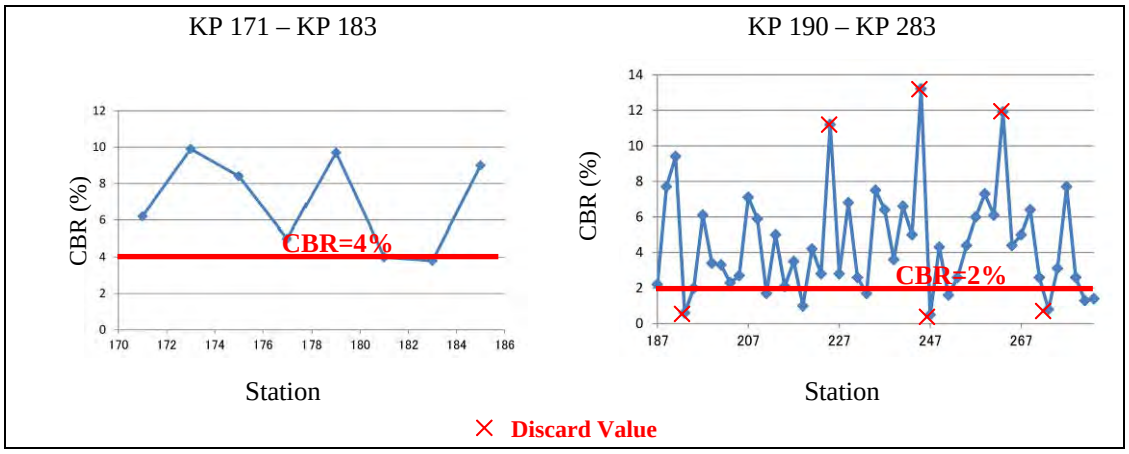


Figure 8.2-5 CBR Value Obtained Through Laboratory Tests

Table 8.2-7 CBR of Existing Subgrade

	KP 171 ~ KP 183	KP 190 ~ KP 255
Existing Subgrade	4%	2%

(c) Subgrade Improvement

The CBR of existing subgrade of KP 190 – KP 255 is under 3%, it is too soft to support pavement. The CBR of existing subgrade in this section needs to be improved to more than 3 %. Three methods for improving existing CBR are compared:

Method (i): Using the existing pavement as for the subgrade of planned new pavement,

Method (ii): Replace the existing pavement with suitable material, and

Method (iii): Cement stabilization.

Table 8.2-8 shows comparison of the improvement methods. As a result of comparison of these three methods, Method (i): "using the existing pavement as subgrade of planned pavement" is the most economical. Therefore, Method (i) is adopted.

Table 8.2-8 Comparison of Subgrade Improvement

Existing CBR of KP 195-255: CBR=2%		Targeted CBR of Improved Subgrade							
		CBR=3%		CBR=4%		CBR=6%		CBR=8%	
Pavement Structure	Surface (cm)	5		5		5		5	
	Binder (cm)	10		10		10		10	
	Base (cm)	30		25		20		20	
	Sub-base (cm)	50		40		30		25	
Cost (include subgrade improvement)		Thickness	Cost (USD)	Thickness	Cost (USD)	Thickness	Cost (USD)	Thickness	Cost (USD)
	Method (i)	-	-	30 cm	1089	-	-	-	-
	Method (ii)	40 cm	1238	50 cm	1194	70 cm	1129	-	-
	Method (iii)	30 cm	1223	40 cm	1190	-	-	70 cm	1019

(d) Conditions of Pavement Design and SN

The new pavement is to be placed on top of the existing pavement. The thickness of new pavement can be reduced by evaluating the strength (CBR) of the existing pavement as a part of the subgrade. The result of evaluation is as shown below.

Table 8.2-9 CBR for Pavement Design on the Middle Section

Item	Adopted Values					
	KP 171 ~ 183		KP 190 ~ 255		KP 255 ~ 283 (Inundation Section)	
	Thickness	CBR	Thickness	CBR	Thickness	CBR
CBR of selected subgrade	—	—	—	—	100 cm	6%
CBR of existing pavement	30 cm	20%	30 cm	20%		
CBR of existing subgrade	70 cm	4%	70 cm	2%		
Composite CBR value	100 cm	**6%**	100 cm	**4%**	100 cm	**6%**

Table 8.2-10 shows the design conditions and required SN of the pavement of the Middle Section. Table 8.2-11 and Figure 8.2-6 show the designed pavement structures.

Table 8.2-10 Conditions of Pavement Design of the Middle Section

Item	Adopted Values		
	KP 171 ~ 183	KP 190 ~ 255	KP 255 ~ 283 (Inundation Section)
Design Period	10 years	10 years	10 years
Reliability	80%	80%	80%
CBR Value of Subgrade	6%	4%	6%
Traffic Load (W_{18}=Cumulative 18 kip ESAL)	1.483×10^7	1.627×10^7	1.627×10^7
Structural Number (SN)	SN=4.64	SN=5.33	SN=4.64

As shown in the table above design section is divided into two sections: KP 171 ~ 183, KP 190 ~ 283 and KP 255 ~ 283 considering traffic load, subgrade's CBR and inundation.

Table 8.2-11 Designed Pavement Structure of the Middle Section

Layer	Thickness			
	Material	KP 171 ~ KP 183	KP 190 ~ KP 255	KP 255 ~ KP 283 (Inundation Section)
Surface & Binder	AC	15 cm	15 cm	15 cm
Base	Stabilized gravel	20 cm	25 cm	20 cm
Subbase	Crusher run	30 cm	40 cm	30 cm
Subgrade	Selected Material	N/A	N/A	75 cm

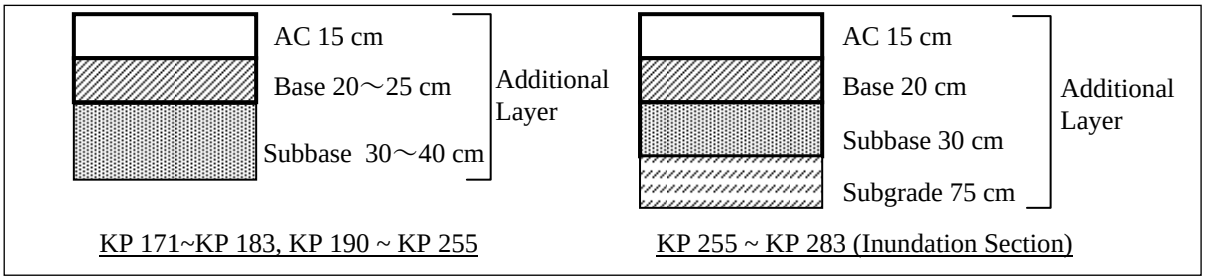


Figure 8.2-6 Pavement Structure of the Middle Section

8.2.7 Intersection

There are intersections with 2 digits national road along the Middle Section. In the urban sections, many major streets are directly connected to the NR 5. In rural sections, numerous minor roads are connected to the NR 5. These minor roads are used for daily activities by the local residents. From a viewpoint of smooth and safe traffic on an arterial highway, the access from those minor roads should be limited as much as possible. However, the NR 5 is indispensable for the daily activities of the local residents and access from the minor roads cannot be limited.

The 3 m-wide median on NR 5 is expected to function as the space for waiting or stopping to turn left in order not to disturb other vehicles.

The typical design for intersections of the NR 5 with major roads and those with minor roads are shown in Figure 8.2-7.

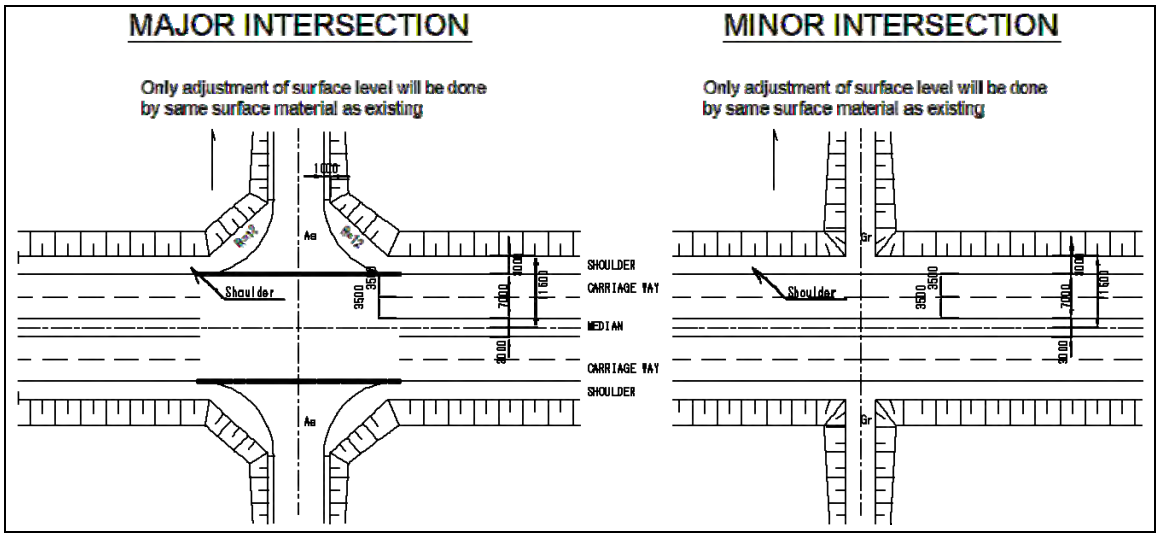


Figure 8.2-7 Typical Plan of Intersection

8.2.8 Appurtenances

(1) Drainage Facilities

The Middle Section of NR 5 passes through flat terrain and crosses many streams. The inventory survey conducted by the Survey Team found there are 35 box culverts and 62 pipe culverts on the Middle Section. All of those culverts are required to be extended to fit with a widened road

width, and it is necessary for the headwalls to be re-constructed.

In addition to the extension of the existing culverts, the capacity of cross drainage facilities needs be increased to meet the volume of discharge from the mountain side. The details of this issue are discussed in Chapter 6.

The typical cross section for urbanized area includes a raised sidewalk and underground drainage pipes. The construction of catch basin at appropriate interval and outlet facilities will be considered during the detailed design stage.

(2) Guardrail and Guide Post

Guardrails will be installed in the following places:

- Any section with an embankment height larger than 4 meters (to prevent vehicles running down the embankment)
- Twenty meters on the both sides of bridges (to prevent vehicles running into river or hitting the wall of a bridge)
- Ten meters on the up-stream side of heavy and sturdy structures, such as a traffic signal control boxes, located within 5 meters of the outside edge of the shoulder.

The locations of box culverts are also hazardous if a vehicle runs out of the road area. However, the height of culvert is much lower than the height of bridges and the stream itself is narrow. Thus, the guide post, instead of guardrail, is to be placed for the caution to the drivers.

Figure 8.2-8 shows an example of a plan view of guardrail on the both sides of a typical bridge and Figure 8.2-9 shows an example of a side view and plan view of a guardrail.

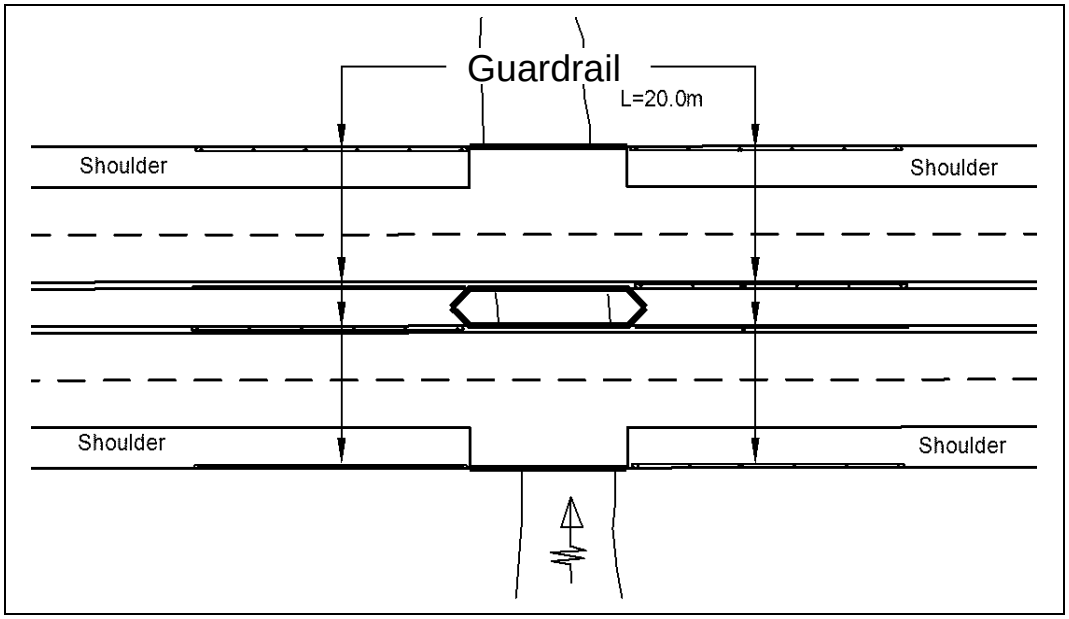


Figure 8.2-8 Plan of Guardrail at Approach of Bridge

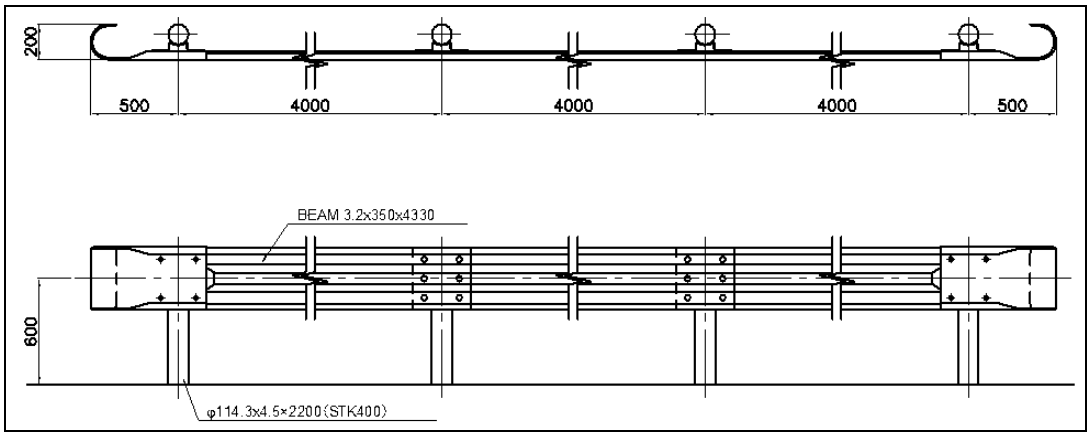


Figure 8.2-9 Example of Guardrail

(3) Rumble Strip

A rumble strip is special pavement with rough surface which causes noise when a vehicle passes over it. It is placed in multiple strips across the carriageway to give drivers an audible warning. Rumble strips shall be placed at entrances to town areas, near schools and markets, and other strategic locations.



Figure 8.2-10 Example of Rumble Strip

(4) Street Light

Lighting is provided at hazardous locations. During the night time, such hazardous locations need to be lit and provide good visibility for drivers. Lighting is planned at the following locations:

- Major intersections
- Bridges

(5) Safety Devices for Crossing

The widened road makes crossing road long distance and time for the pedestrians. To prevent traffic accidents, pedestrian crossings shall be provided at the crowded places, markets, schools,

hospitals and other public buildings, as well as places where the local resident request for certain reason, such as crossing of cattle.

The road sign and marking shall be provided. The regulatory sign such as "speed limit" and the warning sign such as "intersection ahead" are considered. The marking on the pavement such as center line, driving lane and stop line shall be provided. Their detail locations will be studied in the detail design stage.

8.3 Sri Sophorn - Poipet Section

8.3.1 Basic Deign Policy and Design Criteria

The design speed of Sri Sophorn – Poipet Section is proposed to be same as that of the Middle section.

Table 8.3-1 Design Speed and Criteria of Alignment

Standard	Recommended	
Road Class	Rural	Urban
Design Speed	100 km/h	50 km/h
Min. Curve Radius (Super elevation)	350 m (10%)	80 m (10%)

8.3.2 Urban Sections

Through the site inspection, the sections as listed below are classified as urban sections and design speed of 50 km/h is applied:

Table 8.3-2 List of Urban Sections Where Design Speed of 50 km/h is Applied

KP	Length	Name of Location
KP 372+600 ~ KP 373+200	620 m	Soryathmi
KP 376+900 ~ KP 377+400	500 m	Soryathmi
KP 380+000 ~ KP 389+200	1,700 m	Nimit
KP 392+300 ~ KP 394+100	9,200 m	Koun Damrei
KP 401+900 ~ KP 407+300	5,400 m	Poipet

8.3.3 Cross Section

Typical cross sections of Sri Sophorn – Poipet Section are same as those of the Middle Section.

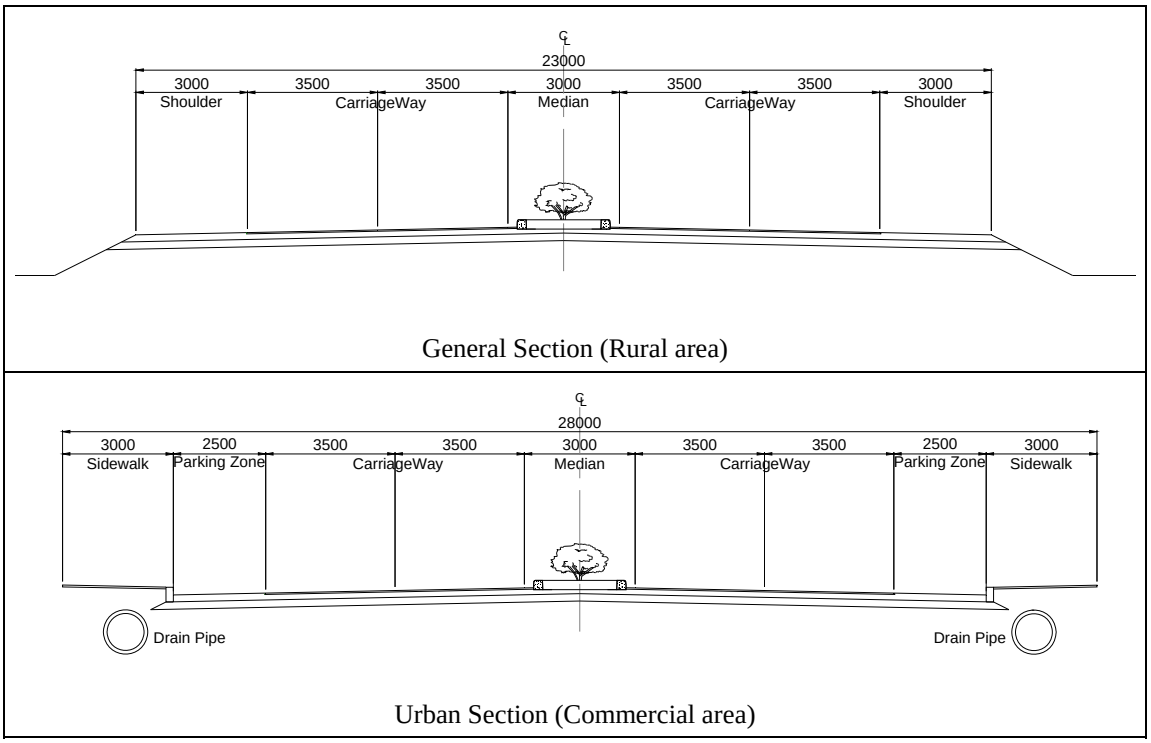


Figure 8.3-1 Typical Cross Section of Sri Sophorn – Poipet Section

8.3.4 Horizontal Alignment

No serious problem is found on the existing horizontal alignment of the Sri Sophorn - Poipet Section. This may be attributed to the fact that this section was improved in 2008 under ADB finance.

8.3.5 Vertical Alignment and Height of Road Surface

The Sri Sophorn – Poipet Section was not damaged during the flood of 2013, but flood water level rose close to the road surface. Therefore, it is recommended to raise the embankment height considering the flood level. Table 8.3-3 shows the level of flood water and the proposed raising of embankment height.

Table 8.3-3 Countermeasures for Flood and Inundation

Location	Depth of Flood from Road Surface	Countermeasure
KP 366+000 ~ KP 371+000	-0.20 m	Raise embankment by 0.30 meters

8.3.6 Pavement Design

The design procedure of Sri Sophorn – Poipet Section is same to that of the Middle Section.

(1) Design of Pavement Structure

(a) Ratio of Heavy Vehicle

The ratios of heavy vehicles at Station 9 for years 2023, 2028 and 2033 are approximately 32%.

Table 8.3-4 Predicted Traffic Volume and Ratio of Heavy Vehicle (Sri Sophorn – Poipet Section)

(Unit: pcu/day)

		MC	LV	HV	Total	Ratio of Heavy Vehicles
Station 9 (KP366 ~ 371)	Year 2023	3,363	7,154	5,095	15,566	32.44%
	Year 2028	4,239	9,459	6,540	20,238	32.32%
	Year 2033	5,225	12,075	8,214	25,514	32.19%

(b) CBR Value of Subgrade

Figure 8.3-2 shows the CBR values of the existing subgrade obtained through the laboratory tests. Design CBR value of 0.8% is adopted for the Sri Sophorn – Poipet Section.

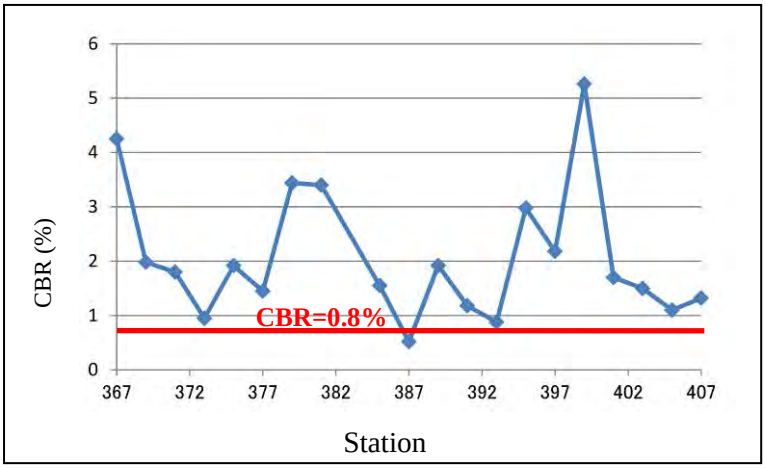


Figure 8.3-2 CBR Value Obtained Through Laboratory Tests

Improved pavement will be placed on top of the existing pavement. The thickness of new pavement can be reduced by evaluating the strength (CBR) of the existing pavement as .a part of the subgrade. The result of evaluation is as shown below.

Table 8.3-5 CBR for Pavement Design on Sri Sophorn – Poipet Section

Item	Adopted Values			
	KP 366 ~ 371 (Inundation Section)		KP 371 ~ 402	
	Thickness	CBR	Thickness	CBR
CBR of selected subgrade	30 cm	6%		
CBR of existing pavement	30 cm	20%	30 cm	20%
CBR of existing subgrade	40 cm	0.8%	70 cm	0.8%
Composite value	100 cm	**8% (6%)**	100 cm	**3%**

(c) Subgrade Improvement

The CBR of existing subgrade of KP 371 – KP 402 is 0.8%, which is very low and insufficient for supporting pavement structure. The CBR of existing subgrade in this section needs to be improved to more than 3%. Likewise to the Middle Section, three methods for improving existing CBR are compared:

Method (i): Using the existing pavement as for the subgrade of planned new pavement,

Method (ii): Replace the existing pavement with suitable material, and

Method (iii): Cement stabilization.

As a result of comparison of these three methods, Method (i): "using the existing pavement as subgrade of planned pavement" is the most economical. Therefore, Method (i) is adopted.

Table 8.3-6 Comparison of Subgrade Improvement

KP 371-402 (CBR=0.8%)		CBR=3%		CBR=4%		CBR=6%	
Pavement composition	Surface (cm)	5		5		5	
	Binder (cm)	10		10		10	
	Base (cm)	30		25		20	
	Sub-base (cm)	50		40		30	
Cost (include subgrade improvement)		Thickness	Cost (USD)	Thickness	Cost (USD)	Thickness	Cost (USD)
	Method (i)	30 cm	1163	-	-	-	-
	Method (ii)	60 cm	1311	70 cm	1262	-	-
	Method (iii)	40 cm	1264	50 cm	1207	70 cm	1168

(d) Conditions of Pavement Design and SN

Table 8.3-7 shows the design conditions and required SN of the pavement the Sri Sophorn – Poipet Section. Table 8.3-8 and Figure 8.3-3 show the designed pavement structures.

Table 8.3-7 Conditions of Pavement Design of the Sri Sophorn - Poipet Section

Item	Adopted Values	
	KP 366 ~ 371 (Inundation Section)	KP 371 ~ 402
Design Period	10 years	10 years
Reliability	80%	80%
Subgrade's CBR for pavement design	6%	3%
Traffic Load (W_{18}=Cumulative 18 kip ESAL)	1.082×10^7	1.082×10^7
Structural Number (SN)	SN=5.067	SN=5.55

As shown in the table above, design section is divided into two sections: KP 366 ~ 371, KP 371 ~ 402, considering both traffic load and CBR of subgrade.

Table 8.3-8 Designed Pavement Structure of Sri Sophorn – Poipet Section

Layer	Thickness		
	Material	KP 366 ~ 371 (Inundation Section)	KP 371 ~ 402
Surface & Binder	AC	15 cm	15 cm
Base	Stabilized gravel	20 cm	25 cm
Subbase	Crusher run	40 cm	45 cm
Subgrade	Selected Material	30 cm	N/A

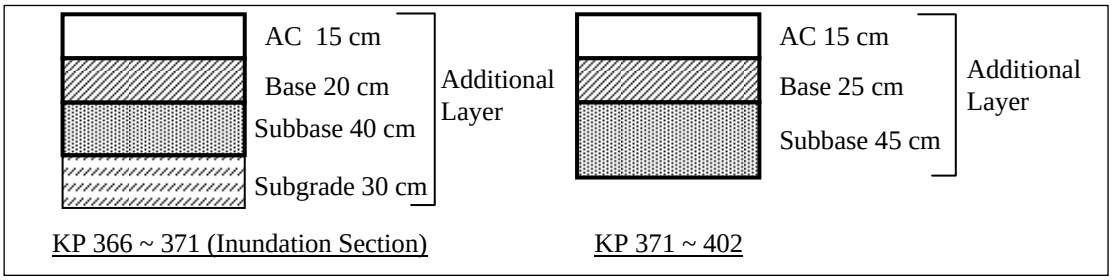


Figure 8.3-3 Pavement Structure of Sri Sophorn – Poipet Section

8.3.7 Intersection

The policy for intersection design for the Sri Sophorn Section is same to that of the Middle Section, except the intersection for access road to the new border facility. The feasibility study for the access road is currently implemented by the government of Thailand, and the route of the access road and the location of intersection of the access road with NR 5 has not been fixed yet. The construction cost of the access road is expected to be financed by the government of Thailand. Under such circumstances, it is difficult to design the intersection of the access road with NR 5. Possible configurations of the intersection are shown in Figure 8.3-4 (roundabout intersection) and Figure 8.3-5 (grade-separated ramp for right-turn traffic from NR 5). It is proposed that the cost of this intersection be excluded from the cost of this project (Project of improvement of the Middle Section and Sri Sophorn – Poipet Section) since the access road is expected be constructed with a financial assistance of Thailand.

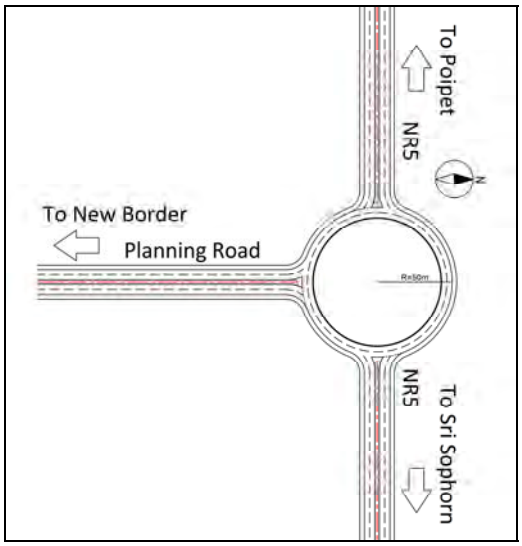


Figure 8.3-4 Roundabout Intersection

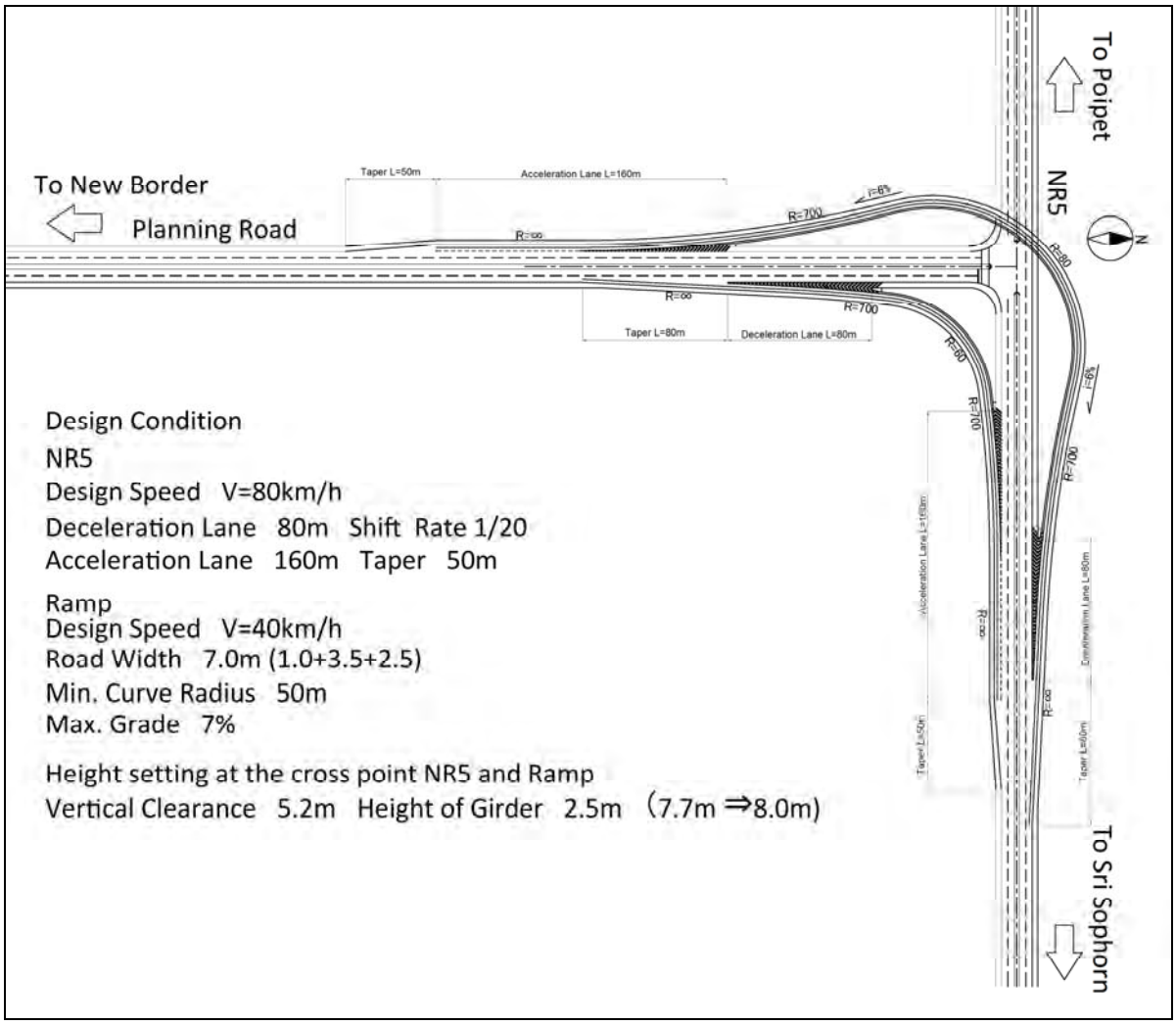


Figure 8.3-5 Grade-Separated Ramp for Right-Turn Traffic from NR 5

8.3.8 Appurtenances

Drainage facilities, guardrails, guide post, ramble strip, street light and safety devices of Sri Sophorn – Poipet Section are planned in a same manner to those of the Middle Section as described in Subsection 8.2.3.

8.4 Pursat Bypass

8.4.1 Cross Section

The design criteria for cross-sectional composition of Pursat Bypass are same as those for the Middle Section.

(1) Estimated Traffic Volume and Number of Lane

As discussed in Chapter 5, the estimated traffic volume on Pursat Bypass in 2033 requires the capacity of 4-lane.

(2) Consistency with Existing Section

After completion of the project, the bypass becomes the main route of NR 5. It implies that the function of Asian Highway No. 1 will be diverted to the bypass from the existing route of NR 5 passing through the urbanized area of Pursat City. Therefore, it is adequate to design the bypass with same design policy with that of the Middle Section. Thus, the cross-sectional composition same to that of the Middle Section, as shown in Figure 8.4-1, is proposed for Pursat Bypass.

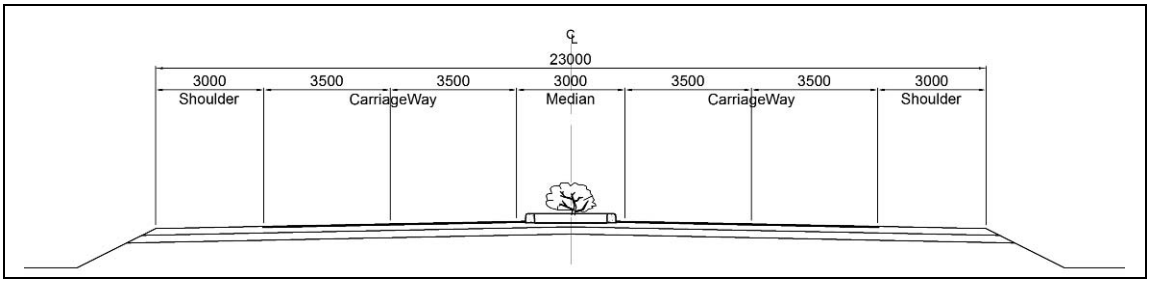


Figure 8.4-1 Typical Cross Section of Pursat Bypass

8.4.2 Horizontal Alignment

N-1 Route is selected as discussed in Chapter 7. The design criteria same with those discussed in Subsection 8.2.2 are proposed to be adopted.

Horizontal alignment was studied on the satellite photograph to avoid major control points such as reservoirs, temples and houses. The route of bypass thus selected is shown in Figure 8.4-2.

Table 8.4-1 shows the curve elements of the bypass route. The total length of the bypass is 8.760 kilometers.

Table 8.4-1 IP & Elements of Curves

Station		Radius (m)	Curve Length (m)	Tangent (m)
0+553.915	IP 01	800	1103.397	656.951
2+261.830	IP 02	800	771.736	418.866
4+098.901	IP 03	800	512.341	265.301
8+553.425	IP 04	700	413.734	214.616

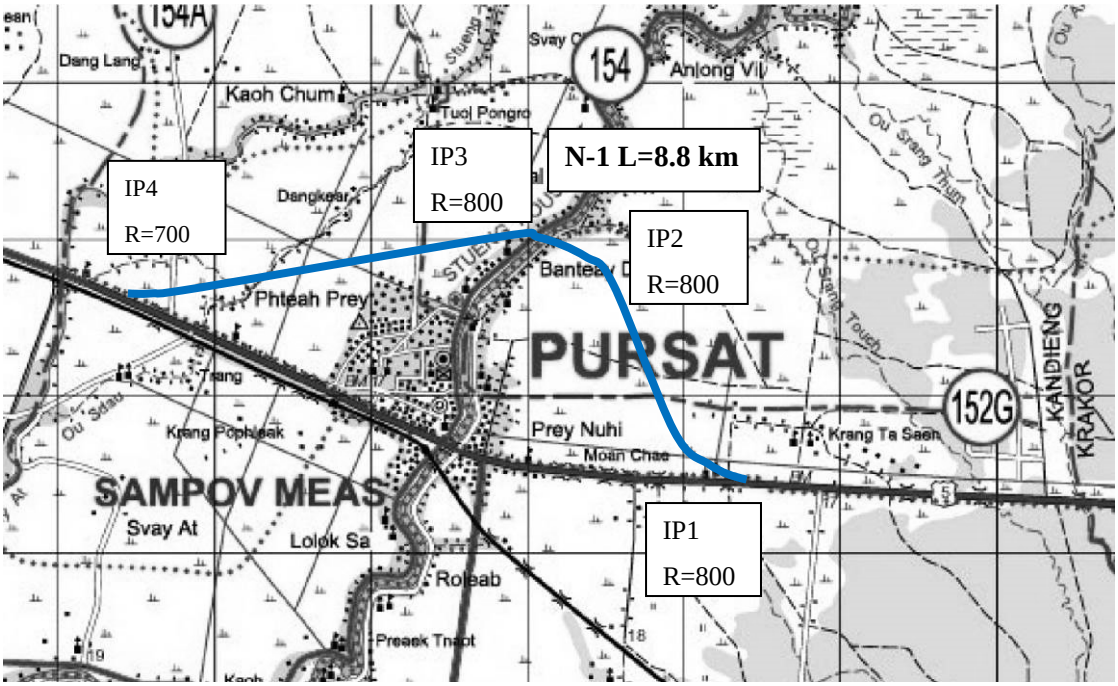


Figure 8.4-2 Route of Pursat Bypass

Topographical survey was carried out along the bypass route in order to obtain the information/data needed for the preliminary design of the bypass.

8.4.3 Vertical Alignment

The proposed route traverses mostly paddy areas. The paddy area is often covered by the water for cultivation of rice and/or by accumulated rain water. The height of embankment of the bypass is needs to be planned sufficiently higher than usual water level of paddy.

The surface levels of the existing NR 5 at the starting point and the end point of the bypass are 16.5 m and 16.0 m MSL, respectively. Thus, the elevation of the surface along the first few kilometers of the bypass will be substantially higher than the flood level of Tonle Sap River (11.13 m MSL). Occurrence of inundation on road surface was not found at these locations through the flood survey. Thus the elevations of the bypass at the intersections with the NR 5 are sufficiently high.



Beginning Point



End Point

Figure 8.4-3 Photo at Pursat Bypass Route

Higher embankment height is desirable from viewpoint of flood/overflow. However, higher embankment height results in higher construction cost of embankment and wider land to be acquired. Considering these, the embankment height is planned at half meter (0.5 m) above the flood water level. With the thickness of pavement structure (65 cm), the road surface will be more than 1.00 m above the flood water level.

In general, embankment height in paddy area is designed to be 1.5 m to keep sufficient safety margin from water level during cultivation. This embankment height (1.5 m) is also necessary to provide sufficient thickness of coverage to for pipe culverts.

8.4.4 Pavement Design

The design procedure of pavement structure for Pursat Bypass is same to that of the Middle Section and is based on the AASHTO's Pavement Design Manual which takes into account the forecasted traffic load and CBR of subgrade and obtain structural number (SN).

(1) Design of Pavement Structure

(a) Ratio of Heavy Vehicle

The ratio of heavy vehicles is forecasted to be approximately 49%, as shown in Table 8.4-2.

Table 8.4-2 Predicted Traffic Volume and Ratio of Heavy Vehicle

(Unit: pcu/day)

	MC	LV	HV	Total	Ratio of Heavy Vehicles
Year 2023	864	5,187	5,860	11,911	49.2%
Year 2028	1,110	7,912	8,618	17,639	48.9%
Year 2033	1,205	8,824	9,463	19,492	48.5%

(b) CBR Value of Subgrade

CBR value of 6.0% is adopted for the subgrade assuming that a selected material be used for

the top portion of the embankment.

(c) Conditions of Pavement Design and SN

Table 8.4-3 shows the design conditions of the pavement for Pursat Bypass. Table 8.4-4 and Figure 8.4-4 show the designed pavement structure for Pursat Bypass.

Table 8.4-3 Conditions of Pavement Design for Pursat Bypass

Item	Adopted Values
Design Period	10 years
Reliability	80%
Subgrade's CBR for pavement design	6%
Traffic Load (W_{18}=Cumulative 18 kip ESAL)	4.010×10^7
Structural Number (SN)	SN=5.33

Table 8.4-4 Designed Pavement Structure

Layer	Material	Thickness
Surface & Binder	AC	15 cm
Base	Stabilized gravel	20 cm
Subbase	Crusher run	30 cm
Subgrade	Selected Material	100 cm

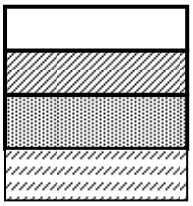


Figure 8.4-4 Pavement Structure of Pursat Bypass

8.4.5 Drainage

The embankment of the bypass will behave as a dike during the flood season and block water flow. In addition, the bypass traverses the paddy fields which needs free flow of surface water. thus, it is necessary to install sufficient cross drainage in order to provide adequate cross-sectional area for water flow.

There are many cannels across the proposed bypass route. The direction of flood water flow is basically from south to north (towards Tonle Sap Lake). Cross drainage facilities will be scheduled as required. For larger streams, such as Pursat River, a bridge is to be constructed. The plans of bridges are presented in Chapter 9.

(1) Box Culvert

Box culverts are installed at the crossing points of relatively wide water channels including irrigation channels. Table 8.4-5 shows the list of box culvert.

Table 8.4-5 List of Box Culvert

STA	TYPE (P-B*H)
1+480	2-3.0*2.0
1+800	1-3.0*2.0
1+900	2-3.0*2.0
2+660	1-3.0*2.0
2+980	2-3.0*2.0
4+780	2-3.0*2.0
4+805	2-3.0*2.0
5+080	1-3.0*2.0
5+685	2-3.0*2.0
6+315	1-3.0*2.0
7+495	1-3.0*2.0

Note:
P = the number of cells
B = breadth of a cell
H = height of a cell
Example:
2-3.0*2.0 = 3.0 m wide x 2.0 m high x 2 cells

(2) Pipe Culvert

Pipe culverts are installed basically at an interval of 250 m and at every crossing point of the existing irrigation canal. This policy is same to those of the North Section and the South Section. The purpose of this is to minimize the difference of the water level between the both sides of the bypass.

8.4.6 Intersection

Intersections of the Bypass with the existing NR 5 are designed in such a way that the main direction is for the Bypass and the direction for the city center of Pursat branches out from the Bypass. Degree of saturation, if it is constructed as an at-grade intersection with signal control, is calculated to be 0.5 for the traffic volume of year 2033. Thus, at-grade intersection can accommodate the traffic. Figure 8.4-5, 8.4-6 show plans of the intersection with the existing NR 5.

8.4.7 Weigh Station

RGC is exerting effort to enforce overloaded trucks. Currently there are three weigh stations along NR 5: Poipet (KP 389+000), Pursat (KP 191+800) and Kampong Chhnang (KP 48+000). These weighbridges need to be relocated as the road is widened. Also, construction of new weighbridges is necessary. The current weigh stations measure the weights of vehicle travelling on the both direction. After the improvement, the two direction of traffic will be physically separated by the median division and weighbridges will be needed on the both sides of the road. Thus the number of the weighbridges needs to be increased to double of the existing ones. Further, the existing weighbridges are old and need renewal, according to MPWT. In addition, MPWT wish to construct a new weigh station near Battambang City and the JICA Team supports this idea. Thus, the number of weigh station will be increased to 4 after the road improvement.

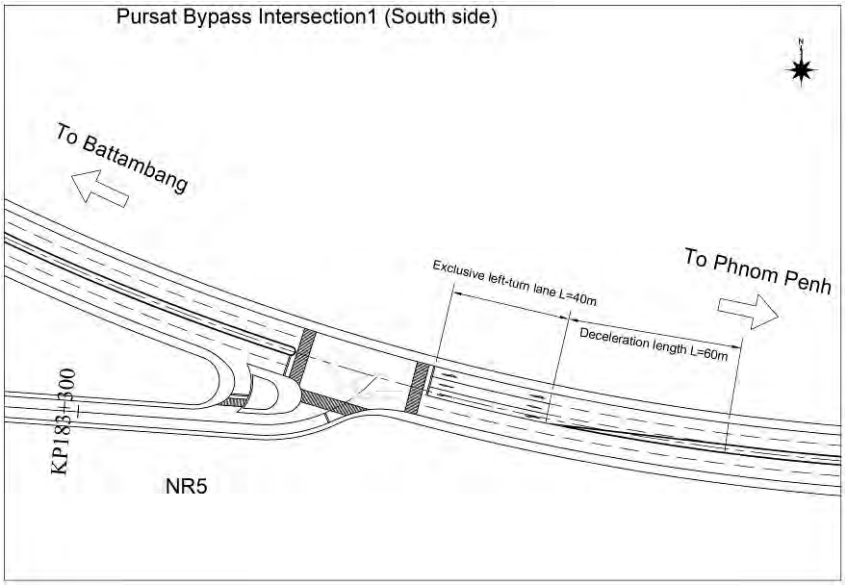


Figure 8.4-5 Southern Intersection of Pursat Bypass

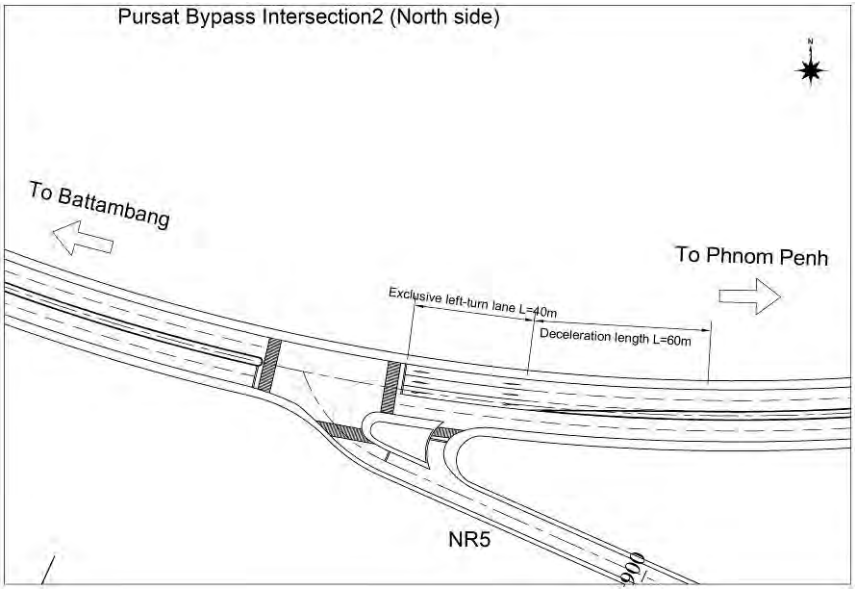


Figure 8.4-6 Northern Intersection of Pursat Bypass

CHAPTER 9 BRIDGE PLANNING

9.1 General Design Policy and Design Criteria

9.1.1 Bridge Design Standard

(1) Design Standard

The Cambodian Road and Bridge Design Standard and Construction Specifications were established in 1999 and are to be used for the design and construction of all new roads and bridges and related rehabilitation works in the Kingdom of Cambodia. The design standards for bridges are:

- CAM PW 04-101-99 Bridge Design Code 1996 (the Base Document)
- CAM PW 04-102-99 Amendments and additions to the Base Document and to the Commentaries on the Cambodian Bridge Design Standard.

The Base Document is in fact the Australian Bridge Design Code 1996 and associated Commentaries. (Note that in Australia and New Zealand, the Australian Bridge Design Code 1996 has now been superseded by the Australian Bridge Design Code AS5100.)

The Base Document is an International Bridge Standard making use of modern limit state design philosophy. The amendments and additions to the Base Document reflect conditions in Cambodia from the viewpoint of loading (traffic, environmental and earthquake loads), design for durability and material requirements. A comparison of nominal traffic loading for a typical 20 m span pre-stressed concrete bridge is presented below. As can be seen the total maximum traffic load effects based on the Cambodian Bridge Design Standard are reasonably comparable to both AASHTO and Japan Road Association (JRA) standards.

As a conclusion, Cambodian Standard is adopted in this survey.

Table 9.1-1 Comparison of Nominal Load Effects for 20 m Span Bridge Cambodian, AASHTO and JRA Standards

Case	Load Standard	Single lane		Standard 10 m wide roadway bridge deck						
		Max Shear (kN)	Max Moment (kN-m)	Impact Factor	No. of Lanes	Load Mod. Factor *	Total Max Shear (kN)	Total Max Moment (kN-m)	Shear Factor	Moment Factor
1	CAM T44	358.3	1,639.2	0.35	3	0.80	1,161.0	5,311.0	1.00	1.00
2	CAM HLP 240	N/A	N/A	0.10	N/A	N/A	1,333.2	6,160.0	1.15	1.16
3	AASHTO LRFD HL-93	368.1	1,690.8	0.33	3	0.85	1,248.5	5,734.4	1.08	1.08
4	JRA L-Load	N/A	N/A	0.22	N/A	N/A	1,184.0	5,209.7	1.02	0.98

Note:
Case 1 & 2 : Cambodian Bridge Design Standard; Case 3 : AASHTO LRFD; Case 4 : JRA Specifications for Highway Bridges
** Load Modification Factor to account for multiple lane loading*

(2) Traffic Loading

The design traffic load specified in the Base Document consists of T44 Truck loading and L44 Lane loading.

The design T44 Truck load is a 44 tonne vehicle with five axles and with maximum axle load of 9.8 tonnes (96 kN). One design truck can occupy one standard design lane width of 3.0 m. Refer to Figure 9.1-1. L44 Lane loading shall consist of the loads shown in Figure 9.1-2. The lane loading shall be assumed uniformly distributed over a 3 m Standard Design Lane. Only one tandem of concentrated loads shall be used per lane except that one additional tandem of concentrated loads of equal force shall be placed in each lane in one other span in such a position to produce maximum negative effect. L44 Lane loading does not apply for spans less than 10 m.

The Dynamic Load Allowance for T44 and L44 loadings shall be 0.35.

T44 Truck and L44 Lane loadings shall be assumed to occupy one Standard Design Lane of 3 m width.

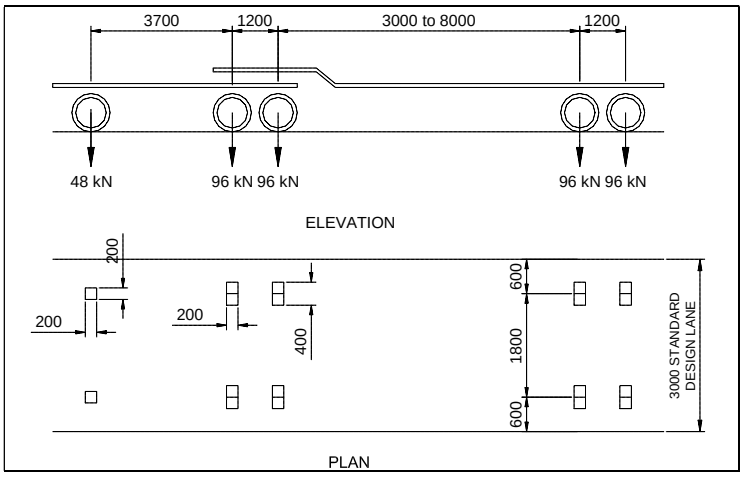
The number of Standard Design Lanes n shall be:

$$n = \frac{b}{3.1}$$ (rounded down to next integer)

where b = carriageway width (in meters) between traffic barriers

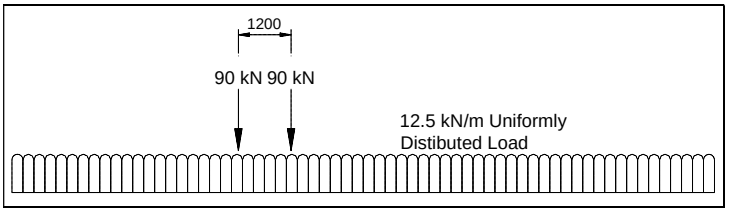
These Standard Design Lanes shall be positioned laterally on the bridge to produce the most adverse effect.

The design of bridges for the simultaneous application of road traffic loading and pedestrian loading is not required.



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

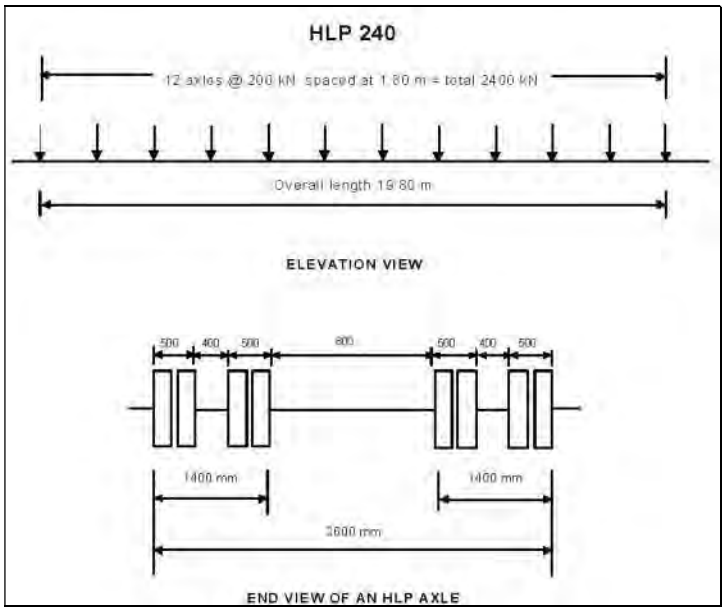
Figure 9.1-1 Design Truck Load T44



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

Figure 9.1-2 Design Lane Loading L44

Heavy Load Platform Loading HLP 240 shall be applied in accordance with the Cambodian Bridge Design Standard. The roads on which Heavy Load Platform Loading apply for bridge design generally will comply with design standards R6/U6, R5/U5 and R4/U4 of the Cambodian Road Design Standard Part 1 – Geometry. On this basis, bridges on National Road No. 5 (NR 5) will be required to support Heavy Load Platform Loading. The configuration of the HLP 240 axle loads is presented in Figure 9.1-3. Heavy Load Platform Loading HPL 240 shall be assumed to centrally occupy two Standard Design Lanes. If the two Standard Design Lanes containing the Heavy Load Platform loadings are positioned such that one or more marked traffic lanes are unobstructed, then a loading of ½ of either the T44 Truck loading or L44 Lane loading shall be applied in those lanes.



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

Figure 9.1-3 Heavy Load Platform Loading

The load modification factors given below shall be applied to T44 Truck and L44 Lane Loading when loading Standard Design Lanes simultaneously. The modification factors shall not apply to Heavy Load Platform loadings.

Number of Standard Design Lanes Loaded	Load Modification Factor
1	1.0
2	0.9
3	0.8
4	0.7

A 70 kN single dual-tyred wheel load, with a contact area of 500 mm x 200 mm, shall be applied for all deck elements for which this loading is critical. This wheel load is designated as the W7 Wheel loading.

(3) Standard Bridges in Cambodia

Standard drawings for pipe culverts, box culverts and bridges have been prepared for MPWT approval under The Strengthening of Construction Quality Control Project, JICA.

With regard to bridges, plans are prepared for carriageway widths of 7 m, 8 m, 10 m, and 12 m for the following bridge types and spans:

- RC Flat Slab (RCS) with spans of 10 m, 12 m, 15 m and 18 m
- RC Deck Girder (RCDG) with spans of 12 m, 15 m, and 18 m
- Pre-tensioned Precast Plank hollow slab (PSC) with spans of 15 m, 18 m, 20 m and 25 m
- Post-tensioned Plank hollow slab with spans of 15 m, 18 m, 20 m and 25 m
- Post-tensioned Precast Concrete Deck Girder (PCDG) with spans of 18 m, 20 m, 25 m and 30 m

Features of these bridge types are as summarized below;

(i) Reinforced concrete flat slab

The reinforced concrete flat slab (RCS) bridge is the simplest form of construction applicable to short spans and offers the largest span/depth ratio of all the options, i.e. the deck slab is minimum thickness. This type of construction will therefore have minimal impact on the road profile. The deck is simply supported on a 30 mm thick cement mortar bed and is located with dowels.

(ii) Reinforced concrete deck girder

The reinforced concrete deck girder (RCDG) bridge is more economic for the longer spans in the range assigned. However this form of construction offers the smallest span/depth ratio of all the options, i.e. the deck construction is relatively deep. Such a relatively deep deck will have a significant effect on the road profile in cases where high flood level controls the deck elevation. The deck also requires the construction of diaphragms, both at the girder ends and in-span, to promote lateral load distribution. The deck is simply supported on rubber pads and is located with dowels.

(iii) Pre-tensioned precast plank hollow slab

The pre-tensioned precast plank hollow slab (PSC) bridge offers the advantages of precast construction, in terms of construction speed and construction quality control, and provides a large span/depth ratio for spans up to 25 m. This type of construction will therefore also have minimal impact on the road profile. The planks are pre-tensioned and incorporate voids, circular or rectilinear, to reduce weight. The planks are placed side by side to form the deck with the narrow gap filled with cement mortar. Once the mortar has gained sufficient strength, the planks are transversely post-tensioned using high tensile strength steel bars posted through holes in the planks and anchored in recesses at each side of the deck. The full depth planks do not require any in-situ concrete topping and can directly

receive the pavement surfacing. The deck is simply supported on a 30 mm thick cement mortar bed and is located with dowels. This type of bridge deck has become the defector standard in Cambodia for short span bridges, with many examples already constructed ranging from 10 m span length.

(iv) Post-tensioned precast concrete deck girder

The post-tensioned precast concrete deck girder (PCDG) bridge spans up to 30 m in the standard established. This type can in fact be applied to spans up to 40 m or so and is economic for the longer spans in the range assigned. The precast concrete girders again offer advantages in terms of construction speed and construction quality control. The precast girders may or may not incorporate a part of the deck slab, with the reinforced concrete deck slab either totally or partially constructed in-situ. The deck slab may feature transverse prestress. The girders also require diaphragm to promote lateral load distribution. This form of construction however has a relatively small span/depth ratio, i.e. the deck construction is relatively deep. Such a relatively deep deck will therefore have a significant effect on the road profile in cases where high flood level controls the deck elevation. The deck is simply supported on elastomeric pads and is located with dowels.

Two types of reinforced concrete abutment are featured in the standard drawings:

- Stub Type
- Cantilever Type

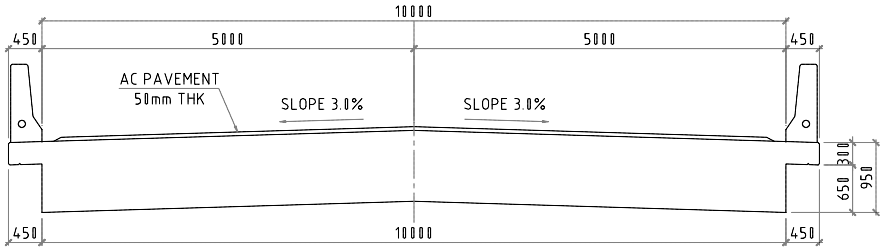
(v) Stub type abutment

The stub type abutment features a simple coping beam, providing a bearing shelf for the deck, supported on a single row of piles, with the wing walls hung off each side. This type is suitable for all the standard deck forms where the approach embankments are relatively low and where there is no threat of local scour attack.

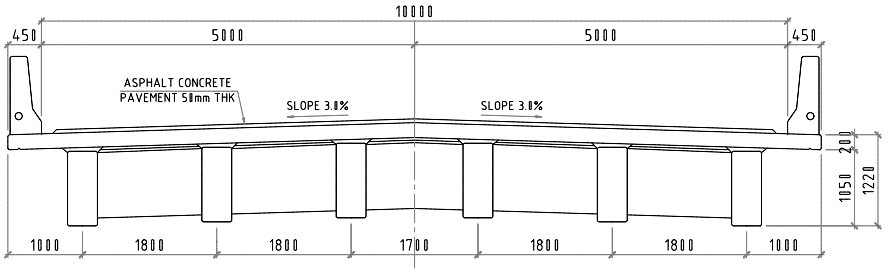
(vi) Cantilever abutment

The cantilever abutment is a substantial structure suitable for high approach embankment situations, or deep waterway locations, and where protection to local scour attack is required. The abutment comprises of a cantilever wall, providing a bearing shelf for the deck, supported on a pile cap with multiple rows of piles. The wing walls are hung off short counterforts at each side. The abutment can support large vertical and horizontal loads.

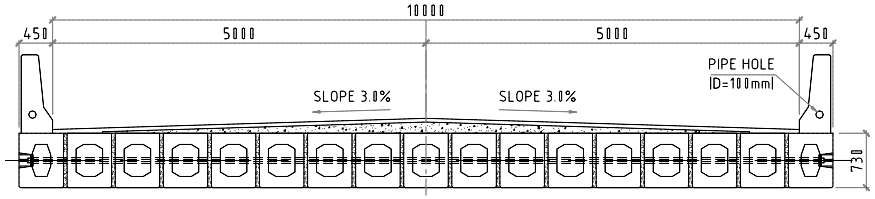
Refer to Figure 9.1-4 for typical sections of the proposed standard bridges (draft). Refer to Figure 9.1-5 for typical abutment layouts for the standard bridges. The standard bridges show a minimum freeboard of 80 cm to high water level.



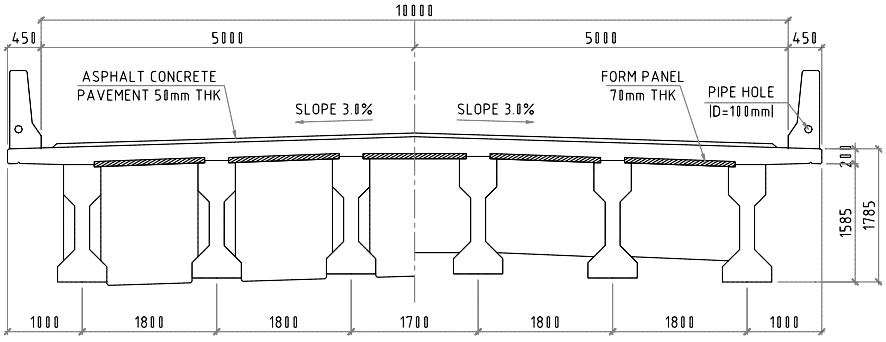
RC Flat Slab (RCS)



RC Deck Girder (RCDG)



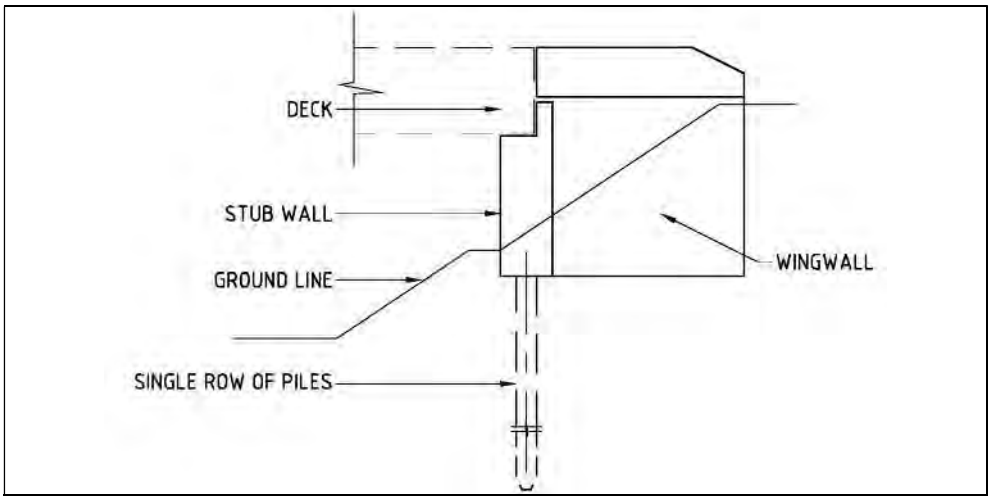
Pre-tensioned Precast Plank (PSC)



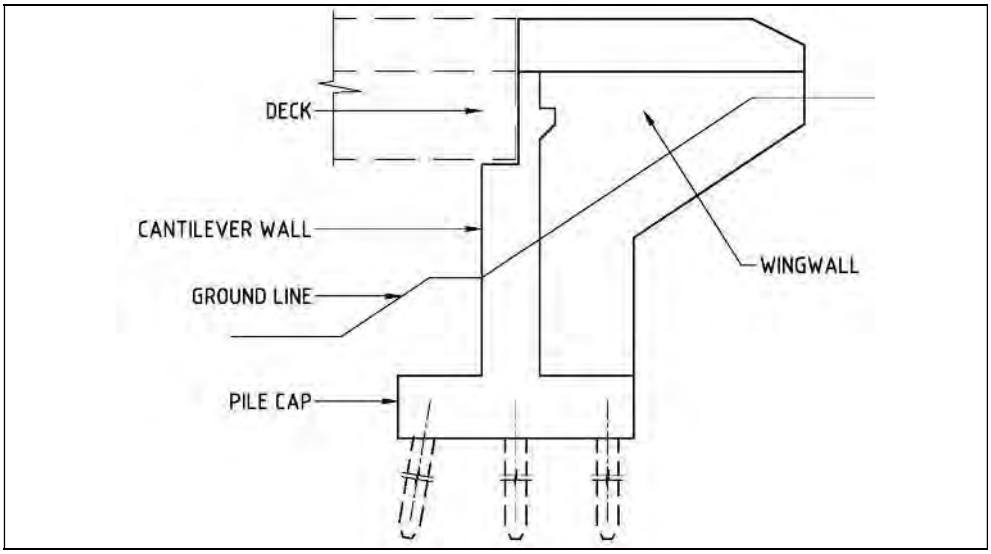
Post-tensioned Precast Concrete Deck Girder (PCDG)

Source: MPWT, The Strengthening of Construction Quality Project, JICA

Figure 9.1-4 Standard Bridge Typical Sections for 10 m-Wide Carriageway



Stub Type Abutment



Cantilever Type Abutment

Source: MPWT, The Strengthening of Construction Quality Project, JICA

Figure 9.1-5 Standard Bridge Abutments

9.1.2 Selection of Widening Method on the Bridges

(1) Basic Policy

The substantial carriageway width needed to accommodate a 4-lane road will require that all bridges will either have to be widened or to be supplemented with an additional adjacent bridge. The bridges that have tangential road approaches are recommended to be equally widened on each side in order to maintain the tangent horizontal alignment of the existing road.

A few widening methods as listed in Table 9.1-2 are considered and employed depending on the conditions of the existing bridge, including the road section on the both sides of the bridge. Figure 9.1-6 shows the flow and criteria for selecting these widening methods and Figure 9.1-7 schematically shows the basic concepts of these widening methods.

Table 9.1-2 Method of Bridge Widening

Method	Applicable Condition	Remarks
Demolish Existing Bridge and Newly Construct 4-lane Bridge	Existing is does not have sufficient bearing capacity.	Old bridge
Construct an Additional Bridge alongside Existing Bridge	Existing bridge is intact & has sufficient bearing capacity.	
Widen Existing Bridge by Installing Additional Girders & Deck Slab	Existing bridge is intact and has sufficient bearing capacity. The structure of the bridge allows installation of additional girders and deck slabs.	PC hollow slab type

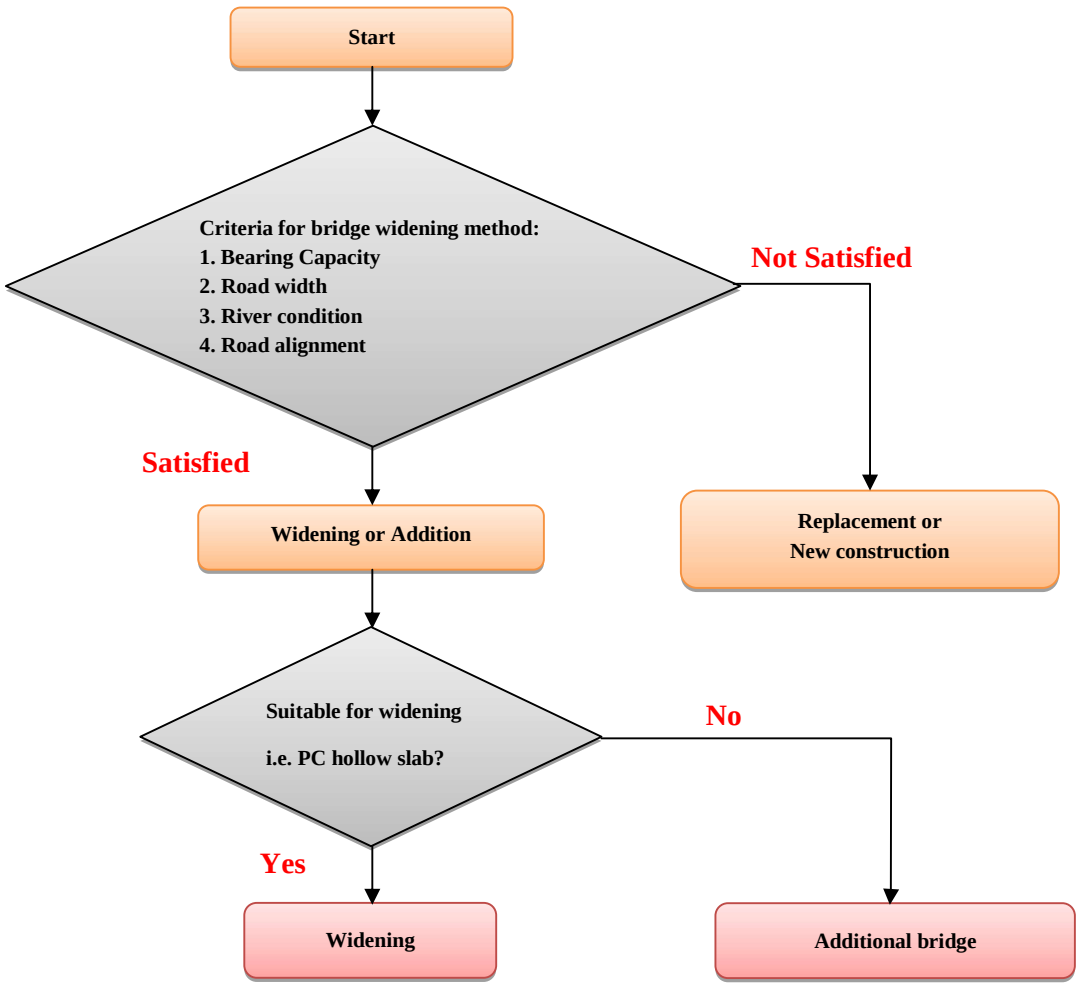


Figure 9.1-6 Flow of Selection of Bridge Widening Method

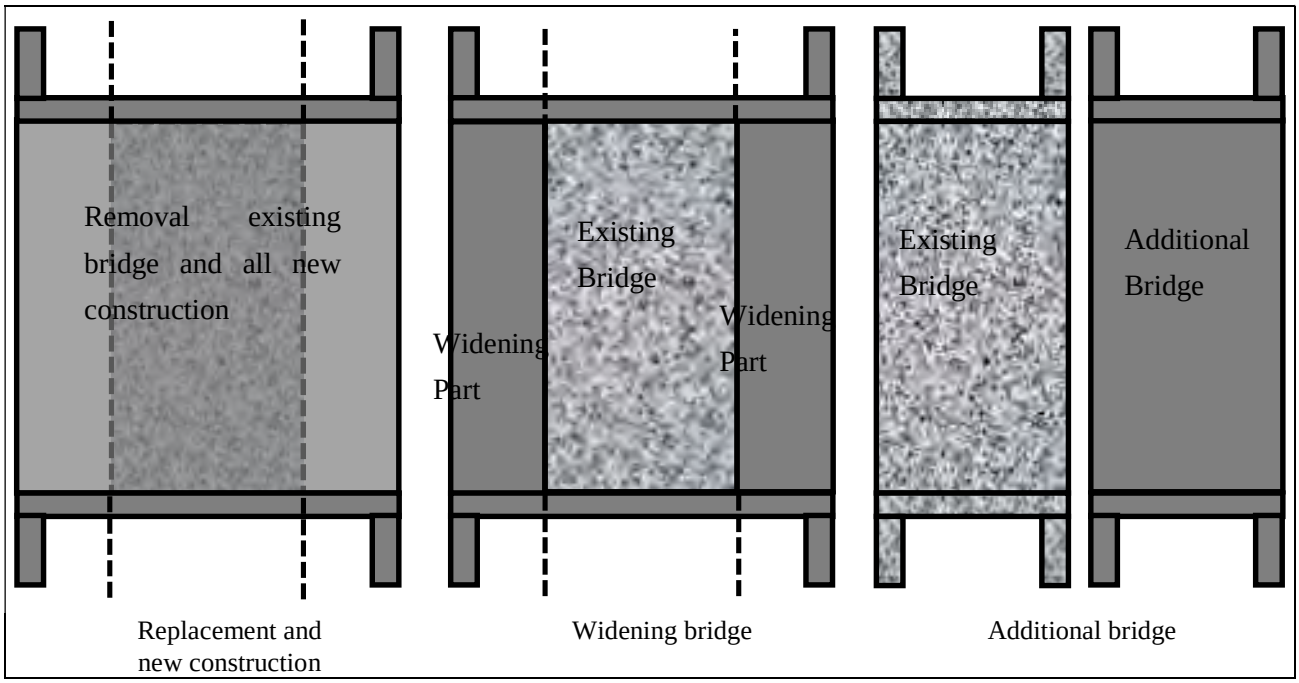


Figure 9.1-7 Concept of Bridge Widening Methods

Table 9.1-3 compares advantage and disadvantage of these widening methods. In the table, three cases are defined as follows:

Case I: Replacement (Demolish the existing bridge and construct a new bridge)

Case II: Widening on both sides of existing bridge

Case III: Construction of additional bridge alongside the existing bridge

Table 9.1-3 Comparison of Widening Methods of the Bridges

	Conceptual Drawing	Land Acquisition	Construction Cost	Structural Performance, Workability		Evaluation
Existing		-	-	-		-
Case I		Good	Poor	Good		3
Case II		Good	Good	PC Hollow	Good	1
				Others	Poor	
Case III		Fair	Good	Good		2

As for the method of widening the existing superstructure in Case II, there are two methods in general. One method is unifying the added portion with the existing portion by tightening the two portions laterally with anchor bars which are extended by connecting additional length. The other is installation of longitudinal joint between existing bridge and widening part allowing separate deflection between them. Either methods are used in case of widening of PC hollow type bridges.

Table 9.1-4 lists the bridge type usually adopted depending on the span length. (These are applied to newly constructed bridges.)

Table 9.1-4 Standard Relations between Span Lengths and Bridge Types

Bridge Type			Denotation	Applicable span length (m)
Simple girder bridge	Pre-tensioned	Slab bridge	PSC	5～25
	Post-tensioned	T-shape girder bridge	PCDG	15～25
Connected girder bridge	Pre-tensioned	Slab bridge	PSC	15～25
	Post-tensioned	T-shape girder bridge	PCDG	25～40

(2) Classification of Existing Bridges

There are 38 bridges on the Middle Section. Among them, 10 bridges (Br. Nos. 44 to 53) are located out of proposed scope of the project (located on the sections parallel to the proposed bypass: see Table 9.1-7). Thus, 28 bridges are required to be widened or to be supplemented with an additional adjacent bridge.

The hearing survey showed that the Middle Section had not been inundated, but the road was actually inundated during the heavy rainfall and flood which occurred from 6 to 8 on October 2013. Accordingly, the elevation of the road surface of this section (KP 255 – 277), as well as the bridges located on the inundation section, is proposed to be raised by around 1.5 m. Thus, the existing bridges (Br. Nos. 66 to 77) on this section are proposed to be replaced (see Table 9.2-1).

The widths of Br. 42, Br. 48 and Br. 66 are 9.0 m, 8.5 m, 9.0 m, respectively. These bridges cannot accommodate full 2-lane (7.0 m) with 3.0 m-wide right shoulder plus 0.5 m-wide left shoulder. Accordingly, these bridges are proposed to be replaced.

Table 9.1-5 summarizes the types of existing bridges and methods of widening.

Table 9.1-5 List of Classification of Existing Bridges

Bridge Type	No. of Bridge	No. of Span	Total Length	Construction Year	Span Length	Bridge Condition	Method of Widening
PSC	23	1 ~ 3	12.1 ~ 54.0	2003	12.1 ~ 18.0	New, Good	Widening/ Replacement*
Steel Girder	3	1, 3	23.0 ~ 91.0	1996	23.0, 30.3	New, Good	Additional Br.
RCDG	2	Br. 42: 4	18.6	-	4.7	Bad	Replacement
		Br. 27: 2	9.0	-	4.5	Old*	

*Replacement for raising road surface as the countermeasure for inundation

(a) PSC Bridges

PSC accounts for the majority of the bridge of this section. These bridges have 1 to 3 spans. The lengths of bridges are 12.0 m to 54.0 m, and the span lengths are less than 20 m. As shown in Table 9.1-2: "Method of Bridge Widening", PSC bridges are suitable for widening, and thus, the existing PSC bridges are planned to be widened by installing additional girder

and deck slab. The span arrangement of the existing bridges can be maintained and will not cause any change in hydrological conditions.

Because PSC girders can be produced in a factory, it is possible that the production cost can be reduced and good quality control is practiced.

(b) Other Types of Bridge

Steel girder bridge

The existing steel girder bridges have been constructed in recent years and their structural condition is still good. Thus, these bridges can be used as 2-lane bridges for one direction, and additional bridges will be constructed beside the existing bridges. Span arrangement of an additional bridge should be, in principle, same to that of the existing bridge or the number of piers should be less than that of the existing bridge so that the influence to the flow of river water be minimum.

RCDG bridge

Two RCDG bridges (Br. 42 and Br. 66) are old and structural conditions are poor. The lengths of these bridges are short. Therefore, these bridges are proposed to be replaced.

Bridge types of additional bridges and replacing bridges will be selected considering the standard relation between span length and bridge type as listed in Table 9.1-4. PSC and PCDG will be mainly adopted. Main features of these bridge types are summarized in Table 9.1-6.

Table 9.1-6 Bridge Type and Main Features

Bridge types	Span Length	Main Feature
PSC	0 ~ 25 m	・Can be fabricated in the workshop. ・Max. girder length is around 25 m (limited by capability for transport). ・Can be erected with truck crane. ・Production cost can be lowered as the work volume increases.
PCDG	20 ~ 42 m	・Fabricated at site. ・Erection can be done with truck crane or erection girder.

Table 9.1-7 shows the proposed types of bridge widening.

Table 9.1-7 Summary of Bridge Widening- Full 4-Lane Design

No.	Code	KP	Existing Bridge Length (m)	No. of Span	Existing Type	Widening Method
1	Br.40	177+200	23.0	1	Steel Girder	Construction of additional bridge (LHS)
2	Br.41	178+500	15.1	1	PSC	Widening of existing bridge
3	Br.42	181+800	18.6	1	RCDG	Replacement of existing bridge
4	Br.43	182+800	36.0	2	PSC	Widening of existing bridge
5	Br.44	183+300	45.6	3	Steel Girder	Out of scope of the project
6	Br.45	183+900	36.0	2	PSC	Out of scope of the project
7	Br.46	184+100	20.0	1	PSC	Out of scope of the project
8	Br.47	185+700	120.0	6	PCDG	Out of scope of the project
9	Br.48	187+400	28.0	1	PCDG	Out of scope of the project
10	Br.49	187+700	24.0	2	PSC	Out of scope of the project
11	Br.50	188+100	54.0	3	PSC	Out of scope of the project
12	Br.51	188+250	45.0	3	PSC	Out of scope of the project
13	Br.52	189+250	30.0	2	PSC	Out of scope of the project
14	Br.53	189+900	18.0	1	PSC	Out of scope of the project
15	Br.54	190+150	18.0	1	PSC	Widening of existing bridge
16	Br. 55	191+100	30.0	2	PSC	Widening of existing bridge
17	Br. 56	201+800	12.0	1	PSC	Widening of existing bridge
18	Br. 57	208+500	28.0	2	PSC	Widening of existing bridge
19	Br. 58	215+750	45.6	3	Steel Girder	Construction of additional bridge (LHS)
20	Br. 59	219+600	91.0	3	Steel Girder	Construction of additional bridge (LHS)
21	Br. 60	220+800	24.1	2	PSC	Widening of existing bridge
22	Br. 61	222+650	12.1	1	PSC	Widening of existing bridge
23	Br. 62	223+650	12.1	1	PSC	Widening of existing bridge
24	Br. 63	242+850	18.0	1	PSC	Widening of existing bridge
25	Br. 64	243+600	30.1	2	PSC	Widening of existing bridge
26	Br. 65	244+400	24.2	2	PSC	Widening of existing bridge
27	Br. 66	245+900	9.0	2	RCDG	Replacement of existing bridge
28	Br. 67	255+250	15.1	1	PSC	Replacement of existing bridge
29	Br. 68	255+600	24.0	2	PSC	Replacement of existing bridge
30	Br. 69	256+550	15.0	1	PSC	Replacement of existing bridge
31	Br. 70	257+900	12.1	1	PSC	Replacement of existing bridge
32	Br. 71	265+900	12.1	1	PSC	Replacement of existing bridge
33	Br. 72	270+900	12.1	1	PSC	Replacement of existing bridge
34	Br. 73	271+700	18.5	1	PSC	Replacement of existing bridge
35	Br. 74	272+650	12.1	1	PSC	Replacement of existing bridge
36	Br. 75	273+300	24.1	2	PSC	Replacement of existing bridge
37	Br. 76	275+650	12.1	1	PSC	Replacement of existing bridge
38	Br. 77	276+550	12.1	1	PSC	Replacement of existing bridge

The numbers of bridges by type of widening are summarized in Table 9.1-8.

Table 9.1-8 Number of Bridge by Type of Widening

Type of Widening	No. of Bridge
Widening of Existing Bridge	12
Construction of Additional Bridge	3
Replacement	13
Total	28

9.2 Replacement of Existing Bridge

Br.42, Br.66 are proposed to be replaced by new bridges since old and do not have bearing abilities. The others are proposed to be replaced for insufficient of clearance above water table in the river. A type of new bridge is selected with taking the following aspects into consideration, (i) to minimize impact on road profile, (ii) to secure required river clearance, and (iii) to ensure necessary waterway opening.

The planed span lengths of bridges in inundation section are rounded up by 5 m from those of existing bridges to prepare future floods.

Span arrangements of Br. 68 and Br. 75 have two possibilities; 2@15 m and 1@30 m. Because PSC girders are used in large quantity, efficiency of production of girders can be improved resulting in lower production cost and shorter production time. Because of these advantages, PSC is planned to be adopted.

Table 9.2-1 shows proposed plan of new bridges.

Table 9.2-1 Proposed Plan of Replacement Bridges

Code	KP	Existing Bridge		New Bridge			Remark
		Type	Length (m)	Type	Length (m)	Number of Span	
Br. 42	181+800	RCDG	18.6	PSC	20.0	1	Old
Br. 66	245+900	RCDG	9	PSC	10.0	1	Old
Br. 67	255+250	PSC	15.1	PSC	15.0	1	Inundation
Br. 68	255+600	PSC	24.0	PSC	30.0	2	Inundation
Br. 69	256+550	PSC	15.0	PSC	15.0	1	Inundation
Br. 70	257+900	PSC	12.1	PSC	15.0	1	Inundation
Br. 71	265+900	PSC	12.1	PSC	15.0	1	Inundation
Br. 72	270+900	PSC	12.1	PSC	15.0	1	Inundation
Br. 73	271+700	PSC	18.5	PSC	20.0	1	Inundation
Br. 74	272+650	PSC	12.1	PSC	15.0	1	Inundation
Br. 75	273+300	PSC	24.1	PSC	30.0	2	Inundation
Br. 76	275+650	PSC	12.1	PSC	15.0	1	Inundation
Br. 77	276+550	PSC	12.1	PSC	15.0	1	Inundation

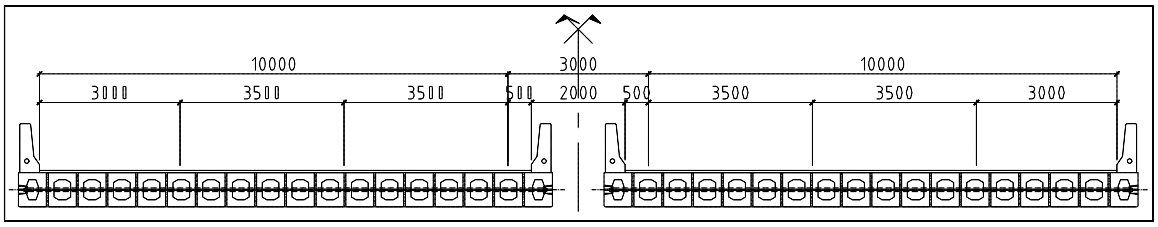


Figure 9.2-1 Typical Cross Section of Replacement Bridge

9.3 Construction of Additional Bridge

As for three bridges (Br. 17, Br, 58 and Br. 59), it is proposed that the existing structure be used to accommodate one of the 2-lane carriageways and an additional bridge be constructed to accommodate the other carriageway. The width of the existing bridge is 10 m. Ten meter width of existing bridge is insufficient for required standard width of 10.5 m for a 2-lane, but is very close to it. The Survey Team proposes to maintain the width of existing bridge, considering expansion of width of existing bridge will required considerable time and cost.

Types of additional bridges are selected taking the following aspects in to consideration, (i) to minimize impact on road profile, (ii) to ensure existing river clearance, (iii) to construct new piers on the same alignment with those of the existing bridge, and (iv) to minimize the maintenance cost. Typical cross sections of a PSC bridge and a PCDG bridge are shown in Figure 9.3-1. An example of general view of PSC is shown in Figure 9.3-2.

Table 9.3-1 Proposed Plan of Additional Bridges

Code	KP	Existing Bridge				Additional Bridge			
		Type	Length (m)	No. of Span	Width (m)	Type	Length (m)	No. of Span	Width (m)
Br. 40	177+200	Steel Girder	23.0	1	9.7	PSC	23.0	1	10.5
Br. 58	215+750	Steel Girder	45.6	3	10.0	PSC	15.0	3	10.5
Br. 59	219+600	Steel Girder	91.0	3	9.6	PCDG	30.0	3	10.5

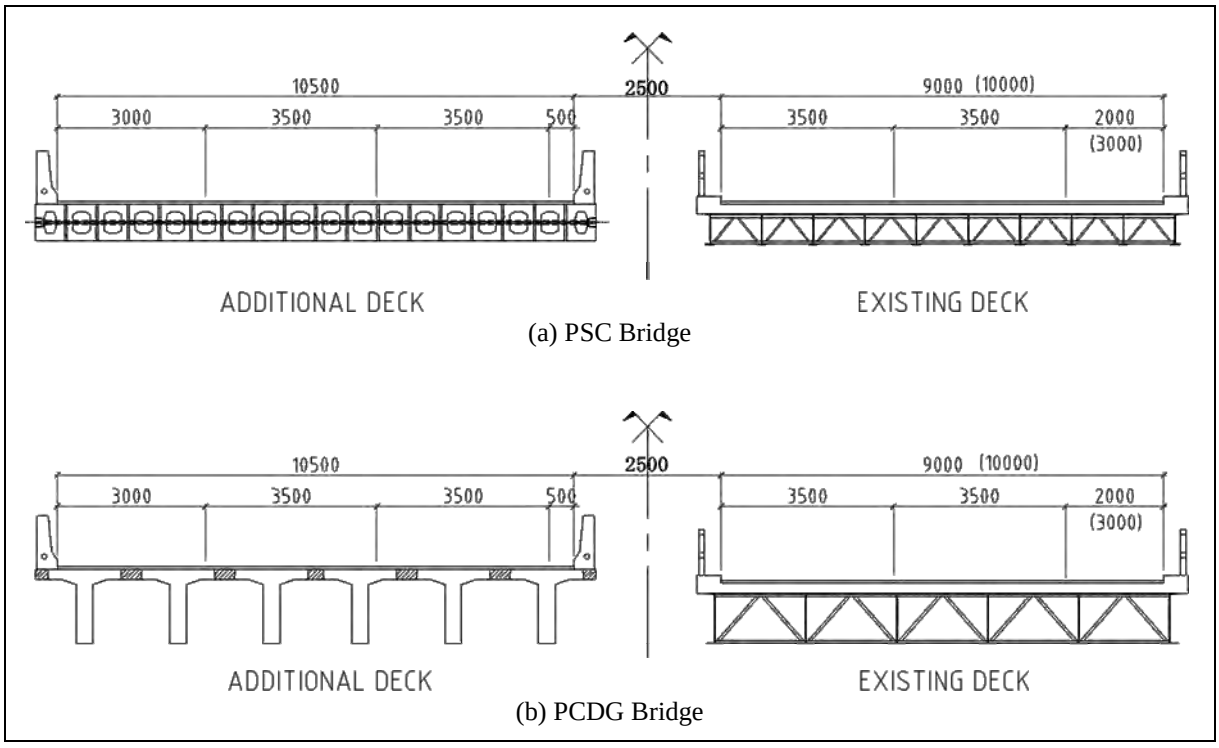


Figure 9.3-1 Typical Cross Section of Additional Bridge

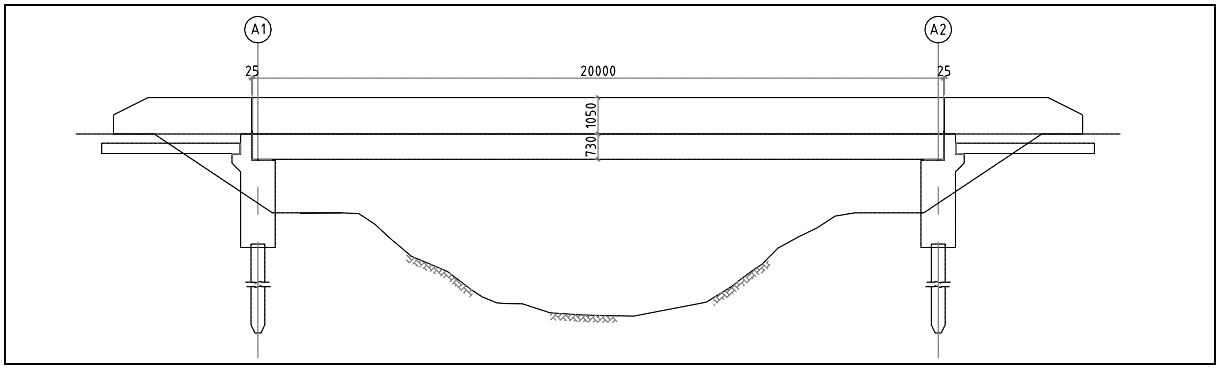


Figure 9.3-2 General View of PSC Bridge

9.4 Widening of Existing Bridge

Widening of existing bridge by adding deck slab and beam, as necessary, is proposed for 4-lane bridges. Substructure may also be widened. Such widening of bridge requires less cost because it does not demolish the existing structure but effectively utilize it. On the other hand, this method requires high-level engineering skill in execution.

This method has been practically adopted in some developed countries including Japan. On the other hand, there has been no such case in Cambodia. Thus, this Project (widening of NR 5) will become the pilot case for this method in Cambodia.

Adoption of the method requires employment of consultant(s) and contractor(s) who have sufficient experience in this method. Once this method is successfully introduced and disseminated in Cambodia, it will substantially reduce the cost of bridge widening which is foreseen in the future

as further strengthening of the function of road network will become necessary to accommodate increased traffic demand which will, in turn, support future socio-economic development.

Twelve bridges of PSC deck are proposed to be widened by adding deck slab. The deck widening concept will therefore be substantially the same for all affected bridges. The deck widening concept will make use of similar section PSC units placed on extended substructure and transversely pre-stressed to the existing units of the deck Refer to Figure 9.4-1 for a typical cross-section of a widened bridge and Figure 9.4-2 for deck widening details.

Table 9.4-1 Proposed Plan of Widening Bridges

Code	KP	Existing Bridge				Widening Width (m)
		Type	Length (m)	Number of Span	Width (m)	
Br.41	178+500	PSC	15.1	1	10.0	11.5
Br.43	182+800	PSC	36.0	2	10.0	11.5
Br.54	190+150	PSC	18.0	1	10.0	11.5
Br.55	191+100	PSC	30.0	2	10.0	11.5
Br.56	201+800	PSC	12.0	1	10.0	11.5
Br.57	208+500	PSC	28.0	2	10.0	11.5
Br.60	220+800	PSC	24.1	2	10.0	11.5
Br.61	222+650	PSC	12.1	1	10.0	11.5
Br.62	223+650	PSC	12.1	1	10.0	11.5
Br.63	242+850	PSC	18.0	1	10.0	11.5
Br.64	243+600	PSC	30.1	2	10.0	11.5
Br.65	244+400	PSC	24.2	2	10.0	11.5

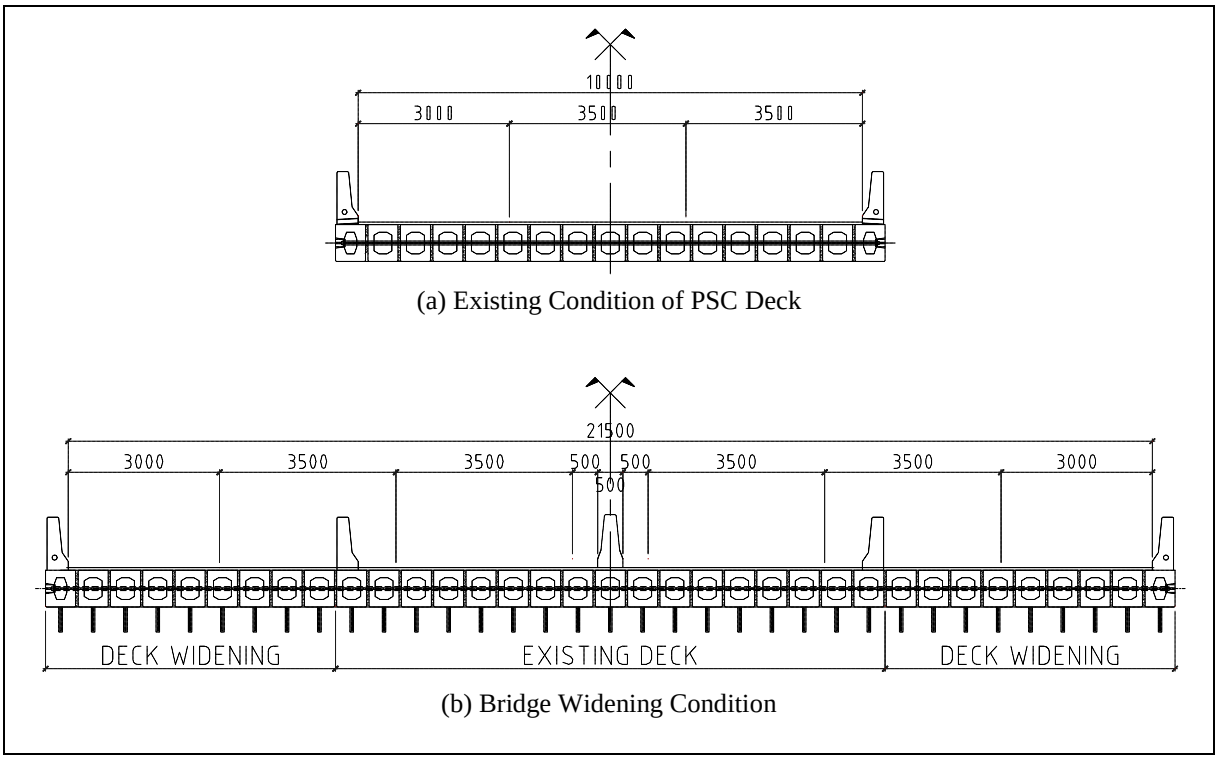
Two options are presented to achieve the extension of the transverse pre-stress for the PSC decks.

Option 1

Option 1 proposes to break out the cement mortar at each anchorage recess and to use couplers to extend the pre-stressing bars. This option using couplers, may not be practicable as the length of existing threaded bar protruding beyond the anchor nut at each anchorage may not be long enough to develop sufficient pre-stress force with the coupler (extended length bars would have been used during construction to enable the pre-stressing operations and then cut back near the anchor nut) or the thread may have been damaged. A trial application of this technique is recommended prior to implementation should this option be selected.

Option 2

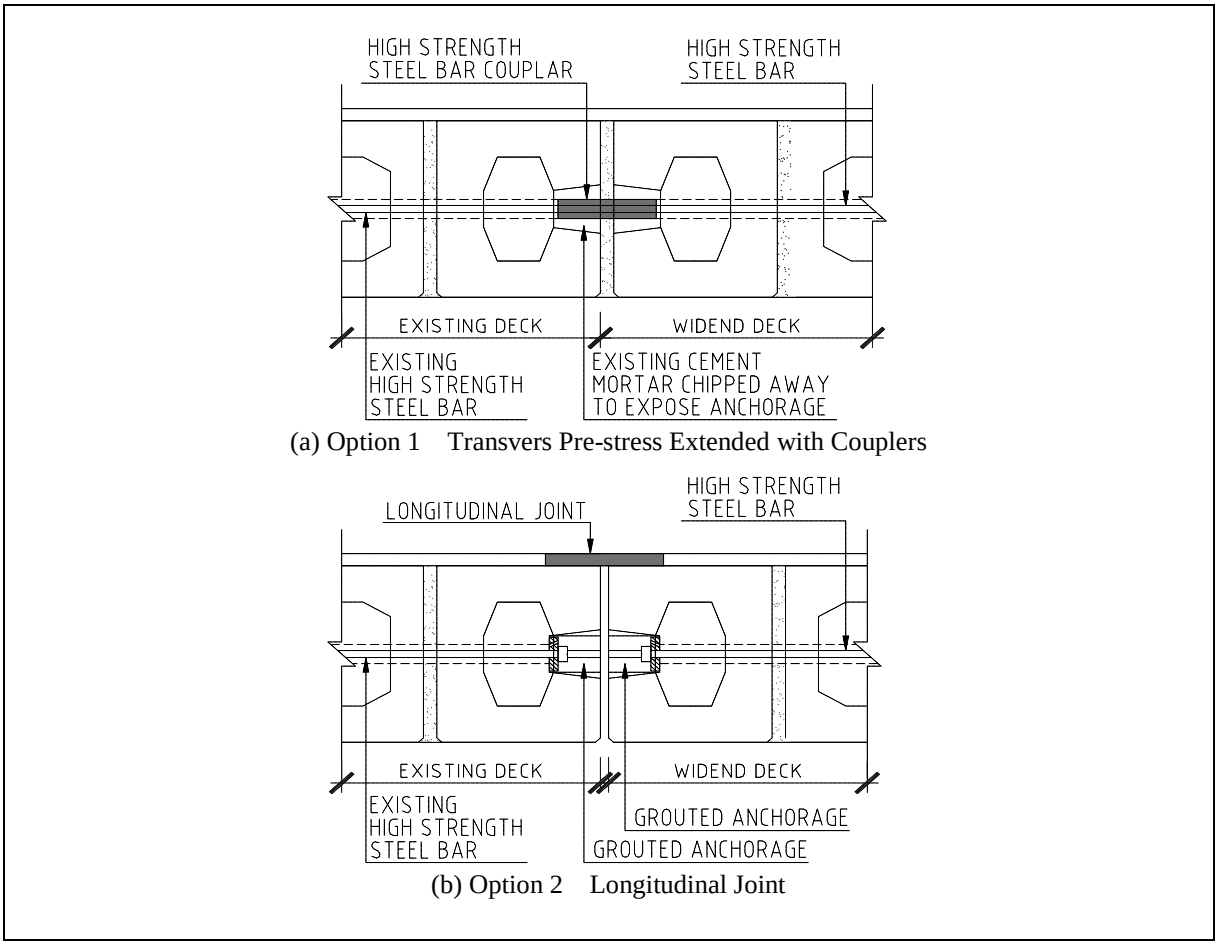
Option 2 proposes to construct separate superstructure connected by longitudinal joint. With this option, the additional deck can be constructed regardless of existing bridge condition. However trafficability is less preferable than Option 1, because longitudinal joint which appears on the road surface will be installed.



(a) Existing Condition of PSC Deck

(b) Bridge Widening Condition

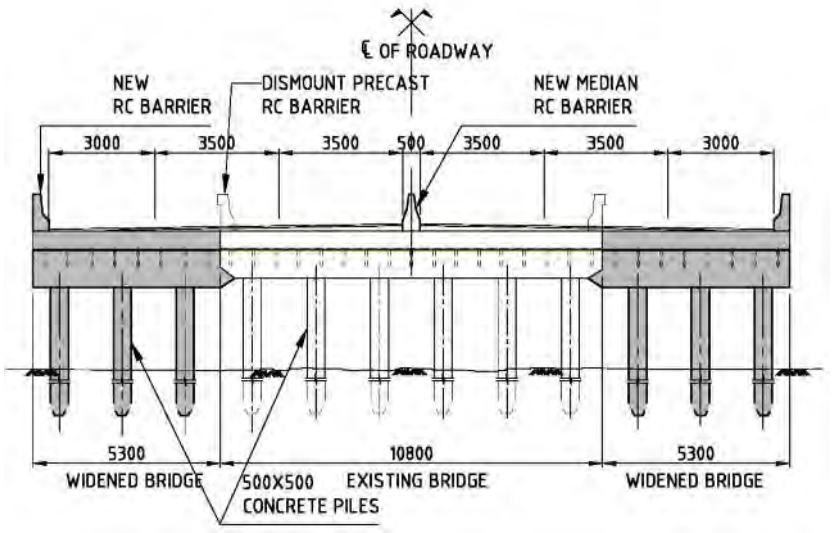
Figure 9.4-1 Typical Cross-Section of Widened Bridge for Full 4-Lane



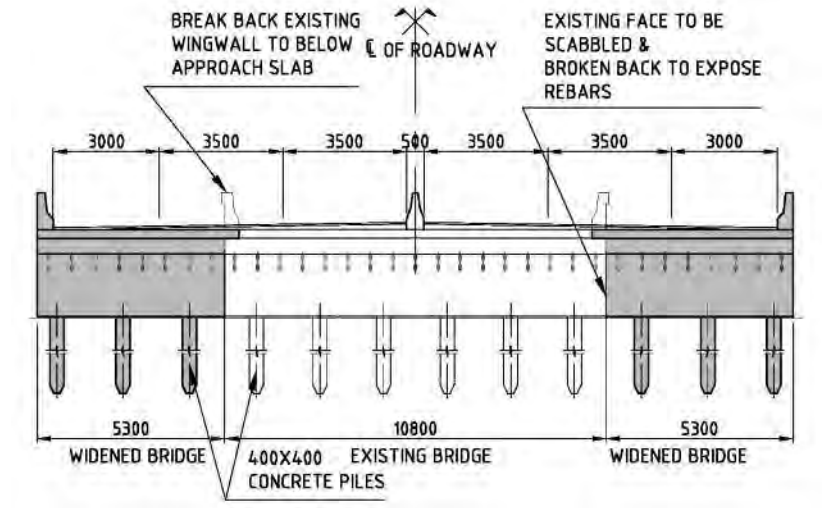
(a) Option 1 Transvers Pre-stress Extended with Couplers

(b) Option 2 Longitudinal Joint

Figure 9.4-2 Deck Widening Connection Details for Full 4-Lane



a) Pier Widening



b) Abutment Widening

Figure 9.4-3 Typical Cross-Section of Substructure Widening for Full 4-Lane

9.5 Rehabilitation of Existing Bridge

Slope protection has been damaged at four bridges (Br. 40, Br. 59, Br. 60, Br. 61). Stone masonry of these slope protections is sitting on sand back fill. It is suspected that sand under the stone was washed away by water flow in rainy season. The damaged part needs to be replaced with new slope protection. Figure 9.5-2 shows details of the proposed rehabilitation.



Br. 40 View on Pursat Side Abutment



Br. 59 View on Phnom Penh Side Abutment



Br. 60 View on Phnom Penh Side Abutment



Br. 60 View on Pursat Side Abutment



Br. 61 View on Abutment



Br. 61 View on Phnom Penh Side Abutment

Figure 9.5-1 Damaged Slope Protections of Existing Bridges

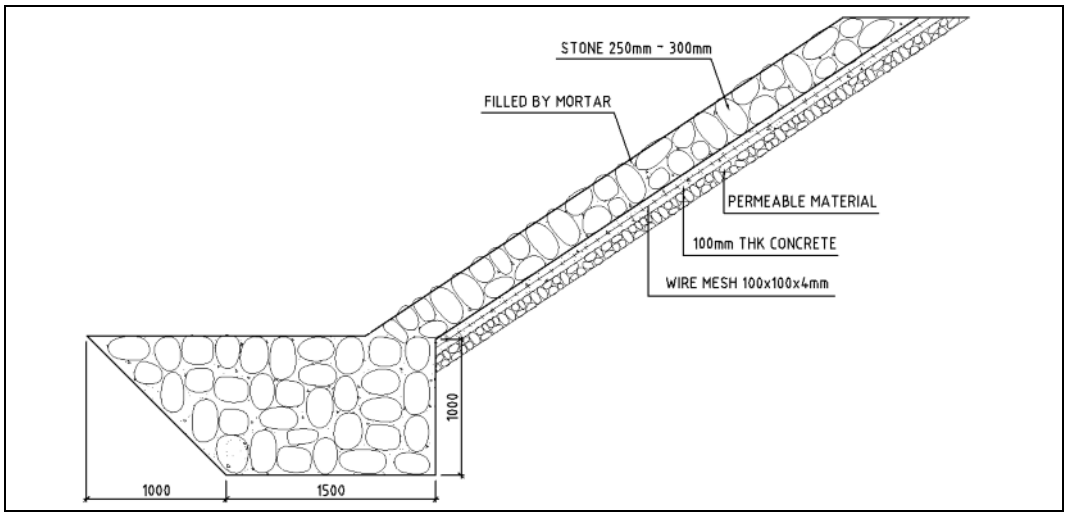


Figure 9.5-2 Repairing Method of Existing Slope Protection

9.6 Bridge on Bypass

Five bridges are planned on Pursat Bypass as follows. Bridge P3 is the only long bridge among the bridges on Purusat Bypass. Other bridges are relatively short.

Table 9.6-1 Bridge on Pursat Bypass

No.	Type of Bridge	Bridge length	Remark
Br. P1	PSC	3@20=60 m	Waterway
Br. P2	PSC	4@25=100 m	Waterway
Br. P3	PSC+PCDG+PSC	9@25+ (42+3@37+42)+11@42=695 m	Pursat River
Br. P4	PSC	5@25=125 m	Waterway
Br. P5	PSC	4@20=80 m	Waterway

Bridge P3 is a bridge which crosses Pursat River. The river is approximately 140 m in width at the crossing point. As a result of the consultation with DPWT of Pursat Province, the bypass is planned to cross the roads on the banks of Pursat River with grade-separation. Thus the height of it is proposed an approximately 695 m-long bridge be constructed to cross the river. Figure 9.6-1 shows the general view of P3 Bridge.

PCDG is proposed for the central spans of P3 Bridge considering that the span lengths are 37 m and 42 m. As discussed in Subsection 9.1.2, PCDG is adopted in relatively long span length. Figure 9.6-2 shows typical cross section of PCDG on the bypass bridge.

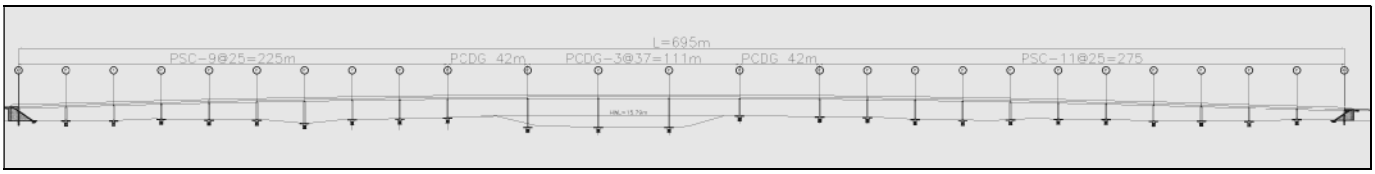


Figure 9.6-1 General View of P3 Bridge of Pursat Bypass over Pursat River

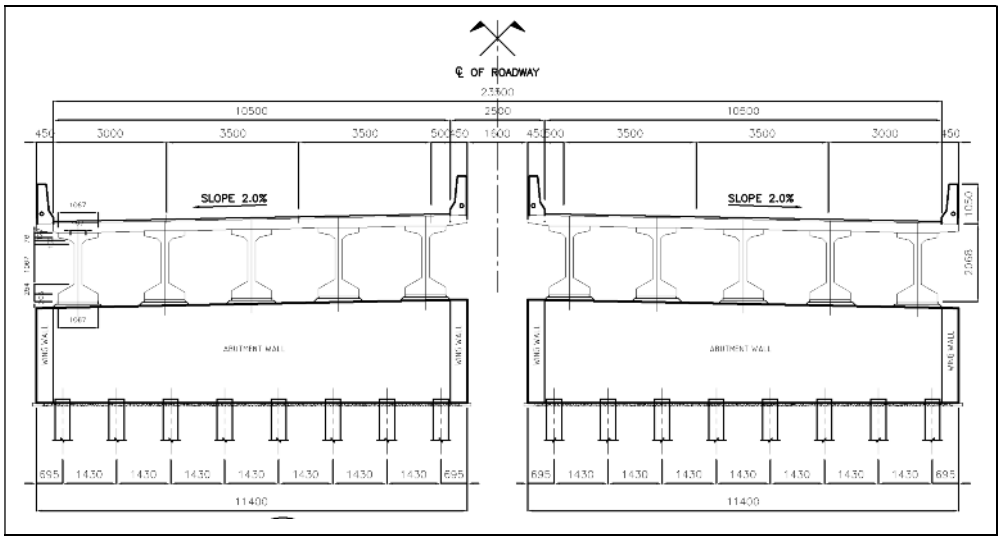


Figure 9.6-2 Typical Cross Section of PCDG Bridges of Pursat Bypass

9.7 Bridge Accessories

(1) Handrail

There are two types of handrail which are concrete type and steel type. Concrete type handrail is heavier than steel type, but it does not need periodical painting. Thus, maintenance cost of concrete type handrail is lower than that of steel type. Concrete handrail has been proposed in "the Strengthening of Construction Quality Project" implemented by JICA. Figure 9.7-1 shows handrail.

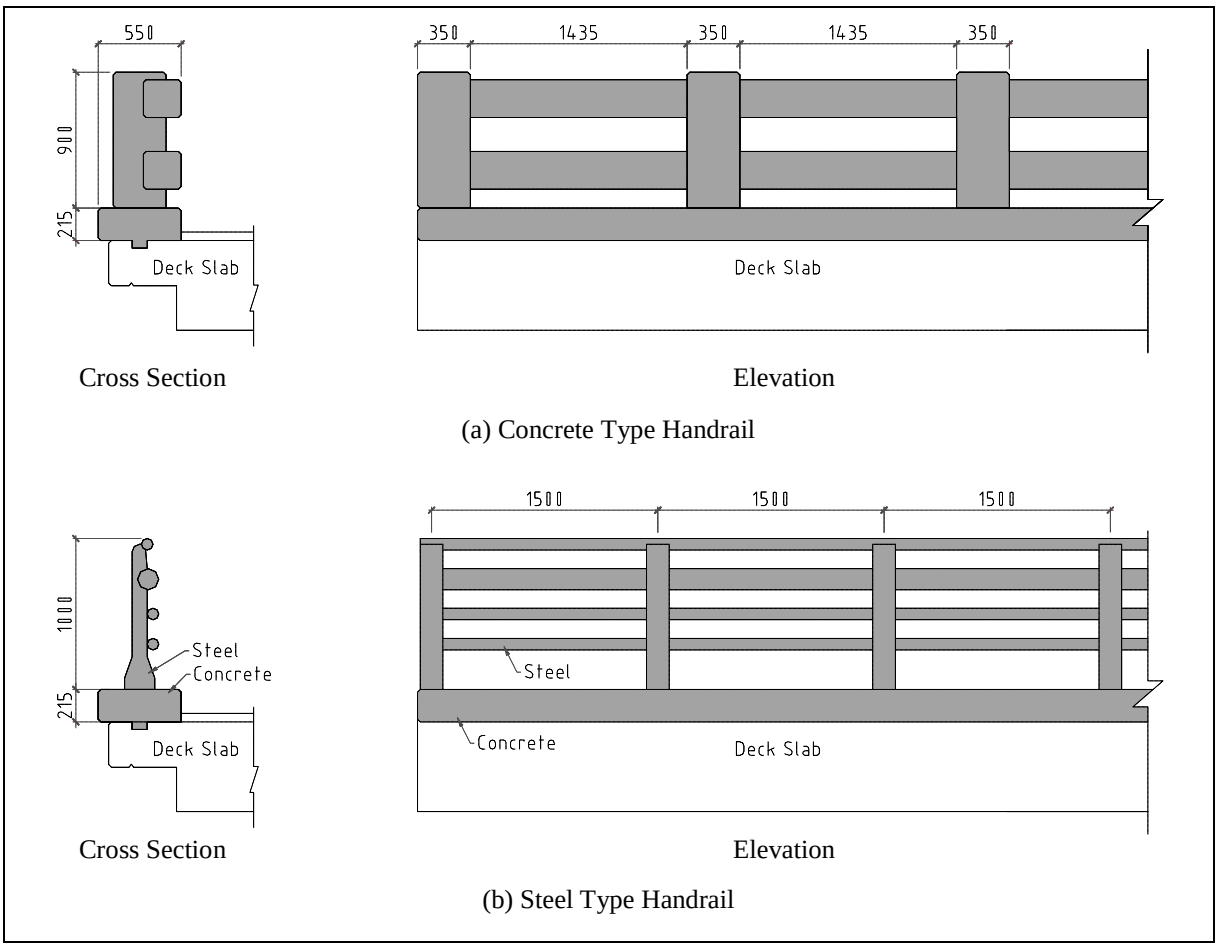
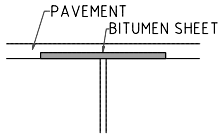
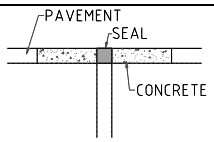
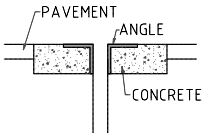
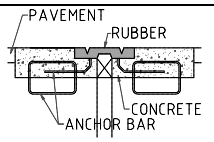
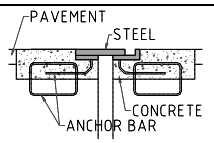


Figure 9.7-1 Handrail

(2) Expansion Joint

Function of expansion joint is to secure smooth running for vehicles, allowing thermal expansion/contraction of bridge decks and beams. Expansion joints of existing bridge are steel angle type or joint less type. Table 9.7-1 shows five types of expansion joint.

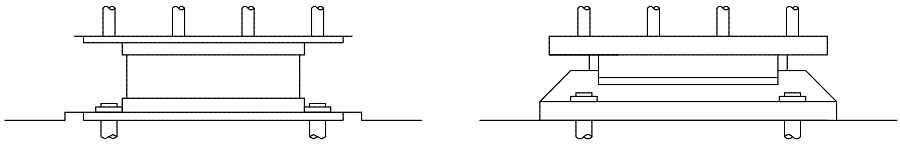
Table 9.7-1 Typical Type of Expansion Joint

Type	Movement (mm)	Type of Bridge	Cross Section
Joint-Less Type	≦ 20	RC , PC	
Sealing Type	≦ 50	RC, PC, Steel	
Steel Angle Type	≦ 50	RC, PC, Steel	
Rubber Type,	20~100	RC, PC, Steel	
Steel Plate Type	20~1000	RC, PC, Steel	

Joint-less type, sealing type and steel angle type are proposed for the bridges on the Middle Section because movements of the planed bridges on the Middle Section are small (less than 50 mm) due to the small magnitude of fluctuation of temperature. These type expansion joints recommended also because they can be repaired without special parts or technique.

(3) Bearing Shoe

Bearing shoes are generally classified into two types; rubber type and steel type. Rubber type bearing is superior to steel type with regard to maintenance and seismo-resistance. Steel type is used for large movement bridge. Figure 9.7-2 shows side views of rubber type bearing and steel type bearing.



(a) Rubber Type Bearing (b) Steel Type Bearing

Figure 9.7-2 Side View of Bridge Bearing

(4) Aseismatic Connector

There are many type of aseismatic connector. Anchor bar type aseismatic connector is proposed in "the Strengthening of Construction Quality Project" implemented by JICA. This type is

suitable for new concrete bridge. Figure 9.7-3 shows anchor bar type aseismatic connector.

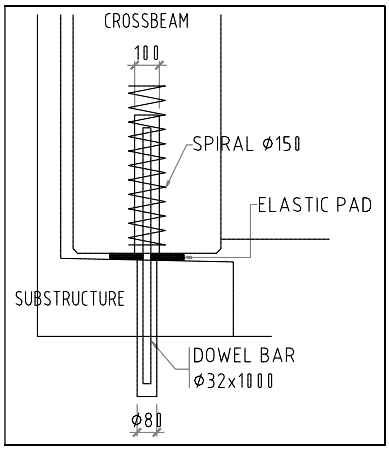


Figure 9.7-3 Anchor Bar Type Aseismatic Connector

9.8 Waterway Opening

There are some sections where capacities for water flow are insufficient as described in Section 6.1. Thus, additional water openings are needed on these sections.

In these sections, additional box culverts need to be constructed to lower the flood water level and protect road bed and pavement from water infiltration. Installation of 16 box culvert (3.0 x 2.0-2) per 1 km can lower the flood water to acceptable level. The detail of this measure is described in subsection 6.1.5 "Study of the flood in 2013". Figure 9.8-1 lists the planned box culverts.

Table 9.8-1 Additional Waterway Opening

KP	Length (km)	Type of Opening Structure	Number of Opening Structure	Note
KP 227+700 ~ KP 235+800	8.1	Box culvert 3.0 x 2.0-2	3	Insufficient of drainage capacity
KP 235+800 ~ KP 239+900	4.1	Box culvert 3.0 x 2.0-2	4	Insufficient of drainage capacity
KP 256+0 ~ KP 260+0	4.0	Box culvert 3.0 x 2.0-2	64	Inundation section
KP 270+0 ~ KP 277+0	7.0	Box culvert 3.0 x 2.0-2	112	Inundation section
KP 280+0 ~ KP 282+0	2.0	Box culvert 3.0 x 2.0-2	32	Inundation section

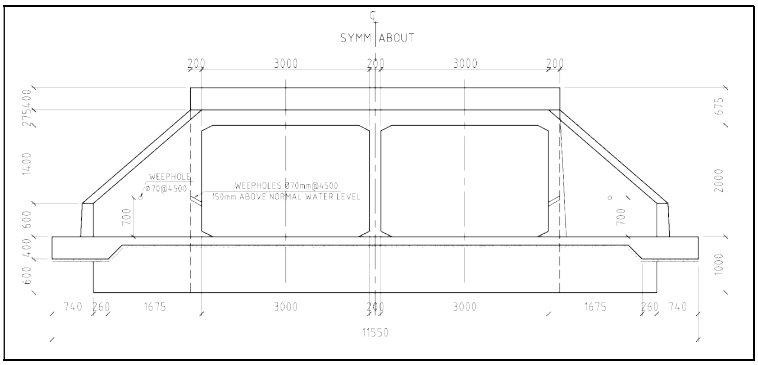


Figure 9.8-1 Box Culvert (3.0 x 2.0-2)

CHAPTER 10 COST ESTIMATION

10.1 Construction Cost

The Middle Section is divided into three components (Middle Section, North Extension and Pursat Bypass), as shown in Figure 10.1-1 below. Figure 10.1-1 also details the start and end points of each component with their lengths.

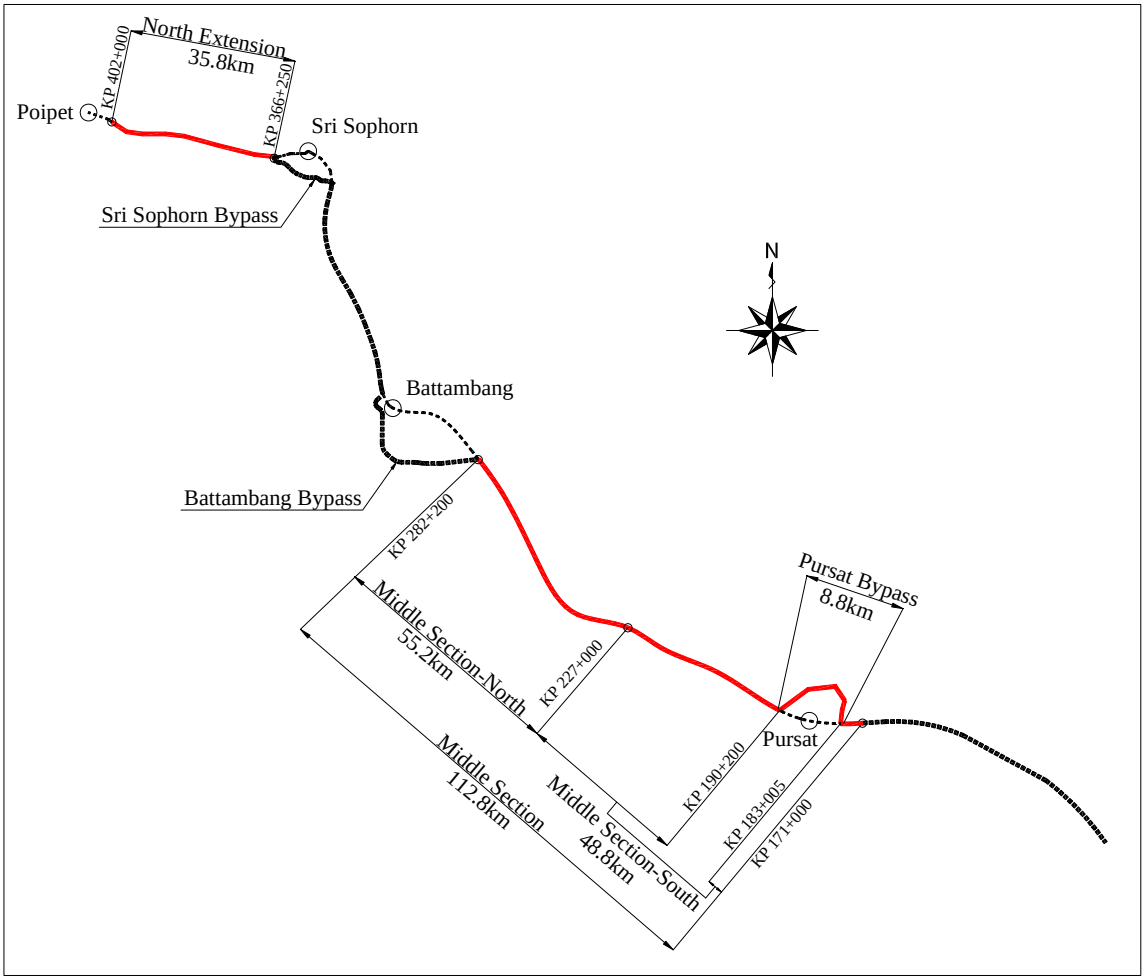


Figure 10.1-1 Map of Packages

Considering the road length and work volume of the components, the project is proposed to be divided into four packages and they are proposed to be implemented in parallel. Package 1 (Middle Section–South) starts at KP 171+000 (Thlea Ma'am; the end point of South Section) and ends at KP 227+000. Package 2 (Middle Section–North) starts at KP 227+000 and ends at KP 282+200 (Battambang; the start point of North Section). Package 3 (Pursat Bypass) is located at Pursat City. Package 4 (North Extension) starts at KP 366+250 (Sri Sophorn) and ends at KP 402+000 (Poipet).

Package 5 (Weigh Stations) is composed of constructions of eight weigh bridges.

The concept of the packaging is described in Section 10.8.

The start and end points of these sections are presented in Table 10.1-1.

Table 10.1-1 Start/End Points and Road Length of Packages

Packages	Package Names	Components	Start Point	End Point	Length (km)
Package 1	Middle Section-South	Existing Road No.5	KP 171+000	KP 227+000	48.8
Package 2	Middle Section-North	Existing Road No.5	KP 227+000	KP 282+200	55.2
Package 3	Pursat Bypass	New bypass	KP 183+005	KP 190+000	8.8
Package 4	North Extension	Existing Road No.5	KP 366+250	KP 402+000	35.8
Package 5	Weigh Station	Eight weighbridges			
				Total	148.6

The components and packages to be actually implemented are to be selected through consultation between the Royal Government of Cambodia (RGC) and the Japan International Cooperation Agency (JICA) in the appraisal process of the Project.

10.1.1 Cost Estimate

The main points of estimation of construction costs are as listed below:

(a) Costs are calculated in United States dollars (USD). This is applied to both the Foreign Currency Portion and Local Currency Portion. Although the official local currency is the Khmer Riel (KHR), the US dollar is widely used in actual business and trade.

(b) Costs are calculated with prices of the year 2013.

(c) Exchange rate of USD 1.00 = JPY 101.7 (as of August 2014) is used for cost estimations, as necessary.

(d) Costs are calculated for Middle Section-South, Middle Section-North, Pursat Bypass, North Extension, and Weigh Stations respectively.

(e) Costs of civil works are calculated based on the basic rates collected in Cambodia and crosschecked against experiences in similar projects in the past in Cambodia after making relevant adjustments to fit the Project.

(f) Materials and equipment not produced in Cambodia, such as cement, reinforcements, PC strands, guardrails, street lights, precast beam launching systems and fuel are assumed to be imported into Cambodia.

Based on the considerations shown above and quantities of work components, unit prices for road works, bridge works, and culvert works are calculated. The unit prices estimated are as shown below.

Table 10.1-2 Unit Price of Road Works

Description	Unit price (USD 1,000)	Comments
Middle Section-South (existing Road No.5)	*****	Existing road rehabilitation
Road works (Pursat Bypass)	*****	New construction
Middle Section-North (existing road No.5)	*****	Existing road rehabilitation
North Extension (existing road No.5)	*****	Ditto

***** Closed due to confidentiality

Table 10.1-3 Unit Price of Bridge Works

Description		Unit price (USD 1,000)	Comments
Middle Section -South	PSC Bridge Widening Works	*****	PC Hollow Slab Bridge
	PSC Bridge Adding Works	*****	Ditto
	PCDG Bridge Adding Works	*****	PC T-Girder Bridge
	PSC Bridge Replacement Works	*****	PC Hollow Slab Bridge
Pursat Bypass	PSC Bridge Works	*****	PC Hollow Slab Bridge
	PCDG Bridge Works	*****	PC I-Girder Bridge
Middle Section -North	PSC Bridge Widening Works	*****	PC Hollow Slab Bridge
	PSC Bridge Replacement Works	*****	Ditto

***** Closed due to confidentiality

Table 10.1-4 Unit Price of Culvert Works

Description	Unit price (USD 1,000)	Comments
Pipe Culvert (φ1000 mm x 1) 16.1 m Widening	*****	Middle Section-South
Pipe Culvert (φ1000 mm x 2) 15.4 m Widening	*****	Middle Section-South
Pipe Culvert (φ1000 mm x 3) 16.2 m Widening	*****	Middle Section-South
Pipe Culvert (φ1000 mm x 4) 18.9 m Widening	*****	Middle Section-South
Pipe Culvert (φ1000 mm x 8) 16.3 m Widening	*****	Middle Section-South
Pipe Culvert (φ1200 mm x 1) 13.9 m Widening	*****	Middle Section-South
Pipe Culvert (φ1200 mm x 3) 15.2 m Widening	*****	Middle Section-South
Box Culvert (3 m x 2 m x 1 cell) 15.8 m Widening	*****	Middle Section-South
Box Culvert (3 m x 2 m x 2 cells) 15.7 m Widening	*****	Middle Section-South
Box Culvert (3 m x 2 m x 3 cells) 17.1 m Widening	*****	Middle Section-South
Pipe Culvert (φ1000 mm x 2) 33.3 m New Construction	*****	Pursat Bypass
Box Culvert (3 m x 2 m x 1 cell) 33.3 m New Construction	*****	Pursat Bypass
Box Culvert (3 m x 2 m x 2 cells) 33.3 m New Construction	*****	Pursat Bypass
Pipe Culvert (φ1000 mm x 1) 14.5 m Widening	*****	Middle Section-North
Pipe Culvert (φ1000 mm x 2) 16.4 m Widening	*****	Middle Section-North
Pipe Culvert (φ1000 mm x 3) 17.3 m Widening	*****	Middle Section-North
Pipe Culvert (φ1200 mm x 2) 15.1 m Widening	*****	Middle Section-North
Pipe Culvert (φ1500 mm x 1) 13.9 m Widening	*****	Middle Section-North
Box Culvert (3 m x 2 m x 1 cell) 16.3 m Widening	*****	Middle Section-North
Box Culvert (3 m x 2 m x 2 cells) 30 m New Construction	*****	Middle Section-North
Box Culvert (3 m x 2 m x 2 cells) 16.5 m Widening	*****	Middle Section-North
Box Culvert (3 m x 2 m x 3 cells) 16.3 m Widening	*****	Middle Section-North
Pipe Culvert (φ1000 mm x 1) 16.5 m Widening	*****	North Extension
Pipe Culvert (φ1000 mm x 2) 16.5 m Widening	*****	North Extension
Pipe Culvert (φ1000 mm x 4) 16.5 m Widening	*****	North Extension
Pipe Culvert (φ1200 mm x 1) 16.5 m Widening	*****	North Extension
Pipe Culvert (φ1200 mm x 2) 16.5 m Widening	*****	North Extension

***** Closed due to confidentiality

Using the above data (quantities and rates), the construction costs are calculated as below.

Table 10.1-5 Construction Cost of Middle Section-South

Item	Unit	Quantity	Rate (USD 1,000)	Amount (USD 1,000)
Road Widening Works in Middle Section South	km	49.0	*****	*****
Pipe Culvert (φ1000 mm x 1) 16.1 m Widening	no	22	*****	*****
Pipe Culvert (φ1000 mm x 2) 15.4 m Widening	no	11	*****	*****
Pipe Culvert (φ1000 mm x 3) 16.2 m Widening	no	4	*****	*****
Pipe Culvert (φ1000 mm x 4) 18.9 m Widening	no	1	*****	*****
Pipe Culvert (φ1000 mm x 8) 16.3 m Widening	no	1	*****	*****
Pipe Culvert (φ1200 mm x 1) 13.9 m Widening	no	3	*****	*****
Pipe Culvert (φ1200 mm x 3) 15.2 m Widening	no	1	*****	*****
Box Culvert (3 m x 2 m x 1 cell) 15.8 m Widening	no	6	*****	*****
Box Culvert (3 m x 2 m x 2 cells) 15.7 m Widening	no	4	*****	*****
Box Culvert (3 m x 2 m x 3 cells) 17.1 m Widening	no	2	*****	*****
PSC Bridge Widening Works	m^2	2,151	*****	*****
PSC Bridge Adding Works	m^2	798	*****	*****
PCDG Bridge Adding Works	m^2	1,026	*****	*****
PSC Bridge Replacement Works	m^2	456	*****	*****
Weigh Station Embankment Works	place	2	*****	*****
Total				*****

***** Closed due to confidentiality

Table 10.1-6 Construction Cost of Middle Section-North

Item	Unit	Quantity	Rate (USD 1,000)	Amount (USD 1,000)
Road Widening Works in Middle Section North	km	55.2	*****	*****
Pipe Culvert (φ1000 mm x 1) 14.5 m Widening	no	4	*****	*****
Pipe Culvert (φ1000 mm x 2) 16.4 m Widening	no	6	*****	*****
Pipe Culvert (φ1000 mm x 3) 17.3 m Widening	no	3	*****	*****
Pipe Culvert (φ1200 mm x 2) 15.1 m Widening	no	4	*****	*****
Pipe Culvert (φ1500 mm x 1) 13.9 m Widening	no	1	*****	*****
Box Culvert (3 m x 2 m x 1 cell) 16.3 m Widening	no	7	*****	*****
Box Culvert (3 m x 2 m x 2 cells) 30 m New Construction	no	215	*****	*****
Box Culvert (3 m x 2 m x 2 cells) 16.5 m Widening	no	10	*****	*****
Box Culvert (3 m x 2 m x 3 cells) 16.3 m Widening	no	6	*****	*****
PSC Bridge Widening Works	m^2	828	*****	*****
PSC Bridge Replacement Works	m^2	4,788	*****	*****
Weigh Station Embankment Works	place	2	*****	*****
total				*****

***** Closed due to confidentiality

Table 10.1-7 Construction Cost of Middle Section-North

Item	Unit	Quantity	Rate (USD 1,000)	Amount (USD 1,000)
Pursat Bypass Road Works	km	7.9	*****	*****
Pipe Culvert (φ1000 mm x 2) 33.3 m New Construction	no	31	*****	*****
Box Culvert (3 m x 2 m x 1 cell) 33.3 m New Construction	no	5	*****	*****
Box Culvert (3 m x 2 m x 2 cells) 33.3 m New Construction	no	6	*****	*****
PSC Bridge Works (Pursat Bypass Flyover + Viaduct)	m^2	19,722	*****	*****
PCDG Bridge Works (Pursat Bypass Flyover + Viaduct)	m^2	4,447	*****	*****
total				*****

***** Closed due to confidentiality

Table 10.1-8 Construction Cost North Extension

Item	Unit	Quantity	Rate (USD 1,000)	Amount (USD 1,000)
Road Widening Works in North Extension	km	35.8	*****	*****
Pipe Culvert (φ1000 mm x 1) 16.5 m Widening	no	13	*****	*****
Pipe Culvert (φ1000 mm x 2) 16.5 m Widening	no	1	*****	*****
Pipe Culvert (φ1000 mm x 4) 16.5 m Widening	no	1	*****	*****
Pipe Culvert (φ1200 mm x 1) 16.5 m Widening	no	31	*****	*****
Pipe Culvert (φ1200 mm x 2) 16.5 m Widening	no	12	*****	*****
Weigh Station Embankment Works	place	2	*****	*****
total				*****

***** Closed due to confidentiality

Table 10.1-9 Summary of Construction Cost

Package	Road Length	Amount (USD 1,000)
Package 1 (Middle Section-South)	58.0 km	*****
Package 2 (Middle Section-North)	55.2 km	*****
Package 3 (Pursat Bypass)	8.9 km	*****
Package 4 (North Extension)	35.8 km	*****
Package 5 (Weigh Station)	8 places	*****
Total	149.0 km	*****

***** Closed due to confidentiality

For reference, major rates are compared with similar projects in the past as shown below. According to the comparison table, the rates in the Middle Section are situated towards the middle of the range. A comparison of contractual components with similar projects in the past is provided in Section 10.8.

Table 10.1-10 Comparison of Basic Rates in Similar Projects

(Unit: USD)

Items	Middle Section	South Section	North Section	Project (1)	Project (2)	Project (3)	Project (4)	Project (5)
Excavation /m^3	*****	*****	*****	*****	*****	*****	*****	*****
Embankment /m^3	*****	*****	*****	*****	*****	*****	*****	*****
Subbase /m^3	*****	*****	*****	*****	*****	*****	*****	*****
Base course /m^3	*****	*****	*****	*****	*****	*****	*****	*****
AC pavement /m^3	*****	*****	*****	*****	*****	*****	*****	*****
Road /m	*****	*****	*****	*****	*****	*****	*****	*****
Bridge /m^2	*****	*****	*****	*****	*****	*****	*****	*****
Year of construction	(*1)	(*1)	(*3)	2009 – 2010	2010 – 2015	2013 – 2015	2009 – 2011	2011 – 2014

Source: Relevant documents in each project

**1: price estimated based on 2013 rates*

**2: laterite to be used for subbase*

**3: price estimated based on 2011 rates*

**4: mostly DBST pavement, thus price for AC (small quantity) is high*

***** Closed due to confidentiality

[List of Similar Projects]

Project (1): Improvement of National Road No. 1 Phase 3 (Japanese Grant)

Project (2): Construction of Neak Loeung Bridge (Japanese Grant)

Project (3): Flood Disaster Rehabilitation and Mitigation (Japanese Grant)

Project (4): Sihanoukville Port SEZ Development (Japanese Loan)

Project (5): Improvement of NR 31, 33, PR 117 and Kampot Bypass (Korean Loan)

10.2 Consultancy Services

Consultancy services are required to support the implementing agency (MPWT) in all phases of the Project, such as the engineering service stage, tender assistance stage and construction supervision stage.

It is recommended that the consultancy services in all phases of the Project are carried out by a consultant employed through the selection procedure for consultants as indicated in the Implementation Schedule of Table 11.3-2. It should be noted that arrangement of consultants will be subject to the discussions between the RGC and JICA.

Major tasks to be undertaken by the consultant, including the professional assignment schedule, are described below.

10.2.1 Major Tasks to be Undertaken by Consultant

(1) Scope of Work

The scope of work for the consultant consists of the following tasks.

(a) Engineering study and basic/detailed design

(b) Project Master Program

(c) Preparation of tender documents for construction

(d) Assistance to the Employer in bidding and bid evaluation

(e) Construction supervision

(f) Inspection for provisional handover

(g) Inspection for final handover

(h) Training for Cambodian engineers

(i) Research of cultural heritage, if applicable

(2) Detailed Task Requirements

The above tasks are to be undertaken in two major stages, namely, the engineering study stage, and the selection of contractors and construction supervision stage. Detailed task requirements of each stage are as listed below.

A. Engineering Service Stage

Task 1-1. Review the previous and ongoing related studies and data collected

Task 1-2. Conduct traffic survey

Task 1-3. Analyze the traffic demand forecast and capacity requirement

Task 1-4. Field survey and investigation

a. Alignment investigation, topographic survey and mapping

b. Soil condition, geological data, water level and deep well impact

c. River, canal, drainage networks, etc.

d. ROW adjacency

e. Utilities survey

f. Road traffic survey for traffic management planning during construction

g. Hydrological survey

h. Survey on cultural/historic heritage and archaeological survey

Task 1-5. Assist the Employer in processing, monitoring and reporting on land acquisition

a. Resettlement plan and procedure for land arrangements

b. Land acquisition plan and resettlement action plan (LAP/RAP)

c. LAP/RAP monitoring and report

d. Temporary land arrangement

e. Assist the Employer in public consultation

Task 1-6. Prepare the construction arrangement plan

a. Land for construction activities (permanent and temporary)

b. Utilities relocation, removal or protection

c. Traffic management plan and road detour/alternative road design

d. Public relations and stakeholder socialization materials

Task 1-7. Design standards and design criteria

Task 1-8. Prepare detailed design for civil works (roads, structures, etc.)

Task 1-9. Review road design in view of traffic safety

Task 1-10. Review and update the Project Master Program

Task 1-11. Review the environmental impact assessment (EIA) and conduct supplemental EIA

Task 1-12. Prepare tender documents including pre-qualification documents

Task 1-13. Cost estimation through tender packages

Task 1-14. Public relations

Task 1-15. Training on design and tendering for Cambodian engineers

Task 1-16. Research on cultural heritage, including review of archives during design stage

B. Tender Assistance Stage

Task 2-1. Selection of contractors

a. Pre-qualification of bidders, including invitation for pre-qualification

b. Tender call and pre-tender conference

c. Tender evaluation and clarification

d. Contract negotiations and contracting

C. Construction Supervision Stage

Task 2-1. Selection of contractors

a. Pre-qualification of bidders, including invitation for pre-qualification

b. Tender call and pre-tender conference

c. Tender evaluation and clarification

d. Contract negotiations and contracting

Task 2-2. Establish project management system

Task 2-3. Review the contractors submittals and design interface

Task 2-4. Site inspection and factory inspection

a. Confirm use of/adherence to approved materials, drawings, work methods and schedule

b. Confirm adherence to approved quality control system

c. Confirm adherence to approved mitigation of environmental impact

d. Confirm third party safety

e. Confirm adherence to health and safety plan

f. Confirm adherence to traffic management plan

Task 2-5. Public relations during construction

Task 2-6. Monitor environmental management plan

Task 2-7. Issue interim payment certificates

Task 2-8. Review and report on alterations, variations and solution of disputes

Task 2-9. Initiate meetings and reports

Task 2-10. Review and inspect road/s in view of traffic safety

Task 2-11. Inspect testing and as-built drawings at completion

Task 2-12. Prepare guideline for HIV/AIDS protection activities

Task 2-13. Inspect and report during defects liability period

Task 2-14. Inspect testing for final handover

Task 2-15. Conduct training for Cambodian engineers and administrators on tendering, contract management, construction management and maintenance of roads

Task 2-16. Research cultural heritage at the commencement of construction

10.2.2 Consultant Assignment Schedule

Based on the tasks to be undertaken by the consultant, the professional assignment schedule is proposed as shown in Tables 10.2-1 for the engineering service, 10.2-2 for the tender assistance, and 10-2-3 for the construction supervision, respectively.

Table 10.2-1 Assignment Schedule for Engineering Service

No.	Title	2015	2016	2017	2018	2019	2020	2021	2022	Total
International Professional										
1	Project Manager	1.0	9.5							10.5
2	Road & Pavement Expert	1.0	9.5							10.5
3	Structure Expert		9.5							9.5
4	Hydrological & Hydraulic Expert		9.5							9.5
5	Construction Planner		9.5							9.5
6	Cost Estimate Expert		8.5							8.5
7	Specification/Quality Management Expert		8.5							8.5
8	HIV/AIDS Protection Campaign Expert		2.0							2.0
9	Traffic Demand Forecast Expert	1.0	1.0							2.0
10	Traffic Safety Expert		1.0							1.0
11	Social Environment Expert		4.0							4.0
12	Natural Environment Expert		1.0							1.0
13	Capacity Development Expert		2.0							2.0
14	Weighbridge Expert		3.0							3.0
15	Building Expert		3.0							3.0
	Total									85.5
Local Professional										
1	Deputy Project Manager	1.0	9.5							10.5
2	Civil Engineer – 1	1.0	9.5							10.5
3	Civil Engineer – 2	1.0	9.5							10.5
4	Civil Engineer – 3	1.0	9.5							10.5
5	Civil Engineer – 4		7.0							7.0
6	Geotechnical Engineer	1.0	6.0							7.0
7	Hydrological & Hydraulic Engineer		6.0							6.0
8	Traffic Management Engineer		6.0							6.0
9	Utilities Management Engineer		7.0							7.0
10	Cost Engineer – 1		7.5							7.5
11	Cost Engineer – 2		5.0							5.0
12	Specification Engineer		7.5							7.5
13	Quality Management / Safety Engineer		7.5							7.5
14	HIV/AIDS Protection Campaign Assistant		2.0							2.0
15	Traffic Demand Forecast Assistant	1.0	2.0							3.0
16	Social Environment Engineer		7.5							7.5
17	Natural Environment Engineer		3.0							3.0
18	Weighbridge Expert		3.0							3.0
19	Building Expert		3.0							3.0
	Total									124.0

Table 10.2-2 Assignment Schedule for Tender Assistance

No.	Title	2015	2016	2017	2018	2019	2020	2021	2022	Total
International Professional										
1	Project Manager		1.5	8.0						9.5
2	Road & Pavement Expert		1.5	2.0						3.5
3	Structure Expert		1.5	2.0						3.5
4	Construction Planner		1.5	2.0						3.5
5	Cost Estimate Expert		1.5	2.0						3.5
6	Specification/Quality Management Expert		1.5	2.0						3.5
7	Procurement & Contract Administration Expert		1.0	2.0						3.0
8	Social Environment Expert		1.0	3.0						4.0
9	Capacity Development Expert			2.0						2.0
10	Weighbridge Expert			1.5						1.5
	Total									37.5
Local Professional										
1	Deputy Project Manager		2.5	8.0						10.5
2	Civil Engineer- 1		2.5	3.0						5.5
3	Civil Engineer- 2		2.5	3.0						5.5
4	Geotechnical Engineer		2.5	3.0						5.5
5	Utilities Management Engineer		1.0							1.0
6	Cost Engineer – 1		2.5	3.0						5.5
7	Specification Engineer		2.5	3.0						5.5
8	Procurement & Contract Administration Assistant		1.0	2.0						3.0
9	Quality Management / Safety Engineer		2.5	3.0						5.5
10	Social Environment Engineer		2.5	5.0						7.5
11	Mechanical Engineer			1.0						1.0
	Total									56.0

Table 10.2-3 Assignment Schedule for Construction Supervision

No.	Title	2015	2016	2017	2018	2019	2020	2021	2022	Total
International Professional										
1	Project Manager			4.0	11.0	11.0	9.0	1.0	1.0	37.0
2	Road & Pavement Expert			4.0	11.0	11.0	8.0			34.0
3	Structure Expert			4.0	11.0	11.0	8.0			34.0
4	Hydrological & Hydraulic Expert			4.0	11.0					15.0
5	Construction Planner			4.0	11.0	11.0	8.0			34.0
6	Cost Estimate Expert			4.0	11.0	11.0	8.0	1.0	1.0	36.0
7	Specification/Quality Management Expert			4.0	11.0	10.0				25.0
8	Procurement & Contract Administration Expert			1.0	2.0	2.0	1.0	1.0	1.0	8.0
9	Traffic Safety Engineer						1.0			1.0
10	HIV/AIDS Protection Campaign			1.0	2.0	0.0				3.0

No.	Title	2015	2016	2017	2018	2019	2020	2021	2022	Total
	Expert									
11	Social Environment Expert			1.0	1.0	1.0				3.0
12	Natural Environment Expert			2.0	1.0	1.0	1.0			5.0
13	Capacity Development Expert				2.0	2.0	2.0			6.0
14	Weighbridge Expert						4.0	2.0		6.0
15	Building Expert						5.0	1.0		6.0
	Total									253.0
Local Professional										
1	Deputy Project Manager			4.0	12.0	12.0	10.0	1.0	1.0	40.0
2	Civil Engineer – 1			4.0	12.0	12.0	10.0			38.0
3	Civil Engineer – 2			4.0	12.0	12.0	8.0			36.0
4	Civil Engineer – 3			4.0	12.0	12.0	8.0			36.0
5	Civil Engineer – 4			4.0	12.0	9.0				25.0
6	Geotechnical Engineer			4.0	12.0	9.0				25.0
7	Hydrological & Hydraulic Engineer			4.0	8.0					12.0
8	Traffic Management Engineer			4.0	12.0	2.0				18.0
9	Utilities Management Engineer			4.0	12.0	8.0				24.0
10	Cost Engineer – 1			4.0	12.0	12.0	10.0	1.0	1.0	40.0
11	Cost Engineer – 2			4.0	12.0	12.0	8.0			36.0
12	Specification Engineer			4.0	12.0	12.0	10.0			38.0
13	Procurement & Contract Administration Assistant			1.0	2.0	2.0	1.0	1.0	1.0	8.0
14	Quality Management & Safety Engineer			4.0	12.0	12.0	10.0			38.0
15	Resident Engineer for Package 1			4.0	12.0	12.0	10.0	1.0		39.0
16	Resident Engineer for Package 2			4.0	12.0	12.0	10.0	1.0		39.0
17	Resident Engineer for Package 3			4.0	12.0	12.0	10.0	1.0		39.0
18	Resident Engineer for Package 4			4.0	12.0	10.0	1.0			27.0
19	Resident Engineer for Package 5						6.0	4.0	1.0	11.0
20	HIV/AIDS Protection Campaign Assistant			4.0	4.0					8.0
21	Social Environment Engineer			3.0	4.0	3.0	3.0			13.0
22	Natural Environment Engineer			2.0	1.0	1.0	1.0			5.0
23	Mechanical Engineer						4.0	2.0		6.0
24	Building Engineer						5.0	1.0		6.0
	Total									607.0

10.2.3 Roles of Professional Staff

The roles of professionals are summarized in Table 10.2-4 below.

Table 10.2-4 Roles of Professionals

Professionals	Roles
[International Professional]	
Project Manager	Overall management during engineering study, contractor selection and supervision stage
Road & Pavement Expert	Plan, survey, design and control on construction of road and pavement, and provisions of traffic safety education to local people
Structure Expert	Plan, survey, design and control on construction of road structures , and provision of traffic safety education to local people
Hydrological & Hydraulic Expert	Plan, survey, design and review hydrology and hydraulics of project site, including catchment area
Construction Planner	Plan and scheduling of overall construction (road and structure, etc.) and its review
Cost Estimate Expert	Calculation cost estimate & analysis of project progress, costs and variations
Specification/Quality Management Expert	Compilation of specification and review & control on quality and safety
Procurement & Contract Administration Expert	Plan, review and monitoring in procurement to ensure compliance with frameworks administration of process including necessary documentation under the Contract during construction
HIV/AIDS Protection Campaign Expert	Campaign and public relation on HIV/AIDS protection
Traffic Demand Forecast Expert	Conduct of traffic survey and computation of traffic demand forecast
Traffic Safety Expert	Review of traffic safety during design stage as well as construction stage prior to traffic opening
Social Environment Expert	Review of EIA, conduct of supplemental assessment during engineering stage and guide for monitor of social environmental management plan during construction
Natural Environment Expert	Review of EIA, conduct of supplemental assessment during engineering stage and guide for monitor of natural environmental management plan during construction
Capacity Development Expert	Plan and conduct of training to Cambodian engineers, provision of traffic safety education to local people
Weighbridge Expert	Plan, survey, design and control on construction of weighbridge, and provision of traffic safety education to local people
Building Expert	Plan, survey, design and control on construction of weighbridge building
[Local Professional]	
Deputy Project Manager	Overall management and assistance of project manager
Civil Engineer	Plan, survey, design, and review / control on construction road, pavement and structures, Assisting the expert
Geotechnical Engineer	Plan, survey, design and review on plans submitted in regard to geotechnical matters, Assisting the expert
Hydrological & Hydraulic Engineer	Plan, survey and design of hydrology and hydraulics of project site, including catchment area, Assisting the expert
Traffic Management Engineer	Survey and plan of traffic management and review of traffic management plan submitted, Assisting the expert, provision of traffic safety education to local

Professionals	Roles
	people
Utilities Management Engineer	Survey and plan of utilities relocation etc. and review of utilities management plan submitted, Assisting the expert
Cost Engineer	Calculation & analysis of construction costs and assisting the expert
Specification Engineer	Compilation of specification and review & control on specification, Assisting the expert
Procurement & Contract Administration Assistant	Assisting the expert for review and monitoring in procurement to ensure compliance with frameworks and administration of process including necessary documentation under the Contract during construction
Quality Management & Safety Engineer	Compilation of requirements in regard to quality & safety and review & control on them, Assisting the expert
Resident Engineer for Package 1	Review on construction plan submitted and check & inspection on daily activities on site in Package 1
Resident Engineer for Package 2	Ditto in Package 2
Resident Engineer for Package 3	Ditto in Package 3
Resident Engineer for Package 4	Ditto in Package 4
Resident Engineer for Package 5	Ditto in Package 5
HIV/AIDS Protection Campaign Assistant	Campaign and public relation on HIV/AIDS protection, Assisting the expert
Traffic Demand Forecast Assistant	Conduct of traffic survey and assisting computation of traffic demand forecast
Social Environment Engineer	Assisting the expert for review of EIA, conduct of supplemental assessment during engineering stage and monitor of social environmental management plan during construction and two years after the completion of construction
Natural Environment Engineer	Assisting the expert for review of EIA, conduct of supplemental assessment during engineering stage and monitor of natural environmental management plan during construction and two years after the completion of construction.
Mechanical Engineer	Plan, survey, design, and review / control on construction weighbridge, Assisting the expert
Building Engineer	Plan, survey, design, and review / control on construction weighbridge building, Assisting the expert

10.2.4 Composition of Consultant Team

Composition of consultant team during the engineering service, tender assistance and construction supervision stages is indicated below.

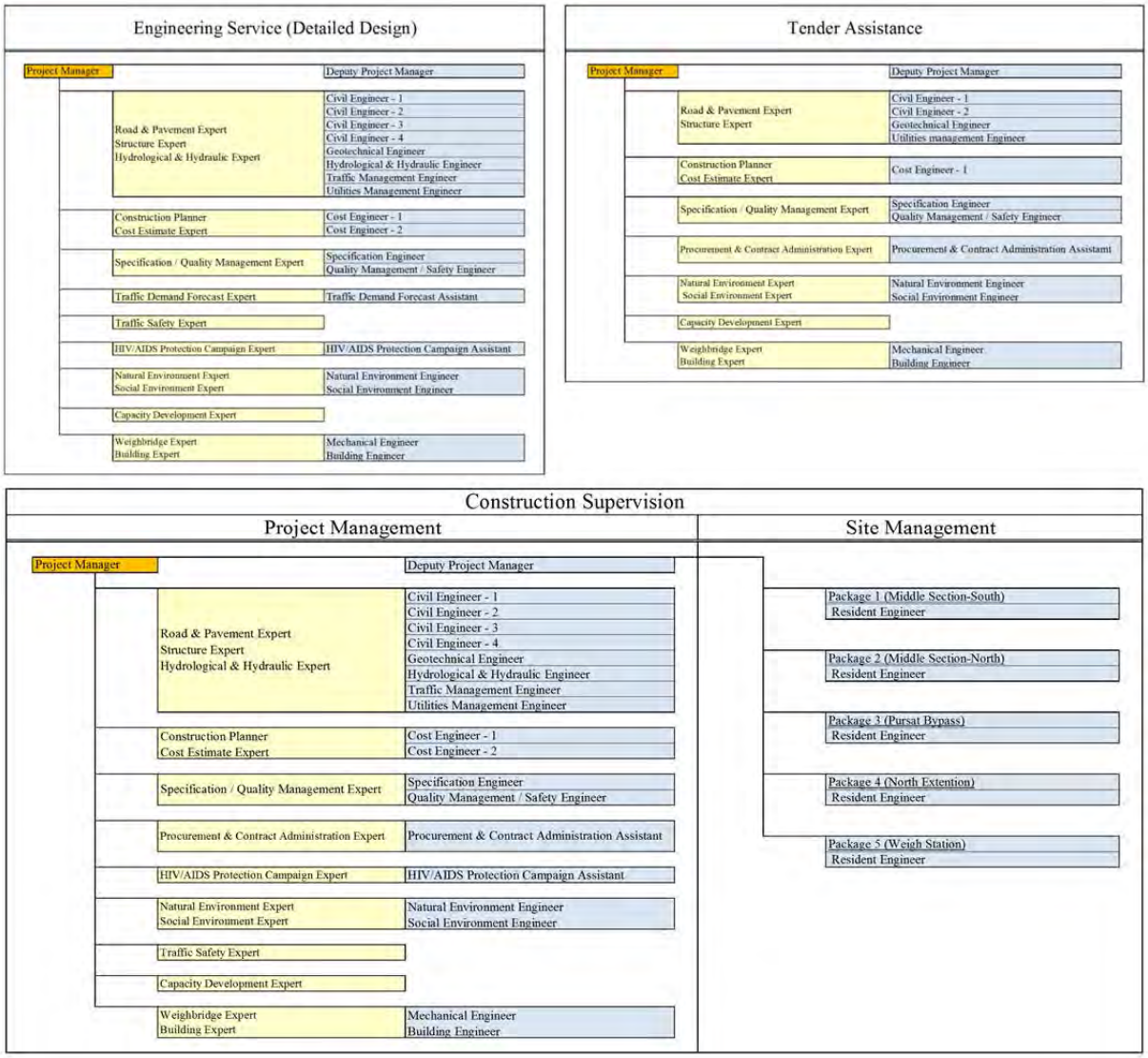


Figure 10.2-1 Organization of Consultant

10.2.5 Cost of Consulting Services

Using the above schedule of professionals (international and local), the costs of consulting services are calculated.

In addition, it is recommended that training for technical and administrative staff in MPWT be conducted utilizing the consultancy services in order to develop their capacity for designing, tendering, contract management, construction management and maintenance of roads as well as public relations and public consultation.

There are two training schemes, which consist of on-the-job training (OJT), etc., in Cambodia and technical training in developed countries, such as Japan. The former comprises the OJT and regular

workshops during the engineering study, selection of contractors and supervision stage in Cambodia and the latter comprises several modules of overseas training. The cost for the latter is calculated assuming training in Japan with a total of 20 staff.

The total cost for consulting services including the training mentioned above is shown below.

Table 10.2-5 Cost of Consulting Services

Description	Amount (USD 1,000)
1) Engineering Service (Basic/Detailed Design and Tender Documents)	*****
2) Tender Assistance	*****
3) Construction Supervision	*****
4) Technical Training	*****
Total	*****

*****Closed due to confidentiality

10.3 Cost Borne by the RGC

The costs borne by the Royal Government of Cambodia (RGC) are comprised of the following items.

(a) Land acquisition and resettlement costs

(b) Utilities relocation, removal and/or protection costs

(c) Detection and removal costs of mines and UXOs

(d) Taxes

(e) Administration costs

It is to note that the above items are to be undertaken by the RGC and special attention is to be paid by the RGC and JICA (and also the consultant) not to hinder the progress of the Project due to budget deficiencies for those items to be prepared by the RGC.

10.3.1 Land Acquisition and Resettlement Cost

Based on what is written in Chapters 15 and 16, land acquisition and resettlement costs are estimated as shown below.

Table 10.3-1 Land Acquisition and Resettlement Cost

Description	Amount(USD 1,000)
Land Acquisition and Resettlement Cost	*****

*****Closed due to confidentiality

10.3.2 Cost of Relocation, Removal and/or Protection of Utilities

Various utilities, such as electric and telephone cables with posts, have been installed along NR 5 and some of them need to be relocated for the Project, depending on the final design. Underground utilities such as water pipes, optic cables and electric cables are also found attached to bridges. Figure 10.3-1 shows utilities attached to bridges. Hence, some of underground utilities need to be relocated and/or replaced for the Project, also depending on the final design. Those buried near bridges (that are to be replaced or widened) definitely need to be removed and re-installed.

These utilities above ground and/or underground are detailed in Section 4.6.




Figure 10.3-1 Utilities at Bridges

The JICA Team has discussed these matters with the counterparts and it was confirmed as current practice in Cambodia that these relocations, removals and/or protections be carried out by relevant organizations utilizing government funds, except those that were laid illegally.

It is difficult to calculate the exact magnitude of this task in the Project at this stage. Referring to past results for utility relocation, removal and/or protection in road widening projects, the cost per kilometer for the Project has been allowed at USD 80,000 /km (similar to in NR 1 Phases 1 to 3) for the whole stretch of NR 5 being widened (Middle Section and North Extension) and 10 percent of the length of the Pursat Bypass of the new road.

Table 10.3-2 Utilities Relocation, Removal and/or Protection Cost

Component	Length	Rate (USD 1,000 /km)	Costs (USD 1,000)	Remarks
1) Middle Section	104.0 km	*****	*****	
2) North Extension	35.8 km	*****	*****	
3) Pursat Bypass	8.8 km	*****	*****	10% of for existing road
Total			*****	

*****Closed due to confidentiality

10.3.3 Cost of Detection and Removal of Mines and UXOs

In accordance with the Minutes of Discussion on the Preparatory Survey for NR 5 Rehabilitation Project between JICA and MPWT, clearance of landmines and UXOs has been carried out for

Pursat Bypass, whereas clearance has not been carried out for the section to be widened of NR 5 (Middle Section and North Extension). The clearance for the whole project site is to be carried out before construction works commence. The cost for this part is calculated on the same basis as Pursat Bypass carried out.

Table 10.3-3 Detection and Removal Cost of Mines and UXOs

Description	Area (1,000 m^2)	Rate (USD /m^2)	Amount (USD 1,000)
1) Clearance in road area	2,600	*****	*****
2) Clearance in bridge area	82	*****	*****
Total			*****

*****Closed due to confidentiality

10.3.4 Taxes

In the cost estimation for taxes, value added tax for the project is calculated and summarized as shown in Table 10.5-1.

10.3.5 Administration Cost

The project management unit of the Employer for the Project is being established, the details of which are described in Section 11.2.1.

Following past cases of Japanese ODA Loan projects, the cost of administration is assumed at 1 percent of the total of construction costs, consultancy services and other costs.

10.4 Escalation and Contingency

Escalation factors are applied to the project cost, as it is calculated using prices of the year 2014.

(a) Different escalation factors are applied on the foreign currency portion and local currency portion although both are estimated in US dollars. 2.0 percent is used for the foreign currency portion and 4.4 percent is used for the local currency portion, in consideration of the average price escalation over the past few years.

(b) The project cost is calculated in US dollars and the escalation factor for foreign currency is applied on the items directly related to international market prices like imported materials, fuel, major construction equipment and systems etc. and the escalation factor for local currency is applied on those related to domestic market prices like workers, and earthwork and quarry materials

(c) Following contingencies are estimated in the project cost additionally.

Contingency for construction cost	10% of base cost + escalation
Contingency for consulting service	5% of base cost + escalation
Contingency for Utilities Relocation, Mines and UXOs Removal	10% of base cost + escalation

10.5 Summary of Project Cost

The summary of project costs calculated in Sections 10.1 to 10.4 is shown below.

Table 10.5-1 Summary of Project Cost

Base Year for Cost Estimation:	August, 2014	
Exchange Rates	USD 1.00	= Yen 101.7
Price Escalation:	FC:	2.0%
	LC:	4.4%
Physical Contingency for Construction	10%	
Physical Contingency for Consultant	5%	
Physical Contingency for Utilities Relocation, Utilities Relocation, Mines and UXOs Removal	10%	
FC & Total : USD 1,000		
LC : USD 1,000		

Item		FC	LC	Total
A. ELIGIBLE PORTION				
I)	Procurement / Construction	*****	*****	*****
	Package 1 (Middle Section-South)	*****	*****	*****
	Package 2 (Middle Section-North)	*****	*****	*****
	Package 3 (Pursat Bypass)	*****	*****	*****
	Package 4 (North Extension)	*****	*****	*****
	Package 5 (Weigh Stations)	*****	*****	*****
	Dispute Board (PKG1)	*****	*****	*****
	Dispute Board (PKG2)	*****	*****	*****
	Dispute Board (PKG3)	*****	*****	*****
	Dispute Board (PKG4)	*****	*****	*****
	Base cost for JICA financing	*****	*****	*****
	Price escalation	*****	*****	*****
	Physical contingency	*****	*****	*****
II)	Consulting services	*****	*****	*****
	Base cost	*****	*****	*****
	Price escalation	*****	*****	*****
	Physical contingency	*****	*****	*****
Total (I+II)		*****	*****	*****
B. NON ELIGIBLE PORTION				
a	Procurement / Construction	*****	*****	*****
	Utilities Relocation	*****	*****	*****
	Mines and UXOs Removal	*****	*****	*****
	Base cost	*****	*****	*****
	Price escalation	*****	*****	*****
	Physical contingency	*****	*****	*****
b	Land Acquisition	*****	*****	*****
	Base cost	*****	*****	*****
c	Administration cost	*****	*****	*****
d	VAT and Import Tax	*****	*****	*****
Total (a+b+c+d+e)		*****	*****	*****

TOTAL (A+B)		*****	*****	*****
C. Interest during Construction		*****	*****	*****
	Interest during Construction(Construction)	*****	*****	*****
	Interest during Construction (Consultant)	*****	*****	*****
GRAND TOTAL (A+B+C)		*****	*****	*****
E. JICA finance portion (A+C)		*****	*****	*****

10.6 Annual Progress

Annual progress is calculated by expanding the project cost of each year in accordance with the implementation schedule discussed in Section 11.3. Then, escalation factors for foreign currency (2.0 percent/year) and local currency (4.4 percent/year) are applied to the amount of each year.

Annual progress, after applying escalation factor, is shown below.

Table 10.6-1 Annual Progress

(Unit: USD 1,000)

Items \ Year		2015	2016	2017	2018	2019	2020	2021	2022	Total
Annual Progress	JICA portion	*****	*****	*****	*****	*****	*****	*****	*****	*****
	RGC portion	*****	*****	*****	*****	*****	*****	*****	*****	*****
	Total	*****	*****	*****	*****	*****	*****	*****	*****	*****

*****Closed due to confidentiality

It should be noted that annual progress for the RGC will be significantly large in the first few years due to land acquisition and resettlement. Ensuring sufficient budget in each year, particularly in the first few years is indispensable for successful implementation of the Project. As land acquisition and resettlement are pre-requisites for commencing construction, special attention to the progress of these tasks will be paid in the years 2015 and 2016.

10.7 Repayment Schedule

JICA loan conditions applying to Cambodia are as follows.

- Interest rate : 0.01%
- Repayment period : 40 years
- Grace period : 10 years

As shown in Table 10.6-1 Annual Progress, the loan will commence in the year 2015 and the total cumulative amount including interest at the end of the grace period is calculated below.

Table 10.7-1 Loan Amount in Grace Period

(Unit: USD 1 million)

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Loan amount	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
Cumulative amount	*****	******	*****	*****	*****	*****	*****	*****	*****	*****

*****Closed due to confidentiality

After the grace period, repayment shall begin which the total of the principal and the interest are equally divided over the years of repayment period. The amount per year is calculated using the following formula.

$$\text{Repayment per year} = \frac{P \times I}{1-(1+I)^{-t}}$$

Where 'P' is the total amount at the end of the grace period, 'I' is the interest rate and 't' is the repayment period.

Using the above formula, repayment is calculated at approximately USD 13.2 million per year over thirty years from 2025 till 2054.

10.8 Contract Package and Contract Conditions

There are four components (Middle Section, North Extension, Pursat Bypass, and Weigh Stations) in the Project shown in Figure 10.1-1. Although, Middle Section component is over 100 km long and seems to be too long for one package contract. On the other hand Pursat Bypass is less than 10 km long but it contains several bridges. Pursat Bypass seems to be enough project size for one package.

Therefore, in view of the volume and length of the works, the JICA Team recommends that the packaging should be divided into following five packages.

Table 10.8-1 Recommended Packaging

Packages	Package Names	Components	Length (km)
Package 1	Middle Section-South	Existing Road No.5	48.8
Package 2	Middle Section-North	Existing Road No.5	55.2
Package 3	Pursat Bypass	New bypass	8.8
Package 4	North Extension	Existing Road No.5	35.8
Package 5	Weigh Stations	Eight weighbridges	
		Total length	148.6

The JICA Team also recommends that the conditions of contract for the above contract packages use the General Conditions of Contract prepared by the International Federation of Consulting Engineers (Fédération Internationale des Ingénieurs-Conseils, or FIDIC) as a base. Other contractual components are recommended as follows.

- Construction period: 36 months
- Tender process: prequalification then tender
- Contract type: Bills of Quantity contract
- Payment terms: advance payment of 10-20 percent then monthly payments with 10 percent retention
- Performance security: 10 percent of contract price
- Defect notification period: one year

As Table 10.1-10 in Section 10.1 shows the Comparison of Basic Rates with Similar Projects, the contractual components of those similar projects are provided below in Tables 10.8-2 and 10.8-3 for comparison with the above.

Table 10.8-2 Comparison of Contractual Components in Similar Projects (1)

Funding country	Japan			
Project name	(1) Improvement of National Road No. 1 Phase 3	(2) Construction of Neak Loeung Bridge	(3) Flood Disaster Rehabilitation and Mitigation	
			NR 5 in Kampong Chhnang	Bridge in NR 11
Grant/Loan	Grant	Grant	Grant	
Construction period	November 2009 – June 2011 (20 months)	December 2010 – March 2015 (51 months)	January 2013 – January 2015 (25 months)	
Contract price	JPY 998 million	JPY 7,874 million	JPY 1,088 million	
Tender process	PQ/tender	PQ/tender	PQ/tender	
Conditions of contract (CC)	CC for grant	CC for grant	CC for grant	
Scope of works	NR 1 rehabilitation: 9.1 km (car lane + bike lane) x 2	Cable stayed bridge: 640 m Approach bridge: 900 m + 675 m Embankment: 840 m + 2,405 m	NR 5 rehabilitation: 2.2 km Street rehabilitation: 2.4 km Drainage way: 2.6 km	8 bridges
Contract type	Lump sum contract	Lump sum contract	Lump sum contract	
Payment term	4 terms (40+30+20+10) % Advance/interim twice/completion	5 terms (3+29+33+28+7) % In portion to expected progress	4 terms (40+30+20+10) % Advance/progress 50%/ and 85%/completion	
Performance security	10% of contract price	10% of contract price	10% of contract price	
Defect notification period	1 year	1 year	1 year	
Supervision	Consultant	Consultant	Consultant	

Source: Relevant documents of each project

Table 10.8-3 Comparison of Contractual Components in Similar Projects (2)

Funding country	Japan	Korea	ADB	China
Project name	(4) Sihanoukville Port SEZ Development	(5) Improvement of NR 31, 33, PR 117 and Kampot Bypass	(6) Improvement of National Road No. 5 Package No. 5F	Enlargement Project of NR 5 from Chruoy Changvar Bridge to Prek Kdam bridge
Grant/Loan	Loan	Loan	Loan	Loan
Construction period	September 2009 – August 2011 (700 days, about 23 months)	August 2011 – January 2014 (913 days, about 30 months)	October 2005 – September 2008 (36 months)	March 2012 – June 2015 (40 months)
Contract price	USD 24.8 million & JPY 847 million (Total JPY 3,131 million)	KRW 27,216 million (USD 24.9 million)	USD 11.6 million	USD 56.8 million
Tender process	PQ/tender	PQ/tender	Information not available	Information not available
Conditions of contract (CC)	FIDIC 1987 edition FIDIC 1999 edition D & B	FIDIC 1999 edition	FIDIC Fourth Edition 1987	No information available
Scope of works	Earthworks: 541,000 m^3 Pavement works: 88,666 m^2 Buildings	NR 31: rehabilitation 55 km NR 33: rehabilitation 36 km PR 117: rehabilitation 11 km Kampot Bypass: new 4 km	NR 5: improvement 47 km Bridge: 102 m (4 span) PC girder	NR 5:widening 30 km Bridges: 4 Interchange: 1
Contract type	BQ contract	BQ contract	BQ contract	Lump sum
Payment term	Advance payment 10% Monthly payment with 10% retention	Advance payment 15% Monthly payment with 10% retention	Advance payment 15% Monthly payment with 10% retention	Information not available
Performance security	10% of contract price	10% of contract price	10% of contract price	Information not available
Defect notification period	365 days	548 days	364 days	Information not available
Supervision	Engineer	Engineer	Engineer	Supervisor

Source: Relevant documents of each project

10.9 Value Engineering

Value analysis and engineering (VA/VE) is a systematic method to improve the "value" of objects by examining their function. In the field of value analysis and engineering, value is defined as the ratio of function to cost i.e., Value = Function/Cost.

Value can, therefore, be increased by either improving the function, reducing the cost, or both. In construction, quality is usually specified in technical specifications and therefore VA/VE is often meant to be achieved by lowering costs. However, providing better function with a higher price may also be within the definition of VA/VE, as long as the value becomes increases.

The process of the feasibility study is to select the best option out of several and in this sense, the feasibility study itself is similar to carrying out the VA/VE process with the result of selection of the best option.

In this study, items of VA/VE are summarized below.

Table 10.9-1 Items of Value Engineering

Item		Criteria	Chapter Reference
Road and pavement design	To select best option of typical cross section of road.	Road geometry and future traffic demand.	8
	To utilize existing materials of subbase course and base course in new design.	Thickness and CBR of existing subbase and base course.	8
Bridge design	Widening of existing bridges instead of reconstruction.	Cost, existing condition, constructability, and traffic management.	9
	Construction of additional bridge next to existing bridges instead of reconstruction.	Cost, existing condition, constructability, and traffic management.	9
	Choice of pile foundation type for additional bridges in NR 5 and Pursat Bypass. Use of either driven piles or bored piles.	Cost, soil conditions, river water depth, piling equipment requirements, and site access.	9
	Span configuration (number of spans and span length) for bridge in Pursat Bypass.	Cost, river width and water depth, soil conditions, girder launching equipment requirements, and site access.	9

CHAPTER 11 IMPLEMENTATION PLAN

11.1 Execution Plan

11.1.1 Road Works

In this Project, there are two types of road works widening of the existing road (Middle Section and North Extension) and construction of bypass (Pursat Bypass) around the city of Pursat.

The improvement projects of the Middle Section and North Extension are to widen the existing NR 5 on one or both sides from one lane in each of both directions to accommodate two lanes in each of both directions mainly by filling. Since NR 5 is part of the major road network in Cambodia, hindrance to traffic during construction needs to be kept minimum. Therefore, construction works should be carried out on one half of the road at a time in order to maintain the traffic capacity of the existing road during the construction period.

The project of Pursat Bypass comprises construction of a new road mainly through paddy fields or vacant land, and construction in this section is relatively straightforward.

Need for special technology is not anticipated in either case.

Generally, the construction of roads is executed in the process as shown below:

(a) Work area is cleared and unsuitable material, if any, is removed.

(b) Embankment is constructed by filling soil in horizontal layers with specified thickness and compaction, and tests are conducted to confirm required dimensions and quality.

(c) Slope is formed as specified and protected with sodding except those near rivers and swampy areas where rip-rap are placed as slope protection.

(d) Subgrade is prepared before pavement structure is constructed.

(e) Subbase course and base course are spread and compacted as specified, and tests are conducted to confirm required dimensions and quality.

(f) Asphalt concrete is laid on top of base course as specified, and tests are conducted to confirm required dimension and quality.

Major materials needed for the road works of this Project are common embankment materials and quarry products for pavement works.

The JICA Team's field survey indicated that embankment materials are obtainable from lands adjacent to, or near NR 5, although such materials are subject to laboratory tests before being used for embankments. It will be spelt out in the specifications during the engineering study that borrow areas for embankment materials should be leveled and drained off during excavation and after removing materials for embankment in order to maintain dry conditions in these areas. It shall also be included in the specifications that a dewatering system should be implemented during

excavation to avoid muddy water from spilling out from the site.

There are several quarries (one at Phnom Tippadei, three at Phnom Sampeaul) near the city of Battambang, three quarries (at Phnom Thom) near the city of Sri Sophon, two quarries near the city of Kampong Chhnang. They are producing aggregates for concrete, asphalt concrete, subbase course, base course and crusher-runs for pavement works. Unfortunately there is no quarry near the city of Pursat, with exception of a dormant quarry, no operational quarry has been recognized. However, Pursat being located near mountain area, there is high potentiality that a new quarry will be operated at the time of construction of the project.

The JICA Study Team observed that these quarries are being managed well and are adequately dealing with dewatering and surrounding road conditions. It appears that the capacity of these quarries is more than sufficient to supply materials to the Project. Hence, the quarries will operate in a highly disciplined manner after the Project. The locations of these quarries are shown in Figure 11.1-1.



Figure 11.1-1 Location of Quarry

The JICA Study Team's survey indicated that there is no commercial asphalt plant in this region. However it was confirmed that several contractors in Cambodia possess movable asphalt plants. The capacities of these movable plants are 60 – 80 tons/hour. It is normal practice in Cambodia that these movable plants are mobilized and used for projects like the NR 5 Improvement Project.

The process of road works for Middle Section and North Extension allowing the flow of traffic is described below.

Filling works are carried out on one side first. After completion of filling to the existing road level and additional space for traffic to travel is available, traffic is shifted to the newly filled space. Then filling on the other side is commenced. This practice is shown in Figure 11.1-2 below. If the embankment needs to be filled higher than the existing road surface, the works shall be executed as shown in Figure 11.1-3.

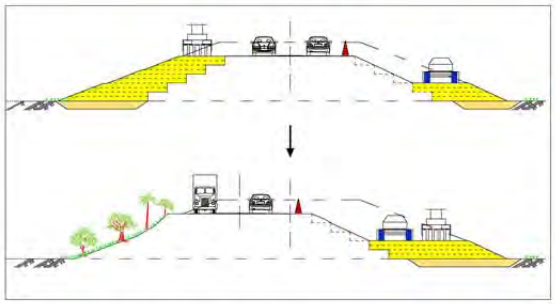


Figure 11.1-2 Embankment Works (1)

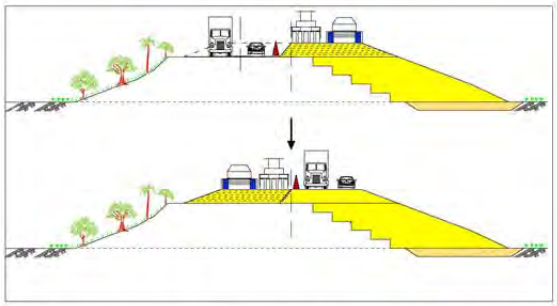


Figure 11.1-3 Embankment Works (2)

After embankment and subgrade preparation is completed, subbase course and base course works are carried out in the same manner as the embankment, with one side being carried out while the other side is maintained for traffic. These are shown in Figures 11.1-4 and 11.1-5, respectively.

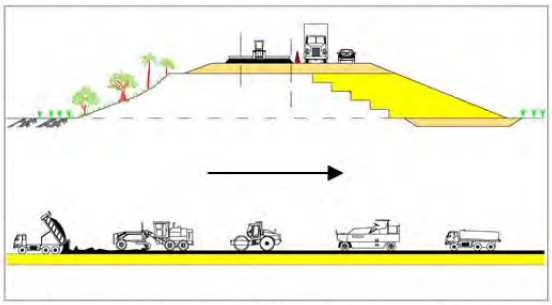


Figure 11.1-4 Subbase Course Works

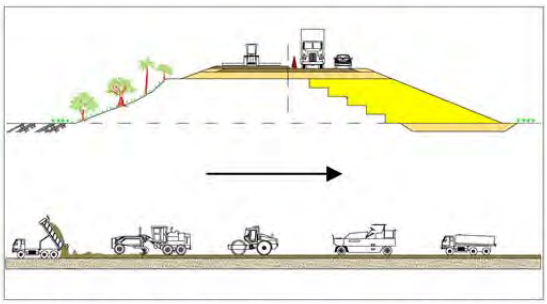


Figure 11.1-5 Base Course Works

Following the base course works, asphalt concrete works are carried out. The asphalt concrete works are also done on one side first, then done on the other side. This is shown in Figure 11.1-6 below.

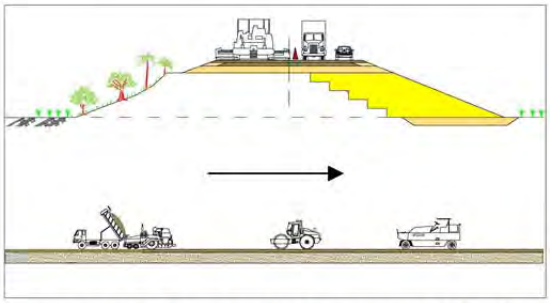


Figure 11.1-6 Asphalt Concrete Works

For Pursat Bypass, the works can be executed without consideration for traffic except at intersections with existing roads, where certain measures are necessary to maintain traffics on the existing roads. It should also be noted that swampy areas are prevalent in certain areas of the route of Pursat Bypass, and therefore the extent of removal of unsuitable materials and replacement with selected materials shall be further investigated and specified during the engineering study.

11.1.2 Bridge Works

There are three types of bridge works: rehabilitation of existing bridges (on the existing NR 5).

- Widening (Existing bridge widened)
- Adding (Additional bridge)
- Replacement (Replace with new bride)

All bridges on the bypass are to be newly constructed.

Three kinds of bridge works are planned as part of the rehabilitation of bridges on the existing NR 5; construction of additional bridges, widening of existing bridges, and construction of new bridges after demolishing the existing bridges. These are described in Chapter 9 in detail and the basic aspects for construction plans are summarized in Table 11.1-1. It should be noted that temporary bridges for detours are required during replacement of bridges.

Table 11.1-1 Bridge Rehabilitation in Middle Section of NR 5

Bridge ID		Existing Bridges						Proposed Bridges					
		KP (Km)	Bridge Type	Length (m)	Span No	Span (m)	Width (m)	Way of Rehabili-tation	Bridge Type	Length (m)	Span No.	Span (m)	Width (m)
1	Br40	177+200	Steel Girder	23.0	1	23.0	9.7	Adding (L)	PSC	25	1	25.0	11.4
2	Br41	178+500	PC Hollow	15.0	1	15.0	10.0	Widening	PSC	15	1	15.0	11.5
3	Br42	181+800	RC Girder	20.0	1	20.0	9.0	Replacement	PSC	20.0	1	20.0	22.8
4	Br43	182+800	PC Hollow	36.0	2	18.0	10.0	Widening	PSC	36.0	2	18.0	11.5
15	Br54	190+150	PC Hollow	18.0	1	18.0	10.0	Widening	PSC	18.0	1	18.0	11.5
16	Br55	191+100	PC Hollow	30.0	2	15.0	10.0	Widening	PSC	30	2	15.0	11.5
17	Br56	201+800	PC Hollow	12.0	1	12.0	10.0	Widening	PSC	12	1	12.0	11.5
18	Br57	208+500	PC Hollow	28.0	2	14.0	10.0	Widening	PSC	28	2	14.0	11.5
19	Br58	215+750	Steel Girder	45.0	3	15.0	10.0	Adding (R)	PSC	45	3	15.0	11.4
20	Br59	219+600	Steel Girder	90.0	3	30.5 ×3	9.6	Adding (R)	PCDG	90.0	3	30.0	11.4
21	Br60	220+800	PC Hollow	24.0	2	12.0	10.0	Widening	PSC	24.0	2	12.0	11.5
22	Br61	222+650	PC Hollow	12.0	1	12.0	10.0	Widening	PSC	12.0	1	12.0	11.5
23	Br62	223+650	PC Hollow	12.0	1	12.0	10.0	Widening	PSC	12.0	1	12.0	11.5
24	Br63	242+850	PC Hollow	18.0	1	25.5.-21.1-25.5	10.0	Widening	PSC	18.0	1	18.0	11.5
25	Br64	243+600	PC Hollow	30.0	2	15.0	10.0	Widening	PSC	30.0	2	15.0	11.5
26	Br65	244+400	PC Hollow	24.0	2	12.0	10.0	Widening	PSC	24.0	2	12.0	11.5
27	Br66	245+900	RC Girder	9.0	1	9.0	9.0	Replacement	PSC	10.0	1	10.0	22.8
28	Br67	255+250	PC Hollow	15.0	1	15.0	10.0	Replacement	PSC	15.0	1	15.0	22.8

Bridge ID		Existing Bridges						Proposed Bridges					
		KP (Km)	Bridge Type	Length (m)	Span No	Span (m)	Width (m)	Way of Rehabili-tation	Bridge Type	Length (m)	Span No.	Span (m)	Width (m)
29	Br68	255+600	PC Hollow	24.0	2	12.0	10.0	Replacement	PSC	30.0	2	15.0	22.8
30	Br69	256+550	PC Hollow	15.0	1	15.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
31	Br70	257+900	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
32	Br71	265+900	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
33	Br72	270+900	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
34	Br73	271+700	PC Hollow	18.0	1	18.0	10.0	Replacement	PSC	20.0	1	20.0	22.8
35	Br74	272+650	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
36	Br75	273+300	PC Hollow	24.0	2	15.15-12.0-15.15	10.0	Replacement	PSC	30.0	2	15.0	22.8
37	Br76	275+650	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8
38	Br77	276+550	PC Hollow	12.0	1	12.0	10.0	Replacement	PSC	15.0	1	15.0	22.8

In summary, 28 bridges in Middle Section-South and Middle Section-North are to be rehabilitated as listed below.

Table 11.1-2 Summary of Bridges in Middle Section of NR 5

Way of rehabilitation		No. of bridges
a	Adding (Additional bridge)	3 in total (Br. 40, 58, 59)
b	Widening (Existing bridge widened)	12 in total (Br. 41, 43, 54, 55, 56, 57, 60, 61, 62, 63, 64, 65)
c	Replacement (Replace with new bridge)	13 in total (Br. 42, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77)

In North Extension there is no bridge works.

In Section Pursat Bypass, there is five bridges to be newly constructed as described in Chapter 9. The basic aspects are summarized in Table 11.1-3 below.

Table 11.1-3 Bridge Construction in Pursat Bypass

Bridge ID		Lane (no)	Bridge Type	Length (m)	Spans (no)	Width (m)	Abutment (no)	Pier (no)	Surface Area (m^2)
P1		4	PSC	60	3	22.8	2	2	1,368
P2		4	PSC	100	4	22.8	2	3	2,280
P3	P3-1	4	PSC	225	9	22.8	1	9	5,130
	P3-2	4	PCDG	42	1	22.8		1	958
	P3-3	4	PCDG	111	3	22.8		2	2,531
	P3-4	4	PCDG	42	1	22.8		1	958
	P3-5	4	PSC	275	11	22.8	1	11	6,270
P4		4	PSC	125	5	22.8	2	4	2,850
P5		4	PSC	80	4	22.8	2	3	1,824

In general, bridge construction is executed through the process as described below;

- Piling works

  If required, a preliminary test pile is to be constructed to confirm pile capacity prior to construction of working piles. Working piles will then be constructed the following procedures.

  a) Setting out pile positions

  b) Driving piles as per drawings with data (number of blows per each length etc.)

  c) Taking data (hammer height, settlement and rebound per blow etc.) at final depth to calculate pile capacity

  d) Re-driving, if required

  Some piles selected from working piles are to be tested to confirm capacity and quality with either a static load test or a dynamic test.

- Substructure

  Because all substructures are near to or in rivers or canals, temporary shoring is to be installed before excavation. Shoring is also necessary to minimize smearing of water in the river. Temporary shoring in general shall be watertight and well braced to sustain earth pressure during excavation. A typical shoring sketch (plan and section) is shown below.

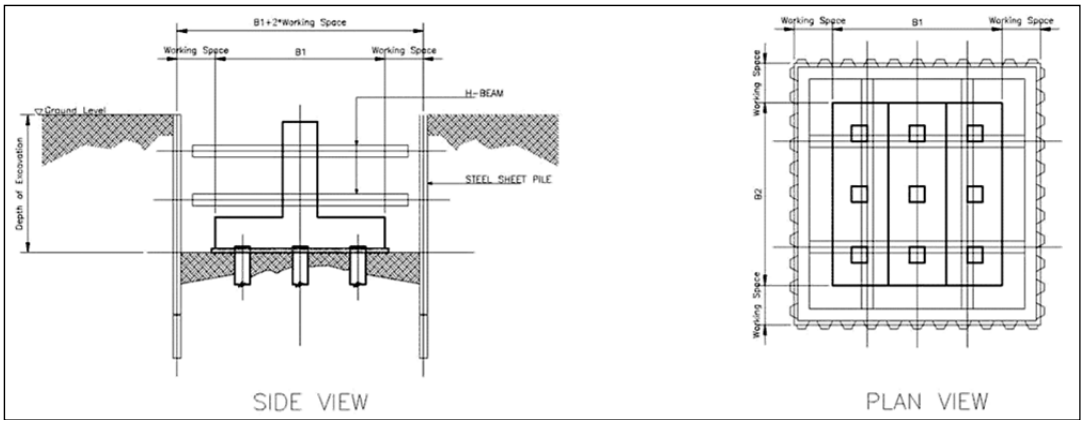


Figure 11.1-7 Schematic View for Structural Excavation

When excavation is completed, pile heads are to be treaded as specified without damage to the piles and lean concrete can be placed. Following the lean concrete, reinforcing bars are to be arranged and forms installed. Prior to placing footing concrete, an inspection is to be conducted and then concreting as per requirements in the specification is to be completed.

Walls, columns and column heads are to be constructed with treatment of construction joints, and firm scaffolding and supports are to be provided. Concrete is to be cured through an appropriate method in a specified period.

After being properly backfilled, temporary shoring is to be carefully removed without damaging

concrete structures.

- Superstructure

  PCS (pre-tensioned precast concrete plank hollow slab) and PCDG (pre-tensioned precast concrete deck girder) with tensioning are to be produced in a casting yard, delivered to site and then erected. The PCS is then to be cast in-situ. Quality control of girders for casting, tensioning and grouting is to be undertaken properly. Delivery and erection of girders is to be planned and carried out as per the requirements detailed in the specification.

  In the case of the existing bridges (12 in total) to be widened in Middle Section-South and Middle Section-North, new PCS beams are to be added to the existing beams with due diligence, as described in Chapter 9.

11.1.3 Widening of Existing Bridges

Twelve bridges are proposed to be widened as listed in Table 11.1-1. Widening of existing bridges has been is practiced in developed countries such as Japan in recent years. The general process of widening is explained in Chapter 9. Details of bridge widening need to be designed and finalized by a bridge design engineer and general contractor, respectively, with substantial experience in bridge widening works.

11.1.4 Other Structural Works

Pipe/box culvert works mainly consist of two kinds of works, earthworks and concrete works. Earthworks for culverts are to be executed in a manner similar to that described in Section 11.1.1 Road Works. Likewise, concrete works for culverts are to be executed in a manner similar to that described in Section 11.1.2 Bridge Works. In the case of culverts in Middle Section and North Extension, pipe/box culverts need to be extended as the road is widened, and these extension works are to be undertaken in conjunction with embankment works stated in Section 11.1.1.

11.1.5 Traffic Management During Construction

When works for Middle Section and North Extension are carried out while allowing traffic to continue to flow, with minimum disruption of traffic. Traffic management is one of the most important tasks during construction, particularly in town areas. The traffic capacity of the road should remain similar to the existing conditions during construction. This can be achieved by providing the same carriageway width. Sometimes providing detours or alternative routes and other measures may be adopted in order to minimize interference to road users. The same principle is to be applied when constructing Pursat Bypass at intersections with the existing roads.

Figure 11.1-8 below shows a general flow chart for preparing a traffic management plan.

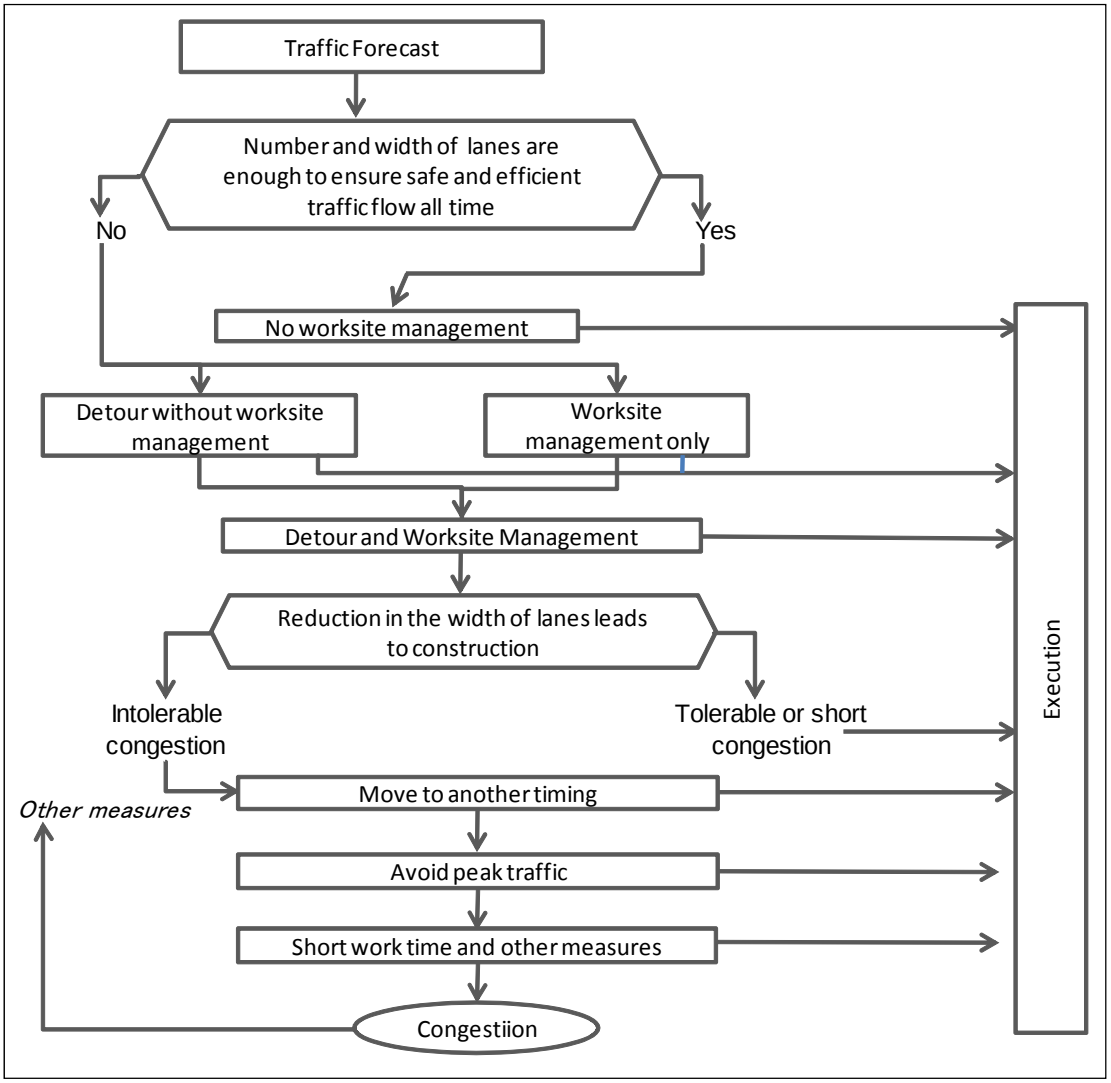


Figure 11.1-8 Flow of Traffic Management Plan

11.1.6 Utilities

Utilities such as electric cables, street light posts, telephone lines, optic fiber cables, water supply pipes and so on are to be checked thoroughly along the route prior to commencing construction. The following activities are to be conducted before, during and after construction.

(a) Contact relevant authorities to access as-built documents and drawings for utilities

(b) Survey actual locations of utilities above ground and underground on site, using detectors for the latter

(c) Excavate trial pits at certain intervals to ascertain exact locations of utilities

(d) Temporarily relocate, remove and/or protect utilities as required

(e) Reinstate utilities after construction works are completed

As per experiences in similar projects in Cambodia, the relocation, removal, protection and reinstatement of utilities is to be carried out by the relevant utility organizations or their designated

companies. This shall be under separate local contracts between the RGC and the utility organizations or designed companies in order to avoid negative impacts on the civil works of the Project.

11.2 Organization for Implementation

11.2.1 Employer

As requested by JICA, the Minister of Public Works and Transport prepared a proposal to the Prime Minister in September 2011 that the Joint Coordinating Committee (JCC) be established to lead and manage the rehabilitation project of NR 5 as well as NR 1 (Asian Highway AH-1) under Japanese Loan and the proposal is being processed. It was specified that the JCC was to be organized with participation from the MPWT, the Ministry of Economy and Finance (MEF), the Council of Ministers and relevant provincial governments.

The Minutes of Discussions between the Royal Government of Cambodia (RGC) and Japan International Cooperation Agency (JICA) on the Project for Improvement of National Road No. 5 (Battambang – Sri Sophorn: North Section) under Japanese ODA Loan were signed in September 2012. Then, the Prakas No. 525 on the Establishment of Project Management Unit (PMU) for the Implementation of the Project for Improvement of National Road No. 5 (Battambang – Sri Sophorn) under Japanese ODA Loan was issued in November 2012 and the PMU was established for the North Section.

A similar PMU to that of the North Section will be established for the project of Middle Section in due course, which is illustrated in the Figure 11.2-1 below based on the above-cited Prakas (No. 525).

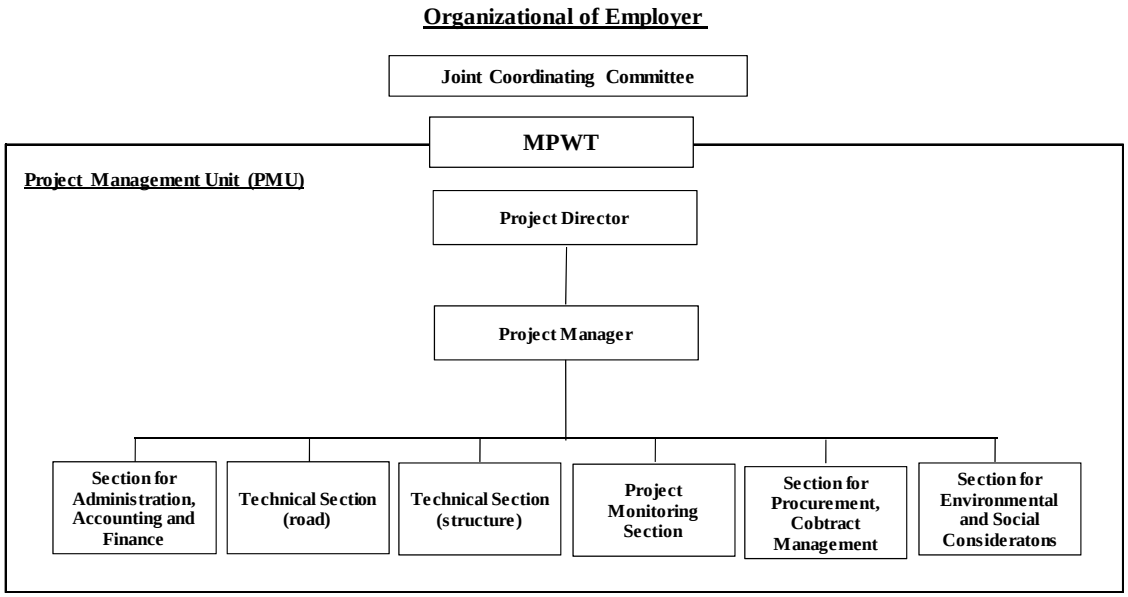


Figure 11.2-1 Organization of Employer

The JCC and PMU are to be established as soon as a similar Prakas for the Middle Section and Sri Sophorn – Poipet Sectionis issued in order to facilitate constructive and effective discussions and negotiations with JICA regarding the loan agreement. During the engineering study and selection of contractors, the PMU will be a small organization that will be developed to full scale during the construction stage.

MPWT is currently accumulating experiences in procurement and project management in JICA loans through implementation of the Project of North Section. Hence, it is assumed that MPWT will have a minimum level of knowledge and capability for project management by the time when the Project of the Middle Section and Sri Sophorn – Poipet Section will start. Nevertheless, the JICA Team recommends enhancing their capacity through trainings sessions referred to in Section 10.2 be implemented.

11.2.2 Consultant

The consultant will be selected after the loan agreement is finalized through "the Guideline for the Employment of Consultants under Japanese ODA Loans" and will be contracted by the Employer in accordance with the contract concurred by JICA. Composition of consultant team during stages of the engineering service, the tender assistance and construction supervision are indicated in Section 10.2.4.

11.2.3 Contractor

Contractor(s) are to be selected through "the Guideline for Procurement under Japanese ODA Loans" and be contracted by the Employer in accordance with the contract recommended by JICA. A detailed design including bill of quantities which are prepared by the consultant, and the conditions of contract between the Employer and the Contractor shall be based on "the Bank Harmonized Edition" of "the General Conditions of Contract" prepared by the International Federation of Consulting Engineers (Fédération Internationale des Ingénieurs-Conseils, or FIDIC). Under FIDIC conditions, the relationship between the Employer, the Consultant (the Engineer) and the Contractor are shown in Figure 11.2-2 below.

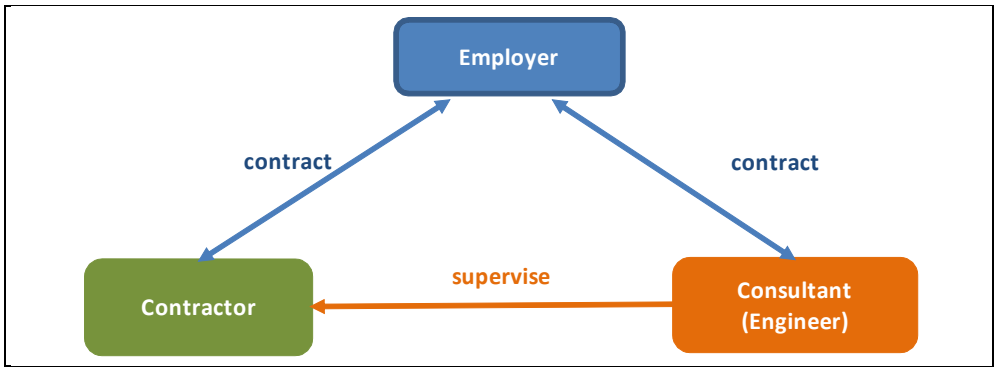


Figure 11.2-2 Relationship of the Employer, Consultant and Contractor

11.3 Implementation Schedule

The JICA Team held discussions with JICA and MPWT counterparts as well as various stakeholders of the Project and local consultants/contractors regarding the implementation of the Project. The following shows the most probable schedule for each task in consideration of the results of these discussions.

(a) Feasibility Study (FS)

The JICA Team commenced the Survey in April 2013 and after incorporating North Extension, the Draft Final Report and Final Report are to be submitted in August and October 2014, respectively.

(b) Royal Government of Cambodia (RGC) Action for Approval on FS

According to interviews with staff in relevant departments in RGC regarding the ODA loan, RGC needs to accept the FS and to prepare a formal request to the Japanese Government. This task is estimated to take a few months.

(c) Negotiation of Loan Agreement

The standard processing time period for an ODA loan project is set by the Japanese Government and the process will commence immediately following receipt of the formal request from RGC. The major activities of the process are as follows.

(i) Fact finding mission from by JICA
(ii) JICA appraisal mission
(iii) Pledge of loan
(iv) Signing of loan agreement

(d) Selection of Consultant

There is a standard schedule for the consultant selection process, which consists of three major stages as follows:

(i) Short-listing or Expression of Interest and Request for Proposal Preparation Stage (approximately 2.6 months)
(ii) Proposal Stage (approximately 5.3 to 5.8 months)
(iii) Contract Negotiation and Signing Stage (approximately 2.6 months)

Total 10 – 11 months

In earlier projects in Cambodia under JICA, the duration of the consultant selection varied from 10 months to 24 months, taking 10 months in the most recent project (West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project). Therefore, the JICA Team assumes that selection of the consultant will take 12 months by taking advance action prior to the formal loan agreement.

(e) Engineering Study and Supervision

The selected consultant is to carry out an engineering study and tender process/evaluation for contractors followed by construction supervision.

The first task, the engineering study consists of a basic design and detailed design and preparation of tender documents. Usually the tender documents (pre-qualification document and tender document) will be compiled simultaneously with the detailed design or soon after the basic design.

As the project is relatively uncomplicated, it is estimated that the engineering study, including the preparation of tender documents, will be completed in a twelve-months, as a twelve months period was allowed in the Final Report for the South Section of NR 5.

The tender process/evaluation for contractors usually consists of two stages: pre-qualification (PQ) stage and tender stage. The former starts during the detailed design stage and the latter is commenced as soon as the detailed design is completed. The duration of this task is discussed in "(f) Selection of Contractors" below. Supervision will follow the selection of contractors.

(f) Selection of Contractors

The selection of contractors begins during the PQ stage and then proceeds through the tender stage. The following tasks and durations comply with the standard time frames stipulated by JICA.

(i)	Preparation of Tender Documents (including JICA's concurrence)	3 months
(ii)	Tender period	2 months
(iii)	Tender Evaluation	2 months
(iv)	JICA's concurrence of Tender Evaluation	1 months (actual period 2 months)
(v)	Negotiation of Contract	2 months
(vi)	Signing of Construction Contract	1 months
(vii)	L/C Opening, L/Com Effectuate	1 months
	Total	12 months

According to past experience in previous projects in Cambodia, the average duration is much longer (approximately 19 months), however the above process could plausibly be achieved in 12 months as stated above through concerted efforts by all concerned parties.

(g) Land Acquisition/Resettlement

The length of time required for land acquisition and relocation is dependent mainly on the number of affected families. JICA has provided technical assistance through the "Project on Capacity Enhancement of Environmental and Social Considerations for Resettlement". This technical assistance is expected to provide positive effects in relation to the land acquisition and relocation for the NR 5 Project.

Thus far, most of the earlier projects under Japanese ODA Loans have not experienced

problems related to land acquisition and relocation, as land was cleared before the commencement of civil works in several projects in the past. According to the study at the current stage, the JICA Team conclude the estimated necessary time to be 19 months.

(h) Relocation, Removal and/or Protection of Utilities

The relocation, removal and/or protection of utilities can be explored after the detailed design is finalized, and those works shall be completed prior to commencing construction works. The duration allowed for those works is therefore 12 months, and this can be achieved providing the Employer manages all stakeholders well.

(i) Detection and Removal of Mines/UXOs

The prerequisites for the calculation of the duration for detection and removal of mines/UXOs are as follows;

- The route to be surveyed for the detection and clearing of mines and UXOs comprises Middle Section-South, Middle Section-North, North Extension, and Pursat Bypass.
- Detection shall be conducted in the dry season. Water in paddy fields and/or excess water in the soil must be avoided.
- Soon after detection of landmines and UXOs, demining works are to be conducted.
- There is no problem for detection and removal works in regard to the land owners after the completion of land acquisition.

The organization responsible for detection and demining is to be the Cambodia Mine Action Center (CMAC). The necessary period for the detection of landmines and UXO is estimated to be around four months in the dry season.

(j) Construction

There are three packages in this Project, which are Package 1: Middle Section-South (National Road No.5) and Pursat Bypass, Package 2: Middle Section-North (National Road No.5), Package 3: Pursat Bypass, Package 4: North Extension and Package 5: Weigh Stations. The scope of work in each package is shown below.

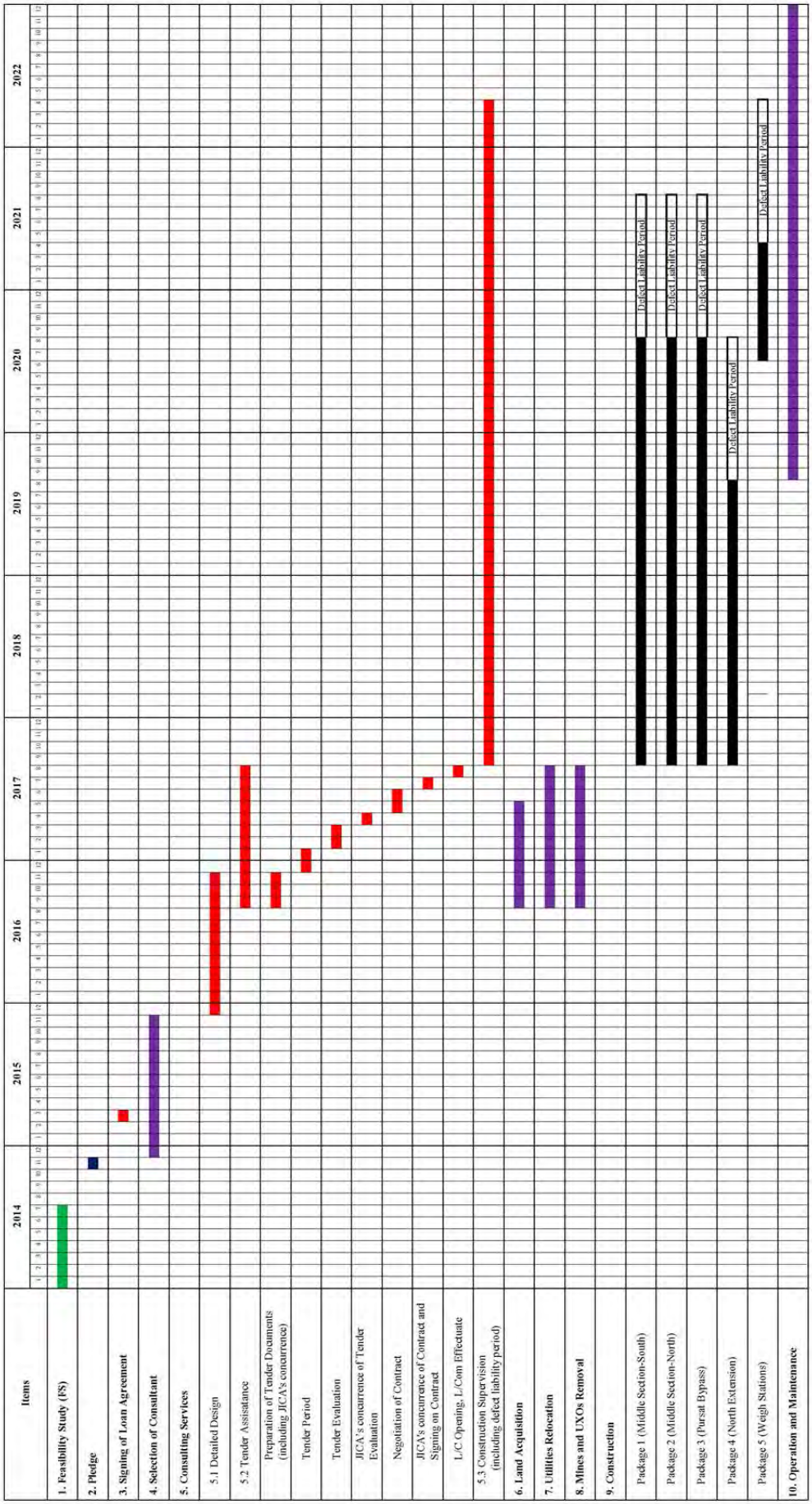
Table 11.3-1 Scope of Work of Contract Package

Description	**Package 1**	**Package 2**	**Package 3**	**Package 4**	**Package 5**
	Middle Section -South	Middle Section -North	Pursat Bypass	North Extension	Weigh Stations
Road length	49.0 km	55.2 km	8.8 km	35.8 km	
No. of bridges	13	15	5	-	
No. of culverts	55	256	42	58	
No.of weighbridges					8

Based on the above and the execution plan, the construction periods for Package 1, Package 2 and Package 3 are estimated to be three years, and that of Package 4 is estimated to be two years. Construction Period of Package 5 is estimated to be 10 months.

Utilizing the explanation above, the implementation schedule is drawn and prepared. The schedule is shown in Table 11.3-2 Implementation Schedule.

Table 11.3-2 Implementation Schedule for National Road 5 Rehabilitation Project



CHAPTER 12 MAINTENANCE AND OPERATION PLAN

12.1 Maintenance and Operation Cost

12.1.1 Organization in Charge of Road Maintenance

The functions of Ministry of Public Works and Transport (MPWT) are stipulated in the Sub-decree on the Organization and Function of MPWT and those of Department of Public Works and Transport (DPWT) in provinces and cities are stipulated in the Declaration on the Management and Process of DPWT. The important articles in the Sub-Decree and Declaration in respect of road maintenance are extracted and shown in Table 12.1-1 below.

Table 12.1-1 Functions and Duties of MPWT and DPWT with Respect to Maintenance

[**Sub-Decree**]

Article 3: MPWT has functions and duties as below;
(2nd Clause)
- Completion, maintenance and management of road, bridge, port, railway, maritime and state building infrastructure.

Article 11: General Department of Public Works and Transport is responsible for direction, introduction, following up and control of construction and maintenance of road and bridge infrastructure, public building construction and construction management, maintenance of national vestiges assigned by the Royal Government of Cambodia. General department is …(omitted)…

Article 12: Road Infrastructure Department (RID) is responsible for:
- Completion, maintenance, management and make regulation for business on road infrastructure, such as road, local road, ferry dock, ferry and urban street.
- For this responsibility, department has two functions.

a) Organize maintenance program and manage roads and bridges
- Selecting data and utilizing data to understand road network.
- Manage technical documents on roads and road network related documents.
- Organize budget, divide follow-up means and control the maintenance.
- Manage public properties, road transport, water transport and rail transport.

b) Manage road and bridge working site.
- Study, manage and organize road and bridge maintenance program.
- Organize budget, divide follow-up means and control road and bridge working site.
- Assess complete working site.
- Manage ferry docks and ferry.

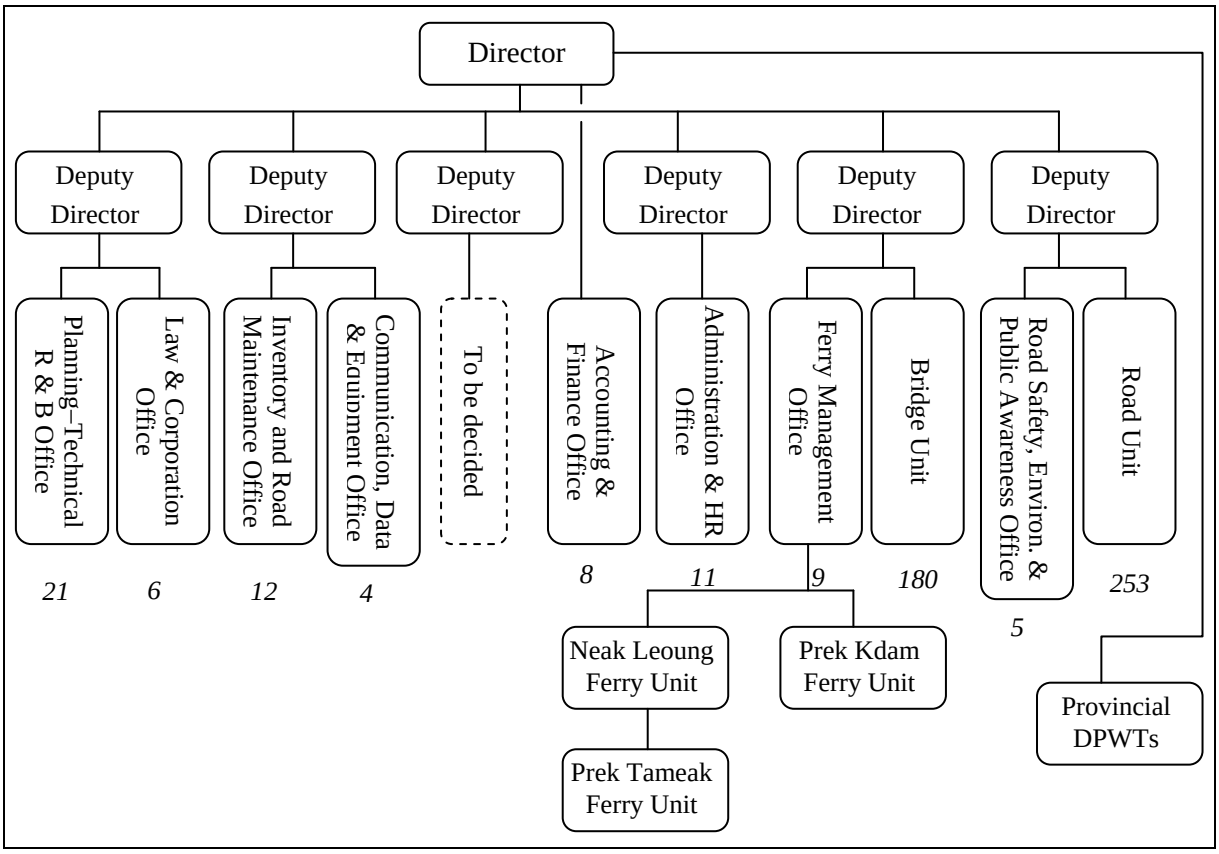
Article 23: In the whole Cambodia, there are Provincial Departments of Public Works and Transport that is responsible for implementation and coordination with Ministry activities. Arrangement and operation of local organization is defined by other document.

[**Declaration**]

Article 1: This proclamation indicates the management and process of the base units under supervision of MPWT- so called Department of Public Works and Transport, Provinces and Cities has the following duties;
(4th Clause)
- Control and maintain all completed works of infrastructures, such as roads, bridges, ports, airports, drainage system, drainage & exhaust pipe stations, harbors, buildings, land plots.

Source: Sub-Decree 14 and Declaration 344, Cambodia

Referring to the above, it is noted that Road Infrastructure Department (RID) under General Department of Public Works and Transport in MPWT and DPWT are responsible for maintaining all roads and bridges in Cambodia. Figure 12.1-1 shows the organizational chart of RID, including number of staff (*italic*) in each office and unit this year. Table 12.1-2 shows number of staff in DPWT office along NR 5.



Source: Road Infrastructure Department, MPWT

Figure 12.1-1 Organizational Chart of Road Infrastructure Department, MPWT

Table 12.1-2 Staff Number in DPWT along National Road 5

Province	Number of Staff
DPWT of Phnom Penh	297
DPWT of Kandal Province	139
DPWT of Kampong Chhnang	56
DPWT of Pursat Province	93
DPWT of Battambang Province	124
DPWT of Banteay Meanchey Province	63

Source: Road Infrastructure Department, MPWT

12.1.2 Practice of Road Maintenance and Operation

MPWT prepared and compiled four guidelines together with JICA experts in 2008 and the maintenance works are being carried out in accordance with those guidelines. Four guidelines are as listed below:

- Guideline for Regular Inspection
- Guideline for Supervision of Routine Maintenance
- Guideline for Supervision of Periodic Maintenance
- Guideline for Repairing Defects of Roads

According to the guidelines, road maintenance works are classified into three types; namely, routine, periodic and emergency.

Table 12.1-3 summarizes typical activities of each type of maintenance works.

Table 12.1-3 Typical Maintenance Activities

Type	Activity
Routine Maintenance	Cleaning of pavement
	Mowing and maintenance of plants
	Cleaning of ditches and culverts
	Repair of traffic signs and road markings
	Shoulder grading
	Pothole patching and crack sealing
	Repair of sealants and expansion joints of bridges
	Repair of cut and fill slopes
Periodic Maintenance	Re-graveling
	Resealing/surface dressing
	Overlay
	Maintenance of traffic signs and road markings
Emergency maintenance	Removal of debris or obstacles from natural causes
	Repair of damage caused by traffic accidents

Routine maintenance is planned based on regular (daily) inspection of the condition of road on the items as listed below:

- Pavement: potholes, cracks, ruts/settlements, deformations, local aggregate loss, edge break, scratches, bleeding etc.
- Cut and fill slopes
- Drainage
- Bridges: bottom, expansion joint etc.
- Other structures and facilities: markings, guardrails/handrails, signboards etc.

The results of regular inspection are categorized into three ranks as listed below.

Table 12.1-4 Rank of Defects

Rank A	Severe defects that may be harmful to traffic or structure and it requires urgent countermeasures.
Rank B	Defects that may be harmful to traffic or structure and it requires countermeasures but not urgent.
Rank C	Small defects that do not require countermeasures but it requires continuous observation.

The results of regular inspection are promptly reported to the operation office for follow-up maintenance works to be undertaken either continually throughout a year or at certain intervals

every year.

Periodic maintenance is substantial repairs carried out at an appropriate time interval (every 3-year, 5-year, 8-year, 10-year etc.) based on the age, investment and initial design of the road. It could also be required when vehicle weight and traffic volume increased. It includes reconstruction, improvement, or rehabilitation works on any road section.

Emergency maintenance basically comprises works to restore road and road related facilities to their normal operating conditions after they are damaged by road accidents or natural causes. It is impossible to foresee the frequency, but such maintenance requires immediate action.

In addition to the above three types of maintenance, there is still another type of maintenance called 'preventive maintenance'. The term "preventive maintenance" refers to repair that addresses causes of deterioration leading to the need for costly rehabilitation work in future.

12.1.3 Necessity of Capacity Enhancement for Road Maintenance

In the past, actual works of road maintenance have been executed mainly by DPWT and the Army under contracts with MPWT. In this case, type of pavement has been mainly DBST or Macadam. DPWTs and the Army have capacity for such types of pavement but they are not supposed to have sufficient capacity for maintenance of AC pavement. Thus, a new system needs to be introduced for maintenance of roads with AC pavement, including to increase staff in the road maintenance office of MPWT and DPWT, and capacity enhancement for maintenance of AC pavement is necessary.

As a part of the effort to improve the capacity for road maintenance, the Strengthening Construction Quality Control Project (SCQCP) in MPWT was completed in 2012 under assistance of JICA and the Follow-up to SCQCP are being implemented in MPWT. Another project, the Road Asset Management Project (RAMP) also implemented under assistance of ADB and WB. As roads are currently being improved in Cambodia and AC pavement roads are increasing, it is highly needed to have capacity development project for AC pavement road maintenance in Cambodia. For this purpose, the project for strengthening of inspection and maintenance of roads and bridges is expected to start in MPWT under assistance of JICA near future and JICA Team recommends that such project shall start in due course and due time.

12.1.4 Budget for Road Maintenance and Operation Works

In the budget situation for road maintenance and operation works under MPWT, it is found that budget has been increased in recent years and the following table shows budget in each category of works under MPWT, including those in year 2013.

Table 12.1-5 Budget for Road Maintenance under MPWT

(Unit: USD million)

Items	2007	2008	2009	2010	2011	2012	2013
Routine maintenance	5.7	8.8	17.1	17.9	16.1	15.8	20.0
Periodic maintenance	12.2	14.3	13.3	15.0	26.6	32.5	37.5
Emergency maintenance	1.6	1.9	2.4	2.9	3.7	4.0	5.0
Flood restoration works	2.4	2.4	0	0	0	23.7	0
Total	21.9	27.4	32.8	35.8	46.3	76.0	62.5

Source: Road Infrastructure Department, MPWT

As per discussion with staff in the road maintenance of Road Infrastructure Department (RID) under MPWT and in the Department of Public Works and Transport (DPWT) in Kampong Chnnang Province, it is found that there are budget for routine maintenance of road spent by MPWT as well as by DPWTs. The amounts of expenditure spent for routine maintenance in 2012 for paved roads are average USD 2,900 /km.

12.1.5 Maintenance and Operation Cost

As described in Chapter 8 Highway Design, the design period of the pavement is 10 years. Thus, overlay of 5 cm thickness as the periodic maintenance becomes necessary every 10-year after completion. Also, routine maintenance needs to be implemented every year after completion.

Unit rate of future routine maintenance cost of the Project road is estimated at USD 3,000 /km as the current unit rate of routine maintenance cost for asphalt concrete and DBST roads is slightly less than USD 3,000. Hence routine maintenance cost for the Project in each year is estimated as follows:

Table 12.1-6 Routine Maintenance of the Project Road

Section	Unit Rate (USD 1,000 /km)	Length (km)	Amount (USD 1,000)
Middle Section-South	3	49.0	147
Middle Section-North	3	55.2	166
North Extension	3	35.8	107
Pursat Bypass	3	9.0	27
Total		149.0	447

Periodic maintenance cost in each 10-year is computed as follows based on unit price of USD 14 /m^2 of overlay (5 cm thick asphalt concrete).

Table 12.1-7 Periodic Maintenance of the Project Road

Items	Unit Rate (USD)	Length (km)	Amount (USD 1,000)
Middle Section-South			
Rural Area	USD 14 /m^2 x 15.0 m x 1,000 = USD 210,000 /km	47.6	9,996
Urban Area	USD 14 /m^2 x 20.0 m x 1,000 = USD 280,000 /km	1.4	392
Sub-Total		49.0	10,388
Middle Section-North			
Rural Area	USD 14 /m^2 x 15.0 m x 1,000 = USD 210,000 /km	54.7	11,487
Urban Area	USD 14 /m^2 x 20.0 m x 1,000 = USD 280,000 /km	0.5	140
Sub-Total		55.2	11,627
North Extension			
Rural Area	USD 14 /m^2 x 15.0 m x 1,000 = USD 210,000 /km	35.1	7,371
Urban Area	USD 14 /m^2 x 20.0 m x 1,000 = USD 280,000 /km	0.7	196
Sub-Total		35.8	7,567
Pursat Bypass			
Rural Area	USD 14 /m^2 x 15.0 m x 1,000 = USD 210,000 /km	9.0	1,890
Urban Area	USD 14 /m^2 x 20.0 m x 1,000 = USD 280,000 /km	0	0
Sub-Total		9.0	1,890
Total		149.0	31,472

In summary, road maintenance and operation cost after completion is estimated in the price of 2013 as shown below.

- Routine maintenance: USD 447,000 /year
- Periodic maintenance: USD 31,472,000 /10-year

12.2 Annual Road Maintenance and Operation Cost

Road maintenance and operation costs after completion of the Project is calculated in the prices of 2013 as described in Section 12.1 above. Thus, escalation factor needs be applied in order to have annual cost in future years. Escalation factor is assumed as follows.

(a) Escalation factor in year 2014 to 2025: 2.0% and 4.4% /year for foreign and local currency portions, respectively, as stated in the Section 10.4.

(b) Escalation factor from year 2026: 0.6% and 1.5% /year for foreign and local currency portions, after twelve years growth with escalation in 1) above

(c) It is assumed that items directly related to international market prices like imported materials, fuel, major construction equipment and systems etc. are applied to the factor for foreign currency and those related to domestic market prices like workers, earthwork and quarry material to the factor for local currency.

Annual road maintenance and operation cost in each year is as shown in Table 12.2-1.

Table 12.2-1 Annual Road Maintenance and Operation Cost

(Unit: USD 1,000)

Year	Costs with 2013 price			Costs with escalation applied		
	Routine Maintenance	Periodic Maintenance	Total	Routine Maintenance	Periodic Maintenance	Total
2020	447		447	536		536
2021	447		447	551		551
2022	447		447	565		565
2023	447		447	581		581
2024	447		447	596		596
2025	447		447	613		613
2026	447		447	618		618
2027	447		447	623		623
2028	447		447	628		628
2029	447	31,472	31,919	634	44,571	45,205
2030	447		447	639		639
2031	447		447	644		644
2032	447		447	649		649
2033	447		447	655		655
2034	447		447	660		660
2035	447		447	666		666
2036	447		447	672		672
2037	447		447	677		677
2038	447		447	683		683
2039	447	31,472	31,919	689	48,450	49,139
2040	447		447	695		695
2041	447		447	700		700
2042	447		447	706		706
2043	447		447	712		712
2044	447		447	718		718
2045	447		447	725		725
2046	447		447	731		731
2047	447		447	737		737
2048	447		447	743		743
2049	447	31,472	31,919	750	52,750	53,500
2050	447		447	756		756
2051	447		447	763		763
2052	447		447	769		769

CHAPTER 13 PROJECT EVALUATION

13.1 General

Project evaluation has been performed by adopting the same method the adopted for the North and South Sections of the NR 5 improvement projects. The objective of the project evaluation is also same as those for North and South Sections of the NR 5 improvements project which is to measure the Project's operational and effectiveness conditions. Appropriate indices are established based on the goals, objectives and functional characteristics of the Project. Improvement of the sections of NR 5 between Thlea Ma'am and Battambang, Sri Sophorn and Poipet and construction of Pursat Bypass, have direct positive impacts on transportation of goods and passengers. As the result of improvement of traffic and transportation, the Project will contribute to socio-economic development of Cambodia as well as to promote regional development. With this concept, goals and objectives of the Project are set as follows:

Goals:

- To facilitate transportation of goods and passengers
- To promote and activate regional economy

Direct Objectives:

- To separate through traffic and intra-urban traffic (mitigation of traffic congestion in Pursat City)
- To dissolve traffic congestion and reduce travel time and travel cost
- To ensure the safety of pedestrian and comfort of travel
- To reduce road maintenance cost by improving the pavement structure
- To improve the condition of environmental pollution

Based on these goals and objectives, indicators of the performance to be achieved during the Project life in specific and measurable terms are selected. Selected indices can, if measured, contribute to attaining better performance of the Project.

13.2 Evaluation Index

Performance of a project is usually evaluated in two aspects; degree of achievement of the targets in operation stage and their effectiveness. Degree of achievement in operation, in case of a road project, mainly refers to traffic volume. Effectiveness of a road project is degree of improvement of traffic conditions against increase of traffic demand.

Selection of Operation and Effect Indicators

Operation and effect indicators to evaluate and monitor the project performance and its effectiveness are selected as shown in Table 13.2-1. The indicators are divided into two; indicators for direct benefit accruing from use of the road and those for indirect benefits which are brought about as the results of improvement in traffic/transport conditions.

Table 13.2-1 Performance Indicator with Project Operation and Effectiveness Measurement

Impact Indicators	Definition	Purpose of Indicator	Method of Measurement
1. Indicator for Direct Effect			
Traffic Volume	Average Traffic Volume (V) = ΣVi / ΣKm Where; Vi: traffic volume on each link in terms of PCU Km: Length on each link	To evaluate to what extent the movement of people and goods is encouraged.	Traffic Volume Counting
Reduction of traffic congestion	Vehicle congestion degree (V/C ratio) is mitigated. Average Congestion Degree (V/C) = ΣV-Km /ΣC-Km Where; V-Km: traffic volume on each link in terms of PCU times length of each link C-Km: capacity on each link in terms of PCU times length of each link		Calculation of V/C ratio using the traffic volume measured in above.
Reduction of travel time	Average travel time required for the whole length of the project road	To evaluate the effect of road improvement on the traffic/ transport and living environment, as well as public expenditure	Travel speed survey
Reduction of travel cost	Saving in total travel time cost for all vehicles running on the project road		Vehicles running cost
Reduction of traffic accident	Record of the number of traffic accidents		Accident statistical data
Savings in road maintenance cost	Road maintenance cost is reduced from DBST to AC pavement.		Annual maintenance cost
Emission gas reduction	Reduction in vehicle emissions and vehicle noise can be lead to environmental benefits		Surveillance of NO_2
2. Indicator for Indirect Effect			
Promotion of regional development	Reduced transportation costs and the time cost saving for economic activities promote development of regional economic and industrial activities	To evaluate the extent of the regional development.	Population, Regional GDP, No. of factories, increase of job opportunity, etc.
Product market expansion	Product market is expanded owing to transport time reduction.		Distance between the place of production and place of consumption
Creation of employment opportunities with project construction	Employment opportunities will increase during the construction period.		Number of people locally employed during construction

13.3 Consideration on Indirect Benefits not Listed in the Table Above

In addition to the listed in Table 13.2-1 above, some more indirect benefits can be considered.

13.3.1 Promotion of Poverty Reduction

Poor people's inability to access jobs and services is an important element of the social exclusion that defines poverty. Regional and transport development can reduce poverty, by contributing to economic growth.

- During the construction period, there will be job opportunities for the local people without particular skills.
- After construction, this Project road will promote development of the region along the Project road by enhancing promotion of agriculture, industry and commerce. It is expected that job opportunities are increased in proportion to the economic development.

13.3.2 Investment Promotion of Local and Foreign Firms

NR 5 is expected to promote economic activities such as foreign and domestic investment by providing efficient land transport to Phnom Penh and Thailand. GMS regional economic cooperation is expected to create opportunities for various types of investments.

13.3.3 Mitigation of the Flood Damage

The road inundation by flood which occur every year. As a result of road improvement, the local people will be able to move with much less difficulty in their daily activities such as going to school, commuting, hospitals, and shopping than today. It is possible to secure a safety and smooth road traffic operation.

13.4 Operation and Effect Monitoring Plan

The operation and effect of the Project will be monitored by measuring impact indicators. The targets of the indictors are estimated in accordance with the planned monitoring timing as shown in Table 13.4-1.

Table 13.4-1 Operation and Effect Indicator

Indicators	Road	Original (2012)	Present (Year)	2 years after completion, projected as year 2022
Daily Traffic (PCU/day)	Thlea Ma'am - Battambang	6,062		12,748 *
	Pursat bypass	-		11,276 *
	Sri Sophorn - Poipet	7,421		14,688 *
Travel Time (minute)	Middle Section	(Existing NR 5 of Middle Section) 116		(Improved NR 5+ Pursat bypass) 107 **
	Sri Sophorn - Poipet	44		36

* Interpolated from value of 2023

** Estimated using STRADA

13.5 Economic Analysis

13.5.1 Objective

The main purpose of economic analysis for this survey is to show the effects of the road improvement of the project from viewpoint of national economy and it aims at evaluating the economic viability of the project implementation.

Economic analysis estimates the project benefits to national economy by analyzing the costs and benefits of the project. The costs component includes various cost items such as cost of road improvement, land acquisition cost and O&M cost. Similarly, the benefits components includes travel time saving, and reduction of VOC which ultimately contribute in national economy.

The approach used for this follows the standard evaluation methodology for road improvement project. "With Project" and "Without Project" cases are compared. "With Project" covers the situation where the proposed road improvement and new bypass are implemented, and "Without Project" covers the situation where no such investment takes place. The quantified economic benefits, which would be realized from the implementation of the project, are defined as savings in vehicle travel costs (vehicle operating costs and vehicle travel time costs) derived from the difference between "With Project" and "Without Project".

The economic analysis procedure as illustrated in Figure 13.5-1 is employed in this survey. In order to estimate the benefit, traffic assignment to the road networks with and without the Project is considered.

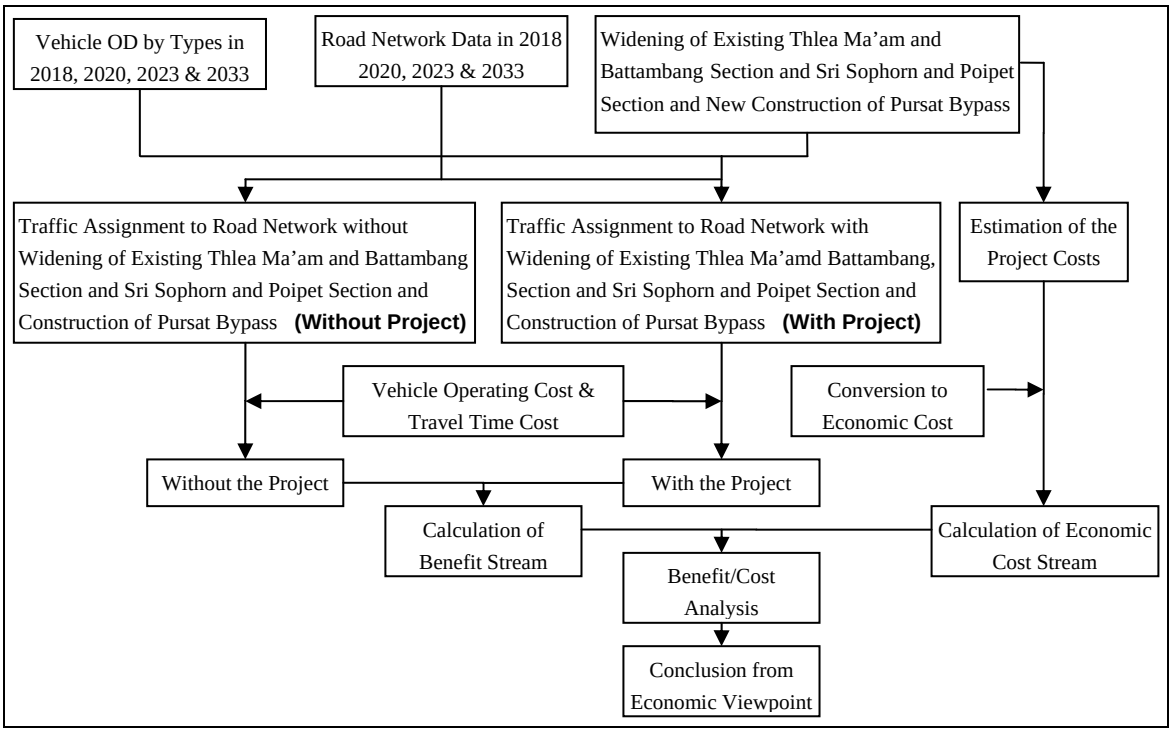


Figure 13.5-1 Procedure of Economic Analysis

13.5.2 Estimation of Economic Cost

Economic cost is a monetary expression of goods and services to be actually consumed for implementation of the Project. Economic cost is converted from financial cost by deducting tax portions and applying the standard conversion factor to the non-trade. Economic benefit is defined as the amount saved in travel costs due to a Project. Travel costs consist of two component;

- Vehicle operating costs (VOC): VOC is the physical costs of operating a vehicle such as consumption of fuel, lubricants, spare parts, deprecation, crew costs, and so on.
- Travel time costs (TTC): TTC is the value of time spent in traveling that could be used in the other activities.

(1) Vehicle Operating Cost (VOC)

The VOC, estimated in "the Preparatory Survey for National Road No. 5 (South Section) Improvement Project in the Kingdom of Cambodia" implemented by JICA in 2012-2013, was used as the basic reference for this survey. The VOC in this Survey was estimated considering consumer price index in 2013. Inputs for vehicle operating costs required for calculating the VOC are as follows.

(a) Shadow wage rate (SWR)

The shadow wage rate (SWR) is an estimate of the economic price of labor. The labor divided into two categories: skilled, and unskilled corresponding on degrees of scarcity. The SWRs as shown below are applied.

Table 13.5-1 Shadow Wage Rate

	Skilled	Unskilled
Shadow Wage Rate	1.00	0.50

Source: Cost-Benefit Analysis for development a practical Guide 2013

(b) Vehicle Price

The vehicle price is estimated on the basis of average prices for new vehicles purchased from car dealer ships. Most of vehicles are imported to Cambodia as second hand reconditioned vehicles. However, as second hand price is uncertain and depends on the frequency of use, a new vehicle prices are used in this Survey. For the purpose of calculating the economic price of each vehicle taxes and import duties have been subtracted from the retail price. The resulting economic price includes elements of Cost Insurance and Freight (CIF) price, retailer's margin.

Table 13.5-2 Vehicle Prices and Characteristics

Type		Fuel Type*	Km per driven (Annual Km)	Service Life	Financial Price (US$)	Economic Price (US$)
Motorcycle	Honda Dream 110	P	10,000	10	1,500	936
Sedan Car	Camry 2000	P	30,000	10	40,000	23,250
Pick-Up	Toyota Hilux	P	30,000	10	30,000	21,360
Mini Bus	Toyota Hiace Commuter	P	30,000	10	47,500	33,428
Big Bus	Hyundai Bus for 45 Pax	D	70,000	10	83,000	58,420
Light Truck	Isuzu NPR 55 E	D	60,000	10	32,000	22,535
Medium Truck	Isuzu FSR 33	D	100,000	12	85,000	59,808
Heavy Truck	Isuzu CYR 80	D	100,000	12	108,000	75,988

Fuel Type : P: Petrol D: Diesel
Source: Car dealerships

(c) Tire Cost

The economic costs of tires are assessed in the same way as vehicle prices. Suppliers in Phnom Penh were surveyed to assess general prices of different types (motorcycle, passenger car, bus and truck) of tire. New tires are subject to import duty and VAT, whose rates vary depending on the type of tire. Custom import duty is principally charged at 15% of the CIF value of the tire. The rate of VAT and special tax are 25% and 15% for all types of tire. Special tax (zero) is applied for motorcycle tire. For the purpose of calculating the economic price of each vehicle tire, taxes and import are subtracted from the retail price. The resulting economic price includes elements of CIF price and retailer's margin.

Table 13.5-3 Tire Cost

Type	Tire Size	No. of Tire	Financial Price (US$)	Economic Price (US$)
Motorcycle	100/17	2	44.0	35.9
Sedan Car	185/70-14	4	224.0	149.3
Small Bus	195/70-14	4	292.0	194.7
Large Bus	11.00-20	6	2,280.0	1,520.0
Light Truck	7.50-16	4	700.0	466.7
Medium Truck	8.25-16	6	1,770.0	1,180.0
Heavy Truck	11.00-20	10	3,800.0	2,533.3

Source: Retail shop,

(d) Fuel and Lubrications

Fuel and lubricants prices are estimated based on a survey of market prices. There are a number of suppliers in Cambodia operating competitively. Fuels are subject to import duty, special tax and VAT. For the purpose of calculating the economic price of fuel and lubricants, these taxes and import duty are subtracted from the retail price. The resulting economic price includes elements of CIF price, customs import duty, value added tax and retailer's margin.

Table 13.5-4 Fuel and Tire Cost

Type	Financial Price (US$) / liter	Economic Price (US$) / liter
Gasoline Regular	1.28	1.04
Diesel	1.23	1.00
Lubricant (motorcycle)	3.60	2.93 (0.8ℓ)
Lubricant (4 wheels or more)	7.50	6.11

Source: Retail shop

(e) Spare Parts Cost

Spare parts costs are assumed to be 1% of the vehicle price .

(f) Maintenance Labor Cost

The maintenance costs estimated based on a survey of the average monthly cost of skilled supervisors and mechanics. Average working hours applied 200 hours per month.

Table 13.5-5 Maintenance Labor Cost

	Motor Cycle	Sedan Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Wages per month (US$)								
Supervisor	600	600	600	600	600	600	600	600
Mechanic	300	300	300	300	300	300	300	300
Owner	0	0	0	0	0	0	0	0
Maintained by (%)								
Supervisor	10	25	25	25	50	25	50	50
Mechanic	40	50	50	50	50	50	50	50
Owner	50	25	25	25	0	25	0	0
Maintenance hours per year	40	70	70	250	300	250	300	350
Average hourly rate for services (US$)	36.0	105.0	105.0	375.0	675.0	375.0	675.0	787.5
Shadow wage rate factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Economic Price (US$/hr)	36.0	105.0	105.0	375.0	675.0	375.0	675.0	787.5

(g) Crew Cost

Crew cost of a vehicle per km is calculated over certain time period (hours) and divided by the distance (km) traveled during this time period. The crew costs per unit of vehicle are estimated based on a survey of drivers and conductors or assistants. In Cambodia, unit costs for drivers are estimated at around US$150 to $300 per driver per month, depending on the type of vehicle, while unit cost for conductors or assistants are estimated to be one half of the average monthly cost of skilled supervisor and semi-skilled worker, respectively.

Table 13.5-6 Crew Cost

	Motor-cycle	Sedan Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Number of drivers	0.01	0.1	0.1	1	1	1	1	1
Average monthly wage rate ($)	150	200	200	250	300	250	300	300
Working Hour	200	200	200	200	200	200	200	200
Average hourly rate for driver ($/hr)	0.008	0.100	0.100	1.250	1.500	1.250	1.500	1.500
Skilled wage factor – Semi - skilled	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Driver cost (Economic) ($/hr)	0.008	0.100	0.100	1.250	1.500	1.250	1.500	1.500
Number of conductors	0	0	0	0.5	1	1	1	1
Average monthly wage rate	0	0	0	125	150	125	150	150
Working Hour	200	200	200	200	200	200	200	200
Average hourly rate for conductor	0.000	0.000	0.000	0.313	0.750	0.625	0.750	0.750
Skilled wage factor – Unskilled	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Conductor cost (Economic) ($/hr)	0.000	0.000	0.000	0.156	0.375	0.313	0.375	0.375
Total Crew Cost ($/hr)	0.008	0.100	0.100	1.406	1.875	1.563	1.875	1.875

(h) Depreciation

Depreciation cost can be expressed as a percent of new vehicle cost and is given by the following formula:

Vehicle per 1,000 veh-km = DEP/ New vehicle prices

A vehicle is a medium-term asset. The purchase cost represents an investment which yields services over several years. The market value of the asset declines with both the passage of time and with amount and type of usage. It is this loss of market value that represents vehicle depreciation. The vehicle depreciation per km is a function of the average annual depreciation and annual utilization.

DEP = ADEP/AKM

Where: ADEP: Average annual depreciation, expressed as % of average new vehicle cost
ADEP: (1 / LIFE)*100
LIF is average vehicle service life
AKM: Average number of kilometers driven per vehicle per year

(i) Insurance Cost

Insurance cost was assumed to be 1% or 3% of vehicle price.

(j) Overhead Cost

Overhead cost was calculated at 10% of the sub-total of the VOC. Based on the above mentioned discussion and estimations the basic vehicle operating costs are calculated and are shown in Table 13.5-7.

Table 13.5-7 Vehicle Operating Cost by Vehicle Type

(Unit US$)

Type	Item	Motor Cycle	Sedan Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Distance related VOC	Fuel cost	311.7	3,116.7	3,116.7	4,051.7	13,974.1	10,181.1	19,963.0	32,938.9
	Lubricant cost	5.9	73.3	91.7	122.2	1604.2	366.7	1833.3	1833.3
	Tire cost	17.9	112.0	112.0	146.0	2128.0	560.0	2360.0	5066.7
	Maintenance cost	9.4	232.5	213.6	334.3	584.2	225.3	598.1	759.9
	Depreciation cost	0.6	14.4	13.2	20.6	36.1	13.9	30.8	39.1
	Sub total	345.4	3,548.9	3,547.1	4,674.8	18,326.5	11,347.0	24,785.2	40,637.9
	Overhead cost	0.0	0.0	354.7	467.5	1,832.7	1,134.7	2,478.5	4,063.8
	Total	345.4	3,548.9	3,901.8	5,142.3	20,159.2	12,481.7	27,263.7	44,701.7
Time related VOC	Crew cost	4.5	75.0	75.0	2,250.0	3,375.0	2,500.0	3,750.0	4,500.0
	Maintenance cost	36.0	105.0	105.0	375.0	675.0	375.0	675.0	787.5
	Insurance cost	28.1	697.5	640.8	334.3	584.2	225.3	598.1	759.9
	Depreciation cost	0.3	7.7	7.1	11.1	19.4	7.5	16.6	21.1
	Sub total	68.9	885.2	827.9	2,970.4	4,653.6	3,107.8	5,039.7	6,068.4
	Overhead cost	0.0	0.0	82.8	297.0	465.4	310.8	504.0	606.8
	Total	68.9	885.2	910.7	3,267.4	5,119.0	3,418.6	5,543.6	6,675.3
Total		414.3	4,434.1	4,812.5	8,409.7	25,278.1	15,900.4	32,807.3	51,376.9
VOC /1000 km		41.4	147.8	160.4	280.3	361.1	265.0	328.1	513.8

(2) Travel Time Cost (TTC)

Travel time cost (TTC) is the cost of time spent on transport/travel. It includes various factors such as the following:

(i) Value of time spent on going to or coming back from to office (passenger car).

(ii) Cost of the crews of trucks/buses.

(iii) Income of trucks/buses obtained by transporting cargo/passenger car.

However, the results of the roadside interview survey, asked to truck drivers, showed that the truck drivers are not aware of the three item above. Thus, item (iii) is not considered for the trucks here. If the alternative activity can have monetary value assigned to it, this can be used as a part of road user cost in the economic appraisal of the projects, particularly road improvement projects.

In order to estimate the travel time costs, the average wage approach method is adopted. The time travel cost of a vehicle is calculated based on the wage level of a passenger/driver and occupancy ratio of each vehicle type. Time value of a passenger/driver is assessed for working time and non-working time as shown in Table 13.5-8.

Table 13.5-8 Estimation of Travel Time Cost

Vehicle Type	Travel Time Value (US$/hour)		Trip Purpose Composition		Weighted Average Value (US$/hr/person)	Average No. of Passengers	Time Value by Vehicle Type (US$/hr)
	Work	Non-Work	Work	Non-Work			
Motorcycle	1.27	0.42	31.0%	69.0%	0.38	1.80	0.68
Light Vehicle	9.93	3.28	57.0%	43.0%	2.02	3.50	7.07
Bus	7.09	2.34	69.0%	31.0%	0.31	18.00	5.61
Truck	1.31	0.43	95.0%	5.0%	0.63	2.00	1.27

TTC in 2018, 2023 and 2033 were calculated with 2014 value derived from the estimated growth rate of GDP per capita. Future result are shown in Table 13.5-9.

Table 13.5-9 Forecast of Time Value Per Vehicle

(Unit: US$/ hour)

Year	Motorcycle	Light Vehicle	Bus	Truck
2014	0.68	7.07	5.61	1.27
2018	0.99	10.23	8.12	1.84
2023	1.28	13.25	10.52	2.38
2033	1.63	16.84	13.37	3.02

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.

(3) Construction Cost, Maintenance Cost and Land Acquisition Cost

The cost of construction, maintenance and land acquisition presented in Chapter 11 and Chapter 12 are used in the economic evaluation. Maintenance costs are classified into annual routine maintenance cost and periodic maintenance cost. Periodic maintenance costs are assumed to be expended each 10 years. Some basic presumptions adopted in the economic analysis are as follows:

- Escalation factor : Price escalation is not taken into account for construction cost, maintenance cost and land acquisition cost.
- Tax and import duty : Value added tax and import duty are excluded from cost.
- Land acquisition cost : Land acquisition cost is included.

13.6 Economic Evaluation

13.6.1 Methodology

Economic evaluation is conducted in terms of comparative analysis between benefits and costs. Benefits contain i) time saving benefit and ii) vehicle operating cost saving benefit, while costs consist of construction cost, land acquisition cost and operation/maintenance cost. Indicators

adopted for economic evaluation are the conventional "economic internal rate of return (EIRR)", "benefit-cost ratio (B/C ratio)" and "net present value (NPV) ". Evaluation was conducted on the basis of transport demand forecast.

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 cost flow 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 opportunity cost of capital. 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 opportunity cost of capital rate. Normally the NPV and EIRR will give the same indications of viability and priority ranking between projects.
- The benefit cost ratio (B/C ratio) refers to the ratio of the present value of the economic benefits stream to the present value of the economic cost stream. The investment is viable for the project if the B/C ratio is greater than 1.0.

(1) Implementation Plan of the Project and Evaluation Period

The economic analysis is based on the Project implementation schedule proposed in Chapter 11 as shown in Table 11.3-2. The evaluation period is assumed to be 30 years from 2020 to 2049 taking the service life of the Project into account.

Table 13.6-1 Project Implementation Schedule for Economic Analysis

	2015	2016	2017	2018	2019	2020	2021	2049
Detailed Design								
Tender Process								
Land Acquisition / Resettlement								
Construction								
Middle Section								
Pursat Bypass								
Sri Sophorn – Poipet Section								
Operation and Maintenance								

(2) Evaluation Period and Daily Factor

Evaluation period is set as 30 years after opening to traffic. The annualized factor of the daily benefits is assumed to be 340 days per year taking into consideration the weekly variation in the volume of traffic on the roads.

(3) Social Discount Rate

The social discount rate of 12% is assumed.

(4) Residual Value and Inflation

Residential value and inflation are not considered in this economic evaluation

(5) Standard Conversion Factor (SCF)

The standard conversion factor (SCF) is a standard method for adjusting domestic prices which are considered to be distorted in the domestic market price. SCF used 0.90 in this Survey.

$$\text{Standard Conversion Factor (SCF)} = \frac{(\text{Import} + \text{Export})}{(\text{Import} + \text{Import Custom}) + (\text{Export} - \text{Export Custom})}$$

Table 13.6-2 Calculation of SCF

(Unit: US$ million)

	2008	2009	2010	2011	2012
CIF	5,076.6	4,489.9	5,466.0	5,219.5	6015.7
FOB	3,492.3	2,995.7	3,884.3	6,709.5	7964.9
Import Custom	1,123.8	1,080.8	1,444.0	1,378.9*	1,589*
Export Custom	76.6	78.1	130.9	226*	268*
SCF	0.891	0.882	0.877	0.912	0.914
				Average	0.90

Source: Key Indicators for Asia and the Pacific 2013, ADB
** Estimation of Study Team*

(6) Cost Benefit Analysis

The result of the economic analysis is shown in Table 13.6-3. The economic analysis is based on the annual user's benefit and VOC shown in Table 13.5-7 above. The result of analysis shows EIRR of 17.0% which is usually considered to be sufficient.

Table 13.6-3 Cost Benefit Stream of the Project

(Unit: x1,000 US$)

SQ	Year	Project Cost	Maintenance Cost	Total Cost	Benefit	Net Benefit	Discount Cash Flow (at 12%)		
							Cost	Benefit	Net Benefit
	2015	******		******		******	******	******	******
	2016	******		******		******	******	******	******
	2017	******		******		******	******	******	******
	2018	******		******		******	******	******	******
	2019	******		******		******	******	******	******
	2020	******		******		******	******	******	******
1	2021	******	436	******	13,148	******	******	******	******
2	2022	******	436	******	15,021	******	******	******	******
3	2023		436	436	19,965	19,529	176	8,064	7,888
4	2024		436	436	23,570	23,135	157	8,500	8,343
5	2025		436	436	27,604	27,168	140	8,888	8,747
6	2026		436	436	32,110	31,674	125	9,231	9,106
7	2027		436	436	37,136	36,701	112	9,532	9,420
8	2028		436	436	54,297	53,861	100	12,443	12,343
9	2029		436	436	71,285	70,849	89	14,586	14,497
10	2030		30,685	30,685	90,348	59,663	5,606	16,506	10,900
11	2031		436	436	111,692	111,256	71	18,219	18,148
12	2032		436	436	135,539	135,103	63	19,740	19,677
13	2033		436	436	200,918	200,482	57	26,127	26,071
14	2034		436	436	213,192	212,756	51	24,753	24,702
15	2035		436	436	226,222	225,786	45	23,452	23,406
16	2036		436	436	240,037	239,601	40	22,218	22,177
17	2037		436	436	254,716	254,280	36	21,050	21,014
18	2038		436	436	341,621	341,186	32	25,208	25,175
19	2039		436	436	362,482	362,046	29	23,881	23,852
20	2040		30,685	30,685	384,615	353,930	1,805	22,624	20,819
21	2041		436	436	408,099	407,663	23	21,434	21,411
22	2042		436	436	433,015	432,579	20	20,306	20,285
23	2043		436	436	553,582	553,147	18	23,178	23,160
24	2044		436	436	587,375	586,939	16	21,958	21,942
25	2045		436	436	617,388	616,952	15	20,607	20,593
26	2046		436	436	648,827	648,392	13	19,336	19,323
27	2047		436	436	681,940	681,504	12	18,146	18,134
28	2048		436	436	716,742	716,306	10	17,028	17,018
29	2049		436	436	587,601	587,165	9	12,464	12,455
30	2050		30,685	30,685	617,539	586,854	581	11,696	11,115
	Total	******	103,823	******	8,707,625	******	******	******	******

NPV (US$ million)	*****
B/C	1.61
EIRR (%)	15.1

*****Closed due to confidentiality

(7) Sensitive Analysis

A sensitivity analysis is conducted to see the influence of fluctuation of benefit and construction cost. Sensitivity analysis is made on the cases with +10% and -10% in the cost and benefit, respectively. These changes in cost and benefit are supposed to represent favorable and unfavorable scenarios. The results of the sensitivity analysis are shown in Table 13.6-4.

As the results of sensitivity analysis, even in the worst case which the benefits are decreased by 10% and the project costs are increased by 10% is occurred, the project EIRR of the all cases exceeds 12 % which is usually considered to be sufficient for road projects. Thus, implementation of the project is economically feasible from view point of national economy.

Table 13.6-4 Results of the Sensitivity Analysis

Case		Economic Indicator	Benefits		
			-10%	Base Case	+10%
Costs	-10%	NPV (US$ million)	*****	*****	*****
		B/C	1.61	1.79	1.97
		EIRR	15.0%	15.8%	16.4%
	Base Case	NPV (US$ million)	*****	*****	*****
		B/C	1.45	1.62	1.77
		EIRR	14.4%	15.1%	15.7%
	+10%	NPV (US$ million)	*****	*****	*****
		B/C	1.32	1.47	1.61
		EIRR	13.8%	14.4%	15.1%

*****Closed due to confidentiality

13.7 Conclusion

The benefit of the project are represented by the reduction of transport cost and reduction of travel time. Environmental conservation and increase job opportunities for the local people have also considered as indirect benefit which are not taken into consideration the above economic analysis.

Project roads serve as the most important freight transport road for Cambodia and Thailand. Also, the majority of domestic product from western provinces which need to be transported through NR 5. The project influential area has a high development potential for Cambodia.

The number of fatalities by traffic accidents recorded on NR 5 is the highest among those on 1-digit trunk roads. Therefore, improvement of NR 5 will not only promote ASEAN connectivity and international/domestic economic development but also traffic safety in Cambodia.

CHAPTER 14 NOTES FOR IMPLEMENTATION AS JAPANESE ODA LOAN PROJECT

Through the long experiences of implementation of Japanese ODA loan projects, JICA has found many important points which need attention from the view point of smooth implementation of projects as well as to fully achieve the objectives of projects. Among those points, some are pertinent to this Project. Some important points were raised in the Survey for the North Section.

MPWT established the Project Management Unit for the North Section in November 2012 to manage the Project (see Section 11.2). The PMU has completed procurement of the consultant services for the detailed design (DD) and construction supervision (C/S) and has accumulated some experience in the procurement of consultant services

Likewise, the experience of implementation of Japanese ODA loan project will be accumulated within this PMU through implementation of the Project of North Section as well as South Section. It is expected that the Project of the Middle Section can be more effectively managed by the PMU than the North Section and the South Section. However, the notes for implementation of Japanese ODA loan project is reiterated here to draw attention to important points.

14.1 Start-up Stage

Start-up delay is one of the focused areas identified in "2011 Joint Country Portfolio Performance Review (JCPPR)" held on April 28 and 29, 2011, jointly by Ministry of Economy and Finance (MEF), Asian Development Bank (ADB), Japan International Cooperation Agency (JICA) and the World Bank. There are some issues discussed in JCPPR such as recruitment of consultant, project launch workshop and project administration manual. Three issues are focused here.

14.1.1 Land Acquisition, Relocation and Mitigation Plan for Affected Families

The issue "Land Acquisition, Relocation and Mitigation Plan for Affected Families" is one of the most important points in the start-up stage. Many projects have faced difficulties with this issue. JICA has tackled with this issue based on its guidelines. However, some projects such as National Road No. 1 and Neak Loeang Bridge have received criticism on this issue.

So far, most of the precedent projects under Japanese ODA Loan have no problem on land acquisition and relocation. In the projects of 'Sihanoukville Port', 'Phnom Penh Water' and 'Telecom Cambodia' land acquisition was completed before the commencement of civil works. For the most recent project under Japanese ODA Loan, West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project, this issue was not so serious because almost of land has already acquired.

JICA provided technical assistance on this issue through the Project on Capacity Enhancement of Environmental and Social Considerations for Resettlement. Under this project, Basic Resettlement Procedures (BRP) was established in March 2012. The result of this technical assistance project is

very helpful for the NR 5 project. It is expected that the land acquisition and resettlement will be implemented smoothly after experiencing the North Section and South Section.

14.1.2 Internal Approval Procedures

In the JCPPR, the development partners indirectly pointed this issue. There are two major points; delay in decision making and insufficient capacity of staff regarding the project implementation procedures.

For the Japanese ODA loan projects, not only the decision in project executing agency but also that of MEF is necessary. Sometimes the final decision needs long time because of the long decision making line in the authorities.

On the side of MPWT, It is necessary for MPWT staff to familiarize themselves with the procedures of project implementation under Japanese ODA loan.

Also, provision of a procurement specialist by JICA, if implemented, is expected to be effective to assist MPWT in approval procedure.

14.2 Procurement Stage

The delays in procurement procedures was also pointed out in the JCPPR. JCPPR identified four issues; enhancing procurement capacity, strengthening governance and building capacity of staff in public procurement, strengthening and streamlining procurement oversight and monitoring, ensuring reasonableness and reliability of cost estimates. In case of Japanese ODA Loan projects, two issues among the issues, enhancing procurement capacity and strengthening and streamlining procurement oversight and monitoring are important points.

JCPPR proposed some measures for this issue. The main points are; strengthening and streamlining the Procurement Review Committee and the quality control of procurement document. It is recommended that JICA consider the following measures:

(i) Use of Sample Procurement Documents prepared by JICA

(ii) Procurement Seminars to not only MPWT but also Procurement Review Committee members including representatives of MEF.

<u>Employment of Competent Consultant and Good Contractor</u>

In the procurement stage, most important thing is to employ competent consultant and good contractors. Competent consultants and good contractors, in many cases, can prevent many risks, such as poor work quality, delay in progress and cost overrun, from occurring.

To recruit a good consultant, weight of financial proposal in the evaluation of proposal with QCBS needs to be as small as possible. In case of consultant services, low price becomes possible only with low-priced experts who often do not have required skill/knowledge/experience.

Offering large-size contract packages is generally believed to be one of practical measures for

employing good contractors. In addition to this, diligent prequalification and bid evaluation are also important. However, it is a fact that there have been several cases in the past where contractors with poor ability were employed. Employment of a competent consultant can prevent to certain extent the problem caused by a contractor with poor capacity.

14.3 Construction Stage

In the construction stage, the development partners including JICA faced some delay and difficulties. The major problems are insufficient quality of civil works and construction safety.

14.3.1 Construction Quality Control

Quality control is utmost important aspect in road construction/rehabilitation. However, MPWT has suffered in the past from substandard quality and consequent premature deterioration of roads which resulted in unexpectedly high maintenance cost and hindrance to traffic. Figure 14.3-1 shows examples of roads where quality is poor.



Photo 1: NH48 Near Koh Kong (in 2010)



Photo 2: NH7 Near Kratie (in Apr., 2009)

Figure 14.3-1 Examples of Road with Poor Quality

The JICA Team considers employment of competent consultant and good contractors is the key to successful quality management. The followings are possible measures for employing good contractors:

(1) Packaging

In order to attract qualified international constructors, the most important point is the size of contract. It is recommended to make the size of procurement package as much as possible.

(2) Local Competitive Bidding

In order to keep the quality of civil works, it is recommended to avoid LCB except for small package. As pointed out in the JCPPR, in Cambodia, the capacity of local constructor is still limited.

(3) Two-Envelope Bidding

In order to select qualified international contractor, it is necessary to use Two-Envelop Bidding following the JICA guidelines. The specification for and evaluation of technical proposal are important points.

14.3.2 Construction Safety

Here the term construction safety refers to two kind of safety; safety of workers and safety of the third party which is traffic and people around the work site.

It is one of the main concerns of JICA in Japanese loan projects that projects are implemented without accidents. Construction safety tends to be given little attention, if not neglected, in many developing countries. However, with rapid socioeconomic development, safety is becoming one of the important issues. Thus, diligent attention needs to be given to this aspect.

Examples of measures for enhancing safety may include the following:

(i) Detailed specification for safety measures in bidding documents

(ii) Strict condition in technical specification on the experience on construction safety

(iii) Continuous training and seminars for MPWT staff, such as the "Seminar on Safety Management and Quality Management of Infrastructure Projects in Cambodia" on Feb. 21, 2011, organized by JICA

(iv) Use of result of study on Construction Safety Management of ODA Projects implemented by the Overseas Construction Association of Japan, Inc. (OCAJI)

Competent consultant and good contractors usually can considerably contribute to both types of safety for worker and third party because good site management is the base of such safety. It should be noted that safety measures often needs some cost. Thus, cost for required safety measures need to be reflected in the cost estimation.

14.4 Operation and Maintenance Stage

14.4.1 Budget for Operation and Maintenance

In 2010, maintenance budget was increased from USD 32.8 million in 2009 to USD 35.8 million (9% increased). This budget will be allocated for the maintenance of the following structures:

1. Routine Maintenance USD 17.9 Million

1.1 National and provincial road (A/C) USD 7.9 Million

1.2 National and provincial road (Laterite) USD 5.9 Million

1.3 Traffic inspection USD 0.1 Million

1.4 Culvert construction at key infrastructure USD 4.0 Million

2. Periodic Maintenance USD 15.0 Million
3. Emergency maintenance USD 2.9 Million

However, the above budget is not sufficient for the maintenance works. So far, the large scale maintenance and improvement works have been financed by Development Partners' assistance. This Project is to improve the pavement type of NR 5 from DBST to AC, and is expected to reduce annual maintenance cost. However, rehabilitation of AC pavement becomes necessary every 10 years in usual practice and MPWT needs to prepare relatively large fund for this pavement rehabilitation.

14.4.2 Traffic Safety

This Project is to widen the carriageway of existing NR 5 and separate slow traffic, such as motorcycles and Motorumoks, and high-speed traffic, such as passenger cars. As a result, the chances of traffic accidents are expected to be reduced in general.

On the other hand, there is a possibility that some pedestrians cannot respond to the increased speed of vehicles, especially that of high-speed vehicles, and may commit miss judgment when crossing the road and hit by a vehicle. Thus it is recommended that campaign to raise awareness of roadside residents against increased vehicle speed be implemented as the road improvement approach to completion. Also so-called '3Es' (engineering, education and enforcement) should be practiced.

14.4.3 Enforcement against Overloaded Trucks

It is widely known that overloaded trucks severely damage pavement. Thus, enforcement against overloaded trucks is indispensable to secure expected life period of pavement and achieve expected project benefit.

The locations of weighing station on National Road No.5 are;

(i) Lung Vek (Kampong Chhnang 048+000),

(ii) Kleang Moeung (Pursat 191+800),

(iii) Anlung Vil (Battambang 282+000), and

(iv) Koun Domrei (B. Meanchey 389 + 000).

Inclusion of renewal and addition of weighing stations in the Project f the South Section is being discussed between MPWT and JICA Fact-Finding/Appraisal Mission and it is expected that the cost of renewing/adding weighing station be included in the Project Cost. Effective operation of these weighing stations is expected to substantially reduce overloaded trucks. MPWT should continue its effort, with cooperation of traffic police, for effective operation of weighing stations.

CHAPTER 15 ENVIRONMENTAL AND SOCIAL CONSIDERATION

15.1 Legal, and Administrative Framework

15.1.1 Legal Framework

(1) Law on Environmental Protection and Natural Resource Management

"Law on Environmental Protection and Natural Resource Management (Preah Reach Kram / NS - RKM - 1296/36)" was enacted in November, 1996 and is the main legal instrument in governing the environmental protection and natural resource management in Cambodia. The purposes are as follows:

- To protect and promote environmental quality and public health through the prevention, reduction, and control of pollution,
- To assess the environmental impacts of all proposed projects prior to the issuance of a decision by the Royal Government of Cambodia (RGC),
- To ensure the rational and sustainable conservation, development, management, and use of the natural resources of the Kingdom of Cambodia,
- To encourage and enable the public to participate in environmental protection and natural resource management,
- To suppress any acts that cause harm to the environment.

The Article 6 and 7 in the Chapter 3 of the above law regulate environmental impact assessment system in Cambodia.

Article 6:

"An environmental impact assessment (EIA) shall be conducted on every project and activity of the private or public, and shall be approved by the Ministry of Environment before being submitted to the RGC for decision. This assessment shall also be conducted for existing activities that have not yet been assessed for environmental impacts. The procedures of the process for environmental impact assessment shall be defined by sub - decree following a proposal of the Ministry of Environment. The nature and size of the proposed projects and / or activities (proposed and existing) both private and public, that shall be subject an environmental impact assessment which shall be defined by sub - decree following a proposal of the Ministry of Environment"

Article 7:

"All investment Project Applications and all proposed State projects shall be subject to an initial Environmental Impact Assessment and / or Environmental Impact Assessment as specified in article 6 of this law. The Ministry of environment shall review and provide recommendations on the initial Environmental Impact Assessment and / or environmental impact assessment to the competent bodies within period determined by the Law on Investment of the Kingdom of

Cambodia."

(2) Sub - Decree on Environmental Impact Assessment Process

"Sub - decree on Environmental Impact Assessment Process (Anukret / 72 ANK - BK / 11 Aug 99)" was prepared in August, 1999. The main objectives of this sub - decree are as follows:

- To determine an Environmental Impact Assessment (EIA) process for every private and public project or activity. The assessment shall be reviewed by the Ministry of Environment prior to submission to the RGC for a decision.
- To determine the type and size of the proposed private and public projects and activities, including existing and ongoing activities subject to the process of EIA.
- To encourage public participation in the implementation of the EIA process and take into account their input and suggestions in the process of project approval.

EIA requirements for proposed projects are mentioned in the Chapter 3 of the described above Sub - Decree (Article 6 ~ 13).

Article 6:

"A Project Owner must conduct Initial Environmental Impact Assessment (IEIA) in order to comply with the EIA requirement as stated in the annex of this sub - decree."

Article 8:

"A Project Owner must apply to the MOE for reviewing their full report of EIA report and Feasibility Study, in case a project tends to cause a serious impact to the natural resources, ecosystem, health and public welfare."

Article 11:

"A Project Owner must cover all the fee's services for reviewing and monitoring upon their project. These service fees shall be approved by the Ministry of Economy and Finance (MEF) following the proposal of the MOE. The said fee shall be incorporated into the national budget."

According to this sub - decree, the types of projects and criteria for mandating IEIA / EIA are stipulated as summarized in Table 15.1-1. National Road construction project with length over 100 km is required an IEIA or EIA. Therefore, this project needs to conduct the IEIA or EIA.

Table 15.1-1 List of Projects and its Criteria Required IEIA / EIA in Cambodia

No.	Type and Activities of Projects	Size / Capacity
A.	INDUSTRIAL	
B.	AGRICULTURE	
C.	TOURISM	
D.	INFRASTRUCTURE	
1.	Urbanization development	All sizes
2.	Industrial zones	All sizes
3.	Construction of bridge - roads	> = 30 Tones weight
4.	Buildings	Height > = 12 m or floor > = 8,000 m^2

No.	Type and Activities of Projects	Size / Capacity
5.	Restaurants	> = 500 Seats
6.	Hotels	> = 60 Rooms
7.	Hotel adjacent to coastal area	> = 40 Rooms
8.	National road construction	> = 100 Kilometers
9.	Railway construction	All sizes
10.	Port construction	All sizes
11.	Air port construction	All sizes
12.	Dredging	> = 50,000 m^3
13.	Damping site	> = 200,000 people

Source: Sub - Decree on Environmental Impact Assessment Process (1999)

(3) General Guideline for Conducting Initial and full Environmental Impact Assessment Reports

"Prakas (Declaration) on General Guideline for Conducting Initial and Full Environmental Impact Assessment Reports" was prepared in September, 2009 and guides the preparation of IEIA (Initial Environmental Impact Assessment) or EIA (Full Environmental Assessment) report for the project owner.

(4) Protected Area Law

"Protected Area Law" was enacted in January 2008. This law defines the framework of management, conservation and development of protected areas. The objectives of this law are to ensure the management, conservation of biodiversity, and sustainable use of natural resources in protected areas.

(5) Sub - Decree on Water Pollution Control

"Sub - Decree on Water Pollution Control (No:27 ANRK.BK)" was prepared in April 1999. The purpose of this sub - decree is to regulate the water pollution control in order to prevent and reduce the water pollution of the public water areas so that the protection of human health and the conservation of bio - diversity should be ensured.

(6) Sub - Decree on Solid Waste Management

"Sub - Decree on Solid Waste Management (No:36 ANK - BK)" was enacted in April, 1999. The purpose of this sub - decree is to regulate solid waste management in a proper technical manner and to provide safety precautions in order to ensure the protection of human health and the conservation of biodiversity.

(7) Sub - Decree on Control of Air Pollution and Noise Disturbance

"Sub - Decree on Control of Air Pollution and Noise Disturbance (No:42 ANK - BK)" was enacted in June, 2000. The purpose of this sub - decree is to protect the quality of the environment and public health from air pollutants and noise disturbance through monitoring, curbing and mitigating activities.

(8) JICA Guidelines

JICA has prepared "Guidelines for Environmental and Social Considerations, April 2010" as the referential guidelines for environmental and social considerations. According to the guidelines, JICA classifies development projects into four categories with regards to the extent of environmental and social impacts, and taking into account the outlines, scale, site and other conditions. The four categories are as follows:

- Category A: Proposed projects are likely to have significant adverse impacts on the environment and society.
- Category B: Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects.
- Category C: Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
- Category FI: A proposed project is classified as Category FI if it satisfies all of the followings:
  - JICA's funding of JICA - REDP is provided to a financial intermediary or executing agency;
  - The selection and appraisal of the components is substantially undertaken by such an institution only after JICA's approval of the funding, so that the components cannot be specified prior to JICA's approval of funding (or project appraisal); and
  - Those components are expected to have a potential impact on the environment.

NR 5 Improvement Project (Thlea Ma'am and Battambang section and Sri Sophorn – Poipet section) to be implemented is classified as "Category A".

15.1.2 EIA Schedule

According to Sub - decree on EIA Process, NR 5 Improvement Project needs to conduct the EIA study and EIA report needs approval of the Ministry of Environment (MOE). Figure 15.1-1 shows general flow of approval of IEIA / EIA.

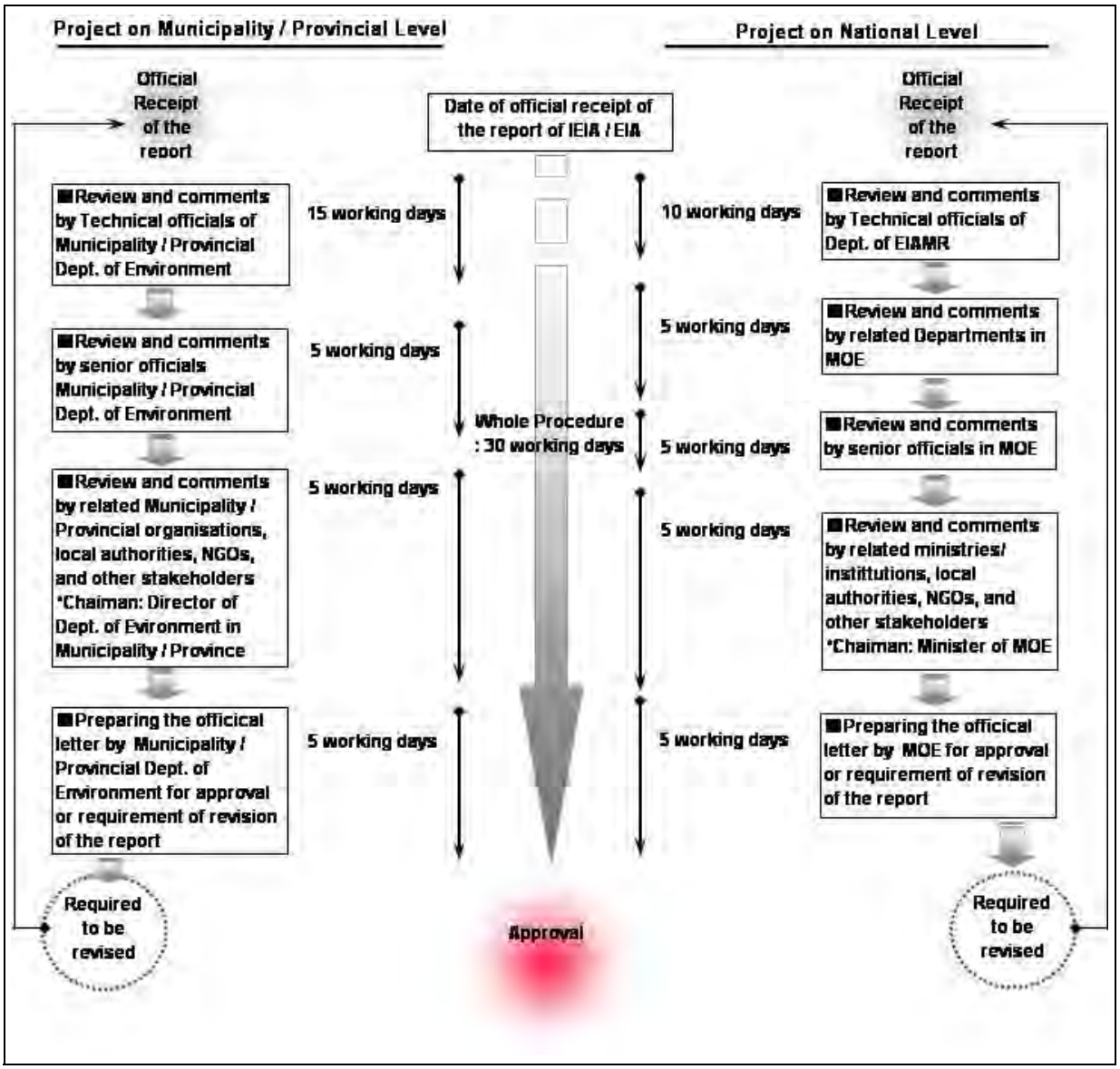


Figure 15.1-1 IEIA / EIA Approval Procedure

Table 15.1-2 shows the schedule of EIA study for this Survey:

Table 15.1-2 Tentative Schedule of EIA Procedure

Year	2013							2014					
Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan ~ May	Jun	Jul	Aug	Sep	Oct
Contract with EIA Consultant	▲												
Literature and Field Survey, EIA Study and Reporting by Consultant		▬	▬	▬									
Meeting with MOE (1)	▲												
Holding of public meetings			▲										
Fixing on conceptual alignment			▲										
Submission of First Draft EIA Report to JICA Survey Team					▲								
Review of First Draft EIA by JICA Survey Team						▬							
Additional Survey by Consultant in Dry Period							▬						
Submission of Draft EIA Report to JICA Survey Team									▲				
Review of Draft EIA by JICA Survey Team									▬	▬			
Meeting with MOE (2)											▲		
Submission of Final EIA Report to MOE											▲		
Review of EIA report by MOE												▬	
Approval on EIA report												▲	

The procedure for Initial EIA will be skipped.
JICA Survey Team will conduct Full EIA form the beginning.

15.1.3 Institutional Framework

The Department of Environmental Impact Assessment (DEIA) in MOE and Municipality / Provincial Department of Environment (DE) are in charge of review and making comment on the IEIA or EIA report of public / private project each on national level and municipality / provincial level following the general guidelines. MOE and Municipality / Provincial DE are also responsible to prepare the official letter for approval or require the project's owner for revision of the IEIA or Full EIA report. Figure 15.1-2 to 15.1-3 show organizational structure of DEIA in MOE and Provincial / Municipal Environmental Department (PMED), respectively.

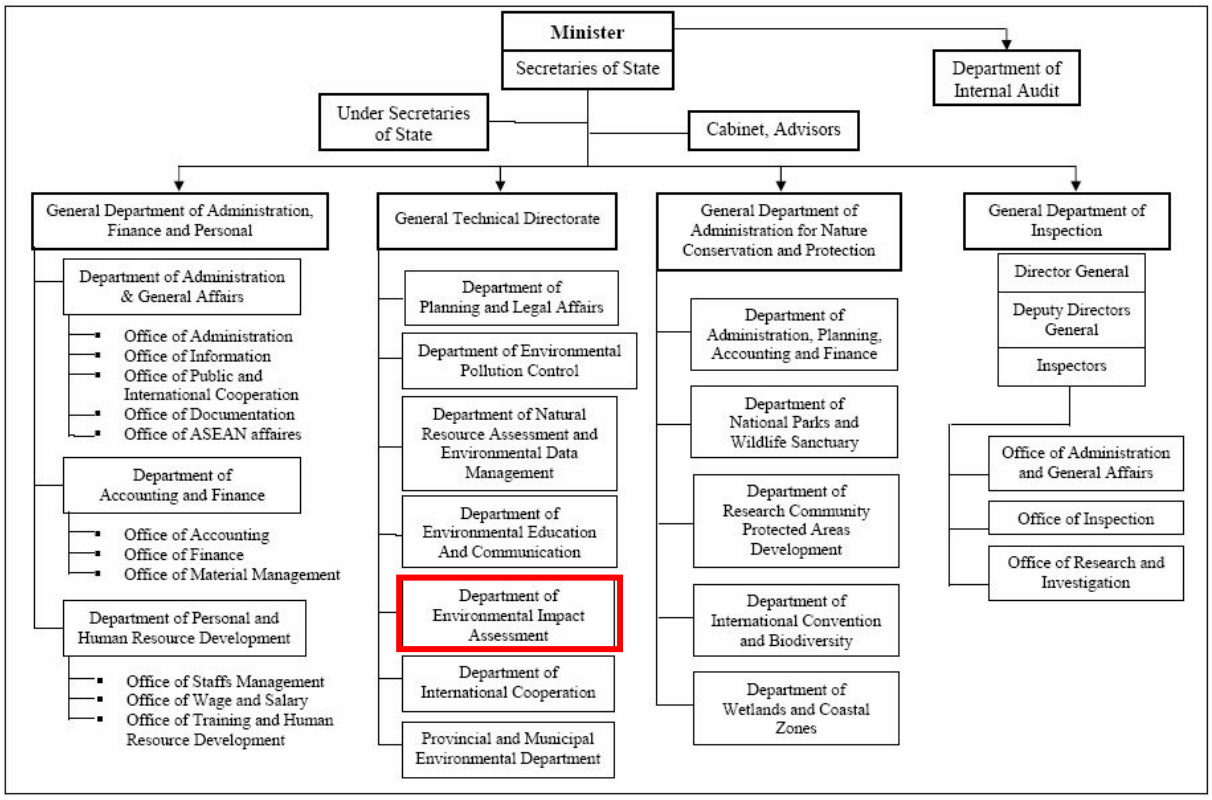


Figure 15.1-2 Organization Chart of MOE

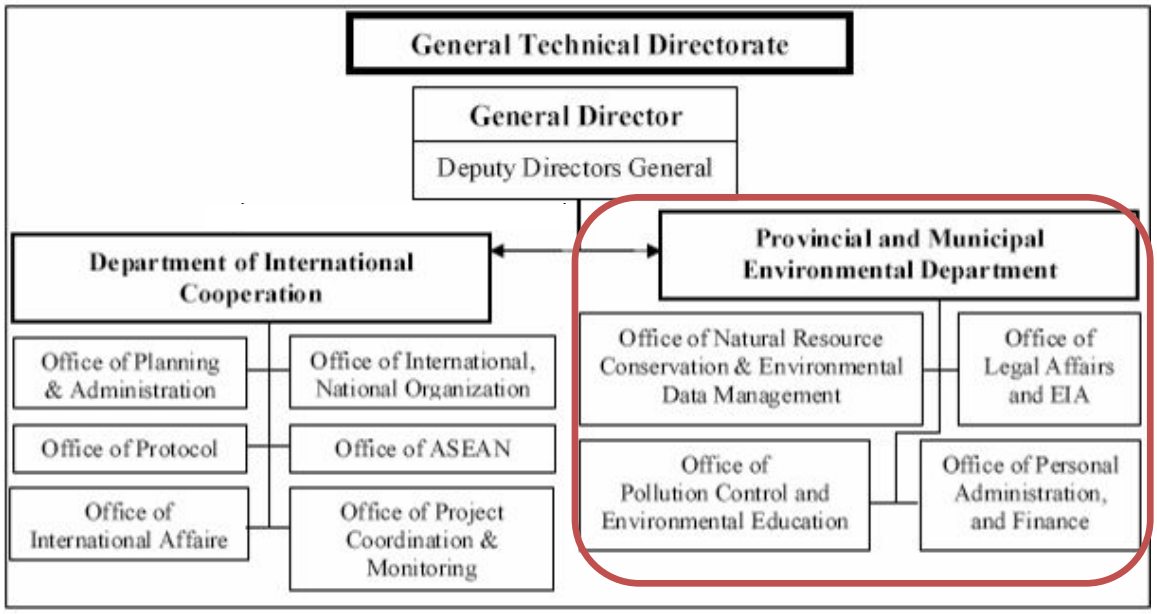


Figure 15.1-3 Organizational Structure of PMED

15.1.4 Environmental Standard

(1) Air Quality

Sub - Decree on Air and Noise Pollution Control (1999) provides the maximum allowable limits for ambient air pollutants.

Table 15.1-3 Ambient Air Quality Standard in Cambodia

No.	Parameter	1 Hour Average mg/m^3	8 Hour Average mg/m^3	24 Hour Average mg/m^3	1 Year Average mg/m^3
1	Carbon monoxide (CO)	40	20	-	-
2	Nitrogen dioxide (NO_2)	0.3	-	0.1	-
3	Sulfur dioxide (SO_2)	0.5	-	0.3	0.1
4	Ozone (O_3)	0.2	-	-	-
5	Lead (Pb)	-	-	0.005	-
6	Total Suspended Particulate (TSP)	-	-	0.33	0.1

Source: Sub - Decree on Air and Noise Pollution Control (2000), Annex 1

(2) Noise

Sub - decree on Air and Noise Pollution Control (2000) provides the maximum allowance of noise level in public and residential area.

Table 15.1-4 Maximum Permitted Noise Level in Public and Residential Area (dB(A))

No.	Area	Period of time		
		From 6:00 to 18:00	From 18:00 to 22:00	From 22:00 to 6:00
1	Quiet areas - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential area: - Hotels - Administration offices - House	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

Remark: This standard is applied to control of noise level of any source of activity that emitted noise into the public and residential area.

Source: Sub - Decree on Air and Noise Pollution Control (2000), Annex 6

(3) Water Quality

Table 15.1-5 to 15.1-6 show Cambodian standards for water quality in public water areas for bio - diversity conservation. Table 15.1-7 shows the water quality standard for discharging water into public water areas.

Table 15.1-5 Water Quality Standard for Bio - Diversity Conservation (for River)

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 - 8.5
2	BOD5	mg/l	1 - 10
3	Suspended Solid	mg/l	25 - 100
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform6	MPN / 100 ml	< 5,000

Source: Sub - Decree on water pollution control (1999), Annex 4

Table 15.1-6 Water Quality Standard for Bio - Diversity Conservation

(for Lakes and Reservoirs)

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 - 8.5
2	COD	mg/l	1 - 8
3	Suspended Solid	mg/l	1 - 15
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN / 100 ml	< 1,000
6	Total Nitrogen	mg/l	1.0 - 0.6
7	Total Phosphorus	mg/l	0.005 - 0.05

Source: Sub - Decree on water pollution control (1999), Annex 4

Table 15.1-7 Standard for Discharging Wastewater into Public Water Area

No.	Pollutant	Unit	Allowable Limit	
			Protected Public Water	Public Water Area & Sewer
1	Temperature	Degrees C	< 45	< 45
2	pH	-	6 - 9	5 - 9
3	BOD5 (5 days at 20°C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 50	< 80
6	Total Dissolved Solids	mg/l	< 1,000	< 2,000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO_3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulfate (as SO_4)	mg/l	< 300	< 500
14	Sulfide (as Sulfur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO_4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0
18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (Bo)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr^{+3})	mg/l	< 0.2	< 1.0
25	Chromium (Cr^{+6})	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 1.0

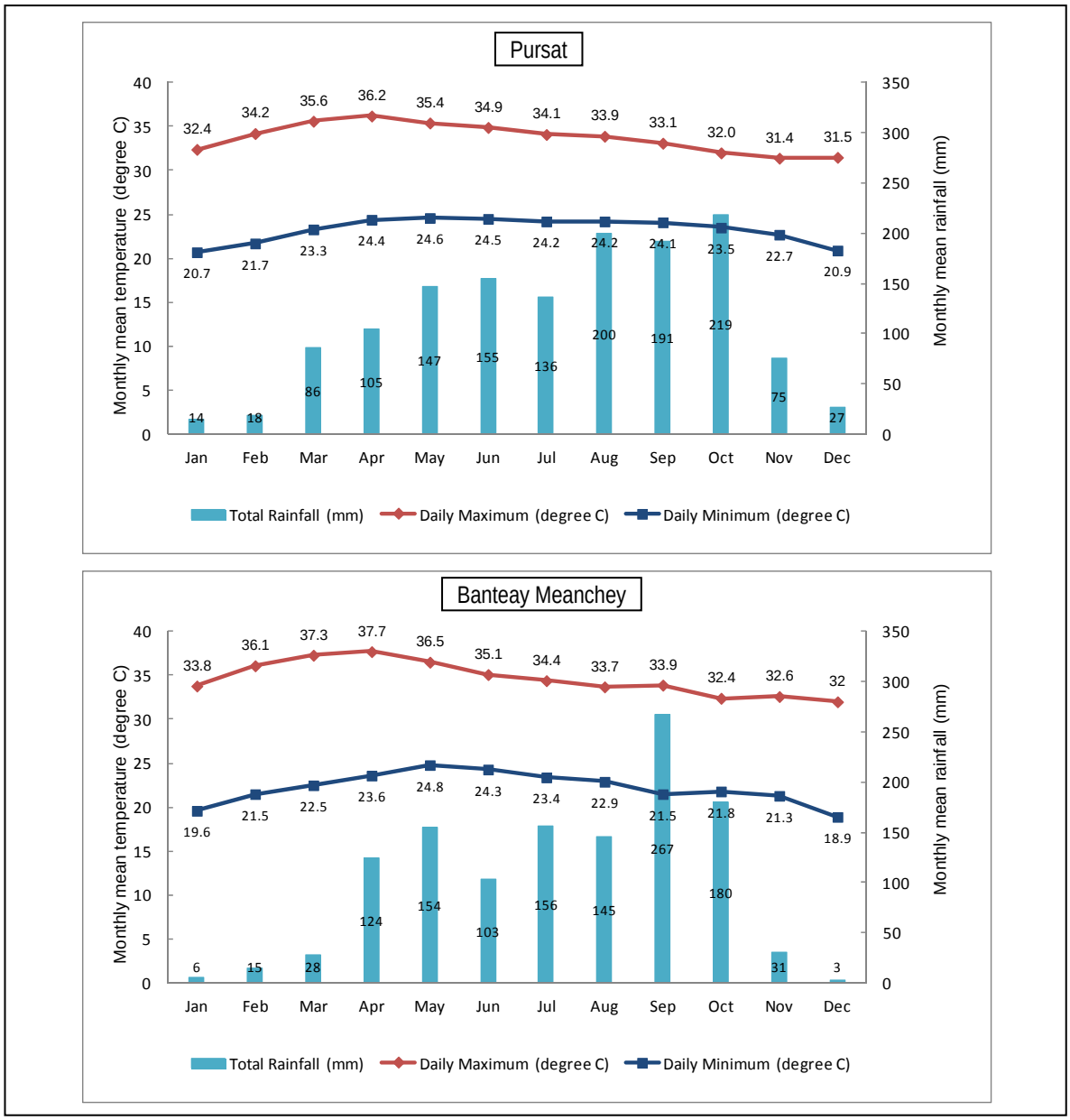
No.	Pollutant	Unit	Allowable Limit	
			Protected Public Water	Public Water Area & Sewer
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH_3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	> 2.0	> 1.0
36	Polychlorinated Biphenyl	mg/l	< 0.003	< 0.003
37	Calcium	mg/l	< 150	< 200
38	Magnesium	mg/l	< 150	< 200
39	Carbon Tetrachloride	mg/l	< 3	< 3
40	Hexachloro Benzene	mg/l	< 2	< 2
41	DDT	mg/l	< 1.3	< 1.3
42	Endrin	mg/l	< 0.01	< 0.01
43	Dieldrin	mg/l	< 0.01	< 0.01
44	Aldrin	mg/l	< 0.01	< 0.01
45	Isodrin	mg/l	< 0.01	< 0.01
46	Perchloro Ethylene	mg/l	< 2.5	< 2.5
47	Hexachloro Butadiene	mg/l	< 3	< 3
48	Chloroform	mg/l	< 1	< 1
49	1,2 - Dichloro Ethylene	mg/l	< 2.5	< 2.5
50	Tricholoro Ethylene	mg/l	< 1	< 1
51	Trichloro Benzene	mg/l	< 2	< 2
52	Hexachloro Cyclohexene	mg/l	< 2	< 2

Source: Sub - Decree on water pollution control (1999), Annex 2

15.2 Natural Environment

15.2.1 Climate

The Project Area is located in tropical monsoon zone. The climate consists of dry season and rainy season. The dry season is from November to March. During dry season, monsoon wind blows from the north bringing cold air from Siberia. Rainy season is from April to October. During rainy season, wind blows from southwest of country bringing moisture from Indian Ocean and make rainfall which is vital for agricultural activities. The annual difference in temperature is a narrow range of 4 ~ 5 degrees Celsius.



(13 years period (2000-2012) in Pursat and 10 years period (2003-2012) in Banteay Meanchey)

Source: Department of Meteorology of Ministry of Water Resources and Meteorology

Figure 15.2-1 Monthly Mean Temperature and Rainfall

15.2.2 Land Use and Forest Area

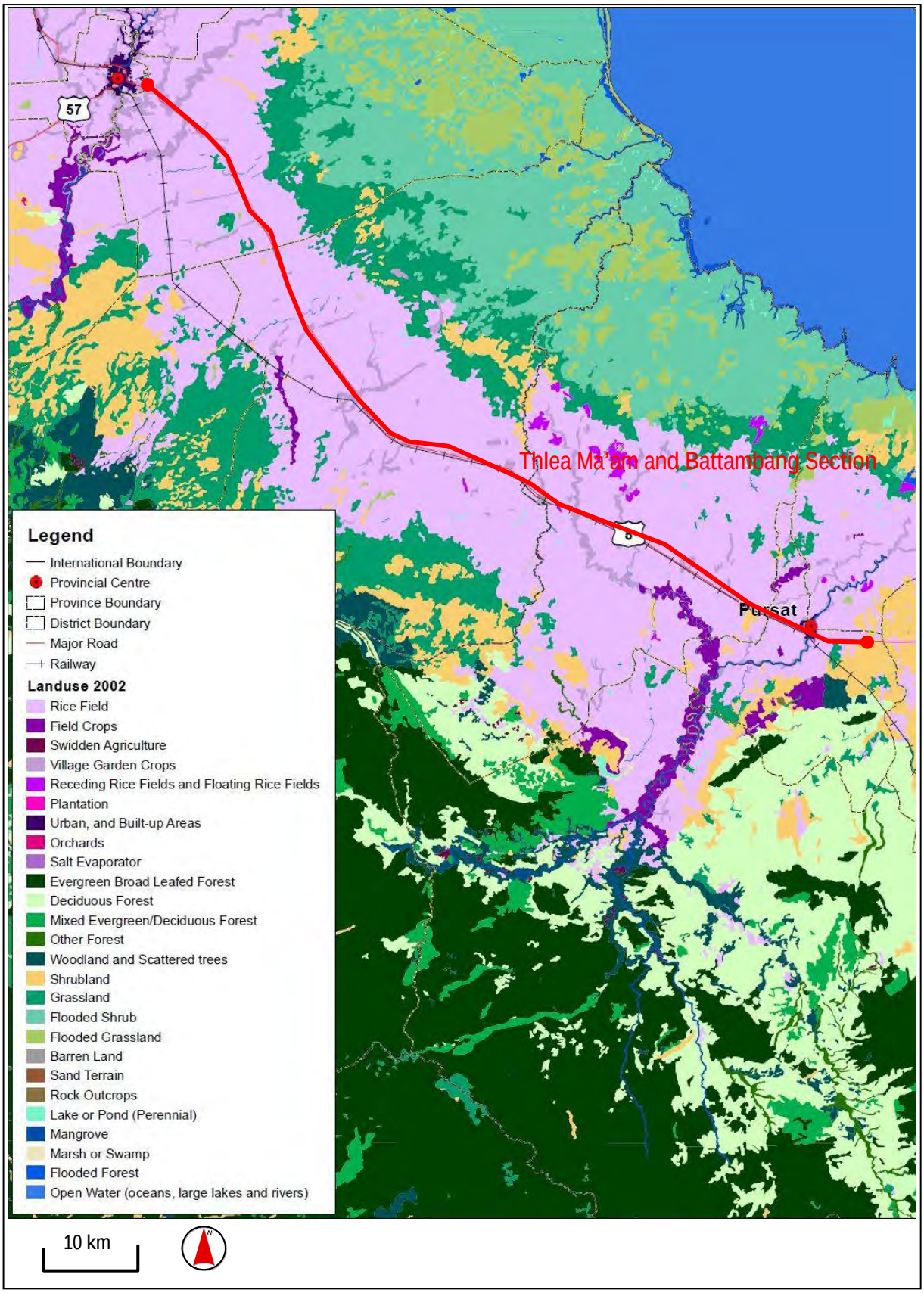
The land use around the project area is mostly agricultural land such as rice field, and vegetable and fruit farm. The other areas are urban build-up areas. There are no forest areas including Community forests along the project area. Flooded forest zone with 10 ~ 30 km width exists around Tonle Sap lake located to the east of NR 5. The distance between NR 5 Thlea Ma'am and Battambang Section and the flooded forest zone is approximately 7 km at the nearest point, and the interval area is agricultural land. There are no flooded forest zone around Sri Sophorn – Poipet Section.

Community forests:

Community forests are defined by "Sub-Decree (No: 79 Or Nor Krar. Bor Kar) on community forestry management, 2003". Forestry Administration is the main implement organization of the sub-decree. Community forests are state forests subject to an agreement to manage and utilize the forest in a sustainable manner between the Forestry Administration and a local community or organized group of people living within or nearby the forest area that depend upon it for subsistence and customary use.

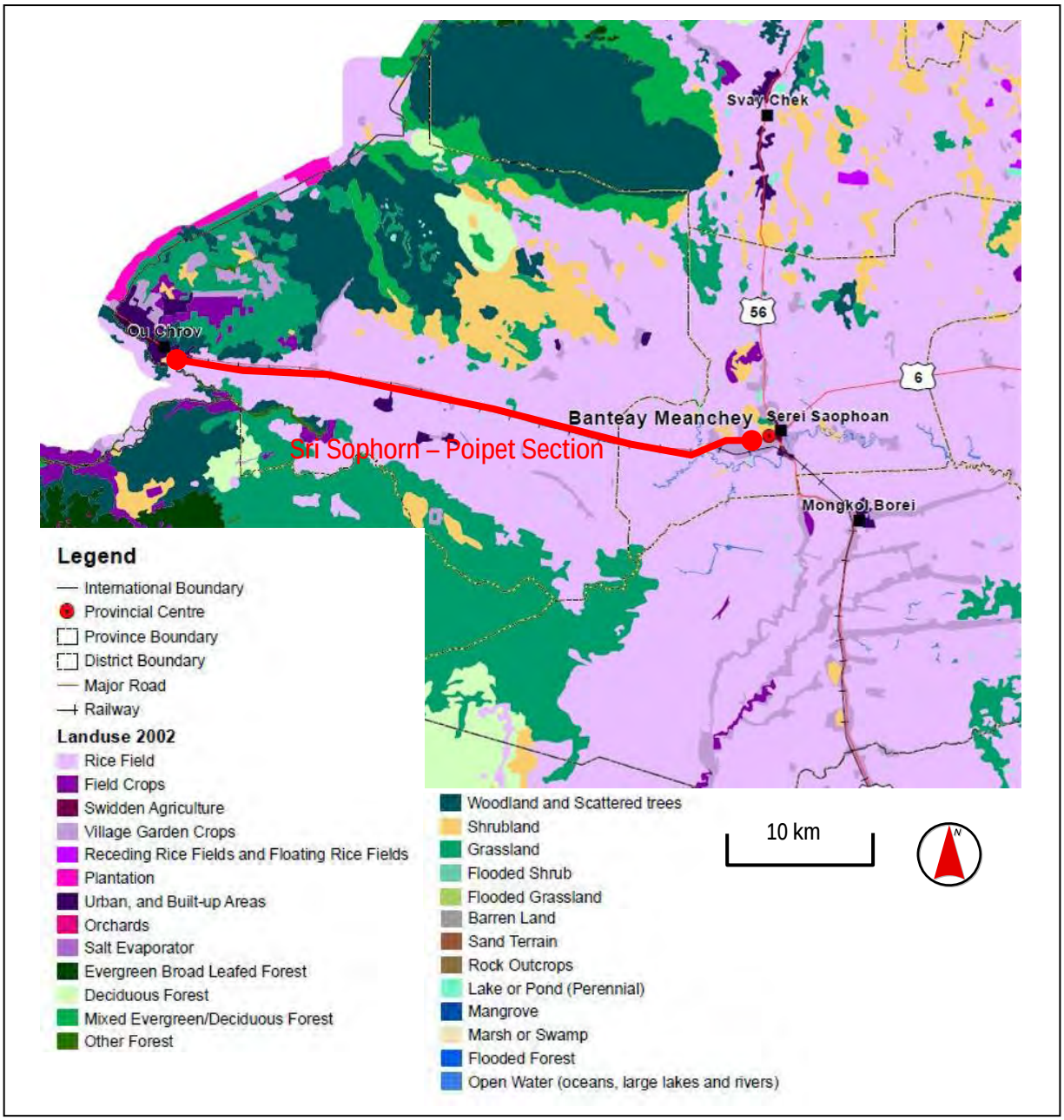
Flooded forest:

The flooded forest is defined by "Sub-decree (Prakas No. 197) on flooded forest, 2011" as a protected forest. Provincial governments and Tonle Sap Authority are the main implement organizations of the sub-decree. The forest has 647,406 hectares of ecologically-rich flooded forest surrounding Tonle Sap lake. The forest is protected against damaging activities caused by excessive exploitation, shifting cultivation, imports of harmful forest vegetation and wildlife species, and so on.



Thlea Ma'am and Battambang Section

Figure 15.2-2 Land Use around Project Area (1)



Sri Sophorn – Poipet section

Source: The Atlas of Cambodia National Poverty and Environment Maps 2007

Figure 15.2-3 Land Use around Project Area (2)



Source: Open Development Cambodia

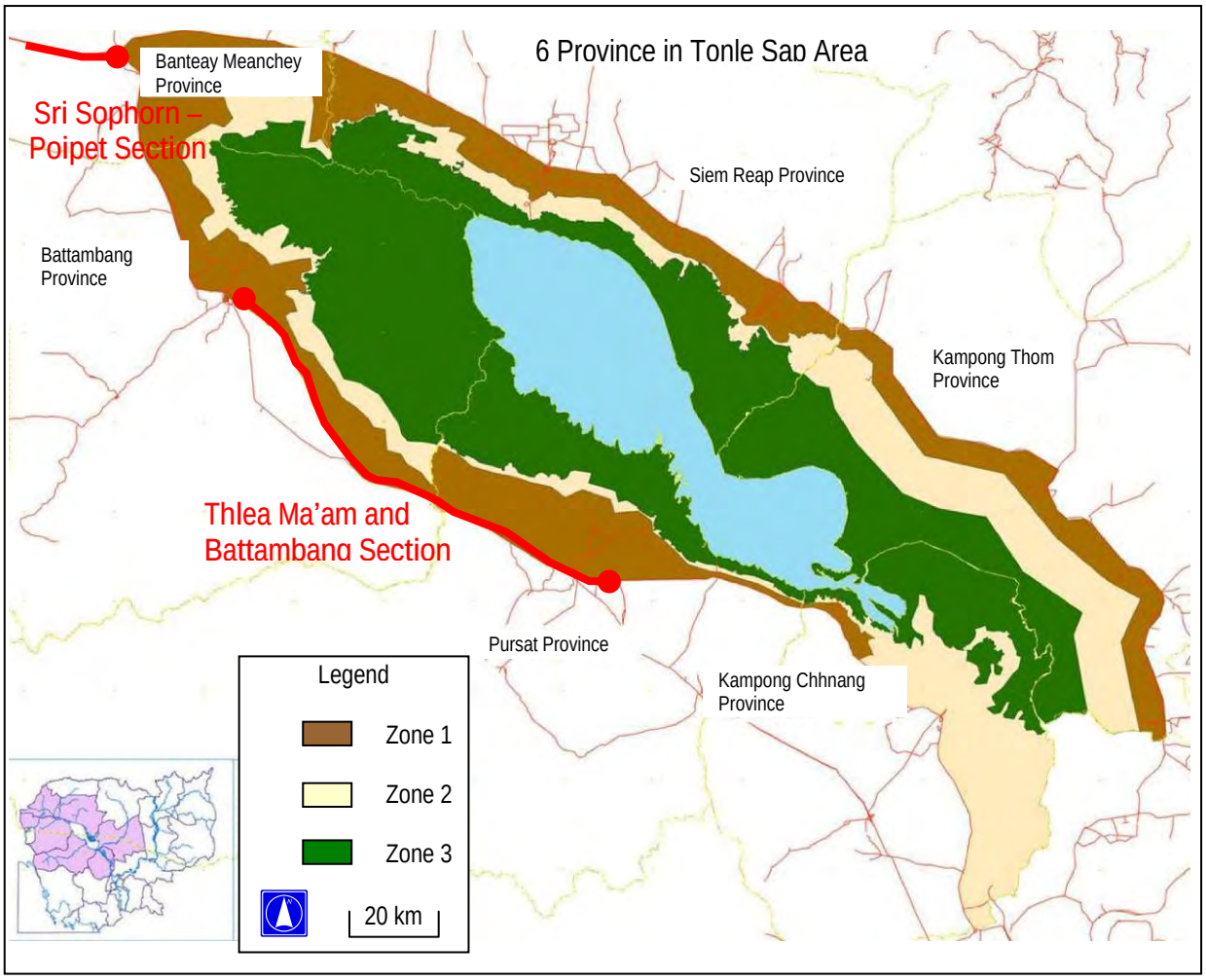
Figure 15.2-4 Flooded Forest around Project Area

Tonle Sap Authority has been classified Tonle Sap Area into three land use zones based on the geographical and hydrological characteristics. The zone 1 and 2 are for agricultural development while the zone 3 is the conservation zone to be fully protected. The middle section of NR 5 runs alongside the line of the zone 1, but does not pass through the zone 2 and 3. The project area including the proposed bypass section is located along or in the zone 1, the agricultural zone, where construction of some physical infrastructures is allowed.

Zone 1 (417,451 ha) : Human habitation and irrigation activity are allowed.

Zone 2 (365,300 ha) : No activity is allowed except irrigation activity.

Zone 3 (642,794 ha) : Strictly protected area



Source: Tonle Sap Authority

Figure 15.2-5 Land Use Classification of Tonle Sap Area

15.2.3 Protected Area

In Cambodia, protected conservation areas cover around 4.6 million hectares. There are 7 national parks, 10 wildlife sanctuaries, 3 protected landscape areas, 3 multiple use management areas and 7 protected forests (Source: Cambodia Environment Outlook 2009).

In general, Right of Way (ROW) and its surrounding area of NR 5 has been already cultivated and developed for human activities with variety of land use form such as agricultural land, residential area, commercial spots, and so on. Therefore, the target sections of NR 5 do not pass through protected areas for natural environment. However, the middle section runs alongside the line of transition zone in "Tonle Sap Biosphere Reserve (TSBR)" that covers Tonle Sap Lake, the largest fresh water lake in Southeast Asia, and its surrounding flood plain and is recognized as a worldwide important zone for sustainable use and conservation of wildlife, and research and educational ground.

In the meeting held between the officials of the Ministry of Environment (MOE) and the JICA Survey Team confirmed that the ROW (30 m width) of NR 5 is defined as the outside of TSBR.

The proposed Pursat Bypass will pass through the transition zone of TSBR. Development activities are not prohibited in the transition zone by related regulations. The Minister of Ministry of water resources and meteorology who also holds the chairperson of Tonle Sap Authority (TSA) that coordinates the management of TSBR has issued the official letter to the proposed Pursat Bypass construction. The letter suggests considerations for the existing irrigation systems and conservation of present water flow as the conditions. As a result, other additional environmental approvals on TSBR are not required for implementation of the project.

Tonle Sap Biosphere Reserve (TSBR):

Tonle Sap Biosphere Reserve was established for the following objectives by "Royal-Decree on The Establishment and Management of Tonle Sap Biosphere Reserve, 2001".

1. Conserve biodiversity, landscape, land shape and ecosystem, including genetic resources, plant, fish and animal species, and restore the biological environment and habitat.
2. Support sustainable ecological, environmental, economic, social and cultural development.
3. Support activities, including implementation of demonstration projects, training, research, and surveys to monitor the environmental changes, in relation to sustainable development and conservation at local, national, and international levels.

The reserve is approximately 1.4 million hectares, designated by UNESCO in 1997 and includes the lake and most of the surrounding area bordered by NR 5 and 6. TSBR is managed by several organizations including TSA, Cambodia National Mekong Committee, MOE and 6 provincial governments. "Tonle Sap Biosphere Reserve Policy Analysis and Secretariat Action Plan, 2005" was prepared as a strategic plan in "Tonle Sap Environmental Management Project" supported by ADB. Moreover, UNDP conducted "Tonle Sap Conservation Project" with the aim of building management capacity for biodiversity conservation in TSBR from 2004 to 2011.

TSBR has been classified into the core area, buffer zone and transition zone. MOE is responsible for the conservation of natural environment and modification of zoning.

Core Area: The core areas are defined likewise national park or wildlife sanctuary, which are devoted to long term protection and conservation of natural resources and ecosystem, in order to preserve flooded forest, fish, wildlife, hydrological system, and natural beauty. MOE is responsible for the management and preparation of protection and conservation plan for the core areas. There are 3 core areas, Boeng Chhmar (14,560 ha), Preak Torl (21,342 ha) and Stung Sen (6,355 ha), in TSBR. These core areas are listed in "Protected Area Law, 2008". The distance between the middle section and the core areas is approximately 30 km at the nearest point.

Buffer Zone (541,482 ha): The buffer zone is subject to experimental research and discovery of method for the management of flooded forest, fishery, agriculture, housing settlement, land use, water resources, navigation and tourism to ensure their

sustainability, increased production, while preserving the environmental quality and fish. Its boundary corresponds to the outer boundary of the Tonle Sap Multiple-Use Area.

Transition Zone (899,600 ha): The flexible transition area is the integrated economic zone, which is managed for the sustainable agriculture, human settlement and land uses, without having adverse effects on the flooded forest, water quality and soils of the region around the Tonle Sap Lake. The area is limited between the outer boundary of the buffer zone and NR 5, and NR 6.

Conflicts about the use of natural resources due to population and development pressure are the main cause for all existing major environmental threats. The major environmental issues in TSBR are as follows:

- Loss of fishery resources due to over fishing and use of destructive and illegal fishing practices
- Clearance of flooded forest due to agricultural development and increase in demand for fuel-wood by local people
- Water contamination due to increase in domestic wastewater, especially around Siem Reap area
- Increase in erosion and sedimentation due to forest cover decline

Considerable development projects have not been conducted in the buffer zone along NR 5 in recent years. The specific environmental management plans for the transition zone are not implemented in irrigation system rehabilitation projects in the transition zone of Pursat Province and a road drainage improvement project in the transition zone of Kampong Chhnang Province. However, ecological issues owing to the construction works have not identified.

Tonle Sap Multiple-Use Area (316,250 ha):

Multiple-Use Area is defined by "Protected Area Law, 2008" and has the following objectives:.

1. Protect and maintain biodiversity and long-term natural value of the area.
2. Promote management for responding to the objective of generating sustainable products.
3. Protect the base of natural resources to prevent diversion of land use in the form that cause threats to the biodiversity of the area.
4. Contribute to the national and local economy and development.

MOE is responsible for the management. The Multiple-Use Area is an area in land and/or water territories, which is rich in natural resources that are intact and require management activities to ensure long-term protection and maintenance of biological resources and ecosystem. In the meantime, it provides natural products and services for use to meet the community needs. The outer boundary of the Tonle Sap Multiple-Use Area corresponds to the boundary of TSBR

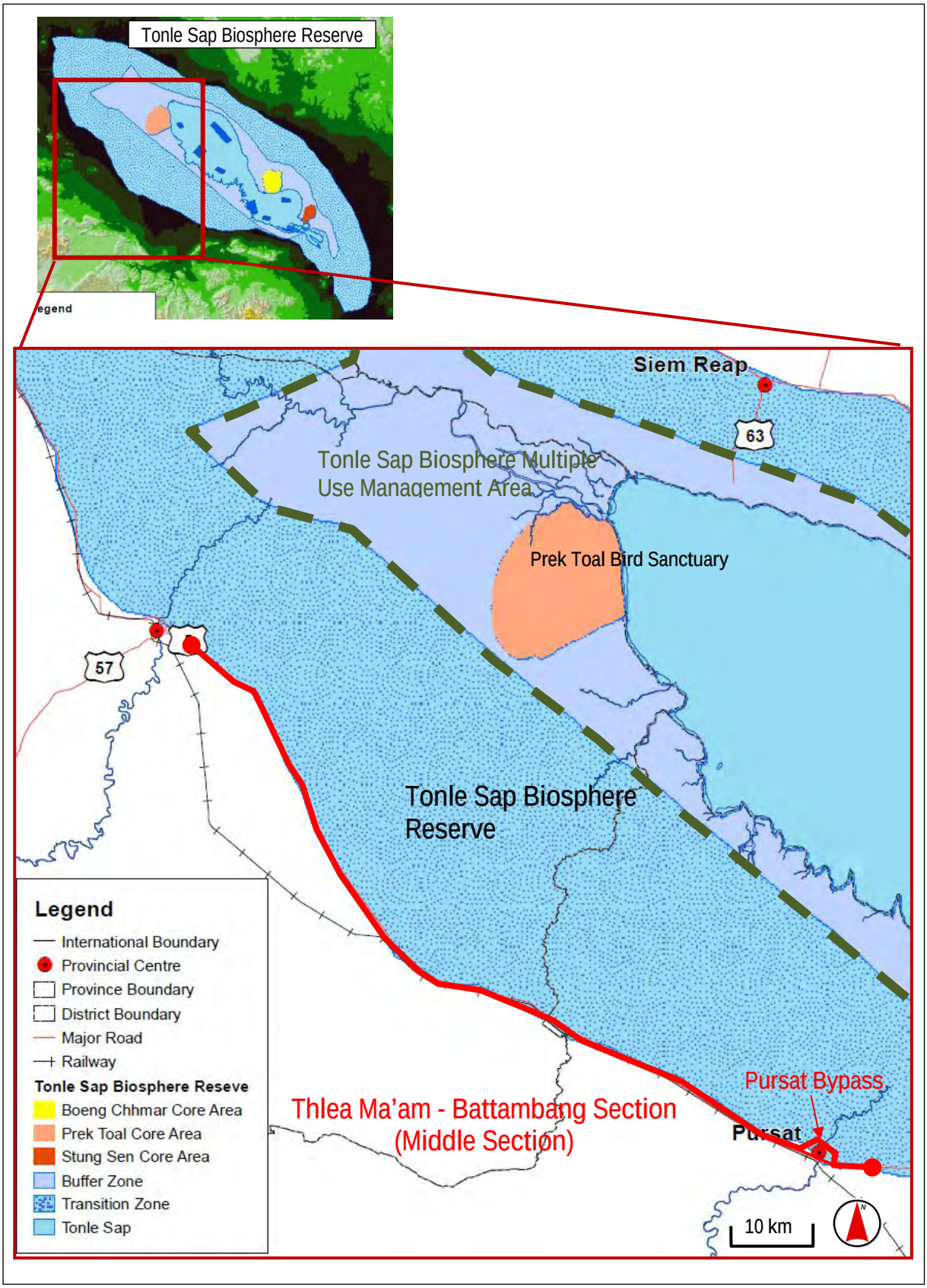
Buffer Zone. The distance between the middle section and Tonle Sap Multiple-Use Area is approximately 20 km at the nearest point.

Roniem Daun Sam Wildlife Sanctuary (40,021 ha):

Wildlife Sanctuary is defined by "Protected Area Law, 2008" and has the following objectives:

1. Protect and maintain the conditions of necessary habitats for living species, particularly important wild animals that require management interventions.
2. Serve the scientific research and environmental surveillance fields with the purpose of sustainably managing the natural resources inside and outside the area.
3. Serve public education and understanding of the interdependency of relevant habitats and wildlife management.
4. Eliminate and prevent illegal use and occupation of any part of the area.
5. Provide people, especially the local community living in the wildlife sanctuary, with benefits at a level that can ensure compatibility with other management objectives.

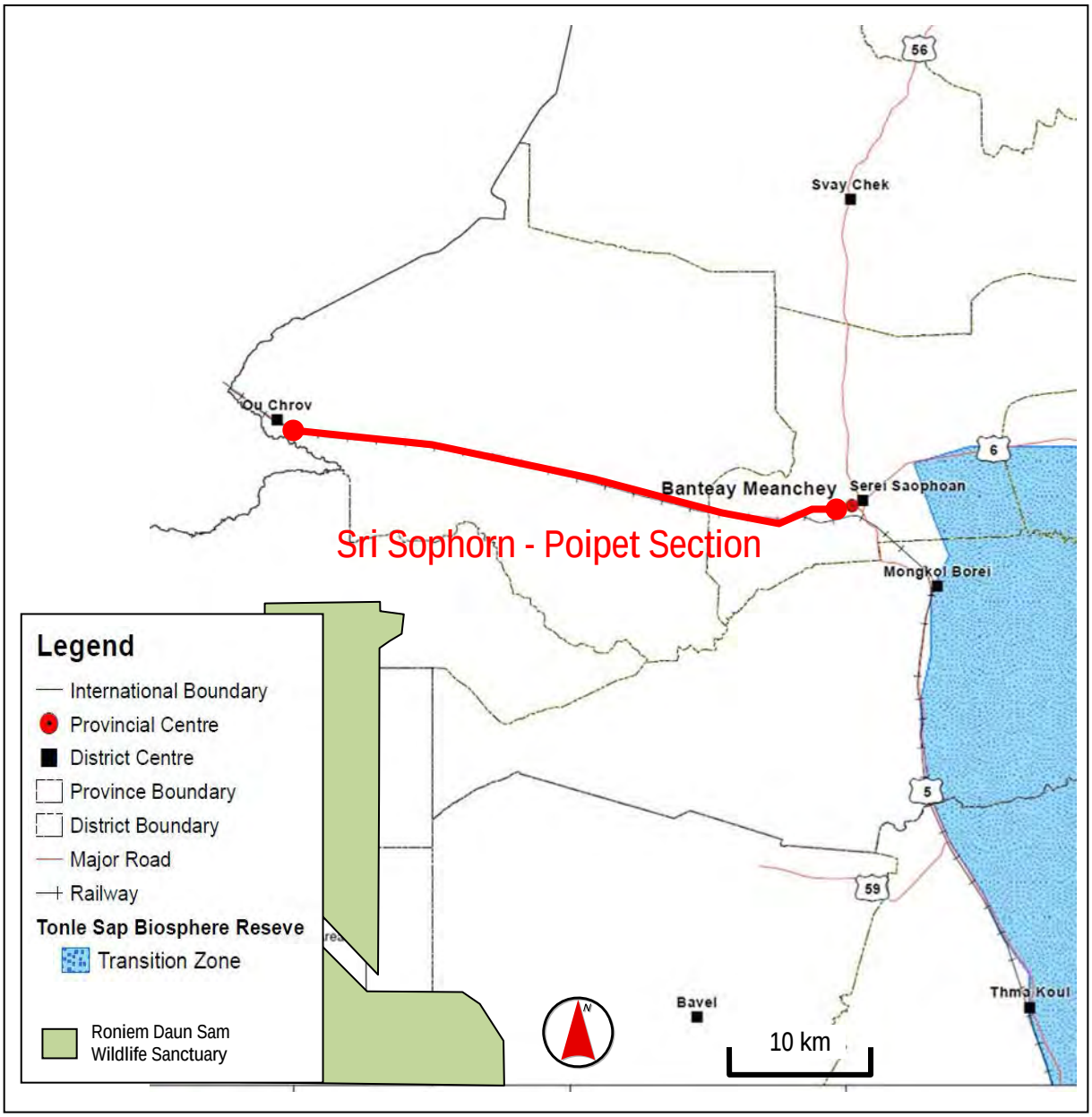
MOE is responsible for the management. The Wildlife sanctuary is an area in land and/or water territories, which requires active interventions for management purposes to ensure maintenance of habitats and/or to meet necessary conditions for any species of animals or plants. The hilly or mountainous areas in Roniem Daun Sam Wildlife Sanctuary are lowland evergreen or semi-evergreen forest, and habitats of pileated gibbon (*Hylobates pileatus*) as "Endangered species" in IUCN red list. The distance between Sri Sophorn - Poipet Section and Roniem Daun Sam Wildlife Sanctuary is approximately 10 km at the nearest point. The land use between NR 5 and the sanctuary is mostly paddy field.



Thlea Ma'am and Battambang Section

Source: The Atlas of Cambodia National Poverty and Environment Maps 2007

Figure 15.2-6 Protected Area around Project Area (1)



Sri Sophorn – Poipet Section

Source: The Atlas of Cambodia National Poverty and Environment Maps 2007

Figure 15.2-7 Protected Area around Project Area (2)

The core areas of TSBR and Roniem Daun Sam Wildlife Sanctuary are located in the outside of the direct impact extent.

15.2.4 Ecosystem

(1) Methodology

Ecosystem survey consisted of 1. Literature search, 2. Field investigation and 3. Interview survey. Because the project area is not ecological sensitive areas, the useful existing literature on fauna and flora is few.

Identification of Land Use

- Air photo (Resolution 1 m to 3 m, 2008)
- GIS Datasets of Forest Administration (2002 and 2006, scale 1:1,000,000)

Field Investigation Period

- Middle Section : July (Rainy Season) and December (Dry Season), 2013
- SP Section : August (Rainy Season) and December (Dry Season), 2013

Field Investigation Area

150 m both sides of the target road sections

- Middle Section (Thlea Ma'am - Battambang) : KP 171 to KP 281+200 (10.13 ha)
- Sri Sophorn - Poipet Section (SP Section) : KP 366+250 to KP 402 (0.43 ha)

Vegetation Survey within Corridor of Impact

20 m both sides of the target road sections

- Middle Section (Thlea Ma'am - Battambang) : KP 171 to KP 281+200 (3,384 ha)
- Sri Sophorn - Poipet Section (SP Section) : KP 366+250 to KP 402 (1,074 ha)

Interview Survey on Wildlife Species

- Interview to 1 to 2 representative person(s) each village and a Commune Councilor who know well wildlife in and surrounding the project area

Fishery Resource Survey

- Surveyed rivers and water bodies are as follows:

Middle Section

- Pursat River (from Damnak Ampil Dam to Cha Reuk irrigation building, about 34 km long)
  - Survey Area 1: From Damnak Ampil hydraulic structure to Svay Meas village (Upstream of the project area)
  - Survey Area 2: From Koh village to Spean Thmor village (Upstream of the project area)
  - Survey Area 3: From Spean Thmor village to Kampong Krabei village (The project area)
  - Survey Area 4: From Svay Laoung village to Boeung Chhuk village (Downstream of the project area)
- Svay Daun Keo River
- Maung River
- Chork River
- Sandas Stream

SP Section

- Sri Sophorn River (from Teuk Thla bridge to Preah Ponlea bridge, about 11 km long)
  - Survey Area-1: From Teuk Thla village to Pro Hoth village along the river with 7 km long
  - Survey Area-2: From Rong Machine village to Preak Russei village with about 5 km long
- Agricultural canals

- Survey periods are as follows:
  - Middle Section : July, August (Rainy Season) and November, December (Dry Season),

2013

- SP Section : August, September (Rainy Season) and November, December (Dry Season), 2013

➢ Number of fisherperson interviewed or met with are as follows:

- Middle Section Detailed Interview : 4 persons, Meeting : 223 households, equal to 14.75% of total 1,612 households in the survey area
- SP Section Detailed Interview : 2 persons, Meeting : 53 households, equal to 12.86% of total 412 households in the survey area

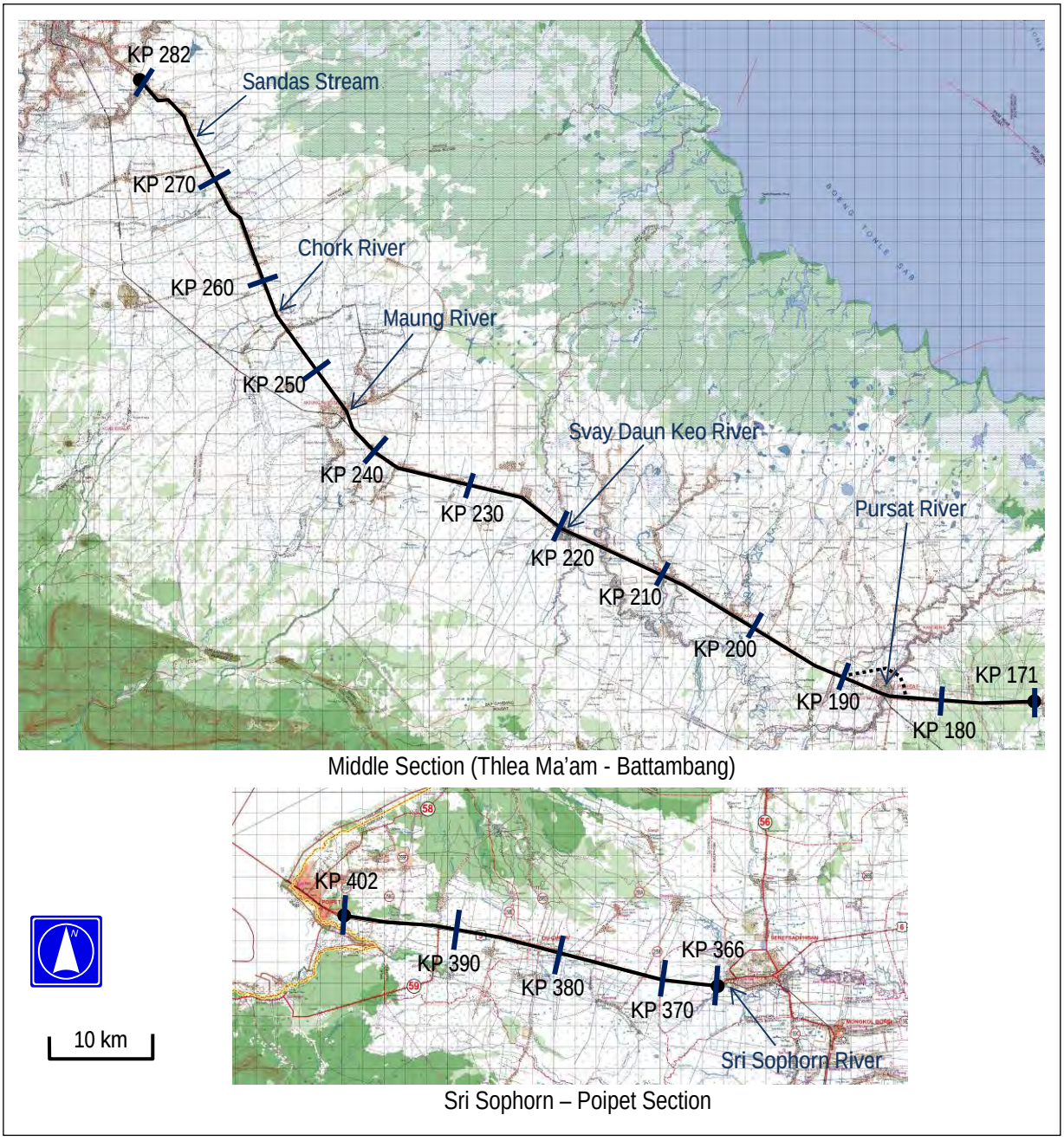


Figure 15.2-8 Location of Surveyed River/Steam and Main Kilometer Post (KP)

(2) Vegetation

Land use of around the project area is mostly agricultural area, mainly paddy field and residential area. There are no forest areas along the target road sections. Therefore, natural vegetation is few or nothing along the road side. The vegetation within the Corridor of Impact (20 m + 20 m width) where the vegetation may be lost due to the construction works, is divided into 1. Roadside tree planted by local forest administrations, 2. Riverside vegetation re-grown in inundated zone, 3. Agricultural plant and 4. Garden plant in private houses.

(a) Middle Section

Roadside Tree

Total 30 species of the roadside trees were identified in Middle section. The total number were 5,210 trees (diameter from 10 cm to 130 cm), 2,621 trees at the northeast side and 2,589 trees at the southwest side or 1,233 trees in Pursat province and 3,977 trees in Battambang province. Earleaf acacia (*Acacia auriculiformis*) is the most popular species and 37% of the total number.

Table 15.2-1 Species and Total Number of Roadside Tree in Middle Section

	Scientific Name	Number		Scientific Name	Number
1	*Sindora cochinchinensis*	1	16	*Eucalyptus camaldulensis*	701
2	*Leucaena glauca Benth.*	5	17	*Schleicheria trijuga, Wi*	4
3	*Delonix regia, (Boj. Ex Hook)*	875	18	*Eugenia sp.*	84
4	*Mitragyna hirsuta Hav.*	6	19	*Tectona grandis L. f.*	1
5	*Feroniella lucida Scheff.*	10	20	*Bombax ceiba L.*	1
6	*Dialium cochinchinensis*	52	21	*Barringtonia acutangula*	12
7	*Ceiba pentandra, (L.) G*	59	22	*Cassia fistula*	268
8	*Swietenia macrophylla King*	3	23	*Combretum quadrangulare Kurz*	37
9	*Butea monosperma (Lam.)*	55	24	*Azadirachta indica*	8
10	*Terminalia catappa L.*	38	25	*Streblus asper Lour.*	4
11	*Morinda citrifolia*	2	26	*Cassia siamea*	11
12	*Borassus flabellifer*	136	27	*Sesbania grandiflora*	7
13	*Dipterocarpus obtusifolou*	2	28	*Acacia auriculiformis, A.*	1,956
14	*Lagerstroemia floribunda*	2	29	*Samanea saman*	786
15	*Peltophorum ferrugineum*	77	30	(Unknown)	7
				Total number of roadside tree	5,210

Riverside Vegetation

Streams, ditches and canals normally found a small riverside vegetation located in inundated zone are as below:

- Ou Srang Thom stream from KP-177+177 to KP-177+263, in Boeng Kantuot Commune and Tnaot Chum Commune;
- Srang Touch stream from KP-177+177 to KP-177+263, in Boeng Kantuot Commune

and Tnaot Chum Commune;

- Svay Art Channel from KP-190+727 to KP-190+785, in Snam Preah Commune;
- Canals along both of the road sides, from KP-248+580 to KP-252+938 and from KP-254+252 to KP-255+121 in Moung Commune, Kear Commune and Kakaoh Commune.

36 species were identified at roadside streams and ditches in Middle section .

Table 15.2-2 Species of Riverside Vegetation in Middle Section

	Scientific Name		Scientific Name
1	*Xanthophyllum glancam*	19	*Zizyphus jujube*
2	*Dalbergia herrida, Var.glabrescens*	20	*Phyllanthus lasodiifolius*
3	*Euphorbia milii*	21	*Breynia rhamnoides*
4	*Cynometra (inaequifolia)*	22	*Hymnocardia wallichii*
5	*Cassia alata, L.*	23	*Barringtonia asiatica*
6	*Combretum trifoliatum*	24	*Cratoxylum cochinchinese*
7	*Phragmites karka Trin*	25	*Ficus racemosa*
8	*Ixora cuneifolia, varians*	26	*Tertracera indica*
9	*Hydrolea zeylanica*	27	*Cayratia trifolia*
10	*Albizia myriophylla*	28	*Merremia hederacea*
11	*Uvaria rufa*	29	*Derris trifolia*
12	*Bridelia ovata, var. Curtisis*	30	*Antidesma ghaesembilla Gaertn.*
13	*Maclura conchinchinensis*	31	*Zizyphus oenoplia mill*
14	*Mimosa pigra Fabaceae*	32	*Passiflora foetida Passifloraceae*
15	*Mimosa pisdica*	33	*Azadirachta indica Meliaceae*
16	*Mitragyna hirsuta Hav.*	34	*Streblus asper Lour. Moraceae*
17	*Croton caudatus*	35	*Sesbania grandiflora*
18	*Schleichera oleosa (Lour) Oken*	36	*Gmelina asiatica*

(b) Sri Sophorn - Poipet Section

Roadside Tree

Total 32 species of the roadside trees were identified in SP section. The total number were 1,034 trees (diameter from 10 cm to 100 cm), 619 trees at the northeast side and 415 trees at the southwest side. Earleaf acacia (*Acacia auriculiformis*) is the most popular species and 30% of the total number.

Table 15.2-3 Species and Total Number of Roadside Tree in Sri Sophorn - Poipet Section

	Scientific Name	Number		Scientific Name	Number
1	*Delonix regia, (Boj. Ex Hook)*	28	17	*Eucalyptus camaldulensis*	23
2	*Mitragyna hirsuta Hav.*	1	18	*Schleicheria trijuga, Wi*	2
3	*Dalbergia entadoides Pierre*	3	19	*Ficus religiosa, L.*	14
4	*Ceiba pentandra, (L.) G*	30	20	*Eugenia sp.*	61
5	*Swietenia macrophylla King*	2	21	*Bombax ceiba L.*	3
6	*Butea monosperma (Lam.)*	5	22	*Ficus sp*	1

	Scientific Name	Number		Scientific Name	Number
7	*Terminalia catappa L.*	37	23	*Cassia fistula*	77
8	*Bauhinia acuminata*	1	24	*Combretum quadrangulare Kurz*	7
9	*Morinda citrifolia*	3	25	*Azadirachta indica*	1
10	*Borassus flabellifer*	14	26	*Pinus merkusii*	8
11	*Acacia intsii*	1	27	*Cassia siamea*	17
12	*Lagerstroemia floribunda*	1	28	*Sesbania grandiflora*	45
13	*Diospyros helferi*	1	29	*Acacia auriculiformis, A.*	311
14	*Peltophorum ferrugineum*	95	30	*Samanea saman*	206
15	*Dipterocarpus intricatus*	1	31	(Unknown 1)	31
16	*Pterocarpus pedatus*	2	32	(Unknown 2)	2
				Total number of roadside tree	1,034

Riverside Vegetation

The riverside vegetation was found at ditches and agricultural canals between KP 366+250 to KP 366+685 in Teuk Thla village, Teuk Thla Sangkat and Sri Sophorn Town.

24 species were identified at roadside streams and ditches in Sri Sophorn - Poipet section.

Table 15.2-4 Species of Riverside Vegetation in Sri Sophorn - Poipet Section

	Scientific Name		Scientific Name
1	*Xanthophyllum glancam*	13	*Zizyphus oenoplia mill*
2	*Mitragyna hirsuta Hav.*	14	*Passiflora foetida Passifloraceae*
3	*Dalbergia herrida, Var.glabrescens*	15	*Dalbergia nigrescens, Varsaigonensis*
4	*Raphanus sativus*	16	*Sesbania javanica*
5	*Samandura harmandii Pierre*	17	*Gmelina asiatica*
6	*Phragmites karka*	18	*(Stixis obusifolia)*
7	*Crateva andansonii Subsp odorata*	19	*Cayratia trifolia*
8	*Ixora cuneifolia*	20	*Merremia hederacea*
9	*Croton caudatus*	21	*Derris trifolia*
10	*Breynia rhamnoides*	22	(Unknown 1)
11	*Hymnocardia wallichii*	23	(Unknown 2)
12	*Barringtonia asiatica*	24	(Unknown 3)



Figure 15.2-9 Roadside Trees along NR 5

The details of roadside tree species and riverside vegetation are presented in Appendix 15-1.

(3) Mammal

(a) Middle Section

Five mammal species were identified in the project area. Lyle's Flying-fox in them is in the appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Moreover, Wroughton's Free-tailed Bat (Phnom Tbeang Bat) classified a rare species by Cambodian forest administration was identified in the project area. However, they just fly across the project area.

(b) Sri Sophorn - Poipet Section

Six mammal species were identified in the project area. Island Flying-fox in them is in the appendix of CITES II. However, this bat lives in temples such as Rattanak Nimit in Yeang Thmey village, Kob commune and just flies across the project area.

Species categorized in Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) of the International Union for Conservation of Nature (IUCN) Red List were not identified in both sections. The list of identified mammal species and distribution are presented in Appendix 15-2.

(4) Bird

(a) Middle Section

34 bird species were identified in the project area. Barn Owl and Black-shouldered kite in them are listed in Appendix II of CITES.

(b) Sri Sophorn - Poipet Section

38 bird species were identified in the project area. Barn Owl and Black-shouldered kite in them are listed in Appendix II of CITES.

Species categorized in CR, EN and VU of the IUCN Red List were not identified in both sections. The list of identified bird species and distribution are presented in Appendix 15-2.

(5) Reptile and Amphibian

(a) Middle Section

29 species of reptiles and amphibians were identified in the project area. Monocle Cobra classified a rare species by Cambodian forest administration and Indochinese Spitting Cobra in them are listed in Appendix II of CITES.

(b) Sri Sophorn - Poipet Section

30 species of reptiles and amphibians were identified in the project area. Monocle Cobra classified a rare species by Cambodian forest administration and Indochinese Spitting Cobra in them are listed in Appendix II of CITES.

Species categorized in CR, EN and VU of the IUCN Red List were not identified in both

sections. The list of identified reptile and amphibian species and distribution are presented in Appendix 15-2.



Natricinae snake: which was run over by car, its picture was taken on July 7, 2013



Striped Keelback which was run over by car, its picture was taken on August 20, 2013



Keeled Rat Snake which was run over by car, its picture was taken on August 9, 2013

Figure 15.2-10 Snakes Found on NR 5

(6) Fish

(a) Middle Section

97 fish species were identified in the selected four areas in Pursat river. Moreover, 56 species in Svay Doun Koe river, 54 species in Maung river, 61 species in Chak river and 57 species in Sandas stream were identified. The total identified fish species were 114 in project area. Finescale tigerfish (*Datnioides undecimradiatus*) in them classified a critically endangered species and Puntius tetrazona (*Systomus partipentazona*) classified an endangered species by "Sub decree No. 123 on Determination of Category/Type of Products and Endangered Fishery Products/Resources (August 12, 2009)" were identified in the project area.

Migration fishes are congested due to flood in rainy season, especially from the middle of July to the end of November when the water level during flooding is same as the height of regulator gates including hydraulic structure of Charoek regulator. Because of breeding and abundant food, the fishes migrate from Tonle Sap Lake to the upstream zone, especially along Pursat river.

In the flooding period, the fishermen always catch some fishes such as *Puntioplites falcifer*, *Mystus nemurus*, Siamese mud carp, Tiny scale barb, Trey krum, Black sharkminnow, Wallago, Goldfin tinfoil barb, Orangefin Loach, Giant snakehead, Toli shad and Spot pangaasius around project area.

On the other hand, some fish species such as *Hemibagrus filamentous*, Trey kame, Dusky face carp, Tinfoil barb, Red tinfoil barb, Waandersii's hard-lipped barb, *Osteochilus microcehalus* and Trey khcha move from the upstream to Tonle Sap Lake.

(b) Sri Sophorn - Poipet Section

91 fish species were identified in the selected two areas in Sisophon river. Moreover, 41

species in canals and 31 species in rice field were identified. The total identified fish species were 91 in project area. Thinlip barb (*Probarbus labeaminor*), Thicklipped Barb (*Probarbus labeamajor*) and Puntius Tetrazona (*Systomus partipentazona*) in them are classified endangered species by "Sub decree No. 123".

Migration fishes are congested due to flood in rainy season, especially from the middle of July to the end of November when the surface water inundate vegetation along rivers, canals and ponds. Because of breeding and abundant food, the fishes migrate from Tonle Sap Lake to the upstream zone. On the other hand, some fish species moving from the upstream to Tonle Sap Lake also exist.

Species categorized in CR of the IUCN Red List were not identified in both sections. Thicklipped Barb (*Probarbus labeamajor*) categorized in EN of the List was identified in Sri Sophorn river. Finescale tigerfish (*Datnioides undecimradiatus*) categorized in VU of the List was identified in Pursat and Svay Donkeo river. The list of identified fish species and distribution are presented in Appendix 15-2.

(7) Biodiversity and Ecosystem

The habitats for birds are mainly on trees in roadside, buildup or residential area, and rice fields. Riverside vegetation with small scale along rivers, streams and ditches are inundated by overflow water through rivers, streams and creeks from Tonle Sap Lake in rainy season and create habitats for reptiles and amphibians.

There are six types of land use along Middle Section and Sri Sophorn - Poipet Section.

1. Residential Area

This area is normal village area, not town or dense residential area. In this area, there are Khmer style houses (thatched house, wooden house with zinc roof and with tiles roof). Most of these houses are surrounded by rice fields and far away from each other. In the land around the houses, there are fruits, garden trees and vegetables planted by season. This area is green in rainy season, from the middle of May to February; when is also the season of farming and animals are not allowed to enter the rice field. For dry season, from February to May, the farmers always allowed animals to enter the fields. The animals pass over NR 5 especially in the morning (at 6:00 am to 9:00 am) and in the evening (at 5:00 pm to 6:00 pm) in this season. Main planted crops or trees are paddy rice, planted fruits such as mango, sugar palm, coconut, banana, jackfruit, milk fruit, lemon, grapefruit, guava and wood apple, and bamboo. There are some birds such as Eurasian tree sparrow, Spotted dove, Red collared dove, Yellow-vented bulbul, House sparrow and Common myna, Peaceful dove, Refescent prinia, pied Fantail, barn owl, and chickens and ducks raised by villagers in the some parts of this area. Also, reptiles or amphibian such as Chequered keelback, Common blind snake, Indochinese rat snake, Gloden tree snake, Paddy frog, frog (*Limnonectes ibanorum*), Common asian bullfrog and Common asian toad were found in the this area. Crabs and cockles also exist in this area.

2. Semi-Urban Area

This area has more people living in than Residential Area. Houses were built in plot of lands closely. The house types are similar to those in Residential Area, however, some houses were built by brick. This area is near the commune office or center. There are some local markets and day markets. In the lots of land, fruits and vegetables were planted depending on the seasons. The planted fruits are greener than those in Residential Area because of more water sources to supply (wells, ponds, pools, and water supply systems at some places). However, species of birds and reptiles are almost same as those in Residential Area.

3. Urban and Town Area

This area has many houses built closely together (wooden house with zinc roof, with a tile roof and brick house with one or more floors). There are a lot of people living in this area such as in Pursat city, Bakan district town, Maung Russei district town. Most of planted trees along the road sides are Khan-na (*Eucalyptus camaldulensis*), Acacia (*Acacia auriculiformis, A*), Rain tree (*Samanea saman*), golden shower tree (*Cassia fistula*), Calabura (*Muntingia calabura L.*). The road trees are one of habitats for birds. The shade areas under some big trees are occupied by shop's owners in the backyards as open booths. There are Eurasian tree sparrow, Spotted dove, Red collared dove, Yellow-vented bulbul, House sparrow, Common myna and Peaceful dove raised by villagers as bird species, and Chequered keelback , Gloden tree snake, Common asian bullfrog, Common asian toad as reptile or amphibian spaces in this area. Cats, dogs and cows also exist in this area.

4. Rice Field Area

This area has no any villager's house, only field guard huts. It is green in rainy season from the middle of May to February, the season of rice cultivation and harvesting, when animals are not allowed to enter rice fields. For dry season, from February to May, most farmers always allowed animals to enter the fields. The animals pass over NR 5 especially in the morning (at 6:00 am to 9:00 am) and in the evening (at 5:00 pm to 6:00 pm) in this season. Main planted crops or trees are paddy rice and fruits planted along bunds such as mango, sugar palm, tamarind, Krasaang, Snay, Sdau and Pring. Some limited areas are brush. This area has richer wildlife than those in three areas above mentioned. Reptiles or amphibians such as Chequered keelback, Blind snake , Indochinese rat snake, Indochinese spitting cobra, Monocled cobra, Russull's viper, Gloden tree snake, Natricinae snake, Keeled rat snake, Paddy frog, frog (*Limnonectes ibanorum*) and Common asian bullfrog were found in this area. Crabs and cockles also exist in this area. Fish in rice fields was rarely found, even though in the flooding time, because the farmers use chemical fertilizer, pesticides and chemical substance as weed killer, which are able to kill fishes and insects that are food for fishes in the rice fields.

5. Riverside Vegetation Area

This area is re-growing vegetation area, where plants are underwater in rainy season and

vegetative in dry season, in inundated zone around rivers, streams and ditches along NR 5. This area is in flood from the middle of June to middle of December. Most of wildlife found in the area are reptiles or amphibian such as Chequered keelback, Blind snake , Indochinese rat snake, Indochinese spitting cobra, Monocled cobra, Russull's viper, Gloden tree snake , Keeled rat snake, Green cat snake, Natricinae snake, Bocourt's water snake, Paddy frog, frog (*Limnonectes ibanorum*), Common asian bullfrog and Common asian toad. Crabs and cockles also exist in this area. This riverside vegetation is re-growing forests which are not vital habitat for fish and aquatic wildlife. The farmers always grow rice with chemical fertilizers, pesticides and chemical substance for killing weed grass and insects, which have extremely impact on young fishes and some insects that are food for fishes.



Figure 15.2-11 Riverside Vegetation along NR 5

6. Water Body Area

This area consist on rivers, lakes, ponds, canals, ditches and streams along NR 5 with culverts and bridges. Pursat River has sufficient flow in both rainy and dry seasons. But Svay Daun Keo River, Moung River, Chark River and Sandan stream do not have water flow in dry season, and the river water remains in some deep spots of river only. There were 97 fish species in Pursat river, 56 fish species in Svay Daun Keo river, 54 fish species in Moung river, 61 fish species in Chark river, 57 fish species in Sandan stream and 91 fish species in Sisophon river. There were some water plant species growing in water of the rivers and streams such as Creeping water primrose (*Ludwigia adscendens*), Water spinach (*Ipomoea aquatica*), Blue star water lily (*Nymphaea stelata*), Water mimosa (*Neptunia oleracae*), Water snowflake, Floating hearts (*Nymphoides indica*), Lotus (*Nelumbo nucifera)*, Water shamrock (*Marsilia quadrifolia*), Whitehead spike sedge (*Cyperus kyllingia nemoralis*) and Yeaplan plant, and alien species such as Water hyacinth (*Eichhornia crassipes*), Madagascar periwinkle (*Catharanthus roseus*), Egyptian white water-lily (*Nymphaea lotus*) and Taro or Eddoe (*Colocasia esculenta, Var.*

esculenta).

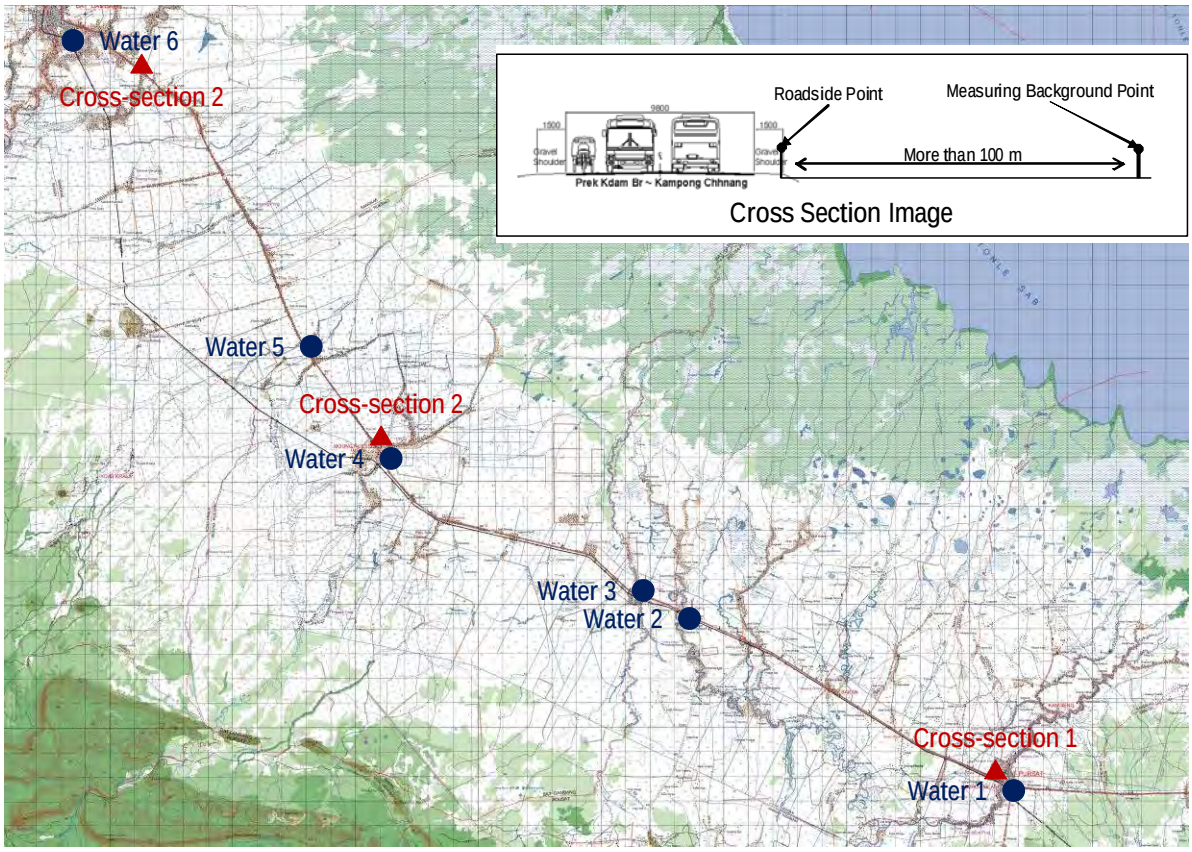
15.2.5 Environmental Quality and Pollution

(1) Scope of Survey

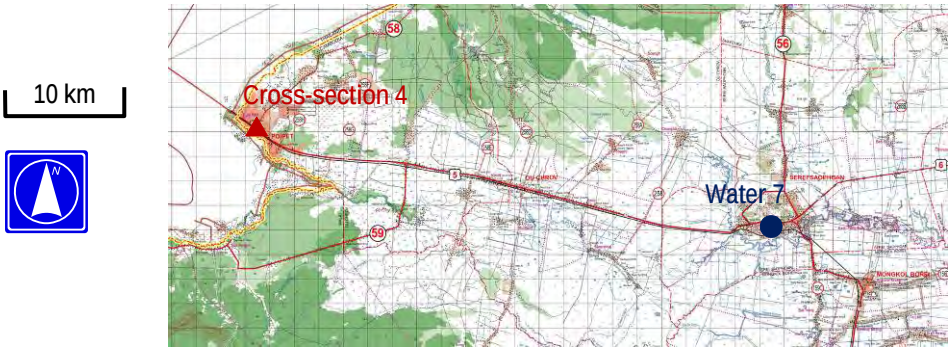
Environmental quality and pollution survey was conducted by a local consultant (Sawac Consultants for Development Ltd) in July and August as the rainy season survey, and December as the dry season survey, 2013. The survey method and location is shown in Table 15.2-5 and Figure 15.2-12.

Table 15.2-5 Survey Method of Environmental Quality and Pollution Survey

	Survey Items	Survey Time and Measuring Period	Survey Points
Air Quality	- PM 10μm - PM 2.5μm - NO_2 - SO_2	- One day in July or August, 2013, except for holiday - One day after three consecutive days with no rain in December, 2013, except for holiday and rainy day - 24 hours in a low	- 4 cross-sections: Middle section 3 and Sri Sophorn - Poipet (SP) section 1 - Total 8 Points: 1 roadside point and 1 point for measuring background (far from the road site more than 100 m) on each cross-section
Noise and Vibration Survey	- Equivalent continuous A-weighted sound pressure Level (LAeq) - Vibration Level	- One day in July or August, 2013, except for holiday - One day in December , 2013, except for holiday and rainy day - 24 hours in a low (SP section : only August)	- Same cross-sections as Air Quality Survey - Total 5 points 4 roadside points and 1 point for measuring background (far from the road site more than 100 m) on each cross-section
Water Quality	- pH - Biochemical Oxygen Demand (BOD) - Chemical Oxygen Demand (COD) - Total Suspended Solids (TSS) - Total Coliform	- One day in July or August, 2013 - One day after three consecutive days with no rain in December, 2013, except for rainy day	- Surface water such as river and channel around project site - Total 7 Points Middle section 6 and SP section 1
Waste	- Outline of major illegal waste dumping sites	-	Both sides of the target sections including Pursat Bypass



Middle Section (Thlea Ma'am and Battambang)



Sri Sophorn – Poipet Section

Cross section 1: Ra village, Phtaesh Prey Sangkat, Pursat Town, Pursat province (KP 187+560)
Cross section 2: Pou Mouy village, Moung commune, Moung Russei district, Battambang province (KP 244+550)
Cross section 3: Dambouk Khpos village, Ou Dambang Pir commune, Sangkae district, Battambang province (KP 282+78)
Cross section 4:Kbal Spean village, Poipet Sangkat, Poipet City, Banteay Meanchey province (KP 407)

Water 1: Pursat River, Prey Nhi village, Prey Nhi Sangkat, Pursat townt, Pursat province
Water 2: Ou Tapaong River, Ou Tapaong village, Ou Tapaong Commune, Bakan district, Pursat province
Water 3: Svay Doun Keo River,Svay Doun Keo Mouy village, Svay Doun Keo commune, Bakan district, Pursat province
Water 4: Maung River, Ream Kon village, Kea commune, Maung Russei district, Battambang province
Water 5: Chak River,Stueng Chak village, Prey Touch commune, Maung Russei district, Battambang province
Water 6: Sangke River, Preaek Moha Tep village, Svay Pao Sangkat, Battambang City, Battambang
Water 7: Sri Sophorn River, Teuk Thla village, Teuk Thla Sangkat, Sri Sophorn Town, Banteay Meanchey province

Figure 15.2-12 Location Map of Environmental Quality and Pollution Survey

(2) Air Quality

The air quality surveys were conducted in July (Middle section) and August (SP section), as rainy season survey, and December, as dry season survey, 2013. The result of the air quality survey is shown in Table 15.2-6.

NO_2 and SO_2 were much lower than the MOE's standards. PM (Particulate Matter) 2.5 and PM 10 was higher than WHO's standard. MP 2.5 and PM 10 levels at the roadside were higher than them at the background. Suspended particulate matter in vehicle emission gas and dust caused by vehicle running may cause the increase in PM 2.5 and PM 10 in addition to the high background level.

Table 15.2-6 Result of Air Quality Survey during Dry Period

Location (Date : 24 hours in a low)	Ambient Air Pollution Concentration (mg/m^3)							
	NO_2		SO_2		PM 2.5		PM 10	
Season	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cross Section 1 Roadside Point (Jul. 15~16 and Dec. 2~3, 2013)	0.011	0.019	0.004	0.010	0.049	0.071	0.099	0.155
Cross Section 1 Background Point (Jul. 16~17 and Dec. 3~4, 2013)	0.005	0.009	0.002	0.007	0.015	0.024	0.049	0.051
Cross Section 2 Roadside Point (Jul. 17~18 and Dec. 4~5, 2013)	0.010	0.022	0.009	0.016	0.041	0.078	0.170	0.208
Cross Section 2 Background Point (Jul. 18~19 and Dec. 5~6, 2013)	0.007	0.015	0.002	0.009	0.017	0.029	0.068	0.075
Cross Section 3 Roadside Point (Jul. 19~20 and Dec. 6~7, 2013)	0.013	0.019	0.005	0.011	0.043	0.059	0.073	0.105
Cross Section 3 Background Point (Jul. 22~23 and Dec. 9~10, 2013)	0.003	0.007	0.002	0.006	0.014	0.027	0.030	0.044
Cross Section 4 Roadside Point (Aug. 19~20 and Dec. 11~12, 2013)	0.010	0.045	0.009	0.024	0.150	0.199	0.231	0.324
Cross Section 4 Background Point (Aug. 20~21. and Dec. 12~13, 2013)	0.008	0.018	0.005	0.011	0.070	0.093	0.101	0.127
Standards of the MOE or WHO	0.1		0.3		0.02*		0.05*	
	(24 Hours)		(24 Hours)		(24 Hours)		(24 Hours)	

Note: No Cambodian Standards for PM2.5 and PM10 The asterisk (*) refers to WHO's Standards

(3) Noise and Vibration

The noise and vibration surveys were conducted from 15 to 19 (Middle section) July and from 19 to 20 August (SP section), 2013, and from 2 to 6 December (Middle section), 2013. The survey results are shown in from Figure 15.2-13 to 15.2-20.

Noise levels at the roadside points of the 4 surveyed cross sections were a bit lower than the MOE's standard during day time and were higher than the night time one. The details of the results are presented in Appendix 15-3. Higher noise level during the night time is mostly due to friction sound of road surface and tires by high speed vehicles and urban noise around the monitoring points.

All vibration levels at the roadside and background points of the 4 cross sections were lower than "Request Limit Concerning Automobile Noise in Japan" either day time or night time. The details of the results are presented in Appendix 15-3. Because threshold level of vibration sense is generally 55 dB, the vibration levels at roadside have no impact on the local residence.

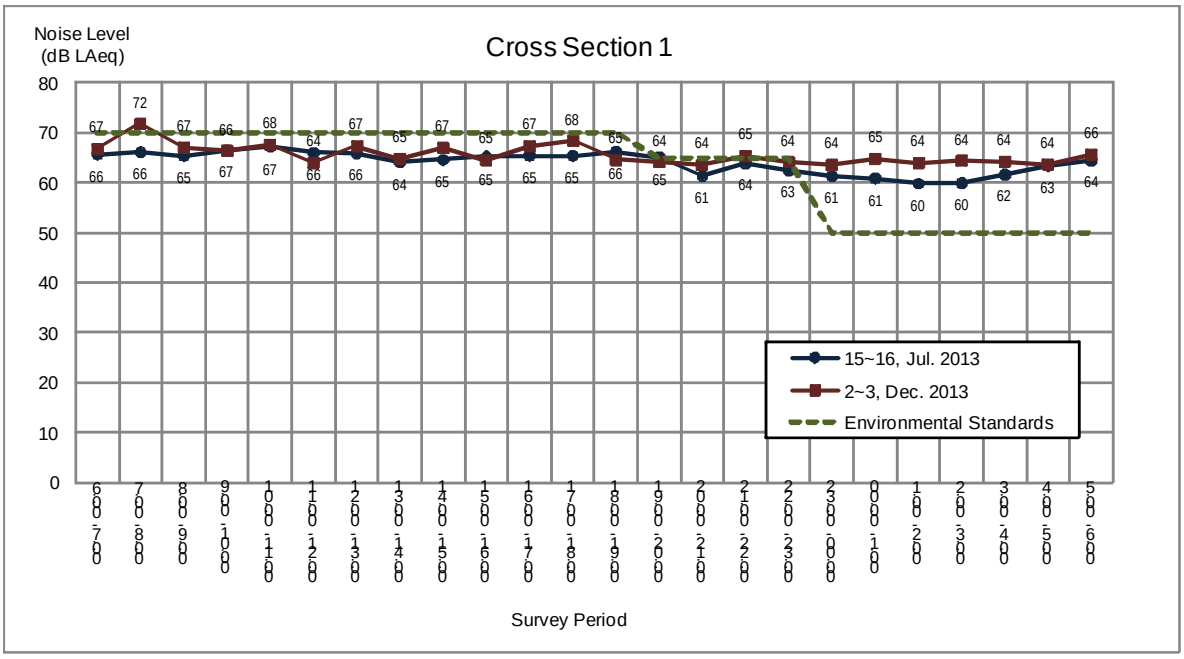


Figure 15.2-13 Result of Noise Survey (1)

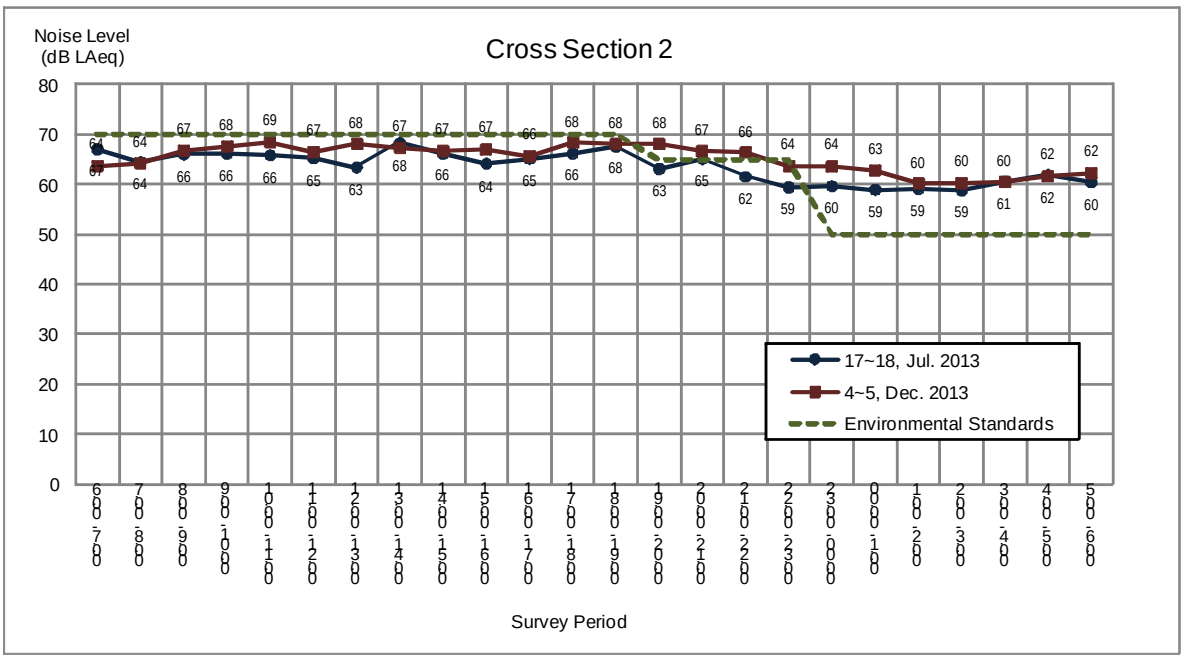


Figure 15.2-14 Result of Noise Survey (2)

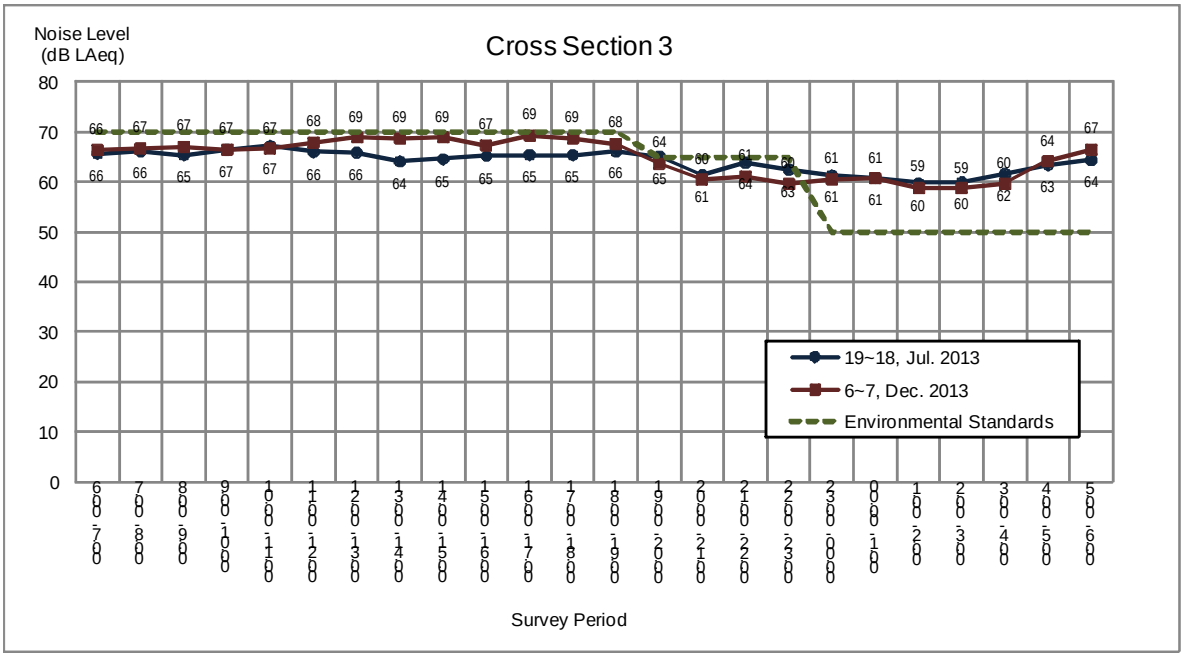


Figure 15.2-15 Result of Noise Survey (3)

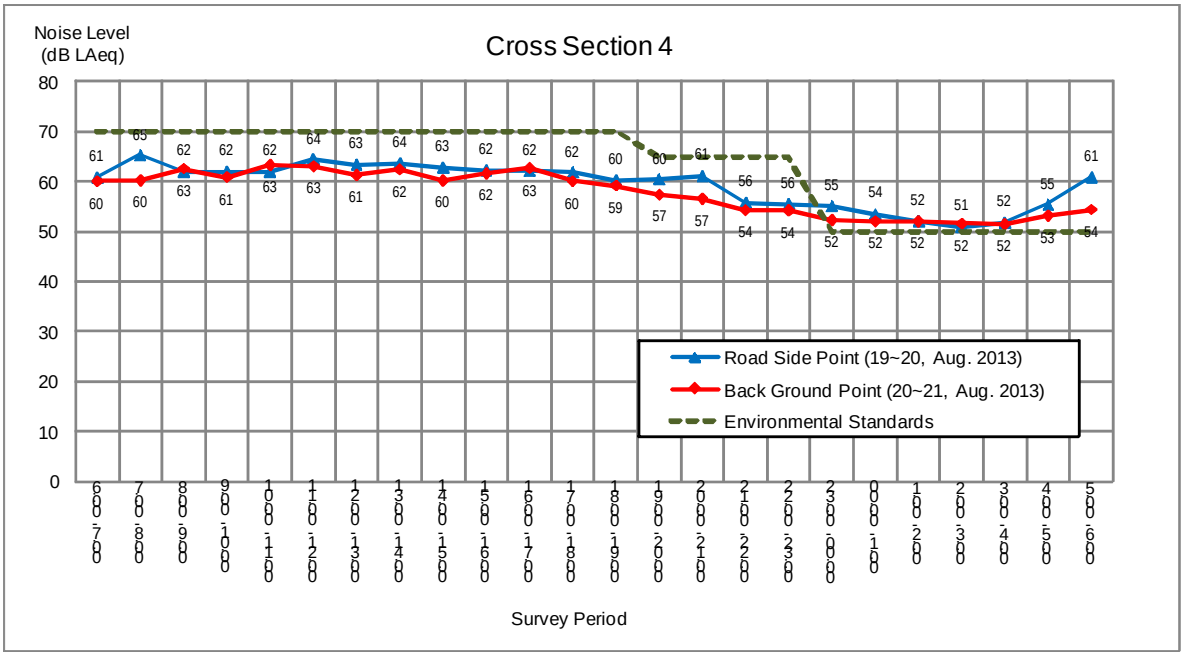


Figure 15.2-16 Result of Noise Survey (4)

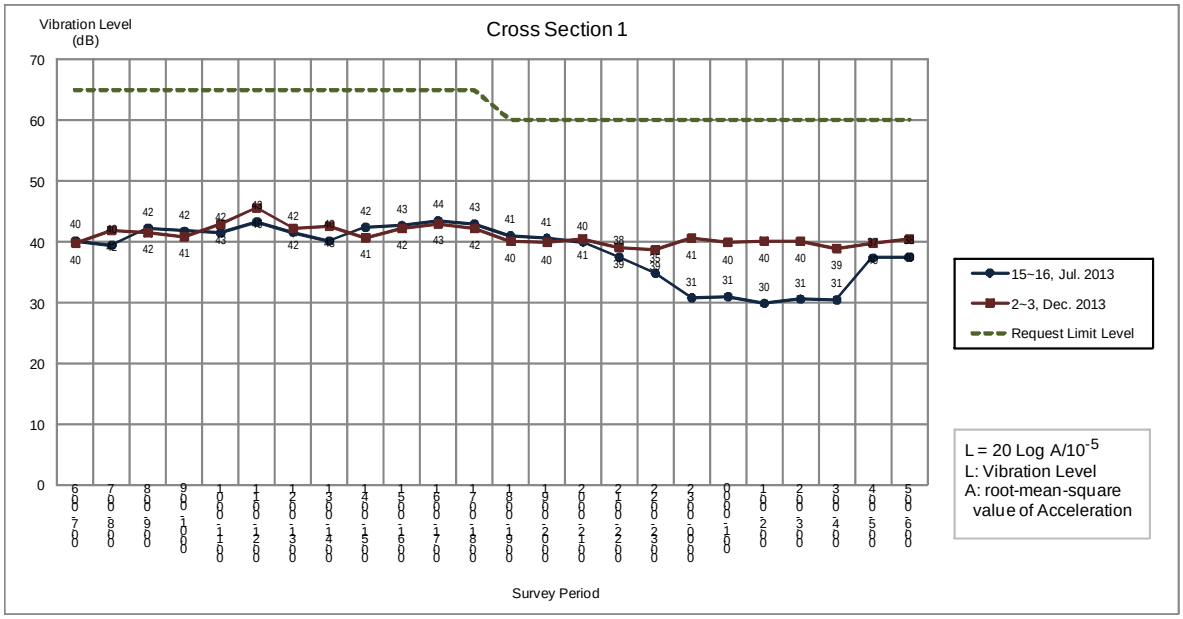


Figure 15.2-17 Result of Vibration Survey (1)

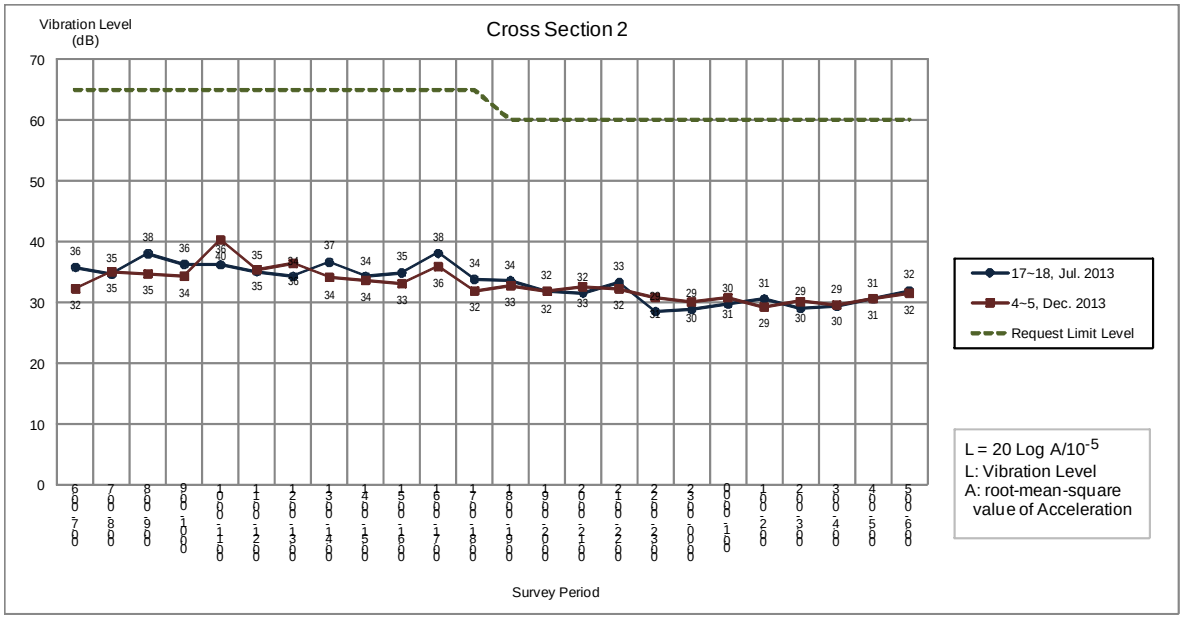


Figure 15.2-18 Result of Vibration Survey (2)

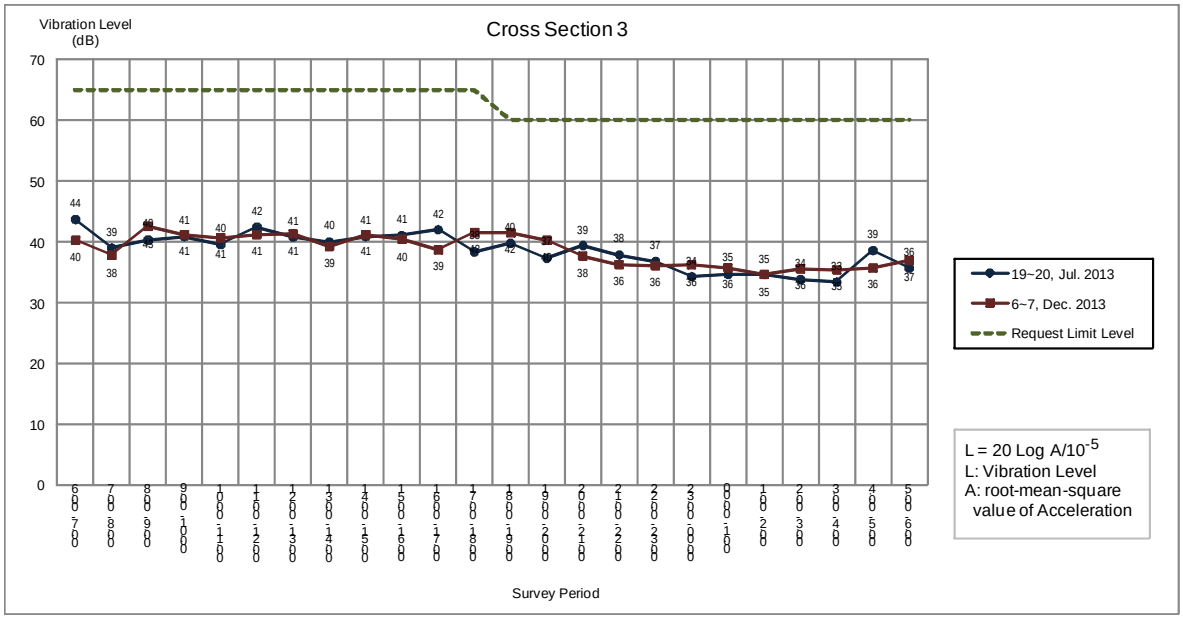


Figure 15.2-19 Result of Vibration Survey (3)

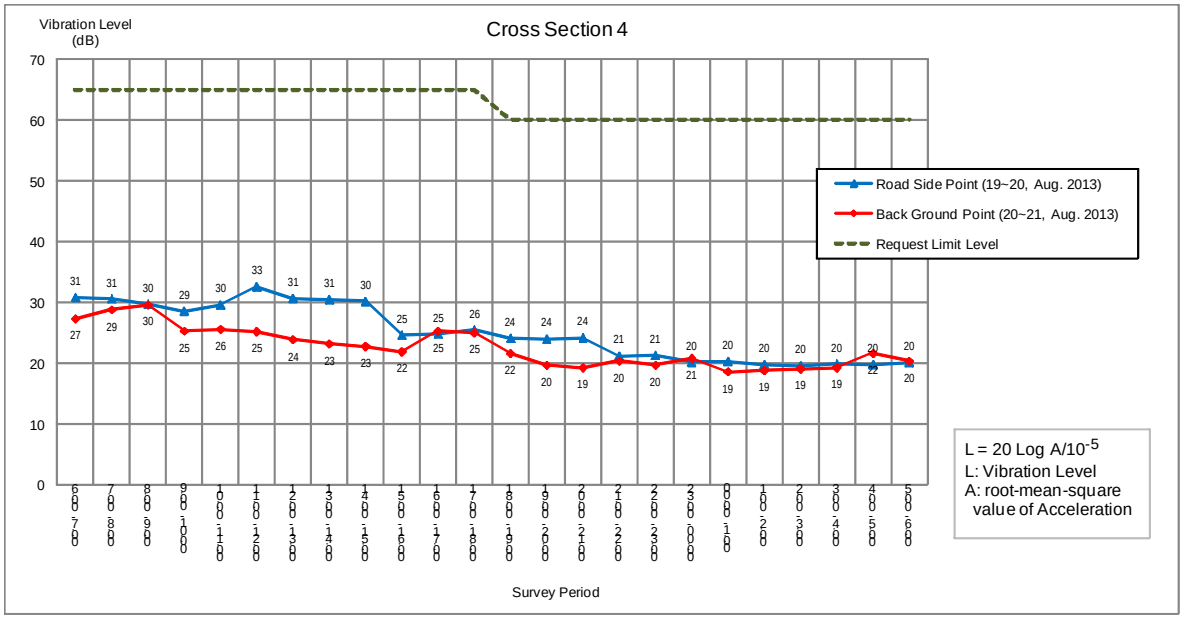


Figure 15.2-20 Result of Vibration Survey (4)

(4) Water Quality

The water sampling was conducted in July (Middle section) and August (SP section), as rainy season survey, and December, as dry season survey, 2013. The result of water quality analysis is shown in Table 15.2-7. The pH levels in rainy season were higher than dry season's them. The TSS in rainy and dry season was found to be higher than the MOE's standard in most of the sampling rivers. The BOD levels were in range of the standard in all the sampling rivers. The levels of TSS, BOD, COD and Total Coliform during rainy season have a tendency to rise. These are probably due to non-point source such as surface runoff and soil erosion caused by rain. The Total Coliform level in Maung River in rainy season exceeded the standard. This is

possibly due to agricultural runoff and animal manures washed out by rain or flowed in through drainages from upstream areas to the rivers and streams.

Table 15.2-7 Result of Water Quality Survey

No.	Location	Survey Date	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	Total Coliform (MPN/100 ml)
1	Pursat River	24 Jul. 2013	8.1	124	2.6	4.7	4,600
		5 Dec. 2013	7.5	92	1.3	3.9	300
2	Ou Tapaong River	24 Jul. 2013	8.8	138	3.8	7.5	150
		5 Dec. 2013	7.3	125	3.4	5.7	110
3	Svay Doun Keo River	24 Jul. 2013	8.3	142	5.2	8.2	350
		5 Dec. 2013	7.2	108	3.5	7.1	750
4	Maung River	24 Jul. 2013	8.6	128	2.1	4.1	11,000
		5 Dec. 2013	7.3	97	1.1	3.4	2,100
5	Chak Rive	24 Jul. 2013	8.6	142	2.7	7.3	280
		5 Dec. 2013	7.1	95	1.2	3.2	94
6	Sangke River	24 Jul. 2013	8.2	140	2.4	4.3	4,600
		5 Dec. 2013	7.9	116	1.4	2.6	1,500
7	Sri Sophorn River	21 Aug. 2013	7.1	117	3.1	5.8	1,500
		5 Dec. 2013	6.7	82	0.4	3.5	110
Standard of the MOE			6.5 – 8.5	25 – 100	1 – 10	-	*<1,000 or **<5,000

Note: Total Coliform Standard in Reservoir <1,000 and Total Coliform Standard in River <5,000

(5) Waste

Illegal waste dumping and landfill along the road mainly occur in the area without waste collection service. The local people collect and dump wastes which are not able to be burn every half or a month. Recyclable wastes such as aluminum cans, plastic bottles, hard rubbers, papers, metals, glass bottles, batteries, electrical wire, copper pots and aluminum pots were sold to waste buyers or junk shops.

8 illegal waste dumping sites along the middle section were surveyed. In short, 1 m^3 in average volume of wastes of 8 targeted locations was 305 kg in total, composing 7 kg (2%) of hazardous wastes (electronic tools, lumps, shoes make from tires and chemical waste), 159 kg (53%) of kitchen garbage and paper wastes, 83 kg (27%) of plastic wastes and 56 kg (18%) of glass, metal and ceramic wastes.

4 illegal waste dumping sites along Sri Sophorn - Poipet section were surveyed. In short, 1 m^3 in average volume of wastes of 4 targeted locations was 275 kg in total, in which composing 3 kg (1%) of hazardous wastes, 199 kg (72%) of kitchen garbage and paper wastes, 47 kg (17%) of plastic wastes, 5 kg (2%) of glass, metal and ceramic wastes and 21 kg (8%) of grease cloth wastes.

Table 15.2-8 Quantity of Waste in Illegal Dumping Site along Middle Section

No.	Number of Kilometer Post and Direction from Phnom Penh to Battambang	Total sample weight of volume 20 cm^3 of Waste (kg)	Hazardous wastes of 20 cm^3 (kg)	Kitchen garbage and paper wastes of 20 cm^3 (kg)	Plastic wastes of 20 cm^3 (kg)	Glass, metal and ceramic wastes of 20 cm^3 (kg)
1	194 - 195 Right Side	5	0	4	1	0
		7	0.1	4.5	2	0.4
		7	0	4.9	2	0.1
	Average volume	6.33	0.03	4.47	6.34	0.03
	Waste volume in 1 m^3	319	2	224	84	9
2	215 - 216 Right Side	5.5	0	3.2	2	0.3
		5	0.3	3.7	1	0
		6	0.3	3.2	1.5	1
	Average volume	5.50	0.20	3.37	5.5	0.2
	Waste volume in 1 m^3	276	10	169	75	22
3	214 - 215 Left Side	5.00	0.20	2.80	2.00	0.00
		6.00	0.50	2.35	2.00	1.15
		6.00	0.00	3.00	2.00	1.00
	Average volume	5.67	0.23	2.72	2.00	0.72
	Waste volume in 1 m^3	284	12	136	100	36
4	216 - 217 Right Side	6.00	0.00	0.50	2.00	3.50
		5.00	0.00	1.00	3.00	1.00
		6.00	0.00	3.50	2.00	0.50
	Average volume	5.67	0.00	1.67	2.33	1.67
	Waste volume in 1 m^3	285	0	84	117	84
5	216 - 217 Left Side	8.00	0.00	8.00	0.00	0.00
		9.00	0.00	8.90	0.10	0.00
		8.00	0.00	7.80	0.10	0.10
	Average volume	8.33	0.00	8.23	0.07	0.03
	Waste volume in 1 m^3	418	0	412	4	2
6	236 - 237 Right Side	5.00	0.00	2.00	2.00	1.00
		6.00	0.00	1.50	3.50	1.00
		5.00	0.10	2.88	2.00	0.02
	Average volume	5.33	0.03	2.13	2.50	0.67
	Waste volume in 1 m^3	268	2	107	125	34
7	268 - 269 Right Side	6.00	0.30	1.70	1.00	3.00
		6.50	0.50	1.00	1.50	3.50
		6.50	0.00	1.50	2.00	3.00
	Average volume	6.34	0.27	1.40	1.50	3.17
	Waste volume in 1 m^3	318	14	70	75	159
8	249 - 250 Right Side	6.00	0.00	2.10	1.00	2.50
		5.00	0.30	1.20	2.00	1.50
		5.50	0.50	1.00	2.00	2.00
	Average volume	5.37	0.27	1.43	1.67	2.00
	Waste volume in 1 m^3	275	14	72	84	100
The average volume of wastes of 8 targeted locations in 1 m^3		305	7	159	83	56

Table 15.2-9 Quantity of Waste in Illegal Dumping Site along SP Section

No.	Number of Kilometer Post and Direction from Phnom Penh to Battambang	Total sample weight of volume 20 cm^3 of Waste (kg)	Hazardous wastes of 20 cm^3 (kg)	Kitchen garbage and paper wastes of 20 cm^3 (kg)	Plastic wastes of 20 cm^3 (kg)	Glass, metal and ceramic wastes of 20 cm^3 (kg)	Cloth wastes of 20 cm^3 (kg)
1	385 - 386 Right Side	4.00	0.00	2.70	1.00	0.30	0.00
		6.00	0.00	0.50	0.50	0.00	5.00
		5.00	0.00	3.50	1.50	0.00	0.00
	Average volume	5.00	0.00	2.23	1.00	0.10	1.67
	Waste volume in 1 m^3	250	0	112	50	5	83
2	383 - 384 Left Side	6.00	0.00	5.00	1.00	0.00	0.00
		5.00	0.00	4.20	0.80	0.00	0.00
		4.00	0.00	3.30	0.50	0.20	0.00
	Average volume	5.00	0.00	4.17	0.77	0.07	0.00
	Waste volume in 1 m^3	250	0	208	38	3	0
3	382 - 383 Right Side	6.00	0.20	5.20	0.50	0.10	0.00
		5.00	0.30	3.70	1.00	0.00	0.00
		6.00	0.30	5.00	0.70	0.00	0.00
	Average volume	5.67	0.27	4.63	0.73	0.03	0.00
	Waste volume in 1 m^3	283	13	232	37	2	0
4	366 - 367 Right Side Left Side	6.00	0.00	4.70	1.00	0.30	0.00
		7.00	0.00	5.30	1.50	0.20	0.00
		6.00	0.00	4.70	1.20	0.10	0.00
	Average volume	6.33	0.00	4.90	1.23	0.20	0.00
	Waste volume in 1 m^3	317	0	245	62	10	0
The average volume of wastes of 8 targeted locations in 1 m^3		275	3	199	47	5	21

15.3 Social Environment

Environmental and social considerations refer not only to the natural environment, but also to social impacts such as involuntary resettlement and respect for the human rights of indigenous peoples. According to "2.3 Impacts to be Assessed" of JICA Guidelines for Environmental and Social Considerations (hereinafter referred as "JICA Guidelines"), "social considerations" cover the impacts on;

- migration of population and involuntary resettlement,
- local economy such as employment and livelihood,
- utilization of land and local resources,
- social institutions such as social capital and local decision-making institutions,
- existing social infrastructures and services,
- vulnerable social groups such as poor and indigenous peoples,
- equality of benefits and losses and equality in the development process,
- gender,

- children's rights,
- cultural heritage,
- local conflicts of interest,
- infectious diseases such as HIV/AIDS, and
- working conditions including occupational safety.

These impacts are examined through scoping process with other environmental factors in natural environment and pollutions. Among the elements of social environment, involuntary resettlement is the focal issue. According to the field survey including socioeconomic survey and inventory of loss survey, the number of affected households are estimated around 2,400 HH. Exact number of affected households will be confirmed in the detailed measurement survey (DMS) which will be implemented after the loan agreement.

15.3.1 Administrative Boundary

(1) Middle Section (from Thlea Ma'am to Battambang)

This section covers two provinces of Pursat and Battambang. Under the two provinces, there are five districts (Moung, Sangke, Bakan, Krakor, and Pursat) in existing National Road No.5 (NR 5) and two districts (Kandieng and Pursat) in Pusat Bypass section (Figure 15.3-1).

(2) Sri Sophorn – Poipet Section

This section covers Banteay Meanchey Province. There are two districts (Ou Chrov and Paoy Paet) in this section of existing NR 5(Figure 15.3-2).

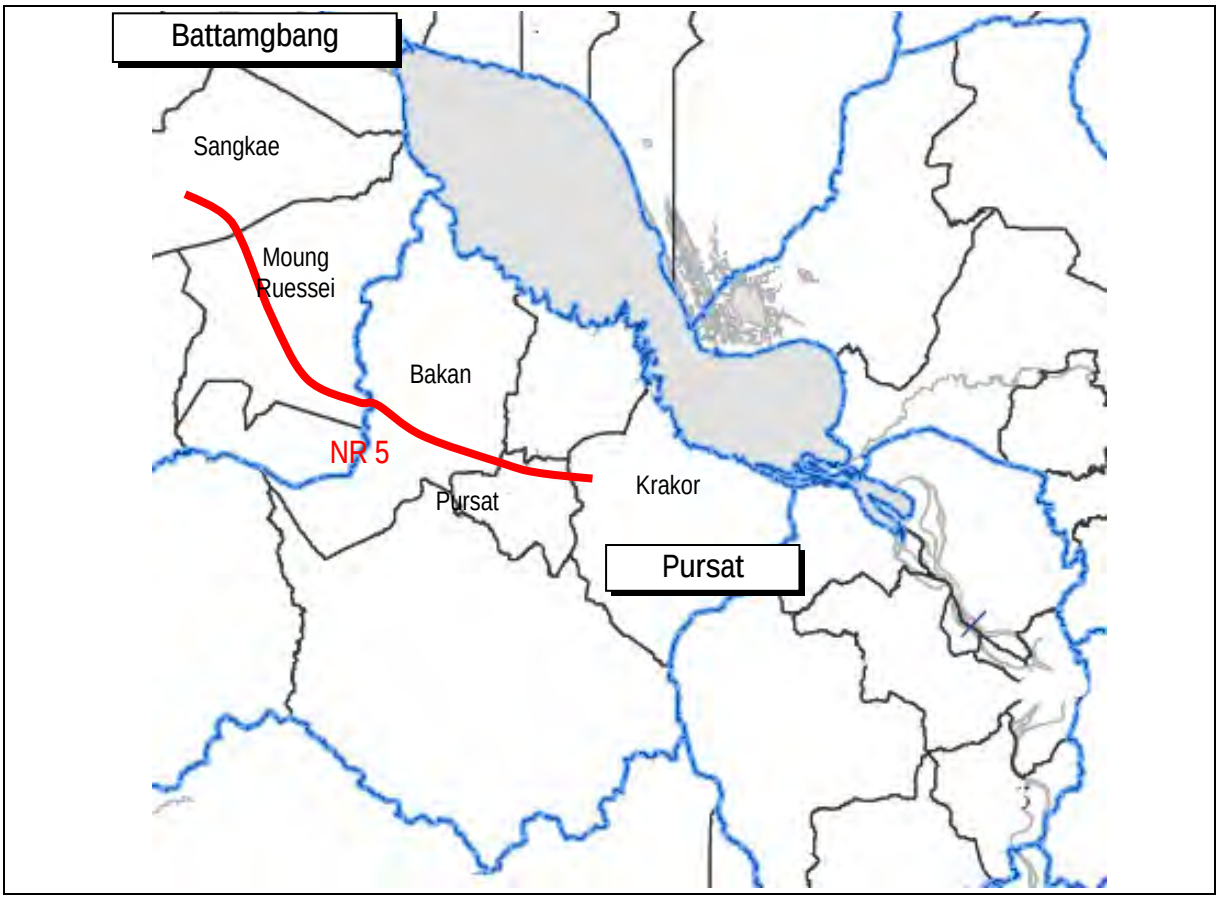


Figure 15.3-1 NR 5 (Middle Section) and Administrative Boundary

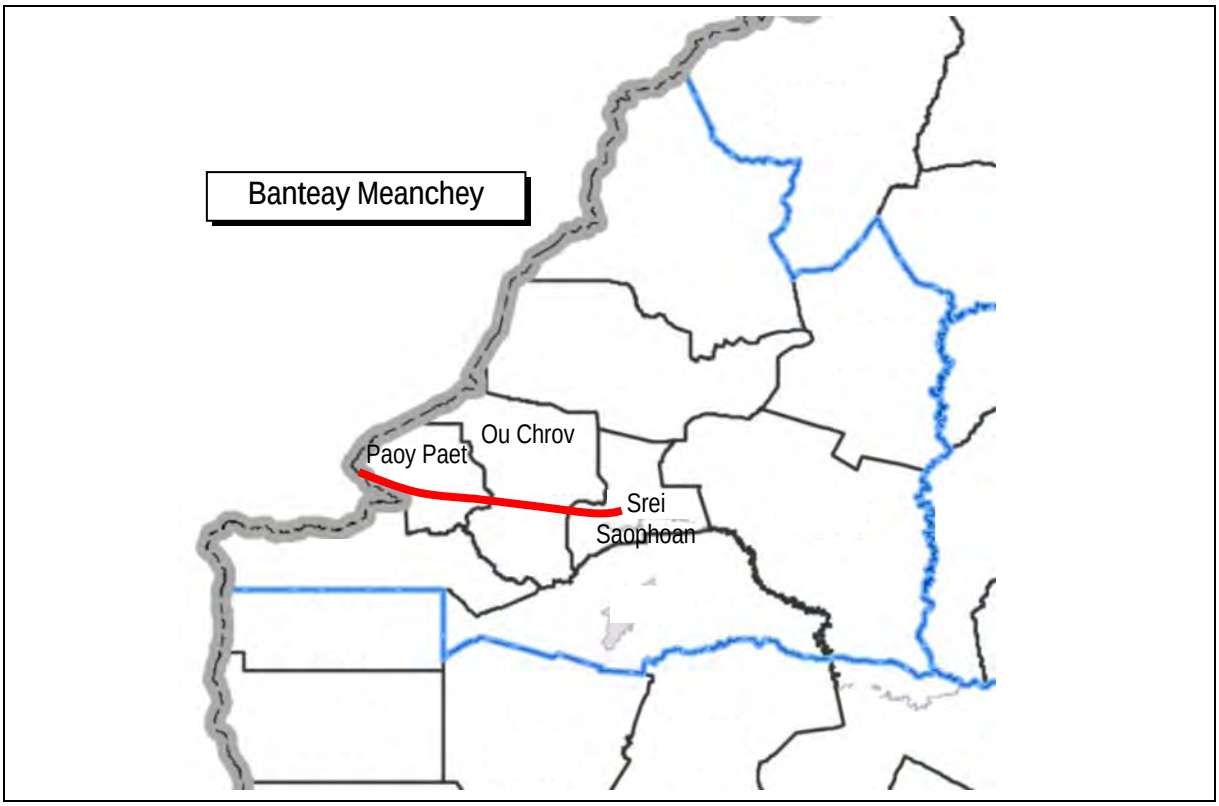


Figure 15.3-2 NR 5 (Sri Sophorn – Poipet Section) and Administrative Boundary

15.3.2 Population

The latest population census was implemented in 2008 as "General Population Census of Cambodia". Based on the census, population and household data on three provinces which is located in the project area, are assembled in Table 15.3-1. "Sex ratio" and "Average house hold size", the total number of person who is living in a household, are almost same among three provinces, however, Battambang Province has much population especially in urban or town area and is more developed comparing to Pursat and Banteay Meanchey Province.

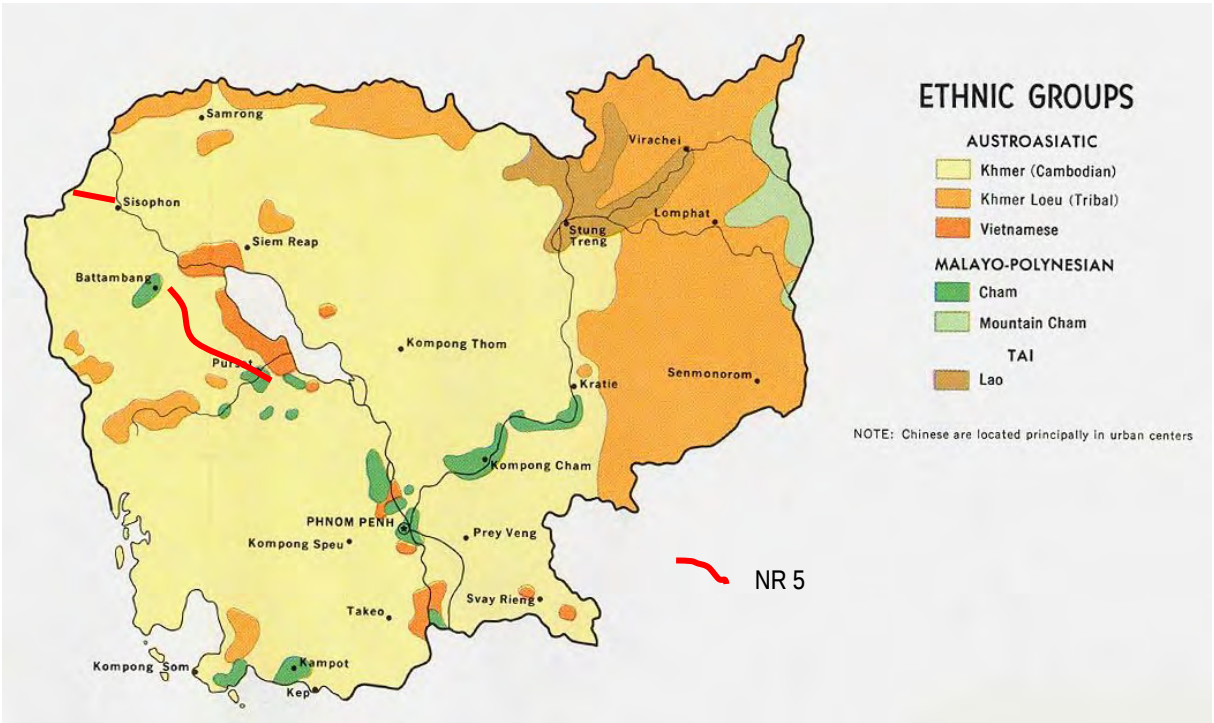
Table 15.3-1 Population and Households in the Project Related Provinces

Province	Population			Sex Ratio (Male/Female)	House holds	Average Household Size
	Total	Male	Female			
Pursat	397,161	192,954	204,207	94.5%	83,745	4.7
Battambang	1,025,174	506,351	518,823	97.6%	210,853	4.9
Banteay Meanchey	677,872	331,715	346,157	95.8%	145,219	4.6

Data Source: General Population Census of Cambodia 2008, National Institute of Statistics, Ministry of Planning

15.3.3 Ethnic Minority

Figure 15.3-3 is the distribution map of ethnic groups in Cambodia. Focusing on the survey area, Cham (or Khmer-Cham) people (green color) lives along National Road No.5, especially in and vicinity of the town of Pursat and Battambang. In general, Cham people can understand Khmer language. In addition, Vietnamese (orange color) lives lakeside area in both Pursat and Battambang Province. Some of them live on floating village and their livelihood has strong connection to aquatic products from Tonle Sap Lake.



Source: Map of Cambodia with detail of ethnic group distributions (1972), Texas University Library

Figure 15.3-3 Ethnic Groups in Cambodia

As a whole country, more than 90% population belong the ethnic group of Khmer. They are followers of Buddhism and speak Khmer language. In and vicinities of the project site, Cham people and Vietnamese immigrant are observed as small groups. In general, Cham and Vietnamese can understand Khmer language, however, they keep their own language, religion, and other social behaviors.



Khmer Monks

Cham people are known as ethnic Muslims originated from the Kingdom of Champa which had gone to ruin in 19th century. Cambodia is one of the areas in Indochina where Cham people resettled after they lost their home country. The number of Cham population is said around 220,000 and most of them are living along Mekong River and Tonle Ssp. They speak Cham Language and usually have mosque as a religious and community center. Their major occupations are fishing, farming and businesses. Some scattered mosques are observed along the project area of NR 5.



Cham's Mosque

Vietnam people in Cambodia have different origin and most of them are living along Vietnam border and inland water area where they feed themselves with fishing. Around 95,000 Vietnamese are living in Cambodia. They speak Vietnamese and their religion varies from Buddhism to Christianity. Their major occupations are small business such as barbershop in urban and fishing in rural. It is estimated that there are not so much Vietnamese population in the project area.



A Vietnamese at Tonle Sap Floating Village

15.3.4 Gender

(1) Key Factors

According to United Nations Development Plan (UNDP) in Cambodia, key facts about gender equality in Cambodia are described as below;

(a) Cambodia ranks 105 out of 152 countries on the Gender Inequality Index (GII) in the Human Development Report 2014. GII is a new measurement replacing the Gender-related Development Index (GDI) and Gender Empowerment Measure (GEM).

(b) Over the past decade, there have been improvements on the status of women in Cambodia. Yet, they remain less visible in public sphere. Women comprise 34 percent of civil servants and hold 22 percent of seats in the National Assembly.

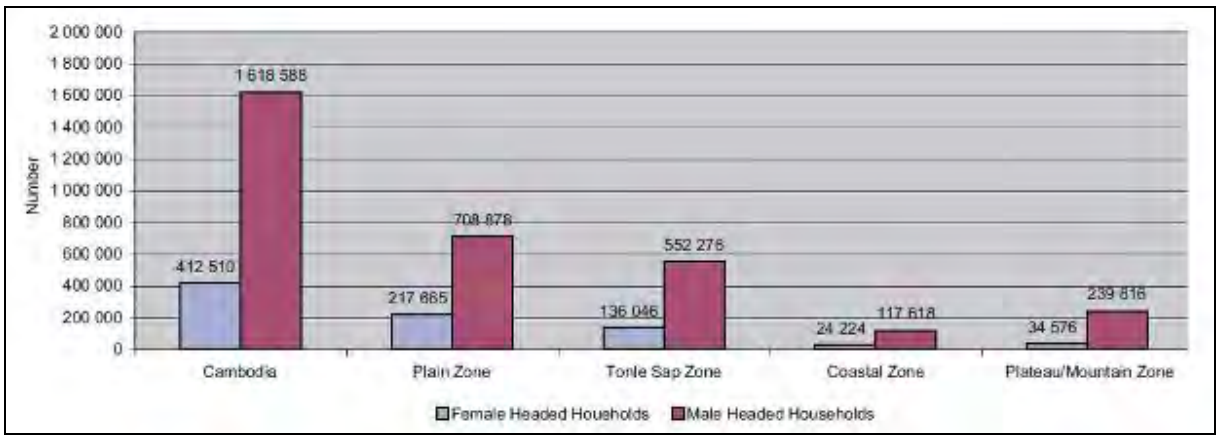
(c) Almost the same number of boys and girls attend school until the age of 14. However, fewer girls continue in higher education. Adult literacy rates are also unequal: only 70.9 percent of adult females are literate, compared to 85.1 percent of their male peers.

(d) The number of men and women in the total workforce is almost the same (49.4 percent women). However, more women are self-employed or unpaid family workers (83 percent of female employment vs. 76 percent of male employment). This informal economy provides low, irregular income and unstable employment. More importantly, because many tend to operate unregistered, there is little or no access to organized markets, credits and training institutions and to other public services.

(e) Like many other countries in East Asia, Cambodia has the Law on Prevention of Domestic Violence and Protection of Victims. Despite the law, 22.5 percent of married women experienced violence within their homes and up to 89 percent do not report the incident, according to a survey by Ministry of Women's Affairs in 2009.

(2) Statistics from Census (2008)

Based on the result from Census (2008), in rural area including Tonle Sap Zone, around 20% of agricultural household is female headed (Figure 15.3-4).

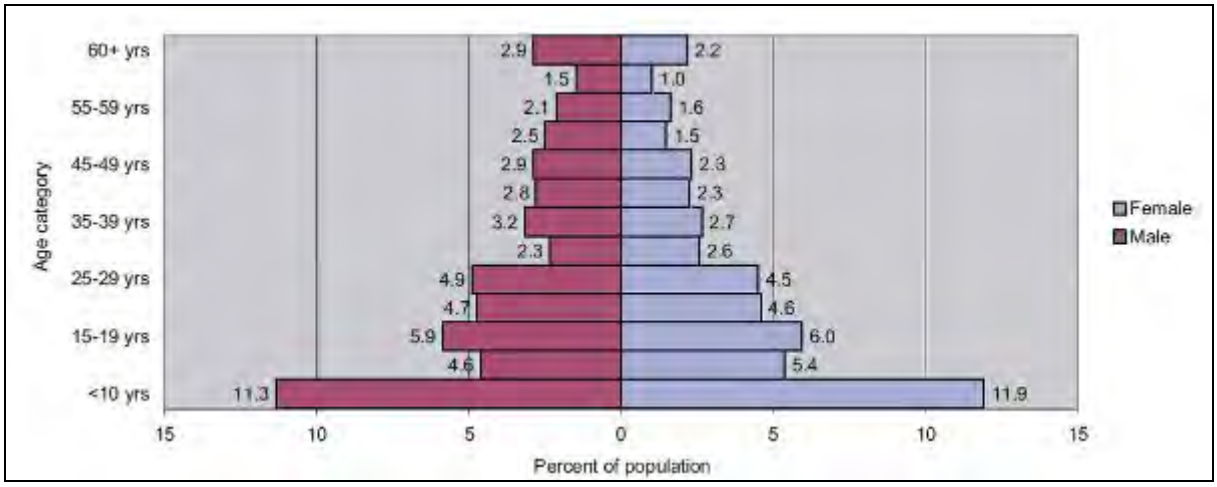


Source: National Gender Profile of Agricultural Households, 2010 (Based on the 2008 Cambodia Socio-Economic Survey), FAO & NIS, Ministry of Planning

Figure 15.3-4 Number of Male and Female Headed Household

According to the survey by FAO & NIS, the median age of the agricultural household heads is 46 years old, and male heads have a lower median age than female heads.

Figure 15.3-5 shows age pyramid in agricultural area in Cambodia.

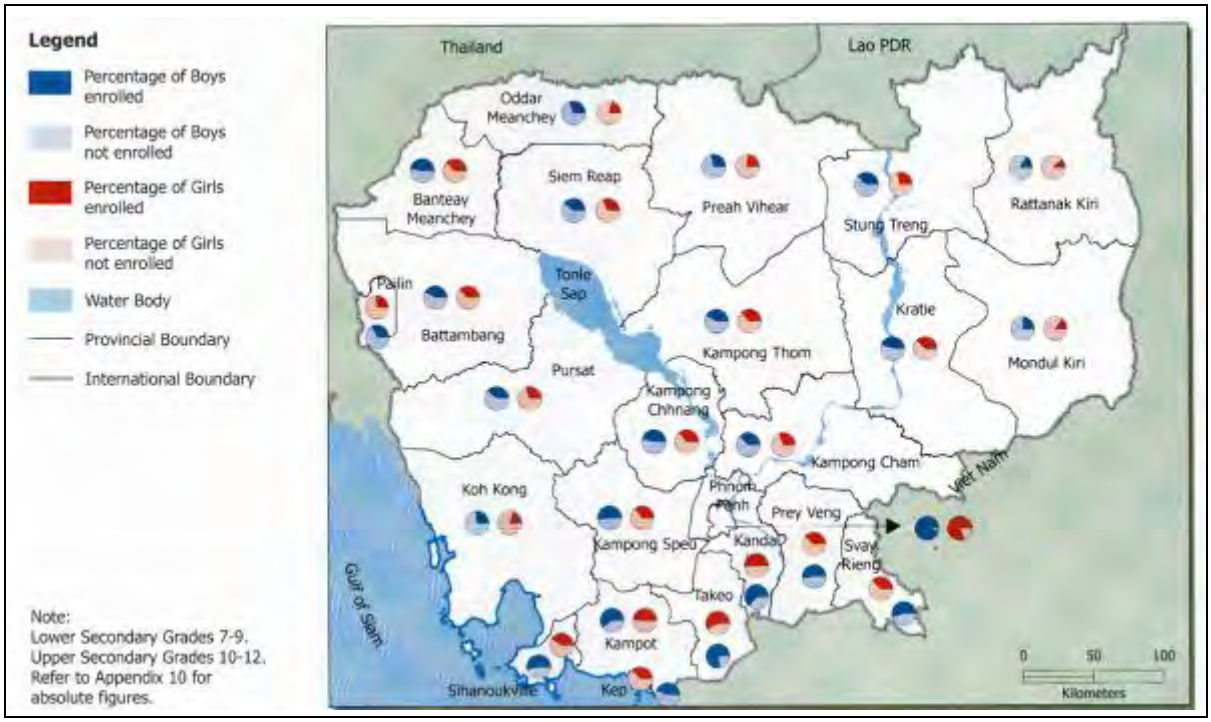


Source: National Gender Profile of Agricultural Households, 2010 (Based on the 2008 Cambodia Socio-Economic Survey), FAO & NIS, Ministry of Planning

Figure 15.3-5 Age Pyramid in Agricultural Area

(3) Gender in Education

As a gender indicator, enrollment ratio shows slightly deference between boys and girls (Figure 15.3-6). Among the provinces across NR 5, Pursat shows the lowest enrollment ratio. According to the result, boys can study at lower secondary school many more than girls in all provinces and this situation causes difference of illiteracy between male and female.



Source: The Atlas of Cambodia, National Poverty and Environment Maps, Save Cambodia's Wildlife (2006)

Figure 15.3-6 Lower Secondary (age 7-9) School Enrollment Status

15.3.5 Agriculture and Fishery

Agriculture is focal point of the economy of Cambodia and rice cropping is the most common land use along NR 5 in rural sections. Most paddy fields are rain-fed lowland and some limited areas are irrigated. In addition to rice growing, some farmers growing livestock such as duck, ox, water buffalo, and so on.



(a) Paddy Field along NR 5, Pursat

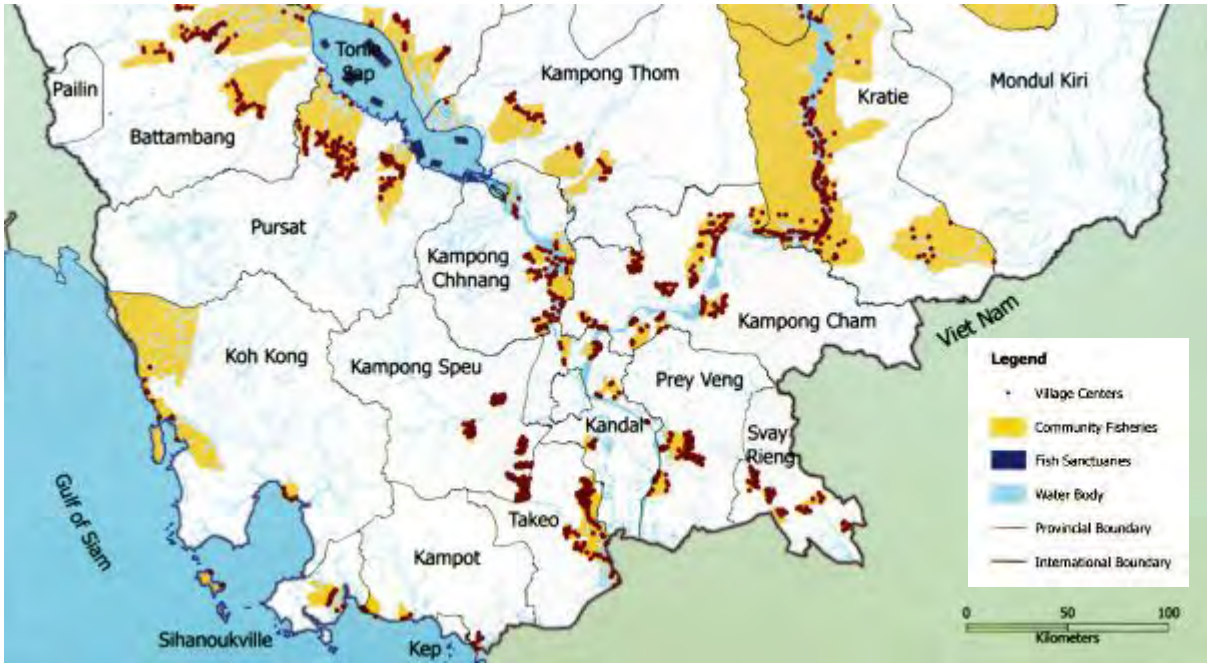


(b) Cow in a rural area, Pursat

Figure 15.3-7 Typical Rural Scene along NR 5

Community Fishery (CF) was proposed and developed under the ADB's initiative to realize the sustainable natural resources management in Tonle Sap Lake. Traditional tendering for fishing lots caused violence and other unfavorable social problems after 1993. As a result, Government tried to introduce CF with aims of ecosystem management, fishery resource management, poverty reduction, and so on.

CF has been set entire country except Mondulkiri Province, and there are some CFs area along NR 5 in Kampong Chhnang and Pursat Provinces (Figure 15.3-8). Some part of unloaded fishes and swamp small animals are transported to neighboring local market or far consumption area including Phnom Penh through NR 5.



Source: The Atlas of Cambodia, National Poverty and Environment Maps, Save Cambodia's Wildlife (2006)

Figure 15.3-8 Community Fishery Distribution



(a) Fish Catch for Domestic Use, Pursat



(b) Common Cooked Fish from Tonle Sap

Figure 15.3-9 Fishery in Tonle Sap Lake

15.3.6 Culture and Tourism

There is not outstanding cultural heritage or tourism site along the NR 5. However, NR 5 is the main access route to minor local cultural places, historical places and tourism area as below.

Battambang City is the largest secondary city in and its name comes from the legend of Bat Dambong, the "Disappearing Stick". During the French protectorate the formerly dispersed settlement was transformed into a busy marketplace, urban agglomeration and administrative stronghold. Battambang City has colonial urban architectures and tourist from both national and international stop for staying one night before they head to farer destinations such as Phnom Penh, Poipet, and Siem Reap. Outside of this area, the New Khmer Architecture of the Battambang University, French-Classical style villas along the river and traditional Khmer wooden houses can

be found. Throughout the city beautiful Wats (Pagodas) are expression of the city's religious places.[1] Pursat province is located in the western part of Tonle Sap Lake and next to Battambong Province. The Pursat River runs through its provincial capital town, originated from the Cardamoms Mountain. There some limited local visiting places including, pagoda, market, and natural resources such as falls and waterfront.



(a) Battambang



(b) Pursat

Figure 15.3-10 Typical Culture and Tourism Spots

There is not outstanding cultural heritage or tourism site along the NR 5. However, some historical or religious properties exist along the targets sections. An old brick fence and ancient gateway of Royal Palace of Preah Bat Monivong constructed in Colonial of French are located along the roadside of the middle section, around the KP 202+200, in Bakan district, Pursat province. Moreover, there is a hermitage of Lok Yeay Mao (Banyan tree) and Lok Ta Krahomkor around the PK-397+100 of Sri Sophorn - Poipet section in Poipet city, where local people always come to pray for safe and rainwater.

[1] http://www.battambang-town.gov.kh, Battambang Municipality Webssite



Figure 15.3-11 Brick Fence and Gateway of Royal Palace of Preah Bat Monivong

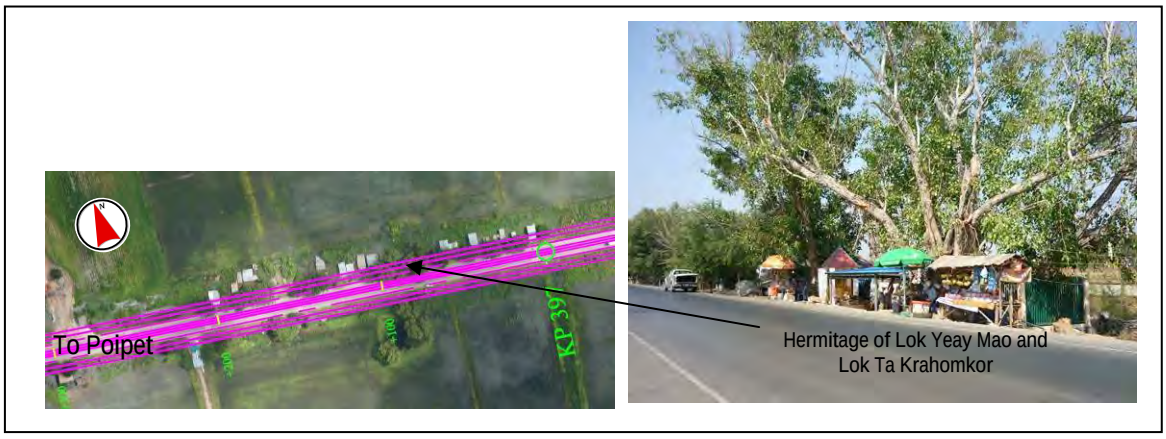


Figure 15.3-12 Hermitage of Lok Yeay Mao and Lok Ta Krahomkor

15.3.7 Land Acquisition / Resettlement

(1) ROW and PRW

In the background of Environmental and Social Considerations (ESC), Social Considerations mainly covers involuntary resettlement. Resettlement has become one of the crucial conditions to plan and implement infrastructure projects in Cambodia since the Peace Pact in 1993. Starting from late 1990s, Government of Cambodia (GOC) has established legal systems and improved its administrative procedures on environmental issues including land and resettlement through development projects, such as National Road No.1, Neak Loeung Bridge,

and so on.

Based on relevant regulations, Right of Way (ROW) of NR 5 is 30 m from center line in both sides. To minimize the resettlement impact, Corridor of Impact (COI) where the Project physically required for civil works, is introduced. COI is shorter than ROW in principle, therefore, private land acquisition (the area located more than 30 m from existing road center) is very limited in the section of existing road improvement and might be needed mainly in the bypass areas. The project needs COI of 15 m in urban areas and COI of 20 m in rural areas in general based on actual project affected areas by construction.

Figure 15.3-13 shows conceptual views of cross-section and plan of ROW and COI.

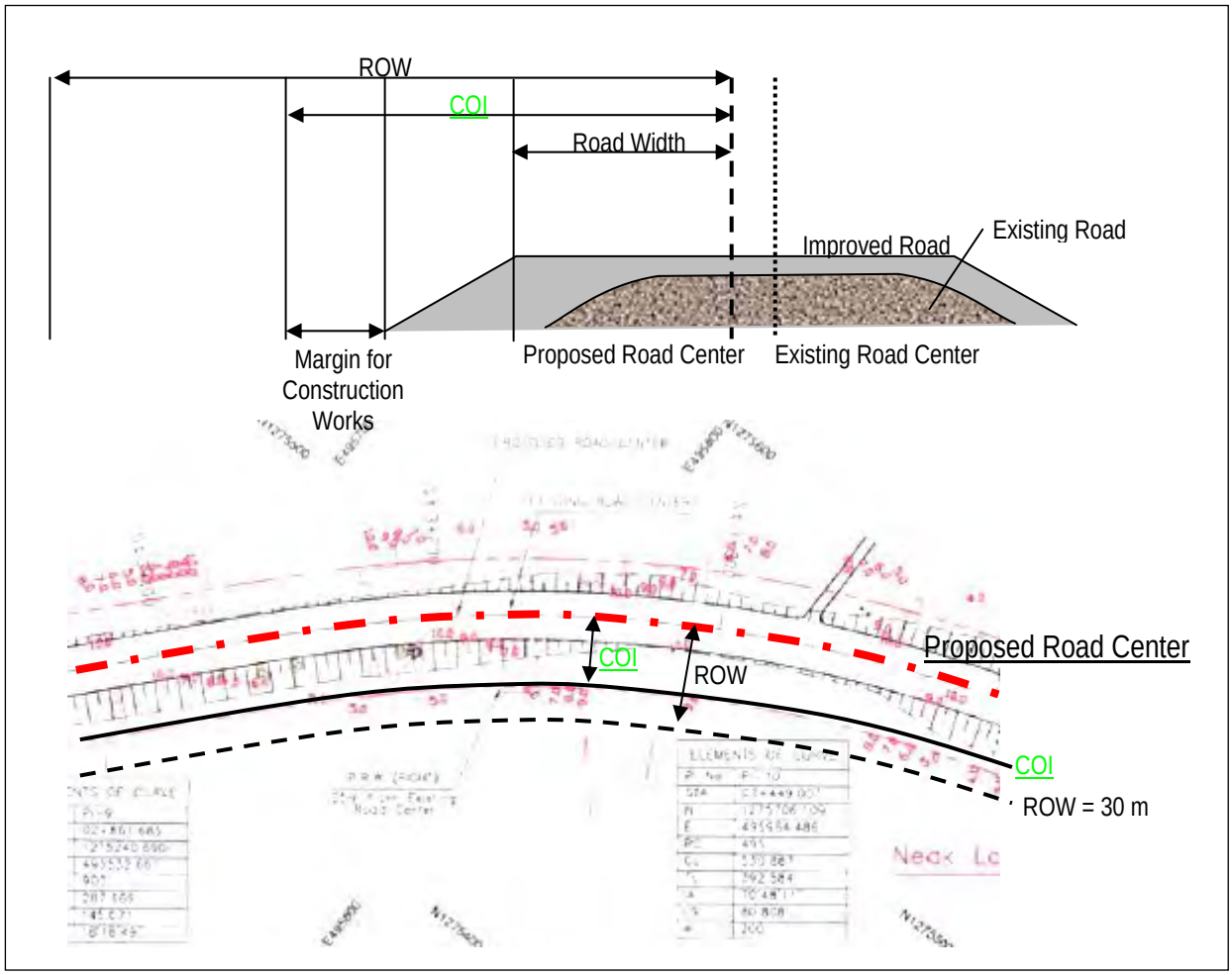


Figure 15.3-13 Conceptual View of ROW and Project Affected Areas

(2) Field Survey

During the preparatory survey stage, each activity, described below, are to be implemented. At the same time of Census and IOL, the Government can declare cut-off-date to recognize household who can be eligible for resettlement compensation.

(a) Census

Census is a kind of Socio-Economic Survey to grasp baseline of the socio-economic conditions on possible project affected households. Gathering data can be used for social considerations, mitigation measures, income restoration and other discussion.



Interview

(b) Inventory of Loss (IOL)

During the feasibility study period, Inventory of Loss (IOL) is implemented for possible impact areas based on temporal project design. Method of IOL is basically same as DMS which is conducted by IRC-Working Group (IRC-WG). Target of inventory covers all kinds of property including land, structures, fruit trees, and others.



Survey

(c) Replacement Cost Survey (RCS)

For estimating the budget on resettlement, Replacement Cost Survey (RCS) is implemented. Based on market price of construction material, classification of structures, land evaluation, and etc., compensation unit price is determined by the same method of RCS after L/A.



Material Survey

15.4 Result of Environmental Scoping

The potential environmental and social impacts were assessed on the basis of available information on the project and baseline data obtained at this stage. The result of the f environmental scoping is shown in Table 15.4-1 and 15.4-2.

Table 15.4-1 Result of Environmental Scoping (1)

Thlea Ma'am and Battambang Section

No.	Impact Item	Assessment: Pre-Construction Phase Construction Phase / Land acquisition Construction works	Assessment: Operation Phase / Existence Service	Reason / Remarks
Pollution				
1	Air pollution	B-	B±	**Construction Phase:** ・ Operation of construction equipment will generate dust and emission gas. ・ Traffic congestion in construction site will cause increase in exhaust gas from vehicles. ・ Dust will occur in borrow pit and quarry site. **Operation Phase:** ・ In the future, total amount of air pollutant caused by vehicle exhaust gas will increase. However, because of improved traffic efficiency, the amount may be reduced compared to without project.
2	Water pollution	B-	C-	**Construction Phase:** ・ Turbid water caused by construction works is likely to affect existing surface water resources. ・ In case of accidental massive leaking of fuel or oil, water pollution including ground water may occur. ・ Turbid water from borrow pit and quarry site by rainfall may cause surface water contamination. ・ Human wastewater will cause surface water contamination. **Operation Phase:** ・ Considerable water pollution is unlikely to occur. ・ Turbid water from borrow pit and quarry site by rainfall may cause surface water contamination until the recovery of vegetation.
3	Waste	B-	C-	**Construction Phase:** ・ Construction waste caused by construction works and general waste from construction office will be generated. **Operation Phase:** ・ Illegal dumping of solid waste may increase along the newly constructed bypass.
4	Soil pollution	D	D	**Construction Phase:** ・ Because materials to cause soil pollution will not be used in the construction works, soil pollution is unlikely to occur. **Operation Phase:** ・ Because materials to cause soil pollution will not be used in the maintenance works, soil pollution is unlikely to occur.
5	Noise and vibration	B-	B-	**Construction Phase:** ・ Construction works is likely to increase in the noise and vibration level. ・ Noise and vibration will occur in borrow pit and quarry site. **Operation Phase:** ・ In the future, noise level caused by vehicle driving will increase. However, because right of way will be widened, the level on road side may be reduced

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				compared to without project.
6	Ground subsidence	C-	C-	**Construction Phase:** ・ Subsidence near the road due to added soil weight may occur. **Operation Phase:** ・ Pressure of loading on road will be too low to cause, subsidence. However, because some portions of NR 5 run through flooded area, subsidence may occur.
7	Offensive odors	D	D	**Construction Phase:** ・ Because materials and equipment to cause offensive odors will not be used in the construction works, offensive odors are unlikely to occur. **Operation Phase:** ・ Because vehicles with incomplete combustion are few, exhaust gas from vehicles is unlikely to cause offensive odors.
8	Bottom sediment	D	D	**Construction Phase:** ・ Filled soil may be eroded by rain water and flow into rivers or streams, and accumulated on the bottom. However, the affected area will be limited only in the roadside. **Operation Phase:** ・ Because filling sections are unlikely to collapse, sedimentation on riverbed will not occur. ・ Erosion from borrow pit and quarry site by rainfall may cause sedimentation on riverbed until the recovery of vegetation. However, the effects will be in limited areas and for a short period.
Natural Environment				
9	Protected areas	C-	C-	**Construction Phase:** **Operation Phase:** ・ Because the target road passes alongside the line of transition zone in "Tonle Sap Biosphere Resave (TSBR)", indirect impacts on some components of the resave may occur. (An additional approval concerning TSBR will not be required.)
10	Ecosystem	B-	C-	**Construction Phase:** ・ Vegetation in roadside including trees will be lost by widening works. However, tree clearing of community or flooded forest will not be required. ・ Agricultural ecosystem will be lost or disturbed by construction works. ・ Turbid water caused by bridge construction is likely to affect aquatic life. **Operation Phase:** ・ Because the target road mostly passes through well developed area such as agricultural land and urban area, impact on biodiversity is unlikely to occur. ・ Because the distance between the target road and Tonle Sap lakeside is approximately 20 km at the nearest point and the area is mostly agricultural land, direct impact on ecosystem in Tonle Sap Lake

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				is unlikely to occur. ・ If embankment sections choke off existing surface water flow, impact on remote aquatic ecosystem may occur.
11	Hydrology	C-	C-	**Construction Phase:** ・ Water flow in the river or stream may be altered during construction works. But the impact will be temporary and in limited area. **Operation Phase:** ・ Because some project sites are located in flood plain, impact caused by newly constructed embankment sections or culverts on surface water flow may occur.
12	Geographical features	B-	D	**Construction Phase:** ・ Topography will be changed in bypass or embankment sections on a small scale. ・ Topography will be changed in borrow pit and quarry site. **Operation Phase:** ・ Impact on geographical features is unlikely to occur.
Social Environment				
13	Resettlement/ Land Acquisition	A-	D	**Pre-Construction Phase:** ・ Resettlement and additional land acquisition will be required. **Construction Phase:** ・ Temporal lease of land and additional small scale resettlement will be required. **Operation Phase:** ・ Additional physical resettlement and land acquisition will not be required.
14	Poor people	B-	B-	**Pre-Construction Phase:** **Operation Phase:** ・ Some of the poor people who do not have their own land living within Right of Way or Provisional Road Width will be seriously affected by resettlement and may lose their business opportunity.
15	Ethnic minorities and indigenous peoples	C-	D	**Pre-Construction Phase:** **Construction Phase:** ・ Road widening may cause resettlement or other impacts on Ethnic Cham and Vietnamese living along NR 5 **Operation Phase:** ・ Impact on ethnic minorities is unlikely to occur.
16	Local economies, such as employment, livelihood, etc.	B±	B±	**Pre-Construction Phase:** ・ Land acquisition and resettlement may cause livelihood degradation of Project Affected Persons (PAPs). **Construction Phase:** ・ Construction will create job opportunities to local people. ・ Bridge construction works may have impact on

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				local fishery. **Operation Phase:** ・ Reduction of travel time will contribute to local economies and promote tourism. ・ Change of access to local resources may widen gap in local economy.
17	Land use and utilization of local resources	B-	B+	**Construction Phase:** ・ Bypass sections will require change of land use such as from agricultural land to road. **Operation Phase:** ・ Especially in bypass sections, land use along NR 5 will be changed and be developed economically and socially. ・ Improved transportation will contribute to effective utilization of local resources.
18	Water usage	B-	C-	**Construction Phase:** ・ Existing agricultural canals located in roadside will be affected by widening works. **Operation Phase:** ・ Newly constructed embankment sections or culverts may change surface water flow.
19	Existing social infrastructures and services	B-	B±	**Pre-Construction Phase:** ・ Relocation or protection of existing utilities, such as electric poll, water pipe and optical fiber cable will be required. **Construction Phase:** ・ Temporary traffic congestion in construction site including NR 5 and other rural roads will occur. **Operation Phase:** ・ Access to social services will be improved. ・ Spilt of local communities or widening disparity may occur in bypass section.
20	Social institutions such as social infrastructure and local decision-making institutions	C-	C-	**Construction Phase:** **Operation Phase:** ・ Because of improvement project of existing road, considerable impact on social institutions is unlikely to occur. ・ Spilt of local communities or widening disparity may occur in bypass section.
21	Misdistribution of benefits and damages	C-	B-	**Pre-Construction Phase:** **Construction Phase:** ・ Because of improvement project of existing road, considerable misdistribution of benefit among local people is unlikely to occur. ・ Misdistribution of benefit among PAPs may occur. **Operation Phase:** ・ After the traffic flow is changed to new bypass, some shops along existing NR 5 (old route) will lose their business opportunity, while shops set up along bypass will make profit.
22	Local conflicts of interest	D	D	**Construction Phase:** **Operation Phase:** ・ Because of improvement project of existing road,

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				considerable impact on local conflict is unlikely to occur.
23	Cultural heritage	C-	C-	**Construction Phase:** ・ Bypass construction depending on the route and widening works may cause partial loss of religious or cultural properties. **Operation Phase:** ・ Road improvement will promote tourism and worship to religious heritage. Religious value may be spoiled by tourism development.
24	Landscape	B-	C-	**Construction Phase:** ・ Vegetation at existing roadside including high trees will be lost by widening works, and cause change of landscape. **Operation Phase:** ・ Because there are no protected scenic view areas, considerable impact on landscape is unlikely to occur.
25	Gender	C-	C-	**Construction Phase:** **Operation Phase:** ・ Impact on street venders, especially women, may occur.
26	Children's rights	D	B±	**Construction Phase:** ・ Considerable impact only on children's rights is unlikely to occur. **Operation Phase:** ・ Road improvement may cause traffic accident of children due to more traffic volume and faster vehicle speed. ・ Traffic venerable people including children can be separated safely from main vehicle lane.
27	Infectious diseases such as HIV/AIDS	B-	D	**Construction Phase:** ・ Infection risks of HIV/AIDS may be increased among construction workers and local business offering food and entertainment. **Operation Phase:** ・ Considerable impact on infectious diseases is unlikely to occur.
28	Working conditions (including occupational safety)	B-	D	**Construction Phase:** ・ Dust and emission gas caused by construction works may affect workers health. ・ Sanitary conditions around construction site may get worse due to waste from workers and toilet. **Operation Phase:** ・ Considerable impact on working conditions is unlikely to occur.
29	Accidents	B-	B±	**Construction Phase:** ・ Traffic accident may occur surrounding of construction site **Operation Phase:** ・ Traffic safety including pedestrians will be improved by road widening and vehicle separation ・ Traffic accident due to more traffic volume and

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				faster vehicle speed may increase ratio of traffic accident.
Other				
30	Trans-boundary impacts or climate change	B-	B±	**Construction Phase:** ・ Trans-boundary impacts including climate change will not occur. ・ Operation of construction equipment will generate CO_2. **Operation Phase:** ・ In the future, total amount of CO_2 emission from vehicles will increase. However, because of improved traffic efficiency, the amount may be reduced compared to without project.

A+/-: Significant positive / negative impact is expected.
B+/-: Positive / negative impact is expected to some extent.
C+/-: Extent of positive / negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
** Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"*

Table 15.4-2 Result of Environmental Scoping (2)

Sri Sophorn – Poipet Section

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
Pollution				
1	Air pollution	B-	B±	**Construction Phase:** ・ Operation of construction equipment will generate dust and emission gas. ・ Traffic congestion in construction site will cause increase in exhaust gas from vehicles. ・ Dust will occur in borrow pit and quarry site. **Operation Phase:** ・ In the future, total amount of air pollutant caused by vehicle exhaust gas will increase. However, because of improved traffic efficiency, the amount may be reduced compared to without project.
2	Water pollution	B-	C-	**Construction Phase:** ・ Bridge construction works will not be included in the target road. However, construction works in and around rivers or streams will cause turbid water. ・ In case of accidental massive leaking of fuel or oil, water pollution including ground water may occur. ・ Surface soil runoff by rainfall in road construction site, borrow pit and quarry site may cause surface water contamination. ・ Human wastewater will cause surface water contamination. **Operation Phase:**

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				・ Considerable water pollution is unlikely to occur. ・ Turbid water from borrow pit and quarry site by rainfall may cause surface water contamination until the recovery of vegetation.
3	Waste	B-	D	**Construction Phase:** ・ Construction waste caused by construction works and general waste from construction office will be generated. **Operation Phase:** ・ Waste is unlikely to increase newly.
4	Soil pollution	D	D	**Construction Phase:** ・ Because materials to cause soil pollution will not be used in the construction works, soil pollution is unlikely to occur. **Operation Phase:** ・ Because materials to cause soil pollution will not be used in the maintenance works, soil pollution is unlikely to occur.
5	Noise and vibration	B-	B-	**Construction Phase:** ・ Construction works is likely to increase in the noise and vibration level. ・ Noise and vibration will occur in borrow pit and quarry site. **Operation Phase:** ・ In the future, noise level caused by vehicle driving will increase. However, because right of way will be widened, the level on road side may be reduced compared to without project.
6	Ground subsidence	C-	C-	**Construction Phase:** ・ Subsidence near the road due to added soil weight may occur. **Operation Phase:** ・ Pressure of loading on road will be too low to cause, subsidence. However, because some portions of NR 5 run through flooded area, subsidence may occur.
7	Offensive odors	D	D	**Construction Phase:** ・ Because materials and equipment to cause offensive odors will not be used in the construction works, offensive odors are unlikely to occur. **Operation Phase:** ・ Because vehicles with incomplete combustion are few, exhaust gas from vehicles is unlikely to cause offensive odors.
8	Bottom sediment	D	D	**Construction Phase:** ・ Filled soil may be eroded by rain water and flow into rivers or streams, and accumulated on the bottom. However, the affected area will be limited only in the roadside. **Operation Phase:** ・ Because filling sections are unlikely to collapse, sedimentation on riverbed will not occur. ・ Erosion from borrow pit and quarry site by rainfall

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				may cause sedimentation on riverbed until the recovery of vegetation. However, the effects will be in limited areas and for a short period.
Natural Environment				
9	Protected areas	C-	C-	**Construction Phase:** **Operation Phase:** ・ Because the target road passes upstream area of transition zone in "Tonle Sap Biosphere Resave (TSBR)" and the distance between the target road and TSBR is approximately 7 km at the nearest point, indirect impacts on some components of the resave may occur. (An additional approval concerning TSBR will not be required.)
10	Ecosystem	B-	C-	**Construction Phase:** ・ Vegetation in roadside including trees will be lost by widening works. However, tree clearing of community or flooded forest will not be required. ・ Agricultural ecosystem will be lost or disturbed by construction works. ・ Turbid water caused by construction works in and around rivers or streams is likely to affect aquatic life. **Operation Phase:** ・ Because the target road mostly passes through well developed area such as agricultural land and urban area, impact on biodiversity is unlikely to occur. ・ Because the distance between the target road and Tonle Sap lakeside is approximately 80 km at the nearest point, direct impact on ecosystem in Tonle Sap Lake is unlikely to occur. ・ If embankment sections choke off existing surface water flow, impact on remote aquatic ecosystem may occur.
11	Hydrology	C-	C-	**Construction Phase:** ・ Water flow in the river or stream may be altered during construction works. But the impact will be temporary and in limited area. **Operation Phase:** ・ Because some project sites are located in flood plain, impact caused by newly constructed embankment sections or culverts on surface water flow may occur.
12	Geographical features	B-	D	**Construction Phase:** ・ Topography will be changed in embankment sections on a small scale. ・ Topography will be changed in borrow pit and quarry site. **Operation Phase:** ・ Impact on geographical features is unlikely to occur.

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
Social Environment				
13	Resettlement/ Land Acquisition	A-	D	**Pre-Construction Phase:** ・ Resettlement and additional land acquisition will be required. **Construction Phase:** ・ Temporal lease of land and additional small scale resettlement will be required. **Operation Phase:** ・ Additional physical resettlement and land acquisition will not be required.
14	Poor people	B-	B-	**Pre-Construction Phase:** **Operation Phase:** ・ Some of the poor people who do not have their own land living within Right of Way or Provisional Road Width will be seriously affected by resettlement and may lose their business opportunity.
15	Ethnic minorities and indigenous peoples	C-	D	**Pre-Construction Phase:** **Construction Phase:** ・ Road widening may cause resettlement or other impacts on Ethnic Cham and Vietnamese living along NR 5 **Operation Phase:** ・ Particular impact on only ethnic minorities is unlikely to occur.
16	Local economies, such as employment, livelihood, etc.	B±	B±	**Pre-Construction Phase:** ・ Land acquisition and resettlement may cause livelihood degradation of Project Affected Persons (PAPs). **Construction Phase:** ・ Construction will create job opportunities to local people. ・ Construction works in and around rivers or streams may have impact on local fishery. **Operation Phase:** ・ Reduction of travel time will contribute to local economies and promote tourism. ・ Change of access to local resources may widen gap in local economy.
17	Land use and utilization of local resources	B-	B+	**Construction Phase:** ・ Widening works will require land acquisition including agricultural or residential land. **Operation Phase:** ・ Land use along NR 5 will be changed and be developed economically and socially. ・ Improved transportation will contribute to effective utilization of local resources.
18	Water usage	B-	C-	**Construction Phase:** ・ Existing agricultural canals located in roadside will be affected by widening works. **Operation Phase:** ・ Newly constructed embankment sections or culverts may change surface water flow.

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
19	Existing social infrastructures and services	B-	B±	**Pre-Construction Phase:** ・ Relocation or protection of existing utilities, such as electric poll, water pipe and optical fiber cable will be required. **Construction Phase:** ・ Temporary traffic congestion in construction site including NR 5 and other rural roads will occur. **Operation Phase:** ・ Access to social services will be improved. ・ Spilt of local communities or widening disparity may occur in bypass section.
20	Social institutions such as social infrastructure and local decision-making institutions	C-	C-	**Construction Phase:** **Operation Phase:** ・ Because of improvement project of existing road, considerable impact on social institutions is unlikely to occur. ・ Spilt of local communities or widening disparity may occur due to widened road.
21	Misdistribution of benefits and damages	C-	D	**Pre-Construction Phase:** **Construction Phase:** ・ Because of improvement project of existing road, considerable misdistribution of benefit among local people is unlikely to occur. ・ Misdistribution of benefit among PAPs may occur. **Operation Phase:** ・ Because of improvement project of existing road, considerable misdistribution of benefit among local people is unlikely to occur.
22	Local conflicts of interest	D	D	**Construction Phase:** **Operation Phase:** ・ Because of improvement project of existing road, considerable impact on local conflict is unlikely to occur.
23	Cultural heritage	C-	D	**Construction Phase:** ・ Widening works may cause partial loss of religious or cultural properties. **Operation Phase:** ・ There are no major cultural heritages along the target road. ・ Because of improvement project of existing road, significant increase in visitors to religious or cultural heritages around the target road is unlikely occur.
24	Landscape	B-	D	**Construction Phase:** ・ Vegetation at existing roadside including high trees will be lost by widening works, and cause change of landscape. **Operation Phase:** ・ Because there are no protected scenic view areas, considerable impact on landscape is unlikely to occur.
25	Gender	C-	C-	**Construction Phase:** **Operation Phase:**

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
		Land acquisition Construction works	Existence Service	
				・ Impact on street venders, especially women, may occur.
26	Children's rights	D	B±	**Construction Phase:** ・ Considerable impact only on children's rights is unlikely to occur. **Operation Phase:** ・ Road improvement may cause traffic accident of children due to more traffic volume and faster vehicle speed. ・ Traffic venerable people including children can be separated safely from main vehicle lane.
27	Infectious diseases such as HIV/AIDS	B-	D	**Construction Phase:** ・ Infection risks of HIV/AIDS may be increased among construction workers and local business offering food and entertainment. **Operation Phase:** ・ Considerable impact on infectious diseases is unlikely to occur.
28	Working conditions (including occupational safety)	B-	D	**Construction Phase:** ・ Dust and emission gas caused by construction works may affect workers health. ・ Sanitary conditions around construction site may get worse due to waste from workers and toilet. **Operation Phase:** ・ Considerable impact on working conditions is unlikely to occur.
29	Accidents	B-	B±	**Construction Phase:** ・ Traffic accident may occur surrounding of construction site **Operation Phase:** ・ Traffic safety including pedestrians will be improved by road widening and vehicle separation ・ Traffic accident due to more traffic volume and faster vehicle speed may increase ratio of traffic accident.
Other				
30	Trans-boundary impacts or climate change	B-	B±	**Construction Phase:** ・ Trans-boundary impacts including climate change will not occur. ・ Operation of construction equipment will generate CO_2. **Operation Phase:** ・ In the future, total amount of CO_2 emission from vehicles will increase. However, because of improved traffic efficiency, the amount may be reduced compared to without project.

A+/-: Significant positive / negative impact is expected.

B+/-: Positive / negative impact is expected to some extent.

C+/-: Extent of positive / negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected

** Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"*

15.5 Alternative Analysis

15.5.1 Cross Section (Middle Section and Sri Sophorn - Poipet Section)

(1) Items of Evaluation

For the improvement of Middle Section and Sri Sophorn – Poipet Section of NR 5, three alternatives of cross section including 0 option were studied. Items of evaluating the alternatives are proposed as below, considering the objectives and adverse impacts of the Project:

(i) Social impact

Social impact, or resettlement of houses and households the impacts which needs diligent consideration. Thus, magnitudes of resettlement is adopted as one of the evaluation items.

(ii) Impact on natural environment

A road project may give some impact to natural environment. Thus this items is considered in evaluation of alternatives.

(iii) Impact on living environment/pollution

When traffic demand is not met, traffic congestion occurs and exhaust gas will increase. Thus, pollution is proposed as one of the evaluation items.

(iv) Traffic safety

Safe traffic is one of the most important aspects in road transport. Thus traffic safety is adopted as one of the evaluation items.

(v) Road/transport function

This refers to the performance of road whose function is to accommodate the traffic and serve for smooth, reliable and fast movement of people and goods. Strengthening of such function is the basic objective of the road improvement.

(vi) Construction cost/maintenance cost

This includes two sub-items. It is expected that improvement of the pavement can reduce the maintenance cost while such improvement need construction cost of the new pavement.

Table 15.5-1 compares advantages and disadvantages of these alternatives.

Table 15.5-1 Comparison of Alternatives of Improvement of Existing NR 5

Evaluation Rank 1st: ◎、2nd: ○、3rd: △、Improper: ×

Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
Traffic Characteristic			
Predicted traffic volume	Middle Section : 14,200 pcu/day in 2023 : 20,800 pcu/day in 2028 : 27,500 pcu/day in 2033	Sri Sophorn – Poipet :15,600 pcu/day in 2023 :20,200 pcu/day in 2028 :25,500 pcu/day in 2033	
Capacity of traffic volume (pcu)	× 19,000	◎ 40,000	× 19,000
Natural Environmental Impact			
Natural Environmental Impact	◎ There is no impact.	○ No great impact is anticipated since this project is widening of the existing road and project site is considerably distant from Tonle Sap Lake and its important natural reserves. However, minor negative impact may occur and diligent consideration to minimize the impacts is required.	○ Same as ALT-1.
Social Impact			
Resettlement, Loss of Agricultural Land	◎ No resettlement will be required. And, no loss of agricultural land is anticipated.	△ Large-scale resettlement is required. And, agricultural land along the road will be lost for by the road.	○ Although they will be less than ALT-1, resettlement of a great number and replacement of agricultural land will arise.
Impact on Living Environment / Pollution	× As traffic volume increases in the future, it will be likely that traffic congestion will arise. In that case, average driving speed being slower and the number of stop and go be increasing make the fuel consumption deteriorate. That will cause increase in	◎ It will not be likely that traffic congestion will arise if traffic volume increased in the future. Therefore increase of car exhaust will be prevented.	○ It is same as ALT-1 basically but the capacity of traffic is smaller than ALT-1. Therefore, traffic congestion will arise earlier than ALT-1 and emission of air-pollution substances will increase.car exhaust.

Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
	emission of air-pollution substances.		
Access to Public Service Facilities	△ Traffic will be not smooth and it will take more time to access schools, hospitals, etc.	◎ Access to public services, such as schools and hospitals,. will become easier as a result of smooth traffic.	○ It is same as ALT-1 basically but the condition of access to the facilities will be deteriorated sooner than that of ALT-1.
Impact on Socio-Economic Activity	× Hindered smooth traffic will obstacle to socio-economic activities. Then, it will affect the regional and country development.	◎ Smooth traffic will enhance socio-economic activities and regional development. The income level of the road side areas will be upgraded due to improvement of employment opportunity and consumption of local goods during the construction work.	○ Basically same sith ALT-1 but the traffic capacity is smaller than that in ALT-1. Therefore, traffic congestion will arise earlier than ALT-1 and affect the socio-economic activities.
Traffic Safety			
Vehicle to Vehicle	× Narrow carriage way width may result in accidents when vehicles overtake.	◎ Slow speed traffic, such as agricultural tractors, and high speed traffic, such as passenger cars, will be separated and traffic safety will be improved. Possibility of serious accidents such as head-on collision will be decreased elimination of necessity of overtaking using the lane in opposite direction.	○ Traffic safety will be improved, in less degree than that of ALT-1, because slow speed traffic and high speed traffic will be separated (but to less degree than in ALT-1). And, Possibility of serious accidents such as head-on collisioin will be decreased by that it will not be so frequently that overtaking vehicles use the oposite lane. Dangerousness of pedestrian crossing the road is smaller than that of ALT-1 because the carriageway width is narrower than that of ALT-1.
Dangerousness of Crossing Road by Pedestrians/farm animals	◎ Possibility of accidents when pedestrians/farm animals crossing road is the lowest among all of the alternatives because the carriage way	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of sufficiently wide median where pedestrians	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of sufficiently wide median.

Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
	width is the narrowest.	and animals can stand and wait passage of vehicles. However, traffic accidents of pedestrians crossing the road hit by high-speed vehicles may increase because of increased speed of vehicles.	
Road and Traffic Function	× As traffic volume increases, traffic congestion will occur and smooth traffic will not be achieved.	◎ Sufficient traffic capacity and smooth traffic will be achieved.	○ Traffic capacity of this alternative is smaller than that of ALT-1, therefore, traffic congestion of this alternative will occur earlier than that of Alt-1 and road widening will be needed again.
Economy			
Construction Cost	◎ No project cost is required.	△ Project including cost for resettlement, cost for road widening and cost for improvement of pavement. is necessary.	○ Cost for this alternative is smaller than that of ALT-1 since the work volume is smaller than that of ALT-1, resulting in reduced cost for resettlement and construction works.
Maintenance Cost	△ Middle Section: Fragile exiting pavement (DBST) is maintained resulting in high maintenance cost. Sri Sophorn – Poipet Section: The life of the existing road was rehabilitated in 2008. Sin the design life period of AC pavement is usually designed to be 10 years, rehabilitation with overlay or reconstruction will be necessary in a few years.	◎ Maintenance cost will be decreased because the pavement is improved to durable AC.	◎ Maintenance cost will be decreased because the pavement is improved to durable AC.

Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
Total Evaluation	×	◎（Recommended）	○
	ALT-1 of the highest total evaluation is recommended. Views on the evaluation items of ALT-1 that are evaluated lower compared to other alternatives are as follows. ・"Construction Cost" of ALT-1 is the largest, however ALT=1 yields largest socio-economic benefits. ・Negative social impacts (resettlement and loss of agricultural land) and negative natural environmental impact of ALT-1 is larger than those of other alternatives. However these impacts are considered to be the minimum for achieving the objectives of the Project (achieving socio-economic development of Cambodia and enhancing integration of regional economy through enhancing transport capacity, improving transport efficiency, and improving traffic safety).		

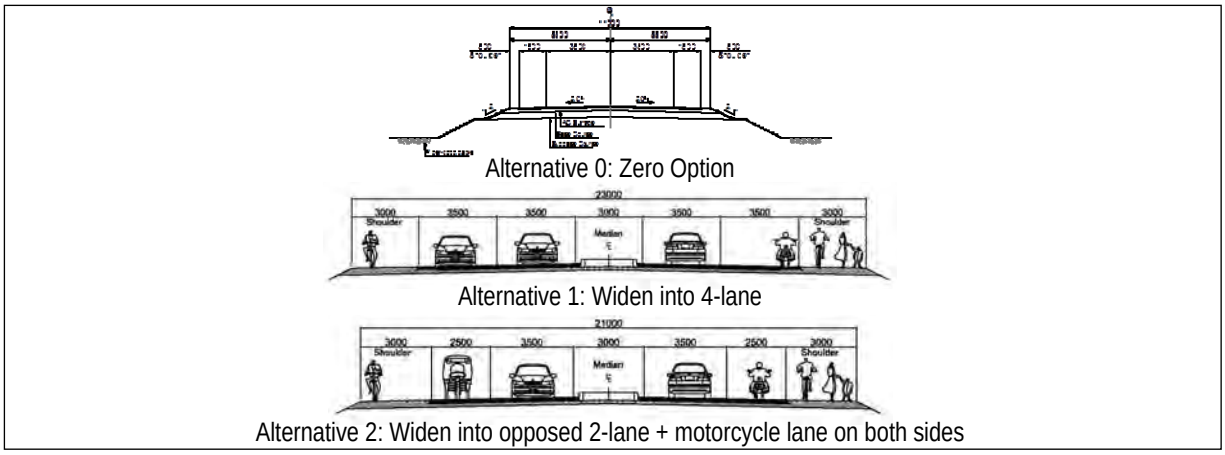


Figure 15.5-1 Typical Cross Sections of Alternatives (General Section)

(2) Overall Evaluation

Overall Evaluation of each alternative is summarized below:

- Alternative-0 (Zero Option):

While this option causes minimum or no negative impacts with regard to social impact (resettlement) and construction cost and causes no impact to natural environment, it will not solve the problems associated with traffic congestion which lead to hampered socio-economic activities and regional development, as well as increase in risk of traffic accident and pollution.

- Alternative-1 (Widening into 4 Lanes)

While this Alternative causes the largest negative impact with regard to social impact (resettlement) and construction cost, it is expected to promote socio-economic activities and regional development and reduce future risk of traffic accident and pollution to the maximum degree among the alternatives. It should be noted that increase in traffic capacity may induce a new demand in road traffic and cause increase in the total emission of pollutants.

While there remains the possibility of impact to the natural environment, it is expected to be small. Negative impact of resettlement is unavoidable in this alternative and need diligent mitigation measures such as compensation.

Another negative impact of Alternative-1 is split of local communities. This is caused by widening of the road width and increase of vehicle speed which make crossing of road difficult. This negative impact can be mitigate to certain degree by providing facilities which assist safe crossing, such as pedestrian crossing road marking, rumble strip on pavement surface and traffic signs to reduce vehicle speed.

The government Cambodia has accumulated experiences in resettlement and is expected to practice it best effort to mitigate the negative impacts. This alternative is expected to fully achieve the objectives of the Project by eliminating traffic congestion which will occur unless some measure is taken.

- Alternative-2 (Widening into 2 Lanes + Motorcycle Lane)

This alternative has an advantage that the degree of negative social impact (resettlement) is smaller than that in Alternative-1. It can accommodate increased traffic demand up to less than 10 years after completion of the Project. Thus, widening into full 4-lane will be needed over sections of considerable length within 10 years after completion of the Project. Thus, this Alternative cannot fully achieve the objectives of the Project.

(3) Recommendation

As stated above, Alternative-1 is evaluated to achieve the objectives of the Project. On the other hand it requires considerable extent of resettlement which needs diligent mitigation measures including adequate compensation and restoration of income and other aspects of resettled people. Thus, Alternative-1 was recommended by the JICA Survey Team, with condition of proper mitigation measures be taken for negative impacts as discussed above. After discussions among relevant organizations including MPWT, DPWT and JICA Team, Alternative-1 was adopted.

15.5.2 Pursat Bypass

(1) Objective and Adverse Impacts of Bypass Construction

The main objectives of constructing bypass are as follows:

- To avoid large scale resettlement which becomes necessary if the exiting NR 5 is to be widened,
- To reduce/mitigate the traffic accidents and pollutions which are caused by traffic passing through the urbanized area of the city/town, and
- To induce desirable form of urban development

While construction of a bypass brings about favorable impact on traffic flow, traffic safety, pollution and urban development, it is possible that it causes some adverse impacts. First, it needs new acquisition of considerable area of land (mainly rice fields), as an adverse impact. Also, construction of road embankment in rice field may cause some impact on ecology and natural environment.

(2) Alternatives and Evaluation Items

For Pursat Bypass of NR 5, six alternatives were studied. Items of evaluating the alternatives are proposed as follows:

- Advantage
- Disadvantage including impact on natural environment in TSBR
- Number of Houses to be Relocated
- Total Cost

Table 15.5-2 compares advantages and disadvantages of these alternatives.

Table 15.5-2 Comparison of Alternative Routes of Pursat Bypass

Evaluation Rank 1st: ◎、2nd: ○、3rd: △、Improper: ×

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
Description	Widen existing NR 5.	Long detour route on the north side of the city.	Short detour on the north side of the city.	Set intersections of BP with NR 5 at the roundabouts with monument which are located 5 km or more distant from the urbanized area.	Short detour on the south side of the city. Flyovers are constructed for railroad crossings at 2 locations .	Set intersections of BP with NR 5 at the roundabouts with monuments which are located 5 km or more distant from the urbanized area. Flyovers are constructed for railroad crossings at 2 locations.
Natural Environmental Impact						
Impact on Natural Environment	◎ There is no big impact.	○ The biosphere might be split because new road will be constructed at the outskirt. Construction of a new road in the suburbs of the existing town area may accelerate expansion of urbanized area.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.
Social Impact						
Resettlement, Loss of Agricultural Land	× Widening of existing road passing town area still cause much resettlement. Resettlement is the largest among all the alternatives. Loss of agricultural	◎ Magnitude of resettlement is the smallest because this route is the farthest from the town. Loss of agricultural land is the 3rd smallest because the length of the route is the 3rd shortest.	× Magnitude of resettlement is the second largest. Loss of agricultural land is the second smallest because the length of the route is the second	× Resettlement is the third largest. Loss of agricultural land is relatively large because the length of the route is the second longest.	△ Resettlement is the third smallest. Loss of agricultural land is the smallest because the length of the route is the shortest.	○ Resettlement is the second smallest. Loss of agricultural land is the largest because the length of the route is the longest.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	land is minimum.		shortest.			
Impact on Living Environment / Pollution	○ Traffic passing the town will make more noise, vibration and air pollution.	◎ Traffic passing through the town will decrease and noise, vibration and pollution in the town will decrease. Noise, vibration and air pollution will be newly created on the bypass but times of stopping and starting will be decreased. Total impact on the living environment will be smaller compared to that in "Widen Existing NR 5".	◎ Mostly same as N-1.	◎ Mostly same as N-1.	◎ Mostly same as N-1.	◎ Mostly same as N-1.
Impact on Socio-Economic Activity	○ Efficiency of transport is lower than those of other alternatives because vehicles passing the town needs to stop at traffic signals.	◎ Smoother traffic than that of "Widen Existing NR 5" will enhance socio-economic activities and promote development of the region.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.
Traffic Safety						
Traffic Safety	× Increased number of vehicles passing the town will worsen the situation of traffic accidents.	◎ Number of traffic accidents in the town will decrease because of decreased number of vehicle passing the town. Meanwhile, traffic accidents in the bypass will occur newly but the total number of traffic accidents will decrease	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.	◎ Same as N-1.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
		because the bypass does not pass the urbanized area.				
Traffic Function						
	○	○	○	△	○	△
Advantage	・Shortest travel distance	・ Smooth connection with existing NR 5 ・ The function of bypass can be maintained for long time in the future even if the urbanized area will expand.	・ Smooth connection with existing NR 5	・ Intersections are sufficiently remote from the urbanized area and remain outside of the urbanized area.	・ Increase in travel distance is the smallest. ・ No serious influence to future expansion of the urbanized area.	・ Intersections are sufficiently remote from the urbanized area and remain outside of the urbanized area.
Disadvantage	・ Vehicles passing the town will stop at traffic signals. ・ Time required for pedestrians to cross the road will become longer resulting in decrease in travel speed.	・ Travel distance will be the longest.	・ The function of the bypass may be reduced as the urbanized area will expand and be close to the bypass in the near future. ・ Travel distance is the second longest.	・ Vehicles are forced to slow down at the intersection on the east which is T-shaped with roundabout.	・ Steep longitudinal grade on the both sides of the flyovers for railroad crossing.	・ Vehicles are forced to slow down at the intersection on the east which is T-shaped with roundabout. ・ Steep longitudinal grade on the both sides of the flyovers for railroad crossing.
Acceptance by PAPs						
Acceptance by PAPs	◎ People along the road generally welcome the road improvement because: ・ The land price becomes higher,	○ People having land along bypass generally welcome because: ・ The land price becomes higher, ・ Smooth traffic is ensured	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.	○ Mostly same as N-1.

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	・ Smooth traffic will be ensured and access to school, hospital, etc. becomes easier, ・ Dust from road is mitigated.	and access to schools hospital, etc. becomes easier.				
Economy						
Construction Cost	◎	△	○	×	×	×
Numeric Data						
Length (km) of construction(BP) + improvement(NR 5)	10.8	12.5	11.9	11.8	11.6	11.8
Length (km) of Bypass	---	8.8	7.7	10.4	5.8	11.8
No. of Houses to be Relocated	240	17	78	55	25	18
Total Cost (US$ Million)	22.6	35.3	31.1	37.7	49.4	60.9
BP. Construction	0	29.4	24.3	33.8	41.9	58.1
Widen NR 5	20.2	3.3	4.5	1.2	5.2	0
Resettlement	2.4	1.3	1.4	1.1	1.4	1.1
Land Acquisition	0	1.3	1.0	1.6	0.9	1.8
		◎(Recommended)	○	△		
Total Evaluation	"Widen Existing NR 5" is not recommended because; the number of houses to be relocated is very large (around 240), although the impact on natural environment of this alternative is minimal,. Alternatives "S-1" and "P-1" are not recommended because; these alternatives pass the southern side of the city crossing the railroad at two location. This result in very high construction costs compared to other alternatives passing the northern side of the city. Thus, N-1, N-2 and N-3 are compared.					

Alternative	Widen Existing NR 5	N-1	N-2	N-3	S-1	P-1
	N-1 has the following advantages to N-2 and N-3: ・N-1 can allow future expansion of the city with maintaining the function of the bypass for a long time because its route is located distant from the exiting urbanized area. ・Number of houses to be relocated is the minimum Considering the above, N-1 is recommended.					

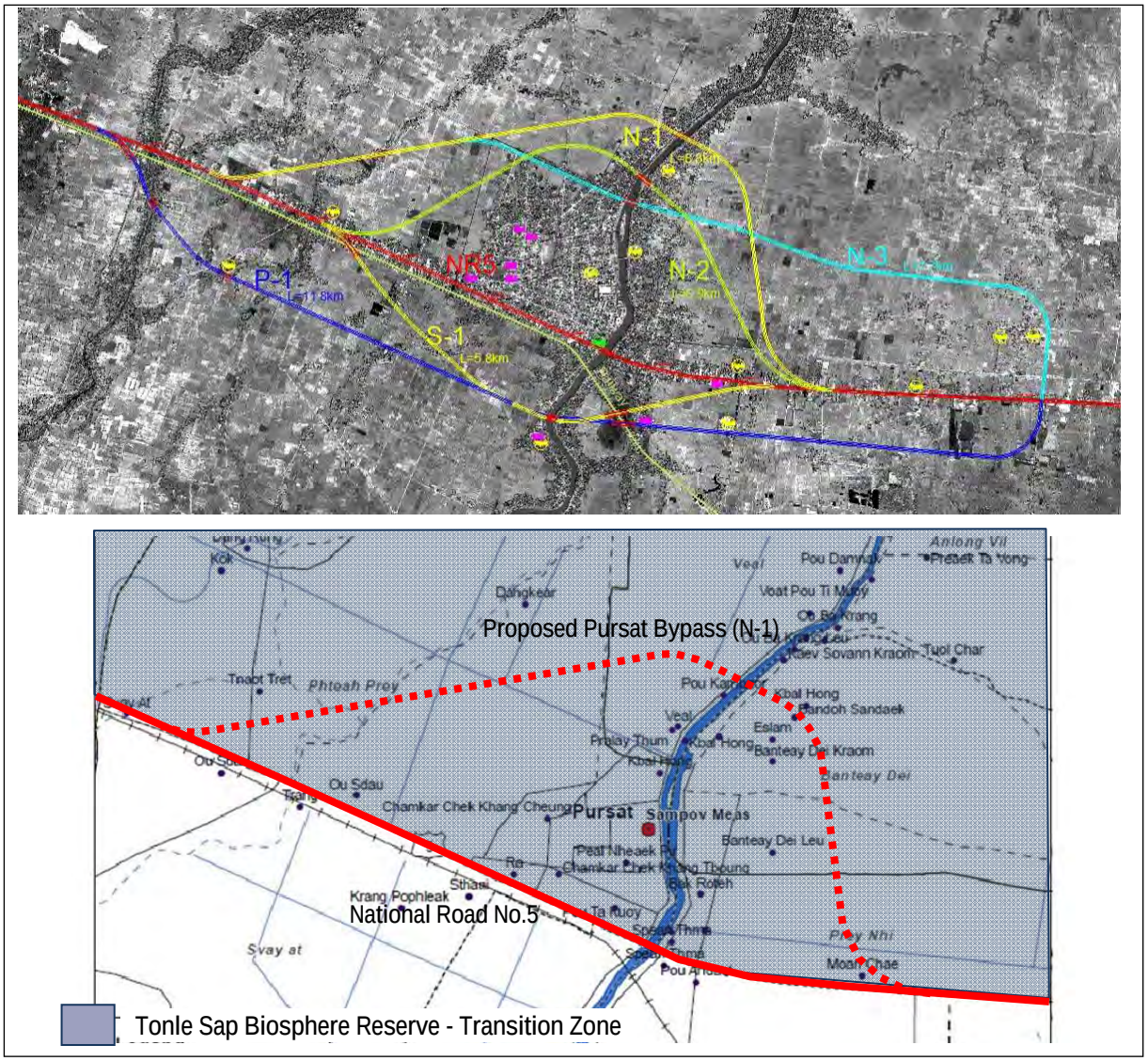


Figure 15.5-2 Alternative Routes of Pursat Bypass

(3) Impact Assessment

➢ Negative Impact on natural environment and TSBR

The N-1, N-2 and N-3 routes pass through the transition zone of TSBR. The areas in and around these bypass routes are mostly irrigated rice field or partially residential zone. The bypass construction of the N-1, N-2 or N-3 routes is unlikely to loss natural vegetation including flooded forest. On the other hand, because Pursat River, agricultural canals and streams in the bypass routes are migration pathways for aquatic life especially in rainy season, the newly constructed bypass may change the hydrological conditions of surface water and have an impact on the migration of aquatic life. However, this impact can be mitigated by installation of bridges and/or culverts with sufficient flow capacity.

➢ Resettlement

"Widen existing NR 5" requires large scale resettlement that is difficult to implement. The

resettlement number of N-1, S-1 or P-1 is much less than one of S-2 or S-3.

- Land Use and Town Planning

Town development plan of Pursat has not prepared yet. However, Pursat government will formulate the town planning to accommodate the future development supported by ADB. Because the N-2, N-3 or S-1 route is close to existing urban area, land use plan in the town planning may be limited by these bypass routes. The N-1, N-3 or P-1 route require much land acquisition in agricultural land.

(4) Recommendation:

After discussions on the best route to achieves the objectives of bypass construction and environmental and social impacts among organizations concerned including MPWT, Ministry of Water Resources and Meteorology (MOWRM), all relevant department in Pursat government and JICA Team, "N-1 route" was selected by following reasons:

- No railroad crossing
- Smooth connection with existing NR 5
- Number of resettlement is the least in all alternative routes.
- Total cost is relatively lower.

Considering that this route best achieves the objectives of bypass construction, this route (alternative) was recommended.

It should be noted that the official letter from the Minister of MOWRM, who also holds the chairperson of Tonle Sap Authority (TSA) coordinating the management of TSBR, suggests that the permission should not be required, however considerations for the existing irrigation systems and conservation of present water flow as the conditions should be needed. Therefore, sufficient number of bridges and/or culverts need to be provided not to substantially change the current flow of surface water and pass for aquatic life.

15.6 Environmental Impacts and Mitigation Measures

15.6.1 Prediction of Environmental Pollution

(1) Prediction of Air Pollution and CO_2 Emission

According to the traffic demand forecast estimated in this survey, the total traffic demand in the each forecasted station in 2018 will increase by 158 ~ 206 percent as Passenger Car Unit from the traffic volume in 2012. Air pollutants and CO_2 emitted by the vehicle traffic will also increase. The total emission volume of SPM (Suspended Particulate Matter), NOx (Nitrogen oxide) and CO_2 emitted by the vehicle traffic from the whole of the target sections (148 km long) in 2018 and 2023 is estimated in case of "With Project" and "Without Project" at a preliminary level. Because the project will not complete in 2018, the emission volume of " in 2018" and "With Project" is estimated as an assumption.

The "total emission volume" is calculated as:

$$BR_i = \sum_j \sum_l (Q_{ijl} \times L_l \times \beta_j) \times 365 \div 1{,}000{,}000$$

where:

BR i	: Total Emission Volume in case of development i (ton/year)
Qi j l	: Traffic Volume in case of development i, link l and vehicle type j (number/day)
Ll	: Length of link l (km)
β *j*	: Emission factor by vehicle type j (gram/ (number*km))
j	: vehicle type
l	: link

Source: Objective Evaluation Index by Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2003

The emission factors are calculated on the basis of "Grounds for the Calculation of Motor Vehicle Emission Factors using Environment Impact Assessment of Road Project etc. (Revision of FY 2010, National Institute for Land and Infrastructure Management, Japan". The details of the used calculation method are presented in Appendix 15-4.

The result of traffic volume forecast, average vehicle travel speed and emission factors to estimate the total emission volume are shown in Table 15.6-1.

Table 15.6-1 Traffic Volume, Average Vehicle Speed and Emission Factors

Item	Motorcycle	Light Vehicle	Heavy Vehicle
Traffic Volume in 2012 (Present Condition, Without Project) (number*km/day)	117,810	161,074	116,216
Traffic Volume "Without Project" in 2018 (number*km/day)	191,688	348,853	164,534
Traffic Volume "With Project" in 2018 (number*km/day)	272,575	365,892	166,049
Traffic Volume "Without Project" in 2023 (number*km/day)	348,317	487,537	219,644

Item	Motorcycle	Light Vehicle	Heavy Vehicle
Traffic Volume "With Project" in 2023 (number*km/day)	369,548	497,061	223,471
Average Vehicle Speed in 2012 (Present Condition, Without Project) (km/hr)	50.00	50.00	50.00
Average Vehicle Speed "Without Project" in 2018 (km/hr)	49.99	49.99	49.99
Average Vehicle Speed "With Project" in 2018 (km/hr)	59.30	59.30	59.30
Average Vehicle Speed "Without Project" in 2023 (km/hr)	48.54	48.54	48.54
Average Vehicle Speed "With Project" in 2023 (km/hr)	59.30	59.30	59.30
Emission Factor SPM in 2012 (Present Condition, Without Project) (g/ (number*km))	0.00053	0.00159	0.04118
Emission Factor SPM "Without Project" in 2018 (g/ (number*km))	0.00053	0.00159	0.04119
Emission Factor SPM "With Project" in 2018 (g/ (number*km))	0.00050	0.00151	0.03727
Emission Factor SPM "Without Project" in 2023 (g/ (number*km))	0.00054	0.00163	0.04208
Emission Factor SPM "With Project" in 2023 (g/ (number*km))	0.00050	0.00151	0.03727
Emission Factor NOx in 2012 (Present Condition, Without Project) (g/ (number*km))	0.019	0.058	1.138
Emission Factor NOx "Without Project" in 2018 (g/ (number*km))	0.019	0.058	1.138
Emission Factor NOx "With Project" in 2018 (g/ (number*km))	0.018	0.053	1.075
Emission Factor NOx "Without Project" in 2023 (g/ (number*km))	0.020	0.059	1.159
Emission Factor NOx "With Project" in 2023 (g/ (number*km))	0.018	0.053	1.075
Emission Factor CO_2 in 2012 (Present Condition, Without Project) (g-CO_2/ (number*km))	45.6	136.9	667.9
Emission Factor CO_2 "Without Project" in 2018 (g-CO_2/ (number*km))	45.6	136.9	668.0
Emission Factor CO_2 "With Project150" in 2018 (g-CO_2/ (number*km))	43.8	131.3	633.5
Emission Factor CO_2 "Without Project" in 2023 (g-CO_2/ (number*km))	46.1	138.3	676.3
Emission Factor CO_2 "With Project150" in 2023 (g-CO_2/ (number*km))	43.8	131.3	633.5

** Source: CO_2 Emissions from Fuel Combustion Highlight, 2012 by International Energy Agency*

The result of estimation of the total emission volume is shown in Figure 15.6-1. The total emissions of SPM, NOx and CO_2 in 2023 in case of "Without Project" increase approximately twice as large volume as in 2012. On the other hand, the volumes of SPM, NOx and CO_2 in case of "With Project" are approximately 9.4, 5.8 and 3.9 percent less than "Without Project" ones, respectively.

The CO_2 emission in 2018 in case of "Without Project" increases approximately 22,000 ton/year from the emission in 2012. The increasing amount is approximately equal to 1.5% of

the CO_2 emission (1.5 million ton: Source "CO_2 EMISSIONS FROM FUEL COMBUSTION Highlights (2012 Edition) by International Energy Agency") from the road transport sector in Cambodia in 2010.

Because the emissions factors will change in the future due to improvement in vehicle efficiency, the recalculation should be considered at the future stage.



Figure 15.6-1 Result of Estimation of Total Emission Volume

Air pollutant levels of SPM and NO_2 emitted by vehicles during operation phase on the roadside are predicted by using a ambient air pollution dispersion model (Plume Model) on the basis of "Environmental Impact Assessment Technique for Road Project No.383-400, June 2007, National Institute for Land and Infrastructure Management, Japan". Plume Model is a general dispersion model used in case of more than 1 m/s wind velocity. The details of the used model are presented in Appendix 15-4.

Because the wind data in the project site are insufficient to calculate pollutant levels of a day and each station forecasted the traffic volume mentioned in "Chapter 5 Future Traffic Demand Forecast", the pollution levels of the forecasted station No. 4, at the eastern suburb of Pursat town, in 2023 after completion of Pursat Bypass, are only calculated as the worst case. This point is forecasted the most traffic volume at the peak traffic volume hour in the target sections.

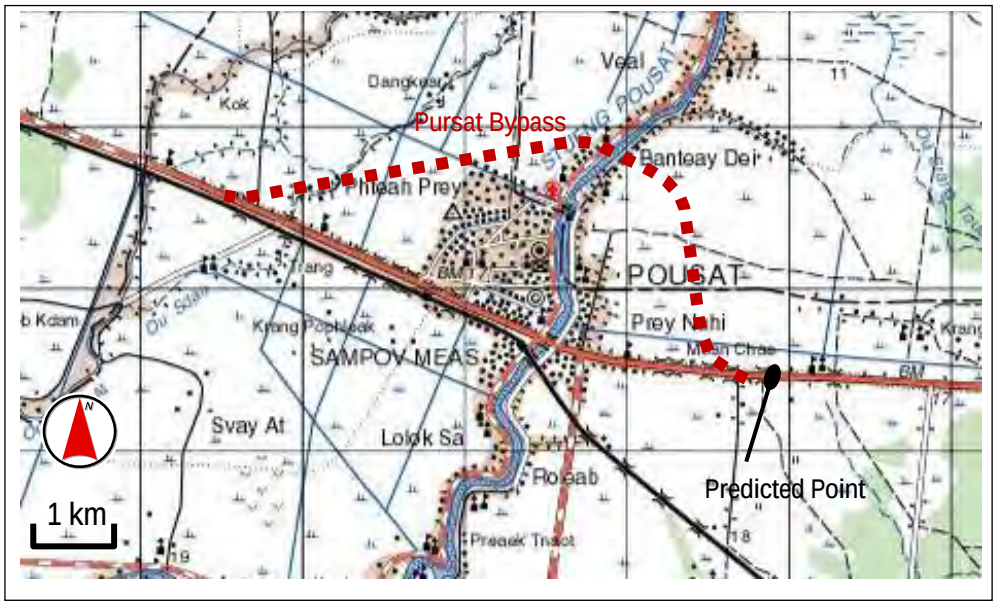


Figure 15.6-2 Point Predicted Air Pollutant Level

The result of air pollutant levels caused by vehicle emission on the roadside is shown in Table 15.6-2. The predicted pollutant levels are very low and these contribution amounts to ambient air quality will not be considerable concentration.

Table 15.6-2 Predicted Air Pollutant Level Caused by Vehicle Emission on Roadside

Parameter	West wind (2 m/s) (Along road direction)	South Wind (2 m/s) (Right angle to road direction)	Cambodia Ambient Air Quality Standard
SPM (mg/m^3)	0.00030	0.00026	0.05* (PM10, 24 Hour)
NO_2 (mg/m^3)	0.0048	0.0042	0.3 (1 Hour)

The asterisk (*) refers to WHO's Standards

(2) Prediction of Noise Level

According to the noise survey, the levels along the target road are less than the environmental standards in the daytime. However, in the future, the noise levels may rise by the environmental standard due to increased traffic volume and speed. The level at the eastern suburb of Pursat town that is a same point as "Air Pollution" in this report in 2023 is predicted by a brief calculation method of LAeq under simple condition in "ASJ RTN-Model 2008 by The Acoustical Society of Japan". The details of the used calculation method are presented in Appendix 15-4.

The result of noise levels caused by vehicle traffic at the end point of road (roadside), on 15 m line from road center and borderline between the ROW and private land are shown in Table 15.6-3. The predicted noise levels on the roadside are higher than the standards during all day. The noise level on 15 m line from road center is almost same as the standard during 6:00 ~ 22:00. The noise levels on the borderline are lower than the standards during 6:00 ~ 22:00. The noise level during 22:00 ~6:00 on the borderline is 7 dB higher than the standard. However, actual noise levels around houses located along the road become lower than the predicted levels depending on the distance to the road and an existing fence.

Table 15.6-3 Predicted Noise Level Caused by Vehicle Traffic on Roadside

Time	6:00 to 18:00	18:00 to 22:00	22:00 to 6:00
Predicted Noise Level (dB) at end point of road (11.75 m from road center)	71	66	62
Predicted Noise Level (dB) on 15 m line from road center	69	65	60
Predicted Noise Level (dB) on borderline (30 m from road center)	66	61	57
Cambodia Maximum Noise Level Standard (Commercial and service and mix area) (dB)	70	65	50

15.6.2 Impact and Mitigation

The potential impacts by the magnitude are shown in Table 15.6-4, 15.6-5 and 15.6-6. The recommended mitigation measures for each identified impact are also presented in these tables.

(1) Significant or Large Impact Items

Table 15.6-4 Impacts and Mitigation Measures (Significant Impact)

Item	Impact	Mitigation
Social Environment		
Resettlement/ Land Acquisition	**Pre-Construction Phase:** ・ Resettlement and additional land acquisition will be required. ・ Affected households including partial asset losses may be more than 1,800 in Middle section and 500 in Sophorn – Poipet section. **Construction Phase:** ・ Additional small scale land acquisition and resettlement may be required. ・ Temporal lease of land will be required for construction yard. **Operation Phase:** ・ Additional physical resettlement and land acquisition will not be required.	**Pre-Construction Phase:** ・ Authorities concerned shall prepare and strictly implement a proper Resettlement Action Plan (RAP) and Land Acquisition Plan (LAP) (see Chapter 16 Resettlement Action Plan). **Construction Phase:** ・ Authorities concerned shall implement the RAP and LAP. ・ The contractor shall provide proper compensation for construction yards to land owners or users. **Operation Phase:** -

(2) Substantial Impact Items

Table 15.6-5 Impacts and Mitigation Measures (Substantial Impact)

Item	Impact	Mitigation
Environmental Pollution		
Air pollution	**Construction Phase:** ・ Operation of construction equipment will generate dust and emission gas. ・ Traffic congestion in construction site will cause increase in exhaust gas from vehicles. ・ Dust will occur in borrow pit or quarry site. **Operation Phase:** ・ In the future, total amount of air pollutant caused by vehicle exhaust gas due to increment of vehicle will increase. In 2023, the total emission will increase approximately twice as large volume as in 2012. ・ On the other hand, the amount is expected to be decreased about 10% due to improved traffic efficiency compared to without project.	**Construction Phase:** ・ The contractor shall prepare and strictly implement dust control measures such as periodical water spray. ・ The contractor actively uses electrically-powered equipment. ・ The contractors shall maintain their construction equipments in adequate working conditions. ・ The contractors shall keep clean road surfaces. ・ The driver of construction vehicles comply with speed limits to minimize road dust. ・ The contractor and supervision consultant shall provide prior notification to the local community on the schedule of construction activities. ・ The contractor shall prepare and strictly implement a traffic management plan around construction site. ・ The supervision consultant shall monitor dust, exhaust gas and complaint from the local people. ・ If the local residents and pedestrians complain about the dust and gas, the supervision consultant and contractors should reconsider the construction technique and method. **Operation Phase:** ・ The regulations on fuel quality and importing old cars are to be prepared by MOE in the future. ・ Emission gas control shall be strictly implemented. ・ A relevant agency shall monitor air quality on roadside.
Water pollution	**Construction Phase:** ・ Turbid water caused by construction	**Construction Phase:** ・ Construction works in and around rivers, streams,

Item	Impact	Mitigation
	works is likely to affect existing surface water resources. ・ Human wastewater will cause surface water contamination. ・ In case of accidental massive leaking of fuel or oil, water pollution including ground water may occur. ・ In case of inadequate management in borrow pit or quarry site, turbid water from borrow pit or quarry site by rainfall may cause surface water contamination. **Operation Phase:** ・ Considerable water pollution is unlikely to occur. However, because of concentration of residences and shops along NR 5, domestic waste water from road side buildings may cause water contamination. ・ In case of inadequate management or recovery in borrow pit or quarry site, turbid water from borrow pit or quarry site by rainfall may cause surface water contamination.	reservoirs or channels shall be concentrated in dry period. ・ The contractors shall maintain their construction equipments in adequate working conditions. ・ To reduce turbid water, steel sheet pile construction method should be selected in bridge construction works as necessary. ・ The contractor should consider installation of cofferdam as necessary. ・ The contractor shall strictly control waste oil and other waste. ・ The contractors will be prohibited from washing the construction tools along the rivers, streams, reservoirs and other public water to prevent further pollution. ・ In construction works in and around rivers streams, reservoirs or channels, the supervision consultant and contractor should monitor and control the turbid water as necessary. ・ The wastewater septic tank facility in the workers camp and/or other necessary locations shall be properly maintained. ・ The supervision consultant shall monitor water quality. ・ The contractor and supervision consultant shall take into account the environmental impacts such as water contamination caused by turbid water and soil erosion in selection of borrow pit and quarry site. ・ The contractor shall prepare and strictly implement an environmental management plan including adequate drainage to avoid accumulation of stagnant water and vegetation recovery plan in borrow pit or quarry site. ・ In case of development of new borrow pit or quarry site, necessary approvals from environmental authorities shall be obtained prior to the operation. ・ In case of purchase from quarry firm, a task on the environmental management should be included in the contract. **Operation Phase:** ・ All local governments along NR 5 should formulate waste water management plans in the future. ・ MPWT shall monitor environmental condition in abandoned borrow pit or quarry site. ・ If the condition has risk of soil erosion in borrow pit or quarry site, MPWT should consider and implement the countermeasures.
Waste	**Construction Phase:** ・ Construction waste caused by construction works and general waste from construction office will be generated. ・ Solid waste due to demolish works of facilities in the ROW will generate. **Operation Phase:** ・ Illegal dumping sites of solid waste	**Construction Phase:** ・ The contractor shall prepare and strictly implement a proper waste management plan including waste due to demolish works. ・ The waste management plan should be approved by the local relevant authority in advance of construction works. ・ The contractors shall provide temporary sanitation facilities such as portable toilets and garbage bins

Item	Impact	Mitigation
	may emerge along the newly constructed bypass.	to ensure that the domestic wastes to be generated by the construction personals. ・ The solid waste should be separated into hazardous, non-hazardous and reusable waste streams and store temporary on site. ・ Office building for construction contractor shall be provided with toilets and septic tanks to handle domestic sewage. ・ The contractor shall consider and implement proper re-use and recycle plans of the construction waste. ・ The supervision consultant shall monitor the waste disposal ・ The local relevant authority should maintain closely consultation with the contractor on the collection of garbage. **Operation Phase:** ・ Provincial authority including DPWT should monitor and control illegal dumping along NR 5. ・ The local government should conduct campaigns to stop waste dumping. ・ To prevent illegal dumping, all local governments along NR5 should formulate domestic waste management plans in the future.
Noise and vibration	**Construction Phase:** ・ Construction works is likely to increase in the noise and vibration level. ・ Noise and vibration will occur in borrow pit or quarry site. **Operation Phase:** ・ In the future, noise level caused by vehicle driving will increase. In 2023, the noise level will be same as the standards during 6:00 ~ 18:00 and 18:00 ~ 22:00. The levels during 22:00 ~6:00 are about 10 dB higher than the standard. ・ On the other hand, noise levels along roadside are expected to be reduced due to widening and improved smooth surface with hot asphalt concrete pavement compared to without project. ・ In the future, vibration level caused by vehicle driving will increase. However, because the present vibration levels at the roadside are lower than "the threshold level of vibration sense", serious impact of vibration on the local people is unlikely to occur in road sections with good surface condition.	**Construction Phase:** ・ A proper work schedules should be prepared not to concentrate the construction equipment at a certain point for long time. ・ The contractors shall maintain their construction equipments in adequate working conditions. ・ Construction works with heavy noise and vibration shall be prohibited during night (10:00 pm - 6:00 am) to avoid noise disturbance in residential, commercial and other noise-sensitive areas. ・ The contractor selects quiet equipment and working methods as much as possible. ・ The contractor and supervision consultant shall provide prior notification to the local community on the schedule of construction activities. ・ The supervision consultant shall monitor noise, vibration and complaint from the local people in construction site, borrow pit and quarry site. ・ If the local residents and pedestrians complain about the noise and vibration, the supervision consultant and contractors should reconsider the construction technique and method. **Operation Phase:** ・ The proper countermeasures to reduce noise and vibration such as slow speed in curve sections should be included in the plan and design. ・ A relevant agency shall monitor noise and vibration on roadside. ・ If the noise level reaches a significant level such as exceeding the environmental standards, the relevant agency should consider and implement mitigation measures on noise control.

Item	Impact	Mitigation
Natural Environment		
Protected areas	**Construction Phase:** · Because the distance between the target sections of NR 5 and the core areas of TSBR is approximately 30 km at the nearest point or sufficient long, the impacts on the core areas are unlikely to occur. · Because the distance between the target sections of NR 5 and Roniem Daun Sam Wildlife Sanctuary is approximately 10 km at the nearest point or sufficient long, and the land use between NR 5 and the sanctuary is mostly paddy field, the impacts on the sanctuary are unlikely to occur. · Because the proposed Pursat Bypass will pass through the transition zone of "Tonle Sap Biosphere Reserve (TSBR)", impact on the agricultural activities such as existing irrigation systems and paddy fields in TSBR are likely to occur. · Because the construction works for widening will be limited within the ROW of NR 5 or the outside of TSBR, the direct impacts on natural resources in transition zone are unlikely to occur. · Rivers or streams that have direct and/or indirect connections with TSBR will be temporarily disturbed by construction works. · The construction works for widening will require loss of existing vegetation along the transition zone of TSBR. **Operation Phase:** · Because natural tree clearing and change of river flow will not be required, direct impacts on the natural resources in TSBR are unlikely to occur. · The project is unlikely to cause new environmental issues or deteriorate existing issues in TSBR. · However, because the proposed Pursat Bypass will pass through the transition zone and existing NR 5 runs alongside the line of the transition zone, indirect impacts on the natural resources may occur sometime in the future.	**Construction Phase:** · In Pusat Bypass section, to maintain existing surface flow condition including irrigation systems, newly constructed bridges and culverts should have sufficient flow capacity and be installed at same locations as existing flow. · Vegetation loss for land clearing should be minimal and in limited areas of the ROW. · To identify impacts on aquatic life and consider the mitigations, the supervision consultant should staff specialists on fauna or ecosystem as necessary. **Operation Phase:** · Relevant agencies should monitor the environmental conditions along the target sections in the transition zone. · If troubles of some sort occur, the agencies should consider and implement the countermeasures.
Ecosystem	**Construction Phase:** · Vegetation in roadside including trees will be lost by widening works. However, tree clearing of community or flooded forest will not be required. · Agricultural ecosystem will be lost or disturbed by construction works.	**Construction Phase:** · Vegetation loss for land clearing should be minimal and in limited areas of the ROW. · The detail design consultant shall discuss vegetative restoration plans with Khan (local) Forest Administration in advance. · The contractor and supervision consultant shall

Item	Impact	Mitigation
	・ Turbid water caused by bridge construction is likely to affect aquatic life. ・ Ecosystem in riverside vegetation with small scale may be disturbed by the construction activity. ・ Because the fishes migrate in flooded period when the construction works of bridges and culverts are suspended, impact on the aquatic life is likely to be limited. **Operation Phase:** ・ Because the target road mostly passes through well developed area such as agricultural land and urban area, impact on biodiversity is unlikely to occur. ・ Because the distance between the target sections and Tonle Sap lakeside is approximately 20 km at the nearest point, direct impact on ecosystem in Tonle Sap Lake is unlikely to occur. ・ If Pursat Bypass or embankment sections choke off or change existing surface water flow, impact on remote aquatic ecosystem may occur. However, actual distribution zones of aquatic life and migration routes of fishes except for rivers have not identified yet.	prepare and strictly implement vegetative restoration plans such as tree planting and sowing on road side. ・ The supervision consultant shall consider impacts of alien species in the vegetative restoration plans. ・ The contractor and supervision consultant shall prepare and strictly implement proper construction plans to minimize disturbance in existing agricultural canals and reservoirs. ・ The supervision consultant shall monitor water quality including turbidity. ・ Construction works in and around rivers, streams, reservoirs or channels shall be concentrated in dry period. ・ To reduce turbid water, steel sheet pile construction method should be selected in bridge construction works as necessary. ・ To identify impacts on aquatic life and consider the mitigations, the supervision consultant should staff specialists on fauna or ecosystem as necessary. ・ The contractor should consider installation of cofferdam as necessary. **Operation Phase:** ・ To maintain existing surface flow condition, locations of newly constructed bridges and culverts should not be changed from the existing sites. ・ To maintain existing surface flow condition, newly constructed bridges and culverts should have sufficient flow capacity. ・ Relevant agencies should monitor the ecosystem along the target sections and in Tonle Sap zone. ・ If troubles of some sort occur, the agencies should consider and implement the countermeasures.
Hydrology	**Construction Phase:** ・ Water flow in the rivers or streams may be altered during construction works. But the impact will be temporary and in limited area. **Operation Phase:** ・ Because some project sites are located in flood plain, impact caused by Pursat Bypass or newly constructed embankment on surface water flow may occur.	**Construction Phase:** ・ The contractor and supervision consultant shall prepare and strictly implement proper construction plans to minimize disturbance in rivers and existing agricultural canals. **Operation Phase:** ・ To maintain existing surface flow condition, locations of newly constructed bridges and culverts should not be changed from the existing sites. ・ To maintain existing surface flow condition, newly constructed bridges and culverts should have sufficient flow capacity. ・ MPWT through provincial authority should responsible for maintain and rehabilitation of culverts in NR 5. ・ Local governments should install signboards to prohibit for garbage disposal into rivers and canals.
Geographical features	**Construction Phase:** ・ Topography will be changed in Pursat Bypass or embankment sections on a small scale. ・ Topography will be changed in borrow pit and quarry site. **Operation Phase:**	**Construction Phase:** ・ The contractor and supervision consultant shall take into account the environmental impacts such as soil erosion and mudslide in selection of borrow pit and quarry site. ・ The contractor shall prepare and strictly implement an environmental management plan including

Item	Impact	Mitigation
	・ Impact on geographical features is unlikely to occur.	adequate drainage to avoid accumulation of stagnant water and vegetation recovery plan in borrow pit or quarry site. ・ In case of purchase from quarry firm, a task on the environmental management should be included in the contract. **Operation Phase:** -
Social Environment		
Poor people	**Pre-Construction Phase /** **Operation Phase:** ・ Some of the poor people who do not have their own land living within Right of Way or Provisional Road Width will be seriously affected by resettlement and may lose their business opportunity.	**Pre-Construction Phase /** **Operation Phase:** ・ Authorities concerned shall prepare and strictly implement a proper RAP and LAP including fair compensating methods.
Local economies, such as employment, livelihood, etc.	**Pre-Construction Phase:** ・ Land acquisition and resettlement may cause livelihood degradation of Project Affected Persons (PAPs). ・ Road widening will require acquisition of agricultural lands as agricultural resources. However, the required land will be very small to the total agricultural land. **Construction Phase:** ・ Construction will create job opportunities to local people. ・ Because the fishes migrate in flooded period when the construction works of bridges and culverts are suspended, impact on local fishery is likely to be limited. ・ Pursat bridge construction works may have impacts on local fishery. **Operation Phase:** ・ Reduction of travel time will contribute to local economies and promote tourism. ・ Change of access to local resources may widen gap in local economy. ・ If the embankment sections choke off or change existing surface water flow, impact on local fishery may occur.	**Pre-Construction Phase:** ・ Authorities concerned shall prepare and strictly implement a proper RAP and LAP including fair compensating methods. ・ Proper compensations including recovery fee for roadside agricultural lands should be provided to the land owners or users. **Construction Phase:** ・ The contractor shall prepare and strictly implement a fair hiring plan of local people as construction worker. ・ The contractor should give priority to the PAPs in hiring local people. ・ The contractor and supervision consultant shall provide prior notification to the local community and fisherpersons on the schedule of construction activities and restricted areas, especially in Pursat bridge construction works. ・ The contractor and supervision consultant should periodically hold sufficient local stakeholder meetings in the pre-construction stage and during construction works, and establish mutual understanding with the PAPs as necessary. **Operation Phase:** ・ The local government should monitor local economy and livelihood. ・ If troubles of some sort occur, the local government should consider and implement the countermeasures.
Land use and utilization of local resources	**Construction Phase:** ・ Pursat Bypass section will require change of land use, mainly from agricultural land to ROW. **Operation Phase:** ・ Especially in the bypass section, land use along NR 5 will be changed and be developed economically and socially. ・ Improved transportation will contribute to effective utilization of local resources.	**Construction Phase:** ・ The contractor and supervision consultant shall provide prior notification to the local community on the schedule of construction activities. ・ The contractor and supervision consultant should periodically hold sufficient local stakeholder meetings in the pre-construction stage and during construction works, and establish mutual understanding with the PAPs as necessary. **Operation Phase:** ・ The local government should monitor local

Item	Impact	Mitigation
		economy and land use. ・ If troubles of some sort occur, the local government should consider and implement the countermeasures.
Water usage	**Construction Phase:** ・ Because there are 6 agricultural canals in Pursat Bypass section, the construction works will affect local water usage for agricultural activities. ・ Existing irrigation systems and agricultural canals located around NR 5 will be affected by widening works. ・ Existing wells within the ROW of the bypass section will be lost. **Operation Phase:** ・ Newly constructed bypass, embankment or culverts may change surface water flow.	**Construction Phase:** ・ The contractor and supervision consultant shall provide prior notification to users of irrigation systems and agricultural canals on the schedule of construction activities. ・ The contractor and supervision consultant should periodically hold sufficient local stakeholder meetings in the pre-construction stage and during construction works, and establish mutual understanding with the PAPs as necessary. ・ The proper countermeasures to reduce impact on present water usage should be included in the construction plan. ・ Water supply systems or additional wells should be provided to owners and users of the lost wells. **Operation Phase:** ・ In Pusat Bypass section, to maintain existing surface flow condition including irrigation systems, newly constructed bridges and culverts should have sufficient flow capacity and be installed at same locations as existing flow. ・ The proper countermeasures to reduce impact on present water usage should be included in the road design. ・ Relevant agencies should monitor water usage and flow. ・ If troubles of some sort occur, the agencies should consider and implement the countermeasures.
Existing social infrastructures and services	**Pre-Construction Phase:** ・ Relocation or protection of existing utilities, such as electric poll, water pipe and optical fiber cable will be required. **Construction Phase:** ・ Temporary traffic congestion in construction site including NR 5 and other rural roads will occur. **Operation Phase:** ・ Access to social services will be improved. ・ Road crossing of pedestrians and livestock will become harder due to widening in existing NR 5 section. ・ Spilt of local communities or widening disparity may occur in Pursat Bypass section.	**Pre-Construction Phase:** ・ Detailed survey on existing utilities should be conducted in the planning stage. ・ The contractor and supervision consultant should periodically hold sufficient meetings with the utility owners in every stage and establish mutual understanding. ・ Proper relocation plans should be prepared and strictly implemented in advance of contraction works. **Construction Phase:** ・ The contractor and supervision consultant shall provide prior notification to local people and drivers on the schedule of construction activities, and location, time and type of traffic restriction. ・ The contractor shall prepare and strictly implement a traffic management plan around construction site. **Operation Phase:** ・ The proper countermeasures to support road crossing of pedestrians and livestock, such as crosswalk or road traffic sign to inform livestock crossing should be considered on the basis of site survey in the detail design stage. ・ The supervision consultant should review the countermeasures to support road crossing of

Item	Impact	Mitigation
		pedestrians and livestock in the construction phase. ・ Relevant agencies should monitor the utility and local communities. ・ If troubles of some sort occur, the agencies should consider and implement the countermeasures.
Misdistribution of benefits and damages	**Pre-Construction Phase / Construction Phase:** ・ Considerable misdistribution of benefit is unlikely to occur. ・ In case of unfair hiring of construction worker, misdistribution of benefit may occur. **Operation Phase:** ・ After the traffic flow is changed to new Pursat Bypass, some shops along existing NR 5 (old route) will lose their business opportunity, while shops set up along the bypass will make profit.	**Pre-Construction Phase / Construction Phase:** ・ The contractor shall prepare and strictly implement a fair hiring plan of local people as construction worker. **Operation Phase:** ・ The local government and supervision consultant shall provide prior notification to the shop owners on schedule of the bypass project in early stage.
Cultural heritage	**Pre-Construction Phase / Construction Phase:** ・ Widening works will have impacts on cultural properties located in the roadsides, especially an old brick fence and ancient gateway of Royal Palace of Preah Bat Monivong in Bakan district, and Lok Yeay Mao (Banyan tree) and Lok Ta Krahomkor (scared house) in Poipet city. **Operation Phase:** ・ Road improvement will promote tourism and worship to religious heritage. Religious value may be spoiled by tourism development.	**Pre-Construction Phase / Construction Phase:** ・ The project owner shall discuss the mitigation and protect measures with Provincial Authorities including Provincial Department of Culture, Fine and Acts in advance. ・ As for Royal Palace of Preah Bat Monivong, a proper relocation or storage plan should be prepared in advance. ・ As for Lok Yeay Maoand Lok Ta Krahomkor, the detail design consultant should consider the alignment to escape these properties at first. If the removals are required, the removal works should respect and follow Khmer tradition and culture. **Operation Phase:** ・ Relevant agencies should monitor the cultural heritage. ・ If troubles of some sort occur, the agencies should consider and implement the countermeasures.
Landscape	**Construction Phase:** ・ Vegetation at existing roadside including high trees will be lost by widening works, and cause change of landscape. **Operation Phase:** ・ Because there are no protected scenic view areas in and around the target section and roadside vegetation will be recovered for a short period due to the warm and rainy climate, considerable impact on landscape is unlikely to occur.	**Construction Phase:** ・ Vegetation loss for land clearing should be minimal. ・ The contractor and supervision consultant shall prepare and strictly implement vegetative restoration plans such as tree planting and sowing on road side. **Operation Phase:** -
Children's rights	**Construction Phase:** ・ Considerable impact only on children's rights is unlikely to occur. **Operation Phase:** ・ Road improvement may cause traffic accident of children due to more traffic volume and faster vehicle speed. ・ Traffic venerable people including	**Construction Phase:** - **Operation Phase:** ・ A relevant agency shall monitor and control vehicle speed to reduce traffic accident. ・ Local educational institutes should conduct traffic safety training to children.

Item	Impact	Mitigation
	children can be separated safely from main vehicle lane.	
Infectious diseases such as HIV/AIDS	**Construction Phase:** ・ Infection risks of HIV/AIDS may be increased among construction workers and local business offering food and entertainment. **Operation Phase:** ・ Considerable impact on infectious diseases is unlikely to occur.	**Construction Phase:** ・ The contractor shall prepare and strictly implement educational program on infection risks for construction workers. ・ The educational program should be included in the construction contract. **Operation Phase:** -
Working conditions (including occupational safety)	**Construction Phase:** ・ Dust and emission gas caused by construction works may affect workers health. ・ Sanitary conditions around construction site may get worse due to waste from workers and toilet. **Operation Phase:** ・ Considerable impact on working conditions is unlikely to occur.	**Construction Phase:** ・ The contractor shall prepare and strictly implement dust control measures such as periodical water spray. ・ The contractors shall maintain their construction equipments in adequate working conditions. ・ The contractors shall provide temporary sanitation facilities such as portable toilets and garbage bins to ensure that the domestic wastes to be generated by the construction personals. ・ The solid waste should be separated into hazardous, non-hazardous and reusable waste streams and store temporary on site. ・ The supervision consultant shall monitor the waste disposal. **Operation Phase:** -
Accidents	**Construction Phase:** ・ Traffic accident may occur surrounding of construction site **Operation Phase:** ・ Traffic safety including pedestrians will be improved by road widening and vehicle separation ・ Traffic accident due to more traffic volume and faster vehicle speed may increase ratio of traffic accident. ・ Moreover, because of center divider newly installed, cars running counter to traffic way may increase and cause accidents. ・ Accident risks between vehicles and livestock due to road widening, and more traffic volume and faster vehicle may increase in rural areas.	**Construction Phase:** ・ The contractor shall prepare and strictly implement a traffic management plan around construction site. ・ The contractor and supervision consultant shall confirm emergency medical facility in advance. **Operation Phase:** ・ The proper countermeasures to reduce traffic accident should be included in the road design. ・ A relevant agency shall monitor and control vehicle speed to reduce traffic accident. ・ Local governments should conduct traffic safety educational programs and campaigns for drivers, pedestrians and owners of livestock. ・ Local governments should install signboards to inform passing livestock zones.

(3) No or Unknown Impact Items

Table 15.6-6 Impacts and Mitigation Measures (No or Unknown Impact Items)

Item	Impact	Mitigation
Environmental Pollution		
Ground subsidence	**Construction Phase:** ・ Subsidence near the road due to added soil weight may occur. ・ Because there are soft ground areas along the proposed bypass, subsidence near the road due to the soil weight filled on the rice field may occur. **Operation Phase:** ・ Because the expected load on road will not be too heavy and ground subsidence in surrounding areas has not occurred in similar projects, impact on ground subsidence is unlikely to occur.	**Construction Phase:** ・ Detailed soil investigations should be conducted at subsidence-prone locations in the planning stage. ・ In the detailed design stage, the detailed geological surveys should be conducted. ・ The proper structure design and construction technique should be considered on the basis of the survey results. ・ The supervision consultant and contractor should monitor the ground subsidence. ・ If the ground subsidence occurs, the consultant and contractors should reconsider the construction technique. **Operation Phase:** -
Social Environment		
Ethnic minorities and indigenous peoples	**Pre-Construction Phase / Construction Phase:** ・ Road widening may cause resettlement or other impacts on Ethnic Cham and Vietnamese living along NR 5. **Operation Phase:** ・ Impact on ethnic minorities is unlikely to occur.	**Pre-Construction Phase / Construction Phase:** ・ Authorities concerned shall prepare and strictly implement a proper RAP and LAP including fair compensating methods. **Operation Phase:** -
Social institutions such as social infrastructure and local decision-making institutions	**Construction Phase / Operation Phase:** ・ Because of improvement project of existing road, considerable impact on social institutions is unlikely to occur. ・ Spilt of local communities or widening disparity may occur in Pursat Bypass section.	**Construction Phase / Operation Phase:** ・ The local government should monitor community relationship around the road. ・ If troubles of some sort occur, the local government should consider and implement the countermeasures.
Gender	**Construction Phase / Operation Phase:** ・ Impact on street venders, especially women, may occur.	**Construction Phase / Operation Phase:** ・ The contractor and supervision consultant should hold sufficient meetings with local people including street venders in the pre-construction stage and during construction works, and establish mutual understanding with the PAPs as necessary.

Item	Impact	Mitigation
Other		
Trans-boundary impacts or climate change	**Construction Phase:** · Operation of construction equipment will generate CO_2. However, the amount of CO_2 emission will be at very low level, and it is not likely that such emission give sensible impact to climate change. · Emission from construction equipment will be diluted within the Project area and its surrounding, and trans-boundary impacts are not likely to occur. **Operation Phase:** · In the future, total amount of CO_2 emission from vehicles will increase. In 2023, the total CO_2 emission volumes will increase approximately twice as large volume as in 2012. · On the other hand, because of improved traffic efficiency, the amount may be decreased 5% compared to without project. (see Figure 15.6-1) · Thus, sensible impacts to climate change or sensible trans-boundary impacts are not likely to occur.	**Construction Phase:** · The contractor actively uses electrically-powered equipment. · The contractors shall maintain their construction equipments in adequate working conditions. **Operation Phase:** · In view of the global effort to reduce CO_2 emission, MPWT shall further strengthen the effort for promoting "environmentally sustainable transport" including promotion of use of mass transit such as bus and railroad for both passenger transport and cargo transport.

15.7 Environmental Management Plan

15.7.1 Introduction

The Environmental Management Plan (EMP) provides institutional arrangement, environmental monitoring plan during construction and operation, and training and staffing. The EMP objectives are to show the tasks which will be implemented by relevant governmental institutions at local, provincial and national levels and to suggest parameters need to be monitored in the project phases. It should be noted that the EMP is considered as an operational document that will be frequently updated by the project owner/ the MPWT with assistance/advice from a supervision consultant to reflect on-site project activities. The EMP is required to update, correction and regularly additional fill-up according to each phase of the project activity.

15.7.2 Institutional Arrangement

Implementation of the EMP will be carried out by the project owner, the MPWT, in cooperation with governmental institutions at national, provincial and local levels.

At the national level, the MPWT will cooperate with Department of EIA and Department of Pollution Control of the MOE, Department of Hydrology and River Works of Ministry of Water Resources and Meteorology, the Ministry of Land Management, Urban Planning and Construction and Inter-Ministerial Resettlement Committee of the Ministry of Economic and Finance.

At the provincial level, the MPWT will closely work with its departments including Provincial Department of Environment, Provincial Department of Water Resources and Meteorology, Provincial Department of Land Management Urbanized Planning and Construction, related governmental departments and local authorities in all the relevant provinces.

At local level, the MPWT will work with local authorities for the facilitation, controlling, and solving of any social conflicts that may happen in the project area.

15.7.3 Environmental Monitoring Plan

Environmental monitoring plan (EMoP) is one of the vital processes of the EMP. It is included items to be monitored by project phase, location, frequency, and responsible unit. The EMoP can help to adjust potential problems that might result from the project activities and allow prompt implementation of effectively corrective measures. It aims at assessing environmental conditions, monitoring the effective implementation of mitigation measures, and warning significant deteriorations in environmental quality for further prevention action. The monitoring results will be a practical document for the MPWT to maintain compliance with environmental laws and regulations, work safety, and appropriate implementation of the mitigation measures.

Implementation of the EMoP will cover the construction and operation phases of the project. This summarizes what important parameters will be monitored and how frequent will be for measurements. Table 15.7-1 shows suggested EMoP need to be monitored. This summarizes what important parameters will be monitored and how frequent will be for measurements.

Table 15.7-1 Monitoring Form (Draft)

1. Construction Stage (Middle Section)

Item	Location	Parameter/ Means of Monitoring	Result (Average / Max / Total, etc.)	Standard (Legal / International Standard)	Frequency	Remarks
Air quality	Construction site	Visual inspection of mechanical condition and exhaust gas			Every day before working	
	Construction site	Visual observation of dust			Every day	
	Storage facilities for dust generating materials					
	Boundary of ROW nearest to construction site	SPM10		0.05 mg/m^3 (WHO, average 24h)	2 times in dry season and 2 times in rainy season during construction period	
		SPM2.5		0.02 mg/m^3 (WHO, average 24h)		
		SO_2		0.30 mg/m^3 (MOE, average 24h)		
		NO_2		0.10 mg/m^3 (MOE, average 24h)		
Water Quality	Rivers including Pursat, Steung, agriculture canals, streams and other public water bodies where construction works are executed.	Visual observation			Every day	
		Analysis using potable pH and turbidity meter			Every week	
		pH		6.5-8.5 (MOE)	When any pollution is suspected	
		TSS		25-100 (mg/l) (MOE)		
		BOD		1-10 (mg/l) (MOE)		
		COD		1-8 (mg/l) (MOE)		
		Other items (as required)				
Noise	Boundary of land plot nearest to the construction site	Noise Level		60 dB (06:00-18:00) 50 dB (18:00-22:00) 45 dB(22:00-06:00) (MOE, residential area)	- When noise/vibration level exceeding the Cambodian standards is suspected - When local residents complain	
Vibration		Vibration Level		65 Hz (05:00-17:00) 60 Hz (17:00-05:00) (Lab. MOE)		

2. Construction Stage (Sophorn - Poipet Section)

Item	Location	Parameter/ Means of Monitoring	Result (Average / Max / Total, etc.)	Standard (Legal / International Standard)	Frequency	Remarks
Air quality	Construction site	Visual inspection of mechanical condition and exhaust gas			Every day before working	
	Construction site	Visual observation of dust			Every day	
	Storage facilities for dust generating materials					
	Boundary of ROW nearest to construction site	SPM10		0.05 mg/m^3 (WHO, average 24h)	2 times in dry season and 2 times in rainy season during construction period	
		SPM2.5		0.02 mg/m^3 (WHO, average 24h)		
		SO_2		0.30 mg/m^3 (MOE, average 24h)		
		NO_2		0.10 mg/m^3 (MOE, average 24h)		
Water Quality	Rivers including Pursat, Steung, agriculture canals, streams and other public water bodies where construction works are executed.	Visual observation			Every day	
		Analysis using potable pH and turbidity meter			Every week	
		pH		6.5-8.5 (MOE)	When any pollution is suspected	
		TSS		25-100 (mg/l) (MOE)		
		BOD		1-10 (mg/l) (MOE)		
		COD		1-8 (mg/l) (MOE)		
		Other items (as required)				
Noise	Boundary of land plot nearest to the construction site	Noise Level		60 dB (06:00-18:00) 50 dB (18:00-22:00) 45 dB(22:00-06:00) (MOE, residential area)	- When noise/vibration level exceeding the Cambodian standards is suspected - When local residents complain	
Vibration		Vibration Level		65 Hz (05:00-17:00) 60 Hz (17:00-05:00) (Lab. MOE)		

3. Service Stage (Middle Section)

Item	Location		Parameter/ Means of Monitoring	Result (Average / Max / Total, etc.)	Standard	Frequency	Remarks
Air quality	Pursat bypass section	Road side	SPM10		0.05 mg/m^3 (WHO, average 24h)	1 time in dry season and 1 time in rainy season per year for 2 years	
		200 m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200 m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200 m away from road side					
	Pursat bypass section	Road side	SPM2.5		0.02 mg/m^3 (WHO, average 24h)		
		200 m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200 m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200 m away from road side					
	Pursat bypass section	Road side	SO_2		0.30 mg/m^3 (MOE, average 24h)		
		200 m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200 m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200 m away from road side					
	Pursat bypass section	Road side	NO_2		0.10 mg/m^3 (MOE, average 24h)		
		200 m away from road side					
	Pou Mouy village, Moung Russei district	road side					
		200 m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200 m away from road side					
Noise	Pursat bypass section, ROW boundary		Noise Level		60 dB (06:00-18:00) 50 dB (18:00-22:00) 45 dB (22:00-06:00) (MOE, residential area)		
	Pou Mouy village, Moung Russei district, ROW boundary						
	Dambouk Khpos village, Sangkae district, ROW boundary						
Vibration	Pursat bypass section, ROW boundary		Vibration Level		65 Hz (05:00-17:00) 60 Hz (17:00-05:00) (Lab. MOE)		
	Pou Mouy village, Moung Russei district, ROW boundary						
	Dambouk Khpos village, Sangkae district, ROW boundary						

4. Service Stage (Sophorn - Poipet Section)

Item	Location		Parameter/ Means of Monitoring	Result (Average / Max / Total, etc.)	Standard	Frequency	Remarks
Air quality	Kbal Spean village, Poipet Town	Road side	SPM10		0.05 mg/m^3 (WHO, average 24h)	1 time in dry season and 1 time in rainy season per year for 2 years	
		200 m away from road side					
		Road side	SPM2.5		0.02 mg/m^3 (WHO, average 24h)		
		200 m away from road side					
		Road side	SO_2		0.30 mg/m^3 (MOE, average 24h)		
		200 m away from road side					
		Road side	NO_2		0.10 mg/m^3 (MOE, average 24h)		
		200 m away from road side					
Noise	Kbal Spean village, Poipet Town		Noise Level		60 dB (06:00-18:00) 50 dB (18:00-22:00) 45 dB (22:00-06:00) (MOE, residential area)		
Vibration	Kbal Spean village, Poipet Town		Vibration Level		65 Hz (05:00-17:00) 60 Hz (17:00-05:00) (Lab. MOE)		

WHO: World Health Organization, MOE: Ministry of Environment (Cambodia)
***Remarks; Past trend and current status including remedial measures if necessary*

Table 15.7-2 Suggested Monitoring Item and Responsible Agency

Items	Implementation Agency	Supervision Agency
Construction Phase		
Air quality	Supervision Consultant and Construction Contractor (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MPWT
Water Quality	Supervision Consultant and Construction Contractor (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MPWT
Noise	Supervision Consultant and Construction Contractor (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MPWT
Vibration	Supervision Consultant and Construction Contractor (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MPWT
General waste	Construction Contractor	Supervision Consultant
Subsidence	Construction Contractor	Supervision Consultant
Hydrology	Supervision Consultant and Construction Contractor	MPWT
Ecosystem Impact on TSBR	Supervision Consultant and Construction Contractor	MPWT and MOE
Service Stage		
Air quality	MPWT and Provincial authority (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MOE
Noise	MPWT and Provincial authority (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MOE

Items	Implementation Agency	Supervision Agency
Vibration	MPWT and Provincial authority (Instrumental analysis will be conducted by an authorized analytical institute under subcontract.)	MOE
Illegal dumping along NR 5	Provincial authority (DPWT)	MPWT
Condition of culvert	Provincial authority (DPWT)	MPWT
Domestic waste water along NR 5	Provincial authority (DPWT)	MPWT
Ecosystem Impact on TSBR	Provincial authority	MPWT, MOE and Cambodia National Mekong Committee

15.7.4 Training and Staffing

Training program is an important factor in the EMP that needs to take into account and put in the Project for the successful implementation. Moreover, in order to promote sustainable development, the Project is needed human resources with adequate capacity for improvement work and perfective both technical and environmental working skilled. Therefore, the project owner will organize or provide training courses to staffs-workers project's such as:

- Technical skills for operating the machines in the project construction and operation
- Providing knowledge to staffs/workers on safety work in construction project
- Training on technical skill, law and procedures that related to the project activities to prevent accidental case on the natural and social resources
- Educate and campaign on methodology of preventing social disease, especially HIV/AIDS
- Provide training course to staff-workers on solid and liquid wastes management and educate them on operation and maintenance of latrine and bathroom including Septic tank
- Educate on important Environmental resources in the project area for social requirement such as: water, land, air, forestry, wildlife especially natural resource in the project area
- Educate on method for environment protection in/around project area and knowledge on project study related with quantity and quality existing environment that it will affect by project activities
- Educate to workers on raw materials management that it is chemical elements use for product chain of the project
- The project owner will recruit international consultants with high capacity to work for design plan and technical monitoring of this road including to help for Khmer workers training in relevant institutions and in this project

(1) Participants

In order to assist the project construction phase smoothly, trainings will be provided for few engineers from the MPWT and the MOE due to their limitations in site monitoring and management and environmental knowledge. List of the proposed trainees is shown as in Table

15.7-3. Training contents will be developed by highly-qualified trainers. The trainings should be commenced before or at early of the construction phase.

Table 15.7-3 List of the Proposed Trainees

No	Institution	Number of trainees	Engineers Involved
1	MPWT	4	Engineers for site monitoring and management
2	MOE	2	Environmental technicians/engineers

(2) Training Budget

The MPWT is responsible for the training budget. Each training session will provide 2 days in class and 2 days for field practice. The trainees for site monitoring and management will work closely with the construction engineers to learn day to day on site monitoring and management. The trainees or environmental technicians/engineers can assist the construction engineers to do daily environmental monitoring and evaluation the contractor performance in compliance with the EMP in the EIA report and other environmental safeguards stated in the construction contract. The detailed cost estimate for the trainings is shown in Table 15.7-4.

15.7.5 Organization for EMP

The proposed draft organization chart of the EMP in the construction phase is shown in Figure 15.7-1.

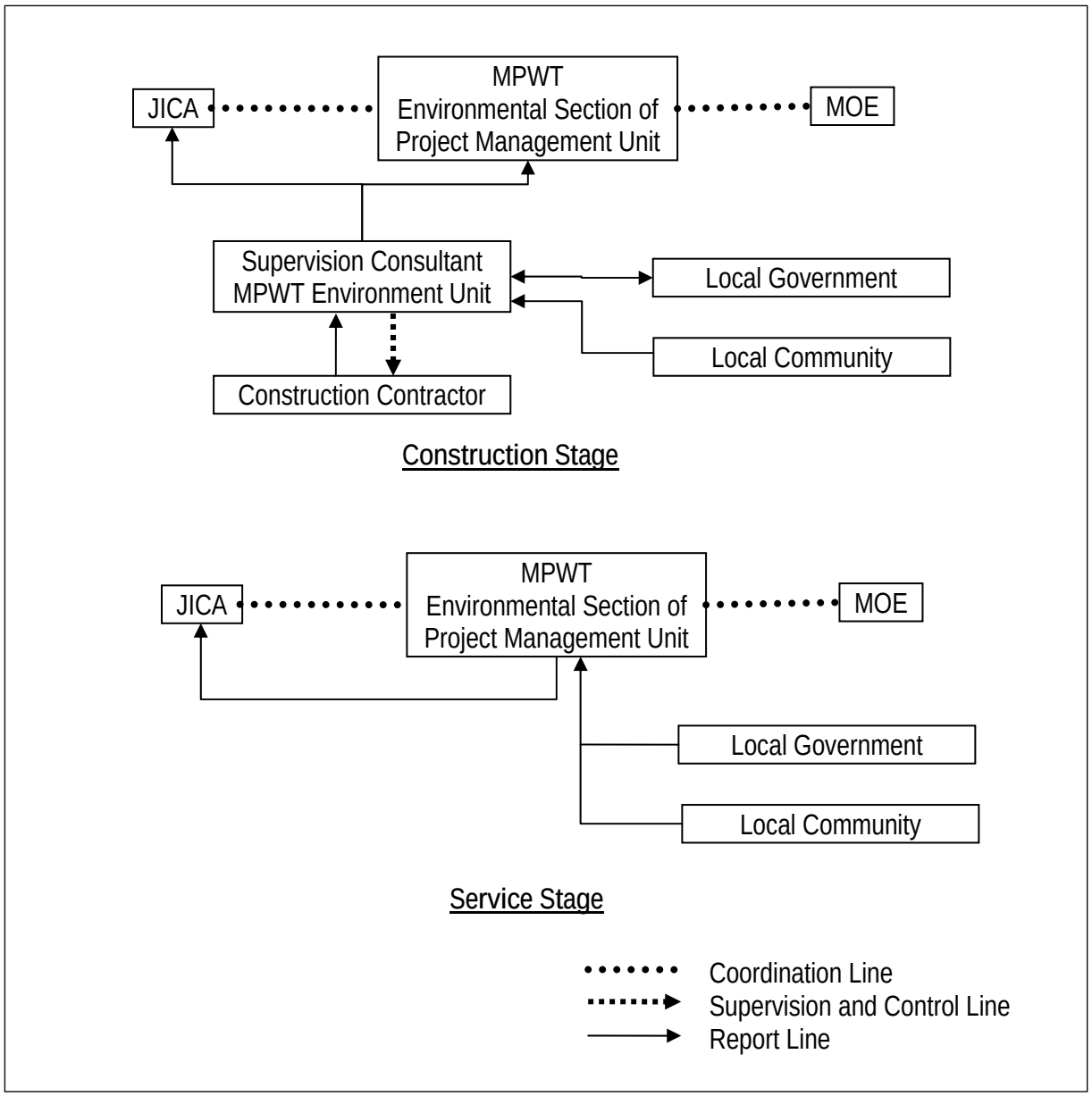


Figure 15.7-1 Proposed Organization for EMP

15.7.6 Cost Estimation of EMP

The cost estimation for EMP such as environmental monitoring cost and training cost is shown in Table 15.7-4. The total EMP cost of the Project was estimated at US$ ***** (Closed due to confidentiality).

Table 15.7-4 Cost Estimation for EMP

1. Middle Section

No	Description	Unit	Quantity	Unit Rate	Total Cost Estimate in US$
I. Environmental Quality Monitoring					
1	Air quality (Construction Phase)	Sample	4	****	****
2	Air quality (Operation and Maintenance Phase)	Sample	12	****	****
3	Water Quality (Construction Phase)	Sample	4	****	****
4	Potable pH Meter	LS	1	****	****
5	Potable Turbidity Meter	LS	1	****	****
6	Noise and Vibration (Construction Phase)	Sample	4	****	****
7	Noise and Vibration (Operation and Maintenance Phase)	Sample	12	****	****
				Sub-Total	****
II. Mitigation Activity					
1	Sowing small trees and plant trees for good aestheticism along the road (Construction Phase)	LS	1	****	****
2	Garbage disposed along the road and illegal dump site	LS	1	****	****
3	To plant the trees for good aestheticism along the road and good maintained (Operation and Maintenance Phase)	LS	1	****	****
4	To prepare a master plan for by-Pass road of Pursat Town development and install big signboard for this project plan	LS	1	****	****
				Sub-Total	****
III. Training Fee					
1	Training course on environmental management and field practice	Course	1	****	****
2	Training course on site monitoring and field practice	Course	1	****	****
3	Training course on general site management	Course	1	****	****
4	Transportation for the field practices	Time	3	****	****
5	Training materials and snacks for all the courses	Lump Sum	1	****	****
				Sub-Total	****
III. Training Allowance					
-	-	-	-	Daily Stipend Allowance (US$)	-
1	Engineers from the MPWT	Man-Day	4	**** x 4 Days	****
2	Engineers from the MOE	Man-Day	2	**** x 4 Days	****
				Sub-Total	****
				Grand Total	****

2. Sophorn - Poipet Section

No	Description	Unit	Quantity	Unit Rate	Total Cost Estimate in US$
I. Environmental Quality Monitoring					
1	Air quality (Construction Phase)	Sample	4	****	****
2	Air quality (Operation and Maintenance Phase)	Sample	4	****	****
3	Water Quality (Construction Phase)	Sample	4	****	****
4	Potable pH Meter	LS	1	****	****
5	Potable Turbidity Meter	LS	1	****	****
6	Noise and Vibration (Construction Phase)	Sample	4	****	****
7	Noise and Vibration (Operation and Maintenance Phase)	Sample	4	****	****
				Sub-Total	****
II. Mitigation Activity					
1	Sowing small trees and plant trees for good aestheticism along the road (Construction Phase)	LS	1	****	****
2	Garbage disposed along the road and illegal dump site	LS	1	****	****
3	To plant the trees for good aestheticism along the road and good maintained (Operation and Maintenance Phase)	LS	1	****	****
				Sub-Total	****
III. Training Fee					
1	Training course on environmental management and field practice	Course	1	****	****
2	Training course on site monitoring and field practice	Course	1	****	****
3	Training course on general site management	Course	1	****	****
4	Transportation for the field practices	Time	3	****	****
5	Training materials and snacks for all the courses	Lump Sum	1	****	****
				Sub-Total	****
III. Training Allowance					
-	-	-	-	Daily Stipend Allowance (US$)	-
1	Engineers from the MPWT	Man-Day	4	**** x 4 Days	****
2	Engineers from the MOE	Man-Day	2	**** x 4 Days	****
				Sub-Total	****
				Grand Total	****

Note: Daily stipend allowance included food, accommodation and transportation.
Venue fee is included for the training courses.

****: Closed due to confidentiality

15.7.7 Recommendation

After the completion of the NR 5 improvement projects (from Prek Kdam to Poipe), the traffic volume will increase in all cities and towns along NR 5, and the local economy, industrialization and urbanization will develop in parallel. On the other side, the environmental qualities in these areas are likely to deteriorate. Comprehensive environmental quality monitoring should be conducted. The recommendable monitoring plan related to road sector is shown in Table 15.7-5.

Table 15.7-5 Recommendable Future Monitoring Plan

Item	Location	Implementation Agency	Frequency	Parameter/ Means of Monitoring
Air quality	Urban area in Kampong Chhnang city	Department of Environment, Kampong Chhnang Province	Continues monitoring	SPM10 SPM2.5 SO_2 NO_2
	Urban area in Pursat town	Department of Environment, Pursat Province		
	Urban area in Battambang city	Department of Environment, Battambang Province		
	Urban area in Sri Sophorn city	Department of Environment, Banteay Meanchey Province		
	Roadside in Kampong Chhnang bypass section	MPWT	1 time in dry season and 1 time in rainy season per year	
	Roadside in Pursat bypass section			
	Roadside in Battambang bypass section			
	Roadside in Sri Sophorn bypass section			
Noise	Urban area in Kampong Chhnang city	Department of Environment, Kampong Chhnang Province	Quarterly	Noise Level (LAeq)
	Urban area in Pursat town	Department of Environment, Pursat Province		
	Urban area in Battambang city	Department of Environment, Battambang Province		
	Urban area in Sri Sophorn city	Department of Environment, Banteay Meanchey Province		
	Roadside in Kampong Chhnang bypass section	MPWT	Yearly	
	Roadside in Pursat bypass section			
	Roadside in Battambang bypass section			
	Roadside in Sri Sophorn bypass section			
Vibration	Urban area in Kampong Chhnang city	Department of Environment, Kampong Chhnang Province	Quarterly	Vibration Level
	Urban area in Pursat town	Department of Environment, Pursat Province		
	Urban area in Battambang city	Department of Environment, Battambang Province		
	Urban area in Sri Sophorn city	Department of Environment, Banteay Meanchey Province		
	Roadside in Kampong Chhnang bypass section	MPWT	Yearly	
	Roadside in Pursat bypass section			
	Roadside in Battambang bypass section			
	Roadside in Sri Sophorn bypass section			

CHAPTER 16 RESETTLEMENT ACTION PLAN (RAP)

16.1 Legal and Policy Framework

Cambodia has experienced severe social, economic, and political turmoil during the last quarter century. Before the Khmer Rouge came to power in 1975, private land ownership was widespread and governed by the Cambodia Civil Code of 1920. Under the Khmer Rouge from 1975 to 1979 however, private property was abolished and all records were destroyed. After the said regime, the new government introduced usufruct rights to facilitate orderly occupation by people returning to urban areas, of vacant land and structures. However, all lands in Cambodia remained under the property of the state until private ownership on residential land of maximum 2,000 m^2 was restored in 1989. The current legislations governing land ownership is the Land Laws of October 1992 and of August 2001, which recognize claims to land made after the downfall of the Khmer Rouge in 1979. In this background, the fundamental system for "resettlement", which are i) land management system, ii) policy and system for land acquisition, illegal occupation, and resettlement, and iii) methodology to fill up the gap between Development Partners' (DPs') policy on resettlement and the Cambodian laws and regulations related to resettlement, are still improving. Therefore, compromise between them is necessary in terms of dealing with resettlement issues caused by development projects.

16.1.1 Relevant Laws

(1) 1993 Constitution

The 1993 Constitution of Cambodia has established one governing principles pertaining to land acquisition.

Article 44 states that "All persons, individually or collectively, shall have the right to ownership. Only Khmer legal entities and citizens of Khmer nationality shall have the right to own land. Legal private ownership shall be protected by law. The right to confiscate properties from any persons shall be exercised only in the public interest as provided for under the law and shall require fair and just compensation in advance."

(2) Land Law

The rights to land and property in Cambodia are governed by *the 2001 Land Law*, which are primarily based on the provisions of *the 1993 Constitution*. The law defines the scope of ownership of immovable properties, such as land, trees and fixed structures.

The Land Law, **Article 5**, states that "No person may be deprived of his ownership, unless it is in the public interest. Any ownership deprivation shall be carried out in accordance with the governing procedures provided by law and regulations, and after the payment of fair and just compensation in advance."

Other provisions of the Land Law that are relevant to land acquisition, compensation and resettlement include:

- Only legal possession as provided by law can be transformed to land ownership. (**Article 6**)
- Any regime of ownership of immovable property prior to 1979 shall not be recognized. (**Article 7**)
- **Article 15** states that "the following properties are included as public properties of state and public legal entities: a) any property that has a natural origin, such as forests, courses and banks of navigable and floatable rivers or natural lakes and seashores; b) that is made available for public use such as quays of harbors, port, railways, railways station and airports; or, c) any property which is made available, either in its natural state or after development, for public use such as roads, tracks, oxcart ways, pathways, gardens or public parks and reserved lands."
- **Article 18** states that "the following are null and void and cannot be made legal in any form whatever: a) any entering into possession of public properties of State and public legal entities and any transformation of possession of private properties of State into ownership rights that was not pursuant to the legal formalities and procedures that have been stipulated prior to that time, irrespective of the date of creation of possession or transformation; e) any entering into possession of private properties of State, through any means, that occurs after this law comes into effect".
- **Article 19** states that "any persons whose land title or factual circumstance fall within the scope of **article 18** of this law shall not have the right to claim compensation or reimbursement of expenses paid for the maintenance or management of immovable property that was illegally occupied. Any illegal and intentional of fraudulent acquisition of public properties of state or of public legal entities shall be penalized pursuant to article 259 of this law. The penalties shall be doubled where any occupation of public properties because damages or delay to works undertaken in the general interest, especially the occupation of roadway reversed land".
- Ownership of immovable properties described in **Article 25** is granted by the state to indigenous minorities[1] as collective ownership. This collective ownership includes all of the rights and protections as enjoyed by private owners. The exercise of collective ownership rights shall be subject to the responsibility of the traditional authorities and decision-making mechanisms of the indigenous community, according to their customs and subject to the laws of general enforcement related to immovable property such as *the law on environmental protection*. (**Article 26**)
- Persons with legally valid possession of land for five years (at the time the law came into

[1] As per Article 23 of the Land Law, "*An indigenous community is a group of people that resides in Cambodia whose members manifest ethnic, social, cultural and economic unity and who practice a traditional lifestyle, and who cultivate the lands in their possession according to the customary rules of collective use.*"

effect) are allowed to be registered as the owner of the land (**Article 30**). Persons who (at the time the law came into effect) held legal possession but had not yet completed the five years were allowed to remain in possession until they were eligible to be registered as the owner. (**Article 31**)

- Any beginning of occupation for possession shall cease when this law comes into effect (**article 29**). After this law comes into force, any new occupant with title to an immovable property belonging to the public bodies or private persons shall be considered as illegal occupant and shall be subject to the penalties provided in **Article 259** of this Law (**Articles 34**).
- **Article 38** states that "in order to transform into ownership of immovable property, the possession shall be unambiguous, non-violent, notorious to the public, continuous and in good faith".
- Landless people may apply for land for residential and subsistence farming purposes at no cost, as part of a social land concessions scheme. The concessionaire may obtain ownership of this land after fulfilling conditions set out in a separate *Sub-Decree on Social Land Concessions*. (**Articles 50, 51**).

(3) Expropriation Law Dec. February 2010 - Procedures for Acquiring Private Properties for National or Public Interest

Article 2: the law has the following purposes: (i) ensure reasonable and just deprivation of a legal right to ownership of private property; (ii) ensure payment of reasonable and just prior compensation; (iii) serve the public and national interests; and (iv) development of public physical infrastructure.

Article 7: Only the state may carry out an expropriation for use in the public and national interests.

Article 8: The state shall accept the purchase of the remaining part of the real property left over from an expropriation at a reasonable and just price at the request of the owner of land/or the holder of rights in the expropriated real property, if he is no longer able to live near the expropriated scheme or build a residence or conduct any business.

Article 16 states that "Prior to make any expropriation project proposal, the Expropriation Committee shall conduct a public survey by recording of a detailed description of all entitlements of the owners and/or of the holder of real right to immovable property and other properties subject to compensation as well as recording of all relevant issues.

In conducting the survey, the Expropriation Committee shall organize public consultations at the Capital, Municipal-Provincial, and District-Khan authority levels with Commune / Sangkat councils and Village or community representative to be affected by the expropriation to provide specific and concise information and collect inputs from all stakeholders regarding the proposed basic public infrastructure project.

In order to set a dateline for the expropriation or relocation or compensation, the Expropriation Committee shall conduct a dateline interview with all concerned parties about the issues of immovable property to be affected by the public physical infrastructure project.

Within 30 (thirty) working days after the completion of the survey, the Expropriation Committee shall produce a report with recommendations and submits it to the Royal Government for approval."

Article 22: Stipulates the amount of compensation to be paid to the owner of and/or holder of rights in the real property, which is based on the market value of the real property or the replacement cost as of the date of the issuance of the *Prakas* on the expropriation scheme. The market value or the replacement cost shall be determined by an independent commission or agent appointed by the expropriation committee.

16.1.2 Other Relevant Regulations

The private ownership of land was re-established in 1989, and confirmed in *the 2001 Land Law* (**Article 4**). Cambodians are able to register the land they occupy with the local Cadastral Administration Office, whereupon a certificate of land title is granted. Issuing land titles is a lengthy process and most offices have a major backlog of applications. People are given a receipt and until the official title deed is issued, this receipt is accepted as a proof of real occupant of the land for land purpose or sale.

The present legal status of land use in Cambodia can be classified as follows:

(1) **Privately owned land with title**: The owner has official title to land, and both owner and the Cadastral Administration Office have a copy of the deed.

(2) **Privately owned land without title**: The owner has made an application for title to land, and is waiting for the issuance of a title deed. The Cadastral Administration Office recognizes the owner.

(3) **Land use rights certified by the Government**: In this case, a receipt for long-term land use has been issued. This land use right is recognized by the Cadastral Administration Office.

(4) **Lease land**: The Government or private owners lease the land, usually for a short period. There is provision for the owner to reclaim land if it is needed for development.

(5) **Non-legal occupation**: The user has no land use rights to State land that he occupies or uses. The Cadastral Administration Office does not recognize the use of this land.

(6) **Sub-Decree on Social Land Concession, March 2003** - provides for allocations of free private state land to landless people of residential or family farming, including the replacement of land lost in the context of involuntary resettlement.

(7) **Prakas No.6**, entitled "*Measures to Crack Down on Anarchic Land Grabbing and*

Encroachments", sets ROW for road and railway. In support of this *Prakas*, MEF on 6 April 2000 issued *Decree No.961* prohibiting compensation for structures and other assets located in the ROWs. Some Road dimensions are modified by *the Sub-decree No.197* adopted on 23 November 2009 on to Management of ROW along the national road and railway in Cambodia.

Table 16.1-1 Road and Railways ROW Dimensions

Road Category	ROW Dimensions under Prakas No.06	ROW Dimensions under Sub-decree No.197
NR-1, 4, and 5	30 m from the centreline	30 m from the centreline
Other 1-digit NRs	25 m from the centreline	30 m from the centreline
2-digit NRs	25 m from the centreline	25 m from the centreline
Provincial roads	20 m from the centreline	not specified
Commune roads	15 m from the centreline	not specified
Railway outside city, province and crowned place	30 m from the centreline	30 m from the centreline
Railways in forest area	100 m from the centreline	100 m from the centreline

16.1.3 Policy Gap Analysis

Law and regulation framework on resettlement and land issues are still in the stage of development in Cambodia, and some implementation documents and institutions are not yet prepared completely, however, RGC understands such situation and DPs' safeguard policies, and considers supplemental measures and assistances in RAP cases case by case.

Thus, in terms of practical operation, there is not so much crucial gap between Cambodian country system and JICA Guidelines' concept and requirements (see Table 16.1-2). Some other discussing points which are not mentioned clearly or concretely in Cambodian country system are also considered based on JICA Guidelines, RAP, and other relevant documents to fulfil gaps.

Table 16.1-2 Verification of and Comparison between Cambodian System and JICA Guidelines for Environmental and Social Considerations (April 2010)

No.	Item	JICA Guidelines Policy	Law/Regulation in Cambodia (officially promulgated)	Actual Operation (Gap Filling Measures)
1	Support system for socially vulnerable groups	It is necessary to give appropriate consideration to vulnerable groups.	*Sub-Decree on Social Land Concession* provides allocations of free private state land to landless people of residential or family farming, including the replacement of land lost in the context of involuntary resettlement.	Income restoration program (IRP) and assistance (allowance) to vulnerable groups will be prepared.
2	Assistance to restore and improve living standards	Living standards and income opportunities, and production levels of project affected people should be improved or at	The government has no clear policy or procedure to restore the livelihood of APs.	Income restoration program (IRP) will be prepared.

No.	Item	JICA Guidelines Policy	Law/Regulation in Cambodia (officially promulgated)	Actual Operation (Gap Filling Measures)
		least restored to pre-project levels.		
3	Enhancement of public participation in planning and implementation of RAP	Appropriate participation of affected people and their communities should be promoted in planning, implementation and monitoring of involuntary AHs and measures taken against the loss of their means of livelihood.	It is clearly declared in *the Expropriation Law (**Article 16**)* that in conducting a survey of entitlements, public consultations shall be organized to provide specific and concise information and collect inputs from all stakeholders regarding the proposed basic public infrastructure project and that a dateline interview with all concerned parties shall be conducted.	Stakeholder meetings and interview of AHs shall be conducted at appropriate stages according to JICA Guidelines and *the Expropriation Law*.
4	Compensation for land acquisition with replacement cost	Prior compensation will be done with replacement cost, which means that compensation for lost assets must be made in full amount at replacement cost and at current market price.	The amount of compensation to be paid to the owner of and/or holder of real right to the immovable property shall be based on the market price or replacement cost as of the date of the issuance of the declaration on the expropriation project. (the *Expropriation Law* (**Article 22**))	AHs will be compensated at replacement cost. The replacement cost will be calculated based on the detailed measurement survey just before implementing resettlement.
5	AHs residing in the Project affected area before cut-off date	People to be resettled involuntarily and those whose means of livelihood will be hindered or lost should be sufficiently compensated and supported by the project proponents in appropriate time.	Under *the Land Law 2001*, those who have occupied ROW or public property are not entitled to any compensation or social support.	Assistance to AHs who are residing in the Project affected area (including public state land) at the time of cut-off date will be prepared (Compensation for properties without land is compensated at replacement cost and resettlement site will be prepared for landless AHs).
6	Grievance redress mechanism	Grievance redress system must be formulated and must function appropriately.	Grievance redress system is stipulated in *the Expropriation Law*; however, it has provisions to exclude public infrastructure projects.	Grievance redress system will be formulated.

Source: JICA Study Team

16.2 Project Resettlement Policy

16.2.1 Objectives

The objective of the Project Resettlement Policy is to ensure that AHs are not worse off because of the Project. The Project should provide an opportunity for the local population to derive benefits from it, and it should likewise serve as an occasion for the local population to participate in its planning and implementation, thereby engendering a sense of ownership over the same.

16.2.2 Key Principles

The key principles of the resettlement policy are as follows:

(i) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.

(ii) People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by RGC in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. RGC must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites.

(iii) Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

(iv) Resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

16.2.3 The Cut-off Date for Eligibility

For the project, the cut-off date coincides with the first day of the census of AHs and the Inventory of Loss (IOL) survey was conducted. The cut-off date for the existing NR-5 from Thlea Ma'am/PST (PK: 171+000) to Battambang (PK: 282+200) and from Serey Sophorn (PK:

366+250) to Poipet (PK: 402+000) is on **2nd September 2013**, and for Pursat Bypass is on **30th December 2013**. This would mean that any land occupation or transfer, or structures to be built on affected land after the cut-off date will not be entitled to any compensation including the land use right.

The cut-off date was informed to AHs at stakeholder meetings before and after the cut-off dates at stakeholder meetings during RAP preparation stage. At those meetings, AHs were informed that all structures constructed after the cut-off date (IOL survey) will not be entitled for any compensation from the Project, and that all people have to stop constructing any new buildings in the delineated area. The information will be continuously disseminated to prevent further population influx.

16.2.4 Eligibility

Persons not covered in the census are not eligible for compensation and other entitlements, unless they can show proof that:

(i) They have been inadvertently missed out during the census and the IOL and certified by local authorities; or
(ii) They have lawfully acquired the affected assets following completion of the census and the IOL and prior to the conduct of the DMS.

Eligible AHs include anyone who, at the cut-off date of the Project, was located within the Project area or any of its component or subproject or part thereof, and would have their:

(i) Standard of living adversely affected;
(ii) Right, title or interest in any house, land (including residential, commercial, agricultural and for grazing), water resources, or any other movable or fixed assets acquired or possessed, in full or in part, temporarily or permanently by public sector acquisition; or
(iii) Business, occupation, place of work or residence or habitat adversely affected by public sector intervention.

An AH refers to households and consists of all members residing under one roof and operating as a single economic unit, who are adversely affected by the Project. For resettlement purposes, Project AHs will be considered as members of the Project AHs including single person households.

16.2.5 Entitlements

The project entitlements were developed and presented as shown in Table 16.2-1 Entitlement Matrix. The entitlements adopted were guided by the applicable national laws and regulations and JICA Guidelines. The entitlements and assistance may be revised based on the actual status of impact, as necessary, in the updated version of this RAP.

Table 16.2-1 Entitlement Matrix

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
A. LOSS OF LAND			
OUTSIDE ROW (PRIVATE LAND)			
I. Loss of Land (all kinds); **Either Partial or Entire Land is Lost**	All Affected Households (AHs) with recognized proof of ownership whose land will be acquired (for the construction of bypass roads in Pursat City).	AHs have two options: 1) Land replacement (land to land): Land replacement will be provided with similar land quality and productivity potential. 2) cash compensation at replacement cost.	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ IRC will ensure payment of all compensation and allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. ▪ IRC will support the AHs to separate or transform the affected land title certificate. Cost of the procedure will be borne by RGC.
INSIDE ROW (PUBLIC STATE LAND)			
I. Partial Loss of Residential and / or Commercial Land, in which the remaining land is **STILL VIABLE** for continued use	AHs with main house and/or small shop (independent/family-owned business)	▪ AHs must be removed entirely from PRW and no cash compensation is available for affected land in ROW. ▪ No new permanent structures (i.e. structures on a foundation or wooden house larger than the affected one) are permitted to be constructed in the ROW.	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ IRC will ensure payment of all compensation and allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. ▪ Remaining ROW is still **public state land**.
II. Entire Loss of Residential and/or Commercial Land, or the remaining land is **NOT VIABLE** [2] for continued use (Landless AHs)	AHs with main house and/or small shop (independent/family-owned business) and no more remaining land.	▪ No cash compensation for affected land in ROW. ▪ The landless AHs have two options: 1) Self relocation: receive in lump sum **$5,000.00** per landless AH as cash assistance for buying a land plot and preparing other basic infrastructure, plus cash compensation for their affected assets. 2) Group relocation: a resettlement site (RS) nearby villages will provided by the government; ▪ A land plot per landless AH will be 7.0 m x 15.0 m = 105.00 m^2. ▪ Basic infrastructures such as access roads, latrines, drainages, and pumping	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ Each self relocate landless AHs will receive the cost for resettle by calculating in average from the Cost Estimate of each RS (see in section 10-3), plus cash compensation for their affected assets. The estimate cost in each site should be updated during DMS phase. ▪ IRC will ensure payment of all compensation and allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. ▪ IRC will ensure allocation of cash or replacement land with sufficient time (at least 90 days) for AHs to rebuild and relocate

[2] The remaining unaffected portion cannot accommodate purpose of activity/structure covered within the affected section. The size of viable land will be discussed between IRC-WG and the AHs during the detailed measurement survey.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
		wells will be provided as part of resettlement development. Electricity connection will also be provided if available in the area. However, AHs will bear the security deposit for electricity consumption required by service provider because the deposit will be refunded to AHs once the consumption is terminated. ▪ Land title for the land plot in the resettlement site with names of husband and wife will be provided to each household after five consecutive years of living on the land at no cost.	completely before the scheduled start of civil works. ▪ IRC will support the AHs to acquire land title certificate after five consecutive years of AHs' living on the land. Cost of the procedure will be borne by RGC. ▪ Remaining ROW is still public state land.
III. Loss of Productive Land Use ; **Either Partial or Entire Land is Lost**	All AHs occupying land or using land in the Provisional Road Width (PRW)	▪ No cash compensation is available for affected land in ROW. ▪ See also [*C. LOSS OF CROPS AND TREES*]	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ AHs will not be moved from the ROW outside the PRW without justifiable cause (i.e. unless or until the land is required by the government for road improvement purposes). ▪ Remaining ROW is still **public state land**.
B. LOSS OF STRUCTURES			
I. Loss of Houses or Shop/Store**; Either Partial or Entire Structure is Lost**	All the AHs confirmed to be residing in, doing business or having right over resources within the project affected area during the conduct of IOL and census of AH (on Cut -off Date)	▪ Cash compensation at replacement cost without deduction for depreciation or salvageable materials (i.e. present cost of construction materials in the locality plus cost of labor). ▪ AHs are also entitled to have transport (moving) allowance (cf. Item E).	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ AHs to get cash compensation at least 30 days ahead of civil works in the locality to allow the AHs sufficient time to gradually reorganize the house and/or shop, thereby avoiding any disruption in their livelihood. ▪ AHs must completely cut, move back or relocate their houses/structures to new site within 30 days after receiving compensation. ▪ If the structure is found no longer viable for living, compensation will be paid for the entire structure and the AH will also be entitled to other allowances.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
	Renters	Renters are entitled to get allowances as below: ▪ **Transportation (moving) allowance**: USD 40 ▪ **Disruption allowance**: A lump sum cash assistance of USD 45 ▪ **Rental allowance**: equivalent to two months' rent of a similar building in the locality. ▪ If AH belongs to any of the **vulnerable group**, see Item E. ▪ Provision of information in finding alternate rental accommodation.	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ IRC will ensure payment of all allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. ▪ AHs that rent house and/or shop are entitled to a one time transport allowance only.
II. Other Structures (porch, extended eaves, spirit house, fence, etc.)	All the AHs confirmed to be residing in, doing business or having right over resources within the project affected area during the conduct of IOL and census of AH (Cut- off Date)	▪ Cash compensation at replacement cost without deduction for depreciation or salvageable materials (i.e. present cost of construction materials and labor in the locality).	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ IRC will ensure payment of all allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works.
C. LOSS OF CROPS AND TREES			
I. Loss of Crops	Owners of crops regardless of land tenure status	▪ To the extent possible, AHs will be **allowed to harvest** their annual and perennial crops prior to construction. ▪ If crops cannot be harvested due to construction schedule, AHs are entitled to cash compensation for the affected crops at replacement cost.	▪ Annual Crops – AHs will be given 90 days' notice that the land on which their crops are planted will be used by the project and that they must harvest their crops before the civil work. ▪ Remaining ROW is still **public state land**.
II. Loss of Fruit or Shade Trees	Owners of trees regardless of land tenure status	▪ Fruit trees will be compensated in cash at replacement cost.	▪ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ Remaining ROW is still **public state land**.
D. LOSS OF COMMON PROPERTY RESOURCES			
I. Partial or Entire Loss of Community and/or Public Assets	Affected communities or concerned government agencies who own the assets	▪ Replacement by similar structures and quality at the area identified in consultation with affected communities and relevant authorities.	▪ Communities to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ▪ Remaining ROW is still **public state land**.
E. ALLOWANCES AND ASSISTANCES			

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
I. Transport (moving) Allowance	AHs that relocate their house or house/shop	▪ Shops and stalls made of light and temporary materials: USD 5 to USD 10 (depending on the scale of the structures to be relocated) ▪ Regular shops and houses moving to residual or adjacent areas: USD 40 ▪ Regular shops and houses relocating within the same village outside of the ROW: USD 60 ▪ Houses relocating in another village outside of the ROW: USD 70	▪ Owners of houses or houses/shops are entitled to a one time transport allowance only. ▪ Remaining ROW is still **public state land**.
II. Severely Affected Households and/or Vulnerable AHs Allowance	Severely affected households [3] and Vulnerable AHs	▪ One time cash assistance equivalent to **USD 100** per Severely Affected households and/or Vulnerable AHs. ▪ See also *[V. Income Restoration Program (IRP)]*	▪ As indicated above, relocating landless AHs are entitled to replacement land with title at no cost
III. Disruption Allowance	▪ Relocating AHs to residual or adjacent areas (whose house type 1A to 2G) with floor area is less than 60 m^2.	▪ One time cash assistance equivalent to USD 35.	▪ Allowance shall be paid at the same time with compensation.
	▪ Relocating AHs to residual or adjacent areas (whose house type 1A to 2G) with floor area is 60 m^2 or more.	▪ One time cash assistance equivalent to USD100.	
	▪ Relocating AHs to residual or adjacent areas (whose house type from 2H or higher)	▪ One time cash assistance equivalent to USD150.	
	▪ Relocating AHs to a new village or resettlement site	▪ One time cash assistance equivalent to USD200.	
IV. Temporary loss of business income during relocation	Owners of shop who relocate their shop	Lump sum cash assistance of USD50.	
V. Income Restoration Program (IRP)	Severely affected households and Vulnerable Ahs	▪ An IRP will be provided during resettlement implementation.	▪ In-kind assistance to strengthen or initiate income-generating activities will be provided after need assessment through consultation with eligible AHs. Forms of assistance may include, but are not limited to, agricultural extension assistance, technical and other assistance to develop

[3] "Severely affected households" include but not limited to the AHs who will (i) lose 10% or more of their total productive land (income generating) and/or assets, and (ii) have to relocate due to the Project.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
			existing or new income-generating activities and project-related employment. ▪ Special attention to the needs of and opportunities for the vulnerable AHs.
F. TEMPORARY IMPACTS DUE TO ROAD CONSTRUCTION AND MAINTENANCE			
I. Affected assets during construction	Owners of assets	▪ Compensation for lost assets in cash at replacement cost, or ▪ Compensation as leasing fee based on replacement cost, and temporarily affected land will be returned to original owner/occupant.	▪ Contractor will be required by contract to pay these costs. ▪ Construction and maintenance will be carried out so as to minimize damage. ▪ Construction will be required by contract to stay within PRW. ▪ As part of the civil works contract, all access roads/driveways to properties adjacent to the road will be repaired or replaced including culverts and other facilities, to a condition equal to or better than at present. ▪ The disruption period will be minimized as much as possible. ▪ The contractor will repair the land back to its original condition before returning to the owners.
II. Damage to fields and private or community infrastructure including bund walls, drains and channels, etc.	Owners or persons using the field	▪ Repair of damage or payment for repair of damage at replacement cost.	

Source: JICA Study Team

16.3 Project Impacts

The IOL was conducted along the existing NR-5 and the Pursat bypass within the PRW of 20 meters from the centerline. Refer to the IOL results, 2,422 households will be affected by the Project. Of the 2,422 AHs, 224 AHs (247 cases) will lose their private land and 819 AHs along NR-5 and the Pursat bypass will lose their main structures (house, house-shop and/or shop/restaurant). A total of 296,069.07 m² of private land in the bypass area, in which 269,026.84 m² (90.87% of the total affected private land) is rice land, will be acquired for the Project. There are a total of 5,792 trees of various species and age in NR-5 and the bypass have been counted during the IOL. All affected trees are not commercially grown, meaning, they are sporadically planted.

Table 16.3-1 Affected Households along National Road No.5 and the Pursat Bypasses

Province/District	#AHs by section			Total (AHs)
	Thlea Ma'am to Battambang	Serei Sophorn to Poipet	Pursat Bypass	
Banteay Mean Chey/BMCH	**0**	**562**	**0**	**562**
Ou Chrov district	0	239	0	239
Poipet City	0	323	0	323
Battambang	**848**	**0**	**0**	**848**
Moung Reussei district	633	0	0	633

Province/District	#AHs by section			Total (AHs)
	Thlea Ma'am to Battambang	Serei Sophorn to Poipet	Pursat Bypass	
Sangke district	215	0	0	215
Pursat	**788**	**0**	**224**	**1,012**
Bakan district	722	0	0	722
Kandieng district	0	0	49	49
Krakor district	29	0	0	29
Pursat City	37	0	175	212
Total (the Project)	**1,636**	**562**	**224**	**2,422**

Data source: Project Survey conducted from September 2013 to January 2014

16.3.1 Methodology Used in Preparing the Resettlement Plan

The following sections describe the processes and methods employed in the survey on adverse social impacts for improving NR-5. The impact survey involved the conduct of IOL wherein all fixed assets (i.e., lands used for residence, commerce, agriculture, including ponds; dwelling units; stalls and shops; miscellaneous structures, such as fences, wells, trees with commercial value; etc.) located inside the PRW were identified, measured. The owners of those properties were identified, and their replacement values were also calculated. Likewise, the severity of impact on the affected assets and to the livelihood and productive capacity of AHs were determined. Photographs of the affected assets along with the AHs had also been taken. Also, information on the members of the AHs, sources of livelihood, income level, and ownership of productive assets had been gathered. The impacts survey and census of AHs were conducted from September 2013 to January 2014.

(1) Data Gathering Instrument

The basic tool used in the IOL and census of AHs was the survey questionnaire. Detailed socio-economic information on AHs whose main structures (i.e., houses and shops excluding government buildings) will be partially or entirely affected was obtained with the use of the survey questionnaire in Khmer. The questionnaire covered concerns on socio-economic conditions of the AH, in addition to basic information on the household head, such as gender, age, educational attainment, and primary source of income. It also included the affected assets and income, and their perception on the Project (see Appendix 16-4: Inventory of Loss and Socio-Economic Survey Questionnaire Form for a copy of the impact survey questionnaire).

(2) Survey Team

In addition to the Study Team leader (resettlement specialist), a recruited team of 46 local research assistants including one field survey coordinator, 3 field supervisors, 18 enumerators, 15 local assistants, 3 data entry clerks, one data developer, and 4 replacement cost (market rates) researchers, including one field team leader, was organized to help prepare this RAP. Except for the data developer, the rest of the local research assistants were based in the field. The survey team is divided into 3 IOL-SES survey groups and one RCS survey group. Each

IOL-SES survey group included one supervisor, 6 enumerators, 5 local assistant (for measuring), one data entry clerk and local authorities. Field data gathering for NR-5 (between Thlea Ma'am – Battambang and between Serei Sophorn – Poipet) commenced on 2nd September 2013 and was completed on 12th December 2013, while for Pursat Bypass it was studied from 30th December 2013 until 15th January 2013. The research team was accompanied by commune or village officials during their data gathering activities.

(3) Setting of the Cut-off Date

The IOL and census of AHs were preceded by a series of public consultation meetings in commune centres along NR-5 and Pursat Bypass area. Among others, the purpose of the public meetings was to brief the local population about the Project background, activities of the survey team, the policy of JICA and the Cambodian government on involuntary resettlement for the NR-5 Project, including the policy requirement on the cut-off date. The local people were informed that the cut-off date is the first day of holding the IOL and census of the AHs, which was on 2nd September 2013 for the exiting NR-5 and on 30th December 2013 for Pursat Bypass.

(4) Basic Unit Costs Used in the Resettlement Plan

In line with the IOL activities, an RCS of affected assets in the Project area was carried out by the research team which was leaded by a local resettlement/architecture specialist. The main objective of the RCS is to determine the rate of land prices based on actual transaction records of the affected areas, of affected main and secondary structures, and of fruit trees, trees and crops. Based on the results of RCS, the AHs will receive compensation at replacement cost (reflecting market price) from RGC for their loss of land and property due to the Project.

The methodology employed in the RCS included the following:

(i) Sale/Market comparison method: This method is based on data provided from recent sales of properties that are highly comparable to the subject property in the vicinity. The method is very useful for cost calculation of structure, land, crops and trees.
(ii) Contingent valuation method: Survey based on willingness to accept (WTA) and/or willingness to pay (WTP). This method was used for land price estimation because of land transactions at the project area are minimal in 2013.
(iii) Income approach: Sum of stream of incomes and sales proceeds. The principle here is that the value of a property is related to its ability to produce cash flow. The technique relies heavily on current market transactions involving the sale of comparable properties. This method was used for estimating the prices of crops and tree, particularly to calculate the compensation rates for temporary impact of agricultural land.
(iv) Replace cost approach: This method was useful for structure cost calculation. The value of a structure is based on the current cost for building the concerned structure and labor cost. For this study, the value of structure and labor cost are derived from the current cost based on market price without depreciation.

(a) Unit Costs of Land

The affected private lands were divided into 5 main categories: rice field, orchard, flooded, residential and commercial lands. The way to obtain data on market rates is to gather data on recent land sales, however sale cost recording could not be found at/around the Project area. Therefore, data of recent sales were collected by direct interviews with (i) land owners at/around the Project area who are both AHs and non-AHs, and (ii) local authorities at/around the Project area. Per results of the RCS, the unit costs of land covered with recognized proofs of ownership, structures, crops, perennials, and timber trees in districts and communes traversed by the Project road are provided.

(b) Unit Costs of Structures

The houses/structures affected by the Project have been categorized into two main groups – house/dwelling and other structures. The methodology employed for costing house/structures were composed of quantity survey and detailed measurement of the component parts of each structure. Labour costs were also assessed at market prices for the structure as a whole based on the information provided by local building contractors at the survey areas.

Although there are 4 main standard categories, some subcategories were introduced based on actual materials in each category. As a result of the survey, a total of 23 categories were identified in the Project area. The unit prices of a typical structure for each category are provided.

Other structures such as wells and fences, and cultural assets such as stupa (Chedey), have to be compensated at their market price, and the results of the specific rates of structures are provided.

(c) Unit Costs of Crops and Trees

The primary data was collected through interviews on the income at which owners/cultivators of crops and trees at the Project area. The market rates of crops and trees have been calculated based on the yield and the period of maturity of trees and crops as determined from interviews with farmers along NR-5.

The formula used for fruit trees is as follows: (Number/Quantity of harvest per year) x (Market price) x (Number of years it will mature) + cost of seedling

In order to simplify the study, perennial trees that have a growth period of more than five years have been classified in to the following three types:

- ✓ Sapling tree (1-3 years), as it can replanted ; 1/3 of full price,
- ✓ Young tree (3-5 years), bearing some fruit ; 2/3 of full price,
- ✓ Mature tree (more than five years), fully bearing fruit; compensate full price.

According to the survey, there are some trees that have a growth period of less than five years. Trees are also equivalent to full compensation cost if mature. Otherwise, their compensation value is their cost as a sapling tree or as a young tree.

16.3.2 Inventory of Affected Assets

(1) Land

The inventory of affected land (PRW: 20 m - 20 m) on both sides from the centreline of the road) in ROW (30 m - 30 m) of NR-5 was not performed since the ROW is public state land. It will not be compensated by the Project for the affected area (20 m - 20 m). Nevertheless, the survey team also determined the categories of the land occupants or users, and if the affected lands are accompanied with immovable assets such as trees, houses, shops and/or other structures. The landless households were also considered.

There were instances when the survey team could not complete their interviews with the AHs because the owners of the affected houses and shops were either closed or unattended during the survey. In such case, the survey team was only able to estimate the area of ROW lands used for residential or commercial purposes (i.e., footprint of the structures), and those that are fenced. These estimates will be validated and corrected as necessary during the updating of the RAP, with the assistance of commune officials who will also sit as members of the Provincial Resettlement Sub-committee-Working Group (PRSC-WG), the main resettlement body that is tasked to carry out the DMS.

A total of 296,069.07 m^2 of land will be required for the construction of the Pursat bypasses. Of these, 90.87% (269,026.84 m^2) is used for growing rice, 5,962.56 m^2 is commercial land and 21,079.67 m^2 is residential land. Table 16.3-2 shows the affected land area and the number of owners identified as AHs.

Table 16.3-2 Number of Affected Households who will lose their Private Lands (due to Pursat Bypasses)

Pursat province	Rice Field		Commercial		House Plot/ Home Garden	
	AH	m^2	AH	m^2	AH	m^2
Kandieng district	34	42,202.20	0	0.00	14	4,395.54
Pursat city	148	226,824.64	2	5,962.56	49	16,684.13
Total	**182**	**269,026.84**	**2**	**5,962.56**	**63**	**21,079.67**

Data source: Project Survey conducted from September 2013 to January 2014

(2) Main Structures

A total of 819 AHs along NR-5 and the Pursat bypass, whose main structures (house, house-shop and/or shop/restaurant) will be affected by the Project. Of the 819 AHs, 802 AHs are residing along NR-5, and 17 AHs residing along the bypasses.

Table 16.3-3 Number of Affected Households who will lose their Main Structures according to Type of Use

Road section	Province	District	AHs According to Type of Structure					
			House	House-Shop	Shop/ Restaurant	Shelter	Other Structures	Total
NR-5	BTB	Moung Reussei	104	70	2	242	64	482
		Sangke	23	40	1	101	12	177
		Subtotal (BTB)	**127**	**110**	**3**	**343**	**76**	**659**
	PST	Bakan	148	81	4	299	53	585
		Krakor	6	2	0	15	0	23
		Pursat	10	2	0	16	5	33
		Subtotal (PST)	**164**	**85**	**4**	**330**	**58**	**641**
	BMCH	Ou Chrov	108	41	0	58	15	222
		Poipet	130	29	1	88	36	284
		Subtotal (BMCH)	**238**	**70**	**1**	**146**	**51**	**506**
	Total (NR-5)		**529**	**265**	**8**	**819**	**185**	**1,806**
Bypass	PST	Kandieng	7	0	0	2	0	9
		Pursat	9	0	1	1	3	14
	Total (Bypasses)		**16**	**0**	**1**	**3**	**3**	**23**
Total	BTB	Moung Reussei	104	70	2	242	64	482
		Sangke	23	40	1	101	12	177
		Subtotal (BTB)	**127**	**110**	**3**	**343**	**76**	**659**
	PST	Bakan	148	81	4	299	53	585
		Krakor	6	2	0	15	0	23
		Pursat	19	2	1	17	8	47
		Kandieng	7	0	0	2	0	9
		Subtotal (PST)	**180**	**85**	**5**	**333**	**61**	**664**
	BMCH	Ou Chrov	108	41	0	58	15	222
		Poipet	130	29	1	88	36	284
		Subtotal (BMCH)	**238**	**70**	**1**	**146**	**51**	**506**
	Total (the Project)		**545**	**265**	**9**	**822**	**188**	**1,829**

Data source: Project Survey conducted from September 2013 to January 2014

Table 16.3-4 Floor Area (in m^2) of Affected Main Structures by Type of Materials

Type of Structure (m^2)	House	House/ Shop	Kitchen	Bath room	Grange/ Storage	Shop/ Restaurant	Craft/ Workshop	Stall / Market stall	Other	Total
1C	60.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	**76.00**
1D	51.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**71.00**
2A	63.00	0.00	13.00	0.00	0.00	0.00	19.25	70.20	24.60	**190.05**
2B	485.99	424.55	0.00	0.00	0.00	30.10	135.27	1,452.47	226.30	**2,754.68**
2C	263.85	242.98	0.00	0.00	0.00	0.00	163.59	772.34	89.10	**1,531.86**
2D	125.00	0.00	0.00	0.00	0.00	0.00	0.00	44.00	0.00	**169.00**
2E	9.00	49.20	0.00	0.00	0.00	0.00	30.00	142.06	22.50	**252.76**
2F	12.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	0.00	**59.00**

Type of Structure (m^2)	House	House/ Shop	Kitchen	Bath room	Grange/ Storage	Shop/ Restaurant	Craft/ Workshop	Stall / Market stall	Other	Total
2G	3,516.58	2,518.51	58.98	15.50	37.00	110.56	642.48	6,214.40	1,648.84	**14,762.85**
2H	59.62	22.00	0.00	0.00	0.00	0.00	0.00	173.50	0.00	**255.12**
2I	5,978.63	2,845.69	14.28	2.55	206.23	104.56	242.99	6,107.20	293.97	**15,796.10**
2J	2,486.03	860.20	45.24	22.77	142.57	91.53	87.00	1,364.25	895.60	**5,995.19**
2L	618.94	87.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**706.34**
3B	308.08	33.00	0.00	0.00	0.00	0.00	0.00	60.85	0.00	**401.93**
3C	74.50	0.00	0.00	3.00	9.50	0.00	32.02	11.20	0.00	**130.22**
3D	414.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**414.23**
4A	253.73	18.90	0.00	0.00	0.00	23.56	0.00	0.00	27.75	**323.94**
4B	122.49	4.80	0.00	0.00	0.00	0.00	0.00	8.12	0.00	**135.41**
4C	35.20	19.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**54.88**
S1	0.00	0.00	0.00	0.00	0.00	0.00	177.70	60.00	30.60	**268.30**
S2	0.00	0.00	0.00	0.00	0.00	0.00	47.50	0.00	7.08	**54.58**
S3	26.02	42.88	10.00	0.00	0.00	0.00	1,091.01	696.55	2,844.12	**4,710.58**
S4	46.00	86.80	29.00	0.00	33.00	0.00	2,357.83	1,151.62	14,106.60	**17,810.85**

Data source: Project Survey conducted from September 2013 to January 2014

Table 16.3-5 Other Structures

Items	Unit	Total
Concrete Well	set	**11**
Pump Well	set	**13**
Cement Mortar	m^2	**32,824**
Carrolage	m^2	**1,965**
Concrete Mortar	m^2	**765**
Concrete Road	m^2	**83**
Vehicle washing place	set	**14**
Separated Toilet	set	**35**
Culvert	m	**97**
Wooden Bridge	m^2	**98**
FENCE		
Timber post with bamboo	lm	**30**
Timber post with wire	lm	**1,945**
Concrete post with wire	lm	**695**
Brick Wall, 100 mm	lm	**2,456**
Brick Wall, 200 mm	lm	**1,002**
PETROL STATION		
Petrol Measure	set	**19**
Fuel Tank (10,000L)	set	**2**
GRAVE/STUPA/CHEDEY		
Concrete grave	set	**1**
Chedey/Stupa (7.0 m x 4.0 m x 4.0 m)	set	**2**
Spirit house with support-leg (small)	set	**5**

Data source: Project Survey conducted from September 2013 to January 2014

(3) Affected Crops and Trees

The start of civil works and the cropping schedule of AHs cultivating within the ROW and bypass will be synchronized to allow smooth transition between harvesting of standing crops and the start of road construction in a particular section of the Project road. Therefore, standing crops will not be affected if those can be harvested before road construction, but if they cannot be harvested before road construction, the unharvested crops will be compensated at replacement cost. However, fruit or timber trees along the PRW will be cleared for the road construction. With regard, there were a total of 3,783 fruit and timber tress with various species and ages along the existing NR-5 middle section and the Pursat bypasses have been counted during the IOL. The affected fruit and timber trees are not commercially grown, meaning they are sporadically planted.

Table 16.3-6 Affected Trees

No.	Type of Tree	Unit	Number
1	Bamboo	Thicket	31
2	Banana	Tree	1,412
3	Coconut	Tree	313
4	Tamarind	Tree	40
5	Chan Kiri	Tree	194
6	Sapodilla	Tree	16
7	Kantuot	Tree	22
8	Kamping Reach	Tree	35
9	Khvet	Tree	27
10	Jack Fruit	Tree	126
11	Krasaing	Tree	10
12	Korki	Tree	11
13	Pring	Tree	97
14	Jujube	Tree	12
15	Mkak	Tree	9
16	Longan	Tree	16
17	Sdau	Tree	9
18	Orange	Tree	26
19	Grapefruit	Tree	15
20	Custard apple	Tree	105
21	Sour sop	Tree	23
22	Guava	Tree	100
23	Teuk Dos Kou	Tree	53
24	Acacia/Eucalyptus	Tree	1,067
25	Lemon	Tree	11
26	Mango	Tree	1,166
27	Papaya	Tree	191
28	Sugar Palm	Tree	221
29	Cashew	Tree	70
30	Other	Tree	364

Data source: Project Survey conducted from September 2013 to January 2014

16.3.3 Impact on Vulnerable Households

The AHs are more vulnerable to impoverishment caused by involuntary resettlement are the poor (i.e. under the national poverty line: income<20$ per month/person), households headed by women, elderly, disabled without support mechanisms and landless households. The households falling within these groups were identified during the IOL will be updated at the time of DSM. They will get special cash assistance is needed to help them. The IOL result showed that there are 421 AHs with a total of 499 vulnerability factors (see Table 16.3-7). The additional special cash assistance for vulnerable AHs is $100.00 per vulnerable AH.

Table 16.3-7 Vulnerable Factors and Vulnerable AHs (VAHs)

Province	District	Aged ≥60 Yrs	Widow	Disabled	Landless	Poor	VAHs
BTB	Moung Reussei	62	26	4	11	4	90
	Sangke	12	11	0	3	1	24
	Sub-total (BTB)	**74**	**37**	**4**	**14**	**5**	**114**
PST	Bakan	66	43	7	37	1	128
	Kandieng	15	5	0	0	0	18
	Krakor	2	2	0	1	0	5
	Pursat	33	19	2	1	4	47
	Sub-total (PST)	**116**	**69**	**9**	**39**	**5**	**198**
BMCH	Ou Chrov	28	14	4	17	1	53
	Poipet	23	13	4	22	1	56
	Sub-total (BMCH)	**51**	**27**	**8**	**39**	**2**	**109**
TOTAL (Project)		**241**	**133**	**21**	**92**	**12**	**421**
		499 factors					**421 AHs**

Data source: Project Survey conducted from September 2013 to January 2014

16.4 Affected Public Assets

The Project also will affect on some public assets along NR-5 and Pursat bypass. The resettlement cost of the affected public assets is calculated and combined into the resettlement cost budget for the project.

16.5 Socio-Economic Profile of the Affected Households

An SES of AHs was also conducted at the same time of IOL survey. Most AHs, losing partially or entirely their assets such as structures, lands and/or trees, were interviewed for the purpose of gaining more information on their situation and present living standards. This activity was carried out aiming to prepare a more responsive RAP for people and households affected by the Project. Since there were instances when the AHs were unattended to during the survey, only 1,611 AHs along the existing NR-5 and the bypass have been interviewed. The number of AHs interviewed represented 66.52% of all AHs (2,422 AHs).

The main objective of the SES is to create baseline survey by collecting accurate statistical

information about living standard of the AHs. The topics are investigated in the survey were basic demography, literacy and education, economically active population, housing condition, possession of durable goods and livestock, household expenditure and income. Additionally, the survey was also directed to studying the perception of AHs on the Project.

16.5.1 Population and Household Composition

The total number of studied households is 1,611, which is composed of a population of 7,772. The population is comprised of 3,900 (50.2%) females and 3,872 (49.8%) males. Table 16.5-1 shows the details of population, sex ratio, as well as household size of the three provinces. An average household size is 4.8 and sex ratio is 99.3.

Table 16.5-1 Population and Household Composition

Stratum	Number of Households	Average HH Size	Population					Sex Ratio*
			Both	Male		Female		
				No.	%	No.	%	
Project Survey	1,611	4.8	7,772	3,872	49.8	3,900	50.2	99.3
BMCH	372	4.8	1,770	912	51.5	858	48.5	106.3
BTB	531	4.7	2,471	1,225	49.6	1246	50.4	98.3
PST	708	5.0	3,531	1,735	49.1	1796	50.9	96.6

Data source: Project Survey conducted from September 2013 to January 2014.
**Sex Ratio = (Number of male) / (Number of female) x 100(%).*

16.5.2 Age Structure and Dependency

The survey results for the age-sex distribution of the affected commune are set out in Table 16.5-2. This entry provides the distribution of the population according to age. Information is included by sex and age group (0-13 years, 14-60 years, 60 years and over). The age structure of a population affects a nation's key socioeconomic issues. They indicate a young population, with about 34.8% under 18 years old. With young populations (high percentage under age 18) need to invest more in schools, while with older populations (high percentage ages 60 and over) need to invest more in the health sector.

Table 16.5-2 Age-Sex Distribution

Stratum	Population		0-5		6-13		14-18		19-60		60+	
			No.	%	No.	%	No.	%	No.	%	No.	%
Project Survey	M	3,872	460	11.9	582	15.0	373	9.6	2,247	58.0	210	5.4
	F	3,900	410	10.5	527	13.5	347	8.9	2,321	59.5	295	7.6
	T	7,772	870	11.2	1,109	14.3	720	9.3	4,568	58.8	505	6.5
BMCH	M	912	112	12.3	145	15.9	104	11.4	513	56.3	38	4.2
	F	858	83	9.7	115	13.4	77	9.0	523	61.0	60	7.0
	T	1,770	195	11.0	260	14.7	181	10.2	1,036	58.5	98	5.5
BTB	M	1,225	148	12.1	200	16.3	121	9.9	685	55.9	71	5.8
	F	1,246	147	11.8	179	14.4	110	8.8	723	58.0	87	7.0

Stratum	Population		0-5		6-13		14-18		19-60		60+	
			No.	%	No.	%	No.	%	No.	%	No.	%
	T	2,471	295	11.9	379	15.3	231	9.3	1,408	57.0	158	6.4
	M	1,735	200	11.5	237	13.7	148	8.5	1,049	60.5	101	5.8
PST	F	1,796	180	10.0	233	13.0	160	8.9	1,075	59.9	148	8.2
	T	3,531	380	10.8	470	13.3	308	8.7	2,124	60.2	249	7.1

Data source: Project Survey conducted from September 2013 to January 2014.

The dependency ratio used to measure the proportion of children (below 15 years) and old people (from 65 years and over) compared to the proportion of people of workforce age (15-64 years). The age dependency ratio is defined as the ratio of the sum of the population below 15 years and population from 65 years taken together divided by the active population between the age groups of 15 to 64 years. The age dependency ratio is a summary indicator that indicates the burden falling on the population of working age.

The age composition in Table 16.5-3 shows that 68.3% of the population was aged between 15-64 years. 27.1% was below 15 years and 4.6% was 65 years and over. The Table 16.5-3 also provided detail about youth dependency ratio (39.6%) and old age dependency ration (6.7%). The total dependency ratio is 46.3%. This means there were 46.3 persons outside the usual working age group for every 100 persons in the age group 15-64 years who are economically dependent for economic support.

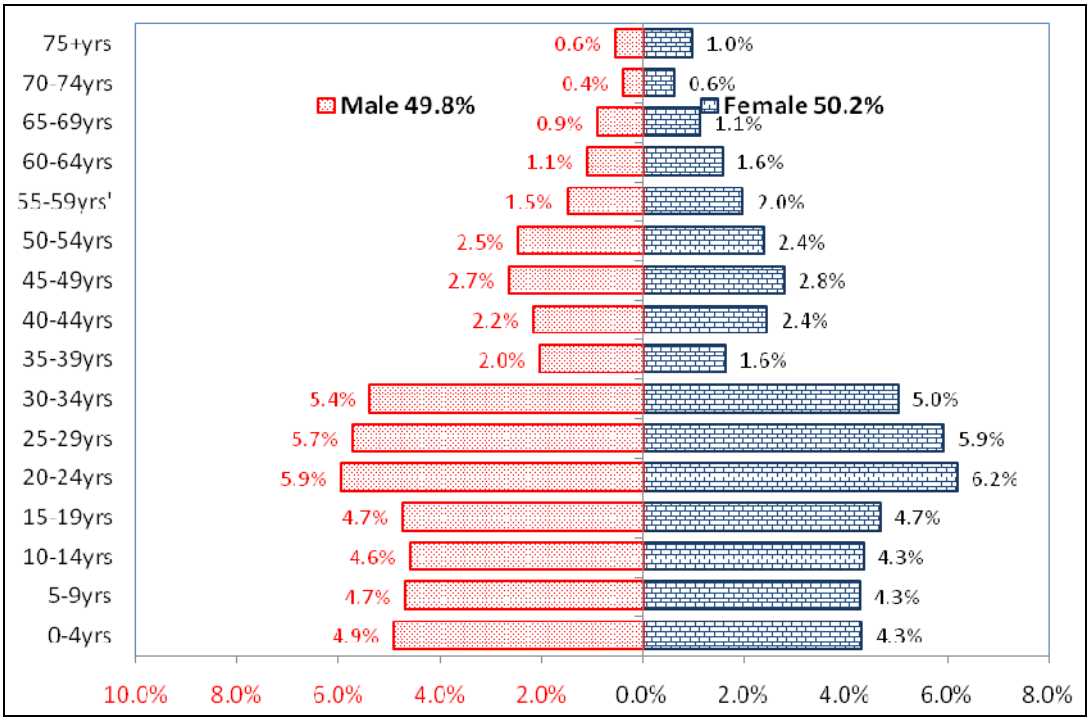
Table 16.5-3 Age Composition and Dependency Ratio

Stratum	Population		Below 15		15-64		65+		Dependency Ratio		
			No.	%	No.	%	No.	%	Youth	Old Age	Total
Project Survey	M	3,872	1,104	28.5	2,624	67.8	144	3.7	39.6%	6.7%	46.3%
	F	3,900	1,002	25.7	2,688	68.9	210	5.4			
	T	7,772	2,106	27.1	5,312	68.3	354	4.6			
BMCH	M	912	275	30.2	612	67.1	25	2.7	40.0%	5.9%	45.9%
	F	858	210	24.5	601	70.0	47	5.5			
	T	1,770	485	27.4	1,213	68.5	72	4.1			
BTB	M	1,225	365	29.8	810	66.1	50	4.1	43.4%	6.9%	50.3%
	F	1,246	348	27.9	834	66.9	64	5.1			
	T	2,471	713	28.9	1,644	66.5	114	4.6			
PST	M	1,735	464	26.7	1,202	69.3	69	4.0	37.0%	6.8%	43.8%
	F	1,796	444	24.7	1,253	69.8	99	5.5			
	T	3,531	908	25.7	2,455	69.5	168	4.8			

Data source: Project Survey conducted from September 2013 to January 2014.

Although not significant statistically, the age-sex figures are valuable in demonstrating that this is, comparatively, an ageing population, with a predominantly middle-aged population with a bulge in the 20-24, 25-29 and 30-34 age group (12.1%, 11.6% and 10.4% respectively) and a corresponding bulge in the 10-19 year old age group (18.3% of the population), while the youngest two age groups, 5-9 year old, have only 9.0%. The relevance of these statistics is the

likely higher impact on secondary school in-take in the project impact area than in the primary-school in-take.



Data source: Project Survey conducted from September 2013 to January 2014.

Figure 16.5-1 Age-Sex Figures

16.5.3 Marital Status

For classifying the marital status, 4 categories were used such as single (never married), currently married, divorced/separate and widowed. The currently married group included person who were living together whether or not their marriage had legal status. Although marital status information was collected for all age groups, it is useful to present data for the population aged 15 years and over only. For both sexes, 34.3% they are never married, 57.7% were currently married, 5.8% were widowed and 2.2% were divorced or separated.

Table 16.5-4 Marital Status for Both Sexes by Age Group

Age Group	Pop.	Single		Married		Divorced/separate		Widowed	
		No.	%	No.	%	No.	%	No.	%
15+ yrs	**5,666**	**1,942**	**34.3**	**3,270**	**57.7**	**123**	**2.2**	**331**	**5.8**
15 – 19 yrs	731	701	95.9	29	4.0	0	0.0	1	0.1
20 - 24 yrs	943	684	72.5	246	26.1	8	0.8	5	0.5
25 - 29 yrs	906	365	40.3	522	57.6	14	1.5	5	0.6
30 - 34 yrs	810	134	16.5	636	78.5	31	3.8	9	1.1
35 - 39 yrs	286	16	5.6	260	90.9	3	1.0	7	2.4
40 - 44 yrs	359	10	2.8	322	89.7	13	3.6	14	3.9
45 - 49 yrs	422	14	3.3	385	91.2	9	2.1	14	3.3
50 - 54 yrs	377	4	1.1	320	84.9	16	4.2	37	9.8
55 - 59 yrs	270	6	2.2	212	78.5	12	4.4	40	14.8
60 - 64 yrs	208	1	0.5	156	75.0	4	1.9	47	22.6

Age Group	Pop.	Single		Married		Divorced/separate		Widowed	
		No.	%	No.	%	No.	%	No.	%
65 - 69 yrs	158	4	2.5	103	65.2	4	2.5	47	29.7
70 - 74 yrs	78	2	2.6	37	47.4	2	2.6	37	47.4
75+ yrs	118	1	0.8	42	35.6	7	5.9	68	57.6

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.4 Ethnic Group and Religion

99.3% of affected household heads are Khmer and Khmer speaking, while only 0.7% are minority ethnic Cham, who are legally registered as Cambodian citizens. They live and work as the Cambodians and they are not vulnerable in terms of their livelihood.

Table 16.5-5 First Language and Ethnic Group of Household Heads

Stratum	No. H/H	Mother tongue and Ethnic Group			
		Khmer		Cham	
		No.	%	No.	%
Project	1,611	1,599	99.3	12	0.7
BMCH	372	368	98.9	4	1.1
BTB	531	528	99.4	3	0.6
PST	708	703	99.3	5	0.7

Data source: Project Survey conducted from September 2013 to January 2014.

Buddhism has been the dominant religion in Cambodia, in one form or another, since the reign of Jayavarman VII (c. 1181-1200). In Cambodia is currently estimated to be the faith of 95% of the population, but through the survey results it was found up to 99.3% is Buddhism and only 0.7% is Muslim.

Table 16.5-6 Religion of Household Heads

Stratum	No. H/H	Mother tongue and Ethnic Group			
		Buddhism		Muslim	
		No.	%	No.	%
Project	1,611	1,599	99.3	12	0.7
BMCH	372	368	98.9	4	1.1
BTB	531	528	99.4	3	0.6
PST	708	703	99.3	5	0.7

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.5 Vulnerable Groups

The study indicates to different type of vulnerable groups include elderly without supporting from youth, window and female-headed households, physically and mentally handicapped, landless and poor household which their income is under national poverty line. Table 16.5-7 reported that 8.2% of sample is widow and female household heads. Poor women heads of household are forced by necessity to increasingly take men's roles and responsibilities, due to absence of male labour and inability to hire adult male labour. Female-headed households are

indeed facing the double burden of taking care of the well-being of family members and other aspects compared to couple households.

Based on the survey results, an average percentage of each vulnerable factor in three different areas (BMCH, BTB and PST) of disabled household head, aged[4] household head, household living below poverty line (<20$/capita/month) and landless household is 1.3%, 14.9%, 0.7%, and 5.6% respectively.

Table 16.5-7 Vulnerable Household Head

Stratum	Number of HHs	Aged (≥60 years)*		Female HHs		Disabled HHs		Landless		<USD 20/month/cap	
		No.	%	No.	%	No.	%	No.	%	No.	%
Project Survey	1,611	240	14.9	132	8.2	21	1.3	91	5.6	12	0.7
BMCH	372	51	13.7	27	7.3	8	2.2	39	10.5	2	0.5
BTB	531	74	13.9	37	7.0	4	0.8	14	2.6	5	0.9
PST	708	115	16.2	68	9.6	9	1.3	38	5.4	5	0.7

** "Aged" Vulnerable Household; HH head is older than 60 years old and with no other means of support.*
** No child-headed household was found in the project area.*
Data source: Project Survey conducted from September 2013 to January 2014.

16.5.6 Literacy

(1) Literacy of the Affected Households' Heads and Spouses

The male household head literacy rates are 96.4% and female spouse literacy rates are 89.9%. There is a small gap between the literacy rates of male household heads and their spouses. Among 318 female household heads, there are only 252 (79.2%) of them are literacy. Women, in general, receive less education than men, especially for widows. The survey results show that female HH are, around 17%, less literate than male HH. Therefore, women enter the labour market with a lower education and less vocational skills than men. Even thought, they (men and women) work the same job and same quality of work, but sometimes women still get a salary less than men.

Table 16.5-8 Literacy of Affected Households' Heads and Spouses

Stratum	Male AH Head			Female AH Head			Female Spouse		
	# AH	Yes	%	# AH	Yes	%	# AH	Yes	%
Project Survey	1,293	1,247	96.4	318	252	79.2	1,232	1,107	89.9
BMCH	303	295	97.4	69	51	73.9	287	257	89.5
BTB	410	393	95.9	121	100	82.6	390	353	86.1
PST	580	559	96.4	128	101	78.9	555	497	89.5

Data source: Project Survey conducted from September 2013 to January 2014.

(2) Adult Literacy (age from 15 years and over)

Adult literacy rate is the percentage of the population aged 15 years and over who can both

[4] Aged was defined as a person who is more than 60 years old and without young to support.

read and write a simple message in any language. The Table 16.5-9 presents an adult literacy rate of both male and female of 92.6% which is considerably high and the single literacy rate of male and female 96.6% and 88.8% respectively.

Table 16.5-9 Adult Literacy (age from 15 years and over)

Stratum	Both Sex			Male			Female		
	Pop.	Yes	%	Pop.	Yes	%	Pop.	Yes	%
Project Survey	5,666	5,246	92.6	2,768	2,673	96.6	2,898	2,573	88.8
BMCH	1,285	1,188	92.5	637	618	97.0	648	570	88.0
BTB	1,758	1,627	92.5	860	832	96.7	898	795	88.5
PST	2,623	2,431	92.7	1,271	1,223	96.2	1,352	1,208	89.3

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.7 Educational Attainment of the Population

Since 2000, education for all Cambodians has been re-energized by the world's commitment to the Millennium Development Goal (MDG). Based on its commitment toward the MDG, RGC, with assistance from its development partners and NGO communities, has made their efforts to develop a National Education Plan. Furthermore, the Ministry of Education, Youth and Sport has developed the Education for all policy documents. Cambodian MDG (Global MDG2) aims 'to ensure that by 2015, all children will be able to complete a full course of 9-year basic education'. (Source: Cambodia Millennium Development Goals Report November 2003).

Table 16.5-10 Education Attainment of Population Aged 5 Years and Over

Stratum	Sex	None or Little	Primary Not Completed	Completed Primary Education	Completed Lower Secondary Education	Completed Upper Secondary Education	Post-Secondary Education
		%	%	%	%	%	%
Project Survey	Male	10.1	23.2	24.5	21.4	12.7	8.1
	Female	16.0	28.9	24.7	16.3	8.7	5.4
	Both	13.1	26.1	24.6	18.8	10.7	6.8
BMCH	Male	12.2	25.5	26.7	19.3	9.7	6.7
	Female	18.6	30.7	22.4	15.9	7.2	5.2
	Both	15.4	28.0	24.6	17.6	8.5	5.9
BTB	Male	10.2	24.1	27.5	19.9	11.6	6.7
	Female	16.1	30.1	26.7	16.3	6.3	4.5
	Both	13.2	27.1	27.1	18.1	8.9	5.6
PST	Male	8.8	21.4	21.2	23.6	15.0	9.9
	Female	14.7	27.1	24.5	16.4	11.1	6.2
	Both	11.8	24.3	22.9	19.9	13.0	8.0

Data source: Project Survey conducted from September 2013 to January 2014.

In the Project area, 13.1% of the population (both male and female) has no or little education. The difference of none and little education between sexes is more than one and half with 16.0% for female and 10.1% for male. Around 24.6% of education attainment for both male and female has at least completed primary education. As shown in Table 16.5-10, there are only 18.8% who have

completed lower secondary schooling, and 6.8% who have attended post-secondary education for both male and female. The gap between sexes increases for higher level of education nearly one and half, i.e. 8.1% of male have post-secondary education, compared to female, which is only 5.4%.

16.5.8 Current School Attendance

Information on school attendance was collected in respect of the population aged from 6 to 14 years old. School attendance was defined as enrolment and studying at a primary and lower secondary school. School attendance in primary education is 96.4%, while lower secondary school is 96.9%. The percentage of primary school attendance is smaller than lower secondary school attendance due to most of pupils in primary school, are too young/small and they often leave school after a few months of school enrolment/registration.

In particular, rural poorer families in the past, young girls are probably allowed to attend school of grade 6 in primary school and after that they stay at home to help their families as additional agricultural labour. At the present, most of the families send and encourage their daughters to go to school in higher level of education. The Table 16.5-11 shows that about 97.6% of female pupils have attended secondary school. They do not have dropped out school.

Table 16.5-11 Current School Attendance for Primary and Lower Secondary

Stratum	Sex	Primary School			Lower Secondary School		
		Age: 6-11	Attending	%	Age: 12-14	Attending	%
Project Survey	Male	430	414	96.3	214	206	96.3
	Female	381	368	96.6	211	206	97.6
	Both	811	782	96.4	425	412	96.9
BMCH	Male	111	108	97.3	52	49	94.2
	Female	85	84	98.8	42	42	100.0
	Both	196	192	98.0	94	91	96.8
BTB	Male	147	138	93.9	70	68	97.1
	Female	124	118	95.2	77	75	97.4
	Both	271	256	94.5	147	143	97.3
PST	Male	172	168	97.7	92	89	96.7
	Female	172	166	96.5	92	89	96.7
	Both	344	334	97.1	184	178	96.7

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.9 Affected Households' Head Engaged in Farming and Non-farming

About 26.8% of household heads are working on farms, while non-farming is 68.9% (Other rests 4.3% are aged or disable or unable to work.). Table 16.5-12 shows that the percentage of household heads working on farms is highest in BMCH with 31.5%. A sizeable number of male and female household heads surveyed (363 persons or 28.1% and 68 persons or 21.4%, respectively) are engaged in farming.

Table 16.5-12 Farming and Non-farming Affected Households' Head

Stratum	Number of Households		Non activity		Non-farming		Farming	
			No.	%	No.	%	No.	%
Project Survey	Male	1,293	45	3.5	885	68.4	363	28.1
	Female	318	25	7.9	225	70.8	68	21.4
	Total	1,611	70	4.3	1,110	68.9	431	26.8
BMCH	Male	303	4	1.3	197	65.0	102	33.7
	Female	69	3	4.3	51	73.9	15	21.7
	Total	372	7	1.9	248	66.7	117	31.5
BTB	Male	410	16	3.9	259	63.2	135	32.9
	Female	121	10	8.3	91	75.2	20	16.5
	Total	531	26	4.9	350	65.9	155	29.2
PST	Male	580	25	4.3	429	74.0	126	21.7
	Female	128	12	9.4	83	64.8	33	25.8
	Total	708	37	5.2	512	72.3	159	22.5

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.10 Fishing Community

Among 151 AHs interviewed, there are only 27 AHs (17.9%) are in fishing activity. Among the 27 AHs of the fishing family, the 24 AHs (15.9%) are only fish just for their leisure or eating, while 3 AHs (2.0%) get income from fishing.

Table 16.5-13 Fishing Activities around Pursat Town (Bypass)

Stratum	Number of HH	Fishing		Leisure/ Eating		Selling/Money	
		Yes	%	Yes	%	Yes	%
Project Survey	151	27	17.9	24	15.9	3	2.0
Pursat City (PST)	118	25	21.2	23	19.5	2	1.7
Kandieng district (PST)	33	2	6.1	1	3.0	1	3.0

Data source: Project Survey conducted from September 2013 to January 2014.

Based on the socio-economic survey, the main source of fishing for the 27 fishing families is a stream or small river, reservoir and Tonle Sap River.

Table 16.5-14 A place to Conduct the Fishing

Stratum	Number of HH	Reservoir		Tonle Sap river		Stream/small river	
		Yes	%	Yes	%	Yes	%
Project Survey	27	11	40.7	1	3.7	15	55.6
Pursat City (PST)	25	10	40.0	1	4.0	14	56.0
Kandieng district (PST)	2	1	50.0	0	0.0	1	50.0

Data source: Project Survey conducted from September 2013 to January 2014.

Of the 27 fishing families, 88.9% do fishing only in rainy season, 7.4% do fishing only in dry season and 3.7% do fishing for the whole year. None of them have joined in fishery community.

Table 16.5-15 Duration of the Fishing

Stratum	Number of HH	Whole year		Rainy season		Dry season	
		Yes	%	Yes	%	Yes	%
Project Survey	27	1	3.7	24	88.9	2	7.4
Pursat City (PST)	25	1	4.0	22	88.0	2	8.0
Kandieng district (PST)	2	0	0.0	2	100.0	0	0.0

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.11 Main Sources of Income of Affected Households

According to the survey, the main sources of income of the AHs include 75.9% business/trade followed by 57.1% from agricultural sector (agricultural production, livestock, fishing and fish culture), and 55.7% depend on wages/salary. Remittance of 7.2% is also another main source of household income from their jobs in other places.

Table 16.5-16 Main Source of Income of the AHs

Province	Project Survey		BMCH		BTB		PST	
Number of Households	**1,611**		**372**		**531**		**708**	
Item	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Wages/salary	897	55.7	208	55.9	218	41.1	471	66.5
Farming hired labor	29	1.8	13	3.5	12	2.3	4	0.6
Business/trade	1,222	75.9	261	70.2	464	87.4	497	70.2
Agricultural production	741	46.0	165	44.4	271	51.0	305	43.1
Livestock	166	10.3	14	3.8	55	10.4	97	13.7
Fishing	6	0.4	2	0.5	2	0.4	2	0.3
Equipment making	10	0.6	0	0.0	8	1.5	2	0.3
Equipment rental	5	0.3	0	0.0	4	0.8	1	0.1
Transportation	60	3.7	12	3.2	19	3.6	29	4.1
House/land rental	98	6.1	14	3.8	37	7.0	47	6.6
Remittance	116	7.2	28	7.5	44	8.3	44	6.2
Fish culture	6	0.4	0	0.0	1	0.2	5	0.7
Other	74	4.6	22	5.9	22	4.1	30	4.2

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.12 Affected Households Income

Under the survey purposes, the affected household income included earnings and receipts from all sources received by all household members during the last year. Participants in the economic activity include employers, own account workers, employees or unpaid family workers, rentals (house, land, equipment, etc.) or recipient of pensions, grants, etc.

A significant number (83.3%) of male household heads reported that they are earning an annual income higher than USD 3,000 (among them, 55.4% earning more than USD 5,000 a year), while 11.4% reported an annual income between USD 2,000 and USD 3,000. Only 0.2% of the male household heads reported that their earnings are less than USD 600 a year.

Table 16.5-17 Annual Income (USD) of AHs Headed by Males

Stratum	<= 600		600+ - 1,000		1,000+ -2,000		2,000+ -3,000		3,000+ - 4,000		4,000+ - 5,000		5,000+		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	2	0.2	6	0.5	61	4.7	147	11.4	176	13.6	185	14.3	716	55.4	1,293	100.00
BMCH	0	0.0	3	1.0	15	5.0	25	8.3	34	11.2	37	12.2	189	62.4	303	100.00
BTB	2	0.5	1	0.2	24	5.9	67	16.3	72	17.6	61	14.9	183	44.6	410	100.00
PST	0	0.0	2	0.3	22	3.8	55	9.5	70	12.1	87	15.0	344	59.3	580	100.00

Data source: Project Survey conducted from September 2013 to January 2014.

Likewise, a significant number (67.0%) of female household heads reported that they are earning an annual income higher than USD 3,000 (among them, 35.8% earning more than USD 5,000 a year), while 16.4% reported an annual income between USD 2,000 and USD 3,000. It is noted that all female household heads in BMCH and PST province earn income higher than USD 600 a year.

Table 16.5-18 Annual Income (USD) of AHs Headed by Females

Stratum	<= 600		600+ - 1,000		1,000+ -2,000		2,000+ -3,000		3,000+ - 4,000		4,000+ - 5,000		5,000+		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1	0.3	12	3.8	40	12.6	52	16.4	54	17.0	45	14.2	114	35.8	318	100.00
BMCH	0	0.0	3	4.3	8	11.6	12	17.4	10	14.5	6	8.7	30	43.5	69	100.00
BTB	1	0.8	3	2.5	21	17.4	17	14.0	24	19.8	20	16.5	35	28.9	121	100.00
PST	0	0.0	6	4.7	11	8.6	23	18.0	20	15.6	19	14.8	49	38.3	128	100.00

Data source: Project Survey conducted from September 2013 to January 2014.

Table 16.5-19 shows the sources of cash income of all 1,611 households interviewed. It reveals that the average monthly income of household and capita is USD 598.79 and USD 124.75, respectively. Of all interviewed households in the Project area, there are 53.8% has their main income source from business/trade, 28.9% has their second main income from wages or salary and 7.82% has their third main income from agricultural sector(i.e. agricultural production, livestock, fishing and fish culture).

Table 16.5-19 Average Annual and Monthly Income (USD) per Capita

Items	Case	Annual Income		
		USD	%	Average
Wages/salary	897	3,343,459.69	28.9	3,727.38
Farming hired labor	29	44,583.75	0.4	1,537.37
Business/trade	1,222	6,224,965.44	53.8	5,094.08
Agricultural production	741	669,125.85	5.8	903.00
Livestock	166	176,411.87	1.5	1,062.72
Fishing	6	2,687.50	0.02	447.92
Equipment making	10	33,116.25	0.3	3,311.63
Equipment rental	5	7,550.00	0.1	1,510.00
Transportation	60	273,775.25	2.4	4,562.92
House/land rental	98	202,606.78	1.8	2,067.42
Remittance	116	151,636.37	1.3	1,307.21
Fish culture	6	62,331.25	0.5	10,388.54

Items	Case	Annual Income		
		USD	%	Average
Other	74	383,539.08	3.3	5,182.96
Total	**3,430**	**11,575,789.08**	**100.00%**	
Currency in USD	Annual		Monthly	
Number of Interviewed HHs = 1,611				
Household income**	**7,185.47**		**598.79**	
Capita income***	**1,496.97**		**124.75**	

** Each household gets income from more than one source*
*** [Household income]=[Total Annual Income]/[Total Number of Interviewed HHs]*
**** A HH has 4.8 persons in average. (Capita income=Household income / 4.8)*
Data source: Project Survey conducted from September 2013 to January 2014.

16.5.13 Credit

Generally, households in the project area have access to credits or loans from various agencies, both private/official and non-official credit institutions. The survey showed that 44.1% (710 AHs) of the 1,611 AHs have received credit from different agencies. The credit sources of the 710 AHs include 35.5% from private bank institutions, 25.2% from NGOs, 11.3% from credit providers, 10.4% from relatives, 5.8% from landlords/traders, and the rest of 11.8% from other credit sources.

Table 16.5-20 Credit Acquired During the Last Year

	Number of HHs	Received credits		Private Bank		NGOs/ Society		Landlord/ Traders		Credit Providers		Relatives		Others	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1,611	710	44.1	252	35.5	179	25.2	41	5.8	80	11.3	74	10.4	84	11.8
BMCH	372	149	40.1	76	51.0	21	14.1	9	6.0	21	14.1	13	8.7	9	6.0
BTB	531	239	45.0	52	21.8	101	42.3	22	9.2	27	11.3	36	15.1	1	0.4
PST	708	322	45.5	124	38.5	57	17.7	10	3.1	32	9.9	25	7.8	74	23.0

Data source: Project Survey conducted from September 2013 to January 2014.

Generally, households acquire loans for various purposes, such as for farming, health treatment, starting/expanding business, and family support. As shown in Table 16.5-21, most households (73.2%) get loans for expanding their businesses follows by 19.7% for farming, 12.4% for food consumption, 11.5% for health care, 9.0% for schooling cost and 8.5% for house repairing/building.

Table 16.5-21 Purposes of Acquiring the Credit

Items	Project		BMCH		BTB		PST	
	No.	%	No.	%	No.	%	No.	%
Number of HHs	710		149		239		322	
Food consumption	88	12.4	6	4.0	63	26.4	19	5.9
Health care	82	11.5	24	16.1	31	13.0	27	8.4
Schooling costs	64	9.0	15	10.1	33	13.8	16	5.0
Building/repairing house	60	8.5	7	4.7	26	10.9	27	8.4
Ceremony/wedding	11	1.5	0	0.0	4	1.7	7	2.2
Farming	140	19.7	36	24.2	67	28.0	37	11.5

Items	Project		BMCH		BTB		PST	
	No.	%	No.	%	No.	%	No.	%
Business expanding	520	73.2	103	69.1	190	79.5	227	70.5
Supporting family members	26	3.7	9	6.0	5	2.1	12	3.7
Others	53	7.5	8	5.4	16	6.7	29	9.0

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.14 Sanitation

(1) Water Sources for Drinking and Cooking

Of the interviewed households in the Project area, only 8.9% use pipe water from waterworks, 19.3% from protected wells, while 5.8% use water from unprotected wells. Moreover, 45.1% buy clean water during the dry season for their daily consumption and approximately, 48.7% use rainwater during the wet season. Lake/pond was also the main source of drinking water for 20.4%, while 0.9% still uses water from stream/river.

Table 16.5-22 Water Sources for Drinking and Cooking

Stratum	#HHs	Stream/River		Lake/Pond		Protected Well		Unprotected Well		Rainwater		Buying		Waterworks	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1,611	14	0.9	329	20.4	311	19.3	93	5.8	785	48.7	727	45.1	143	8.9
BMCH	372	0	0.0	117	31.5	133	35.8	36	9.7	135	36.3	98	26.3	0	0.0
BTB	531	0	0.0	170	32.0	103	19.4	35	6.6	429	80.8	217	40.9	20	3.8
PST	708	14	2.0	42	5.9	75	10.6	22	3.1	221	31.2	412	58.2	123	17.4

Data source: Project Survey conducted from September 2013 to January 2014.

71.7% of the interviewed households always boil their drinking water. Boiling water is by far the most common method for Cambodian people to protect from any bacteria. 8.6% of the interviewed households sometimes boil water before drinking, while 19.7% drink water without boiling.

Table 16.5-23 Boiling Water for Drinking

Stratum	Number of Households	Boiling Water for Drinking					
		Always		Sometimes		Never	
		No.	%	No.	%	No.	%
Project Survey	1,611	1,155	71.7	139	8.6	317	19.7
BMCH	372	271	72.8	33	8.9	68	18.3
BTB	531	363	68.4	44	8.3	124	23.4
PST	708	521	73.6	62	8.8	125	17.7

Data source: Project Survey conducted from September 2013 to January 2014.

Approximately 40.1% of interviewed households have to buy water for washing/bathing during the dry season. Wells and rainwater are the most common water sources for the local people (63.1%) to make a bath and wash (see Table 16.5-24 for detailed information).

Table 16.5-24 Water Sources for Washing and Bathing

Stratum	#HHs	Stream/River		Lake/Pond		Protected Well		Unprotected Well		Rainwater		Buying		Waterworks	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1,611	18	1.1	378	23.5	348	21.6	92	5.7	576	35.8	646	40.1	154	9.6
BMCH	372	1	0.3	129	34.7	147	39.5	37	9.9	113	30.4	64	17.2	0	0.0
BTB	531	0	0.0	175	33.0	116	21.8	32	6.0	306	57.6	190	35.8	21	4.0
PST	708	17	2.4	74	10.5	85	12.0	23	3.2	157	22.2	392	55.4	133	18.8

Data source: Project Survey conducted from September 2013 to January 2014.

(2) Toilet

In the Project area, 79.6% of the interviewed households have own latrine, while 20.4% do not have access to toilet facilities as they depend on "open defecation" or sharing toilets with their neighbours. In particular, 97.0% of respondents in Kandieng District/PST and only 71.4% of AHs in Krakor District/PST have their own toilet.

16.5.15 Energy Sources for Lighting and Cooking

Battery is still the most commonly used energy source for lighting in Cambodia's rural areas, where electricity is not available. However, in the Project area, only 1.7% of the surveyed AHs claimed that they use rechargeable stationary batteries for lighting. Moreover, 94.7% use publicly provided electricity (state electricity) as their source, while 1.3% use kerosene lamp. About 2.4% of AHs claim that they use their own generators.

Table 16.5-25 Energy Sources for Lighting

Stratum	Number of HHs	Private Generator		State Electricity		Battery		Gas/Kerosene	
		No.	%	No.	%	No.	%	No.	%
Project Survey	1,611	39	2.4	1,525	94.7	27	1.7	21	1.3
BMCH	372	39	10.5	324	87.1	4	1.1	5	1.3
BTB	531	0	0.0	520	97.9	9	1.7	2	0.4
PST	708	0	0.0	681	96.2	14	2.0	14	2.0

Data source: Project Survey conducted from September 2013 to January 2014.

Based on the survey results, 23.1% of interviewed households use liquefied petroleum gas as their source for cooking, while 64.7% and 53.5% use charcoal and firewood, respectively. Only 6.5% of interviewed households in the Project area use electricity as their energy source for cooking

Table 16.5-26 Energy Sources for Cooking

Stratum	Number of HHs	Firewood		State Electricity		Charcoal		Gas/Kerosene	
		No.	%	No.	%	No.	%	No.	%
Project	1,611	862	53.5	105	6.5	1043	64.7	372	23.1
BMCH	372	228	61.3	21	5.6	235	63.2	102	27.4
BTB	531	296	55.7	30	5.6	362	68.2	89	16.8
PST	708	338	47.7	54	7.6	446	63.0	181	25.6

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.16 Transportation

Bicycles are more commonly used as a mode of transportation in rural areas, while motorcycles are more conveniently and more commonly used in urban areas. In the study, it reveals that around 58.9% of interviewed households have bicycles and 76.0% have motorbikes. Only a small number of households have trucks, at about 5.1%, and 13.2% have a car/pickup/minivan. It was estimated that the average value of transport equipment in the Project area is around USD 2,614 per household.

Table 16.5-27 Transport Equipment and Its Values

Mode of Transport	Total Value (USD)	Total AHs = 1,611	
		# Having	%
Bicycle	23,234.00	949	58.9
Motorbike	1,304,410.00	1,225	76.0
Car/pickup/minivan	1,889,600.00	212	13.2
Truck	994,200.00	82	5.1
Boat without engine	235.00	4	0.2
Grand Total	4,211,679.00 (USD)		
Average/Household	2,614.00 (USD)		

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.17 Household Appliances

Telephones are the most common household appliance among the AHs interviewed, with 1,535 households (95.3%) reporting that they own at least one up to more than five per household. The second most common appliance is TV/VRC/VCP (87.4%). Table 16.5-28 shows the percentage of households owning other types of electrical appliances, such as 17.3% owning radio/cassette players, and 13.8% owning sewing machines. A small proportion of households own equipment for convenience such as generators at 3.8%, washing machines at 4.5%, air conditioners at 4.0%, and refrigerators 9.9%. It was estimated that the average value of other assets in the target area is around USD 224.60 per household.

Table 16.5-28 Household Appliances and Its Values

Stratum	Total Value (USD)	Total Households = 1,611	
		#Having	%
Radio/cassette player	3,464.25	278	17.3
TV/VCR/VCP	86,938.75	1,408	87.4
Sewing machine	29,963.00	223	13.8
Air conditioner	19,750.00	65	4.0
Washing machine	13,175.00	73	4.5
Refrigerator	31,526.00	159	9.9
Telephone	155,872.00	1,535	95.3
Generator	21,205.00	61	3.8
Grand Total	361,894.00 (USD)		
Average/Household	224.60 (USD)		

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.18 Housing Characteristic

(1) Dwelling Space by Household

There are 1,611 dwellings in the sample. Average floor area of dwellings is 53.5 square meters (sqm) per household or 11.15 square meters per person (average household size is 4.8). For all Cambodia (CSES-2004), the average dwelling space per household is 42.0 sqm. The average floor area of dwelling ranged from 39.0 sqm per household in rural areas to 48.8 sqm in other urban areas, and to 64.3 sqm in urban Phnom Penh.

Table 16.5-29 Dwelling Space

Stratum	No. H/H	Total size in m^2	Average in m^2	≤ 20 m^2		20+ - 50 m^2		50+ - 100 m^2		100+ m^2	
				No.	%	No.	%	No.	%	No.	%
Project	1,611	86,215	53.5	151	9.4	777	48.2	520	32.3	131	8.1
BMCH	372	18,027	48.5	63	16.9	163	43.8	107	28.8	28	7.5
BTB	531	27,678	52.1	39	7.3	302	56.9	154	29.0	35	6.6
PST	708	40,510	57.2	49	6.9	312	44.1	259	36.6	68	9.6

Data source: Project Survey conducted from September 2013 to January 2014.

(2) Building Material

In the studied area 66.2% of the roofs are built from galvanized iron, fibrocement and plastic sheet. There is 26.0% from roofing title and only 2.8% from thatch. 53.8% of houses have wooden walls, the rest being mainly brick with 21.9%. 47.2% have wooden floors. The remaining 21.7% and 23.7% are of floor tile and mortar, respectively.

Table 16.5-30 Building Material

Construction Material (Total HH = 2,111)	Roof		Wall		Floor	
	No.	%	No.	%	No.	%
Thatch	10	0.62	26	1.61	0	0.0
Tin / Fibro/ Plastic Sheet	1,200	74.49	325	20.17	0	0.0
Wood	0	0.0	921	57.17	697	43.27
Bamboo	0	0.0	7	0.43	5	0.31
Roofing Tile	327	20.30	0	0.0	0	0.0
Floor Tile	0	0.0	0	0.0	297	18.44
Mortar	0	0.0	0	0.0	498	30.91
Concrete	39	2.42	0	0.0	0	0.0
Earth	0	0.0	0	0.0	82	5.09
Brick	0	0.0	291	18.06	0	0.0

Data source: Project Survey conducted from September 2013 to January 2014.

16.5.19 People's Perception of the Project

(1) Expectation with the Project

AHs showed satisfaction with the Project since it was reported that 15.1% rated the Project as 'very good', and 58.4% rated it as 'good'. However, about 24.0% of the total households rated the Project as 'good and bad'.

Table 16.5-31 Satisfaction with the Project

Items	Project		BMCH		BTB		PST	
	No.	%	No.	%	No.	%	No.	%
Bad	40	2.5	10	2.7	2	0.4	28	4.0
Good and bad	387	24.0	81	21.8	60	11.3	246	34.7
Good	940	58.4	218	58.6	389	73.2	333	47.0
Very good	244	15.1	63	16.9	80	15.1	101	14.3
Total	1,611	100.0	372	100.0	531	100.0	708	100.0

"Bad": because the Project they will: 1) increase daily expend; 2) loss of good trading site; 3)increase accident;4)disturbs people and community;5) affect on house/shop; 6) loss of land use in PRW; 7) worsen access to school; 8) worsen environmental impact; 9) decrease household income;10) affected on public facilities; 11) loss of occupation; 12) worsen people health condition; and 13) make people migration away.
Data source: Project Survey conducted from September 2013 to January 2014.

(2) Benefits of the Project

In the area of improvements, interviews revealed that around 86.0% of AHs believed that the Project will help decrease congestion/accident when travelling, while 55.7% mentioned it will improve access to other facilities. About 45.1% responded that the Project will improve cargo transportation. Table 16.5-32 shows more detailed information on the Project benefits.

Table 16.5-32 Three Ranks of Project Benefits

Most Important Benefits	Total Number of HHs = 2,111							
	Total		First		Second		Third	
	No.	%	No.	%	No.	%	No.	%
Improve cargo transportation	726	45.1	311	19.3	270	16.8	145	9.0
Appreciation of land prices	81	5.0	11	0.7	27	1.7	43	2.7
Reduced daily expenditures	86	5.3	3	0.2	15	0.9	68	4.2
Decrease of congestion/accidents	1385	86.0	874	54.3	399	24.8	112	7.0
Improve access to other facilities	897	55.7	149	9.2	436	27.1	312	19.4
Flood prevention	40	2.5	3	0.2	12	0.7	25	1.6
Improve travel of tourists	461	28.6	86	5.3	179	11.1	196	12.2
Improve environment	214	13.3	21	1.3	71	4.4	122	7.6
Big push to outskirts area	376	23.3	53	3.3	70	4.3	253	15.7
Attract more investment	169	10.5	31	1.9	52	3.2	86	5.3
Create more direct/indirect jobs	139	8.6	24	1.5	25	1.6	90	5.6
Improve local product marketing	24	1.5	1	0.1	4	0.2	19	1.2
Other	8	0.5	4	0.2	1	0.1	3	0.2

Data source: Project Survey conducted from September 2013 to January 2014.

(3) Perception of Affected Households with Regards to Relocation

In terms of the perception of AHs concerning relocation due to the Project, 95.4% of interviewed households said that they agree to move from the PRW but will need some assistance from the Project. Meanwhile, 2.9% replied that they will voluntarily move without any compensation or assistance. About 1.5% did not answer. However, 0.2% of AHs refused to move from the PRW (see Table 16.5-33 for details).

Table 16.5-33 Perception of AHs with Regards to Relocation

Stratum	Number of Households	No Answer		Refuse to Relocate		Agree with Assistance		Voluntarily Move	
		No.	%	No.	%	No.	%	No.	%
Project	1,611	24	1.5	3	0.2	1,537	95.4	47	2.9
BMCH	372	3	0.8	1	0.3	362	97.3	6	1.6
BTB	531	0	0.0	0	0.0	526	99.1	5	0.9
PST	708	21	3.0	2	0.3	649	91.7	36	5.1

Data source: Project Survey conducted from September 2013 to January 2014.

16.6 Organizational Framework

The owner of the Project is the Executing Agency (EA) which is MPWT; therefore, it has overall responsibility for the successful implementation of the RAP. The EA will be assisted by a number of offices within and outside MPWT, starting with the Project Management Unit (PMU) which is tasked with undertaking the Project. The Environmental Section of PMU (PMU-ES) will be established to work closely with the RD (Resettlement Department) of the Inter-ministerial Resettlement Committee (IRC) for the preparation, updating, and implementation of the RAP.

16.6.1 The Environmental Section of the Project Management Unit (PMU-ES)

PMU-ES of MPWT under guidance of IRC will work closely with RD/MEF as the lead arm of the PMU in the preparation and implementation of the RAP.

Its tasks include the followings:

(a) Secure the approval of the RAP by IRC;

(b) Secure prior approval from IRC and JICA for any variations in the approved RAP;

(c) Secure the database of AHs and assets that will be gathered during the preparation and updating of the RAP;

(d) Prepare progress reports on RAP implementation for submission to MPWT, PMU and JICA.

16.6.2 The Inter-ministerial Resettlement Committee (IRC) and the Resettlement Department (RD)

IRC is a collegial body headed by the representative from MEF and composed of representatives from concerned line ministries, such as the Ministry of Interior; MPWT, MLMUPC; MEF and MAFF. Created by the Prime Minister through *Decision No.13, dated 18 March 1997*, in connection with the resettlement of AHs in the Highway 1 Project (Loan 1659-CAM), IRC has since been involved in other foreign-assisted government infrastructure projects with involuntary resettlement. IRC will be established on ad hoc basis for each project upon the request from Executing Agency. RD is a secretariat of IRC and will work closely with other relevant institutions to deal with all resettlement issues caused by the project. The IRC will be established for NR-5

project.

The institutional setup for resettlement and land acquisition is indicated in Figure 16.6-1.

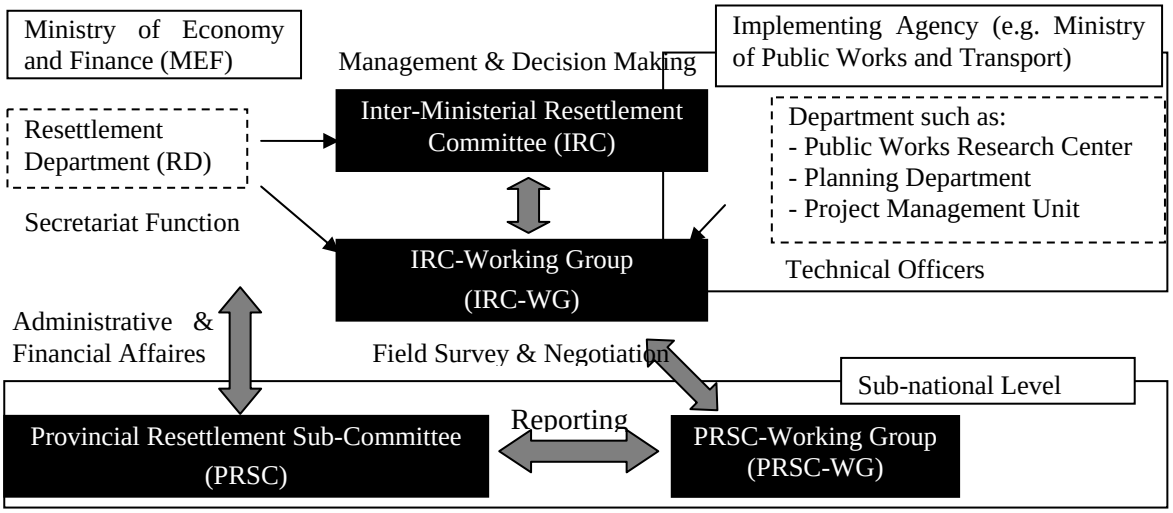


Figure 16.6-1 Inter-Ministerial Resettlement Committee (IRC) and Relevant Organizations

IRC will assume the function of a quasi-regulatory body, ensuring that funds for resettlement are spent properly and that the RAP is carried out as intended. The technical arm of IRC is its RD.

The RD will assist IRC in the following tasks:

(a) Reviewing and approving the RAP, ensuring its consistency with JICA Guidelines and, later, the loan agreement;

(b) Submitting the approved RAP to JICA;

(c) Request to Provincial Governor to establish PRSC and PRSC-WG;

(d) Orienting, as needed, PRSC and its WG (PRSC-WG) on their tasks relative to RAP updating and implementation;

(e) Manage and supervise the implementation of RAP such as DMS;

(f) Negotiation and Contract making with APs;

(g) Securing from the national treasury the budget for carrying out the RAP, ensuring that funds are available in a timely manner and in sufficient amounts;

(h) Ensuring the approval of all disbursements connected with the implementation of the RAP, such as payment for compensation and other entitlements, acquisition and preparation of replacement plots, operational expenses of personnel, etc.;

(i) Ensuring that funds for resettlement are spent judiciously; and

(j) Hire External Monitoring Agency to monitor the implementation of the RAP, ensuring that this is carried out in compliance with the Project resettlement policy and with the loan agreement.

16.6.3 Provincial Resettlement Sub-Committee

The Provincial Resettlement Sub-Committee (PRSC) is a collegial body at the provincial level. Headed by the Provincial Governor or Provincial Vice-Governor, its members are provincial department directors of line ministries represented in IRC, and also the chiefs of the districts and communes traversed along the Project road.

The technical arm of PRSC is PRSC-WG, which is headed by the Director (or a representative) of the Provincial Department of Public Works and Transport (PDPWT). The regular members of PRSC-WG come from the Provincial Government, the Provincial Department of Economy and Finance (PDEF), and the Ministry of Interior.

In an effort to make the whole process of resettlement effective, participatory and transparent, the chiefs of the affected communes and villages in affected communes will seat in PRSC-WG to tackle matters concerning their respective areas of jurisdiction.

PRSC, through PRSC-WG, will have the following functions:

(a) Facilitate a sustained public information campaign, ensuring that the public, especially the AHs, are updated on any development regarding the Project and resettlement activities;

(b) Cooperate with IRC-WG in conducting the implementation of RAP and assist public consultation and information disclosure meeting;

(c) Manage the delivery of compensation and other entitlements to the AHs;

(d) Receive and act on the complaints and grievances of AHs in accordance with the Project resettlement policy; and

(e) Maintain a record of all public meetings, grievances, and actions taken to address complaints and grievances.

16.7 Implementation Schedule

During the detailed design stage, DMS and RCS will be conducted under management of IRC-WG. DMS will be implemented by IRC-WG in close cooperation with PRSC-WG and relevant local authorities. RSC will be updated by independent agency hired by IRC. Based on the result of DM an RCS, IRC will calculate compensation amount and request budget disbursement to RGC.

During the DMS, consultation meeting will be held and project information booklet will be distributed to all AHs by IRC-WG assisted by PRSC-WG. The information program will precede the marking of the PRW. Grievance procedures and structure will be established prior to DMS. The preparation for the updating of the RAP will follow immediately after the final identification survey and DMS.

After the compensation amount is expected to be undertaken simultaneously for different sections of the road, the compensation process, including agreement and certified record of quantities and

valuation of properties and physical payment of cash compensation and formal transfer of property in the form of land will take place before any construction start in a designated stretch of the road. Compensation payments are made at least 30 days before construction starts. The external monitor will be conducted during all of the above stages of implementation of the RAP. The external monitor's benchmark survey will be carried out prior to any physical relocation of AHs and AH structures.

IRC will mobilize its working group to work closely with PRSC-WG and the EMA before commencement of any resettlement activities, i.e., before RAP updating. Land acquisition and relocation of AHs will not commence until the updated RAP has been reviewed and approved by both IRC and JICA.

MPWT will ensure that contractor will not be issued notice to commence for any part of a section of a road to begin construction work unless it has (a) satisfactorily completed in accordance with the approved updated RAP, compensation payment and relocation; (b) ensured that income restoration program is in place; and (c) area required for civil works is free of all encumbrances. Table 16.7-1 summarizes the various inter-related activities connected with the updating and implementation of the RAP.

Table 16.7-1 Indicative Schedule of Resettlement Activities (Temporal)

ACTIVITIES	SCHEDULE
JICA Approval of Draft RAP	August 2014
RAP Updating following Detailed Design	Early 2016
Submission and JICA Approval of Updated RAP	Middle 2016
Implementation of the Approved Updated RAP	Middle 2016
Internal Monitoring (Submission of Quarterly Progress Reports)	Middle 2016 and forwarding
External Monitoring (Intermittent)	Middle 2016 to 2018
Post-evaluation	Middle 2018
Start of Civil Works*	Middle 2017

** For sections where there are no resettlement impacts.*

16.8 Public Participation and Consultation

Stakeholders of the Project include provincial/district, commune/village officials, local people along the existing NR-5 (Thlea Ma'am – Battambang and Serei Sophorn – Poipet) and Pursat Bypass, and managers and staff of PDPWT (See Table 16.7-1). Participation provides for the opportunity and the process by which stakeholders influence and become co-responsible for development initiatives and decisions that affect them. Through participation, the needs and priorities of the local population are solicited; the adverse social impacts of the Project, including the corresponding mitigating measures, are collectively identified; and the commitment and feeling of ownership over the Project is engendered among the AHs.

16.8.1 Participatory Activities in Resettlement Plan's Planning

The public, especially the AHs, the local governments and road users will be consulted and their opinions solicited. They will in fact participate in the preparation of the RAP. Table 16.8-1 summarizes the roles and responsibilities of the EA, local governments, and AHs in the reparation.

Table 16.8-1 Participatory Activities in RAP Planning

Project Process Stage	Participatory Activities and Participants	Outputs	Responsible Institution
Preparation or Feasibility	Briefing of the provincial, district, commune, village officials, local people along NR-5 and Pursat Bypass, and PDPWT about the Project technical assistance, the resettlement impact, and activities of the consultant (provincial and first commune stakeholder meeting).	The local population including AHs and their representatives, local government officials, and managers and technical staff of PDPWT participated in the meeting and were consulted on the objectives, planning and impact of the project and of resettlement.	MPWT and Consultant (JICA Study Team)
	Conduct of IOL, census of AHs, social impact assessment, and RCS.	An IOL, census of AHs and RCS were conducted and the results were included in the RAP.	Consultants (JICA Study Team), assisted by local authorities and PDPWT.
	Discussion/consultation with IRC-RD and PMU-MPWT about the proposed project resettlement policy.	IRC were made fully aware of and consulted about social impact and resettlement policy.	Consultant (JICA Study Team)
	Initial disclosure meeting with AHs to discuss the results of the IOL and gather suggestions on how to minimize and mitigate impacts, and discuss about relocation options (second commune stakeholder meeting).	AHs and community leaders are informed of social impact and any damage or loss of property including land losses, and consulted on impact mitigation and resettlement including any relocation.	MPWT and Consultant (JICA Study Team)
	Drafting of the RAP and project information booklet (PIB) [5] and submission to PMU-MPWT, IRC-RD and JICA for review and approval.	Draft of RAP and PIB will be provided to and reviewed by MPWT, IRC-RD and JICA for approval.	Consultant (JICA Study Team)

16.8.2 Public Consultations During Resettlement Action Plan Preparation

During RAP preparation stage, the following public consultations were held at different stages.

(i) Provincial stakeholder meeting

(ii) Public Consultation Meeting on cut-off date

[5] The Project information booklet will be written in Khmer. The PIB will be distributed to each AH during the DMS, and updated PIB will be distributed before signing contract with AHs. An English version draft of PIB in *Appendix 16-1: Project Information Booklet (English Draft Version)* will be translated in Khmer and be distributed during the DMS. The updated PIB to be distributed before signing contract with AHs, information of rehabilitation options (including outline of IRP) will be added.

(1) Schedule of Stakeholder Meetings

The schedules of stakeholder meetings held regarding NR-5 and Pursat Bypass are shown in Table 16.8-2. Female participants were limited for the provincial stakeholder meetings because of original gender balance of local authorities in Cambodia. For the commune level meetings, MPWT collaborated with local authorities requested active participation from both male and female. As a result, certain ratio of female participation was observed in commune level meetings.

Table 16.8-2 Public Meetings Held Regarding National Road No.5 and the PST Bypass

Province	District/Commune	Venue	Date	Participants
Provincial Stakeholder Meeting				
PST	Krong Pursat	PDPWT Office	7 Aug. 2013 at 2:30 pm	Male=19 Female=2
BTB	Krong Battambang	PDPWT Office	8 Aug. 2013 at 8:30 am	Male=27 Female=2
BMCH	Krong Serei Sophorn	PDPWT Office	8 Aug. 2013 at 2:30 pm	Male=21 Female=1
Public Consultation Meeting on cut-off date (at commune level)				
1-PST	Pursat City - Svay Att	Svay Att commune center	26 Aug. 2013 at 2:00 pm	Male=31 Female=8
2-PST	Bakan District - Snam Preah - Trapaing Chorng	Trapaing Chorng commune center	26 Aug. 2013 at 3:30 pm	Male=45 Female=45
3-PST	Bakan District - Boeung Khnar	Boeung Khnar commune center	27 Aug. 2013 at 8:30 am	Male=37 Female=35
4-PST	Bakan District - Au Ta Poang - Savy Daun Keo	Pouth Raingsei pagoda	27 Aug. 2013 at 10:00 am	Male=80 Female=40
5-BTB	Moung Reussei District - Reussei Kraing - Prey Svay	Kraloam Phlok pagoda	27 Aug. 2013 at 2:00 pm	Male=44 Female=16
6-BTB	Moung Reussei District - Kear - Moung	Moung Reussei Gov. Hall	27 Aug. 2013 at 3:30 pm	Male=80 Female=60
7-BTB	Moung Reussei District - Kakoh - Prey Touch	Dob Krasaing primary school	28 Aug. 2013 at 8:30 am	Male=70 Female=55
8-BTB	Sangke District - Kampong Preang	Kampong Preang commune center	28 Aug. 2013 at 10:00 am	Male=49 Female=31
9-BTB	Sangke District - Kampong Preah	Kampong Preah Commune Centre	28 Aug. 2013 at 2:00 pm	Male=25 Female=11
10-BTB	Sangke District - Anlong Vil - Au Dambang 2	Pok Chhmar primary school	28 Aug. 2013 at 3:30 pm	Male=35 Female=17
11-BMCH	Ou Chrov District - Samroang - Koub	Chan Sy Samky Ratnaream pagoda	29 Aug. 2013 at 8:30 am	Male=110 Female=120
12-BMCH	Poipet City - Nimitt	Nimitt 1 Rest Hall	29 Aug. 2013 at 10:00 am	Male=60 Female=50
13-BMCH	Poipet City - Psar Kandal	Mong Chin pagoda	29 Aug. 2013 at 2:00 pm	Male=26 Female=20
14-BMCH	Poipet City - Poipet	Paleley pagoda	29 Aug. 2013 at 3:30 pm	Male=55 Female=21

Province	District/Commune	Venue	Date	Participants
15-PST	Krakor District - Thnoat Chum	Thnoat Chum Commune Centre	26 Dec. 2013 at 2:30 pm	Male=17 Female=14
16-PST	Pursat City - Prey Nhy	Commune Council House	26 Dec. 2013 at 4:00 am	Male=25 Female=12
17-PST	Pursat City - Banteay Dei	Banteay Dei pagoda	27 Dec. 2013 at 8:30 am	Male=26 Female=6
18-PST	Kandieng District - Veal	Veal Commune Center	27 Dec. 2013 at 10:00 am	Male=20 Female=15
19-PST	Pursat City - Phteah Prey	Au Sdoa village center	27 Dec. 2013 at 2:00 am	Male=25 Female=13

(2) Key Points Raised and Discussed

(a) PROVINCIAL Stakeholder Meetings

Three provincial stakeholder meetings were conducted in Pursat, Battambang and Banteay Mean Chey province. During the meetings, a representative of MPWT made a short presentation which focused on background of NR-5 and its current situation, the Project and its impacts (positive and negative), result of initial survey, information about schedule of IOL and baseline survey (in July 2011). All participants were also provided with opportunities to discuss on bypass options.

The key points raised and discussed during the pre-IOL public meetings are the followings and the questions and responses of the meeting are summarized in Table 16.8-3.

(i) Background of NR-5 and its current situation;
(ii) TA objective, including Project background and its impacts (both positive and negative);
(iii) The schedule of main activities for conduct an IOL, census of APs, social impact assessment, and replacement cost study (RCS);
(iv) Discussion about the bypass options;
(v) Discussion of other issues, including question and answer portion.

(b) PUBLIC Consultation Meeting on cut-off date

A few days before the IOL commenced on 2nd September 2013 and 30th December 2013, the first of a series of public meetings with stakeholders (e.g., road users, residents of traversed communities, transport operators, government agencies, civil society, etc.) was held in Pursat, Battambang and Banteay Mean Chey Provinces by the PMU-MPWT and the Consultant (JICA Study Team) for the purpose of discussing the following:

(i) Project outline, technical assistance background and objectives;
(ii) Main activities of the research team (i.e., conduct of socio-economic household survey, IOL, RCS, etc.);
(iii) Briefing on Key Principal of the project's policy on involuntary resettlement;
(iv) Probable positive and adverse impacts of the Project, and recommendations on how to avoid and mitigate negative impacts;

(v) Informing on Cut-Off Date: 2nd September 2013 for NR-5 and 30th December 2013 for Pursat Bypass; and

(vi) Question and Response.

After an introduction of Local Authority, representative of MPWT/ICD described the background of NR-5 and its current situation, background of the Project and its impacts, both positive and negative. During the meetings, all participants were reinformed and explained about the Cut-off Date is 2nd September 2013 for the existing NR-5 and 30th December 2013 for the Pursat Bypass. In each meeting, there was also an open floor for discussion among the participants. The results of discussion are summarized in Table 16.8-3.

Table 16.8-3 Questions and Responses of the Public Consultation Meeting (Provincial level and on cut-off date)

Question	Response
1. About the project implementation	
Could you tell us, when the project will be started implementation?	**ICD/MPWT**: This study is the primary process to collect all impact data and consultation information from people. After this process, the RAP will be submitted to JICA and Gov. for approval. In case both parties agreed, the detailed design phase will be continued. At the moment, an exactly time schedule could not be specific.
Will the improved road consist of protected fence to avoid any accident to people, or not?	**ICD/MPWT**: The NR-5 will be developed in to 4 lances as well as the way for bicycle riding and walking. So, the detailed design will be taking high consideration in avoiding traffic accident. The traffic signs will be also equipped adequately like slowing down sign, cross way sign and so on.
Will the project construct a drainage system along the improved road?	**ICD/MPWT**: Engineers will design carefully, so the people should not concern about this issue. The designing will be much considered on social and environmental negative impacts as much as possible.
Which one is better between improving the existing road and a new bypass construction in Pursat town?	**ICD/MPWT**: At the moment there is no any decided option (bypass or widening existing road or flyover) for the Pursat town. But based on the idea of SHM at provincial level, the bypass construction is a very good option. Because the bypass will be: • Minimized project impact in both social and environmental. The study found that it will be more affected to people who are living in the town. So a negative impact of the project is more. • Reduced a traffic volume due to the road is ASEAN High Way that will be caused to increase traffic accident, noisier and more pollution. • The bypass will bring economic growth into the area, because the land along it will become an industry zone. • Expend the city that will be over capacity to load people due to the population increase from day to day.
The suggestion from villagers	- The project should construct system drainage for rain water. - The project should also include cross ways above the NR-5, especially where are a hospital and school for people as well as animals. - The designing should be focused on bridge construction rather than constructing a box culvert. It is to avoid the flooding that destroyed our rice.
2. About the ROW/PRW and Relocation	
After the relocation, could we continue to	**ICD/MPWT**: Of course, people could keep living as normal. In order

Question	Response
live on the remained ROW land (10 meters)?	to avoid any loss, they could not build any more permanent structures such as houses or shops on it. But for the people who have more land outside the ROW, they should move out. People can also continue to use the remained land for crop cultivation purpose.
How many meter of ROW land will be used to build this road (PRW)?	**ICD/MPWT**: Due to the agreement from MPWT and JICA study team, the survey was covered only 20 meters in both sides from the road center line, because engineer needs enough space for truck moving during the construction and road embankment due to the land level. Therefore, the drawing will be detailed designed after this study if RGC and JICA approved on the study report. However, the people who are living on remained ROW (10 meters), they can still continue to live.
What is the size of the actual road after the construction?	**ICD/MPWT**: The Project will take 40 m for the road construction area (PRW), but do not mean that the actual road is 40 m width. The actual road size will be known during the detailed design. According to the government policy, the Project will try to minimize its resettlement impact as much as possible. The road will be constructed in 4 lanes and two road sides for pedestrian and bicycle.
To avoid any lost in the future, how many meters from the road that people can construct their houses?	**ICD/MPWT**: People have to construct their houses outside the ROW. It means more than 30 m from the road center line.
Can people continue to use on their remained land (10 m) in the ROW?	**ICD/MPWT**: People can continue to use the remained land only in crop cultivation purpose. In order to avoid any loss, new permanent structures such as houses or shops will not be allowed to be built. For AHs that has remained land in ROW, they have 2 options: i) First option is to continue to live on the remained land if they would like to do so and ii) second option is to inform to IRC-WG during the DMS process that they are landless HH. Then, the AHs will be registered in landless HH list. However, the APs should not be so worry. The Government will strongly consider on the issue.
I will lose all land (landless) after the road construction, what the project will deal with me?	**ICD/MP WT**: Now, we do not know how many there are landless household. Therefore, we have to conduct an IOL survey and then the Project will find a solution to solve the problem. The Project is development project. Therefore, local people will get the benefit from the project. It means their livelihood will be better because of the road construction.
Is the road expending (PRW) in the same size for both sides?	**ICD/MPWT**: In principal, the PRW is the same size (20 m) for both sides, but for the detailed design is not really the same due to land situation. For IOL will study in 20 m-20 m in both sides.
What size is the ROW in urban area?	**ICD/MPWT**: According to the sub-degree No.197, issued on 23 November 2009 stated that in urban are, the ROW will be defined by provincial or city governor in particularly.
The suggestion from villagers	The detailed design should be take more attention on road curve near Kampong Preah Bridge and Panha Pagoda that life accidents happened many time already.
3. About the compensation and other assistance	
Will the compensation start in 2nd September 2013?	**ICD/MPWT**: The compensation will start when the construction plan is approved and before the road construction. People should continue to live as normal because the road construction might be started in 4 to 5 years more. This study is only to collect impact data for resettlement budget estimation and RAP preparing. Therefore, it is very useful for people to raise any concern for including in the RAP.
Is there any compensation for affected	**ICD/MPWT**: Any affected properties in ROW that settled before the

Question	Response
structures in the PRW?	cut-off date will be compensated by the project. For any structure is built after the cut-off date will not eligible for the compensation.
How the project will compensate for my affected house that was built since 1979?	**ICD/MPWT**: It will be compensated at replacement cost which will study by an independent consultant. The affected structures will be classified by types of structures. Please remember that only those structures are constructed before the cut-off date will be eligible for the compensation.
How to compensate between the old and new building?	**ICD/MPWT**: The compensation will be based on replacement cost. It means all affected structures (new and old) will be compensated as new structure cost.
The Project implementation will affect my house in PRW. The remained land will be too small. What can the Project do for that?	**ICD/MPWT**: 1- The affected house will be compensated at replacement cost which will be calculated by independent consultant. The construction materials and labor cost will be calculated in market price in the local area. 2- Because the affected land in PRW/ROW, it is a state land and will not be compensated. But during the Project implement phase, RGC would have a clear policy to help AHs. In case, affected people do not have any more land or the remained land is not suitable for living, the Project will help them to solve the problem.
Will the Project compensate for land improvement in PRW?	**ICD/MPWT**: If the land has been filled up for house construction or business activity, cost for land improvement will not be compensated, because land within PRW belonging to state.
Do the Project will compensate for land improvement in PRW?	**ICD/MPWT:** If the people filling the land in PRW, it will not be compensated, because land within PRW belonging to state.
Currently, many people are having business stall in the ROW, how the project will compensate to us?	**ICD/MPWT**: During the RAP updating, the study team will conduct updated RCS. The RCS results are based on market price for both construction materials and labor cost. Therefore, with the compensation rate people can rebuild their stall as the same previous condition.
How to compensate for affected pagoda gate?	**ICD/MPWT**: Affected public or community properties will not compensate in cash, but it will be reinstated by the project.
Is there any compensation to non fruit trees?	**ICD/MPWT**: The compensation will be provided too.
Will the Project compensate for my affected well in PRW?	**ICD/MP WT**: Of course, people will get compensation for their affected wells, even though it is constructed in ROW.
I have paid about USD 20,000.00 for my house construction. Would the Project compensate for the same amount?	**ICD/MPWT**: The replacement cost will be conducted by independent consultant who has well experienced on it. The RCS results are based on market price for both construction materials and labor cost. Therefore, with the compensation rate people can rebuild their houses in the same previous houses.
Will the compensation be done before the construction work?	**ICD/MPWT**: The compensation will be done before the construction work. This study is not for compensating, it is just for impact data collecting for preparing RAP. If the project was approved to construct, then the DMS will be done by IRC-WG for compensation payment.
Do they compensate affected drainage and gates in the ROW?	**ICD/MPWT**: The affected properties will divided into 2 types: (i) public property: it will be reconstructed by IRC and (ii) Private property: it will be compensated in cash by the project. The compensation will be done after resettlement DMS process is

Question	Response
	approved. Any properties before the cut-off date will included into the resettlement budget.
Is there a compensation for affected private culverts?	**ICD/MP WT**: Those affected culverts will be replaced with new ones, if it is belong to public property. In case it is a private property, the Project will compensate to the owner with replacement cost. It means people can restore their culverts with the compensation amount.
Will the Project compensate for crops in PRW?	**ICD/MPWT**: The Project will compensate in order to support AH income, because their incomes from the crops or trees will be temporarily decreased by the Project Impact.
Will the Project compensate for the whole structure if it is affected in a part (30%)?	**ICD/MP WT**: It will be based on the actual structure figure. Sometimes, the structure is affected a part, but it cannot be cut so the compensation have to be done for the whole structure. On the contrary, if the structure can cut in affected part, so the compensation will be done only the affected size. The compensation for the affected structure will be divided by type, size and number of floor.
If the construction work affects religious worship places such as spirit houses, how does the Project compensate for the community?	**ICD/MPWT**: In this case, the Project will be tried to avoid its impact as much as possible. In case, it could not avoid the Project will discuss with the community to find a suitable place to reconstruct it. It ensure that the new one is the same as or better than the old one. The cost for ceremony also will be provided if it is needed.
How to deal with the affected public or community property?	**ICD/MPWT**: The affected public or community property will be replaced with new ones. IRC WG will invite a few contractors to bide for rebuilding the affected properties.
Who is responsible for the property loss compensate? Is it JICA?	**ICD/MPWT**: No, the compensation will be a responsibility of the Cambodia Government side, which is implemented through IRC based on the approved policy by JICA and the Government of Cambodia. JICA will provide only a loan for road construction. Even though, JICA is also much considerate on resettlement policy and resettlement implementation.

16.9 Grievance Redress

Grievances of AHs in connection with the implementation of the RAP will be handled through negotiation with the aim of achieving consensus. Complaints will go through three stages before they may be elevated to a court of law as a last resort.

16.9.1 First Stage, Commune Level

An aggrieved AH may bring his/her complaint to the commune leader. The commune leader will call for a meeting of the group to decide the course of action to resolve the complaint within 15 days, following the lodging of complaint by the aggrieved AH. The meeting of the group consists of the commune leader, representative/s from PRSC-WG of the district offices, and the aggrieved AH. The commune leader is responsible for documenting and keeping file of all complaints that are coursed through him/her. If after 15 days the aggrieved AH does not hear from Village or Commune, or if the AH is not satisfied with the decision taken by in the first stage, the complaint may be brought to the District Office either in writing or verbally.

16.9.2 Second Stage, District Office

The District office has 15 days within which to resolve the complaint to the satisfaction of all concerned. If the complaints cannot be solved in this stage, the district office will bring the case to the Provincial Grievance Redress Committee.

16.9.3 Third Stage, Provincial Grievance Redress Committee

The Provincial Grievance Redress Committee, which consists of Provincial Governor or Deputy Governor as a committee chairman and Directors of relevant Provincial Departments as members will be established in each province prior to DMS, meets with the aggrieved party and tries to resolve the complaint. The Committee may ask to PRSC-WG for a review of the DMS by the EMA. Within 30 days of the submission of the grievance the Committee must make a written decision and submit a copy of the same to MPWT, the EMA, IRC and the AH.

16.9.4 Final Stage, the Court Procedures

If the aggrieved AH is not satisfied with the solution made by the Provincial Grievance Redress Committee based on the agreed policy in the RAP, the committee shall file administrative procedures against the AHs with the participation of provincial prosecutors. The case will be brought to the Provincial Court and the same will be litigated under the rules of the court. At the same time, the AH can bring the case to the Provincial court. During the litigation of the case, RGC will request to the court that the project proceed without disruption while the case is being heard. If any party is unsatisfied with the ruling of the provincial court, that party can bring the case to a higher court. The RGC shall implement the decision of the court.

16.10 Relocation Strategy

16.10.1 Preferred Option by Landless AHs

Landless AHs have expressed their preferred option for relocation during stakeholder meeting in August 2013. They expressed their desire to relocate near the road or at near public facilities such as public hospitals, schools, markets, worships, and with provision of basic infrastructures such as access road in the resettlement sites, toilets, water supply connection, etc. Another consultation with them on relocation options and schedule to the new resettlement site will be conducted again during this RAP implementation.

16.10.2 Relocation Strategy

Landless AHs will be given opportunities to decide on two relocation options during for their relocation. The two options are (1)-self relocation (individual household) with project assistance

and (2)-group relocation to resettlement sites prepared by the project.

Self relocation option: For the road section with landless AHs, they can have their own relocation to any location they preferred. The cash assistance for land use will be provided them to make their own relocation arrangements. This cash assistance will be calculated based on the cost resettlement site per landless household, if it is prepared by the project.

Group relocation to resettlement sites prepared by the project: IRC-WG in collaboration with PRSC will acquire a piece of land for preparing a resettlement site based on consultation with landless AHs or their representatives. The location of the land will be as close as possible to their original land and will have acess to nearby or on-site primary and secondary schools, health facilities and market facilities. For this option, each landless AH will be relocated together in one resettlement site on a District basis, regardless commune of his/her existing location.

Under group relocation option, each landless AH will be provided a plot of land of 105 m^2 (7 m x 15 m) for free. After 5 consecutive years of living on the land, title to the land plot (secure tenure status) will be provided to the AHs. Similarly to private land owners who opt for land replacement, IRC will facilitate Ministry of Land Management, Urban Planning and Construction (MLMUPC) to provide the secure tenure status.

Prior to relocation of AHs, site development will ensure basic infrastructure including the following:

(i) Source of water supply;
(ii) Drainage system;
(iii) Electricity to site and, as necessary, local distribution system; and
(iv) Road access to and within the resettlement site.

All basic infrastructures at the resettlement site should be ready before AHs are asked to relocate there. Furthermore, impact on livelihood activities of all shop owners will be minimized. IRC-WG and PRSC-WG will consult with landless AHs about the relocation and civil work schedule including site development schedule during the DMS.

In addition to these, owners of affected private land can also opt for land replacement if they preferred and the land replacement will be equal size and located as close as possible to the existing location. All replacement lands will be provided for free with secure tenure status. IRC will facilitate Ministry of Land Management, Urban Planning and Construction (MLMUPC) to provide the secure tenure status.

16.10.3 Summary Cost of Resettlement Site Development

The land location and price were identified and surveyed by the consultant team during the project preparation, and the budget for resettlement site development was also estimated. Since the final selection of the land locations for Bakan, Moung Reussei and Ou Chrov District will be done

during the RAP implementation through consultation with landless AHs, the budget for relocation site development will be revised based on the actual land location selection and its price.

(1) Resettlement Site at Bakan District

In Bakan District, PST Province, there are only 39 landless AHs. Each of them will be entitled to a land plot of 105 m^2 (7 m x 15 m) at the new resettlement site. Basic infrastructures at resettlement site such as access roads, latrines, electricity and deep well will be provided.

(2) Resettlement Site at Moung Reussei District

In Moung Reussei District, BTB province, there are 14 landless AHs. The AHs will be encouraged to relocate to a new resettlement site with basic infrastructures such as access roads, latrines, drainages, and pumping wells, etc. Each landless AH will receive a land plot of 105 m^2 (7 m x 15 m), plus other basic infrastructures.

(3) Resettlement Site at Ou Chrov District

As mentioned in entitlement matrix, the project has two options with regard to relocation: (i) self-relocation and (ii) project sponsored site, calling resettlement site (RS) with security of tenure and basic infrastructure. In Ou Chrov District, BMCH province, there are 39 landless AHs. The same as other RS, the AHs are encouraged to relocate to a new resettlement site with basic infrastructures such as access roads, latrines, drainages, and pumping wells, etc. Each landless AH will receive a land plot of 105 m^2 (7 m x 15 m).

16.11 Income Restoration Strategy

Restoring the incomes of AHs, whose means of livelihood has been disturbed or removed, is a high priority for RGC and JICA. This is of particular concern with respect to households whose livelihoods as well as property are lost as a result of the road improvement. Therefore, an Income Restoration Program (IRP) will be developed during resettlement implementation stage, after DMS is conducted. IRC will contract out to implement IRP (See Appendix 16-3: Terms of Reference for Income Restoration Programs).

Possible measures to restore livelihood depend on sort of income sources. The Vulnerable, Severely and Relocating AHs will be entitled to an IRP to restore income and livelihood as affected by the project. Thus, the contents of income restoration should be discussed based on situations and need assessment of target groups. The result of SES and other surveys such as DMS can be utilized for the discussion to design an effective IRP.

16.12 Cost and Budget

The cost for resettlement will be covered by the government counterpart funds. Funds for the implementation of the RAP are part of the Project Cost. The land acquisition and resettlement cost has been estimated based on results of the IOL and the RCS conducted during the Project Study from September 2013 to January 2014.

16.12.1 Procedures for Flow of Funds

IRC will request the resettlement budget from MEF and the compensation amount will be transferred to relevant PDEF for releasing compensation and allowances to AHs. Payment of compensation and other entitlements will be in cash and will be distributed in public place (commune centre, school, pagoda etc.). The AHs will be notified through the village chiefs with regards to the schedule of payment of compensation and other entitlements.

16.12.2 Updating of the Compensation Rates

An RCS were conducted by local consultant during the project preparatory study as basis unit rate to estimate the cost for resettlement and land acquisition. Since compensation to AHs will be commenced in 2016 or 2017 (tentative schedule), the conducted RCS will be updated to reflect the current market price of affected property. The RCS updating will be conducted in parallel with the DMS.

16.12.3 Estimated Costs for Resettlement

The estimated costs for resettlement and land acquisition based on the RCS and the IOL during the project preparatory study is USD 8,059,913.55, which includes cash compensation, assistance and reinstate public assets for USD 888,815.00, external monitoring and income restoration of USD 482,217.05, administration cost of 5% equivalent to USD 344,440.75, and contingency of 5% or equivalent to USD 344,440.75. The Government will ensure timely provision of funds for resettlement costs and will meet any unforeseen obligations in excess of the resettlement budget in order to satisfy resettlement objectives. The resettlement estimated cost will be updated during the resettlement implementation based on the Detailed Measurement Survey (DMS) and the updated RCS.

16.13 Monitoring and Evaluation

16.13.1 Internal Monitoring

PMU-ES in close coordination with IRC will conduct an internal monitoring on resettlement implementation. The monitoring will include progress reports, the status of the RAP

implementation, information on location and numbers of people affected, compensation amounts paid by item, and assistance provided to AHs. The report of monitoring results will be prepared by MPWT and submitted to IRC and JICA on quarterly basis.

The following indicators will be monitored periodically by PMU-ES/MPWT:

(i) Compensation and entitlements are computed at rates and procedures as provided in the approved RAP;
(ii) AHs are paid as per agreed policy provided in the RAP by the Project authorities;
(iii) Public information, public consultation and grievance redress procedures are followed as described in the approved RAP;
(iv) Public facilities and infrastructure affected by the Project are restored; and
(v) The transition between resettlement and civil works is smooth.

16.13.2 External Monitoring

The external monitor has the specific responsibility of studying and reporting on measures for income restoration and on social and economic situations of AHs particularly disrupted by the road works, including all households whose houses or shops and stalls are relocated. The external monitor also has the responsibility of reviewing potentials for job opportunities and training for AHs, including women and youth, which would be assisted by provincial authorities, and for which the Commune Resettlement Committees and local NGOs may provide additional support.

IRC will hire an External Monitoring Agency (EMA) to carry out external monitoring and post-implementation evaluation. The TOR for the engagement of the EMA is provided in Appendix 16-2: Terms of Reference for External Monitoring Agency. The external monitoring reports will be submitted to IRC on quarterly basis, and then IRC will forward to MPWT/PMU and JICA. The post evaluation will be conducted within one year after all resettlement activities are completed.

The EMA will assess (i) the achievement of resettlement objectives, (ii) changes in living standards and livelihoods, (iii) the restoration of the economic and social conditions of the AHs, (iv) the effectiveness, impact and sustainability of assistance measures, (v) the need for further mitigation measures, if any; and, (vi) identify strategic lessons for future policy formulation and planning. The EMA will also be responsible for checking the procedures and resolutions of grievances and complaints. The EMA may recommend further measures to be taken to redress unresolved grievances.

MINISTRY OF PUBLIC WORKS AND TRANSPORT(MPWT)
THE ROYAL GOVERNMENT OF THE KINGDOM OF CAMBODIA

PREPARATORY SURVEY FOR NATIONAL ROAD NO. 5 IMPROVEMENT PROJECT (MIDDLE SECTION: THLEA MA'AM – BATTAMBANG, AND SRI SOPHORN – POIPET) IN THE KINGDOM OF CAMBODIA

FINAL REPORT

(VOLUME II APPENDIX)

OCTOBER 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

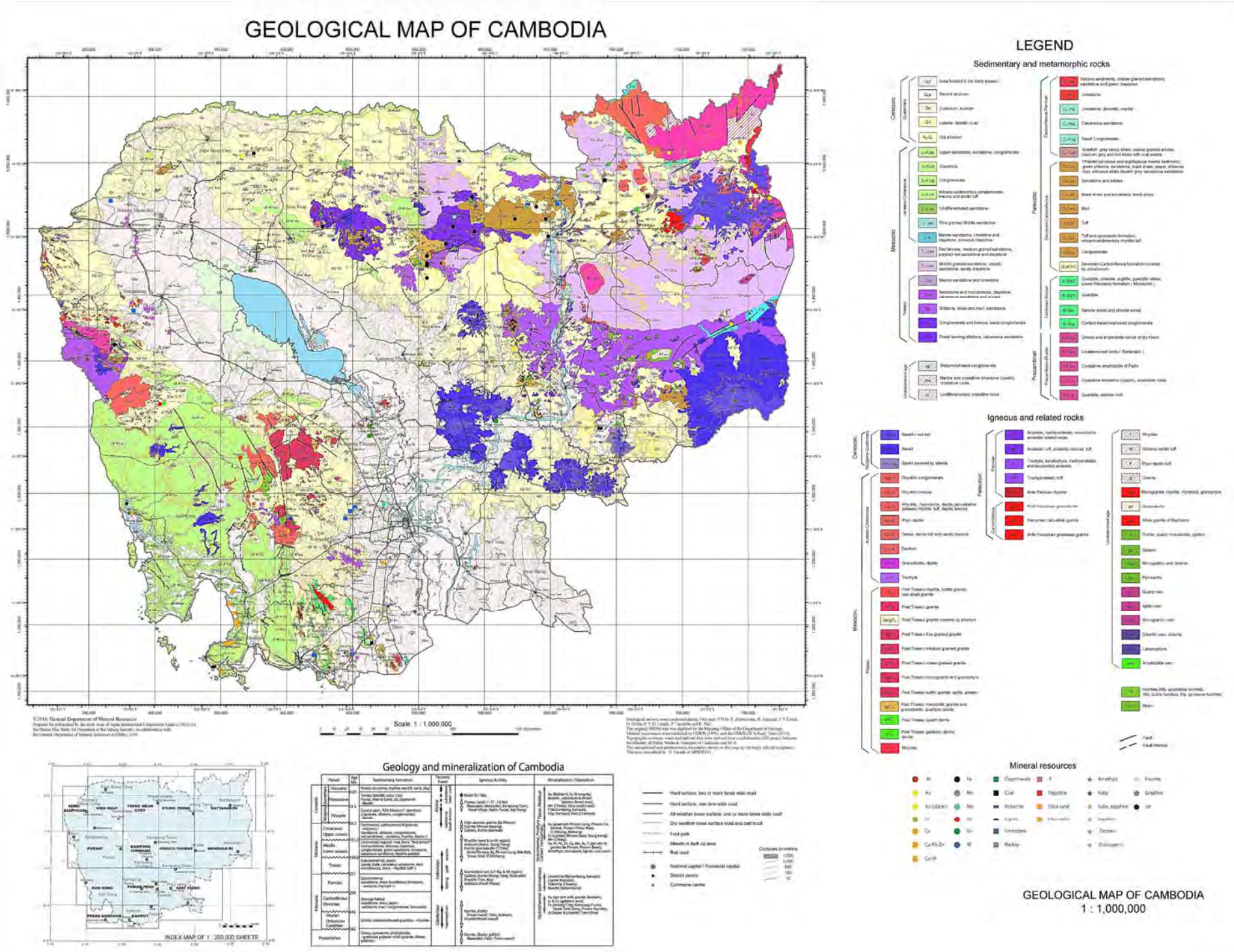
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NATIONAL ROAD NO. 5 IMPROVEMENT PROJECT (MIDDLE SECTION: THLEA MA'AM – BATTAMBANG, AND SRI SOPHORN – POIPET)
FINAL REPORT
Appendix Volume
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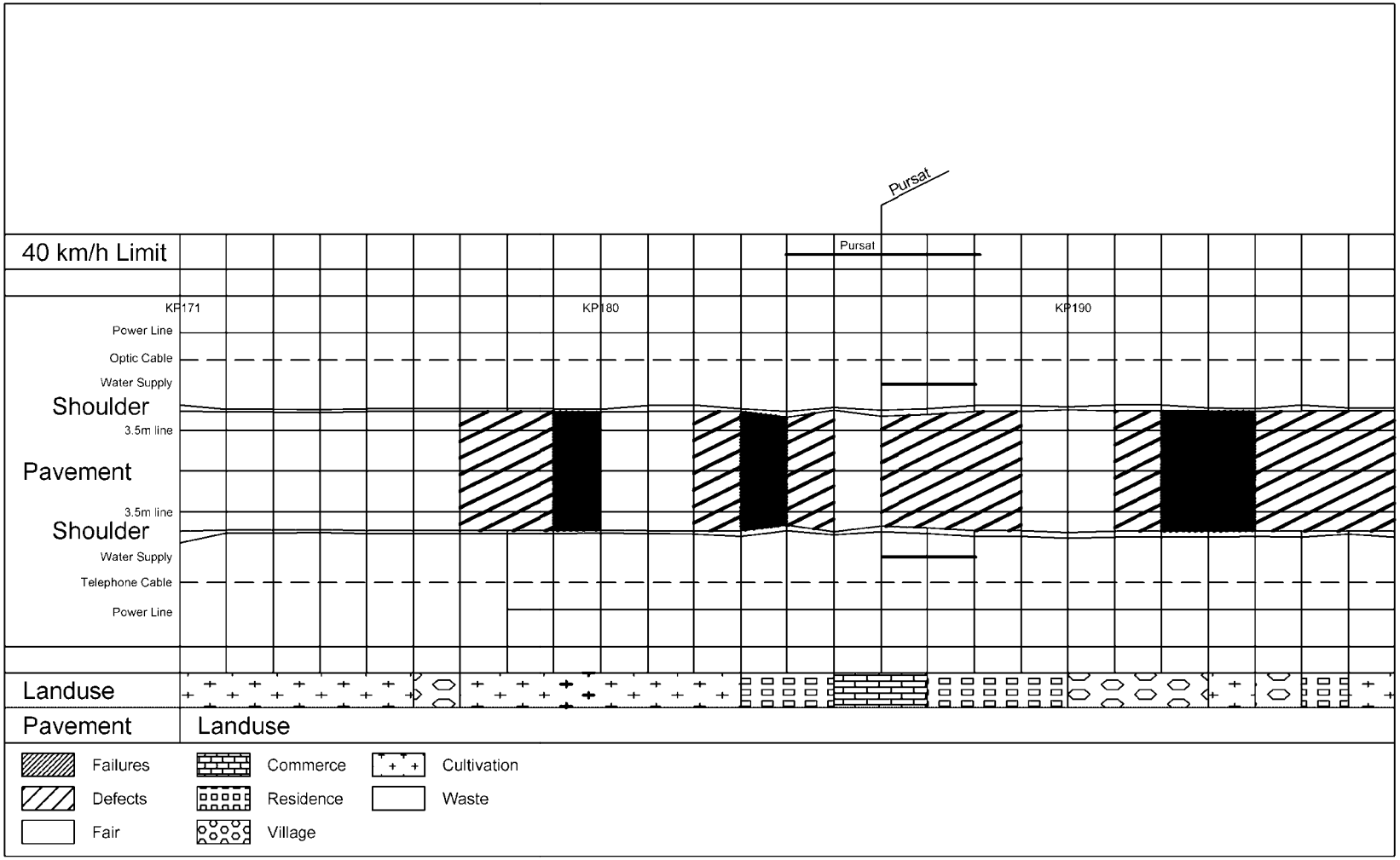
APPENDIX 2-1

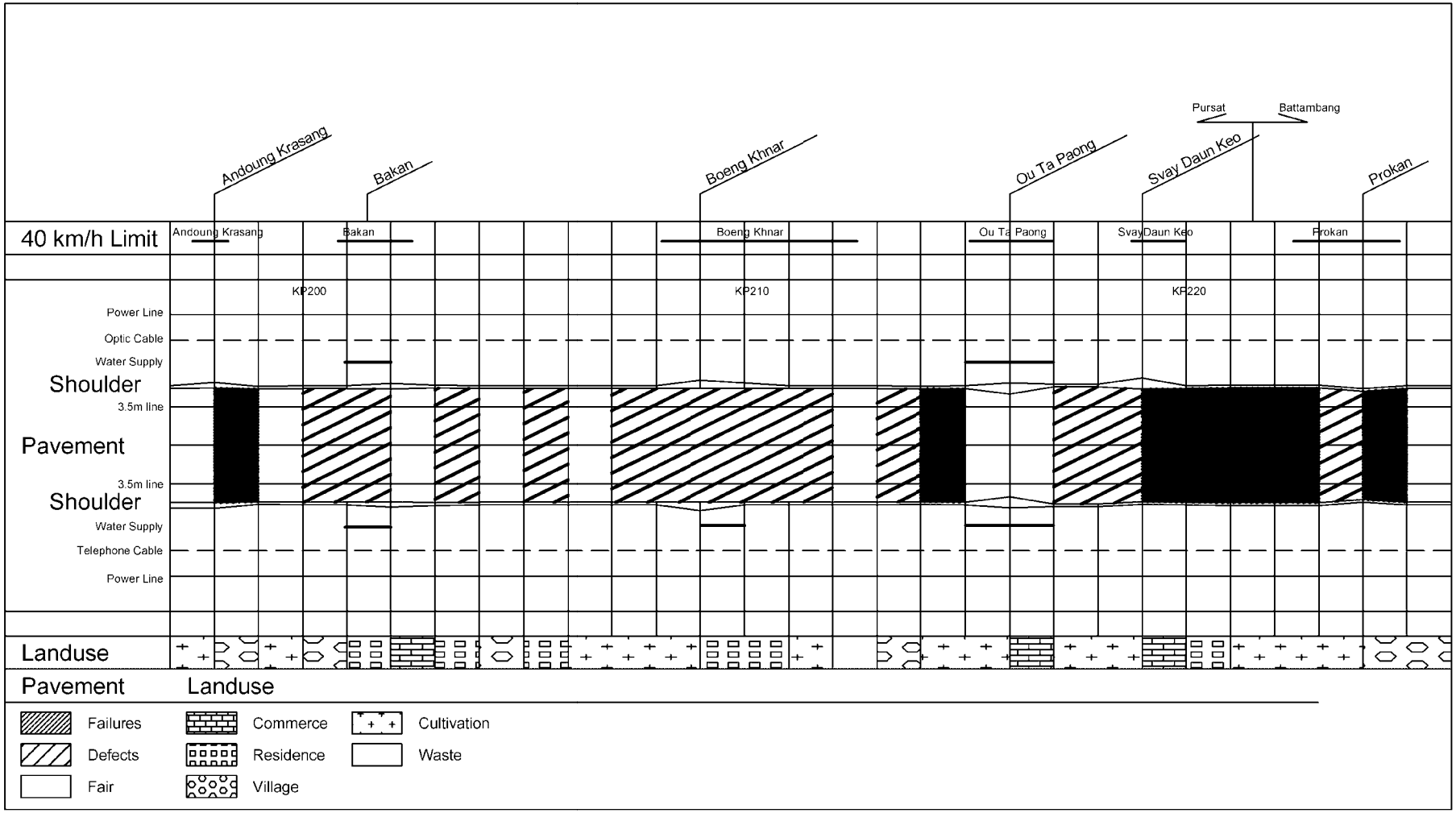
GEOLOGICAL MAP

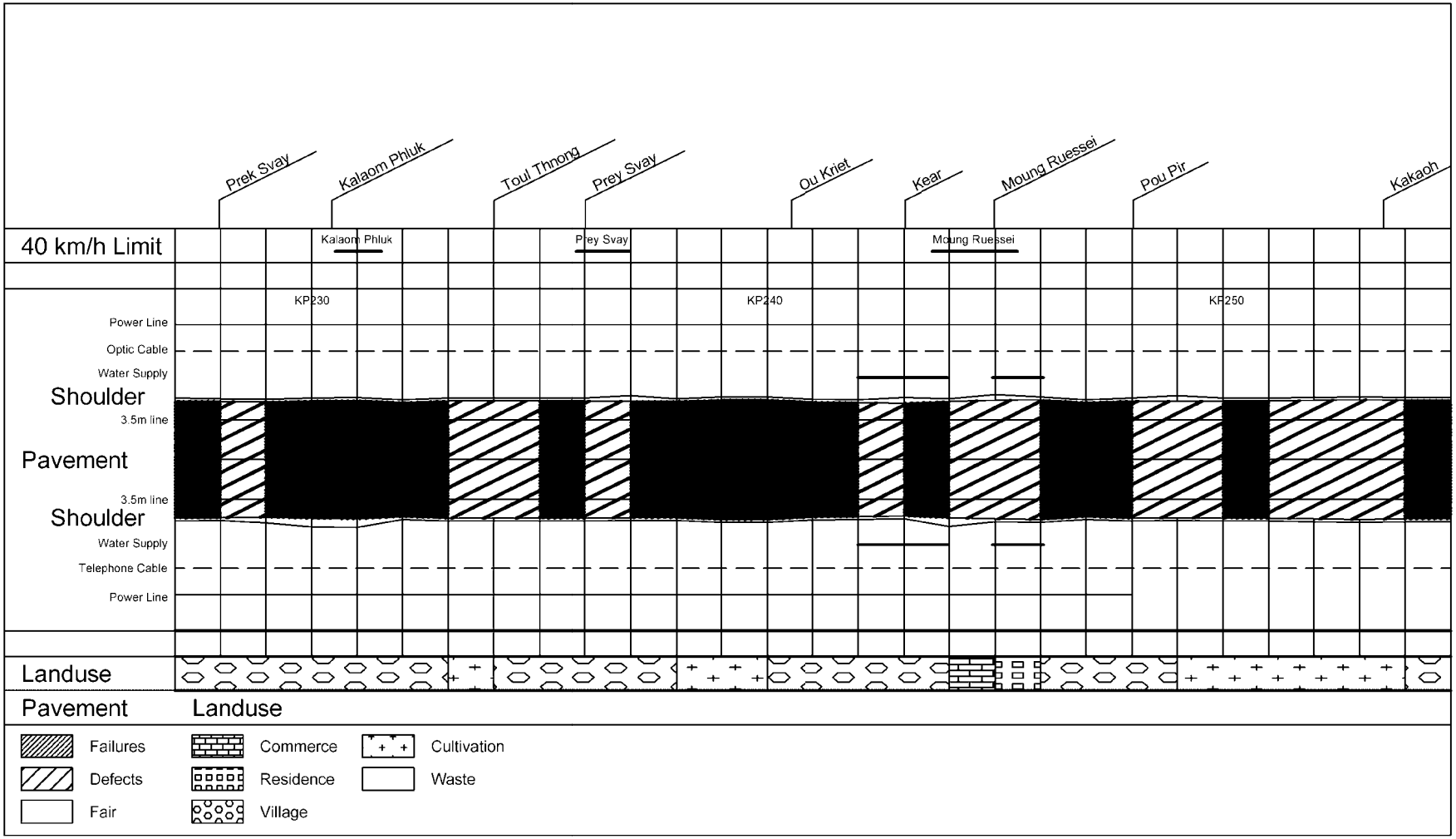

GEOLOGICAL MAP OF CAMBODIA
LEGEND
Sedimentary and metamorphic rocks
Igneous and related rocks
Mineral resources
Geology and mineralization of Cambodia
INDEX MAP OF 1 : 200,000 SHEETS
Scale 1 : 1,000,000
GEOLOGICAL MAP OF CAMBODIA
1 : 1,000,000

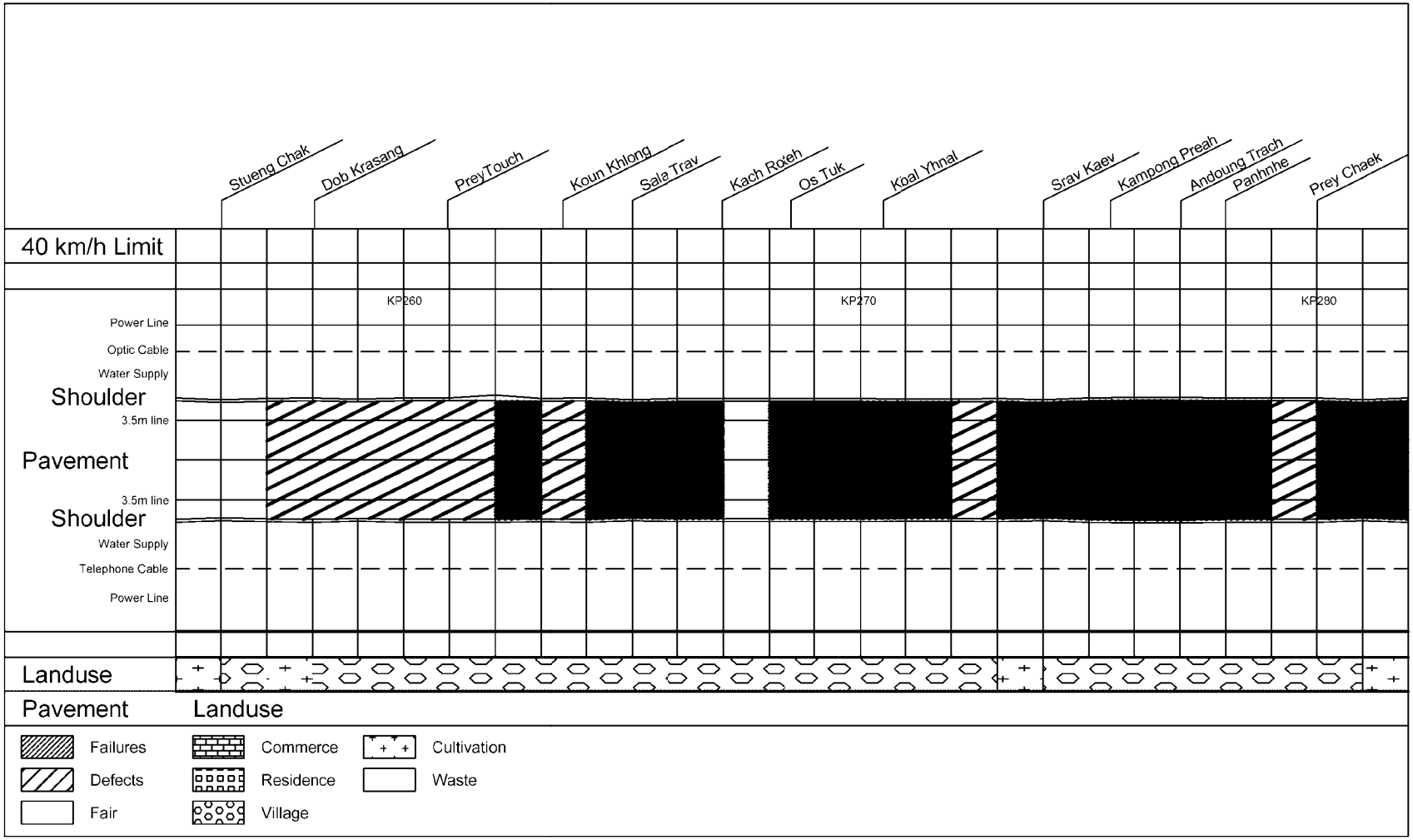
APPENDIX 4-1

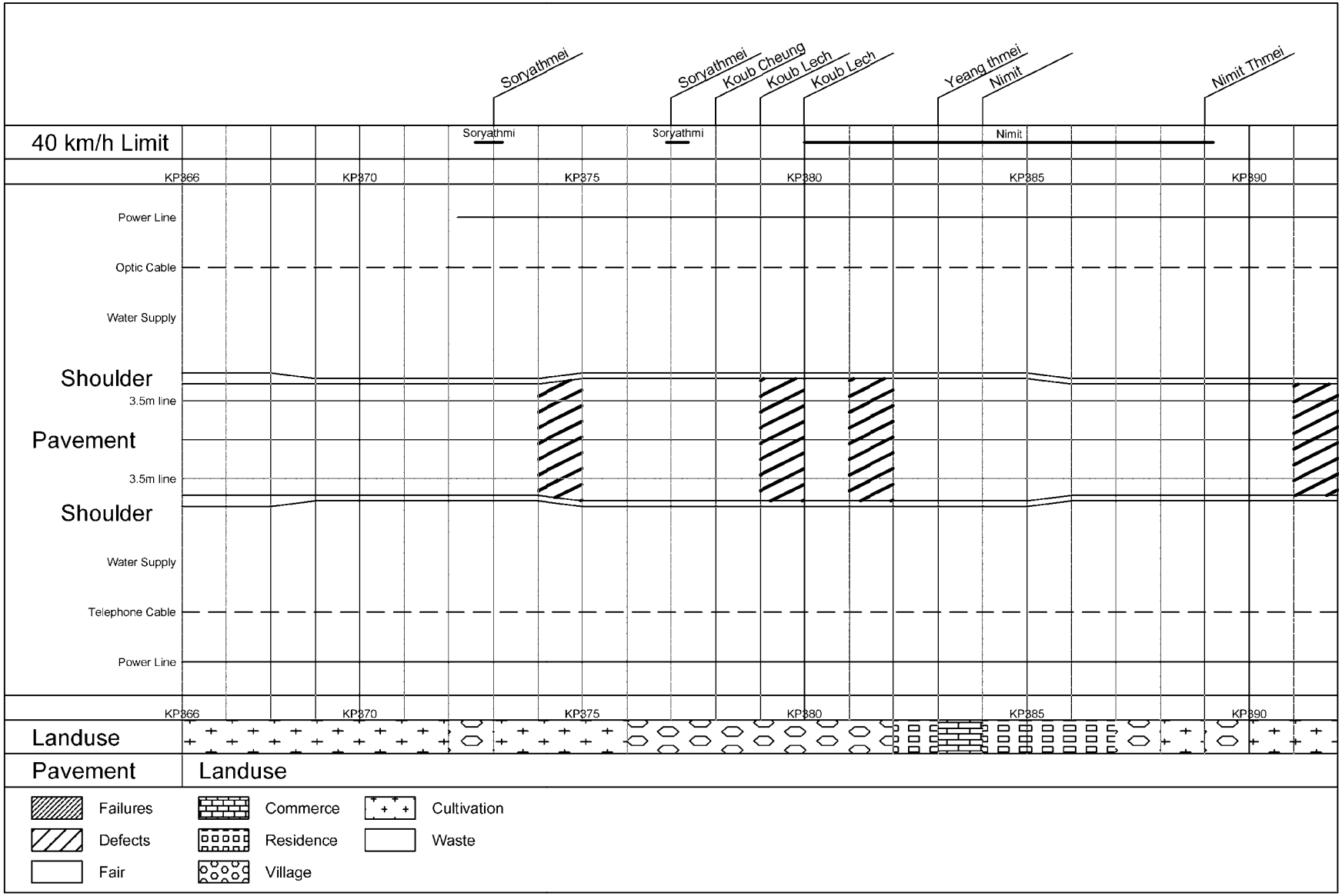
STRAIGHT LINE DIAGRAM

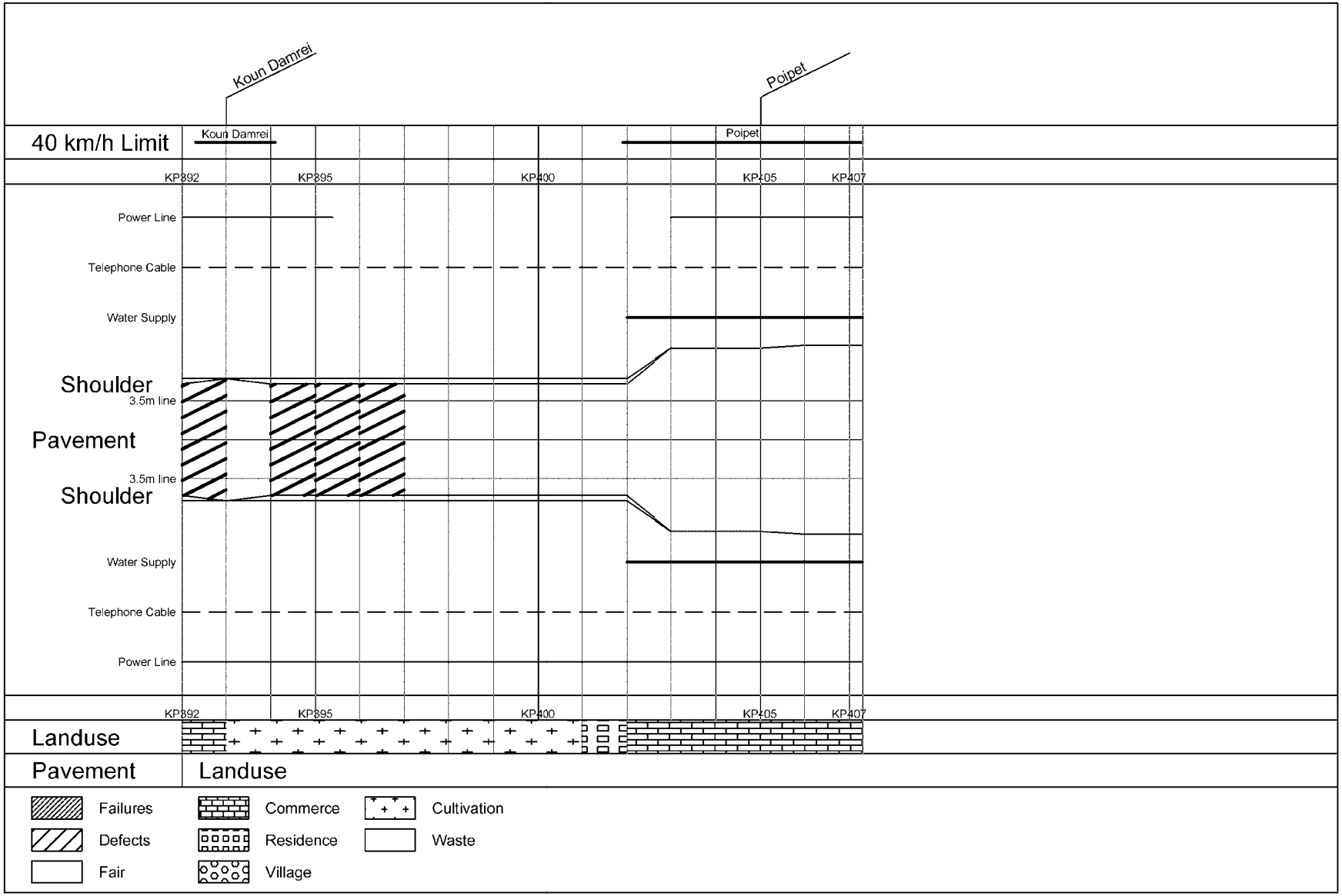

Pursat
40 km/h Limit
Pursat
KP171
KP180
KP190
Power Line
Optic Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste


Andoung Krasang
Bakan
Boeng Khnar
Ou Ta Paong
Pursat
Battambang
Svay Daun Keo
Prokan
40 km/h Limit
Andoung Krasang
Bakan
Boeng Khnar
Ou Ta Paong
SvayDaun Keo
Prokan
KP200
KP210
KP220
Power Line
Optic Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste


Prek Svay
Kalaom Phluk
Toul Thnong
Prey Svay
Ou Kriet
Kear
Moung Ruessei
Pou Pir
Kakaoh
40 km/h Limit
Kalaom Phluk
Prey Svay
Moung Ruessei
KP230
KP240
KP250
Power Line
Optic Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste


Stueng Chak
Dob Krasang
PreyTouch
Koun Khlong
Sala Trav
Kach Roteh
Os Tuk
Koal Yhnal
Srav Kaev
Kampong Preah
Andoung Trach
Panhnhe
Prey Chaek
40 km/h Limit
KP260
KP270
KP280
Power Line
Optic Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste


Soryathmei
Soryathmei
Koub Cheung
Koub Lech
Koub Lech
Yeang thmei
Nimit
Nimit Thmei
40 km/h Limit
Soryathmi
Soryathmi
Nimit
KP366
KP370
KP375
KP380
KP385
KP390
Power Line
Optic Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
KP366
KP370
KP375
KP380
KP385
KP390
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste

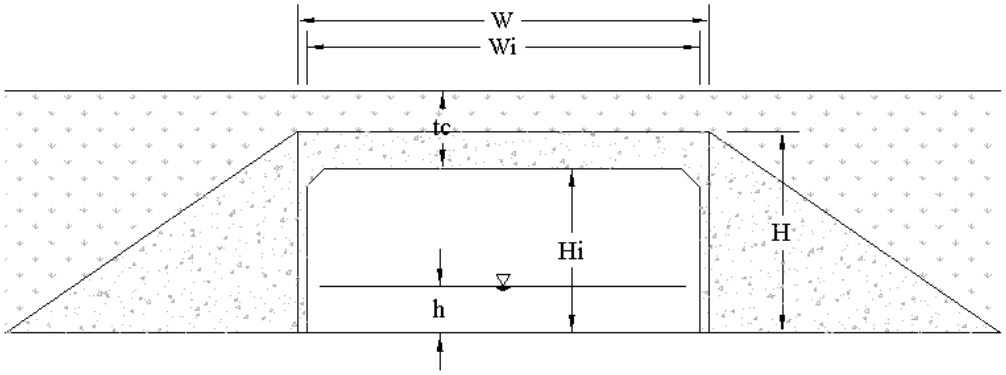

Koun Damrei
Poipet
40 km/h Limit
Koun Damrei
Poipet
KP392
KP395
KP400
KP405
KP407
Power Line
Telephone Cable
Water Supply
Shoulder
3.5m line
Pavement
3.5m line
Shoulder
Water Supply
Telephone Cable
Power Line
KP392
KP395
KP400
KP405
KP407
Landuse
Pavement
Landuse
Failures
Defects
Fair
Commerce
Residence
Village
Cultivation
Waste

APPENDIX 6-1

INVENTORY SURVEY ON

BOX CULVERT

KP: ***171+800*** No.: ***Bc54*** Date: ***20-May-2013***



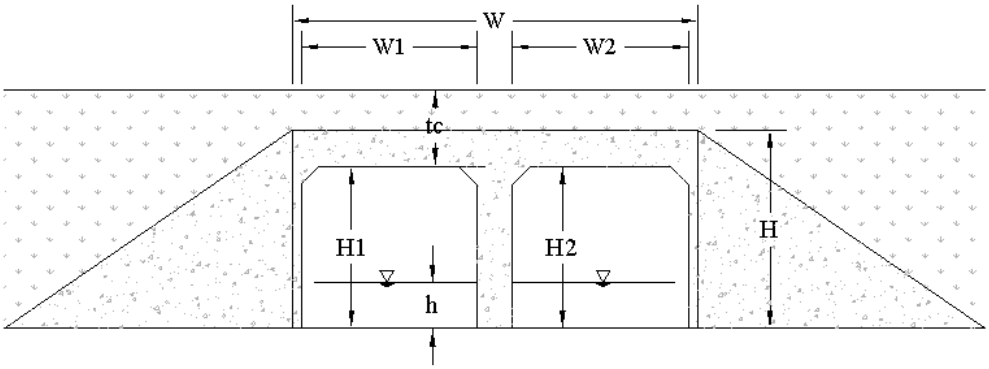


1-BC

W	=	***2.90***	(m)
W_i	=	***2.80***	(m)
H	=	***2.10***	(m)
H_i	=	***1.70***	(m)
L	=	***13.60***	(m)
h	=	***0.20***	(m)
tc	=	***0.85***	(m)

Lake Side (Outlet)

KP: ***179+100*** No.: ***Bc55*** Date: ***20-May-2013***





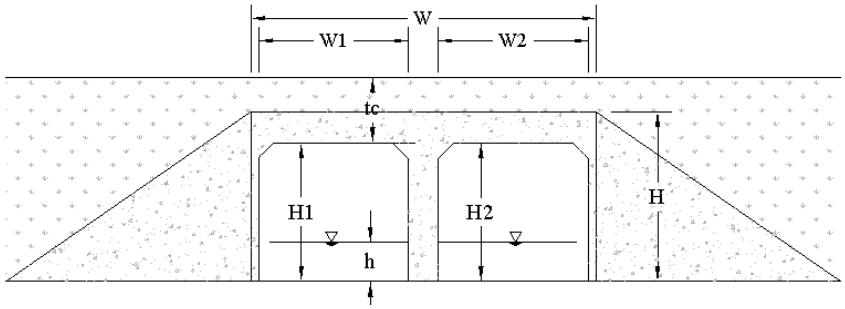
2-BC

W	=	***6.40***	(m)
W_1, W_2	=	***2.80***	(m)
H	=	***2.30***	(m)
H_1, H_2	=	***1.90***	(m)
L	=	***13.60***	(m)
h	=	***0.20***	(m)
tc	=	***0.53***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_i$ =Net Width, H=Total Height, $H_1/H_2/H_i$ =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top, River means Tonle Sap River

KP: ***179+500*** No.: ***Bc56*** Date: ***20-May-2013***



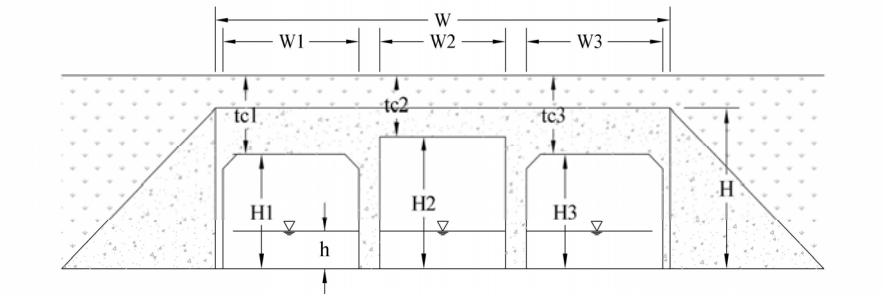


2-BC

W	=	***6.25***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***2.25***	(m)
H_1, H_2	=	***1.90***	(m)
L	=	***13.60***	(m)
h	=	***0.20***	(m)
tc	=	***0.62***	(m)

Lake Side (Outlet)

KP: ***179+800*** No.: ***Bc57*** Date: ***20-May-2013***





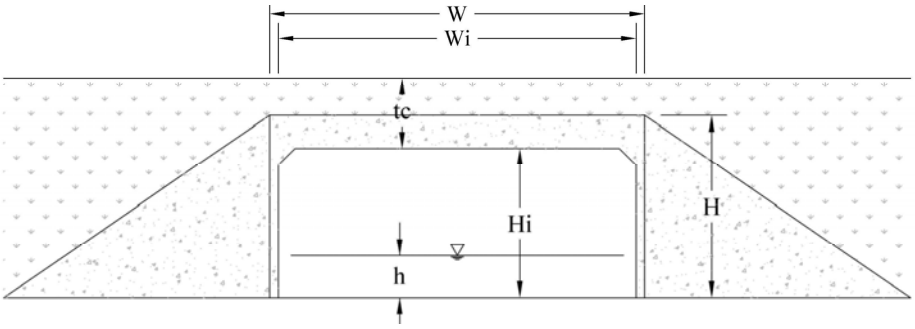
3-BC

W	=	***9.60***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.20***	(m)
H_1, H_3	=	***1.65***	(m)
H_2	=	***1.80***	(m)
L	=	***12.20***	(m)
h	=	***0.40***	(m)
tc_1, tc_3	=	***0.73***	(m)
tc_2	=	***0.48***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$ =Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***182+200*** No.: ***Bc58*** Date: ***20-May-2013***



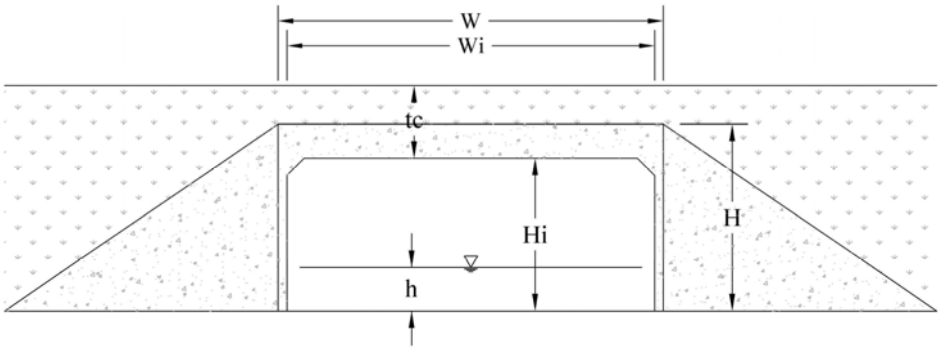


1-BC

W	=	***2.90***	(m)
W_i	=	***2.80***	(m)
H	=	***2.15***	(m)
H_i	=	***1.75***	(m)
L	=	***13.60***	(m)
h	=	***0.20***	(m)
tc	=	***0.65***	(m)

Lake Side (Outlet)

KP: ***196+500*** No.: ***Bc59*** Date: ***21-May-2013***





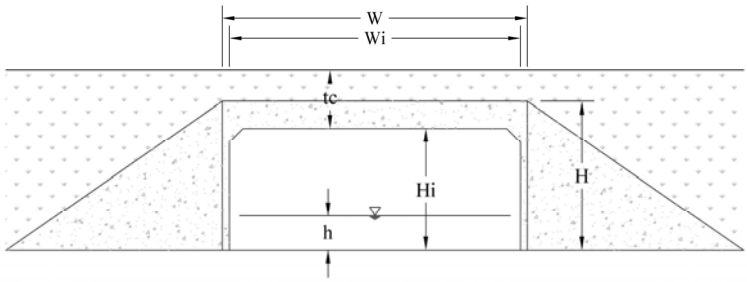
1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.20***	(m)
H_i	=	***1.60***	(m)
L	=	***14.00***	(m)
h	=	***0.10***	(m)
tc	=	***0.80***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_i=Net Width, H=Total Height, H_i= Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top, River means the Tonle Sap River

KP: ***199+300*** No.: ***Bc60*** Date: ***21-May-2013***



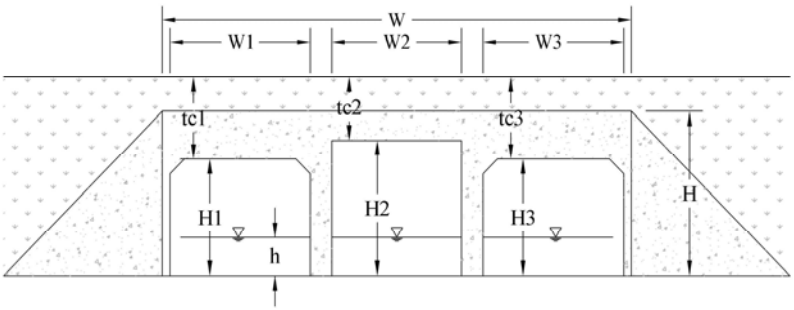


1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***1.90***	(m)
H_i	=	***1.45***	(m)
L	=	***13.80***	(m)
h	=	***0.10***	(m)
tc	=	***0.75***	(m)

Lake Side (Outlet)

KP: ***214+100*** No.: ***Bc61*** Date: ***22-May-2013***





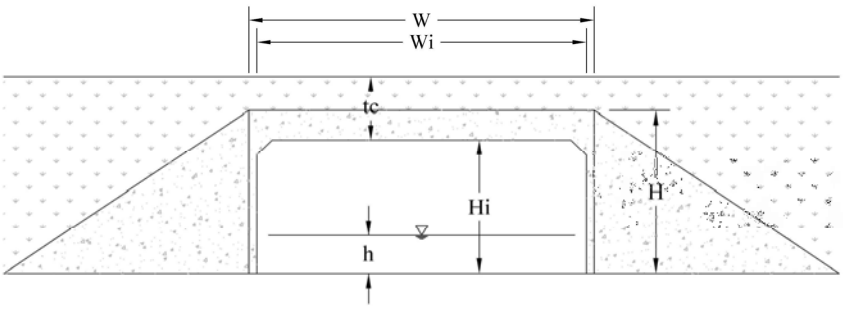
3-BC

W	=	***9.45***	(m)
W_1, W_3	=	***2.80***	(m)
W_2	=	***2.95***	(m)
H	=	***2.40***	(m)
H_1, H_3	=	***1.75***	(m)
H_2	=	***2.00***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.97***	(m)
tc_2	=	***0.72***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_i/W_1/W_2/W_3$=Net Width, H=Total Height, $H_i/H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***218+800*** No.: ***Bc62*** Date: ***22-May-2013***



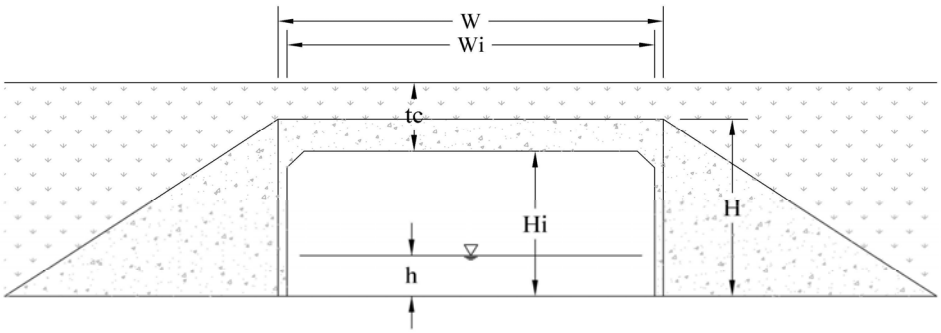


1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.95***	(m)
H_i	=	***2.55***	(m)
L	=	***15.20***	(m)
h	=	***0.10***	(m)
tc	=	***0.75***	(m)

Lake Side (Outlet)

KP: ***218+900*** No.: ***Bc63*** Date: ***22-May-2013***





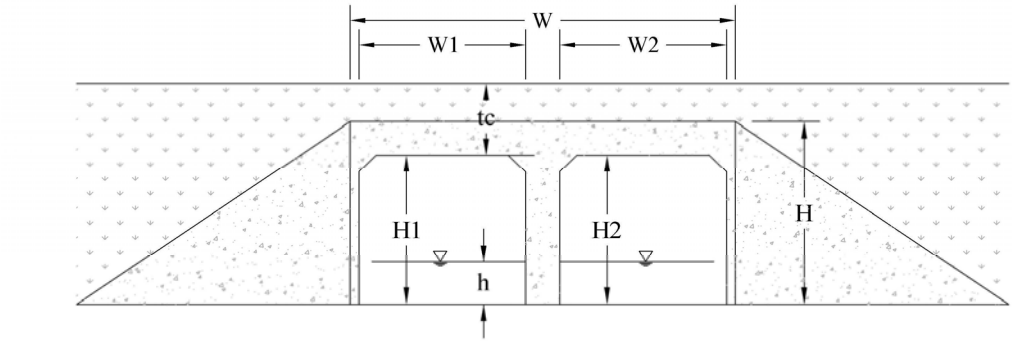
1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.35***	(m)
H_i	=	***1.95***	(m)
L	=	***15.30***	(m)
h	=	***0.10***	(m)
tc	=	***1.05***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top, River means the Tonle Sap River

KP: ***221+400*** No.: ***Bc64*** Date: ***22-May-2013***



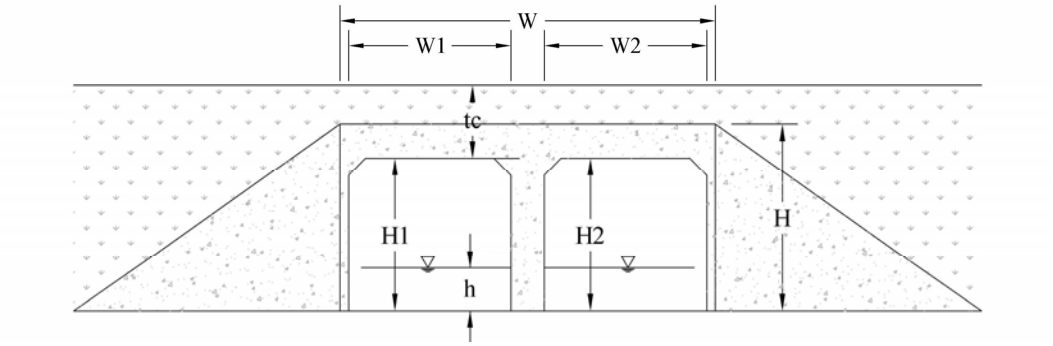


2-BC

W	=	***4.10***	(m)
W_1, W_2	=	***1.80***	(m)
H	=	***2.40***	(m)
H_1, H_2	=	***2.00***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.80***	(m)

Lake Side (Outlet)

KP: ***221+700*** No.: ***Bc65*** Date: ***22-May-2013***





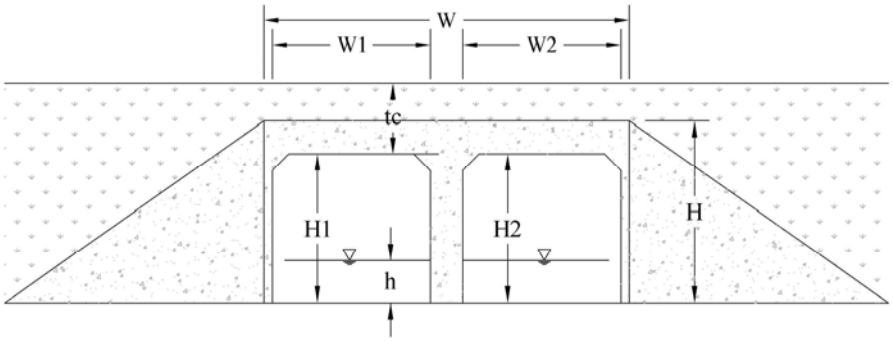
2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***3.00***	(m)
H	=	***2.25***	(m)
H_1, H_2	=	***1.80***	(m)
L	=	***16.02***	(m)
h	=	***0.00***	(m)
tc	=	***1.25***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2=Net Width, H=Total Height, H_1/H_2=Net Height, L=Total Length, h=Water Depth,, tc=Height of Soil over Top, River means the Tonle Sap River

KP: ***230+400*** No.: ***Bc66*** Date: ***22-May-2013***



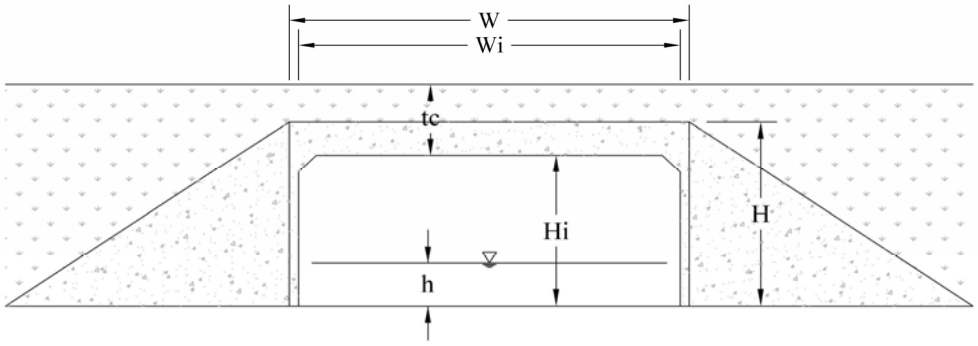


2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***3.00***	(m)
H	=	***2.20***	(m)
H_1, H_2	=	***1.80***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.65***	(m)

Lake Side (Outlet)

KP: ***232+800*** No.: ***Bc67*** Date: ***23-May-2013***





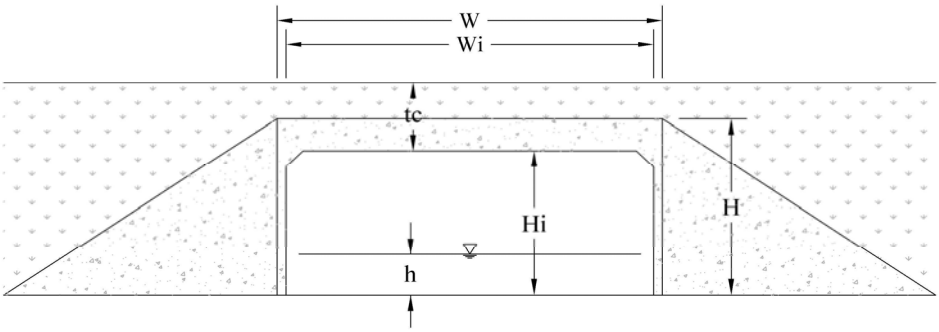
1-BC

W	=	***3.20***	(m)
W_i	=	***3.10***	(m)
H	=	***1.85***	(m)
H_i	=	***1.45***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.75***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_i$ =Net Width, H=Total Height, $H_1/H_2/H_i$ =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***237+400*** No.: ***Bc68*** Date: ***23-May-2013***



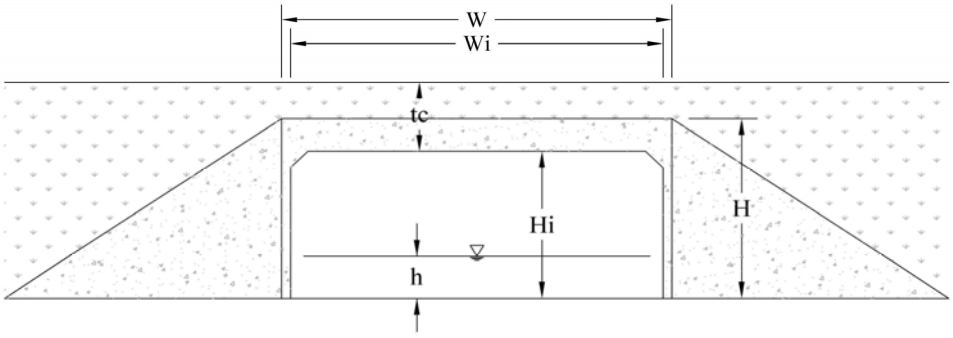


1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***1.95***	(m)
H_i	=	***1.55***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.80***	(m)

Lake Side (Outlet)

KP: ***238+200*** No.: ***Bc69*** Date: ***23-May-2013***





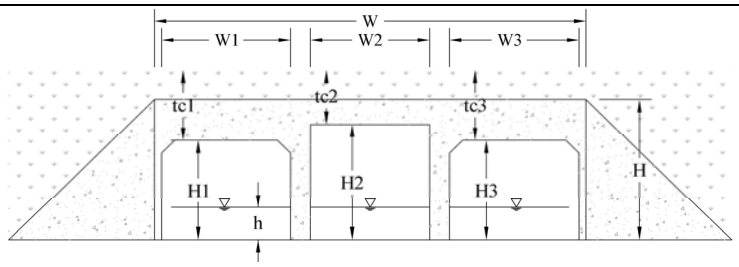
1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.30***	(m)
H_i	=	***1.90***	(m)
L	=	***13.70***	(m)
h	=	***0.10***	(m)
tc	=	***0.62***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***240+000*** No.: ***Bc70*** Date: ***23-May-2013***



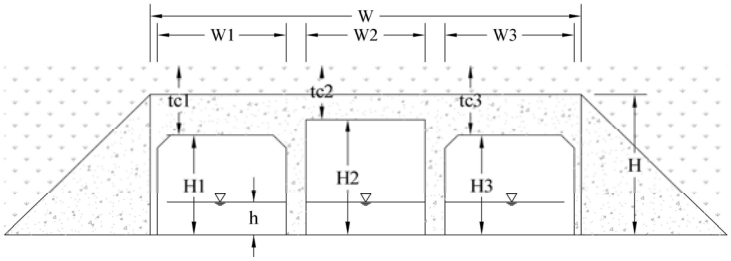


3-BC

W	=	***6.65***	(m)
W_1, W_3	=	***2.80***	(m)
W_2	=	***3.00***	(m)
H	=	***2.50***	(m)
H_1, H_3	=	***1.85***	(m)
H_2	=	***2.10***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.75***	(m)
tc_2	=	***0.50***	(m)

Lake Side (Outlet)

KP: ***245+400*** No.: ***Bc71*** Date: ***23-May-2013***





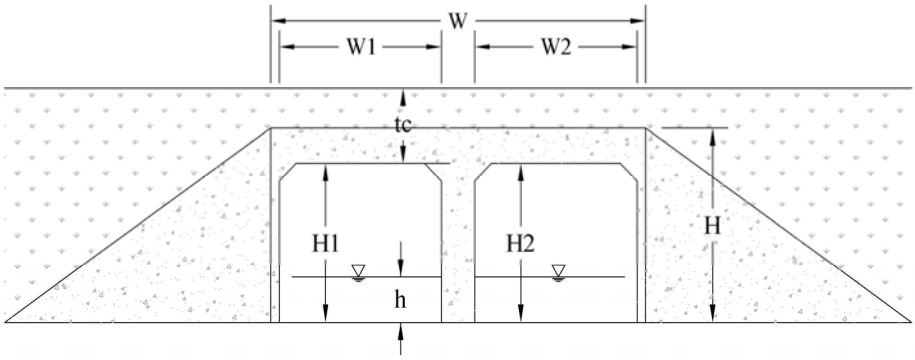
3-BC

W	=	***7.50***	(m)
W_1, W_3	=	***2.80***	(m)
W_2	=	***3.00***	(m)
H	=	***2.45***	(m)
H_1, H_3	=	***1.80***	(m)
H_2	=	***2.05***	(m)
L	=	***13.80***	(m)
h	=	***1.40***	(m)
tc_1 ,tc_3	=	***1.30***	(m)
tc_2	=	***1.05***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***248+500*** No.: ***Bc72*** Date: ***23-May-2013***



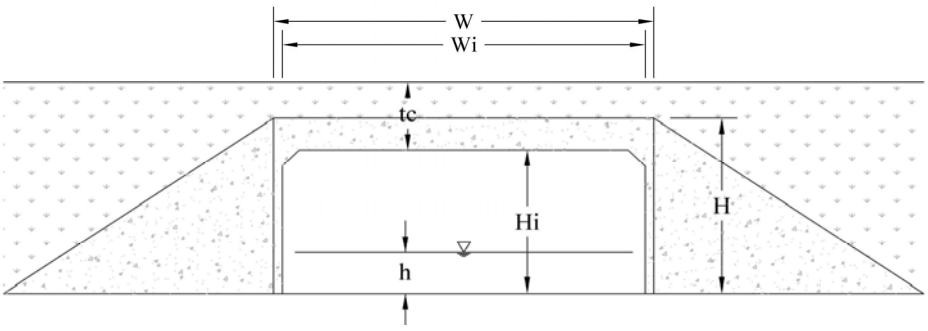


2-BC

W	=	***6.35***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***2.45***	(m)
H_1, H_2	=	***2.00***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.45***	(m)

Lake Side (Outlet)

KP: ***249+000*** No.: ***Bc73*** Date: ***23-May-2013***





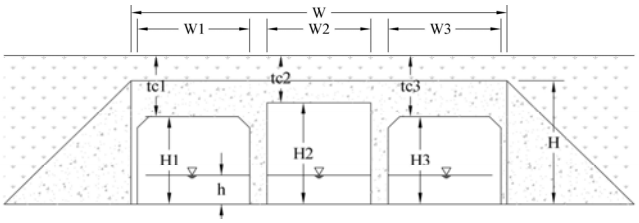
1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.45***	(m)
H_i	=	***2.05***	(m)
L	=	***13.80***	(m)
h	=	***0.00***	(m)
tc	=	***0.65***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_i$ =Net Width, H=Total Height, $H_1/H_2/H_i$ =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top, River means the Tonle Sap River

KP: ***251+000*** No.: ***Bc74*** Date: ***23-May-2013***



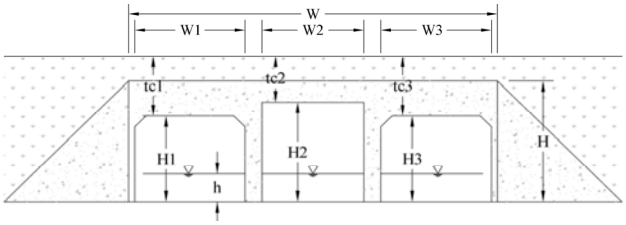


3-BC

W	=	***9.70***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.60***	(m)
H_1, H_3	=	***2.00***	(m)
H_2	=	***2.20***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.72***	(m)
tc_2	=	***0.52***	(m)

Lake Side (Outlet)

KP: ***252+400*** No.: ***Bc75*** Date: ***23-May-2013***





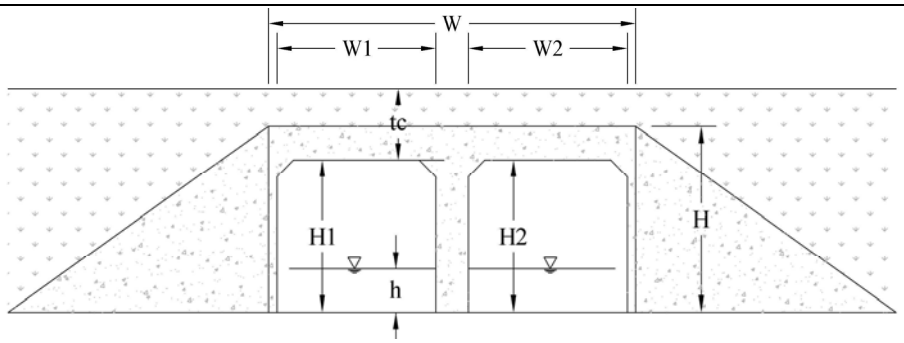
3-BC

W	=	***9.50***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***1.35***	(m)
H_1, H_3	=	***0.75***	(m)
H_2	=	***1.00***	(m)
L	=	***13.70***	(m)
h	=	***0.30***	(m)
tc_1 ,tc_3	=	***1.20***	(m)
tc_2	=	***0.95***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***254+700*** NO.: ***Bc76*** Date: ***23-May-2013***



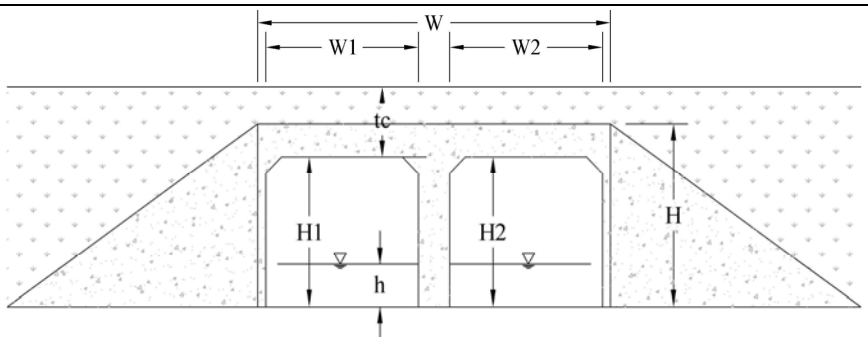


2-BC

W	=	***8.80***	(m)
W_1, W_2	=	***4.30***	(m)
H	=	***1.90***	(m)
H_1, H_2	=	***1.45***	(m)
L	=	***13.50***	(m)
h	=	***0.00***	(m)
tc	=	***1.10***	(m)

Lake Side (Outlet)

KP: ***255+900*** No.: ***Bc77*** Date: ***23-May-2013***





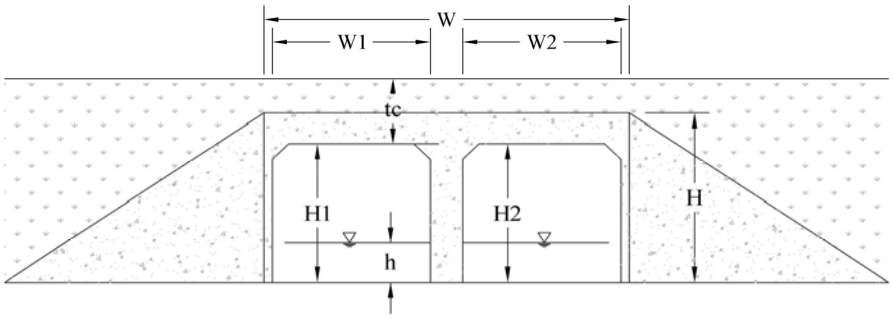
2-BC

W	=	***6.20***	(m)
W_1	=	***2.80***	(m)
W_2	=	***2.85***	(m)
H	=	***2.00***	(m)
H_1, H_2	=	***1.60***	(m)
L	=	***13.80***	(m)
h	=	***0.00***	(m)
tc	=	***0.70***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2=Net Width, H=Total Height, H_1/H_2=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***259+100*** No.: ***Bc78*** Date: ***23-May-2013***



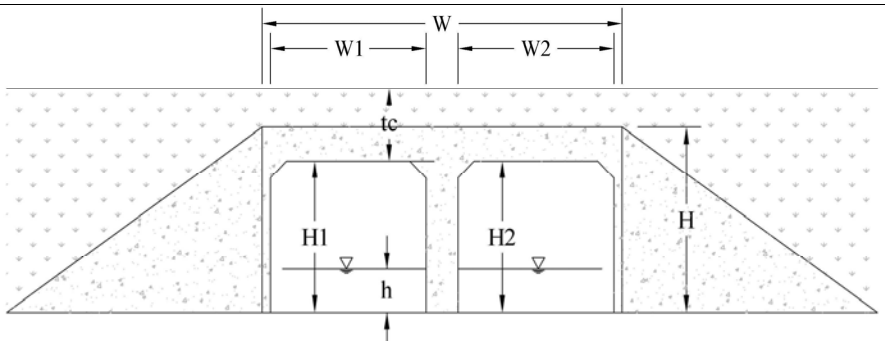


2-BC

W	=	***6.20***	(m)
W_1	=	***2.75***	(m)
W_2	=	***2.85***	(m)
H	=	***2.30***	(m)
H_1, H_2	=	***1.90***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.75***	(m)

Lake Side (Outlet)

KP: ***261+400*** No.: ***Bc79*** Date: ***23-May-2013***





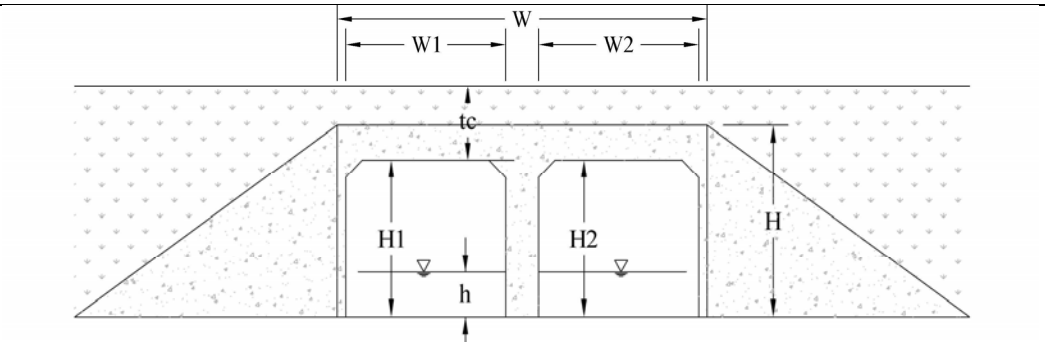
2-BC

W	=	***8.60***	(m)
W_1, W_2	=	***4.15***	(m)
H	=	***2.35***	(m)
H_1, H_2	=	***1.90***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***1.05***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2=Net Width, H=Total Height, H_1/H_2=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***262+300*** No.: ***Bc80*** Date: ***24-May-2013***



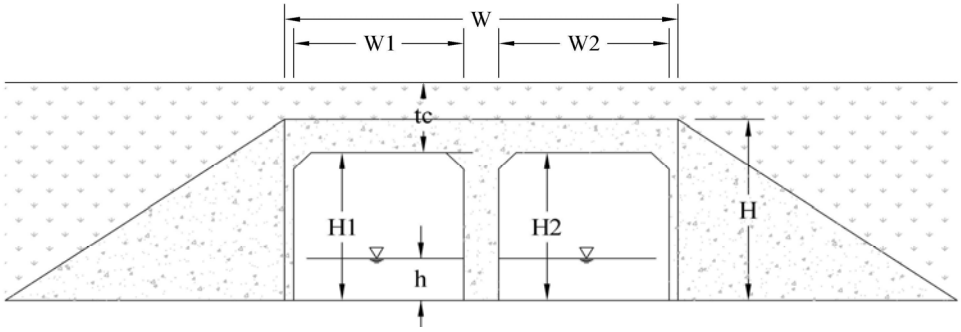


2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***2.40***	(m)
H_1, H_2	=	***2.00***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.45***	(m)

Lake Side (Outlet)

KP: ***264+100*** No.: ***Bc81*** Date: ***24-May-2013***





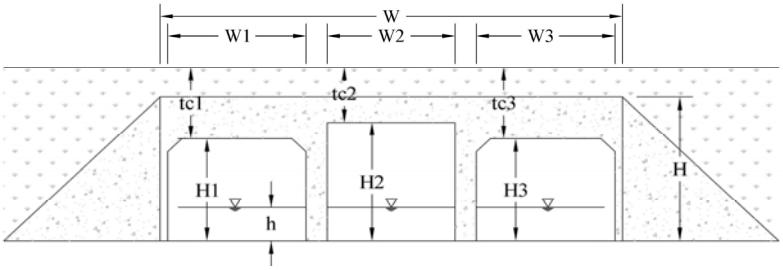
2-BC

W	=	***6.20***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***2.20***	(m)
H_1, H_2	=	***1.80***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.55***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2=Net Width, H=Total Height, H_1/H_2=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***267+000*** No.: ***Bc82*** Date: ***24-May-2013***



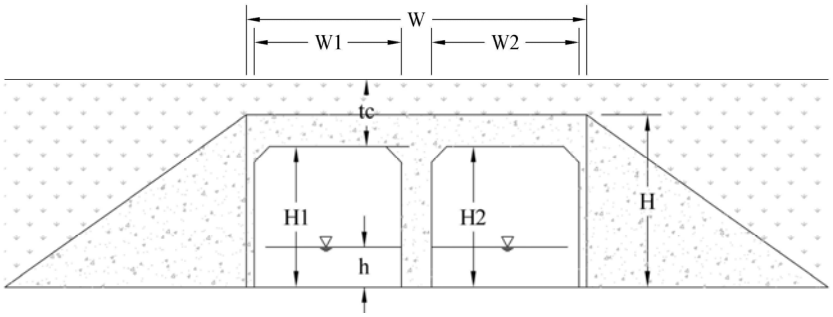


3-BC

W	=	***9.60***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.60***	(m)
H_1, H_3	=	***1.95***	(m)
H_2	=	***2.20***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.75***	(m)
tc_2	=	***0.50***	(m)

Lake Side (Outlet)

KP: ***269+700*** No.: ***Bc83*** Date: ***24-May-2013***





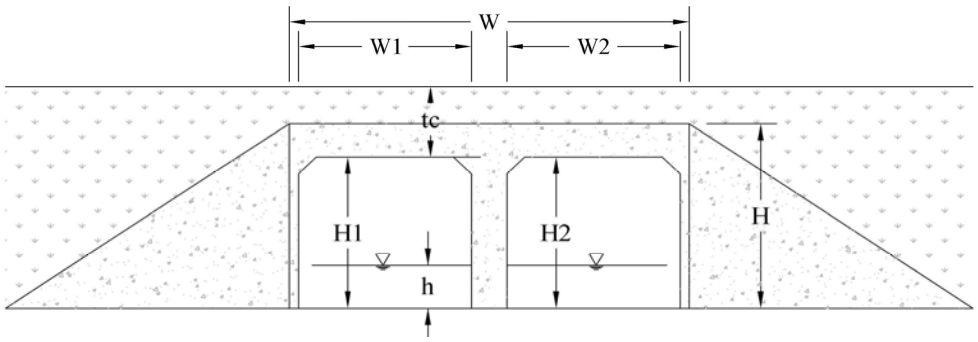
2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***3.00***	(m)
H	=	***2.40***	(m)
H_1, H_2	=	***2.00***	(m)
L	=	***13.00***	(m)
h	=	***0.00***	(m)
tc	=	***0.55***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***270+400*** No.: ***Bc84*** Date: ***24-May-2013***



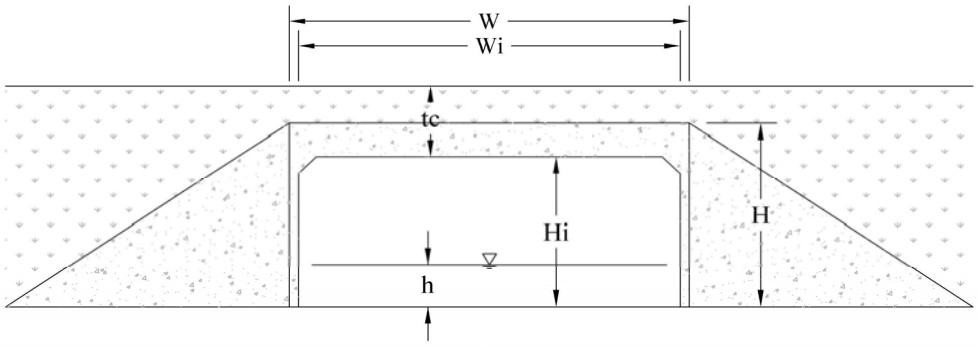


2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***3.00***	(m)
H	=	***2.25***	(m)
H_1, H_2	=	***1.90***	(m)
L	=	***13.10***	(m)
h	=	***0.00***	(m)
tc	=	***0.60***	(m)

Lake Side (Outlet)

KP: ***274+200*** No.: ***Bc85*** Date: ***26-May-2013***





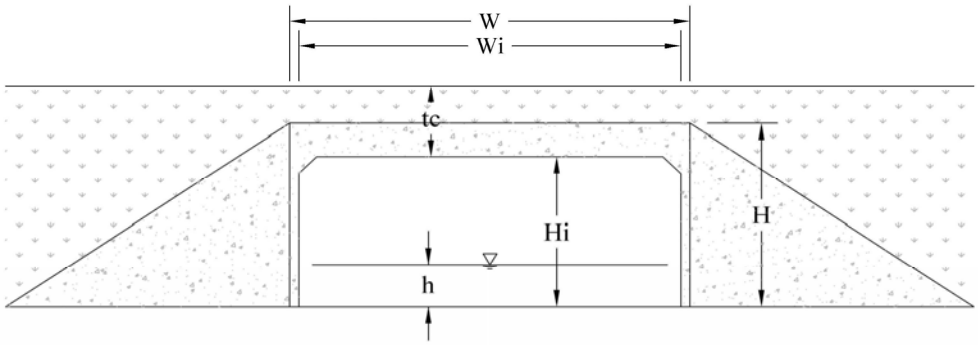
1-BC

W	=	***2.90***	(m)
W_i	=	***2.85***	(m)
H	=	***2.05***	(m)
H_i	=	***1.65***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.55***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_i$ =Net Width, H=Total Height, $H_1/H_2/H_i$ =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***276+100*** No.: ***Bc86*** Date: ***26-May-2013***



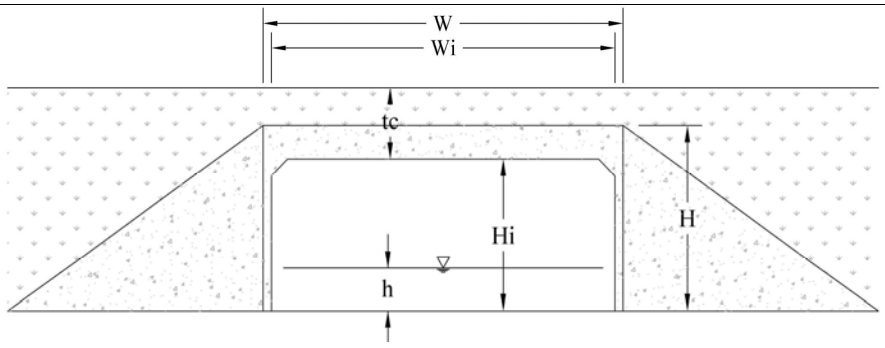


1-BC

W	=	***2.90***	(m)
W_i	=	***2.85***	(m)
H	=	***2.35***	(m)
H_i	=	***1.95***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.55***	(m)

Lake Side (Outlet)

KP: ***280+700*** No.: ***Bc87*** Date: ***26-May-2013***





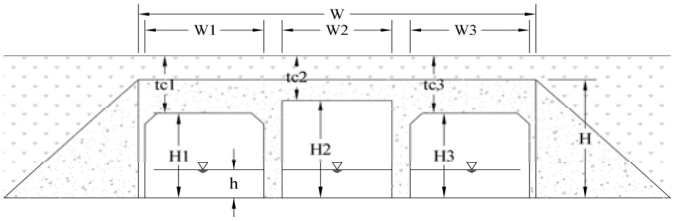
1-BC

W	=	***3.10***	(m)
W_i	=	***3.00***	(m)
H	=	***2.20***	(m)
H_i	=	***1.80***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.65***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_i=Net Width, H=Total Height, H_i =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top, River means the Tonle Sap River

KP: ***281+700*** No.: ***Bc88*** Date: ***26-May-2013***



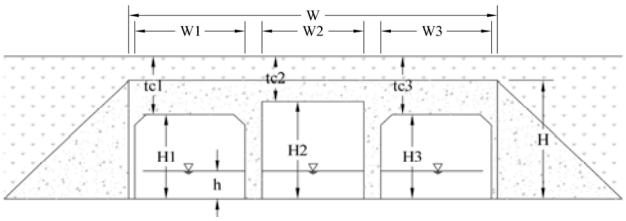


3-BC

W	=	***9.50***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.60***	(m)
H_1, H_3	=	***1.95***	(m)
H_2	=	***2.20***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***1.05***	(m)
tc_2	=	***0.80***	(m)

Lake Side (Outlet)

KP: ***283+700*** No.: ***Bc89*** Date: ***27-May-2013***





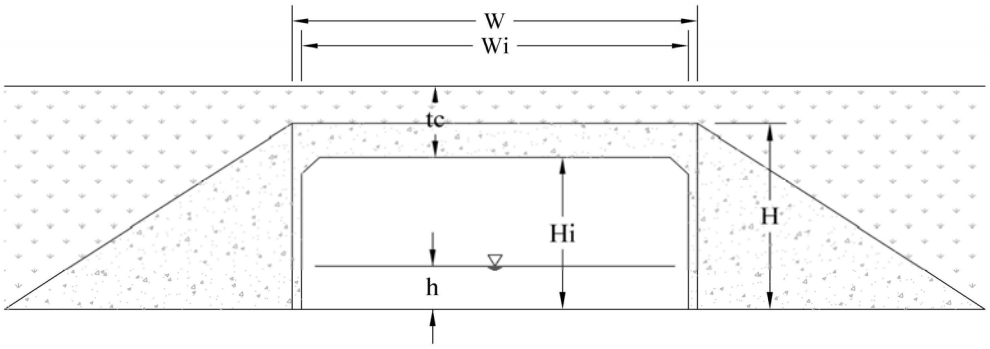
3-BC

W	=	***9.55***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.60***	(m)
H_1, H_3	=	***1.95***	(m)
H_2	=	***2.20***	(m)
L	=	***26.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***3.15***	(m)
tc_2	=	***2.90***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, River means the Tonle Sap River

KP: ***285+100*** No.: ***Bc90*** Date: ***27-May-2013***



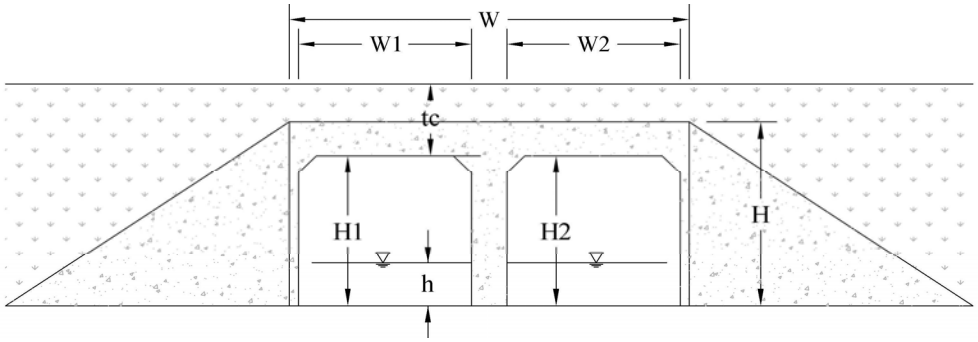


1-BC

W	=	***2.00***	(m)
W_i	=	***1.90***	(m)
H	=	***2.35***	(m)
H_i	=	***2.00***	(m)
L	=	***14.40***	(m)
h	=	***0.00***	(m)
tc	=	***0.85***	(m)

Lake Side (Outlet)

KP: ***294+000*** No.: ***Bc91*** Date: ***27-May-2013***





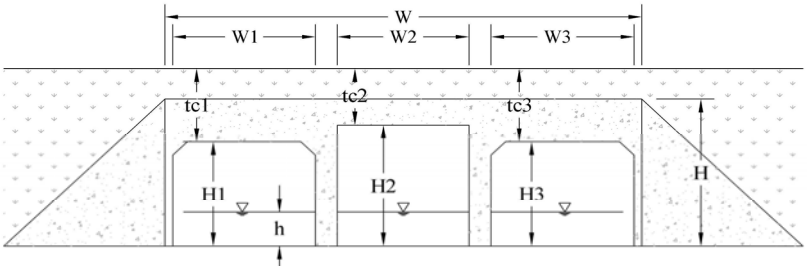
2-BC

W	=	***6.30***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***2.30***	(m)
H_1, H_2	=	***1.85***	(m)
L	=	***23.20***	(m)
h	=	***0.80***	(m)
tc	=	***0.80***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_i$ =Net Width, H=Total Height, $H_1/H_2/H_i$ =Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***295+000*** No.: ***Bc92*** Date: ***27-May-2013***



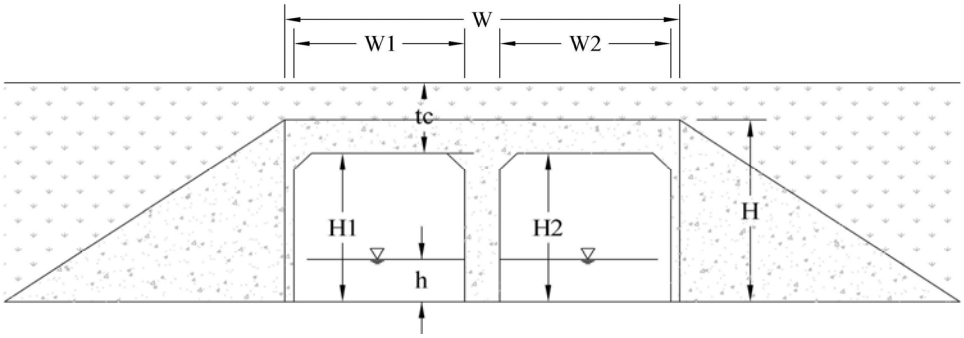


3-BC

W	=	***9.35***	(m)
W_1,	=	***2.85***	(m)
W_2	=	***2.90***	(m)
W_3	=	***2.75***	(m)
H	=	***2.65***	(m)
H_1, H_2, H_3	=	***2.00***	(m)
L	=	***23.10***	(m)
h	=	***1.60***	(m)
tc_1 , tc_2, tc_3	=	***0.65***	(m)

Lake Side (Outlet)

KP: ***297+500*** No.: ***Bc93*** Date: ***27-May-2013***





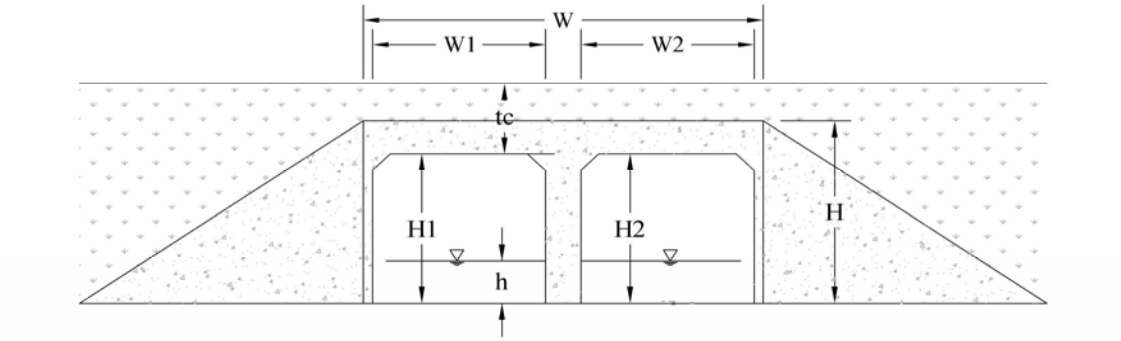
2-BC

W	=	***6.20***	(m)
W_1,W_2	=	***2.85***	(m)
H	=	***1.90***	(m)
H_1, H_2	=	***1.50***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.55***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2/W_3=Net Width, H=Total Height, H_1/H_2/H_3=Net Height, L=Total Length, h=Water Depth, tc_1/tc_2/tc_3=Height of Soil over Top,

KP: ***302+300*** No.: ***Bc94*** Date: ***28-May-2013***



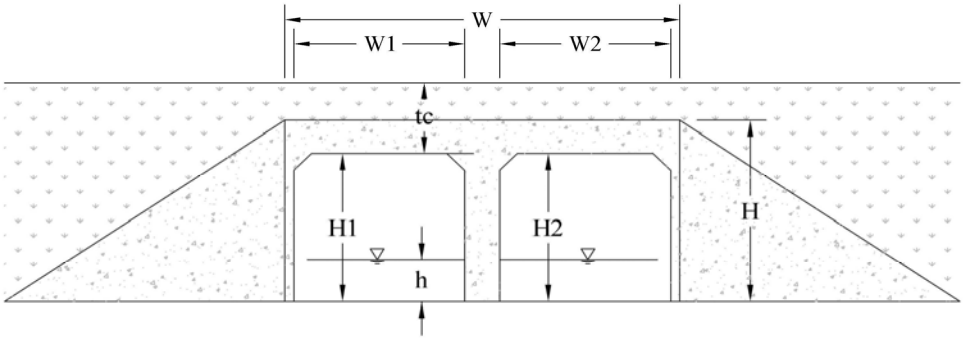


2-BC

W	=	***6.20***	(m)
W_1,W_2	=	***2.85***	(m)
H	=	***2.25***	(m)
H_1, H_2	=	***1.85***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc	=	***0.52***	(m)

Lake Side (Outlet)

KP: ***303+600*** No.: ***Bc95*** Date: ***28-May-2013***





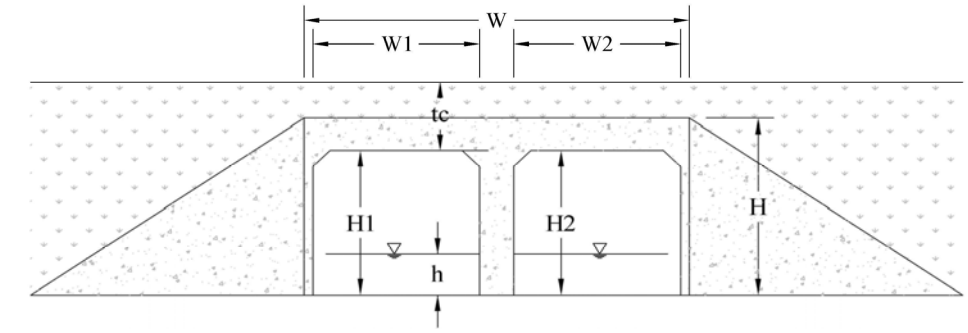
2-BC

W	=	***6.30***	(m)
W_1,W_2	=	***2.85***	(m)
H	=	***2.25***	(m)
H_1, H_2	=	***1.85***	(m)
L	=	***10.50***	(m)
h	=	***0.00***	(m)
tc	=	***0.70***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, W_1/W_2=Net Width, H=Total Height, H_1/H_2=Net Height, L=Total Length, h=Water Depth, tc=Height of Soil over Top,

KP: ***306+400*** No.: ***Bc96*** Date: ***28-May-2013***



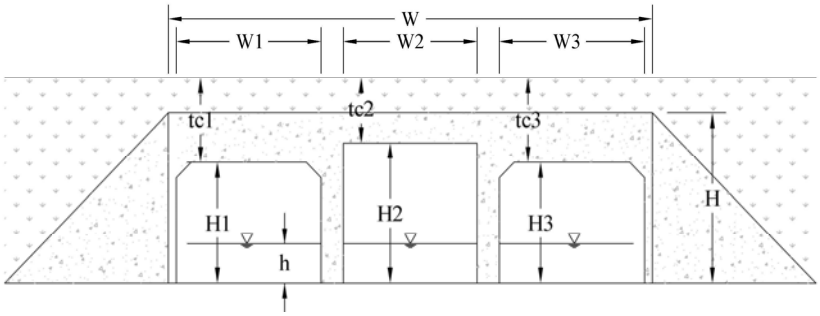


2-BC

W	=	***6.25***	(m)
W_1, W_2	=	***2.85***	(m)
H	=	***1.95***	(m)
H_1, H_2	=	***1.55***	(m)
L	=	***12.30***	(m)
h	=	***0.00***	(m)
tc	=	***0.56***	(m)

Lake Side (Outlet)

KP: ***309+100*** No.: ***Bc97*** Date: ***28-May-2013***





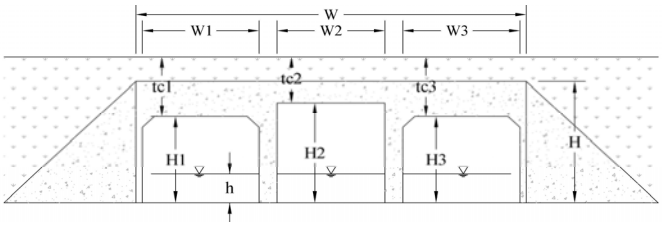
3-BC

W	=	***9.60***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.55***	(m)
H_1, H_3	=	***1.90***	(m)
H_2	=	***2.15***	(m)
L	=	***13.70***	(m)
h	=	***0.10***	(m)
tc_1 ,tc_3	=	***0.85***	(m)
tc_2	=	***0.60***	(m)

Lake Side (Outlet)

Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top,

KP: ***310+400*** No.: ***Bc98*** Date: ***28-May-2013***



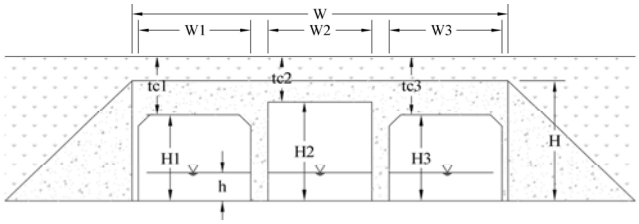


3-BC

W	=	***9.60***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.40***	(m)
H_1, H_3	=	***1.75***	(m)
H_2	=	***2.00***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.77***	(m)
tc_2	=	***0.52***	(m)

Lake Side (Outlet)

KP: ***311+300*** No.: ***Bc99*** Date: ***28-May-2013***





3-BC

W	=	***9.60***	(m)
W_1, W_3	=	***2.85***	(m)
W_2	=	***3.00***	(m)
H	=	***2.60***	(m)
H_1, H_3	=	***1.95***	(m)
H_2	=	***2.20***	(m)
L	=	***13.70***	(m)
h	=	***0.00***	(m)
tc_1 ,tc_3	=	***0.75***	(m)
tc_2	=	***0.50***	(m)

Lake Side (Outlet)

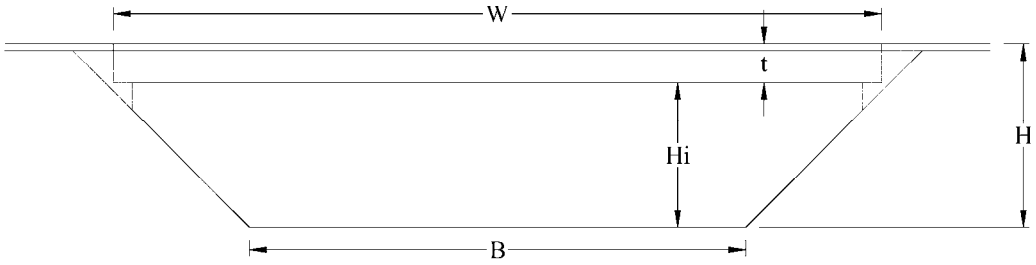
Note: BC means Box Culvert, W=Total Width, $W_1/W_2/W_3$=Net Width, H=Total Height, $H_1/H_2/H_3$=Net Height, L=Total Length, h=Water Depth, $tc_1/tc_2/tc_3$=Height of Soil over Top, Lake means the Tonle Sap Lake

APPENDIX 6-2

INVENTORY SURVEY ON

BRIDGE

KP: ***177+200*** No.: ***Br40*** Date: ***May 20, 2013***



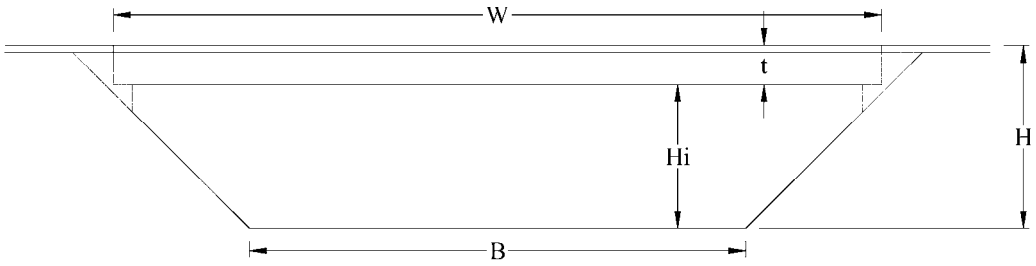


1-Br

W	=	***23.1***	(m)
W_i	=	***23.1***	(m)
H	=	***5.5***	(m)
H_i	=	***4.3***	(m)
L	=	***9.6***	(m)
B	=	***12.2***	(m)
t	=	***1.2***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***178+500*** No.: ***Br41*** Date: ***May 20, 2013***





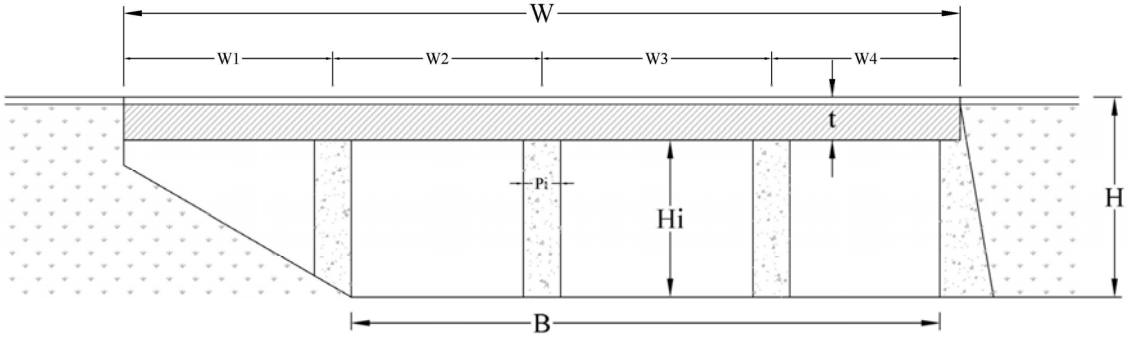
1-Br

W	=	***19.8***	(m)
W_i	=	***19.8***	(m)
H	=	***4.4***	(m)
H_i	=	***2.8***	(m)
L	=	***10.0***	(m)
B	=	***11.0***	(m)
t	=	***1.6***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***181+800*** No.: ***Br42*** Date: ***May 20, 2013***



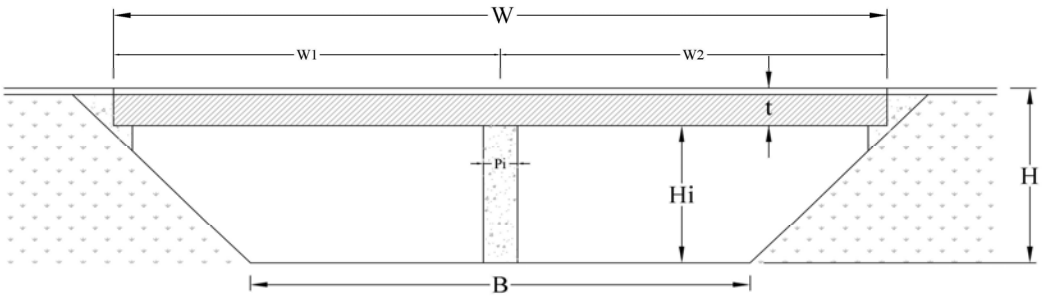


4-Br

W	=	***19.2***	(m)
W_1,W_2,W_3,W_4	=	***4.8***	(m)
H	=	***2.2***	(m)
H_i	=	***1.4***	(m)
L	=	***9.1***	(m)
B	=	***14.8***	(m)
t	=	***0.8***	(m)
Pi	=	***0.8***	(m)

Lake Side (down stream)

KP: ***182+800*** No.: ***Br43*** Date: ***May 20, 2013***





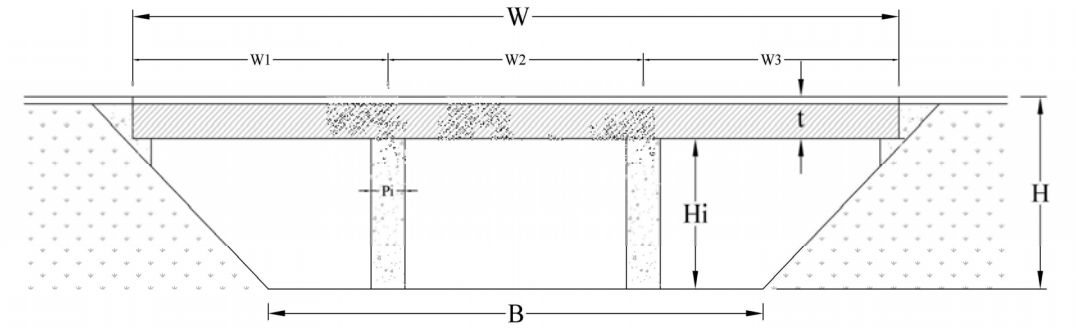
2-Br

W	=	***42.6***	(m)
W_1,W_2	=	***21.3***	(m)
H	=	***3.5***	(m)
H_i	=	***2.9***	(m)
L	=	***10.0***	(m)
B	=	***35.7***	(m)
t	=	***0.55***	(m)
Pi	=	***0.9***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***183+300*** No.: ***Br44*** Date: ***May 20, 2013***



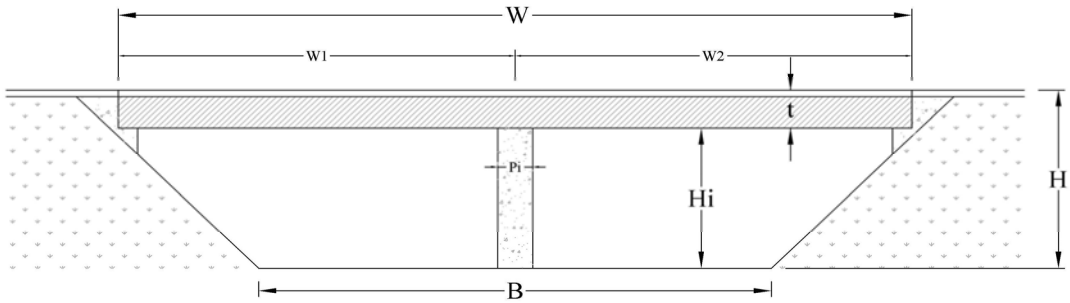


3-Br

W	=	***45.3***	(m)
W_1,W_2,W_3	=	***15.1***	(m)
H	=	***4.9***	(m)
H_i	=	***3.6***	(m)
L	=	***9.0***	(m)
B	=	***35.6***	(m)
t	=	***1.25***	(m)
Pi	=	***1.5***	(m)

Lake Side (down stream)

KP: ***183+900*** No.: ***Br45*** Date: ***May 21, 2013***





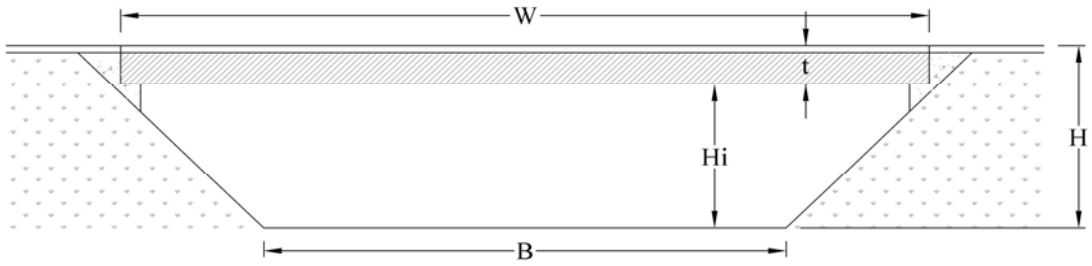
2-Br

W	=	***42.5***	(m)
W_1,W_2	=	***21.25***	(m)
H	=	***6.0***	(m)
H_i	=	***5.3***	(m)
L	=	***10.0***	(m)
B	=	***30.6***	(m)
t	=	***0.65***	(m)
Pi	=	***0.6***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***184+100*** No.: ***Br46*** Date: ***May 21, 2013***





1-Br

W	=	***26.5***	(m)
W_i	=	***26.5***	(m)
H	=	***3.2***	(m)
H_i	=	***2.5***	(m)
L	=	***10.1***	(m)
B	=	***20.2***	(m)
t	=	***0.65***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***185+700*** No.: ***Br47*** ✗ Date: ***May 21, 2013***

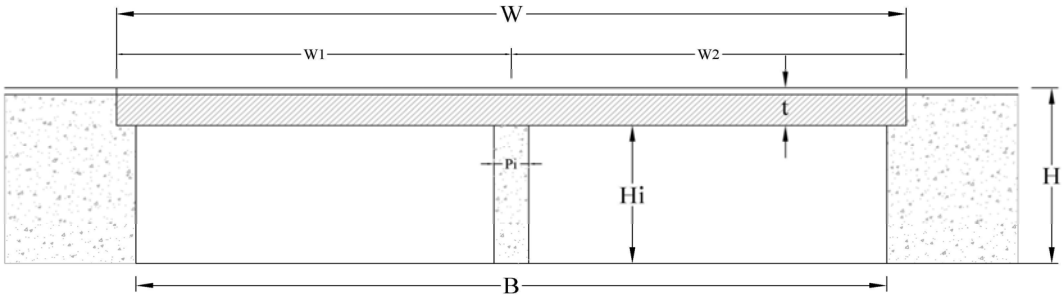
1-Br

W	=	(m)
W_i	=	(m)
H	=	(m)
H_i	=	(m)
L	=	(m)
B	=	(m)
t	=	(m)
Pi	=	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***187+400*** No.: ***Br48*** Date: ***May 21, 2013***



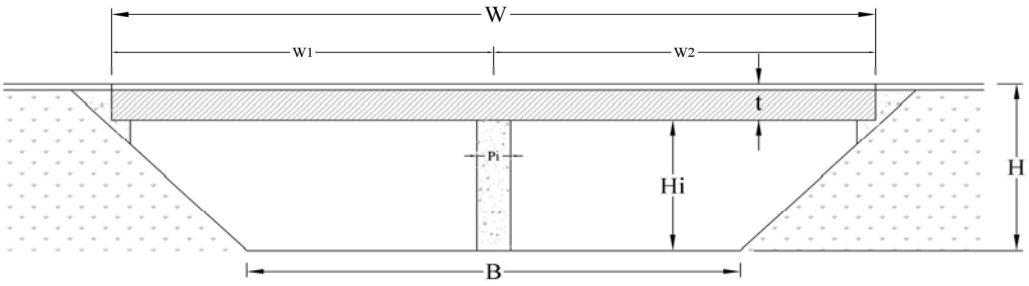


2-Br

W	=	***39.1***	(m)
W_1,W_2	=	***19.55***	(m)
H	=	***6.1***	(m)
H_i	=	***4.5***	(m)
L	=	***8.8***	(m)
B	=	***39.1***	(m)
t	=	***1.6***	(m)
Pi	=	***1.6***	(m)

Lake Side (down stream)

KP: ***187+700*** No.: ***Br49*** Date: ***May 21, 2013***





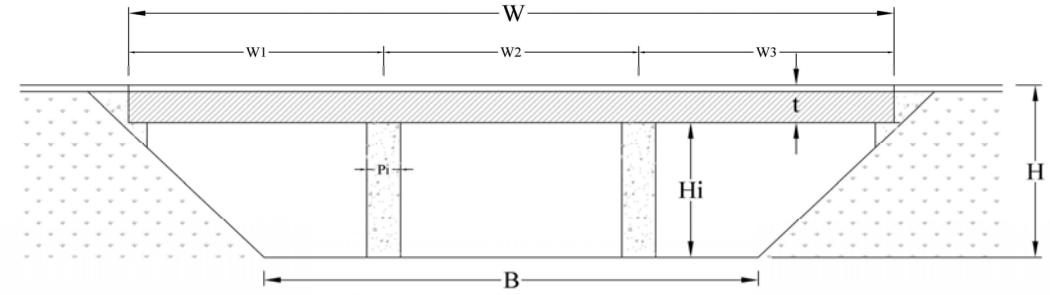
2-Br

W	=	***30.5***	(m)
W_1,W_2	=	***15.25***	(m)
H	=	***3.4***	(m)
H_i	=	***2.5***	(m)
L	=	***10.0***	(m)
B	=	***23.8***	(m)
t	=	***0.9***	(m)
Pi	=	***0.7***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***188+100*** No.: ***Br50*** Date: ***May 21, 2013***



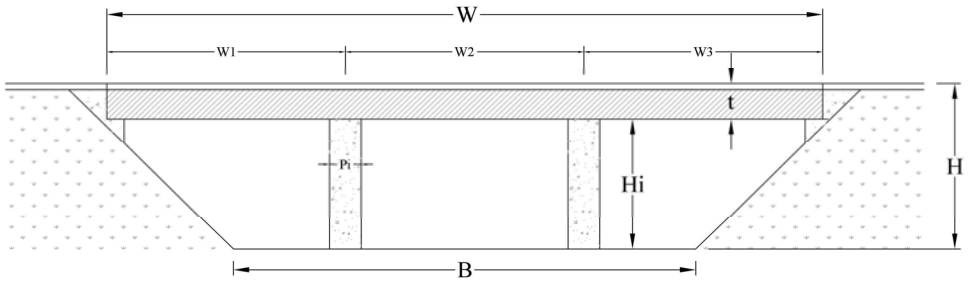


3-Br

W	=	***61.0***	(m)
W_1	=	***18.0***	(m)
W_2,W_3	=	***21.5***	(m)
H	=	***2.5***	(m)
H_i	=	***1.9***	(m)
L	=	***10.0***	(m)
B	=	***56.0***	(m)
t	=	***0.65***	(m)
Pi	=	***0.9***	(m)

Lake Side (down stream)

KP: ***188+250*** No.: ***Br51*** Date: ***May 21, 2013***





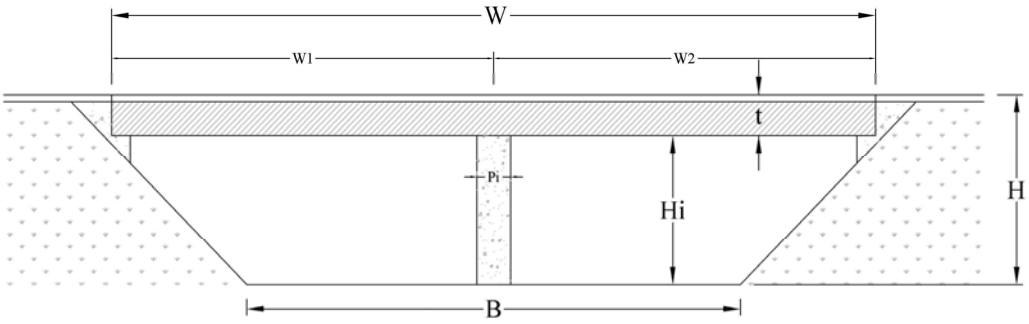
3-Br

W	=	***51.5***	(m)
W_1	=	***15.0***	(m)
W_2,W_3	=	***18.25***	(m)
H	=	***2.9***	(m)
H_i	=	***2.2***	(m)
L	=	***10.0***	(m)
B	=	***45.8***	(m)
t	=	***0.65***	(m)
Pi	=	***0.9***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***189+250*** No.: ***Br52*** Date: ***May 21, 2013***



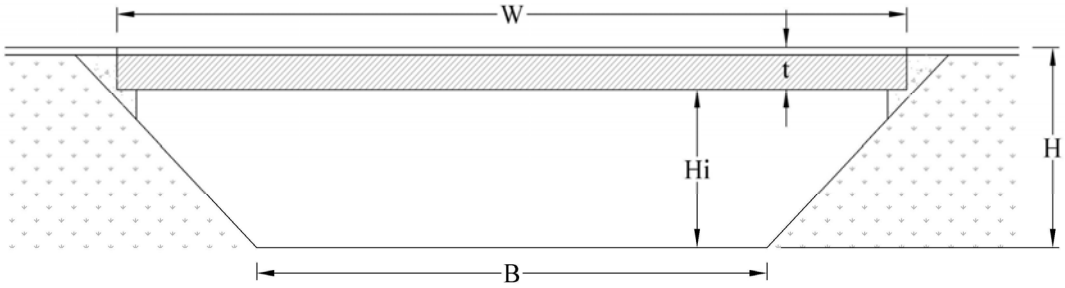


4-Br

W	=	***36.5***	(m)
W_1,W_2	=	***18.25***	(m)
H	=	***3.6***	(m)
H_i	=	***3.0***	(m)
L	=	***10.0***	(m)
B	=	***29.4***	(m)
t	=	***0.6***	(m)
Pi	=	***0.9***	(m)

Lake Side (down stream)

KP: ***189+900*** No.: ***Br53*** Date: ***May 21, 2013***





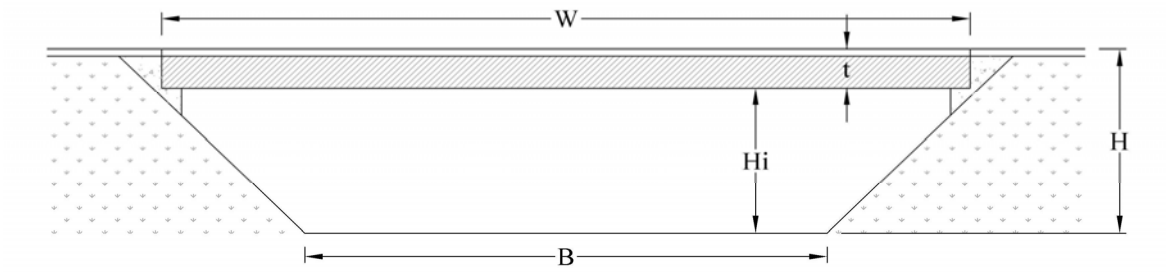
1-Br

W	=	***24.5***	(m)
W_i	=	***24.5***	(m)
H	=	***2.1***	(m)
H_i	=	***2.5***	(m)
L	=	***10.0***	(m)
B	=	***20.3***	(m)
t	=	***0.6***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***190+150*** No.: ***Br54*** Date: ***May 21, 2013***



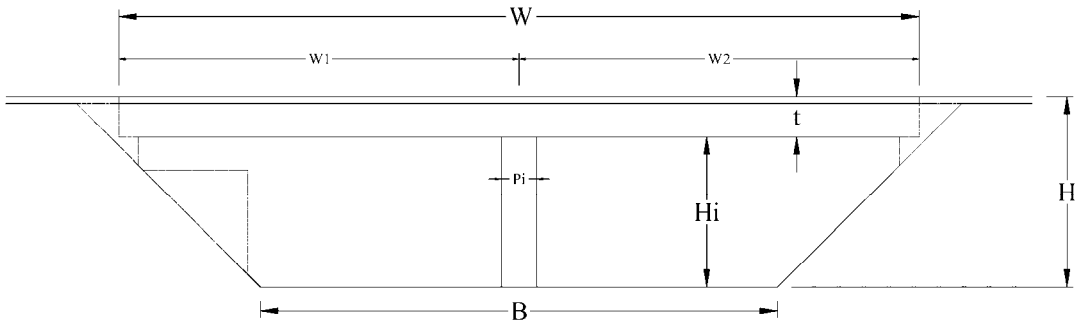


1-Br

W	=	***24.5***	(m)
W_i	=	***24.5***	(m)
H	=	***1.9***	(m)
H_i	=	***1.3***	(m)
L	=	***10.0***	(m)
B	=	***20.8***	(m)
t	=	***0.55***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***191+100*** No.: ***Br55*** Date: ***May 21, 2013***





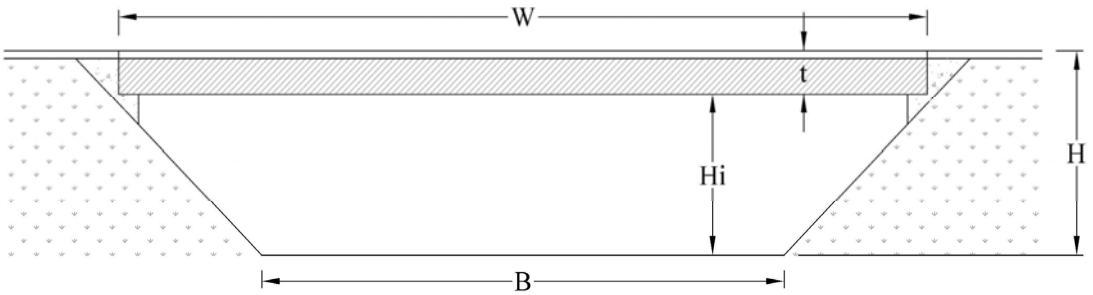
2-Br

W	=	***36.4***	(m)
W_1,W_2	=	***18.2***	(m)
H	=	***4.9***	(m)
H_i	=	***4.3***	(m)
L	=	***10.0***	(m)
B	=	***26.7***	(m)
t	=	***0.55***	(m)
Pi	=	***0.4***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***201+800*** No.: ***Br56*** Date: ***May 21, 2013***





1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.4***	(m)
H_i	=	***2.0***	(m)
L	=	***10.0***	(m)
B	=	***13.8***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***208+500*** No.: ***Br57*** ✗ Date: ***May 21, 2013***

2-Br

W	=	(m)
W_1,W_2	=	(m)
H	=	(m)
H_i	=	(m)
L	=	(m)
B	=	(m)
t	=	(m)
Pi	=	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***215+750*** No.: ***Br58*** ✕ Date: ***May 22, 2013***

3-Br

W	=	(m)
W_1	=	(m)
W_2,W_3	=	(m)
H	=	(m)
H_i	=	(m)
L	=	(m)
B	=	(m)
t	=	(m)
Pi	=	(m)

Lake Side (down stream)

KP: ***219+600*** No.: ***Br59*** ✕ Date: ***May 22, 2013***

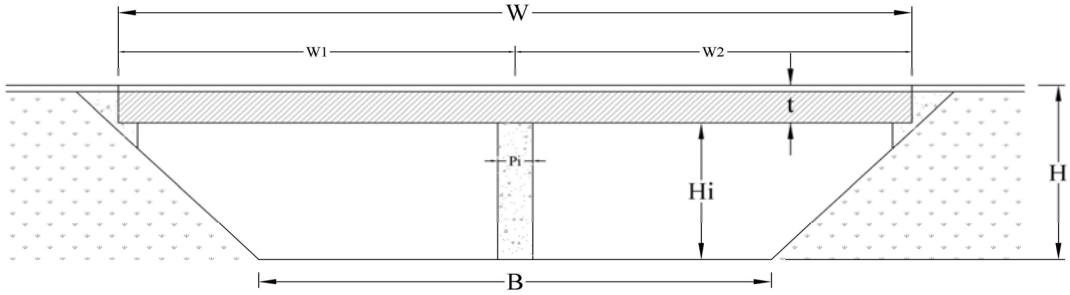
3-Br

W	=	(m)
W_1	=	(m)
W_2	=	(m)
W_3	=	(m)
H	=	(m)
H_i	=	(m)
L	=	(m)
B	=	(m)
t	=	(m)
Pi	=	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***220+800*** No.: ***Br60*** Date: ***May 22, 2013***



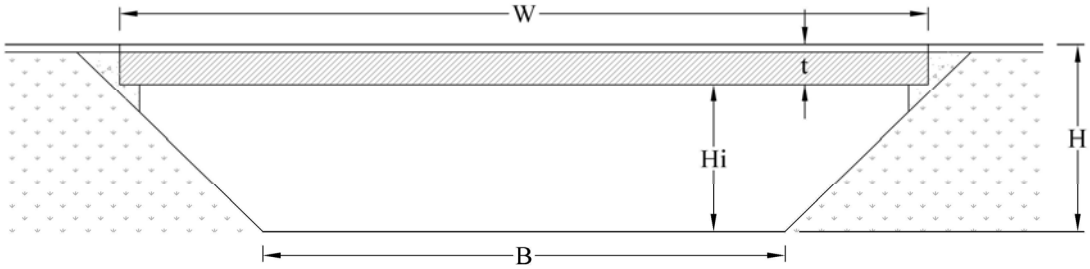


2-Br

W	=	***30.4***	(m)
W_1, W_2	=	***15.2***	(m)
H	=	***4.2***	(m)
H_i	=	***3.8***	(m)
L	=	***10.0***	(m)
B	=	***22.1***	(m)
t	=	***0.4***	(m)
Pi	=	***0.4***	(m)

Lake Side (down stream)

KP: ***222+650*** No.: ***Br61*** Date: ***May 22, 2013***





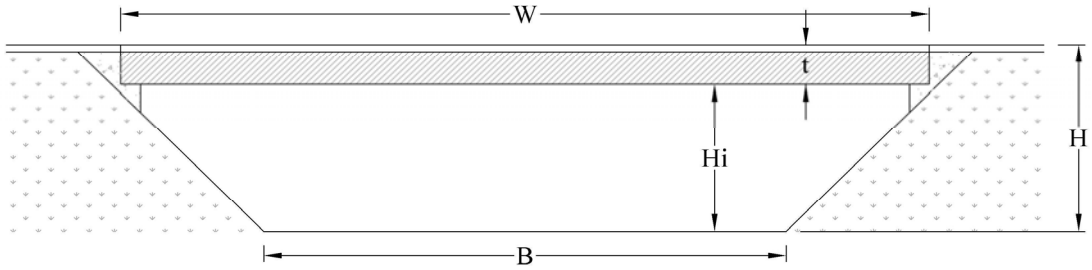
1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.9***	(m)
H_i	=	***2.5***	(m)
L	=	***10.0***	(m)
B	=	***12.7***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***223+650*** No.: ***Br62*** Date: ***May 22, 2013***



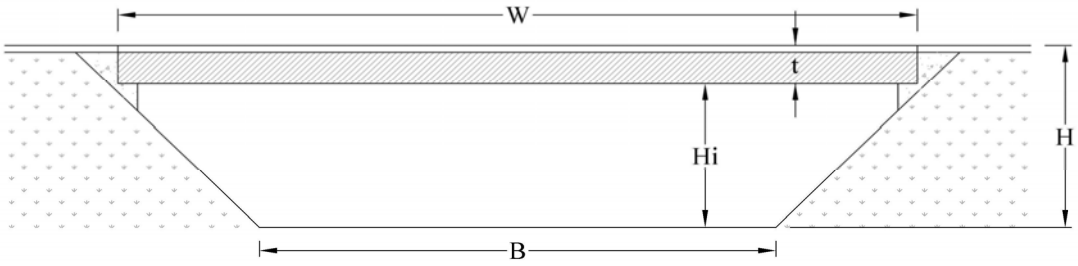


1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***3.0***	(m)
H_i	=	***2.6***	(m)
L	=	***10.0***	(m)
B	=	***12.5***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***242+850*** No.: ***Br63*** Date: ***May 23, 2013***





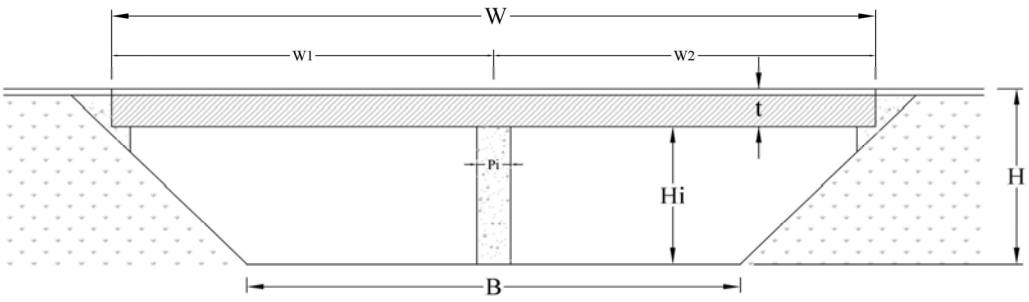
1-Br

W	=	***24.5***	(m)
W_i	=	***24.5***	(m)
H	=	***3.0***	(m)
H_i	=	***2.4***	(m)
L	=	***10.0***	(m)
B	=	***18.6***	(m)
t	=	***0.6***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***243+600*** No.: ***Br64*** Date: ***May 23, 2013***





2-Br

W	=	***37.0***	(m)
W_1, W_2	=	***18.5***	(m)
H	=	***3.1***	(m)
H_i	=	***2.6***	(m)
L	=	***10.0***	(m)
B	=	***30.9***	(m)
t	=	***0.5***	(m)
Pi	=	***0.4***	(m)

Lake Side (down stream)

KP: ***244+400*** No.: ***Br65*** ✗ Date: ***May 23, 2013***

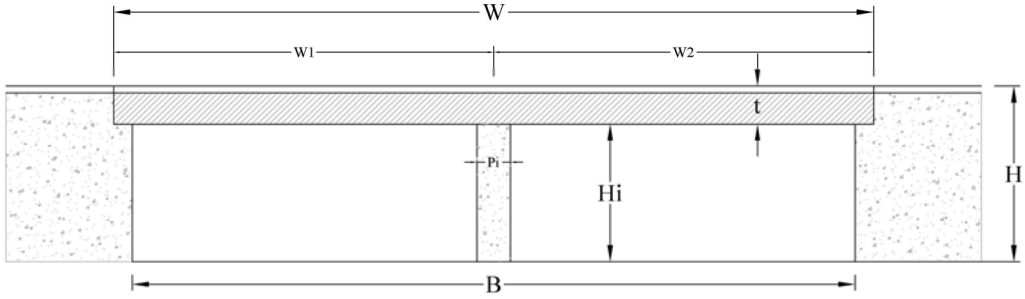
3-Br

W	=		(m)
W_1	=		(m)
H	=		(m)
H_i	=		(m)
L	=		(m)
B	=		(m)
t	=		(m)
Pi	=		(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***245+900*** No.: ***Br66*** Date: ***May 23, 2013***



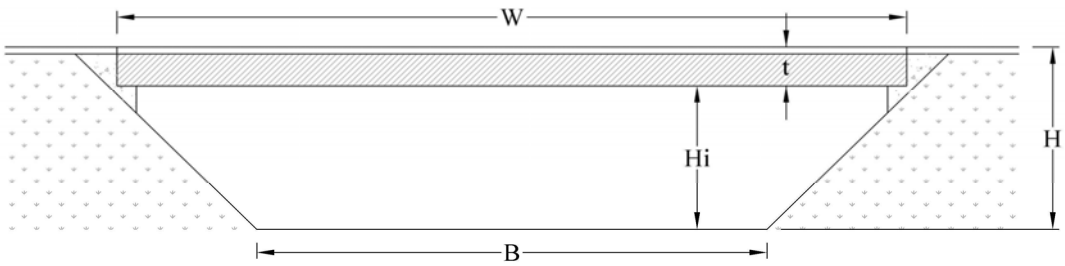


2-Br

W	=	***15.8***	(m)
W_1,W_2	=	***7.9***	(m)
H	=	***2.4***	(m)
H_i	=	***1.9***	(m)
L	=	***9.1***	(m)
B	=	***15.8***	(m)
t	=	***0.5***	(m)
Pi	=	***0.8***	(m)

Lake Side (down stream)

KP: ***255+250*** No.: ***Br67*** Date: ***May 23, 2013***





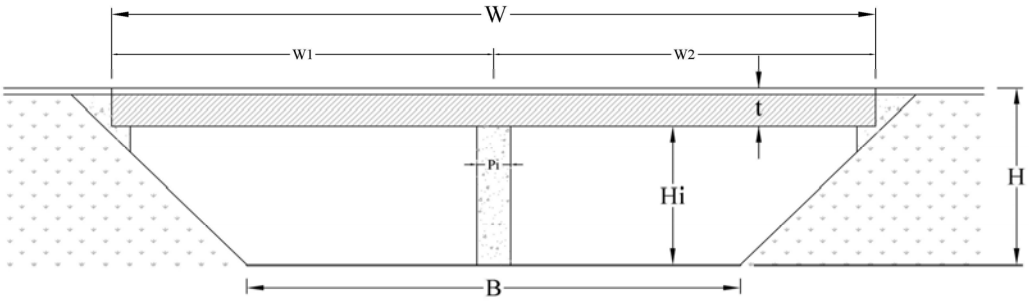
1-Br

W	=	***21.5***	(m)
W_i	=	***21.5***	(m)
H	=	***2.4***	(m)
H_i	=	***1.9***	(m)
L	=	***10.0***	(m)
B	=	***16.7***	(m)
t	=	***0.5***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***255+600*** No.: ***Br68*** Date: ***May 23, 2013***



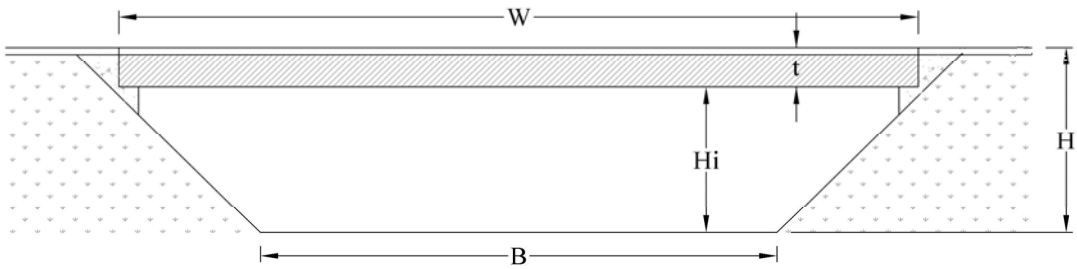


2-Br

W	=	***30.5***	(m)
W_1, W_2	=	***15.25***	(m)
H	=	***2.3***	(m)
H_i	=	***1.9***	(m)
L	=	***10.0***	(m)
B	=	***25.9***	(m)
t	=	***0.4***	(m)
Pi	=	***0.4***	(m)

Lake Side (down stream)

KP: ***256+550*** No.: ***Br69*** Date: ***May 23, 2013***





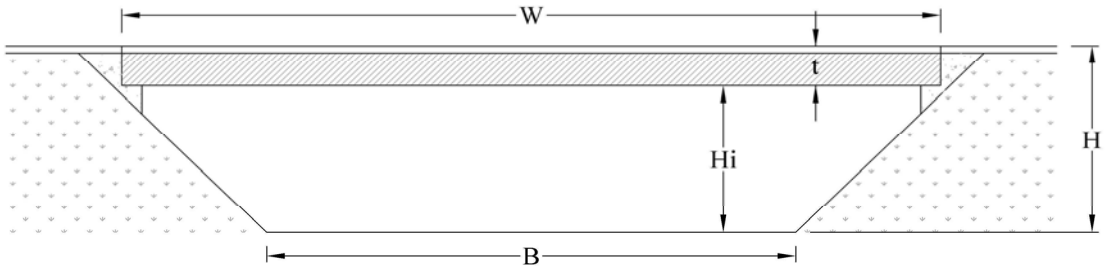
1-Br

W	=	***21.5***	(m)
W_i	=	***21.5***	(m)
H	=	***2.5***	(m)
H_i	=	***2.0***	(m)
L	=	***10.0***	(m)
B	=	***16.5***	(m)
t	=	***0.5***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***257+900*** No.: ***Br70*** Date: ***May 23, 2013***



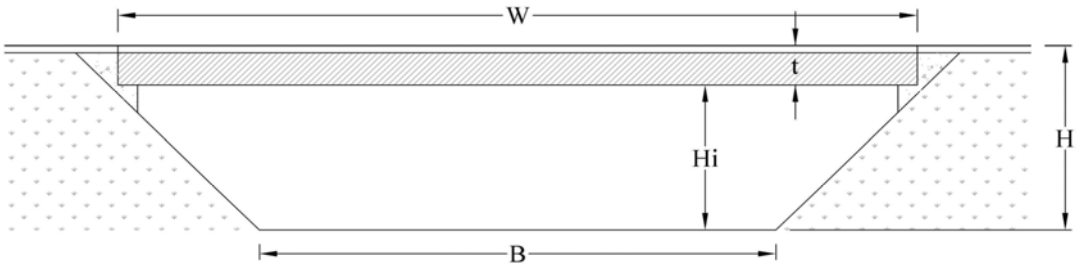


1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***3.0***	(m)
H_i	=	***2.5***	(m)
L	=	***10.0***	(m)
B	=	***12.6***	(m)
t	=	***0.45***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***265+348*** No.: ***Br71*** Date: ***May 24, 2013***





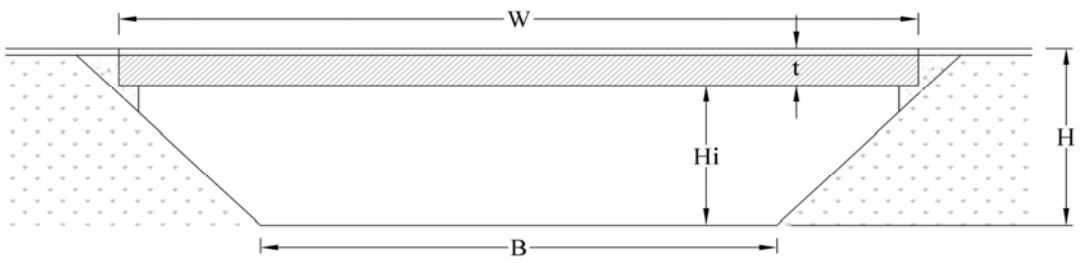
1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.9***	(m)
H_i	=	***2.4***	(m)
L	=	***18.5***	(m)
B	=	***12.8***	(m)
t	=	***0.45***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***270+900*** No.: ***Br72*** Date: ***May 24, 2013***



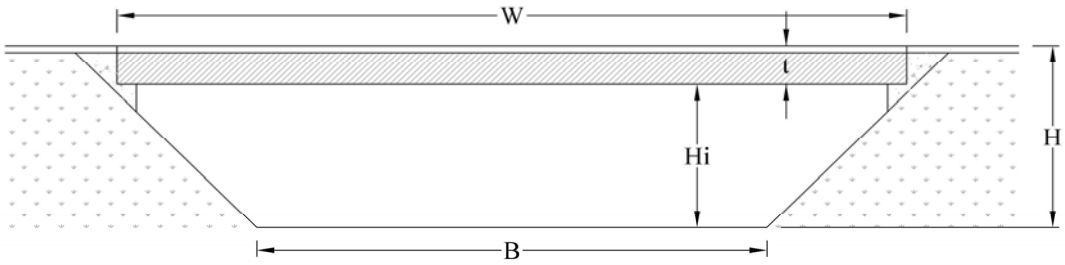


1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.8***	(m)
H_i	=	***2.4***	(m)
L	=	***10.0***	(m)
B	=	***12.9***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***271+700*** No.: ***Br73*** Date: ***May 24, 2013***





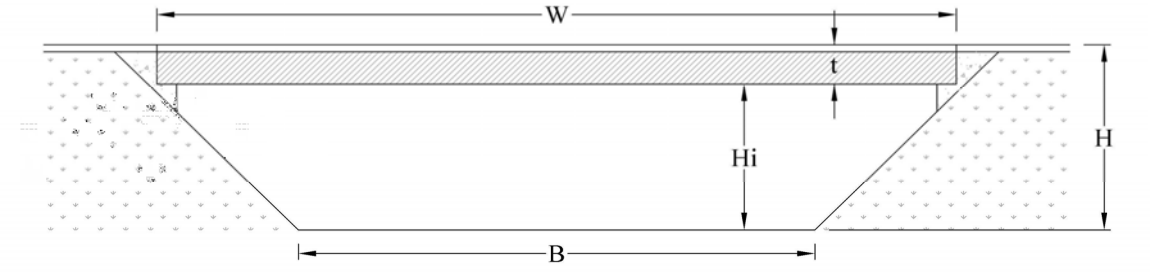
1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.4***	(m)
H_i	=	***2.0***	(m)
L	=	***10.0***	(m)
B	=	***13.7***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***272+650*** No.: ***Br74*** Date: ***May 24, 2013***



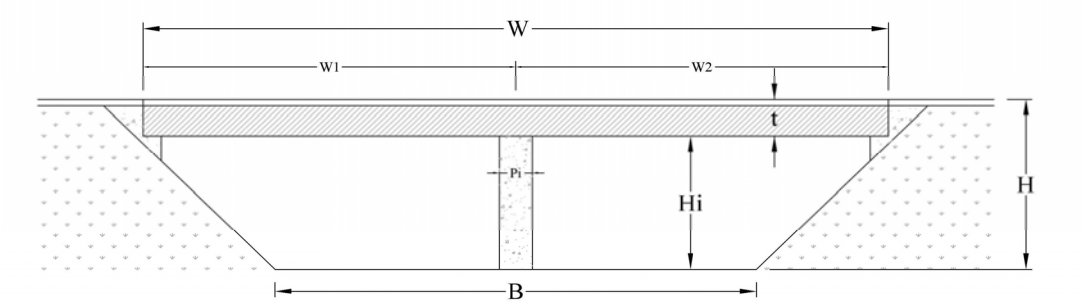


1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.3***	(m)
H_i	=	***1.9***	(m)
L	=	***10.0***	(m)
B	=	***14.0***	(m)
t	=	***0.4***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***273+300*** No.: ***Br75*** Date: ***May 24, 2013***





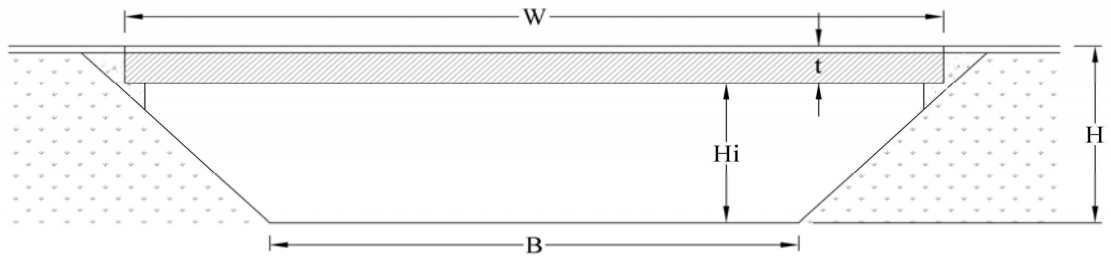
2-Br

W	=	***30.5***	(m)
W_1, W_2	=	***15.25***	(m)
H	=	***3.4***	(m)
H_i	=	***2.9***	(m)
L	=	***10.0***	(m)
B	=	***23.8***	(m)
t	=	***0.45***	(m)
Pi	=	***0.4***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***275+650*** No.: ***Br76*** Date: ***May 26, 2013***



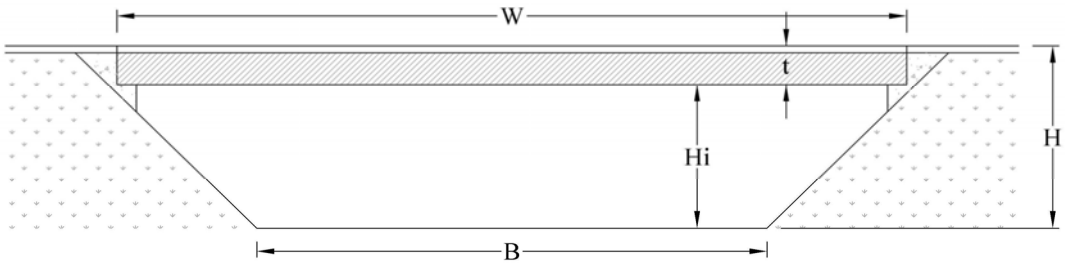


1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.5***	(m)
H_i	=	***2.1***	(m)
L	=	***10.0***	(m)
B	=	***13.5***	(m)
t	=	***0.45***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***276+550*** No.: ***Br77*** Date: ***May 26, 2013***





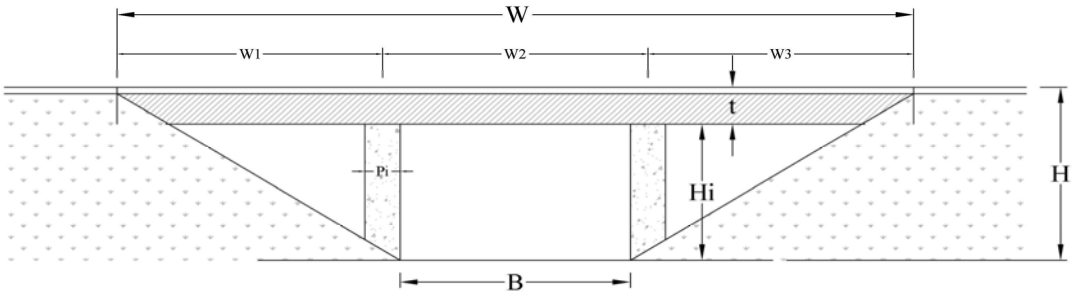
1-Br

W	=	***18.5***	(m)
W_i	=	***18.5***	(m)
H	=	***2.4***	(m)
H_i	=	***2.0***	(m)
L	=	***10.0***	(m)
B	=	***13.7***	(m)
t	=	***0.45***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***292+000*** No.: ***Br78*** Date: ***May 27, 2013***



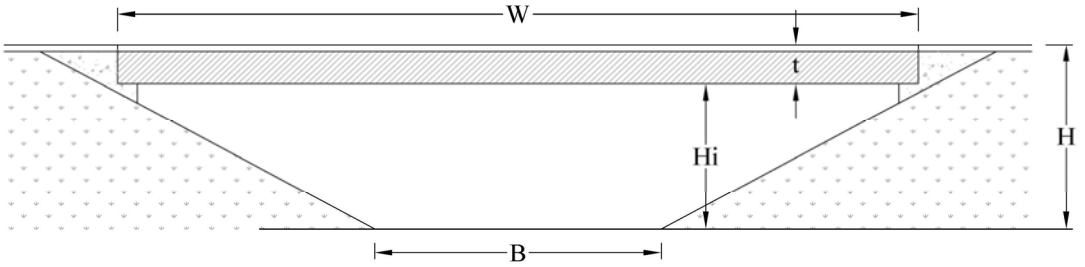


3-Br

W	=	***130.8***	(m)
W_1,W_2,W_3	=	***43.6***	(m)
H	=	***12.6***	(m)
H_i	=	***12.6***	(m)
L	=	***6.6***	(m)
B	=	***12.6***	(m)
t	=	***N/A***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***303+400*** No.: ***Br79*** Date: ***May 28, 2013***





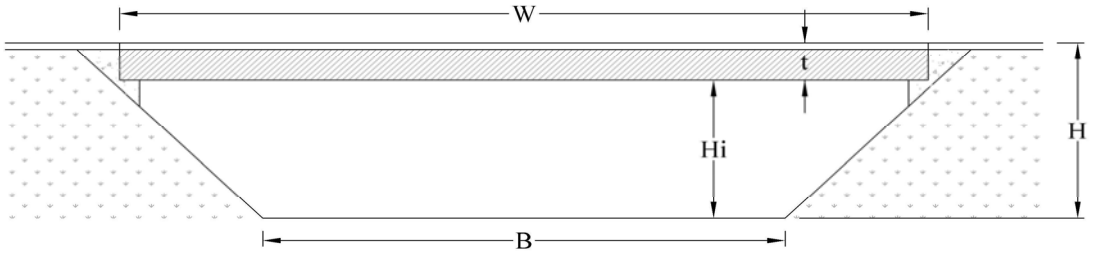
1-Br

W	=	***13.7***	(m)
W_i	=	***13.65***	(m)
H	=	***5.1***	(m)
H_i	=	***3.8***	(m)
L	=	***7.0***	(m)
B	=	***3.8***	(m)
t	=	***1.35***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***305+800*** No.: ***Br80*** Date: ***May 28, 2013***



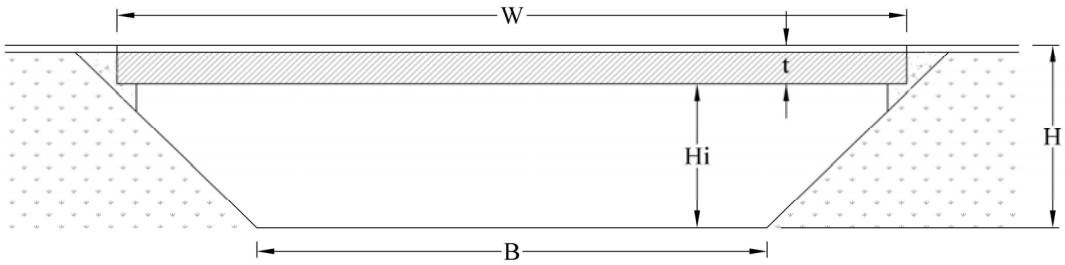


1-Br

W	=	***26.3***	(m)
W_i	=	***26.25***	(m)
H	=	***3.4***	(m)
H_i	=	***2.8***	(m)
L	=	***10.0***	(m)
B	=	***2.8***	(m)
t	=	***0.6***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

KP: ***307+200*** No.: ***Br81*** Date: ***May 28, 2013***





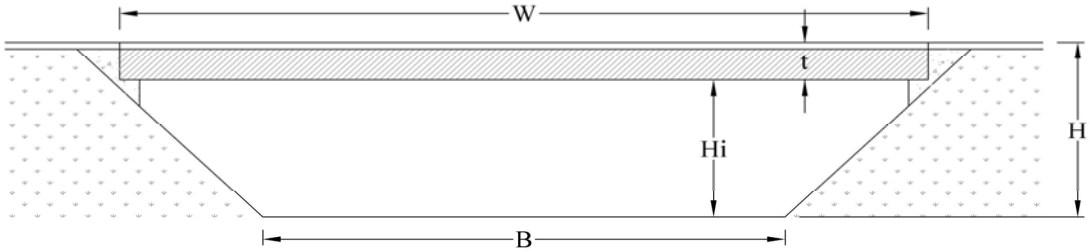
1-Br

W	=	***26.3***	(m)
W_i	=	***26.25***	(m)
H	=	***2.5***	(m)
H_i	=	***1.8***	(m)
L	=	***10.0***	(m)
B	=	***1.8***	(m)
t	=	***0.65***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

KP: ***312+000*** No.: ***Br82*** Date: ***May 28, 2013***





1-Br

W	=	***24.5***	(m)
W_i	=	***24.5***	(m)
H	=	***4.2***	(m)
H_i	=	***3.0***	(m)
L	=	***7.0***	(m)
B	=	***3.0***	(m)
t	=	***1.2***	(m)
Pi	=	***N/A***	(m)

Lake Side (down stream)

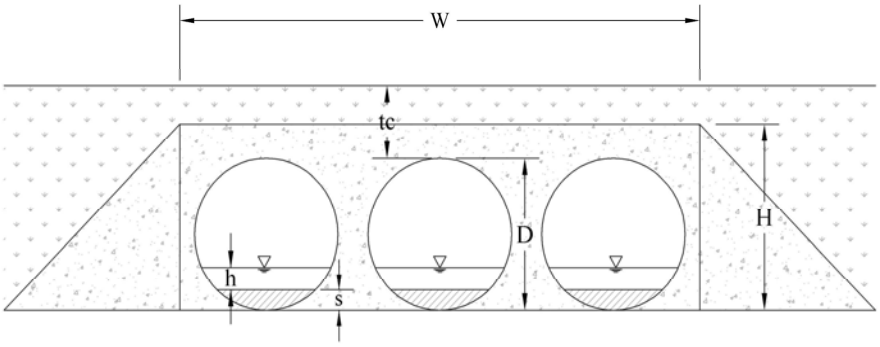
Note: Br means Bridge, W=Total Width, W_i=Net Width, H=Total Height, H_i=Net Height, L=Total Length, B=River bed Width, t=Girder thickness, N/A means data not available. Lake means Tonle Sap Lake

APPENDIX 6-3

INVENTORY SURVEY ON

PIPE CULVERT

KP: ***171+800*** No.: ***Pc148*** Date: ***20-May-2013***



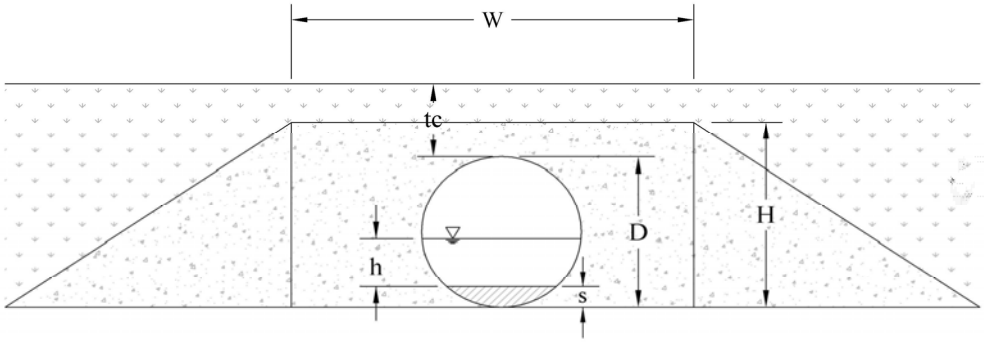


3Φ100

D	=	***1.00***	(m)
L	=	***15.60***	(m)
H	=	***1.35***	(m)
W	=	***4.55***	(m)
tc	=	***1.45***	(m)
h	=	***0.10***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***172+200*** No.: ***Pc149*** Date: ***20-May-2013***





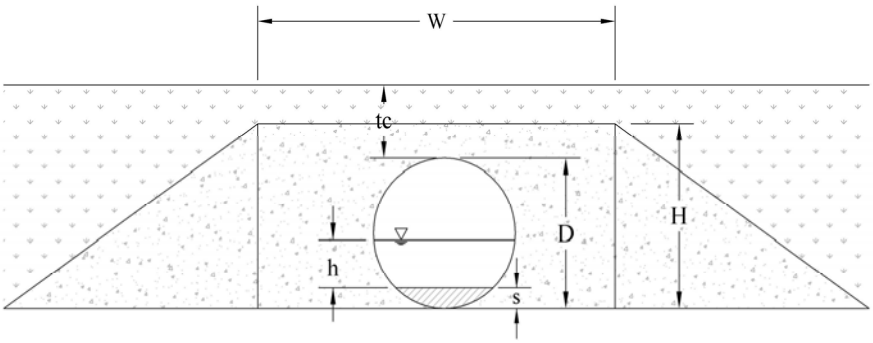
1Φ100

D	=	***1.00***	(m)
L	=	***15.60***	(m)
H	=	***1.25***	(m)
W	=	***1.20***	(m)
tc	=	***0.65***	(m)
h	=	***0.25***	(m)
s	=	***0.35***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River.

KP: ***174+100*** No.: ***Pc150*** Date: ***20-May-2013***



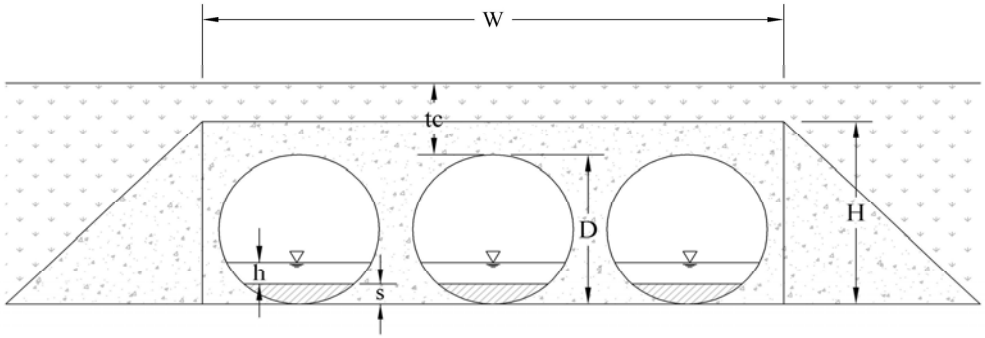


1Φ100

D	=	***1.00***	(m)
L	=	***13.50***	(m)
H	=	***1.50***	(m)
W	=	***1.23***	(m)
tc	=	***0.80***	(m)
h	=	***0.00***	(m)
s	=	***0.05***	(m)

Lake Side (Outlet)

KP: ***174+700*** No.: ***Pc151*** Date: ***20-May-2013***





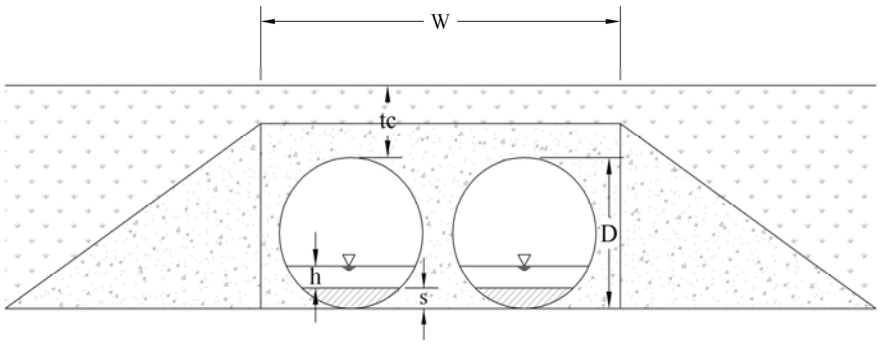
3Φ100

D	=	***1.00***	(m)
L	=	***13.30***	(m)
H	=	***1.35***	(m)
W	=	***4.70***	(m)
tc	=	***0.75***	(m)
h	=	***0.05***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***174+000*** No.: ***Pc152*** Date: ***20-May-2013***



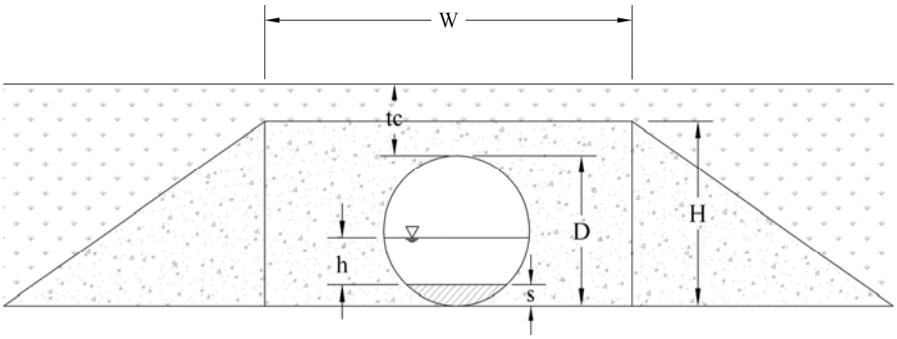


2Φ100

D	=	***1.00***	(m)
L	=	***12.80***	(m)
H	=	***1.30***	(m)
W	=	***2.90***	(m)
tc	=	***0.90***	(m)
h	=	***0.15***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***175+600*** No.: ***Pc153*** Date: ***20-May-2013***





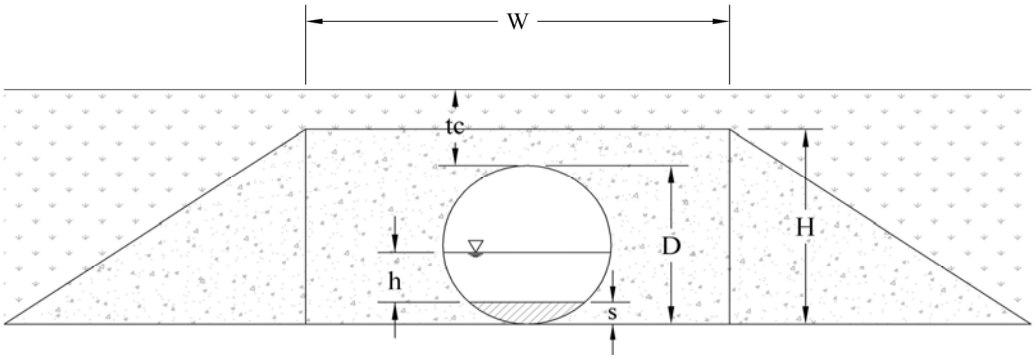
1Φ100

D	=	***1.00***	(m)
L	=	***13.30***	(m)
H	=	***1.40***	(m)
W	=	***1.25***	(m)
tc	=	***0.98***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

KP: ***176+100*** No.: ***Pc154*** Date: ***20-May-2013***



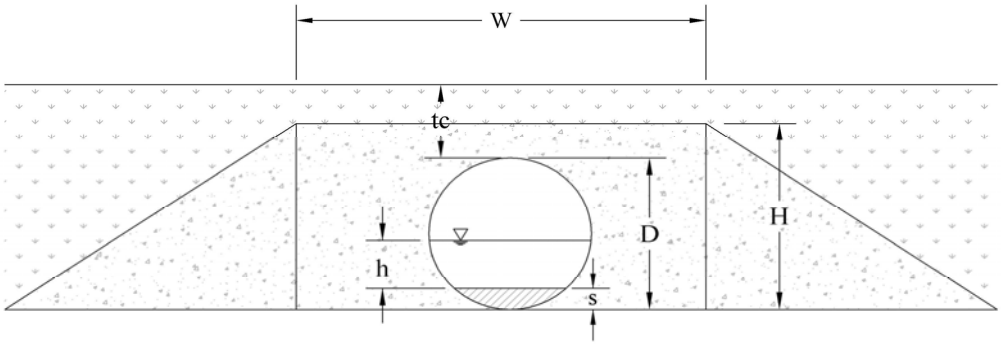


1Φ100

D	=	***1.00***	(m)
L	=	***13.20***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***1.08***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***176+200*** No.: ***Pc155*** Date: ***20-May-2013***





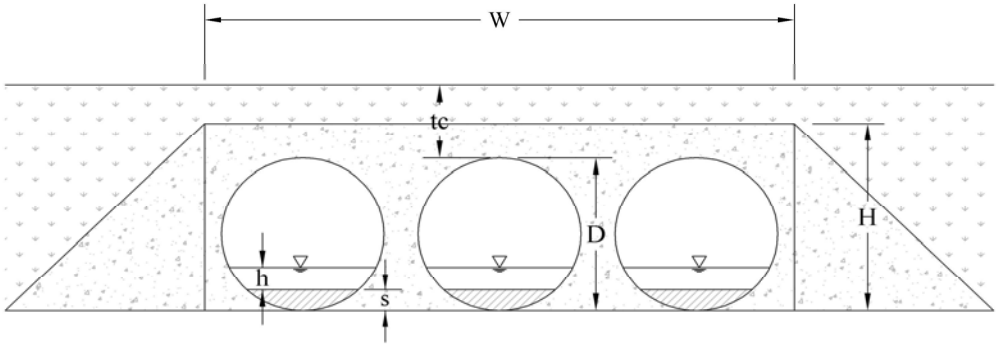
1Φ100

D	=	***1.00***	(m)
L	=	***13.40***	(m)
H	=	***1.40***	(m)
W	=	***1.30***	(m)
tc	=	***0.90***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***176+400*** No.: ***Pc156*** Date: ***20-May-2013***



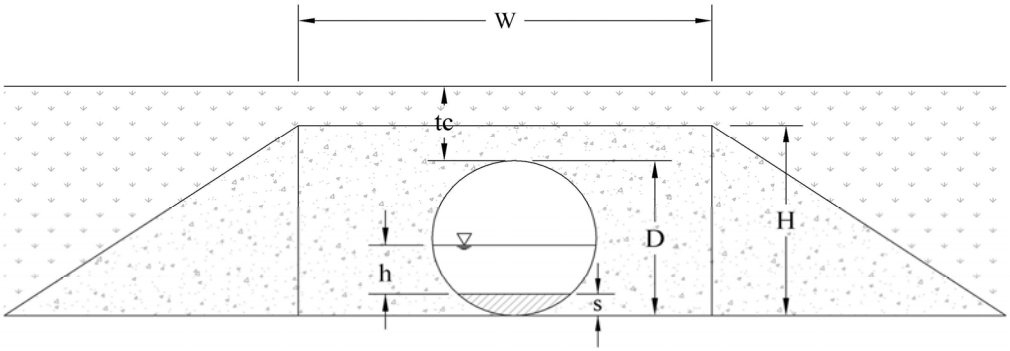


3Φ100

D	=	***1.00***	(m)
L	=	***15.50***	(m)
H	=	***1.40***	(m)
W	=	***4.70***	(m)
tc	=	***1.55***	(m)
h	=	***0.05***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***176+500*** No.: ***Pc157*** Date: ***20-May-2013***





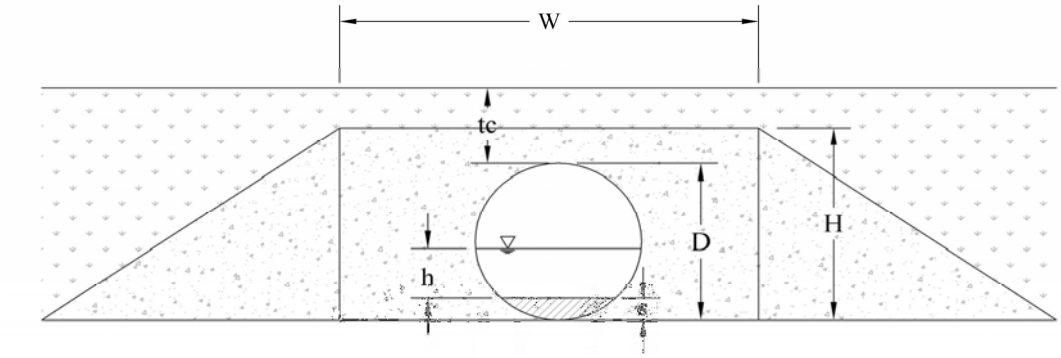
1Φ100

D	=	***1.00***	(m)
L	=	***14.80***	(m)
H	=	***1.35***	(m)
W	=	***1.30***	(m)
tc	=	***1.22***	(m)
h	=	***0.30***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***176+700*** No.: ***Pc158*** Date: ***20-May-2013***



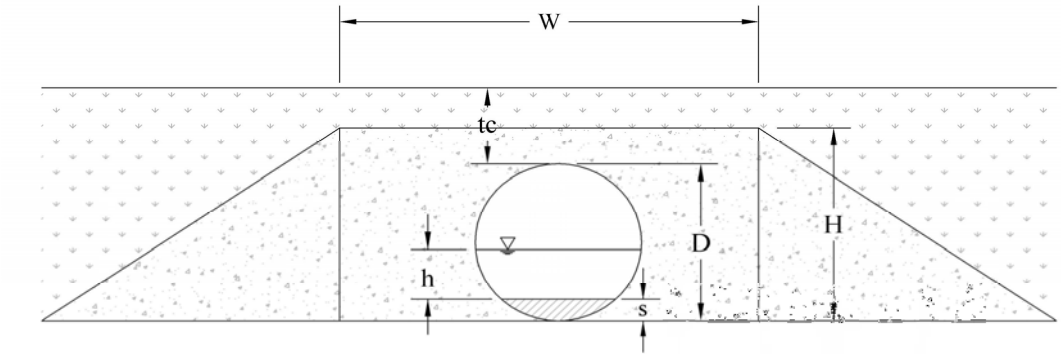


1Φ100

D	=	***1.00***	(m)
L	=	***14.50***	(m)
H	=	***1.10***	(m)
W	=	***0.95***	(m)
tc	=	***1.15***	(m)
h	=	***1.10***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***177+900*** No.: ***Pc159*** Date: ***20-May-2013***





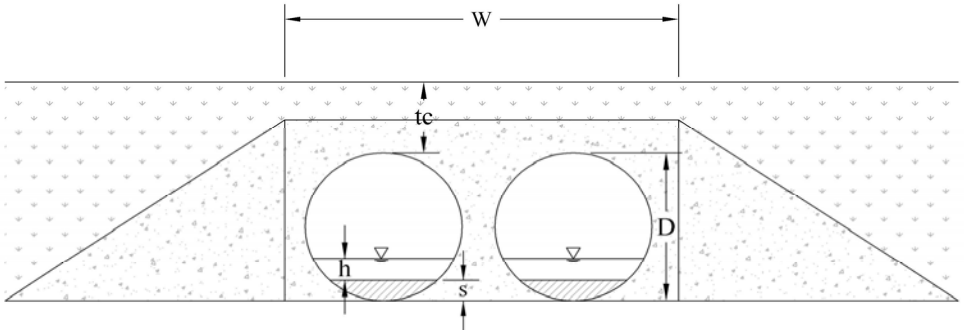
1Φ80

D	=	***0.80***	(m)
L	=	***14.50***	(m)
H	=	***1.00***	(m)
W	=	***1.00***	(m)
tc	=	***1.15***	(m)
h	=	***0.15***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***180+500*** No.: ***Pc160*** Date: ***20-May-2013***



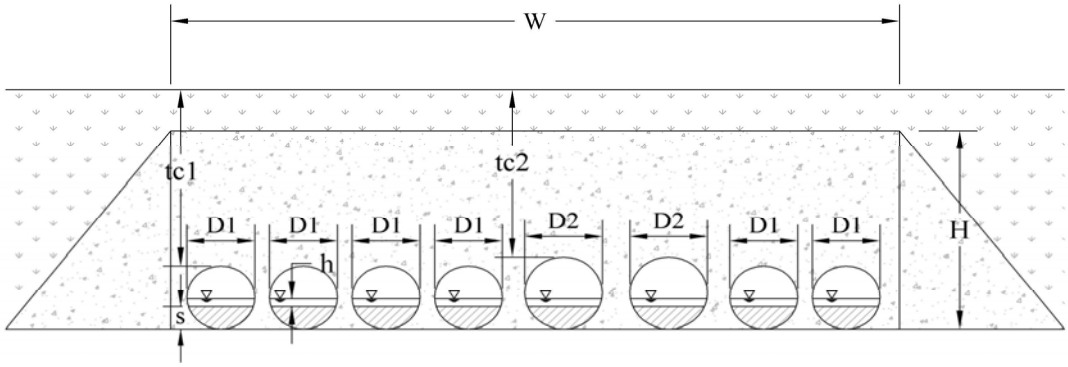


2Φ80

D	=	***0.80***	(m)
L	=	***N/A***	(m)
H	=	***N/A***	(m)
W	=	***N/A***	(m)
tc	=	***N/A***	(m)
h	=	***N/A***	(m)
s	=	***N/A***	(m)

Lake Side (Outlet)

KP: ***182+600*** No.: ***Pc161*** Date: ***20-May-2013***





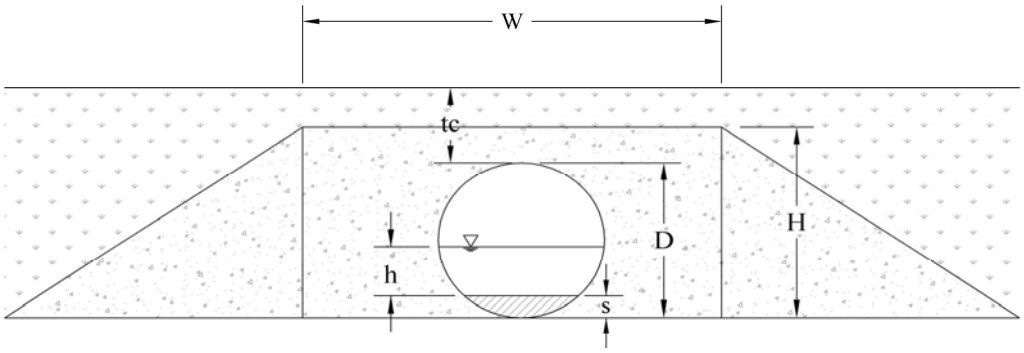
8Φ(6Φ80,2Φ100)

D_1	=	***0.80***	(m)
D_2	=	***1.00***	(m)
L	=	***13.70***	(m)
H	=	***2.45***	(m)
W	=	***10.50***	(m)
tc_1	=	***1.65***	(m)
tc_2	=	***1.45***	(m)
h	=	***0.15***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, $D/D_1/D_2$=Diameter, L=Total Length, H=Total Height, W=Width, $tc/tc_1/tc_2$=Height of Soil over Top, h=Water Depth, s=Deposition Height, N/A means data not available, River means the Tonle Sap River

KP: ***192+100*** No.: ***Pc162*** Date: ***21-May-2013***



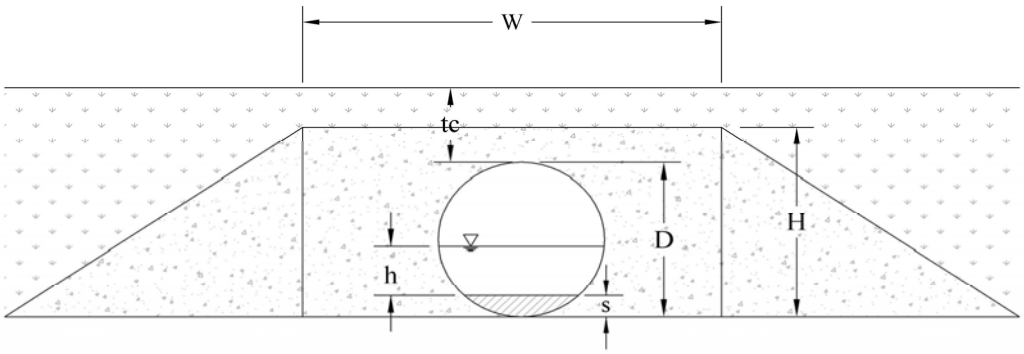


1Φ80

D	=	***0.80***	(m)
L	=	***13.50***	(m)
H	=	***1.10***	(m)
W	=	***0.95***	(m)
tc	=	***0.95***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***192+700*** No.: ***Pc163*** Date: ***21-May-2013***





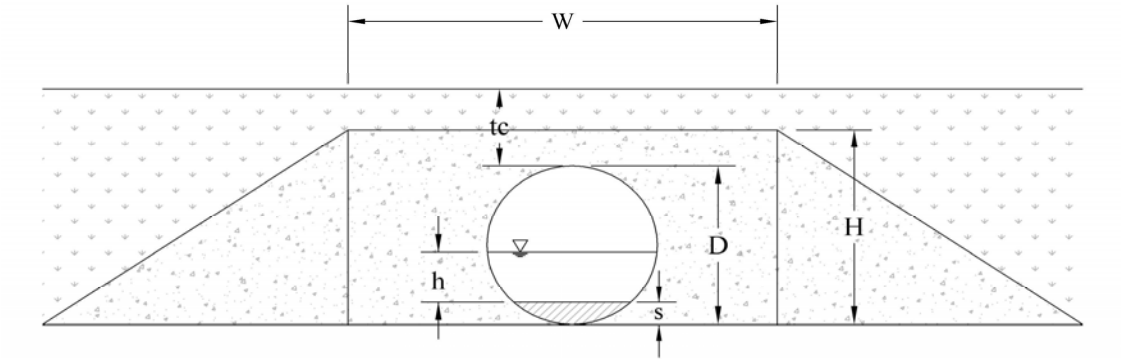
1Φ100

D	=	***1.00***	(m)
L	=	***17.30***	(m)
H	=	***1.60***	(m)
W	=	***1.50***	(m)
tc	=	***1.60***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

KP: ***193+600*** No.: ***Pc164*** Date: ***21-May-2013***



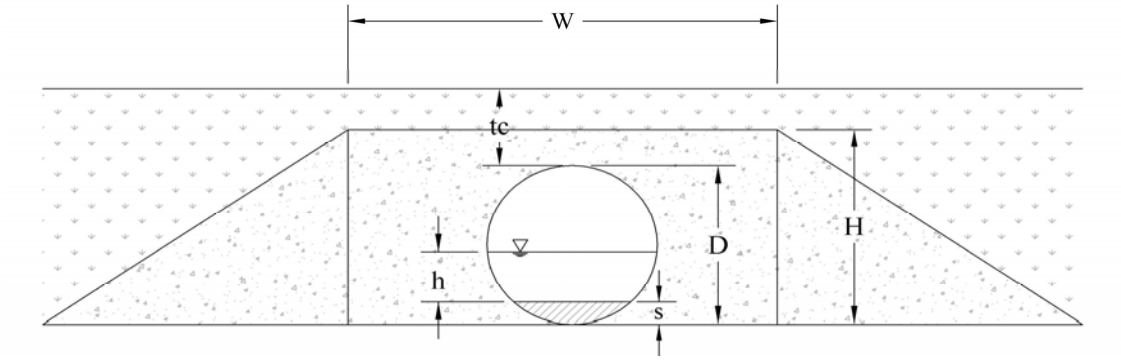


1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.30***	(m)
W	=	***1.25***	(m)
tc	=	***1.05***	(m)
h	=	***0.15***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***194+100*** No.: ***Pc165*** Date: ***21-May-2013***





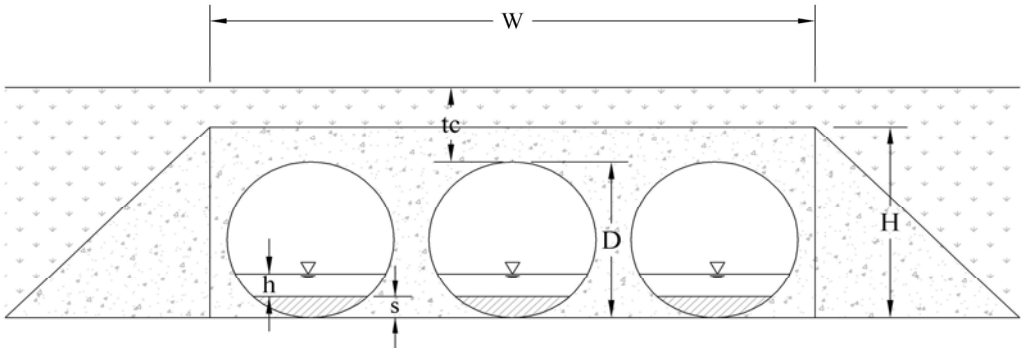
1Φ120

D	=	***1.20***	(m)
L	=	***16.00***	(m)
H	=	***1.60***	(m)
W	=	***1.50***	(m)
tc	=	***1.55***	(m)
h	=	***0.00***	(m)
s	=	***0.05***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***194+400*** No.: ***Pc166*** Date: ***21-May-2013***



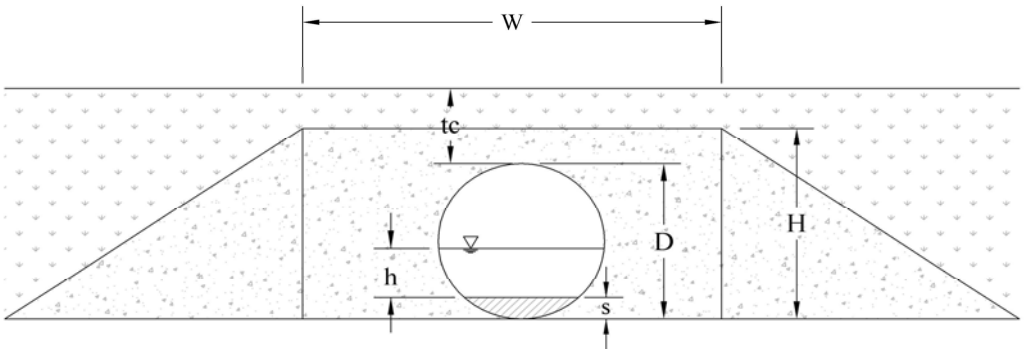


3Φ120

D	=	***1.20***	(m)
L	=	***14.80***	(m)
H	=	***1.60***	(m)
W	=	***5.25***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***197+300*** No.: ***Pc167*** Date: ***21-May-2013***





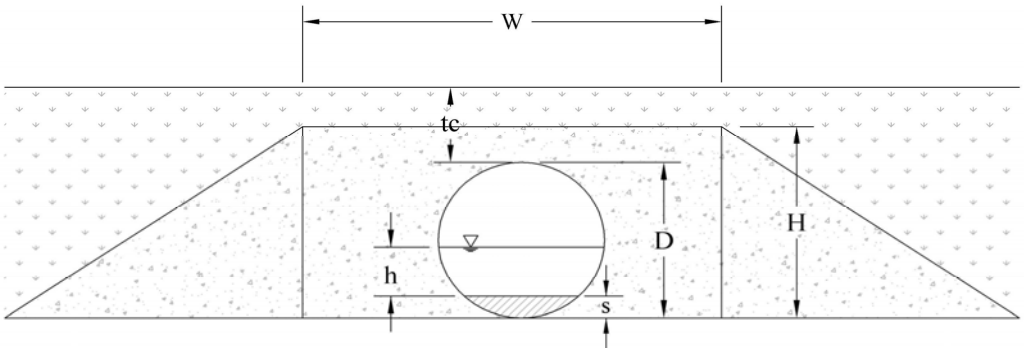
1Φ100

D	=	***1.00***	(m)
L	=	***13.50***	(m)
H	=	***1.35***	(m)
W	=	***1.25***	(m)
tc	=	***0.90***	(m)
h	=	***0.05***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***198+800*** No.: ***Pc168*** Date: ***21-May-2013***



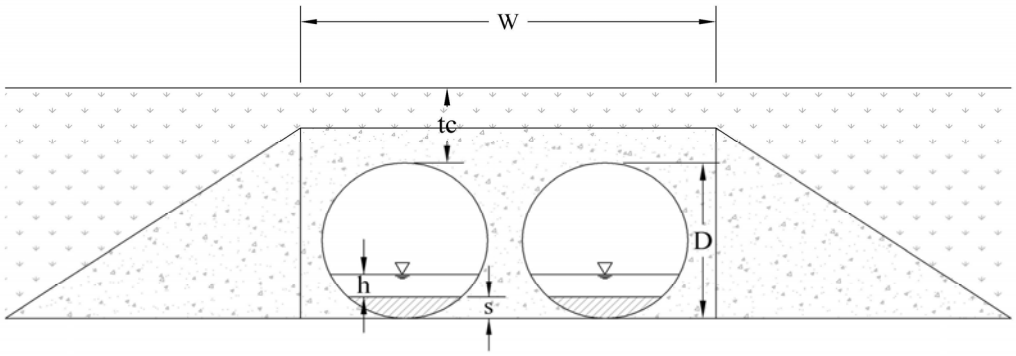


1Φ100

D	=	***1.00***	(m)
L	=	***13.40***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.65***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***200+300*** No.: ***Pc169*** Date: ***21-May-2013***





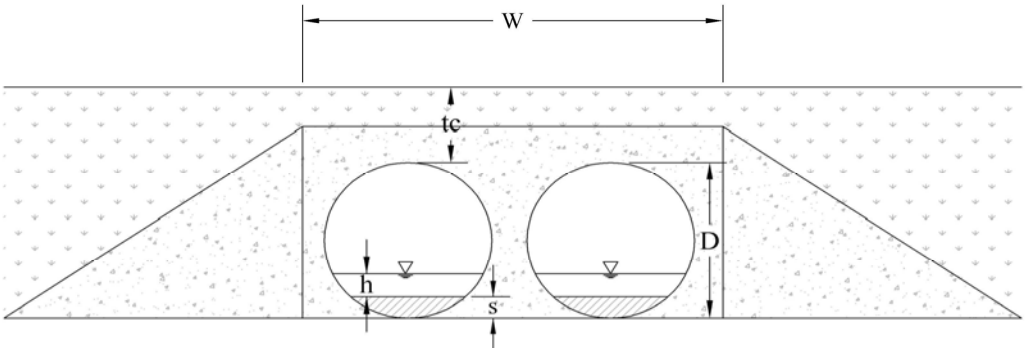
2Φ100

D	=	***1.00***	(m)
L	=	***13.50***	(m)
H	=	***1.35***	(m)
W	=	***3.00***	(m)
tc	=	***0.90***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***203+400*** No.: ***Pc170*** Date: ***21-May-2013***



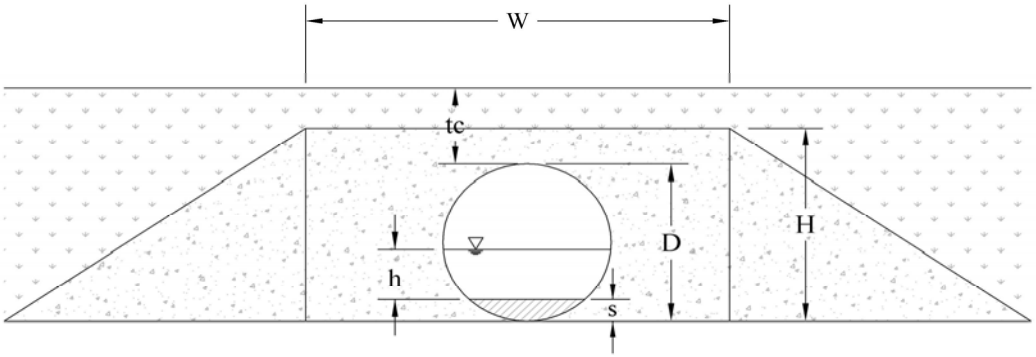


2Φ100

D	=	***1.00***	(m)
L	=	***13.70***	(m)
H	=	***1.35***	(m)
W	=	***3.00***	(m)
tc	=	***0.85***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

KP: ***204+000*** No.: ***Pc171*** Date: ***21-May-2013***





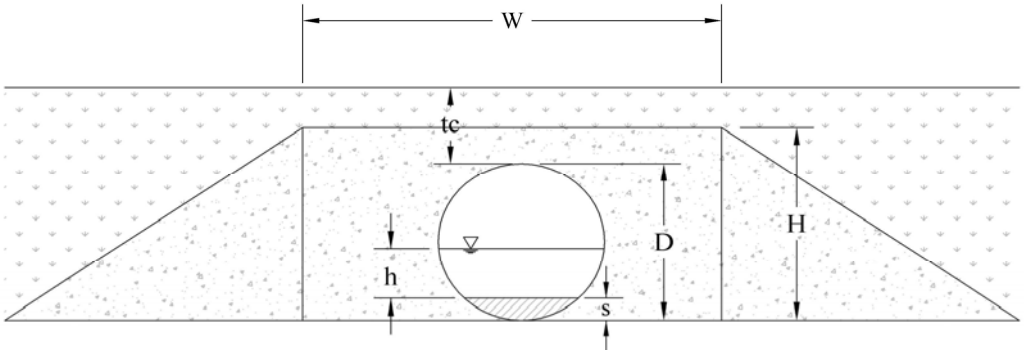
1Φ80

D	=	***0.80***	(m)
L	=	***13.50***	(m)
H	=	***1.15***	(m)
W	=	***1.05***	(m)
tc	=	***0.80***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***204+700*** No.: ***Pc172*** Date: ***21-May-2013***



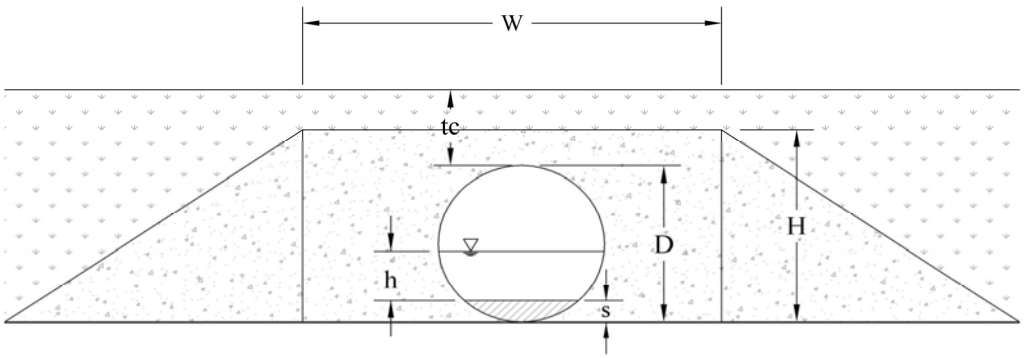


1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

KP: ***206+600*** No.: ***Pc173*** Date: ***21-May-2013***





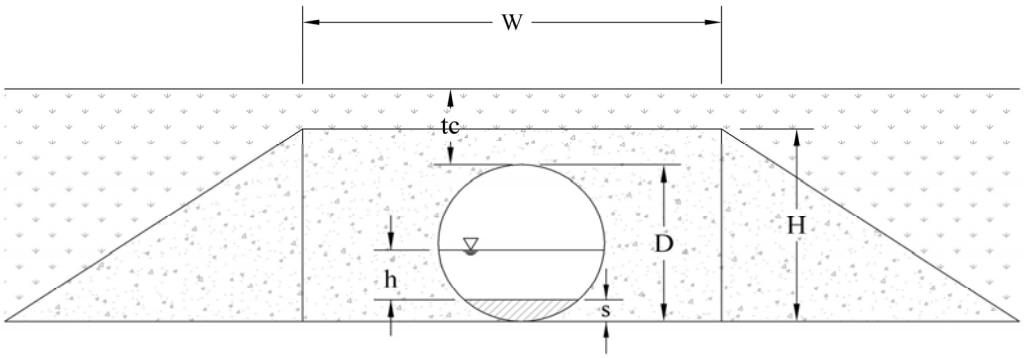
1Φ100

D	=	***1.00***	(m)
L	=	***14.80***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.98***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***206+300*** No.: ***Pc174*** Date: ***21-May-2013***



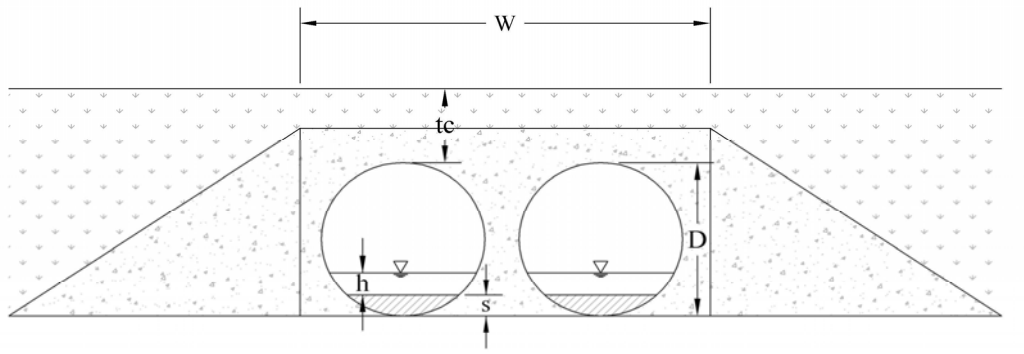


1Φ100

D	=	***1.00***	(m)
L	=	***14.70***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***1.10***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***207+200*** No.: ***Pc175*** Date: ***21-May-2013***





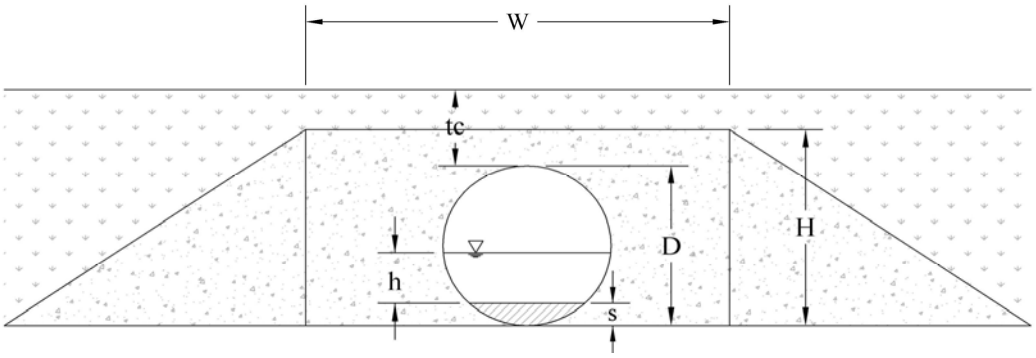
2Φ100

D	=	***1.00***	(m)
L	=	***16.10***	(m)
H	=	***1.35***	(m)
W	=	***3.00***	(m)
tc	=	***1.45***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, flood occurred among Pc032 ~ Pc035 from eastern mountain side (Tonle Sap River side)

KP: ***207+400*** No.: ***Pc176*** Date: ***21-May-2013***



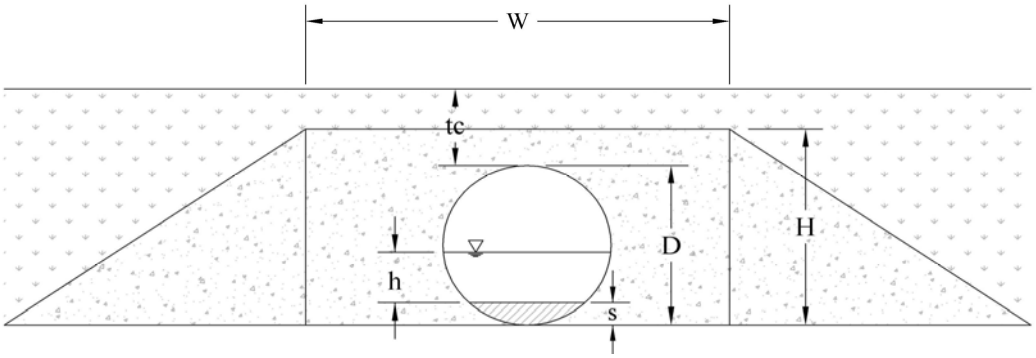


1Φ100

D	=	***1.00***	(m)
L	=	***16.00***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***1.68***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***210+300*** No.: ***Pc177*** Date: ***21-May-2013***





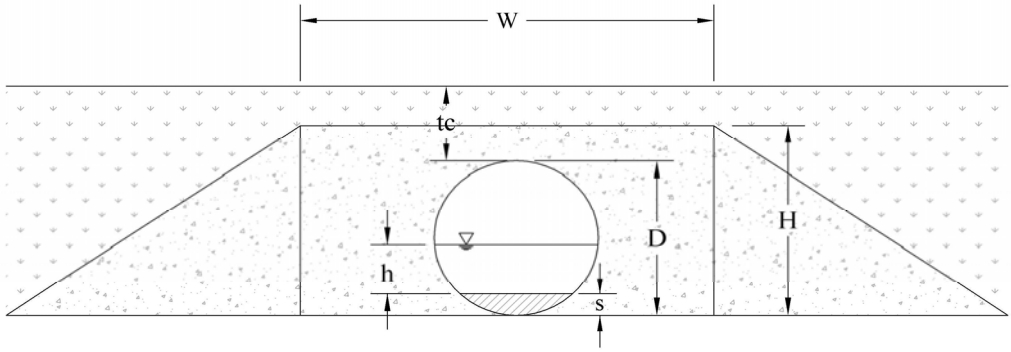
1Φ120

D	=	***1.20***	(m)
L	=	***14.90***	(m)
H	=	***1.60***	(m)
W	=	***1.40***	(m)
tc	=	***1.45***	(m)
h	=	***0.00***	(m)
s	=	***0.15***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, flood occurred among Pc032 ~ Pc035 from eastern mountain side (Tonle Sap River side)

KP: ***211+100*** No.: ***Pc178*** Date: ***21-May-2013***



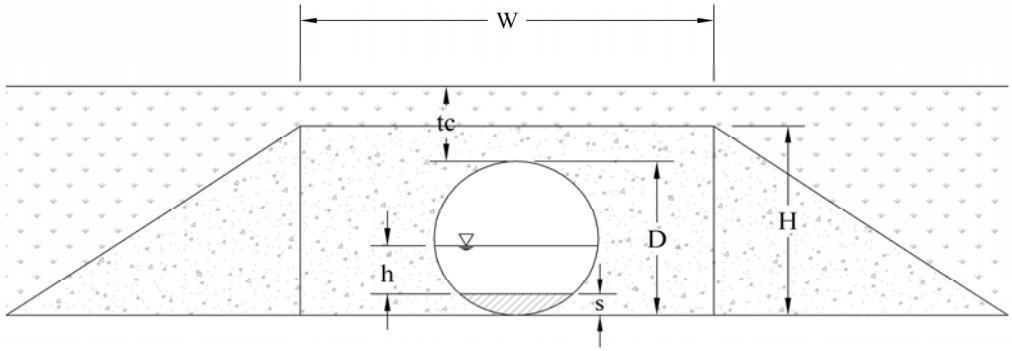


1Φ100

D	=	***1.00***	(m)
L	=	***13.50***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.90***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

KP: ***211+400*** No.: ***Pc179*** Date: ***21-May-2013***





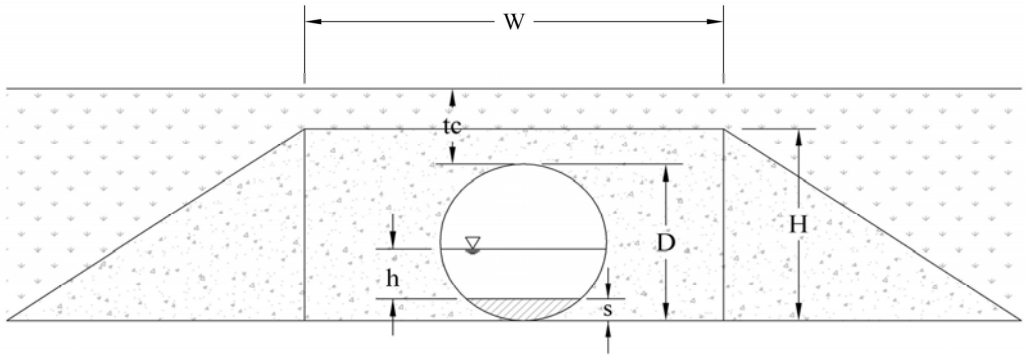
1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.95***	(m)
h	=	***0.00***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

KP: ***211+500*** No.: ***Pc180*** Date: ***21-May-2013***



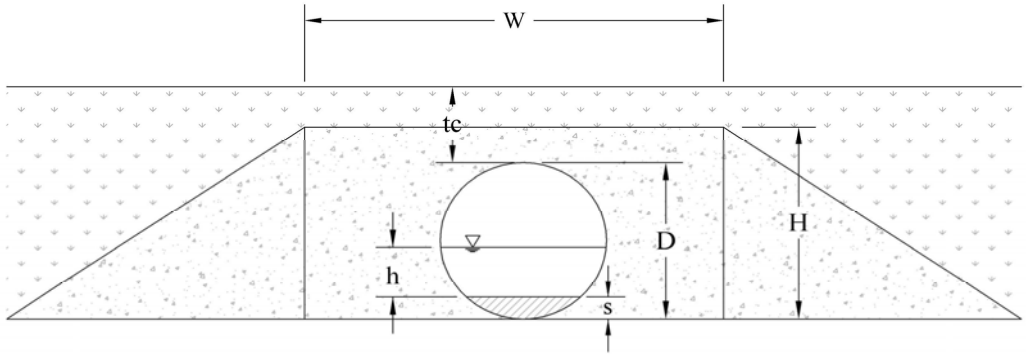


1Φ80

D	=	***0.80***	(m)
L	=	***13.60***	(m)
H	=	***1.10***	(m)
W	=	***1.05***	(m)
tc	=	***0.65***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

KP: ***212+800*** No.: ***Pc181*** Date: ***22-May-2013***





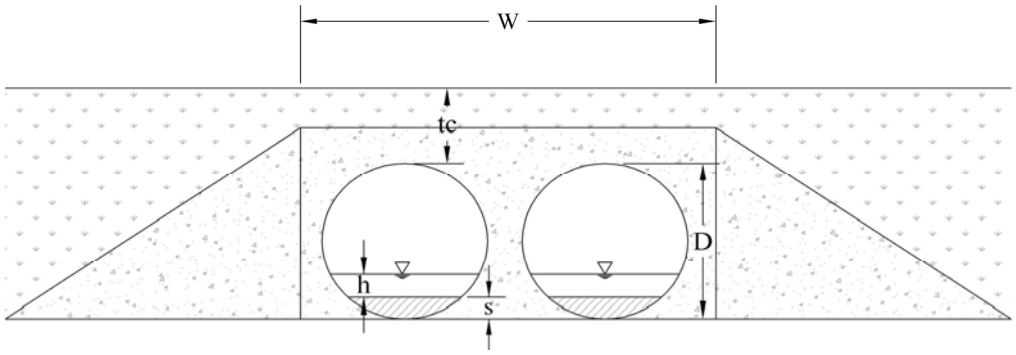
1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.35***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***213+200*** No.: ***Pc182*** Date: ***22-May-2013***



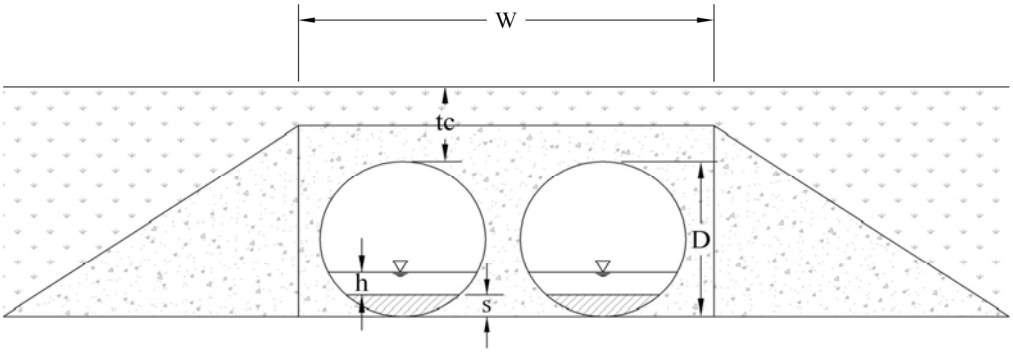


2Φ100

D	=	***1.00***	(m)
L	=	***14.80***	(m)
H	=	***1.15***	(m)
W	=	***2.50***	(m)
tc	=	***0.43***	(m)
h	=	***0.00***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

KP: ***213+500*** No.: ***Pc183*** Date: ***22-May-2013***





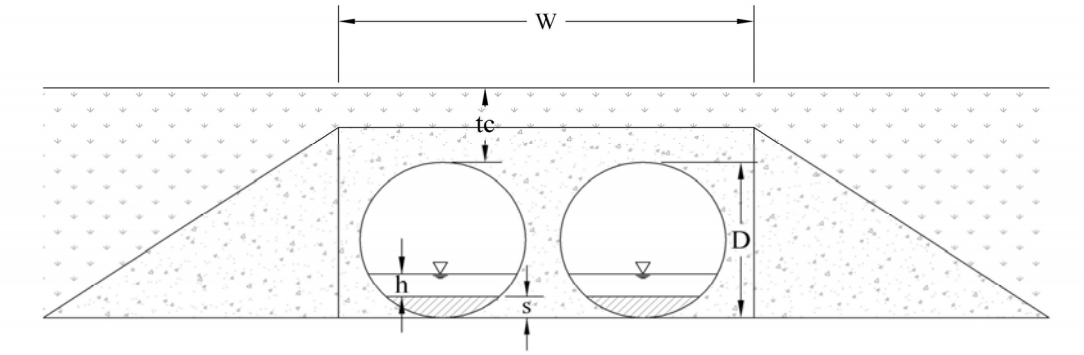
2Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***3.20***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***213+600*** No.: ***Pc184*** Date: ***22-May-2013***



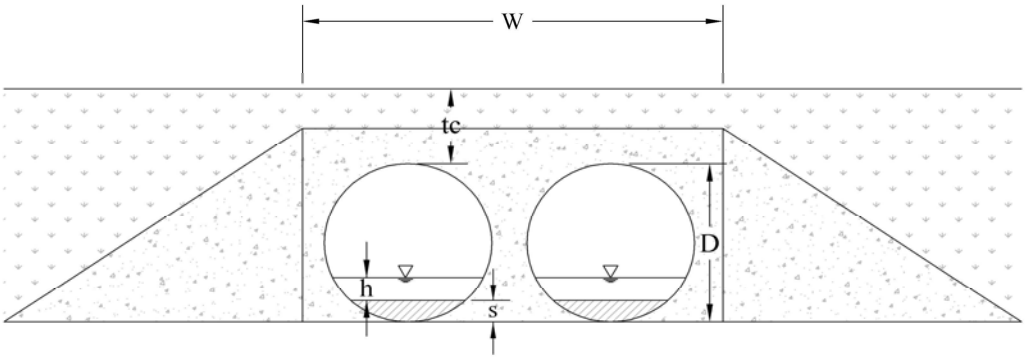


2Φ80

D	=	***0.80***	(m)
L	=	***13.50***	(m)
H	=	***1.15***	(m)
W	=	***2.60***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

KP: ***214+500*** No.: ***Pc185*** Date: ***22-May-2013***





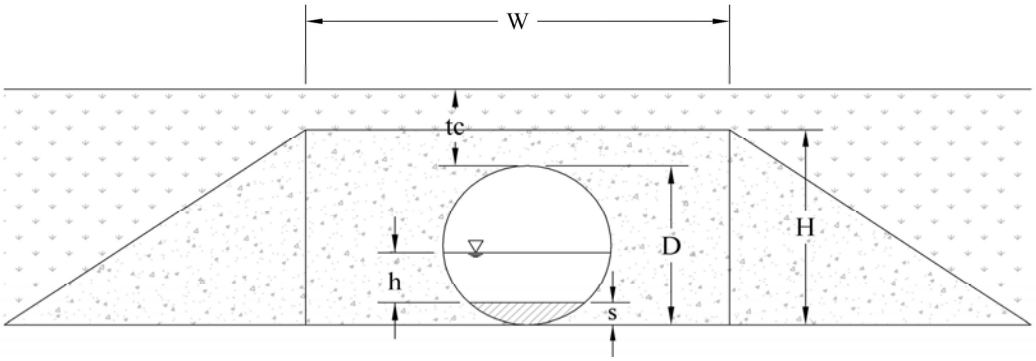
2Φ100

D	=	***1.00***	(m)
L	=	***16.10***	(m)
H	=	***1.40***	(m)
W	=	***3.10***	(m)
tc	=	***1.15***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***214+900*** No.: ***Pc186*** Date: ***22-May-2013***



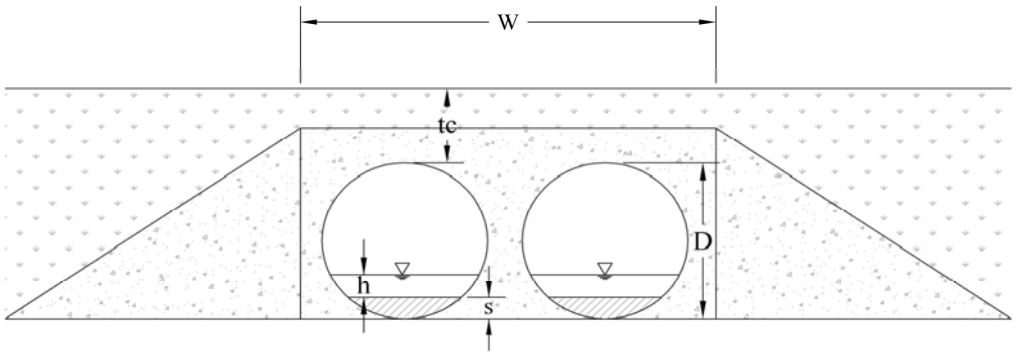


1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***1.15***	(m)
tc	=	***0.75***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***216+800*** No.: ***Pc187*** Date: ***22-May-2013***





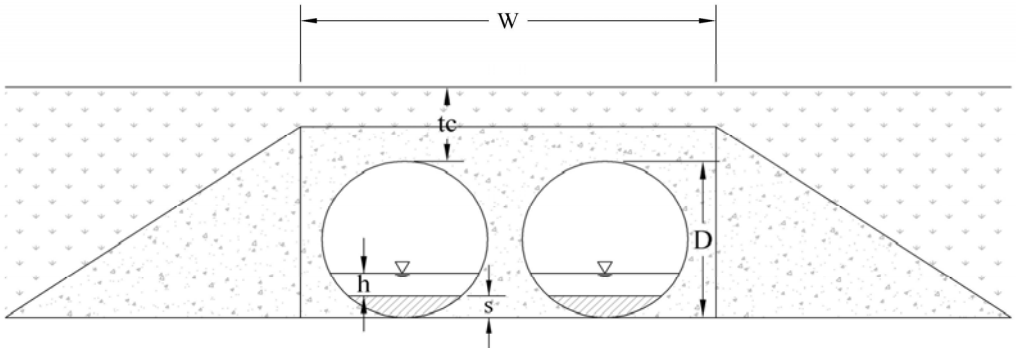
2Φ100

D	=	***1.00***	m
L	=	***15.90***	(m)
H	=	***1.35***	(m)
W	=	***3.10***	(m)
tc	=	***1.45***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***217+800*** No.: ***Pc188*** Date: ***22-May-2013***



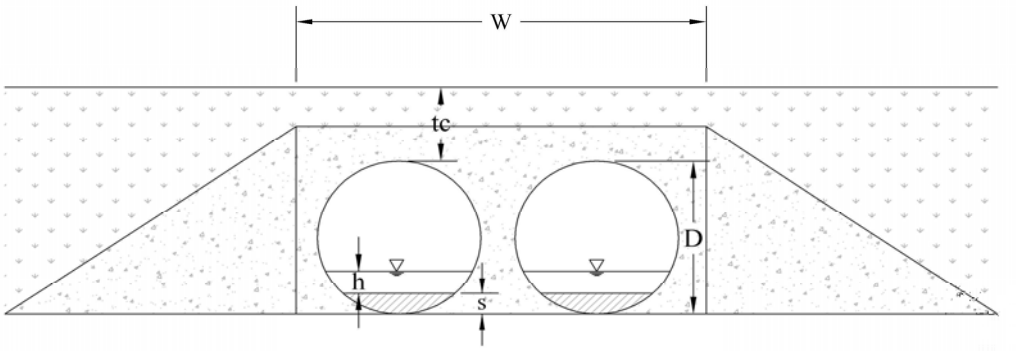


2Φ100

D	=	***1.00***	(m)
L	=	***14.90***	(m)
H	=	***1.35***	(m)
W	=	***3.10***	(m)
tc	=	***1.05***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***218+300*** No.: ***Pc189*** Date: ***22-May-2013***





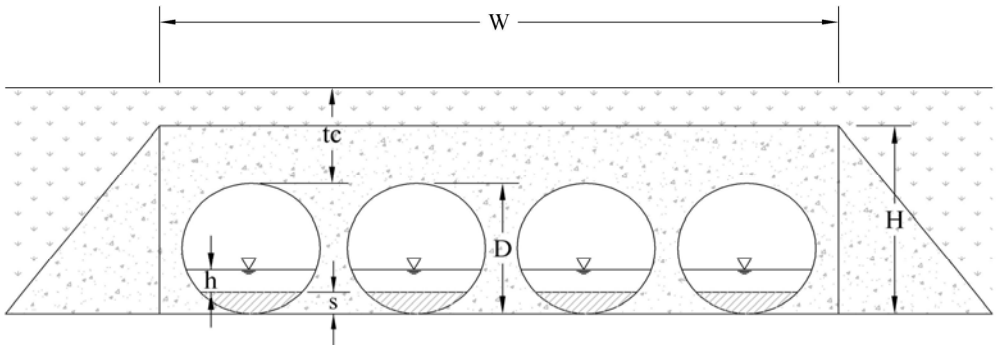
2Φ100

D	=	***1.00***	(m)
L	=	***16.00***	(m)
H	=	***1.35***	(m)
W	=	***3.10***	(m)
tc	=	***1.35***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***224+700*** No.: ***Pc190*** Date: ***22-May-2013***



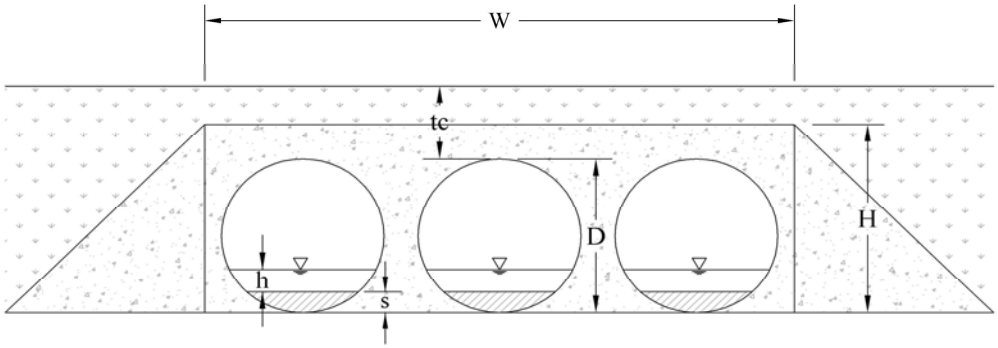


4Φ100

D	=	***1.00***	(m)
L	=	***11.10***	(m)
H	=	***1.85***	(m)
W	=	***5.30***	(m)
tc	=	***1.20***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***226+700*** No.: ***Pc191*** Date: ***22-May-2013***





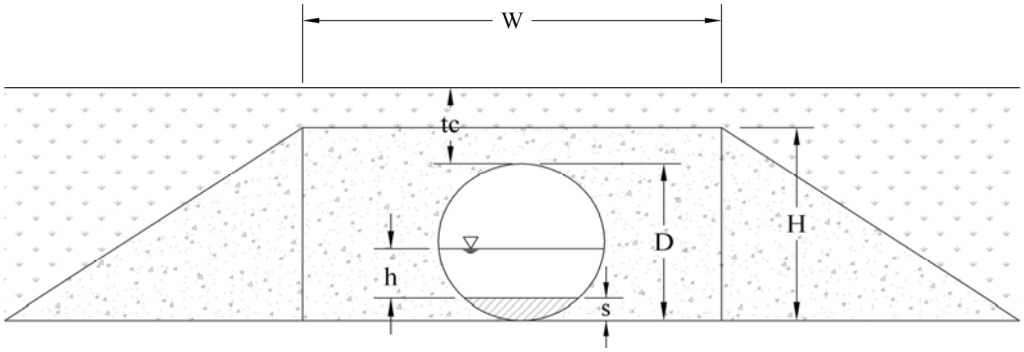
3Φ100

D	=	***1.00***	(m)
L	=	***10.90***	(m)
H	=	***1.85***	(m)
W	=	***4.20***	(m)
tc	=	***1.22***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***227+700*** No.: ***Pc192*** Date: ***22-May-2013***



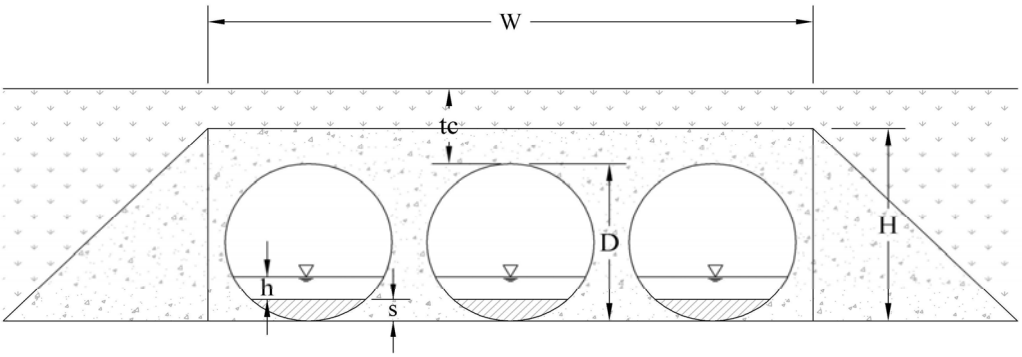


1Φ100

D	=	***1.00***	(m)
L	=	***N/A***	(m)
H	=	***N/A***	(m)
W	=	***N/A***	(m)
tc	=	***N/A***	(m)
h	=	***N/A***	(m)
s	=	***N/A***	(m)

Lake Side (Outlet)

KP: ***228+000*** No.: ***Pc193*** Date: ***22-May-2013***





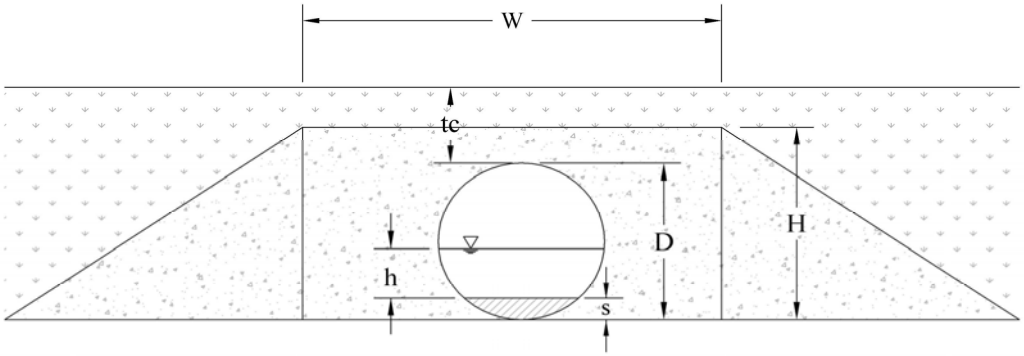
3Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.60***	(m)
W	=	***5.20***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, N/A means data not available, River means the Tonle Sap River

KP: ***228+600*** No.: ***Pc194*** Date: ***22-May-2013***



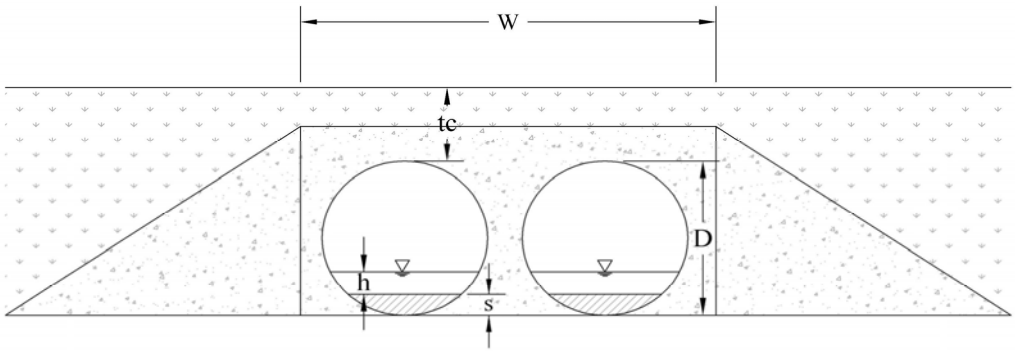


1Φ100

D	=	***1.00***	(m)
L	=	***11.70***	(m)
H	=	***1.55***	(m)
W	=	***1.15***	(m)
tc	=	***1.03***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***230+700*** No.: ***Pc195*** Date: ***22-May-2013***





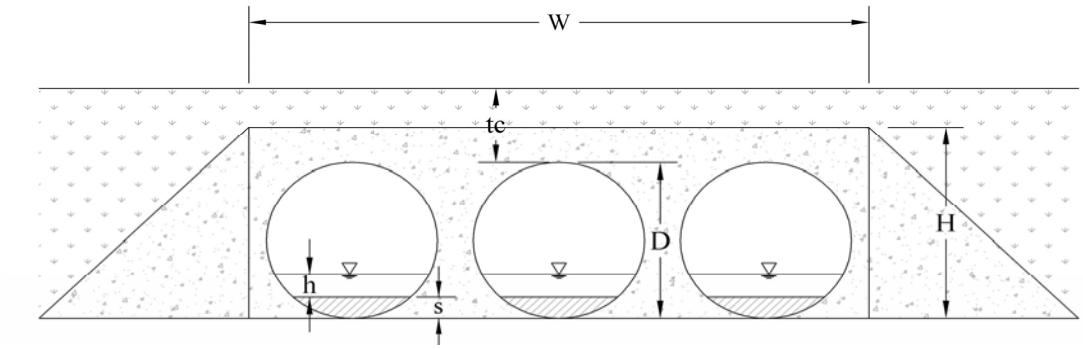
1Φ100

D	=	***1.00***	(m)
L	=	***9.90***	(m)
H	=	***1.70***	(m)
W	=	***2.75***	(m)
tc	=	***1.20***	(m)
h	=	***0.00***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***231+700*** No.: ***Pc196*** Date: ***22-May-2013***



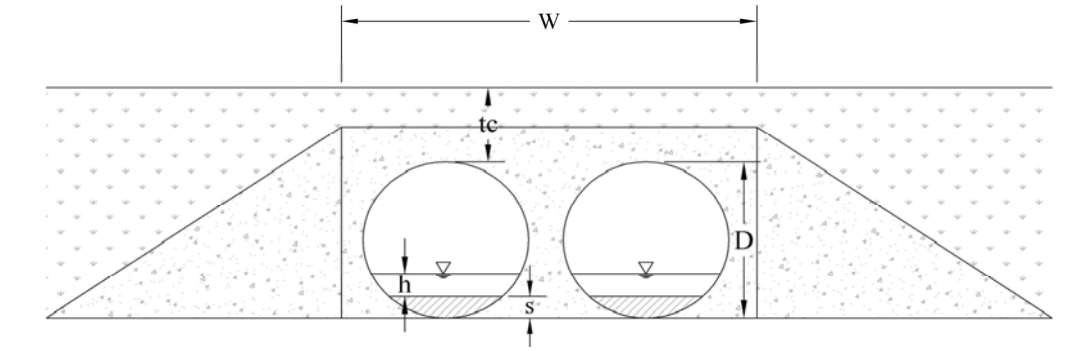


3Φ100

D	=	***1.00***	(m)
L	=	***10.90***	(m)
H	=	***1.75***	(m)
W	=	***4.00***	(m)
tc	=	***1.40***	(m)
h	=	***0.00***	(m)
s	=	***0.25***	(m)

Lake Side (Outlet)

KP: ***232+200*** No.: ***Pc197*** Date: ***22-May-2013***





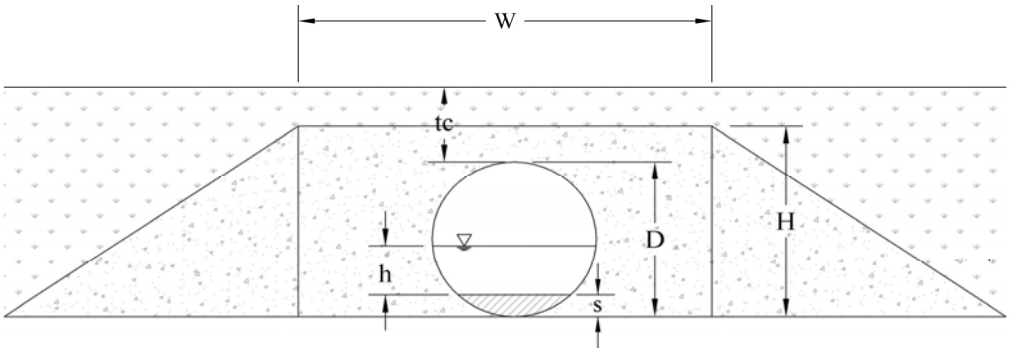
2Φ100

D	=	***1.00***	(m)
L	=	***11.20***	(m)
H	=	***1.70***	(m)
W	=	***2.45***	(m)
tc	=	***1.25***	(m)
h	=	***0.00***	(m)
s	=	***0.60***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***239+200*** No.: ***Pc198*** Date: ***23-May-2013***



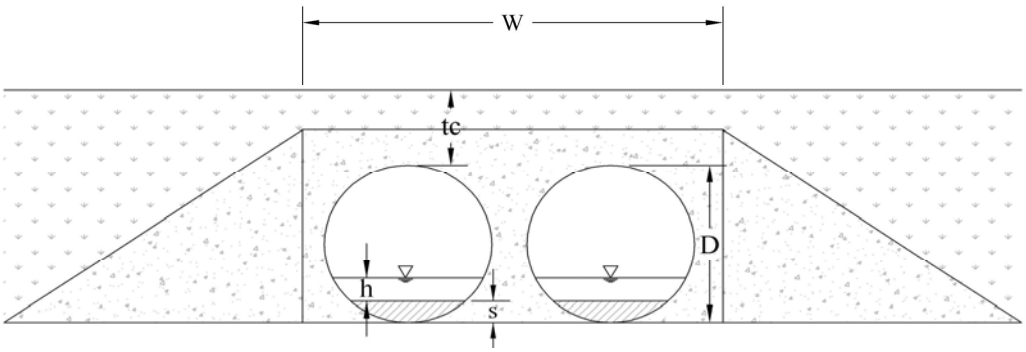


1Φ100

D	=	***1.00***	(m)
L	=	***16.00***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***1.20***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

KP: ***250+100*** No.: ***Pc199*** Date: ***23-May-2013***





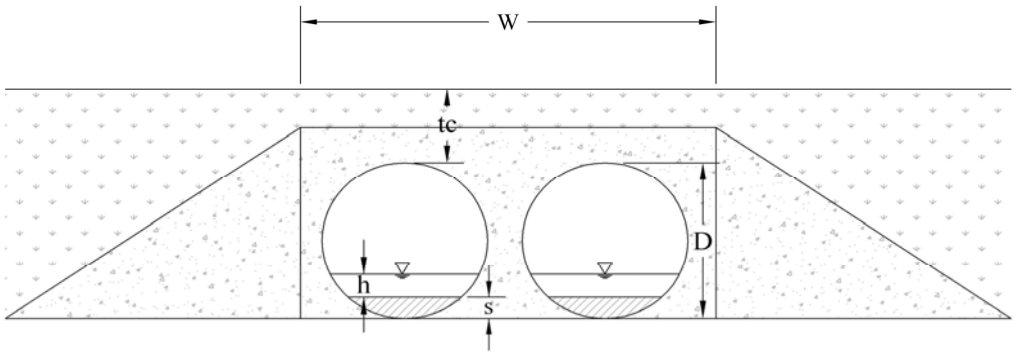
2Φ120

D	=	***1.20***	(m)
L	=	***13.80***	(m)
H	=	***1.55***	(m)
W	=	***3.30***	(m)
tc	=	***0.93***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***253+100*** No.: ***Pc200*** Date: ***23-May-2013***



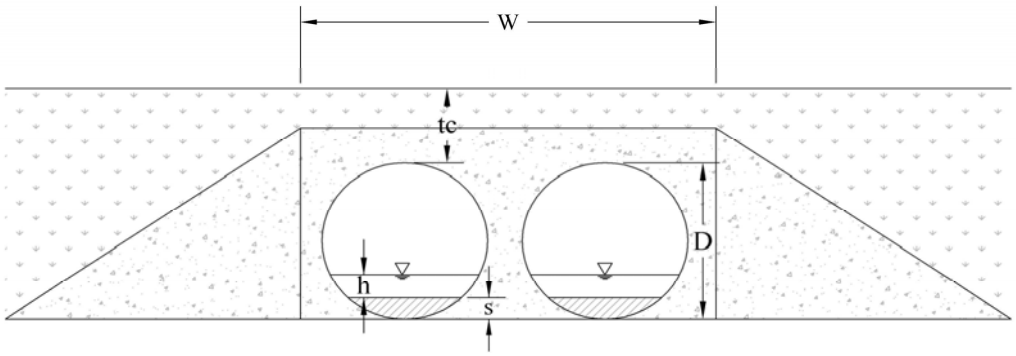


2Φ120

D	=	***1.20***	(m)
L	=	***16.10***	(m)
H	=	***1.55***	(m)
W	=	***3.30***	(m)
tc	=	***1.25***	(m)
h	=	***0.10***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***253+600*** No.: ***Pc201*** Date: ***23-May-2013***





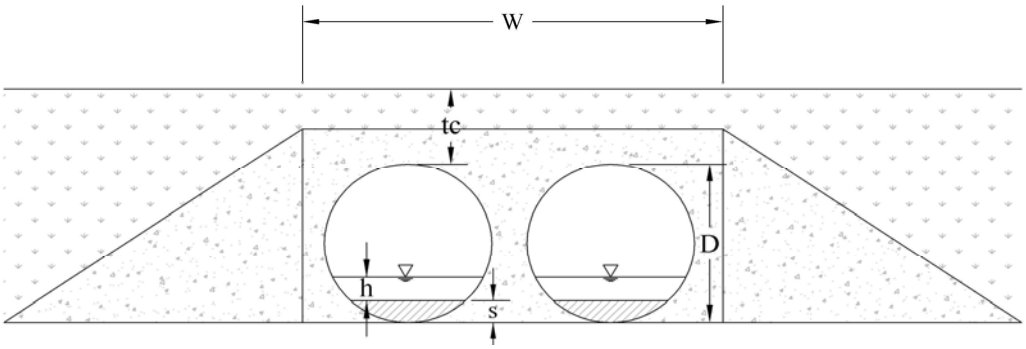
2Φ120

D	=	***1.20***	(m)
L	=	***15.30***	(m)
H	=	***1.55***	(m)
W	=	***3.00***	(m)
tc	=	***1.55***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***257+000*** No.: ***Pc202*** Date: ***23-May-2013***



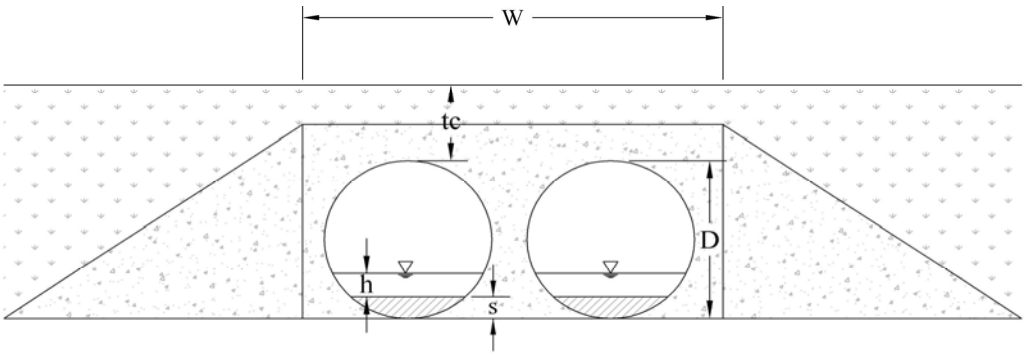


2Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***3.00***	(m)
tc	=	***0.95***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***260+800*** No.: ***Pc203*** Date: ***23-May-2013***





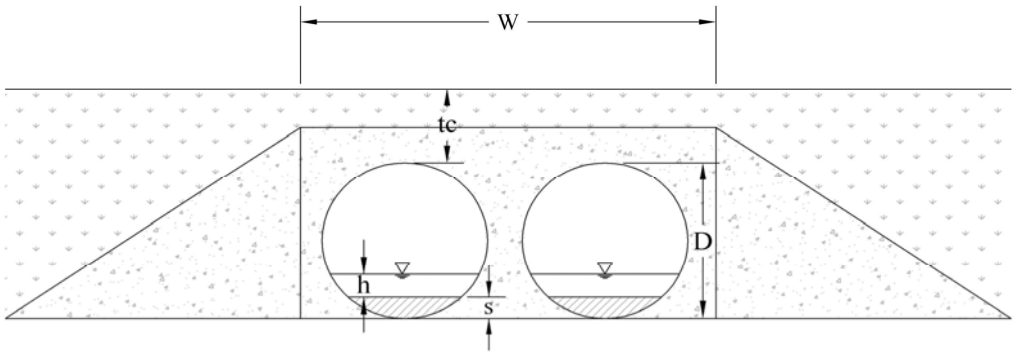
2Φ100

D	=	***1.00***	(m)
L	=	***16.00***	(m)
H	=	***1.35***	(m)
W	=	***2.00***	(m)
tc	=	***1.00***	(m)
h	=	***0.00***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***268+500*** No.: ***Pc204*** Date: ***24-May-2013***



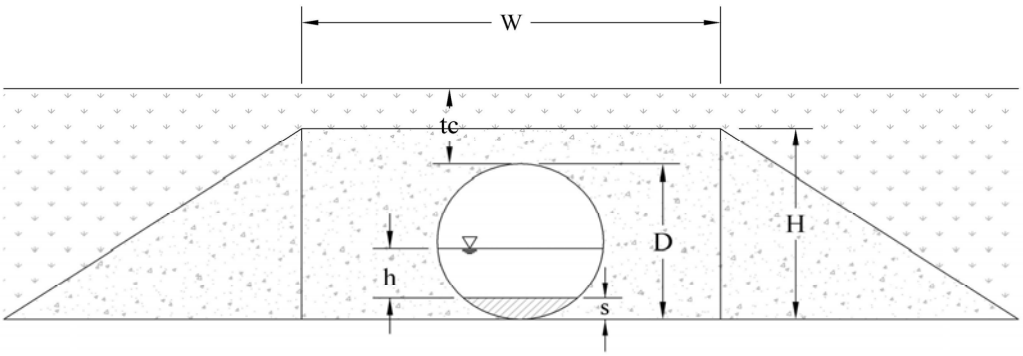


2Φ100

D	=	***1.00***	(m)
L	=	***17.20***	(m)
H	=	***1.35***	(m)
W	=	***2.80***	(m)
tc	=	***1.20***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP.: ***269+600*** No.: ***Pc205*** Date: ***24-May-2013***





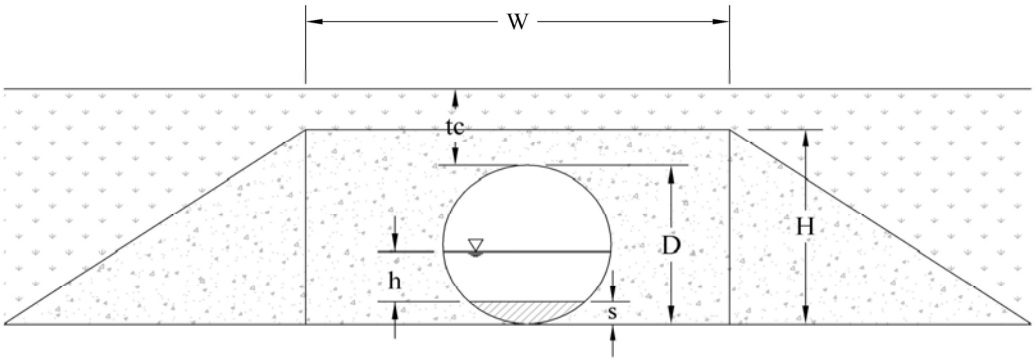
1Φ100

D	=	***1.00***	(m)
L	=	***18.30***	(m)
H	=	***1.40***	(m)
W	=	***1.30***	(m)
tc	=	***1.85***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP.: ***272+200*** No.: ***Pc206*** Date: ***24-May-2013***



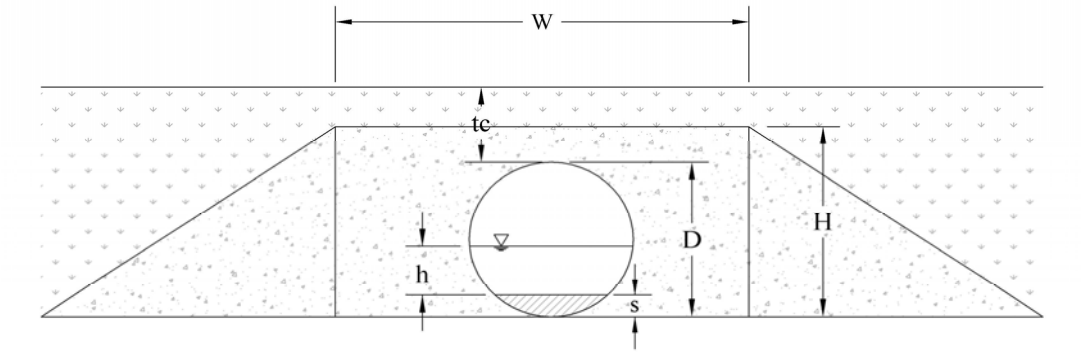


1Φ100

D	=	***1.00***	(m)
L	=	***16.10***	(m)
H	=	***1.55***	(m)
W	=	***1.40***	(m)
tc	=	***0.89***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***275+000*** NO.: ***Pc207*** Date: ***26-May-2013***





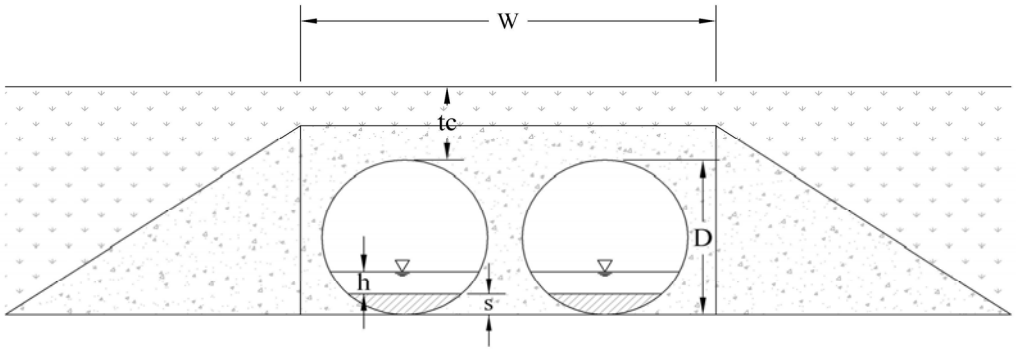
1Φ80

D	=	***0.80***	(m)
L	=	***14.60***	(m)
H	=	***1.10***	(m)
W	=	***2.20***	(m)
tc	=	***0.30***	(m)
h	=	***0.07***	(m)
s	=	***0.01***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***278+000*** NO.: ***Pc208*** Date: ***26-May-2013***



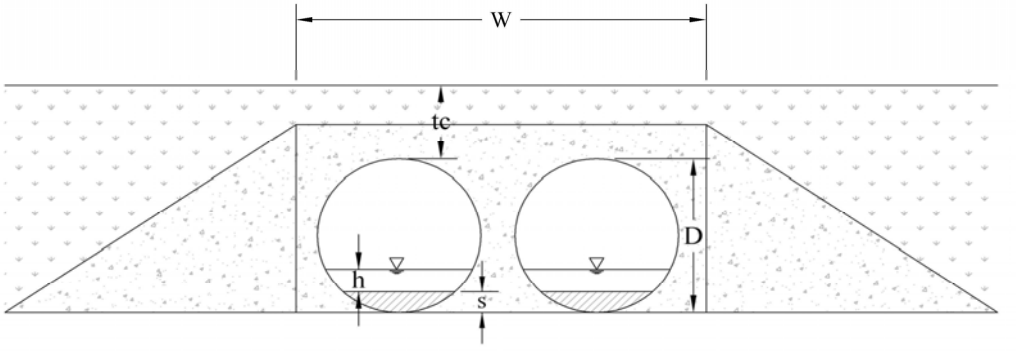


2Φ120

D	=	***1.20***	(m)
L	=	***14.50***	(m)
H	=	***1.60***	(m)
W	=	***3.30***	(m)
tc	=	***0.72***	(m)
h	=	***0.00***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

KP: ***279+200*** No.: ***Pc209*** Date: ***26-May-2013***





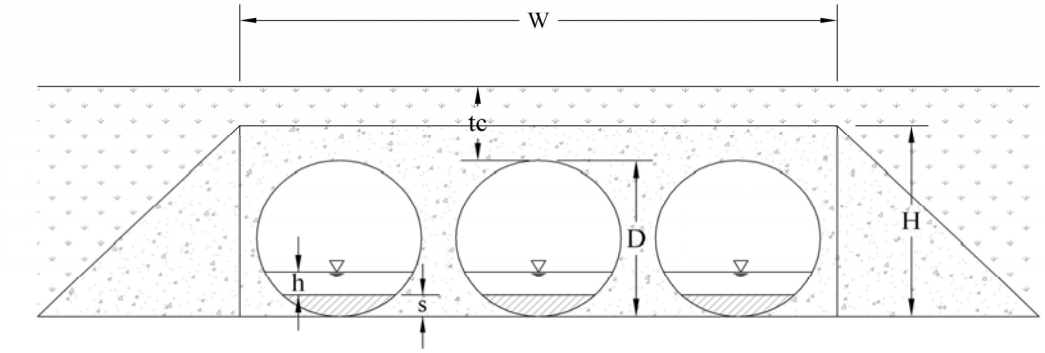
2Φ120

D	=	***1.20***	(m)
L	=	***13.80***	(m)
H	=	***1.60***	(m)
W	=	***3.85***	(m)
tc	=	***0.70***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***282+300*** No.: ***Pc210*** Date: ***27-May-2013***



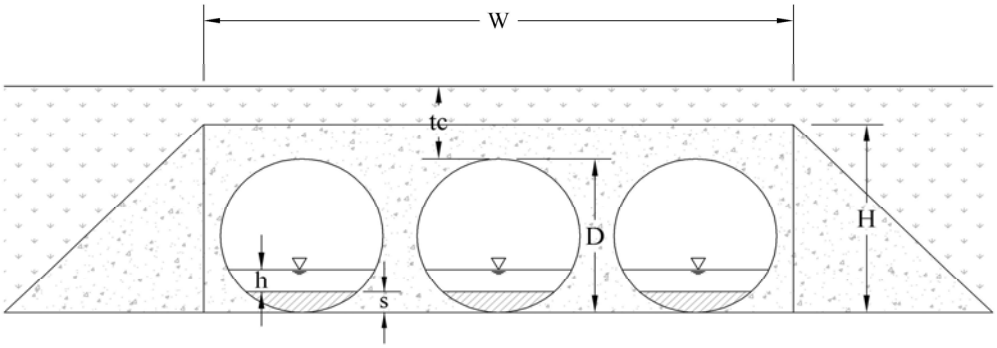


3Φ120

D	=	***1.20***	(m)
L	=	***13.70***	(m)
H	=	***1.20***	(m)
W	=	***3.75***	(m)
tc	=	***0.74***	(m)
h	=	***0.00***	(m)
s	=	***0.15***	(m)

Lake Side (Outlet)

KP: ***283+100*** No.: ***Pc211*** Date: ***27-May-2013***





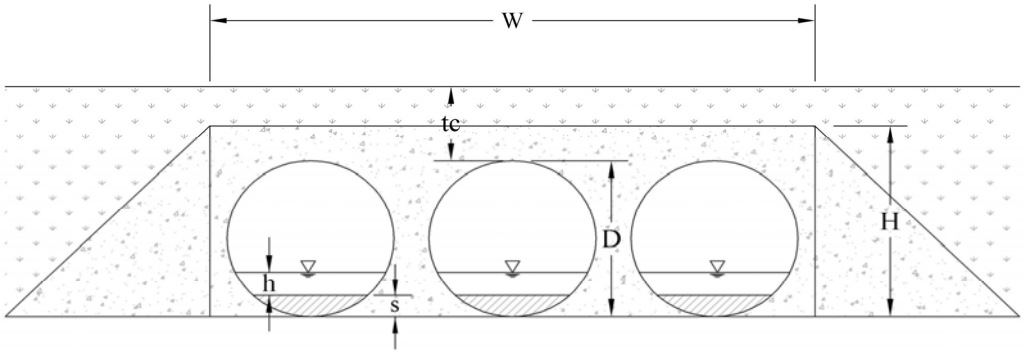
3Φ120

D	=	***1.20***	(m)
L	=	***13.80***	(m)
H	=	***1.60***	(m)
W	=	***5.35***	(m)
tc	=	***0.88***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***284+300*** No.: ***Pc212*** Date: ***27-May-2013***



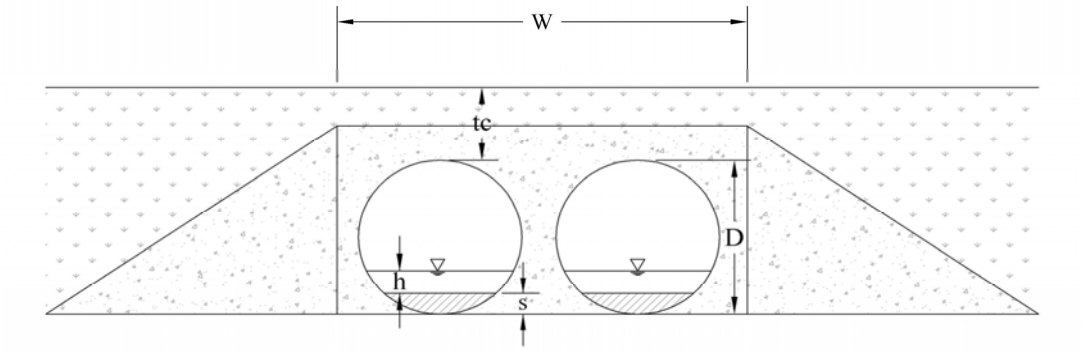


3Φ120

D	=	***1.20***	(m)
L	=	***12.50***	(m)
H	=	***1.60***	(m)
W	=	***5.25***	(m)
tc	=	***0.80***	(m)
h	=	***0.10***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***285+600*** No.: ***Pc213*** Date: ***27-May-2013***





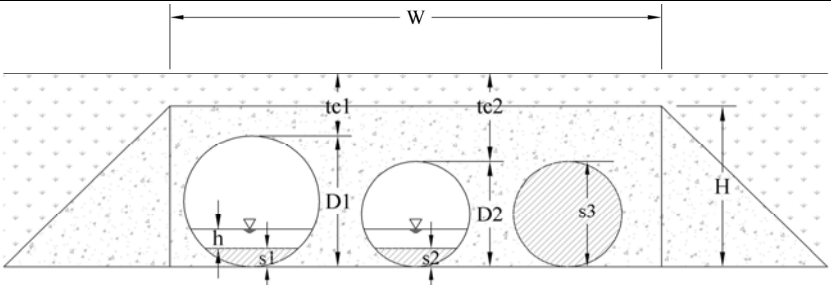
2Φ120

D	=	***1.20***	(m)
L	=	***14.50***	(m)
H	=	***1.60***	(m)
W	=	***3.00***	(m)
tc	=	***1.00***	(m)
h	=	***1.60***	(m)
s	=	***0.20***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***286+400*** No.: ***Pc214*** Date: ***27-May-2013***



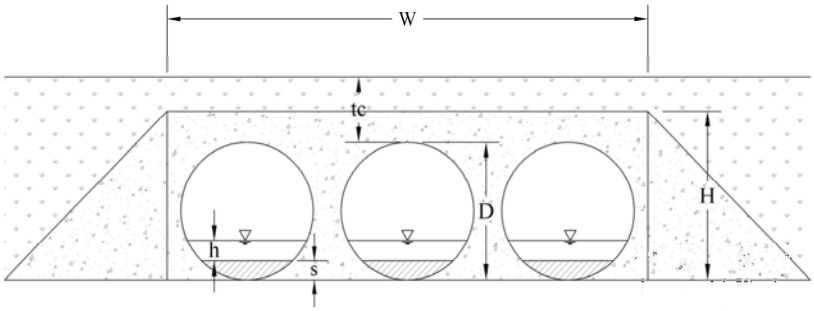


3Φ150

D_1	=	***1.50***	(m)
D_2	=	***1.20***	(m)
L	=	***24.30***	(m)
H	=	***1.80***	(m)
W	=	***5.65***	(m)
tc_1	=	***2.50***	(m)
tc_2	=	***2.80***	(m)
h	=	***0.00***	(m)
s_1	=	***0.00***	(m)
s_2	=	***0.50***	(m)
s_3	=	***1.20***	(m)

Lake Side (Outlet)

KP: ***288+000*** No.: ***Pc215*** Date: ***27-May-2013***





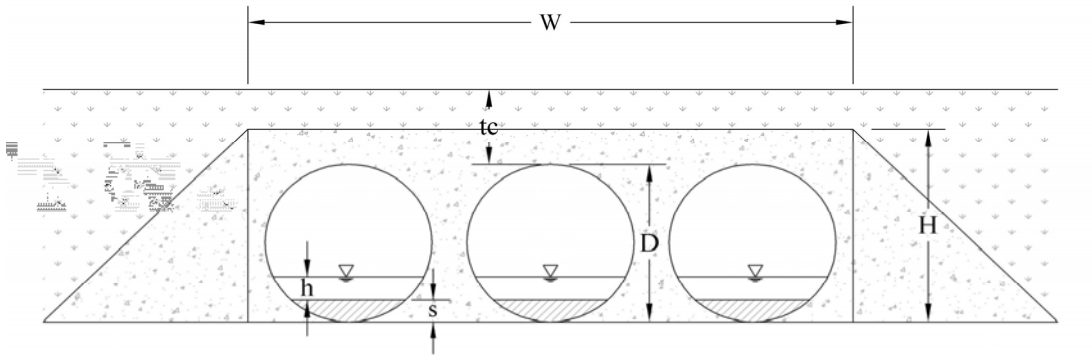
3Φ100

D	=	***1.00***	(m)
L	=	***32.80***	(m)
H	=	***1.30***	(m)
W	=	***3.50***	(m)
tc	=	***0.60***	(m)
h	=	***0.85***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, $D/D_1/D_2$=Diameter, L=Total Length, H=Total Height, W=Width, tc/ tc_1/tc_2=Height of Soil over Top, h=Water Depth, $s/s_1/s_2/s_3$=Deposition Height, River means the Tonle Sap River

KP: ***288+400*** No.: ***Pc216*** Date: ***27-May-2013***



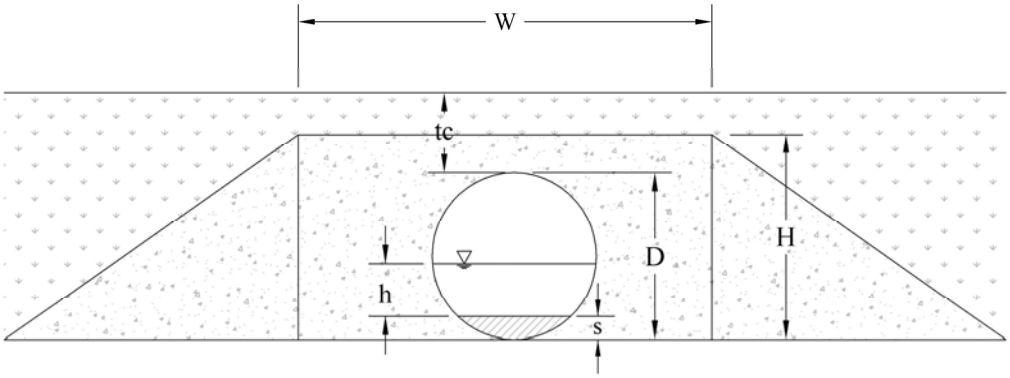


3Φ100

D	=	***1.00***	(m)
L	=	***25.90***	(m)
H	=	***1.60***	(m)
W	=	***9.90***	(m)
tc	=	***0.85***	(m)
h	=	***0.05***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

KP: ***288+1000*** No.: ***Pc217*** Date: ***27-May-2013***





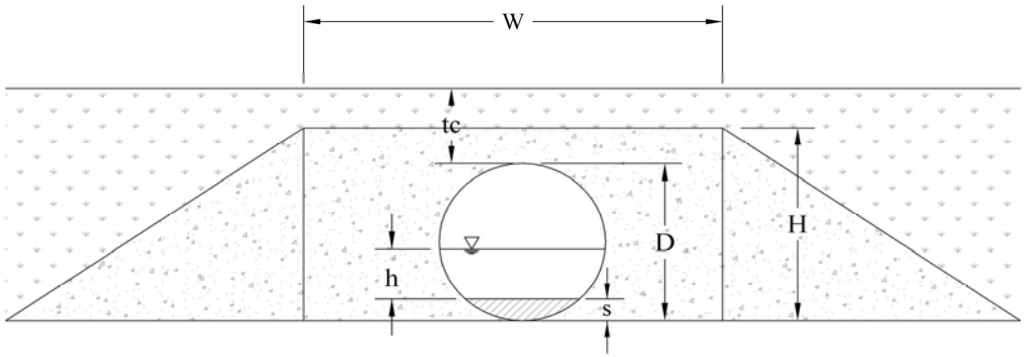
1Φ120

D	=	***1.20***	(m)
L	=	***26.00***	(m)
H	=	***1.00***	(m)
W	=	***1.00***	(m)
tc	=	***0.50***	(m)
h	=	***0.10***	(m)
s	=	***0.35***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, River means the Tonle Sap River

KP: ***289+200*** No.: ***Pc218*** Date: ***27-May-2013***



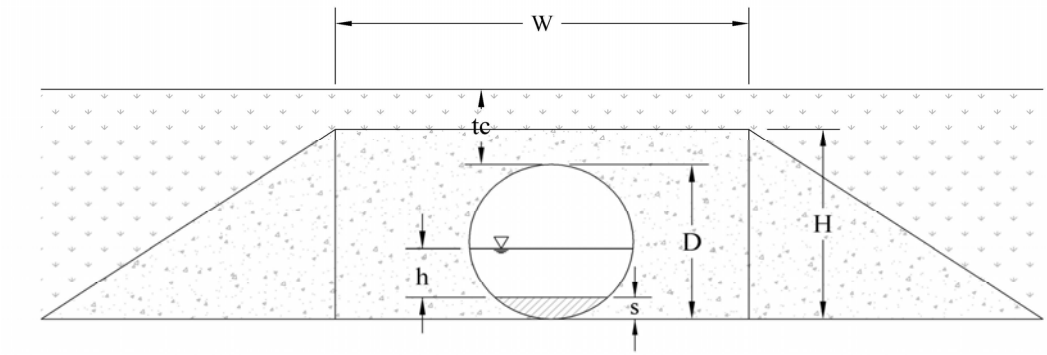


1Φ80

D	=	***0.80***	(m)
L	=	***N/A***	(m)
H	=	***N/A***	(m)
W	=	***N/A***	(m)
tc	=	***N/A***	(m)
h	=	***N/A***	(m)
s	=	***N/A***	(m)

Lake Side (Outlet)

KP: ***290+300*** No.: ***Pc219*** Date: ***27-May-2013***





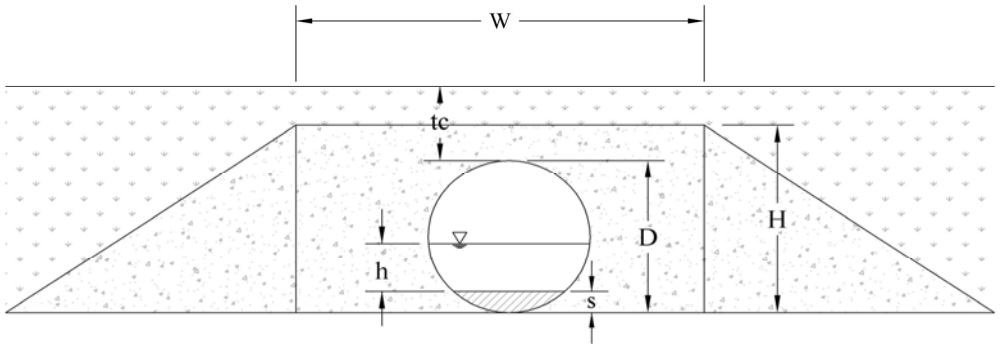
1Φ80

D	=	***0.80***	(m)
L	=	***23.50***	(m)
H	=	***0.80***	(m)
W	=	***0.80***	(m)
tc	=	***0.40***	(m)
h	=	***0.15***	(m)
s	=	***0.40***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, N/A means data not available, River means the Tonle Sap River

KP: ***290+700*** No.: ***Pc220*** Date: ***27-May-2013***



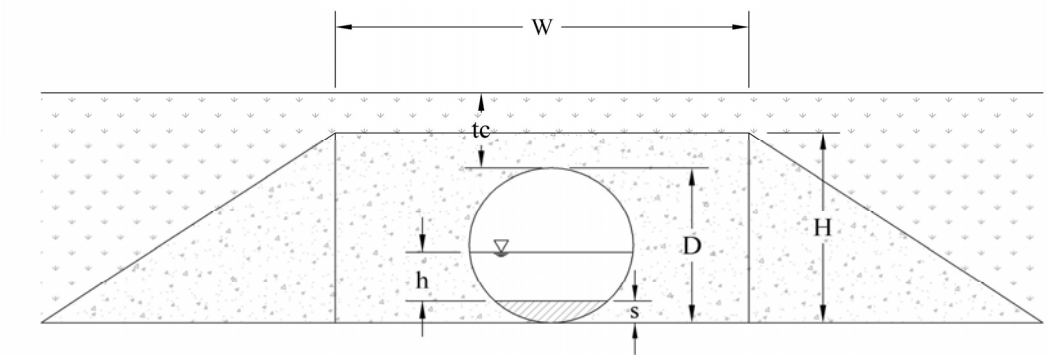


1Φ80

D	=	***0.80***	(m)
L	=	***14.60***	(m)
H	=	***1.05***	(m)
W	=	***1.00***	(m)
tc	=	***0.75***	(m)
h	=	***0.60***	(m)
s	=	***0.05***	(m)

Lake Side (Outlet)

KP: ***291+300*** No.: ***Pc221*** Date: ***27-May-2013***





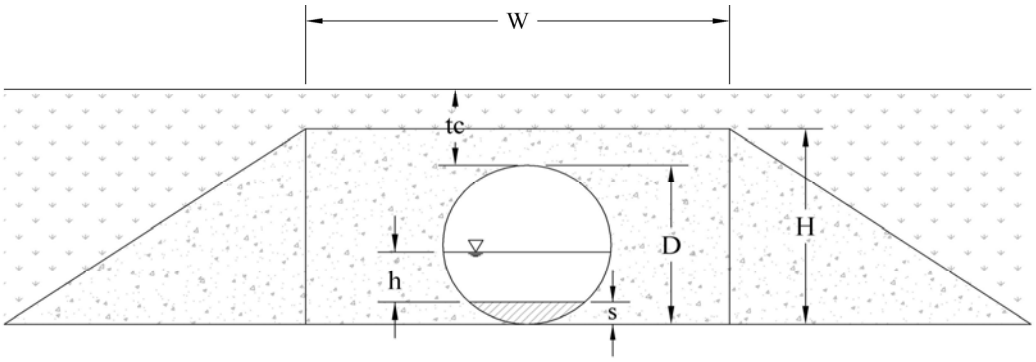
1Φ80

D	=	***N/A***	(m)
L	=	***N/A***	(m)
H	=	***N/A***	(m)
W	=	***N/A***	(m)
tc	=	***N/A***	(m)
h	=	***N/A***	(m)
s	=	***N/A***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, N/A means data not available,

KP: ***296+100*** No.: ***Pc222*** Date: ***27-May-2013***



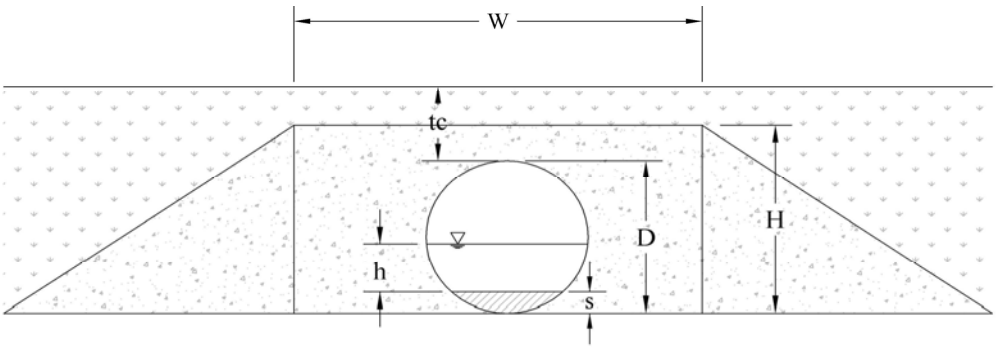


1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.30***	(m)
W	=	***1.35***	(m)
tc	=	***0.70***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***296+900*** No.: ***Pc223*** Date: ***27-May-2013***





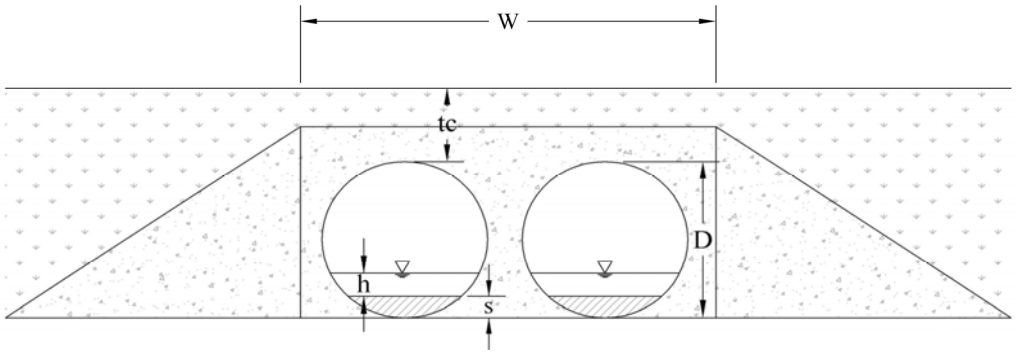
1Φ100

D	=	***1.00***	(m)
L	=	***N/A***	(m)
H	=	***N/A***	(m)
W	=	***N/A***	(m)
tc	=	***N/A***	(m)
h	=	***N/A***	(m)
s	=	***N/A***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height, N/A means data not available, River means the Tonle Sap River

KP: ***297+900*** No.: ***Pc224*** Date: ***28-May-2013***



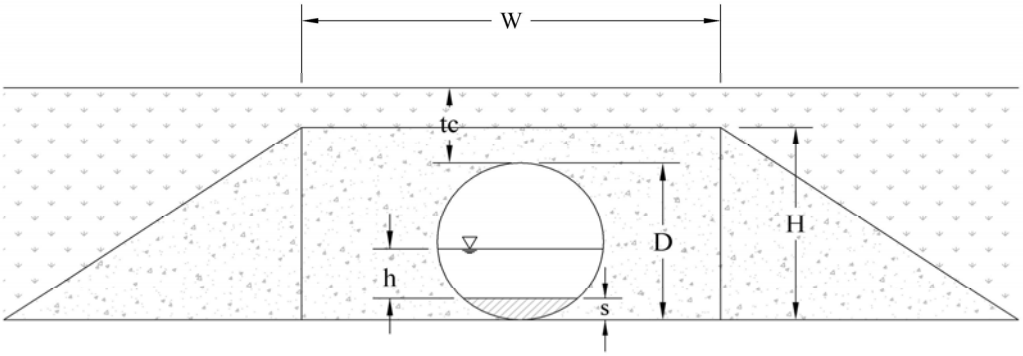


2Φ100

D	=	***1.00***	(m)
L	=	***13.50***	(m)
H	=	***1.30***	(m)
W	=	***2.95***	(m)
tc	=	***0.55***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

KP: ***300+700*** No.: ***Pc225*** Date: ***28-May-2013***





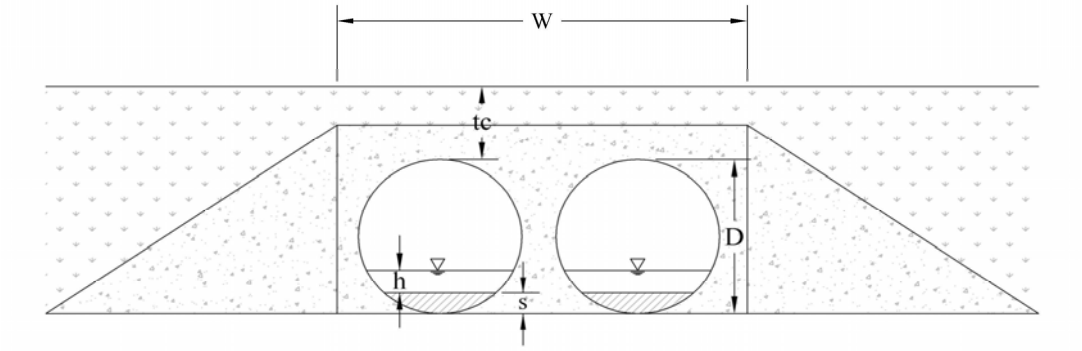
1Φ100

D	=	***1.00***	(m)
L	=	***13.60***	(m)
H	=	***1.35***	(m)
W	=	***1.20***	(m)
tc	=	***0.50***	(m)
h	=	***0.00***	(m)
s	=	***0.15***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

KP: ***302+900*** No.: ***Pc226*** Date: ***28-May-2013***



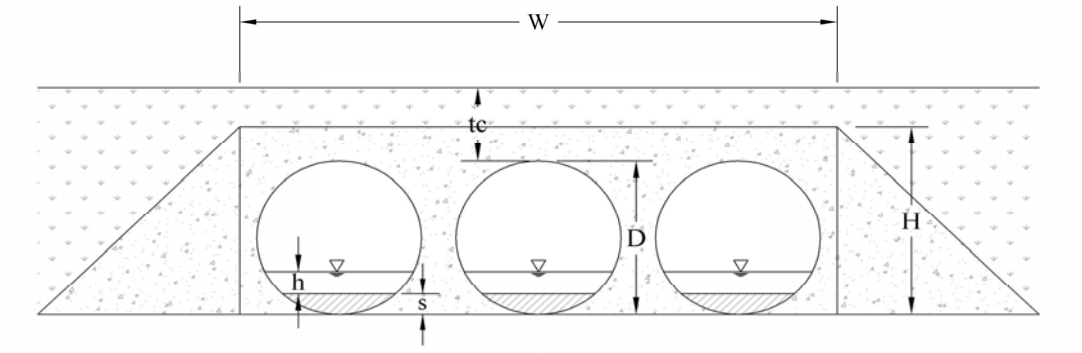


2Φ100

D	=	***1.00***	(m)
L	=	***13.70***	(m)
H	=	***1.35***	(m)
W	=	***2.85***	(m)
tc	=	***0.90***	(m)
h	=	***0.00***	(m)
s	=	***0.25***	(m)

Lake Side (Outlet)

KP: ***307+700*** No.: ***Pc227*** Date: ***28-May-2013***





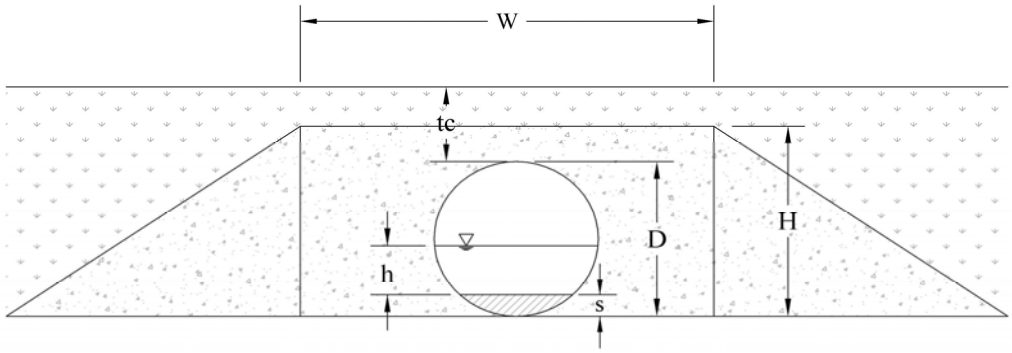
3Φ120

D	=	***1.20***	(m)
L	=	***14.80***	(m)
H	=	***1.55***	(m)
W	=	***5.00***	(m)
tc	=	***1.30***	(m)
h	=	***0.00***	(m)
s	=	***0.30***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

KP: ***308+300*** No.: ***Pc228*** Date: ***28-May-2013***



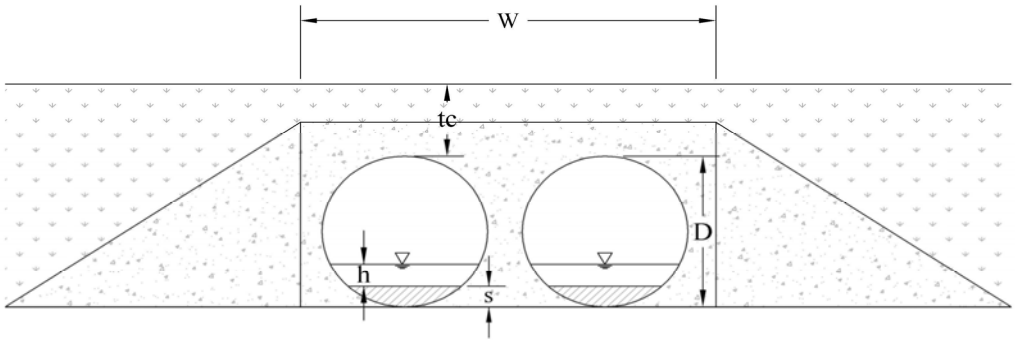


1Φ80

D	=	***0.80***	(m)
L	=	***14.90***	(m)
H	=	***1.20***	(m)
W	=	***1.05***	(m)
tc	=	***1.15***	(m)
h	=	***0.00***	(m)
s	=	***0.10***	(m)

Lake Side (Outlet)

KP: ***309+300*** No.: ***Pc229*** Date: ***28-May-2013***





2Φ120

D	=	***1.20***	(m)
L	=	***13.80***	(m)
H	=	***1.55***	(m)
W	=	***3.50***	(m)
tc	=	***0.70***	(m)
h	=	***0.00***	(m)
s	=	***0.00***	(m)

Lake Side (Outlet)

Note: PC means Pipe Culvert, D=Diameter, L=Total Length, H=Total Height, W=Width, tc=Height of Soil over Top, h=Water Depth, s=Deposition Height,

APPENDIX 6-4

INQUIRING SURVEY ON

INFORMATION OF

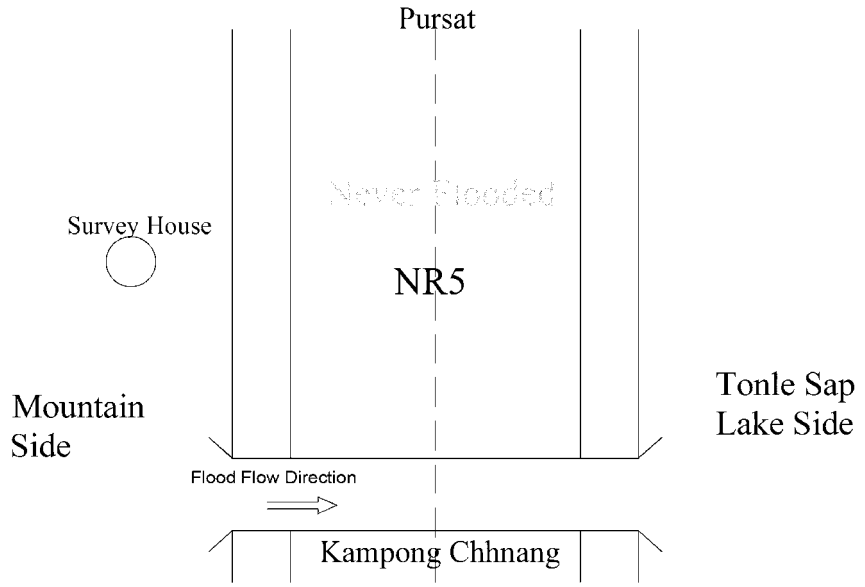
FLOODING CONDITIONS

20th May to 29th May 2013

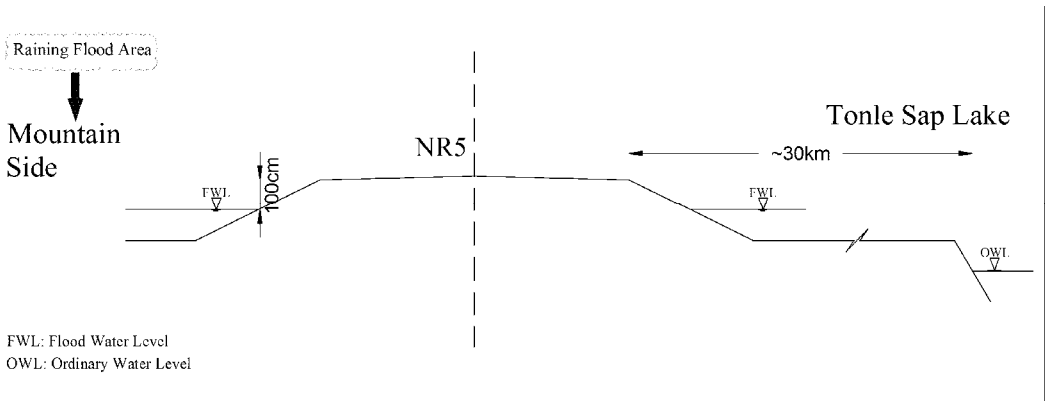
Inventory Sheet on Information of Flooding Conditions

	No.:	1

Date	20 May-2013		
Interview with	Chief villager		
PK (km)	172+800	**Province**	Pursat
Circumstance	Residential area(Ta Kaev Leu)	**Drainage Facility**	Pc150
Flood Level	No flood on the road 100cm below from NR5(+10cm around houses) (2001)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Seldom		
Duration Per Flood	2 ~ 3 days	**Occurrence Month**	Rainy season(2001)
Remark			



Plain View

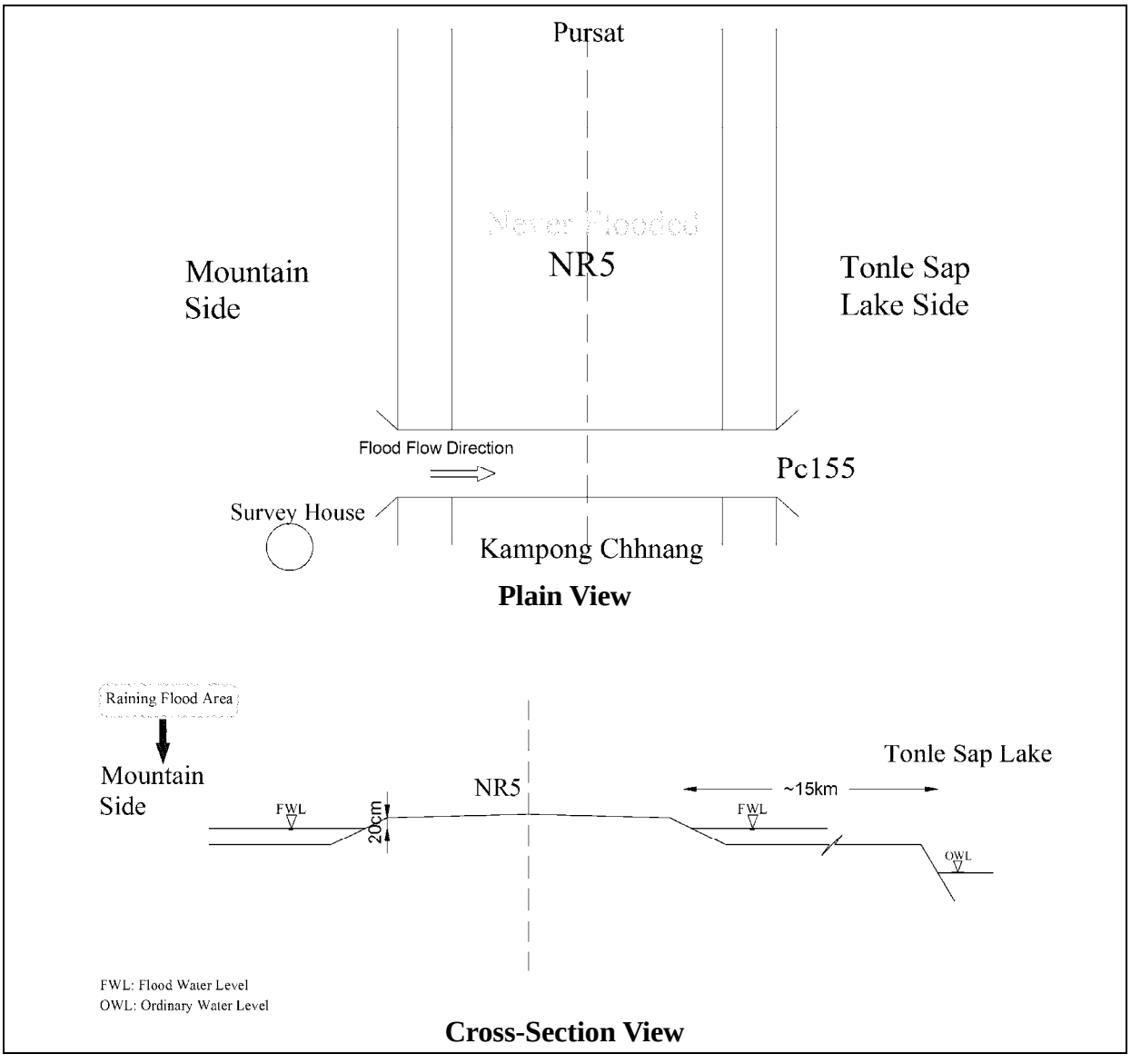


Cross-Section View

Inventory Sheet on Information of Flooding Conditions

	No.:	2

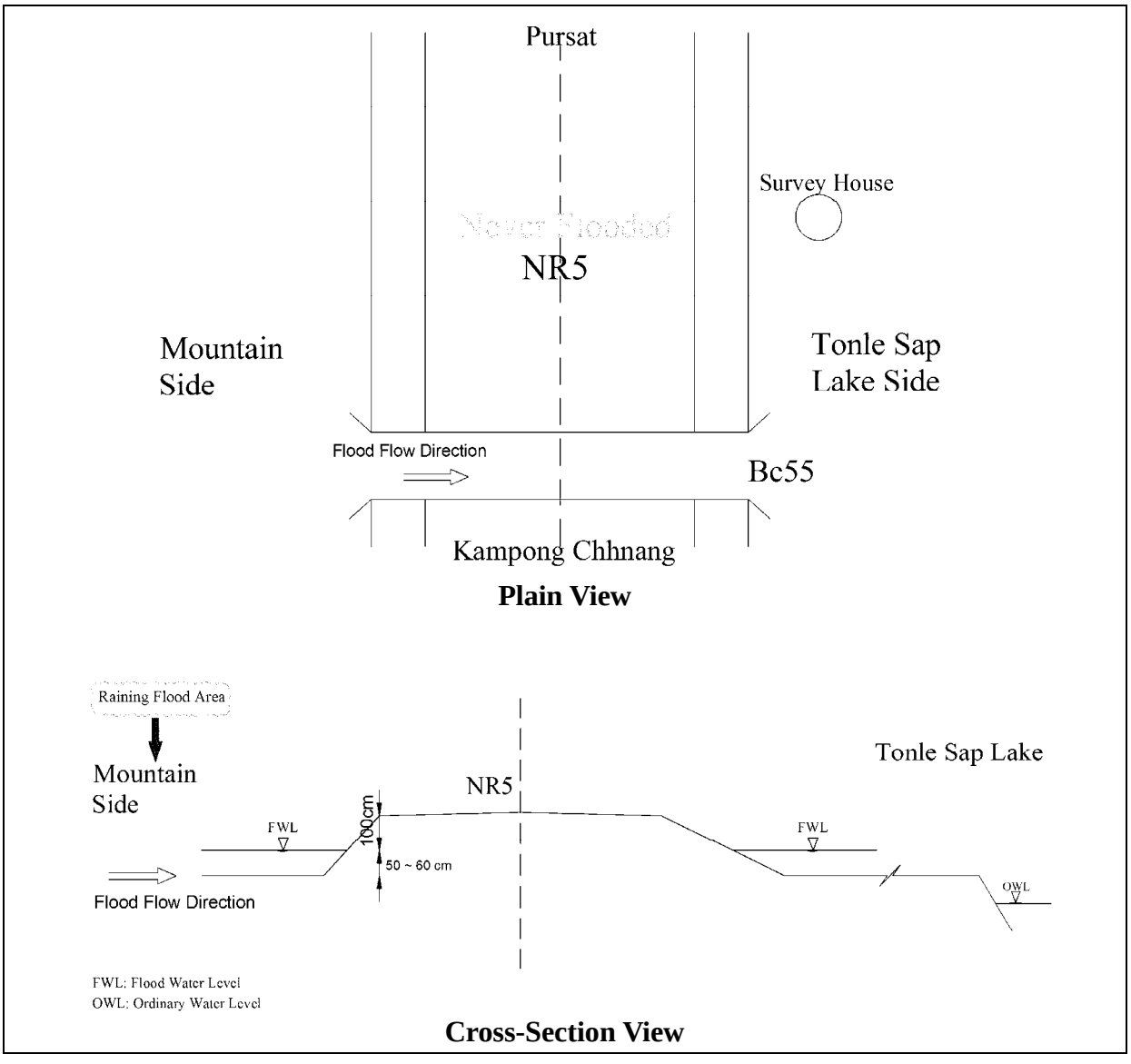
Date	20 May-2013		
Interview with	Mr. Choem Loun (shopkeeper)		
PK (km)	176+200	**Province**	Pursat
Circumstance	Residential (Ta Kaev Leu)	**Drainage Facility**	Pc155
Flood Level	No flood on the road. 10cm around houses(generally) After road repairing, the flood below 20cm(+50cm around houses) (2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Every year		
Duration Per Flood	2 ~ 3 days	**Occurrence Month**	Rainy season
Remark	Water level is raising, even if it is not raining.		



Inventory Sheet on Information of Flooding Conditions

	No.:	3

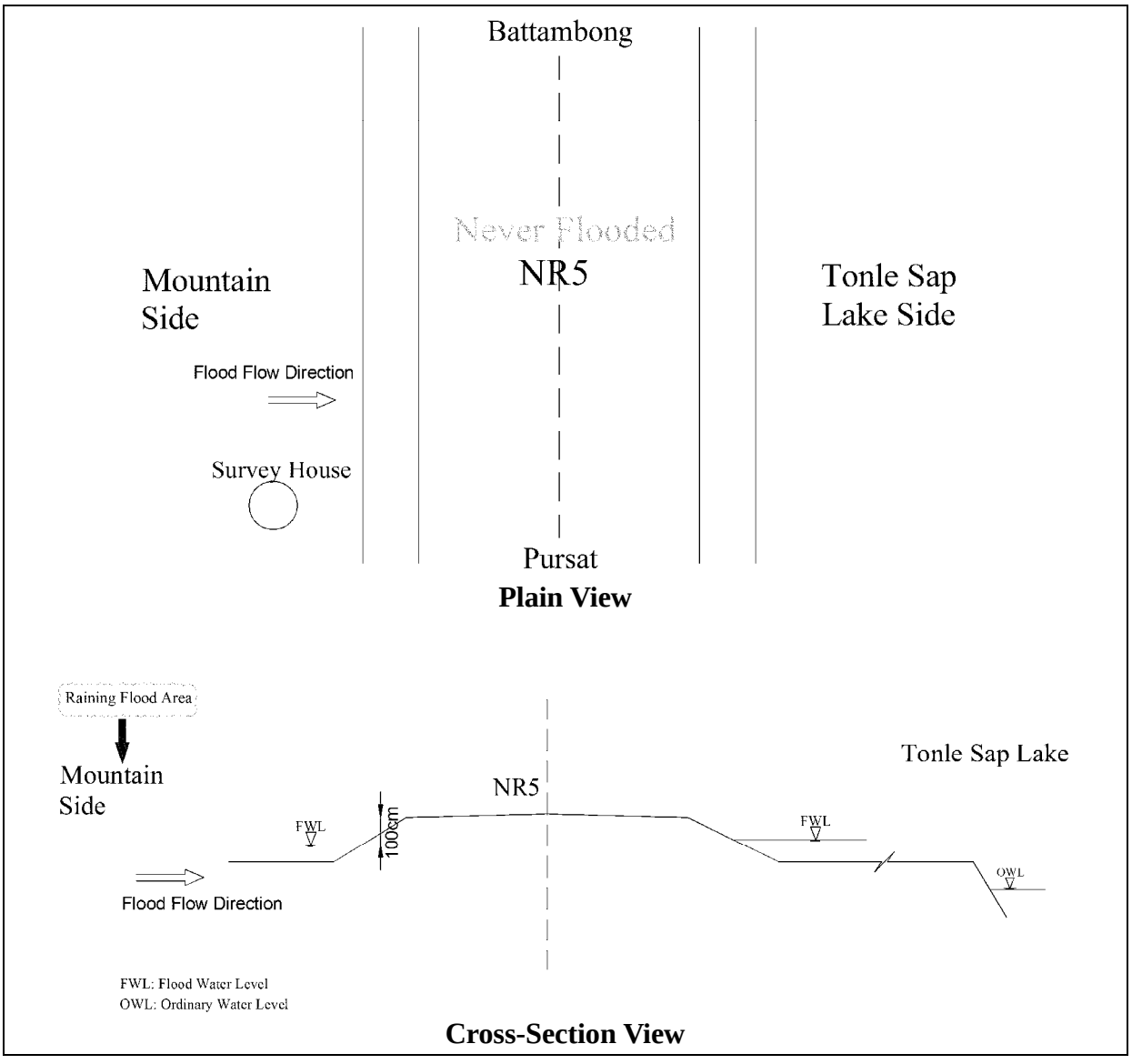
Date	20 May-2013		
Interview with	Resident		
PK (km)	179+100	**Province**	Pursat
Circumstance	Residential area(Krang Ta Saen)	**Drainage Facility**	Bc 55
Flood Level	No flood on the road 100cm below from NR5(+50 ~ 60cm around houses) (2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Every year		
Duration Per Flood	1 week	**Occurrence Month**	Rainy season
Remark	From Mountains		



Inventory Sheet on Information of Flooding Conditions

	No.:	4

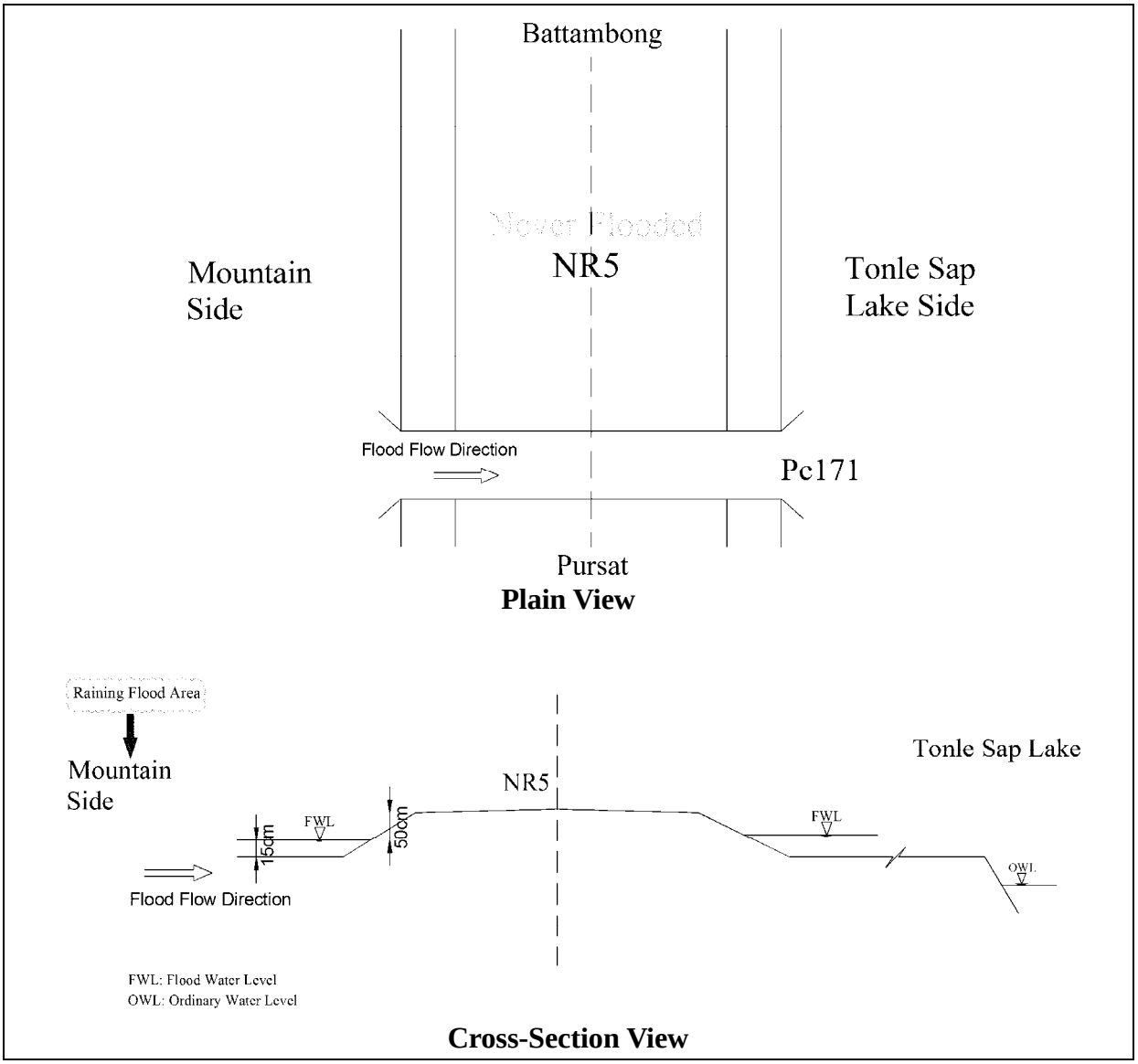
Date	21 May-2013		
Interview with	Mr. Ven Sea, Resident		
PK (km)	188+200	**Province**	Pursat
Circumstance	Residential area(Phteah Prey)	**Drainage Facility**	Br51
Flood Level	No flood on the road		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Seldom / Every year / (concretely)		
Duration Per Flood	No flood	**Occurrence Month**	No flood
Remark	Before road repaired 100cm below from NR5.(Road repaired from 2004 to 2006)		



Inventory Sheet on Information of Flooding Conditions

	No.:	5

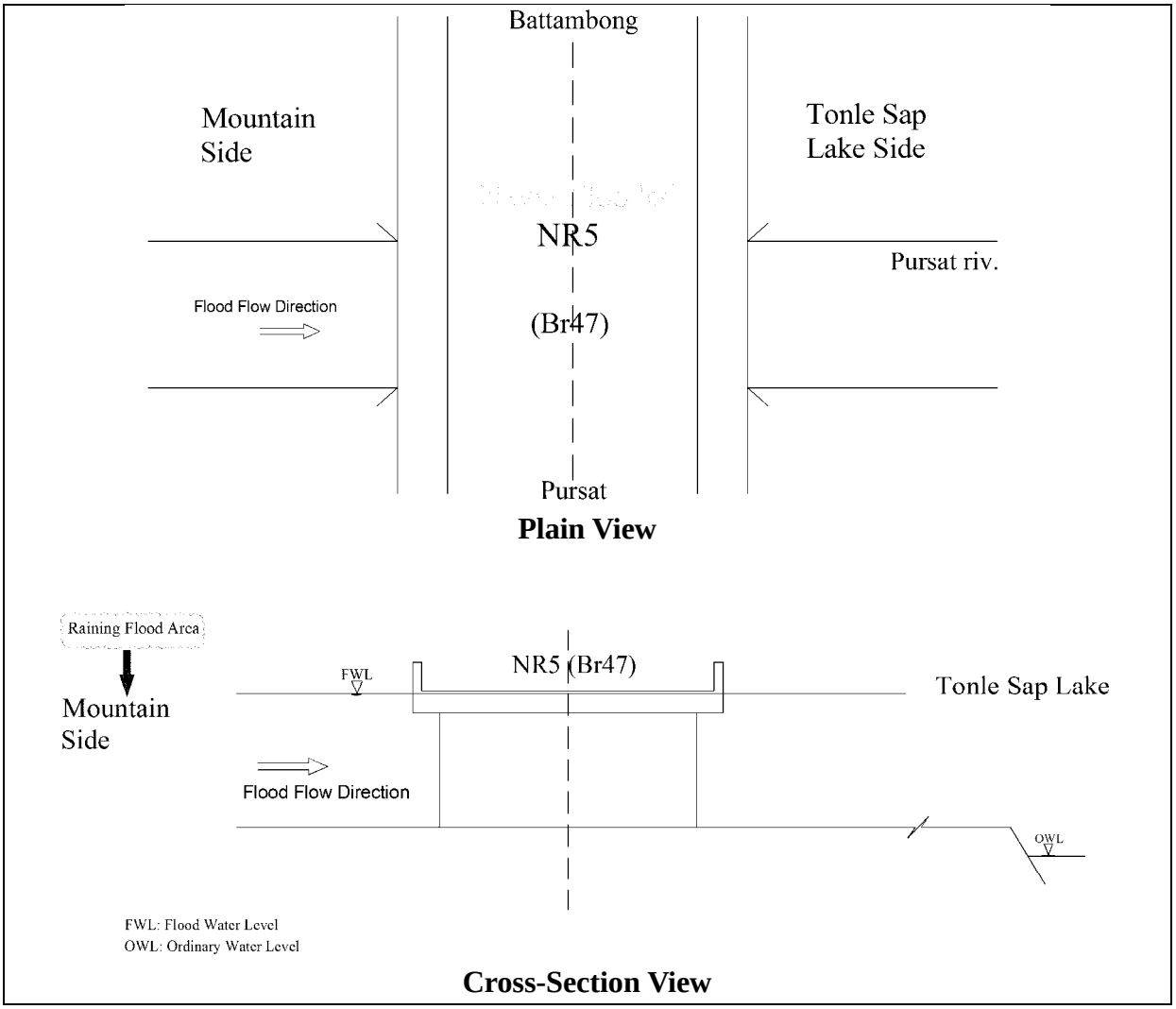
Date	21 May-2013		
Interview with	Shop Keeper (Resident)		
PK (km)	204+000	**Province**	Pursat
Circumstance	Residential area(Trapeang Chang)	**Drainage Facility**	Pc171
Flood Level	No flood on the road 50cm below from NR5(+15cm around houses) (2007)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Seldom		
Duration Per Flood	2~3 days	**Occurrence Month**	Rainy season
Remark			



Inventory Sheet on Information of Flooding Conditions

	No.:	6

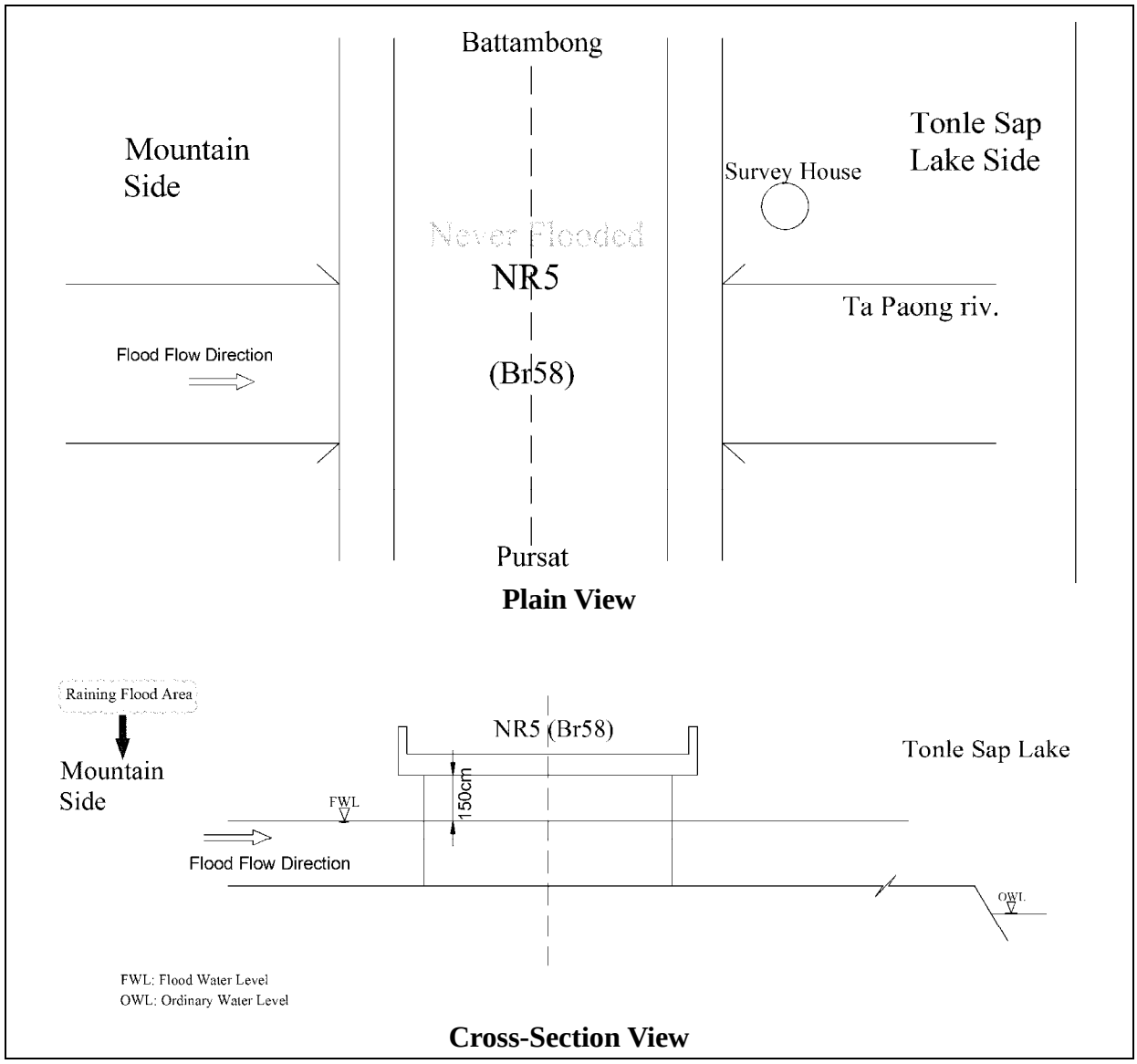
Date	22 May-2013		
Interview with	Mr. Kang Begn Hak Director of Department of Public Work and Transportation (DPWT)		
PK (km)	185+700	**Province**	Pursat
Circumstance	Commercial and residential area	**Drainage Facility**	Br47
Flood Level	No flood on the road(KP171 ~ KP220) Water level was just below of surface of Br47(2008)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Seldom		
Duration Per Flood	3 ~ 4 days	**Occurrence Month**	Rainy season
Remark	Sometime flood flow from Tonle Sap Lake but it is lower than flood flow because of heavy rain.		



Inventory Sheet on Information of Flooding Conditions

	No.:	7

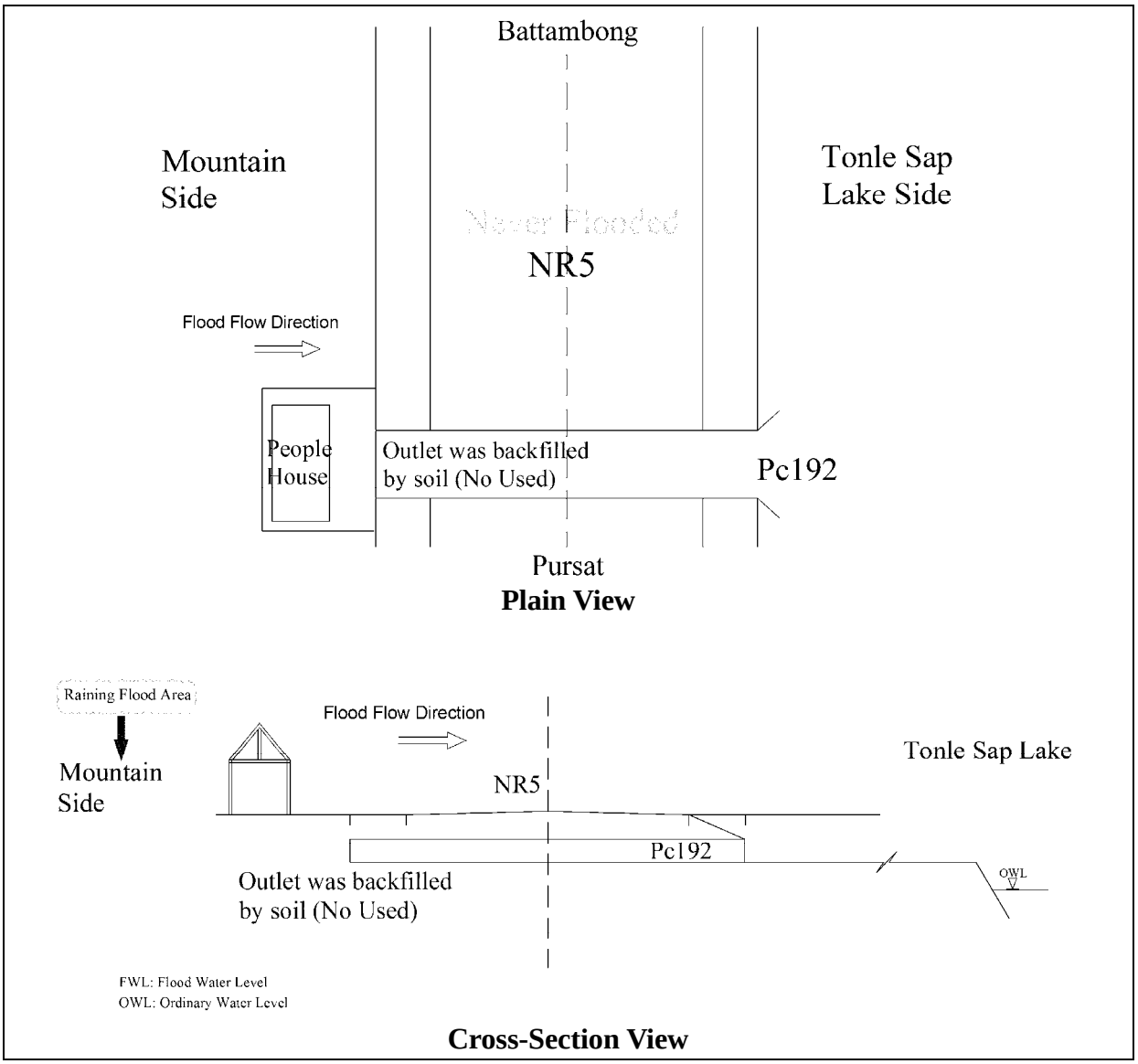
Date	22 May-2013		
Interview with	Resident		
PK (km)	215+700	**Province**	Pursat
Circumstance	Residential area(Ou Ta Paong)	**Drainage Facility**	Br58
Flood Level	No flood on the road 150cm below from the bridge(Br58)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	No flood		
Duration Per Flood	3 ~ 4 days	**Occurrence Month**	Rainy season
Remark			



Inventory Sheet on Information of Flooding Conditions

	No.:	8

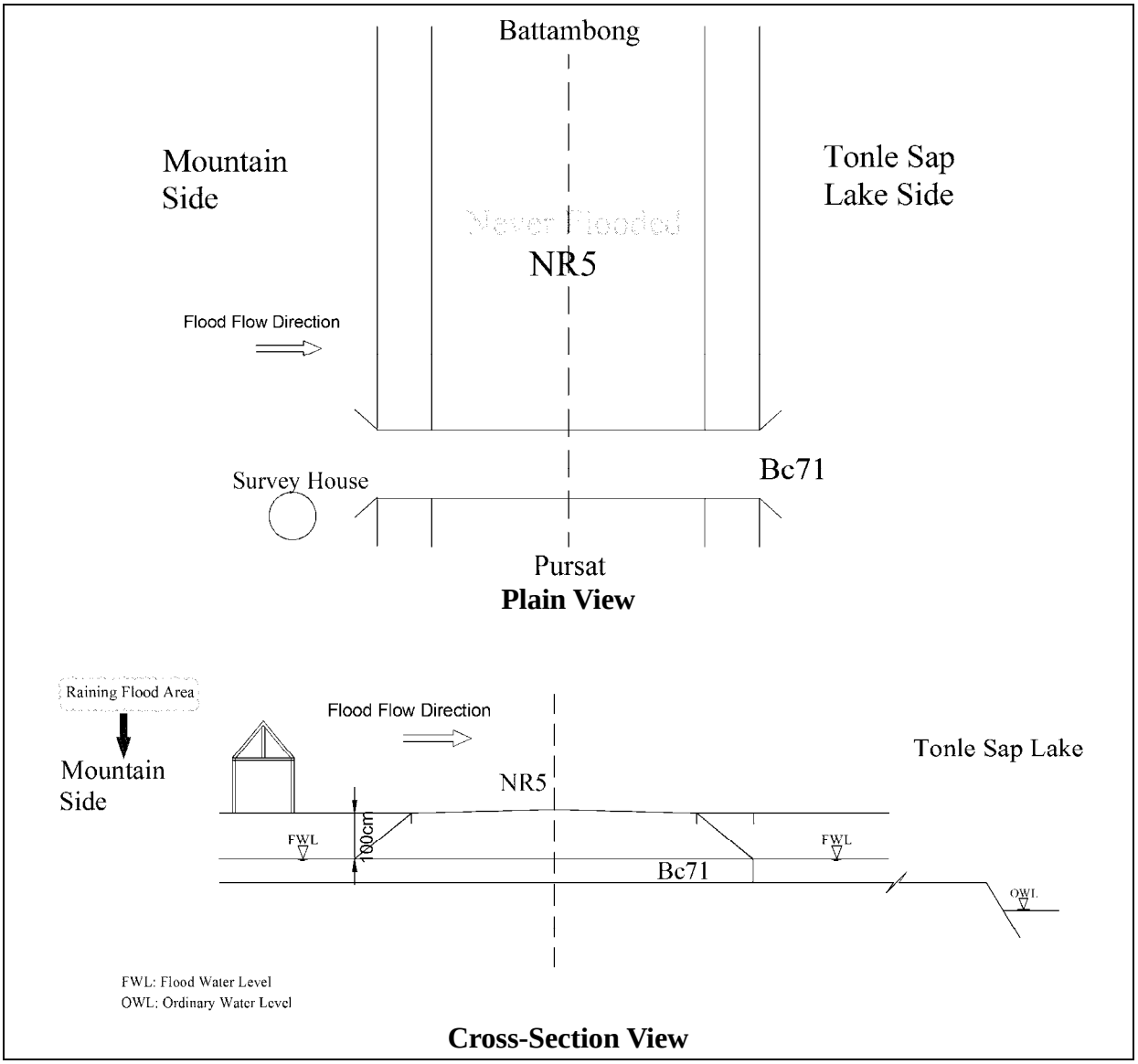
Date	22 May-2013		
Interview with	Coffee Shopkeeper		
PK (km)	227+700	**Province**	Pursat
Circumstance	Residential area(Ampil Chhung)	**Drainage Facility**	Pc192
Flood Level	No flood on the road Houses and road surface are same elevation		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	No flood		
Duration Per Flood	No flood	**Occurrence Month**	No flood
Remark	Heavy rain (48hr to 72hr) occurred every years, but no flood Pc192 was backfilled by residents at 2008		



Inventory Sheet on Information of Flooding Conditions

	No.:	9

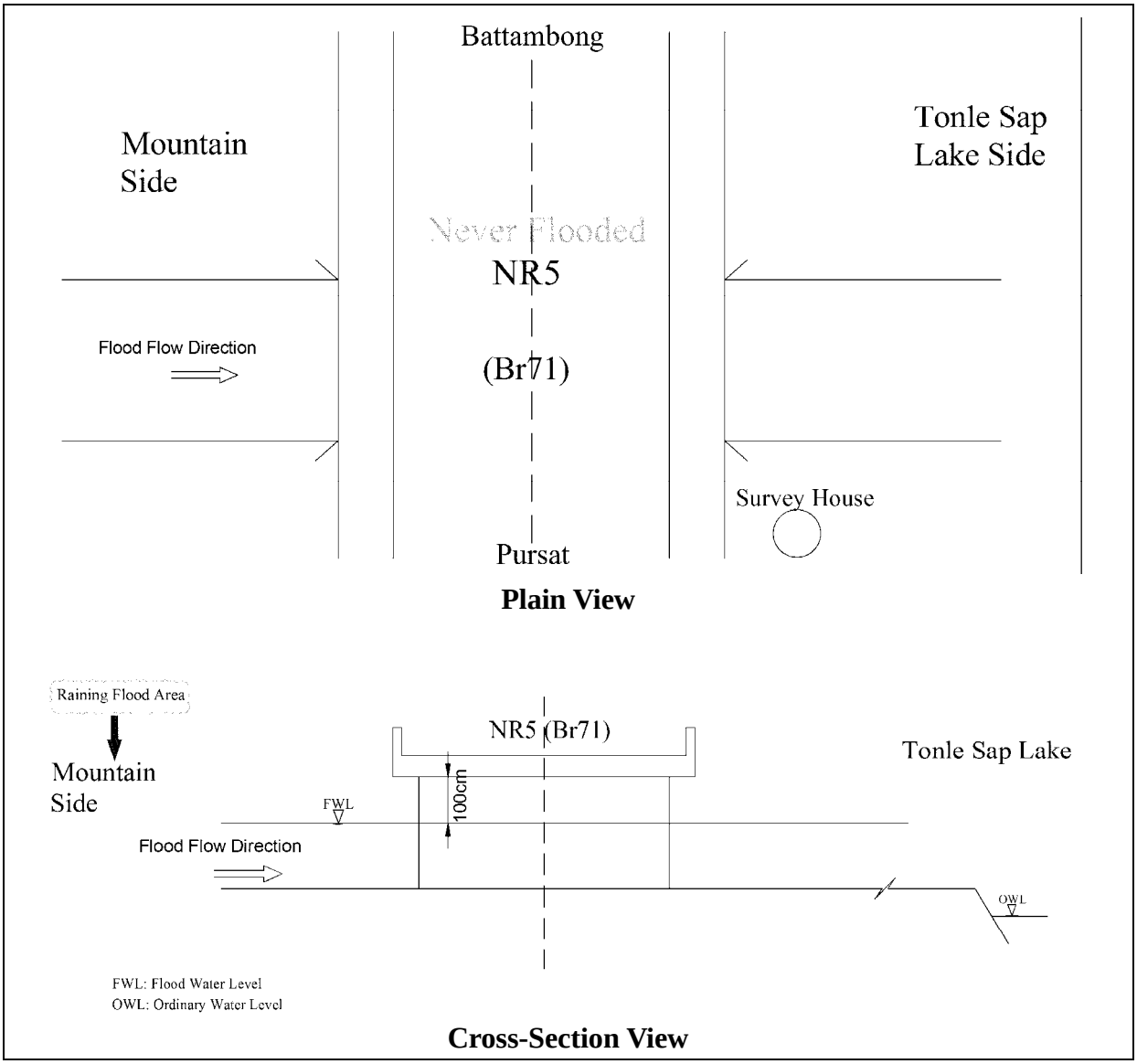
Date	23 May-2013		
Interview with	Shop keeper		
PK (km)	245+400	**Province**	Pursat
Circumstance	Residential area(Moung Ruessei)	**Drainage Facility**	Bc71
Flood Level	No flood on the road 100cm below from NR5 at Bc71(2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Every year		
Duration Per Flood	2~3 days	**Occurrence Month**	Raining Season
Remark	Houses and road surface are same elevation		



Inventory Sheet on Information of Flooding Conditions

	No.:	10

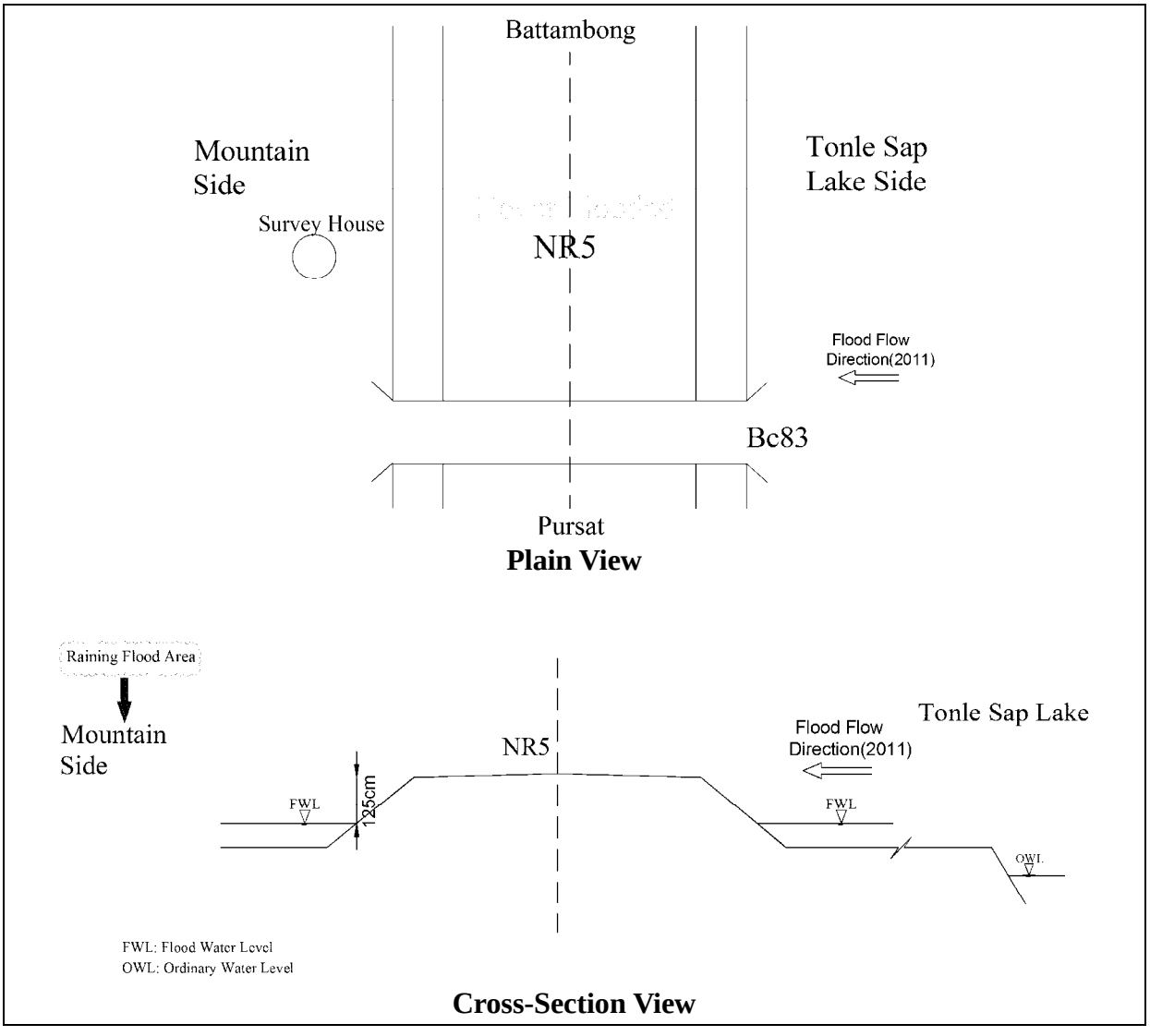
Date	24 May-2013		
Interview with	Resident		
PK (km)	265+900	**Province**	Battambong
Circumstance	Residential area(Sala Trav)	**Drainage Facility**	Br71
Flood Level	No flood on the road 100cm below from NR5 (+10cm around houses)(2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Seldom		
Duration Per Flood	2~3 days	**Occurrence Month**	Rainy season
Remark	Downstream of the channel is under restoration		



Inventory Sheet on Information of Flooding Conditions

	No.:	11

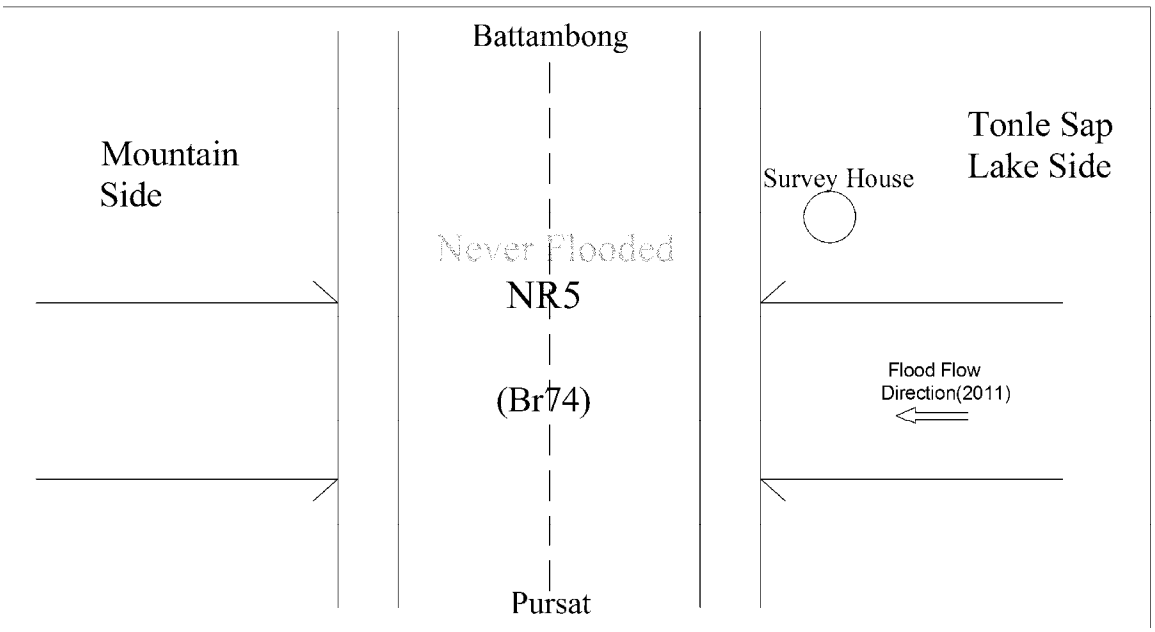
Date	24 May-2013		
Interview with	Resident		
PK (km)	269+700	**Province**	Battambong
Circumstance	Residential area(Kbal Thnal)	**Drainage Facility**	Bc83
Flood Level	No flood on the road 130~150cm below from NR5 because of heavy rain(2012) 125cm below from NR5 because of backwater of Tonle Sap Lake(2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake (generally) Tonle Sap Lake → Residential area (2011)		
Frequency	Seldom		
Duration Per Flood	4 ~ 5days	**Occurrence Month**	October ~ November 2011
Remark			



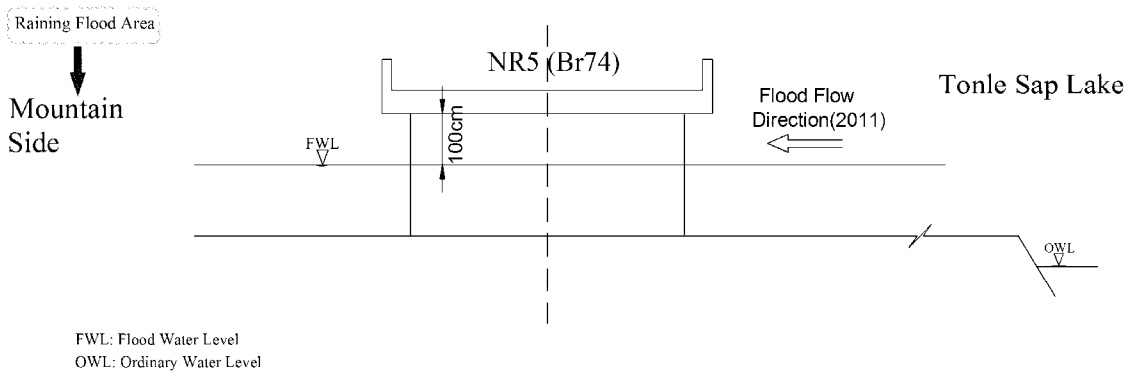
Inventory Sheet on Information of Flooding Conditions

	No.:	12

Date	24 May-2013		
Interview with	Resident		
PK (km)	272+600	**Province**	Battambong
Circumstance	Residential area(Kbal Thnal)	**Drainage Facility**	Br74
Flood Level	No flood on the road 100cm below from NR5 (2011)		
Flood Flow Direction	Mountain side → Tonle Sap Lake (generally) Tonle Sap Lake → Residential area (2011)		
Frequency	Seldom		
Duration Per Flood	4 to 5 days	**Occurrence Month**	October to November 2011
Remark	Before road repaired, flood crossed over the road(1997)		



Plain View

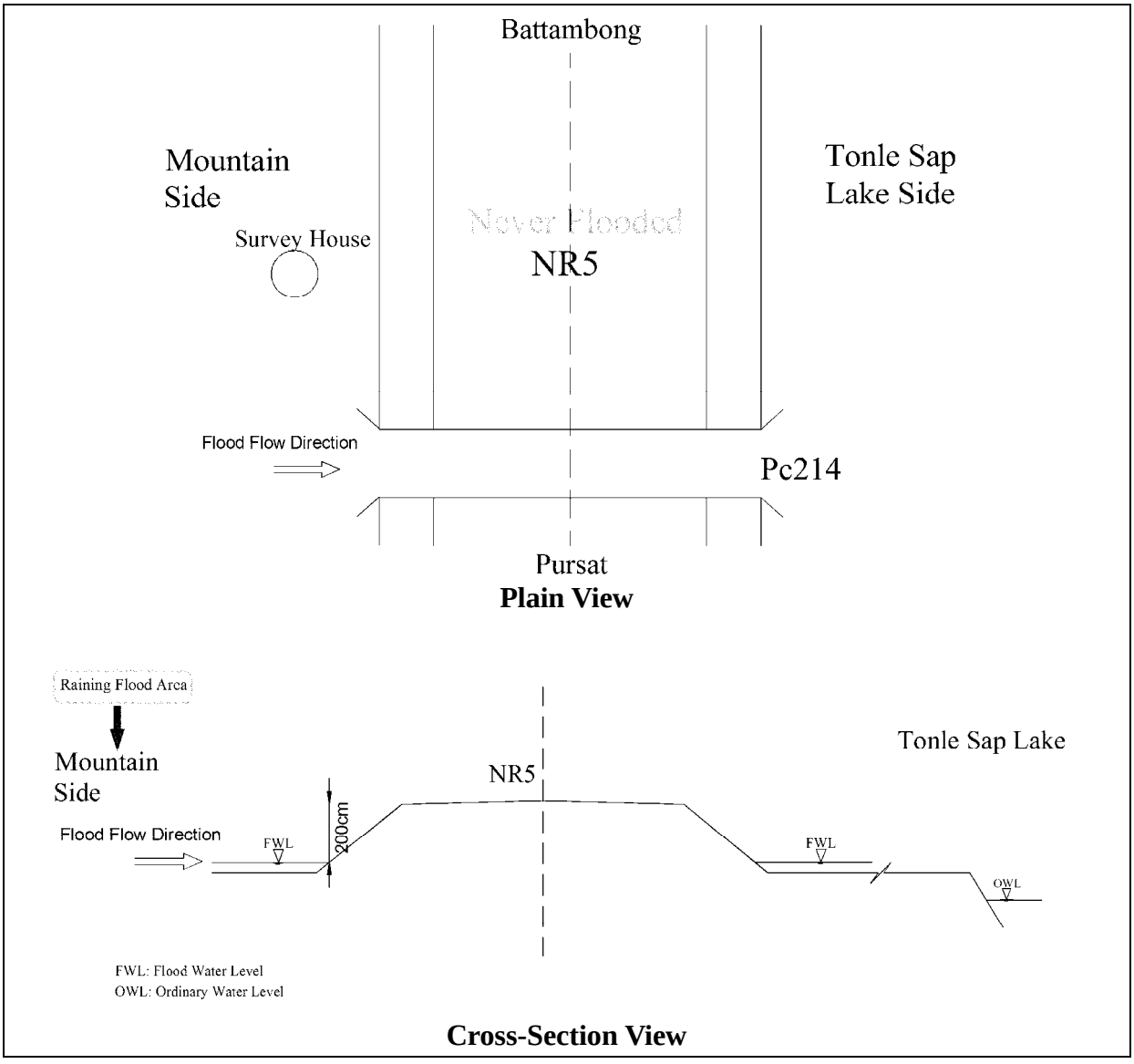


Cross-Section View

Inventory Sheet on Information of Flooding Conditions

	No.:	13

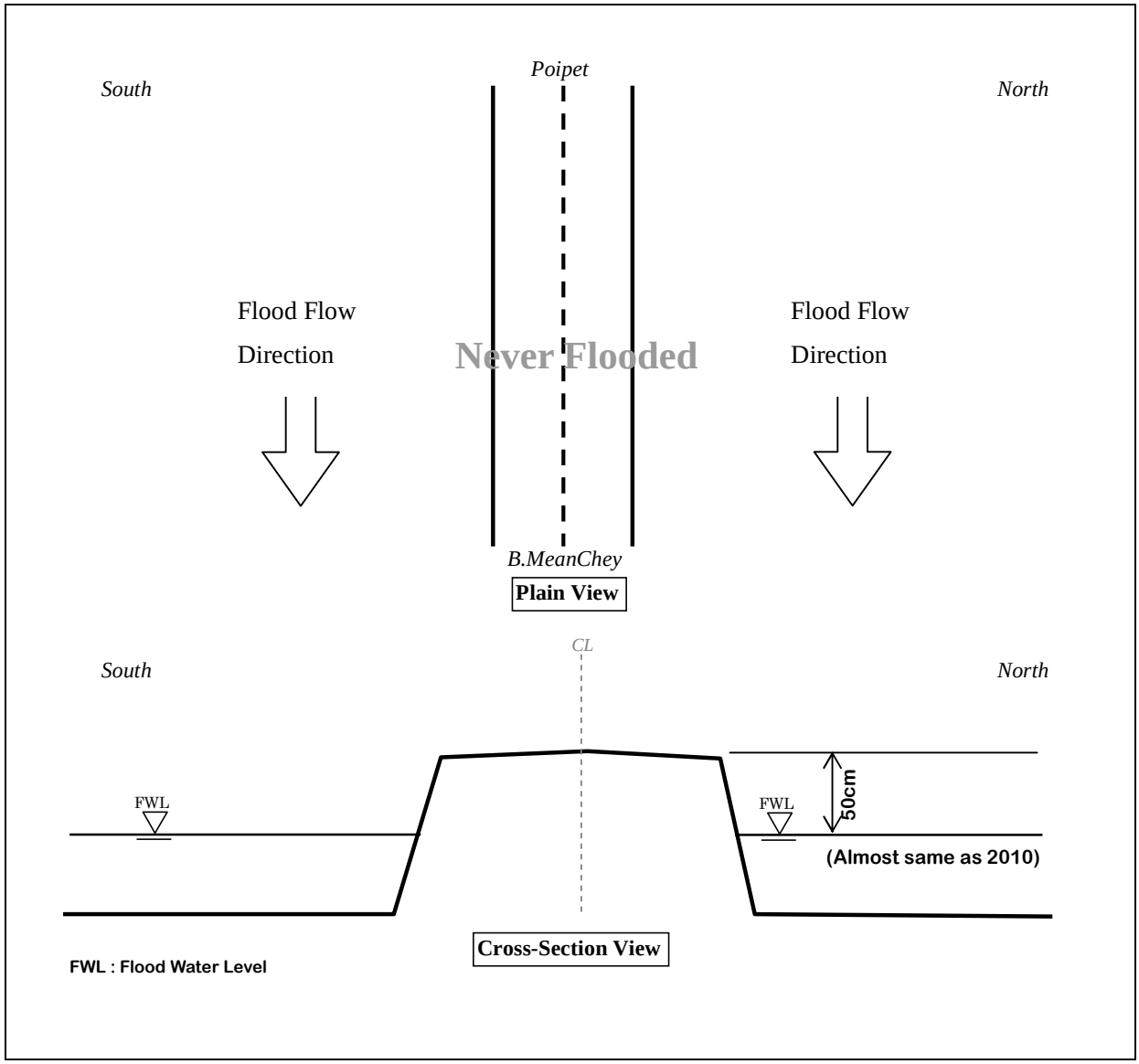
Date	27 May-2013		
Interview with	Resident (Shop keeper)		
PK (km)	286+400	**Province**	Battambong
Circumstance	Residential area(Sangkae)	**Drainage Facility**	Pc214
Flood Level	No flood on the road 200cm below from NR5 (2010)		
Flood Flow Direction	Mountain side → Tonle Sap Lake		
Frequency	Every year		
Duration Per Flood	2~4 days	**Occurrence Month**	Rainy season
Remark	Around houses and road surface are same elevation		



Inventory Sheet on Information of Flooding Conditions

	No.:	14

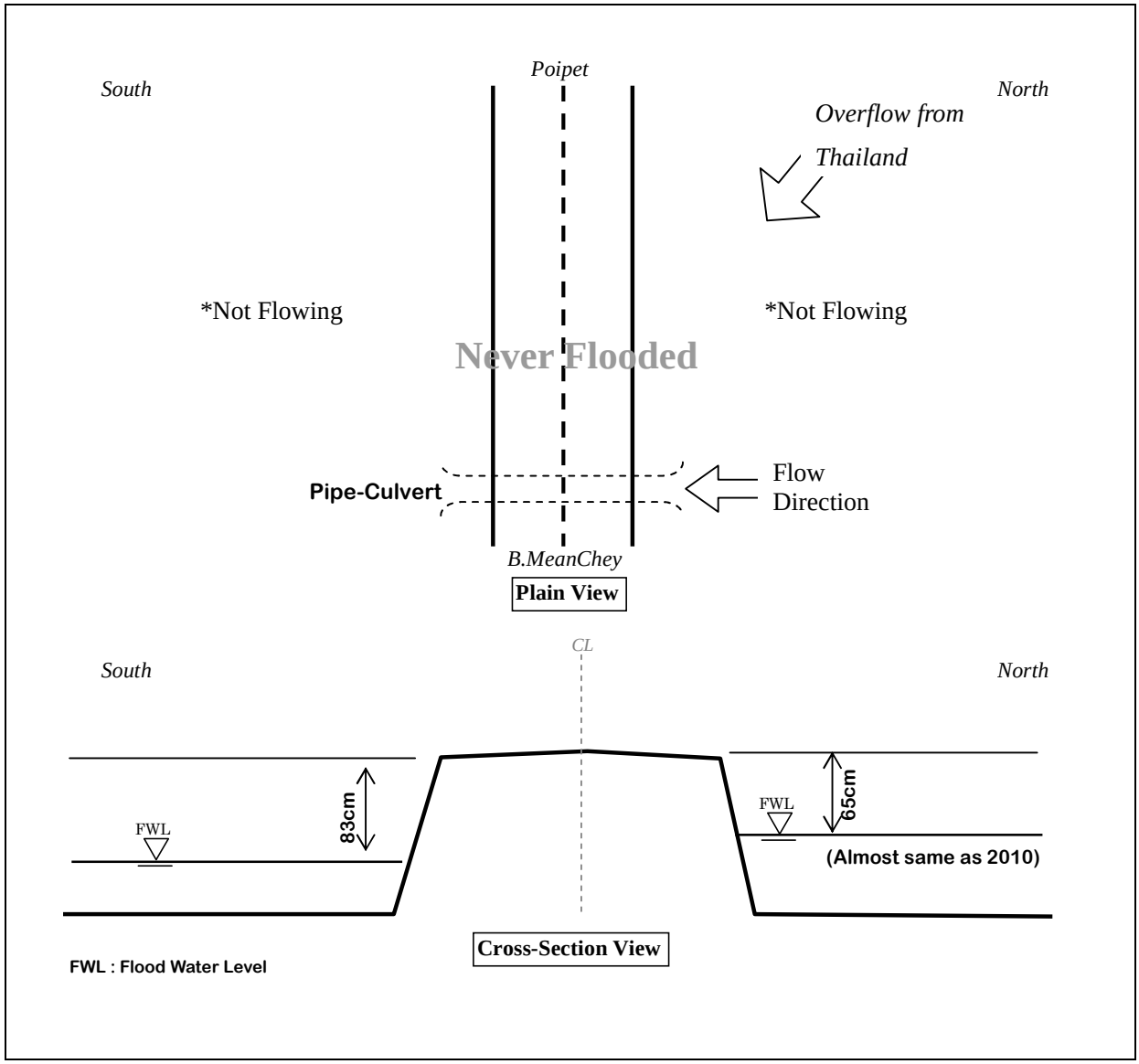
Date	7 Oct-2013		
Interview with	Horn Sophola (Shop keeper)		
PK (km)	366+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	-
Flood Level	No flood on the road 50cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	1 month	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand		



Inventory Sheet on Information of Flooding Conditions

	No.:	15

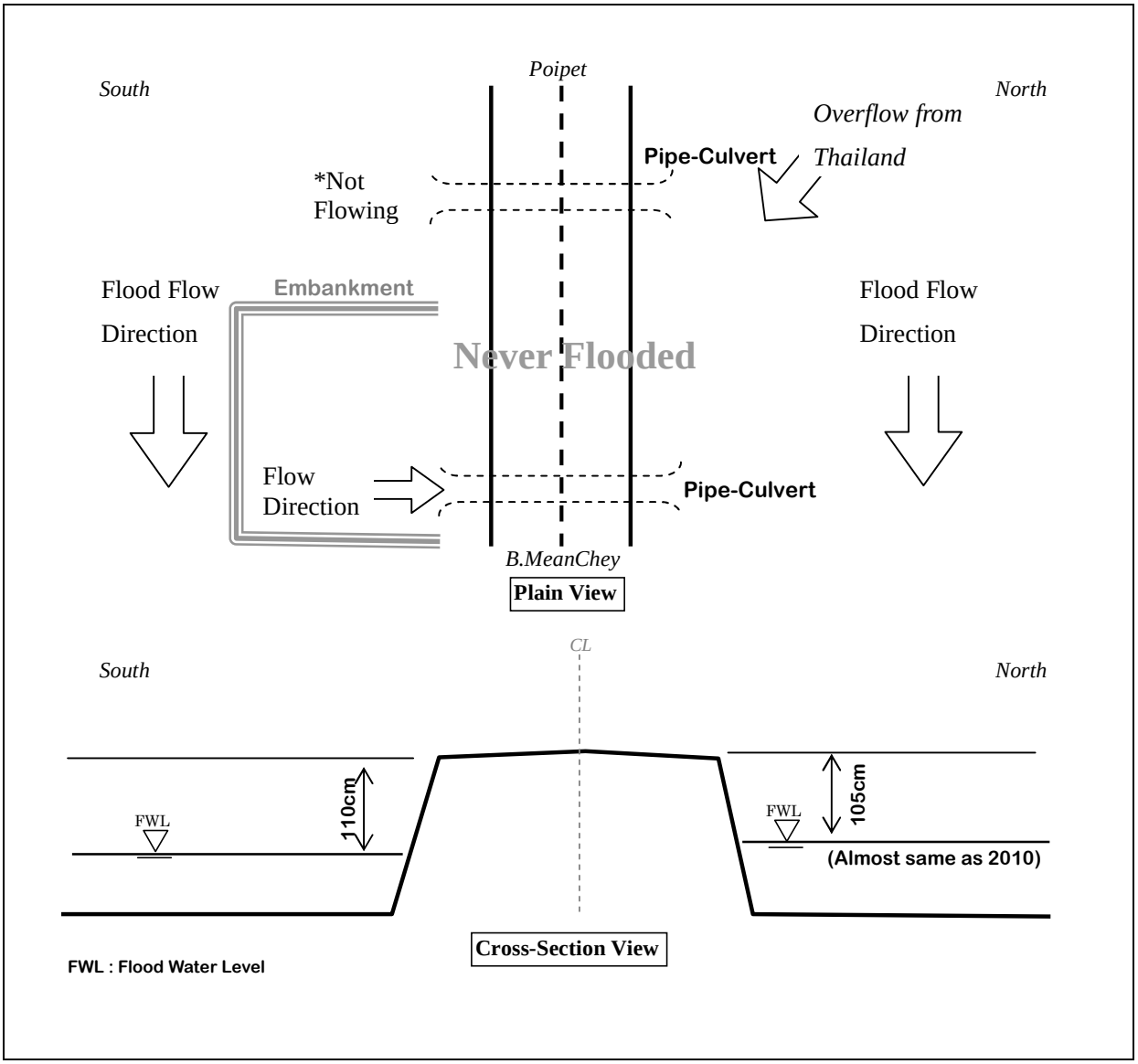
Date	7 Oct-2013		
Interview with	Vireak (Resident)		
PK (km)	368+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 65 ~ 85cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand		



Inventory Sheet on Information of Flooding Conditions

No.:	16

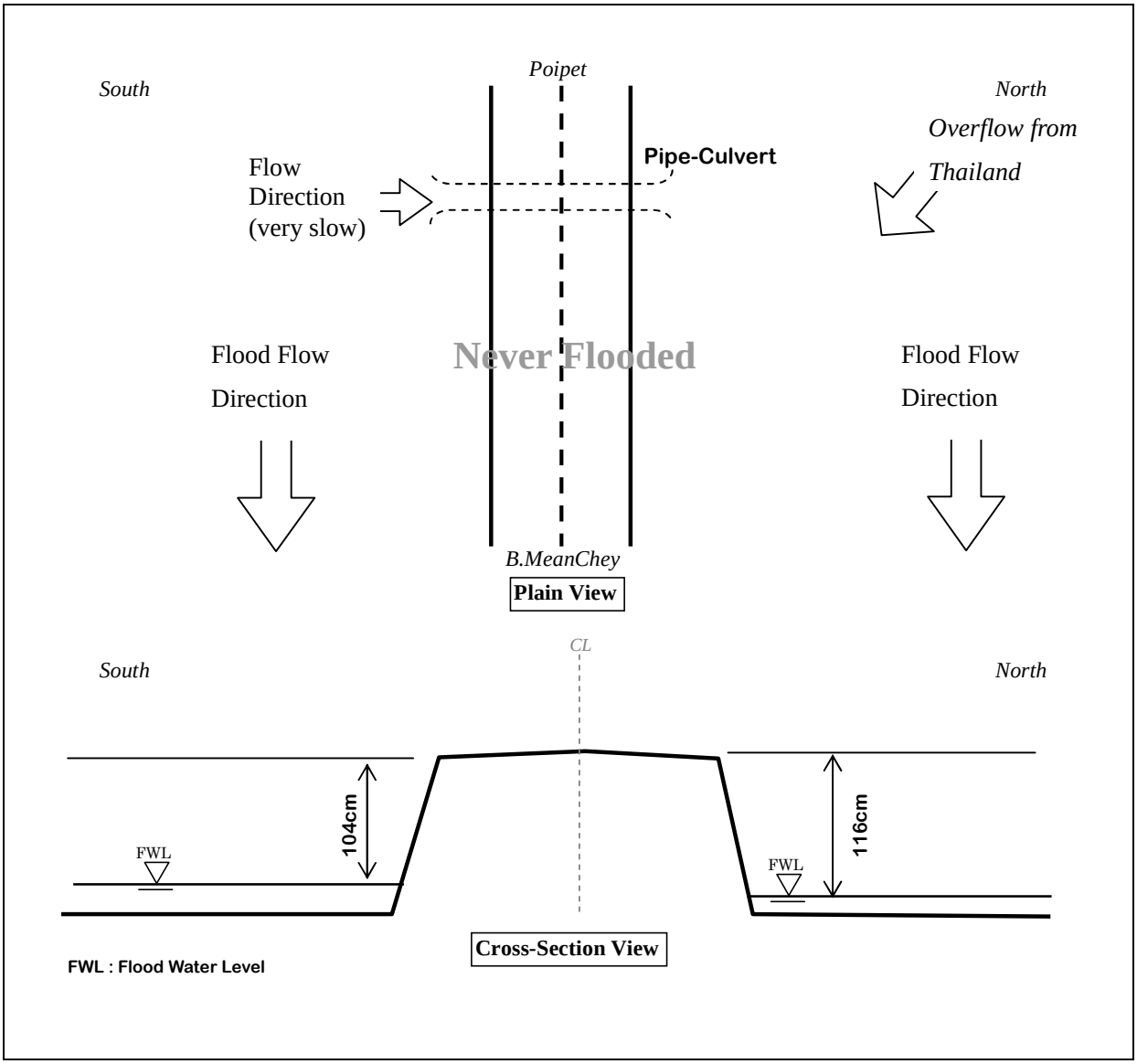
Date	7 Oct-2013		
Interview with	Chin (Resident)		
PK (km)	372+000	**Province**	BanteyMeanchey
Circumstance	Rice Field	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 105 ~ 110cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand		



Inventory Sheet on Information of Flooding Conditions

	No.:	17

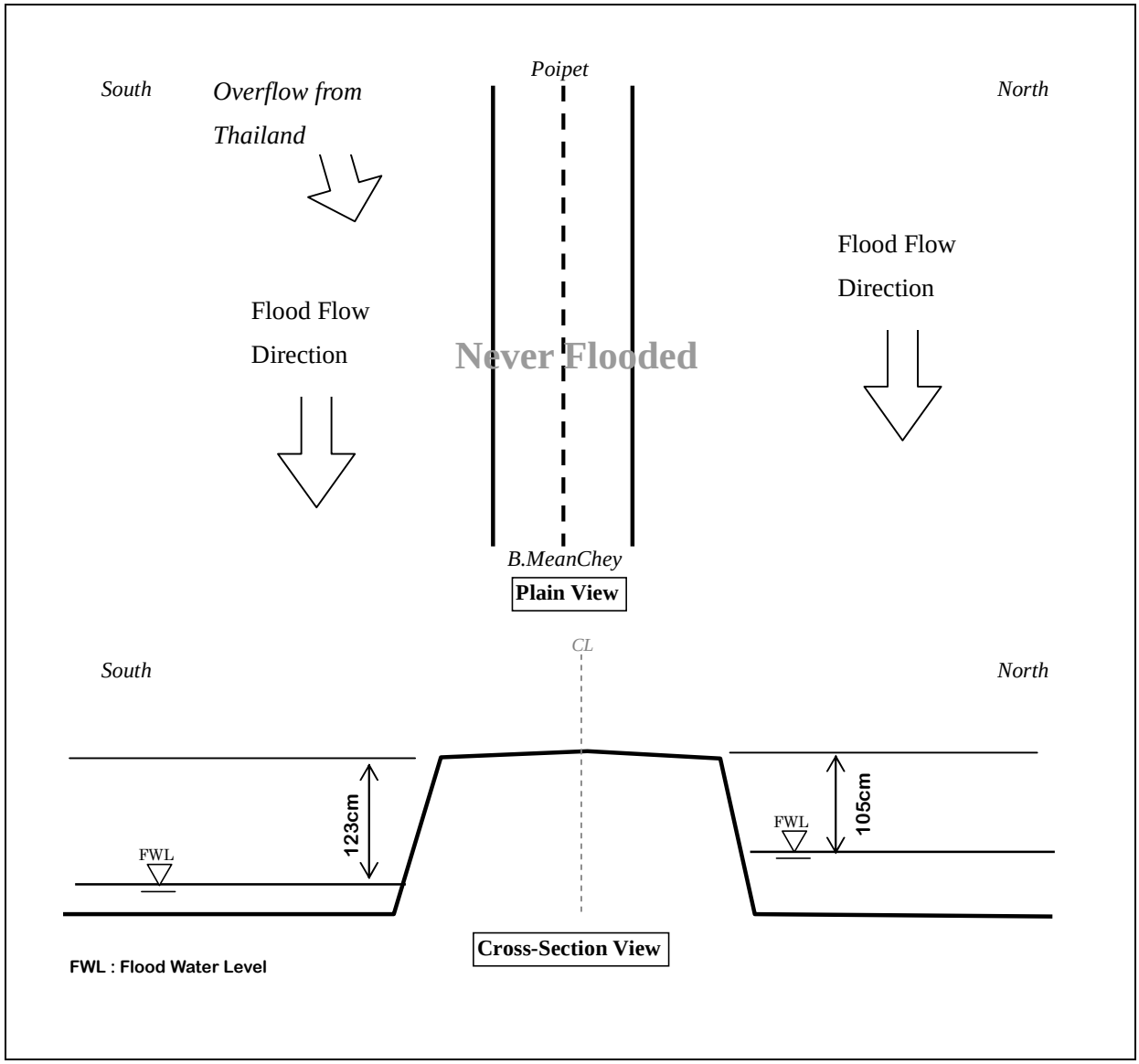
Date	7 Oct-2013		
Interview with	Noun Mao (DPWT staff)		
PK (km)	374+000	**Province**	BanteyMeanchey
Circumstance	Rice Field	**Drainage Facility**	-
Flood Level	No flood on the road 105 ~ 115cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	No Flood	**Occurrence Month**	Sep – Oct 2013
Remark	Around this area is higher than others.		



Inventory Sheet on Information of Flooding Conditions

	No.:	18

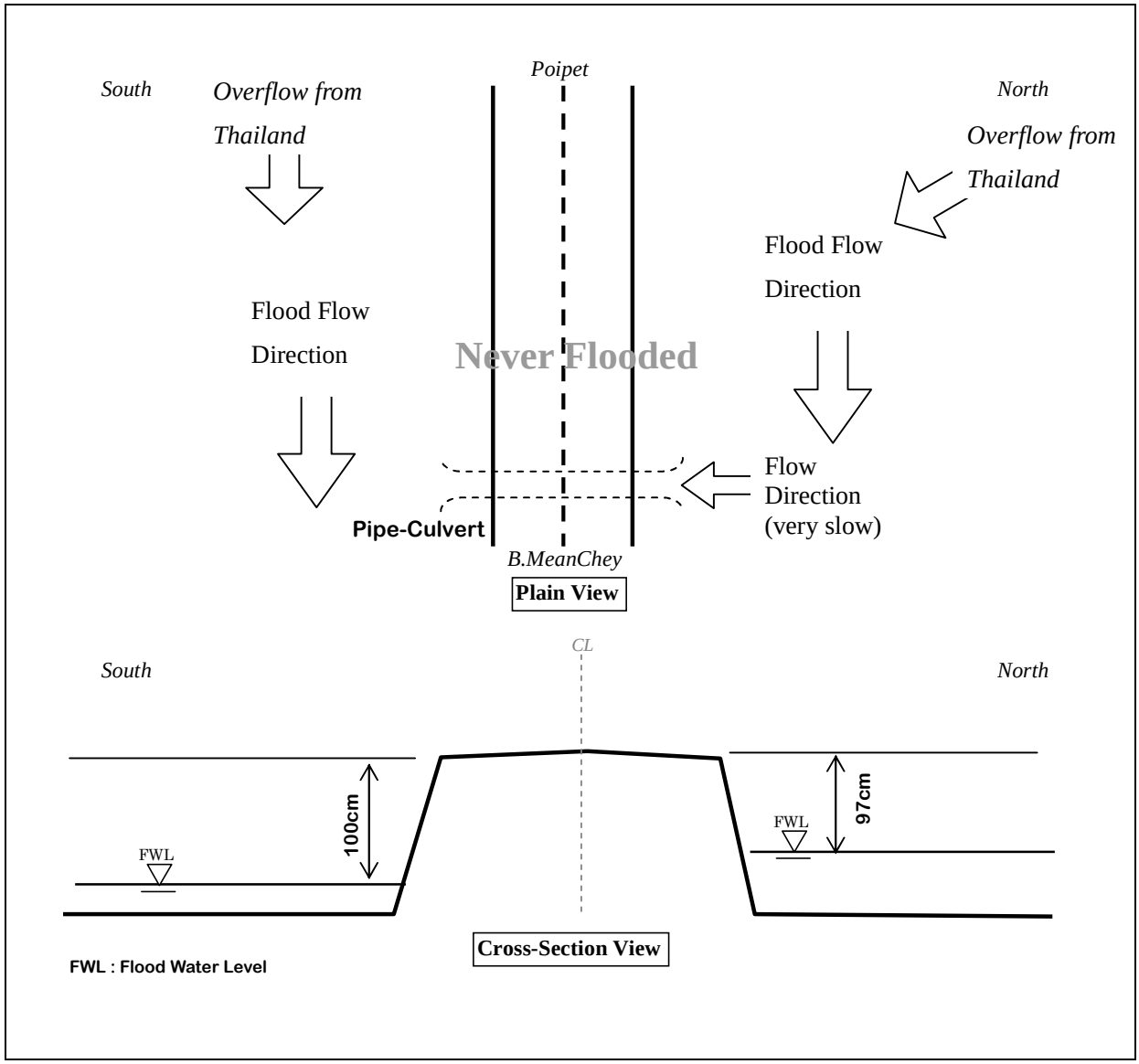
Date	7 Oct-2013		
Interview with	Nget Nak (Resident)		
PK (km)	376+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	-
Flood Level	No flood on the road 105 ~ 125cm below from NR5 (2013) (Usually no Flood)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Rainfall is much heavier and longer than usual in this season.		



Inventory Sheet on Information of Flooding Conditions

No.:	19

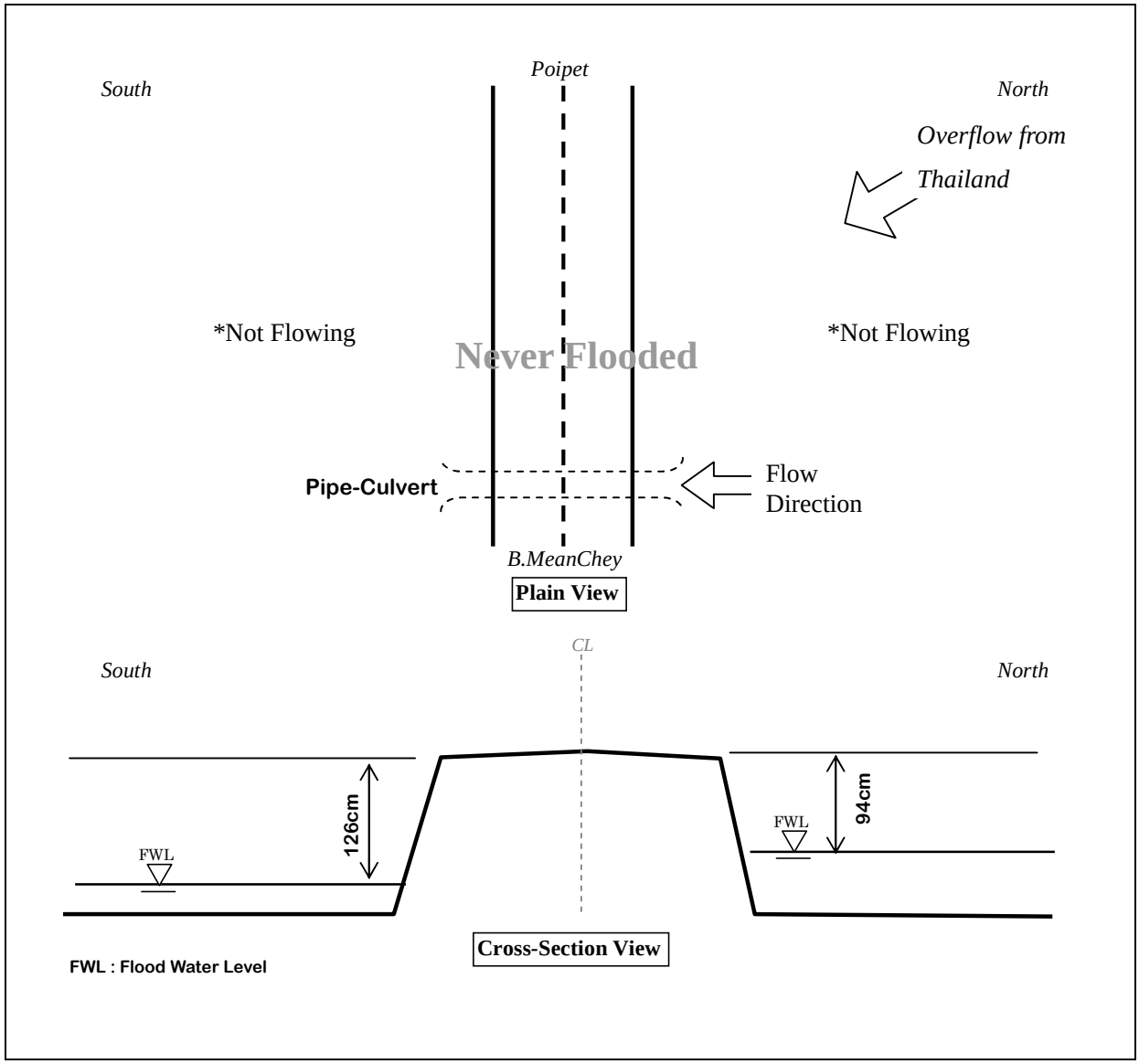
Date	7 Oct-2013		
Interview with	Sam Oun (Resident)		
PK (km)	378+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 95 ~ 100cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	10 Days	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand		



Inventory Sheet on Information of Flooding Conditions

	No.:	20

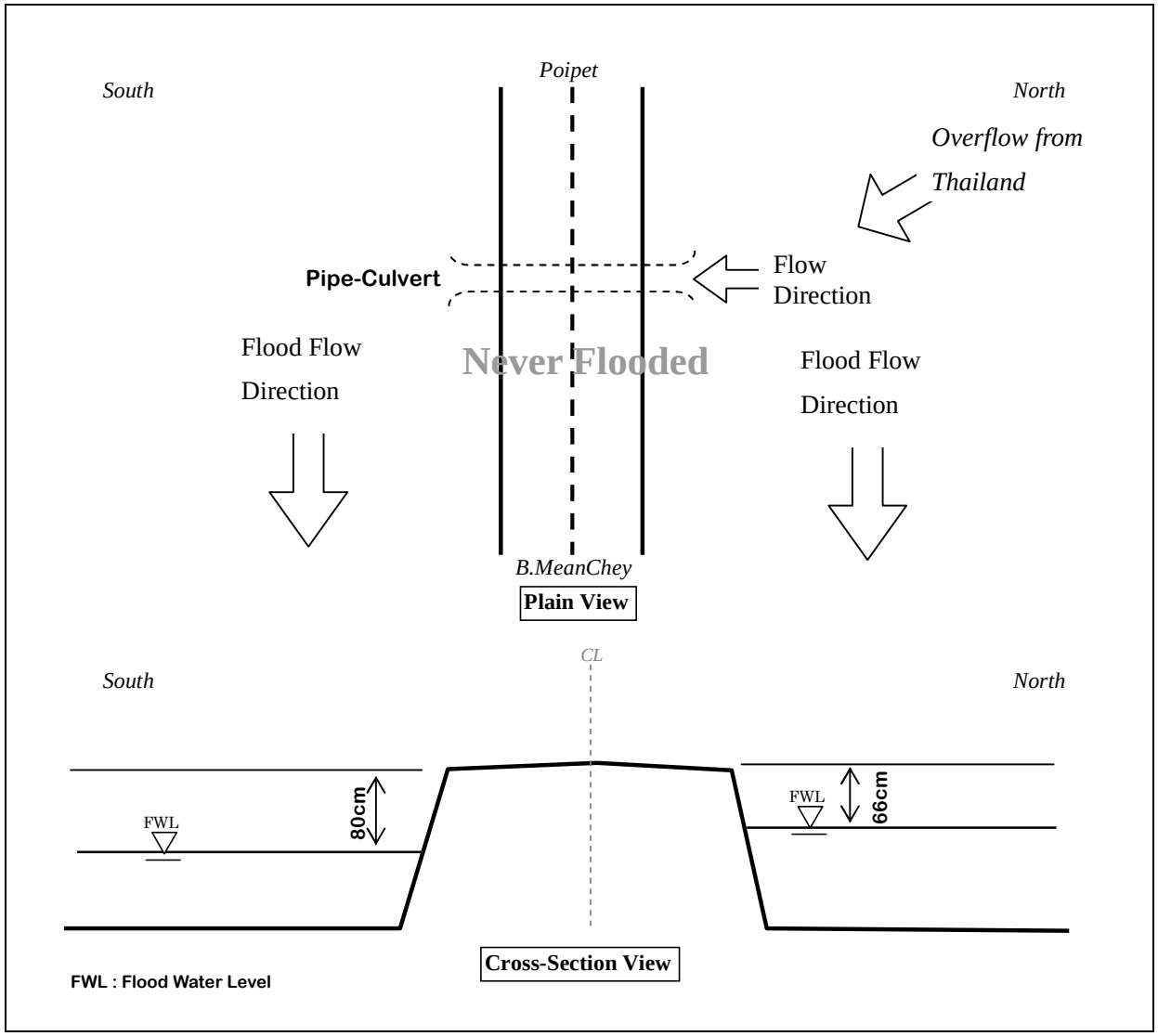
Date	7 Oct-2013		
Interview with	Chan Ra (Resident)		
PK (km)	380+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 95 ~ 100cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 ~ 3 weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by heavy rains		



Inventory Sheet on Information of Flooding Conditions

	No.:	21

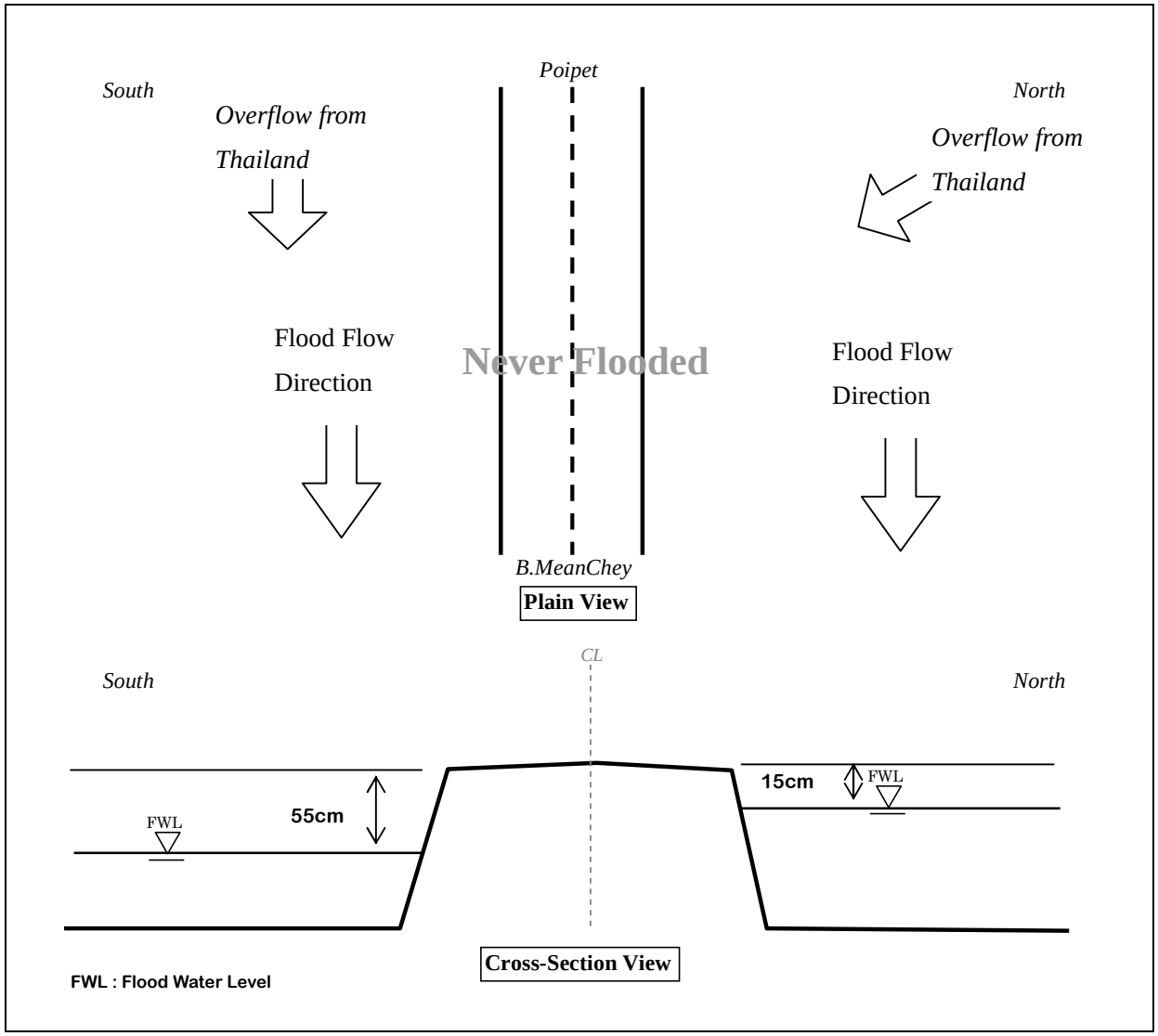
Date	7 Oct-2013		
Interview with	Pil Chantha (Resident)		
PK (km)	382+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 65 ~ 80cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	10 Days	**Occurrence Month**	Sep – Oct 2013
Remark	Flood level of north side is higher than south side usually. Flood level of 2010 was much lower than 2013.		



Inventory Sheet on Information of Flooding Conditions

	No.:	22

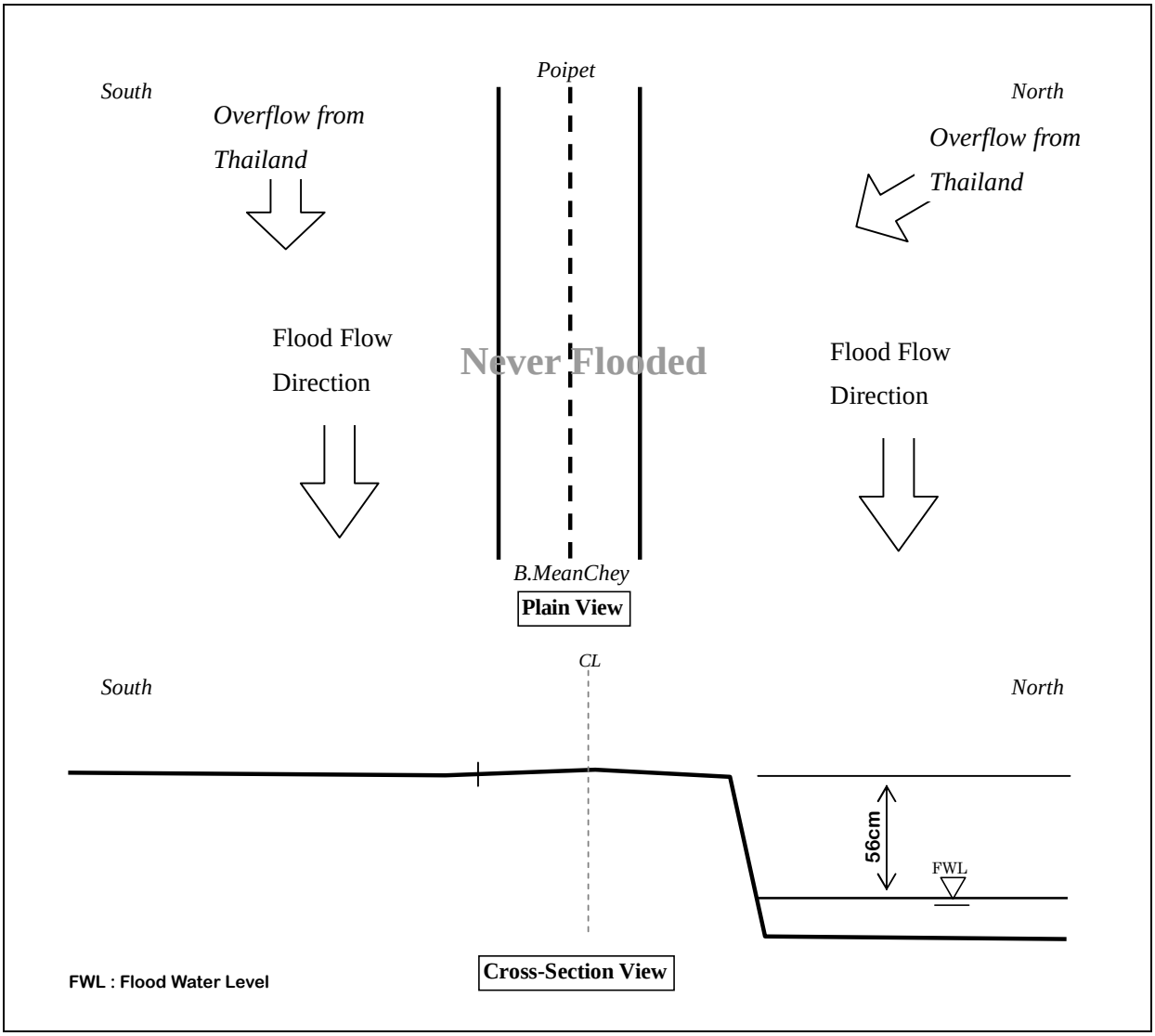
Date	7 Oct-2013		
Interview with	Rai (Resident)		
PK (km)	384+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	-
Flood Level	No flood on the road 15 ~ 55cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	10 ~ 15 Days	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand. Flood level has gotten higher since 5 Oct.		



Inventory Sheet on Information of Flooding Conditions

	No.:	23

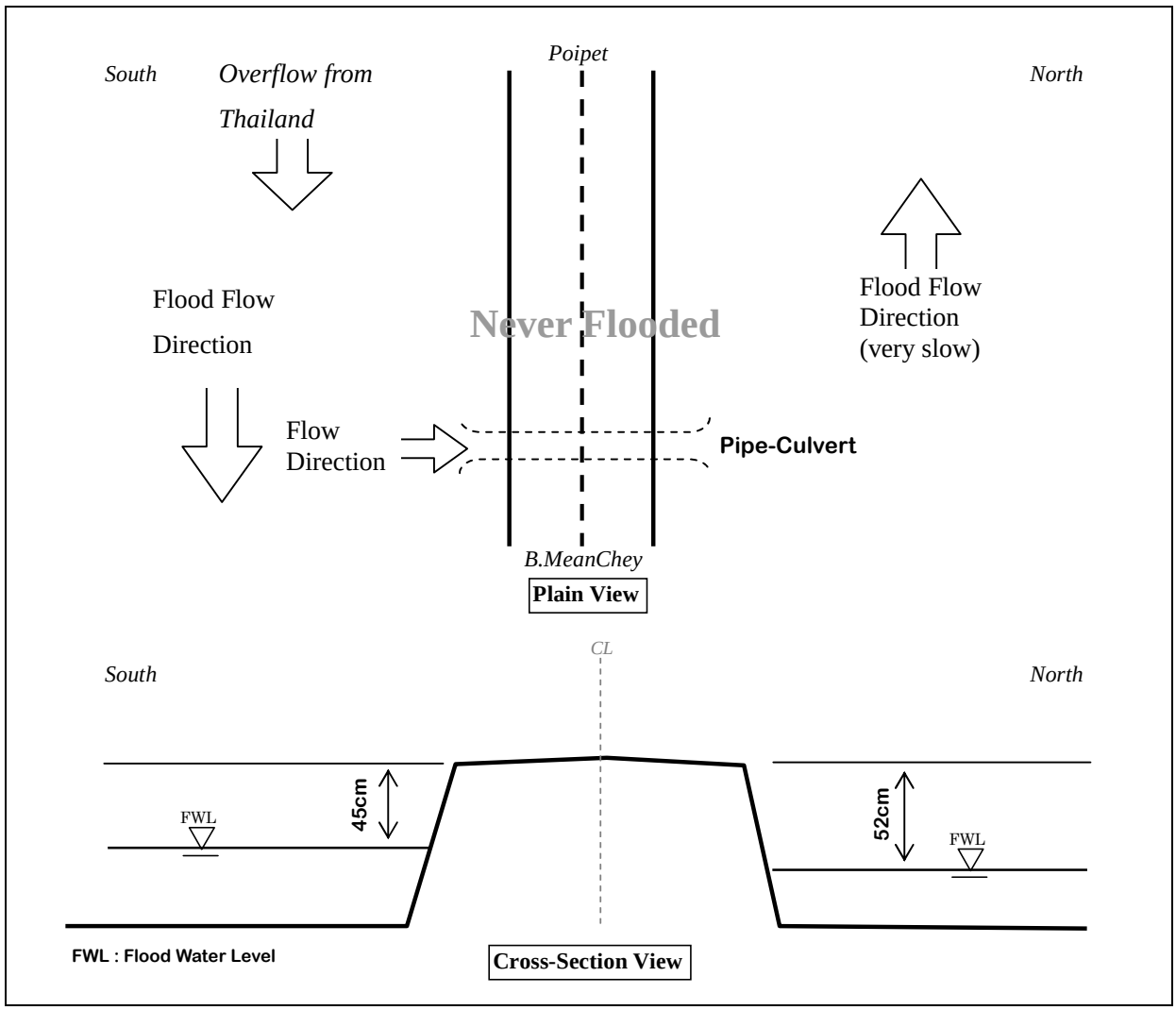
Date	7 Oct-2013		
Interview with	Chan Bo (Resident)		
PK (km)	386+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	-
Flood Level	No flood on the road 55cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 Weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand.		



Inventory Sheet on Information of Flooding Conditions

	No.:	24

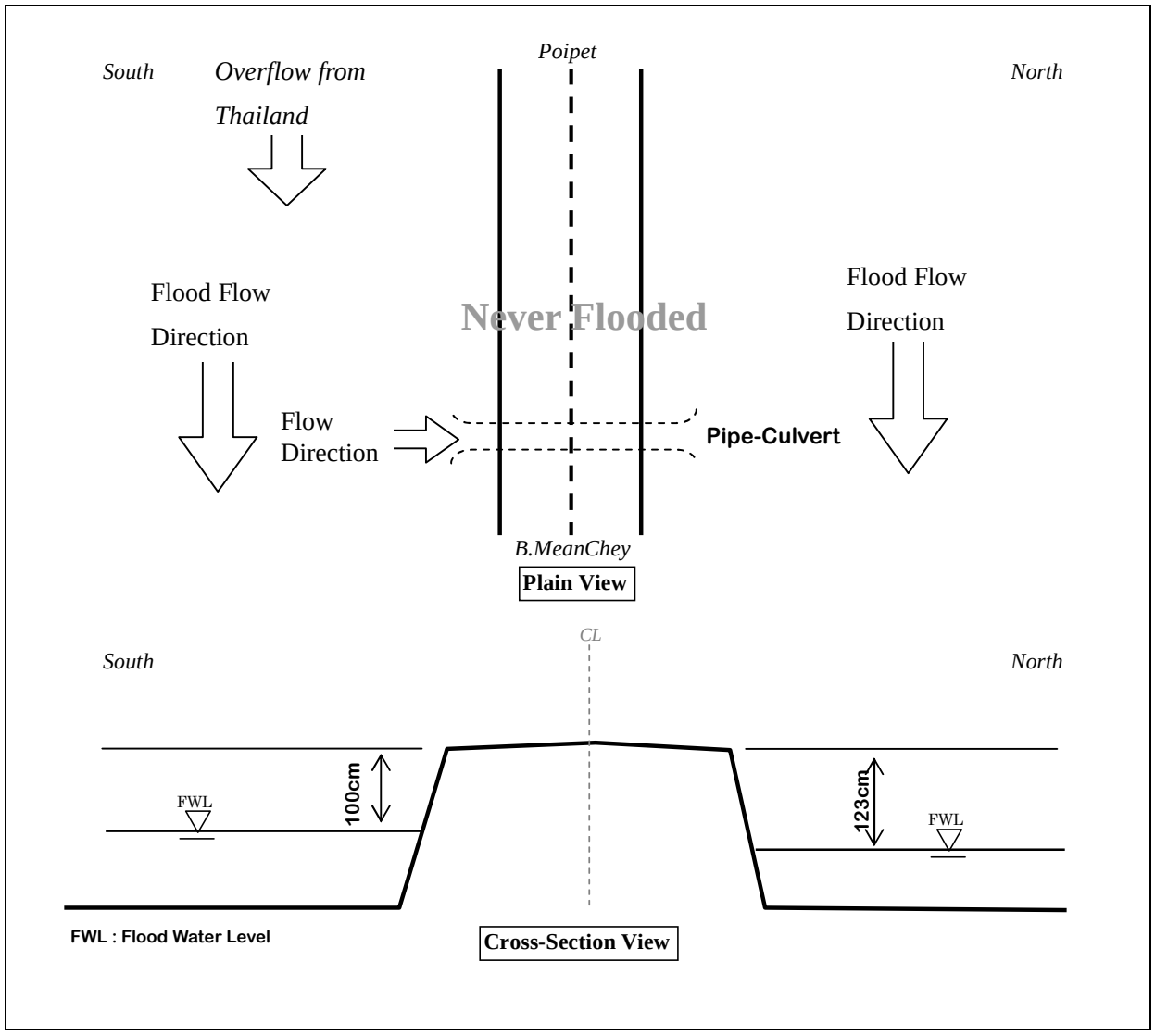
Date	7 Oct-2013		
Interview with	Peng (Resident)		
PK (km)	388+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 45 ~ 55cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	10 Days	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand in 2013. In 2010, flood also overflowed from Thailand but rainfall was much less than in2013. Duration of rainfall is 2 ~ 3 hr normally.		



Inventory Sheet on Information of Flooding Conditions

	No.:	25

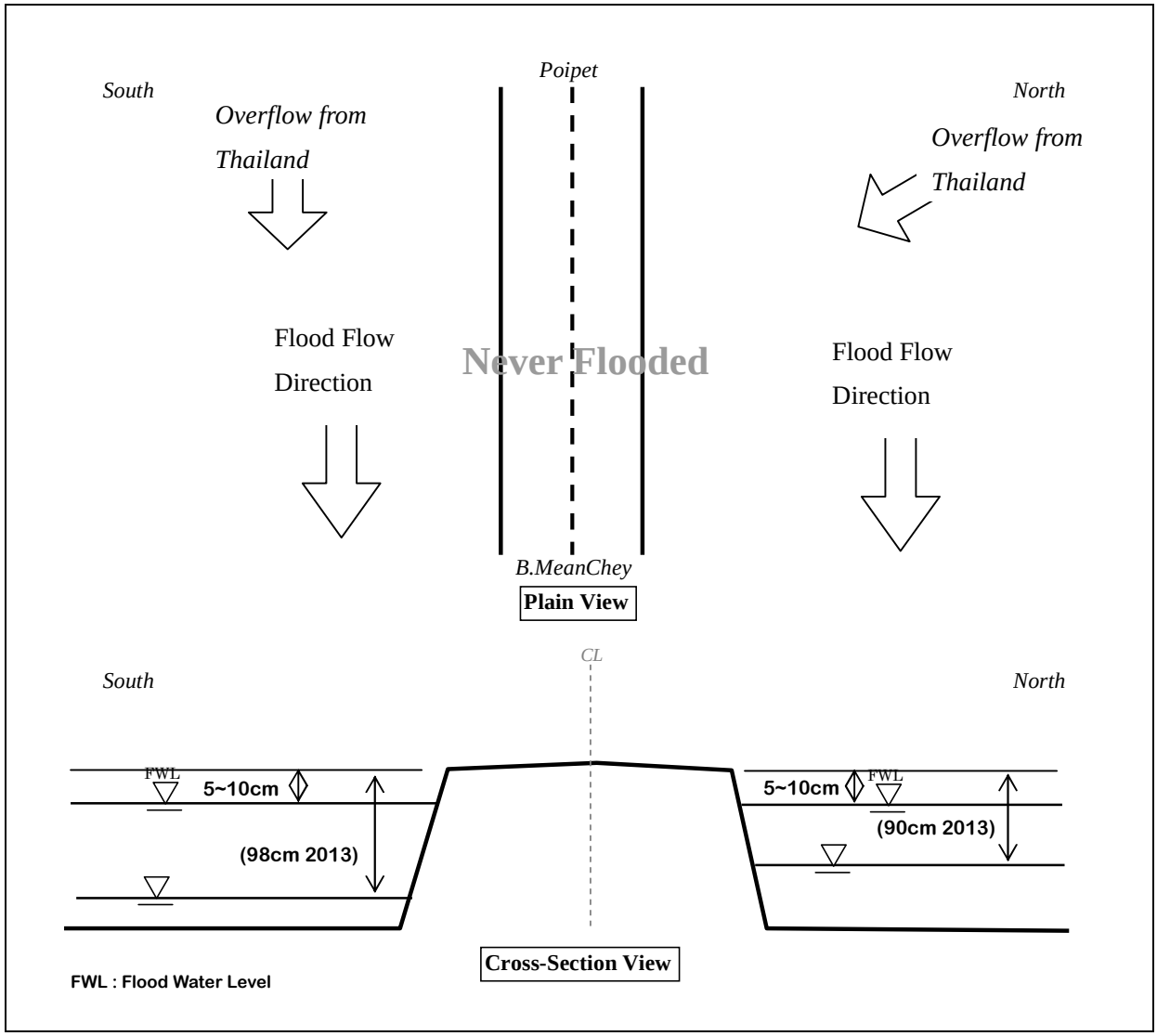
Date	7 Oct-2013		
Interview with	Oun Seuy (Resident)		
PK (km)	390+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 100 ~ 125cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	1 Week	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from the river along the border between Cambodia and Thailand.		



Inventory Sheet on Information of Flooding Conditions

No.:	26

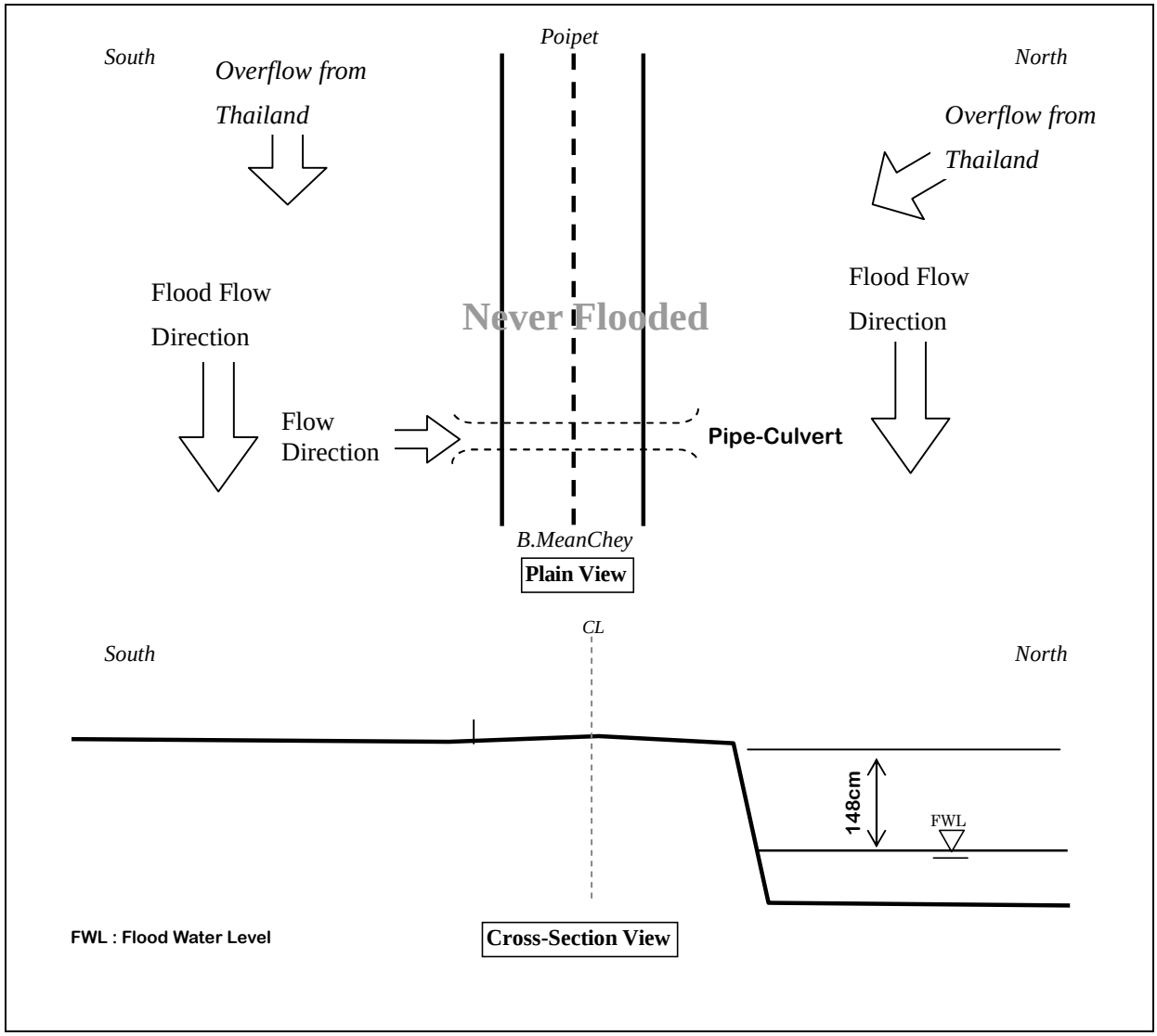
Date	7 Oct-2013		
Interview with	Som Kimlaorn (Resident)		
PK (km)	392+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	-
Flood Level	No flood on the road 5 ~ 10cm below from NR5 (2012)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	1 Week	**Occurrence Month**	Oct 2012
Remark			



Inventory Sheet on Information of Flooding Conditions

	No.:	27

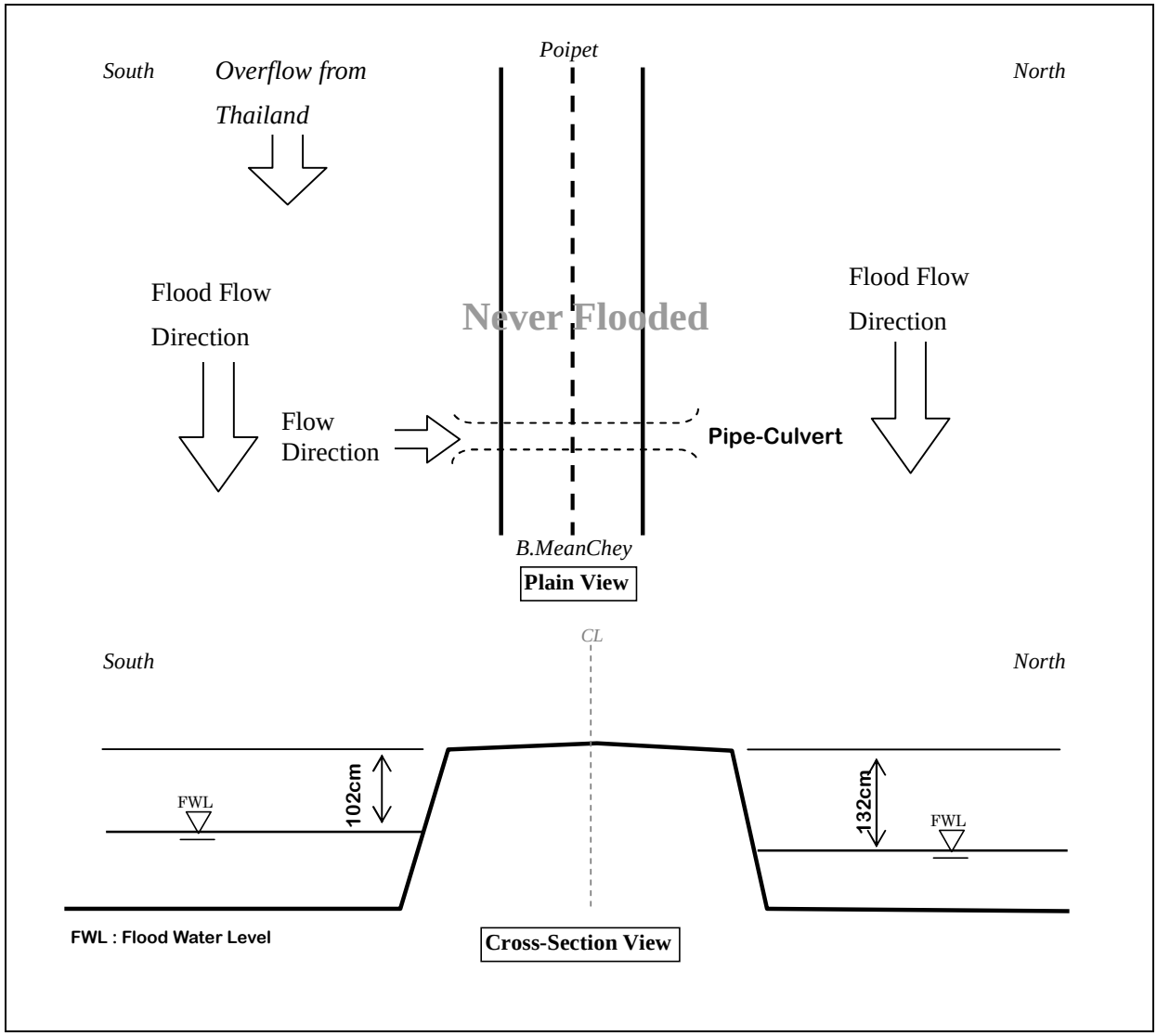
Date	7 Oct-2013		
Interview with	Tob Si Tharn (Resident)		
PK (km)	394+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 145cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	10 Days	**Occurrence Month**	Sep – Oct 2013
Remark	Flood level of 2013 is almost same as it of 2012.		



Inventory Sheet on Information of Flooding Conditions

	No.:	28

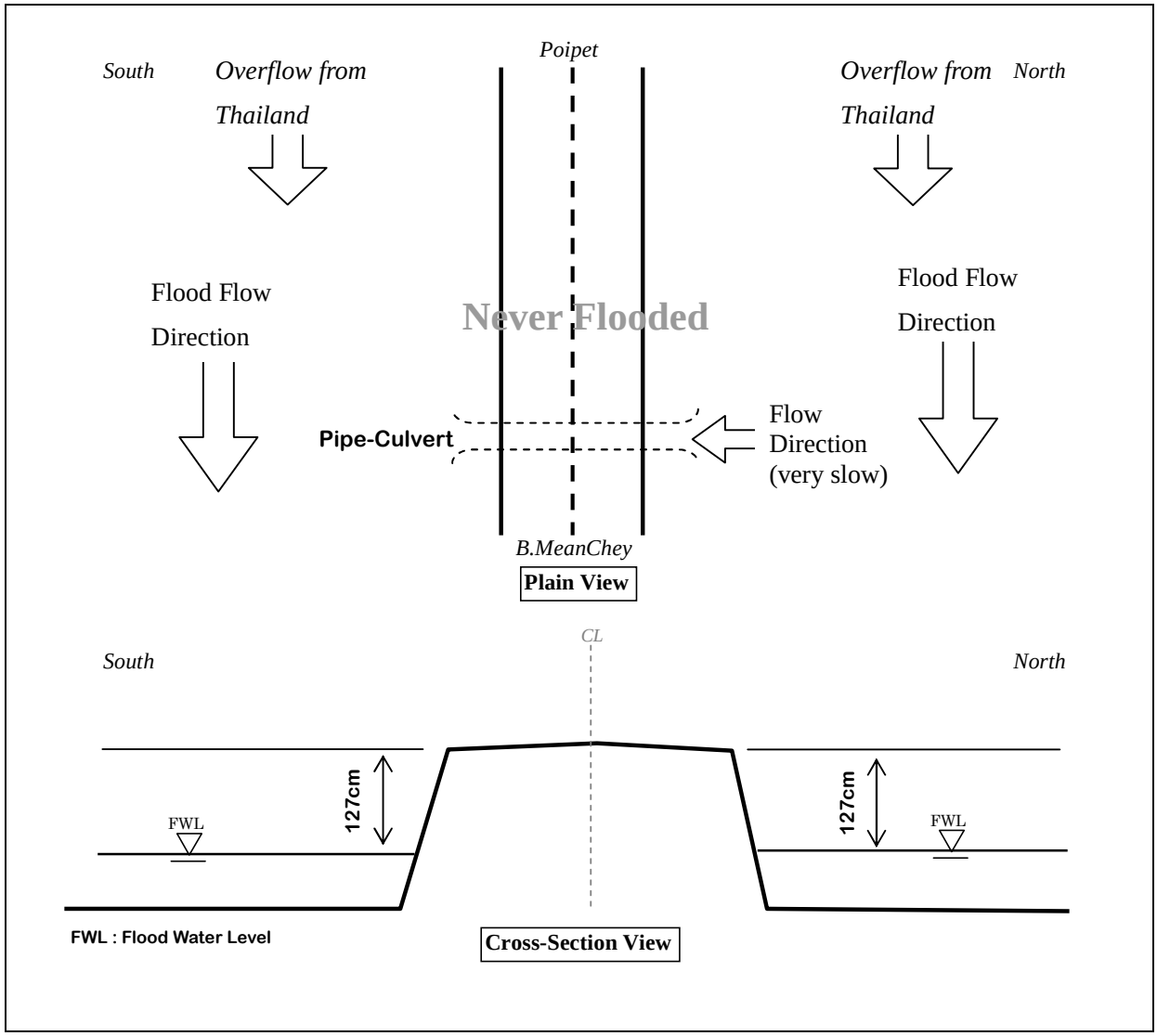
Date	7 Oct-2013		
Interview with	Seng Hak (Worker)		
PK (km)	396+000	**Province**	BanteyMeanchey
Circumstance	Residential area	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 100 ~ 135cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	1 Week	**Occurrence Month**	Sep – Oct 2013
Remark	Flood is affected by overflow from Thailand much more than rainfall.		



Inventory Sheet on Information of Flooding Conditions

	No.:	29

Date	7 Oct-2013		
Interview with	San Sok Chheun (Resident)		
PK (km)	400+000	**Province**	BanteyMeanchey
Circumstance	Rice Field	**Drainage Facility**	Pipe-C
Flood Level	No flood on the road 100 ~ 135cm below from NR5 (2013)		
Flood Flow Direction	East side → West side (Sisophon River)		
Frequency	Seldom		
Duration Per Flood	2 Weeks	**Occurrence Month**	Sep – Oct 2013
Remark	Flood caused by combination of heavy rains and overflow from Thailand.		



APPENDIX 6-5

SKETCHES OF THE TEST PITS

IN THE MIDDLE SECTION

Field Test Record

Date: .....21...../...05..../..2013....

Work Item: Digging Hole

Trial Pit No: 01

Location : KP: 171 + 035M

PVC Water Pipe: No

Optical Cable: No

Bituminous: 25 mm

Base Course: No mm

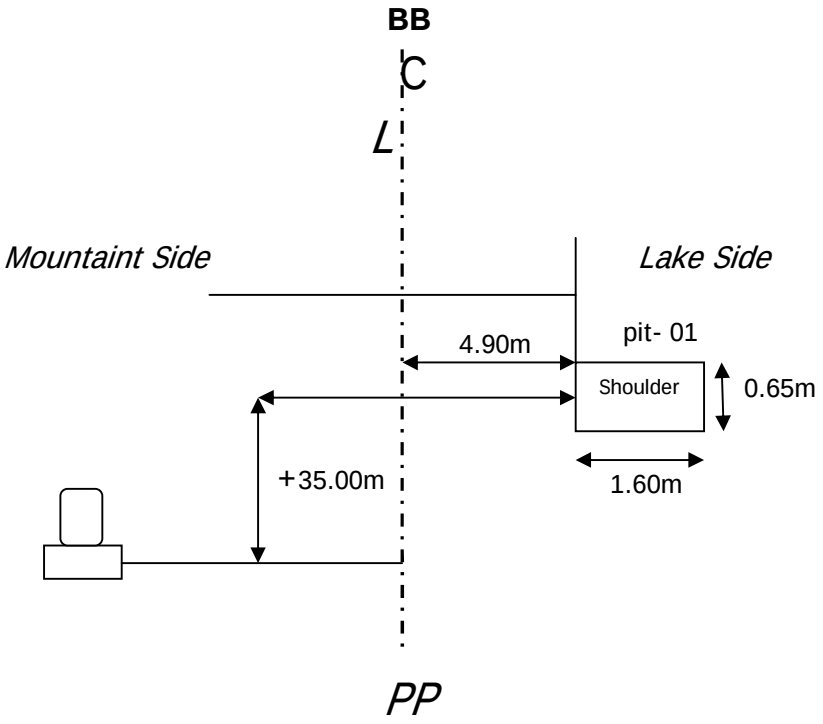
Sub-Base Course: No mm

Sub-Grade: 800 mm

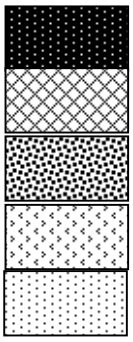
Embankment: 675 mm

N: 1384674. E: 0397309.

SKETCH



Note:



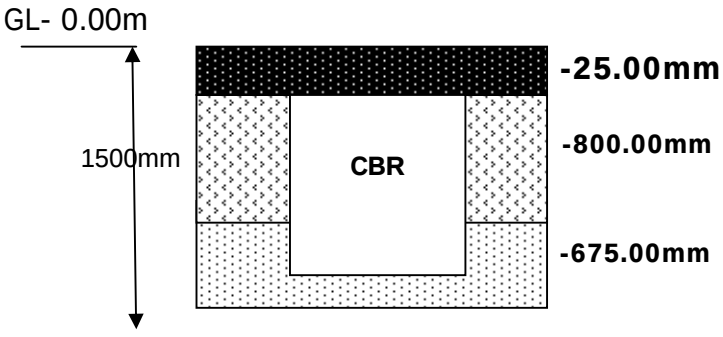
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....21../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....02.....

Location : KP....173.....+...000...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

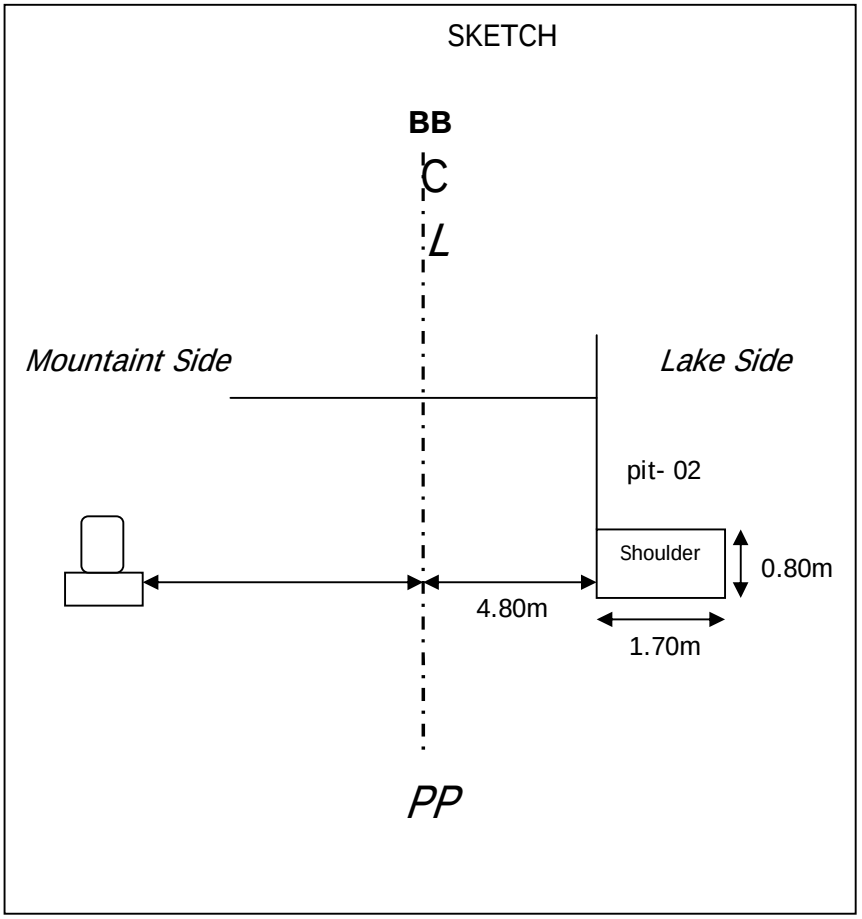
Base Course:.....No.....mm

Sub-Base Course:.....No.....mm

Sub-Grade:.....650.....mm

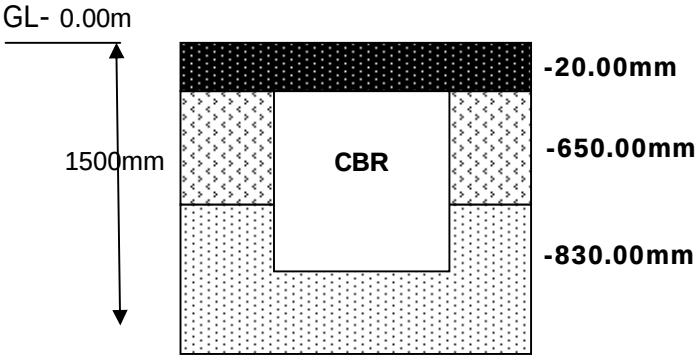
Embankment:.....830.....mm

N:..1384634...., E:..0395356.....



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....21../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....03.....

Location : KP....175.....+...000...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

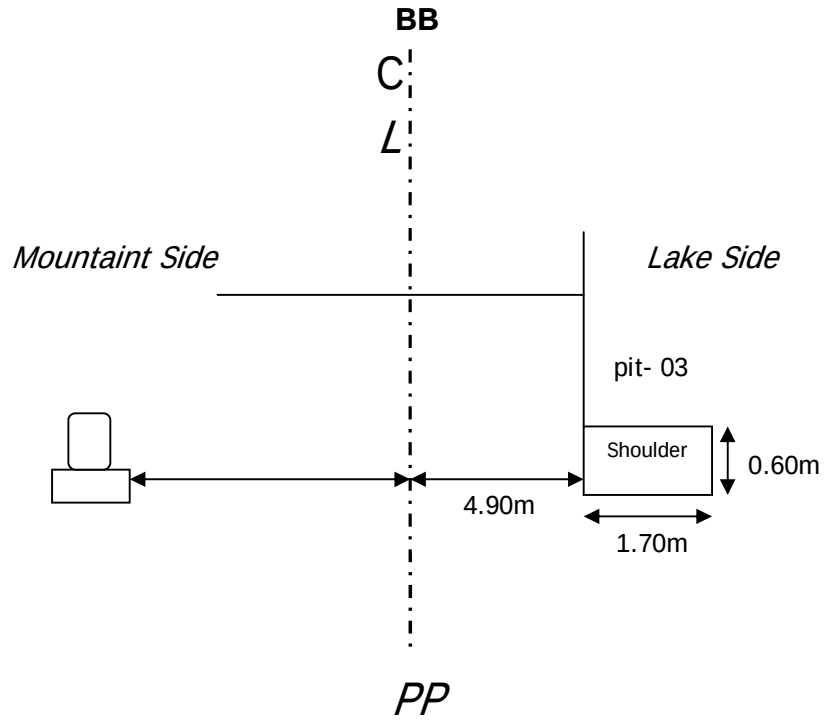
Sub-Base Course:.....No.....mm

Sub-Grade:.....650.....mm

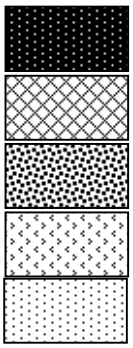
Embankment:.....830.....mm

N:..1384580...., E:..0393378.....

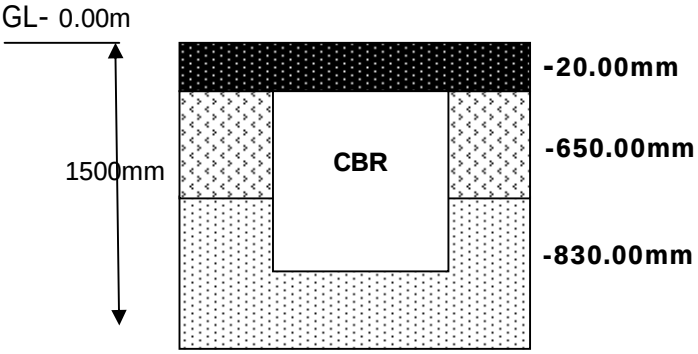
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....21../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....04.....

Location : KP....177.....+...005M..

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....15.....mm

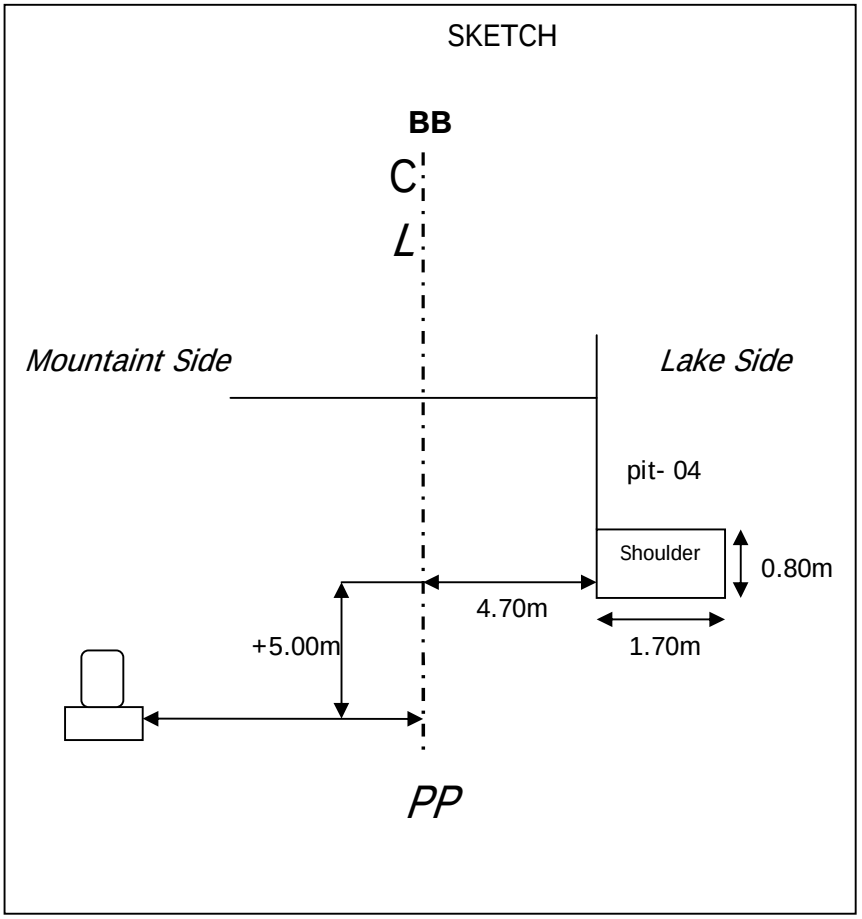
Base Course:.....No.....mm

Sub-Base Course:.....No.....mm

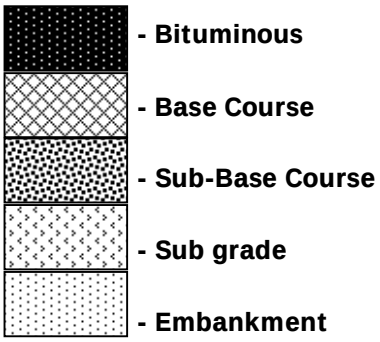
Sub-Grade:.....700.....mm

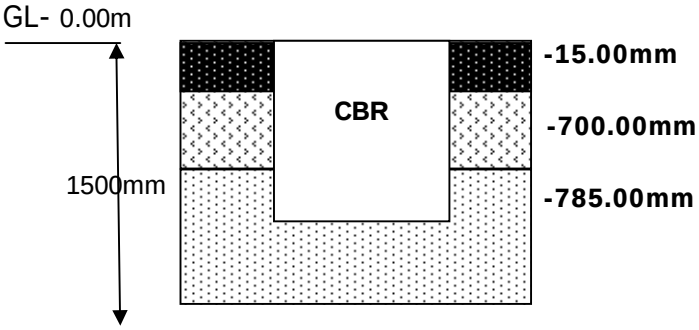
Embankment:.....785.....mm

N:..1384646...., E:..0391397.....



Note:





Field Test Record

Date: .....22../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....05.....

Location : KP....179.....+...000...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....15.....mm

Base Course:.....No.....mm

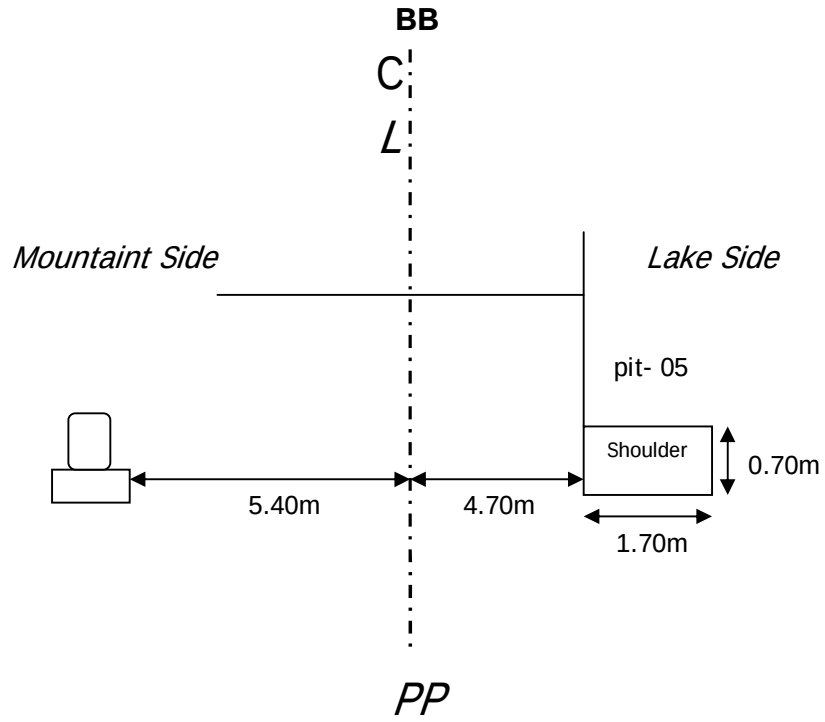
Sub-Base Course:.....No.....mm

Sub-Grade:.....700.....mm

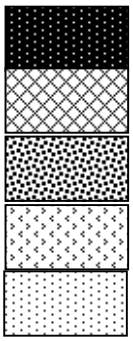
Embankment:.....785.....mm

N:..1384762...., E:..0389368.....

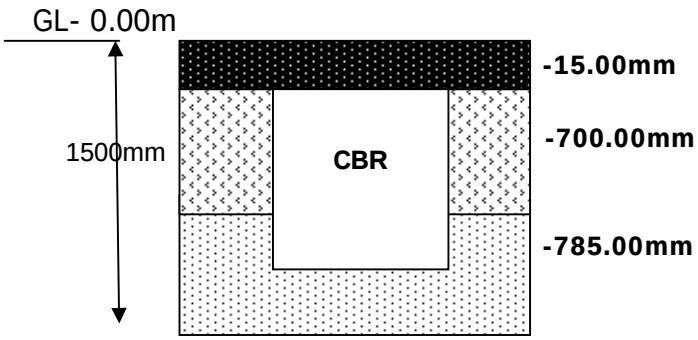
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....22../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....06.....

Location : KP....181.....+...004M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

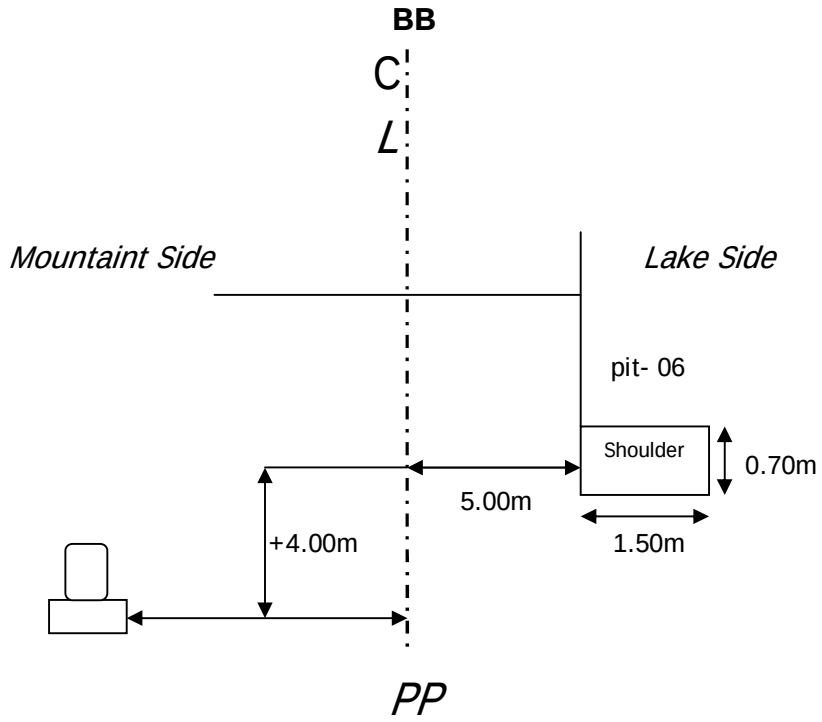
Sub-Base Course:.....No.....mm

Sub-Grade:.....700.....mm

Embankment:.....780.....mm

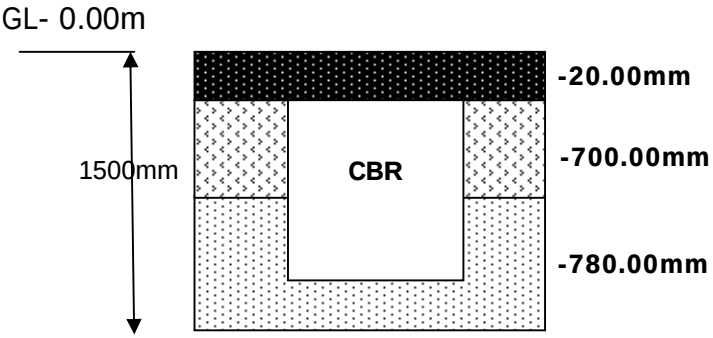
N:..1384869...., E:..0384869.....

SKETCH



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....22../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....07.....

Location : KP....183.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

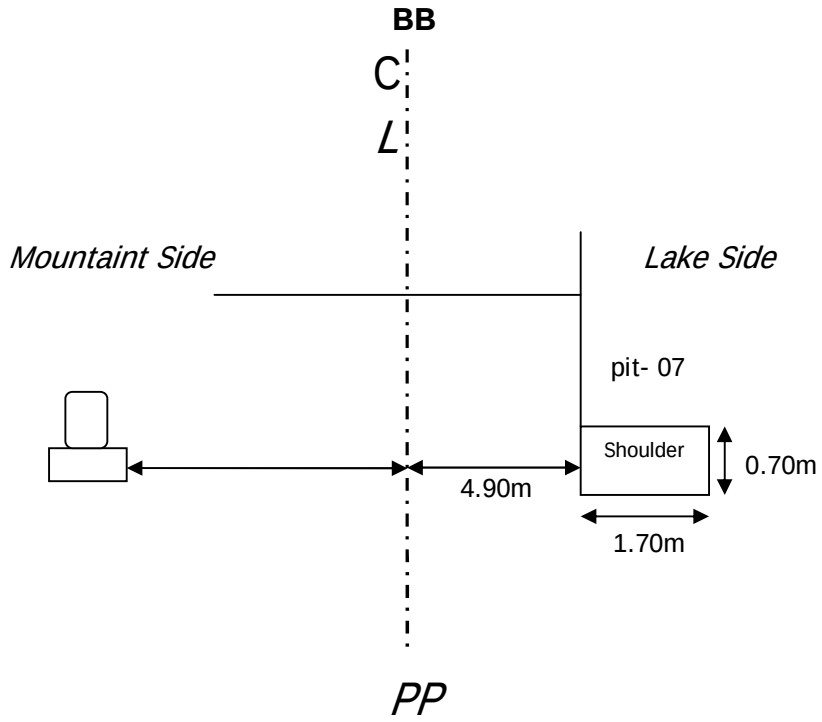
Sub-Base Course:.....No.....mm

Sub-Grade:.....700.....mm

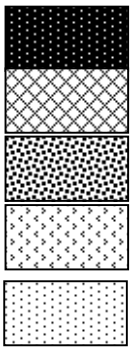
Embankment:.....780.....mm

N:..1384963...., E:..0385514.....

SKETCH



Note:



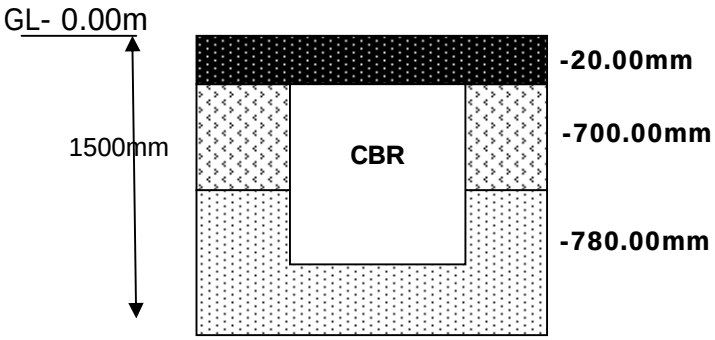
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....22../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....08.....

Location : KP....185.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

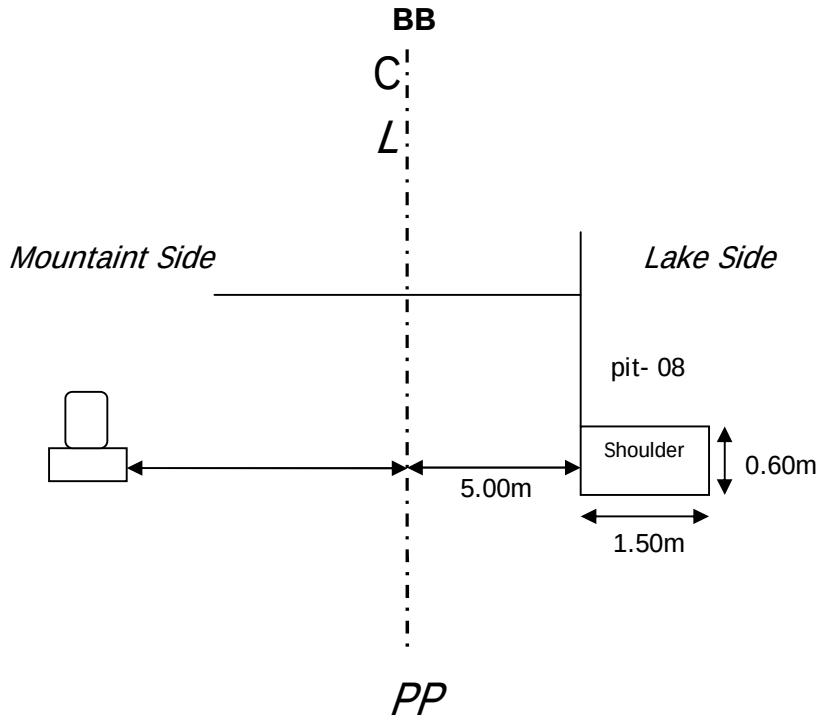
Sub-Base Course:.....No.....mm

Sub-Grade:.....700.....mm

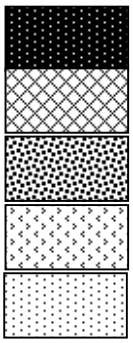
Embankment:.....780.....mm

N:..1385185...., E:..0383623.....

SKETCH



Note:



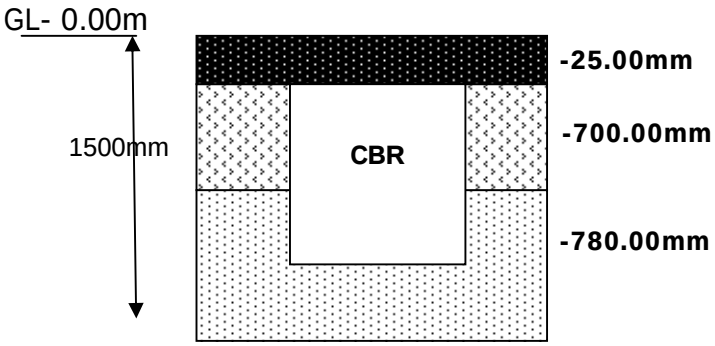
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....23../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....09.....

Location : KP....187.....+...0.10M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

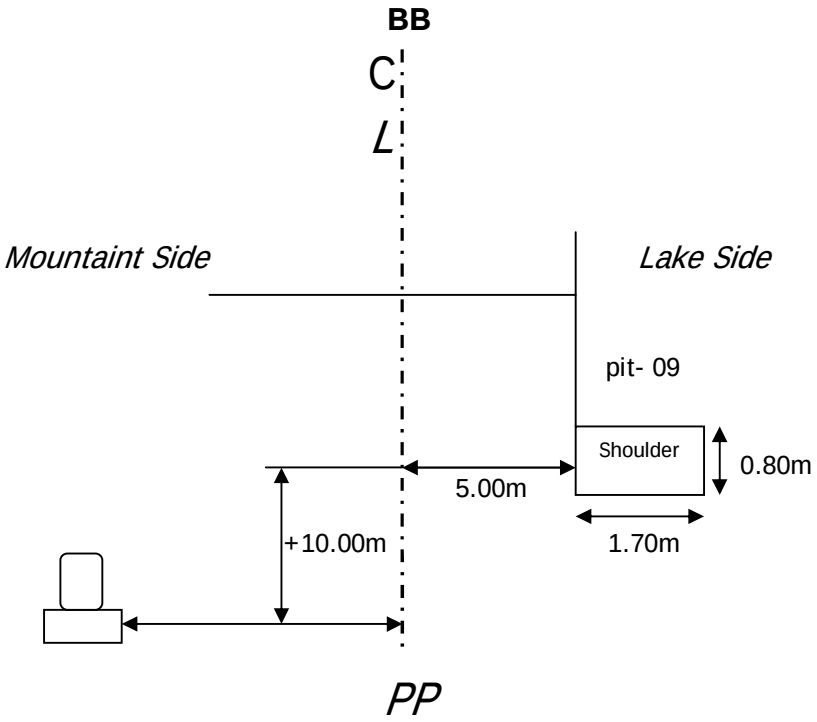
Sub-Base Course:.....No.....mm

Sub-Grade:.....600.....mm

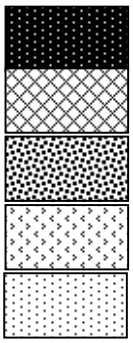
Embankment:.....880.....mm

N:..1385916...., E:..0381834.....

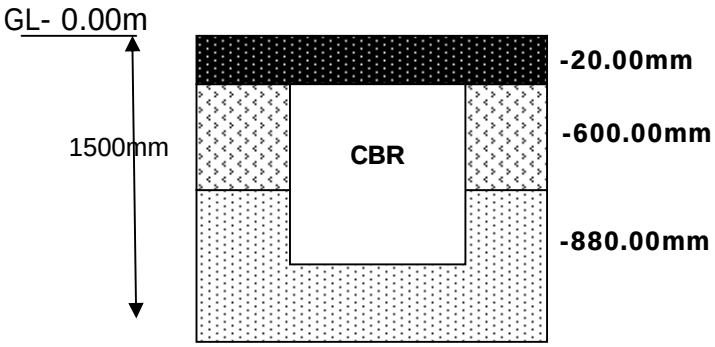
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....23../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....10.....

Location : KP....189.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

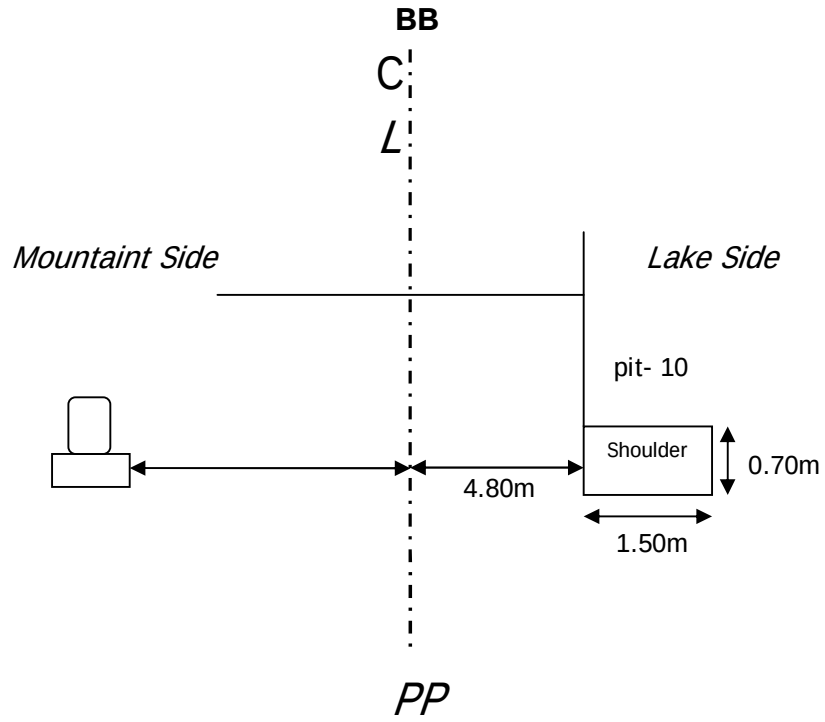
Sub-Base Course:.....No.....mm

Sub-Grade:.....700.....mm

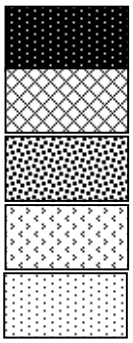
Embankment:.....780.....mm

N:..1386716...., E:..0380068.....

SKETCH



Note:



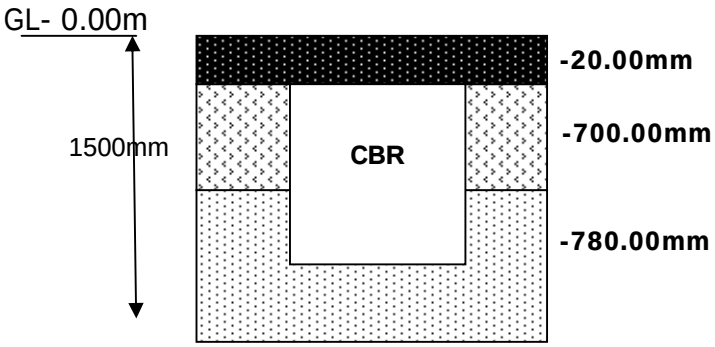
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....23../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....11.....

Location : KP....191.....+...0.02M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

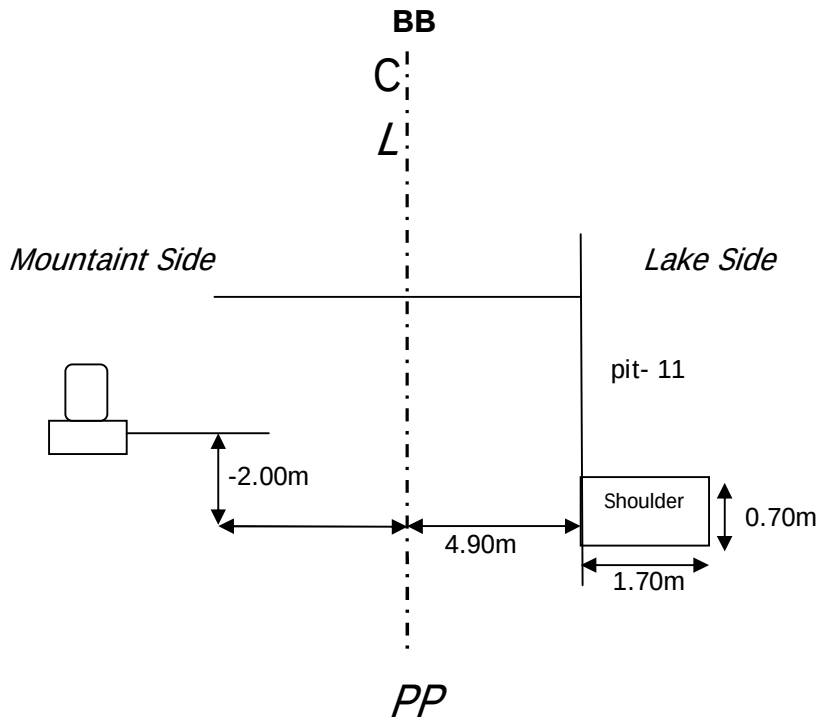
Sub-Base Course:.....No.....mm

Sub-Grade:.....600.....mm

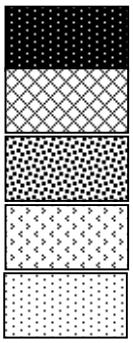
Embankment:.....880.....mm

N:..1387519...., E:..0378230.....

SKETCH



Note:



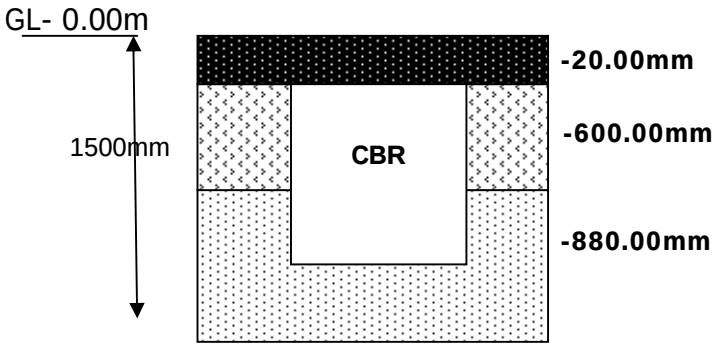
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....23../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....12.....

Location : KP....193.....-...0.08...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

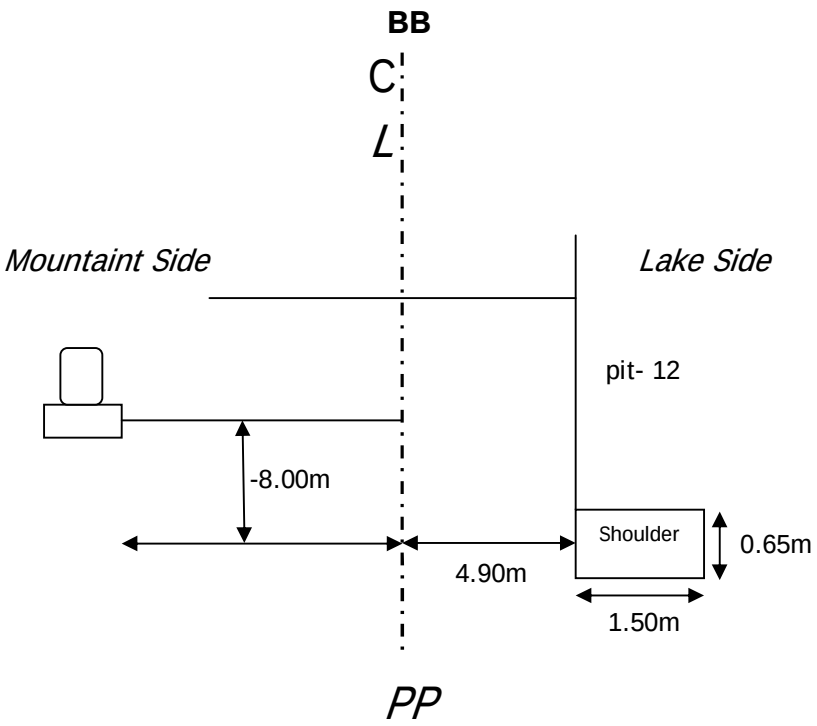
Sub-Base Course:.....180.....mm

Sub-Grade:.....500.....mm

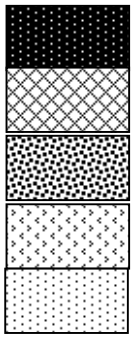
Embankment:.....800.....mm

N: 1388280, E: 0376320

SKETCH



Note:



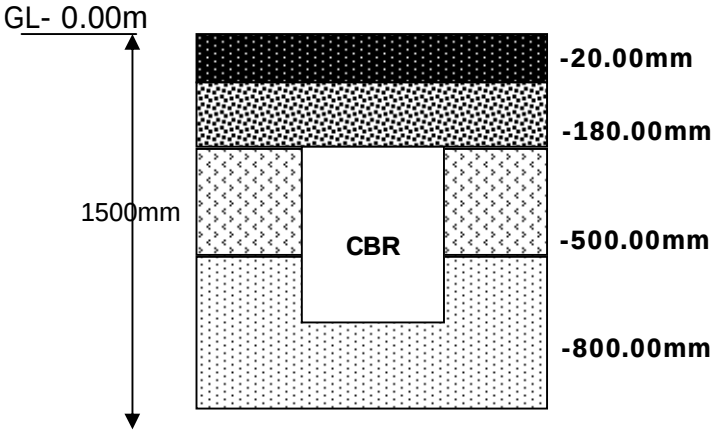
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....23../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....13.....

Location : KP....195.....-...0.05M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

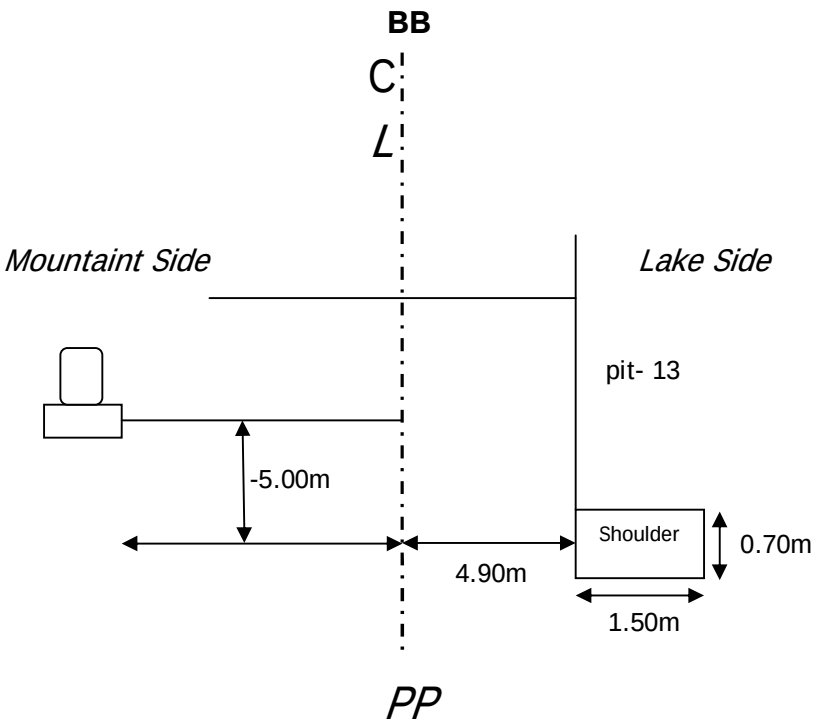
Sub-Base Course:.....230.....mm

Sub-Grade:.....400.....mm

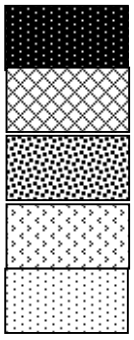
Embankment:.....850.....mm

N: 1389389, E: 0374556

SKETCH



Note:



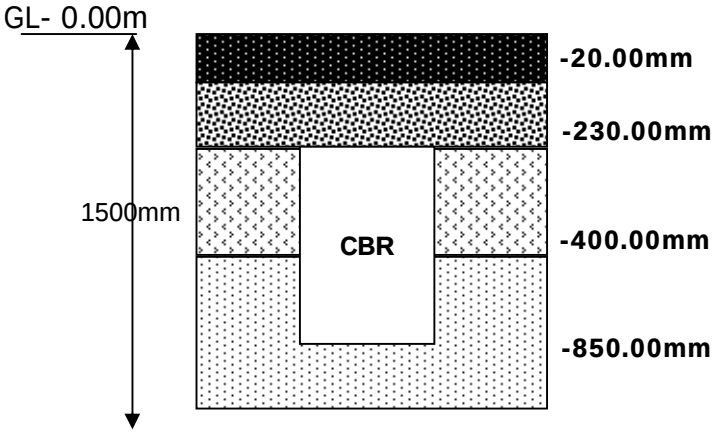
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....14.....

Location : KP....197.....+...0.04M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

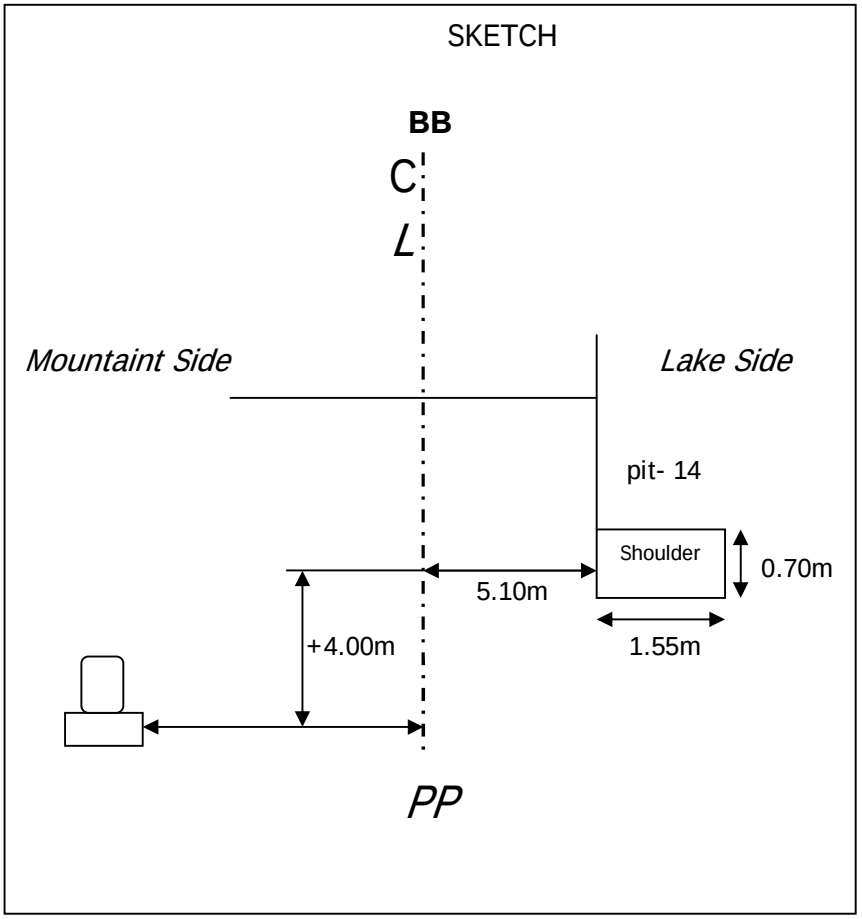
Base Course:.....No.....mm

Sub-Base Course:.....330.....mm

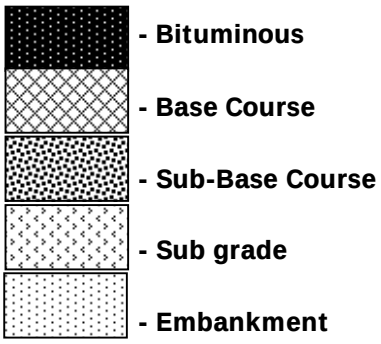
Sub-Grade:.....300.....mm

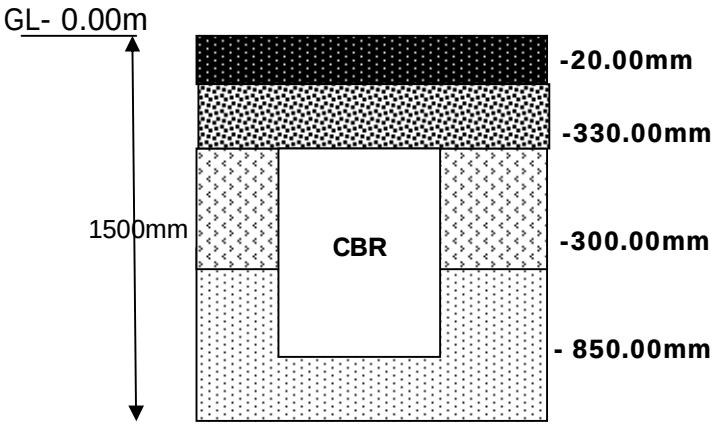
Embankment:.....850.....mm

N: 1390488, E: 0372801



Note:





Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....15.....

Location : KP....199.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

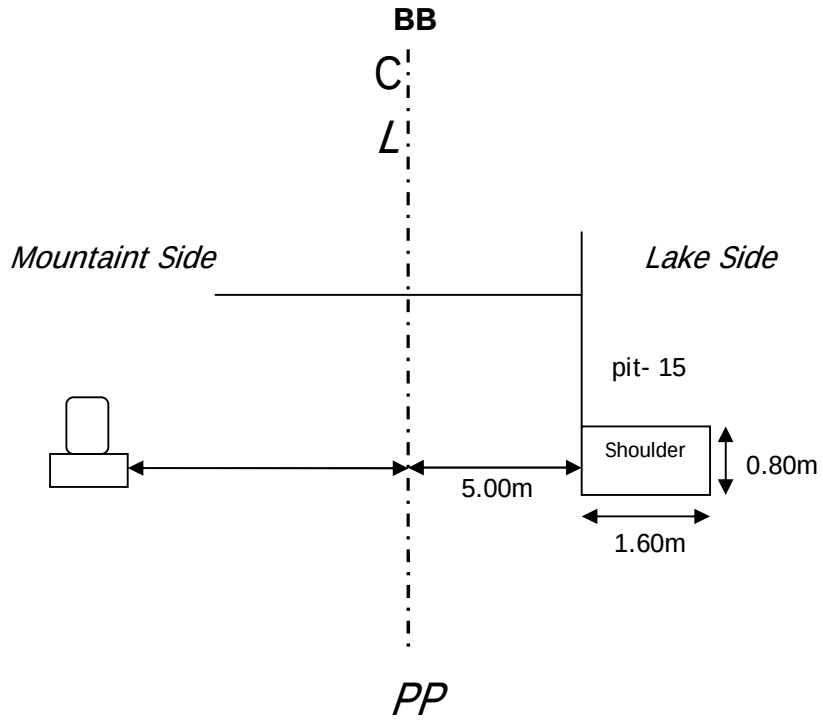
Sub-Base Course:.....300.....mm

Sub-Grade:.....400.....mm

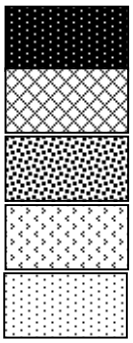
Embankment:.....780.....mm

N: 1391575, E: 0371082

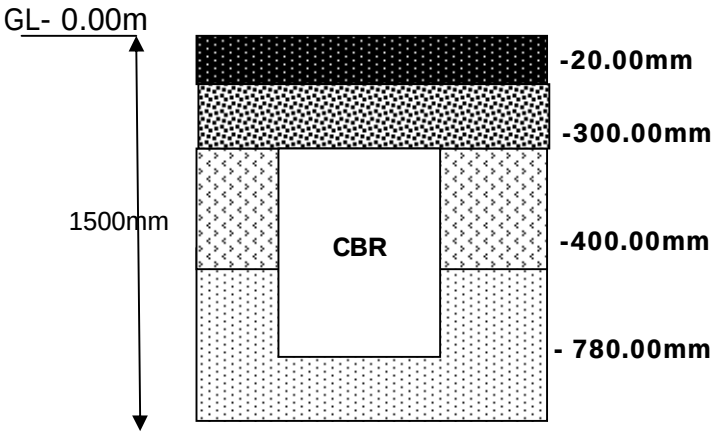
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....16.....

Location : KP....201.....+...0.03M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

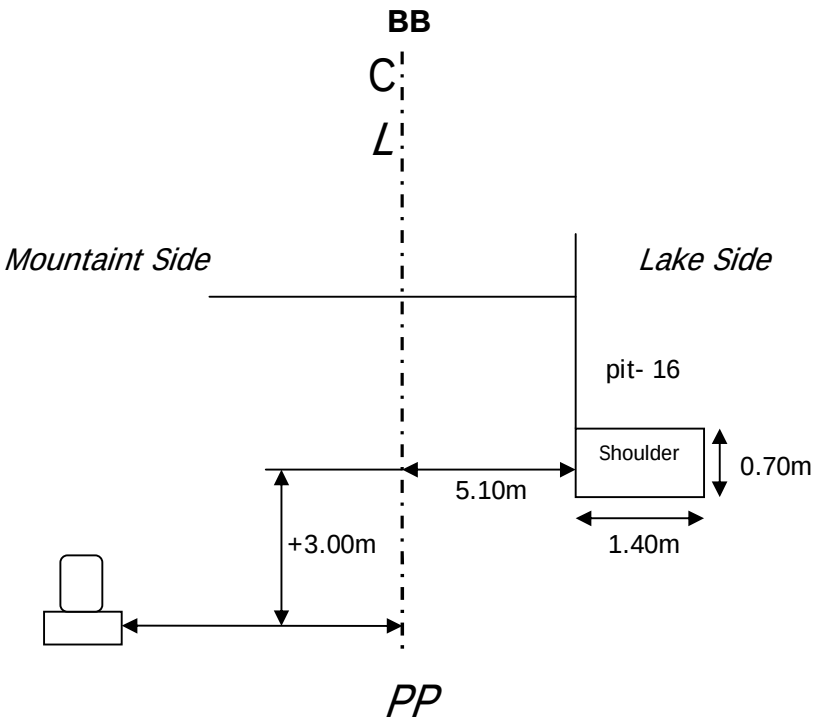
Sub-Base Course:.....250.....mm

Sub-Grade:.....500.....mm

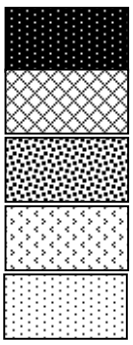
Embankment:.....730.....mm

N: 1392639, E: 0369395

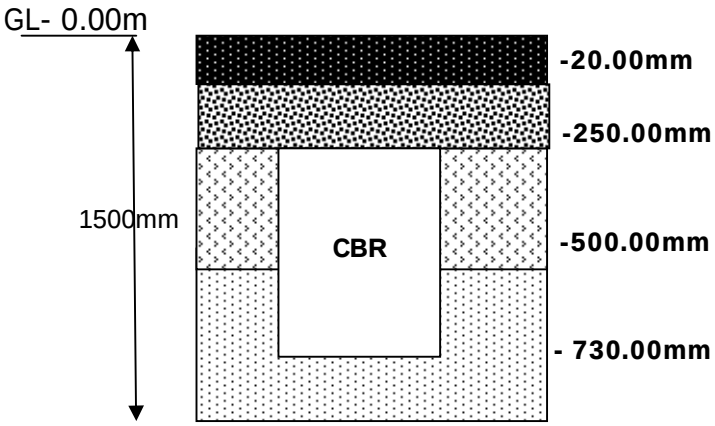
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....17.....

Location : KP....203.....+...0.07M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

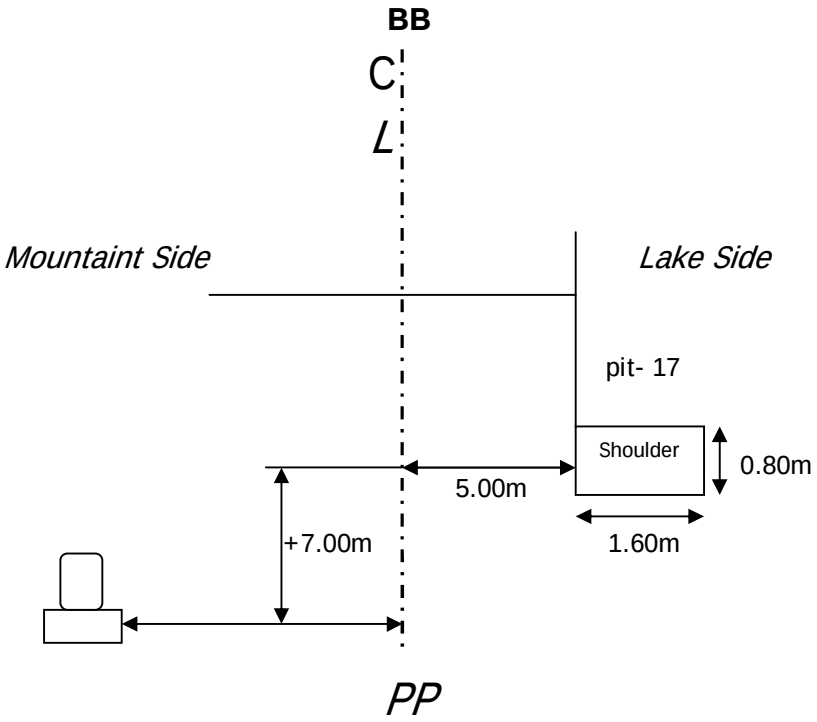
Sub-Base Course:.....300.....mm

Sub-Grade:.....400.....mm

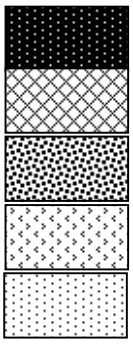
Embankment:.....780.....mm

N: 1393711, E: 0367682

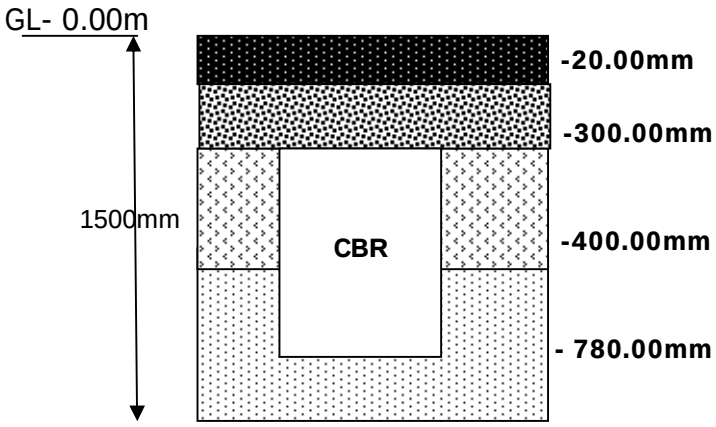
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....18.....

Location : KP....205.....+...0.02M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

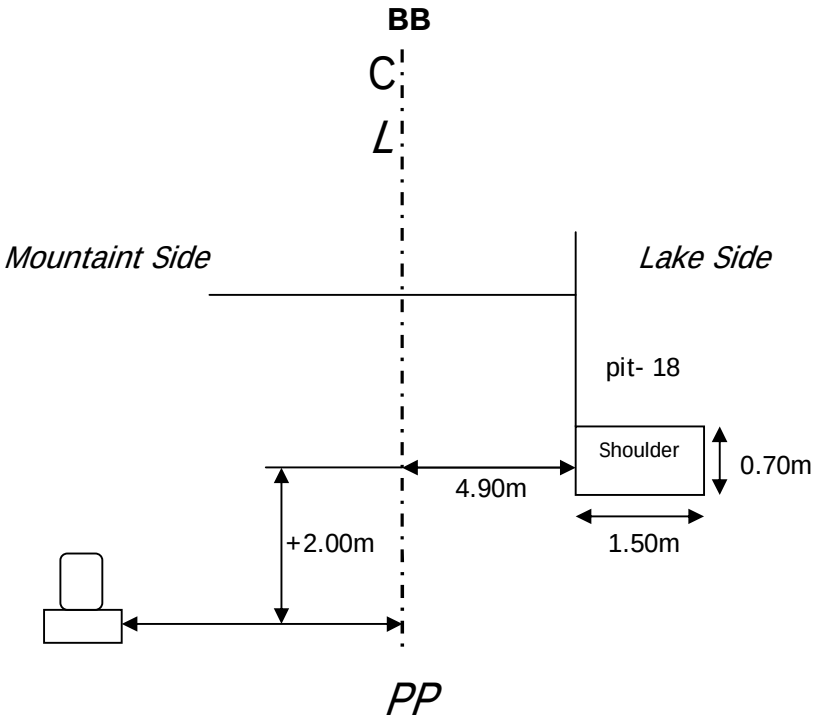
Sub-Base Course:.....200.....mm

Sub-Grade:.....400.....mm

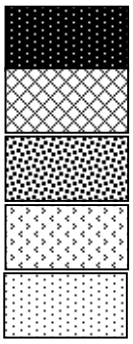
Embankment:....880.....mm

N: 1393711, E: 0367682

SKETCH



Note:



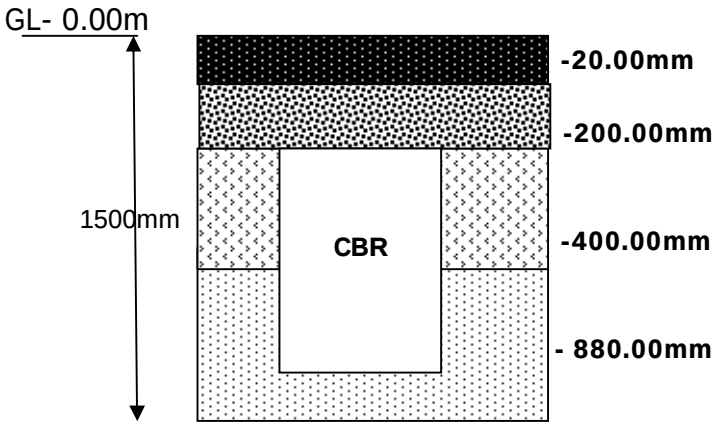
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....19.....

Location : KP...207.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

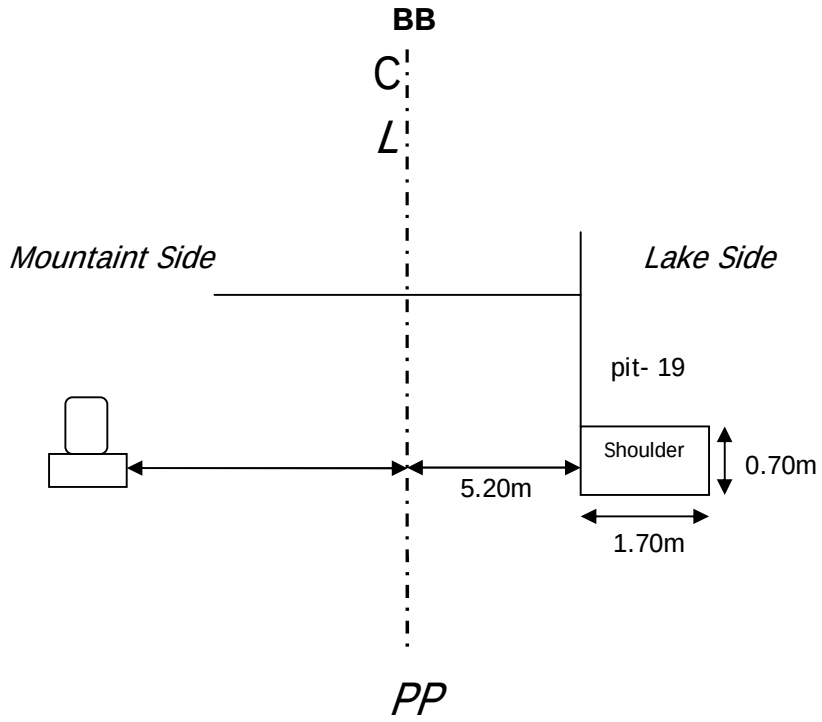
Sub-Base Course:.....250.....mm

Sub-Grade:.....500.....mm

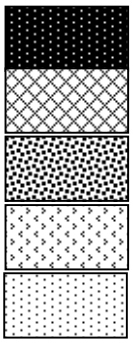
Embankment:.....770.....mm

N: 1395829, E: 0364314

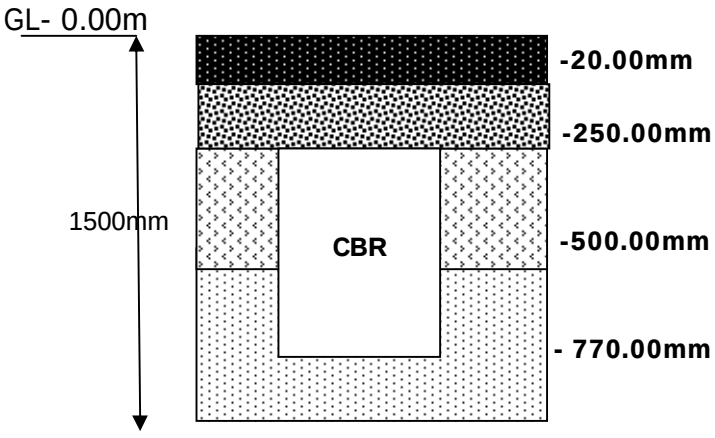
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....25../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....20.....

Location : KP...209.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

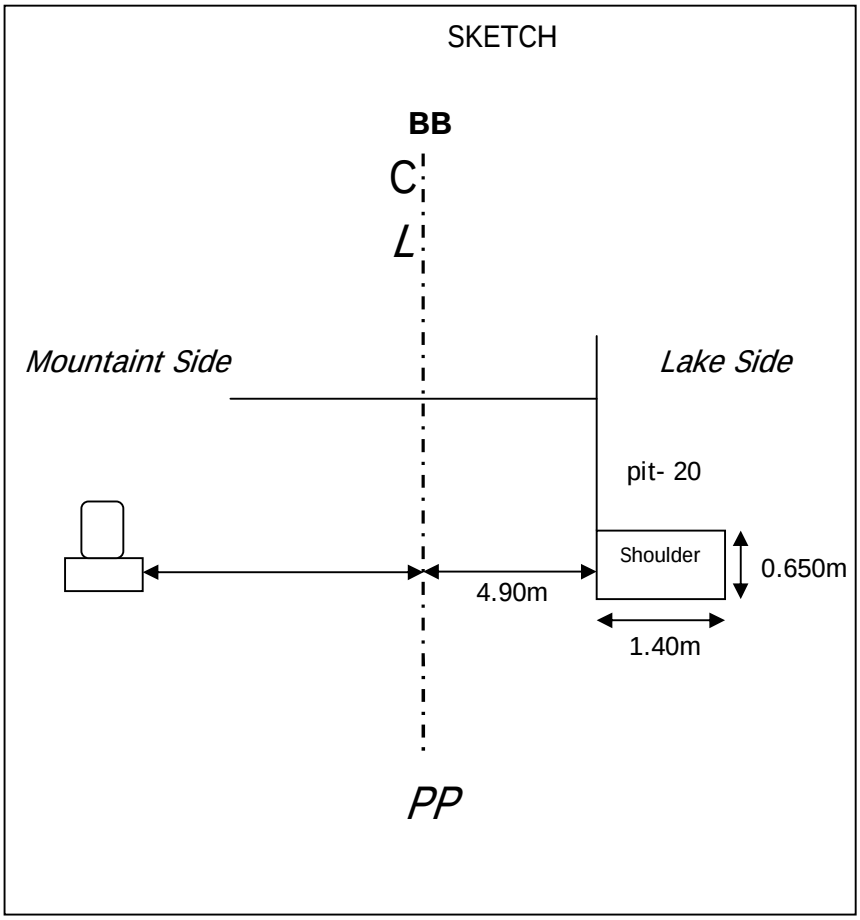
Base Course:.....No.....mm

Sub-Base Course:.....200.....mm

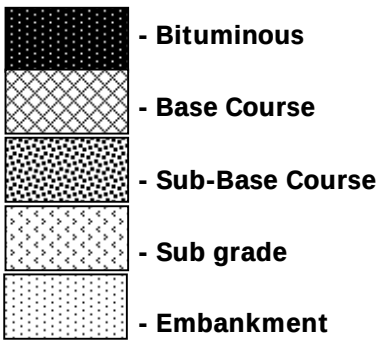
Sub-Grade:.....400.....mm

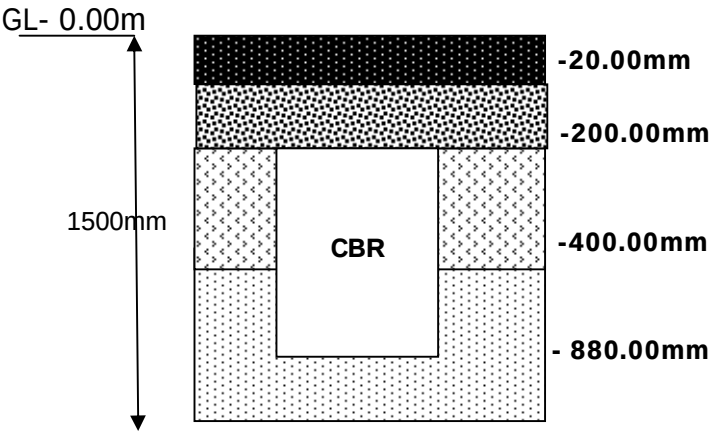
Embankment:.....880.....mm

N: 1396702, E: 0362520



Note:





Field Test Record

Date: .....25../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....21.....

Location : KP...211.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

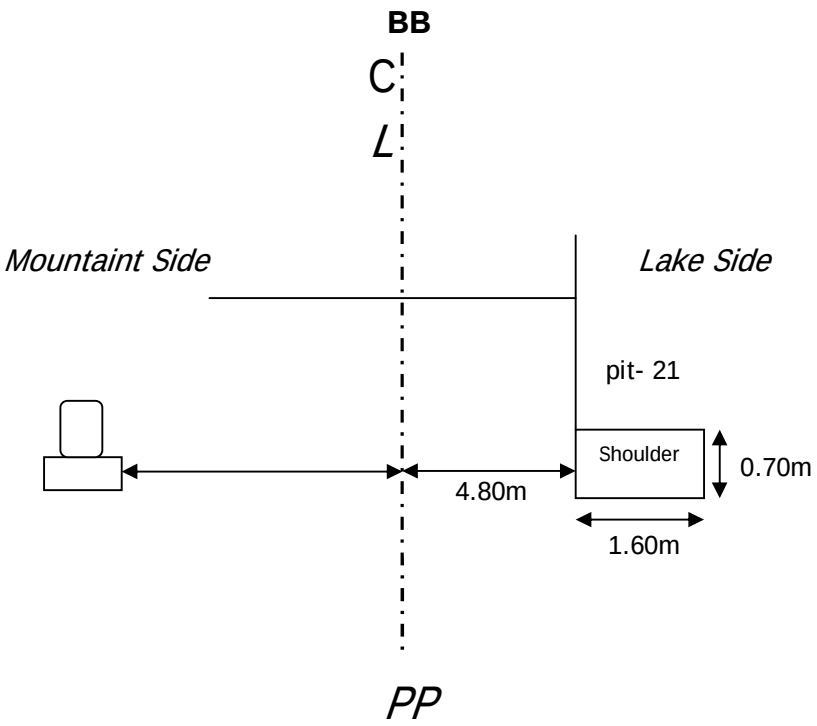
Sub-Base Course:.....200.....mm

Sub-Grade:.....500.....mm

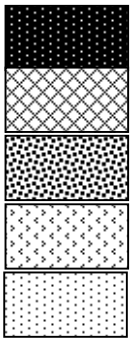
Embankment:.....780.....mm

N: 1397512, E: 0360670

SKETCH



Note:



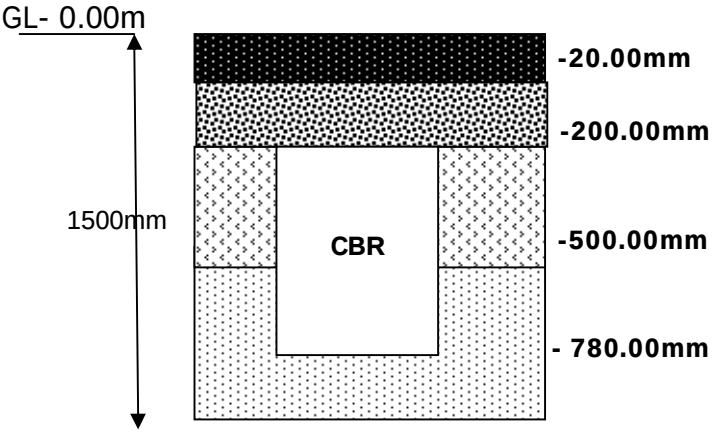
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....24../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....22.....

Location : KP....213.....+...016M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....15.....mm

Base Course:.....No.....mm

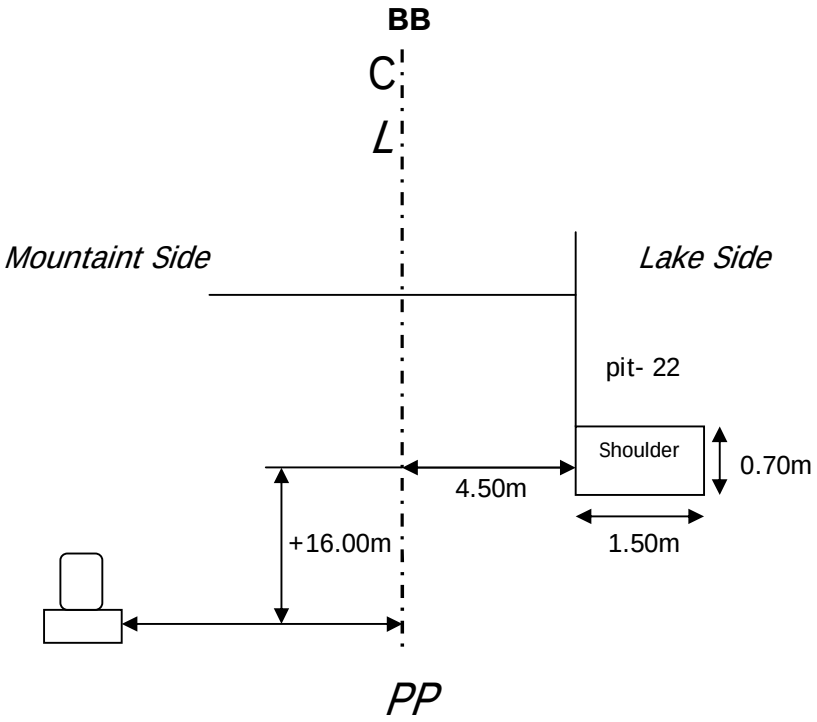
Sub-Base Course:.....300.....mm

Sub-Grade:.....500.....mm

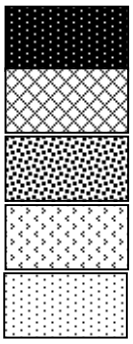
Embankment:....685.....mm

N: 1398312, E: 0358851

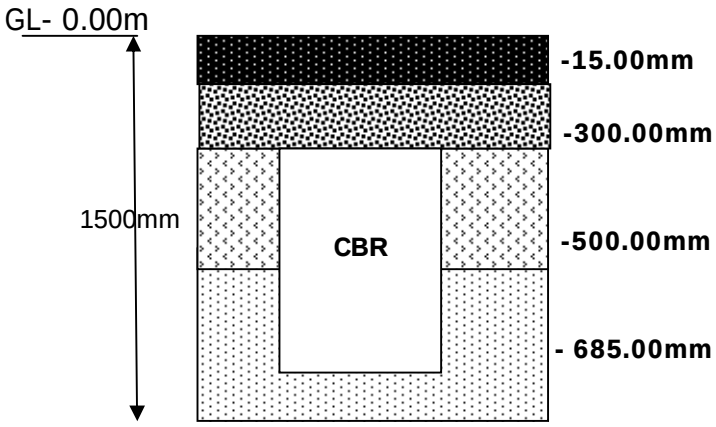
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....25../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....23.....

Location : KP...215.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

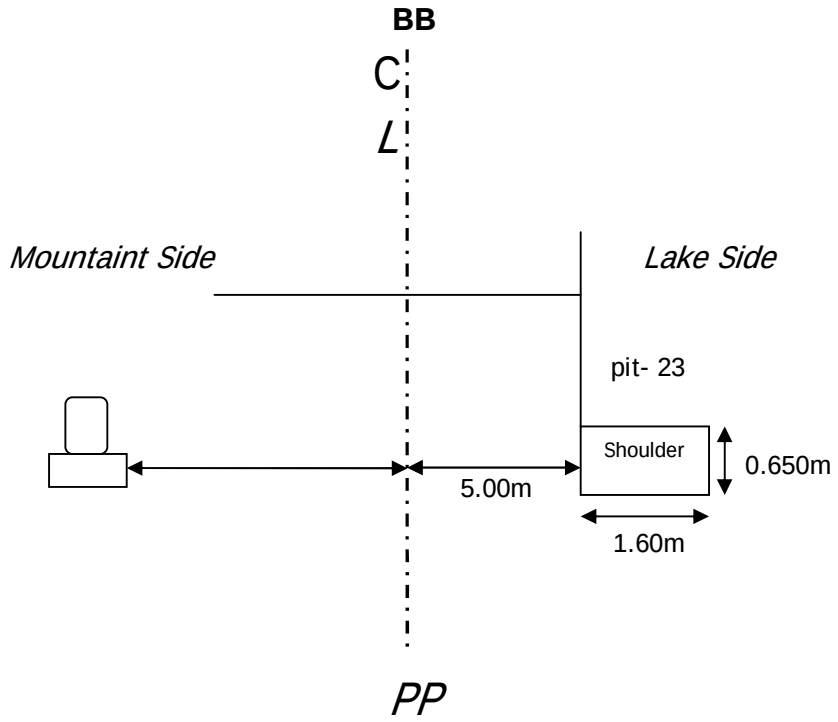
Sub-Base Course:.....180.....mm

Sub-Grade:.....400.....mm

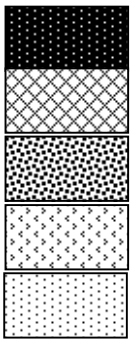
Embankment:.....900.....mm

N: 1399153, E: 0357069

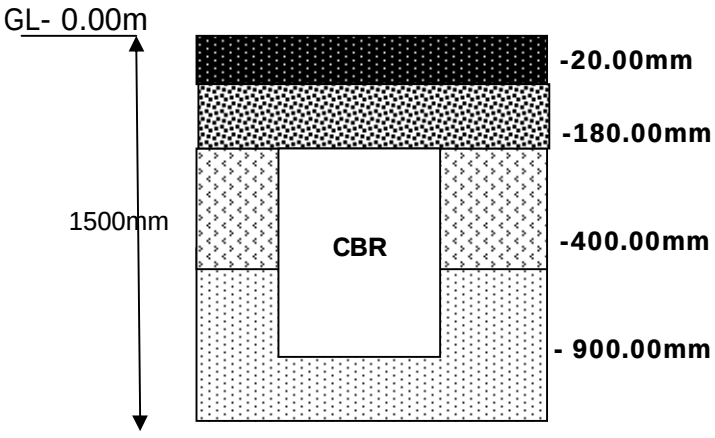
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....25../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....24.....

Location : KP...217.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

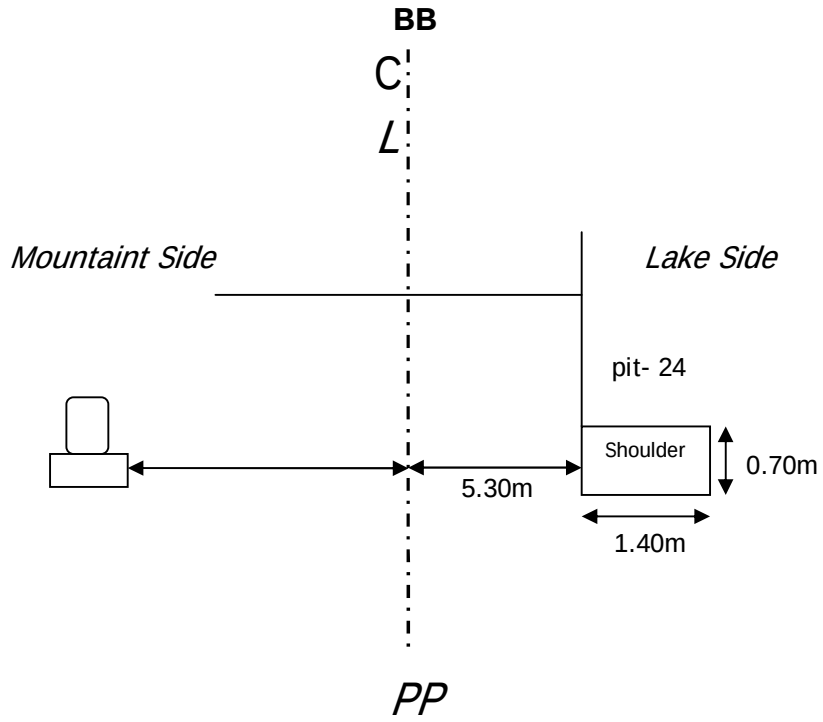
Sub-Base Course:.....NO.....mm

Sub-Grade:.....500.....mm

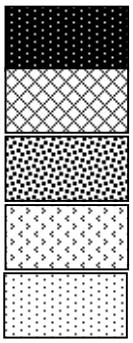
Embankment:.....980.....mm

N: 1400033, E: 0355270

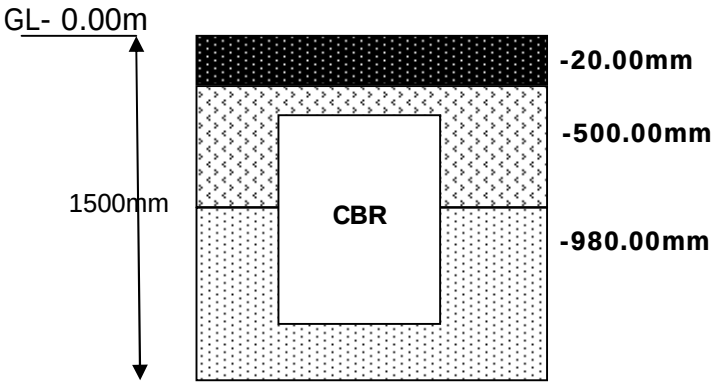
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....26../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....25.....

Location : KP...219.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

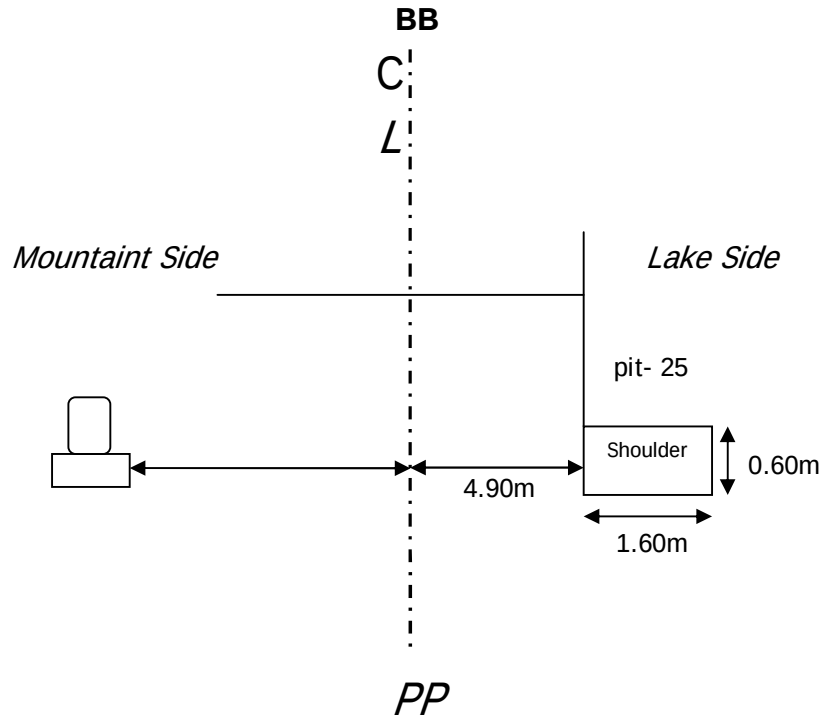
Sub-Base Course:.....300.....mm

Sub-Grade:.....400.....mm

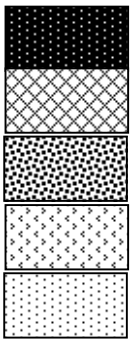
Embankment:.....780.....mm

N: 1400724, E: 0353412

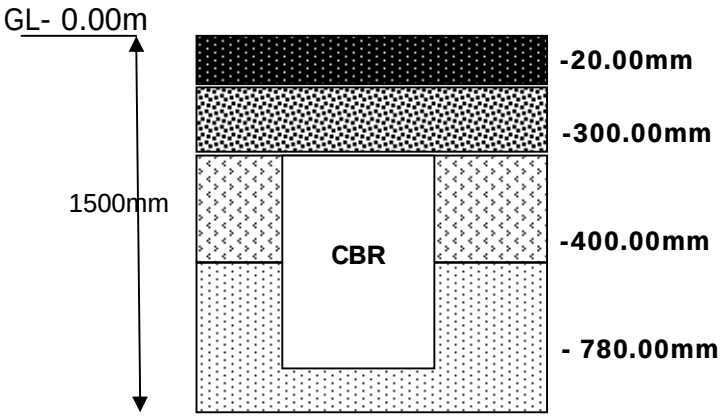
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....26../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....26.....

Location : KP...221.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....10.....mm

Base Course:.....No.....mm

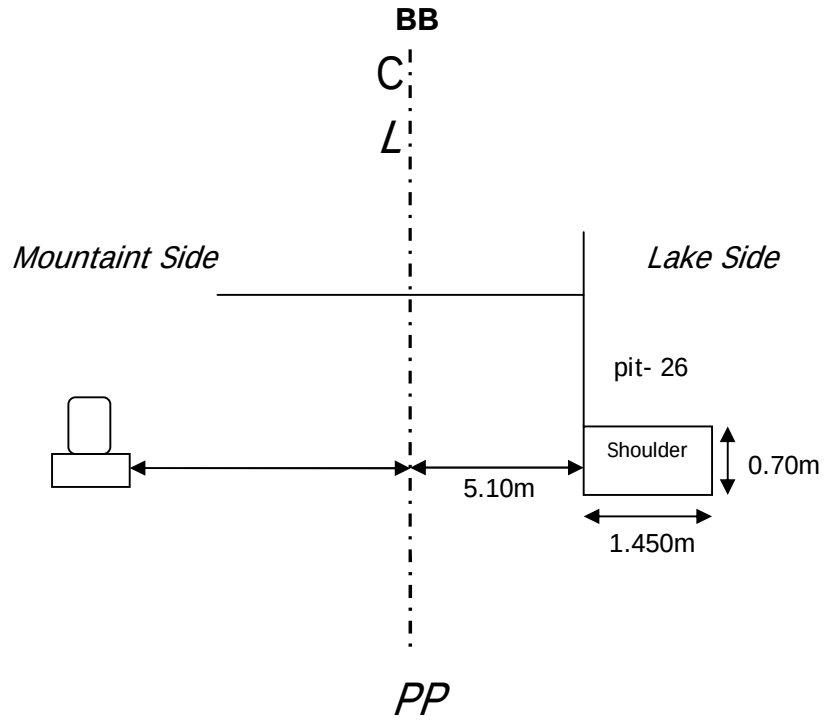
Sub-Base Course:.....180.....mm

Sub-Grade:.....600.....mm

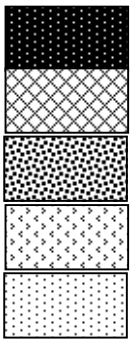
Embankment:.....710.....mm

N: 1401685, E: 0351696

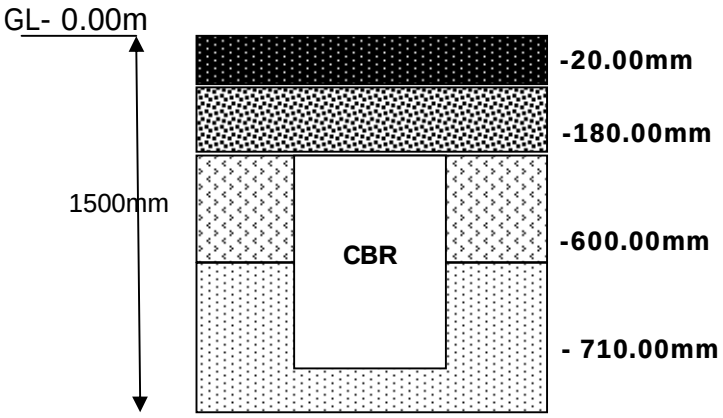
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....26../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....27.....

Location : KP...223.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

Base Course:.....No.....mm

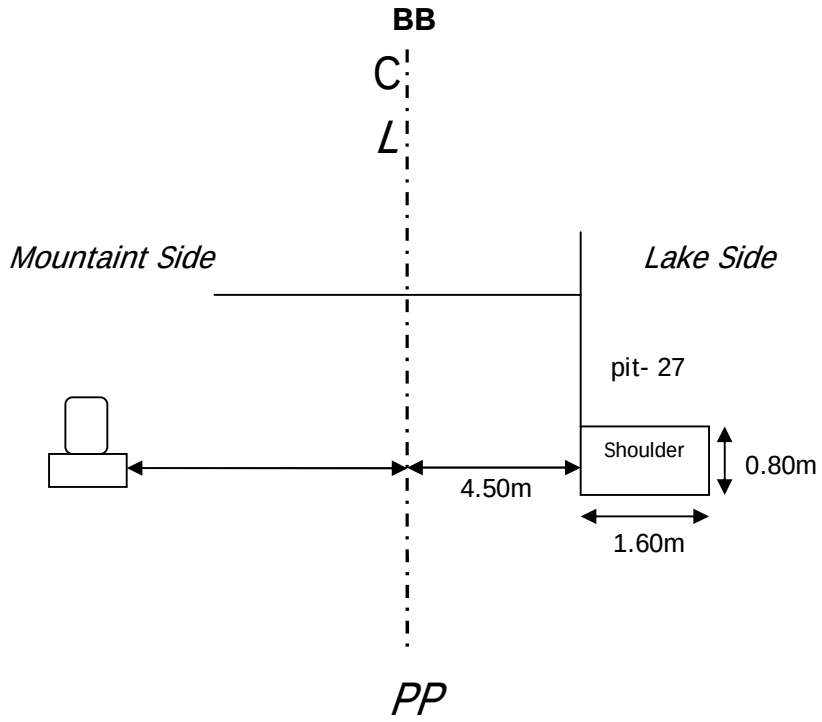
Sub-Base Course:.....200.....mm

Sub-Grade:.....400.....mm

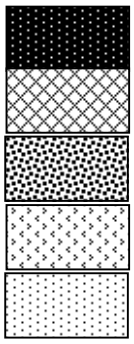
Embankment:.....875.....mm

N: 1403031, E: 0350240

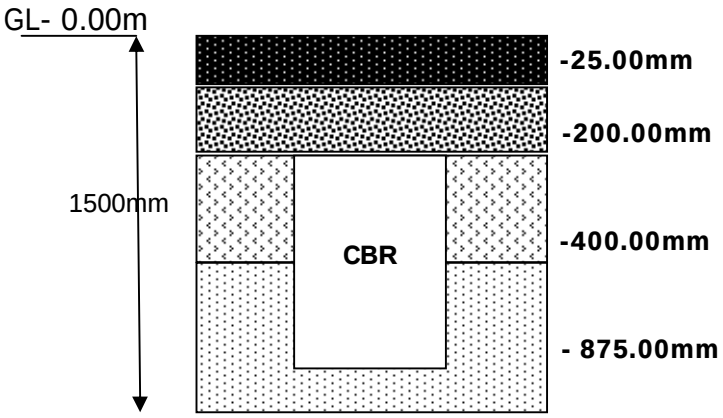
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....26../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....28.....

Location : KP....225.....-...0.08M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....250.....mm

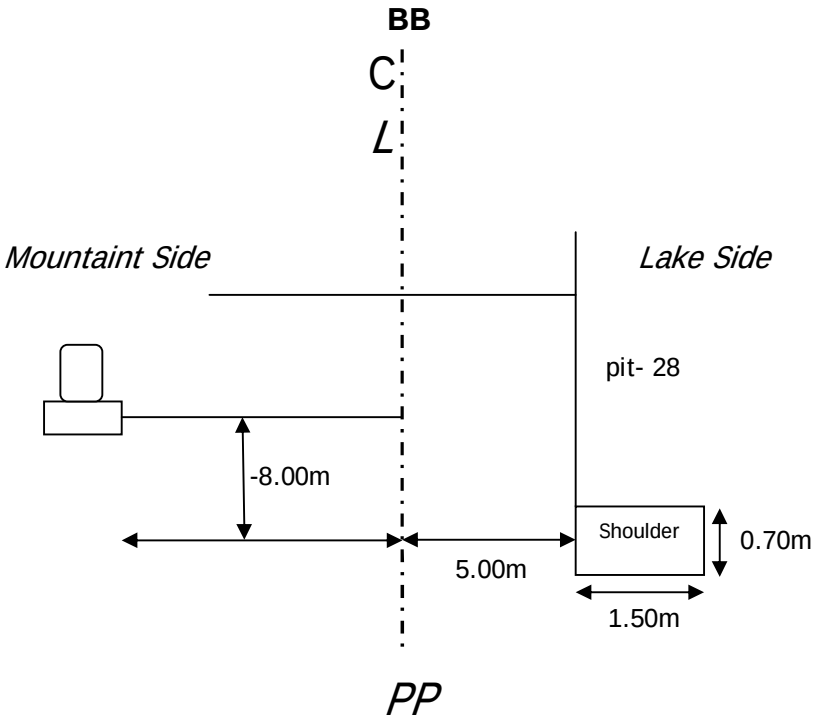
Sub-Base Course:.....NO.....mm

Sub-Grade:.....700.....mm

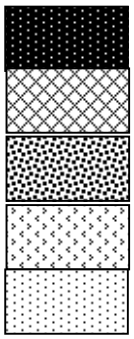
Embankment:.....530.....mm

N: 1404144, E: 0348634

SKETCH



Note:



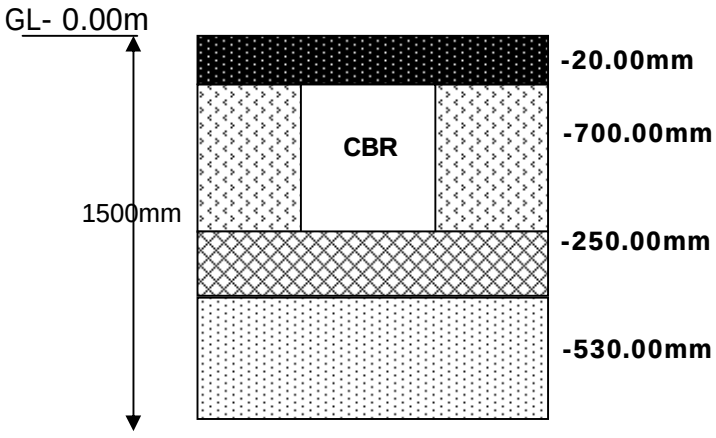
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....26../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....29.....

Location : KP....227.....-...0.03M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

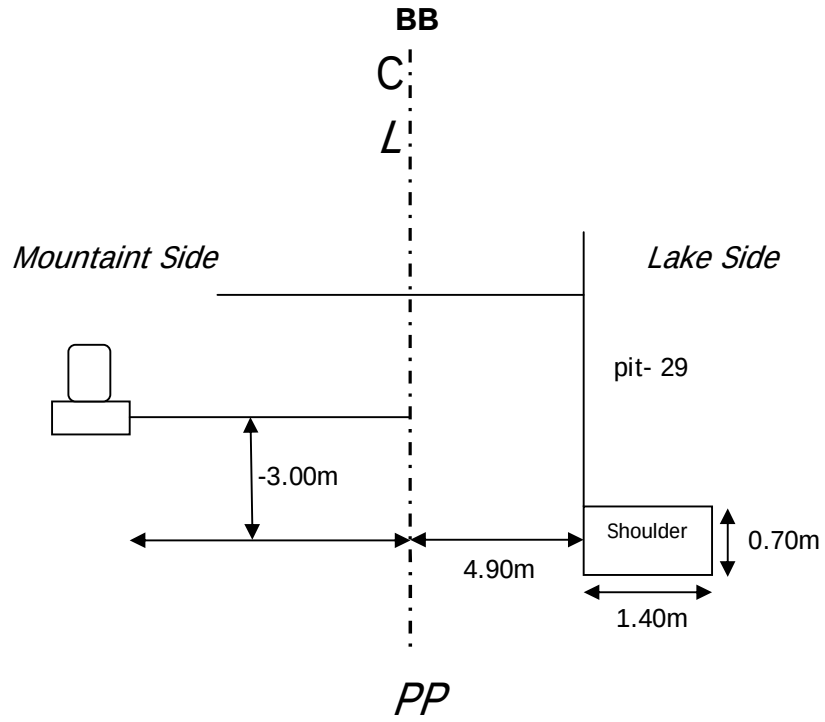
Sub-Base Course:.....250.....mm

Sub-Grade:.....600.....mm

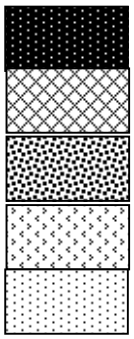
Embankment:.....630.....mm

N: 14054601, E: 0346692

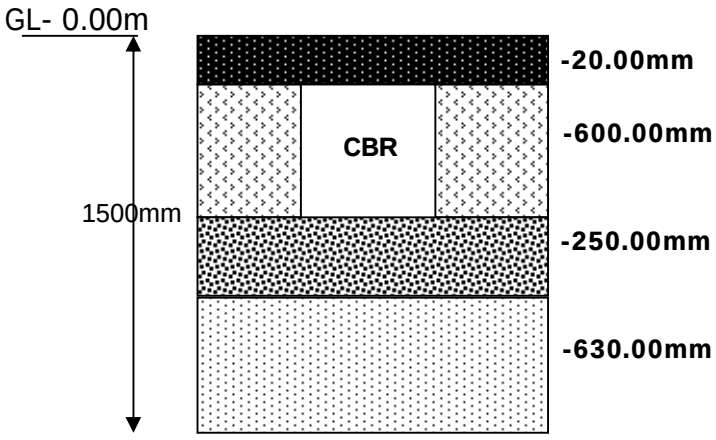
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....30.....

Location : KP...229.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

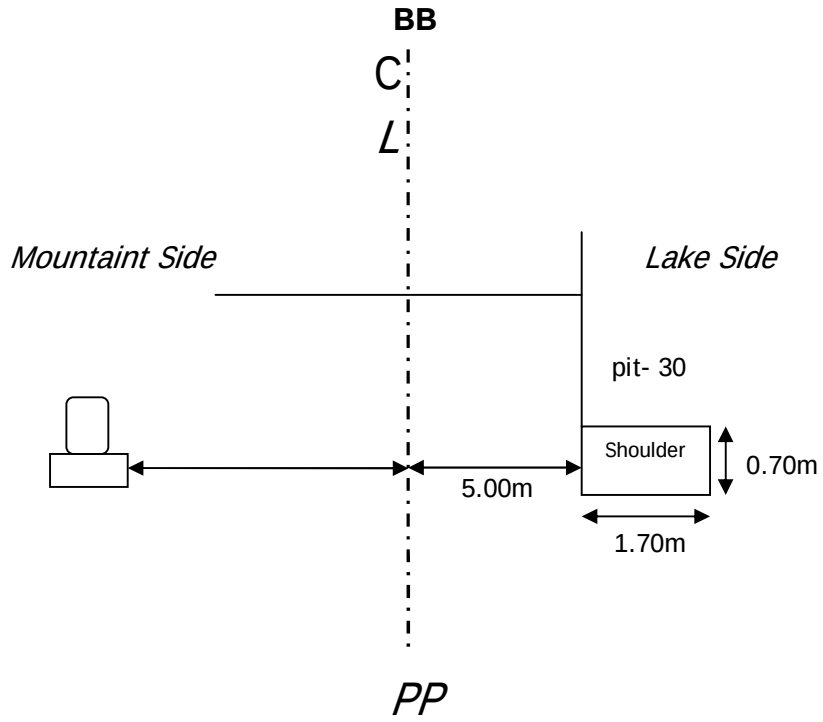
Sub-Base Course:.....NO.....mm

Sub-Grade:.....700.....mm

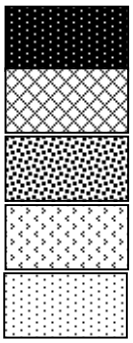
Embankment:.....780.....mm

N: 1405073, E: 0344746

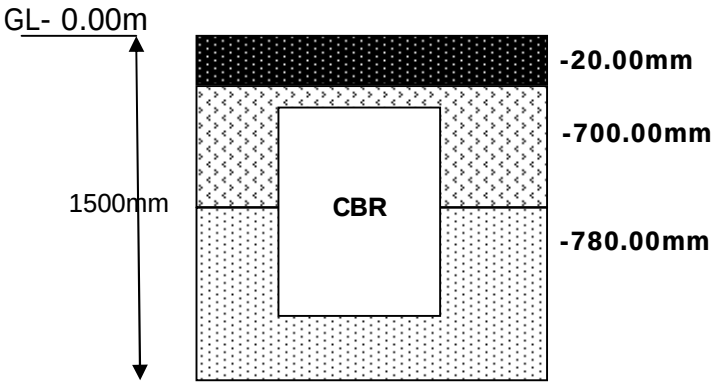
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....31.....

Location : KP....231.....+...0.04M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

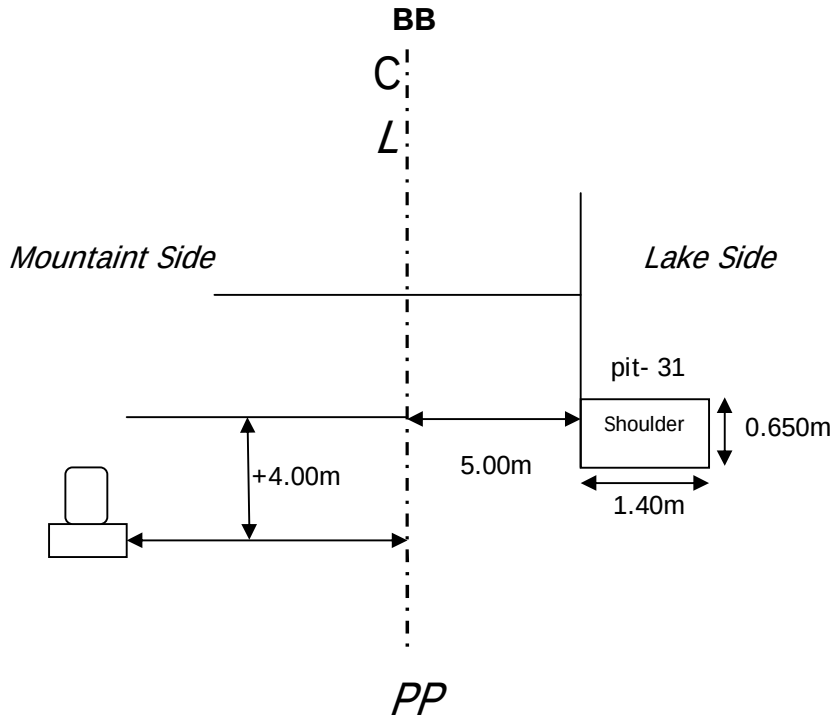
Sub-Base Course:.....150.....mm

Sub-Grade:.....500.....mm

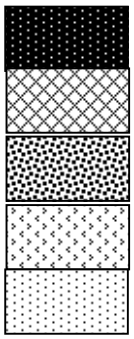
Embankment:.....830.....mm

N: 1405533, E: 0342812

SKETCH



Note:



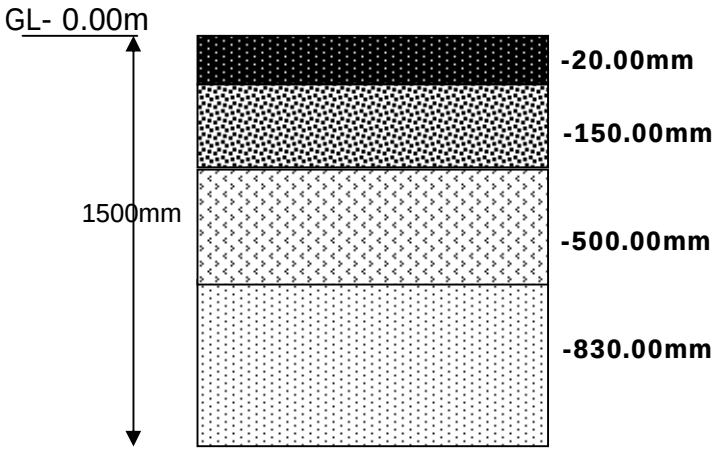
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....32.....

Location : KP...233.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

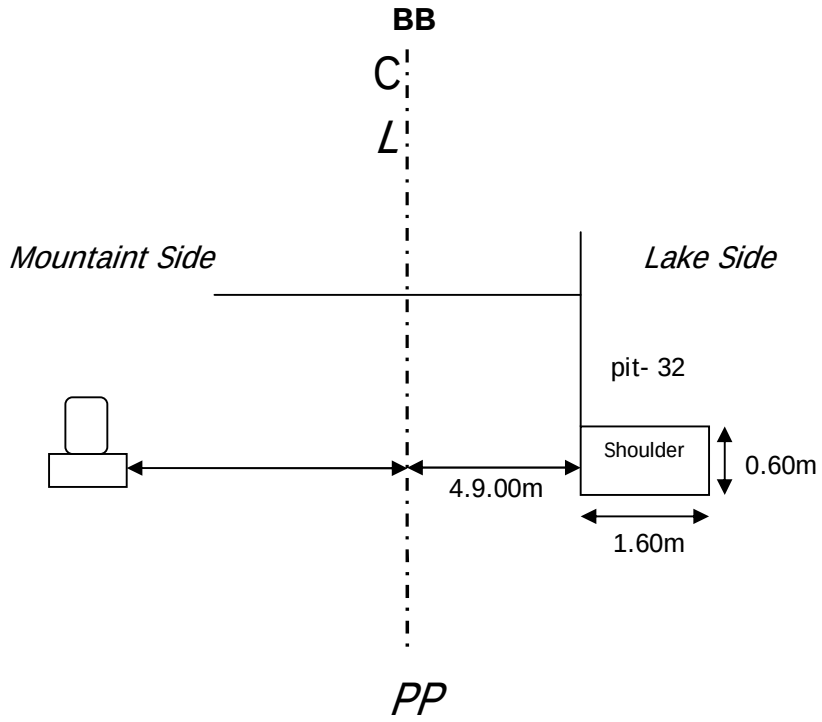
Sub-Base Course:.....NO.....mm

Sub-Grade:.....600.....mm

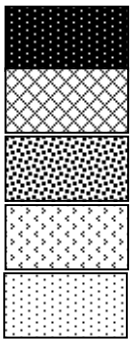
Embankment:.....880.....mm

N: 1405994, E: 0340877

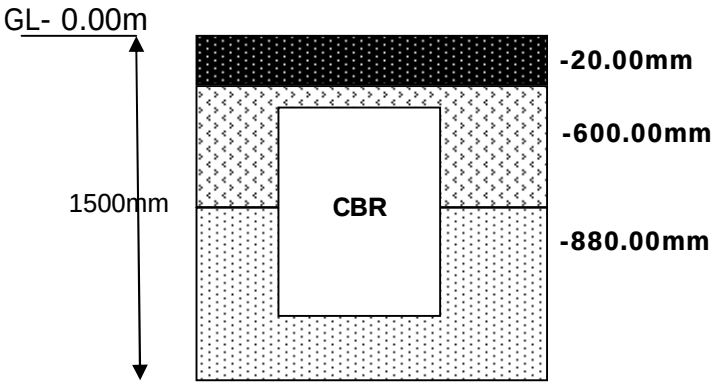
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....33.....

Location : KP...235.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

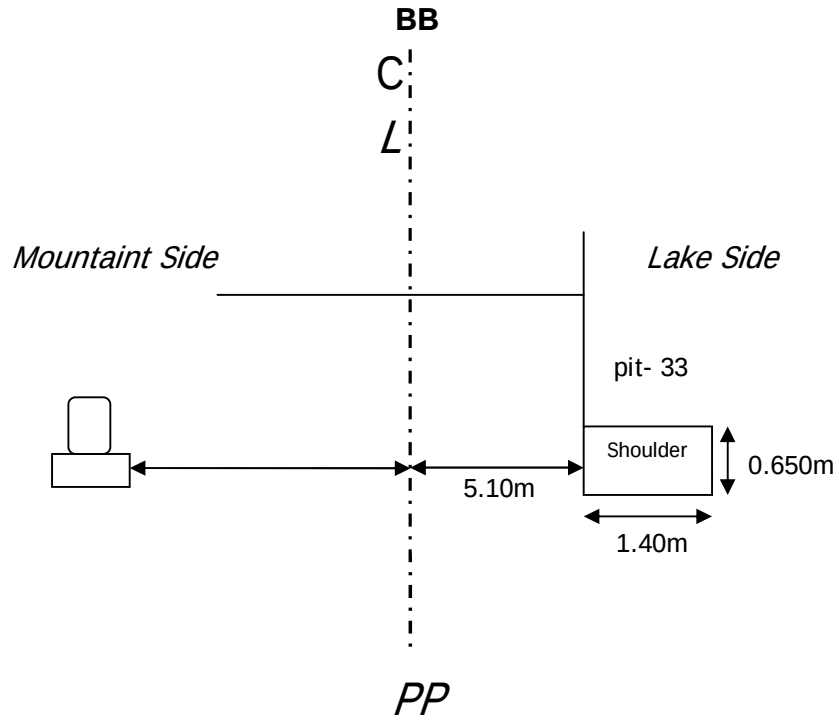
Sub-Base Course:.....NO.....mm

Sub-Grade:.....800.....mm

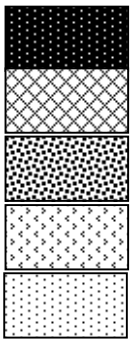
Embankment:.....680.....mm

N: 1406463, E: 0338927

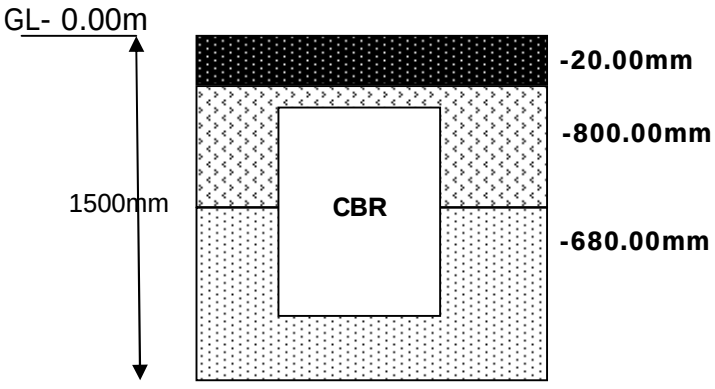
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....34.....

Location : KP...237.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

Base Course:.....No.....mm

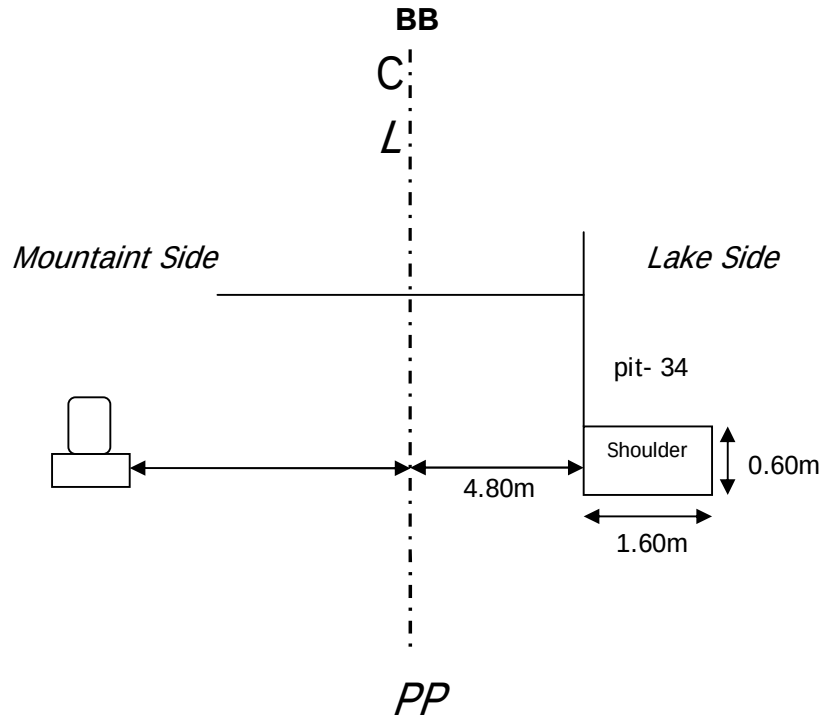
Sub-Base Course:.....NO.....mm

Sub-Grade:.....600.....mm

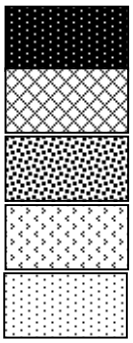
Embankment:.....875.....mm

N: 1406463, E: 0338927

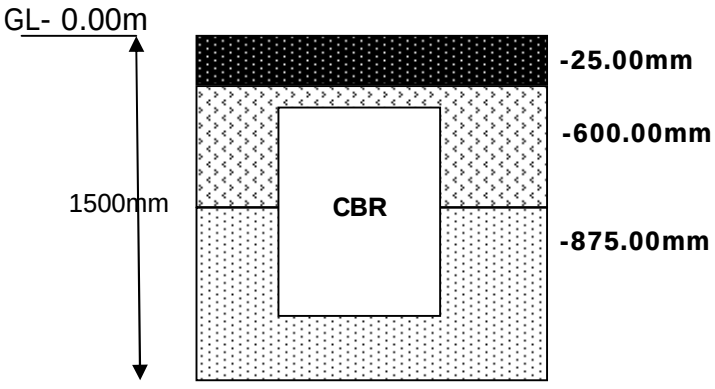
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....35.....

Location : KP...239.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

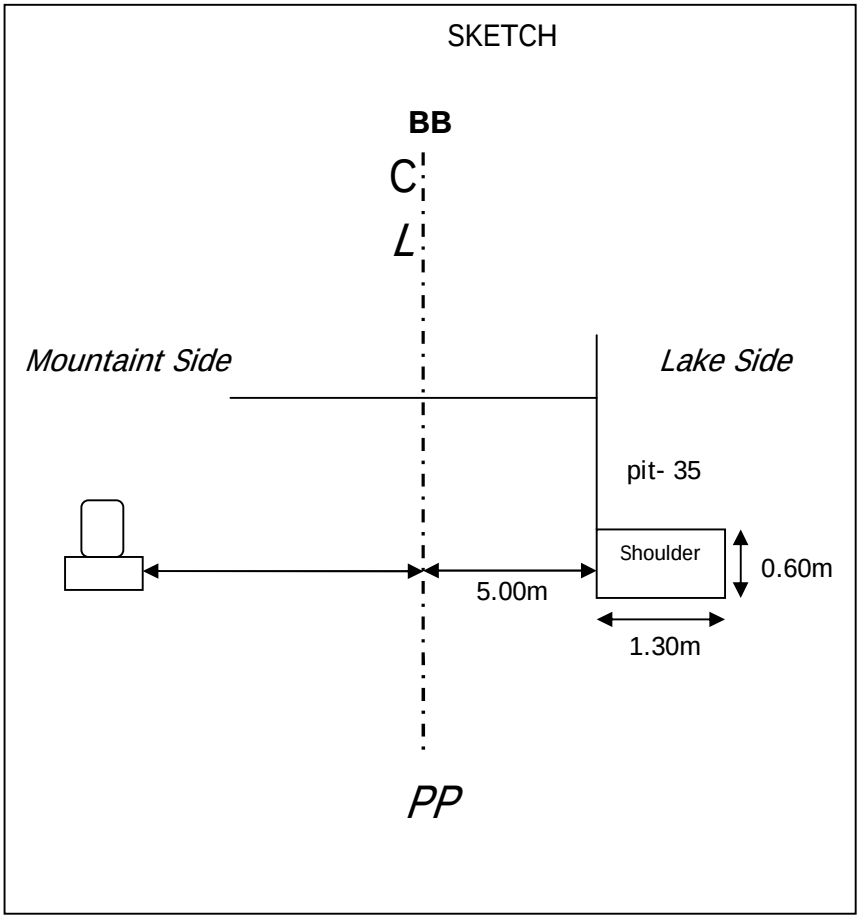
Base Course:.....No.....mm

Sub-Base Course:.....NO.....mm

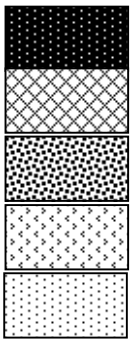
Sub-Grade:.....700.....mm

Embankment:.....775.....mm

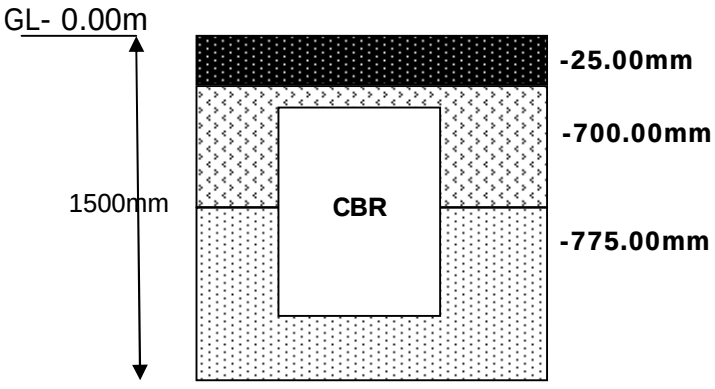
N: 1407996, E: 0335337



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....36.....

Location : KP....241.....+...011M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

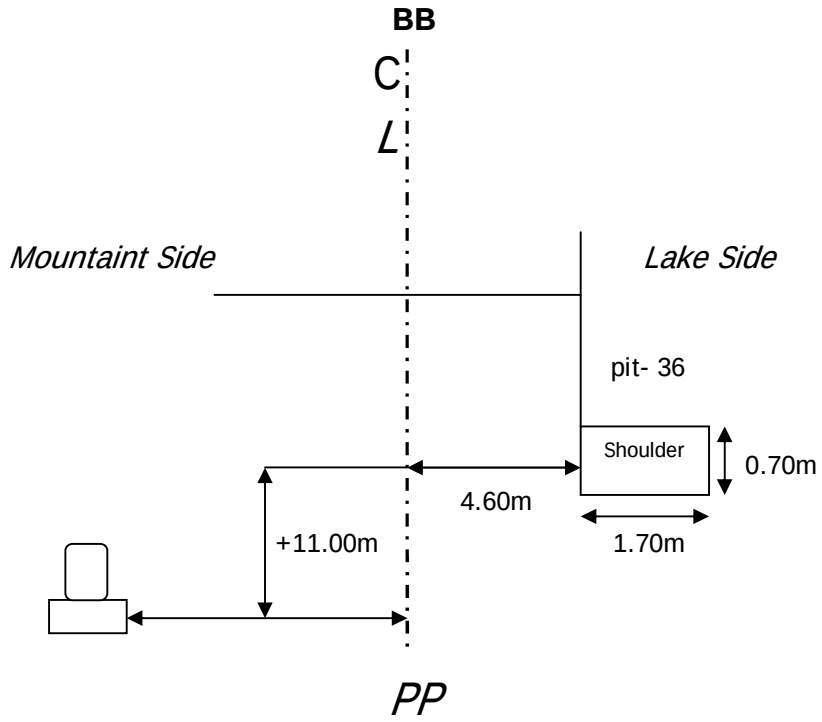
Sub-Base Course:.....No.....mm

Sub-Grade:.....1200.....mm

Embankment:.....280.....mm

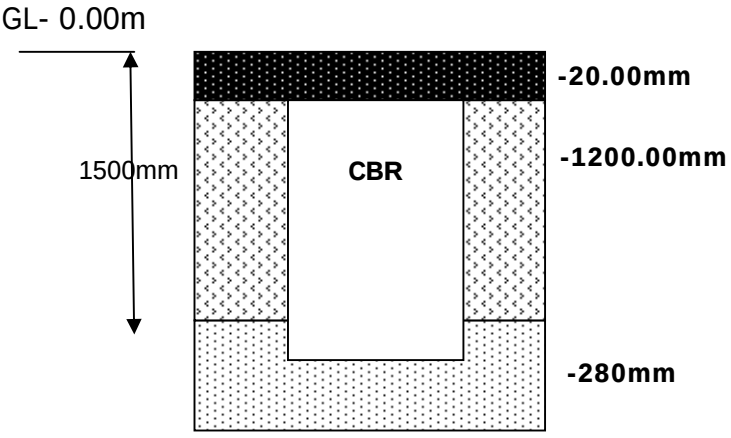
N: 1409408., E:0333932

SKETCH



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....27../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....37.....

Location : KP...243.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

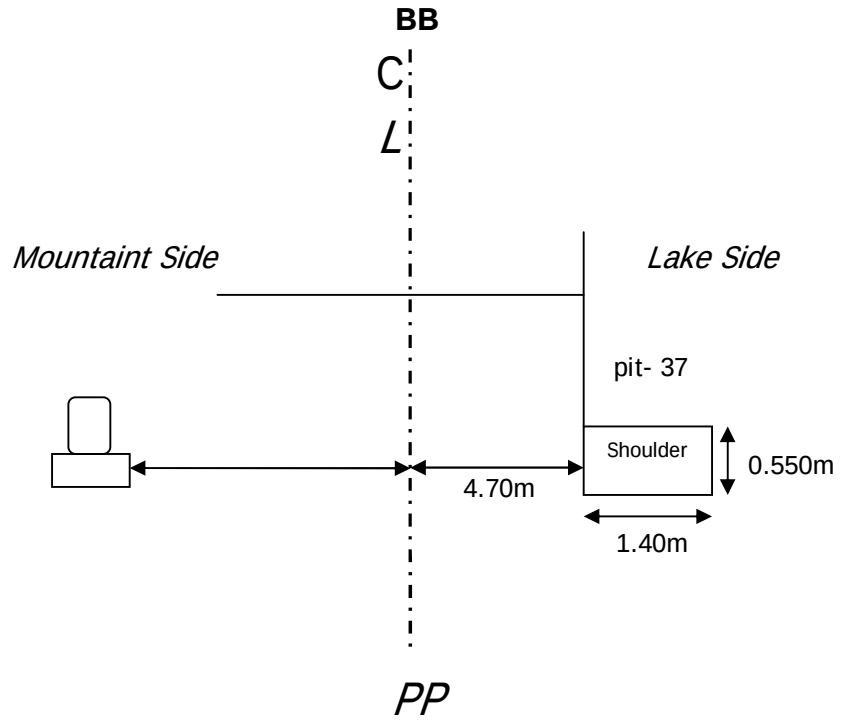
Sub-Base Course:.....200.....mm

Sub-Grade:.....500.....mm

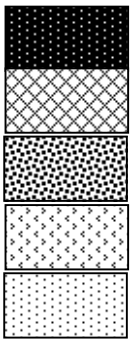
Embankment:.....780.....mm

N: 1410936, E: 0332682

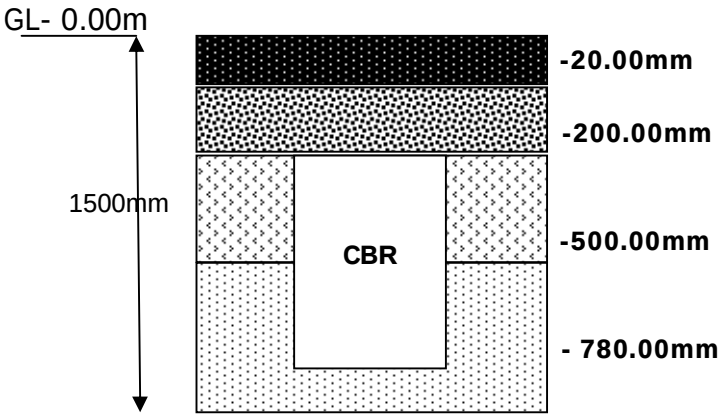
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....38.....

Location : KP....245.....+...0.08M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

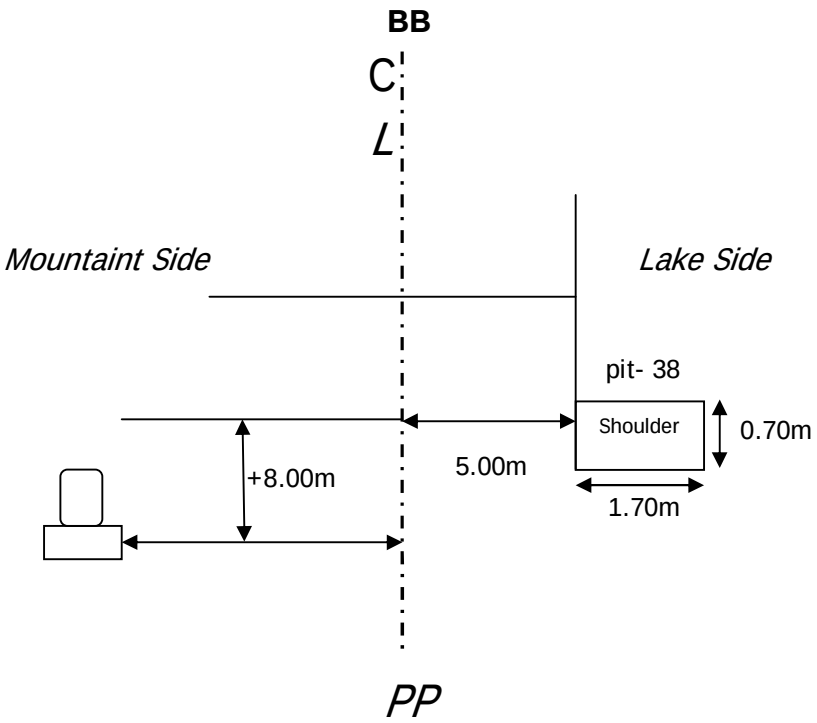
Sub-Base Course:.....200.....mm

Sub-Grade:.....500.....mm

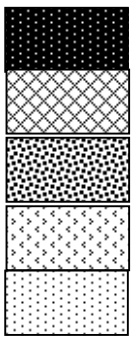
Embankment:.....780.....mm

N: 1412725, E: 0331810

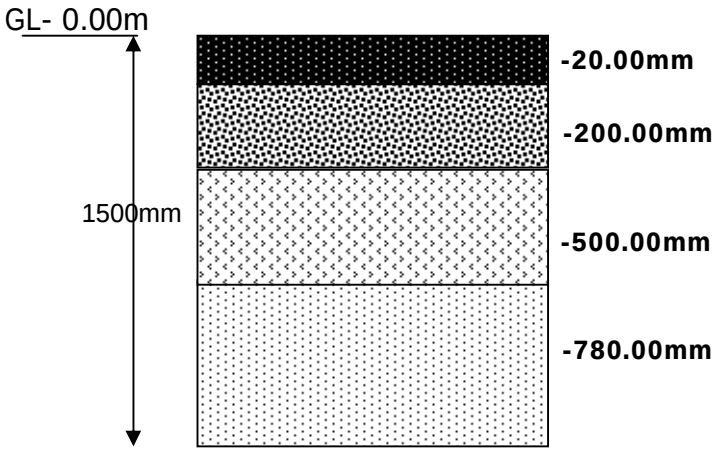
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No....39.....

Location : KP....247.....-...0.07M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

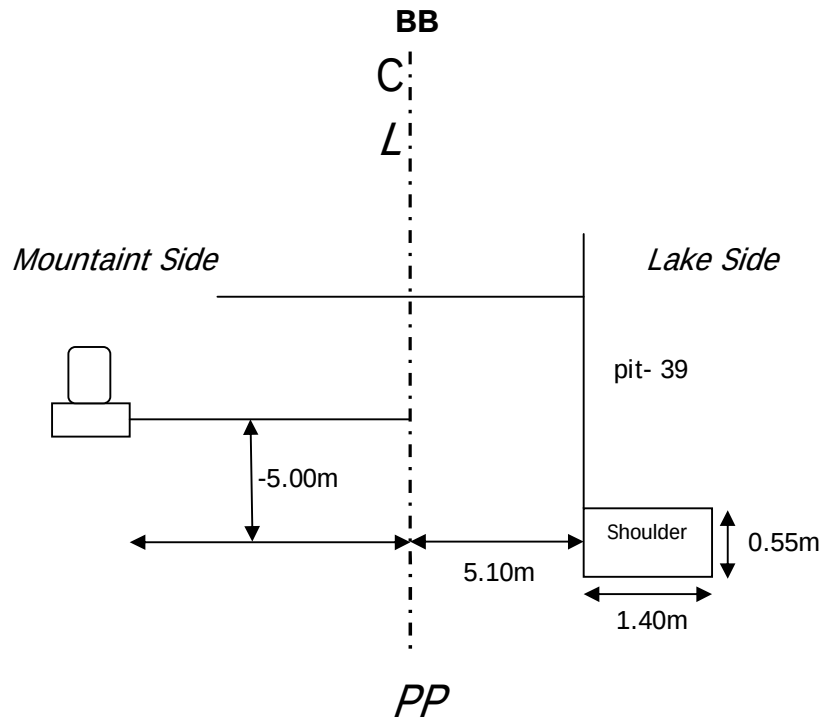
Sub-Base Course:.....No.....mm

Sub-Grade:.....850.....mm

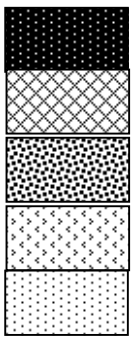
Embankment:.....630.....mm

N: 1414332, E: 0330651

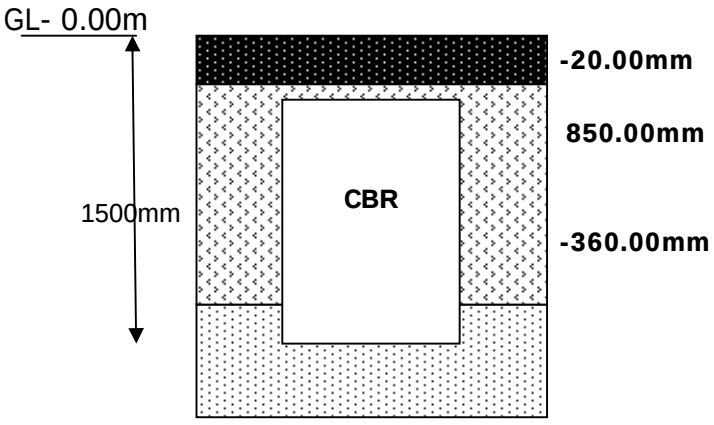
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....40.....

Location : KP...249.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

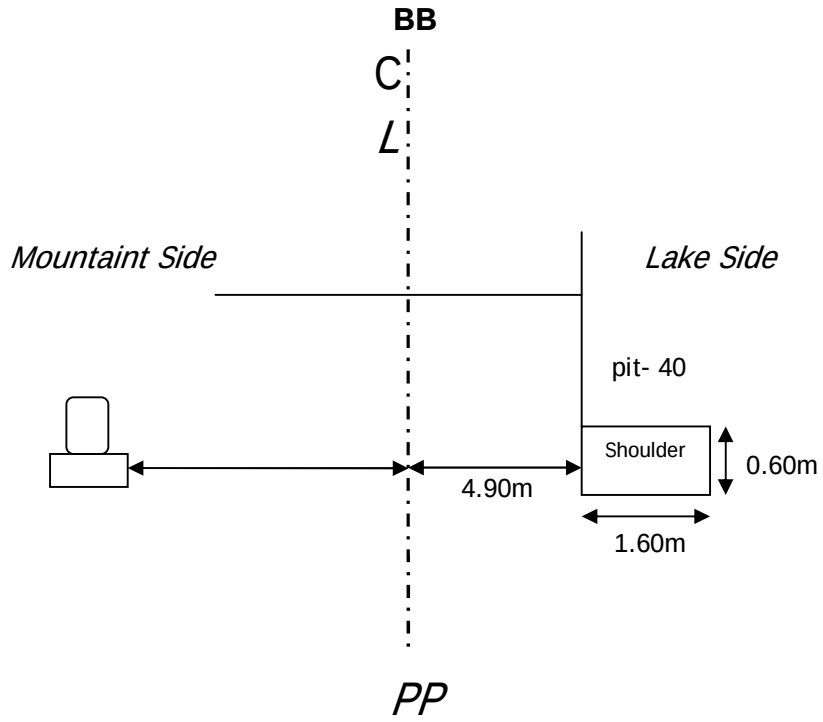
Sub-Base Course:.....NO.....mm

Sub-Grade:.....800.....mm

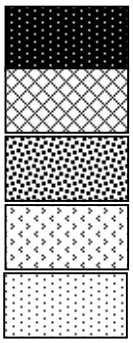
Embankment:.....680.....mm

N: 1415939, E: 0329471

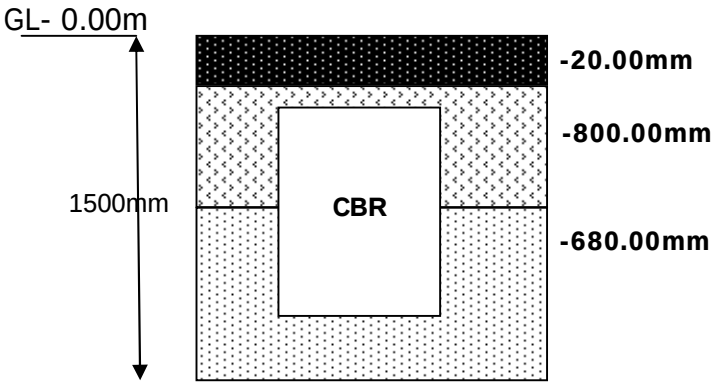
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....41.....

Location : KP...249.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

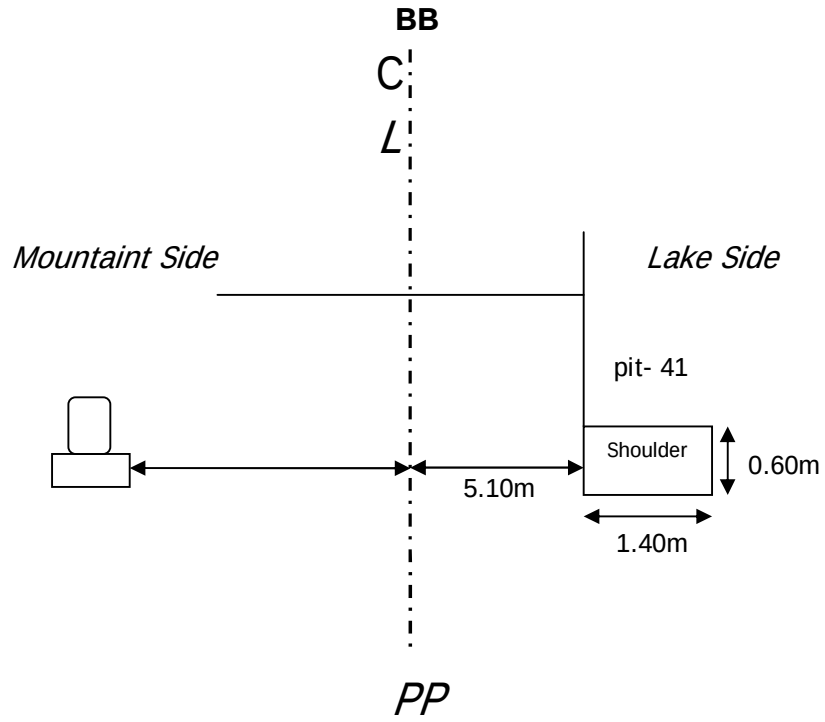
Sub-Base Course:.....NO.....mm

Sub-Grade:.....700.....mm

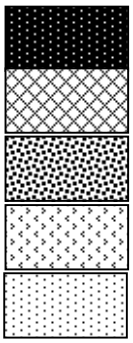
Embankment:.....780.....mm

N: 1417538, E: 0328300

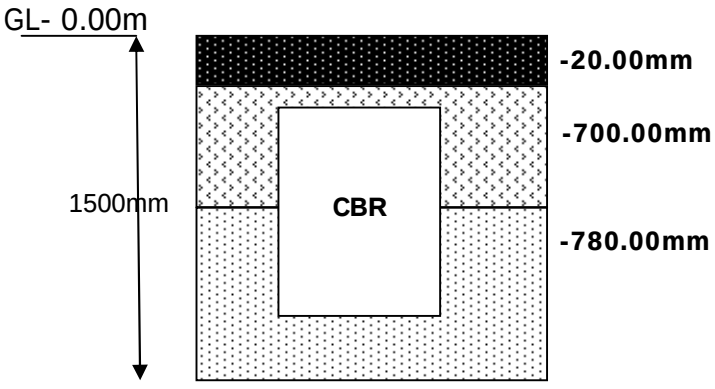
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....42.....

Location : KP...253.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

Base Course:.....No.....mm

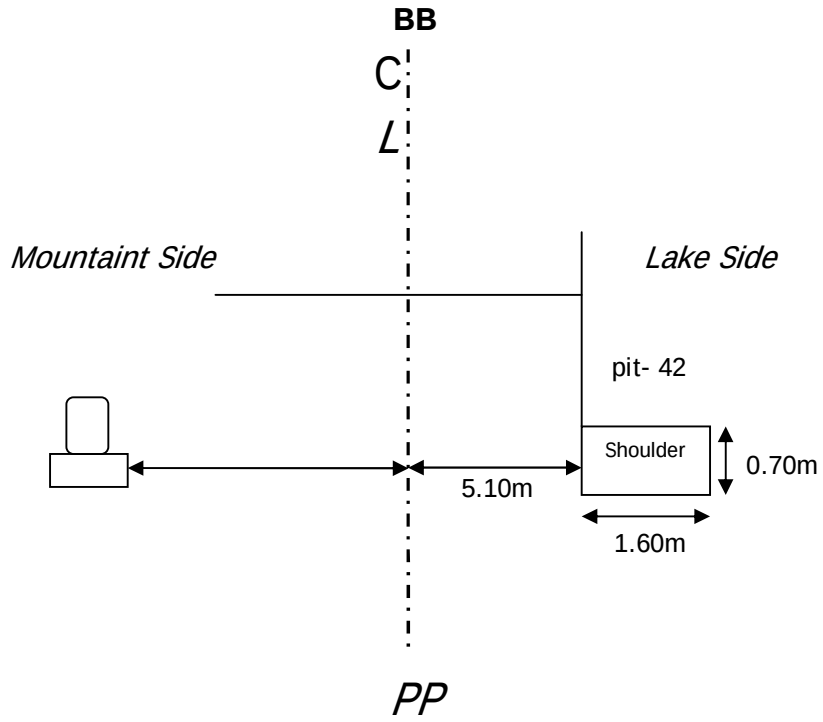
Sub-Base Course:.....200.....mm

Sub-Grade:.....500.....mm

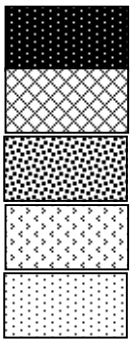
Embankment:.....775.....mm

N: 1419149, E: 0327138

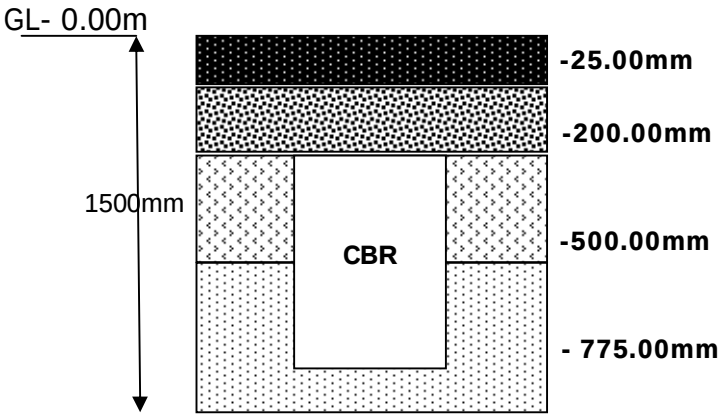
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....43.....

Location : KP...255.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

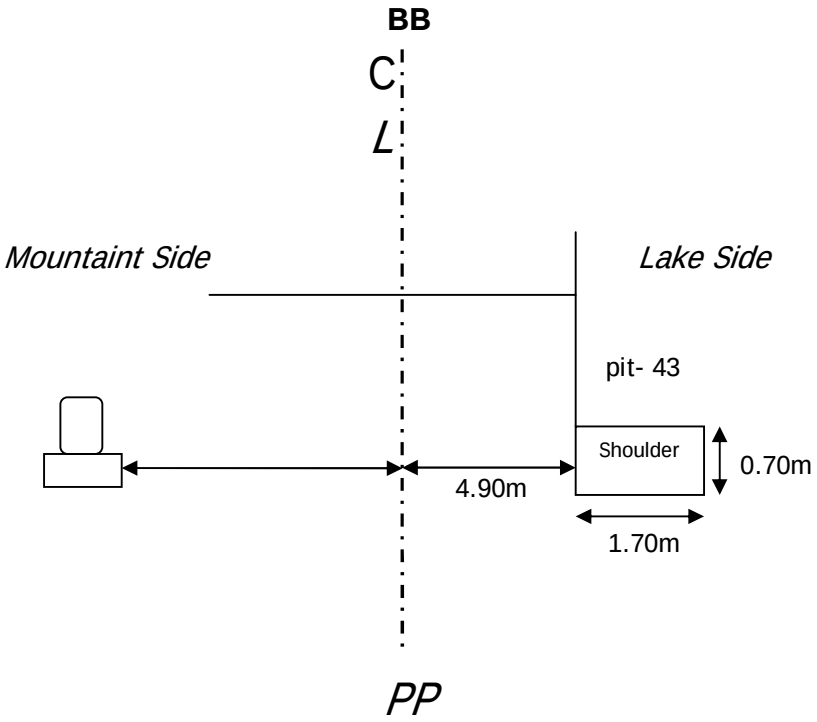
Sub-Base Course:.....200.....mm

Sub-Grade:.....600.....mm

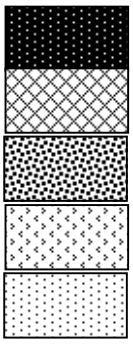
Embankment:.....680.....mm

N: 1420781, E: 0326006

SKETCH



Note:



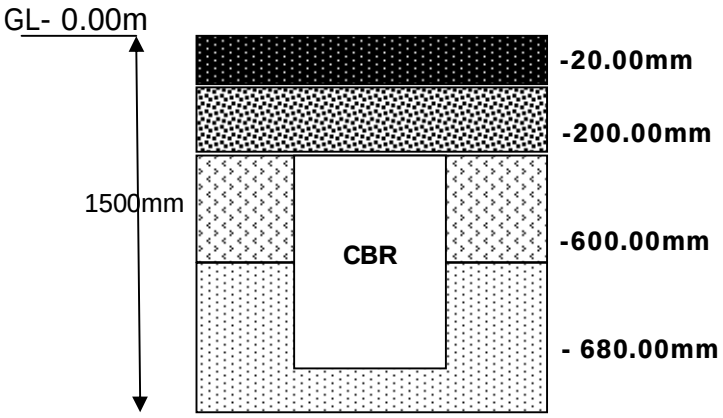
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....44.....

Location : KP...257.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

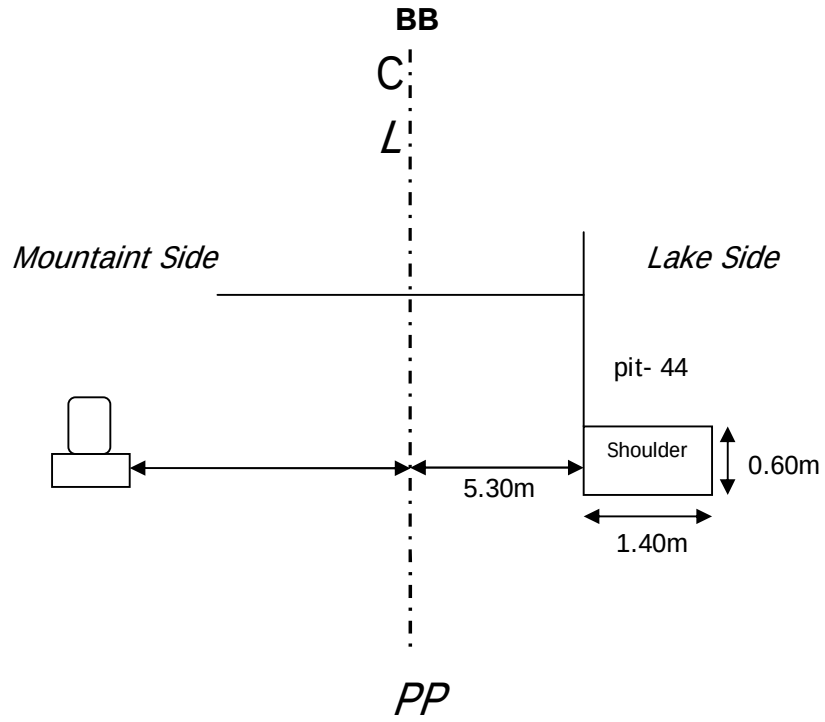
Sub-Base Course:.....250.....mm

Sub-Grade:.....450.....mm

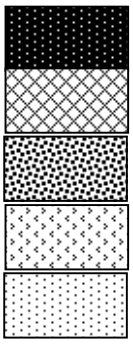
Embankment:.....780.....mm

N: 1422526, E: 0325066

SKETCH



Note:



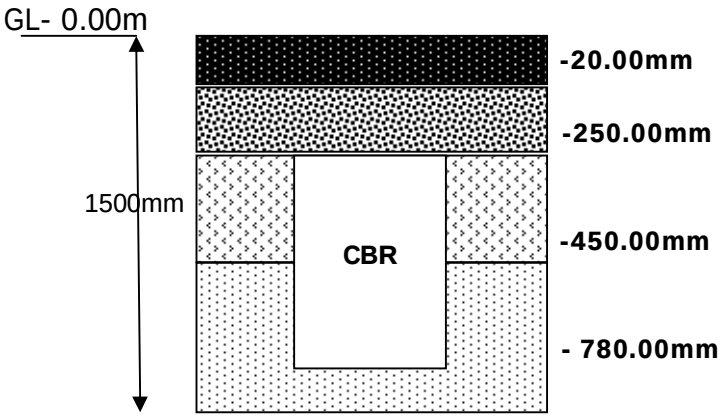
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....30../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....45.....

Location : KP...259.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

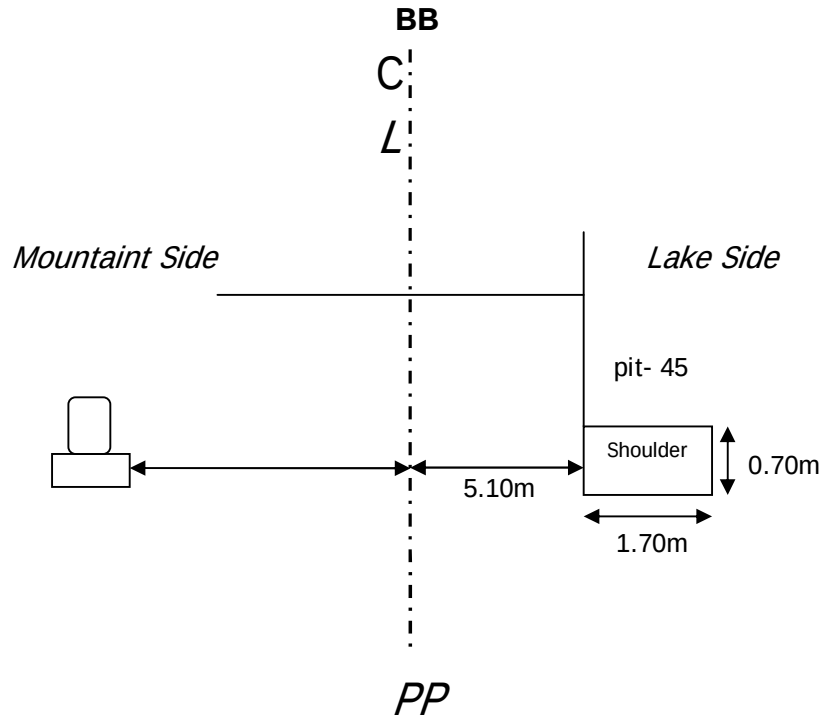
Sub-Base Course:.....NO.....mm

Sub-Grade:.....850.....mm

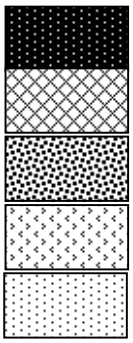
Embankment:.....630.....mm

N: 1424354, E: 0324259

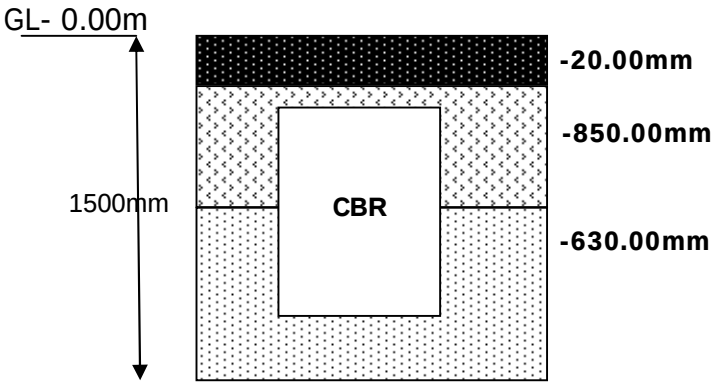
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....28../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....46.....

Location : KP...261.....-...0.08...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

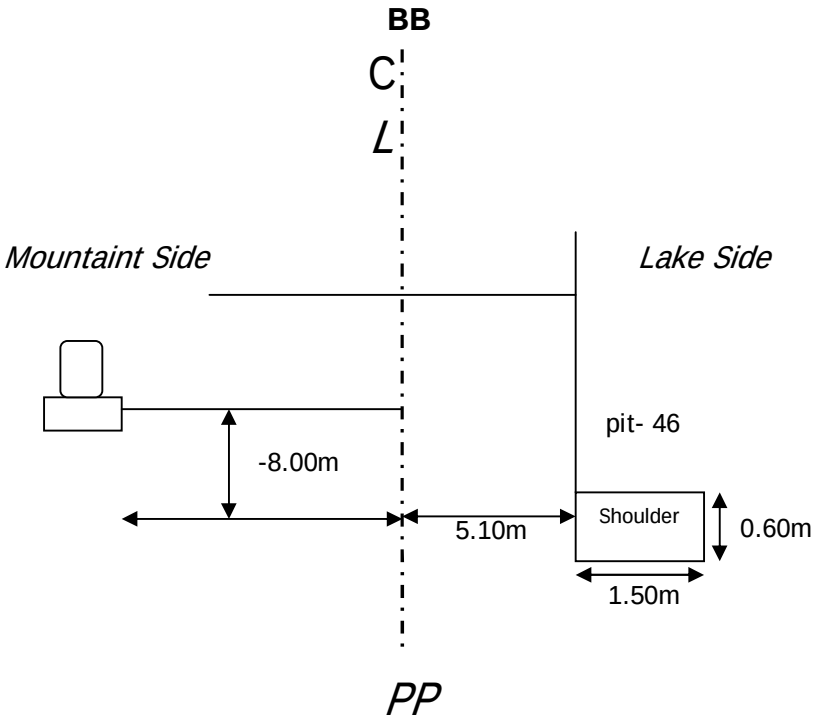
Sub-Base Course:.....200.....mm

Sub-Grade:.....400.....mm

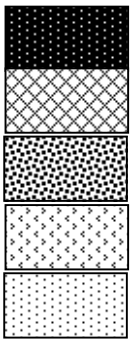
Embankment:.....880.....mm

N: 1426232, E: 0323539

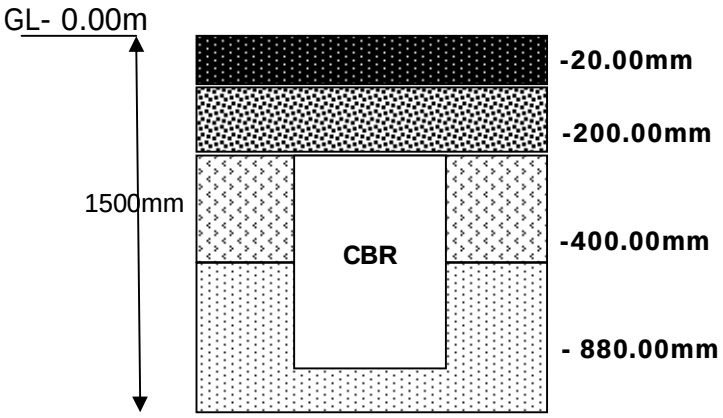
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....30../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....47.....

Location : KP...263.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....30.....mm

Base Course:.....No.....mm

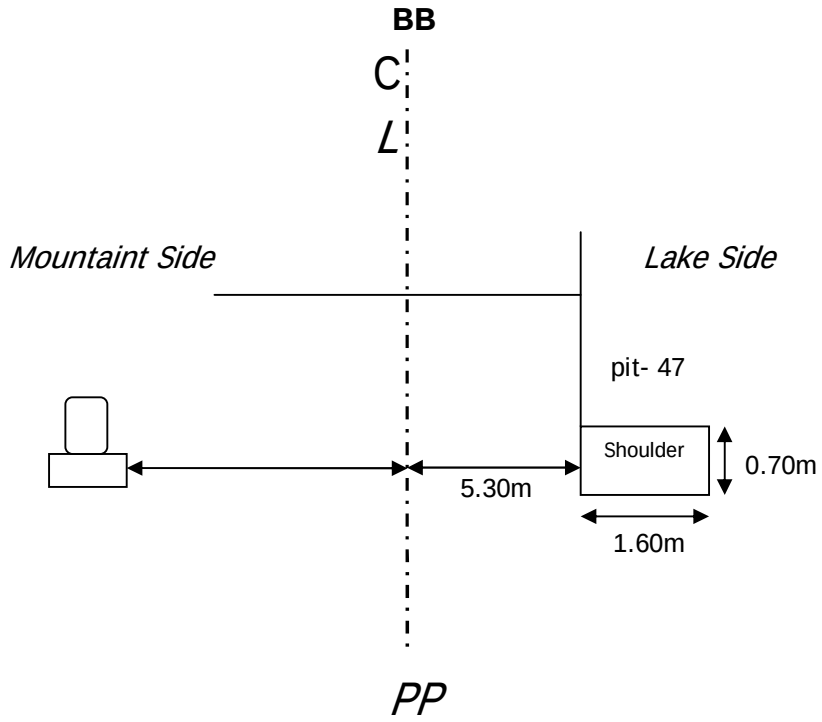
Sub-Base Course:.....200.....mm

Sub-Grade:.....600.....mm

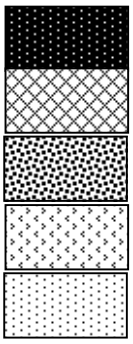
Embankment:.....670.....mm

N: 1422526, E: 0325066

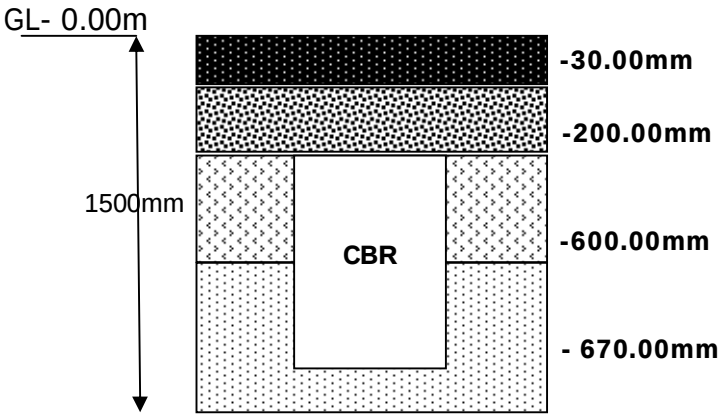
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....30../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....48.....

Location : KP...265.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

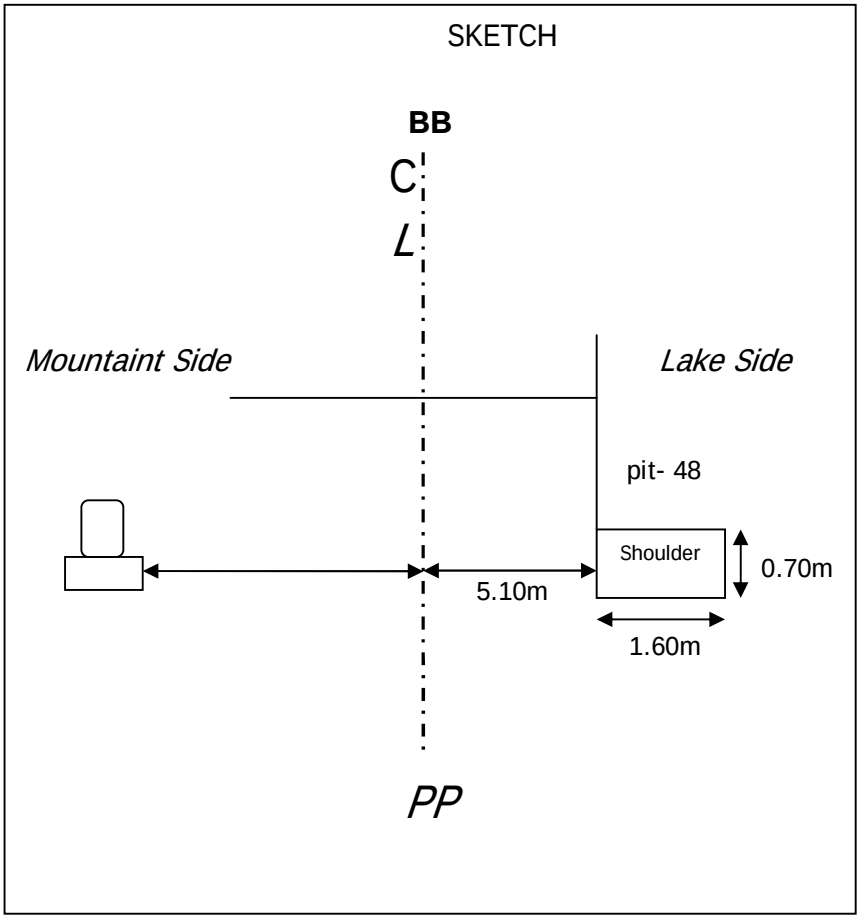
Base Course:.....No.....mm

Sub-Base Course:.....200.....mm

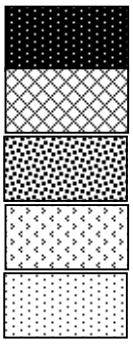
Sub-Grade:.....450.....mm

Embankment:.....830.....mm

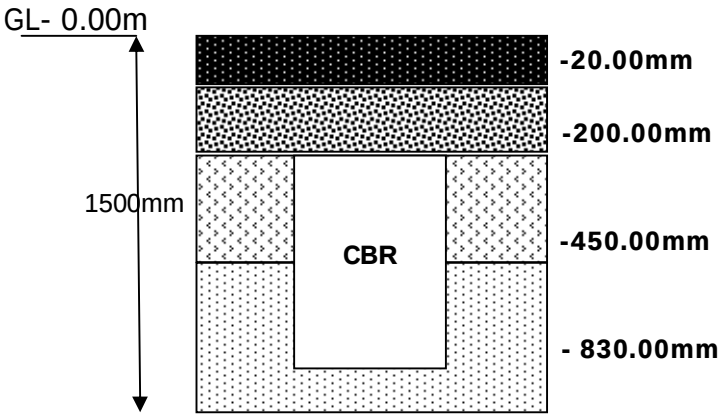
N: 1429977, E: 0322191



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....30../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....49.....

Location : KP....267.....+...0.08M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

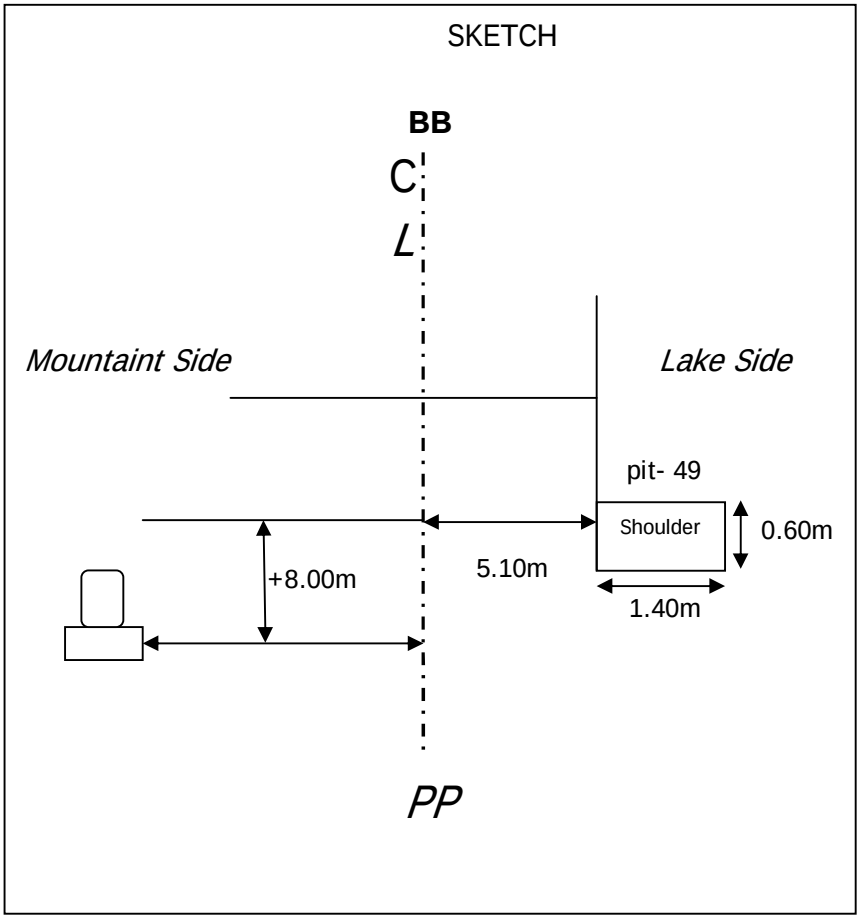
Base Course:.....No.....mm

Sub-Base Course:.....200.....mm

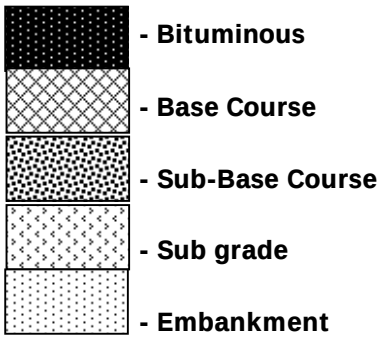
Sub-Grade:.....300.....mm

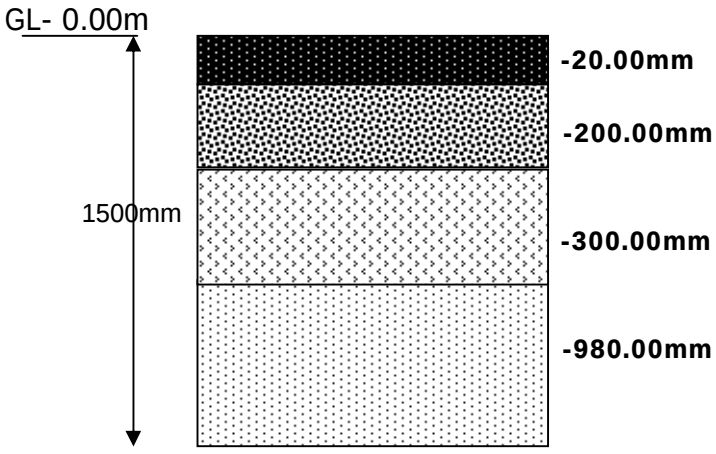
Embankment:.....980.....mm

N: 1431659, E: 0321132



Note:





Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....50.....

Location : KP...269.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

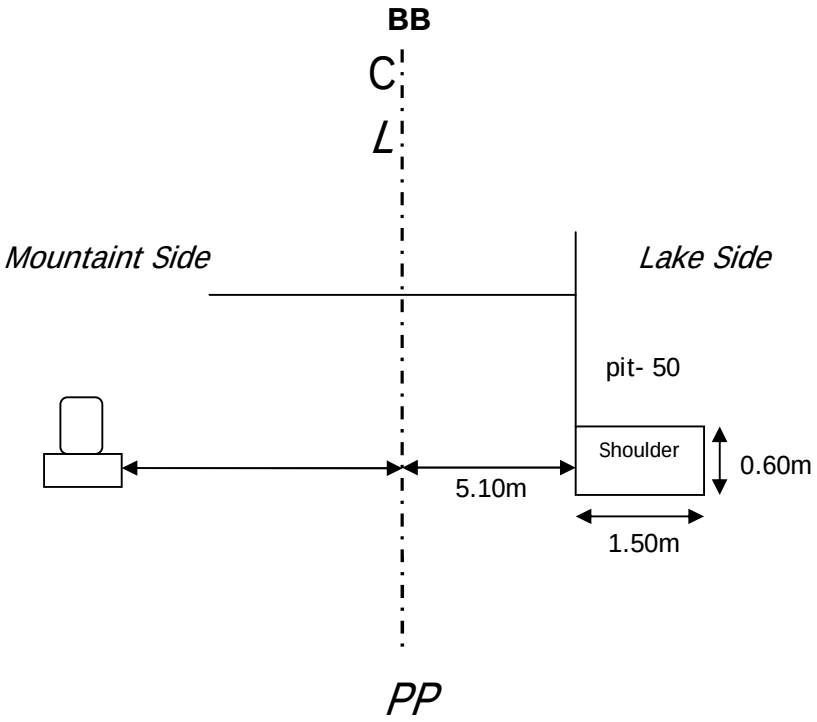
Sub-Base Course:.....200.....mm

Sub-Grade:.....600.....mm

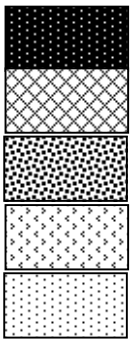
Embankment:.....680.....mm

N: 1433383, E: 0320093

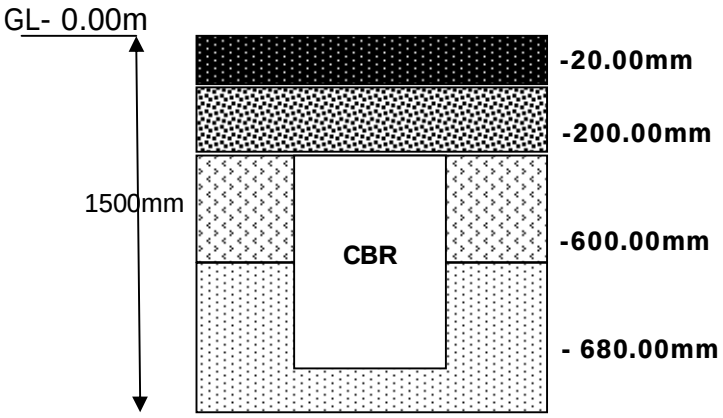
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....30../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....51.....

Location : KP....271.....+...0.08M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

Base Course:.....No.....mm

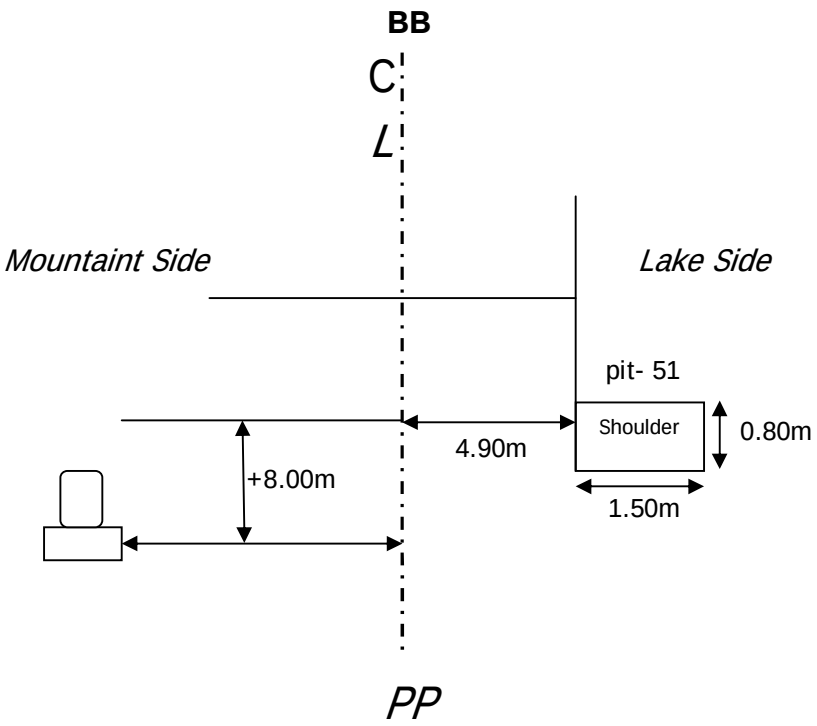
Sub-Base Course:.....230.....mm

Sub-Grade:.....500.....mm

Embankment:.....450.....mm

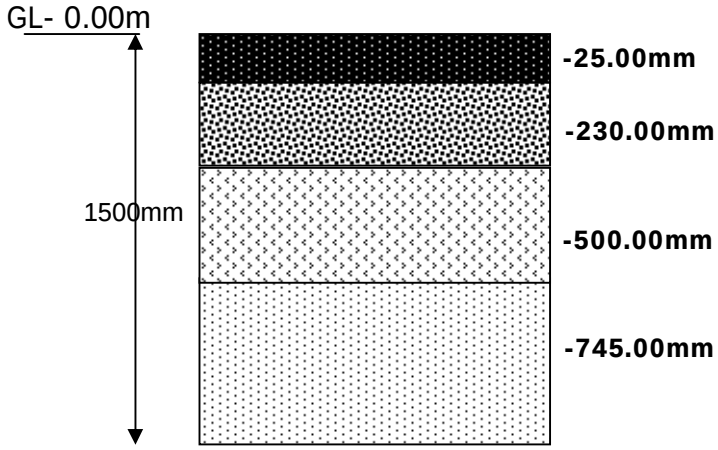
N: 1435134, E: 0319122

SKETCH



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....52.....

Location : KP....273.....+...0.00M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

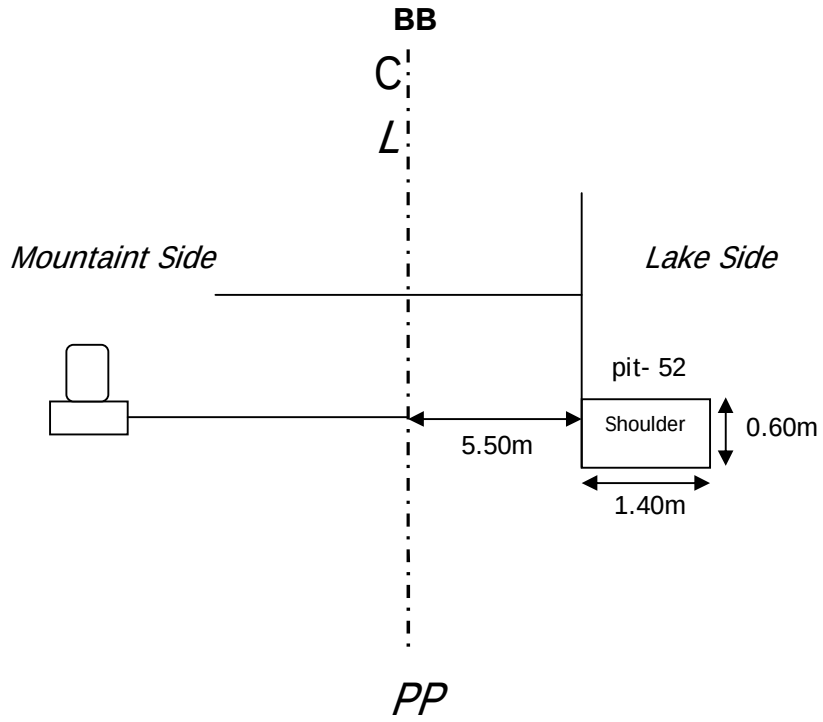
Sub-Base Course:.....180.....mm

Sub-Grade:.....400.....mm

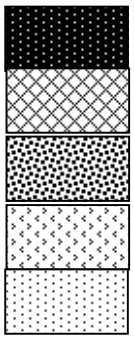
Embankment:.....900.....mm

N: 1436866, E: 0318172

SKETCH



Note:



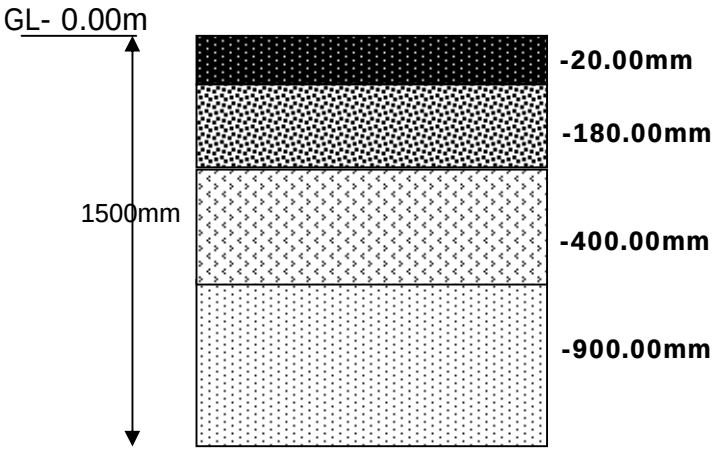
- Bituminous

- Base Course

- Sub-Base Course

- Sub grade

- Embankment



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....53.....

Location : KP....275.....+...012M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

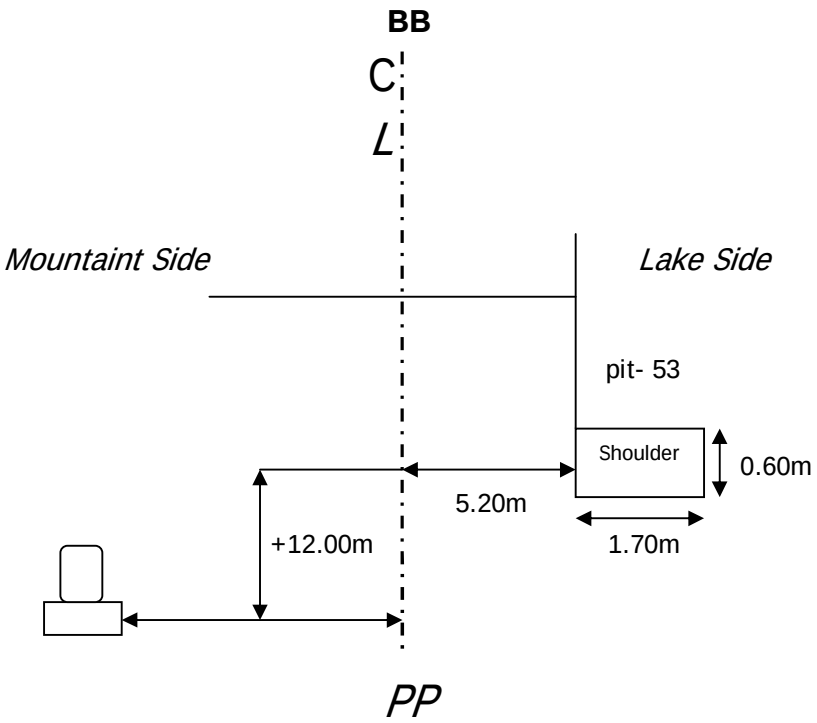
Sub-Base Course:.....No.....mm

Sub-Grade:.....1000.....mm

Embankment:.....480.....mm

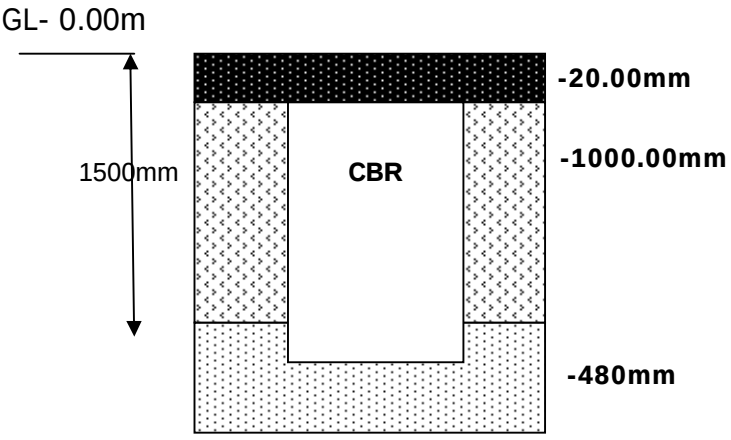
N: 1438743., E:0317452

SKETCH



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....54.....

Location : KP...277.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....25.....mm

Base Course:.....No.....mm

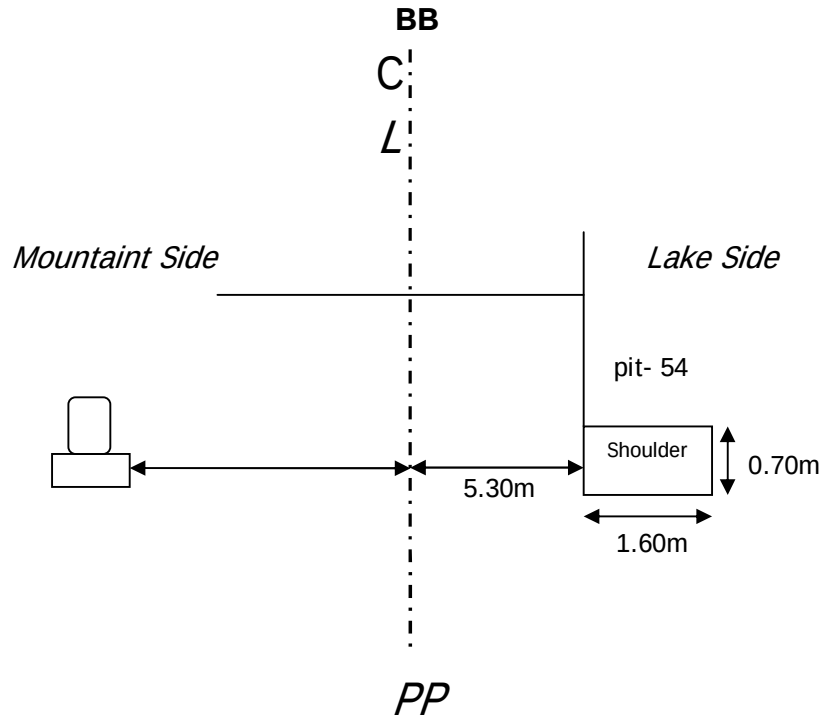
Sub-Base Course:.....NO.....mm

Sub-Grade:.....600.....mm

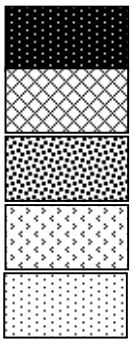
Embankment:.....875.....mm

N: 1440463, E: 0316487

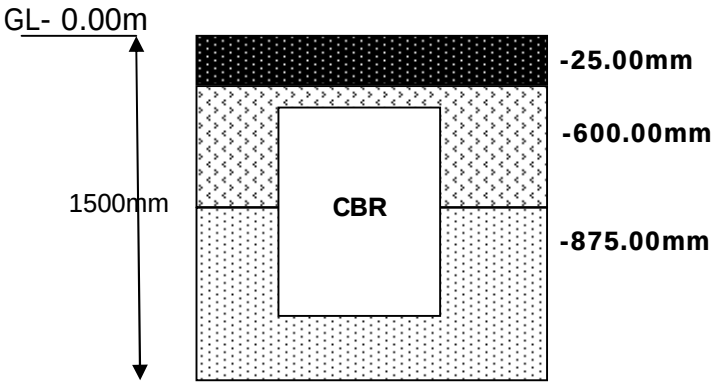
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....55.....

Location : KP...279.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

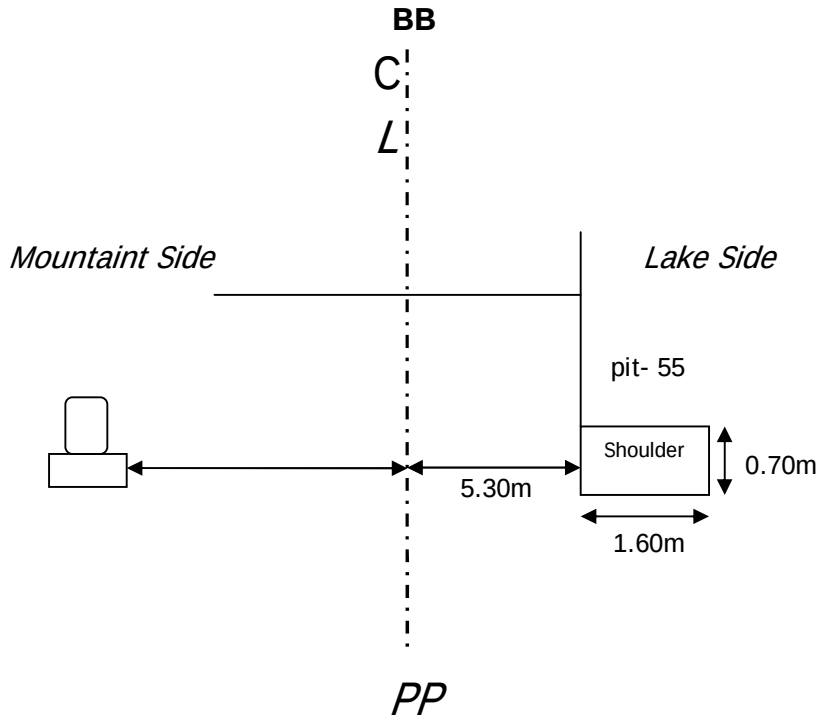
Sub-Base Course:.....NO.....mm

Sub-Grade:.....600.....mm

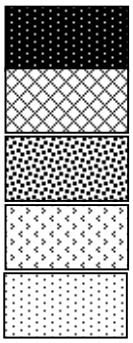
Embankment:.....880.....mm

N: 1440463, E: 0316487

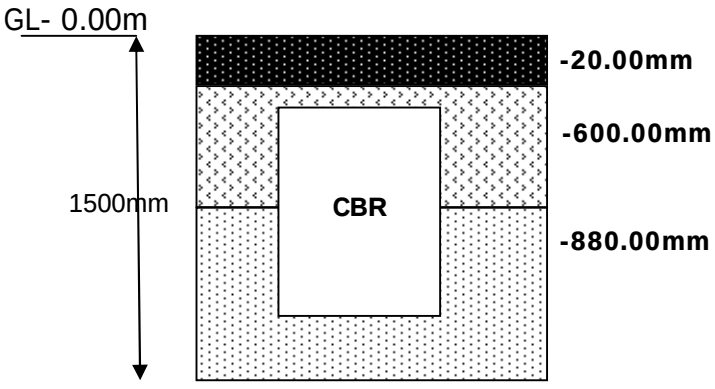
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....56.....

Location : KP...281.....+...0.00...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

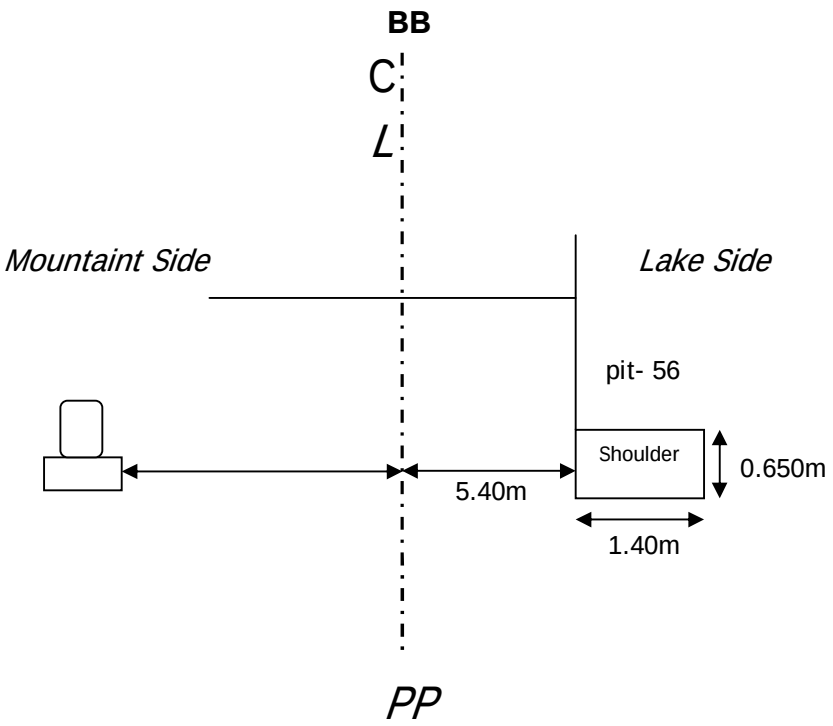
Sub-Base Course:.....NO.....mm

Sub-Grade:.....700.....mm

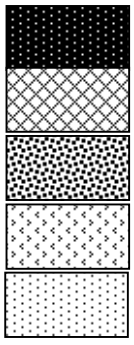
Embankment:.....780.....mm

N: 1440463, E: 0316487

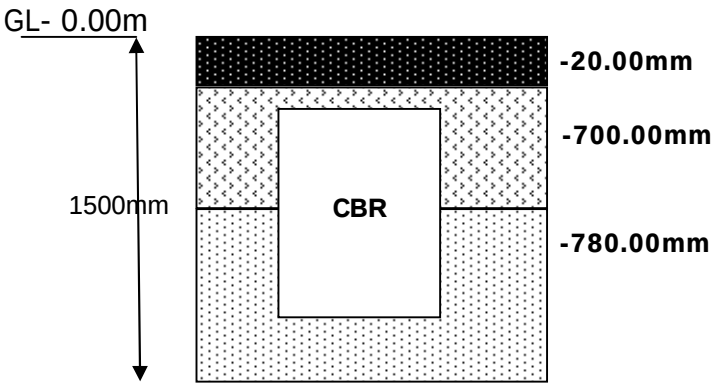
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....29../....05...../..2013..

Work Item: Digging Hole

Trial Pit No.....57.....

Location : KP....283.....+...0.00M...

PVC Water Pipe: ..No.....mm

Optical Cable:.....No.....

Bituminous:.....20.....mm

Base Course:.....No.....mm

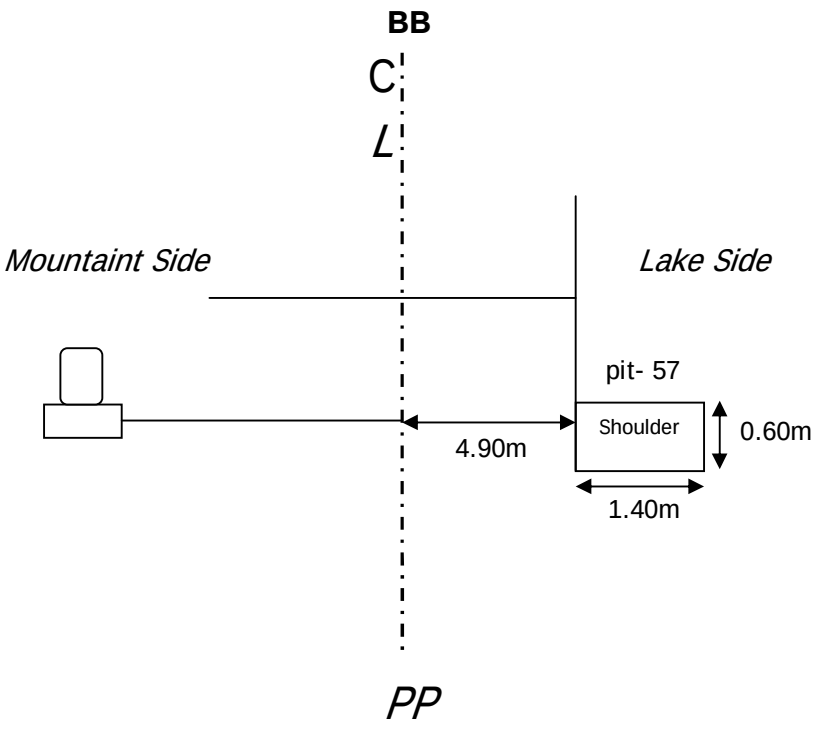
Sub-Base Course:.....200.....mm

Sub-Grade:.....500.....mm

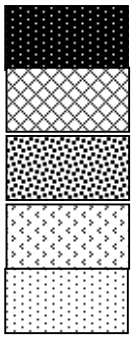
Embankment:.....780.....mm

N: 1444021, E: 0311819

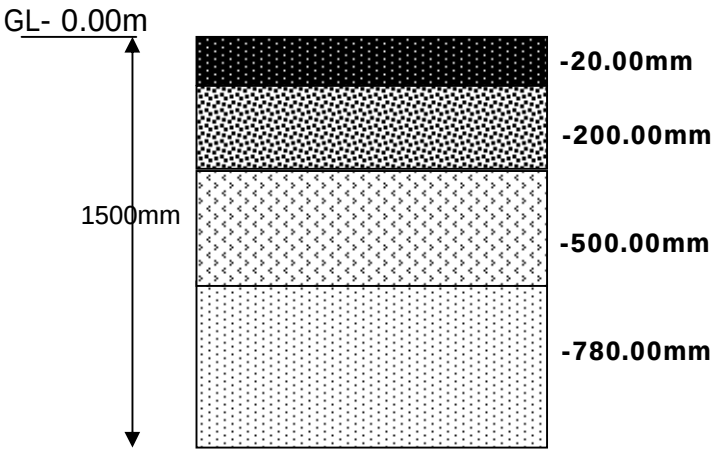
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



APPENDIX 6-6

SKETCHES OF THE TEST PITS

IN THE SRI SOPHORN – POIPET SECTION

Field Test Record

Date: .....21...../...05..../..2013....

Work Item: Digging Hole

Trial Pit No: 01

Location : KP: 367 + 000

PVC Water Pipe: No

Optical Cable: No

Bituminous: 40 mm

Base Course: No

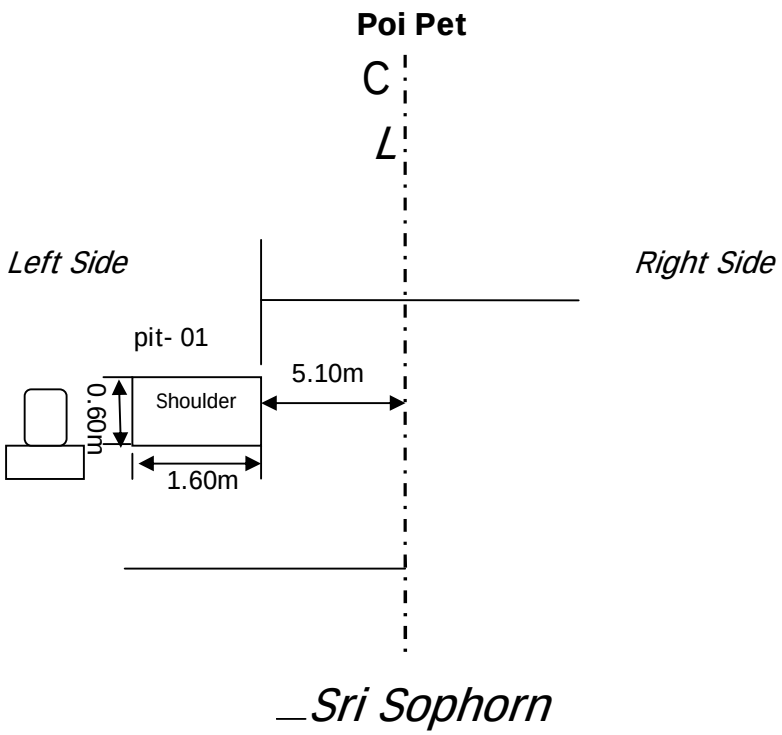
Sub-Base Course: 300.00 mm

Sub-Grade: 300.00 mm

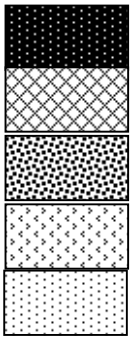
Embankment: 880.00 mm

N: 1501887. E: 0274458.

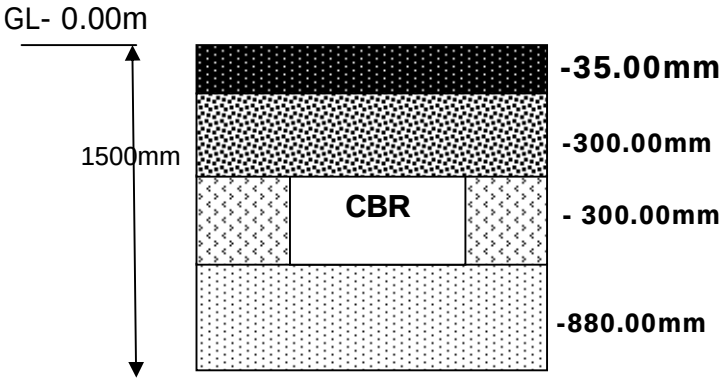
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....01../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....02.....

Location : KP....369....+...000...

PVC Water Pipe: ..No

Optical Cable:.....No...

Bituminous:.....35...mm

Base Course:.....400...mm

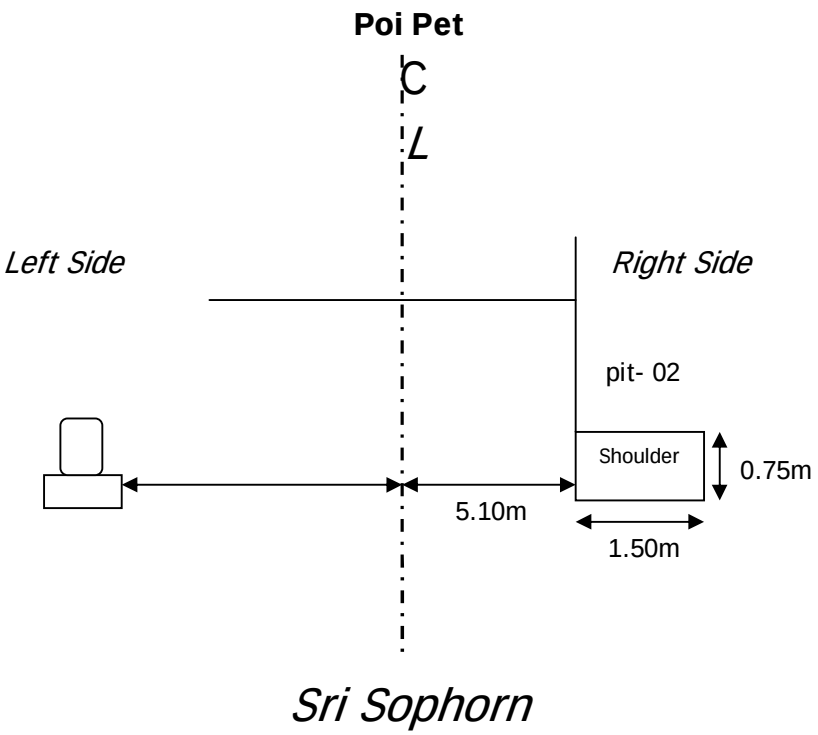
Sub-Base Course:.....No..

Sub-Grade:.....450....mm

Embankment:.....665.....mm

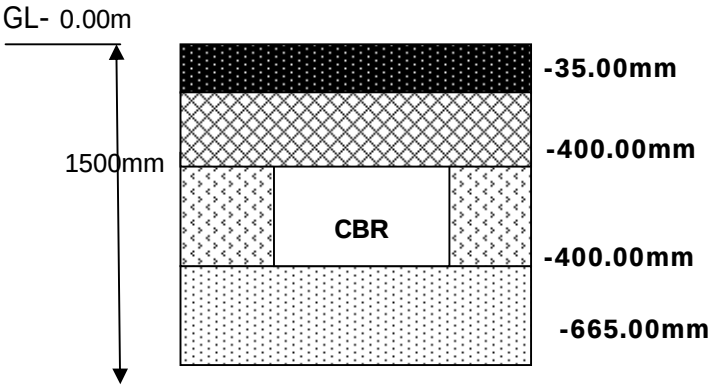
N:..1502081...., E:..0272442...

SKETCH



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....01../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....03.....

Location : KP....371.....+...000...

PVC Water Pipe: ..No...

Optical Cable:.....No....

Bituminous:.....40....mm

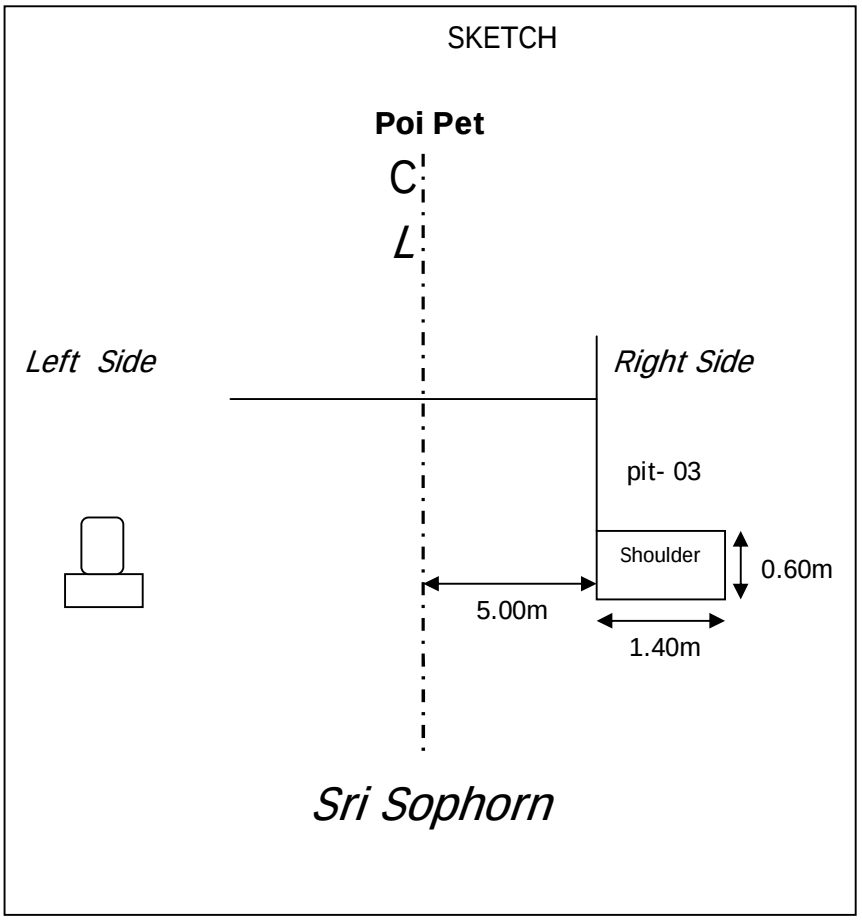
Base Course:.....300.....mm

Sub-Base Course:.....No..

Sub-Grade:.....300.....mm

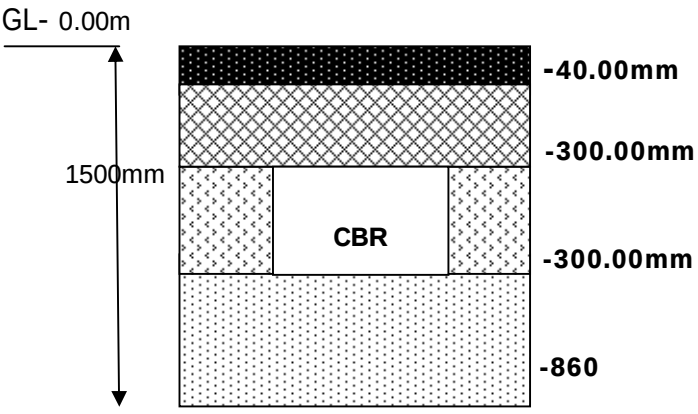
Embankment:.....860.....mm

N:..1502337...., E:..0270484.....



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....01../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....04.....

Location : KP....373.....+...000..

PVC Water Pipe: ..No...

Optical Cable:.....No....

Bituminous:.....30....mm

Base Course:.....300....mm

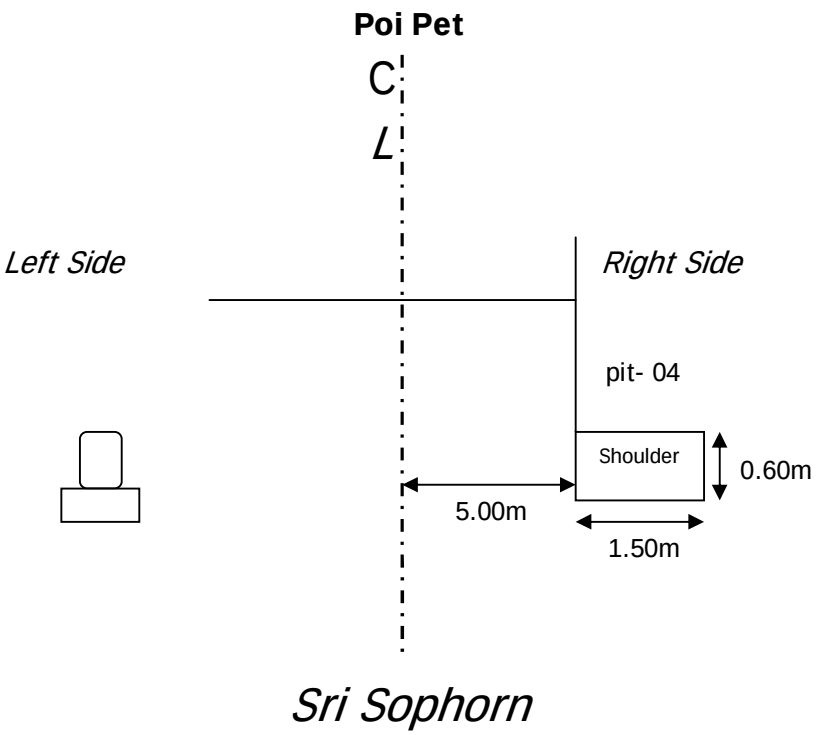
Sub-Base Course:.....No...

Sub-Grade:.....300.....mm

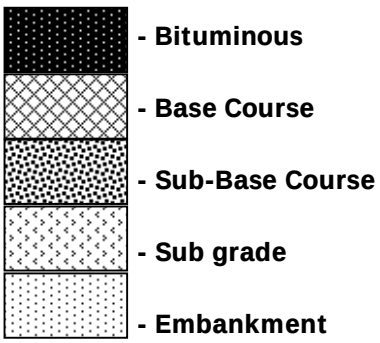
Embankment:.....870.....mm

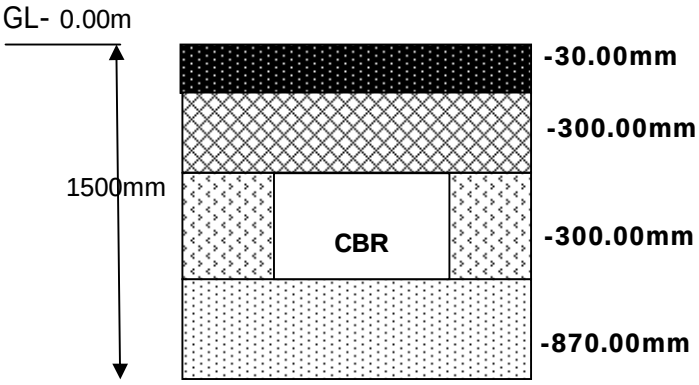
N:..1502781...., E:..0268536.....

SKETCH



Note:





Field Test Record

Date: .....02../....08...../..2013.

Work Item: Digging Hole

Trial Pit No.....05.....

Location : KP...375.....+...000...

PVC Water Pipe: ..No...

Optical Cable:...No...

Bituminous:....30.....mm

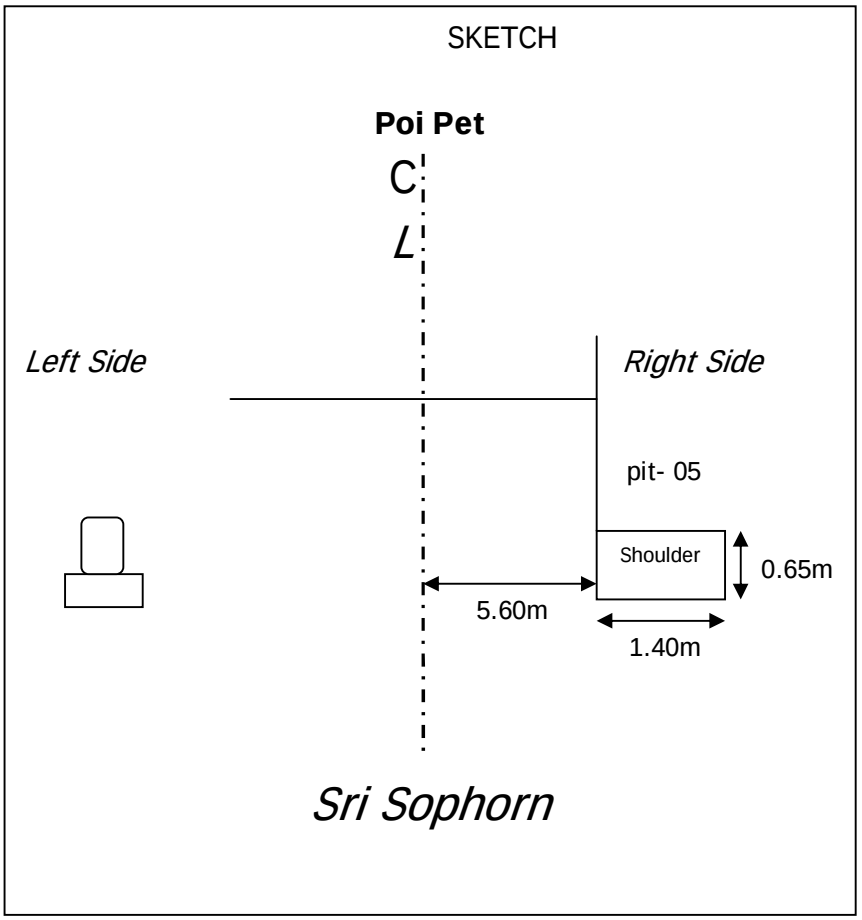
Base Course:...300.....mm

Sub-Base Course:....No....

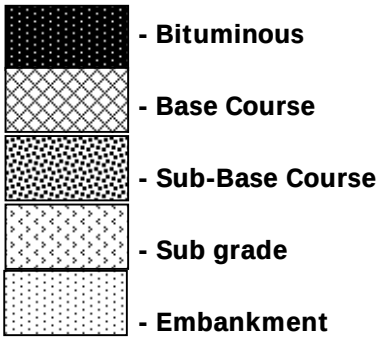
Sub-Grade:.....250.....mm

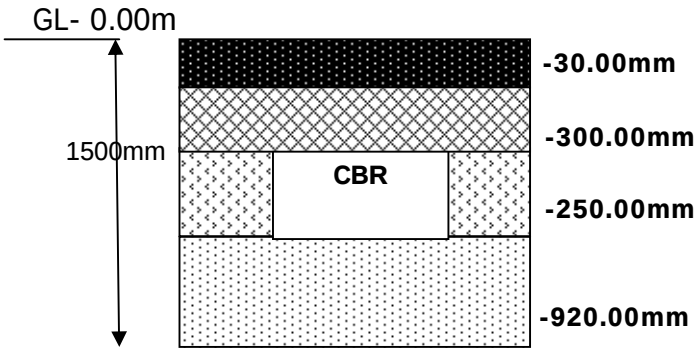
Embankment:...920.....mm

N:..1503310...., E:..0266605...



Note:





Field Test Record

Date: ...02.../....08...../..2013

Work Item: Digging Hole

Trial Pit No.....06.....

Location : KP....377.....+...000

PVC Water Pipe: ..No...

Optical Cable:.....No....

Bituminous:.....50.....mm

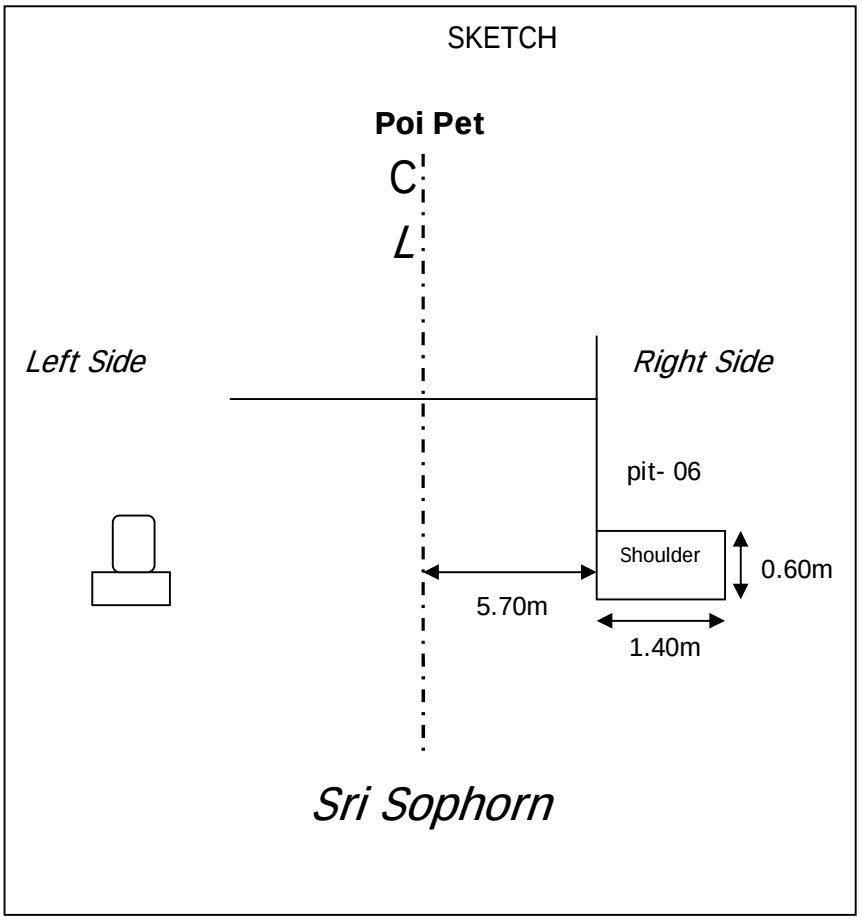
Base Course:.....No.....mm

Sub-Base Course:.....No....

Sub-Grade:.....250.....mm

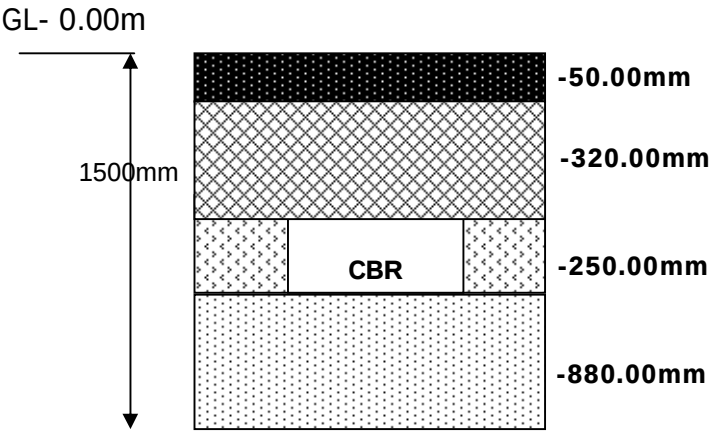
Embankment:.....880.....mm

N:..1503832..., E:..0264679.....



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ....02../....08..../..2013

Work Item: Digging Hole

Trial Pit No.....07.....

Location : KP....379.....+...0.00...

PVC Water Pipe: ..No.....

Optical Cable:...No....

Bituminous:.....40.....mm

Base Course:.....300.....mm

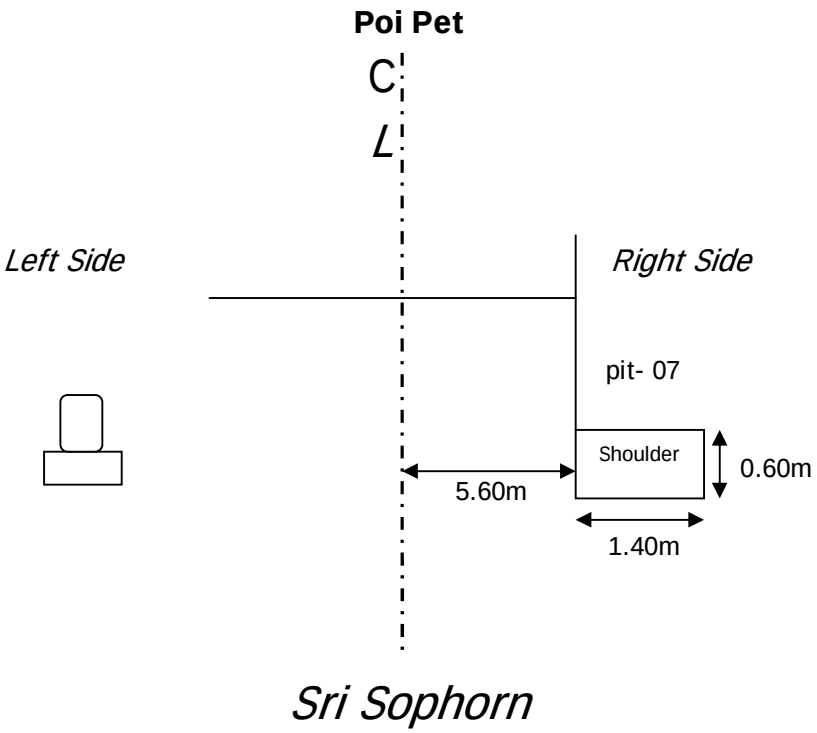
Sub-Base Course:.....No....

Sub-Grade:....250.....mm

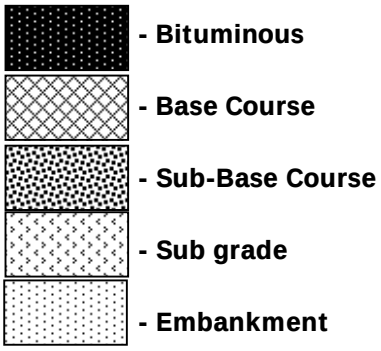
Embankment:.....910.....mm

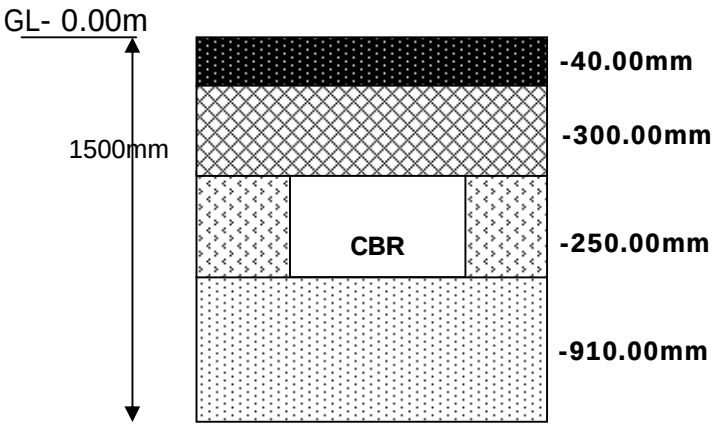
N:..1504351...., E:..0262741....

SKETCH



Note:





Field Test Record

Date: ...02../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....08.....

Location : KP....381.....+...0.00

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....40.....mm

Base Course:.....300.....mm

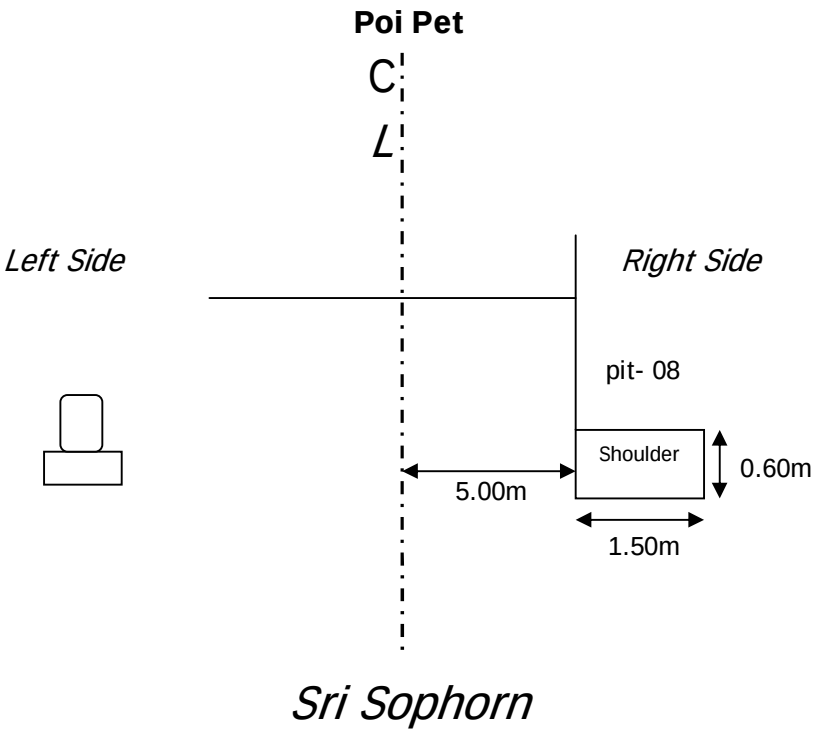
Sub-Base Course:.....No.....

Sub-Grade:.....250.....mm

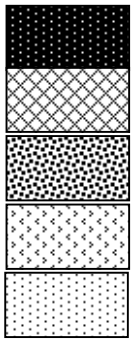
Embankment:.....910.....mm

N:..1504859...., E:..0260800....

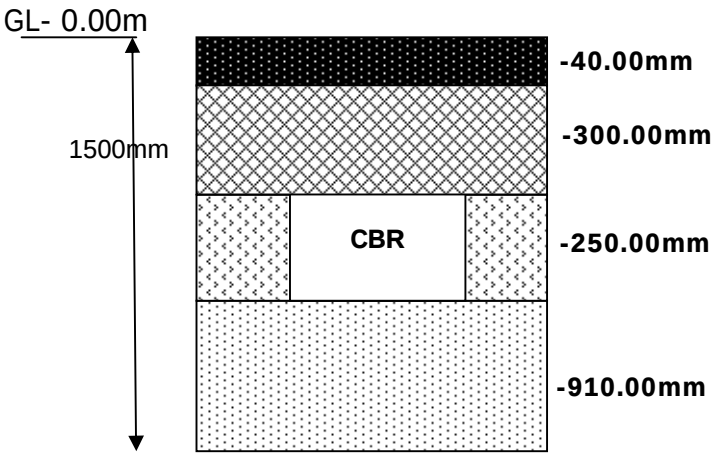
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: .....02../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....09.....

Location : KP....385.....+...000.

PVC Water Pipe: ..No....

Optical Cable:.....No...

Bituminous:.....40.....mm

Base Course:.....400.....mm

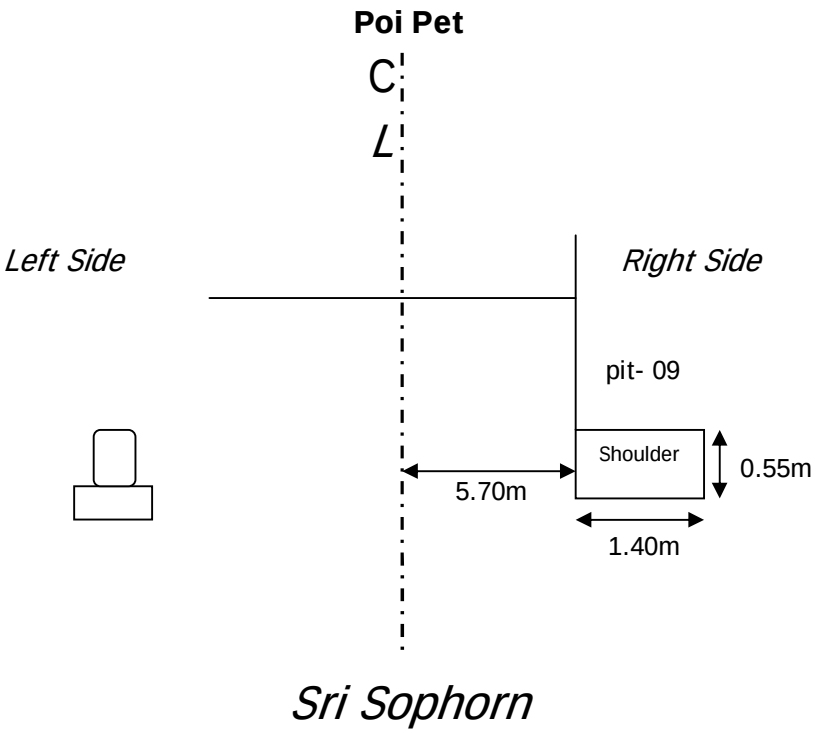
Sub-Base Course:.....No.....

Sub-Grade:.....180.....mm

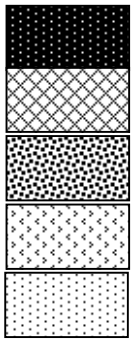
Embankment:.....880.....mm

N:..1505870...., E:..0256934..

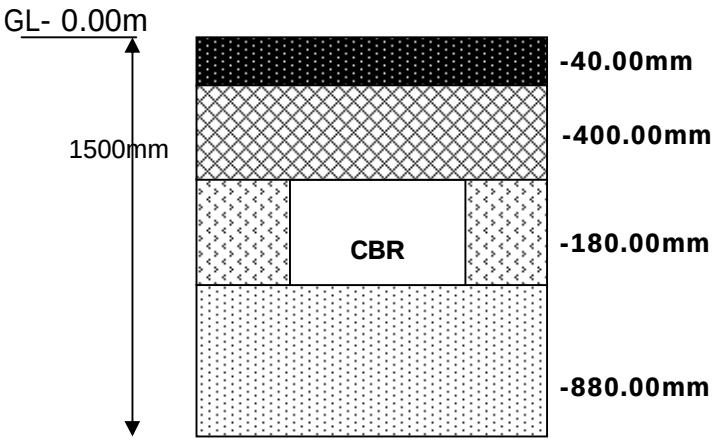
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ...02../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....10.....

Location : KP....387....+...74m...

PVC Water Pipe: ..No....

Optical Cable:.....No.....

Bituminous:.....40.....mm

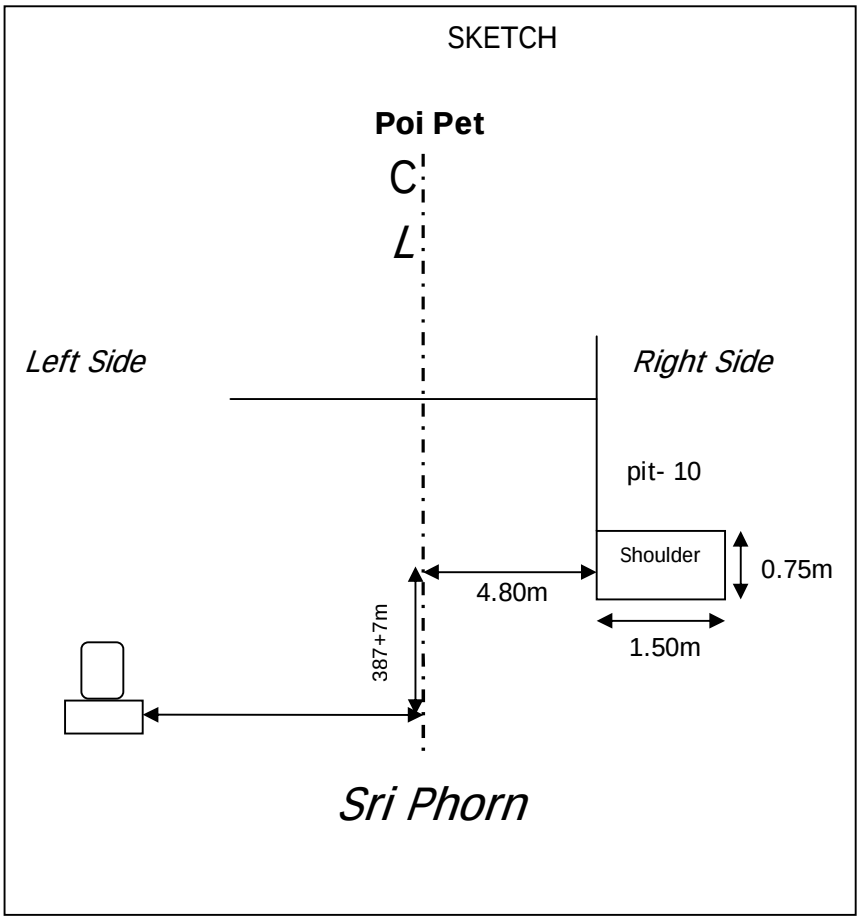
Base Course:.....360.....mm

Sub-Base Course:.....No....

Sub-Grade:.....250.....mm

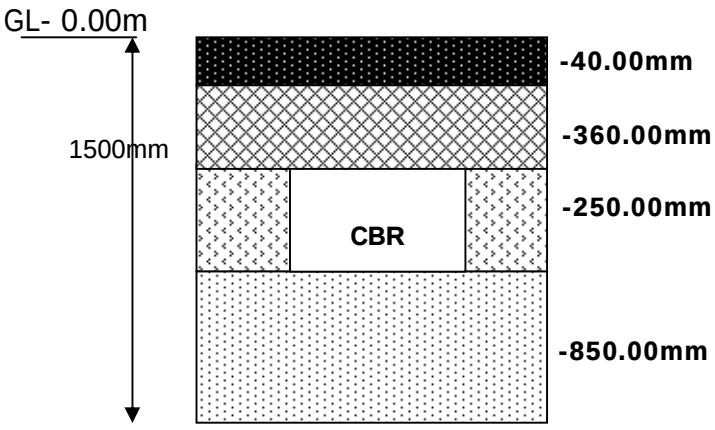
Embankment:.....850.....mm

N:..1506379...., E:..0254991...



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ...03../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....11.....

Location : KP....389.....+...000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....30.....mm

Base Course:.....440.....mm

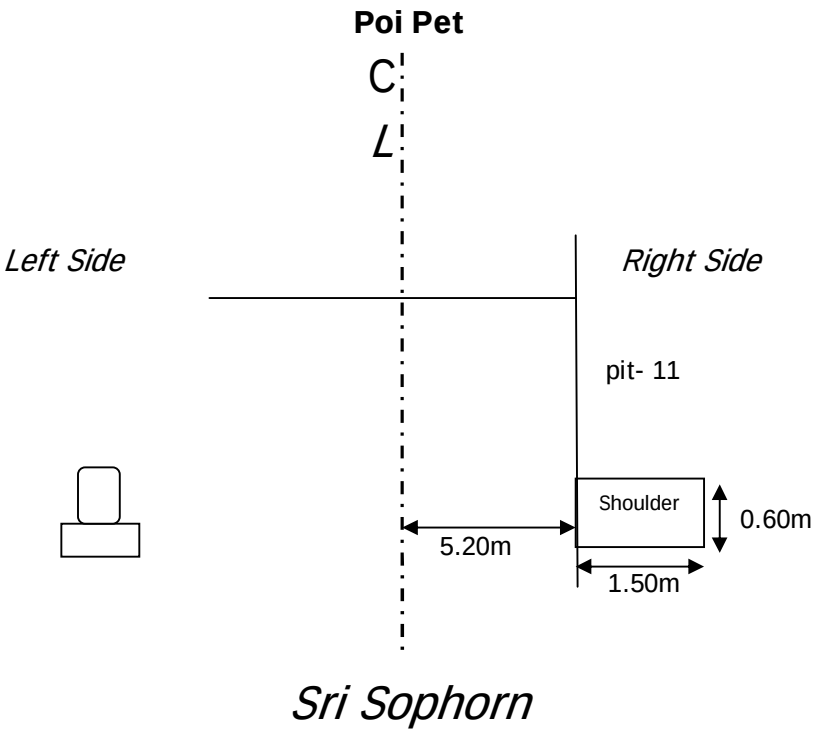
Sub-Base Course:.....No...

Sub-Grade:.....300.....mm

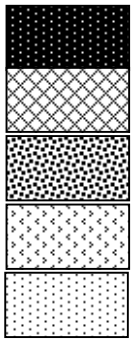
Embankment:.....710.....mm

N:..1506686..., E:..0253037...

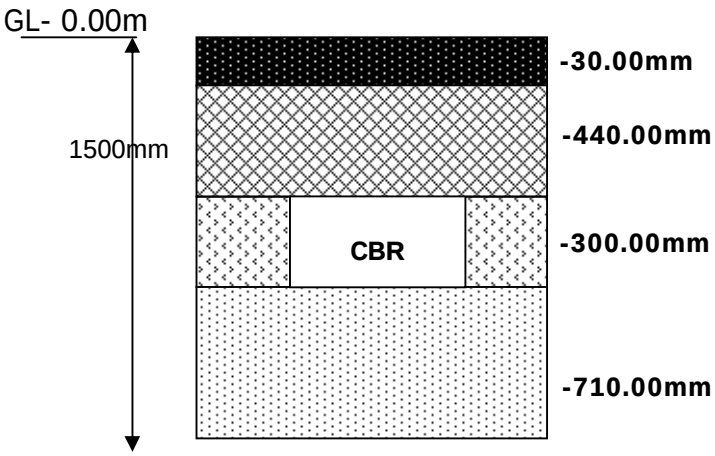
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ....03../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....12.....

Location : KP....391.....+..000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....30.....mm

Base Course:.....430.....mm

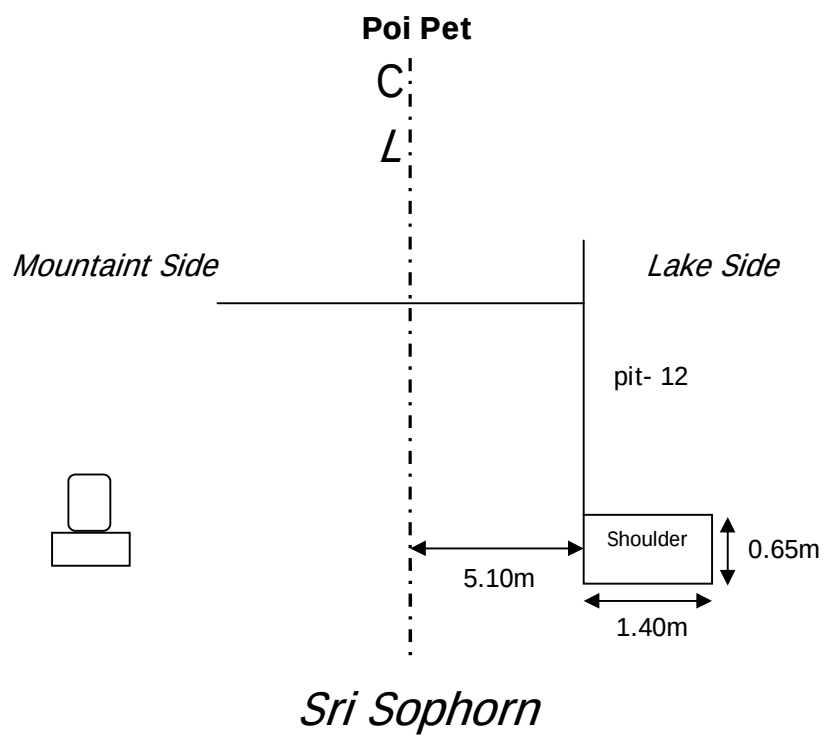
Sub-Base Course:.....No...

Sub-Grade:.....400.....mm

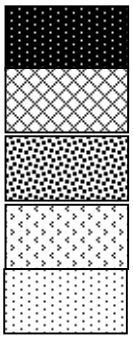
Embankment:.....640.....mm

N: 1507031, E: 0251053

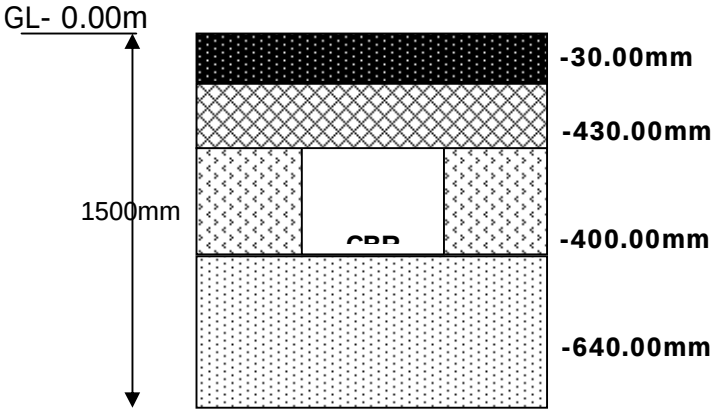
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ...03../....08..../..2013..

Work Item: Digging Hole

Trial Pit No.....13.....

Location : KP....393....+..000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....40.....mm

Base Course:.....250.....mm

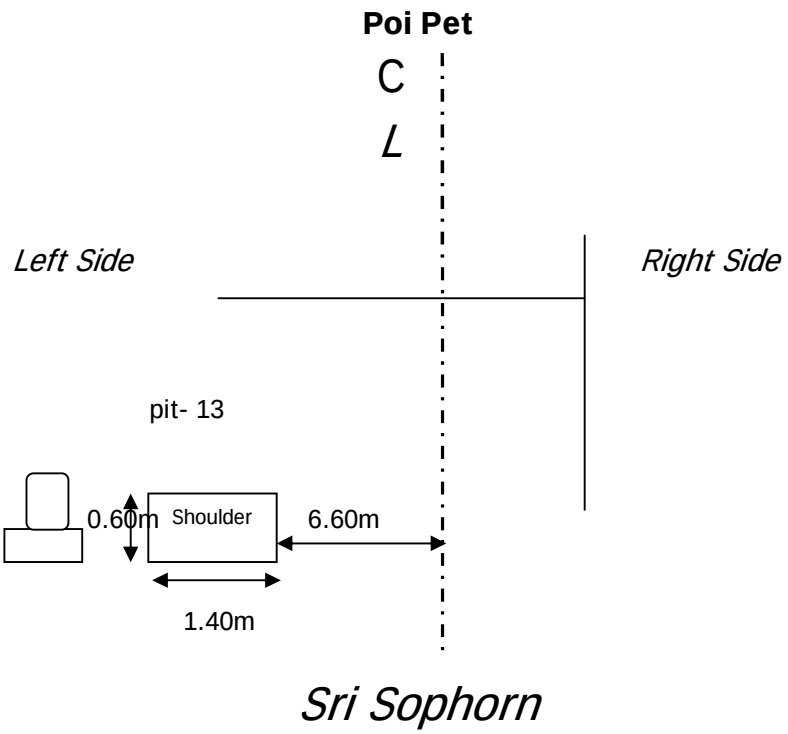
Sub-Base Course:.....No....

Sub-Grade:.....400.....mm

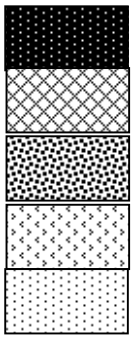
Embankment:.....810.....mm

N: 1507438, E: 0249084

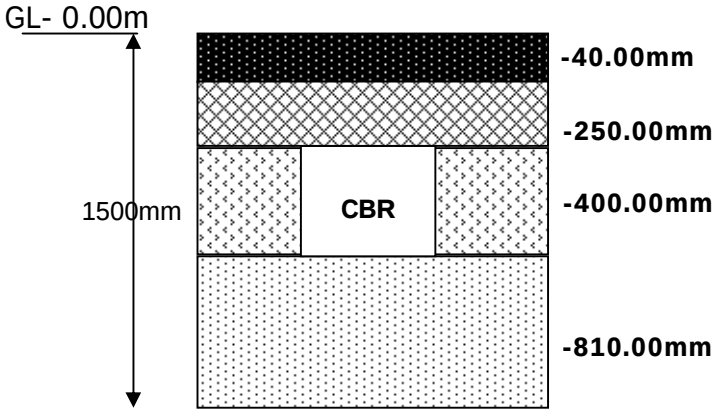
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ....04../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....14.....

Location : KP....401....+...000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....35.....mm

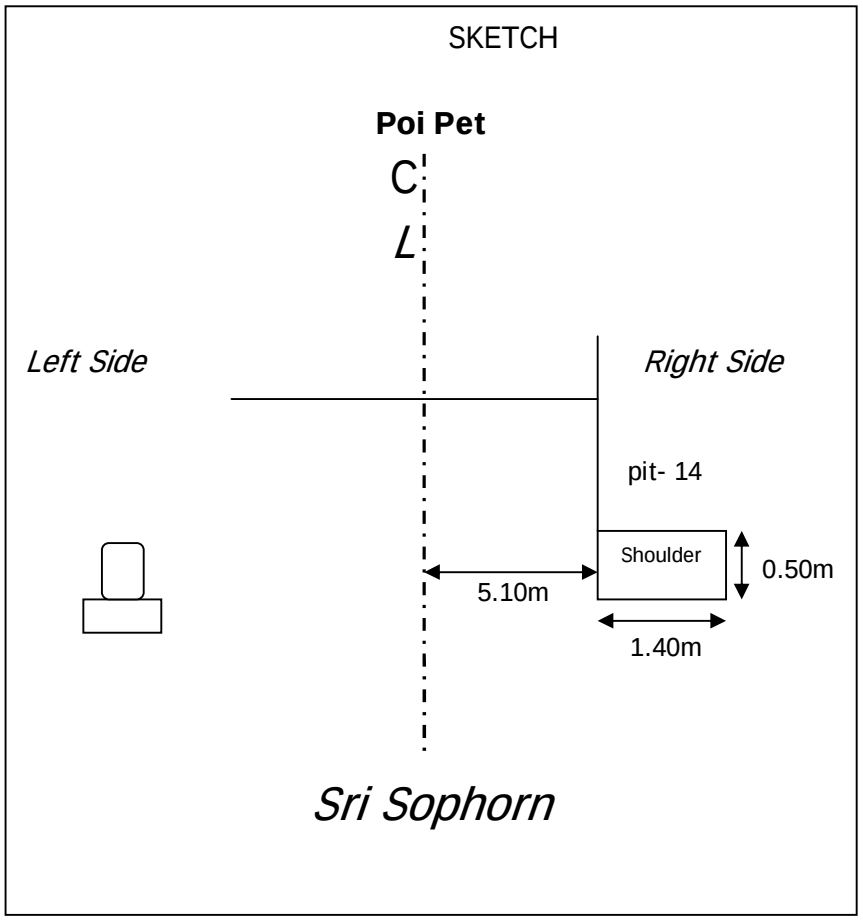
Base Course:.....430.....mm

Sub-Base Course:.....No.....

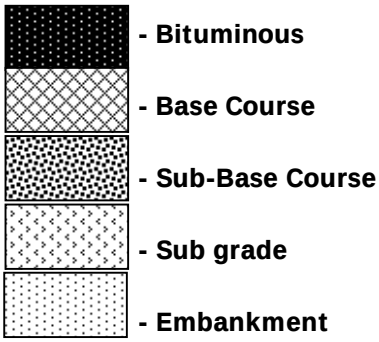
Sub-Grade:.....150.....mm

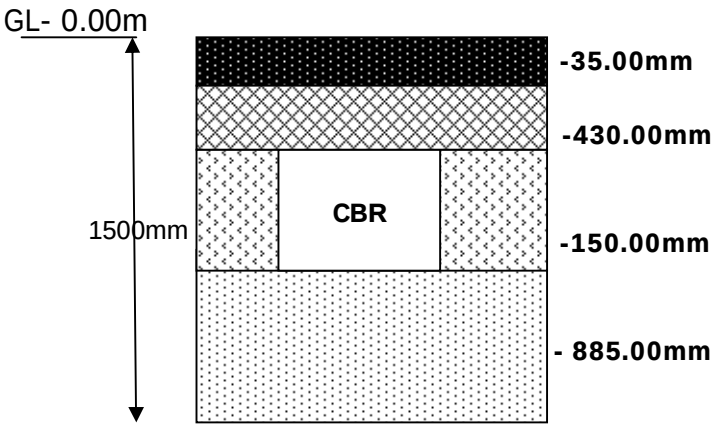
Embankment:.....885.....mm

N: 1508186, E: 0241137



Note:





Field Test Record

Date: ...04../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....15.....

Location : KP....399.....+...0.00...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....40.....mm

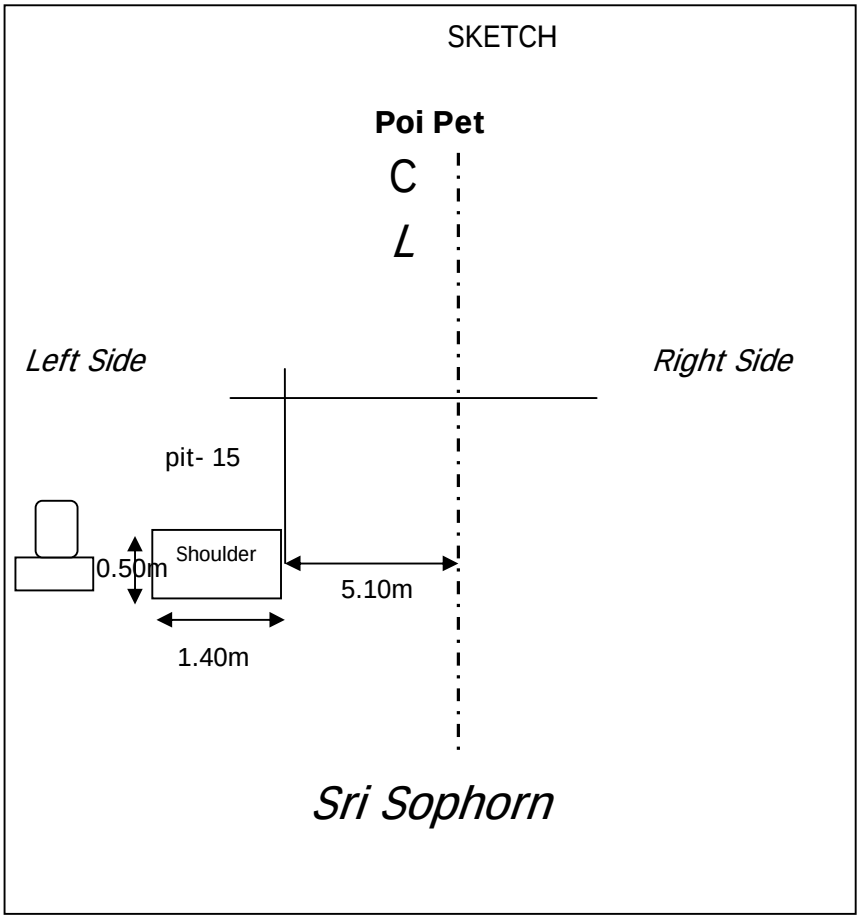
Base Course:.....300.....mm

Sub-Base Course:.....No.....

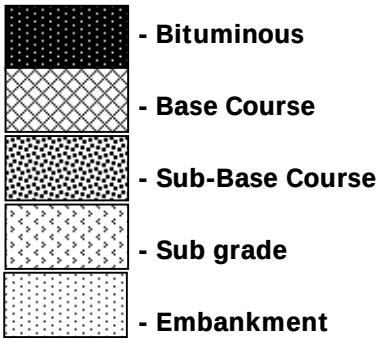
Sub-Grade:.....250.....mm

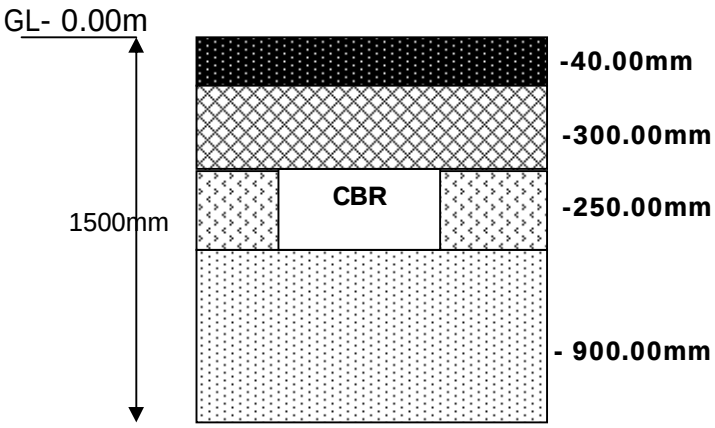
Embankment:.....900.....mm

N: 1507878, E: 0243111



Note:





Field Test Record

Date: ...04../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....16.....

Location : KP....397.....+...000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....30.....mm

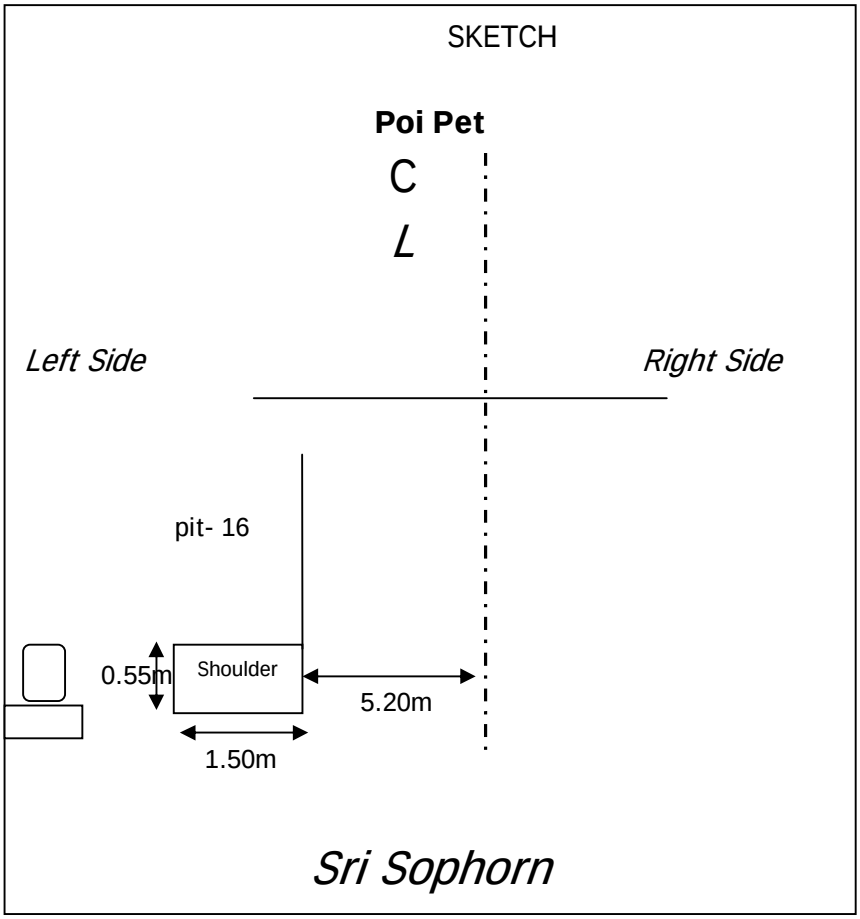
Base Course:.....300.....mm

Sub-Base Course:.....No.....

Sub-Grade:.....280.....mm

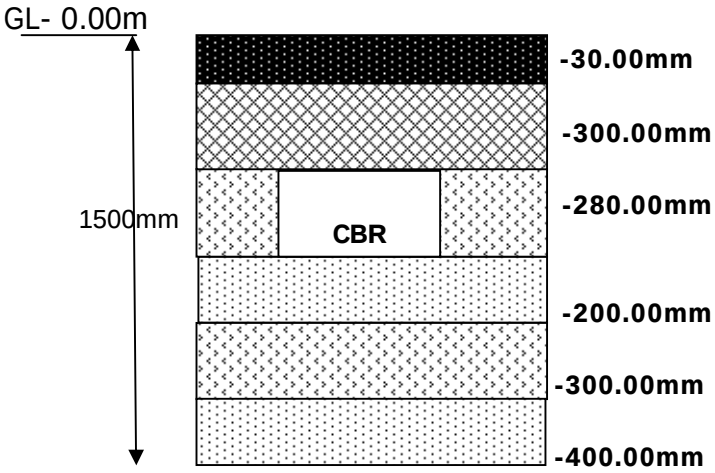
Embankment:.....200.....mm

N: 1507708, E: 0245105



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ....04../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....17.....

Location : KP....395.....+...000...

PVC Water Pipe: ..No.....

Optical Cable:.....No.....

Bituminous:.....35.....mm

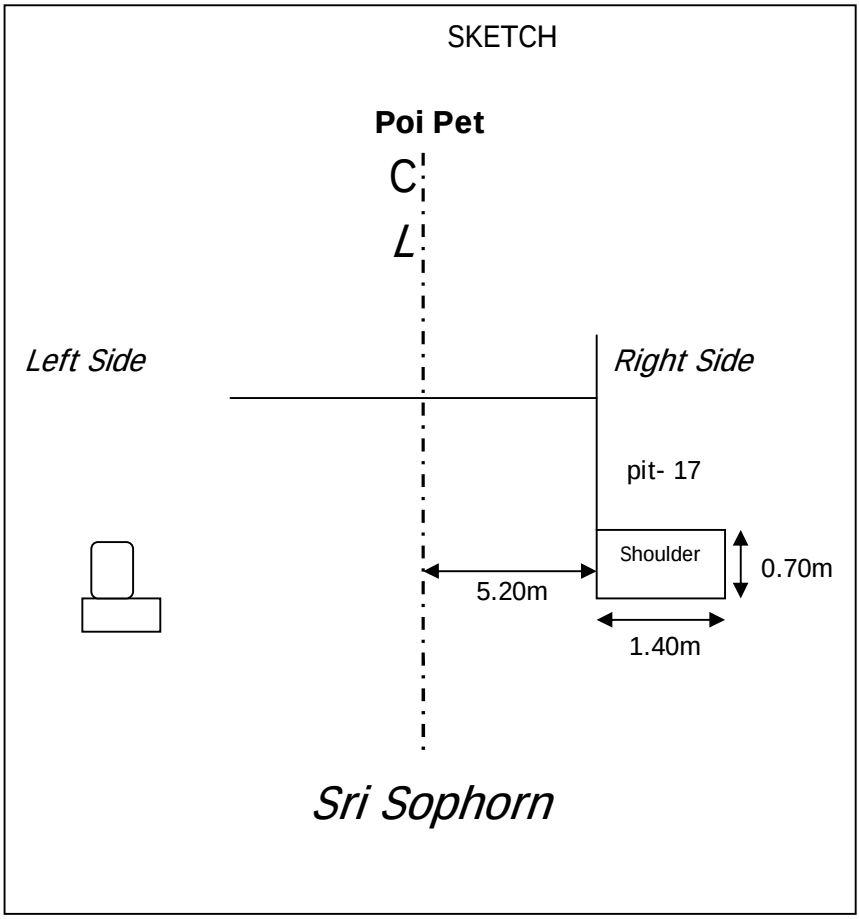
Base Course:....300.....mm

Sub-Base Course:.....No...

Sub-Grade:.....250.....mm

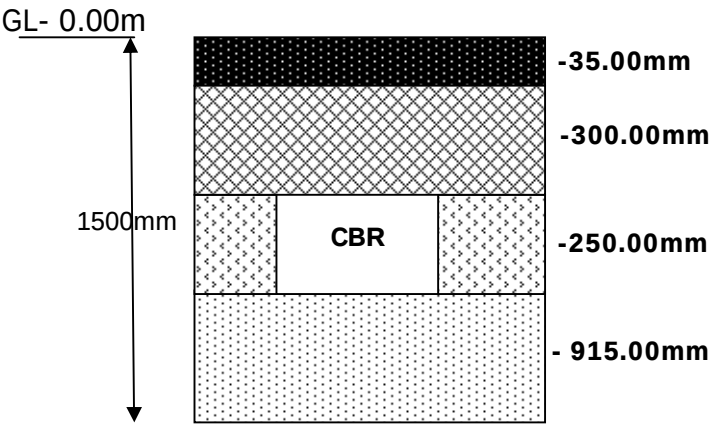
Embankment:.....915.....mm

N: 1507621, E: 0247104



Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ....04../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....18.....

Location : KP....403.....+...000...

HDPE Water Pipe: ..Ø63mm and Ø163mm

Optical Cable:.....No.....

Bituminous:.....No

Base Course:.....No.....

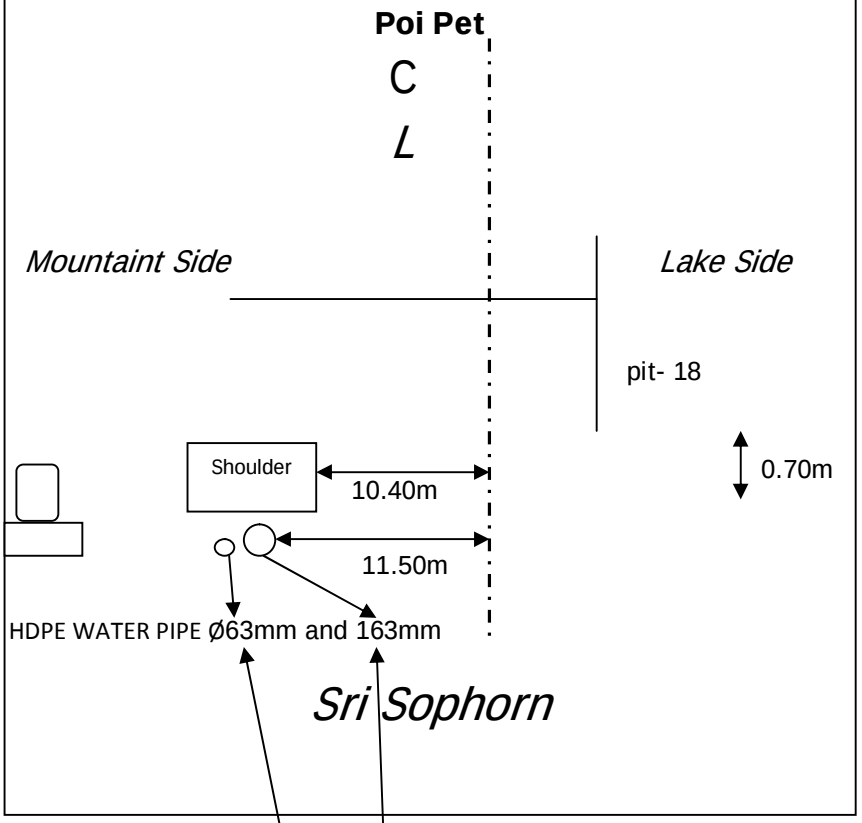
Sub-Base Course:.....No

Sub-Grade:.....400.....mm

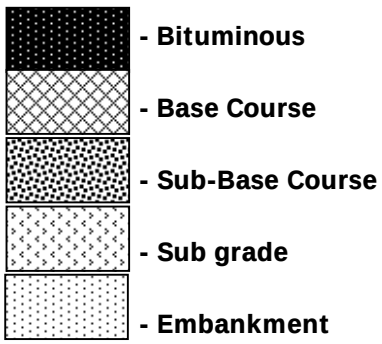
Embankment:....1100.....mm

N: 1508719, E: 0239194

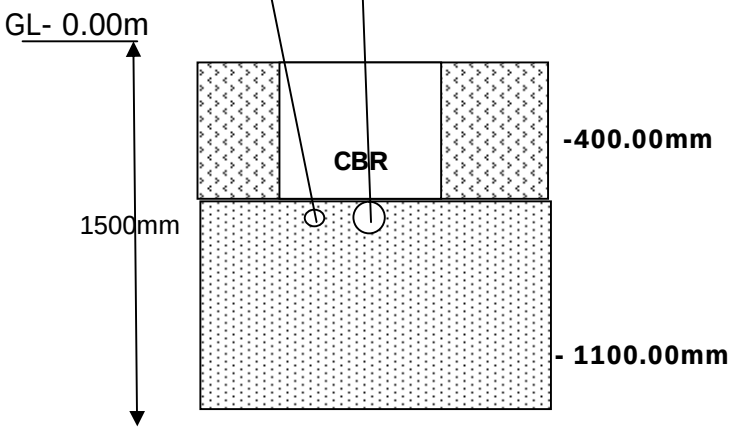
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ...05../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....19.....

Location : KP...405....+...000...

HDPE Water Pipe: .Ø163..mm

Optical Cable:....Ø80mm.....

Bituminous:.....No...

Base Course:.....No.....

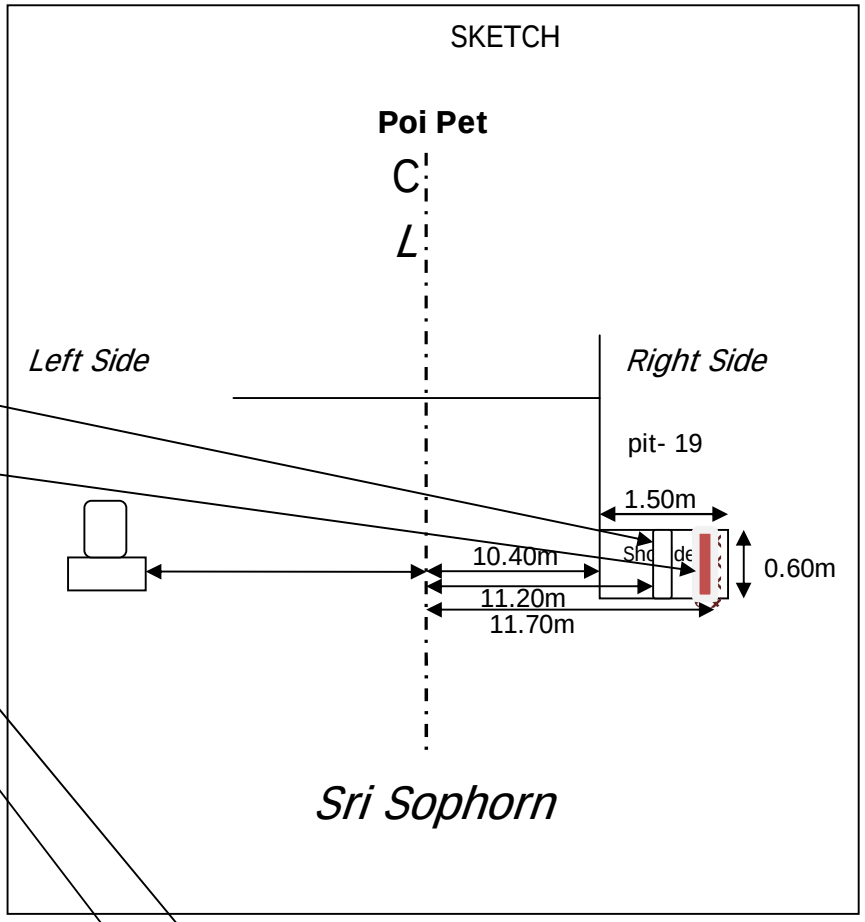
Sub-Base Course:.....200.....mm

Sub-Grade:.....200.....mm

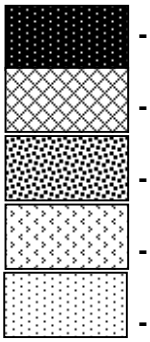
Embankment:.....1010.....mm

N: 1509790, E: 0237523

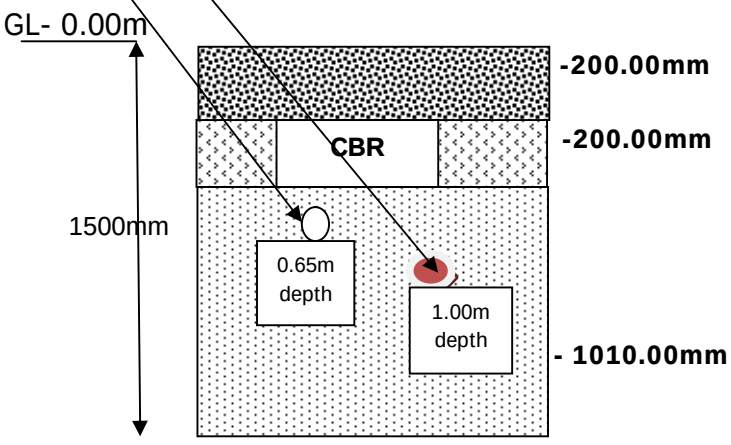
SKETCH



Note:



- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**



Field Test Record

Date: ...05../....08...../..2013..

Work Item: Digging Hole

Trial Pit No.....20.....

Location : KP...407.....+...008m...

PVC Water Pipe: ..Ø115..mm

Optical Cable:.....No.....

Bituminous:.....No....

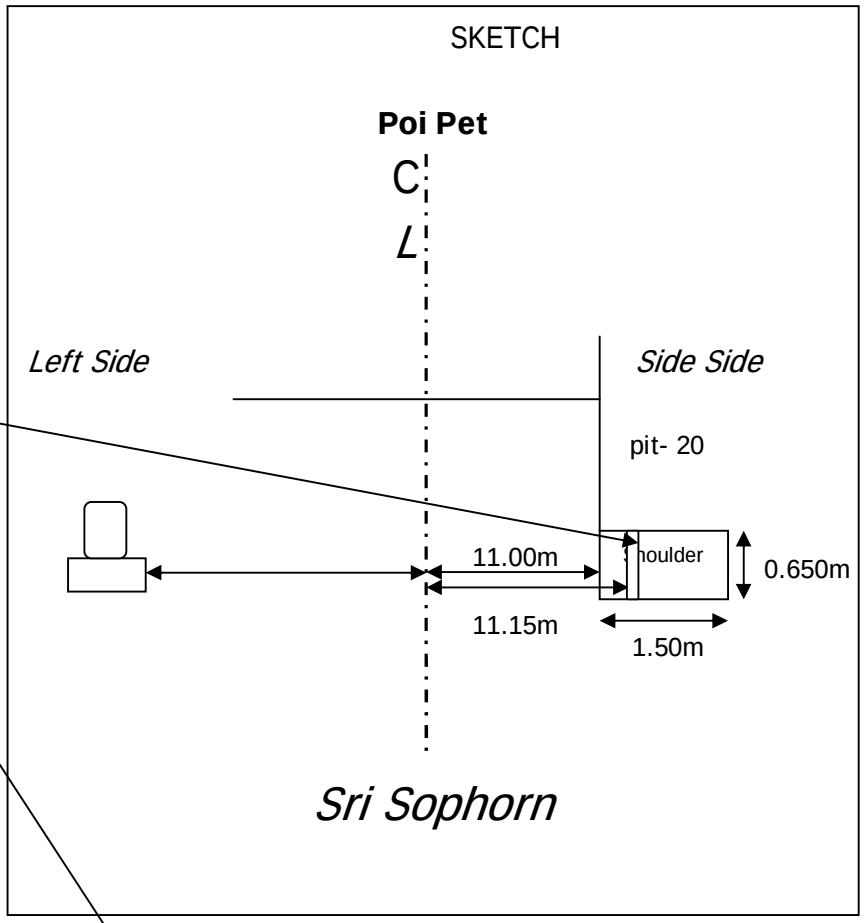
Base Course:.....No.....

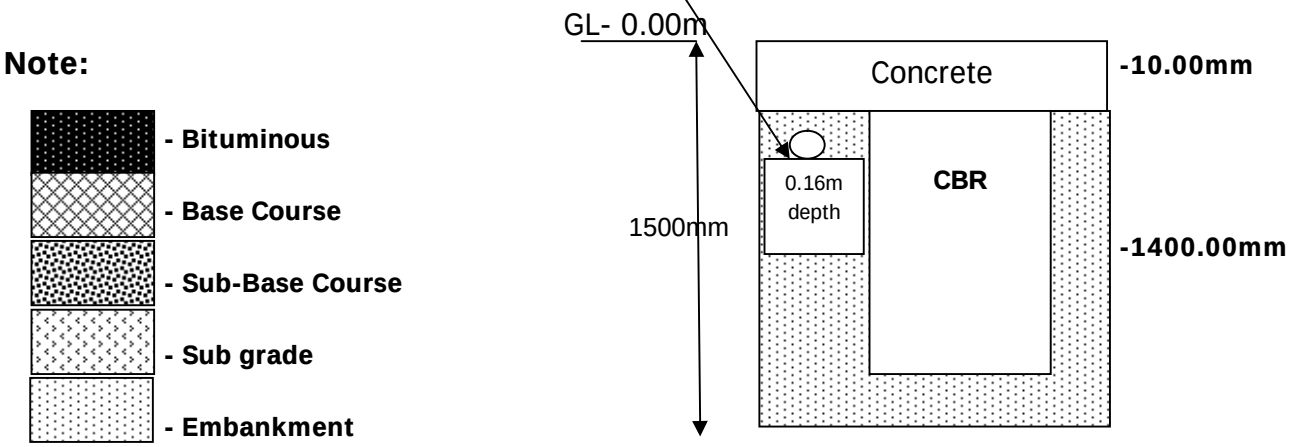
Sub-Base Course:.....No...

Sub-Grade:.....No....

Embankment:.....1400.....mm

N: 1510973, E: 0235917





Note:

- **Bituminous**
- **Base Course**
- **Sub-Base Course**
- **Sub grade**
- **Embankment**

APPENDIX 6-7

SUMMARY OF CBR TESTS

IN THE MIDDLE SECTION

Soil Investigation Data

Pit & CBR-No.		1	2	3	4	5
PK, (km)		171 + 35M	173 + 000	175 + 000	177 + 005M	179 + 000
Thickness (mm)	Bituminous Material	25	20	20	15	15
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Grade	800	650	650	700	700
Laboratory Test	CBR at 95%	6.20	9.90	8.40	5.00	9.70
	OMC, (%)	7.30	6.10	8.30	7.70	8.30
	MDD, (g/cc)	2.162	2.182	2.125	2.148	2.14
	Soil Classfication	A6	A4	A6	A7	A6
	Clay+Silt (%)	42.86	40.49	66.65	35.71	39.58
	Sand, (%)	40.64	45.08	31.16	44.86	40.17
	Gravel, (%)	16.51	14.43	2.19	19.42	20.25
	Specific Gravity	2.685	2.662	2.569	2.818	2.690
	Liquid Limit, (%)	24.2	32.60	30.20	27.30	32.30
	Plastisity Index, (%)	12.01	15.7	18.02	15.15	18.67
	Moisture Content, (%)	5.78	3.45	11.51	9.64	8.99

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		6	7	8	9	10
PK, (km)		181 +004M	183 + 000	185 +000	187 + 010M	189 + 000
Thickness (mm)	Bituminous Material	20	20	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Grade	700	700	700	600	700
Laboratory Test	CBR at 95%	4.00	3.80	9.00	2.20	7.70
	OMC, (%)	8.30	8.60	7.40	7.40	9.40
	MDD, (g/cc)	2.158	2.108	2.140	2.135	2.095
	Soil Classfication	A6	A7	A4	A7	A6
	Clay+Silt (%)	38.16	49.09	33.07	38.61	35.53
	Sand, (%)	51.31	47.54	48.72	50.03	35.92
	Gravel, (%)	10.53	3.37	18.21	11.36	28.55
	Specific Gravity	2.637	2.618	2.687	2.644	2.784
	Liquid Limit, (%)	34.40	18.70	25.40	25.60	33.70
	Plastisity Index, (%)	23.01	8.67	13.10	12.89	15.8
	Moisture Content, (%)	9.66	8.32	4.90	7.97	8.13

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		11	12	13	14	15
PK, (km)		191 + 002	193 - 008M	195 - 005M	197 + 004M	199 + 000
Thickness (mm)	Bituminous Material	20	20	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	0.00	180	230	330	300
	Sub-Grade	600	500	400	600	400
Laboratory Test	CBR at 95%	9.40	0.60	2.01	6.10	3.35
	OMC, (%)	9.20	6.75	8.56	8.50	9.25
	MDD, (g/cc)	2.135	2.184	2.114	2.057	2.02
	Soil Classfication	A4	A7	A7	A6	A7
	Clay+Silt (%)	50.25	34.99	28.85	45.56	51.43
	Sand, (%)	33.15	43.3	30.48	32.49	28.93
	Gravel, (%)	16.60	21.7	40.68	21.95	19.64
	Specific Gravity	2.644	2.741	2.829	2.753	2.708
	Liquid Limit, (%)	30.60	18.70	36.40	34.60	32.60
	Plastisity Index, (%)	17.99	7.15	19.63	21.28	19.69
	Moisture Content, (%)	9.81	3.91	10.51	12.20	12.46

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		16	17	18	19	20
PK, (km)		201 + 003M	203 + 007M	205 + 002M	207 + 000	209 + 000
Thickness (mm)	Bituminous Material	20	20	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	250	300	200	250	200
	Sub-Grade	500	400	400	500	400
Laboratory Test	CBR at 95%	3.25	2.30	2.70	7.10	5.90
	OMC, (%)	9.50	8.90	7.90	8.20	8.20
	MDD, (g/cc)	2.180	2.057	2.160	2.145	2.110
	Soil Classfication	A7	A7	A7	A7	A7
	Clay+Silt (%)	31.99	56.37	43.87	44.32	51.97
	Sand, (%)	34.75	23.6	28.46	33.21	30.68
	Gravel, (%)	33.26	20.01	27.67	22.47	17.35
	Specific Gravity	2.846	2.675	2.816	2.781	2.722
	Liquid Limit, (%)	32.00	35.80	33.00	34.60	30.80
	Plastisity Index, (%)	19.04	18.57	19.06	21.11	12.63
	Moisture Content, (%)	8.29	10.64	10.95	10.89	11.45

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		21	22	23	24	25
PK, (km)		211 + 000	213+ 016M	215+ 000	217 + 000	219 + 000
Thickness (mm)	Bituminous Material	20	15	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	200	300	180	0.00	300
	Sub-Grade	500	500	400	500	400
Laboratory Test	CBR at 95%	1.65	5.00	2.05	3.50	1.00
	OMC, (%)	8.20	9.30	8.30	9.40	8.60
	MDD, (g/cc)	2.100	2.049	2.117	2.098	2.049
	Soil Classfication	A7	A7	A7	A7	A7
	Clay+Silt (%)	46.52	34.59	43.70	45.65	72.65
	Sand, (%)	34.08	27.4	29.87	25.98	19.08
	Gravel, (%)	19.40	38.01	26.43	28.37	8.27
	Specific Gravity	2.715	2.684	2.734	2.760	2.680
	Liquid Limit, (%)	19.80	27.90	32.60	39.20	32.40
	Plastisity Index, (%)	6.36	14.48	16.07	23.21	19.63
	Moisture Content, (%)	12.85	8.09	11.07	9.89	8.39

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		26	27	28	29	30
PK, (km)		221 + 000	223 + 000	225 - 008M	227 - 003M	229 + 000
Thickness (mm)	Bituminous Material	10	25	20	20	20
	Base Course	0.00	0.00	250	0.00	0.00
	Sub-Base Course	180	200	0.00	250	0.00
	Sub-Grade	600	400	700	600	700
Laboratory Test	CBR at 95%	4.20	2.76	11.20	2.80	6.80
	OMC, (%)	8.60	8.20	7.80	9.00	7.90
	MDD, (g/cc)	2.114	2.175	2.165	2.132	2.180
	Soil Classfication	A7	A7	A6	A7	A7
	Clay+Silt (%)	38.80	33.48	27.07	40.21	44.48
	Sand, (%)	38.19	32.74	29.10	35.32	34.49
	Gravel, (%)	23.01	33.78	43.83	24.48	21.03
	Specific Gravity	2.708	2.800	2.773	2.679	2.707
	Liquid Limit, (%)	27.00	31.00	27.10	21.20	27.30
	Plastisity Index, (%)	15.09	19.27	13.25	7.53	14.91
	Moisture Content, (%)	9.95	10.99	7.43	6.51	4.40

Soil Investigation Data

Pit & CBR-No.		31	32	33	34	35
PK, (km)		231 + 004M	233 + 000	235 + 000	237 + 000	239 + 000
Thickness (mm)	Bituminous Material	20	20	20	25	25
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	150	0.00	0.00	0.00	0.00
	Sub-Grade	500	600	800	600	700
Laboratory Test	CBR at 95%	2.58	1.65	7.500	6.35	3.55
	OMC, (%)	9.20	9.78	8.00	8.20	8.65
	MDD, (g/cc)	2.010	2.045	2.115	2.100	2.051
	Soil Classfication	A7	A7	A6	A7	A7
	Clay+Silt (%)	40.25	41.75	40.50	39.83	42.24
	Sand, (%)	39.89	32.27	31.72	33.06	37.99
	Gravel, (%)	19.86	25.97	27.78	27.11	19.77
	Specific Gravity	2.576	2.717	2.788	2.742	2.656
	Liquid Limit, (%)	29.10	38.00	26.20	23.20	34.30
	Plastisity Index, (%)	16.48	23.34	13.51	9.91	16.63
	Moisture Content, (%)	10.71	11.46	5.50	7.01	7.72

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		36	37	38	39	40
PK, (km)		241 + 011M	243 + 000	245 + 008M	247 -007M	249 + 000
Thickness (mm)	Bituminous Material	20	20	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	0.00	200	200	0.00	0.00
	Sub-Grade	1200	500	500	850	800
Laboratory Test	CBR at 95%	6.60	5.03	13.20	0.47	4.30
	OMC, (%)	7.76	9.40	7.90	7.25	8.80
	MDD, (g/cc)	2.082	2.022	2.060	2.113	2.087
	Soil Classfication	A7	A6	A6	A7	A7
	Clay+Silt (%)	35.76	38.30	48.01	35.83	41.00
	Sand, (%)	33.94	33.02	37.09	27.27	36.01
	Gravel, (%)	30.30	28.68	14.90	36.89	22.99
	Specific Gravity	2.654	2.754	2.621	2.691	2.649
	Liquid Limit, (%)	27.40	61.00	30.80	33.00	27.40
	Plastisity Index, (%)	14.85	48.35	18.03	21.09	11.65
	Moisture Content, (%)	5.40	8.33	12.38	11.48	13.20

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		41	42	43	44	45
PK, (km)		251 + 000	253 + 000	255 + 000	257 + 000	259 + 000
Thickness (mm)	Bituminous Material	20	25	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	0.00	200	200	250	0.00
	Sub-Grade	700	500	600	450	850
Laboratory Test	CBR at 95%	1.60	2.80	4.50	5.95	7.30
	OMC, (%)	8.50	9.90	7.70	6.77	6.70
	MDD, (g/cc)	2.157	1.995	2.160	2.135	2.150
	Soil Classfication	A7	A7	A7	A6	A6
	Clay+Silt (%)	45.15	47.55	36.85	42.15	43.25
	Sand, (%)	26.23	27.11	26.31	40.84	36.65
	Gravel, (%)	28.62	25.34	36.84	17.01	20.10
	Specific Gravity	2.741	2.657	2.662	2.699	2.750
	Liquid Limit, (%)	27.80	30.60	30.60	24.80	25.10
	Plastisity Index, (%)	9.68	20.04	18.13	10.45	10.26
	Moisture Content, (%)	4.83	12.38	10.67	8.78	6.87

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		46	47	48	49	50
PK, (km)		261 -008M	263 + 000	265 +000	267 + 008M	269 + 000
Thickness (mm)	Bituminous Material	20	30	20	20	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	200	200	200	200	200
	Sub-Grade	400	600	450	300	600
Laboratory Test	CBR at 95%	6.10	11.90	7.20	5.00	6.40
	OMC, (%)	10.75	8.50	10.55	8.10	11.40
	MDD, (g/cc)	2.009	2.081	1.991	2.170	1.983
	Soil Classfication	A7	A4	A7	A7	A7
	Clay+Silt (%)	58.63	53.85	53.18	19.16	60.93
	Sand, (%)	27.83	31.66	25.49	57.44	26.59
	Gravel, (%)	13.53	14.48	21.33	23.40	12.48
	Specific Gravity	2.563	2.605	2.593	2.702	2.607
	Liquid Limit, (%)	33.00	32.50	37.30	33.00	41.00
	Plastisity Index, (%)	19.77	17.13	13.31	17.20	26.60
	Moisture Content, (%)	11.32	11.44	13.02	11.29	13.90

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		51	52	53	54	55
PK, (km)		271 + 008M	273 + 000	275 + 012M	277 + 000	279 + 000
Thickness (mm)	Bituminous Material	25	20	20	25	20
	Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Base Course	200	180	0.00	0.00	0.00
	Sub-Grade	400	400	1000	600	600
Laboratory Test	CBR at 95%	2.56	0.80	3.10	7.65	2.51
	OMC, (%)	8.30	8.55	8.50	8.00	11.75
	MDD, (g/cc)	2.158	1.891	1.937	2.048	1.875
	Soil Classfication	A7	A7	A7	A7	A7
	Clay+Silt (%)	54.04	39.54	33.80	46.35	40.42
	Sand, (%)	29.33	29.10	31.10	30.80	32.89
	Gravel, (%)	16.63	31.36	35.10	22.85	26.69
	Specific Gravity	2.576	2.556	2.608	2.632	2.582
	Liquid Limit, (%)	35.00	36.00	33.20	32.00	29.10
	Plastisity Index, (%)	21.38	23.23	21.35	19.03	12.99
	Moisture Content, (%)	15.73	19.50	15.76	7.44	10.68

Preparatory Survey for National Road No.5 Improvement

Soil Investigation Data

Pit & CBR-No.		56	57			
PK, (km)		281 + 000	283 + 000			
Thickness (mm)	Bituminous Material	20	20			
	Base Course	0.00	0.00			
	Sub-Base Course	0.00	200			
	Sub-Grade	700	500			
Laboratory Test	CBR at 95%	1.30	1.40			
	OMC, (%)	9.10	9.90			
	MDD, (g/cc)	2.014	1.927			
	Soil Classfication	A7	A7			
	Clay+Silt (%)	34.43	45.32			
	Sand, (%)	32.59	29.04			
	Gravel, (%)	32.98	25.63			
	Specific Gravity	2.611	2.621			
	Liquid Limit, (%)	34.20	44.20			
	Plastisity Index, (%)	21.12	28.48			
	Moisture Content, (%)	11.06	14.04			

APPENDIX 6-8

SUMMARY OF CBR TESTS

IN THE SRI SOPHORN – POIPET SECTION

Soil Investigation Data

CBR-No.		1	2	3	4	5
PK, km		367+0.00	369+0.00	371+0.00	373+0.00	375+0.00
Thickness (mm)	Bituminous Material	40	35	40	30	30
	Base Course	0.00	400	300	300	300
	Sub-Base Course	300	0.00	0.00	0.00	0.00
	Sub-Grade	300	400	300	300	250
Laboratory Test	CBR at 95%	4.25	1.98	1.80	0.95	1.92
	OMC, (%)	10.75	10.45	10.60	11.60	10.50
	MDD, (g/cc)	1.910	1.975	1.952	1.920	1.925
	Soil Classfication	A6	A6	A6	A6	A6
	Clay+Silt (%)	39.01	49.43	34.91	43.29	58.86
	Sand, (%)	48.20	43.73	44.26	46.01	38.81
	Gravel, (%)	12.78	6.83	20.83	10.69	2.33
	Specific Gravity	2.686	2.639	2.637	2.554	2.573
	Liquid Limit, (%)	36.30	38.20	43.90	43.00	36.10
	Plastisity Index, (%)	14.49	16.59	16.97	16.26	15.31
	Moisture Content, (%)	18.16	15.71	9.01	12.87	15.29

Soil Investigation Data

CBR-No.		6	7	8	9	10
PK, km		377+0.00	379+0.00	381+010M	385+0.00	387+007.40M
Thickness (mm)	Bituminous Material	50	40	40	40	40
	Base Course	320	300	300	400	360
	Sub-Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Grade	250	250	250	180	250
Laboratory Test	CBR at 95%	1.45	3.44	3.40	1.55	0.52
	OMC, (%)	11.25	9.75	11.70	7.75	8.90
	MDD, (g/cc)	1.910	1.975	1.915	2.120	2.035
	Soil Classfication	A6	A5	A6	A6	A7
	Clay+Silt (%)	43.50	39.17	40.05	55.05	44.52
	Sand, (%)	41.63	42.02	42.19	33.01	30.93
	Gravel, (%)	14.87	18.81	17.76	11.94	24.55
	Specific Gravity	2.662	2.567	2.688	2.650	2.676
	Liquid Limit, (%)	60.20	57.90	40.60	37.40	29.10
	Plastisity Index, (%)	12.71	17.35	14.10	11.98	12.05
	Moisture Content, (%)	13.04	15.93	13.28	13.38	12.50

Soil Investigation Data

CBR-No.		11	12	13	14	15
PK, km		389+0.00	391+004M	393+0.00	401+0.00	399+0.00
Thickness (mm)	Bituminous Material	30	30	40	35	40
	Base Course	440	430	250	430	300
	Sub-Base Course	0.00	0.00	0.00	0.00	0.00
	Sub-Grade	300	400	400	150	250
Laboratory Test	CBR at 95%	1.92	1.18	0.88	2.98	2.18
	OMC, (%)	9.25	9.40	10.50	7.75	7.90
	MDD, (g/cc)	2.060	2.040	1.955	2.105	2.090
	Soil Classfication	A6	A6	A5	A6	A6
	Clay+Silt (%)	34.11	64.43	54.12	44.94	32.12
	Sand, (%)	30.83	21.51	26.17	35.37	28.68
	Gravel, (%)	35.06	14.06	19.71	19.69	39.19
	Specific Gravity	2.682	2.693	2.735	2.681	2.803
	Liquid Limit, (%)	41.40	42.00	46.80	38.80	34.20
	Plastisity Index, (%)	13.38	15.16	13.47	12.05	17.01
	Moisture Content, (%)	12.03	10.79	15.15	12.46	12.40

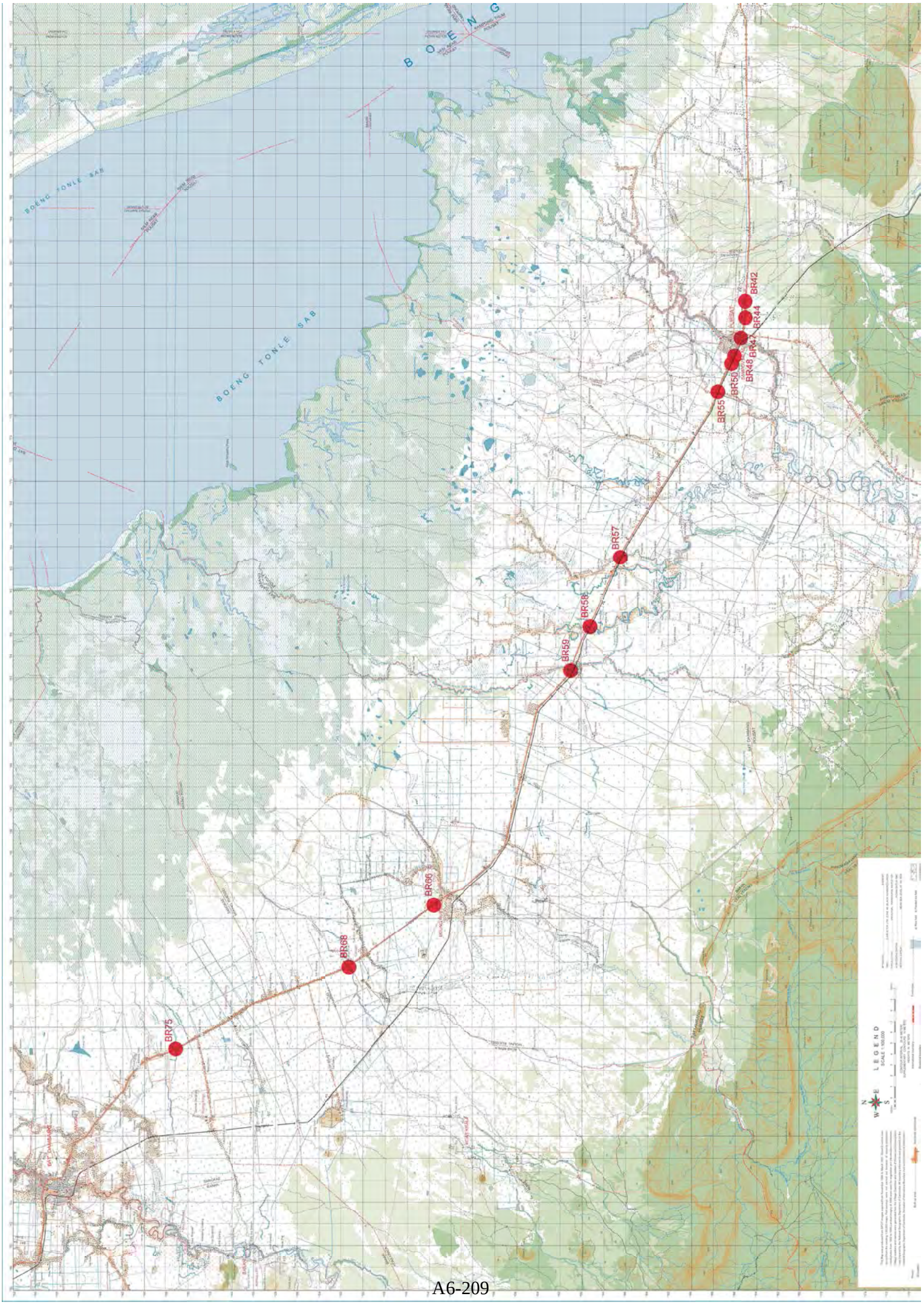
Soil Investigation Data

CBR-No.		16	17	18	19	20
PK, km		397+0.00	395+0.00	403+0.00	405+0.00	407+008M
Thickness (mm)	Concrete Material	30	35	0.00	0.00	10
	Base Course	300	300	0.00	0.00	0.00
	Sub-Base Course	0.00	0.00	0.00	200	0.00
	Sub-Grade	280	250	400	200	0.00
Laboratory Test	CBR at 95%	5.26	1.70	1.50	1.10	1.32
	OMC, (%)	7.75	7.70	11.40	11.50	11.90
	MDD, (g/cc)	2.100	2.090	2.000	1.930	1.894
	Soil Classfication	A6	A6	A6	A6	A6
	Clay+Silt (%)	45.25	52.18	36.69	44.80	53.07
	Sand, (%)	42.26	25.47	32.86	50.03	34.74
	Gravel, (%)	12.49	22.35	30.46	5.89	12.19
	Specific Gravity	2.679	2.686	2.724	2.755	2.661
	Liquid Limit, (%)	39.20	38.00	46.80	38.40	58.40
	Plastisity Index, (%)	16.50	13.39	15.71	17.00	12.41
	Moisture Content, (%)	10.82	15.94	17.21	23.57	27.42

APPENDIX 6-9

LOCATION MAP OF BOREHOLES

IN THE MIDDLE SECTION


BOENG
BOENG TONLE SAB
BOENG TONLE SAB
BR42
BR44
BR47
BR48
BR50
BR55
BR57
BR58
BR59
BR66
BR68
BR75
LEGEND
SCALE 1:100,000

APPENDIX 6-10

BOREHOLE LOG

IN THE MIDDLE SECTION

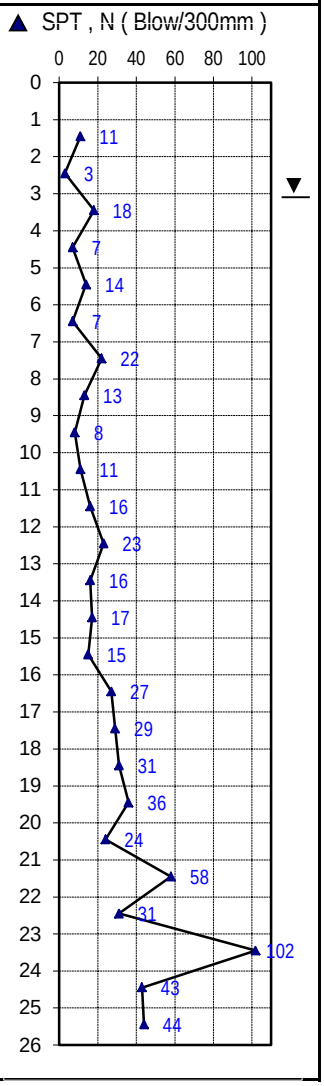
BORE HOLE LOG BH-1

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: .....m E: 0386542, N: 1384891	Date started : 11/06/2013 Date finished : 12/06/2013 **PROJECT : Br 42 NR-5 Improvement** Location: PK 181+900 Pursat Province

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Very loose to medium dense yellowish Clayey Sand	4	5	6	11
D2: 2.00 -	2.45	SPT				1	1	2	3
D3: 3.00 -	3.45	SPT	1.00		Very stiff yellowish, light gray Sandy Clay	3	6	12	18
D4: 4.00 -	4.45	SPT	3.00		Firm to stiff yellowish, grayish Sandy Clay	4	3	4	7
D5: 5.00-	5.45	SPT				5	7	7	14
D6: 6.00 -	6.45	SPT				2	3	4	7
D7: 7.00 -	7.45	SPT	9.00		Stiff to very stiff yellowish, grayish, reddish-gray Sandy Clay	5	9	13	22
D8: 8.00 -	8.45	SPT				3	5	8	13
D9: 9.00 -	9.45	SPT				3	4	4	8
D10: 10.00 -	10.45	SPT				3	5	6	11
D11: 11.00 -	11.45	SPT				5	7	9	16
D12: 12.00 -	12.45	SPT				5	9	14	23
D13: 13.00 -	13.45	SPT				5	8	8	16
D14: 14.00 -	14.45	SPT				5	8	9	17
D15: 15.00 -	15.45	SPT				5	7	8	15
D16: 16.00-	16.45	SPT	3.00		Very stiff to hard yellowish, grayish, reddish-gray Clay with Sand	6	11	16	27
D17: 17.00 -	17.45	SPT				8	13	16	29
D18: 18.00 -	18.45	SPT				7	14	17	31
D19: 19.00 -	19.45	SPT	1.00		Dense reddish-gray Clayey Sand	7	13	23	36
D20: 20.00 -	20.45	SPT	2.00		Very stiff to hard yellowish, grayish, light gray Sandy Clay	4	11	13	24
D21: 21.00 -	21.45	SPT				13	21	37	58
D22: 22.00 -	22.45	SPT	4.00		Dense to very dense grayish, light gray Clayey Sand	9	12	19	31
D23: 23.00 -	23.45	SPT				10	52	50	102
D24: 24.00 -	24.45	SPT				7	21	22	43
D25: 25.00 -	25.45	SPT				7	17	27	44
					END of SPT Test 25.45m Depth				

Depth to water flow: 6.15m

Depth to water Level: 2.35m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Clayey coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)
SPT
SPT - N Value

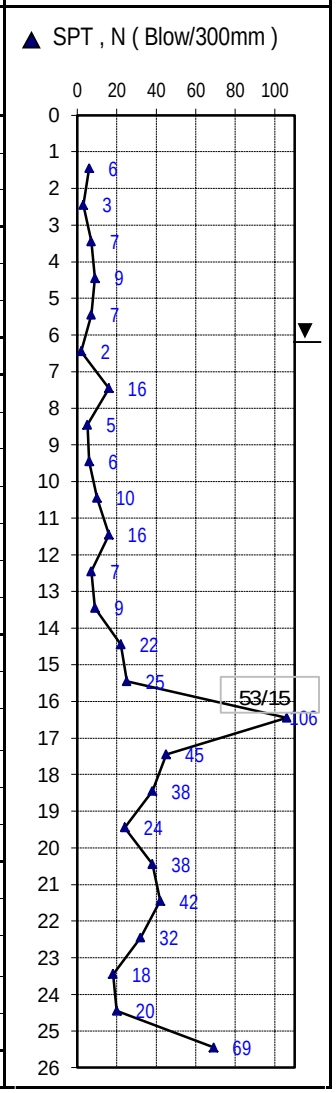
BORE HOLE LOG BH-2

Sub-Contractor: Partner of Construction and Development Services Inc.	Method :Rotary Auger	Date started : 16/06/2013
	Casing Size : 180 mm	Date finished : 16/06/2013
Owner : Katahira Engineers International	Elevation: 17.56 m	**PROJECT : Br 44 NR-5 Improvement**
	E: 0385166, N: 1384967	Location: PK 183+200

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	3.00		Very loose to loose yellowish-red, yellowish Silty fine SAND with gravels at the bottom, loose Clayey SAND	3	3	3	6
D2: 2.00 -	2.45	SPT				3	2	1	3
D3: 3.00 -	3.45	SPT				3	4	3	7
D4: 4.00 -	4.45	SPT	3		Stiff to soft yellowish, grayish Sandy CLAY and Organic silt with gravel	1	3	6	9
D5: 5.00-	5.45	SPT				3	4	3	7
D6: 6.00 -	6.45	SPT				2	1	1	2
D7: 7.00 -	7.45	SPT	1.00		Medium dense yellowish, grayish Clayey coarse SAND	3	7	9	16
D8: 8.00 -	8.45	SPT	7.00		Firm to very stiff grayish, yellowish Sandy CLAY or CLAY with Sand	2	1	4	5
D9: 9.00 -	9.45	SPT				3	2	4	6
D10: 10.00 -	10.45	SPT				3	5	5	10
D11: 11.00 -	11.45	SPT				8	8	8	16
D12: 12.00 -	12.45	SPT				2	2	5	7
D13: 13.00 -	13.45	SPT				2	2	7	9
D14: 14.00 -	14.45	SPT				6	10	12	22
D15: 15.00 -	15.45	SPT	6.00		Medium dense to very dense yellowish, grayish, light gray Clayey coarse SAND with gravel	7	14	11	25
D16: 16.00-	16.45	SPT				53			106
D17: 17.00 -	17.45	SPT				15	20	25	45
D18: 18.00 -	18.45	SPT				12	17	21	38
D19: 19.00 -	19.45	SPT				8	10	14	24
D20: 20.00 -	20.45	SPT				5	16	22	38
D21: 21.00 -	21.45	SPT	5.00		Very stiff to hard reddish-gray, reddish-yellow, light gray Sandy CLAY with gravel	9	16	26	42
D22: 22.00 -	22.45	SPT				5	12	20	32
D23: 23.00 -	23.45	SPT				3	7	11	18
D24: 24.00 -	24.45	SPT				3	8	12	20
D25: 25.00 -	25.45	SPT				7	32	37	69
					END of SPT Test 25.45m Depth				

Depth to water flow: 6.40m

Depth to water Level: 6.00m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

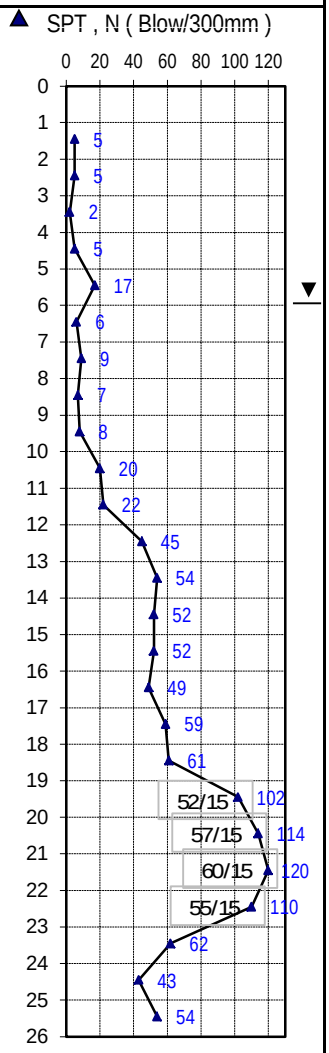
BORE HOLE LOG BH-3

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 16.75m E: 0382985, N: 1385405	Date started : 18/06/2013 Date finished : 18/06/2013 **PROJECT : Br 47 NR-5 Improvement** Location: PK 185+700

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	3.00		Soft to firm yellowish, grayish sandy CLAY	1	2	3	5
D2: 2.00 -	2.45	SPT				1	2	3	5
D3: 3.00 -	3.45	SPT			At the top, Sandy CLAY with Gravel	1	1	1	2
D4: 4.00 -	4.45	SPT	5.00		Loose to medium dense yellowish, grayish, dark gray fine to medium SAND At the top, Clayey SAND	1	2	3	5
D5: 5.00-	5.45	SPT				4	9	8	17
D6: 6.00 -	6.45	SPT				2	3	3	6
D7: 7.00 -	7.45	SPT				6	5	4	9
D8: 8.00 -	8.45	SPT				3	3	4	7
D9: 9.00 -	9.45	SPT	6.00		Stiff to hard reddish-gray, light gray, yellowish Sandy CLAY	3	4	4	8
D10: 10.00	10.45	SPT				6	9	11	20
D11: 11.00	11.45	SPT				7	10	12	22
D12: 12.00	12.45	SPT				12	17	28	45
D13: 13.00	13.45	SPT				8	20	34	54
D14: 14.00	14.45	SPT				17	20	32	52
D15: 15.00	15.45	SPT	1.00		Very dense grayish Silty coarse SAND	18	23	29	52
D16: 16.00	16.45	SPT	3.00		Hard yellowish, light gray CLAY with Sand or Sandy CLAY	14	24	25	49
D17: 17.00	17.45	SPT				12	27	32	59
D18: 18.00	18.45	SPT				14	24	37	61
D19: 19.00	19.45	SPT	2.00		Very dense yellowish, light gray Clayey coarse SAND with gravels	52			102
D20: 20.00	20.45	SPT				14	57		114
D21: 21.00	21.45	SPT	5.00		Hard yellowish, reddish-gray, light gray Sandy CLAY with gravel	26	60		120
D22: 22.00	22.45	SPT				27	55		110
D23: 23.00	23.45	SPT				11	23	39	62
D24: 24.00	24.45	SPT				10	20	23	43
D25: 25.00	25.45	SPT				13	24	30	54
					END of SPT Test 25.45m Depth				

Depth to water flow: 5.00m

Depth to water Level: 5.10m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

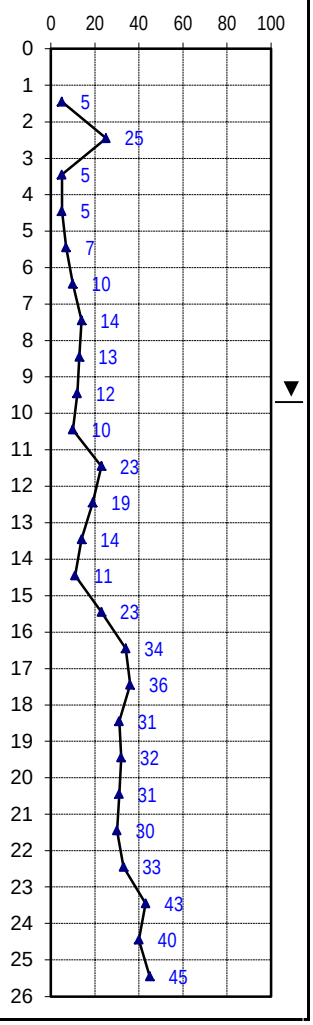
SPT - N Value

BORE HOLE LOG BH-4

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 17.55m E: 0385166, N: 1384967	Date started : 15/06/2013 Date finished : 15/06/2013 **PROJECT : Br 48 NR-5 Improvement** Location: PK 187+500 Pursat Province

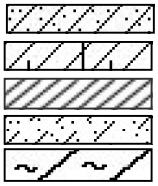
Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Firm to very stiff yellowish, grayish Sandy CLAY with gravels	2	2	3	5
D2: 2.00 -	2.45	SPT				7	10	15	25
D3: 3.00 -	3.45	SPT	1.00		Loose grayish, yellowish Silty fine SAND	6	3	2	5
D4: 4.00 -	4.45	SPT	7.00		Firm to stiff yellowish, brownish, grayish Sandy CLAY or CLAY with Sand	3	3	2	5
D5: 5.00-	5.45	SPT				2	3	4	7
D6: 6.00 -	6.45	SPT				3	4	6	10
D7: 7.00 -	7.45	SPT				3	8	6	14
D8: 8.00 -	8.45	SPT				4	7	6	13
D9: 9.00 -	9.45	SPT				4	5	7	12
D10: 10.00 -	10.45	SPT				2	5	5	10
D11: 11.00 -	11.45	SPT	3.00		Medium dense yellowish, yellowish-gray Clayey medium to coarse SAND	6	13	10	23
D12: 12.00 -	12.45	SPT				5	9	10	19
D13: 13.00 -	13.45	SPT				6	7	7	14
D14: 14.00 -	14.45	SPT	12.00		Very stiff to hard light gray, yellowish, grayish-yellow Sandy CLAY	5	5	6	11
D15: 15.00 -	15.45	SPT				7	9	14	23
D16: 16.00-	16.45	SPT				10	14	20	34
D17: 17.00 -	17.45	SPT				6	14	22	36
D18: 18.00 -	18.45	SPT				10	15	16	31
D19: 19.00 -	19.45	SPT				10	14	18	32
D20: 20.00 -	20.45	SPT				11	14	17	31
D21: 21.00 -	21.45	SPT				9	13	17	30
D22: 22.00 -	22.45	SPT				10	14	19	33
D23: 23.00 -	23.45	SPT				11	18	25	43
D24: 24.00 -	24.45	SPT				12	16	24	40
D25: 25.00 -	25.45	SPT				10	22	23	45
					END of SPT Test 25.45m Depth				

Depth to water flow: 14.25m
Depth to water Level: 9.70m

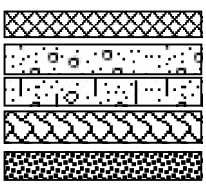


Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, $\gamma_{sat,}$ kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND



Stiff to hard sandy clay, lean Clay
Firm to stiff silty clay/ lean Clay
stiff to hard clay , fat Clay
Clayey sand,Silty Sand
V. Soft to soft clay, organic clay



Fill/topsoil
Gravelly Sand, Clean Sand
Silty coarse sand with gravel
Weather Rock
Sandstone

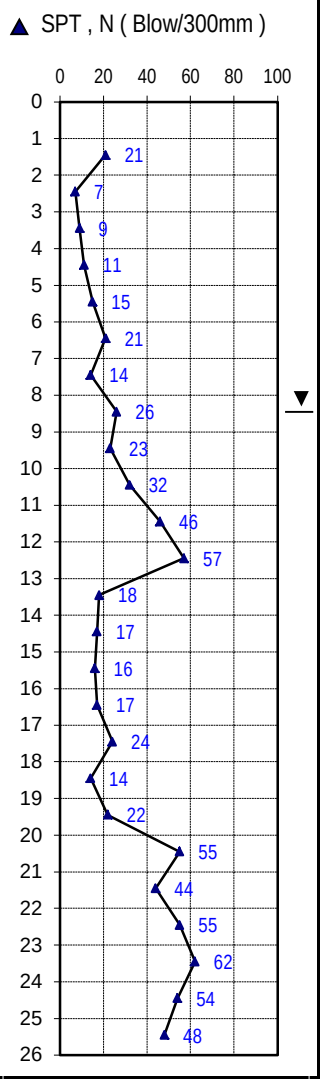
Standard Penetration Test (SPT)
SPT
▲ SPT - N Value

BORE HOLE LOG BH-5

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 16.06m E: 0380336, N: 1386358	Date started : 13/06/2013 Date finished : 14/06/2013 **PROJECT : Br 50 NR-5 Improvement** Location: PK 188+100

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Medium dense to loose reddish-brown Clayey SAND with Gravel	7	10	11	21
D2: 2.00 -	2.45	SPT				3	4	3	7
D3: 3.00 -	3.45	SPT	6.00		Stiff to very stiff brownish, dark brown, light gray CLAY (upper) or Sandy CLAY (middle to lower)	3	4	5	9
D4: 4.00 -	4.45	SPT				3	5	6	11
D5: 5.00-	5.45	SPT				3	7	8	15
D6: 6.00 -	6.45	SPT				7	8	13	21
D7: 7.00 -	7.45	SPT				5	6	8	14
D8: 8.00 -	8.45	SPT				7	12	14	26
D9: 9.00 -	9.45	SPT	3.00		Medium dense to dense grayish, light gray Clayey coarse SAND	7	9	14	23
D10: 10.00 -	10.45	SPT				12	15	17	32
D11: 11.00 -	11.45	SPT				10	14	32	46
D12: 12.00 -	12.45	SPT	1.00		Hard grayish Sandy CLAY	17	30	27	57
D13: 13.00 -	13.45	SPT	6.00		Stiff to very stiff grayish, yellowish, light gray Sandy CLAY or CLAY with Sand	7	8	10	18
D14: 14.00 -	14.45	SPT				6	8	9	17
D15: 15.00 -	15.45	SPT				6	7	9	16
D16: 16.00-	16.45	SPT				7	8	9	17
D17: 17.00 -	17.45	SPT				7	9	15	24
D18: 18.00 -	18.45	SPT				6	7	7	14
D19: 19.00 -	19.45	SPT	7.00		Very stiff to hard yellowish, light gray Sandy CLAY	5	10	12	22
D20: 20.00 -	20.45	SPT				8	21	34	55
D21: 21.00 -	21.45	SPT				17	20	24	44
D22: 22.00 -	22.45	SPT				15	26	29	55
D23: 23.00 -	23.45	SPT				16	24	38	62
D24: 24.00 -	24.45	SPT				8	22	32	54
D25: 25.00 -	25.45	SPT				9	19	29	48
					END of SPT Test 25.45m Depth				

Depth to water flow: 6.00m
Depth to water Level: 8.40m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)
SPT
SPT - N Value

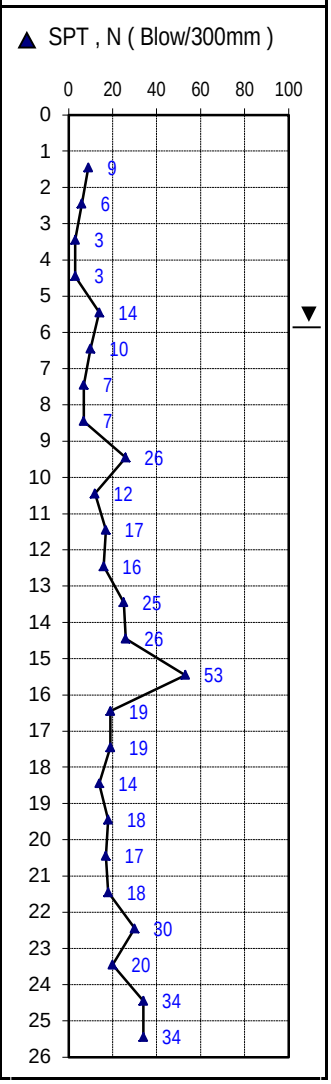
BORE HOLE LOG BH-6

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 18.40m E: 0378132, N: 1387549	Date started : 12/06/2013 Date finished : 13/06/2013 **PROJECT : Br 55 NR-5 Improvement** Location: PK 191+100 Pursat Province.

Depth to water flow: 6.00m

Depth to water Level: 5.85m

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	4.00		Soft to stiff reddish-brown, yellowish-gray CLAY or CLAY with Sand	6	4	5	9
D2: 2.00 -	2.45	SPT				3	4	2	6
D3: 3.00 -	3.45	SPT				2	2	1	3
D4: 4.00 -	4.45	SPT				1	1	2	3
D5: 5.00-	5.45	SPT	3.00		Loose to medium dense yellowish fine to medium SAND with gravel	6	7	7	14
D6: 6.00 -	6.45	SPT				2	5	5	10
D7: 7.00 -	7.45	SPT				5	3	4	7
D8: 8.00 -	8.45	SPT	3.00		Firm to very stiff yellowish, grayish Sandy CLAY	3	4	3	7
D9: 9.00 -	9.45	SPT				4	9	17	26
D10: 10.00	10.45	SPT				4	5	7	12
D11: 11.00	11.45	SPT	4.00		Medium dense grayish, yellowish, light gray Clayey fine to coarse SAND	9	7	10	17
D12: 12.00	12.45	SPT				6	8	8	16
D13: 13.00	13.45	SPT				5	12	13	25
D14: 14.00	14.45	SPT				8	12	14	26
D15: 15.00	15.45	SPT	5.00		Hard to very stiff yellowish, reddish-gray, light gray Sandy CLAY or CLAY with Sand	8	19	34	53
D16: 16.00-	16.45	SPT				7	7	12	19
D17: 17.00	17.45	SPT				5	8	11	19
D18: 18.00	18.45	SPT				3	7	7	14
D19: 19.00	19.45	SPT				4	8	10	18
D20: 20.00	20.45	SPT	1.00		Medium dense grayish Clayey fine SAND	5	8	9	17
D21: 21.00	21.45	SPT	1.00		Very stiff yellowish, grayish CLAY with Sand	5	8	10	18
D22: 22.00	22.45	SPT	1.00		Dense yellowish-gray Clayey coarse SAND	6	12	18	30
D23: 23.00	23.45	SPT	1.00		Very stiff yellowish, grayish Sandy CLAY	8	10	10	20
D24: 24.00	24.45	SPT	1.00		Dense yellowish Clayey coarse SAND	11	17	17	34
D25: 25.00	25.45	SPT	1.00		Hard grayish, brownish CLAY	10	13	21	34
					END of SPT Test 25.45m Depth				



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

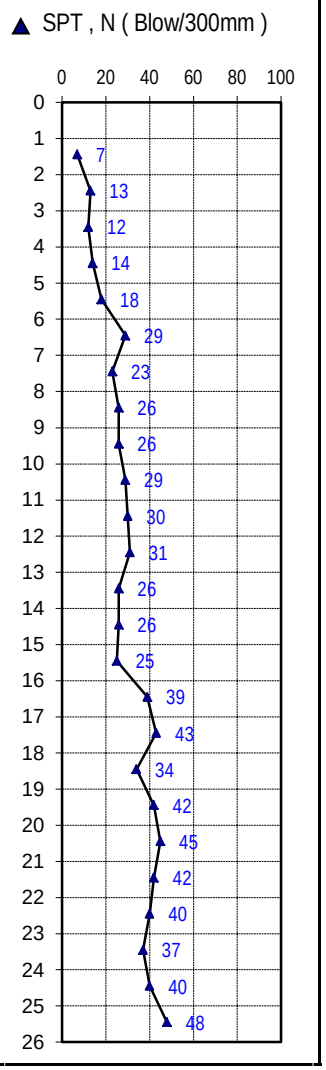
BORE HOLE LOG BH-7

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 13.36m E: 0362905, N: 1396533	Date started : 17/06/2013 Date finished : 17/06/2013 **PROJECT : Br 57 NR-5 Improvement** Location: PK 208+500

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	4.00		Firm to stiff brownish, grayish CLAY with Sand (upper) or CLAY (lower)	6	3	4	7
D2: 2.00 -	2.45	SPT				6	7	6	13
D3: 3.00 -	3.45	SPT				5	6	6	12
D4: 4.00 -	4.45	SPT				4	7	7	14
D5: 5.00-	5.45	SPT	6.00		Very stiff grayish, brownish, yellowish-brown CLAY with Sand	8	8	10	18
D6: 6.00 -	6.45	SPT				9	12	17	29
D7: 7.00 -	7.45	SPT				9	10	13	23
D8: 8.00 -	8.45	SPT				8	10	16	26
D9: 9.00 -	9.45	SPT				10	13	13	26
D10: 10.00	10.45	SPT				12	13	16	29
D11: 11.00	11.45	SPT	7.00		Medium dense to dense dark gray, yellowish-gray, yellowish Clayey fine to coarse SAND	17	15	15	30
D12: 12.00	12.45	SPT				11	16	15	31
D13: 13.00	13.45	SPT				11	13	13	26
D14: 14.00	14.45	SPT				10	13	13	26
D15: 15.00	15.45	SPT				6	10	15	25
D16: 16.00	16.45	SPT				10	20	19	39
D17: 17.00	17.45	SPT				10	21	22	43
D18: 18.00	18.45	SPT	8.00		Hard grayish-brown, reddish-gray, CLAY with Sand	7	14	20	34
D19: 19.00	19.45	SPT				11	18	24	42
D20: 20.00	20.45	SPT				11	15	30	45
D21: 21.00	21.45	SPT				10	17	25	42
D22: 22.00	22.45	SPT				10	15	25	40
D23: 23.00	23.45	SPT				9	14	23	37
D24: 24.00	24.45	SPT				9	13	27	40
D25: 25.00	25.45	SPT				10	17	31	48
					END of SPT Test 25.45m Depth				

Depth to water flow: No

Depth to water Level: No



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, $\gamma_{sat,}$ kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

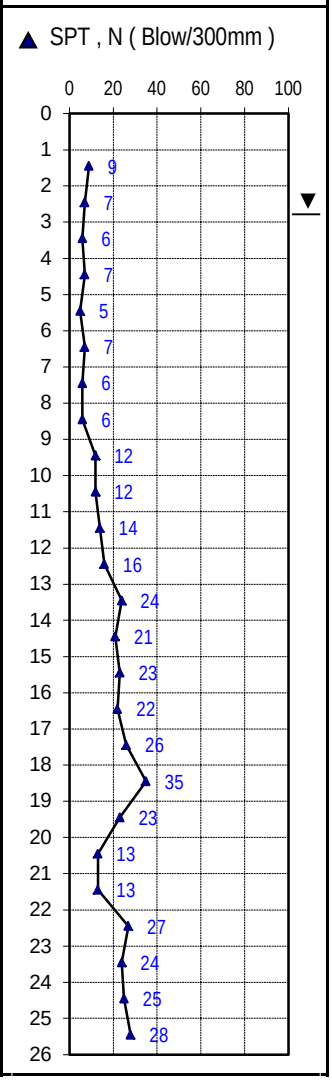
BORE HOLE LOG BH-8

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 12.17 m E: 0356344, N: 1399502	Date started : 19/06/2013 Date finished : 19/06/2013 **PROJECT : Br 58 NR-5 Improvement** Location: PK 215+800

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Firm to stiff brownish, grayish CLAY with Sand	2	5	4	9
D2: 2.00 -	2.45	SPT				5	3	4	7
D3: 3.00 -	3.45	SPT	4.00		Loose grayish Clayey fine SAND	2	3	3	6
D4: 4.00 -	4.45	SPT				2	2	5	7
D5: 5.00-	5.45	SPT				3	2	3	5
D6: 6.00 -	6.45	SPT				3	3	4	7
D7: 7.00 -	7.45	SPT	5.00		Firm to stiff brownish, yellowish CLAY with Sand	2	3	3	6
D8: 8.00 -	8.45	SPT				2	3	3	6
D9: 9.00 -	9.45	SPT				3	4	8	12
D10: 10.00	10.45	SPT				5	6	6	12
D11: 11.00	11.45	SPT				6	7	7	14
D12: 12.00	12.45	SPT	3.00		Stiff to very stiff yellowish, brownish CLAY with Sand	6	7	9	16
D13: 13.00	13.45	SPT				7	9	15	24
D14: 14.00	14.45	SPT				8	9	12	21
D15: 15.00	15.45	SPT	5.00		Very stiff to hard yellowish, grayish-brown, reddish-yellow CLAY with Sand	8	9	14	23
D16: 16.00-	16.45	SPT				5	8	14	22
D17: 17.00	17.45	SPT				6	11	15	26
D18: 18.00	18.45	SPT			18.00m~, Clayey SAND with Gravel	10	15	20	35
D19: 19.00	19.45	SPT			19.00m~, Sandy CLAY	6	10	13	23
D20: 20.00	20.45	SPT	6.00		Medium dense yellowish, light gray, yellowish-gray Clayey fine SAND	5	6	7	13
D21: 21.00	21.45	SPT				3	4	9	13
D22: 22.00	22.45	SPT				6	11	16	27
D23: 23.00	23.45	SPT				3	11	13	24
D24: 24.00	24.45	SPT				10	13	12	25
D25: 25.00	25.45	SPT				10	15	13	28
					END of SPT Test 25.45m Depth				

Depth to water flow: 4.40m

Depth to water Level: 2.60m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

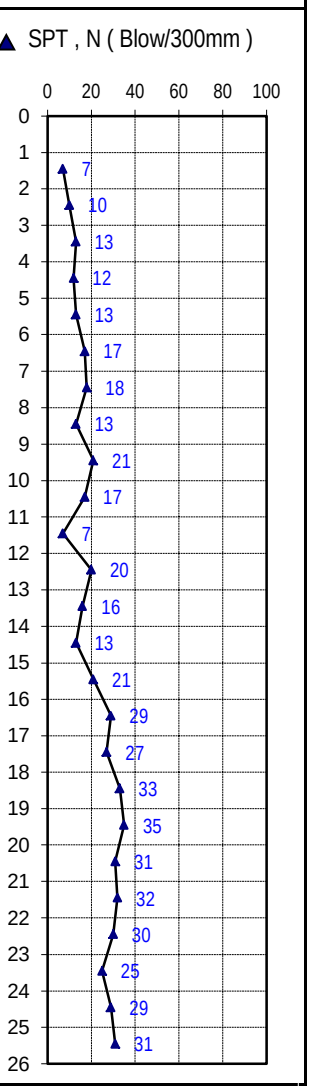
BORE HOLE LOG BH-9

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 8.32 m E: 0352844, N: 1400909	Date started : 20/06/2013 Date finished : 20/06/2013 **PROJECT : Br 59 NR-5 Improvement** Location: PK 219+700

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Firm to stiff brownish, reddish-gray CLAY with Sand	3	3	4	7
D2: 2.00 -	2.45	SPT				5	5	5	10
D3: 3.00 -	3.45	SPT	3.00		Medium dense yellowish Clayey fine SAND	4	6	7	13
D4: 4.00 -	4.45	SPT				6	6	6	12
D5: 5.00-	5.45	SPT				6	6	7	13
D6: 6.00 -	6.45	SPT	9.00		Stiff to very stiff brownish, grayish, yellowish CLAY with Sand (upper and middle) or Sandy CLAY (lower)	6	7	10	17
D7: 7.00 -	7.45	SPT				7	8	10	18
D8: 8.00 -	8.45	SPT				8	6	7	13
D9: 9.00 -	9.45	SPT				6	9	12	21
D10: 10.00	10.45	SPT				6	7	10	17
D11: 11.00	11.45	SPT				6	2	5	7
D12: 12.00	12.45	SPT				5	9	11	20
D13: 13.00	13.45	SPT				6	6	10	16
D14: 14.00	14.45	SPT				4	6	7	13
D15: 15.00	15.45	SPT	3.00		Medium dense yellowish, grayish, light gray Clayey coarse SAND	7	13	8	21
D16: 16.00-	16.45	SPT				6	14	15	29
D17: 17.00	17.45	SPT				7	13	14	27
D18: 18.00	18.45	SPT	8.00		Very stiff to hard grayish, light gray, brownish Sandy CLAY	10	13	20	33
D19: 19.00	19.45	SPT				11	15	20	35
D20: 20.00	20.45	SPT				7	12	19	31
D21: 21.00	21.45	SPT				10	12	20	32
D22: 22.00	22.45	SPT				8	14	16	30
D23: 23.00	23.45	SPT				8	11	14	25
D24: 24.00	24.45	SPT				9	13	16	29
D25: 25.00	25.45	SPT				11	14	17	31
					END of SPT Test 25.45m Depth				

Depth to water flow: 15.15m

Depth to water Level: No



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

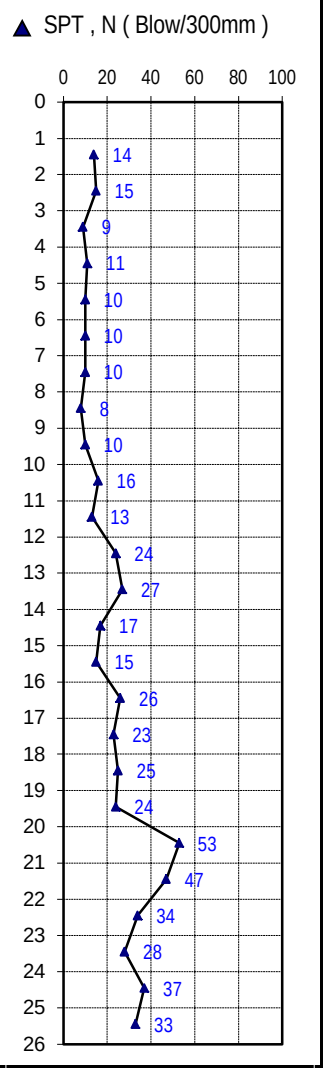
BORE HOLE LOG BH-10

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 15.96 m E: 0331290, N: 1413450	Date started : 21/06/2013 Date finished : 21/06/2013 **PROJECT : Br 66 NR-5 Improvement** Location: PK 245+900

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	4.00		Stiff brownish, dark brown, yellowish CLAY with Sand or Sandy CLAY (2.00~3.00m)	3	7	7	14
D2: 2.00 -	2.45	SPT				5	7	8	15
D3: 3.00 -	3.45	SPT				4	4	5	9
D4: 4.00 -	4.45	SPT				4	5	6	11
D5: 5.00-	5.45	SPT	9.00		Stiff to very stiff brownish, yellowish CLAY or CLAY with Sand	3	4	6	10
D6: 6.00 -	6.45	SPT				3	4	6	10
D7: 7.00 -	7.45	SPT				3	5	5	10
D8: 8.00 -	8.45	SPT				5	4	4	8
D9: 9.00 -	9.45	SPT				4	5	5	10
D10: 10.00	10.45	SPT				4	6	10	16
D11: 11.00	11.45	SPT				4	6	7	13
D12: 12.00	12.45	SPT				5	9	15	24
D13: 13.00	13.45	SPT				8	11	16	27
D14: 14.00	14.45	SPT	4.00		Medium dense brownish, yellowish, light gray Clayey fine to medium SAND	6	8	9	17
D15: 15.00	15.45	SPT				6	7	8	15
D16: 16.00	16.45	SPT				8	12	14	26
D17: 17.00	17.45	SPT				6	10	13	23
D18: 18.00	18.45	SPT	2.00		Very stiff brownish, yellowish, grayish CLAY or CLAY with Sand	7	11	14	25
D19: 19.00	19.45	SPT				7	10	14	24
D20: 20.00	20.45	SPT	1.00		Very dense reddish-gray Clayey SAND with Gravel	19	23	30	53
D21: 21.00	21.45	SPT	5.00		Very stiff to hard brownish, yellowish, grayish CLAY with Sand or Sandy CLAY	11	17	30	47
D22: 22.00	22.45	SPT				10	15	19	34
D23: 23.00	23.45	SPT				4	11	17	28
D24: 24.00	24.45	SPT				8	15	22	37
D25: 25.00	25.45	SPT				11	14	19	33
					END of SPT Test 25.45m Depth				

Depth to water flow: No

Depth to water Level: No



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)

SPT

SPT - N Value

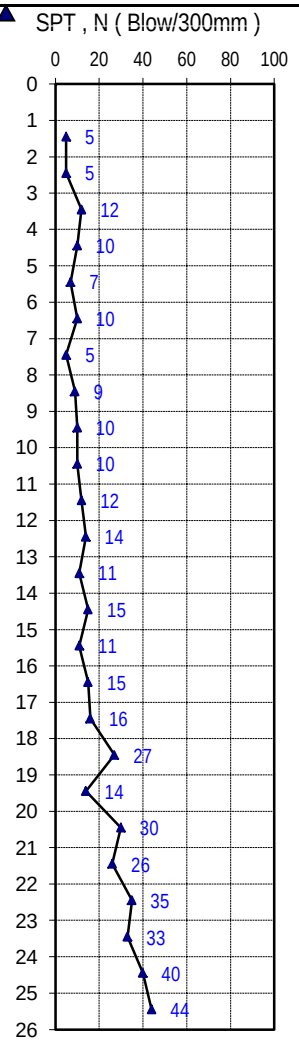
BORE HOLE LOG BH-11

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 13.29 m E: 0325642, N: 1421288	Date started : 22/06/2013 Date finished : 22/06/2013 **PROJECT : Br 68 NR-5 Improvement** Location: PK 255+500

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Firm reddish-gray, grayish Sandy CLAY	1	2	3	5
D2: 2.00 -	2.45	SPT				1	2	3	5
D3: 3.00 -	3.45	SPT	1.00		Medium dense grayish Clayey GRAVEL with Sand	3	4	8	12
D4: 4.00 -	4.45	SPT	3.00		Firm to stiff grayish, light brown CLAY with Sand or Sandy CLAY	3	5	5	10
D5: 5.00-	5.45	SPT				2	3	4	7
D6: 6.00 -	6.45	SPT				2	5	5	10
D7: 7.00 -	7.45	SPT	1.00		Loose grayish Clayey fine SAND	2	2	3	5
D8: 8.00 -	8.45	SPT	2.00		Stiff light brown, brownish CLAY (upper) or Sandy CLAY (lower)	3	4	5	9
D9: 9.00 -	9.45	SPT				3	4	6	10
D10: 10.00 -	10.45	SPT	10.00		Stiff to very stiff brownish, yellowish-brown, grayish CLAY or CLAY with Sand	3	3	7	10
D11: 11.00 -	11.45	SPT				5	5	7	12
D12: 12.00 -	12.45	SPT				4	5	9	14
D13: 13.00 -	13.45	SPT				3	5	6	11
D14: 14.00 -	14.45	SPT				4	6	9	15
D15: 15.00 -	15.45	SPT				4	5	6	11
D16: 16.00-	16.45	SPT				4	6	9	15
D17: 17.00 -	17.45	SPT				5	7	9	16
D18: 18.00 -	18.45	SPT				7	10	17	27
D19: 19.00 -	19.45	SPT				5	6	8	14
D20: 20.00 -	20.45	SPT	6.00		Very stiff to hard grayish, yellowish, brownish CLAY with Sand (upper and middle) or CLAY (lower)	7	15	15	30
D21: 21.00 -	21.45	SPT				6	11	15	26
D22: 22.00 -	22.45	SPT				11	15	20	35
D23: 23.00 -	23.45	SPT				10	12	21	33
D24: 24.00 -	24.45	SPT				12	17	23	40
D25: 25.00 -	25.45	SPT				14	19	25	44
					END of SPT Test 25.45m Depth				

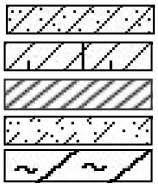
Depth to water flow: 5.10m

Depth to water Level: No



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND



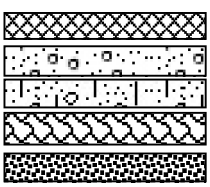
Stiff to hard sandy clay, lean Clay

Firm to stiff silty clay/ lean Clay

stiff to hard clay , fat Clay

Clayey sand,Silty Sand

V. Soft to soft clay, organic clay



Fill/topsoil

Gravelly Sand, Clean Sand

Silty coarse sand with gravel

Weather Rock

Sandstone

Standard Penetration Test (SPT)

SPT

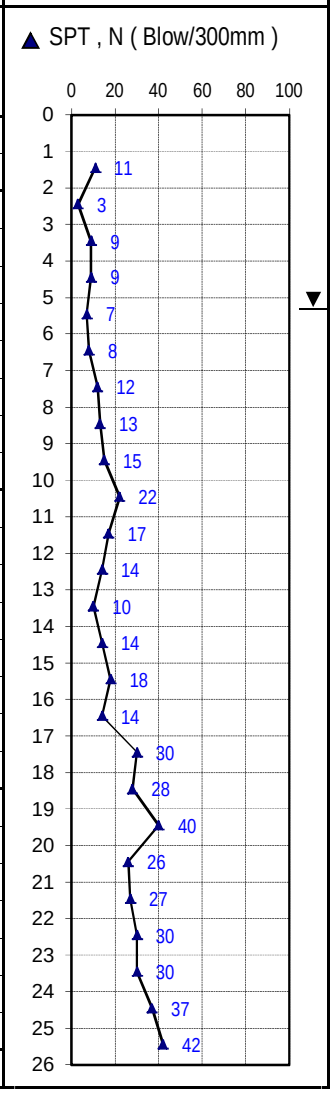
SPT - N Value

BORE HOLE LOG BH-12

Sub-Contractor: Partner of Construction and Development Services Inc. Owner : Katahira Engineers International	Method :Rotary Auger Casing Size : 180 mm Elevation: 11.99 m E: 0318011, N: 1437142	Date started : 23/06/2013 Date finished : 23/06/2013 **PROJECT : Br 75 NR-5 Improvement** Location: PK 273+300

Sampling Depth, m From	To	Type of Sampling U / SPT	Strata, (m)	Legend	Description of soil	SPT - N Value Blow/300mm N1=150mm	N2=300mm	N3=450mm	N=N2+N3
D1: 1.00 -	1.45	SPT	2.00		Stiff to soft dark gray Sandy organic SILT with gravels	3	4	7	11
D2: 2.00 -	2.45	SPT				2	2	1	3
D3: 3.00 -	3.45	SPT	8.00		Firm to stiff reddish-gray, yellowish-red, dark brown Sandy SILT	3	4	5	9
D4: 4.00 -	4.45	SPT				4	3	6	9
D5: 5.00-	5.45	SPT				2	3	4	7
D6: 6.00 -	6.45	SPT				2	3	5	8
D7: 7.00 -	7.45	SPT				3	5	7	12
D8: 8.00 -	8.45	SPT				3	6	7	13
D9: 9.00 -	9.45	SPT				4	6	9	15
D10: 10.00 -	10.45	SPT				4	9	13	22
D11: 11.00 -	11.45	SPT	8.00		Medium dense grayish, brownish-gray, light gray Silty fine to coarse SAND	5	7	10	17
D12: 12.00 -	12.45	SPT				4	6	8	14
D13: 13.00 -	13.45	SPT				4	5	5	10
D14: 14.00 -	14.45	SPT				5	6	8	14
D15: 15.00 -	15.45	SPT				5	10	8	18
D16: 16.00 -	16.45	SPT				9	8	6	14
D17: 17.00 -	17.45	SPT				6	19	11	30
D18: 18.00 -	18.45	SPT				8	12	16	28
D19: 19.00 -	19.45	SPT	7.00		Very stiff to hard grayish, brownish-gray Sandy SILT	8	12	28	40
D20: 20.00 -	20.45	SPT				8	12	14	26
D21: 21.00 -	21.45	SPT				8	12	15	27
D22: 22.00 -	22.45	SPT				8	13	17	30
D23: 23.00 -	23.45	SPT				10	15	15	30
D24: 24.00 -	24.45	SPT				9	17	20	37
D25: 25.00 -	25.45	SPT				13	18	24	42
					END of SPT Test 25.45m Depth				

Depth to water flow: 13.00m
Depth to water Level: 5.20m



Consistency	Very soft	Soft	Firm	Stiff	Very Stiff	Hard
Blows 30Cm, Clay	Less 2	2 - 4	4 - 8	8 - 15	15 - 30	> 30
Relate. Density, Blows/300mm		Very Loose	Loose	Med. Dense	Dense	Very Dense
Fine		1 - 2	3 - 6	7 - 15	16 - 30	?
medium		2 - 3	4 - 7	8 - 20	21 - 40	> 40
coarse		3 - 6	5 - 9	10 - 25	26 - 45	> 45
Unit weight of granular soil base, γ_{sat}, kN/m^3		11 - 16	14 - 18	17 - 20	17 - 22	20 - 23

LEGEND

- Stiff to hard sandy clay, lean Clay
- Firm to stiff silty clay/ lean Clay
- stiff to hard clay , fat Clay
- Clayey sand,Silty Sand
- V. Soft to soft clay, organic clay
- Fill/topsoil
- Gravelly Sand, Clean Sand
- Silty coarse sand with gravel
- Weather Rock
- Sandstone

Standard Penetration Test (SPT)
SPT
SPT - N Value

APPENDIX 6-11

SUMMARY OF

LABORATORY TEST OF BOREHOLE

IN THE MIDDLE SECTION

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 42 NR-5 Improvement
Location: PK 181+900 Pursat Province E: 0386542, N: 1384891

DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.1	D1	1.00	1.45	4	5	6	11	Very loose to medium dense yellowish Clayey Sand	SC	14.89				30.60	11.74	18.86	29.48	70.52	0.00	-	-	
	D2	2.00	2.45	1	1	2	3			8.98				31.00	12.75	18.25	40.02	50.09	9.89	-	-	
	D3	3.00	3.45	3	6	12	18	Very stiff yellowish, light gray Sandy Clay	CL	13.62				44.00	15.23	28.77	54.31	45.69	0.00	-	-	
	D4	4.00	4.45	4	3	4	7	Firm to stiff yellowish, grayish Sandy Clay	CL	16.05				28.40	12.07	16.33	64.12	35.88	0.00	-	-	
	D5	5.00	5.45	5	7	7	14			13.04				28.40	12.66	15.74	59.06	40.94	0.00	-	-	
	D6	6.00	6.45	2	3	4	7			17.33				30.20	11.99	18.21	62.41	37.59	0.00	-	-	
	D7	7.00	7.45	5	9	13	22	Stiff to very stiff yellowish, grayish, reddish-gray Sandy Clay	CL	14.16				30.60	13.68	16.92	51.30	48.70	0.00	-	-	
	D8	8.00	8.45	3	5	8	13			13.21			2.640	24.40	13.01	11.39	50.87	49.13	0.00	-	-	
	D9	9.00	9.45	3	4	4	8			12.27				24.30	11.91	12.39	63.21	36.79	0.00	-	-	
	D10	10.00	10.45	3	5	6	11			13.92				24.10	12.74	11.36	56.93	43.07	0.00	-	-	
	D11	11.00	11.45	5	7	9	16			13.28	2.272			30.90	12.07	18.83	67.06	32.94	0.00	248.398	124.20	
	D12	12.00	12.45	5	9	14	23			15.05				33.10	16.43	16.67	62.55	37.45	0.00	-	-	
	D13	13.00	13.45	5	8	8	16			14.18			2.669	38.90	12.30	26.60	68.82	31.18	0.00	-	-	
	D14	14.00	14.45	5	8	9	17			15.09	2.246			40.40	13.20	27.20	67.41	32.59	0.00	188.646	94.32	
	D15	15.00	15.45	5	7	8	15			13.19				38.00	14.78	23.22	56.70	42.50	0.80	-	-	
	D16	16.00	16.45	6	11	16	27	Very stiff to hard yellowish, grayish, reddish-gray Clay with Sand	CL	14.22				32.00	14.04	17.96	70.46	28.49	1.05			
	D17	17.00	17.45	8	13	16	29			14.22	2.105			32.00	13.01	18.99	66.20	33.72	0.08	685.545	342.77	
	D18	18.00	18.45	7	14	17	31			14.12			2.584	30.80	11.89	18.91	70.20	29.80	0.00			
	D19	19.00	19.45	7	13	23	36	Dense reddish-gray Clayey Sand	SC	12.04				27.80	13.21	14.59	48.93	48.50	2.57			
	D20	20.00	20.45	4	11	13	24	Very stiff to hard yellowish, grayish, light gray Sandy Clay	CL	12.90				27.50	12.33	15.17	51.54	48.46	0.00	-	-	
	D21	21.00	21.45	13	21	37	58			10.80				26.00	11.12	14.88	51.92	48.08	0.00	-	-	
	D22	22.00	22.45	9	12	19	31	Dense to very dense grayish, light gray Clayey Sand	SC	15.39				28.00	12.46	15.54	38.83	55.70	5.47	-	-	
	D23	23.00	23.45	10	52	50	102			13.08				32.40	13.13	19.27	42.14	57.86	0.00	-	-	
	D24	24.00	24.45	7	21	22	43			15.52				32.40	12.06	20.34	47.04	52.56	0.40	-	-	
	D25	25.00	25.45	7	17	27	44			13.71				31.20	12.41	18.79	43.18	56.82	0.00			
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 44 NR-5 Improvement
Location: PK 183+200
Elevation: 17.56 m
E: 0385166, N: 1384967
DATE : 12/06/2013
TESTED BY : Mr. Chea Sery Vuth

Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.2	D1	1.00	1.45	3	3	3	6	Very loose to loose yellowish-red, yellowish Silty fine SAND with gravels at the bottom, loose Clayey SAND	ML-GW	9.31				19.00	12.80	6.20	26.69	50.11	23.20	-	-	
	D2	2.00	2.45	3	2	1	3			8.52				20.40	14.55	5.85	23.35	51.25	25.40	-	-	
	D3	3.00	3.45	3	4	3	7			10.16				33.70	14.06	19.64	39.95	56.59	3.46	-	-	
	D4	4.00	4.45	1	3	6	9	Stiff to soft yellowish, grayish Sandy CLAY and Organic silt with gravel	CL	14.19				32.80	17.72	15.08	58.07	41.36	0.57	-	-	
	D5	5.00	5.45	3	4	3	7			12.93				32.60	13.64	18.96	67.58	31.32	1.10	-	-	
	D6	6.00	6.45	2	1	1	2		ML	13.93				20.20	15.16	5.04	62.29	37.39	0.32	-	-	
	D7	7.00	7.45	3	7	9	16	Medium dense yellowish, grayish Clayey coarse SAND	SC	8.74				27.10	13.48	13.62	41.95	57.19	0.86	-	-	
	D8	8.00	8.45	2	1	4	5	Firm to very stiff grayish, yellowish Sandy CLAY or CLAY with Sand	CL	16.57				26.20	14.71	11.49	75.71	24.29	0.00	-	-	
	D9	9.00	9.45	3	2	4	6			16.30				27.20	13.91	13.29	79.06	20.94	0.00	-	-	
	D10	10.00	10.45	3	5	5	10			16.19			2.513	34.20	17.59	16.61	78.66	21.34	0.00	-	-	
	D11	11.00	11.45	8	8	8	16			11.47	2.276			27.20	12.34	14.86	57.20	42.50	0.30	169.750	84.88	
	D12	12.00	12.45	2	2	5	7			14.28				26.70	14.55	12.15	66.35	33.65	0.00	-	-	
	D13	13.00	13.45	2	2	7	9			17.21			2.650	29.20	15.05	14.15	69.42	30.00	0.58	-	-	
	D14	14.00	14.45	6	10	12	22			18.25	2.110			28.00	16.28	11.72	84.78	15.22	0.00	339.250	169.63	
	D15	15.00	15.45	7	14	11	25	Medium dense to very dense yellowish, grayish, light gray Clayey coarse SAND with gravel	SC-GW	20.28				22.90	14.41	8.49	33.63	63.03	3.34	-	-	
	D16	16.00	16.45	53	-	-	53/15			12.01				21.80	13.00	8.80	36.60	57.54	5.86	-	-	
	D17	17.00	17.45	15	20	25	45			8.61				25.00	13.25	11.75	34.92	62.46	2.62	-	-	
	D18	18.00	18.45	12	17	21	38			9.81				24.10	13.81	10.29	24.94	73.23	1.83	-	-	
	D19	19.00	19.45	8	10	14	24			12.79				34.40	13.73	20.67	27.63	71.97	0.40	-	-	
	D20	20.00	20.45	5	16	22	38			15.02				30.20	14.85	15.35	25.03	74.66	0.31	-	-	
	D21	21.00	21.45	9	16	26	42	Very stiff to hard reddish-gray, reddish-yellow, light gray Sandy CLAY with gravel	CL-GW	16.67			2.505	25.20	13.46	11.74	68.48	31.40	0.12	-	-	
	D22	22.00	22.45	5	12	20	32			11.96	2.268			27.70	14.34	13.36	64.36	35.64	0.00	827.165	413.58	
	D23	23.00	23.45	3	7	11	18			12.81				27.20	13.75	13.45	61.16	38.84	0.00	-	-	
	D24	24.00	24.45	3	8	12	20			15.86				27.10	13.09	14.01	57.78	40.02	2.20	-	-	
	D25	25.00	25.45	7	32	37	69			14.40				26.60	13.67	12.93	57.16	42.70	0.14	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 47 NR-5 Improvement
Location: PK 185+700
Elevation: 16.75m
E: 0382985, N: 1385405
DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth
Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion, Kpa	Friction Angle Degree (°)
BH.3	D1	1.00	1.45	1	2	3	5		CL-GW	13.35				23.20	12.90	10.30	44.74	36.29	18.97	-	-	
	D2	2.00	2.45	1	2	3	5	Soft to firm yellowish, grayish sandy CLAY		17.28				22.80	12.98	9.82	66.13	31.28	2.59	-	-	
	D3	3.00	3.45	1	1	1	2	At the top, Sandy CLAY with Gravel		21.08				21.80	12.78	9.02	64.33	35.67	0.00	-	-	
	D4	4.00	4.45	1	2	3	5			17.82				21.50	12.43	9.07	43.97	56.03	0.00	-	-	
	D5	5.00	5.45	4	9	8	17	Loose to medium dense yellowish, grayish, dark gray	SP	19.76				-	-	-	8.66	91.34	0.00	-	-	
	D6	6.00	6.45	2	3	3	6	fine to medium SAND	~	22.38				-	-	-	21.11	78.89	0.00	-	-	
	D7	7.00	7.45	6	5	4	9	At the top, Clayey SAND	SC	17.77				-	-	-	1.53	98.47	0.00	-	-	
	D8	8.00	8.45	3	3	4	7			20.45				-	-	-	5.12	94.88	0.00	-	-	
	D9	9.00	9.45	3	4	4	8			17.46				29.20	15.44	13.76	71.54	27.45	1.01	-	-	
	D10	10.00	10.45	6	9	11	20			14.15				29.00	12.89	16.11	59.01	40.29	0.70	-	-	
	D11	11.00	11.45	7	10	12	22	Stiff to hard reddish-gray, light gray, yellowish Sandy		14.17	2.206			32.70	14.99	17.71	56.18	42.40	1.42	186.78	93.39	
	D12	12.00	12.45	12	17	28	45	CLAY or CLAY with Sand	CL	15.19			2.611	32.80	14.98	17.82	68.13	31.87	0.00	-	-	
	D13	13.00	13.45	8	20	34	54			15.86	2.234			38.80	18.92	19.88	79.57	20.43	0.00	510.21	255.11	
	D14	14.00	14.45	17	20	32	52			16.81				36.00	13.39	22.61	80.01	19.99	0.00	-	-	
	D15	15.00	15.45	18	23	29	52	Very dense grayish Silty coarse SAND	SM	16.71				-	-	-	27.05	72.95	0.00	-	-	
	D16	16.00	16.45	14	24	25	49			16.45			2.620	38.90	19.23	19.67	74.88	25.12	0.00	-	-	
	D17	17.00	17.45	12	27	32	59	Hard yellowish, light gray CLAY with Sand	CL	17.27	2.105			37.60	17.59	20.01	72.41	27.59	0.00	919.86	459.93	
	D18	18.00	18.45	14	24	37	61	or Sandy CLAY		14.46				36.60	18.66	17.94	64.53	35.47	0.00	-	-	
	D19	19.00	19.45	52	-	-	102	Very dense yellowish, light gray Clayey coarse SAND	CL-GW	11.21				37.80	18.70	19.10	42.81	45.08	12.11	-	-	
	D20	20.00	20.45	14	57	-	114	with gravels		10.56				34.00	17.49	16.51	42.20	38.64	19.16	-	-	
	D21	21.00	21.45	26	60	-	120			13.40				33.40	13.75	19.65	67.82	31.17	1.01	-	-	
	D22	22.00	22.45	27	55	-	110			13.00				33.00	14.93	18.07	61.40	37.42	1.18	-	-	
	D23	23.00	23.45	11	23	39	62	Hard yellowish, reddish-gray, light gray Sandy CLAY	CL-GW	13.05			2.701	32.60	15.49	17.11	61.63	34.72	3.65	-	-	
	D24	24.00	24.45	10	20	23	43	with gravel		11.58				34.20	17.34	16.86	60.36	39.15	0.49	-	-	
	D25	25.00	25.45	13	24	30	54			12.87				35.60	16.86	18.74	62.53	35.29	2.18	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 48 NR-5 Improvement
DATE : 12/06/2013
Location: PK 187+500 Pursat Province
Elevation: 17.55m
TESTED BY : Mr. Chea Sery Vuth
Table.2
E: 0385166, N: 1384967

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.4	D1	1.00	1.45	2	2	3	5	Firm to very stiff yellowish, grayish Sandy CLAY with gravels	CL-GW	14.89				23.40	11.56	11.84	59.76	36.31	3.93	-	-	
	D2	2.00	2.45	7	10	15	25			9.14				24.60	12.25	12.35	45.14	39.12	15.74	-	-	
	D3	3.00	3.45	6	3	2	5	Loose grayish, yellowish Silty fine SAND	SM	8.42				-	-	-	31.87	65.39	2.74	-	-	
	D4	4.00	4.45	3	3	2	5	Firm to stiff yellowish, brownish, grayish Sandy CLAY or Clay with Sand	CL	13.75				27.20	15.09	12.11	55.75	35.34	8.91	-	-	
	D5	5.00	5.45	2	3	4	7			31.92				47.00	18.52	28.48	87.72	12.28	0.00	-	-	
	D6	6.00	6.45	3	4	6	10			21.76				45.90	15.94	29.96	97.02	2.98	0.00	-	-	
	D7	7.00	7.45	3	8	6	14			10.46				27.80	12.82	14.98	65.02	34.98	0.00	-	-	
	D8	8.00	8.45	4	7	6	13			11.90				37.30	18.76	18.54	76.89	22.63	0.48	-	-	
	D9	9.00	9.45	4	5	7	12			13.38				37.30	18.39	18.91	84.47	15.53	0.00	-	-	
	D10	10.00	10.45	2	5	5	10			15.29	2.005			39.00	13.32	25.68	68.24	31.76	0.00	171.679	85.84	
	D11	11.00	11.45	6	13	10	23	Medium dense yellowish, yellowish-gray Clayey SAND with gravel	SC-GW	10.25				37.60	15.87	21.73	17.38	81.29	1.33	-	-	
	D12	12.00	12.45	5	9	10	19			15.25				30.20	15.48	14.72	17.89	81.84	0.27	-	-	
	D13	13.00	13.45	6	7	7	14			15.96				36.40	13.87	22.53	23.37	74.35	2.28	-	-	
	D14	14.00	14.45	5	5	6	11	Very stiff to hard light gray, yellowish, grayish-yellow Sandy CLAY	CL	11.16			2.571	36.40	16.14	20.26	51.92	48.08	0.00	-	-	
	D15	15.00	15.45	7	9	14	23			13.17	2.221			28.20	14.30	13.90	69.62	30.38	0.00	203.230	101.62	
	D16	16.00	16.45	10	14	20	34			15.83				27.80	13.07	14.73	72.85	27.15	0.00		-	
	D17	17.00	17.45	6	14	22	36			15.08			2.606	26.80	13.43	13.37	73.28	26.72	0.00	-	-	
	D18	18.00	18.45	10	15	16	31			13.34	2.173			30.20	15.68	14.52	61.55	38.45	0.00	406.430	203.22	
	D19	19.00	19.45	10	14	18	32			14.22				30.30	15.88	14.42	62.78	37.00	0.22	-	-	
	D20	20.00	20.45	11	14	17	31			14.91			2.607	31.80	16.25	15.55	66.29	33.71	0.00	-	-	
	D21	21.00	21.45	9	13	17	30			15.78				33.50	16.03	17.47	63.79	36.21	0.00	-	-	
	D22	22.00	22.45	10	14	19	33			15.13				32.90	18.53	14.37	59.16	40.84	0.00	-	-	
	D23	23.00	23.45	11	18	25	43			14.98				34.20	12.73	21.47	63.07	36.93	0.00	-	-	
	D24	24.00	24.45	12	16	24	40			15.16				37.40	15.77	21.63	67.69	32.31	0.00	-	-	
	D25	25.00	25.45	10	22	23	45			15.35				37.80	15.29	22.51	66.65	33.35	0.00			
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 50 NR-5 Improvement
Location: PK 188+100
Table.2

Elevation: 16.06 m
E: 0380336, N: 1386358

DATE : 12/06/2013
TESTED BY : Mr. Chea Sery Vuith

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.5	D1	1.00	1.45	7	10	11	21	Medium dense to loose reddish-brown Clayey SAND with Gravel	SC-GW	9.25				23.60	12.62	10.98	41.20	36.86	21.94	-	-	
	D2	2.00	2.45	3	4	3	7			11.42				24.60	12.08	12.52	47.48	30.32	22.20	-	-	
	D3	3.00	3.45	3	4	5	9	Stiff to very stiff brownish, dark brown, light gray CLAY (upper) or Sandy CLAY (middle to lower)	CL	16.54				30.20	15.41	14.79	86.83	13.17	0.00	-	-	
	D4	4.00	4.45	3	5	6	11			21.37				36.50	11.80	24.70	89.50	10.50	0.00	-	-	
	D5	5.00	5.45	3	7	8	15			13.60				26.60	14.54	12.06	63.05	36.95	0.00	-	-	
	D6	6.00	6.45	7	8	13	21			9.24				26.60	12.78	13.82	55.55	37.62	6.83	-	-	
	D7	7.00	7.45	5	6	8	14			11.81				30.40	16.40	14.00	64.28	35.72	0.00	-	-	
	D8	8.00	8.45	7	12	14	26			13.29				39.30	12.62	26.68	62.15	37.85	0.00	-	-	
	D9	9.00	9.45	7	9	14	23	Medium dense to dense grayish, light gray Clayey coarse SAND	SC	5.99				22.50	12.12	10.38	25.51	74.49	0.00	-	-	
	D10	10.00	10.45	12	15	17	32			7.73				23.10	11.74	11.36	19.20	79.93	0.87	-	-	
	D11	11.00	11.45	10	14	32	46			8.98				35.60	13.59	22.01	21.83	75.98	2.19	-	-	
	D12	12.00	12.45	17	30	27	57	Hard grayish Sandy CLAY with gravel	CL-GW	34.25			2.525	47.00	18.72	28.28	58.10	29.47	12.43	-	-	
	D13	13.00	13.45	7	8	10	18	Stiff to very stiff grayish, yellowish, light gray Sandy CLAY or CLAY with Sand	CL	33.82				46.80	17.73	29.07	85.08	14.92	0.00	-	-	
	D14	14.00	14.45	6	8	9	17			35.47				42.10	16.05	26.05	94.22	5.78	0.00	-	-	
	D15	15.00	15.45	6	7	9	16			13.36	2.215		2.575	28.60	12.12	16.48	63.82	34.66	1.52	207.495	103.75	
	D16	16.00	16.45	7	8	9	17			14.20				28.20	12.02	16.18	68.62	29.85	1.53	-	-	
	D17	17.00	17.45	7	9	15	24			15.24	2.157			35.20	11.56	23.64	78.99	21.01	0.00	555.044	277.52	
	D18	18.00	18.45	6	7	7	14			16.87			2.620	30.70	11.28	19.42	45.90	40.04	14.06	-	-	
	D19	19.00	19.45	5	10	12	22	Very stiff to hard yellowish, light gray Sandy CLAY	CL	12.12	2.209			28.80	12.18	16.62	59.92	40.08	0.00	356.579	178.29	
	D20	20.00	20.45	8	21	34	55			14.01				29.10	12.46	16.64	67.45	32.55	0.00	-	-	
	D21	21.00	21.45	17	20	24	44			13.18				32.80	13.67	19.13	65.77	34.23	0.00	-	-	
	D22	22.00	22.45	15	26	29	55			12.96				34.80	15.64	19.16	65.83	34.17	0.00	-	-	
	D23	23.00	23.45	16	24	38	62			13.61				32.10	13.47	18.63	68.40	31.60	0.00	-	-	
	D24	24.00	24.45	8	22	32	54			13.82				34.10	15.86	18.24	65.09	32.25	2.66	-	-	
	D25	25.00	25.45	9	19	29	48			13.29				29.60	12.73	16.87	64.61	33.11	2.28			
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 55 NR-5 Improvement
Location: PK 191+100 Pursat Province.
Table.2

Elevation: 18.40 m
E: 0378132, N: 1387549

DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u kg/cm^2	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.6	D1	1.00	1.45	6	4	5	9	Soft to stiff reddish-brown, yellowish-gray CLAY or CLAY with Sand	CL	13.05				48.40	16.11	32.29	76.61	20.92	2.47	-	-	
	D2	2.00	2.45	3	4	2	6			16.22				45.00	16.08	28.92	89.75	9.38	0.87	-	-	
	D3	3.00	3.45	2	2	1	3			17.92				46.00	15.35	30.65	73.44	24.50	2.06	-	-	
	D4	4.00	4.45	1	1	2	3			17.47				25.20	11.85	13.35	80.28	19.72	0.00	-	-	
	D5	5.00	5.45	6	7	7	14	Loose to medium dense yellowish fine to medium SAND with gravel	SP	4.35				-	-	-	4.83	94.99	0.18	-	-	
	D6	6.00	6.45	2	5	5	10			19.78				-	-	-	5.05	94.33	0.62	-	-	
	D7	7.00	7.45	5	3	4	7			16.65				-	-	-	2.89	90.33	6.78	-	-	
	D8	8.00	8.45	3	4	3	7	Firm to very stiff yellowish, grayish Sandy CLAY with gravel	CL-GW	14.34			2.578	24.60	11.46	13.14	58.83	40.95	0.22	-	-	
	D9	9.00	9.45	4	9	17	26			11.48				19.20	11.52	7.68	51.57	43.95	4.48	-	-	
	D10	10.00	10.45	4	5	7	12			14.34	2.106			19.30	11.28	8.02	63.07	36.93	0.00	84.346	42.17	
	D11	11.00	11.45	9	7	10	17	Medium dense grayish, yellowish, light gray Clayey fine to coarse SAND	SC	10.78				20.50	10.81	9.69	28.60	70.20	1.20	-	-	
	D12	12.00	12.45	6	8	8	16			13.49				18.90	11.07	7.83	23.42	76.58	0.00	-	-	
	D13	13.00	13.45	5	12	13	25			14.66				18.80	12.93	5.87	20.36	79.64	0.00	-	-	
	D14	14.00	14.45	8	12	14	26			15.14				23.30	15.88	7.42	21.26	78.35	0.39	-	-	
	D15	15.00	15.45	8	19	34	53	Hard to very stiff yellowish, reddish-gray, light gray Sandy CLAY or CLAY with Sand	CL	40.11				39.40	22.60	16.80	62.54	31.83	5.63	-	-	
	D16	16.00	16.45	7	7	12	19			15.16	2.125			35.10	14.27	20.83	78.77	20.06	1.17	314.433	157.22	
	D17	17.00	17.45	5	8	11	19			16.28				35.40	11.73	23.67	84.26	14.11	1.63	-	-	
	D18	18.00	18.45	3	7	7	14			14.07			2.577	29.30	12.19	17.11	64.06	35.94	0.00	-	-	
	D19	19.00	19.45	4	8	10	18			16.40	2.297			26.60	11.14	15.46	50.10	49.90	0.00	252.697	126.35	
	D20	20.00	20.45	5	8	9	17	Medium dense grayish Clayey fine SAND	SC	21.01				20.80	11.90	8.90	23.94	76.06	0.00	-	-	
	D21	21.00	21.45	5	8	10	18	Very stiff yellowish, grayish CLAY with Sand	CL	21.23			2.551	33.40	16.39	17.01	80.03	19.97	0.00	-	-	
	D22	22.00	22.45	6	12	18	30	Dense yellowish-gray Clayey coarse SAND	SC	15.44				21.60	11.38	10.22	15.06	82.30	2.64	-	-	
	D23	23.00	23.45	8	10	10	20	Very stiff yellowish, grayish Sandy CLAY	CL	16.34				37.20	15.63	21.57	60.47	39.07	0.46	-	-	
	D24	24.00	24.45	11	17	17	34	Dense yellowish Clayey coarse SAND	SC	14.01				49.20	15.95	33.25	23.86	73.36	2.78	-	-	
	D25	25.00	25.45	10	13	21	34	Hard grayish, brownish CLAY	CL	14.69				42.20	24.15	18.05	88.57	11.43	0.00	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 57 NR-5 Improvement
Location: PK 208+500
Elevation: 13.36 m
E: 0362905, N: 1396533
DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.7	D1	1.00	1.45	6	3	4	7	Firm to stiff brownish, grayish CLAY with Sand (upper) or CLAY (lower)	CL	11.62				35.30	18.70	16.60	71.84	27.72	0.44	-	-	
	D2	2.00	2.45	6	7	6	13			14.28				35.30	17.41	17.89	81.45	18.25	0.30	-	-	
	D3	3.00	3.45	5	6	6	12			18.15				48.40	16.74	31.66	91.88	8.12	0.00	-	-	
	D4	4.00	4.45	4	7	7	14			16.96				49.20	14.85	34.35	87.86	12.14	0.00	-	-	
	D5	5.00	5.45	8	8	10	18	Very stiff grayish, brownish, yellowish-brown CLAY with Sand	CL	12.46				36.60	15.68	20.92	79.66	20.34	0.00	-	-	
	D6	6.00	6.45	9	12	17	29			11.45				36.00	16.72	19.28	79.76	20.24	0.00	-	-	
	D7	7.00	7.45	9	10	13	23			11.93				29.40	12.51	16.89	83.55	16.45	0.00	-	-	
	D8	8.00	8.45	8	10	16	26			11.42				30.40	17.55	12.85	71.01	28.20	0.79	-	-	
	D9	9.00	9.45	10	13	13	26			11.37				32.00	15.12	16.88	71.37	24.96	3.67	-	-	
	D10	10.00	10.45	12	13	16	29			10.66	2.212			22.50	12.00	10.50	75.55	24.45	0.00	1250.488	625.24	
	D11	11.00	11.45	17	15	15	30	Medium dense to dense dark gray, yellowish-gray, yellowish Clayey fine to coarse SAND	SC	7.36				22.30	13.96	8.34	45.84	54.16	0.00	-	-	
	D12	12.00	12.45	11	16	15	31			5.13			2.565	21.20	12.12	9.08	30.25	69.75	0.00	-	-	
	D13	13.00	13.45	11	13	13	26			9.80				22.20	12.55	9.65	19.07	80.93	0.00	-	-	
	D14	14.00	14.45	10	13	13	26			15.99				21.30	11.70	9.60	20.98	79.02	0.00	-	-	
	D15	15.00	15.45	6	10	15	25			12.62				28.40	11.98	16.42	19.51	80.49	0.00	-	-	
	D16	16.00	16.45	10	20	19	39			12.09				28.10	14.64	13.46	22.50	77.00	0.50	-	-	
	D17	17.00	17.45	10	21	22	43			9.84				26.10	15.08	11.02	21.94	78.06	0.00	-	-	
	D18	18.00	18.45	7	14	20	34	Hard grayish-brown, reddish-gray, CLAY with Sand	CL	12.88	2.209			36.60	17.02	19.58	77.82	22.18	0.00	905.915	452.96	
	D19	19.00	19.45	11	18	24	42			12.85			2.548	37.20	16.22	20.98	77.10	22.90	0.00	-	-	
	D20	20.00	20.45	11	15	30	45			15.89	2.181			35.80	15.43	20.37	79.65	18.73	1.62	948.428	474.21	
	D21	21.00	21.45	10	17	25	42			14.14				36.00	14.71	21.29	81.42	17.75	0.83	-	-	
	D22	22.00	22.45	10	15	25	40			12.87			2.572	36.40	17.07	19.33	85.11	14.89	0.00	-	-	
	D23	23.00	23.45	9	14	23	37			13.13				36.70	16.01	20.69	70.27	21.42	8.31	-	-	
	D24	24.00	24.45	9	13	27	40			13.56				33.80	16.81	16.99	78.65	21.35	0.00	-	-	
	D25	25.00	25.45	10	17	31	48			13.77				33.80	16.41	17.39	83.05	16.95	0.00	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 58 NR-5 Improvement
Location: PK 215+800
Elevation: 12.17 m
E: 0356344, N: 1399502
DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuith

Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.8	D1	1.00	1.45	2	5	4	9	Firm to stiff brownish, grayish CLAY with Sand	CL	13.57				29.40	12.83	16.57	76.34	21.44	2.22	-	-	
	D2	2.00	2.45	5	3	4	7			11.32				28.40	15.16	13.24	77.05	22.95	0.00	-	-	
	D3	3.00	3.45	2	3	3	6	Loose grayish Clayey fine SAND	SC	19.19				23.00	12.16	10.84	46.41	53.59	0.00	-	-	
	D4	4.00	4.45	2	2	5	7			22.09				23.30	13.37	9.93	10.21	89.79	0.00	-	-	
	D5	5.00	5.45	3	2	3	5			25.54				35.70	18.52	17.18	40.93	59.07	0.00	-	-	
	D6	6.00	6.45	3	3	4	7			25.29				-	-	-	4.90	95.10	0.00	-	-	
	D7	7.00	7.45	2	3	3	6	Firm to stiff brownish, yellowish CLAY with Sand	CL	20.93				38.40	14.23	24.17	76.42	23.58	0.00	-	-	
	D8	8.00	8.45	2	3	3	6			19.61				34.00	13.77	20.23	68.77	31.23	0.00	-	-	
	D9	9.00	9.45	3	4	8	12			19.40				35.40	13.32	22.08	82.47	17.53	0.00	-	-	
	D10	10.00	10.45	5	6	6	12			16.47	2.161			31.60	13.06	18.54	75.15	24.85	0.00	209.829	104.91	
	D11	11.00	11.45	6	7	7	14			16.54			2.664	30.80	15.36	15.44	83.17	16.83	0.00	-	-	
	D12	12.00	12.45	6	7	9	16	Stiff to very stiff yellowish, brownish CLAY with Sand	CL	15.76				37.90	18.66	19.24	83.99	16.01	0.00	-	-	
	D13	13.00	13.45	7	9	15	24			14.92	2.144			26.20	13.08	13.12	76.42	22.50	1.08	406.691	203.35	
	D14	14.00	14.45	8	9	12	21			16.05				29.20	13.92	15.28	80.75	19.25	0.00	-	-	
	D15	15.00	15.45	8	9	14	23	Very stiff to hard yellowish, grayish-brown, reddish-yellow CLAY with Sand 18.00m~, Clayey SAND with Gravel 19.00m~, Sandy CLAY	CL	16.63				41.20	17.33	23.87	74.17	21.82	4.01	-	-	
	D16	16.00	16.45	5	8	14	22			16.77			2.664	36.10	14.63	21.47	77.00	20.04	2.96		-	
	D17	17.00	17.45	6	11	15	26			14.16	2.182			29.20	13.87	15.33	80.15	19.85	0.00	568.298	284.15	
	D18	18.00	18.45	10	15	20	35			13.28				27.20	12.51	14.69	49.05	26.72	24.23		-	
	D19	19.00	19.45	6	10	13	23			14.41			2.681	28.40	13.63	14.77	59.53	36.19	4.28		-	
	D20	20.00	20.45	5	6	7	13	Medium dense yellowish, light gray, yellowish-gray Clayey fine SAND	SC	16.18				23.40	15.84	7.56	45.16	54.84	0.00	-	-	
	D21	21.00	21.45	3	4	9	13			13.28				26.50	13.73	12.77	29.28	70.72	0.00	-	-	
	D22	22.00	22.45	6	11	16	27			13.70				26.20	13.61	12.59	26.64	73.36	0.00	-	-	
	D23	23.00	23.45	3	11	13	24			13.83				-	-	-	15.57	84.43	0.00	-	-	
	D24	24.00	24.45	10	13	12	25			18.82				-	-	-	18.95	81.05	0.00	-	-	
	D25	25.00	25.45	10	15	13	28			19.47				-	-	-	18.65	81.35	0.00			
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 59 NR-5 Improvement
Location: PK 219+700
Table.2

Elevation: 8.32 m
E: 0352844, N: 1400909

DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.9	D1	1.00	1.45	3	3	4	7	Firm to stiff brownish, reddish-gray CLAY with Sand	CL	16.20				46.20	17.49	28.71	78.83	21.17	0.00	-	-	
	D2	2.00	2.45	5	5	5	10			16.18				42.10	18.88	23.22	70.32	29.68	0.00	-	-	
	D3	3.00	3.45	4	6	7	13	Medium dense yellowish Clayey fine SAND	SC	10.63				25.20	14.14	11.06	41.86	58.14	0.00	-	-	
	D4	4.00	4.45	6	6	6	12			9.51				25.10	14.00	11.10	32.21	67.79	0.00	-	-	
	D5	5.00	5.45	6	6	7	13			10.92				23.60	13.21	10.39	41.78	58.22	0.00	-	-	
	D6	6.00	6.45	6	7	10	17	Stiff to very stiff brownish, grayish, yellowish CLAY with Sand (upper and middle) or Sandy CLAY (lower)	CL	16.02				47.00	17.13	29.87	95.71	4.29	0.00	-	-	
	D7	7.00	7.45	7	8	10	18			13.97				37.60	16.66	20.94	71.64	28.36	0.00	-	-	
	D8	8.00	8.45	8	6	7	13			16.29				43.10	18.48	24.62	83.56	16.44	0.00	-	-	
	D9	9.00	9.45	6	9	12	21			15.38				37.10	13.40	23.70	80.57	19.22	0.21	-	-	
	D10	10.00	10.45	6	7	10	17			15.08	2.272			37.70	17.23	20.47	83.05	16.95	0.00	563.991	282.00	
	D11	11.00	11.45	6	2	5	7			14.62				35.20	17.08	18.12	79.89	20.11	0.00	-	-	
	D12	12.00	12.45	5	9	11	20			14.27			2.625	34.90	17.04	17.86	73.96	26.04	0.00	-	-	
	D13	13.00	13.45	6	6	10	16			15.12				30.10	14.99	15.11	67.32	32.68	0.00	-	-	
	D14	14.00	14.45	4	6	7	13			17.77				23.60	12.79	10.81	56.64	43.36	0.00	-	-	
	D15	15.00	15.45	7	13	8	21	Medium dense yellowish, grayish, light gray Clayey coarse SAND		13.54				-	-	-	20.77	79.23	0.00	-	-	
	D16	16.00	16.45	6	14	15	29		SC	15.06				25.30	11.91	13.39	26.60	71.96	1.44	-	-	
	D17	17.00	17.45	7	13	14	27			17.39				23.40	13.21	10.19	28.10	71.69	0.21	-	-	
	D18	18.00	18.45	10	13	20	33	Very stiff to hard grayish, light gray, brownish Sandy CLAY	CL	14.34			2.652	30.60	17.45	13.15	80.57	19.43	0.00	-	-	
	D19	19.00	19.45	11	15	20	35			14.43				33.70	14.71	18.99	80.70	19.30	0.00	-	-	
	D20	20.00	20.45	7	12	19	31			15.47	2.136			38.60	13.57	25.03	81.01	18.99	0.00	295.559	147.78	
	D21	21.00	21.45	10	12	20	32			14.88				33.20	14.92	18.28	83.16	16.84	0.00	-	-	
	D22	22.00	22.45	8	14	16	30			15.26	2.142			30.40	17.97	12.43	83.58	16.42	0.00	295.340	147.67	
	D23	23.00	23.45	8	11	14	25			16.19			2.618	31.20	13.91	17.29	84.80	14.29	0.91	-	-	
	D24	24.00	24.45	9	13	16	29			15.67				32.50	14.18	18.32	83.00	13.19	3.81	-	-	
	D25	25.00	25.45	11	14	17	31			15.90				32.20	13.27	18.93	88.39	10.93	0.68	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 66 NR-5 Improvement
Location: PK 245+900
Table.2

Elevation: 15.96 m
E: 0331290, N: 1413450

DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuith

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.10	D1	1.00	1.45	3	7	7	14	Stiff brownish, dark brown, yellowish CLAY with Sand or Sandy CLAY (2.00~3.00m)	CL	11.80				46.20	15.85	30.35	63.40	29.40	7.20	-	-	
	D2	2.00	2.45	5	7	8	15			11.56				41.00	15.82	25.18	65.58	31.03	3.39	-	-	
	D3	3.00	3.45	4	4	5	9			14.23				32.20	15.19	17.01	70.70	17.86	11.44	-	-	
	D4	4.00	4.45	4	5	6	11			14.86				29.10	16.33	12.77	75.31	21.88	2.81	-	-	
	D5	5.00	5.45	3	4	6	10	Stiff to very stiff brownish, yellowish CLAY or CLAY with Sand	CL	15.85				36.70	18.19	18.51	86.58	13.42	0.00	-	-	
	D6	6.00	6.45	3	4	6	10			17.44				35.90	14.18	21.72	86.59	13.41	0.00	-	-	
	D7	7.00	7.45	3	5	5	10			17.31				35.60	16.28	19.32	73.76	24.98	1.26	-	-	
	D8	8.00	8.45	5	4	4	8			15.32				33.60	15.49	18.11	77.60	21.67	0.73	-	-	
	D9	9.00	9.45	4	5	5	10			14.02				35.00	15.10	19.90	74.16	21.85	3.99	-	-	
	D10	10.00	10.45	4	6	10	16			16.58	2.217			46.60	17.51	29.09	87.60	12.40	0.00	587.823	293.91	
	D11	11.00	11.45	4	6	7	13			16.36			2.597	42.60	16.75	25.85	84.90	14.18	0.92	-	-	
	D12	12.00	12.45	5	9	15	24			16.01				35.90	12.01	23.89	83.12	16.41	0.47	-	-	
	D13	13.00	13.45	8	11	16	27			14.97				32.90	15.80	17.10	84.95	15.05	0.00	-	-	
	D14	14.00	14.45	6	8	9	17	Medium dense brownish, yellowish, light gray Clayey fine to medium SAND	CL	14.49				26.70	12.33	14.37	43.48	56.52	0.00	-	-	
	D15	15.00	15.45	6	7	8	15			15.52			2.644	27.20	12.44	14.76	42.35	57.55	0.10	-	-	
	D16	16.00	16.45	8	12	14	26			14.02				26.50	13.22	13.28	38.93	61.07	0.00	-	-	
	D17	17.00	17.45	6	10	13	23			13.97				25.60	11.54	14.06	30.18	68.43	1.39	-	-	
	D18	18.00	18.45	7	11	14	25	Very stiff brownish, yellowish, grayish CLAY or CLAY with Sand	CL	18.23	2.024			32.10	15.80	16.30	88.78	11.22	0.00	708.072	354.04	
	D19	19.00	19.45	7	10	14	24			14.50			2.639	37.00	15.66	21.34	78.10	21.90	0.00	-	-	
	D20	20.00	20.45	19	23	30	53	Very dense reddish-gray Clayey SAND with Gravel	SC	9.84				24.60	11.54	13.06	24.26	55.59	20.15	-	-	
	D21	21.00	21.45	11	17	30	47	Very stiff to hard brownish, yellowish, grayish CLAY with Sand or Sandy CLAY	CL	14.68	2.129			34.20	16.66	17.54	76.39	23.61	0.00	296.338	148.17	
	D22	22.00	22.45	10	15	19	34			13.94				31.60	15.92	15.68	67.30	31.77	0.93	-	-	
	D23	23.00	23.45	4	11	17	28			15.82				37.10	16.15	20.95	84.57	15.43	0.00	-	-	
	D24	24.00	24.45	8	15	22	37			14.23				30.40	17.60	12.80	57.99	31.71	10.30	-	-	
	D25	25.00	25.45	11	14	19	33			16.41				34.60	18.98	15.62	86.65	12.62	0.73	-	-	
								END of SPT Test 25.45m Depth														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 68 NR-5 Improvement
Location: PK 255+500
Table.2

Elevation: 13.29 m
E: 0325642, N: 1421288

DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.11	D1	1.00	1.45	1	2	3	5	Firm reddish-gray, grayish Sandy CLAY	CL	21.82				40.20	17.09	23.11	57.61	40.83	1.56	-	-	
	D2	2.00	2.45	1	2	3	5			22.70				36.40	17.92	18.48	64.91	35.09	0.00	-	-	
	D3	3.00	3.45	3	4	8	12	Medium dense grayish Clayey GRAVEL with Sand	GC	12.68				27.60	14.54	13.06	36.88	30.95	32.17	-	-	
	D4	4.00	4.45	3	5	5	10	Firm to stiff grayish, light brown CLAY with Sand or Sandy CLAY	CL	20.50				37.60	17.95	19.65	87.56	12.30	0.14	-	-	
	D5	5.00	5.45	2	3	4	7			22.20				37.60	17.83	19.77	63.10	36.90	0.00	-	-	
	D6	6.00	6.45	2	5	5	10			23.52				39.50	17.41	22.09	70.48	29.52	0.00	-	-	
	D7	7.00	7.45	2	2	3	5	Loose grayish Clayey fine SAND	SC	22.68				22.80	11.56	11.24	36.94	62.83	0.23	-	-	
	D8	8.00	8.45	3	4	5	9	Stiff light brown, brownish CLAY (upper) or Sandy CLAY (lower)	CH	26.55				51.40	19.96	31.44	91.72	8.28	0.00	-	-	
	D9	9.00	9.45	3	4	6	10			25.35	1.930			53.40	20.82	32.58	68.57	31.43	0.00	212.187	106.09	
	D10	10.00	10.45	3	3	7	10	Stiff to very stiff brownish, yellowish-brown, grayish CLAY or CLAY wirh Sand	CL	23.53			2.648	36.40	19.89	16.51	96.71	3.29	0.00	-	-	
	D11	11.00	11.45	5	5	7	12			21.91				41.60	15.88	25.72	94.88	5.12	0.00	-	-	
	D12	12.00	12.45	4	5	9	14			21.35	2.014			35.70	13.88	21.82	96.74	3.26	0.00	318.503	159.25	
	D13	13.00	13.45	3	5	6	11			19.63				32.00	14.38	17.62	93.17	6.83	0.00	-	-	
	D14	14.00	14.45	4	6	9	15			18.68			2.657	32.20	11.94	20.26	77.36	22.64	0.00	-	-	
	D15	15.00	15.45	4	5	6	11			21.80				31.60	13.43	18.17	88.08	11.92	0.00	-	-	
	D16	16.00	16.45	4	6	9	15			20.69				33.70	14.21	19.49	76.43	22.74	0.83	-	-	
	D17	17.00	17.45	5	7	9	16			19.47				32.30	14.91	17.39	82.48	16.66	0.86	-	-	
	D18	18.00	18.45	7	10	17	27			20.47	2.088			40.80	17.58	23.22	96.20	3.80	0.00	417.485	208.74	
	D19	19.00	19.45	5	6	8	14			22.18			2.625	38.00	15.76	22.24	89.02	10.98	0.00	-	-	
	D20	20.00	20.45	7	15	15	30	Very stiff to hard grayish, yellowish, brownish CLAY with Sand (upper and middle) or CLAY (lower)	CL	19.80				36.80	18.86	17.94	75.44	24.56	0.00	-	-	
	D21	21.00	21.45	6	11	15	26			19.22				34.40	16.45	17.95	73.89	24.94	1.17	-	-	
	D22	22.00	22.45	11	15	20	35			18.53				38.20	14.37	23.83	73.72	26.28	0.00	-	-	
	D23	23.00	23.45	10	12	21	33			18.99				38.00	18.08	19.92	81.76	16.27	1.97	-	-	
	D24	24.00	24.45	12	17	23	40			20.32				39.00	16.44	22.56	90.34	9.66	0.00	-	-	
	D25	25.00	25.45	14	19	25	44			19.76				45.80	19.29	26.51	84.91	14.20	0.89	-	-	
								END OF SPT TEST 25.45m DEPTH														

Partner of Construction and Development Services Inc.
Soil Quality Analysis Office.

Summary of Laboratory Test

PROJECT : Br 75 NR-5 Improvement
Location: PK 273+300
Elevation: 11.99 m
E: 0318011, N: 1437142
DATE : 28/06/2013
TESTED BY : Mr. Chea Sery Vuth

Table.2

Boring No	Sample	Depth(m)		SPT - N Value, Every 150Cm Blows / 300mm				Soil description	Unified Clasification	NMC W (%)	Bulk density γ_w (g/cm^3)	Dry density γ_d (g/cm^3)	Specific gravity γ_s (g/cm^3)	Atterberg limit			Grain size			Unconf. Strength q_u (kg/cm^2)	Shear Strength	
		From	To	N1	N2	N3	N							LL (%)	PL (%)	PI (%)	Clay and Silt %	Sand %	Gravel %		Cohesion Kpa	Friction Angle Degree (°)
BH.12	D1	1.00	1.45	3	4	7	11	Stiff to soft dark gray organic CLAY with Sand or Sandy CLAY	CL	22.00				40.80	16.58	24.22	73.17	22.37	4.46	-	-	
	D2	2.00	2.45	2	2	1	3			18.70				31.50	15.98	15.52	52.54	45.07	2.39	-	-	
	D3	3.00	3.45	3	4	5	9	Firm to very stiff reddish-gray, yellowish-red, dark brown CLAY with Sand or CLAY	CH	24.57				57.80	15.74	42.06	84.13	15.87	0.00	-	-	
	D4	4.00	4.45	4	3	6	9			21.47				39.20	16.88	22.32	69.57	30.43	0.00	-	-	
	D5	5.00	5.45	2	3	4	7			22.10				36.60	16.79	19.81	83.53	15.88	0.59	-	-	
	D6	6.00	6.45	2	3	5	8			23.81				43.60	17.82	25.78	94.96	4.96	0.08	-	-	
	D7	7.00	7.45	3	5	7	12		CL	20.48				41.50	17.50	24.00	86.62	9.39	3.99	-	-	
	D8	8.00	8.45	3	6	7	13			19.79				41.50	15.31	26.19	83.61	15.50	0.89	-	-	
	D9	9.00	9.45	4	6	9	15			20.36				39.60	16.26	23.34	90.75	9.25	0.00	-	-	
	D10	10.00	10.45	4	9	13	22			16.72	2.147			38.00	18.16	19.84	70.06	26.16	3.78	215.803	107.90	
	D11	11.00	11.45	5	7	10	17	Medium dense grayish, brownish-gray, light gray Clayey fine to coarse SAND 16.00~17.00m, Sandy CLAY	SC	17.66				28.30	11.88	16.42	39.17	60.83	0.00	-	-	
	D12	12.00	12.45	4	6	8	14			17.36			2.643	28.10	12.50	15.60	38.59	61.32	0.09	-	-	
	D13	13.00	13.45	4	5	5	10			21.58				26.60	12.87	13.73	23.19	76.81	0.00	-	-	
	D14	14.00	14.45	5	6	8	14			20.24				22.80	11.75	11.05	26.67	73.33	0.00	-	-	
	D15	15.00	15.45	5	10	8	18			20.56				-	-	-	15.36	84.64	0.00	-	-	
	D16	16.00	16.45	9	8	6	14			16.89				27.70	13.53	14.17	50.41	49.59	0.00	-	-	
	D17	17.00	17.45	6	19	11	30			18.02			2.668	27.70	14.29	13.41	35.09	61.77	3.14	-	-	
	D18	18.00	18.45	8	12	16	28			20.43				23.30	11.26	12.04	34.03	65.97	0.00	-	-	
	D19	19.00	19.45	8	12	28	40	Very stiff to hard grayish, brownish-gray CLAY with Sand or CLAY 21.00~22.00m, Snady CLAY	CL	21.13				39.50	15.92	23.58	89.53	10.47	0.00	-	-	
	D20	20.00	20.45	8	12	14	26			20.24			2.647	41.80	16.43	25.37	83.71	16.29	0.00	-	-	
	D21	21.00	21.45	8	12	15	27			18.80				43.00	16.66	26.34	57.17	42.61	0.22	-	-	
	D22	22.00	22.45	8	13	17	30			19.31	2.096			41.50	16.01	25.49	73.31	26.69	0.00	110.297	55.15	
	D23	23.00	23.45	10	15	15	30			17.41				36.30	17.19	19.11	86.46	13.54	0.00	-	-	
	D24	24.00	24.45	9	17	20	37			18.99	2.239			40.80	15.87	24.93	90.54	9.46	0.00	338.381	169.19	
	D25	25.00	25.45	13	18	24	42			17.59				38.30	16.28	22.02	80.71	19.29	0.00	-	-	
								END of SPT Test 25.45m Depth														

APPENDIX 6-12

CALCULATED SOIL PARAMETER

IN THE MIDDLE SECTION

Soil Parameters for Br. 42

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 1.00	Clayey Sand	SC			1.7	0.51		32
2.00	Clayey Sand	SC	30.60	18.86	1.7	2.21		34
3.00	Clayey Sand	SC	31.00	18.25	1.7	3.91		< 31
4.00	Sandy Clay	CL	44.00	28.77	1.8	4.69	130	
5.00	Sandy Clay	CL	28.40	16.33	1.7	5.46	50	
6.00	Sandy Clay	CL	28.40	15.74	1.8	6.19	100	
7.00	Sandy Clay	CL	30.20	18.21	1.7	6.96	50	
8.00	Sandy Clay	CL	30.60	16.92	1.8	7.69	150	
9.00	Sandy Clay	CL	24.40	11.39	1.8	8.49	90	
10.00	Sandy Clay	CL	24.30	12.39	1.8	9.29	55	
11.00	Sandy Clay	CL	24.10	11.36	1.8	10.09	80	
12.00	Sandy Clay	CL	30.90	18.83	1.8	10.89	110	
13.00	Sandy Clay	CL	33.10	16.67	1.8	11.69	160	
14.00	Sandy Clay	CL	38.90	26.60	1.8	12.49	110	
15.00	Sandy Clay	CL	40.40	27.20	1.8	13.29	120	
16.00	Sandy Clay	CL	38.00	23.22	1.8	14.09	110	
17.00	Clay with Sand	CL	32.00	17.96	1.8	14.89	190	
18.00	Clay with Sand	CL	32.00	18.99	1.8	15.69	200<	
19.00	Clay with Sand	CL	30.80	18.91	1.8	16.49	200<	
20.00	Clayey Sand	SC	27.80	14.59	1.9	17.32		35
21.00	Sandy Clay	CL	27.50	15.17	1.8	18.19	170	
22.00	Sandy Clay	CL	26.00	14.88	1.8	18.99	200<	
23.00	Clayey Sand	SC	28.00	15.54	1.9	19.82		34
24.00	Clayey Sand	SC	32.40	19.27	1.9	20.72		38
25.00	Clayey Sand	SC	32.40	20.34	1.9	21.62		35
25.45	Clayey Sand	SC	31.20	18.79	1.9	22.52		36

Soil Parameters for Br. 44

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Silty Sand	SM	19.00	6.20	1.7	2.21		33
3.00	Silty Sand	SM	20.40	5.85	1.7	3.91		< 31
4.00	Sandy Clay	CL	33.70	19.64	1.7	5.61	50	
5.00	Sandy Clay	CL	32.80	15.08	1.8	7.34	60	
6.00	Sandy Clay	CL	32.60	18.96	1.7	9.11	50	
7.00	Sandy Clay	CL	20.20	5.04	1.6	10.48	10	
8.00	Clayey Sand	SC	27.10	13.62	1.7	11.11		34
9.00	Sandy Clay	CL	26.20	11.49	1.7	11.81	35	
10.00	Sandy Clay	CL	27.20	13.29	1.7	12.51	40	
11.00	Sandy Clay	CL	34.20	16.61	1.8	13.24	70	
12.00	Sandy Clay	CL	27.20	14.86	1.8	14.04	110	
13.00	Sandy Clay	CL	26.70	12.15	1.7	14.81	50	
14.00	Sandy Clay	CL	29.20	14.15	1.8	15.54	60	
15.00	Sandy Clay	CL	28.00	11.72	1.8	16.34	150	
16.00	Clayey Sand	SC	22.90	8.49	1.7	17.11		34
17.00	Clayey Sand	SC	21.80	8.80	1.9	17.87		38<
18.00	Clayey Sand	SC	25.00	11.75	1.9	18.77		36
19.00	Clayey Sand	SC	24.10	10.29	1.9	19.67		35
20.00	Clayey Sand	SC	34.40	20.67	1.7	20.51		35
21.00	Clayey Sand	SC	30.20	15.35	1.9	21.27		35
22.00	Sandy Clay	CL	25.20	11.74	1.8	22.14	200<	
23.00	Sandy Clay	CL	27.70	13.36	1.8	22.94	200<	
24.00	Sandy Clay	CL	27.20	13.45	1.8	23.74	130	
25.00	Sandy Clay	CL	27.10	14.01	1.8	24.54	140	
25.45	Sandy Clay	CL	26.60	12.93	1.8	25.34	200<	

Soil Parameters for Br. 47

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Sandy Clay	CL	23.20	10.30	1.7	2.21	35	
3.00	Sandy Clay	CL	22.80	9.82	1.7	3.91	35	
4.00	Sandy Clay	CL	21.80	9.02	1.6	5.58	10	
5.00	Sand	SP~SC	21.50	9.07	1.7	7.21		31
6.00	Sand	SP~SC	-	-	1.7	8.71		34
7.00	Sand	SP~SC	-	-	1.7	9.41		31
8.00	Sand	SP~SC	-	-	1.7	10.11		32
9.00	Sand	SP~SC	-	-	1.7	10.81		31
10.00	Sandy Clay	CL	29.20	13.76	1.8	11.54	55	
11.00	Sandy Clay	CL	29.00	16.11	1.8	12.34	140	
12.00	Sandy Clay	CL	32.70	17.71	1.8	13.14	150	
13.00	Clay with Sand	CL	32.80	17.82	1.8	13.94	200<	
14.00	Clay with Sand	CL	38.80	19.88	1.8	14.74	200<	
15.00	Clay with Sand	CL	36.00	22.61	1.8	15.54	200<	
16.00	Silty Sand	SM	-	-	1.9	16.37		37
17.00	Clay with Sand	CL	38.90	19.67	1.8	17.24	200<	
18.00	Clay with Sand	CL	37.60	20.01	1.8	18.04	200<	
19.00	Clay with Sand	CL	36.60	17.94	1.8	18.84	200<	
20.00	Clayey Sand	SC	37.80	19.10	1.9	19.67		38<
21.00	Clayey Sand	SC	34.00	16.51	1.9	20.57		38<
22.00	Sandy Clay	CL	33.40	19.65	1.8	21.44	200<	
23.00	Sandy Clay	CL	33.00	18.07	1.8	22.24	200<	
24.00	Sandy Clay	CL	32.60	17.11	1.8	23.04	200<	
25.00	Sandy Clay	CL	34.20	16.86	1.8	23.84	200<	
25.45	Sandy Clay	CL	35.60	18.74	1.8	24.64	200<	

Soil Parameters for Br. 48

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Sandy Clay	CL	23.40	11.84	1.7	2.21	35	
3.00	Sandy Clay	CL	24.60	12.35	1.8	3.94	180	
4.00	Silty Sand	SC	-	-	1.7	5.71		31
5.00	Sandy Clay	CL	27.20	12.11	1.7	7.41	35	
6.00	Sandy Clay	CL	47.00	28.48	1.7	9.11	50	
7.00	Sandy Clay	CL	45.90	29.96	1.8	10.84	70	
8.00	Sandy Clay	CL	27.80	14.98	1.8	12.64	100	
9.00	Sandy Clay	CL	37.30	18.54	1.8	14.44	90	
10.00	Sandy Clay	CL	37.30	18.91	1.8	16.24	85	
11.00	Sandy Clay	CL	39.00	25.68	1.8	17.44	70	
12.00	Clayey Sand	SC	37.30	21.43	1.7	18.21		34
13.00	Clayey Sand	SC	30.20	14.72	1.7	18.91		33
14.00	Clayey Sand	SC	36.40	22.53	1.7	19.61		32
15.00	Sandy Clay	CL	36.40	20.26	1.8	20.34	80	
16.00	Sandy Clay	CL	28.20	13.90	1.8	21.14	160	
17.00	Sandy Clay	CL	27.80	14.73	1.8	21.94	200<	
18.00	Sandy Clay	CL	26.80	13.37	1.8	22.74	200<	
19.00	Sandy Clay	CL	30.20	14.52	1.8	23.54	200<	
20.00	Sandy Clay	CL	30.30	14.42	1.8	24.34	200<	
21.00	Sandy Clay	CL	31.80	15.55	1.8	25.14	200<	
22.00	Sandy Clay	CL	33.50	17.47	1.8	25.94	200<	
23.00	Sandy Clay	CL	32.90	14.37	1.8	26.74	200<	
24.00	Sandy Clay	CL	34.20	21.47	1.8	27.54	200<	
25.00	Sandy Clay	CL	37.40	21.63	1.8	28.34	200<	
25.45	Sandy Clay	CL	37.80	22.51	1.8	29.14	200<	

Soil Parameters for Br. 50

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clayey Sand	SC	23.60	10.98	1.7	2.21		37
~ 3.00	Sandy Clay	CL	24.60	12.52	1.7	3.91	50	
~ 4.00	Sandy Clay	CL	30.20	14.79	1.8	5.94	60	
~ 5.00	Sandy Clay	CL	36.50	24.70	1.8	7.74	80	
~ 6.00	Sandy Clay	CL	26.60	12.06	1.8	9.54	110	
~ 7.00	Sandy Clay	CL	26.60	13.82	1.8	11.34	150	
~ 8.00	Sandy Clay	CL	30.40	14.00	1.8	13.14	100	
~ 9.00	Sandy Clay	CL	39.30	26.68	1.8	14.94	185	
~ 10.00	Clayey Sand	SC	22.50	10.38	1.7	15.81		34
~ 11.00	Clayey Sand	SC	23.10	11.36	1.9	16.57		35
~ 12.00	Clayey Sand	SC	35.60	22.01	1.9	17.47		36
~ 13.00	Sandy Clay	CL	47.00	28.28	1.8	18.34	200<	
~ 14.00	Clay with Sand	CL	46.80	29.07	1.8	19.14	130	
~ 15.00	Clay with Sand	CL	42.10	26.05	1.8	19.94	120	
~ 16.00	Clay with Sand	CL	28.60	16.48	1.8	20.74	110	
~ 17.00	Clay with Sand	CL	28.20	16.18	1.8	21.54	120	
~ 18.00	Clay with Sand	CL	35.20	23.64	1.8	22.34	170	
~ 19.00	Clayey Sand	SC	30.70	19.42	1.7	23.11		32
~ 20.00	Sandy Clay	CL	28.80	16.62	1.8	23.84	150	
~ 21.00	Sandy Clay	CL	29.10	14.64	1.8	24.64	200<	
~ 22.00	Sandy Clay	CL	32.80	19.13	1.8	25.44	200<	
~ 23.00	Sandy Clay	CL	34.80	19.16	1.8	26.24	200<	
~ 24.00	Sandy Clay	CL	32.10	18.63	1.8	27.04	200<	
~ 25.00	Sandy Clay	CL	34.10	18.24	1.8	27.84	200<	
~ 25.45	Sandy Clay	CL	29.60	16.87	1.8	28.64	200<	

Soil Parameters for Br. 55

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay	CL	48.40	32.29	1.8	2.34	60	
3.00	Clay	CL	45.00	28.92	1.7	4.11	40	
4.00	Clay	CL	46.00	30.65	1.6	5.78	20	
5.00	Clay	CL	25.20	13.35	1.6	7.38	20	
6.00	Sand	SP	-	-	1.8	9.04		35
7.00	Sand	SP	-	-	1.8	10.39		33
8.00	Sand	SP	-	-	1.8	11.19		33
9.00	Sandy Clay	CL	24.60	13.14	1.7	11.96	50	
10.00	Sandy Clay	CL	19.20	7.68	1.8	12.69	185	
11.00	Sandy Clay	CL	19.30	8.02	1.8	13.49	85	
12.00	Clayey Sand	SC	20.50	9.69	1.7	14.26		33
13.00	Clayey Sand	SC	18.90	7.83	1.7	14.96		33
14.00	Clayey Sand	SC	18.80	5.87	1.7	15.66		34
15.00	Clayey Sand	SC	23.30	7.42	1.7	16.36		34
16.00	Clay with Sand	CL	39.40	16.80	1.8	17.09	200<	
17.00	Clay with Sand	CL	35.10	20.83	1.8	17.89	135	
18.00	Clay with Sand	CL	35.40	23.67	1.8	18.69	135	
19.00	Clay with Sand	CL	29.30	17.11	1.8	19.49	100	
20.00	Clay with Sand	CL	26.60	15.46	1.8	20.29	130	
21.00	Clayey Sand	SC	20.80	8.90	1.7	21.06		33
22.00	Clay with Sand	CL	33.40	17.01	1.8	21.79	130	
23.00	Clayey Sand	SC	21.60	10.22	1.9	22.62		34
24.00	Sandy Clay	CL	37.20	21.57	1.8	23.49	140	
25.00	Clayey Sand	SC	49.20	33.25	1.9	24.32		33
25.45	Clay	CL	42.20	18.05	1.8	25.19	200<	

Soil Parameters for Br. 57

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay with Sand	CL	35.30	16.60	1.7	2.21	50	
3.00	Clay with Sand	CL	35.30	17.89	1.8	3.94	90	
4.00	Clay with Sand	CL	48.40	31.66	1.8	5.74	85	
5.00	Clay with Sand	CL	49.20	34.35	1.8	7.54	100	
6.00	Clay with Sand	CL	36.60	20.92	1.8	9.34	130	
7.00	Clay with Sand	CL	36.00	19.28	1.8	11.14	200<	
8.00	Clay with Sand	CL	29.40	16.89	1.8	12.94	160	
9.00	Clay with Sand	CL	30.40	12.85	1.8	14.74	185	
10.00	Clay with Sand	CL	32.00	16.88	1.8	16.54	185	
11.00	Clay with Sand	CL	22.50	10.50	1.8	18.34	200<	
12.00	Clayey Sand	SC	22.30	8.34	1.9	20.17		34
13.00	Clayey Sand	SC	21.20	9.08	1.9	22.07		34
14.00	Clayey Sand	SC	22.20	9.65	1.7	21.31		34
15.00	Clayey Sand	SC	21.30	9.60	1.7	23.01		34
16.00	Clayey Sand	SC	28.40	16.42	1.7	24.71		33
17.00	Clayey Sand	SC	28.10	13.46	1.9	29.67		34
18.00	Clayey Sand	SC	26.10	11.02	1.9	31.57		34
19.00	Clay with Sand	CL	36.60	19.58	1.8	33.44	200<	
20.00	Clay with Sand	CL	37.20	20.98	1.8	35.24	200<	
21.00	Clay with Sand	CL	35.80	20.37	1.8	37.04	200<	
22.00	Clay with Sand	CL	36.00	21.29	1.8	38.84	200<	
23.00	Clay with Sand	CL	36.40	19.33	1.8	40.64	200<	
24.00	Clay with Sand	CL	36.70	20.69	1.8	42.44	200<	
25.00	Clay with Sand	CL	33.80	16.99	1.8	44.24	200<	
25.45	Clay with Sand	CL	33.80	17.39	1.8	46.04	200<	

Soil Parameters for Br. 58

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv' (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay with Sand	CL	29.40	16.57	1.8	2.34	60	
3.00	Clay with Sand	CL	28.40	13.24	1.7	4.11	50	
4.00	Clayey Sand	SC	23.00	10.84	1.7	5.11		32
5.00	Clayey Sand	SC	23.30	9.93	1.7	5.81		32
6.00	Clayey Sand	SC	35.70	17.18	1.7	6.51		31
7.00	Clayey Sand	SC	-	-	1.7	7.21		32
8.00	Clay with Sand	CL	38.40	24.17	1.7	7.91	40	
9.00	Clay with Sand	CL	34.00	20.23	1.7	8.61	40	
10.00	Clay with Sand	CL	35.40	22.08	1.8	9.34	85	
11.00	Clay with Sand	CL	31.60	18.54	1.8	10.14	85	
12.00	Clay with Sand	CL	30.80	15.44	1.8	10.94	100	
13.00	Clay with Sand	CL	37.90	19.24	1.8	11.74	110	
14.00	Clay with Sand	CL	26.20	13.12	1.8	12.54	170	
15.00	Clay with Sand	CL	29.20	15.28	1.8	13.34	150	
16.00	Clay with Sand	CL	41.20	23.87	1.8	14.14	160	
17.00	Clay with Sand	CL	36.10	21.47	1.8	14.94	150	
18.00	Clay with Sand	CL	29.20	15.33	1.8	15.74	185	
19.00	Clayey Sand	SC	27.20	14.69	1.9	16.57		35
20.00	Sandy Clay	CL	28.40	14.77	1.8	17.44	160	
21.00	Clayey Sand	SC	23.40	7.56	1.7	18.21		32
22.00	Clayey Sand	SC	26.50	12.77	1.7	18.91		32
23.00	Clayey Sand	SC	26.20	12.59	1.7	19.61		34
24.00	Clayey Sand	SC	-	-	1.7	20.31		34
25.00	Clayey Sand	SC	-	-	1.7	21.01		34
25.45	Clayey Sand	SC	-	-	1.7	21.71		34

Soil Parameters for Br. 59

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay with Sand	CL	46.20	28.71	1.7	2.21	50	
3.00	Clay with Sand	CL	42.10	23.22	1.8	3.94	70	
4.00	Clayey Sand	SC	25.20	11.06	1.7	5.71		34
5.00	Clayey Sand	SC	25.10	11.10	1.7	7.41		33
6.00	Clayey Sand	SC	23.60	10.39	1.7	9.11		33
7.00	Clay with Sand	CL	47.00	29.87	1.8	10.84	120	
8.00	Clay with Sand	CL	37.60	20.94	1.8	12.64	130	
9.00	Clay with Sand	CL	43.10	24.62	1.8	14.44	90	
10.00	Clay with Sand	CL	37.10	23.70	1.8	16.24	150	
11.00	Clay with Sand	CL	37.70	20.47	1.8	18.04	120	
12.00	Clay with Sand	CL	35.20	18.12	1.7	19.81	50	
13.00	Clay with Sand	CL	34.90	17.86	1.8	21.54	140	
14.00	Clay with Sand	CL	30.10	15.11	1.8	23.34	110	
15.00	Clay with Sand	CL	23.60	10.81	1.8	25.14	90	
16.00	Clayey Sand	SC	-	-	1.7	26.76		33
17.00	Clayey Sand	SC	25.30	13.39	1.7	27.46		34
18.00	Clayey Sand	SC	23.40	10.19	1.7	28.16		34
19.00	Sandy Clay	CL	30.60	13.15	1.8	28.89	200<	
20.00	Sandy Clay	CL	33.70	18.99	1.8	29.69	200<	
21.00	Sandy Clay	CL	38.60	25.03	1.8	30.49	200<	
22.00	Sandy Clay	CL	33.20	18.28	1.8	31.29	200<	
23.00	Sandy Clay	CL	30.40	12.43	1.8	32.09	200<	
24.00	Sandy Clay	CL	31.20	17.29	1.8	32.89	180	
25.00	Sandy Clay	CL	32.50	18.32	1.8	33.69	200<	
25.45	Sandy Clay	CL	32.20	18.93	1.8	34.49	200<	

Soil Parameters for Br. 66

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay with Sand	CL	46.2	30.35	1.8	2.34	100	
3.00	Clay with Sand	CL	41	25.18	1.8	4.14	110	
4.00	Clay with Sand	CL	32.2	17.01	1.8	5.94	60	
5.00	Clay	CL	29.1	12.77	1.8	7.74	80	
6.00	Clay	CL	36.7	18.51	1.8	9.54	70	
7.00	Clay	CL	35.9	21.72	1.8	11.34	70	
8.00	Clay	CL	35.6	19.32	1.8	13.14	70	
9.00	Clay	CL	33.6	18.11	1.8	14.94	55	
10.00	Clay	CL	35	19.9	1.8	16.74	70	
11.00	Clay	CL	46.6	29.09	1.8	18.54	110	
12.00	Clay	CL	42.6	25.85	1.8	20.34	90	
13.00	Clay	CL	35.9	23.89	1.8	22.14	170	
14.00	Clay	CL	32.9	17.1	1.8	23.94	190	
15.00	Clayey Sand	SC	26.7	14.37	1.7	25.71		32
16.00	Clayey Sand	SC	27.2	14.76	1.7	27.41		32
17.00	Clayey Sand	SC	26.5	13.28	1.7	29.11		32
18.00	Clayey Sand	SC	25.6	14.06	1.7	30.81		33
19.00	Clay	CL	32.1	16.3	1.8	32.54	180	
20.00	Clay	CL	37	21.34	1.8	34.34	170	
21.00	Clayey Sand	SC	24.6	13.06	1.9	36.17		35
22.00	Sandy Clay	CL	34.2	17.54	1.8	38.04	200<	
23.00	Sandy Clay	CL	31.6	15.68	1.8	39.84	200<	
24.00	Sandy Clay	CL	37.1	20.95	1.8	41.64	200	
25.00	Sandy Clay	CL	30.4	12.8	1.8	43.44	200<	
25.45	Sandy Clay	CL	34.6	15.62	1.8	45.24	200<	

Soil Parameters for Br. 68

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv' (t/m2)	C (kPa)	φ (°)
~ 2.00	Sandy Clay	CL	40.20	23.11	1.7	1.7	35	
3.00	Sandy Clay	CL	36.40	18.48	1.7	3.4	35	
4.00	layey Gravel with Sar	GC	27.60	13.06	1.7	5.1		37
5.00	Clay with Sand	CL	37.60	19.65	1.8	7.23	70	
6.00	Clay with Sand	CL	37.60	19.77	1.7	9	50	
7.00	Clay with Sand	CL	39.50	22.09	1.8	11.33	70	
8.00	Clayey Sand	SC	22.80	11.24	1.7	13.1		31
9.00	Clay	CH	51.40	31.44	1.8	14.83	60	
10.00	Sandy Clay	CH	53.40	32.58	1.8	16.63	70	
11.00	Clay	CL	36.40	16.51	1.8	18.43	70	
12.00	Clay	CL	41.60	25.72	1.8	20.23	85	
13.00	Clay	CL	35.70	21.82	1.8	22.03	100	
14.00	Clay	CL	32.00	17.62	1.8	23.83	80	
15.00	Clay with Sand	CL	32.20	20.26	1.8	25.63	110	
16.00	Clay with Sand	CL	31.60	18.17	1.8	27.43	80	
17.00	Clay with Sand	CL	33.70	19.49	1.8	29.23	110	
18.00	Clay with Sand	CL	32.30	17.39	1.8	31.03	110	
19.00	Clay	CL	40.80	23.22	1.8	32.83	190	
20.00	Clay	CL	38.00	22.24	1.8	34.63	100	
21.00	Clay with Sand	CL	36.80	17.94	1.8	36.43	200<	
22.00	Clay with Sand	CL	34.40	17.95	1.8	38.23	185	
23.00	Clay with Sand	CL	38.20	23.83	1.8	40.03	200<	
24.00	Clay with Sand	CL	38.00	19.92	1.8	41.83	200<	
25.00	Clay	CL	39.00	22.56	1.8	43.63	200<	
26.00	Clay	CL	45.80	26.51	1.8	45.43	200<	

Soil Parameters for Br. 75

Depth (m)	Soil Type	USCS	LL(%)	PI	γt (t/m3)	δv (t/m2)	C (kPa)	φ (°)
~ 2.00	Clay with Sand	CL	40.80	24.22	1.8	2.34	80	
3.00	Sandy Clay	CL	31.50	15.52	1.6	4.08	20	
4.00	Clay	CH	57.80	42.06	1.8	5.74	60	
5.00	Clay	CL	39.20	22.32	1.8	7.54	60	
6.00	Clay	CL	36.60	19.81	1.7	9.21	50	
7.00	Clay	CL	43.60	25.78	1.8	9.94	55	
8.00	Clay	CL	41.50	24.00	1.8	10.74	85	
9.00	Clay	CL	41.50	26.19	1.8	11.54	90	
10.00	Clay	CL	39.60	23.34	1.8	12.34	110	
11.00	Clay	CL	38.00	19.84	1.8	13.14	150	
12.00	Clayey Sand	SC	28.30	16.42	1.7	13.91		33
13.00	Clayey Sand	SC	28.10	15.60	1.7	14.61		32
14.00	Clayey Sand	SC	26.60	13.73	1.7	15.31		31
15.00	Clayey Sand	SC	22.80	11.05	1.7	16.01		32
16.00	Clayey Sand	SC	-	-	1.7	16.71		33
17.00	Sandy Clay	CL	27.70	14.17	1.8	17.44	100	
18.00	Clayey Sand	SC	27.70	13.41	1.9	18.27		35
19.00	Clayey Sand	SC	23.30	12.04	1.7	19.11		34
20.00	Clay	CL	39.50	23.58	1.8	19.84	200<	
21.00	Clay with Sand	CL	41.80	25.37	1.8	20.64	185	
22.00	Sandy Clay	CL	43.00	26.34	1.8	21.44	190	
23.00	Clay with Sand	CL	41.50	25.49	1.8	22.24	200<	
24.00	Clay with Sand	CL	36.30	19.11	1.8	23.04	200<	
25.00	Clay	CL	40.80	24.93	1.8	23.84	200<	
26.00	Lean Clay	CL	38.30	22.02	1.8	24.64	200<	

APPENDIX 8-1

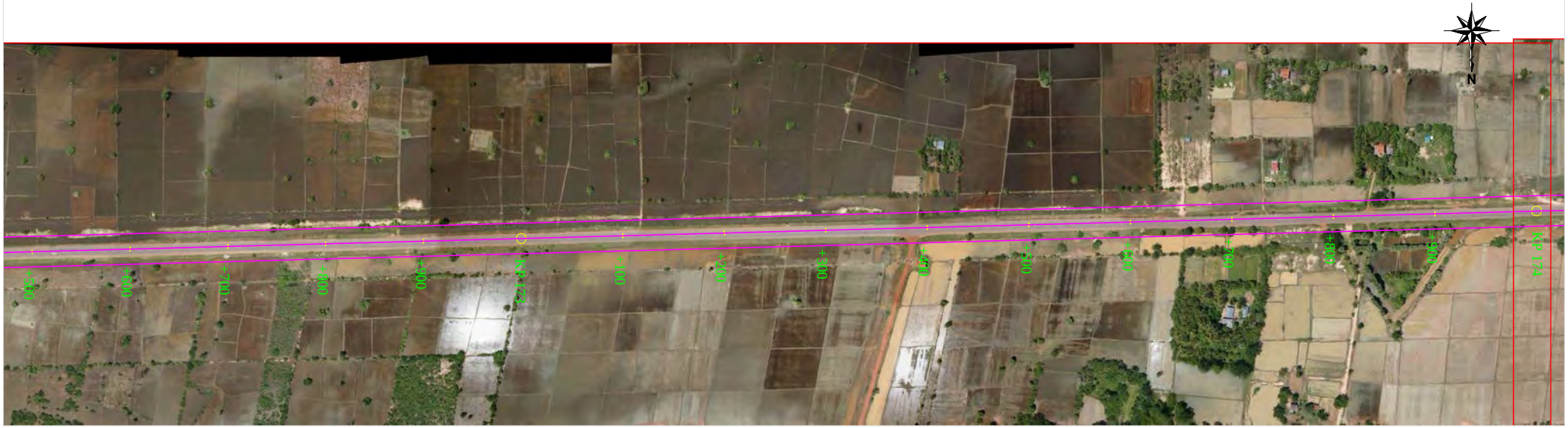
KEY PLAN OF NATIONAL ROAD NO.5

IN THE MIDDLE SECTION

A8-1

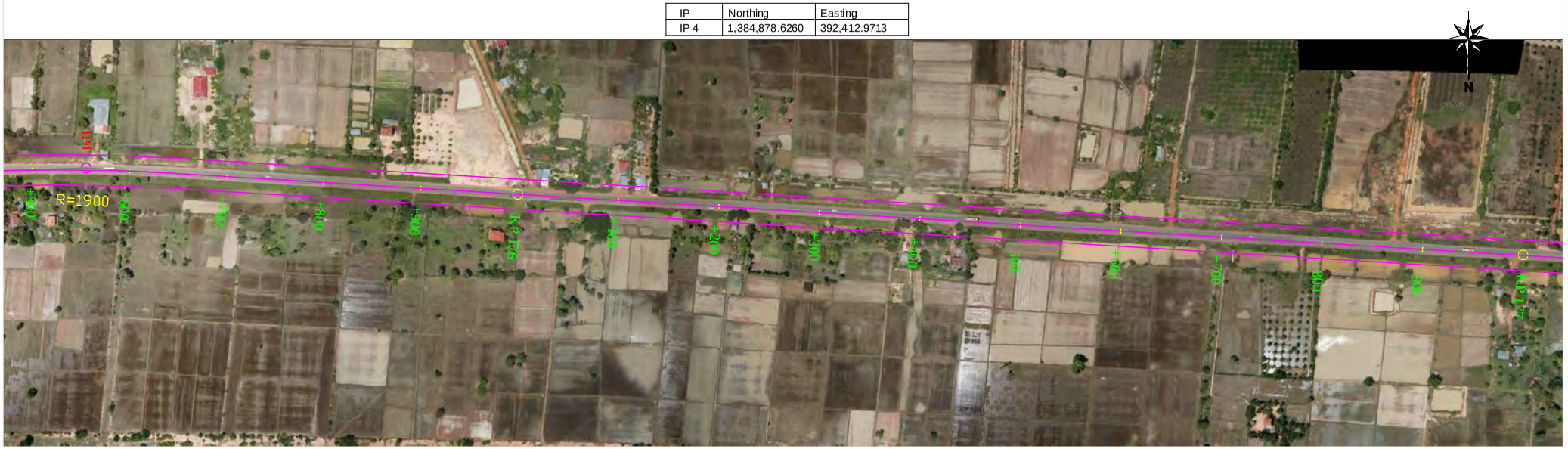


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IP 1	1,384,981.0923	396,329.2496
IP 2	1,384,962.6336	395,473.1451



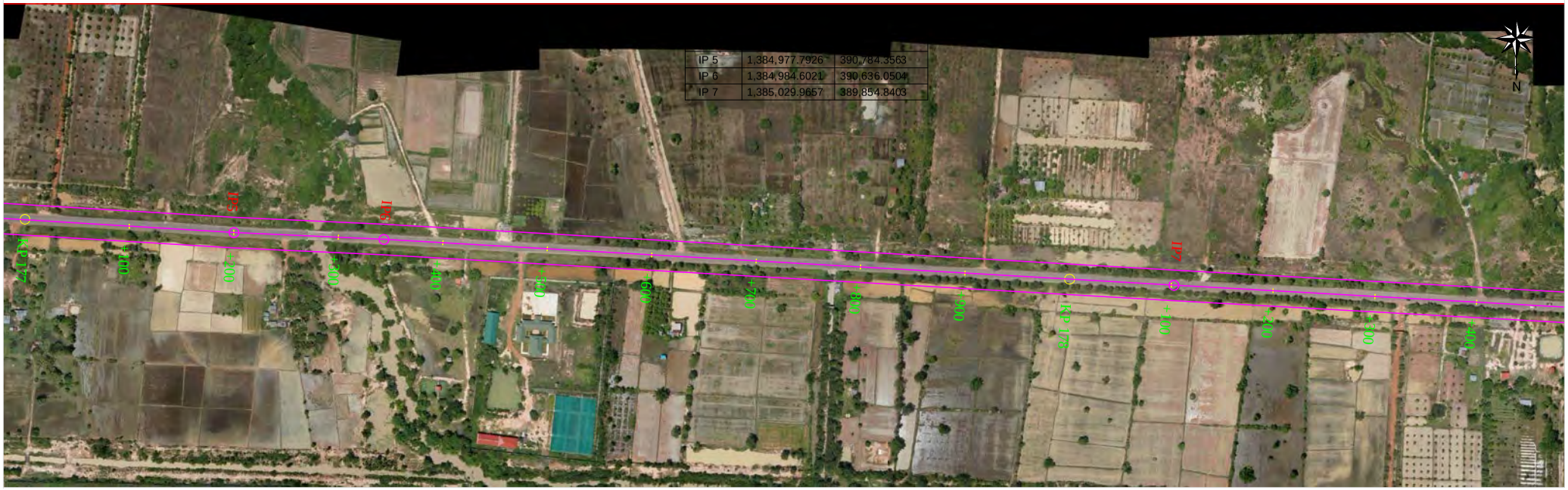
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP171+000~KP174+000)	Drawing No.	KP - 1
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	

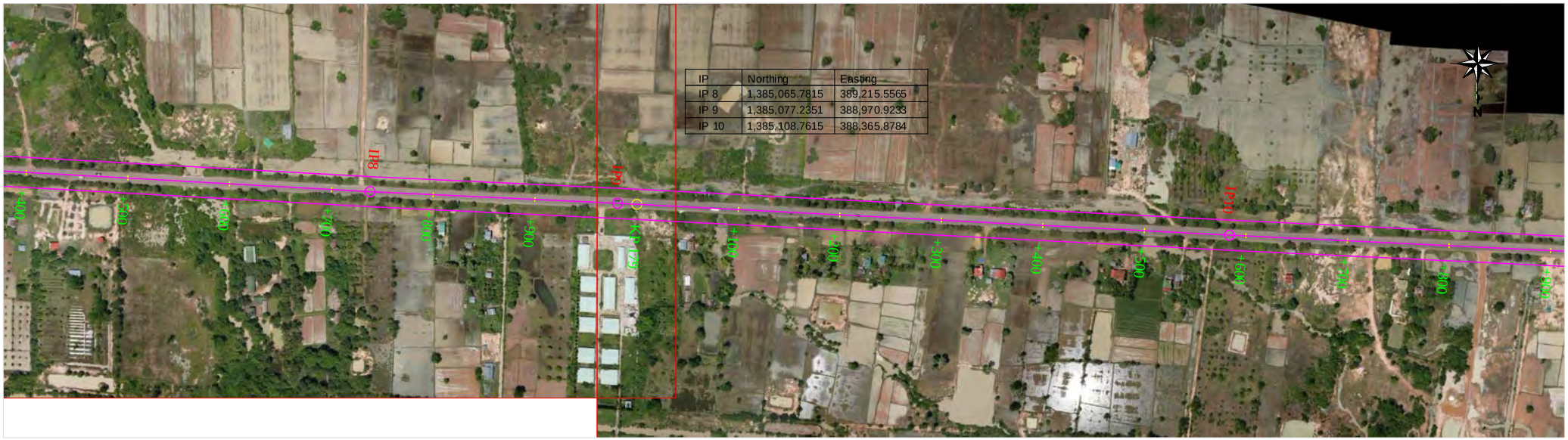




A8-2

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP174+000~KP177+000)	Drawing No. KP - 2 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP177+000~KP179+900)	Drawing No. KP - 3 Scale : A1: 1/2,000 A3: 1/4,000 Date :

A8-3





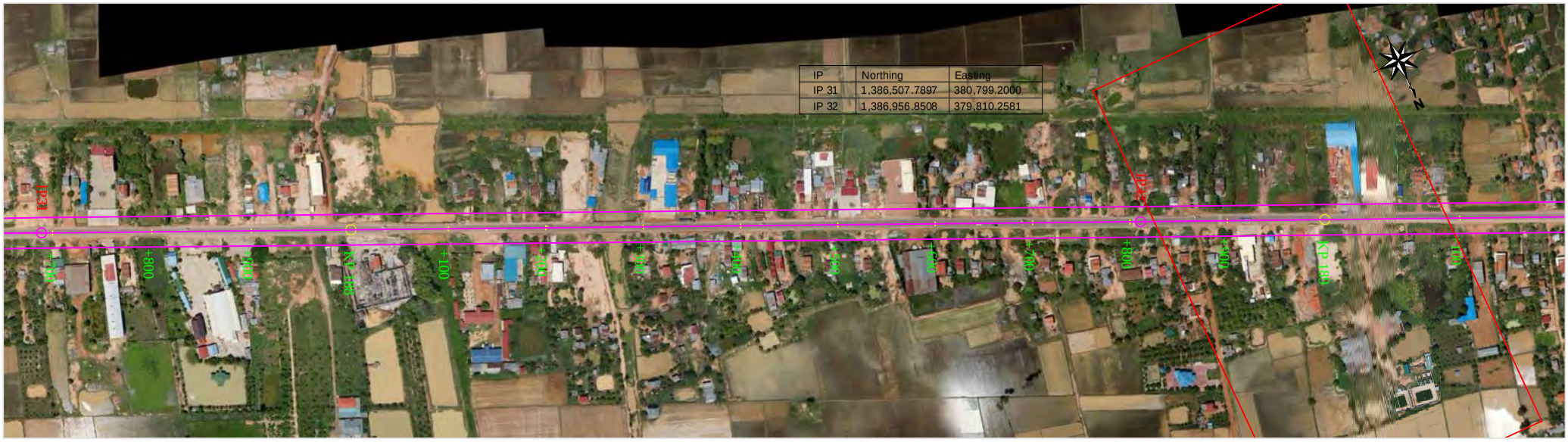
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP179+900~KP183+000)	Drawing No. KP - 4 Scale : A1: 1/2,000 A3: 1/4,000 Date :





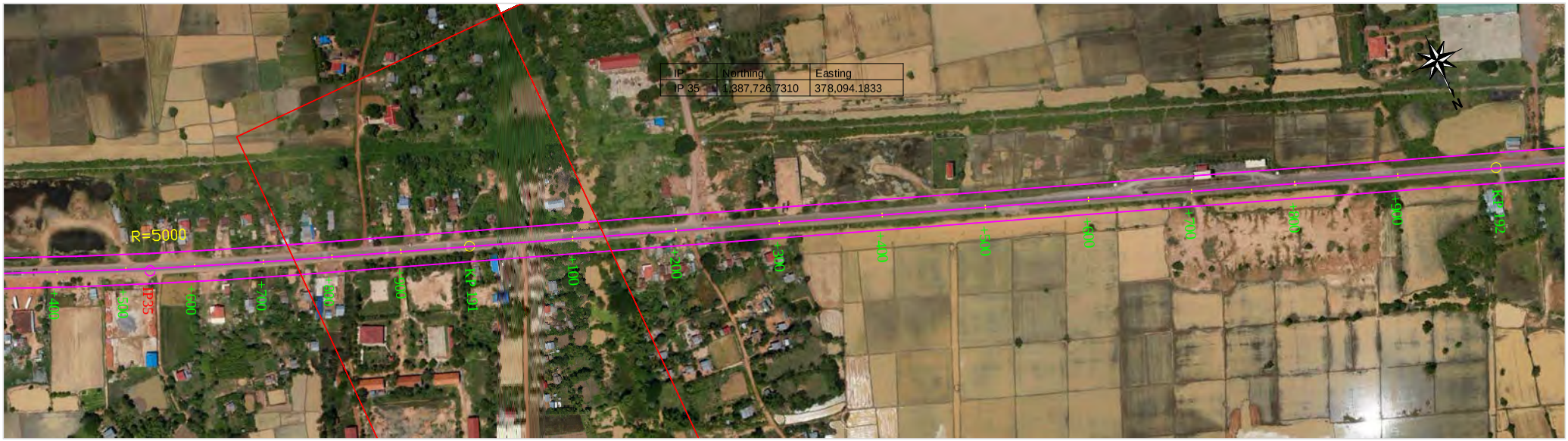
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP183+000~KP186+200)	Drawing No. KP - 5 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP186+200~KP189+100)	Drawing No. KP - 6 Scale : A1: 1/2,000 A3: 1/4,000 Date :





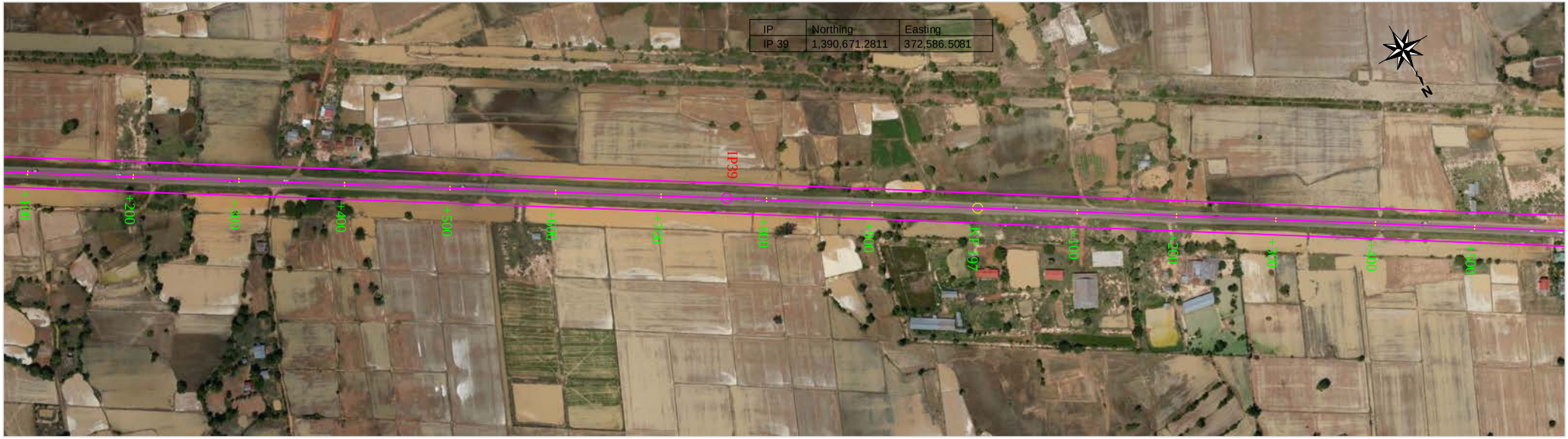
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP189+100~KP192+000)	Drawing No. KP - 7 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP192+000~KP194+800)	Drawing No.	KP - 8
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	



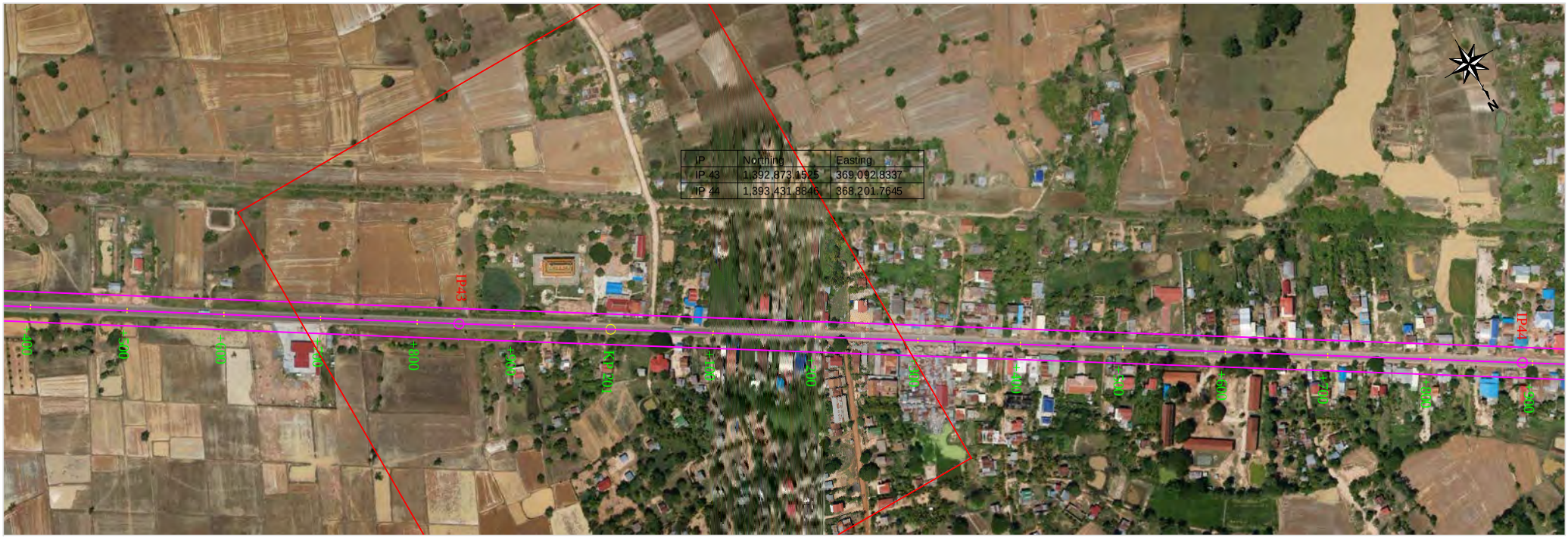


MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP194+800~KP197+500)	Drawing No. KP -9 Scale : A1: 1/2,000 A3: 1/4,000 Date :





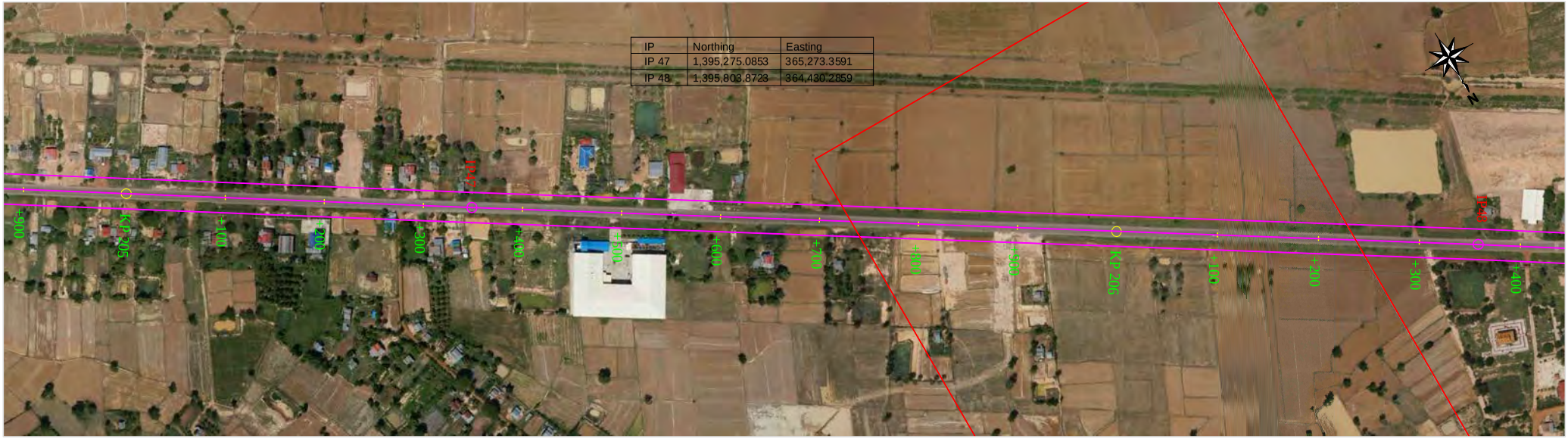
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP197+500~KP200+400)	Drawing No. KP -10 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP200+400~KP203+400)	Drawing No.	KP -11
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





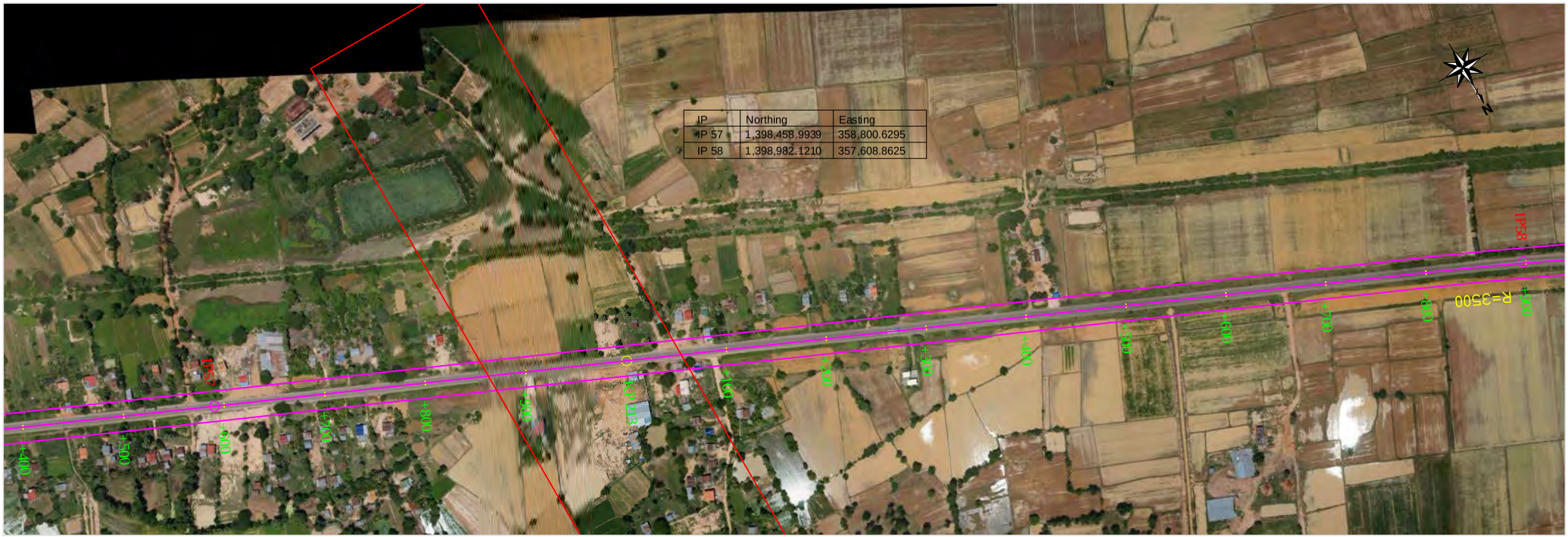
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP203+400~KP206+400)	Drawing No.	KP -12
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP206+400~KP209+400)	Drawing No. KP -13 Scale : A1: 1/2,000 A3: 1/4,000 Date :

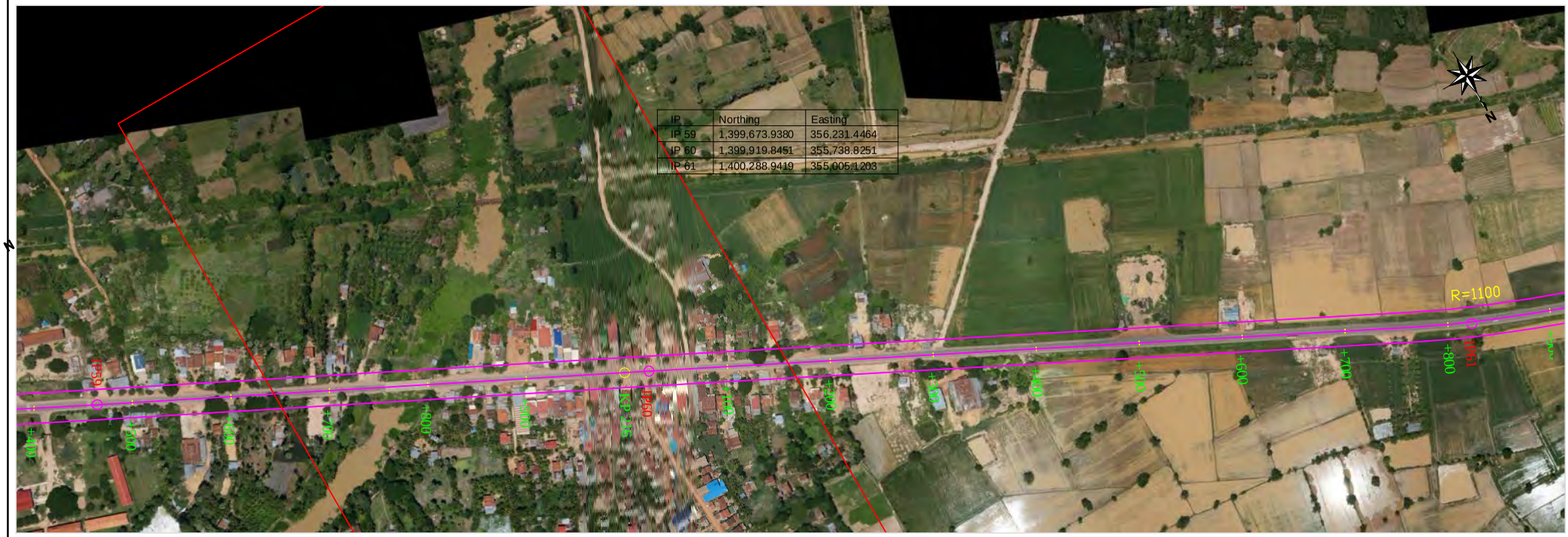

IP | Northing | Easting
IP 53 | 1,397,243.7164 | 361,571.8140
IP 54 | 1,397,408.0844 | 361,193.6025
IP 55 | 1,397,630.3597 | 360,689.2762
IP53
IP54
IP55
+000
+050
+100
+150
+200
+250
+300
+350
+400
+450
+500
+550
+600
+650
+700
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+850
+900
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+1050
+1100
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+1400
+1450
+1500
+1550
+1600
+1650
+1700
+1750
+1800
+1850
+1900
+1950



IP	Northing	Easting
IP 57	1,398,458.9939	358,800.6295
IP 58	1,398,982.1210	357,608.8625



MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP212+400~KP215+400)	Drawing No. KP -15 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP215+400~KP218+400)	Drawing No.	KP -16
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP218+400~KP221+400)	Drawing No.	KP -17
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP221+400~KP224+400)	Drawing No.	KP -18
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP224+400~KP227+200)	Drawing No. KP -19 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP227+200~KP230+200)	Drawing No.	KP -20
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	


KP 231
+200
+100
+300
+400
+500
+600
+700
+800
+900
+1000
+1100
+1200
+1300
+1400
+1500
+1600
+1700
+1800
+1900
+2000
+2100
+2200
+2300
+2400
+2500
+2600
+2700
+2800
+2900
+3000
+3100
+3200
+3300
+3400
+3500
+3600
+3700
+3800
+3900
+4000
+4100
+4200





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP233+200~KP236+200)	Drawing No. KP -22 Scale : A1: 1/2,000 A3: 1/4,000 Date :

A8-22

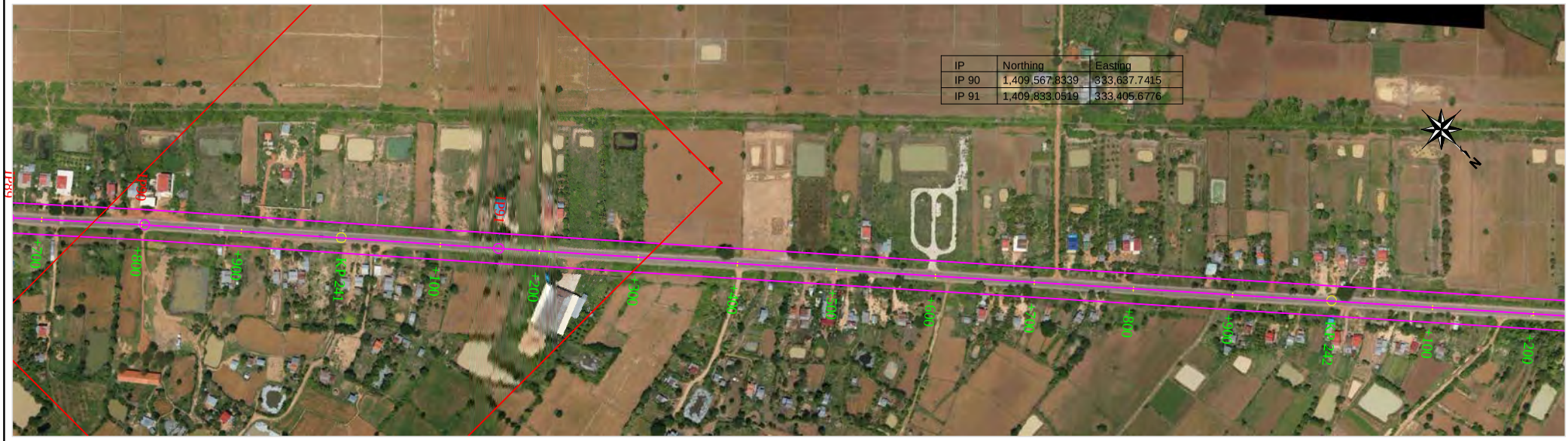




MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP236+200~KP239+200)	Drawing No. KP -23 Scale : A1: 1/2,000 A3: 1/4,000 Date :



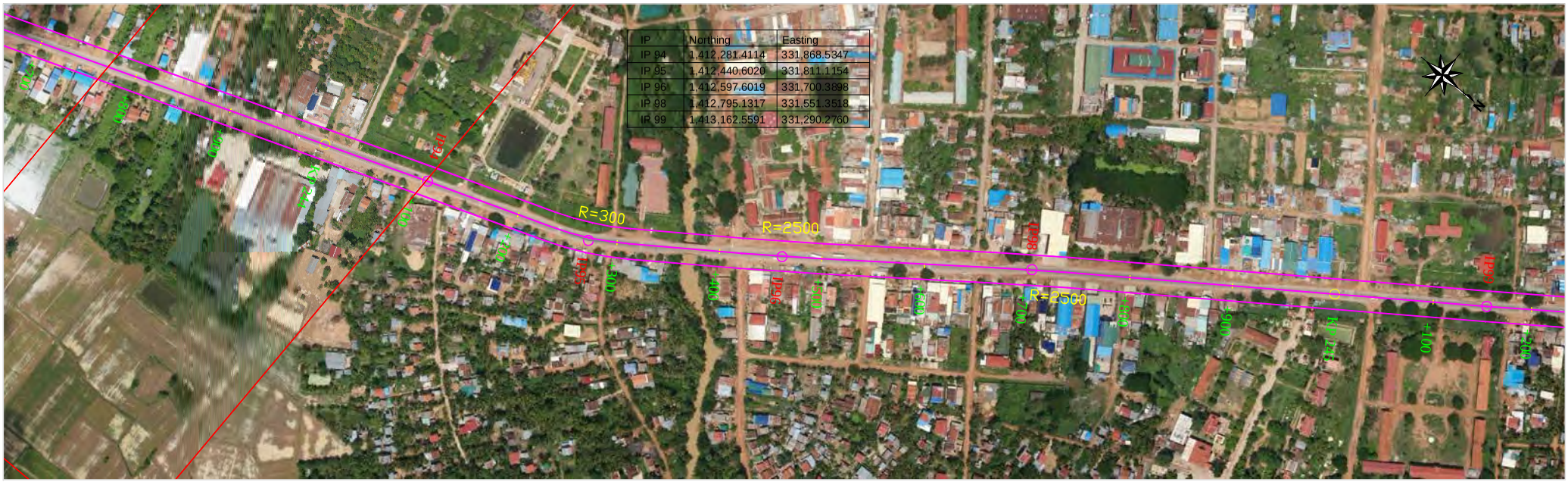
IP	Northing	Easting
IP 87	1,408,666.9170	334,434.3131
IP 88	1,409,134.1876	334,020.4314
IP 89	1,409,514.6993	333,686.3507



IP	Northing	Easting
IP 90	1,409,567.8339	333,637.7415
IP 91	1,409,833.0519	333,405.6776

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP239+200~KP242+200)	Drawing No.	KP -24
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





A8-25

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP242+200~KP245+200)	Drawing No. KP -25 Scale : A1: 1/2,000 A3: 1/4,000 Date :


IP100
IP101
IP102
+200
+300
+400
+500
+600
+700
+800
+900
+1000
+1100
+1200
+1300
+1400
+1500
+1600
+1700
+1800
+1900
+2000
+2100
+2200
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+2400
+2500
+2600
+2700
+2800
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+3800
+3900
+4000
+4100

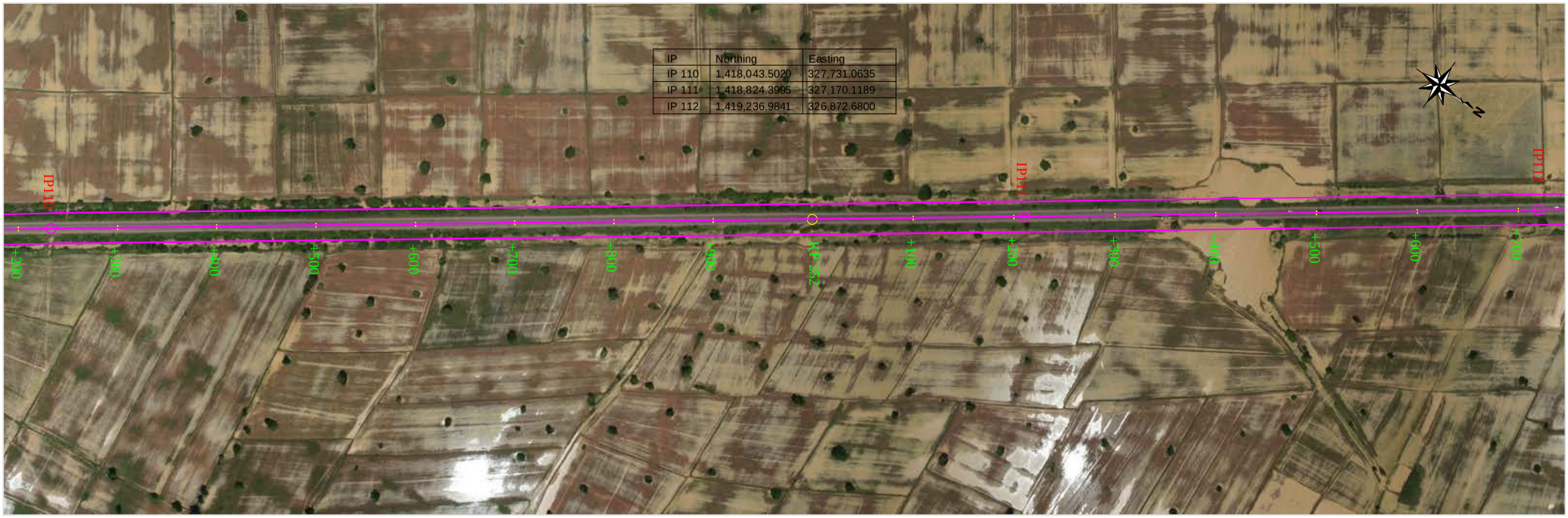


IP	Northing	Easting
IP 105	1,415,946.6870	329,269.8378
IP 106	1,416,333.6207	328,983.4803
IP 107	1,416,518.5939	328,848.9440



IP	Northing	Easting
IP 108	1,416,888.6576	328,578.0080
IP 109	1,417,840.9556	327,878.2732

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP248+200~KP251+200)	Drawing No.	KP -27
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	

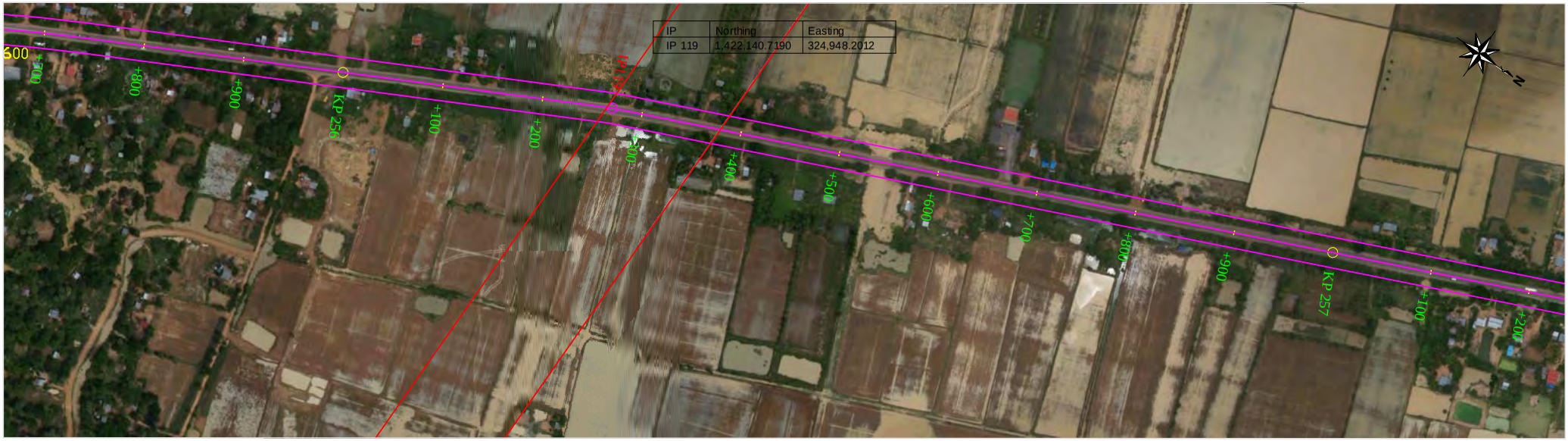




A8-28

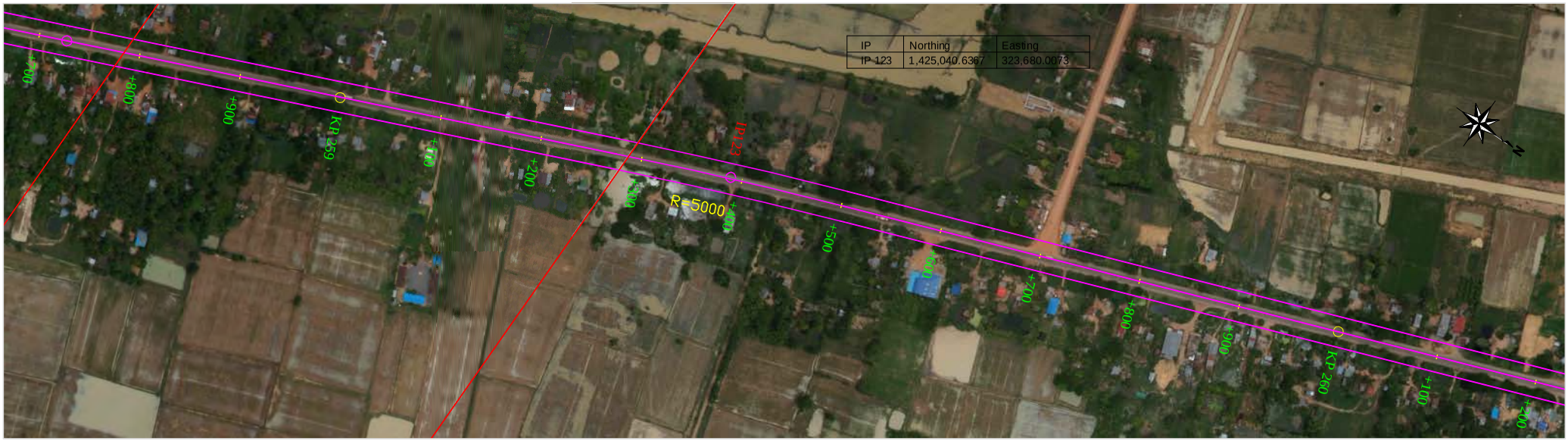
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP251+200~KP254+200)	Drawing No.	KP -28
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





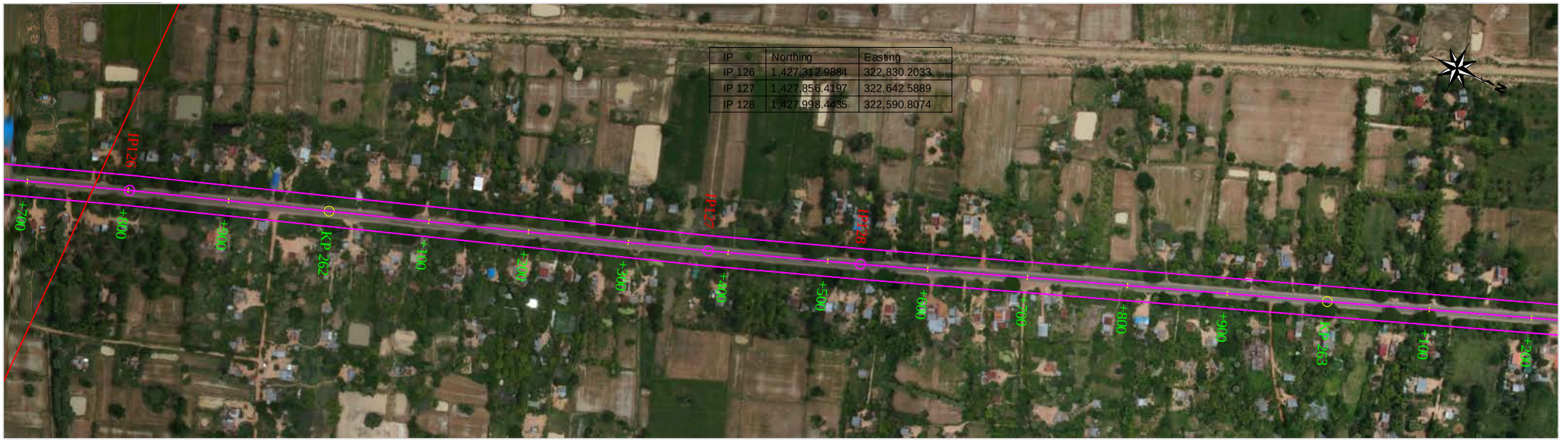
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP254+200~KP257+200)	Drawing No. KP -29 Scale : A1: 1/2,000 A3: 1/4,000 Date :





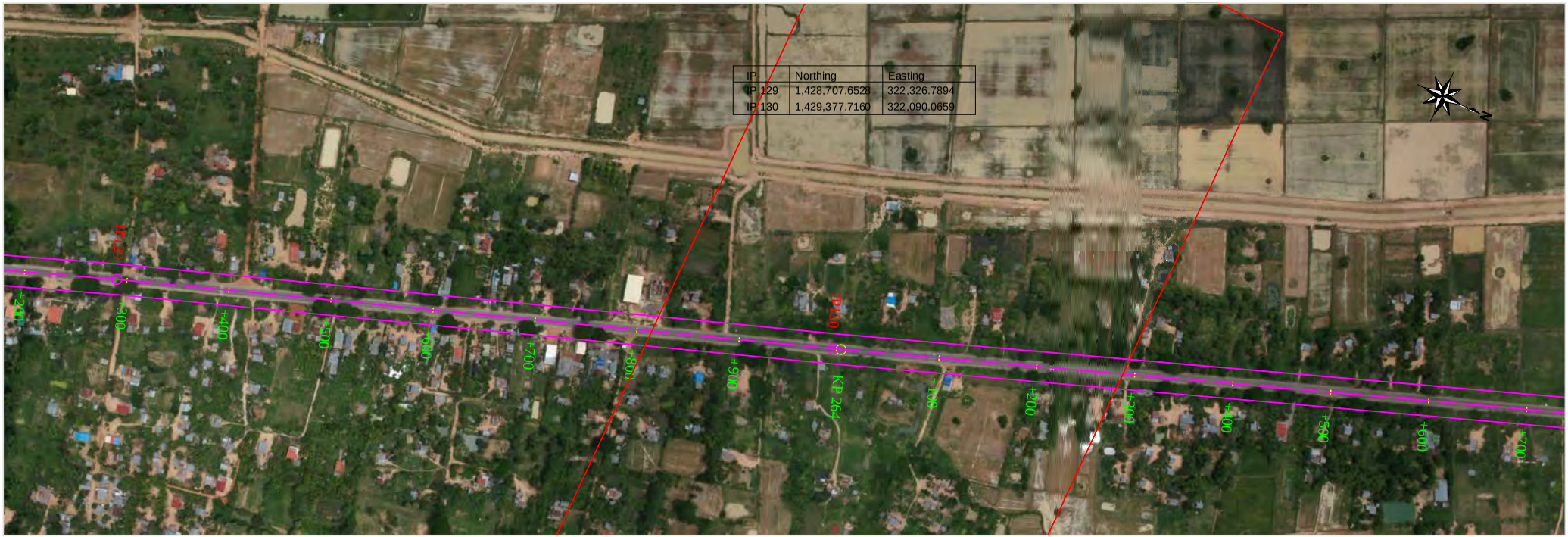
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP257+200~KP260+200)	Drawing No. KP -30 Scale : A1: 1/2,000 A3: 1/4,000 Date :





A8-31

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP260+200~KP263+200)	Drawing No. KP -31 Scale : A1: 1/2,000 A3: 1/4,000 Date :

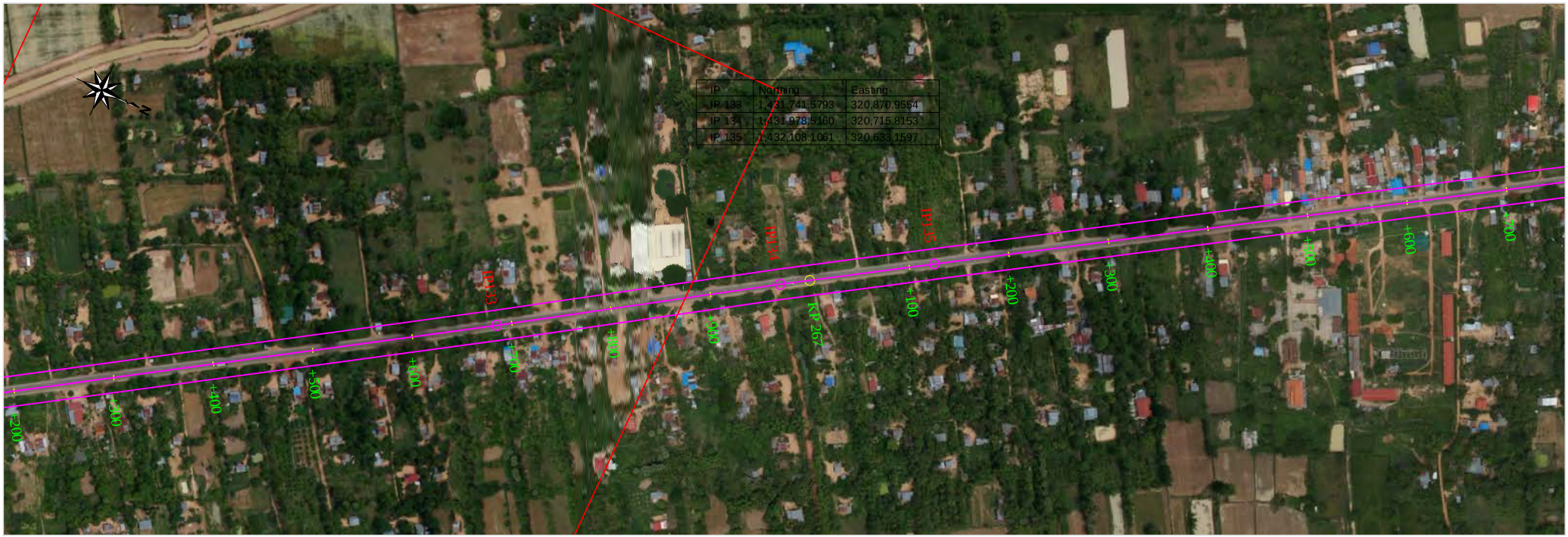


IP	Northing	Easting
IP 129	1,428,707.6528	322,326.7894
IP 130	1,429,377.7160	322,090.0659

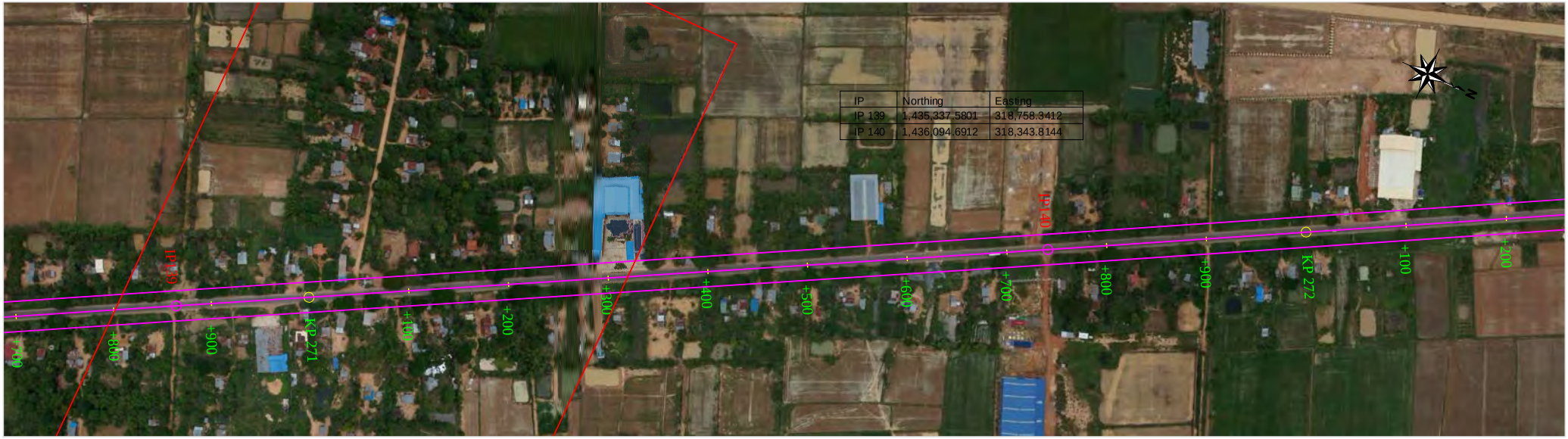


IP	Northing	Easting
IP 131	1,430,492.8101	321,683.8513
IP 132	1,430,944.3645	321,383.6289

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP263+200~KP266+200)	Drawing No.	KP -32
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	


IP
Northing
Easting
IP 133
1,431,741.5793
320,870.9554
IP 134
1,431,978.5160
320,715.8153
IP 135
1,432,108.1061
320,633.1597
IP133
IP134
IP135
KP 267
+200
+300
+400
+500
+600
+700
+800
+900
+100
+200
+300
+400
+500
+600
+700
+800
+900
+100
+200
+300
+400
+500
+600
+700
+800
+900
+100





IP	Northing	Easting
IP 139	1,435,337.5801	318,758.3412
IP 140	1,436,094.6912	318,343.8144

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP269+200~KP272+200)	Drawing No.	KP -34
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP272+200~KP275+200)	Drawing No. KP -35 Scale : A1: 1/2,000 A3: 1/4,000 Date :



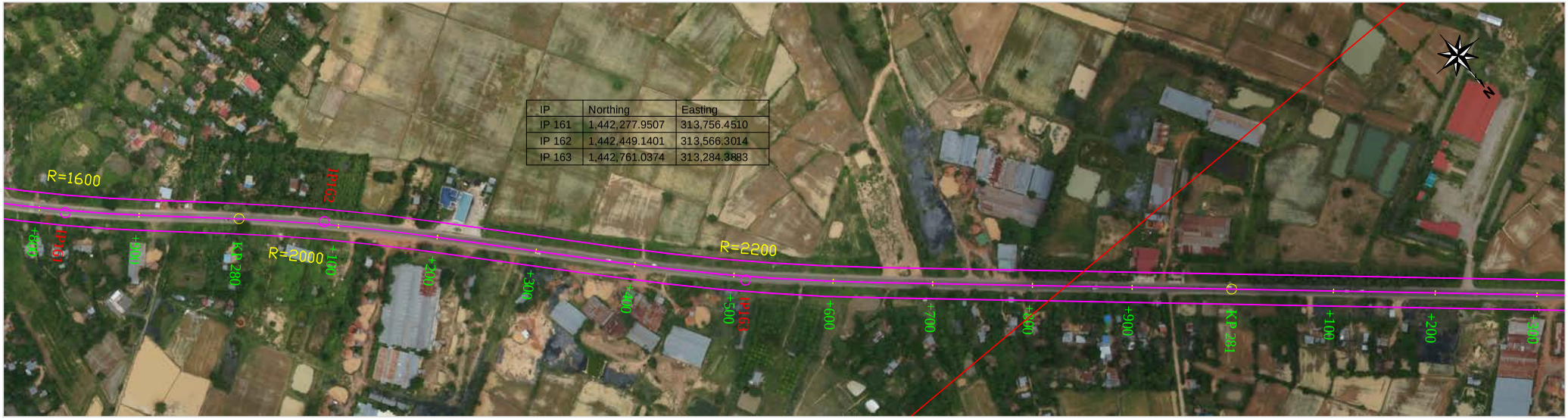
IP	Northing	Easting
IP 146	1,439,671.6042	316,787.7318
IP 147	1,439,972.9463	316,650.7544
IP 148	1,440,214.7497	316,489.4293
IP 149	1,440,506.9289	316,367.2624



IP	Northing	Easting
IP 150	1,440,731.0238	316,117.1457
IP 151	1,441,068.1994	315,725.1091
IP 152	1,441,306.1433	315,482.7108
IP 153	1,441,478.4026	315,236.4791

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP275+200~KP278+200)	Drawing No.	KP -36
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP278+200~KP281+300)	Drawing No. KP -37 Scale : A1: 1/2,000 A3: 1/4,000 Date :



MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP281+300~KP282+200)	Drawing No.	KP -38
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	

APPENDIX 8-2

KEY PLAN OF NATIONAL ROAD NO.5

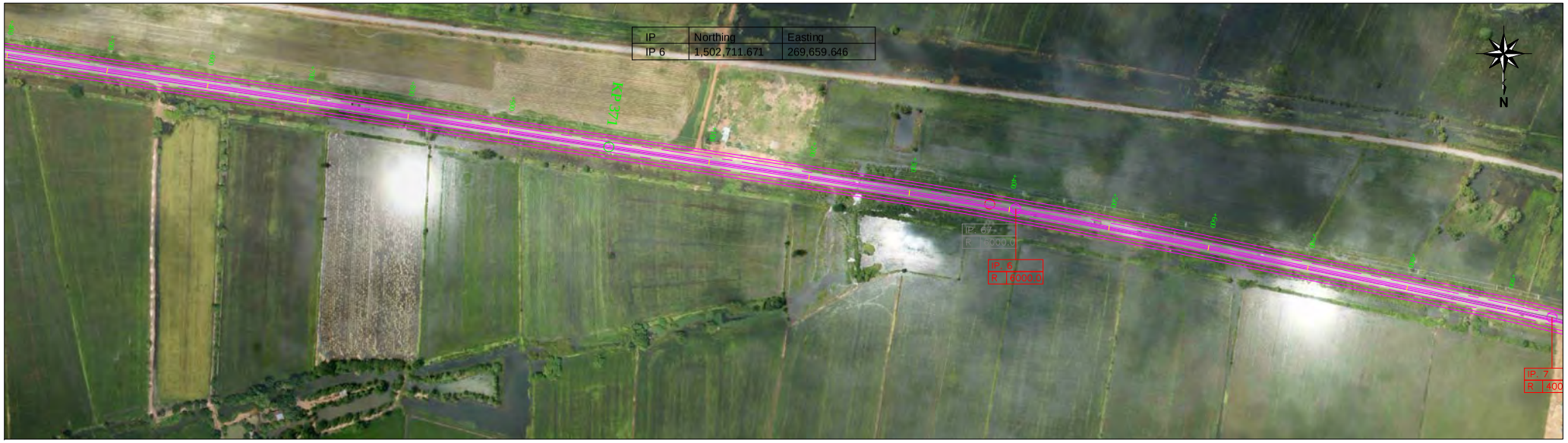
IN THE SRI SOPHORN – POIPET SECTION





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP366+000~KP368+900)	Drawing No.	KP - 1
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				Date :	



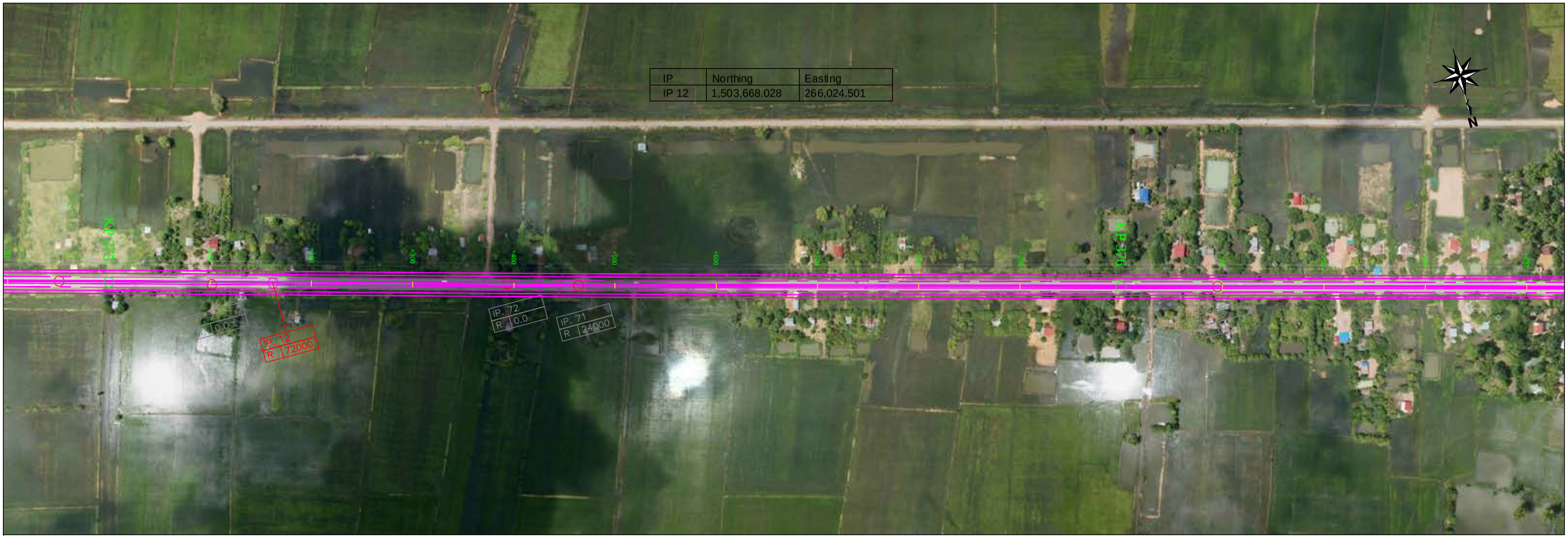


MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP368+900~KP371+900)	Drawing No.	KP - 2
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP371+900~KP374+900)	Drawing No.	KP - 3
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP374+900~KP377+900)	Drawing No.	KP - 4
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP377+900~KP380+900)	Drawing No. KP - 5 Scale : A1: 1/2,000 A3: 1/4,000 Date :





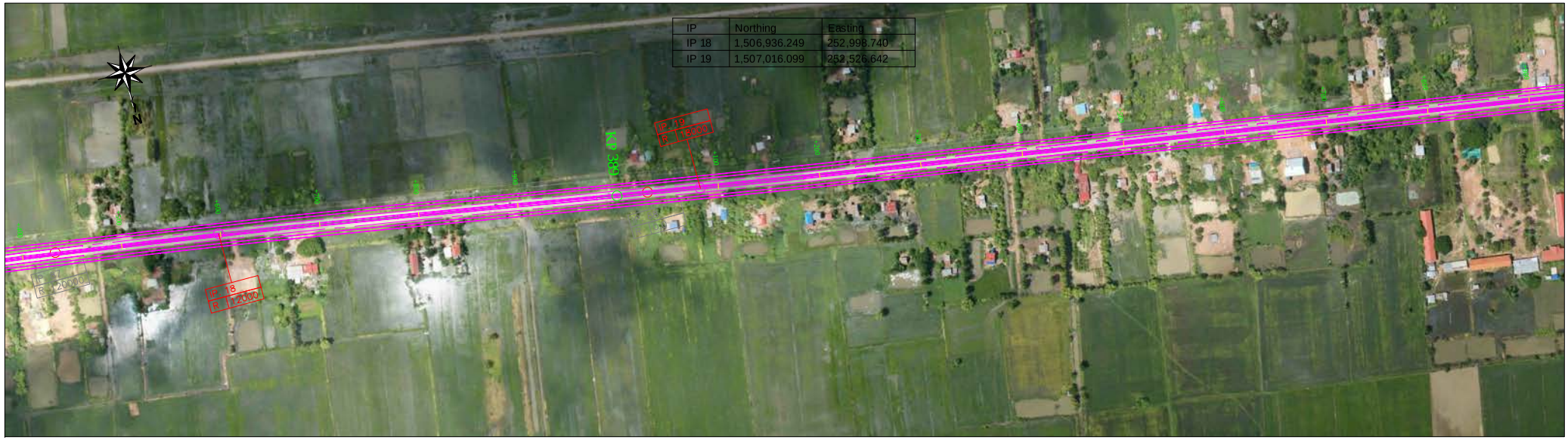
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP380+900~KP383+900)	Drawing No. KP - 6 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP383+900~KP386+900)	Drawing No. KP - 7 Scale : A1: 1/2,000 A3: 1/4,000 Date :





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP386+900~KP389+900)	Drawing No.	KP - 8
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				Date :	



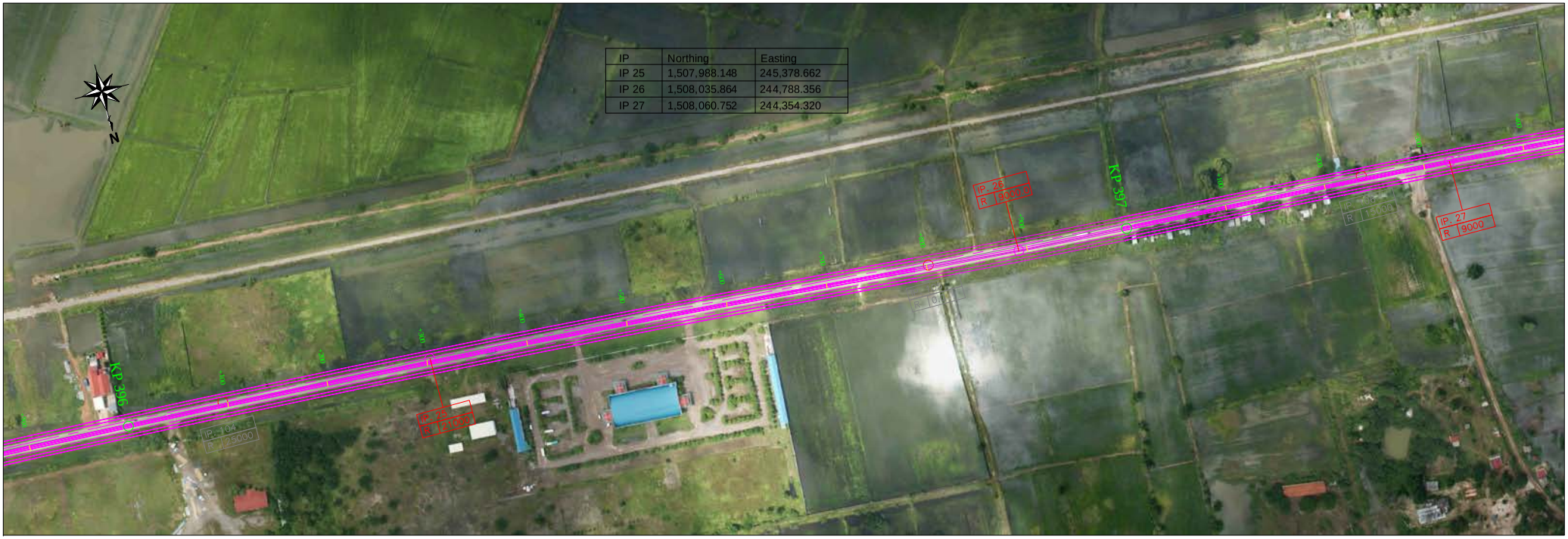


MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP389+900~KP392+900)	Drawing No.	KP - 9
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP392+900~KP395+900)	Drawing No.	KP - 10
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				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP395+900~KP398+900)	Drawing No.	KP - 11
				Scale :	A1: 1/2,000 A3: 1/4,000
				Date :	





MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP398+900~KP401+900)	Drawing No. KP - 12 Scale : A1: 1/2,000 A3: 1/4,000 Date :

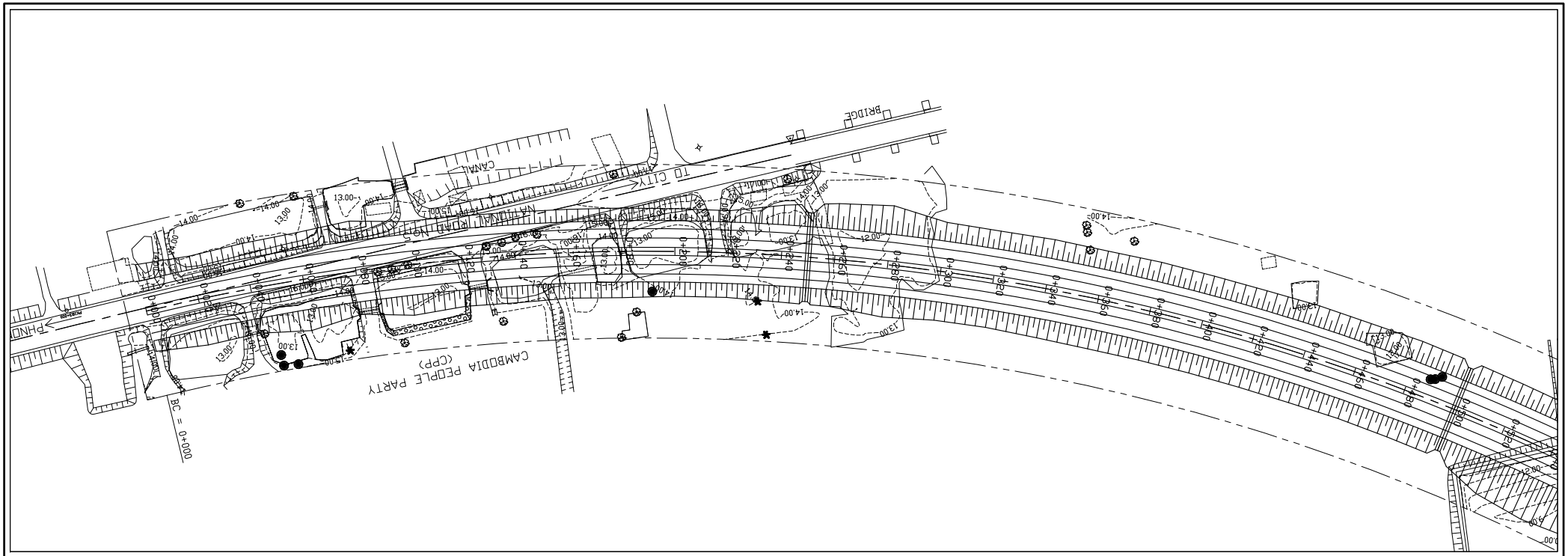


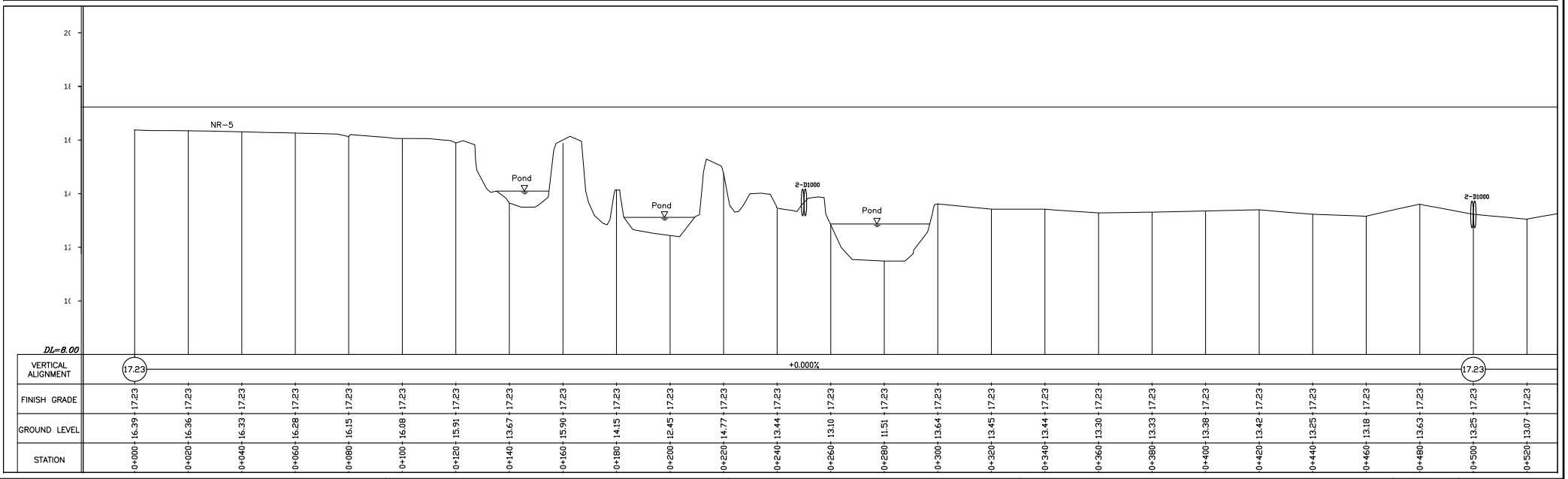
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 IMPROVEMENT PROJECT (MIDDLE SECTION)	TITLE : KEY PLAN (KP401+900~KP402+200)	Drawing No.	KP - 13
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				Date :	

APPENDIX 8-3

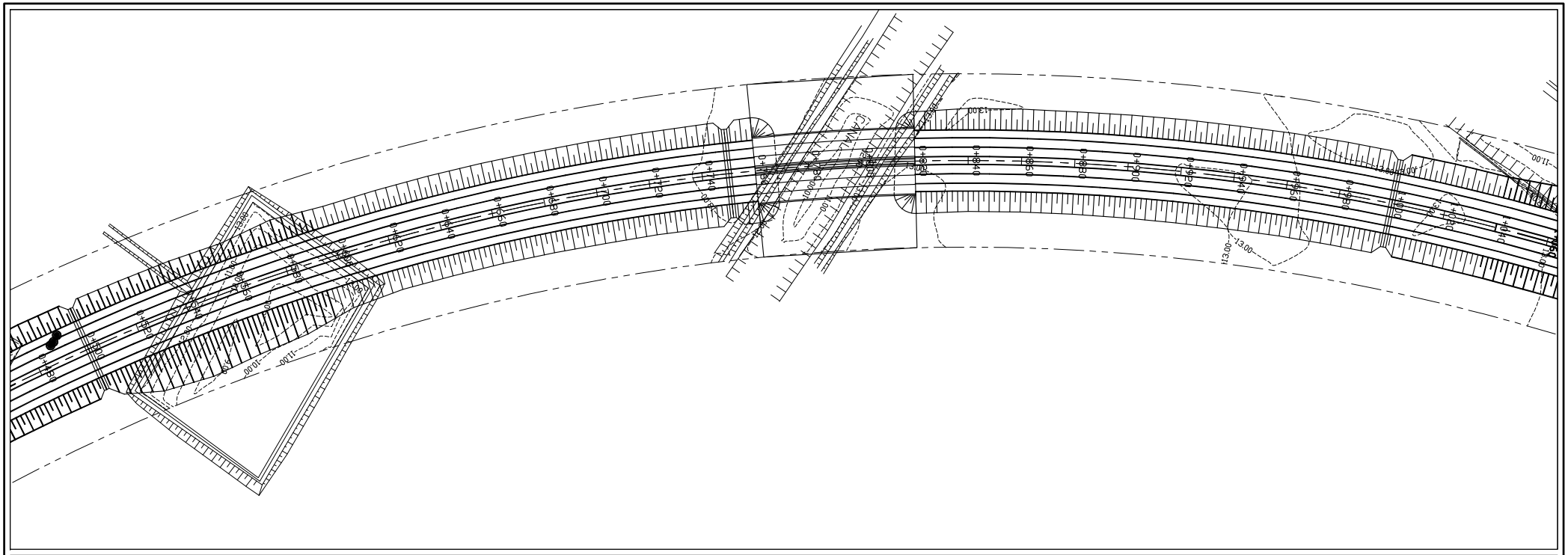
PLAN AND PROFILE OF PURSAT

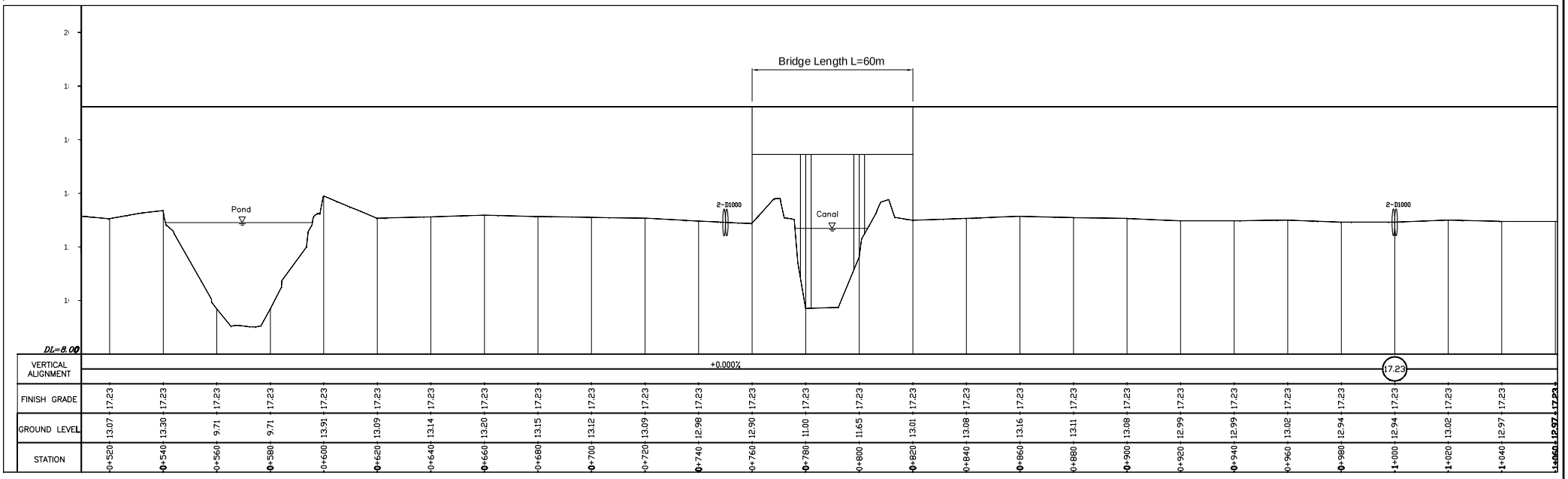
BYPASS





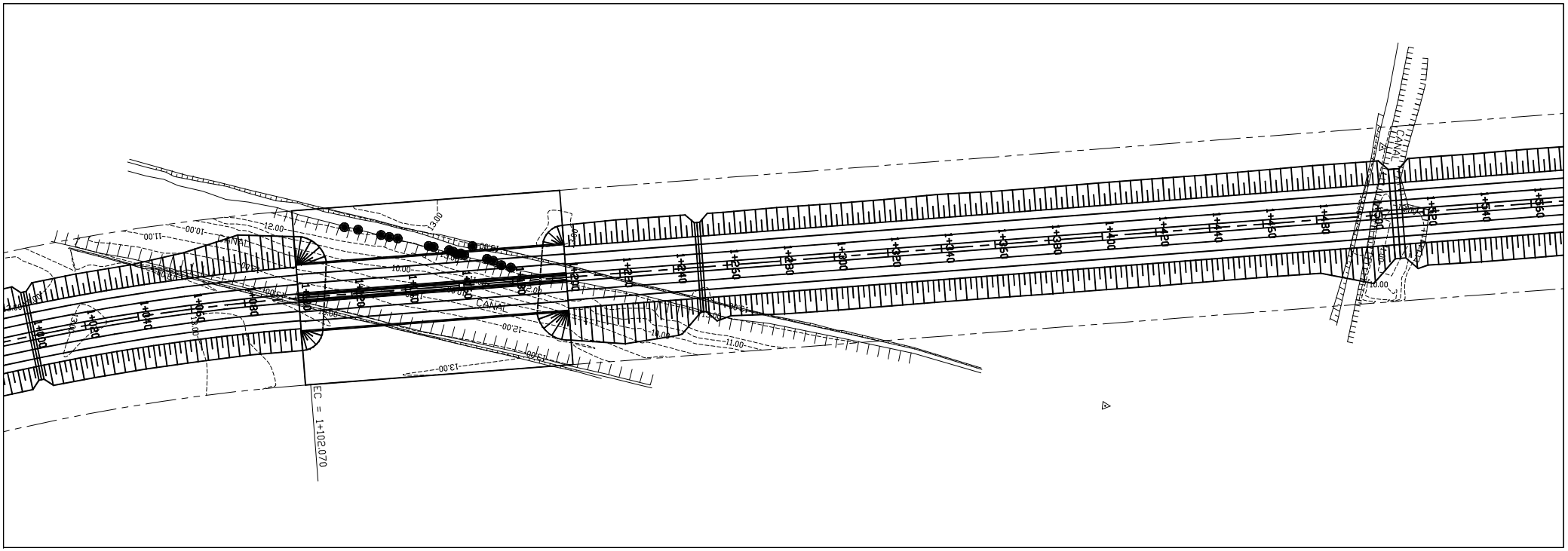
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				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014

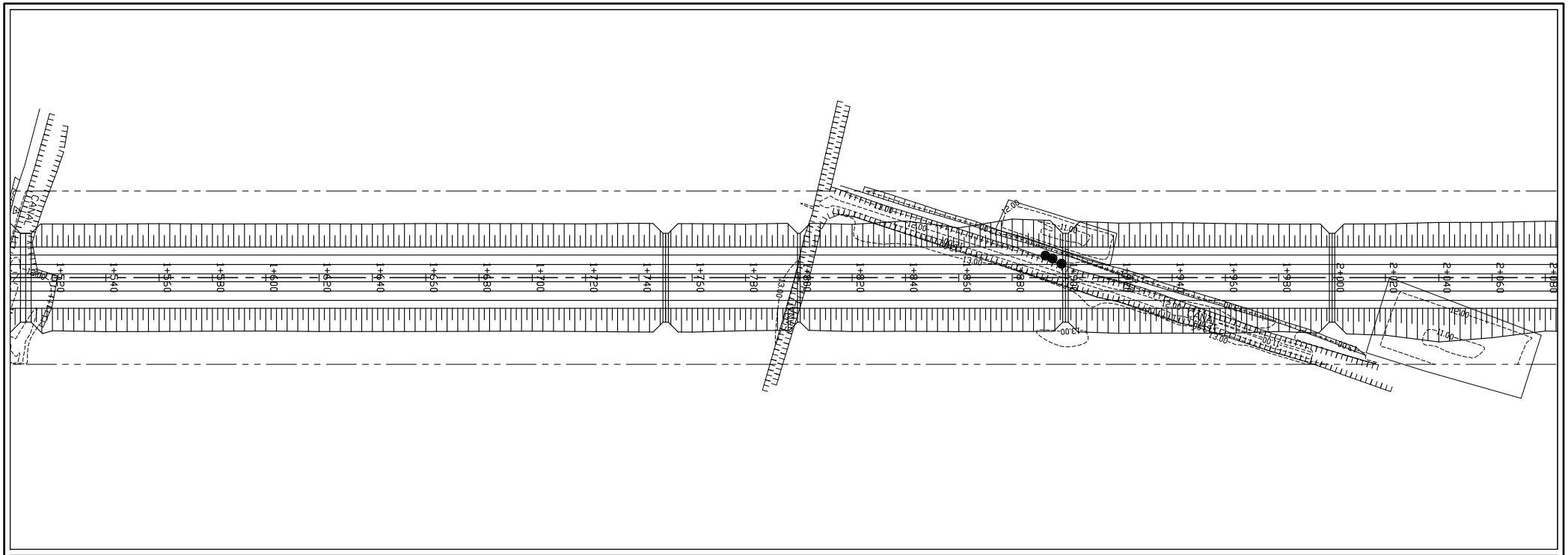


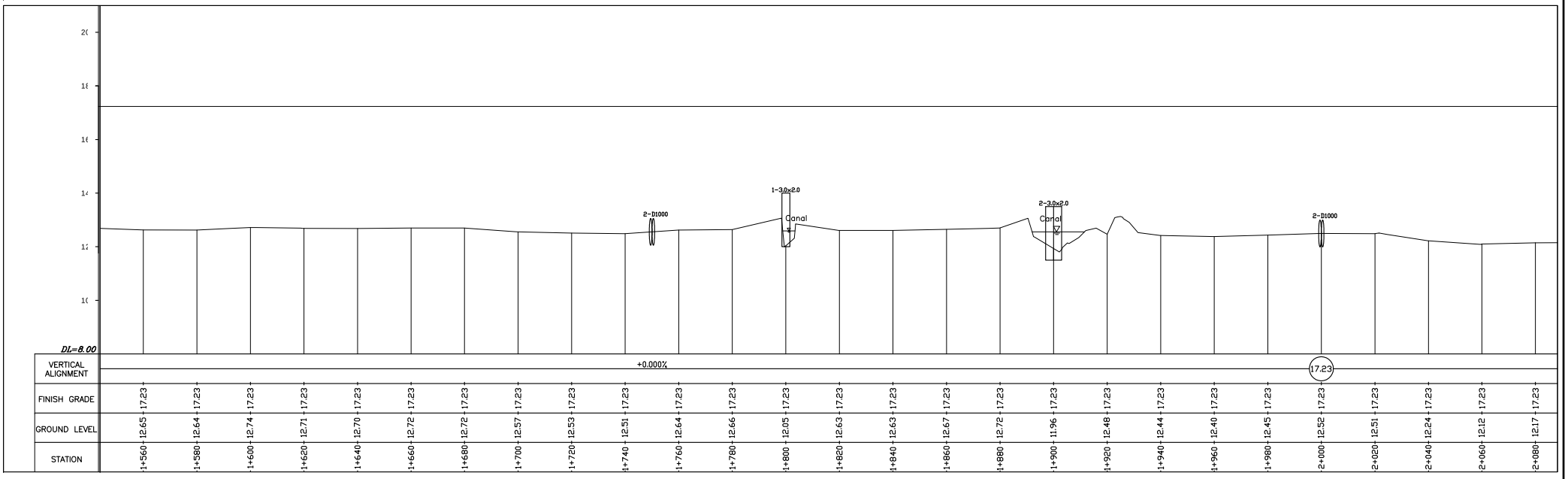


STATION	GROUND LEVEL	FINISH GRADE	VERTICAL ALIGNMENT
0+520	13.07	17.23	
0+540	13.30	17.23	
0+560	9.71	17.23	
0+580	9.71	17.23	
0+600	13.91	17.23	
0+620	13.09	17.23	
0+640	13.14	17.23	
0+660	13.20	17.23	
0+680	13.15	17.23	
0+700	13.12	17.23	
0+720	13.09	17.23	
0+740	12.98	17.23	
0+760	12.90	17.23	
0+780	11.00	17.23	
0+800	11.65	17.23	
0+820	13.01	17.23	
0+840	13.08	17.23	
0+860	13.16	17.23	
0+880	13.11	17.23	
0+900	13.08	17.23	
0+920	12.99	17.23	
0+940	12.99	17.23	
0+960	13.02	17.23	
0+980	12.94	17.23	
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1+040	12.97	17.23	
1+060	12.97	17.23	

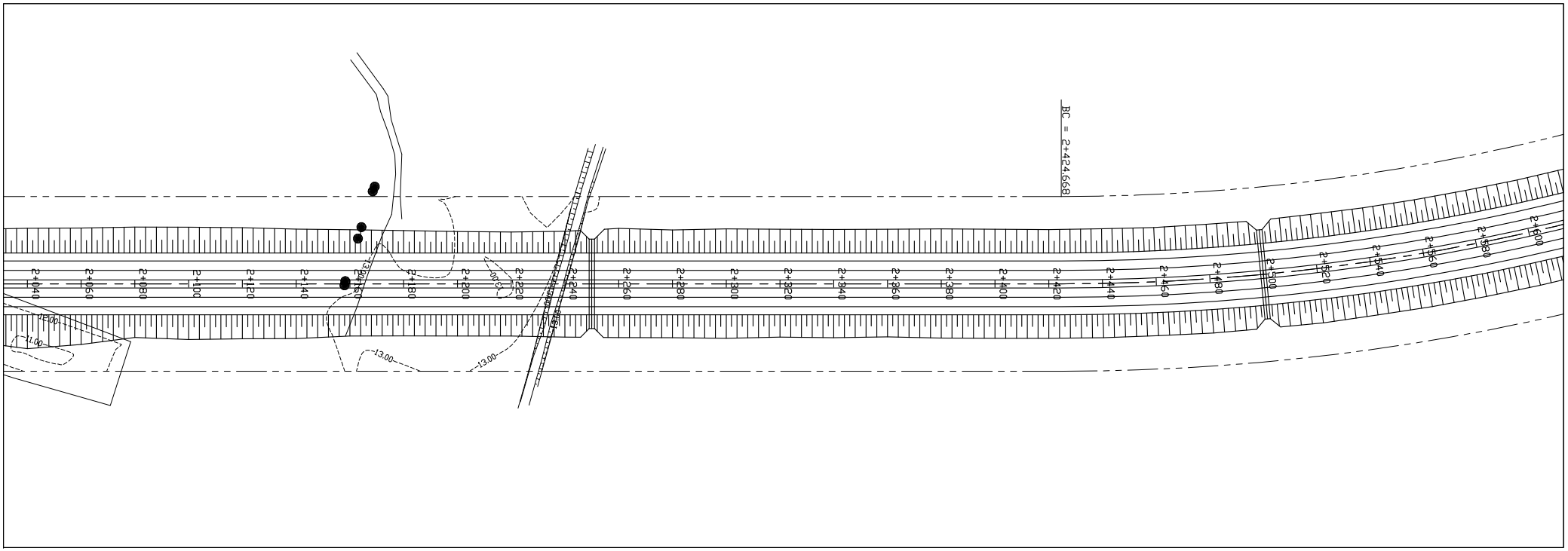
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.0+520-Sta.1+040)	Drawing No.	PP-02
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014

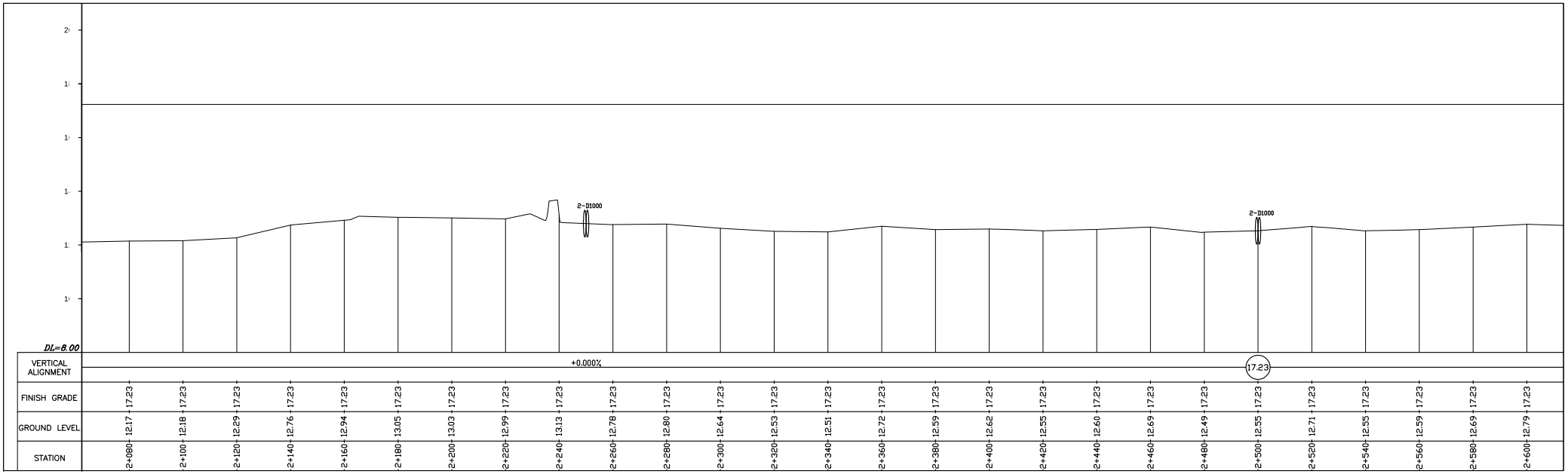

EC = 1+102.070
CANAL
CANAL
CANAL



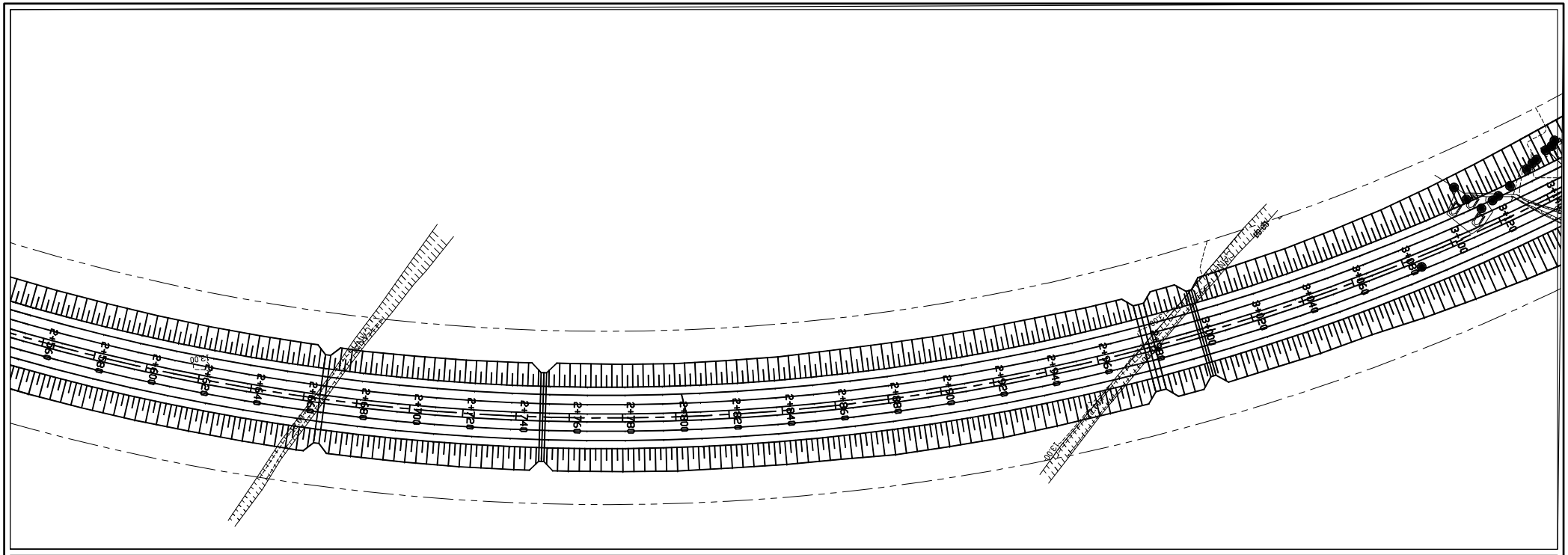


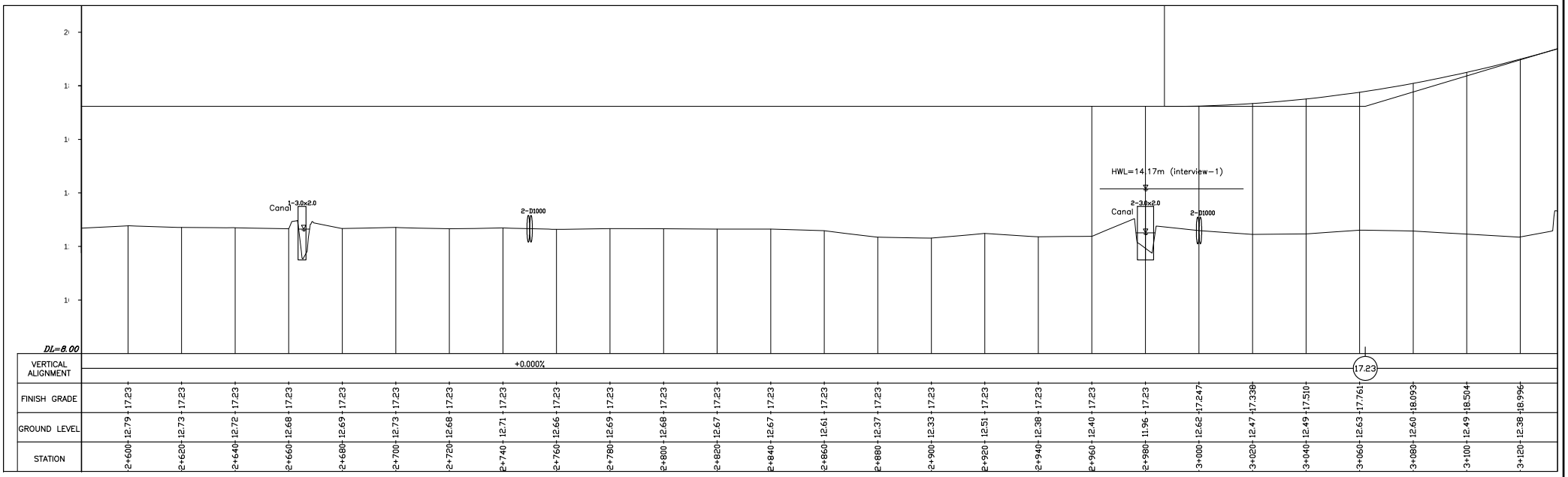
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.1+560-Sta.2+080)	Drawing No. PP-04 Scale : H 1/1500 V 1/150 Date : JAN. 2014



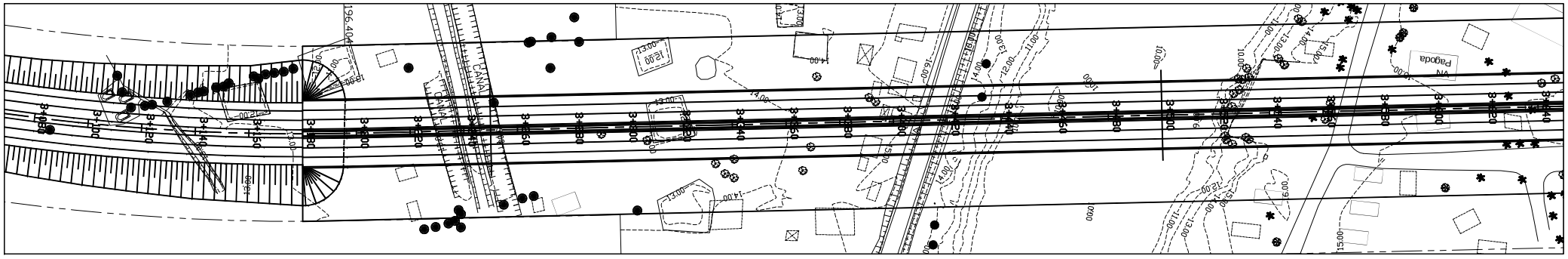


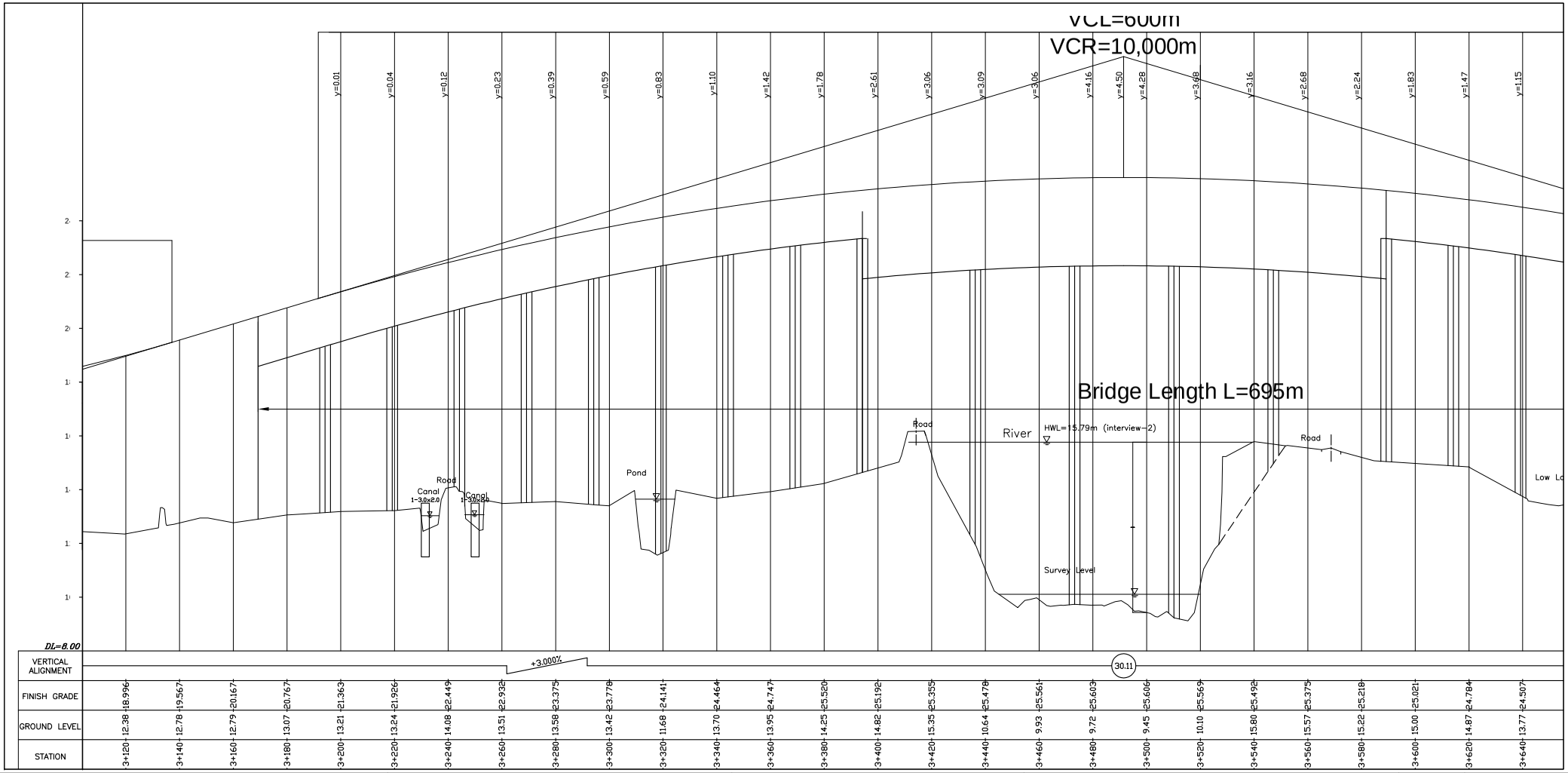
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.2+080-Sta.2+600)	Drawing No.	PP-05
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014



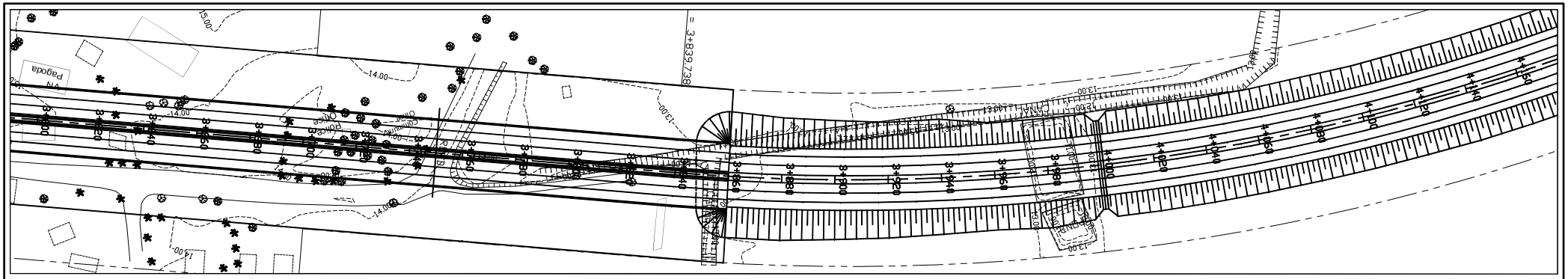


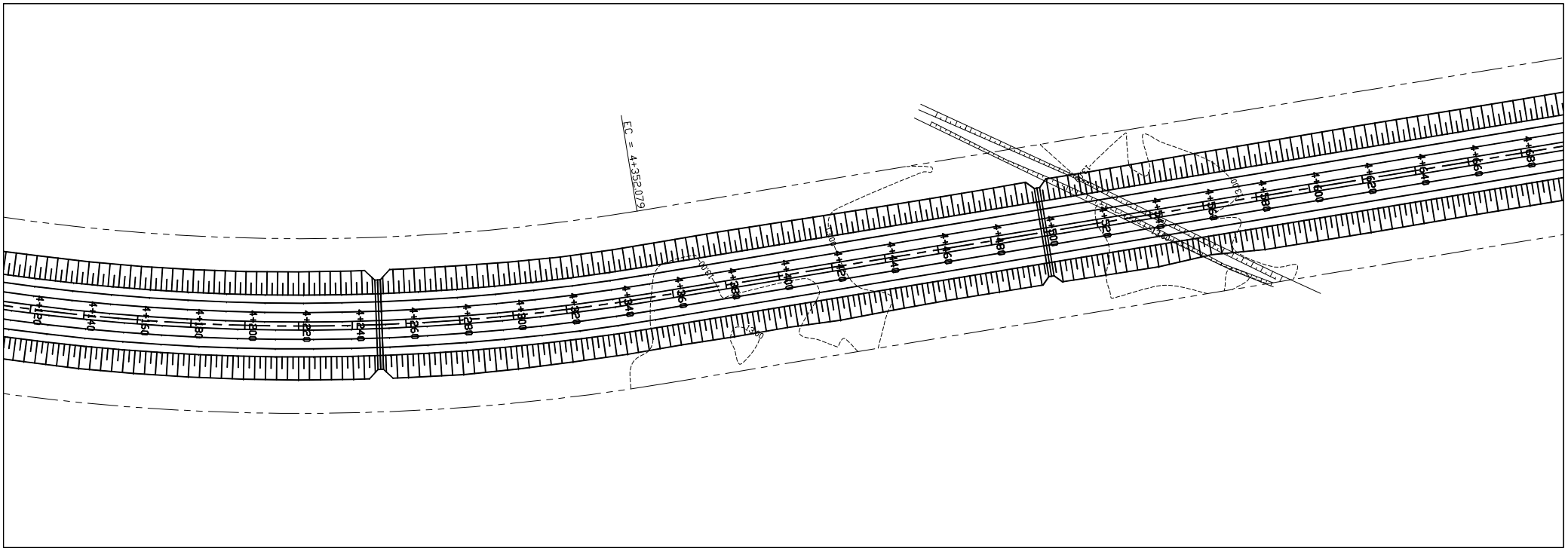
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.2+600-Sta.3+120)	Drawing No. PP-06 Scale : H 1/1500 V 1/150 Date : JAN. 2014

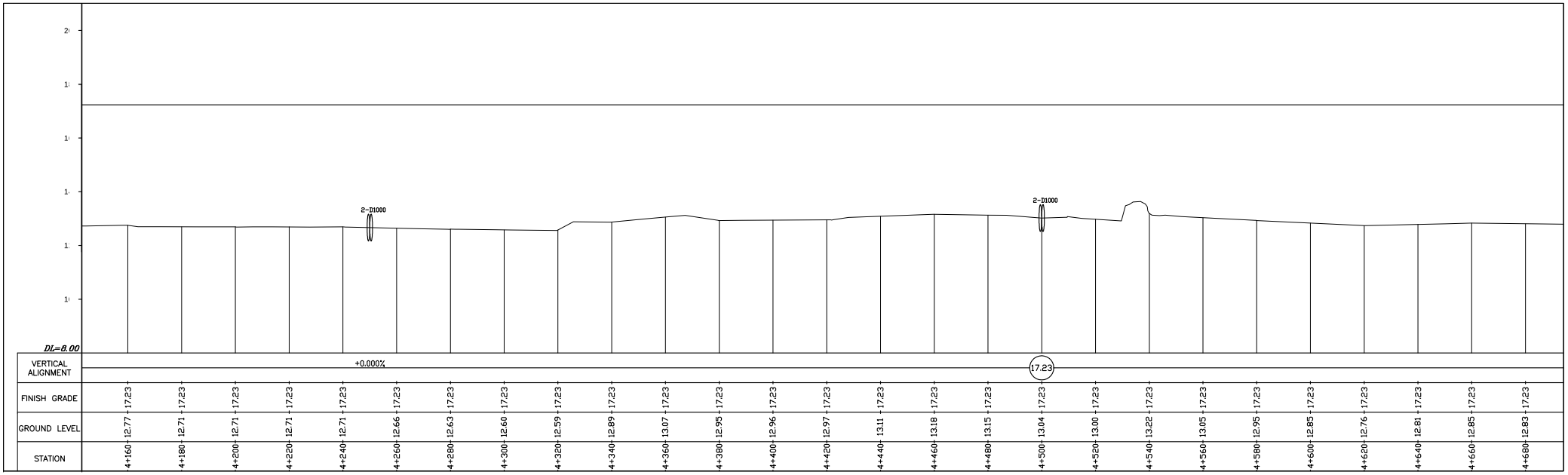




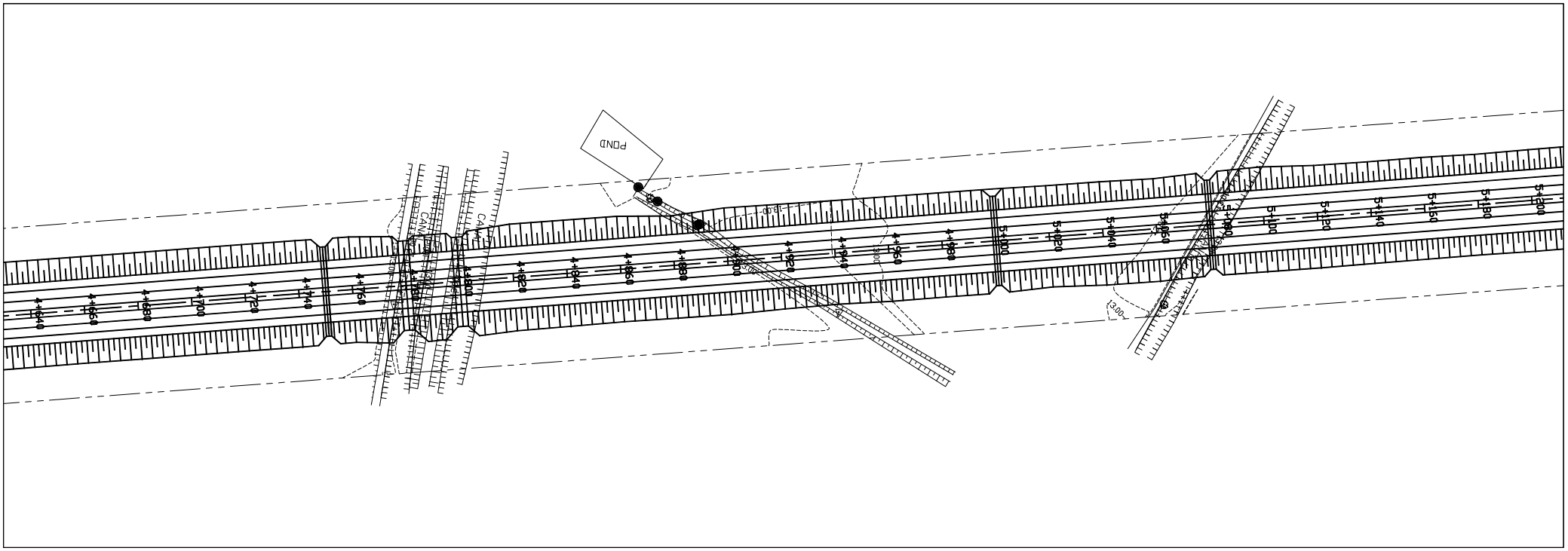
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.3+120-Sta.3+640)	Drawing No.	PP-07
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014


Pagoda
Culvert
Culvert
Culvert

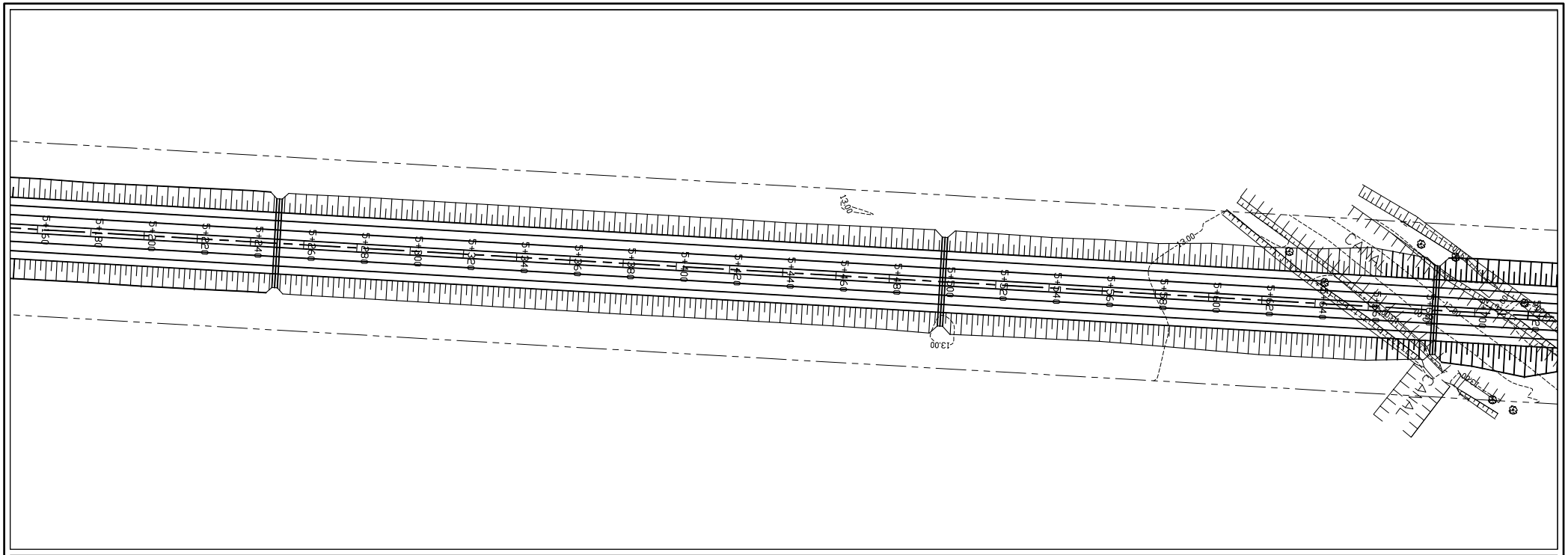


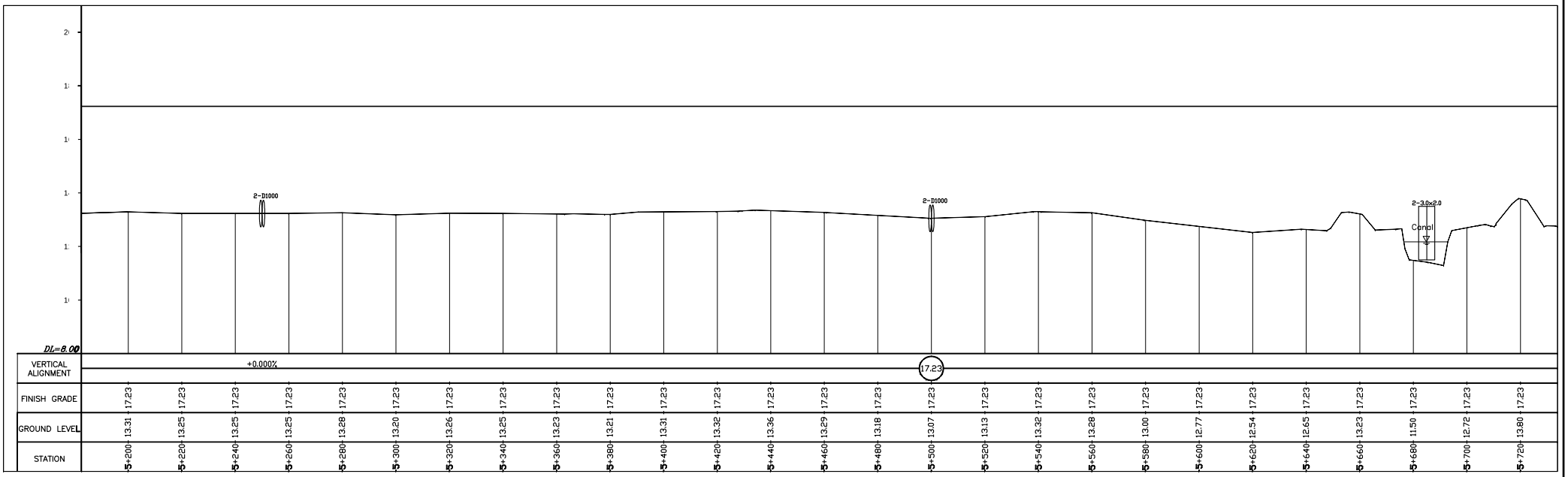


MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.4+160-Sta.4+680)	Drawing No. PP-09 Scale : H 1/1500 V 1/150 Date : JAN. 2014

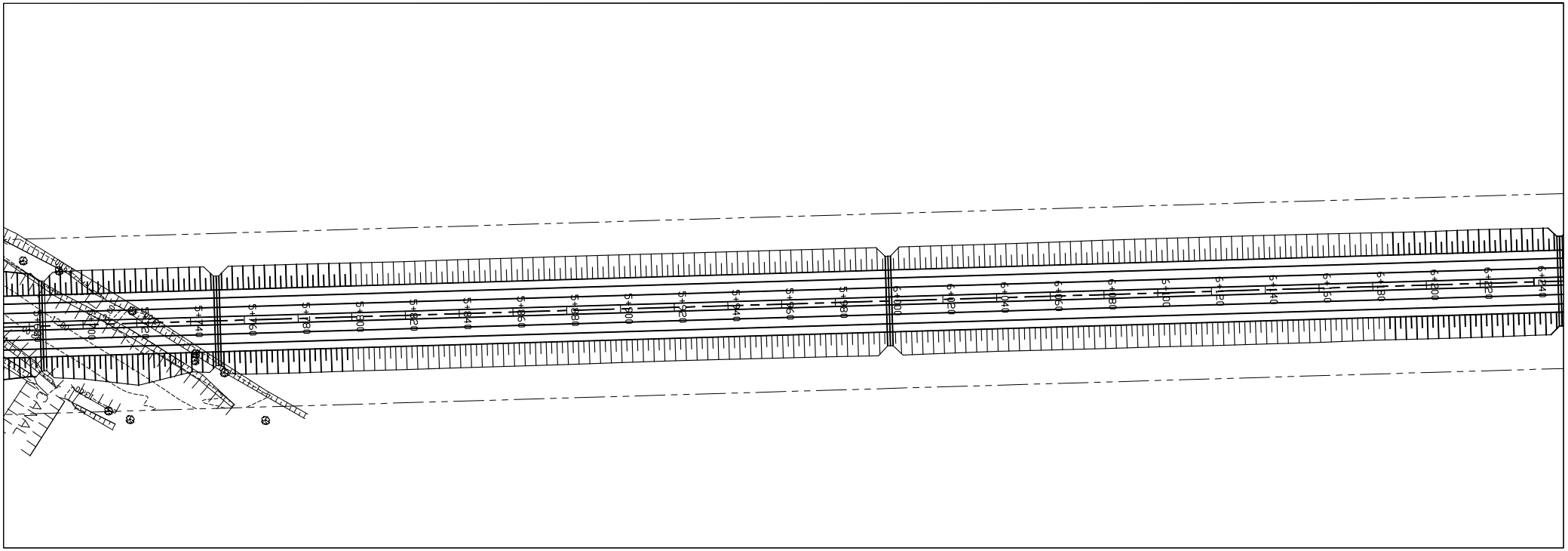


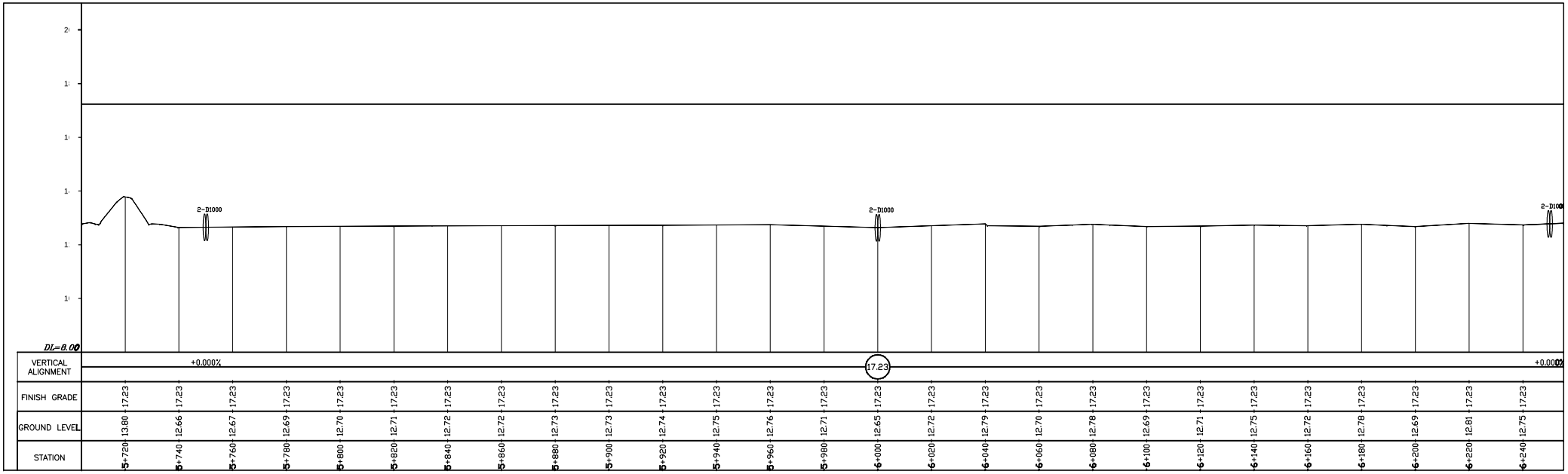
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.4+680-Sta.5+200)	Drawing No.	PP-10
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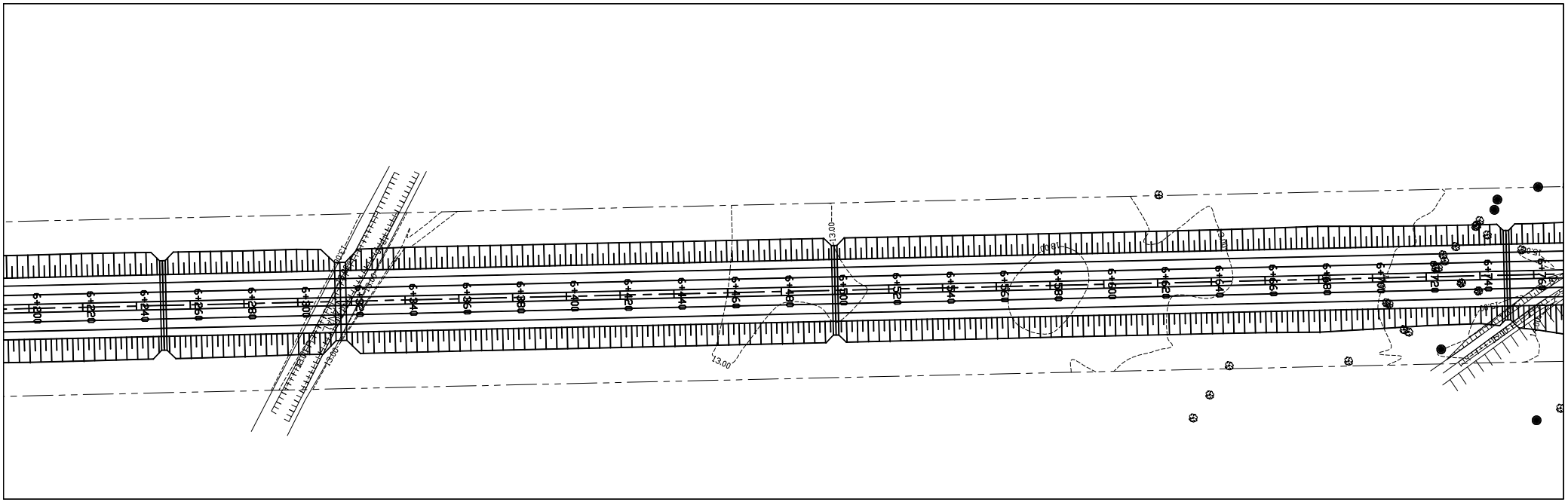


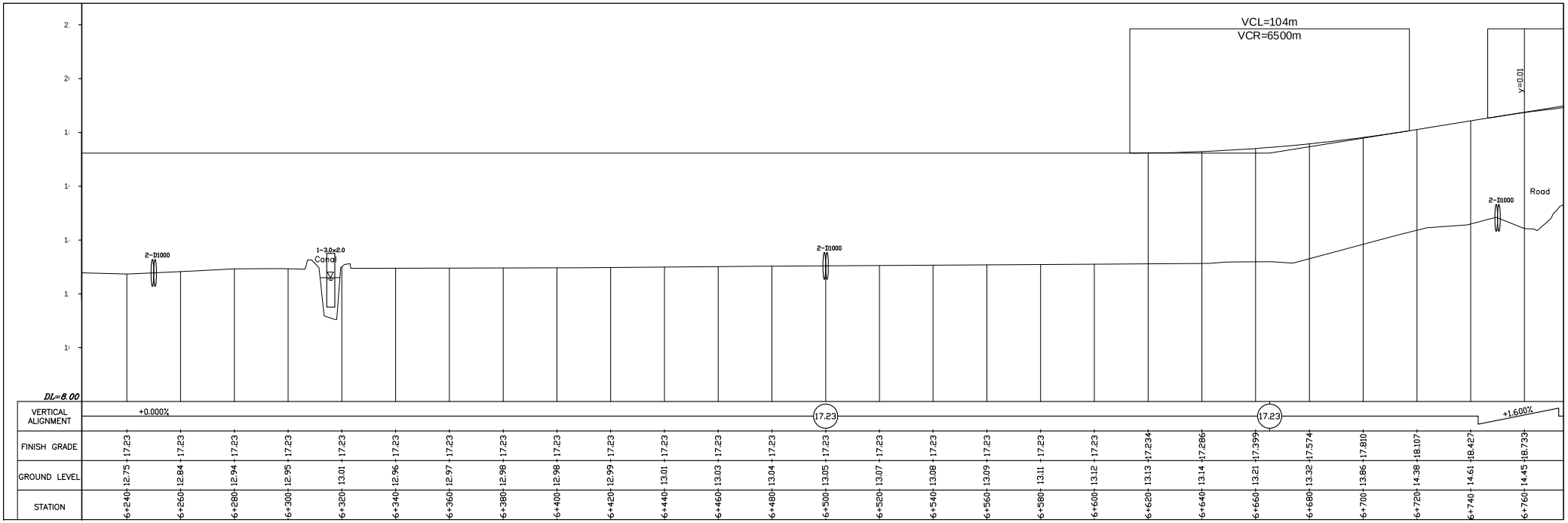
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.5+200-Sta.5+720)	Drawing No.	PP-11
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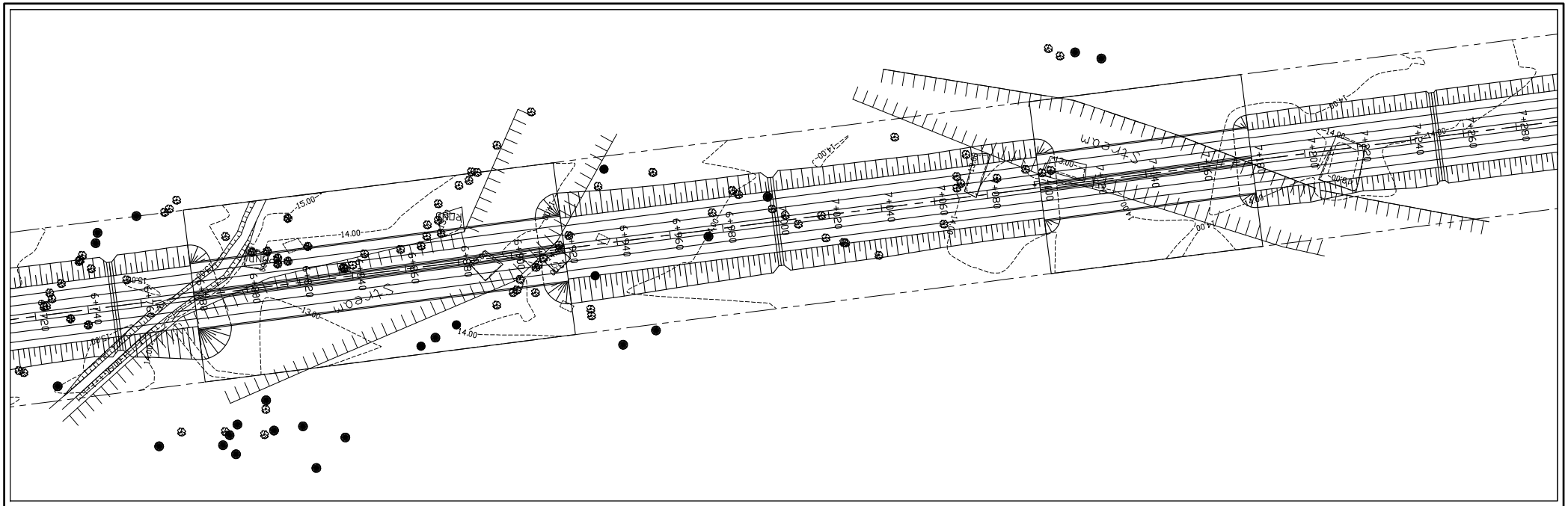


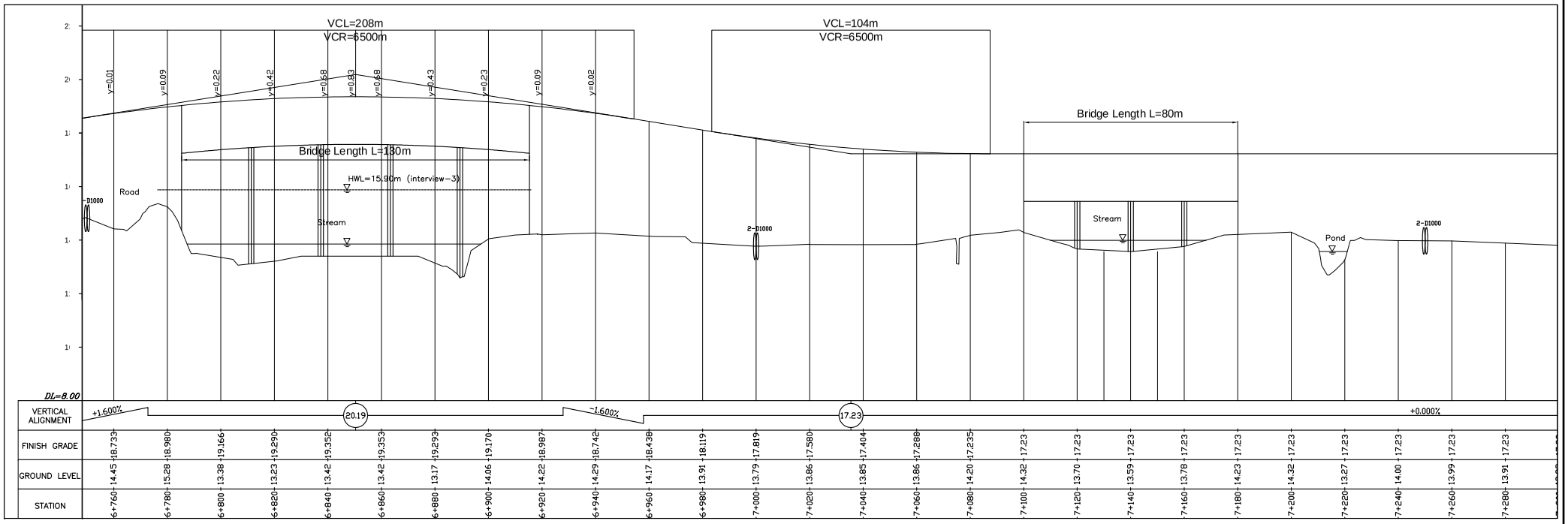
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.5+720-Sta.6+240)	Drawing No.	PP-12
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				Date :	JAN. 2014



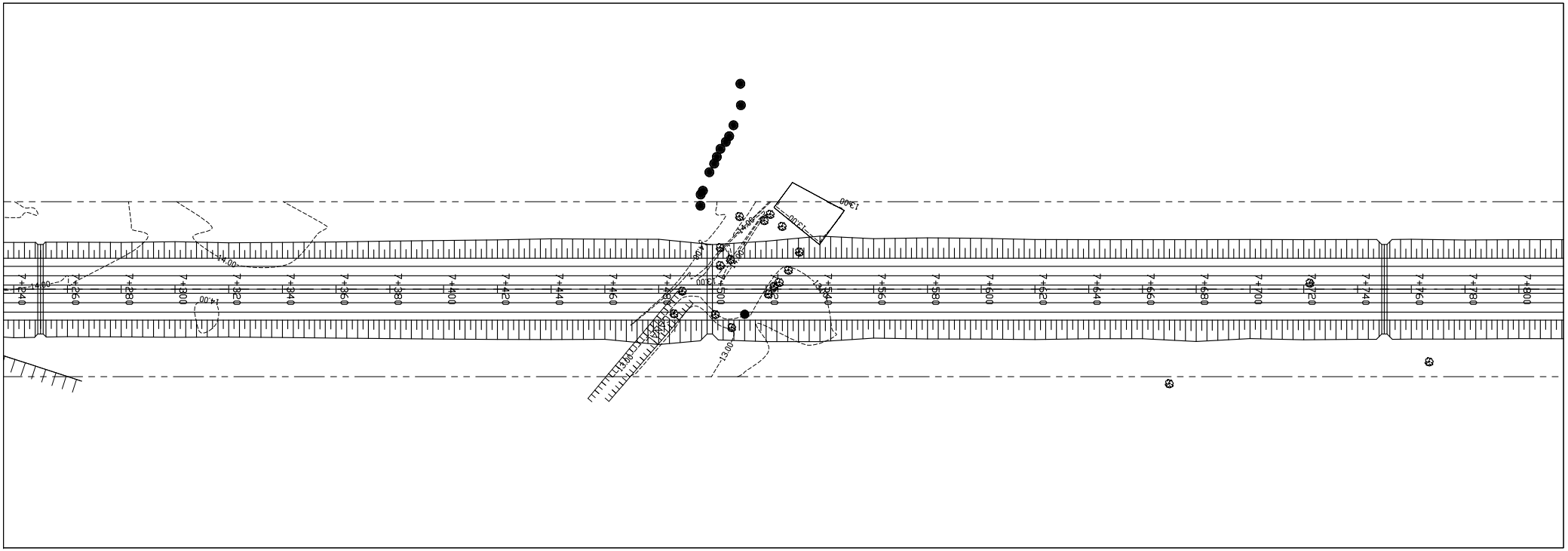


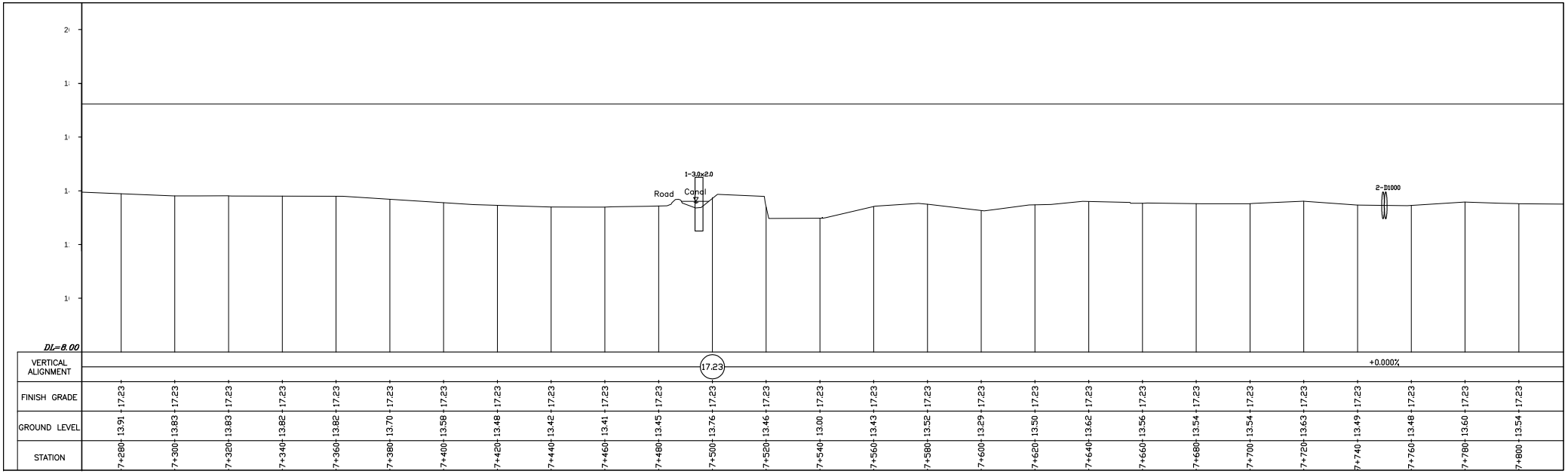
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.6+240-Sta.6+760)	Drawing No.	PP-13
				Scale :	H 1/1500 V 1/150
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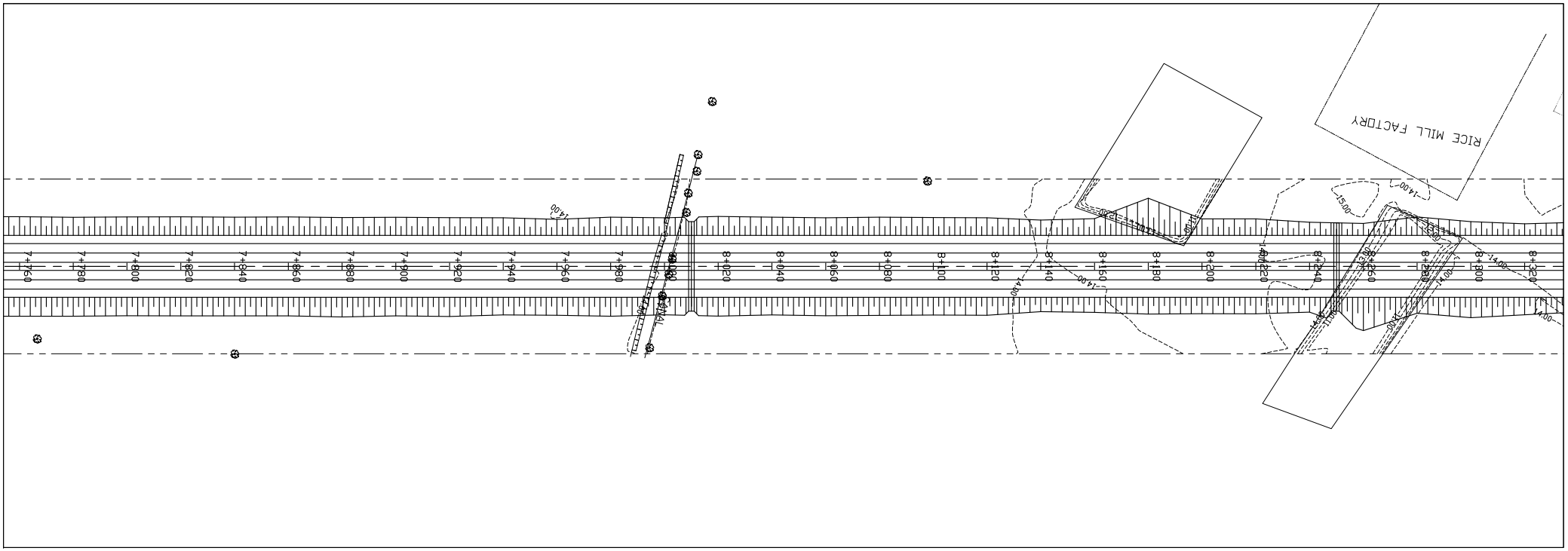


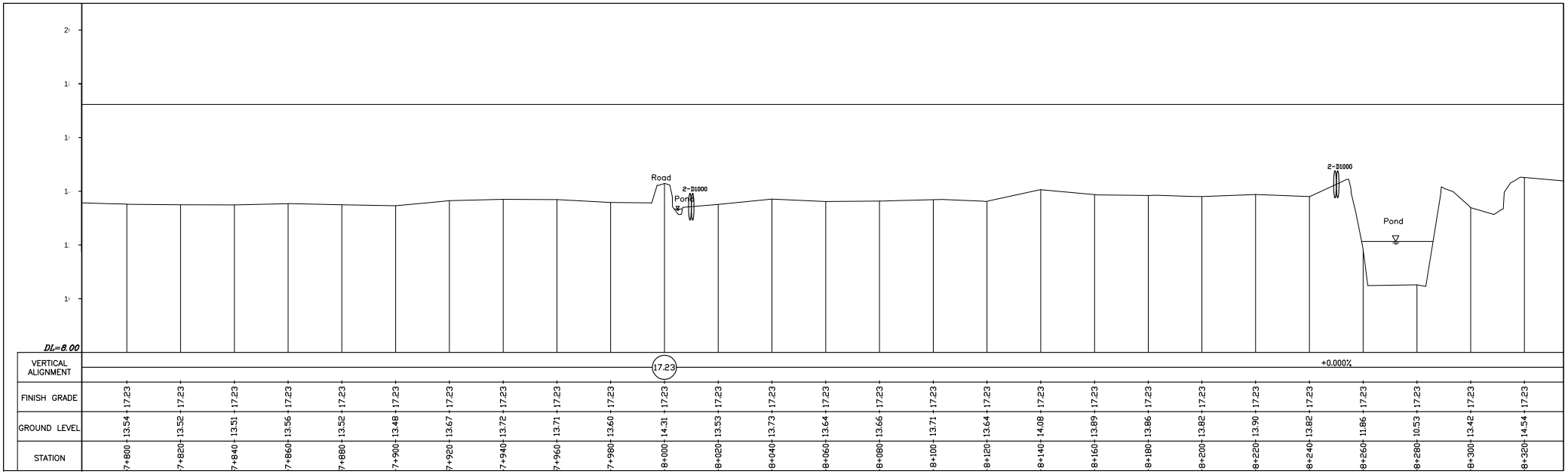
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.6+760-Sta.7+280)	Drawing No.	PP-14
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014



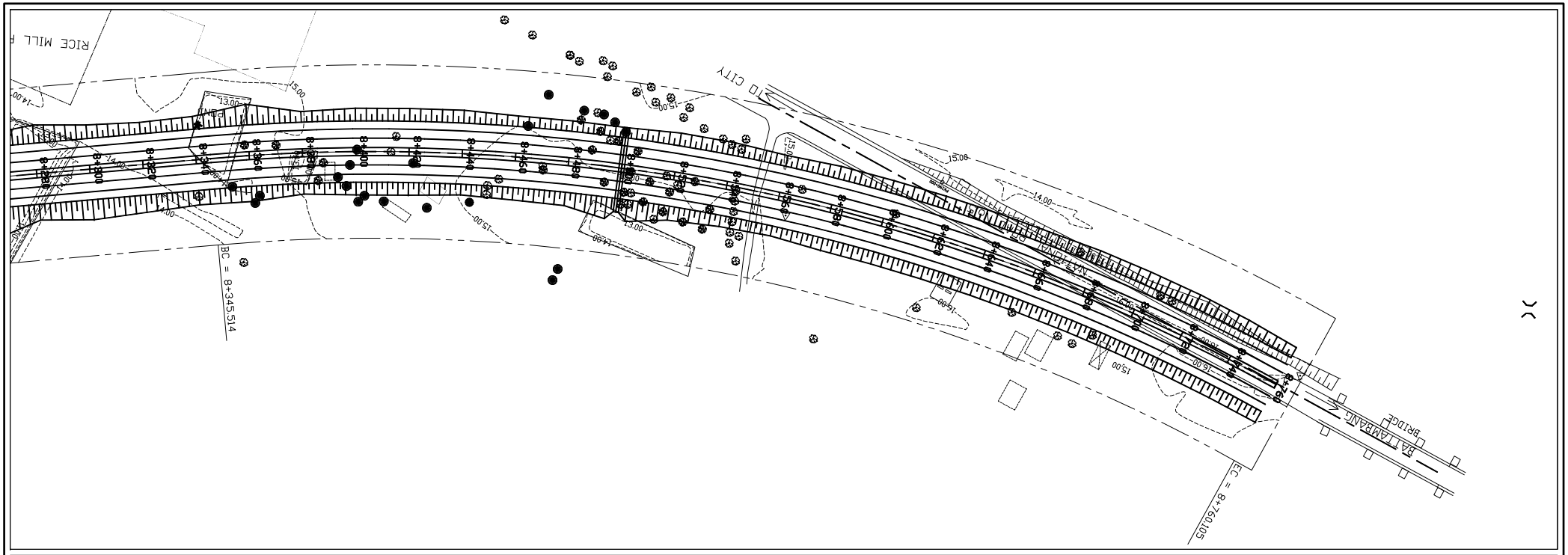


MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.7+280-Sta.7+800)	Drawing No.	PP-15
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014





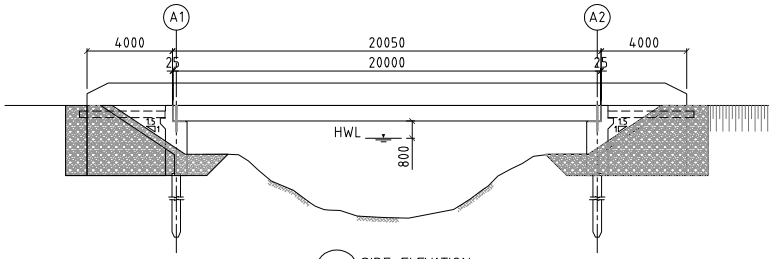
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.7+800-Sta.8+320)	Drawing No.	PP-16
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014



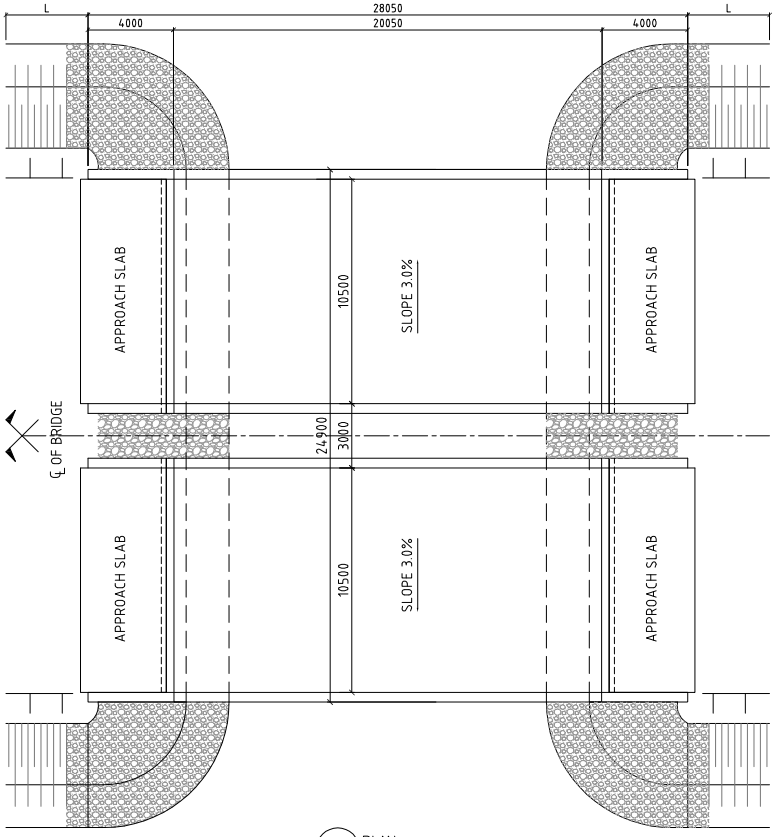
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (MIDDLE SECTION) IMPROVEMENT PROJECT	TITLE : Pursat Bypass Plan and Profile (Sta.8+320-Sta.8+760)	Drawing No.	PP-17
				Scale :	H 1/1500 V 1/150
				Date :	JAN. 2014

APPENDIX 9-1

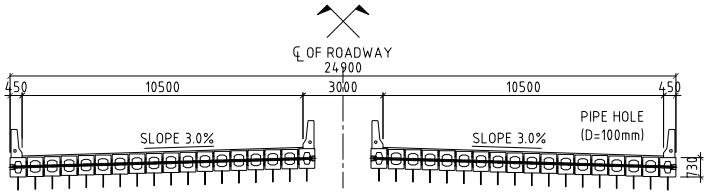
BRIDGE DESIGN



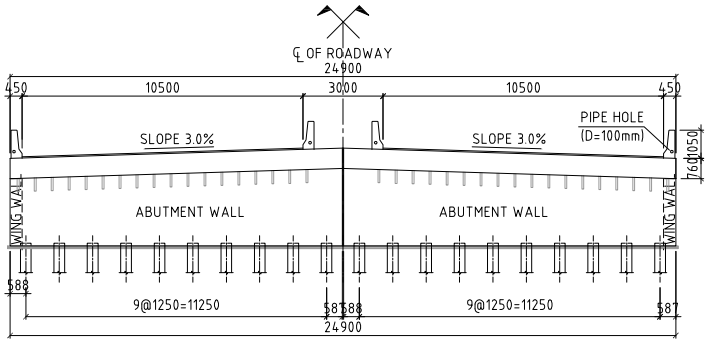
1 SIDE ELEVATION
SCALE 1:250



2 PLAN
SCALE 1:250



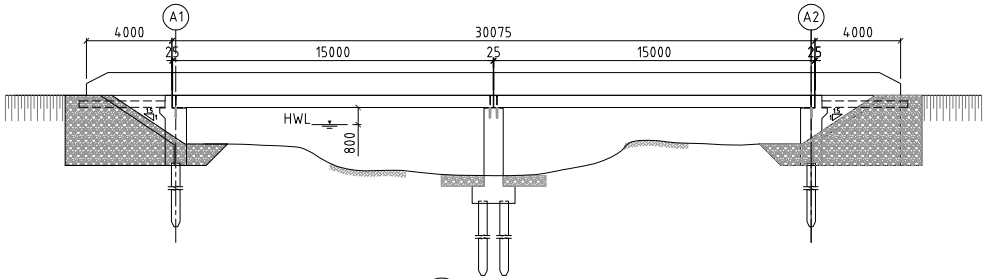
3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:200



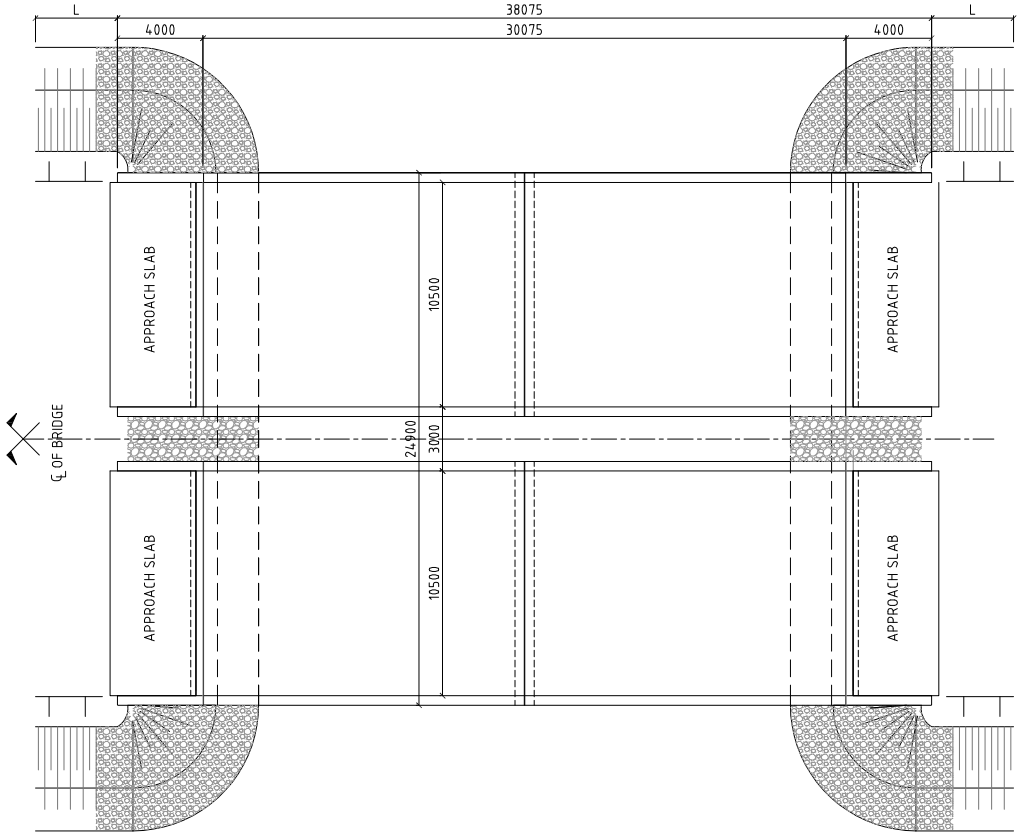
4 CROSS SECTION OF ABUTMENT
SCALE 1:200

A9-1

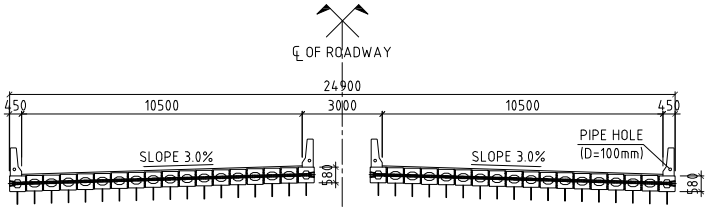
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	REPLACEMENT OF EXISTING BRIDGE PSC BRIDGE (L=20m) - Br.11, 13 - GENERAL VIEW	Drawing No.	BR-01
				Scale :	
				Date :	MAR. 2013



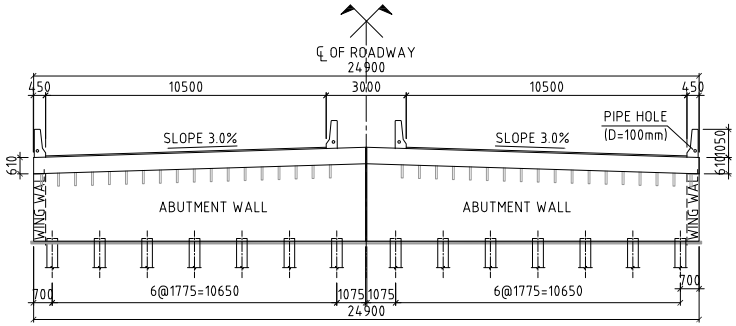
1 ELEVATION
SCALE 1:250



2 PLAN
SCALE 1:250



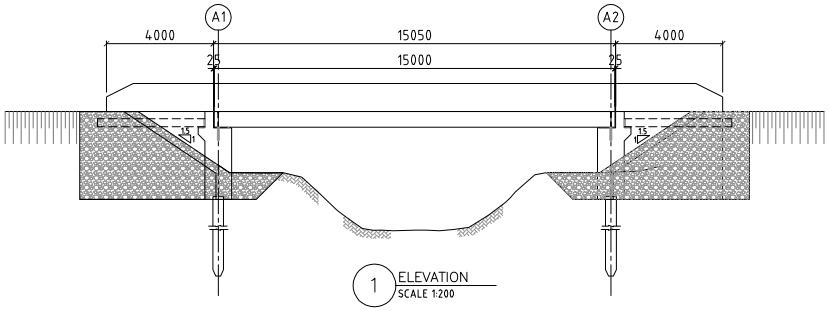
3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:200



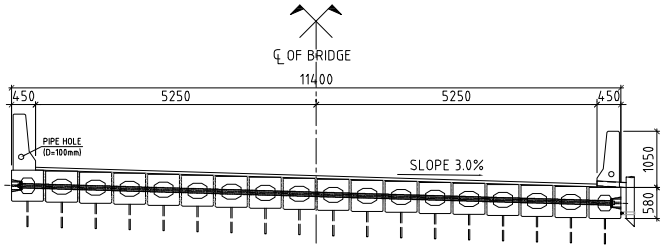
4 CROSS SECTION OF ABUTMENT
SCALE 1:200

A9-2

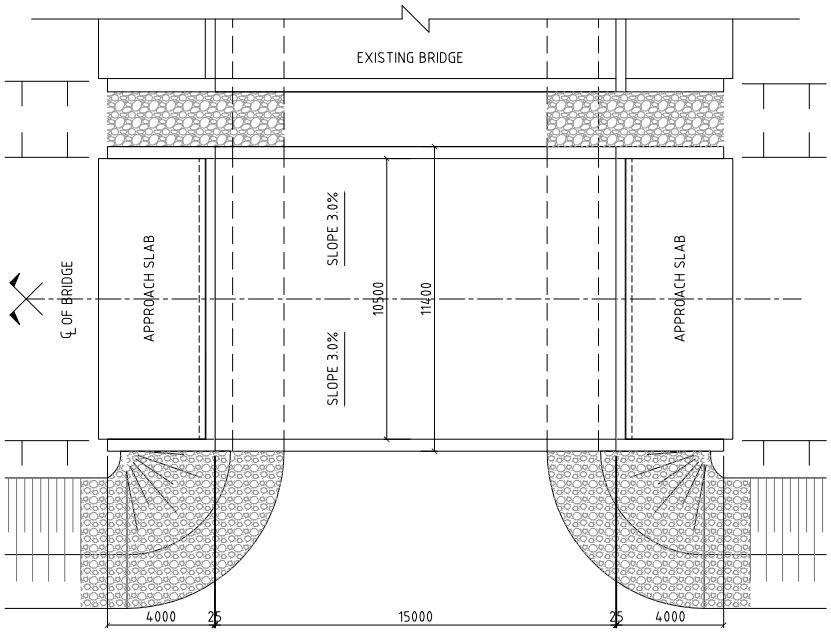
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	REPLACEMENT OF EXISTING BRIDGE PSC BRIDGE (L=30m) - Br.39 - GENERAL VIEW	Drawing No.	BR-02
				Scale :	
				Date :	MAR. 2013



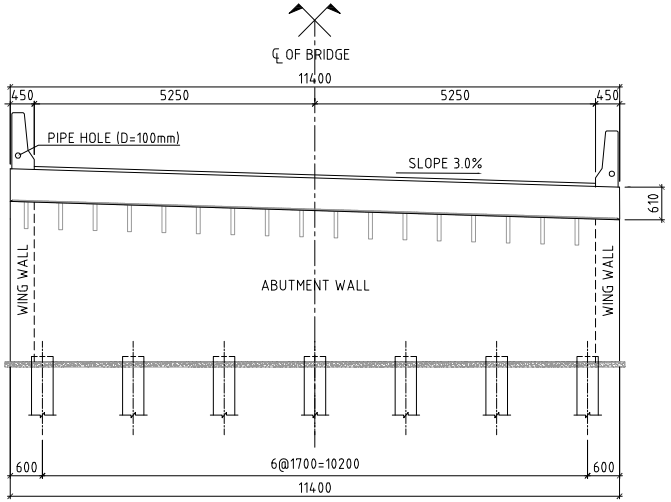
1 ELEVATION
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:100



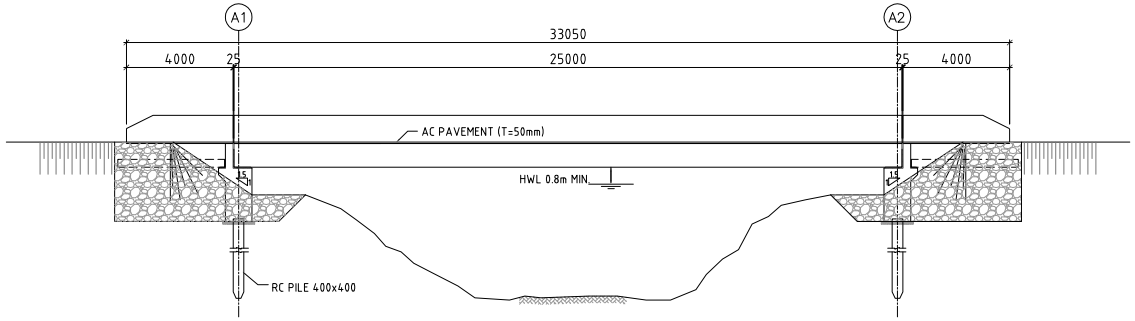
2 PLAN
SCALE 1:200



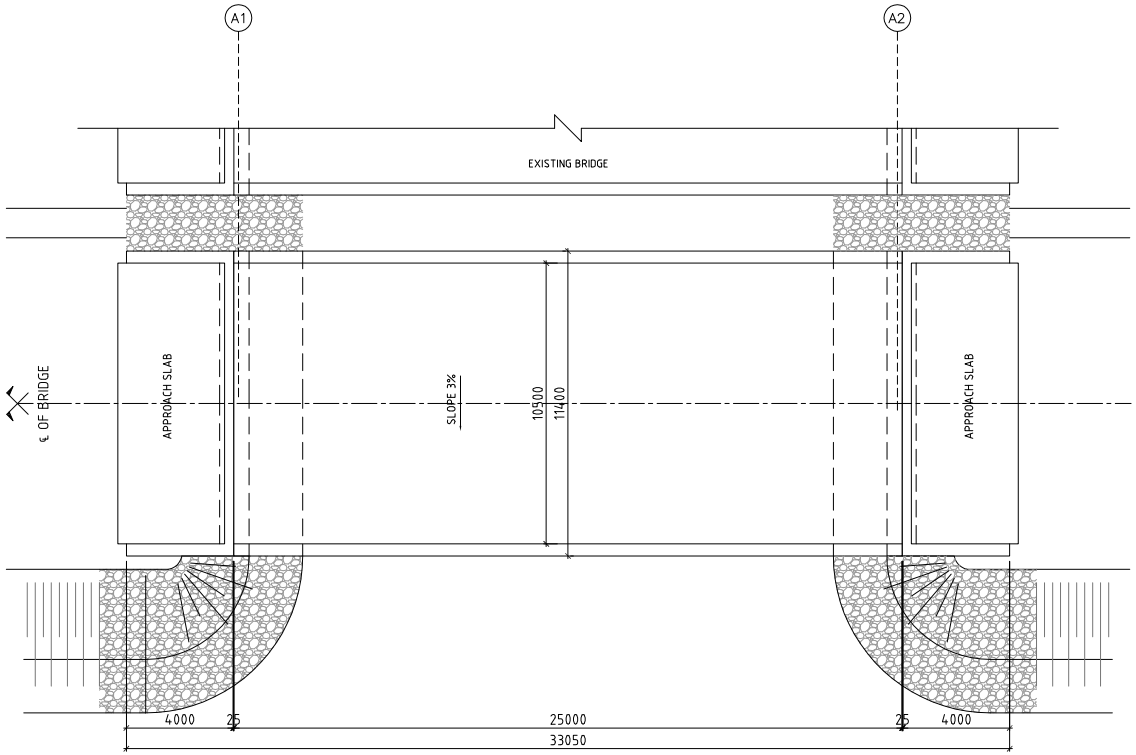
4 CROSS SECTION OF ABUTMENT
SCALE 1:100

A9-3

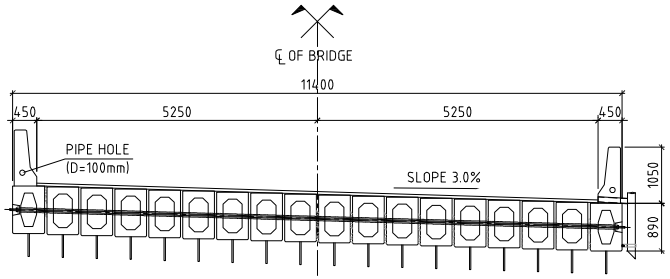
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	CONSTRUCTION OF ADDITIONAL BRIDGE PSC BRIDGE (L=15m) - Br.7, 14, 16' - GENERAL VIEW	Drawing No.	BR-03
				Scale :	
				Date :	MAR. 2013



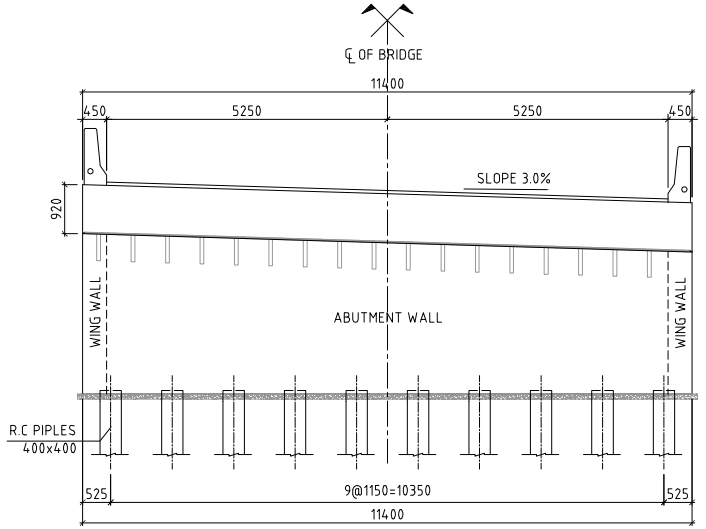
1 SIDE ELEVATION
SCALE 1:200



2 PLAN
SCALE 1:200



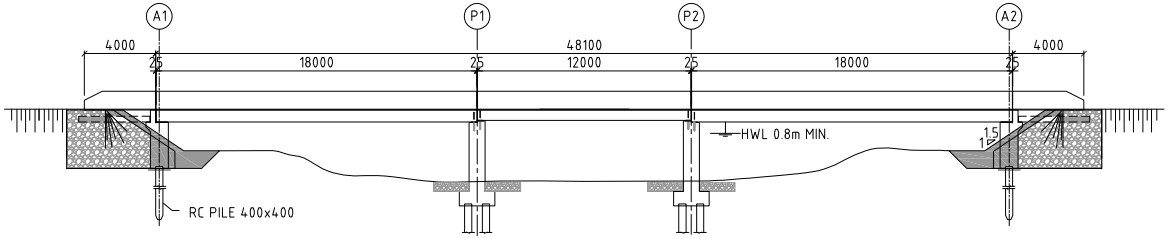
3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:100



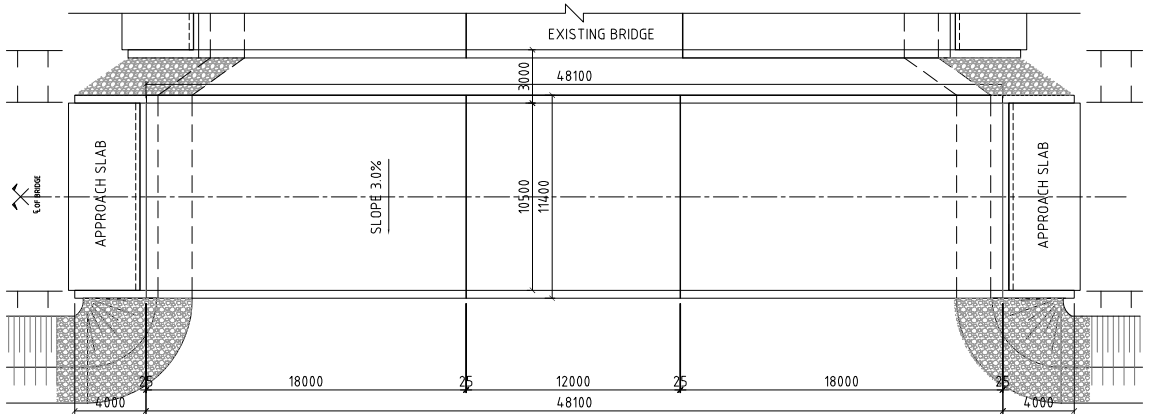
4 CROSS SECTION OF ABUTMENT
SCALE 1:100

A9-4

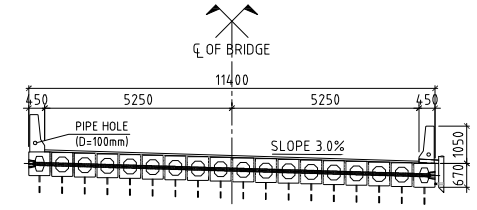
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	CONSTRUCTION OF ADDITIONAL BRIDGE PSC BRIDGE (L=25m) - Br.8, 9, 10, 12, 13', 15, 16 - GENERAL VIEW	Drawing No. Scale : Date :	BR-04 MAR. 2013



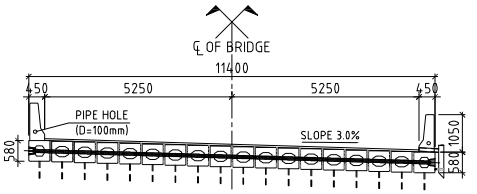
1 SIDE ELEVATION
SCALE 1:300



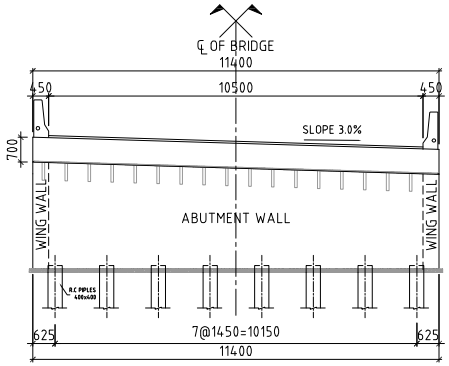
2 PLAN
SCALE 1:300



3 CROSS SECTION OF SUPERSTRUCTURE (A1–P1, P2–A2)
SCALE 1:150



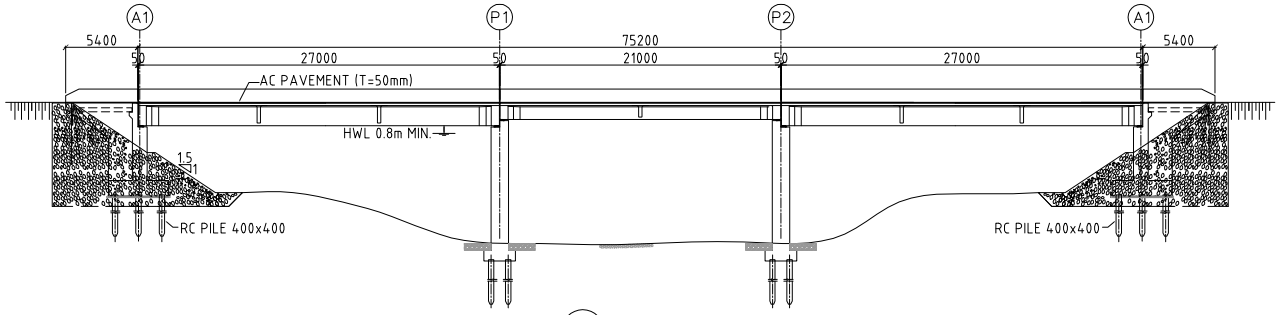
4 CROSS SECTION OF SUPERSTRUCTURE (P1–P2)
SCALE 1:150



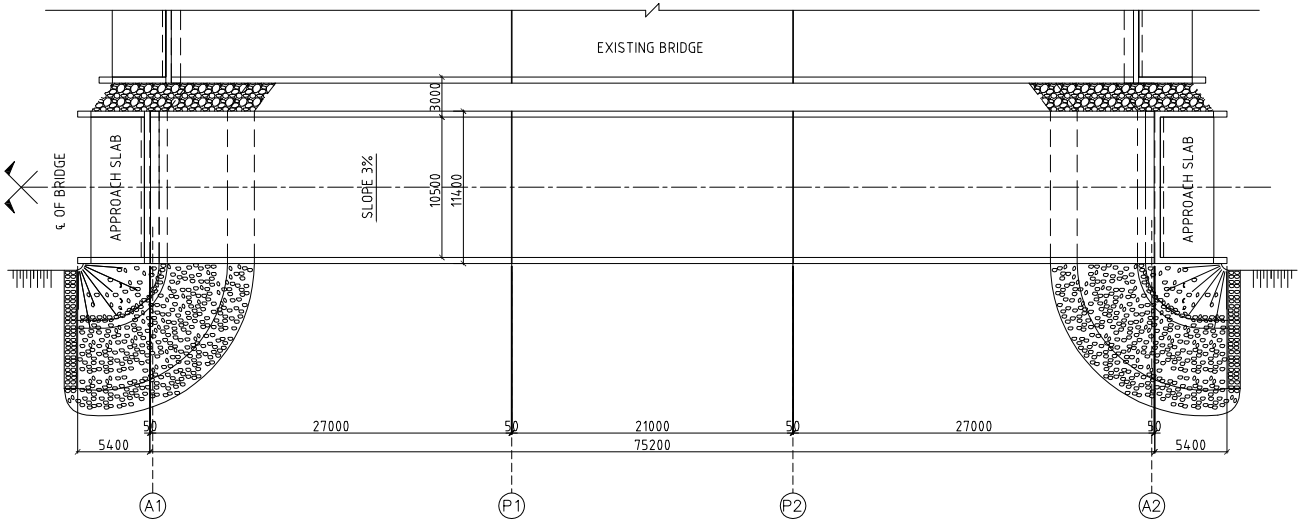
5 CROSS SECTION OF ABUTMENT
SCALE 1:150

A9-5

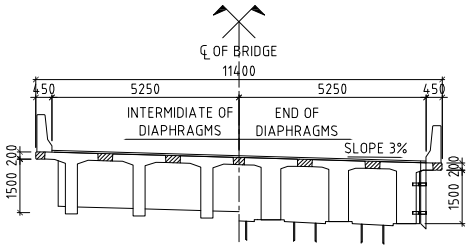
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	CONSTRUCTION OF ADDITIONAL BRIDGE PSC BRIDGE (L=48m) - Br.38 - GENERAL VIEW	Drawing No.	BR-05
				Scale :	
				Date :	MAR. 2013



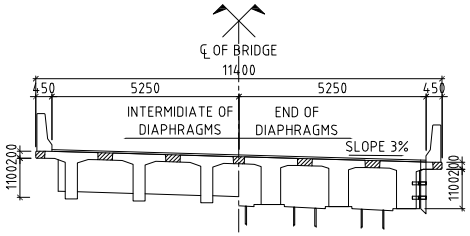
1 SIDE ELEVATION
SCALE 1:400



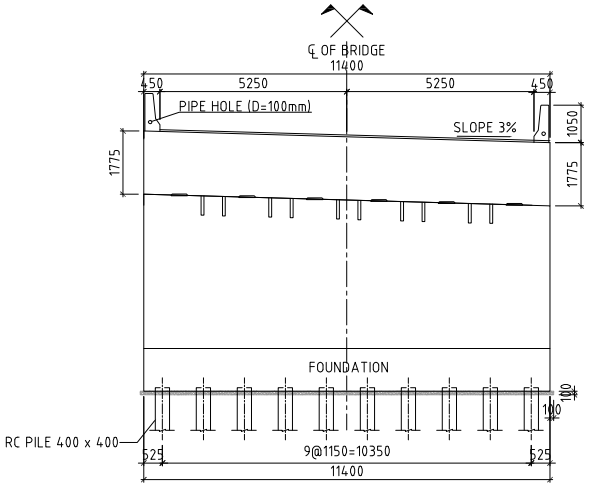
2 PLAN
SCALE 1:400



3 CROSS SECTION OF SUPERSTRUCTURE (P1–P2)
SCALE 1:150

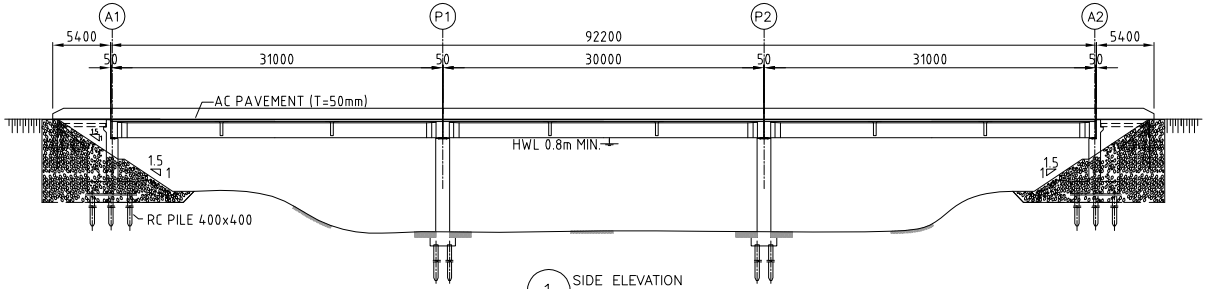


4 CROSS SECTION OF SUPERSTRUCTURE (A1–P1, P2–A2)
SCALE 1:150

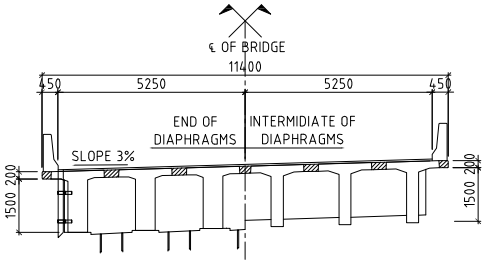


5 CROSS SECTION OF ABUTMENT
SCALE 1:150

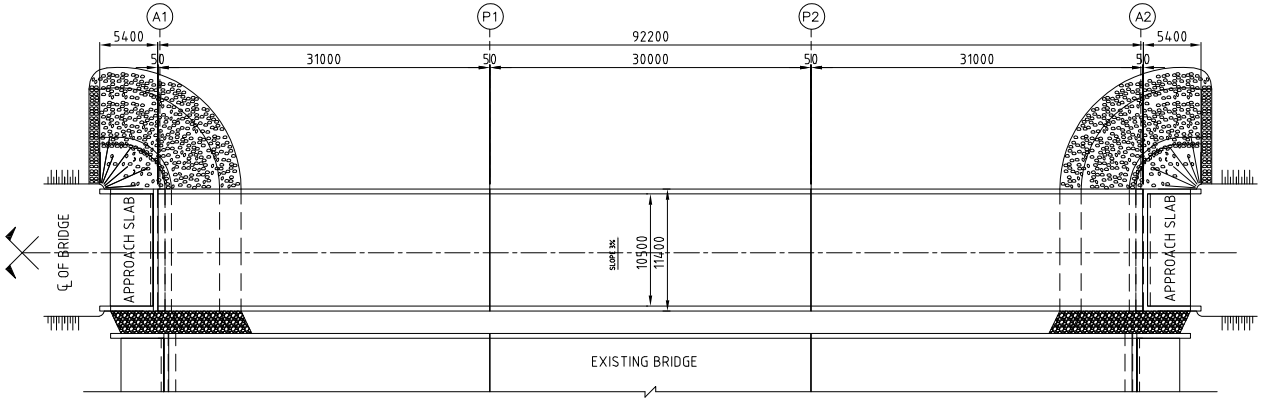
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	TITLE : CONSTRUCTION OF ADDITIONAL BRIDGE PCDG BRIDGE (L=75m) - Br.26 - GENERAL VIEW	Drawing No.	BR-06
				Scale :	
				Date :	MAR. 2013



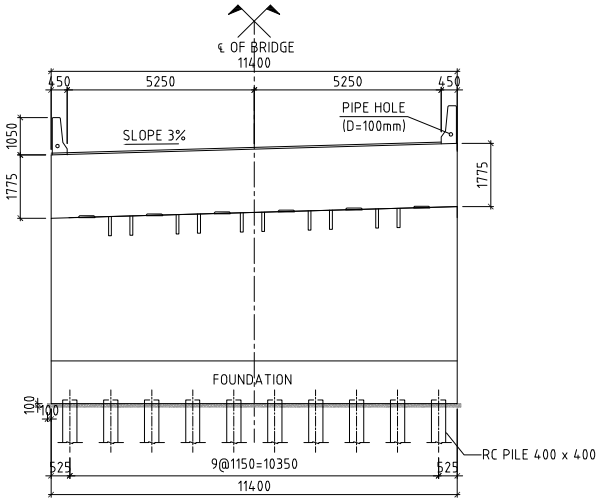
1 SIDE ELEVATION
SCALE 1:500



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



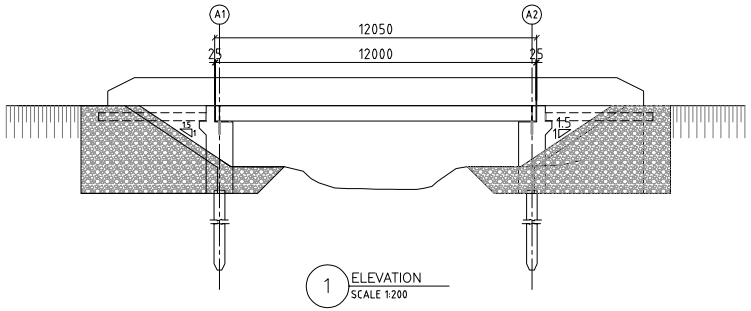
2 PLAN
SCALE 1:500



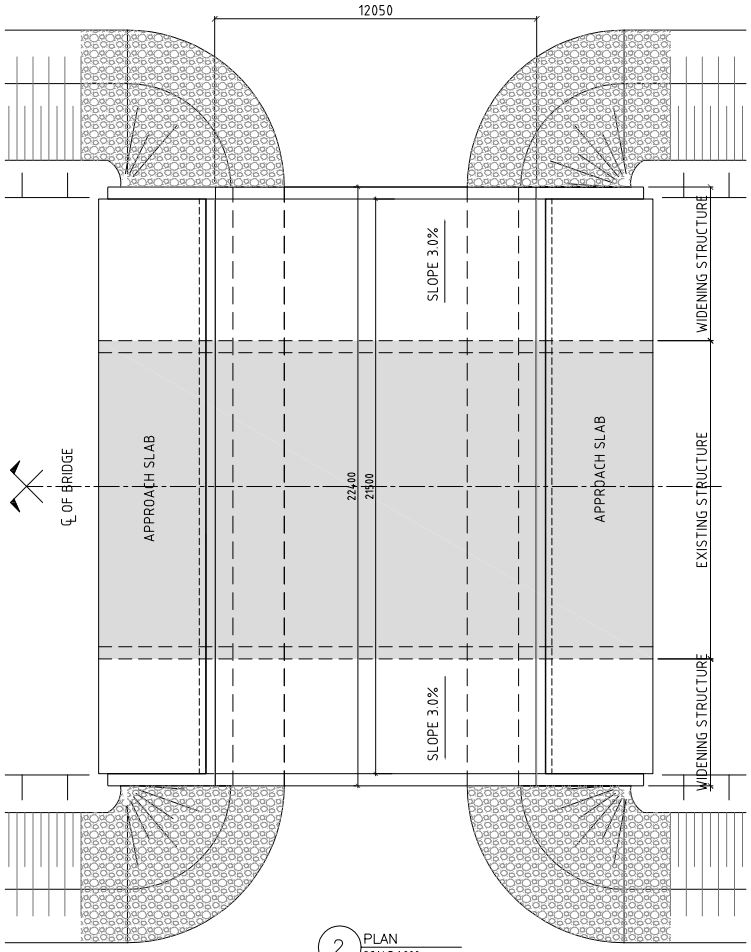
4 CROSS SECTION OF ABUTMENT
SCALE 1:150

A9-7

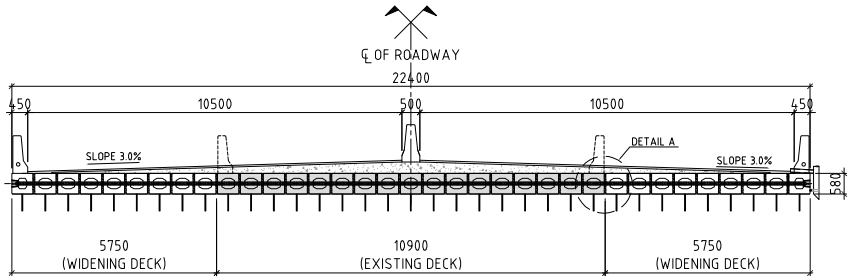
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	TITLE : CONSTRUCTION OF ADDITIONAL BRIDGE PCDG BRIDGE (L=92m) - Br.22 - GENERAL VIEW	Drawing No. BR-07 Scale : Date : MAR. 2013



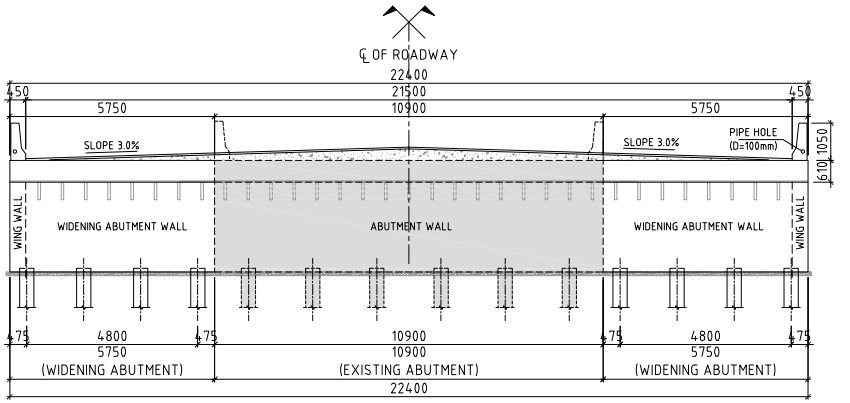
1 ELEVATION
SCALE 1:200



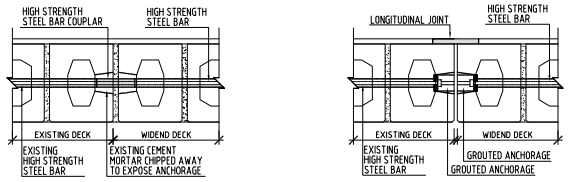
2 PLAN
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



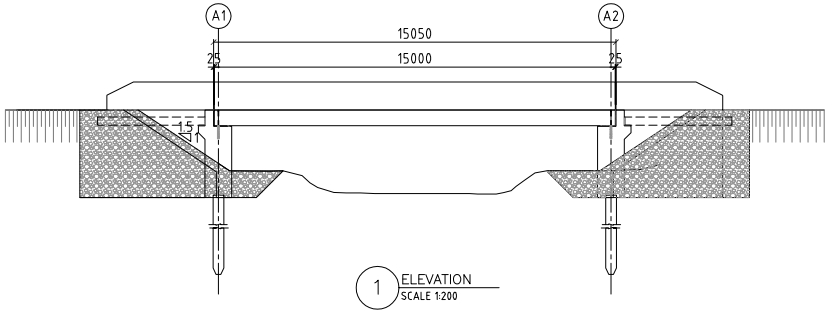
4 CROSS SECTION OF ABUTMENT
SCALE 1:150



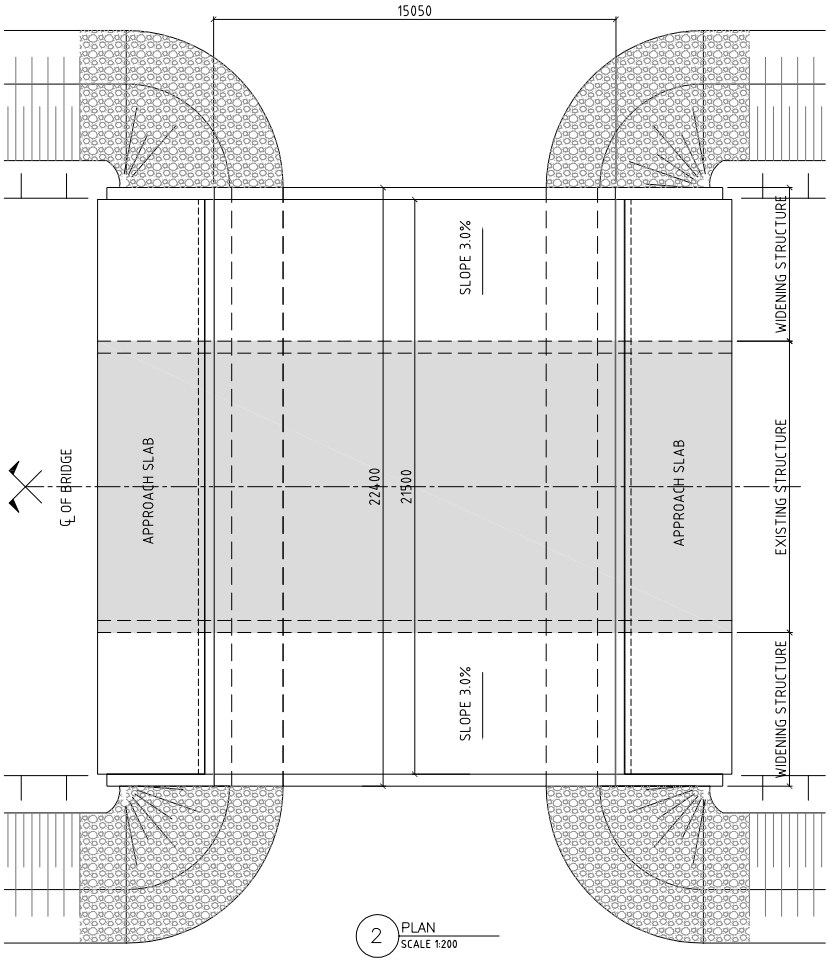
5 DETAIL
SCALE 1:50

A9-8

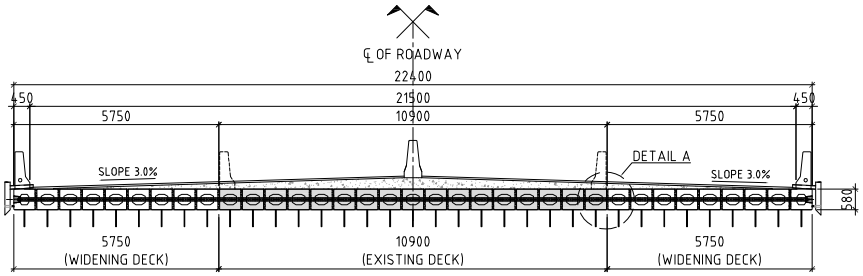
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	TITLE : WIDENING OF EXISTING BRIDGE PSC BRIDGE (L=12m) - Br.25, 27, 28, 29, 30, 31, 32, 35 - GENERAL VIEW	Drawing No.	BR-08
				Scale :	
				Date :	MAR. 2013



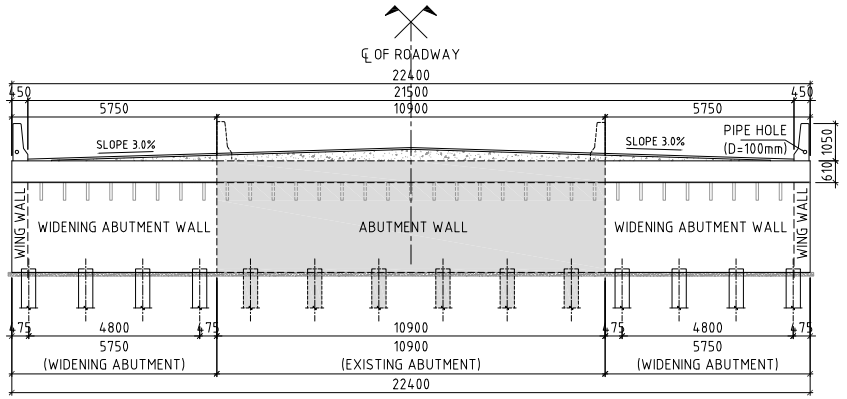
1 ELEVATION
SCALE 1:200



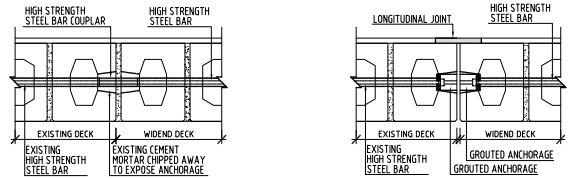
2 PLAN
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150

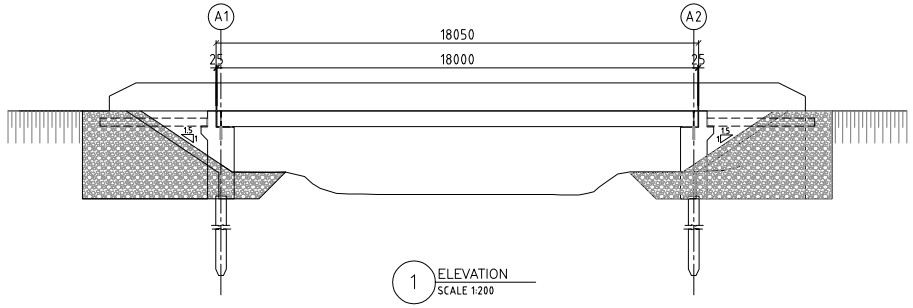


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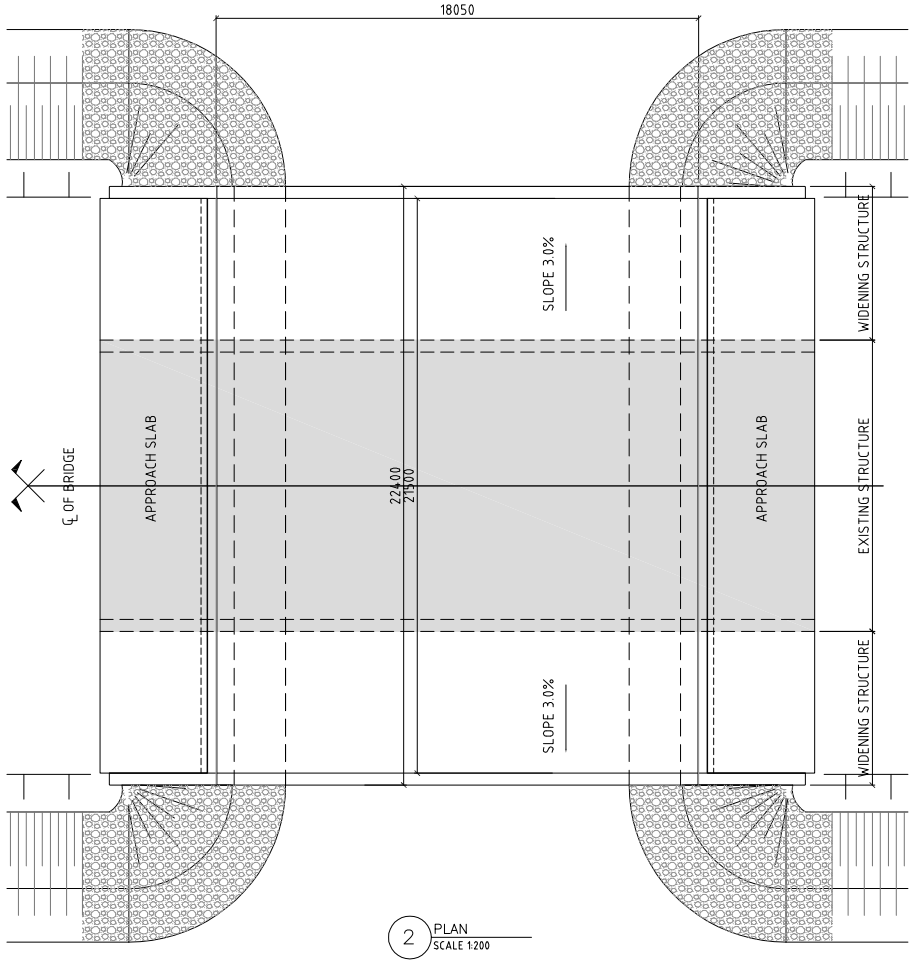


5 DETAIL
SCALE 1:50

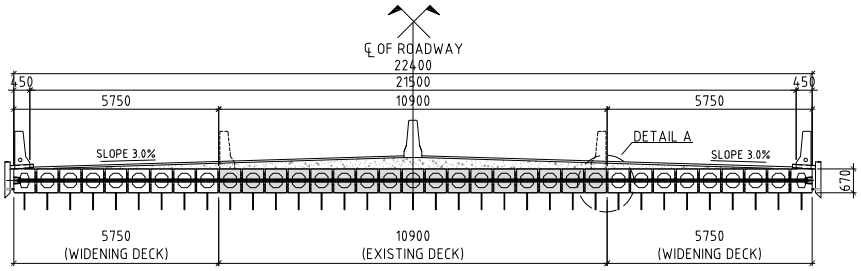
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	WIDENING OF EXISTING BRIDGE PSC BRIDGE (L=15m) - Br.24, 34 - GENERAL VIEW	Drawing No.	BR-09
				Scale :	
				Date :	MAR. 2013



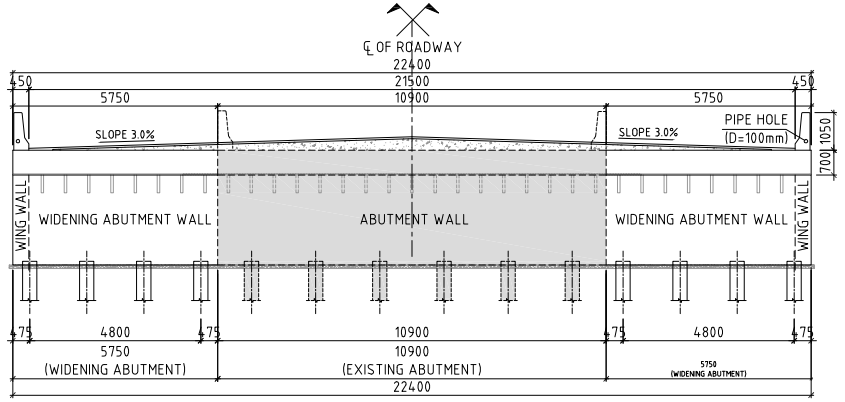
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SCALE 1:200



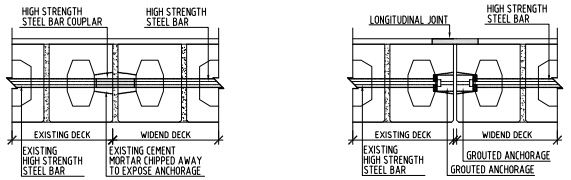
2 PLAN
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



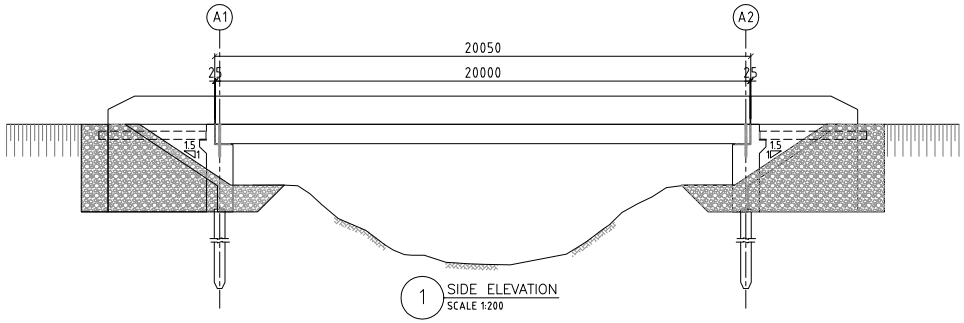
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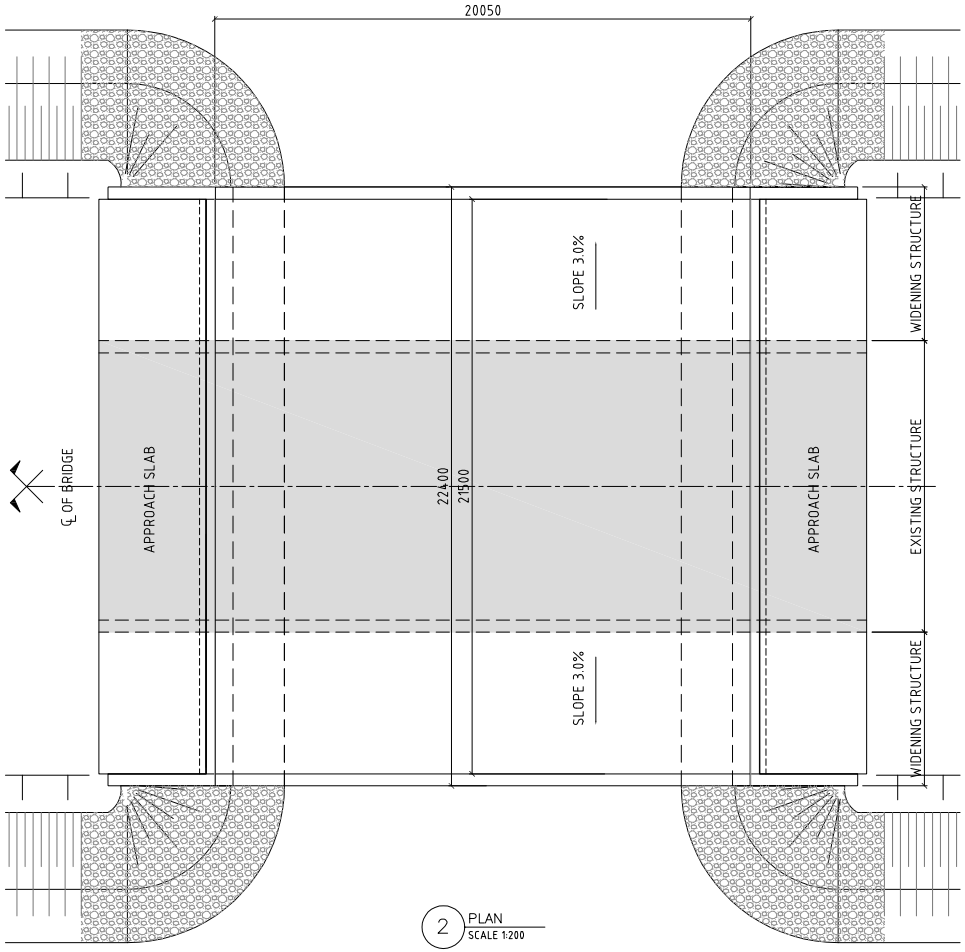
5 DETAIL
SCALE 1:50

A9-10

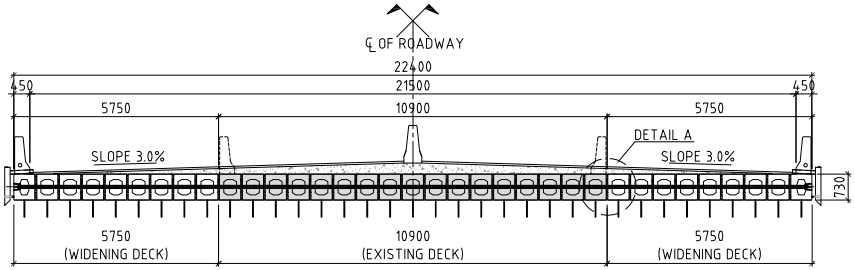
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	WIDENING OF EXISTING BRIDGE PSC BRIDGE (L=18m) - Br.33 - GENERAL VIEW	Drawing No.	BR-10
				Scale :	
				Date :	MAR. 2013



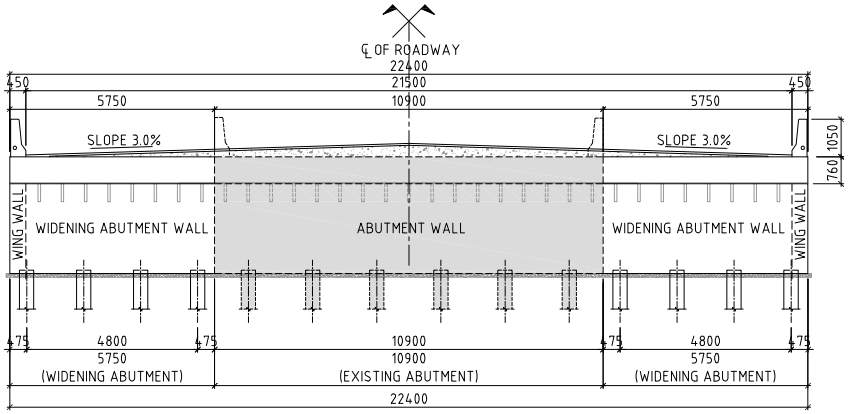
1 SIDE ELEVATION
SCALE 1:200



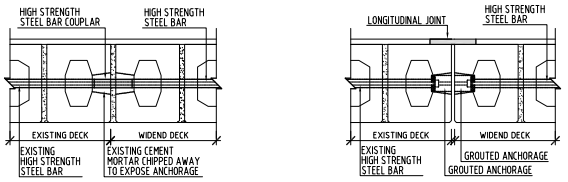
2 PLAN
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



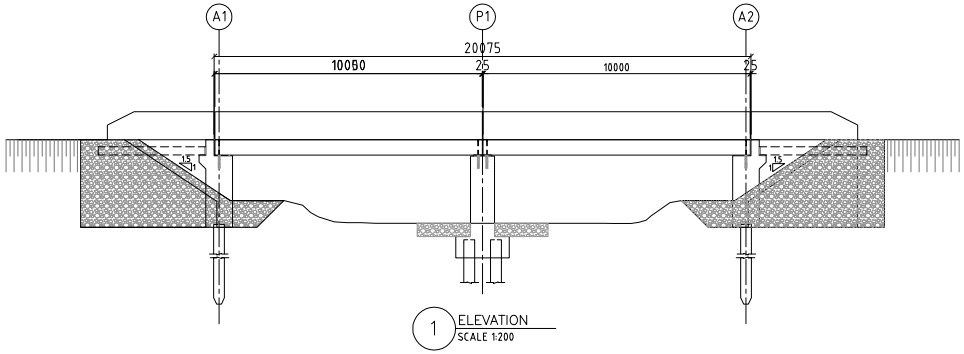
4 CROSS SECTION OF ABUTMENT
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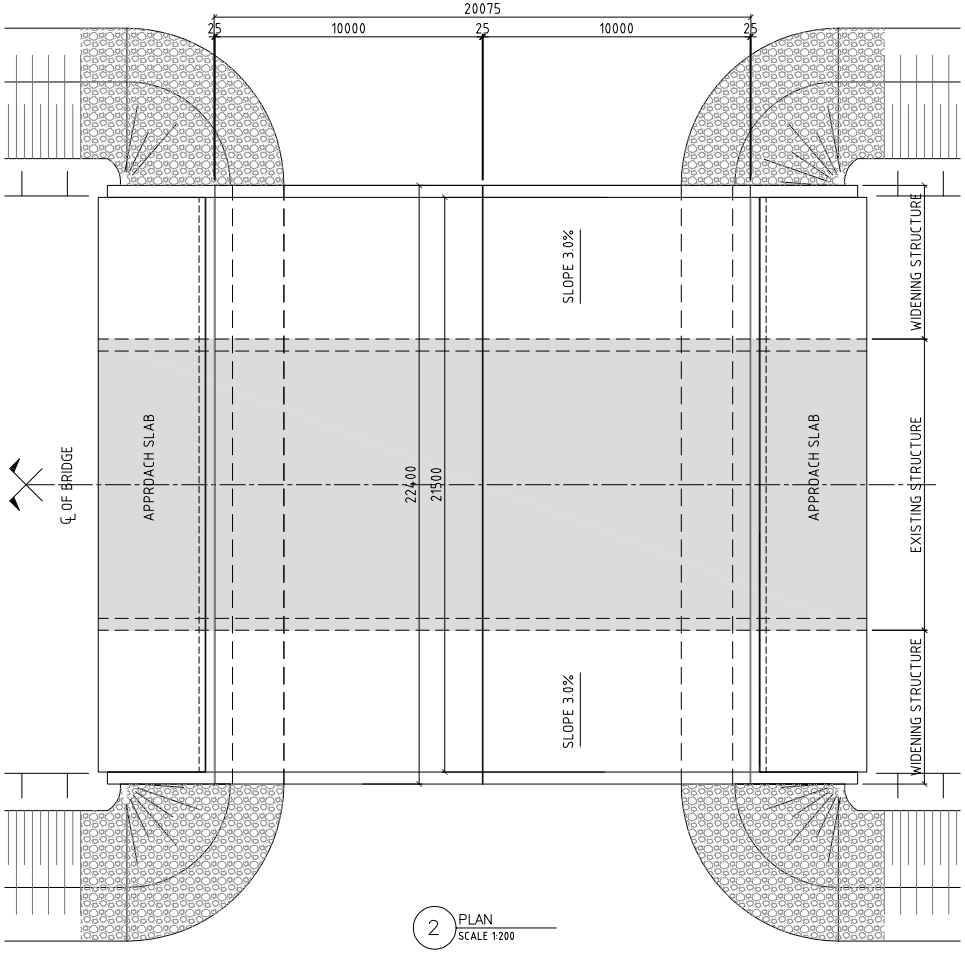
5 DETAIL
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A9-11

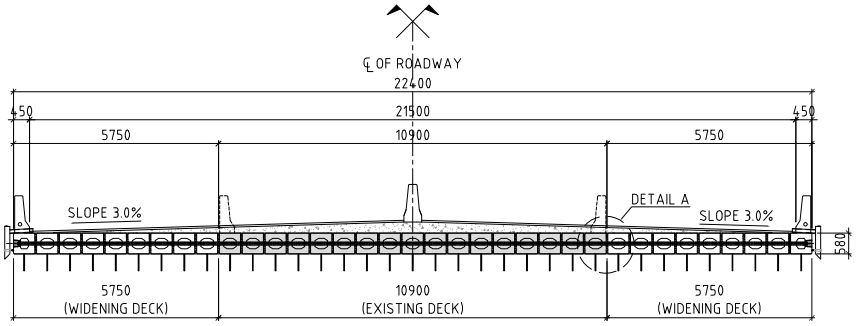
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	WIDENING OF EXISTING BRIDGE PSC BRIDGE (L=20m) - Br.23, 37 - GENERAL VIEW	Drawing No.	BR-11
				Scale :	
				Date :	MAR. 2013



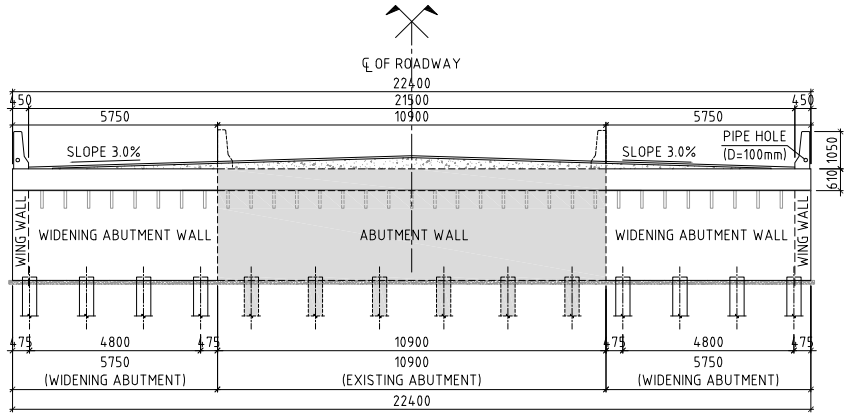
1 ELEVATION
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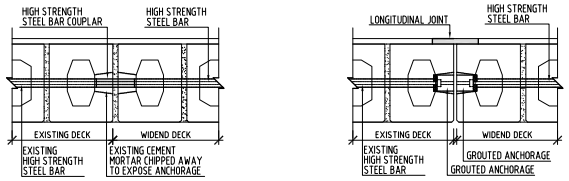
2 PLAN
SCALE 1:200



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



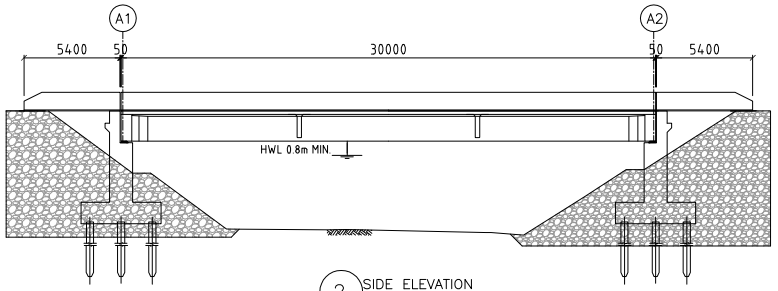
4 CROSS SECTION OF ABUTMENT
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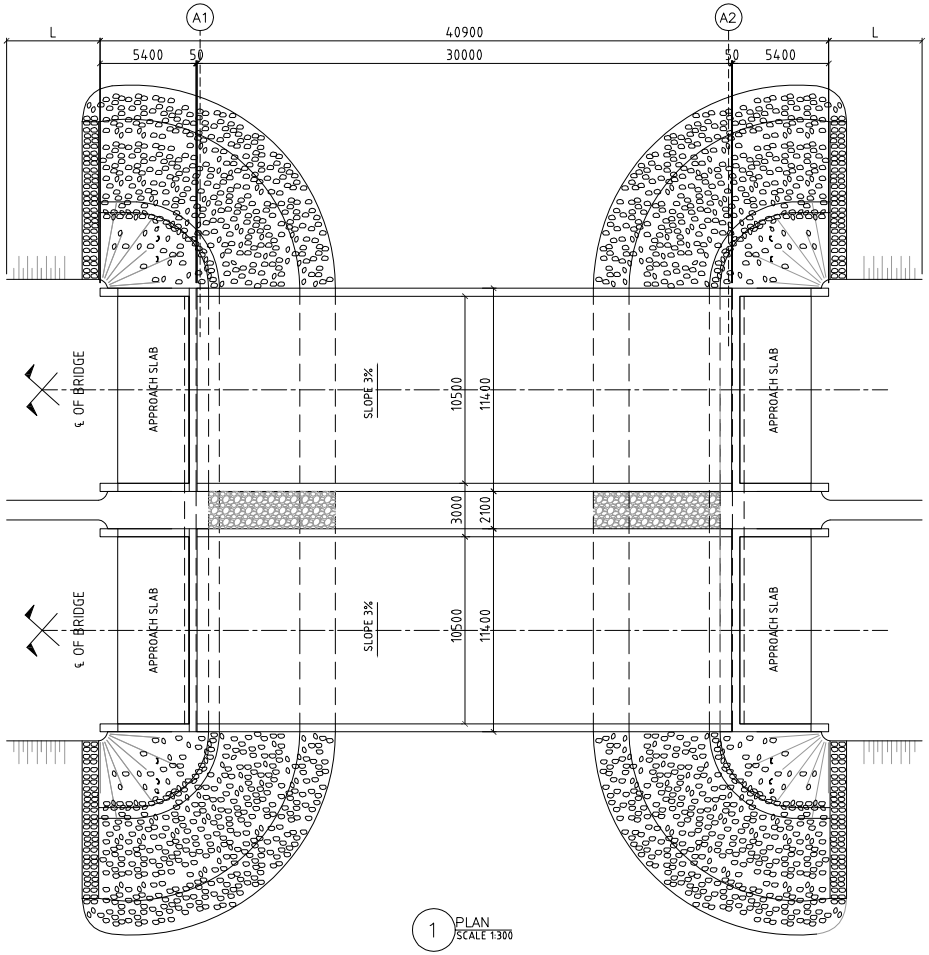
5 DETAIL
SCALE 1:50

A9-12

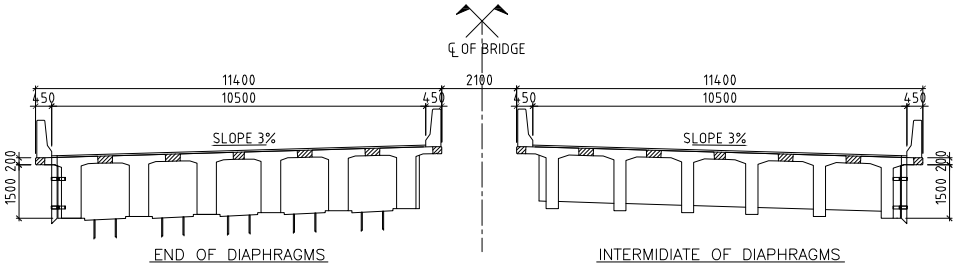
MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	TITLE : WIDENING OF EXISTING BRIDGE PSC BRIDGE (L=20m) - Br.36 - GENERAL VIEW	Drawing No.	BR-12
				Scale :	
				Date :	MAR. 2013



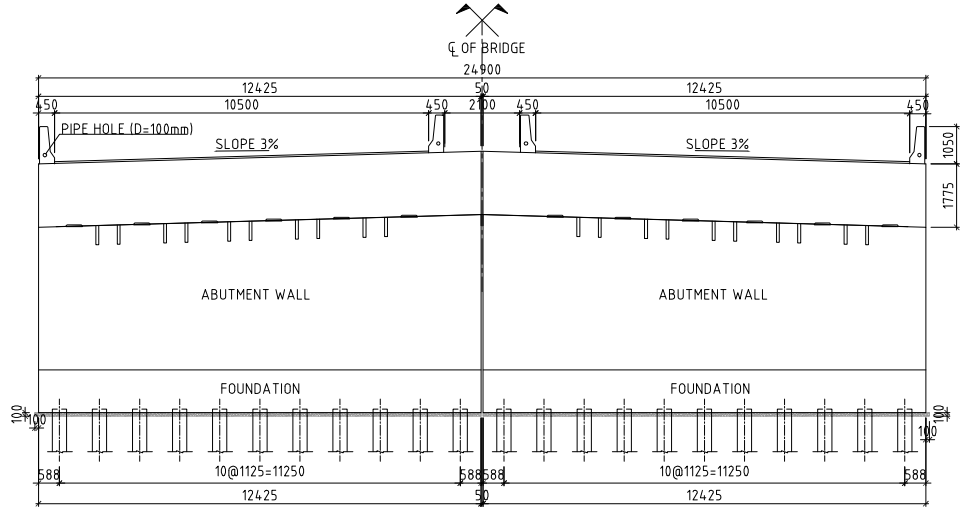
2 SIDE ELEVATION
SCALE 1:300



1 PLAN
SCALE 1:300



3 CROSS SECTION OF SUPERSTRUCTURE
SCALE 1:150



4 CROSS SECTION OF ABUTMENT
SCALE 1:150

A9-13

MINISTRY OF PUBLIC WORKS & TRANSPORT KINGDOM OF CAMBODIA	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	PREPARATORY SURVEY FOR NATIONAL ROAD NO.5 (SOUTH SECTION) IMPROVEMENT PROJECT	TITLE : CHREY BAK RIVER BRIDGE ON KAMPONG CHHNANG BYPASS GENERAL VIEW	Drawing No. BR-13 Scale : Date : MAR. 2013

APPENDIX 15-1

LIST OF FLORA

1 Riverside Vegetation in Corridor of Impact

Table 1 Name of Riverside Vegetation Species along Road from Thlea Ma'am to Battamabng
(Survey area: 20 m + 20 m from Road center, Survey Month: July and December, 2013)

Name of Riverside Vegetation along Northeast Side of Road (Width:20m)			
Kilometer Post (KP)	Communes	Scientific Name	Name of River (Ou) or Canals
177+177 to 177+263	Beung Kanthouth	*Euphorbia milii*	Ou Srang Thom
		Cassia alata, L.	
		Combretum trifoliatum	
		Ixora cuneifolia, varians	
		Bridelia ovata, var. Curtisis	
		Phyllanthus lasodiifolius	
		Hymnocardia wallichii	
		Barringtonia acutangula	
		Cratoxylum cochinchinese	
		Passiflora foetida Passifloraceae	
		Azadirachta indica Meliaceae	
		Streblus asper Lour. Moraceae	
		Sesbania grandiflora	
		Zizyphus jujube	
		Gmelina asiatica	
		Tertracera indica	
		Cayratia trifolia	
		Derris trifolia	
178+484 to 178+537	Prey Nhei	*Barringtonia acutangula*	Ou Srang Touch
		Ixora cuneifolia, varians	
		Euphorbia milii	
		Passiflora foetida Passifloraceae	
		Bridelia ovata, var. Curtisis	
		Phyllanthus lasodiifolius	
		Combretum trifoliatum	
		Streblus asper Lour. Moraceae	
		Zizyphus jujube	
		Gmelina asiatica	
		Derris trifolia	
		Tertracera indica	
		Cayratia trifolia	
190+727 to 190+785	Snam Preash	*Dalbergia herrida, Var.glabrescens*	Ou Svay At Khang Krom called Stung Touch
		Combretum trifoliatum	
		Phragmites karka Trin	
		Albizia myriophylla	
		Zizyphus oenoplia mill	
		Streblus asper Lour. Moraceae	
		Tertracera indica	
		Merremia hederacea	
208+378 to 208+457	Beung Khna	*Cassia alata, L.*	Ou Beung Khna
		Bridelia ovata, var. Curtisis	
		Cratoxylum cochinchinese	
		Zizyphus oenoplia mill	

		Azadirachta indica Meliaceae	
		Streblus asper Lour. Moraceae	
		Gmelina asiatica	
		Dalbergia herrida, Var.glabrescens	
		Combretum trifoliatum	
248+580 to 250+565	Kear	*Dalbergia herrida, Var.glabrescens*	Rigth Canal along Por 2 village road
		Uvaria rufa	
		Combretum trifoliatum	
		Phragmites karka Trin	
		Ixora cuneifolia, varians	
		Hydrolea zeylanica	
		Mimosa pigra Fabaceae	
		Mimosa pisdica	
		Mitragyna hirsuta Hav.	
		Phyllanthus lasodiifolius	
		Breynia rhamnoides	
		Barringtonia acutangula	
		Antidesma ghaesembilla, G	
		Passiflora foetida Passifloraceae	
		Streblus asper Lour. Moraceae	
		Sesbania grandiflora	
		Zizyphus jujube	
		Gmelina asiatica	
		Cayratia trifolia	
250+725 to 252+052, 252+169 to 252+938, 254+252 to 254+521, 254+578 to 254+884, 254+936 to 255+015, 255+024 to 255+088	Kor Koh	*Xanthophyllum glancam*	Rigth Canal along Kor Koh village road
		Uvaria rufa	
		Cynometra (inaequifolia)	
		Combretum trifoliatum	
		Ixora cuneifolia, varians	
		Hydrolea zeylanica	
		Maclura conchinchinensis	
		Mimosa pigra Fabaceae	
		Mimosa pisdica	
		Mitragyna hirsuta Hav.	
		Croton caudatus	
		Breynia rhamnoides	
		Barringtonia acutangula	
		Antidesma ghaesembilla, G	
		Zizyphus oenoplia mill	
		Passiflora foetida Passifloraceae	
		Gmelina asiatica	
		Cayratia trifolia	
		Merremia hederacea	
Name of Riverside Vegetation along Southwest Side of Road (Width:20m)			
Kilometer Post (KP)	Communes	Scientific Name	Name of River (Ou) or Canals
177+180 to 177+231	Thoth Choum	*Cassia alata, L.*	Ou Srang Thom
		Combretum trifoliatum	
		Bridelia ovata, var. Curtisis	
		Cratoxylum cochinchinese	

		Antidesma ghaesembilla, G	
		Zizyphus oenoplia mill	
		Passiflora foetida Passifloraceae	
		Streblus asper Lour. Moraceae	
		Gmelina asiatica	
		Tertracera indica	
178+488 to 178+530	Prey Nhei	*Barringtonia acutangula*	Ou Srang Touch
		Ixora cuneifolia, varians	
		Euphorbia milii	
		Bridelia ovata, var. Curtisis	
		Phyllanthus lasodiifolius	
		Combretum trifoliatum	
		Streblus asper Lour. Moraceae	
		Gmelina asiatica	
		Derris trifolia	
		Cayratia trifolia	
190+727 to 190+772	Snam Preash	*Cassia alata, L.*	Ou Svay At Khang Krom called Stung Touch
		Bridelia ovata, var. Curtisis	
		Breynia rhamnoides	
		Cratoxylum cochinchinese	
		Zizyphus oenoplia mill	
		Azadirachta indica Meliaceae	
		Streblus asper Lour. Moraceae	
		Sesbania grandiflora	
		Gmelina asiatica	
		Cynometra (inaequifolia)	
208+382 to 208+460	Beung Khna	*Bridelia ovata, var. Curtisis*	Ou Beung Khna
		Cratoxylum cochinchinese	
		Zizyphus oenoplia mill	
		Streblus asper Lour. Moraceae	
		Gmelina asiatica	
		Dalbergia herrida, Var.glabrescens	
		Combretum trifoliatum	
248+580 to 250+123	Maung	*Uvaria rufa*	Left Canal along Maung village road
		Combretum trifoliatum	
		Mimosa pigra Fabaceae	
		Mimosa pisdica	
		Mitragyna hirsuta Hav.	
		Antidesma ghaesembilla, G	
		Passiflora foetida Passifloraceae	
		Streblus asper Lour. Moraceae	
		Ixora cuneifolia, varians	
		Cayratia trifolia	
250+123 to 250+573, 250+730 to 252+054, 252+184 to 252+938, 254+261 to 254+914, 254+948 to 255+121	Kor Koh	*Combretum trifoliatum*	Left Canal along Kor Koh village road
		Mimosa pigra Fabaceae	
		Mimosa pisdica	
		Schleichera oleosa (Lour) Oken	
		Breynia rhamnoides	
		Xanthophyllum glancam	

		Barringtonia acutangula	
		Ficus racemosa	
		Ixora cuneifolia, varians	
		Dalbergia herrida, Var.glabrescens	
		Zizyphus jujube	
		Gmelina asiatica	
		Hydrolea zeylanica	
		Cynometra (inaequifolia)	
		Merremia hederacea	
		Cayratia trifolia	

Table 2 Name of Riverside Vegetation Species along Road from Sri Sophorn to Poipet

(Survey area: 20 m + 20 m from Road center, Survey Month: August and December, 2013)

Kilometer Post (KP)	Communes	Scientific Name	Name of River (Ou) or Canals
366+250 to 366+685	Teuk Thla	*Xanthophyllum glancam*	Along the road on the left hand in Teuk Thla village
		Mitragyna hirsuta Hav.	
		Dalbergia herrida, Var.glabrescens	
		Raphanus sativus	
		Samandura harmandii Pierre	
		Phragmites karka	
		Crateva andansonii Subsp odorata	
		Ixora cuneifolia	
		Croton caudatus	
		Breynia rhamnoides	
		Hymnocardia wallichii	
		Barringtonia asiatica	
		Zizyphus oenoplia mill	
		Passiflora foetida Passifloraceae	
		Dalbergia nigrescens, Varsaigonensis	
		Sesbania javanica	
		Gmelina asiatica	
		(Stixis obusifolia)	
		Cayratia trifolia	
		Merremia hederacea	
		Derris trifolia	
		(3 unknown species)	

2 Planted Trees along Road

Table 3 Name and Numbers of Road Side Trees of NR5 from Tlea Ma'am to Battambang

(Survey Month: July and December, 2013)

Name and Number of Road Side Trees on Northeast Side of Road					
Kilometer Post (KP)	Communes	Provinces	Scientific Name	Diameter of Tree (m)	Quantity
171 to 177+280	Boeung Kantaout	Pursat (PST)	*Sindora cochinchinensis*	0.1 to 0.6	1
			Delonix regia, (Boj. Ex Hook)		2
			Feroniella lucida Scheff.		4
			Dialium cochinchinensis		11
			Borassus flabellifer		1

			Lagerstroemia floribunda		2
			Eucalyptus camaldulensis		42
			Azadirachta indica		1
			Acacia auriculiformis, A.		157
			Samanea saman		2
177+285 to 183	Prey Nhi	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 1	9
			Acacia auriculiformis, A..		392
190+200 to 191+132	Phtesh Prey	PST	*Dialium cochinchinensis*	0.1	1
191+132 to 198+875	Snam Preah	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.6	5
			Dialium cochinchinensis		2
			Combretum quadrangulare Kurz		1
			Acacia auriculiformis, A.		11
			Samanea saman		1
198+875 to 206+150	Trapaing Chong	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	1
			Dialium cochinchinensis		11
			Eucalyptus camaldulensis		2
			Acacia auriculiformis, A.		2
206+150 to 213+670	Boeung Khna	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	4
			Feroniella lucida Scheff.		1
			Acacia auriculiformis, A.		37
213+670 to 217+840	O-Tapaong	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.13	2
			Feroniella lucida Scheff.		1
			Butea monosperma (Lam.)		3
			Acacia auriculiformis, A.		4
			Samanea saman		5
217+840 to 221+470	Svay Daun Keo	PST	*Dialium cochinchinensis*	0.1 to 0.2	4
			Butea monosperma (Lam.)		1
			Eugenia sp.		1
			Acacia auriculiformis, A.		60
			Samanea saman		3
Total Quantity of Road Side Trees on Northeast Side in Pursat Province					787
221+470 to 228+040	Russei Kraing	Battambang (BTB)	*Leucaena glauca Benth.*	0.1 to 0.2	2
			Delonix regia, (Boj. Ex Hook)		38
			Dialium cochinchinensis		4
			Eucalyptus camaldulensis		120
			Eugenia sp.		6
			Acacia auriculiformis, A.		91
			Samanea saman		38
228+040 to 240+030	Prey Svay	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.3	100
			Dialium cochinchinensis		3
			Eucalyptus camaldulensis		25
			Eugenia sp.		1
			Acacia auriculiformis, A.		55
			Samanea saman		50
240+030 to 250+960	Kea	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.3	2
			Swietenia macrophylla King		2
			Terminalia catappa L.		2
			Borassus flabellifer		1
			Peltophorum ferrugineum		11

			Eucalyptus camaldulensis		1
			Barringtonia acutangula		4
			Acacia auriculiformis, A.		37
			Samanea saman		31
250+960 to 255+600	Kokoh	BTB	*Leucaena glauca Benth.*	0.1 to 0.6	2
			Delonix regia, (Boj. Ex Hook)		2
			Mitragyna hirsuta Hav.		1
			Butea monosperma (Lam.)		1
			Terminalia catappa L.		1
			Borassus flabellifer		1
			Peltophorum ferrugineum		8
			Eugenia sp.		1
			Combretum quadrangulare Kurz		6
			Acacia auriculiformis, A.		1
			Samanea saman		8
255+600 to 264+620	Prey Touch	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.4	38
			Ceiba pentandra, (L.) G		15
			Butea monosperma (Lam.)		7
			Borassus flabellifer		13
			Peltophorum ferrugineum		12
			Eucalyptus camaldulensis		1
			Eugenia sp.		11
			Bombax ceiba L.		1
			Combretum quadrangulare Kurz		3
			Azadirachta indica		1
			Acacia auriculiformis, A.		131
			Samanea saman		100
264+620 to 271+900	Kampong Preang	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.6	102
			Ceiba pentandra, (L.) G		4
			Butea monosperma (Lam.)		7
			Terminalia catappa L.		2
			Borassus flabellifer		13
			Peltophorum ferrugineum		13
			Eucalyptus camaldulensis		45
			Eugenia sp.		8
			Barringtonia acutangula		2
			Cassia fistula		41
			Azadirachta indica		1
			Sesbania grandiflora		1
			Acacia auriculiformis, A.		29
			Samanea saman		106
271+900 to 280+460	Kampong Preah	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.5	136
			Mitragyna hirsuta Hav.		1
			Feroniella lucida Scheff.		1
			Ceiba pentandra, (L.) G		4
			Butea monosperma (Lam.)		3
			Terminalia catappa L.		14
			Morinda citrifolia		2
			Borassus flabellifer		19

			Peltophorum ferrugineum		3
			Eucalyptus camaldulensis		4
			Eugenia sp.		4
			Tectona grandis L. f.		1
			Cassia fistula		96
			Combretum quadrangulare Kurz		6
			Azadirachta indica		2
			Streblus asper Lour.		1
			Cassia siamea		4
			Sesbania grandiflora		2
			Acacia auriculiformis, A.		39
			Samanea saman		52
			(Unknown Species)		2
280+460 to 282+200	Along Vill	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.4	35
			Ceiba pentandra, (L.) G		1
			Butea monosperma (Lam.)		1
			Terminalia catappa L.		1
			Eugenia sp.		2
			Cassia fistula		15
			Combretum quadrangulare Kurz		4
			Azadirachta indica		1
			Cassia siamea		1
			Acacia auriculiformis, A.		7
			Samanea saman		7
Total Quantity of Road Side Trees on Northeast Side in Battambang Province					1,834
Total on Northeast Side					2,621

Name and Number of Road Side Trees on Southwest Side of Road

Kilometer Post (KP)	Communes	Provinces	Scientific Name	Diameter of Tree (m)	Quantity
171 to 177+280	Tnaot Chum	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	1
			Dipterocarpus obtusifolou		2
			Eucalyptus camaldulensis		7
			Acacia auriculiformis, A.		37
177+280 to 183+000	Roleab	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.12	12
			Azadirachta indica		1
			Acacia auriculiformis, A.		291
190+200 to 191+138	Svay Ath	PST	*Dialium cochinchinensis*	0.1	5
191+138 to 198+875	Snam Preah	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.6	4
			Dialium cochinchinensis		1
			Acacia auriculiformis, A.		5
			Samanea saman		1
198+875 to 206+150	Trapaing Chuong	PST	*Delonix regia, (Boj. Ex Hook)*	0.1	1
			Dialium cochinchinensis		7
			Acacia auriculiformis, A.		4
206+150 to 213+460	Boeung Khna	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	2
			Feroniella lucida Scheff.		1
			Dialium cochinchinensis		3
			Eucalyptus camaldulensis		1
			Acacia auriculiformis, A.		7
213+460 to 217+840	O-Tapaong	PST	*Leucaena glauca Benth.*	0.1 to 0.2	1

			Ceiba pentandra, (L.) G		1
			Butea monosperma (Lam.)		14
			Eucalyptus camaldulensis		1
			Samanea saman		4
217+840 to 221+470	Svay Daun Keo	PST	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	1
			Butea monosperma (Lam.)		1
			Eucalyptus camaldulensis		1
			Acacia auriculiformis, A.		25
			Samanea saman		4
Total Quantity of Road Side Trees on Southwest Side in Pursat Province					446
221+470 to 228+040	Russei Kraing	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.2	6
			Feroniella lucida Scheff.		1
			Borassus flabellifer		18
			Eucalyptus camaldulensis		337
			Eugenia sp.		7
			Acacia auriculiformis, A.		44
			Samanea saman		15
228+040 to 240+030	Prey Svay	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.3	81
			Eucalyptus camaldulensis		46
			Eugenia sp.		2
			Acacia auriculiformis, A.		65
			Samanea saman		37
240+030 to 244+380	Kea	BTB	*Acacia auriculiformis, A.*	0.1 to 0.12	81
			Samanea saman		15
244+380 to 250+390	Moung	BTB	*Peltophorum ferrugineum*	0.1 to 0.4	8
			Combretum quadrangulare Kurz		1
			Acacia auriculiformis, A.		3
			Samanea saman		5
250+390 to 255+600	Kokoh	BTB	*Borassus flabellifer*	0.1 to 0.3	5
			Peltophorum ferrugineum		2
			Schleicheria trijuga, Wi		4
			Eugenia sp.		2
			Barringtonia acutangula		2
			Cassia fistula		1
			Combretum quadrangulare Kurz		1
			Acacia auriculiformis, A.		15
			Samanea saman		9
255+600 to 264+620	Prey Touch	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.4	27
			Ceiba pentandra, (L.) G		10
			Butea monosperma (Lam.)		5
			Terminalia catappa L.		3
			Borassus flabellifer		21
			Peltophorum ferrugineum		2
			Eucalyptus camaldulensis		17
			Eugenia sp.		9
			Cassia fistula		6
			Combretum quadrangulare Kurz		1
			Sesbania grandiflora		2
			Acacia auriculiformis, A.		110

			Samanea saman		83
			(Unknown Species)		3
264+620 to 272+950	Kampong Preang	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.6	105
			Ceiba pentandra, (L.) G		12
			Butea monosperma (Lam.)		6
			Terminalia catappa L.		4
			Borassus flabellifer		20
			Peltophorum ferrugineum		11
			Eucalyptus camaldulensis		43
			Eugenia sp.		18
			Cassia fistula		60
			Combretum quadrangulare Kurz		3
			Azadirachta indica		1
			Sesbania grandiflora		1
			Acacia auriculiformis, A.		47
			Samanea saman		133
272+950 to 280+245	Kampong Preah	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.5	142
			Mitragyna hirsuta Hav.		4
			Ceiba pentandra, (L.) G		12
			Swietenia macrophylla King		1
			Butea monosperma (Lam.)		5
			Terminalia catappa L.		7
			Borassus flabellifer		17
			Peltophorum ferrugineum		4
			Eucalyptus camaldulensis		8
			Eugenia sp.		12
			Barringtonia acutangula		4
			Cassia fistula		46
			Combretum quadrangulare Kurz		10
			Streblus asper Lour.		3
			Cassia siamea		6
			Sesbania grandiflora		1
			Acacia auriculiformis, A.		32
			Samanea saman		71
280+245 to 282+200	O-Tambang-2	BTB	*Delonix regia, (Boj. Ex Hook)*	0.1 to 0.5	17
			Feroniella lucida Scheff.		1
			Butea monosperma (Lam.)		1
			Terminalia catappa L.		4
			Borassus flabellifer		7
			Peltophorum ferrugineum		3
			Cassia fistula		3
			Combretum quadrangulare Kurz		1
			Acacia auriculiformis, A.		137
			Samanea saman		6
			(Unknown Species)		2
Total Quantity of Road Side Trees on Southwest Side in Battambang					2,143
Total on Southwest Side					2,589
Total on Both Sides					**5,210**

Table 4 Name and Numbers of Road Side Trees of NR5 from Sri Sophorn to Poipet

(Survey Month: August and December, 2013)

Name and Number of Road Side Trees on Northeast Side of Road				
Kilometer Post (KP)	Communes	Scientific Name	Diameter of Tree (m)	Number
366+250 to 371+477	Teuk Thla	*Delonix regia, (Boj. Ex Hook)*	0.10 to 0.52	1
		Cassia fistula		2
		Pinus merkusii		1
		Acacia auriculiformis, A.		76
		Samanea saman		12
371+477 to 372+931	Chang Ngha	*Acacia auriculiformis, A.*	0.10 to 0.30	3
		Samanea saman		4
372+931 to 383+497	Kob	*Ceiba pentandra, (L.) G*	0.10 to 0.83	12
		Terminalia catappa L.		4
		Morinda citrifolia		1
		Borassus flabellifer		1
		Peltophorum ferrugineum		33
		Eucalyptus camaldulensis		4
		Ficus religiosa, L.		3
		Eugenia sp.		18
		Bombax ceiba L.		1
		Cassia fistula		19
		Cassia siamea		3
		Sesbania grandiflora		13
		Acacia auriculiformis, A.		24
		Samanea saman		59
		(Unknown Species)		13
383+497 to 394+930	Nimith	*Delonix regia, (Boj. Ex Hook)*	0.10 to 0.79	11
		Dalbergia entadoides Pierre		2
		Ceiba pentandra, (L.) G		10
		Swietenia macrophylla King		1
		Butea monosperma (Lam.)		1
		Terminalia catappa L.		7
		Borassus flabellifer		6
		Lagerstroemia floribunda		1
		Peltophorum ferrugineum		11
		Eugenia sp.		17
		Bombax ceiba L.		2
		Cassia fistula		24
		Combretum quadrangulare Kurz		1
		Pinus merkusii		3
		Cassia siamea		1
		Sesbania grandiflora		9
		Acacia auriculiformis, A.		45
		Samanea saman		55
		(Unknown Species)		6
394+930 to 402+000	Phsa Kandal	*Ceiba pentandra, (L.) G*	0.10 to 1	1
		Swietenia macrophylla King		1
		Morinda citrifolia		1
		Ficus religiosa, L.		8
		Eugenia sp.		2

		Combretum quadrangulare Kurz		1
		Acacia auriculiformis, A.		65
		Samanea saman		4
		(Unknown Species)		16
			Total on Northeast Side	619
Name and Number of Road Side Trees on Southwest Side of Road				
	Communes	Scientific Name	Diameter of Tree (m)	Number
366+250 to 371+084	Teuk Thla	*Ceiba pentandra, (L.) G*	0.10 to 0.52	1
		Peltophorum ferrugineum		4
		Eugenia sp.		1
		Combretum quadrangulare Kurz		1
		Acacia auriculiformis, A.		30
		Samanea saman		8
371+084 to 372+931	Samrong	*Mitragyna hirsuta Hav.*	0.10 to 0.30	1
		Acacia auriculiformis, A.		3
		Samanea saman		3
372+931 to 383+497	Kob	*Delonix regia, (Boj. Ex Hook)*	0.10 to 0.83	12
		Ceiba pentandra, (L.) G		2
		Terminalia catappa L.		6
		Borassus flabellifer		3
		Peltophorum ferrugineum		15
		Eucalyptus camaldulensis		1
		Schleicheria trijuga, Wi		2
		Eugenia sp.		11
		Ficus sp		1
		Cassia fistula		9
		Pinus merkusii		4
		Cassia siamea		6
		Sesbania grandiflora		11
		Acacia auriculiformis, A.		20
		Samanea saman		40
		(Unknown Species)		3
383+497 to 397+000	Nimith	*Delonix regia, (Boj. Ex Hook)*	0.10 to 1	4
		Butea monosperma (Lam.)		4
		Terminalia catappa L.		20
		Bauhinia acuminata		1
		Morinda citrifolia		1
		Borassus flabellifer		4
		Diospyros helferi		1
		Peltophorum ferrugineum		4
		Ficus religiosa, L.		1
		Eugenia sp.		9
		Cassia fistula		23
		Combretum quadrangulare Kurz		2
		Azadirachta indica		1
		Cassia siamea		7
		Sesbania grandiflora		10
		Acacia auriculiformis, A.		13
		Samanea saman		21

		(Unknown Species)		9
		(Unknown Species)		2
397+000 to 402+000	Phsa Kandal	*Dalbergia entadoides Pierre*	0.10 to 1	1
		Ceiba pentandra, (L.) G		4
		Acacia intsii		1
		Peltophorum ferrugineum		12
		Dipterocarpus intricatus		1
		Pterocarpus pedatus		2
		Eucalyptus camaldulensis		18
		Ficus religiosa, L.		2
		Eugenia sp.		3
		Combretum quadrangulare Kurz		2
		Sesbania grandiflora		2
		Acacia auriculiformis, A.		32
			Total on Southwest Side	415
			Total on Both Sides	**1,034**

APPENDIX 15-2

LIST OF FAUNA

1 Mammal

Table 1 Identified Mammals in Project Area

(Survey area: 150 m + 150 m from Road center, Survey Month: July, August and December, 2013)

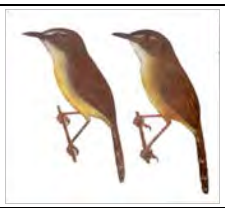
No.	Scientific Name	English Name	Kilometer Post (KP)	Remarks	Pictures
1	*Herpestes javanicus*	Small Asiun Mongoose	172 to 179 191 to 194		
2	*Tamiops rodolphii*	Cambodian Striped Tree Squirrel	171 to 175 277 to 282 373 to 392		
3	*(Order: CHIROPTERA)*	Bats	171 to 282+300 366 to 407+300 (Rattanak Nimit, Yeang Thmey village)		
4	*Otonops wroughtoni*	Wroughton's Free-tailed Bat	214 to 216 366 to 407+300 (Rattanak Nimit, Yeang Thmey village)	R	
5	*Pteropus lylei*	Lyle's Flying-fox	218 to 222	II	
6	*Pteropus hypomelanus*	Island Flying-fox	366 to 404	II	
7	*Cynopterus sphinx*	Lesser Short-nosed Fruit Bat	373 to 403		
8	*Cynopterus brachyotis*	Lesser Short-nosed Fruit Bat	373 to 405		

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Endangered species (En), Rare species (R), Critically endangered species (Cr) and Vulnerable species (Vu) classified by forest administration in Cambodia.

2 Bird

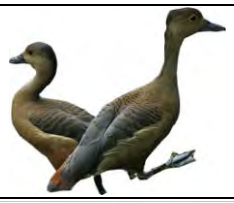
Table 2 Identified Birds in Project Area

(Survey area: 150 m + 150 m from Road center, Survey Month: July, August and December, 2013)

No.	Scientific Name	English Name	Kilometer Post (KP)	Remarks	Pictures
1	*Caprimulgus indicus*	Grey Nightjar	172 to 181, 192 to 194, 248 to 278		
2	*Emberiza aureola*	Yellow-breasted Bunting	217 to 236		
3	*Prinia rufescens*	Rufescent Prinia	171 to 282 366 to 407		
4	*Orthotomus sutorius*	Common Tailorbird	171 to 282 366 to 407		
5	*Passer montanus*	Eurasian Tree Sparrow	171 to 282 366 to 407		
6	*Passer flaveolus*	Plain-backed Sparrow	217 to 223 372 to 402		
7	*Passer domesticus*	House Sparrow	171 to 282 366 to 407		
8	*Pycnonotus goiavier*	Yellow-vented Bulbul	171 to 282 366 to 404		

9	*Anastomus oscitans*	Asian Openbill	217 to 230 397 to 402		
10	*Corvus macrohynchos*	Large-billed Crow	247 to 259 397 to 402		
11	*Dicrurus macrocercus*	Black Drongo	171 to 183 190 to 244 246 to 282 366 to 402		
12	*Tyto alba*	Barn Owl	171 to 282 366 to 402	II	
13	*Gallinago gallinago*	Common Snipe	217 to 224		
14	*Rhipidura javanica*	Pied Fantail	171 to 282 374 to 403		
15	*Rhipidura albicollis*	White-throated Fantail	171 to 282 374 to 402		
16	*Alcedo atthis*	Common Kingfisher	219 to 223 255 to 257 366 to 371		
17	*Lacedo pulchella*	Banded Kingfisher	219 to 223 255 to 257 366 to 371		

18	*Gallicrex cinerea*	Watercock	215 to 223 254 to 256 273 to 274 366 to 402		
19	*Bubulcus ibis*	Cattle Egret	172 to 179 215 to 223 254 to 256 273 to 274 366 to 402	III	
20	*Egretta alble*	Great Egret	221 to 224 370 to 375 397 to 402	III	
21	*Ixobrychus cinnamomeus*	Cinnamon Bittern	172 to 179 215 to 223 254 to 256 273 to 274 366 to 402		
22	*Ardeola bacchus*	Javan Pond Heron	172 to 179 215 to 223 254 to 256 273 to 274 366 to 383 388 to 402		
23	*Ixobrychus sinensis*	Yellow Bittern	172 to 179 215 to 223 254 to 256 273 to 274 370 to 375 397 to 402		
24	*Streptopelia chinensis*	Spotted Dove	171 to 282 366 to 405		
25	*Streptopelia tranquebarica*	Red Collared Dove	171 to 282 366 to 405		
26	*Geopelia striata*	Zebra Dove	173 to 179 192 to 200 214 to 221 245 to 260 366 to 405		

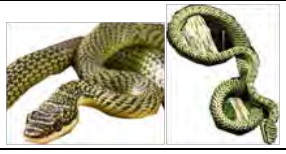
27	*Gallinula chloropus*	Common Moorhen	172 to 179 215 to 223 254 to 256 273 to 274 366 to 372 395to 402		
28	*Dendrocygna javanica*	Lesser Whistling Duck	217 to 223 254 to 258 273 to 274 366 to 372 395to 402		
29	*Cypsiurus balasiensis*	Asian Palm Swift	171 to 282 366 to 402		
30	*Acridotheres tristis*	Common Myna	171 to 282 366 to 402		
31	*Acridotheres javanicus*	White-vented Myna	214 to 223		
32	*Coracias benghalensis*	Indian Roller	171 to 183		
33	*Elanus coeruleus*	Black-shouldered Kite	214 to 216 366 to 402	II	
34	*Lanius cristatus*	Brown Shrike	216 to 219		
35	*Anthus rufulus*	Paddy field Pipit	366 to 403		

36	*Caprimulgus macrurus*	Large-tailed Nightjar	366 to 403		
37	*Ploceus philippinus*	Baya Weaver	366 to 403		
38	*Lonchura punctulata*	Scaly-breasted Munia	366 to 403		
39	*Acrocephalus bistrigiceps*	Black-browed Reed Warbler	366 to 403		
40	*Acrocephalus aedon*	Thick-billed Warbler	366 to 403		
41	*Dupetor flavicollis*	Black Bittern	396 to 402		
42	*Phalacrocorax niger*	Little Cormorant	366 to 383 388 to 402		
43	*Merops viridis*	Blue-throated Bee-eater	394 to 402		
44	*Hypsipetes leucocephalus*	Black Bulbul	394 to 402		

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Endangered species (En), Rare species (R), Critically endangered species (Cr) and Vulnerable species (Vu) classified by forest administration in Cambodia.

3 Reptile and Amphibian

Table 3 Identified reptiles and amphibians in Project Area
(Survey area: 150 m + 150 m from Road center, Survey Month: July, August and December, 2013)

No.	Scientific Name	English Name	Kilometer Post (KP)	Remarks	Pictures
1	*Calotes versicolor*	Garden Fence Lizard	171 to 282 366 to 405		
2	*Ahaetulla nasuta*	Long-nosed Whip Snake	177 to 179 191 to194 246 to 258 366 to 405		
3	*Ahaetulla prasina*	Oriental Whip Snake	177 to 179 191 to194 246 to 258 366 to 372 389 to 402		
4	*Boiga cyanea*	Green Cat Snake	177 to 179 191 to194 246 to 258 366 to 372 389 to 402		
5	*Cylindrophis ruffus*	Red-tailed Pipe Snake	171 to 185 188 to 201 204 to 282 366 to 402		
6	*Daboia russelli*	Russell's Viper	212 to 243 246 to 282 366 to 370		
7	*Dendrelaphis subocularis*	Mountain Bronzeback	171 to 185 188 to 201 204 to 282 366 to 402		
8	*Chrysopelea ornata*	Golden Tree Snake	171 to 185 188 to 201 204 to 282 366 to 405		
9	*Naja kaouthia*	Monocled Cobra	171 to 185 188 to 201 204 to 282 366 to 372 388 to 402	II, R	
10	*Naja siamensis*	Indochinese Spitting Cobra	171 to 185 188 to 201 204 to 282 366 to 405	II	

11	*Oligodon taeniatus*	Striped Kukri Snake	171 to 185 188 to 201 204 to 282 366 to 405		
12	*Ptyas korros*	Indochinese Rat Snake	171 to 185 188 to 201 204 to 282 366 to 372 388 to 402		
13	*Xenochrophis piscator*	Chequered Keelback	171 to 282 366 to 372 388 to 402		
14	*Xenochrophis piscator*	Chequered Keelred	Pursat Bypass Section 366 to 372 388 to 402		
15	*Xenopeltis unicolor*	Sunbeam Snake	211 to 215 217 to 219 366 to 372 388 to 402		
16	*Enhydris bocourti*	Bocourt's Watersnake	177 to 179, 219 to 224, 247 to 256		
17	*Enhydris enhydris*	Rainbow Water Snake	171 to 185 188 to 201 204 to 282 366 to 372		
18	*Elaphe radiata*	Radiated Rat Snake	217 to 219 366 to 372 388 to 402		
19	*Enhydris longicauda*	Tonle Sap Watersnake	366 to 370		
20	*Ptyas carinata*	Keeled Rat Snake	366 to 372 388 to 402		
21	*Gekko gecko*	Tokay Gecko	171 to 282 366 to 405		
22	*Cosymbotus platyurus*	Flat-tailed Gecko	171 to 282 366 to 407		

23	*Scincella reevesii*	Speckled Leaf-litter Skink	171 to 282 366 to 405		
24	*Mabuya multifasciata*	Many-lined Sun Skink	171 to 282 366 to 405		
25	*Polypedates cf. leucomystax*	Common Tree Frog	171 to 282 366 to 404		
26	*Bufo melanosstictus*	Common Asian Toad	171 to 282 366 to 405		
27	*Kaloula pulchra*	Banded Bullfrog	171 to 282 366 to 405		
28	*Glyphoglossus molossus*	Truncate snouted spadefoot frog	212 to 243 246 to 282 366 to 405		
29	*Fejervarga limnocharis*	Rice Field Frog	171 to 185 187 to 243 246 to 282 366 to 405		
30	*Limnonectes ibanorum*	Rough Backed River Frog	171 to 185 187 to 243 246 to 282 366 to 372 388 to 402		
31	*Hoplobatrachus tigerinus*	Tiger Frog	171 to 185 187 to 243 246 to 282 366 to 372 388 to 402		

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Endangered species (En), Rare species (R), Critically endangered species (Cr) and Vulnerable species (Vu) classified by forest administration in Cambodia.

4 Fish

Table 4 Identified Fishes in Project Area

Survey Rivers or Water Bodies

Middle Section: Pursat River, Svay Daun Keo River, Maung River, Chork River and Ou Sandas (Sandas Stream)

Sri Sophorn – Poipet Section (SPS): Sri Sophorn River and Agricultural canals

Survey Month

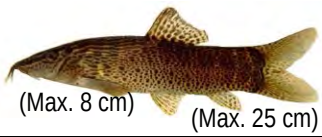
Middle Section: July, August, November and December, 2013

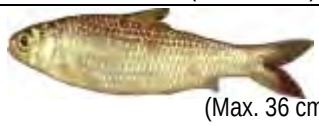
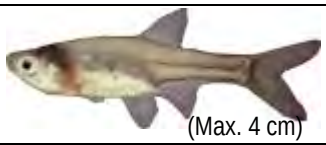
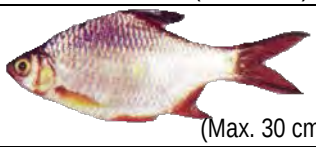
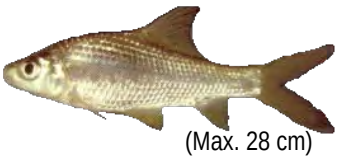
Sri Sophorn – Poipet Section (SPS): August, September, November and December, 2013

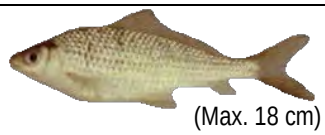
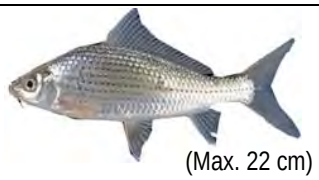
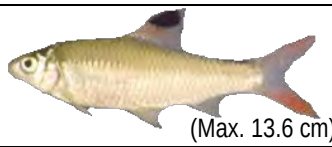
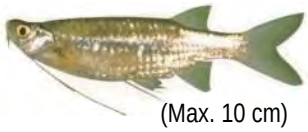
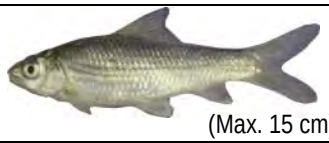
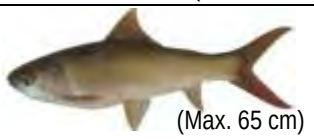
No	Food and Agriculture Organization name	Scientific Name	Family Name	River Name	Remarks	Picture
1	Duskyfin glassy perchlet	*Parambassis wolffii*	AMBASSIDAE	Pursat Moung Chork O Sandas		 (Max. 20 cm)
2	Siamese glassfish	*Pseudambassis siamensis*	AMBASSIDAE	Pursat Svay Donkeo Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 6 cm)
3	Inridescent glassy perclet	*Parambassis apogonoides*	AMBASSIDAE	Pursat Moung Sri Sophorn		 (Max. 10 cm)
4	Climbing perch	*Anabas testudineus*	ANABANTIDAE	Svay Donkeo Chork, Moung O Sandas Sri Sophorn Canals in SPS		 (Max. 25 cm)
5		*Mystus wolffi*	BAGRIDAE	Pursat Chork		 (Max. 20 cm)
6		*Mystus singaringan*	BAGRIDAE	Pursat Chork Sri Sophorn		 (Max. 35 cm)
7		*Mystus albolineatus*	BAGRIDAE	Moung Chork O Sandas		 (Max. 35 cm)
8		*Mystus bocouti*	BAGRIDAE	Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 24 cm)

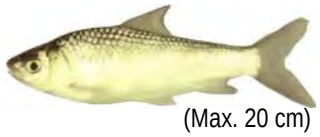
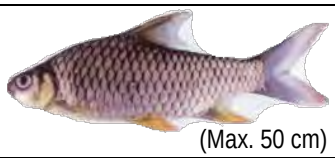
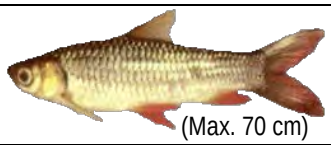
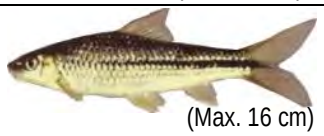
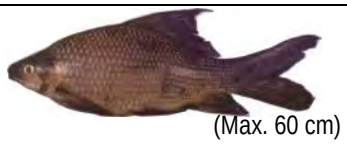
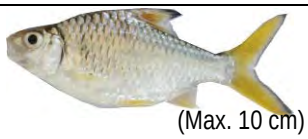
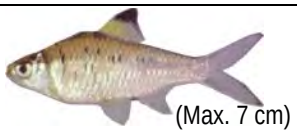
9	Asian bumblebee catfish	*Pseudomystus siamensis*	BAGRIDAE	Pursat Svay Donkeo Chork Sri Sophorn		 (Max. 20 cm)
10	false black lancer	*Bagrichthys obscurus*	BAGRIDAE	Svay Donkeo O Sandas		 (Max. 30 cm)
11		*Mystus atrifasciatus*	BAGRIDAE	Pursat O Sandas Sri Sophorn Canals in SPS		 (Max. 15 cm)
12	Striped catfish	*Mystus mysticetus*	BAGRIDAE	Svay Donkeo Moung O Sandas Sri Sophorn Canals in SPS		 (Max. 13 cm)
13	Striped catfish	*Mystus myaticetus*	BAGRIDAE	Sri Sophorn Canals in SPS		 (Max. 14 cm)
14		*Hemibagrus spilopterus*	BAGRIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn		 (Max. 31 cm)
15		*Hemibagrus filamentus*	BAGRIDAE	Pursat (Damnak Ampil upstream) O Sandas		 (Max. 60 cm)
16		*Hemibagrus nemurus*	BAGRIDAE	Sri Sophorn Canals in SPS		 (Max. 65 cm)
17		*Hemibagrus wyckioides*	BAGRIDAE	Pursat O Sandas Sri Sophorn		 (Max. 130 cm)
18		*Xenentodon cancila*	BELONIDAE	Pursat Svay Donkeo, Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 40 cm)
19	Talking gourami	*Trichopsis pumila*	BELONTIIDAE	Svay Donkeo Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 4 cm)

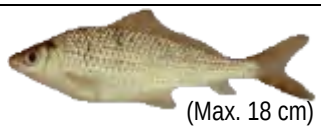
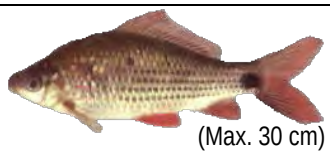
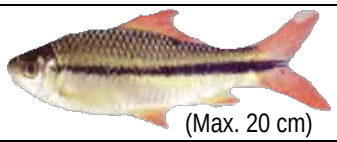
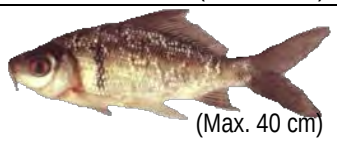
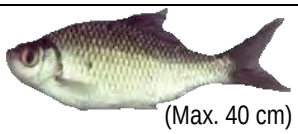
20	Croaking gourami	*Trichopsis vittata*	BELONTIIDAE	Svay Donkeo Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 7 cm)
21	Siamese fighting	*Batta splendens*	BELONTIIDAE	Svay Donkeo Chork Sri Sophorn		 (Max. 6.5 cm)
22	Walking snakehead	*Channa orientalis*	CHANNIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn Canals in SPS		 (Max. 20 cm)
23	Giant snakehead	*Channa micropeltes*	CHANNIDAE	Pursat Svay Donkeo Chork O Sandas Sri Sophorn		 (Max. 130 cm)
24	Snackehead murrel	*Channa striata*	CHANNIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 100 cm)
25	Nile tilapia	*Oreochromis niloticus*	CICHLIDAE	Pursat		 (Max. 46 cm)
26		*Clarias nieuhofi*	CLARIIDAE	Pursat O Sandas Sri Sophorn		 (Max. 50 cm)
27	Walking catfish	*Clarias batrachus*	CLARIIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 47 cm)
28	Broad head catfish	*Clarias macrocephalus*	CLARIIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 35 cm)
29	Blackskin catfish	*Clarias meladerma*	CLARIIDAE	Pursat Chork O Sandas Sri Sophorn		 (Max. 35 cm)

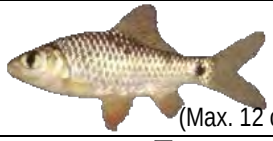
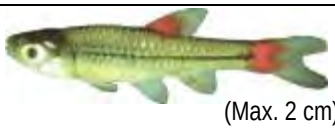
30	Dwaf houseface	*Lepidocephalichthys birmanicus*	COBITIDAE	Pursat		 (Max. 11 cm)
31		*Lepidocephalichthys berdmorei*	COBITIDAE	Pursat		 (Max. 11 cm)
32	Striped horseface loach	*Acantopsis sp. 2*	COBITIDAE	Pursat Sri Sophorn		 (Max. 13 cm)
33	Spotted horseface loach	*Acantopsis sp. "Large spot"*	COBITIDAE	Pursat		 (Max. 12 cm)
34		*Acantopsis sp. "Stripe"*	COBITIDAE	Pursat Chork		 (Max. 35 cm)
35		*Acanthopsoides hapalias*	COBITIDAE	Sri Sophorn		 (Max. 6 cm)
36		*Pangio anguillaris*	COBITIDAE	Pursat		 (Max. 9 cm)
37	Silver botia	*Botia lecontei*	COBITIDAE	Pursat		 (Max. 15 cm)
38	Chameleon botia	*Botia nigrolineata*	COBITIDAE	Sri Sophorn		 (Max. 8 cm)
39	Dwarf botia	*Yasuhikotakia sidthimunki*	COBITIDAE	Sri Sophorn		 (Max. 5.5 cm)
40	Chameleon botia	*Syncrossus beauforti*	COBITIDAE	Sri Sophorn		 (Max. 8 cm)
41	Chameleon loach	*Syncrossus beauforti*	COBITIDAE	Pursat (Damnak Ampil Upstream)		 (Max. 8 cm) (Max. 25 cm)
42	Skunk botia	*Yasuhikotakia morleti*	COBITIDAE	Pursat Sri Sophorn		 (Max. 9.5 cm)
43		*Yasuhikotakia caudipunctata*	COBITIDAE	Pursat		 (Max. 9 cm)

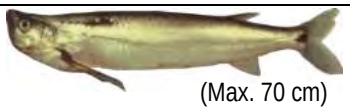
44	Speckletail botia	*Botia sp. juvenile*	COBITIDAE	Pursat Sri Sophorn		 (Max. 20 cm)
45	Tiger botia	*Syncrossus helodes*	COBITIDAE	Pursat		 (Max. 35 cm)
46	Orangefin loach	*Yasuhikotakia modesta*	COBITIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn		 (Max. 25 cm)
47		*Albulichthys albuloides*	CYPRINIDEA	Sri Sophorn		 (Max. 36 cm)
48		*Amblypharyngodon chulabomae*	CYPRINIDEA	Sri Sophorn		 (Max. 4 cm)
49	Tinfoil barb	*Barbodes schwanefeldi*	CYPRINIDAE	Pursat Moung Chork		 (Max. 30 cm)
50	Bangkok river sprat	*Corica laciniata*	CYPRINIDAE	Pursat Moung		 (Max. 7 cm)
51	Beardless barb	*Cyclocheilichthys apogon*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 15 cm)
52		*Cyclocheilicthys repasson*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 28 cm)
53		*Cyclocheilichthys lagleri*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas		 (Max. 23 cm)
54		*Cyclocheilichthys enoplos*	CYPRINIDAE	Pursat Sri Sophorn		 (Max. 75 cm)

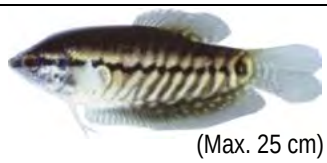
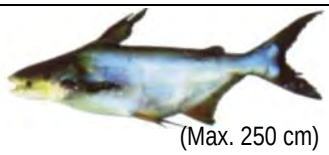
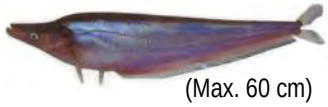
55		*Labiobarbus Lineatus*	CYPRINIDAE	Pursat Svay Donkeo Chork		 (Max. 18 cm)
56	Siamese long fin carp	*Labiobarbus siamensis*	CYPRINIDAE	Pursat Svay Donkeo Chork O Sandas		 (Max. 22 cm)
57	Redtail barb	*Discherodontus ashmeadi*	CYPRINIDAE	Moung Chork O Sandas		 (Max. 13.6 cm)
58	Esomus goddardi	*Esomus longimanus*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 10 cm)
59	Striped flying bard	*Esomus metallicus*	CYPRINIDAE	Sri Sophorn, Canals in SPS		 (Max. 7.5 cm)
60		*Crossocheilus reticulatus*	CYPRINIDAE	Pursat		 (Max. 15 cm)
61		*Crossocheilus atrilimes*	CYPRINIDEA	Sri Sophorn		 (Max. 16 cm)
62		*Hampala dispar*	CYPRINIDAE	Pursat Moung O Sandas		 (Max. 35 cm)
63		*Hampala macrolepidota*	CYPRINIDAE	Pursat Svay Donkeo O Sandas Sri Sophorn		 (Max. 70 cm)
64	Cirrhinus lineatus	*Henicorhynchus cryptopogon*	CYPRINIDAE	Pursat Svay Donkeo		 (Max. 15 cm)
65	Labeo pruol	*Cirrhinus microlepis*	CYPRINIDAE	Sri Sophorn		 (Max. 65 cm)

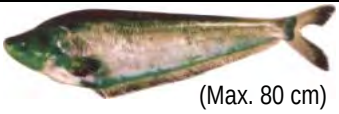
66	Siamese mud carp	*Henicorhynchus siamensis*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 20 cm)
67	Tawes	*Barbodes gonionotus*	CYPRINIDAE	Pursat Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 33 cm)
68	Goldfin tinfoil barb	*Hypsibarbus malcolmi*	CYPRINIDAE	Pursat O Sandas		 (Max. 50 cm)
69		*Hypsibarbus wetmorei*	CYPRINIDAE	Pursat Svay Donkeo O Sandas Sri Sophorn Canals in SPS		 (Max. 25 cm)
70	Mad barb	*Leptobarbus hoeveni*	CYPRINIDAE	Pursat Chork O Sandas Sri Sophorn		 (Max. 70 cm)
71	Loboheilus nigrovittantus	*Lobocheilos melanotaenia*	CYPRINIDAE	Pursat Svay Donkeo O Sandas Sri Sophorn Canals in SPS		 (Max. 16 cm)
72	Luciosoma bleekeri	*Luciosoma bleekeri*	CYPRINIDAE	Pursat Sri Sophorn		 (Max. 26 cm)
73	Black sharkminnow	*Morulius chrysophekadion*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn Canals in SPS		 (Max. 60 cm)
74	Mystacoleucus chilopterus	*Mystacoleucus marginatus*	CYPRINIDAE	Pursat		 (Max. 10 cm)
75		*Mystacoleucus sp.*	CYPRINIDAE	Pursat (Damnak Ampil upstream)		 (Max. 7 cm)
76		*Labeo erythropterus*	CYPRINIDAE	Sri Sophorn Canals in SPS		 (Max. 45 cm)

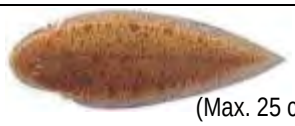
77		*Labiobarbus Lineatus*	CYPRINIDAE	Sri Sophorn, Canals in SPS		 (Max. 18 cm)
78	Silver sharkminnow	*Osteochilus hasselti*	CYPRINIDAE	Pursat Savy Donkeo Chork O Sandas Sri Sophorn		 (Max. 30 cm)
79	Labeo soplaoensis	*Osteochilus waandersi*	CYPRINIDAE	Pursat O Sandas		 (Max. 20 cm)
80	Bonylip barb	*Osteochilus microcephalus*	CYPRINIDAE	Say Donkeo Chork O Sandas Sri Sophorn		 (Max. 24 cm)
81		*Osteochilus melanopleurus*	CYPRINIDAE	Pursat Svay Donkeo O Sandas Sri Sophorn		 (Max. 40 cm)
82	Grey bony-lip carp	*Osteochilus schlegeli*	CYPRINIDAE	Svay Donkeo Chork Sri Sophorn		 (Max. 40 cm)
83		*Paralaubuca typus*	CYPRINIDAE	Pursat Moung Chork O Sandas Sri Sophorn		 (Max. 18 cm)
84	Thinlip barb	*Probarbus labeamamjor*	CYPRINIDAE	Sri Sophorn	En	 (Max. 150 cm)
85	Thicklip barb	*Probarbus labeamamjor*	CYPRINIDAE	Sri Sophorn	En	 (Max. 70 cm)
86		*Paralaubuca riveroi*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 18 cm)
87		*Parachela oxygastroides*	CYPRINIDAE	Pursat		 (Max. 15 cm)
88		*Puntioplites falcifer*	CYPRINIDAE	Pursat Sri Sophorn		 (Max. 35 cm)

89	Puntioplites proctorysron	*Puntioplites proctozysron*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 25 cm)
90	Swamp barb	*Puntius brevis*	CYPRINIDAE	Pursat Sri Sophorn Canals in SPS		 (Max. 12 cm)
91		*Systomus aurotaeniatus*	CYPRINIDAE	Pursat		 (Max. 2.5 cm)
92	Sidestripe rasbora	*Rasbora paviei*	CYPRINIDAE	Moung Chork		 (Max. 12 cm)
93	Pale rasbora	*Rasbora aurotaenia*	CYPRINIDAE	Pursat Svay Donkeo O Sandas Sri Sophorn Canals in SPS		 (Max. 17 cm)
94	Yellowtail rasbora	*Rasbora tornieri*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork O Sandas		 (Max. 17 cm)
95	Stoplight rasbora	*Rasbora sp.cf. beauforti*	CYPRINIDAE	Sri Sophorn Canals in SPS		 (Max. 2 cm)
96	Slender rasbora	*Rasbora daniconius*	CYPRINIDAE	Sri Sophorn, Canals in SPS		 (Max. 4.5 cm)
97	Puntius simus	*Puntius orphoides*	CYPRINIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn Canals in SPS		 (Max. 25 cm)
98	Puntius tetrazona	*Systomus partipentazona*	CYPRINIDAE	Pursat Sri Sophorn Canals in SPS	En	 (Max. 5 cm)
99		*Thynnichthys thynnoides*	CYPRINIDAE	Pursat O Sandas Sri Sophorn		 (Max. 25 cm)
100	Finescale tigerfish	*Datnioides undecimradiatus*	DATNIOIDIDAE	Pursat Svay Donkeo	Cr	 (Max. 40 cm)

101	Marbled sleeper	*Oxyeleotris marmorata*	ELEOTRIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn		 (Max. 30 cm)
102	Spotted algae eater	*Gyrinocheilus pennocki*	GYRINOCHELIDAE	Pursat		 (Max. 28 cm)
103	Siames algae eater	*Gyrinocheilus aymonieri*	GYRINOCHELIDAE	Pursat		 (Max. 28 cm)
104	Peacock eel	*Macrognathus siamensis*	MASTACEMBELIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 30 cm)
105		*Macrognathus taeniagaster*	MASTACEMBELIDAE	Svay Donkeo Moung Chork		 (Max. 16 cm)
106	Tiretrack spiny eel	*Mastacembelus armatus*	MASTACEMBELIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 90 cm)
107		*Macrochirichthys macrochirus*	CYPRINIDAE	Moung		 (Max. 70 cm)
108	Catopra	*Pristolepis fasciata*	NANDIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 20 cm)
109	Gangetic leaffish	*Nandus nandus*	NANDIDAE	Sri Sophorn, Canals in SPS		 (Max. 10 cm)
110	Clown featherback	*Chitala ornata*	NOTOPTERIDAE	Pursat Sri Sophorn		 (Max. 100 cm)

111	Bronze featheback	*Notopterus notoperus*	NOTOPTERRUS	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 60 cm)
112	Moon light gourami	*Trichogaster microlepis*	BELONTIIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 15 cm)
113	Threespot gourami	*Trichogaster trichopterus*	BELONTIIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 15 cm)
114	Snakeskin gourami	*Trichogaster pectoralis*	BELONTIIDAE	Pursat Svay Donkeo Moung Chork O Sandas		 (Max. 25 cm)
115		*Pangasius larnaudii*	PANGASIIDAE	Pursat Svay Donkeo		 (Max. 130 cm)
116		*Pteropangasius micronema*	PANGASIIDAE	Pursat		 (Max. 100 cm)
117		*Pangasius sanitwongsei*	PANGASIIDAE	Pursat		 (Max. 250 cm)
118		*Pangasius macronema*	PANGASIIDAE	Pursat Moung		 (Max. 35 cm)
119		*Micronema micronema*	SILURIDAE	Pursat Moung Sri Sophorn		 (Max. 33 cm)
120		*Micronema bleekeri*	SILURIDAE	Svay Donkeo Chork O Sandas		 (Max. 60 cm)

121		*Kryptopterus hexapterus*	SILURIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 24 cm)
123		*Kryptoperus cheveryi*	SILURIDAE	Pursat Moung Chork Sri Sophorn		 (Max. 35 cm)
124		*Hemisilurus mekongensis*	SILURIDAE	Pursat Moung		 (Max. 80 cm)
125	Butter catfish	*Ompok bimaculatus*	SILURIDAE	Pursat Svay Donkeo Moung Chork Sri Sophorn Canals in SPS		 (Max. 45 cm)
126		*Ompok hypophthalmus*	SILURIDAE	Svay Donkeo Chork		 (Max. 30 cm)
127		*Wallago attu*	SILURIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn		 (Max. 200 cm)
128		*Belodontichthys dinema*	SILURIDAE	Sri Sophorn		 (Max. 70 cm)
129		*Thryssocypeis tonlesapensis*	CYPRINIDAE	Moung O Sandas		 (Max. 7 cm)
130		*Euryglossa harmandi*	SOLEIDAE	Pursat		 (Max. 10 cm)
131		*Achiroides leucorhyncchos*	SOLEIDAE	Sri Sophorn		 (Max. 8 cm)
132	Whitelip sole	*Achiroides melanorthynchus*	SOLEIDAE	Sri Sophorn		 (Max. 14 cm)
133	Smallscale tonuesole	*Cynoglossus microlepis*	CYNOGLOSSIDAE	Moung		 (Max. 35 cm)

134	River tonguesole	*Cynoglossus feldmanni*	CYNOGLOSSIDAE	Sri Sophorn		 (Max. 25 cm)
135	Onegilled eel (Bengal mud eel)	*Ophisternon bengalense*	SYNBRANCHIDAE	Pursat Moung Chork Sri Sophorn Canals in SPS		 (Max. 100 cm)
136	Swamp eel	*Monopterus albus*	SYNBRANCHIDAE	Pursat Svay Donkeo Moung Chork O Sandas Sri Sophorn Canals in SPS		 (Max. 70 cm)
137		*Monotreta cambodgiensis*	TETRAODONTIDAE	Pursat Chork O Sandas		 (Max. 16 cm)
138	Redeye puffer	*Carinotetraodon lorteti*	TETRAODONTIDAE	Sri Sophorn		 (Max. 6 cm)
139		*Monotreta cambodgiensis*	TETRAODONTIDAE	Sri Sophorn Canals in SPS		 (Max. 16 cm)
140		*Monotreta leiurus*	TETRAODONTIDAE	Sri Sophorn		 (Max. 13 cm)

Note: Critically endangered species (Cr), Endangered species (En) and Vulnerable species (Vu) listed in "Sub decree No. 123 on Determination of Category/Type of Products and Endangered Fishery Products/Resources (August 12, 2009)"

APPENDIX 15-3

RESULT OF NOISE AND

VIBRATION SURVEY

1 Result of Noise Survey

Cross Section 1

Ra village, Phtaesh Prey Sangkat, Pursat Town, Pursat province (KP 187+560)

Time	Survey Period	Noise Level dB (A) 15 .July 2013 (Rainy Season)					Noise Level dB (A) 2 December. 2013 (Dry Season)				
		L Aeq	Standard L Aeq	L max	L min	Mean	L Aeq	Standard L Aeq	L max	L min	Mean
Day	6:00 - 7:00	65.7	70	81	40.7	65.67	66.7	70	87.3	44.8	66.72
	7:00 - 8:00	66.1		79.4	41.9		71.7		92.4	48.4	
	8:00 - 9:00	65.4		84.8	44		67.1		89	47.7	
	9:00 - 10:00	66.5		82.7	50.2		66.4		90.8	49.4	
	10:00 - 11:00	67.2		85.4	49.5		67.6		90.5	47.3	
	11:00 - 12:00	66		84.2	49.8		64		81.3	46.5	
	12:00 - 13:00	65.9		83.2	50		67.4		85.6	45.3	
	13:00 - 14:00	64.1		81.5	42.2		64.8		88.3	45.9	
	14:00 - 15:00	64.6		82.4	44.3		67		88.1	46	
	15:00 - 16:00	65.2		81.6	45.3		64.5		81.7	45	
	16:00 - 17:00	65.4		79.5	45.9		67.3		86.1	46.2	
	17:00 - 18:00	65.4		80.5	45.7		68.3		85.2	46.4	
	18:00 - 19:00	66.2		81.3	45.6		64.6		86.1	49.9	
Evening	19:00 - 20:00	65.1	65	81.5	43	63.23	64.1	65	81.2	47.7	64.30
	20:00 - 21:00	61.4		75.3	43.4		63.6		80.2	47.1	
	21:00 - 22:00	63.9		79.6	45.9		65.4		81.3	44.1	
	22:00 - 23:00	62.5		79.1	41.6		64.1		80.1	44.5	
Night	23:00 - 00:00	61.3	50	78.7	40.4	61.61	63.6	50	78.9	42.2	64.31
	00:00 - 1:00	60.9		76.8	40.1		64.8		81.4	42.6	
	1:00 - 2:00	59.8		76.6	40.6		63.9		80.6	42.8	
	2:00 - 3:00	59.9		77.5	40.7		64.4		84.1	42.7	
	3:00 - 4:00	61.6		80.4	40.1		64.2		78.3	44.4	
	4:00 - 5:00	63.4		81.7	40.6		63.7		79.6	44.6	
	5:00 - 6:00	64.4		81.4	40.3		65.6		80.3	45.8	
24 hours Average		64.08		80.67	43.83		65.62		84.10	45.72	

Cross Section 2

Pou Mouy village, Moung commune, Moung Russei district, Battambang province (KP 244+550)

Time	Survey Period	Noise Level dB (A) 17 July 2013 (Rainy Season)					Noise Level dB (A) 4 .December 2013 (Dry Season)				
		L Aeq	Standard L Aeq	L max	L min	Mean	L Aeq	Standard L Aeq	L max	L min	Mean
Day	6:00 - 7:00	67	70	86.6	51.2	65.8	63.7	70	77.2	52.1	66.79
	7:00 - 8:00	64.4		81.7	55.6		64.3		78.4	53.6	
	8:00 - 9:00	66		87.3	56.8		66.8		83.2	55.1	
	9:00 - 10:00	66.1		83	57.4		67.6		85.4	55.4	
	10:00 - 11:00	65.8		83.9	54.2		68.5		88.9	56.7	
	11:00 - 12:00	65.2		80.2	51		66.5		83.8	54.9	
	12:00 - 13:00	63.4		77.3	52.6		68		88.5	53.4	
	13:00 - 14:00	68.3		83	52.9		67.3		88.8	54.4	
	14:00 - 15:00	66.2		83.5	52.5		66.7		86.9	51.7	
	15:00 - 16:00	64.1		80.5	53.2		67		88.6	53.3	
	16:00 - 17:00	65.1		81.6	52.6		65.6		84.1	53.6	
	17:00 - 18:00	66.2		83.5	51.1		68.3		92.3	54.7	
	18:00 - 19:00	67.6		88.4	50.6		68		84.3	53.9	
Evening	19:00 - 20:00	63.1	65	84.7	54.4	62.3	68	65	86.6	53.9	66.18
	20:00 - 21:00	65.1		83.8	49.7		66.6		84.3	53.4	
	21:00 - 22:00	61.5		77.3	53.1		66.4		80.7	51.4	
	22:00 - 23:00	59.4		72	51.8		63.7		79.6	51.3	
Night	23:00 - 00:00	59.6	50	70.6	50.8	59.9	63.6	50	75.3	50.8	61.59
	00:00 - 1:00	58.9		70.2	49.5		62.8		75.1	50.6	
	1:00 - 2:00	59.1		74.5	46.7		60.1		72.1	50.1	
	2:00 - 3:00	58.8		72.6	46.6		60.3		76.4	50.6	
	3:00 - 4:00	60.6		78.4	48.8		60.4		72.3	50.4	
	4:00 - 5:00	61.8		80.7	48.6		61.6		73.4	51.6	
	5:00 - 6:00	60.4		78.9	49		62.3		78.9	51.7	
24 hours Average		63.49		80.18	51.7		65.17		81.88	52.86	

Cross Section 3

Dambouk Khpos village, Ou Dambang Pir commune, Sangkae district,
Battambang province (KP 282+78)

Time	Survey Period	Noise Level dB (A) 19 .July 2013 (Rainy Season)					Noise Level dB (A) 6 December. 2013 (Dry Season)				
		L Aeq	Standard L Aeq	L max	L min	Mean	L Aeq	Standard L Aeq	L max	L min	Mean
Day	6:00 - 7:00	65.7	70	81	40.7	65.7	66.4	70	82.6	47.1	67.75
	7:00 - 8:00	66.1		79.4	41.9		66.7		85.7	50.5	
	8:00 - 9:00	65.4		84.8	44		67.1		80.1	50.3	
	9:00 - 10:00	66.5		82.7	50.2		66.5		80.5	49.7	
	10:00 - 11:00	67.2		85.4	49.5		66.6		83.1	49.8	
	11:00 - 12:00	66		84.2	49.8		67.9		84.7	50.3	
	12:00 - 13:00	65.9		83.2	50		68.9		86.1	51.5	
	13:00 - 14:00	64.1		81.5	42.2		68.7		88.6	50.1	
	14:00 - 15:00	64.6		82.4	44.3		68.9		87.2	49.8	
	15:00 - 16:00	65.2		81.6	45.3		67.3		82.4	47.6	
	16:00 - 17:00	65.4		79.5	45.9		69.3		86.6	48.1	
	17:00 - 18:00	65.4		80.5	45.7		68.8		86	49	
	18:00 - 19:00	66.2		81.3	45.6		67.6		83.4	48.8	
Evening	19:00 - 20:00	65.1	65	81.5	43	63.2	63.7	65	79.6	45.4	61.20
	20:00 - 21:00	61.4		75.3	43.4		60.4		72.8	45.1	
	21:00 - 22:00	63.9		79.6	45.9		61.1		73.4	45.2	
	22:00 - 23:00	62.5		79.1	41.6		59.6		70.9	44.8	
Night	23:00 - 00:00	61.3	50	78.7	40.4	61.6	60.6	50	74.6	45.2	61.29
	00:00 - 1:00	60.9		76.8	40.1		60.7		72.4	44.8	
	1:00 - 2:00	59.8		76.6	40.6		58.8		73.6	44.7	
	2:00 - 3:00	59.9		77.5	40.7		58.7		74.3	44.4	
	3:00 - 4:00	61.6		80.4	40.1		59.6		77.1	44.6	
	4:00 - 5:00	63.4		81.7	40.6		64.1		82	44.3	
	5:00 - 6:00	64.4		81.4	40.3		66.5		85	44.6	
24 hours Average		64.08		80.67	43.83		64.77		80.53	47.32	

Cross Section 4

Kbal Spean village, Poipet Sangkat, Poipet City, Banteay Meanchey province (KP 407)

Time	Survey Period	Noise Level dB (A) Roadside Point, 19 Aug 2013					Noise Level dB (A) Background Point, 20 Aug 2013				
		L Aeq	Standard L Aeq	L max	L min	Mean	L Aeq	Standard L Aeq	L max	L min	Mean
Day	6:00 - 7:00	60.8	70	72.4	53.2	62.5	60.1	70	75.6	52.8	61.4
	7:00 - 8:00	65.2		78.9	55.1		60.3		75.7	52.1	
	8:00 - 9:00	61.9		81.3	55.9		62.6		79.3	55.9	
	9:00 - 10:00	62.0		82.0	58.4		60.9		77.2	55.5	
	10:00 - 11:00	61.9		75.0	58.3		63.3		76.5	56.0	
	11:00 - 12:00	64.4		80.4	58.7		63.1		78.2	57.1	
	12:00 - 13:00	63.4		80.7	58.0		61.3		81.5	54.6	
	13:00 - 14:00	63.6		78.8	58.1		62.4		77.6	54.3	
	14:00 - 15:00	62.8		78.7	58.4		60.2		77.6	53.8	
	15:00 - 16:00	62.3		79.6	58.2		61.6		78.0	54.0	
	16:00 - 17:00	62.1		77.0	58.3		62.7		78.1	54.9	
	17:00 - 18:00	61.8		74.3	56.4		60.1		75.3	53.9	
	18:00 - 19:00	60.2		76.3	55.3		59.2		76.7	54.1	
Evening	19:00 - 20:00	60.4	65	74.5	55.5	58.2	57.4	65	75.5	54.2	55.2
	20:00 - 21:00	61.1		73.4	55.2		56.6		70.9	53.7	
	21:00 - 22:00	55.8		69.0	49.9		54.3		70.9	50.5	
	22:00 - 23:00	55.5		63.9	49.3		54.2		73.6	50.6	
Night	23:00 - 00:00	55.0	50	68.0	48.2	54.2	52.3	50	77.7	50.9	52.5
	00:00 - 1:00	53.5		65.4	47.9		52.1		68.0	50.8	
	1:00 - 2:00	52.1		61.6	47.7		52.1		68.2	50.8	
	2:00 - 3:00	50.9		61.1	47.4		51.6		67.7	51.6	
	3:00 - 4:00	51.8		62.3	46.9		51.5		66.8	50.1	
	4:00 - 5:00	55.3		61.9	47.0		53.2		66.9	50.7	
	5:00 - 6:00	60.9		68.8	51.4		54.4		65.8	50.9	
24 hours Average		59.36		72.72	53.70		57.81		74.14	53.08	

2 Result of Vibration Survey

Cross Section 1

Ra village, Phtaesh Prey Sangkat, Pursat Town, Pursat province (KP 187+560)

Time	Survey Period	Vibration Level dB 15 .July 2013 (Rainy Season)					Vibration Level dB 2 December. 2013 (Dry Season)				
		L eq	Standard L eq	L max	L min	Mean	L eq	Standard L eq	L max	L min	Mean
Day	6:00 - 7:00	40.2	65	56.5	20.1	41.8	39.8	65	55.5	20.2	42.13
	7:00 - 8:00	39.5		56.8	21.8		41.9		57.6	21.2	
	8:00 - 9:00	42.3		57.8	21.4		41.5		59	21.3	
	9:00 - 10:00	41.8		59.1	20.6		40.9		58.3	25.3	
	10:00 - 11:00	41.5		59.5	23.4		42.9		60.7	22.4	
	11:00 - 12:00	43.3		59	21.8		45.6		61.8	23.5	
	12:00 - 13:00	41.6		58.2	19.7		42.2		61.3	23	
	13:00 - 14:00	40.2		60.3	18.5		42.6		62.9	25.9	
	14:00 - 15:00	42.4		60.6	19.6		40.7		58.8	24.9	
	15:00 - 16:00	42.7		59.7	18.7		42.2		60.7	23.2	
	16:00 - 17:00	43.5		60.1	20.9		43		61.3	24.6	
	17:00 - 18:00	43		57.9	20.3		42.2		65.4	24.8	
Night	18:00 - 19:00	41	60	56.4	18.2	35.1	40.1	60	57	20.5	39.85
	19:00 - 20:00	40.6		56.6	18.6		39.9		56.6	20.4	
	20:00 - 21:00	40		56.6	18.7		40.5		55.8	20.5	
	21:00 - 22:00	37.5		54.1	18.6		39.1		56	24.1	
	22:00 - 23:00	34.8		51.4	18.1		38.7		55.1	20.1	
	23:00 - 00:00	30.8		50.7	18.4		40.6		58.4	21.6	
	00:00 - 1:00	31		50.6	19		39.9		56.4	21.5	
	1:00 - 2:00	29.9		51.4	18.3		40.2		58.8	21.6	
	2:00 - 3:00	30.6		50.9	18.5		40.1		61.4	22.2	
	3:00 - 4:00	30.5		50.7	18.4		38.9		58.3	21.7	
	4:00 - 5:00	37.4		56.9	18.2		39.8		58.6	21.6	
	5:00 - 6:00	37.5		54.5	18.3		40.4		56.8	21.5	
24 hours Average		38.48		56.1	19.5		40.99		58.85	22.40	

Cross Section 2

Pou Mouy village, Moung commune, Moung Russei district, Battambang province (KP 244+550)

Time	Survey Period	Vibration Level dB 17 .July 2013 (Rainy Season)					Vibration Level dB 4 December. 2013 (Dry Season)				
		L eq	Standard L eq	L max	L min	Mean	L eq	Standard L eq	L max	L min	Mean
Day	6:00 - 7:00	35.8	65	56.3	24.6	35.7	32.3	65	55.6	21.9	34.77
	7:00 - 8:00	34.6		56.7	24.7		35.1		58.9	22.4	
	8:00 - 9:00	38		58.3	24.4		34.7		50.9	22	
	9:00 - 10:00	36.3		49.2	23.3		34.3		54.3	22.1	
	10:00 - 11:00	36.2		52.9	22.5		40.3		60.7	19.9	
	11:00 - 12:00	35.1		52.7	22		35.4		54.8	19.7	
	12:00 - 13:00	34.3		52.1	21.7		36.4		56.9	21.8	
	13:00 - 14:00	36.6		66.5	20		34.1		53.7	19.8	
	14:00 - 15:00	34.3		49.3	20.9		33.7		51.5	20.1	
	15:00 - 16:00	34.9		54.7	23.3		33.1		52.5	21	
	16:00 - 17:00	38.1		55.3	21		35.9		58.1	23.4	
	17:00 - 18:00	33.8		47.5	20.9		31.9		49.8	19.1	
Night	18:00 - 19:00	33.6	60	49.6	20.5	30.9	32.8	60	51.9	19.8	31.06
	19:00 - 20:00	31.8		48.1	20.6		31.8		59.2	19.8	
	20:00 - 21:00	31.6		49.4	20.1		32.6		50.7	19.1	
	21:00 - 22:00	33.3		51.7	21.2		32.3		47.7	17.1	
	22:00 - 23:00	28.5		55.4	20.1		30.9		49.5	17.4	
	23:00 - 00:00	28.9		49.3	20.2		30.1		48.4	16.7	
	00:00 - 1:00	29.7		49.2	19.6		30.8		51.6	16.8	
	1:00 - 2:00	30.6		51.3	20.5		29.3		48.1	16.6	
	2:00 - 3:00	29.1		52.8	20.7		30.2		47.8	16.5	
	3:00 - 4:00	29.4		49.9	19.9		29.6		50.1	16.7	
	4:00 - 5:00	30.6		51.1	20.8		30.7		51.1	17.8	
	5:00 - 6:00	31.9		49.2	20.8		31.6		53.3	19.9	
24 hours Average		33.21		52.44	21.43		32.91		52.80	19.48	

Cross Section 3

Dambouk Khpos village, Ou Dambang Pir commune, Sangkae district,
Battambang province (KP 282+78)

Time	Survey Period	Vibration Level dB 19 .July 2013 (Rainy Season)					Vibration Level dB 6 December. 2013 (Dry Season)				
		L eq	Standard L eq	L max	L min	Mean	L eq	Standard L eq	L max	L min	Mean
Day	6:00 - 7:00	43.7	65	39.8	39.8	40.8	40.3	65	58.6	18.9	40.52
	7:00 - 8:00	39		37.3	37.3		37.8		58.1	16.6	
	8:00 - 9:00	40.3		39.4	39.4		42.5		59.1	16.7	
	9:00 - 10:00	40.9		37.9	37.9		41.2		59.1	16.2	
	10:00 - 11:00	39.6		36.8	36.8		40.7		58	16.8	
	11:00 - 12:00	42.4		34.3	34.3		41.2		57.6	17.9	
	12:00 - 13:00	40.8		34.7	34.7		41.3		58.9	17	
	13:00 - 14:00	40		34.6	34.6		39.3		60.5	16.8	
	14:00 - 15:00	40.9		33.8	33.8		41.2		60.5	16.1	
	15:00 - 16:00	41.1		33.4	33.4		40.4		56.6	15.7	
	16:00 - 17:00	42		38.6	38.6		38.7		59	15.8	
	17:00 - 18:00	38.4		35.7	35.7		41.6		58.4	16	
Night	18:00 - 19:00	39.8	60	58.7	20.9	36.4	41.5	60	58.7	17.1	36.85
	19:00 - 20:00	37.3		54.6	19.8		40.3		56.6	18	
	20:00 - 21:00	39.4		51.1	19.6		37.7		55.6	16.9	
	21:00 - 22:00	37.9		56.6	18.6		36.3		54.3	16.6	
	22:00 - 23:00	36.8		55.9	17.9		36.1		56.6	16.1	
	23:00 - 00:00	34.3		53.8	17.5		36.2		58.4	16.2	
	00:00 - 1:00	34.7		54.6	17.3		35.8		56.9	16.1	
	1:00 - 2:00	34.6		54.8	18.6		34.6		57.7	16.3	
	2:00 - 3:00	33.8		55.2	20.1		35.6		58.8	16.4	
	3:00 - 4:00	33.4		52.7	19.6		35.4		59.6	16.1	
	4:00 - 5:00	38.6		59.4	18.1		35.7		57.7	16.4	
	5:00 - 6:00	35.7		59.1	20.5		37		54.9	16.4	
24 hours Average		38.56		57.77	20.89		38.68		57.93	16.63	

Cross Section 4

Kbal Spean village, Poipet Sangkat, Poipet City, Banteay Meanchey province (KP 407)

Time	Survey Period	Vibration Level dB Roadside Point, 19 .Aug 2013					Vibration Level dB Background Point, 20 .Aug 2013				
		L eq	Standard L eq	L max	L min	Mean	L eq	Standard L eq	L max	L min	Mean
Day	6:00 - 7:00	30.9	65	41.8	21.9	22.7	27.3	65	39.9	18.7	25.0
	7:00 - 8:00	30.6		47.8	22.2		28.8		46.3	18.6	
	8:00 - 9:00	29.7		40.3	23.5		29.6		40.4	19.5	
	9:00 - 10:00	28.6		46.0	23.6		25.3		42.9	20.2	
	10:00 - 11:00	29.6		45.3	24.1		25.6		41.6	21.0	
	11:00 - 12:00	32.6		50.8	24.7		25.2		40.4	19.8	
	12:00 - 13:00	30.7		46.4	23.8		23.9		39.0	20.3	
	13:00 - 14:00	30.5		47.6	23.2		23.2		35.1	20.3	
	14:00 - 15:00	30.2		38.7	22.6		22.8		42.0	18.9	
	15:00 - 16:00	24.6		37.8	19.5		21.9		44.0	17.4	
	16:00 - 17:00	24.8		37.7	19.6		25.3		39.9	17.1	
	17:00 - 18:00	25.5		43.3	19.4		25.0		43.0	17.3	
Night	18:00 - 19:00	24.1	60	34.8	19.7	20.6	21.6	60	43.7	17.6	19.8
	19:00 - 20:00	24.0		35.6	19.4		19.7		40.1	17.0	
	20:00 - 21:00	24.2		35.7	19.1		19.3		35.9	15.8	
	21:00 - 22:00	21.2		33.4	18.2		20.4		32.7	15.1	
	22:00 - 23:00	21.3		34.5	17.9		19.7		40.2	15.6	
	23:00 - 00:00	20.2		31.6	17.4		20.8		36.4	14.3	
	00:00 - 1:00	20.3		27.4	17.6		18.6		35.6	14.3	
	1:00 - 2:00	19.8		31.7	17.4		18.8		29.9	15.4	
	2:00 - 3:00	19.6		30.8	17.6		19.1		30.1	16.7	
	3:00 - 4:00	19.9		31.0	17.5		19.3		33.3	16.8	
	4:00 - 5:00	19.8		33.4	17.9		21.6		30.4	17.2	
	5:00 - 6:00	20.1		34.4	18.7		20.4		34.7	18.1	
24 hours Average		25.12		38.24	20.27		22.63		38.23	17.63	

APPENDIX 15-4

PREDICTION METHOD AND MODEL

1 Calculation Method of Emission Factor

The approximation formulas are as follows:

$FE=A/V+B \times V+C \times V^2+D$

where:

FE : Emission factor

V : Average vehicle travel speed (km/h)

	A	B	C	D
Light Vehicle				
NOx	-0.1874248100	-0.0039820000	0.0000312900	0.1827117200
SPM	0.0204858053	-0.0001713205	0.0000015448	0.0058884575
CO_2	1501.20185	-2.40935	0.02115	174.47635
Heavy Vehicle				
NOx	5.3968052000	-0.0782455300	0.0006706800	3.2657883600
SPM	0.5264308649	-0.0017836421	0.0000140949	0.0846006568
CO_2	908.52069	-23.49899	0.18396	1364.81344

Source : "Grounds for the Calculation of Motor Vehicle Emission Factors using Environment Impact Assessment of Road Project etc. (Revision of FY 2010, National Institute for Land and Infrastructure Management, Japan"

The emission factors for motorcycles are adopted 30 percent of the light Vehicle values.

2 Ambient Air Pollution Dispersion Model (Plume Model)

$$C(x,y,z)=\frac{Q}{2\pi \cdot u \cdot \sigma_y \cdot \sigma_z}\exp\left(-\frac{y^2}{2\sigma_{y^2}}\right)\left[\exp\left\{-\frac{(z+H)^2}{2\sigma_{z^2}}\right\}+\exp\left\{-\frac{(z-H)^2}{2\sigma_{z^2}}\right\}\right]$$

where:

C (x,y,z) : Air pollutant concentration at survey point (x,y,z) (ppm or mg/m^3)

Q : Air pollutant emission rate of point source (ml/s or mg/s)

u : Wind velocity (m/s)

H : Height of emission source (m)

σ_y, σ_z : Horizontal (y) and vertical (z) dispersion coefficient (m)

x : Downwind distance from emission point source to survey point along wind (m)

y : Horizontal distance at right angle to x axis

z : Vertical distance at right angle to x axis

Q is calculated by the following formulations:

$$Q_t = V_w \times \frac{1}{3600} \times \frac{1}{1000} \times \sum_{i=i}^{2} (N_{it} \times E_i)$$

where:

Q_t : Average air pollutant emission rate by time (ml/(m*s) or mg/(m*s))

E_i : Emission factor by vehicle type i (g/ (number*km))

N_{it} : Traffic volume by vehicle type and time (number/hr)

V_w : Conversion factor NOx : 532 ml/g SPM : 1000 mg/g

σ_y and σ_z are calculated by the following formulations:

$\sigma_y = W/2 + 0.46\, L^{0.81}$

$\sigma_z = 1.5 + 0.31\, L^{0.83}$

where:

L : Distance from survey point to roadside (L = x – W/2) (m)

W : Road width (m)

Source : "Environmental Impact Assessment Technique for Road Project No.383-400, June 2007, National Institute for Land and Infrastructure Management, Japan"

Conversion from NOx to NO_2 is calculated by the following formulations:

$[NO_2] = 0.54*[NOx]$

Source : Total Nitrogen Oxide Emission Control Manual, 2000, Japan

The input data are base on the conceptual road design and traffic forecast result in this survey, and collected relevant information. These input data to predict air pollution level are setting as follows:

H :	1 m
x :	11.5 m
z :	1.5 m
Ei :	see Table 16.4-3 "With Project"
Nit :	Motorcycle 334 (Number/hr) (Daily Volume x 0.08)
	Light Vehicle 508 (Number/hr) (Daily Volume x 0.08)

	Heavy Vehicle 167 (Number/hr) (Daily Volume x 0.08)
Wind Direction :	West (Along road direction) or South (Right angle to road direction)
Wind velocity :	2 m/s Source (Annual average wind velocity in Cambodia): Ministry of Water Resources and Metrology
Alignment of Point Sources	0 ~ 20 m on both sides : 2 m interval 20 ~ 180 m on both sides : 10 m interval

3 Brief Calculation Method of LAeq under Simple Condition (Noise Prediction Model)

$$L_{Aeq,T} = 82.3 + 10\log_{10}(1+3.47\,q) - 10\log_{10} l + 20\log_{10} V + 10\log_{10} N_T + 10\log_{10} 3.6/2T$$

where:

$L_{Aeq,T}$: Equivalent continuous A-weighted sound pressure Level of time T (dB)

V : Vehicle speed (km/h)

T : Time (s)

N_T : Traffic volume in time T (number)

l : Distance from carriageway to survey point (l)

q : Heavy vehicle ratio (< 1)

Source : "ASJ RTN-Model 2008 by The Acoustical Society of Japan"

The input data are base on the conceptual road design and traffic forecast result in this survey. These input data to predict noise level are setting as follows:

V :	59 km/hr
T :	From 6:00 to 18:00 43,200 s
	From 18:00 to 22:00 14,400 s
	From 22:00 to 6:00 28,800 s
N_T	From 6:00 to 18:00 842 (Number/hr) x 12 hr (Daily Volume x 0.824)
	From 18:00 to 22:00 261 (Number/hr) x 4 hr (Daily Volume x 0.102)
	From 22:00 to 6:00 313 (Number/hr) x 8 hr (Daily Volume x 0.074)
l	6.5 m and 16.5 m (End Point of Road)
	10.0 m and 20.0 m (15 m line from road center)
	25.0 m and 35.0 m (Borderline between ROW and private land)
q	0.17

APPENDIX 16-1

PROJECT INFORMATION BOOKLET

(ENGLISH DRAFT VERSION)

PROJECT INFORMATION BOOKLET
for
THE RESETTLEMENT ACTION PLAN
NATIONAL ROAD No.5 IMPROVEMENT PROJECT (MIDDLE SECTION)



1. **QUESTION:** What is the National Road No.5 Improvement Project?

   ANSWER: National Road No.5 (NR-5) is the trunk road reaching Bangkok through the border between Cambodia and Thailand. It is also designated as Asian Highway (AH-1) or Southern Economic Corridor of GMS. The Survey Road was damaged by the flood in 2000, and the section between Prek Kdam and Thlea ma'Am and the section between Battambang and Sri Sophon have been temporarily repaired. Therefore, Royal Government of Cambodia firstly requested Japanese loan for rehabilitating 2 sections of NR-5, Prek Kdam – Thlea ma'Am and Battambang – Sri Sophon, and construction of 4 bypasses around Banteay Mean Chey, Battambang, kampong Chhnang and Udong. Then, the middle section from Thlea M'am to Battambang and construction of Pursat bypass also will rehabilitate.

2. **QUESTION:** Who is responsible for the Project?

   ANSWER: The Royal Government of Cambodia represented by IRC (Inter-ministerial Resettlement Committee) will supervise the resettlement action plan implementation. MPWT (Ministry of Public Works and Transport) implements and monitors Resettlement Plan for affected houses, land and other properties on the roads.

3. **QUESTION:** Is the improvement of the road intended to benefit us?

   ANSWER: Yes. The improved road will allow the transportation of goods and people to be quicker, more efficient and cheaper between towns and villages and also from Thailand to all parts of Cambodia. It will help everybody to market their products, get supplies, reduces poverty and to reach public services.

4. **QUESTION:** If there will be road improvements along our road, will we be affected?

   ANSWER: The design and improvement of the highway will affect the use of land, trees and some houses, trading stalls and gardens and entrances in the government owned right of way. During detailed design, these potential effects may be avoided or minimized since actual alignments of the improved road will be determined through consultation with you and the rest of the local communities.

   In case negative impact on land, trees, house and structures cannot be avoided, the owners of affected properties will be properly compensated in cash or in kind for their land use, houses, structures, crops, trees and communal properties in order for them to restore their lost assets, resource or income. Rehabilitation assistance will also be provided to Affected Persons who will be required to relocate in another location.

5. **QUESTION:** What if my private land will be affected by the Project?

   ANSWER: For affected land, compensation can be in the form of replacement land or cash at current market value. If land replacement has been agreed by AHs, the replacement land should be of equal or better productive capacity of the lost land and satisfactory to AHs.

6. **QUESTION:** Does compensation apply to my affected houses or structures?

   ANSWER: Yes. Houses and structures that will be affected by the Project shall be compensated at replacement cost without deduction for depreciation or salvageable materials.

7. **QUESTION:** What about my crops and trees?

   ANSWER: For annual crops, AHs will be given 3 month notice that the land on which their crops are planted will be used by the Project and that they must harvest their crops in time. If standing crops are ripening and cannot be harvested, eligible AHs can be compensated for the loss of the un-harvested crops at the current market value.

   For perennial crops, AHs will be compensated for the loss of fruit and timber trees located within the project area at replacement cost.

8. **QUESTION:** What about our common property resources like school building, pagoda, fence of pagoda and school, irrigation, well and ponds?

   ANSWER: For common property resources, the affected land will be replaced in areas identified in consultation with affected communities and relevant organizations. Affected building and structures will be restored to original and better condition.

9. **QUESTION:** If in case there will be relocation of houses or businesses involved, how can the Project help me rebuild my house during relocation?

   ANSWER: Houses or other properties will be compensated at replacement cost, which includes labor cost to build the houses and the properties. Apart from the compensation for loss of private land and other assets at replacement costs, the Project will ensure that the standard of living of AHs are maintained or better improved after the Project.

<<Entitlement Matrix will be inserted here>>

10. QUESTION: When will the detailed measurement survey be conducted?

ANSWER: The activity will be carried out after the actual alignment has been identified. The DMS survey team will be composed of:

- Representative of IRC;
- Team of Working Group MPWT;
- Provincial Sub-Committee, also Involved representative District, Commune and Village authority; and
- External Monitoring Organization.

The activity will only be carried out in the presence of the AHs. The AHs and the local authorities will be informed a few days prior to the activity.

11. QUESTION: If there will be disagreements or problems that arise during project implementation such as compensation, technical and general project-related disputes, do I have the right to voice my complaint?

ANSWER: Yes. If the AH is not satisfied with the compensation package offered or, if for any reason, the compensation does not materialize according to the agreed schedule, the AH has the right to lodge a complaint based on the Grievance Redress Mechanism as provided below.

- First Stage, Commune Level: An aggrieved AH may bring his/her complaint to the commune leader. The commune leader will call for a meeting of the group to decide the course of action to resolve the complaint within 15 days, following the lodging of complaint by the aggrieved AH. The meeting of the group consists of the commune leader, representative/s from PRSC-WG of the district offices, and the aggrieved AH. The commune leader is responsible for documenting and keeping file of all complaints that are coursed through him/her. If after 15 days the aggrieved AH does not hear from Village or Commune, or if the AH is not satisfied with the decision taken by in the first stage, the complaint may be brought to the District Office either in writing or verbally.
- Second Stage, District Office: The District office has 15 days within which to resolve the complaint to the satisfaction of all concerned. If the complaints cannot be solved in this stage, the district office will bring the case to the Provincial Grievance Redress Committee.
- Third Stage, Provincial Grievance Redress Committee: The Provincial Grievance Redress Committee, which consists of Provincial Governor or Deputy Governor as a committee chairman and Directors of relevant Provincial Departments as members will be established in each province prior to DMS, meets with the aggrieved party and tries to resolve the complaint. The Committee may ask to PRSC-WG for a review of the DMS by the EMA. Within 30 days of the submission of the grievance the Committee must make a written decision and submit a copy of the same to MPWT, the EMA, IRC and the AH.
- Final Stage, the Court Procedures: If the aggrieved AH is not satisfied with the solution made by the Provincial Grievance Redress Committee based on the agreed policy in the RAP, the committee shall file administrative procedures against the AHs with the participation of provincial prosecutors. The case will be brought to the Provincial Court and the same will be litigated under the rules of the court. At the same time, the AH can bring the case to the Provincial court. During the litigation of the case, RGC will request to the court that the project proceed without disruption while the case is being heard. If any party is unsatisfied with the ruling of the provincial court, that party can bring the case to a higher court. The RGC shall implement the decision of the court.

The complaint issues will be solved under the agreed policy in the approved RAP.

The concerned Grievance committees will properly document all complaints and resolutions. AHs will be exempted from all taxes, administrative and legal fees.

12. **QUESTION:** How will you know if these undertakings are kept and the objectives of this Project are met?

ANSWER: All project activities will be monitored by IRC, Provincial Sub-Committee, Ministry of Public Works and Transport, and an external monitoring agency. Quarterly reports will be prepared and submitted to IRC and then IRC will forward it to JICA. A post- resettlement impact evaluation will also be undertaken to assess whether impacts of the Project have been mitigated adequately and the pre-project standard of living of AHs have been restored as a result of the resettlement and project. The JICA will also monitor these activities in its regular supervision missions during the period of project implementation.

If you have further queries and suggestions, please contact us at:

Pursat, Battambang and Banteay Mean Chey Province, also Provincial Department of Public Works: Pursat, Battambang and Banteay Mean Chey

APPENDIX 16-2

TERMS OF REFERENCE FOR

EXTERNAL MONITORING AGENCY

Terms of Reference
for External Monitoring Agency (EMA)
Resettlement Action Plan (RAP) Implementation
for the National Road No.5 Improvement Project

I. Background

1. In the Kingdom of Cambodia ("Cambodia"), road transport accounts for around 65% of passenger transport, and 70% of freight transport, and plays the most important role in domestic transport. During the civil war in the 70's and 80's, most of the roads were deteriorated due to poor (practically non-existent) maintenance. Since 1993, the rehabilitation has progressed with the assistance from multilateral and bilateral development partners.

2. National Road No.5 (NR-5) is the trunk national road connecting the capital city of Phnom Penh to major city of Battambang and then to Bangkok through Thai border city of Poipet. It is also designated as Asian Highway No. 1 (AH-1) or the Southern Economic Corridor of Greater Mekong Sub-region (GMS). However, all the road surface type is double-layered bituminous surface treatment (DBST) and the surface condition is being deteriorated due to rapidly increasing heavy vehicles, as well as inundation/flood except the surface of the sections of 12.6 km from Phnom Penh and between Serei Sophorn and Poipet where asphalt concrete (AC) is adopted to their surfaces.

3. Under such situation, Japan International Cooperation Agency (JICA) dispatched a survey team to Cambodia in November 2010 and reached agreement to conduct the Preparatory Survey on improvement of North Section (between Battambang and Serei Sophorn) and South Section (between Prek Kdam Bridge and Thlea Ma'am) of NR5. The survey named as "Preparatory Survey for National Road No.5 Rehabilitation Project" started in February 2011. As the result of this survey the North Section (Approx. 68 km) was selected as the high priority section.

4. Following the RGC's request to ensure sustainable transportation of the NR5, the South Section (Approximately 139Km) has been also surveyed by the consultant team since January 2013. The survey named as "Preparatory Survey for National Road No.5 (South Section) Improvement Project". From a viewpoint of consistency in road improvement, RGC requested that remaining section of NR5 (between Thlea Ma'am and Battamabng including the bypass around Pursat and between Serei Sophorn and Poipet Section) be surveyed and this survey started in September 2013.

5. The RAP contains the measures to be carried out by the Inter-ministerial Resettlement Committee (IRC) of which the Ministry of Public Works & Transport (MPWT) is a member to avoid and/or minimize impacts on the affected households (AHs), particularly on their sources of livelihood, and for the purpose of improving or at least restoring their standards of living to pre-project level consistent with the JICA Guidelines for Environmental and Social Considerations (April 2010).

6. The purpose of the RAP is to identify the impact on the local population of upgrading and improvement of the road; and to provide measures for compensation where the population is negatively affected by the work, primarily through the acquisition of farmland and encroachment on to residential and commercial sites.

7. AHs are grouped into three broad categories, viz. Individual, Household and Communities, and other sub-groups are defined within each group. In particular within the household category, there are vulnerable groups defined as those that are socially or economically disadvantaged and who will suffer more economically and socially from relocation and improvement than the general population.

8. AHs falling into one or more of the following categories are defined as vulnerable groups;

(i) households headed by women with dependents,

(ii) disabled household heads with no other means of support,

(iii) households falling under the generally accepted indicator for poverty, and

(iv) children (younger than 18 years old) and the elderly (older than 60 years old) households who are landless and with no other means of support.

9. From September 2013 - January 2014, a RAP has been prepared based on census and Inventory of Loss (IOL), baseline socio-economic survey (SES) and Stakeholder Meeting. The RAP has been prepared based on i) census and inventory of all affected households; ii) baseline SES; and iii) replacement cost study for affected land, structure and trees.

10. Centre of the resettlement policy is that the affected people will be compensated for their lost assets at replacement cost and provided with rehabilitation assistance to ensure improvement, or at least maintaining their living standards and income to the level they would have without the Project. The cut-off date for the existing NR-5 from Thlea Ma'am/PST (PK: 171+000) to Battambang (PK: 282+200) and from Serey Sophorn (PK: 366+250) to Poipet (PK: 402+000) is on **2nd September 2013**, and for Pursat Bypass is on **30th December 2013**.

11. Refer to the IOL results, 2,377 households to be affected by the Project. Among them, 247 AHs will lose their private land. A total of 296,069.07 m² of private land along Pursat bypasses will be acquired for the Project. Of these, 90.87% (269,026.84 m²) is used for growing rice.

12. A total of 817 AHs along NR-5 and the Pursat bypass, whose main structures (house, house-shop and/or shop/restaurant) will be affected by the Project. With regard to fruit and timber trees, a total of 3,783 trees of various species and age in NR-5 and the bypass have been counted during the IOL. The affected fruit and timber trees are not commercially grown, meaning they are sporadically planted.

II. Management and Monitoring

13. The RAP requires that the external agency is contracted to provide external monitoring on the Implementation of the approved RAP. The external monitor will indicate any corrective measures necessary to the approved RAP during its implementation.

14. A particular responsibility of the EMA will be to monitor and evaluate, based on the approved RAP, the effectiveness of measures to replace any loss and livelihoods of AHs and of measures to utilize resettlement planning and implementation to maximize the benefits to the immediately adjacent and wider populations of the road improvement and of its integration with social, economic and infrastructural development in the road corridor and the wider region.

III. Requirement for external monitoring

3.1 Monitoring and Evaluation

15. The monitoring and evaluation agency will address specific issues as the following:

(i) Field check/site visits coordinated with the resettlement activities that are taking place based on the approved RAP:
   a) Compensation payments, participatory design of relocation and rehabilitation options, and relocation;
   b) Random review of DMS forms, if complaints exist, compared to the inventory of assets and entitlements; and

c) Random review of entitlement and compensation documents to ensure that the assessment of compensation is based on the agreed compensation matrix and that all entitlements have been accurately applied;

(ii) Payment of compensation and allowances as per approved Update RAP (URAP). Identify whether all AHs are covered under the URAP and confirm that they are all eligible for compensation, resettlement and rehabilitation assistance, irrespective of tenure status, social or economic standing, and any such factors that may discriminate against achieving the project objectives.

(iii) Timing of disbursement of payment and documentation Detailed Measurement Survey (DMS) and payments;

(iv) Public consultation and awareness of resettlement entitlements;

(v) Coordination of resettlement activities with the construction schedule;

(vi) Land acquisition and transfer produces;

(vii) Progress of construction/rebuilding of structures on residual land or to new relocation sites;

(viii) Level of satisfaction of AHs with the provisions of each kind of compensation and implementation of the URAP;

(ix) Grievance redress mechanism (documentation, process, and resolution);

(x) Capacity of AHs to restore/re-establish livelihoods and living standard. Special attention will be given to relocating AHs and vulnerable AHs;

(xi) Trends in living standards. Throughout the RAP implementation process, the EMA will observe and conduct surveys to monitor the progress AHs are making to restore living standards. Special attention will be paid to any differences based on gender. Any potential problems in the restoration of living standards will be reported;

(xii) Effectiveness, impact and sustainability of entitlements and rehabilitation measures and the needs for further improvement, as required under the approved RAP;

(xiii) Gender impacts and strategy;

(xiv) Capacity of AHs to restore/reestablish their livelihood and living standards. Special attention provided or to be provided to severely affected and/or vulnerable households;

(xv) Resettlement impacts caused during construction activities; and

(xvi) Receive complaints from AHs if any and explain to the aggrieved AHs the eligibility for compensation and livelihood restoration set out in the approved URAP.

(xvii) Participation of AHs in RAP updating and implementation;

(xviii) Institutional capacity, internal monitoring and reporting.

3.2 Post evaluation

16. Post-evaluation activities will also be carried out one (1) year after the completion of all relocation activities.

IV. Specific Purpose of External Monitoring

17. The Project requires the services of a domestic monitoring and evaluation team to conduct an independent assessment of the extent to which resettlement and rehabilitation objectives are being met.

18. Specifically, the objectives of the monitoring program are:

(i) to ensure that the standard of living of AHs are restored or improved;

(ii) to monitor whether the overall project and resettlement objectives are being met in accordance with the approved RAP, and if not to suggest corrective measures;

(iii) to assess if rehabilitation measures and compensation are sufficient and comply with JICA Guidelines;
(iv) to identify problems or potential problems; and
(v) to identify methods of responding immediately to mitigate and resolve problems.

V. Methodology of Monitoring and Evaluation

19. The methods for external monitoring and evaluation include:

(i) Review of RAP approved by RGC.
(ii) Check on a random basis the DMS process with AHs from identification to agreement on DMS results.
(iii) Review of SES baseline prepared during RAP preparation (Feasibility Study) and SES conducted at the detailed design stage. If land acquisition (i.e., RAP implementation) does not occur for at least two (2) years, EMA will carry out another SES.
(iv) A post resettlement survey will be carried out one (1) year following completion of resettlement activities. Sampling will include 20% of relocating AHs as well as at least 10% of all other AHs. The same AHs interviewed during RAP updating will be interviewed.
(v) Participatory rapid appraisals (PRA): Consultation with AHs and various stakeholders such as resettlement committee, the Project Management Unit, community leaders; key informant interviews; community public meetings; focus group discussions; direct field observations; and in-depth case studies of good practices and problems identified by internal or external monitoring and required special efforts to resolve.
(vi) Random checks of payments disbursed to AHs during monitoring. The EMA will submit a post evaluation report per project one (1) year following completion of resettlement activities.

VI. Team Composition, Timing, and Submission of Reports

20. The domestic EMA will be composed of one team leader with extensive experience in monitoring and evaluation of resettlement activities in Cambodia and with strong ability in preparing resettlement compliance/monitoring reports. He/she should demonstrate good communication skill and have at least a bachelor degree in a relevant field. The team leader will be assisted by two (2) social enumerators. All reports will be submitted to IRC and MPWT.

21. The monitoring work will be consisted in period of two (2) years and post evaluation will be conducted one (1) year after completion of all resettlement activities.

22. The monitoring reports will include one inception report, 8 quarterly monitoring reports, one base line survey report (six months after signing the contract) and one post evaluation report.

23. Duration of Field visits and report preparation will be as follows:

No.	Position	Working Day	Number	Total Input
	Monitoring Work			
1	Team Leader	178	1	178
2	Social Enumerator	119	2	238
	Base Line Survey			
1	Team Leader	50	1	50
2	Social Enumerator	30	2	60

No.	Position	Working Day	Number	Total Input
	Post Evaluation			
1	Team Leader	50	1	50
2	Social Enumerator	30	2	60
			Total	636

24. Submission of inception and quarterly report will be within two weeks (14 days) after monitoring activities while submission of post-evaluation report will be within one (1) month after post-evaluation activities.

25. The quarterly report will summarize the findings of the EMA, including (a) progress of RAP implementation, including any deviations from the provisions of the RAP; (b) identification of problem issues and recommended solutions to inform implementing agencies and resolve issues in a timely manner; (c) identification of specific gender issues, as relevant; and (d) report on progress of the follow-up of issues and problems identified in the previous reports.

VII. Expression of Interest

26. Please prepare an estimation of the time and finances required to undertake this work. Should you be awarded the contract, a price would be negotiated to undertake and initial consultation and investigation with the community, after which a fixed amount contract would be set and agreed.

Expressions of interest should be addressed to:

27. [Mr. XXX, Resettlement Department, Ministry of Economy and Finance, St 92, Sngkat Wat Phnom, Khan Daunpenh, Phnom Penh]

28. Expressions of interest should be received no later than [time, date]

29. Inquiries may be directed to: [INSERT name, position, phone number]

APPENDIX 16-3

TERMS OF REFERENCE FOR

INCOME RESTORATION PROGRAMS

Terms of Reference for Training and Income Restoration

I. Background Information

1. A Training and Income Restoration Program (IRP) is part of the compensation package provided to all severely affected households and vulnerable affected households by works and land acquisition for the National Road No.5 Improvement Project (Middle Section). Severely affected households include but not limited to the affected households who will (i) lose 20% or more of their total productive land (income generating) and/or assets, and (ii) have to relocate due to the Project.

2. A Consulting firm/Non-Government Organization (NGO) will undertake overall management of the Training and IRP, and will be appointed for that purpose by Inter-ministerial Resettlement Committee (IRC) in the Ministry of Economy and Finance (MEF). The Program will be supervised by the Resettlement Department of the Ministry of Economic and Finance (RD/MEF).

3. The Consulting firm/NGO will directly administer the off-farm training and IRP and will, for that purpose, manage a Training Fund and Income Restoration Training including an Apprenticeship Program[1] (i.e. vocational training) and agricultural extension and training for the entitled AHs. It will provide management support for the Agricultural Relocation and Extension Program and will provide a training of trainers program for the Provincial and District agencies taking part.

4. From September 2013 - January 2014, a RAP has been prepared based on census and Inventory of Loss (IOL), baseline socio-economic survey (SES) and Stakeholder Meeting. The RAP has been prepared based on i) census and inventory of all affected households; ii) baseline SES; and iii) replacement cost study for affected land, structure and trees. Refer to the IOL results, 2,377 households to be affected by the Project. Among them, 247 AHs will lose their private land. A total of 296,069.07 m² of private land along Pursat bypass will be acquired for the Project. Of these, 90.87% (269,026.84 m²) is used for growing rice. A total of 817 AHs along NR-5 and the Pursat bypass, their main structures (house, house-shop and/or shop/restaurant) will be affected by the Project. With regard to fruit and timber trees, a total of 3,783 trees of various species and age in NR-5 and the bypass have been counted during the IOL.

II. Appointment of NGO/Consulting firm

5. For that purpose IRC proposes to enlist the services of suitably qualified Consulting Firm or NGO to develop and implement the IRP which is required for the severely affected households and vulnerable affected households.

6. The Consulting firm/NGO should have the following qualifications:

   (i) Must have good track records in designing and implementing IRP and Gender Development Program within Cambodia;
   (ii) Must have the necessary community development and gender orientation and experience to appropriately deal with the poor and vulnerable affected households;
   (iii) Must be familiar with the use of Participatory Rapid Appraisal tools; and
   (iv) An inclusion of Gender Specialist in the Team.

[1] The apprenticeship program is available for one member of the severely and/or vulnerable affected households, although all the working adults who belong to severely and/or vulnerable affected households are eligible to agricultural extension and training.

III. Objectives of Training and Income Restoration Program

7. The Consulting firm/NGO shall undertake overall management of the Training and IRP, and will be appointed for that purpose by the IRC. The Program will be supervised by RD/MEF.

3.1 General objective

8. The general objective or goal of the program is to minimize the impact of the project on the livelihoods of affected households, to restore their income and to reduce poverty and social exclusion in the project area.

3.2 Specific project purposes

9. The specific project purposes are:

   (i) to improve the vocational skills of severely and/or vulnerable affected households by other means to restore and improve their livelihoods and incomes from off-farm (non-agricultural) employment; and
   (ii) to provide opportunities for production and marketing of crops for households severely affected by losses of land, by means of the provision of appropriate and sustainable IRPs.

IV. Activities

10. To prepare the training and IRP, the Consulting firm/NGO will carry out the following tasks:

   (i) Carry out Situational and Needs Assessment Analysis
      - Analyze existing sources of income of severely and/or vulnerable affected households and existing sources of income in the relocated area to establish a baseline to gauge the success of IRP and estimate current actual income of the affected households;
      - Conduct consultations, needs, aptitude, and preference surveys among the affected households;
      - Determine whether poor/vulnerable affected households have special needs different to other households;
      - Identify the major socio-economic situations and problems of the affected households and it must be understood in the context of the basic profile and culture of the affected communities and the concrete descriptions of their way of life and livelihoods.
   (ii) Identify existing or planned programs of the Government, NGOs, and other agencies within the project area to design appropriate strategies to link up with or expand such programs.
   (iii) Prepare a gender strategy to include enhancement of opportunities for women's participation, and to provide women increased opportunities to learn new skills and participate in the decision-making process, and take advantage of new employment and income-generating opportunities.

11. Based on the results of the activities above, the Consulting firm/NGO will design the appropriate training and sustainable IRPs based on the number of severely and/or vulnerable AHs.

4.1 Off farm training

12. The Consulting firm/NGO will conduct a training needs survey during the first month of the program, making use of data from existing socio-economic surveys of the Project. On this basis the Consulting firm/NGO will provide 6 months vocational or pre-vocational training

to a member of each severely affected household either household head, spouse, son or daughter.

13. Training will be mainly in skills for which there is an established employment demand, but may include basic literacy and numeracy. Skills for which training has provisionally been proposed include crafts production, building trades, motor repair, languages, computer, hairdressing and tailoring.

4.2 Job creation

14. Job creation will be undertaken by the Consulting firm/NGO as 6 month apprenticeships with established enterprises, if available in the area, primarily in Pursat, Battambang and Banteay Mean Chey province aimed at providing on-the-job training and employment for a member in the severely and/or vulnerable affected households.

15. The Consulting firm/NGO will also facilitate hiring of affected households on a priority basis on ongoing project construction activities in order for affected households to benefit directly from the Project.

4.3 Small agricultural and agro-industrial credit

16. The Consulting firm/NGO will facilitate access to existing credit program such as small agricultural production or agro-industrial loans. Loans will be for plant materials, livestock, on-farm irrigation, agricultural tools and equipment, and for small agricultural, depending on the outcome of training capability of the trainees.

4.4 Agricultural extension and training

17. The Consulting firm/NGO will provide training of trainers (concerned Provincial Departments in each of the two provinces) and management support for an agricultural extension program. Agricultural extension and farmer training will be specifically for land use and production development such as livestock, cash crop, home garden and etc. The Consulting firm/NGO will also provide training for women in agricultural and food processing and marketing. All the working adults who belong to severely and/or vulnerable affected households are eligible to this program.

4.5 Access to small enterprise credit

18. The Consulting firm/NGO will facilitate access to existing credit programs to enable affected households to obtain small enterprise loans. Loans will be for crafts production equipment, tools for construction or repair work, and for shop and stall equipment and stock.

V. Staffing and Other inputs

19. The Consulting firm/NGO will provide training personnel in accordance with the following requirements. Durations given below are indicative and subject to variation, during the currency of the services, by agreement with MEF, and estimated on the following basis.

    (i) It is assumed that the training and income restoration will be completed within 24 months;
    (ii) Person -month of personnel has been considered only the period stayed on the site or relevant institution, organizations or factories for training purpose. Time spent in other place such as Home office of Phnom Penh shall not be included in the person-month.

Personnel Inputs of Consulting Services

Position	Number	Person-month[2]
Team Leader	1	12
Vocational Trainer	4	24
Credit Coordinator	2	8
Apprenticeship Trainer 1	2	12
Agricultural Trainer 1	2	14
Agricultural Trainer 2	2	12
Total	13	82

VI. Requirement for report and Reporting

6.1 Requirement for report

20. The Training and IRP must include concrete actions for income restoration, including budget, timetables, responsibility for implementation, economic assumptions and risks and contingency arrangements. The Reports will include, but not limited, to the following:

21. Inception report

- A review of current socioeconomic conditions of the affected household including income baseline. If the existing baseline data is not sufficient, the Consulting firm/NGO is required to carry out supplementary socio-economic survey;
- A summary of Affected households' preferences for training and income restoration (indicating description of methods used to elicit Affected households' views);
- A summary of potential training and IRPs (based on identified economic activities and opportunities prevalent in the area) and options available to affected households and of the process of matching affected households to particular programs or activities;
- A gender strategy.

22. Training and IRP plan

- Detailed feasibility studies of the technical, economic, financial and institutional viability of the proposed IRP[3], including realistic estimation of incomes to be received by participating affected households and the number of affected households that can participate in each activity;
- A time-bound plan on specific programs for affected households who have lost their productivity means;
- A time-bound plan for development of human capital (appropriate trainings which have an established employment demand);
- A time-bound plan on job creation and provision of access to capital for small enterprise, small agricultural, and agro-industrial credit;
- Arrangements and indicators for monitoring the effectiveness of training and IRPs and for modifying plans found to be ineffective;
- Budget and Implementation Schedule.

[2] The amount of person-month will be revised during the RAP updating.

[3] Can be existing or planned programs of the Government, NGOs, and other agencies within the project area with appropriate strategies to link up with or expand such programs.

23. Progress reports (Quarterly)

- The content will include progress based on arrangements and monitoring indicators as set out in the income restoration plan report. It will also include satisfaction of affected households, problems encountered and strategies or resolutions agreed on.

24. Completion report

- It will include concise history of the program, evaluation of the implementation, including financial audit statements.

6.2 Reporting

25. The selected Consulting firm/NGO will submit the following to IRC-MEF:

- Inception Report, one month after mobilization
- Training and Income Restoration Plan, within two months after submission of Inception report (contents as indicated in section VI above),
- Quarterly progress reports
- Completion Report

VII. Schedule

7.1 Schedule

26. The selected consulting firm/NGO for the IRP program will be hired for two and a half years. The consulting firm/NGO will be engaged full-time for the first two years while in the third last year, the consulting firm/NGO will provide back-stop support to the participating affected households, as needed. Post-IRP evaluation will be carried at the end of year 3 or completion of the program.

APPENDIX 16-4

INVENTORY OF LOSS AND

SOCIO-ECONOMIC SURVEY

QUESTIONNAIRE FORM

INVENTORY OF LOSS AND SOCIO-ECONOMIC QUESTIONNAIRE

QID: ☐

Date of interview:...../...../..... Starting time:.....……..

Interviewer's name:..... Ending time:……

Supervisor's name:.....…… Village Headman: ……

I. LOCATION

☐ 1=NR#5 (Thlea Ma'am - Battambang)
2= NR#5 (Serei Sophorn - Poipet) 3= Pursat Bypass

PK: ..... 1= Left 2= Right ☐ (Direction is from Phnom Penh to Poipet).

House No: ……. Village: ...……..

Commune: ..... District: ……..... Province: .....

1.1 Do you know, what is size of the ROW (NR-5)? Left: .....m Right: .....m

1.2 Distance from road centreline to people's house .....m (first column or wall).

1.3 Which option do you prefer for the Pursat city?

1= Flyover 2=NR-5 widening 3=Bypass ☐

1.4 Are there herd animals traverse in this area? 1=Yes 2=No ☐
If yes, what support do you need from the project: .....

1.5 Do you think the bypass construction will disturb to people fishing? ☐ Yes ☐ No
If yes, what is the reason? .....

1.6 Tick the option that will be affected the HH properties:

- ☐ in interval 0 – 12.5m
- ☐ in interval 12.5 – 20.0m
- ☐ in interval 0 – 20.0m

II. PROFILE OF HOUSEHOLD HEAD

Ask for head of household (if not present ask spouse or other adult, but over 18 years old)

2.1 H/H Name: …… Call Name: ……

2.2 Age: ……. Sex: Male ☐ Female ☐

2.3 Occupation: .....

2.4 Language and Ethnic group: ☐

Code: 1=Khmer 2=Chinese 3=Cham 4= Vietnamese
5=Other (specify).....

2.5 Religion: ☐

Code: 1=Buddhism 2=Muslim 3=Christianity
4=Other (specify).....

2.6 The respondent is the household head? ☐ Yes (If yes go to 2.9) ☐ No

2.7 If no, what is the relationship with the household head? .....

Name of the respondent: ……..

2.8 Age: ……. Sex: Male☐ Female ☐

2.9 Fill H\H head status in the box below **(multi answers)** ☐

1= Aged (From 60 years old and older) 2=Widow 3=Disabled 4=Landless
5= Income<20$/month/person (National Poverty Line for Urban Area-2007)
6= Loss agricultural land from 20% of productive land (bypass)
7= Affected on main house from 40% 8= Loss of business or selling place

III. SOCIOECONOMIC PROFILE OF AFFECTED HOUSEHOLD

3.1 How many members are in the household? .....

3.2 How many couple are there in the household? .....

3.3 If there is more than one family, who are living in this house, give all.

No.	Relationship to H/H **(code)**	Age	Sex **1=M 2=F**	Marital status **(code)**	Literate **1=No 2=Yes**	School attending **1=No 2=Yes**	# Years of graded completed education	Working Activities **(code)**		
								1st	2nd	3rd
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										

Code B: 1=Self, 2=Spouse, 3=Son/Daughter, 4=Parent, 5=Brother/Sister, 6=Relative, 7=Other (specify).....

Code E: 1=Single, 2=Married, 3=Divorced/separate 4= Widowed 5 = Other.....

Code I, J and K:

00	None or Unable to work	09	Batery charging	18	Government officer
01	Small business	10	Construction Worker	19	Manufacturer/Craftsman
02	Food processing for sale*	11	Garment factory worker	20	Farmer (on own farm)
03	Hotel/tourism/restaurant	12	Company staff	21	Fishman
04	Hair cut/dresser/Beauty shop	13	Credit provider/ Money exchange	22	Livestock Raising
05	Wedding host	14	Motor transporter	23	NGO staff
06	Merchant/Market trader	15	Taxi driver	24	Migration out for job
07	Machinery/Vehicle mechanic	16	Agricultural laborer/Worker	25	Pupil/Student
08	Electrician	17	Non agricultural laborer/Worker	26	Other (specify) ……..

3.4 Household Assets

3.4.1 Agricultural equipments:

Equipment types	**Number**	**Total Cost (USD)**	**Equipment types**	**Number**	**Total Cost (USD)**
Oxcart			Tractor		
Plow			Hand tractor		
Harrow			Rice mill machine		
Water pump			Other.....		

3.4.2 Other Assets:

Equipment types	Number	Total Cost (USD)	Equipment types	Number	Total Cost (USD)
Bicycle			TV/VCR/VCP		
Motorbike			Sewing machine		
Bamboo rail			Air conditioner		
Car/ Pickup/Minivan			Washing machine		
Truck			Refrigerator		
Boat without engine			Telephone		
Boat with engine			Generator		
Radio/Cassette Player			Other (specify) …….		

3.4.3 Livestock:

Type of livestock	Total Number		Sales of livestock in last year	
	Quantity	Value in USD	Quantity	Value in USD
Oxen				
Buffalo				
Pigs				
Horses				
Chickens				
Ducks				
Other (spec.).....				

3.4.4 Main Trees:

Code of Trees

1=Bamboo	2=Banana	3=Coconut	4=Tamarind
5=Chan Kiri	6=Sapodilla	7=Deum Chan	8=Kamping Reach
9=Kantuot	10=Khvet	11=Jack Fruit	12=Korki
13=Kor	14=Krasang	15=Mkak	16=Longan
17=Pring	18=Jujube	19=Sdau	20= Orange
21=Soda	22=Grapefruit	23=Custard apple	24=Sour sop
25=Guava	26=Teuk Dos Kou	27=Acacia/Eucalyptus	28=Lemon
29=Mango	30=Papaya	31= Sugar Palm	32=Cashew
33=Other.....			

No.	Tree types	Unit	Total Quantity	Income in last year (Riel)	Number of affected trees	
					0 – 12.5 (m)	12.5 – 20.0 (m)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Total Income (Riel)						

3.4.5 Land and Agricultural products:

A. What is your affected land in ROW? (The question "A" is not for bypass)

Land Category	Total of using (m^2)	Affected Area		
		Length (m)	Width (m)	Size (m^2)
Rice field (Sre)				
Orchard (Chamkar)				
Flooded Area				
Commercial				
House Plot / Home Garden				
Other (specify).....				

B. What is your affected land outside ROW?

Land Category	Total Owning (m^2)	Affected Area		
		Length (m)	Width (m)	Size (m^2)
Rice field (Sre)				
Orchard (Chamkar)				
Flooded Area				
Commercial				
House Plot / Home Garden				
Other (specify).....				

C. Agricultural production (all land):

Crop	Area grown (m^2)	Harvested Amount (Kg)	Unit price (Riel/Kg)	Production cost (Riel)	Farming Expend (Riel)	Gross Return (Riel)
Dry rice						
Wet rice						
Vegetable						
Other crop …..						
Other crop …..						
Other crop …..						
Total (Riel)						

3.4.6 House and other Structures

Structure Type Code:

1=House 2=House/Shop 3=Kitchen 4=Bathroom
5= Grange/Storage 6=Shop/Restaurant 7=Craft / Workshop
8= Stall / Market stall 9= Animal table/pigsty 10=Other (specify) .....

Floor Code:

1st=One floor 2nd=Two floors 3=Khmer Style 4= Other .....

Construction Material Code:

1- Temporary Material	2- Thatch	3- Tin / Fibro/ Plastic Sheet	4- Wood
5- Bamboo	6- Roofing Tile	7- Floor Tile	8- Mortar
9- Concrete	10- Earth	11-Metal	12- Brick

13-Others (spec.): ……..

A. Interval: 0 – 12.5 (m):

Material	Structure: …	Structure: …	Structure: …	Structure: …
Roof				
Wall				
Floor				
Column				
Story				
Total floor area, m^2				
Affected area, m^2				

B. Interval: 12.5 – 20.0 (m):

Material	Structure: …	Structure: …	Structure: …	Structure: …
Roof				
Wall				
Floor				
Column				
Story				
Total floor area, m^2				
Affected area, m^2				

- How many years have you been living here? ..... year(s)
- If you rent the affected structure, how much do you pay per month? .....……Riels
- Where will you relocate to resettle? Shifting back, to same village, other village

3.4.7 Other fixed assets:

No.	TYPE OF ASSETS	UNIT	Affected Quantity	
			0 – 12.5 (m)	12.5 – 20.0 (m)
1.	Concrete Well	set		
2.	Pump Well	set		
3.	Timber post with wire	Meter long		
4.	Concrete post with wire	Meter long		
5.	Brick Wall, 100mm	Meter long		
6.	Brick Wall, 200mm	Meter long		
7.	Water supply system	m		
8.	Mortar	m^2		
9.	Vehicle washing place			
10.	Toilet			
11.	Other (spec.): …….			

3.5 Incomes

3.5.1 What are the main sources of total income in your household?

1st ☐ 2nd ☐ 3rd ☐ 4th ☐

1. Wages or salary 2. Farming hired labor 3. Business or trade 4. Agricultural production
5. Livestock 6. Fishing 7. Equipment making 8. Equipment renting
9. Transportation 10. House/land renting 11. Remittance 12. Fish culture
13. Fish production 14. Other (spec.)……

3.5.2 How much the total income (cash and kind) from these activities in ***Last Year***:

1st ..... Riels
2nd ..... Riels
3rd ..... Riels
4th (others)..... Riels

Total in ……..……. Riels (convert to USD ……)

3.6 Amount of income getting from the ROW using (0-20m): .....Riel
Income source: .....

3.7 Expenses

Annual expense ……Riel converts to USD: ……

3.7.1 Daily expense (recently expense):

Item	Unit	Price per unit/Riel	Total price (Riel)
Rice			
Food (fish, meat, vegetable, and spices)			
Snack			
Wood/charcoal/fuel/gas			
Other (spec.)….....			
Total:			
Annual total (365 days)			

3.7.2 Monthly expense:

Item	Unit	Price per unit/Riel	Total price (Riel)
Cosmetics (perfume, powder, and soap)			
Health (drug, treatment fee).			
Water			
Electricity power			
Other service			
Gasoline			
Other (spec.).....			
Total:			
Annual total (12 months)			

3.7.3 Yearly expense:

Item	Unit	Price per unit/Riel	Total price (Riel)
Clothes			
Education (material, tutoring, and meals at school)			
Furniture			
House repairing			
Ceremonies/marriages			
Entertainment/travel			
Other (spec.).....			
Annual total:			

3.8 Health

3.8.1 Where do you and your household members often go for? (Please tick)

Facility	Health Treatment	Serious Illness	Birth Delivery	How far? (Km)

Traditional Midwife				
Traditional Healer				
Drug shop				
Private Pharmacy				
Health Centre				
Provincial Hospital				
Private Clinic				
Private Hospital				
Other:				

3.8.2 What are the three most important problems with the public health services for the people in this village?

1 = Lack of beds/Equipment 2 = Not enough medicine
3 = No physician medical 4 = Poor quality of service
5 = No midwife 6 = High price
7= Long distance 8 = Unsanitary
9 = Unhelpful staff 10 = Other (Describe).....

1. Most important ☐
2. Second important ☐
3. Third important ☐

3.9 Education

3.9.1 How many children in household is primary school age (6-11)? ☐

3.9.2 How many children in household attend primary school? ☐

3.9.3 If children of primary school age, not attending school, main reason for non-attendance? ☐

1 = Cannot afford school costs 2 = Have to help in business
3 = Takes too long to get to school 4 = other (describe).....

3.9.4 How many children in household is lower secondary school age (12-14)? ☐

3.9.5 How many children in household attend lower secondary school? ☐

3.9.6 If children of lower secondary school age, not attending school, main reason for non-attendance? ☐

1 = Cannot afford school costs 2 = Have to help in business
3 = Takes too long to get to school 4 = other (describe).....

3.10 Credit:

3.10.1 Have you taken any loan? ☐ No **(skip to Q. 3.11)** ☐ Yes

3.10.2 If yes, please fill the table below:

When did you borrow money? **Month/year**	Credit Amount **(Riel)**	From Whom **(Code)**	Interest rate **%**

Code: 1 = Govt. /Bank 2 = NGOs / Society 3 = Landlord / traders
4 = Credit provider 5 = Relative 6 = other (specify).....

3.10.3 What did you use this money for **(multi answers)**? ☐

1 = Food consumption 2 = Health care 3 = Schooling costs
4 = Building/Repairing house 5 = Ceremony/Wedding 6 = Farming
7 = Business improving 8 = Supporting to family members
9 = To meet cost caused by the Project 10 = other (specify).....

3.11 Living condition

A. Water source:

3.11.1 Drinking/cooking: ……. Washing/bathing…….

1= Stream/river 2= Lake/pond 3= Protected well 4 = Unprotected wel
5= Rain water 6= Buying 7= Waterworks 8 = other (specify).....

3.11.2 If buying from vendor, how much it cost per day? ..... Riels

3.11.3 If you collect by yourself, how much time you spend to do so? ..... minutes

3.11.4 Is the drinking water filter? ☐ Yes ☐ No

3.11.5 Is the drinking water boiled? ☐ Yes, always ☐ Yes, sometimes ☐ No

3.11.6 Is the drinking water filtered? ☐ Yes ☐ No

B. Sanitation:

3.11.7 Do you have a pit latrine? ☐ Yes ☐ No

3.11.8 Is there any drainage system near your house? ☐ Yes ☐ No

3.11.9 If yes, please tick in box as follow:

- Proper rain water drainage ☐
- Waste water drainage ☐
- An open drain ☐

C. Energy source:

3.11.10 Lighting: ……. Cooking: …….

1 = None 2 = Fire wood 3 = Private generator
4 = State Electricity 5= Battery 6 = Charcoal
7 = Gas / Kerosene 8 = Torch/Rubber 9 = Other (specify)…….

3.12 Accessibility to other facility service

Please indicate the distance of following facility service:

Facilities	Average Distance (Km)
Nearest School	
Market	
Religious centre (Pagoda)	
Drug shop	
Health Centre/ Referral(or District) hospital	
Provincial/Municipality hospital	
Police Administrative Post	
Commune Centre	
District Centre	
Other Urban	

IV. PERCEPTION ON THE PROJECT

4.1 What do you think about the project? ☐

0 = No answer 1 = Bad 2 = Good & Bad 3 = Good 4 = Very good

4.2 If good/very good, rank the 3 following statements in the boxes:

☐ Improve cargo transportation
☐ Decrease of congestion/accident
☐ Improve travel of tourist
☐ Attract more investment
☐ Increase land price
☐ Improve environment
☐ Create more direct/indirect job
☐ Reduced daily expenditures
☐ Flood prevent
☐ Big push to outskirts area (Bypass)

☐ Improve access other facilities ☐ Improve local product marketing

☐ Others (spec.) ……..

4.3 If you think there are some bad things about the project, rank 3 following statement in the boxes:

☐ Increase daily expenditures
☐ Loss of good trading site
☐ Increase accident
☐ Disturbs families and community
☐ Loss house / shop
☐ Loss of land use in ROW
☐ Worsen access to school
☐ Worsen environmental impact
☐ Decrease household income
☐ Affected on public facilities
☐ Loss occupation
☐ Worsen people health condition
☐ Makes people migrate away
☐ other (spec.) …….

4.4 Will you agree to move your affected properties from PRW? ☐

0 = No answer 1 = Not agree 2 = Agree with assistant 3=Voluntary to move

SIGNATURE

Household Head **Village Headman** **Interviewer**

Sketch map of the affected house

