Appendix-5:
Technical Notes(T/N)

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TECHNICAL NOTES

ON

PREPARATORY SURVEY ON

THE PROJECT FOR URGENT REPLACEMENT

OF BRIDGES IN FLOOD-PRONE AREAS

IN THE KINGDOM OF CAMBODIA

The Preparatory Survey Team (Team) commissioned to undertake the Outline Design, under Japan International Cooperation Agency (JICA) conducted field surveys and review of existing documents and held several discussions on the technical aspect with the implementing agency and other relevant agencies in relation to "The Project for Urgent Replacement of Bridges in Flood-prone Areas in the Kingdom of Cambodia".

This note is signed between The Team and Ministry of Public Works and Transport (MPWT) to share mutual understandings and agreement as mentioned in Appendix-1.

Phnom Penh, 8th July, 2016

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Director of Road Infrastructure Department
Ministry of Public Works and Transport (MPWT)

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WITNESS:

Mr. Chao Sopheak Phibal
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Ministry of Public Works and Transport (MPWT)

Appendix -1

1. Project Background

The Kingdom of Cambodia is located in the Mekong delta region and the wide area of the country lies in low and flood-prone land. Cambodia has experienced two severe floods recently, in 2011 and 2013. The 2013 flood brought about huge damage. 188 people died, 1.7 million people injured and the total number of people evacuated reached 140 thousand. Many infrastructures such as roads and bridges were also damaged by the floods.

National Road 11 (NR11) and 73 (NR73) are Secondary National Roads functioning as an arterial for transportation of goods and daily commodities to the suburban areas. These roads serve the people of the areas that are located along the Mekong River and are prone to floods. There are many bridges along these roads. The Government of Cambodia (GOC) has been undertaking replacement/reconstruction of the bridges that are sub-standard (temporary Bailey bridge) and/or vulnerable to flood. At present, there are only seven bridges that are either sub-standard and/or vulnerable on NR11 and NR73. The replacement of these bridges will not only ensure safety, smooth and stable transportation and logistics in the area, but will also contribute in mitigating the potential risks from natural disaster.

To remedy the situation, the GOC made a request to the Government of Japan (GOJ) for a grant aid assistance to replace the seven bridges. The GOJ decided to conduct a preparatory survey on "the Project for the Urgent Replacement of Bridges in Flood-prone Areas in the Kingdom of Cambodia" and examine the viability of the project and entrusted the survey to Japan International Cooperation Agency (JICA).

2. General Items

2.1 Inception Report

- MPWT has basically agreed regarding the contents of the Inception Report (IC/R) submitted by the Team on May 15, 2016.
- MPWT assured it will provide the answers to the questionnaire attached to the IC/R by July 15, 2016.

2.2 Project Scope

MPWT understands the scope of the project is to reconstruct seven existing bridges. Two bridges (Ba Baong 1 and Ba Baong 2) are on National Road 11 (NR11) and five bridges (Prek Sandan, Prek Rus, Anglong Khle, Prek Chhloung and Peam Te) are along National Road 73 (NR73). However, the number of bridges that would actually be reconstructed will depend on the availability of the budget. For this purpose, the priority of the bridges will be studied taking into consideration various aspects such as soundness/vulnerability of the existing bridges, impact on the existing road network, enhancement of road function, construction efficiency, environmental and social consideration etc.

2.3 Consistency with Future Plan

MPWT clarified that currently there are no plans/projects for renovation/rehabilitation of NR11 and/or NR73. Therefore, any development plan to be implemented after this project that is

anticipated to affect this project will make its plan consistent with the scope of this project.

2.4 Coordination with Concerned Authorities

Coordination with authorities relevant to this project is important for smooth implementation of the project. Some of the major relevant agencies and purpose for coordination are indicated in Table 1. MPWT assured it will closely coordinate with these agencies and others if necessary.

. Table 1 Relevant Agencies

No.	Agencies	Purpose
1	Department of Public Works and Transport	Coordinate with private companies
2	Ministry of Environment	Environmental consideration (EIA procedure)
3	Ministry of Social Affairs, Veterans and Youth Rehabilitation Ministry of Economy and Finance, Resettlement Department Inter-Ministerial Resettlement Committee	Resettlement Action Plan procedure
4	Ministry of Economy and Finance, General Department of Taxation and, General Department of Custom and Excise	Tax exemption and Import duty exemption
5	Rorka Kandal Station (private company)	Relocation of water pipes
6	Electricity Authority of Cambodia (EDC) Chhlong District electricity supply (private company)	Relocation of electricity
7	Ministry of Economy and Finance	Budget request for land acquisition and other expenses to be borne by GOC
8	C Fock Company (Chinese private company) Department of Post and Telecommunication	Relocation of fiber optic cable (cable TV)
9	Chhlong Potable Water Service Touch Saren Potable Water Headquarter	Relocation of water pipe at Chhlong Bridge Relocation of water pipe at Peam Te Bridge
10	METFONE Department of Post and Telecommunication	Relocation of telephone cables

2.5 Restriction of Overloaded Vehicles

The result of axle weight survey carried out under this project in May 2016 indicates that the percentage of overloaded vehicles is about 29% on NR11 and about 23% on NR73. Overloaded (axle load exceeding 10 tons) vehicles can have heavy adverse impact on the pavement and on the bridge structure. Therefore, it is utterly important that these vehicles are restricted from plying on the roads.

MPWT assured it will coordinate with relevant agencies and urge to step up law enforcement to stop overloaded trucks on the objective bridges including the approach roads.

2.6 UXO Clearance

Detection and clearance of unexploded ordinaries and mines within the Corridor of Impact (COI) of the project shall be responsibility of Cambodian side.

2.7 Provision of Temporary Bridge

The Team confirmed that MPWT does not have any temporary bridges in its possession that could be used on detours during the construction period.

2.8 Removal/Demolition of Existing Bridges

If the reconstructed bridges are aligned along the present alignment, the Project will include removal of existing bridges and installation/removal of temporary detour roads. If the alignment is modified, the existing bridges will be utilized for securing traffic and will be removed after the completion of the Project by the Cambodian side. The Team explained that the Draft Final Report would include recommendable method of removal including the estimated cost for removal and demolition.

2.9 Design Obstacles

The following facilities/objects are likely to be influenced (might need demolition or relocation) by the design. These facilities will be avoided to the possible extent. However, in case these facilities are affected by the design, these facilities will be appropriately removed/relocated by the GOC.

No.	Bridge Name	Potential Obstacles	Pictures
1	Ba Baong No.2	Houses, Gate to commune, Electricity Transmission Line, trees.	
2	Ba Baong No.1	Electricity Transmission Line, trees.	
3	Prek Sandan	Electricity Transmission Line, trees.	
4	Prek Rus	Electricity Transmission Line, trees	
5	Anglong Khle	Electricity Transmission Line, trees	
6	Prek Chhlong	Houses, Pagoda, Restaurant, trees, Electricity Transmission Line, Water Pipe, Optical Fiber Cable, Telephone Cable.	
7	Peam Te	Houses, Praying/resting house, Urban/Rural boundary monument, Gasoline stand, Optical Fiber Cable, Telephone Cable, Water Pipe.	

3. Technical Items

3.1 Road Category and Road Standard

- The administrative category of the objective roads (NR11 and NR73) in accordance with the Cambodian Standard is Secondary National Road (2-digit National Road). Functionally, they are categorized into Urban Arterials.
- The standard of these roads depends on 30-year projected Average Daily Traffic (ADT). The standard of the objective roads will be determined based on the traffic forecast using the traffic volume counted under this project. The relation between the ADT and the road standard is indicated in the Cambodian Standard, as shown in Table 2.

Table 2 ADT for Determining the Road Standard

Area	Road Category	30 Year Projected ADT					
		All Traffic Volume	**>10,000**	**10,000 to 3,000**	**3,000 to 1,000**	**1,000 to 150**	**<150**
URBAN	Expressway	U6	-	-	-	-	-
	Arterial	**-**	**U5**	**U4**	**-**	**-**	**-**
	Collector	-	-	U4	U3	-	-
	Local	-	-	-	-	U2	U1

Source: Road Design Standard (CAM PW.03.101.99), 2003

3.2 Applicable Standards

The following Cambodian standards/guidelines and/or International Standards such as AASHTO Standards, and Japanese Standards would be applied for planning and design of bridge/roads, structures and road ancillaries.

1) Bridge Design Standard (CAM.PW.04.102.99), 2003
2) Road Design Standard Part 1.Geometry (CAM.PW.03.101.99), 2003
3) Pavement Design Standard Part2. Geometry (CAM.PW.03.101.99), 2003

- Pavement design can be calculated using either the Cambodian Standard, the Japanese Standard or AASHTO Pavement Design Guideline 1993. However, a different standard will be used to cross-check the results.

4) Construction Specification, 2003

3.3 Design Speed

Design speed depends on Design Standard and Design Standard depends on the 30-year Projected ADT as shown in Table-2. Therefore, design speed will be determined based on the result of the traffic forecast.

Table-3 extracted from the Cambodian Road Standard 2003 will be referred in determining the design speed for the Project in consideration of "Area Type" depending on the condition of land

acquisition. Particularly, the Area Type for Prek Chhlong Bridge and/or Peam Te Bridge shall be deemed as Area Type II.

Table-3 Design Speed (Urban)

Design Standard	Design Speed (km/hr)		
	Area Type I	Area Type II	Area Type III
U6	100	80	60
U5	**80**	**60**	**50**
U4	**70**	**60**	**50**
U3	60	50	40
U2	50	40	30
U1	40	30	20

Area Type I: Relatively free in road location with very little problem as regards land acquisition, affected building or other socially sensitive areas.

Area Type II: Intermediate between I and III

Area Type III: Very restrictive in road location with problem as regards land acquisition, affected building and other sensitive areas

3.4 Design Volume and Design Year

- Design volume (volume of traffic estimated to use the road during the design year) is taken as 20 years from the completion of the road. The design year is therefore set for 2039.
- However in compliance to MPWT's request, traffic forecast will be carried out for the period of 30 years (2049).

3.5 Geometric Conditions

Parameters of geometric conditions to be applied for design of roads are shown in Table-4.

Table-4: Standards and Geometric Conditions (Road Design Standard 2003)

HIGHWAY / ROAD CLASSIFICATION			Secondary National Road (NR2-digits)	
			U5	U4
GENERAL				
Min. Design Speed (km/hr)	Area Type I		80	70
	Area Type II		60	60
	Area Type III		50	50
CROSS-SECTION ELEMENTS				
Road Cross Section Width	ROW Width (m)	Urban	50	50
	Median Shoulder		-	-
	Vehicle Lane	Flat/Rolling	3.50	3.50
	Shoulder (m)	Road	1.50	1.50
		Bridge	0.60	0.60
	Sidewalk	Road	-	-
		Bridge	0.9 ~ 1.50	0.9 ~ 1.50
VERTICAL ELEVATION CONTROLS				
Minimum Vertical Clearance (m)		Minimum	5.0	5.0
		Desirable	5.5	5.0
TRAFFIC VOLUME				
Design Traffic Volume (ADT)			3,000-10,000	3,000-10,000
STRUCTURE LOADING				
Structure Live Loading (Minimum)			HS20-44×25%	
PAVEMENT STRUCTURE				
Pavement	Surface Type		Cement Concrete Pavement	

	Crossfall (%)	Pavement		3.0	3.0
		Shoulder (earthen)		6.0	6.0
GEOMETRIC CONDITIONS					
HORIZONTAL ALIGNMENT				Design Speed	
				80 (km/hr)	60 (km/hr)
Min. Horizontal Curvature		Desirable (5% SE)	m	255	135
		Minimum (9%SE)	m	210	115
Maximum Superelevation			%	6.0	9.0
Min. Curvature Length			m	140	100
Min. Transition Curve Length			m	44	33
Radius not requiring Transition Curve			m	379	213
Values of Superelevation with respect to Radius of Curvature			6%	255	135
			5%	265	145
			4%	280	150
			3%	300	160
			Reverse (2.5%)		
Min. Radius not requiring Superelevation			m	1,250	5,000
Superelevation Run-off				$(e_1 - e_2)V_d/0.09$	$(e_1 - e_2)V_d/0.126$
VERTICAL ALIGNMENT					
Max. Gradient		Standard	%	4.0	5.0
		Gradient with limitations	% (m)	5 (500)	6 (300)
			% (m)	6 (400)	7 (250)
			% (m)	7 (300)	8 (200)
Sight Distance		Stopping	m	115	70
		Passing	m	550	450
Min. Radius Crest Curve		K-Value		30	15
Min. Radius Sag Curve		K-Value		28	15
Min. Vertical Curve Length			m	-	-
Widening not requiring Radius			m	250	250
Widening for Radius 30 ~ 50			m	1.5	1.5
Widening for Radius 50 ~ 100			m	1.0	1.0
Widening for Radius 100 ~ 250			m	0.5	0.5

3.6 Type of Pavement

Asphalt pavement is preferable as it is very common in Cambodia. However, given that there is justifiable reason(s), concrete pavement is also acceptable.

3.7 Target Year for Pavement Design

Target year for calculation of Asphalt pavement and Concrete pavement will be 15 years and 20 years respectively.

3.8 Bridge Design Criteria/Standards

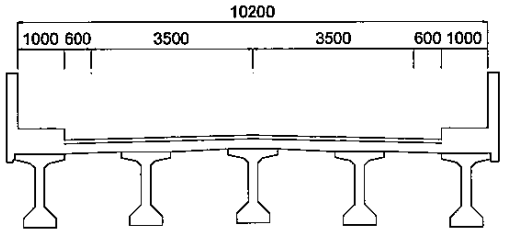
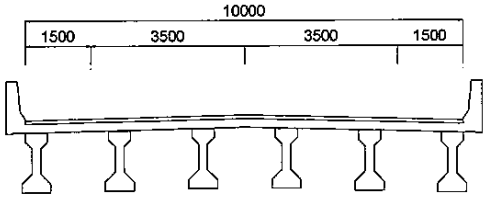
3.8.1 Designed Standard

Described in section 3.2.

3.8.2 Bridge Width

Bridge widths differ depending on whether sidewalk is provided or not. Typical Cross Sections of each bridge are shown in Table-5. The number of girders and the span length of deck slabs are determined in consideration with structure design.

Table-5 Cross Section Type on Bridge

Type-A Case Sidewalk Provided	Type-B Sidewalk not Provided
	
• Prek Chhloung • Peam Te	• Ba Baong No.1 • Ba Baong No.2 • Prek Sandan • Anlong Khle • Prek Rus

3.8.3 Locations of New Bridges

The location of new bridges shown in Table-6 was agreed between MPWT and the JICA Study Team through discussion based on comprehensive assessment in consideration with environmental impact, constructability, cost, etc.. The MPWT and the JICA Study Team have also agreed that the final locations would be presented in the Draft Final Report to be submitted in the end of November 2016 through detailed study in Japan.

Table-6 Locations of New Bridge

Bridge Name	Location of New Bridge
Ba Baong No.1	East side (right side as seen from Phnom Penh) of existing bridge
Ba Baong No.2	East side (right side as seen from Phnom Penh) of existing bridge
Prek Sandan	Reconstruction at same location of the existing bridge
Prek Rus	Reconstruction at same location of the existing bridge
Prek Anlong Khle	East side (right side as seen from Phnom Penh) of existing bridge
Prek Chhloung	South side (right side as seen from Phnom Penh) of existing bridge
Peam Te	West side (left side as seen from Phnom Penh) of existing bridge

3.8.4 Design Criteria

Based on the Cambodian standard (Bridge Design Standard (CAM.PW.04.102.99), 2003), the following criteria is applied to the Project.

- Temperature change: ±17℃ (8-42℃)
- Earthquake load: Acceleration coefficient = 0.05
- Minimum Freeboard (clearance between H.W.L and bridge): 0.8m

3.8.5 Concrete Specification

Based on the Cambodian standard (Construction Specification, 2003), the criteria on concrete structure is determined as below.

(1) Design strength

- Pre-stressed concrete girder 45MPa
- Concrete deck slab 40MPa
- Other reinforced concrete member 32MPa
- Substructure (including cast-in-place pile) 32MPa
- Lean concrete 18MPa

(2) Concrete cover thickness

Based on the criteria in Cambodia (Refer to AASHTO LRFD Sec.5 Table 5.12.3-1)

3.8.6 Steel Materials

Grade 400 deformed bars (Min, yield point 400Mpa)

In design, SD390 (Japanese Industrial standard) will be applied since it is equivalent to the Cambodian criteria Grade 400.

3.9 Access for Inspection

Upon request from MPWT for provision of access at all sub-structures on all objective bridges, the Team explained that such access is deemed necessary only at two bridges in Kratie Province (Prek Chhloung and Peam Te) as they are erected across a river. Other five bridges are located in flood area and the substructures are easily accessible during dry season.

Therefore, the Team will consider provision of access for inspection on the piers of the two bridges mentioned above. Furthermore, the provision will be limited to high piers that cannot be easily accessed from the ground.

3.10 Hydraulic Design of Bridges

Design High Water Level:

- Design High Water Level (HWL) of the Bridges will be set based on the historical maximum flood water level.

  For reference, HWL on bridges designed and constructed under Japanese Grant Aid Assistance are as follows;

  HWL of NR1 (3 Bridges): 2000 Flood Water Level

  HWL of NR6A (Bridge No.24, 25 and 26): 1996 Flood Water Level

  HWL of NR11 (8 Bridges): 2011 Flood Water Level

- Freeboard between the HWL and the bottom of beam will be set based on the discharge and also by considering the difference between the probable flood water level of 50-year return period and the historical maximum flood water level and future water level rise by

possible climate change.

- Historical maximum flood water level will be applied for determining the high water level at bridges on the detours to be installed to secure existing traffic during construction period. Freeboard between the HWL and the bottom of beam of the temporary bridge of the detours will be set at 0.50m.

Design Bed Elevation:

- Design bed elevation of the openings of the Bridges will be set so that design longitudinal bed profile around the Bridges will be smooth.

Bank and Bed Protection:

- Considering the condition of current bank erosion and scouring conditions at each site of the Bridges, appropriate bank and bed protection around the Bridges will be provided against erosion and scouring.

Treatment Method of Overflow between Babaong No.1 and No.2 Bridges

- Overflow over the road dike between Babaong No.1 and No.2 Bridges occurred during 2011 Flood.
- Considering the possibility of elevating the road dike between these two bridges in the future, in order to increase safety against floods, there are two options for treating the overflow discharge. Option_1 is to add the overflow discharge into the design discharges of Babaong No.1 and No.2 Bridges. Option_2 is to make an additional opening such as bridge or culvert in the road dike between these Bridges in the future, which will have to be undertaken by the Cambodian side.
- Cambodian side prefers Option_1, because Option_2 will possibly have adverse impacts to the land use such as agricultural lands around the road between these two Bridges. Therefore, Option_1: To include the overflow discharge over the road dike between Babaong No.1 and No.2 Bridges will be studied.

4. Environmental and Social Considerations

The Team confirmed Cambodian Environmental Act (Anukret on Environmental Impact Assessment Process) does not require carrying out EIA process for this project. The Team will prepare Abbreviated Resettlement Action Plan and Environmental Management Plan. MPWT will take the necessary procedure.

5. Temporary Yard

Temporary Yards shall be provided by Cambodian side during the construction period. The Team confirmed that there should be two locations, one for the five bridges on NR73 and the other for the two bridges on NR11, since these two areas are approximately 160kms away from each other. The Team identifies two particular areas as shown on the attached sketch, each approximately 12,000m2 (1.2 hectors), for establishing offices (consultant office and contractor's office),

batching plant and other material stocks.

6. Others

- The Team will prepare the Abbreviated Resettlement Action Plan and submit it to MPWT. The expected target for the submission is mid of November 2016. Soon after submission, MPWT will commence procedures for obtaining approval on the report and subsequently carry out negotiation with the PAPS as well as take necessary steps for allocation of the budget for acquisitioning land and resettlement. Basic agreement of the PAPS and required budget shall be obtained prior to signing of the Exchange of Notes (scheduled in February).
- The Team will provide information relating to the items and quantity of utilities that have to be relocated by mid-September 2016. The relocation of the utilities will be undertaken by GOC.
- Road ancillaries including facilities for traffic safety will be considered. However, installation of street lights will not be included. Also, regarding traffic sign. Only prohibitory and warning signs will be provided. Other traffic signs shall be responsibility of GOC.

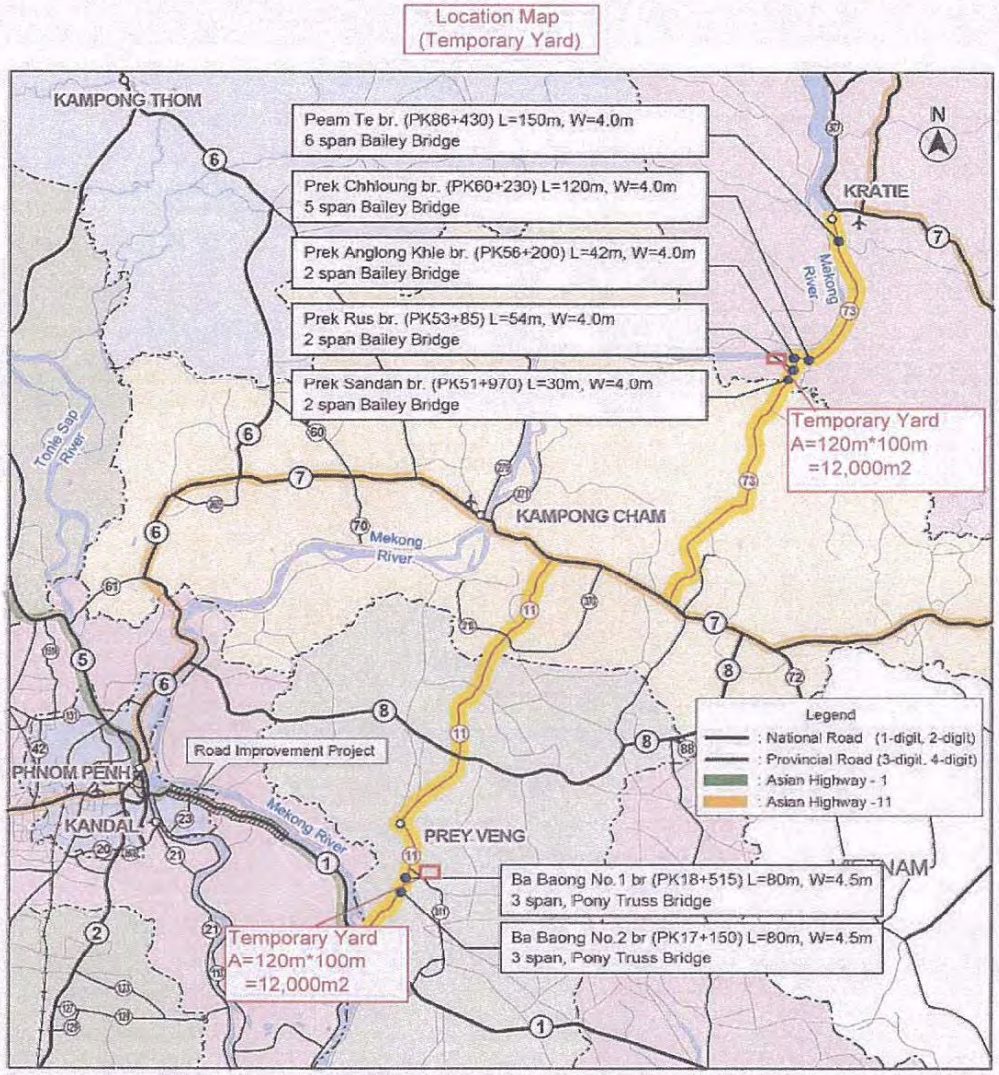
Attachment 1: Temporary Yard

Location Map of Temporary Yard

Figure 1-1 Temporary Yard on NR11

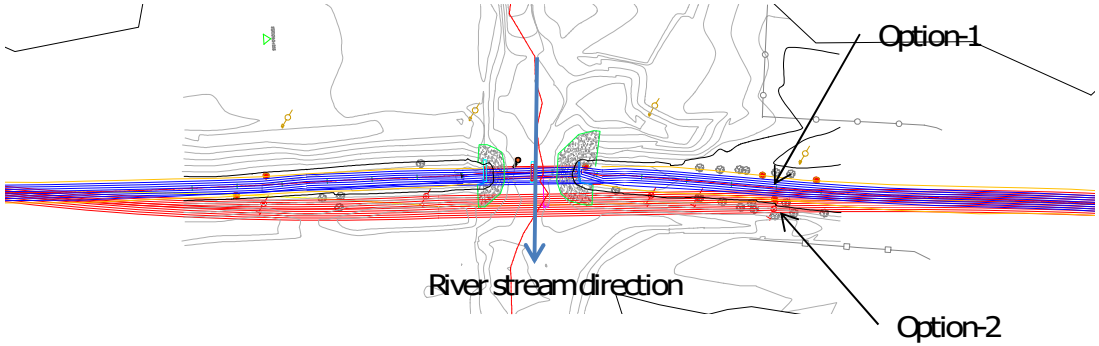
Figure 1-2 Temporary Yard on NR73

Attachment 2: Temporary Yard

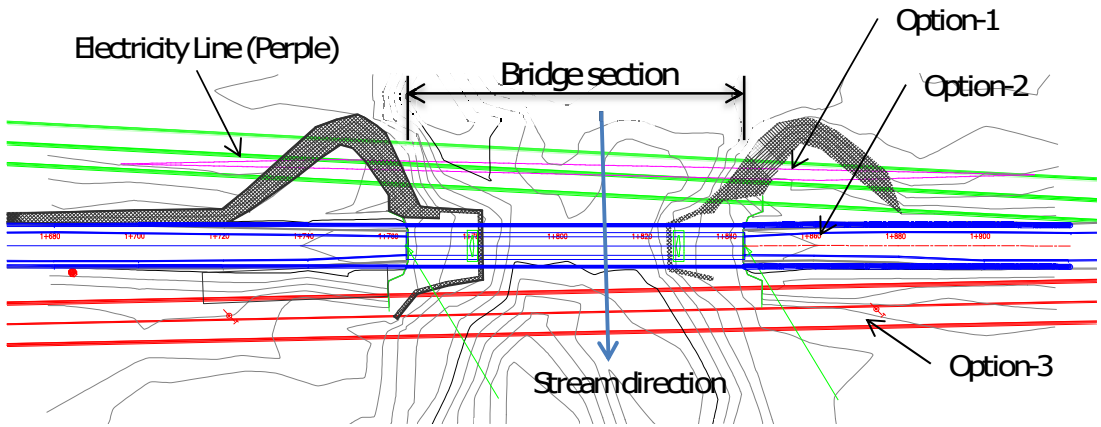


Appendix-6:
Bridge Location after Relocation

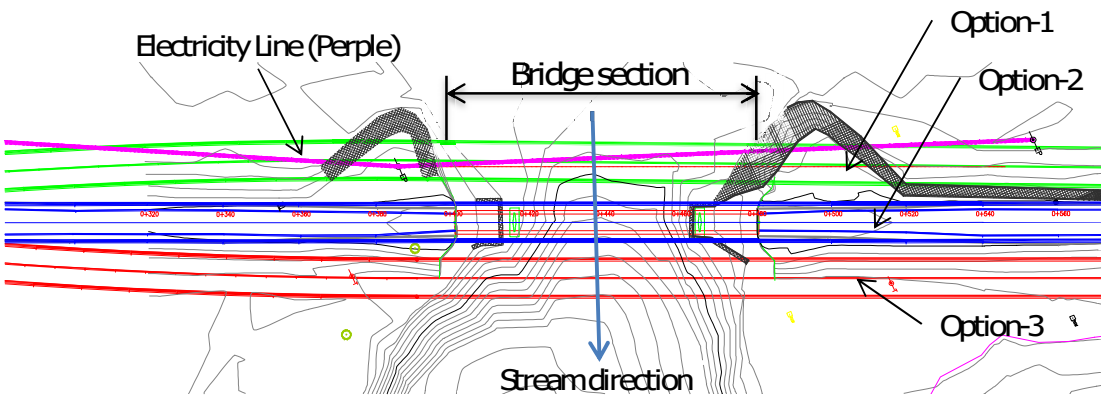
Options of New Bridge Location for Anlong Khle Bridge

Plan			 View from upstream side			
Option	Option-1 Existing (Blue)		Option-2 Downstream side (Red)		Option-3 Upstream side	
Obstacle	Trees (Because the width of approach road will be wider.)	Fair	Trees	Fair	This option is not consider because this option is clear that the undesirable from the perspective of the road alignment.	
Environmental impact	Ressetlement of residents is not required.	Fair	Ressetlement of residents is not required.	Fair		
Road alingment	Not changed	Fair	Road alignment becomes straight. Because original road alignment was estimated in this alignment.	Good		
Construction period	Approximately 1.5 year	Fair	Approximately 1.5 year	Fair		
Economic	Cheaper than option-2.	Good	Expensive than Option-1. Because the length of approach road is longer than option-1 because road alingment change.	Bad		
Total evaluation	Recommended		Not Recommended			

Options of New Bridge Location for Babaong No.1 Bridge

Plan			 View from downstream side				
Option	Option-1 Upstream side (Green)		Option-2 Existing (Blue)		Option-3 Downstream side (Red)		
Obstacles	Electricity Transmission Line	Fair	None	Good	None	Good	
Environmental impact	Ressetlement of residents is not required.	Good	Ressetlement of residents is not required.	Good	Ressetlement of residents is not required.	Good	
Road alingment	Approach road is curve since bridge section is shifted to left side as seen from Phnom Penh.	Fair	Not changed	Good	Approach road is curve since bridge section is shifted to right side as seen from Phnom Penh.	Fair	
Construction period	Approximately 1.5 year	Good	Approximately 2 years	Fair	Approximately 1.5 year	Good	
Economic	Cheaper than Option-2	Good	Expensive than other option. Because the bridge has about 100m length, therefore temporary bridge for detour becomes big.	Fair	Cheaper than Option-2	Good	
Hydrological	Light scouring is found but it is shallow. Safety for scouring around bridge is the highest.This is the best option as hydrological.	Good	Not changed	Fair	The ground in downstream side is precipitously scouring by water. And, there is possibility to progress scouring in the future.	Not Good	
Total evaluation	Recommended		Not Recommended		Not Recommended		

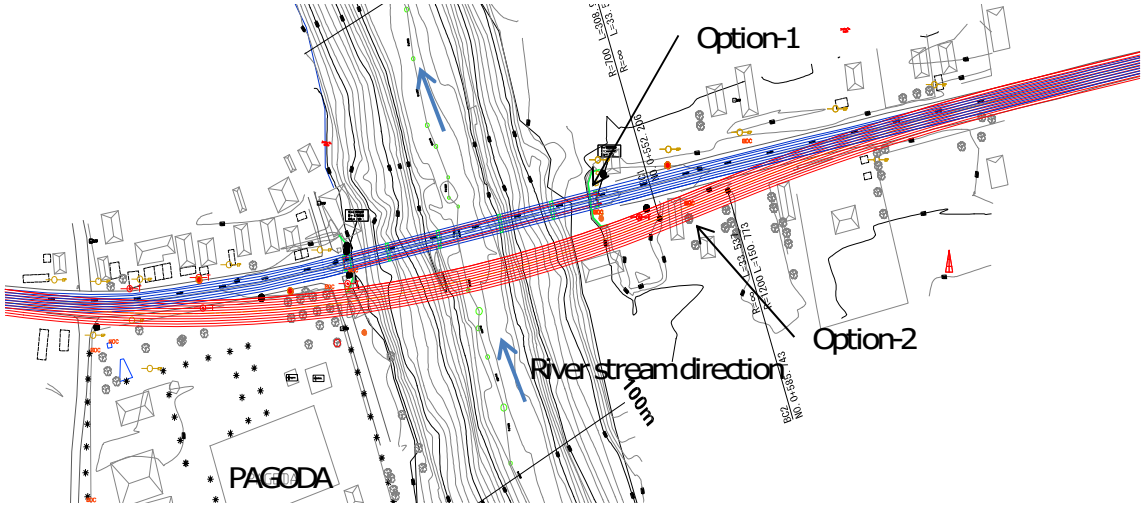
Options of New Bridge Location for Babaong No.2 Bridge

Plan			 View from downstream side				
Option	Option-1 Upstream side (Green)		Option-2 Existing (Blue)		Option-3 Downstream side (Red)		
Obstacles	Electricity Transmission Line	Fair	None	Good	None	Good	
Environmental impact	Ressetlement of residents is required. About 5 families are affected.	Not Good	Ressetlement of residents is not required.	Good	Ressetlement of residents is required. One family is affected.	Not Good	
Road alingment	Approach road is curve since bridge section is shifted to left side as seen from Phnom Penh.	Fair	Not changed	Good	Approach road is curve since bridge section is shifted to right side as seen from Phnom Penh.	Fair	
Construction period	Approximately 1.5 year	Good	Approximately 2 years	Fair	Approximately 1.5 year	Good	
Economic	Cheaper than Option-2	Good	Expensive than other option. Because the bridge has about 100m length, therefore temporary bridge for detour becomes big.	Fair	Cheaper than Option-2	Good	
Hydrological	Light scouring is found but it is shallow. Safety for scouring around bridge is the highest.This is the best option as hydrological.	Good	Not changed	Fair	The ground in downstream side is precipitously scouring by water. And, there is possibility to progress scouring and stability of the structure is reduced in the	Not Good	
Total evaluation	Recommended		Not Recommended		Not Recommended		

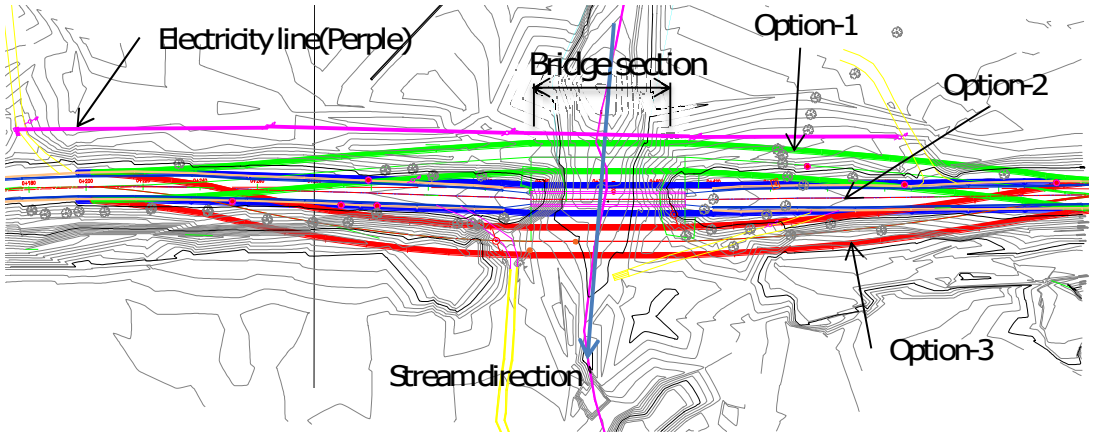
Options of New Bridge Location for Peam Te Bridge

Plan	 View from upstream side						
Option	Option-1 Upstream side (Green)		Option-2 Existing (Blue)		Option-3 Downstream side (Red)		
Obstacle	*8 houses (Right bank) *7 houses (Left bank) *Gas station (Right bank)	Fair	*3 houses (Right bank) *5 houses (Left bank)	Fair	*5 houses (right bank) *9 houses (left bank) *2.2 kV eletric transmission	Fair	
Environmental impact	*Ressetlement of residents is required. *Land acquision is required.	Fair	*Ressetlement of residents is required.	Fair	*Ressetlement of residents is required. *Land acquision is required. (Less than Option-1)	Fair	
Drivability	Good	Good	Longitudinal slope of the road will become steeper than other option. It will be about 4%.	Fair	Good	Good	
Structural	Skew bridge	Fair	Skew bridge	Fair	Straight bridge	Good	
Construction period	Approximately 1.5 year	Good	Approximately 3 year	Fair	Approximately 1.5 year	Good	
Economic	Equal to the option-3.	Good	Expensive than other option. Because installation and removal of the temporary bridge and detour are needed.	Fair	Equal to the option-1.	Good	
Total evaluation	Not recommended		Not recommended		Recommended		

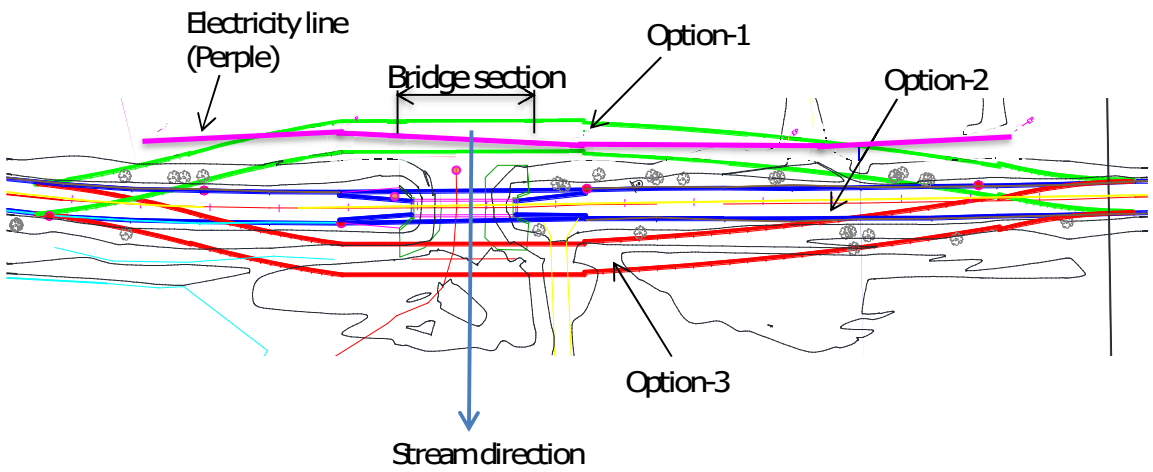
Options of New Bridge Location for Prek Chhloung Bridge

Plan			 View from upstream side				
Option	Option-1 Existing (Blue)			Option-2 Upstream side (Red)		Option-3 Downstream side	
Obstacle	*1 house (Right bank) *6 houses (Left bank)	Fair		*3 houses (Right bank) *1 houses (Left bank)	Fair	This option is not consider because there are many houses in the area of downstream side. Therefore, it is cleary inappropriate.	
Environmental impact	*Ressetlement of residents is required.	Fair		*Ressetlement of residents is required. *Land acquision is required.	Fair		
Drivability	Good	Good		Good	Good		
Structural	Skew bridge	Fair		Skew bridge	Fair		
Construction period	Approximately 2.5 year	Fair		Approximately 1.5 year	Good		
Economic	Expensive than option-2. Because installation and removal of the temporary bridge and detour are needed.	Fair		Cheeper	Good		
Total evaluation	Not Recommended			Recommended			

Options of road alignment for Prek Rus Bridge

Plan			 View from downstream side				
Option	Option-1 Upstream side (Green)			Option-2 Existing (Blue)		Option-3 Downstream side (Red)	
Obstacles	Electricity Transmission Line Trees	Not Good		Trees (less than other option) (Because the width of approach road will be wider.)	Good	Trees	Fair
Environmental impact	*Ressetlement of residents is not required. *Felling of trees is required.	Fair		*Ressetlement of residents is not required. *Felling of trees is required.	Fair	*Ressetlement of residents is not required. *Felling of trees is required.	Fair
Road alingment	Approach road is curve since bridge section is shifted to left side as seen from Phnom Penh.	Fair		Not changed	Good	Approach road is curve since bridge section is shifted to right side as seen from Phnom Penh.	Fair
Construction period	Approximately 1.5 year	Good		Approximately 2 years	Fair	Approximately 1.5 year	Good
Economic	Expensive than Option-2. Because the length of approach road is longer than option-2.	Fair		Cheaper than other option	Good	Expensive than Option-2. Because the length of approach road is longer than option-2.	Fair
Total evaluation	Not Recommended			Recommended		Not Recommended	

Options of road alignment for Prek Sandon Bridge

Plan			 View from downstream side				
Option	Option-1 Upstream side (Green)		Option-2 Existing (Blue)		Option-3 Downstream side (Red)		
Obstacles	Electricity Transmission Line Trees	Not Good	Trees (less than other option) (Because the width of approach road will be wider.)	Good	Trees	Fair	
Environmental impact	*Ressetlement of residents is not required. *Felling of trees is required.	Fair	*Ressetlement of residents is not required. *Felling of trees is required.	Fair	*Ressetlement of residents is not required. *Felling of trees is required.	Fair	
Road alingment	Approach road is curve since bridge section is shifted to left side as seen from Phnom Penh.	Fair	Not changed	Good	Approach road is curve since bridge section is shifted to right side as seen from Phnom Penh.	Fair	
Construction period	Approximately 1.5 year	Good	Approximately 2 years	Fair	Approximately 1.5 year	Good	
Economic	Expensive than Option-2. Because the length of approach road is longer than option-2.	Fair	Cheaper than other option	Good	Expensive than Option-2. Because the length of approach road is longer than option-2.	Fair	
Total evaluation	Not Recommended		Recommended		Not Recommended		