CHAPTER 7

PROBLEMS OF EXISTING ROAD CONDITION AND GENERAL SHCEME OF IMPROVEMENT

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

7.1 Problems of the Existing Road

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

7.1.1 Problems of Existing Road Condition of the Middle Section

(1) Insufficient Road Width

- The average width of the existing carriageway is 10.4m. Due to the large volume of slow-speed traffic (such as motorumocks, agricultural tractors and motorcycles), high-speed traffic is 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 conditions. 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 10.4m-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, damage occurs every year, especially after the 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 its funds in the repair of damaged pavement every year. This is imposing a financial burden on the Royal Government of Cambodia (RGC) which can be reduced if the pavement is improved to asphalt concrete (AC) construction.
- Thus, improvement of pavement to AC is needed.

(3) Insufficient Road Height

- Flood water flowed over the road surface in 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 11.0m, composed of 2 lanes + a MC lane in the rural areas. A carriage way with this width cannot provide 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, a 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 the 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.

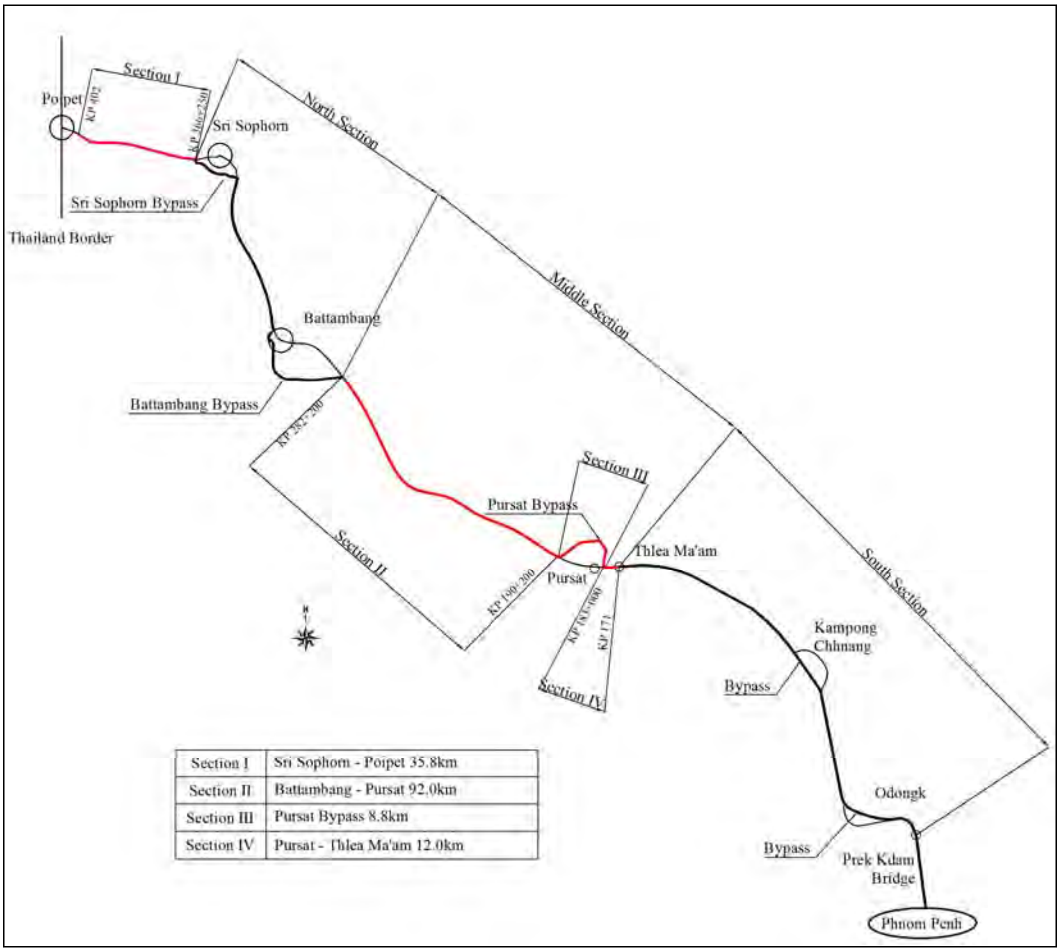


Figure 7.2-1 Section to be Improved

Section I (Sri Sophorn–Poipet Section):

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

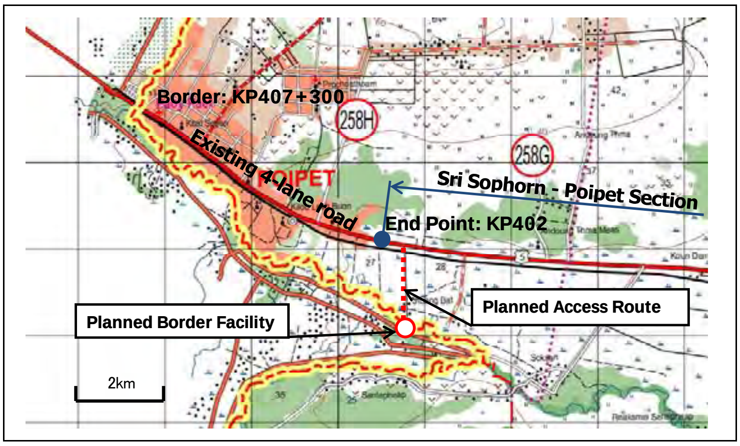


Figure 7.2-2 End Point of Sri Sophorn–Poipet Section

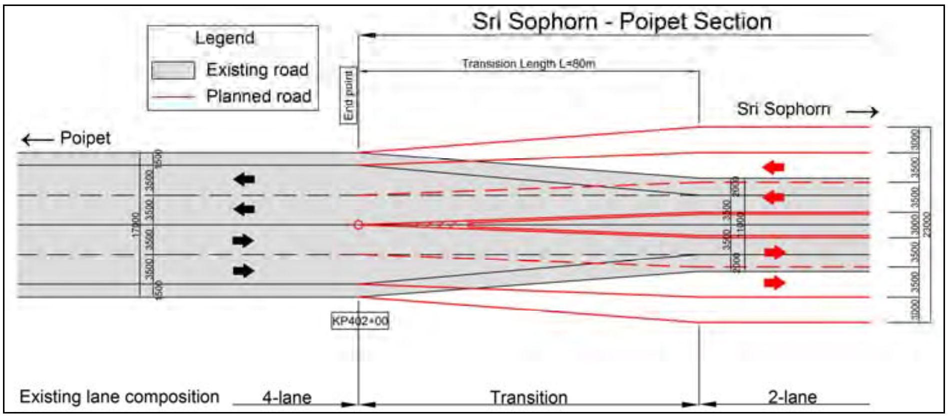


Figure 7.2-3 Plan Drawing of the End Point of Sri Sophorn–Poipet Section

Section II and IV:

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

Section IV starts from KP 171 + 000 in Thlea Ma'am at the end of the South Section and ends 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 a full 4-lanes in order to lead to the better working of logistics network of Cambodia. Modern logistics require reliable transportation infrastructure which can transport goods in the planned time. Carriageway of 10.4m 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 lanes.

(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 part of drivers. Of course, design standards are 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, a 4-lane cross section is recommended.

(3) The Traffic Situation and Traffic Accidents on the 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 accidents in Cambodia are over-speeding, drunken driving, hazardous overtaking and not observing traffic rules. These 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 crashes 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 in urban areas.
Percentage of fatalities by type of collisions	Head-on collisions accounted for 36% of the total fatalities, followed by rear-end collisions (16%), right-angle collisions (15%) and overturned by itself (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 Crash and Victim Information System, 2011 Annual Report" issued by National Road Safety Committee.

The road improvement should include traffic control facilities that guide drivers to observe the traffic rules. 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 a serious crash. Physically blocking vehicles' travelling on the opposite lane is expected to substantially reduce serious crashes even if there are vehicles of over speeding and/or drunken driving on the road. Thus, a 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

The 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. A type of median division is selected considering the following points.

・Smooth traffic must be assured as the function of both a national and international trunk road.

・Cross sections 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 of the type of "double line with road stud/chatter bar".

・U-turn lane shall be installed at a regular interval and at strategic locations.

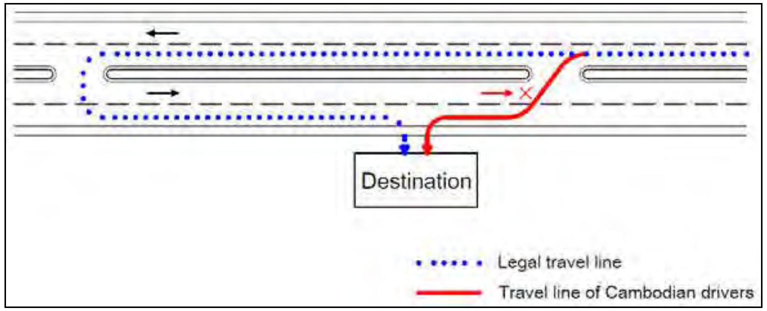
・Opening in median should be provided at strategic locations.

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 curb. 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 used in Japan) 	**91.7%** (Example rate of Raised Median with Fence used 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 of the South Section, the capacity of the existing NR 5 was estimated at 19,000 pcu/day as the practical capacity of a '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 the cost of the project are considered in the selection of the cross section design. Three alternatives of cross section design are proposed including a 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

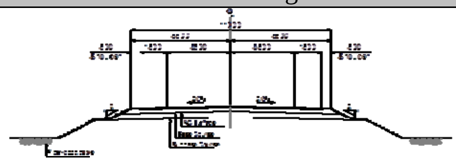
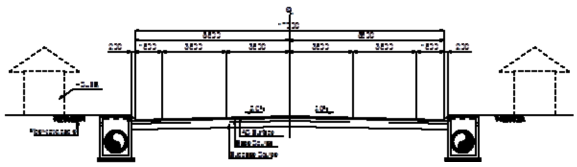
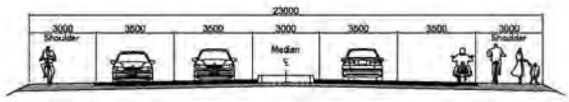
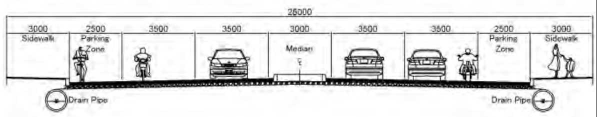
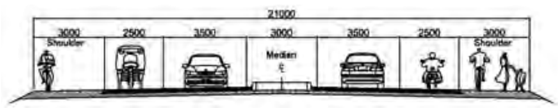
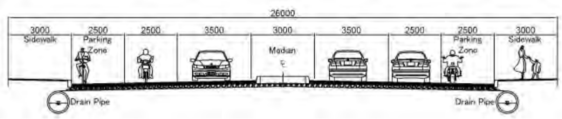
Alternative	Description	Schematic Diagram
ALT-0: Zero Option	No improvement of the road will be made.	 Rural Section  Urban Section
ALT-1: Widening road to full 4-lane and pavement improvement	Smooth traffic will be ensured against the future traffic volume. Slow speed vehicles such as motorcycles and 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 (3.5m) to reduce the impact to social and natural environment and the project cost.	 Rural Section  Urban Section

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

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

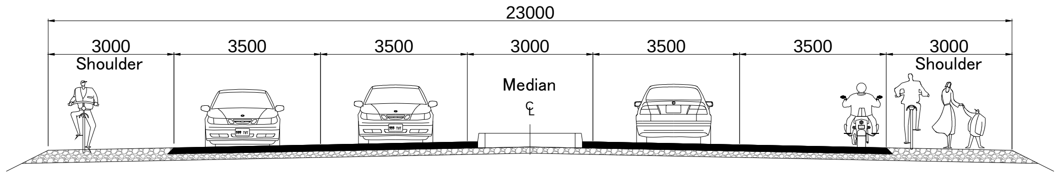
Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
Traffic Characteristic			
Predicted Traffic Volume	Middle Section : 14,200 pcu/day in 2023 : 20,800 pcu/day in 2028 : 27,500 pcu/day in 2033	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 to the road.	○ Although they will be less than ALT-1, resettlement of a great number and replacement of agricultural land will still arise.
Impact on Living Environment/Pollution	× As traffic volume increases in the future, traffic congestion is likely to occur. In that case, the average driving speed will be slower and the increased stop and go will result in an increase in the fuel consumption. This will cause increase in the 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 be 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.	○ Ease 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 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.
Risks of Crossing Road by Pedestrians and Farm Animals	◎ Possibility of accidents when pedestrians/farm animals cross the road is the	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of	◎ Level of safety approximately same to that of ALT-0 will be achieved with installation of

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
	lowest among all of the alternatives because the carriageway width is the narrowest.	sufficiently wide median where pedestrians 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.	sufficiently wide median.
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.

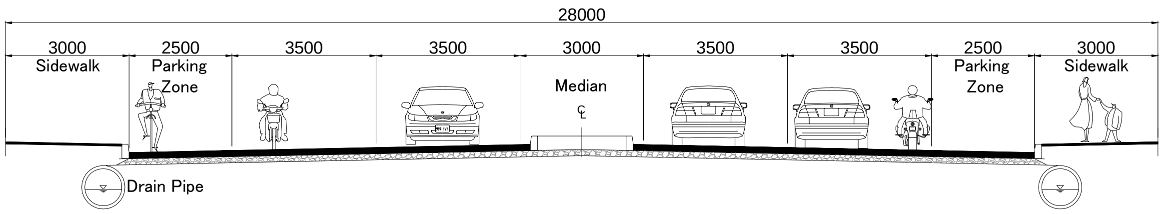
Alternative	ALT-0: Zero Option	ALT-1: Widening Road to full 4-Lane and Pavement Improvement	ALT-2: Widening Road to 2-Lane with MC Lanes and Pavement Improvement
Maintenance Cost	△ Middle Section: Fragile exiting pavement (DBST) is just maintained resulting in high maintenance cost. Sri Sophorn–Poipet 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.
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 = 3.0m) + full 4-lane Carriageway (w = 3.5m)
+ Shoulder (w = 3.0m)

Figure 7.2-4 Proposed Cross Section (Rural Area)



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

Figure 7.2-5 Proposed Cross Section (Urban Area)

7.2.3 Horizontal Alignment of the Road

The Middle Section and the Sri Sophorn–Poipet Section of NR 5 will be improved while maintaining the present road centreline in general. However, the horizontal alignment of some sections of the road, that do not satisfy the minimum radius of curve, will be improved.

7.2.4 Elevation of the Road Surface

The elevation of most parts of the existing road surface of the Middle Section is more than 1.0m higher than the flood water level of Tonle Sap. Nevertheless, it was observed in October 2013 that water flowed over the road on 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 for the heavy traffic which has increased rapidly in recent years. Also, in terms of the smoothness of its 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 remaining design life period of this section should be five years or less. 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 the Pursat Bypass

The section between KP 184 and KP 188 passes 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 most practical solution to avoid the large scale resettlement needed for widening of the existing NR 5.

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

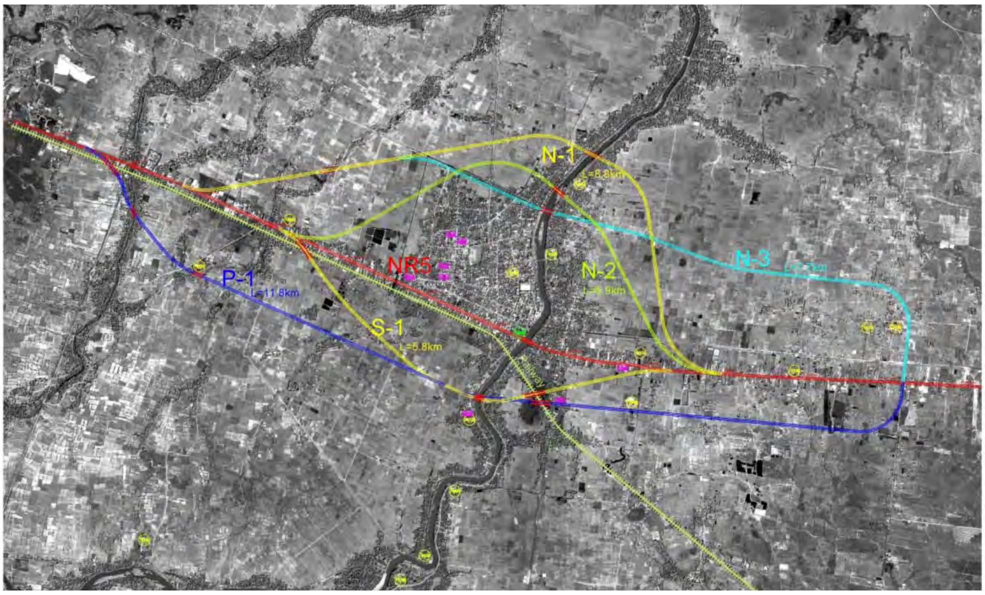


Figure 7.2-6 Alternative Routes of Pursat Bypass

One of the important points in evaluating the alternative routes is that the railroad passes on the southern periphery of the city and this is somewhat hindering the development of urban areas towards the 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 a 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 outskirts of the city. Also, the northern routes are closer to the 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 the 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 5km 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 5km 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 on 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 the town area will 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 the 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 also decrease. Noise, vibration and air pollution will arise 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 flows 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.	◎ The number of traffic accidents in the town will decrease because of decreased number of vehicle passing through the town. Meanwhile, traffic accidents in the bypass will occur as a new issue but the total	◎ 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
		number of traffic accidents will decrease 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 a long time in the future even if the urbanized area 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 least. • No serious influence on 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 for the pedestrians to cross 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 a T-junction 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 a T-junction 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	○ People having land along bypass generally welcome	○ 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 road improvement because: ・ The land price becomes higher, ・ Smooth traffic will be ensured and access to school, hospital, etc. becomes easier, ・ Dust from road is mitigated.	because: ・ The land price becomes 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					

<table>
<tr><th>Alternative</th><th>Widen Existing NR 5</th><th>N-1</th><th>N-2</th><th>N-3</th><th>S-1</th><th>P-1</th></tr>
<tr><td></td><td colspan="6">compared to other alternatives passing the northern side of the city.

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

After consideration of all the above, N-1 is recommended.</td></tr>
</table>

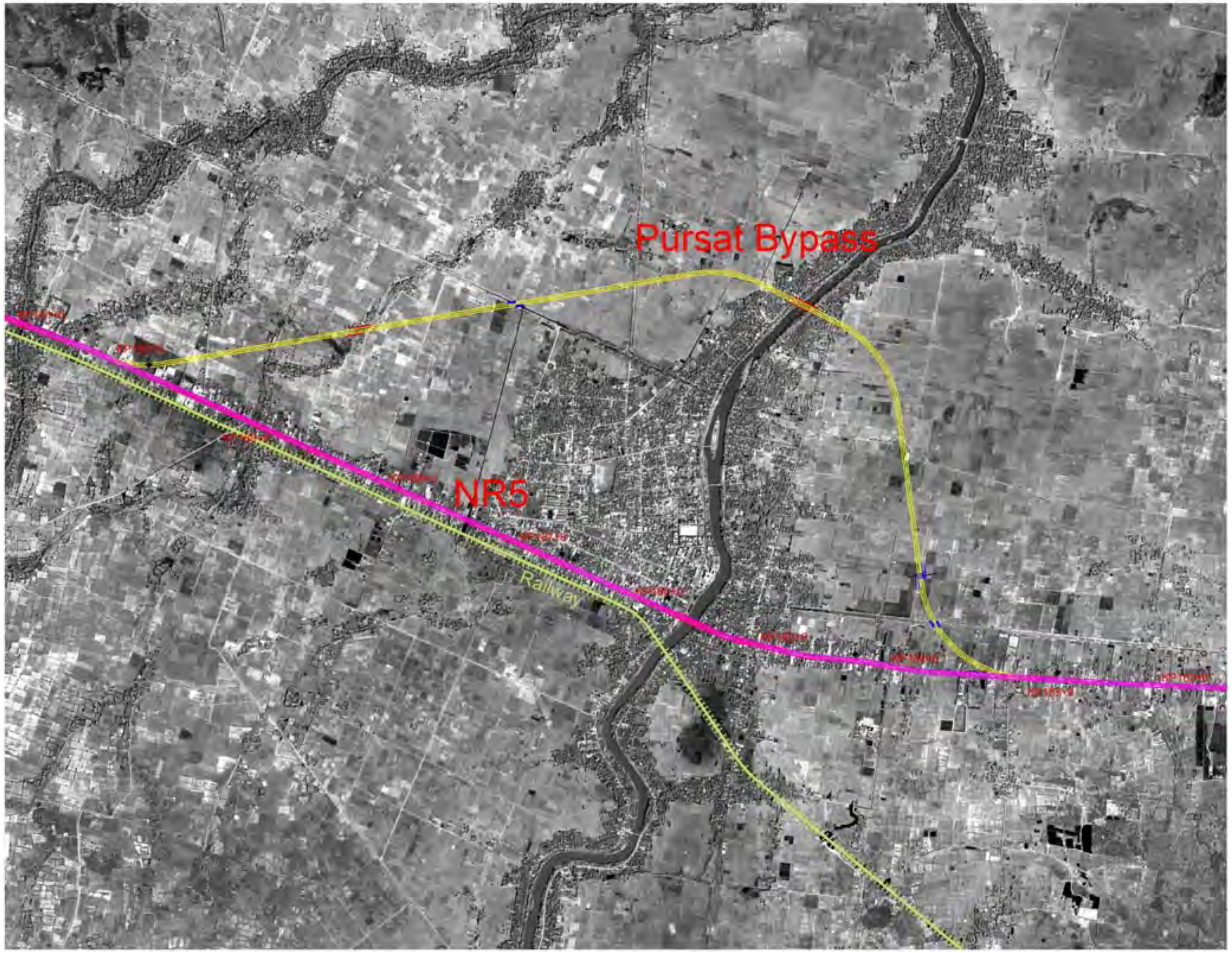


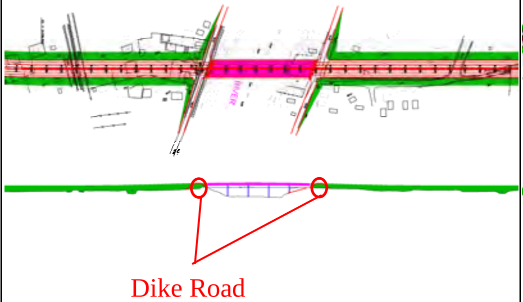
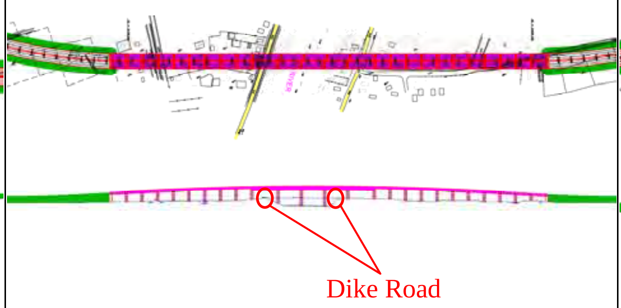
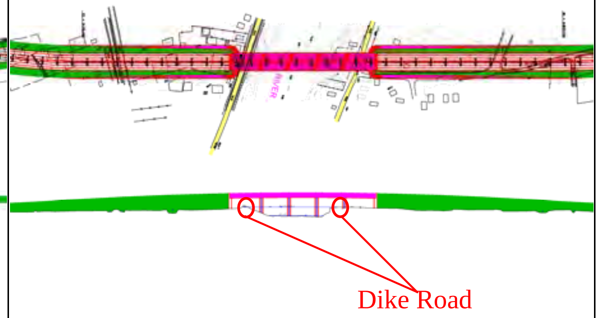
Figure 7.2-7 Selected Route of Pursat Bypass

7.2.7 Bridge over the Pursat River in Bypass

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

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

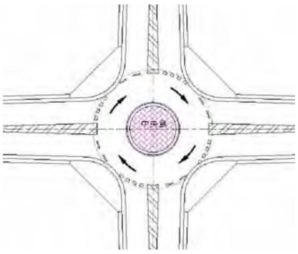
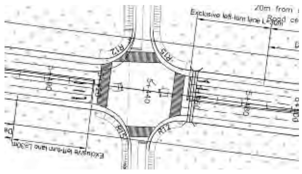
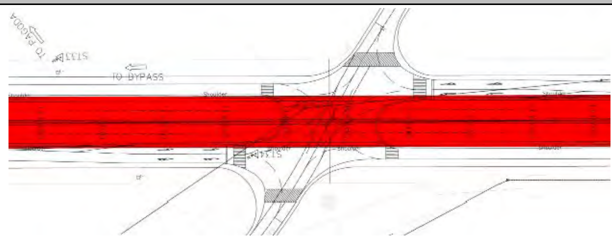
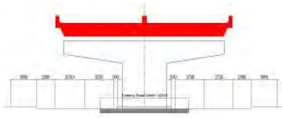
Table 7.2-6 Comparison of Alternatives for Crossing of Pursat River

	At Grade	Grade Separation-1	Grade Separation-2
Plan Longitudinal Cross Section			
Length	Embankment Road: L = 8,410m Bridge: L = 137.5m (5@27.5)	Embankment Road: L = 7,910m Bridge: L = 695m (9@25 + 42 + 3@27 + 42 + 11@25)	Embankment Road: L = 8,468m Bridge: L = 195m (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 on 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 on 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	USD36 million	USD49 million	USD39 million
Recommendation		○	

7.2.8 Improvement of the 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, a normal intersection without traffic signal is adopted in the highway design, considering the forecasted traffic volume which can be accommodated by signalized intersections. However, a 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 (30m from the road centreline).

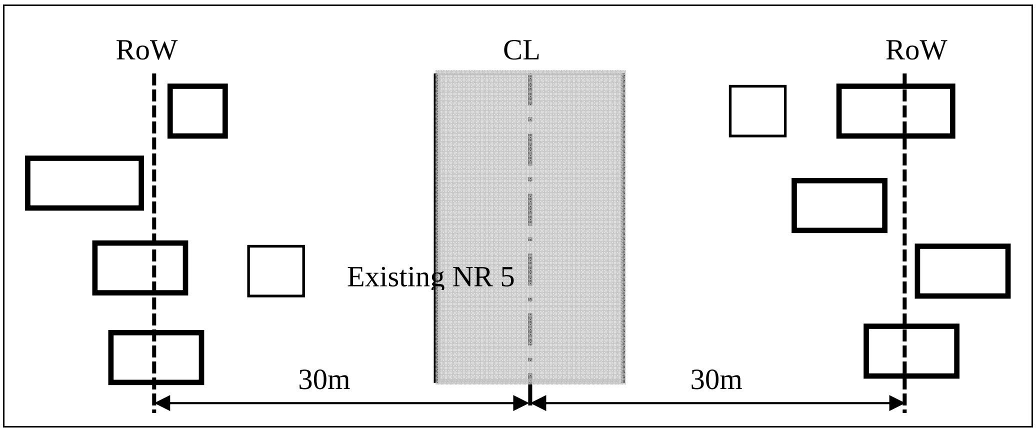


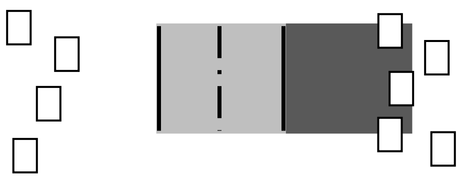
Figure 7.2-8 Schematic Illustration of Density of Houses with Regard to Distance from Centerline of Road

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

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

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. On the other hand, 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

CHAPTER 8 HIGHWAY DESIGN

8.1 Highway Design Sections

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 of the road due to flooding and subsequent failure of the pavement, the level of the road surface needs to be set a sufficient amount higher than the flood water level. (see Subsection 8.2.5 for explanation of the height of the road surface and flood water level). Considering the conditions of flood, the Thlea Ma'am–Battambang Section and the Sri Sophorn–Poipet Section are divided into 6 sections for the purpose of highway design:

<u>Thlea Ma'am–Battambang Section</u>

Design Section 1 (KP 171 – KP 138): Flood water level is lower than the existing road surface by 50cm 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 50cm above the recorded flood water level.

<u>Sri Sophorn–Poipet Section</u>

Design Section 5 (KP 366 – KP 371): Flood water level exceeded the 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.

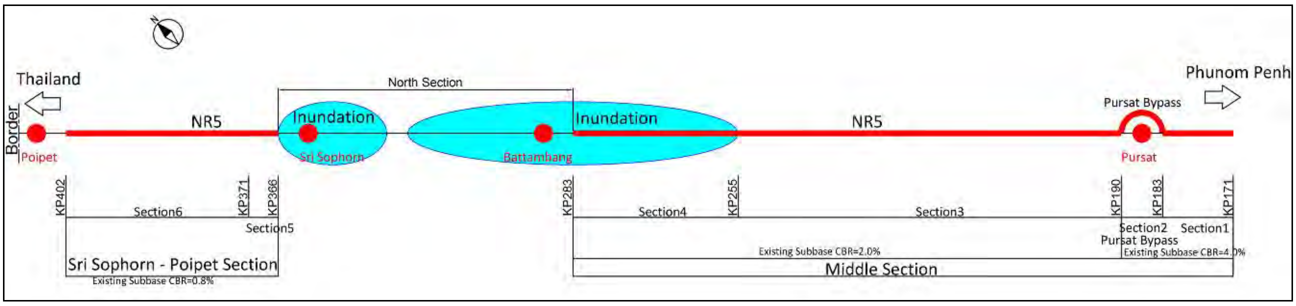
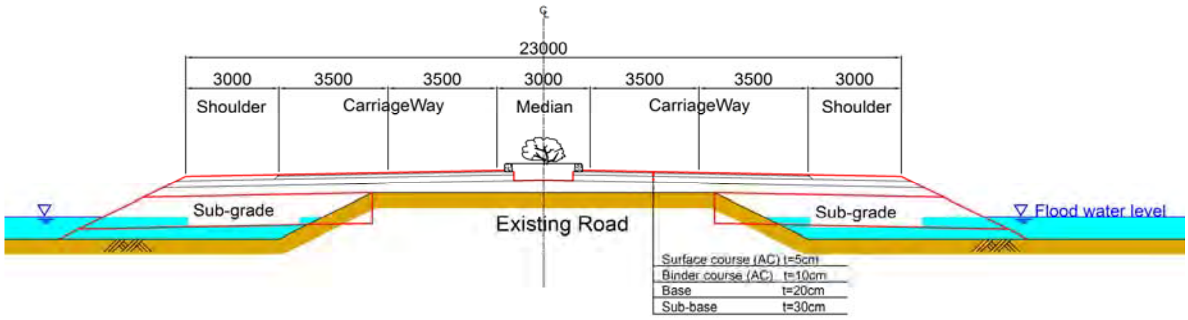
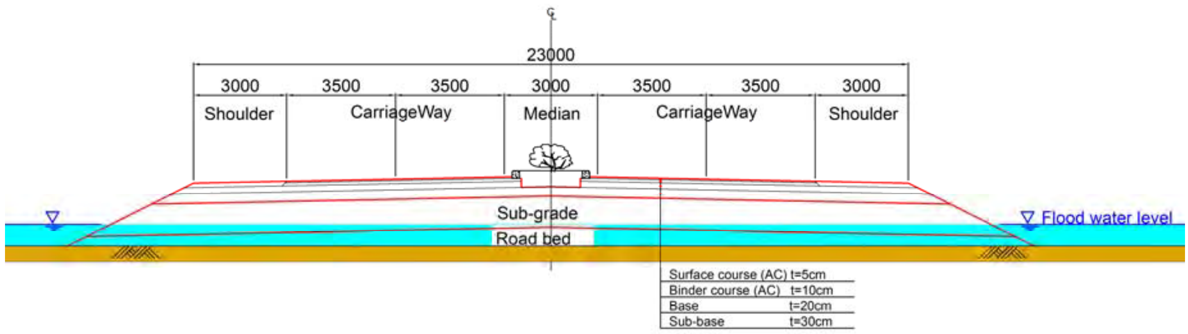


Figure 8.1-1 Design Sections

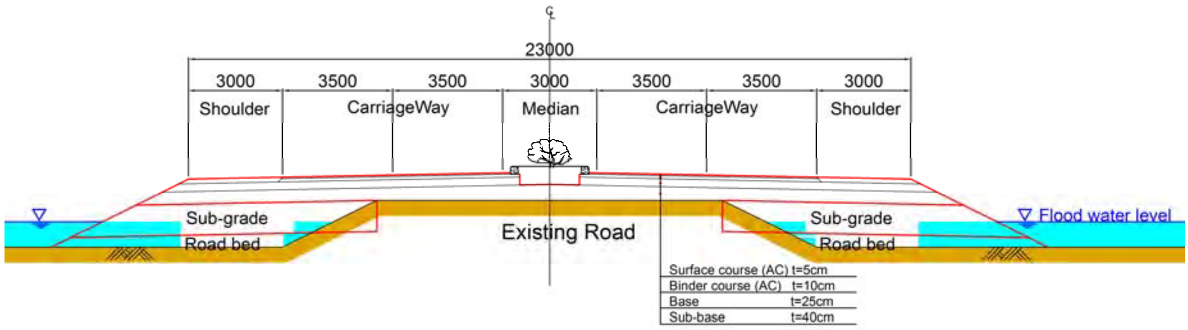
Section1 KP171-183



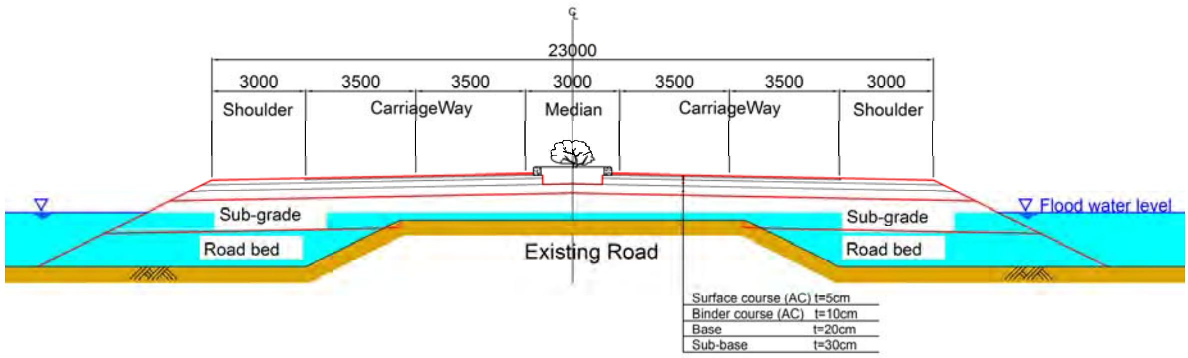
Section2 KP183-190 (Pursat BP)



Section3 KP190-255



Section4 KP255-283 Inundation section



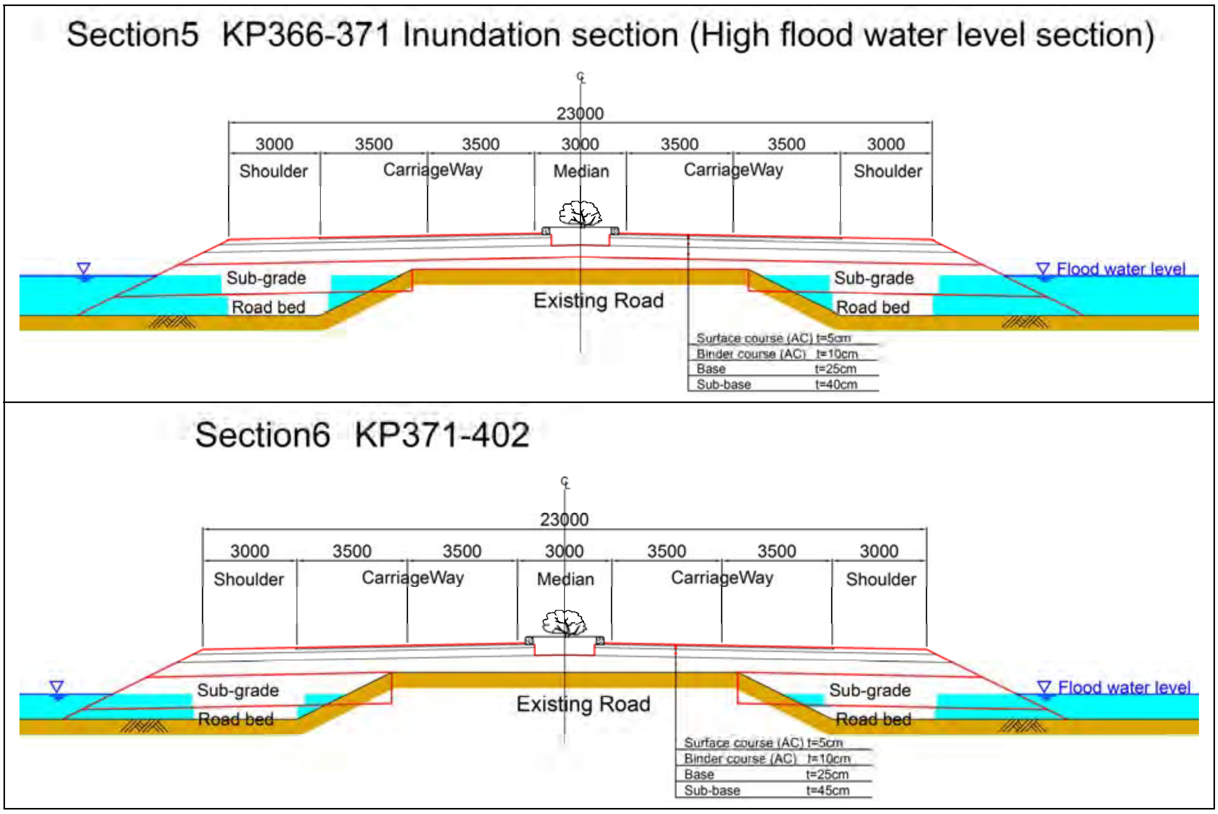


Figure 8.1-2 Typical Cross Sections on the Middle Section and Sri Sophorn–Poipet Section

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 the 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	100km/h (Flat)	100km/h (flat)	50km/h (Type3)	100km/h	50km/h
Min. Curve Radius (Super elevation)	350m (10%)	415m (6%)	90m (6%)	350m (10%)	80m (10%)

8.2.2 Urban Sections

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

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

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

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

8.2.3 Cross Section

Table 8.2-3 compares the design criteria of cross-sectional composition of the Asian Highway standard 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	3.50m	3.50m		3.50m
Shoulder Width	3.00m (Flat)	3.00m (Flat)	2.50m (Type3)	3.00m
Median Strip	3.00m (Flat)	4.0-12.0m (Flat)	2.0-4.0m (Type3)	3.0m
Cross Slope	2.0% (AC)	2.5-3.0% (AC)		2.0%
Shoulder Slope	3.0-6.0%	3-4% (sealed)	3%	
Vertical Clearance	4.5m			4.5m

As discussed in Chapter 7, it is proposed that the existing NR 5 is to be widened to 4 lanes. From the viewpoint of consistency of design standards, 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 the median strip, a 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 the median division for left-turn and u-turn should be provided at regular intervals and at the necessary places.
- U-turn lanes 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 2.5m-wide parking spaces is proposed on both sides.

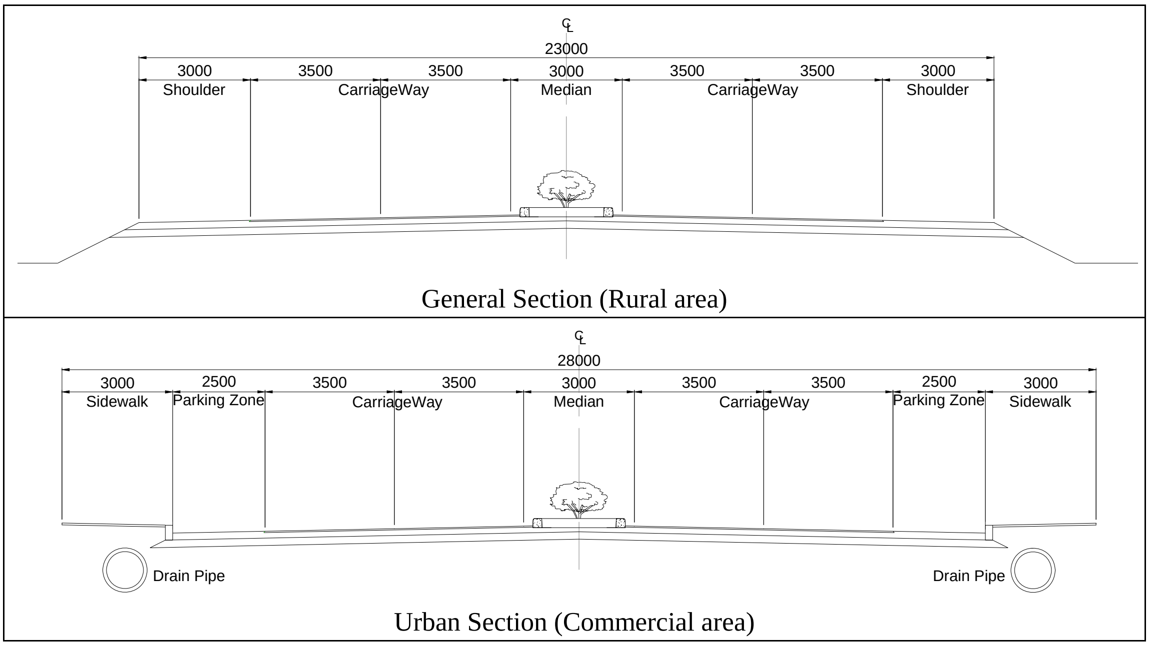


Figure 8.2-1 Typical Cross Section

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 the 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 the design criteria. In addition, there are some curve sections where the lengths of the curves are too short to meet the design criteria. In such short curves, drivers are confused and, are forced into making quick steering operations. These short curve sections and many bending points need to be improved by introducing the 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 170m and 80m are achieved for design speed of 100km/h (general section) and 50km/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 155m: Proposed to improve to radius of 400m)

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

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

(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 the 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.

The road embankment is planned to be raised a sufficient amount taking into account 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	0.05m	Raise embankment by 0.55 meters
KP 258 + 500 – KP 260 + 000	0.05m	Raise embankment by 0.55 meters
KP 270 + 500 – KP 271 + 500	0.25m	Raise embankment by 0.75 meters
KP 272 + 000 – KP 274 + 000	0.15m	Raise embankment by 0.65 meters
KP 276 + 500 – KP 277 + 000	0.10m	Raise embankment by 0.60 meters
KP 280 + 500 – KP 281 + 500	0.20m, low surface	Raise embankment by 0.70 meters

In principle, the height of the road surface is designed to be raised so that the top of embankment (subgrade) be 50cm higher than flood water level to prevent seepage of flood water into subgrade and consequent reduction in bearing capacity of subgrade. Also, the height of the 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.

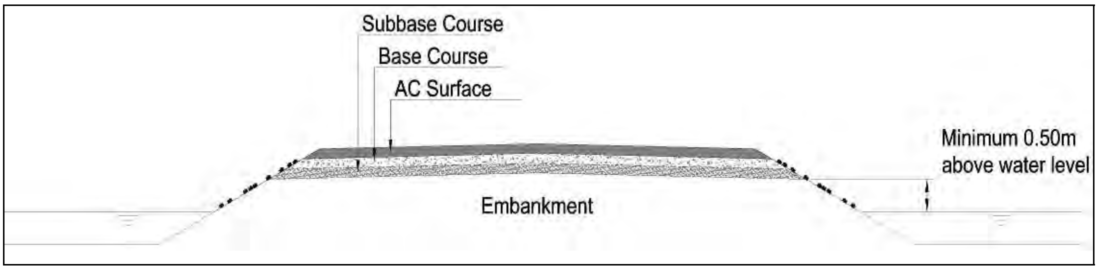


Figure 8.2-4 Conceptual Illustration of Minimum Height of Embankment

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 a Structural Number (SN).

(1) Structural Number (SN)

The 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 the 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 by the 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 150mm-thick AC layer is adopted for highways with a large traffic volume of heavy vehicles, while 100mm-thick AC surface course is adopted for highways with less traffic volume of heavy vehicles. Also, a 150mm-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 a 150mm-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.

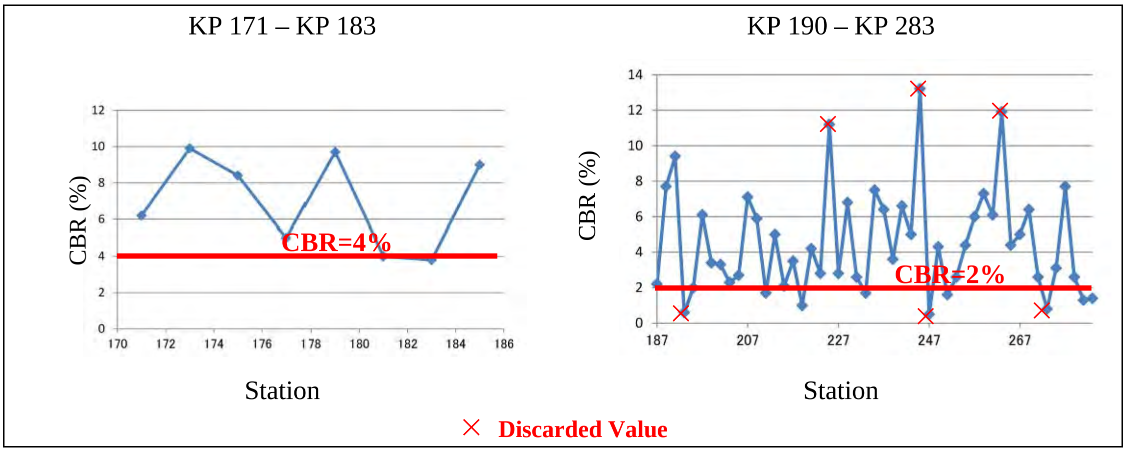


Figure 8.2-5 CBR Value Obtained Through Laboratory Tests

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 the existing subgrade between KP 190 – KP 255 is under 3%, and is too soft to support pavement. The CBR of the 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 the subgrade of the 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)	-	-	30cm	1089	-	-	-	-
	Method (ii)	40cm	1238	50cm	1194	70cm	1129	-	-
	Method (iii)	30cm	1223	40cm	1190	-	-	70cm	1019

(d) Conditions of Pavement Design and SN

The new pavement is to be placed on top of the existing pavement. The thickness of the 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	-	-	-	-	100cm	6%
CBR of existing pavement	30cm	20%	30cm	20%		
CBR of existing subgrade	70cm	4%	70cm	2%		
Composite CBR value	100cm	**6%**	100cm	**4%**	100cm	**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	15cm	15cm	15cm
Base	Stabilized gravel	20cm	25cm	20cm
Subbase	Crusher run	30cm	40cm	30cm
Subgrade	Selected Material	N/A	N/A	75cm

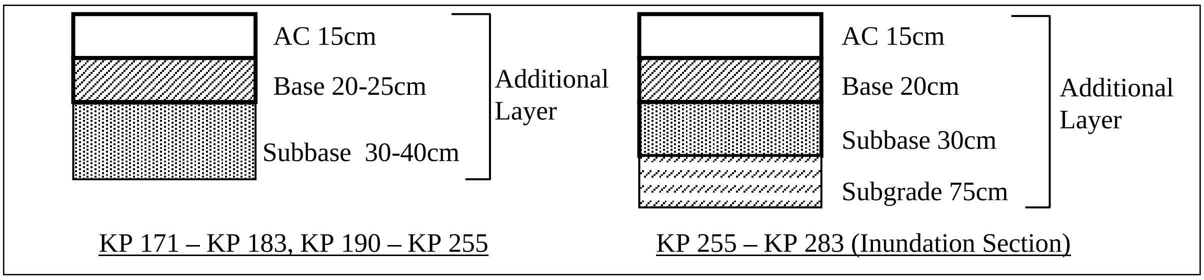


Figure 8.2-6 Pavement Structure of the Middle Section

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 3m-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.

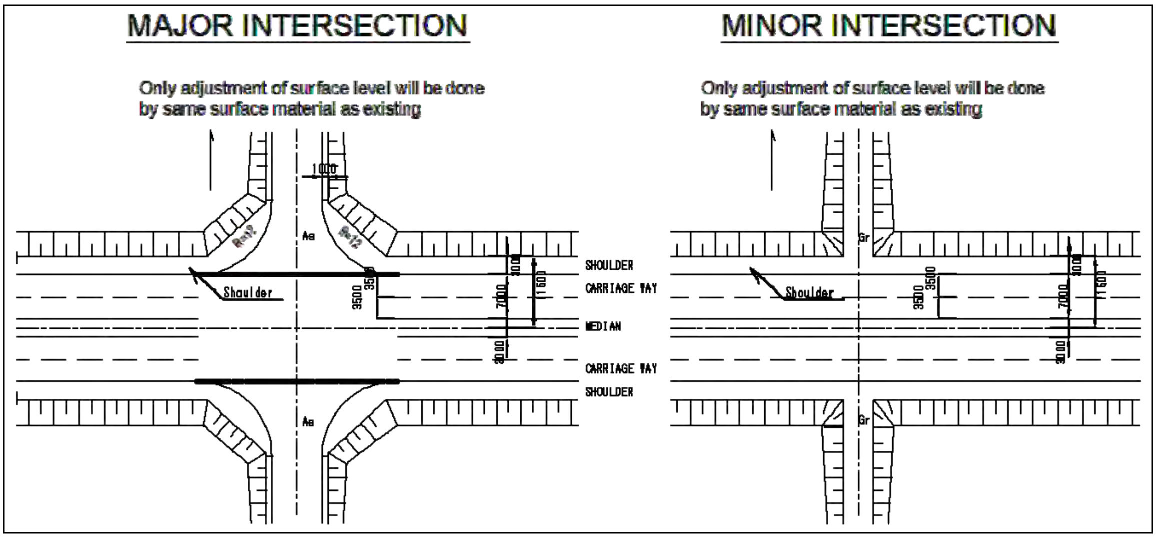


Figure 8.2-7 Typical Plan of Intersection

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 these 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 areas 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.

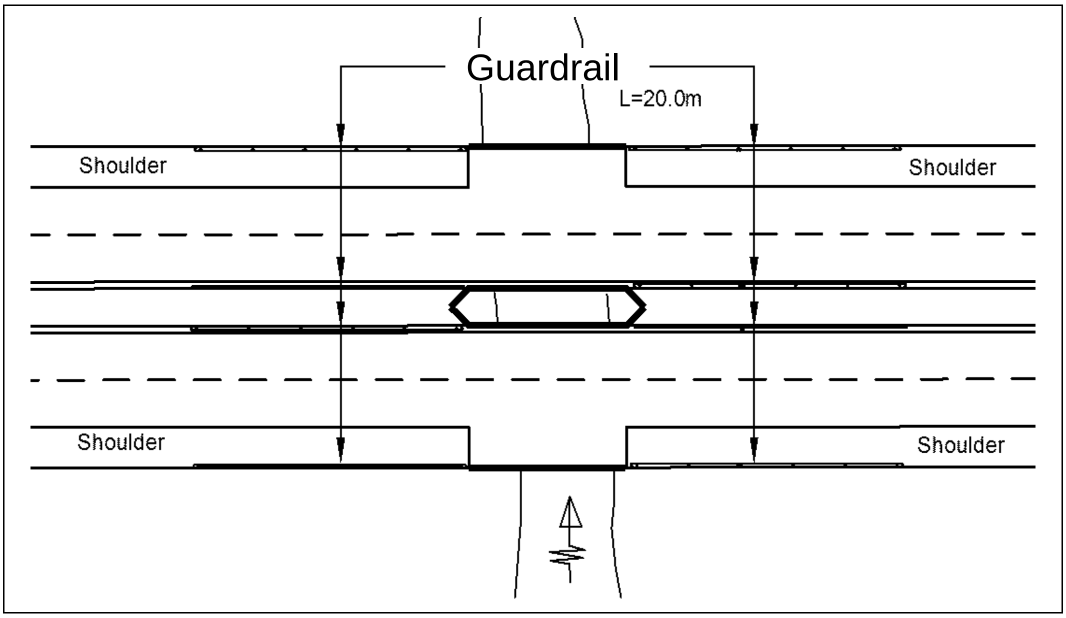


Figure 8.2-8 Plan of Guardrail at Approach of Bridge

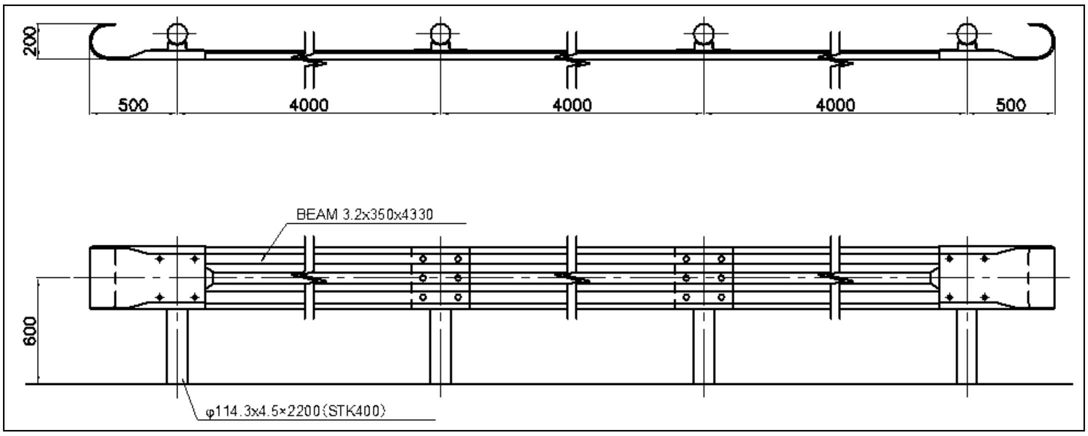


Figure 8.2-9　Example of Guardrail

(3) Rumble Strip

A rumble strip is a 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 it longer in both time and distance for pedestrians. To prevent traffic accidents, pedestrian crossings shall be provided at 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.

Road signs and markings shall be provided. Regulatory signs such as "speed limit" and warning signs such as "intersection ahead" will also be considered. Markings on the pavement such as center lines, driving lanes and stop lines shall be provided. Their detail locations will be studied in the detail design stage.

8.3 Sri Sophorn–Poipet Section

8.3.1 Basic Design Policy and Design Criteria

The design speed of the 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	100km/h	50km/h
Min. Curve Radius (Super elevation)	350m (10%)	80m (10%)

8.3.2 Urban Sections

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

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

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

8.3.3 Cross Section

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

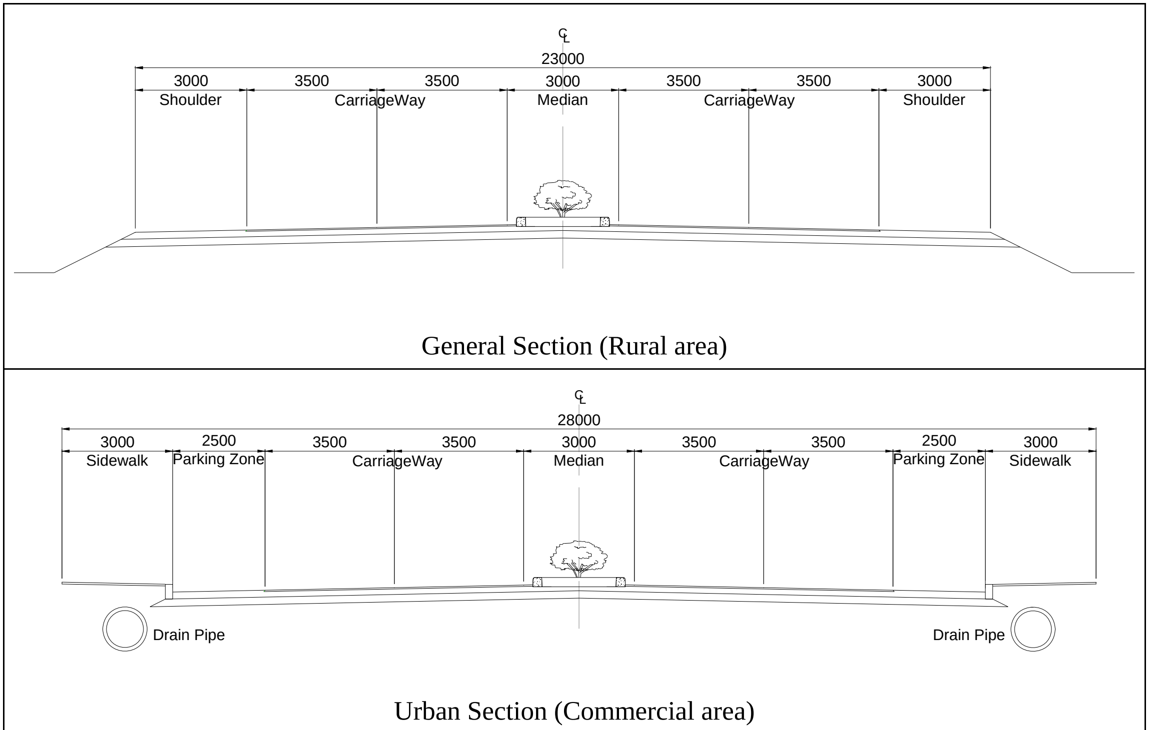


Figure 8.3-1 Typical Cross Section of Sri Sophorn–Poipet Section

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	-0.20m	Raise embankment by 0.30 meters

8.3.6 Pavement Design

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

(1) Design of Pavement Structure

(a) Ratio of Heavy Vehicle

The predicted 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 (KP 366–371)	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 from laboratory tests. A design CBR value of 0.8% is adopted for the Sri Sophorn–Poipet Section.

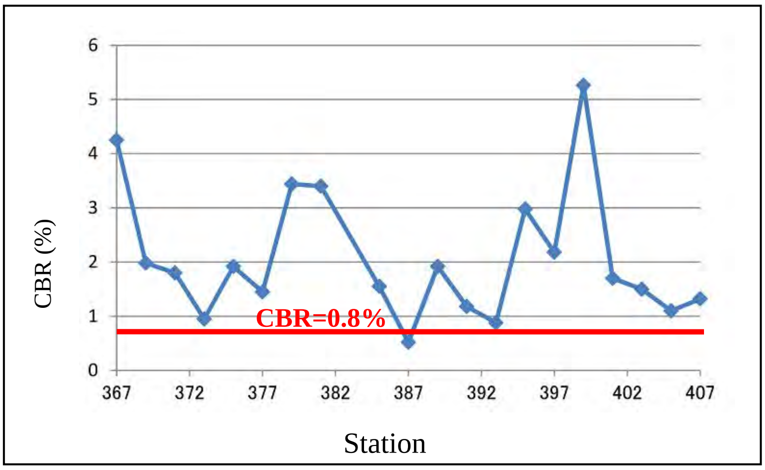


Figure 8.3-2 CBR Value Obtained Through Laboratory Tests

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	30cm	6%		
CBR of existing pavement	30cm	20%	30cm	20%
CBR of existing subgrade	40cm	0.8%	70cm	0.8%
Composite value	100cm	**8% (6%)**	100cm	**3%**

(c) Subgrade Improvement

The CBR of the existing subgrade of KP 371 – KP 402 is 0.8%, which is very low and insufficient for supporting pavement structure. The CBR of the 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)	30cm	1163	-	-	-	-
	Method (ii)	60cm	1311	70cm	1262	-	-
	Method (iii)	40cm	1264	50cm	1207	70cm	1168

(d) Conditions of Pavement Design and SN

Table 8.3-7 shows the design conditions and required SN of the pavement for 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, the 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	15cm	15cm
Base	Stabilized gravel	20cm	25cm
Subbase	Crusher run	40cm	45cm
Subgrade	Selected Material	30cm	N/A

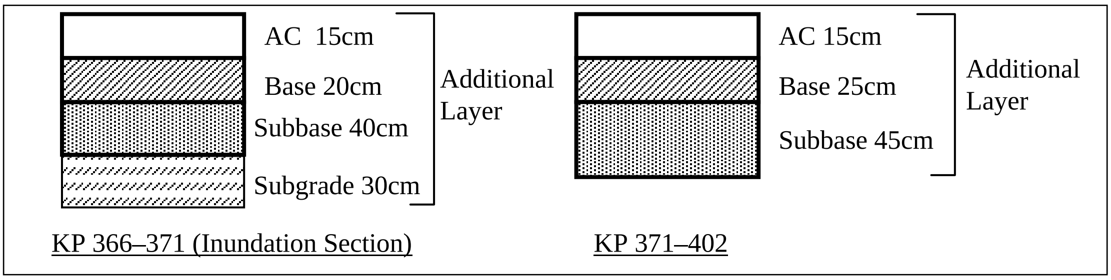


Figure 8.3-3 Pavement Structure of Sri Sophorn–Poipet Section

8.3.7 Intersection

The policy for intersection design for the Sri Sophorn Section is the same as that of the Middle Section, except for the intersection for the 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 the 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 to be constructed with the financial assistance of Thailand.

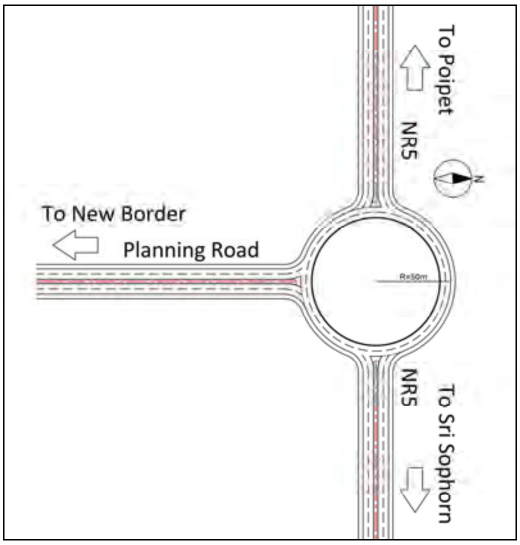


Figure 8.3-4 Roundabout Intersection

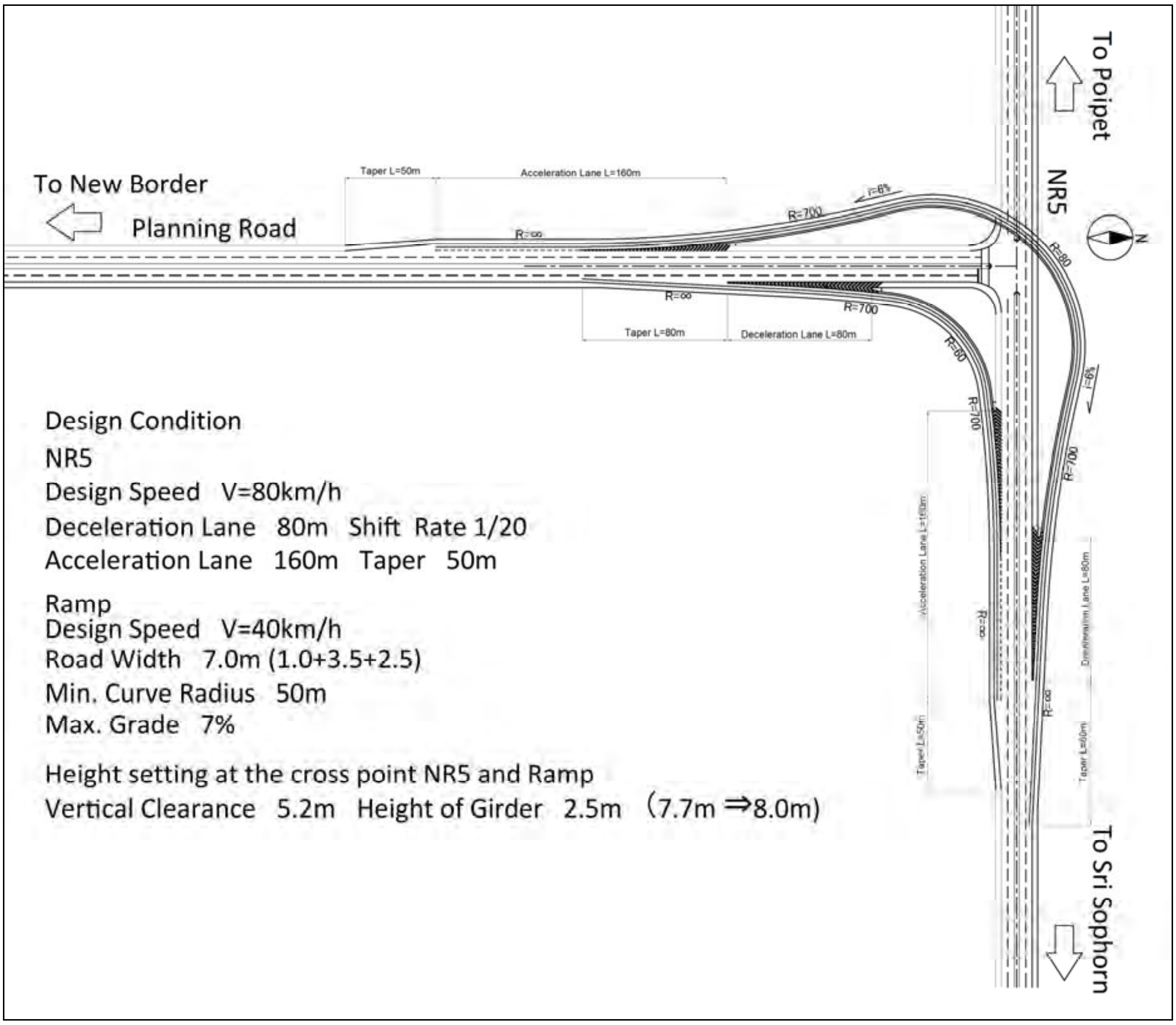


Figure 8.3-5 Grade-Separated Ramp for Right-Turn Traffic from NR 5

8.3.8 Appurtenances

Drainage facilities, guardrails, guide posts, rumble strips, street lights and safety devices for the Sri Sophorn–Poipet Section are planned in the 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 the cross-sectional composition of Pursat Bypass are the same as those for the Middle Section.

(1) Estimated Traffic Volume and Number of Lanes

As discussed in Chapter 5, the estimated traffic volume on Pursat Bypass in 2033 requires the capacity of 4 lanes.

(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 the same design policy with that of the Middle Section. Thus, the cross-sectional composition, the same to as that of the Middle Section, as shown in Figure 8.4-1, is proposed for Pursat Bypass.

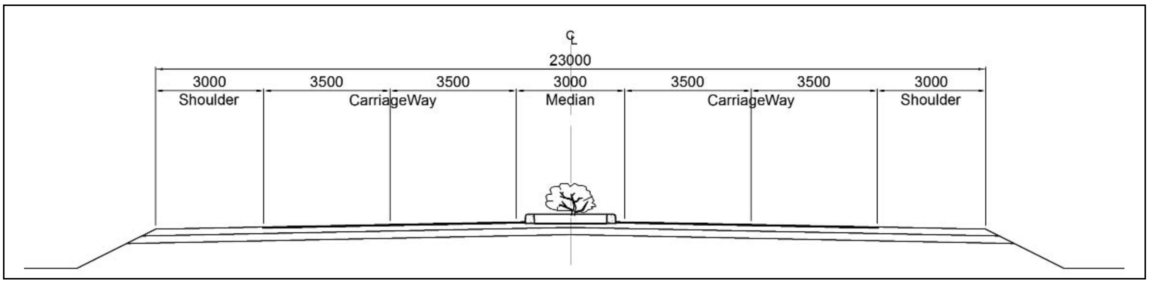


Figure 8.4-1 Typical Cross Section of Pursat Bypass

8.4.2 Horizontal Alignment

N-1 Route is selected as discussed in Chapter 7. It is proposed to adopt the same design criteria as those discussed in Subsection 8.2.2.

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

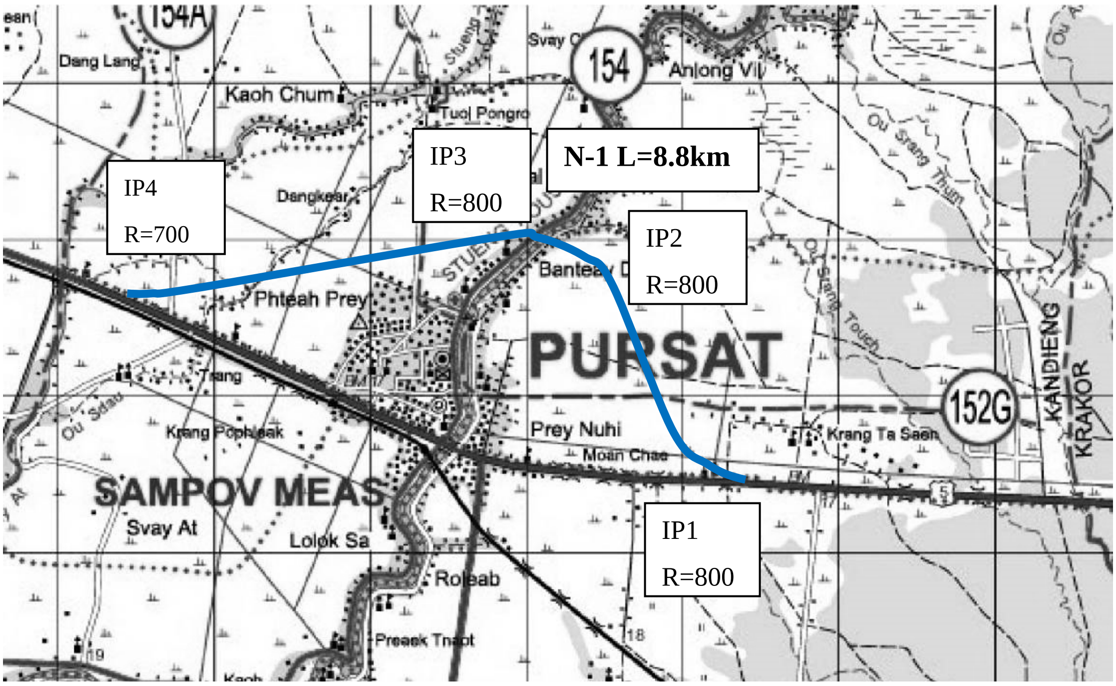


Figure 8.4-2 Route of Pursat Bypass

A 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 field areas. The paddy fields are often covered by the water for cultivation of rice and/or by accumulated rain water. The height of the embankment of the bypass needs to be planned to be sufficiently higher than the usual water level of the paddy fields.

The surface levels of the existing NR 5 at the starting point and the end point of the bypass are 16.5m and 16.0m 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 (11.13m 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

A higher embankment height is desirable from the viewpoint of flood/overflow. However, higher embankment height results in higher construction cost of embankment and wider area of land to be acquired. Considering these, the embankment height is planned at half meter (0.5m) above the flood water level. With the thickness of pavement structure (65cm), the road surface will be more than 1.00m above the flood water level.

In general, the embankment height in the paddy field area is designed to be 1.5m to keep a sufficient safety margin from water level during cultivation. This embankment height (1.5m) is also necessary to provide a sufficient thickness of coverage to the pipe culverts.

8.4.4 Pavement Design

The design procedure for the pavement structure for Pursat Bypass is same as that of the Middle Section and is based on the AASHTO's Pavement Design Manual which takes into account the forecasted traffic load and the CBR of the subgrade to obtain the 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	15cm
Base	Stabilized gravel	20cm
Subbase	Crusher run	30cm
Subgrade	Selected Material	100cm

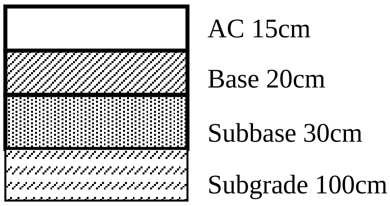


Figure 8.4-4 Pavement Structure of Pursat Bypass

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 paddy fields which need a 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 channels 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 culverts required.

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 = 3.0m wide x 2.0m high x 2 cells

(2) Pipe Culvert

Pipe culverts are installed basically at an interval of 250m 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. The 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 intersections can accommodate the traffic. Figure 8.4-5, 8.4-6 show plans of the intersection with the existing NR 5.

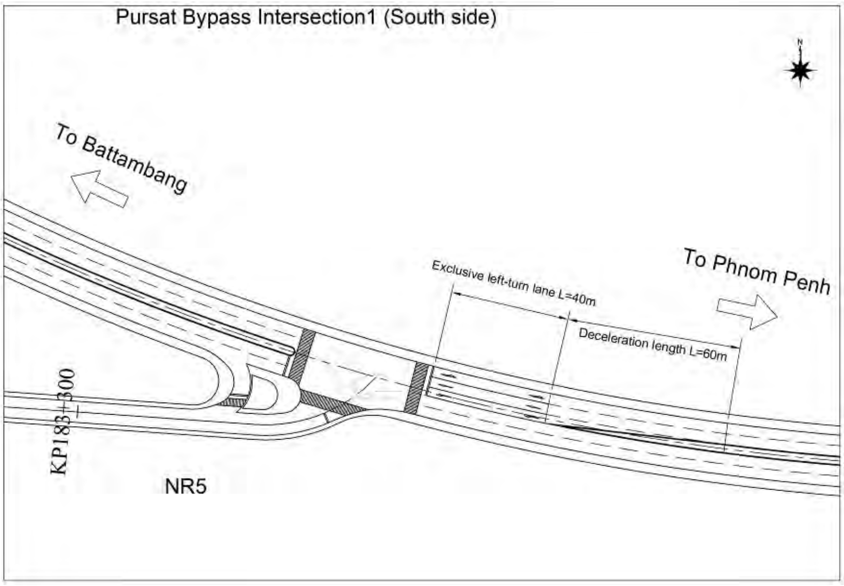


Figure 8.4-5 Southern Intersection of Pursat Bypass

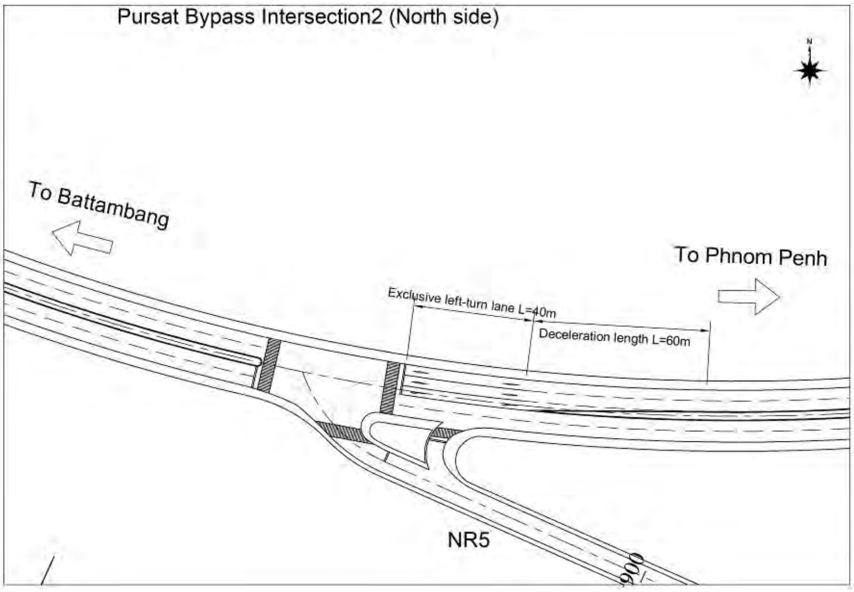


Figure 8.4-6 Northern Intersection of Pursat Bypass

CHAPTER 9

BRIDGE PLANNING

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 20m 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 20m Span Bridge Cambodian, AASHTO and JRA Standards

Case	Load Standard	Single lane		Standard 10m 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 3.0m. 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 3m 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 10m.

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 3m width.

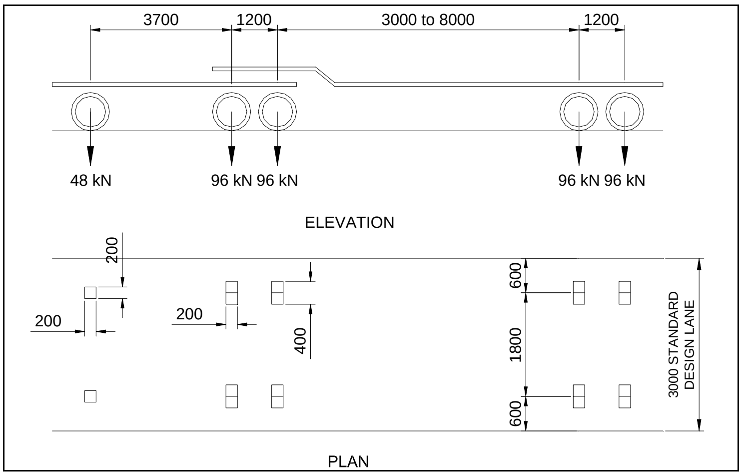
The number of Standard Design Lanes n shall be:

$$n = \frac{b}{3.1}$$

(rounded down to next integer)
where b = carriageway width (in meters) between traffic barriers

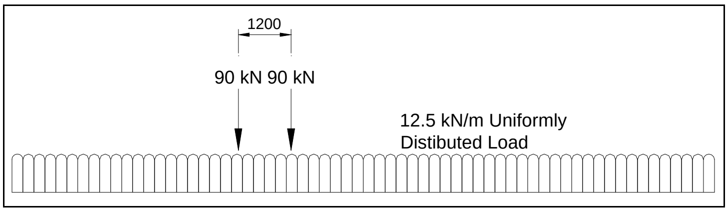
These Standard Design Lanes shall be positioned laterally on the bridge to produce the most adverse effect.

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

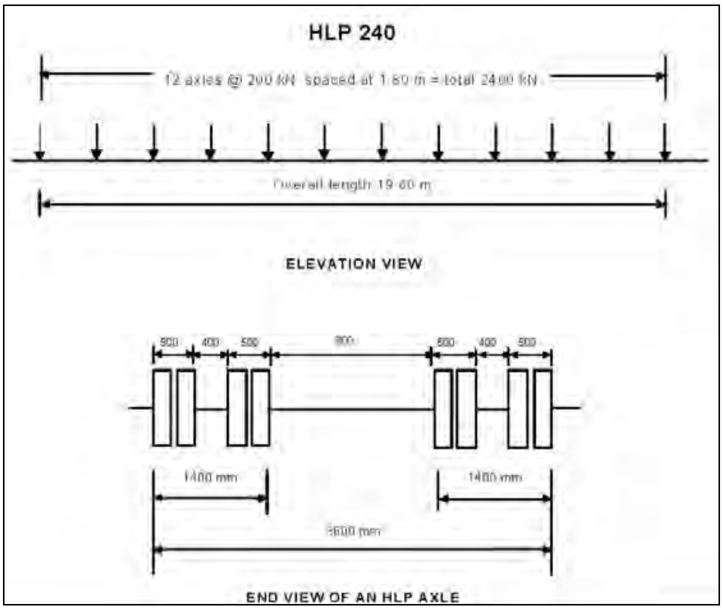
Figure 9.1-1 Design Truck Load T44



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 500mm x 200mm, 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 7m, 8m, 10m, and 12m for the following bridge types and spans:

- RC Flat Slab (RCS) with spans of 10m, 12m, 15m and 18m
- RC Deck Girder (RCDG) with spans of 12m, 15m, and 18m
- Pre-tensioned Precast Plank hollow slab (PSC) with spans of 15m, 18m, 20m and 25m
- Post-tensioned Plank hollow slab with spans of 15m, 18m, 20m and 25m
- Post-tensioned Precast Concrete Deck Girder (PCDG) with spans of 18m, 20m, 25m and 30m

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 30mm 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 25m. 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 30mm thick cement mortar bed and is located with dowels. This type of bridge deck has become the de facto standard in Cambodia for short span bridges, with many examples already constructed ranging from 10m span length upwards.

(iv) Post-tensioned precast concrete deck girder

The post-tensioned precast concrete deck girder (PCDG) bridge spans up to 30m in the standard established. This type can in fact be applied to spans up to 40m 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 diaphragms 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

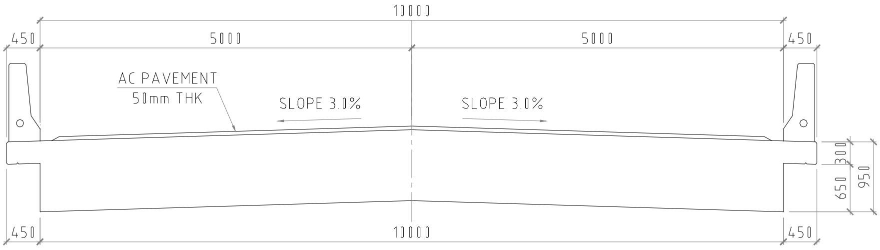
(v) Stub type abutment

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.

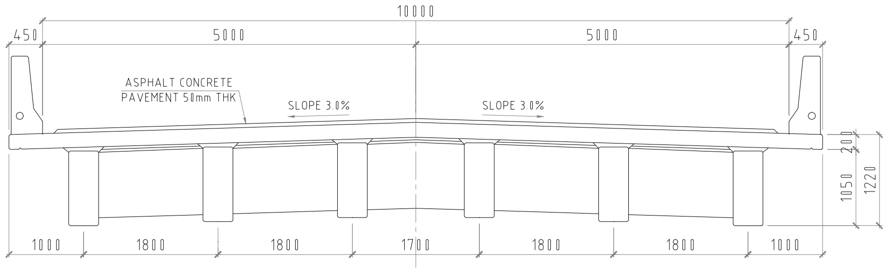
(vi) Cantilever abutment

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.

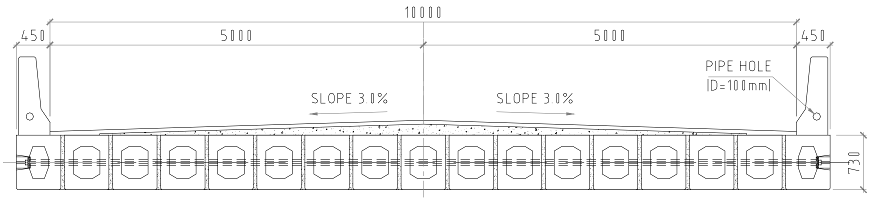
Refer to Figure 9.1-4 for typical sections of the proposed standard bridges Refer to Figure 9.1-5 for typical abutment layouts for the standard bridges. The standard bridges show a minimum freeboard of 80cm to high water level.



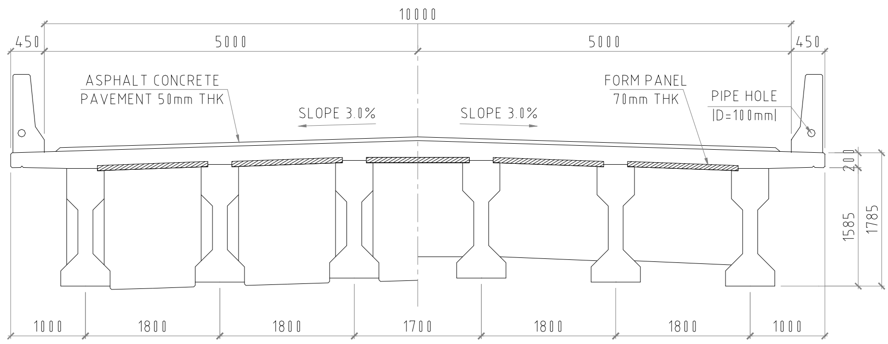
RC Flat Slab (RCS)



RC Deck Girder (RCDG)



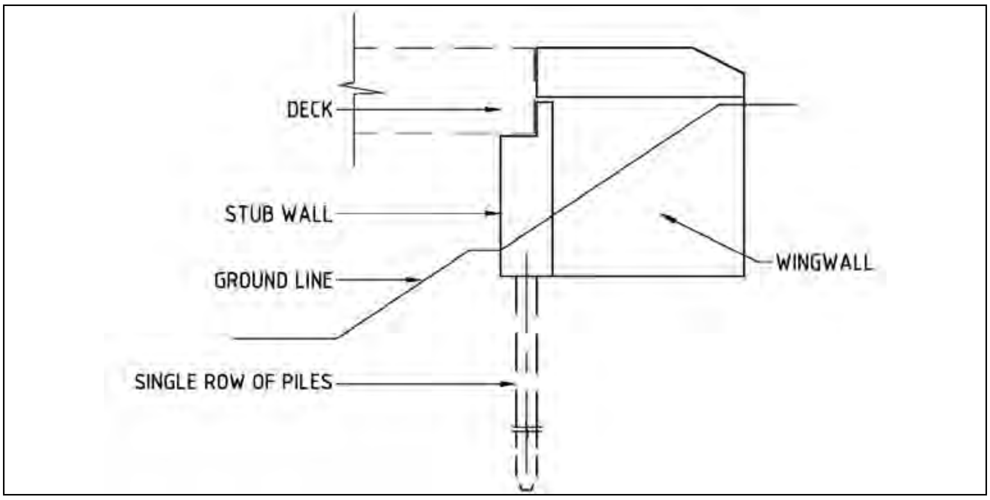
Pre-tensioned Precast Plank (PSC)



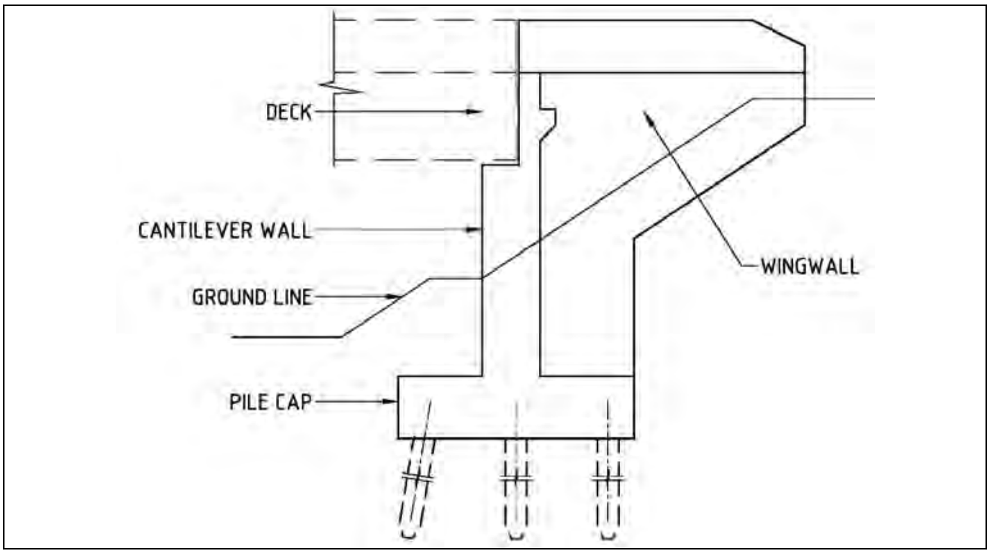
Post-tensioned Precast Concrete Deck Girder (PCDG)

Source: MPWT, The Strengthening of Construction Quality Project, JICA

Figure 9.1-4 Standard Bridge Typical Sections for 10m-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 Planning of Bridge Widening

(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 decision tree 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 Construct New 4-lane Bridge	Existing bridge 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

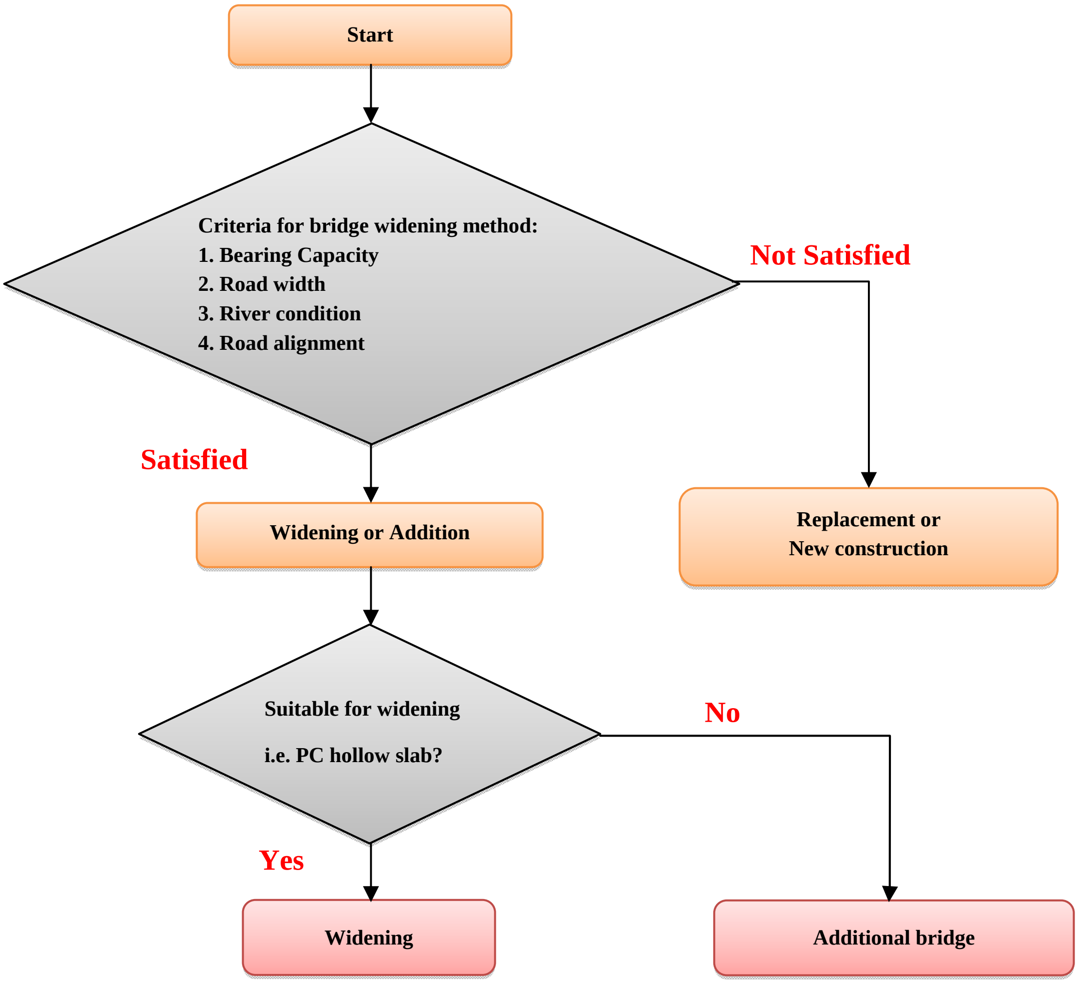


Figure 9.1-6 Decision Tree of Selection of Bridge Widening Method

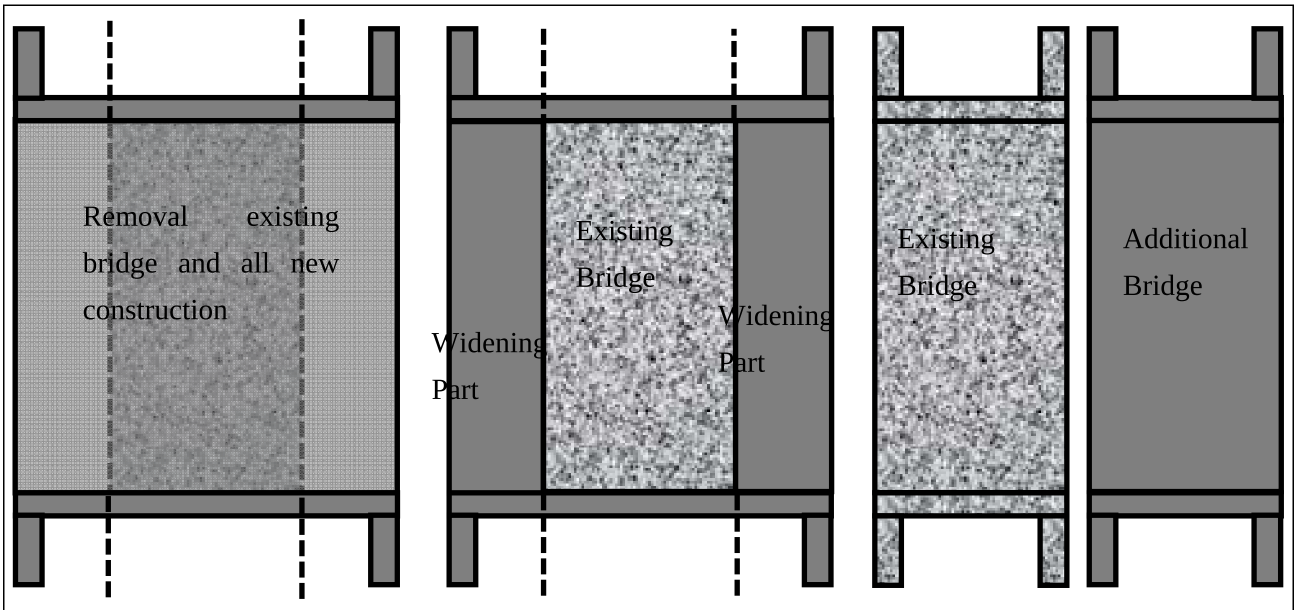


Figure 9.1-7 Concept of Bridge Widening Methods

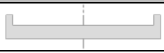
Table 9.1-3 compares the advantage and disadvantage of these widening methods. In the table, three cases are defined as follows:

Case I: Replacement (Demolish the existing bridge and construct a new bridge)

Case II: Widening on both sides of the existing bridge

Case III: Construction of an 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 Others: Poor	1
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 an additional length. The other is installation of longitudinal joints between the existing bridge and the widened part allowing separate deflection between them. Either methods are used in case of the 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 outside of the proposed scope of the project (i.e. 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 interview to the local residents 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, it is proposed to raise the elevation of the road surface of this section (KP 255–277), as well as the bridges located on the inundation section, by around 1.5m. As a consequence, 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 9.0m, 8.5m, 9.0m, respectively. These bridges cannot accommodate full 2-lane (7.0m) with 3.0m-wide right shoulder plus 0.5m-wide left shoulder. Accordingly, it is proposed to replace these bridges.

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 required to raise road surface as the countermeasure for inundation

(a) PSC Bridges

PSC accounts for the majority of the bridges in this section. These bridges have 1 to 3 spans. The lengths of bridges are 12.0m to 54.0m, and the span lengths are less than 20m. 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 girders and deck slabs. The span arrangement of the existing bridges can be maintained and will not cause any change in hydrological conditions.

As PSC girders can be produced in a factory, it is possible that the production cost can be reduced and good quality control ensured.

(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. The span arrangement of an additional bridge should be, in principle, same as that of the existing bridge or the number of piers should be less than that of the existing bridge so that the influence on the flow of river water be minimized.

RCDG bridge

Two RCDG bridges (Br. 42 and Br. 66) are old and their structural condition is poor. The lengths of these bridges are short. Therefore, it is proposed to replace these bridges.

The Bridge types of additional bridges and replacement 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. The 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	0-25m	・Can be fabricated in the workshop. ・Max. girder length is around 25m (limited by capability for transport). ・Can be erected with truck crane. ・Production cost can be lowered as the work volume increases.
PCDG	20-42m	・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 they are old and do not have the required bearing abilities. The others are proposed to be replaced due to insufficient clearance above the water table in the river. A type of new bridge is selected by 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 width.

The planed span lengths of bridges in the inundation prone section are rounded up by 5m from those of existing bridges to prepare for future floods.

The span arrangements of Br. 68 and Br. 75 have two possibilities; 2@15m and 1@30m. Because PSC girders are used in large quantities, the efficiency of girder production can be improved resulting in lower production costs 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

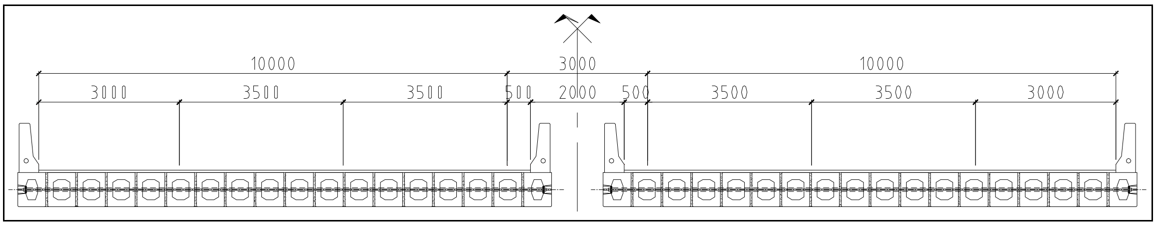


Figure 9.2-1 Typical Cross Section of Replacement Bridge

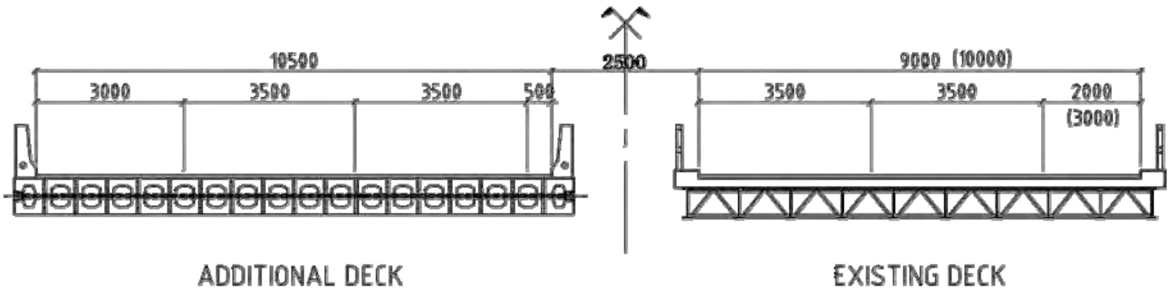
9.3 Construction of Additional Bridge

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 10m. The ten-meter width of existing bridge is insufficient for required standard width of 10.5m 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.

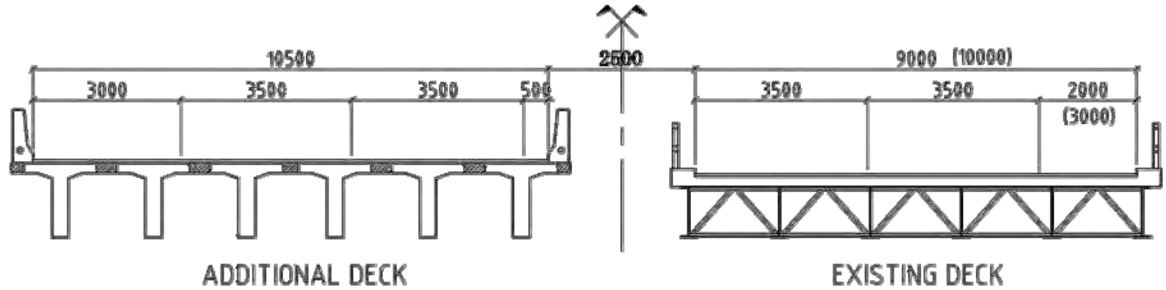
The types of additional bridges are selected taking the following aspects into consideration, (i) to minimize impact on road profile, (ii) to ensure existing river clearance, (iii) to construct new piers on the same alignment as those of the existing bridge, and (iv) to minimize the maintenance cost. 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



(a) PSC Bridge



(b) PCDG Bridge

Figure 9.3-1 Typical Cross Section of Additional Bridge

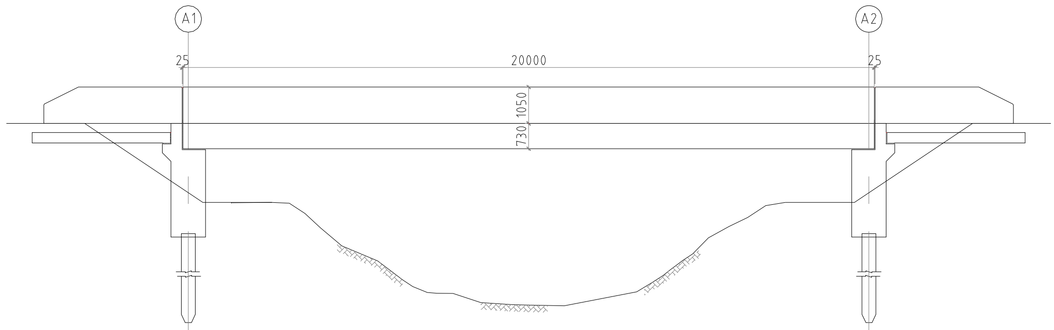


Figure 9.3-2 General View of PSC Bridge

9.4 Widening of Existing Bridges

Widening of existing bridges by adding a deck slab and beam, as necessary, is proposed for 4-lane bridges. The substructure may also be widened. Such widening of a bridge requires less cost because it does not demolish the existing structure but effectively utilizes it. On the other hand, this method requires high-level engineering skill in execution.

This method has been widely adopted in practice 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 this method however 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 the PSC deck type are proposed to be widened by adding a 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

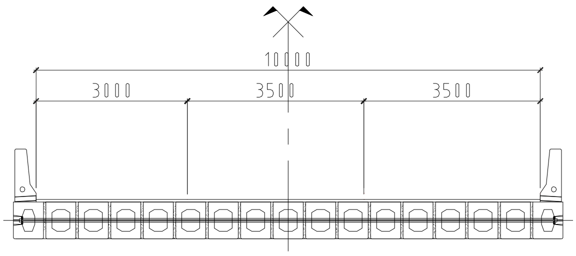
Two options are presented to achieve the extension of the transverse pre-stress for the PSC decks.

Option 1

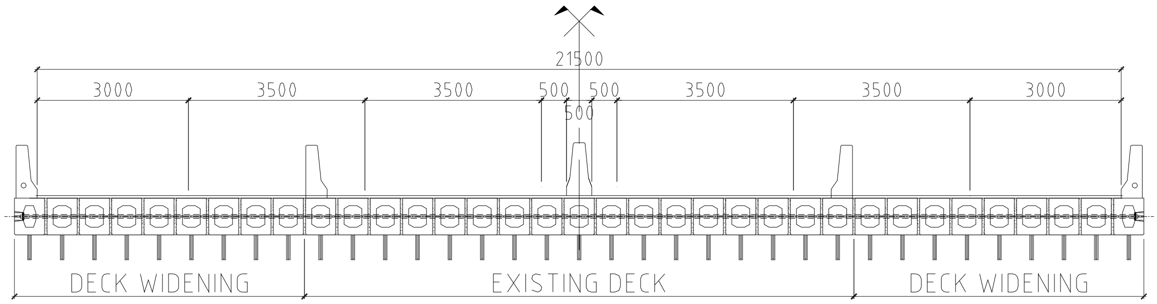
Option 1 proposes to break out the cement mortar at each anchorage recess and to use couplers to extend the pre-stressing bars. This option using couplers, may not be practicable as the length of existing threaded bar protruding beyond the anchor nut at each anchorage may not be long enough to develop 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 a 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 a longitudinal joint appears on the road surface needs to be installed.

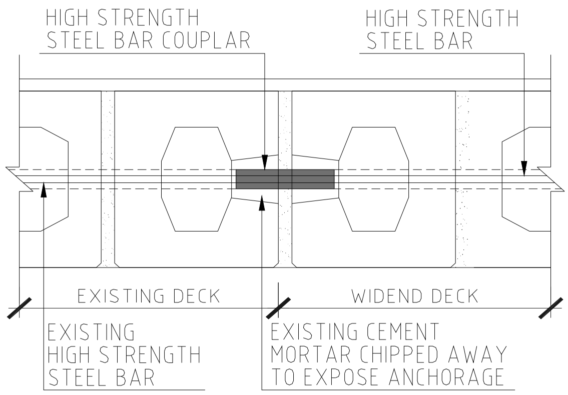


(a) Existing Condition of PSC Deck

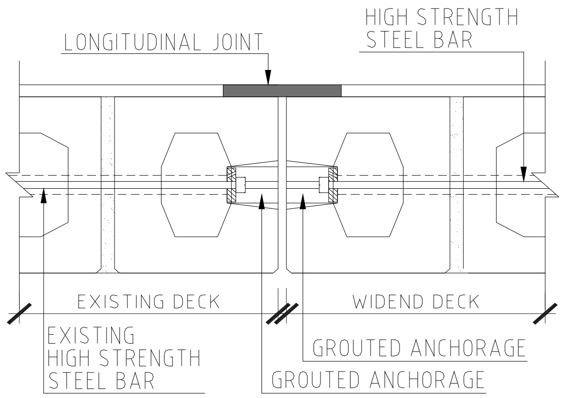


(b) Bridge Widening Condition

Figure 9.4-1 Typical Cross-Section of Widened Bridge for Full 4-Lane

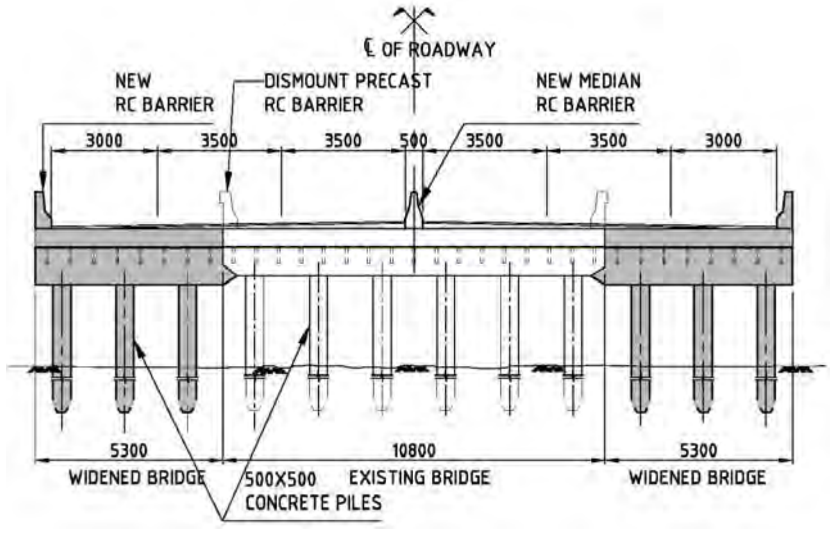


(a) Option 1 Transverse Pre-stress Extended with Couplers

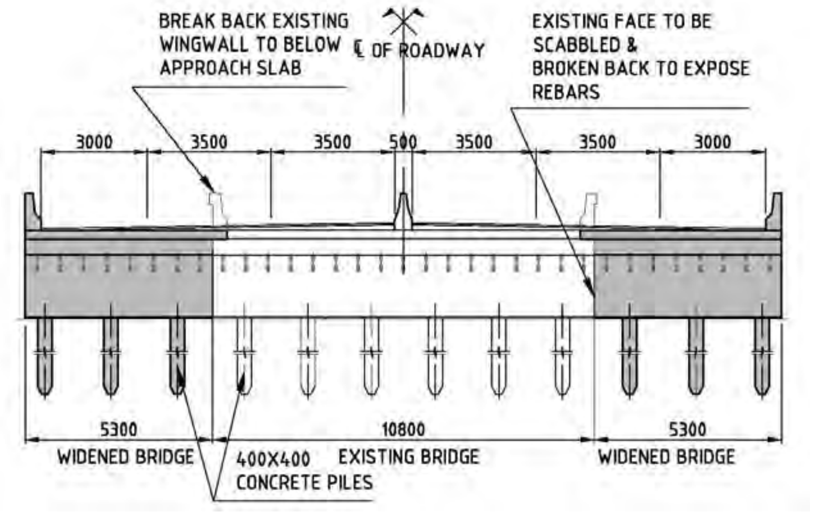


(b) Option 2 Longitudinal Joint

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). The 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

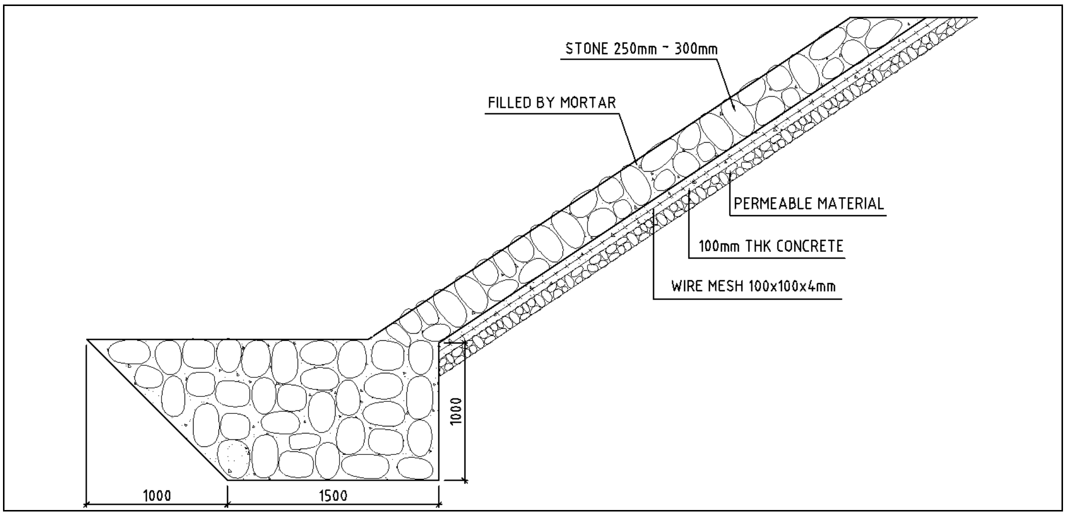


Figure 9.5-2 Repairing Method of Existing Slope Protection

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 = 60m	Waterway
Br. P2	PSC	4@25 = 100m	Waterway
Br. P3	PSC + PCDG + PSC	9@25 + (42 + 3@37 + 42) + 11@42 = 695m	Pursat River
Br. P4	PSC	5@25 = 125m	Waterway
Br. P5	PSC	4@20 = 80m	Waterway

Bridge P3 is a bridge which crosses Pursat River. The river is approximately 140m 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. Consequently it is proposed an approximately 695m-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 37m and 42m. As discussed in Subsection 9.1.2, PCDG is adopted for relatively long span length. Figure 9.6-2 shows typical cross section of PCDG on the bypass bridge.

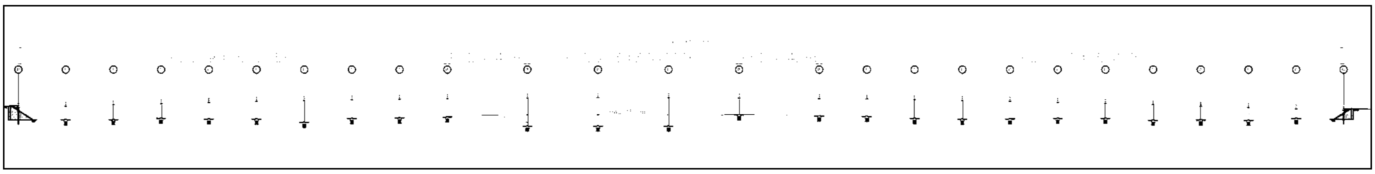


Figure 9.6-1 General View of P3 Bridge of Pursat Bypass over Pursat River

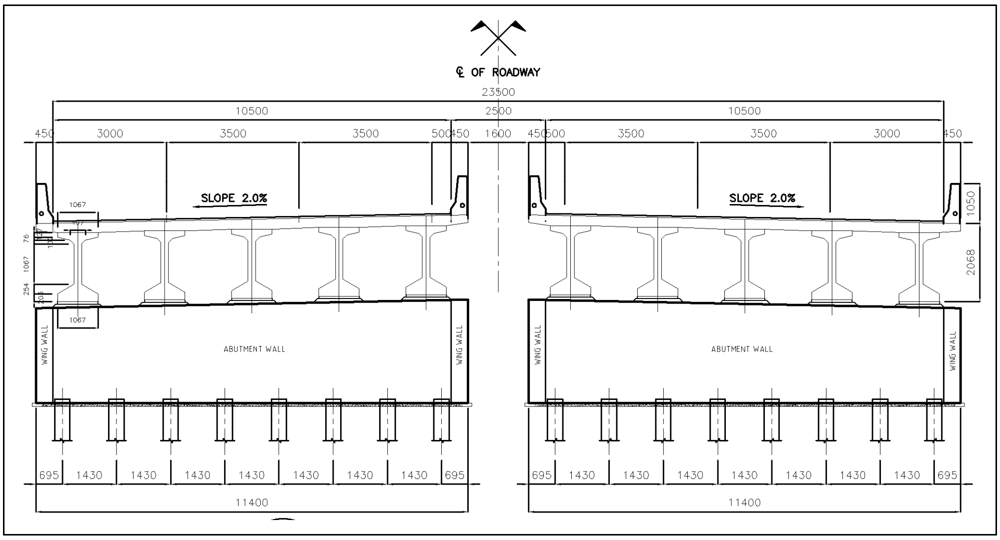


Figure 9.6-2 Typical Cross Section of PCDG Bridges of Pursat Bypass

9.7 Bridge Accessories

(1) Handrail

There are two types of handrail designs; the concrete type and the steel type. The concrete type handrail is heavier than the steel type, but it does not need periodic painting. Thus, the maintenance cost of the concrete type handrail is lower than that of the steel type. Concrete handrails have been proposed in "the Strengthening of Construction Quality Project" implemented by JICA. Figure 9.7-1 shows handrail.

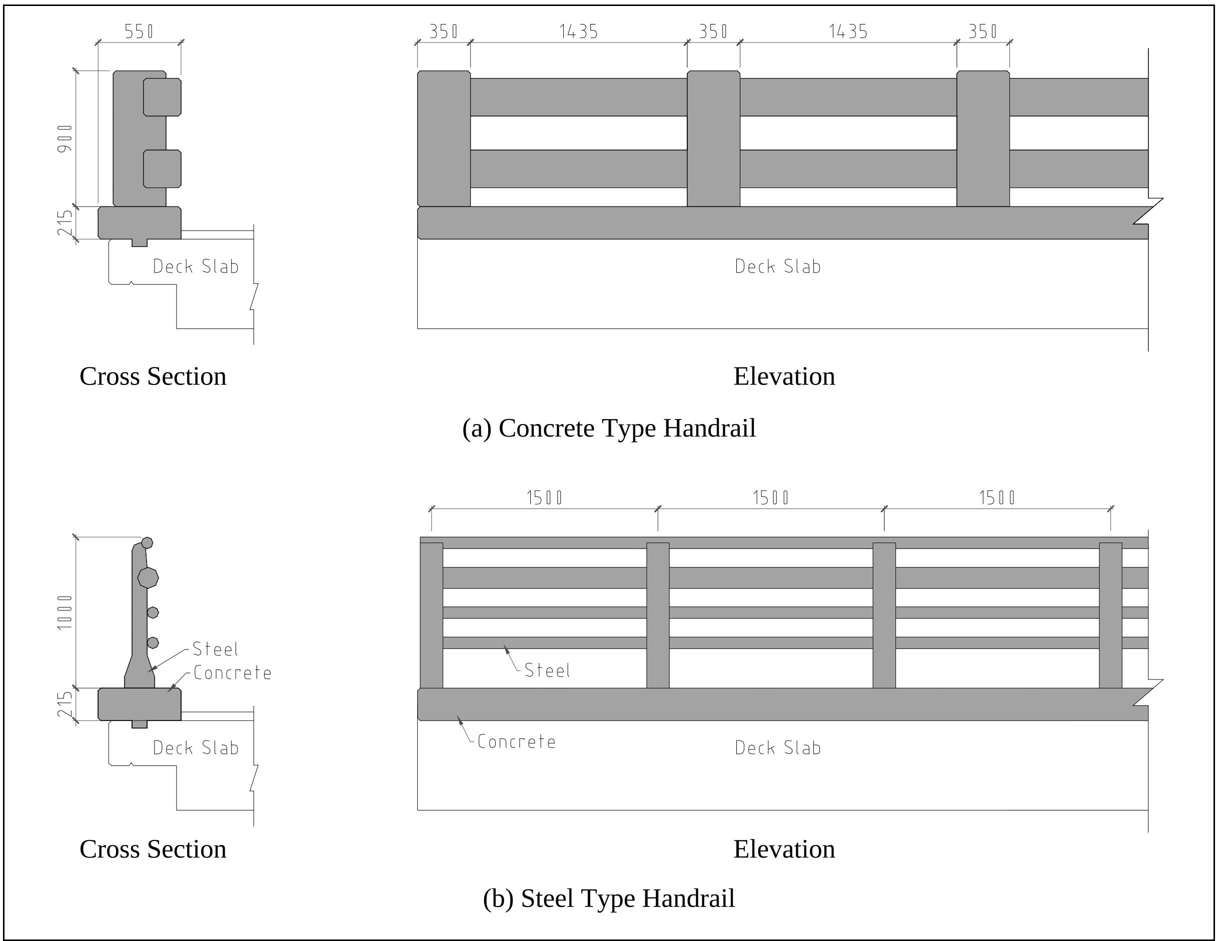
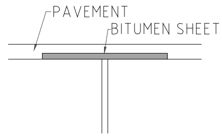
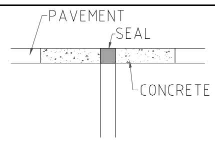
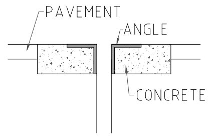
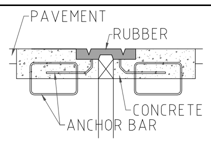
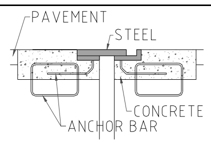


Figure 9.7-1 Handrail

(2) Expansion Joint

Function of an expansion joint is to secure smooth running for vehicles, allowing thermal expansion/contraction of bridge decks and beams. The expansion joints of existing bridges are the steel angle type or the 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 50mm) due to the small magnitude of fluctuation of temperature. These type of expansion joints are also recommended 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. The rubber type bearing is superior to the steel type with regard to maintenance and seismo-resistance. The 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.

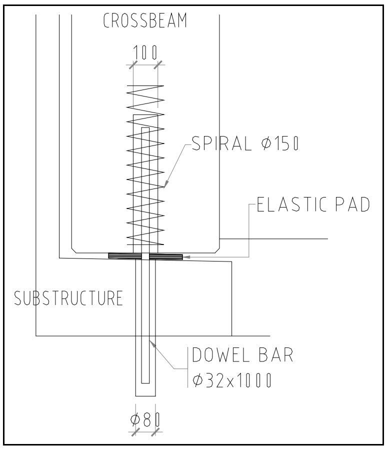


Figure 9.7-3 Anchor Bar Type Aseismatic Connector

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 the road bed and pavement from water infiltration. Installation of 16 box culverts (width x Height - No. of Cell: 3.0 x 2.0-2) per 1km can lower the flood water to acceptable level. The detail of this measure is described in Subsection 6.1.5. Figure 9.8-1 lists the planned box culverts.

Table 9.8-1 Additional Waterway Opening

KP	Length (km)	Type of Opening Structure (Width x Height-No. of Cell)	Number of Opening Structure	Note
KP 227 + 700 – KP 235 + 800	8.1	Box culvert 3.0 x 2.0-2	3	Insufficient drainage capacity
KP 235 + 800 – KP 239 + 900	4.1	Box culvert 3.0 x 2.0-2	4	Insufficient 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

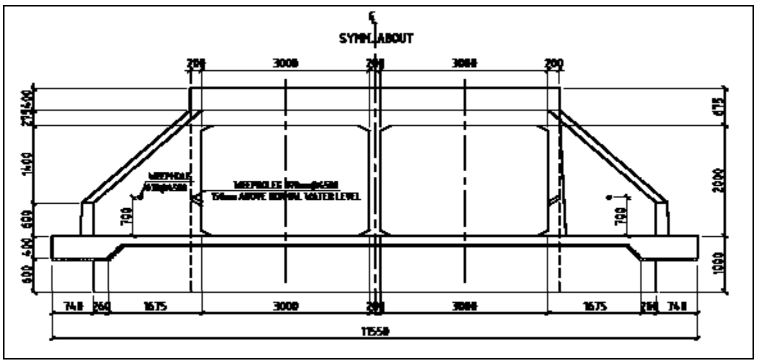


Figure 9.8-1 Box Culvert (3.0 x 2.0-2)

CHAPTER 10

COST ESTIMATION

CHAPTER 10 COST ESTIMATION

10.1 Construction Cost

The Middle Section is divided into three components (Middle Section, North Extension (Sri Sophorn–Poipet Section) 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.

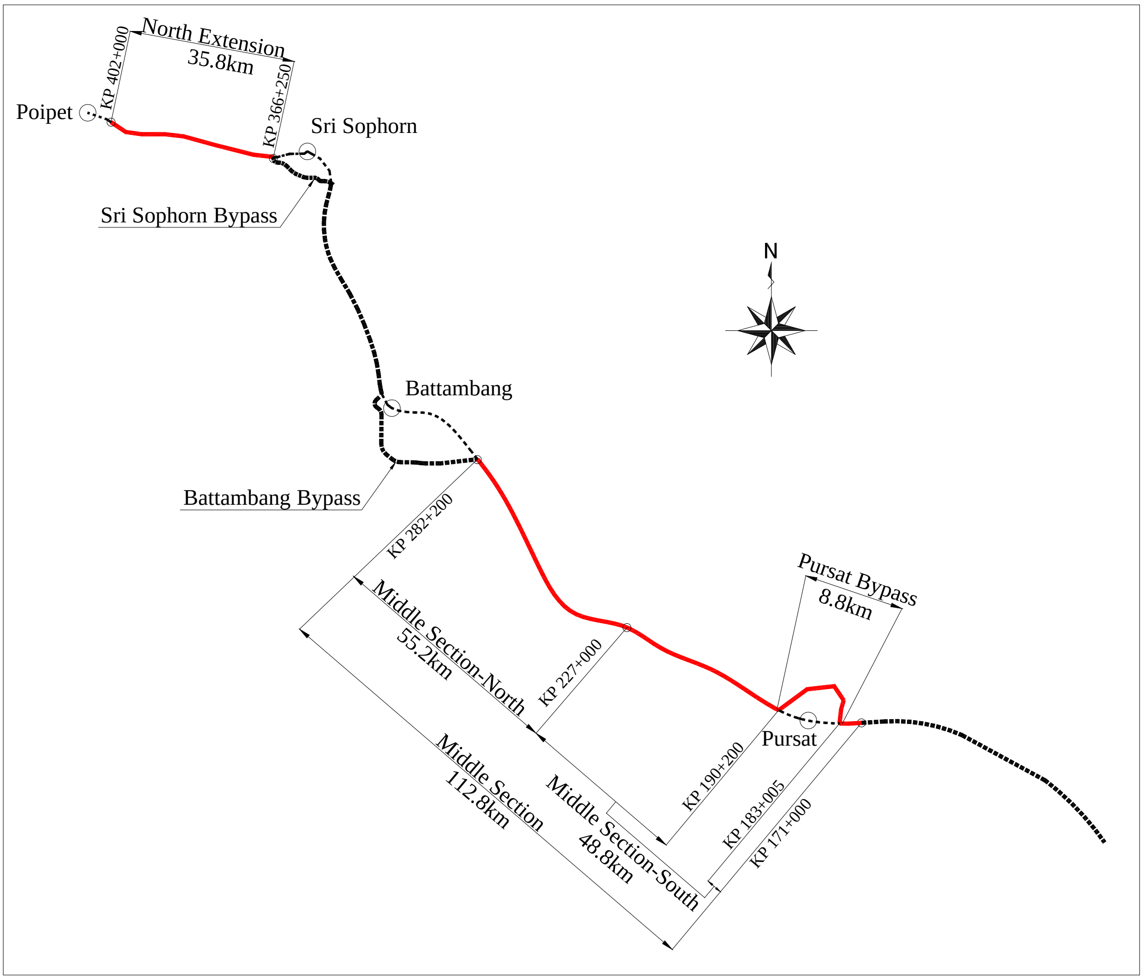


Figure 10.1-1 Map of Packages

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 around 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)	Remarks
Middle Section-South (existing Road No.5)	1,490 /km	Existing road rehabilitation
Road works (Pursat Bypass)	1,940 /km	New construction
Middle Section-North (existing road No.5)	1,480 /km	Existing road rehabilitation
North Extension (existing road No.5)	1,510 /km	Ditto

Table 10.1-3 Unit Price of Bridge Works

Description		Unit price (USD 1,000)	Remarks
Middle Section -South	PSC Bridge Widening Works	1.74 /m^2	PC Hollow Slab Bridge
	PSC Bridge Adding Works	1.48 /m^2	Ditto
	PCDG Bridge Adding Works	1.91 /m^2	PC T-Girder Bridge
	PSC Bridge Replacement Works	1.66 /m^2	PC Hollow Slab Bridge
Pursat Bypass	PSC Bridge Works	1.23 /m^2	PC Hollow Slab Bridge
	PCDG Bridge Works	1.94 /m^2	PC I-Girder Bridge
Middle Section-North	PSC Bridge Widening Works	1.74 /m^2	PC Hollow Slab Bridge
	PSC Bridge Replacement Works	1.66 /m^2	Ditto

Table 10.1-4 Unit Price of Culvert Works

Description	Unit price (USD 1,000)	Remarks
Pipe Culvert (φ1000mm x 1) 16.1m Widening	6.77 /unit	Middle Section-South
Pipe Culvert (φ1000mm x 2) 15.4m Widening	10.31 /unit	Middle Section-South
Pipe Culvert (φ1000mm x 3) 16.2m Widening	13.98 /unit	Middle Section-South
Pipe Culvert (φ1000mm x 4) 18.9m Widening	19.95 /unit	Middle Section-South
Pipe Culvert (φ1000mm x 8) 16.3m Widening	33.01 /unit	Middle Section-South
Pipe Culvert (φ1200mm x 1) 13.9m Widening	7.61 /unit	Middle Section-South
Pipe Culvert (φ1200mm x 3) 15.2m Widening	17.26 /unit	Middle Section-South
Box Culvert (3m x 2m x 1 cell) 15.8m Widening	33.22 /unit	Middle Section-South
Box Culvert (3m x 2m x 2 cells) 15.7m Widening	48.50 /unit	Middle Section-South
Box Culvert (3m x 2m x 3 cells) 17.1m Widening	70.60 /unit	Middle Section-South
Pipe Culvert (φ1000mm x 2) 33.3m New Construction	16.92 /unit	Pursat Bypass
Box Culvert (3m x 2m x 1 cell) 33.3m New Construction	53.06 /unit	Pursat Bypass
Box Culvert (3m x 2m x 2 cells) 33.3m New Construction	81.23 /unit	Pursat Bypass
Pipe Culvert (φ1000mm x 1) 14.5m Widening	6.40 /unit	Middle Section-North
Pipe Culvert (φ1000mm x 2) 16.4m Widening	10.72 /unit	Middle Section-North
Pipe Culvert (φ1000mm x 3) 17.3m Widening	14.59 /unit	Middle Section-North
Pipe Culvert (φ1200mm x 2) 15.1m Widening	12.85 /unit	Middle Section-North
Pipe Culvert (φ1500mm x 1) 13.9m Widening	10.82 /unit	Middle Section-North
Box Culvert (3m x 2m x 1 cell) 16.3m Widening	33.85 /unit	Middle Section-North
Box Culvert (3m x 2m x 2 cells) 30m New Construction	74.58 /unit	Middle Section-North
Box Culvert (3m x 2m x 2 cells) 16.5m Widening	50.11 /unit	Middle Section-North
Box Culvert (3m x 2m x 3 cells) 16.3m Widening	68.31 /unit	Middle Section-North
Pipe Culvert (φ1000mm x 1) 16.5m Widening	6.86 /unit	North Extension
Pipe Culvert (φ1000mm x 2) 16.5m Widening	10.76 /unit	North Extension
Pipe Culvert (φ1000mm x 4) 16.5m Widening	18.17 /unit	North Extension
Pipe Culvert (φ1200mm x 1) 16.5m Widening	8.36 /unit	North Extension
Pipe Culvert (φ1200mm x 2) 16.5m Widening	13.57 /unit	North Extension

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	1,490	72,988
Pipe Culvert (φ1000mm x 1) 16.1m Widening	no	22	6.77	149
Pipe Culvert (φ1000mm x 2) 15.4m Widening	no	11	10.31	113
Pipe Culvert (φ1000mm x 3) 16.2m Widening	no	4	13.98	56
Pipe Culvert (φ1000mm x 4) 18.9m Widening	no	1	19.95	20
Pipe Culvert (φ1000mm x 8) 16.3m Widening	no	1	33.01	33
Pipe Culvert (φ1200mm x 1) 13.9m Widening	no	3	7.61	23
Pipe Culvert (φ1200mm x 3) 15.2m Widening	no	1	17.26	17
Box Culvert (3m x 2m x 1 cell) 15.8m Widening	no	6	33.22	199
Box Culvert (3m x 2m x 2 cells) 15.7m Widening	no	4	48.50	194
Box Culvert (3m x 2m x 3 cells) 17.1m Widening	no	2	70.60	141
PSC Bridge Widening Works	m^2	2,151	1.74	3,743
PSC Bridge Adding Works	m^2	798	1.48	1,181
PCDG Bridge Adding Works	m^2	1,026	1.91	1,960
PSC Bridge Replacement Works	m^2	456	1.66	757
Weigh Station Embankment Works	place	2	51.54	103
Total				81,677

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	1,480	81,696
Pipe Culvert (φ1000mm x 1) 14.5m Widening	no	4	6.40	26
Pipe Culvert (φ1000mm x 2) 16.4m Widening	no	6	10.72	64
Pipe Culvert (φ1000mm x 3) 17.3m Widening	no	3	14.59	44
Pipe Culvert (φ1200mm x 2) 15.1m Widening	no	4	12.85	51
Pipe Culvert (φ1500mm x 1) 13.9m Widening	no	1	10.82	11
Box Culvert (3m x 2m x 1 cell) 16.3m Widening	no	7	33.85	237
Box Culvert (3m x 2m x 2 cells) 30m New Construction	no	215	74.58	16,035
Box Culvert (3m x 2m x 2 cells) 16.5m Widening	no	10	50.11	501
Box Culvert (3m x 2m x 3 cells) 16.3m Widening	no	6	68.31	410
PSC Bridge Widening Works	m^2	828	1.74	1,441
PSC Bridge Replacement Works	m^2	4,788	1.66	7,948
Weigh Station Embankment Works	place	2	51.54	103
Total				108,567

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	1,940	15,345
Pipe Culvert (φ1000mm x 2) 33.3m New Construction	no	31	16.92	525
Box Culvert (3m x 2m x 1 cell) 33.3m New Construction	no	5	53.06	265
Box Culvert (3m x 2m x 2 cells) 33.3m New Construction	no	6	81.23	487
PSC Bridge Works (Pursat Bypass Flyover + Viaduct)	m^2	19,722	1.23	24,258
PCDG Bridge Works (Pursat Bypass Flyover + Viaduct)	m^2	4,447	1.94	8,627
Total				49,507

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	1,510	53,983
Pipe Culvert (φ1000mm x 1) 16.5m Widening	no	13	6.86	89
Pipe Culvert (φ1000mm x 2) 16.5m Widening	no	1	10.76	11
Pipe Culvert (φ1000mm x 4) 16.5m Widening	no	1	18.17	18
Pipe Culvert (φ1200mm x 1) 16.5m Widening	no	31	8.36	259
Pipe Culvert (φ1200mm x 2) 16.5m Widening	no	12	13.57	163
Weigh Station Embankment Works	place	2	51.54	103
Total				54,626

Table 10.1-9 Summary of Construction Cost

Package	Road Length	Amount (USD 1,000)
Package 1 (Middle Section-South)	58.0 km	81,677
Package 2 (Middle Section-North)	55.2 km	108,567
Package 3 (Pursat Bypass)	8.9 km	49,507
Package 4 (North Extension)	35.8 km	54,626
Package 5 (Weigh Station)	8 places	6,027
Total	149.0 km	300,404

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	3.00	3.60	3.60	2.38	-	7.42	-	-
Embankment /m^3	4.88	5.86	5.16	4.85	-	7.35	6.06	5.90
Subbase /m^3	19.00	22.80	13.56 (*2)	18.42	-	27.69	13.24	10.69
Base course /m^3	21.20	25.44	19.84	23.44	-	26.60	23.18	20.45
AC pavement /m^3	224.00	224.00	224.00	200.82	-	243.80	290.00	313.00 (*4)
Road /m	1,480-1,940	1,060-2,010	880-950	1,205	2,891	1,721	-	235 (*4)
Bridge /m^2	1,230-1,940	1,550-1,680	1,550-1,700	-	2,431	1,401	-	-
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*

[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

No.	Title	2015	2016	2017	2018	2019	2020	2021	2022	Total
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 Expert			1.0	2.0	0.0				3.0
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.
Electric or 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.

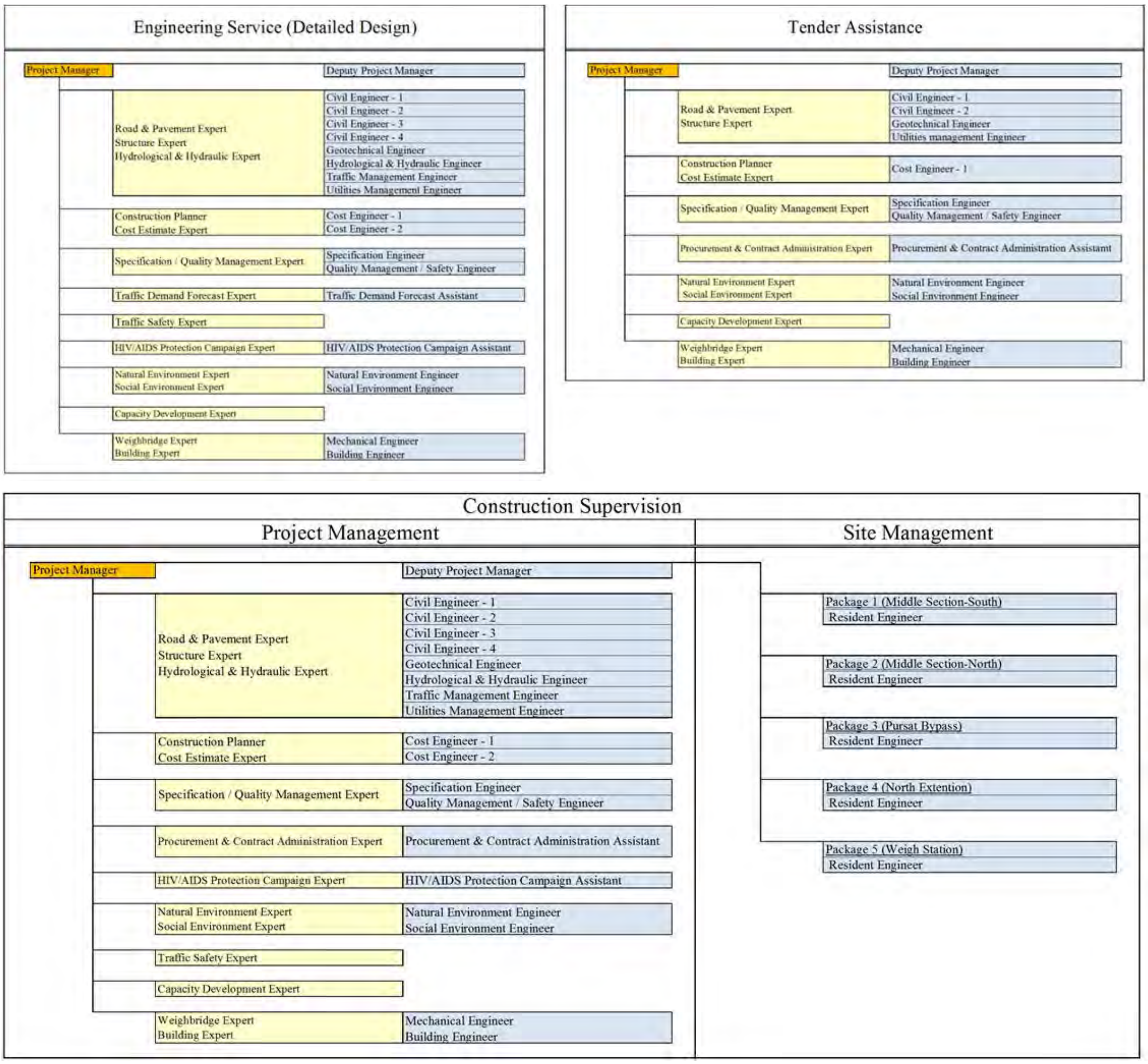


Figure 10.2-1 Organization of Consultant

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)	4,132
2) Tender Assistance	1,522
3) Construction Supervision	11,632
4) Technical Training	300
Total	17,586

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	8,060

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 USD80,000 /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	104.0km	80	8,320	
2) North Extension	35.8km	80	2,864	
3) Pursat Bypass	8.8km	8	70	10% of for existing road
Total			11,254	

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 (1,000m^2)	Rate (USD /m^2)	Amount (USD 1,000)
1) Clearance in road area	2,600	0.20	520
2) Clearance in bridge area	82	5.00	410
Total			930

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 : USD1,000		
LC : USD1,000		

	Item	FC	LC	Total
A. ELIGIBLE PORTION				
I)	Procurement/Construction	277,969	95,916	373,885
	Package 1 (Middle Section-South)	61,667	20,010	81,677
	Package 2 (Middle Section-North)	82,754	25,813	108,567
	Package 3 (Pursat Bypass)	38,813	10,694	49,507
	Package 4 (North Extension)	40,969	13,657	54,626
	Package 5 (Weigh Stations)	4,816	1,211	6,027
	Dispute Board (PKG1)	260	0	260
	Dispute Board (PKG2)	779	0	779
	Dispute Board (PKG3)	260	0	260
	Dispute Board (PKG4)	177	0	177
	Base cost for JICA financing	230,495	71,385	301,880
	Price escalation	22,204	15,811	38,015
	Physical contingency	25,270	8,720	33,990
II)	Consulting services	13,362	7,121	20,483
	Base cost	11,843	5,743	17,586
	Price escalation	883	1,039	1,922
	Physical contingency	636	339	975
Total (I+II)		291,331	103,037	394,368
B. NON ELIGIBLE PORTION				
a	Procurement/Construction	0	15,036	15,036
	Utilities Relocation	0	11,254	11,254
	Mines and UXOs Removal	0	930	930
	Base cost	0	12,184	12,184
	Price escalation	0	1,485	1,485
	Physical contingency	0	1,367	1,367
b	Land Acquisition	0	8,060	8,060

	Base cost	0	8,060	8,060
c	Administration cost	0	4,175	4,175
d	VAT and Import Tax	0	40,940	40,940
Total (a+b+c+d+e)		0	68,211	68,211
TOTAL (A+B)		291,331	171,248	462,579
C. Interest during Construction		173	0	173
	Interest during Construction(Construction)	162	0	162
	Interest during Construction (Consultant)	11	0	11
GRAND TOTAL (A+B+C)		291,504	171,248	462,752
E. JICA finance portion (A+C)		291,504	103,037	394,541

10.6 Annual Progress

Annual progress of the project cost is calculated by distributing the project cost to 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: USD1,000)

Items \ Year		2015	2016	2017	2018	2019	2020	2021	2022	Total
Annual Progress	JICA portion	2,030	3,870	71,885	109,620	106,057	81,419	19,072	588	394,541
	RGC portion	223	9,449	23,714	12,056	11,663	8,952	2,093	61	68,211
	Total	2,253	13,319	95,599	121,676	117,720	90,371	21,165	649	462,752

It should be noted that annual progress for the RGC will be significantly large in the first few years due to the 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 the land acquisition and resettlement are pre-requisites for commencing the construction, special attention needs to be paid to the progress of these tasks 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. 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: USD1 million)

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Loan amount	2	3.9	71.9	109.6	106.1	81.4	19.1	0.6	0	0
Cumulative amount	2	5.9	77.8	187.4	293.5	374.9	394	394.6	394.6	394.6

After the grace period, repayment shall begin. In the repayment, 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 USD13.2 million per year over thirty years from 2025 to 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 100km long and considered to be too long for one contract package. On the other hand Pursat Bypass is less than 10km long but it contains several bridges. The work volume and contract amount of the Pursat Bypass is considered to be large enough as one package.

Therefore, in view of the volume and length of the works, the JICA Team recommends that the packaging be divided into the 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 published by the International Federation of Consulting Engineers (Fédération Internationale des Ingénieurs-Conseils, or FIDIC) as the basis of the genral conditions of the contract of the civil work of the Project. 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	JPY998 million	JPY7,874 million	JPY1,088 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: 9.1km (car lane + bike lane) x 2	Cable stayed bridge: 640m Approach bridge: 90m + 675m Embankment: 840m + 2,405m	NR 5 rehabilitation: 2.2km Street rehabilitation: 2.4km Drainage way: 2.6km	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	USD24.8 million & JPY847 million (Total JPY3,131 million)	KRW27,216 million (USD24.9 million)	USD11.6 million	USD56.8 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: 541,000m^3 Pavement works: 88,666m^2 Buildings	NR 31: rehabilitation 55km NR 33: rehabilitation 36km PR 117: rehabilitation 11km Kampot Bypass: new 4km	NR 5: improvement 47km Bridge: 102m (4 span) PC girder	NR 5: widening 30km 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

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 a bypass around the city of Pursat (Pursat Bypass).

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 the 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 or sophisticated technology is not anticipated in either case.

Generally, the construction of roads is executed in the process as shown below:

(a) The work area is cleared and unsuitable material, if any, is removed.

(b) The 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) The 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) The subgrade is prepared before pavement structure is constructed.

(e) The material of subbase course and base course are spread and compacted as specified, and tests are conducted to confirm required dimensions and quality.

(f) The materials of asphalt concrete is laid on top of the 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 Sophorn, 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 the filling to the existing road level and additional space for the traffic to travel is available, the 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.

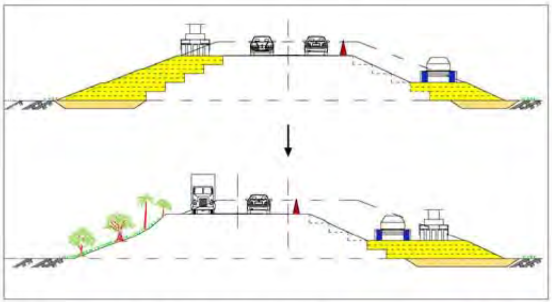


Figure 11.1-2 Embankment Works (1)

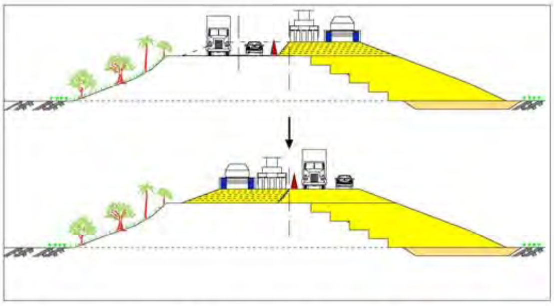


Figure 11.1-3 Embankment Works (2)

After the embankment and subgrade preparation is completed, the 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.

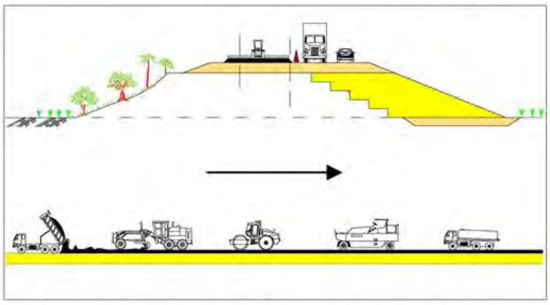


Figure 11.1-4 Subbase Course Works

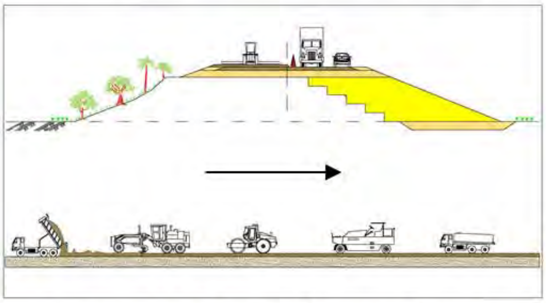


Figure 11.1-5 Base Course Works

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.

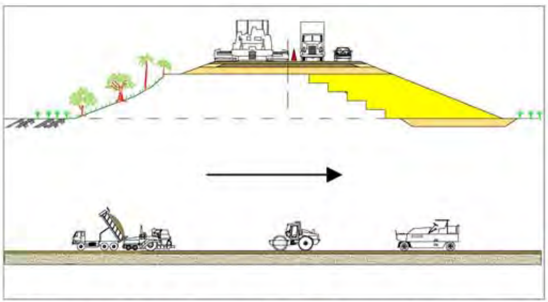


Figure 11.1-6 Asphalt Concrete Works

For the Pursat Bypass, the works can be executed without consideration for traffic except at intersections with existing roads, where certain measures are necessary to maintain the traffic on the existing roads. It should also be noted that swampy areas are prevalent in certain areas along the route of the 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

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)
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
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 the Middle Section-South and the 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 the North Extension (Sri Sohorn–Poipet Section), there is no bridge works.

In Section Pursat Bypass, it is planned that five bridges 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 piles are constructed to confirm the bearing capacity of the piles prior to construction of the working piles. The working piles will then be constructed in the following procedures.

  a) Set out pile positions

  b) Drive piles as per drawings with data (number of blows per each length etc.)

  c) Record the required data (hammer height, settlement and rebound per blow etc.) at final depth to calculate the bearing capacity of pile

  d) Re-drive, if required

  Some piles selected from the working piles are tested to confirm capacity and quality with either a static load test or a dynamic test.

- Substructure

  Because all substructures are near, or in, the 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.

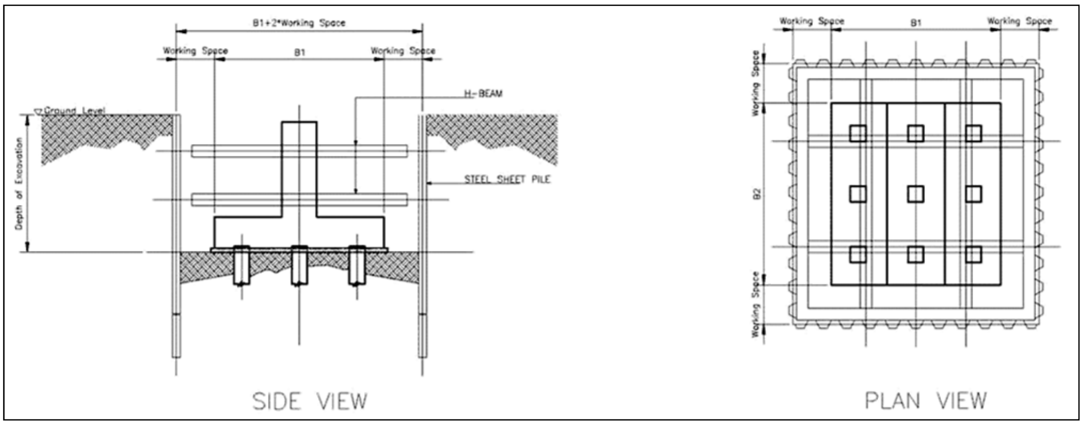


Figure 11.1-7 Schematic View for Structural Excavation

When the excavation is completed, the pile heads are treated as specified without damage to the piles and lean concrete is 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 constructed after treatment of the construction joints, and firm scaffolding and supports are provided. The concrete is cured through an appropriate method for the specified period.

After being properly backfilled, the temporary shoring is 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 produced in a casting yard, delivered to the site and then erected. Then the deck slab is cast in-situ. Quality control of girders for casting, tensioning and grouting are undertaken properly. Delivery and erection of girders are 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 the Middle Section-South and the Middle Section-North, new PCS beams are 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 practiced in the 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 the culverts are executed in a manner similar to that described in Subsection 11.1.1. Likewise, concrete works for culverts are executed in a manner similar to that described in Subsection 11.1.2. In the case of culverts in the 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 the embankment works stated in Subsection 11.1.1.

11.1.5 Traffic Management During Construction

The works for the Middle Section and the North Extension are carried out 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 be maintained close 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 the road users. The same principle is to be applied when constructing the Pursat Bypass at intersections with the existing roads.

Figure 11.1-8 below shows a general flow chart for preparing a traffic management plan.

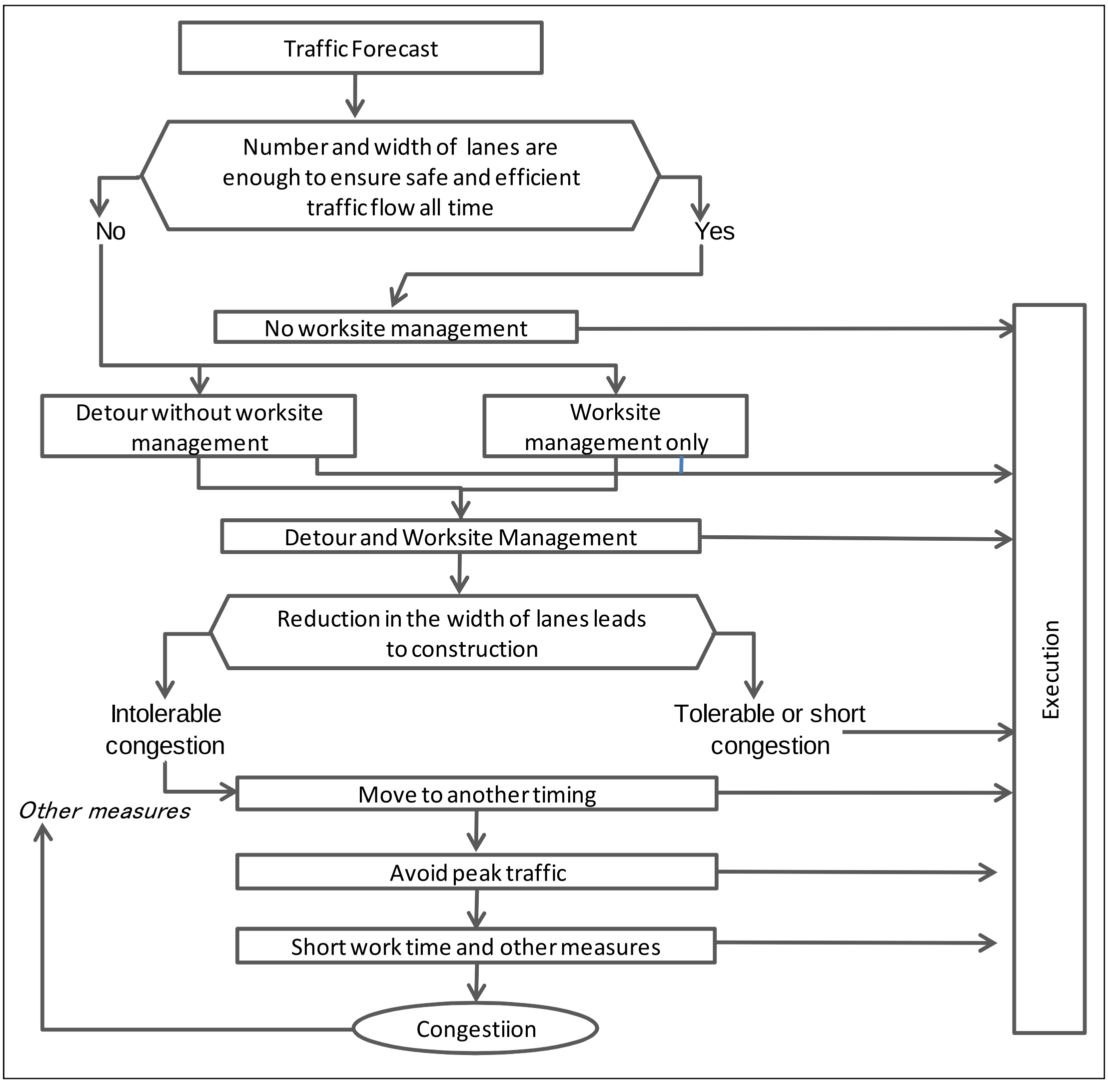


Figure 11.1-8 Flow of Traffic Management Plan

11.1.6 Utilities

Utilities such as electric cables, street light posts, telephone lines, optic fiber cables and water supply pipes along the route need to be checked thoroughly before 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 experienced in the similar projects in Cambodia, the relocation, removal, protection and reinstatement of utilities is carried out by the owners of the concerned utilities or their designated agents. Contracts between the RGC and the owners of the concerned utilities, or the designed agent, which are separate from the contracts of the civil works, should be made so that the owners of the utilities directly supervise the relocation of the utilities.

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. 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 for the North Section was established.

A PMU similar to that for the North Section will be established for the project of the Middle Section in due course, which is illustrated in the Figure 11.2-1 below based on the above-cited Prakas (No. 525).

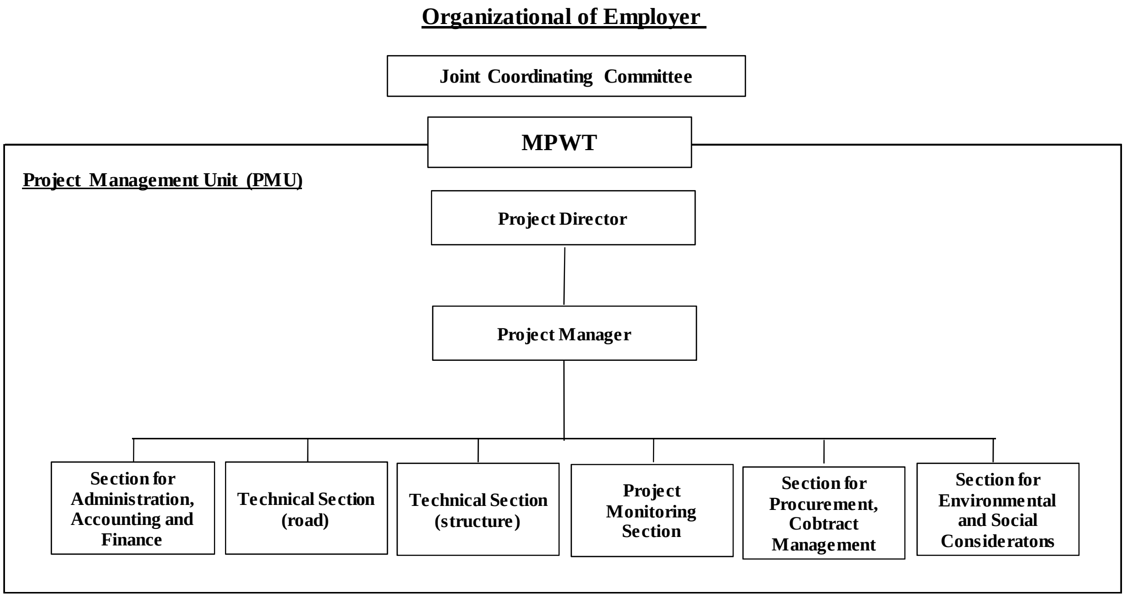


Figure 11.2-1 Organization of Employer

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 required 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. However, such knowledge and capability for project management will be relatively limited. Thus, 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 a bill of quantities which is 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.

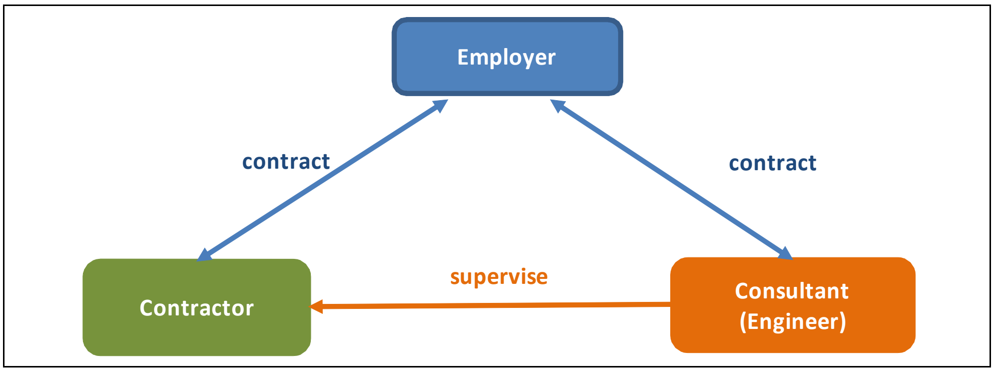


Figure 11.2-2 Relationship of the Employer, Consultant and Contractor

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 the North Extension, the Draft Final Report was submitted in August 2014 and Final Report is to be submitted in October 2014.

(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 2-3 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. In the case of the North Section, the period from issuance of RFP to signing of the contract was 10 months (12 Sep. 2013 – 3 July 2014) Therefore, the JICA Team assumes that selection of the consultant will take 12 months by taking time required for short-listing.

(e) Engineering Study and Supervision

The selected consultant carries 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 the 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 preparation of the tender documents, will be completed in twelve months. Same period was proposed 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 in the later stage of the detailed design 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.

(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 utilities can be explored after the detailed design is finalized, and relocation, removal and/or protection of the utilities needs to be completed before commencing the 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. The route of Pursat Bypass was already surveyed and cleared during this preparatory survey.
- The survey needs to 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 will be conducted.
- There is no problem for detection and removal works with 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 five packages in this Project, which are Package 1: Middle Section-South (National Road No.5), 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 for 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	49.0km	55.2km	8.8km	35.8km	N. A.
No. of bridges	13	15	5	-	N. A.
No. of culverts	55	256	42	58	N. A.

Based on the above and the execution plan, the construction periods for Package 1 and Package 2 are estimated to be three years, and that of Package 3 is estimated to be two years.

Utilizing the explanation above, the implementation schedule as shown in Table 11.3-2 is prepared.

Table 11.3-2 Implementation Schedule for National Road 5 Rehabilitation Project

CHAPTER 12

MAINTENANCE AND OPERATION PLAN

CHAPTER 12 MAINTENANCE AND OPERATION PLAN

12.1 Maintenance and Operation Cost

12.1.1 Organization in Charge of Road Maintenance

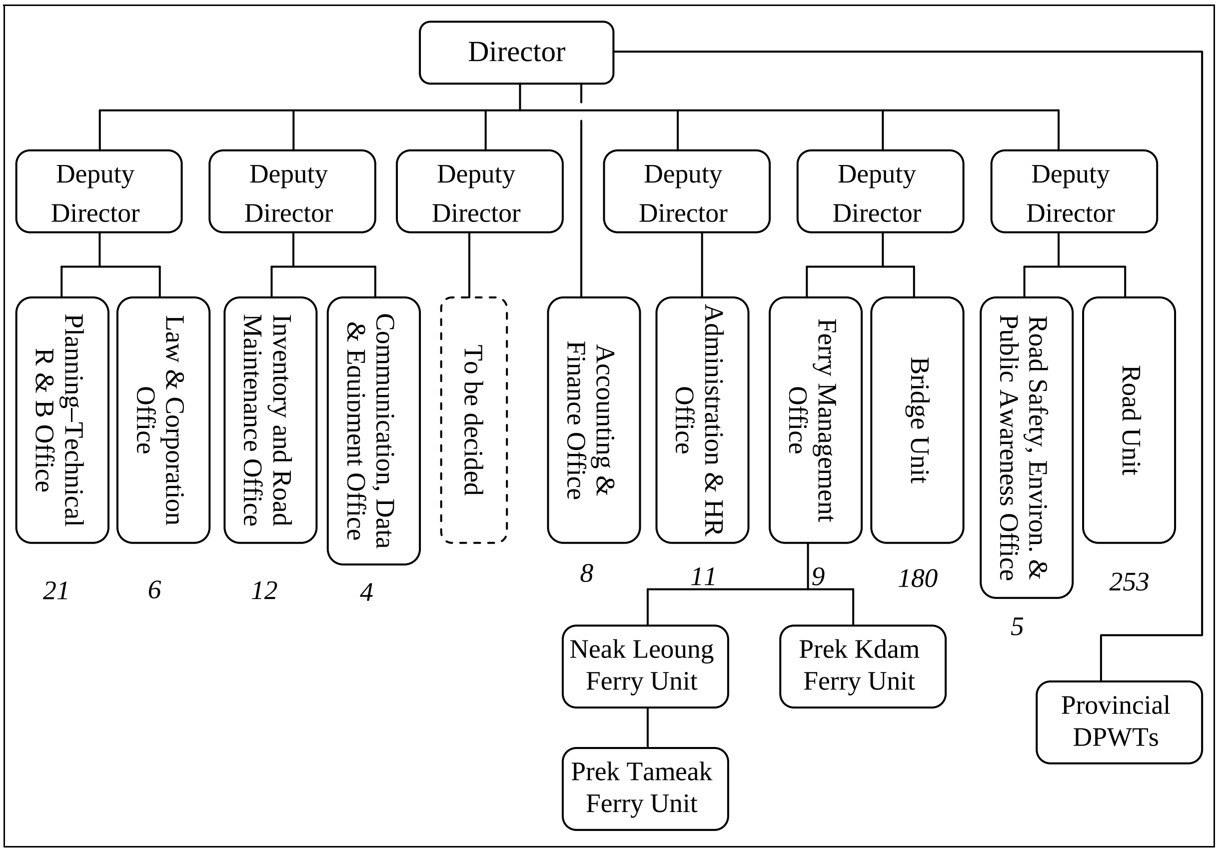
The functions of Ministry of Public Works and Transport (MPWT) are stipulated in the Sub-decree on the Organization and Function of MPWT and those of Department of Public Works and Transport (DPWT) in provinces and cities are stipulated in the Declaration on the Management and Process of DPWT. The important 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 was implemented and completed in January 2014. Another project, the Road Asset Management Project (RAMP) implemented under assistance of ADB and WB also contributes to capacity development for road maintenance. 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 Chhnang 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 5cm 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 (5cm 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 15.0m x 1,000 = USD 210,000/km	47.6	9,996
Urban Area	USD 14/m^2 x 20.0m 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 15.0m x 1,000 = USD 210,000/km	54.7	11,487
Urban Area	USD 14/m^2 x 20.0m 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 15.0m x 1,000 = USD 210,000/km	35.1	7,371
Urban Area	USD 14/m^2 x 20.0m 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 15.0m x 1,000 = USD 210,000/km	9.0	1,890
Urban Area	USD 14/m^2 x 20.0m 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

12.2.1 Maintenance and Operation Cost Based on the Current Practice

Road maintenance and operation costs after completion of the Project is calculated in the prices of 2013 which is estimated based on the current practice 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

12.2.2 Road Maintenance and Its Cost Required after Project Completion

The above discussion on the cost of road maintenance is based on the current expenditure for the maintenance of national roads.

It is supposed that the largest portion of the maintenance cost for national roads, especially those for single-digit national roads, is spent for repair of pavement (DBST). After this Project will be completed and the pavement will be improved to asphalt concrete (AC), the maintenance cost is expected to be reduced since AC pavement is more durable than DBST.

On the other hand, more diligent maintenance/operation than those currently practiced will be required after the road improvement will be completed and travel speed of vehicles will increase. Also increased volume of international traffic in the future will require road maintenance and operation of international level. As a part of ASEAN Highway No. 1, NR 5 will have to be maintained in a good condition.

Table 12.2-2 show the proposed work items and their costs of routine maintenance required for "international arterial highway". Many of such maintenance works are not currently being practiced but they are required for maintaining the function of "improved NR 5" and let NR 5 play the role expected on it.

The unit rate maintenance cost per km is estimated at $6,400 which is more than two times of the current expenditure on maintenance of national roads. It is strongly recommended that MPWT and MEF consult and secure sufficient budget for such appropriate road maintenance. It is possible that the revenue of RGC will be increased in the near future as the national economy will grow and RGC will be able to allocate adequate budget for road maintenance by the time when the project of improvement of NR 5 will be completed.

Table 12.2-2 Work Item and Cost of Appropriate Routine Maintenance Required after Improvement of NR 5

Work Item		Unit Rate (USD 1,000)	Quantity		Frequency per year	Amount (USD 1,000)	Basis for Assumed Unit Rate	
							Description of Works & Assumed Peromance (per Day)	Output per day
Road	Road Cleaning	0.274	149.0	km	2	82	Clean road surface, and dispose of trash and dust: 5 day-men/km x 2km x 2 (both sides) = 20 day-men	2km of road
	Repair of pavement defects	0.861	149.0	km	2	257	Repair pot holes (assuming 6m2 pot hole per 1km road) with cold mix asphalt	1km of road
	Cleaning of side ditch & drainage	0.385	74.5	km	1	29	Clean out side ditchs & drainage along road, and dispose trash and mud: 1 day-man/100m x 2,000m x 2 (both sides) = 40 day-men	2km of road
	Repair of defective traffic sign	0.311	149.0	km	1	46	Clean & check traffic signs, and replace one traffic sign post in 4km of road: 2 signs/km x 4 km x 2 (both sides) = 8 signs; 1.7 case of accident/km/yr x 4 km = 6.8 cases/yr	4km of road
	Repair of defective lane mark	1.080	149.0	km	1	161	Clean lane maks, and remark lines (assuming 300m per 1km of road):	1km of road
Culvert	Cleaning of culverts	0.347	411	nos	1	143	Clean and wash culverts, and dispose of trash and mud: 3m x 2 x 30m x 0.2 m = 36m3/culvert	2 culverts
Guard Rail	Repair of damaged gurd rail	0.010	3,200	m	1	32	Clean & check guard rails, and replace damaged portion (4m per 100m of guard rails): 1.7 accicent/1,000m/yr x 100m = 0.17 accident/yr/100m; Replace 20m/accident 0.17 x 20m = 3.4m -> 4m	100m of guard rails
Street Light	Repair of defective street light	0.176	114	nos	1	20	Clean & check street lights, and replace 2 sets of lamp and lamp shed in 10 of streeet lights	10 street lights
Bridge	Cleaning of bridge surface	0.001	34,216	m2	2	68	Clean out bridge surface & bridge rails, and dispose of trash and dust	460m2 of bridge surface
	Repair of bridge pavement defects	0.001	34,216	m2	2	68	Repair pot holes (1m2 pot hole per 690m2 per bridge surface)	690m2 of bridge surface
	Cleaning of expansion joints of bridges	0.011	2,265	m	2	50	Clean out expansion joints, and dispose of trash and dust, etc.	50m of expansion joint
	Total					956		

Unit Rate per Road Length: $956,000/149km = $6,416/km

CHAPTER 13

PROJECT EVALUATION

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 improvement projects 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:

<u>Goals:</u>

- To facilitate transportation of goods and passengers
- To promote regional economy

<u>Direct Objectives:</u>

- To separate through traffic and intra-urban traffic (mitigation of traffic congestion in Pursat City)
- To eliminate/mitigate 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.

<u>Selection of Operation and Effect Indicators</u>

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.

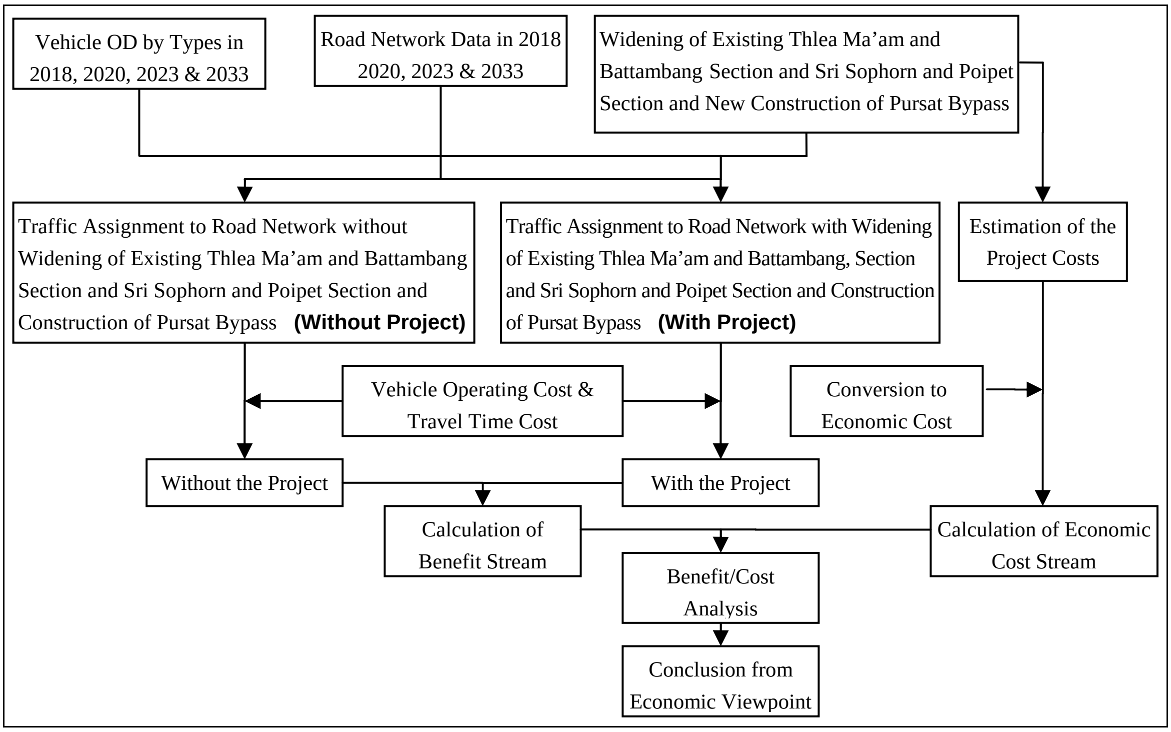


Figure 13.5-1 Procedure of Economic Analysis

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/1000km		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.

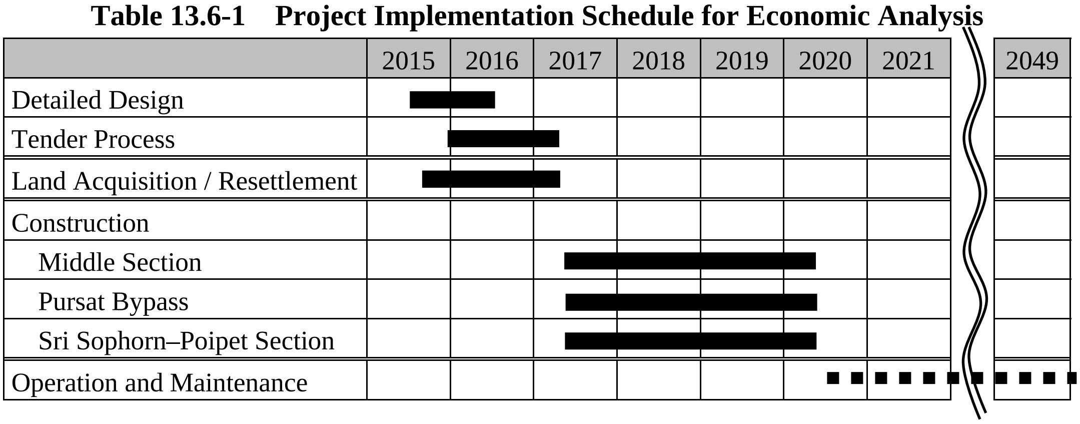
In order to evaluate the road projects from an economic view point, the following economic indicator were considered:

- 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



(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: x 1,000US$)

SQ	Year	Project Cost	Maintenance Cost	Total Cost	Benefit	Net Benefit	Discount Cash Flow (at 12%)		
							Cost	Benefit	Net Benefit
	2015	2,231		2,231		-2,231	2,231	0	-2,231
	2016	12,382		12,382		-12,382	11,055	0	-11,055
	2017	93,244		93,244		-93,244	74,333	0	-74,333
	2018	120,470		120,470		-120,470	85,748	0	-85,748
	2019	116,554		116,554		-116,554	74,072	0	-74,072
	2020	89,476		89,476		-89,476	50,771	0	-50,771
1	2021	20,956	436	21,392	13,148	-8,243	10,838	6,661	-4,176
2	2022	641	436	1,077	15,021	13,944	487	6,795	6,308
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	455,953,600	103,823	559,776	8,707,625	8,147,849	318,989	514,631	195,643

NPV (US$ million)	195.64
B/C	1.61
EIRR (%)	15.1

(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)	156.3	202.3	248.2
		B/C	1.61	1.79	1.97
		EIRR	15.0%	15.8%	16.4%
	Base Case	NPV (US$ million)	128.7	195.6	220.6
		B/C	1.45	1.61	1.77
		EIRR	14.4%	15.1%	15.7%
	+10%	NPV (US$ million)	101.1	147.1	195.7
		B/C	1.32	1.47	1.61
		EIRR	13.8%	14.4%	15.1%

(8) Cost-Benefit Analysis with Cost for Proper Road Maintenance

The economic analysis described in (6) and (7) above adopts the maintenance cost of $3,000/km/year based on the current practice. However, it is recommended that the budget for maintenance of NR 5 be increased to $6,400/km/year in order to implement proper road maintenance as described in Subsection 12.2.2.

The values of EIRR and other economic indicators are to be reduced if the cost of road maintenance is increased. Table 13.6-5 shows results of calculation of the economic indicators adopting the increased maintenance cost of $6,400/km/year. The EIRR is calculated to be 15.0%; slightly lower than in the case where $3,000/km/year was adopted, but still high enogh.

Table 13.6-6 shows the result of sensitivity analysis. EIRR for the worst case (+10% in costs and -10% in benefits) is calculated to be 13.7%; 0.1% less than the EIRR of the worst scenario where $3,000/km/year was adopted.

Table 13.6-5 Cost-Benefit Stream with the Cost for Proper Maintenance

SQ	Year	Project Cost	Maintenance Cost	Total Cost	Benefit	Net Benefit	Discount Cash Flow (at 12%)		
							Cost	Benefit	Net Benefit
	2015	2,231		2,231		-2,231	2,231	0	-2,231
	2016	12,382		12,382		-12,382	11,055	0	-11,055
	2017	93,244		93,244		-93,244	74,333	0	-74,333
	2018	120,470		120,470		-120,470	85,748	0	-85,748
	2019	116,554		116,554		-116,554	74,072	0	-74,072
	2020	89,476		89,476		-89,476	50,771	0	-50,771
1	2021	20,956	930	21,886	13,148	-8,737	11,088	6,661	-4,427
2	2022	641	930	1,571	15,021	13,450	711	6,795	6,084
3	2023		930	930	19,965	19,035	376	8,064	7,688
4	2024		930	930	23,570	22,641	335	8,500	8,164
5	2025		930	930	27,604	26,674	299	8,888	8,588
6	2026		930	930	32,110	31,180	267	9,231	8,964
7	2027		930	930	37,136	36,207	239	9,532	9,293
8	2028		930	930	54,297	53,367	213	12,443	12,230
9	2029		930	930	71,285	70,355	190	14,586	14,396
10	2030		30,685	30,685	90,348	59,663	5,606	16,506	10,900
11	2031		930	930	111,692	110,762	152	18,219	18,068
12	2032		930	930	135,539	134,609	135	19,740	19,605
13	2033		930	930	200,918	199,988	121	26,127	26,006
14	2034		930	930	213,192	212,262	108	24,753	24,645
15	2035		930	930	226,222	225,292	96	23,452	23,355
16	2036		930	930	240,037	239,107	86	22,218	22,132
17	2037		930	930	254,716	253,786	77	21,050	20,974
18	2038		930	930	341,621	340,692	69	25,208	25,139
19	2039		930	930	362,482	361,552	61	23,881	23,820
20	2040		30,685	30,685	384,615	353,930	1,805	22,624	20,819
21	2041		930	930	408,099	407,169	49	21,434	21,385
22	2042		930	930	433,015	432,085	44	20,306	20,262
23	2043		930	930	553,582	552,653	39	23,178	23,139
24	2044		930	930	587,375	586,445	35	21,958	21,923
25	2045		930	930	617,388	616,458	31	20,607	20,576
26	2046		930	930	648,827	647,898	28	19,336	19,308
27	2047		930	930	681,940	681,010	25	18,146	18,121
28	2048		930	930	716,742	715,812	22	17,028	17,006
29	2049		930	930	587,601	586,671	20	12,464	12,445
30	2050		30,685	30,685	617,539	586,854	581	11,696	11,115
	Total	455,953,600	117,159	573,113	8,707,625	8,134,513	321,118	514,631	193,514

NPV (US$ million)	193.51
B/C	1.60
EIRR (%)	15.0

Table 13.6-6 Sensitivity Analysis with the Cost for Proper Maintenance

Case		Economic Indicator	Benefits		
			-10%	Base Case	+10%
Costs	-10%	NPV (US$ million)	154.4	200.4	246.3
		B/C	1.60	1.77	1.95
		EIRR	15.0%	15.7%	16.4%
	Base Case	NPV (US$ million)	126.8	193.5	218.7
		B/C	1.44	1.60	1.76
		EIRR	14.3%	15.0%	15.7%
	+10%	NPV (US$ million)	99.2	145.2	193.6
		B/C	1.32	1.46	1.60
		EIRR	13.7%	14.4%	15.0%

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

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 upgraded maintenance works which will be required for NR 5 after improvement. This Project is to improve the pavement type of NR 5 from DBST to AC, and is expected to reduce annual maintenance cost. However, more diligent maintenance works, as discussed in Subsection 12.2.2 will be required since the travel speed of vehicles will become higher and risks of traffic accident will increase if proper maintenance will not be practiced.

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).

Renewal and addition of weighing stations will be included in the scope of the Project. 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

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 a 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/72ANK-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 100km 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 > = 12m or floor > = 8,000m^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	> = 50,000m^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.

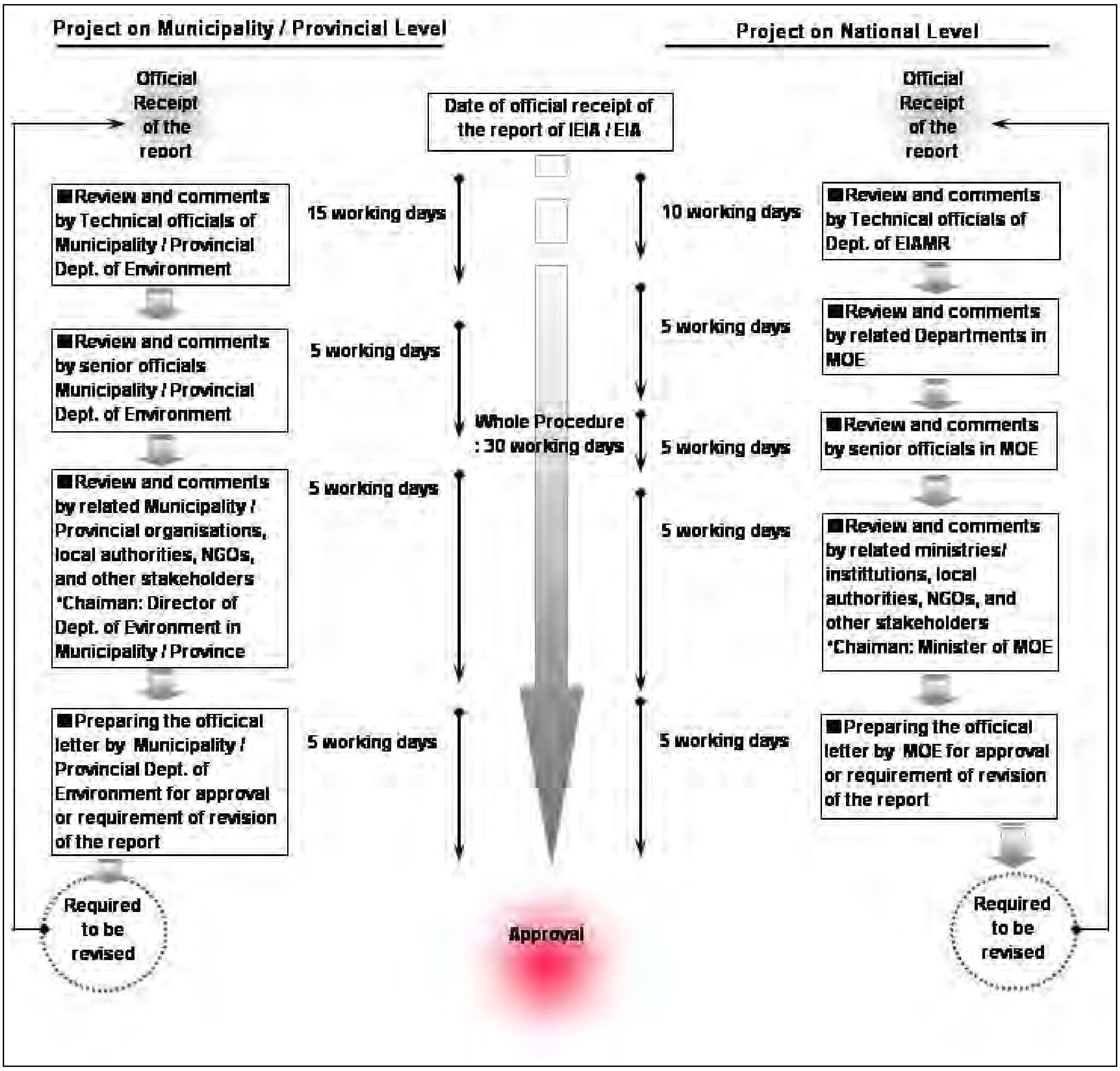


Figure 15.1-1 IEIA/EIA Approval Procedure

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.

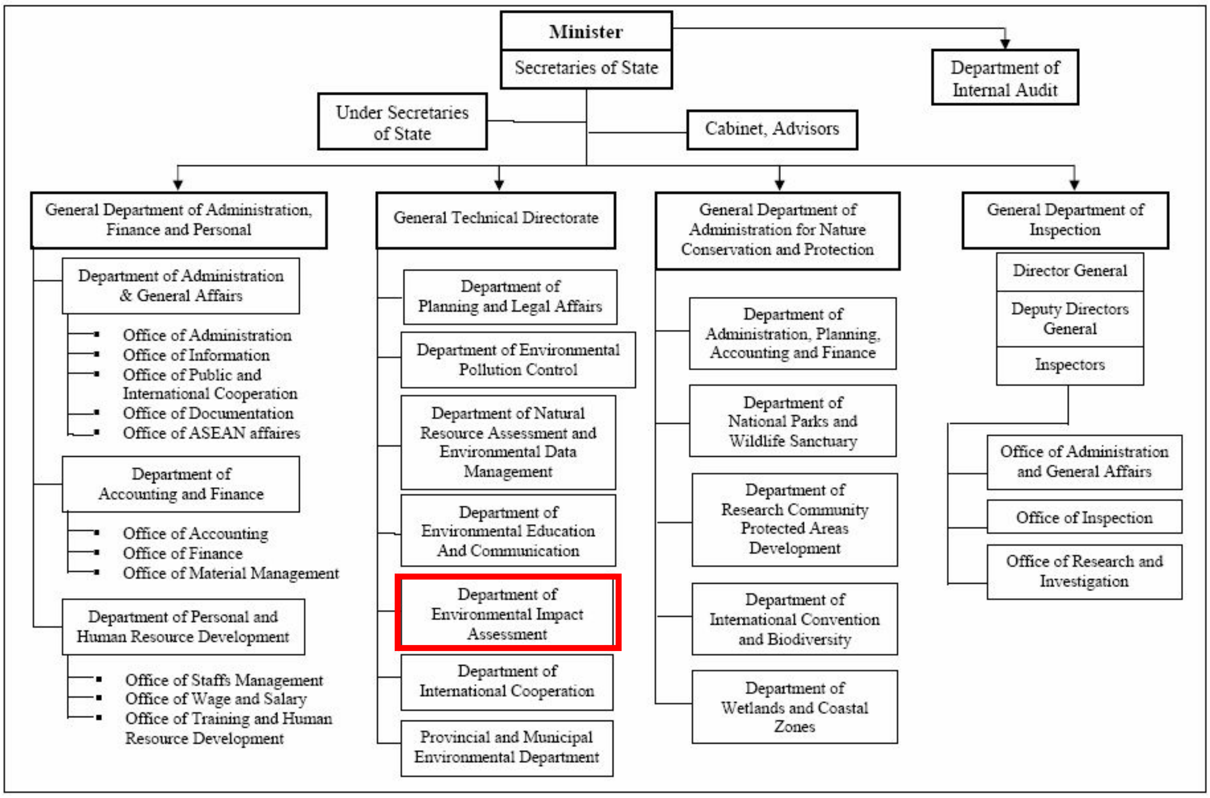


Figure 15.1-2 Organization Chart of MOE

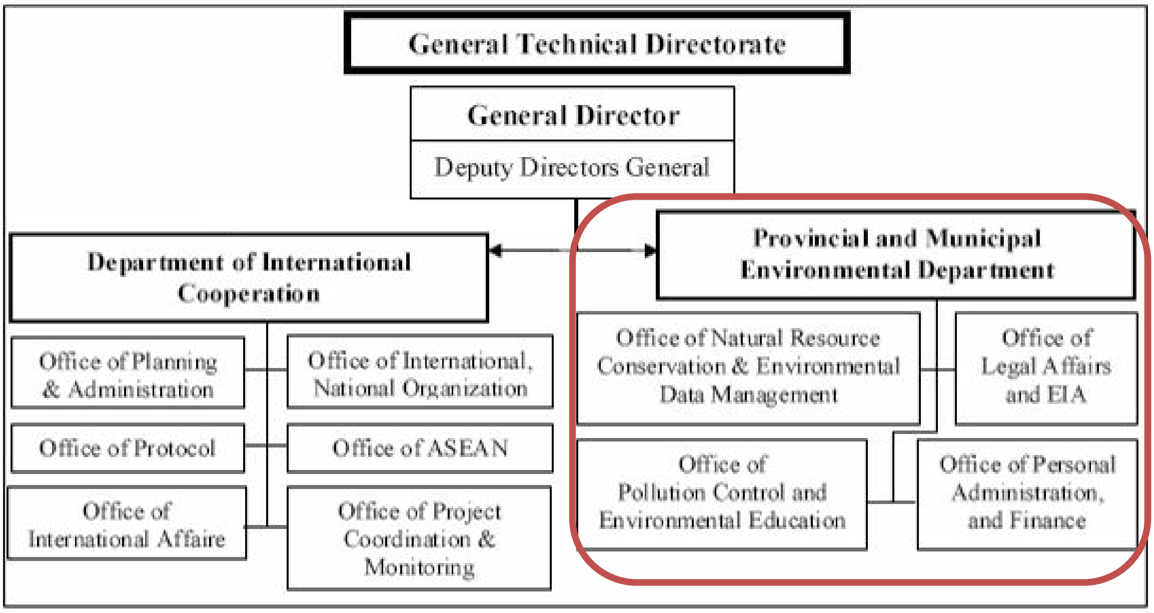


Figure 15.1-3 Organizational Structure of PMED

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/100ml	< 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/100ml	< 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

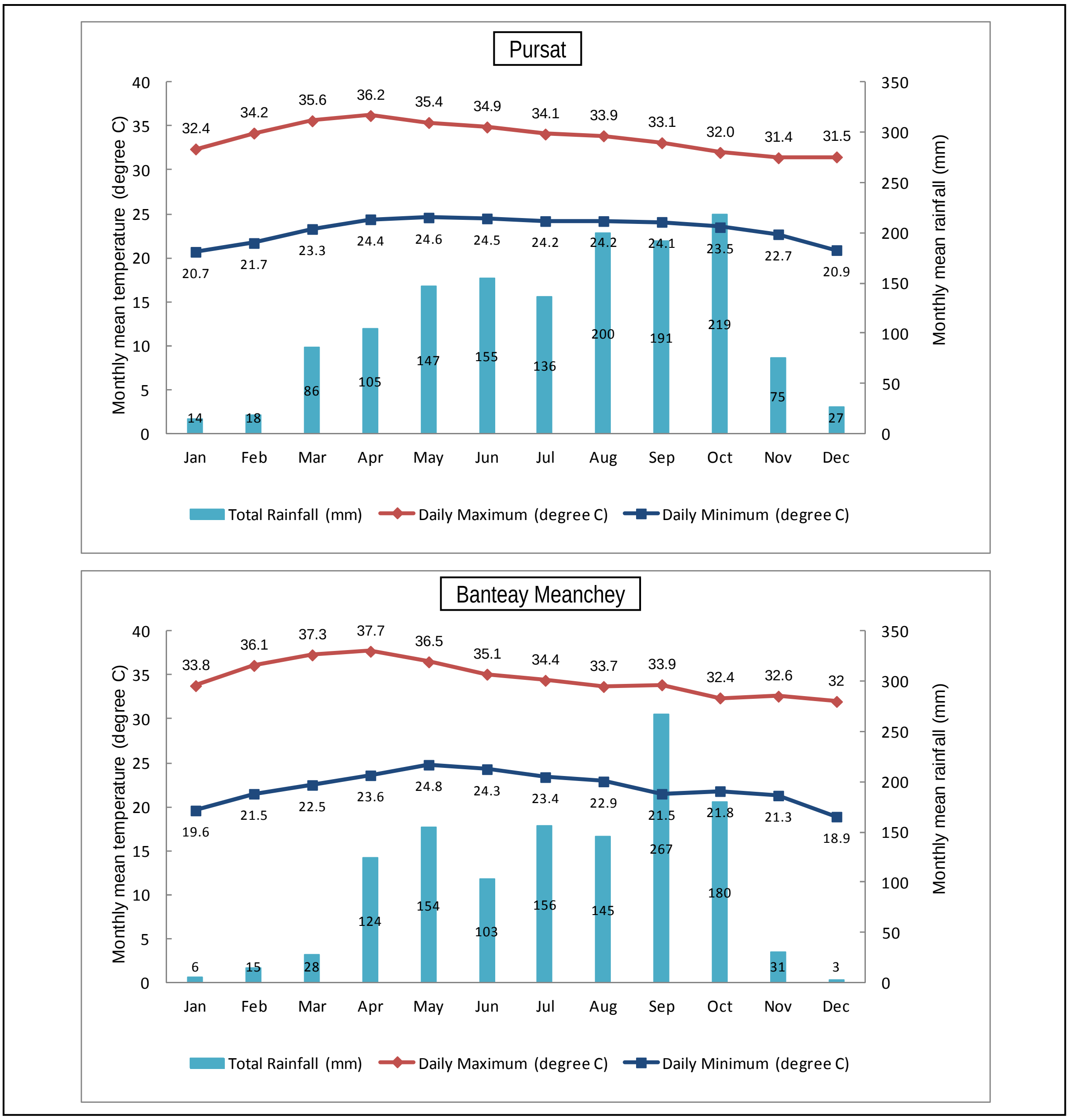
No.	Pollutant	Unit	Allowable Limit	
			Protected Public Water	Public Water Area & Sewer
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH_3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	> 2.0	> 1.0
36	Polychlorinated Biphenyl	mg/l	< 0.003	< 0.003
37	Calcium	mg/l	< 150	< 200
38	Magnesium	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

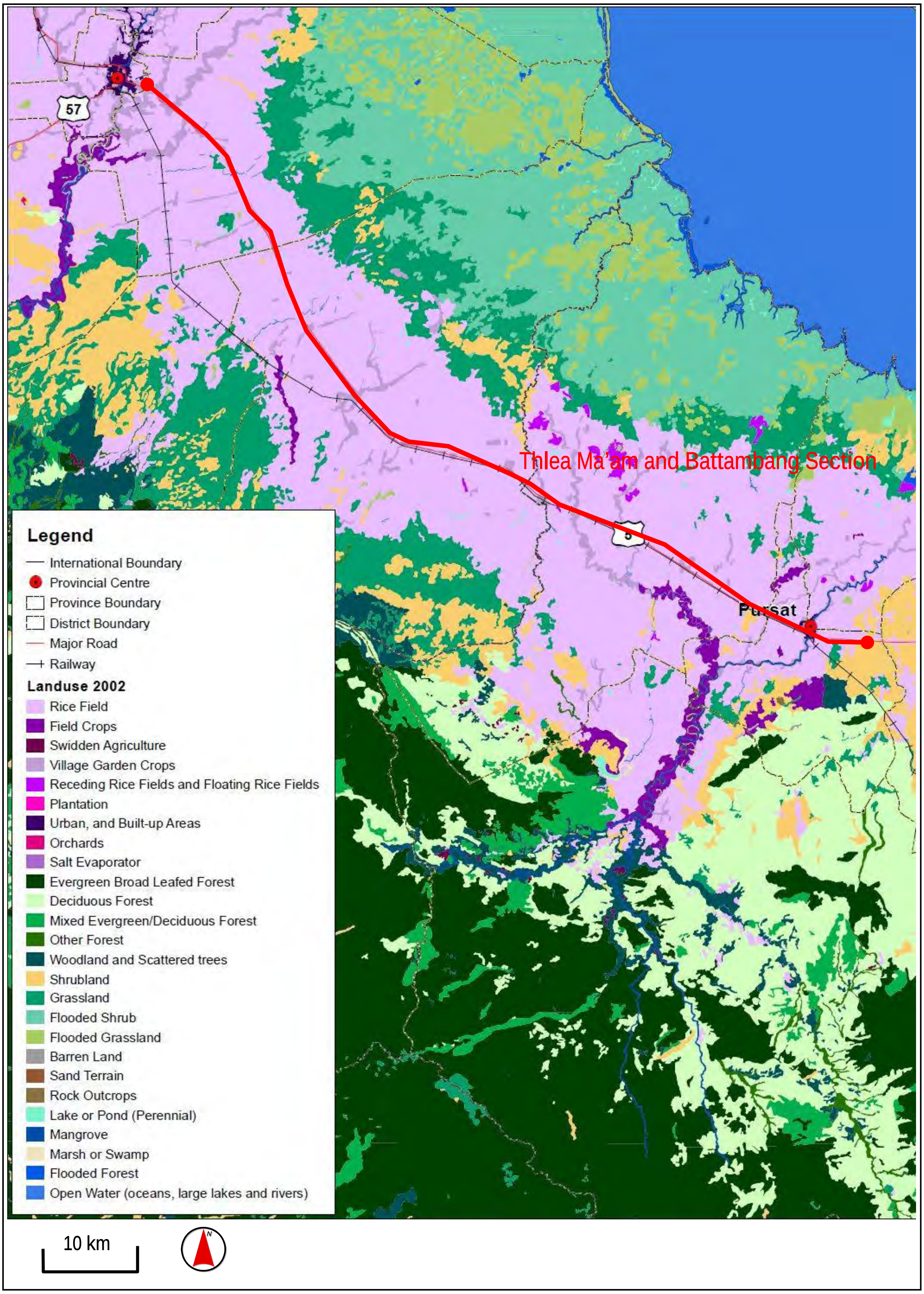
The land use around the project area is mostly agricultural land such as rice field, and vegetable and fruit farm. The other areas are urban build-up areas. There are no forest areas including Community forests along the project area. Flooded forest zone with 10-30km width exists around Tonle Sap lake 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 7km 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.

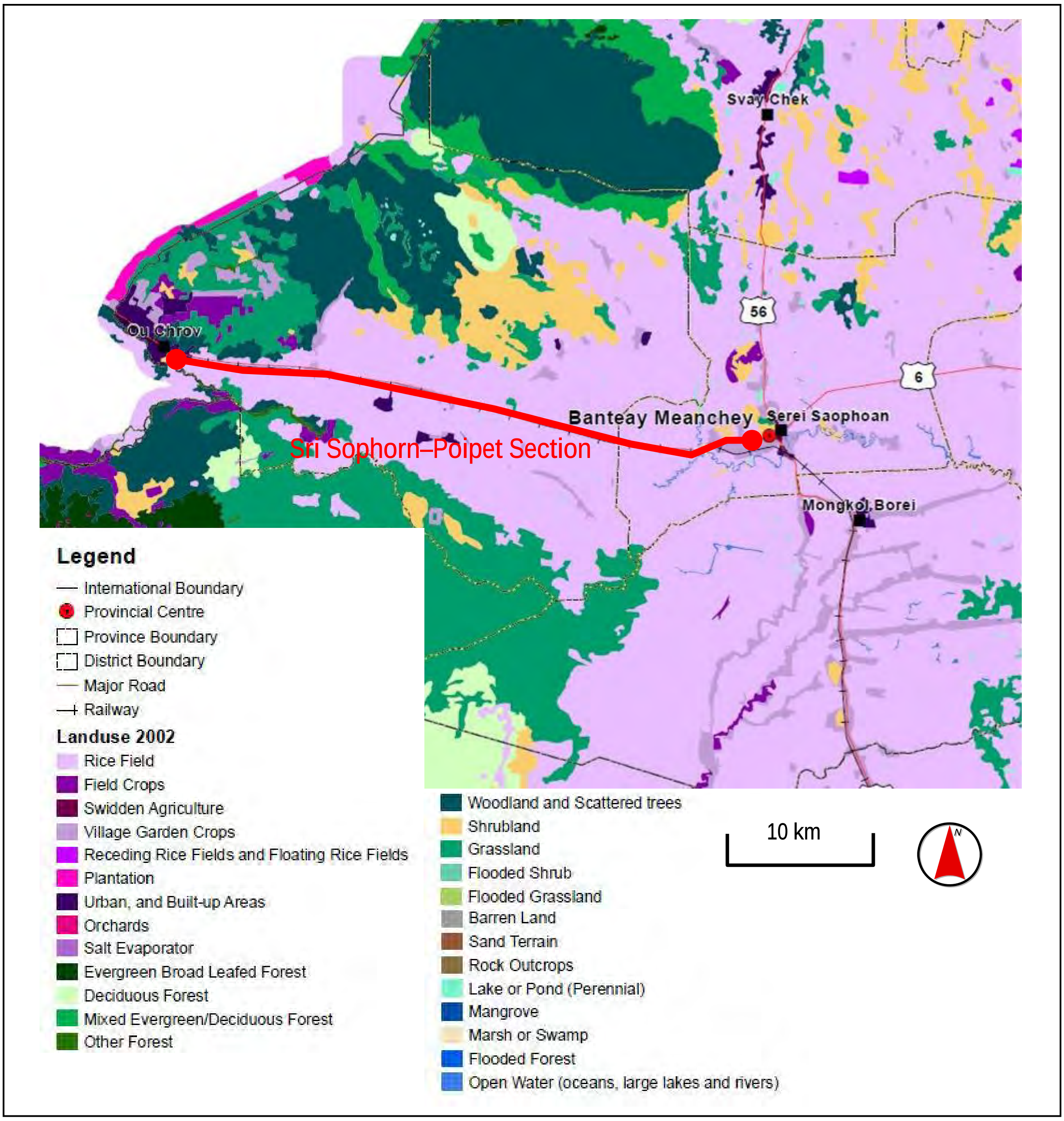
Flooded forest:

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

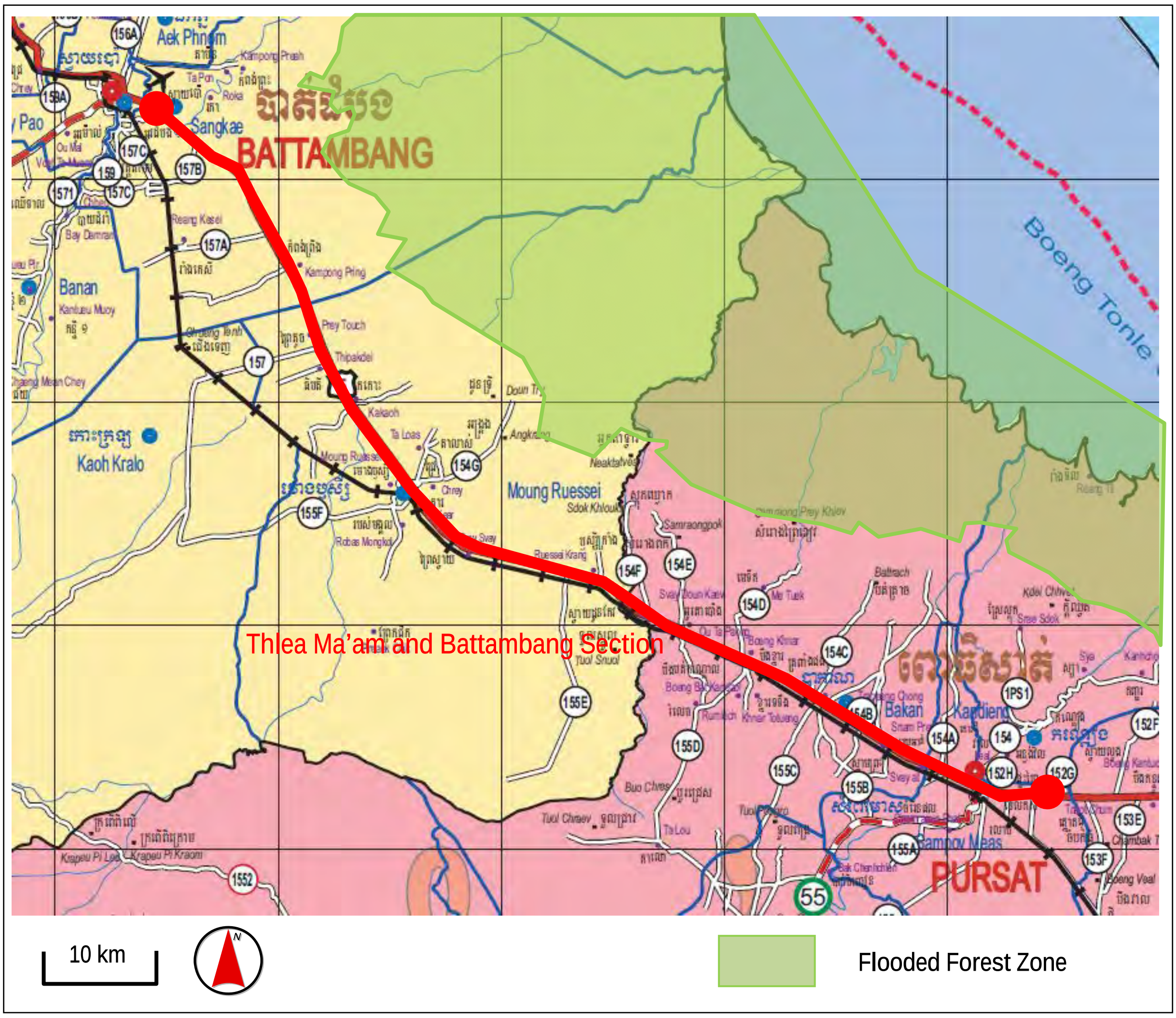
Figure 15.2-2 Land Use around Project Area (1)



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

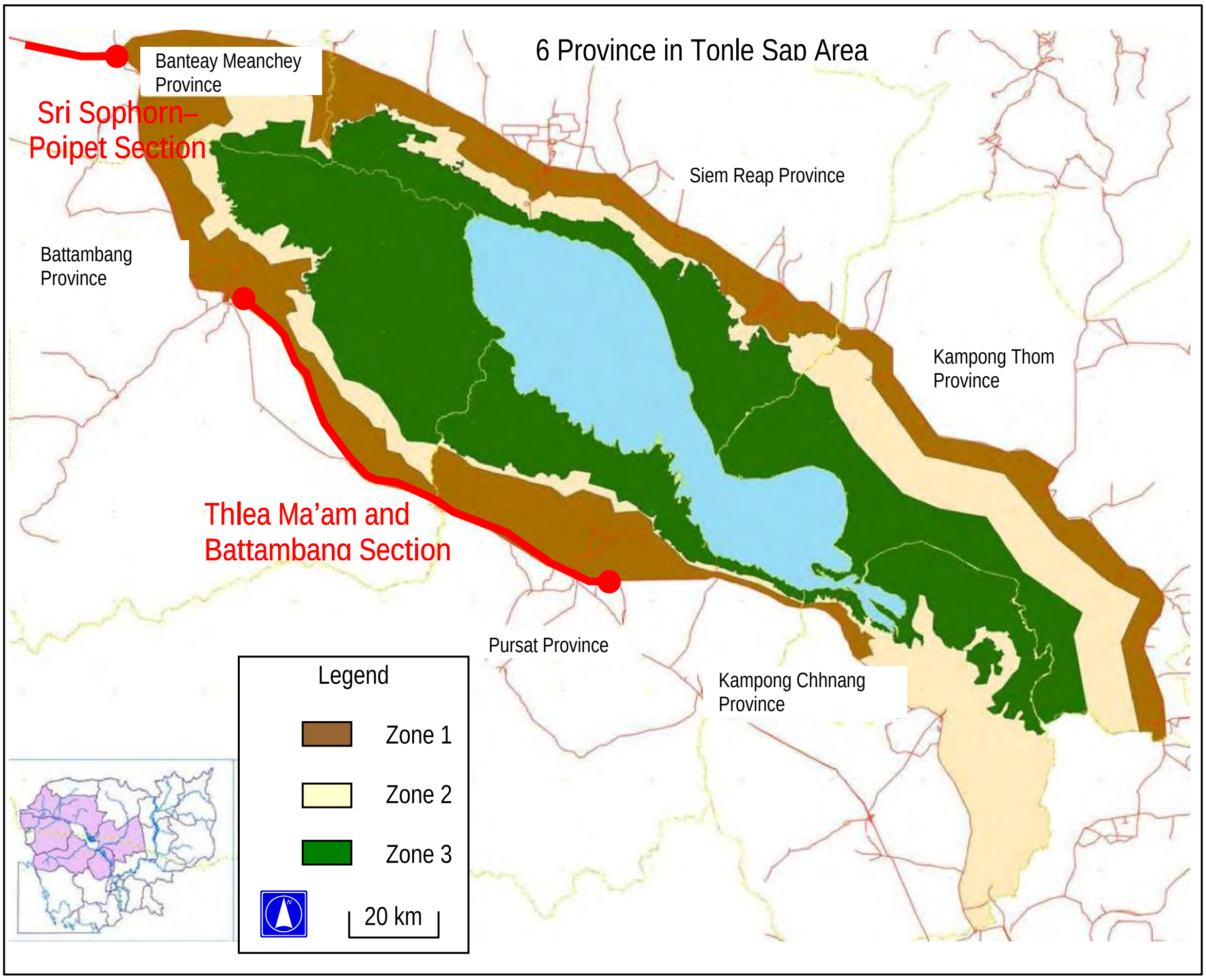
Figure 15.2-4 Flooded Forest around Project Area

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 (417,451ha) : Human habitation and irrigation activity are allowed.

Zone 2 (365,300ha) : No activity is allowed except irrigation activity.

Zone 3 (642,794ha) : 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 (30m 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.

<u>Tonle Sap Biosphere Reserve (TSBR):</u>

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 (14,560ha), Preak Torl (21,342ha) and Stung Sen (6,355ha), in TSBR. These core areas are listed in "Protected Area Law, 2008". The distance between the middle section and the core areas is approximately 30km at the nearest point.

Buffer Zone (541,482ha): 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 (899,600ha): 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.

<u>Tonle Sap Multiple-Use Area (316,250ha):</u>

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

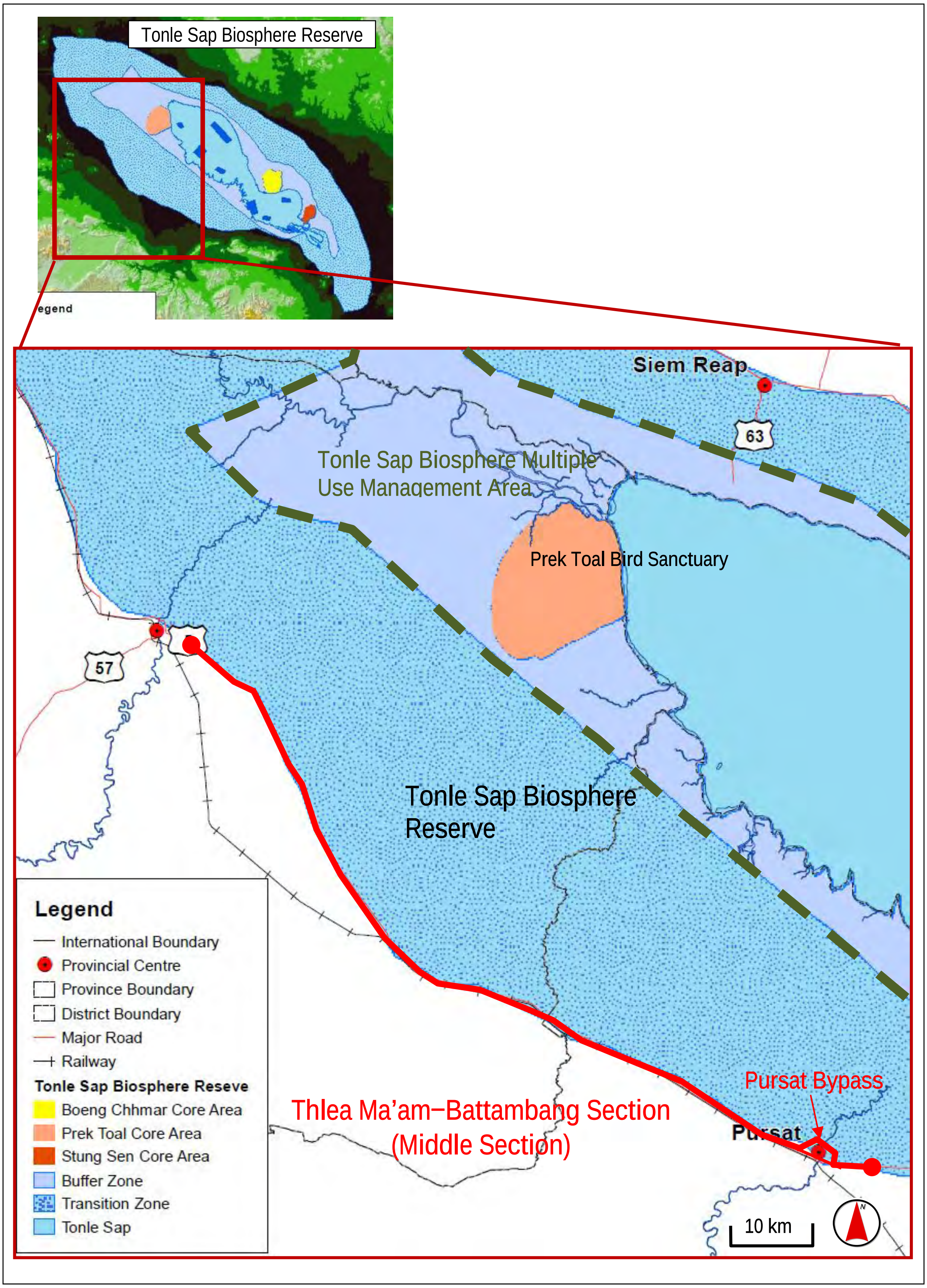
Buffer Zone. The distance between the middle section and Tonle Sap Multiple-Use Area is approximately 20km at the nearest point.

Roniem Daun Sam Wildlife Sanctuary (40,021ha):

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.

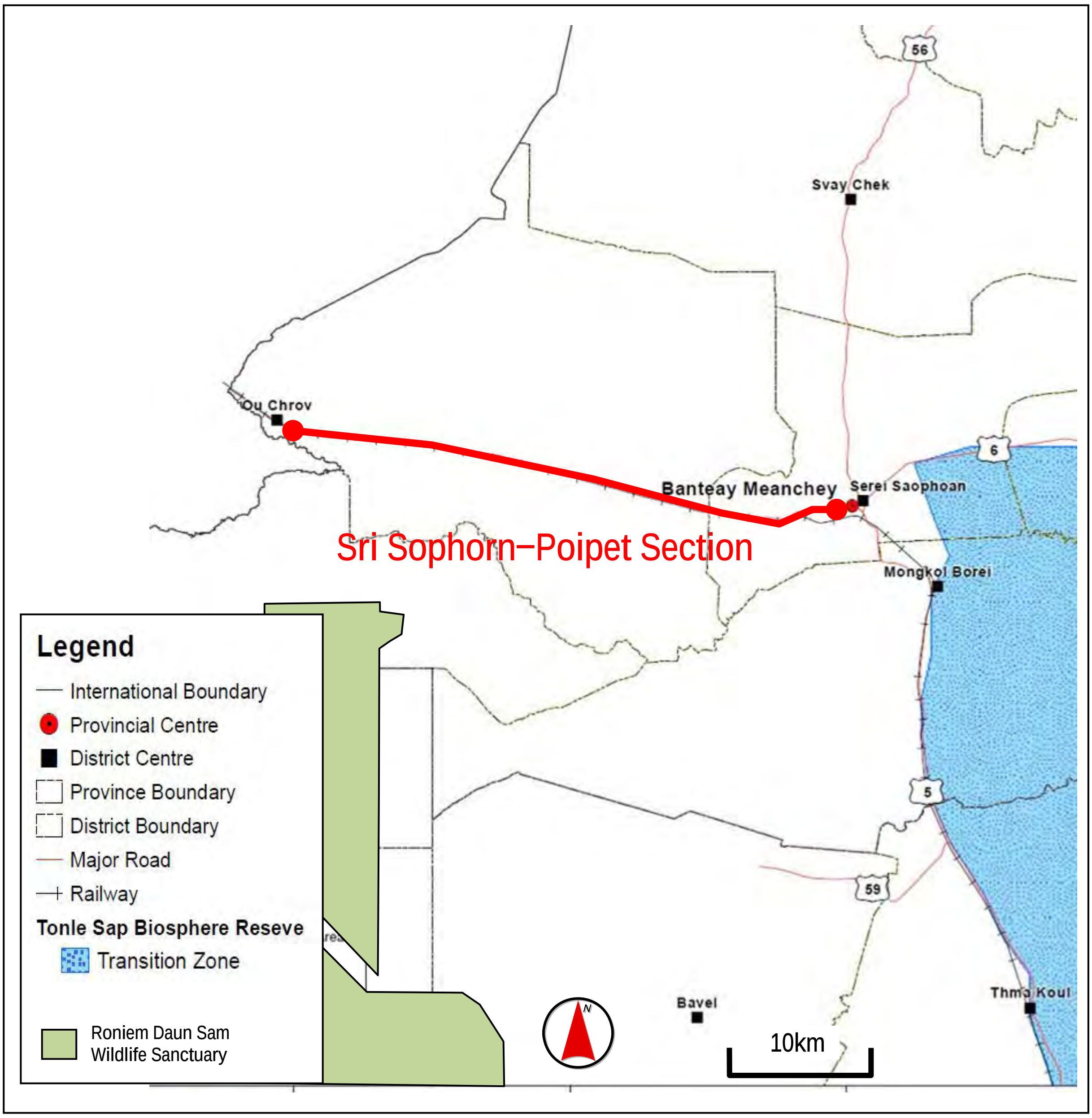
MOE is responsible for the management. The Wildlife sanctuary is an area in land and/or water territories, which requires active interventions for management purposes to ensure maintenance of habitats and/or to meet necessary conditions for any species of animals or plants. The hilly or mountainous areas 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 10km 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 1m to 3m, 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

150m both sides of the target road sections

- Middle Section (Thlea Ma'am–Battambang) : KP 171 to KP 281+200 (10.13ha)
- Sri Sophorn–Poipet Section (SP Section) : KP 366+250 to KP 402 (0.43ha)

Vegetation Survey within Corridor of Impact

20m both sides of the target road sections

- Middle Section (Thlea Ma'am–Battambang) : KP 171 to KP 281+200 (3,384ha)
- Sri Sophorn–Poipet Section (SP Section) : KP 366+250 to KP 402 (1,074ha)

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:

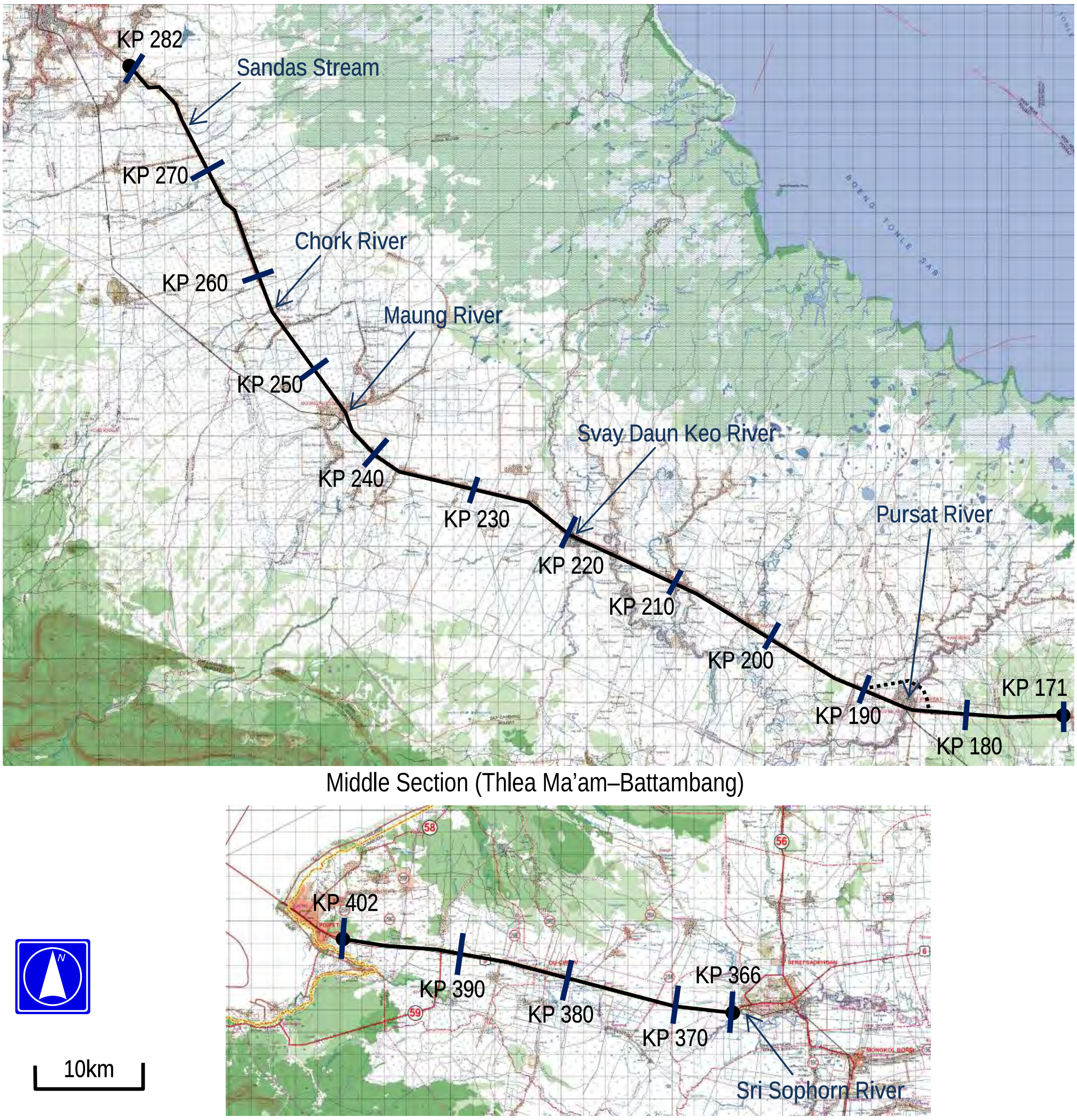
Middle Section

- Pursat River (from Damnak Ampil Dam to Cha Reuk irrigation building, about 34km 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 11km long)
  - Survey Area-1: From Teuk Thla village to Pro Hoth village along the river with 7km long
  - Survey Area-2: From Rong Machine village to Preak Russei village with about 5km 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



Middle Section (Thlea Ma'am–Battambang)

Sri Sophorn–Poipet Section

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 (20m + 20m 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 10cm to 130cm), 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

<u>Roadside Tree</u>

Total 32 species of the roadside trees were identified in SP section. The total number were 1,034 trees (diameter from 10cm to 100cm), 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
7	*Terminalia catappa L.*	37	23	*Cassia fistula*	77
8	*Bauhinia acuminata*	1	24	*Combretum quadrangulare Kurz*	7

	Scientific Name	Number		Scientific Name	Number
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

<u>Riverside Vegetation</u>

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 Tbeng 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*).

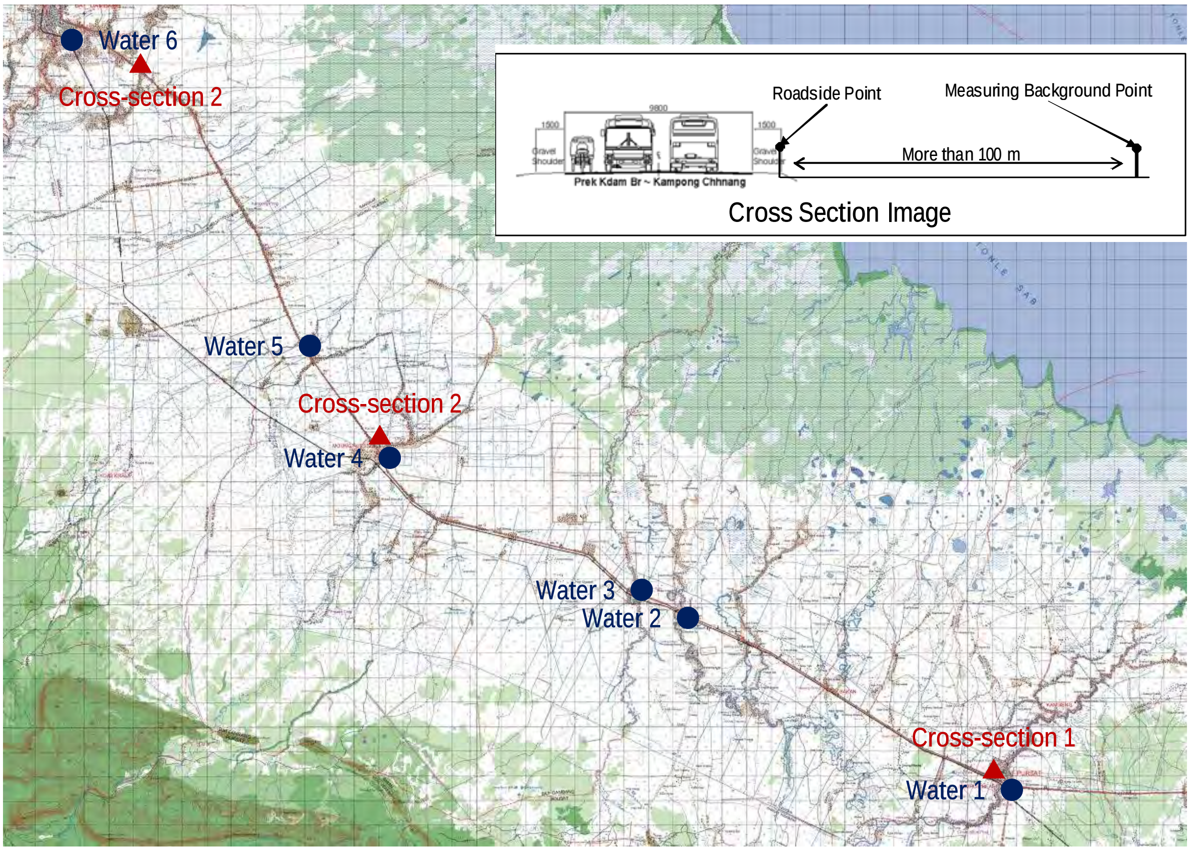
15.2.5 Environmental Quality and Pollution

(1) Scope of Survey

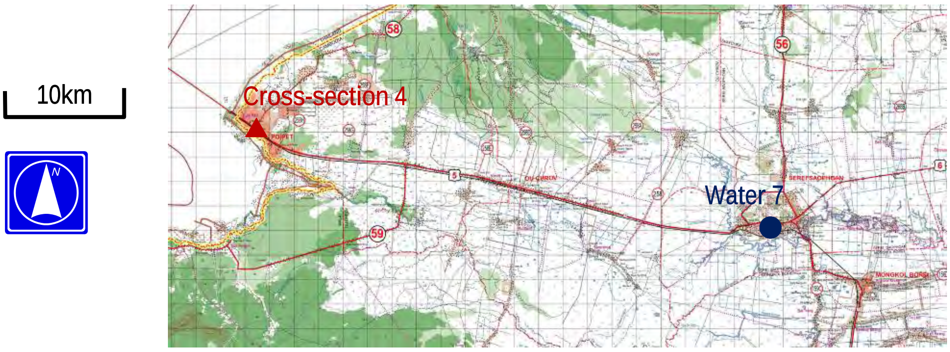
Environmental quality and pollution survey was conducted by a local consultant (Sawac Consultants for Development Ltd) in July and August as the rainy season survey, and December as the dry season survey, 2013. The survey method and location is shown in Table 15.2-5 and Figure 15.2-12.

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 100m) 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 100m) 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 55dB, the vibration levels at roadside have no impact on the local residence.

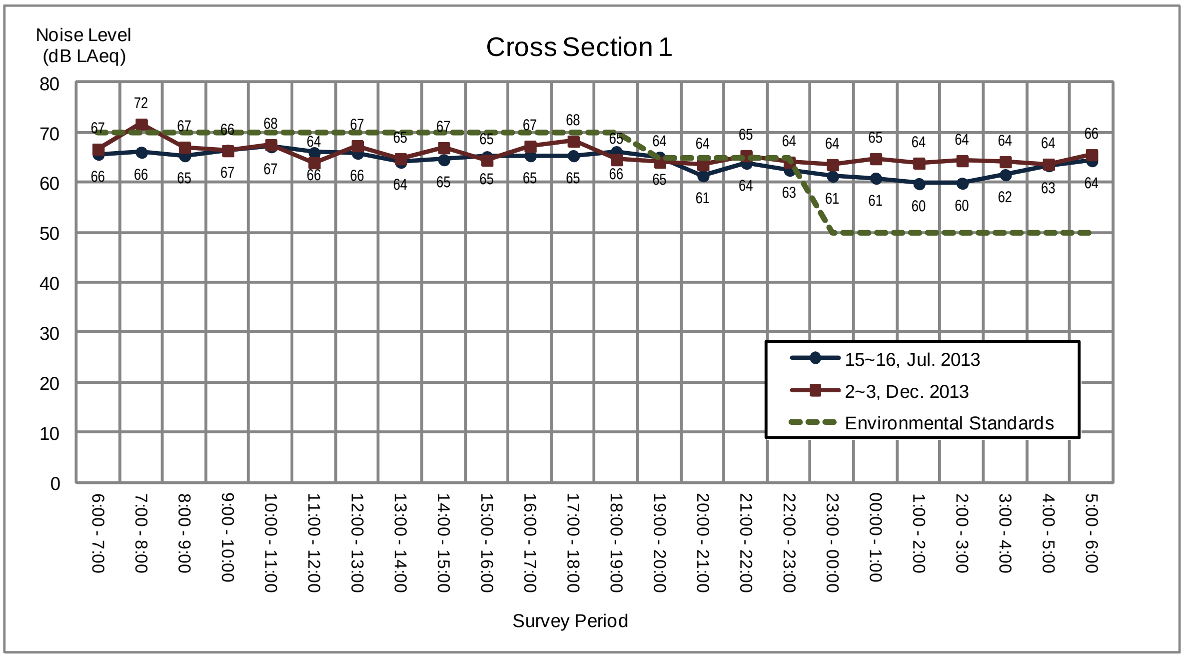


Figure 15.2-13 Result of Noise Survey (1)

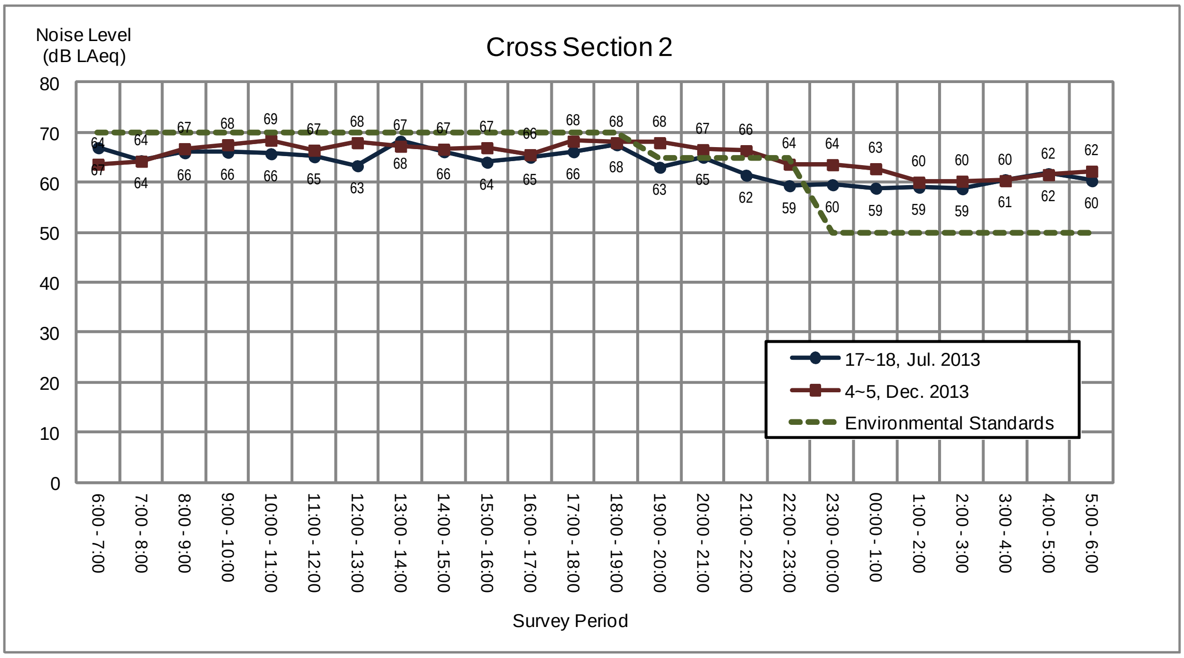


Figure 15.2-14 Result of Noise Survey (2)

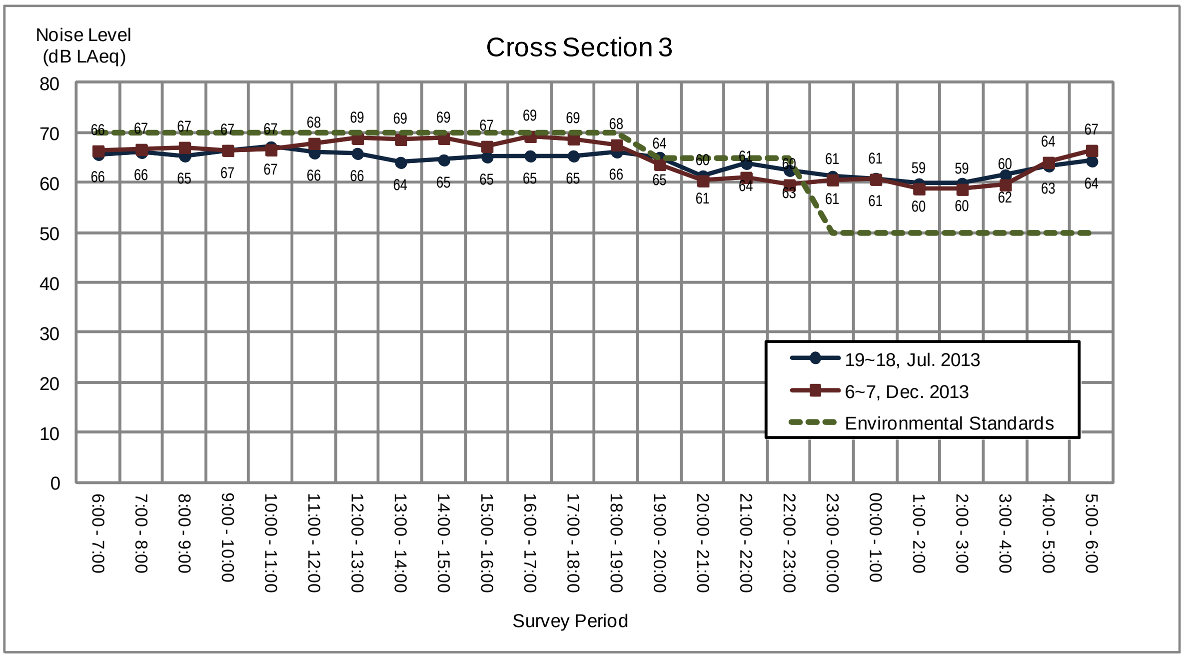


Figure 15.2-15 Result of Noise Survey (3)

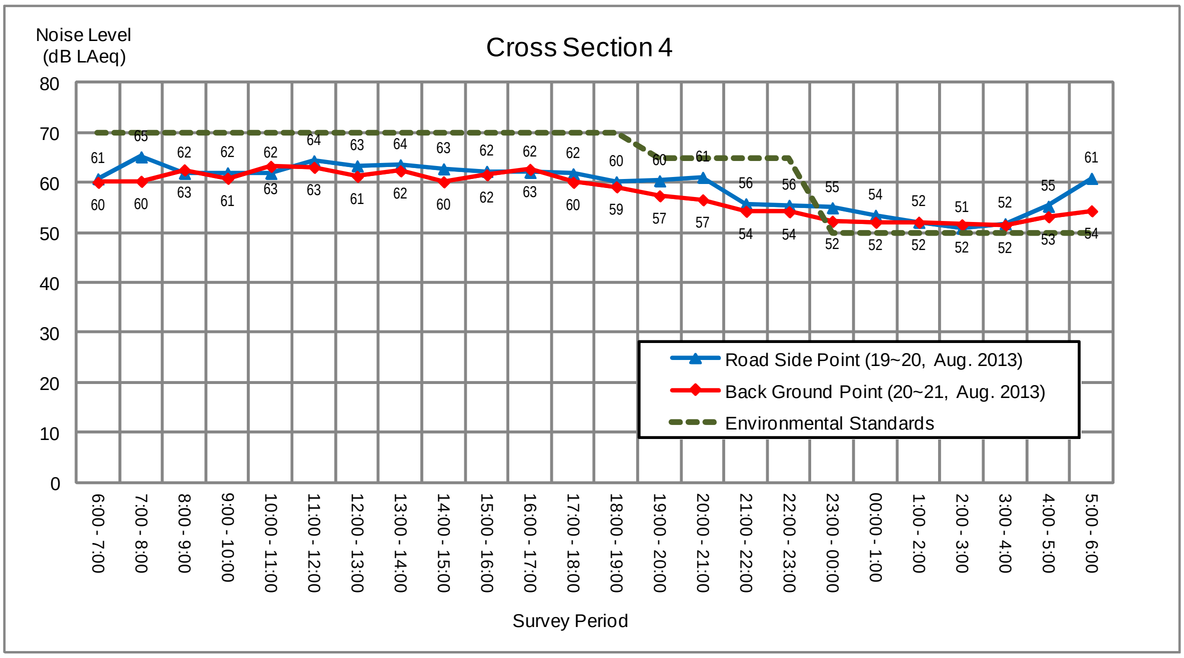


Figure 15.2-16 Result of Noise Survey (4)

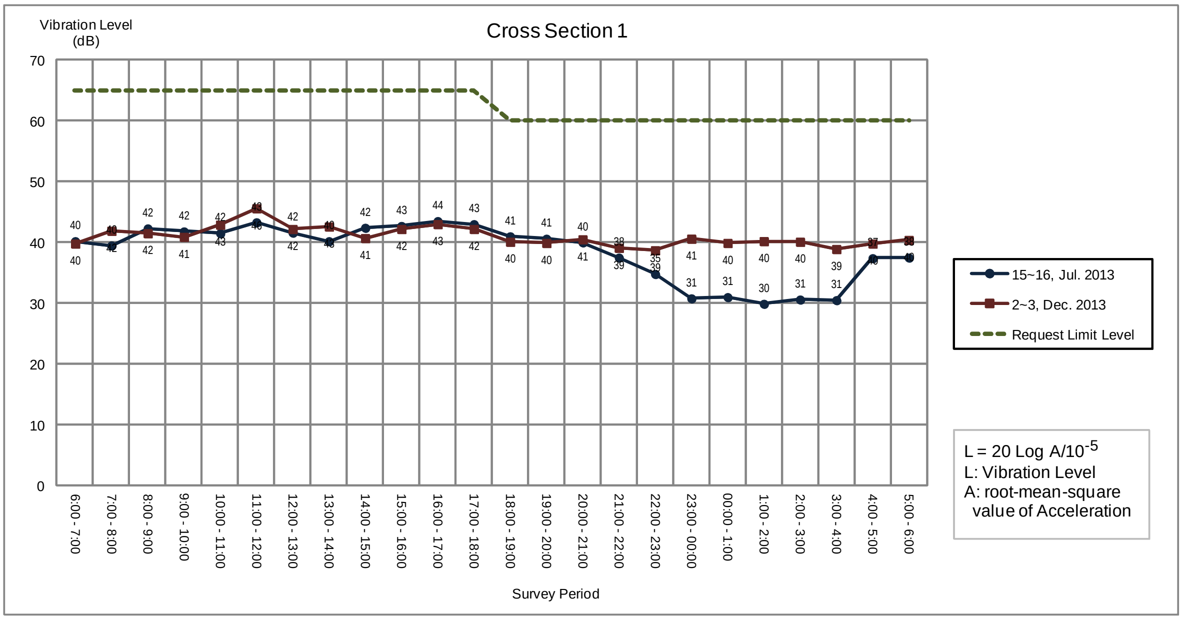


Figure 15.2-17 Result of Vibration Survey (1)

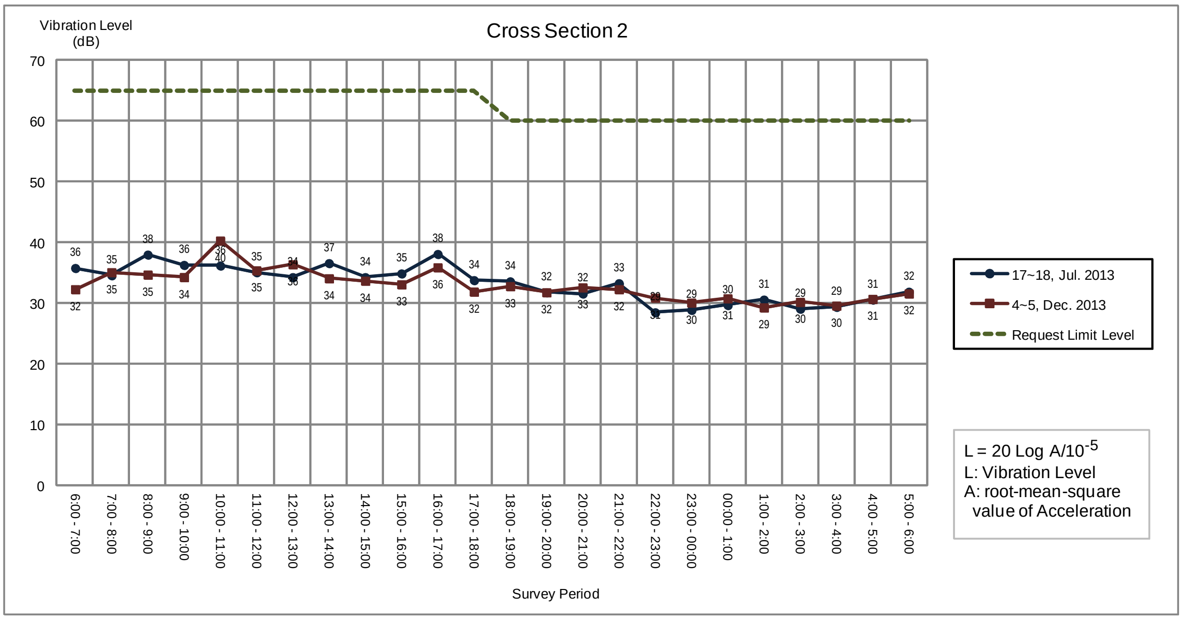


Figure 15.2-18 Result of Vibration Survey (2)

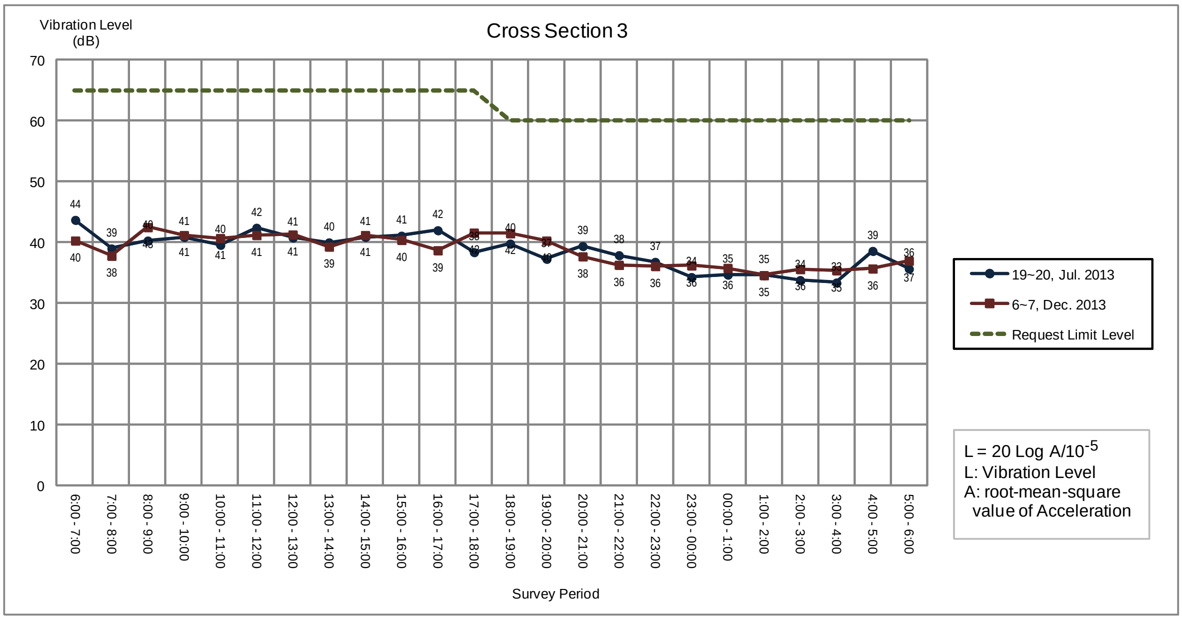


Figure 15.2-19 Result of Vibration Survey (3)

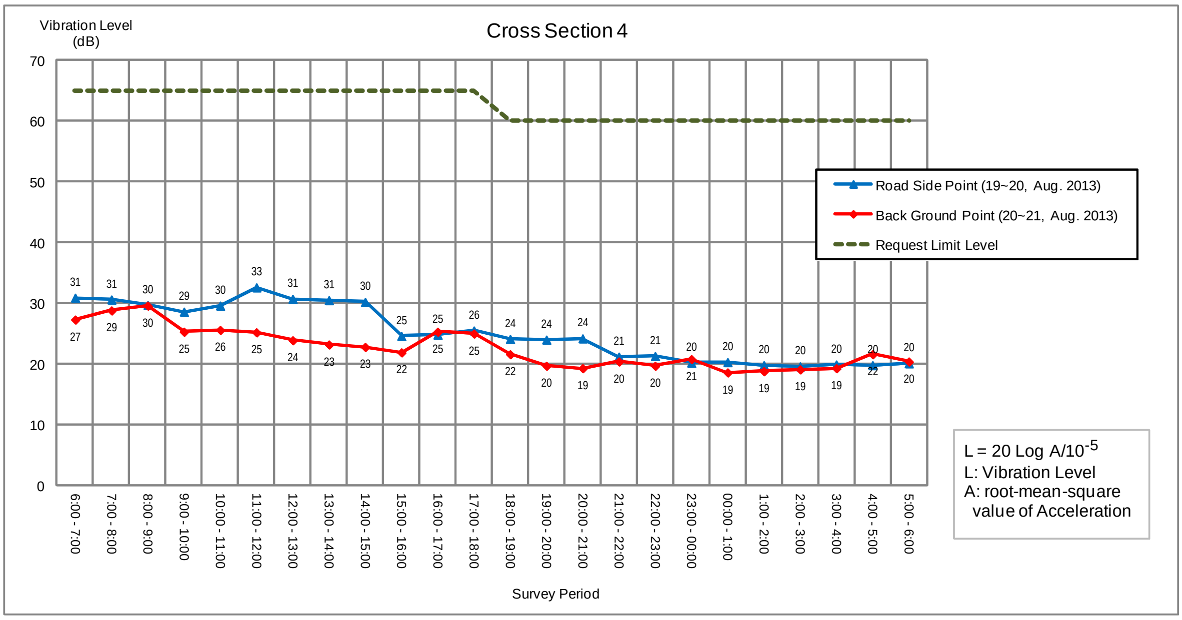


Figure 15.2-20 Result of Vibration Survey (4)

(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, 1m^3 in average volume of wastes of 8 targeted locations was 305kg in total, composing 7kg (2%) of hazardous wastes (electronic tools, lumps, shoes make from tires and chemical waste), 159kg (53%) of kitchen garbage and paper wastes, 83kg (27%) of plastic wastes and 56kg (18%) of glass, metal and ceramic wastes.

4 illegal waste dumping sites along Sri Sophorn–Poipet section were surveyed. In short, 1m^3 in average volume of wastes of 4 targeted locations was 275kg in total, in which composing 3kg (1%) of hazardous wastes, 199kg (72%) of kitchen garbage and paper wastes, 47kg (17%) of plastic wastes, 5kg (2%) of glass, metal and ceramic wastes and 21kg (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 20cm^3 of Waste (kg)	Hazardous wastes of 20cm^3 (kg)	Kitchen garbage and paper wastes of 20cm^3 (kg)	Plastic wastes of 20cm^3 (kg)	Glass, metal and ceramic wastes of 20cm^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 1m^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 1m^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 1m^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 1m^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 1m^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 1m^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 1m^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 1m^3	275	14	72	84	100
The average volume of wastes of 8 targeted locations in 1m^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 20cm^3 of Waste (kg)	Hazardous wastes of 20cm^3 (kg)	Kitchen garbage and paper wastes of 20cm^3 (kg)	Plastic wastes of 20cm^3 (kg)	Glass, metal and ceramic wastes of 20cm^3 (kg)	Cloth wastes of 20cm^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 1m^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 1m^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 1m^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 1m^3	317	0	245	62	10	0
The average volume of wastes of 8 targeted locations in 1m^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;

Ø migration of population and involuntary resettlement,
Ø local economy such as employment and livelihood,
Ø utilization of land and local resources,
Ø social institutions such as social capital and local decision-making institutions,
Ø existing social infrastructures and services,
Ø vulnerable social groups such as poor and indigenous peoples,
Ø equality of benefits and losses and equality in the development process,
Ø gender,
Ø 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).

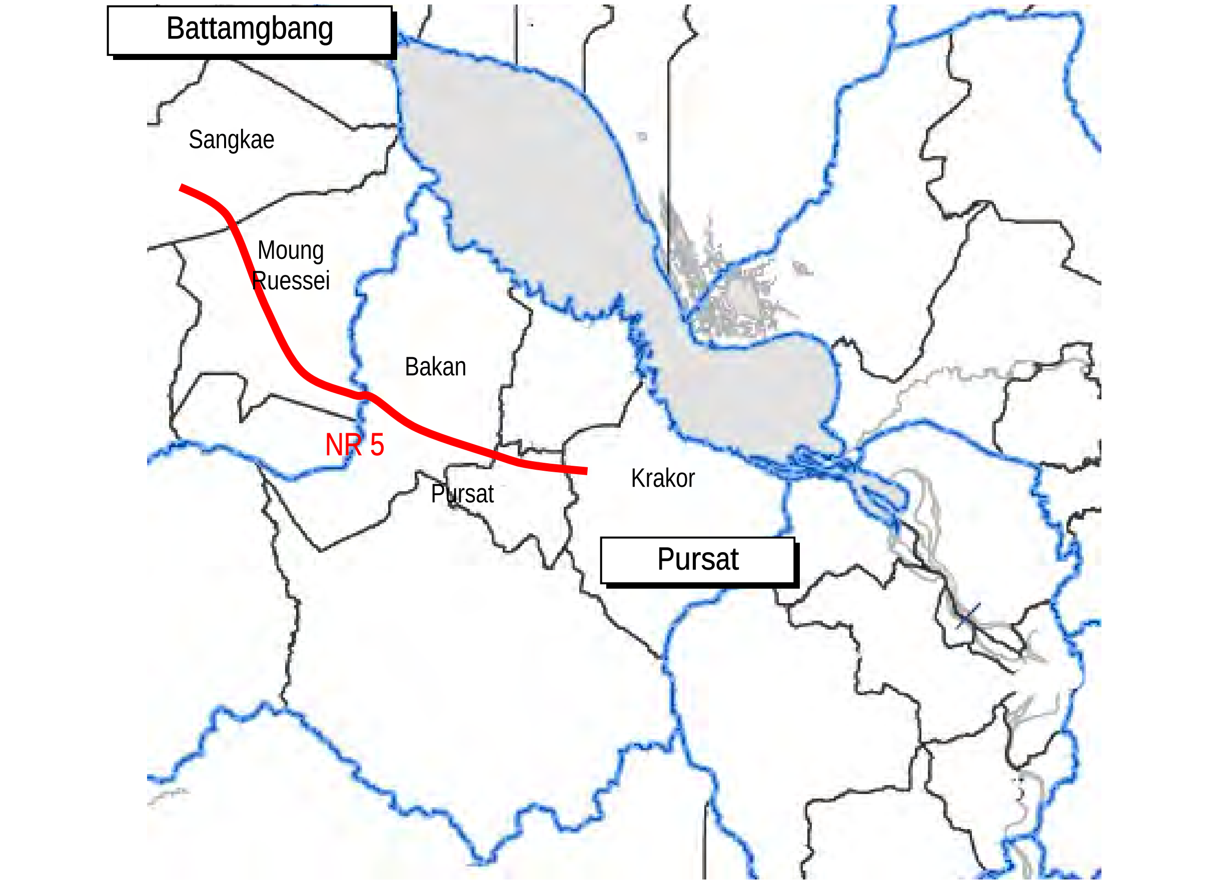


Figure 15.3-1 NR 5 (Middle Section) and Administrative Boundary

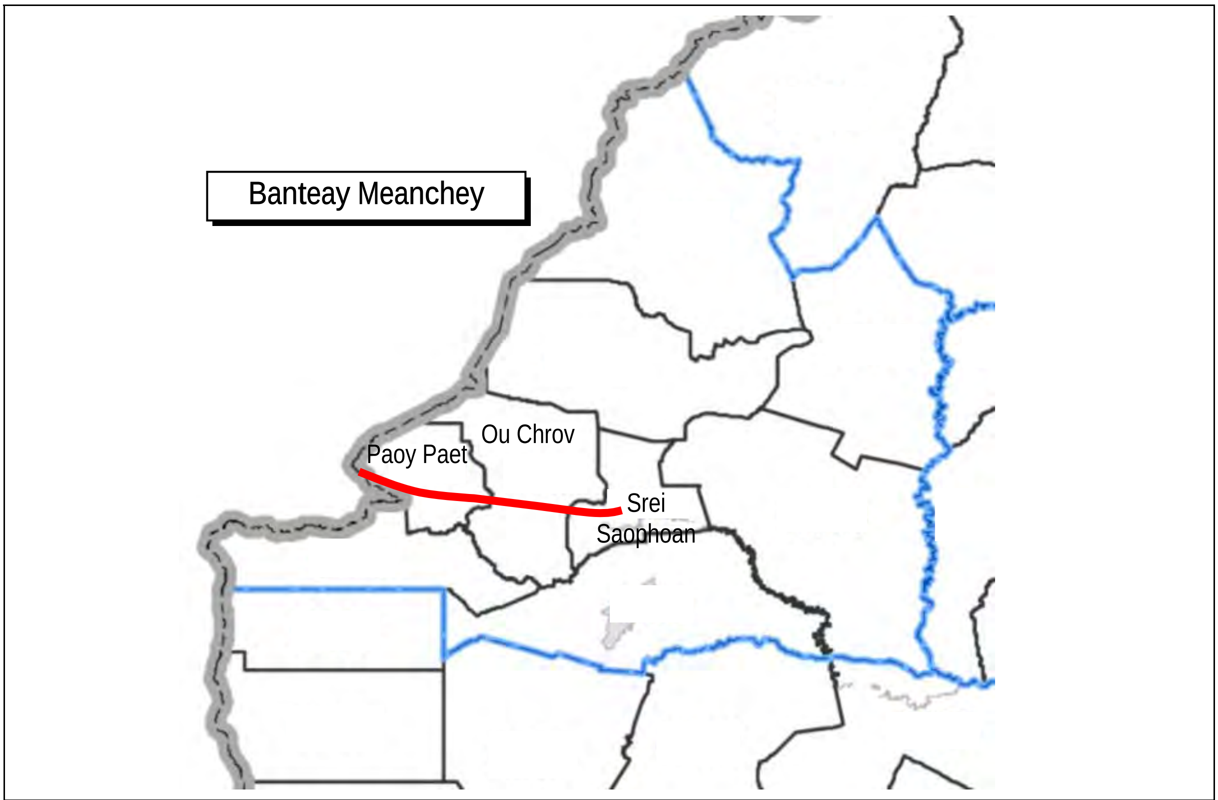


Figure 15.3-2 NR 5 (Sri Sophorn–Poipet Section) and Administrative Boundary

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.

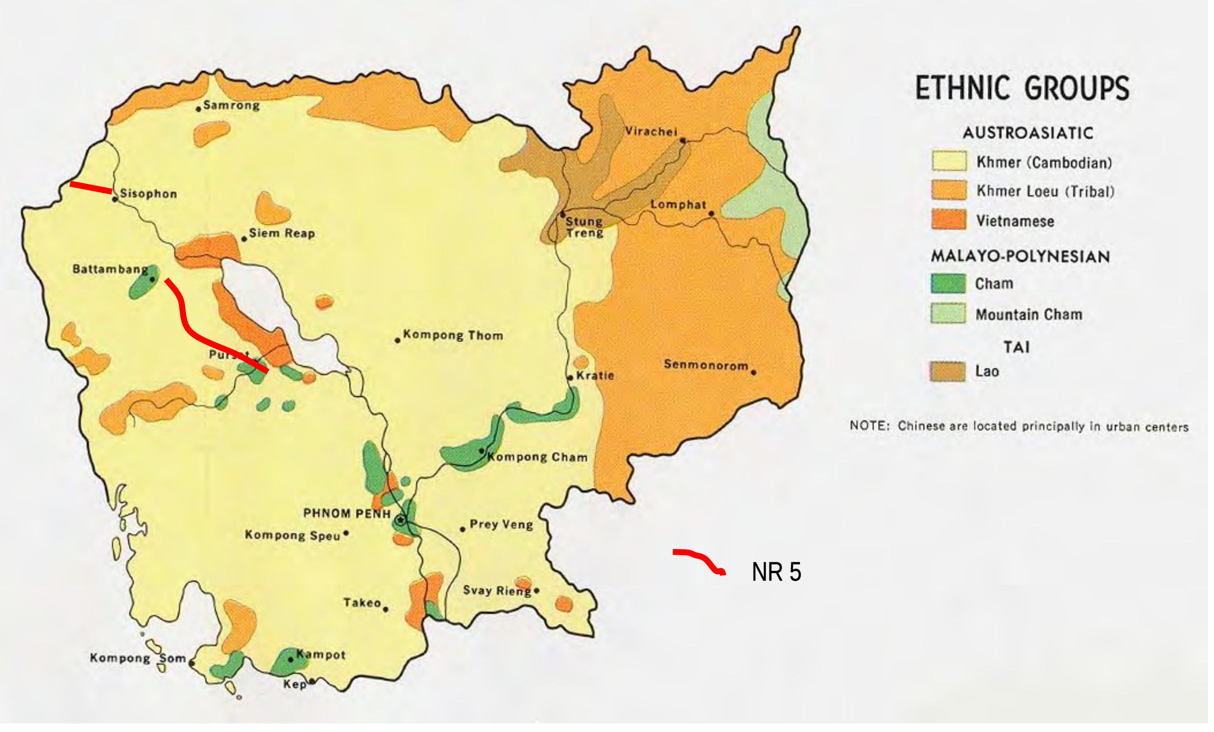
Table 15.3-1 Population and Households in the Project Related Provinces

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.

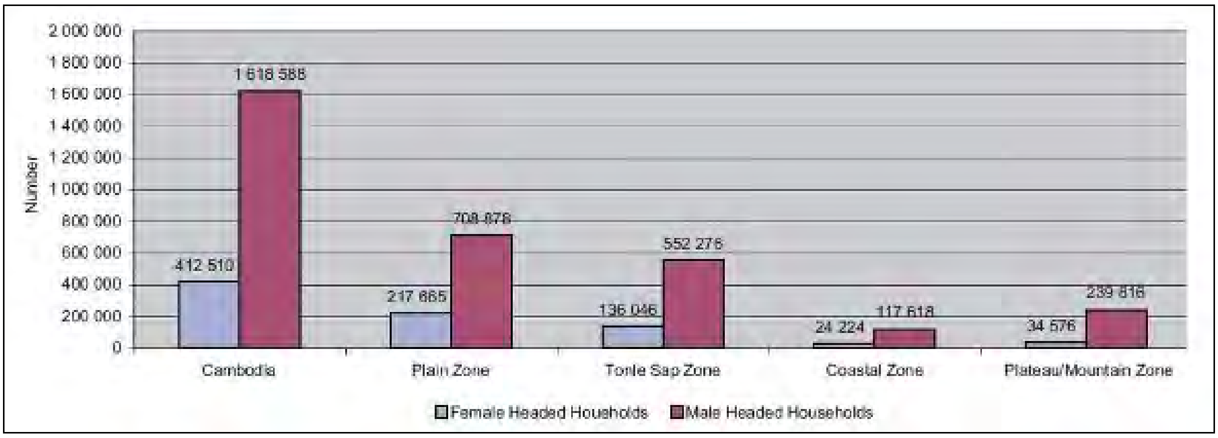
(c) Almost the same number of boys and girls attend school until the age of 14. However, fewer girls continue in higher education. Adult literacy rates are also unequal: only 70.9 percent of adult females are literate, compared to 85.1 percent of their male peers.

(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).

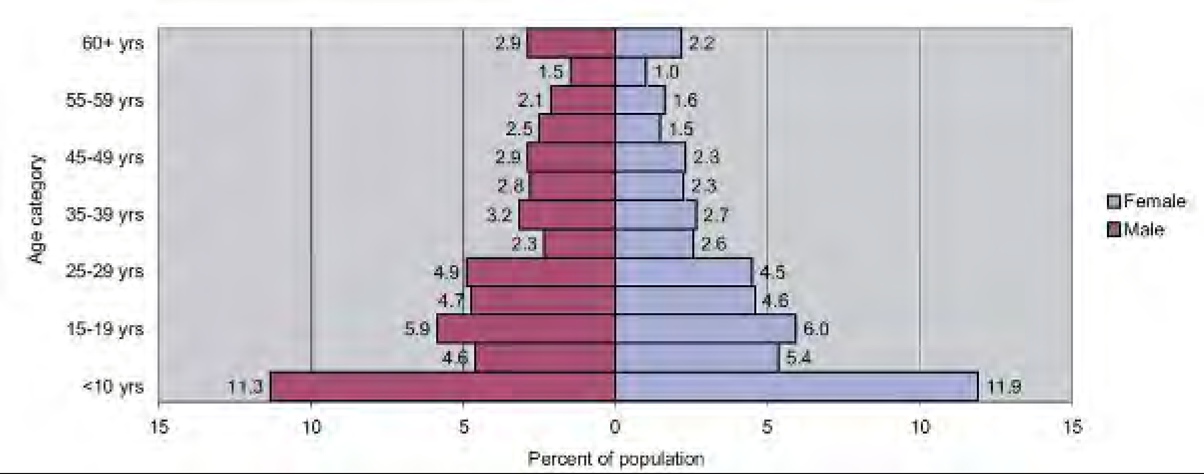


Source: National Gender Profile of Agricultural Households, 2010 (Based on the 2008 Cambodia Socio-Economic Survey), FAO & NIS, Ministry of Planning

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.

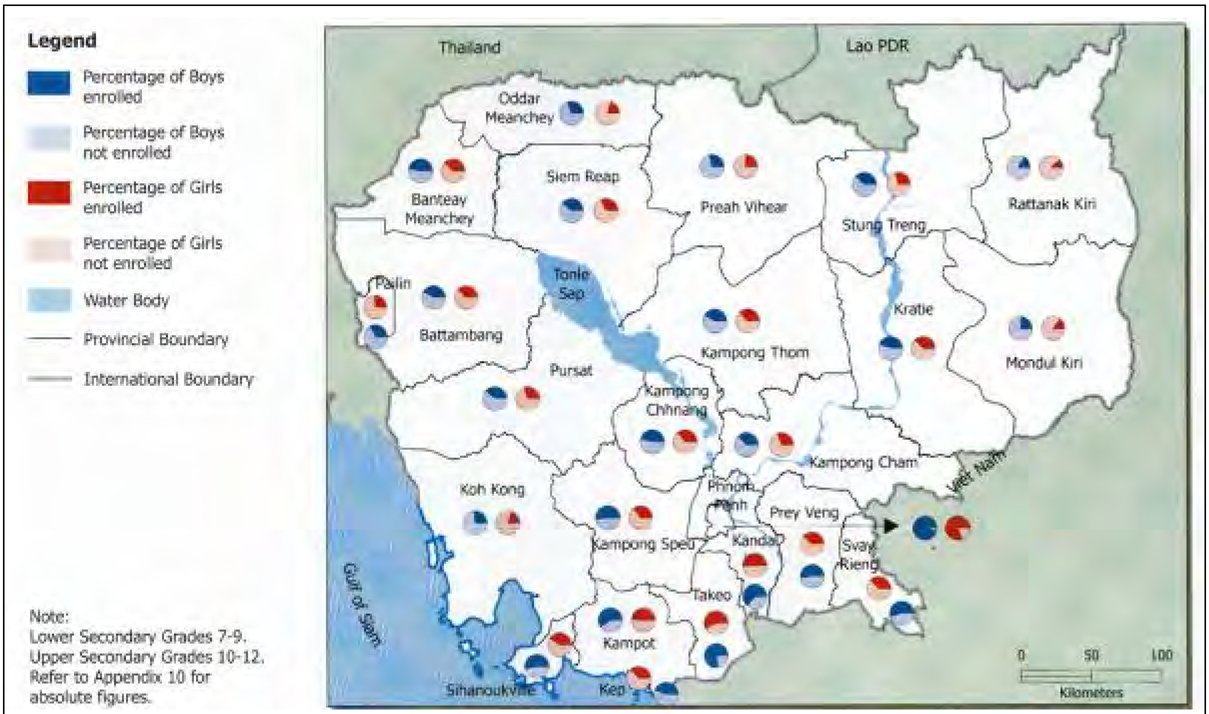


Source: National Gender Profile of Agricultural Households, 2010 (Based on the 2008 Cambodia Socio-Economic Survey), FAO & NIS, Ministry of Planning

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.

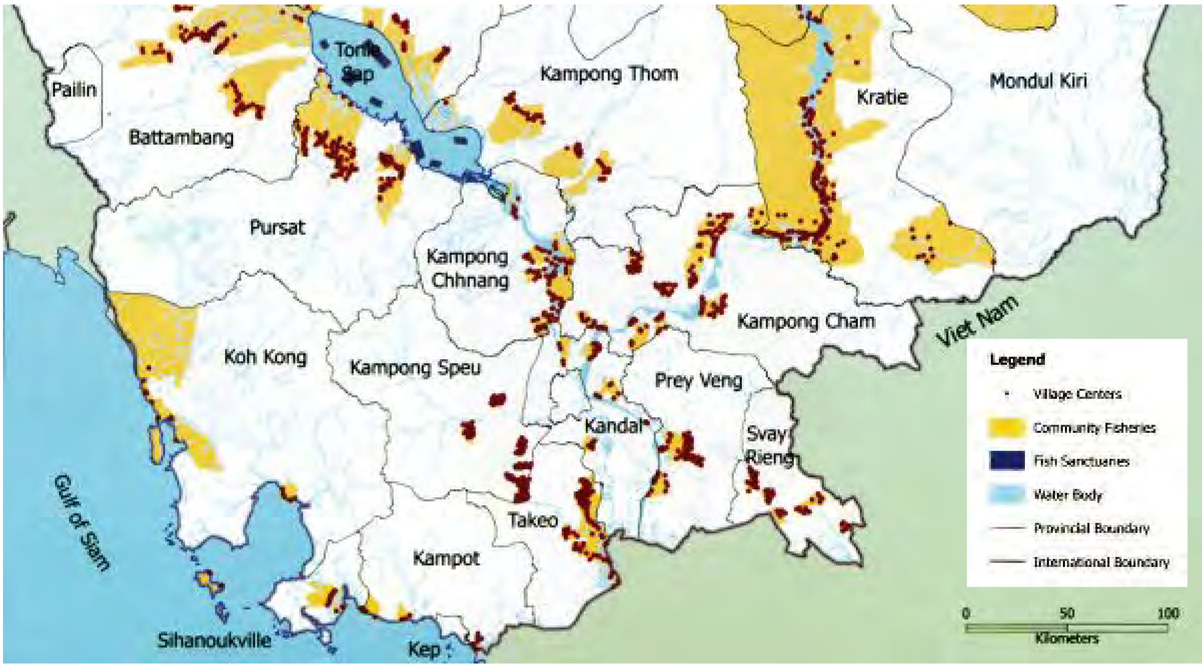
(a) Paddy Field along NR 5, Pursat

(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 KP 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 Website

Figure 15.3-11 Brick Fence and Gateway of Royal Palace of Preah Bat Monivong

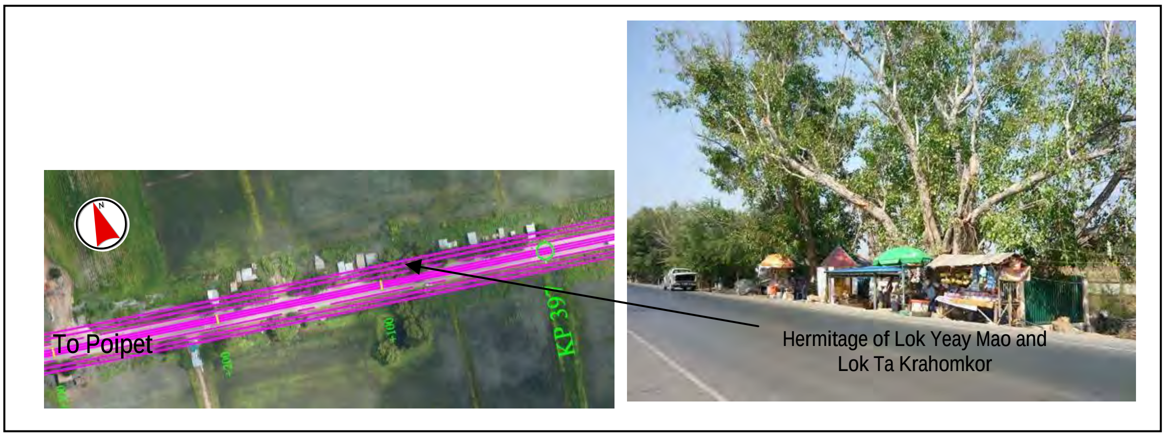


Figure 15.3-12 Hermitage of Lok Yeay Mao and Lok Ta Krahomkor

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 30m 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 30m 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 15m in urban areas and COI of 20m 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.

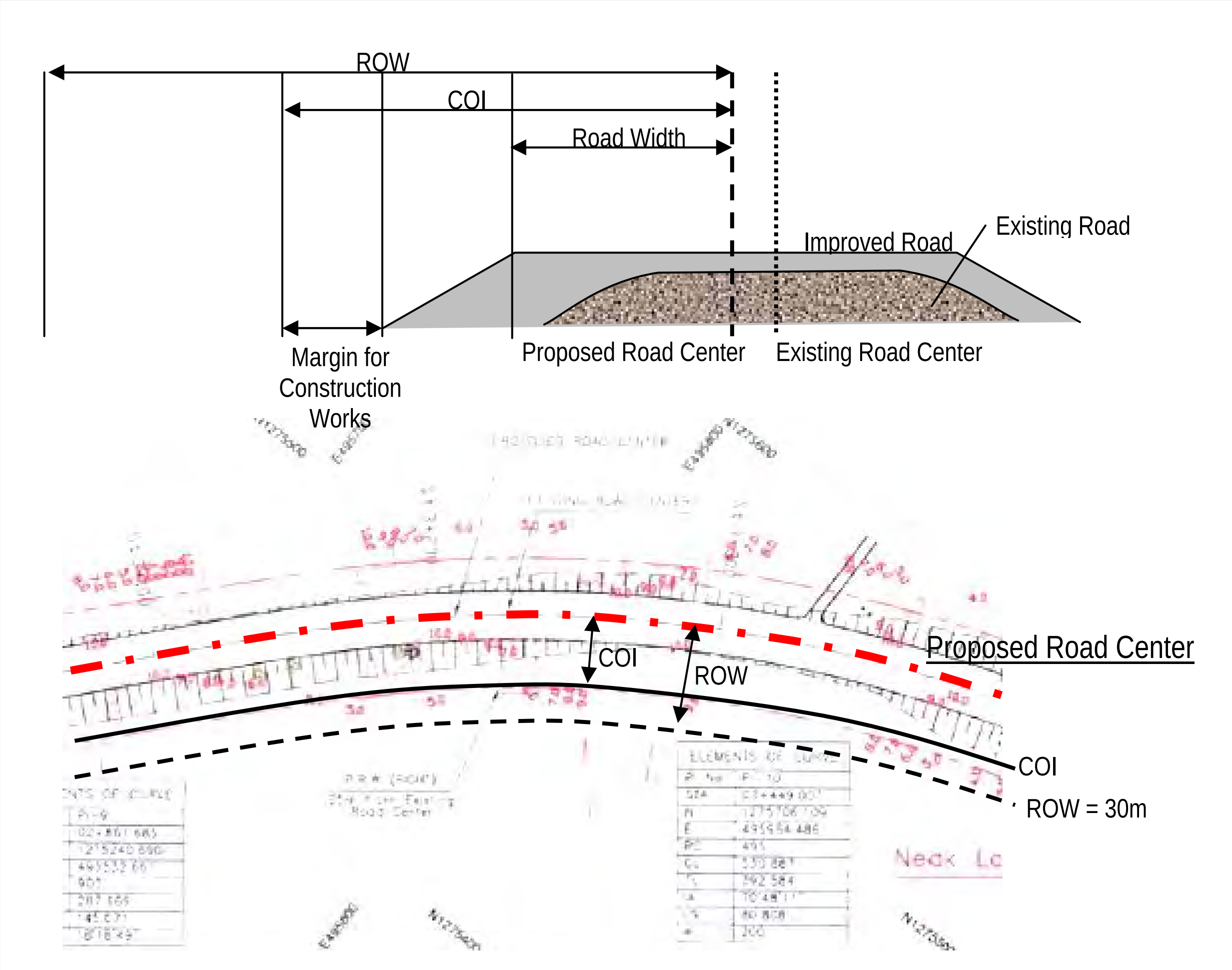


Figure 15.3-13 Conceptual View of ROW and Project Affected Areas

(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 20km at the nearest point and the area is mostly agricultural land, direct impact on ecosystem in Tonle Sap Lake

No.	Impact Item	Assessment: Pre-Construction Phase / Construction Phase — Land acquisition / Construction works	Assessment: Operation Phase — Existence / Service	Reason/Remarks
				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: Pre-Construction Phase / Construction Phase — Land acquisition / Construction works	Assessment: Operation Phase — Existence / Service	Reason/Remarks
				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 Pre-Construction Phase Construction Phase Land acquisition Construction works	 Operation Phase Existence Service	Reason/Remarks
				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 Pre-Construction Phase Construction Phase Land acquisition Construction works	 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:** ・ 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 7km 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 80km 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: Pre-Construction Phase / Construction Phase (Land acquisition / Construction works)	Assessment: Operation Phase (Existence / Service)	Reason/Remarks
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.

<table>
<tr><th rowspan="3">No.</th><th rowspan="3">Impact Item</th><th colspan="2">Assessment</th><th rowspan="3">Reason/Remarks</th></tr>
<tr><th>Pre-Construction Phase
Construction Phase</th><th>Operation Phase</th></tr>
<tr><th>Land acquisition
Construction works</th><th>Existence
Service</th></tr>
<tr><td>19</td><td>Existing social infrastructures and services</td><td>B-</td><td>B±</td><td>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.</td></tr>
<tr><td>20</td><td>Social institutions such as social infrastructure and local decision-making institutions</td><td>C-</td><td>C-</td><td>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.</td></tr>
<tr><td>21</td><td>Misdistribution of benefits and damages</td><td>C-</td><td>D</td><td>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.</td></tr>
<tr><td>22</td><td>Local conflicts of interest</td><td>D</td><td>D</td><td>Construction Phase:
Operation Phase:
・ Because of improvement project of existing road, considerable impact on local conflict is unlikely to occur.</td></tr>
<tr><td>23</td><td>Cultural heritage</td><td>C-</td><td>D</td><td>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.</td></tr>
<tr><td>24</td><td>Landscape</td><td>B-</td><td>D</td><td>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.</td></tr>
<tr><td>25</td><td>Gender</td><td>C-</td><td>C-</td><td>Construction Phase:
Operation Phase:</td></tr>
</table>

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

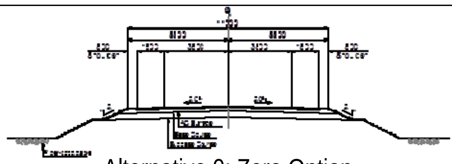
Evaluation Rank 1st: ◎, 2nd: ○, 3rd: △, Improper: ×

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.

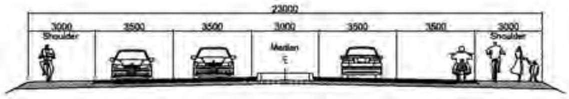
Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
	emission of air-pollution substances.		
Access to Public Service Facilities	△ Traffic will be not smooth and it will take more time to access 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 collision will be decreased by that it will not be so frequently that overtaking vehicles use the opposite 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 and	◎ 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.	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.
Total Evaluation	×	◎ （Recommended）	○

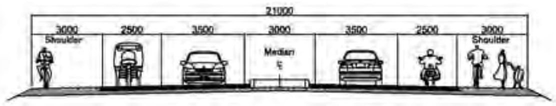
Alternative	ALT-0: Zero Option	ALT-1: Widening road to full 4-lane and Pavement Improvement	ALT-2: Widening road to 2-lane with MC lanes and Pavement Improvement
	ALT-1 of the highest total evaluation is recommended. Views on the evaluation items of ALT-1 that are evaluated lower compared to other alternatives 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).		



Alternative 0: Zero Option



Alternative 1: Widen into 4-lane



Alternative 2: Widen into opposed 2-lane + motorcycle lane on both sides

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 5km 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
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. Thus, N-1, N-2 and N-3 are compared.					

<table>
<tr><th>Alternative</th><th>Widen Existing NR 5</th><th>N-1</th><th>N-2</th><th>N-3</th><th>S-1</th><th>P-1</th></tr>
<tr><td></td><td colspan="6">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.</td></tr>
</table>

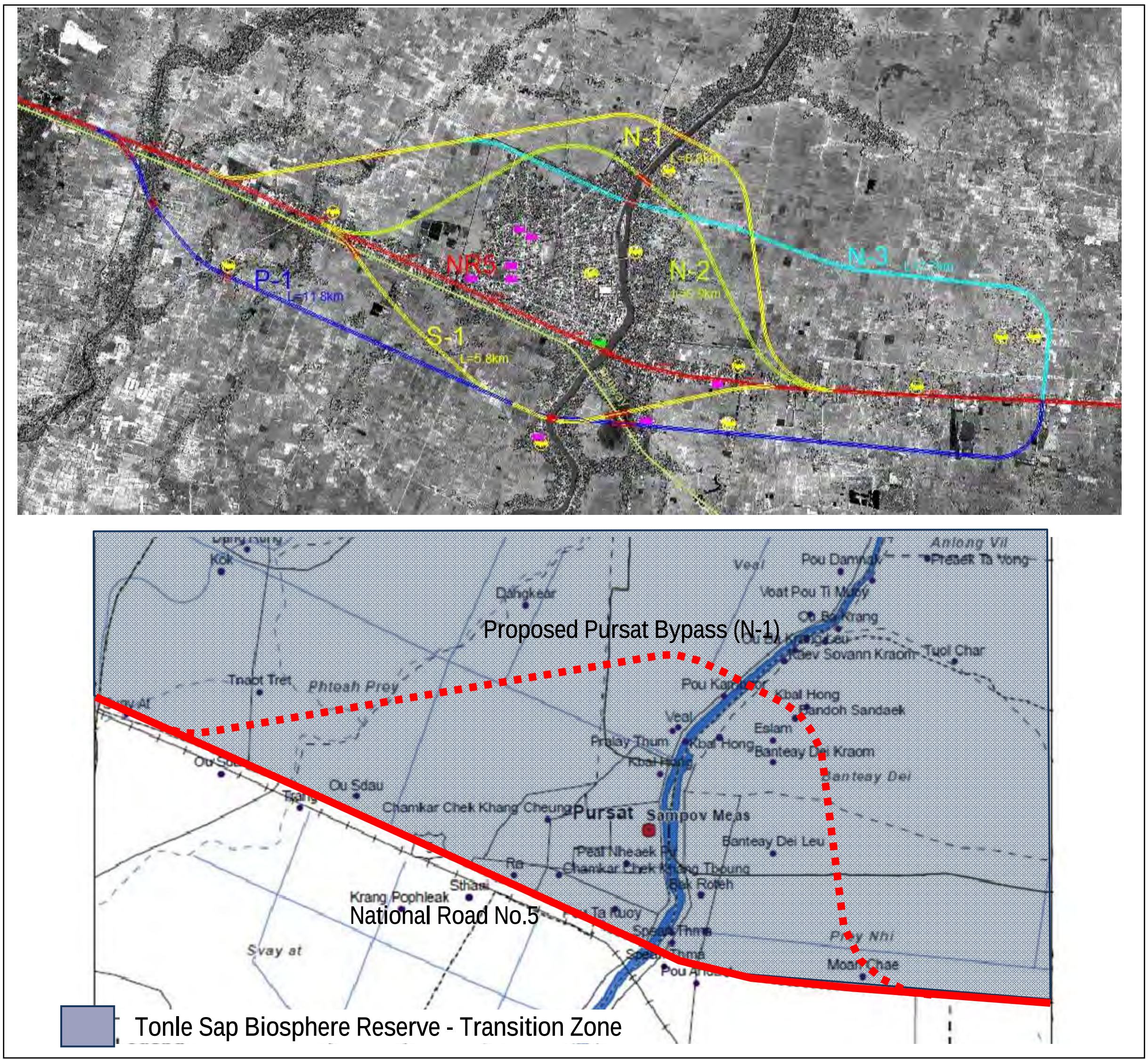


Figure 15.5-2 Alternative Routes of Pursat Bypass

(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 (148km 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.

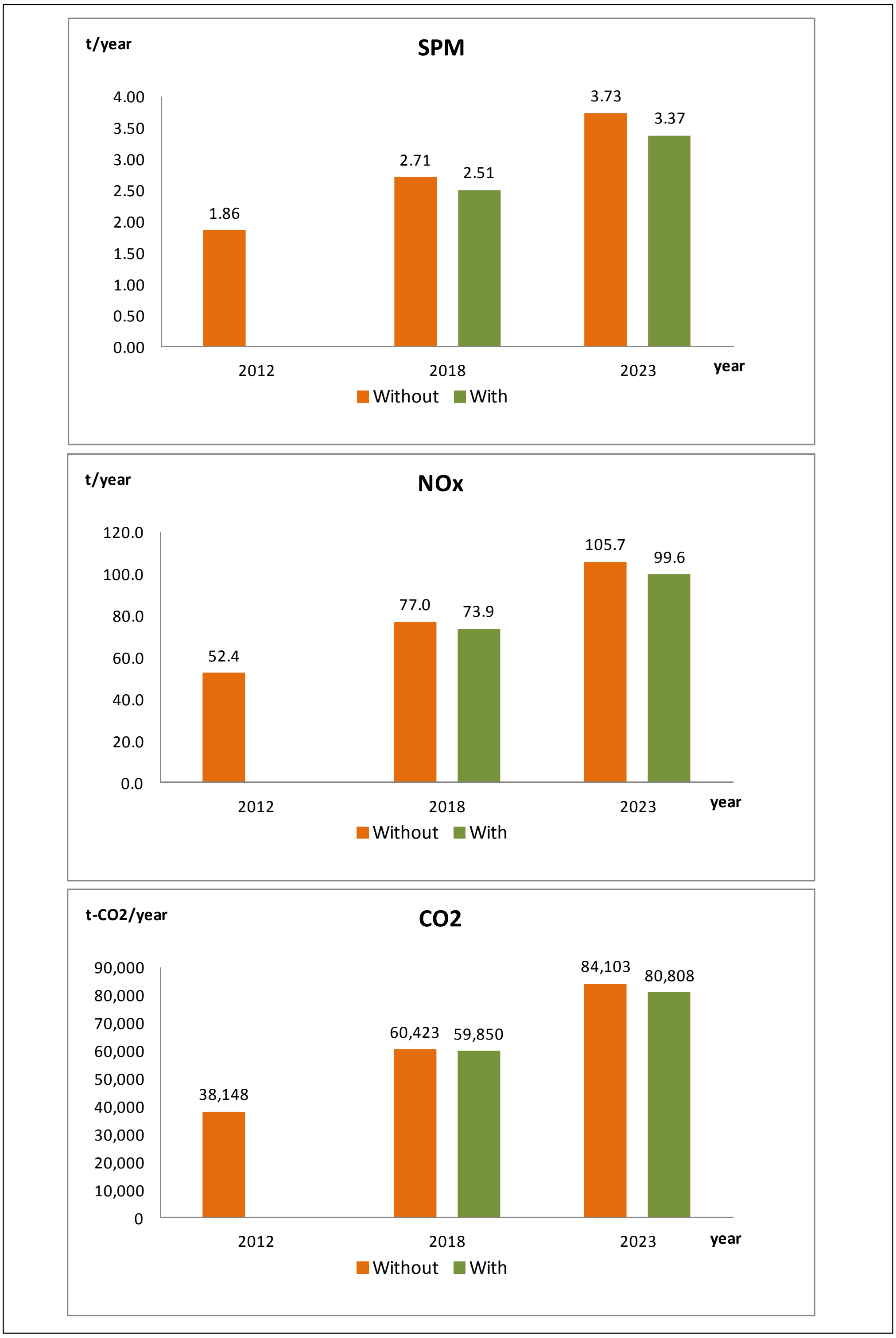


Figure 15.6-1 Result of Estimation of Total Emission Volume

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 1m/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.

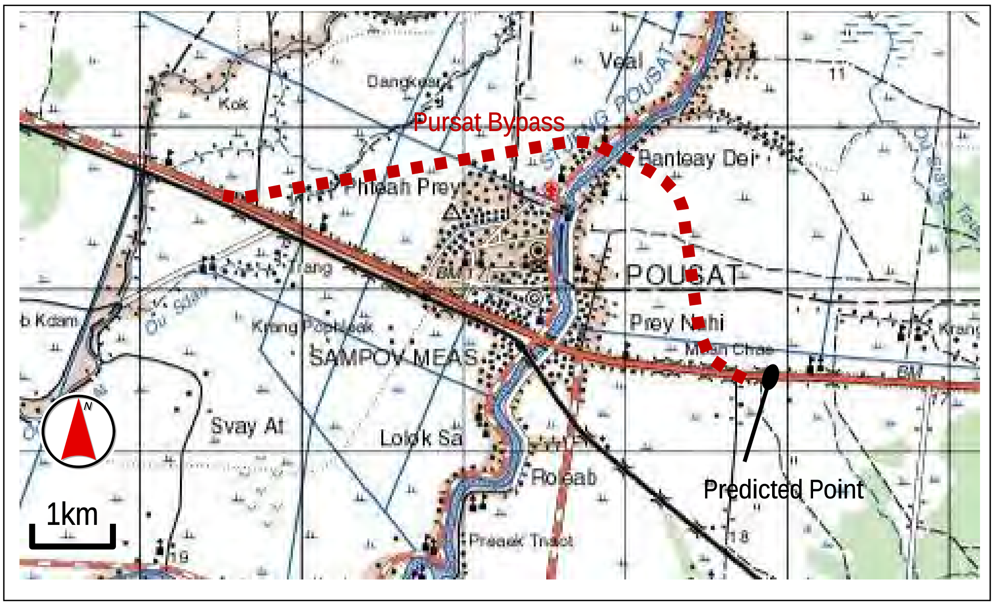


Figure 15.6-2 Point Predicted Air Pollutant Level

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 (2m/s) (Along road direction)	South Wind (2m/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 15m 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 15m 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 7dB 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 (11.75m from road center)	71	66	62
Predicted Noise Level (dB) on 15m line from road center	69	65	60
Predicted Noise Level (dB) on borderline (30m 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 NR 5 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 10dB 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 30km 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 10km 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 20km 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		0.05mg/m^3 (WHO, average 24h)	2 times in dry season and 2 times in rainy season during construction period	
		SPM2.5		0.02mg/m^3 (WHO, average 24h)		
		SO_2		0.30mg/m^3 (MOE, average 24h)		
		NO_2		0.10mg/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		60dB (06:00-18:00) 50dB (18:00-22:00) 45dB(22:00-06:00) (MOE, residential area)	- When noise/vibration level exceeding the Cambodian standards is suspected - When local residents complain	
Vibration		Vibration Level		65Hz (05:00-17:00) 60Hz (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		0.05mg/m^3 (WHO, average 24h)	2 times in dry season and 2 times in rainy season during construction period	
		SPM2.5		0.02mg/m^3 (WHO, average 24h)		
		SO_2		0.30mg/m^3 (MOE, average 24h)		
		NO_2		0.10mg/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		60dB (06:00-18:00) 50dB (18:00-22:00) 45dB(22:00-06:00) (MOE, residential area)	- When noise/vibration level exceeding the Cambodian standards is suspected - When local residents complain	
Vibration		Vibration Level		65Hz (05:00-17:00) 60Hz (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		$0.05mg/m^3$ (WHO, average 24h)	1 time in dry season and 1 time in rainy season per year for 2 years	
		200m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200m away from road side					
	Pursat bypass section	Road side	SPM2.5		$0.02mg/m^3$ (WHO, average 24h)		
		200m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200m away from road side					
	Pursat bypass section	Road side	SO_2		$0.30mg/m^3$ (MOE, average 24h)		
		200m away from road side					
	Pou Mouy village, Moung Russei district	Road side					
		200m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200m away from road side					
	Pursat bypass section	Road side	NO_2		$0.10mg/m^3$ (MOE, average 24h)		
		200m away from road side					
	Pou Mouy village, Moung Russei district	road side					
		200m away from road side					
	Dambouk Khpos village, Sangkae district	Road side					
		200m away from road side					
Noise	Pursat bypass section, ROW boundary		Noise Level		60dB (06:00-18:00) 50dB (18:00-22:00) 45dB (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		65Hz (05:00-17:00) 60Hz (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		0.05mg/m^3 (WHO, average 24h)	1 time in dry season and 1 time in rainy season per year for 2 years	
		200m away from road side					
		Road side	SPM2.5		0.02mg/m^3 (WHO, average 24h)		
		200m away from road side					
		Road side	SO_2		0.30mg/m^3 (MOE, average 24h)		
		200m away from road side					
		Road side	NO_2		0.10mg/m^3 (MOE, average 24h)		
		200m away from road side					
Noise	Kbal Spean village, Poipet Town		Noise Level		60dB (06:00-18:00) 50dB (18:00-22:00) 45dB (22:00-06:00) (MOE, residential area)		
Vibration	Kbal Spean village, Poipet Town		Vibration Level		65Hz (05:00-17:00) 60Hz (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.

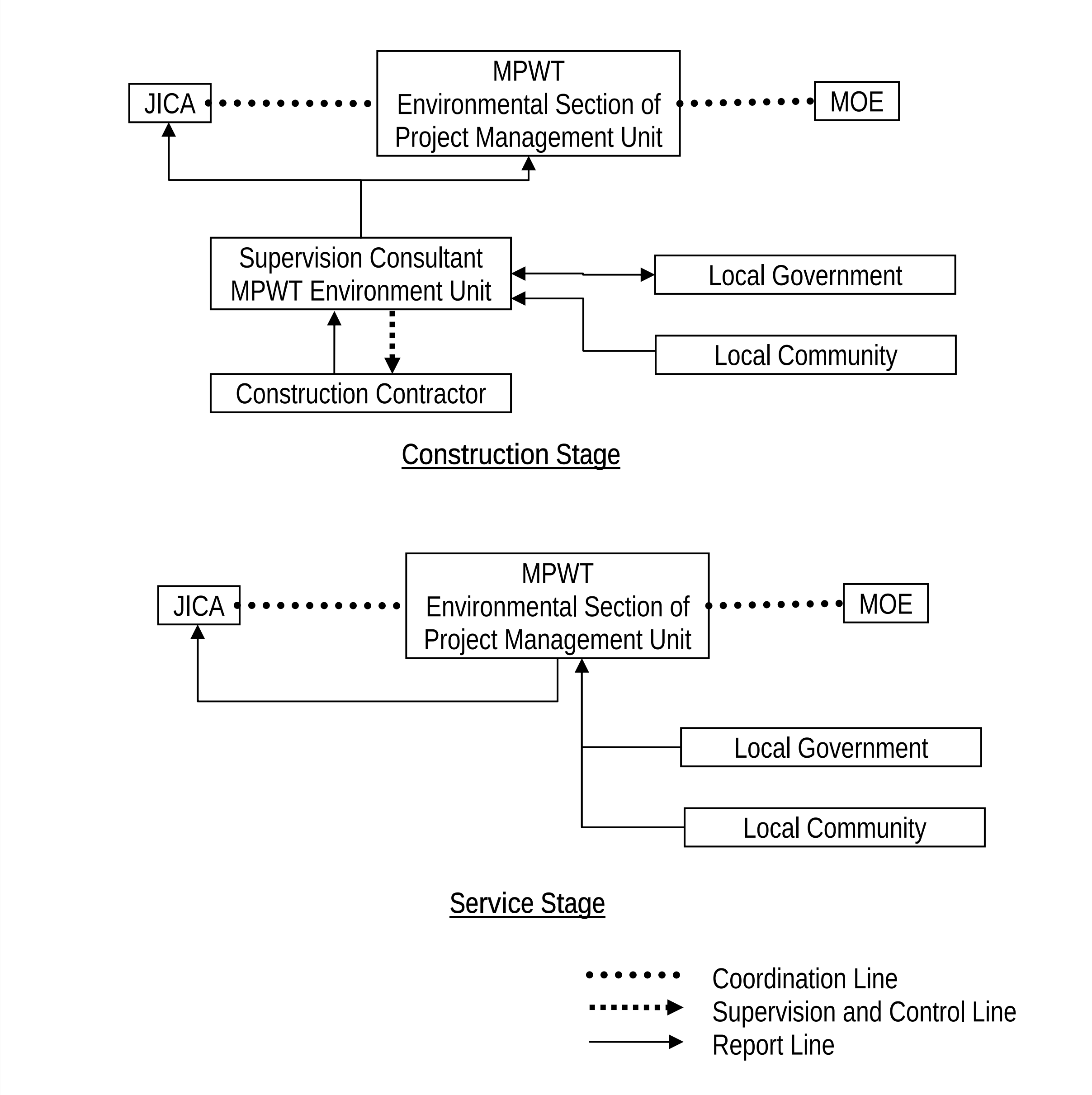


Figure 15.7-1 Proposed Organization for EMP

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$ 306,000.

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	1,400	5,600
2	Air quality (Operation and Maintenance Phase)	Sample	12	1,400	16,800
3	Water Quality (Construction Phase)	Sample	4	700	2,800
4	Potable pH Meter	LS	1	100	100
5	Potable Turbidity Meter	LS	1	1,900	1,900
6	Noise and Vibration (Construction Phase)	Sample	4	800	3,200
7	Noise and Vibration (Operation and Maintenance Phase)	Sample	12	800	9,600
				Sub-Total	40,000
II. Mitigation Activity					
1	Sowing small trees and plant trees for good aestheticism along the road (Construction Phase)	LS	1	29,000	29,000
2	Garbage disposed along the road and illegal dump site	LS	1	35,800	35,800
3	To plant the trees for good aestheticism along the road and good maintained (Operation and Maintenance Phase)	LS	1	37,700	37,700
4	To prepare a master plan for by-Pass road of Pursat Town development and install big signboard for this project plan	LS	1	21,500	21,500
				Sub-Total	124,000
III. Training Fee					
1	Training course on environmental management and field practice	Course	1	1,500	1,500
2	Training course on site monitoring and field practice	Course	1	1,500	1,500
3	Training course on general site management	Course	1	1,500	1,500
4	Transportation for the field practices	Time	3	400	1,200
5	Training materials and snacks for all the courses	Lump Sum	1	450	450
				Sub-Total	6,150
III. Training Allowance					
-	-	-	-	Daily Stipend Allowance (US$)	-
1	Engineers from the MPWT	Man-Day	4	100 x 4 Days	1,600
2	Engineers from the MOE	Man-Day	2	100 x 4 Days	800
				Sub-Total	2,400
				Grand Total	**172,550**

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	1,400	5,600
2	Air quality (Operation and Maintenance Phase)	Sample	4	1,400	5,600
3	Water Quality (Construction Phase)	Sample	4	700	2,800
4	Potable pH Meter	LS	1	100	100
5	Potable Turbidity Meter	LS	1	1,900	1,900
6	Noise and Vibration (Construction Phase)	Sample	4	800	3,200
7	Noise and Vibration (Operation and Maintenance Phase)	Sample	4	800	3,200
				Sub-Total	22,400
II. Mitigation Activity					
1	Sowing small trees and plant trees for good aestheticism along the road (Construction Phase)	LS	1	29,000	29,000
2	Garbage disposed along the road and illegal dump site	LS	1	35,800	35,800
3	To plant the trees for good aestheticism along the road and good maintained (Operation and Maintenance Phase)	LS	1	37,700	37,700
				Sub-Total	102,500
III. Training Fee					
1	Training course on environmental management and field practice	Course	1	1,500	1,500
2	Training course on site monitoring and field practice	Course	1	1,500	1,500
3	Training course on general site management	Course	1	1,500	1,500
4	Transportation for the field practices	Time	3	400	1,200
5	Training materials and snacks for all the courses	Lump Sum	1	450	450
				Sub-Total	6,150
III. Training Allowance					
-	-	-	-	Daily Stipend Allowance (US$)	-
1	Engineers from the MPWT	Man-Day	4	100 x 4 Days	1,600
2	Engineers from the MOE	Man-Day	2	100 x 4 Days	800
				Sub-Total	2,400
				Grand Total	**133,450**

Note: Daily stipend allowance included food, accommodation and transportation.
Venue fee is included for the training courses.

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

<table>
<tr><th>Item</th><th>Location</th><th>Implementation Agency</th><th>Frequency</th><th>Parameter/ Means of Monitoring</th></tr>
<tr><td rowspan="8">Air quality</td><td>Urban area in Kampong Chhnang city</td><td>Department of Environment, Kampong Chhnang Province</td><td rowspan="4">Continues monitoring</td><td rowspan="8">SPM10
SPM2.5
SO_2
NO_2</td></tr>
<tr><td>Urban area in Pursat town</td><td>Department of Environment, Pursat Province</td></tr>
<tr><td>Urban area in Battambang city</td><td>Department of Environment, Battambang Province</td></tr>
<tr><td>Urban area in Sri Sophorn city</td><td>Department of Environment, Banteay Meanchey Province</td></tr>
<tr><td>Roadside in Kampong Chhnang bypass section</td><td rowspan="4">MPWT</td><td rowspan="4">1 time in dry season and 1 time in rainy season per year</td></tr>
<tr><td>Roadside in Pursat bypass section</td></tr>
<tr><td>Roadside in Battambang bypass section</td></tr>
<tr><td>Roadside in Sri Sophorn bypass section</td></tr>
<tr><td rowspan="8">Noise</td><td>Urban area in Kampong Chhnang city</td><td>Department of Environment, Kampong Chhnang Province</td><td rowspan="4">Quarterly</td><td rowspan="8">Noise Level (LAeq)</td></tr>
<tr><td>Urban area in Pursat town</td><td>Department of Environment, Pursat Province</td></tr>
<tr><td>Urban area in Battambang city</td><td>Department of Environment, Battambang Province</td></tr>
<tr><td>Urban area in Sri Sophorn city</td><td>Department of Environment, Banteay Meanchey Province</td></tr>
<tr><td>Roadside in Kampong Chhnang bypass section</td><td rowspan="4">MPWT</td><td rowspan="4">Yearly</td></tr>
<tr><td>Roadside in Pursat bypass section</td></tr>
<tr><td>Roadside in Battambang bypass section</td></tr>
<tr><td>Roadside in Sri Sophorn bypass section</td></tr>
<tr><td rowspan="8">Vibration</td><td>Urban area in Kampong Chhnang city</td><td>Department of Environment, Kampong Chhnang Province</td><td rowspan="4">Quarterly</td><td rowspan="8">Vibration Level</td></tr>
<tr><td>Urban area in Pursat town</td><td>Department of Environment, Pursat Province</td></tr>
<tr><td>Urban area in Battambang city</td><td>Department of Environment, Battambang Province</td></tr>
<tr><td>Urban area in Sri Sophorn city</td><td>Department of Environment, Banteay Meanchey Province</td></tr>
<tr><td>Roadside in Kampong Chhnang bypass section</td><td rowspan="4">MPWT</td><td rowspan="4">Yearly</td></tr>
<tr><td>Roadside in Pursat bypass section</td></tr>
<tr><td>Roadside in Battambang bypass section</td></tr>
<tr><td>Roadside in Sri Sophorn bypass section</td></tr>
</table>

CHAPTER 16

RESETTLEMENT ACTION PLAN (RAP)

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 2,000m^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	30m from the centreline	30m from the centreline
Other 1-digit NRs	25m from the centreline	30m from the centreline
2-digit NRs	25m from the centreline	25m from the centreline
Provincial roads	20m from the centreline	not specified
Commune roads	15m from the centreline	not specified
Railway outside city, province and crowned place	30m from the centreline	30m from the centreline
Railways in forest area	100m from the centreline	100m 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 <u>90 days</u> 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 <u>30 days</u> 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 <u>90 days</u> 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 <u>30 days</u> 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 7.0m x 15.0m = 105.00m^2. ▪ Basic infrastructures such as access roads, latrines,	▪ AHs to be notified at least <u>90 days</u> 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 <u>30 days</u> prior to the scheduled start of civil works. ▪ IRC will ensure allocation of cash or replacement land with sufficient time (at least <u>90 days</u>)

[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
		drainages, and pumping 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.	for AHs to rebuild and relocate 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 <u>90 days</u> 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 <u>90 days</u> 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 <u>30 days</u> 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 <u>30 days</u> 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 60m^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 60m^2 or more.	▪ One time cash assistance equivalent to USD 100.	
	▪ Relocating AHs to residual or adjacent areas (whose house type from 2H or higher)	▪ One time cash assistance equivalent to USD 150.	
	▪ Relocating AHs to a new village or resettlement site	▪ One time cash assistance equivalent to USD 200.	
IV. Temporary loss of business income during relocation	Owners of shop who relocate their shop	Lump sum cash assistance of USD 50.	
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 296,069.07m² of private land in the bypass area, in which 269,026.84m² (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 centers along NR-5 and the 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: 20m–20m) on both sides from the centerline of the road) in ROW (30m–30m) 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 (20m–20m). 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 296,069.07m^2 of land will be required for the construction of the Pursat bypasses. Of these, 90.87% (269,026.84m^2) is used for growing rice, 5,962.56m^2 is commercial land and 21,079.67m^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, 100mm	lm	**2,456**
Brick Wall, 200mm	lm	**1,002**
PETROL STATION		
Petrol Measure	set	**19**
Fuel Tank (10,000L)	set	**2**
GRAVE/STUPA/CHEDEY		
Concrete grave	set	**1**
Chedey/Stupa (7.0m x 4.0m x 4.0m)	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 crops which are not harvested 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
	T	2,471	295	11.9	379	15.3	231	9.3	1,408	57.0	158	6.4

Stratum	Population		0-5		6-13		14-18		19-60		60+	
			No.	%	No.	%	No.	%	No.	%	No.	%
PST	M	1,735	200	11.5	237	13.7	148	8.5	1,049	60.5	101	5.8
	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.

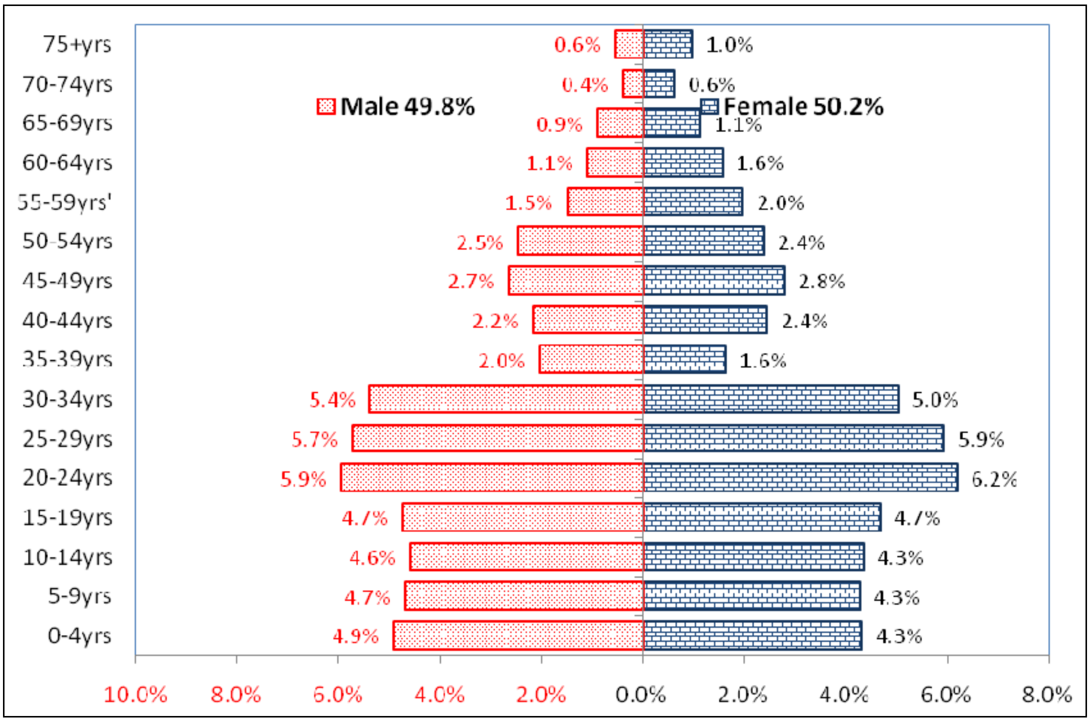
The age composition in Table 16.5-3 shows that 68.3% of the population was aged between 15-64 years. 27.1% was below 15 years and 4.6% was 65 years and over. The Table 16.5-3 also provided detail about youth dependency ratio (39.6%) and old age dependency ration (6.7%). The total dependency ratio is 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
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.

[4] Aged was defined as a person who is more than 60 years old and without young to support.

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 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

Stratum	Number of Households		Non activity		Non-farming		Farming	
			No.	%	No.	%	No.	%
	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
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
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

Mode of Transport	Total Value (USD)	Total AHs = 1,611	
		# Having	%
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.

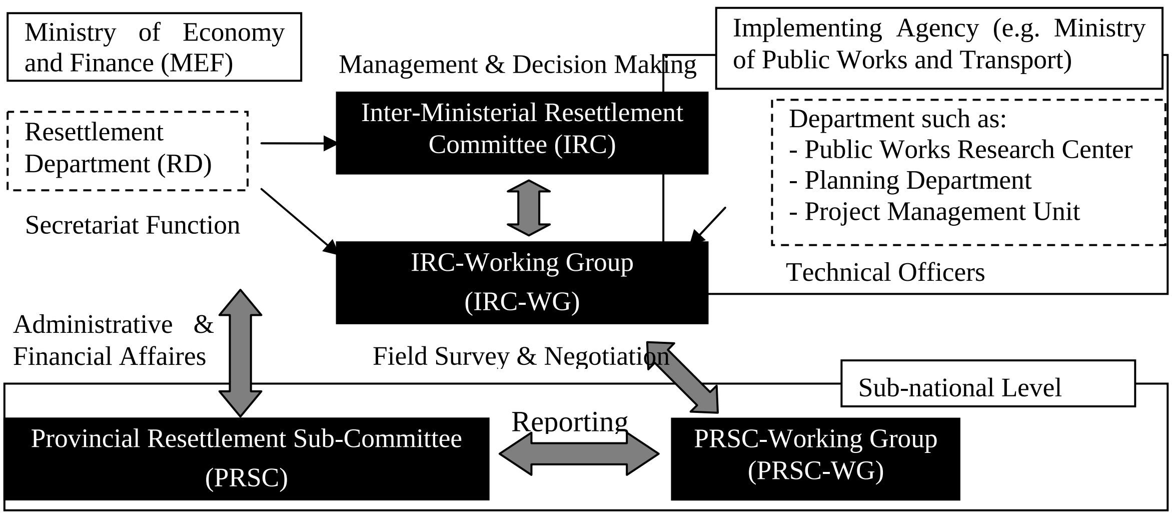


Figure 16.6-1 Inter-Ministerial Resettlement Committee (IRC) and Relevant Organizations

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

(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.

[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.

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
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 live on the remained ROW land (10 meters)?	**ICD/MPWT**: Of course, people could keep living as normal. In order 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 40m for the road construction area (PRW), but do not mean that the actual road is 40m 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	**ICD/MPWT**: People have to construct their houses outside the ROW. It means more than 30m from the road center line.

Question	Response
that people can construct their houses?	
Can people continue to use on their remained land (10m) 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 (20m) for both sides, but for the detailed design is not really the same due to land situation. For IOL will study in 20m-20m 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 structures in the PRW?	**ICD/MPWT**: Any affected properties in ROW that settled before the 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.

Question	Response
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 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 access 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 105m^2 (7m x 15m) 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 105m^2 (7m x 15m) 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 105m^2 (7m x 15m), 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 105m^2 (7m x 15m).

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.

CHAPTER 17

CONCLUSION AND RECOMMENDATION

CHAPTER 17 CONCLUSION AND RECOMMENDATION

17.1 Conclusion

Based on what have been described in the preceding chapters, the followings can be concluded:

(1) Existing Condition of South Section of NR 5 and Its Problems

- NR 5 plays a very important role not only as the major primary road of Cambodia but also as one of the trunk road of the ASEAN highway network and Asian Highway network.
- NR 5 is expected to support the development of socio-economic activities of Cambodia, as well as to promote regional cooperation among the ASEAN countries, especially those of GMS.
- The width of the existing pavement of the Middle Section is 10.4m and that of the Sri Sophorn–Poipet Section is 10.0m which are not sufficient in view of the rapidly growing traffic volume.
- Traffic volume is increasing, and is anticipated to increase in the future, in accordance with the rapid economic growth of Cambodia, resulting in the traffic congestion in the future.
- Existing pavement of the Middle Section is DBST. Because of small bearing capacity of DBST, severe damages occur every year, especially after flood/inundation season. Pavement is damaged also by the increasing heavy traffic.
- Although the pavement of the Sri Sophorn–Poipet Section has been improved to AC, the remaining design life period is considered to be around 6 years, and rehabilitation will be necessary in the near future.
- MPWT is spending considerable amount of fund in repair of damaged pavement every year. This is an avoidable financial burden to the Royal Government of Cambodia.
- Every year, many sections are inundated or flooded, hampering the traffic flow. This results in economic loss.
- Number of traffic accidents on NR 5 is the largest among those on the single-digit national roads of Cambodia.

(2) Necessity and Justification of Improvement of the South Section of NR 5

- In view of the problems of the existing NR 5 as cited above, improvement of NR 5 is an urgent need.
- Improvement of NR 5 is necessary not only for the growth of socio-economic activities of Cambodia but also for regional cooperation among the ASEAN and GMS countries.
- Improvement of NR 5 is expected to benefit the business activities of Japanese firms who have established factories and offices in Cambodia.

- In view of the fact that the North Section and the South Section are planned to be widened into 4 lanes, it is necessary to improve the Middle Section and Sri Sophorn–Poipet Section.
- The cost of the National Road No. 5 (the Middle Section and the Sri Sophorn–Poipet Section) Improvement Project is estimated at USD 62.74 million. EIRR of this investment is calculated at approximately 15% which is considered to be sufficiently high. Thus, the project is economically justified.
- The Middle Section of NR 5 traverses the southwestern periphery of the Tonle Sap Biosphere Reserve, but the right of way is designated to be outside of the reserve area.
- Approximately 2,420 households are estimated to be affected by the project.
- Necessary actions and measures are to be taken in accordance with the relevant legislations of Cambodia.

17.2 Recommendation

- It is recommended that the South Section of NR 5 be widened into 4-lane with a 3 m-wide median division.
- Construction of the bypasses is proposed around the city of Pursat.
- Construction of the bypasses can greatly reduce the number of affected houses and/or families which will be very large if the existing NR 5 is to be widened.
- It is proposed that the sections of the existing NR 5 which will be parallel to the bypasses be excluded in the section to be improved under the financial assistance of Japanese ODA loan.
- It is recommended that the resettlement and land acquisition be implemented in accordance with the Resettlement Action Plan (RAP) and Land Acquisition Plan (LAP) prepared in this survey.
- It is proposed that the impacts on the natural and living environments be mitigated by implementing adequate measures and the impacts be monitored during and after the implementation of the project as recommended in this report.