CHAPTER 5 OUTLINE OF ROAD IMPROVEMENT PROJECT

5.1 Overview

The most appropriate road improvement projects, which were selected for further detailed examination in the Feasibility Study, are:

Route 14 A from B. **Houay Phek to B. Sukhuma (59.301km)**.

Route 16A from B. 1km mark east of **Paksong** on Route 16 to **B. Lak 52 (64.138km)**.

Tables 5.1.1 and 5.1.2 summarize the Project Routes 14A and 16A respectively.

The design takes into account the interdependence between geometric features and behavior of drivers. The major design objectives for the Study are as follows:

- To ensure minimum levels of safety and comfort for drivers by taking into consideration adequate sight distances, coefficients of frictions, and road space for vehicle maneuvering.
- To ensure uniformity of alignment
- To ensure that the road design is economical

Table 5.1.1 Summary of Route 14A

<table>
<tr><th>Route</th><th>14 A</th><th>Road Length</th><th>L = 59.301 km</th></tr>
<tr><th>Origin</th><td>Ban Houay Phek</td><th>Destination</th><td>Ban Sukhuma</td></tr>
<tr><td colspan="4">Existing Road Surface Type :
Earth / Gravel road : 31.601 km, (New Construction : 27.700 km)</td></tr>
<tr><td colspan="4">Terrain Conditions :
This road runs through the flat terrain with paddy field.</td></tr>
<tr><td colspan="4">Socio-economic Conditions:
This is the northern part of Route 14A and located in Phonthong, Champasack, and Sukhuma Districts of Champasack Province. The route goes through rice rich and densely populated area along the Mekong River. These three districts have considerable size of work force in industrial and service sector. Wat Phou, a ruin of ancient Kumer civilization with World Heritage status, generate more traffic into this route.</td></tr>
<tr><td colspan="4">Traffic Demand Forecast : year 2020
North Section (B.Houay Phek-B.Phonngam 34.1km) 1,100VPD(incl. motorcycle 3,000) 2,250PCU
South Section(B.Phonngam-B.Sukhuma 25.2km) 800VPD(incl. motorcycle 4,600) 2,400PCU</td></tr>
<tr><td colspan="4">Road Specification:
Pavement : Asphalt Concrete, Design Speed : 80km/hour, Carriageway : 7.0m(3.5m*2-lane), Paved Shoulder : 1.0m (2.0m for populated section)
Pavement Area : 450,000m2, Embankment Volume : 790,000m3, Cutting Volume : 89,000m3</td></tr>
<tr><td colspan="4">Bridge Specification:
Effective Width : 8m for 2-lane
Type and Nos. : PC-I 22-50m length (11Nos.), RC-I 15m length (3Nos)</td></tr>
</table>

Table 5.1.2 Summary of Route 16A

Route	**16 A**	**Road Length**	L = 64.138 km
Origin	Junction of Route 16(East Pakson)	**Destination**	Junction of Route 1 I(Ban Lak52)
Existing Road Surface Type : Earth/Gravel road : 57.838 km, (New Construction : 6.300km)			
Terrain Conditions : This road runs through either a flat (31.7km), rolling (16.4 km) or mountainous (16.0 km) terrain mainly covered with copse. There are some small villages along the road.			
Socio-economic Conditions: This road link passes through the Boloven Plateau area located in Paksong District (Champasack Province) and Saysettha District (Attapeu Province). Ethnic minorities hold majority of the population and literacy rate of the district is 62.3% and student ratio is 22.5%. Cash crops like coffee are cultivated here rather than rice. Accessibility to the market is already secured with the connection to Thai border through Pakse. Route 16A rather contributes to the connection of Attapeu and Sekong province to the west part of the country. Upon the completion of Route 16 east and 18B that run to the Vietnamese border, Route 16A will contribute to transmit traffic from Vietnam to Pakse and to Thai.			
Traffic Demand Forecast : year 2020 Flat Section 1,300 VPD (incl. motorcycle 2,320) 1,950PCU Mountainous Section 3,950PCU			
Road Specification: **Pavement** : Asphalt Concrete, **Design Speed** : 80km/hour (40km/hour for mountainous), **Carriageway** : 7.0m (3.5m*2-lane), **Paved Shoulder** : 1.0m (2.0m for populated section) **Pavement Area** : 471,000m2, **Embankment Volume** : 398,000m3, **Cutting Volume** : 332,000m3(soil) 382,000(rock)			
Bridge Specification: **Effective Width** : 8m for 2-lane, 5m for 1-lane (1No. of PC-I type is 1-lane type, because an existing bridge can be utilized for another lane) **Type and Nos.** : PC-I 25-60m length (6Nos.), RC-I 15m length (1No.)			

5.2 Road Classification

Route 14A is designated as a ClassIII road with traffic volumes of **2,250PCU** for the design year 2020.

Route 16A, Class III road would normally be recommended for level terrain(**1,950 PCU**) and Class II road for mountainous terrain (3,950PCU). However, given priority to economy, it is decided that a Class IIIroad has been applied for the entire route.

Table 5.2.1 Traffic Forecasts (Route 14A)

Part	**PCU Year 2008**	**PCU Year 2020**
STA.0+000 B.Houay Phek – STA.34.100 B.Phonngam	880	2250
STA.34+100 B.Phonngam– STA.59.300 Sukhuma	930	2400

Table 5.2.2 Traffic Forecasts (Route 16A)

Part	PCU Year 2008	PCU Year 2020
Mountainous (STA.42+000 – STA.58.000)	1550	3950
Flat (Others)	740	1950

5.3 Design Vehicle

The sizes and physical characteristics of vehicles using the road are positive controls in geometric design. The principal vehicle dimensions affecting design are:

- Minimum turning radius
- Path of inner rear tire, tread width and wheel base

The design elements affected are cross-section, road widening in horizontal curves and intersection layout. The design vehicles applied for the Project road are in conformity to the 'Road Design Manual, MCTPC' and its maximum size of vehicle type is the Trailer-truck Combination (WB12) as the following size:

Vehicle width : 2.6 m

Vehicle length : 16.7 m

5.4 Design Speed

The design speed should be determined taking into account correlation of the physical features of roads that influence vehicle operation. It is the maximum safe speed that can be maintained over a specified section of road when conditions are so favorable that design features of the roads govern. The following consideration should be taken for the selection of design speed:

- Classification and function of the road
- Nature of the terrain
- Density and character of the adjoining land use
- Traffic volumes expected to use the road

Both Routes 14A and 16A are expected to function as arterial roads and national road links. Most sections passes thorough less populated areas. The design speed applying is based on the Road Class and terrain conditions as shown in Table 5.4.1.

Table 5.4.1 Design Speed for Each Route

Route No.	Road Class	Flat Section	Mountainous Section
Route 14A	Class III	80 km/hr	-
Route 16A	Class III	80 km/hr	40 km/hr

As density and character of the adjoining land use vary along a route of some length, the design speed does not have to be constant for the whole length of a road. Changes in the design speed are required in order to obtain proper correlation between the road layout and the above factors.

5.5 Cross Section Elements

The cross-section of the Project road is composed of the following element:

- Carriageway
- Paved Shoulder (hard shoulder)
- Unpaved Shoulder (soft shoulder)

The cross section elements for the Project road are shown in Figure 5.5.1 and Figure 5.5.2 for rural section and populated section respectively. The design concepts for deciding the elements of the cross-section are described below.

Carriageway

The lane width of the Project road is to be 3.5 meters, which can ensure a basic minimum level of safety and comfort for drivers, by taking into consideration adequate sight distance, coefficients of frictions and road space for vehicle maneuvering, under the maximum design speed of 80km/hour. The lane width for rural sections and populated sections is the same in order to ensure uniformity of alignment.

Paved Shoulder/Unpaved Shoulder

As for paved shoulder, a 2.0 m width is applied for populated section and a 1.0 m width is applied for rural section taking economic consideration. A 2.0 m paved shoulder in populated section enable a pedestrian and a cyclist to pass while a 1.0 m one in rural sections is passable for either a pedestrian or cyclist. A 0.5 m unpaved shoulder function to keep road pavement and road structures in maintainable conditions. A 2.5% cross fall is applied for asphalt pavement in the Project roads.

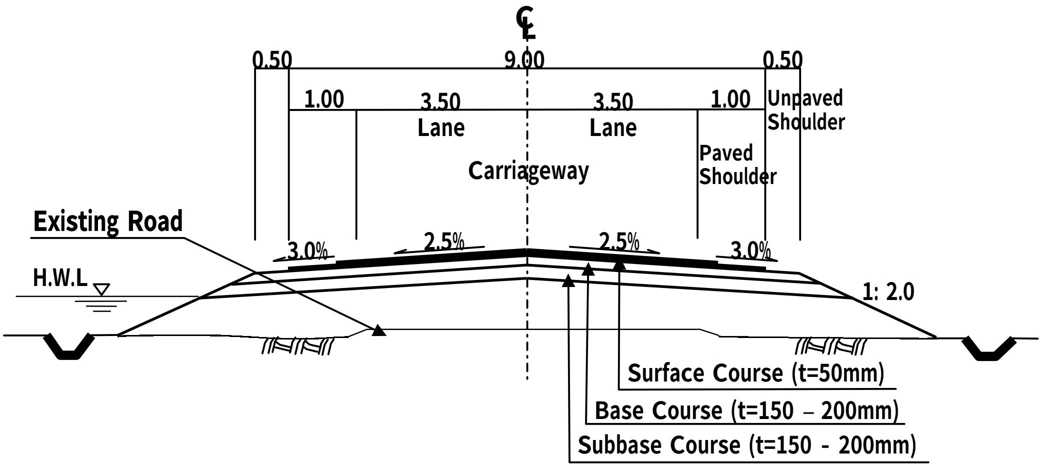


Figure 5.5.1 Typical Cross Section for Rural Section (Flat Area)

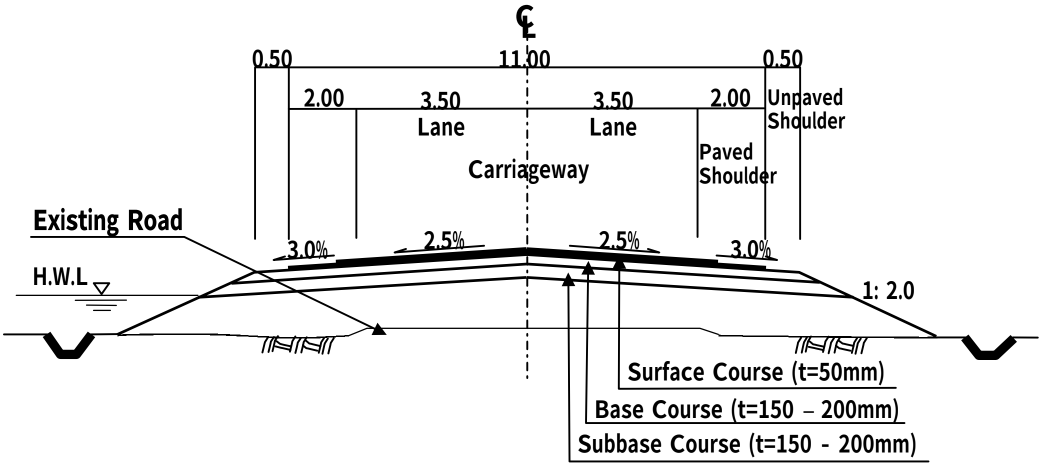


Figure 5.5.2 Typical Cross Section for Populated Section (Flat Area)

5.6 Alignment Setting

The road geometric form is a three-dimensional (3-D) alignment which is represented in horizontal and vertical alignment. The other elements are super-elevation and sight distance.

The basic concept for the determination of the horizontal alignment is described below.

- The alignment must take into account the control points such as temple, graveyards, cemetery, religious monument, school and hospital.
- The alignment must take into account connection with each existing road and configuration of intersection.
- Dividing villages must be avoided as much as possible.
- Due care must be taken to minimize the effects on non-inhabited areas by having the Project roads.
- The alignment must be such that the amount of cutting and filling can be minimized.

The basic concept for the determination of the vertical alignment is described below.

- The alignment must take into account connection with each existing road at grade crossing.
- Road surface height must be determined based on the hydrological analysis.
- Road surface height is increase by 0.6 meters from the existing road surface, even though there has been no sign of flood.
- The alignment must ensure the minimum earth cover overt the road crossing facilities.
- The gentlest gradient can be less than 0.5% while 2.5% is applied for cross fall for asphalt pavement road.
- The alignment must be such that the amount of cutting and filling can be minimized.

5.7 Road Surface Elevation

Between the starting point and Ban Phonsao(Km35) on Route 14A, the route runs along the Mekong, from which river water overflows area during the rainy season. Accordingly, it is a major issue how to define the road surface elevation in this section. The road surface elevation should therefore consider the flooding levels of the Mekong at each return period. The return period adopted for this preliminary design is 50 years same as one of design flood level for bridge planning.

(1) Flooding Level and Return Period

The flood elevation of the Mekong at each return period was estimated on the basis of the past water level data at Pakse observatory by the Thomas plotting method. The Champasack flooding elevation is converted from the Pakse elevation. Table 5.7.1 shows the flood levels at Champasack and its return period examined by the Study Team.

Table 5.7.1 Estimated Flooding Level and Return Period at Champasack Observatory

Return Period	Flood Level	Remarks
20 Years	97.11 m	Recorded data in 2000
50 Years	97.41 m	
100 Years	97.61 m	
More than 500 Years	98.36 m	Recorded data in 1978

Two large floods were recorded in 1978 and in 2000. The flood in 1978 is the largest and this can be assumed to have a return period of more than 500 years.

(2) Road Surface Elevation at Champasack Observatory Point

The minimum road surface height at flooding is 60cm higher than the 50-year return period, because the estimated pavement thickness is 60 cm, and the surface pavement should be protected from the flooding. As a result, the minimum road surface height near the Champasack town point is estimated to be 98.01m. Comparing this height with historic flood levels for other return periods, the following can be said:

- The surface height is 40cm higher than the flooding level (97.61m) for a return period of 100 years.
- The surface height is 35 cm lower than the flooding level (98.36m) recorded in 1978. However, emergency vehicles, such as pick-up trucks and other trucks could pass through. In this case, it is estimated that flooding of this scale would have an effect for less than 5 days.

Consequently, the Study team identifies that the 50-year return period is appropriate for the Project Route 14A, and a minimum surface height of 98.01m is adopted for STA. 25+000.

(3) Road Surface Elevation in Other Sections

The following water surface gradient can be applied to estimate the design flood water level at various points on the Route 14A. The figure is estimated based on actual flood water level data at three observatory along the Mekong.

Table 5.7.2 Water Surface Gradient for Determination of Road Height

Section	Water Surface Gradient
North Side from Champasack Observatory	0.011%
South Side from Champasack Observatory	0.008%

5.8 Pavement Structure

The pavement design has been carried out according to the following procedure according to AASHTO standard.

(i) Set up time constraints (analysis and design period)
(ii) Estimate cumulative axle loads during analysis period
(iii) Identify flexible pavement structural number (SN) to withstand the axle load
(iv) Identify a set of pavement layer thickness corresponding SN
(v) Design pavement structure
(vi) Design overlay thickness

(1) Analysis and Design Period

The design period means service life of pavement without overlaying. Several road projects based on AASHTO realized that a 10 to 20 yeas design period is realistic for the analysis taking account of overall factors such as economic, construction and maintenance performance. Note after the design period, periodic maintenance work (i.e., overlaying) will be implemented. Basing on the above, the study applies 10 years (2008 – 2017) for the design period and 15 years (2008-2022) for analysis period in this preliminary design.

(2) Pavement Structure

As a result of trial calculation with using an equation following pavement structure is determined. Since there is a large difference in traffic volume between the north and south section, different pavement structure shall be required.

(i) Route 14A North (STA. 0 +000 – STA. 34+000)

Layer	Thickness
Asphalt Concrete	50mm (1.97 inches)
Granular Base (CBR=80)	175mm (6.89 inches)
Crushed Stone (CBR=30)	175mm (6.89 inches)

(ii) Route 14A South (STA. 34 +000 – STA. 59+301)

Layer	Thickness
Asphalt Concrete	50mm (1.97 inches)
Granular Base (CBR=80)	150mm (5.91 inches)
Crushed Stone (CBR=30)	150mm (5.91 inches)

(iii) Route 16A

Layer	Thickness
Asphalt Concrete	50mm (1.97 inches)
Granular Base (CBR=80)	200mm (7.87 inches)
Crushed Stone (CBR=30)	200mm (7.87 inches)

5.9 Bridge Structure

(1) Design Standard and Criteria

A 50-year return period of flood shall be adequate for the design water level for bridge planning in this Study. The reasons in detail are described below.

- All previous bridge projects have applied a 50-year return period.
- Both study roads have a detour route connecting with district centers and all bridges on both routes are categorized into small to medium size. Accordingly, a 100-year return period is too high considering social and economic impacts induced by bridge failure due to flooding.

- For bridges on Rt. 14A, more accurate estimation of the water level at each return period can be obtained because of abundant water level data at the Pakse observatory.

Whereas the minimum one meter is required from the design water level to determine the bridge elevation at rivers with debris such as drift timber, the minimum 60 cm is required for other rivers.

HS-25-44 of AASHTO standard is applied as the design live load to bridge design in this Study.

(2) Determination of Total Bridge Length and Span Arrangement

The following policy is applied when determining the bridge length and span arrangement.

- The bridge length over the rivers on Route 14A, where frequently overflow to the surrounding area, is determined taking into account the river width of upstream or downstream side.
- Bridge length of river crossing with no dike is determined to take the river width in flooding condition into account bridges on Route 16A.
- The minimum span length of bridges is determined to limit obstruction by piers during flooding to approximately 5% of the sectional area of the river. Also from an aesthetic point of view, all span lengths should be as constant as possible.

(3) Superstructure Design

1) Basic Bridge Type

A concrete bridge type is applied to the Project bridges because of the following reasons:

- Most of materials except for a PC cable are locally available. Accordingly, cost effectiveness can be achieved comparing with a steel type bridge.
- A concrete bridge type is a major bridge type in previous bridge projects in Lao PDR, and local contractors have also some experience to build it.
- Maintenance burden on the road agency is less than one of a steel type, which is periodically required re-painting at least.

2) Bridge Type by Span Length

Since there is no requirement of navigation clearance for any rivers on either Route 14A or 16A, a pre-cast type with less than 30m in span length is appropriate from the view point of cost effectiveness, workability of construction and minimizing construction time. Based on a relationship between span length and standard type of bridge mentioned before and current practice in Lao PDR and neighboring countries, the Study team selected the following superstructure types by various span lengths. (See Table 5.9.1)

Table 5.9.1 Superstructure Types by Span Length

Span Length (m)	Superstructure Types	**Remark**
L<=10	RC Slab	Supporting required
10< L<18	RC I – Girder	Supporting not required
18=<L<=33	PC I - Girder	Supporting not required

In order to ease of maintenance burden on expansion joints, a connected continuous girder is designed.

(4) Substructure Design

1) Abutments

The height of abutments ranges from 5m to 15m. Based on this and considering current construction practices in Lao PDR, the adoption of the following types of abutment is made (See Table 5.9.2).

Wing walls and approach slabs are required in most of the locations. The wing wall length is limited to about 8m, and approach slabs are required when embankment height of backside of abutment is more than 5m.

Table 5.9.2 Abutment Type by Its Height

Abutment Height (m)	**Abutment Type**
H <= 5	Concrete Gravity Type
6 <= H <=12	RC Reversed T - Type
13<H	RC Boxed Type

2) Piers

There are many failures of pile-bent type by scouring, particularly in rapid flow rivers in developing countries. Accordingly, the Study Team adopts the wall type, with round faces against flow for piers in rivers to provide smooth flow of water.

(5) Foundation Design

1) Foundation Type

The geological survey clarified the location of the bearing strata suitable for bridge foundation. At rivers on Route 14A, approximately 7-8m of the alluvial soil generally covers on the sand stone or mudstone. Accordingly, some abutments and piers require to be supported by piles. On the one hand, all foundations are to be of a spread footing type when a bearing strata consisting of gravel, boulder or rock is situated at shallow depth.

2) Types of Pile

Pre-cast RC square piles (40cm x 40cm) is appropriate for economic reasons and in light of current construction practice in Lao PDR, if piles are required from the viewpoint of cost effectiveness.

(6) Preliminary Design Results

Table 5.9.3 List of Bridges on Route 14A

			Superstructure							Substructure								
										A1Abutment			P1 Pier			A2Abutment		
No	River Name	Km post	Br. L (m)	Nos. Span	Span (m)	Br. Type	Effective W(m)	HWL (1/50)	Clear-ance	Type	Hight (m)	Founda. Type	Type	Hight (m)	Founda. Type	Type	Hight (m)	Founda. Type
1	Huay Thok	5+330	25	1	25	PC-I	8.0	99.60	0.6	Rev.-T	9.0	Spread	-	-	-	Rev.-T	10.0	Spread
8	Huay Imet	11+140	15	1	15	RC-I	8.0	99.70	0.6	Rev.-T	6.0	Spread	-	-	-	Rev.-T	6.0	Spread
11	Huay Thakhong	13+420	25	1	22	PC-I	8.0	98.80	0.6	Rev.-T	11.5	Pile	-	-	-	Rev.-T	9.0	Pile
12	Huay Tabxan	14+325	30	1	30	PC-I	8.0	98.70	0.6	Box	16.0	Spread	-	-	-	Box	16.0	Spread
14	Huay Khonken	16+810	25	1	25	PC-I	8.0	98.40	0.6	Rev.-T	10.5	Pile	-	-	-	Rev.-T	8.5	Pile
15	Huay Hong	18+075	25	1	25	PC-I	8.0	98.20	0.6	Rev.-T	11.0	Pile	-	-	-	Rev.-T	10.0	Pile
16	Huay He	18+760	30	1	30	PC-I	8.0	98.10	0.6	Rev.-T	10.5	Pile	-	-	-	Rev.-T	11.0	Pile
18	Huay Sai	21+160	44	2	22	PC-I	8.0	97.70	0.6	Rev.-T	6.5	Pile	Wall	12.5	Spread	Rev.-T	13.0	Spread
19	Huay Phaphin	24+010	22	1	22	PC-I	8.0	97.50	0.6	Rev.-T	11.5	Pile	-	-	-	Rev.-T	11.5	Pile
20	Huay Phabang	29+020	50	2	25	PC-I	8.0	97.00	0.6	Rev.-T	8.5	Pile	Wall	15.0	Spread	Rev.-T	9.5	Pile
21	Huay Sahoua	31+715	30	1	30	PC-I	8.0	96.80	0.6	Rev.-T	11.0	Spread	-	-	-	Rev.-T	11.0	Spread
22	Huay Kok	32+140	15	1	15	RC-I	8.0	96.80	0.6	Rev.-T	10.5	Spread	-	-	-	Rev.-T	10.5	Spread
24	Huay Thateng	40+035	15	1	15	RC-I	8.0	100.50	0.6	Rev.-T	7.5	Spread	-	-	-	Rev.-T	7.0	Spread
25	Huay Manpha	45+040	22	1	22	PC-I	8.0	98.40	0.6	Rev.-T	5.0	Spread	-	-	-	Rev.-T	5.0	Spread

Table 5.9.4 List of Bridges on Route 16A

No	River Name	Km post	Superstructure							Substructure								
										A1Abutment			P1 Pier			A2Abutment		
			Br. L(m)	Nos Span	Span L(m)	Br.Type	Effective W(m)	HWL (1/50)	Clear-ance	Type	Hight (m)	Founda. Type	Type	Hight (m)	Founda. Type	Type	Hight (m)	Founda. Type
1	Huay Mckchan-Gunai	17+580	25	1	25	PC-I	8.0	1143.30	0.6	Rev.-T	5.0	Spread	-	-	-	Rev.-T	6.5	Spread
2	Huay Namtang	35+530	30	1	30	PC-I	8.0	818.70	1.0	Rev.-T	10.0	Spread	-	-	-	Rev.-T	9.0	Spread
3	Xe Katam	45+740	50	2	25	PC-I	8.0	496.40	1.0	Rev.-T	11.5	Spread	Wall	13.0	Spread	Rev.-T	11.5	Spread
4	Xe Namnoy 1	51+390	60	2	30	PC-I	8.0	262.50	1.2	Rev.-T	8.0	Spread	Wall	13.5	Spread	Rev.-T	12.5	Spread
5	Xe Namnoy 2	51+585	25	1	25	PC-I	5.0	257.60	1.0	Rev.-T	11.5	Spread	-	-	-	Rev.-T	11.5	Spread
6	Huay Ho	51+935	30	1	30	PC-I	8.0	266.80	1.0	Rev.-T	8.0	Spread	-	-	-	Rev.-T	8.0	Spread
7	No name	61+560	15	1	1	RC-I	8.0	187.60	1.0	Rev.-T	7.0	Spread	-	-	-	Rev.-T	7.0	Spread

CHAPTER 6 EVALUATING ENVIRONMENTAL IMPACTS

6.1 Introduction

Routes 14A and 16A are high priority project of the national government in the southern part of the country. It is within this context that the Initial Environmental Examination (IEE) reports were prepared for each route. It must also be recognized that the environmental dimensions of the project are but one input into the final design and location of the road.

6.2 IEE Assessment Methodology

The IEE studies used a full range of methods to gather relevant information including examining the work from the Master Plan, discussions with relevant stakeholders as listed below, conducting a major social and economic study through the survey of a number of communities along the road, water quality studies, and a thorough assessment of the physical, cultural and ecological impacts of the project. It is important to note that the project is very much concerned with minimizing any negative impacts. The Project should be equally concerned with achieving the potential benefits that the significant investment in road construction and improvement will provide for the overall social and economic development of the country and the people in the immediate area and the province.

A number of stakeholders were consulted including the following:

- Science, Technology and Environmental Agency (STEA)
- National Tourism Authority of Lao PDR
- Ministry of Agriculture and Forestry
- Ministry of Information and Culture
- Local and provincial governments in Champasack
- Women's Union
- Ministry of Health
- Urban Research Institute
- Ministry of Education
- Lao Front from National Construction
- Ministry of Industry and Handicraft
- National Committee for Control of AIDS
- International organizations – ADB, IUCN, UNESCO, UNDP, SUNV-UNDP and WWF.

In order to organize the assessment process each route was divided into sections as can be seen in Figures 6.2.1 and 6.2.2.

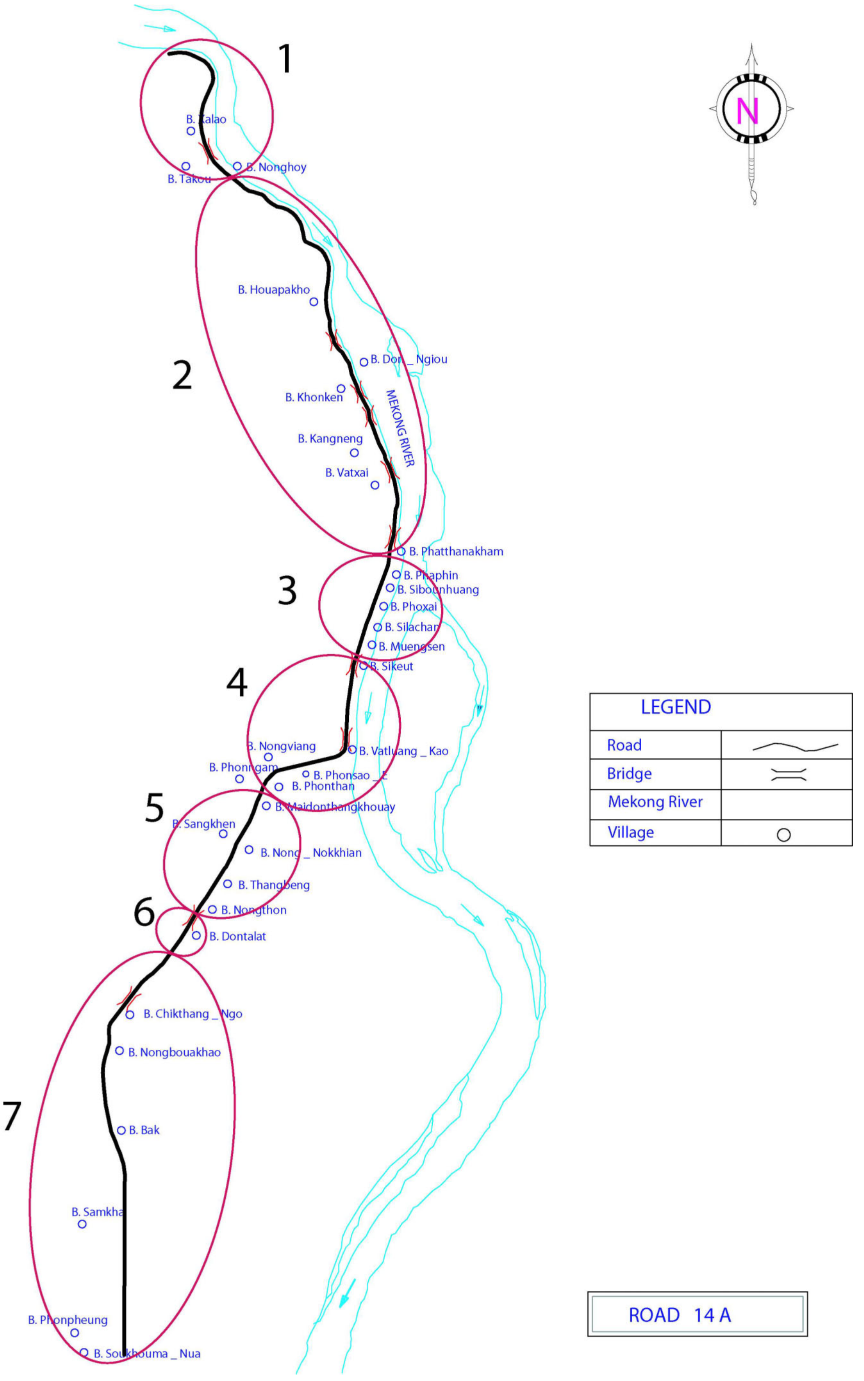


Figure 6.2.1 Route 14A Sections

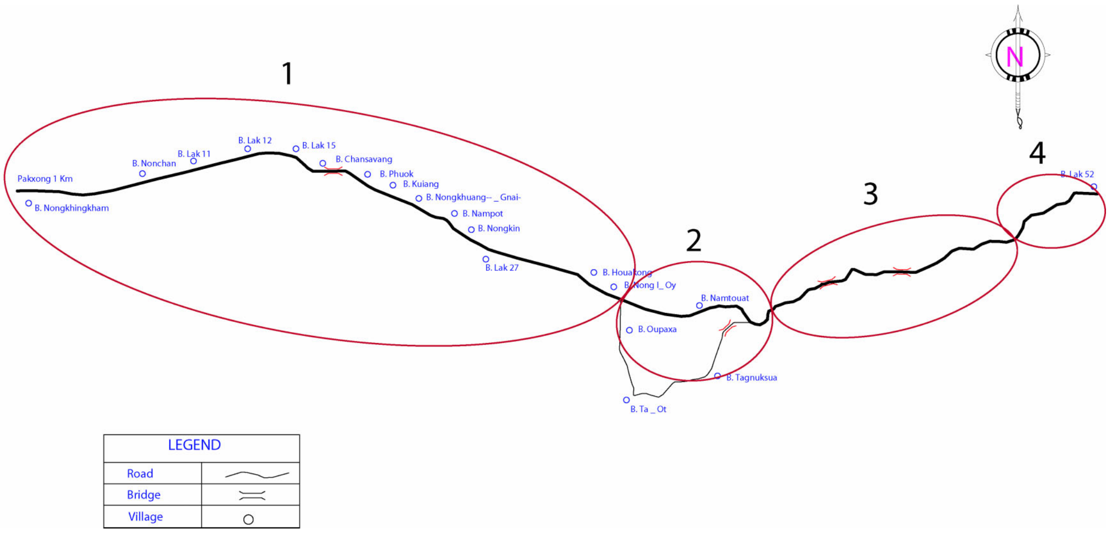


Figure 6.2.2 Route 16A Sections

6.3 Major Environmental Issues for Route 14A

Specific impacts in the case of Route 14A are related to culture and historical characteristics of the area. It is important to note that Champasack Town, Wat Phou, the Ancient City and the surrounding landscape form part of the protected area of the world heritage site as identified by the UNESCO in the Champasack Management Plan.

6.3.1 Champasack Town

The townscape of Champasack Town is recognized as having international significance. It represents an important cultural landscape that must be respected. This significance has been recognized in the road design process and the construction of a new road along the provincial road will ensure that the construction process does not in any way destroy this cultural landscape. The increased visitation to Wat Phou will have a potential negative impact on the community if development is not properly managed and controlled. There can be no argument that there is the potential to provide for the economic benefit of the local people through tourism development. However, there is also the possibility that attempts to meet the needs of the tourists (provision of hotels, restaurants, retail services etc.) within the existing village environment could have negative impacts on the physical characteristics of the community.

6.3.2 Wat Phou and Ancient City

Wat Phou is of the highest cultural significance not only for the country but for world heritage purposes. The significance of the site has been recognized internationally and a very comprehensive plan has been prepared for the management and protection of the cultural resources. Given the national decision to improve Route 14A the challenge is to protect this heritage while accommodating the road. It is also recognized that the improvement of the road and access to Pakse will provide increased access to a wide range of visitors thereby both improving the local economy and providing visitors with the possibility of experiencing the heritage value of the site.

The increased visitation should also allow heritage interests to obtain further resources to carry out conservation and interpretive work at the world heritage site.

The alignment that has been chosen avoids the Ancient City and has the immediate benefit of removing any further pressures on this important dimension of the overall cultural landscape. The overall alignment that has been chosen and approved by both the Ministry of Information and Culture and the UNESCO is sited in such a way as to avoid any significant visual impacts.

It is recognized that increased access to the site will bring with it the negative impacts that normally come about from increased visitation. All measures must be taken to protect the significance of the site through proper visitor management.

With the proposed bypass route in section 3 at Champasack town people living on the existing road will not benefit from the improved road conditions. It is important that the local community be connected to the new road alignment.

6.4 Major Environmental Issues for Route 16A

Only Section 2 is a new road construction section with approximately 8.4km in length along Route 16A.This is planned to shorten the entire road length to save the travel time. However, there is a significant intervention to the undeveloped area.

In Section 3 there are significant physical disturbances. There is no doubt that the disturbances in road section 3 constitute a significant physical impact given the fact that in this section 30% of the physical environment will be disturbed. In some cases the physical disturbance is of significance. Since there is not information available that documents the ecological systems nor the plant ecology in these locations it is impossible to gauge the impact of the planned improvements. It is important to note that this area is not included in any of the national inventories nor is it a nationally protected area.

While it would be preferable not to subject the environment to this level of intervention there are a series of imperatives that drive the detail design process. The first and most important is that after an exhaustive study of all of the roads in southern Lao PDR this route has been chosen along with 14A as having the highest level of priority for development given economic and social development purposes. While the standard for national roads is designed to accommodate speeds of 80 Kph the design speed of this section through the Boloven Plateau has been reduced to 40 Kph in order to protect the natural environment. However, even with a 50% reduction in speed there are still requirements to undertake the construction work as outlined in order to provide the necessary performance and safety requirements.

With the proposed shortcut route in Section 2 people living on the existing road will not benefit from the improved road conditions. Some of these people may already be moving to the new settlement, which is presently being built on the existing road and it is important that this new community be connected to the new road alignment.

6.5 Planning and Design Stage Mitigation Measures

(1) Resident Consultation and Participation:

In order to ensure that the road construction meets the needs of the local people and does not negatively impact their existing social and economic conditions it is essential to have an ongoing process of discussion and information sharing with local residents. This must range from major issues such as compensation and resettlement to more localized problems such as ensuring that the road does not directly negatively impact individual families. Given the changing nature of community needs it is essential that during the construction process this consultation process be undertaken in a comprehensive matter. This will require that staff from the Department of Roads as well as other ministries and departments be involved in the process. It will also be important that staff from these departments and ministries be trained in order to be able to effectively deal with the feedback and that a forum be provided for the local residents to voice their concerns.

It is also equally important however to consider that the road serves national, provincial and district needs and that there will be instances where decisions must be made that may not be in complete accordance with the views and perspectives of local people. In these instances it is vitally important that solutions with the minimum negative impacts be sought.

During the construction phase it is essential that residents be kept informed of activities and that they be alerted to any of the potential negative impacts that may come from temporary construction activity. Contact points in various villages along the road will be established where village heads and/or local people can communicate their concerns directly.

(2) Public Information Program:

The project will ensure that a public information program is put in place. Local people will receive relevant information regularly during both the pre-construction and construction period. Information disseminated to local people will be in an easily understandable format using various media such as a poster, radio, public hearing and local officials. Necessary information should include the following:

- A clear description of the negative and positive impacts that will occur during construction period.
- The development and implementation of transparent compensation procedures.
- Information on plans and a timetable that is updated on a regular basis.
- Information and consultation with local people on activities which could disturb their daily life. This would be particularly true of activities such as blasting or transporting hazardous materials used in the plant
- Making people aware of the traffic control measures.
- Providing residents with the results of the ongoing monitoring process.

(3) Land Acquisition Plan:

Before construction begins a land acquisition plan must be in place and implemented.

(4) Resettlement Plan:

While there is no large-scale resettlement that will occur in the project there will be instances where some small-scale moving on Routes 14A and 16A may be required. There may be some voluntary resettlement that will occur. In whatever resettlement occurs it is important that MCTPC ensure that the quality of life of the families affected by the project implementation is not in anyway diminished. In other words as a result of resettlement those directly impacted must be at least as well-off as they were prior to the resettlement process.

The MCTPC resettlement plan should place an emphasis on public participation and must include a clear articulation of resettlement policies and principles of compensation for affected families. A monitoring program must also be established to ensure that the resettlement plan is implemented within the timeline provided for in the plan and to ensure that the affected villagers are satisfied with the compensation process.

(5) Compensation:

There are a number of possible impacts on the local people that must be considered in the compensation process. In some cases the impacts may be relatively insignificant such as the loss of a tree or the need to move a house back by several meters in order to accommodate the improvement of the road. Compensation for affected people could be in kind (extra land or materials) or in cash for losses sustained.

6.6 Construction and Operational Mitigation Measures

Based on the nature of the possible impacts identified earlier these regulations and guidelines are designed to mitigate negative impacts and to ensure the positive impacts to the local communities. It is assumed that international standards and practices are adopted in construction operations.

6.7 Development of Environmental Management Plan (EMP)

The environmental management plan is designed to minimize the negative impacts and to ensure that the full benefits of the road will be realized in order to increase the quality of life of the residents. The environmental management plan is divided into two parts.

- Plan, Policies and Regulations discussed earlier.
- Monitoring and Remediation Plan, which will be discussed in this section.

According to the Regulation on Environment Assessment in the Lao PDR prepared by STEA 2002, an environment management plan must contain:

- Protective or reductive measures for environmental impacts.
- Compensation measures (if any).
- Institutional arrangements, timing and budgets for implementation of EMP.
- An environmental monitoring program.
- Community preparation including dissemination of information about the Project prior to work commencing.

The IEE for Routes 14A and 16A have been developed to incorporate these factors. The nature of the environmental management planning process adopted in the IEE process can be seen in Figure 6.7.1.

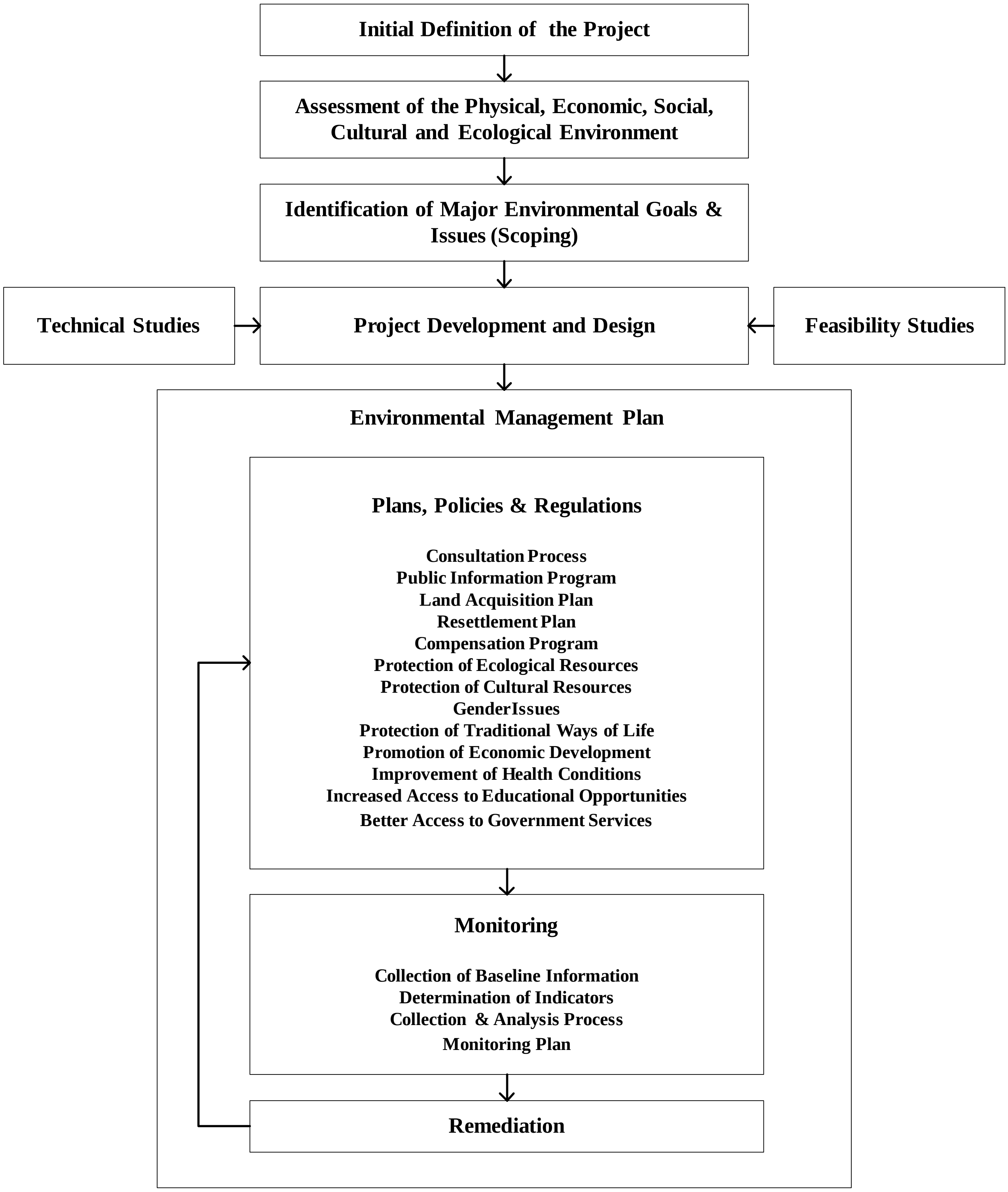


Figure 6.7.1 Environmental Assessment Process

6.8 Evaluating Environmental Impacts of Proposed Roads

Overall environmental impacts from construction of both Routes 14A and 16A are assessed as minor because:

- The project significantly increases the access of residents to markets for their produce as well as a range of social services (especially schools and hospitals).
- The residents in the Route 14A section without a road will have access where none has existed. This increased access must be seen as a major positive impact for the residents.
- The project provides additional protection for heritage resources with the moving of the road away from the ancient city.
- Increased access to Wat Phou, if properly managed, will generate additional income possibilities to local people.
- Increased access to the Xe Katam Tok Waterfall, if properly managed, will generate additional income possibilities for local people on Route 16A.
- Given that the natural/ecological environment is not of national significance there are little or no negative impacts on the ecological system of the area.
- Provisions have been made to mitigate whatever negative impacts through compensation as well as government programs.
- The project has recognized that there are significant benefits than can accrue from the road construction and improvement if mitigation measures and programs are put into place in the help realize the potential of the significant investment that will be provided to improve Route 16A.

The IEE concludes that the overall adverse impacts of the Project will be minor. Careful consideration has been given to Project location, design, construction and operational issues to minimize impacts on environmentally sensitive areas. Compensation procedures and mitigation actions have been identified.

The Project is at the stage where the two IEE reports are in the hands of the Department of Road of MCTPC, which they will have to submit the IEE reports for STEA approval on environmental certificate.

CHAPTER 7 PROJECT COST ESTIMATES

7.1 Introduction

The project cost is estimated by applying “Estimation Method based on Productivity” in order to obtain more accurate output. The project cost composes of the following items.

<u>Project Cost</u>

[1] Pre-Construction Stage

1. Field Survey (i.e., archeological remains and natural forest resources) and UXO Clearance
2. Environmental Monitoring

[2] Construction Stage

1. Civil Works
   (1) Direct Works (Road & Bridge Construction)
   (2) Indirect Works (Temporary Work & Site Expense)
   (3) Overhead (Administration Cost for HQ)
2. Engineering Service (Detailed Design and Construction Supervision)
3. Project Management
   (1) Management by MCTPC
   (2) Environmental Monitoring
4. Borrow Pit Restoration (for Route 14A)
5. Physical Contingency

<u>Road Operation and Maintenance Cost</u>

1. Environmental Monitoring
2. Routine and Periodic Maintenance

7.2 Basis of Cost Estimate

(1) Contractor

All construction works will be executed by international contractor(s).

(2) Applied Exchange Rate (TTS rate dated as of 15th October, 2002)

US$ 1 = JPY 125.55 = Kip 10,940

Kip 1 = JPY 0.01148

(3) Rate of Operation: 0.75

(4) Foreign and Domestic Sources

Procurement items are divided into **Component A** and **Component B** by its source.

Component A is imported items other than items purchased in the local market.

Component B is domestic items including imported items purchased in the local market.

(6) Tax and Duty

Following taxes and duties are deducted from financial cost to obtain economic cost. The assumptions are as follows.

- The taxes and duties on imported equipment/machinery will be exempted because it will be re-exported at the end of the project.
- The taxes and duties for fuel are calculated by import tax (10%), consumption tax (2%) and VAT (5%) multiplicatively.
- The average rate of other local components is 5.4 per cent of Component B in Civil works cost and Physical contingency cost.

7.3 Project Cost Estimate

Total project cost (economic cost) for Routes 14A and 16A is shown in Table 7.3.1. Total costs of civil works and engineering service (financial cost), excluding fuel tax and duty is shown in Table 7.3.2.

Table 7.3.1 Total Project Costs (Rt. 14A & Rt. 16A) :Economic Cost **(US$ 1,000)**

Rt. 14A			Rt. 16A		
A	B	Total	A	B	Total
8,606.5	23,096.5	31,703.1	8,894.0	23,779.3	32,673.3

Table 7.3.2 Total Costs of Civil Works & Engineering Service excluding Fuel Tax (Rt. 14A & Rt. 16A) **(US$ 1,000)**

Rt. 14A			Rt. 16A		
A	B	Total	A	B	Total
8,484.0	23,130.7	31,614.7	8,767.7	24,160.7	32,928.4

<u>NOTE</u>
A: Component A, B: Component B

Table 7.3.3 and 7.3.4 show summaries of the project cost for Routes 14A and 16A respectively.

Table 7.3.3 Summary of the Project Cost for Route 14A (Total Length = 59.301km)

(US$ 1,000)

	Material			Labor			Equipment			Total		
	A	B	Total	A	B	Total	A	B	Total	A	B	Total
[1] Pre-Construction												
1. Survey & Clearance											13.3	13.3
2. Land Acquisition & Resettlement											618.6	618.6
3. Environmental Monitoring											3.2	3.2
Pre-Construction Total										0.0	635.1	635.1
[2] Construction												
1. Civil Works												
(1) Direct Works												
1) Road Works												
(i) Preparatory Works	0.0	0.0	0.0	0.0	558.1	558.1	0.0	558.1	558.1	0.0	1,116.1	1,116.1
(ii) Earthworks	0.0	705.5	705.5	0.0	495.8	495.8	0.0	2,612.3	2,612.3	0.0	3,813.6	3,813.6
(iii) Pavement	0.0	9,324.2	9,324.2	0.0	438.8	438.8	0.0	1,206.7	1,206.7	0.0	10,969.6	10,969.6
(iv) Drainage	0.0	740.7	740.7	0.0	603.5	603.5	0.0	484.6	484.6	0.0	1,828.8	1,828.8
(v) Apparatus Works	0.0	152.6	152.6	0.0	82.1	82.1	0.0	0.0	0.0	0.0	234.7	234.7
(vi) Other Works	0.0	212.5	212.5	0.0	137.2	137.2	549.4	244.0	793.4	549.4	593.7	1,143.1
Total (Road Works)	0.0	11,135.4	11,135.4	0.0	2,315.5	2,315.5	549.4	5,105.7	5,655.1	549.4	18,556.6	19,106.0
2) Bridge Works	315.3	1,991.8	2,307.1	389.8	595.6	985.3	1,852.6	1,390.4	3,243.0	2,557.6	3,977.8	6,535.4
Total (Direct Cost)	315.3	13,127.2	13,442.5	389.8	2,911.1	3,300.8	2,402.0	6,496.1	8,898.1	3,107.0	22,534.4	25,641.4
(2) Indirect Cost										1,140.6	804.8	1,945.4
(3) Overhead										1,879.2	0.0	1,879.2
Total (Civil Works)										6,126.7	23,339.2	29,465.9
2. Engineering Service										2,357.3		2,357.3
3. Project Management											36.3	36.3
4. Borrow Pit Restoration											47.5	47.5
5. Physical Contingency										122.5	466.8	589.3
Construction Total										8,606.5	23,889.8	32,496.3
Project Cost Total										8,606.5	24,524.9	33,131.5
[3] Tax & Duty												
1. Fuel											208.5	208.5
2. Others											1,219.9	1,219.9
Total (Tax & Duty)											1,428.4	1,428.4
Economic Cost (Project Cost - Tax & Duty)										8,606.5	23,096.5	31,703.1

NOTE **(US$ 1 = JPY 125.55)**

A: Component A defines imported items excluding items purchase in the local market.

B: Component B defines domestic items including imported items purchase in the local market.

Project Management includes management cost & environmental monitoring cost at construction stage

Table 7.3.4 Summary of the Project Cost for Route 16A (Total Length = 64.138km) (US$ 1,000)

	Material			Labor			Equipment			Total		
	A	B	Total	A	B	Total	A	B	Total	A	B	Total
[1] Pre-Construction												
1. Survey & Clearance											92.6	92.6
2. Land Acquisition & Resettlement											259.3	259.3
3. Environmental Monitoring											3.2	3.2
Pre-Construction Total										0.0	355.2	355.2
[2] Construction												
1. Civil Works												
(1) Direct Works												
1) Road Works												
(i) Preparatory Works	0.0	0.0	0.0	0.0	405.2	405.2	0.0	405.2	405.2	0.0	810.5	810.5
(ii) Earthworks	0.0	778.5	778.5	0.0	508.4	508.4	0.0	3,479.3	3,479.3	0.0	4,766.2	4,766.2
(iii) Pavement	0.0	11,330.0	11,330.0	0.0	533.2	533.2	0.0	1,466.2	1,466.2	0.0	13,329.4	13,329.4
(iv) Drainage	0.0	673.1	673.1	0.0	548.5	548.5	0.0	440.4	440.4	0.0	1,662.0	1,662.0
(v) Apparatus Works	0.0	92.4	92.4	0.0	49.8	49.8	0.0	0.0	0.0	0.0	142.2	142.2
(vi) Other Works	0.0	248.1	248.1	0.0	159.1	159.1	1,490.6	338.9	1,829.6	1,490.6	746.2	2,236.8
Total (Road Works)	0.0	13,122.1	13,122.1	0.0	2,204.2	2,204.2	1,490.6	6,130.2	7,620.8	1,490.6	21,456.5	22,947.1
2) Bridge Works	183.0	874.6	1,057.6	303.2	273.8	577.1	1,242.6	983.0	2,225.7	1,728.9	2,131.4	3,860.3
Total (Direct Cost)	183.0	13,996.7	14,179.7	303.2	2,478.0	2,781.3	2,733.3	7,113.2	9,846.4	3,219.5	23,587.9	26,807.4
(2) Indirect Cost										1,140.6	804.8	1,945.4
(3) Overhead										1,951.3	0.0	1,951.3
Total (Civil Works)										6,311.4	24,392.7	30,704.1
2. Engineering Service										2,456.3		2,456.3
3. Project Management											36.3	36.3
4. Borrow Pit Restoration												0.0
5. Physical Contingency										126.2	487.9	614.1
Construction Total										8,894.0	24,916.8	33,810.8
Project Cost Total										8,894.0	25,272.0	34,166.0
[3] Tax & Duty												
1. Fuel											232.0	232.0
2. Others											1,260.7	1,260.7
Total (Tax & Duty)											1,492.7	1,492.7
Economic Cost (Project Cost - Tax & Duty)										8,894.0	23,779.3	32,673.3

NOTE **(US$ 1 = JPY 125.55)**

A: Component A defines imported items excluding items purchase in the local market.

B: Component B defines domestic items including imported items purchase in the local market.

Project Management includes management cost & environmental monitoring cost at construction stage

7.4 Road Operation and Maintenance Cost

This component comprises the following items.

(1) Environmental Monitoring Cost

The work will be required annually after completion of construction works. Major components of the work are socio-economic surveys, water quality testing and reporting. The estimated cost is US$10,500 per year.

(2) Routine and Periodic Maintenance Cost

After the start of road operation, daily and periodic maintenance is required to keep its service level. The unit cost for periodic maintenance assumes asphalt overlay at the end of the design period of the initial pavement structure (2018). The costs are shown in Table 7.4.1.

Table 7.4.1 Unit Costs of Routine and Periodic Maintenance (Rt. 14A & Rt. 16A)

Routine (US$/km/year)	Periodic (US$/km/time)
700	59,400

CHAPTER 8 PROJECT ECONOMIC ANALYSIS AND EVALUATION

8.1 Introduction

This chapter describes the Feasibility Study economic evaluation of the two priority projects. The main changes to the methodology and assumptions between the Master Plan and the Feasibility Study's analyses, were as follows:

Route 14A. The southern endpoint of the project has been changed from the junction with Route 14C1 to the junction to Sukhuma. The length increases from 54.0 to 59+301km. Upgrading of the existing sub-standard paved section through the town of Champasack has been considered impractical due to the extent of existing development within the required ROW and the section's traversal of the site of the ancient city. A replacement westerly by-pass of Champasack is proposed, extending the new construction section southwards to join the existing route just to the south of its intersection with the approach road to Wat Phou (km 35+440). Also proposed is a 1.5km easterly bypass of Ban Dontalat, which avoids a heavily congested market area on the existing alignment.

Route 16A. An 8.3km new construction section (km 34-42) is proposed based on preliminary engineering design. This provides a short cut, reducing the route length by 6.3km from the existing 70.4 to 64+138km.

Construction costs. Costs have been estimated at October 2002 prices, based on preliminary engineering design quantities. Road design is based on asphalt concrete pavement.

User benefits. Benefits have been evaluated using the World Bank's Roads Economic Decision Model. The model has been calibrated with economic cost data for October 2002.

Vehicle classes. The number of classes has been increased from four to eight, with light vehicles divided into cars and pick-ups; buses divided into light, medium and heavy; and light trucks added to the medium and heavy truck classes.

Traffic forecasts. The forecasts have been revised to incorporate supplementary 2002 survey data and data collected for the ADB Smallholder Development Project.

8.2 Traffic Forecast

In addition to serving existing traffic, both projects will divert substantial volumes from other routes. Traffic will divert to Route 14A from two existing routes: Routes 16/14A1 to the west and Route 13S/Mekong ferry to the east. Traffic will divert to Route 16A from the existing paved route through Sekong on Routes 16/1I. Committed projects which will be completed before 2008, the construction of Route 18B Attapeu – Vietnamese border and the completion of paving of Route 1I Attapeu – Xe namnoy, will generate traffic and open new routes Vietnam/Attapeu – Pakse/Thailand, which will form part of the diversion to Route 16A.

Distance changes

The distance changes resulting from the projects are given in Table 8.2.1. They are for traffic to/from Pakse (measured from the intersection of Routes 16/13S immediately east of Pakse bridge), to/from Ban Lak 12 (representing the savings for traffic from the west and Thailand) and for Paksong-Xe namnoy.

Table 8.2.1 Distance Changes with Projects (in km.)

Trip	Now	Project	Change	Now	Project	Change
Route 14A:	**From Pakse**			**From Ban Lak 12 (Thai)**		
Champasack via:						
Route 13S/Ferry	33.0	29.0	- 4.0	50.0	38.0	-12.0
Routes 16/14A1/14A	77.7	29.0	-48.7	60.7	38.0	-22.7
Wat Phou approach via:						
Route 13S/Ferry	43.5	38.3	- 5.2	60.5	47.3	-13.2
Routes 16/14A1/14A	67.2	38.3	-28.9	50.2	47.3	- 2.9
Ban Donthalath* via:						
Route 13S/Ferry	51.2	46.0	- 5.2	68.2	55.0	-13.2
Routes 16/14A1/14A	59.5	46.0	-13.5	42.5	55.0	+12.5
Route 16A:	**Paksong – Xe namnoy**					
Route 16A existing	70.4	64.1	- 6.3			
Routes 16/1I diverting	111.0	64.1	-46.9			

Note: Distance traveled on the ferry crossing is excluded from the table.

* The same savings apply for points south to Sukhuma.

In addition to the distance savings (and their associated time savings) the Route 14A project will provide time savings estimated at 35 minutes for each user of the Champasack ferry diverting to the new road.

Generated traffic will result directly from the reduction in road user costs produced by the project. Additional trips will be made that would not otherwise be made. Induced traffic, additional to generated traffic, is expected on Route 14A, with the opening up of the west bank area, for tourism in particular. The Route 14A project will stimulate tourism-related and other development in the west bank corridor. For example, the number of visitors to Wat Phou is likely to grow substantially. The long term potential for domestic and international tourism is substantial.

Route 16A also has some tourist potential. The spectacular Katam Tok waterfall can be viewed at km 47 and the route passes through attractive scenery descending the Boloven Plateau escarpment.

The forecast traffic volumes in project opening year 2008 by category are given in Table 8.2.2.

Table 8.2.2 Traffic Composition 2008 (Excluding motorcycles)

Component	Normal/Diverting	Generated	Induced	Total
Route 14A:				
Diverting from ferry	111	48	28	187
Diverting from Route 14A1	124	85	27	236
Total km 0.0-34.0	235	133	55	423
As %	56	31	13	100
Km 34.0-59.3	179	82	40	301
As %	59	27	13	100
Route 16A:				
Diverting from Rt16/1I	251	115	0	366
Existing route*	85	43	0	128
Total	336	158	0	494
As %	68	32	0	100

Note: *weighted by distance.

The forecast motorcycle volumes in 2008 are: Route 14A new construction section 476 diverted plus 238 generated, Route 14A improvement section 1461 normal and Route 16A 292 normal.

8.3 Project Costs

Project costs comprise the economic cost of project implementation 2005-2007, the cost of an overlay in 2018 and the net annual cost of routine maintenance for the with and without project situations. These are considered below.

Economic cost. The financial cost estimates are at constant 2002 prices. No price contingency is included, inflation for the period 2002-2007 is assumed to be zero. To derive economic cost, taxes and duties have been deducted from the financial cost.

Table 8.3.1 Project Cost Estimates Summary (in US$ million)

	Route 14A			Route 16A				
Item	0-34	34-59	All	0-34	34-42	42-58	58-64	All
Land acquisition	0.38	0.30	0.68	0.25	0.03	0.04	0.04	0.35
Civil works	20.52	8.94	29.47	13.27	4.85	9.91	2.67	30.70
Engineering services	1.37	1.02	2.40	1.32	0.31	0.62	0.24	2.50
Physical contingency	0.41	0.18	0.59	0.26	0.10	0.20	0.05	0.61
Financial cost	**22.68**	**10.45**	**33.13**	**15.11**	**5.29**	**10.77**	**3.00**	**34.17**
Taxes and duties	-1.00	-0.43	-1.43	-0.65	-0.25	- 0.48	-0.12	-1.49
Economic cost	**21.69**	**10.02**	**31.70**	**14.46**	**5.04**	**10.29**	**2.88**	**32.67**
Economic cost/km	0.64	0.40	0.53	0.43	0.63	0.64	0.47	0.51

Note: Land acquisition includes surveys and clearance. Engineering services includes project management.

Disbursement schedule. The annual disbursements for financial and economic costs are summarized in Table 8.3.2

Table 8.3.2 Project Disbursement Summary (in US$ million)

Project	**2004**	**2005**	**2006**	**2007**	**Total**
Route 14A:					
Financial cost	0.01	4.57	15.04	13.51	33.13
Economic cost	0.01	4.37	14.39	12.94	31.70
Economic cost in %	0.0	13.8	45.4	40.8	100.0
Route 16A:					
Financial cost	0.02	5.95	14.74	13.47	34.17
Economic cost	0.01	5.70	14.07	12.90	32.67
Economic cost in %	0.0	17.5	43.1	39.4	100.0

8.4 Project Benefits

Project benefits comprise vehicle operating cost and passenger time savings for normal and diverted traffic and benefits for generated and induced traffic. Benefits have been evaluated with the Road Economic Decision Model (RED).

Benefits to motorcycles are significant, in particular for Route 14A, where motorcycle volume is high.

The distribution of user benefits by traffic component for 2008 is as follows (in per cent):

Table 8.4.1 User Benefits by Traffic Component for 2008

Section	**Normal**	**Diverted**	**Generated/ Induced**	**Mot/C**	**Time on Ferry**
Route 14A:					
Km 0.0-34.0	-	51.6	23.8	18.5	6.1
Km 34.0-59.3	51.0	-	17.9	31.1	-
Combined	14.2	37.2	22.2	22.0	4.4
Route 16A:	22.5	52.6	18.9	6.0	-

The total amount of the user benefits over the 20-year analysis period (2008-2027) is given below:

Table 8.4.2 Total Amount of User Benefit 2008-2027

Section	Undiscounted	Discounted at 12%
	(in US$ million)	
Route 14A:		
Km 0.0-34.0	85.2	15.9
Km 34.0-59.3	33.6	6.2
Combined	118.9	22.2
Route 16A:	127.0	23.5

The ratios of undiscounted total benefits to construction cost are: Route 14A 3.75 and Route 16A 3.89.

8.5 Economic Analysis Results

A separate analysis has been performed for the new construction (km 0.0-34.0) and for the improvement (km 34.0-59.3) sections of Route 14A. A combined result for the whole Route 14A project has also been calculated. For Route 16A, a sectional analysis is not meaningful, because most of the benefits are from diverting traffic, which are only achievable if the whole project is implemented.

The results of the economic analysis are presented in Table 8.5.1. The indicators evaluated are: economic internal rate of return (EIRR); net present value (NPV) of costs and benefits discounted at the test discount rate of 12 per cent; first (opening) year benefit (FYB), expressed as a percentage of construction cost, escalated to opening year at 12 per cent per annum; and benefit cost ratio (B/C) at a discount rate of 12 per cent. The FYB is an indicator of the optimum year of project opening, while the EIRR, NPV and B/C indicate economic performance over the whole of the economic analysis period. A rate of 12 per cent has been used for the test discount rate as an indicator of the opportunity cost of capital for public sector projects of moderate risk.

The costs and benefits of the Route 14A project (for both analysis sections combined) are given in Table 8.5.2 and those for Route 16A in Table 8.5.3. In these tables annual benefits are shown by traffic component: normal, diverted and generated/induced and benefits are divided into road user cost savings and time savings.

The economic feasibility study outcomes for the two routes are very similar: there is no significant difference between the results. The new construction section of Route 14A has a higher EIRR than the improvement section, in spite of a 60 per cent larger construction cost per km, due to the distance savings it produces for diverting traffic and its 40 per cent higher traffic volume.

Table 8.5.1 Economic Analysis Results

Project	EIRR (in%)	NPV (US$ mill)	FYB (in%)	B/C
Route 14A;				
New construction km 0.0-34.0	11.1	-1.41	6.1	0.92
Improvement km 34.0-59.3	9.2	-1.91	5.0	0.77
Combined km 0.0-59.3	10.5	-3.32	5.8	0.87
Route 16A:				
Km 0.0-64.1	10.7	-2.97	5.8	0.89

Table 8.5.2 Costs and Benefits Route 14A(in US$ Thousand)

	Economic Costs		Benefits: Normal Traffic		Diverted Traffic		Generated/Induced Traffic		Ferry	Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	VOC	Time	Time	VOC/Time	Benefits	Benefits
2005	-4375	0	0	0	0	0	0	0	0	0	0	-4375
2006	-14393	0	0	0	0	0	0	0	0	0	0	-14393
2007	-12935	0	0	0	0	0	0	0	0	0	0	-12935
2008	0	-41	265	57	702	138	420	81	100	498	2260	2219
2009	0	-41	286	61	757	149	454	87	108	553	2455	2413
2010	0	-41	310	66	821	161	492	94	116	597	2658	2616
2011	0	-41	336	71	890	174	534	102	126	645	2878	2836
2012	0	-41	365	77	964	189	579	110	136	697	3116	3075
2013	0	-41	396	83	1046	204	628	119	146	752	3374	3333
2014	0	-41	429	90	1133	221	681	129	158	812	3654	3613
2015	0	-41	466	97	1229	239	738	139	171	877	3957	3915
2016	0	-41	505	105	1332	258	801	151	184	948	4285	4244
2017	0	-41	548	114	1445	279	869	163	199	1023	4640	4599
2018	0	-3356	595	123	1566	302	942	176	215	1105	5025	1670
2019	0	-41	646	133	1698	327	1022	190	232	1194	5443	5401
2020	0	-41	701	144	1842	354	1108	206	251	1289	5895	5853
2021	0	-41	760	156	1997	382	1202	223	271	1367	6358	6317
2022	0	-41	825	169	2166	414	1304	241	293	1449	6860	6818
2023	0	-41	896	183	2349	448	1414	261	316	1535	7401	7360
2024	0	-41	972	197	2547	484	1534	282	341	1628	7986	7945
2025	0	-41	1055	214	2762	524	1664	305	369	1725	8618	8577
2026	0	-41	1145	231	2996	567	1805	330	398	1829	9301	9259
2027	12681	-41	1243	250	3249	613	1958	357	430	1938	10038	22678

Results: EIRR 10.5% NPV 12% -3323 FYB % 5.8 B/C 0.87

Table 8.5.3 Costs and Benefits Route 16A(in US$ Thousand)

	Economic Cost		Benefits:Normal Traffic		Diverted Traffic		Generated Traffic		Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	VOC	Time	VOC/Time	Benefits	Benefits
2005	-5718	0	0	0	0	0	0	0	0	0	-5718
2006	-14082	0	0	0	0	0	0	0	0	0	-14082
2007	-12873	0	0	0	0	0	0	0	0	0	-12873
2008	0	-36	484	45	1125	113	403	41	142	2353	2317
2009	0	-36	523	49	1212	122	435	44	157	2542	2507
2010	0	-36	567	53	1313	132	472	48	175	2760	2724
2011	0	-36	615	58	1421	143	513	52	194	2996	2960
2012	0	-36	668	62	1539	155	556	56	215	3252	3217
2013	0	-36	725	68	1667	168	604	61	239	3531	3495
2014	0	-36	787	73	1805	182	655	66	265	3834	3798
2015	0	-36	854	79	1955	197	711	71	294	4163	4127
2016	0	-36	926	86	2118	214	772	78	327	4521	4485
2017	0	-36	1006	93	2294	232	838	84	363	4909	4874
2018	0	-3627	1091	101	2484	251	910	91	403	5332	1705
2019	0	-36	1185	110	2691	273	988	99	447	5791	5756
2020	0	-36	1286	119	2915	295	1073	107	496	6291	6255
2021	0	-36	1396	129	3158	320	1164	116	536	6819	6784
2022	0	-36	1516	139	3421	347	1264	126	578	7392	7357
2023	0	-36	1645	151	3706	376	1373	137	625	8013	7978
2024	0	-36	1786	164	4016	408	1491	148	675	8687	8652
2025	0	-36	1939	178	4351	442	1618	161	729	9418	9382
2026	0	-36	2105	192	4714	479	1757	175	787	10210	10174
2027	13069	-36	2286	209	5107	520	1908	189	850	11069	24102
Results:	EIRR	10.7%	NPV 12%	-2970	FYB	5.8%	B/C	0.89			

8.6 Sensitivity Tests

The results of the sensitivity tests for Route 14A (two sections combined) are given in Table 8.6.1. The tests for Route 16A are given in Table 8.6.2.

Table 8.6.1 Route 14A Sensitivity Analysis

Case	EIRR (in %)	NPV (US$ mill)	FYB (in%)
Base case	10.5	-3.32	5.8
Construction cost –20%	12.7	1.41	7.2
Construction cost +20%	8.9	-8.05	4.8
Master Plan per km constr. cost	18.1	8.24	11.2
Residual value of 25% (-38%)	10.3	-3.67	#
Residual value of 50% (+25%)	10.6	-3.09	#
Excluding motorcycle benefits	8.2	-7.93	4.4
Excluding generated/induced	8.1	-8.06	4.4
Value of time US$0.26/hr. (-33%)	10.0	-4.48	5.4

Note: # outcome unaffected.

Table 8.6.2 Route 16A Sensitivity Analysis

Case	**EIRR (in%)**	**NPV (US$ mill)**	**FYB (in%)**
Base case	10.7	-2.97	5.8
Construction cost –20%	13.0	1.94	7.2
Construction cost +20%	9.1	-7.87	4.8
Master Plan per km constr. cost	21.9	11.68	14.5
Residual value of 25% (-38%)	10.6	-3.33	#
Residual value of 50% (+25%)	10.9	-2.73	#
Excluding motorcycle benefits	10.0	-4.57	5.4
Excluding generated/induced	8.8	-7.2	4.7
Value of time US$0.26/hr. (-33%)	10.4	-3.74	5.6
Route 18A paved in 2015	8.0	-7.95	#
Route 18A paved in 2020	9.2	-5.77	#

Note: # outcome unaffected.

8.7 Conclusions

This chapter has evaluated the economic feasibility of raising the standard of Routes 14A and 16A to that of high quality paved roads, with asphalt concrete pavement. The analysis shows that both projects would produce substantial economic benefits, of a similar magnitude. The Route 14A project, with an economic implementation cost of US$32 million, produces benefits in its first 20 years in service of US$119 million, while the corresponding figures for Route 16A are benefits of US$127 million for an economic cost of US$33 million.

Route 16A performs a little better than Route 14A on all economic performance indicators. The results for the two projects are, however, too close for one to be selected as of higher economic priority. The difference between the outcomes is well within the range of the sensitivity tests. The northern, new construction, section of the Route 14A project performs significantly better than the reconstruction section, with undiscounted benefits 3.9 times economic cost, compared with 3.4 times for the southern section. This is a result of its diversion potential and of its 40 per cent higher traffic volume.

The base case EIRRs for the two projects, 10.5 per cent for Route 14A and 10.7 per cent for Route 16A, are close to the test discount rate of 12 per cent, indicating that project implementation 2005-2007 may be appropriate based solely on their benefits to road users. In fact, these particular projects are likely to produce significant social and other benefits in their influence areas and beyond, in addition to their direct economic benefits.

CHAPTER 9 PROJECT IMPLEMENTATION PLAN

9.1 Overview

Improvement of Routes 14A and 16A would clearly provide a valuable addition to infrastructure of the southern region of Lao P.D.R. The improvement cost however is considerable. Therefore, the implementation schedule is based on financing i.e. grant aid. There are no serious land acquisition issues for the Projects.

9.2 Project Implementation Schedule

The project implementation schedule should be consistent with technical needs and the proper sequencing of activities consistent with institutional capacity and the availability of resources for the project. The proposed project implementation schedule is shown in the bar chart Figure 9.2.1.

Project construction will be divided into two packages (i.e., Route 14A and 16A) in consideration of financeable amount, and a contract size which is attractive, and manageable by international contractors, but not so large as to limit the numbers likely to bid. Each package will be scheduled for completion in a period of 30 months. Commencement of earthworks and foundation works for structures should begin at the end of the rainy season (middle of October). A possible schedule would be for construction to commence mid-2005 for completion by end 2007.

The schedule is subject to the followings constraints:

Finance Processing

Request for project finance will be applied by the GoL by August 2003. Approximately a year will be required for the formalities of securing finance.

Field Survey

- Field survey for **UXO**, **archaeological remains** and **natural forest resource** will be executed by the GoL in order to identify the existence for setting the final road alignment as well as to calculate the yield that will come from the clearance activities, before commencement of detailed design, that is by end-2004.

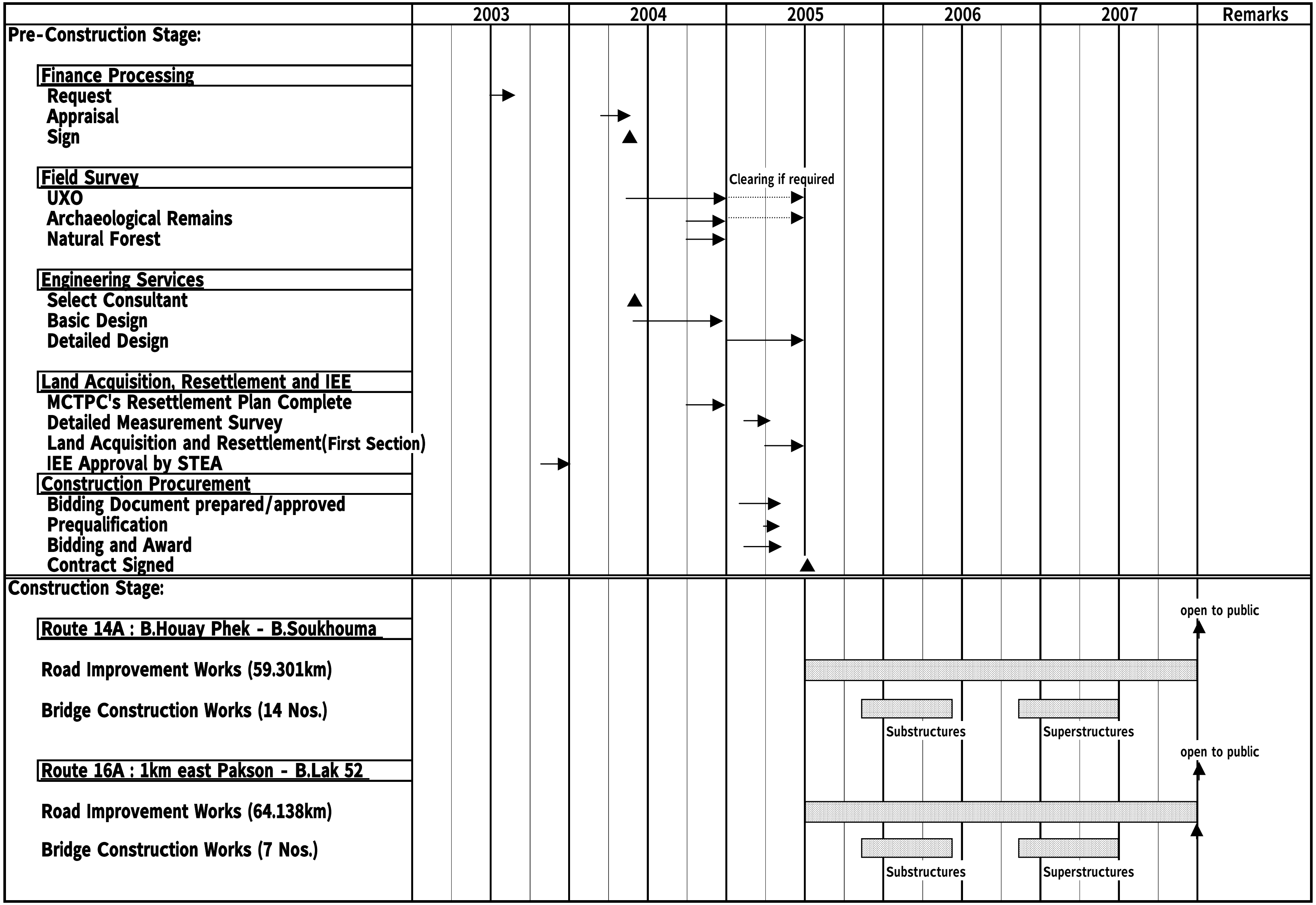


Figure 9.2.1 Project Implementation Schedule

- If clearing of UXO and/or archaeological remains is required, clearing by the GoL shall be completed, before commencement of construction work, that is by end June 2005. Surveys are required on new road construction sections.
- The survey and clearance for UXO will be managed by the Lao National UXO Program (**UXO LAO**) and the Ministry of Labor and Social Welfare.
- The survey and clearance for archaeological remains will be managed by the **Department of Museum and Archaeology**, Ministry of Information and Culture.
- The survey for natural forest will be managed by the **Department of Forestry**, Ministry of Agriculture and Forestry.

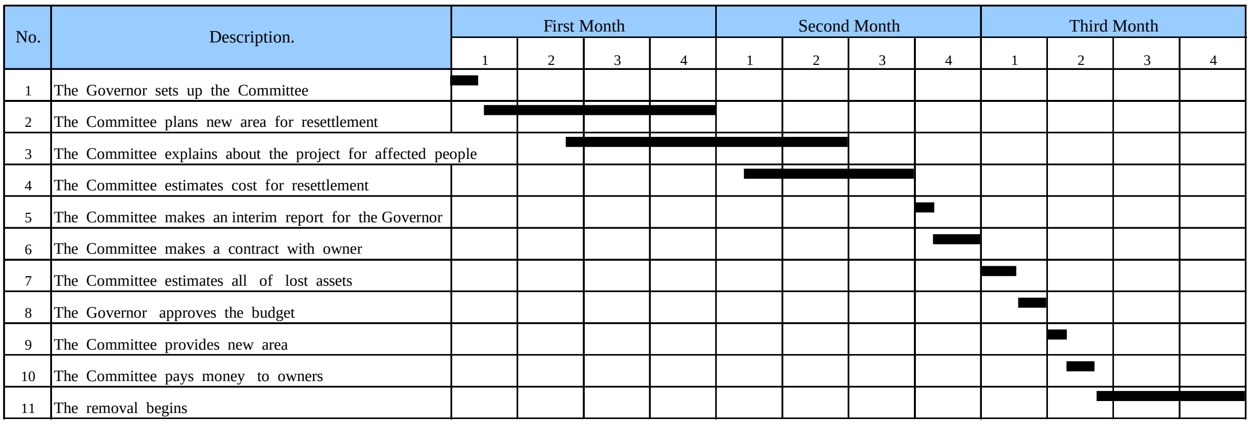
Engineering Services

The initial road alignment based on the trace of the Feasibility Study will be established at **basic design** stage prior to **detailed design**. The final road alignment will be determined during detailed design, that is around March 2005.

Land Acquisition and Resettlement

The resettlement plan will be completed before basic design completion. The legal process and acquisition / resettlement actions required should be undertaken in parallel with detailed design. The amount of land actually affected, number of households and assets will be determined and measured during the detailed measurement survey. All the required land should be acquired prior to the award of construction contracts and be cleared by the commencement of construction work. This legal process will take about three months. It is shown in Figure 9.2.2.

The Provincial Governor sets up a committee to undertake the legal action for land acquisition and resettlement. The Committee is composed of staff from the Governor's Office, D.C.T.P.C, the Department of Planning and Cooperation, the Department of Finance, District Office, and Head of District, Head of Village and a representative of village. Soon after compensation money is paid to the owner, the removal will begin and complete in two to four weeks.



The Committee is composed of : staff from Governor's Office, D.C.T.P.C, Department of Planning and Cooperation, Department of Finance, District Office and Head of Village

Figure 9.2.2 Resettlement Process

IEE Approval

The Social and Environment Division of the Department of Roads (**DOR**) will be closely cooperated with the implementation of the Environmental Management Plan and DOR should obtain the approval of IEE from **STEA** by end-2003.

Contractor Selection

The construction procurement activity will commence at the beginning of 2005 and the contractor will be selected in mid - 2005.

Construction

The construction will commence about mid-2005 and be completed by end-2007. It is suggested that earthworks and foundation works for structures commence at the end of the rainy season (mid October).

9.3 Disbursement Schedule

Based on the above implementation schedule, the disbursement program indicating maintenance for 20 years after project completion, that is a project life, is established in Table 9.3.1. Initial project management and construction costs and maintenance costs are indicated.

Table 9.3.1 (1) Summary of Disbursement Schedule (Rt. 14A)

(1,000 US$)

Year	Pre-Construction Stage	Construction Stage: Civil Works		Construction Stage: E/S (DD & SV)		Construction Stage: Others	Construction Stage: Physical Contingency		Operation: Maintenance & Monitoring	TOTAL		
	B	A	B	A	B	B	A	B	B	A	B	Total
2004	16.5									0.0	16.5	16.5
2005	618.6	940.5	2,465.2	471.5	0.0	4.7	18.8	49.3		1,430.7	3,137.8	4,568.6
2006		2,588.0	11,194.2	942.9	0.0	39.6	51.8	223.9		3,582.7	11,457.6	15,040.3
2007		2,598.3	9,679.8	942.9	0.0	39.6	52.0	193.6		3,593.1	9,913.0	13,506.1
2008									52.0	0.0	52.0	52.0
2009									52.0	0.0	52.0	52.0
2010									52.0	0.0	52.0	52.0
2011									52.0	0.0	52.0	52.0
2012									52.0	0.0	52.0	52.0
2013									52.0	0.0	52.0	52.0
2014									52.0	0.0	52.0	52.0
2015									52.0	0.0	52.0	52.0
2016									52.0	0.0	52.0	52.0
2017									52.0	0.0	52.0	52.0
2018									3,534.9	0.0	3,534.9	3,534.9
2019									52.0	0.0	52.0	52.0
2020									52.0	0.0	52.0	52.0
2021									52.0	0.0	52.0	52.0
2022									52.0	0.0	52.0	52.0
2023									52.0	0.0	52.0	52.0
2024									52.0	0.0	52.0	52.0
2025									52.0	0.0	52.0	52.0
2026									52.0	0.0	52.0	52.0
2027									52.0	0.0	52.0	52.0
TOTAL	635.1	6,126.7	23,339.2	2,357.3	0.0	83.8	122.5	466.8	4,523.1	8,606.5	29,048.0	37,654.6
		29,465.9		2,357.3			589.3					

Table 9.3.1 (2) Summary of Disbursement Schedule (Rt. 16A)

(1,000 US$)

Year	Pre-Construction Stage	Construction Stage: Civil Works		Construction Stage: E/S (DD & SV)		Construction Stage: Others	Construction Stage: Physical Contingency		Operation: Maintenance & Monitoring	TOTAL		
	B	A	B	A	B	B	A	B	B	A	B	Total
2004	18.9									0.0	18.9	18.9
2005	336.2	1,203.5	3,808.4	491.3	0.0	4.7	24.1	76.2		1,718.8	4,225.5	5,944.4
2006		2,354.7	11,113.7	982.5	0.0	15.8	47.1	222.3		3,384.3	11,351.8	14,736.1
2007		2,753.2	9,470.6	982.5	0.0	15.8	55.1	189.4		3,790.8	9,675.8	13,466.6
2008									55.4		55.4	55.4
2009									55.4		55.4	55.4
2010									55.4		55.4	55.4
2011									55.4		55.4	55.4
2012									55.4		55.4	55.4
2013									55.4		55.4	55.4
2014									55.4		55.4	55.4
2015									55.4		55.4	55.4
2016									55.4		55.4	55.4
2017									55.4		55.4	55.4
2018									3,822.4		3,822.4	3,822.4
2019									55.4		55.4	55.4
2020									55.4		55.4	55.4
2021									55.4		55.4	55.4
2022									55.4		55.4	55.4
2023									55.4		55.4	55.4
2024									55.4		55.4	55.4
2025									55.4		55.4	55.4
2026									55.4		55.4	55.4
2027									55.4		55.4	55.4
TOTAL	355.1	6,311.4	24,392.7	2,456.3	0.0	36.3	126.2	487.9	4,874.9	8,894.0	30,146.9	39,040.9
		30,704.1		2,456.3			614.1					

NOTE

All costs are 'financial costs'. "Others" contains 'borrow pit restoration cost' & 'project management cost'.

A: Component A defines imported items excluding items purchase in the local market. B: Component B defines domestic items including imported items purchase in local market.

E/S: Engineering Service, DD: Detailed Design, SV: Construction Supervision

CHAPTER 10 IMPROVEMENT PLAN FOR ROUTE 18A

10.1 Concept of Improvement of Route 18A

This chapter develops a methodology to establish an improvement plan for the low-trafficked road or link, which has a high ranking in terms of socio-economic impact. This road will provide "**Basic Access** and a **Road for Regional Economic Activity**" to reduce current poverty levels. This improvement plan with the methodology will enable the Government to execute the plan by **using its own economic and technical resources**.

From the social development viewpoint, the Master Plan found that there are several routes or links that should be improved. Although the upgrading of these routes or links to all-weather two-lane roads with two-lane permanent bridges in not justified on the basis of economic analysis, there is a need for them to be improved to a minimum basic access standard, in order to raise living standards and to alleviate poverty.

Route 18A is considered here **as an example,** because the people who live along a significant portion of this route have some of the lowest income levels and literacy in southern Lao. This can be attributed to a lack of access to jobs and educational opportunities, with large sections of the road being impassable for long periods of time.

The approach is from the social development perspective, not a pure road and traffic engineering one to road structure. In order to achieve this, a concept of "**improvement suitable for development stage**" is established, with road and bridge structures suitable for each stage defined. Economic feasibility is also examined to evaluate the approach.

10.2 Establishment of Road Improvement Policy

10.2.1 Evaluation of Current Condition

(1) Road Condition of Route 18A

Route. 18A is an east-west route of 112.5 km that connects Route 13S south of Pakse to Route 1I near Attapeu. This route can be divided into three sections: (1) the section from Route 13S to Xe Khampho River at the 30.6 km mark, (2) the section from Xe Khampho River to Xe Pian River at the 70.3 km mark, and (3) the section from Xe Pian River to Route 1I. In addition to these rivers, there are 33 other medium- to large-scale rivers on the route.

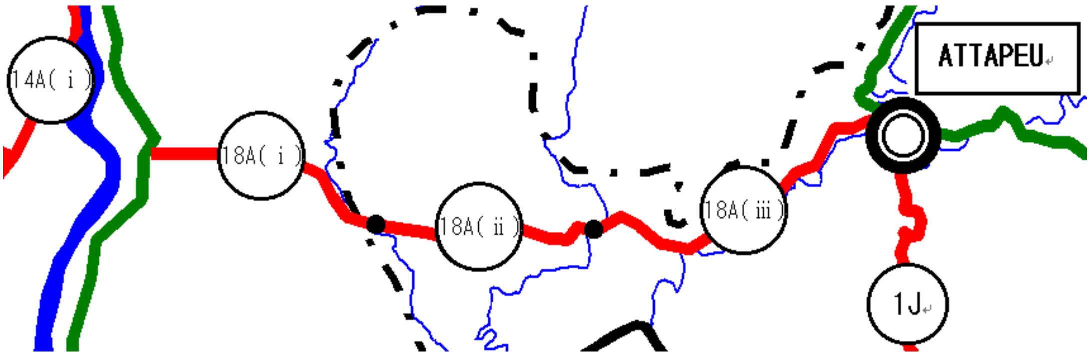
The first section is located in flat to rolling terrain and runs mainly through copse and small villages. The road surface is in fair condition and its width ranges from 5m to 8m in flat sections and 3.5m to 4.0m in rolling sections.

The second section, which between the Xe Khampho and Xe Pian rivers, is located in rolling terrain and passes mainly through areas of forest or copse. This section is regarded as a missing link because there are many rivers without bridges and the road surface is in poor condition, particularly during the rainy season. In fact, this section is only passable for a few months of the year. The road width is also very narrow, varying from 1.5m to 3.0m. This physical isolation makes it extremely difficult (if not impossible) for local people to access education, health, or work facilities.

The third section, which runs from km 70.3 - 112.5 mark, is mainly flat terrain covered by copse or paddy field. There are some villages along the route and population density is relatively high. The road surface, which is earth, is kept in relatively fair condition and is 4.0m to 6.7m in width.

(2) Socio-Economic Characteristics of Route 18A

As Figure 10.2.1 and Table 13.2.1 indicate, there are large differences in the socio-economic character of the three routes section. The middle section, which has poor accessibility, has the lowest socio-economic indicators. The other two sections have socio-economic indicators that are approximately equal to the national average.



Section 1(L=30.6km)	Section 2(L=39.7km)	Section3(L=42.2km)
Literacy rate: Above national average	Literacy Rate: Substantially Below National Average	Literacy rate: Approx. equal national average
Income level: Approx. equal to national average	Income Levels: Substantially Below national Average	Income level: Approx. equal to national average

Figure 10.2.1 Categorization of Route 18A according to Their Development Level

10.2.2 Identification of Development Stages

(1) Definition of Staged Development

Improvements to Rt. 18A should be carried out to satisfy the needs of the different stages of development of the surrounding area. Below, development is defined as occurring in three stages.

Development Stage 1: Provision of Basic Access

Most local people along the road are **living at subsistence levels** and therefore economic activity is local-based. Occasionally, they may go to the nearest district center. At this stage of development, simple all-season access (i.e., basic access) for the prevalent mode of transport (which is walking, bicycle, or motorbike) should be provided over the entire route, so that local people can go to schools, hospitals, and pursue job opportunities. Accordingly, minimum standards and specifications can be applied to the design of road and crossing structures. That is, a **one-lane earth road with one-lane crossing structures** should be sufficient. The load capacity of bridges can be limited to 8 tons and be made of timber type maybe also allowable for a short span bridge.

Development Stage 2: Development from Local to Regional Economic Activity

As **agricultural activity continues to gradually develop**, local people may wish to start accessing markets to sell their produce and buy commodities. In addition, with increased income, some parents may wish to send their children to secondary school or high school outside of their village. This process would result in the **local economy becoming more integrated into the surrounding region**, and traffic between Attapeu and Pakse increasing.

In this stage, a road should be upgraded to a **two-lane gravel road with one-lane bridges**, and the load capacity of bridges should be increased to 20 tons to deal with the larger volumes of motorized traffic.

Development Stage 3: Development into an International Corridor

In this stage, economic activity with neighbouring countries would result in further increases in traffic demand and the need for greater road capacity to serve as an **international corridor**. In order for a road to play this role, **a two-lane DBST road with two-lane permanent bridges** will be necessary. The load capacity of bridges should be a minimum of 20 tons.

(2) Selection of Appropriate Development Stage for Route 18A

In consideration of the current low traffic volumes and low levels of economic activity, as well as a realistic assessment of future traffic and economic potential, the Study team has identified that the road development plan for Rt. 18A should consider work up to Development Stage 2. It is assumed that this level of development will be reached in 5-10 years.

10.2.3 Road Improvement Policy for Route 18A

In order to establish an appropriate road improvement plan suitable for **Development Stage 2**, roads and crossing structures should consider the following requirements.

- **To improve the route to an all-weather road, excluding periods with exceptionally high water levels**
- **To select an appropriate road cross-section, bridge width, geometric standard and surface type based on traffic forecasts**
- **To consider the possibility of further improvements in the future**
- **To plan crossing structures passable throughout the year for small-to medium-sized rivers.**

10.3 Determination of Road and Crossing Structures

10.3.1 Road Class and Structure for Route 18A

(1) Assumptions of Road and Traffic Conditions

The road structure, which must eventually meet the needs of Development Stage 2, shall be determine based on the assumptions given below.

1) Terrain

As a result of site reconnaissance, the whole route can be regarded as being located on flat terrain.

2) Traffic Conditions

Forecast annual traffic volumes by section were calculated on the assumption that Route 16A would be improved to a paved road.

(2) Road Class and Pavement Type

Based on the traffic volume in 5-10 years, a Class IV road for sections l and 3, and a Class V road for section 2 are appropriate. This road structure also meets the minimum requirement for Development Stage 2 and the socio-economic characteristics of each section. The typical cross-section proposed for Route 18A is shown in Figure 10.3.1. A gravel surface is adequate for Development Stage 2. DBST can be applied if traffic volume is large enough.

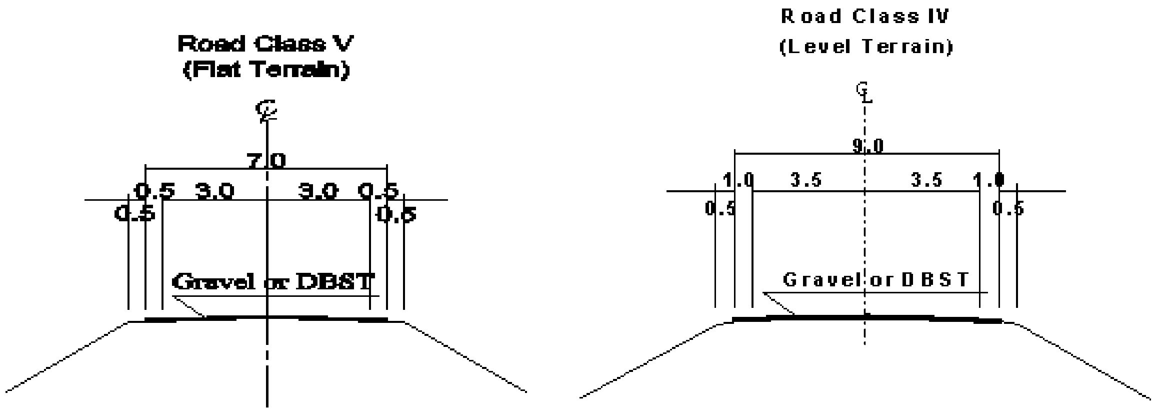


Figure 10.3.1 Typical Cross-Section of Rt. 18A

(3) Pavement Structure

The structure of a gravel surface is determined by the method described in the Road Design Manual. Assumptions are indicated below

CBR : 7 – 13

Traffic volume : 150 – 500 PCU

As a result, 325 mm gravel thickness is required.

10.3.2 Crossing Structure for Route 18A

(1) Crossing Structure Alternatives

From the Master Plan Study, it is known that crossing structures such as bridges and culverts are a major component of construction costs for Route 18A. In fact, structures account for approximately 45% of the total cost. Therefore, **reducing bridge costs is an important** method to increase route feasibility. Accordingly, the following crossing structure alternatives have been examined. These alternatives are limited to streams and rivers more than 10m in width.

Alternative A: Submersible bridge

Alternative B: Bailey bridge

Alternative C: One-lane permanent bridge

The characteristics of each alternative are summarized in Table 10.3.1.

(2) Application of Alternatives

Depending on the conditions of the bridge site and river, the usefulness of the characteristics of the different crossing structure alternatives will vary. Consequently, the most suitable alternative for a bridge site have been selected taking the following into consideration:

- Alternative A, a **submergible bridge** type, is suitable for bridge sites crossing medium to large-scale rivers with exposed hard rock riverbeds or composed of hard soils.
- Alternative B, a **Bailey bridge** type, is suitable for bridge sites crossing deep valleys in Section 1 and 3 or for crossing small to medium rivers in Section 2.
- Alternative C, a **permanent one-lane bridge**, is suitable for bridge sites crossing small to medium rivers in Section 1 and 3 where have more traffic volumes than Section 2.

(3) Selection of Appropriate Alternative for Each Bridge Site

Table 10.3.2 shows the alternatives for each bridge site on the basis of the above application policy. From the Table 10.3.2, the total seven of a submersible type, nineteen of a Bailey type and nine of a permanent one-lane type are applied at bridge sites.

Table 10.3.1 Crossing Structure Alternatives for Route 18A

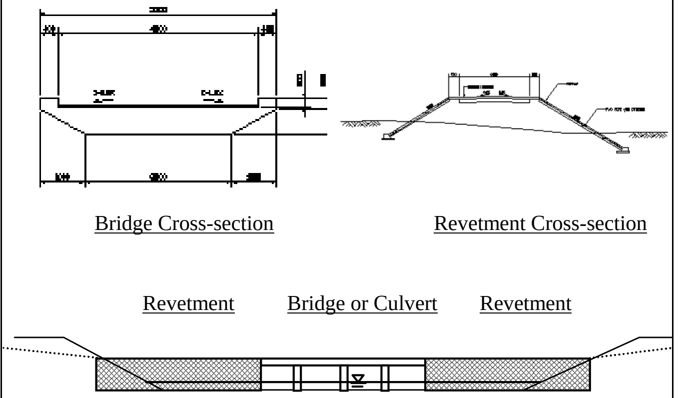
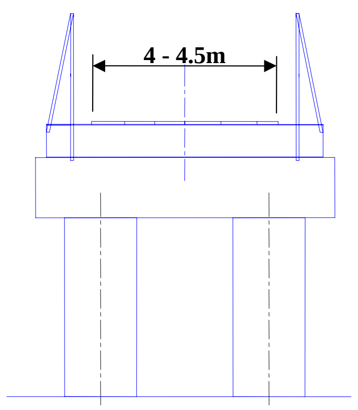
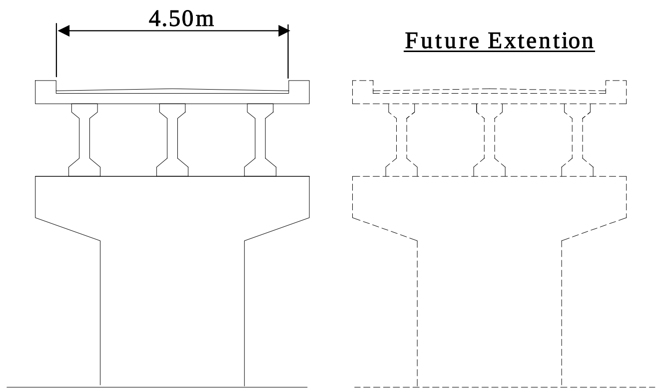
STRUCTURE TYPE	SKETCH	DESCRIPTION	CHARACTERISTICS	COST (US$)	ADAPTABILITY	EVALUATION
Alternative-A **Submersible Bridge or Structure**	 **Side View of Submergible Bridge**	-A crossing structure passable for most of the year and impassable when flooding reaches a predetermined level -A combination of a box culvert or bridge with an embankment section covered by wet masonry.	- Most cost effective alternative in terms of initial cost. - Cannot ensure that traffic and people can pass throughout the year, but greatly improves the level of accessibility - Periods of inaccessibility should not be so long as to adversely affect the current socio-economic status of the area	800$/m2 for bridge portion, and 710US$/m for road portion.	-Should be placed on solid ground to prevent structure collapse from scouring. -Unsuitable for rivers running through deep valleys. -An appropriate length of time for impassable periods should be set to keep construction costs reasonable.	- Suitable for sites crossing large-scale rivers with significant differences in water level between the dry and wet seasons.
Alternative-B **One-lane Bailey Bridge**		- A Bailey type bridge with a 4.5m effective width. - Single truss-type bridge suitable for light traffic flows and for minimizing costs.	-Can secure passage for traffic and people throughout the year. -Commonly used even for national roads in Lao PDR. -Initial cost is lower as compared to permanent type bridge. -Superstructure maybe applicable if MCPTC has spare ones. - Frequent maintenance work required for deck slab. -Future replacement with permanent superstructure possible if future capacity of substructure and foundation properly considered.	1220/m2 (in case that truss panels are newly procured)	-Suitable for to any crossing site.	-Suitable for sites crossing deep valleys
Alternative-C **One-lane permanent bridge**		- Permanent type bridge with a 4.5 m effective width - An additional one-lane bridge can be constructed next to the bridge if increases in future traffic volume justify it - Concrete bridge appropriate for economic reasons and also current practice in Lao PDR.	-Can secure passage for traffic and people throughout the year. -Can be improved in the future without having a major impact on the existing structure and traffic flow. -Cost effective over the long period of time and can be superior to other alternatives if the improvement goal is to provide a 2-lane permanent bridge.	1,530/m2 (for medium span bridge)	- Unsuitable for a long bridge when reducing initial cost.	-Suitable for sites where economic activity is relatively developed and road alignment is almost fixed.

Table 10.3.2 Bridge Type by Section

Section	Bridge Type	Nos.	Total Length (m)
Section 1 (Km0-Km30.6)	Submersible Type	1	50
	Bailey Type	0	0
	Permanent One-lane Type	3	45
Section 2 (Km30.6-Km70.3)	Submersible Type	6	345
	Bailey Type	12	345
	Permanent One-lane Type	0	0
Section 3 (Km70.3-Km112.5)	Submersible Type	0	0
	Bailey Type	7	365
	Permanent One-lane Type	6	92
Total	Submersible Type	7	395
	Bailey Type	19	710
	Permanent One-lane Type	9	137

10.4 Project Cost for Route 18A

Total project cost by section has been estimated on the basis of the above assumptions. The costs are given in Table 10.4.1.

Table 10.4.1 Total Project Cost by Section

Route	Road Class	Start	End	Road Length (km)	Total Project Cost (1000US)				
					Road Cost	Bridge Cost	Compen -sation	UXO Clearing	Total
18A - 1	IV	Jct. Rt. 13S	Province Border	30.6	3,577.1	469.3	8.0	0.0	4,054.4
18A - 2	V	Province Borde	Se Piane River	39.7	3,823.1	2,967.0	5.0	0.0	6,795.1
18A - 3	IV	Xe Piane River	Jct. Route 16B	42.2	4,933.2	2,930.3	8.0	52.5	7,924.0
Total				112.5	12,333.4	6,366.6	21.0	52.5	18,773.5

10.5 Road Improvement Implementation Plan for Route 18A

Due to in accessibility of sites in the section 2 which has two large rivers (**Xe Khampto** and **Xe Pian**) and no crossing structures within the section, the construction schedule should be established. Major works in each dry season shall be undertaken as follows:

1st dry season: Road work: all works for Section 1
Bridge work: Xe Khampo bridge and bridges in Section 1&3

2nd dry season: Road work: all works for Section 3 and earth work for Section 2

Bridge work:Xe Pian bridge and bridges in Section 2

3rd dry season: Road work: the rest of road works in Section 2

The construction period for improvement of Route 18A will be required approximately 35 months.

Table 10.5.1 Construction Schedule for Route 18A

Work Items		1st Year					2nd Year												3nd Year												4th Year				
		8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Preparation Work		—	—																																
Earth Work	Sec. 1			—	—	—	—	—	—																										
	Sec. 2															—	—	—	—	—	—	—	—	—											
	Sec. 3															—	—	—	—	—	—														
Drainage Work	Sec. 1					—	—	—	—																										
	Sec. 2																—	—	—	—	—	—	—	—											
	Sec. 3																—	—	—	—	—														
Pavement Work	Sec. 1							—	—	—																									
	Sec. 2																												—	—	—				
	Sec. 3																			—	—	—													
Miscellaneous Work	Sec. 1									—	—	—																							
	Sec. 2																														—	—	—		
	Sec. 3																					—	—	—											
Bridge Work	Sec. 1			—	—	—	—	—	—	—	—	—																							
	Sec. 2			—	—	—	—	—	—	—	—	—				—	—	—	—	—	—	—	—	—											
	Sec. 3			—	—	—	—	—	—	—	—	—																							
Clean-up Work																																		—	

10.6 Economic Analysis and Evaluation

10.6.1 Route Function

An economic analysis of Route 18A was undertaken as an example to establish how a staged improvement program might be developed to meet the needs of poorer areas, where local inhabitants have no all-weather access to health care and other services. Clearly, Route 18A is in some respects atypical: it is potentially multi-purpose, serving local, inter-regional and international traffic; it parallels Route 16A, which also serves the two latter purposes; the central section is particularly environmentally sensitive, while the inhabitants in this area are poor, disadvantaged and predominantly ethnic minorities; and, unfortunately, the large volume of structural work means that the road is particularly costly to improve.

The first essential in developing an improvement program is to define the function of the route: is it to be primarily local or primarily inter-regional and international. If Route 16A is to be developed, then the function should be primarily local. If Route 16A is not to be developed, then the function should be inter-regional and international. For the latter function, a high quality paved route is essential. The cost of such a project would be beyond the capacity of local resources. International support may, however, be difficult to obtain, given the poor economic return and the cheaper alternative of upgrading Route 16A. Nevertheless, if another country or countries were willing to finance the project for their own purposes, this would be the ideal solution, provided environmental safeguards can be put in place. The possibility ought to be investigated before any decision is taken to pave Route 16A. If the outcome is negative, the question then is, how may the route best be developed to serve local needs.

10.6.2 Economic Analysis

The results of an economic analysis of improving Route 18A to all-weather gravel standard at a financial cost of US$18.8 million (economic cost US$17.3 million) are given in Table 10.6.1. The route was analyzed in three sections, eastern 42km, western 31km and the whole route 118km.

Table 10.6.1 Economic Analysis Results

Section	EIRR (in %)	NPV (US$ mill)	FYB (in%)	B/C
Eastern only	5.9	- 3.02	3.5	0.54
Western only	3.4	- 2.02	2.7	0.42
Whole Route	1.6	-10.59	2.0	0.33

The central section performs very poorly and is of lowest economic value. It drags down the overall result. The eastern section, although more costly per km, is significantly better than the western section, due to its higher traffic volume.

10.6.3 Sensitivity Tests

The sensitivity of the results to a 30 per cent reduction in construction costs is shown in Table 10.6.2. The figures in this table show changes to the indicators compared with the base case results in Table 10.6.1.

Table 10.6.2 Sensitivity to Construction Cost Reduction of 30%

Section	EIRR (in %)	NPV (US$ mill)	FYB (in%)	B/C
Eastern	+2.8	+1.76	+1.5	+0.21
Western	+2.3	+0.89	+1.2	+0.15
Whole Route	+2.0	+4.15	+0.9	+0.12

10.6.4 Improving Short Section

Traffic volume increases towards each end of the route. Improving only the first half of the western and eastern sections was also evaluated, assuming that average traffic on these parts of the route would be 90 per cent of the volumes at the ends. The results of this test are given in Table 10.6.3.

Table 10.6.3 Improving Short Sections of the Route

Section		EIRR (in %)	NPV (US$ mill)	FYB (in%)	B/C
Eastern	km 92.5-112.5	9.1	-0.79	5.1	0.78
Western	km 0.0-15.0	6.1	-0.75	3.9	0.59

10.6.5 Conclusion on Route 18A

It can be concluded on the basis of the economic analysis (at Master Plan level of detail), but without taking into account the associated social benefits and potential environmental disbenefits, that a staged upgrading of Route 18A to all-weather gravel standard would be the most economic solution to serve local needs. This might be affected in three stages, for example:

Table 10.6.4 Improvement Staging

Period	Improvement Section
2005/7	Km 0.0-15.0 + 92.5-112.5
2010/12	Km 15.0-30.6 + 70.3- 92.5
2020/22	Km 30.6-70.3

At the time of stage 1 improvement of the end sections, a low cost upgrading of the other sections should be considered, to provide basic access. The primary objective would be to minimize the time during the rainy season when the central section is inaccessible Access to at least one end of the route should be provided, whichever is the cheaper.

10.7 Recommendation on Upgrading Methodology

There are some findings on the approach proposed in this chapter through the discussion.

- It is difficult to achieve the economic viability of an upgrading plan for a low-trafficked road even applying the minimum requirement from the viewpoint of social development to road and bridge structure.

- A tactical approach, which focuses each end of the sections to improve economic viability in this case study, is also required together with a strategic approach, which employs the staged development, in order to make a plan more feasible.

To conclude, the following procedure will be recommended the road administrator to utilize this approach for an upgrading plan of a low-trafficked road:

(1) Establish Road Improvement Policy taking into account social benefits and potential environmental disbenefits;

(2) Identify the Development Stage of the area along the study route based on improvement requirements of a local society;

(3) Examine technical requirements of road structure considering to realize an all-weather road, excluding periods with exceptionally high water level; and

(4) Develop the Staged Construction Plan to improve its feasibility on the basis of balance between economic viability and Government priority.

10.8 Approach to Provide Basic Access for Roads Suitable for Development Stage 1

10.8.1 Approach and Methodology

(1) Approach

The following approach shall be taken for a road upgrading in Development Stage 1.

- Applies the methodology proposed in Chapter 10.7.
- Involves communities along the target road from the planning stage.
- Identifies the roles of the road agency and communities in the implementation process.

(2) Role of Road Agency and Community in Implementation Process

<u>Road Planning Stage</u>

In order to foster the sense of "ownership" by community, following role separation shall be appropriate. The road agency should confirm the development stage, and identify approximate route (start and end) and its basic structure. On the one hand, the communities participate in selecting portion of route which community is to be responsible for and in selecting the detailed route selection and passability level.

Road Improvement & Maintenance Stage

Labour-based method for improvement and maintenance (i.e., Lengthman and community contract system) should be applied to achieve cost effectiveness and foster the sense of ownership by community. The road agency should play the following roles:

- Hand over ownership of relevant parts of road to relevant communities
- Fund provision for improvement
- Lease equipment for road improvement
- Provision of support consisting of technical assistance and quality assurance

On the other hand, the communities should provide labor force to execute road improvement and maintenance work

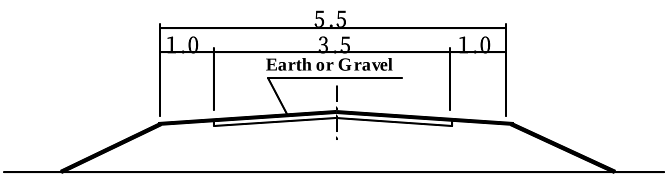
(3) Issues to be Considered

Involving a community to build and maintain a low-trafficked road is an effective alternative to achieve cost effectiveness and reduce maintenance burden of the road agency. Some issues to accomplish the original purpose are as follows.

- Financial support from the road agency or the measures to earn funds for maintenance by community should be considered.
- In order to execute maintenance work properly, ownership shall shift back from communities to the road agency at Development Stage 2.
- The road agency should promote private sector capacity regarding access to resources and establishing an enabling environment.

(4) Proposed Road Structure Suitable for Development Stage 1

Road structure suitable for Development Stage 1 is proposed as follows (50 to 100 VPD). As for the crossing structure, one-lane bailey/submersible type (8 tons loading capacity) is appropriate and a timber type is also allowable in a short span bridge.



CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions of the Study, the project evaluation and project implementation requirements, and recommendations to achieve the overall objective of furthering the development of the southern provinces.

11.1 Project Benefits

The economic analysis of improving Routes 14A and 16A concluded that project implementation 2005-2007 may be appropriate based solely on benefits to road users. Both projects would produce substantial economic benefits, of a similar magnitude. The base case EIRRs, 10.5 per cent for Route 14A and 10.7 per cent for Route 16A, are too close for one project to be selected as of the higher economic priority.

In addition to direct economic benefits, these particular projects are likely to produce significant social and other benefits in their influence areas and beyond. Except for economic benefit, other qualitative social benefits are summarized as follows. First, both projects would accelerate development of the Southern Region and they would help to **reduce poverty** by improving **access to hospital, school and market, public extension services, income and employment opportunities** and **enhancing local development potential.** Second**,** they would also **facilitate trade and investment** in the area and generate **income and employment opportunities** by improving links to neighboring countries.

On the basis of these benefits, the expected role and function of both routes are defined again here. The Improvement of **Route 14A (59.301km: from B. Houay Phek to B. Sukhuma)** would provide direct access to the west bank of the Mekong as well as to Thai / Cambodian border areas, which would fuel development of the Emerald Triangle.

- This route would be improved to all weather paved standard connecting **Pakse** (core communication center of the southern region) and major points on the **west bank of the Mekong** (i.e., Champasack, B.Phonnggam, Wat Phou, B.Dontalat and B.Sukhuma etc.) **via the Pakse Bridge**. This would promote regional development and stimulate international tourism in the area.
- The route is located in one of Lao PDR’s most rice-rich areas. The local population has a high literacy rate, which may facilitate industry and commercial activities.
- This route would also promote development of the lower south area of the west bank, which remains undeveloped.
- The project would provide all weather access to the ‘missing link section’ north of

Champasack Town. Development and poverty reduction in this area would be promoted.

- Vehicles currently using the ferry to cross the Mekong at Champasack would divert to the improved route, with significant reductions in travel times.

The improvement of **Route 16A (64.138km: from 1km mark east of Paksong to B.Lek 52)** would contribute to rural development in an area near the Champasack-Attapeu provincial border and also substantially improve East-West connectivity between Thailand, Lao and Vietnam.

- This route would be improved to all weather paved standard between Paksong and Route 1I, promoting development in the area and the region.
- Improvement of this route would provide better access to markets for the coffee-rich Boloven Plateau.
- Improvement of this route would stimulate development of the until recently isolated eastern districts.
- Improvement of this route together with Route 18B (under improvement assisted by Vietnam Government) and **Pakse Bridge** (construed under the assistance of the Japanese Government), would complete an important new east-west corridor connecting Thailand via Pakse with Vietnam via Attapeu (provincial capital).

Given the **qualitative benefits** for regional development together with the **quantifiable economic benefits** for the road users, the **conclusion** is that the improvement of Routes 14A and 16A is **socio-economically viable** and **necessary**. The Initial Environmental Examination (IEE) shows that most negative impacts can be avoided or reduced to an acceptable level through compliance with laws and regulations and effective implementation of mitigation measures and a rigorous monitoring program. Based on this assessment an Environmental Impact Assessment (EIA) will not be required. There are no significant negative factors from Project implementation and road maintenance activities.

Both projects are viable and would clearly provide valuable additions to infrastructure of the southern region. The implementation cost however may be beyond the resources of the Government. Therefore, it is advisable to finance the Projects on a grant-aid basis.

11.2 Project Implementation Requirements

The Feasibility Study identified no serious problems concerning land acquisitions for the Projects. The Study Team however identified a number of issues on which Government assurances will be required to ensure smooth project implementation. The following specific activities should be undertaken.

(1) Project Management

MCTPC has a successful track record in implementing road and bridge works under project financing and/or grants from external agencies, and has sufficient capacity and experience to be the Executing Agency for the Project. Under MCTPC, Department of Roads (DoR) will be responsible for implementation and overall coordination. DoR will be responsible for the operation and maintenance of the Project through proper technical supervision and adequate allocation of funds. The completed project will be maintained to a standard consistent with an international link of the national road network under the Road Maintenance Fund.

(2) Pre-Construction Activities

Both Routes 14A and 16A improvement could be implemented in a period of 30 months, exclusive of design and pre-construction activities, with completion by end 2007.

Prior to detailed design and/or construction, the following activities need to be carried out:

(a) Field survey for **UXO** managed by UXO LAO, in order to identify the existence and clearing (if required). Financing for the survey and clearing activities needs to be determined.

(b) Field Survey for **archaeological remains** by Ministry of Information and Culture (Department of Museums and Archaeology) in order to determine whether or not there are any significant archaeological remains that need to be avoided in the final design stages and to estimate the findings, that will come from remains clearance.
This survey will be necessary only on new construction sections (i.e., 27.7km on Route 14A and 6.3km on Route 16A). Financing for the survey and clearance activities (if required) needs to be determined.

(c) Field Survey for **natural forest** by Ministry of Agriculture and Forestry (Department of Forestry) in order to determine if there are any trees of significance that should be avoided in the final design stages and to estimate impact of forest clearance. This survey will be necessary for the new construction section of Route 16A (6.3km). Financing for the survey and compensation needs to be determined.

(d) **Land Acquisition and Resettlement**
The Project will require land acquisition of 88 hectares (ha) for Route 14A and 38ha for 16A, mainly paddy field, and 12.5 ha for Route 14A and 9ha for 16A of residential land, affecting 180 dwellings on Route 14A and 70 dwellings on 16A, all of which need to be relocated. Some gardens and plantations may also be affected. There may be some temporary impacts during construction, including disruption to

irrigation systems, which will need to be restored. Financing for compensation for resettlement, relocation and restoration needs to be determined.

The final alignment will be determined during detailed design, following which an inventory of lost assets will be carried out to determine the amount of actually affected land, number of households and assets.

The Provincial Governor will set up a committee composed of relevant organizations' representatives and village people, to take legal action for land acquisition and resettlement to ensure the timely commencement of construction work.

(e) **IEE approval by Science, Technology and Environment Agency** (Environmental Research Institute). The Social and Environment Division of the Department of Roads (DoR) will closely cooperated with the implementation of the Environmental Management Plan and the DoR will obtain the approval of IEE from STEA. DoR will monitor the impacts of road construction within environmentally sensitive areas. Financing for environmental management and monitoring needs to be determined.

(3) Post-Opening Activities

(a) Appropriate maintenance of accesses between existing and new bypass roads. With the proposed shortcut or bypass routes in both Routes 14A and 16A, people living on the existing road will not benefit from the improved roads. Accordingly, appropriate maintenance of access roads to the new roads will be required after opening the roads.

11.3 Recommendations

In addition to the above implementation arrangements, the Study Team has identified a number of areas where Government effort is required to ensure a successful project outcome. Achievement of the objectives of the World Bank Road Maintenance Project, as well addressing the following technical and financial concerns, will enhance contribution of the Project to enhance socioeconomic development of the region.

(1) Legal and Institutional Set up

(a) **Cross-border agreements** for passenger and freight traffic with neighboring countries are essential for the development of the Southern Region. The necessary implementing rules, regulations and protocols need to be in place to facilitate smooth cross-border traffic movement.

(2) Funding Maintenance

(a) Since April 2002, bridge tolls on national roads have been levied to fund the Road Maintenance Fund (RMF). A detailed study of road user charging is needed to determine charging levels, rules and regulation for implementation and institutional arrangements to guarantee appropriate funding for road maintenance.

(3) Environmental Management

(a) Appropriate prohibitions should be included in the contract documents for contractors' work so that negative environmental and social impacts are mitigated during construction.

(b) DoR will develop and implement a Project Environmental Management and will monitor the impacts of road improvement work in environmentally sensitive areas. The Environmental Management Plan will minimize the negative impacts and ensure that the full benefits of the road are realized.

(c) The monitoring process will be designed to ensure that as far as possible legislative and regulatory measures will be met within a realistic implementation framework.

(4) Operation and Maintenance

(a) The **design** and construction quality of the original pavement needs to be strictly controlled to ensure maximum pavement life to protect the investment.

(b) Weighing stations (**axle load control**) on the Project Road, one in each district, will be needed to control overloading. Axle-load controls are a crucial factor not only to protect the road itself but to prevent road surface damage that would reduce its economic life.

(c) A road safety program to develop and deliver road **safety** awareness and education for rural children in affected communities will be needed.

(d) Road **inventory data,** road **condition** and **traffic data** should be updated continuously to enable sensible decisions on maintenance activities and to provide a basis for the justification for the allocation of funds.

(e) In the future, **maintenance records and data** should be computerized to enable engineers to monitor maintenance activities and costs for each road surface type. A user-friendly database is needed for all maintenance data to allow it to be used for analysis and forecasting.

(f) A national system of guidance for the preparation of **Work Plans** is required, including a review of unit rates for maintenance works to develop the maintenance plan effectively and efficiently.

(g) **Standard** contract documents need to be developed for maintenance works (simplified form of contract) to encourage small-scale contractors' participation in road maintenance.

(5) Capacity Building

(a) Promotion of **private sector capacity** building for road maintenance is recommended. The small-scale contracting needs to be helped in two main areas - access to resources (i.e. credit, works, equipment, materials) and an enabling environment for contracting (i.e. prompt payment, simplified contract, contactors association and contractor registration and evaluation procedures).

(b) The Telecom and Communication Training Institute (TCTI) has insufficient capacity for road maintenance training, especially for practical skills. The TCTI needs to be enhanced or a Training Center for Road Maintenance needs to be established to develop capacity building for both public and private sectors. New training products (courses) i.e. management, engineering, supervising, monitoring and maintenance activity in the field through on / off job training, are required. Quality control management is an essential issue to ensure that funds are used efficiently and effectively. The TCTI or the Training Center should address quality control issues.