Ⅳ FEASIBLITY STUDY

CHAPTER 12

ROAD MAINTENANCE & TRAFFIC MANAGEMENT

CHAPTER 12 ROAD MAINTENANCE AND TRAFFIC MANAGEMENT

12.1 Introduction

This chapter describes the road maintenance and traffic management plan to be applied to ensure the ultimate goal of the Project in implementation of road improvement.

12.2 Maintenance Activity Plan

12.2.1 Maintenance Activity Flow

The purpose of maintenance is not only protecting roads, but preventing damage to the road surface and structures to ensure the maximum pavement life. On completion of the projects, timely maintenance work, i.e., inspection, defect evaluation and maintenance work should be carried out to ensure smooth and economic traffic operation as well as to reduce traffic accidents. Figure 12.2.1 shows the maintenance activity flow recommended.

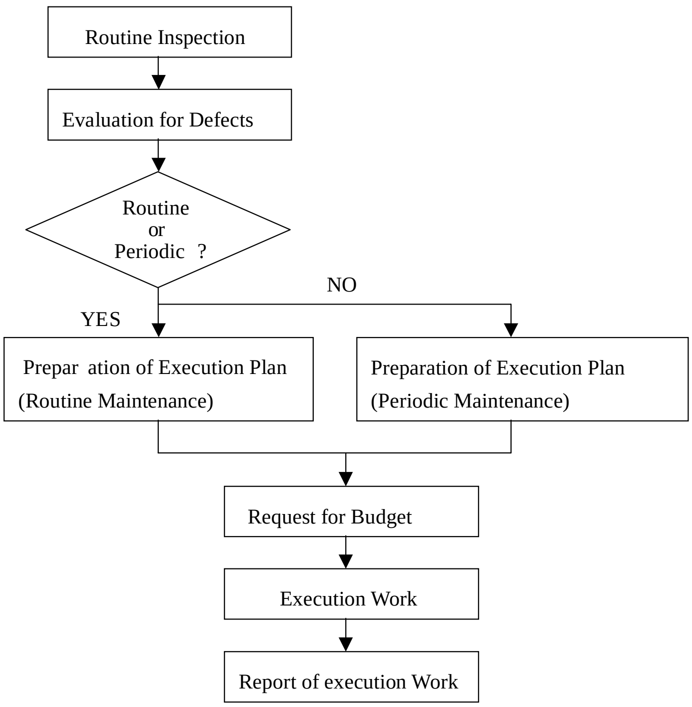


Figure 12.2.1 Maintenance Activity Flow

12.2.2 Inspection Activity

1) Inspection Items

Pavement is classified into two types: AC (Asphalt Concrete) and DBST. Once the roads are improved, a vehicle can run at higher running speed. If the road is damaged, it will result in a decrease in traffic speed and a higher risk of traffic accidents. Frequent and appropriate maintenance activities are required to keep the road in good and safe conditions.

Besides the pavement surface, all the road structures should also be well maintained in order to keep the proper road function. The road components and their major anticipated defects are summarized in Table 12.2.1. Inspection items for bridges are shown in Table 12.2.2

Table 12.2.1 Inspection Items for Paved Roads

Component	Sub-component	Defects
Paved Roads	Surface	Cracking, Potholes, Rutting/Deformation, Heaving/Shoving, Stripping/Fretting, Bleeding, Glazing, Edge damage, Waving, Obstruction
	Base Course	Spot failure
	Sub-base	Spot failure
	Subgrade	Sport failure
Shoulder		Obstruction, High vegetation, Scour, Shoulder/carriageway step, Rutting Depressions, Potholes
Slopes		High vegetation, Erosion, Earth slip/landslide, Rock avalanche, Collapse of slope protection
Embankment		Collapse, Settlement
Drainage	Culverts	Silting, Blockage by debris Settlement cracks, Collapse of culvert Erosion of stream bed at culvert outlet Headwall/apron/wing-wall damage
	Ditches and Drains	Obstruction, Silting, Erosion at drainage outfall Ponding in ditch or on shoulder Invert and sides of ditch are eroded. Ditch lining is damaged.
Structure	Drifts and Causeways	Settlement, Erosion, Debris, Guideposts are damaged or missing.
	Retaining Wall /Stone Masonry	Settlement, Cracking, Collapse
Road Furniture		Dirty, Damaged, Missing

Table 12.2.2 Inspection Items for Bridges

Bridge Type	Components	Defects
RC or PC Bridge	Surface	Cracks, deformation, pot-holes
	Slab and beams	Cracks, deformation, loss
	Railing and curb	Cracks, deformation, loss, destruction
	Bearing	Cracks, deformation, corrosion, loosened connection, displacement
	Expansion joint	Loss of device, leakage of water, deformation, loud noise
	Drainage	Debris, damage on cover and pipe
	Substructure	Cracks, deformation, loss,
	Protection work	Debris, scouring damage, deformation, displacement, destruction of gabions

2) Frequency of Inspection Activity

Routine Maintenance

The inspection for routine maintenance should be carried out according to the intervention level indicated in Tables 12.2.3 and 12.2.4, for roads and bridges respectively. Cleaning or repair work should be executed according to the evaluation results, on the basis of defects found.

Table 12.2.3 Frequency of Inspection for Routine Maintenance

Items	Frequency		Remarks
	Minimum	Desirable	
Carriageway Shoulder	2 months	1 week	
Slope Embankment	4 months	1 month	Include after rainy season
Drainage	4 months	1 month	Include before rainy season
Roadside Structures	4 months	1 month	
Road Furniture	4 months	1 week	

Table12.2.4 Bridge Maintenance Requirements

Bridge Type	Work Activities	Interval
RC or PC Bridge	-Cleaning of surface and drainage facility -Minor repair of accessories (railing etc.) and surface -Removal of debris built-up against piers -Repair to scour damage around substructures and protection works	Every year

Periodic Maintenance

Periodic maintenance of paved roads should be executed at least once every within ten years. Table 12.2.5 shows the periodic maintenance requirement for bridges.

Table 12.2.5 Periodic Maintenance Requirements for Improved Bridges

Bridge Type	Work Items	Interval
RC or PC Bridge	-Resurfacing -Repair of severe cracks and railing -Replacement of expansion joint -Repair of protection work (gabions)	5 years Responsive 10 years Responsive

12.2.3 Defects Evaluation (Ranking)

Routine Maintenance

The evaluation ranking of defects is divided into two, i.e., roads and structures. One is for pavement surface; the other for other road structures. Examples of the evaluation criteria for ranking are shown in the ANNEX M-8.

Periodic Maintenance

In order to determine an efficient periodic maintenance activity for damaged pavement surface, the surface roughness (IRI: International Roughness Index), will be utilized as an indicator according to the pavement type. A relation between the IRI value and its countermeasure is described below as reference.

(**AC Roads**)

IRI < 2.0 : No periodic maintenance but only routine maintenance,

IRI = 6.0 : Overlay will be required when the IRI value increase to 6.0,

IRI = 8.0 : Rehabilitation will be required when the IRI value increase to 8.0, including subbase course (if necessary)

10.0 < IRI : Reconstruction of pavement structure will be required and minor improvement for insufficient width of carriageway pavement, shoulder and for inadequate loading capacity of pavement structures, and AC pavement and subbase will be executed.

(**DBST Roads**)

IRI < 6.0 : No periodic maintenance,

IRI = 6.0 : Resealing,

IRI = 8.0 : Rehabilitation of DBST structure, including subbase etc., if necessary,

IRI =10.0 : Reconstruction of DBST structure, including subbase etc., will be required and minor improvement for insufficient width of carriageway and shoulders will be required, if necessary.

12.2.4 Execution of Maintenance Work

The maintenance work by road component is shown in Table 12.2.6. Execution of work items will be determined on the basis of the following conditions:

- Defect type
- Defect scale
- Traffic volume
- Execution cost and budget
- Defect records (frequency)

Table 12.2.6 Execution Maintenance Work Plan by Defect

Component	Sub-component	Routine Maintenance	Periodic Maintenance
Paved Roads	Surface	Spot or crack sealing Patching Spot planning Sanding Moving obstruction	Resealing DBST Overlay Planing Spot reconstruction
	Base Course	Base repair	
	Subbase Course	Subbase repair	
	Subgrade	Subgrade repair	
Shoulder		Bush clearing Filling Spot reconstruction Patching	Reconstruction Add ditch Reshaping Grading Filling
Slopes		Bush clearing Filling Re-cut Benching Grassing Drainage Netting installation	Grassing Planing Re-cut Slope protection Benching
Embankment		Filling	Filling
Drainage	Culverts	Cleaning Sealing of crack Repair lining Headwall repair	Reconstruct culvert
	Ditch and Drain	Cleaning Sealing	Flatten gradient Construct cascade Reconstruct ditch
Structure		Cleaning Repair Sealing	Reconstruction
Road Furniture		Cleaning Replace	Repair/replacement

12.3 Effective Road Maintenance System

The Study Team noted in II .Chapter 2 that there would be budgetary constrains for maintenance. This section makes recommendations to enhance the road maintenance capabilities of the DOR.

12.3.1 Approach

To realize an effective road maintenance system, it is first necessary to determine the gap between the needs and resources for road maintenance, and then to implement appropriate measures to deal with this "needs gap".

To accomplish this, it is necessary to analyze factors affecting the costs of road maintenance. These factors are then incorporated into the construction of plausible road maintenance scenarios to assess the existence and size of the needs gap. After determining the needs gap, it is necessary to draw up proposals to eliminate it. The proposals consist of development of a core road network prioritizing maintenance, development of operability and systematic maintenance, development of road maintenance capacity building, and axle load control.

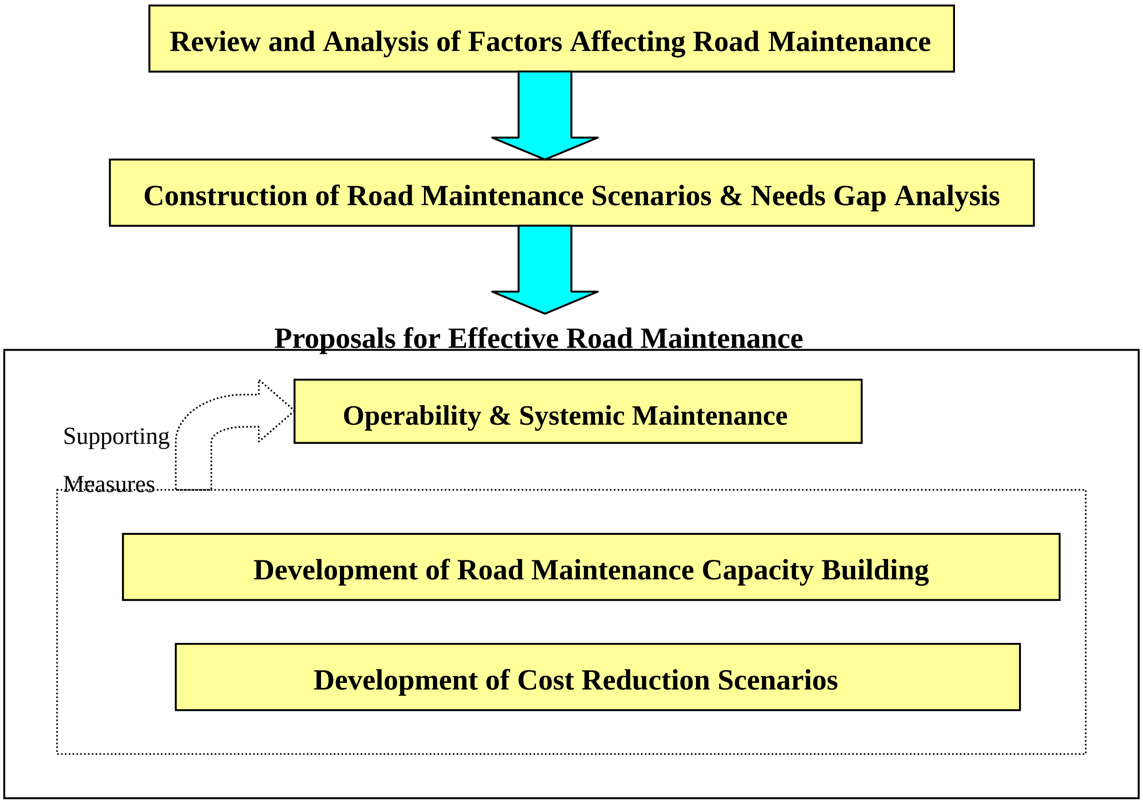


Figure 12.3.1 Developing an Effective Road Maintenance System

The proposals are comprehensive in order to integrate the relevant road maintenance components and thereby realize the most effective road maintenance system. The workflow for this approach is shown in Figure 12.3.1.
As the workflow indicates, before road maintenance scenarios can be constructed and proposals drawn up, the factors that have an impact on the costs of road maintenance must be defined.

12.3.2 Impacting Factors

There are a number of key factors impacting upon road maintenance costs and these can be split into **physical** and **non-physical**. Key **physical** factors that affect road maintenance, which taken together represent interactions between levels of use, the natural environment, and the deterioration of road materials, are defined by the Study Team to be as follows:

- Road surface type
- Traffic flows and composition
- Road surface condition
- Climate
- Terrain

Data on these factors can be reviewed and incorporated into the World Bank's HDM model, which also includes data on maintenance frequency and unit costs as well as on vehicle operating costs. The model shall be calibrated and used to derive the required costs (funding) for different road maintenance scenarios.
As for the **non-physical** factors that affect road maintenance cost, which are more complex than the **physical** factors due to their intangible nature, these are defined by the Study Team to consist basically of the following:

- DOR capability
- Capacity building
- Interactions between personnel/organizations

The non-physical factors are for the most part management-related in that their effect on road maintenance costs are dependent on the efficient use and allocation of organizational resources. This means the greatest leeway for satisfying any needs gap lies here, since the effects from physical factors for a given level of service and technology are basically fixed (i.e., costs can't be reduced).

12.3.3 Construction of Road Maintenance Scenarios and Needs Gap Analysis

Applying the above **physical** and **non-physical** factors, the methodology shown below is adopted by the Study Team to determine the (funding) needs of the Lao road network and the possible scenarios to satisfy those needs. Note that **physical** factors determine the costs required to maintain the road network at a minimum and ideal condition level, while the **non-physical** factors represent cost-reduction measures to match costs with funds. Note, however, that even with current and new funding sources, there would still be a significant shortfall in funding to maintain the entire road network, even at a minimum level of service. The Study Team therefore introduces the workflow for need gap analysis, as shown in Figure 12.3.2, to realize an effective road maintenance system.

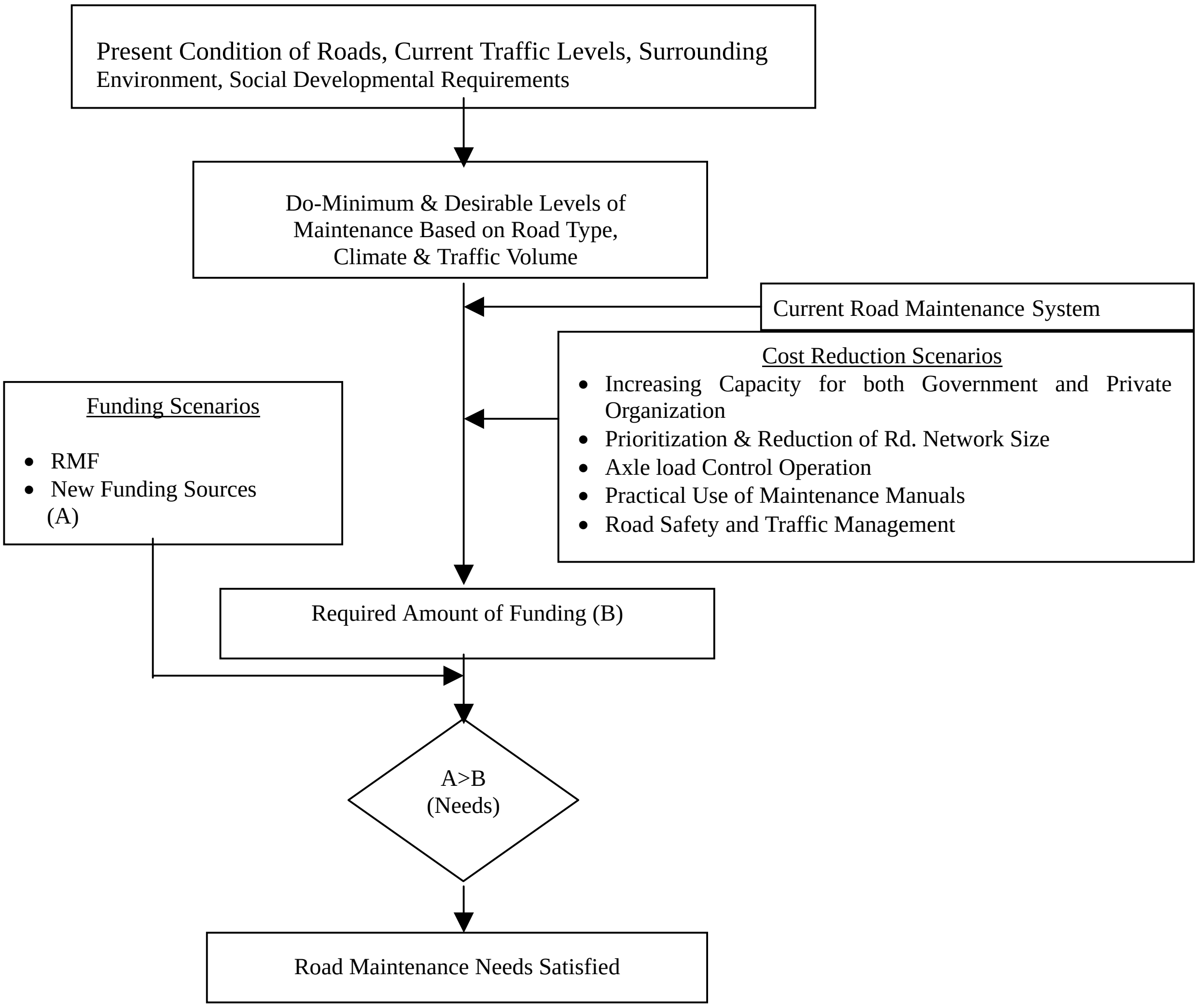


Figure 12.3.2 Workflow for Needs Gap Analysis

12.3.4 Realizing an Effective Road Maintenance System

Even though, the Project, road improvement with paved surface, will help to reduce the cost for the regional road maintenance, the Study Team would like to note that, if the Government draws up a plan detailing its core network and possible scenarios for funding it, together with better management and operation, there should be no problems concerning a future road maintenance activity for the entire national road network in Lao P.D.R. Recommendations that would increase the effectiveness of road maintenance and thereby eventually reduce its costs are described below.

(1) Development of Core Road Network for Prioritizing Maintenance

It is recommended that the following data be obtained from all DCTPCs to be sent to MCTPC for planning and analysis purposes (to be incorporated into the HDM model) and be updated continuously by DCTPC to enable sensible decision on maintenance to be made and to provide a basis for the justification for fund allocation.

- **Road Inventory Data**
- **Road Condition Data**
- **Traffic Data**

In addition, maintenance records and data should be retained on a computer database to enable DCTPC engineers to monitor the maintenance activities and costs of each road type. A user-friendly database is needed for all maintenance data to allow the data to be used for analysis and forecasting.

(2) Development of Operability and Systematic Maintenance

A national system of guidance for the preparation of a work-plan for maintenance is required, including a review of unit rates for maintenance works to develop the maintenance plan effectively and efficiently. Standard simplified contract documents also needs to be prepared for maintenance work. This encourages small-scale contractors participation, especially for routine maintenance work.

(3) Development of Road Maintenance Capacity Building

Private sector participation in road maintenance is effective in providing timely maintenance work especially in the rainy season, while enhancing income and employment generating activities for local people. 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).

Concerning the training, the Telecom and Communication Training Institute (TCTI) has insufficient capacity for road maintenance training, especially for practical skill and TCTI needs to be enhanced or a Training Center for Road Maintenance needs to be established to develop capacity building of staff of both public and private sectors. New training products (courses) i.e. management, engineering, supervising, monitoring and maintenance activity on the field through on / off job training, are required. Quality control management is one essential issue to use funds for the road sector efficiently and effectively.

(4) Development of Road Maintenance Manuals for Capacity Building

Lao version of 'International Road Maintenance Hand Book: Transport and Road Research Laboratory (TRRL)' is wildly used for road maintenance by MCTPC and DCTPC. However, it is recommended that the present manuals be reviewed to achieve some consistency, taking account of local conditions. It is recommended that the TCTI design and carry out training, which will include on-site practice, using the road maintenance manuals as a standard.

The road maintenance manuals should be updated periodically to reflect changes in the field of road maintenance or to make necessary modifications, revisions, or corrections.

(5) Axle Load Control Operation

The deterioration of paved roads caused by traffic flow is a result of both the magnitude of individual wheel loads and the number of times these loads occur. The objective of controlling axle load is to maximize road life and thereby minimize the cost of maintenance. Normally, when axle-load limits are exceeded, the total cost and damage to roads increases rapidly, which can have an adverse effect on the economy. Therefore, axle-load controls are a crucial factor to protect roads and prevent road surface damage.

The most of existing method of controlling overloading relies on the use of portable axle-load weighing machines located on major national roads. As a result of this operation, the average daily total weight of overloaded vehicles has been greatly reduced. The results of the axle-load survey executed by the Study Team also showed that the survey location on Route 9 where's usual axle-load control point indicated the percentage of overloaded trucks was least.
Therefore, it is possibly to say that weighing station will be important measures in dealing with the problem of overloaded vehicles. To progress further, the following is recommended:

- Continue with the strict enforcement of axle-load regulations.
- Set up a weighing station at an access route to logging are (e.g. at Junction 14A and 14C1 for Route 14A, and Paksong on 16A and on 1I for Route 16A), quarry, factory and/or plant.

- Educate those dealing with logging, heavy industry and transportation

12.4 Traffic Management and Road Safety Operation

The current level of road fatalities, almost 20 persons per 10,000 vehicles, is the highest among Southeast Asian countries. A draft Lao PDR National Road Safety Strategy has been prepared, is built around five elements:

- Education
- Enforcement
- Technical Environment
- Coordination
- Research and Evaluation

The key issues in the Strategy relate to:

- Improved driving skills
- Use of helmets and a belts
- Drunk driving and speeding
- Improved night-time visibility for motorcyclist and cyclists
- Traffic management, signing and delineation of roads

The Strategy envisages implementation through a National Road Safety Committee under MCTPC and the forging of a Road Safety Partnership between the Traffic Police Department, the Department of Transport and the Department of Education.

The above efforts of the GoL will surely help to reduce the level of road fatalities. The following measures are recommended:

- Propaganda on road safety via mass media
- Road safety awareness and education for rural children in communities and schools
- Strict enforcement of driver's license issuance and renewal
- Severe enforcement of traffic violations
- Strict vehicle inspection for registration and renewal

The following measures are recommended to designs of road improvement projects:

- Signs, guide posts and road marking
- Extra width sealed shoulders in areas with pedestrians and cyclists
- Sealed bus stop areas to allow bus to move off the road
- Speed control devices, such as rumble strips, located at either end of villages, as well as at a regular spacing through large village
- Speed limit should be appropriate for local conditions, neither too low nor too high
- Roadside service development (shops, restaurant etc.) should be outside the road

reserve, with provision for customer parking where the shoulders are narrow

Failure to maintain the signs and speed markings provided will significantly diminish their usefulness as they fade and cannot be seen. Surface texture needs to be maintained with regular reseals, especially where traffic speeds are expected to be high.

CHAPTER 13

IMPROVEMENT PLAN FOR ROUTE 18A

CHAPTER 13 IMPROVEMENT PLAN FOR ROUTE 18A

13.1 Introduction

This chapter considers an improvement plan for Route 18, a link, which has high ranking in terms of socio-economic impacts in the Master Plan.

The Master Plan recommended upgrading to the level of providing "**Basic Access and a Road for Regional Economic Activity**" to reduce current poverty levels. This chapter provides a methodology to upgrade existing roads (such as Route 18A) to the above level. **The Government can execute such road improvements using its own economic and technical resources.**

From the viewpoint of social development, 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, concept of "**development stage**" is established, with road and bridge structures suitable for each stage defined. Economic feasibility is also evaluated.

13.2 Establishment of Road Improvement Policy

13.2.1 Evaluation of Current Condition

(1) Road Condition of Rt. 18A

On the basis of the Master Plan road and bridge inventory survey, the existing condition of Route 18A is as follows.

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.

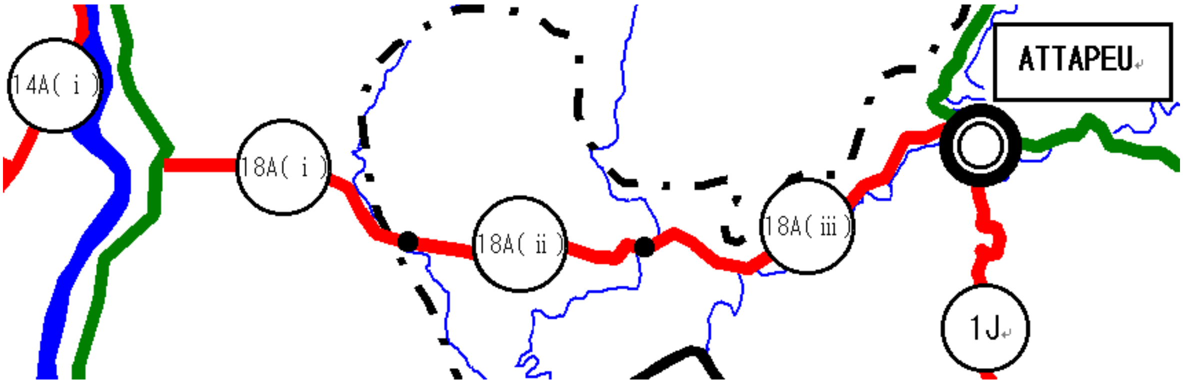
The first section is located in flat to rolling terrain and runs mainly through copse and small villages. The road surface is in fair condition and its width ranges from 5m to 8m in flat sections and 3.5m to 4.0m in rolling sections.

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 Rt. 18A

As Figure 13.2.1 and Table 13.2.1 indicate, there are large differences in the socio-economic character of the three route 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)
Literacy rate: Above national average
Income level: Approx. equal to national average

Section 2(L=39.7km)
Literacy Rate: Substantially Below National Average
Income Levels: Substantially Below National Average

Section3(L=42.2km)
Literacy rate: Approx. equal national average
Income level: Approx. equal to national average

Figure 13.2.1 Categorization of Route 18A according to Their Development Level

Table 13.2.1 Major Socio-economic Characteristics of Three Sections of Rt. 18A

Section	Major Characteristics
18A(i)	• Population density within 5km of the route is 445 persons/km. • This section is located in the Pathoomphone District of Champasack Province, which is a district with adequate rice production and a large industrial and service-sector workforce. • There is some tourism potential owing to elephant villages in the area.
18A(ii)	• This section is isolated by two large rivers, the Xe Khampho and Xe Pian, located at either end of the section. • Population within 5km of the route is 79 persons/km. • Almost no industry of any kind.
18A(iii)	• The route serves two districts; namely, Sanaxay and Samaxhixay of Attapeu Province. • Population within 5km of the route is 683 persons/km, with ethnic minorities accounting for more than half of the population. • The route runs through rich paddy fields.

13.2.2 Identification of Development Stages

(1) Definition of Staged Development

Improvements to Route 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 Route 18A should consider work up to Development Stage 2. It is assumed that this level of development will be reached in 5-10 years.

13.2.3 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.**

13.3 Determination of Road and Crossing Structures

13.3.1 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 are given in Table 13.7.4. These volumes 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 13.3.1. A gravel surface is adequate for Development Stage 2. DBST can be applied if traffic volume is large enough.

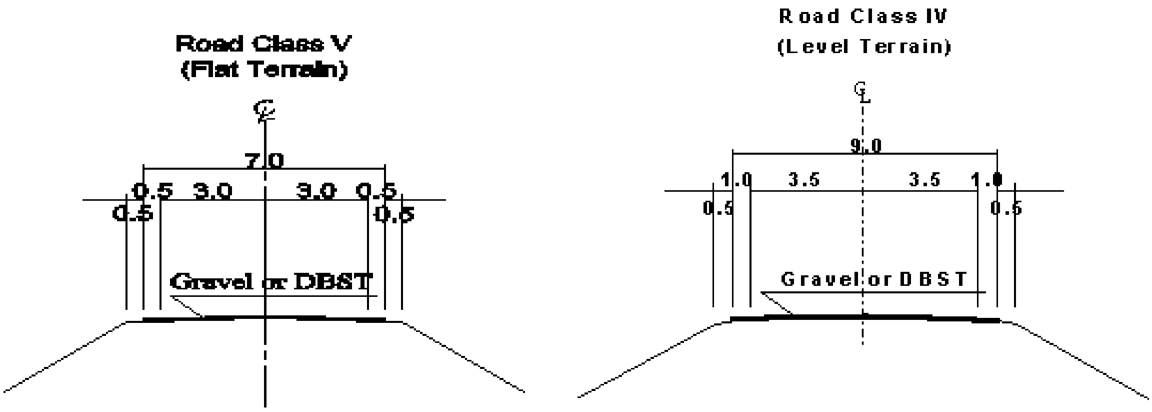


Figure 13.3.1 Typical Cross-Section of Rt. 18A

(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 the gravel thickness is required.

13.3.2 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 13.3.1.

(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 13.3.2 shows the alternatives for each bridge site on the basis of the above application policy. From the Table 13.3.2, 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. The results in detail are indicated in ANNEX F-13.

Table 13.3.1 Crossing Structure Alternatives for Route 18A

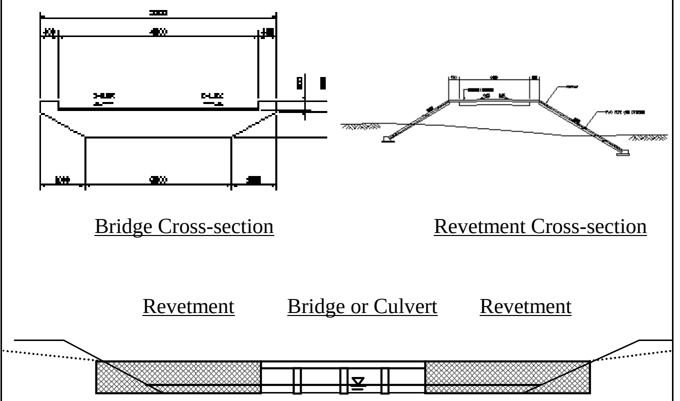
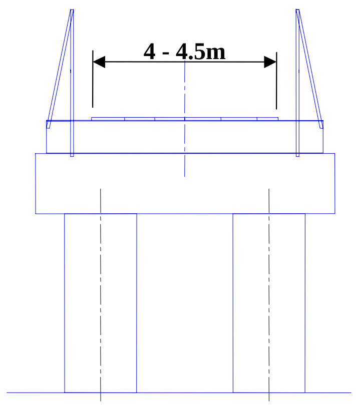
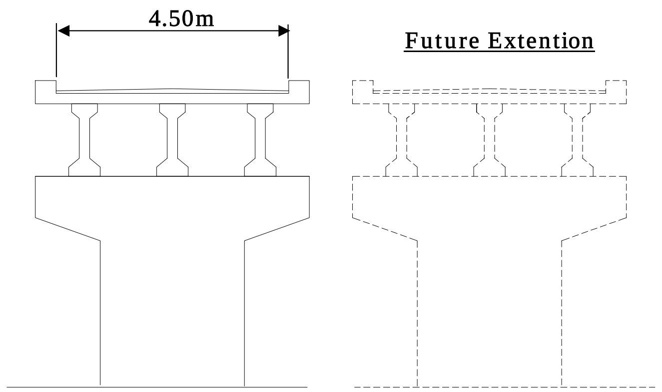
STRUCTURE TYPE	SKETCH	DESCRIPTION	CHARACTERISTICS	COST (US$)	ADAPTABILITY	EVALUATION
Alternative-A **Submersible Bridge or Structure**	 **Side View of Submergible Bridge**	-A crossing structure passable for most of the year and impassable when flooding reaches a predetermined level -A combination of a box culvert or bridge with an embankment section covered by wet masonry.	- Most cost effective alternative in terms of initial cost. - Cannot ensure that traffic and people can pass throughout the year, but greatly improves the level of accessibility - Periods of inaccessibility should not be so long as to adversely affect the current socio-economic status of the area	800$/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
<u>Alternative-C</u> **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 13.3.2 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

13.4 Cost Estimates

13.4.1 Basis of Cost Estimates

The road improvement cost was estimated at Master Plan level of detail. The total project cost comprises five components:

- Construction Cost
- Physical Contingency
- Construction Facility Cost (contractor camp etc.)
- Detailed Engineering and Construction Supervision Cost
- Other Costs

Construction cost is divided into road cost and bridge cost. Each has been estimated based on the established assumptions, with unit costs based on a cost analysis of previous road projects.

13.4.2 Road

(1) Cost Assumptions

1) Road Class and Conditions

The unit costs for a road are set according to road class, terrain and road conditions. Assumptions for Route 18A are as follows.

- **Typical cross sections**
  - Section 1 : Road Class IV
  - Section 2 : Road Class V
  - Section 3 : Road Class IV
- **Terrain condition** : Flat.
- **Road condition** (Terrain condition and Road length)
  - Section 1 : Rank 2 (L=30.6 km)
  - Section 2 : Rank 3 (L=39.7 km)
  - Section 3 : Rank 2 (L=42.2 km)

Since the existing road condition significantly affects the improvement cost, the existing road condition is classified into three cases, as follows. Different unit costs are set depending on the case:

Case 1: sufficient road width already exits, and in relatively good condition. Accordingly, it is easy to undertake the improvement at reasonable cost

Case 2 : Better condition than Case 3 but worse than Case 1

Case 3: Missing link or road with narrow width, less than 2m, accordingly, much work for widening, cut and filling needed, with improvement cost.

2) Construction Cost

The construction cost comprises the following components:

- Earthwork, including filling work
- Pavement work: gravel surface
- Drainage (pipe culverts) : one pipe culvert (dia.=1m) with 12m in length/ Km
- Miscellaneous including slope protection, safety facilities, clearing, temporary roads, side ditches, walls and box culverts, etc.

3) Physical contingency

Physical contingency is assumed to be 10 % of the construction cost.

4) Construction Facility Cost

Construction facility cost such as establishment of contractor camp is assumed to be 2.5 % of the total construction cost including physical contingency.

5) Detailed Engineering and Construction Supervision Cost

Detailed engineering and construction supervision cost is assumed to be 8 % of the total of the above costs.

6) Other Costs

Resettlement cost

Other Costs include resettlement cost and UXO clearance in accordance with previous practice in Lao PDR. Resettlement costs by section has been estimated based on the road inventory survey results. These are summarized in Table 13.4.1.

Table 13.4.1 Housing Resettlement Cost

	STA. 0+000 STA. 30+600	STA. 30+600 STA. 70+300	STA. 70+300 STA. 112+500	Total
No. of Houses	10	10	10	30
Unit Cost (US$)	800	500	800	-

UXO clearing cost

The unit cost is estimated based on the number of UXO. The number of UXO is assumed to be eight bombs per km, according to the UXO severity survey. Table 13.4.2 shows the UXO clearing cost.

Table 13.4.2 Unit Cost for UXO Field Survey

	STA. 0+000 STA. 30+600	STA. 30+600 STA. 70+300	STA. 70+300 STA. 112+500
Length (km)	30.6	38.7	42.2
Unit Cost (US$/km)	Low impact	Low impact	1000 moderate impact

(2) Unit Cost for Road Improvement Route 18A

The cost of road improvement per km is calculated on the basis of the above assumptions for construction cost, contingency, engineering cost and resettlement cost etc. These unit costs are determined according to the cost analysis for previous road projects in Lao P.D.R.

Table 13.4.3 Unit Cost for Road Improvement

Section	Condition	Unit Cost (US$/km)	Remarks
Section 1&3	Class IV, Flat Terrain, Road Condition: Rank 2	96,000	
Section 2	Class V, Flat Terrain, Road Condition: Rank 3	79,100	

13.4.3 Bridges

The bridge cost was estimated by bridge type: submersible, Bailey and permanent one-lane. Costs have been calculated on the basis of the unit cost per square meter of slab deck, set according to the cost analysis of previous bridge projects in Lao and neighbouring countries. Table 13.4.4 shows the unit cost of each bridge type. The bridge unit cost includes construction cost, physical contingency, construction facility cost, and detailed engineering and supervision cost, as for road cost. For applying a submersible type, it is assumed that the bridge portion accounts for half of the total length.

Table 13.4.4 Unit Cost of Each Bridge Type

Bridge Type	Unit Cost (US$/m2)	Remarks
Submersible Bridge	900 100	For bridge section For road section
Bailey Bridge	1,220	
Permanent One-lane Bridge	1,530	

13.4.4 Total 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 13.4.5.

Table 13.4.5 Total Project Cost by Section (in US$ thousand)

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 Border	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

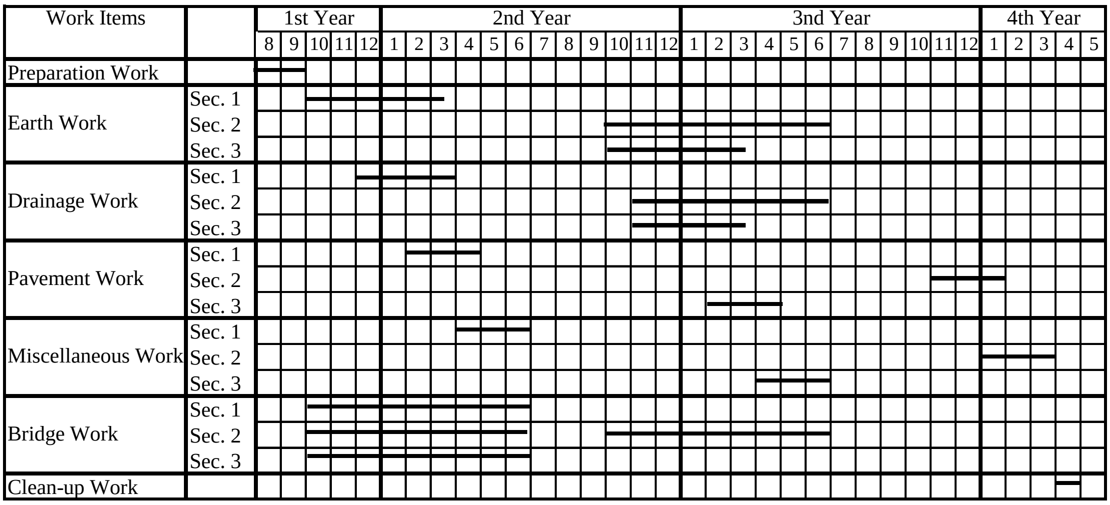
13.5 Road Improvement Implementation Plan for Route 18A

In consideration of bad accessibility to sites in the section 2 due to existence of 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 approx. 35 months.

Table 13.5.1 Construction Schedule for Route 18A



13.6 Road Maintenance Plan for Route 18A

The purpose of maintenance of the road and bridges is to keep the original functions and service level. For this purpose, road maintenance should be executed according to the following standards and systems.

13.6.1 Road

Since the road is planned to have a gravel surface, inspection should be carried out to find defects and evaluate their level on the road components, as described in Table 13.6.1.

Table 13.6.1 Inspection Requirements for Roads

Components	Sub-component	Defects
Unpaved surface	Carriageway	-Loss of camber, Rutting, Potholes, -Corrugations, Erosion gullies, Soft spots, -Obstructions, Loss of gravel depth
Shoulder		-Obstruction, High vegetation, Scour, -Shoulder/carriageway step, Rutting, -Depressions, Potholes
Slopes		-High vegetation, Erosion, -Earth slip/landslide, Rock avalanche, -Collapse of slope protection
Embankment		-Collapse, Settlement
Drainage	Culverts	-Silting, Blockage by debris -Settlement cracks, Collapse of culvert -Erosion of stream bed at culvert outlet -Headwall/apron/wing-wall damage
	Ditches and Drains	Obstruction, Silting, Erosion at drainage outfall Ponding in ditch or on shoulder Invert and sides of ditch are eroded. Ditch lining is damaged.
Structure	Drifts and Causeways	Settlement, Erosion, Debris, Guideposts are damaged or missing.
	Retaining Wall /Stone Masonry	Settlement, Cracking, Collapse
Road Furniture		Dirty, Damaged, Missing

Inspection should be executed at least at 2 monthly interval, and after the rainy season. The evaluation results should be reflected to determine the type and work items for maintenance activities. Based on available resources, such as budget, staff and equipment, the basic maintenance activities and their intervention level for a gravel road are proposed as shown in Table 13.6.2

Table 13.6.2 Intervention Level and Maintenance Activities for Gravel Road

Maintenance Type	Maintenance Activities	
	Items	**Frequency**
Routine	Grading,	twice per year (After rainy season and others)
	Repair of minor damage on shoulder, slope, drainage, embankment, structure, and road furniture	When necessary
Periodic	Re-gravelling, Shaping,	Five yearly interval
	Repair of major damage of shoulder, slope, drainage, embankment, and structure	When necessary

13.6.2 Bridge Structure

The maintenance requirement for the improved crossing structures should be established according to bridge type, because the characteristics of each bridge type differ. Three bridge types are planned, namely: Bailey, concrete slab or girder, and submersible.

Table 13.6.3 Inspection Items for Existing Bridges

Bridge Type	Items to be checked	Checking Items
Bailey	Slab	Cracks, deformation, loss, destruction
	Steel members	Cracks, deformation, corrosion, loosened connection
	Bearing	Cracks, deformation, corrosion, loosened connection, displacement
	Painting	Rust, peeling, fading
	Substructure	Cracks, deformation, loss,
	Protection work	Debris, scouring damage, deformation, displacement, destruction
Concrete-slab or girder	Surface	Cracks, deformation, pot-holes
	Slab and beams	Cracks, deformation, loss
	Railing and curb	Cracks, deformation, loss, destruction
	Bearing	Cracks, deformation, corrosion, loosened connection, displacement
	Drainage	Silting
	Substructure	Cracks, deformation, loss,
	Protection work	Debris, scouring damage, deformation, displacement, destruction
Submersible	Pavement	Cracks, deformation, loss, destruction
	Protection work	Debris, scouring damage, deformation, displacement, destruction
	Fittings	Cracks, Loss, destruction

In order to maintain the bridge function, the following inspection and maintenance activities will be required on a routine or periodic basis. These are listed in Tables 13.6.4, and 13.6.5.

Table 13.6.4 Routine Maintenance Requirements for Crossing Structures

Bridge Type	Work Activities	Intervention level
Bailey (Wooden slab)	-Cleaning of surface -Minor repair of slabs and structural steel members -Removal of debris built-up against piers -Repair to scour damage around substructures	Every year
Concrete-slab or girder	-Cleaning of surface and drainage facility -Minor repair of fittings (railing etc.) and surface -Removal of debris built-up against piers	Every year

	-Repair to scour damage around substructures and protection structures	
Submersible	-Cleaning of surface and drainage facility -Minor repair of fittings (railing etc.) and surface -Removal of debris built-up against piers -Repair to scour damage around protection structures	Every year

Table 13.6.5 Periodic Maintenance Requirements for Crossing Structures

Bridge Type	Work Items	Interval
Bailey (Wooden slab)	Replacement of wooden slab Replacement of some structural panel Repair of protection work	3-5 years when necessary ditto
Concrete-slab or girder	Resurfacing Repair of sever cracks Repair of protection work	5 years when necessary ditto
Submersible	Resurfacing Repair of sever cracks on pavement Repair of revetments Replace of fitting	5 years when necessary ditto ditto

13.6.3 Maintenance Cost

Maintenance cost after road improvement has been estimated using the unit costs per km in Table 13.6.6. The major component of periodic maintenance is re-gravelling work. These costs have been set on the basis of the maintenance cost analysis of the Master Plan Study.

Table 13.6.6 Maintenance Unit Cost after Improvement

Routine Maintenance (US$/km/year)	Periodic Maintenance (US$/km/5yrs)
400	17,000

13.7 Economic Analysis

13.7.1 Introduction

An economic analysis of improving Route 18A to all-weather gravel standard has been performed using the same methodology used for the analysis of Routes 14A and 16A (for details see chapter IV-11). The route functions at present as two local access roads, one at each end, but not as a through route. The central section, km 30-70, is impassable due to unbridged rivers for all but a short period at the end of the dry season. Some parts of the eastern and western sections are also impassable at times during the rainy season. After improvement the route would serve twin purposes: for existing local movements and as an alternative inter-regional and international route Vietnam/Attapeu – Pakse/Thailand to Route 16A.

The analysis compares the costs and benefits of improving either or both the eastern and the western sections and of improving the whole route. It uses simplified cost estimates and traffic forecasts, at Master Plan level of detail. As such, it is subject to a higher margin of error than the analysis of Routes 14A and 16A in chapter IV-11.

13.7.2 Existing and Future Traffic

Existing Traffic. Traffic volume at the eastern end of the eastern section, recorded in the Master Plan traffic survey in December 2001, is shown in Table 13.7.1. Daily traffic volume has not been established for the western section, where a 24-hour count would be required at 5-10 km from the junction with Route 13S to obtain a representative figure. Some 30 articulated logging trucks were observed during the Study team's field trips, parked 20-30km from the junction with Route 13S. A number of local movements of logs from the central section to the log storage areas in the western section were observed. Long distance movement of the logs may take place at night. Little traffic was observed on the western section during the middle of the day. The illustrative volumes for the western end of the section, given in Table 13.7.1, have been used in the analysis. On the central section, apart from local movement of logs, there is virtually no existing traffic, even in the dry season.

Table 13.7.1 Normal Traffic by Section 2001

Vehicle Class	Eastern	Western
Car/Pick-Up	34	15
Bus	20	10
Medium truck	9	5
Heavy Truck	4	10
Total	67	40
Motorcycle	104	60

Future Normal Traffic. By applying the traffic growth rates used for the analysis of Routes 14A and 16A (given in Table IV-11.4.1) to the 2001 volumes, normal traffic by section in 2008 is as given in Table 13.7.2.

Table 13.7.2 Normal Traffic by Section 2008

Vehicle Class	Eastern	Western
Car/Pick-Up	58	25
Bus	32	16
Medium truck	14	8
Heavy Truck	6	16
Total	110	65
Motorcycle	205	118

Traffic declines along both sections away from the ends, to almost nil at the start of the central section. Average normal traffic volume over the eastern and western sections in 2008 has been assumed to be 60 per cent of the volumes towards the ends, given in Table 13.7.2.

Diverting Traffic. Improving the whole road to all-weather gravel standard would open an important new route for through traffic, diverting some trips from Route 16A. In order to estimate such diversion with confidence, a more detailed OD survey than that made for the Master Plan would be required. The Attapeu-Pakse distance via Route 16A will be slightly less than via Route 18A, after the improvement of Route 16A, with a short-cut section, to a length of 64km. Traffic from Attapeu for Pakse/Thailand/the north would be unlikely to divert to a gravel Route 18A, although a few users might prefer the easier driving, avoiding the climb over the Boloven Plateau. A few buses would also divert to serve the Route 18A corridor. Traffic from Attapeu for destinations south of Pakse would be more likely to divert, although the volume of such traffic may be small.

In the absence of specific data, the indicative volume of diverting traffic in opening year 2008 given in Table 13.7.3 has been assumed. Diverting traffic would use all sections of Route 18A.

Table 13.7.3 Diverting and Generated Through Traffic 2008

Vehicle Class	Diverting	Generated
Car/Pick-Up	15	15
Bus	2	2
Medium truck	6	6
Heavy Truck	1	1
Total	24	24
Motorcycle	25	50

Generated Traffic. An improved Route 18A would generate traffic in two ways: as a result of the lower operating cost for existing users of the eastern and western sections and as a result of the new opportunities opened up for through trips. The first component of generation is determined directly in the RED model economic analysis. The second component has been assumed to be 100 per cent of the diverting volume for vehicles and 200 per cent of the diverting volume for motorcycles, as given in Table 13.7.3.

Traffic Forecast to 2027. The traffic volumes in 2008, as developed above, have been forecast to 2027 by applying the Feasibility Study growth rates (shown in Table IV-11.4.1). Forecast annual traffic volumes by section are given in Table 13.7.4. These volumes assume that all sections are improved. Traffic on the eastern or western sections, if improved alone, would be as given in the table, but deducting in each case the volume on the central section.

Average daily traffic volume in the 10th year of operation, 2017, is forecast to be 427 vehicles (plus 875 motorcycles) at the end of the eastern section, 100 vehicles (192 motorcycles) on the central section and 286 vehicles (583 motorcycles) at the end of the western section.

Table 13.7.4 Traffic Forecast Route 18A

	Eastern Section						Central Section						Western Section					
			Trucks		Vehicles				Trucks		Vehicles				Trucks		Vehicles	
Year	Cars/P-Up	Buses	Medium	Heavy	Total	Motorcycle	Cars/P-Up	Buses	Medium	Heavy	Total	Motorcycle	Cars/P-Up	Buses	Medium	Heavy	Total	Motorcycle
2002	35	21	9	5	70	110	0	0	0	0	0	0	15	10	5	11	41	63
2003	38	22	10	5	76	122	0	0	0	0	0	0	17	11	5	11	45	70
2004	41	24	11	6	82	135	0	0	0	0	0	0	18	12	6	12	48	78
2005	45	26	11	6	88	150	0	0	0	0	0	0	20	13	6	13	52	86
2006	49	28	12	7	95	167	0	0	0	0	0	0	21	14	7	14	56	95
2007	53	30	13	7	103	185	0	0	0	0	0	0	23	15	7	15	60	106
2008	117	49	30	9	205	342	30	4	12	2	48	75	68	27	22	22	139	228
2009	128	53	32	10	222	380	33	4	13	2	52	83	74	29	24	24	151	253
2010	139	57	35	10	241	421	36	5	14	2	56	92	81	31	25	25	163	281
2011	152	62	37	11	262	468	39	5	15	2	61	103	88	34	27	27	177	312
2012	165	67	40	12	284	519	42	5	16	3	66	114	96	37	29	29	191	346
2013	180	72	43	13	308	576	46	6	17	3	72	126	105	40	32	32	207	384
2014	196	78	46	14	334	640	50	6	19	3	78	140	114	43	34	34	225	426
2015	214	84	50	15	363	710	55	7	20	3	85	156	124	46	36	36	244	473
2016	233	91	54	16	393	788	60	7	21	4	92	173	135	50	39	39	264	525
2017	254	98	58	17	427	875	65	8	23	4	100	192	148	54	42	42	286	583
2018	277	106	62	19	463	971	71	9	25	4	109	213	161	58	45	45	310	647
2019	302	114	66	20	503	1078	77	9	27	4	118	236	175	63	49	49	336	719
2020	329	123	71	21	545	1196	84	10	29	5	128	262	191	68	52	52	364	798
2021	359	133	77	23	592	1292	92	11	31	5	139	283	208	73	56	56	395	861
2022	391	144	83	25	642	1396	100	12	33	6	151	306	227	79	61	61	428	930
2023	426	155	89	27	697	1507	109	13	36	6	163	331	248	86	65	65	464	1005
2024	465	168	95	29	756	1628	119	14	38	6	177	357	270	93	70	70	502	1085
2025	506	181	103	31	821	1758	130	15	41	7	193	386	294	100	75	75	545	1172
2026	552	196	110	33	891	1899	142	16	44	7	209	416	321	108	81	81	590	1266
2027	602	211	119	36	967	2051	154	17	47	8	227	450	350	117	87	87	640	1367

Notes: ssuming all sections improve

13.7.3 Project Costs

The project costs comprise the economic cost of implementation 2005-2007, the annual cost of routine maintenance and each fifth year from opening the cost of periodic maintenance (regravelling). The maintenance costs per km are given in Table 13.6.6. The estimated project financial construction cost is US$18.8 million. The construction period is expected to be about 3 years. The financial and economic costs by section are given in Table 13.7.5. Economic cost has been taken to be 92 per cent of financial cost.

Table 13.7.5 Project Cost Estimates (in US$ million)

Item	Eastern Km 112.5-70.3	Central 70.3-30.6	Western 30.6-0.0	Total
Financial cost	7.92	6.80	4.05	18.77
Economic cost	7.29	6.25	3.73	17.27
Economic cost/km	0.17	0.16	0.12	0.15

The project disbursement schedule is given in Table 13.7.6.

Table 13.7.6 Project Disbursement Schedule (in US$ million)

Item	2005	2006	2007	Total
Financial cost	7.28	8.11	3.39	18.77
Economic cost	6.69	7.46	3.12	17.27
Economic cost in %	38.7	43.2	18.1	100.0

Environmental Monitoring. The particular environmental sensitivity of the route was determined at the Master Plan stage. A pre-requisite for improvement would likely be an environmental monitoring programme. The cost of such a programme, estimated at US$10,000 a year, has been included as a project cost (added to maintenance cost in the analysis tables).

13.7.4 Project Benefits

Project road user benefits comprise vehicle operating cost and travel time savings. These have been evaluated with the RED model. Improvement of either or both the eastern and western sections would provide benefits to the normal (and associated generated) traffic on these sections. Improvement of the whole route would provide the addition of benefits to through traffic, both diverted and generated.

The maximum possible benefits from diverting traffic would be obtained by traffic for points south of the Route 18A/13S intersection. Such traffic would have a distance saving via Route 18A of 84 km compared with the alternative via Pakse on Routes 1I16A/16/13S. The average saving for diverting traffic is assumed to be half this, 42km, the saving for traffic originating at the Champasack ferry. Even with this saving, VOC on the longer paved route is slightly less than for the shorter gravel route. There are, however, time savings from Route 18A.

The before and after improvement road surface conditions used for the benefit modeling are as follows:

	Existing		
Route	Dry	Rainy	Improved
18A	20	25	10
1I/16/16A/13S	4	4	-

Residual Value. The residual value of the investment at the end of the analysis period has been taken as 25 per cent. The road will be due for periodic maintenance in 2028, lowering its value somewhat for 2027.

13.7.5 Economic Analysis Results

The results of the economic analysis for the eastern and western sections alone and for the whole route are given in Table 13.7.7.

Table 13.7.7 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 little economic value. It drags down the overall results. The eastern section, although more costly per km, is significantly better than the western section, due to its higher traffic volume.

The annual costs and benefits 2005-2027 for the eastern section are given in Table 13.7.8, for the western section in Table 13.7.9 and for the whole route in Table 13.7.10.

Table 13.7.8 Economic Analysis Eastern Section (in US$ thousand)

	Economic Cost		Benefits:Normal Traffic		Generated Traffic		Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	VOC/Time	Benefits	Benefits
2005	-2820	0	0	0	0	0	0	0	-2820
2006	-3148	0	0	0	0	0	0	0	-3148
2007	-1319	0	0	0	0	0	0	0	-1319
2008	0	-20	211	35	47	8	49	350	330
2009	0	-20	228	38	51	8	54	379	359
2010	0	-20	247	41	55	9	60	413	393
2011	0	-20	269	45	60	10	66	450	430
2012	0	-20	292	48	65	11	74	490	470
2013	0	-786	317	52	71	11	82	533	-253
2014	0	-20	344	57	77	12	91	581	561
2015	0	-20	373	62	84	13	101	633	613
2016	0	-20	405	67	91	15	112	689	669
2017	0	-20	440	72	99	16	124	751	731
2018	0	-786	477	78	108	17	138	818	32
2019	0	-20	518	85	117	18	153	892	872
2020	0	-20	563	92	127	20	170	972	952
2021	0	-20	611	99	138	22	189	1059	1039
2022	0	-20	664	107	150	23	210	1154	1134
2023	0	-786	721	116	163	25	233	1258	472
2024	0	-20	783	126	177	28	258	1372	1352
2025	0	-20	850	136	193	30	287	1496	1476
2026	0	-20	923	148	210	32	318	1631	1611
2027	1822	-20	1002	160	228	35	353	1778	3580

Results: EIRR : 5.9 NPV at 12% : -3.02 FYB % : 3.5 B/C : 0.54

Table 13.7.9 Economic Analysis Western Section (in US$ thousand)

	Economic Cost		Benefits:Normal Traffic		Generated Traffic		Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	VOC/Time	Benefits	Benefits
2005	-1442	0	0	0	0	0	0	0	-1442
2006	-1610	0	0	0	0	0	0	0	-1610
2007	-674	0	0	0	0	0	0	0	-674
2008	0	-15	93	13	18	3	20	146	131
2009	0	-15	100	13	20	3	22	158	143
2010	0	-15	108	15	21	3	25	172	157
2011	0	-15	117	16	23	3	28	187	172
2012	0	-15	127	17	25	4	31	203	188
2013	0	-566	137	19	27	4	34	221	-345
2014	0	-15	149	20	30	4	38	240	225
2015	0	-15	161	22	32	5	42	261	246
2016	0	-15	174	23	35	5	47	284	269
2017	0	-15	189	25	38	6	52	309	294
2018	0	-566	205	28	41	6	57	336	-230
2019	0	-15	222	30	45	6	64	366	351
2020	0	-15	240	32	48	7	71	398	383
2021	0	-15	260	35	53	8	78	433	418
2022	0	-15	282	38	57	8	87	472	457
2023	0	-566	305	41	62	9	97	514	-53
2024	0	-15	331	44	67	10	107	559	544
2025	0	-15	358	48	73	10	119	609	593
2026	0	-15	388	52	79	11	132	663	647
2027	932	-15	420	56	86	12	147	722	1638

Results: EIRR : 3.4 NPV at 12% : -2.02 FYB % : 2.7 B/C : 0.42

Table 13.7.10 Economic Analysis Whole Route (in US$ thousand)

	Economic Cost		Benefits: Normal Traffic		Generated Traffic		Diverting Traffic		Through Generated		Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	VOC	Time	VOC	Time	VOC/Time	Benefits	Benefits
2005	-6683	0	0	0	0	0	0	0	0	0	0	0	-6683
2006	-7460	0	0	0	0	0	0	0	0	0	0	0	-7460
2007	-3126	0	0	0	0	0	0	0	0	0	0	0	-3126
2008	0	-55	304	48	65	10	-1	4	0	2	69	502	447
2009	0	-55	328	52	71	11	-1	5	0	2	76	544	489
2010	0	-55	356	56	77	12	-1	5	0	3	85	591	536
2011	0	-55	386	61	83	13	-1	6	-1	3	94	643	588
2012	0	-55	418	66	90	14	-2	6	-1	3	104	700	645
2013	0	-2080	454	71	98	15	-2	7	-1	3	116	761	-1319
2014	0	-55	492	77	107	17	-2	7	-1	4	129	829	774
2015	0	-55	534	83	116	18	-3	8	-1	4	143	902	847
2016	0	-55	579	90	126	20	-3	8	-2	4	159	982	927
2017	0	-55	629	98	137	21	-4	9	-2	5	176	1069	1014
2018	0	-2080	682	106	149	23	-4	10	-2	5	195	1163	-917
2019	0	-55	740	114	162	25	-5	11	-2	5	217	1267	1212
2020	0	-55	803	124	176	27	-6	12	-3	6	241	1379	1324
2021	0	-55	871	134	191	29	-6	13	-3	6	267	1502	1447
2022	0	-55	945	145	207	32	-7	14	-4	7	297	1636	1581
2023	0	-2080	1026	157	225	34	-8	15	-4	7	329	1782	-298
2024	0	-55	1113	170	245	37	-9	16	-5	8	365	1941	1886
2025	0	-55	1208	184	266	40	-11	18	-5	9	406	2114	2059
2026	0	-55	1311	200	289	44	-12	19	-6	10	450	2304	2249
2027	4317	-55	1423	216	314	47	-14	21	-7	10	500	2510	6772

Results: EIRR: 1.6 PV at 12% : -10.59 FYB % : 2 B/C: 0.33

13.7.6 Sensitivity Tests

The sensitivity of the results to a 30 per cent reduction in construction costs is shown in Table 13.7.11. The figures in this table are the changes to the indicators compared with the base case results in Table 13.7.7.

Table 13.7.11 Sensitivity to Construction Cost

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

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 13.7.12.

Table 13.7.12 Improving Short Sections

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

13.7.7 Conclusions

The economic analysis of Route 18A has been undertaken as an example to establish how a staged improvement programme 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 programme 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.

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 the route 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 13.7.13 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.

13.7.8 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.

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

13.8.1 Introduction

This sub-chapter tries to establish an approach and methodology to provide basic access for roads suitable for Development Stage 1 on the basis of discussions on the approach to one for Development Stage 2. It is inevitable to involve a community to build and maintain a road suitable for Development Stage 1.

13.8.2 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 13.7.8
- Involves communities along the target road from the planning stage to ensure sustainability of a basic access level of service for said the road
- Identifies the roles of the road agency and communities in the implementation process with the aim of exploiting potential a synergy effects.

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

<u>Road Planning Stage</u>

It is important for road agency to promote interface with community from this planning stage in order to foster the sense of “ownership” by community. However, roles of both road agency and community should be clarified to avoid any conflict induced by different interest of communities along the road. The following role separation shall be appropriate.

(Role of Road Agency)

- Confirms the development stage, and identify approximate route (start and end) and its basic structure.

(Community Involvement)

- Participates in selecting portion of route which community is to be responsible for.
- Participates in selecting the detailed route selection and passability level.

<u>Road Improvement & Maintenance Stage</u>

In order to achieve cost effectiveness and foster the sense of ownership by community, labour-based method for improvement and maintenance should be applied. Two systems, Lengthman or community contract system, shall be applicable depending on nature of the community. If the community is well organized, the latter maybe adequate.

(Role of Road Agency)

- 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

(Community Involvement)

- Provide labor force to execute road improvement and maintenance work

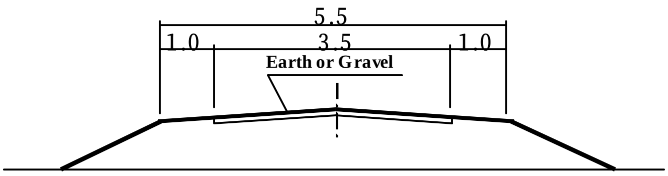
(3) Issues to be Considered

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. However, there are some issues in order to accomplish the original purpose.

- Financial sustainability is the key to maintaining a road based on community involvement. Financial support from the road agency or establishing measures to earn funds for maintenance by community itself should be considered.
- In order to execute maintenance work properly, ownership shall shift back from communities to the road agency once development stage reaches Stage 2.
- The road agency should make an effort to promote private sector capacity such as access to resources and establishing an enabling environment.(See Chapter 14.3 (5))

(4) Proposed Road Structure Suitable for Development Stage 1

Road structure suitable for Development Stage 1 is proposed as follows. It is assumed that traffic volume will range from 50 to 100 VPD in this stage.



As for the crossing structure, one-lane Bailey, or submersible type is appropriate and timber type is also allowable in a short span bridge. 8 tons of the loading capacity shall be sufficient in this development stage.

CHAPTER 14

CONCLUSIONS & RECOMMENDATIONS

CHAPTER 14 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.

14.1 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. The **roles and functions** of the two Projects are described below.

Both projects would accelerate the development of the Southern Region. They would help to **reduce poverty** by improving **access to hospitals, schools and markets, extension public services, income and employment opportunities** and **enhancing local development potential.** They would also **facilitate trade and investment** in the area and the region enhancing income and employment **generating activities** by improving links to neighboring countries.

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.Soukhouma 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. 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 1H, 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** (constructed 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 clearly would provide valuable additions to the 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.

14.2 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 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 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 exact 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.

(d) **IEE approval by Science, Technology and Environment Agency** (Environmental Research Institute).

The Social and Environment Division of the Department of Roads (DoR) will be closely associated 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.

14.3 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 the contribution of the Project to 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 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** require to 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.