Ⅳ FEASIBLITY STUDY

CHAPTER 9
PROJECT COST ESTIMATES

CHAPTER 9 PROJECT COST ESTIMATES

9.1 Introduction

The project cost estimate is based of the results of the preliminary design, the quantity of each work item, and the study of construction planning and road maintenance. Output of the estimate will utilize for economic analysis in Ⅳchapter 11.

Cost estimation in many feasibility studies has been carried out by analyzing unit costs of work items applied in related/similar projects in Lao P.D.R. However, this study use the "Estimation Method based on Productivity" in order to obtain more accurate output. Normally, this method is applied at detailed design stage. The unit cost of each item is divided into material, labor and equipment cost. Unit costs for previous road projects funded by international donors (i.e., JICA and ADB) were compared and examined to justify the suitability of the method. The project cost composes of the following items.

Project Cost

[1] Pre-Construction Stage
1. Field Survey and UXO Clearance
2. Land Acquisition and Resettlement
3. 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

Road Operation and Maintenance Cost

1. Environmental Monitoring
2. Routine and Periodic Maintenance

9.2 Basis of Cost Estimate

(1) Contractor

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

(2) Applied Exchange Rate

The exchange rate used were as follows:

US$ 1 = JPY 125.55 = Kip 10,940

Kip 1 = JPY 0.01148

Source: TTS rate dated as of 15th October, 2002

(3) Rate of Operation: 0.75

- Workable Period: October to June (9 months)
- National Holiday: 9days from October to June
- Rainy Days: 10% of working days
- Paid Holiday: 15 days

(4) Foreign ad Domestic Sources

Procurement sourcing divided into **Component A** and **Component B**.

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 in Table 9.3.3 and Table 9.3.4. The assumptions for this item 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. For example, the price for diesel is calculated as follows.

  ₵ 22.80 (border price) x 1.10 x 1.02 x 1.05 = ₵ 26.86 (retail price)
- The average rate of other local components is 5.4 per cent of Component B in Civil works cost and Physical contingency cost.

The tax and duty in other local components contain income tax for labor, import tax on new goods/equipment brought into the country and company tax. A recent report for ADB (*Preparing the Northern Economic Corridor* Draft Final Report, August 2002, Nathan Associates Inc.) assessed the current tax and duty component of an ICB new construction project in some detail. The rate in the above report shows equivalent to the assumed rate in this estimate (5.4%).

9.3 Project Cost Estimate

9.3.1 Overall Project Cost

Total project cost (economic cost) for Route 14A and Route 16A is shown in Table 9.3.1. Total costs of civil works and engineering service (financial cost), excluding fuel tax and duty is shown in Table 9.3.2. The procurement sourcing is described.

Table 9.3.1 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 9.3.2 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

NOTE
A: Component A, B: Component B

According to the Environmental Management Plan (EMP) of MCTPC, The environmental monitoring is required during three stages of the project. The cost is estimated on each stage.

(i) Pre-Construction
(ii) Construction
(iii) Road Operation

Tables 9.3.3 and 9.3.4 show summaries of project cost for Route 14A and Route 16A respectively. The estimates are described in following sections.

Table 9.3.3 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 9.3.4 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

9.3.2 Pre-Construction Stage

(1) Field Survey and UXO Clearance

This component comprises the following items.

1) UXO Survey and Clearance
2) Survey of Archeological Remains
3) Survey of Natural Forest Resources

1) UXO Survey and Clearance

Survey work is required in uninhabited areas (e.g., forest, bush) in new road construction, and possible borrow pit sites and access roads for Route 14A and Route 16A. Clearance work is assumed for the whole of Route 16A. No clearance work is required for the Route 14A. These assumptions have been made based on analysis of survey result of UXO Lao and report for ADB (Rural Access Roads Improvement Project Final Report).

The survey work contains 1-week field survey (mainly interview with local people) by 20 surveyors, plus reporting. The cost is estimated US$10,000 for Route 14A and Route 16A respectively. Clearance work shall be executed in the right of way, the sites for borrow pits, temporary yards and site camps, and their access roads in Route 16A. Estimated cost is US$1,200 per km. Total costs are shown in Table 9.3.5.

Table 9.3.5 UXO Survey & Clearance Cost (Rt. 14A & Rt. 16A)

Route	Section	Item	Total Cost (US$)
14A	STA.4+700 – STA.24+400	Survey	10,000
16A	STA.33+900 – STA.40+200	Survey	10,000
	STA.0+000 – STA.64+138	Clearance	76,900
		Total (16A)	86,900

2) Survey of Archeological Remains

Survey work is required for new road construction sections of Routes 14A and 16A. The cost includes allowance and accommodation for 6 surveyors, equipment, 10 local staff and reporting. Survey period is estimated of 20 days for Route 14A and 10 days for Route 16A. The costs are shown in Table 9.3.6.

Table 9.3.6 Archeological Survey Cost (Rt. 14A & Rt. 16A)

Route	Section	Total Cost (US$)
14A	STA.4+700 – STA.24+400 STA.28+700 – STA.35+500	3,300
16A	STA.33+900 – STA.40+200	1,700

3) Survey of Natural Forest Resources

Survey work is required in the new road construction section and mountainous section of Route 16A. The estimated costs are shown in Table 9.3.7.

Table 9.3.7 Survey Cost of Natural Forest Resources (Rt. 16A)

Section	Cost (US$)
New Road Section (STA. 33+900 – STA. 40+200)	1,000
Mountain Section (STA. 42+000 – STA. 58+000)	3,000
Total	4,000

(2) Land Acquisition and Resettlement Cost

This component comprises the following items.

1) House Resettlement Cost
2) Site Preparation Cost
3) Facility Relocation Cost
4) Agricultural Production Loss
5) Bridge Demolition Cost

1) House Resettlement Cost

The Government of Lao P.D.R. shall make compensation for house resettlement (i.e., demolition and construction). The Government introduces maximum unit costs for resettlement depending on type of house (i.e., bamboo, timber, masonry/concrete). However, normally these unit costs are applied with modification based on local condition. There is no compensation for land, because the land belongs to the nation. The Government prepares substitute sites for houses and farmland.

The Study Team surveyed the number of houses and their total area to be removed for road construction by type of house (i.e. bamboo, timber, masonry/concrete). Further, the Study Team examined the cases of previous projects and had discussion with DCTPC Champasack to determine the appropriate unit cost applied for this project. This cost includes house

demolition and construction. See Table 9.3.8.

Table 9.3.8 Unit Costs of House Resettlement (US$/m2)

Type of House	Max. Unit Cost	Applied Cost
Bamboo	50	10
Timber	140	20
Masonry/Concrete	150	20

House resettlement cost is estimated in Tables 9.3.9 and 9.3.10.

Table 9.3.9 House Resettlement Cost (Rt. 14A)

Type of House	No.	Area (m2)	Total Cost (US$)
Bamboo	38	1,100	11,300
Timber	136	8,800	176,000
Masonry/Concrete	4	400	8,000
Total	178	10,300	195,300

Table 9.3.10 House Resettlement Cost (Rt. 16A)

Type of House	No.	Area (m2)	Total Cost (US$)
Bamboo	41	1,200	11,700
Timber	29	1,200	23,900
Masonry/Concrete	1	100	2,200
Total	71	2,500	37,700

2) Site Preparation Cost

Site preparation work for housing includes site clearance and grading. The work for farmland is site clearing. The Study Teams estimated the cost based on contents of the work. See Table 9.3.11and Table 9.3.12.

Table 9.3.11 Substitute Site Preparation Cost (Rt. 14A)

Type of Land	Area (m2)	Total Cost (US$)
House	124,500	232,800
Farmland	876,700	78,900
Total	1,001,200	311,700

Table 9.3.12 Substitute Site Preparation Cost (Rt. 16A)

Type of Land	Area (m2)	Amount (US$)
House	89,500	167,300
Farmland	378,100	34,000
Total	467,600	201,300

3) Facility Relocation Cost

The relocation cost for electric facilities (i.e., cables and poles) has been estimated on the basis of study at Electricity of Lao, Pakse. This costs is necessary for Route 14A (STA.0+000 – STA.24+500). See Table 9.3.13.

Table 9.3.13 Relocation Cost for Electric Facilities (Rt. 14A)

Length of Cable (m)	Unit Cost (US$/m)	Total (US$)
11,800	5.00	59,000

4) Loss of Agricultural Production

This cost is estimated using average yield (per hectare) and market price in Pakse for three major cash crops (i.e., paddy rice, dry rice and coffee) based on the information provided by Agriculture Department, Pakse and Paksong. Total costs are shown in Tables 9.3.14 and 9.3.15.

Table 9.3.14 Agricultural Production Loss (Rt. 14A)

Crop	Area (m2)	Total Cost (US$)
Paddy Rice	876,700	52,600

Table 9.3.15 Agricultural Production Loss (Rt. 16A)

Crop	Area (m2)	Total Cost (US$)
Dry Rice	90,000	2,500
Coffee	288,000	10,100
Total	378,000	12,600

5) Bridge Demolition Cost

The bridge demolition cost contains demolition of the piers and superstructure of three existing bridges on Route 16A to avoid an adverse effect on the new bridge. The estimated cost is US$ 7,700.

(3) Environmental Monitoring

The work at pre-construction stage will be executed monthly from 1 year before construction work (in total 12 times). Major work components are 1-week socio-economic surveys and reporting. The cost includes allowance, accommodation and transportation fare for three surveyors.

9.3.3 Construction Stage

(1) Civil Works

1) Construction Quantity

Base on the results of the preliminary design stage, the quantities of major construction work item were estimated. These are shown in Table 9.3.16.

Table 9.3.16 Construction Quantities

Route 14A

WORK ITEM		UNIT	QUANTITY
1. Preparatory Works			
(1) Site Clearing		m2	1,075,923
2. Earthwork			
(1) Embankment		m3	790,793
(2) Cut		m3	89,258
3. Pavement			
(1) Surface course		m2	450,688
(2) Base course		m2	648,940
(3) Subbase course		m2	712,392
(4) Subgrade		m3	223,148
(5) Paved shoulder		m2	107,521
4. Drainage			
(1) Pipe culvert (Single)	Dia 0.8m	m	340.5
	Dia 1.0m	m	664.3
	Dia 1.5m	m	240.5
(2) Pipe culvert (Double)	Dia 0.8m	m	0.0
	Dia 1.0m	m	1,175.5
	Dia 1.5m	m	826.9
(3) Box culvert (Single)	W1.5xH1.5	m	84.5
	W2.0xH2.0	m	136.1
	W2.5xH2.5	m	118.1
(4) Box culvert (Double)	W1.5xH1.5	m	78.7
	W2.0xH2.0	m	166.6
	W2.5xH2.5	m	122.1
(5) Side ditch	Stone masonry	m	22,075
5. Slope protection			
(1) Embankment	Turf	m2	362,500
(2) Cut	Turf	m2	12,930
6. Retaining wall	Stone masonry	m2	1,232
7. Apparatus Work			
(1) Guard-rail		m	4,825
(2) Traffic sign		nos.	119
8. Temporary road		m2	302,750
9. Bridge Work			
(1) Girder Fabrication Work			
(i) RC-I Girder	L=15m	nos.	12
(ii) PC-I Girder	L=22m	nos.	16
(iii) RC-I Girder	L=25m	nos.	24
(iv) RC-I Girder	L=30m	nos.	12
(2) Deck Slab Work			
(i) RC-I Type	L=15m	m2	405
(ii) PC-I Type	L=22m	m2	792
(iii) RC-I Type	L=25m	m2	1,350
(iv) RC-I Type	L=30m	m2	810
(3) Substructure Work			
(i) Abutment		nos.	28
(ii) Pier		nos.	2
(4) Pile Foundation Work			
Pile	400*400	m	5,427
		nos.	649

Route 16A

WORK ITEM		UNIT	QUANTITY
1. Preparatory Works			
(1) Site Clearing		m2	1,025,750
2. Earthwork			
(1) Embankment		m3	397,945
(2) Cut (soil)			332,241
(3) Rock excavation		m3	382,187
3. Pavement			
(1) Surface course		m2	471,449
(2) Base course		m2	684,373
(3) Subbase		m2	753,001
(4) Subgrade		m3	236,098
(5) Paved shoulder		m2	114,793
4. Drainage			
(1) Pipe culvert (Single)	Dia 0.8m	m	724.7
	Dia 1.0m	m	758.8
	Dia 1.5m	m	122.9
(2) Pipe culvert (Double)	Dia 0.8m	m	0.0
	Dia 1.0m	m	549.5
	Dia 1.5m	m	501.4
(3) Box culvert (Single)	W1.5xH1.5	m	15.0
	W2.0xH2.0	m	0.0
	W2.5xH2.5	m	0.0
(4) Box culvert (Double)	W1.5xH1.5	m	0.0
	W2.0xH2.0	m	82.8
	W2.5xH2.5	m	0.0
(5) Side ditch	Stone masonry	m	85,338
5. Slope protection			
(1) Embankment	Turf	m2	273,570
(2) Cut	Turf	m2	55,780
6. Retaining wall	TOTAL	m2	3,972
7. Apparatus Work			
(1) Guard-rail		m	850
(2) Traffic sign		nos.	129
8. Temporary road		m2	262,500
9. Bridge Work			
(1) Girder Fabrication Work			
(i) RC-I Girder	L=15m	nos.	4
(ii) PC-I Girder	L=22m	nos.	0
(iii) RC-I Girder	L=25m	nos.	15
(iv) RC-I Girder	L=30m	nos.	16
(2) Deck Slab Work			
(i) RC-I Type	L=15m	m2	135
(ii) PC-I Type	L=22m	m2	0
(iii) RC-I Type	L=25m	m2	825
(iv) RC-I Type	L=30m	m2	1,080
(3) Substructure Work			
(i) Abutment		nos.	14
(ii) Pier		nos.	2
(4) Pile Foundation Work			
Pile	400*400	m	0
		nos.	0

2) Unit Cost

Unit Rate of Material, Labor & Equipment

The Study Team collected quotations prepared by six construction companies (i.e. three local and three international) to develop unit rates for material, labor and equipment. Table 9.3.17 to 9.3.19 show the unit rate of major components of material, labor and equipment applied.

Table 9.3.17 Unit Rate for Major Materials

Material	Unit	Unit Rate (US$)
Cement	ton	72.00
Reinforcing bar	ton	456.00
Gasoline	liter	0.30
Diesel	liter	0.27
Fine aggregate	m3	10.34
Coarse aggregate	m3	13.66
Crushed stone	m3	18.40
Straight asphalt	ton	256.00

Table 9.3.18 Unit Rate for Labor

Classification	Unit	Unit Rate (US$)
Senior engineer (10yrs experience)	Month	1,300.0
Junior engineer (5yrs experience)	Month	800.0
Foreman	Day	37.0
Equipment operator	Day	11.0
Skilled labor	Day	9.0
Unskilled labor	Day	5.0

Table 9.3.19 Unit Rate for Major Equipment

Equipment	Capacity	Unit	Unit Rate (US$)
Dump truck	4 ton	Day	80.00
Dump truck	10 ton	Day	112.00
Truck crane	25 ton	Day	280.00
Back hoe	0.6 m3	Day	176.00
Motor grader	3.1 m	Day	200.00
Tire roller	10 ton	Day	160.00
Road roller	11 ton	Day	160.00
Bull dozer	21 ton	Day	200.00

Unit Cost of Construction Work

The unit cost of construction work is estimated by applying “Estimation method based on Productivity”. The estimated costs were compared with unit costs of previous road projects funded by international donors to justify the suitability. Estimated unit costs for major construction works item are shown in Table 9.3.20.

Table 9.3.20 Unit Costs for Major Construction Work Items

WORK ITEM		UNIT	UNIT COST (US$)	
1. Earthwork				
(1) Embankment (Borrow, spreading, compaction)		m3	2.8	
(2) Cut (Cutting & Filling)		m3	1.6	
(3) Rock excavation		m3	6.8	(*)
2. Pavement				
(1) Surface course (t=50mm)		m2	7.6	(*)
(2) Base course (t=200mm)		m2	7.4	
(3) Subbase course (t=200mm)		m2	6.0	
3. Drainage				
(1) Pipe culvert (Double)	Dia 1.5m	m	371	
(2) Box culvert (Double)	W2.5xH2.5	m	1,443	
4. Bridge Work				
(1) Girder fabrication work				
(i) RC-I girder	L=15m	no	9,730	
(ii) PC-I girder	L=22m	no	18,900	
(iii) RC-I girder	L=25m	no	22,800	
(iv) RC-I girder	L=30m	no	27,300	
(2) Pile foundation work	400x400, L=9m	no	470	(*)

NOTE
Works with (*) need imported equipments. The unit cost excluded transport & rental cost for them.

3) Estimated Civil Works Cost

The estimated civil works cost is composed of the following items.

- Direct Cost (Road and bridge construction work including transport of imported equipment)
- Indirect Cost (Temporary works and site expense)
- Overhead (Administration cost for HQ)

Direct cost is composed of material, labor and equipment. Major components of indirect cost are assumed to be salary and allowances of local and foreign staff, preparation of site office and insurance.

(2) Engineering Services

The cost of engineering services including detailed design and construction supervision, is estimated at 8% of the total cost of Civil Works.

(3) Project Management Cost

This component comprises the following items.

1) Management Cost by MCTPC
2) Environmental Monitoring Cost

1) Management Cost by MCTPC

A project manager and three deputies will be assigned by MCTPC as permanent staff during the construction stage (30 months) for each route. The cost includes basic salary, site allowance and their transport fee. The estimated cost is US$21,900 for Route 14A and Route 16A respectively.

2) Environmental Monitoring Cost

The work will be executed monthly during the construction stage (in total 30 times) based on the EMP. Three government staff will execute 1-week socio-economic surveys. Special work items (e.g., water quality and air pollution testing) shall be contracted out. The cost includes allowance, accommodation for three staff and the fee for contracting out. The estimated cost is US$14,400 for Route 14A and Route 16A respectively.

(4) Borrow Pit Restoration Cost

A large scale borrow pit site is required for construction of Route 14A. The Study Team estimated total area (approx. 350,000m2) of possible borrow pit site. Planting of trees (1 tree per 10m2) will be undertaken as restoration of this area. This cost contains the cost for purchase of trees and labor fee for planting.

(5) Physical Contingency

Applying “Estimate Method using Productivity” in this study, physical contingency is estimated at 2% of the total civil works cost.

9.3.4 Road Operation and Maintenance Cost

This component comprises the following items.

(1) Environmental Monitoring
(2) Routine and Periodic Maintenance

(1) Environmental Monitoring Cost

The work will be required annually after completion of construction works based on the EMP. Major components of the work are 1-week socio-economic surveys, water quality testing and reporting by 20 surveyors. The estimated cost is US$10,500 per year.

(2) Routine and Periodic Maintenance

The unit cost for routine maintenance has been estimated base on the Road Maintenance Program: MP1 (2001 – 2002). The unit cost for periodic maintenance assumes an asphalt overlay at the end of the design period of the initial pavement structure (2018). The costs are shown in Table 9.4.1.

Table 9.4.1 Unit Costs of Routine and Periodic Maintenance (Rt. 14A & Rt. 16A)

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

CHAPTER 10
PROJECT IMPLEMENTATION PLAN

CHAPTER 10 PROJECT IMPLEMENTATION PLAN

10.1 Introduction

This chapter describes the Project Implementation Plan that contains the project schedule and the investment and maintenance costs, to assist the economic analysis. The availability of construction resources is discussed in Chapter Ⅳ8 Project Construction Planning.
Even though it will be judged that the project is sufficiently justified in various issues and clearly provides a valuable addition to the southern region of Lao P.D.R., the cost however is a sizable sum of money. Therefore, the implementation schedule is based on financing i.e. grant aid. There are no serious land availability problems associated with providing an adequate solution of acquiring land for the Project.

10.2 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.10.2.1.

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 completing in a period 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 for by the GoL by August 2003. Approximately a year will be required for the formalities of securing finance.

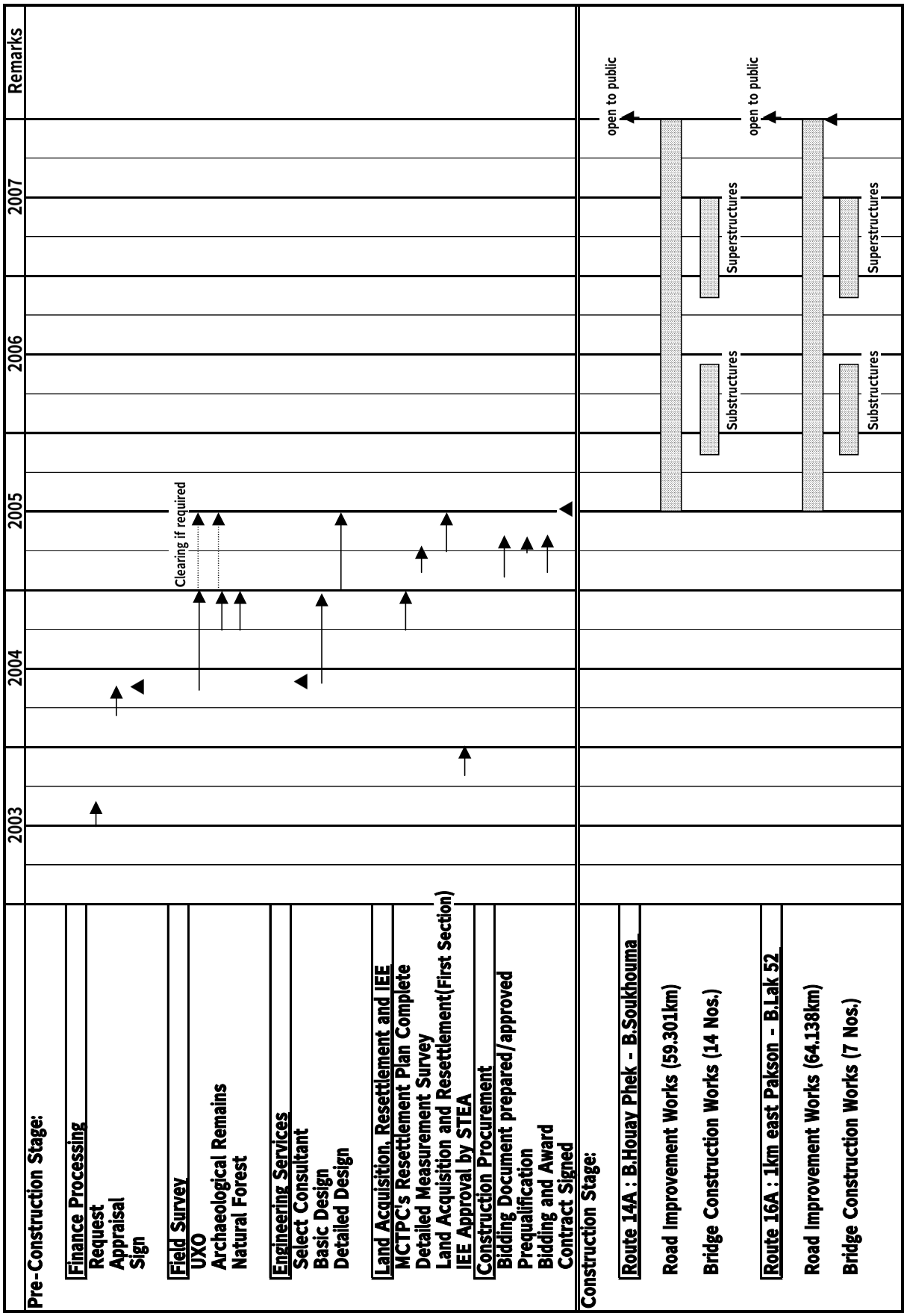

Figure 10.2.1 Project Implementation Schedule

Field Survey

- Field survey for **UXO**, **archaeological remains** and **natural forest** will be executed by the GoL in order to identify the existence in order to finalize the 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.
- 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 have been acquired prior to the award of construction contracts and be cleared by the commencement of construction work. The legal process will take about three months. It is shown in Figure 10.2.2.

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 2(two) to (four) weeks.

No.	Description.	First Month				Second Month				Third Month			
		1	2	3	4	1	2	3	4	1	2	3	4
1	The Governor sets up the Committee												
2	The Committee plans new area for resettlement												
3	The Committee explains about the project for affected people												
4	The Committee estimates cost for resettlement												
5	The Committee makes an interim report for the Governor												
6	The Committee makes a contract with owner												
7	The Committee estimates all of lost assets												
8	The Governor approves the budget												
9	The Committee provides new area												
10	The Committee pays money to owners												
11	The removal begins												

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 10.2.2 Resettlement Process

IEE Approval

The Social and Environment Division of the Department of Roads (**DOR**) will be closely associated with the implementation of the Environmental Management Plan and DOR will 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).

10.3 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 Table10.3.1 and Table 10.3.2. Table 10.3.1 indicates the summary and Table 10.3.2 indicates the breakdown. Initial project management and construction costs and maintenance costs are indicated.

Table 10.3.1 (1) Summary of Disbursement Schedule (Rt. 14A)

(1,000 US$)

Year	Pre-Construction Stage	Construction Stage							Operation	TOTAL		
		Civil Works		E/S (DD & SV)		Others	Physical Contingency		Maintenance & Monitoring			
	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 10.3.1 (2) Summary of Disbursement Schedule (Rt. 16A)

(1,000 US$)

Year	Pre-Construction Stage	Construction Stage							Operation	TOTAL		
		Civil Works		E/S (DD & SV)		Others	Physical Contingency		Maintenance & Monitoring			
	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

Table 10.3.2 (1) Breakdown of Disbursement Schedule (Rt. 14A)

(1,000 US$)

Year	Pre-Construction Stage			Construction Stage																Road Operation Stage		TOTAL			Remark	
	Survey & Clearance	Land Acquisition & Resettlement	Environmental Monitoring	Civil Works																Maintenance	Environmental Monitoring				Tax & Duty	
				Direct Cost										Total (Direct + Indirect)		E/S (DD & SV)		BP Restoration	Project Management	Physical Contingency						Fuel	Others
				Material		Labor		Equipment		Fuel		Transport															
	B	B	B	A	B	A	B	A	B	B	A	B		A	B	A	B	B	B	A	B	B	B	A	B	Total	B	B
2004	13.3		3.2																					0	16.5	16.5		
2005		618.6		0.4	607.8	0	623.3	112.9	732.7	70.4	146.1	149.3		940.5	2,465.2	471.5	0		4.7	18.8	49.3			1,430.7	3,137.8	4,568.6	10.8	132.9
2006				163.5	5,137.1	207.4	1,415.7	707.4	3,363.1	595.2	472.9	481.9		2,588.0	11,194.2	942.9	0	23.7	15.8	51.8	223.9			3,582.7	11,457.6	15,040.3	91.1	588.3
2007				151.4	6,019.3	182.3	872.1	635.9	1,436.5	697.4	326.7	332.6		2,598.3	9,679.8	942.9	0	23.7	15.8	52.0	193.6			3,593.1	9,913.0	13,506.1	106.7	498.6
2008																				41.5	10.5	0	52.0	52.0				
2009																				41.5	10.5	0	52.0	52.0				
2010																				41.5	10.5	0	52.0	52.0				
2011																				41.5	10.5	0	52.0	52.0				
2012																				41.5	10.5	0	52.0	52.0				
2013																				41.5	10.5	0	52.0	52.0				
2014																				41.5	10.5	0	52.0	52.0				
2015																				41.5	10.5	0	52.0	52.0				
2016																				41.5	10.5	0	52.0	52.0				
2017																				41.5	10.5	0	52.0	52.0				
2018																				3,524.4	10.5	0	3,534.9	3,534.9				
2019																				41.5	10.5	0	52.0	52.0				
2020																				41.5	10.5	0	52.0	52.0				
2021																				41.5	10.5	0	52.0	52.0				
2022																				41.5	10.5	0	52.0	52.0				
2023																				41.5	10.5	0	52.0	52.0				
2024																				41.5	10.5	0	52.0	52.0				
2025																				41.5	10.5	0	52.0	52.0				
2026																				41.5	10.5	0	52.0	52.0				
2027																				41.5	10.5	0	52.0	52.0				
TOTAL	13.3	618.6	3.2	315.3	11,764.2	389.8	2,911.1	1,456.2	5,532.3	1,363.0	945.8	963.8		6,126.7	23,339.2	2,357.3	0.0	47.5	36.3	122.5	466.8			4,313.1	210.0	8,606.5	29,048.0	37,654.6	208.5	1,219.9
				12,079.5		3,300.8		6,988.5			1,909.6			29,465.9		2,357.3				589.3							1,428.4	
				25,641.4																								

Table 10.3.2 (2) Breakdown of Disbursement Schedule (Rt. 16A)

(1,000 US$)

Year	Pre-Construction Stage			Construction Stage																		Road Operation Stage		TOTAL			Remark	
	Survey & Clearance	Land Acquisition & Resettlement	Environmental Monitoiroing	Civil Works																		Maintenance	Environmental Monitoring				Tax & Duty	
				Direct Cost										Indirect Cost		Total (Direct + Indirect)		E/S (DD & SV)		Project Management	Physical Contingency						Fuel	Others
				Material		Labor		Equipment		Fuel		Transport																	
	B	B	B	A	B	A	B	A	B	B	A	B		A	B	A	B	A	B	B	A	B	B	A	B	Total	B	B
2004	15.7		3.2																					0	18.9	18.9		
2005	76.9	259.3		0.0	1,099.2	0.0	743.1	393.6	1,431.1	133.6	118.0	119.8		691.9	281.7	1,203.5	3,808.4	491.3	0	4.7	24.1	76.2			1,719	4,225.5	5,944.4	20.4	202.5
2006				34.3	5,264.7	62.8	1,026.2	855.9	3,640.2	639.8	336.0	341.6		1,065.7	201.2	2,354.7	11,113.7	982.5	0	15.8	47.1	222.3			3,384	11,351.8	14,736.1	97.9	577.2
2007				148.7	6,116.2	240.4	708.7	811.7	1,358.7	743.2	218.0	221.8		1,334.3	321.9	2,753.2	9,470.6	982.5	0	15.8	55.1	189.4			3,791	9,675.8	13,466.6	113.7	481.0
2008																						44.9	10.5	0	55.4	55.4		
2009																						44.9	10.5	0	55.4	55.4		
2010																						44.9	10.5	0	55.4	55.4		
2011																						44.9	10.5	0	55.4	55.4		
2012																						44.9	10.5	0	55.4	55.4		
2013																						44.9	10.5	0	55.4	55.4		
2014																						44.9	10.5	0	55.4	55.4		
2015																						44.9	10.5	0	55.4	55.4		
2016																						44.9	10.5	0	55.4	55.4		
2017																						44.9	10.5	0	55.4	55.4		
2018																						3,811.9	10.5	0	3,822.4	3,822.4		
2019																						44.9	10.5	0	55.4	55.4		
2020																						44.9	10.5	0	55.4	55.4		
2021																						44.9	10.5	0	55.4	55.4		
2022																						44.9	10.5	0	55.4	55.4		
2023																						44.9	10.5	0	55.4	55.4		
2024																						44.9	10.5	0	55.4	55.4		
2025																						44.9	10.5	0	55.4	55.4		
2026																						44.9	10.5	0	55.4	55.4		
2027																						44.9	10.5	0	55.4	55.4		
TOTAL	92.6	259.3	3.2	183.0	12,480.1	303.2	2,478.0	2,061.2	6,430.0	1,516.6	672.0	683.2		3,091.9	804.8	6,311.4	24,392.7	2,456.3	0.0	36.3	126.2	487.9			4,664.9	210.0	8,894.0	30,146.9	39,040.9	232.0	1,260.7
				12,663.1		2,781.3		8,491.2			1,355.2			3,896.7		30,704.1		2,456.3			614.1							1,492.8	
				26,807.4																								

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 11
PROJECT ECONOMIC ANALYSIS & EVALUATION

CHAPTER 11 PROJECT ECONOMIC ANALYSIS AND EVALUATION

11.1 Introduction

This chapter describes the economic feasibility study of the new construction and improvement of Routes 14A (northern section) and Route 16A. These routes were recommended in the Master Plan for priority upgrading. The main changes to the methodology and assumptions of the Master Plan economic analysis, which is presented in chapter III-6, are 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 Donthalath, 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 September 2002 prices, based on preliminary engineering design quantities. For the Master Plan analysis, average cost per km was used. Road design is based on asphalt concrete pavement, the Master Plan cost estimates were based on DBST.

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 September 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.

11.2 Project Roads and Road Network

Project Roads

The project roads for the feasibility study are:

- Route 14A the section from the northern starting point at the junction with Route 16, south to the junction to Sukhuma;
- Route 16A the whole route from Paksong to Xe namnoy.

An inventory of the roads is provided in chapter IV-1. The proposed improvement plan for Route 14A is described in chapter IV-2 and the plan for Route 16A in chapter IV-5. The socio-economic characteristics of the project influence areas are discussed in chapter III-2. The economic significance of the projects is considered below.

Road Network

Traffic volume on the project roads will be in part determined by the state of development of the local and regional road network. In project opening year 2008, the position is taken to be as follows:

- Route 1I Attapeu-Xe namnoy paved (Current status: contract signed for unpaved section, under construction);
- Route 18B Attapeu-Vietnamese Border open/paved (Current status: 37km under construction, contract signing for remaining 76km scheduled for November 2002);
- other routes, condition as in 2002.

Before the end of the analysis period (2027), Route 14A1 is likely to be paved. Route 18A may be improved first to all weather gravel standard and subsequently paved. Paving of Route 14A1 would divert some traffic from Thailand and west of Ban Lak 12 primarily from the section of Route 14A north of Wat Phou, with the section south of km42 unaffected. Diversion volume would be relatively small and within the sensitivity test for lower traffic volume (see section 11.9).

An all weather gravel surface on Route 18A would divert some traffic from Route 16A, but this diversion is not expected to have a significant impact on project benefits. Paving of Route 18A would have a major impact. The Attapeu-Pakse distance is almost the same via an improved Route 16A and via Route 18A However, most of the through traffic would diverting from Route 16A to a paved Route 18A to take advantage of the easier route, avoiding the climb over the Boloven Plateau. The impact is assessed as a sensitivity test in section 11.9. For this test, Route 18A is assumed to be paved by 2015 or 2020 and 75 per cent of diverted traffic on Route 16A is taken to switch to Route 18A. Paving Route 18A may not

be economic even by 2020, given that Route 16A is improved: the sensitivity test is a risk assessment, for the case that Route 18A is improved before it is economical to do so. The economic feasibility of providing an all-weather gravel road on Route 18A is evaluated in section 13.7.

11.2.1 Route 14A

Route 14A is wholly within Champasack province. The improvement section passes through the districts of Phonthong, Champasack and Sukhuma, which had an estimated total population in 2001 of 188,000. The forecast population for 2020 is 277,000, an annual growth rate 2001-2020 of 2.1 per cent. The main town in the immediate project influence area, apart from Champasack, is Sukhuma, which had an urban population of 5,900 in 2001.

The whole area west of the Mekong south of Route 16 is without a single paved road, apart from 13.8km of Route 14A, which is paved from the ferry terminal in Champasack through the town to the approach to Wat Phou. Currently the Route 16 – Champasack section of Route 14A is largely impassable and the section does not function as a through route. From Pakse to Champasack/Wat Phou the existing alternatives are via Routes 16/14A1/14A or via Route 13S and the vehicle ferry from Ban Muang across the Mekong. Route 14A1 is almost impassable at times during the rainy season, with the ferry providing the only route.

An improved Route 14A would serve the populous area along the west bank of the Mekong, provide access from Pakse and Thailand to the World Heritage Site of Wat Phou and, in the long term, could form part of a cross-border route between Lao PDR and the western areas of Cambodia, including Angkor Wat and Tonle Sap.

The currently functioning section south from Champasack ferry, serves both local traffic in the Champasack – Sukhuma corridor and traffic to Pakse and other areas via the Mekong ferry/Route 13S or Routes 14A1/16. There is little local traffic on Route 14A south of Sukhuma, where the road deteriorates to a track.

11.2.2 Route 16A

Route 16A runs east from a junction with Route 16 on the eastern outskirts of Paksong to a junction with Route 1I at Xe namnoy. The section Paksong – Xe namnoy Bridge (km 0.0 – 51.4 after proposed improvement) is in Paksong District of Champasack province and the section Xe namnoy Bridge – Xe namnoy (km 51.4 – 64.1) in the Samakhixay District of Attapeu province. The estimated population of the two districts in 2001 was 75,000, with a forecast population in 2020 of 124,000, an annual growth rate 2001-2020 of 2.7 per cent.

Paksong is the main town in the immediate project influence area, with an urban population of 5,600 in 2001. Route 16A crosses the Boloven Plateau, starting at an elevation of 1285m. It reaches its highest point of 1325m at km3.2, then descends to an elevation of 170m at Xe namnoy.

After improvement, Route 16A would be of local, regional and international importance. It already serves a developed agricultural area of the Boloven Plateau at its western end; paved, it would provide a much shorter high standard route Pakse-Attapeu; and with the construction of Route 18B would form part of a new transit corridor Thailand-Vietnam/Cambodia, with easy access to the Vietnamese ports of Da Nang and Quy Nhon via Vietnam Route 14.

The route now functions primarily as a local access road, with through traffic mainly in the dry season. The paved, but much longer, alternative via Sekong on Routes 16/1I is preferred by most through traffic, even in the dry season. With heavy rain falling on the Boloven Plateau between June and October, the condition of the route deteriorates. The mountainous section km 42-58 becomes passable only by 4-wheel drive vehicles. Average operating speed in such a vehicle on a test run on 10th September 2002 was 40 kph for the first 35 km from Paksong, 37 kph for km 35-49 and 29 kph for km 49-Xe namnoy. The end to end running time was 122 minutes, at an average speed of 35 kph. In a dry season speed test for the Master Plan, the average end-to-end speed was 52 kph.

11.3 Base Year Traffic Volume 2002

11.3.1 Traffic Counts

Normal traffic is defined as traffic which would use the project roads if maintained in their existing surface condition. Base year 2002 normal traffic volumes have been determined on the basis of recent survey data. Traffic counts and surveys undertaken for the Master Plan are described in chapter III-3. The Master Plan counts and the supplementary counts for the Feasibility Study for the project roads are listed below:

- a 2-day 12-hour classified count at Ban Nongkingkham, the western end of Route 16A (December 2001);
- a 5-day 24-hour classified count both north and south of the Route 14A/14A1 intersection at Ban Dontalath (Tuesday 5th –Saturday 9th February 2002). This count was made for the ADB Smallholder Development Project;
- a classified count of dry season traffic on the Ban Muang – Champasack ferry (Friday 15th February 2002);
- a 16-hour turning movement classified count at the Route 14A/14A1 intersection at Ban Dontalath (Tuesday 30th April 2002);

- a classified count of wet season traffic on the Ban Muang – Champasack ferry (Tuesday 29th October 2002).

The results of the turning movement survey are given in the Annex F-12.

11.3.2 Route 14A

There is no through traffic from the junction with Route 16 to Champasack ferry (km 26.5). There is light local traffic at the northern and southern ends. Traffic volume to the south is represented by an average of volumes each side of the intersection with Route 14A1 at Ban Dontalath (km 42.0), which is at the mid-point of the trafficked section of the project route. Count data for 2002 are summarized in Table 11.3.1. Base year normal traffic volume for 2002, also shown in the table, has been calculated as an average of the ADB and study counts.

Table 11.3.1 Route 14A Km 34.0-59.3 Normal Traffic 2002

	ADB February			Study April		2002
Vehicle Type	**Day**	**Night**	**24-Hr**	**Day***	**24-Hr**	**Base**
Car	10	2	12	24	26	19
Pick-up	21	4	25	33	36	30
Light bus	4	1	5	v	v	5
Medium bus	10	3	13	33	38	14
Heavy bus	13	4	17	^	^	19
Light truck	11	2	13	15	16	14
Medium truck	8	1	9	11	12	11
Heavy truck	3	2	5	1	1	3
Total	**80**	**19**	**99**	**117**	**129**	**115**
M/c and Tuk-tuk	508	120	628	834	934	781

Notes: ADB Day 06:00–18:00, night 18:00-06:00.
*06:00–22:00, expanded to 24-hours by 50% of ADB day/night factors.

11.3.3 Route 16A

Table 11.3.2 shows average traffic volume recorded during the 2-day December 2001 count. This has been increased by 4 per cent (half a year's growth) to represent base year 2002 normal traffic, given in the table. Traffic volume declines along the route to the east. The poor state of the road on the mountainous section makes through trips impractical in the rainy season. Traffic for km 42.0-64.1 has been taken as half that for km 0.0-42.0.

Table 11.3.2 Route 16A Normal Traffic 2002

Vehicle Type	Dec. 2001 Day	Dec. 2001 24-Hr*	2002 Base Km 0-42	2002 Base Km 42-64
Car	5	6	6	3
Pick-Up	19	23	24	12
Bus	11	13	13	7
Light truck	13	15	16	8
Medium truck	4	5	5	2
Heavy truck	0	0	0	0
Total	**52**	**62**	**64**	**32**
Motorcycle/Tuk-tuk	146	180	188	94

Notes: Day 06:00 – 18:00

* expanded using ADB day/night factors in Table 11.3.1.

11.4 Future Traffic Volume

11.4.1 Normal Traffic

No count data are available for the project roads to establish previous traffic growth rates. In the Master Plan stage of the study, the growth of the vehicle fleet outside the Vientiane area was forecast. The central forecast was based on a uniform annual growth rate in GDP of 6.0 per cent to 2020. Current economic performance is in line with this figure. The ADB *Lao PDR Country Strategy and Programme Update 2003-2005*, dated July 2002, estimated that GDP growth in 2001 was 5.5 per cent. It forecast growth rates for 2002 and 2003 of 5.8 – 6.0 per cent.

The registered vehicle fleet in the four southernmost provinces: Champasack, Attapeu, Sekong and Saravan, is small, averaging 2.9 vehicles and 17 motorcycles per thousand population in 2000. Fleet growth from this small base is expected to exceed the GDP growth rate, with expansion stimulated by improvements to the road network. An overall growth rate of 7.6 per cent to 2009 and 8.1 per cent 2009-2020 was forecast in the Master Plan for areas other than Vientiane Municipality. The growth rates for motorcycles were 11.3 per cent to 2009 and 11.1 per cent 2009-2020. The population of the four provinces is forecast to increase by 59 per cent 2000-2020. The vehicle fleet in 2020 is forecast to be 8.1 per thousand population and the motorcycle fleet 94 per thousand. These levels are below those in Vientiane Municipality in 2000, which were 43 vehicles and 136 motorcycles and tuk-tuks per thousand population.

Growth of normal traffic is taken to be in line with the forecast growth in the vehicle fleet. Given that the vehicle fleet is still small in 2020, the 2009-2020 growth rates have been maintained for 2020-2027. The growth rate will vary by vehicle class, with a faster rate for light vehicles than for buses and a faster rate for buses than for trucks. Motorcycle growth is forecast to vary between the routes, with a slower growth on Route 14A from 2009 due to the high existing ownership level in the Pakse area.

The growth rates adopted for each vehicle class are shown in Table 11.4.1. These have been applied to the base year 2002 traffic volumes derived in section 11.3.1. There is no normal traffic on the new construction section of Route 14A, all traffic on this section is diverted traffic. The growth rates for normal traffic have also been applied to diverted, generated and induced traffic from 2008.

Table 11.4.1 Traffic Growth Rates (annual per cent)

Vehicle Class	2002-09	2009-20	2020-27
Car	8.5	9.0	9.0
Pick-Up	8.5	9.0	9.0
Light bus	7.5	8.0	8.0
Medium bus	7.5	8.0	8.0
Heavy bus	7.5	8.0	8.0
Light truck	7.0	7.5	7.5
Medium truck	7.0	7.5	7.5
Heavy truck	7.0	7.5	7.5
Motorcycle Rt.14A	11.0	8.0	6.0
Motorcycle Rt.16A	11.0	11.0	8.0

11.4.2 Diverting and Generated Traffic

Diverting Traffic

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 11.4.2. 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 11.4.2 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.

The average distance saving for traffic diverting from Route 14A1 is estimated at 22.3km. 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.

Route 14A Diversion. The results of the Champasack ferry counts in February and October 2002 are given in Table 11.4.3. The counts covered the whole period of normal ferry operation (12-14 hours). Vehicles are carried at night only by special request and in emergencies. The number of ferry crossings (arrivals plus departures) was 72 in the dry season and 38 in the rainy season.

Table 11.4.3 Traffic Counts Champasack Ferry

Vehicle Type	February Dry Season	October Rainy Season
Car/Pick-Up	22	42
Light bus	14	6
Other bus	26	22
Light/Medium truck	14	11
Heavy truck	2	3
Total	**78**	**84**
Motorcycle/Tuk-tuk	122	132

Ferry traffic is mainly for the Pakse area and it is assumed that 90 per cent of vehicles will divert to the new construction section of Route 14A. Motorcycle traffic is more local and 30 per cent diversion has been assumed. Traffic entering Route 14A from Route 14A1 at Ban Donthalath is mainly through traffic and 90 per cent of it is assumed to divert, with 30 per cent of motorcycles diverting. The forecast diversion in opening year 2008 is given in Table 11.4.4.

Table 11.4.4 Diverting Traffic Route 14A 2008

Vehicle Class	From Ferry	From Rt. 14A1	Total
Car	17	30	47
Pick-up	25	26	51
Light bus	16	12	28
Medium bus	32	23	55
Heavy bus	0	0	0
Light truck	10	18	28
Medium truck	8	11	19
Heavy truck	3	4	7
Total	**111**	**124**	**235**
Motorcycle/Tuk-tuk	68	408	476

Route 16A Diversion. The feasibility of paving the remaining 32.2km unpaved section of Route 1I Attapeu-Xe namnoy was reevaluated for the Rural Access Roads Improvement Project. Work commenced on 1st July 2002 under the ADB9 loan. Completion is scheduled for June 2005. The forecast traffic volumes are given in Table 11.4.5.

Table 11.4.5 Traffic Forecast Route 1I

Vehicle Type	2008	2020	Growth 2008-20 % pa
Car	85	220	8.2
Pick-Up	81	211	8.3
Bus	31	81	8.3
Medium truck	60	157	8.3
Heavy truck	21	57	8.7
Total	**278**	**726**	**8.3**

Source: Economic Report, February 2001.

These figures include traffic generated by the paving project itself, plus 88 vehicles per day (volume for 2008) of Vietnam-Pakse/Thailand traffic, following completion of Route 18B. The figure for through traffic was estimated in an earlier ADB study. Work commenced on Contract 1 of Route 18B, the initial 37km east from Attapeu, in December 2001, for completion in December 2003. The contract for the final 76km section to the Vietnam border was expected to be signed in November 2002. Work on this section is scheduled for December 2002 – December 2005. A 30km road section in Vietnam, connecting Route 18B to the main Vietnamese Route 14, is also being paved. This project will also be complete by 2005.

The Master Plan traffic assignment (described in chapter III-3) for 2007, with Route 16A paved, shows the split of Attapeu – Xe namnoy traffic between Route 16A and Route 1I north by vehicle class given in Table 11.4.6.

Table 11.4.6 Route 1I Traffic Assignment

Vehicle Class	Route 16A (in %)	Route 1I (north)
Light vehicles	71	29
Buses	82	18
Medium trucks	89	11
Heavy trucks	65	35

These splits have been applied to the 2008 volumes in Table 11.4.5. Some additional traffic will divert from the Xe namnoy-Sekong area. This is estimated at 20 per cent of the Attapeu-Xe namnoy volumes. The resulting volumes diverting to Route 16A in 2008 are given in Table 11.4.7

Table 11.4.7 Diverting Traffic Route 16A 2008

Vehicle class	Diverting to Route 16A
Car	72
Pick-up	54
Light bus	7
Medium bus	10
Heavy bus	14
Light truck	15
Medium truck	63
Heavy truck	16
Total	**251**

Some motorcycle trips will also be diverted, but with an improved bus service the number of such long distance trips is expected to be small and has been disregarded.

Generated and Induced Traffic

Generated traffic is defined as traffic resulting 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 defined as that which results from development stimulated by the project. Induced traffic is expected on Route 14A, with the opening up of the west bank area, for tourism in particular.

In the RED model the number of generated trips and their benefit is calculated for each vehicle class in either of two ways: specifying percentages of generated traffic or setting an elasticity of demand. The elasticity is applied to the road user cost saving resulting from the project. Feasibility studies in Lao PDR have typically assumed that generation would be substantial, 50 per cent or more of normal traffic and up to 100 per cent of normal traffic for roads in poor condition.

The elasticities applied are 1.0 for cars; 0.9 for pick-ups; 0.8 for buses; and 0.6 for trucks. The resulting volume of generated traffic in 2008 is given in Table 11.4.8. As a percentage of normal/diverted traffic, generated traffic varies by component, depending on the extent of

user cost savings and the traffic composition by vehicle class. Traffic generation as a result of the time savings from avoiding the ferry crossing at Champasack is not calculated in the RED model, generated traffic has been added for this factor. For motorcycles, no generation has been assumed for Route 16A and for the improvement section of Route 14A. For the new construction section of Route 14A, generation at 50 per cent of diverted traffic has been assumed.

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 RED model calculates induced traffic benefits for traffic volumes determined exogenously. The long term potential for domestic and international tourism is substantial. The assumed volume of induced traffic in 2008 is given in Table 11.4.8.

Route 16A also has some tourist potential. The spectacular Katamtok waterfall can be viewed at km 47 and the route passes through attractive scenery descending the Boloven Plateau escarpment. Some induced traffic may result, benefits for this traffic have not been taken and would be an additional project benefit.

Table 11.4.8 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.

11.4.3 Forecast Traffic Volumes

Forecast annual traffic volume by vehicle class 2008-2027 for the new construction section of Route 14A (km 0.0-34.0) is given in Table 11.4.9. There is no traffic on this section prior to opening in 2008. For the Route 14A improvement section (km34.0-59.3) the forecast for 2002-2027 is given in Table 11.4.10. Average traffic on Route 16A is given in Table 11.4.11. The jump in volumes in 2008 is a result of the addition of diverted, generated and induced traffic from that year.

11.5 Road User Cost Model

The Roads Economic Decision Model (RED) was developed under the World Bank's Road Management Initiative Sub-Saharan Africa Transport Policy Programme specifically for roads with current traffic volumes in the range of 25–300 vpd and which, before improvement, exhibit different operating characteristics in the dry and rainy seasons. Both of these conditions currently apply to Routes 14A and 16A. Version 2.0 of the RED model, dated 15th March 2001, has been used to evaluate project benefits.

RED is modular, with interlinked modules covering: base vehicle operating costs (VOC), calculation of project benefits and economic analysis, and project risk analysis. Two modular options are available to calculate VOCs: the World Bank's *Highway Design and Maintenance Standards Model* (HDM-III) and the Bank's *Highway Development and Management Model* (HDM-4). VOCs can also be entered manually to the analysis module. For this study, the HDM-III option has been selected. Although HDM-4 has been used in Lao PDR (for the ADB *Rural Access Roads Improvement Project*), the extensive country-specific road database required to calibrate the RED HDM-4 module was unavailable.

The vehicle operating cost and passenger time data used to calibrate the HDM-III module for Lao PDR in 2002 are given below. Further information about the RED model is given in the Annex F-11.

Table 11.4.9 Traffic Forecast Route 14A Km 0.0-34.0

			Buses			Trucks			Vehicles	
Year	Cars	Pick-ups	Light	Medium	Heavy	Light	Medium	Heavy	Total	Motorcycle
2008	90	88	42	78	24	45	32	24	423	714
2009	98	96	45	84	26	48	34	26	458	793
2010	107	105	49	91	28	52	37	28	496	856
2011	117	114	53	98	30	56	40	30	537	924
2012	127	124	57	106	33	60	43	32	582	998
2013	138	135	62	115	35	65	46	34	630	1078
2014	151	148	67	124	38	69	49	37	683	1165
2015	165	161	72	134	41	75	53	40	740	1258
2016	179	175	78	144	44	80	57	43	801	1358
2017	195	191	84	156	48	86	61	46	868	1467
2018	213	208	91	168	52	93	66	49	940	1584
2019	232	227	98	182	56	100	71	53	1019	1711
2020	253	248	106	196	60	107	76	57	1104	1848
2021	276	270	114	212	65	115	82	61	1196	1959
2022	301	294	123	229	70	124	88	66	1296	2076
2023	328	321	133	247	76	133	95	71	1404	2201
2024	357	349	144	267	82	143	102	76	1521	2333
2025	389	381	155	289	89	154	109	82	1648	2473
2026	425	415	168	312	96	165	118	88	1786	2621
2027	463	452	181	337	104	178	126	95	1936	2779

Table 11.4.10 Traffic Forecast Route 14A Km 34.0-59.3

			Buses			Trucks			Vehicles	
Year	Cars	Pick-ups	Light	Medium	Heavy	Light	Medium	Heavy	Total	Motorcycle
2002	19	30	5	14	19	14	11	3	115	781
2003	21	33	5	15	20	15	12	3	124	867
2004	22	35	6	16	22	16	13	3	134	962
2005	24	38	6	17	24	17	13	4	144	1068
2006	26	42	7	19	25	18	14	4	155	1186
2007	29	45	7	20	27	20	15	4	168	1316
2008	58	84	14	34	45	30	23	13	301	1461
2009	63	92	15	37	49	32	25	14	326	1621
2010	69	100	16	40	52	35	27	15	353	1751
2011	75	109	18	43	57	37	29	16	383	1891
2012	82	119	19	46	61	40	31	17	415	2043
2013	89	129	21	50	66	43	33	19	450	2206
2014	97	141	22	54	71	46	35	20	488	2382
2015	106	154	24	58	77	50	38	22	528	2573
2016	116	167	26	63	83	54	41	23	573	2779
2017	126	182	28	68	90	58	44	25	621	3001
2018	137	199	30	73	97	62	47	27	673	3241
2019	150	217	33	79	105	66	51	29	729	3501
2020	163	236	35	86	113	71	55	31	791	3781
2021	178	258	38	92	122	77	59	33	857	4008
2022	194	281	41	100	132	83	63	36	929	4248
2023	211	306	44	108	143	89	68	38	1008	4503
2024	230	334	48	116	154	95	73	41	1092	4773
2025	251	364	52	126	167	103	79	44	1184	5059
2026	274	396	56	136	180	110	85	48	1284	5363
2027	298	432	60	147	194	119	91	51	1392	5685

Table 11.4.11 Traffic Forecast Route 16A

			Buses			Trucks			Vehicles	
Year	Cars	Pick-ups	Light	Medium	Heavy	Light	Medium	Heavy	Total	Motorcycle
2002	5	20	4	7	0	13	4	0	53	156
2003	5	22	4	8	0	14	4	0	57	173
2004	6	24	5	8	0	15	5	0	62	192
2005	6	26	5	9	0	16	5	0	66	213
2006	7	28	5	9	0	17	5	0	72	237
2007	8	30	6	10	0	18	6	0	77	263
2008	127	136	19	29	20	47	95	21	494	292
2009	138	148	21	31	22	51	102	23	535	324
2010	151	162	22	34	23	54	110	24	580	360
2011	164	176	24	37	25	58	118	26	629	399
2012	179	192	26	39	27	63	127	28	681	443
2013	195	209	28	43	29	67	136	30	739	492
2014	213	228	30	46	32	73	147	32	801	546
2015	232	249	33	50	34	78	158	35	868	606
2016	253	271	35	54	37	84	169	37	941	672
2017	276	295	38	58	40	90	182	40	1020	746
2018	301	322	41	63	43	97	196	43	1105	828
2019	328	351	44	68	47	104	210	47	1198	920
2020	357	383	48	73	50	112	226	50	1299	1021
2021	389	417	52	79	54	120	243	54	1409	1102
2022	424	454	56	85	59	129	261	58	1527	1191
2023	463	495	60	92	63	139	281	62	1656	1286
2024	504	540	65	99	69	149	302	67	1796	1389
2025	550	589	70	107	74	161	325	72	1947	1500
2026	599	642	76	116	80	173	349	77	2111	1620
2027	653	699	82	125	86	186	375	83	2290	1749

Note: weighted by distance.

11.5.1 Vehicle Operating Costs

Vehicle Classes

The eight vehicle classes defined for the RED model analysis of road user benefits are:

- cars (including jeeps and sports utility vehicles);
- pick-ups (for personal and business use);
- light buses/minibuses (including converted pick-ups and small trucks);
- medium buses (including converted medium trucks);
- heavy buses;
- light trucks (including small 6-wheel trucks);
- medium trucks (large 6-wheel trucks);
- heavy trucks (trucks with 3 or more axles).

Vehicle Acquisition Cost

The characteristics of the vehicle fleet are changing and the representative vehicle for a class in 2008, the first year of project benefits, will be different from that representative of the existing fleet. Purpose-built buses are likely to displace truck conversions. Second hand trucks and buses, imported completely knocked down (CKD) from Japan and Korea for local

assembly, may become the main components of the fleet. The capital employed in the commercial vehicle fleet will be considerably less than if new vehicles were used. This has been reflected in the vehicle acquisition costs assumed. The unified tax rates on CKD vehicles are much lower than those on complete vehicles and encourage their use. The respective tax rates, which have applied since 1st July 2000, are as follows:

Vehicle Type	Complete	CKD
	(Tax rate per cent)	
Car	180	98
Jeep	111	55
Pick-Up	84	43
Minibus,bus, tuk-tuk	61	34
Truck	58	29
Motorcycle	120	61

Vehicle sales agencies, local assemblers and bus operators were interviewed in Vientiane in to assess vehicle prices. Typical sales prices and economic costs for the current mix of new and locally assembled reconditioned vehicles were as follows (in US$):

Vehicle Class	Financial Cost	Economic Cost
Motorcycle	630-1,500	450-1,100
Car	30,000+	15,000+
4WD sports	45,000+	27,000+
Pick-up	21,000-38,000	11,000-23,000
Minibus	4,000-15,000	3,400-10,000
Medium bus*	-	14,000+
Large bus*	-	18,000+
Light truck	4,000-25,000	3,500-17,000
Medium truck	14,000-45,000	11,500-30,000
Heavy truck	21,000+	17,000+

Note: * prices given were for tax/duty free imports.

The bus and truck figures are lower than have typically been used in recent feasibility studies in Lao PDR. However, given the six-year period before the start of benefits and the rapid development of the vehicle assembly business, it appears justifiable to adopt them. The

economic vehicle acquisition costs used for the RED analysis are as follows (in US$ thousand): car 20, pick-up 16, light bus 10, medium bus 16, heavy bus 22, light truck 10, medium truck 20 and heavy truck 35.

Fuel Cost

Price data were obtained from the Lao State Fuel Co. Prices are quoted in both US$ and Kip. The US$ prices have not been changed for more than a year. There is a slight variation in retail prices between provinces, with ordinary petrol 1.7 per cent and diesel 0.9 per cent more expensive in Pakse than in Vientiane. Premium petrol is not generally obtainable in Champasack. The Pakse-based price applies for all sales within a 40km radius of the town and has been taken as representative for the study areas. The retail price includes consumption tax of 2.0 per cent, import tax of 10.0 per cent and VAT at 5.0 per cent. These have been excluded to derive economic costs. Fuel prices and economic fuel costs in Pakse are given below:

Fuel Type	Retail Price (in US cents per litre)	Economic Cost (in US cents per litre)
Ordinary petrol	30.49	25.88
Diesel	26.86	22.80

The economic cost of lubricating oil is US$1.20 per litre.

Tire Cost

Tire prices were obtained from distributors of major brands in Vientiane. The economic costs for each vehicle class, after removing duty of 10 per cent from the sales price, are (in US$ per tire): car 25, pick-up 40, light bus/truck 110, medium bus/truck 125 and heavy bus/truck 140.

Road Surface Condition

RED calculates benefits from improved surface condition separately for the dry and rainy season conditions of the existing road. The rainy season condition has been assumed to apply for 90 days per year, on all unpaved road sections. The road surface conditions used (in terms of IRI) are as follows:

Route	Existing Dry	Rainy	Improved
14A	12	22	3
16A	15	22	3
Diverting Routes:			
1I	4	4	-
13S	4	4	-
14A1	15	22	-
16	4	4	-

11.5.2 Road User Time Savings

Travel time saved as a result of higher speeds on improved road surface and from distance savings is calculated directly in the RED model. A single value of passenger time is applied to the time savings for all years to determine user benefits. The value of time developed for the Master Plan (described in chapter III-6) changes over time, to reflect the increase in real income per capita as the economy develops. The Master Plan values are: US$0.34 per person hour in 2010, US$0.40 in 2015 and US$0.48 in 2020. The representative average value of time over the benefit analysis period 2008-2027 has been derived from the Master Plan values by applying weights from 2008. Weights have been decreased by 12 per cent per annum, the test discount rate. The weighted average value of time is then US$0.39, which has been applied in RED for passenger time savings. The average number of passengers per vehicle, been derived from the Master Plan traffic surveys, is: car 3, pick-up 4, light bus 12, medium bus 17 and heavy bus 30. For commercial vehicle time savings, crew costs are assumed to be US$0.50 per person per hour.

Time saved by avoiding the ferry crossing at Champasack has been calculated separately. The crossing time varies by season. The water level of the Mekong at Champasack may change by some 7m between the dry and rainy seasons. The crossing can take 30 minutes during high water and 15 minutes with low water. Loading/unloading times are also longer in the rainy season due to poor condition of the ferry approaches. Average waiting time, plus boarding/disembarking time is about 15 minutes. It has been assumed that a total of 35 minutes per person is saved by avoiding the ferry crossing.

11.6 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.

11.6.1 Construction

Project cost estimates have been prepared on the basis of preliminary engineering design. The cost estimation process is described in chapter IV-9. The detailed cost estimates are given in section 9.7. The proposed project implementation schedule and the annual disbursement schedule are given in chapter 10. Construction of both projects is taken to begin 1st July 2005 with completion by 31st December 2007, a 30-month construction period. Advance work would commence in 2004.

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. A recent report for ADB (*Preparing the Northern Economic Corridor* Draft Final Report, August 2002, Nathan Associates Inc.) assessed the tax and duty component of an ICB new construction project in some detail. The tax and duty in the local component was calculated to be 5.4 per cent and in the foreign component 6.5 per cent. The foreign component was estimated to be 71 per cent of project cost and the local component 29 per cent. The average rate of tax and duty was 6.2 per cent.

Project costs have been divided into foreign sourced (including Yen) and local sourced, the latter comprising both local and imported elements (Kip, US$ and Thai Baht). A slightly lower tax and duty rate would be expected than estimated for ADB, because of the foreign sourced component, estimated at 26 per cent of the total for each route, which it is assumed would be free of taxes and duties. For locally sourced items, taxes and duties at a rate of 6.0 per cent have been deducted from the civil works element, based on the ADB figure. The tax and duty component in total financial cost is 4.3 per cent for Route 14A and 4.4 per cent for Route 16A. A summary of the financial and economic cost estimates is given in Table 11.6.1.

Table 11.6.1 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 11.6.2.

Table 11.6.2 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

For the economic analysis, the small amounts disbursed in 2004 have been included in 2005.

11.6.2 Routine and Periodic Maintenance

Both routes are designed with asphalt concrete pavement, with periodic maintenance after 10 years in service. The cost of an overlay is included in year 11 of operation, 2018, at a financial cost of US$59,400 per km, an economic cost of US$55,800 per km. The net additional cost of routine maintenance with the projects, compared with maintenance of the existing routes, is taken as US$400 per km per annum. For the section of Route 14A north of Champasack ferry, where there is no existing maintenance, the net cost is US$700 per km.

11.6.3 Environmental Monitoring

A total each year of US$10,000 per project has been included in costs for environmental monitoring. This is included with maintenance in the economic analysis tables.

11.7 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 RED model (described in section 11.4). The minor benefits from a reduced frequency of ferry service at Champasack with the project have been disregarded.

Benefits to motorcycles have been ignored in some feasibility studies in Lao PDR. It is considered that, for this study, motorcycle benefits should be evaluated. Such benefits are significant, in particular for Route 14A, where motorcycle volume is high. Benefits to motorcycles could not be calculated from the RED model. Benefits have been determined using the operating cost data by road surface condition derived for the Master Plan (see Table III-6.2.1). The impact on the economic analysis of excluding motorcycle benefits is shown as a sensitivity test, in section 11.9.

Residual value. The residual value of the investment at the end of the analysis period is a project benefit. In the Master Plan, residual values of 30 per cent for the road cost component and 40 per cent for the bridge component were taken as project benefits. The percentage for the road component was for DBST pavement. With asphalt concrete pavement, the residual value after 20 years will be higher. A residual value of 40 per cent has been assumed for both the road and bridge components. The sensitivity of the results to residual values of 25 or 50 per cent is given in section 11.9.

Benefit analysis sections. The RED model has been run for the following cases to determine road user benefits:

Route 14A:

- section km 0.0-34.0, diversion from Route 13S/ferry;
- section km 0.0-34.0, diversion from Routes 14A1/16:
- section km 34.0-59.3, improvement.

Route 16A:

- section km 0.0-34.0 improvement, normal traffic;
- section km 34.0-42.0, new alignment, normal traffic diverted;
- section km 42.0-58.0 mountainous terrain, normal traffic;
- section km 58.0-64.1 improvement, normal traffic;
- whole route km 0.0-64.1, diversion from Route 1I/16.

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

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:

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.

11.8 Economic Analysis Results

The economic analysis compares project costs, as given in section 11.6, with project benefits, as discussed in section 11.7, over the period from the start of construction until 20 years after project opening, 2005-2027. 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 11.8.1. 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 11.8.2 and those for Route 16A in Table 11.8.3. 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 individual results for the two Route 14A analysis sections are given in the Annex F-12.

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 11.8.1 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 11.8.2 Economic Analysis 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 11.8.3 Economic Analysis 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**			

11.9 Sensitivity Tests

11.9.1 Risk Factors

There are a number of risk factors, positive and negative, that could cause the actual outcome of the projects to differ from that of the economic analysis. The main project risks are:

Construction cost. A change in cost could occur at detailed design stage, there could be a cost overrun/saving during construction, the project implementation period could be extended/reduced, the yen, Thai baht, kip and US dollar exchange rates could change.

The impact of a 20 per cent increase/decrease in construction costs has been tested. The analysis has also been performed using the Master Plan per km costs (based on DBST pavement). Setting the residual value of investment at 25 or 50 per cent has also been tested.

Traffic volume. The estimated base year 2002 volumes are subject to significant error due to data limitations. The traffic growth rates and the volumes of diverted and generated/induced traffic are subject to forecasting error, in particular they are sensitive to the actual growth rate of the economy.

To test the sensitivity to the traffic growth rate, the improvement section of Route 14A was reevaluated with annual growth 2002-2027 set at 6.0 per cent throughout for all vehicle classes and motorcycles. Induced traffic in 2008 was reduced pro rata.

User benefits. Unit benefits could be reduced due to improved vehicle design and higher fuel efficiency. The existing condition of the roads might not represent their long term state in the "without project" case. The impacts of excluding motorcycle benefits, of excluding generated/induced benefits and of reducing the value of time by one-third have been evaluated.

Route 18A. The impact on the results for Route 16A if Route 18A were to be paved from 2015 and from 2020 has been evaluated, assuming that 75 per cent off traffic diverting from Route 1I/16 to Route 16A, would re-divert to Route 18A.

11.9.2 Results of Sensitivity Tests

The results of the sensitivity tests for Route 14A (two sections combined) are given in Table 11.9.1. The tests for Route 16A are given in Table 11.9.2. The test of sensitivity to traffic growth rates is shown in Table 11.9.3.

Table 11.9.1 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 11.9.2 Route 16A Sensitivity Analysis

Case	EIRR (in%)	NPV (US$ mill)	FY (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.

Table 11.9.3 Sensitivity to Traffic Growth Rate

Case	EIRR (in %)	NPV (US$ mill)	FYB (in %)
Route 14A km 34.0-59.3:			
Base case	9.2	-1.91	5.0
Traffic growth rate of 6.0%	5.6	-3.79	4.1

11.10 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.