



JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATION,TRANSPORT,
POST AND CONSTRUCTION
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

THE STUDY ON IMPROVEMENT OF ROADS IN THE SOUTHERN REGION IN LAO PEOPLE'S DEMOCRATIC REPUBLIC



FINAL REPORT

VOLUME 4 OF 4
ANNEXES

February 2003



Oriental Consultants Company Limited

 PADECO Padeco Company Limited

SSF
JR
03-20



JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATION, TRANSPORT,
POST AND CONSTRUCTION
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

**THE STUDY
ON IMPROVEMENT OF ROADS
IN THE SOUTHERN REGION
IN LAO PEOPLE'S
DEMOCRATIC REPUBLIC**

FINAL REPORT

VOLUME 4 OF 4

ANNEXES

February 2003



Oriental Consultants Company Limited



PADECO Padeco Company Limited

TABLE OF CONTENTS

FINAL REPORT

VOLUME 1 of 4 : EXECUTIVE SUMMARY

VOLUME 2 of 4 : MAIN TEXT

PREFACE

LETTER OF TRANSMITTAL

LOCATION MAP S

PERSPECTIVE

PROJECT SUMMARY

ABBREVIATIONS & ACRONYMS / FOREIGN EXCHANGE RATE

SUMMARY OF THE STUDY

. OVERALL APPROACH AND IMPLEMENTATION

PROGRAM OF THE STUDY	1-1
1.1 Introduction.....	1-1
1.2 Background.....	1-1
1.3 Objectives	1-2
1.4 Study Area.....	1-2
1.5 Scope of the Study	1-3
1.6 Study Approach.....	1-4
1.7 Study Implementation.....	1-6

. GENERAL APPRECIATION	1-1
-------------------------------------	------------

CHAPTER 1 ROAD SYSTEM.....	1-1
1.1 Overview.....	1-1
1.2 Road System	1-2
1.3 Study Area Network.....	1-4
1.3.1 General	1-4
1.3.2 National Road 1 (Route 1).....	1-8
1.3.3 National Road 13 (Route 13).....	1-8

1.3.4 National Road 14 (Route 14).....	1-8
1.3.5 National Road 15 (Route 15).....	1-9
1.3.6 National Road 16 (Route 16).....	1-10
1.3.7 National Road 18 (Route 18).....	1-10
1.3.8 National Road 20 (Route 20).....	1-11
CHAPTER 2 CAPACITY FOR ROAD CONSTRUCTION AND MAINTENANCE	
2.1 Current Capital Expenditure on Road System.....	2-1
2.2 Expenditure and Funding Plan for Road Maintenance	2-2
2.2.1 Funding Needs and Allocation	2-2
2.2.2 Funding Plan and Available Fund.....	2-3
2.3 Organization Responsible for Road and Road Transport	2-5
2.3.1 Ministry of Communication, Transport, Post and Construction (MCTPC).....	2-5
2.3.2 Department of Roads (DOR).....	2-5
2.3.3 Department of Communication, Transport, Post and Construction (DCTPC).....	2-7
2.3.4 Institutional Capacity of Road Agencies	2-7
2.4 Level of Technology for Road Construction and Maintenance ..	2-8
2.4.1 Road and Bridge Construction Work.....	2-8
2.4.2 Road and Bridge Maintenance Work.....	2-9
2.4.3 Materials for Road Construction and Maintenance	2-9
2.4.4 Equipment and Machinery for Road Construction and Maintenance.....	2-10
2.4.5 Unit Costs for Road Construction and Maintenance	2-11
. MASTER PLAN.....	1-1
CHAPTER 1 CONCEPT FOR ESTABLISHMENT OF MASTER PLAN.....	
1.1 Introduction.....	1-1
1.2 Selection Process and Priorities	1-1
1.3 Road Links to be Improved	1-4
1.4 Bridges and Structures for Improvement.....	1-21
1.4.1 Improvement Goal for Bridges & Crossing Structures	1-21
1.4.2 Bridges and Structures.....	1-21

1.4.3 Bridges and Structures to be Improved on Other Roads ...	1-22
CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK AND IMPACTS 2-1	
2.1 Introduction.....	2-1
2.2 Socio-Economic Framework	2-1
2.2.1 Traffic Analysis Zone and Administrative District	2-1
2.2.2 GDP	2-2
2.2.3 Population	2-5
2.2.4 Vehicle Ownership.....	2-11
2.3 Regional Development	2-17
2.3.1 Urban Development.....	2-17
2.3.2 Focal Site Project.....	2-19
2.3.3 Rice Irrigation.....	2-21
2.3.4 Hydrological Power Plant Development	2-22
2.3.5 Agriculture Development in Boloven Plateau.....	2-23
2.3.6 Spatial Distribution of Major Development	2-24
2.3.7 Development Scenario of the Southern Region	2-25
2.4 Methodology of Socio-Economic Analysis on Regional Development	2-27
2.4.1 Introduction.....	2-27
2.4.2 Eight Socio-Economic Criteria.....	2-27
2.5 Evaluation Results on Economic Aspect of the Region	2-30
2.5.1 Economic Efficiency (Criterion 1)	2-30
2.5.2 Tourism Potential (Criterion 2).....	2-33
2.5.3 Network Connectivity (Criterion 3)	2-36
2.5.4 Unexploded Ordnance (UXO) (Criterion 4).....	2-37
2.6 Evaluation Result of Social Aspect of the Region.....	2-41
2.6.1 Rice Product per Person (Criterion 5).....	2-41
2.6.2 Literacy & Education (Criterion 6)	2-44
2.6.3 Ethnic Minorities (Criterion 7)	2-49
2.6.4 Accessibility (Criterion 8)	2-54
2.7 Overall Socio-Economic Evaluation Results.....	2-57
2.7.1 Districts & Road Links	2-57
2.7.2 Evaluation Results of Road Links with Socio-Economic Criteria.....	2-57

CHAPTER 3 TRAFFIC DEMAND	3-1
3.1 Introduction.....	3-1
3.2 Traffic Survey	3-1
3.2.1 Roadside OD Survey, Traffic Volume Survey, Bus Passenger Volume Survey.....	3-1
3.2.2 Axle-Load Survey.....	3-3
3.2.3 Travel Speed & Traffic Rolling Count Survey	3-4
3.3 Traffic Survey Results.....	3-6
3.3.1 Roadside OD Survey	3-6
3.3.2 Traffic Volume Survey.....	3-8
3.3.3 Axle-Load Survey.....	3-10
3.3.4 Travel Speed Survey	3-10
3.4 Traffic Demand Model.....	3-12
3.4.1 Trip Generation/Attraction	3-13
3.4.2 Trip Distribution	3-17
3.4.3 Modal Split	3-24
3.4.4 Traffic Assignment	3-24
3.5 Future Traffic Demand.....	3-27
 CHAPTER 4 EVALUATING ENVIRONMENTAL IMPACTS.....	 4-1
4.1 Introduction.....	4-1
4.2 National Legislative and Stakeholder Involvement.....	4-2
4.3 Policy Context	4-4
4.3.1 Economic Growth.....	4-4
4.3.2 Poverty Reduction	4-4
4.3.3 National Integration.....	4-5
4.3.4 Environmental Protection	4-5
4.3.5 Resolving Conflicting Objectives.....	4-6
4.4 Definitions	4-6
4.4.1 Poverty	4-6
4.4.2 Access	4-8
4.5 Factors in Measuring Environmental Changes & Impacts	4-9
4.6 Environmental Resources/Assessment Factors	4-11
4.6.1 Socio-Economic Resources & Assessment Factors.....	4-11
4.6.2 Cultural Resources & Assessment Factors	4-14
4.6.3 Natural/Ecological Resources & Assessment Factors	4-15

4.6.4 Composite Environmental Conditions	4-21
4.7 Evaluating Changes & Impacts in the Overall Systems & Environments.....	4-22
4.8 Assessing Construction Phase Impacts	4-23
4.9 Discussion of Overall Operational Impacts	4-24
4.9.1 Socio-Economic Impacts	4-24
4.9.2 Cultural Impacts	4-25
4.9.3 Natural/Ecological Impacts	4-26
4.9.4 Physical Impacts	4-27
4.9.5 Conclusion on Impacts	4-27
4.10 Route Specific Assessments.....	4-27
4.10.1 Low Negative/High Positive Impact Routes	4-28
4.10.2 Medium/High Negative Impact Routes.....	4-30
4.11 Overall Conclusions.....	4-34
4.11.1 Potential Negative Impacts	4-34
4.11.2 Potential Positive Impacts.....	4-34
 CHAPTER 5 MAINTENANCE AND IMPROVEMNET PLAN	
FOR ROAD AND BRIDGE.....	5-1
5.1 Introduction.....	5-1
5.2 Maintenance Activities for Roads and Bridges.....	5-1
5.2.1 Road Maintenance Plan	5-1
5.2.2 Bridge Maintenance Plan.....	5-2
5.2.3 Maintenance Program by Each Candidate Road in the Region.....	5-3
5.2.4 Maintenance Cost for Road and Bridge.....	5-4
5.3 Improvement Plan for Road and Bridge	5-5
5.3.1 Road Improvement Plan	5-5
5.3.2 Bridge Improvement Plan.....	5-6
5.3.3 Summary of Improvement Plan for Candidate Roads and Bridges	5-6
5.3.4 Improvement Cost for Roads and Bridges.....	5-6
 CHAPTER 6 ECONOMIC ANALYSIS	
6.1 Introduction.....	6-1
6.2 Vehicle Operating Costs.....	6-2

6.3 Value of Time.....	6-3
6.4 Cost Benefit Analysis.....	6-4
6.5 Economic Analysis of Road Improvements.....	6-5
6.5.1 Overview.....	6-5
6.5.2 Restoring/Improving Route 1	6-6
6.5.3 Improving West Bank Access to Champasack & the South.....	6-8
6.5.4 Improving East-West Links	6-10
6.5.5 Sensitivity Tests	6-12
6.6 Economic Analysis of Bridges.....	6-13
6.6.1 Bailey Bridges	6-13
6.6.2 Route 16: Sekong Bridge.....	6-13
6.7 Project Priorities	6-14
6.8 Cost Benefit Project Ranking	6-15
CHAPTER 7 MASTER PLAN & MOST APPROPRIATE ROAD IMPROVEMENT PROJECTS FOR FESIBILITY STUDY	
7.1 Introduction.....	7-1
7.2 Preferred Road Links & Bridges	7-2
7.2.1 Priority Setting	7-2
7.2.2 Ranking.....	7-2
7.3 Establishment of Road Improvement Master Plan to 2020	7-6
7.4 Selection of Priority Road Improvement Projects	7-13
.. FEASIBILITY STUDY.....	1-1
CHAPTER 1 INVENTORY SURVEY FOR PROJECT ROADS	
1.1 Introduction	1-1
1.2 Road Inventory Survey	1-1
1.2.1 Objective.....	1-1
1.2.2 Survey Items	1-2
1.2.3 Survey Work Method	1-3
1.2.4 Survey Results	1-7
1.2.5 Analysis of Findings	1-9
1.3 Bridge Inventory Survey.....	1-31
1.3.1 Objective.....	1-31

1.3.2 Survey Scope	1-31
1.3.3 Survey Work Method	1-32
1.3.4 Survey Results	1-32
1.3.5 Analysis of Findings	1-36
 CHAPTER 2 NATURAL CONDITION ON THE PROJECT AREA	2-1
2.1 Introduction.....	2-1
2.2 Topographic Survey	2-4
2.2.1 Outline of Survey	2-4
2.3 Geological Survey	2-6
2.3.1 Outline of Survey	2-6
2.3.2 Geological Stratigraphy	2-6
2.3.3 Geological Conditions along the Route.....	2-9
2.3.4 Geological Condition at River Crossings	2-10
2.3.5 Design Value.....	2-21
2.3.6 Consideration for Design Works	2-22
2.4 Material Survey	2-22
2.4.1 Outline of Survey	2-22
2.4.2 Existing Road Bed.....	2-23
2.4.3 Materials for Embankment and Sub-grade (Borrow Pit) ..	2-24
2.4.4 CBR Applied for Design	2-26
2.4.5 Consideration for Design Work on Filling Materials	2-28
2.4.6 Material of Base Course	2-29
 CHAPTER 3 HYDROLOGICAL ANALYSIS OF PROJECT AREA.....	3-1
3.1 Introduction.....	3-1
3.2 Outline of Hydrology on Each Route	3-1
3.2.1 Route 14A	3-1
3.2.2 Route 16A	3-9
3.3 Hydrological Analysis of the Study River	3-15
3.3.1 Hydrological Analysis Approach.....	3-15
3.3.2 Selection of Hydrological Station.....	3-16
3.3.3 Probability Analysis on River Water Level and Daily Rain Fall.....	3-19
3.3.4 Average Daily Rainfall of Each River Basin for Design at Each Probability.....	3-20

3.3.5 Water Discharge	3-21
3.3.6 Discharge Calculation for Bridge No. 3, No.4 & No.5 on Route 16A	3-25
3.3.7 Design Water Level for Bridge and Road of Route 14A	3-26
CHAPTER 4 ROAD IMPROVEMENT CONCEPT FOR ROUTE 14A 4-1	
4.1 Introduction.....	4-1
4.2 Road Alignment, Design and Alternatives.....	4-3
4.2.1 Section (1): STA.0+000 – STA. 6+400 (Survey Length = 6.40km)	4-3
4.2.2 Section (2): STA. 6+400 – STA. 25+000 (Survey Length = 18.60km)	4-5
4.2.3 Section (3): STA. 25+000 – STA. 29+050 (Survey Length = 4.05km)	4-7
4.2.4 Section (4): STA. 29+050 – STA. 35+800 (Survey Length = 6.75km)	4-9
4.2.5 Section (5): STA. 35+800 – STA. 41+500 (Survey Length = 5.70km)	4-11
4.2.6 Section (6): STA. 41+500 – STA. 43+000 (Survey Length = 1.50km)	4-12
4.2.7 Section (7): STA. 43+000 – STA. 59+750 (Survey Length = 16.75km)	4-14
4.3 Bridge and Structure	4-15
4.4 Outline of Road Improvement Project.....	4-16
CHAPTER 5 ROAD IMPROVEMENT CONCEPT FOR ROUTE 16A 5-1	
5.1 Introduction.....	5-1
5.2 Road Alignment, Design and Alternatives.....	5-3
5.2.1 Section (1): STA.0+000 – STA. 33+800 (Survey Length = 33.80km)	5-3
5.2.2 Section (2): STA. 33+800 – STA. 42+200 (Survey Length = 8.40km)	5-4
5.2.3 Section (3): STA. 42+200 – STA. 58+000 (Survey Length = 15.80km)	5-6
5.2.4 Section (4): STA. 58+000 – STA. 64+500	

(Survey Length = 6.50km)	5-7
5.3 Bridges and Structures	5-8
5.4 Outline of Road Improvement Project.....	5-8
CHAPTER 6 EVALUATING ENVIRONMENTAL IMPACTS.....	6-1
6.1 Introduction	6-1
6.2 IEE Assessment Methodology	6-1
6.2.1 Socio-Economic Survey	6-1
6.2.2 Water Quality Survey	6-1
6.2.3 Physical, Cultural and Ecological Environment Assessment.....	6-2
6.3 Major Environmental Issues for Route 14A.....	6-4
6.3.1 Champasack Town.....	6-4
6.3.2 What Phou and Ancient City	6-5
6.4 Major Environmental Issues for Route 16A	6-5
6.5 Planning and Design Stage Impacts (Pre Construction)	6-6
6.5.1 Land Acquisition	6-6
6.5.2 Resettlement	6-7
6.6 Construction and Operation Stage Impacts.....	6-7
6.6.1 Physical Environmental Impacts	6-8
6.6.2 Ecological Impacts	6-9
6.6.3 Cultural Resources Impacts	6-10
6.6.4 Socio-Economic Impacts	6-10
6.7 Planning and Design Stage Mitigation Measures	6-12
6.8 Construction and Operational Mitigation Measures.....	6-14
6.8.1 Physical Environment Design/Engineering Criteria	6-14
6.8.2 Protection of Ecological Resources.....	6-17
6.8.3 Protection of Culture Resources	6-19
6.8.4 Socio-Economic Mitigation Measures	6-20
6.9 Development of Environmental Management Plan (EMP).....	6-26
6.9.1 Monitoring Plan.....	6-28
6.9.2 Monitoring Program	6-31
6.9.3 Remediation Process	6-34
6.9.4 Capacity Building	6-35
6.10 Application for Environmental Certificate	6-35

CHAPTER 7 PRELIMINARY ENGINEERING AND DSIGN	7-1
7.1 Introduction.....	7-1
7.2 Road Design Criteria	7-3
7.2.1 Road Classification and Geometric Design Criteria	7-3
7.2.2 Pavement Design Criteria.....	7-5
7.2.3 Drainage Design Criteria	7-6
7.2.4 Earthwork Design Criteria.....	7-7
7.3 Bridge Design Criteria.....	7-8
7.3.1 Review of Design Standard and Criteria	7-8
7.3.2 Bridge Cross Section	7-9
7.3.3 Loading Criteria for Bridges.....	7-11
7.3.4 Flood, Navigation and Other Clearances.....	7-14
7.4 Preliminary Design for Roads.....	7-16
7.4.1 Road Classification	7-16
7.4.2 Design Vehicle	7-16
7.4.3 Design Speed	7-17
7.4.4 Cross Section Elements	7-18
7.4.5 Alignment Setting	7-20
7.4.6 Road Surface Elevation	7-22
7.4.7 Pavement Structure	7-23
7.5 Assessment of Existing Bridges on Route 16A	7-28
7.5.1 Necessity of Assessment.....	7-28
7.5.2 Existing Structures and Conditions	7-28
7.5.3 Structural Examination of Retaining Existing Bridges	7-29
7.5.4 Conclusion on Retaining Study Bridges.....	7-30
7.6 Preliminary Design for Bridges	7-32
7.6.1 Selection of Bridge Types.....	7-32
7.6.2 Design of Bridge Structure	7-35
7.6.3 Bridge Protection Work	7-37
7.6.4 Results of Preliminary Design of Bridges	7-38
CHAPTER 8 CONSTRUCTION PLANNING.....	8-1
8.1 Introduction.....	8-1
8.2 Pre-Construction Stage	8-1
8.3 Construction Plan for Route 14A Improvement	8-1

8.3.1 Construction Conditions	8-1
8.3.2 Road Construction Plan	8-4
8.3.3 Bridge Construction Plan.....	8-8
8.4 Construction Plan for Route 16A Improvement	8-10
8.4.1 Construction Conditions	8-10
8.4.2 Road Construction Plan.....	8-13
8.4.3 Bridge Construction Plan.....	8-17
8.5 Construction Schedule	8-18
8.5.1 Estimated Construction Time	8-18
8.5.2 Construction Schedule for Route 14A Improvement.....	8-19
8.5.3 Construction Schedule for Route 16A Improvement.....	8-23
 CHAPTER 9 PROJECT COST ESTIMATES	9-1
9.1 Introduction.....	9-1
9.2 Basis of Cost Estimate	9-2
9.3 Project Cost Estimate.....	9-3
9.3.1 Overall Project Cost.....	9-3
9.3.2 Pre-Construction Stage	9-6
9.3.3 Construction Stage.....	9-10
9.3.4 Road Operation and Maintenance Cost	9-13
 CHAPTER 10 PROJECT IMPLEMENTATION PLAN.....	10-1
10.1 Introduction.....	10-1
10.2 Project Implementation Schedule	10-1
10.3 Disbursement Schedule.....	10-4
 CHAPTER 11 PROJECT ECONOMIC ANALYSIS AND EVALUATION	11-1
11.1 Introduction.....	11-1
11.2 Project Roads and Road Network	11-2
11.2.1 Route 14A	11-3
11.2.2 Route 16A	11-3
11.3 Base Year Traffic Volume 2002	11-4
11.3.1 Traffic Counts	11-4
11.3.2 Route 14A	11-5
11.3.3 Route 16A	11-5
11.4 Future Traffic Volume	11-6

11.4.1 Normal Traffic.....	11-6
11.4.2 Diverting and Generated Traffic	11-7
11.4.3 Forecast Traffic Volumes	11-13
11.5 Road User Cost Model.....	11-13
11.5.1 Vehicle Operating Costs.....	11-15
11.5.2 Road User Time Savings.....	11-18
11.6 Project Costs	11-19
11.6.1 Construction.....	11-19
11.6.2 Routine and Periodic Maintenance	11-21
11.6.3 Environmental Monitoring.....	11-21
11.7 Project Benefits	11-21
11.8 Economic Analysis Results.....	11-23
11.9 Sensitivity Tests	11-25
11.9.1 Risk Factors	11-25
11.9.2 Results of Sensitivity Tests	11-26
11.10 Conclusions.....	11-27
 CHAPTER 12 ROAD MAINTENANCE AND TRAFFIC MANAGEMENT.....	12-1
12.1 Introduction.....	12-1
12.2 Maintenance Activity Plan.....	12-1
12.2.1 Maintenance Activity Flow.....	12-1
12.2.2 Inspection Activity	12-2
12.2.3 Defects Evaluation (Ranking).....	12-4
12.2.4 Execution of Maintenance Work	12-5
12.3 Effective Road Maintenance System.....	12-6
12.3.1 Approach.....	12-6
12.3.2 Impacting Factors	12-7
12.3.3 Construction of Road Maintenance Scenarios and Needs Gap Analysis.....	12-8
12.3.4 Realizing an Effective Road Maintenance System.....	12-9
12.4 Traffic Management and Road Safety Operation	12-11
 CHAPTER 13 IMPROVEMENT PLAN FOR ROUTE 18A	13-1
13.1 Introduction.....	13-1
13.2 Establishment of Road Improvement Policy	13-1
13.2.1 Evaluation of Current Condition	13-1

13.2.2 Identification of Development Stages	13-3
13.2.3 Road Improvement Policy for Route 18A.....	13-5
13.3 Determination of Road and Crossing Structures	13-5
13.3.1 Road Class and Structure for Route 18A.....	13-5
13.3.2 Crossing Structure for Route 18A	13-6
13.4 Cost Estimates.....	13-9
13.4.1 Basis of Cost Estimates	13-9
13.4.2 Road.....	13-10
13.4.3 Bridges.....	13-12
13.4.4 Total Project Cost for Route 18A	13-12
13.5 Road Improvement Implementation Plan for Route 18A.....	13-13
13.6 Road Maintenance Plan for Route 18A	13-13
13.6.1 Road.....	13-13
13.6.2 Bridge Structure.....	13-15
13.6.3 Maintenance Cost	13-16
13.7 Economic Analysis	13-16
13.7.1 Introduction	13-16
13.7.2 Existing and Future Traffic.....	13-17
13.7.3 Project Costs.....	13-20
13.7.4 Project Benefits	13-21
13.7.5 Economic Analysis Results	13-22
13.7.6 Sensitivity Tests	13-24
13.7.7 Conclusions	13-25
13.7.8 Recommendation on Upgrading Methodology	13-26
13.8 Approach to Provide Basic Access for Roads Suitable for Development Stage 1.....	13-27
13.8.1 Introduction	13-27
13.8.2 Approach & Methodology	13-27
 CHAPTER 14 CONCLUSIONS AND RECOMMENDATIONS	14-1
14.1 Project Benefits.....	14-1
14.2 Project Implementation Requirements.....	14-3
14.3 Recommendations.....	14-4

VOLUME 3 of 4 : PRELIMINARY DRAWINGS

VOLUME 4 of 4 : ANNEXES

ANNEXES FOR MASTER PLAN

ANNEX M-1 TRAFFIC SURVEY RESULTS

ANNEX M-2 ROAD & BRIDGE INVENTORY ON STUDY AREA NETWORK

ANNEX M-3 FIELD SURVEY SHEET OF RIVER SITUATION

ANNEX M-4 POPULATION DISTRIBUTION

ANNEX M-5 UXO MAPS IN THE STUDY AREA

ANNEX M-6 COST BENEFIT ANALYSIS

ANNEX M-7 ECONOMIC ANALYSIS OF PAKSE XE DON BRIDGE

ANNEX M-8 MAINTENANCE & TRANSPORT STANDARDS FOR CANDIDATE ROADS

ANNEXES FOR FEASIBILITY STUDY

ANNEX F-1 SUMMARY OF PRESENT CONDITION OF SURVEY ROUTE

ANNEX F-2 UXO LOCATION MAP IN CHAMPASACK PROVINCE

ANNEX F-3 BRIDGE INVENTORY SURVEY DATA

ANNEX F-4 SOIL INVESTIGATION RESULTS

ANNEX F-5 MATERIAL INVESTIGATION RESULTS

ANNEX F-6 IEE REPORT FOR ROUTE 14A

ANNEX F-7 IEE REPORT FOR ROUTE 16A

ANNEX F-8 SOCIO-ECONOMIC SURVEY RESULTS

ANNEX F-9 WATER QUALITY SURVEY RESULTS

ANNEX F-10 HYDROLOGICAL INVESTIGATION RESULTS

ANNEX F-11 ECONOMIC ANALYSIS : RED MODEL

ANNEX F-12 ECONOMIC ANALYSIS ROUTE 14A Km 0.0-34.0/34.0-59.3

ANNEX F-13 BRIDGE LIST ON ROUTE 18A

ANNEX F-14 CONSTRUCTION SCHEDULE OF SUPERSTRUCTURE
& SUBSTRUCTURE

ANNEX F-15 PROVINCIAL DECREE FOR THE PRESERVATION OF THE
HISTORICAL SITES

ANNEX F-16 GEOLOGICAL CROSS SECTION FOR THE RIVER

ANNEX F-17 BIBLIOGRAPHY & LIST OF PEOPLE MET

FIGURE

. OVERALL APPROACH AND IMPLEMENTATION PROGRAM OF THE STUDY	
1.6.1 Study Flow	1-5
1.7.1 Organizational Chart for the Study	1-6
. GENERAL APPRECIATION	
1.3.1 Road Network in Study Area.....	1-6
2.3.1 MCTPC Organizational Chart	2-6
. MASTER PLAN	
1.1.1 Selection Process and Priority Setting Method	1-3
2.2.1 Distribution of Total Population in the Study Area	2-9
2.2.2 Present Land Use of the Study Area.....	2-10
2.3.1 Spatial Distribution of Major Development Projects and National Roads.....	2-24
2.5.1 Major Tourism Resources.....	2-35
2.5.2 Record of Bombardment During Indo-China War	2-39
2.5.3 UXO Impact by Village.....	2-40
2.6.1 Rice Production per Person by District	2-43
2.6.2 Literacy Rate by District	2-47
2.6.3 Student Ratio by District	2-47
2.6.4 Female Student Ratio.....	2-48
2.6.5 Secondary Student Ratio	2-48
2.6.6 Spatial Distribution of Ethnic Minorities	2-51
2.6.7 Spatial Distribution of Ethnic Lao.....	2-52
2.6.8 Ratio of Ethnic Minorities in Villages.....	2-53
2.7.1 Road Links and Relevant Districts	2-59

3.2.1 Survey Stations for the OD Passenger/Goods Survey, Traffic Volume Survey, & Bus Passenger Volume Survey	3-2
3.2.2 Axle-Load Survey Stations.....	3-4
3.2.3 Travel Speed Survey Roads.....	3-5
3.3.1 Study Area Vehicle Trip Composition	3-7
3.3.2 Study Area Vehicle Goods Composition	3-7
3.3.3 Outline of Vehicle Trip Movements	3-8
3.3.4 Study Area Traffic Composition.....	3-8
3.3.5 Average Bi-Directional 12-hour Traffic Volumes.....	3-9
3.3.6 Road Condition & Average Travel Speed.....	3-10
3.3.7 Average Road Travel Speed.....	3-11
3.4.1 Overall Workflow for Estimating Future Traffic Demand	3-12
3.4.2 Zoning Map for Study Area.....	3-14
3.4.3 Average Vehicle Occupancy	3-16
3.4.4 Flow for Building of Daily OD Matrices	3-17
3.4.5 Average Daily Traffic at Screen Line (2001).....	3-19
3.4.6 Desired Line Chart for Study Area (for 2001).....	3-21
3.4.7 Desired Line Chart for Study Area (for 2007).....	3-22
3.4.8 Desired Line Chart for Study Area (for 2020).....	3-23
3.4.9 QV for Paved Roads	3-25
3.4.10 QV for Unpaved Roads	3-26
3.5.1 Present Traffic Flows (2001)	3-29
3.5.2 2007 Base Case.....	3-30
3.5.3 2007 Scenario 1	3-31
3.5.4 2007 Scenario 2	3-32
3.5.5 2007 Scenario 3	3-33
3.5.6 2007 Scenario 4	3-34
3.5.7 2007 Scenario 5	3-35
3.5.8 2020 Scenario 1	3-36
3.5.9 2020 Scenario 2	3-37
4.2.1 Environmental Assessment Process for the Lao PDR Department of Roads...	4-3
4.2.2 Project Stakeholders	4-3
4.5.1 Socio-Economic Changes & Impacts	4-9
4.5.2 Cultural Environment Changes & Impacts.....	4-10
4.5.3 Natural/Ecological Changes & Impacts	4-10

4.5.4 Physical Environment Changes & Impacts	4-11
4.6.1 Key Natural/Ecological Resources.....	4-17
5.3.1 Pavement Structure for Road Design	5-5
7.3.1 Road Improvement Master Plan to 2020.....	7-11
7.4.1 Future Traffic Assignment (Year 2007, with 14A & 16A improved)	7-15

. FEASIBILITY STUDY

1.2.1 Typical Cross Section of Survey Routes	1-3
1.2.2 Road Inventory Survey Sheet	1-4
1.2.3 Survey Route Map on Missing Link Section	1-9
1.2.4 Present Status of Junction with Route 16	1-10
1.2.5 Survey Route Behind Village (at 17.4km)	1-11
1.2.6 Mountain Stream (at 8.0km)	1-11
1.2.7 Survey Route Map on Champasack Town.....	1-12
1.2.8 Access Road to Route 14A (at 28.0km)	1-12
1.2.9 Typical Cross Sections (Paddy Field: at 26.5km & Village: at 27.5km).....	1-13
1.2.10 Development Plan of Champasack Town.....	1-14
1.2.11 Survey Route Map of Ancient City Section	1-15
1.2.12 Typical Views of Ancient City Section.....	1-15
1.2.13 Survey Route Map of Flat Paddy Field Section	1-16
1.2.14 Typical Cross Section (at 40.3km).....	1-17
1.2.15 Survey Route Map on Populated Town Section	1-17
1.2.16 Sketch & Photograph of Ban Dontalat	1-18
1.2.17 Present Status of Junction with Route 14A1 (at 42.3km).....	1-18
1.2.18 Survey Route Map on Flat Paddy Field Section	1-19
1.2.19 Present Status of Flat Paddy Field Section (at 58.4km)	1-20
1.2.20 Present Status of Junction with Route 14C1 (at 55.55km).....	1-20
1.2.21 Survey Route Map on Large-Scale Afforestation Section.....	1-21
1.2.22 Present Status of Large-Scale Afforestation Section (at 3.4km)	1-22
1.2.23 Sketch of Junction with Route 16.....	1-22
1.2.24 Damaged Surface – Rutting (at 2.0km)	1-22
1.2.25 Survey Route Map on Minority Villages and Coffee Plantation Section.....	1-23
1.2.26 Damaged Surface – Ravelling (at 8.9km)	1-23

1.2.27 Layout of Control Points at Ban Chansavang Village	1-24
1.2.28 Survey Route Map on Shortcut Section	1-24
1.2.29 Present Status of Shortcut Section (Forest & Coffee Plantation)	1-25
1.2.30 Present Status of Junction with Existing Road (at 42.2km)	1-25
1.2.31 Survey Route Map on Existing Road Section	1-26
1.2.32 Typical Cross Section & Resettlement Village.....	1-26
1.2.33 Layout of Bridge Approach.....	1-27
1.2.34 Present Status of Bridge Approach (at 10.3km)	1-27
1.2.35 Survey Route Map on Steep Mountainous Section	1-28
1.2.36 Typical Cross Section on Steep Mountain Section (at 53.9km)	1-28
1.2.37 Sketch of Typical Cross Section	1-29
1.2.38 Survey Route Map on Forest & Rice Plantation Section	1-29
1.2.39 Typical Cross Section & Rice Plantation.....	1-30
1.2.40 Present Status of Jct. with Route 1I (at 64.5km)	1-30
2.1.1 Geomorphological Map of the Project Area.....	2-2
2.1.2 Geological Profiles of the Bolaven Plateau.....	2-3
2.3.1 Geological Map in the Southern Part of Lao P.D.R.	2-8
2.3.2 Geological Cross Section for the Sahoua River (No.14-21-1).....	2-15
2.3.3 Geological Cross Section for the Namtang River (No.16-2)	2-16
2.3.4 Soil Classification.....	2-20
3.1.1 Location Map of Rivers – Rt. 14A	3-2
3.1.2 Location Map of Rivers – Rt. 16A	3-3
3.2.1 Max, Min of W.L at Pakse	3-4
3.2.2 Max, Min. Temperature at Pakse.....	3-4
3.2.3 Mean, Max, Min. Precipitation at Pakse	3-5
3.2.4 Monthly Rainy Day at Pakse	3-6
3.2.5 Monthly Max. Min. Humidity at Pakse.....	3-7
3.2.6 Max. & Min. Wind Velocity at Pakse.....	3-7
3.2.7 Max. & Min. Temperature at Paksong	3-9
3.2.8 Max. & Min. Temperature at Sekong	3-10
3.2.9 Max. & Min. Precipitation at Paksong	3-10
3.2.10 Max. & Min. Precipitation at Sekong.....	3-11
3.2.11 Max. & Min. Rainy Day at Paksong.....	3-12
3.2.12 Max. & Min. Rainy Day at Sekong	3-13

3.3.1 Location of Observatory Station.....	3-17
3.3.2 Estimated High Water Level at Each Probability at Pakse.....	3-19
3.3.3 Plan Sketch of Bridge No.4, No.5 & No.6	3-26
3.3.4 Estimation of Water Level for Mekong River	3-28
4.2.1 Alternatives for STA.0+000 – STA.6+400	4-3
4.2.2 Typical Cross Section for Alternative 2 (L = 6.40km)	4-4
4.2.3 Alternatives for STA.6+400 – STA.25+000	4-5
4.2.4 Typical Cross Section for Alternative 1 (L = 18.60km)	4-6
4.2.5 Alternatives for STA.25+000 – STA.29+050	4-7
4.2.6 Typical Cross Section for Alternative 3 (L = 4.05km)	4-8
4.2.7 Alternatives for STA.29+050 – STA.35+800	4-9
4.2.8 Typical Cross Section for Alternative 1 (L = 6.75km)	4-10
4.2.9 Proposed Route for STA.35+800 – STA.41+500	4-11
4.2.10 Typical Cross Section for Proposed Route (L = 5.70km).....	4-11
4.2.11 Alternatives for STA.41+500 – STA.43+000	4-12
4.2.12 Typical Cross Section for Alternative 2 (L = 1.70km)	4-13
4.2.13 Proposed Route for STA.43+000 – STA.59+750	4-14
4.2.14 Typical Cross Section for STA.43+000 – STA.59+750 (L = 16.75km)	4-14
5.2.1 Proposed Route for STA.0+000 – STA.33+800	5-3
5.2.2 Typical Cross Section for Proposed Route (L = 33.80km).....	5-3
5.2.3 Alternatives for STA.33+800 – STA.42+200	5-4
5.2.4 Typical Cross Section for Alternative (i) (L = 8.40km).....	5-4
5.2.5 Proposed Route for STA.42+200 – STA.58+000	5-6
5.2.6 Typical Cross Section for Proposed Route (L = 15.80km).....	5-6
5.2.7 Proposed Route for STA.58+000 – STA.64+500	5-7
5.2.8 Typical Cross Section for Proposed Route (L = 6.50km).....	5-7
6.2.1 Route 14A Sections	6-3
6.2.2 Route 16A Sections	6-4
6.9.1 Environmental Assessment Process.....	6-27
6.9.2 Monitoring Process.....	6-30
7.3.1 Bridge Widths for Route 14A and 16A	7-11
7.3.2 Earthquake Records between 1964 and 1998 in the Study Area.....	7-13

7.3.3 Drift Timber in Xe Namnoy River in Rainy Season	7-15
7.4.1 Typical Cross Section for Rural Section (Flat Area)	7-18
7.4.2 Typical Cross Section for Populated Section.....	7-19
7.5.1 Typical Cross-section of Steel-I Bridge.....	7-29
8.3.1 Typical Cross-section of Rt. 14A.....	8-2
8.3.2 Existing & Potential Borrow Pit Area & Haulage Plan (Rt. 14A)	8-5
8.3.3 Construction Procedure of Superstructure.....	8-9
8.3.4 Construction Procedure of Substructure & Foundation	8-10
8.4.1 Typical Cross-section for Mountainous Sections	8-11
8.4.2 Existing & Potential Borrow Pit Area & Haulage Plan (Rt. 16A)	8-14
8.4.3 Construction Procedure for Superstructure for Route 16A	8-18
8.5.1 Construction Schedule for Road Works: Route 14A.....	8-20
8.5.2 Construction Schedule for All Bridge Works for Route 14A & 16A	8-22
8.5.3 Construction Schedule for Road Works: Route 16A	8-23
10.2.1 Project Implementation Schedule.....	10-2
10.2.2 Resettlement Process	10-4
12.2.1 Maintenance Activity Flow	12-1
12.3.1 Developing and Effective Road Maintenance System	12-6
12.3.2 Workflow for Needs Gap Analysis	12-8
13.2.1 Categorization of Route 18A according to Their Development Level.....	13-3
13.3.1 Typical Cross-Section of Rt. 18A.....	13-6

TABLE

. GENERAL APPRECIATION

1.1.1 Lao and Lower Mekong Sub-Region	1-1
1.2.1 Road Lengths by Surface Type.....	1-4
1.3.1 Length of National Roads in Study Area (year 2002)	1-7
2.1.1 Trend of Budgets for Road Sector	2-1
2.2.1 Prospected Maintenance Needs FY 2001/2-2004/5	2-2
2.2.2 Planned Funding Allocation 2001-2015	2-3
2.2.3 Prospected RMF Revenue FY 2001/2-2004/5.....	2-4
2.4.1 Availability of Construction Materials for Roads and Bridges.....	2-10

. MASTER PLAN

1.3.1 Candidate Roads for Improvement.....	1-4
1.3.2 Road Conditions by Route.....	1-5to1-20
1.4.1 List of Bridges on by Road.....	1-21
1.4.2 List of Bridge Projects.....	1-22
1.4.3 Additional Bridge Project	1-22
2.2.1 Population Living in Poverty 1997/98	2-2
2.2.2 Sectoral Contributions to GDP	2-3
2.2.3 Sectoral Growth in 1996-2000	2-3
2.2.4 GDP Forecasts to 2020	2-4
2.2.5 Basic Statistics by Province (1)	2-4
2.2.6 Basic Statistics by Province (2)	2-5
2.2.7 Population Forecast to 2020	2-6
2.2.8 Population Forecast – Study Area	2-6
2.2.9 Population Forecast by District	2-7
2.2.10 Vehicle Fleet by Province Mid-2000	2-11
2.2.11 National Vehicle Fleet 1999-2000	2-12
2.2.12 Vehicle Fleet Excluding Vientiane 1990-1999	2-12
2.2.13 GDP & Vehicle Fleet Forecast to 2020.....	2-14
2.2.14 Study Area Vehicle Fleet Forecast.....	2-15

2.2.15 Vehicle Fleet Estimation by District.....	2-16
2.3.1 Urban Infrastructure & Service Target for 2005.....	2-18
2.3.2 Small Towns in the Study Area	2-19
2.3.3 List of Focal Sites in the Study Area	2-20
2.3.4 Major Hydroelectric Power Development in the Study Area.....	2-22
2.5.1 Evaluation of Road Links with Economic Efficiency	2-30
2.5.2 Estimation of District GDP/Capita (US\$) in 2001	2-31
2.5.3 Evaluation of District Work Force in Industrial & Service Sector.....	2-32
2.5.4 Road Links & Population Impacted per km of Road	2-33
2.5.5 Prominent Tourism Resources by Road Link.....	2-34
2.5.6 Function of Road Links for Inter-national & Inter-provincial Connection	2-37
2.5.7 Estimated UXO Impact of Each Road Link	2-38
2.6.1 Rice Production (kg/person) by District.....	2-42
2.6.2 Literacy Rate & Student Rate	2-46
2.6.3 Evaluation of Road Links with Ethnic Minority Population.....	2-49
2.6.4 Evaluation of Road Links with Insufficient Accessibility.....	2-54
2.6.5 Evaluation of District with Road Sufficiency.....	2-56
2.6.6 Insufficiency of Road Function	2-57
2.7.1 Overall Evaluation Results of Road Links with Socio-Economic Criteria	2-60
3.3.1 OD Survey Sampling Rates (12 hours)	3-6
3.3.2 Average Total Axle-Load & % of Overloaded Trucks.....	3-10
3.4.1 Total Future Daily Trips for Study Area	3-13
3.4.2 Trip Generation Models.....	3-15
3.4.3 Trip Attraction Models	3-15
3.4.4 Trip Distribution Models	3-19
3.4.5 Design Capacity & Free-Flow Speeds for Road Network Links	3-25
3.4.6 Capacity Adjustment Factor for Shoulder Width	3-25
3.4.7 Comparison of Model Estimates with Observed Traffic Volumes	3-26
4.6.1 Percentage Poor by Regions & Provinces	4-12
4.6.2 Access to Primary Health Care	4-12
4.6.3 Access to Main Roads	4-13
4.6.4 Education Profile	4-13
4.6.5 Physical & Tangible Cultural Resources	4-14
4.6.6 Minority Groups in Southern Lao PDR.....	4-14

4.6.7 NBCAs by Province	4-16
4.6.8 Wetlands	4-20
4.6.9 Natural/Ecological Resources	4-21
4.6.10 Composite Environmental Conditions	4-21
4.10.1 Assessment Criteria	4-27
4.10.2 Overall Impacts	4-28
5.2.1 Frequency of Inspection for Routine Maintenance	5-1
5.2.2 Maintenance Intervention Level for Gravel/Earth Roads.....	5-2
5.2.3 Routine Maintenance Requirements for Bridges	5-2
5.2.4 Periodic Maintenance Requirements for Bridges.....	5-3
5.2.5 Basic Maintenance Program.....	5-3
5.2.6 Maintenance Unit Cost for Existing Road.....	5-4
5.2.7 Maintenance Unit Cost for Improved Road	5-4
5.3.1 Improvement Plan in 2020 for Roads & Bridges	5-7 to 5-8
5.3.2(1) Basic Unit Road Improvement Costs (Road Design Class III).....	5-9
5.3.2(2) Basic Unit Road Improvement Costs (Road Design Class IVI)	5-9
5.3.3 Unit Bridge Improvement Costs & Assumption	5-10
5.3.4 Total Project Cost for Each Candidate Roads	5-11
6.2.1 VOC & Passenger Time Values	6-2
6.2.2 Comparison of HDM III/IV VOC Benefits	6-3
6.4.1 Financial Improvement Costs	6-5
6.5.1 Economic Cost Benefit Analysis	6-6
6.5.2 Cost Benefit Sensitivity Tests Route 1H	6-12
6.6.1 Traffic Volumes on Bailey Bridges.....	6-13
6.6.2 Sekong Crossing Dailey Vehicles.....	6-14
6.7.1 Cost Benefit Indicative Program for Candidate Projects	6-15
6.8.1 Project Ranking: Cost Benefit Analysis	6-16
7.2.1 Grade & Score	7-3
7.2.2 Overall Impacts	7-4
7.2.3 Criteria & Weight (example)	7-5
7.3.1 Outline of Road Links to be Improved.....	7-8
7.3.2 Work Items by Project	7-12

. FEASIBILITY STUDY

1.2.1 Length of survey Routes (km)	1-8
1.2.2 List of Villages on Missing Link Section	1-10
1.2.3 List of Control Points on Missing Link Section	1-11
1.2.4 List of Villages Part of Champasack Town	1-13
1.2.5 List of Control Points in Champasack Town.....	1-13
1.2.6 List of Villages on Flat Paddy Field Section	1-16
1.2.7 List of Villages on Flat Paddy Field Section	1-19
1.2.8 List of Control Points on Minority Villages & Coffee Plantation Section	1-24
1.2.9 List of Villages on Existing Road Section.....	1-26
1.2.10 List of Control Points on Steep Mountainous Section	1-29
1.3.1 River List of Route 14A	1-33
1.3.2 River List of Route 16A	1-34
2.2.1 Quantity of Topographic Survey for Route 14A and Route 16A	2-4
2.2.2 List of National Bench Mark	2-5
2.2.3 Scale of Mapping.....	2-5
2.3.1 List of Boring Sites.....	2-6
2.3.2 Geological Stratigraphy	2-7
2.3.3 Result of Standard Penetration Test.....	2-17
2.3.4 Result of Laboratory Test for Undisturbed Samples	2-19
2.3.5 Result of Laboratory Test for Rocks.....	2-19
2.3.6 Design Values for Geological Formations.....	2-21
2.4.1 Test Pits for the Route 14A and the Route 16A.....	2-24
2.4.2 Result of Laboratory Test for Test Pit Samples	2-24
2.4.3 Existing Borrow Pits alongside the Route 14A and the Route 16A	2-25
2.4.4 Result of Laboratory Test for Borrow Pit Samples	2-26
2.4.5 List of Quarry and River Bed Materials	2-29
3.2.1 Monthly Water Level of Mekong at Pakse (Period 1991-2000).....	3-4
3.2.2 Monthly Precipitation at Pakse (1991 – 2000).....	3-5
3.2.3 Monthly Rainy Day at Pakse (1991 – 2000)	3-6
3.2.4 Characteristics of Waterways at the Bridge Site for Route 14A	3-8
3.2.5 Monthly Precipitation at Paksong (1991 – 2000).....	3-10

3.2.6 Monthly Precipitation at Sekong (1989 – 2001)	3-11
3.2.7 Monthly Rainy day at Paksong (1991 – 2000).....	3-12
3.2.8 Monthly Rainy day at Sekong (1991 – 2001)	3-13
3.2.9 Characteristics of Each River at the Bridge Site for Route 16A	3-14
3.3.1 Water Level (Mekong River) Observatory and Data Availability	3-18
3.3.2 Rainfall Observatory and Data Availability.....	3-18
3.3.3 Rainfall Station and Availability Data	3-18
3.3.4 Result of Probability of Max. W. L. for Mekong River at Pakse	3-19
3.3.5 Probability for Max. Daily Rainfall.....	3-20
3.3.6 Average Daily Rainfall of the Basin for Design at Each Probability	3-21
3.3.7 Calculation for Rainfall Intensity and Discharge for Route 14A	3-23
3.3.8 Calculation for Rainfall Intensity and Discharge for Route 16A	3-24
3.3.9 Analysis of Water Level for Mekong River – Route 14A	3-28
3.3.10 Design Water Level & Velocity at Each Bridge for Route 14A	3-30
3.3.11 Design Water Level & Velocity at Each Bridge for Route16A	3-31
4.1.1 Traffic Volume Forecast for Design 2020	4-1
4.1.2 Sections to Consider Improvement Concept	4-1
4.1.3 Summary of Route 14A.....	4-2
4.2.1 Comparison of Alternatives 1 & 2.....	4-3
4.2.2 Comparison of Alternatives 1,2 & 3.....	4-5
4.2.3 Comparison of Alternatives 1,2 & 3.....	4-7
4.2.4 Comparison of Alternatives 1 & 2.....	4-9
4.2.5 Comparison of Alternatives 1 & 2.....	4-12
4.3.1 Structural Type at Each Candidate River.....	4-15
4.4.1 Improvement Approach by Section	4-16
5.1.1 Traffic Volume Forecast for Design 2020	5-1
5.1.2 Sections to Consider Improvement Concept	5-1
5.1.3 Summary of Route 16A.....	5-2
5.2.1 Comparison of Alternatives (i) & Alternative (ii)	5-5
5.3.1 Structure Type on Rivers on Route 16A.....	5-8
5.4.1 Improvement Approach by Section	5-8
7.1.1 Summary of Route 14A	7-1
7.1.2 Summary of Route 16A	7-2

7.2.1 Road Classification and Geometric Design Criteria	7-3
7.2.2 Super-elevation and Radius of Horizontal Curve.....	7-4
7.2.3 Widening (Rolling Area)	7-4
7.2.4 Widening (Mountainous Area)	7-4
7.2.5 Values for Transition Curve.....	7-4
7.2.6 Stopping Sight Distance	7-5
7.2.7 Passing Sight Distance	7-5
7.2.8 Minimum Proportion of Passing Sight Distance	7-5
7.2.9 Criteria for Selecting Pavement Type.....	7-6
7.2.10 Comparison of Return Periods	7-6
7.2.11 Minimum and Maximum Velocities	7-6
7.2.12 Minimum Diameter for Pipe Culverts.....	7-7
7.2.13 Rainfall Intensity	7-7
7.2.14 Grade for Cutting Slope (1).....	7-7
7.2.15 Grade for Cutting Slope (2).....	7-8
7.2.16 Grade for Embankment	7-8
7.3.1 Bridge Design Standards and Criteria in Previous Bridge Project.....	7-10
7.3.2 Range of Temperature Considered in Bridge Design.....	7-13
7.3.3 Flood Clearance by Design Flood Discharge	7-15
7.4.1 Traffic Forecasts (Route 14A)	7-16
7.4.2 Traffic Forecasts (Route 16A)	7-16
7.4.3 Design Speed for Each Route	7-17
7.4.4 Sections with 2m Shoulder for Route 14A.....	7-19
7.4.5 Sections with 2m Shoulder for Route 16A.....	7-20
7.4.6 Alignment Setting (Horizontal/Vertical) for Route 14A	7-21
7.4.7 Alignment Setting (Horizontal/Vertical) for Route 16A	7-21
7.4.8 Estimated Flooding Level and Return Period at Champasack Observatory	7-22
7.4.9 Water Surface Gradient.....	7-23
7.4.10 Forecast Cumulative '18-kip ESAL (W18)' per 1 lane (2008-2017)	7-24
7.4.11 Traffic Volume Forecast VPD (2008-2022).....	7-24
7.4.12 Pavement Structural Number (SN).....	7-25
7.4.13 W18' and SNy (2018-2022).....	7-27
7.4.14 SN _{OL} and D _{OL} of the Projected Routes	7-27
7.5.1 Major Characteristics of Existing Steel-I Beam Bridges.....	7-28
7.5.2 Examination Results	7-30
7.5.3 Result of Examination of Retaining Existing Steel-I Bridges	7-31

7.6.1 Standard Applicable Span.....	7-33
7.6.2 Range of Heights for Type of Abutment.....	7-34
7.6.3 Superstructure Types by Span Length	7-36
7.6.4 Abutment Type by Its Height.....	7-36
7.6.5 Preliminary Design Results of Bridges on Route 14A.....	7-38
7.6.6 Preliminary Design Results of Bridges on Route 16A.....	7-38
8.3.1 Major Features of Construction by Section for Rt. 14A	8-2
8.3.2 Procurement Conditions for major Construction Machinery	8-3
8.3.3 Haulage Plan for Borrow Materials.....	8-6
8.3.4 Construction Method of Earthworks	8-6
8.3.5 Construction Method for Pavement Work	8-7
8.4.1 Major Features of Construction By Section for Rt. 16A.....	8-11
8.4.2 Haulage Plan for Borrow Materials.....	8-15
8.4.3 Construction Method of Earthworks	8-15
8.5.1 Standard Work Volume per day for Major Road Works	8-19
9.3.1 Total Project Costs (Rt. 14A & Rt. 16A): Economic Cost	9-3
9.3.2 Total Costs of Civil Works & Engineering Service excluding Fuel Tax (Rt. 14A & Rt. 16A).....	9-3
9.3.3 Summary of the Project Cost for Route 14A.....	9-4
9.3.4 Summary of the Project Cost for Route 16A.....	9-5
9.3.5 UXO Survey and Clearance Cost (Rt. 14A & Rt. 16A)	9-6
9.3.6 Archeological Survey Cost (Rt. 14A & Rt. 16A)	9-7
9.3.7 Survey Cost of Natural Forest Resources (Rt. 16A)	9-7
9.3.8 Unit Costs of House Resettlement.....	9-8
9.3.9 House Resettlement Cost (Rt. 14A)	9-8
9.3.10 House Resettlement Cost (Rt. 16A)	9-8
9.3.11 Substitute Site Preparation Cost (Rt. 14A)	9-8
9.3.12 Substitute Site Preparation Cost (Rt. 16A).....	9-8
9.3.13 Relocation Cost for Electric Facilities (Rt. 14A)	9-9
9.3.14 Agricultural Production Loss (Rt. 14A)	9-9
9.3.15 Agricultural Production Loss (Rt. 16A)	9-9
9.3.16 Construction Quantities	9-10
9.3.17 Unit Rate for Major Materials	9-11
9.3.18 Unit Rate for Labor	9-11

9.3.19 Unit Rate for Major Equipment.....	9-11
9.3.20 Unit Costs for Major Construction Work Items	9-12
9.4.1 Unit Costs of Routine and Periodic Maintenance (Rt. 14A & Rt. 16A)	9-14
10.3.1(1) Summary of Disbursement Schedule (Rt. 14A)	10-5
10.3.1(2) Summary of Disbursement Schedule (Rt. 16A)	10-5
10.3.2(1) Breakdown of Disbursement Schedule (Rt. 14A)	10-6
10.3.2(2) Breakdown of Disbursement Schedule (Rt. 16A)	10-6
11.3.1 Route 14A Km 34.0-59.3 Normal Traffic 2002.....	11-5
11.3.2 Route 16A Normal Traffic 2002	11-6
11.4.1 Traffic Growth Rates (annual per cent)	11-7
11.4.2 Distance Changes with Projects.....	11-8
11.4.3 Traffic Counts Champasack Ferry	11-9
11.4.4 Diverting Traffic Route 14A 2008.....	11-9
11.4.5 Traffic Forecast Route 1I.....	11-10
11.4.6 Route 1I Traffic Assignment.....	11-10
11.4.7 Diverting Traffic Route 16A 2008.....	11-11
11.4.8 Traffic Composition 2008 (Excluding motorcycles)	11-12
11.4.9 Traffic Forecast Route 14A Km 0.0-34.0	11-14
11.4.10 Traffic Forecast Route 14A Km 34-59.3	11-14
11.4.11 Traffic Forecast Route 16A.....	11-15
11.6.1 Project Cost Estimates Summary.....	11-20
11.6.2 Project Disbursement Summary	11-20
11.8.1 Economic Analysis Results.....	11-24
11.8.2 Economic Analysis Route 14A.....	11-24
11.8.3 Economic Analysis Route 16A	11-25
11.9.1 Route 14A Sensitivity Analysis	11-26
11.9.2 Route 16A Sensitivity Analysis	11-27
11.9.3 Sensitivity to Traffic Growth Rate.....	11-27
12.2.1 Inspection Items for Paved Roads	12-2
12.2.2 Inspection Items for Bridges	12-3
12.2.3 Frequency of Inspection for Routine Maintenance	12-3
12.2.4 Bridge Maintenance Requirements	12-3
12.2.5 Periodic Maintenance Requirements for Improved Bridges	12-4

12.2.6 Execution Maintenance Work Plan by Defect.....	12-5
13.2.1 Major Socio-economic Characteristics of Three Sections of Rt. 18A	13-3
13.3.1 Crossing Structure Alternatives for Route 18A.....	13-8
13.3.2 Bridge Type by Section	13-9
13.4.1 Housing Resettlement Cost	13-11
13.4.2 Unit Cost for UXO Field Survey.....	13-11
13.4.3 Unit Cost for Road Improvement	13-12
13.4.4 Unit Cost of Each Bridge Type.....	13-12
13.4.5 Total Project Cost by Section	13-12
13.5.1 Construction Schedule for Route 18A.....	13-13
13.6.1 Inspection Requirements for Roads.....	13-14
13.6.2 Intervention Level and Maintenance Activities for Gravel Road.....	13-14
13.6.3 Inspection Items for Existing Bridges	13-15
13.6.4 Routine Maintenance Requirements for Crossing Structures.....	13-15
13.6.5 Periodic Maintenance Requirements for Crossing Structures.....	13-16
13.6.6 Maintenance Unit Cost after Improvement	13-16
13.7.1 Normal Traffic by Section 2001	13-17
13.7.2 Normal Traffic by Section 2008	13-18
13.7.3 Diverting and Generated Through Traffic 2008	13-19
13.7.4 Traffic Forecast Route 18A	13-20
13.7.5 Project Cost Estimates	13-20
13.7.6 Project Disbursement Schedule	13-21
13.7.7 Economic Analysis Results	13-22
13.7.8 Economic Analysis Eastern Section	13-23
13.7.9 Economic Analysis Western Section	13-23
13.7.10 Economic Analysis Whole Route	13-24
13.7.11 Sensitivity to Construction Cost	13-24
13.7.12 Improving Short Sections	13-25
13.7.13 Improvement Staging	13-26