

REPUBLIC OF THE PHILIPPINES
MINISTRY OF PUBLIC WORKS & HIGHWAYS

**THE FEASIBILITY STUDY
OF
PHILIPPINE ROAD DISASTER PREVENTION PROJECT**

FINAL REPORT

TEXT

(VOLUME II)

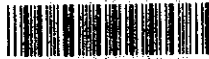
JUNE, 1984

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国際協力事業団

受入 月日 85. 6. 10	118
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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a feasibility study on the Philippine Road Disaster Prevention Project and entrusted the study to the Japan International Cooperation Agency (JICA).

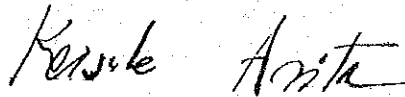
The JICA sent to the Philippines a study team headed by Mr. Masahiko Thoi, from May 1983 to March 1984 under the guidance of the Supervisory Committee chaired by Mr. Kazuhiro Matsuno, Chief of Road and City Planning Division, Hokkaido Development Agency.

The Team had discussions with the officials concerned of the Government of the Philippines and conducted a field survey in the Philippines. After the field survey, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the team.

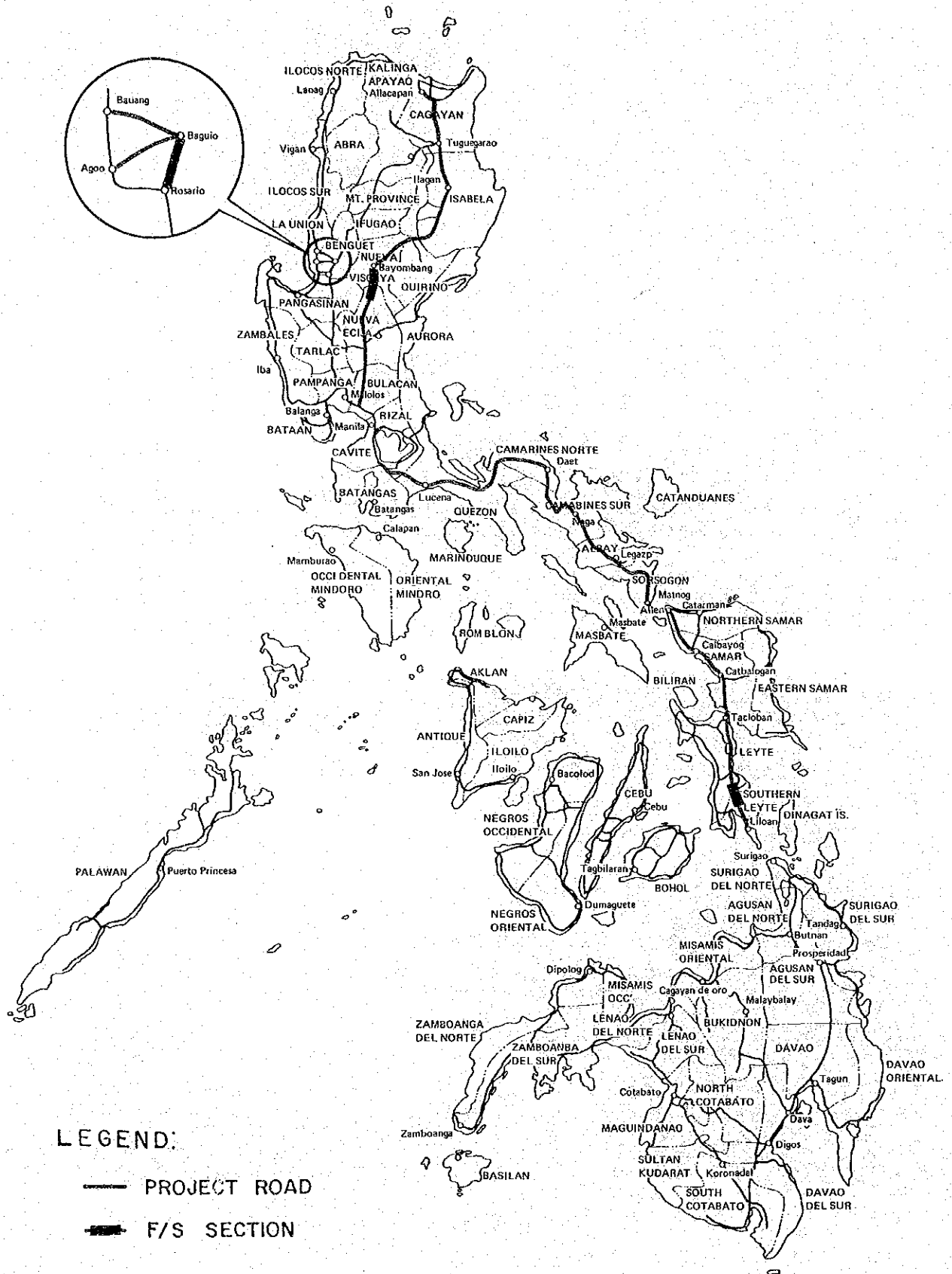
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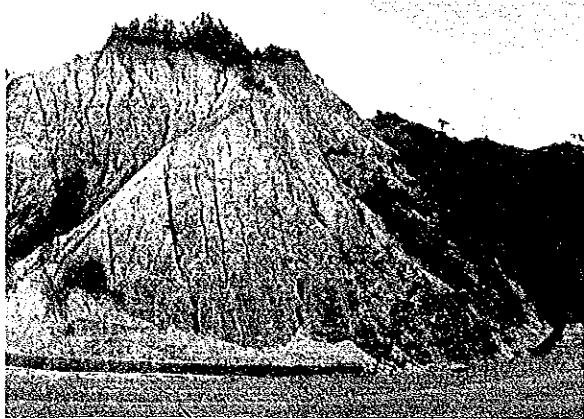


Keisuke Arita
President

Japan International Cooperation Agency

LOCATION MAP





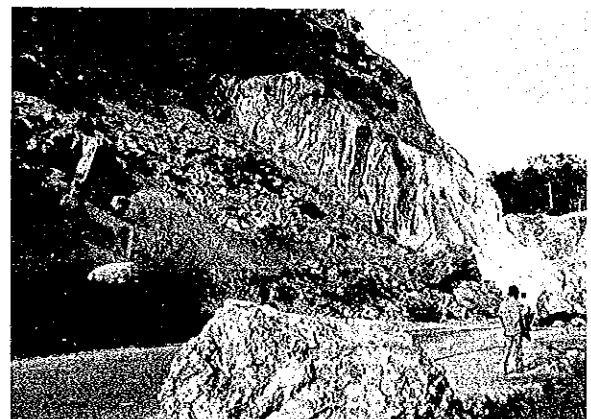
**CUT SLOPE
SURFACE FAILURE
(EROSION)
C-S.F (E)** **MAHARLIKA HIGHWAY,
NORTH LUZON
km 215 + 600**



**CUT SLOPE
DEEP FAILURE
(SCOURING)
S-D.F (S)** **MAHARLIKA HIGHWAY,
LEYTE
km 1019 + 690**



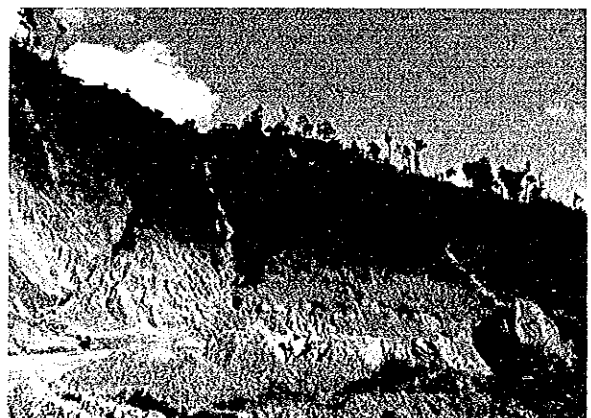
**CUT SLOPE
SURFACE FAILURE
(WEATHERING)
C-S.F (W)** **KENNON ROAD
km 237 + 800**



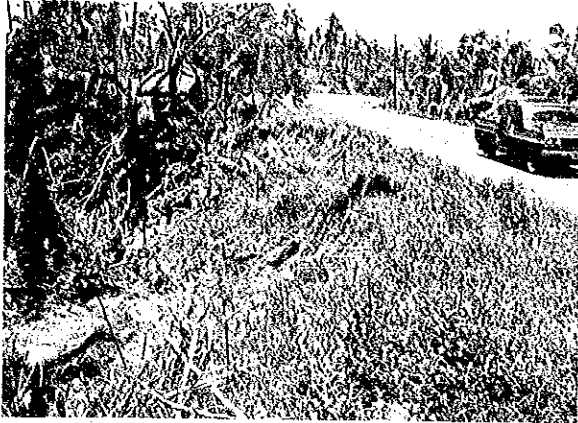
**CUT SLOPE
DEEP FAILURE
(ROTATIONAL)
C-D.F (R)** **MAHARLIKA HIGHWAY,
SOUTH LUZON
km 158 + 500**



**CUT SLOPE
SURFACE FAILURE
(STRUCTURAL WEAKNESS)
C-S.F (S)** **AGOO-BAGUIO ROAD
km 272 + 600**

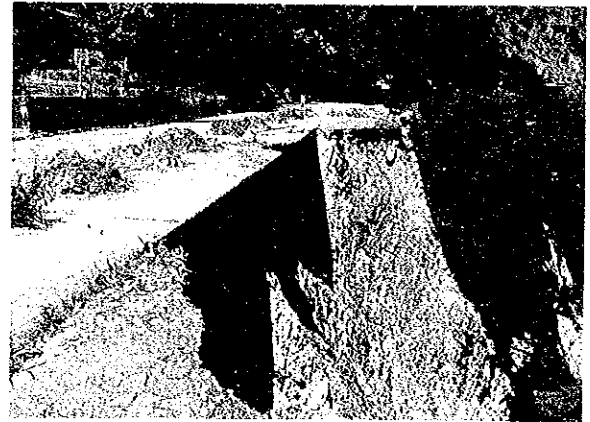


**CUT SLOPE
DEEP FAILURE
(TRANSLATIONAL)
C-D.F (T)** **MAHARLIKA HIGHWAY,
LEYTE
km 1009 + 600**



EMBANKMENT SLOPE
SURFACE FAILURE
(EROSION)
E-S.F (E)

MAHARLIKA HIGHWAY,
SOUTH LUZON
km 406 + 490



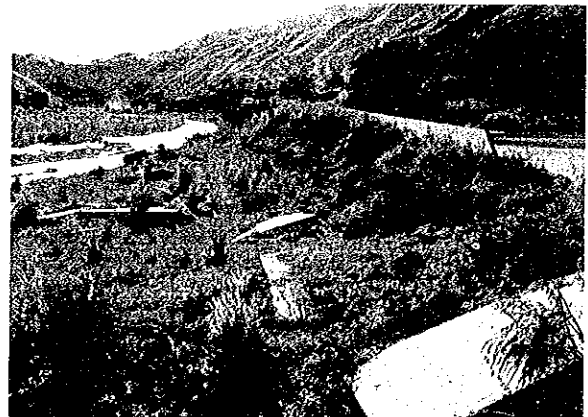
EMBANKMENT SLOPE
DEEP FAILURE
(SATURATION)
E-D.F (P)

KENNON ROAD
km 227 + 750



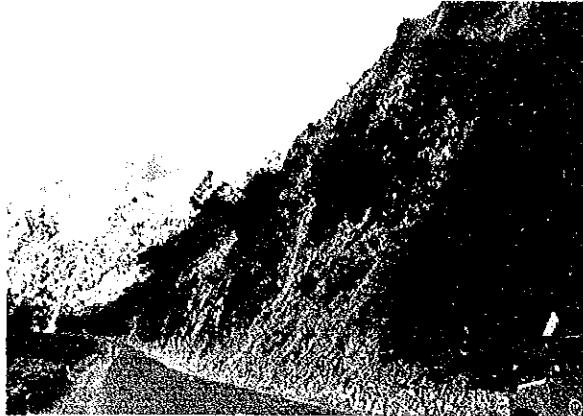
EMBANKMENT SLOPE
DEEP FAILURE
(SCOURING BY
SURFACE WATER)
E-D.F (S)

MAHARLIKA HIGHWAY,
LEYTE
km 1009 + 700



EMBANKMENT SLOPE
DEEP FAILURE
(SCOURING BY RIVER)
E-D.F (S)

MAHARLIKA HIGHWAY,
NORTH LUZON
km 225 + 700



FALLS
ROCK FALL
C-F (R)

KENNON ROAD
km 235 + 800



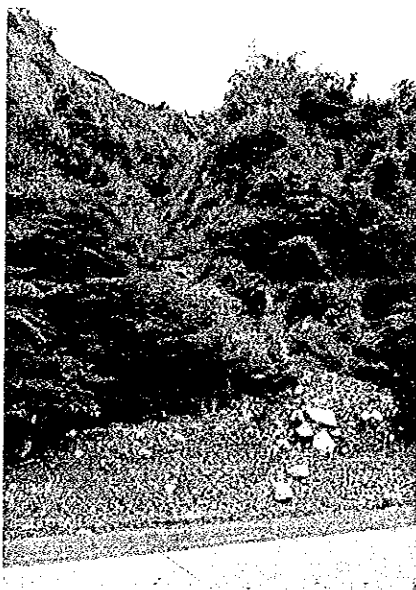
FALLS
DEBRIS FALL
C-F (D)

AGOO-BAGUIO ROAD
km 277 + 600



LANDSLIDE
SOIL LANDSLIDE
L.S (S)

MAHARLIKA HIGHWAY,
LEYTE
km 1021 + 100



DEBRIS FLOW
DEBRIS FLOW
D.F (D)

MAHARLIKA HIGHWAY,
NORTH LUZON
km 173 + 450



DEBRIS FLOW
MUD FLOW
D.F (M)

MAHARLIKA HIGHWAY,
NORTH LUZON
km 188 + 200

TABLE OF CONTENTS

SUMMARY AND RECOMENDATIONS

PART A		INTRODUCTION	Page
CHAPTER 1		INTRODUCTION	1
1.1		BACKGROUND	1
1.2		OBJECTIVES	1
1.3		SCOPE OF WORK	2
1.3.1		Project Roads	2
1.3.2		Road Disasters Subject to the Study	2
1.4		EXECUTION OF THE STUDY	2
1.4.1		Organization of the Study	2
1.4.2		Study Approach	4
1.5		REPORTS	4
PART B		SELECTION OF FEASIBILITY SECTIONS	
CAPTER 2		SIGNIFICANCE OF PROJECT ROADS	7
2.1		DEPENDENCE OF ROAD TRANSPORT	7
2.2		TRUNK ROAD NETWORK	8
2.2.1		Development Level	8
2.2.2		Trunk Road Network	8
2.3		MAHARLICA HIGHWAY	12
2.3.1		General Description	12
2.3.2		Significance	12
2.4		PROJECT ROADS LEADING TO BAGUIO	14
2.4.1		General Description of Baguio City	14
2.4.2		General Description of the Project Roads Leading to Baguio	14
2.4.3		Functions of the Three Roads	15
2.5		IMPORTANCE OF DISASTER CONTROL	16

	Page
CHAPTER 3 PROFILE OF STUDY AREA	19
3.1 NATURE	19
3.1.1 Topography and Geology	19
3.1.2 Climate	23
3.2 POPULATION	25
3.2.1 National and Regional Demographic Trend	25
3.2.2 Population Distribution	25
3.3 ECONOMY	29
3.3.1 National Economy	29
3.3.2 Regional Economy	30
CHAPTER 4 ROAD FACILITIES AND TRAFFIC CHARACTERISTICS	33
4.1 TRAFFIC FACILITIES	33
4.1.1 Road Traffic Facilities	33
4.1.2 Other Traffic Facilities	34
4.2 TRAFFIC CHARACTERISTICS	36
4.2.1 Traffic Data	36
4.2.2 Traffic Characteristics	40
4.3 ROAD NETWORK ISSUES	52
CHAPTER 5 ROAD DISASTER	55
5.1 IDENTIFICATION PROCEDURE	55
5.2 CLASSIFICATION OF ROAD DISASTERS	55
5.2.1 Cut Slope Failures (including natural slopes)	56
5.2.2 Embankment Slope Failures (including natural slopes)	56
5.2.3 Falls	62
5.2.4 Landslides	62
5.2.5 Debris Flows	63
5.2.6 Others	63
5.3 IDENTIFICATION AND EVALUATION OF SPOTS	63
5.3.1 Identification of Spots with Disaster Potential	63
5.3.2 Evaluation of Disaster Potential	66
5.3.3 Distribution of Spots with Disaster Potential	68
5.4 CAUSES OF ROAD DISASTER	68

	Page
5.5	ROAD DISASTER AND RAINFALL 72
5.6	CURRENT RESTORATION OF DISASTER 75
5.6.1	Procedure to Restore Disasters 75
5.6.2	Current Restoration Work 76
5.6.3	Fund for Restoration Work 77
5.6.4	Problems on Disaster Restoration 77
CHAPTER 6	SELECTION OF FEASIBILITY STUDY SECTIONS .. 79
6.1	APPROACH OF SELECTION OF F/S SECTIONS 79
6.1.1	Procedure 79
6.2	ESTABLISHMENT OF SECTIONS 81
6.3	EVALUATION OF DISASTER POTENTIAL OF SECTION . 86
6.3.1	Evaluation of Disaster Potential of Spot 86
6.3.2	Evaluation of Disaster Potential of Section 86
6.4	EVALUATION OF IMPORTANCE OF ROAD SECTIONS .. 90
6.4.1	Methodology 90
6.4.2	Assessment by Factor 90
6.4.3	Overall Evaluation 92
6.5	PRIORITY OF SECTIONS AND SELECTION OF SECTIONS FOR FEASIBILITY STUDY 95
6.5.1	Ranking of Section Based on Disaster Potential and Importance 95
6.5.2	Selection of Sections for Feasibility Study 95

PART C

FEASIBILITY STUDY OF SELECTED SECTIONS

CHAPTER 7	A PROFILE OF EACH FEASIBILITY STUDY SECTION 99
7.1	DALTON PASS SECTION 99
7.1.1	Role 99
7.1.2	Socio-Economic Features 99
7.1.3	Traffic 101
7.2	MAHAPLAG-SOGOD SECTION 109
7.2.1	Role 109
7.2.2	Socio-Economic Features 109
7.2.3	Traffic 111
7.3	KENNON ROAD 117

	Page
7.3.1	Role 117
7.3.2	Socio-Economic Features 117
7.3.3	Traffic 118
CHAPTER 8	EXISTING CONDITION OF ROAD DISASTER 127
8.1	DALTON PASS SECTION 127
8.2	MAHAPLAG-SOGOD SECTION 130
8.3	KENNON ROAD 132
CHAPTER 9	TRAFFIC DEMAND FORECAST 135
9.1	PLANNING FRAMEWORK 135
9.1.1	Development Policies and Strategies 135
9.1.2	Economic Framework 137
9.1.3	Population Forecast 140
9.1.4	Other Major Indices 140
9.2	TRAFFIC FORECAST 142
9.2.1	Methodology 142
9.2.2	Future Traffic Volume 150
CHAPTER 10	PRELIMINARY DESIGN 159
10.1	DESIGN POLICY 159
10.1.1	Spots Subject to Design 159
10.1.2	Level and Scope of Improvement 159
10.1.3	Basic Policy in Countermeasures Selection 161
10.2	LAND AND GEO-TECHNICAL SURVEYS 164
10.2.1	Land Survey 164
10.2.2	Geo-Technical Survey 165
10.3	SELECTION OF COUNTERMEASURES 168
10.3.1	General 168
10.3.2	Cut Slope Failure 168
10.3.3	Embankment Slope Failure 173
10.3.4	Fall 174
10.3.5	Landslide 174
10.3.6	Debris Flow 175
10.4	PRELIMINARY DESIGN 185

	Page
10.4.1	Surface Drainage 185
10.4.2	Subsurface Drainage 186
10.4.3	Removal Work for Cut Slope Failure and Fall 187
10.4.4	Re-cutting 187
10.4.5	Seed Mud Spraying 188
10.4.6	Concrete Spraying 189
10.4.7	Stone Pitching Revetment and Foot Protection 190
10.4.8	Crib 190
10.4.9	Retaining Wall 191
10.4.10	Anchoring 193
10.4.11	Re-filling 193
10.4.12	Catch Fence 195
10.4.13	Anchor Wire Net 195
10.4.14	Earth Removal for Landslide 196
10.4.15	Counterweight Fill for Landslide 198
10.4.16	Piling 198
10.4.17	Water Way and Sabo Dam 198
10.4.18	Other Designs 199
10.5	APPLIED COUNTERMEASURE 200
CHAPTER 11	PROJECT COST 203
11.1	GENERAL 203
11.2	CONSTRUCTION COST 203
11.3	DETAILED ENGINEERING AND CONSTRUCTION SUPERVISION COST 207
11.4	LAND ACQUISITION COST 207
11.5	PROJECT COST 207
CHAPTER 12	PROJECT EVALUATION 211
12.1	ECONOMIC EVALUATION 211
12.1.1	Outline 211
12.1.2	Prediction of Disaster 214
12.1.3	Traffic Benefit 228
12.1.4	Savings in Restoration Cost 231
12.1.5	Economic Evaluation of F/S Sections 236

	Page
12.2	FINANCIAL EVALUATION 241
12.2.1	Expenditures on Road Development 241
12.2.2	Possible Amount of Budget Allocations to One Project 242
12.2.3	Financial Evaluation 243
12.3	PROJECT IMPACTS 244
12.3.1	Dalton Pass Section 244
12.3.2	Mahaplag-Sogod Section 245
12.3.3	Kennon Road 246
12.4	OVERALL EVALUATION 249
CHAPTER 13	PROJECT IMPLEMENTATION 251
13.1	IMPLEMENTATION SCHEDULE 251
13.2	PREPARATION OF PROJECT FUNDS 251
13.3	DETAILED ENGINEERING STUDY 252
13.4	CONSTRUCTION 252
13.5	SUMMARY 252
CHAPTER 14	PROPOSITION BASED ON FINDINGS 255

LIST OF TABLES

			Page
Table	2.1-1	Approximate National Model Split, 1980 (Domestic Traffic Only)	7
Table	2.2-1	Road Development (1975 – 1982)	8
Table	2.3-1	Annual Passenger Movement in Main Corridors, by Mode 1981 (X 1,000)	13
Table	2.4-1	Traffic Movement Related to Baguio City	16
Table	2.4-2	Traffic Volume by Vehicle Type	16
Table	3.2-1	Past Population Trend (1960 – 1980)	26
Table	3.2-2	Number of Inter-regional Migrants by Region and Destination, 1970 – 1975	28
Table	3.3-1	National and Regional Economic Performance 1970 – 1981	29
Table	4.1-1	National Road Length by Region : 1982	33
Table	4.2-1	Traffic Surveys Conducted	37
Table	4.2-2	AADT at Each Survey Station	39
Table	4.2-3	Existing Public Utility Vehicle Passenger and Commodity Flow	46
Table	4.2-4	Summary of Traffic on Dalton Pass, Leyte and Kennon Road	47
Table	5.2-1	Classification of Cut Slope Failure	57
Table	5.2-2	Classification of Embankment Slope Failure	59
Table	5.2-3	Classification of Fall	60
Table	5.2-4	Classification of Landslide	61
Table	5.2-5	Differential Characteristics of Slope Failure Versus Landslide	62
Table	5.2-6	Classification of Debris Flow	64
Table	5.3-1	Category of Impact to Road	67
Table	5.3-2	Summary of Disaster Spots by Types of Disaster, Disaster Potential and Region	69
Table	5.5-1	Road Disaster Occurrence and 24-Hour Rainfall	74
Table	5.6-1	Maintenance Fund	78

			Page
Table	6.2-1	Summary of Sections	82
Table	6.3-1	Evaluation of Disaster Potential of Sections	88
Table	6.4-1	Importance of Road Section	93
Table	6.5-1	Ranking of Section Based on Disaster Potential and Importance	96
Table	6.5-2	Characteristics of the First Priority Sections	98
Table	7.1-1	Population Development, Philippines and Cagayan Valley, 1960 – 1980	100
Table	7.1-2	Gross Regional Domestic Product, Employment and Labor Productivity by Sector in 1980	100
Table	7.2-1	Population Development, 1970 – 1980 Population (‘000)	110
Table	7.2-2	Inbound Manufactured Commodity and its Volume per 1,000 Persons	116
Table	7.3-1	Population Development of Baguio City Benguet Province and Region I, 1960 – 1980	118
Table	9.1-1	Regional Rankings on Intensity of Development Potentials	138
Table	9.1-2	Estimated GNP and GRDP Projections, 1983 – 2010	139
Table	9.1-3	Future Populations 1980 – 2010	141
Table	9.2-1	Transport Demand (or Goods Consumption Income Elasticity)	149
Table	9.2-2	Future Traffic Volume on Dalton Pass Section	154
Table	9.2-3	Future Traffic Volume on Mahaplag-Sogod Section of Maharlika Highway	155
Table	9.2-4	Future Traffic Volume on Kennon Road	156
Table	9.2-5	Future Traffic Growth by F/S Section	157
Table	10.1-1	Number of Designed Spots	159
Table	10.2-1	Volume of Surveys	164
Table	10.2-2	Length of Conducted Surveys	164
Table	10.2-3	Number of Designed Spots and Surveyed Spots	165
Table	10.2-4	Quantities of Geo-technical Survey Conducted for Investigation of Sliding Plane and Ground-water	166
Table	10.3-1	Countermeasures for Cut Slope Failure	169

			Page
Table	10.3-2	Countermeasures for Embankment Slope Failure	177
Table	10.3-3	Countermeasures for Fall	179
Table	10.3-4	Countermeasures for Landslide	181
Table	10.3-5	Countermeasures for Debris Flow	183
Table	10.4-1	Standard of Re-cutting	188
Table	10.4-2	Design Condition	192
Table	10.4-3	Relationship Between Thickness of Sliding Mass and Cohesion	197
Table	10.5-1	Number of Applied Countermeasures	201
Table	11.2-5	Construction Cost - October 1983 Price	203
Table	11.2-1	Schedule of Unit Cost - October 1983 Price	204
Table	11.2-2	Hourly/Daily Cost of Construction Equipment - October 1983 Price	205
Table	11.2-3	Cost of Main Materials - October 1983 Price	206
Table	11.2-4	Labor Cost-October 1983 Price	206
Table	11.5-1	Summary of Project Cost - October 1983 Price	207
Table	11.5-2	Project Cost - October 1983 Price	208
Table	11.5-3	Project Cost - Current Price	209
Table	12.1-1	Basic Vehicle Operating Costs by Vehicle Type	214
Table	12.1-2	Duration of Road Closure at Dalton Pass Section	221
Table	12.1-3	Duration of Road Closure at Mahaplag-Sogod Section	223
Table	12.1-4	Duration of Road Closure at Kennon Road	224
Table	12.1-5	Classification of Typhoons and Estimated Duration of Road Closure at Kennon Road	226
Table	12.1-6	Detour Duration/Trip Length	230
Table	12.1-7	Past and Estimated Future Restoration Cost	236
Table	12.1-8	Economic Evaluation	237
Table	12.1-9	Economic Cost - Benefit Streams of Dalton Pass Section	238
Table	12.1-10	Economic Cost - Benefit Streams of Mahaplag-Sogod Section, Leyte	239
Table	12.1-11	Economic Cost - Benefit Streams of Kennon Road	240
Table	12.2-1	MPWH Expenditures (Highway Portion) - Current Price	241

			Page
Table	12.2-2	MPWH Medium Term Infrastructure Program Current Price	242
Table	12.2-3	Budget Allocation to Local Portion of Foreign Assisted Project in 1983	242
Table	12.2-4	Possible Amount of Budget Allocation (Local Portion) - Current Price	243
Table	13.2-1	Total Fund Requirement	251
Table	13.2-2	Annual Fund Requirement	252

LIST OF FIGURES

			Page
Figure	1.4-1	Organization Diagram	3
Figure	1.4-2	Study Flow Diagram	5
Figure	2.2-1 (1)	Major Trunk Road Network (Central and Northern Luzon)	9
Figure	2.2-1 (2)	Major Trunk Road Network (Southern Luzon)	10
Figure	2.2-1 (3)	Major Trunk Road Network (Samar and Leyte)	11
Figure	2.4-1	Service Sphere of Project Roads Leading to Baguio	17
Figure	3.1-1	Topography, Geology and Climate of Study Area	20
Figure	3.2-1	1980 Population Density by Province	27
Figure	3.3-1	Trend of GNP and GRDP at Current 1972 Prices	30
Figure	3.3-2	Regional Distribution by Industrial Sector, 1981	31
Figure	4.1-1	Other Transport Facilities	35
Figure	4.2-1	Traffic Survey Stations/Routes	38
Figure	4.2-2	Road Network and Traffic Volume in 1980	41
Figure	4.2-3 (1)	Surplus/Deficit by Commodity Type in 1980	44
Figure	4.2-3 (2)	Surplus/Deficit by Commodity Type in 1980	45
Figure	4.2-4	Expansion of Affected Area of Each Survey Station	49
Figure	4.2-5	Functional Characteristics of Each Section	51
Figure	4.3-1	Schematic Trunk Road Network	53
Figure	6.1-1	Procedure to Select F/S Sections	80
Figure	6.2-1 (1)	Road Sections (Central and Northern Luzon)	83
Figure	6.2-1 (2)	Road Sections (Southern Luzon)	84
Figure	6.2-1 (3)	Road Sections (Samar and Leyte)	85
Figure	6.3-1 (1)	Disaster Spot Density of Section	87
Figure	6.3-1 (2)	Width of Spots with a and b Disaster Potential	87
Figure	6.3-2	Evaluation of Disaster Potential of Section	89
Figure	6.4-1	Study on Socio-Economic Aspect: Importance of Road Section on Subject Roads	91
Figure	6.4-2	Importance of Road Section	94

			Page
Figure	7.1-1	Origin and Destination of Total Traffic Through Dalton Pass Section of Maharlika Highway	103
Figure	7.1-2	Origin and Destination of Total Commodity Through Dalton Pass Section and Maharlika Highway	104
Figure	7.1-3	Modal Share by Section	105
Figure	7.1-4	Purpose Composition of Passengers at Dalton Pass Section	105
Figure	7.1-5	Composition of Commodity at Dalton Pass Section	107
Figure	7.1-6	Truck Traffic by Type at Dalton Pass Section	107
Figure	7.1-7	Commodity Flow in Dalton Pass Section	108
Figure	7.2-1	Origin and Destination of Total Traffic Through Mahaplag-Sogod Section of Maharlika Highway in Leyte	112
Figure	7.2-2	Origin and Destination of Total Commodity Through Mahaplag-Sogod Section of Maharlika Highway in Leyte	113
Figure	7.2-3	Purpose Composition of Passengers at Mahaplag-Sogod Section (Leyte)	114
Figure	7.2-4	Commodity Flow in Mahaplag-Sogod Section in Leyte	115
Figure	7.2-5	Truck Traffic by Type at Mahaplag-Sogod Section (Leyte)	117
Figure	7.3-1	Origin and Destination of Total Traffic Through Kennon Road	120
Figure	7.3-2	Origin and Destination of Total Traffic Through Kennon Road	121
Figure	7.3-3	Daily Fluctuation of Traffic in Kennon Road	122
Figure	7.3-4	Purpose Composition of Passengers at Kennon Road Section	122
Figure	7.3-5	Composition of Commodity at Kennon Road Section	124
Figure	7.3-6	Truck Traffic by Type at Kennon Road Section	124
Figure	7.3-7	Commodity Flow in Kennon Road Section	125
Figure	8.1-1	Location of Disaster Spots in Dalton Pass Section	128
Figure	8.2-1	Location of Disaster Spots in Mahaplag-Sogod Section and in Kennon Road	131
Figure	9.1-1	Process of Future Planning Framework	136
Figure	9.2-1	Work Procedure of Future Traffic Estimates	143
Figure	9.2-2	Procedure of Future Traffic Forecast	144

			Page
Figure	9.2-3	Factors to Forecast Future Commodity Volume in Dalton Pass Section	146
Figure	9.2-4	Factors to Forecast Future Commodity Volume in Mahaplag-Sogod Section (Leyte)	147
Figure	9.2-5	Factors to Forecast Future Commodity Volume in Kennon Road	148
Figure	9.2-6	Commodity Expenditure - Income Elasticity	150
Figure	9.2-7	Future Traffic/Commodity Volume	153
Figure	9.2-8	Modal Share by Section	158
Figure	9.2-9	Functional Characteristics of Each F/S Section	158
Figure	10.4-1	Closed Conduit	186
Figure	10.4-2	Horizontal Drain Hole	187
Figure	10.4-3	Seed Mud Spraying	189
Figure	10.4-4	Concrete Spraying	189
Figure	10.4-5	Stone Pitching Revetment and Gabion Foot Protection	190
Figure	10.4-6	Cast - in - Place Concrete Crib	191
Figure	10.4-7	Retaining Walls	192
Figure	10.4-8	Re-filling	195
Figure	10.4-9	Catch Fence	195
Figure	10.4-10	Anchor Wire Net	196
Figure	10.4-11	Stability Calculation (Circular Rapture Plane)	197
Figure	10.4-12	Linear Equation Pertaining to C and \emptyset	197
Figure	10.4-13	Stone Pitching Water Way	199
Figure	12.1-1	Quantified Benefits of the Project	212
Figure	12.1-2	Procedure of Economic Analsvis	213
Figure	12.1-3	Procedure of Disaster Prediction	216
Figure	12.1-4	Number of Typhoon Attacks	218
Figure	12.1-5	Assumption on Detour and Stocks in Dalton Pass Section	229
Figure	12.1-6	Detour Movement of Truck Trips in Dalton Pass Section	229
Figure	12.3-1	Expansion of Influence Area by F/S Section	248
Figure	13.5-1	Implementation Schedule	253

SUMMARY AND RECOMMENDATIONS

	Page
I INTRODUCTION	S-1
II CONCLUSIONS AND RECOMMENDATIONS	S-3
III SUMMARY	S-9
1. IDENTIFICATION OF PRIORITY SECTIONS	S-9
1.1 The Project Roads	S-9
1.2 Identification of Road Disaster	S-12
1.3 Description of Identified Disaster Spots	S-15
1.4 Records of Road Disaster and Restoration Work	S-17
1.5 Selection of Feasibility Study Sections	S-18
2. FEASIBILITY STUDY OF SELECTED SECTIONS	S-20
2.1 Role of Selected Sections	S-20
2.2 Future Traffic	S-22
2.3 Existing Condition of Road Disaster	S-24
2.4 Recommended Countermeasures	S-26
2.5 Project Cost	S-30
2.6 Project Evaluation	S-31
2.7 Project Implementation	S-37
3. GENERAL REVIEW OF DISASTER PREVENTION MEASURES	S-38
IV PROPOSITION BASED ON FINDINGS	S-39

I INTRODUCTION

1. BACKGROUND

The development of the highway network in the Philippines is one of the major programs being implemented by the government in support of the overall socio-economic development goals of the country. Major road improvement and construction activities began in early 1970 and has been pursued continuously since then. At present, the main roads system would now seem adequate in terms of location and extent. Despite the achievements made, however, some of the most important roads suffer many deficiencies including, among others, disasters due to slope failures, fall, landslide, debris flow, and the like, which impairs the efficiency of the road transport system and, if not corrected, will appreciably set back the economic gains already achieved.

Cognizant with the problems attached to road disaster which has recently become increasingly alarming, the Government of the Philippines (GOP) envisaged a road disaster prevention program for which the Japan International Cooperation Agency (JICA) has generously provided technical assistance, thru a request from the GOP, in the formulation of the same under the Feasibility Study of the Philippine Road Prevention Project, hereinafter called the Study.

The implementing agreement for the said technical assistance was signed in February 1983 between the JICA and the GOP represented by the Ministry of Public Works and Highways (MPWH) as the implementing agency. The Study started in May 1983 and was completed in June 1984.

2. OBJECTIVE OF THE STUDY

The objectives of the study are:

- 1) To identify the sections with high incidence of disasters or those with such possibilities along the project roads.
- 2) To prepare a program for implementation of the recommended counter measures along the selected sections.
- 3) To develop techniques of road disaster prevention.

3. PROJECT ROADS

- 1) Maharlika Highway (Luzon and Samar-Leyte Sections only)
- 2) Kennon Road
- 3) Naguilan Road
- 4) Marcos Highway (Agoo-Baguio City Road)

4. SCOPE OF THE STUDY

Road disaster dealt with were generally cut slope failure, embankment slope failure, fall, landslide and debris flow. The scope of the Study was, however, limited where the disasters are considered of reasonable size from the viewpoint of a road project. Thus, large scale riparian and Sabo works were excluded.

The Study was conducted in the following phases:

Press – 1 : Identification of priority Section for Feasibility Study
Press – 2 : Feasibility Study
Technical Review : General review on disaster prevention measures

5. REPORTS

The following reports were prepared during the Study.

INCEPTION REPORT
PROGRESS REPORT (I) (Phase – 1)
PROGRESS REPORT (II) (Phase – 2)
DRAFT FINAL REPORT

The DRAFT FINAL REPORT is presented in five volumes:

VOLUME I : EXECUTIVE SUMMARY
VOLUME II : TEXT
VOLUME III : APPENDIX
VOLUME IV : DRAWINGS
VOLUME V : AN APPROACH ON ROAD DISASTER PREVENTION

The FINAL REPORT has been modified from the draft final report in accordance with the GOP's comments.

The Study was carried out jointly by a team composed of eight JICA experts and a group of GOP counterparts and support staff. Technical guidance in the conduct of the Study was provided thru periodic review by the Steering Committee of the Philippines and the Supervisory Committee of Japan, both were especially created to oversee the overall implementation of the Study.

II CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION

1. IMPORTANCE OF ROSD DISASTER PREVENTION

- 1.1 Road disaster prevention in the Philippines must be carried out in a stern environment. In most parts of the country, the topography is mountainous with rugged terrain. The geology is generally of a fragile structure of the Tertiary period that has been fractured due to the presence of numerous tectonic lines, the most severe representative of which is the Philippine Fault. Furthermore, the geographical location of the country lies in the South Pacific typhoon belt where typhoon-bearing heavy rains hit nine times or more each year on the average.
- 1.2 The overall transport system of the country is highly dependent upon road transport which is at present catering for 97% of intra-island passenger and commodity transport demand. However, the efficiency of the system particularly in the role of the trunk roads is interfered due to road disasters, among others, causing substantial detrimental impacts upon the economic and social activities of the nation.
- 1.3 The trunk road network in the Philippines has been gradually developed in recent years. In terms of providing the basic access requirement to the areas served, the network may be considered adequate. However, in view of the increasing transport demand, the network still needs to be complemented with logical alternative routes to function in cases of emergency or closure of the main road due to disaster, but areas still remain where no alternative route is available in an emergency situation.
- 1.4 The existing trunk roads as developed have not been provided, if at all, significant protection against disaster, where these are required. Due to the susceptibility of the roads to disasters and in view of said stern natural environment of the country, even the Maharlika Highway which is considered the most important trunk road has often been closed in many sections due to disasters and which have impaired the efficiency of the system during these periods.
- 1.5 The present restoration work of road damage caused by disasters is no more than a stopgap measure. If potential disaster spots are left alone without drastic and complete disaster prevention measures, the scope of potential disaster will be greater and some road sections are liable to be completely destroyed beyond economic restoration measures before long.
- 1.6 Measures to prevent disaster damage on trunk roads are, therefore, of a vital and urgent issue in view of the above.

2. ROAD SECTIONS SUBJECT TO FEASIBILITY STUDY

The project roads included in the Study were divided into 24 road sections which were ranked into three priority categories, in accordance with the extent of potential disaster and road section importance, as shown in Table-A. After the comprehensive assessment of road sections included under the first priority category, the following three road sections have been selected for feasibility study.

- Aritao-San Jose Section (Dalton Pass Section)
- Mahaplag-Sogod Section (Leyte)
- Kennon Road

TABLE-A RANKING OF SECTIONS

Location	Factor for Evaluation		Rating	Ranking
	Disaster Potential	Importance		
Aritao – San Jose (Dalton Pass)	A	B	A	First Priority Sections
Kennon Road	A	B	A	
Agoo – Baguio	A	C	A	
Mahaplag – Sogod (Leyte)	A	C	A	
Allen – Calbayog (Samar)	A	C	A	
Lucena – Calauag (Region IV)	B	A	A	
Santiago – Bagabag (Region II)	B	B	B	Second Priority Sections
Naguilian Road	B	B	B	
Calauag – Daet (Region V)	B	B	B	
Bagabag – Aritao (Region II)	B	B	B	
Sogod – Liloan (Leyte)	B	C	B	
Calbayog – Catbalogan (Samar)	B	C	B	
San Jose – Sta. Rosa (Region III)	C	A	B	
Calamba – Lucena (Region V)	C	A	B	
Daet – Naga (Region V)	C	B	C	Third Priority Sections
Daraga – Sorsogon (Region V)	C	C	C	
Catbalogan – Tacloban (Samar)	C	C	C	
Sorsogon – Matnog (Region V)	C	C	C	
Allacapan – Tuguegarao (Region II)	C	C	C	
Tuguegarao – Naguilian (Region II)	C	C	C	
Naguilian – Santiago (Region II)	C	C	C	
Sta. Rosa – Sta. Riza (Region III)	C	A	C	
Naga – Daraga (Region V)	C	A	C	
Tacloban – Mahaplag (Leyte)	C	C	C	

3. FINDING OF THE FEASIBILITY STUDY

3.1 PROJECT EVALUATION

The evaluation carried out for the three road sections have proven that the projects are technically, economically and financially feasible.

The feasibility assessment result is summarized in Table-B.

TABLE-B PROJECT EVALUATION

	Technical Evaluation	Economic Evaluation	Financial Evaluation
Dalton Pass Section	<ul style="list-style-type: none"> • 73 spots with high disaster potential. • Suffered destructive road damages twice in 7 years. • Month-long traffic interruptions almost every 4 years. • Immediate restoration works required in many spots. • Practically no detour road. 	<ul style="list-style-type: none"> • IRR = 18.7% • Provides the only access to the Cagayan Valley Region. • Socio-economic activities and development of the Cagayan Valley Region depended upon. 	<ul style="list-style-type: none"> • 5-year implementation period assumed (1985 – 1990). • 3-year construction period (1987 – 1990) • Maximum annual financial requirement: P220 Million • Maximum annual financial requirement of local portion estimated at P79 million is within the Government's funding capability. • Foreign funds for foreign cost components will be required.
Mahaplag-Sogod Section	<ul style="list-style-type: none"> • 40 spots with high disaster potential. • Extent of disaster will increase year by year. • Would be totally destroyed in future, unless measures are taken. • Months-long traffic interruption almost every year. • No reliable detour road. 	<ul style="list-style-type: none"> • IRR = 14.4% • Efficient operation of ferry service between Leyte and Mindanao relied on. • Enhance socio-economic development of Southern Leyte. 	
Kennon Road	<ul style="list-style-type: none"> • 46 spots with high disaster potential. • Highly dangerous to traffic due to narrow roadway and shoulders. • Weeks-long traffic interruptions almost every year. • No reliable detour road. 	<ul style="list-style-type: none"> • IRR = 16.6%. • Provides shortest access from Metro Manila to Baguio City. • Vitally supports the development of tourism industry and vegetable production in Baguio City and adjacent provinces. 	

3.2 PROJECT COST

The total estimated project cost to implement the three sections is approximately P367.85 Million. The details are shown in Table-C.

TABLE-C PROJECT COST

Price : As of Oct. 1983
Unit : Million Pesos

	Detailed Engineering	Suoversion and Construction				Total
		Daiton Pass Section	Mahaplag-Sogod Section	Kennon Road	Sub Total	
Foreign	14.67	101.14	53.06	56.78	210.98	225.65
Local/Tax	7.91	67.30	33.82	33.17	134.29	142.20
Total	22.58	168.44	86.88	89.95	345.27	367.85

RECOMMENDATIONS

1. PROMOTION OF ROAD DISASTER PREVENTION PROJECT

- 1.1 Roads play a particularly important role in the Philippines' transport system in enhancing the overall socio-economic development objectives of the country thru the formation of well balanced and self reliant regional communities. Of all the truck roads, the importance of the Maharlika Highway and the Kennon road, which constitute in providing basic traffic access, will further increase along with the future economic and social development in the Philippines.
- 1.2 Road disaster prevention projects will secure the functions of these important roads by improving their reliability to the users. Such projects will result in the ensurance against road closures with reasonable investment, while realizing the maximum effect of the huge amount of road development funds that have already been invested. In this view, it is highly recommended that the road disaster prevention projects should be positively considered and actively implemented.
- 1.3 The Study has been carried out based mainly on Japanese experience with some time constraints and limited area coverage of the national trunk road network where potential disaster spots have been identified. Countermeasures were investigated on the same basis and were recommended, where appropriate. In view of the fact that the natural conditions in the Philippines are generally more stern than that in Japan, it is recommended that a disaster prevention system and technology be developed, using the experience and findings of the Study as a basis in achieving (1) compilation and accumulation of systematic disaster records, (2) the identification of potential disaster spots and the assessment of potential disaster intensity, (3) the formulation of guidelines for periodic monitoring of road disaster areas, and (4) the development of countermeasures using locally available materials.

2. IMPLEMENTATION OF THREE ROAD SECTIONS

2.1 EARLY IMPLEMENTATION

It is recommended that disaster prevention projects be implemented as soon possible on the three road sections subjected to Feasibility Study. Any delay in the project implementation will just increase the disaster potential and will compound the seriousness of the existing condition which inevitably may result in more expensive restoration works and longer traffic shutdown, thereby, further incurring greater costs to the economy.

2.2 IMPLEMENTATION SCHEDULE AND INVESTMENT PROGRAM

Assuming the simultaneous implementation of projects on the three road sections, recommended project implementation schedule and annual financial investment program are as shown in Table-D. Also presented is the foreign exchange component portion which has been assumed to be financed with external assistance from a foreign country or an international financial institution.

TABLE-D IMPLEMENTATION SCHEDULE

		1984	1985	1986	1987	1988	1989	1990
Feasibility Study (This Study)		■						
Financing Arrangement for Implementation		■	■					
Detailed Engineering Study (15 months)			■	■				
Tender (6 months)					■			
Construction (36 months)					■	■	■	■
Construction Supervision (36 months)					■	■	■	■
Financial Requirement — October 1983 Price — Unit: Million Pesos	Foreign Component	—	1.47 (1.70)	13.20 (16.09)	10.55 (13.69)	73.85 (101.18)	84.39 (122.61)	42.19 (64.92)
	Local and Tax Component	—	0.79 (1.06)	7.12 (10.52)	6.72 (10.59)	47.00 (79.54)	53.71 (97.25)	26.86 (52.04)
	TOTAL	—	2.26 (2.76)	20.32 (26.61)	17.27 (24.28)	120.85 (180.72)	138.10 (219.86)	69.05 (116.96)

Note : Figure in () shows financial requirement in current price.

III SUMMARY

1. IDENTIFICATION OF PRIORITY SECTIONS

1.1 THE PROJECT ROADS

Maharlika Highway

The Maharlika Highway is undoubtedly the most important trunk line in the country's highway network linking the four major islands of Luzon, Samar, Layte and Mindanao. This artery extends as long as 2100 km starting from the province of Cagayan (Luzon) and ends in the City of Davao in the island of Mindanao. The Study, however covered only the Cagayan-Leyte Section, approximately 1,530 kms of the whole stretch.

The Highway is generally concrete paved with 2 lanes —6.7 m wide with 2 to 2.5 m shoulders each side. It almost passes along the steep mountainous terrain in Dalton Pass, Lucena and Camarines sections where it runs parallel to the fractured zone of the main Philippine Fault, which was identified as the main cause of large-scale slope failures.

The Highway plays an important role in the overall highway transport system of the country, more inevitably in these regions where there are no alternative routes such as in Cagayan Valley, Bicol, Samar and Leyte.

Roads leading to Baguio

Baguio City is located about 300 kilometers North of Manila in a plateau with an elevation of 1500 m above sea level. Favoured by its cool climate, the city is famous as a tourist spot and regarded as the summer capital of the country. Leading to City are the Kennon, Naguilian and Agoo-Baguio Roads all branching off from Manila North Road at different points.

Kennon Road provides the nearest and shortest route to Baguio City from Manila. It has a total length of 34 km with 2 lanes asphalt pavement of 6 m wide with 0.5 to 1.0 m shoulders. The route runs alongside the Bued River in a winding alignment and stitching the steep mountainous terrain owing to the curved alignment and the sharp profile of the road. The slopes are composed of rocks such as conglomerate, andesite, deorite and the like.

Naguilian Road is the northernmost among the three access roads to Baguio City from Metro Manila. It has a total length of 47 km with poorly asphalted 2 lanes of 6 m wide and narrow shoulders. This road proceeds from the town of Bauang in rolling area for about 17 km and proceeds towards Baguio city through the steep mountainous terrain. The slopes are observed to be generally made up of sandstone, shale, tuff and the like.

Agoo-Baguio Road is located in between the two above mentioned roads having a length of 49 km with newly concreted pavement of 6.7 m in width and 2.0 to 2.5 m shoulders. About 36 km in Baguio side are generally steep mountainous sections. The slopes are mainly composed of strongly weathered mudstone, conglomerate, tuff and the like. Figure 1-1 shows present traffic volume of the Project Roads. Geology, topography and climate of the Study Area are presented in Figure 1-2.

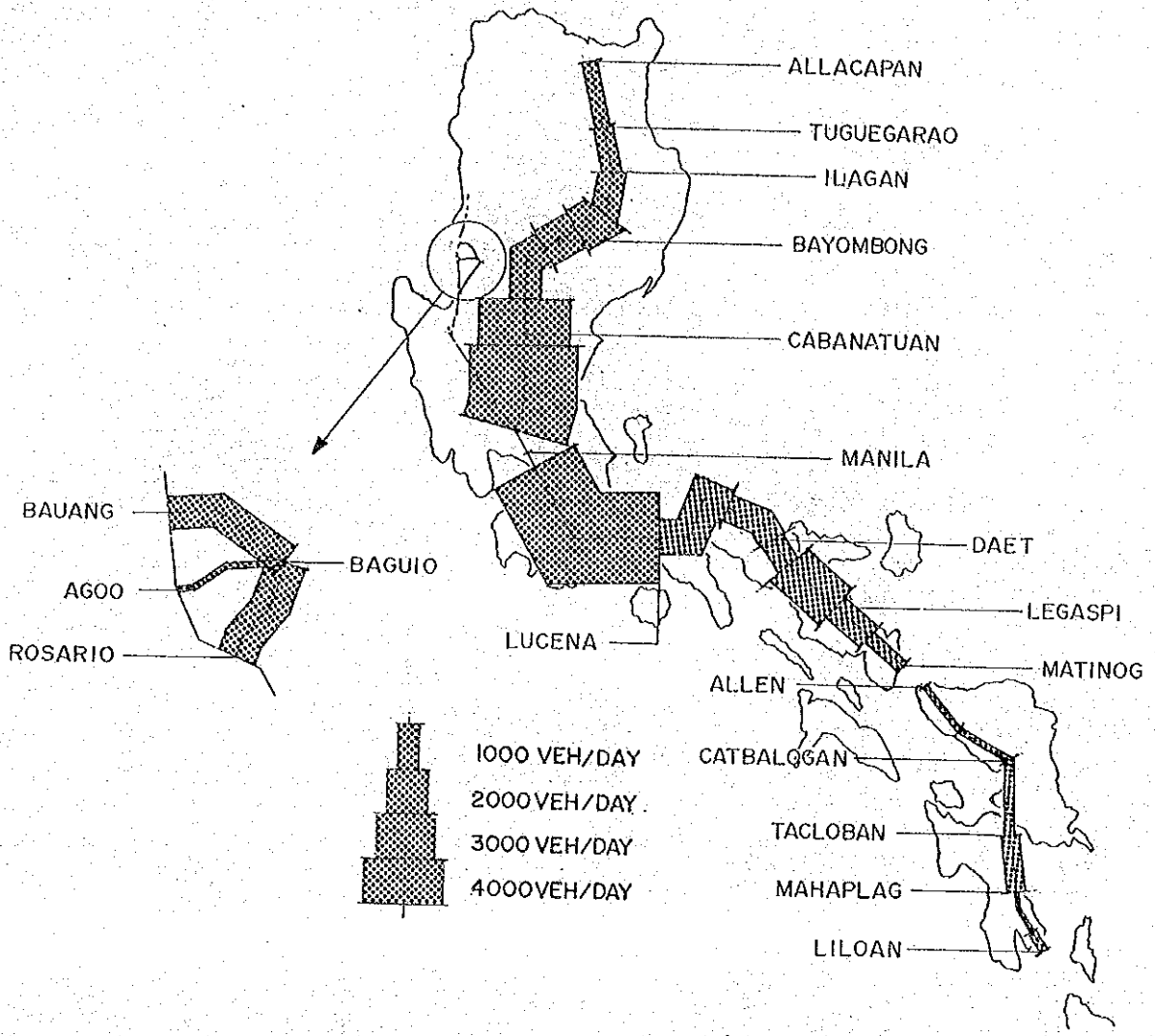


FIGURE 1-1 PRESENT TRAFFIC VOLUME

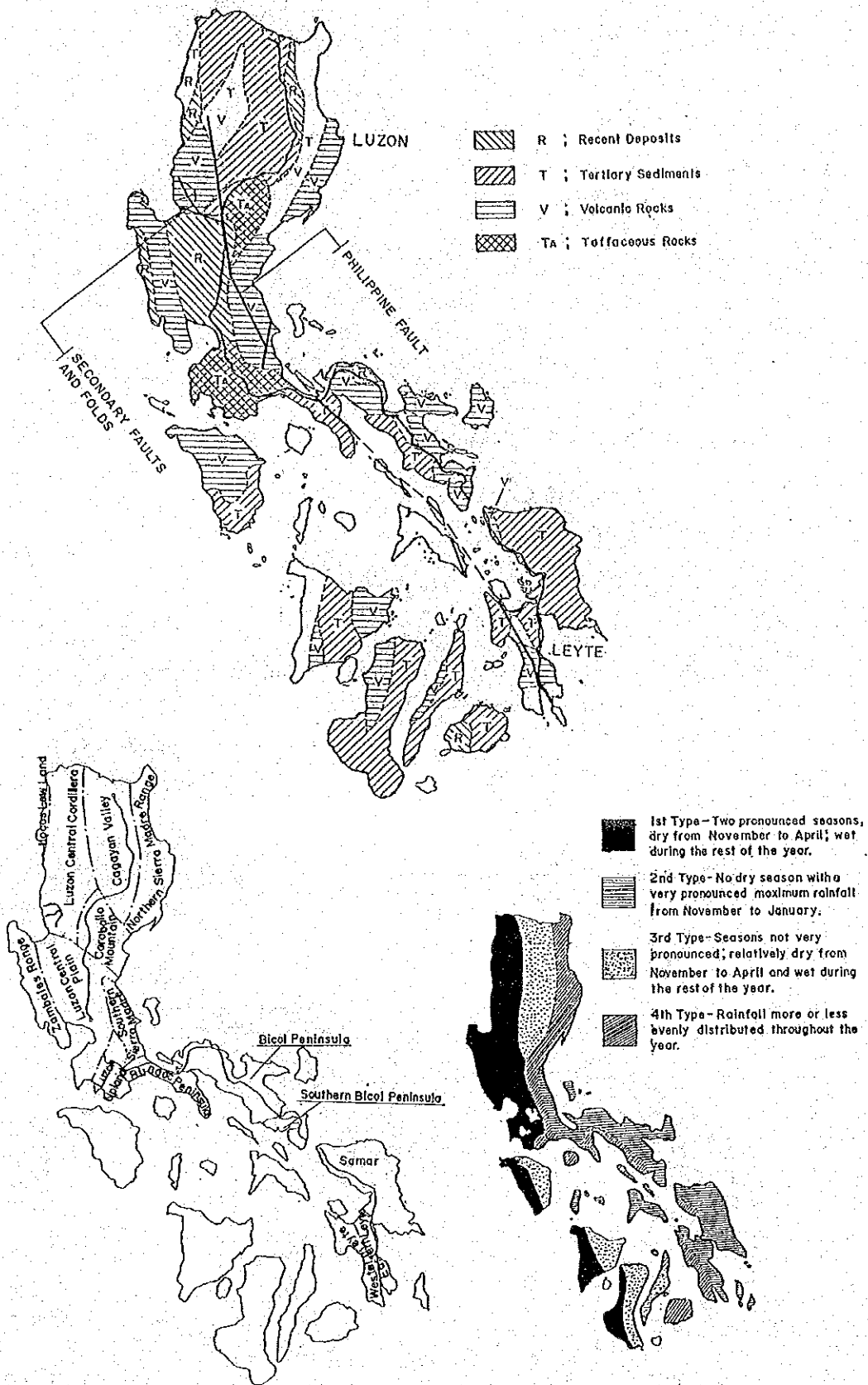


FIGURE 1-2 GEOLOGY, TOPOGRAPHY AND CLIMATE OF THE STUDY AREA

1.2 IDENTIFICATION OF ROAD DISASTERS

Types of Road Disasters

Road disasters are classified into five types based generally on the shapes of failures which were assessed thru visual inspection as shown in Figure 1–3.

Identification of Disaster Potential Spots

Disaster potential spots were generally identified thru actual field investigation considering the following items.

- Height and gradient of slope
- Types of rocks
- Conditions of weathering, cracks, joints and faults
- Thickness and compactness of topsoil
- Degree of water saturation of slope
- Existence of seepage water
- Influence of force of waves from sea or stream
- Evidence and scale of past disaster

Each spot investigated was ranked into three categories, Category A (Heavy), Category B (Medium) and Category C (Light) considering the above items and giving emphasis on the impact of the disaster on traffic. The criteria adopted in determining the disaster potential are shown in Table 1–1.

TABLE 1-1 CRITERIA FOR DISASTER POTENTIAL

IMPACT	Type of Disaster		
	Cut Slope Failure, Landslide, Debris Flow, etc.	Rock Fall	Embankment Slope Failure
Category A (Heavy) (Urgent countermeasure is required)	● Failure or moved material may cover full lanes of pavement. Expected to be closed to traffic.	● Fallen materials may cover full lanes or large sized rocks (more than 50 cm) may fall to part of carriageway.	● Pavement structure may collapse.
Category B (Medium) (Urgent countermeasure is required)	● Failure or moved materials may cover about one lane.	● Fallen materials with size of less than 50 cm may cover about one lane.	● Shoulder may fully collapse.
Category C (Light) (No urgent countermeasure is required.)	● Failure or moved materials may not extend to carriageway.	● Fallen materials may not extend to carriageway.	● Shoulder may partially collapse.

Road Disaster is classified into the following five (5) types.

1. Cut Slope Failure

This type is sub-classified into surface and deep failures. Causes of the former are erosion, weathering and structural weakness. The latter is classified into scouring, rotational and translational failure. Figures 1 (a) and (b) show a surface failure due to erosion, while (c) and (d) show a deep failure due to scouring.

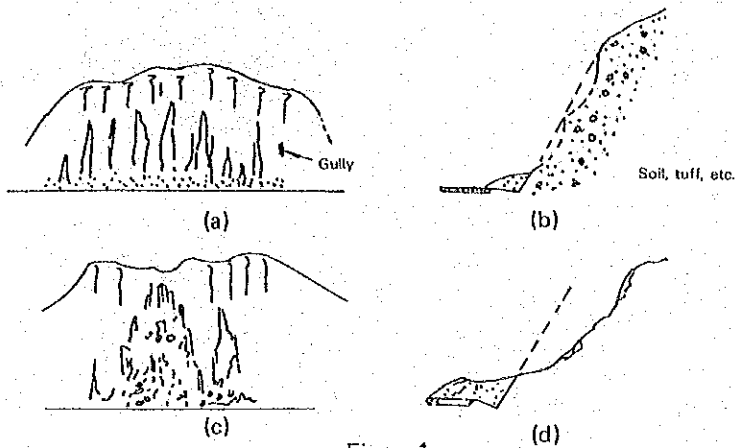


Figure 1

2. Embankment Failure

This type is sub-classified into surface failure due to erosion and deep failure due to scouring and saturation. Figures (a) and (b) show a deep failure due to scouring.

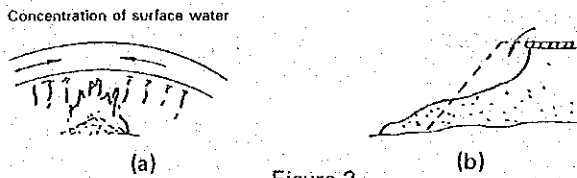


Figure 2

3. Fall

This type is sub-divided into rock and debris falls. Figures 3 (a) and (b) show rock and debris falls, respectively.

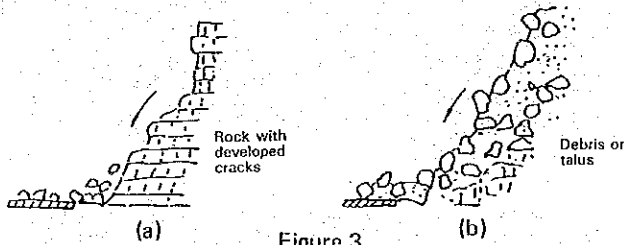


Figure 3

4. Landslide

This type is sub-classified into rock and soil landslides. Figures 4 (a) and (b) show a soil landslide.

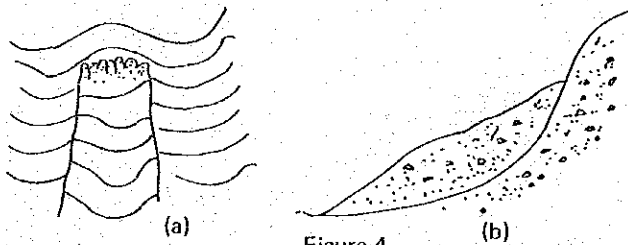


Figure 4

5. Debris Flow

Debris flow is sub-classified into debris and mudflow. Figures 5 (a) and (b) show a debris flow.

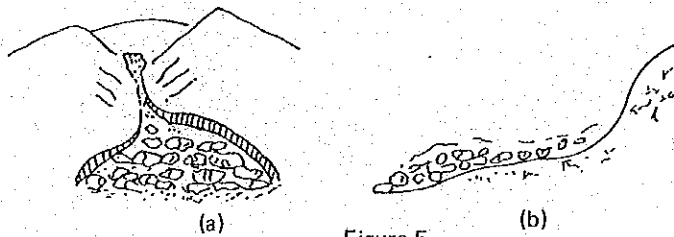


Figure 5

FIGURE 1-3 CONCEPTUAL ILLUSTRATION OF FAILURES

Summary of Road Disasters

There are a total of 545 disaster spots identified along the project roads of which 390 are along the Cagayan to Leyte section of the Maharlika Highway and 155 disaster spots along the three roads leading to Baguio City (Kennon = 48; Agoo-Baguio = 84; Naguilian = 23).

Distribution of the disaster spots by road sections and types are shows in Figure 1-4 below.

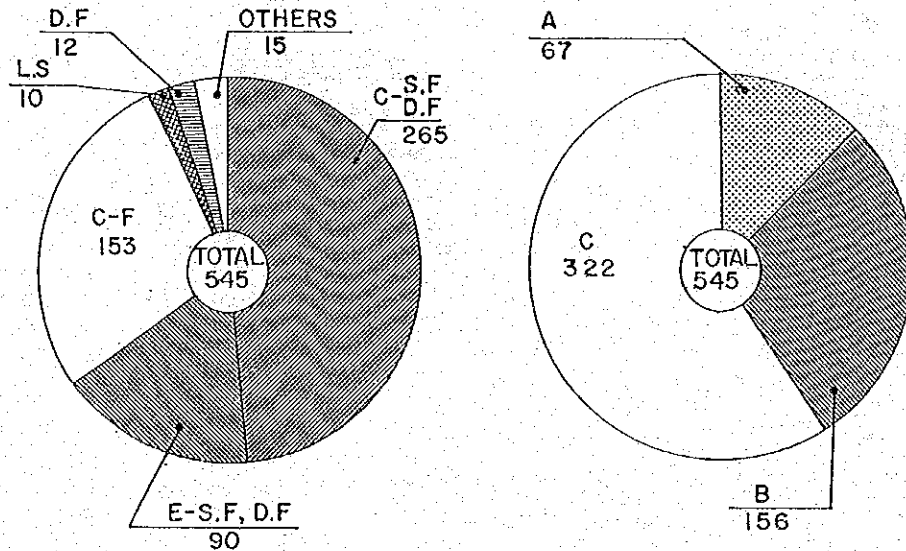
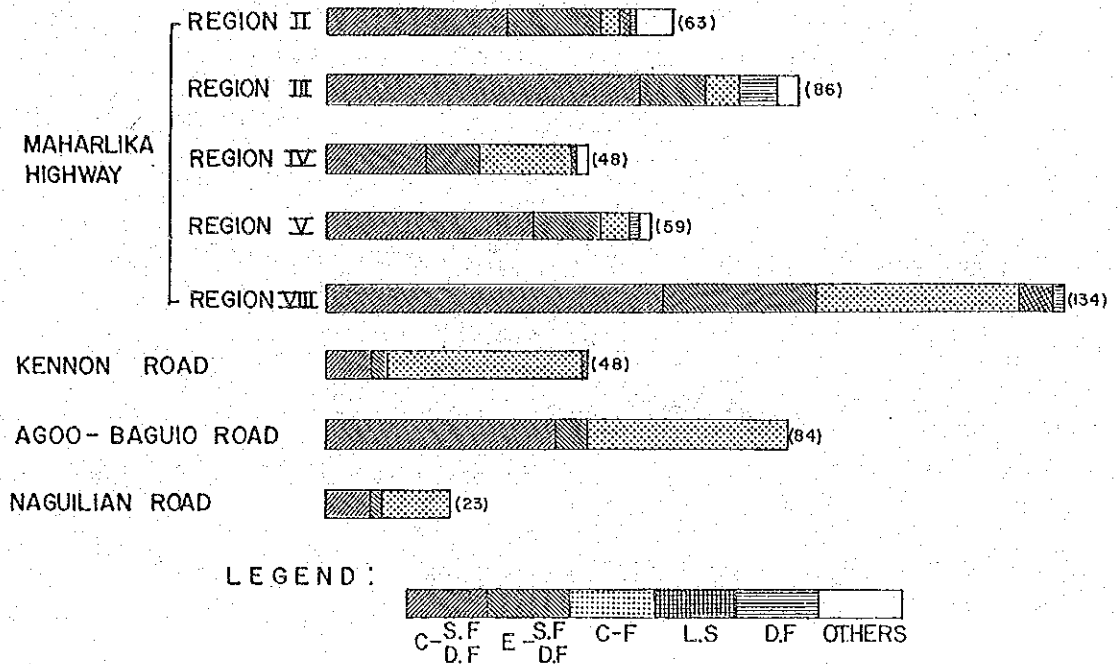


FIGURE 1-4 DISASTER SPOTS BY REGION, TYPE AND POTENTIAL

1.3 DESCRIPTION OF IDENTIFIED DISASTER SPOTS

Of the 545 disaster spots observed along the project roads, cut slope failure is more prevalent with 265 spots or 49 percent of the total, followed by fall with 153 spots or 28 percent, embankment slope failure with 90 spots or 17 percent and debris flow, landslide, and others representing 6 percent.

Cut Slope Failure

This type of failure is predominant in all mountainous sections, specifically in: i) Dalton Pass section in Nueva Vizcaya ii) Agoo-Baguio road: iii) Mahaplag-Sogod section in Southern Leyte; and iv) Sta. Elena-Daet section in Camarines Norte. Large-scale failures were recognized in i) and iii).

The average scale of cut slope failures have occurred in all types of rocks. It is no exaggeration to mention that the cause of these failures is water. The water flowing down on the surface of the slope has created erosion and scouring. On the other hand, the large-scale failure observed in sections i) and iii) may be due to the fractured zone of Philippine Fault.

As predicted, the failures could not have been prevented because of the following deficiencies.

- No drainage facilities to prevent erosion and scouring due to heavy rain.
- No berms on high slopes to ease velocity of surface water.
- No slope protection by vegetation and the like.

Embankment Slope Failure

This type of failure was also widely observed along the project roads, especially at the spots with the following topographical conditions: i) spot inside the curve with the steep gradient, ii) sections along sea coast and river and iii) approach to bridges.

Embankment failures were generally attributed to scouring due to rains. Therefore, the failure frequently occurred for the following reasons.

- Inadequate drainage facilities in terms of number and capacity
- Inadequate connection and protection at the outlet of cross drain facilities
- No or inefficient protection of slopes

Fall

Falls were predominantly observed in the section along Kennon Road, Agoo-Baguio Road, and the two sections between San Isidro and Calbayog in Samar and between Mahaplag and Sogod in Leyte.

This type of failure arises mainly at the portion with developed open cracks and at the open boundaries of different types of rocks on slopes. These slopes are composed of debris, diorite, andesite, sandstone and the like. The size of fallen rocks varies from 2.0 to 0.5 meters in diameter, but the biggest is about 3 m in the section along Agoo-Baguio Road.

The deficiencies which may have caused the failure are similar to those mentioned in "cut slope failure" of this section.

Landslide

Landslides are observed only in ten spots. Among these, largescale failures were noted in four spots; at Diadi along Dalton Pass section, along Kennon Road near Baguio City and near Layong Bridge and Libagon along the Mahaplag-Sogod section in Southern Leyte.

The deposited earth on bedrocks such as sandstone, tuff and mudstone can easily slide with rising of groundwater level during heavy rains.

The main causes of these failures are attributed to the following:

- No drainage facilities to prevent seepage of water
- No remedial facilities such as horizontal drain holes
- No proper consideration in design such as removal of earth or counter weight.

Debris Flow

Debris flows were identified mainly along the Dalton Pass section. The largest debris flow occurred during typhoon Aring in 1980, causing extensive destruction to property and death to many people.

Ordinary type of debris flow comes from small torrents in the mountains where the geology consists mainly of transfigured granite by weathering.

No countermeasures such as consolidation work and sabo dam were observed.

1.4

RECORDS OF ROAD DISASTER AND RESTORATION WORK

Road Disaster Record

The project roads were often reported closed to traffic due to disasters occurring during typhoons and heavy rains. Records of major traffic interruptions at Dalton Pass Section during and Mahaplag-Sogod Section along Maharlika Highway and at Kennon Road are summarized in Table 1-2.

TABLE 1-2 MAJOR ROAD DISASTER AT SELECTED SECTIONS

Section	Year	Name of Typhoon	Date of Occurance	Duration of Traffic Interruption
Dalton Pass Section	1976	Didang	May 15-25	30 days
	1978	Kading	Oct. 25-27	7 days
	1980	Nitang/Osang	July 18-27	7 days
	1980	Aring	Nov. 1-7	29 days
	1981	Anding	Nov. 21-27	7 days
Mahaplag- Sogod Section	1979	Karing	May 10-16	30 days
	1980	Heavy Rain	Dec. 10-Jan. 26	90 days
	1981	Heavy Rain	Nov. 23-Dec. 3	60 days
	1982	Bising	March 22-29	60 days
Kennon Road	1974	Susang	Oct. 8-12	21 days
	1979	Ising-Mameng	July 29-Aug. 15	120 days
	1980	Nitang/Osang	July 18-27	135 days
	1981	Rubing	Sept. 15-21	14 days

Source: District/City Engineering Offices

Present Restoration Work

Application of a full-scale countermeasures to prevent slope failures has not yet been effected along the project roads. If at all, only small scale temporary countermeasures are being applied along the disaster spots. More often only remedial works and quick restoration of the damaged sections are being resorted to.

The sediments and debris deposited on the road surface are removed some time after the occurrence of slope failures. In many spots, stone masonry is widely adopted as a remedial measure of embankment slope protection. However, these are constructed structurally weak which can only withstand very small lateral pressure.

1.5 SELECTION OF FEASIBILITY STUDY SECTIONS

Ranking of Sections

The project roads were divided into 24 sections of which 21 are within the Maharlika Highway and the three roads leading to Baguio were considered each a section. Each section was evaluated in terms of its disaster potential and importance.

- The disaster potential of each section was evaluated based on the high concentration of potential failures within. The degree of concentration has been expressed at the disaster spot density derived with the following relationships shown below.

$$\text{Disaster Spot Density of Each Section } (\alpha) = \frac{\text{Total Length of Spots with High Disaster Potential (Category A and B)}}{\text{Section Length}}$$

The sections were ranked A, B and C using the following criteria.

- Rank A : $30 \text{ m/km} \leq \alpha$
- Rank B : $5 \text{ m/km} \leq \alpha < 30 \text{ m/km}$
- Rank C : $\alpha < 5 \text{ m/km}$

- The importance of each section was assessed based on traffic volume and the quality of traffic with the same weight. The quality of traffic was assessed on three factors: commercial commodities, basic food and other consumption commodities, and passenger flow.
- The results of the evaluation based on disaster potential and the importance of road were integrated giving the higher weight to the former. The disaster spot density and importance of road of each section is illustrated in Figure 1–5.

Final Selection

Six sections ranked as the first priority were further studied in consideration of other factors such as the availability of detour road, constraints during implementation of the project and the characteristics of each section.

Finally, the following three links were identified as the subjects for the Feasibility Study.

- . Aritao-San Jose (Dalton Pass Section)
- . Mahaplag-Sogod (Leyte)
- . Kennon Road

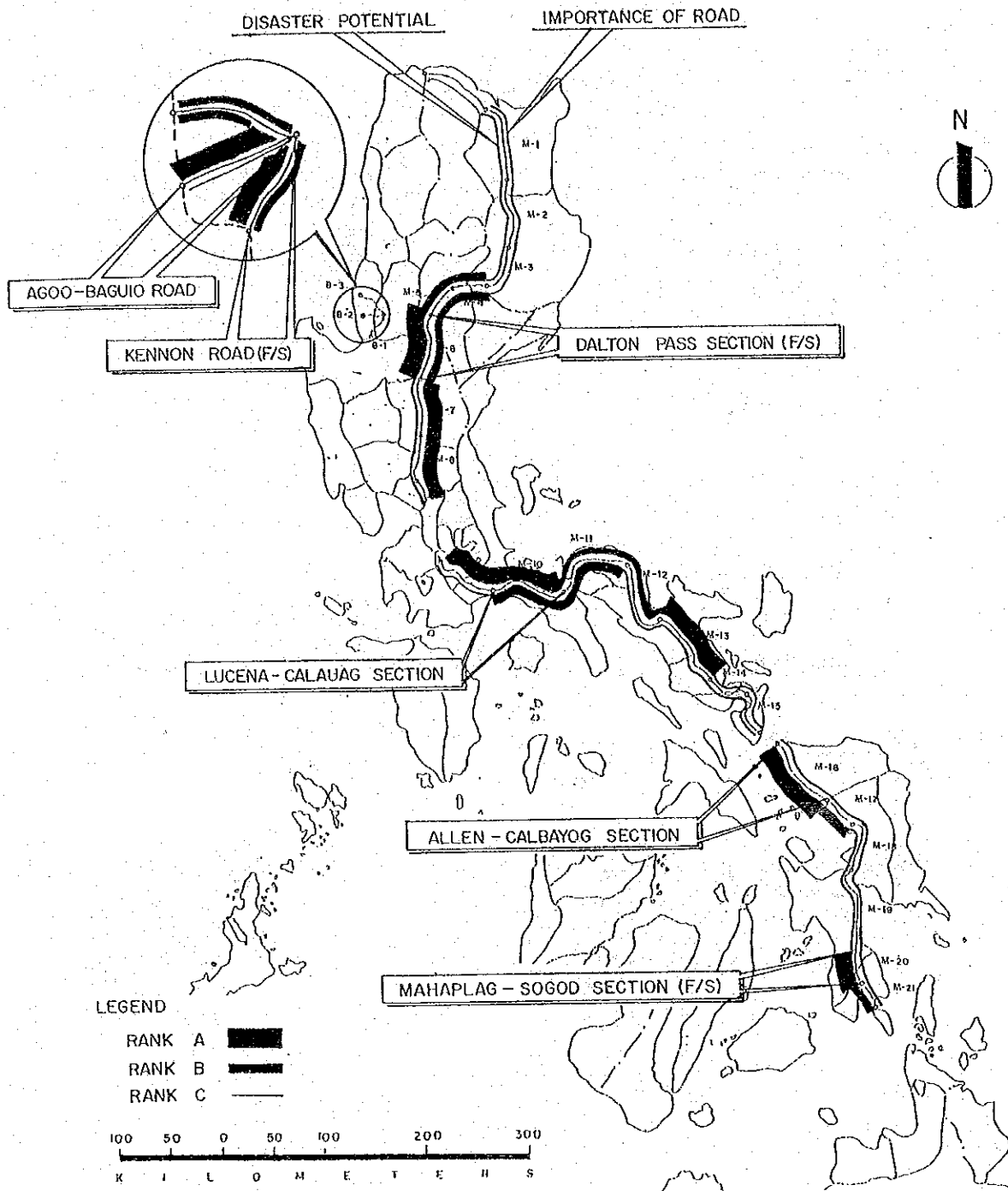


FIGURE 1-5 DISASTER POTENTIAL AND IMPORTANCE OF ROAD

2. FEASIBILITY STUDY OF SELECTED SECTIONS

2.1 ROLES OF SELECTED SECTIONS

Dalton Pass Section

The only road connecting Cagayan Valley with Metro Manila is the Maharlika Highway. The Dalton Pass Section of the Maharlika Highway is located at the gateway to the Cagayan Valley Region whose influence area extends to Aparri in the northern tip of Luzon Island and to Metro Manila in the south. The road transport has an overwhelming share of 99% of total transport demand in the Cagayan Valley corridor where the main traffic generating sources are located at Ilagan in the province of Isabela, Bayombong in Nueva Vizcaya and Tuguegarao in Cagayan.

Mahaplag-Sogod Section

The key section along the Maharlika Highway which links Southern Leyte and Tacloban City, the center of Region VIII, with the shortest access is the Mahaplag-Sogod Section. The direct Leyte Island. However, upon operation of the ferry service between Leyte and Mindanao islands which is expected to start in 1984, the influence area will expand further to Mindanao. The said ferry service will finally realize the linkage of the four major islands in the Philippines by vehicle traffic by way of the Maharlika Highway. This section is one of the critical sections to be improved to ensure the continuity of the Maharlika Highway and in view of road disaster potentials inherent to it.

Kennon Road

Baguio City, largely depending on the tourism industry, Vegetable production and education center north of Manila has strong linkage with Metro Manila in the aspects. The shortest access is provided by Kennon Road which serves approximately 98 percent of traffic generated south of Baguio City. It has a long stretch of influence area extending to 310 kilometers in length. Traffic on it is mainly composed of inter-regional trips and commuting trips. Thus, Kennon Road has two functions; one as an inter-regional trunk road and two, as a local road.

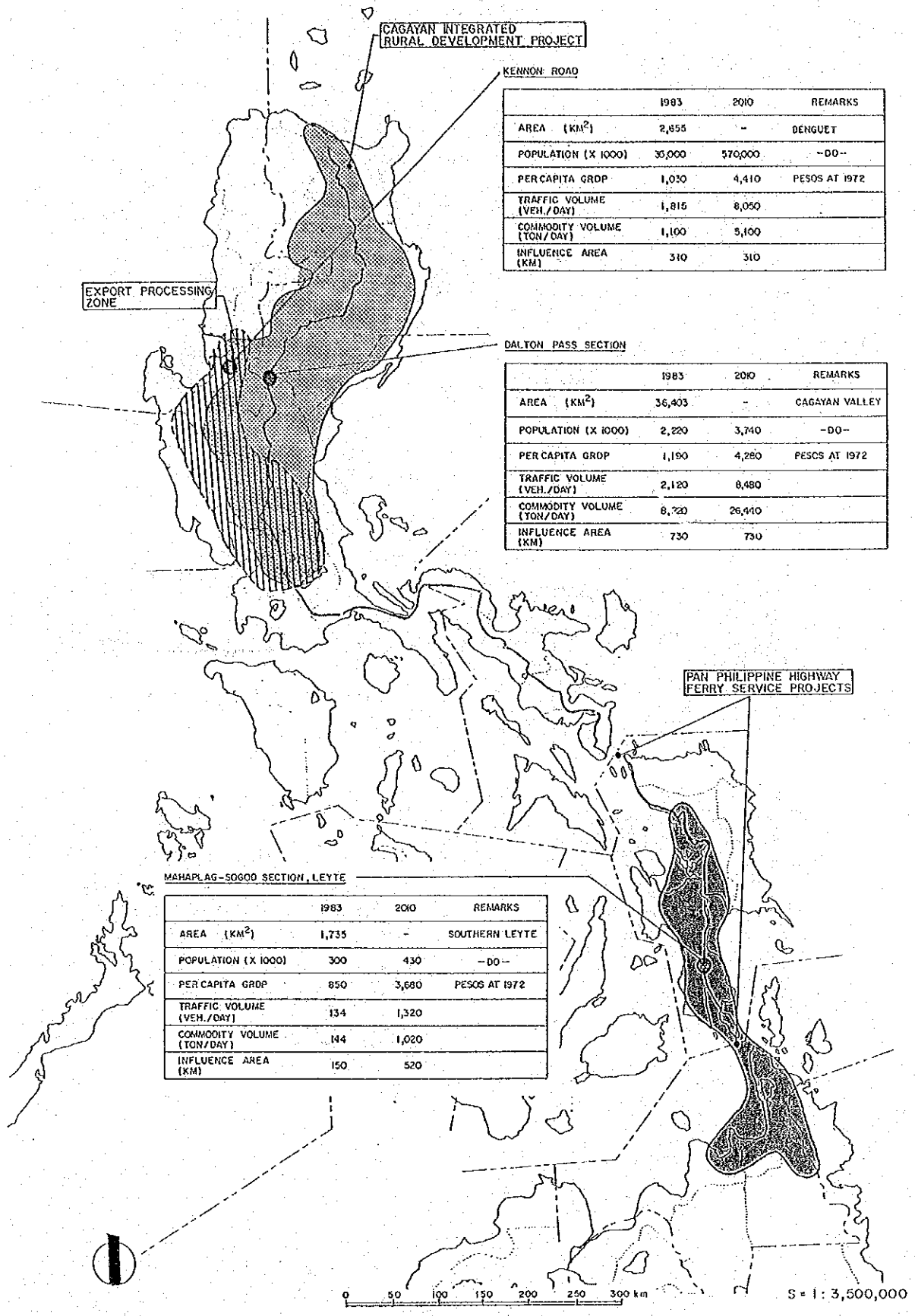


FIGURE 2-1 EXPANSION OF INFLUENCE AREA BY F/S SECTION

2.2 FUTURE TRAFFIC

Dalton Pass Section

Present 1983 traffic passing this section is about 2120 vehicles per day with the predominant share of 50% of truck traffic. With an anticipated annual average growth rate of 5.3%, the traffic volume will be 8,500 veh/day in the year 2010, of which truck traffic will share 44%, reaching nearly the traffic capacity of the road section. The Philippines is predicted to suffer staggered economic development in 1980s, but will achieve sustained economic growth in the 1990s. Reflecting such economic development trend, traffic growth rate in 1990s will, therefore, slightly higher than that in 1980s.

Backed up by the vast agro-timber resources of the Cagayan Valley Region, quite large volume of commodities (8,200 tons/day) is transported through the section. Owing to extensive efforts to develop the region by such projects as the Cagayan Integrated Rural Development Project, volume of commodities carried through the Section will be 26,400 tons/day (or 3.2 times of the present volume) in the year 2010.

Mahaplag-Sogod Section

Present traffic volume is quite low at 134 veh/day partly due to the deteriorating road condition brought about by the recent disasters which have occurred in the section. Nevertheless, considering the socio-economic development potentials of the area served, including the impact of the ferry service between Leyte and Mindanao islands which will be operational in 1984, high traffic growth rate of 8.8% per annum is forecasted between 1983 and the year 2010. This will mean that the traffic volume will reach 1,300 veh/day in the year 2010.

Kennon Road

Kennon Road has present (1983) traffic of an average volume of 1,815 vehicles per day. This is anticipated to increase at an average annual growth rate of 5.7%. By the year 2010, the traffic would have increased to 8,100 vehicles per day. Due to the limited geometric standards of the section characterized with narrow roadway and steep grades, its traffic capacity is lower than a standard 2-lane road. That traffic volume of 8,100 veh/day will be almost the maximum traffic volume it will be able to accommodate.

Volume of commodity flow was 1,100 tons/day in 1983 and will be 5,100 tons/day in the year 2010.

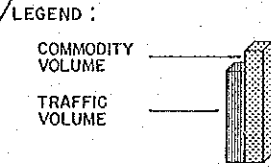
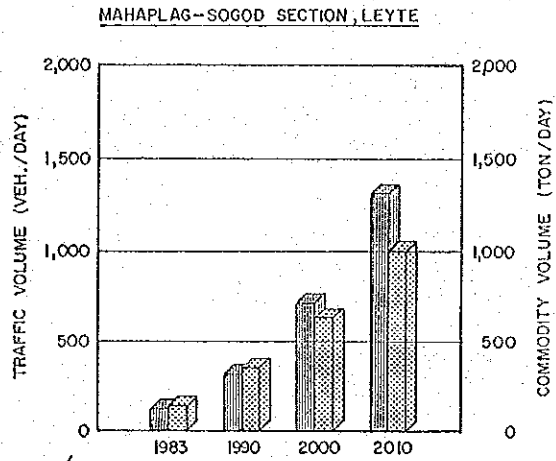
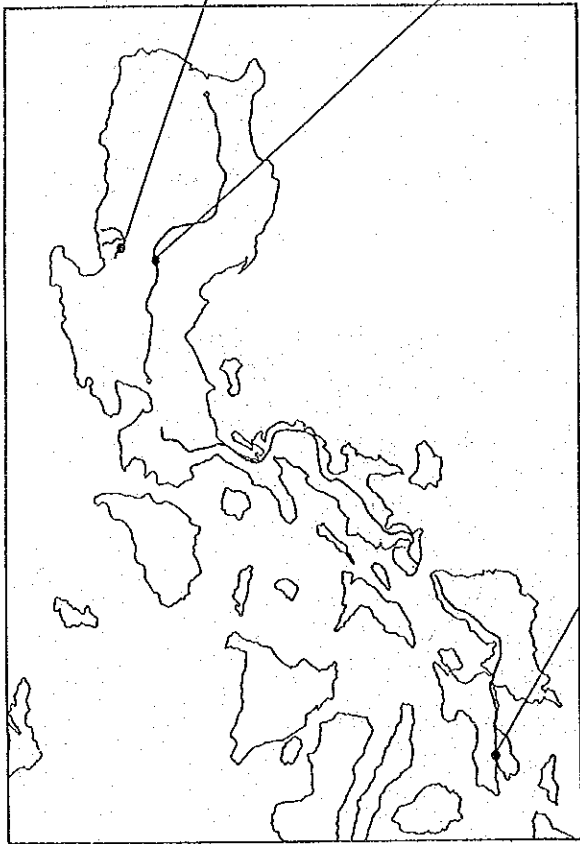
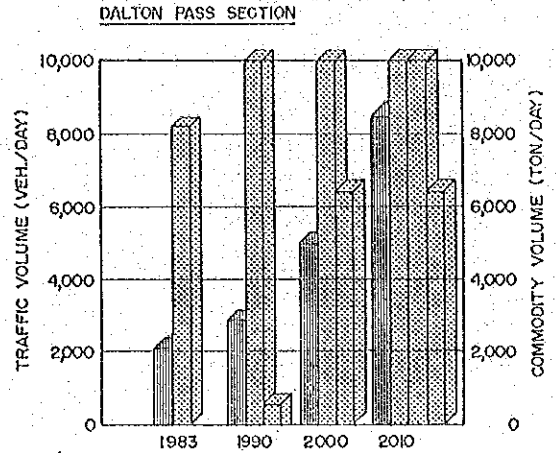
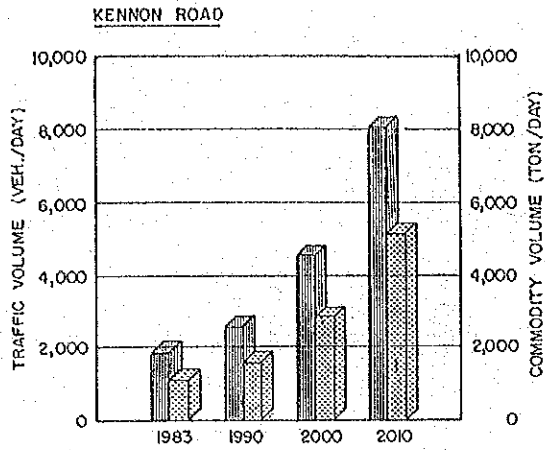


FIGURE 2-2 FUTURE TRAFFIC/COMMODITY VOLUME

2.3

EXISTING CONDITIONS OF ROAD DISASTER

Dalton Pass Section

After the improvement of the section in 1975, two large scale road disasters occurred. One in 1976 and the other in 1980 caused by typhoons "Didang" and "Aring", respectively. During these periods, substantial damages on the section were attributed to cut slope failures and embankment failures, resulting in interrupted traffic for quite sometimes. From there on, small scale of road disasters occurred every year, disrupting traffic for 3 to 7 days.

The middle portion of the section passes through rugged and mountainous terrain with steep slopes on both sides of a roadway. The remaining portion runs along the Digidig River or Sta. Fe River with steep slopes and winding alignment.

Of the total of 73 spots evaluated as disaster potential category A or B, cut slope failure is dominant with 39 spot, followed by debris flow with 14 spots and embankment slope failure with 13 spots.

Occurrence of a large number of cut slope failures is mainly due to strongly weathered and fractured rocks.

The evidence of a large scale debris flow was observed at kms 221 + 500. In 1980 during typhoon "Aring", many lives of nearby residents were lost. Other spots are small in scale, but likewise often interrupt traffic after every heavy rain.

A large scale of embankment slope failures are mainly due to scouring caused by the strong stream flow of Digidig River or Sta. Fe River. In some spots, the embankment as well as the pavement are being washed out.

Mahaplag-Sogod Section

Since the opening of the section in 1978, months long traffic interruptions have occurred at least 5 times already, mainly due to continuous heavy rains and typhoons. The majority of slopes are still in unstable and the scale of failures are predicted to become bigger year by year, if no countermeasures are adopted.

The section about 16 kms north of Mahaplag is in flat and rolling terrain and runs along Layag River. The remaining section of about 20 kms is in steep mountainous terrain.

Of the total of 40 spots evaluated as disaster potential category A or B, 19 spots were identified as cut slope failure, 14 as embankment slope failure and 3 as landslides.

Rocks along the section are mainly andesite, tuff and sandstone which are fractured by the effect of the Philippine Fault. Therefore, these are easily eroded or scoured by surface water flowing down the slope during heavy rains.

The largest scale of cut slope failure exists at kms 1010 + 700 where the height of the slope is about 100 meters and deep gully valleys caused by scouring are observed on the slope. Large mass of soil falls down from the slope directly on to the road almost everytime during heavy rains causing the interruption of traffic.

Large scale embankment slope failures are also observed because the route is constructed along a deep valley. Scouring by surface water concentrated on the road surface have been the main cause of embankment slope failures in the section.

There are three spots of landslide noted. The main cause of the landslide in these spots is high groundwater level. At kms 1004 + 950 the slope continues to move causing upheaval of the road surface.

Kennon Road

Disaster along this road must have occurred many times during the last 47 years since its completion in 1937. However, no disaster records are available until two large scale disaster occurred in 1979 and 1980 when the road was closed to traffic for long periods. These disasters were caused by the damming up of Bued River caused by natural slope failure of the mountain on one side of the river. Apart from this special case, disasters do occur in other spots at an average of two times a year causing traffic interruption for one to three weeks.

About 30 kms from the town of Rosario where it starts, the road follows the generally mountainous terrain along the Bued river, then climbs up the mountain to Baguio City with steep gradients and many hairpin curves.

Of the total of 46 spots recorded, rock falls are dominant in 31 spots, followed with 9 spots of embankment slope failure and 5 spots with cut slope failure.

Rocks along the section are mainly conglomerate, limestone, andesite, and diorite. Since these are relatively hard with many open cracks, falls occur in many cut slopes.

The embankment slope failures are mainly due to scouring caused by Bued river and surface water concentrated from the road surface and the cut slope. A large scale of embankment slope failure which occurred at kms 227 + 500 in August 1983 is mainly due to the fill material being saturated by seepage water.

A large scale of landslide exists near the end point of the road in Baguio City. It is said setting is at the rate of about 10 cm every year.

2.4 RECOMMENDED COUNTERMEASURES

Number of Designed Spots

As a general rule, preliminary design of the countermeasures was carried out only in spots classified under disaster potential categories A and B.

The number of spots where disaster countermeasure designed are listed in Table 2-1.

TABLE 2-1 NUMBER OF DESIGNED SPOTS

Type of Disaster	Section			Total
	Dalton Pass	Mahaplag-Sogod	Kennon Road	
Cut Slope Failure	39	19	5	63
Embankment Slope Failure	13	14	9	36
Fall	6	2	31	39
Landslide	—	3	1	4
Debris Flow	14	1	—	15
Others	1	1	—	2
TOTAL	73	40	46	159

Selection of Countermeasures

Various countermeasures commonly adopted in other countries have been studied in accordance with the types and the causes of disaster. These were closely examined with regard to effectiveness and practicability in this country. Various countermeasures are presented in the attached tables.

The countermeasures were selected in due consideration of geology, topography, surface water, groundwater and other conditions of each disaster spot. In addition to these local conditions, the following considerations were paid in the selection of countermeasures;

- Introduction of new technology on disaster prevention
- Minimal traffic obstruction during construction
- Harmony with the environment
- Minimal maintenance work

Table 2-2 shows the number of countermeasures by section and type of disaster in relation with type of countermeasure adopted in the preliminary design.

TABLE 2-2 TYPES AND NUMBER OF COUNTERMEASURES

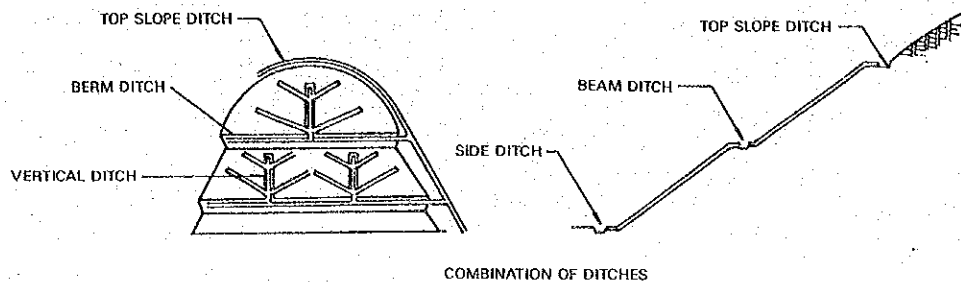
Type of Countermeasures		No. of countermeasures by section			No. of countermeasures by type of disaster						TOTAL 159 spots
		Dalton Pais Section 73 spots	Mahoolog- Sogod Section 40 spots	Kenon Road 46 spots	C.S.F. D.F. 63 spots	E.S.F. D.F. 36 spots	C-F 30 spots	L.S 4 spots	O.F 15 spots	O.F 2 spots	
EARTH WORK	REMOVAL/RE-CUTTING	37	22	36	55	0	38	2	0	0	95
	RE-FILLING/COUNTER-WEIGHT FILL	13	15	6	1	30	0	1	1	0	33
DRAINAGE WORK	SURFACE DRAINAGE	37	28	11	40	28	6	2	0	0	76
	SUBSURFACE DRAINAGE	11	17	4	2	28	0	2	0	0	32
PROTECTION WORK	VEGETATION	23	23	1	32	13	0	2	0	0	47
	SPRAYING	19	8	14	27	0	14	0	0	0	41
	CONCRETE CRIB	11	5	9	13	8	4	0	0	0	25
	PITCHING	9	1	0	0	9	0	0	0	1	10
CATCH WORK		3	3	22	1	0	27	0	0	0	28
STRUCTURAL WORK	STONE MASONRY	8	5	3	5	9	0	0	0	2	16
	GRAVITY TYPE	3	1	4	1	5	0	0	2	0	8
	SUPPORTED TYPE	1	1	3	0	4	1	0	0	0	5
	GABION RETAINING WALL	1	8	2	1	8	0	2	0	0	11
	ANCHORING	0	1	3	1	2	1	0	0	0	4
	PILING	0	0	1	0	0	0	1	0	0	1
TORRENT WORK	STONE PITCHING WATER WAY	13	2	0	1	0	0	0	14	0	15
	GABION FOOT PROTECTION	9	1	1	1	9	0	0	1	0	11
CONCRETE SABO DAM		11	0	0	0	0	0	0	11	0	11
CULVERT		6	2	2	0	2	2	0	4	2	10
TOTAL		215	143	121	181	155	93	12	33	5	479

Type of Disaster
C-S, F, D.F Cut Slope Surface Failure, Deep Failure L.S Landslide
E-S, F, D.F Embankment Slope Surface Failure, Deep Failure D.F Debris Flow
C-F Cut Slope Rock Fall O.F Overflow

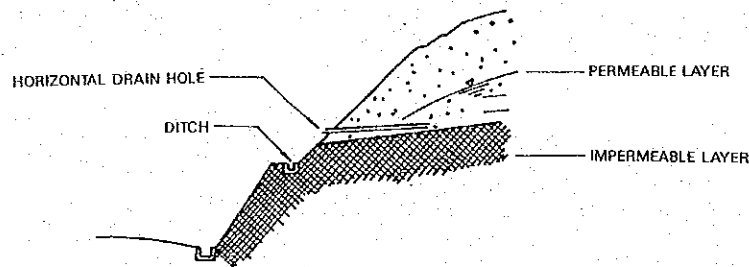
Typical Countermeasures

The following are typical countermeasures adopted.

Surface drain : Major cause of cut slope and embankment slope failures is surface water. Various kinds of ditches were applied in many sections. A side ditch is specifically planned for almost the whole section in Dalton Pass and Mahaplag-Sogod Sections.

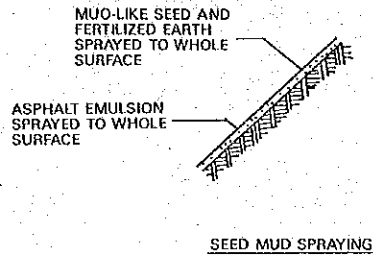


Subsurface drain : Horizontal drain holes were mainly applied for the spots of cut slope failure and landslide where seepage water was observed. In re-filled sections, horizontal drain holes were provided in the fill body to drain out seepage water from the ground.

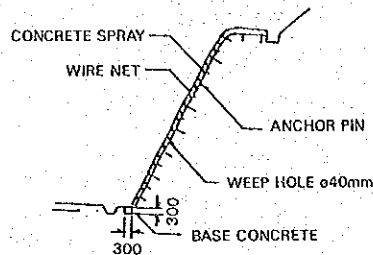


Re-cutting : Although re-cutting is one of appropriate countermeasures to ensure stability of cut slope with steep gradient, a large amount of excavation may disrupt traffic during the re-cutting. The application of re-cutting was avoided as much as possible, when traffic is anticipated to be greatly disturbed.

Slope protection : Except on slopes made out hard rock not susceptible to erosion and scouring, slope protection works were generally applied for all kinds of slope. Slope protection with vegetation works are applied for the slopes with soil and weathered rocks where vegetation can grow. For other slopes, concrete spraying, concrete pitching, stone pitching, concrete crib, etc. were applied.

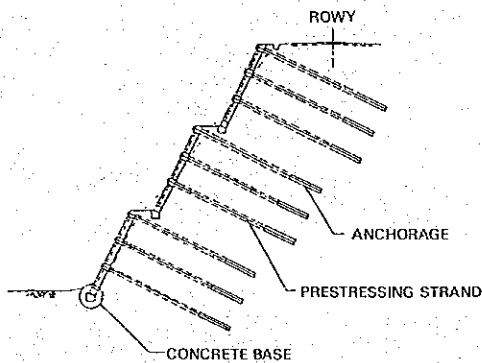


SEED MUD SPRAYING

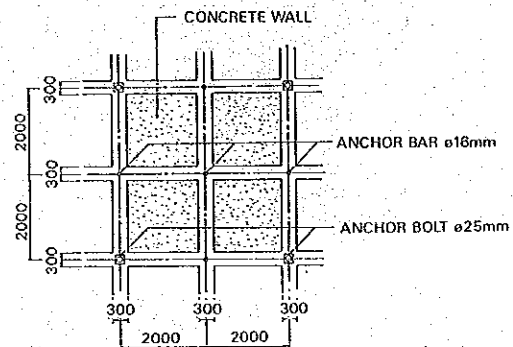


CONCRETE SPRAYING

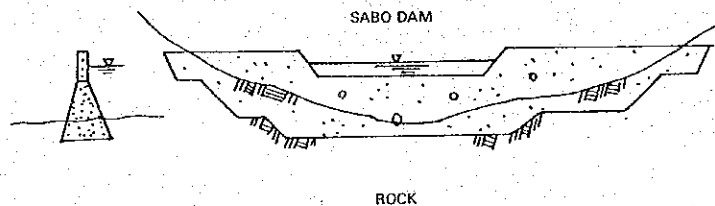
Structural Work : For steep and unstable cut and embankment slopes where the slope gradient can not be improved, such structures as stone masonry, gravity type retaining wall, cast-in-place concrete crib with P.C. anchor, which can resist lateral earth pressure, were applied.



CAST-IN-PLACE CONCRETE CRIB



Sabo Dam : This type of countermeasures in relation to waterway, was applied to prevent debris flow from spreading on road surface.



2.5 PROJECT COST

The project costs were estimated based on the unit cost analysis in October 1983 prices. The aggregate total cost of the three sections was estimated at 367.9 million pesos, of which foreign currency component amounts to 225.7 million pesos (or 61%) and local currency component including taxes to 142.2 million pesos (or 39%).

Construction cost of Dalton Pass Section was estimated at 157.42 million pesos, Mahaplag-Sogod Section at 81.20 million pesos and Kennon Road at 84.07 million pesos.

The cost for detailed engineering and construction supervision services were estimated respectively to be 7% of the construction cost. (See Table 2-3)

TABLE 2-3 PROJECT COST

Unit: Million Pesos

	October 1983 Price			Current Price ^{2/}		
	Foreign	Local/Tax	Total	Foreign	Local/Tax	Total
Detailed Engineering	14.67	7.91	22.58	17.79	11.58	29.37
Construction Supervision	14.67	7.91	22.58	19.58	15.65	35.43
Construction ^{1/} Dalton Pass Section	93.98	63.44	157.42	135.46	112.15	247.61
Mahaplag-Sogod Section	49.37	31.83	81.20	71.07	56.36	127.43
Kennon Road	52.96	31.11	84.07	76.09	55.26	131.35
Sub-Total	196.31	126.38	322.69	282.62	223.77	506.39
TOTAL	225.65	142.20	367.85	320.19	251.00	571.19

^{1/} Includes 10% physical contingency

^{2/} 1983 prices are escalated

2.6 PROJECT EVALUATION

The viability of the projects was evaluated mainly from the viewpoints of economic, technical and financial viability but considering as well in the final analysis the various socio-economic impacts contributed by the project.

Quantifiable benefits were mainly derived from savings on reduced vehicle operation costs, traffic efficiency and from construction and restoration related costs savings, as discussed briefly below. The assessment of the unquantifiable benefits from the projects is discussed under the *Socio-economic Impact Evaluation*.

1) Economic Evaluation

The economic viability of the project was evaluated on the basis of the following quantified benefits/savings:

Project Contribution	Quantified Benefits
• No traffic interruption	• Savings in detour cost
	• Savings in commodity opportunity cost
• Improved vehicle running condition	• Savings in traffic accident cost
	• Savings in travel time cost
• No restoration work	• Savings in restoration cost

Savings in detour cost

Savings in detour cost were estimated based on assessments of the kinds of detour trips, detour lengths, duration of traffic interruption, future traffic volume and basic vehicle operation costs.

Savings in commodity opportunity cost

Interruption of cargo truck trips results in economic losses. However, in anticipation of possible traffic interruption during the typhoon season, additional commodity reserves or stocks are maintained to ensure adequate supply for normal operation of factories, stores, etc. In such a case, the commodities lose these opportunity cost.

This benefit was considered only for the Dalton Pass Section as basic commodities were found being reserved for the typhoon season period in the Cagayan Valley region.

Savings in traffic accident cost

Based on the traffic accident records, the number of traffic accidents caused by road disaster was estimated. The unit cost of traffic accident suggested in the "Highway Planning Manual" of MPWH was up-dated and used to estimate this benefit.

Savings in travel time cost

Even after urgent restoration work to make a road passable, one-lane traffic operation remains and road surface as well remains in bad condition. Under such circumstances, drivers tend to reduce speed, resulting in loss of travel time. These benefits were estimated based on travel time results and in relation with duration of restoration work.

Savings in restoration cost

Based on the predicted scale of damage by a large typhoon and a typhoon attack pattern, average annual cost for restoration work was estimated. Estimated costs were compared with previous Government expenditures on restoration works of similar situations.

A 20-year project life was assumed in the analysis. The results of the cost-benefit analysis and sensitivity analysis are presented in Table 2-4.

TABLE 2-4 RESULTS OF ECONOMIC ANALYSIS

	IRR (%)			
	Dalton Pass Section	Mahaplag – Sogod Section	Kennon Road	
Best Estimate Case	18.7	14.4	16.6	
SENSITIVITY ANALYSIS	Case – 1 (Cost – 20 %)	22.5	17.7	20.1
	Case – 2 (Cost + 20 %)	16.0	12.0	14.0
	Case – 3 (Benefit + 20 %)	21.8	17.1	19.4
	Case – 4 (Benefit – 20 %)	15.4	11.5	13.4
	Case – 5 (Cost – 20 %, Benefit + 20 %)	26.0	20.7	23.3
	Case – 6 (Cost + 20 %, Benefit – 20 %)	12.9	9.3	11.1

2) Financial Evaluation

The maximum budget allocation for the local cost component in a single foreign assisted project in 1983 was 253 million pesos equivalent to about 1/12 of the total budget for construction/improvement of national roads. In the 5-year (1983-1987) highway investment program of the country the ratio of the possible allocation for the local cost component in a single project to that of the total yearly budget is estimated at 1/15, 1/25 and 1/40 for high, medium and low assumptions respectively. The medium assumption of 1/25 is, however, taken as the most realistic.

The maximum local fundings requirement of the Project with the six-year implementation period (1985-1990) is estimated to occur in 1989 at 97.3 million pesos in current prices which almost equivalent to the estimated possible amount of local budget allocation under the medium assumption.

**TABLE 2-5 POSSIBLE AMOUNT OF BUDGET ALLOCATION
- CURRENT PRICE -**

Unit : Million Pesos

Year	Estimated Budget from Major Roads ^{1/}	Possible Amount of Local Budget Allocation To a Single Project			Required Investment of the Project
		Low Assumption	Medium Assumption	High Assumption	
1983	3,155	79	126	210	-
1984	2,311	58	92	154	-
1985	2,137	53	85	142	1.1
1986	2,255	56	90	150	10.5
1987	2,338	58	94	156	10.6
1988	2,398	60	96	160	79.5
1989	2,590	65	104	173	97.3
1990	2,660	67	106	177	52.0

^{1/} MPWH Medium Term Infrastructure Program

3) Socio-Economic Impacts

Benefits which could not be easily quantified but which have direct socio-economic impact within the influence areas were assessed for each project and are summarized as project impacts. Generally, traffic interruption due to road disasters adversely affects socio-economic activities in the influence areas of a section. These adverse impacts of the "without project" case which are described hereunder will be alleviated when the projects are implemented.

Dalton Pass Section

- . The total population in the influence area of the project is estimated about 2.2 million in 1983 and 3.7 million in 2010.
- . Transport of basic commodities for daily life consumption in the Cagayan Valley Region amounting to 1,900 tons/day in 1983 can not be assured without the project.
- . Intentional price increases, social uneasiness and unstable peace and order situation could be induced due to inaccessibility to the region.
- . Transport of major products from Cagayan Valley Region to Metro Manila can not be assured under the present conditions of the section. Forty percent of the demands of rice and logs/lumbers in Metro Manila are supplied from the region.
- . Traffic flow of 2,100 veh/day and commodity flow of 8,200 tons/day (both in 1983 volume) will be seriously interrupted during disasters.
- . An additional 300 to 400 kilometers in detour route will be needed to complete a trip from Manila to Cagayan Valley and vice versa. This detour trip will require additional transport cost of 600 pesos for passenger vehicle.
- . The Manila North Road which is at present the only logical alternative route, will be congested for a stretch of about 680 kilometers in the year 2000 if traffic diverts into this route.
- . Economic return from investments in other developmental projects such as the Cagayan Integrated Rural Development Project will be hindered.
- . Overall economic development of the region will substantially slow down.

Mahaplag-Sogod Section

Without the project:

- . Wide areas extending about 150 kilometers will be affected including 300,000 persons in 1983 and 430,000 persons in the year 2010.
- . Transport of basic commodities for daily life consumption in Southern Leyte of about 90 tons/day (1983) can not be assured.
- . Intentional price increase, social uneasiness and unstable peace and order situation could be induced.
- . Medical services, educational and social amenities could be seriously affected.

- Disparity in per capita income between national average and Southern Leyte will be further widened. Per capita income of Southern Leyte is, at present, only a half of the figure of the national average.
- Effective use of ferry services between Leyte and Mindanao will not be realized resulting in the loss of economic returns of the ferry service project.

Kennon Road

- Delivery of basic commodities for daily life consumption in Baguio City estimated at 700 tons/day (1983) will have to follow a longer route.
- Community centered at Baguio City and extended along the road will be divided into two. About 2,300 commuters and students will be stranded.
- Tourist industry of Baguio City could substantially suffer some serious set backs resulting to further economic loss.
- Traffic flow of 1,800 veh/day and commodity flow of 1,200 tons/day (both in 1983 volume) will be disturbed.
- Naguilian Road and Manila North Road, an alternative route, will suffer traffic congestion for a stretch of about 100 kilometers, if Kennon Road is closed.
- Productivity of Export Processing Zone in Baguio City could be affected drastically.
- When all the three roads are damaged by a strong typhoon and closed to traffic, Baguio City could be considered completely isolated.

4) Overall Evaluation

Dalton Pass Section

- The best estimate of the Internal Rate of Return (IRR) of the Project in the Dalton Pass section is 18.7%. Results of the sensitivity analysis performed show that except in the worst case (cost + 20%; benefit – 20%) the IRRs exceed 15% in all cases.
- The section have suffered destructive road damages twice in seven years, resulting in traffic interruption for about a month, respectively. The section would suffer the same again, if no measures are taken immediately, as it contains a large number of spots with high disaster potential amounting to 73.
- In the year 2010, 8,500 vehicles and 26,400 tons of commodities will be transported daily through this section. Occurrence of a road disaster will seriously affect the socioeconomic activities within the influence areas particularly the Cagayan Valley Region.
- The Project will enhance the economic development resulting to increase productivity of which shares 2.8% at present in the overall GRDP of the country.

Implementation of disaster prevention work of this section is feasible as indicated by its economic rate of return as well in consideration with the various favorable impacts on social and developmental activities which could be also induced by the project.

Mahaplag-Sogod Section

- The best estimate of the IRR is 14.4%.
- The extent of road disaster in this section which is now serious will increase year by year, if countermeasures are not implemented. Technical assessment suggest that countermeasures for road disaster should be undertaken immediately, otherwise, the section would be totally destroyed in the near future.
- The section will be critical to the efficient operation of the ferry service between Leyte and Mindanao, which will be operational in 1984, as well as to effect the linkage of vehicle traffic along four major islands in the country by way of the Maharlika Highway.

Despite the marginal economic feasibility of the project in this section, it is, nevertheless, a project worthwhile undertaking considering its important role in the overall highway system of the country and its related socio-economic impact upon the direct influence area. Furthermore, it is reiterated that the problems and potentialities of disasters in the section are quite serious and to delay the implementation of the proposed countermeasure works will only aggravate the situation that can only lead to higher project costs and investment requirements later on.

Kennon Road

- The best estimate of IRR of the project along the Kennon Road is 16.6%.
- 46 spots with high disaster potential concentrated causing traffic interruption for one to three weeks every year. Even a small scale road disaster greatly affects traffic flow on the road due to narrow roadway and shoulders. Road users are always exposed to danger of being hit by falling rocks and the like, resulting in high incidence of traffic accidents caused by road disasters.
- Baguio City must be provided with at least one reliable and all-weather access roads. Kennon Road, the shortest route to link Baguio City and Metro Manila, should be given top priority.
- The project when realized, will substantially enhance the development of the tourism industry, vegetable and other agricultural production, and the overall socio-economic well-being of the population served.

The project is feasible in terms of its economic rate of return and various favorable impacts to the social and developmental activities in Baguio City and adjacent provinces.

2.7 PROJECT IMPLEMENTATION

Recommended implementation schedule and annual financial requirements broken down into foreign and local currency components are presented in Figure 2-3.

FIGURE 2-3 IMPLEMENTATION SCHEDULE

		1984	1985	1986	1987	1988	1989	1990
Feasibility Study (This Study)		■						
Financing Arrangement for Implementation		■	■					
Detailed Engineering Study (15 months)				■	■			
Tender (6 months)					■			
Construction (36 months)					■	■	■	■
Construction Supervision (36 months)					■	■	■	■
Financial Requirement — October 1983 Price — Unit : Million Pesos	Foreign Component	—	1.47 (1.70)	13.20 (16.09)	10.55 (13.69)	73.85 (101.18)	84.39 (122.61)	42.19 (64.92)
	Local and Tax Component	—	0.79 (1.06)	7.12 (10.52)	6.72 (10.59)	47.00 (79.54)	53.71 (97.25)	26.86 (52.04)
	TOTAL	—	2.26 (2.76)	20.32 (26.61)	17.27 (24.28)	120.85 (180.72)	138.10 (219.86)	69.05 (116.96)

Note : Figure in () shows financial requirement in current price.

3. GENERAL REVIEW OF DISASTER PREVENTION MEASURES

In accordance with the implementing arrangement of the Study, a report entitled "An Approach on Road Disaster Prevention" was prepared. This report basically consolidates the findings of the research works and assessments conducted along the project roads in the course of the Study.

The emphasis of the review was given to the causes and problems on cut slope failures, embankment slope failures, rock falls, landslides, debris flow. Large scale riparians and sabo works were excluded.

This report is organized with the following five (5) parts.

- PART I : GENERAL
- PART II : IDENTIFICATION AND SURVEYS
- PART III : DESIGN OF SLOPES AND SLOPE PROTECTION WORKS
- PART IV : COUNTERMEASURES FOR ROAD DISASTERS
- PART V : ADMINISTRATION AND MAINTENANCE

Road disasters are classified in accordance with their nature as described in Chapter 2 of PART I – CLASSIFICATION OF ROAD DISASTERS,

Potential of disaster spots are evaluated in accordance with the established rating method, with some modifications whenever deemed necessary, discussed in Chapter 3 of PART II – IDENTIFICATION OF ROAD DISASTERS.

The methodology of the surveys and analysis required for identified types of road disaster are presented in Chapter 4 of PART II – SURVEY FOR ROAD DISASTERS.

The outline of design of cut slope, embankment slope, drainage, protection works and retaining wall, which are the most fundamental methods as countermeasures, are discussed from Chapters 5 to 9 of PART III – DESIGN OF SLOPES AND SLOPE PROTECTION WORKS.

The types, the purpose and the application of countermeasures and the procedure in selecting the most appropriate countermeasure for the different types of disaster are discussed in Chapters 10 to 14 of PART IV – COUNTERMEASURES FOR EACH TYPE OF DISASTERS.

The recording of disaster and traffic control and information system during the occurrence of disaster are mentioned in Chapter 15 of PART V – ADMINISTRATION.

Required maintenance works for road disasters including periodical and emergency cases are covered in Chapter 16 of PART V – MAINTENANCE.

IV PROPOSITON BASED ON FINDINGS

It should be realized that the effects of disaster along the roads, without exception, are potential to be grave and severe if no protection works or countermeasures are adopted and can cause a lot of inconveniences or inflict substantial damages to lives and property.

Cognizant of the seriousness of the problems related to road disasters, it would thus be logical at this point to consider ways and means not only in finding immediate solutions, but perhaps in the longer term, a more systematic approach in considering the solutions to the problems. To do this several initial steps are suggested hereunder.

1) RECORD OF DISASTER

The records of heavy rain, typhoon, and calamity should be comprehensive and systematically compiled. These records can provide the basic engineering data to be analyzed for the identification of disaster spots, the frequency of the occurrence of disaster, and the selection of the appropriate countermeasures. The informations to be covered are topography, geology, influence of water, cause and size of road disaster, precipitation and the like.

The format prepared in the study is recommended for this purpose.

2) INVESTIGATION OF DISASTER POTENTIAL SPOT

All spots where failures are likely to occur should be identified and recorded by the concerned agencies. The availability of the data will enable those concerned to prepare and install appropriate warning signs at specific location for the information of the road users. Moreover, with the availability of such records, the engineering approach to the solution of the problem can be developed and corresponding preventive measures can be formulated.

The check table used in the study is recommended for the purpose.

3) PROVISIONAL REMEDIAL MEASURE

The study shows that the main cause of road disaster is water and the simple measures recommended to control water include;

- provision of earth ditch
- provision of drainage facilities for groundwater and spring water such as horizontal drain hole and closed conduits
- utilization of gabion, whenever applicable

4) ROAD ALIGNMENT

As mentioned in sections 1.3 and 2.2, the Maharlika Highway runs parallel to the Philippine Fault as a result of which large scale slope failures have occurred, the protection works needed are more extensive.

In the planning of new road alignment, a more comprehensive route study is suggested. Alternative routes should be evaluated according to the road functions, costs and extent of disaster control works.

5) DISASTERS BEYOND THE SCOPE OF HIGHWAY WORKS

Some spots along the existing roads are heavily damaged mainly due to meandering or altering river channel, large scale debris flow, devastation of hillside caused by mining activities, etc. Countermeasures to solve these problems normally involve large scale riparian works, sabo dam, hillside works, etc., which are all beyond scope of highway works. In such cases, it is recommended that coordination with various sectors and/or agencies concerned be initiated as soon as possible to prevent further damage on the road section. For new highways, these problems should be anticipated and considered in the overall project implementation.

PART A INTRODUCTION

	Page
CHAPTER 1 INTRODUCTION	1
1.1 BACKGROUND	1
1.2 OBJECTIVES	1
1.3 SCOPE OF WORK	2
1.3.1 Project Roads	2
1.3.2 Road Disasters Subject to the Study	2
1.4 EXECUTION OF THE STUDY	2
1.4.1 Organization of the Study	2
1.4.2 Study Approach	4
1.5 REPORTS	4

CHAPTER 1

INTRODUCTION



1.1 BACKGROUND

The Government of Republic of the Philippines (GOP) has long been emphasizing the development of trunk roads in view of their importance as a vital infrastructure of the nation's social and economic activities. Owing to the efforts, the total length of national roads expanded from 21,260 kilometers in 1975 to 23,960 kilometers in 1982, marking a growth of 1.13 times in seven years.

Despite the fact, however, that a quantitative expansion of trunk roads has been realized, the qualitative improvement of the roads is still far from adequate. There is in fact an increase in landslide, slope failures, rock falls and other road disasters caused by typhoons and heavy rains and resulting in interrupted traffic. Since only temporary measures such as removal of collapsed earth on a road to let traffic through have been effected to counter such disasters and no basic measures have been implemented, the same road disasters are occurring every year.

In the Philippines, where 90 percent of passenger transport and 60 percent of cargo transport depend on roads, road disasters and accompanying traffic interruption not only endanger road user's lives, but also cause damaging effects to the country's socio-economic activities and necessitate huge government expenditures on restoration work.

With the recognition of its importance, GOP has planned the formulation of a long term road disaster prevention program. The prerequisite to such program formulation is the introduction of techniques for identifying spots with a high potential of disaster and for the selection, designing, and evaluation of control works.

In June 1982, GOP requested the Government of Japan (GOJ) to execute the present Study. GOJ through the Japan International Cooperation Agency (JICA), which implements technical cooperation programs, dispatched a preliminary survey mission to the Philippines in February 1983 and defined the scope of work together with GOP. A Study team composed of the members of the JICA consultant team and a counterpart Philippine team was organized in May 1983 and the Study was executed by the Study Team.

1.2 OBJECTIVE OF THE STUDY

The objectives of this study are:

- a) To identify the sections with high incidence of disasters or those with such possibilities along the project roads.
- b) To prepare a program for implementation of the recommended countermeasures along the selected sections.
- c) To develop techniques of road disaster prevention.

1.3 SCOPE OF WORK

1.3.1 Project Roads

Project Roads under Phase-I are as follows (refer to Location Map);

- Maharlika Highway (Luzon, Samar and Leyte sections only)	1,530 kilometers
- Kennon Road	34 kilometers
- Naguilian Road	47 kilometers
- Agoo-Baguio Road (Marcos Highway)	49 kilometers
<hr/>	
TOTAL	1,660 kilometers

The Study Area consists of the three islands of Luzon, Samar and Leyte.

The Phase-II Study Sections are selected on the basis of Phase-I results. The influence zones of the F/S sections are determined mainly on the basis of origin-destination survey results. The zones are called the Project Areas.

1.3.2 Road Disasters Subject to Study

All road disasters which occur on Project Roads, namely slope failures, rock falls, landslide, scouring and debris flow, are subject to this Study. However, those requiring large-scale riparian or sabo work are excluded.

1.4 EXECUTION OF THE STUDY

1.4.1 Organization of the Study

The study was undertaken by the Study Team composed of Japanese Consultants from JICA and local counterpart members from the Project Management Office -Feasibility Studies- of the Ministry of Public Works and Highways (MPWH).

The Study Team was guided by the Steering Committee of the Government of the Republic of the Philippines and the Supervisory Committee of the Government of Japan.

Most of the work for the Study was done in the Philippines up to the completion of the Draft Final Report to enable the effective transfer of technology from the Japanese Consultants to the local counterpart members.

The organization diagram with names of members of the Steering Committee, the Supervisory Committee, the Japanese and the Local Counterpart Study Team is shown in Figure 1.4-1.

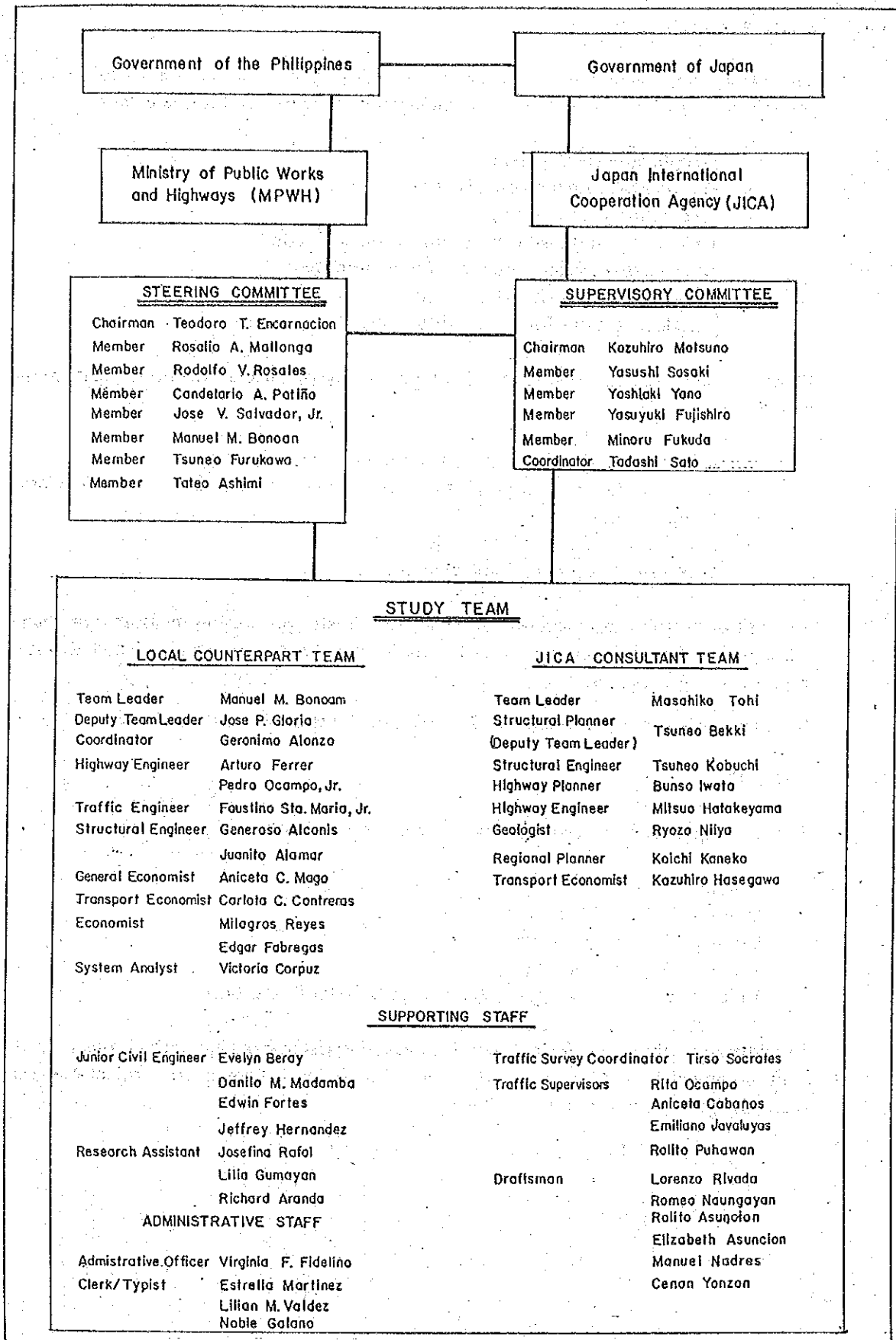


FIGURE 1.4-1 ORGANIZATION DIAGRAM

1.4.2 Study Approach

The Study was divided into two (2) phases. The Phase-I Study was to select high priority sections for a feasibility study. Main study activities in this phase were;

- To collect necessary data
- To undertake field reconnaissance
- To conduct traffic survey
- To identify all disaster spots along Project Roads
- To evaluate disaster potential of each section
- To determine priority of each section
- To select sections for a feasibility study

Phase-II Study was to undertake a feasibility study of selected Sections. Main study activities were;

- to undertake the geo-technical and the topographic surveys
- to select the most appropriate countermeasures as well as to conduct preliminary design
- to evaluate viability of the project
- to prepare the project implementation program

In addition to these studies, general review on disaster prevention measures was made through the Phase-I and the Phase-II Studies and "An Approach to Road Disaster Prevention " was prepared.

In general procedure to achieve the objectives of the study is illustrated in Figure 1.4-2.

1.5 REPORTS

The final report is organized with the following five (5) volumes;

- Volume I : Executive Summary
- Volume II : Main Text
- Volume III : Appendix
- Volume IV : Drawings
- Volume V : An Approach on Road Disaster Prevention

In addition to the Final Report, check tables of disaster spots along the Project Roads were compiled in a volume in September 1983, which is kept in the Project Management Office -Feasibility Study -, MPWH.

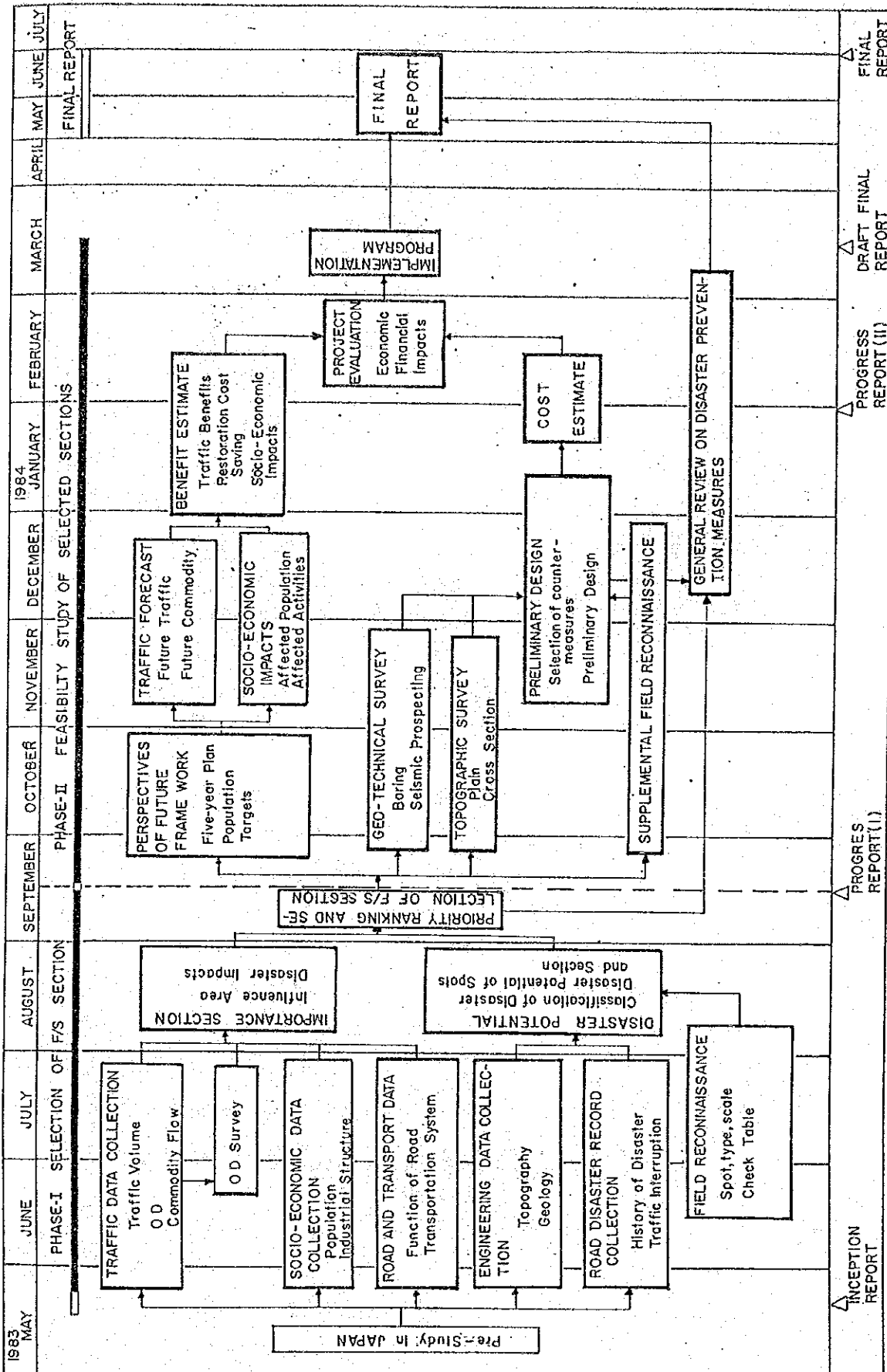


FIGURE 1.4.2 STUDY FLOW DIAGRAM

PART B SELECTION OF FEASIBILITY SECTIONS

	Page
CAPTER 2 SIGNIFICANCE OF PROJECT ROADS	7
2.1 DEPENDENCE OF ROAD TRANSPORT	7
2.2 TRUNK ROAD NETWORK	8
2.2.1 Development Level	8
2.2.2 Trunk Road Network	8
2.3 MAHARLICA HIGHWAY	12
2.3.1 General Description	12
2.3.2 Significance	12
2.4 PROJECT ROADS LEADING TO BAGUIO	14
2.4.1 General Description of Baguio City	14
2.4.2 General Description of the Project Roads Leading to Baguio	14
2.4.3 Functions of the Three Roads	15
2.5 IMPORTANCE OF DISASTER CONTROL	16
CHAPTER 3 PROFILE OF STUDY AREA	19
3.1 NATURE	19
3.1.1 Topography and Geology	19
3.1.2 Climate	23
3.2 POPULATION	25
3.2.1 National and Regional Demographic Trend	25
3.2.2 Population Distribution	25
3.3 ECONOMY	29
3.3.1 National Economy	29
3.3.2 Regional Economy	30
CHAPTER 4 ROAD FACILITIES AND TRAFFIC CHARACTERISTICS	33
4.1 TRAFFIC FACILITIES	33
4.1.1 Road Traffic Facilities	33
4.1.2 Other Traffic Facilities	34
4.2 TRAFFIC CHARACTERISTICS	36
4.2.1 Traffic Data	36
4.2.2 Traffic Characteristics	40
4.3 ROAD NETWORK ISSUES	52

	Page
CHAPTER 5 ROAD DISASTER	55
5.1 IDENTIFICATION PROCEDURE	55
5.2 CLASSIFICATION OF ROAD DISASTERS	55
5.2.1 Cut Slope Failures (including natural slopes)	56
5.2.2 Embankment Slope Failures (including natural slopes)	56
5.2.3 Falls	62
5.2.4 Landslides	62
5.2.5 Debris Flows	63
5.2.6 Others	63
5.3 IDENTIFICATION AND EVALUATION OF SPOTS	63
5.3.1 Identification of Spots with Disaster Potential	63
5.3.2 Evaluation of Disaster Potential	66
5.3.3 Distribution of Spots with Disaster Potential	68
5.4 CAUSES OF ROAD DISASTER	68
5.5 ROAD DISASTER AND RAINFALL	72
5.6 CURRENT RESTORATION OF DISASTER	75
5.6.1 Procedure to Restore Disasters	75
5.6.2 Current Restoration Work	76
5.6.3 Fund for Restoration Work	77
5.6.4 Problems on Disaster Restoration	77
CHAPTER 6 SELECTION OF FEASIBILITY STUDY SECTIONS ..	79
6.1 APPROACH OF SELECTION OF F/S SECTIONS	79
6.1.1 Procedure	79
6.2 ESTABLISHMENT OF SECTIONS	81
6.3 EVALUATION OF DISASTER POTENTIAL OF SECTION ..	86
6.3.1 Evaluation of Disaster Potential of Spot	86
6.3.2 Evaluation of Disaster Potential of Section	86
6.4 EVALUATION OF IMPORTANCE OF ROAD SECTIONS ..	90
6.4.1 Methodology	90
6.4.2 Assessment by Factor	90
6.4.3 Overall Evaluation	92
6.5 PRIORITY OF SECTIONS AND SELECTION OF SECTIONS FOR FEASIBILITY STUDY	95
6.5.1 Ranking of Section Based on Disaster Potential and Importance	95
6.5.2 Selection of Sections for Feasibility Study	95

CHAPTER 2

SIGNIFICANCE OF PROJECT ROADS

2.1 DEPENDENCE ON ROAD TRANSPORT

Transport in the Philippines consists of sea, road, rail and air. Table 2.1-1 gives transport volumes in 1980 by transport mode. The dominant mode is road, which accounts for 90 percent of passenger transport and 65 percent of freight transport. Despite the fact that the Philippines, made up of about 7,100 islands, depend largely on sea for inter-island transport, dependence on road transport is stronger than on sea. Moreover, intra-island (coastal) freight transport represents only 6 percent of domestic sea freight; the rest are all inter-island cargo. Hence, a major proportion (97 percent) of intra-island freight transport depends on roads.

Rail transport peaked out in the 1960s and is now on a downward trend. The shift from rail to road transport has been marked since trunk roads became paved. Intra-island sea transport is also gradually giving way to road transport along with the development of trunk roads, as can be seen in the fact that the sea transport service between Manila and Bicol was terminated several years ago. It is thus obvious that both passenger and freight transport will continue to rely heavily on roads even in the future.

Given the strong dependence on road transport in this country, making effective use of existing roads is as important as implementing further developments of road networks in order to maintain the healthy state of the country's socio-economic activities.

TABLE 2.1-1 APPROXIMATE NATIONAL MODAL SPLIT, 1980 (DOMESTIC TRAFFIC ONLY)

Mode	Freight		Passenger	
	Ton-Kilometers (Billion)	Share (%)	Passenger-Kilometers (Billion)	Share (%)
Sea	12	(35)	4	(7)
Road	22	(65)	53	(90)
Rail	0.04	(-)	0.4	(1)
Air	Negligible	(-)	1.2	(2)

Source: NTPP