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REPUBLIC OF THE PHILIPPINES
MINISTRY OF PUBLIC WORKS & HIGHWAYS

THE FEASIBILITY STUDY OF PHILIPPINE ROAD DISASTER PREVENTION PROJECT

STAGE II

FINAL REPORT

TEXT

(VOLUME II)

JULY, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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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 Stage II which focused on the disaster spots along the Maharlika Highway and main national roads around Baguio City, and entrusted the study to the Japan International Cooperation Agency (JICA).

The feasibility study on Stage I was started in May 1983 and completed in June 1984 on the following three sections which claimed the highest priority, namely: i) Dalton Pass section; ii) Mahaplag – Sogod section (both along the Maharlika Highway); and iii) Kennon Road.

Based on the Stage I Study, the Stage II Study has placed priority on the following three sections namely: i) Lucena – Calauag section, ii) Allen – Calbayog section (both along the Maharlika Highway), and iii) Naguilian Road, and the JICA sent to the Philippines a survey team headed by Mr. Tsuneo Bekki from October 1984 to March 1985.

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

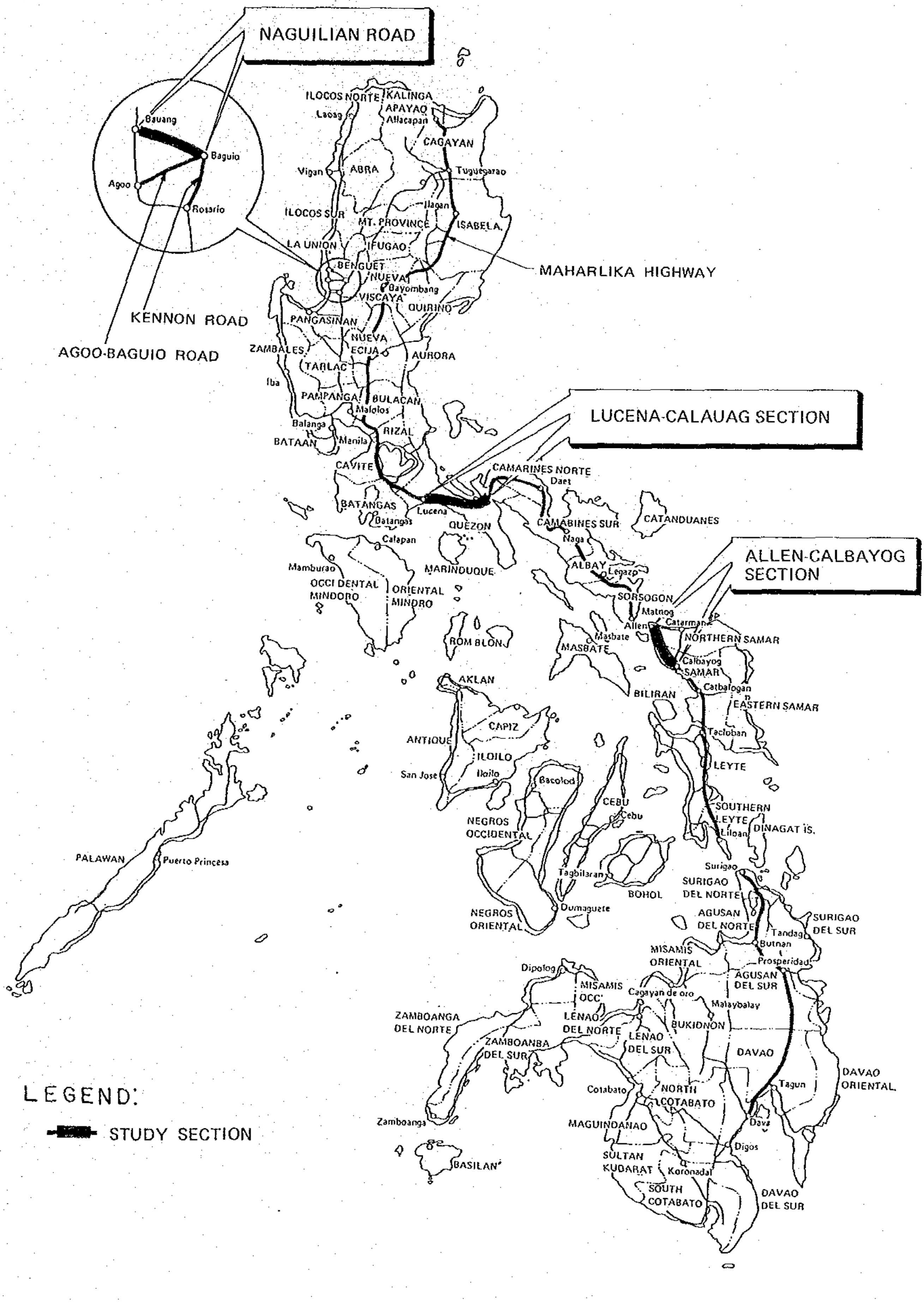
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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.

July, 1985

Keisuke Arita
President
Japan International Cooperation Agency

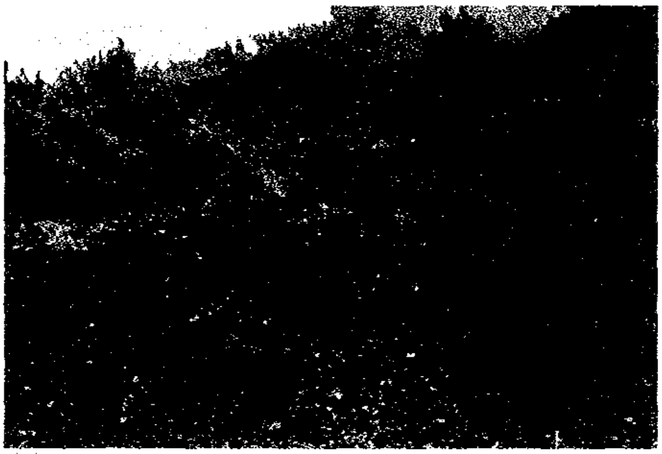
LOCATION MAP



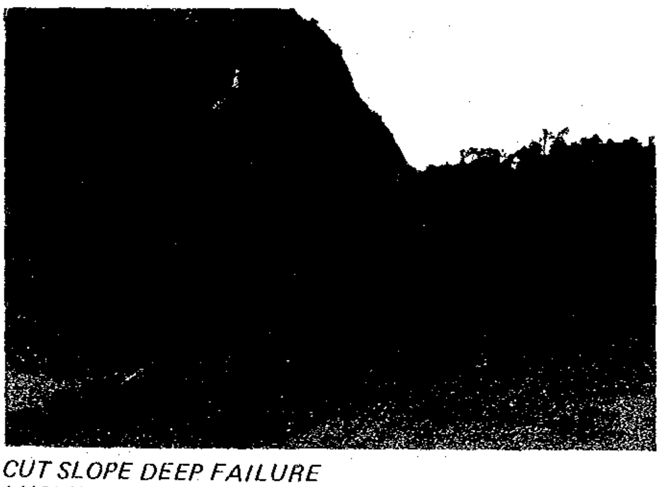
LEGEND:

STUDY SECTION

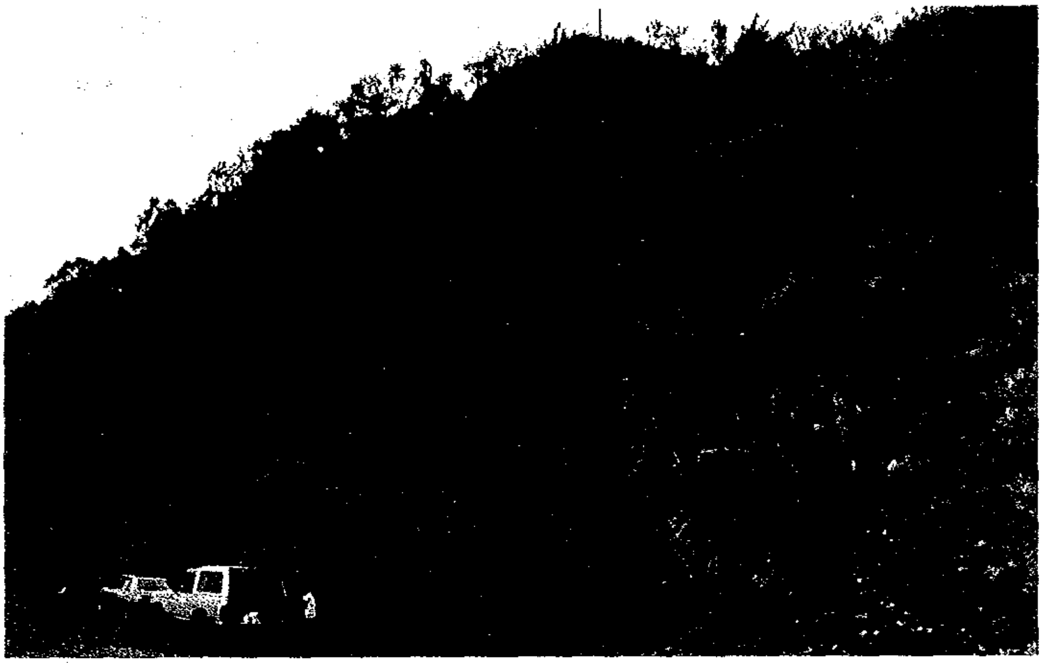
CUT (NATURAL) SLOPE SURFACE FAILURE
NAGUILIAN ROAD
km 294 + 800



CUT SLOPE DEEP FAILURE
NAGUILIAN ROAD
km 281 + 500



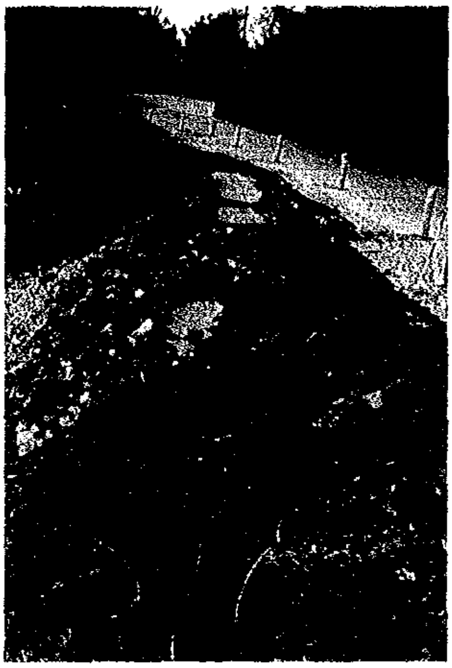
CUT SLOPE DEEP FAILURE
LUCENA – CALAUAG SECTION
km 158 + 500



FALLS
NAGUILIAN ROAD
km 294 + 100

FALLS
LUCENA – CALAUAG SECTION
km 153 + 900

FALLS
ALLEN – CALBAYOG SECTION
km 705 + 600



EMBANKMENT SLOPE DEEP FAILURE
NAGUILIAN ROAD
km 286 + 600

LANDSLIDE
LUCENA – CALAUAG SECTION
km 160 + 800

DEBRIS FLOW
ALLEN – CALBAYOG SECTION
km 718 + 100

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SUMMARY AND RECOMENDATIONS

I INTRODUCTION

1. BACKGROUND

The government of Republic of the Philippines (GOP) has long been emphasizing the development of trunk roads in view of their importance to the overall socio-economic development program of the country. This has been manifested by the present network which could now be considered as sufficient in extent and location. Owing to the efforts, a quantitative expansion of trunk roads has been realized. 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 impair the efficiency of the road transport system. Such disasters are eagerly desired to be resolved in order not to hamper the socio-economic activities in the country.

In the recognition to the importance of road disaster prevention, GOP has planned the formulation of a long term program for which the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) provided technical assistance in the formulation of the same under the Feasibility Study of the Philippine Road Disaster Prevention Project (Stage I), hereinafter called as the Stage I Study.

The Stage I Study which started in May 1983 and completed in June 1984, was implemented in two phases; Phase I, was focused in the identification of disaster spots and prioritization of disaster sections along four national roads namely:
i) Maharlika Highway (Luzon and Samar, Leyte section only); ii) Kennon Road; iii) Agoo-Baguio City Road; iv) Naguilian Road. On the basis of the prioritized sections, Phase II was conducted for the feasibility studies of only three specific sections under category A namely; i) Dalton Pass section; ii) Mahaplag-Sogod section (both along the Maharlika Highway); and iii) Kennon Road.

Drawn from the experience and the results and recommendations from the Stage I Study, the seriousness of the related problems have been exemplified and their immediate solutions emphasized so that further deterioration and/or eventual disaster in these sections could be avoided. On this premise, therefore, the Government of the Philippines is more than ever determined to pursue the implementation of the initial road disaster prevention program and at the same continue further in the conduct of feasibility studies for the other identified disaster potential sections along the above mentioned road network.

Thus, the GOP has requested the GOJ to provide technical assistance for the conduct of "the Philippine Road Disaster Prevention Project (Stage II)', hereinafter referred to as "the Study", which aims to undertake feasibility studies of the specific remaining sections of the above mentioned road network. In response to this request, the GOJ determined to provide technical assistance through the JICA.

The implementing arrangement for the said technical assistance was signed in August 1984 between the JICA and the GOP represented by the Ministry of Public Works and Highways (MPWH) as the implementing agency. The Study started in October 1984 and completed in June 1985.

2. OBJECTIVES OF THE STUDY

The objectives of the Study are to:

1) Assess the disaster potential and recommend countermeasures along the relevant project roads/sections.
2) Prepare a program for implementation for the disasters prevention.
3) Develop techniques of road disaster prevention.

3. PROJECT ROAD/SECTIONS

1) Lucena—Calauag Section (Region IV)
2) Allen—Calbayog Section (Region VIII)
3) Naguilian Road (Region I)

4. SCOPE OF THE STUDY

Subject to the Study are slope failures, rock falls, landslides, debris flow, scourings and other disasters on the said roads/sections. Large scale riparian and sabo works are excluded.

5. REPORTS

The following reports were prepared during the Study

INCEPTION REPORT
INTERIM REPORT
DRAFT FINAL REPORT

The Final Report was developed based on the GOP's comments on the draft final report, and presented in four (4) volumes as follows;

VOLUME I	:	EXECUTIVE SUMMARY
VOLUME II	:	TEXT
VOLUME III	:	APPENDIX
VOLUME IV	:	DRAWINGS

The Study was carried out jointly by a team composed of seven 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 Advisory Committee of Japan, both were especially created to oversee the overall implementation of the Study.

II FINDINGS AND RECOMMENDATIONS

IMPORTANCE OF ROAD DISASTER PREVENTION

The overall transport system of the country is highly dependent upon road transport which is at present catering for 97 percent of intra-island passenger and 60 percent of commodity transport demand. However, the efficiency of the system particularly with the role of the trunk roads is interfered due to road disasters, among others, causing substantial detrimental impacts upon the economic and socio activities of the nation.

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 appropriate disaster prevention measures, the scope of potential disaster will be aggravated and some road sections are liable to be completely destroyed beyond economic restoration measures before long, resulting in necessitating huge government expenditures.

Measures to prevent disaster damage on trunk roads are, therefore, of a vital and urgent issue in view of the above.

PROMOTION OF ROAD DISASTER PREVENTION PROJECT

The existing trunk roads as developed have not been provided, if at all, significant protection against disasters, where these are required. Due to the susceptivity of the roads to disasters and in view of 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.

Road disaster prevention project can secure the functions of these important roads by improving their reliability to the users. Such project will result in the ensurance against road closures with reasonable investments, which 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 project should be positively considered and actively implemented.

1. BASIC INFORMATIONS

LENGTH OF STUDY SECTIONS

	Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road	Total
Section Length (km.)	95.7	72.9	47.2	215.8

NUMBER OF DESIGN DISASTER SPOTS

Type of Disaster	Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road	Total
Cut Slope Failure	1	1	5	7
Embankment Slope Failure	1	2	5	8
Fall	4	9	5	18
Landslide	1	—	—	1
Debris Flow	—	2	—	2
Total	7	14	15	36

PROJECT COSTS

Unit: Million Pesos

			Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road	Total
November 1984 Price	Detailed Engineering	Foreign	—	—	—	2.97
		Local/Tax	—	—	—	1.60
		Total	—	—	—	4.57
	Construction 1/	Foreign	13.44	16.82	9.54	39.80
		Local/Tax	8.89	11.01	5.66	25.56
		Total	22.33	27.83	15.20	65.36
	Construction Supervision	Foreign	—	—	—	2.97
		Local/Tax	—	—	—	1.60
		Total	—	—	—	4.57
	Total	Foreign	—	—	—	45.74
		Local/Tax	—	—	—	28.76
		Total	—	—	—	74.50
Current Price 2/	Detailed Engineering	Foreign	—	—	—	3.98
		Local/Tax	—	—	—	2.97
		Total	—	—	—	6.95
	Construction	Foreign	19.98	25.01	14.19	59.17
		Local/Tax	18.53	22.95	11.79	53.27
		Total	38.51	47.96	25.98	112.45
	Construction Supervision	Foreign	—	—	—	3.98
		Local/Tax	—	—	—	2.97
		Total	—	—	—	6.95
	Total	Foreign	—	—	—	67.59
		Local/Tax	—	—	—	59.58
		Total	—	—	—	127.17

1/ Includes 10% physical contingency.
2/ 1984 prices are escalated.

INTERNAL RATE OF RETURN

	Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road
IRR (%)	16.0	14.4	15.4

2. RECOMMENDATION

The evaluation for the three study sections have proven that the projects are technically, economically and financially feasible. The project evaluation result is summarized in Table-A.

It is, therefore, recommended that disaster prevention project on the three study sections be implemented in the earliest possible time. 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 incuring greater costs to the economy.

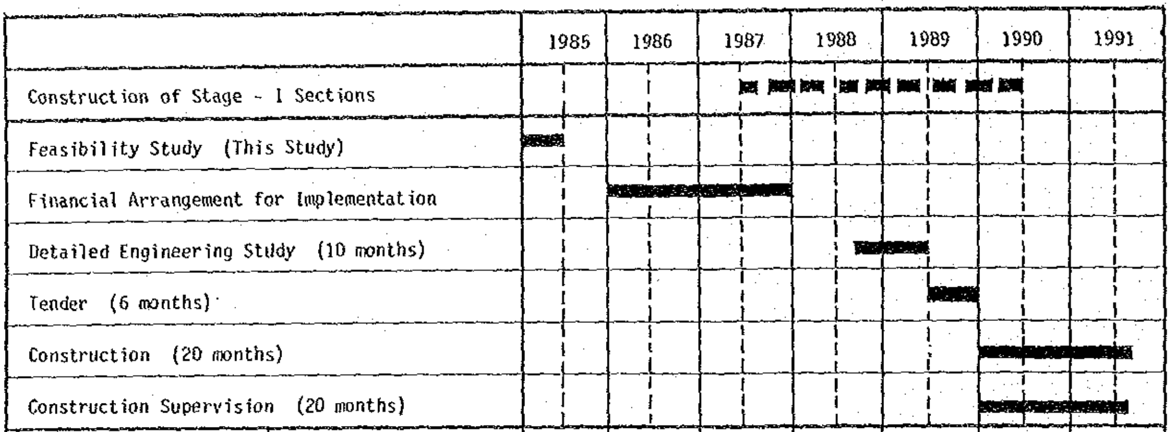
TABLE-A PROJECT EVALUATION

	Technical Evaluation	Economic Evaluation	Financial Evaluation
Lucena-Calauag Section	• 7 spots with high disaster potentials. • Fast aggravation of disaster condition because of limestone. • 8 days of traffic interruption a year. • Necessity of immediate restoration work. • Practically no detour road.	• IRR = 16.0%. • Provided the only access to the Bicol Region. • Vitally supports socio-economic activities and development of Quezon Province and Bicol Region.	• 3-year implementation period (mid 1988-mid 1991) assumed. • 1.5-year construction period 1990-mid 1991) assumed.
Allen-Calbayog Section	• 14 spots with high disaster potentials • Fast aggravation of disaster condition because of alternative layer of rocks. • 9 days of traffic interruption a year. • Necessity of chronic maintenance and restoration work. • No reliable detour road.	• IRR = 14.4%. • The only trunk road in Samar Island. • Daily life of Northern Samar's citizens relied on. • Efficient operation of ferry service between Luzon and Samar depended upon.	• Maximum annual financial requirement be 70.3 million pesos in 1990. • Maximum annual financial requirement of local portion estimated at 33.0 million pesos is within the Government funding capability.
Naguilian Road	• 15 spots with high disaster potentials. • Entire cut of road. • 4 days of traffic interruption a year. • Urgency of restoration work. • No access for inhabitants along road.	• IRR = 15.4%. • Transportation of daily consumption goods in Baguio relied on. • Commuting of more than 3,400 workers and students depended upon.	• Foreign funds for foreign cost component recommended.

3. PROJECT IMPLEMENTATION

Successive implementation of the Stage I Sections and the Stage II Sections is recommended. As construction work of Stage I Sections was targeted to the completed in 1990, it is recommended that construction work of the Stage II Sections be started in 1990. Recommended implementation schedule and annual financial investment program are shown in Table-B.

TABLE B IMPLEMENTATION SCHEDULE



Financial Requirement - November 1984 Price - (Unit : Million ¥)		1985	1986	1987	1988	1989	1990	1991
	Foreign Component				1.19 (1.54)	1.78 (2.44)	25.66 (37.27)	17.11 (26.34)
	Local/Tax Component				0.64 (1.14)	0.96 (1.83)	16.29 (33.03)	10.87 (23.58)
	Total				1.83 (2.68)	2.74 (4.27)	41.95 (70.30)	27.98 (49.92)

Note: Figure in ( ) shows financial requirement in current price.
Annual escalation rate (%)

Year	1985	1986	1987	1988	1989～1991
Foreign Component	7.5	7.0	6.0	6.0	6.0
Local Component	25.0	15.0	12.0	10.0	7.0

III SUMMARY

1. STUDY SECTIONS

For general location of the study sections, please see Figure 1.1 which also indicate basic information along the respective influence areas.

Lucena—Calauag Section

The Bicol Region in the southern most part of Luzon is connected by land transport with Metro Manila and the rest of the island only thru the Maharlika Highway. The project section, Lucena—Calauag Section is located at the gateway of the Bicol Region. Although there are other transport modes such as rail, sea and air, none of these pose any significant competition with road transport, despite the fact that there is only one road access to the region.

In actuality, the whole section is located in the province of Quezon within the Southern Tagalog Region. It starts from the southern end of South Sierra Madre Range in Lucena and extends up to the northern part of the Bondoc Peninsula in Calauag. The whole section is approximately 96 km. The Philippine Fault runs on the east of the Bondoc Peninsula and by Calauag. The section between Pagbilao—Atimonan runs through a rolling or mountainous terrain for about 30 kilometers. The spots with high disaster potential are concentrated in this mountainous section. Other than this mountainous section the topography of the section is generally flat.

The geology of this section is generally made up of the rocks formed during the Oligocene era, when land upheavals and submergences formed the present shape of the Philippines. They are chiefly sandstone and limestone and occasionally andesite and mudstone.

The broad influence area considered for this section covers about 650 kilometers from Metro Manila to the southern end of Bicol Region.

This section is functioning as a major inter-regional trunk road with heavy passenger and commodity movements serving long distance trips.

Allen—Calbayog Section

This section is located in the Samar Island along the existing coastal alignment starting from Allen to the outskirts of Calbayog City, extending about 73 km. The Samar Island generally consists of hills at an elevation of about 800 meters above sea level without any obvious range and a developed coastal terrace.

The geology of this section is mainly sandstone, with some limestone, andesite and shale. Sandstone is of an old origin, dating back to the Mesozoic Cretaceuous to the Palaeogene, and is therefore hard but has developed cracks caused by the diastrophism which continued for a long time. Thus, the sandstone is prone to fall in large pieces.

Again, the Maharlika Highway which include the Allen—Calbayog Section is the trunk road in Samar Island which also serves as the main route linking the Island with Luzon and Leyte Islands. The influence area considered in the assessment of the section has been limited to Northern Samar, Western Samar and Northern Leyte areas only.

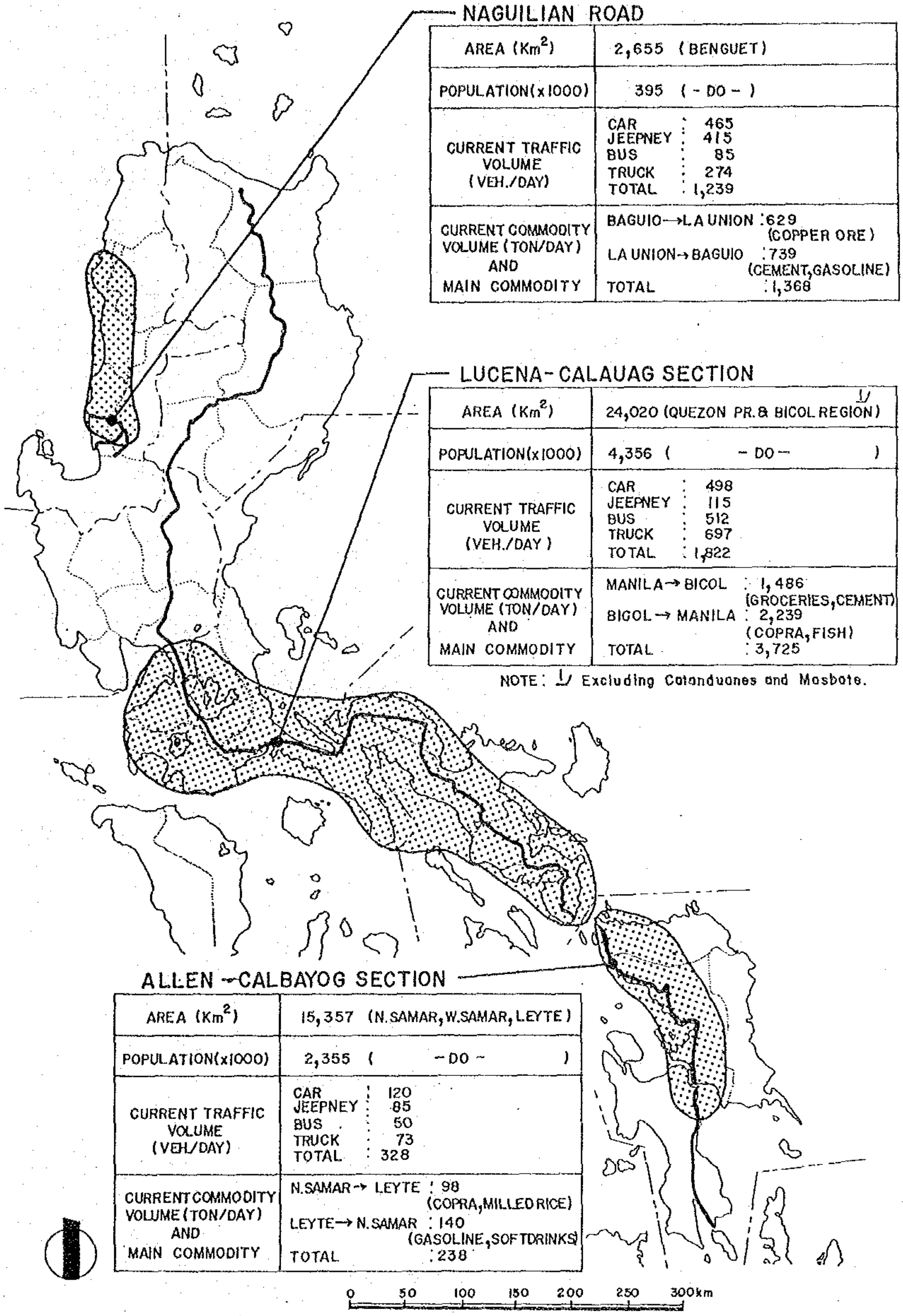
At present, the section is functioning as a secondary trunk road. However, when the development efforts currently pursued by the Government for depressed areas of Samar and Leyte would have been realized, the interlinkages between these islands with the rest of the country and that of Metro Manila will certainly become more important and thus the section will consequently function as a major inter-regional trunk road in the network.

Naguilian Road

The Naguilian Road is situated in the northern part of Luzon island. It is one of the three roads leading to Baguio City, the summer resort of the country. It starts in Bauang, La Union and runs through a rolling terrain for about 16 kilometers and from there on to Baguio City it runs through a mountainous area for about 31 kilometers with difference in elevation of about 1400 meters. With the torrential rains peculiar to Baguio area, moreover, slope failures have been experienced as the road was constructed mostly on the steep mountain slopes.

The geology of this section is chiefly tuff, tuff breccia, conglomerate, limestone and sandstone.

Although this road can be classified only as a secondary trunk road due to predominant medium distance traffic which is mainly between Baguio City and San Fernando, La Union, this road, nevertheless, has a very important role to the overall trnasport demand of the areas served. It is this road that is mainly used for the transport of bulk cargoes to and from Baguio City. Furthermore, of the three roads leading to Baguio City, namely the Kennon Road, the Agoo-Baguio Road and the Naguilian Road, the Naguilian Road offers better geometrical standard and at present the most stable route in terms of road disasters.



NAGUILIAN ROAD

AREA (Km^2)	2,655 (BENGUET)
POPULATION(x1000)	395 (- DO -)
CURRENT TRAFFIC VOLUME (VEH./DAY)	CAR : 465 JEEPNEY : 415 BUS : 85 TRUCK : 274 TOTAL : 1,239
CURRENT COMMODITY VOLUME (TON/DAY) AND MAIN COMMODITY	BAGUIO→LA UNION : 629 (COPPER ORE) LA UNION→BAGUIO : 739 (CEMENT, GASOLINE) TOTAL : 1,368

LUCENA - CALAUAG SECTION

AREA (Km^2)	24,020 (QUEZON PR. & BICOL REGION) 1/
POPULATION(x1000)	4,356 (- DO -)
CURRENT TRAFFIC VOLUME (VEH./DAY)	CAR : 498 JEEPNEY : 115 BUS : 512 TRUCK : 697 TOTAL : 1,822
CURRENT COMMODITY VOLUME (TON/DAY) AND MAIN COMMODITY	MANILA→BICOL : 1,486 (GROCERIES, CEMENT) BICOL→MANILA : 2,239 (COPRA, FISH) TOTAL : 3,725

NOTE: 1/ Excluding Catanduanes and Masbate.

ALLEN - CALBAYOG SECTION

AREA (Km^2)	15,357 (N.SAMAR, W.SAMAR, LEYTE)
POPULATION(x1000)	2,355 (- DO -)
CURRENT TRAFFIC VOLUME (VEH/DAY)	CAR : 120 JEEPNEY : 85 BUS : 50 TRUCK : 73 TOTAL : 328
CURRENT COMMODITY VOLUME (TON/DAY) AND MAIN COMMODITY	N.SAMAR→LEYTE : 98 (COPRA, MILLED RICE) LEYTE→N.SAMAR : 140 (GASOLINE, SOFTDRINKS) TOTAL : 238

FIGURE 1-1 INFLUENCE AREA OF STUDY SECTION

2. FUTURE TRAFFIC

Figure 2-1 presents in graphical form the estimated present and future traffic and commodity volume along the study sections.

Lucena—Calauag Section

The current traffic through the Pagbilao—Atimonan Sub-section is 1,822 vehicles/day. This traffic is estimated to increase at an average annual growth rate of 4.8 percent during the period of 1984—2015. Traffic volume will therefore, reach about 7,700 vehicles/day in the year 2015. Growth of traffic during the 1990s and thereafter is expected to be slightly higher than in the 1980s. This based on the assumptions that the overall trend of the Philippine economy in the 1980s will be the decade for transition period for economic recovery and the economy will remain stable after 1990. The present volume of commodity transported is about 3,725 tons/day. This is estimated to increase to 16,807 tons/day in the year 2015.

Allen—Calbayog Section

The present traffic passing thru the Allen—Calbayog Section is relatively low at about 328 vehicles/day. It is however expected to increase at an average annual growth rate at 5.3 percent up to year 2015 when the traffic at that time is estimated to be about 1,600 vehicles/day. Although the growth of passenger car traffic is higher than that of other vehicles types, over 80 percent of passenger transport on this section will still rely on the public transportation up to year 2015. Commodity flow through this section is currently about 238 tons/day. This is expected to increase at 5.5 percent average annual growth rate up to year 2015 when the volume of commodity transported would then be about 1,245 tons/day.

Naguilian Road

The current traffic on the Naguilian Road is about 1,239 vehicles/day which is increasing at an average annual growth rate of 5.2 percent up to the year 2015. This will mean that by year 2015 an average 6,000 vehicles/day would be travelling along the project section. The traffic capacity of the Naguilian Road is rather small compared to the ordinary two-lane roads due to its narrow roadway width and steep vertical gradient. Traffic volume of 6,000 vehicles/day in 2015 will be closed to the maximum traffic the road would be able to accomodate.

The current commodity flow of 1,368 tons/day will increase to 7,935 tons/day in the year 2015. Average annual growth rate of 5.8 percent will be the highest among three Study Sections.

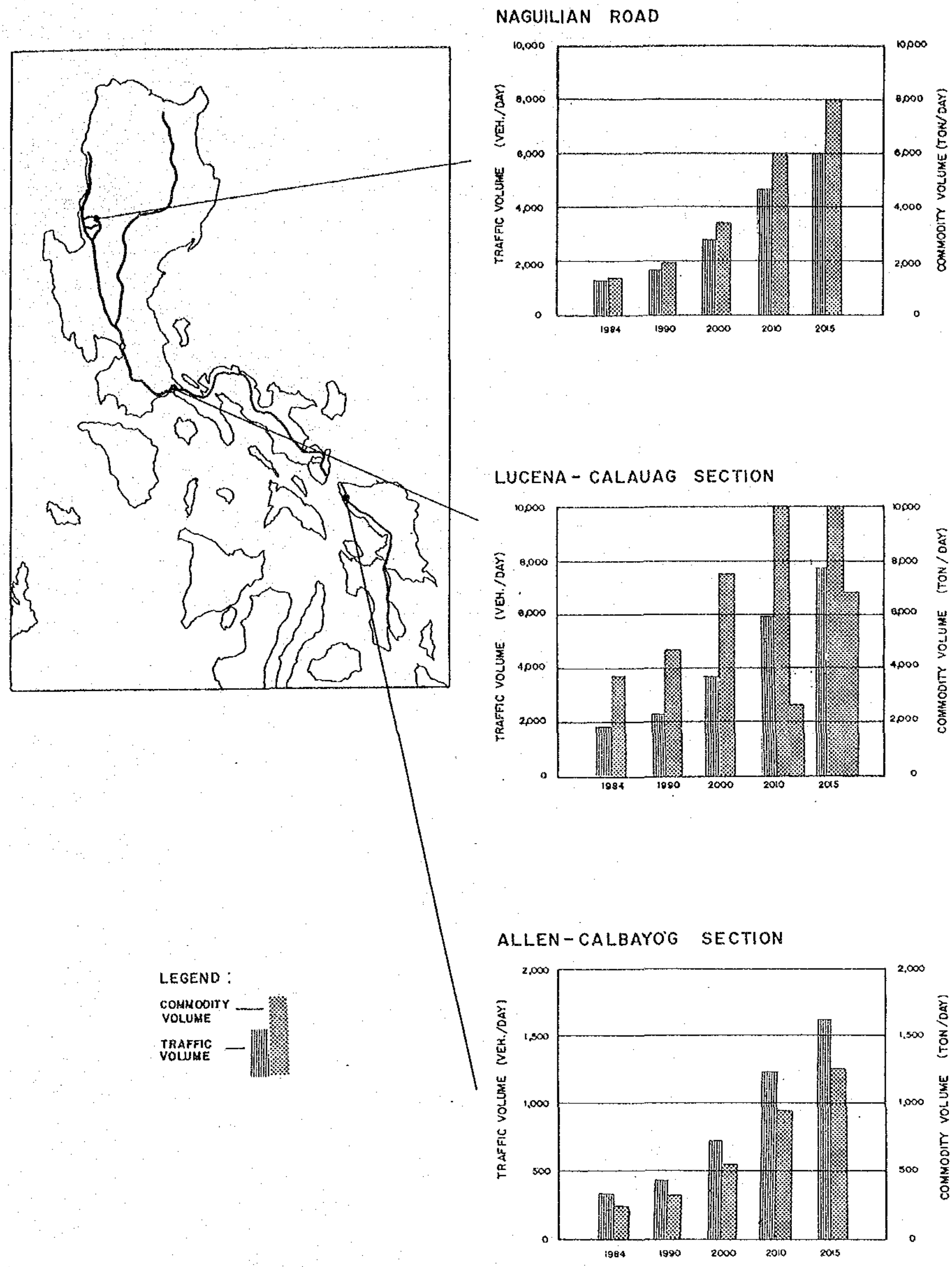


FIGURE 2-1 FUTURE TRAFFIC/COMMODITY VOLUME

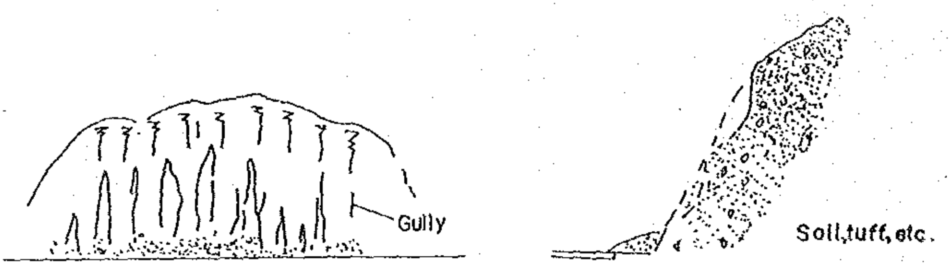
3. IDENTIFICATION OF ROAD DISASTERS

3.1 TYPES OF ROAD DISASTERS

Road disaster were classified into five types based generally on the shapes of failures which were assessed through visual inspection and land and geo-technical surveys.

Cut Slope Failure

This type is sub-classified into surface and deep failures. Surface failures are generally caused by erosion, weathering and structural weakness while deep failures are caused by scouring, rotational and translation failures. See Figure 3-1.



(a) (b)

Surface Failure due to erosion

(c) (d)

Deep Failure due to scouring

FIGURE 3-1 CUT SLOPE FAILURE

Embankment Slope Failure

This type is sub-classified into surface failure due to erosion and deep failure due to scouring and saturation. See Figure 3-2.

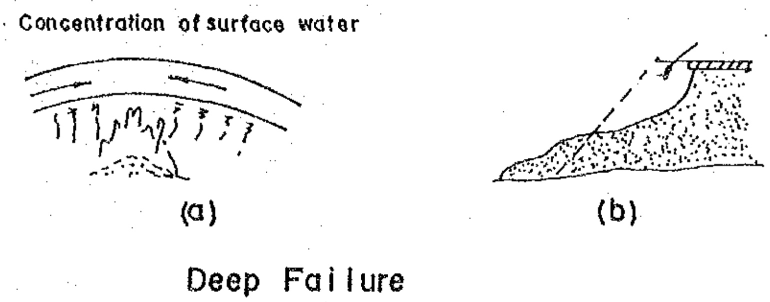


FIGURE 3-2 EMBANKMENT SLOPE FAILURE

Fall

This type is sub-classified into rock and debris falls. The former is free fall of rocks detached from bedrocks, while the latter in that of unsupported pebbles, cobbles, and boulders on a slope. See Figure 3-3.

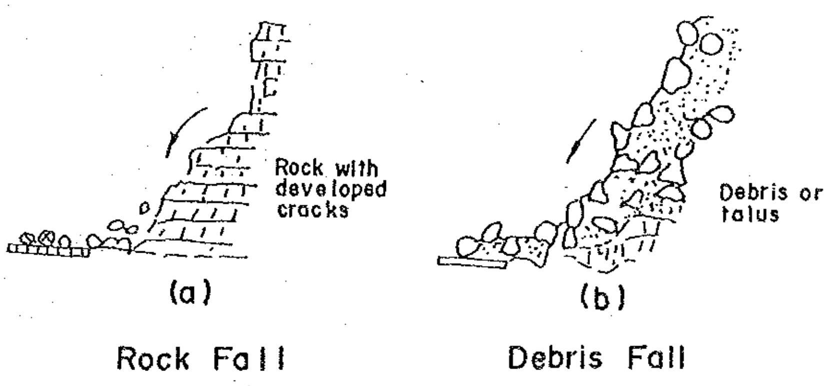


FIGURE 3-3 FALL

Landslide

Landslide is caused by loss of balance between shear strength of materials and movement force along a specific slide plane. This type is sub-classified into rock and soil landslides. See Figure 3-4.

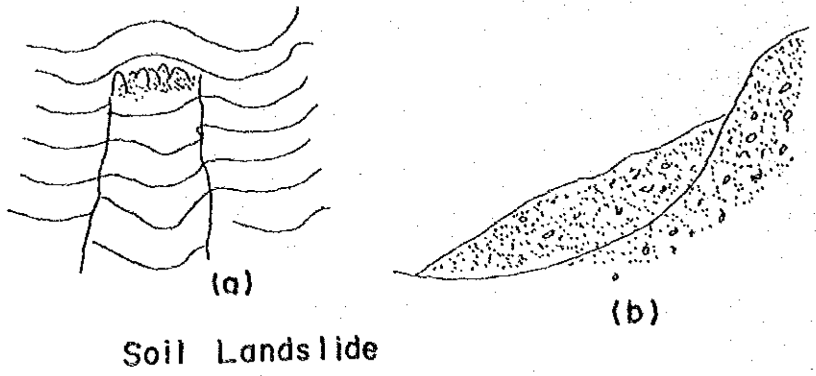


FIGURE 3-4 LANDSLIDE

Debris Flow

Debris flow is induced by a force of flow caused by floods where there exist deposites on torrent or riverbed. This type is sub-classified into debris and mud flows. See Figure 3-5.

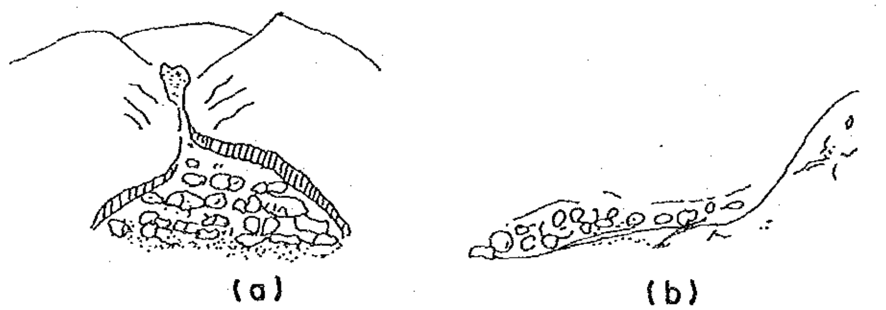


FIGURE 3-5 DEBRIS FLOW

3.2 DISASTER POTENTIAL

Each spot identified was ranked into three categories. Category A (Heavy), Category B (Medium) and Category C (Small) giving emphasis on the impact of the disaster on traffic. The criteria adopted in determining the disaster potential are shown in Table 3-1.

TABLE 3-1 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 50cm) 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 50cm may cover about one lane.	• Shoulder may fully collapse.
Category C (Small) (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.

3.3 DISASTER SPOTS IDENTIFIED

Disaster potential spots were 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

A total of 123 disaster potential spots, 38 along the Lucena—Calauag Section, 41 along the Allen—Calbayog Section and 44 along Naguilian Road were identified as shown in Table 3-2.

TABLE 3-2 SUMMARY OF DISASTER SPOTS BY TYPES OF DISASTER AND DISASTER POTENTIAL

	Disaster Potential	C-S.F. D.F.	F-S.F.D.F.	C-F	L.S.	D.F	Others	Total
Lucena-Calauag Section	H	1	—	2	—	—	—	3
	M	—	2	2	1	—	—	5
	S	16	4	10	—	—	—	30
	Total	17	6	14	1	—	—	38
Allen-Calbayog Section	H	—	2	2	—	—	—	4
	M	1	3	7	—	2	—	13
	S	3	2	19	—	—	—	24
	Total	4	7	28	—	2	—	41
Naguilian Road	H	2	—	1	—	—	—	3
	M	3	8	4	—	—	—	15
	S	13	6	7	—	—	—	26
	Total	18	14	12	—	—	—	44
Grand Total	H	3	2	5	—	—	—	10
	M	4	13	13	1	2	—	33
	S	32	12	36	—	—	—	80
	Grand Total	39	27	54	—	2	—	123

Type of Disaster

(1) Cut Slope Failure
C-S.F. = Surface Failure
C-D.F. = Deep Failure

(2) Embankment Slope Failure
E - S.F = Surface Failure
E - D. F = Deep Failure

(3) Fall
C-F

(4) Landslide
L.S

(5) Debris Flow
D.F.

(6) Others

Disaster Potential

H : Heavy
M : Medium
S : Light

Shown in Figure 3-6 is the number of cut slope failures and falls with the disaster potential of Heavy and Medium in relation to kinds of rocks. This number do not tally with the number of disaster spots because slope is often composed of more than two kinds of rocks.

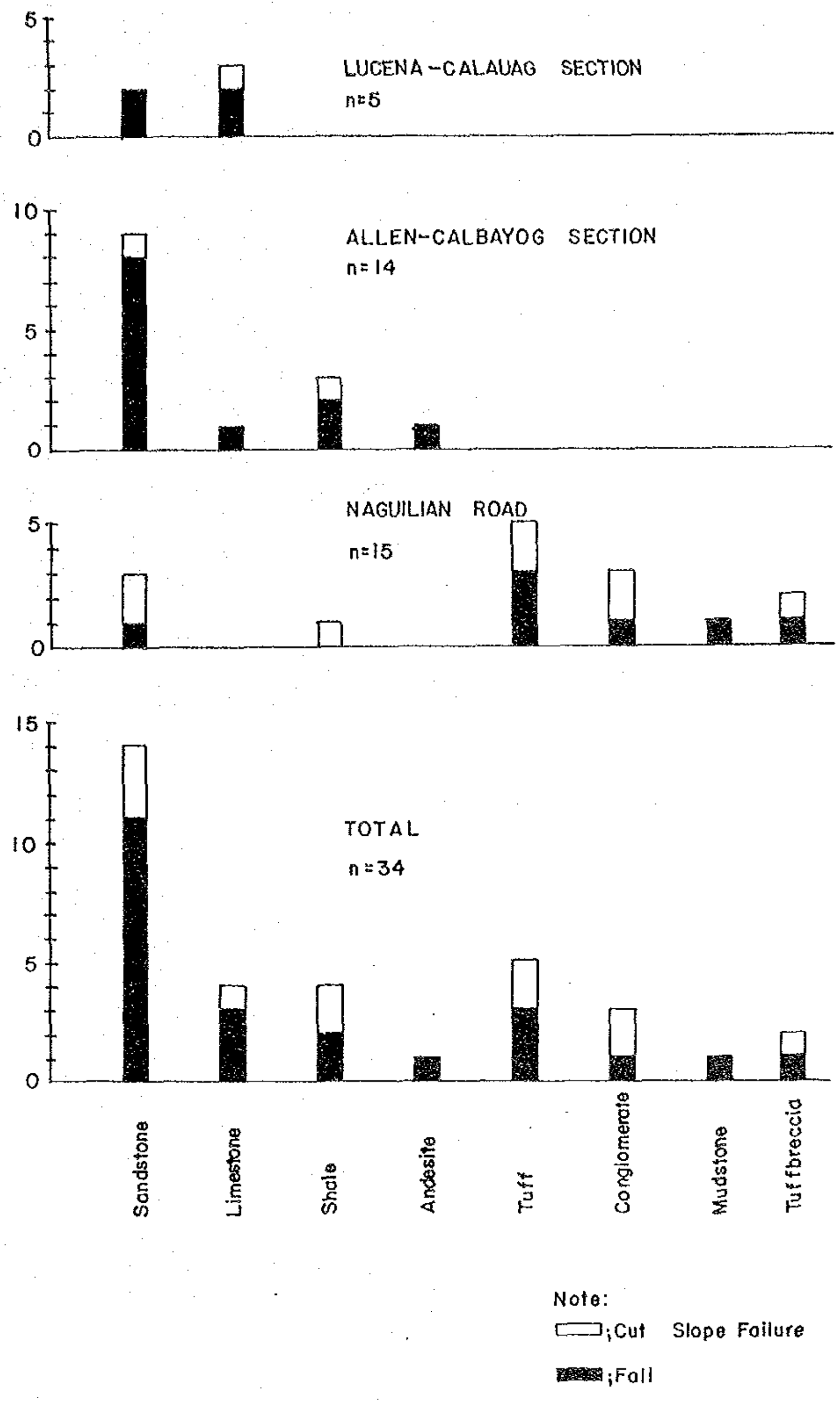


FIGURE 3-6 NUMBER OF CUT SLOPE FAILURES AND FALLS AND KINDS OF ROCKS

4. EXISTING CONDITIONS AND CAUSES OF ROAD DISASTERS

4.1 EXISTING CONDITIONS OF ROAD DISASTERS

Lucena—Calauag Section

Since the opening of the Pagbilao—Atimonan sub-section in the section in 1979, substantial damages on the section were attributed not only to pavement deterioration but failures of cut and embankment slopes and falls of severely weathered limestones. The number traffic interruptions is reported to be an average of about 8 days a year.

The topography of this section is generally flat with exception of rolling or mountainous terrain from Pagbilao to Atimonan. The geologic formation is of sandstone and limestone and occasionally andesite and mudstone. These bedrocks, especially limestone are severely weathered and feared to collapse in the future.

Most of 38 disaster spots identified in this section are located in the Pagbilao—Atimonan sub-section (about 30 kilometers). The disaster spots density in this sub-section (the number of disaster spots per kilometer) is 1.13 spots per kilometer.

Moreover, of 38 disaster spots, eight spots are considered of the Heavy (H) and Medium (M) category requiring urgent implementation of countermeasures. These type of spots are concentrated within the old zigzag road section which extends only for about 9.6 kilometers. The disaster density of H and M in this particular sub-section is 0.83 spots per kilometer.

Of the eight disaster spots mentioned, fall is dominant in four spots, followed by embankment slope failures in two spots and cut slope failure and landslide in one spot each.

Occurrence of a large number of fall is mainly due to severely weathered limestone with developed cracks. The sizes of fallen rocks are 1.5 to 2.5 meters. More of these failures are feared to occur in the future.

The embankment slope failures are mainly caused by scouring due to the concentration of surface water, particularly at inner curves of roads with steep vertical gradients. Side ditches are recommended to be adequately constructed.

Allen—Calbayog Section

After the improvement of the section in 1978, the section was exposed to the danger of rock falls. This type of disaster has often caused the interruption of traffic flow at an average of 9 days a year specially after heavy rains and typhoons. The majority of slopes still seem to be unstable.

This section can be divided into the moderately hill segment that passes through the foot of Samar's central range and the flat coastal terrace segment passing along the coast. The geology is of sandstone, shale, andesite and limestone with folds and faults. These rocks have many developed cracks and are highly weathered. The sandstone is prone to fall in large sizes.

The 41 disaster spots identified along the section are almost equally scattered between San Isidro (km. 686 + 500) and Tinambacan (km. 723 + 300) with disaster spot density of 1.11 spots per kilometer.

Of the total number, 17 spots were evaluated of the Heavy and Medium category which require the immediate application of countermeasures.

By type of disaster belonging to the H and M spots, fall is predominant in nine spots, followed by embankment slope failure, debris flow and cut slope failure with 5, 2 and 1 spots, respectively.

The majority of fall occurred on cut slopes of highly weathered sandstone with developed cracks. Most of fallen rocks are 30 to 50 centimeters in size but occasionally over 3 meters. These falls may continue if no countermeasures are applied.

Almost all embankment slope failures observed along the coastline are caused by scouring due to sea waves and flood water.

Naguilian Road

Disasters along this road must have occurred many times during the last 64 years since its completion in 1919. Although no accurate records are available, it is predicted that disasters occurred at an average of two times a year causing traffic interruption for 4 days.

The road runs in rolling areas for about 17 kilometers from the town of Bauang and the rest of the section as it proceeds towards Baguio City through steep mountainous terrain. The geology of this road is chiefly tuff, tuff brecciea, conglomerate limestone and sandstone.

Of the total of 44 disaster spots recorded, there are only four disaster spots in the rolling area, while 40 spots are in the remaining mountainous section with approximately 30 kilometers. The disaster density is 0.24 in the former and 1.33 in the latter.

A total of 18 disaster spots are classified of the Heavy and Medium category. Embankment failures are dominant amounting in eight spots, followed by five spots each respectively of cut slope failure and fall.

In this road, embankment slope failures means the collapse of stone masonry applied to embankment slopes at the valley side. These failures were observed widely in several spots and are feared increase along the road in the future.

Cut slope failures and falls were observed on slopes composed of hard rocks such as tuff, tuff brecciea and conglomerate.

4.2 CAUSES OF ROAD DISASTERS

Cut Slope Failure

Cut slope failures were observed in all the mountainous sections of the three Study sections, especially in the Lucena—Calauag section and Naguilian Road. These sections have many high cut slopes with the rocks highly weathered and fractured due to faults.

This type of failure has been observed to be predominant on slopes of soil and rock such as diabase, andesite, limestone, sandstone, mustone, tuff, tujff brecciea, conglomerate, etc. Nearly all of cut slope failures observed were due to the effect of unabated water flow. Many were caused by erosion or scouring resulting from the flow of surface water during rainfalls, and some by groundwater seepage.

As noted, 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 protections by vegetation and the like.

Embankment Slope Failure

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

Embankment failures were generally attributed to scouring and, therefore, the failures frequently occur due to the following reasons:

—Inadequate drainage facilities in terms of number and capacity

—Inadequate connections and protections at the outlet of cross drain facilities

—No or inefficient protections of slopes.

Fall

The predominant type of disaster observed along the project section is fall. Falls are categorized into debris falls and rock falls, but all falls in the study sections are rock falls. Falls mainly occur in the slopes composed of debris or diorite, andesite, sandstone, conglomerates, limestone, etc. Slopes of highly weathered or fractured rocks usually produced cut slope failure, while falls mainly occur on slopes of hard rock with developed open cracks or on slopes with (alternative of) different rocks layers.

Most of the fallen rocks were 30 to 50 centimeters in size, but occasionally over 3.0 meters were seen on the Allen-Calbayog section and the Lucena-Calauag section. The deficiencies which may have caused the failure are similar to those mentioned in cut slope failure.

Landslide

Landslides are classified into soil and rock landslides, but only soil landslide at one spot in the Lucena-Calauag section was noted among the Study sections. The landslide at this spot is a movement of a thick layer of soil covering over the bedrock. Judging from the land formation in which surface water easily concentrates, the landslide is due to the affect of uncontrolled surface water flow.

Debris Flow

Debris flows are classified into debris flow and mud flows. There are only two spots of debris flows identified along the Study sections and both are debris flow types. These are located in the Allen-Calbayog section.

At a spot, a large quantity of spring water was observed at the toe of the slope and, therefore, the debris flow is likely to have been caused by the high level of ground-water. Debris flow at the another spot is caused by torrent due to the absence of countermeasures such as cross drains, water ways, small scale sabo dam etc.

5. RECOMMENDED COUNTERMEASURES

5.1 Design Spots

The disaster spots requiring urgent countermeasure work and where the design of the proposed countermeasures were prepared are shown in Table 5-1.

Some spots where countermeasures are being implemented or require large scale riparian were excluded from design.

TABLE 5-1 DESIGN SPOTS

Type of Disaster	Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road	Total
Cut Slope Failure	1	1	5	7
Embankment Slope Failure	1	2	5	8
Fall	4	9	5	18
Landslide	1	—	—	1
Debris Flow	—	2	—	2
Total	7	14	15	36

5.2 *Policies for Countermeasure Selection*

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

The proposed countermeasures were selected in due consideration of geology, topography, surface water, groundwater and other condition of each disaster spot. In addition to these local conditions, the following policy considerations were also taken in the selection of countermeasure:

—Introduction of new technology on disaster prevention

—Minimal traffic obstruction during construction

—Harmony with the environment

—Minimal maintenance work

5.3 TYPES OF APPLIED COUNTERMEASURES

Table 5-2 shows the number of countermeasures by section and type of disaster in relation with type of countermeasures adopted in the study.

TABLE 5-2 NUMBER OF APPLIED COUNTERMEASURES

SECTION	DISASTER		APPLIED COUNTERMEASURES														
			EARTH WORK		DRAINAGE WORK		PROTECTION WORK		CATCH WORK		STRUCTURE WORK			TORRENT WORK		AVOIDING WORK	
	TYPE	SPOT NUMBER	REMOVAL/ RE-CUTTING	RE-FILLING	SURFACE DRAIN	SUB-SURFACE DRAIN	VEGETATION	CONCRETE SPRAYING	ANCHOR WIRE NET	CATCH WALL	STONE MASONRY R.W.	GRAVITY TYPE R.W.	ANCHORING	STONE PITCHING WATER WAY	GABION F.P.	RE-ALIGNMENT	TOTAL
LUCENA-CALAUAG SECTION	C-SF, DF	1	1	-	1	-	-	-	-	1	-	-	-	-	-	1	4
	E-SF, DF	1	-	1	1	-	-	-	-	-	1	-	-	-	-	-	3
	C-F	4	4	-	4	-	-	2	-	2	-	-	1	-	-	2	15
	L.S	1	1	-	1	-	1	-	-	-	-	-	-	1	-	-	4
	D.F	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	SUB-TOTAL	7	6	1	7	0	1	2	0	3	1	0	1	1	0	3	26
ALLEN-CALBAYOG SECTION	C-SF, DF	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
	E-SF, DF	2	-	2	-	-	-	-	-	-	2	1	-	-	1	-	6
	C-F	9	9	-	9	-	-	3	1	7	-	-	-	-	-	5	34
	L.S	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	D.F	2	2	-	2	1	1	-	-	1	-	-	-	2	-	-	9
	SUB-TOTAL	14	12	2	12	1	1	3	1	8	2	1	-	2	1	5	51
NAGUILIAN ROAD	C-SF, DF	5	4	1	5	-	2	-	2	1	1	1	1	1	-	-	19
	E-SF, DF	5	-	5	5	-	-	-	-	-	5	1	-	-	-	-	16
	C-F	5	5	-	5	-	-	1	3	-	-	-	1	-	-	-	15
	L.S	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	D.F	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	SUB-TOTAL	15	9	6	15	0	2	1	5	1	6	2	2	1	0	0	50
TOTAL	C-SF, DF	7	6	1	7	-	2	-	2	2	1	1	1	1	-	1	25
	E-SF, DF	8	-	8	6	-	-	-	-	-	8	2	-	-	1	-	25
	C-F	18	18	-	18	-	-	6	4	9	-	-	2	-	-	7	64
	L.S	1	1	-	1	-	1	-	-	-	-	-	-	1	-	-	4
	D.F	2	2	-	2	1	1	-	-	1	-	-	-	2	-	-	9
	TOTAL	36	27	9	34	1	4	6	6	12	9	3	3	4	1	8	127

NOTE :

TYPE OF DISASTER
- C-S.F, D.F — Cut slope surface failure, deep failure
- E-S.F, D.F — Embankment slope surface failure, deep failure
- C-F — Cut slope rock fall
- L.S — Landslide
- D.F — Debris flow

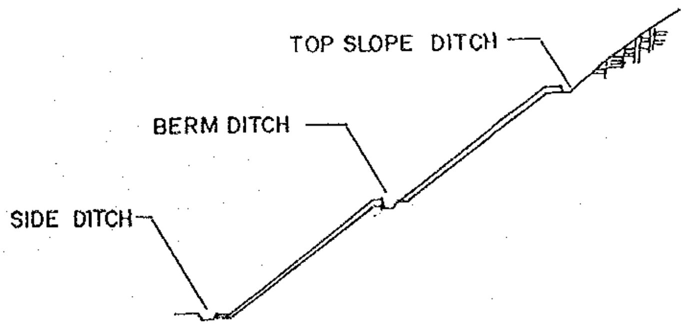
R.W — RETAINING WALL
F.P — FOOT PROTECTION

5.4 TYPICAL COUNTERMEASURES

The following are typical countermeasures adopted in the Study.

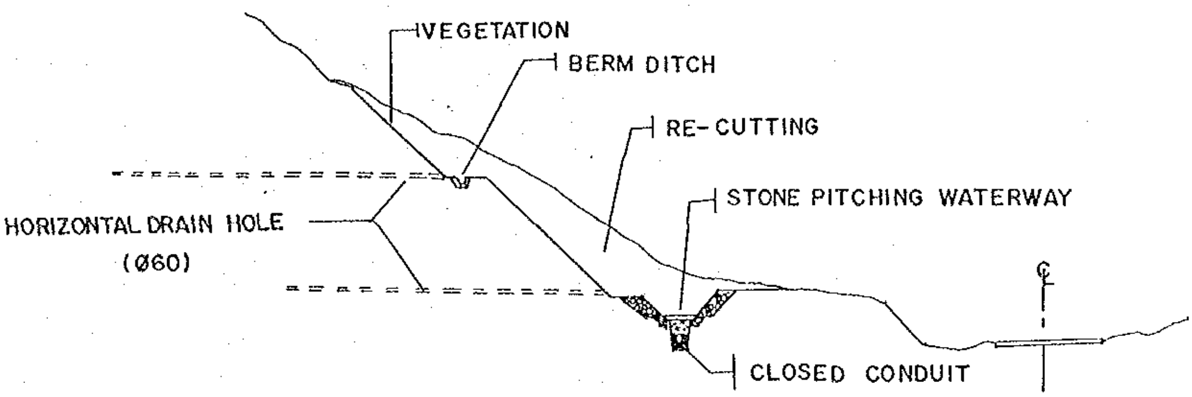
Surface Drain

The main cause of cut slope and embankment slope failures is surface water. Various kinds of ditches were applied in many sections. Top slope ditches were placed where running water from adjacent hinterland area was expected and berm ditches adopted everytime berms were proposed. Side ditches were applied as a prerequisite in all disaster spots because of the non-existence of drainage facilities.



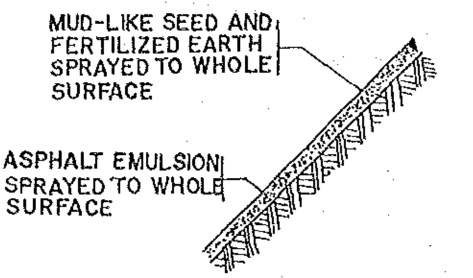
Subsurface Drain

Horizontal drain hole and closed conduit were applied to check debris flow where the level of groundwater seems to be high and seepage water was observed.

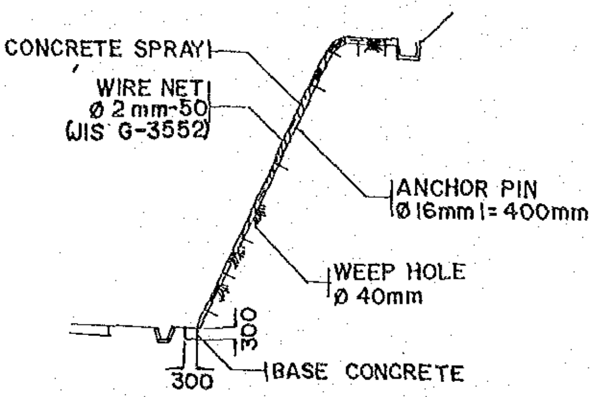


Slope Protection

Except on slopes composed of hard rock not susceptible to erosion and scouring, protection works were generally applied for all kinds of slope. Slope protection with vegetation was applied for the slopes with soil and weathered rocks where vegetation can grow. For other slopes, concrete spraying was applied.



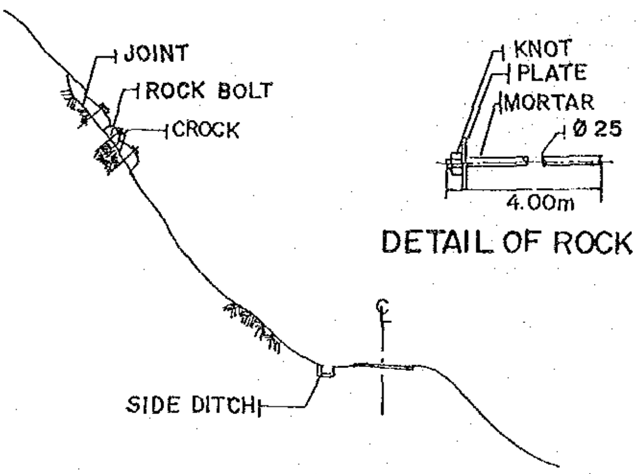
SEED MUD SPRAYING



CONCRETE SPRAYING

Anchoring

Unstable rocks susceptible to fall on slopes were proposed fixed to the bedrocks by anchoring with rockbolts. This measure was applied on slopes where big size but few number of rocks exist.

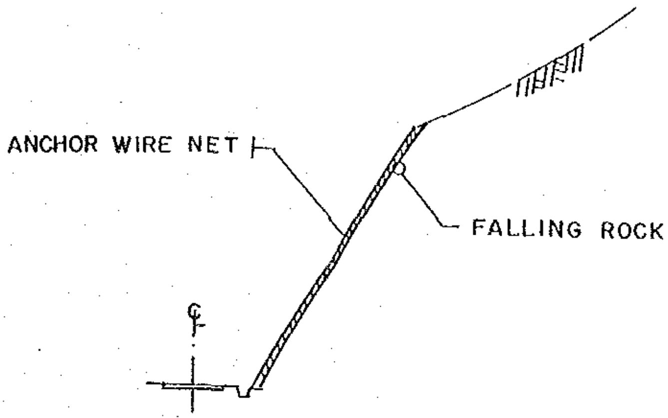


DETAIL OF ROCK BOLT

ANCHORING

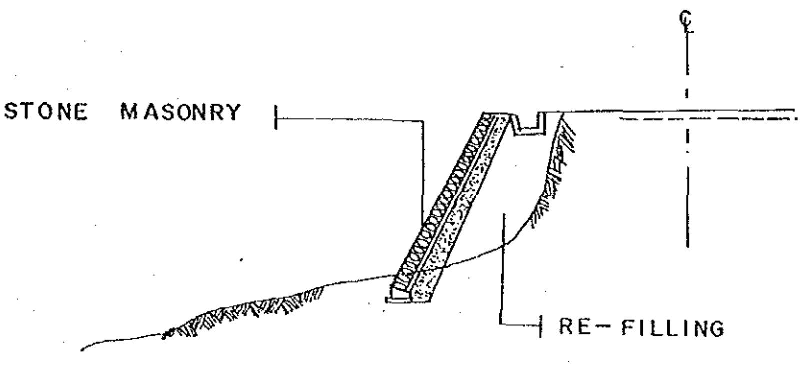
Anchor Wire Net

For slopes where small size but many unstable materials exist, anchor wire net was applied. Since this type cannot provide a completed protection for the prevention of erosion and scouring of slope surface, this was adopted mainly on slopes composed of hard rocks.



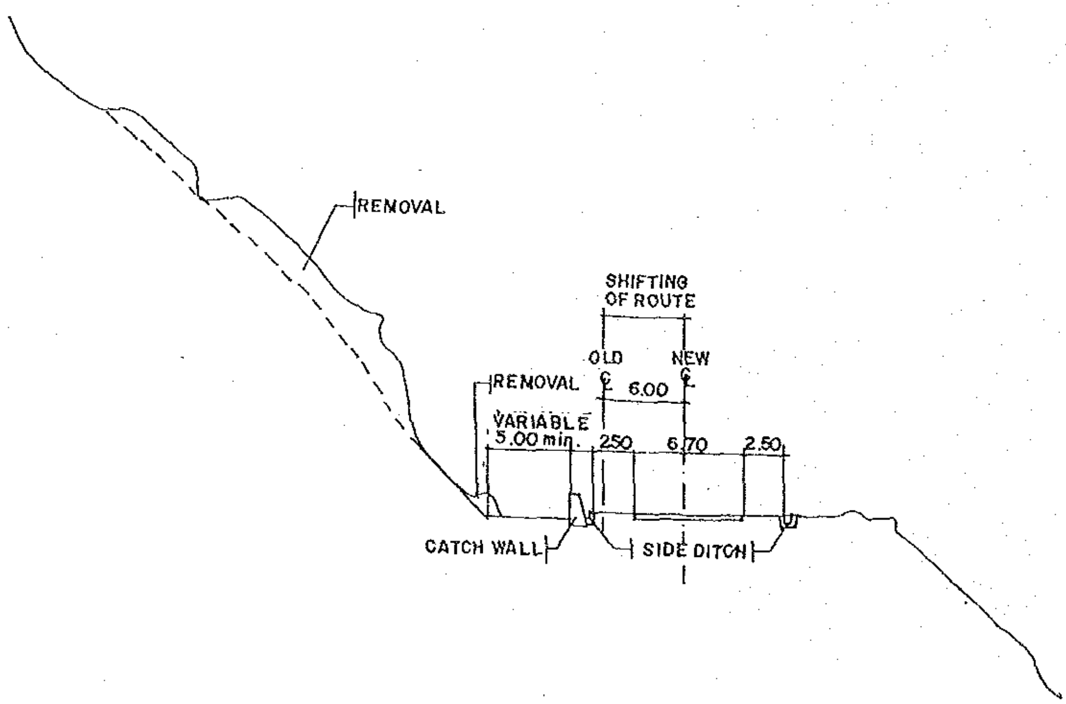
Stone Masonry Retaining Wall

For steep embankment slopes where the slope gradient cannot be improved, stone masonry retaining wall with re-filling was applied. It should be noted that side ditches were invariably provided at these spots.



Re-alignment with Catch Wall

Re-alignment was positively applied at the spots where there is enough flat space to allow shifting of the existing road. This is almost always more economical than the slope protections applied directly on slope. The maximum shift adopted in the study was six meters. Catch walls were always used to prevent spreading of damage due to falling rocks.



6. PROJECT COST

The project costs were estimated based on a unit cost analysis in November 1984 prices. The aggregate total cost of the three sections was estimated at 74.50 million pesos, of which foreign currency component amounts to 45.74 million pesos (61%) and local currency component including taxes to 28.76 million pesos (39%).

Construction cost of the countermeasures along Lucena-Calauag section was estimated at 22.33 million pesos; the Allen-Calbayog section at 27.83 million pesos; and the Naguilian Road at 15.20 million pesos. Major countermeasures applied were re-alignment method and concrete spraying both for the Lucena-Calauag section and the Allen-Calbayog section, and stone masonry retaining wall and anchor wire net for the Naguilian Road.

The cost for detailed engineering and construction supervision services were estimated respectively at 7% of the construction cost.

TABLE 6-1 PROJECT COST

Unit: Million Pesos

	November 1984 Price			Current Price[2/]		
	Foreign	Local/Tax	Total	Foreign	Local/Tax	Total
Detailed Engineering	2.97	1.60	4.57	3.98	2.97	6.95
Construction[1/]						
• Lucena-Calauag	13.44	8.89	22.33	19.98	18.53	38.51
• Allen-Calbayog	16.82	11.01	27.83	25.01	22.95	47.96
• Naguilian	9.54	5.66	15.20	14.19	11.79	25.98
• Sub-Total	39.80	25.56	65.36	59.17	53.27	112.45
Construction Supervision	2.97	1.60	4.57	4.43	3.34	7.77
Total	45.74	28.76	74.50	67.59	59.58	127.17

1/ Includes 10% physical contingency.
2/ 1984 prices are escalated. For escalation rate, See Figure 8-1.

7. PROJECT EVALUATION

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

7.1 Technical Evaluation

Lucena—Calauag Section

- Of the total of 38 disaster spots, 8 are with high disaster potential.
- Limestone, the predominant type of a rock in this Section, is easily weathered, therefore, slope conditions will be quickly aggravated.
- An average number of traffic interruption is estimated to be eight days per year.
- The detour route of this Section is very substandard with many hairpin curves, steep gradients of nearly 10% and narrow roadway width of 5.0 to 6.0 meters.

Allen—Calbayog Section

- Of the total of 41 disaster spots, 17 are with high disaster potential.
- The formation of most of slope bedrocks sandwiches weak strata between sandstone layers, thus slope condition will likely to become worse year by year.
- An average number of traffic interruption is estimated to be nine days per year.
- The 21 temporary bridges along the detour route cannot allow heavy vehicles (buses and trucks) to pass.

Naguilian Road

- Of the total of 44 disaster spots, 18 are with high disaster potential.
- Due to the narrow roadway and shoulders, even a small scale road disaster greatly affects traffic flow. Road users are always exposed to danger of being hit by falling rocks and the like.
- An average number of traffic interruption is estimated to be four days per year.

- The capacity of the Kennon Road which functions as a detour road, will not be sufficient enough to accommodated detour traffic from the Naguilian Road after year 2000.

7.2 Economic Evaluation

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

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**

  When cargo truck trips are stopped or delayed due to road disasters, commodities will not be used as scheduled which means they lose opportunity cost. The implementation of this project will eliminate such situations.

  Savings in commodity opportunity cost of the Study section were considered negligible. The additional time due to detour is not considerable for both the Lucena-Calauag section and the Naguilian Road. Similarly the small commodity volume on the Allen-Calbayog section is negligible.

- **Savings in Traffic Accident Cost**

  The implementation of this Project will reduce the number of traffic accidents caused by road disasters. This benefit can be quantified according to the traffic accident records. However, there are very a few traffic accident records on the Study Section caused by road disaster. Therefore, this benefit was considered negligible.

- **Savings in Travel Time Cost**

  Savings in travel time cost is quantified from the amount of reduced travel time as a result of the project. The travel speed of vehicles is suppressed due to the insecurity of the environment. Delays are also encountered during restoration works of damaged sections are carried out. With the project which will not only secure physically the environment will also give the drivers more confidence while negotiating the route, thus, will result in faster travel speeds.

- **Savings in Restoration Cost**

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

A 20-year project life was assumed in the analysis. The results of the cost benefit analysis and sentivity are presented in Table 7-1.

TABLE 7-1 RESULTS OF ECONOMIC ANALYSIS
Internal Rate of Return

%

		Lucena-Calauag Section	Allen-Calbayog Section	Naguilian Road
Best Estimate Case		16.04	14.37	15.43
Sensitivity Tests	Case-1 (Cost -20%)	20.02	18.21	19.16
	Case-2 (Cost +20%)	13.18	11.60	12.73
	Case-3 (Benefit + 20%)	19.25	17.44	18.44
	Case-4 (Benefit -20%)	12.55	10.99	12.20
	Case-5 (Cost -20% Benefit +20%)	23.75	21.78	22.63
	Case-6 (Cost +20%, Benefit -20%)	10.04	8.56	9.81

7.3 Financial Evaluation

The maximum budget allocation for the local cost component in a single foreign assisted highway project was 253 million pesos in 1983 and 144 million pesos in 1984, which was equivalent to about 1/12 and 1/15 of the total budget for construction and improvement of major road, respectively.

The ratio of the possible allocation for the local cost component in a single project to the total yearly budget for major roads is estimated at 1/18, 1/30 and 1/50 for high, medium and low assumptions, respectively. The medium assumption of 1/30 is taken as the most realistic.

The total yearly budget for major roads was based on the MPWH Medium Term Infrastructure Program (1984-1992).

The maximum local fund requirement of the Project with the four-year implementation period (1988-1991) is estimated to occur in 1990 at 33 million pesos in current prices which is within the estimated possible amount of local budget allocation under the medium assumption. The project is affordable within the resources of GOP and, therefore, financially feasible.

7.4 Project Impact

Lucena-Calauag Section

- The total population in the influence area which covers the Quezon Province and the Bicol Region is estimated about 4.4 million in 1984 and 7.2 million in 2010. Without the project, traffic interruptions on this section will directly affect the day-to-day socio-economic activities of these two areas. Particularly with the Bicol Region which is largely dependent of its supplies in Metro Manila. Traffic flows of 1,800 vehicles and 13,000 passengers per day (both in 1984 volume) will be greatly disturbed.

- The old zigzag road, considered as the detour route of the Pagbilao-Atimonan Sub-section, is a very substandard road with many hairpin curves, steep gradients of nearly 10% and narrow roadway width of 5.0 to 6.0 meters. Due to the substandard geometrics, large vehicles (buses and trucks) have great difficulty in negotiating the route resulting in substandard travel time and vehicle operation costs.

- In the year 2000, traffic volume will exceed the traffic capacity of the old zigzag road.

- About 3,700 tons of commodities transported daily (in 1984) will be directly affected. Perishable commodities and foodstuff such as fish and other marine products which are major commodities from Bicol to Metro Manila will lose, to some extent, commercial value without the project.

Allen-Calbayog Section

- The influence area of this section covers Northern Samar, Western Samar and Northern Leyte. About 2.4 million people in 1984 and 3.6 million people in 2010 in the influence area will be directly or indirectly affected.

- Daily traffic of 328 vehicles in 1984 which is estimated to increase to 1,230 vehicles by 2010 will be directly affected.

- The detour route is composed of the Calbayog North Road (from Calbayog to Catarman) and the Catarman—Allen Road. Along this route are many temporary bridges with narrow timber floor and low loading capacity. In the Calbayog North Road, heavy vehicles (buses and trucks) can not pass due to substandard of the road as well as the limited capacity of the bridges. Therefore, when the section is closed to traffic due to road disasters, buses and trucks will be stranded.

- Commodity flow of about 240 tons per day (in 1984) will be stopped, which means supply of daily consumption commodities to Northern Samar will be suspended, thus daily life of people in the area will be seriously affected.

- Operation of the ferry service between Luzon and Samar will be suspended. Economic return from the investment on the ferry service project will be hampered.

Naguilian Road

- The direct influence area is the whole of Benguet Province. Population of 395,000 in 1984 and 661,000 in 2010 will be directly or indirectly affected.

- The alternative route is the Kennon Road via the Manila North Road. Additional travel time of one (1) hour and travel cost of 95 pesos per vehicle will be incurred for an additional route length of about 37 kms.

- Future traffic on the Naguilian Road will reach 4,600 veh./day in 2010, while that on the Kennon Road will be 8,050 veh./day. When traffic on the Naguilian Road is detoured to the Kennon Road, severe traffic congestion on the Kennon Road will be observed.

- About 1,400 tons of commodities in 1984 which will increase to about 6,000 tons in 2010, will be directly affected. Since fuel consumed in Baguio is mostly transported through the Naguillan Road, stable supply of fuel will be seriously disturbed.

- About 10,000 of passengers per day in 1984 will be directly affected.

7.5 Overall Evaluation

Lucena-Calauag Section

- The best estimate of the Internal Rate of Return (IRR) of the Project in the Lucena-Calauag Section is 16.0%. Results of the sensitivity test shown that except in the worst case (cost +20%, benefit -20%), the IRRs exceed 12% in all cases.

- Due to substandard geometrics of the detour road of this section, transport efficiency of the Section will be greatly lowered, thus seriously affecting socio-economic as well as developmental activities within the influence areas, particularly Quezon Province and the Bicol Region.

- Limestone, the predominant type of a rock in this Section, is easily weathered, therefore, slope conditions will be quickly aggravated, unless proper counter-measures are taken immediately.

Implementation of disaster prevention work of this Section is feasible as indicated by its economic rate of return as well as by the engineering aspects and favorable socio-economic impacts produced by the project.

Allen-Calbayog Section

- The best estimated of the IRR is 14.4%.

- Due to low loading capacity of many temporary bridges on the detour road, large vehicles (buses and trucks) will have to terminate their trips when the Section is closed to traffic. Citizen's daily lives in Northern Samar where supply of daily needs depends on this section will be seriously affected.

- Operation of the ferry service between Luzon and Samar will be suspended when traffic on this Section is interrupted, thus economic return from the investment on the ferry service project will be hampered.

- As the formation of most of slope bedrocks sandwiches weak strata between sandstone layers, slope condition will become worse year by year, if the project is not implemented.

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 impacts upon the direct influence area.

Naguilian Road

- The best estimated of IRR of the Project is 15.4%.

- Daily consumption such as fuel, seafoods, etc. for Baguio City and copper ore, the major products of Benguet Province are transported through this road, therefore, it is functioning as a life line of Baguio City and its adjacent areas. Traffic interruption of this road will create serious socio-economic problems within the direct influence area.

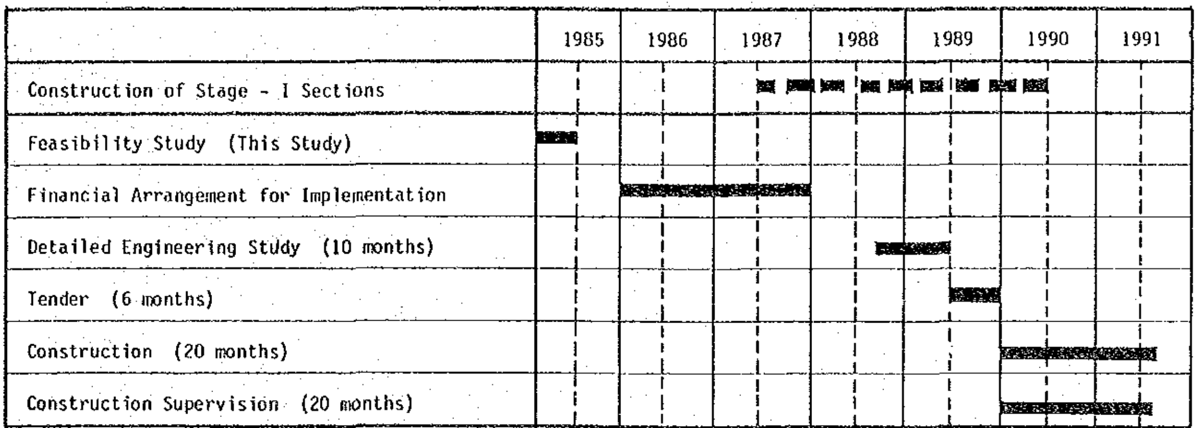
- Due to narrow roadway and shoulders, even a small scale road disaster greatly affects traffic flow on the road. Road users are always exposed to danger of being hit by falling rocks and the like.

The project is feasible in terms of its economic rate of return and various favorable impacts to the socio-economic activities in the direct influence area.

8. PROJECT IMPLEMENTATION

Recommended implementation schedule and annual financial requirements broken down into foreign and local currency components are presented in Figure 8-1.

FIGURE 8-1 IMPLEMENTATION SCHEDULE



Financial Requirement - November 1984 Price - (Unit : Million ₱)		1985	1986	1987	1988	1989	1990	1991
	Foreign Component				1.19 (1.54)	1.78 (2.44)	25.66 (37.27)	17.11 (26.34)
	Local/Tax Component				0.64 (1.14)	0.96 (1.83)	16.29 (33.03)	10.87 (23.58)
	Total				1.83 (2.68)	2.74 (4.27)	41.95 (70.30)	27.98 (49.92)

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

Annual escalation rate (%)

Year	1985	1986	1987	1988	1989～1991
Foreign Component	7.5	7.0	6.0	6.0	6.0
Local Component	25.0	15.0	12.0	10.0	7.0

IV SPECIAL PROPOSITIONS

In view of the urgency of the Project and on the basis of the findings of the Study, special propositions are prepared for the development of sound engineering practices and methods on road disaster prevention in the country.

Realizing the fact that road disasters are potential and likely to be grave and severe if no countermeasures are adopted, it is recommended to develop and work out ways not only in the search of immediate solutions, but in the longer term, a more systematic approach in considering the solutions to the problems.

1 SHORT TERM MEASURES

1.1 Recording of Road Disasters

The recording of disaster should be comprehensive and systematically compiled. The information to be covered should include topography, geology, type, size and causes of road disaster, precipitation and influence of water.

These records can provide the basic engineering data to be analyzed for the identification of disaster spots, the frequency of the occurence of disaster and even the selection of the appropriate countermeasures.

1.2 Identification of Disaster Potential Spots

All spots where failures are likely to occur should be investigated and recorded by the agency concerned. The types, size and damage of roads due to failures should be identified and the potential disaster intensity of each spot should be assessed.

The availability of data will enable to prepare and install appropriate warning signs at strategic locations for the information of the road users, well ahead of the disaster potential areas. 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.

1.3 Provisional Remedial Measures

It can be safely condluced through the Study that the main cause of road disaster, without exception, is the effect of water, and therefore, the provisional remedial measures recommended to control water include;

—Provision of side and cross drainage pipe

—Vegetable on slopes

—Utilization of gabion, whenever applicable

—Provision of closed conduits for groundwater and spring water

2 LONG TERM MEASURES

2.1 Development of Techniques of Road Disaster Prevention

The Study has been carried out mainly based on techniques of road disaster prevention experienced in Japan. Time constraint and limited study area coverage of the trunk road has not permitted to allow the Study to generalize the findings on the projects which can be adopted on a nationwide scale. So much so that road disaster prevention in this country must be carried out in a stern environment. In most parts of the country, the topography is mountainous with rugged terrain and the geology is generally of a fragile structure of the tertiary period. Furthermore, the geographical location of the country lies in the South Pacific typhoon belt where typhoon-bearing heavy rains passes the country's area of responsibility nineteen times or more each year on the average.

In view of the fact that such natural conditions in the Philippines are generally more stern than that in Japan, it is recommended that a disaster prevention system and technology suitable and adaptable to environmental characteristics of the country should be developed.

2.2 Road Planning

The Philippines' Fault Line traverses the archiepalgo from north to south. Secondary faults and holds resulting from this major fault are observed in all region. Where road run parallel to those faults, large scale slope failures are likely to occur. The typical example is the failure of some sections on the Maharlika Highway which runs along the Philippines Fault.

In the planning of new road alignment, therefore, a more comprehensive route study is suggested to avoid such cases. Alternative routes should be evaluated taking into full consideration the extent of disaster control works as well as road functions and costs.

2.3 Road Design and Construction

In designing new roads, a completed and detailed investigations related to road disasters should be carried out. A general policy to include the design of slope protection works and countermeasures for road disasters, is suggested whenever any road improvement is planned.

In which cases, a thorough study for selection of proper countermeasures should be made taking into account the class of road, traffic demand, future development of the area and the like.

2.4 Disaster Beyond the Scope of Highway Works

There exists a considerable number of spots which were seriously damaged due to scouring by sea wave, meandering of river, and the like. Countermeasures to solve these types of problems normally involve large scale riparian works 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 to prevent further damage on the road sections.

CHAPTER 1 INTRODUCTION

PAGE

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

1

The development of the highway network in the Philippines is one of the major programs being implemented by the Philippine Government in support of the overall socio-economic development goals of the country. Major road improvement and construction activities began in early 1970s and has been continuously pursued since then. At present, the main roads system would seem adequate in terms of location and extent. Despite the achievements made, some of the most important roads suffer many deficiencies including, among others, occurence of road 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 of the problems related to road disasters which have become increasingly alarming, the Government of the Philippines (GOP) envisaged a road disaster prevention program for which the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) has provided technical assistance for program formulation under the Feasibility Study of the Philippine Road Disaster Prevention Project (Stage I), hereinafter called as the Stage I Study.

The Stage I Study, started in May 1983 and completed in June 1984, was implemented in two phases: Phase I was focused on the identification and prioritization of disaster spots along four national roads namely: i) Maharlika Highway (Luzon and Samar, Leyte section only); ii) Kennon Road; iii) Agoo-Baguio City Road and iv) Naguilian Road. The results of the assessments indicated that there are a total of 545 disaster spots in 24 sections along the four projects roads which were prioritized into three categories: six sections under Category A (High Disaster Potential); eight sections under Category B (Medium Disaster Potential); and ten sections under Category C (Low Disaster Potential). On the basis of the prioritized sections, Phase II was conducted for the feasibility studies of only three sections under category A, namely: i) Dalton Pass section, ii) Mahaplag-Sogod section (both along the Maharlika Highway), and iii) Kennon Road. The rest of the sections remain to be studied.

From the experience and the results and recommendations from the Stage I Study, the nature and seriousness of the related problems have been exemplified and their immediate solutions emphasized so that further deterioration and/or eventual disasters in these sections could be avoided.

On this premise, therefore, the Government of the Philippines is more than ever determined to pursue the implementation of the initial road disaster prevention program and at the same time continue further in the conduct of feasibility studies for the other identified disaster potential sections along the aforecited road network.

Thus, GOP has requested GOJ to provide technical assistance for the conduct of "the Philippine Road Disaster Prevention Project (Stage II)", hereinafter referred to as "the Study," which aims to undertake feasibility studies of the following three (3) specific remaining sections of the above mentioned road network.

- Lucena—Calauag Section, Maharlika Highway (Region IV)
- Allen—Calbayog Section, Maharlika Highway (Region VIII)
- Naguilian Road (Region I)

In response to this request, GOJ has decided to provide technical assistance through the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of GOJ technical cooperation programs, which has been entrusted by GOJ with execution of the Study. JICA dispatched a team of seven experts to be engaged in the Study.

The study team comprised of JICA experts and MPWH counterpart staff was organized. The study started in October 1984 and was completed in June 1985.

1.2 OBJECTIVES

The objectives of the Study are to;

1) Assess the disaster potentials and recommend countermeasures along the relevant project roads/sections.
2) Prepare a program for implementation for the disaster prevention.
3) Develop techniques of road disaster prevention.

1.3 SCOPE OF WORK

1.3.1 Project Roads/Sections

1) Lucena—Calauag Section (Region IV)
2) Allen—Calbayog Section (Region VIII)
3) Naguilian Road (Region I)

1.3.2 Road Disasters Subject to the Study

All road disasters which occur on the Project Road/Sections, namely: slope failures, rock falls, landslides, scouring and debris flow, are subject to the Study. However, those requiring large-scale riparian or sabo works which considered beyond the scope of highway project 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 Advisory 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 Advisory Committee, the Japanese and the Local Counterpart Study Team is shown in Figure 1.4-1.

1.4.2 Study Approach

General procedure to achieve the objectives of the Study is illustrated in Figure 1.4-2. As the Study is continuation of the Stage I Study, study methodologies adopted in the Stage I Study were generally followed. In the execution of the Study, special considerations were given to the following:

a) The utilization of available data as well as data previously collected during the Stage 1 Study.
b) Reevaluation of the disaster spots identified during the Stage I Study and the identification of new spots wherein disaster potential has developed and became critical after the Stage I Study.
c) Preparation of check tables of all disaster spots. These tables were designed to provide important engineering information not only for this Study but also for future road disaster prevention studies.
d) Since past road disaster records were not well compiled, intensive interviews with maintenance engineers, foremen and other concerned persons were conducted in order to collect past disaster information.

Government of the Philippines — Government of Japan

Ministry of Public Works and Highways (MPWH)

Japan International Cooperation Agency (JICA)

STEERING COMMITTEE

Chairman	Teodoro T. Encarnacion
Member	Rosalio A. Mallonga
Member	Rodolfo V. Rosales
Member	Candelario A. Patiño
Member	Jose. V. Salvador, Jr.
Member	Manuel M. Bonoan
Member	Tsuneo Furukawa

ADVISORY COMMITTEE

Chairman	Tatsuo Oki
Member	Akiomi Shimazu
Member	Yoshiaki Yano
Member	Yasuyuki Fujishiro
Coordinator	Toshio Morooka

STUDY TEAM

LOCAL COUNTERPART TEAM

Team Leader	Manuel M. Bonoan
Coordinator	Geronimo Alonzo
Highway Engineer	Arturo Ferrer
	Pedro Ocampo, Jr.
Traffic Engineer	Faustino Sta. Maria, Jr.
Structural Engineer	Generoso Alconis
	Juanito Alamar
General Economist	Aniceta Mago
Economist	Carmelino Tizon
	Milagros Reyes
	Richard Aranda
System Analyst	Victoria Corpuz

JICA CONSULTANT TEAM

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Highway Planner (Deputy Team Leader)	Mitsuo Hatakeyama
Geologist	Ryozo Niiya
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Research Assistant	Josefina Rafol
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	Rebecca Callangan
Traffic Data Transcriber	Aniceta Cabanos
Draftsman	Lorenzo Rivada
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	Rolito Asuncion
	Elizabeth Asuncion
	Manuel Nadres

ADMINISTRATIVE STAFF

Administrative Officer	Virginia F. Fidelino
Clerk/Typist	Estrella T. Martinez
	Lilian M. Valdez

FIGURE 1.4-1 ORGANIZATION DIAGRAM

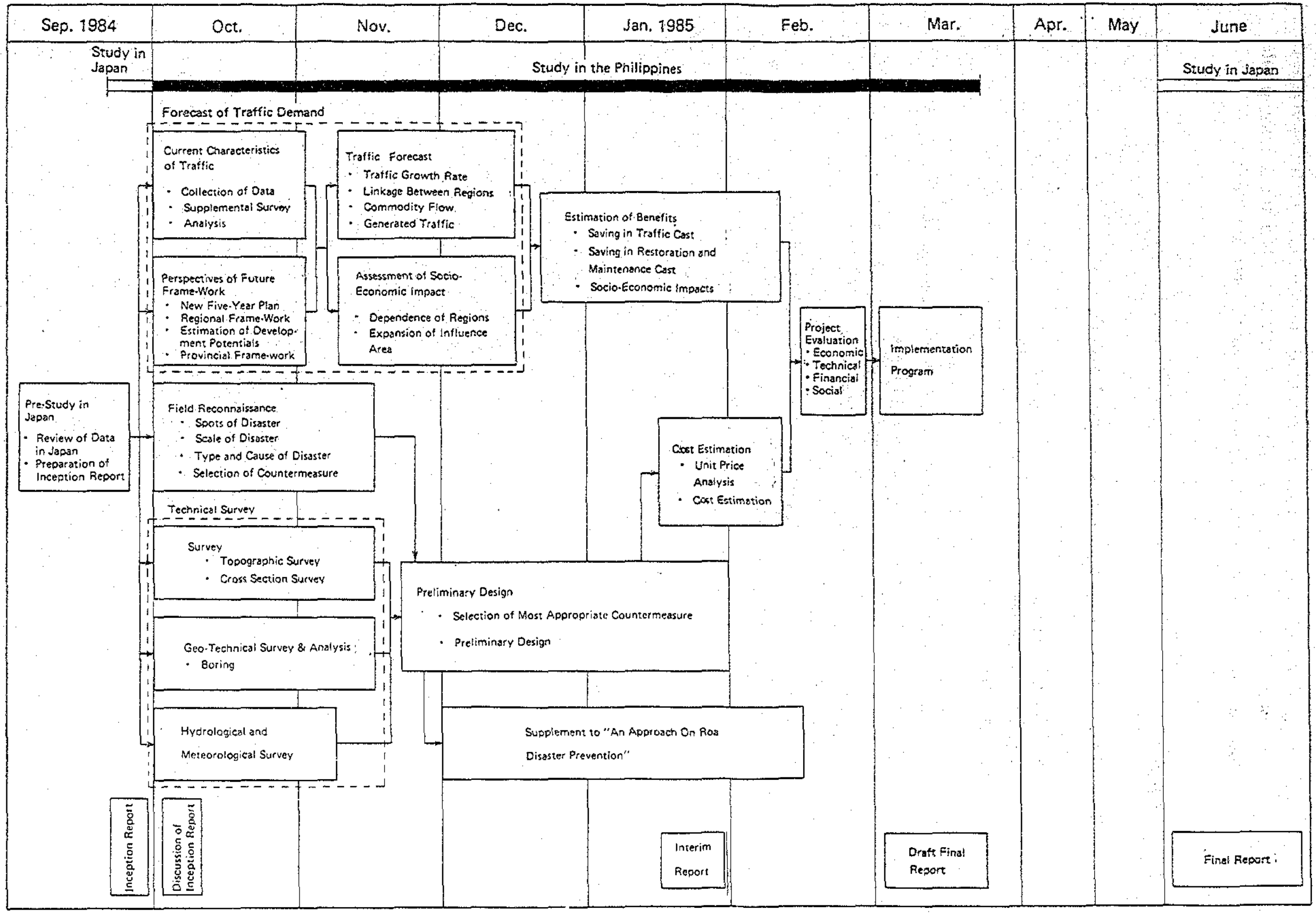


FIGURE 1.4-2 STUDY FLOW DIAGRAM

e) To realize the effective transfer of technology in connection with road disaster prevention techniques, especially in selecting the most appropriate countermeasure, several examples were prepared as case studies.

1.5 REPORTS

The following reports were prepared during the Study.

INCEPTION REPORT
INTERIM REPORT
DRAFT FINAL REPORT

The final report was developed based on the GOP's comments on the draft final report and presented in four (4) volumes as follows:

VOLUME I	:	EXECUTIVE SUMMARY
VOLUME II	:	TEXT
VOLUME III	:	APPENDIX
VOLUME IV	:	DRAWINGS

CHAPTER 2 THE STUDY AREA

PAGE

CHAPTER 2 STUDY AREA

2.1 NATURE

2.1.1 Topography and Geology

Some 7,100 large and small islands comprising the Philippine Islands occur between two trenches: the Philippine on the east and the Manila on the west. The Philippine Islands is divided into three main groups of islands: Luzon in north, Mindanao in south, and Visayas in between. Of these islands, the largest and northmost is Luzon Island, while the second largest and southmost is Mindanao Island. The Visayas group includes the islands of Samar and Leyte.

The geologic formation of Samar and other Visayas Islands are of limestone, schist, and other metamorphic rocks, believed to have been formed by the earliest orogenic movement which took place from the late Cretaceous to the Palaeogene periods. The Bondoc Peninsula and the Sierra Madre Range in eastern Luzon were believedly created by the subsequent (second) movement during the middle to late Miocene. The third orogenic movement, which took place from the Pliocene to the Pleistocene periods and was somewhat weaker than the former two, is believed to have created northern Luzon by land upheavals.

Judging from such formative process, the foundation of the Philippine Islands is believed to be of sedimentary rocks and metamorphic rocks from the Paleozoic era, which are mainly found in Visayas. On the other hand, the geologic formation of the Cagayan Valley and Baguio plateau dates back to the Oligocene to the Miocene epochs and is generally composed of relatively soft rocks such as sandstone, conglomerate, tuff, and mudstone with sporadic diorite, andesite, and diabase as volcanic eruptives. See Figure 2.1-1(1).

Ranges by folding, waste-filled valleys at cyncline, block mountains, and volcanic belt made up the islands of the Philippines. The physical features of northern Luzon are the Sierra Madre Range, the Cordillera Range, the Cagayan Valley, and the Ilocos Coastal Plain. The first two were formed by land upheaval, while the latter two were formed by submergence. See Figure 2.1-1(2).

The Philippine Fault, created by the second orogenic movement, traverses the Philippine Islands north to south. Secondary faults and holds resulting from the major fault can be seen in all regions. Fault and developed fracture zones are found in:

—The Dalton Pass section, between San Jose and Aritao,
—The South Sierra Madre section in southern Lucena,
—The Mahaplag-Sogod section in southern Leyte, and
—The Cordillera Central Mountain, through which the three access roads to Baguio City run.

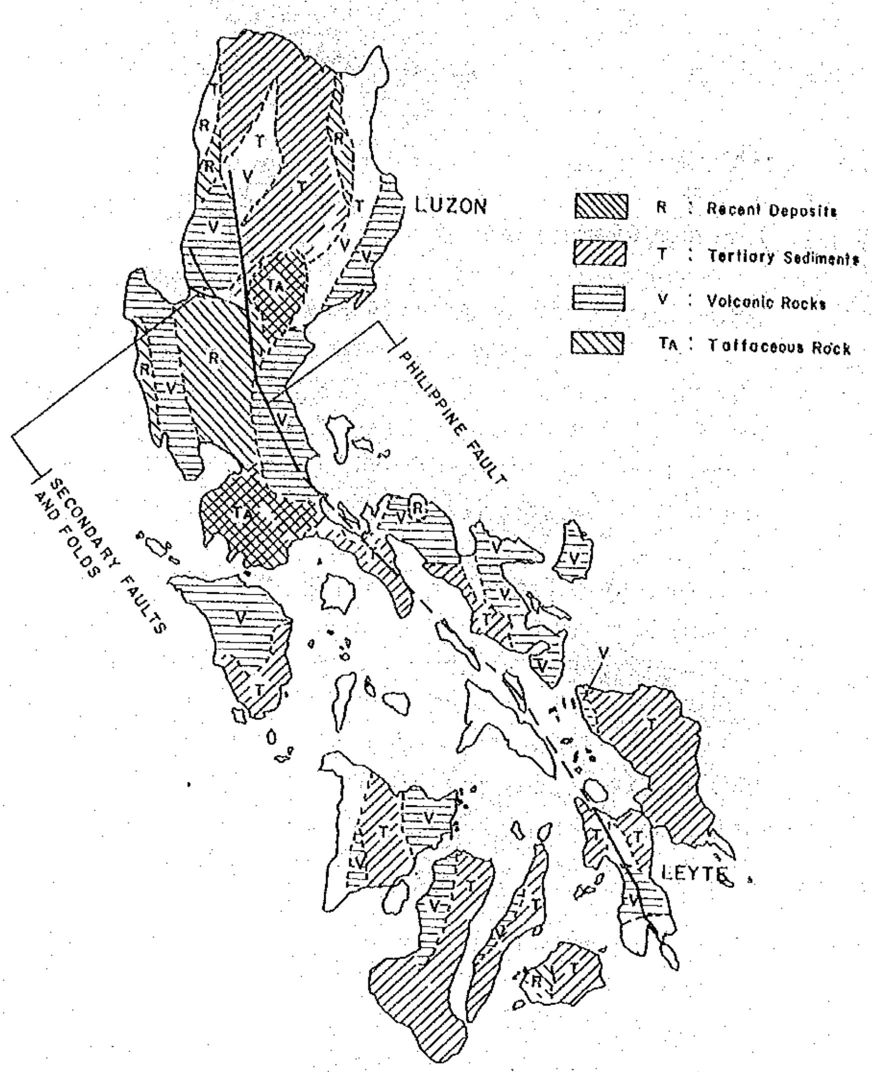


FIGURE 2.1-1(1) GEOLOGY

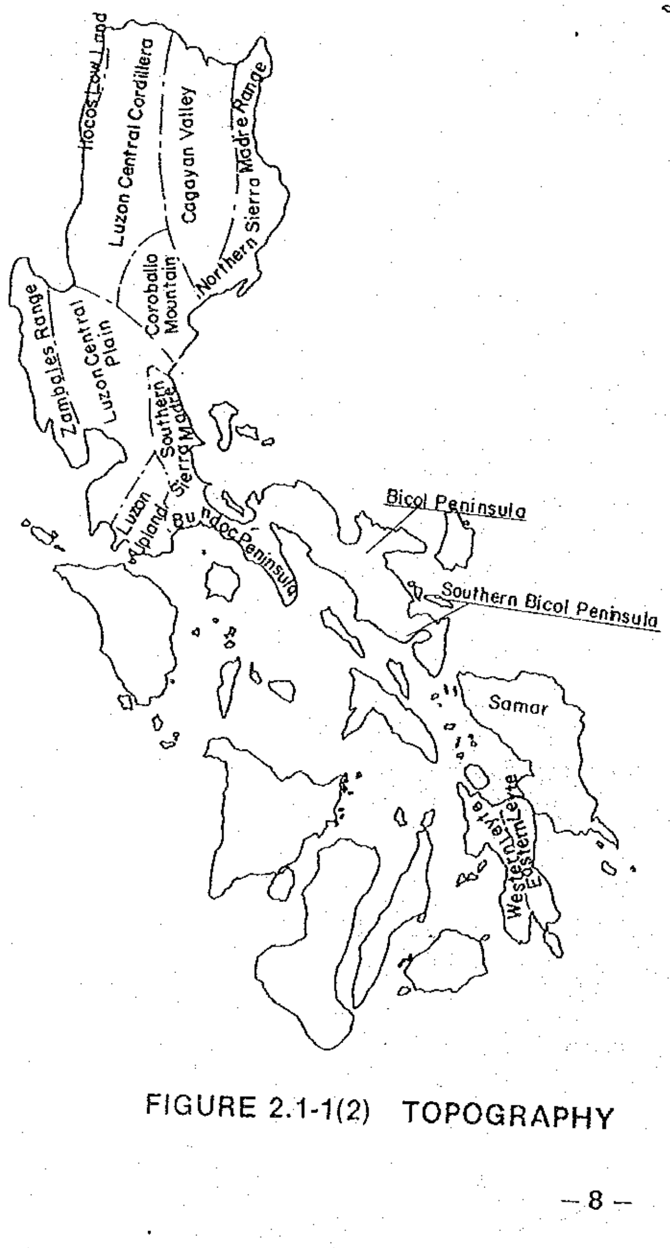


FIGURE 2.1-1(2) TOPOGRAPHY

Road disasters mostly occur with high frequencies in these fault and developed fracture zones. Geological features of road disaster prone areas can be characterized as:

—Badly weathered,
—Highly altered,
—On interface between different kinds of rocks, and/or
—On a tectonic line.

Rocks generally found in badly weathered zones are granite, tuff, tuff breccia, sandstone, and limestone which are quickly and badly weathered under heavy rain and high temperature. Diabase, andesite, and diorite are frequently observed in highly altered zones and on interface between kinds of rocks. Various kinds of rocks are found near a tectonic line.

Of the disaster prone sections, diabase is most representative in the Dalton Pass section, while limestone and sandstone are typical in Lucena. Of the access roads to Baguio, diabase and andesite are most frequently seen along Kennon Road, while sandstone, conglomerate, and andesite are the major rocks seen along Agoo-Baguio Road. Along Naguilian Road, which is subject to the present Study, tuff, sandstone, and conglomerate are representative.

It is, thus, noted that road disasters occur not to any specific type or types of rocks but to a variety of rocks in the Philippines.

2.1.2 Climate

i) Air Streams

The climate of the Philippines is controlled to a great extent by air streams and tropical cyclones as well as geography and topography.

The principal air streams affecting the Philippines are the Northeast Monsoon, the Southwest Monsoon and the North Pacific Trades. The Northeast Monsoon first affects the Philippines in October as a weak stream, attaining maximum strength in January. It gradually weakens in March and finally disappears in April. It starts as a continental polar air mass with a low temperature of about -20°C and a low humidity. As it passes over the Pacific, it is transformed into a maritime polar air mass. It finally reaches the Philippines as a maritime tropical air mass with a surface temperature of about 25°C.

The Southwest Monsoon first appears in early May, attains maximum intensity in August and gradually disappears in October. It is warm and very humid. Its temperature near the surface is generally between 25.5°C and 27.5°C. Its relative humidity is rarely below 70% near the surface.

The North Pacific Trades are generally dominant over the entire Philippines in April and early May and over the central and southern Philippines in October. These are the warmest air streams that affect the Philippines and have a temperature of about 27°C near the earth's surface.

ii) Type of Climate

Recognizing the fact that temperature differences in the Philippines are very small, while rainfall variations are large, climate is classified into four (4) types based solely on rainfall characteristics (See Figure 2.1-2).

- First Type : Two pronounced seasons, dry from November to April, wet during the rest of the year.
- Second Type : No dry season with a very pronounced maximum rainfall from November to January.
- Third Type : No very pronounced maximum rain period with relatively dry from November to April and wet during the rest of the year.
- Fourth Type : No very pronounced maximum rain period and no dry season. Rainfall more or less evenly distributed through the year.

iii) Tropical Cyclones

The Philippines is located in a region which is recognized as having the greatest frequency of tropical cyclones in the world. Tropical cyclones are classified into the following three (3) categories:

- Tropical depression—maximum wind speed within the disturbance up to 63 kilometers per hour.
- Tropical storm—maximum wind speed within the disturbance ranges from 64 to 118 kilometers per hour.
- Typhoon—maximum wind speed within the disturbance exceeds 188 kilometers per hour.

Average annual frequency of tropical cyclones in 36 years (1948-1983) is 19.9, of which 4.0 are tropical depressions, 5.1 tropical storms and 10.8 typhoons.

The tropical cyclone season lasts from June to December, although the other months are not entirely free of these cyclones. The period from June to December accounts for 88% of the mean annual total number of tropical cyclones. July and August have the greatest mean frequency with 3.3 and September is second with 3.2. February and March have the smallest mean frequency with about 0.3. (See Figure 2.1-4).

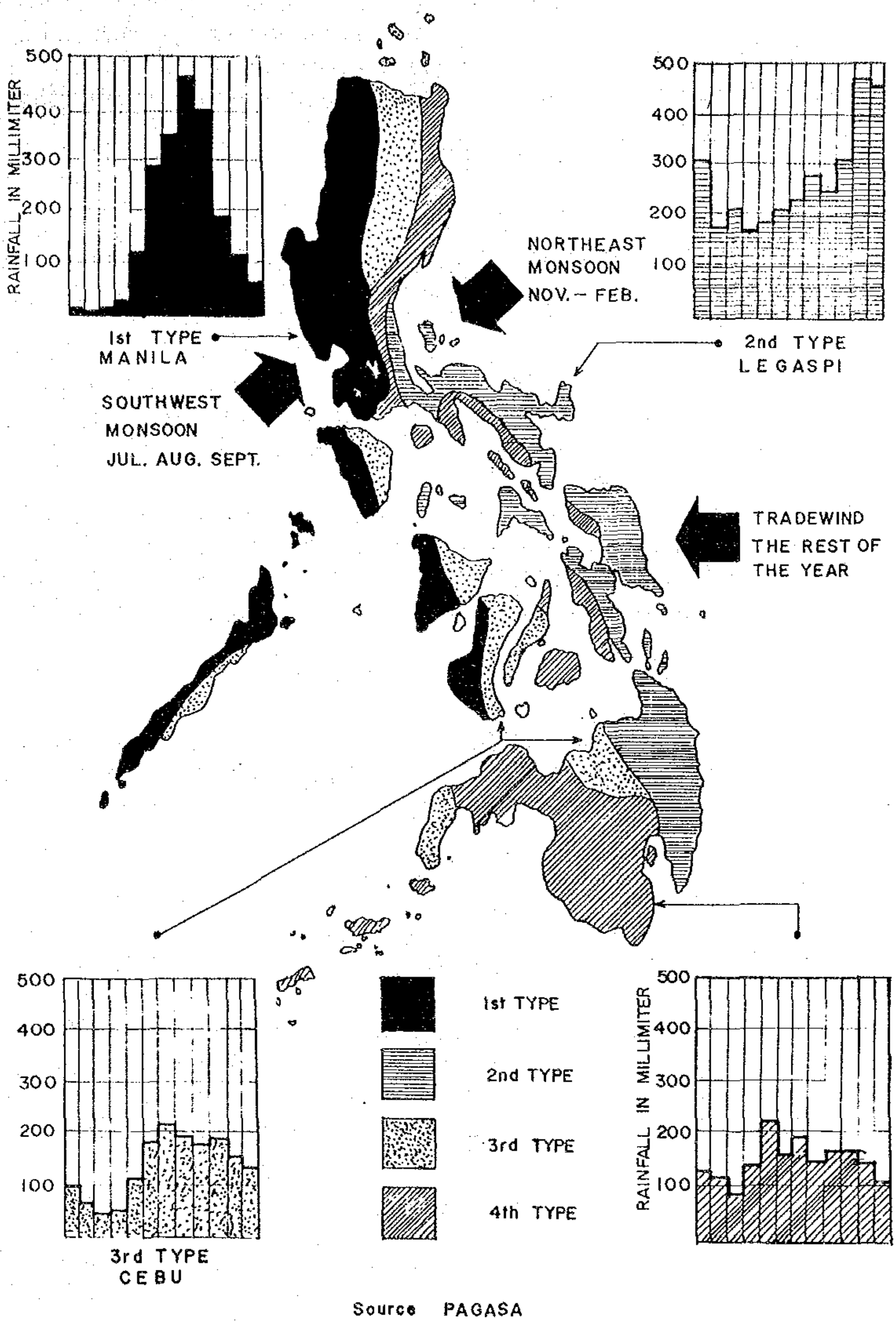


FIGURE 2.1-2 TYPE OF CLIMATE AND DISTRIBUTION OF RAINFALL

Tropical cyclones follow widely variable tracks in the vicinity of the Philippines. During the months of April, May and June, the cyclones which hit the Philippines generally cross the Visayas. During the months of July, August and September, most of the cyclones cross northern Luzon or the Batanes Islands. During the period from October to March, cyclones generally cross the Visayas. Mean monthly tracks of tropical cyclones in the vicinity of the Philippines are shown in Figure 2.1-5.

iv) Rainfall

The average annual rainfall for the Philippines is 2,533.4 mm. Luzon has an annual average of 2,724.4 mm, Visayas has 2,391.7 mm and Mindanao has 2,349.8 mm.

August has the highest average monthly rainfall with 304 mm, while April has the smallest average with about 100 mm. In Luzon, August has the highest average with 402 mm, while March has the smallest average with 88 mm.

Baguio City holds the annual, monthly and 24-hour absolute maximum rainfall records for Luzon and the entire Philippines. The absolute maximum annual, monthly and 24-hour rainfall was 9,038 mm in 1911, 3,462 mm in August 1919 and 1,168 mm from noon of July 14 to noon of July 15, 1911, respectively.

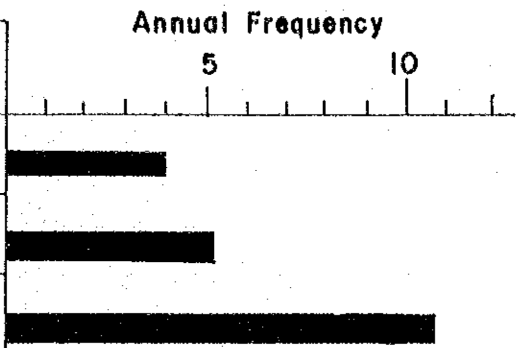
v) Temperature

The mean annual temperature of the Philippines is 27.0°C. The average of annual temperature in Luzon is 26.8°C, 27.3°C in Visayas and 26.9°C in Mindanao. The mean annual temperature in Baguio City is 18.2°C due to the effect of its high elevation.

For the whole country in general, the hottest months are may with 28.2°C, June with 27.9°C and April with 27.2°C. The coldest months are January with 25.6°C, February with 25.9°C and December with 25.9°C.

The absolute maximum temperature recorded in the Philippines was 42.2°C at Tuguegarao on April 29, 1912. The absolute minimum of 3.0°C was recorded at Baguio City in January 1903.

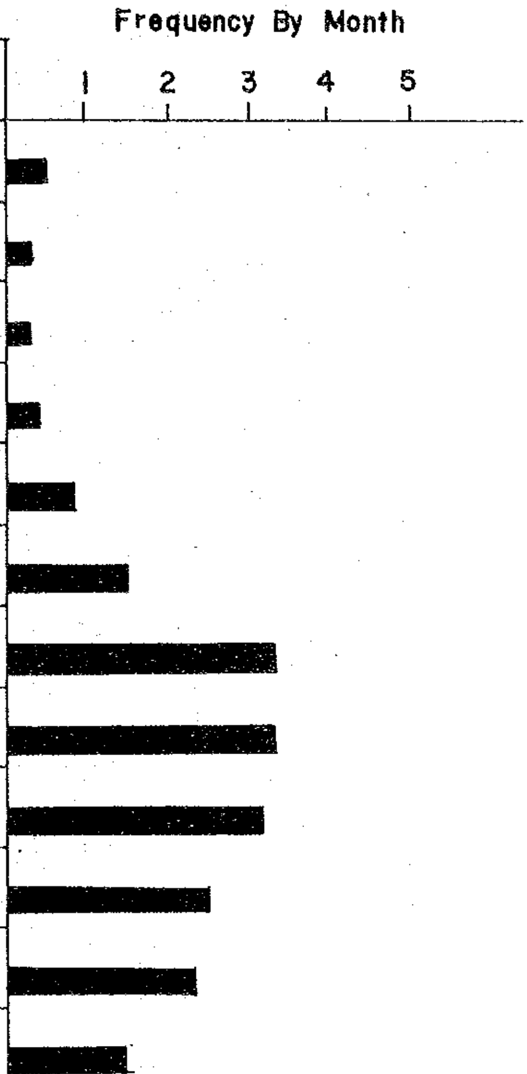
Tropical Cyclones	Annual Average Frequency
Tropical Depression	4.0
Tropical Storm	5.1
Typhoon	10.8
TOTAL	19.9



Source : PAGASA

FIGURE 2.1-3 ANNUAL FREQUENCY OF TROPICAL CYCLONES BY INTENSITY (1948-1983)

Month	Average Frequency
January	0.5
February	0.3
March	0.3
April	0.4
May	0.8
June	1.5
July	3.3
August	3.3
September	3.2
October	2.5
November	2.3
December	1.5
TOTAL	19.9



Source: PAGASA

FIGURE 2.1-4 FREQUENCY OF TROPICAL CYCLONES IN THE PHILIPPINE AREA OF RESPONSIBILITY (1948-1983)

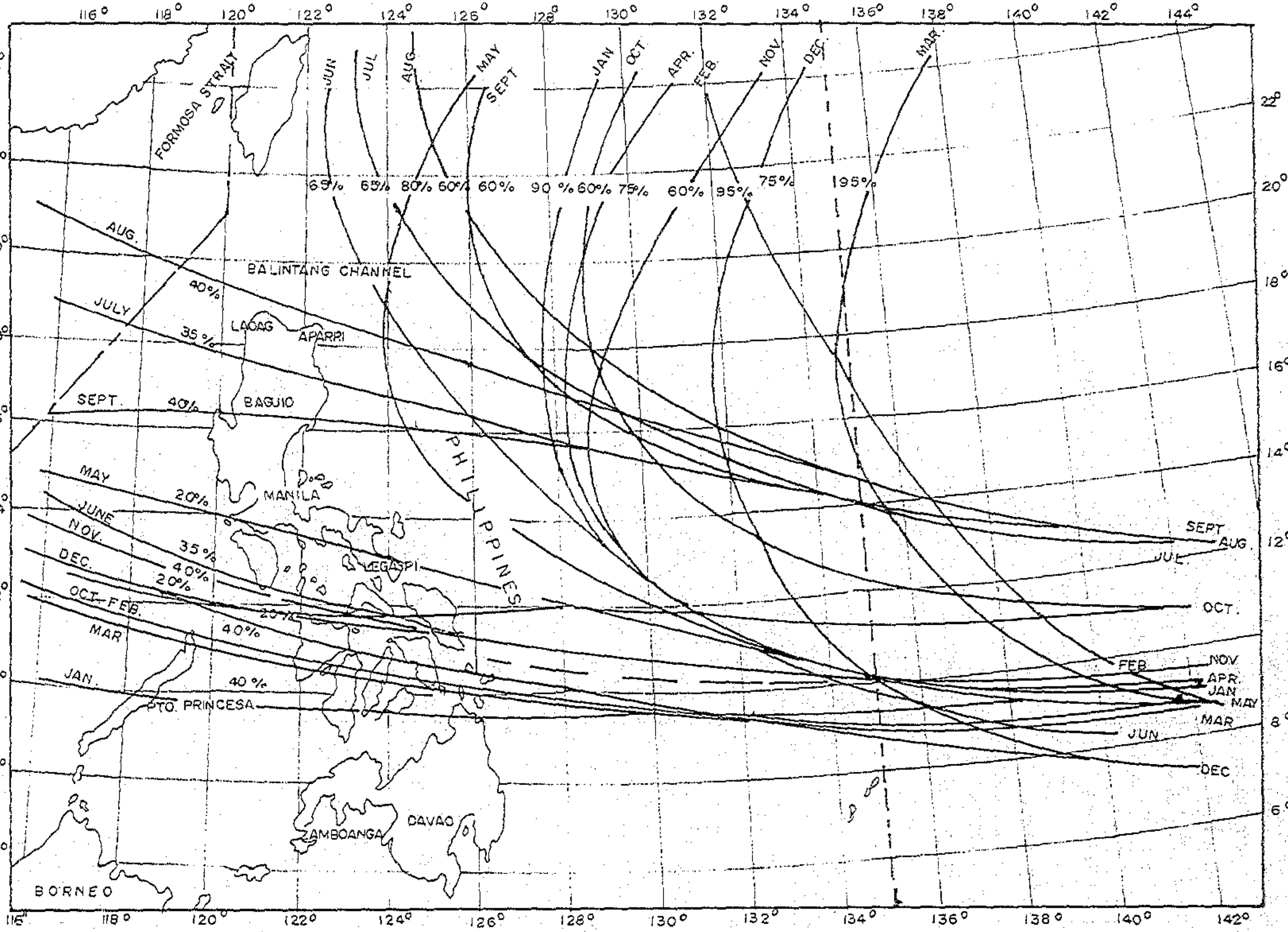


FIGURE 2.1-5 MEAN MONTHLY TRACKS OF TROPICAL CYCLONES AFFECTING THE PHILIPPINES

2.2 TRANSPORTATION

2.2.1 Dependence on Road Transport

Transport modes in the Philippines consist of sea, road, rail and air. Table 2.2-1 gives transport volumes in 1980 by transport mode. Road transport is dominant and accounts for 90 percent of passenger and 65 percent of freight transport. Despite the fact that the Philippines is made up of about 7,100 islands whereby it should be largely dependent upon sea travel for inter-island transport, dependence on road transport is stronger than by sea. Moreover, intra-island (coastal) freight transport represents only 6 percent of domestic sea freight, while the rest are all inter-island cargo. Hence, a major proportion (97 percent) of intra-island freight transport depends on road transport.

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 services 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 2.2-1 APPROXIMATE NATIONAL MODAL SPLIT, 1980 (DOMESTIC TRAFFIC ONLY)

Mode	Freight Ton-Kilometers (Billion)	Share (%)	Passenger 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

2.2.2 Transport Facilities

1) Roads

Total road length as of 1983 is 155,475 kms., and road density is 0.52 kms/square km. The total length of national roads, which comprise the trunk road network, is 23,961 kms. There has been active development of national roads. During the seven years between 1975 and 1983, road extension grew 2,296 kms. (or 1.1 times), road density increased from 0.07 to 0.08, and pavement ratio rose from 39% to 44% (see Table 2.2-2).

TABLE 2.2-2 ROAD DEVELOPMENT (1975-1983)

	Length				Ratio 1983/1975	Road Density	
	1975 (kms)	(%)	1983 (kms)	(%)		1975	1983
National Road							
Paved	8,413	(39)	10,658	(44)	1.27		
Un-paved	13,252	(61)	13,303	(56)	1.00		
Sub-total	21,665	(100)	23,961	(100)	1.11	0.07	0.08
Local Road							
Paved	9,131	(11)	13,710	(10)	1.50		
Un-paved	73,634	(89)	117,804	(90)	1.60		
Sub-total	82,765	(100)	131,514	(100)	1.59	0.28	0.44
Total							
Paved	17,544	(17)	24,368	(16)	1.39		
Un-paved	86,886	(83)	131,107	(84)	1.51		
Total	104,430	(100)	155,475	(100)	1.49	0.35	0.52

Source: Planning Service, MPWH

Table 2.2-3 shows national road length by Region included in the Study Area.

Both road densities and pavement ratios in Regions I, III and IV-A are higher than the national average. On the other hand, both road density and pavement ratio in Region II are lower than the national average. The Region II has the lowest level of the national road development within the Study Area. Road density in Region VIII is slightly higher than the national average, while pavement ratio is lower than the national average.

TABLE 2.2-3 NATIONAL ROAD LENGTH BY REGION: 1983

	Philippine	Region I	Region II	Region III	Region IV-A	Region V	Region VIII
National Road							
Paved (km)	10,658	1,227	493	1,266	1,390	886	672
Unpaved (km)	13,303	932	1,691	595	544	759	1,211
Total (km)	23,961	2,159	2,284	1,861	1,934	1,645	1,883
Road Density (km/km2)	0.08	0.10	0.06	0.10	0.10	0.09	0.09
Pavement Ratio (%)	44	57	22	68	72	54	36

Source: Planning Service, MPWH

2) Other Transport Facilities

i) Rail

Two lines of the Philippine National Railways (PNR) operate within the Study Area.

—Main Line North (Manila-San Fernando, La Union) . . . . 226 kms.
—Main Line South (Manila-Camalig) . . . . 460 kms.

There is also a branch line of the Main Line North:

—Branch Line (Tarlac-San Jose) . . . . 55 kms.

The Maharlika Highway and the Main Line South run more or less parallel to each other and compete with each other in South Luzon. However, rail transport is gradually losing ground to road transport due to the deteriorated equipment and lower service standard caused by poor management and inadequate maintenance.

ii) Sea

Figure 2.2-1 shows the locations of public ports which handle over 15,000 tons of commodities annually. There are three (3) such ports in North Luzon, eight (8) in South Luzon, five (5) in Samar and five (5) in Leyte.

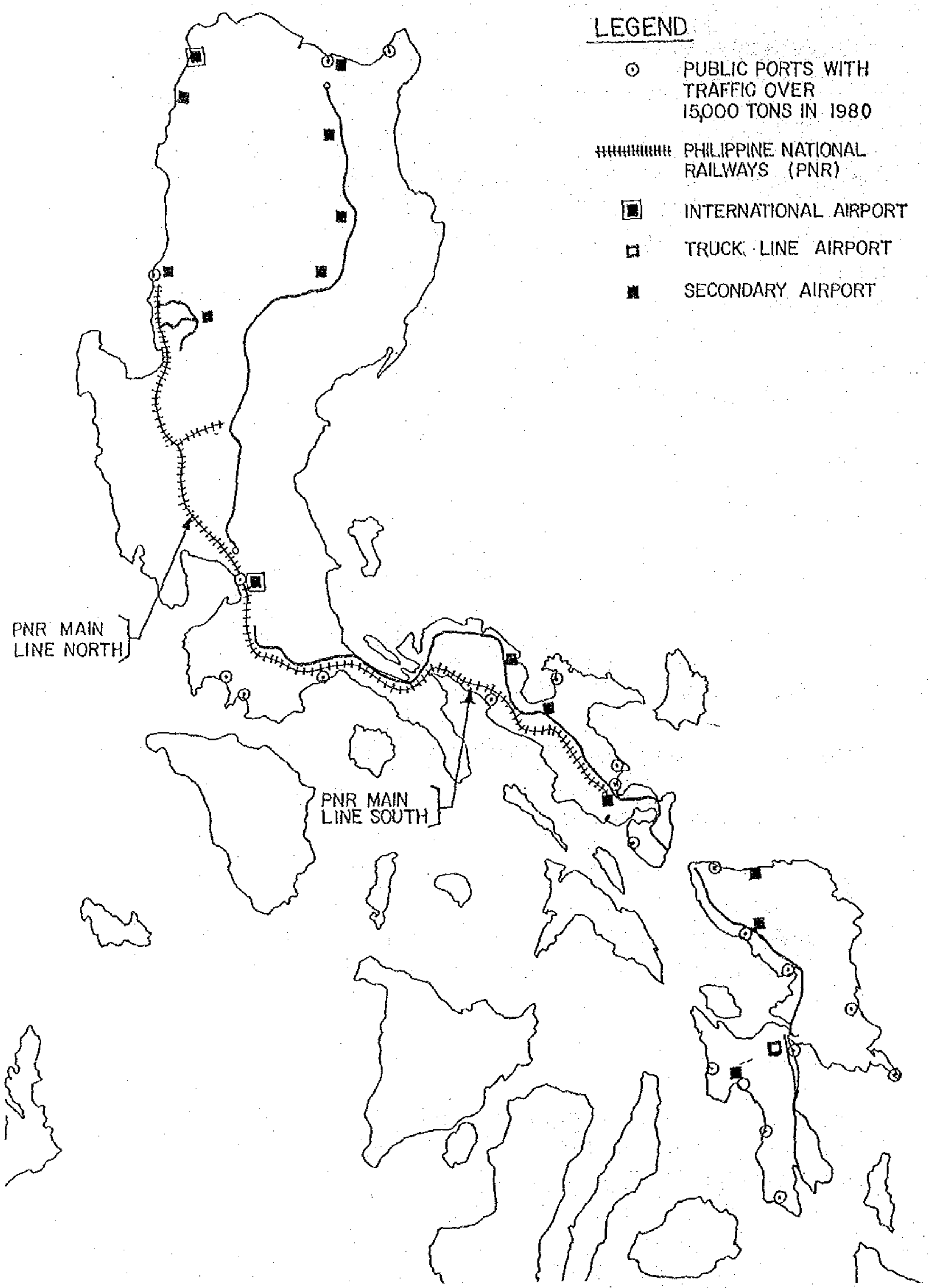


FIGURE 2.2-1 **OTHER TRANSPORT FACILITIES**

Sea transport is mostly inter-island. Intra-island (coastal) transport is quite small, as indicated by the fact that only 6 percent of domestic sea freight are intra-island cargo.Among intra-island cargo, oil accounts for 98 percent of coastal transport.
The National Transport Planning Project (NTPP) estimates that road transport can compete effectively with sea transport within the following trip distances:

—For passenger transport, up to 1,000 kilometers (corresponds to Manila-Sogod, Southern Leyte)
—For general mixed freight, up to 600 kilometers (corresponds to Manila-Sorsogon)
—Less than the above distances for large volume-bulk and semi-bulk cargoes.

If the mode of transport is selected along the above guidelines, road transport will be selected for all Manila based passenger trips within the Study Area and sea transport will be selected mainly for cargo trips between Manila and Samar or Leyte.

iii) Air

Figure 2.2-1 shows the location of international, trunkline, and secondary airports within the Study Area. There are eight (8) airports, in North Luzon, four (4) in South Luzon, two (2) in Samar and two (2) in Leyte.

Reliance on air transport for either passenger or cargo transport is, at present, extremely slight.

2.2.3 Trunk Road Network

Defining roads actually functioning as trunk roads a ''interprovincial roads with pavement widths of 6.1 meters or more'', existing trunk roads in the Study Area are as shown in Figure 2.2-2.

Two trunk roads running north and south, the Maharlika Highway and the Manila North Road, form the trunk road framework of North Luzon. The Maharlika Highway serves the entire Cagayan Valley, which is bordered on three sides by the Sierra Madre Range along the eastern coast, the Luzon Central Cordillera located slightly to the west of center and the Caraballo Mountains to the south. The Manila North Road runs through the narrow flat land along the western coast. The Luzon Central Cordillera range located in between the two trunk roads prevents these roads from being linked. For this reason, trunk roads in North luzon are not functioning as a network yet.

Trunk roads in Central Luzon are rather well developed owing to favorable topographical conditions in this region.

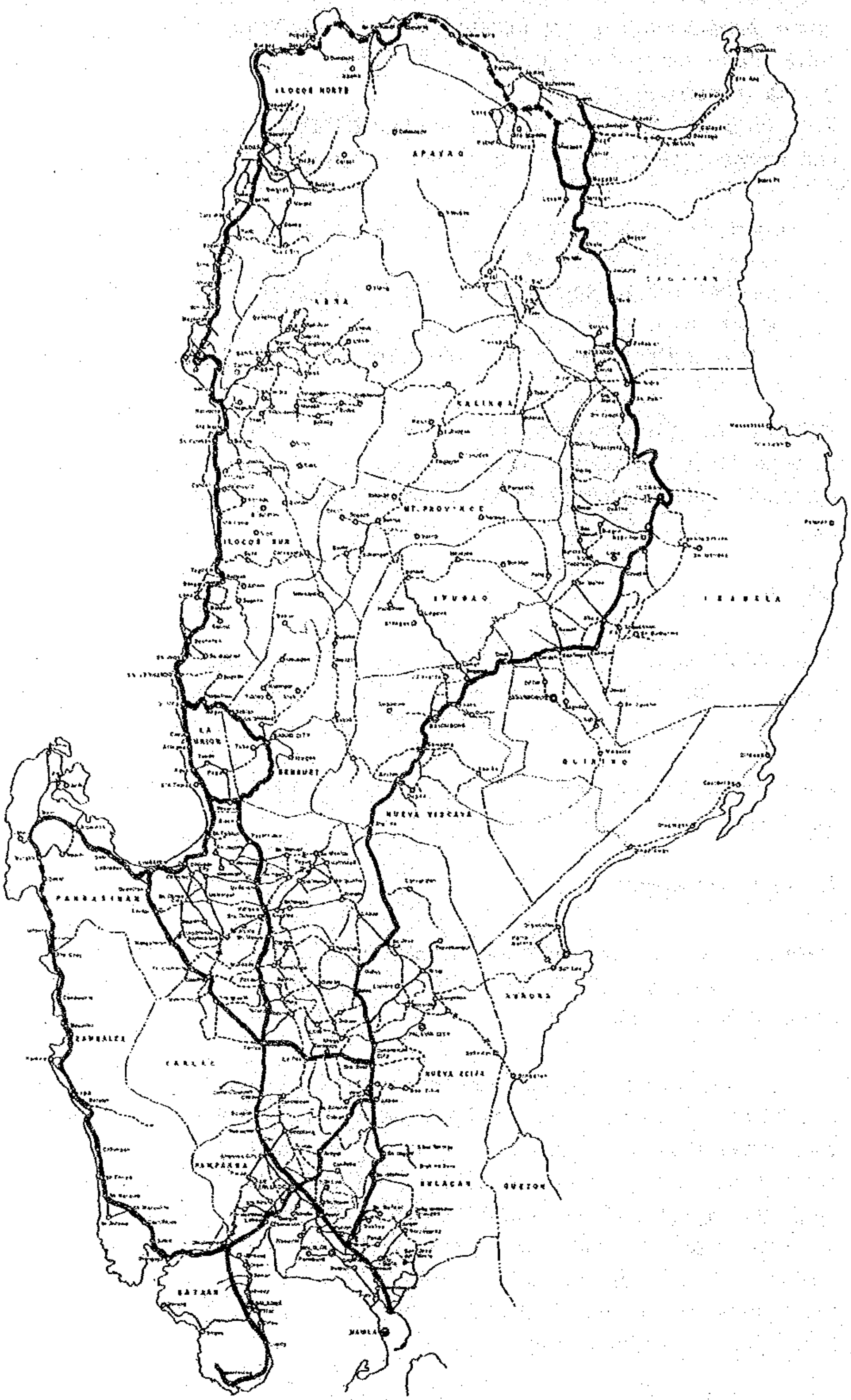


FIGURE 2.2-1 (1) MAJOR TRUNK ROAD NETWORK
(CENTRAL AND NORTHERN LUZON)

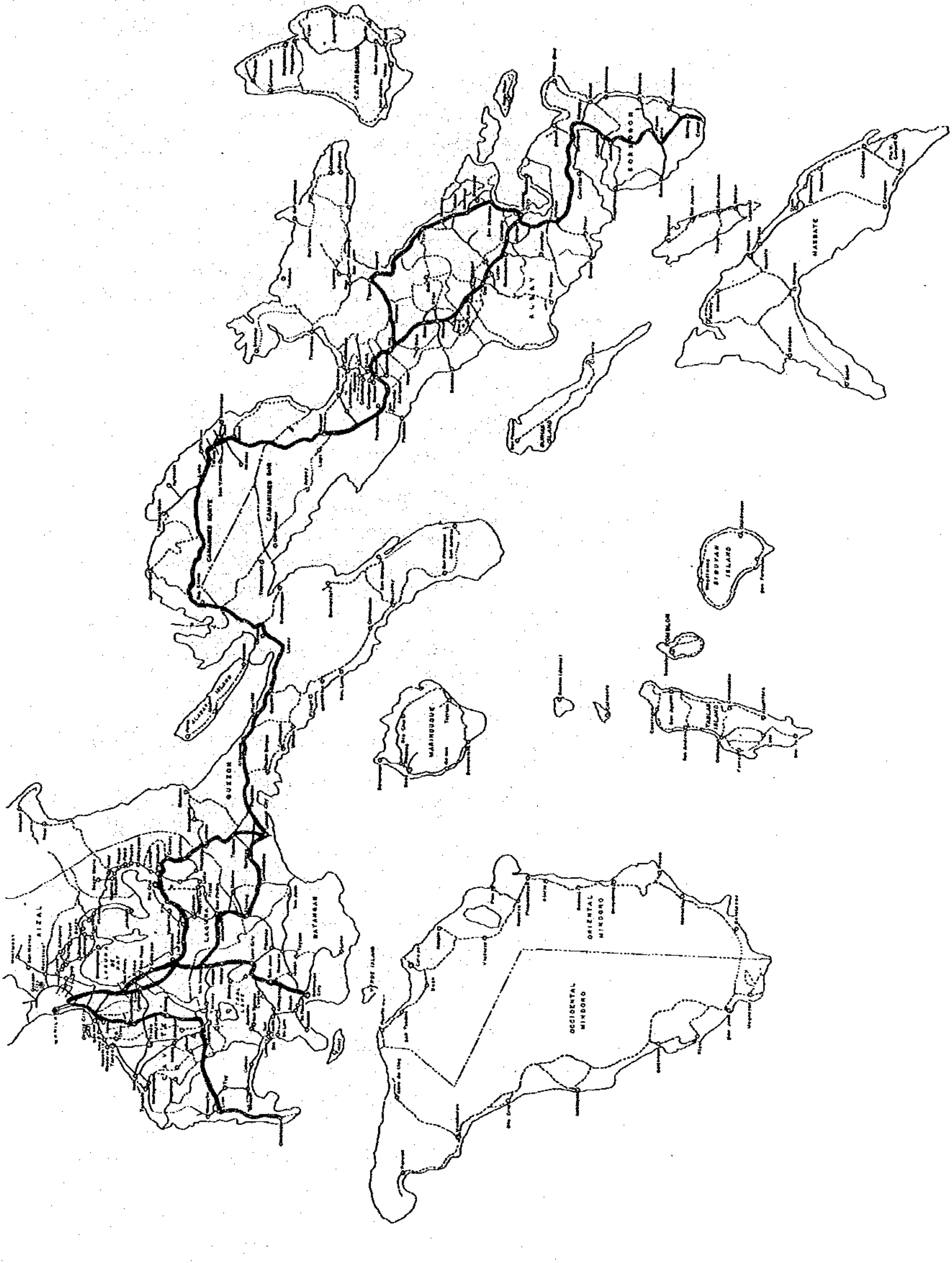


FIGURE 2.2-2(2) MAJOR TRUNK ROAD NETWORK (SOUTHERN LUZON)

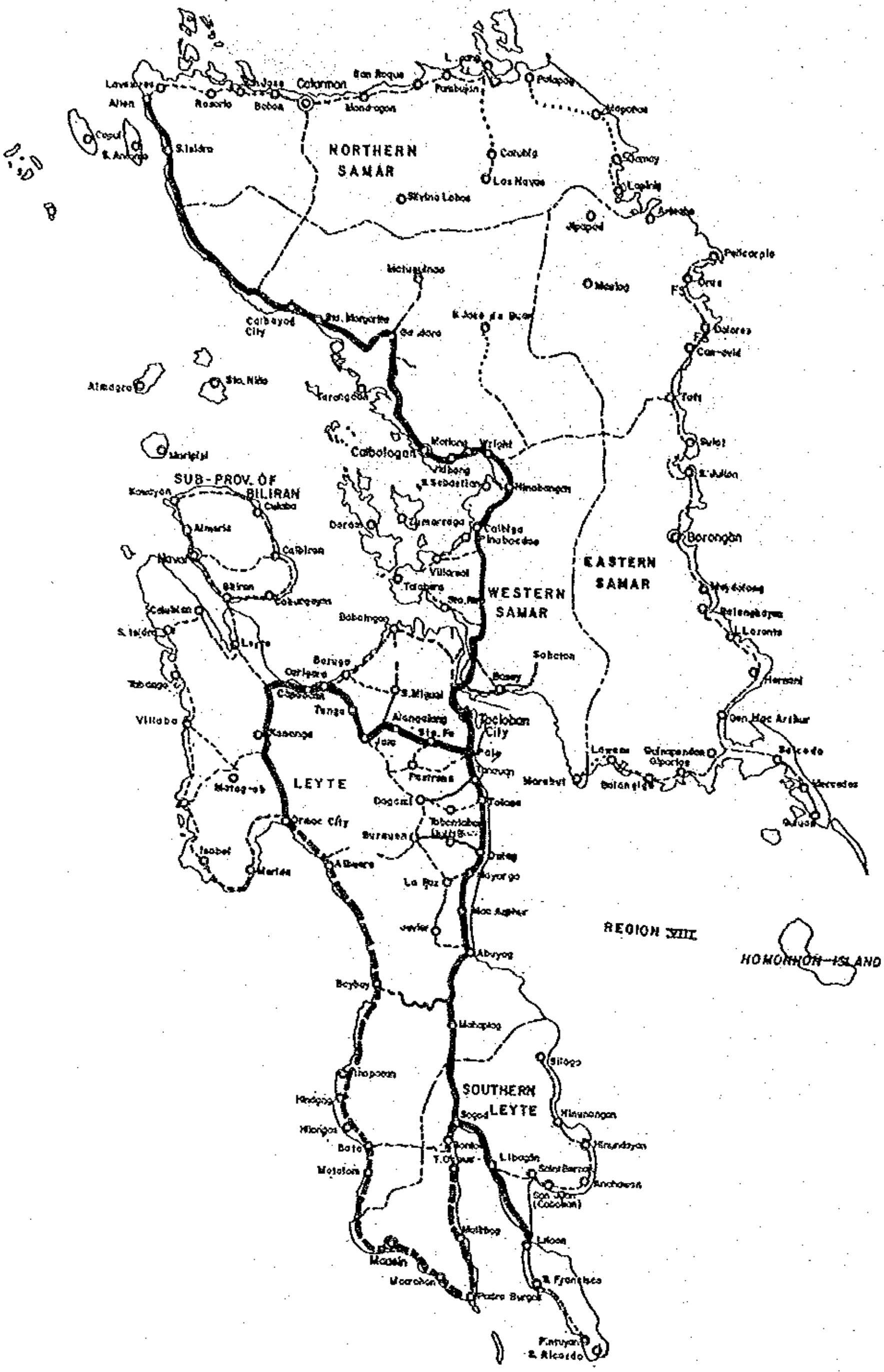


FIGURE 2.2-1 (3) MAJOR TRUNK ROAD NETWORK
(SAMAR AND LEYTE)

South of Luzon, from Quezon Province southward, is a generally long and narrow land with only about 20 to 50 kilometers wide. The sole trunk road is the Maharlika Highway, which runs through almost the center of the region.

The Maharlika Highway is also the only trunk road in Samar, where it runs along the western coast of the island. Roads on the eastern coast are as yet substandard.

There are two trunk roads in Leyte: the Maharlika Highway on the eastern coast and the West Leyte Road on the western coast. The latter, however, contains may gravel sections and temporary bridges such as wooden bridges and is not up to the standard of a trunk road yet.

2.2.4 Road Network Issues

Figure 2.2-3 shows the conceptual structure of trunk road network in the Study Area.

The Maharlika Highway and Manila North Road are the two axes in North Luzon. Roads leading to various areas branch off from the two axes. However, the Luzon Central Cordillera range located in between the two roads prevent them from being linked to each other, with the result that each is functioning independently of the other. For this reason, access to the Cagayan Valley Region, for example, can be made only from the Maharlika Highway. If the Highway becomes impassable due to road disaster, the Cagayan Valley is isolated.

South Luzon has only one axis, the Maharlika Highway

In Samar, the Maharlika Highway is the western coast axis as well as the sole axis in the island until the eastern coast axis is completed.

Leyte has two axes, the Maharlika Highway on the eastern coast and the West Leyte Road on the western coast. The West Leyte Road, however, is still substandard.

Under the current situation, only one axis provides access to most regions. If the axis becomes impassable at any point due to road disaster, the region will become isolated, and if the axis remains impassable for too long a period, the socio-economic activities of the region will become paralyzed. The structure of the current trunk road network is such that emergency situations can not be countered effectively or reliably.

The solution to this problem is to provide a flexible road network with links between trunk roads so as to have alternative routes within short distances. To achieve this, however, huge investments over a long period of time will be required.

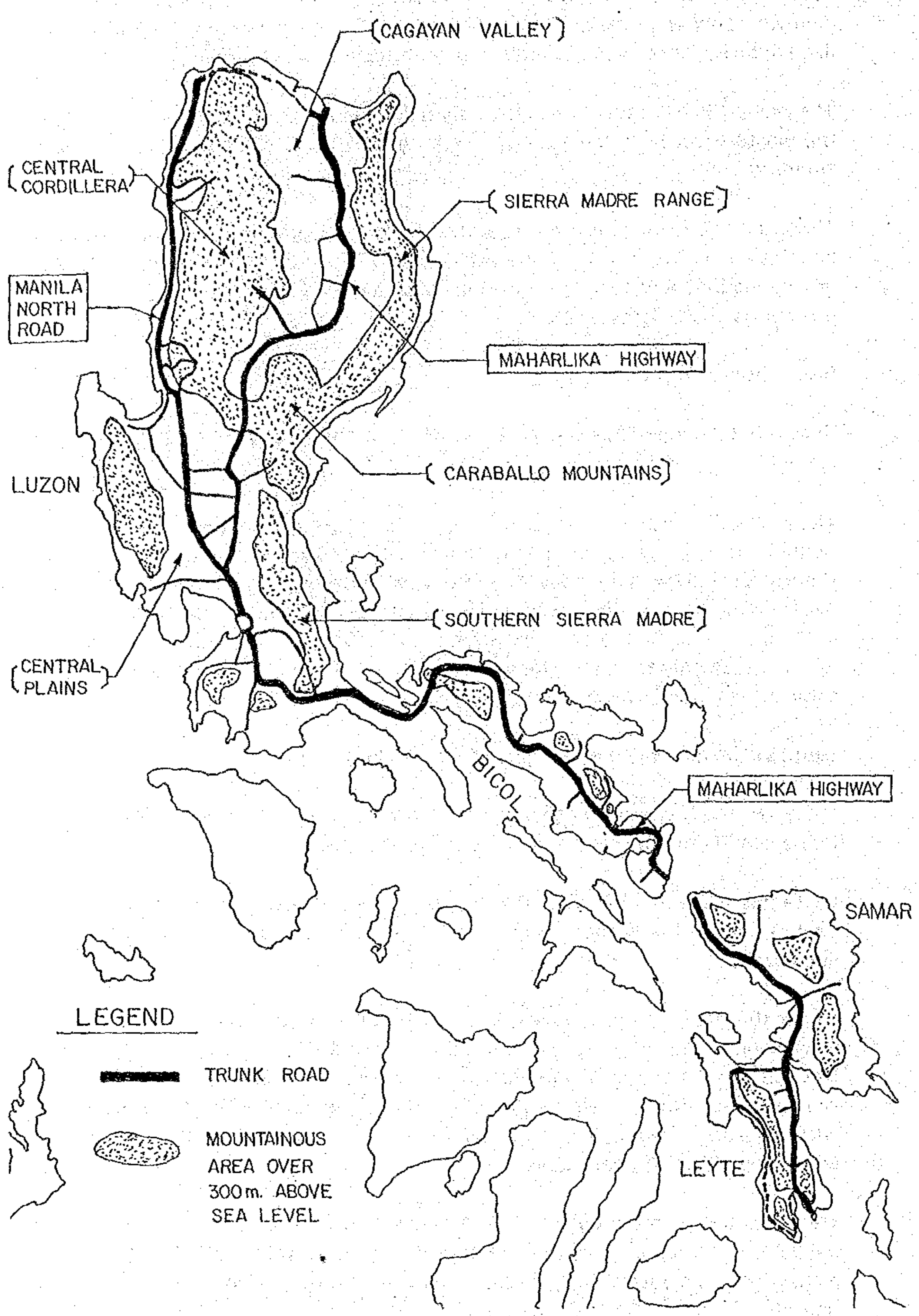


FIGURE 2.2-3 SCHEMATIC TRUNK ROAD NETWORK

A more realistic solution, therefore, is to correct the weaknessess of existing roads so that traffic can be secured throughout the year. This measure is also necessary to take full advantage of past investments.

Even on the most important trunk roads in this country, like the Maharlika Highway, road disasters due to typhoons or heavy rainfalls occur and often cause traffic interruption. Implementing disaster control measures on existing trunk roads and making them "disasterproof" in order to secure traffic throughout the year is quite an important issue.