SUPPLEMENTARY BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR CONSTRUCTING
BRIDGES ALONG RURAL ROADS
(PHASE III)
IN
THE REPUBLIC OF THE PHILIPPINES

JANUARY 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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P R E F A C E

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a supplementary basic design study on the Project for Constructing Bridges Along Rural Roads (Phase III) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Michio OKAHARA, Chief, Foundation Engineering Division, Structure and Bridge Department, Public Works Research Institute, Ministry of Construction, from September 18th to Novenber 1st, 1991.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field study at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

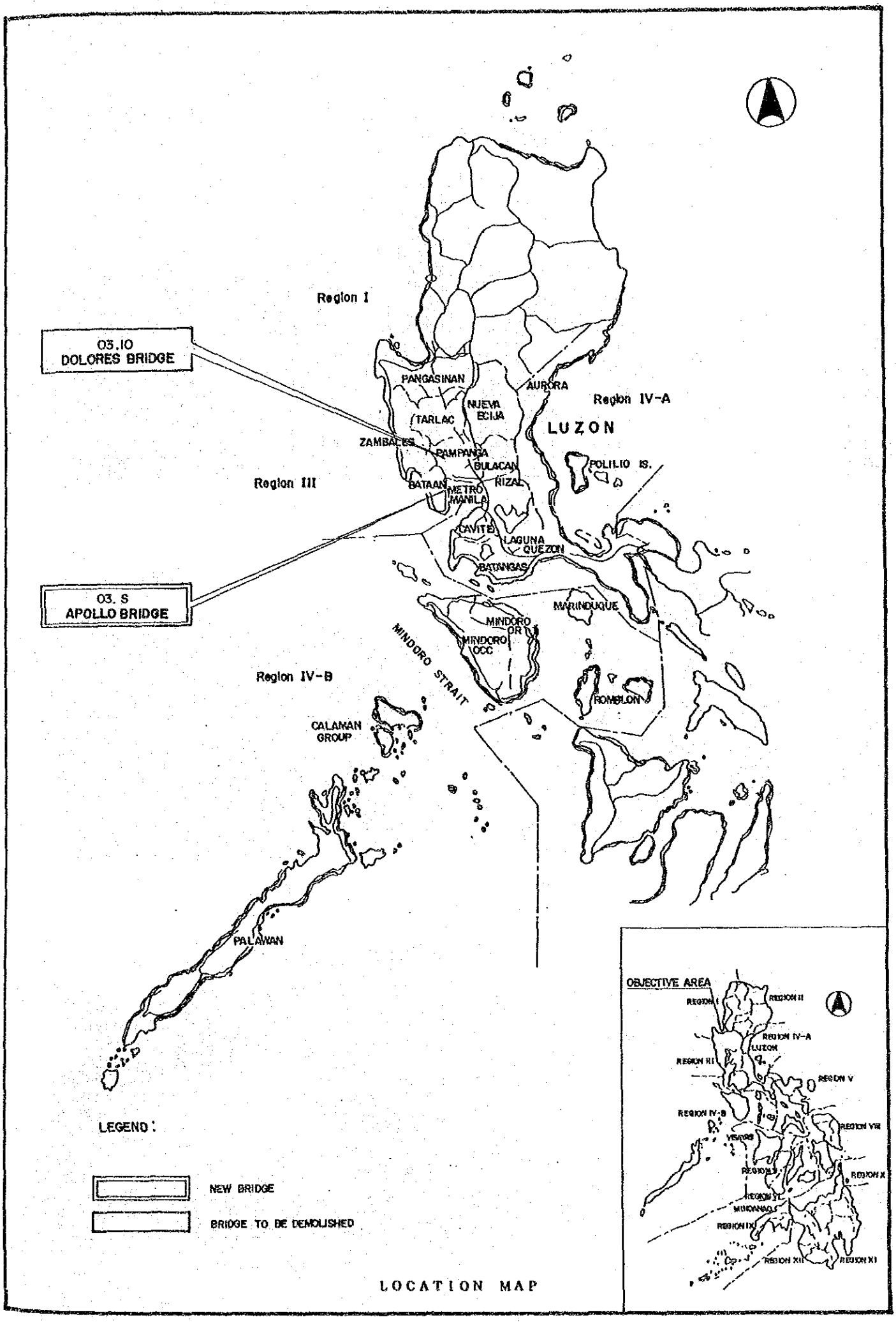
I hope that this report will contribute to the promotion of the Project and to the enhancement of friendly relations between our two countries.

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

January, 1992

Kensuke Yanagiya

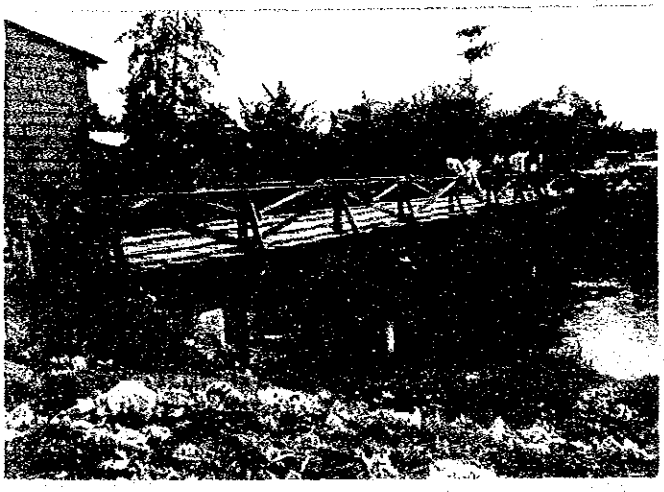
Kensuke Yanagiya
President
Japan International Cooperation Agency

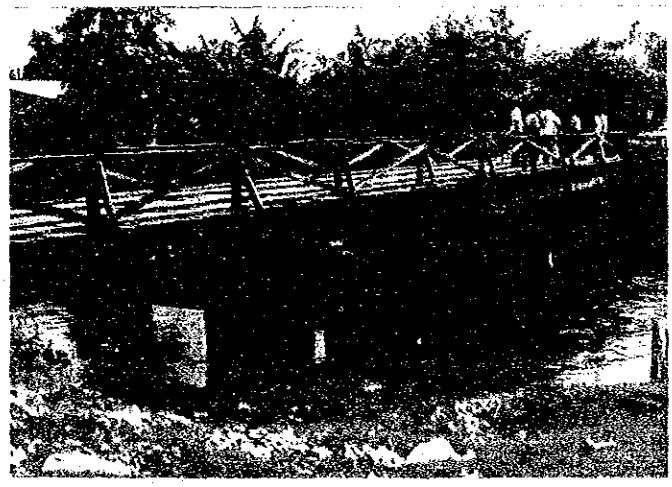

03.10
DOLORES BRIDGE
03. S
APOLLO BRIDGE
Region I
Region III
Region IV-A
Region IV-B
LUZON
PANGASINAN
AURORA
NUEVA ECIJA
TARLAC
ZAMBALES
PAMPANGA
BULACAN
BATAAN
METRO MANILA
RIZAL
POLILIO IS.
CAVITE
LAGUNA
QUEZON
BATANGAS
MARINDUQUE
MINDORO OR
MINDORO OCC
MINDORO STRAIT
ROMBLON
CALAMIAN GROUP
PALAWAN
OBJECTIVE AREA
REGION I
REGION II
REGION IV-A
LUZON
REGION III
REGION V
REGION IV-B
REGION VIII
REGION X
REGION XI
REGION XII
LEGEND :
NEW BRIDGE
BRIDGE TO BE DEMOLISHED
LOCATION MAP

BRIDGE NO. :
BRIDGE NAME : APOLLO
LOCATION : APOLLO - ST. JOSEPH ROAD
BRGY. APOLLO, ORANI, BATAAN

FIRST APPROACH

SECOND APPROACH





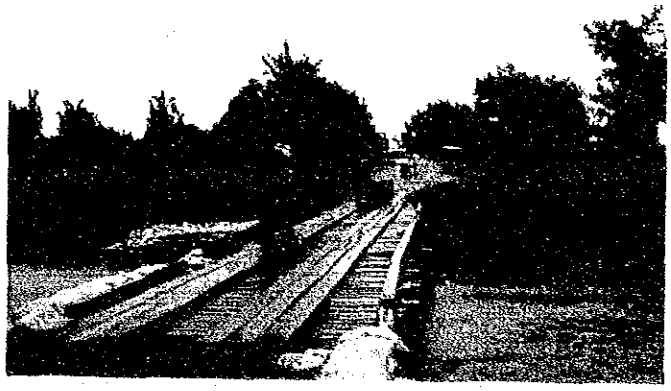
VIEW FROM RIGHT SIDE OF SECOND APPROACH

UPSTREAM VIEW

DOWNSTREAM VIEW

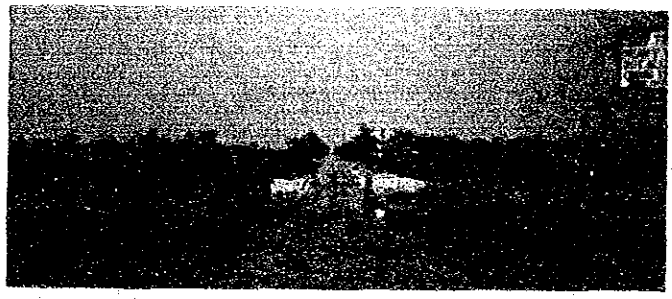
Photo - 1

BRIDGE NO. : 03.10
BRIDGE NAME : DOLORES
LOCATION : KM. 76+870
DOLORES-DEL ROSARIO RD.
DOLORES, BACOLOR, PAMPANGA



FIRST APPROACH

FULL VIEW OF THE BRIDGE FROM UPSTREAM



SECOND APPROACH

UPSTREAM

Photo – 2

SUMMARY

The Republic of the Philippines has a total population of approximately 60 million persons in 1990 with the total land area of about 300,000 square kilometers, and the most principal economic activities are agriculture, forestries and fisheries, and followed by manufacture industry. In the country, the main infrastructure, which supports mainly these industries and socio-economic activities, is the road transport sector. This sector has a share of 77% of the total freight transportation.

However, some of the bridges in rural areas of the country are already old and dilapidated or temporary timber bridges, which are too weak to carry vehicles for transporting materials and equipment for development. In some locations, there are no bridges or spillways so that traffic are often closed during rainy season. These missing or weak bridges diminish the usefulness of many existing roads resulting in restrained the development of rural areas.

In this context, the Government of the Republic of the Philippines has drawn up the roads development plan with emphasis on the improvement of rural roads, and giving particular attention to the replacement of temporary or weak bridges with permanent structures, in the Medium Term Philippines Development Plan 1987-1992.

The Government of the Republic of the Philippines intends to improve the roads by the assistance of Japan's Grant Aid, and requested the Basic Design Study on the Project for Construction Bridges for the replacement of temporary or weak bridges along rural roads. As Phase I, 24 bridges were supplied as steel materials in 1987, and in Phase II, 10 bridges were constructed by Japan in 1988 under Japan's Grant Aid program. These bridges are already completed in 1989 and are utilized.

Based on the results of the said Phase I and Phase II projects, the Government of the Philippines formulated "FIVE YEAR COMPREHENSIVE BRIDGE RECONSTRUCTION PROGRAM ALONG SECONDARY ROADS" in 1989, and requested the Basic Design study on the Project for Constructing Bridges along Rural Roads (Phase III) named by the First Program under Japan's Grant Aid program to the Government of Japan.

In response to the request of the Government of the Philippines, the Government of Japan decided to conducted the Basic Design Study and Japan International Cooperation Agency (hereinafter referred to JICA) executed the study on the project for constructing bridges along rural roads (PHASE III) on Nov. 1989. Based on the study, 37 bridges out of proposed 57 bridges were selected, and the Final Report was submitted on March 1990.

Out of the selected 37 bridges, 27 bridges are included in the project of steel material supply which was already executed as Japan's Grand Aid program of 1990, and will be completed in 1992. On the other hand, the other 10 bridges are included in the project of constructing bridges and are scheduled to be executed during this year.

After over 600 years of quiescence, Mt. Pinatubo suddenly erupted on June 1991. Mt. Pinatubo is located in central Luzon, where 3 bridges of 27 bridges (group 1) and 5 bridges of 10 bridges (group 2) under phase III are located in the influenced area. Due to the eruption, lava flows, pyroclastic fall and pyroclastic flow occurred, and topographic and river conditions changed. Therefore, it was necessary to carry out a supplementary basic design study for Phase III.

In the context, the Government of the Philippines requested the Government of Japan to carry out a supplementary study on the 5 bridges of the basic design study for Phase III (group 2) and 6 substitute candidate bridges instead of any bridges judged as impossible to construct by using the existing basic design and technical advise of 3 bridges for phase III (group 1).

Based on the request of the Government of the Philippines, the Government of Japan decided to conducted the Supplementary Basic Design Study and JICA send to the Philippine the Study Team from September 18th 1991 to November 1st 1991.

The Study Team executed the field survey which consisted of reviewing the background and the requested contents of the project, investigating the influence on topographic, geology, river condition and bridge structures due to eruption of Mt. Pinatubo, collecting the necessary data for basic design of the project and the proprieties as Japan's Grant Aid.

Based on the field survey and collected data, the Study Team carried out the analysis in Japan which consisted of studying the influence on subjective bridges for Phase III (group 2) due to eruption of Mt. Pinatubo, reviewing the necessities and urgency of the candidate bridge, propriety, socio-economic impact and organization of existing agency for the project.

In the results which the Study Team came out in the supplementary basic design, 1 bridge out of 5 bridges for Phase III (group 2) was excluded as judged not to be propriety to construct because of the influence of the eruption, and 1 bridge out of 6 candidate bridges was selected. A comparison between the two bridges is presented below.

	Excluded Bridge	Substitute Bridge
Name of Bridge	Dolores Bridge	Apollo Bridge
(1) Bridge length	49.49 m	37.49 m
(2) Span length	24 x 2 m	18 x 2 m
(3) Width	6.7 m	6.7 m
(4) Type of superstructure	H-beam	H-beam
(5) Type of substructure	T-type,column	T-type,column
(6) Type of foundation	pile	pile
(7) Length of approach road	249.51 m	130 m

Regarding 3 bridges for Phase III (group 1) affected by eruption of Mt. Pinatubo, the shift of river water way and influence of mud flow in each site was remarkable, and measures must be taken for the protection of the substructure and approach roads.

The executing agency of the Government of the Philippines for the project is the Department of Public Works and Highways.

The project aims at contributing in the activation of regional socio-economics, and improving the living standard and income by distributing safe and reliable traffic facilities in the region resulted from reconstructing old and dilapidated bridges to permanent bridges. The region that will receive benefits has 10% of the total area of the Philippines, about 0.73 million people and an area of 30,500 square kilometers.

The project will not only activate the socio-economic of the region but also contribute in the development of the country in view of the importance of transport sector and scale of the influence.

In conclusion, the study team judges that the project has the significance to be executed under Japan's Grant Aid.

SUPPLEMENTARY BASIC DESIGN STUDY
ON THE PROJECT FOR CONSTRUCTING BRIDGES
ALONG RURAL ROAD (PHASE 3)

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

The Government of the Republic of the Philippines formulated the Medium Term Philippine Development Plan (1987-1992) in 1987. The basic policy is the economic recovery in order to decrease the number of the unemployees and moderate the poverty. For the target accomplishment, it is necessary to upgrade the productivities in rural areas, and to improve the direct development. In relation with the accomplishment, the Government of the Philippines is recognizing that it is indispensable to improve the road network in rural areas. In the Highway development plan of the Medium-term Philippine Development Plan, the Government stresses to improve the roads connected between the rural areas and markets. The Department of Public of Works and Highways is considering the 5 Year Comprehensive Bridge Reconstruction Program along Secondary Roads as the highway development strategy, and requested the Government of Japan to execute the project for constructing bridges along rural roads (Phase III) as the first program of the five year plan which reconstructs 57 bridges in Regions III, IV, and a part of Region I.

The Basic Design Study on the Project for Constructing Bridges along Rural Roads (Phase III) was executed in November 1989. Of the 57 bridges proposed under Phase III, the Study Team has selected 37 bridges appropriate for Japan's Grant Aid Program. And the Final Report was prepared by the Study Team on March 1990.

Out of 37 bridges, 27 bridges were executed as steel material supply project (group 1) under Japan's Grant Aid program of 1991. Of the rest for the Phase III, 10 bridges (group 2) were scheduled to be constructed during this year by Japan under Japan's Grant Aid program. This project was approved by the Cabinet meeting of the Government of Japan. But Mt. Pinatubo, which is located at central Luzon, erupted in June 1991, and out of the 10 bridges for Phase III (group 2), 5 bridges are located in the influenced area. The topographical and river conditions of the said 5 bridges site changed due to the eruption of Mt. Pinatubo. And a Supplementary Basic Design Study for the 10

bridges of Phase III (group 2) became necessary because it was difficult to cope with the change of nature conditions using the prior basic design.

In this context, the Government of the Republic of the Philippines requested the Government of Japan to execute the study of the 5 bridges out of 10 subjective bridges for Phase III (group 2) and the basic design study of the substitute bridges instead of subjective bridges for Phase III (group 2) excluded by the Study.

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Supplementary Basic Design Study on the Project for Constructing Bridges along Rural Roads (Phase III) and JICA dispatched the study team which was headed by Mr. Michio Okahara (Chief, Foundation Engineering Division, Structure and Bridge Department, Public Works Research Institute, Ministry of Construction) to the Philippines from September 18th 1991 to November 1st 1991.

The project (Phase 3) is the supplementary basic design study of 5 bridges, which their topological and river conditions changed due to eruption of Mt. Pinatubo, out of 10 subjective bridges (group 2) in Phase III, which is the first program of "Five-year Comprehensive Bridges Reconstruction Program Along Secondary Roads" formulated in 1989, and the basic design study for substitute bridges instead of some bridges excluded from the subjective bridges for Phase III, group 2.

The Study Team reviewed the background, objectives and contents of the project, collected the related data and executed the field survey. Based on the field survey, the study and the data collected, it was judged that 1 subjective bridge for Phase III (group 2) was not appropriate.

Further the Study Team studied the natural condition, urgency of bridge replacement, the population of the influenced area, the access road condition between the project site and main cities, and the socio-economic impact with field investigation. As the result, the Study Team had selected the 3 high priority candidate bridges out of the 6 substitute candidate bridges.

Out of 5 subjective bridges (Group 2), 1 bridge was excluded from the project. And 1 bridge out of 3 high priority candidate bridges was selected as the substitute bridge.

The Minutes of Discussions on the Phase III Study was signed on October 30th 1991. (Referred to Appendix 4). Based on the result of the study and data collected, the Study Team executed the basic design of the bridge and reviewed the propriety, urgency and socio-economic impact of the project in Japan.

This Report is compiled to include the implementation arrangement and evaluation of the project on January 1992. The member list of the Study Team, survey schedule, member list of concerning party in the Philippines, minutes of discussions and other information are attached as the appendices of the Report.

CHAPTER 2

BACKGROUND AND OBJECTIVES OF THE PROJECT

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2.1 Background of the Project

Some of the bridges along rural roads and even on national roads are too old and weak to carry the present traffic load. These bridges are often closed to traffic, especially during the rainy season, and consequently people living in their influence area are sometimes isolated.

The Republic of the Philippines proposed the Meidum-Term Philippine Development Plan 1987-1992 which aims at the economic recovery and its sustained growth. In the highway sector of the Development Plan, the project for constructing bridges along rural roads (Phase I and II) was given high priority. Cognizant with the effect of the project, the Government of the Philippines formulated the Five-Year Comprehensive Bridge Reconstruction Program along Secondary Roads.

As the first year program of the Five-Year Plan, reconstruction of bridges in Region III, IV and a part of I was requested to the Government of Japan, and it is named as the Project for Constructing Bridge along Rural Roads (Phase III) and subject to the Basic Design Study.

In response to the request of the Government of the Philippines, the Government of Japan decided to conduct the Basic Design Study on the Project (hereinafter referred at the Phase III Project) and Japan International Cooperation Agency (hereinafter referred to as JICA) executed the Basic Design Study for Phase III and studied for the necessities and proprieties as Japan's Grant Aid on November 1989.

On the 57 bridges proposed under Phase III, the Study Team has selected 37 bridges appropriate for Japan's Grant Aid Program. And the Final Report was prepared by the Study Team on March 1990.

These 37 bridges were classified into two groups. Group 1 consists of 27 bridges which were decided for the Government of

the Philippines to construct and carry out the design for sub-structure and the erection of steel girders provided by the Government of Japan under the Grant program. Group 2 consists of 10 bridges which have been decided for the Government of Japan to execute the design and construction of the said bridges. The 27 bridges under Group 1 are presently implemented by the Government of the Philippines and expected to be complet-ed on the early part of 1992, while the 10 bridges under Group 2 are expected to be implemented this year.

Table 2.1-1 BACKGROUND OF THE SUPPLEMENTARY BASIC DESIGN STUDY

Title of Study	Contents of Study	Duration of Study
Phase I Basic Design Study	Basic design of superstructures of bridges subject to steel material supply	November 1987 - January 1988
Phase II Basic Design Study	Basic design of superstructures and substructures of bridges subject to construction	February 1988 - June 1988
Phase I Detailed Design and Construction Supervision	Detailed design and construction supervision of superstructures subject to steel material supply	May 1988 - March 1989
Phase II Detailed Design and Construction Supervision	Detailed design and construction supervision of bridges subject to construction	October 1988 - March 1990
Phase III, Group 1 Basic Design Study	Basic design of superstructures of bridge subject to steel material supply	November 1989 - March 1990
Phase III, Group 2 Basic Design Study	Basic design of superstructures and substructures of bridges subject to construction	November 1989 - March 1990
Phase III, Group 1 Detailed Design and Construction Supervision	Detailed design and construction supervision of superstructures subject to construction	June 1991 - May 1992

As Mt. Pinatubo erupted last June 1991, 5 bridges out of 10 bridges for Group 2 and 3 bridges out of 27 bridges for Group 1, were seriously affected by the eruption due to their proximity to Mt. Pinatubo and its influence areas.

In this situation, it became necessary to re-study 10 bridges under Phase III (Group 2) described in the Basic Design Study Report (March 1989), particular 5 bridges of which were affected due to the eruption of Mt. Pinatubo, and to study 6 candidate bridges requested by the Government of the Philippines, as well as to plan the basic design of bridges under Phase III (Group 2) for Japan's Grant Aid.

Thus, the Government of the Republic of the Philippines requested the Government of Japan to carry out a Supplementary Basic Design Study for Constructing Bridges along Rural Road (Phase III) in order to review the basic design of the five (5) bridges affected by the eruption, select the bridges to be substituted/replaced, select the substitute candidate bridges and design the selected bridges.

Table 2.1-2 shows the 5 bridges for Phase III, Group 2 affected by the eruption of Mt. Pinatubo. And the locations are shown in Figure 2.1-1 (No.1), (No.2).

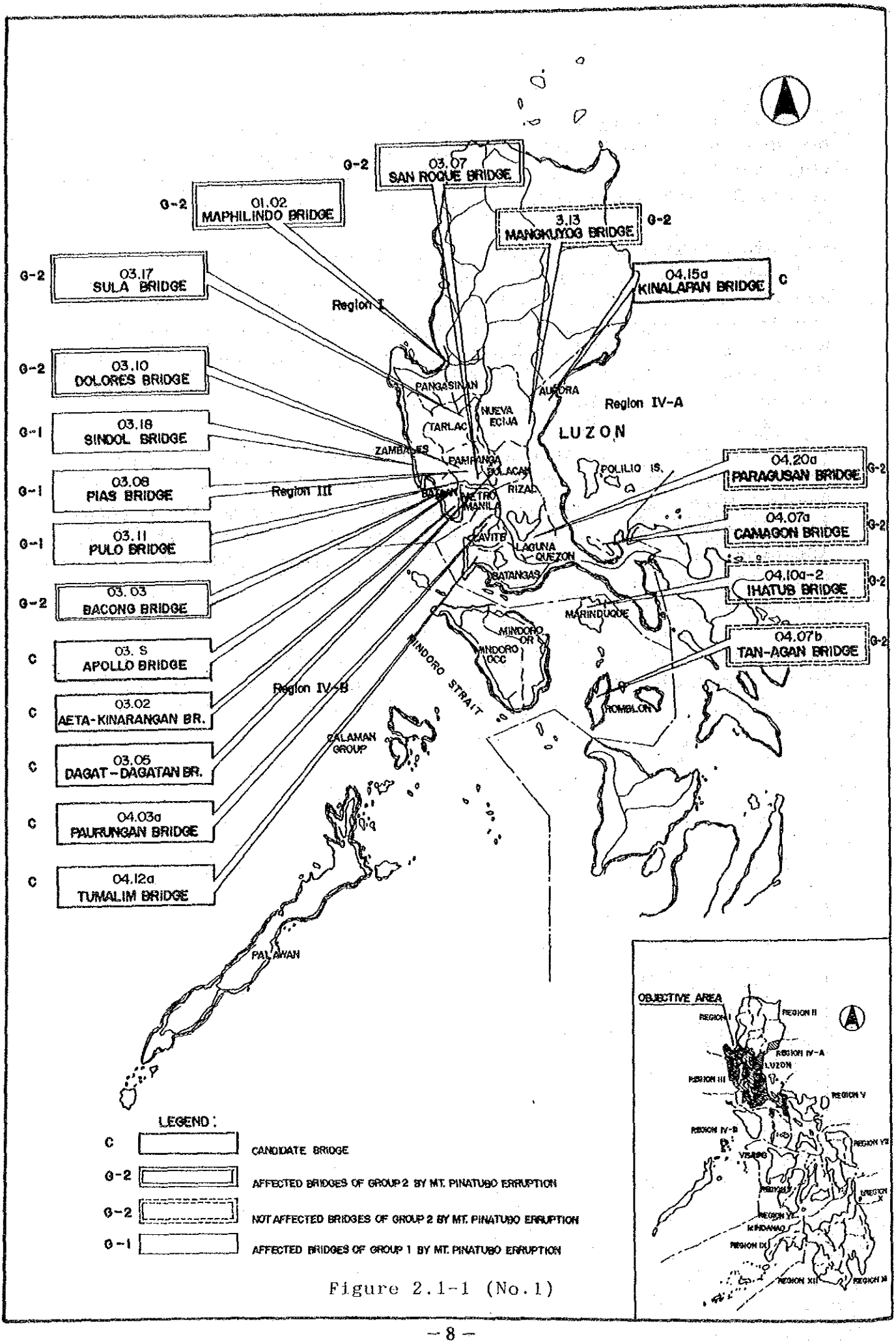

Figure 2.1-1 (No.1)

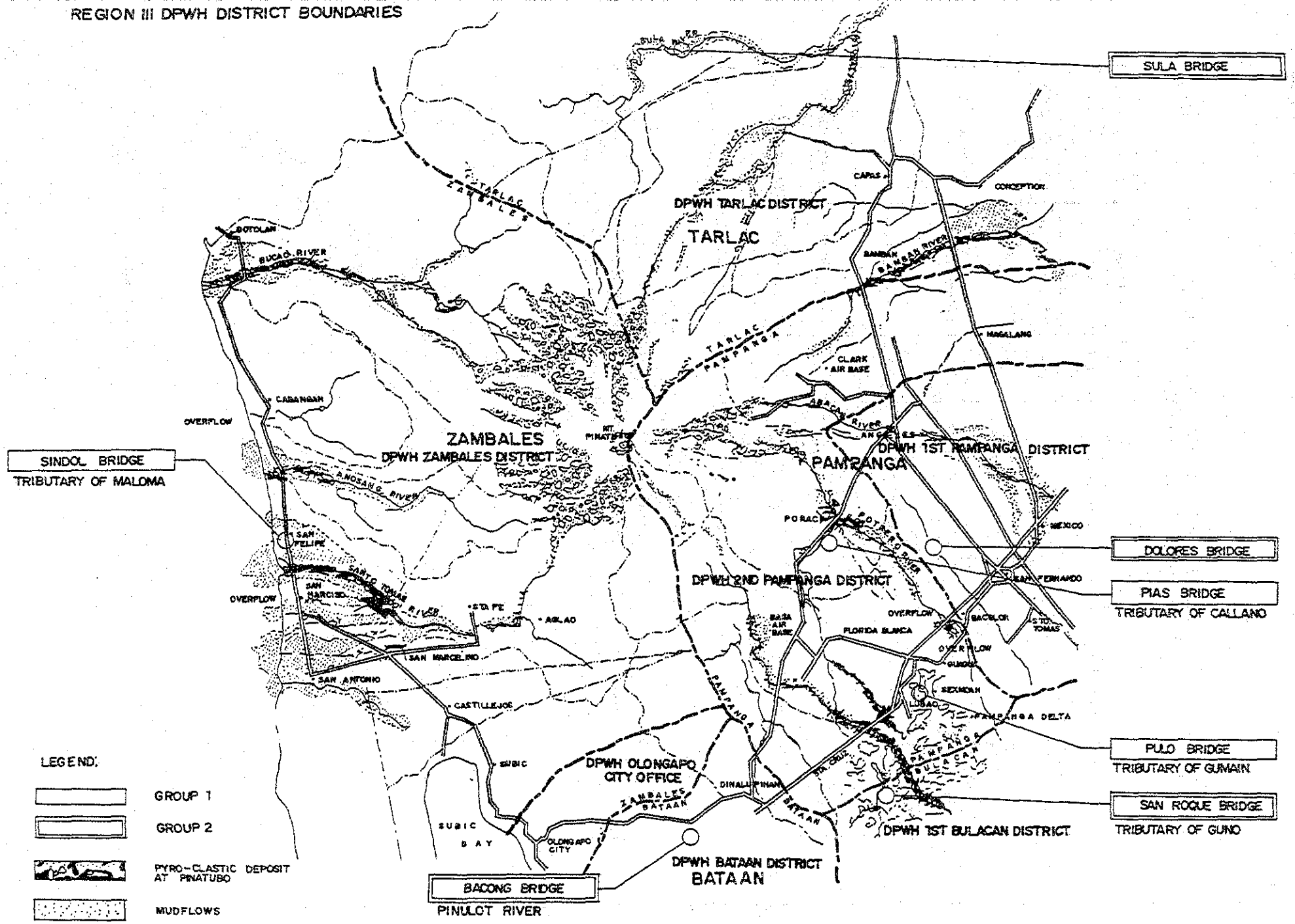

Figure 2.1-1 (No.2)

Table 2.1-2 LIST OF BRIDGES (GROUP 2) AFFECTED BY ERUPTION OF MT. PINATUBO

No.	Bridge Number	Name of Bridge	Location	Existing Bridge		Basic Design
				Length (m)	Type	Length (m)
1	03.10	Dolores Bridge	Km. 76 + 870 Dolores - Del Rosario Road Bacolor, Pampanga	24.65	Timber Bridge	24+24 = 48
2	03.17	Sula Bridge	Km. 143 + 104 Tarlac - Sula Road Sula, Tarlac, Tarlac Tarlac	(50.00)	No Existing Bridge	20+20+20 = 60
3	03.03	Bacong Bridge	Km. 105 + 360 Luacan - Bacong Road Bacong, Bataan	46.00	Bailey Bridge	26+26 = 52
4	03.07	San Roque Bridge	Km. 57 + 284 Hagonoy, Bulacan	63.30	Timber Bridge	18+18+18 = 54
5	01.02	Maphilindo Bridge Biec - Lomboy Road Binmaley, Pangasinan	Km. 220 + 900	128.35	Bailey Bridge	32+32+32+32+32 = 160

On the other hand, the candidate bridges for substitution proposed by the Government of the Philippines are shown in Table 2.1-3. Further, the location is shown in Figure 2.1-1 (No.3).

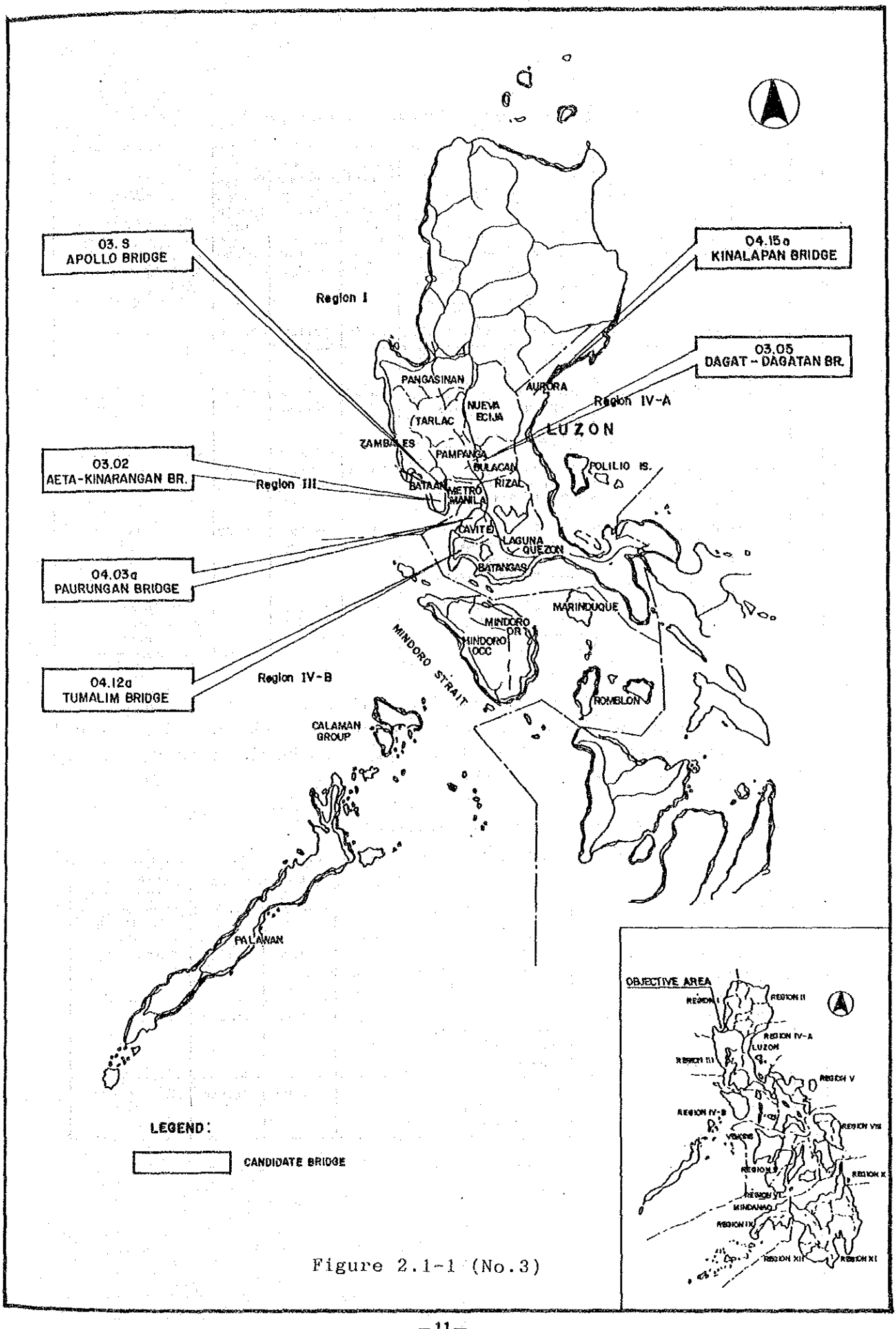

Figure 2.1-1 (No.3)

Table 2.1-3 LIST OF CANDIDATE BRIDGES

No.	Bridge Number	Name of Bridge	Location	Existing Bridge		Basic Design	Remarks
				Length (m)	Type	Length (m)	
1	03.05	Dagat - Dagatan Bridge	Km. 62 + 500 San Rafael - Bustos Road San Rafael, Bulacan	46.00	Bailey Bridge	60.00	Original requirement 22, August 1991
2	03.02	Aeta - Kinaranga Bridge	Km. 143 + 654 Aeta - Kinarangan Road Limay, Bataan	18.40	Bailey Bridge	33.00	- do -
3	04.12a	Tumalim Bridge	Km. 91 + 750 Nasugbu - Tagaytay Road Nasugbu, Batangas	53.10	Bailey Bridge	57.00	- do -
4	04.15a	Kinalapan Bridge	Km. 233 + 033 Baler - Aurora Road Pingit, Baler, Aurora	63.30	Timber Bridge	60.00	- do -
5	04.03a	Paurungan Bridge	Km. 29 + 118 Zapote - Salawag - Salitran Road Dasmarinas, Cavite	61.55	Bailey Bridge	65.00	- do -
6	03.S	Apollo Bridge	Km. 107 + 000 Brgy. St. Joseph Orani, Bataan	30.00	Timber Bridge	35.00	Additional requirement 20, September 1991

Table 2.1-4 shows the list of 3 bridges for Phase III, Group 1 affected by eruption of Mt. Pinatubo and the location is shown in Figure 2.1-1 (No.1), (No.2).

Table 2.1-4 LIST OF THE BRIDGES FOR GROUP 1

No.	Number of Bridge	Name of Bridge	Location	Existing Bridge		Basic Design
				Length (m)	Type	Design Length (m)
1	03.08	Pias Bridge	Km. 90 + 470 Porac-Pias-Ebos Road Pora, Pampanga	8.00	Bailey	23+23 = 46
2	03.11	Pulo Bridge	Km. 85 + 925 Sta. Catalina-Pulong Buyu Road Lubao, Pampanga	11.85	Timber	23
3	03.18	Sindol Bridge	Km. 172 + 350 Brgy. Sindol Road San Felipe, Zambales	24.00	Timber	15+ 15 = 30

2.2 Objectives of the Study

The objectives of the project are to investigate the natural condition of some bridges for Phase III (Group 2) affected by the eruption of Mt. Pinatubo, to study substitute bridges instead of the affected bridges, to review whether this project is proper as Japan's Grant Aid or not and to execute the supplementary basic design.

The subjective area is shown the following below.

Region I:	Maphilindo Br.	
Region III:	Sula Br. Dolores Br. San Roque Br. Bacong Br.	
Substitute Br.:	Region III	Dagat. Dagatan Br. Aeta-Kinarangan Br. Apollo Br.
	Region IV	Tumalim Br. Kinalapan Br. Paurungan Br.

2.3 Scope of the Supplementary Basic Design Study Report

This Report is to complement the Basic Design Study Report (Phase III) submitted to the Republic of the Philippines on March, 1990. Accordingly, in the result of the supplementary study, the items, which were judged no revision, follow the Basic Design Study Report (Phase III). In this Report, only the revised items are described. In case that the expressions and the numerical value are different between the Basic Design Study Report (Phase III) and this Report, this Report is prior to the Basic Design Study Report (Phase III).

CHAPTER 3

SUMMARY OF DAMAGES CAUSED BY ERUPTION

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Eruption of Mt. Pinatubo influenced the nature conditions around Mt. Pinatubo due to volcanic ejecta, pyroclastic flow and air-fall material caused by the eruption of Mt. Pinatubo, and brought some disasters. Especially the changes of the nature condition to some rivers originated on Mt. Pinatubo are remarkable and the damages to the basin of the rivers are very serious.

3.1 General

After over 600 years of dormancy, Mt. Pinatubo in Central Luzon showed its first sign of unrest on April 2, 1991 in the form of small-scale steam explosions. Intermittent ejections of ash and pyroclastic flows continued until June 12, when intensified seismic activity resulted in the volcano emitting ash-laden steam clouds reaching heights of 20,000 meters above its vent. Strong eruption continued through until June 15, 1991. The eruption of Mt. Pinatubo on June 15, 1991 has created a lunar like landscape for approximately a 30 km radius surrounding the volcano, devastating the area ecology and adversely impacting agricultural and urban communities. These ash clouds caused night-like darkness at daytime and deposited ash in huge quantities in many areas resulting in the collapse of roofs of buildings over a wide area. Average depths of ash deposition for the 12-15 eruptions are shown in Figure 3.1.

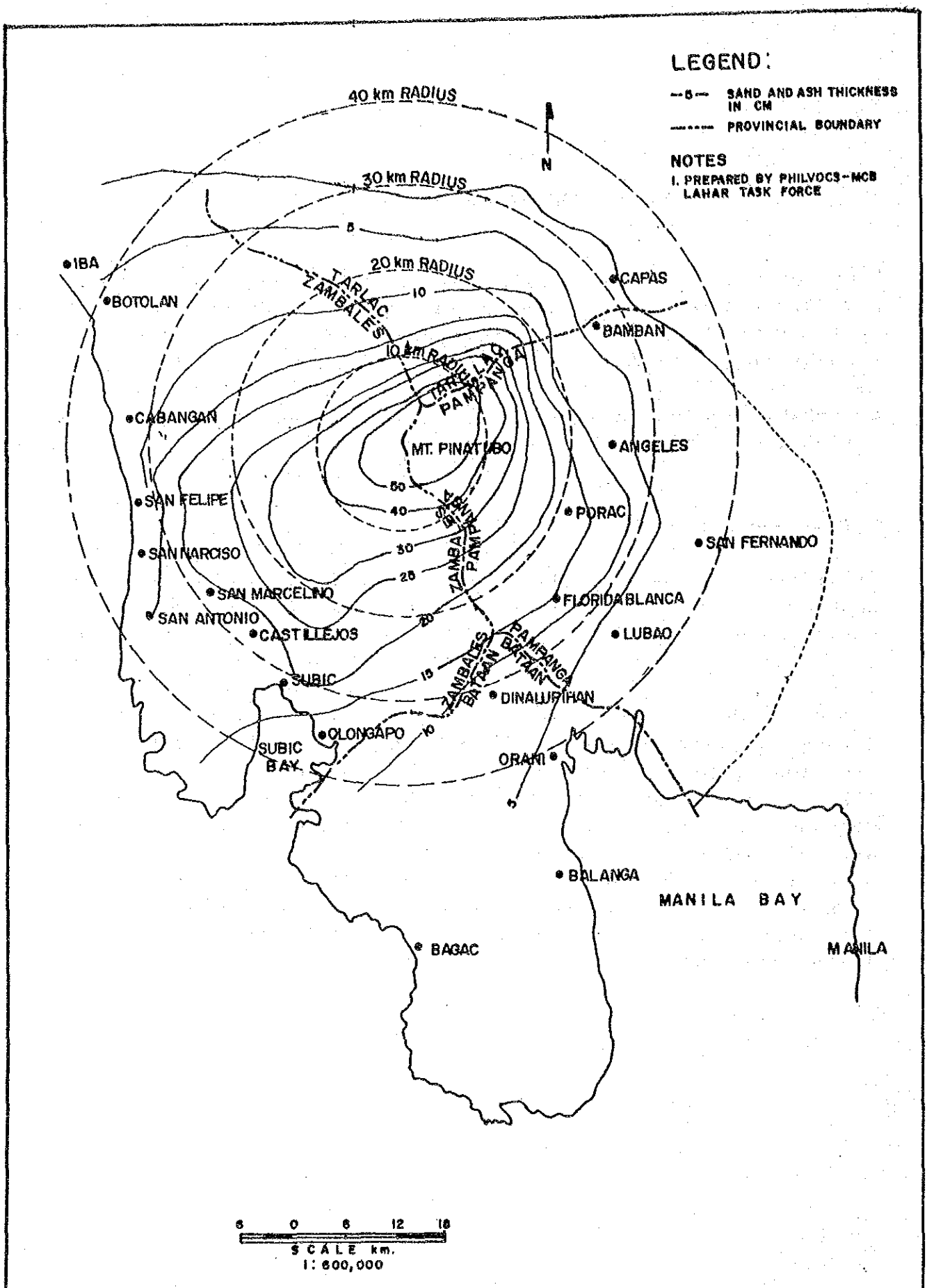


Figure 3.1 ISOPACH MAP (12-15 JUNE 1991)

Volcanic ejecta and materials, which were deposited by the volcanic activities of a series of Mt. Pinatubo eruption, began to flow and changed to mudflow because of Typhoon Diding. The population hardest hit by the mudflow are centered in the provinces of Pampanga, Tarlac and Zambales.

According to the announcement of the Department of Social Welfare and Development on September 15, 1991, it was reported that about 249,000 families became victims of the eruption of Mt. Pinatubo. Recently, mudflow with the thickness of about 6 m struck some cities and barangays in Pampanga province. Due to this mudflow, approximately 1600 thousand of people became homeless, victims of losses to home and jobs.

Table 3.1 shows the number of families and persons suffered by eruption of Mt. Pinatubo by province on September 15, 1991.

Estimated costs of damage to public infrastructure due to Mt. Pinatubo eruption, especially for roads, bridges, irrigation, water supply, schools, hospitals, city halls, public halls, and churches, were enormous amount of money. Total amount of the restoration expenditures of all infrastructure was estimated at approximately 9 billion Pesos on September 1991 in accordance with the project team of ADB.

Table 3.1 DATA ON AFFECTED POPULACE, STATUS OF EVACUEES AND DAMAGED HOUSES

Region/ Province/ Municipality	Affected		Damaged Houses		Reported Number of Evac. Center
	Families	Persons	Totally	Partially	
PAMPANGA	113,640	529,578	3,665	9,072	54
ZAMBALES	48,367	422,413	16,234	16,413	34
TARLEC	9,077	49,118	1,303	38	27
OLOGAPO CITY	17,815	88,935	6,412	21,476	6
BATAAN	7,551	31,322	-	-	2
NUEVA ECIJA	-	-	-	-	15
ANGELES CITY	15,688	62,700	5,317	8,183	18
BULACAN	-	-	25	-	-
OTHERS	-	-	-	-	25
TOTAL	212,138	1,183,833	32,931	55,182	181

3.2 River Disasters

3.2.1 River Systems of Mount Pinatubo

The Mount Pinatubo area is drained by the following nine major rivers (Refer to Figure 3.2-1):

- O'Donnell River
- Sacobia-Bamban River
- Abacan River
- Pasig-Potrero River
- Porac River
- Gumain River
- Marella-Santo Tomas River
- Maloma River
- Balin-Baquero-Bucao River

As Agno and Pampanga are the two main river systems in Luzon Island, the O'Donnell River belongs to the Agno River System, and the Sacobia-Bamban to Gumain rivers in the above listing belong to the Pampanga River System.

Each of these rivers is fed by numerous tributaries in the riverheads near the volcanic peak and is drained radially. In the lower reaches, they form alluvial fans in flat land. Conditions of the Mount Pinatubo area before the eruption are briefed hereunder.

The upper portions of Mount Pinatubo down to an elevation of 200-400 m are characterized by steep slopes of 1/10 and steeper, with minimal sediment cover or overburden. River morphology in this elevation zone reflects the nature of the terrain through which it flows, i.e., rivers tend to be relatively straight and to follow the well-defined rills and valleys that have been cut into the volcanic bedrock.

In areas below 200 m, slopes decrease to 1/200 - 1/300 and bed rock is overlain by sediments eroded in upper reaches and carried downward by flowing water of gravity. On the eastern side of the mountain, this lower slope area extends to a broad alluvial plane where rivers meander or braid.

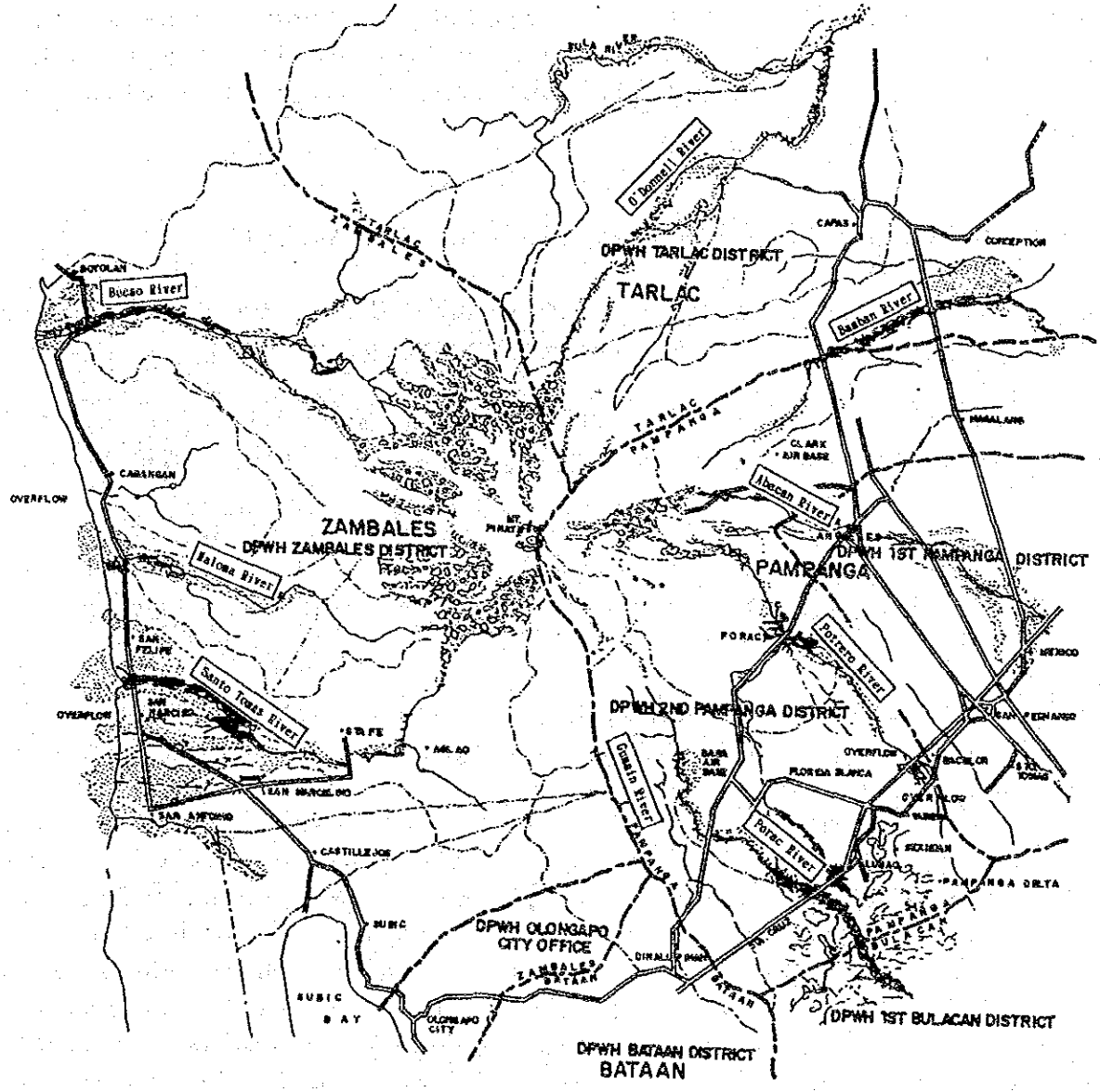


Figure 3.2-1 RIVER SYSTEMS OF MOUNT PINATUBO

Mount Pinatubo is bordered on the west by a series of peaks, with elevations ranging from about 300 m - 1,200 m. These peaks separate it from the low-lying land along the South China Sea coast. Between the range of coastal hills and the mountain proper, a north-south trending valley sloping down toward the north is interposed. Materials eroded from Mount Pinatubo are confined either to the north-south valley or to several other river valleys that dissect the westernmost range in an east-west direction.

3.2.2 Distribution of Pyroclastic Flow and Ashfall

Two modes of material have been deposited in the mountain and adjacent areas due to Mt. Pinabuto eruption, namely;

- pyroclastic flows that were exuded over the lip of the crater and came to rest primarily on the steep upper slopes of two volcano, and

- gravitational settling of ash particles that were ejected into the air by the explosive eruption and then transported by winds.

The pyroclastic type of deposition occurs as lobate fills in the rills and valleys that radiate outward in all directions from the lip of the crater. Pyroclastic flows occupy an area of approximately 130 km^2 with a diameter of about 13 km, on the steeper slopes of the mountain. It is comprised of a wide range of particle sizes, much of it substantially coarser than the airfall deposits. Estimates of thickness and volume of the pyroclastic flows are made in various methods, these ranges from few to 200 m and 1 to 8 km^3 respectively. All rills and valleys in the upstream most portion of the Mount Pinatubo originate from the nine major rivers which are seem to be filled by the pyroclastic flow deposit. Pyroclastic flow deposit map is shown in Fig. 3.2-2, and estimated pyroclastic flow deposit volume and possible volume for the source of lahar are indicated in Table 3.2-1.

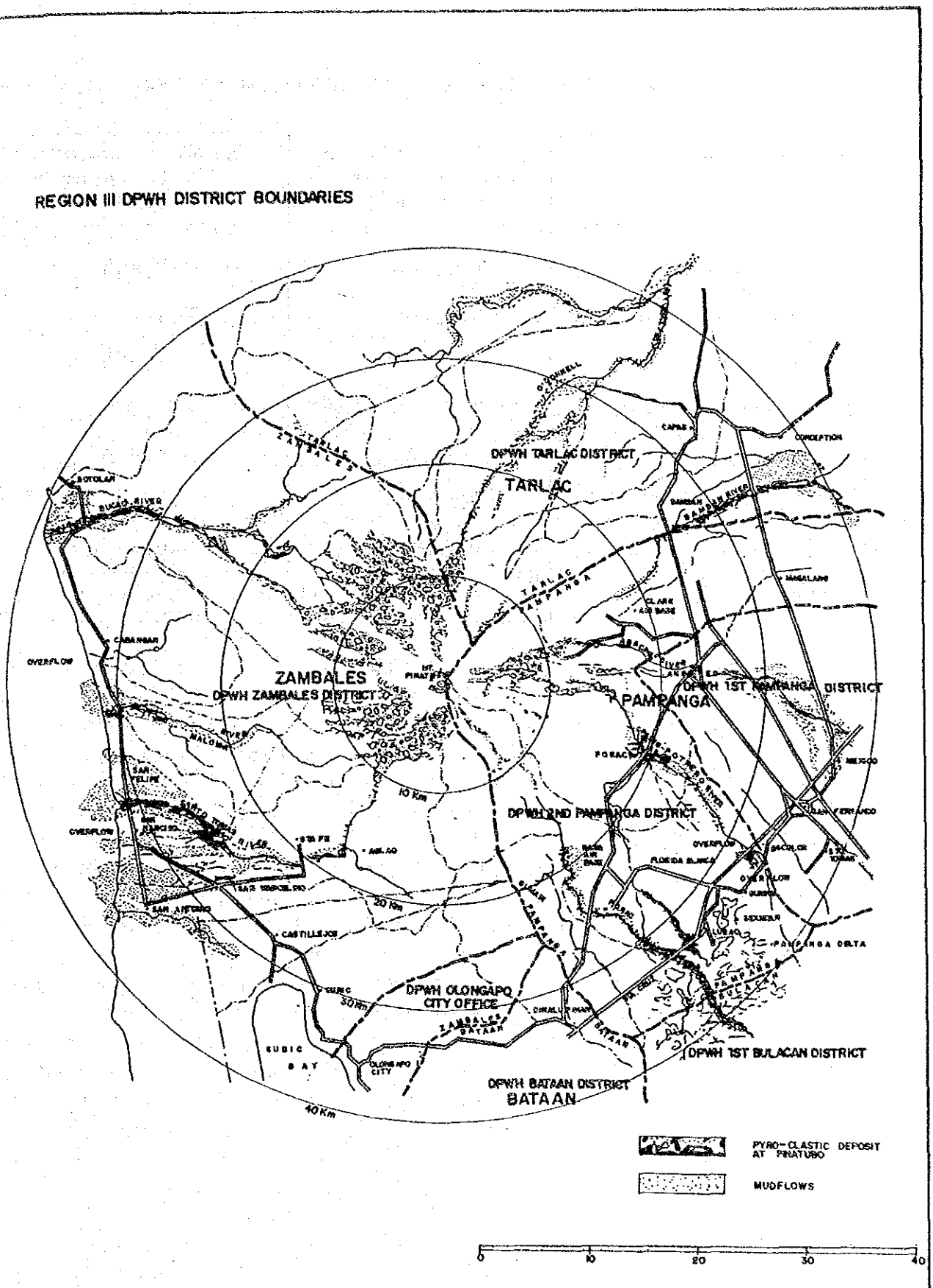


Figure 3.2-2 PYRO-CLASTIC DEPOSIT HAZARD MAP

Table 3.2-1 PYROCLASTIC FLOW DEPOSIT VOLUME BY RIVER

No.	River Name	Pyroclastic Flow Deposit Volume ($1,000\ m^3$)	Volume Susceptible to Lahar ($1,000 m^3$)
1.	O'donnell	478,500	47,850
2.	Sacobia-Bamban	442,200	44,220
3.	Abacan	29,700	2,970
4.	Pasing-Potrero	178,200	17,800
5.	Gumain	46,200	4,620
6.	Santo Tomas	726,000	72,600
7.	Balin-Baquero-Buca	3,804,900	380,490

Source: "Assessment of Damages to Infrastructure Caused by the June 1991 Eruption of Mount Pinatubo", DPWH

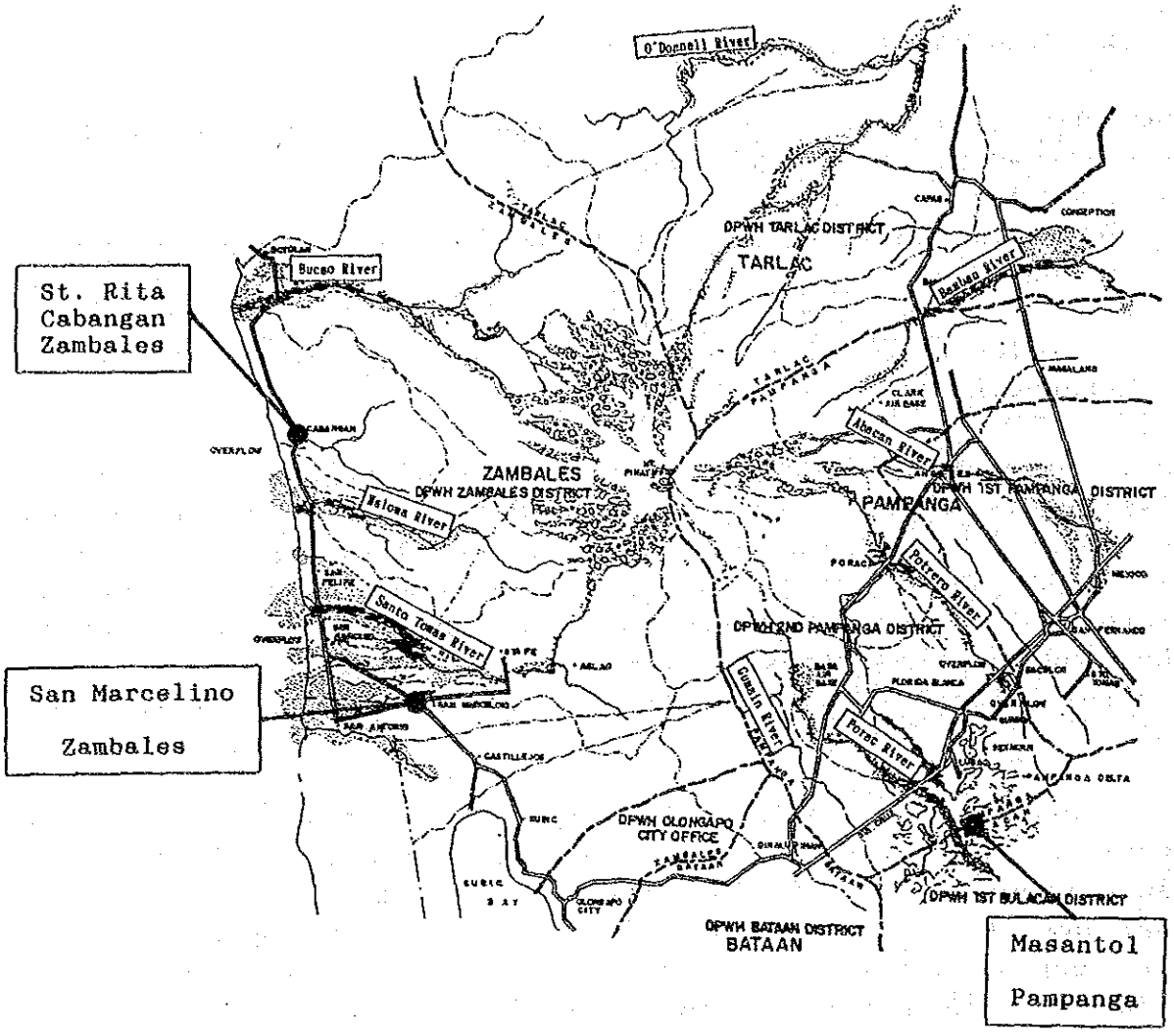
3.2.3 Type and Scale of River Disasters

Two major problems on rivers created by the pyroclastic flow deposit and volcanic ash deposit are:

- potential mass movement of large volumes of material downslope, and
- overflow of river water due to filling of existing drainage channels.

Mass movements frequently evolve into rapidly moving, destructive debris or mudflow. Volcanic mudflow is especially called as "lahar". Lahar that occurred between 12-15 June in association with the volcanic eruption and a contemporaneous tropical storms (Typhoon Diding) and the same caused by rainfall after the typhoon did extensive damage to river channels and flood control structures both to the east and the west of Mt. Pinatubo.

The cause of lahar is not only the strong storm rainfall brought about by the typhoon but also normal rainfall which will not cause problems in ordinary cases. The reason of this fact is that pyroclastic flow deposit and ashfall settling are mortar-like and consolidated and accordingly run-off coefficient in the area is very large. This mortar-like cover of the ashfall settling prevent infiltration of the rainfall and raise run-off coefficient, but once it is eroded by a flux of flow, it is easily side eroded and created lahar. A relationship between daily rainfall at stations around Mt. Pinatubo and disasters is depicted in Fig. 3.2-3. The rainfall of Sta. Rita area on Figure 3.2-3 is the most. But there were not mudflow. And the rainfall of Masantol on Figure 3.2-3 is a half of the rainfall of Sta Rita. But pyro-clastic deposit and Lahar were remarkable at Masantol. As the result, it can be said from the illustration that lahar is not always caused by very intense rainfall but also by normal rainfall.



Monthly Rainfall [Unit : mm]

Place / Month	St. Rita Cabangan Zambales	San Marcelino Zambales	Masantol Pampanga
June	558	424	313
July	934	639	746
August	1,384	1,567	495
September	945	1,029	255
Average	955	915	452
Degree of Disaster	small	big	medium

Figure 3.2-3 RELATION BETWEEN MONTHLY RAINFALL AND DISASTER

In accordance with the field investigation, major river disasters are categorized as follow:

- Riverbed and bank erosion by lahar (change in longitudinal and cross sections)
- Reduction in water flow area due to deposit of material created and transported by lahar (change in longitudinal and cross sections)
- Washout of dike due to overbanking of lahar and flood (damage of flood control structures)
- Mud overflow and settling in outside of the river due to lahar
- Flood overflow and resultant inundation

Status of river disasters is summarized by river in related with the project as follows:

(1) O'Donnell River (Sula Bridge)

Lahar occurred many times. In the upper reaches, several hydraulic narrow points create natural sand retarding basin and deposition of sand is observed in this part. Riverbed has been extremely aggraded near Barangay Antonio about 10 km south of Tarlac City and two irrigation intakes were buried under the deposit. Lahar reached up to Tarlac River.

(2) Abacan River (Dolores Bridge)

Riverbank and riverbed are severely eroded in a large scale by lahar at Sapangbato Spillway site, in the upper reaches, where more than 100 houses were washed-out. Eroded banks form cliffs which will be easily eroded by normal water flow. Abacan Bridge is located on the border of erosion and deposition stretch; the bridge was washed-out due to bank and bed erosion and below this point is deposition stretch where right bank was washed-out at upstream portion of Capaya Bridge resulting in heavy mud settling in the adjoining area. Downstream areas are severely damaged by mudflow lahar.

(3) Pasig-Potrero River (Dolores Bridge,Sula Bridge)

The Pasig River at an apex of the alluvial fan is severely eroded in bank and bed and form a deeper valley compared to the pre-lahar shape. Below this point is deposition stretch where both banks were washed-out at about 5 km northwest of Bacolor and mud flooded from this point to areas of more than 30 km^2. Depth of mud exceeds 2 m in some places. Inundation of mud exceeds National Road Route No.7. Mudflow reached to Gugu Creek in the left bank and Patutero Creek in the right bank. Riverbed of the Potrero River below the bank's washed-out portion is aggraded due to sediment settling, but a relatively enough water flow area is maintained.

(4) Porac River (Pulo Bridge,Pias Bridge)

Riverbed elevation has been aggraded almost to the left bank elevation by lahar and Porac Town is endangered by lahar attack. At Floridablanca, the mudflow overflowed the bank to adjoining areas, but below this point, lahar flows in the river channel of the Porac-Gumain diversion channel. Riverbed elevation has been, however, raised in the channel. Sediments brought by lahar through the Porac-Gumain diversion channel have been deposited in Pasag and low-wet land in the downstream areas. This seems to reduce water flow area and clogs drainage to Manila Bay. Cause of inundation for a long period in the Lubao area where Pulo Bridge is located seems to be clogging.

(5) Maloma River (Sindol Bridge)

Riverbed was aggraded at Maloma Bridge of the Route No. 7. Right bank at upstream portion of the bridge was washed-out and mud flowed out of the river. The scale of lahar is somewhat smaller compared to other rivers. It is probably because pyro-clastic flow deposit is smaller than in other rivers. Mudflow has not flowed over National Road Route No.7. The Tanguay River, which is located in the north of the Maloma River, has changed its course to the left bank just at the upstream portion of the bridge of National Road Route No.7, resulting in the washed-out of the national road.

3.2.4 Countermeasures Undertaken to Date

The following countermeasures have been undertaken for reconstruction and prevention of disaster expansion. These are the main emergency works.

- Excavation, dredging and channelization of river channel
- Construction of cut-off-channel
- Reconstruction and construction of dike and revetment.
- Construction of spur dike

3.2.5 Future Disaster Prediction and Countermeasures

The Government of the Philippines has responded to the calamity. Four committees, ie., Infrastructure Committee, Resettlement Committee, Livelihood Committee and Social Services Committee, have been organized, corresponding to the major concerns of the Task Force on the rehabilitation of areas affected by eruption of Mt. Pinatubo and its effects, and inaugulated the respective approach to the rehabilitation works.

The Department of Public Works and Highways under the Infrastructure Committee has started the rehabilitation works of the damaged infrastructure especially roads, bridges and adjoining river systems. At present, the following countermeasures are under consideration.

(1) Urgent Plan

- Establishment of mudflow warning system (established under Japan's Technical Cooperation)
- Establishment of public education and awareness program
- Desilting of channel, channelization to maintain enough water flow area.
- Installation of check dams and groundsills in the river channel
- Re-establishment of original drainage patterns
- Construction of ring dikes
- Construction of islands of refuge
- Development of mudflow retention basins.

(2) Intermediate Plan

- Re-establishment of river/drainage system
- Conduct of topographic survey
- Construction of river dike

(3) Long-term Plan

- Construction of sabo works
- River planning and implementation

3.3 Bridges

3.3.1 Type and Scale of Bridge Disasters

The bridge disasters are divided into the following 3 types.

(1) Scouring of riverbed, collapsing and inclination of piers due to erosion of riverbanks and washing out of the backfill of abutments. (Refer to Figure 3.3-1. Santa Fe Bridge)

(2) Lahar accumulation on the riverbed results in narrowing the clearance between water level and bottom of girder, and the superstructure or approach road are washed out. As a special case, the whole bridge buries under the lahar. (Refer to Figure 3.3-2. Bamban Bridge)

(3) Collapsing or inclination of piers and washing out of the backfill of abutments occur as a result of the disasters of (1) and (2). On the other hand, the clearance between the bottom of girder and water level became narrow due to the lahar accumulation on the riverbed. (Refer to Figure 3.3-3. Capaya Bridge)

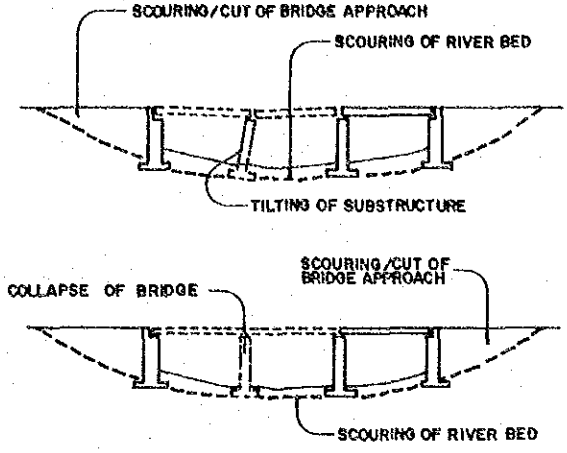


Figure 3.3-1

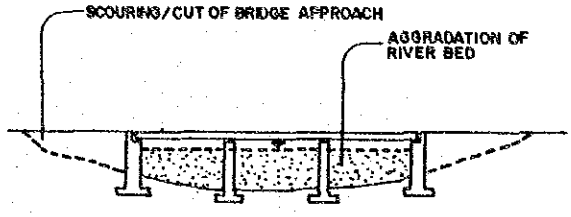


Figure 3.3-2

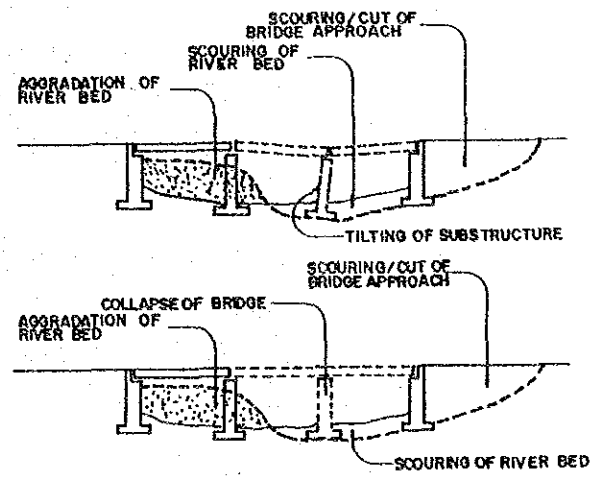


Figure 3.3-3

CHAPTER 4

OUTLINE OF THE PROJECT

CHAPTER 4

OUTLINE OF THE PROJECT

4.1 OBJECTIVE

The objectives of the project are to investigate the natural condition of some bridges for Phase III (Group 2) affected by the eruption of Mt. Pinatubo, to study substitute bridges instead of the affected bridges, to review whether this project is proper as Japan's Grant Aid and to execute the supplementary basic design.

4.2 Examination on Contents of the Request

4.2.1 Methodology of Examination

(1) The objective bridges affected by eruption of Mt. Pinatubo (Phase III, Group 2)

The study team executed the examination on contents of the Request by the manner shown as the Figure 4.2-1 in order to accomplish the objects.

Instead of the 5 bridges, Phase III, Group 2, affected by eruption of Mt. Pinatubo, substitute bridges should be decided based on the present natural condition and the review of the executable possibility whether these bridges are proper for Japan's Grant Aid.

The decision in evaluating the bridge objectives follows the items below :

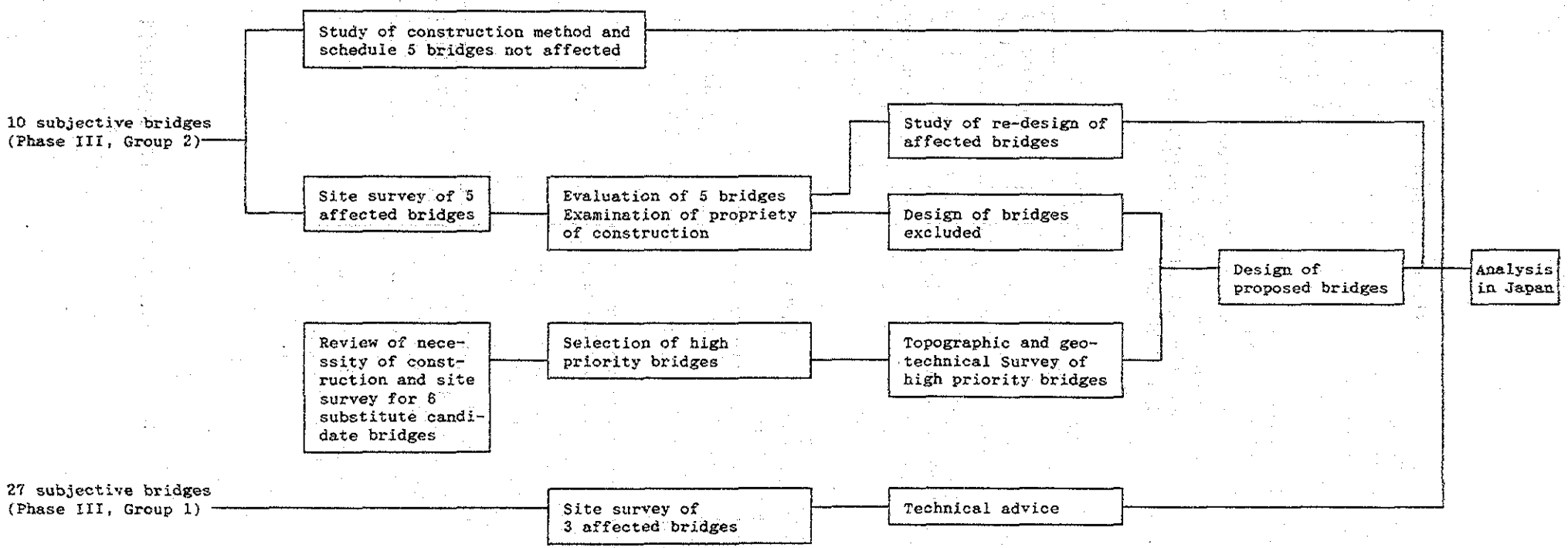
- Influence caused by outflow of present volcanic mudflow and volcanic ash
- Influence caused by outflow of future volcanic mudflow and volcanic ash
- Possibility of shifting the future river flow course

. Change of socio-economic characteristics caused by eruption of Mt. Pinatubo in the future and the feasibility for construction of bridges in these areas

. The condition of damage of the access roads to the bridge construction areas in the present and the possibility of damage in the future

The Study Team investigated the above mentioned objectives and reviewed the executable possibility for constructing the bridges. Some items related with river condition and sabo are the imperative factors for the decision of these substitute bridges. The study team selected the rejectable bridges taking into consideration the magnitude of damages caused by nature and executable bridges by taking countermeasures based on the flowchart related with river and sabo. The flowchart is shown in Figure 4.2-2. A detailed flowchart is explained in Appendix 8 "Analysis of Hydrology".

Figure 4.2-1 MANNER OF EXAMINATION



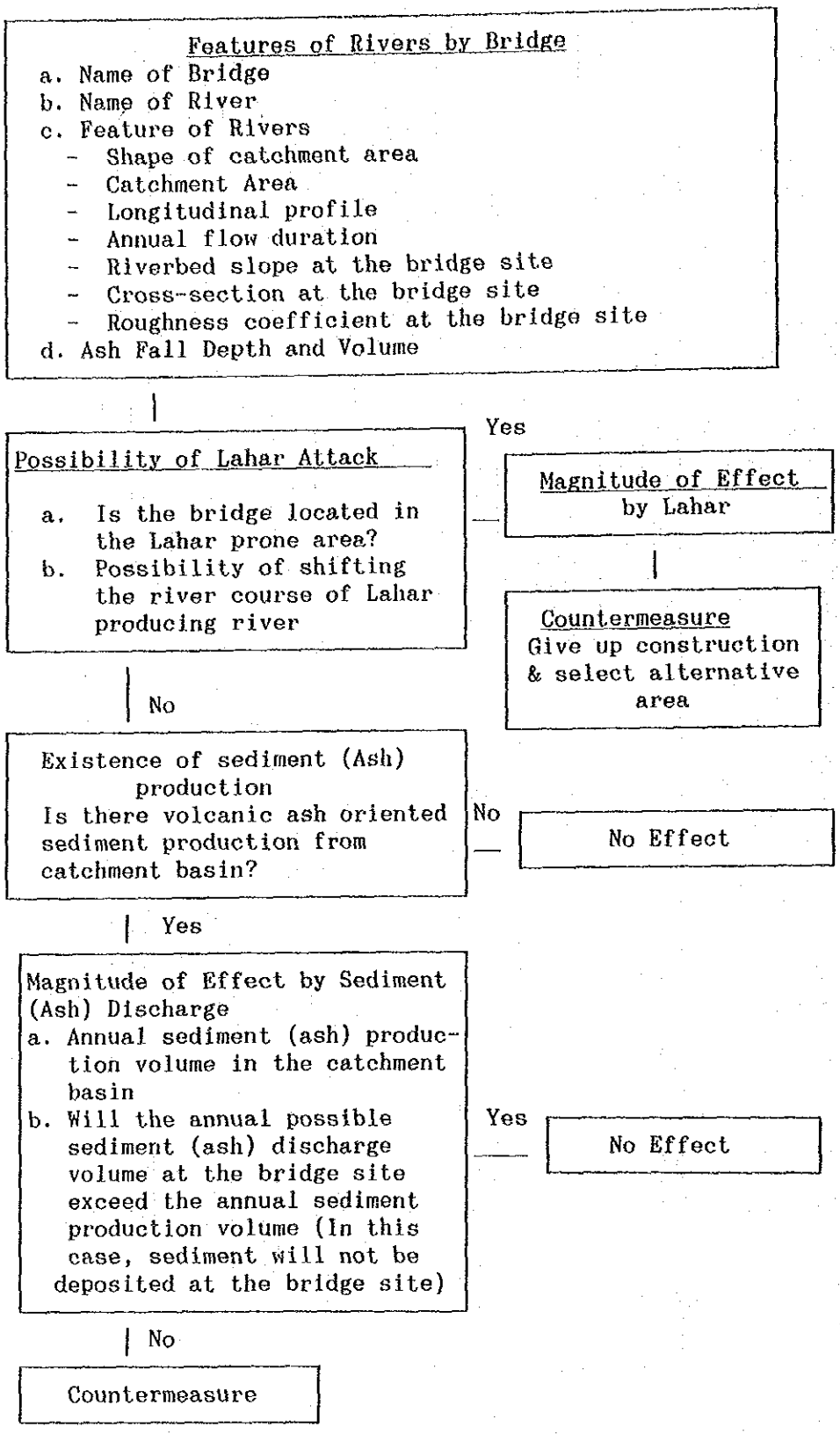


Figure 4.2-2 METHODOLOGY FLOWCHART

(2) The candidate substitate bridges (Phase III, Group 2)

Substitute bridges are selected from the list of candidate bridges (Refer to Table 2.1-3), which have lower cost than rejectable bridges (Phase III, Group 2). The selection methodology for the substitute bridges are the follows:

1) Loading within the regions III, IV-A and IV-B.
2) Confirmed bridges will not be affected by eruption of Mt. Pinatubo in present and future.
3) Population of the influential area caused by bridge replacement.
4) Relating condition between the side and main cities.
5) The Extent of damage to existing bridges.
6) Improvement plan for the route in the feature.
7) Completion of the necessary data for detailed design.
8) Construction to be finished within one year.

On the study of the above mentions, some bridges would be selected as high priority candidate bridges.

(3) Selection of substitute bridge out of high priority candidate bridges.

For the high priority candidate bridges, topographic and geotechnical surveys are hydrological analysis are executed and based on the result of (1) and the studies of topographic and geotechnical survey and hydrological analysis, selection of substitute bridges is executed out of high priority bridges.

(4) The study team executed the investigation and review of some problems on construction and countermeasures needed of the said 3 bridges of Group 1 in the same procedure as in Group 2. (Refer to Table 2.1-4).

4.2.2 Result of the Examination

Based on the methodology described in Item 4.2.1, the bridges mentioned below (14 bridges) were studied. As a result of the Study, Dolores bridge out of 5 subjective bridges affected by eruption of Mt. Pinatubo (Group 2) was excluded from the project. In stead of Dolores bridge, Apollo bridge was judged to be proper to plan as substitute bridge.

(1) Study on the objective bridges affected by eruption of Mt. Pinatubo (Phase III, Group 2) ---------- 5 bridges

(2) Study on the candidate substitute bridges (Phase III, Group 2) ---------- 6 bridges

(3) Study on the objective bridges (Phase III, Group 1) ---------- 3 bridges

Study on the objective bridges ---------- 14 bridges

(1) Subjective bridges affected by eruption of Mt. Pinatubo (Phase III, Group 2)

1) 03.10 Dolores Bridge

. Proposed bridge site is located at a distance of about 30 km in the southeast of Mt. Pinatubo, surrounded by rice fields and plain.

. Thickness of ashfall is reported as 9 cm, but the result of calculating the thickness of basin average ashfall was 13 cm. Now, ashfall is deposited along the road on both side and its quantity is little, but the evidence is able to be found out on the farm.

. Gugu Creek is a small river located approximately in the center of the alluvial fan formed by the Abacan and Pasig-Potrero rivers which originate in higher elevations around Mount Pinatubo proper. Gugu Creek originate in the apex of the alluvial fan. The catchment area of Gugu Creek is 28.9 km^2 at the proposed bridge site, and the river length at the same point is 19 km. The catchment basin forms a long and

narrow shape along the river course with widths varying from 1-3 km. The creek flows down in a dissected channel on the alluvial fan with a riverbed gradient of about 1/60 in the riverhead and about 1/470 at the bridge site.

. It can be judged that lahar will not occur in the future in Gugu Creek within its own catchment since it does not originate in the Mount Pinatubo proper. There is, however, a possibility of shifting the course to the direction of Gugu Creek for the Abacan and Pasig-Potrero rivers which developed many lahars to date. In this case, lahar in the Abacan or Pasig-Potrero river will flow down along Gugu Creek. Accordingly, construction of Dolores Bridge is not recommended.

. Existing bridge is a timber bridge with a total length of 24.65 meters with concrete pier, and its traffic volume is comparably low.

Result of the study

The water source of Gugu Creek does not originate in the Mount Pinatubo proper. There is, however, a possibility of shifting the course to the direction of Gugu Creek due to the Abacan and Pasig-Potrero rivers which created many lahar to date. The existing bridge is stable with concrete piers. In spite that it is an obstacle for traffic, it is judged to be able to be beared by the existing bridge in short-term. Then, the bridge construction should not be executed.

2) 0.3 17 Sula Bridge

. Proposed bridge site is located at a distance of 30 km in the north of Mt. Pinatubo, and is surrounded by some mountains, in a wide field area.

. According to the report of the Philippine Institute of Seismology and Volcanology (PHIVOLCS), both of thickness of ashfall and thickness of basin average ashfall is less than 1 cm. But as a result of field survey, deposit of more than 1 cm was found out in the field.

. The Sula River is one of the left bank tributaries of the Bulsa River, a northern tributary of the O'Donnell River

which originates and flows down in the northern slope of Mount Pinatubo. The Bulsa River does not originate in Mount Pinatubo proper but in Mount Gates which is located 10 km north of Mount Pinatubo. The Sula River flows down in a mountainous terrain from west to east with a gentle arc curve. The catchment forms a long and narrow shape with the river length and width of about 30 km and 3 km, respectively.

. Catchment area at the proposed bridge site is 50.8 km^2, and riverbed gradient is 1/10 and steeper in the headwaters and about 1/120 at the proposed bridge site located at 500 m upstream the confluence to the Bulsa River. The Sula River Basin is located at a distance of about 35 km from Mount Pinatubo, and ashfall depth is 1 cm and less in accordance with data of PHIVOLCS. Ocular observation during the field investigation revealed, however, more thicker ashfall settling especially in the Bulsa River Basin.

. The site will not be affected by lahar. Effect of ashfall settling inside the basin has been studied as follows: If the specific sediment discharge in the Sula River Basin is assumed to be 3,840 m^3/year km^2 (60,000 *A^-0.7), annual sediment production is 195,100 m^3. While annual possible sediment transportation volume at the same point is estimated at 2,040,000 m^3, thus, sediment will not be deposited at the bridge (for details, see Appendix-9).

. There is no existing bridge, but a bridge is necessary for agriculture activity. And the improvement project for this route was executed last year so that this bridge is very important for the rural road network.

Result of the study

The water source of Sula river does not originate in the Mt. Pinatubo proper. It can be judged that lahar will not occur in the future in Sula river and it is not considered that river bed will rise because the annual possible sediment transportation volume is more than annual sediment production volume. As a result, the influence caused by eruption of Mt. Pinatubo is not against the bridge construction. It is proper to construct the bridge in the project.

3) Bacong Bridge:

. Proposed bridge side is located at a distance of 35 km in the south of Mt. Pinatubo. The topographical condition is the hill, with flat fields.

. According to the report of PHIVOLCS, thickness of ashfall and average ashfall are 10 cm. But based on the field survey, thickness of ashfall is not found out.

. The Pinulot River flows in a mountainous terrain in the south of Mt. Pinatubo. The catchment basin is divided into two parts by National Road Route 7 which runs east and west in the groin of Bataan Peninsular. The northern part of the basin originates in Bitnug mountains and the southern part originates in Mount Santa Rosa. Both the northern and southern basins consist of numerous long and slender sub-basins, and the Pinulot River has a comparatively large catchment area of 122.8 km^2 in comparison to its river length of about 18 km. Riverbed gradient in headwaters is 1/10 and steeper, and for the stretch from 8 km upstream point of the proposed bridge site where the river exits the mountainous terrain to the bridge site and at the bridge site gradiants are about 1/250 and 1/300, respectively. The Pinulot River Basin falls in distances from 25 to 44 km, with an average ashfall depth is 10 cm corresponding to about 12 million m^3 in the whole catchment. The site will not be affected by lahar. Effect of ashfall oriented sediment discharge will be as follows: Annual sediment production at the proposed bridge site will be 254,200 m^3 if specific value is assumed to be 2,070 $m^3/year/km^2$ (60,000*A^-0.7), while possible sediment transportation volume at the same point will be 1,336,000 m^3 (for details, see Appendix-9). Accordingly, no sediment deposition will occur at the bridge site.

. Exiting bridge is a bailey bridge of a length of 46 meter. The substructure is pile bent pier. The traffic volume is in big number, and the bridge is important in the area.

Result of the study

The site will not be affected by lahar. Possible sediment transportation volume is more than annual sediment produc-

tion. So, it is not considered that the riverbed will rise in the future. The site will not be affected by eruption of Mt. Pinatubo in the future. The bridge is an important bridge for rural road network. It is proper to construct the bridge.

4) San Roque Bridge

. The proposed bridge site is located at a distance of about 50 km in the south of Mt. Pinatubo, and is near Manila bay. The circumference is swamp area. The topographical condition is flat and there are many houses on both sides of the river.

. Ashfall and basin average ashfall depth were assumed at about 2 cm by PHIVOLCS. But ashfall depth was not find out at the time of the field survey.

. San Roque Bridge is proposed to cross the Hagonoy River. The Hagonoy River is one of river mouth blanches near Manila Bay in the Pampanga River system. It is blanched from the Pampanga River at Santa Lucia and has a catchment area of approximately 20 km^2. It is, however, not clear since rivers and drainage channels are complicatedly joined and blanched in the low-wet land. Almost all water is the one diverted from the Pampanga River at Santa Lucia. The river at the proposed bridge site is a tidal river flowing in the low-wet land near Manila bay and fish ponds extend in the surrounding areas. No flood has been reportedly observed in the Hagonoy River in accordance with interviews to the local residents, but the area frequently suffers from inundations due to high tide. There will be no affect of lahar. Sediment production due to basin's ashfall settling will be minimal because the area is in flat land, and no affect is conceived.

. Existing bridge is a timber bridge and its middle portion was destroyed by earthquake in 1990. Now as the part of the bridge was repaired, only tricycle can pass. Before the earthquake, the traffic volume was in many numbers.

Result of the study

The site will not be affected by lahar, and sediment produc-

tion on the riverbed. Rise of the riverbed is not suspected, For this reason, it is proper to construct the bridge on the project.

5) 01.02 Maphilindo Bridge

. The proposed bridge site is located at a distance of about 100 km in the north of Mt. Pinatubo and is located near Lingayen Bay. The topographical condition is flat and the surrounding area has many fishponds.

. Ashfall and basin average ashfall depth were not find out by the field survey.

. Maphilindo Bridge is located in low flatland near the river mouth as in the case of San Roque Bridge. The Basina River belongs to the Agno River system and it is a blanch of the Calmay River which flows in the east part of the Agno River. The Basina River flows into the Agno River at 1 km upstream the river mouth. The Calmay River is a downstream part of the Camangbogan River, downstream name of the San Juan River which heavily meanders in the wet and flat land of the former Agno River course. The Basina River blanches from the Calmay River at about 10 km upstream the river mouth; a large portion of the discharge of the Calmay River flows down the main course, and the discharge of the Basina River is usually small. The Basina River at the bridge site is a tidal river. The site is located at about 100 km north of Mt. Pinatubo and a slight ashfall was observed during the eruption according to an interview, but no deposit of ash has been presently observed in the area.

. There will be no affect of lahar. As in the case of San Roque Bridge, basin's ashfall settling will not be discharged to the river, and no effect is conceived.

. Existing bridge is a bailey bridge with a pile bent pier. The traffic volume is comparatively in many numbers, and the bridge is important for the rural road network.

Result of the study

The site will not be affected by lahar and sediment production on the river bed. It is not considered that the river

bed will rise. This bridge is very important for the rural road network. For this reason, it is proper to construct the bridge in the project.

Conclusion

The Study Team examined the 5 subjective bridges (Phase III, Group 2) affected by eruption of Mt. Pinatubo. As a result, Dolores bridge was judged that it is not proper to construct because of a possibility of shifting of the course to the direction of Guga Creek due to the Abacan and Pasig-Potrero rivers which created many Lahar to date. And the other 4 bridges were judged not to be affect by eruption of Mt. Pinatubo, at present and in the future. And these 4 bridges were judged that it was no problem to construct.

Table 4.2-1 shows the summary of river evaluation affected by eruption of Mt. Pinatubo for 5 subjective bridges (Phase III, Group 2).

Table 4.2-1 SUMMARY OF RIVER EVALUATION AFFECTED BY THE ERUPTION OF MT. PINATUBO

	Bridge No.	Name of Bridge	Bridge Length Designed (m)	Distance from Mt. Pinatubo	Thickness of Ashfall (cm)	Source of River	Possibility of River Shifting Mudflow and Debris Flow	Evaluation
Subjective Bridges Affected by Eruption of Mt. Pinatubo (Phase III, Group 2)	03.10	Dolores Bridge	48	SE 30 (km)	9 (13)	Mt. Pinatubo	Shifting waterway, mudflow and lahar is suspicious	Affected, excluded
	03.17	Sula Bridge	60	N 35	Less than 1	Mt. Gatas	Not suspicious	Not affected, proposed for construction
	03.03	Bacong Bridge	52	S 35	10	Mt. Santa Rosa	Not suspicious	Not affected, proposed for construction
	03.07	San Roque Bridge	54	SE 50	2	Tributary of Pampanga	Not suspicious	Not affected, proposed for construction
	01.02	Maphilindo Bridge	160	N 100	0	Agano	Not suspicious	Not affected, proposed for construction

(2) Substitute candidate bridges (Phase III, Group 2)

1) Dagat-Dagatan Bridge

. The proposed bridge site is located at a distance of about 60 km east of Mt. Pinatubo. The topological condition is soft hill and the surrounding area is rice fields.

. Ashfall and basins ashfall settling depth were assumed at less than 1 cm by PHIVOLCS. There was no ashfall during the

field survey.

. The Dagat-Dagatan River is a drainage channel-like small river flowing into a tributary of the Maasin River in the Pampanga River system. Adjoining areas are almost flat hill areas and presently used as paddy fields. Riverbed gradient is gentle and ordinary flow is slow. The site is located at a distance of 60 km north of Mt. Pinatubo. Although the PHIVOLCS data show an ashfall depth of less than 1 cm, no deposit of ash was observed in the area during field investigation. No effect of either lahar nor basin's ashfall oriented sediment discharge will be conceived.

Result of the study

The site will not be affected by Lahar Population of the influential area and traffic volume are big. And the bridge is very important for the rural road network. So, this bridge is satisfied with the conditions for substitute bridge. For this reason this bridge is selected as one of high priority candidate bridges.

2) 03.02 Aeta-Kinarangan Bridge

. The proposed bridge site is located at a distance of 75 km south of Mt. Pinatubo, in the southern end of Bataan peninsula which is a fruit garden.

. Ashfall and basin ashfall settling are assumed at less than 1 cam by PHIVOLCS. As a result of the field survey, there was no ashfall.

. The Duate River is a mountain river in the east slope of Mount Mariveles located in the tip of Bataan peninsular. It flows in a steep valley with gravel riverbed finally into Manila Bay at Barangay Limay. The catchment area of the river at the proposed bridge site is about 12 km^2, and riverbed gradient is 1/50. Ashfall depth is less than 1 cm according to PHIVOLCS data, but no ash was observed in the area during field investigation. No effect of either lahar nor basin's ashfall oriented sediment discharge will be conceived.

. Existing bridge is a bailey bridge of the length of 18 m

with concrete abutments and is stable. The traffic volume is low.

Result of the study

It is not conceived that the site will be affected by eruption of Mt. Pinatubo. Existing bridge is stable and the traffic volume passing the bridge is in small number. So, replacement of this bridge is not urgent, and does not satisfied with the condition as the said substitute bridge. For this reason, this bridge should be excluded from this project.

3) 04.12a Tumalim Bridge

. The proposed bridge site is located at a distance of 180 km southeast of Mt. Pinatubo, and is surrounded with the hills.

. There is no ashfall and basin's ashfall settling.

. The Tumalim river has a catchment in the west side of the Taal Lake catchment in Batangas Province and flows westward into South China Sea. The river which Tumalim Bridge crosses is a left bank small tributary of the Tumalim River with a catchment area of 1.5 km^2. The river flows in a 15 m deep dissected valley. No effect of Mt. Pinatubo eruption is conceived.

. Existing bridge is a stable bailey bridge of the length of 53 m supported by new concrete and timber piers. This bridge is the rural road bridge with a traffic volume of a big number.

Result of the study

The site will not be affected by Lahar. According to the basic data of substitute candidate bridges, population of the influential area is relatively large and the traffic volume is high. As satisfied with the conditions of the substitute bridge, this bridge is selected as one of high priority candidate bridges.

4) 04.15a Kinalapan Bridge

. The proposed bridge site is located at a distance of 145 km northeast of Mt. Pinatubo, at Barangay, Pingit in Baley, Aurora. The surrounding area is flat with coconut plantation.

. Ashfall depth was assumed at 0 cm by PHIVOLCS. In the field survey, it was reported that there was a little bit ash fell, but now there is no ash.

. The Pingit River is a blanch of the San Luis River which flows in Aurora Province to Baler Bay in the Pacific Ocean side of Luzon Island. It flows in low and flat land near the river mouth and it is a tidal river. No effect of Mt. Pinatubo eruption is conceived.

. Exiting bridge is a stable timber bridge of the length 52 m with wooden piers. The traffic volume is low.

Result of the study

The site will not be affected by the eruption of Mt. Pinatubo in the future. The superstructures and substructures of this bridge are in good condition. Traffic volume on this bridge is low. The urgency for replacement this bridge is low. Accordingly, it is not considered that the bridge has a conditions as a substitute bridge. For this reason, this bridge should be excluded from this project.

5) 04.03a Paurungan Bridge

. The proposed bridge site is located at a distance of about 110 km southeast of Mt. Pinatubo and is in the rice fields of Cavite plain. The bridge is on the dam.

. Ashfall depth and basin's average ash settling were assumed at less than 1 cm by PHIVOLCS. On the field survey, ash was not find out.

. The Salawag River is one of numerous rivers flowing into Manila Bay in the northwestern slope of Taal Lake in Cavite Province. The proposed bridge site is just after the river

flows out from gentle hill areas to lowlands. No effect of Mt. Pinatubo eruption is anticipated.

. Existing bridge is a stable bailey bridge of the length 54 m with concrete pier. The traffic volume on the bridge is low.

Result of the study

The site will not be affected by eruption of Mt. Pinatubo. The substructures made by concrete piers and the superstructures are stable. The traffic volume on this bridge is low. The road network system in this region has been developed very well. In view of this point, it is considered that the urgency of replacement this bridge is low and its situation is not satisfied with the conditions as a substitute bridge. For this reason, this bridge should be excluded from this project.

6) Apollo Bridge

. The proposed bridge site is located at a distance of about 40 km south from Mt. Pinatubo, in neighborhood of Orani in Bataan. Topographical condition is formed by moderate hills around rice fields.

. Ashfall depth was assumed at 5 cm by PHIVOLCS. In the field survey, it was found out that there were a little bit ashfall.

. The Orani River originates in Mt. Natib located in the northern part of bataan Peninsular, and flows northeastward to Pampanga Bay, a northernmost part of Manila Bay. The river is one of numerous rivers which originate in Mt. Natib. It dissects a 700 m wide slender valley with a length of about 20 km. Catchment area at the proposed bridge is 18.8 km^2. Riverbed gradient is generally steep throughout its length and it is 1/250 at the bridge site. The average ashfall depth is 6 cm corresponding to 1.1 million m^3 in the entire basin, ashfall deposit is, however, not so much according to field investigation.

. Effect of lahar is not conceived; effect of ashfall oriented sediment production is studied as follows: Annual sediment

production volume at the proposed bridge site is estimated at 144,800 m^3 assuming the specific volume at 7,700 m^3/year/km^2 (60,000*A^-0.7), while possible sediment transportation volume is calculated at 154,000 m^3. Accordingly, no sediment deposition will take place at the bridge site.

. Existing bridge is a timber bridge of the length of 30 m with pile bent piers. The traffic volume on this bridge is high. The bridge is important for the rural traffic system.

Result of the study

The site will not be affected by Lahar. According to the basic data of the substitute candidate bridge, the population of the influential area is so many and the traffic volume is high. As satisfied with the conditions of substitute bridge this bridge is selected as one of high priority candidate bridges. The bridge is the most dilapidated among the selected high priority candidate bridges.

Conclusion

In accordance with the manner of the study described the beginning of this chapter, it was examined whether 6 substitute candidate bridges have the conditions of substitute bridge or not. And out of 6 substitute candidate bridges, 3 bridges were selected as high priority candidate bridge. Among 3 bridge, Apollo bridge has the highest priority and Dagat-Dagatan bridge and Tamalim bridge follow. For the 3 bridges, topographical and geological survey were executed.

As the result of the study for subjective bridges (Group 2) affected by eruption of Mt. Pinatubo, 1 bridge out of 5 subjective bridges (Group 2) was excluded from the project. It was decided to select 1 bridge out of 3 high priority candidate bridges.

Apollo bridge was a substitute bridge instead of Dolores bridge which was excluded from the project because that Apollo bridge has the highest priority.

Basic data of 6 substitute candidate bridges and the result of selection for high priority candidate bridge follow below.

Table 4.2.2 BASIC DATA OF SUBSTITUTE CANDIDATE BRIDGES AND SELECTION OF HIGH PRIORITY CANDIDATE BRIDGES

No.	Bridge No.	Name and Location of Bridge	Present Condition of Bridge			Socio-Economic and Traffic Information								Engineering Information				Construction Information		Reason of selection no selection as high priority cadidate br
			Length (m)	Type	Present Condition	No. of Brangay	Population Affected	Main Product	Development Plan	Traffic Volume (ADT)	Traffic Composition	Trip Product	Design Traffic Road (t)	TOPO Condition	Geological Condition	River/ Hydrological Condition	Condition of Access Road	Erection Equipment Local Material	Transportation of Steel Girder Road/ Condition	
1	03.05	.Dagat-Dagaton Bridge Km.62+500 San-Rafael-Buston Road, San-Rafael, Bulacan	46.00	Bailey Bridge	Good Newly repaired Non-Passable for heavy vehicles	5	8,000	.Palay .Vegetables .Duck-raising .Garment	—	550	.Light Trucks .Tricycles .Jeepneys	For transformation and transporting products	20	Flat, curve terrin approached	—	.HWL=1.0 .OWL=5.5 .LWL=7.65	.Good Condition .Proposed width for Improvement 5 m wide	.Available all const. Equip. .Cement .Gravel .Lumber, etc.	Good Condition	Selection .Population of the tial area is many .Traffic volume is
2	03.02	.Aeta-Kinarangan Bridge Km.143+654 Aeta-Kinarangan Road, Limay, Bataan	18.40	Bailey Bridge	Dilapidated Bridge	8	13,872	.Palay .Corn .Livestock	—	30	.Tricycles .Jeepney .Truck .Cars	Agricultural & Insdustrial Purpoases	5	Rolling Terrain	—	—	.Passable .Proposed Width for Improvement 6.0 m	.Cement .Gravel .Boulder .Steel Bars .Limber	—	No selection .Traffic volume is .Pier is made by co .Existing bridge is
3	04.12a	.Tumalim Bridge Km.91 + 750 Ganilad-Tumalim -M Indang Road, Nasugbu,Batangas	53.10	Bailey Bridge	Dilapidated	3	2,630	.Sugar Cane	.Livestock	500	.Truck .Jeep	Agricultural Products	10	—	—	—	.Rough Rd. .Proposed Width for Improvement 6 m	.Sand .Gravel .Timber	.Nasugbu-Tgaytay Rd. .Smooth	Selection .Population of the tial area is middl .Traffic volume is
4	04.15a	.Kinalapan Bridge Km.233 + 033 Baler-Auirora Rd. Brgy. Pingit. Baler. Aurora	60.00	Bailey Bridge	Dilapidated	3	2,000	.Vegetable Coco nuts .Rice	Commercial Port	30	.Cars .Jeep .Truck .Tricycles .Animal Driving	Transport Products and People to Market	1	Flat	—	—	Good	.Can Purchase local Materials	.Nueva Ecija-Aurora Rd. .Good	No selection .Population of the tial area is not s .Traffic volume is .It is difficult to port construction
5	04.03a	.Paurungan Bridge Km.29 + 118 Zapote-Zalawag-Salitran Road, Dasmarina, Cavite	61.55	Bailey Bridge	Dilapidated Bridge	10	10,000	.Vegetable .Fruits .Sugar cane	Residential	150-200	.Light trucks .Heavy trucks .Jeepneys .Cars .Dump trucks	Transport agricultrual Products, Community Construction material	—	Rolling Terrain	Sandy Clayey Soil	—	.Fair .Proposed Width for Improvement 6.1 m	.Can Purchase local Materials	.Zapote-Zalawag-Salitran Road .Fair	No selection .Traffic volume is .Flooded area .Existing bridge is dum .Existing bridge is
6	03.S	.Apollo Bridge 107 Km Orani Orani, Bataan	30.00	Timber Bridge	Dilapidated Bridge	2	15,000	.Vegetable .Livestock .Sugar cane	Residential	600	.Light trucks .Tricycles	Transport Passengers	1.5	Flat	Sandy	.OWL=15.5m .HWL=18.0m	.Fair	.Cement .Lumber .Hardware .Aggregates .R.S.B.	.Layac-Balanga-Mariveles Port Road	Selection .Population of the tial area is so ma .Traffic volume is

Note: ◎ : First priority ○ : Second priority △ : Third priority X : No priority

TA OF SUBSTITUTE CANDIDATE BRIDGES AND SELECTION OF HIGH PRIORITY CANDIDATE BRIDGES

ion	Present Condition of Bridge			Socio-Economic and Traffic Information							Design Traffic Road (t)	Engineering Information				Construction Information		Reason of selection and no selection as high priority cadidate bridges	Priority
	Length (m)	Type	Present Condition	No. of Brangay	Population Affected	Main Product	Development Plan	Traffic Volume (ADT)	Traffic Composition	Trip Product		TOPO Condition	Geological Condition	River/ Hydrological Condition	Condition of Access Road	Erection Equipment Local Material	Transportation of Steel Girder Road/ Condition		
	46.00	Bailey Bridge	Good Newly repaired Non-Passable for heavy vehicles	5	8,000	.Palay .Vegetables .Duck-raising .Garment	—	550	.Light Trucks .Tricycles .Jeepneys	For transformation and transporting products	20	Flat, curve terrin approached	—	.HWL=1.0 .OWL=5.5 .LWL=7.65	.Good Condition .Proposed width for Improvement 5 m wide	.Available all const. Equip. .Cement .Gravel .Lumber, etc.	Good Condition	Selection .Population of the influential area is many .Traffic volume is high	○
an an	18.40	Bailey Bridge	Dilapidated Bridge	8	13,872	.Palay .Corn .Livestock	—	30	.Tricycles .Jeepney .Truck .Cars	Agricultural & Insdustrial Purpoases	5	Rolling Terrain	—	—	.Passable .Proposed Width for Improvement 6.0 m	.Cement .Gravel .Boulder .Steel Bars .Limber	—	No selection .Traffic volume is low .Pier is made by concrete .Existing bridge is stable	X
e im l, gas	53.10	Bailey Bridge	Dilapidated	3	2,630	.Sugar Cane	.Livestock	500	.Truck .Jeep	Agricultural Products	10	—	—	—	.Rough Rd. .Proposed Width for Improvement 6 m	.Sand .Gravel .Timber	.Nasugbu-Tgaytay Rd. .Smooth	Selection .Population of the influential area is middle .Traffic volume is high	△
dge	60.00	Bailey Bridge	Dilapidated	3	2,000	.Vegetable Coco nuts .Rice	Commercial Port	30	.Cars .Jeep .Truck .Tricycles .Animal Driving	Transport Products and People to Market	1	Flat	—	—	Good	.Can Purchase local Materials	.Nueva Ecija-Aurora Rd. .Good	No selection .Population of the influential area is not so many .Traffic volume is low .It is difficult to transport construction equipment	X
dge -	61.55	Bailey Bridge	Dilapidated Bridge	10	10,000	.Vegetable .Fruits .Sugar cane	Residential	150-200	.Light trucks .Heavy trucks .Jeepneys .Cars .Dump trucks	Transport agricultrual Products, Community Construction material	—	Rolling Terrain	Sandy Clayey Soil	—	.Fair .Proposed Width for Improvement 6.1 m	.Can Purchase local Materials	.Zapote-Zalawag-Salitran Road .Fair	No selection .Traffic volume is low .Flooded area .Existing bridge is on the dum .Existing bridge is stable	X
	30.00	Timber Bridge	Dilapidated Bridge	2	15,000	.Vegetable .Livestock .Sugar cane	Residential	600	.Light trucks .Tricycles	Transport Passengers	1.5	Flat	Sandy	.OWL=15.5m .HWL=18.0m	.Fair	.Cement .Lumber .Hardware .Aggregates .R.S.B.	.Layac-Balanga-Mariveles Port Road	Selection .Population of the influential area is so many .Traffic volume is high	◎

ority ○ : Second priority △ : Third priority X : No priority

(3) Subjective bridges affected by eruption of Mt. Pinatubo (Phase III, Group 1)

1) Pias Bridge

. The proposed bridge site is located at a distance of 25 km southeast of Mt. Pinatubo. Topographical condition is hills on the foot of Mt. Pinatubo.

. Ashfall and basin's average ashfall depth were both assumed at 15 cm by PHIVOLCS. At the time of the field survey, it was not find out there were ashfall.

. Pias bridge is planned to cross a tributary of the Callano River. The tributary flows between the Pasig-Potrero and Porac rivers on the alluvial fan in the southeast of Mt. Pinatubo. The site has not yet been affected by lahar as of the present time, however, there is a possibility of lahar affection due to river shifting of the Porac and/or Pasig-Potrero rivers.

. Now, there is no exiting bridge. It is possible to cross the river except at the flood time. Traffic on this road is low due to non existing bridge.

. ADB has a resettlement project of the victions due to eruption of Mt. Pinatubo near the site. So this route is important for rural road network.

Result of the study

The tributary between the Pasig-Potrero and Porac river on the alluvial fan does not originate in Mt. Pinatubo, but is located on the foot of Mt. Pinatubo. In the case of shifting the course to the direction of the tributary, there is a possibility to be affected by eruption of Mt. Pinatubo, which will interrupt the progress of the construction. However, this bridge is very important for the resettlement project of ADB. And DPWH desired to construct this bridge.

For this reason, the Study Team recommends to construct the bridge in consideration of the following.

. Construction of river bank protection of approach roads

. Construction of stabile substructure
. Maintenance of water way of the river

2) 03.11 Pulo Bridge

. The proposed bridge site is located at a distance of about 40 km southeast of Mt. Pinatubo, and is on the alluvial fan of Pampanga delta.

. Ashfall and basin's average ashfall depth were 5 cm in according to PHILVOCS. During the field survey, it was find out there were ash settling with the clearance of 1 meter between the bottom of girder and the riverbed.

. The river which Pulo Bridge is planned to cross is a left bank tributary of the Gumain River flowing to the latter at just upstream the confluence to the Pasag River. The proposed bridge site is a inundation prone area of the Pasag River.

. Now, this bridge construction is completed except the approach road construction work. (Progress percentage is 85%)

Result of the study

The clearance between the bottom of girder and riverbed was not enough because of accumulation of mudflow. But construction of the bridge was completed except the construction of approach road. So, it is not adequate to remove it to other place. As the result, it was recommended to take some countermeasure as followings.

. Removal of the accumulation on the riverbed
. Construction of river bank protection
. Reinforcement work for the approach road
. Maintenance for the shifting of the water way in the future

3) 03.18 Sindol Bridge

. The proposed bridge site is located at a distance of about 35 km west of Mt. Pinatubo.

. Ashfall and basin's average ashfall depth were assumed at

both of 12 cm according to PHILVOCS. During the field survey, it was found out that there were ash due to eruption of Mt. Pinatubo.

. The objective river is a blanch of the Maloma River which flows in the western slope of Mt. Pinatubo. The blanch is located 500 m off the South China Sea coast and runs almost parallel to the coast. It is an old river course and seems to be a 15 m wide narrow pond and there is almost no water flow. Adjoining areas are covered by mud and sand brought by lahar in the Maloma River, but the site has not been affected due to minor topography in the area. This tendency will be maintained in the future.

. Now, construction of the superstructures and the substructures is completed, and the approach road is under construction. (Progress percentage is about 70%)

Result of the study

Now, the influence due to eruption of Mt. Pinatubo was not observed. But in the future, it may be considered that the accumulation from the neighborhood will inflow to the site. But construction of the new bridge was completed all most. It is not adequate to remove the bridge to other place. As the result, the Study Team recommends the followings.

. Reinforcement of the approach road
. Maintenance for the shifting of the river water way in the future

Conclusion

3 subjective bridges (Phase III, Group 1) on this study were affected or are under dangerous situations by eruption of Mt. Pinatubo. But in relating with the progress of bridges construction and other plan, it is not proper to remove the construction site to other places. It is recommended to execute the plan to cope with taking countermeasures. The result of examination for Group 1 bridges shows in the Table 4.2-3.

Table 4.2-3 SUMMARY OF RIVER EVALUATION AFFECTED BY THE ERUPTION OF MT. PINATUBO

	Bridge No.	Name of Bridge	Bridge Length Designed (m)	Distance from Mt. Pinatubo	Thickness of Ashfall (cm)	Source of River	Possibility of River Shifting Mudflow and Debris Flow	Evaluation
Subjective Bridges affected by Eruption of Mt. Pinatubo (Phase III, Group 1)	03.08	Pias Bridge	46	SE 25	15	Mt. Pinatubo	Shifting waterway, mudflow and lahar is suspicious	Affected, present construction status 0%, study of countermeasure
	03.11	Pulo Bridge	23	SE 10	5	Tributary of Pampanga	Shifting waterway and lahar is suspicious	Affected, present construction status 85%, study of countermeasure
	03.18	Sindol Bridge	30	W 35	12	Mt. Pinatubo	Shifting waterway and mudflow is suspicious	Affected, present construction status 75%, study of countermeasure

4.2.3 Examination on Necessity and Appropriateness of The Project

Based on the analysis of the site investigations and collected data, propriety of this project is summarized as following.

Propriety of this project

. The project has the highest urgency and necessity.

. The beneficiary of the project is the residents and beneficial population is many.

. The project contributes to the improvement of income and living standard of the residents due to providing safe traffic facilities.

. The maintenance and management of the bridge are easy and it is possible for the Philippines to execute them.

. There is no problem that the project will be executed within the frame of Japan's Grant Aid program.

4.2.4 Study on Implementation Plan

The Department of Public Works and Highways (DPWH) is the executing agency for the project. DPWH executes the land acquisition and the demolish of existing bridge for the project. DPWH has a schedule to inspect the bridge one time by a month as the normal inspection and one time by 3 years as periodical inspection.

Annual budget of DPWH is as follows.

ANNUAL DPWH BUDGET

(in thousand Pesos)

	1989	1990	1991
1. Infrastructure Program			
a. PWA (Public Works Act)	8,568,288	3,369,533	4,279,912
b. GAA (General Appropriation Act)	2,152,000	11,835,018	7,383,168
2. Current Operating Expenses	2,589,682	2,896,463	2,547,435
3. NALGU Roads Capital Outlay (Barangay)	2,000,000	1,530,000	1,659,886
TOTAL	15,309,970	19,631,014	15,870,401

Source: DPWH

Further, special budget is earmarked for the project for constructing bridges along rural roads by DPWH. The special budget is shown as followings.

ANNUAL INFRASTRUCTURE PROGRAM

(in thousand Pesos)

	1988	1989	1990	1991	1992
Bridge Reconstruction Project (Japanese Grant Aid)	20,000	50,000	20,000	334,754	200,000

The table of annual DPWH budget shows the budget stabilization for 3 years. The budget trend from the 1992th on is estimated at the same trend. DPWH earmarks the special budget for bridge reconstruction project (Japan's Grant Aid). In relation with

the implementation and management for the bridge reconstruction project, it is enough to cope with using the budget. (Refer to Appendix 10.) Number of personnel of DPWH is shown as follows.

Staff Bureaus	No. of Position	Daily/ Casual
Bureau of Construction	172	53
Bureau of Design	199	8
Bureau of Maintenance	158	18
Bureau of Equipment	453	6
Bureau of Research Standards	230	33
TOTAL	1,212	188

This project is located in Region III, number of personnel of Regional Office III, DPWH is 1,149 with the daily/casual of 1,666 persons. DPWH has a schedule to execute as normal bridge inspection one time by a month and as the periodical bridge inspection one time by 3 years. Bureau of Maintenance takes charge in the inspection. The personnel of 176 persons belong to the Bureau of Maintenance and the personnel of 167 persons belong to the maintenance section in Regional Office III. It is enough to maintain and manage the bridge.

4.2.5 Study in Relation with Similar Project/Assistance Plan

DPWH, which is the executing agency for this project, has some similar projects/assistance plans of international organization.

Similar Project

1) Rehabilitation and Maintenance of Bridges along Arterial Roads Project. OECF.

   This project is for rehabilitation and maintenance of 36 bridges along arterial roads. On November 1991, tender preparations for 3 bridges and detailed design for 33 bridges were executed.

Assistance Plan

Aritao-Sta. Rita Road Rehabilitation Project OECF: This project is the road rehabilitation project of the following sections out of the Pan-Philippine Friendship Road with total road length of 2,100 km.

Section A: the section between Allacapan and Aritao
Section B: the section between Aritao and Sta. Rito
Section C: the section between Calamba and Calanag

At present (November, 1991), detailed design were completed. Part of the sections are under construction, and parts of the sections is under tender preparations.

These two projects are not directly related to the project.

4.3 Outline of Planned Substitution Bridge (Apollo Bridge)

Bridge construction plan is formulated based on the result of topographic survey, geological survey and hydrological analysis.

. Bridge location

The roads of both river banks are along the river. So, it is not restrict by the road alignment of the direction of bridge center. As a result, the proposed bridge is planned to cross at a right angle to the centerline of the river because it is possible to use the existing bridge as the detour under construction. The intersection on the left bank is improved and the influence to houses does not affect the downstream side.

. Bridge length and location of the abutment

Existing abutments, which were set up inside the running water section of the river, are checking the running water. New abutments are planned to set up outside of the point that planned highwater level and river bank line cross. The length of planed bridge is 36 meters length with 7 meters more than the length of existing bridge.

. Location of the pier

The pier is planned to set up the middle of the bridge in view of necessary span length based on the river discharge, big girder height of long span bridge and its un-economy.

. Planned bridge elevation

The bridge elevation is decided to keep more than 1.0 meter between the bottom of the girder and highwater level.

. Bridge type

H-beam composite girder is adopted as the superstructure because of small girder height, economical and constructability. The type of pier is column type, because the bridge is located in the point of curse section of the river. The type of abutment is T-type from a view point of construction and economy. The foundation is rectangular R.C. piles of 400 x 400, which are used generally in the Philippines.

CHAPTER 5

BASIC DESIGN

CHAPTER 5

BASIC DESIGN

5.1 DESIGN POLICY

In this chapter, basic design of 9 subjective bridges (Phase III, Group 2) not affected by Eruption of Mt. Pinatubo was omitted because the basic design of the 9 bridges was same as the basic design study report (Phase III) submitted to the Government of the Philippines on March 1990. And it is described about the Apollo bridge which is the substitute bridge.

The basic plan for substitute bridges is prepared based on the following design policies in order to establish an implementation and construction plan suited with the environmental aspects and construction method in the site. The design policies are:

- To adopt the superstructure which corresponds to the topographic, geographic and other technical terms.
- To adopt the type of substructure to be constructed by using the available local materials in the jobsite.
- To construct river toe protection in order to avoid damage to abutments by river flow.
- To set the footings of piers embedded below existing river bed.
- To determine the steel girders to be fabricated in sizes and lengths which provide safe and convenient transport.
- Construction supervision plan and material procurement plan are regarded same as the last report (Phase III).

5.2 STUDY AND EXAMINATION ON DESIGN CRITERIA

Description of Bridge Site Condition

The most appropriate type of bridge at a proposed site is decided by taking into consideration the topographical, geological and hydrological conditions as well as the construction condition, available materials and equipment, and the economic condition.

For substitute bridges, the hydrological and geological conditions of bridge were discussed to determine the most appropriate type of bridge. Table 5.2-1 summarized a brief description of the condition.

03.S Apollo Bridge

Hydrological Condition:

The Orani River originates in Mt. Natib in the northern part of Bataan Peninsular, and flows northeastward to Pampanga Bay, a northernmost part of Manila Bay. The river is one of numerous rivers which originate in Mt. Natib. It dissects a 700 m wide slender valley with a length of about 20 km. Catchment area at the proposed bridge is 18.8 km^2. Riverbed gradient is generally steep throughout its length and it is 1/250 at the bridge site.

Topographical and Geological Condition:

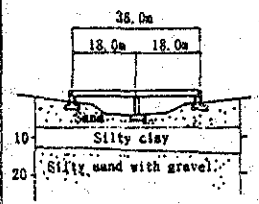
The proposed bridge site is situated on the hill area surrounding by agricultural land. The geological feature is composed of strata of sediment of diluvial formation and alluvial formation. The upper is alluvial formation composed sand (N = 2-50, Thickness = 5-10 m) and the lower is diluvial formation composed clay. (N > 50, Thickness = 10-21 m)

Pile foundation is recommended before reaching the hard strata, by where spread footing would not be undertaken.

Construction Condition:

Soil cofferdam is required for the construction of pier inside the river because of shallow water depth.

Table 5.2-1 SUMMARY OF APOLLO BRIDGE

Bridge No.	Bridge Name	Location of Bridge Site	Geological Profile (Approximation)	Topographical Feature	Geological Feature	Hydrological Condition	Remarks
03.S	Apollo Bridge	km. 107 + 000 Brgy. Apollo-St. Joseph Road Brgy. Apollo, Orani, Bataan		·Bridge site is in the form of a riverbank therrace, surrounding by rice field. ·There are many houses around the bridge site. ·Existing bridge is a timber bridge with pile bent piers. ·Traffic volume is high. ·This bridge is very important for urban district traffic system.	·The upper sstrata are consisted of sand. ·The middle strata are consisted of silty clay. ·The lower strata are consisted of silty sand and gravel. This strata is appropriate as bridge foundation.	·River is formed muldental valley and long and narrow arrangement. ·Riverbed gradient is steep and its gradient is 1/250 at the bridge site. ·River has a large flood area. ·River width is narrow at the bridge site.	