社会開発調査部報告書

No. 32

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

DETAILED ENGINEERING DESIGN STUDY

ON

PAN-PHILIPPINE HIGHWAY IMPROVEMENT PROJECT
(MINDANAO SECTION)

FINAL REPORT
MAIN TEXT

MARCH 1997

KATAHIRA & ENGINEERS INTERNATIONAL
NIPPON ENGINEERING CONSULTANTS CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

DETAILED ENGINEERING DESIGN STUDY

ON

PAN-PHILIPPINE HIGHWAY IMPROVEMENT PROJECT
(MINDANAO SECTION)

FINAL REPORT
MAIN TEXT

MARCH 1997

KATAHIRA & ENGINEERS INTERNATIONAL
NIPPON ENGINEERING CONSULTANTS CO., LTD.

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a detailed engineering design study on Pan-Philippine Highway Improvement Project (Mindanao Section) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Kunihiko Sawano of Katahira & Engineers International, and composed of members from Katahira & Engineers International and Nippon Engineering Consultants Co., Ltd., twice between September 1995 to January 1997.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted field surveys 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.

March 1997

Kimio Fujita
President
Japan International Cooperation Agency

March 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the Final Report of the Detailed Engineering Design Study on Pan-Philippine Highway Improvement Project (Mindanao Section) in the Republic of the Philippines. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines.

This report presents the results of the detailed engineering design including the preparation of construction plan and tender documents, cost estimate and environmental impact assessment. The project aims to cope with the various problems that the road presently suffers from, and to make the road solid, reliable and comfortable.

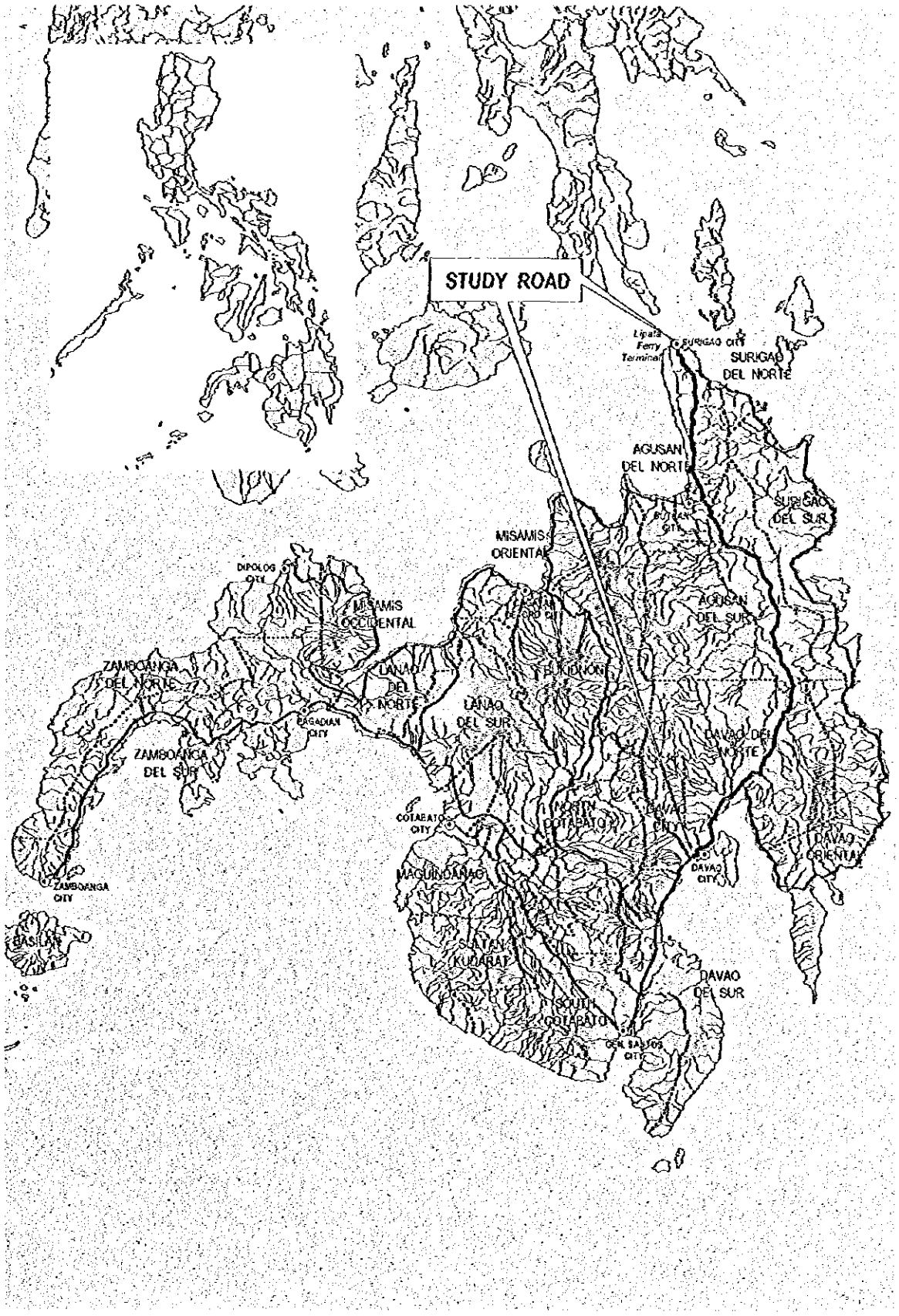
In view of the urgency of improving the project road which is the only axis in the east Mindanao, and of the need for socio-economic development in Mindanao Island as a whole, we recommend that the Government of the Philippines implement this project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines for the close cooperation and assistance extended to us during our investigations and study.

Very truly yours,

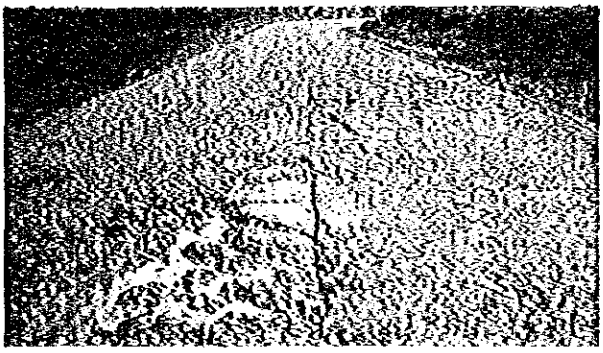
Kunihiko Sawano
Team Leader,
Detailed Engineering Design Study
on Pan-Philippine Highway
Improvement Project (Mindanao Section)

TABLE OF CONTENTS



LOCATION MAP

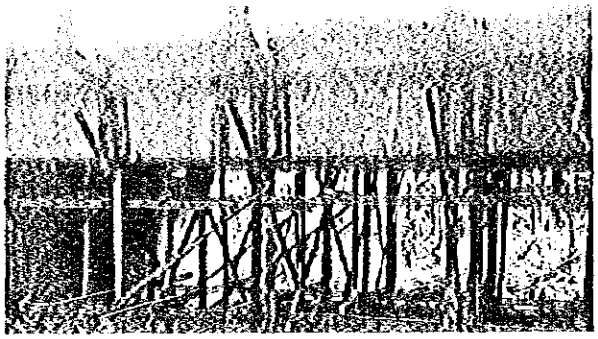
TYPICAL SITE CONDITION AND IMPROVEMENT WORKS



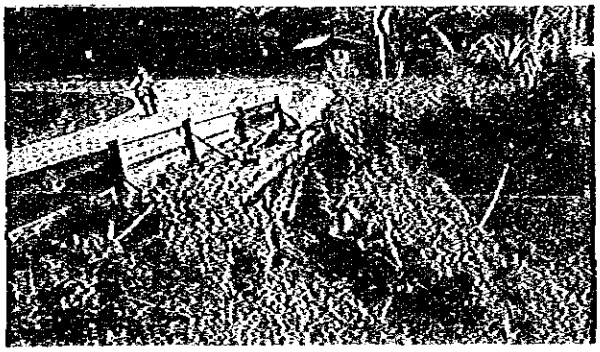
CONCRETE PAVEMENT IN VERY BAD CONDITION. TOTAL RECONSTRUCTION WITH CONCRETE PAVEMENT.

CONCRETE PAVEMENT IN BAD CONDITION WITH PARTIALLY BROKEN SLABS. REPLACEMENT OF BROKEN SLABS WITH CONCRETE PAVEMENT AND AC OVERLAY.

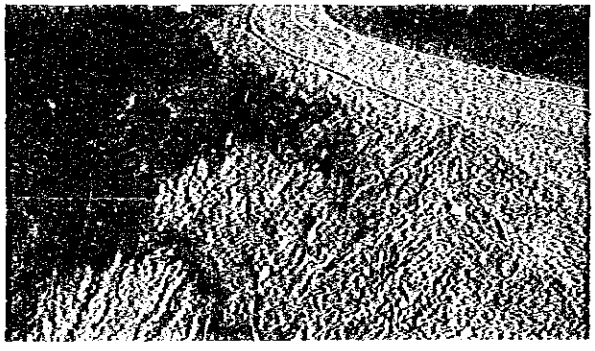
ANDANAN BRIDGE. SERIOUSLY DETERIORATED SUPERSTRUCTURE WITH DEEP LOCAL SCOURING AT PIERS. TOTAL RECONSTRUCTION.



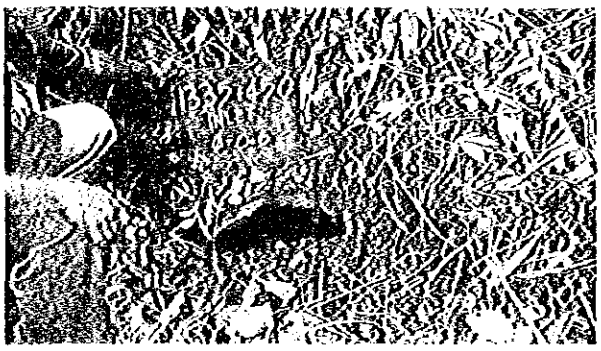
BAYUGAN BRIDGE. SERIOUSLY DETERIORATED SUPERSTRUCTURE. REPLACEMENT OF SUPERSTRUCTURE.



EMBANKMENT SLOPE FAILURE. ONE LANE AFFECTED. SLOPE PROTECTION WITH SURFACE AND SUBSURFACE WATER CONTROL.



EMBANKMENT SLOPE FAILURE. SHOULDER AFFECTED. SLOPE PROTECTION.



BURIED PIPE CULVERT WITHOUT INLET FACILITY. REPLACEMENT WITH NEW PIPE CULVERT.

GRAVEL SECTION AT SOFT GROUND AREA. AC PAVEMENT AFTER PRE-LOADING.

PART IV COST ESTIMATES AND TENDER DOCUMENTS

PART V PREPARATION FOR PROJECT IMPLEMENTATION

TABLES **PAGE**

CHAPTER 2

CHAPTER 3

CHAPTER 5

CHAPTER 6

CHAPTER 7

CHAPTER 8

CHAPTER 12

CHAPTER 13

CHAPTER 14

FIGURES PAGE

CHAPTER 13

CHAPTER 16

ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
ACEL	:	Associated Construction Equipment Lessors, Inc.
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
ARMM	:	Autonomous Region for Muslim Mindanao
AWP	:	Annual Work Program
B/C	:	Benefit/Cost
BOE	:	Bureau of Equipment
BOM	:	Bureau of Maintenance
CAR	:	Cordillera Autonomous Region
CBR	:	California Bearing Ratio
CEO	:	City Engineering Office
DEO	:	District Engineering Office
DENR	:	Department of Environment and Natural Resources
DPWH	:	Department of Public Works and Highways
ECA	:	Environmentally Critical Area
ECC	:	Environmental Compliance Certificate
ECP	:	Environmentally Critical Project
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact System
EMB	:	Environmental Management Bureau
EMK	:	Equivalent Maintenance Kilometer
EO	:	Executive Order
ESAL	:	Equivalent Single Axle Load
FWD	:	Falling Weight Deflectometer
FYB	:	First Year Benefit
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
GPDP	:	Gross Provincial Domestic Product
GRDP	:	Gross Regional Domestic Product
GVA	:	Gross Value Added
HCM	:	Highway Capacity Manual
IACEP	:	Inter-Agency Committee on Environmental Protection
IBRD	:	International Bank for Reconstruction and Development
IEE	:	Initial Environmental Examination
IRI	:	International Roughness Index
IRF	:	Immediate Response Fund
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
LOI	:	Letter of Instruction
LTO	:	Land Transportation Office
MBA	:	Maintenance By Administration
MBC	:	Maintenance By Contract
MTPDP	:	Medium Term Philippine Development Plan
MTPIP	:	Medium Term Public Investment Program

NCR	:	National Capital Region
NCSO	:	National Census and Statistical Office
NDT	:	Non-Destructive Test
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Protection Council
NIA	:	National Irrigation Administration
NPV	:	Net Present Value
NRR	:	Net Reproduction Rate
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistics Office
NTCP	:	National Traffic Count Program
OD	:	Origin-Destination
OECF	:	Overseas Economic Cooperation Fund
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PB	:	Performance Budget
PCC	:	Portland Cement Concrete
PCDG	:	Prestressed Concrete Deck Girder
PD	:	Philippine Description
P.D.	:	Presidential Decree
PHIVOLCS	:	Philippine Institute of Volcanology and Seismology
PHMMS	:	Philippine Highway Maintenance Management System
PPP	:	Philippine Population Projection
PSI	:	Present Serviceability Index
PSR	:	Present Serviceability Rating
RCBC	:	Reinforced Concrete Box Culvert
RCDG	:	Reinforced Concrete Deck Girder
RCPC	:	Reinforced Concrete Pipe Culvert
RES	:	Reinforced Equipment Service
ROW	:	Right-of-Way
RRI	:	Rehabilitation Requirement Index
RRR	:	Rehabilitation Requirement Rating
SN	:	Structural Number
SPT	:	Standard Penetration Test
VOC	:	Vehicle Operating Cost

PART I

INTRODUCTION

CHAPTER 1 INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Government of the Philippines, in the Medium-Term Philippine Development Plan, 1993-1998, puts emphasis on the infrastructure development to support the productive sector growth and reduce the regional disparities.

The Pan-Philippine Highway is the most important trunkline in the country's road network running through the four major islands of Luzon, Samar, Leyte and Mindanao with a total length of 2,100 km. The construction of the Highway, which was then a long-cherished desire of the country to attain the national targets such as regional development, industrial growth, preservation of peace and order, national unification, etc., was started in 1969 and completed in 1979.

Now, in 17 to 26 years after opening to traffic, the Pan-Philippine Highway suffers various problem such as progress of pavement deterioration, repeated slope failures in the mountainous areas, damage of bridges and so on.

To cope with the said problems, the Government of the Philippines conducted the following studies with technical assistance provided by JICA: Feasibility Study of Philippine Road Disaster Prevention Project (June 1984), Feasibility Study of Philippine Road Disaster Prevention Project, Stage II (July 1985), Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway (September 1987), and Feasibility Study on Rehabilitation and Maintenance of Bridges along Arterial Roads (June 1989). These studies cover the Luzon, Samar and Leyte sections of the Pan-Philippine Highway and the rehabilitation projects formulated therein are now being implemented.

Mainly for the reason of peace and order problem, rehabilitation of Mindanao section of the Highway has been left behind although it is of urgent necessity to promote the development of Mindanao. In the restoration of peace and order situation, the Government of the Philippines has decided to start the rehabilitation of the Mindanao section of the Highway and conducted the Feasibility Study on Pan-Philippine Highway Rehabilitation Project (Mindanao Section) from March 1994 to May 1995 with technical assistance provided by JICA.

In view of the priority and urgency of the project, the Government of the Philippines further sought a technical assistance from the Government of Japan for the conduct of the **DETAILED ENGINEERING DESIGN STUDY ON PAN-PHILIPPINE HIGHWAY IMPROVEMENT PROJECT (MINDANAO SECTION)** (the Study).

In response to the request of the government of the Philippines, the Government of Japan decided to conduct the Study. JICA, the official agency responsible for the implementation of the technical cooperation programs of the Government of

Japan, organized a study team to be engaged in the Study. The JICA Study Team, in close collaboration with the DPWH Counterpart Team, commenced work in August 1995 and completed the Study in March 1997.

1.2 OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the detailed engineering design and tender documents for the Pan-Philippine Highway Improvement Project (Mindanao Section).

1.3 STUDY ROAD

The Study Road is the Pan-Philippine Highway from Lipata Ferry Terminal (Km. 1,113+397) up to the end of the Davao City Diversion Road (Km. 1,515+949) with a length of 403.4 km.

1.4 SCOPE OF THE STUDY

In order to achieve the objective mentioned above, the Study covered the following items:

First Period of the Study
- Collection and Review of Relevant Studies
- Detailed Investigation on Existing Road Condition
- Topographic Survey and Mapping
- Geotechnical Investigation
- Hydrological Investigation
- Detailed Design (1) *

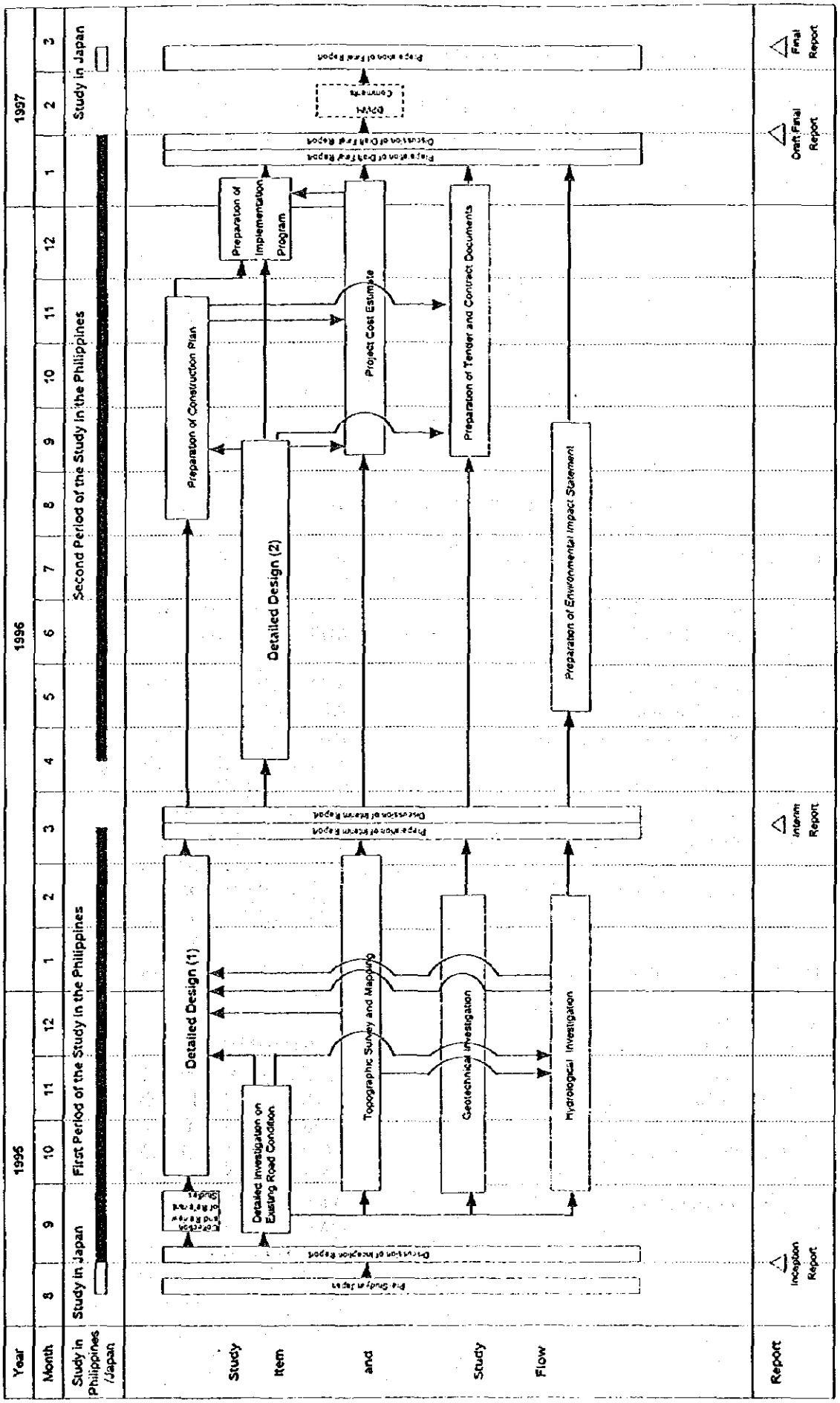
Second Period of the Study
- Detailed Design (2) *
- Preparation of Environmental Impact Statement for the Monkayo Bypass Construction Project
- Preparation of Construction Plan
- Project Cost Estimate
- Preparation of Implementation Program
- Preparation of Tender and Contract Documents

* Note: Detailed Design (1) covers 11 contract packages with higher priority out of 19 packages in total (see Chapter 6 as for contract packaging), while Detailed Design (2) covers the rest packages.

1.5 STUDY FLOW

The Study flow of the whole work is schematically shown in Figure 1.5-1.

FIGURE 1.5-1 STUDY FLOW DIAGRAM



1.6 ORGANIZATION OF THE STUDY

JICA organized a Study Team and DPWH organized a Counterpart Team and a Steering Committee. The Study was carried out jointly by the JICA Study Team and the DPWH Counterpart Team under the guidance of the DPWH Steering Committee. The organization chart is shown in Figure 1.6-1.

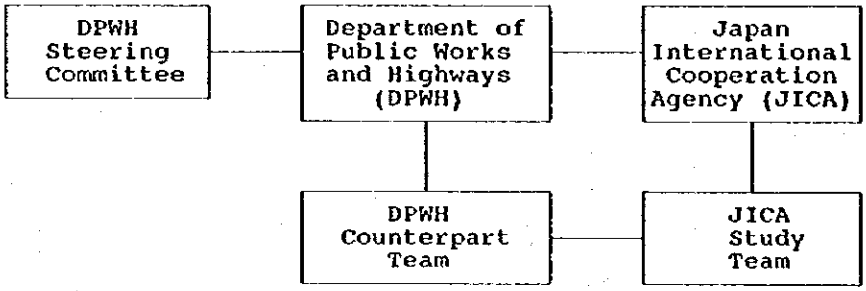


FIGURE 1.6-1 ORGANIZATION CHART

The JICA Study Team was composed of the following members:

- Team Leader/Highway Planner : KUNIHIKO SAWANO
- Deputy Team Leader/Highway Engineer 1 : MITSUO HATAKEYAMA
- Highway Engineer 2 : KEIJI AOKI
- Bridge Engineer 1 : MOUSHUN YABIKU
- Bridge Engineer 2 : AL HILER
- Slope Protection Engineer : RICHARD PURSER
- Drainage Engineer : MITSUNORI MIZUISHI
- Geotechnical Engineer : SHIGERU KOBAYASHI
- Survey Engineer : SYUNICHI USAMI
- Hydrological/Hydraulic Engineer : SUSUMU HONDA
- Environmental Engineer : KAZUHIRO HASEGAWA
- Construction Engineer/Cost Estimator : MASARU IWAKI
- Specification Engineer : TERUMI MOCHIZUKI

The DPWH Counterpart Team was composed of the following members:

A. Key Staff:

- Team Leader : GERONIMO ALONZO
- Project Coordinator : JUANITO ALAMAR
- Highway Engineers : GENEROSO ALCONIS
  CORAZON ARCETA
- Bridge Engineers : REMEGIO CALEZE
  ANTONIO YAPTANGCO
- CAD Engineers : ARTURO FLORES
  CASAN BUSRAN
  ARIEL GAYO

- Slope Engineer : GENEROSO JOVES
- Drainage Engineers : FILOMENA VALES
  FRANCIS ESCOBAR

B. Supporting Staff:

- Draftsmen : ROMEO NAUNGAYAN
  ANTONIO VALENZUELA
  ANTHONY CASTUERAS
  DIOSDADO DIEGO
- Bookkeeper/Secretary : MA. LOURDES SANTOS
- Typist/Word Processor : JASMIN FIGUERAS
  ESPERANZA AGUSTIN
- Xerox Machine Operator : RICARDO TING
- Utilityman : DANTE ZAMORA

The DPWH Steering Committee was composed of the following members:

- Chairman : TEODORO T. ENCARNACION
  Undersecretary
- Member : MANUEL M. BONOAN
  Assistant Secretary
- Member : BIENVENIDO LEUTERIO
  Director, Bureau of Design
- Member : CLARITA BANDONILLO
  Director, Bureau of Construction
- Member : DOMINADOR Y. SANTOS
  Director, PMO-PJHL
- Member : JOSE P. GLORIA
  Project Manager III, PMO-FS
- Member : JUAN D. LUALHATI
  Director, Planning Service
- Member : ERNESTO SILVELA
  Director, Region XI
- Member : CONRADO REPATO
  Director, Region XIII
- Member : TAKAAKI KUSAKABE
  JICA Adviser for Highway Engineering

1.7 REPORTS

The following reports were prepared during the Study:

- Inception Report (September, 1995)
- Interim Report (March, 1996)
- Implementation Program (August, 1996)
- Environmental Impact Statement
  For Monkayo Bypass Construction (October, 1996)
- Draft Final Report (January, 1997)

The final report is organized with the following:

- Executive Summary
- Main Text
- Appendix
- Drawings
- Design Analysis Reports
- Pre-qualification Documents
- Tender and Contract Documents
- Cost Analysis Report
- Quantity Calculation Reports

PART II

ENGINEERING SURVEY

CHAPTER 2

EXISTING ROAD CONDITION SURVEY

2.1 ROADWAY AND DRAINAGE SURVEY

2.1.1 Pavement Condition Survey

Pavement condition survey was undertaken for the entire stretch of the Study Road. Pavement distresses of the following were sketched on the field survey sheet for each slab:

Pavement Distress Surveyed
- Cracks (open cracks as well as sealed cracks)
- Cracks with faulting
- Potholes
- Scaling
- Depression
- Pop-out
- Patching

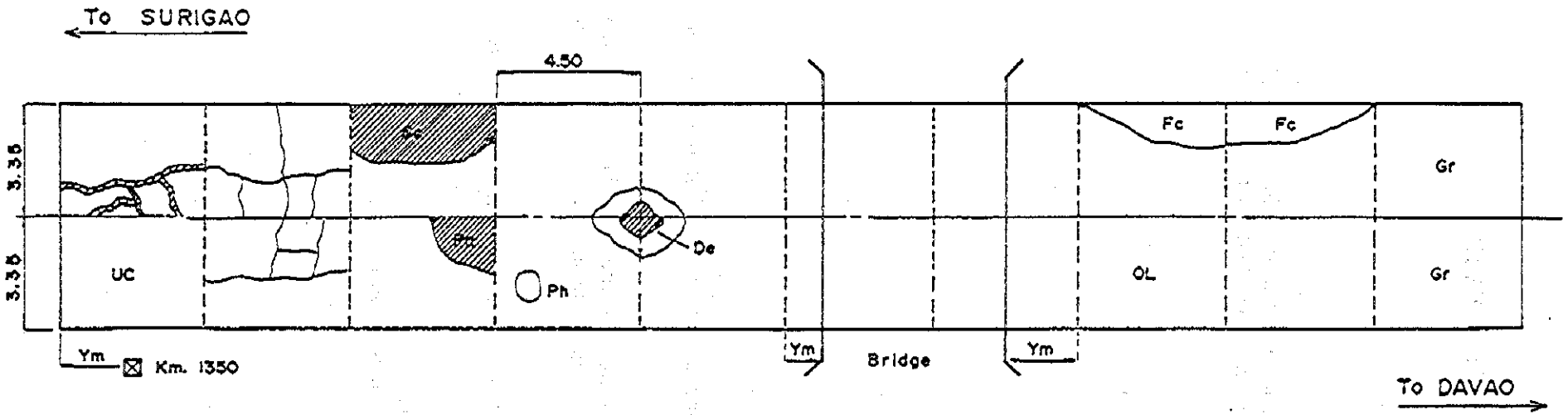
Other Information
- Pavement with overlay
- Section under construction
- Gravel section
- Location of kilometer post
- Bridge section

Figure 2.1-1 shows legends used for sketching and Figure 2.1-2 shows an example of accomplished field survey format.

The survey team walked all along the Study Road in order to sketch pavement distresses. Average speed of the survey of one survey team was about 10 km per day.

Data obtained were processed as shown in Table 2.1-1, using the following two indices:

- Crack ratio = crack length (m)/1,000 sq.m.
- Number of slabs with depressions and cracks with faulting.



LEGENDS :

1. Cracks — Open Cracks ——— Sealed Cracks ~~~~~
2. Potholes – Ph
3. Patching – Pa
4. Cracks with Faulting – Fc
5. Scaling – Sc
6. Depression – De
7. Pop out – Po
8. Overlay – OL
   (Sketch area of pavement with overlay)
9. Under Construction - UC
10. Gravel – Gr
    (Except Under Construction)
11. Other Information
    - Kilometer Post
    - Bridge

FIGURE 2.1-1 LEGENDS USED FOR SKETCHING PAVEMENT DISTRESS

FIGURE 2.1-2 EXAMPLE OF ACCOMPLISHED FIELD SURVEY FORMAT

Date : 10-15-95

Km. 1266+000

Sheet No : 1/3

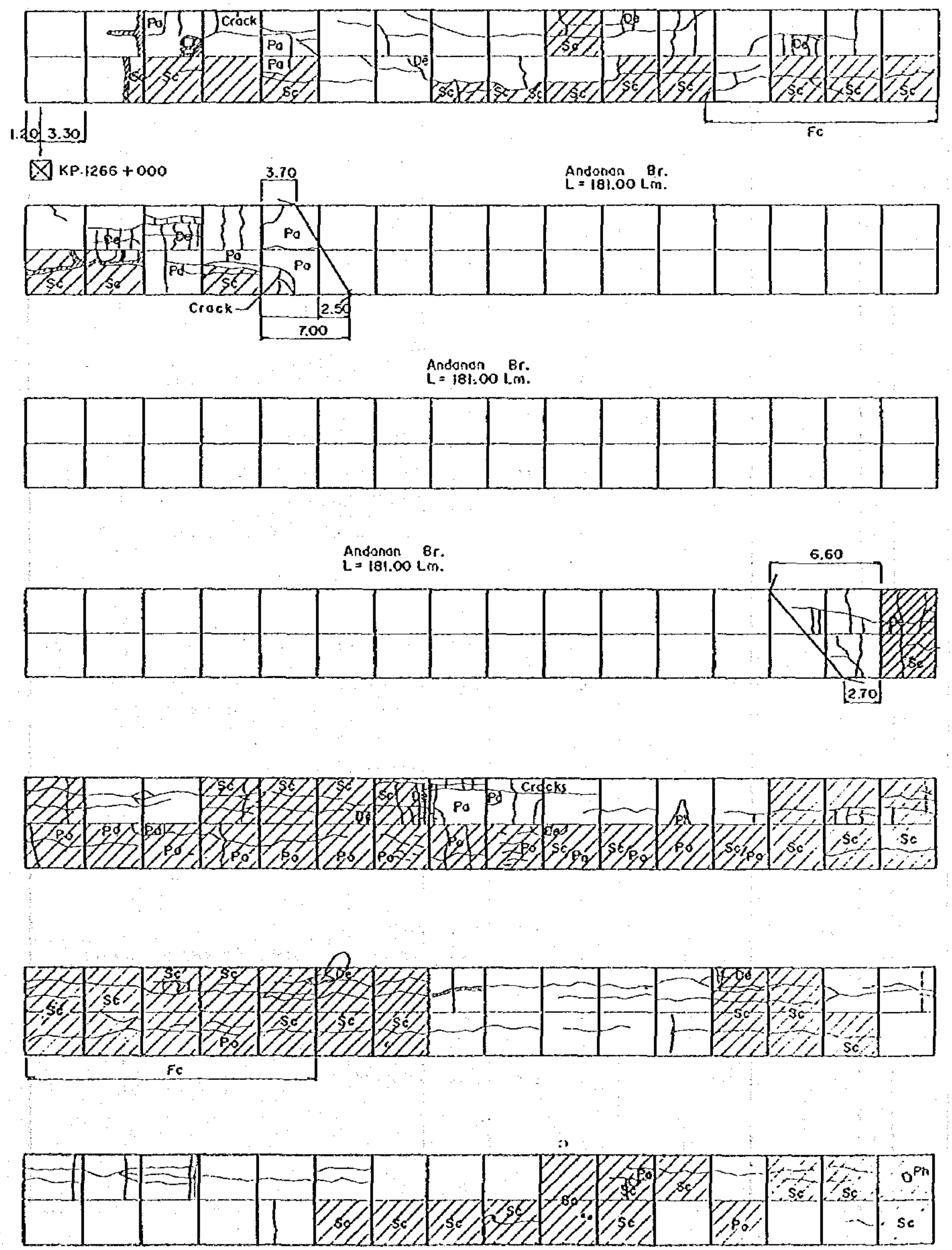


TABLE 2.1-1 PAVEMENT DISTRESS SURVEY RESULT

				Cracks					
		Length (m)	Area (sq.m.)	Transverse Cracks (m)	Longitudinal Cracks (m)	Block/Alligator Cracks (m)	Total (m)	Crack Ratio (m/1000 sq.m.)	
Km. 1246	1	71.4	478.4	3.4	49.5	0	52.9	110.5	
	2	72	482.4	6.7	9.0	0	15.7	32.5	
	3	72	482.4	0	18.0	0	18.0	37.3	
	4	72	482.4	3.4	27.0	0	30.4	62.9	
	5	72	482.4	0	22.5	0	22.5	46.6	
	6	72	482.4	6.7	13.5	0	20.2	41.9	
	7	72	482.4	30.2	0	44	73.9	153.2	
	8	72	482.4	33.5	94.5	0	128.0	265.3	
	9	72	482.4	0	216.0	0	216.0	447.8	
	10	72	482.4	13.4	63.0	36	112.4	233.0	
	11	72	482.4	23.5	103.5	88	215.0	445.6	
	12	72	482.4	16.8	117.0	0	133.8	277.3	
	13	72	482.4	20.1	72.0	0	92.1	190.9	
	14	22.5	150.7	20.1	45.0	0	65.1	432.0	
	15								
	16								
	17								
	Total		6,417.9	177.6	850.5	167.8	1195.8	186.3	
Km. 1247	1	72	482.4	30.2	148.5	31.5	210.2	435.6	
	2	72	482.4	7.7	94.5	27.0	188.6	411.6	
	3	72	482.4	6.7	103.5	0	110.2	228.4	
	4	72	482.4	20.1	36.0	0	56.1	116.3	
	5	72	482.4	0	0	0	0	0	
	6	72	482.4	13.4	13.5	0	26.9	55.8	
	7	72	482.4	0	0	0	0	0	
	8	72	482.4	0	0	0	0	0	
	9	72	482.4	0	36.0	26.8	62.8	130.2	
	10	72	482.4	36.9	121.5	60.3	218.7	453.3	
	11	72	482.4	20.1	40.5	0	60.6	125.6	
	12	72	482.4	23.5	81.0	9.0	113.5	235.2	
	13	72	482.4	16.8	108.0	23.5	148.2	307.2	
	14	53.7	359.8	23.5	72.0	0	95.5	265.3	
	15								
	16								
	17								
	Total		6,631.0	268.0	855.0	178.1	1301.1	196.2	

2.1.2 Shoulder and Side Ditch Survey

Shoulder and side ditch survey was undertaken along the entire stretch of the Study Road. Following were surveyed for each 100-m section:

Shoulder
- Existing shoulder material
- Present condition
- Proposed shoulder improvement

Side Ditch
- Cross-section type of road (to judge need of side ditch)
- Side ditch material
- Dimension of side ditch
- Present condition of side ditch
- Water flow direction
- Present condition of side ditch
- Proposed side ditch improvement

Legends used for accomplishing field survey format are shown in Figure 2.1-3 and an example of the accomplished field survey format is shown in Table 2.1-2.

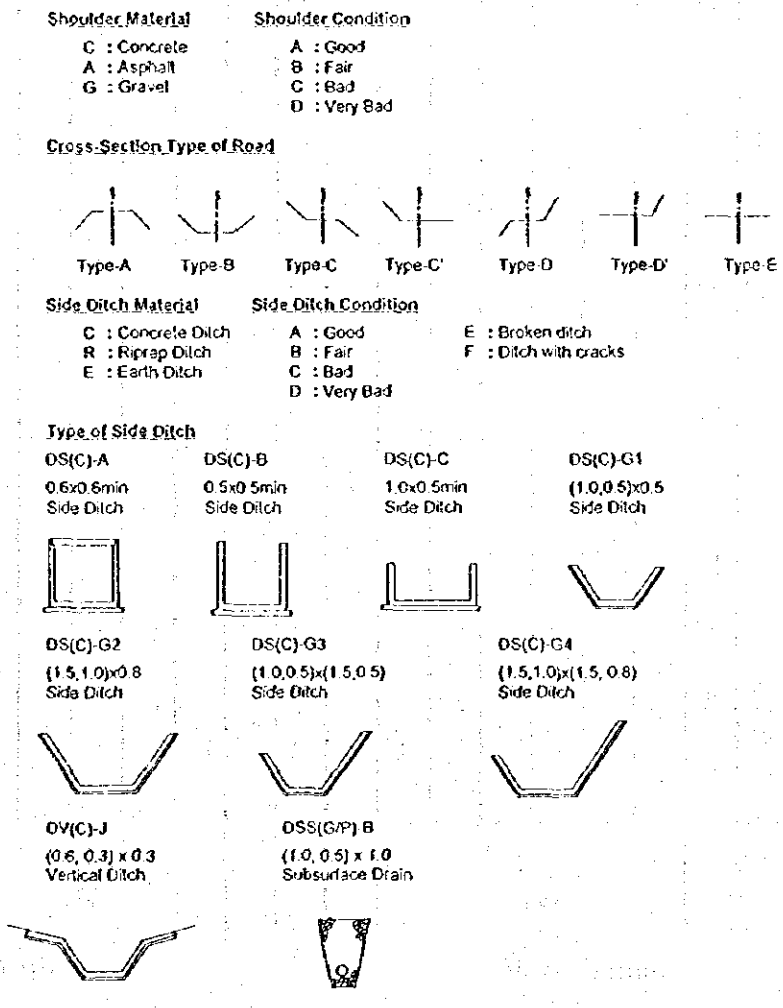


FIGURE 2.1-3 LEGENDS USED FOR ACCOMPLISHING FIELD FORMAT

TABLE 2.1-2 EXAMPLE OF ACCOMPLISHED FIELD SURVEY FORMAT

PACKAGE: 5 — Date: 10/13/95

1241 km. — No. 2/14

Proposed	Shoulder										
	Side Ditch	DS(C)-G1	DS(C)-G1		DS(C)-G1	DS(C)-G1	DS(C)-G1	DS(C)-G1	DS(C)-G1	DS(C)-G1	DS(C)-G1

North Bound

Shoulder	Condition	A	B	B	B	B	B	B	B	B	B
	Material	G	G	G	G	G	G	G	G	G	G
Side Ditch	Condition										
	c										
	b										
	a										
	Mat'l / Type										
	Flow										

	100	200	300	400	500	600	700	800	900	
CROSS SECTION	C	C	C	C	C	C	C	C	C	C

South Bound

Side Ditch	Flow										
	Mat'l / Type										
	a										
	b										
	c										
	Condition										
Shoulder	Material	G	G	G	G	G	G	G	G	G	G
	Condition	A	B	B	B	B	B	C	B	B	B

Proposed	Side Ditch						DS(C)-G1	DS(C)-G1	DS(C)-G1		
	Shoulder										

2.1.3 Pipe/Box Culvert Survey

All pipe/box culverts were surveyed their present conditions and possible improvement measures for each of the following portions:

- Inlet facility
- Culvert itself
- Outlet facility
- Upstream
- Downstream
- Others such as nearby embankment, etc.

Two field survey formats were prepared as shown in Table 2.1-3 and Figure 2.1-4. Figure 2.1-5 shows classification of headwall types.

During the field survey, maintenance engineers and foremen of District/City Engineering Offices accompanied with the JICA Study Team to assist in locating the pipe/box culverts as well as to provide information on conditions during heavy rain.

TABLE 2.1-3 EXAMPLE OF ACCOMPLISHED FIELD SURVEY FORMAT-1

PACKAGE: 5 PAGE: 5-1

LOCATION (STATION)	CULVERT SIZE	CONDITION/RECOMMENDATION 1 INLET 2 CULVERT 3 OUTLET 4 UPSTREAM 5 DOWNSTREAM 6 OTHERS
1240+950	Ø = 0.60m	1. No headwall, clogged with debris (100%)/catch basin, cleaning 2. /Change to Ø = 1.20m 3. No headwall/Headwall Type B 4. Clogged 5. /Vertical Ditch 6. -
1241+000	Ø = 1.20m	1. No headwall, clogged with debris (30%)/Headwall Type A, Cleaning 2. No damage 3. Riprap headwall 4. - 5. /Vertical ditch, Concrete foundation 6. -
1241+050	Ø = 0.90m	1. Riprap headwall damaged, Clogged with debris (50%)/Catch basin, Cleaning 2. Damaged Culvert (2.0m) (Outlet)/Change to Ø = 1.20m 3. No headwall/Headwall Type B 4. - 5. /Vertical ditch with foundation 6. -
1241+200	Ø = 1.20m	1. No headwall, Clogged with debris (60%)/Catch basin, cleaning 2. Damaged culvert (2.0m) (Outlet)/Replacement of culvert (Outlet) 3. No headwall/Headwall Type A 4. - 5. /Vertical ditch 6. /Embankment protection (S.B.)

FIGURE 2.1-4 EXAMPLE OF ACCOMPLISHED FIELD SURVEY FORMAT-2

PACKAGE: 5

DATE:

NO.: 5 - 1

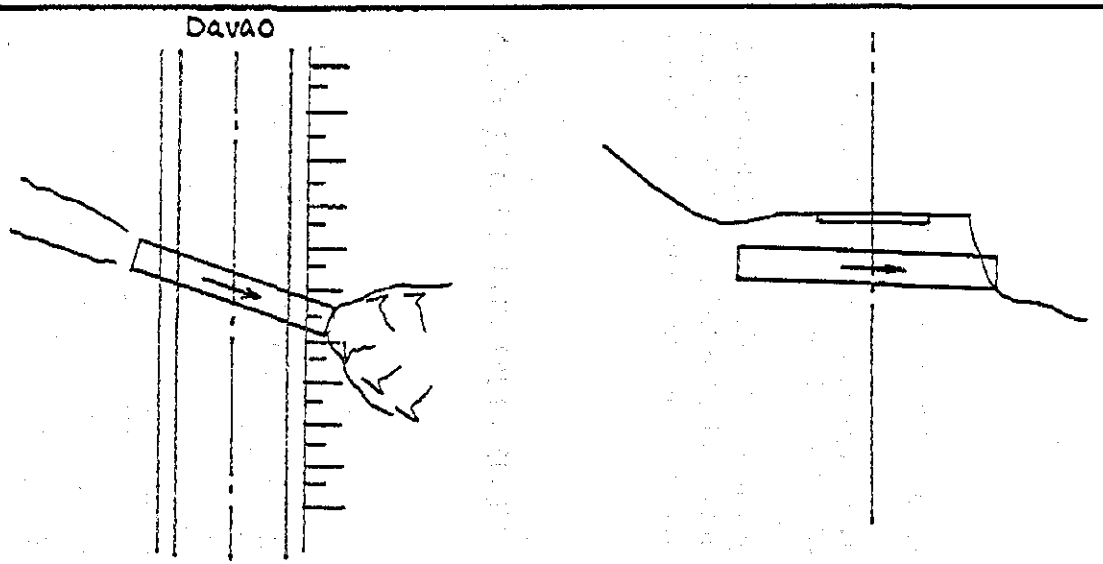
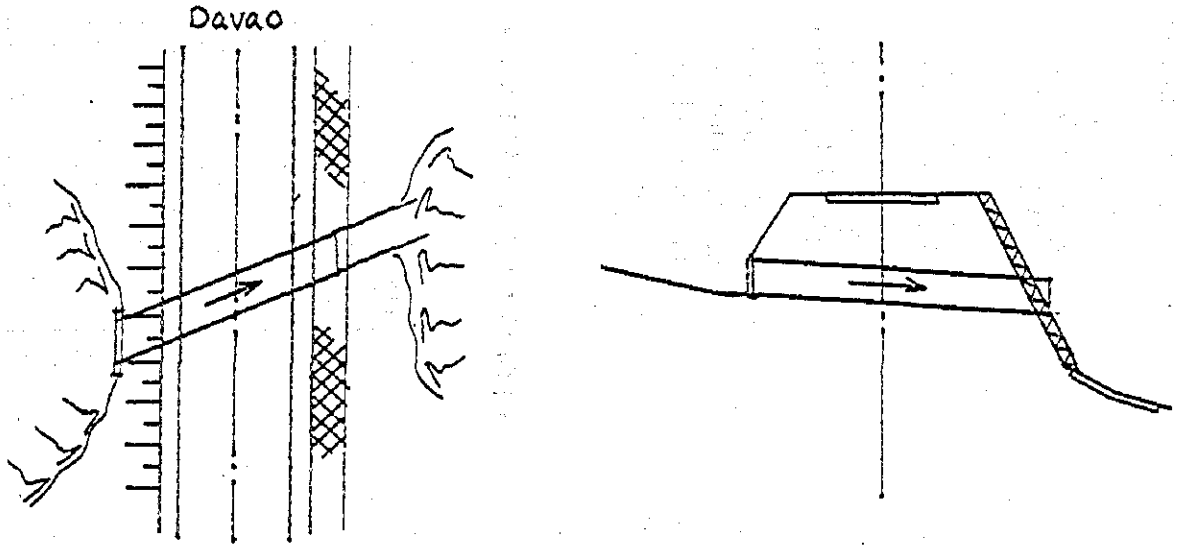
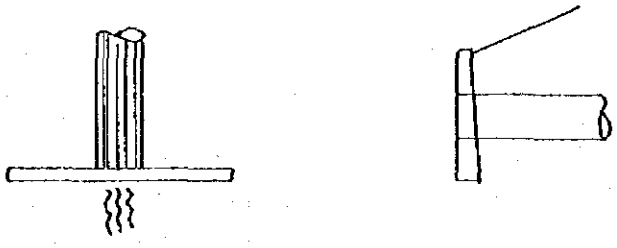
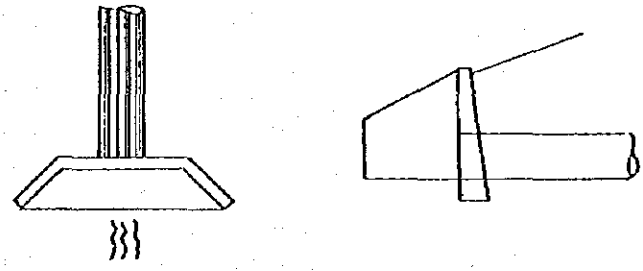
STATION	CULVERT SIZE	PLAN AND CROSS-SECTION
1240 + 950	Pipe ⌀ 0.60	
1241 + 000	Pipe ⌀ 1.20	

FIGURE 2.1-5 CLASSIFICATION OF HEADWALL TYPES

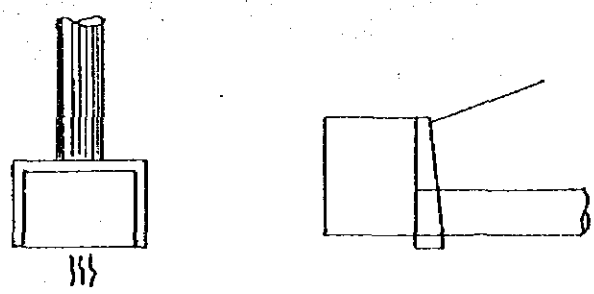
HW (C) - A



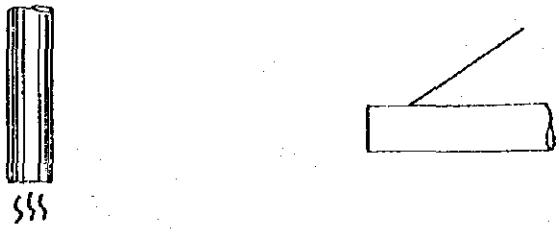
HW (C) - B



HW (C) - C



HW (C) - D



2.2 SLOPE SURVEY

The field survey team revisited all damaged slope sections reported in the feasibility study and made supplimentary observations and additional measurements. Of the original 76 selected slope sites, 6 sites were undergoing rehabilitation at the time of the site inspections and another 9 sites had been completely restored. an additional 26 extra slope sites were noted with various forms of damage. Three of these had completed restoration works. Those slopes which had been completed, or were undergoing restoration at the time of site inspection were as follows:

Slope Number	Location	Type of Disaster	Status
1-04	Km 1116+200	C-F	Completed
2-07	Km 1173+430	E-F	"
2-08	Km 1177+000	Debris	"
2-09	Km 1177+200	Debris	"
5-01	Km 1378+500	E-F	"
5-07	Km 1401+850	E-F	"
5-19	Km 1445+700	E-F	"
E-26	Km 1449+700	E-F	"
E-27	Km 1449+950	E-F	"
1-03	Km 1115+800	E-F	On-going
1-07	Km 1135+150	E-F	"
5-02	Km 1378+800	E-F	"
5-05	Km 1395+800	E-F	"
5-13	Km 1430+950	E-F	"
E-25	Km 1449+400	E-F	"

The underlying causes of the damage was reappraised and the geology was checked. The size of each area of damage was remeasured to check on any changes since the feasibility study site inspections. All previously identified sites were re-photographed and the extra sites were comprehensively measured as well as photographed.

2.3 BRIDGE SURVEY

All bridges along the Study Road were re-visited to re-check and update bridge conditions as well as to obtain additional data required for the detailed design. Field survey formats accomplished during the feasibility study were updated, if there are any changes in condition occuring in the interim period between the feasibility study and the detailed design.

Additional data gathering were concentrated mainly on the following:

- Detailed dimension survey of Structural Members
- Crack survey of RC/PC beams

Detailed Dimension Survey of Structural Members

Detailed dimension survey of structural members was undertaken for bridges to be rehabilitated or reconstructed. An example of survey result is shown in Figure 2.3-1.

Crack Survey of RC/PC Beams

Crack survey of RC/PC beams was undertaken for critical bridges. Cracks were classified as follows:

Hairline (or thin) crack (T)	: Less than 0.2mm
Medium crack (M)	: 0.2 to 0.6mm
Large crack (L)	: More than 0.6mm

An example of field measurement of cracks is shown in Figure 2.3-2.

Photographs of the bridge portions where damaged or deteriorated were taken.

All bridges were re-assessed their structural soundness based on the data obtained in the field.

Pan Philippine Highway - Mindanao
Bridge Inventory Sheet No. 4
Station : 1269.766

Bridge No. : 4-07
Bridge Name : Taglatavan
Inventory Date : 04/30/94

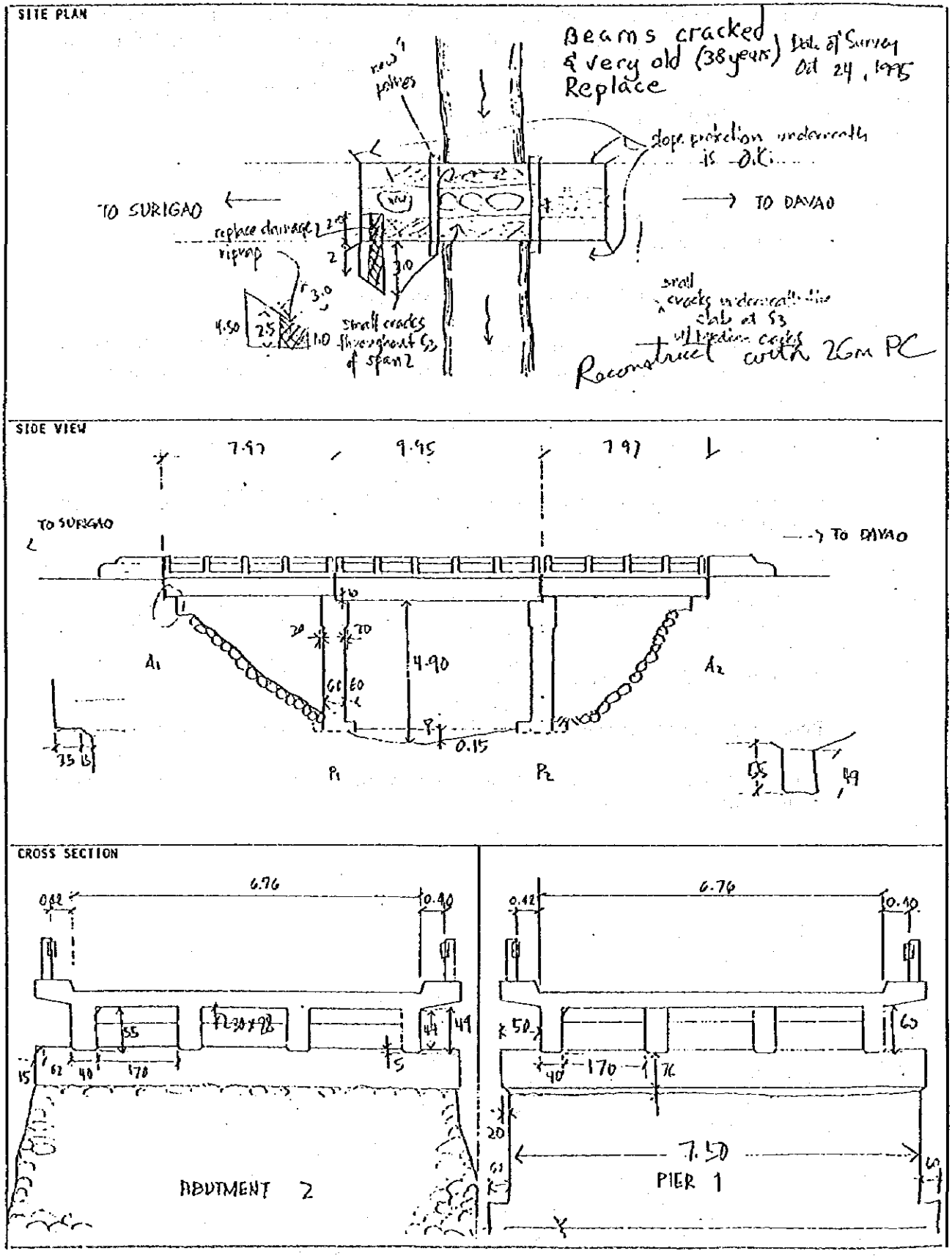
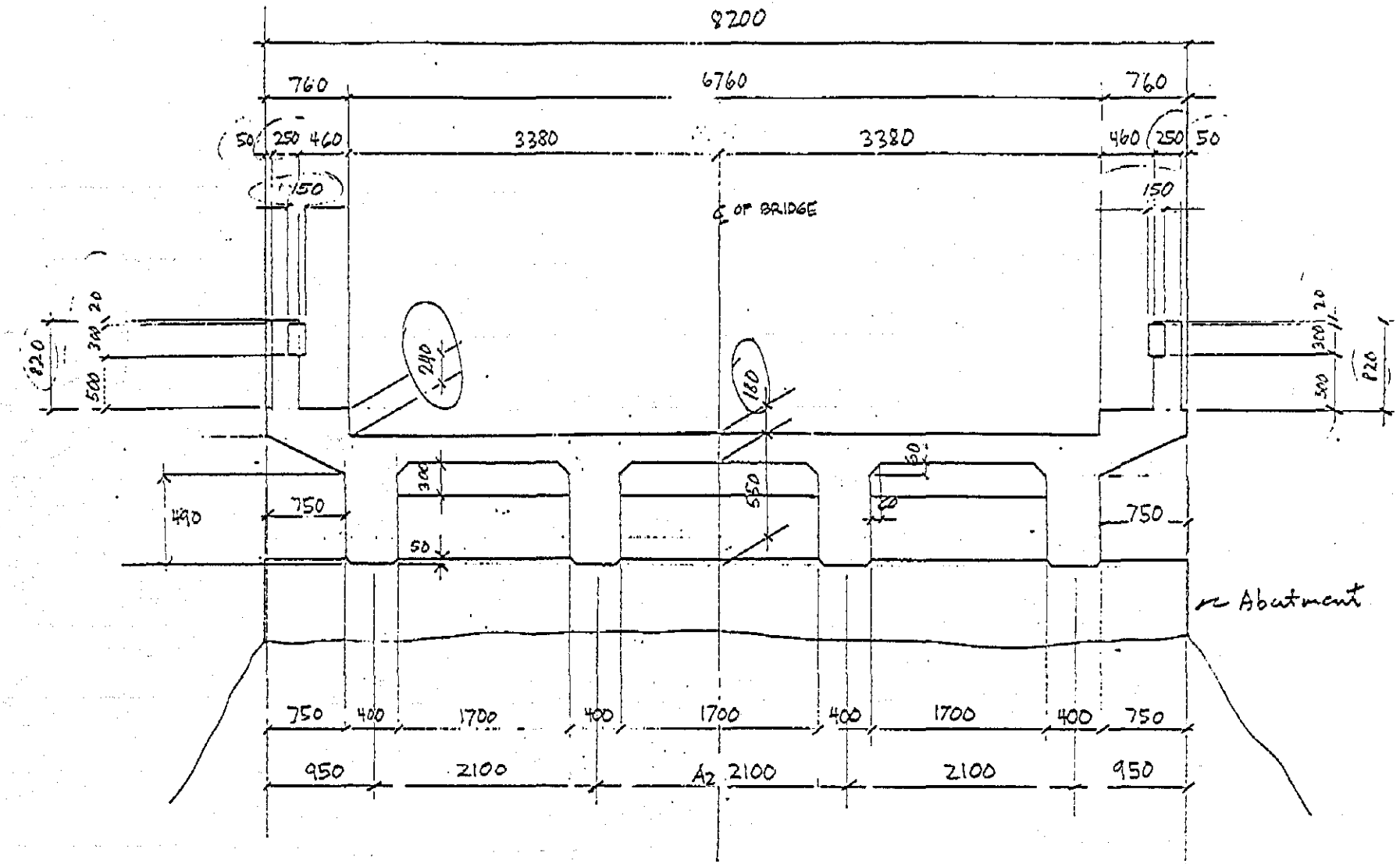


FIGURE 2.3-1(1) AN EXAMPLE OF DETAILED DIMENSION SURVEY

BRIDGE NO. 4-07
TAGLATAWAN BRIDGE



CROSS SECTION (SPAN 1 & SPAN 3)

BR # 4-07

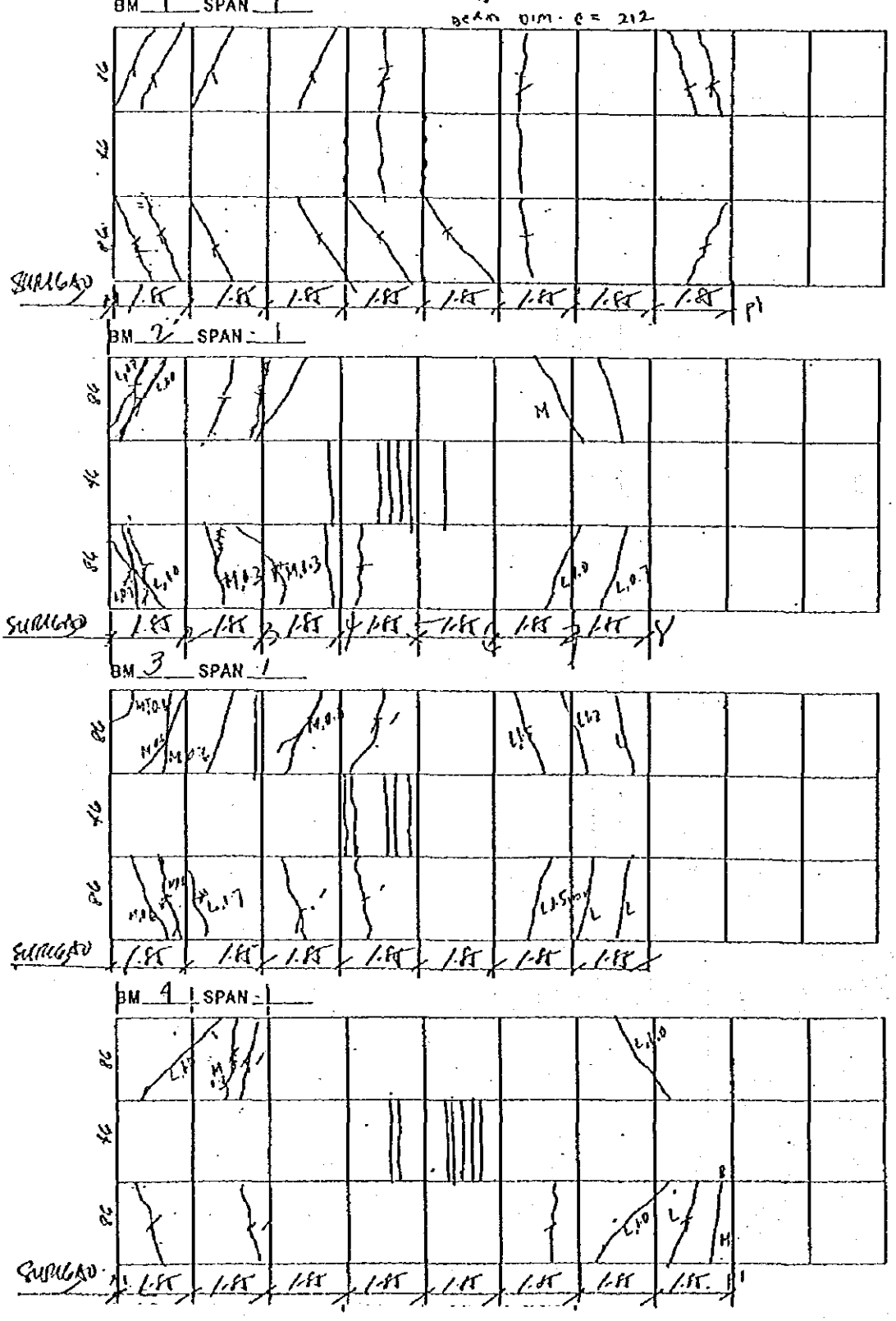
(#) assumed dimensions

FIGURE 2.3-1(2) AN EXAMPLE OF DETAILED DIMENSION SURVEY

FIELD SKETCH
CRACK SURVEY

PAN PHILIPPINE HIGHWAY - MINDANAO
BRIDGE INVENTORY SHEET NO. 1/3
STATION: 1390.2 KM

BRIDGE NO. : 5-01
BRIDGE NAME : GARAYAN
INVENTORY DATE : 12-18



CRACK WIDTH < 0.2 mm HAIRLINE T
= 0.2 mm to 0.6 mm M
= 0.6 mm to 3.0 mm L

FIGURE 2.3-2 AN EXAMPLE OF CRACK SURVEY

CHAPTER 3

TRAFFIC SURVEY

3.1 TRAFFIC SURVEY

No traffic survey was undertaken, as the extensive traffic survey was undertaken during the feasibility study of which results were utilized under this Study.

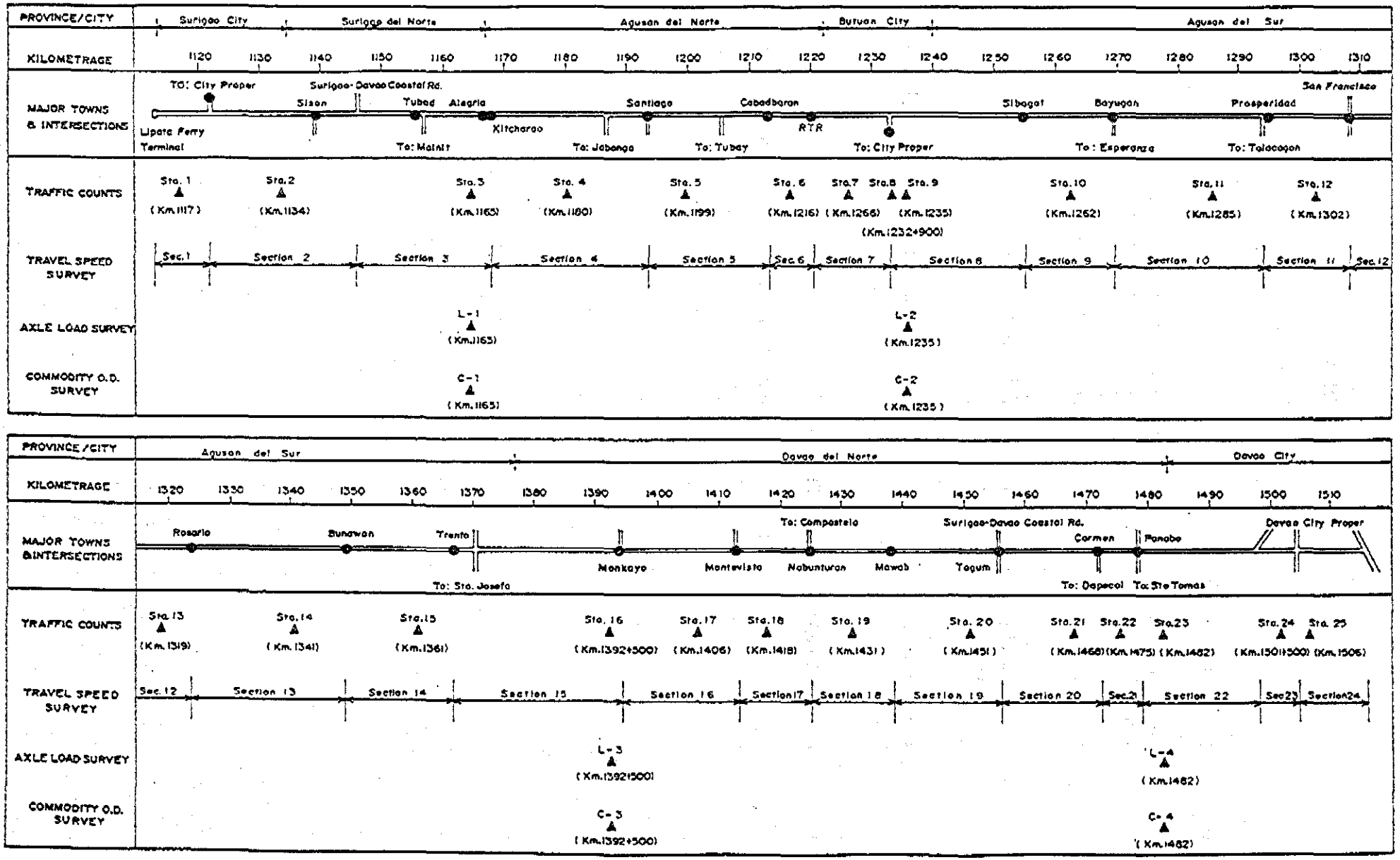
The traffic surveys undertaken during the feasibility study were as follows:

- Traffic count survey at 24 stations
- Travel speed survey along the Study Road
- Axle load survey at 4 stations
- Commodity OD survey at 4 stations

Traffic survey stations and AADT (1994) are shown in Figure 3.1-1 and 2, respectively.

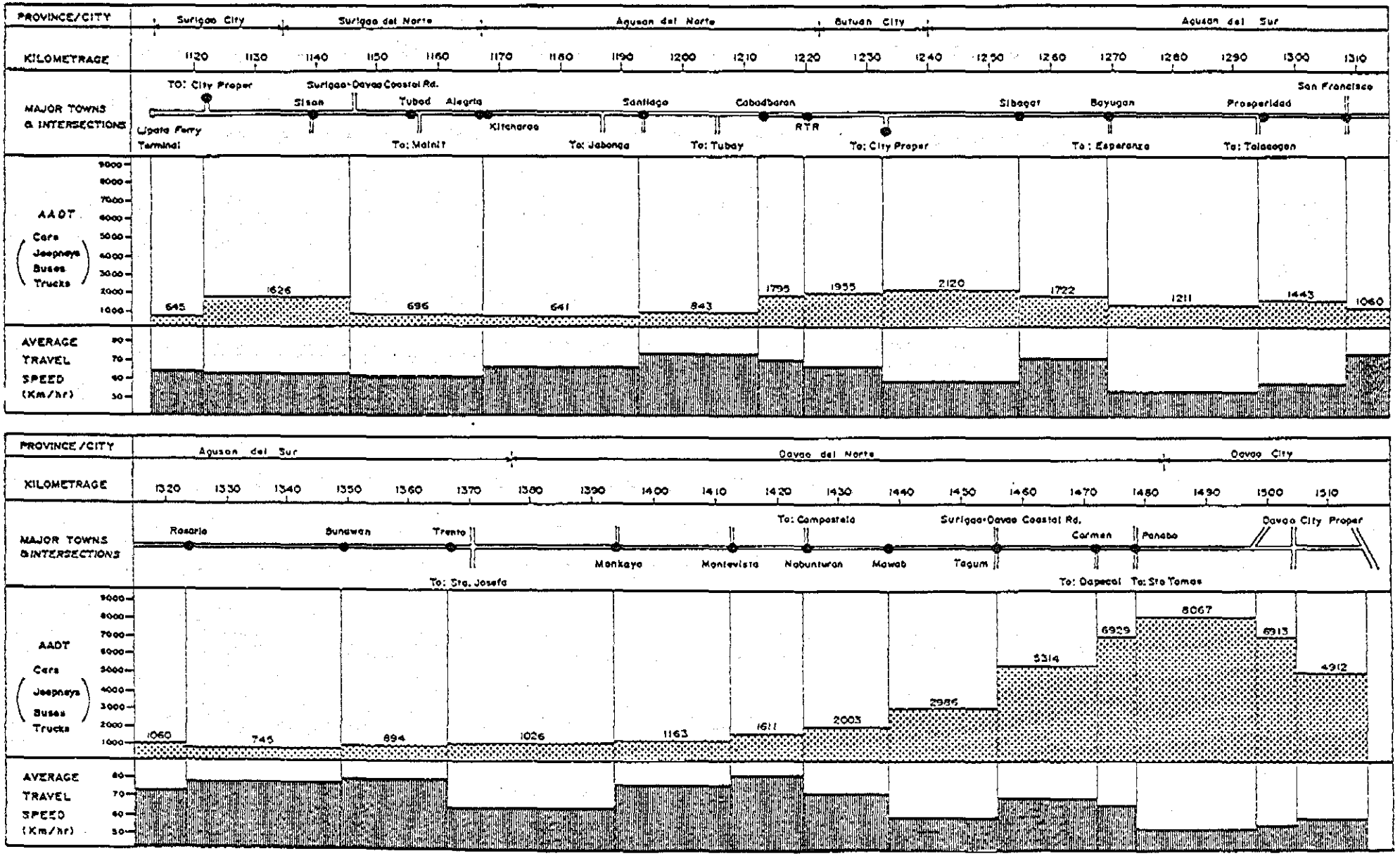
3.2 ESTIMATED FUTURE TRAFFIC

Future traffic estimated by the feasibility study was utilized under this Study. Estimated future traffic is shown in Table 3.2-1.



SOURCE: F/S Report

FIGURE 3.1-1 TRAFFIC SURVEY STATIONS



SOURCE: F/S Report

FIGURE 3.1-2 AADT (1994) AND AVERAGE TRAVEL SPEED

TABLE 3.2-1 (1/2) FUTURE TRAFFIC VOLUME BY SECTION

Section	Year	Vehicles with 4 or more wheels					Others		Total
		Car	Jeepney	Bus	Truck	Sub-Total	Tricycle	M'cycle	
1	1994	251	115	41	238	645	449	199	1,293
	2000	383	179	67	364	993	663	308	1,964
	2010	686	323	119	739	1,867	1,192	538	3,597
	2020	1,098	514	186	1,271	3,069	1,933	864	5,866
2	1994	372	595	61	596	1,624	16	134	1,774
	2000	571	898	103	922	2,494	24	218	2,736
	2010	1,024	1,617	177	1,863	4,681	44	371	5,096
	2020	1,635	2,601	282	3,239	7,757	70	588	8,415
3	1994	236	241	68	153	698	5	82	785
	2000	383	384	120	222	1,109	8	144	1,261
	2010	674	687	201	443	2,005	15	235	2,255
	2020	1,061	1,092	318	720	3,191	23	368	3,582
4	1994	200	194	61	186	641	7	49	697
	2000	339	320	113	274	1,046	9	95	1,150
	2010	588	569	183	533	1,873	21	147	2,041
	2020	914	899	290	863	2,966	30	229	3,225
5	1994	252	312	73	206	843	4	91	938
	2000	428	508	140	304	1,380	8	168	1,556
	2010	739	904	219	586	2,448	12	270	2,730
	2020	1,154	1,448	351	942	3,895	20	420	4,335
6	1994	612	673	70	440	1,795	73	238	2,106
	2000	985	1,067	137	649	2,838	110	396	3,344
	2010	1,753	1,907	210	1,252	5,122	199	676	5,997
	2020	2,801	3,085	339	2,047	8,272	327	1,067	9,666
7	1994	771	636	74	475	1,956	40	186	2,182
	2000	1,237	1,024	145	692	3,098	63	331	3,492
	2010	2,216	1,836	222	1,315	5,589	116	551	6,256
	2020	3,568	2,986	359	2,117	9,030	190	858	10,078
8	1994	712	782	164	462	2,120	39	250	2,409
	2000	1,157	1,258	308	667	3,390	61	435	3,886
	2010	2,076	2,295	492	1,252	6,115	115	744	6,974
	2020	3,350	3,763	801	2,005	9,919	191	1,180	11,290
9	1994	547	495	189	491	1,722	134	195	2,051
	2000	905	817	349	696	2,767	211	348	3,326
	2010	1,598	1,460	567	1,296	4,921	412	581	5,914
	2020	2,558	2,373	931	2,058	7,920	701	914	9,535
10	1994	459	225	184	343	1,211	6	156	1,373
	2000	770	394	343	491	1,998	9	287	2,294
	2010	1,342	668	553	931	3,494	18	465	3,977
	2020	2,143	1,053	907	1,486	5,589	31	726	6,346
11	1994	554	293	175	421	1,443	33	291	1,767
	2000	924	501	327	594	2,346	53	507	2,906
	2010	1,640	881	525	1,094	4,140	102	882	5,124
	2020	2,651	1,416	857	1,724	6,648	175	1,427	8,250
12	1994	386	264	115	295	1,060	72	794	1,926
	2000	658	456	215	422	1,751	113	1,306	3,170
	2010	1,131	797	345	794	3,067	225	2,447	5,739
	2020	1,794	1,283	561	1,267	4,905	385	4,090	9,380

SOURCE: Feasibility Study Report

TABLE 3.2-1 (2/2) FUTURE TRAFFIC VOLUME BY SECTION

Section	Year	Vehicles with 4 or more wheels					Others		Total
		Car	Jeepney	Bus	Truck	Sub-Total	Tricycle	M'cycle	
13	1994	334	101	119	191	745	8	178	931
	2000	572	191	219	278	1,260	13	322	1,595
	2010	981	303	357	530	2,171	25	531	2,727
	2020	1,547	462	580	860	3,449	43	837	4,329
14	1994	371	151	120	252	894	20	549	1,463
	2000	632	273	218	368	1,491	34	911	2,436
	2010	1,090	455	360	684	2,589	60	1,652	4,301
	2020	1,724	707	586	1,110	4,127	100	2,697	6,924
15	1994	405	113	153	355	1,026	202	633	1,861
	2000	679	208	274	516	1,677	315	1,041	3,033
	2010	1,190	339	459	924	2,912	588	1,889	5,389
	2020	1,888	516	748	1,478	4,630	964	3,059	8,653
16	1994	489	126	183	358	1,156	11	450	1,617
	2000	809	227	323	527	1,886	22	753	2,661
	2010	1,434	377	549	934	3,294	33	1,349	4,676
	2020	2,292	583	891	1,508	5,274	55	2,170	7,499
17	1994	649	157	305	500	1,611	80	511	2,202
	2000	1,061	274	529	733	2,597	128	847	3,572
	2010	1,900	467	910	1,284	4,561	232	1,523	6,316
	2020	3,055	733	1,474	2,047	7,309	370	2,457	10,136
18	1994	855	157	318	673	2,003	20	605	2,628
	2000	1,380	271	542	990	3,183	36	989	4,208
	2010	2,500	466	944	1,713	5,623	60	1,797	7,480
	2020	4,030	743	1,528	2,704	9,005	96	2,899	12,000
19	1994	1,029	332	488	1,137	2,986	1,050	1,110	5,146
	2000	1,644	548	811	1,674	4,677	1,640	1,777	8,094
	2010	3,005	980	1,442	2,862	8,289	3,020	3,255	14,564
	2020	4,854	1,568	2,326	4,458	13,206	4,827	5,242	23,275
20	1994	2,368	515	905	1,526	5,314	153	947	6,414
	2000	3,739	833	1,469	2,281	8,322	243	1,522	10,087
	2010	6,901	1,516	2,658	3,971	15,046	450	2,791	18,287
	2020	11,134	2,431	4,289	6,214	24,068	719	4,507	29,294
21	1994	2,807	957	1,043	2,122	6,929	1,016	1,596	9,541
	2000	4,425	1,527	1,675	3,215	10,842	1,603	2,538	14,983
	2010	8,205	2,805	3,060	5,666	19,736	2,973	4,689	27,398
	2020	13,238	4,513	4,947	8,901	31,599	4,770	7,566	43,935
22	1994	3,284	1,733	940	2,110	8,067	147	651	8,865
	2000	5,188	2,759	1,502	3,208	12,657	236	1,045	13,938
	2010	9,639	5,117	2,768	5,680	23,204	433	1,922	25,559
	2020	15,581	8,263	4,479	8,931	37,254	694	3,113	41,061
23	1994	2,666	2,237	442	1,568	6,913	15	858	7,786
	2000	4,217	3,558	706	2,388	10,869	28	1,368	12,265
	2010	7,841	6,628	1,302	4,228	19,999	45	2,537	22,581
	2020	12,675	10,725	2,107	6,641	32,148	73	4,114	36,335
24	1994	2,475	0	291	2,146	4,912	265	806	5,983
	2000	3,923	0	460	3,310	7,693	424	1,281	9,398
	2010	7,309	0	860	5,917	14,086	790	2,387	17,263
	2020	11,827	0	1,391	9,339	22,557	1,279	3,870	27,706

SOURCE: Feasibility Study Report

CHAPTER 4

TOPOGRAPHIC SURVEY

Following four kinds of topographic survey were undertaken:

- Route survey along the whole stretch of the Study Road
- Topographic survey at bridge sites, slopes and flood-prone areas
- River profile and cross-section survey
- Aerial photographic survey and mapping

4.1 ROUTE SURVEY

The route survey was undertaken for the entire stretch of the Study Road (or about 403 km) and for the proposed alignment of the Monkayo Bypass (about 2.5km) in accordance with the following procedure:

- GPS Survey
- Traverse Survey
- Establishment of Temporary Bench Marks (TBMs)
- Centerline Survey
- Centerline Stake-out Survey
- Profile Survey
- Cross-Section Survey
- Topographic Survey
- Preparation of Topographic Maps, Profiles and Cross-Sections

All data obtained in the field surveys were stored in the diskettes and mapping/drafting works were done by using computer softwares.

1) GPS Survey

GPS stations were established at about 10 km. interval, which were used as the control points for the traverse survey. An average of six satellites were observed. In order to check accuracy of the survey as well as to tie to National GPS Stations, five GPS stations established under the Philippine Geodetic Network were also measured. A total of 50 GPS stations were measured.

2) Traverse Survey

The traverse points were established at an interval of 200 to 1,000 meters. The traverse route was tied to GPS stations established under this project.

3) Establishment of TBMs

TBMs were established at about 500m interval and tied to the National Bench Marks.

4) Centerline Survey

The centerline survey was undertaken in order to determine the existing centerline alignment. Coordinates along the longitudinal joint of PCC pavement were measured. Curve elements were determined by using computer software developed by the JICA Study Team.

Problems encountered were as follows:

- The existing centerline at a curved section was not always follow a certain radius of curvature. Errors or deviations from the designed centerline were oftenly observed. This may be due to construction error and/or errors during PCC slab reconstruction.

- Thus, it was impossible to determine radius which exactly follows the existing centerline which is the alignment along the existing longitudinal joint of PCC pavement.

- Therefore, the Study Team selected radius which was least error to the existing centerline. Thus, the centerline alignment established by the Study Team was the nearest alignment to the existing alignment and there are minor deviation from the existing centerline.

5) Centerline Stake-out Survey

Centerline stake-out was undertaken at the interval of 20 meters and at points of beginning and end of each curve.

6) Profile Survey

Elevation of centerline stakes established at 20m interval and other points of inclination was measured. Levelling was tied to TBM and closed.

7) Cross-Section Survey

Cross-section survey was undertaken at 20m interval and other points of topographical changes. Distance covered by the survey was as follows:

Flat terrain	: 30m either side from the centerline
Rolling terrain	: 50m either side from the centerline
Mountainous terrain	: 60m either side from the centerline

8) Topographic Survey

All structures such as houses, buildings, electric posts, side ditches, cross-drainage facilities, existing Km posts, and all other man-made facilities as well as topographic changes such as small vallies, creeks, etc. were measured. The topographic survey was so undertaken that the contour interval of 1m was attained.

9) Preparation of Topographic Maps, Profiles and Cross-Sections

Following maps/drawings were prepared:

Topographic Map
Scale : 1/1,000
Contour interval : 1m

Profile
Scale : H = 1/1,000
V = 1/100

Cross-Section
Scale : 1/100

4.2 TOPOGRAPHIC SURVEY AT BRIDGE SITES, SLOPES AND FLOOD-PRONE AREAS

Topographic survey for the following sections:

- 10 slopes which remarkably failed
  scale : 1/500 with contour interval of 1 meter.
- 71 bridge sites proposed to be rehabilitated/ improved/reconstructed
  scale : 1/200 for short bridges and 1/500 for long bridges with contour interval of 1 meter
- 2 flood-prone sections
  scale : 1/1,000 with contour interval of 1 meter

4.3 RIVER PROFILE AND CROSS-SECTION SURVEY

River profile and cross-section survey was undertaken for 39 rivers which require detailed hydraulic analysis and/or dredging/rechanneling.

Scale : Profile H = 1/1,000
V = 1/100
Cross-Section 1/100

4.4 AERIAL PHOTOGRAPHIC SURVEY AND MAPPING

For the purposes of detailed hydraulic analysis, route selection of a proposed bypass road, and dike planning, etc., aerial photographic survey and mapping was undertaken for the following three flood-prone areas:

- Simulao River Flood Area

  Area covered = 10km x 3km = 30 sq.km
  Scale : 1/5,000 with contour interval of 1 meter

- Monkayo Bypass Construction Site

  Area covered = 2.5km x 2.5km = 6.25 sq.km
  Scale : 1/2,000 with contour interval of 1 meter

- Liboganon River Flood Area

  Area covered = 16km x 4km = 64 sq.km
  Scale : 1/5,000 with contour interval of 1 meter

CHAPTER 5

SOILS/MATERIAL AND GEOTECHNICAL INVESTIGATION

The following investigations were undertaken:

- Geotechnical investigation for pavement rehabilitation design
- Geotechnical investigation for slope protection design
- Geotechnical investigation for bridge foundation design
- Soils investigation for soft ground sections
- Soils investigation for Sianib Section
- Soils investigation for Liboganon River bank design
- Material sources investigation

5.1 GEOTECHNICAL INVESTIGATION FOR PAVEMENT REHABILITATION DESIGN

Following investigations were undertaken:

- Concrete pavement coring
- Test pitting
- Auger boring

1) Concrete Pavement Coring

In order to examine PCC slab thickness and concrete strength, coring of PCC slabs was undertaken basically at 1 km interval for 214 km sections where pavement rehabilitation was proposed. A total of 197 concrete specimen were sampled and subjected to compressive strength test after measurement of thickness.

2) Test Pitting

In order to examine soil layer composition under PCC slab and characteristics of each soil layer including bearing capacity, test pitting to a depth of 1.5 meters was undertaken basically at 0.5 km interval for 214 km sections proposed for pavement rehabilitation. Test pitting was also undertaken for Monkayo Bypass section. A total of 414 test pittings were undertaken. Two soil samples per test pit were basically obtained. In-situ density tests were undertaken during test pitting. Soil samples obtained were subjected to the following laboratory tests:

- Soil classification
- Natural moisture content
- Sieve analysis
- Atterberg limits
- Moisture-density relation
- CBR

3) Auger Boring

In order to examine soil layer composition under PCC slab and characteristics of each soil layer, auger borings to a depth of 1.5 meters were undertaken basically at 0.5 meters were undertaken basically at 0.5 km interval for 214 km sections proposed for pavement rehabilitation. Auger borings were also undertaken for Monkayo Bypass section.

A total of 434 auger borings were conducted and basically two samples per auger boring were collected. Soil samples were subjected to the following laboratory tests:

- Soil classification
- Natural moisture content
- Sieve analysis
- Atterberg limits

5.2 GEOTECHINICAL INVESTIGATION FOR SLOPE PROTECTION DESIGN

One boring test per slope was undertaken at two embankment slopes which have already slided. Location of two slopes is as follows:

- Km 1282 + 500
- Km 1283 + 400

Total drilling length was 20.9 meters.

5.3 GEOTECHINICAL INVESTIGATION FOR BRIDGE FOUNDATION DESIGN

Geotechnical investigation was undertaken at 19 bridge sites and 42 borings with a total drilling length of 1,235.8 meters were conducted (see Table 5.3-1).

TABLE 5.3-1 GEOTECHNICAL INVESTIGATION AT BRIDGE SITES

Bridge Name	Km	No. of Bore Holes	Drilling Length (m)
1. New Camalig	1180+157	3	29.0
2. Guinoyoran	1197+535	1	37.0
3. Sanghan	1217+339	2	78.8
4. Ampayon	1232+785	1	55.4
5. Andanan	1266+097	4	87.3
6. Taglatawan	1269+766	2	42.6
7. Lagcogangan	1320+472	1	50.5
8. Tagbayagan	1323+317	1	42.5
9. Wasian	1330+888	2	95.6
10. Gabanan	1390+242	3	36.3
11. Tina	1397+365	2	34.7
12. Banlag	1398+108	2	32.5
13. Nabunturan	1424+698	2	64.7
14. Liboganon	1465+285	1	57.4
15. Ilang	1494+420	1	37.0
16. Monkayo Bypass No. 1		2	46.7
17. Monkayo Bypass No. 2		4	55.3
18. Monkayo Bypass No. 3		2	26.7
19. New Gov. Miranda		6	330.8
Total		42	1,240.8

5.4 SOILS INVESTIGATION FOR SOFT GROUND SECTIONS

Soils investigation for soft ground sections was undertaken at six locations as follows:

- Km 1303+900
- Km 1322+800
- Km 1333+350
- Km 1333+500
- Km 1346+100
- Km 1357+300

One boring test per location was undertaken and total drilling length was 92.7 meters.

5.5 SOILS INVESTIGATION FOR SIANIB SECTION

Sianib Section (about Km 1280 - Km 1283) has been suffering very fast pavement deterioration and slope failures. At about Km 1281+600, PCC pavement constructed in 1994 during the Feasibility Study Stage, had already severe cracks with faulting in 1995. In order to examine soil layers and their characteristics, three borings were undertaken with the total drilling length of 31.4 meters.

5.6 SOILS INVESTIGATION FOR LIBOGANON RIVER BANK DESIGN

For the purposes of examining soil conditions and analysis of the river bank stability, two borings were undertaken with a total length of 51.9 meters.

5.7 MATERIAL SOURCES INVESTIGATION

Prior to selection of material sources to be investigated, all possible material sources were identified based on DPWH material sources maps, information from contractors, etc., and visited to assess accessibility to each sources and to estimate approximate volume of materials. Number of material sources identified and visited were as follows:

Borrow Sources	: 30
Base/Subbase Sources	: 34
Aggregate Sources for Concrete	: 25

To be noted is that aggregate sources for concrete in Agusan del Sur are scarce and aggregates for concrete are expected to be hauled for a long distance in the Province.

Material sources to be investigated were selected from above possible material sources and following investigations were conducted:

1) Borrow Sources

A total of 19 sources were investigated (see Figure 5.7-1). One test pitting per source was undertaken. Two samples per test pit were collected and the following field/laboratory tests were conducted for each sample:

- In-situ density
- Soil classification
- Natural moisture content
- Sieve analysis
- Atterberg limits
- Moisture-density relation
- CBR

2) Base/Subbase Sources

A total 19 sources were investigated (see Figure 5.7-2). Two test pittings per source or 38 test pittings were undertaken. Two samples per test pit or a total of 76 samples were collected and subjected to the following laboratory tests:

- Sieve analysis
- Atterberg limits
- Moisture - density relation
- CBR
- Los Angeles abrasion (base material only)

3) Concrete Aggregate Sources

A total of 19 sources were investigated (see Figure 5.7-3). Two test pittings per source or 38 test pittings were undertaken. Two samples per test pit or a total of 76 samples were collected and the following laboratory tests were conducted:

- Sieve analysis
- Los Angeles abrasion
- Specific gravity
- Absorption
- Soundness
- Flakiness index

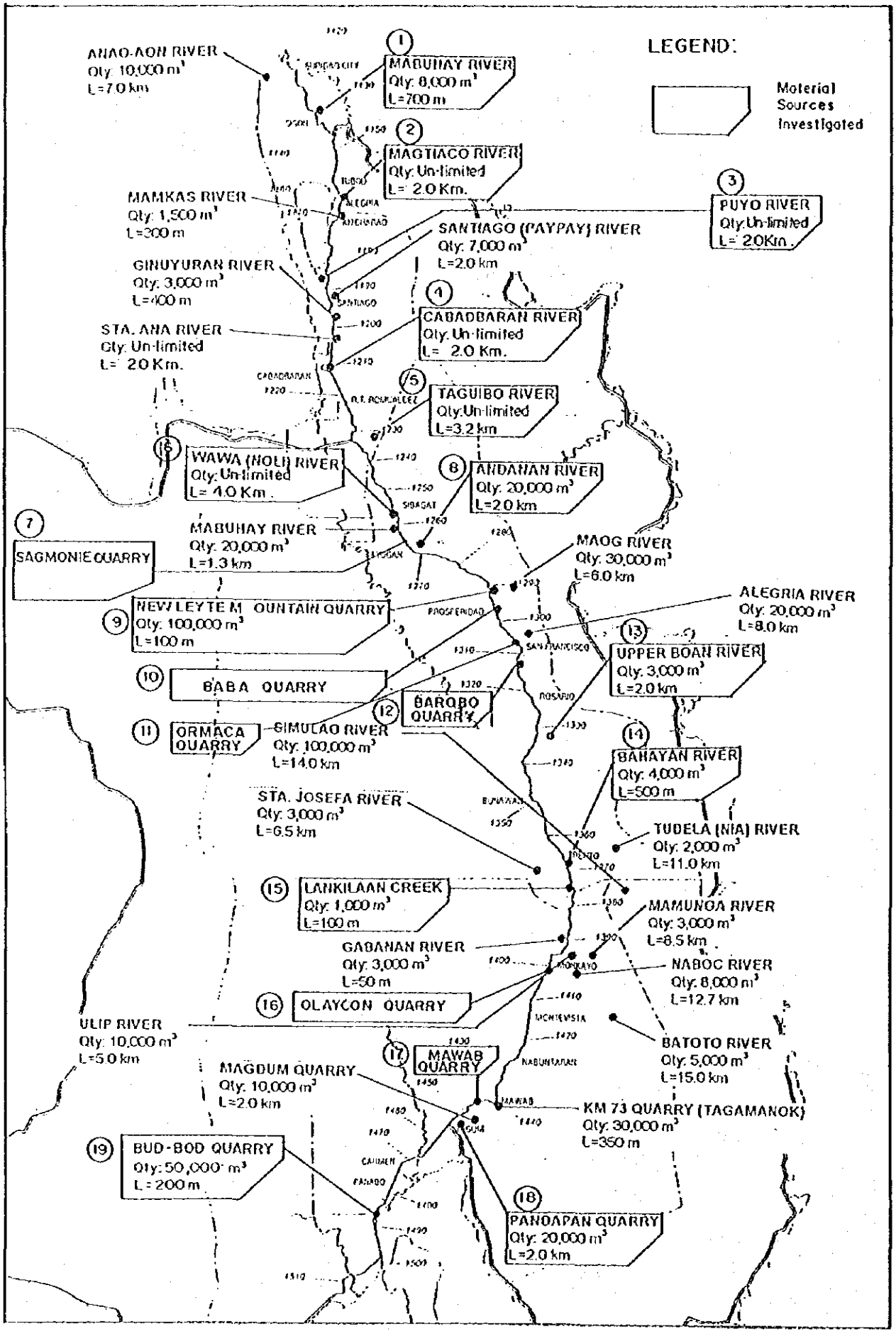


FIGURE 5.7-1 BORROW SOURCES INVESTIGATED

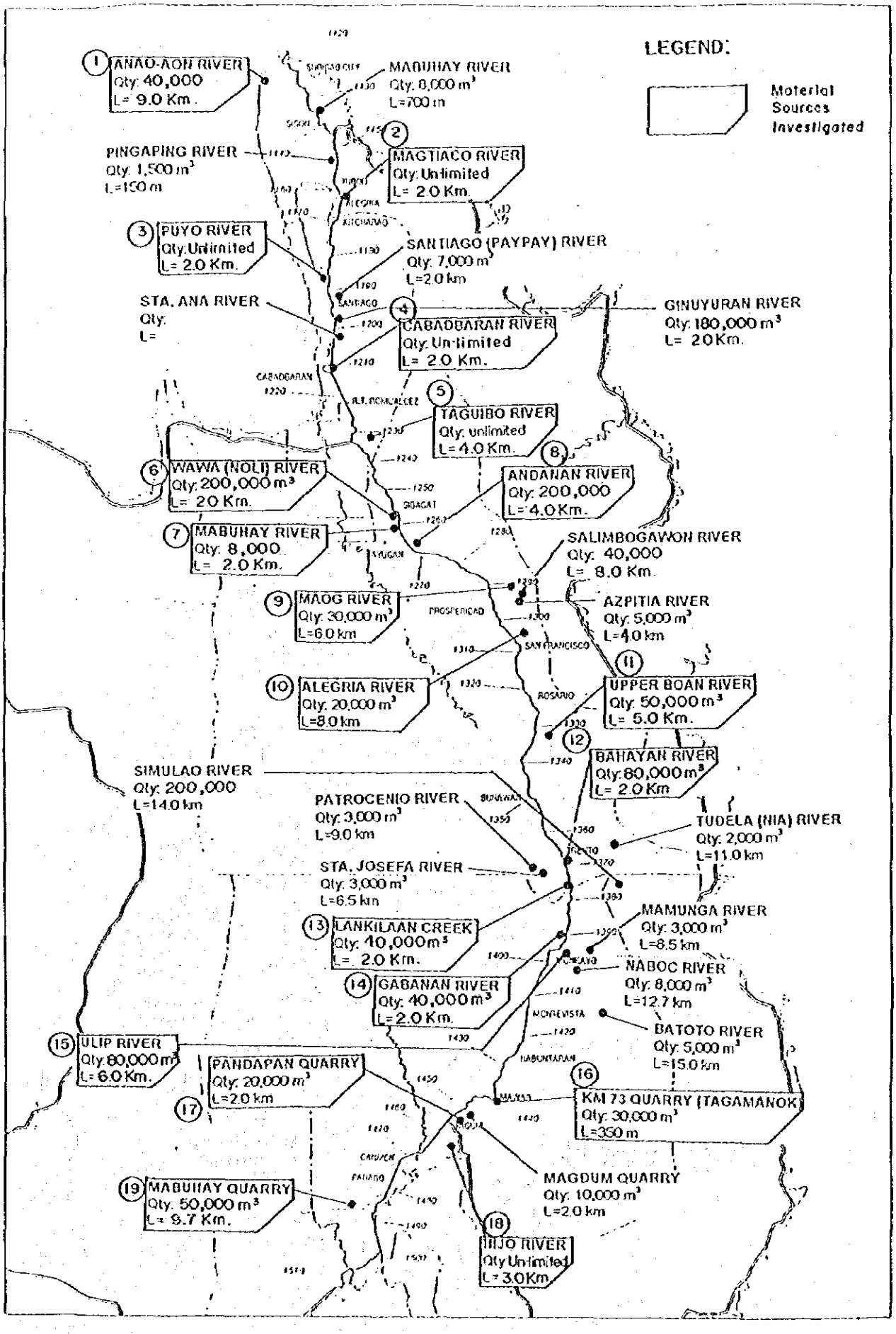


FIGURE 5.7-2 BASE/SUBBASE MATERIAL SOURCES INVESTIGATED

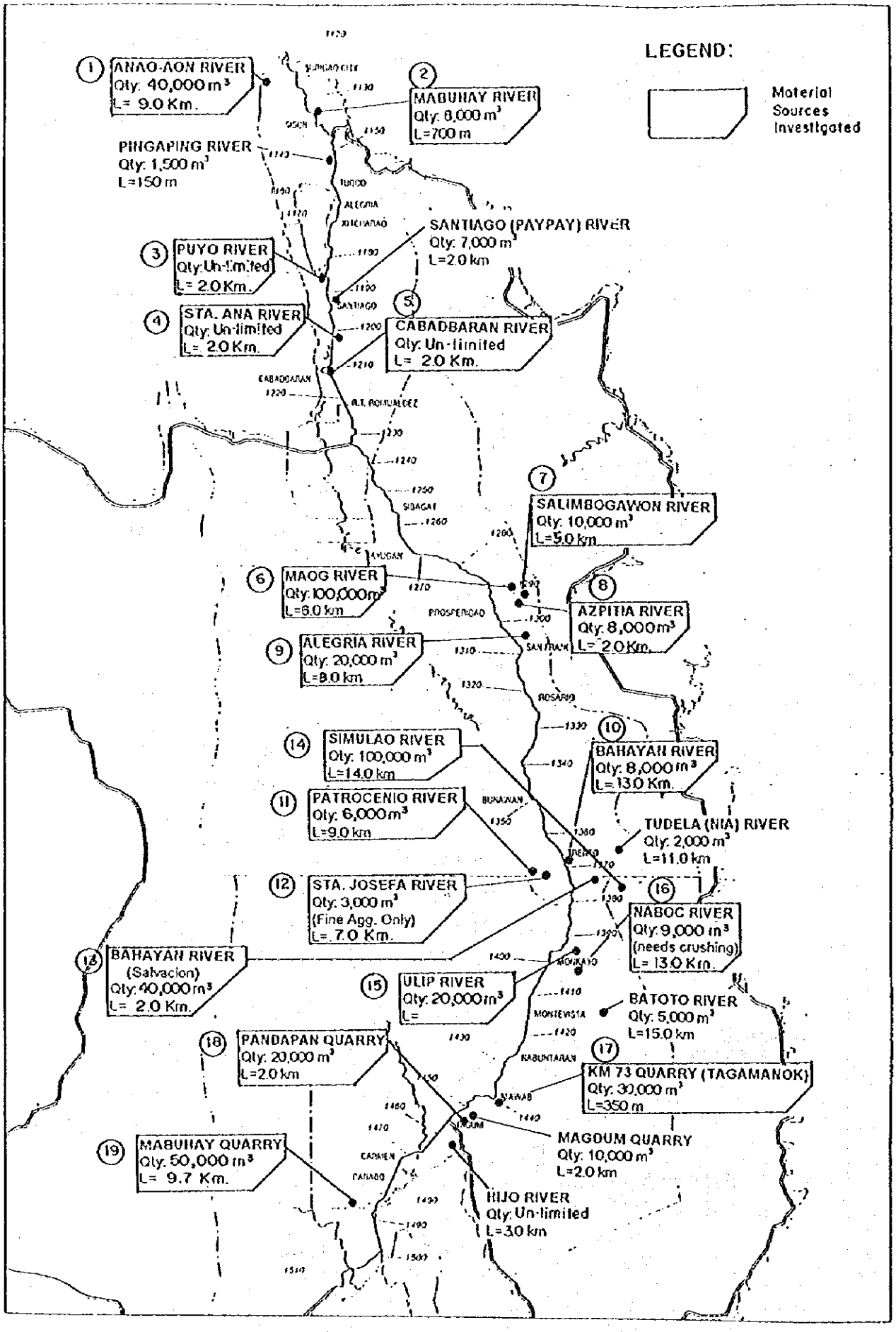


FIGURE 5.7-3 CONCRETE AGGREGATE SOURCES INVESTIGATED