社会開発調査部報告書

No. 12

JICA THE FEASIBILITY STUDY ON ARTERIAL ROAD DEVELOPMENT PROJECT IN THE CENTRAL EASTERN AREA IN THE REPUBLIC OF PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF PUBLIC WORKS AND COMMUNICATIONS

THE REPUBLIC OF PARAGUAY

THE FEASIBILITY STUDY ON ARTERIAL ROAD DEVELOPMENT PROJECT IN THE CENTRAL EASTERN AREA IN THE REPUBLIC OF PARAGUAY

FINAL REPORT

(Volume I - Main Report)

FEBRUARY, 1997

CENTRAL CONSULTANTING (JAPAN)

IN ASSOCIATION WITH

YACHIYO ENGINEERING CO., LTD. (JAPAN)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF PUBLIC WORKS AND COMMUNICATIONS
THE REPUBLIC OF PARAGUAY

THE FEASIBILITY STUDY
ON
ARTERIAL ROAD DEVELOPMENT PROJECT
IN
THE CENTRAL EASTERN AREA
IN
THE REPUBLIC OF PARAGUAY

FINAL REPORT
(Volume I - Main Report)

FEBRUARY, 1997

CENTRAL CONSULTANT INC. (JAPAN)
IN ASSOCIATION WITH
YACHIYO ENGINEERING CO., LTD. (JAPAN)

PREFACE

In response to a request from the Government of Paraguay, the Government of Japan decided to conduct the Feasibility Study on Arterial Road Development Project in The Central Eastern Area in The Republic of Paraguay, end entrusted the study to Japan International Cooperation Agency (JICA).

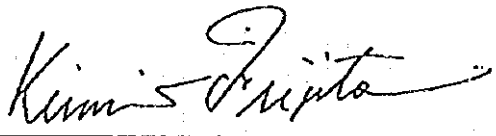
JICA sent to Paraguay a study team headed by Mr. Takashi Tachikawa of Central Consultant Inc. and composed of members form Central Consultant Inc. and Yachiyo Engineering CO.,LTD., three times between February 1996 and February 1997.

The team held discussions with the officials concerned of the Government of Paraguay, 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 Paraguay for their close cooperation extended to the Study Team.

February 1997



Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

February 1997

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

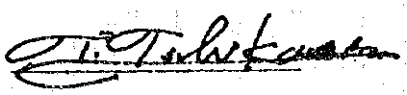
We are pleased to submit to you the Final Report for the Feasibility Study on Arterial Road Development Project in the Central Eastern Area in the Republic of Paraguay.

This study was conducted by Central Consultant Inc. as per the contract with JICA, from February 1996 to February 1997. In conducting the study, we have examined the necessity and effectiveness of the Project and completed the plan based on the actual situation of public works and road development projects in Paraguay.

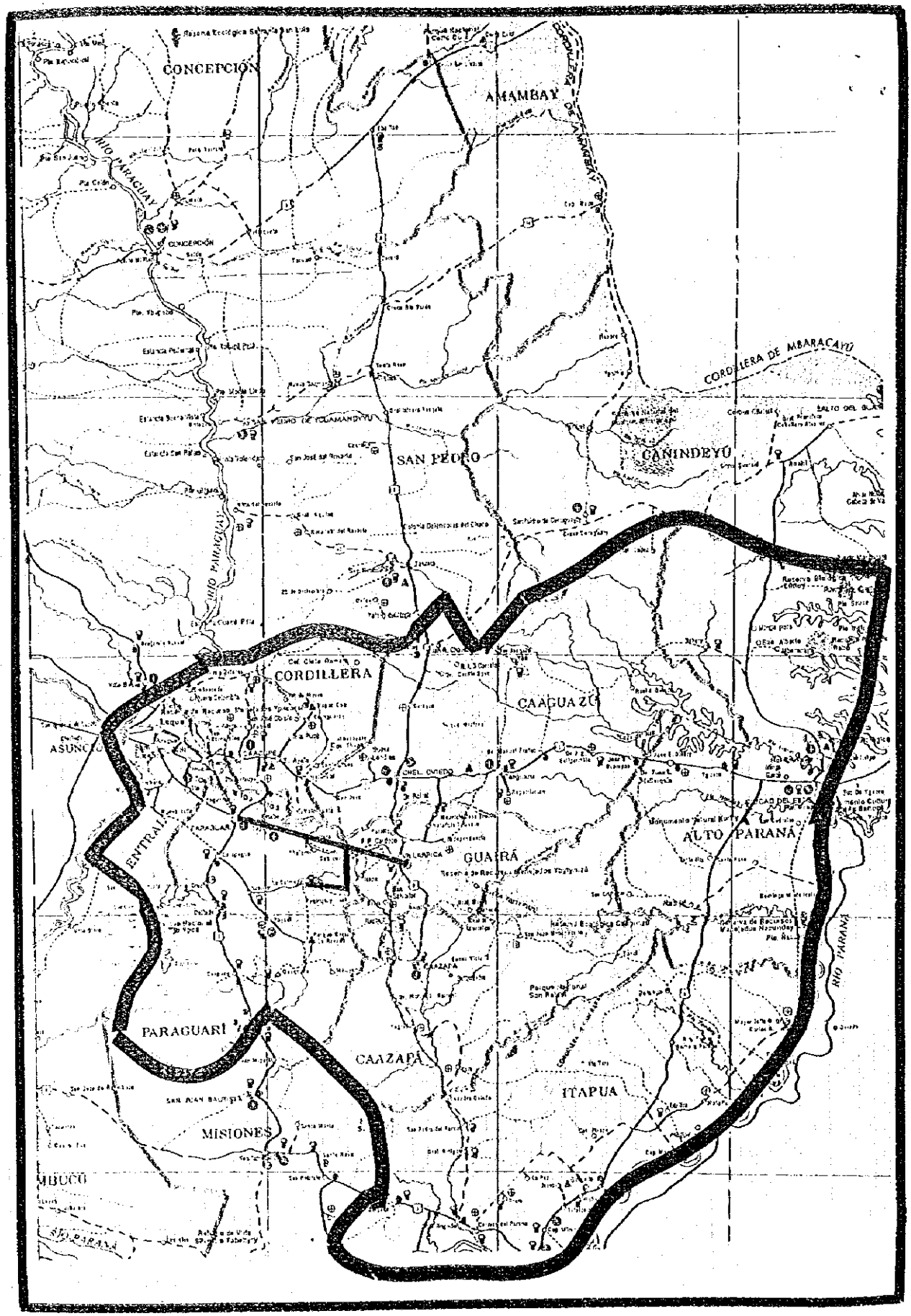
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs and other authorities. We would also like to express our gratitude to the Paraguayan officials concerned of the Study and the officials of JICA Paraguay office and the Embassy of Japan in Paraguay for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to the promotion of the project.

Truly yours,



Takashi Tachikawa
Project manager,
Study Team on the Feasibility Study on Arterial Road Development Project in the Central Eastern Area in the Republic of Paraguay
Central Consultant Inc.


CONCEPCION
AMAMBAY
RIO PARAGUAY
CORDILLERA DE MBARACAYU
SAN PEDRO
CANINDEYU
CORDILLERA
CAAGUAZU
ASUNCION
ENTRAL
GUAIRÁ
ALTO PARANÁ
PARAGUARÍ
CAAZAPÁ
ITAPUA
MISIONES
RIO PARANÁ

STUDY AREA

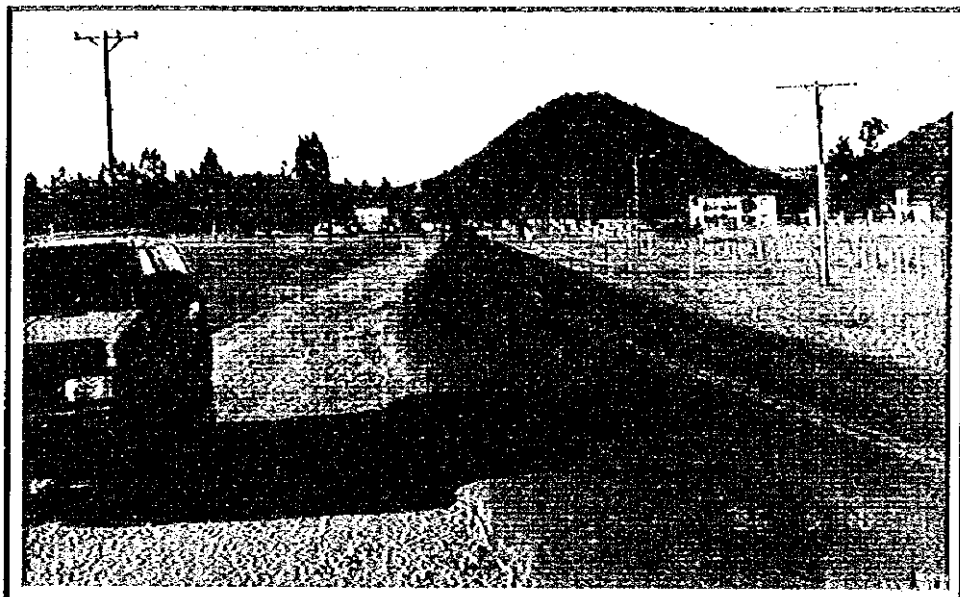


Photo-1
Junction point with Paraguarí - Piribebuy road at Paraguarí city.

Photo-2
Section between Paraguarí and Escobar.
(11km from Paraguarí)

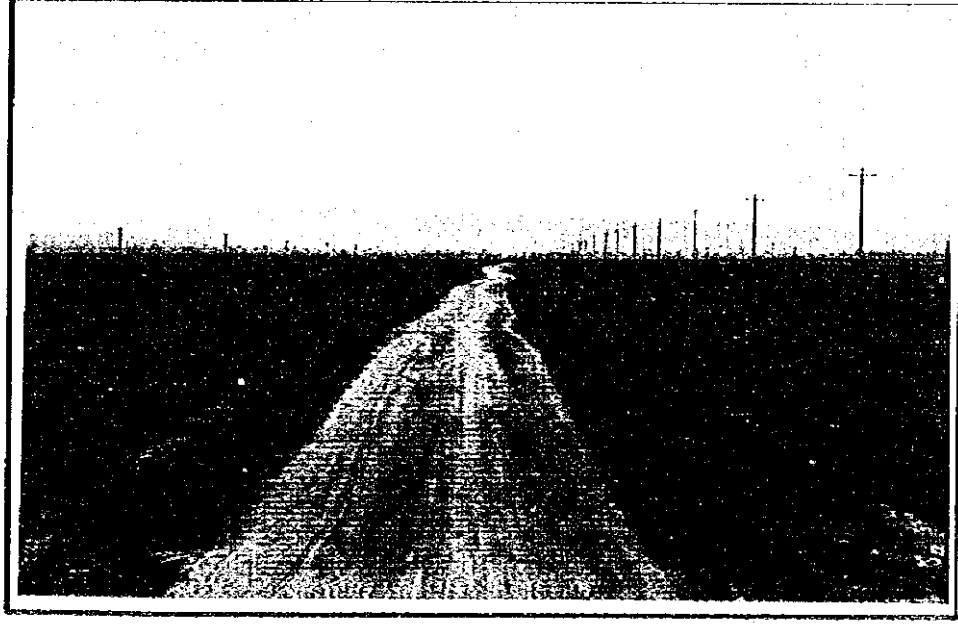


Photo-3
Section between Caballero and Ybytimi.
(41km from Paraguarí)

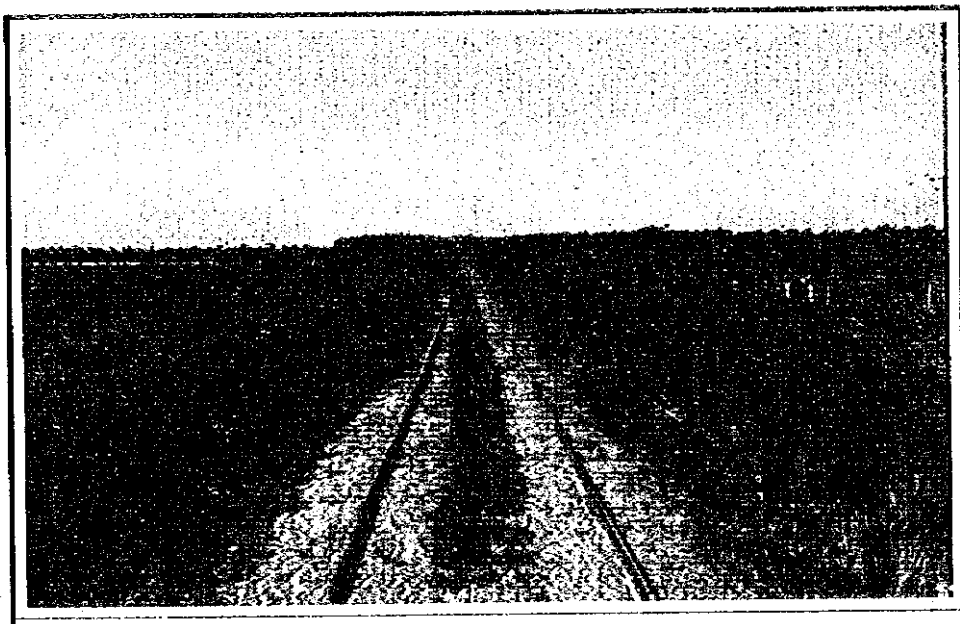


Photo-4
Railway between Yby-timi and Tebicuary.
(48km from Paraguarí)

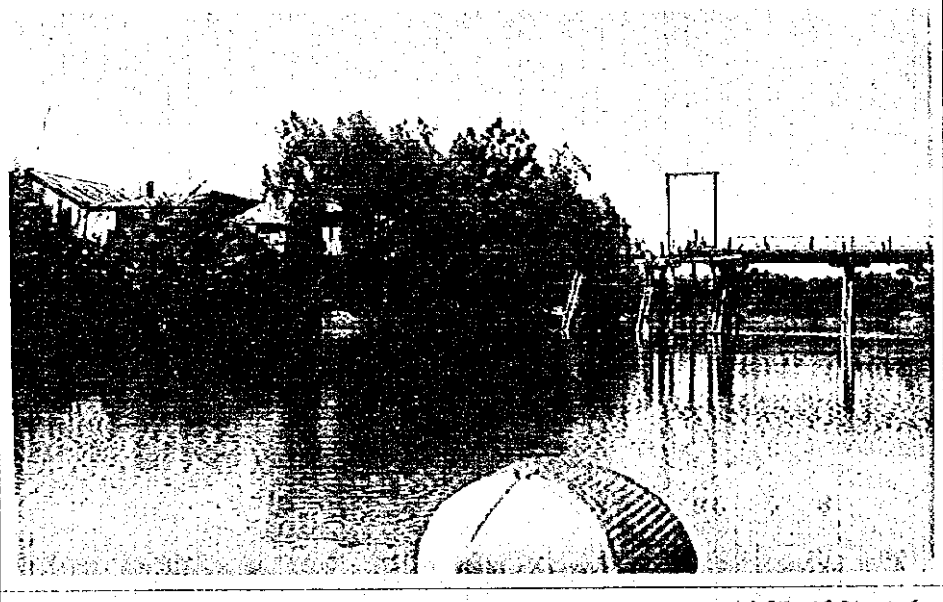


Photo-5
Existing wood bridge on Tebicuary-mi River.
(Bridge length = 70m)

Photo-6
Existing road passing through Villarrica city.

Photo-7
Junction point with Acahay - La Colmena road.

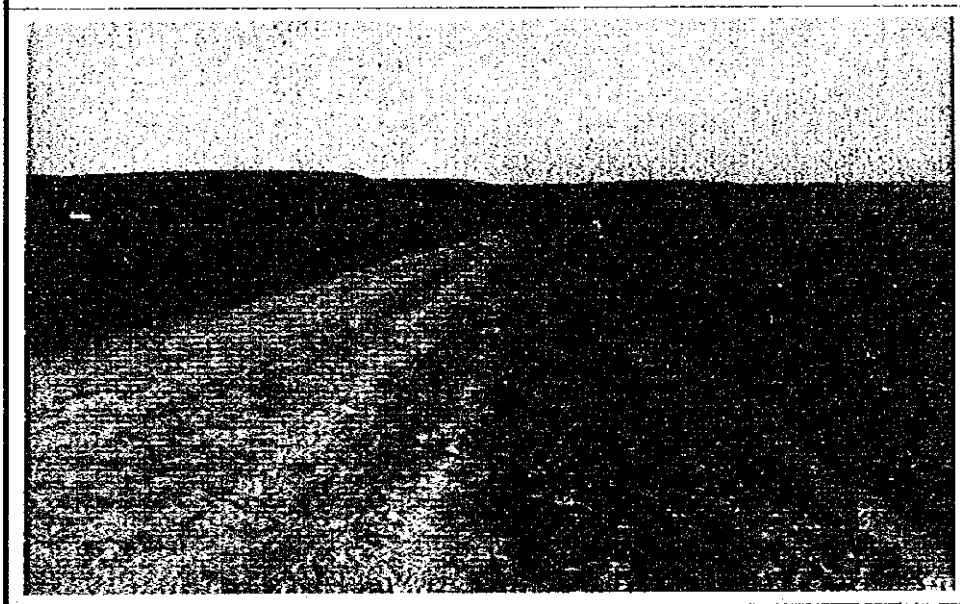


Photo-8
Section between Tebicury-mi and Tebicuary.
(20km from La Colmena)

Photo-9
Existing road near to the town of Hector Vera.

TABLE OF CONTENTS

CHAPTER 7 PRELIMINARY DESIGN AND CONSTRUCTION PLAN

CHAPTER 8 COST ESTIMATION

CHAPTER 9 ENVIRONMENTAL STUDY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway Technical Officials
ADT	Average Daily Traffic
ANDE	National Administration of Electricity
ANNP	National Administration of Navigation and Ports
Ao.	Branch river
Arq.	Architect
B/C (B-C)	Benefit and Cost
CBR	California Bearing Ratio
CDC	Conservation Data Center
CI	Inter-institutional Committee
CORPOSANA	Corporation of Sanitary Work
DGEEC	Bureau of Statistic survey and Census
DOA	Department of Environmenta Control
Dpt.	Department
Dr.	Doctor
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ESAL	Equivalent Single Axle Load
ETAE	Technical Specifications of Special Environment
ETAG	General Specifications of Environmental Mitigation
ETNA	JICA Master Plan on National Transport
FCCAL	Railway Company
F/R	Final Report
F/S	Feasibility Study
G/A (G-A)	Generation and Attraction
GDP	Gross Domestic Products
GOP	Government of Paraguay
HS	HS loading
H.W.L	High Water Level
IEE	Initial Environmental Evaluation
IBRD	International Bank for Reconstruction and Development
IC/R	Inception Report

IDB	Inter-American Development Bank
Ing.	Engineer
IRR	Internal Rate of Return
IT/R	Interim Report
IVA	Value Added Tax
JICA	Japan International Cooperation Agency
Lic.	Bachelor of Arts
MAG	Ministry of Agriculture and Livestock
MOPC	Ministry of Public Works and Communications
M/P	The Master Plan for Development of Transportation System in Paraguay
NPV	Net Present Value
OECF	Overseas Economic Cooperation Fund of Japan
O/D (O-D)	Origin and Destination
ODA	Official Development Assistance
OPIT	Office of Integral Transport Planning
PC	Prestressed Concrete
RC	Reinforced Concrete
R.O.W	Right of Way
SIAMV	Integral System of Road Maintenance Administration
S/W	Scope of Work
SENASA	Center of Public Health of the Ministry of Health
THM	Triangular Hydrograph Method
UA	Environmental Unit
UNDI	Institute of the Paraguayan Indigenous People
UNDP	United Nations Development Programme
U.S.A	United States of America
VOC	Vehicle Operating Cost

SUMMARY

SUMMARY

Background of the Study

In 1993, the Government of the Republic of Paraguay established "The Master Plan for Development of the Transportation System in Paraguay" (hereinafter, referred to as "M/P") with the technical cooperation of the Government of Japan. The M/P gave priority to the development, improvement and/or rehabilitation of national roads and rural roads selected for the purpose of promoting activity in the agricultural sector, and boosting exports.

Based on the results and recommendations in the M/P, the Government of Paraguay requested the Government of Japan to conduct a feasibility study on the development of the road between Paraguarí and Villarrica, and its branch to La Colmena. In response to this request, the Government of Japan decided to conduct a study, which was named and called hereafter "the Feasibility Study on Arterial Road Development Project in the Central Eastern Area" (hereinafter referred to as "Study"), and assigned the Japan International Cooperation Agency (hereinafter, referred to as "JICA"), the official agency responsible for the technical cooperation programs of the Government of Japan, to undertake the Study in close cooperation with the concerned authorities of the Government of Paraguay.

JICA dispatched a mission in September of 1995 to Paraguay to discuss and mutually determine the Scope of Work for the Study. The JICA study team was mobilized in Paraguay on February 25th, 1996. The Study continued until November of 1996, and the Draft Final Report were submitted to the Ministry of Public Works and Communications, the concerned body for the Study on the Paraguayan side (hereinafter referred to as "MOPC"), by the JICA's study team at the end of November. After receiving the comments of paraguayan side on the Draft, the Final Report was completed referring to them, and submitted officially to the Government of Paraguay by JICA in February, 1997.

Objectives of the Study

The objectives of the Study are to carry out a feasibility study on the construction project of the previously mentioned road (hereinafter referred to as "Project"), of which the development is expected to promote:

- to mitigate the terrible congestion of actual traffic on National Road No.2,
- to enable easy access from the area surrounding the objective road (the primary influenced area of the Project) to the main transportation centers, such as the Central Market in Asunción, the Bus Terminal, the Port of Villeta, etc.,
- to connect the locally scattered community centers in the influenced area, and
- to contribute to a more efficient agricultural development in the influenced area.

Moreover, once the Project is completed, its effects will be multiplied in relation with other road development projects which are currently under way, such as the new road construction from Asunción to Itá, financed by the World Bank, the Rural Roads Development Program, financed by the IDB (Interamerican Development Bank), and the road construction between Caazapá and Cnel. Bogado. It has the same relation with the Rehabilitation Project of National Road No. 1 between Paraguarí and San Juan Bautista, which was completed in 1995.

Outline of the Country

The Republic of Paraguay, located in the south central part of South America and encompassing 407 thousand km², has a population of 4.2 million, according to a 1992 census. Though the total population has increased at around 3% per annum since 1962, its density is low, and there is a big difference between the east and the west, divided by the Paraguay River; 25.3 and 0.4 person/km², meaning that 95% of the population lives in the Eastern region.

As Paraguay is well known as an exclusively agricultural country, 26% of GDP is shared by that sector as of 1994, and land use in the Eastern region also reflects this, consisting of 45% of farmland, 30% of land for stock farming, 15% of forest, and 10% of others.

Road transport is the essential mode of transport in the country both for passenger/goods and domestic/international, except that rivers are also used in the transport of international goods. The total road length administrated by MOPC is 24 thousand km, of which 10 thousand km are classified as primary roads; 4.8 thousand km as national roads, only 28% of primary roads being paved.

The number of motor vehicles registered in the country has increased; 323 thousand in 1994, with 67% being registered in the capital region. Traffic volume has also increased at all major points on national roads; for instance, 3,700 vehicles/day (1992) to 8,200 (1994) at Ybyraro on national road No. 1 ('94/'92 = 2.24), 5,900 to 10,700 at

Ypacarai on No. 2 (1.81) and 1,400 to 3,400 at Pastoreo on No. 7 (2.45), respectively. Under these circumstances, road development/maintenance work by MOPC has aggressively been performed over the past few years, mainly for the following purposes:

- completion of paved national road network
- improvement/rehabilitation of existing paved roads
- development of rural roads in strategically important areas
- development of an international transport corridor in light of MERCOSUR

Although it is a fact that the most part of the existing paved roads have been somewhat improved, MOPC's performance has not wholly produced sufficient benefits due to a shortage of funds. Looking at the activities of road development in recent years, more than half of the necessary funds has come from foreign sources, however, a shortage of supporting local funds has prevented planned executions.

Central Eastern Area

The central eastern area, consisting of Asunción and 10 departments, dominates the majority of the national economy; 82% of population, 77% of the net farmland for the six main crops, etc., even though it accounts for only 23% of the entire land area. The regional structure in relation with transport corridors can be conceptually summarized from three development directions, both at present and in the future, as illustrated in Figure S-1.

- Triangle Development Direction: Socioeconomic/industrial activities would be concentrated in the three urban centers, Asunción, Encarnación and Ciudad del Este, and development would stretch along the bases of the triangle and connect with each other.
- Capital-Centered Development: Development potential would spread in accordance with the distance from Asunción.
- East-West and North-South Corridors: The most intensive development would occur in an east-west direction, connecting Asunción and Este (main gateway to Brazil), and on a north-south corridor along national road No. 3 and No. 8 in light of the MERCOSUR agreement.

The major socioeconomic framework for the years 2005 and 2015, population, and the production of the six main crops, were estimated by department, taking into account past trends, previous studies, etc.

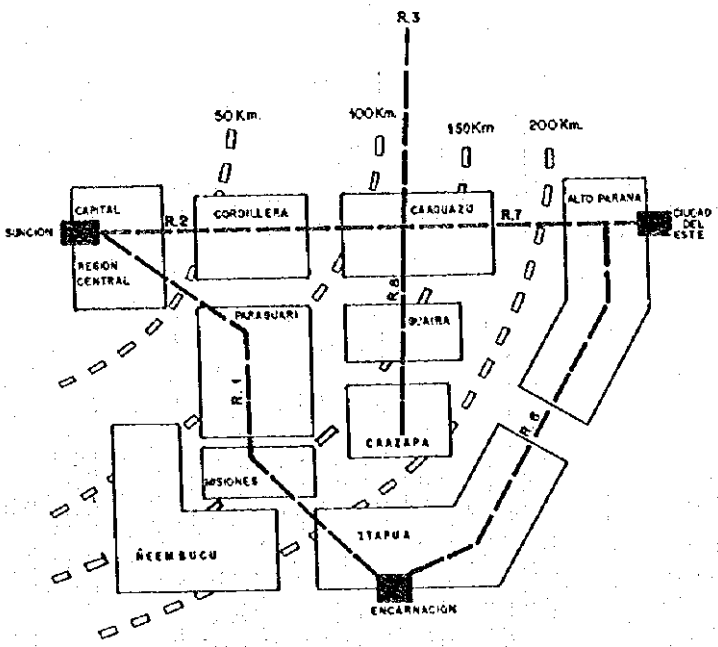


Figure S-1 Regional Structure of the Central Eastern Area

Future Potential of the Planning Area

The planning area, the secondarily influenced area of the Project if the road side area is considered the primarily influenced area, consisting of parts of each of the four departments; Cordillera, Caaguazú, Paraguarí and Guairá, is located within a 50 to 150 km radius of the center of Asunción. In other words, this area is the gate of the three development direction alternatives mentioned before.

A comprehensive study on population distribution, land use, agricultural development potential, road network, etc. was carried out, and a regional development scenario was proposed in conjunction with the road improvement framework.

- Regional road network to develop an integrated agricultural zone : The grid pattern of a road network composed of two east-west routes (Paraguarí - Villarrica & Carapeguá - La Colmena - Itrube - national road No.8) and two north-south routes (Itacurubi - La

Colmena & San José - Tebicuary - Tebicuary-mí - Iturbe), connecting to the national trunk network on the fringe of the planning area.

- Road network for agricultural development: Road development to encourage the three major agricultural activities.
  i) Urban-market-oriented farming, and farming for food processing
  ii) Sugar cane farming and processing
  iii) Agro-linkage farming/processing between La Colmena and Iturbe
- Adequate services to regional communities:

These development scenarios were established in the light of the MERCOSUR agreement. In other words, they show the direction of future development of the region under the MERCOSUR system.

Moreover, these scenarios were finally reflected both in the future socioeconomic framework for traffic demand forecast, and in the proposed road network structure.

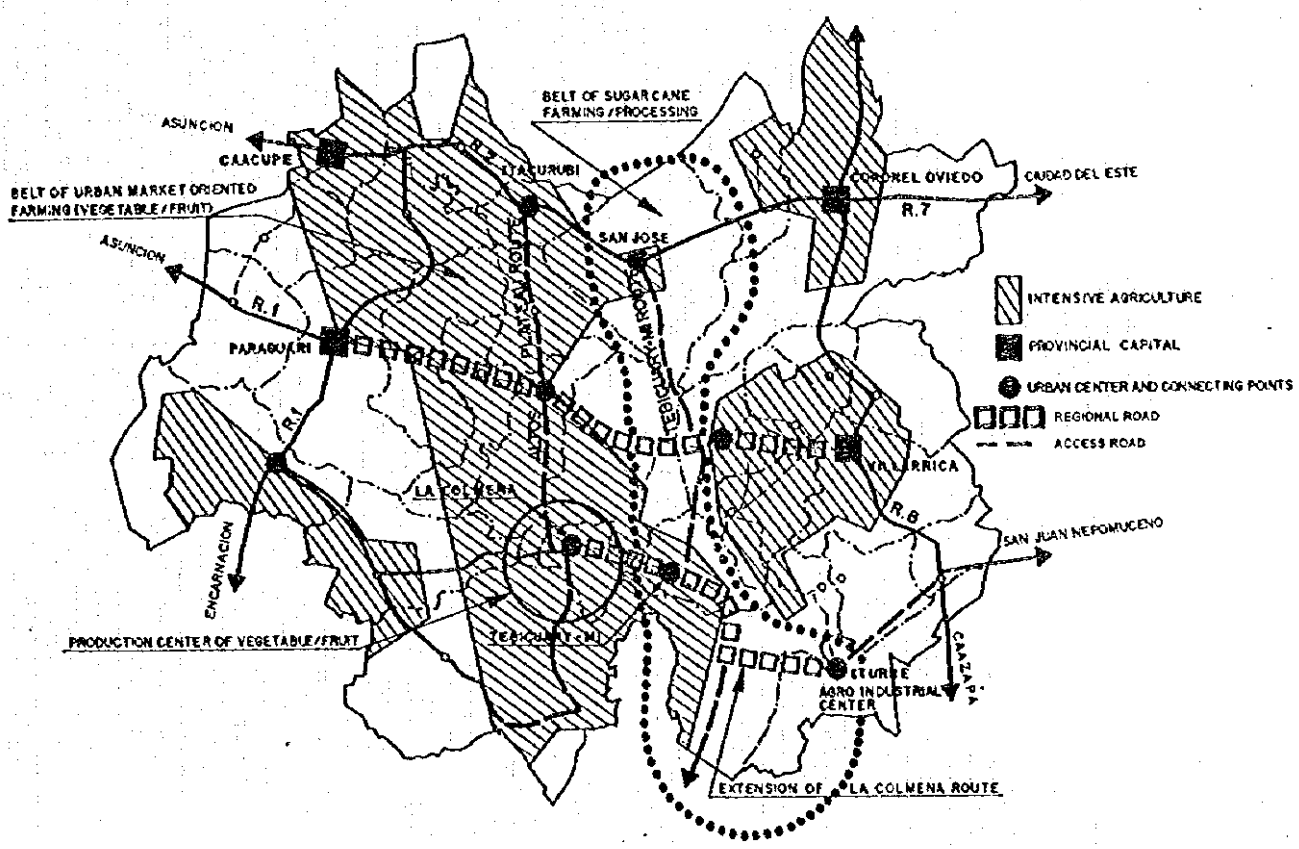


Figure S-2 Proposed Future Road Network Structure

Traffic Demand Forecast

Future traffic demand on the proposed road sections, for the years 2005 and 2015, was estimated through a vehicle Origin-Destination (O-D) forecast based on the overall regional/national development and the traffic assignment to the proposed network.

Future traffic volume along the proposed roads in 2005 and 2015 are estimated by the traffic assignment based on future O-D tables and future road networks. The future road network in 2005 is formulated based on the present road network adding the proposed road sections between Paraguarí and Villarrica, and an access route to/from La Colmena. Another future road network in 2015 is based on the ETNA Master Plan road network, which includes the proposed routes.

The traffic forecast results revealed a demand of 1,400 - 2,400 vehicles per day in 2005 between the Paraguarí and Villarrica sections, of which 60 -70% was traffic diverted from existing national roads Nos. 1, 2, and 8. On the other hand, 250 vehicles per day was estimated for the section between Tebicuary and La Colmena, as a result of encouraged regional development along the road, and this volume amounted to four to ten times the existing traffic volume.

Table S-1 Traffic Volume Forecast by Section

(Unit : vehicle/day)

Route/Section	Length (km)	Passenger Car			Bus			Truck			Total		
		1996	2005	2015	1996	2005	2015	1996	2005	2015	1996	2005	2015
I. Paraguarí-Villarrica													
1) Paraguarí-Escobar	14.0	248	1,206	1,692	39	216	416	125	950	1,454	412	2,372	3,562
2) Escobar-Sapucai	9.0	159	1,104	1,638	25	209	436	64	843	1,362	248	2,156	3,436
3) Sapucai-Caballero	10.0	61	948	1,518	13	174	411	20	782	1,301	94	1,904	3,230
4) Caballero-Ybytymí	9.0	2	785	1,355	0	153	395	2	747	1,260	4	1,685	3,010
5) Ybytymí-Tebicuary	16.0	6	699	1,284	0	110	369	3	673	1,196	9	1,482	2,849
6) Tebicuary-Cnl.Martínez	4.0	43	830	1,231	7	193	462	30	693	1,033	80	1,716	2,726
7) Cnl.Martínez-Félix P.Cardozo	10.0	105	655	1,182	7	120	414	32	592	1,018	144	1,367	2,614
8) Félix P.Cardozo-Villarrica	11.0	231	661	1,169	7	120	414	53	608	1,029	291	1,389	2,612
II. Tebicuary - La Colmena													
9) Tebicuary-Tebicuary-mí	20.0	41	159	49	7	83	323	12	20	209	60	262	941
10) Tebicuary-mí-La Colmena	18.1	19	142	167	1	81	242	3	21	118	23	244	527

Basic Engineering Study

(1) Design Standards

Although there are no authorized design codes for road construction nor bridge construction in Paraguay, the Directorate of Road of MOPC has a draft of them, which has practically been used for other road construction projects in these years. The Environmental Unit of MOPC also has a specifications for road construction works.

The design standards for this Study were determined by referring to both the draft design

codes and the specifications as shown in Table S-2.

At the same time, a typical cross section of the Project roads was also proposed as shown in Figure S-3.

Table S-2 Geometric Design Criteria for the Study Road

Geometric Criterion	Value	
	Flat Land	Hilly Land
Road classification	I-b(2lanes,>1400v./day	
Design vehicle	SR (Semi-trailer)*1	
Design speed	100km/h	80km/h *2
Stopping sight distance	>210 m	>140 m
Passing sight distance	>680 m	>560 m
Radius of horizontal alignment	>375 m	>230 m
Grade for vertical alignment	<3 %	<4.5 %
Superelevation rates	<8%	
Normal cross slope	2%	
Lane width	2×3.5 m=7.0 m	
Shoulder width	2×2.5 m	
Total width of the road cross section	>12.0 m	
Gradient of embankment slope	1:4 (h<2 m), 1:2(h>2 m)	
Gradient of cut slope	1:2 (soil), 1:1(rock)	
Standard Width of Right of Way	40 m (Paraguarí - Villarrica) 30 m (Branch to La Colmena) *3	

Note - *1 : "Norma" specifies 4 types of vehicles: passenger car, conventional truck, truck, and semi-trailer. The dimensions of the semi-trailer, which is the biggest and most important vehicle for road design are also defined as follows:
- total width = 2.6 m
- total length = 16.8 m
- min. radius of the outside front wheel when turning = 13.7 m
- min. radius of the inside back wheel when turning = 6.0 m

*2 : A design speed of 60km/h can be applied in some special and limited sections as exceptional cases.

*3 : The width of the "Right of Way" could be reduced in urban areas or in special limited areas.

*4 : When other criteria must be required to determine, the standards of the United States and Japan may be adopted.

*5 : In the branch section toward La Colmena, where the future traffic demand will be less than 1,400 vehicles per day, the geometric criteria described in this table should be adopted; however, this diminished traffic demand should be taken into account in the pavement structure determination.

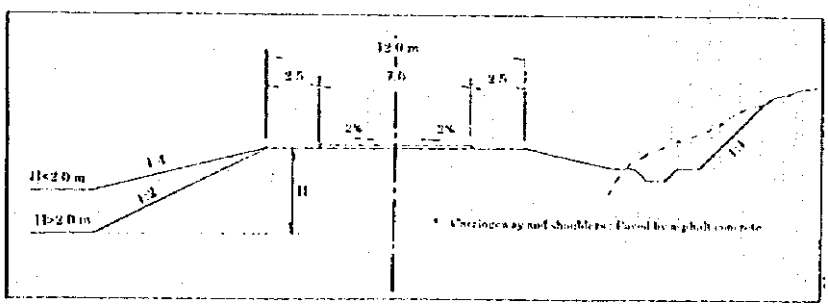


Figure S-3 Typical Cross Section of the Study Road

(2) Hydrographical Analysis

Based on existing data, such as the water level observation records of Rfo Tebicuary-mf at Tebicuary, rainfall records, and the results of a topographic survey performed in this Study, a hydrological analysis at 14 river-crossing points along the objective road were carried out, and of these seven principal river points were selected to calculate the Design High Water Level (H.W.L.), which was reflected at the design formation height of the road and bridge. The results are shown in Table S-3 below.

Table S-3 Design High Water Level at the Principal River Sites

River Name	Design H.W.L	Discharge Capacity	Dischrge (Q) by Rational	Dischrge (Q) by T.H.M.	Hydraulic Conditions and Remarks
Arroyo Tulio	El. 121.5	55	49	55	
Arroyo Tororo	El. 138.2	150	106	148	
Arroyo Pirayuvy	El. 138.5	142	108	138	
Arroyo Pachóng	El. 141.9	52	38	51	The discharge capacity of railway structure is checked.
Arroyo Caundy	El. 118.5	64	45	64	
Río Tebicuary-mí	El. 106.5	1,190 (**)	1,500	1,821	The water level is regulated by the flood plain storage. The experienced maximum water level was El. 106.5 m on the flood of 1983 and 1994.
Arroyo Tebicuary-mí (upstream)	El. 119.3 (*)	102 (***)	269	354 (*)	The flood plain exists in the upstream 2.5 km of the bridge site. Inundation W.L by the interview was 0.2 m below the bridge surface during the flood in November 1994.
Arroyo Tebicuary-mí (Existing Bailey bridge site)	El. 107.2 (*)	328 (***)	280	358 (*)	The discharge is regulated by 2 flood plains in the upstream of the bridge site. The water level rises up by back water of Río Tebicuary -mí. Based on the interview, the flood water level during the flood in 1994 was El. 107.2 m below the existing Bailey bridge.

Note : * El. 119.3 and El.107.2 of experienced maximum W.L are adopted as D.H.W.L
** reduced by flood plain
*** Q will be more reduced by flood plain

(3) Possible Borrow Pits and Quarry Sites

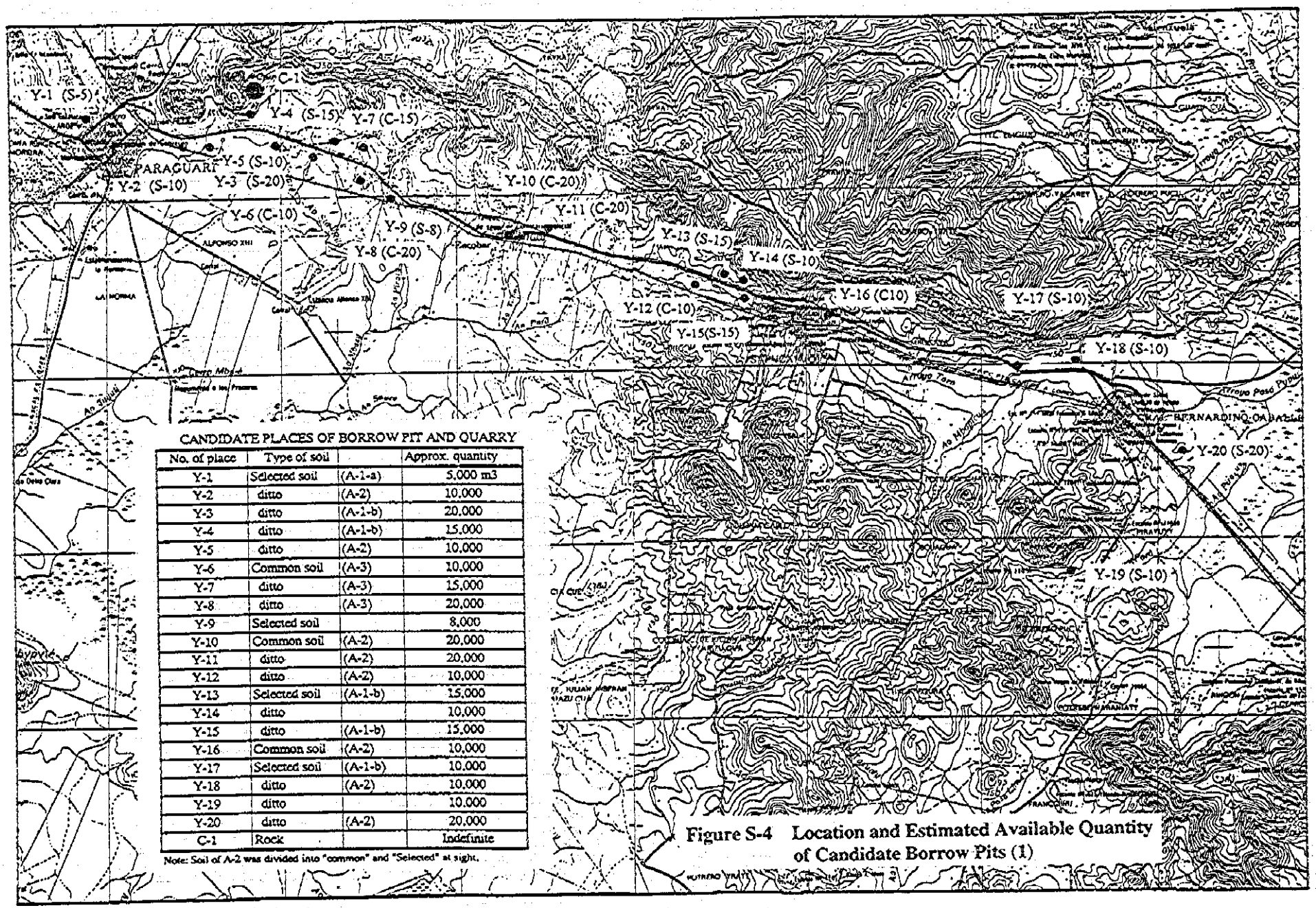
As it is apparent that it will be impossible to complete the required earthwork by using the "side borrow pit system" for every segment of the study road, some borrow pits outside of the right of way will be required along the road to obtain material for embankment.

On this understanding, more than 50 candidate places of borrow pit for embankment soil were preliminarily investigated in the Study. The result is summarized in Figure S-4.

By this investigation, it was confirmed that required volume of soil with required quality for embankment, including subgrade, could possibly be obtained in the vicinity of the project road.

Several candidate places of quarry site are also indicated in Figure S-4. It was considered that those places could sufficiently supply necessary quantity of rock material with

specified characteristics, however, in order to verify the quality, more detailed laboratory

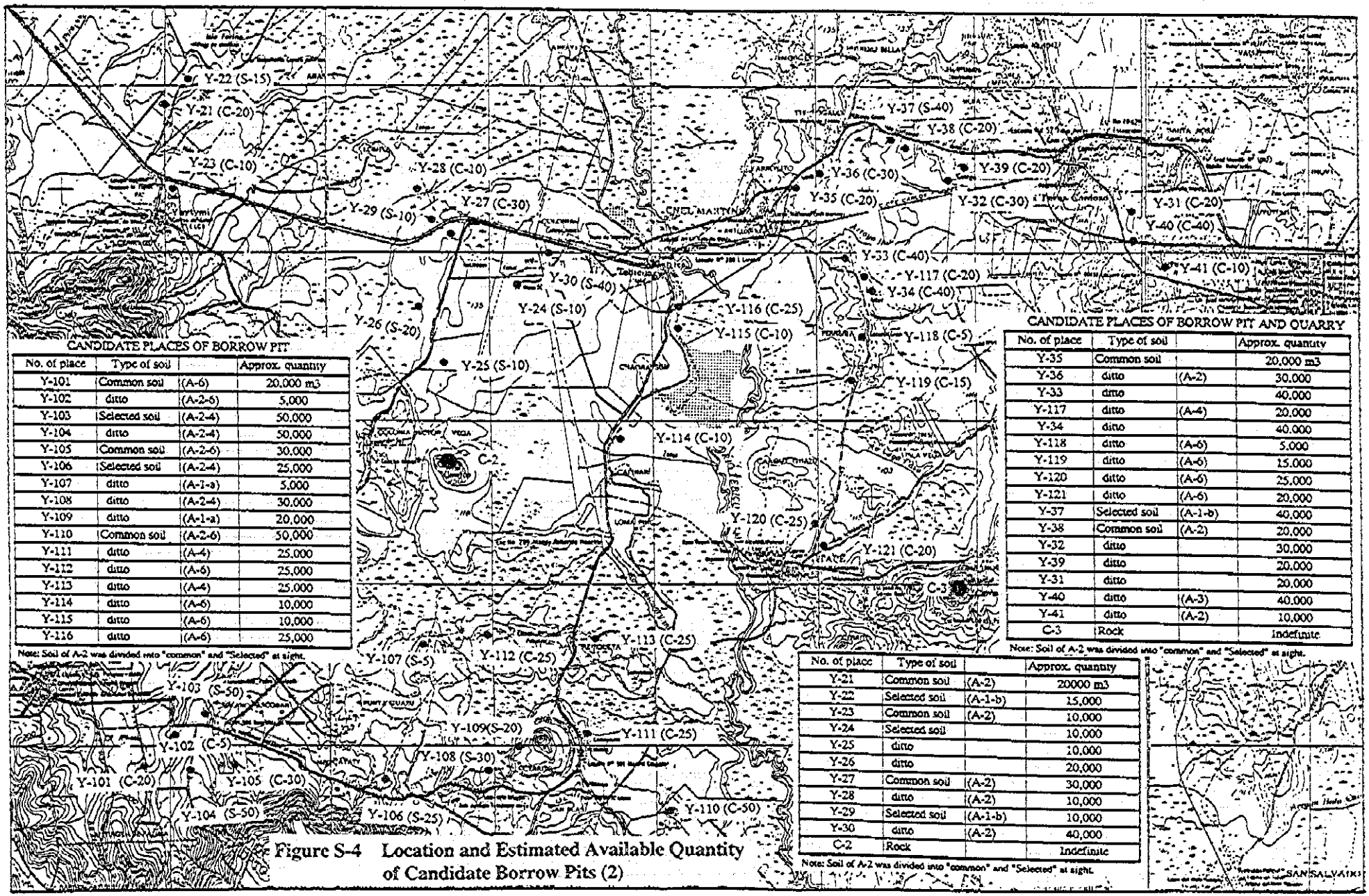


CANDIDATE PLACES OF BORROW PIT AND QUARRY

No. of place	Type of soil		Approx. quantity
Y-1	Selected soil	(A-1-a)	5,000 m3
Y-2	ditto	(A-2)	10,000
Y-3	ditto	(A-1-b)	20,000
Y-4	ditto	(A-1-b)	15,000
Y-5	ditto	(A-2)	10,000
Y-6	Common soil	(A-3)	10,000
Y-7	ditto	(A-3)	15,000
Y-8	ditto	(A-3)	20,000
Y-9	Selected soil		8,000
Y-10	Common soil	(A-2)	20,000
Y-11	ditto	(A-2)	20,000
Y-12	ditto	(A-2)	10,000
Y-13	Selected soil	(A-1-b)	15,000
Y-14	ditto		10,000
Y-15	ditto	(A-1-b)	15,000
Y-16	Common soil	(A-2)	10,000
Y-17	Selected soil	(A-1-b)	10,000
Y-18	ditto	(A-2)	10,000
Y-19	ditto		10,000
Y-20	ditto	(A-2)	20,000
C-1	Rock		Indefinite

Note: Soil of A-2 was divided into "common" and "Selected" at sight.

Figure S-4 Location and Estimated Available Quantity of Candidate Borrow Pits (1)



CANDIDATE PLACES OF BORROW PIT

No. of place	Type of soil		Approx. quantity
Y-101	Common soil	(A-6)	20,000 m3
Y-102	ditto	(A-2-6)	5,000
Y-103	Selected soil	(A-2-4)	50,000
Y-104	ditto	(A-2-4)	50,000
Y-105	Common soil	(A-2-6)	30,000
Y-106	Selected soil	(A-2-4)	25,000
Y-107	ditto	(A-1-a)	5,000
Y-108	ditto	(A-2-4)	30,000
Y-109	ditto	(A-1-a)	20,000
Y-110	Common soil	(A-2-6)	50,000
Y-111	ditto	(A-4)	25,000
Y-112	ditto	(A-6)	25,000
Y-113	ditto	(A-4)	25,000
Y-114	ditto	(A-6)	10,000
Y-115	ditto	(A-6)	10,000
Y-116	ditto	(A-6)	25,000

Note: Soil of A-2 was divided into "common" and "Selected" at sight.

CANDIDATE PLACES OF BORROW PIT AND QUARRY

No. of place	Type of soil		Approx. quantity
Y-35	Common soil		20,000 m3
Y-36	ditto	(A-2)	30,000
Y-33	ditto		40,000
Y-117	ditto	(A-4)	20,000
Y-34	ditto		40,000
Y-118	ditto	(A-6)	5,000
Y-119	ditto	(A-6)	15,000
Y-120	ditto	(A-6)	25,000
Y-121	ditto	(A-6)	20,000
Y-37	Selected soil	(A-1-b)	40,000
Y-38	Common soil	(A-2)	20,000
Y-32	ditto		30,000
Y-39	ditto		20,000
Y-31	ditto		20,000
Y-40	ditto	(A-3)	40,000
Y-41	ditto	(A-2)	10,000
C-3	Rock		Indefinite

Note: Soil of A-2 was divided into "common" and "Selected" at sight.

No. of place	Type of soil		Approx. quantity
Y-21	Common soil	(A-2)	20000 m3
Y-22	Selected soil	(A-1-b)	15,000
Y-23	Common soil	(A-2)	10,000
Y-24	Selected soil		10,000
Y-25	ditto		10,000
Y-26	ditto		20,000
Y-27	Common soil	(A-2)	30,000
Y-28	ditto	(A-2)	10,000
Y-29	Selected soil	(A-1-b)	10,000
Y-30	ditto	(A-2)	40,000
C-2	Rock		Indefinite

Note: Soil of A-2 was divided into "common" and "Selected" at sight.

Figure S-4 Location and Estimated Available Quantity of Candidate Borrow Pits (2)

S-11

tests on the material from "Cerro Santo Thomas (C-1)" were recommended to carry out in the final design stage. The characteristics of materials from those candidate quarry sites known in the Study are shown in Table S-4.

Table S-4 Principal Characteristics of the Rock Materials

Quarry site	Cerro Santo Tomás at Paraguarí (C1)	Hector Vera (C2)	Cerro Itapé (C3)
Rock type	Granite	Basalt family	Basalt
Present condition	Exploited	Not exploited	Not exploited
Available quantity	Indefinite	Unknown	Indefinite
Abrasion	(A) : 19.0% (B) : 18.9%	Unknown	(B) : 16% * (C) : 19% *
Absorption	0.07%	Unknown	
Specific Gravity	2.84 gs/cm³	Unknown	
CBR	128 (soaked) 170 (unsoaked)	Unknown	
Observation	• Rock material is white gray granite, heavy and hard. • Abrasion is limited in the range complying with the specifications for pavement material. • Further tests of this rock in the final design stage are recommended. • Quarry is now being exploited by hand chisels and hammers .	• Rock looks to be a kind of basalt with a reddish color, fairly breakable and not adequate for base and surface course material. • It is worth studying in detail in the final design stage to evaluate if useful for sub-base.	• Rock material is a black and heavy basalt. • It looks to be good material for the pavement structure.

Note : 1) * : Those data were obtained in the study of Plan Triánglo in 1977.
2) A, B and C in the abrasion test indicate the gradation of specimen according to AASHTO.
3) The results of the tests conducted in this study on C1 material are included in Annex D.
4) The material of the CBR test is a composite material: (crushed stone: sand: A-2-4)=82:8:10. The value corresponds to 100% density of the Proctor test.

(4) Comparative Study of Pavement Structure

Pavement structure was studied according to the design method stipulated in the "AASHTO - Guide for the Design of Pavement Structure (1986)" in both cases of flexible and rigid pavement. Then, the accumulated cost required for the period of 25 years from the initial development were compared to determine which structure should be applied.

It was assumed in this comparison that the initial flexible pavement structure would stand for ten (10) years from the commencement of use of the developed roads, then an overlay would be required for the next 15 years, while the rigid pavement would endure for 25 years without any additional investment.

The comparison results shown in Table S-5 indicated that a flexible pavement structure with an asphalt concrete surface layer was considerably more advantageous, and therefore, it was applied in this Study.

Table S-5 Cost Comparison of Rigid and Flexible Pavement

Rigid Pavement

	Assumed	Parag.- R/Teb.(58.5km)		R/Teb.-Villarrica(24.5km)		La Colmena-Teb.(38.1km)		Total(121.1km)
	Price ($/m3)	Thick(cm)	1,000$	Thick(cm)	1,000$	Thick(cm)	1,000$	1,000 $
Cement Concrete	135	28	15,479	28	6,483	23	8,281	30,243
Subbase	40.4	16	2,647	16	1,109	16	1,724	5,480
Total (1,000$)=R			18,126		7,591		10,005	35,722
Flexible Pavement								
Asphalt Concrete	119.6	14	6,857	14	2,872	12	3,828	13,556
Base	40.4	15	2,482	15	1,039	15	1,616	5,137
Subbase	40.4	15	2,482	25	1,732	15	1,616	5,830
Prime Coat	581	0.15	357	0.15	149	0.15	232	739
Sub-total (1,000$)=A			12,177		5,792		7,293	25,262
Overlay (A/C)=B	119.6	8	3,918	11	2,256	8	2,552	8,726
discounted B=C	8 % x 9years		1,960		1,129		1,276	4,365
Total (1,000$)=F=A+C			14,137		6,921		8,569	29,627
Difference of Cost R - F (1,000$)			3,990		670		1,436	6,096

(5) Comparative Study on Structure Type of the Bridge on Rfo Tebicuary-mi

The hydrological study revealed that construction of a bridge with a length of 215 meters on Rfo Tebicuary-mi, which is the biggest river crossing the study road would be necessary.

The six structure types of the bridge shown in Table S-6 were compared to find the most adequate one. As the result, the 1st alternative, i.e., (Metal truss + 5 continuing spans of PC composite girder), was the most recommendable type among the six types considered. More detailed comparison results are described in Table 6.4.22.

Table S-6 Comparison of Alternative Bridge Types

Type	Type of Superstructure	Construction Method	Span & Length(m)	Relative Cost
1st.	Metal Truss+	Cable erection	85+	1.00
	5 span PC composite girder	Fixed timbering	5 @ 26=215	
2nd	2 span PC-T rigid frame box	Cantilever erect.	2 @ 42.5+	1.17
	5 span PC composite girder	Fixed timbering	5 @ 26=215	
3rd	Metal 2 span continuous plate	Fixed timbering	2 @ 42.5+	1.08
	5 span PC composite girder		5 @ 26=215	
4th	3 span PC continuous box	Cantilever erect.	3 @ 72=216	1.66
5th	4 span PC continuous box	Push out erection	4 @ 54=216	1.46
6th	7 span PC composite girder	Fixed timbering	7 @ 31=217	1.10

(6) Alternative Routes of the Road and Selection of the Optimum Route

In the following sections, two or three alternative road routes were selected and evaluated:

- urban area of Sapucaf
- urban area of Caballero
- between Ybytymf and Tebicuary

- between Tebicuary and C. Martínez (crossing Río Tebicuary-mí)
- between F. P. Cardozo and Villarrica
- between La Colmena and Tebicuary

The optimum route was determined on the basis of various factors, such as construction costs, area of land to be acquired, geometric features of route, difficulty of construction, function in the road network in relation to regional development, impact on the social and natural environments, etc.

The evaluated alternative routes and comparison results for the major 4 sections among above-described 6 sections are shown in Figures S-5～S-8 and Tables S-7～S-10, respectively.

The route selected as a result of this evaluation of the alternatives is shown in Figure 6.4.9, in Volume I of this Report. The total length of the objective roads along the selected route is summarized in Table S-11. In order to terminate the project implementation in the practically appropriate period, it was recommended to divide the route into 3 sections as shown in Table S-10 and to construct them individually.

Table S-11 Length of the Road by Segment

Segment	From - To -	Distance
Section 1 : Paraguarí - Rio Tebicuary-mí (58.5 km)		
1	Paraguarí - Sapucaí	L= 22.5km
2	Sapucaí - Caballero	L= 10.5km
3	Caballero - Ybytymí	L= 9.0km
4	Ybytymí - Punto Unido	L= 10.0km
5	Puto Unido - Río Tebicuary-mí	L= 6.5km
Section 2 : Río Tebicuary-mí - Villarrica (24.5 km)		
6	Rio Tebicuary-mí - Martínez	L= 4.5km
7	Martínez - Cardozo	L= 8.0km
8	Cardozo - Villarrica	L= 12.0km
Section 3 : Branch to La Colmena (38.1 km)		
9	La Colmena - Sta.126+100	L= 25.3km
10	Sta.126+100 - Sta.138+100	L= 2.4km
11	Sta.138+100 - Tebicuary	L= 10.4km
Total		L=121.1km

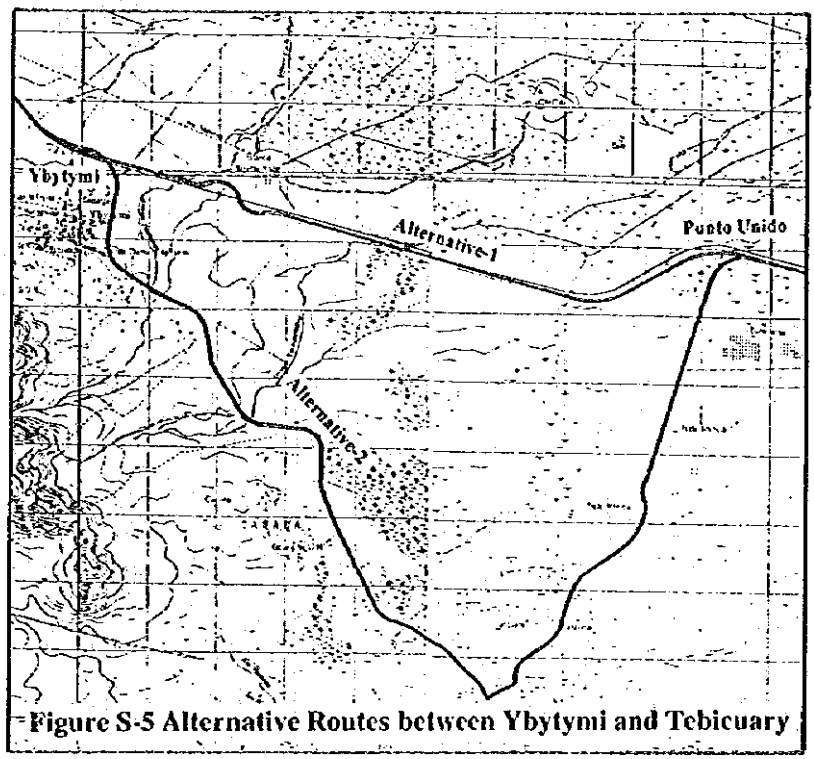


Figure S-5 Alternative Routes between Ybytymi and Tebicuary

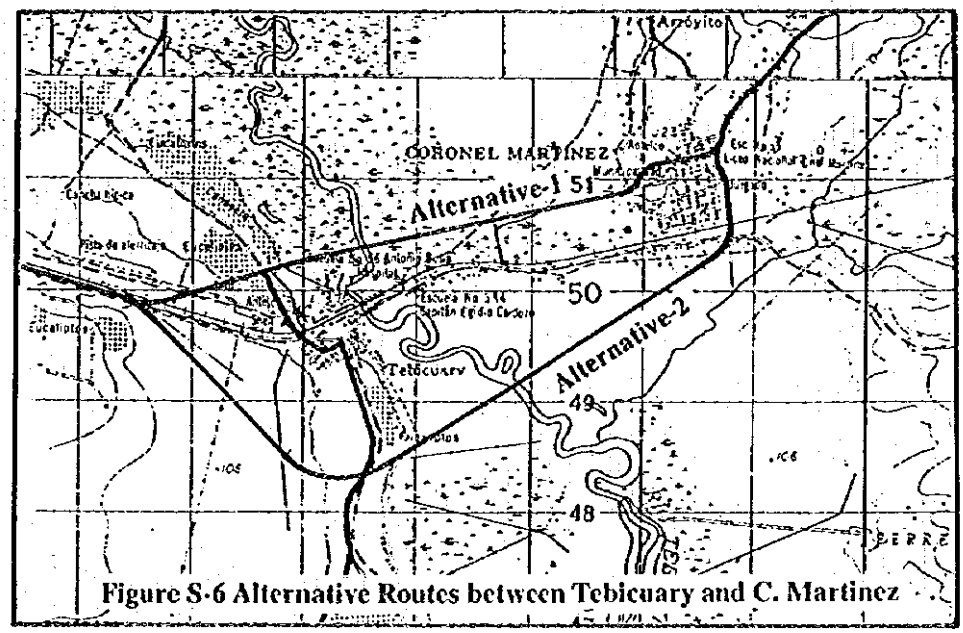


Figure S-6 Alternative Routes between Tebicuary and C. Martinez

Table S-7 Comparison of Alternative Routes between Ybytymi and Tebicuary

Items for Comparison	Route: Ybytimi - Punto Unido Alternative - 1 (Short Cut Route)	Alternative - 2 (Route Along Existing Road)	Comparison 1	Comparison 2
1. Planning Policy	-Short cut parallel to the railway	-Maximum use of the existing road		
2. Total length	10.3 km	18.7 km		
3.Forecast Traffic Vol. (2015)	2,849 vehicles/day	2,076 vehicles/day		
4.Principal Work Items & Volume	1) Road -Earth Works 142,800 m3 -Pavement 72,100 m2 2)Bridge (total length) -RC 18.0 m -PC 53.0 m -at Tebicuary	1) Road -Earth Works 133,600 m3 -Pavement 188,490 m2 2)Bridge (total length) -RC 12.0 m -PC 18.0 m -Tebicuary		
5.Total Construction Cost	1.00	1.46	++	
6.Construction Cost (cost/km)	1.00	0.80		+
7. Land Acquisition	length (m) / width (m) / area(ha)	length (m) / width (m) / area(ha)		
-Side expantion	0 / / 0.0	16,200 / 20 / 32.4		
-New acquisition	10,300 / 40 / 41.2	2,500 / 40 / 10.0		
Total	10,300 / / 41.2	18,700 / / 42.4		
8. Geometric Design 1)Horizontal Curve 2)Max.vertical grade	(R > 300.0m) x 6 curves i = 0.80 %	(R > 300.0m) x 21 curves i= 4.45 % (280.0 m long)	+	
9. Running performance	-Very flat -Saving 6 minutes of travelling time compared with Alternative	-Steep slopes -More travelling time than Alternative 1	+ +	
10. Difficulties of construction	-No detour route is required for the present traffic -Necessary to take special measures for low land areas	-Necessary to build a temporary bridge and detour. for the present traffic	++	
11. Connection with surrounding road network	-Separated from existing roads -No service to Hector L. Vera area	-Maintain the present service area		+
12. Impact on socio-economic environment	-Negative impact on Hector L. Vera area -Possibility of agricultural dev't in the new road side area	-Promotion of rural development in the Hector Vera area		+
13. Impact on natural environment	-Impacts of embankment in the low land areas -Risk of inudation over railway (partial section)	-Deforesting, but on a small scale	-	-
14. General opinion of local communities	-Objection (by the inhabitants of Hector L .Vera	-Preferred (by the inhabitants of Hector L. Vera		+
Comprehensive Evaluation	O	X		

Table S-8 Comparison of Alternative Routes between Tebicuary and Martinez

Route:	Tebicuary - Mrtinez									
Items for Comparison	Alternative - 1 (Northern route)				Alternative - 2 (Southern route)				Comparison	
1. Planning Policy	-Point with stable river bank & smooth flow in the upperstream				-Point with stable river bank & smooth flow downstream					
2. Total length	7.0 km				8.8 km				1	2
3.Forecast Traffic Vol. (2015)	2,726 vehicles/day				2,726 vehicles/day					
4.Principal Work Items & Volume	1) Road		2)Bridge (total length)		1) Road		2)Bridge (total length)			
	-Earth Works	143,000 m3	-RC	0.0m	-Earth Works	180,100 m3	-RC	0.0 m		
	-Pavement	49,000 m2	-PC	214.0m	-Pavement	61,600 m2	-PC	220.0 m		
			-Tebicuary	85.0m			-Tebicuary	85.0 m		
5.Total Construction Cost	1.00				1.17				++	
6.Construction Cost (cost/km)	1.00				0.93					+
7. Land Acquisition	length (m)	width (m)	area(ha)		length (m)	width (m)	area(ha)			
-Side expantion	0		0		0		0			
-New acquisition	7,000	40	28.0		8,800	40	35.2			
Total			28.0				35.2		+	
8. Geometric Design 1)Horizontal Curve 2)Max.vertical grade	(R > 400.0 m) x 5 curves i = 4.367 % (300.0 m long)				(R > 500.0 m) x 5 curves i = 3.475 %					+
9. Running performance	-Steeper slope, but smooth horizontal alignment -Less traveling time than Alternative - 2				-Less steep slope -More travelling time than Alternative - 1				+	
10. Difficulties of construction	-Access to bridge site (right bank=0.9km left=0.6km) -Construction length in low land areas : 2.75km -Need for clearance of dense woods in low lands (right)				-Longer access to bridge site (right =1.7km left=1.5km) -Longer length in low land area : 3.15km				+ -	
11. Connection with surrounding road network	-Better connection with the trunk road to San Jose -Bad connection with branch section to La Colmena				-Far from the existing road -Better connection with the branch section to La Colmena					
12. Impact on socio-economic environment	-Negative impact on existing shops (better than alternative 2)				-Negative impact on existing shops				-	-
13. Impact on natural environment	-Need to deforest gallery woods along river -Impact of embankment in low land areas				-Need to deforest gallery woods along river -Risk of inundation of the existing town by bridge const. -Impact on embankment in low land areas				+	
14. General opinion of local communities	-No objection				-No objection				+	+
Comprehensive Evaluation	O				X					

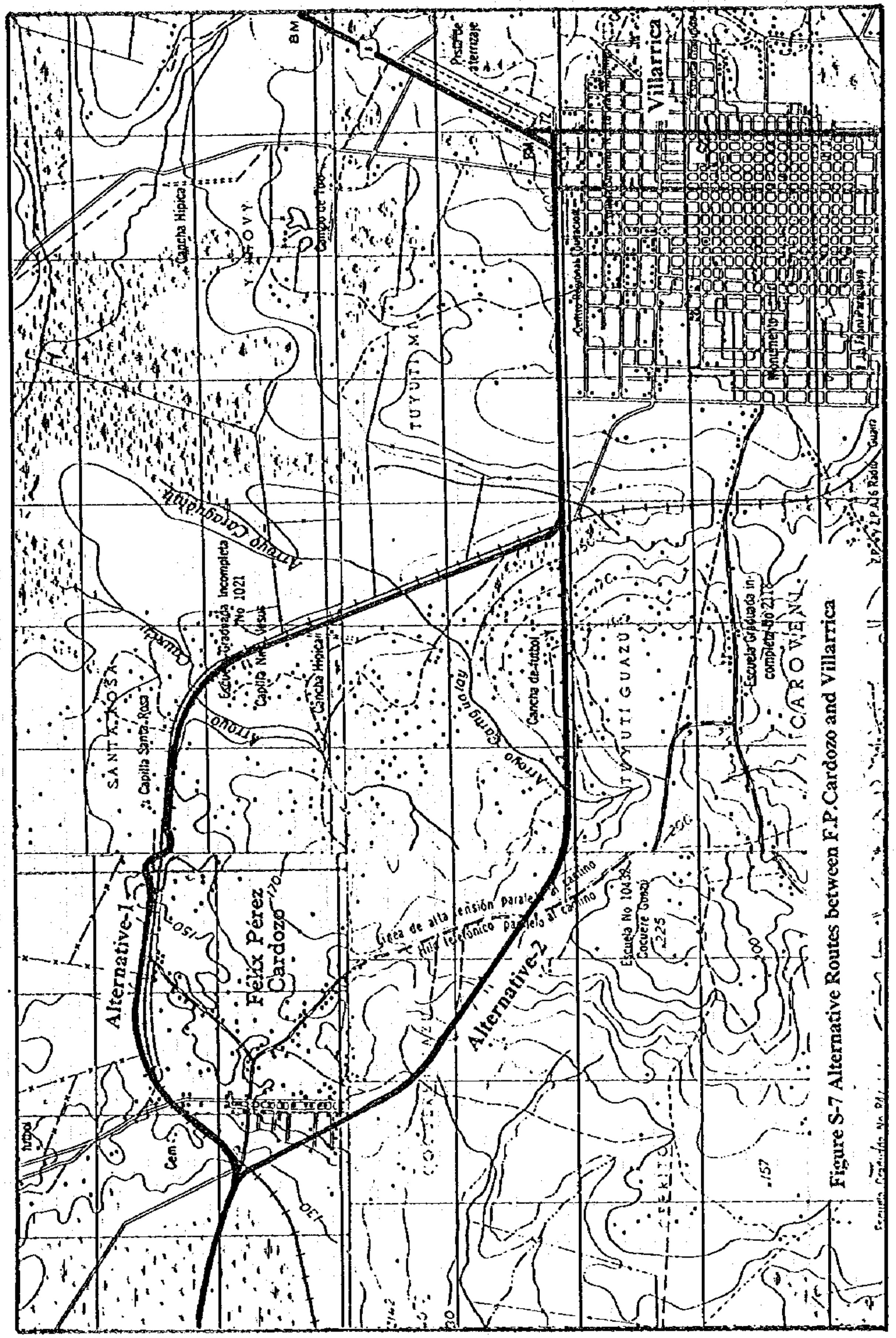


Figure S-7 Alternative Routes between F.P.Cardozo and Villarrica

Table S-9 Comparison of Alternative Routes between Cardozo and Villarrica

Items for Comparison	Route: Cardozo-Villarrica **Alternative - 1** (Northern route along the rail)	**Alternative - 2** (Southern route crossing hilly land)	Comparison 1	Comparison 2
1. Planning Policy	-Promotion of agricultural dev't along the railway area	-Better service for already developed hilly land		
2. Total length	8.6 km	7.9 km		
3.Forecast Traffic Vol. (2015)	2,785 vehicles/day	2,785 vehicles/day		
4.Principal Work Items & Volume	1)Road: -Earth Works 111,000 m3; -Pavement 60,200 m2 2)Bridge (total length): -RC 11.0 m; -PC 0.0m; -Tebicuary	1) Road: -Earth Works 96,000 m3; -Pavement 55,300 m2 2)Bridge (total length): -RC 0.0m; -PC 0.0m; -Tebicuary		
5.Total Construction Cost	1.00	0.91		
6.Construction Cost (cost/km)	1.00	0.98		
7. Land Acquisition	length (m) / width (m) / area (ha)	length (m) / width (m) / area (ha)		
-Side expantion	8,600 / 10 / 8.6	0 / / 0.0		
-New acquisition	0 / / 0.0	7,900 / 40 / 31.6		
Total	/ / 8.6	/ / 31.6	++	
8. Geometric Design 1)Horizontal Curve 2)Max.vertical grade	(R > 300.0 m) x 9 curves i = 1.599 %	(R > 700.0 m) x 3 curves i = 4.412 % (915.0 m long)	+	
9. Running performance	-Flat vertical and smooth horizontal alignment	-Smooth horizontal alignment but steep slopes -Many up and down & crossings with a path	+	
10. Difficulties of construction	-Need for detour routes, but very little traffic	-No need for detour route, but many houses exist -Easy to get earth work materials in the vicinity	+	+
11. Connection with surrounding road network	-Far from existing road	-Better connection with the existing road to Itape		+
12. Impact on socio-economic environment		-Loss of cultivated lands and resettlement -Split of communities, but new service to comunity		- +
13. Impact on natural environment		-Impact of cutting earth works -Decrease of forest & cultivated land	++	
14. General opinion of local communities	-Preferred, in order to promote rural dev't along railway area	-Difficulty of land acquisition	++	
Comprehensive Evaluation	O	X		

Figure S-8 Alternative Routes between La Colmena and Tebicuary

Table S-10 Comparison of Alternative Routes for Branch Section to La Colmena

Items for Comparison	Alternative - 1 (Eastern route along Tebicuary Mi River basin)	Route: Branch Section to la Colmena Alternative - 2 (Central route passing H. Vera)	Alternative - 3 (Route proceeding north directly from La Colmena)	comparison		
				1	2	3
1. Planning Policy	-Promotion of much suger cane producing area	-Shorter route to Tebicuary, promoting small scale agri.	-Shortest route to road Paraguari - Villarrica	+		
2. Total length	38.1 km	27.0 km	26.3 km			
3.Forecast Traffic Vol. (2015)	941 vehicles/day	343 vehicles/day	343 vehicles/day			
4.Principal Work Items & Volume	1) Road -Earthworks 470,000 m3 -Pavement 266,700 m2 2)Bridge (total length) -RC 69.0 m -PC 65.0 m -Tebicuary	1) Road -Earthworks 192,000 m3 -Pavement 189,000 m2 2)Bridge (total length) -RC 0m -PC 31.0 m -Tebicuary	1) Road -Earth Work 144,000 m3 -Pavement 184,100 m2 2)Bridge (total length) -RC -PC 15.0 m -Tebicuary			
5.Total Construction Cost	1.00	0.63	0.54		+	++
6.Construction Cost (cost/km)	1.00	0.89	0.78			
7. Land Acquisition	length (m) / width (m) / area (ha)	length (m) / width (m) / area (ha)	length (m) / width (m) / area (ha)			
-Side expantion	36,600 / 20 / 73.2	25,500 / 25 / 63.8	26,300 / 30 / 78.9			
-New acquisition	1,500 / 40 / 6.0	1,500 / 40 / 6.0	0 / / 0.0			
Total	38,100 / / 79.2	27,000 / / 69.8	26,300 / / 78.9			
8. Geometric Design 1)Horizontal Curve 2)Max.vertical grade	(R > 150.0 m) x 35 curves= (0.9 curves/km) i = 4.200% (600.0 m long)	(R > 250.0 m) x 22 curves= (0.8curves/km) i = 4.482 % (560.0 m long)	(R > 250.0 m) x 30 curves= (1.1curves/km) i = 4.435 % (250.0 m long)			
9. Running performance	-Most flat vertical alignment among the 3 alternatives -Limited speed sections exist	-Moderate performance among the 3 alternatives -Passing through the urban area of H. Vera	-Lower performance by up and down & many curves	+	+	
10. Difficulties of construction	-Easy detour route preparation in wide existing ROW -Longer section in lower area	-Difficult detour route preparation in narrow ROW	-Easy detour preparation in mostly pasture area			+
11. Connection with surrounding road network	-Better connection with existing road -Contributes to a future wider road network (toward Iturbe)	-Better connection with local community roads -Will play still local road even in future	-Far from existing roads and communities -Possibly be a part of direct connecting route with #2	+++	+	+
12. Impact on socio-economic environment	-more beneficial (soc. traffic volume) -Promotes & supports sugar cane industry directly	-Loss of agricultural lands -Promotes sugar cane industry	-Less beneficiary, surrounded by large scale pastures -Less potential of future development	++	+	
13. Impact on natural environment	-Decrease of gallery forest, but on a small scale -Minimum impacts among three alternatives	-Decrease of gallery forest and roadside forest	-Increase deforestration opportunities	+		
14. General opinion of local communities	-Preferable -Understood this is the best choice for La Colmena	-Preferred in Vera				
Comprehensive Evaluation	O	X	XX			

Preliminary Design and Cost Estimation

A preliminary design was prepared out based on aerial photographs taken in 1994 at a scale of about 1: 20,000 and 1: 5,000, which was an enlarged version of the former. To supplement these photos, a longitudinal leveling survey and a cross sectional survey along the proposed route were also performed in this Study.

A geometric design of the roads is shown on the drawings in a separate volume of the Report. The roads have to have two T-crossings, besides those at both ends of the road at Paraguarí and Villarrica. One exists at the junction of the road from Paraguarí to Villarrica and the branch road to La Colmena, and while is at the joining point with the road from Paraguarí to Piribebuy.

Although the intended width of the Right-of-Way was 40 m and 30 m for the section between Paraguarí and Villarrica and its branch road, respectively, a somewhat smaller Right-of-Way had to be planned in some urban areas.

The vertical gradient of the planned roads will generally be less than 3%, except in several small sections near to Sapucaí, F.P. Cardozo, and La Colmena, where it will be between 3% and 4.5%.

The required volume of earthwork is summarized in Table S-12. As shown in this table, it is impossible to keep the soil balance in the Right-of-Way only. That is, soil mainly for the subgrade, in quantities of 371, 193, 250 thousand cubic meters for sections 1, 2, and 3, respectively, must be brought from some borrow pits outside the Right-of-Way. Many candidate sites for borrow pits for this purpose along the road side area were studied in this Study, and the possibility of obtaining the necessary volume of soil was confirmed, as described before.

Proposed flexible pavement structure was determined according to the AASHTO's Guideline as shown in Figure S-9, and based on it, the required volume of the pavement material was calculated as summarized in Table S-13.

Table S-12 Summary of Earthwork Volume

(Unit : 1,000m³)

Road Segment	Distance km	Embankment selected	common	total	m³/m	Cut	From Borrow in ROW	Outside
Parguarí - Río Tebicuary-mí								
1	22.5	116	101	218	9.7	11	90	100
2	10.5	67	77	144	13.7	83	78	0
3	9.0	107	5	112	12.5	0	36	107
4	10.0	106	117	223	22.3	0	117	106
5	6.5	57	61	118	18.2	18	42	57
Total	58.5	454	362	816	13.9	112	362	371
Río Tebicuary-mí - Villarrica								
6	4.5	42	77	119	26.4	0	78	42
7	8.0	54	12	66	8.2	0	32	54
8	12.0	98	48	146	12.1	6	48	98
Total	24.5	193	137	330	13.5	6	158	193
La Colmena - Tebicuary								
9	25.3	103	23	126	5.0	0	101	103
10	2.4	59	19	78	32.5	0	19	59
11	10.4	89	6	95	9.1	4	42	89
Total	38.1	250	49	299	7.8	4	162	250
Grand Total	121.1	897	547	1,444	11.9	122	682	815

Total Earthwork = 1,566×1,000m³

Note: ROW = Borrow pit in Right of Way
Outside = Borrow pit outside of Right of Way
Selected = Soil for subgrade
Common = Soil for embankment beneath subgrade

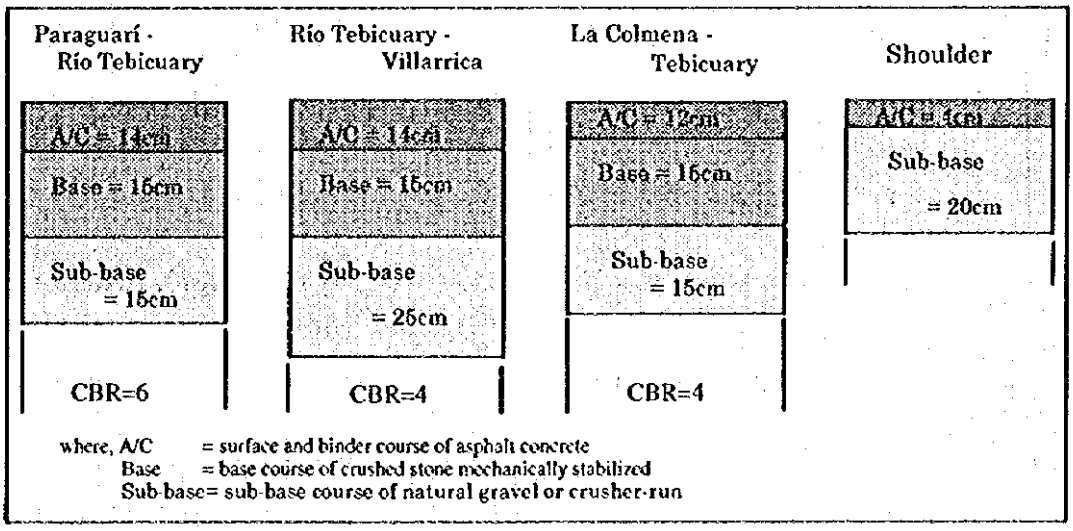


Figure S-9 Result of Flexible Pavement Design

Table S-13 Volume of Pavement Materials

Flexible Pavement	Section 1 Paraguarí - Río Tebicuary-mí (58.5km)		Section 2 Río Tebicuary-mí - Villarrica (24.5km)		Section 3 La Colmena - Tebicuary (38.1km)	
	Thick(cm)	Volume (m^3)	Thick(cm)	Volume (m^3)	Thick(cm)	Volume (m^3)
Asphalt Concrete	14	57,330	14	24,010	12	32,004
Base	15	61,425	15	25,725	15	40,005
Sub-base	15	61,425	25	42,875	15	40,005
Prime Coat	0.15	614	0.15	257	0.15	400

Note: Asphalt Concrete is for binder course and surface course.

Based on a hydrological analysis, site reconnaissance, and boring survey results, the construction of the following bridges was proposed for the Project.

Table S-14 Required Number and Size of Bridges

(Paraguarí - Villarrica) - Sección 1

From	To	RC single span			PC single span			Multi Spans
		5 (m)	10 (m)	15 (m)	20 (m)	25 (m)	30 (m)	
Paraguarí	Sapucaí	0	1	0	0	0	0	0
Sapucaí	Caballero	0	0	0	0	1	0	0
Caballero	Ybytymí	0	0	1	1	0	0	0
Ybytymí	Punto Unido	1	3	2	0	0	1	0
Punto Unido	Tebicuary	2	1	0	0	0	0	0
Total		3	5	3	1	1	1	0

(Tebicuary - Villarrica) - Sección 2

Tebicuary	C. Martínez	0	0	0	0	0	3	(215m)
C. Martínez	Cardozo	0	0	0	0	0	0	0
Cardozo	Villarrica	0	0	0	0	0	0	0
Total		3	5	3	1	1	4	1

(La Colmena - Tebicuary) - Sección 3

La Colmena	No.253+10	0	0	2	1	0	1	0
No.253+10	No.277+00	0	1	2	0	0	0	(50m)
No.277+00	Tebicuary	0	0	1	0	0	0	0
Total		0	1	5	1	0	1	1
Grand Total		3	6	8	2	1	5	2

Two multi-span bridges were proposed for Río Tebicuary-mí and Arroyo Tebicuary-mí. The former consists of a metal truss span and five PC girder spans, as described before, while the latter has two PC composite girder spans.

For all the above-mentioned jobs, a cost estimation was prepared. Furthermore, costs necessary for the environmental management plan proposed as a result of the environmental study described later, for engineering services, for land acquisition, and for contingencies were also estimated. As those estimated costs were only financial costs, economic costs were also estimated thereafter.

Since no import taxes for construction equipment and material, nor income taxes, are

charged in Paraguay, the factors which produce the difference between financial costs and economic costs are taxes for fuel and IVA (indirect sales tax) only. As the result, the difference between financial construction costs and economic costs was very small; just 11.55% (78,881.1/70,748.3). The estimation results are tabulated in Table S-15.

Furthermore, road maintenance costs including costs for the overlay of pavement and the repainting of the metal bridge 10 years later, as well as environmental post-construction costs were estimated, and an investment plan by year was established assuming that:

- construction of the Project would be executed in three sections,
- the construction period would be three years, and
- construction would be commenced in March of 1999.

Table S-15 Summary of Financial and Economic Costs of the Project

(Unit : US$ 1,000)

	Financial Cost		Economic Cost				
	Cost with IVA	Ratio (%)	Section 1 Cost	Section 2 Cost	Section 3 Cost	Total Cost	Ratio (%)
Construction Cost	68,054.9	71.0	28,211.8	15,062.9	17,631.6	60,906.3	86.1
Environment Management Cost	1,584.9	1.7	767.5	348.1	325.2	1,440.9	2.0
Engineering Cost	9,241.2	9.6	2,567.5	3,938.4	1,895.2	8,401.1	11.9
Final Design	1,991.8	2.1	367.2	1,055.5	388.0	1,810.7	2.6
Construction Supervision	7,249.4	7.6	2,200.3	2,882.9	1,507.2	6,590.4	9.3
Total	78,881.1	82.3	31,546.8	19,349.4	19,852.1	70,748.3	100
Land Acquisition	1,984.0	2.3	0	0	0	0	0
Contingency	14,797.9	15.4	0	0	0	0	0
For Readjustment	9,226.7	9.6	0	0	0	0	
Physical Contingency	5,571.2	5.8	0	0	0	0	
Grand Total	95,861.4	100	31,546.8	19,349.4	19,852.1	70,748.3	100

Table S-16 shows the investment plan in terms of economic costs, which is reflected in the economic evaluation described later.

Table S-16 Economic Cost of the Project with Investment Program

(Unit : US$ 1,000)

Year	Detail Design	Environmental Measures	Construction	Construction supervision	Annual Maintenance	Total
1998	1,810.7	474.8			0	2,285.5
1999		190.5	15,226.6	1,597.6	0	17,014.7
2000		162.8	20,302.1	2,196.8	0	22,661.7
2001		612.8	20,302.1	2,196.8	0	23,111.7
2002		185.5	5,075.5	599.2	90.1	5,950.3
2003		89.4			90.1	179.5
2004					90.1	90.1
2005					90.1	90.1
2006					90.1	90.1
2007					196.1	196.1
2008					196.1	196.1
2009					196.1	196.1
2010					306.0	306.0
2011					306.0	306.0
2012					4,481.7	4,481.7
2013					4,481.7	4,481.7
2014					90.1	90.1
2015					90.1	90.1
2016					90.1	90.1
2017					90.1	90.1
2018					90.1	90.1
2019					196.1	196.1
2020					196.1	196.1
2021					196.1	196.1
Total	1,810.7	1,715.8	60,906.3	6,590.4	11,653.0	82,676.2

Environmental Study

The environmental impact assessment study concluded that the Project, with its environmental management measures, will have significant direct and indirect positive impacts on the social environment in the project area. It will not negatively affect the natural environment, if the environmental management plan is completed and the construction works follow the regulations of ETAG's "General Specifications for Environmental Protection in Road Construction Works" established by MOPC in 1993.

To mitigate potential negative impacts while promoting positive impacts, the following programs were proposed;

i) The environmental auditory program, which is intended to handle the comprehensive evaluation and management of all works related to environmental issues, shall extend from the design stage of the Project to a few years after completion. The auditors shall be selected from various fields concerned with the natural and social environments.

ii) Environmental mitigation programs shall be taken for reforestation, traffic safety facilities and education, roadside planting in urban areas, and to ensure smooth

connections between existing community roads and the planned road.

iii) Environmental monitoring programs shall be continued periodically. Before, driving and after the project construction works, it will evaluate changes in topography, air quality, noise levels, and water quality along the planned road. It will also check for the possible existence of cultural properties at construction sites.

iv) The Ybycui National Park requires special programs. Because of the increase in traffic flow and the improvement of accessibility, the possibility of illegal deforestation and fire risks will increase. Therefore, the introduction of a patrol system, as well as services for visitors and control facilities are planned.

v) In order to realize the full benefits of the project, measures such as the improvement of bus service facilities and emergency services shall be facilitated to promote social development in the project area. An assistance program for about 50 households that must be involuntarily resettled shall be included in the program, in addition to the compensation to be provided for their land and buildings.

Economic Evaluation

The economic feasibility of the proposed project was examined by applying a "Benefit-Cost analysis", based on the proposed investment program and estimated economic benefits of project implementation. VOC savings, elimination of impassability caused by rainfall, and a reduction in the maintenance costs of the existing road were quantified as tangible economic benefits. The results showed that the Project as a whole promises very high economic returns, assuming a discount rate of 12%; EIRR of 25.6 %, B/C ratio of 2.3, and NPV of US$ 70.7 million. Therefore, this project is economically feasible.

A comparative evaluation by section (Section 1 : Paraguarí - Tebicuary, 2 : Tebicuary - Villarrica and 3 : Tebicuary - La Colmana), indicates some differences. Although section 3 shows a narrower economic feasibility than the others, this does not assume the priority implementation of sections 1 and 2. A comprehensive evaluation will be necessary to determine the feasibility of the project, since all the sections are indispensable for the completion of a desirable future road network in the planning area, from the viewpoint of regional development. Therefore, each section cannot be implemented individually without others, and therefore the project should be carried out in accordance with the proposed program.

Comprehensive Evaluation of the Project

From a socio-economic viewpoint, the Project was evaluated to be sufficiently feasible, as described above.

Apart from that, the Project was evaluated from various points of view, and the results obtained were positive. That is:

- from the viewpoint of road development, the Project can be said to be planned in a timely manner, to comply with the nation's strategic policy for this sector and to conform to the movement of other international financial sources, such as IDB.
- from the viewpoint of regional development, the Project is expected to be implemented earlier in response to national agricultural development in light of the MERCOSUR agreement.

These evaluation results indicate that the Project is surely feasible and viable, and therefore, the earliest possible implementation of the Project is recommended.

Recommendations

(1) On the Final Design

- Preparation of a detailed topographic map is indispensable.
- A more detailed investigation of the candidate quarry site "C-2", which is not accessible now, and the hills to the south of La Colmena - Tebicuary-mf road, is recommended to determine the possibility of obtaining subbase materials.
- Execution of more detailed laboratory tests of the stone material from the quarry "C-1" is recommended to verify that it is useful for aggregate of asphalt concrete.
- The possibility of transporting stone materials from "Cerro Itapé" (C-3) to the other side of Rfo Tebicuary-mf should be studied.
- Careful attention must be paid to the construction method used for embankments for the low-lands on both sides of Rfo Tebicuary-mf
- Adjustment clause on contracted price, which is popularly included in contract in Paraguay, shall be examined carefully for this Project.

(2) On Implementation

- For earlier implementation of the Project, necessary administrative procedures and steps should proceed as soon as possible.
- Construction shall be executed under the contract(s) with private contractor(s) selected by international tender(s).

- The door for international tenders shall be opened wide to ensure adequate competition.
- The Project shall be divided into three sections and tenders and contracts for construction shall be made independently for each section.

(3) On the Environmental Management Plan

The following items shall be planned in coordination with the authorities concerned in order to promote the project's indirect positive impacts:

- Improvement of educational facilities and availability of teachers in major towns, because punctual bus services will increase attendance in higher education institutions.
- Promotion of agricultural development and technology transfer, due to the transportation cost and time-saving effects will increase the potential of diversifying the agro-industrial opportunities.
- Promotion of tourism resources because the planned road will promote domestic tourism, while the utilization of unknown resources will promote regional development.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Outline of the Study

1-1-1 General

In response to the request of the Government of the Republic of Paraguay (hereinafter referred to as "GOP"), the Government of Japan decided to conduct the Feasibility Study on Arterial Road Development Project in the Central Eastern Area (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations as part of technical cooperation programs of the Government of Japan.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), official agency responsible for technical cooperation programs of the Government of Japan, was assigned to undertake the Study in close cooperation with authorities concerned of the GOP.

In September 1995, JICA dispatched a mission headed by Mr. Tetsuo KOMATSUBARA to Paraguay for the preparatory work as well as mutual consent of the Scope of Work for the Study. Then, the Study Team was mobilized into Paraguay and started the Study on February 25th, 1996. The Study continued until November of 1996, and the Draft Final Report were submitted to the Ministry of Public Works and Communications, the concerned body for the Study on the Paraguayan side (hereinafter referred to as "MOPC"), by the JICA's study team at the end of November. After receiving the comments of paraguayan side on the Draft, the Final Report was completed referring to them, and submitted officially to the Government of Paraguay by JICA in February, 1997.

1-1-2 Background of the Study

In the Republic of Paraguay, three fourths of the total population of about four million two hundred thousand (in 1992) lives in the "Triangle Area", formed by three major cities - Asunción, Encarnación, and Ciudad de Este. Economic activity can be classified as a "mono-culture" involving agriculture and livestock farming. Agricultural and livestock products account for nearly 90 percent of the total value of the country's exports; therefore, the development and promotion of this sector is the GOP's most important policy.

However, the transportation facilities that enable the movement of these export products between the producing region and the borders of the country, i.e., the road network

system, in this case, is neither sufficient to meet demand nor in good condition. Given this situation, the GOP has made great efforts to improve road conditions, occasionally receiving various kinds of cooperation from foreign countries and multi-lateral organizations.

In 1993, the GOP established "The Master Plan for Development of Transportation System in Paraguay" (hereinafter referred to as "M/P") with the technical cooperation of the Japanese Government. The M/P gave priority to the development, improvement and/or rehabilitation of national trunk roads and rural roads selected for the purpose of further promoting of activities in the agricultural sector, and boosting exports.

Based on the result and recommendations of the M/P, the GOP requested to the Japanese Government to conduct a feasibility study on the development of the road between Paraguarí and Villarrica and its branch to La Colmena, and it was agreed in the meeting between the GOP and the JICA mission in September, 1995 that the study would be carried out by the JICA Study Team as part of the technical cooperation program of the Japanese Government.

1-1-3 Objectives of the Study

The objectives of the Study are to carry out a feasibility study on the construction project of the road between Paraguarí and Villarrica with a branch section to La Colmena, as described in the previous section. The approximate length of the objective roads of the Study is 140 kilometers.

The technology transfer to the counterpart personnel through on-the-job training in the course of the Study is also one of the objectives of the Study.

The development of the objective roads of the Study is expected to promote:

- to mitigate the terrible congestion of actual traffic on National Road No.2,
- to enable easy access from the surrounding area of the objective roads to the main transportation centers, such as the Bus Terminal, the Central Food Market of Asunción and the Port of Villeta, without passing through the City of San Lorenzo where the junction of National Road No.1 and No.2 is located and always congested, utilizing the new National Road between Asunción and Itá which is under construction with financing from the World Bank, and
- to contribute to the agricultural development of the surrounding area of the objective roads.

Moreover, once the objective roads are completed, their effects will be multiplied in relation with the other road development projects that are currently under way, such as the road between Asunción and Itá, mentioned above, the road between Caazapá and Gral. Bogado, the National Road No.1 between Paraguarí and San Juan Bautista, etc.

1-1-4 Flow Chart of the Study

The work flow diagram of the Study is shown in Figure 1.1.1. The timing of the principal transactions during the Study is also indicated in the diagram.

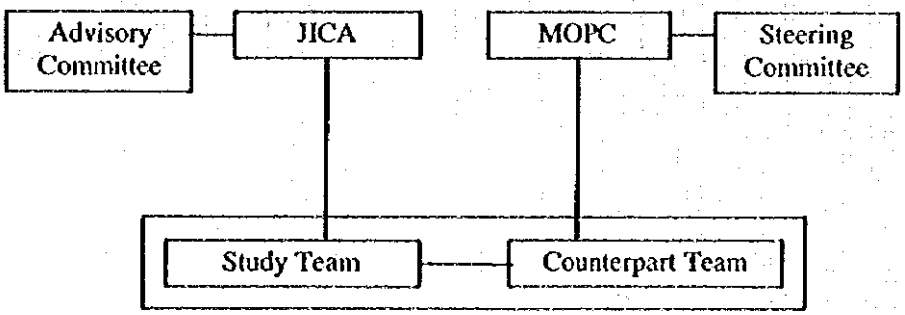
1-1-5 Organizations concerned with the Study and their Relationships

The Study is being conducted jointly by the JICA Study Team and MOPC, which is acting as the counterpart agency, as well as the coordinating body between all the governmental and non-governmental organizations concerned.

A steering committee has been organized to ensure smooth implementation of the Study.

JICA has set up an Advisory Committee in Japan to assist the Study Team by providing advice and suggestions from time to time.

The relationships between these organizations is shown below:



The JICA Advisory Committee comprises 2 members as follows:

- Mr. Tsuguo Ohishi : Chairman : Japan Highway Corporation
- Mr. Osamu Yoshizaki : Committee Member : Ministry of Construction

Mr. Mitsuyoshi Kawasaki serves as a JICA coordinator.

The Steering Committee members are shown below:

[MOPC]

- Mr. Miguel A. Caballero : Director, Highway Directorate
- Mr. Félix Zelaya : Chief, Dept. of Planning & Design, Highway Directorate
  (Chief of Counterpart Personnel for the Study)
- Mr. José R. Gómez : Dept. of Planning & Design, Highway Directorate
  (Counterpart Personnel for the Study)

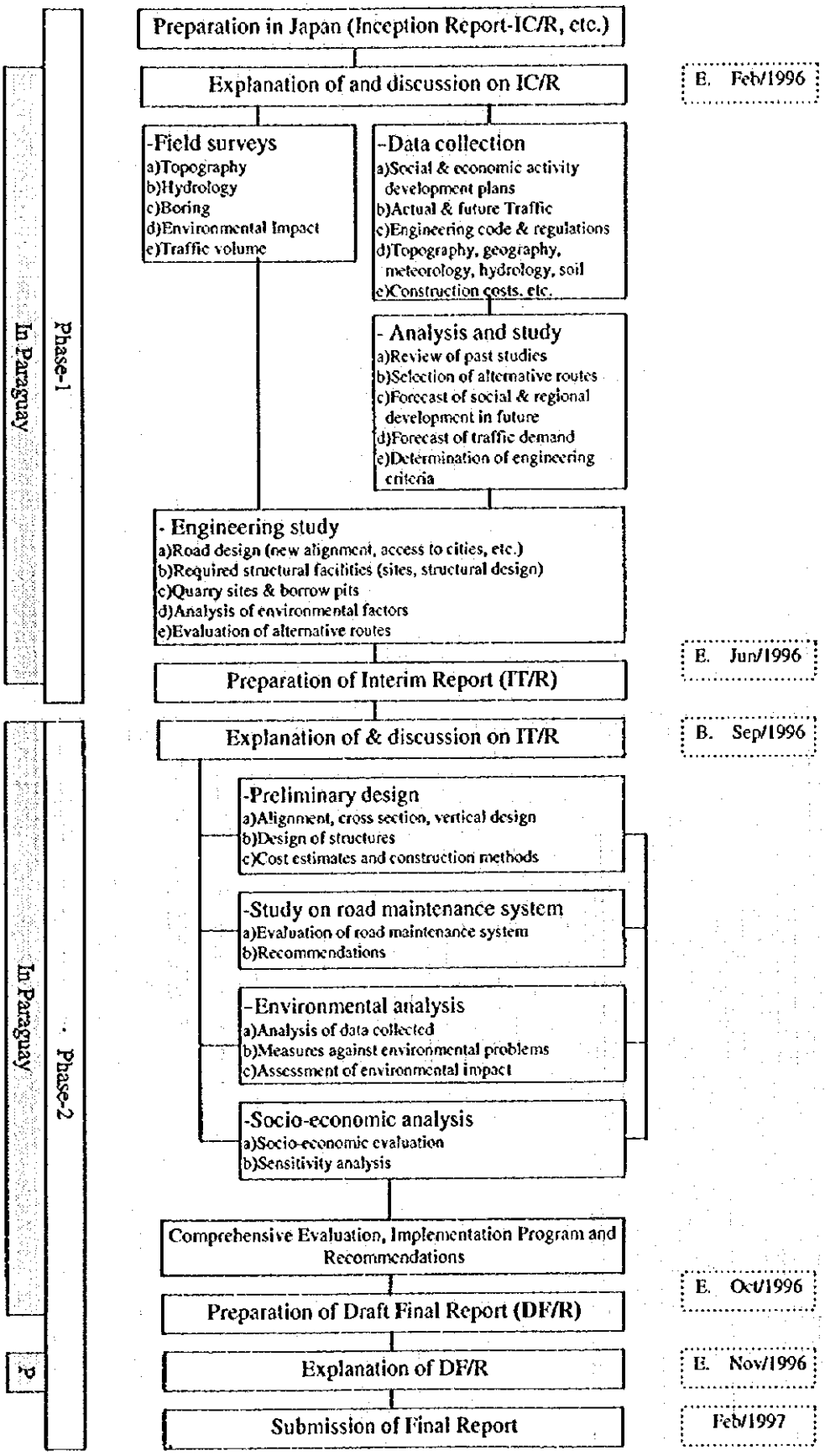


Figure 1.1.1 Flow Chart of the Study

[MAG (Ministry of Agriculture)]

- Mr. Francisco Ibarra

[FCCAL (Railway Company)]

- Mr. Jorge Jara Servían : Grencia Técnica

[Government of Dept. of Guairá]

- Mr. Mario Domínguez Duarte

[Government of Dept. of Paraguarí]

- Mr. Victor Rodriguez

The members of the Study Team and their counterparts are as follows:

Study Team Member	Field in Charge	Counterparts
Takashi Tachikawa	Chief, Road Planning	Ing. Félix Zelaya, Ing. José Gómez
Kenji Tanaka	Regional Planning	Arq. Cabral (OPIT)
Osamu Ohtsu	Economic Evaluation	Dr. Aquino
Tetsuo Horie	Traffic Study	Ing. Genaro Paredes
Tsutomu Kameyama	Hydrographic Study	Ing. Federico Gandorfo
Lee Sang Gyoon	Study on Structures	Ing. Luis Caballero
Katsuyuki Ohno	Road Study	Ing. Santiago Rojas
Yoshiaki Ohtoku	Topographic Survey	Ing. Santiago Rojas
Takashi Onodera	Environmental Study	Lic. Nelson Fleitas
Seiichi Aoto	Coordination	

1-2 Definition of the Study Area

1-2-1 Introduction

In accordance with the description of the study area in the Scope of Work which was signed by the both governments on 19th September, 1995, the area covers a great broad region in comparison with the road sections to be studied. That is, the Guairá and Paraguarí Departments where study road sections of approximately 140 km are located, and their peripheral Departments - Caazapá, Cordillera, Caaguazú, Alto Paraná, Itapúa & Central - and Asunción City (Total area : 72,224 km^2). In addition to the above, the JICA Advisory Committee recommended that the study team add one more department, Misiones.

The relationship between the objective road sections and the study area might be obscure as shown in Figure 1.2.1. Therefore, the study team suggests the following classification and definition of the study area, in terms of the level or contents of the analyses.

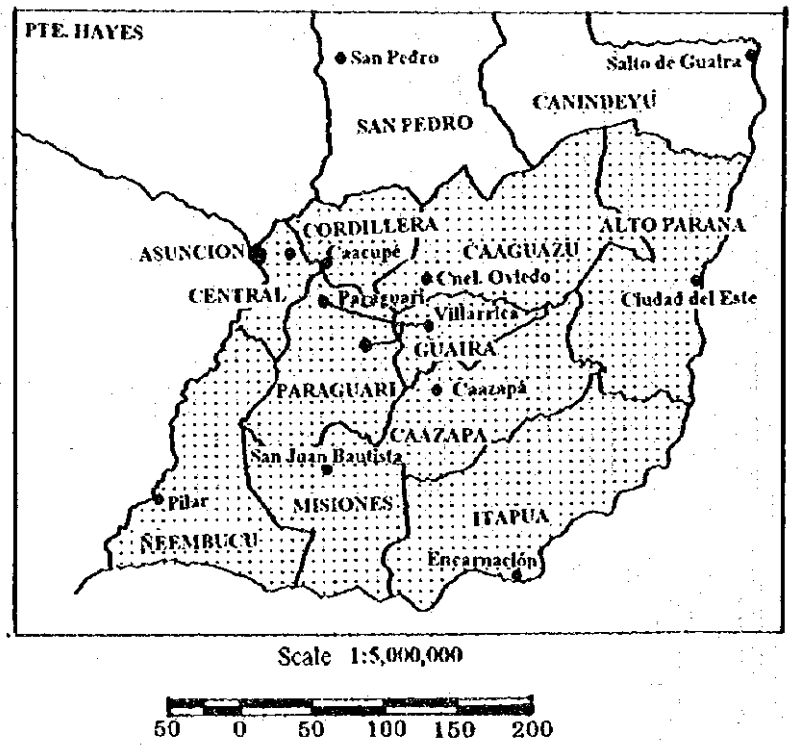


Figure 1.2.1 Study Road Section and Study Area

The region/area will be classified throughout the Study using the following four (4) categories.

i) National level,

ii) Central Eastern Area (Overall Study Area),

iii) Secondary Influenced Area (Planning Area = Hinterlands of the roads), and

iv) Primary Influenced Area (Road-side area).

1-2-2 National Level

This first category serves as an introduction and a general background of the Study, encompassing matters such as land use, economy, transportation, etc. A full description is provided in Chapter 2, 2-1 "Overview of the Nation".

1-2-3 Central Eastern Area (Overall Study Area)

In Paraguay, there are no specific classifications of the region between the nation and Departments, except for the Western and Eastern regions, which are divided by the Paraguay River. Meanwhile, the area which consists of the above-mentioned eight (8) Departments is called as the 'Central Eastern Area' in the Scope of Work (S/W).

The area, with the addition of two departments - Misiones and Neembucu - to the study area confirmed in the S/W, has been defined as the 'Overall Study Area'. This area can be said to include the southern part of the Eastern region and covers the entire 'triangle zone', where the major national economic activities in Paraguay are concentrated. The major road transport in this region is along arterial national roads, Route Nos.1, 2, 6, 7 and 8. Though the objective roads of the Study are not the arterial national roads, they are expected to play a very important role as trunk roads in the regional road network of this area. Therefore, basic studies on social and economic conditions, regional development, etc. will be conducted over this area.

1-2-4 Secondary Influenced Area (Planning Area)

The area of detailed study mainly on the socioeconomic framework and traffic demand forecast, based on the estimated future regional development, results of traffic surveys, etc. is prepared for the 'Planning Area', where the area might be substantially served, either directly or indirectly in various aspects, by the development of the study roads. This area consists of 30 Districts which the arterial national roads Route Nos. 1, 2, 7 and 8 and the study roads directly serve, and is the basic area for traffic demand forecast by traffic zoning. The area and basic traffic zoning are illustrated in Figure 3.2.1.

1-2-5 Primary Influenced Area (Road-side Area)

This area consists of the districts through which the study roads run, that is, the road-side area, which will be directly affected by the development of the study roads.

This area includes the following towns and cities;
Paraguarí, Escobar, Sapucai, Caballero, Ybytymí, Héctor Vega, La Colmena, Tebicuary and Tebicuary-mi in Paraguarí Department, and
Coronel Martínez, Félix Pérez Cardozo and Villarica in Villarica Dept.

The necessary physical/natural conditions are carefully examined within this area in order to analyze the engineering aspects of the study roads, and at the same time, various environmental factors related to the objective road development are also examined in depth.

CHAPTER 2

GENERAL BACKGROUND OF THE STUDY AREA

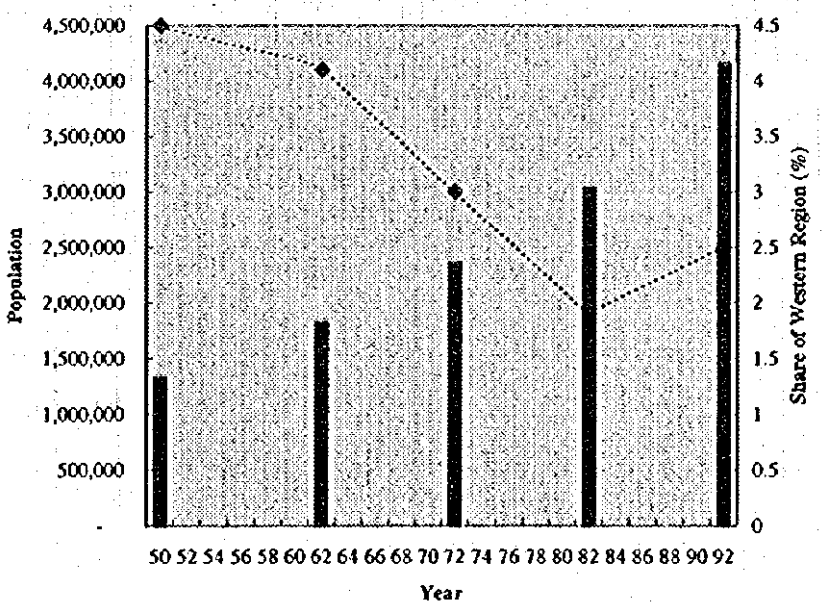
CHAPTER 2 GENERAL BACKGROUND OF STUDY AREA

2-1 Overview of the Nation

The Republic of Paraguay is located in the south central part of South America, encompassing an area of 407 thousand km^2 and a population of 4,153 thousand in 1992. The country is landlocked, surrounded by Brazil (east), Argentina (south and west) and Bolivia (north). The country is almost entirely flat, except for the mountain range at the northeast border shared with Brazil, which has an altitude of approximately 800 m. The Paraguay River runs through the middle of the country from north to south.

2-1-1 Demography

Though the total population has increased from 1,328 thousand in 1950 to 3,030 thousand in 1982 and 4,153 thousand in 1992, the average population density is still low; 10.2 person/km^2 in 1992. Total population growth for these four decades are stable at a high level; 2.6 to 3.2% per annum. Population distribution by region is very different is the west and east, where population densities are 0.4 person/km^2 and 25.3 person/km^2, respectively. As over 95% of the total population lives in the eastern region, the share of the western region has shown a slight increase since it hit bottom in 1982; 4.5% in 1950, 4.1% in 1962, 3.0% in 1972, 1.9% in 1982, and 2.5% in 1992, respectively.



Source : Population Census 1992

Figure 2.1.1 Population Growth, 1950-1992

A major segment of the population is concentrated around Asunción, the capital city with its populations of 501 thousand, and most of the cities with higher urban populations are located within a 50 km radius of the center of Asunción. Only Ciudad del Este, which is outside of this region, has a population of over 100 thousand (134), and recorded a very high increase rate of 7.9% per annum between 1982 and 1992. Population of major cities is shown in Table 2.1.1.

Table 2.1.1 Major Urban Population Distribution

Urban Population, 1992 (more than 10 thousand pop.)

	Name of City	Department	No. of Houses	Urban Population	Population /Houses	Growth % 1982-92
1	Asunción		105,746	500,938	4.7	1.0
2	Ciudad del Este	Alto Paraná	29,518	133,881	4.5	7.9
3	San Lorenzo	Central	28,266	133,395	4.7	6.0
4	Lambare	Central	20,341	99,572	4.9	4.0
5	Fernado de la Mora	Central	20,249	95,072	4.7	3.6
6	Luque	Central	17,249	84,877	4.9	6.1
7	Capiata	Central	17,824	83,773	4.7	6.5
8	Encarnación	Itapúa	12,151	56,261	4.6	3.8
9	Pedro Juan Caballero	Amambay	10,424	53,566	5.1	4.3
10	Mariano Roque Alonso	Central	8,092	39,289	4.9	10.1
11	Coronel Oviedo	Caaguazú	7,916	38,316	4.8	0.6
12	Caaguazú	Caaguazú	7,801	38,220	4.9	2.3
13	Concepción	Concepción	6,655	35,276	5.3	2.2
14	Presidente Franco	Alto Paraná	6,681	31,825	4.8	5.5
15	Villa Elisa	Central	6,308	29,796	4.7	9.5
16	Hernandarias	Alto Paraná	5,613	28,180	5.0	4.0
17	Villarrica	Guairá	6,302	27,818	4.4	2.3
18	Nemby	Central	5,778	26,999	4.7	12.4
19	Limpio	Central	5,579	26,177	4.7	8.2
20	Pilar	Ñeembucú	4,677	19,121	4.1	1.9
21	Ita	Central	3,040	14,259	4.7	2.6
22	Itaugua	Central	3,013	13,910	4.6	3.8
23	Villa Hayes	Hayes	2,357	11,859	5.0	-
24	San Ignacio	Misiones	2,584	11,580	4.5	1.9

No. of Cities by Population Size, 1992

Department	No.of Cities	Population Size (in thousand)								
		500 -	300 -	100 -	50 -	30 -	10 -	5 -	1 -	less 1
Asunción	1	1								
Concepción	8					1		1	4	2
San Pedro	17							1	13	3
Cordillera	20						1	3	8	8
Guairá	16						1		10	5
Caaguazú	19					2		1	10	6
Caazapá	10								4	6
Itapúa	29				1			1	18	9
Misiones	10						1	3	5	1
Paraguarí	17							2	11	4
Alto Parana	18			1		1	1	2	8	5
Central	19			1	4	1	5	5	3	0
Ñeembucú	16						1		2	13
Amambay	3				1			1	1	0
Canindeyu	7							1	5	1
Pte. Hayes	8						1	1	1	5
Boqueron	6								2	4
Alto Paraguay	3								2	1
Total	227	1	0	2	6	5	11	22	107	73
(%)	100	0.44	0.00	0.88	2.64	2.20	4.85	9.69	47.14	32.16

Source: 1992 Census Summary

2-1-2 Land Use

As Paraguay is well known as an exclusively agricultural country, almost all the land in the eastern region has been developed into cultivable and pasture land in 1990's. Table 2.1.2 shows the land use composition in 1991; 43% of the land in the eastern region is farmland for agriculture, 30-35% is for stock farming, and the rest, 10-15%, is forest or woodlands. The capacity for future agricultural development, therefore, is very limited within the eastern region.

Table 2.1.2 Land Use of Eastern Region, 1991

Spanish	English	Comment	Area (000ha)	Ratio (%)
1 Bosque alto continuo	Rich Forest	for reserve	2,197.043	13.75
2 Bosque alto degradado	Woods		742.537	4.65
3 Bosque ralo en islas	Grove Land	only in north	402.748	2.52
4 Uso agropecuario*	Cultivable Land	Farm (Agriculture)	6,814.739	42.64
5 Pradera alta	Plateau	Pasture A (stock farming)	2,577.263	16.13
6 Pradera baja inundable	Floodable Area(seldom)	Pasture B	2,386.337	14.93
7 Pradera baja inundada	Floodable Area(often)	Pasture C	795.878	4.98
9 Espejos de agua	Water		66.155	0.41
Total			15,982.700	100.00
8 Deforestación '84-91	Deforestation '84-'91		2,019.858	12.64

Source : Map of land use 1994 and progress of deforestation from 1984 to 1991
Note : * Cultivating field+Deforested land

2-1-3 Economy

Though it is well known that the country's primary economic sector is agriculture and stock farming, the recent structure of Gross Domestic Product (GDP) by sector shows slightly different characteristics. The total share of agriculture has decreased, while other sectors, especially commerce and finance, have increased.

Table 2.1.3 Gross Domestic Product by Economic Sector

(Unit : Gs. in million -1982 constant)

Sector	1985	%	1990	%	1992	%	1994	%
Agricultural Products	206,042	26.9	255,385	27.5	254,013	26.3	266,608	25.7
Agriculture			159,082	17.2	150,061	15.5	156,562	15.1
Livestock			69,847	7.5	75,066	7.8	79,441	7.6
Forestry			25,201	2.7	27,562	2.8	29,201	2.8
Hunting & Fishing			1,255	0.1	1,324	0.1	1,404	0.1
Other Goods	175,350	22.9	201,831	21.8	208,465	21.6	217,337	20.9
Mining			4,300	0.5	4,741	0.5	4,917	0.5
Manufacturing			149,045	16.1	151,287	15.6	156,628	15.1
Construction			48,486	5.2	52,437	5.4	55,792	5.4
Basic Services	52,711	6.9	72,480	7.8	82,039	8.5	99,071	9.5
Electricity, Water, Gas			29,934	3.2	36,249	3.7	49,880	4.8
Transport & Comm.			42,546	4.6	45,790	4.7	49,191	4.7
Other Services	332,050	43.3	397,621	42.9	422,795	43.7	455,531	43.9
Commerce & Finance			244,732	26.4	256,958	26.6	278,209	26.8
Government			41,774	4.5	46,382	4.8	51,546	5.0
Real Estate			24,100	2.6	26,690	2.8	28,315	2.7
Others			87,015	9.4	92,765	9.6	97,461	9.4
Gross Domestic Product	766,153	100.0	927,317	100.0	967,312	100.0	1,038,547	100.0
(Annual Growth Rate)			(3.89%)		(2.13%)		(3.62%)	

Source : Annual Statistics of Transport, 1994