No. 2

THE STUDY OF ROAD IMPROVEMENT BETWEEN SAN BORJA AND TRINIDAD IN THE REPUBLIC OF BOLIVIA (PHASE II)

FINAL REPORT

SUMMARY

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

THE STUDY OF ROAD IMPROVEMENT BETWEEN SAN BORJA AND TRINIDAD IN THE REPUBLIC OF BOLIVIA (PHASE II)

FINAL REPORT

SUMMARY

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of Bolivia, the Government of Japan decided to conduct a study on the Road Improvement between San Borja and Trinidad (Phase II) Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bolivia a study team headed by Mr.Shunichi Tateishi, comprised of members from Central Consultant Inc. and Kokusai Kogyo Co.,Ltd. firstly from September, 1987 to March, 1988, secondly from June to October, 1988.

The team held discussions with officials concerned of the Government of Bolivia, and conducted field surveys. 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 development of the Project and to the promotion of friendly relations between our two countries.

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

January, 1989

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

January 1989

His Excellency Mr. Kensuke Yanagiya,
President,
Japan International Cooperation Agancy,
Tokyo, Japan

Letter of Transmittal

Dear Sir :

We are pleased to be able to submit herewith the final report of the "Study of Road Improvement between San Borja and Trinidad".

This study report includes executive summaries, main texts, drawings, specifications statements of costs, five (5) technical reports and studies on the Tijamuchi Bridge, and embodies the results of the study undertaken from September 1987 to January 1989.

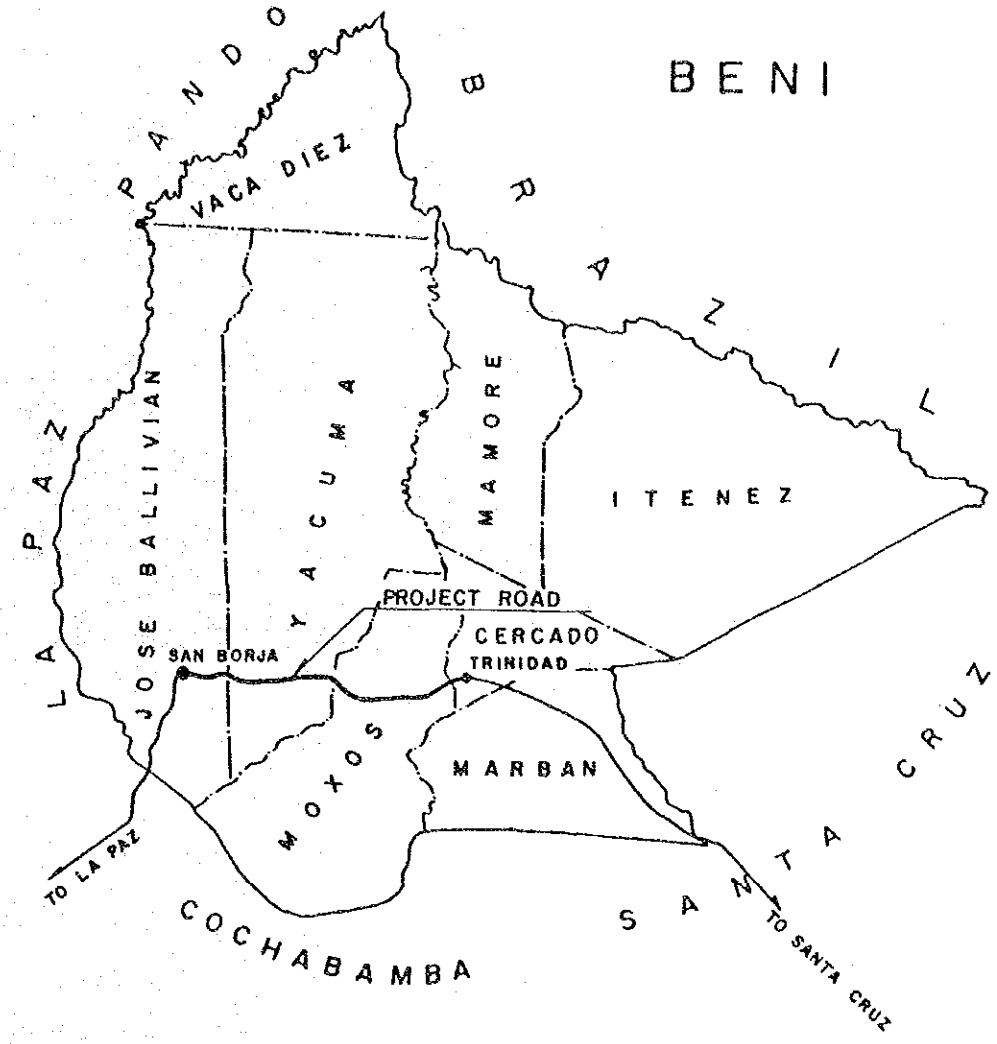
We hope this study will contribute towards the improvement of the transportation system and the economic development of the project area and will be of value in the future development of the Republic of Bolivia.

We wish to express our appreciation and sincere gratitude to the officials of your Agency, the Advisory Committee and the Embassy of Japan in the Republic of Bolivia , as well as the officials of the agencies concerned in the Government of Bolivia, particularly, the SNC (Servicio Nacional de Caminos), for the assistance and the cooperation extended to the Study Team.

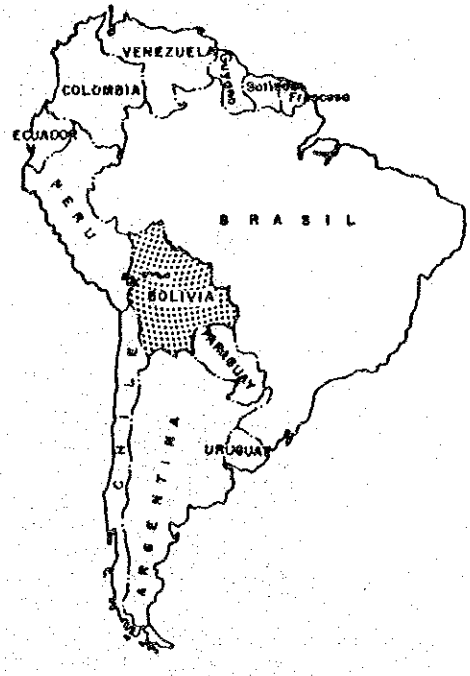
Very Truly Yours,

Shunichi Tateishi

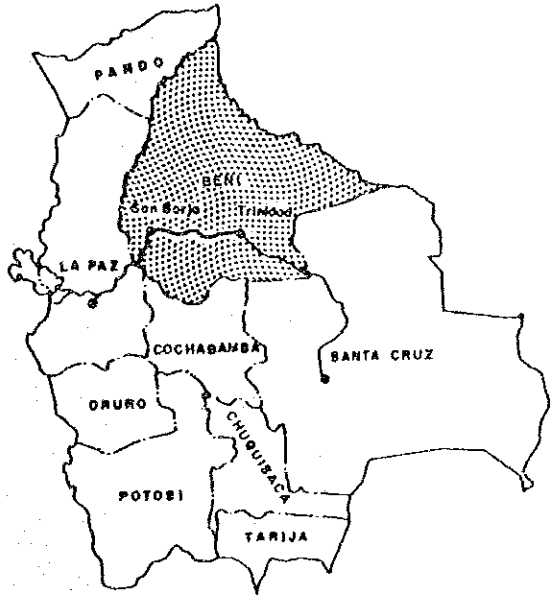
Shunichi Tateishi,
Team Leader,
The Study of Road Improvement
between San Borja and Trinidad
(Central Consultant Inc.)



SOUTH AMERICA



BOLIVIA



Road Improvement between San Borja-Trinidad

Location Map

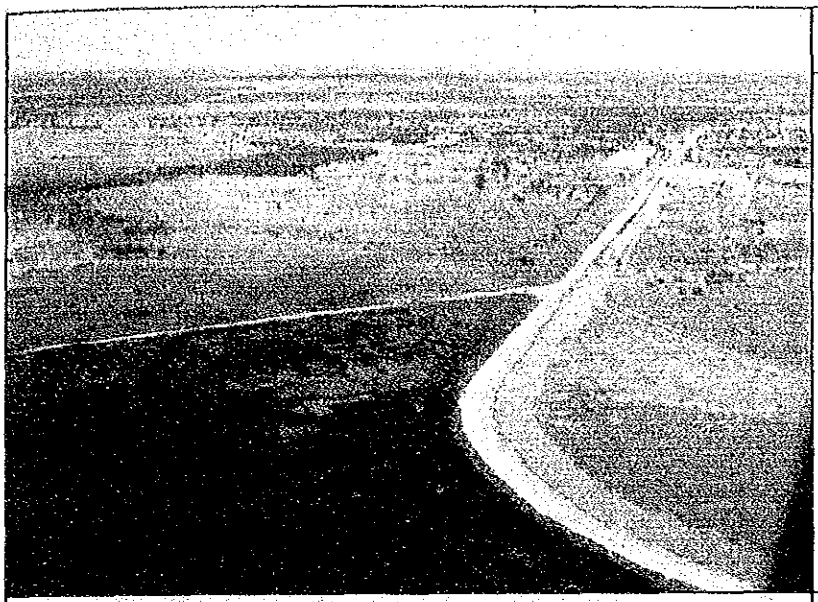


Photo. – 1

Origin of the project road in Trinidad City:

Aspect of the circle levee in Trinidad City and flood condition.

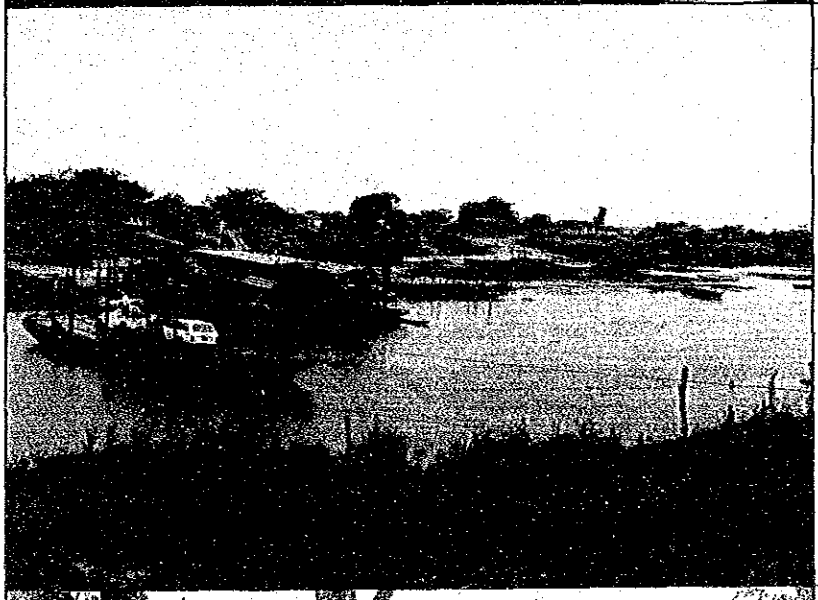


Photo. – 2

At the point of 8 km apart from Trinidad City:

Aspect of present transportation system by ferry boat in the Ibare River.

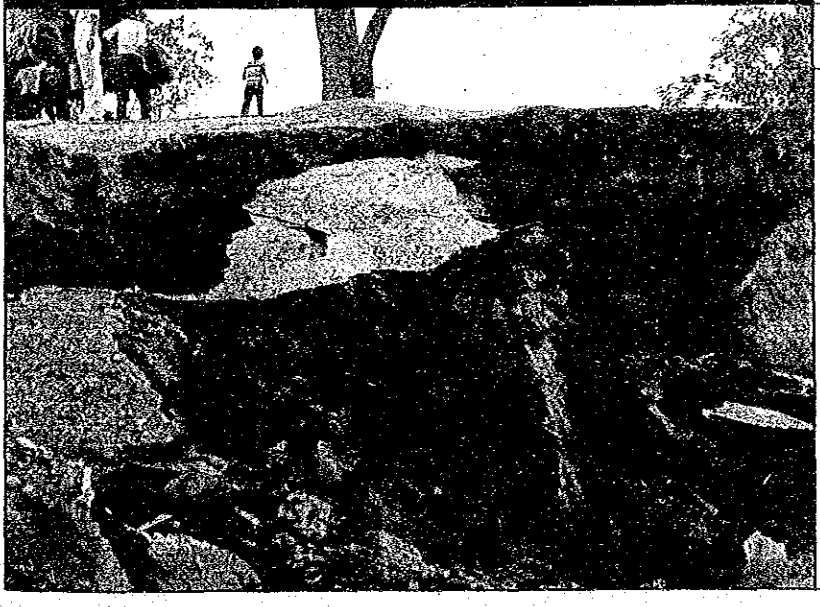


Photo. – 3

At the point of 10 km apart from Trinidad City (Pto. Ganadero):

Collapse of the levee due to erosion on the Mamore River.
5m collapse within 3 weeks was obserbed.

Photo. – 4

At the point of 10 km apart from Trinidad City:

Aspect of present river chnnel of the Mamore River.

Photo. – 5

As the point of 21 km apart from Trinidad City:

Aspect of present road in Pampa area and cross drain pipes.

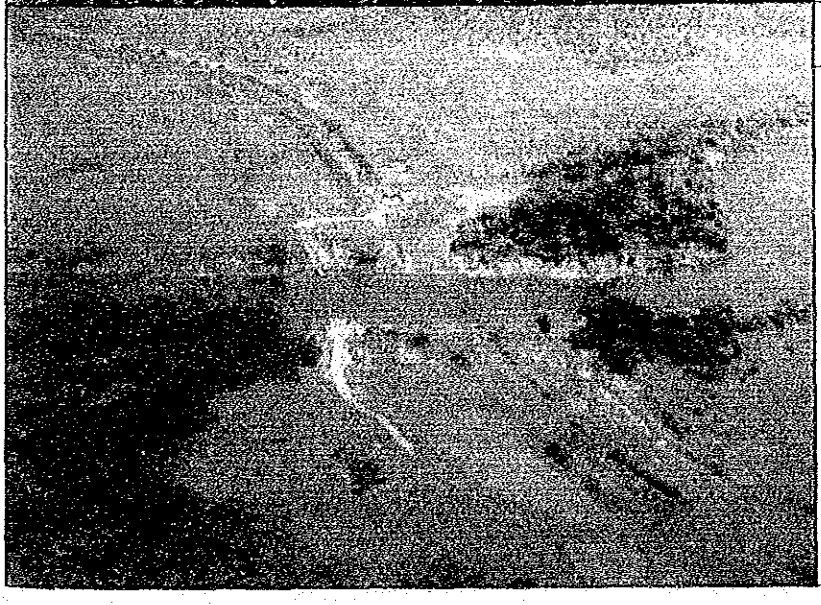


Photo. – 6

At the point of 22 km apart from Trinidad City:

Aspect of the Tijamuchi River and present road. Proposed construction site of Tijamuchi Bridge. (Bridge length 136 m)

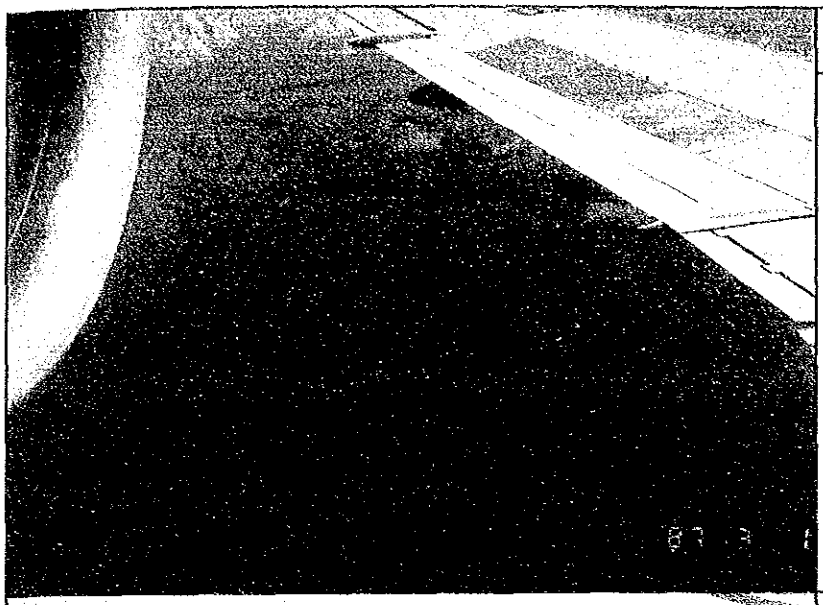


Photo. – 7

At the point of 22 km apart from Trinidad City:

Aspect of flood condition along the Tijamuchi River in rainy season.
Roads are completely inundated.

Photo. – 8

At the point of 107 km apart from Trinidad City:

Aspect of present road condition around El Tajibo in rainy season.
Present construction site of Tajibo Bridge (Bridge length 30.7 m)

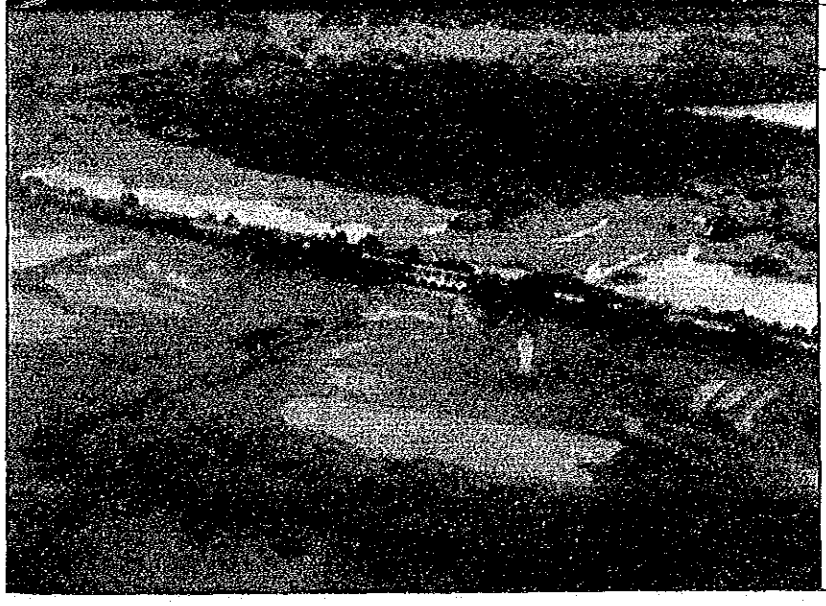


Photo. – 9

At the point of 108 km apart from Trinidad City:

Aspect of continuous 8 corrugate pipes and present road condition.

Photo. – 10

At the point of 119 km apart from Trinidad City:

Aspect of present road condition in the forest area.

Photo. – 11

At the point of 208 km apart from Trinidad City:

Present bridge on the Curiraba River.

Photo. – 12

At the point of 219 km apart from Trinidad City:

Aspect of present ferry service on the Maniqui River. Bridge construction, being executed, is seen across the river.

CONCLUSIONS AND RECOMMENDATIONS

1. General

1.1 The substance of this project is the improvement of the 229 km of road connecting the cities of San Borja and Trinidad in the Department of Beni, a food producing region for the capital city of La Paz.

1.2 The Presidential Decree No. 547, of May 1983, considers the completion and the maintenance of the road between San Borja and Trinidad a matter of the highest order of priority for the Nation.

The main reasons for the urgency of the completion of this road are as follows:

1) To transport economically and without hindrances to the central marckets the goods produced in the road influence area.

2) To facilitate the policy of internal migration for encouraging the future development of this region.

3) To establish government control in the frontier areas.

1.3 The completion of an all-weather road between the cities of San Borja and Trinidad, besides benefiting the development of Bolivia, is fundamental to the establishment of a national network of roads.

1.4 The results of the analysis of the flood and the investigations for the methods of the crossing of the Mamoré RIver indicate that the construction of an all-weather road is technically feasible.

1.5 To reduce the construction costs, narrowing of the road shoulders, paving in stages, utilization of the present road, etc. were considered in the design. The cost of the project is estimated at US$ 61,800,000.

The planned construction period is four years, between 1990 and 1993.

1.6 The economic benefits that will be brought about by the completion of this project such as savings on travelling and transportation costs is estimated to total US$ 25 millone in 2003 and US$ 41 million in 2013.

1.7 It was also established through this study that the project is economically feasible taking into consideration economic indicators such as the internal rate of return (IRR), the Benefit/Cost ratio (B/C) and the present net value (PNV). The above project values are as follows:

Internal Rate of Return (IRR).....24.75%
Benefit/Cost (B/C).....2.5
Present Net Value (PNV).....US$ 75,185,000

1.8 The San Borja - Trinidad road improvement project should be implemented as soon as possible in view of the favourable return on investments and its significant collateral benefits.

1.9 Because of the large economic investment required in a short period of time, it will be reasonable to apply to international financial institutions for the financing of the construction.

The Inter American Development Bank (IDB) seems to be the most appropriate institution for the financing of the Project.

1.10 As a condition for financing of projects, the Inter American Development Bank requires the execution of environmental studies and studies of the different social strata, which were not included in the present study. These studies are due to be carried out by the SNC.

2. Impact of the Project

2.1 Besides connecting La Paz and Santa Cruz, the two most important cities in Bolivia, the completion of the planned route will result in the creation of a large circular road connecting the main cities of the country and in the formation of the framework of the national road network.

2.2 The completion of the Project, will not only improve communications, and transportation of people and goods, but will also be a positive element in the efficient administration of the region..

2.3 After the completion of this Project, Trinidad, the departmental capital of Beni, which has up to the present time had an image of isolated island, will be more fully integrated with other regions of the country. Towns and villages in the neighbourhood of Trinidad will also greatly benefit from the Project.

2.4 Conveyance of agricultural products such as meat and wheat from the area along the existing road to La Paz depends largely on aerial transportation at present. The completion of an all-weather road will make trasportation by land the prevalent method of transportation and this change in the method of transportation will result in a significant reduction in transportation costs of goods.

2.5 The change from a dry season road to an improved all-weather road will stimulate private investments in the large territory covered by the road influence area.

The development of the area along the road will be a demonstration of the strength and stability of the Nation not only to those within the country but also at an international level.

3. Aspects Related to the Execution of the Project

3.1 The cost of this Project at August 1988 prices, was calculated at US$61.800.000. The major component of the total cost is that of the transportation of aggregates for the subbase and the pavement, which makes up 42% of the total cost.

Efforts should be made to reduce these transportation costs.

3.2 Since the projected road is a part of the trunk route connecting La Paz, Santa Cruz and Trinidad, its full effect will depend on the condition of the roads at both ends.

For this reason, the improvement of the road sectors La Paz - San Borja, and Santa Cruz - Trinidad, is of high priority in obtaining the planned impact with the present Project.

3.3 Seventeen bridges are to be built between San Borja and Trinidad. while ten out of the seventeen are to be constructed under the present project, the remaining seven are to be completed by SNC before the implementation of the Project.

3.4 In the execution of the present Project, care must be taken to avoid damages being caused by flooding to parts already constructed and lowering of the quality of the road due to use by traffic during the rainy season. Plans should be made taking sufficient account of the rainy season and adhered to faithfully.

Before the rainy season starts, for example, the earthwork already initiated must be completed up to the subbase work, the drainage pipes started must be completed up to the earthfill and headers, and the abutments of the bridges should be completed up to their protection work.

3.5 In the maintenance and administration of the improved road, special attention should be given to the following: periodic leveling and supply of gravel, cleaning of drainage pipes , inspection and emergency repair of the banking around the abutment of bridges, and dredging and maintenance of the ferryboat terminals and facilities.

OUTLINE OF THE PROJECT

1. Description of the Project

Starting point of the Project: Trinidad
Cercado Province
Departament of Beni

Ending point of the Project: San Borja
Ballivian Province
Departament of Beni.

Length of the Project

Total length of the work:	221.93kms.
(Not including the length of the river crossing)	
Length of the road:	220.94kms.
Asphaltic concrete:	10.37kms.
Gravel wearing surface:	210.57kms.
Total length of bridges:	0.99kms.
Length of the Ferryboat crossing (Mamoré River):	7.06kms.

2. Technical Specifications (Manual and Norms for the geometric design of roads, 1984: SNC)

Road Classification:	Class III
Design Speed:	100 km/h
Traffic Lanes:	2
Road Width:	9 m.
Wearing Surface Width	7 m.

3. Quantity of Work

Earthfill:	2,524,963 m3
Pavement:	
Asphalt t = 6cm.	71,000 m2
Gravel t = 20cm.	2,032,000 m2
Corrugated pipes	177 locations.
Bridges	17
(Seven to be completed by 1990)	
Total length of bridges (17)	987.2 m.
Total length of bridges (10) to be built under the Project.	381.9 m.
Ferryboat Terminals	2 locations.
Total length of channels (3)	2,414 m.

4. Costs of the Project

(1988'S PRICES)

Foreign Currency portion	US$	37.122.000	60.1%
Local Currency portion	US$	24.649.000	39.9%
(Taxes US$ 9.171.000 14.8%)			
(Others US$ 15.478.000 25.0%)			
T O T A L	US$	61.771.000	100%

5. **Term of Execution**

1990 - 1993 4 years

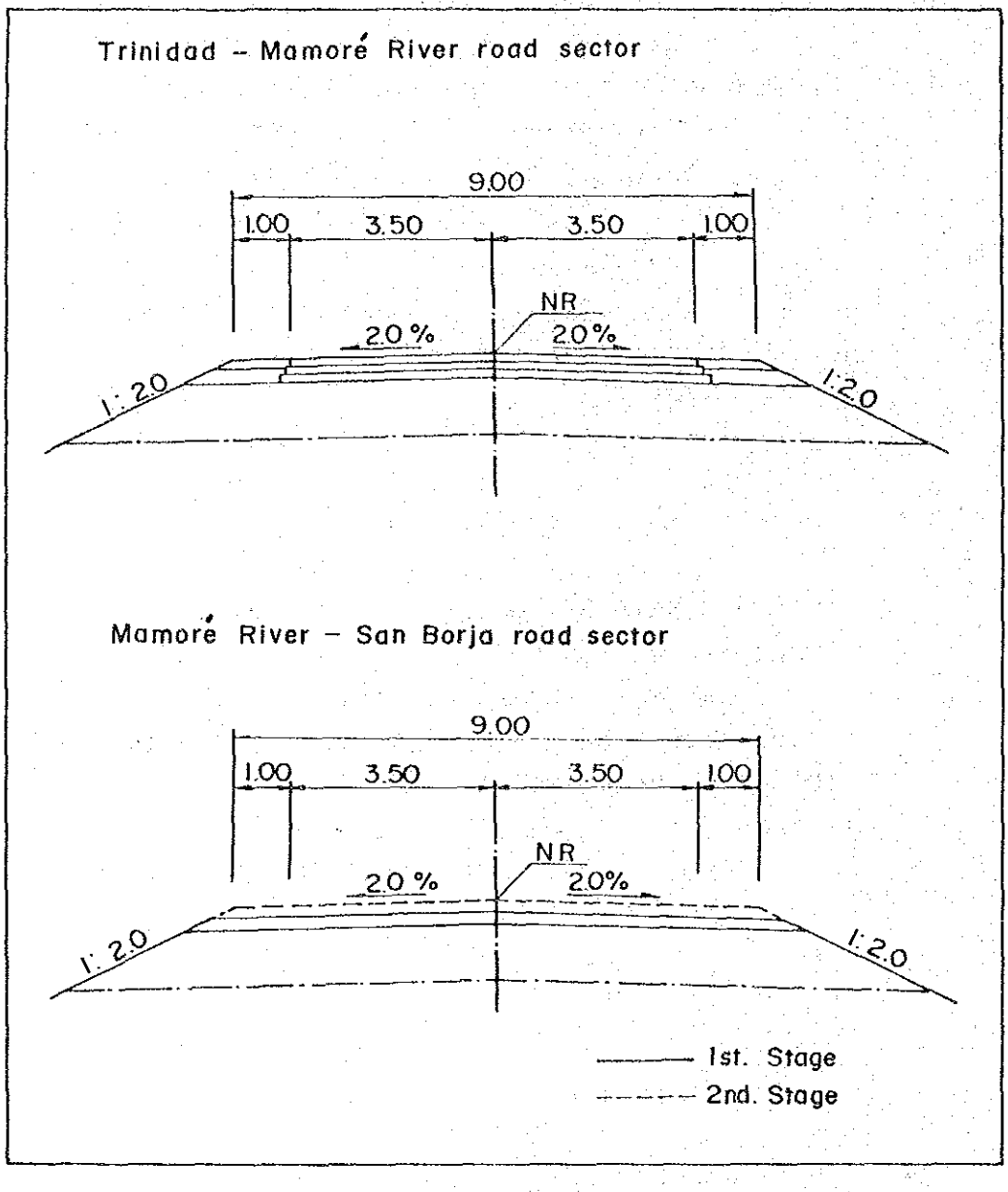
6. **Program of Budgets for the Construction**

1990.....	US$ 11,360,000.-
1991.....	US$ 18,685,000.-
1992.....	US$ 19,717,000.-
1993.....	US$ 12,009,000.-
Total	US$ 61,771,000.-

7. **Economic Evaluation Indicators**

Internal Rate of Return	24.75%
Benefit/Cost Ratio (Discount Rate 12%)	2.5
Valor Actual Neto (Discount Rate 12%)	US$ 75,185,000.-

8. Typical Cross Section



9. Projected Traffic Volume

PROJECTED TRAFFIC VOLUME

(Vehicles/day)

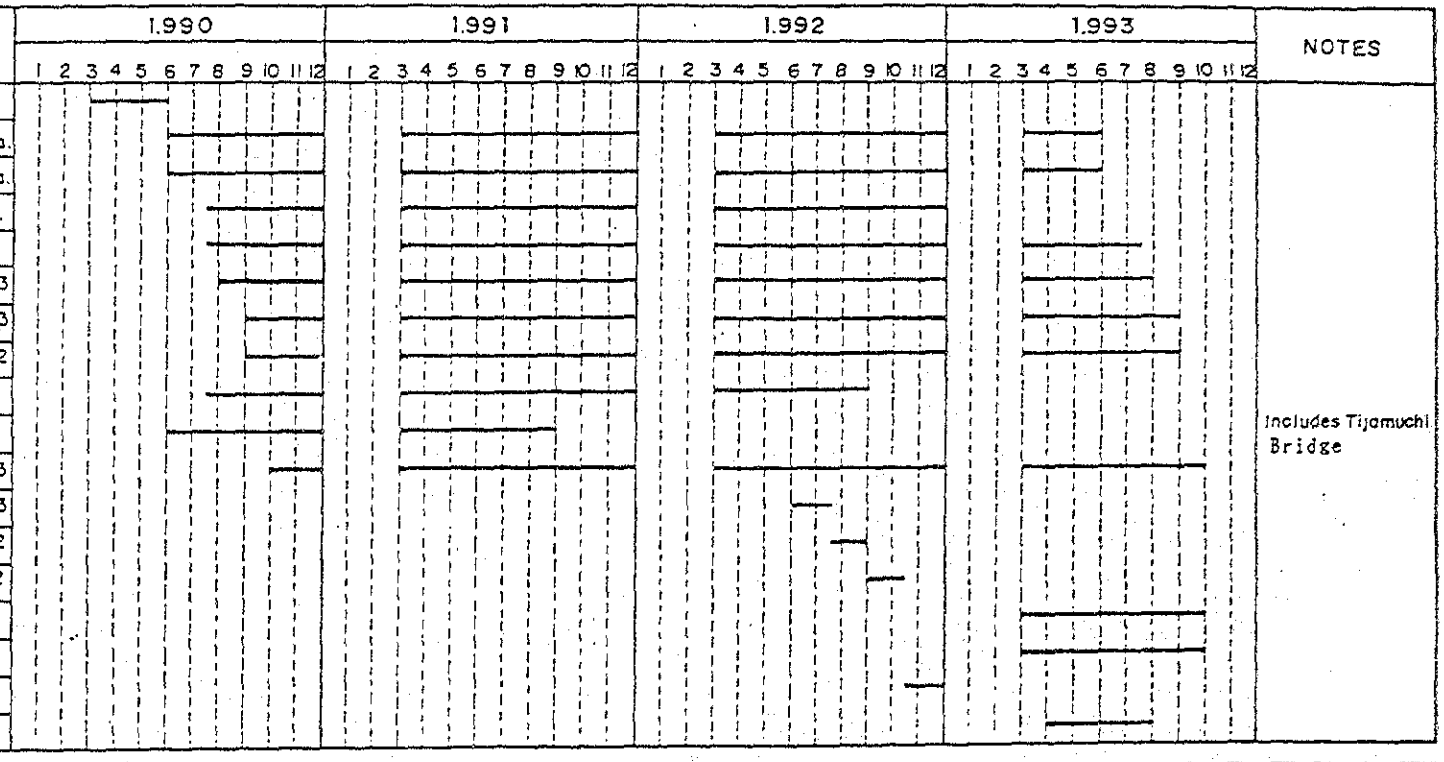
ROAD SECTOR / TYPE OF VEHICLE / YEAR	SAN BORJA - SAN IGNACIO					SAN IGNACIO - PTO. GANADERO					PTO. GANADERO - PTO. VARADOR					PTO. VARADOR - TRINIDAD				
	A	B	C	D	TOTAL	A	B	C	D	TOTAL	A	B	C	D	TOTAL	A	B	C	D	TOTAL
1984 (Present Traffic)	20	7	7	0	34	23	5	7	0	35	23	5	7	0	35	141	12	113	0	266
1994 (First Year of Operation)	39	14	14	61	128	45	10	14	51	120	45	10	14	45	114	277	24	222	67	590
1998	51	18	18	66	153	59	13	18	55	145	59	13	18	49	139	362	31	290	76	759
2003	72	25	25	75	197	83	18	25	64	190	83	18	25	56	182	507	43	407	89	1.046
2008	101	35	35	84	255	116	25	35	71	247	116	25	35	63	239	711	61	569	102	1.443
2013 (20th Year of Operation)	141	49	49	93	332	162	35	49	83	329	162	35	49	71	317	996	85	798	116	1.995

Pto.Ganadero: Left Margin of the Mamore River
Pto. Varador : Right Margen of the Mamore River

A : Small Vehicle
B : Medium Vehicle
C : Large vehicle: Trucks and buses (based on the present traffic
D : Large Vehicle: Trucks and buses (converted traffic)

10. WORK SCHEDULE

ITEMS	QUANTITY	NOTES
Preparation		Includes Tijamuchi Bridge
Stripping	1,347 ha.	
Clearing and swamping	579 ha.	
Removal of present culverts	930 m.	
Corrugated metal culverts	3,935 m.	
Earthfill body	1,240,982 m^3	
Subgrade	373,709 m^3	
Shaping of subgrade	2,159,903 m^2	
Ferry boat facilities	Global	
Bridges	10 ptes.	
Subbase layer	438,357 m^3	
Base layer	7,179 m^3	
Asphalt top layer	70,781 m^2	
Shoulder paving	20,223 m^2	
Protections	8,892 m.	
Vertical signals	Global	
Horizontal signals	Global	
Ferry boat administration office	Global	



EQUIPMENT	QUANTITI
Bulldozer (21 ton.)	26
Back hoe (0.6m^3)	6
Tractor shovel (2.1m^3)	4
Dump truck (11 ton.)	141
Pneumatic tire roller	4
Vibrating roller	2
Motorgrader (3.7m.)	2
Concrete mixer (0.6 m^3)	6
Asphalt plant	1
Asphalt finishing machine	1
Stone crusher(complete set)	1

11. Quantity of work and cost of the project

Unit : US$

Type of Work	Name of the Activity	Size and Type	Unit	Volume	Unit Cost			Costs			SUB TOTAL
					Local currency		Foreign currency	Local currency		Foreign currency	
					Tax	Others		Tax	Others		
Earthfill	Strip		ha	1,347.16	240.00	270.0	1,020.00	323,318.40	363,733.20	1,374,103.20	2,061,155
	Clearing and swamping		ha	578.90	618.44	696.33	2,617.78	358,014.92	403,105.44	1,515,432.84	2,276,553
	Filling (earthfill)		m³	1,222,408.00	0.30	0.35	1.26	366,722.40	427,842.80	1,540,234.08	2,334,799
	(subgrade)		m³	1,302,555.00	0.12	0.16	0.53	156,306.60	208,408.80	690,354.15	1,055,070
	Earth transportation		Set	1.00	-	-	-	357,848.24	356,039.84	1,804,501.98	2,518,390
	Finishing		m²	2,159,903.00	0.013	0.018	0.054	28,078.74	38,878.25	116,634.76	183,592
Rem.of pipes	With excavation		Set	1.00	-	-	-	2,562.02	6,036.13	9,122.87	17,721
	Without excavation and filling		Set	1.00	-	-	-	424.25	2,198.26	949.58	3,572
Placing of corrugated pipes	Excavation		m³	19,152.81	0.15	0.22	0.59	2,872.92	4,213.62	11,300.16	18,387
	Foundation		m³	3,621.74	0.57	1.49	2.03	2,064.39	5,396.39	7,352.13	14,813
	Placing of pipes		Set	1.00	-	-	-	303,535.00	220,076.54	1,012,280.36	1,535,892
	Earthfill material		m³	29,718.96	0.57	1.49	2.03	16,939.81	44,281.25	60,329.49	121,551
Redders	Concrete		m³	3,067.70	7.10	49.82	8.32	21,780.67	152,832.81	25,523.26	200,137
	Foundations		m²	10,762.34	0.19	1.41	0.26	2,044.84	15,174.90	2,798.21	20,018
	Forms		m²	14,176.77	1.00	8.83	0.12	14,176.77	125,180.88	1,701.21	141,059
	Brick walls		m²	2,591.01	10.43	88.80	5.43	27,024.23	230,081.69	14,068.18	271,175
	Concrete layer		m³	322.87	8.86	68.09	7.26	2,860.63	21,984.22	2,344.04	27,189
Pavements	Top later		m²	70,781.00	2.64	2.98	7.53	186,861.84	210,927.38	532,980.93	930,770
	Base layer		m³	7,179.00	10.17	12.90	42.63	73,010.43	92,609.10	306,040.77	471,660
	Shoulder paving		m²	20,223.00	1.40	1.74	5.64	28,312.20	35,188.02	114,057.72	177,558
	Subbase		Set	1.00	-	-	-	3,172,915.04	3,995,133.80	13,637,818.21	20,805,867
Complementary Works	Side ditches		m	1,300.00	0.30	0.44	1.18	390.00	572.00	1,534.00	2,496
	Protections		m	8,892.00	5.91	1.74	14.05	52,551.72	15,472.08	124,932.60	192,956
	Fluvial by-pass gutters		m	270.00	7.44	9.60	30.48	2,008.80	2,592.00	8,229.60	12,830
	Signs		Set	1.00	-	-	-	5,128.32	13,373.97	14,070.65	32,573
	Pavement signs		m	26,341.10	0.02	0.18	-	526.82	4,741.40	-	5,268
	Administrative office		m²	4,380.00	28.00	252.00	-	122,640.00	1,103,760.00	-	1,226,400
	Ferryboat office		m²	214.00	28.00	252.00	-	5,992.00	53,928.00	-	59,920
Struc-ture	Ferryboat instalations		Set	1.00	-	-	-	273,709.13	438,230.86	1,092,967.75	1,804,908
	Bridges	9 Bridge	Bridge	-	-	-	-	242,280.20	773,754.91	782,880.11	1,798,915
		Tijaeuchi	Bridge	-	-	-	-	214,333.93	340,660.19	717,912.81	1,272,907
Cost Distribution											
	Total direct cost of the construction		(D)					6,367,235.26	9,706,408.73	25,522,456.65	41,596,101
	General costs (administration)		(G=D×25%)					1,591,764.74	2,426,591.27	6,380,543.35	10,398,899
	Total construction cost		(C=D+G)					7,959,000	12,133,000	31,903,000	51,995,000
	Engineering Cost		(I=C×6.5%) (M.L. 40%, M.E. 60%)					307,000	1,299,000	1,844,000	3,380,000
	Administration Cost		(A=C×1.5%)					71,000	709,000	-	780,000
	Total		(T=C+I+A)					8,337,000	14,071,000	33,747,000	56,155,000
	Contingencies		(B=T×10%)					834,000	1,407,000	3,375,000	5,616,000
	Cost of Project		(T+B)					9,171,000	15,478,000	37,122,000	61,771,000
	Percentage							14.8 %	25.1 %	60.1 %	-
	Cost of Project without taxes							-	15,478,000	37,122,000	52,600,000
	Percentage							-	29.4 %	70.6 %	-

SUMMARY

CONTENTS

1. INTRODUCTION

1.1 Background of the Study

The early completion of Route No. 3 of the National Road Network Linking La Paz, the capital of Republic of Bolivia, and Trinidad, the departmental capital of Beni, as an all-weather road has been considered for long time to be the top priority project in the country.

The improvement of Route No.3 has been carried out gradually from La Paz and the improvement work of the road up to San Borja, with the exception of a few sections, is within sight of completion. In the section between San Borja and Trinidad, on the other hand, with a distance of approximately 230 km, the existing road becomes impassable during the rainy season. This is the last section that requires improvement and the accomplishment of the improvement of this section will result in the completion as an all-weather road system of the whole of the circular road network mentioned above covering a wide area of the country.

Under these circumstances, and in response to a request from the Bolivian Government, the Japanese Government decided in 1985, to execute the Study for the Improvement of the Trinidad - San Borja Road, within the Technical Cooperation Program between the two countries.

The first phase of the Study (Phase I) was dedicated to the technical examination and the field investigation at the project site, and was carried out between October 1985 and July 1987. The technical examination at this stage was carried out at the level of a feasibility study.

On the basis of the results of Phase I of the Study, the Japanese Government went on to the execution of a second stage, in response to a further request from the Bolivian Government. This is the Phase II of the Study which entailed field investigation, road design, economic evaluation and other aspects of the road improvement project for the above-mentioned road sector.

In order to implement this phase of the Study, the Japan International Cooperation Agency sent (June and July 1987) an official mission to Bolivia to discuss with the Bolivian Government representatives the principle and the substance of Phase II of the Study and the Scope of Work Document (S/W) was signed by both parties.

After the signing of the Scope of Work Document, the Japan International Cooperation Agency sent the study team in charge of the execution of Phase II of the Study to Bolivia in September 1987.

The study team completed the Phase II Study in October 1988 compiling the results in this draft of the Final Report.

It is hoped that this road improvement project will be implemented with the financing of the Interamerican Development Bank.

1.2 Purpose of the Study

The purpose of this Study was to carry out examinations from technical and economic points of view for the improvement of the road between San Borja and Trinidad, making use of the results of the Phase I of the study, to carry out the necessary research and to work out the design for the improvement and equipment of the road at the level of an all-weather road and, at the same time, to extimate and to analyze social and economic impact resulting from the improvement of the road.

Furthermore, the transfer of technology to local Bolivian technicians, through the execution of the Study, was included as another objective of the project.

1.3. Object of the Study

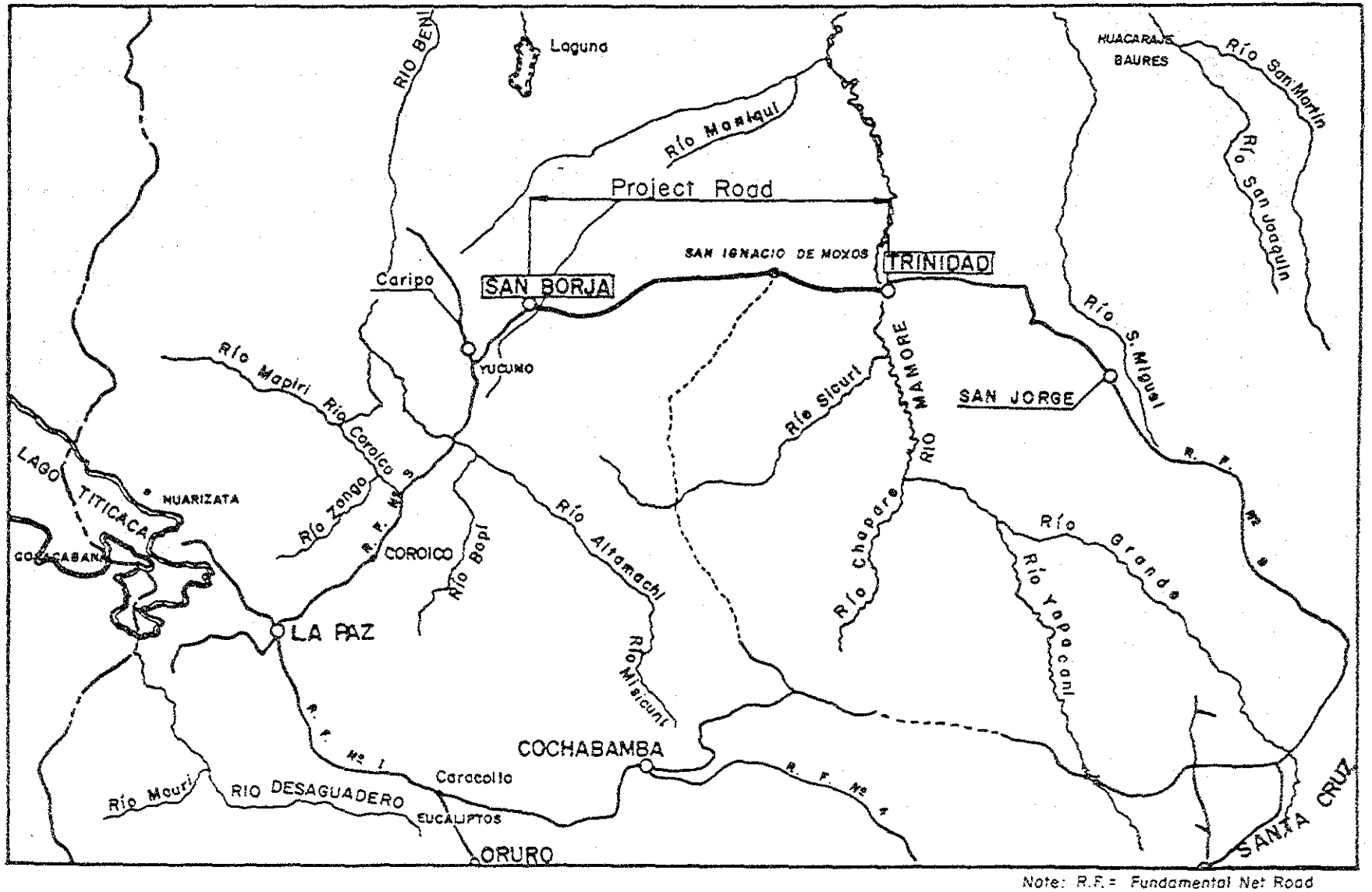
The road sector, which is the object of this Study, starts in the city of Trinidad, located in the Cercado Province of the Departament of Beni, and ends in the city of San Borja, located in the José Ballivian Province of the Departament of Beni. The approximate distance between the two is 230 kms. (Figure 1-1).

It is planned that a ferryboat system should be instituted for the crossing of the Mamoré River which occurs along the road. The length of the road excluding the length of the crossing is 222km. The construction of the terminals and the channels for the Mamoré River crossing, however, were examined in the present study.

A total of 17 bridges have been considered for construction in the road sector of reference. Eight out of these 17 bridges, have been excluded from the present Study, since their designs have already been

completed and it is planned that their construction should be executed before the implementation of the San Borja-Trinidad road improvement project.

During the last year of the Study, however, the Bolivian Government requested that the construction cost and the construction program for the Tijamuchi Bridge proposed by the Bolivian side be included in the study and those items as were requested were accordingly included in the study.



Note: R.F.= Fundamental Net Road

Fig. 1-1 Location Map

1.4 Method of the Study

In order to comply with the above mentioned purpose of the Study, studies under Phase II were carried out according to the flowchart and the schedule described in Figure 1-2.

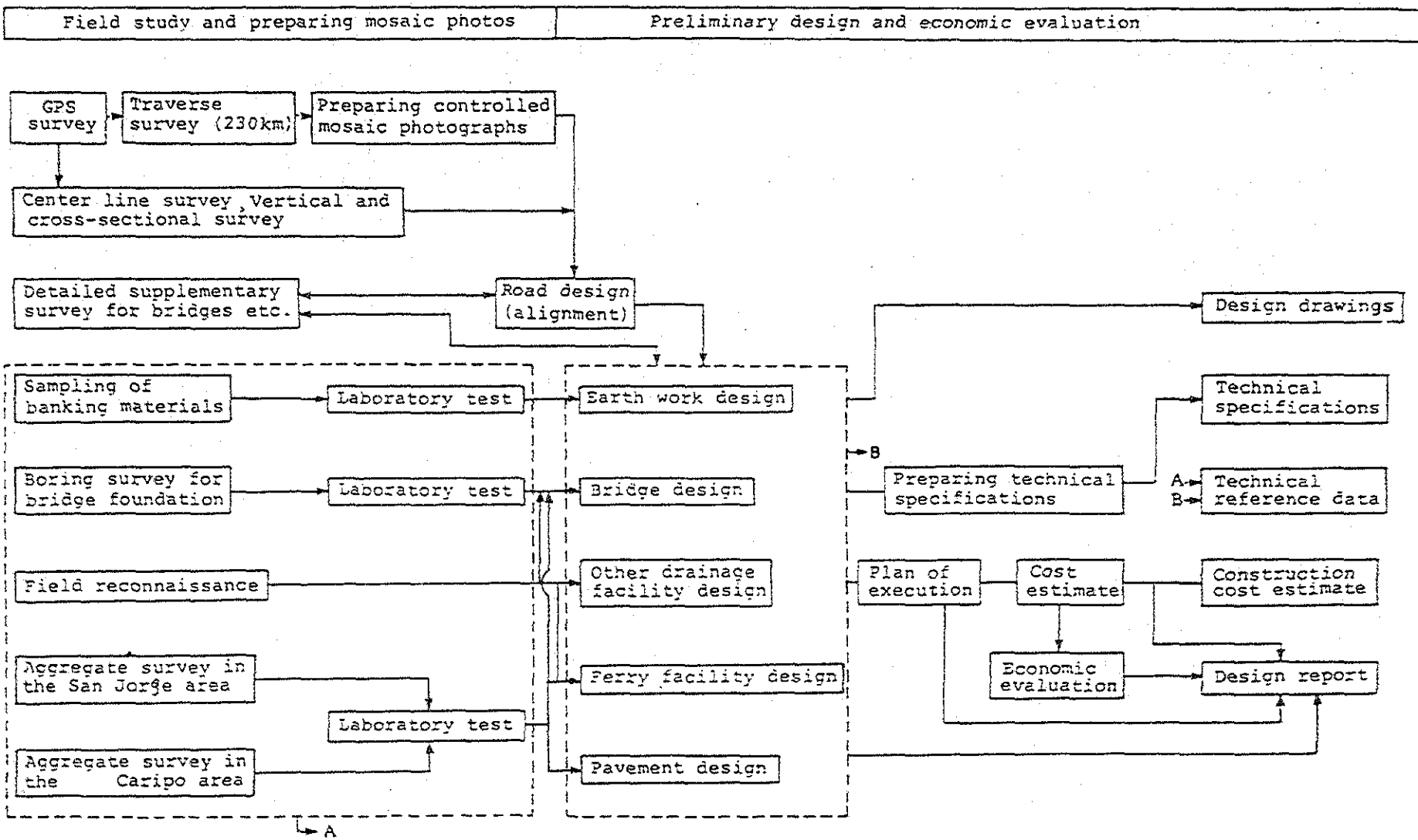


Fig.1 - 2 WORK FLOW CHART

1.5 Proposed Dimensions of the Project

1) Road Sector

City of San Borja - City of Trinidad, both in the Department of Beni.

2) Basic Specifications of the Project.

Road Width:	Total	= 9m.
	Carriage 3.5 x 2	= 7m.
Length of the Project:	Road	= 221.9km.
	Transfer (Mamoré River)	= 7.1km.
	TOTAL	= 229.0km.
Main Structures:	17 bridges, total length 987.2m. (Seven of them currently under construction and/or with the construction planned prior to the execution of the present Project).	
Ferryboat Terminals:	Two (Mamoré River)	
Channels:	Three (Mamoré River)	
Type of Pavement:	Trinidad-Mamoré River: Asphalt Concrete But gravel wearing surface also used between San Borja and Mamoré River.	

2. PREPARATION OF THE PHOTO-MOSAIC AND FIELD INVESTIGATION

2.1. Ground Control Survey and Traverse Survey

1) Ground Control Survey through the Global Positioning System (GPS).

Points Surveyed	
Existing Local Triangulation	1 point
New Ground Control Points	8 points
Azimuth Reference Signs	9 points
TOTAL	18 points

2) Traverse with GPS Connected Points

Routes Surveyed: 8 routes (230 linear kms.)
Monumentation: 41 points (approx. every 5km.)

Accuracy of the Observation:

Route / Error of closure								
Azimuth	-42"	+14"	-39"	-74"	-61"	-14"	-11"	-3"
Coordinates	1/13078	1/19491	1/13117	1/10439	1/21811	1/51178	1/13366	1/21196

2.2. Aerial Triangulation and Photo-Mosaic Preparation

1) Aerial Triangulation

Control Points used: 60 points
Stereo Base Models: 20 courses, 104 models
Accuracy

Block			1	2	3	4	5
Course No.			C1 - C7	C8 - C11	C12 - C13	C14 - C15	F1 - F5
Residual at Control Points	Horizontal	Maximum	2.48m	2.69m	1.19m	2.20m	2.55m
		Standard Deviation	0.96	1.08	0.69	1.01	1.63
	Elevation	Maximum	-0.70	1.43	-1.37	1.80	-0.78
		Standard Deviation	0.39	0.36	0.53	0.50	0.42

Preparation of the Rectified Photo-mosaic

Photo-mosaic: 176 sheets (84cm. x 59cm. polyester base)

Accuracy: The maximum rectification error is less than 2.5mm. in the 1/2000 scale photo-mosaic, or within 0.2mm. in the 1/25000 scale negatives.

2.3 Investigation of Soils and Aggregates

(1) Soils Investigation

1) Most of the material in the whole of road sector was clasified as A-7, A-6 and A-4, and there was also a small amount classified as A-2. Each category takes up 45%, 29%, 23% and 3% of the total length of the road, respectively.

All these materials can be used for filling the embankment and also as subgrade material for the projected road, with the exception of the soils clasified as A-7 in some parts of the road sector.

2) The soil (A-7) around the road between Trinidad (Starting Point) and the right margin of the Mamoré River (10.4 km Point) shows low CBR values ranging from 1 to 3 and is unsuitable as subgrade material.

There is, however, high quality soil (A-4) in the last part of this section (in the natural embankment at the right margin of the Mamoré River) which can be used as subgrade material.

3) Most of the soil between the left margin of the Mamoré River (10.4 km Point) and the 19 km point shows low CBR values ranging from 1 to 3 and better quality soil should be used in the top part of the subgrade.

For the material for the top part of the subgrade, the high quality soil of the natural embankment at the left margin of the Mamoré River can be used.

2.4 Aggregate Investigation

The quarries, the selected gravel and sand pits, and the types of aggregates are as follows:

1) Materials for the Subbase Course

- San Borja Sector Borrow Pits
  (for the road between San Borja and the 29.1 km station)

  Caripo and Dartagñan--pit-run gravel.
  The use of a mix of materials both banks is recommended.

- Trinidad Sector Borrow Pits
  (for the road between Trinidad and the 29.1 km station.)
  Cerro Chico--crusher run.

2) Materials for the Base Course and the Surface Layers

- Trinidad Sector Borrow Pits
  (To be used only between Trinidad and the Mamoré river.)

Cerro San Jorge-graded crushed stone.
(Deposit No. 1)

3) Aggregates for Concrete in Bridges

- San Borja Sector Borrow Pits
  Rio Quiquibey--fine aggregate (sand)
  --coarse aggregate (gravel)*
  * This aggregate should not be used for high strength concretes.

  Rio Alto Beni--coarse aggregate (gravel)

- Trinidad Sector Borrow - Pits
  Cerro San Jorge--coarse aggregate (crushed stone)
  (Deposit No. 1)
  Rio Blanco-fine aggregate (sand)
  (Urubicha)

3. DESIGN

3.1 Norms for the Design

(1) Road: "MANUAL AND NORMS FOR THE GEOMETRIC DESIGN OF ROADS" 1984, SNC.

(2) Pavement: "AASHTO INTERIM GUIDE"

(3) Bridges: "AASHTO - STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES"
"ACI CODE"

3.2 Design of the Road

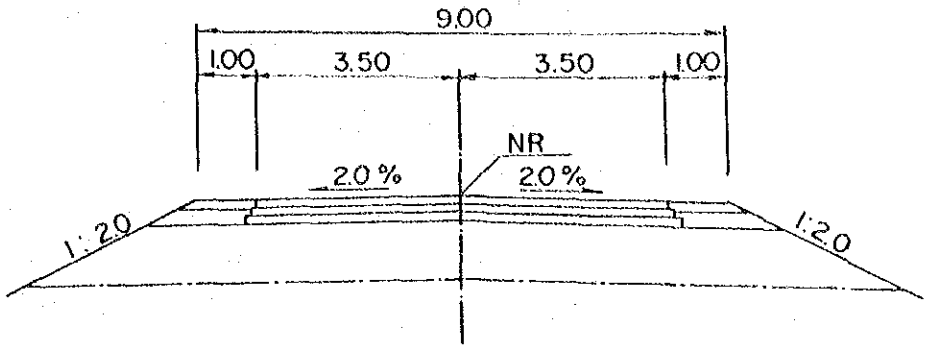
(1) Geometric Design

Table 3.2-1 Geometric Design Standards

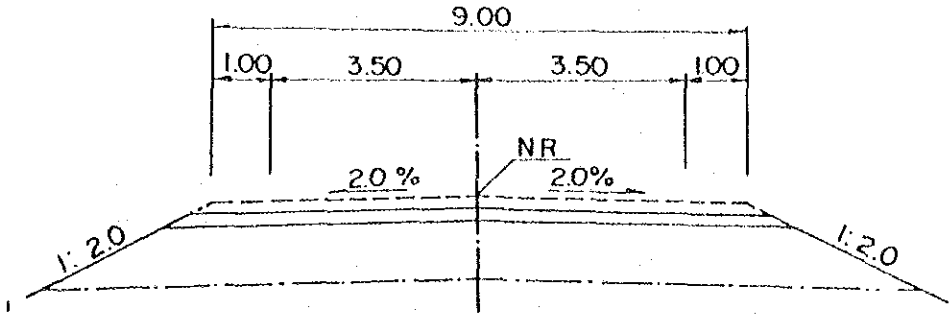
ITEMS		Basic	Actually Used
Topography		Plane	Plane
Design Speed (km/h)		100	100
Minimum Radius of Horizontal Curves (m.)		415	425
Maximum Grade %	Recommended	4	
	Admissible	5	3
Minimum Visibility Distance (m)			
	Braking	155	208
	Passing	425	
Superelevation (%)	Recommended	6	6
	Admissible	8	
Vertical Curves (K)			
Crest	Recommended	107	
	Admissible	58	58
Sag	Recommended	52	
	Admissible	36	50
Minimum Vertical Clearances (m)		5.5	more than 5.5

(2) Typical Cross Section

Trinidad-Mamoré River Road Sector



Mamoré River-San Borja Road Sector



1st. Construction Stage
2nd. Construction Stage

Fig. 3.2-1 Typical Cross Section

(3) Horizontal Alignment

The maximum use of the present road was been considered during the selection of the route.

(4) Principles for the Vertical Alignment Design

1) Geometric Design standards must be conformed to.

2) In areas liable to be flooding , the elevation of the designed subbase course must be more than 60cm above the maximum level of the water, which is 154.80m above the sea level, as established in Phase I.

3) In areas not liable to be flooding, the elevation of the designed subbase course must be 60cm or more, above the natural level of the present terrain. This criterion, however, does not apply to the road sectors with isolated higher elevations.

4) In road sectors close to bridges, the elevations proposed for the bridges will be adopted.

5) No excavation of the existing road should be carried out. This criterion, however, does not apply where there are isolated higher elevations on the existing road.

3.3 Design of the Pavement

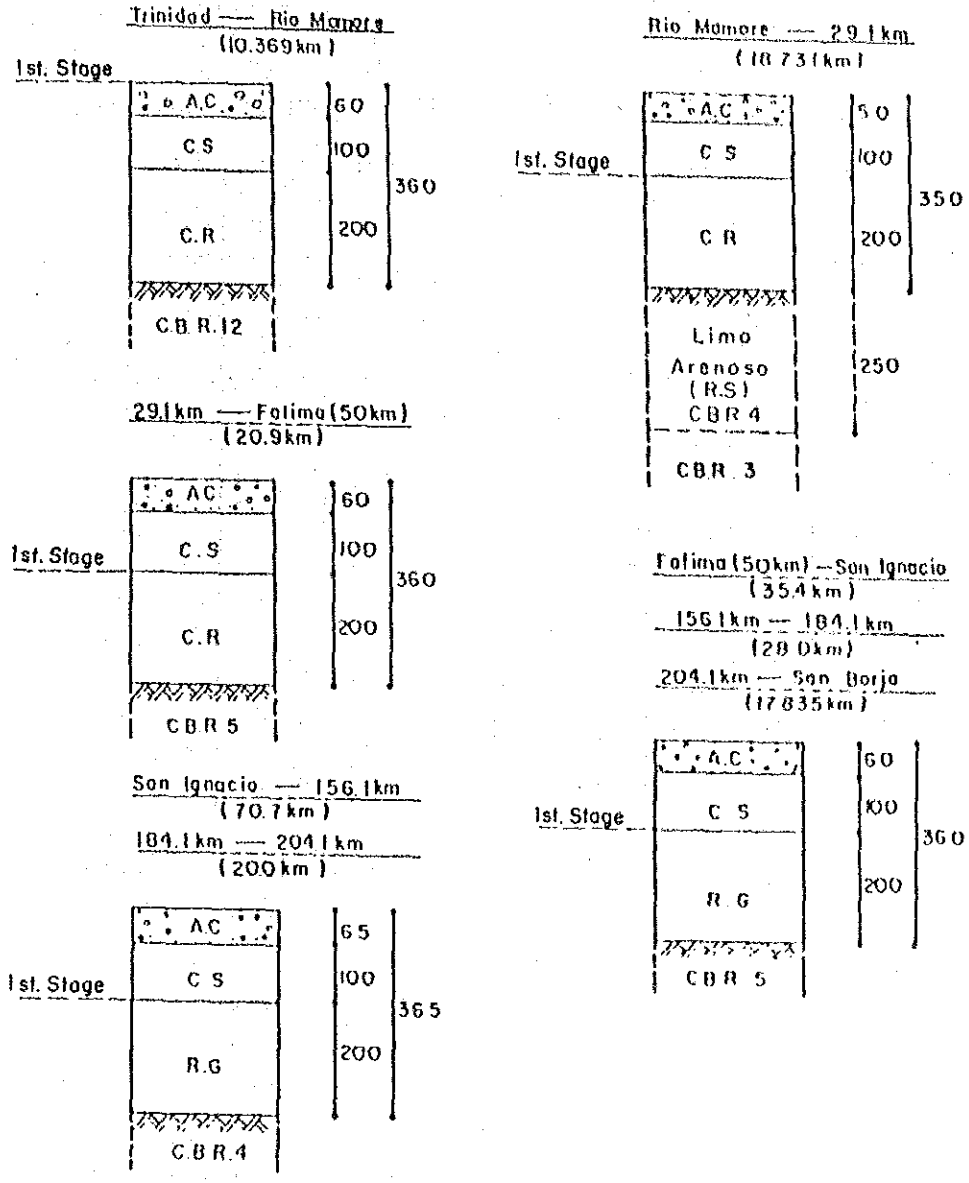


Fig. 3.3-1 Pavement structures

A.C.: Asphalt Concrete (hot mix, from Cerro San Jorge.....Top layer

C.S.: Crushed Stone (from San Jorge)...Base layer (CBR80)

C.R.: Crusher - run (from Cerro Chico).....Subbase layer (CBR60)

R.G.: River Gravel (from Carlpo and Rio Dartagñan).....Subbase layer (CBR60)

R.S.: Sandy silt from Mamoré River (left margin).....Improved Subgrade

3.4 Design of the Bridges

Table 3.4-1 Lengths of the Bridge, Girders, and Span

STATION	NAME OF THE BRIDGE	LENGTH OF THE BRIDGE	LENGTH OF THE GIRDER	LENGTH OF THE SPAN	NOTE
No. 0 + 695.0	San Juan	25.660	25.600	25.000	
No. 3 + 446.0	San Gregorio	25.660	25.600	25.000	
No. 6 + 000.0	Pto. Almacen	25.660	25.600	25.000	
No. 20 + 129.0	Amistad	30.660	30.600	30.000	
No. 23 + 900.0	Sicuri	30.660	30.600	30.000	
No.107 + 556.0	Tajibo	30.660	30.600	30.000	
No.116 + 292.0	Mururita	30.660	30.600	30.000	
No.203 + 443.0	Curirabita	20.660	20.600	20.000	
No.208 + 825.0	Curiraba	25.660	25.600	25.000	

Type of Bridge: Simple Composite girders, prestressed concrete

Abutment: Cellular Abutment

Foundation: Reinforced Concrete Pile.

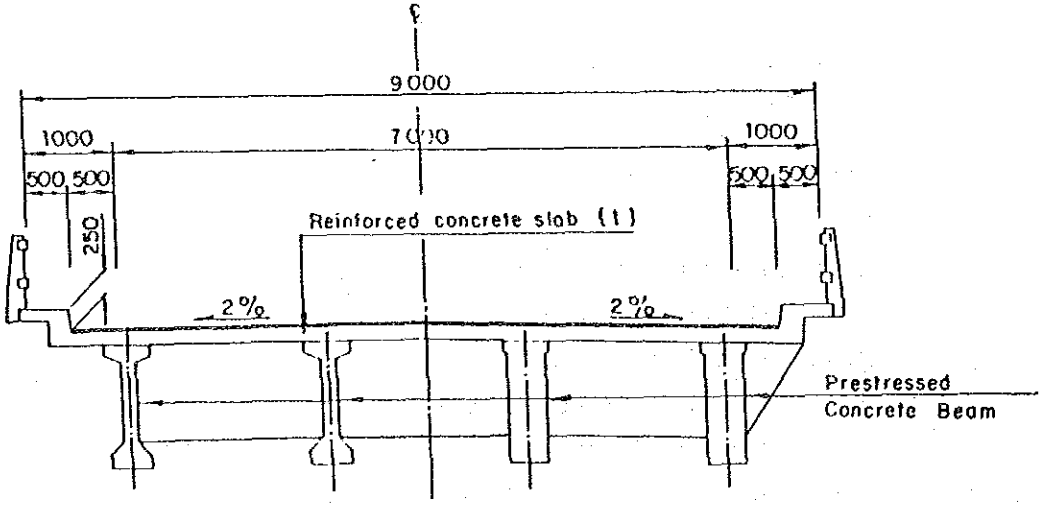
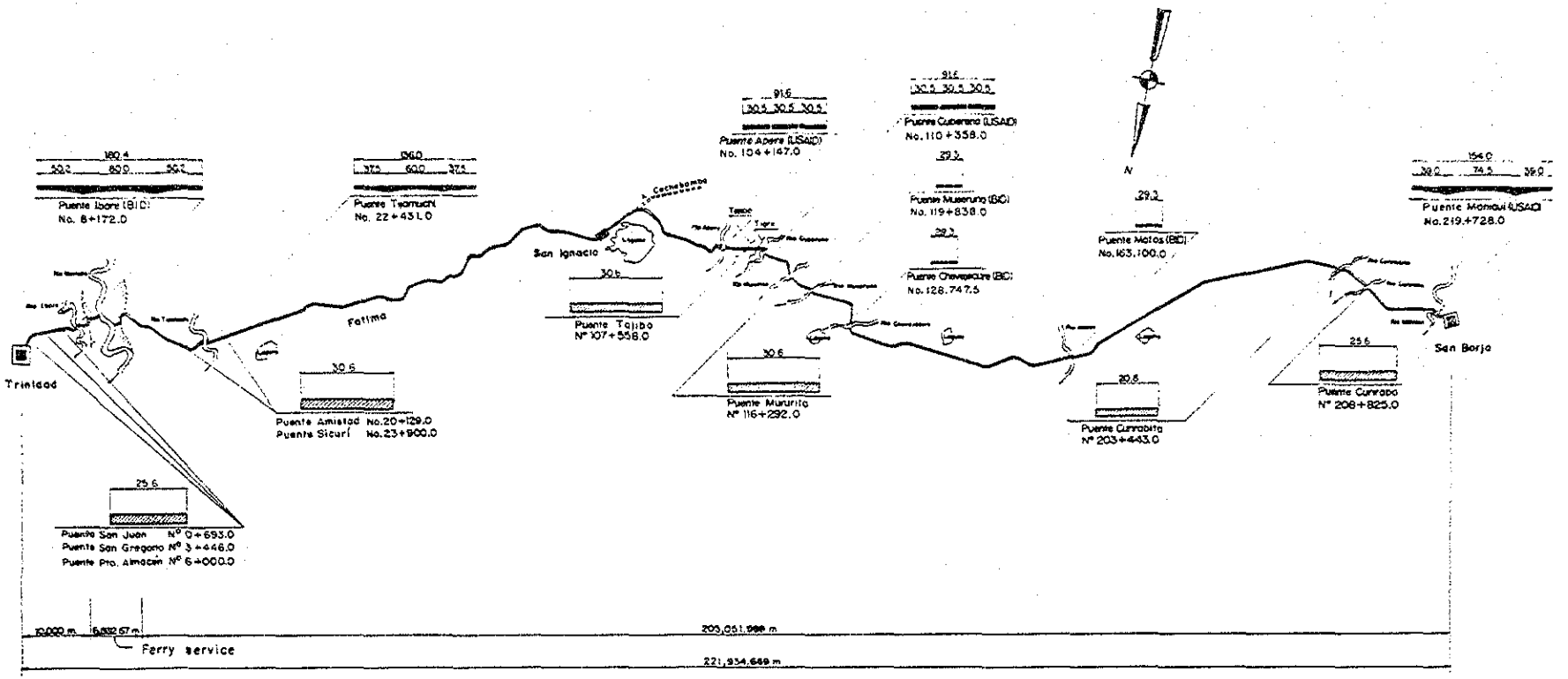


Fig. 3.4-3 Cross Section



NOTA:

: 8 Bridges designed preliminary

: Bridges designed in this Study.

Fig. 3.4-2 Location Map of the Bridges

3.5. Design of the Corrugated Pipes for Transverse Drainage

Table 3.5.1 Quantity of Corrugated Metal Pipes

Project Section	Station Number	Circular								Total
		ϕ0.90	ϕ1.20	ϕ1.50	ϕ1.80	ϕ2.10	ϕ2.40	ϕ2.70	ϕ3.00	
I	No. 0+000 ~ No. 10+368.937	—	—	—	—	—	—	—	—	—
II	No. 10+368.937 ~ No. 29+100	—	—	2	—	—	—	7	10	19
III	No. 29+100 ~ No. 50+000	1	6	1	1	2	5	2	14	32
IV	No. 50+000 ~ No. 85+400	8	15	3	—	3	—	—	—	29
V	No. 85+400 ~ No. 156+100	18	15	16	22	19	13	15	16	134
VI	No. 156+100 ~ No. 184+100	19	4	2	4	—	—	—	—	29
VII	No. 184+100 ~ No. 204+100	51	10	8	1	—	—	—	—	70
VIII	No. 204+100 ~ No. 221+934.669	2	3	13	3	—	—	—	15	36
Total		99	53	45	31	24	18	24	55	349

3.6 Design of the Ferryboat Facilities

Levels Determined

Maximum water level	154.8 m.
Minimum water level	144.5 m.
Minimum required depth	1.7 m.
Channel bed level	142.8 m.
Tolerance between the channel bed and the bottom of the ferryboat	0.8 m.

Ferryboat Dimensions

Width:	9.00 m.
Length:	30.00 m.
Draft:	0.90 m.

Ferryboat Terminal

Ferry slip grade:	15%
Ferry slip width:	9.0 m.
Ferry slip surface:	Concrete pavement (slab) Slab thickness t = 250mm. Base layer thickness t = 250mm.
Ferry slip slope:	Grade: 1:1.5 Concrete block frames with bricks filling as revetment.

Channel

Minimum Depth:	1.70 m.
Channel bed width:	21.00 m.
Channel slope:	Cutting
Lateral slopes grade:	1 : 2

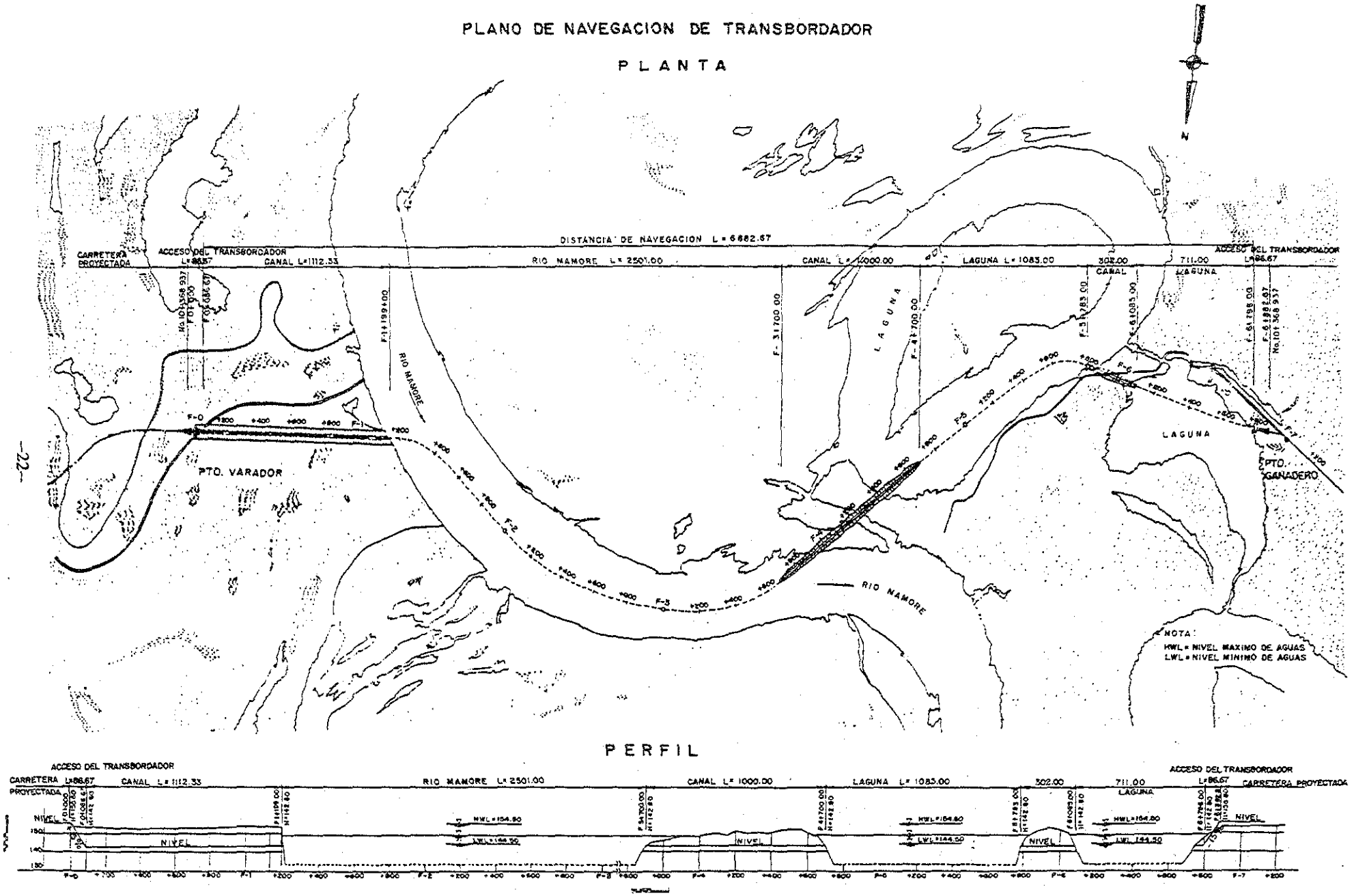


Fig. 3.6-1 Facilidades de Transbordador

4. Program execution

Table. 4-1 GENERAL EXECUTION SCHEDULE

ITEMS	QUANTITY	1.990	1.991	1.992	1.993	NOTES
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
Preparation						
Stripping	1.347 ha.					
Clearing and swamping	579 ha.					
Removal of present culverts	930 m.					
Corrugated metal culverts	3.935 m.					
Earthfill body	1,240.982 m^3					
Subgrade	373.709 m^3					
Shaping of subgrade	2,159.903 m^2					
Ferry boat facilities	Global					
Bridges	10 ptes.					Includes Tijamuchi Bridge
Subbase layer	438.357 m^3					
Base layer	7.179 m^3					
Asphalt top layer	70.781 m^2					
Shoulder paving	20.223 m^2					
Protections	8.892 m.					
Vertical signals	Global					
Horizontal signals	Global					
Ferry boat administration office	Global					

EQUIPMENT	QUANTITI
Bulldozer (21 ton.)	26
Back hoe (0.6m^3)	6
Tractor shovel (2.1m^3)	4
Dump truck (11 ton.)	141
Pneumatic tire roller	4
Vibrating roller	2
Motorgrader (3.7m.)	2
Concrete mixer (0.6 m^3)	6
Asphalt plant	1
Asphalt finishing machine	1
Stone crusher(complete set)	1

5. QUANTITY OF WORK AND COST OF THE PROJECT

Table 5 - 1 Sumaary of Works

TYPE OF WORK	NAME OF THE ACTIVITY	SIZE AND TYPE	UNIT	SECTION								TOTAL
				I	II	III	IV	V	VI	VII	VIII	
EARTHFILL	Strip	t = 15 cm	ha	66.21	158.32	113.76	160.11	395.18	199.74	166.80	95.84	1347.16
	Clearing and stumping	t = 10 cm	ha	23.25	80.69	68.98	148.66	219.35	43.56	6.89	58.32	578.90
	Filling	Earthfill	m3	264932	625357	110524	30004	83915	2139	4062	101435	* 1222438
		Subgrade	m3	73230	196215	208812	218389	371707	90593	82284	81385	1302555
	Earth transportation	Horizontal Removal	m3	-	36051	164257	185462	364025	38021	3841	78045	847672
		Longitudinal Removal	m3	73230	160165	43730	53155	7258	54512	58473	3348	453863
		Distance for Transportation	m	5200	2218	1572	1651	1500	1934	3153	2000	19228
	Finishing	Levelling and Compaction	m2	97071	192751	203148	344088	684963	271576	194359	171507	2158993
REMOVAL OF PIPES	With Excavation	ϕ 0.90	m	-	-	38.10	-	-	-	-	-	38.10
		ϕ 1.50	m	59.00	134.20	60.76	-	45.08	-	-	-	298.96
		ϕ 1.80	m	49.10	90.00	-	-	100.00	-	-	-	238.10
		ϕ 3.00	m	-	26.00	-	-	-	-	-	-	26.00
	Without Excavation	ϕ 0.90	m	-	41.00	-	-	-	-	-	-	41.00
		ϕ 1.50	m	-	-	50.40	-	27.40	-	-	-	77.80
		ϕ 1.80	m	-	29.20	-	-	86.10	-	-	-	115.30
		ϕ 2.10	m	-	-	-	-	21.40	-	-	-	21.40
		ϕ 2.70	m	-	-	-	-	73.50	-	-	-	73.50
PLACING OF CORRUGATED PIPES	Excavation	Back hoe 0.6 m3	m 3	-	3884.47	3268.38	885.19	7839.83	441.47	1406.62	2305.95	19152.81
	Foundation		m 3	-	440.28	515.22	247.17	1441.21	133.97	451.88	382.84	3621.74
	Placing of Corregated Pipes	ϕ 0.90	m	-	-	3.00	90.00	110.00	109.00	512.00	-	833.00
		ϕ 1.20	m	-	-	51.00	197.00	21.00	52.00	125.00	39.00	535.00
		ϕ 1.50	m	-	16.00	14.00	15.00	194.00	8.00	74.00	95.00	416.00
		ϕ 1.80	m	-	-	14.00	-	177.00	26.00	-	32.00	249.00
		ϕ 2.10	m	-	-	28.00	42.00	292.00	-	-	-	362.00
		ϕ 2.40	m	-	-	78.00	-	244.00	-	-	-	314.00
		ϕ 2.70	m	-	105.00	45.00	-	215.00	-	-	-	365.00
		ϕ 3.00	m	-	245.00	241.00	-	172.00	-	-	202.00	861.00
	Earthfill Material		m 3	-	4383.41	4852.44	1540.00	12129.00	784.51	2563.70	3465.04	29718.96
HEADERS	Concrete		m 3	-	488.06	517.36	153.46	1121.50	105.11	189.23	442.98	3067.70
	Foundation		m 2	-	1472.33	1734.67	550.67	4249.33	425.00	843.67	1486.97	10762.34
	Forms		m 2	-	1914.32	2143.75	946.15	5402.76	663.28	1198.94	1907.55	14176.77
	Brick Walls		m 3	-	327.62	431.63	125.72	1017.17	93.86	180.55	364.46	2591.01
	Concrete Layer	1 : 3	m 3	-	44.17	52.04	15.52	127.46	12.35	25.31	44.66	322.87
		"	-	-	-	-	-	-	-	-	-	-
PAVIMENT	Top Layer		m 2	70781	-	-	-	-	-	-	-	70781
	Base Layer		m 3	7179	-	-	-	-	-	-	-	7179
	Subbase		m 3	84763	37867	42069	71154	141498	59221	40159	35487	636357
	Shoulder Paving		m 2	20223	-	-	-	-	-	-	-	20223
COMPLEMENTARY WORKS	Guide Ditches		m	-	-	-	-	1300	-	-	-	1300
	Protections		m	2356	1224	-	920	2704	80	80	1458	8892
	Fluvial by-pass Gutters		m	270	-	-	-	-	-	-	-	270
	Signs	Tipe P	Set	8	7	1	2	19	4	3	4	48
		R - 19	Set	10	19	21	35	70	28	20	18	221
COMPLEMENTARY WORKS	Signs	S - 31	Set	1	1	-	-	-	-	-	-	2
		Identification	Set	10	19	21	35	70	28	20	18	221
		Destination	Set	1	-	2	1	3	2	-	1	10
		B.V.	Set	2	4	4	7	14	6	4	4	45
	Pavement Signs	R = 10 cm	m	26341.1	-	-	-	-	-	-	-	26341.1
	Administrative Offices	3 Set	m 2	1450	-	-	-	1450	1450	-	-	4300
	Administrative Offices	2 Set	m 2	107	107	-	-	-	-	-	-	214
STRUCTURES	Ferryboat Instalations	2 Set	Set	-	-	-	-	-	-	-	-	1
	Bridges		Bridge	3	3	-	-	2	-	1	1	10

Quantity of work and cost of the project

Unit : US$

Type of Work	Name of the Activity	Size and Type	Unit	Volume	Unit Cost			Costs			SUB TOTAL
					Local currency		Foreign currency	Local currency		Foreign currency	
					Tax	Others		Tax	Others		
Earthfill	Strip		ha	1,347.16	240.00	270.0	1,020.00	323,318.40	363,733.20	1,374,103.20	2,061,155
	Clearing and swamping		ha	578.90	618.44	696.33	2,617.78	358,014.92	403,105.44	1,515,432.84	2,276,553
	Filling (earthfill)		m³	1,222,408.00	0.30	0.35	1.26	366,722.40	427,842.80	1,540,234.08	2,334,799
	(subgrade)		m³	1,302,555.00	0.12	0.16	0.53	156,306.60	208,408.80	690,354.15	1,055,070
	Earth transportation		Set	1.00	-	-	-	357,848.24	356,039.84	1,804,501.98	2,518,390
	Finishing		m²	2,159,903.00	0.013	0.018	0.054	28,078.74	38,878.25	116,634.76	183,592
Rem.of pipes	With excavation		Set	1.00	-	-	-	2,562.02	6,036.13	9,122.87	17,721
	Without excavation and filling		Set	1.00	-	-	-	424.25	2,198.26	949.58	3,572
Placing of Corrugated pipes	Excavation		m³	19,152.81	0.15	0.22	0.59	2,872.92	4,213.62	11,300.16	18,387
	Foundation		m³	3,621.74	0.57	1.49	2.03	2,064.39	5,396.39	7,352.13	14,813
	Placing of pipes		Set	1.00	-	-	-	303,535.00	220,076.54	1,012,280.36	1,535,892
	Earthfill material		m³	29,718.96	0.57	1.49	2.03	16,939.81	44,281.25	60,329.49	121,551
Headers	Concrete		m³	3,067.70	7.10	49.82	8.32	21,780.67	152,832.81	25,523.26	200,137
	Foundations		m²	10,762.34	0.19	1.41	0.26	2,044.84	15,174.90	2,798.21	20,018
	Forms		m²	14,176.77	1.00	8.83	0.12	14,176.77	125,160.66	1,701.21	141,059
	Brick walls		m³	2,591.01	10.43	88.80	5.43	27,024.23	230,081.69	14,069.18	271,175
	Concrete layer		m³	322.87	8.86	68.09	7.26	2,860.63	21,984.22	2,344.04	27,189
Pavements	Top fater		m²	70,781.00	2.64	2.98	7.53	186,861.84	210,927.38	532,980.93	930,770
	Base layer		m³	7,179.00	10.17	12.90	42.63	73,010.43	92,609.10	306,040.77	471,660
	Shoulder paving		m²	20,223.00	1.40	1.74	5.64	28,312.20	35,188.02	114,057.72	177,558
	Subbase		Set	1.00	-	-	-	3,172,915.04	3,995,133.80	13,637,818.21	20,805,867
Complementary Works	Side ditches		m	1,300.00	0.30	0.44	1.18	390.00	572.00	1,534.00	2,496
	Protections		m	8,892.00	5.91	1.74	14.05	52,551.72	15,472.08	124,932.60	192,956
	Fluvial by-pass gutters		m	270.00	7.44	9.60	30.48	2,008.80	2,592.00	8,229.60	12,830
	Signs		Set	1.00	-	-	-	5,128.32	13,373.97	14,070.65	32,573
	Pavement signs		m	26,341.10	0.02	0.18	-	526.82	4,741.40	-	5,268
	Administrative office		m²	4,380.00	28.00	252.00	-	122,640.00	1,103,760.00	-	1,226,400
	Ferryboat office		m²	214.00	28.00	252.00	-	5,992.00	53,928.00	-	59,920
Structure	Ferryboat instalations		Set	1.00	-	-	-	273,709.13	438,230.86	1,092,967.75	1,804,908
	Bridges	9 Bridge	Bridge	-	-	-	-	242,280.20	773,754.91	782,880.11	1,798,915
		Tijamuchi	Bridge	-	-	-	-	214,333.93	340,660.19	717,912.81	1,272,907
Cost Distribution	Total direct cost of the construction			(D)				6,367,235.26	9,706,408.73	25,522,456.65	41,596,101
	General costs (administration)			(G=D×25%)				1,591,764.74	2,426,591.27	6,380,543.35	10,398,899
	Total construction cost			(C=D+G)				7,959,000	12,133,000	31,903,000	51,995,000
	Engineering Cost			(I=C×6.5%) (M.L. 40%, M.E. 60%)				307,000	1,299,000	1,844,000	3,380,000
	Administration Cost			(A=C×1.5%)				71,000	709,000	-	780,000
	Total			(T=C+I+A)				8,337,000	14,071,000	33,747,000	56,155,000
	Contingencies			(B=T×10%)				834,000	1,407,000	3,375,000	5,616,000
	Cost of Project			(T+B)				9,171,000	15,478,000	37,122,000	61,771,000
	Percentage							14.8 %	25.1 %	60.1 %	-
	Cost of Project without taxes							-	15,478,000	37,122,000	52,600,000
	Percentage							-	29.4 %	70.6 %	-

Table. 5 - 2

6. COST OF ROAD MAINTENANCE

Table 6. -1 Operation and Maintenance Costs

Unit : 1000US$, Costs. 1988

	Road Administration Cost				Operation and maintenance costs for ferry boats and facilities				Global			
	Local currency		Foreign currency	Total	Local currency		Foreign currency	Total	Local currency		Foreign currency	Total
	Tax	Others			Tax	Others			Tax	Others		
1994	126	246	481	853	41	205	145	391	167	451	626	1244
5	"	"	"	"	41	212	"	398	167	458	"	1251
6	"	"	"	"	42	219	"	406	168	465	"	1259
7	252	492	963	1707	43	225	"	413	295	717	1108	2120
8	"	"	"	"	43	232	"	420	295	724	"	2127
9	"	"	"	"	44	241	"	430	296	733	"	2137
2000	"	"	"	"	45	250	"	440	297	742	"	2147
1	"	"	"	"	46	258	"	449	298	750	"	2154
2	"	"	"	"	224	282	961	1467	476	774	1924	3174
3	"	"	"	"	60	292	185	537	312	784	1148	2244
4	"	"	"	"	61	304	"	550	313	796	"	2257
2005	"	"	"	"	62	315	"	562	314	807	"	2269
6	"	"	"	"	64	326	"	575	316	818	"	2282
7	"	"	"	"	65	337	"	587	317	829	"	2294
8	"	"	"	"	66	349	"	600	318	841	"	2307
9	"	"	"	"	243	381	1092	1626	475	873	1965	3333
2010	"	"	"	"	81	336	226	703	333	889	1189	2410
11	"	"	"	"	82	412	"	720	334	964	"	2427
12	"	"	"	"	84	427	"	737	336	919	"	2444
13	"	"	"	"	85	443	"	754	337	935	"	2461

$ Ferry boat purchase cost included

7. ECONOMIC EVALUATION

7.1. Impact of the Present Project

(1) Impact during the planning and design stage

- Demonstration effect.
- Economic and educational benefits accompanying the investigation.

(2) Impact during the construction stage

- Increased demand in equipment and construction materials.
- Creation of new jobs.
- Technology transfer.
- Development of resources.

(3) Impact after completion

- Benefit of the presence of the road
- Benefits for users, such as reduction of travel costs, reduction of travel time, increased comfort during travel, reduction of damage to goods and of packing expenses, reduction of ferry transfer costs, increased reliability and reduction of transportation costs.
- Collateral effects, such as increase in the incomes of the producers, promotion of development along the road and its influence area, stimulation for implementation of other projects in the Department of Beni, expansion of the economic territory of Beni, reliable supply of goods and consequent reduction of storage capacity required.

7.2. Economic Analysis and Evaluation

(1) Items considered as real benefits

- Operation costs.
- Travel time
- Transportation costs.
- Increase in the incomes of the producers.
- Savings in the road maintenance costs and in the river transfer costs.

(2) Evaluation results

Cost of the Project.....US$ 61,800,000.-
Subject Period of the evaluation
From 1994 through 2013 (20 years)

1) Internal Rate of Return (IRR)..... 24.75
2) Net Present Value (NPV).....US$ 75.185.000.-
3) Benefit/Cost Ratio (B/C).....2.5

A discount rate of 12% has been adopted, according to the IDB recommendations, which are included in the Loans Form Guide.