CHAPTER 19 ENVIRONMENTAL IMPACT ASSESSMENT

19 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

19.1 Introduction

19.1.1 Objective of EIA

The objective of the EIA is summarized as follows:

- to identify existing environmental situations in the project area
- to predict possible impacts of the proposed project.
- to consider countermeasures to mitigate negative impacts of the projects
- to prepare an environmental management plan for the projects

19.1.2 Environmental Items

As a "scoping" result of the initial environmental examination (IEE), the environmental items requiring an environmental impact assessment (EIA) of the projects and further surveys have been selected already in Table 15.3.2 of the section 15. These items are reviewed in Table 19.1.1

Table 19.1.1 Environmental Items requiring EIA and Further Study

Environmental Items	Requiring EIA	Requiring Further Study	
Social Environment	- Resettlements	- Economic Activities - Split of Communities - Water Rights & Common Rights	- Traffic and Public Facilities - Cultural Property - Hazards (Risk)
Natural Environment	—	- Soil erosion	- Fauna and Flora
Pollution	- Prediction of NO_x and CO_2 - Prediction of Noise level	—	

19.1.3 Projects

Projects proposed in this feasibility study consist of mini bypass projects, climbing lane projects and at-grade intersection projects. Table 19.1.2 shows briefly locations of each project.

Table 19.1.2 Projects List

Project		Mini bypass	Climbing lane	At-grade intersection
Route	Location			
2	*San Lorenzo*	-	-	At-grade
	Capiata	-	-	At-grade
	Ypacarai	Bypass	-	-
	Caacupe	Bypass	-	-
	Eusebio Ayala	-	Lane 68	-
	Itacurubi	Bypass	Lane 79	-
			Lane 91	
	San Jose	Bypass	Lane 120	-
	Coronel Oviedo	-	Lane 147	At-grade
			Lane 153	
7	*Caaguazu*	-	Lane 162	-
			Lane 166	

19.2 Methodology

In accordance with the environmental items shown in Table 19.1.1, the following detailed surveys were carried out to collect necessary data and information for predicting possible impacts on each project.

19.2.1 Surveys

(1) Survey Area

All locations of bypass and climbing lane projects proposed in this feasibility study were selected as "Survey Area" for the detailed surveys as shown in Table 19.2.1. In the table, columns filled with oblique line identify the survey area.

Table 19.2.1 Survey Area

	Ypacarai	*Caacupe*	*E. Ayala*	*Itacurubi*	*San Jose*	*Cnel. Oviedo*	*Caaguazu*
Mini bypass							
Climbing lane							

As for every "At-grade intersection project", detailed survey is not required due to following reasons;

- Project scale of each "At-grade intersection project" is relatively small.
- Every project will be implemented within each present rights of way (ROW) respectively.
- Assessments of each project can be carried out based on existing data and information.

(2) Surveys

1) Social Condition Survey and Natural Environmental Survey

Social condition survey and natural environment survey were carried out based on results in the IEE to identify actual conditions of survey area, and to predict possible impacts on social environment and natural environment respectively which would be caused by implementation of each proposed project. These data, information surveyed and the primary prediction were used for environmental impact assessment (EIA) to each proposed project. Following are the method used for the social condition survey and the natural environmental survey.

- **Collection of existing data:** Related data and information were collected from governmental agencies, other organizations concerned and existing literature and documents, etc.
- **Interviews**: Interviews were held with officials in the related governmental agencies, specialists of various fields, municipality office and people who understand the environmental conditions in the project areas well and so on.
- **Reconnaissance survey:** To verify the present conditions in the project areas, reconnaissance surveys were carried out in the areas.

2) Air Pollution and Noise Level Prediction Survey

– Air Pollution
The principal method of air pollutant prediction was applied to calculate air pollutant of NO_x and CO_2 by use of several parameters such as "traffic volume by each vehicle type", "vehicle velocity (km/h)" etc.

– Noise Level
As one of the models of noise level prediction, Weighted equivalent sound levels in each project area were calculated by use of several parameters such as "vehicle velocity (km/h)", "traffic volume by vehicle type" and so on.

3) Household Opinion Survey

Purpose of the household opinion survey is to supplement the social survey and to identify household opinion on implementation of the projects, and possible resettlement which would be caused by each project.

This survey was conducted in each survey area of the mini bypass project using a questionnaire and interviewing the head of every sampled household in these areas.

– **Questionnaire:** A questionnaire was prepared in accordance with the purposes of the survey.
– **Interview:** Interview with household using a questionnaire and the interviewee was principally the head of the family.
– **Sampling Number:** Total 266 households in the survey area were interviewed.

19.2.2 Implementation of EIA

(1) Laws, Norms and Guidelines

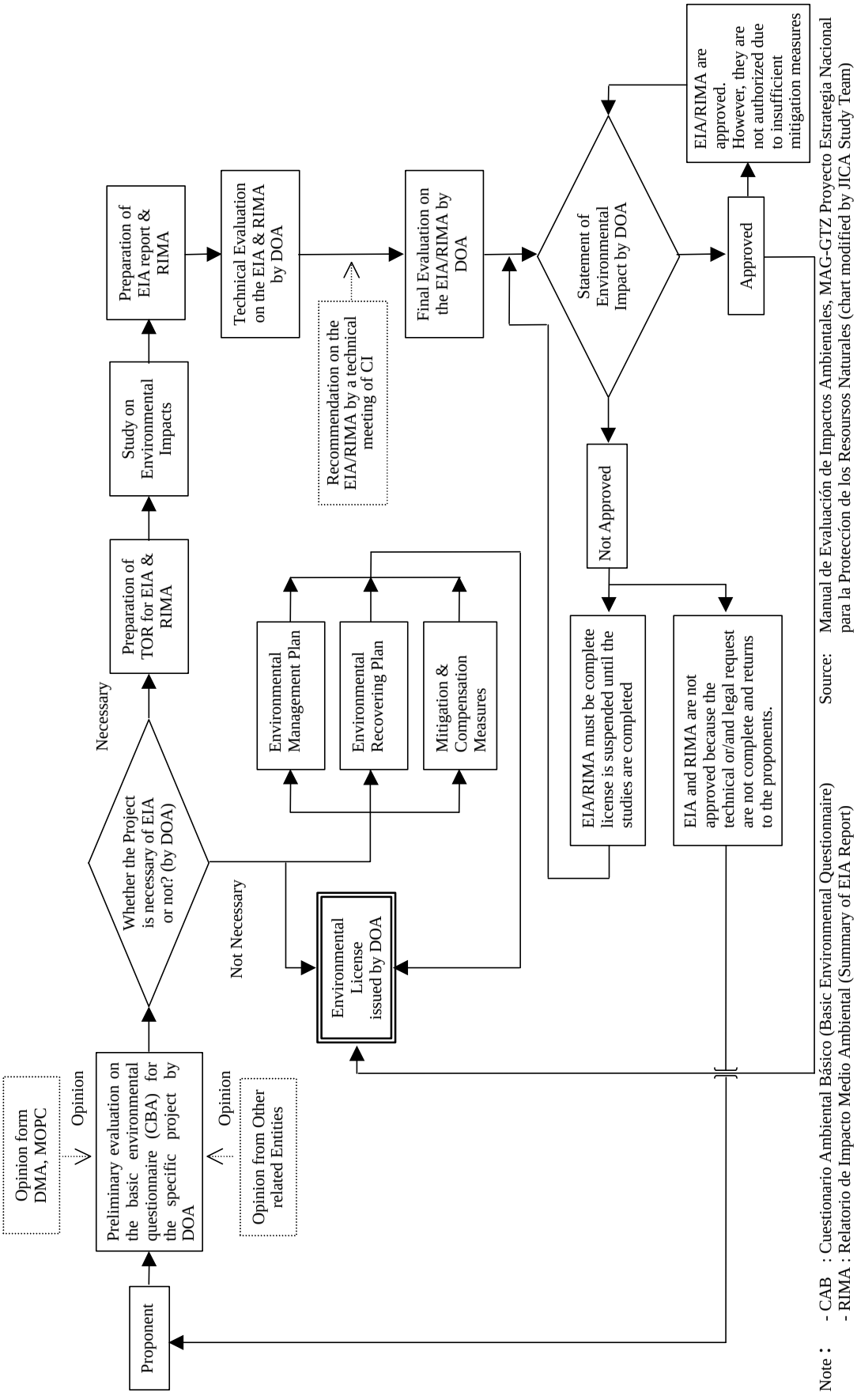
The EIA was carried out principally in accordance with Law No. 294/93 concerning EIA system of Paraguay and in consideration of the following other laws, norms and guidelines, some of which have been summarized already in section 9.

Table 19.2.2 Laws, Norms and Guidelines concerning EIA

Laws and Norm	- Law No. 294/93 (EIA system of Paraguay) - Other Laws, Decrees and Ordinances related to the Environment - Technical Norm on Environmental Impacts (NTA), 1992, MOPC
Guidelines	- General Technical Specification on Environment (ETAG), MOPC - Environmental Guidelines for Infrastructure Projects III Roads, JICA Environmental Guidelines, September 1992, Japan International Cooperation Agency (JICA) - OECF Guideline for Environmental Consideration, August 1995, Overseas Economic Cooperation Fund (OECF) – Present JBIC (Japan Bank for International Cooperation)

(2) EIA flow of Paraguay

Figure 19.2.1 is the official procedural flow of EIA of Paraguay.



Note : - CAB : Cuestionario Ambiental Básico (Basic Environmental Questionnaire) Source: Manual de Evaluación de Impactos Ambientales, MAG-GTZ Proyecto Estrategia Nacional para la Protecciòn de los Resoursos Naturales (chart modified by JICA Study Team)
- RIMA : Relatorio de Impacto Medio Ambiental (Summary of EIA Report)

Figure 19.2.1 Flowchart of EIA

19.3 Social Environmental Impact Assessment

19.3.1 Impacts on Resettlement

(1) Household

1) Existing Situation

Table 19.3.1 shows households and population living in the surroundings of the proposed location of the mini bypass projects in the survey area. The total number of households which require resettlement due to by the bypass project in each survey area is shown in the Table.

Table 19.3.1 Population and Number of Households around the Mini Bypass Projects

	Ypacarai	*Caacupe*	*Itacurubi*	*San José*
Households located around the project location (households)	171	381	92	49
Population living around the project location (people)	940	2,096	506	273
Total households requiring resettlement (households)	33	66	20	2

Source: JICA Study Team, 1999

2) Prediction of Impact

– Bypass project

Resettlements of number of households will be necessary for the construction of mini-by pass in *Ypacarai*, *Caacupe*, *Itacurubi* and *San Jose* as shown in Table 19.3.1. However, each proposed mini bypass was already designed to mitigate impacts on the existing environment in consideration of the results of the IEE. Namely, special consideration has been given to the location of each mini by-pass at the initial design stage to minimize resettlement issues as much as possible in the project area. In addition to the consideration already made, further attention and concern including necessary communications with the population, alternative land for resettlement and environmentally sound design with good engineering standards are required before implementation of the projects to minimize resettlement issues.

As a result of a survey of household opinion, there is an objection to implement the project from only one household among all the households interviewed in the mini by pass project areas. Accordingly, almost all the households interviewed in the cities affected by the by-pass projects approve the implementation of the project. As for the compensation for resettlement, many are of the opinion that compensation should be based on a indemnity in money which is equivalent to actual price of each property.

– Climbing lane and at-grade intersection projects

Every climbing lane project the except project at Lane 147 in *Coronel Oviedo* and at-grade intersection project is planned to be implemented in the present right of way (ROW) of each project location. Therefore, no resettlements will be required by the execution of these projects except the project in *Coronel Oviedo*.

As for the climbing lane project at Lane 147 in *Coronel Oviedo*, this project is planned to be constructed over a new right of way (ROW). Therefore, resettlement of several households will be necessary.

(2) Indigenous Community

1) Existing Situation

According to National Indigenous Institution (INDI), there are no indigenous communities located near the project area. In addition to this information, two indigenous communities have been identified as shown in Table 19.3.2. However, these communities are located outside the survey area.

Table 19.3.2 Indigenous Communities in the Survey Area

	Ypacarai	Caacupe	E. Ayala	Itacurubi	San Jose	C. Oviedo
Number of Indigenous Communities	none	none	none	none	none	2
Population of these Communities	none	none	none	none	none	152
Communities affected by the projects	none	none	none	none	none	none

Source: Compilation of Ramon Fogel's "Mbya Recove". Center of Interdisciplinary Rural Studies (CERI) and the National University of Pilar. 1997

2) Prediction of Impact

Based on the existing situation reviewed above, no negative impact on the indigenous communities caused by the implementation every project is predicted in the survey area.

(3) Illegal Settlement

1) Existing Situation

In *Eusebio Ayala*, two illegal settlements have been identified along route 2. One is located in the north side of an area called "*Carmencita*" at the 73 km section of route 2. This settlement is occupied in organized peasants of a homeless group. Another is located in south side of the "*Curuguaty*" colony and is occupied by a landless group of peasants. However, no bypass project has been proposed in *Eusebio Ayala* Except for these 2 cases, other illegal settlements have not been identified in the survey area as shown in Table 19.3.3.

Table 19.3.3 Illegal Settlement

	Ypacarai	Caacupe	E. Ayala	Itacurubi	San Jose	C. Oviedo
Number of illegal settlement	none	None	2	none	none	none
Number of illegally occupied slums	none	None	2	none	none	none
Population of the illegal settlements	none	None	56	none	none	none

Source: Each Municipality in the study area, 1999

2) Prediction of Impact

Based on the existing situation reviewed above, no negative impact on the illegal settlements caused by the project implementation is predicted in the survey area.

19.3.2 Impacts on Economic Activities

(1) Commercial Activities

1) Existing Situation

The commercial activities in the survey area can be categorized by average monthly income as shown in Table 19.3.4.

Table 19.3.4 Average Income

Average Income/Month (Gs.)	US$	Area
Not higher than 10,000,000.-	300	*Ypacarai*, *Caacupe*, *Itacurubi* and *San Jose*
Around 20,000,000.-	600	*Coronel Oviedo* and *Caaguazu*
Very high for sale of Paraguayan typical food called "*Chipa*"	n/a	*Eusebio Ayala*

Source: JICA Study Team

Table 19.3.5 shows commercial activities and sales value (net) of areas of bypass project along route 2.

Table 19.3.5 Commercial Activities of Areas of Bypass Project along Route 2

Commercial Activities	*Ypacaraí*		*Caacupé*		*Itacurubí*		*San José*	
	Num.	Sales (net, Gs)	Num.	Sales (net, Gs)	Num.	Sales (net, Gs)	Num.	Sales (net, Gs)
Bar- Cocktail Lounge	5	4,500,000	8	7,000,000	3	6,000,000	1	4,000,000
Gas Station	4	not supplied	2	not supplied	2	not supplied	1	not supplied
Cars Repair Shop	3	1,500,000	4	2,000,000	3	1,500,000	1	1,500,000
Tires Repair Shop	4	1,300,000	6	1,500,000	4	1,000,000	1	1,000,000
Food Sale	2	3,000,000	8	3,500,000	3	3,000,000	-	-
Medical Clinic/Dentist	-	-	3	not supplied	2	not supplied	2	not supplied
Lodge – Hotel	-	-	3	not supplied	1	not supplied	1	not supplied
Drugstore	1	5,500,000	3	6,000,000	1	5,000,000	1	5,000,000
Supermarket	2	9,000,000	2	15,000,000	1	8,000,000	1	8,000,000
Supplies Shop	10	6,500,000	12	9,500,000	8	5,000,000	6	5,000,000
Bazaar	1	1,800,000	1	2,000,000	2	1,600,000	2	1,700,000
Ice Cream Parlor	1	1,300,000	1	3,000,000	-	-	1	1,800,000
Restaurant	3	8,000,000	2	9,000,000	-	-	-	-
Building Materials Shop	1	20,000,000	-	-	2	15,000,000	-	-
Warehouse	1	not supplied	-	-	1	not supplied	1	not supplied
Beauty Parlor	3	1,200,000	2	1,600,000	2	1,000,000	-	-
TOTAL	41		57		35		19	

Source: JICA Study Team, Year 1999.

2) Prediction of Impact

– Bypass Project

According to the present situation of commercial activities of every areas of bypass projects reviewed above, it can be evaluated that many of these activities depend largely on route 2. Accordingly, the construction of mini bypasses would have both positive and negative impacts on these activities as follows.

Positive Impacts

It is considered that construction of a bypass in these areas would increase convenience to commercial and industrial activities including transportation of goods. New economic activities along each bypass route will be promoted to lead the regional developments after the construction. Therefore, several positive impacts on the commercial activities are expected by the bypass construction.

Negative Impacts
Possibility of changes to commercial buildings, land use values and job opportunities may result from the construction of the bypass. Specially, in sections of the existing route 2, commercial activities are likely to decrease in accordance with the decrease of traffic caused by the bypass construction. In addition to this, it is considered that there will be the possibility of disorderly development along the bypass route.

– Climbing Lane and at-grade Intersection Projects

Positive Impacts
Climbing lane and at-grade intersection projects would increase the transportation of commercial products and other goods. This circumstance is considered as a positive impact.

Negative Impacts
Every climbing lane project the except project at Lane 147 in Coronel Oviedo and at-grade intersection project is planned to be implemented in the present right of way (ROW) of each project location. Therefore, no negative impact on commercial activities can be predicted by the execution of these projects except the project at Lane 147.

As for climbing lane project at Lane 147 in *Coronel Oviedo*, this project will have the same possible potential impact of "Bypass project" as discussed above.

(2) Farming (Cultivation and Stock Raising)

1) Existing Situation

– Cultivation
Departments of *Central*, *Cordillera* and *Caaguazu*, where the study area is located, are farming areas called "*Central Agricultural Zone*". The total area of farming is shown in Table 19.3.6.

Table 19.3.6 Total Area

	Total area (1,000 ha)	Potential land for farming (1,000 ha)	Unused farming land (1,000 ha)	Farming land (1,000 ha)
Central	246.5	60.0	39.0	21.0
Cordillera	494.8	123.7	73.1	50.6
Caaguazú	1229.8	799.0	565.1	233.9
TOTAL	1971.1	982.7	677.2	305.5

Source: Technical Planning Division of the Republic's Presidency. Description of the National Surface and Proposal for Regionalization, OP.CIT and National Account No. 25, Central Bank of Paraguay, 1994

This zone has produced many kinds of agricultural products as shown in Table 19.3.7.

Table 19.3.7 Agricultural Products/year (Average of 4 years; 1991- 1994)

Yields	*Cordillera*		*Caaguazu*		*Central*	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Cotton	7,051	6,625	72,798	99,232	2,665	2,782
Rice	984	3,133	306	589	572	252
Everlasting Pea	258	225	231	212	46	33
Sweet Potato	465	2,891	1,591	14,767	1,033	6,446
Sugar Cane	5,169	242,404	8,342	467,074	5,267	252,021
Sunflower	11	11	22	24	-	-
Corn	8,844	10,671	30,596	60,372	2,223	2,006
Manioc	11,072	59,110	31,370	244,758	4,085	10,056
Peanut	1,462	1,161	3,717	3,283	154	126
Pea	6,409	4,186	9,098	7,541	1,465	712
Soya	17	27	24,498	47,981	0.75	1.5
Tomato	82	3,554	232	9,708	421	15,646
Wheat	41	56	10,693	20,433	2	3.75

Source: Ministry of Agriculture and Livestock. DCEA.

Among the products, this zone produces approximately 33% cotton, 30% corn, 31% manioc, 48% pea, 76% sugar cane, 28% everlasting pea, 67% tomato, 53% pineapple, 58% grape, 38% tangerine, 28% pea and 43% lemon of each total production in Paraguay respectively.

– Stock Raising

Among these three Departments where the study area is located, Department of *Caaguazu* has the highest number of the livestock population of 83.1 % in the eastern region of Paraguay (1981 to 1994).

Table 19.3.8 Cattle in Three Departments

Departments	Number of Cattle			1981 – 1994
	1981 *	1991*	1994 **	rate (%)
Central	116,806	110,931	133,339	14.6
Cordillera	207,694	237,984	331,380	59.9
Caaguazu	344,102	463,246	630,033	83.1

Source: * Agricultural Census of 1981 - 1991
** Annual Survey (Statistical Synthesis 1993/4)

The Department of *Caaguazu*, *San Jose* and *Coronel Oviedo* are supporting the highest number of stock animal in the eastern region of Paraguay. In the Central Department, breeding of milk cows is active compared with other departments The total number of milk cows is 51,487, which is 38% of the total number of cattle in the department.

Table 19.3.9 Cattle Rising Area in Three Departments

Departments	Area * (ha)	Number of Cattle	Cattle Density (ha/cattle)
Central	36,895	133,339	0.2
Cordillera	350,966	331,380	1.0
Caaguazu	514,675	630,033	0.6

*The area includes farmed prairies, natural prairies and woodlands for livestock use.
Source: Statistical Synthesis 1993/94.

2) Prediction of Impact

– Bypass project

Positive Impacts

The Bypass projects will facilitate the smooth and increased transportation of agricultural and livestock products, other related goods and so on. This is considered to have a positive impact.

Negative Impacts

As a matter of fact, extensive areas of farming and livestock extend along routes 2 and 7, and surrounding the survey areas. Therefore, traffic accidents of affecting livestock can be expected due to the bypass projects during the construction and implementation stages.

– Climbing lane and at-grade intersection projects

Positive Impacts

Climbing lane and at-grade intersection projects would increase the transportation of agricultural and livestock products, other related goods and so on. This circumstance is considered to be a positive impact.

Negative Impacts

Every climbing lane project except the project at Lane 147 in *Coronel Oviedo* and at-grade intersection project is planned to be implemented in the present right of way (ROW) of each project location. As for the project at Lane 147, the elevation of the climbing lane is not planned in an existing stock raising area. Therefore, no negative impact on farming activities can be predicted by the execution of these projects.

19.3.3 Impacts of Public Facilities

(1) Traffic and Public Facilities

1) Existing Situation

The locations of bypass projects are planned for construct in outside the center of each municipality and the climbing lane projects and at-grade intersection projects are planned to be implemented in the present right of way (ROW).

2) Prediction of Impact

It is considered that there are no negative impacts on existing traffic and public facilities by the implementation of the projects.

(2) Nicho

1) Existing Situation

A lot of monuments called "*Nicho*" have been built along routes 2 and 7 by the families or relatives of the victim(s) of traffic accidents to mourn their dead.

According to the officials of the MOPC, many of them were constructed without any permission. Occasionally, based on requests, the Department of Planning and Projects of the Direction of Roads of the MOPC gives the temporary permission for the reconstruction. However such permission can be cancelled in the case of extensions or improvements to specific roads. Consequently, there is no location data of *Nicho*. In addition to this, as a matter of course, the number of *Nicho* will increase in accordance with the increase of serious traffic accidents.

As an example, Table 19.3.10 shows the present situation of *Nicho* in the section from 131 km to 181 km. More than 90 *Nichos* have been identified in this section of 51 km distance.

2) Prediction of Impact

According to a field reconnaissance survey, almost all *Nicho* have been built at the edge of the right of way (ROW) and the distances of *Nicho* from edge of route are identified as 0.75 m to 20 m.

Special consideration should be paid to these monuments during construction of bypasses and widening of existing routes. If necessary, these monuments should be moved to suitable locations during the preparation and construction stage in accordance with local religious practice.

Based on interview survey, it is identified that the average cost to construct one *nicho* is Gs.200,000 and the cost of relocation from its original location to a new one will be Gs.200,000 to Gs.300,000. It is confirmed as a response from persons who are taking care of *Nicho*s that there would be no objection at all to relocate them due to road improvement projects. This is done in keeping with local manners.

Table 19.3.10 (1) *Nicho* in the Section from 131 km to 181 km

Section (km)	No.	Size	Distance from road edge (m)	Value (Gs.)	Remarks
131 to 134	1	0.20 × 0.25	8.00	200,000	
	2	1.00 × 1.00	15.00	700,000	Nicho with grille.
	3	0.20 × 0.25	15.00	200,000	
	4	1.00 × 0.50	17.00	100,000	
	5	0.10 × 0.10	15.00	200,000	
	6	0.40 × 0.50	7.00	200,000	
134 to 137	7	0.30 × 0.40	15.00	180,000	
	8	1.00 × 1.00	20.00	350,000	
	9	2.00 × 1.00	17.00	400,000	
	10	1.00 × 1.00	18.00	350,000	
	11	0.20 × 0.40	20.00	300,000	With wooden fence
	12	1.00 × 1.00	10.00	300,000	
	13	1.00 × 1.00	18.00	200,000	
	14	1.00 × 1.00	10.00	500,000	
	15	2.00 × 2.00	10.00	100,000	
	16	0.30 × 0.40	7.00	300,000	
139	17	0.30 × 0.40	10.00	200,000	
141 to 144	18	0.20 × 0.30	3.00	150,000	
	19	0.40 × 0.30	12.00	250,000	
	20	0.20 × 0.30	15.00	100,000	
	21	0.30 × 0.20	10.00	150,000	
	22	0.50 × 0.50	1.00	350,000	Made of mock brick
	23	0.20 × 0.20	0.75	200,000	
	24	0.20 × 0.20	12.00	500,000	
	25	0.20 × 0.20	10.00	150,000	
	26	0.20 × 0.30	12.00	80,000	
	27	0.30 × 0.30	10.00	600,000	Nicho that imitates the Church of *Caacupe*
	28	0.10 × 0.20	7.00	100,000	
145 to 147	29	0.60 × 0.60	17.00	350,000	Green color
	30	1.00 × 1.00	5.00	400,000	
	31	0.40 × 0.40	8.00	500,000	
	32	0.30 × 0.40	7.40	200,000	
148 to 151	33	0.20 × 0.20	11.60	200,000	
	34	1.00 × 1.00	8.00	250,000	
	35	1.00 × 1.50	20.00	500,000	
	36	0.40 × 0.50	10.00	350,000	2 nichos. One is covered with tiles.
152 to 154	37	1.00 × 0.50	12.00	300,000	
	38	0.25 × 0.30	15.00	250,000	
	39	0.30 × 0.20	8.00	180,000	
	40	0.20 × 0.30	2.00	200,000	
155 to 158	41	1.00 × 0.50	1.50	150,000	
	42	1.00 × 1.00	7.00	350,000	
	43	0.30 × 0.40	17.00	600,000	
	44	0.20 × 0.25	10.00	100,000	
	45	2.00 × 2.00	20.00	700,000	
	46	2.00 × 2.00	10.00	500,000	
	47	0.25 × 0.25	17.00	150,000	
159 to 162	48	0.20 × 0.25	20.00	200,000	
	49	2.00 × 2.00	15.00	1,000,000	With iron fence.
	50	0.25 × 0.25	15.00	100,000	
162	51	0.25 × 0.30	8.00	300,000	
163 to 166	52	1.00 × 1.00	4.00	250,000	
	53	0.40 × 0.30	3.00	300,000	
	54	1.50 × 1.50	7.00	350,000	With wooden fence.
	55	0.20 × 0.30	20.00	350,000	
	56	1.50 × 1.50	20.00	200,000	
	57	2.00 × 2.00	8.00	200,000	
	58	0.20 × 0.20	8.00	200,000	
167 to 169	59	0.40 × 0.40	20.00	250,000	
	60	0.20 × 0.30	20.00	350,000	
	61	1.50 × 1.50	20.00	200,000	
	62	2.00 × 2.00	8.00	600,000	
	63	0.20 × 0.20	8.00	200,000	
	64	0.40 × 0.40	8.00	600,000	With wooden fence.
	65	0.30 × 0.20	20.00	300,000	

Source; JICA Study Team, Year 1999.

Table 19.3.10 (2) *Nicho* in the Section from 131 km to 181 km

Section (km)	No.	Size	Distance from road edge (m)	Value (Gs.)	Remarks
170 to 173	66	0.20 × 0.20	12.00	200,000	
	67	0.25 × 0.20	12.00	200,000	
	68	0.30 × 0.20	12.00	200,000	
	69	0.20 × 0.20	12.00	180,000 c/u	There are 4 niches together
	70	0.25 × 0.20	20.00	200,000	
	71	0.30 × 0.30	12.00	220,000	
	72	0.20 × 0.20	10.00	250,000	
	73	0.25 × 0.25	12.00	200,000	
	74	0.25 × 0.30	17.00	250,000	
	75	0.25 × 0.25	17.00	200,000	
174 to 175	76	0.30 × 0.25	8.00	200,000	
	77	0.25 × 0.20	15.00	200,000	
	78	0.20 × 0.30	12.00	250,000	
	79	0.25 × 0.20	10.00	300,000	
	80	2.00 × 2.00	10. 00	300,000	
176 to 177.5	81	0.25 × 0.30	10.00	250,000	
	82	0.50 × 0.50	10.00	200,000	
	83	0.50 × 0.50	10.00	200,000	
	84	0.30 × 0.20	12.00	250,000	
	85	0.40 × 0.30	10.00	300,000	With wooden fence.
	86	1.00 × 1.50	15.00	200,000	
	87	0.20 × 0.25	15.00	300,000	With wooden fence.
	88	0.20 × 0.20	1.00	200,000	
178 to 181	89	2,00 × 2,00	7.00	150,000	

Source; JICA Study Team, Year 1999.

19.3.4 Impacts on Water Rights and Common Use Rights

1) Existing Situation

Specific water rights and common use rights have not been identified for the all project locations.

As a matter of the fact, town structure of each municipality has a center called "*Centro*" where usually a Christian church is located. In general, the local population has a special "rights" to use the *Centro* and space and/or a small park around the church in accordance with local religious and cultural practice. It can be said that these rights are a kind of "common use rights".

As for the potable water in the survey area, all municipalities have water supply systems. The systems are provided by the Corporation of Sanitary Works (CORPOSANA; created by Law No. 244/1954 and enlarged by the Law No.1095/1966. The CORPOSANA has a responsibility to serve potable water to all cities that have more than 4,000 inhabitants) or the Environmental Cleaning Service (SENASA) according to the population scale as shown in Table 19.3.11.

The cities of *Caacupe* (31,319 inhabitants), *Eusebio Ayala* (15,521 inhabitants) and *Coronel Oviedo* (73,034 inhabitants) are served potable water by CORPOSANA because they have more than 4,000 inhabitants. The cities of *Ypacarai*, *Itacurubi*, *San José* and *Coronel Oviedo* are provided potable water by SENASA for they have less than 4,000 inhabitants.

Table 19.3.11 Potable Water Supply System

Municipality	Supplying Entity		Water Tank	Water Well	Coverage ratio (%)
	CORPOSANA	SENASA			
Ypacarai			1	0	0.3
Caacupe *			4	3	56.5
Eusebio Ayala			1	0	1.2
Itacurubi			1	0	60.0
San José			1	0	67.5
Coronel Oviedo *			0	0	47.2

* Caacupe and Coronel Oviedo, have treatment water plant and a water pumping station.-
Source: Corporation of Sanitary Works of the Nation (CORPOSANA)
The Environmental Cleaning Service (SENASA), 1999

2) Prediction of Impact
All projects will be constructed outside the urban area of municipalities. Therefore no impact on water rights and common use rights will be expected.

19.3.5 Impacts on Cultural Property

(1) Existing Situation

Most of the cities in the survey area were established during the colonial period (1700-1800). There are several old buildings which are considered to have cultural and historic value. However, many of these buildings and houses are not registered as cultural patrimony.

***Ypacarai*:** According to the city Major and technical staff of the Municipality, the city has several buildings and houses which have historical value as follows:

- General *Bernardino Caballero* and *Mariscal Francisco Solano* Lopez (former house of the *Baruja* family).
- Public Square (Train Station of the "*Carlos Antonio Lopez* Railroad").
- Francisco Solano Lopez and *Carlos Antonio Lopez* (*Guastella* house, former "*Avenida*" motel).
- *Mariscal Estigarribia* Road and *Yegros* (present location of the Municipality).

Source; Municipality of Ypacarai

***Caacupe*:** Established in 1710. The city has the Church of the *Virgin* of *Caacupe* which is identified as a spiritual place in the Republic of Paraguay.

There are two houses of historical value close to the Church of *Caacupe*, on the *Eligio Ayala* street and corner of *Constitucion* street, and on the 14 *de Mayo* street and corner of *Concepcion* street. There are no other properties of historical value on either side of route 2.
Source; Municipality of Caacupe.

***Itacurubi de la Cordillera*:** This Municipality does not provide the value of cultural and historical patrimony to the properties located within its urban area. As a natural patrimony, there is a cave called *Ita Coty grotto*.
Source; Municipality of Itacurubi de la Cordillera.

***San Jose de los Arroyos*:** Established in May of 1884. Several old buildings exist, however, there is no special property having cultural or historical values in the city.
Source: Municipality of San Jose de los Arroyos.

(2) Prediction of Impact

Almost all the buildings considered to have cultural and historic value are situated in the present urban area of each municipality. However, every bypass project will be constructed outside the urban area. In addition to this situation, no cultural boundary has been identified in the study area. Therefore, no impacts will affect on such properties.

19.3.6 Impacts on Waste

(1) Existing Situation

1) Solid Waste Management
Municipalities of *Ypacarai*, *Caacupe*, *Eusebio Ayala*, *San Jose* and *Coronel Oviedo* are conducting solid waste management by Department of Works and Urban Cleaning of each municipality respectively. *Itacurubi de la Cordillera has* implemented solid waste collection and treatment by a private company. (See Table 19.3.12)

Table 19.3.12 Solid Waste Management

Research Area	*Ypacarai*	*Caacupe*	*Eusebio Ayala*	*Itacurubi*	*San José*	*Coronel Oviedo*
Final Treatment	Open Dump	Open Dump	Open Dump	Open Dump	Open Dump	Open Dump
Amount of Waste	10 tons *	10 tons	10 tons	5 tons	5 tons	23 tons
Transportation	Tractor with 3 m³ trailer	Collector and Dump Truck***	Dump Truck**	Truck with load capacity of 4,000 kg.	Tractor with 3m³ trailer	Dump Truck tractor with 3 m³ trailer
Waste Composition	More than 60% is organic waste	More than 60% is organic waste	More than 60% is organic waste	More than 60% is organic waste	More than 60% is organic waste	More than 60% is organic waste
Collection Entity	Municipal (in process of public bidding)	Municipal	Municipal	Private Company	Municipal	Municipal

Note: * Data checked with municipal employees, ** $5m^3$ dump truck without compactor, *** Collector truck with compactor.
Source: Municipalities of the research area. Year: 1999.

2) Road Waste
According to the municipalities of *Ypacarai*, *Caacupe*, *Itacurubi* and *San Jose*, each of them is in charge of implementing sweeping and cleaning of the urban area and the national route 2. As for road cleaning in *Eusebio Ayala* and *Coronel Oviedo*, MOPC conducts a periodic cleaning of the soft shoulders of section of route 2 in these municipalities.

(2) Prediction of Impact

In general, generation of surplus soil, construction and demolition waste, debris and logs can be predicted during the construction stage of the projects. In addition to the construction stage, during the operation stage, the total amount of road waste from vehicles will increase in accordance with the increase of traffic volume. Therefore, proper solid waste management will be required during the construction and operation stage respectively.

19.3.7 Impacts on Disaster

(1) Flooding

1) Existing Situation

Due to overflow from the water basin and the land configuration of floating meadow, flooding has been observed in several areas in the study area. Among them, critical locations of flooding in the study area are shown in Table 19.3.13.

Table 19.3.13 Locations of Flooding

	Ypacaraí	*Eusebio Ayala*	*San Jose*
Section (km from *Asuncion*)	36.5 km - 38.0 km	71.5 km - 73.0 km	101.0 km - 105.0 km

Source: JICA Study Team

2) Prediction of Impact

There are past records of flooding in the study area, specially areas around *Ypacarai* lake and *San Jose*. As a matter of course, necessary countermeasures such as embankment structures and culvert construction have already been considered at the design stage to mitigate flooding.

(2) Landslide

1) Existing Situation

In *Caaguazu*, between 150 km and 160 km from *Asuncion*, there are landslides or collapse of slopes, due to the configuration of steep slopes and the intensive agricultural use of the land.

2) Prediction of Impact

The location of each proposed project has been designed to avoid in the critical areas of landslide in *Caaguazu*. Therefore, no impacts due to landslide can be predicted by the projects. However, lane 162 of the climbing lane project will be located in the vicinity of the critical area of landslides. Accordingly, special consideration shall be paid on the lane at the final design and construction stages to avoid such a negative impact.

(3) Traffic Accidents

1) Existing Situation

According to MOPC, 63% of traffic accidents on national roads in 1998 took place on routes 2 and 7. The following table shows the data of traffic accidents on routes 2 and 7 in 1998.

Table 19.3.14 Traffic Accidents on Routes 2 and 7 in 1998

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Route 2	131	123	128	121	119	125	139	137	149	144	151	163	1,630
Route 7	21	19	23	27	22	26	29	27	20	21	23	31	289

Source: Files and Statistics, Highway Patrol, Traffic Safety and Control Division, Ministry of Public Works and Communications (MOPC).

2) Prediction of Impact

It is considered that there will be no special negative impacts due to traffic accidents by the construction of the by-pass project because each bypass route is designed to go around the present urban area. However, the increase of traffic volume will generally lead to an increase in traffic accidents if there are no adequate countermeasures. In addition to this, in consideration of future expansion of each urban area, traffic facilities to mitigate traffic accidents such as pedestrian crossings, guard fence and traffic signs etc. are expected to be constructed.

19.4 Natural Environmental Impact Assessment

19.4.1 Impacts on Soil Erosion

(1) Existing Situation

A critical area of soil erosion has been identified in the surroundings at a section 167 km from Asuncion on route 7 called Caaguazu. Table 19.4.1 gives summary of soil erosion level in the survey area.

Table 19.4.1 Soil Erosion Level in Eco-regions

Eco-regions	*Central Littoral*				*Central Forest*		
Study Area	*Ypacaraí*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San Jose*	*C. Oviedo*	*Caaguazu*
Inclination	Low	High	Medium	High	Low	Low	High
Erosion Level	Medium	High	Medium	High	Low	Medium	High
Rainfall/year	1,400 mm to 1,550 mm				1,550 mm to 1,650 mm		
Main land use	Urban, Agricultural and Cattle Raising				Cattle Raising and Forestry		

Source: Soils inspection and use capability of lands. Ministry of Agriculture and Cattle. Project regarding the rationalization of the land's use. Agreement 3445 Paraguay-World Bank.

(2) Prediction of Impact

Lane 166 of the climbing lane project will be located around the critical area for soil erosion. Accordingly, special consideration shall be paid to this lane at the detailed design and construction stages to mitigate possible impact on the erosion.

19.4.2 Impacts on Fauna and Flora

(1) Existing Situation

1) Ecological Regions

The survey area of Ypacaraí, Caacupe, Eusebio Ayala, Itacurubí and San Jose belongs to the Central Littoral ecological region (eco-region). Total area of this region is approximately 26,310 km^2 and is surrounded by the Departments of San Pedro, Cordillera and Central as its fringe regions. Configuration of the eco-region is principally flat with an altitude between 63 m in the surroundings of San Pedro and 318 m in the surroundings of San Estanislao. As the principal biological feature of this eco-region, it can be classified as a thermo-mesophyllous region formed by arboreal groups of clumps, irregular and heterogeneous masses,

that alternate with clearings (space between two forestal masses) and fields, of edaphic origin and sometimes of anthropic origin (Tortorelli, 1996). The eco-region consists of lagoons, swamps, bogs, bushes in saturated soils, rivers, creeks, water ponds, medium and low semi-caducipholeous bushes and savannas. This eco-region is largely influenced by the fauna and flora of Chaco region and has a protected wild life area of "Ypacarai reservation of managed resources (Reserva de Recursos Manejados Ypacarai)" with 16,000 ha established in May 1990.

The survey area between Coronel Oviedo and Caaguazu belongs to the Central Forest eco-region. Configuration of the region is undulating and not flat with an altitude between 86 m in the surroundings of Yuty and 516 m at Mbocayá hill. The biological features of this region are classified as sub-tropical jungle (Tortorelli, 1996) and humid/temperate/warm bush (Holdridge, 1969).

The natural appearance of this region consists of lakes, lagoons, swamps, bushes in saturated soils, rivers, creeks, water ponds, cascades, high and medium semi-caducipholeous bushes, Savannah's, rocky places and cliffs.

2) Fauna and Flora

Fauna and flora in the survey area can be summarized as shown in following tables.

Table 19.4.2 Fauna and Flora by Ecological Regions

		Central Littoral	Central Forest
Typical Fauna	**Birds**	*Crotophaga ani* (anó); *Machetornis rixosus* (picabuey); *Pitangus* sulphuratus (pitogué); *Polyborus planchus* (carancho); *Myopsitta monacha* (cotorrita), *Columbina picui* (tortolita); *Thraupis sayaca* (saii jhovy); *Paroaria coronata* (cardenal); *Leptotila verreauxi* (yerutí); *Aramus guarauma* (Carau); *además de Passeriformes varios*, *Trochilidae* (picaflores); *Sicales flaveola* (Canario paraguay); *Zonotrichia capensis* (San Francisco); *Coragyps atratus* (Yryvú); *Furnarius rufus* (hornero); *Guira guira* (piririta); y *el Molothrus bonariensis* (Guyrahú).	*Amazona vinacea* **(**Loro pecho vináceo), *Leptasthenura setaria*. (el coludito de los pinos); *Vanellus chilensis* (tero); *Egretta thula* (garcita blanca); *Trochilidae* (picaflores); *Turdus rufiventris* (Zorzal); *Thraupis sayaca* (Sai Jhovy); *Troglodytes aedon* (ratona); *Fornarius rufus* (hornero).
	Reptiles	*Philodryas olfersii* (mboi jhovy), *Liophis poecilogyrus* (mboi capitán); *Bothrops neumiedi* (Kyryryó), *Crotalus durissus* (Mboí chini), *Ameiva ameiva* (teyú asayé), *Tropidurus sp.* (teyú lelé); *bufo paracnemis* (kururu), *Melanophryniscus stelzneri* (kururu pytá), *varias ranas del genero Hyla, Olygon, Leptodaptylus*.	*Liophis sp.* (serpiente); *Tropidurus sp* (teyú lelé); *Ameiva ameiva* (teyú asaye); *Tupinambis teguixin* (teyú guazú); *Bothrops neuwiedi* (Kyryryo), *ranas de los géneros Hyla, Olygon, leptodactylus, Physalaemus y anfibios como bufónidos, Hylidae y Leptodactylidae*.
	Mammals	*Cerdocyon thous* (Aguaraí), *Cavia aperea* (Aperea), *Mazoma sp.* (venado); *Didelphys albiventris* (Mykure); *Rattus sp*. (rata); *y quirópteros* (mbopí)	*Chrysocyon thous* (aguaraí); *Sylvilagus brasiliensis* (tapití); *Didelphis albiventris* (Mykuré).
Typical Flora		*Sapium haematospermum* (Kurupika'y); *Pithecellobium scalare* (Tatare); *Enterobium contortisiliquum* (Timbo); *Gleditsia amosphoides* (Espina de corona); *Erythrina crista-galli* (Ceibo); *Salix humboldtiana* (Sauce); *Diplokeleba floribunda* (Ybyra ita); *Schinopsis balansae* (Quebracho colorado); *Copernicia alba* (karariida'y).	*Tabebuia sp* (Lapacho); *Cedrela sp* (Cedro); *Peltophorum dubium* (Ybyra pyta); *Pterogyne nitens* (Ybyra-ro); *Myrocarpus frondosus* (Incienso); *Balfourodeudron riedelianum* (Guatambu); *Albizzia hassleri* (Ybyra-ju); *Cabralea sp*. (Cancharana).

Source: Data Center for the Conservancy, National Parks and Wild Life Department, Ministry of Agriculture and Cattle. 1990.

Table 19.4.3 Endangered Fauna and Flora by Ecological Regions

		Central Littoral	Central Forest
Fauna	Birds	Pandion haliaetus (sangual); Leptodon cayanensis (taguató morotí); Harpagus diodon (gavilán bidentado); Accipiter poliogaster (esparvero grande); Leucopternis polionota (aguilucho blanco); Harpyhaliaetus coronatus (taguató jhovy); Morphnus guianensis (yryvutingá), Harpia harpyja (taguató ruvichá); Penelope superciliaris (jacú po'í); Penelope oscura (jacú jhú).	Tinamus solitarius (ynambú mocoicogué); Cochlearius cochlearius (hokó yuru cuchara); Leptodon cayanensis (taguató morotí); Harpagus diodon (gavilán bidentado); Accipiter poliogaster (esparvero grande); Leucopternis polionota (aguilucho blanco); Harpyhaliaetus coronatus (taguató jovy); Morphnus guianensis (yryvutingá); Harpia harpyja (taguató ruvichá); Penelope superciliaris (jacú po'í); Aburrua jacutinga (jacú tingá), Ara chloroptera (gua'á pyta); A. vinacea (loro garganta roja); Strix hylophila (lechuza listada); Dryocopus galeatus (carpintero listado); Psilorhamphus guttatus (gallito overo); Procnias nudicollis (pájaro campana); Piprites pileatus (saltarín dorso castaño); Thraupidae (tangarás).
	Reptiles	Eunectes murinus (mboí-yaguá); Boa constrictor (mboí-roí), Caimán latirostris (yacaré overo)	Eunectes murinus (mboí-yaguá); Boa constrictor (mboi-ro'í); Caiman latirostris (yacaré overo);
	Mammals	Lutra longicaudis (Lobope); Felis pardalis (yaguarete-í); Panthera onca (yaguareté); Blastocerus dichotomus (guasupucú); Ozotoceros bezoarcticus (guasuti).	Priodontes maximus (tatú carreta); Speothos venaticus (Yagua yvygui); Lutra longicaudis (Lobope); Pteronura brasiliensis (Arirai); Felis tigrina (tirica); F. Pardalis (yaguarete-í); F. wiedi (margay); Panthera onca (yaguareté); Mazama rufina (Guazú pyta).
Flora		Tillandsia duratii variedad confusa (cactus), Aspidosperma pyricollum Turnera aurelii.	Aspidosperma polyneruron (Peroba), Callisthene hassleri, Myrcia genmiflora, Frailea sp. (Cactus); Faramea eyanea, Lactistema hasslerianum, Trichilia stellato - tormentosa, Vachysia annamomea

Source: World Conservation Union (IUCN). Endangered flora of Paraguay, Data Center for the Conservancy, National Parks and Wild Life Department, Ministry of Agriculture and Cattle. 1990.

Table 19.4.4 Fauna (Bird) observed in Survey Area

Ypacarai	Caacupe	Eusebio Ayala	Itacurubi	San José	Coronel Oviedo
Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)
Piculus chysochloros (carpintero dorado)	Sicalis flaveola (canario paraguayo)	Columbina picui (tortolita)	Furnarices rufus (Hornero)	Tyrannus savana (Tijereta)	Vanellus chilensis (tero)
Leptotila verreauxi (Yerutí)	Polyborus plancus (carancho)	Vanellus chilensis (Tero)	Leptatila verreauxi (Paloma)	Guira guira (piririta)	Egretta thula (garcita blanca)
Aramus guarauma (carau)	Thraupis sayaca (Sai jhovy)	Furmarius rufus (hornero)	Coragyps atratus (yry vú)	Furnarius rufus (hornero)	Turdus rufiventris (Zorzal)
Trochilidae (picaflores)	Zonotrichia capensis (San Francisco)	Tinamus sp (Inambú)	Croto phaga ani (ano)	Mimus saturninus (Calandria)	Thraupis sayaca (sai jhovy)
Furnarius rufus (hornero)	Coragyps atratus (Yry vú)	Guira guira (piririta)	Paroaria capitata (Cardenal)	Molothrus bonariensis (guyrahú)	Furnarius rufus (Hornero)
Crotophaga ani (ano)	Guira guira (piririta)	Thraupis sayaca (sai jhovy)	Thraupis sayaca (sai jhovy)	Polyborus plancus (carancho)	Troglodytes aedon (ratona)
Machetornes rixosus (picabuey)	Crotophaga ani (ano)	Pitangus sulphuratus (pitogue)	Pitangus sulphuratus (pitogue)	Coragyps atratus (yryvú)	Zonotrichia capensis (San Francisco)
Pitangus sulphuratus (pitogue).	Paroaria capitata (Cardenal)	Zonotrichia capensis (San Francisco)	Zonotrichia capensis (San Francisco)	Crotophaga ani (ano)	-
Polyborus planchus (carancho)	Molothrus sp. Guyra'u	-	-	Nothura maculosa (Inambu del campo)	-
Myopsitta monacha (cotorita)	Thraupis sayaca (say jhovy)	-	-	Buteo magnirostris (taguató)	-
Columbina picui (Tortolita)	-	-	-	Accipiter poliogaster (Espavero grande)	-
Thraupis sayaca (sai jhovy)	-	-	-	Tinamus sp. (Inambú)	-
Paroaria coronata (cardenal)	-	-	-	Zonotrichia capensis (San Francisco)	-

Source: Study Team ,1999

Table 19.4.5 Fauna (Reptile) Observed in Survey Area

Ypacarai	Caacupe	Eusebio Ayala	Itacurubi	San José	Coronel Oviedo
Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)
Philodryas olfersii (Mboi jhovy)	Bufo paracnemis (Kururu)	Bufo paracnemis (Kururu)	Bufo paracnemis (Kururu)	Bufo paracnemis (Kururu)	Bufo paracnemis (Kururu)
Liophis poecilogyrus (Mboi capitán)	Hyla sp. (ranas)	Hyla sp. (ranas)	Hyla sp. (ranas)	Bothrops neuwiedi (Yarara)	Tropidurus sp. (Teyu lele)
Bothrops neumiedi (Kyryryo)	Ololygon sp (ranas)	Ololygon sp (ranas)	Ololygon sp (ranas)	Hyla sp. (ranas)	Tupinambis teguixin (Teyu Guazu)
Crotalus durissus (Mboi chini)	Leptodaptylus sp. (ranas)	Leptodaptylus sp. (ranas)	Leptodaptylus sp. (ranas)	Ololygon sp (ranas)	Physalaemus sp (rana)
Ameiva ameiva (Teyu asaye)	Ameiva ameiva (Teyu asaye)	Ameiva ameiva (Teyu asaye)	Ameiva ameiva (Teyu asaye)	Leptodaptylus sp. (ranas)	Hyla sp. (ranas)
Bufo paracnemis (Kururu)	-	-	-	Ameiva ameiva (Teyu asaye)	Ololygon sp (ranas)
Melanophryniscus stelzneri (Kururu pyta)	-	-	-	-	Leptodaptylus sp. (ranas)
Hyla sp. (ranas)	-	-	-	-	Ameiva ameiva (Teyu asaye)
Ololygon sp (ranas)	-	-	-	-	-
Leptodaptylus sp. (ranas)	-	-	-	-	-
Typhlops sp (culebrilla ciega)	-	-	-	-	-

Source Study Team ,1999

Table 19.4.6 Fauna (Mammal) Observed in Survey Area

Ypacarai	Caacupe	Eusebio Ayala	Itacurubi	San José	Coronel Oviedo
Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)
Euphractus sexcinctus (Tatú pojú)	Euphractus sexcinctus (Tatú pojú)	Euphractus sexcinctus (Tatú pojú)	Euphractus sexcinctus (Tatú pojú)	Euphractus sexcinctus (Tatú pojú)	Euphractus sexcinctus (Tatú pojú)
Dasypus novemcinctus (tatú jhu)	Dasypus novemcinctus (tatú jhu)	Dasypus novemcinctus (tatú jhu)	Dasypus novemcinctus (tatú jhu)	Dasypus novemcinctus (tatú jhu)	Dasypus novemcinctus (tatú jhu)
Cavia aperea (Aperea)	Cavia aperea (Aperea)	Cavia aperea (Aperea)	Cavia aperea (Aperea)	Cavia aperea (Aperea)	Cavia aperea (Aperea)
Didelphis albiventris (mykure /Zarigueya)	Didelphis albiventris (mykure /Zarigueya)	Didelphis albiventris (mykure /Zarigueya)	Didelphis albiventris (mykure /Zarigueya)	Didelphis albiventris (mykure /Zarigueya)	Didelphis albiventris (mykure /Zarigueya)
Tolypeutes matacus (Tatú bolita)	Tolypeutes matacus (Tatú bolita)	Tolypeutes matacus (Tatú bolita)	Tolypeutes matacus (Tatú bolita)	Tolypeutes matacus (Tatú bolita)	Tolypeutes matacus (Tatú bolita)
Sylvilagus brasiliensis (conejo / tapiti)	Sylvilagus brasiliensis (conejo / tapiti)	Sylvilagus brasiliensis (conejo / tapiti)	Sylvilagus brasiliensis (conejo / tapiti)	Sylvilagus brasiliensis (conejo / tapiti)	Sylvilagus brasiliensis (conejo / tapiti)
Cerdocyon thous (Aguaraí)	Cerdocyon thous (Aguaraí)	Cerdocyon thous (Aguaraí)	Cerdocyon thous (Aguaraí)	Cerdocyon thous (Aguaraí)	Cerdocyon thous (Aguaraí)
Rattus sp (Ratas)	Rattus sp (Ratas)	Rattus sp (Ratas)	Rattus sp (Ratas)	Rattus sp (Ratas)	Rattus sp (Ratas)

Source: Study Team ,1999

Table 19.4.7 Flora Observed in Survey Area

Ypacarai	Caacupe	Eusebio Ayala	Itacurubi	San José	Coronel Oviedo
Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)	Scientific Name (Local Name)
Pithecellobium sealare (tataré)	Parapiptademia rigida (Kurupayra)	Enterobium contortisiliqum (timbo)	Tabernaemontana australis (sapirangy)	Prosopis sp (algarrabo)	Campomanesia xanthocarpa (guavira pyta)
Peltophorum dubium (Ybyra pytá)	Enterobium Contortisiliqum (Timbo)	Cecropia Pachystachya (ambay)	Cecropia pachystachya (ambay)	Peltophorum dubium (ybyra pyta)	Eugenia uniflora (ñanga piry)
Tabebuia sp. (Lapacho)	Pithecellobium sanan (manduvira)	Melicoccus lepidopetalus (yvapovo)	Acrocomia totai (coco)	Pithecellobium scalare (tatare)	Peltophorum dubium (yvyra pyta)
Pterogyne nitens (Ybyraro)	Cecropia pachystachya (Ambay)	Sapium haematospermum (kurupillay)	Pithecellobium sanan (manduvira)	Erythina crista galli (ceibo)	Lanchocarpus leucanthus (ybyra ita)
Alsibia hassleri (Ybyra ju)	Acrocomia totai (mbocaya coco)	Erythina crista galli (ceibo)	Alsibia hassleri (yvyra ju)	Cordia trichotoma (petereby)	Tabebuia sp (lapacho)
Jacaranda mimosifolia (Jacaranda)	Vitex megapotamica (taruma)	Acrocomia totai (coco)	Pithecellobium scalare (tatare)	Phytolacca dioica (ombu)	Cordia trichotoma (petereby)
Patagonuia americana (Guayaiví)	Erythina crista galli (ceibo)	Allophylus edulis (koku)	Jacaranda mimosifolia (jacaranda)	Cecropia pachystachya (ambay)	Balfourodendron riedelianum (guatambu)
Inga sp. (Inga)	Cordia trichotoma (petereby)	Cordia thichotoma (petereby)	Pterogyne nitens (ybyraro)	Enterobium contortisiliqum (timbo)	Cedrela sp. (cedro)
Melicoccus lepidopetalus (Yva povo)	Tabebuia sp. (lapacho)	Tabebuia sp (lapacho)	Tabebuia sp (lapacho)	Acrocomia totai (coco)	Cabralea sp (caucharana)
Tabernaemontana australis (Sapirangy)	Parapiptadenia rígida (kurupayva)	-	Erythina cristagalle (ceibo)	Pterogyne nitens (ybyra ro)	Parapiptadenia rígida (kurupayva)
Sapium hacmatos permum (Kurupika'y)	Allophylus edulis (koku)	-	-	Jacaranda mimosifolia (jacaranda)	Myrocarpus frondosus (incienso)
Erythina crista galli (Ceibo)	-	-	-	Tabebuia sp (lapacho)	-
Pithecellobium sanan (manduvirá)	-	-	-	Inga sp. (inga)	-
Acrocomia totai (Mbocaya coco)	-	-	-	P. Americana (guayayvi)	-

Source : Study Team, 1999

(2) Prediction of Impact

Along the survey area in routes 2 and 7, there are no specific rare, endangered and indigenous spices of fauna and flora have not been identified. Therefore, there will be no impacts on the specific rare, endangered and indigenous spices of flora and fauna.

However, as mentioned above, Ypacarai reservoir resource management has been set up around Ypacarai lake. In particular, close attention shall be paid to the swampy area between the south of Ypacarai lake and route 2. Location of the bypass project will be designed to be constructed on one part of this swamp area. However, necessary designs for the bypass such as for construction of culverts have already been done to mitigate such impact on the swampy area.

In addition to this, however, this area is cared for by a local NGO(Non Governmental Organization). Therefore, necessary negotiation and communication will be required to produce a good relationship with the NGO at the early stage of the projects.

19.5 Pollution

19.5.1 Air Pollution

(1) Improvement Pollutant Loads

By the implementation of improvement projects(with projects), average travel speed will increase as compared with "without project (do nothing)" in the sections of mini bypass and climbing lane projects at the target year of 2010". Generally, it is expected that the emission of NO_x and CO_2 from traffic vehicle will decrease in accordance with the increase of the average travel speed by the implementation of the projects.

To evaluate improvement of emission quantity of each pollutant load, the difference of the quantified load between the case of "with project (do project)" and the other case of "without project (do nothing)" have been calculated by use of parameters of project length (km), total traffic volume (t-vehicle), heavy vehicle traffic volume (h-vehicle) and velocity(km/h). Following are the calculation results.

Table 19.5.1 Air Pollutants Improvement Quantity by Bypass Project

Pollutant	Project	*Ypacarai*		*Caacupe*		*Itacurubi*		*San Jose*	
		Existing	Bay pass	Existing	Bay pass	Existing	Bay pass	Existing	Bay pass
NO_x (g/day)	With	8,820.6	120,226.9	11,375.4	91,494.3	339.2	96,408.9	271.7	83,582.7
	Without	191,864.0	-	163,996.6	-	154,035.0	-	137,080.9	-
CO_2-C (g/day)	With	1,513,418.4	7,362,653.6	1,315,916.0	7,198,656.5	58,996.8	7,237,788.3	30,297.8	
	Without	13,049,212.5	-	14,285,250.0	-	10,479,465.7	-	9,265,571.3	-

Table 19.5.2 Air Pollutants Improvement Quantity by Climbing Lane Project

Pollutant	Project	*E. Ayala*	*Itacurubi*		*San Jose*	*Cnel. Oviedo*		*Caaguazu*	
		Lane68	Lane79	Lane91	Lane 120	Lane 147	Lane 153	Lane162	Lane 166
NO_x (g/day)	With	10,185.4	20,408.8	28,575.0	33,726.3	70,032.9	16,875.4	30,375.7	33,750.8
	Without	14,129.6	26,789.8	43,656.8	51,378.8	86,592.7	20,865.7	37,558.3	41,731.4
CO_2-C (g/day)	With	721,297.8	1,448,687.0	2,028,280.8	2,524,188.0	5,112,551.0	1,231,940.0	2,217,492.0	2,463,880.0
	Without	982,424.3	1,791,067.0	2,986,643.8	3,741,651.0	5,767,545.5	1,389,770.0	2,501,586.0	2,779,540.0

Table 19.5.3 Air Pollutants Total Improvement Quantity

Pollutants	Unit	Project	Improvement Quantity	Total Improvement Quantity
NO_X	g/day	By-pass Project	234,457.0	313,229.81
		Climbing Lane Project	78,772.8	
CO_2	g-c/day	By-pass Project	16,096,340.3	20,288,251.26
		Climbing Lane Project	4,191,911.0	

(2) Prediction of Impact

As a result of the calculation above, apparently, environmental loads of NO_x and CO_2 caused by vehicle traffic will decrease by the implementation of the projects as compared with "without project".

19.5.2 Noise

(1) Prediction of Noise Level

Increase of noise level from vehicle transportation will be expected in accordance with the increase of average travel speed by the implementation of the projects. Noise level at 1.2 m height and horizontal distance of 7.5 m from the centerline of "the existing road section" and "the project road section" in each project area are respectively predicted by use of parameters of project length (km), total traffic volume (t-vehicle), heavy vehicle traffic volume (h-vehicle) and velocity(km/h). Following are the calculation results.

Table 19.5.4 Noise Level Forecast in Bypass Project (dB(A))

Location	*Ypacarai*		*Caacupe*		*Itacurubi*		San Jose	
	Existing	Bypass	Existing	Bypass	Existing	Bypass	Existing	Bypass
With Project	66.1	75.2	64.5	73.6	51.0	72.9	49.2	72.9
Without Project	69.8	-	68.2	-	67.9	-	67.9	-

Table 19.5.5 Noise Level Forecast in Climbing Lane Project (dB(A))

Location	*E. Ayala*	*Itacurubi*		*San Jose*	*Cnel Oviedo*		*Caaguazu*	
	Lane 68	Lane79	Lane 91	Lane 120	Lane 147	Lane 153	Lane 162	Lane166
With Project	71.9	72.9	72.9	72.4	73.4	73.4	73.4	73.4
Without Project	68.9	70.9	68.9	68.4	71.4	71.4	71.4	71.4

(2) Prediction of Impact

Each by-pass route is designed go round the present urban area. Therefore, it is considered that there will be until direct impact on the increasing of noise level in the urban area.

19.6 Countermeasures and Environmental Management Plan

19.6.1 Countermeasures

(1) Social Environment

a. Resettlement

In Paraguay, specific laws and regulations for resettlement of population and acquisition of land affected by the implementation of a road project do not exist at present. However, some legislative framework and past experience related to land acquisition and resettlements are identified as follows;

– General Rules
  - National Constitution
  - Administrative Organization Law
  - Paraguayan Civil Code
  - Rural Code and Law No.40 which modifies the code partially

– Special Rules
  - Municipal Organization Law
  - Law No. 75 which modifies the organization of the Director General of National Route
  - Law of Institute of Rural Welfare (IBR)
  - Law of Land Statues

– Past Experience
  - Law No. 378/1994 of Project of construction of Ring Road and Northern and Southern access road to Asuncion

Accordingly, related laws and regulations listed above and past experience of resettlements for a road project shall be reviewed to mitigate the impact of resettlements for the projects.

As a result of household opinion surveys, almost all households interviewed in all the cities of the by-pass projects approve the implementation of the project. As for compensation for resettlement, many are of the opinion that compensation should be based on an indemnity in money equivalent to actual price of each property. Therefore, suitable estimation of properties affected by the implementation of the projects and necessary negotiation and communication on the specific measures are indispensable at the early stage of the projects.

b. Economic Activities

– Commercial Activities
  - Design of bypass construction project and climbing lane project at Lane 147 in Coronel Oviedo shall be considered to mitigate possible negative impacts in accordance with future developments and land use plans.
  - Special regulation or policy to promote new economic activities along the bypass route shall be considered to mitigate negative impacts on existing economic activities by the projects in accordance with the circumstances of each bypass project.

– Farming (Cultivation and Stock Raising)
  - To mitigate traffic accidents of livestock predicted as a negative impact of the bypass projects, construction of a fence, traffic sign board warning for livestock and necessary crossing section for the livestock are considered as suitable countermeasures for such impacts during the construction and implementation stages in accordance with the circumstances of the project area.

c. Road Waste

– To mitigate impacts on solid waste of the projects, proper solid waste management by official management will be required during the construction and operation stage respectively.
– Education of the population that lives in the study area, and the drivers, is considered to be a useful measure to decrease road waste.

d. Disaster

– Landslide
  - Lane 162 of the climbing lane project will be located in a critical landslide area. Accordingly, at the detailed design and construction stages, to mitigate such a negative impact, several countermeasures such as slope protection will be necessary in accordance with the topological circumstances of the lane.

– Traffic Accident
  - Traffic facilities to mitigate traffic accidents such as pedestrian crossing, guard fence and traffic signs and so on are expected to be constructed.
  - Education of the population that lives in the study area, and the drivers is considered to be a useful and principal measure to decrease traffic accidents.

(2) Natural Environment

a. Soil Erosion

– Lane 166 of the climbing lane project will be located around the critical area for erosion of soil. Accordingly, at the final design and construction stages to mitigate such a negative impact, several countermeasures such as planting and slope protection will be necessary in accordance with the soil circumstances encountered.

(3) Pollution

a. Air Pollution

– Establishment of a national standard regarding air quality, emission of vehicle exhaust gas quantity and quality
– Establishment of a Mercosur standard regarding air quality, emission of vehicle exhaust gas quantity and quality among the Mercosur countries
– Introduction of an obligatory car inspection system
– Set up a system to monitor the diffusion of exhaust gas, etc.

b. Noise

– In consideration of future expansion of each urban area, facilities to mitigate future noise level issue such as a planted area, green belt and so on are expected to be constructed on the urban side of each bypass project.

19.6.2 Environmental Management Plan

The following recommendation shall be considered as an environmental management plan to realize the countermeasures mentioned above.

(1) Monitoring Committee

- To realize and monitor countermeasures recommended above, a monitoring committee shall be organized.
- The monitoring committee shall consist of related officials of MOPC, MAG, each Municipality of the project area, Inter-Institutional Committee (CI), local NGOs (Non Governmental Organizations) and other related official and private entities.
- The monitoring committee shall organize an advisory board which shall consist of several kinds of experts in related fields such as an university professors.
- The monitoring committee shall take into consideration the present related regulations and laws in Paraguay when the committee prepares individual monitoring plans for each project.
- The monitoring committee shall review past experience and similar projects such as "Project of construction of Ring Road and Northern and Southern access road to *Asuncion*" when the committee prepares individual monitoring plans for each project.

(2) *Mercosur* Committee

- To discuss establishment of a *Mercosur* standard regarding air quality, emission of vehicle exhaust gas quantity and quality among the *Mercosur* countries, Mercosur committee shall be organized in cooperation with MOPC, MAG and related official entities.

(3) Interactive System

- The environmental management plan shall prepare an interactive communication system at an early stage of the projects to communicate with the population affected by the project, existing community organizations, and NGOs active in each project area to discuss the environmental impacts and issues of the projects.

(4) Educational Program

- The environmental management plan shall prepare educational programs of traffic safety and environmental care to educate the population living in the project area and the drivers utilizing routes 2 and 7.
- These educational programs should be carried out in cooperation with schools, mass media, police stations, community halls, local NGO's and other public and private organizations including medical health centers, hospitals, toll gate staff, restaurants, drive-ins, hotels and so on.

(5) Environmental Conservation Program of *Ypacarai* Reservoir Resource Management

- To negotiate and communicate with local NGO's active in this reservoir area.
- To organize patrol system for the swampy area around the bypass project located in the reservoir area.

19.7 Household Opinion Survey

19.7.1 Introduction

As mentioned before, the main purpose of the household opinion survey is to identify household opinion on each project proposed and resettlement issues which would be caused by the implementation of each project. The survey was carried out by the method of onsite interview with head of each sampled household in each by-pass project area using a questionnaire. The sample number of each survey area had been selected depending on scale, population density and characteristic of the area. Table 19.7.1 shows its number of sampled households interviewed in each survey area.

Table 19.7.1 Sampling Number

Survey Areas	Number
Ypacarai	42
Caacupe	61
Eusebio Ayala	25
Itacurubí	36
San José	40
Coronel Oviedo	22
Caaguazu	40
Total	266

19.7.2 Survey Results

The survey results can be summarized as follows:

- Almost all population interviewed in the survey area approve the projects.
- Majority of population interviewed in the survey area favor indemnification in money equivalent to the value of the present house they are living.
- The price of indemnification is considered not to be so high in value
- The main problems identified by the interviewees are the traffic accidents and lack of facilities, e.g. pedestrians.

19.7.3 Survey Data

(1) Profile of Interviewee

a. Interviewees

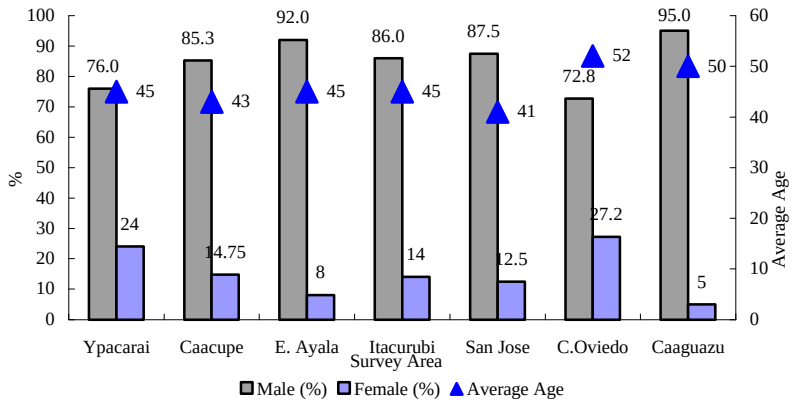


Figure 19.7.1 Interviewee

b. Occupation

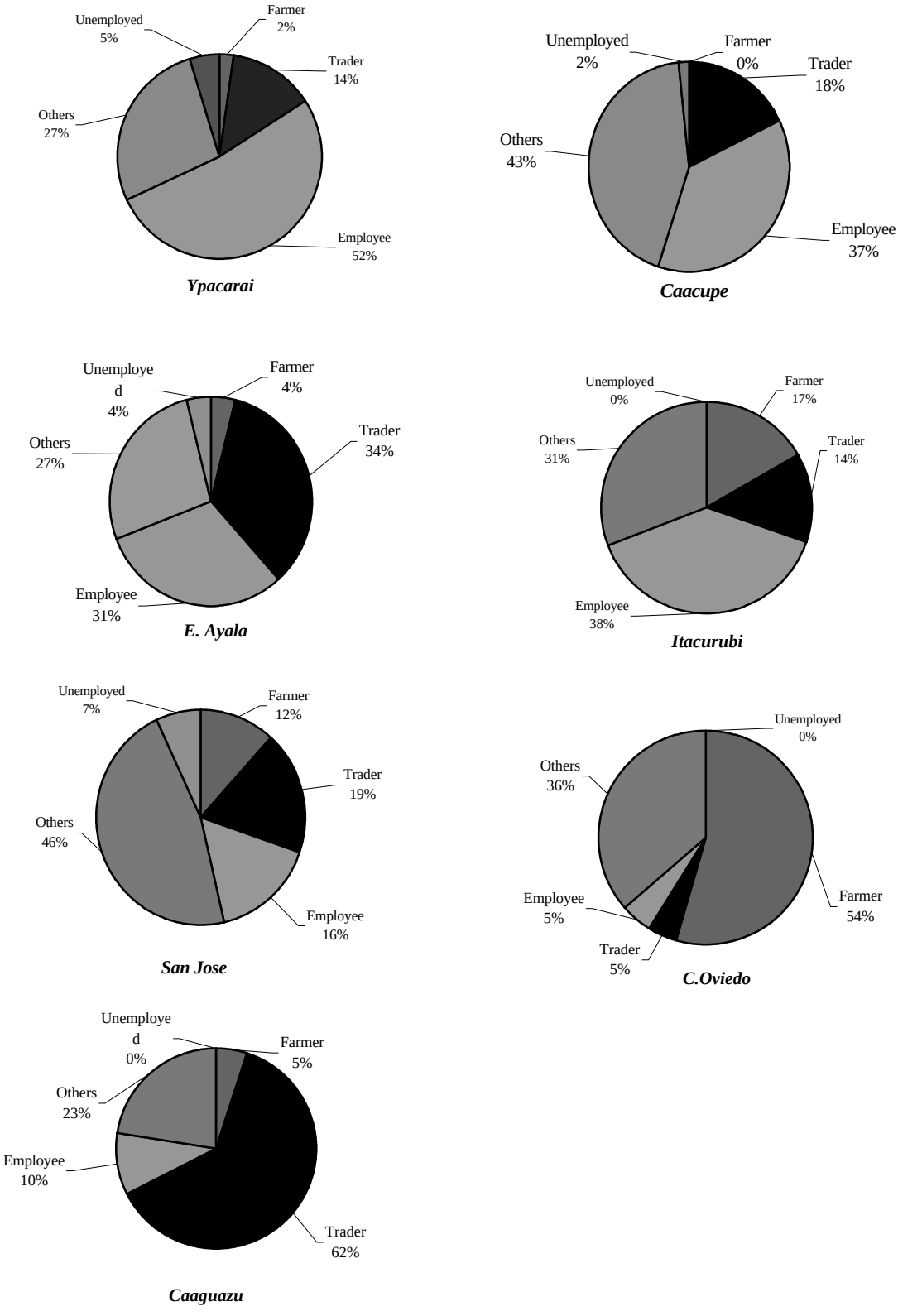


Figure 19.7.2 Occupation

c. Average Income

Table 19.7.2 Average Income/ month

Income/month	*Ypacarai*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	%	%	%	%	%	%	%
1) < LMW	31	34.4	36	52.8	55	77.5	20
2) =< LMW	14.2	6.5	12	13.8	22.5	13.5	17.5
3) > LMW	38.2	47.5	32	25	15	9	30
4) 2×LMW	16.6	11.6	20	8.4	7.5	0	32.5

Note:
1) : Less than the Legal Minimum Wage
2) : Equal than the Legal Minimum Wage
3) : Higher than the Legal Minimum Wage
4) : Twice the amount of the Legal Minimum Wage

d. Family member

Table 19.7.3 Number of Family Members

Family members	*Ypacarai*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	%	%	%	%	%	%	%
Less than 5	62	51	68	38.9	55	77.5	70
5	12	13	20	22.2	10	9	2.5
More than 5	26	36	12	38.9	35	13.5	27.5

e. Settlement Team

Table 19.7.4 Term of Settlement

Years	*Ypacarai*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	%	%	%	%	%	%	%
Less than 5	24	28	28	27.7	25	4.5	30
6 to 10	19	26.2	20	22.2	27.5	9	12.5
10 to 15	4.8	9.8	12	13.8	22.5	4.5	5
15 to 20	4.8	11.5	4	5.6	20	0	15
More than 20	47.8	24.5	36	30.7	27.5	82	37.5

(2) Living Environment

a. House Ownership

Table 19.7.5 Status of House Ownership

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Own house	41	97.6	52	85	23	92	33	91.7	37	92.5	20	91	29	72.5
Rental house	1	2.4	9	15	2	8	3	8.3	3	7.5	2	9	11	27.5

b. Houses Used for Job

Table 19.7.6 Houses Used for Job Activities

	Ypacarai	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
%	16.5	21	28	14	20	45.5	60

c. Construction Structure

Table 19.7.7 Construction Structure of Interviewee's House

Structure	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Flat	42	100	60	98.4	23	92	36	100	36	90	22	100	38	95
Two stories	0	0	1	1.6	2	8	0	0	4	10	0	0	2	5

d. Construction Material

Table 19.7.8 Construction Material of Interviewee's House

Construction materials	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Bricks & Tiles	41	97.6	58	95	23	92	34	94.6	19	47.5	8	36.5	34	85
Wood	1	2.4	3	5	1	4	1	2.7	17	42.5	14	63.5	3	7.5
Adobe & Straw	0	0	0	0	0	0	1	2.7	4	10	0	0	0	0
Iron& Concrete	0	0	0	0	1	4	0	0	0	0	0	0	3	7.5

e. Construction Area

Table 19.7.9 Total Constructed Area

m^2	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
- 50	10	24	15	24.6	6	24	27	75.1	21	52.5	8	36.5	8	20
50 - 100	23	55	32	52.4	15	60	6	16.6	15	37.5	14	63.5	16	40
100 - 150	7	16	11	18	1	4	2	5.6	2	5	0	0	9	22.5
150-	2	5	3	5	3	12	1	2.7	2	5	0	0	7	17.5

f. Basic Services

Table 19.7.10 Houses with Connection of Basic Services

With Connection	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Water	36	86	54	88.5	21	84	20	72,3	19	45	0	0	13	32.5
Electricity	39	93	55	90.1	25	100	34	94,6	0	0	20	91	39	97.5
Sewage line	0	0	0	0	0	0	0	0	36	90	0	0	0	0

g. Estimated Price of Existing House

Table 19.7.11 Price of House

Price (1million Gs)	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
- 10	1	2.4	3	5	5	20	6	16.6	26	65	14	63.5	0	0
10 - 20	14	33.4	16	27.8	5	20	17	47.6	11	27.5	2	9	0	0
20 - 30	6	14	15	24.6	3	12	6	16.6	1	2.5	1	4.5	2	5
30 - 40	5	12	11	18	5	20	2	5.4	0	0	0	0	6	15
40 -	16	38.2	15	24.6	7	28	5	13.8	2	5	6	23	32	80

Gs. = Guaranies (local currency of Paraguay)

h. Access Time to Public Facility

Table 19.7.12 Access Time to Educational Facility

Time (minutes)	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
- 5	24	57	48	78.7	25	100	27	75	32	80	13	59.2	34	85
5 - 10	11	26	7	11.5	0	0	6	16.6	4	10	7	31.8	5	12.5
10 - 15	6	14	1	1.6	0	0	2	5.6	4	10	1	4.5	1	2.5
15 -	1	3	5	8.2	0	0	1	2.8	0	0	1	4.5	0	0

Table 19.7.13 Access Time to Medical Care Facility

Time (minutes)	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
- 5	17	40.6	44	72	24	96	17	47.6	21	52.5	5	22.7	22	55
5 - 10	11	26	7	11.5	1	4	15	41.2	7	17.5	3	13.7	2	5
10 - 15	7	16.7	3	5	0	0	2	5.6	3	7.5	7	31.8	8	20
15 -	7	16.7	7	11.5	0	0	2	5.6	9	22.5	7	31.8	8	20

i. Community Activity

Table 19.7.14 Participation in Community Activity

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Participate	12	28.6	23	37.7	3	12	13	36	9	22.5	0	0	5	12.5
no participate	30	71.4	38	62.3	22	88	23	64	31	77.5	22	100	35	87.5

Table 19.7.15 Type of Community Activities Participated

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Neighbors Committee	4	33.3	10	43.5	2	66.6	10	77	2	22.2	0	0	1	20
Cooperative	2	16.7	8	34.8	1	33.4	3	23	6	66.6	0	0	3	60
Religious Activities	6	50	4	17.4	0	0	0	0	1	11.1	0	0	0	0
Others	0	0	1	4.3	0	0	0	0	0	0	0	0	1	20

(3) Actual Condition of use of Route 2 & 7

a. Vehicle Ownership

Table 19.7.16 Rate of Vehicle Ownership

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Vehicle owner	11	26	18	29.5	3	12	9	25	7	17.5	5	22.7	17	42.5
No vehicle	31	74	43	70.5	22	88	27	75	33	82.5	17	77.3	23	57.5

Table 19.7.17 Total Number of Vehicles Owned

Vehicle	*Ypacarai*		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
1 vehicle	8	73	15	83.5	3	100	7	78	7	100	5	100	10	59
2 vehicles	2	18	1	5.5	0	0	2	22	0	0	0	0	5	29.5
3 vehicles	1	9	2	11	0	0	0	0	0	0	0	0	1	5.75
More than 3	0	0	0	0	0	0	0	0	0	0	0	0	1	5.75

b. Objective of Use of Routes

Table 19.7.18 Major Objectives of Use of Routes 2 & 7
(Two major objectives were selected by each interviewee)

Purpose	*Ypacarai*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	Number	Number	Number	Number	Number	Number	Number
Pleasure	7	17	4	11	17	5	12
Attending school	12	32	16	13	13	4	10
Shopping	40	43	17	31	31	19	34
Freighting	6	15	4	8	7	10	8
Commuting	16	14	9	9	11	6	16
Others	3	1	0	0	1	0	0
Total	84	122	50	72	80	44	80

c. Major Problem

Table 19.7.19 Major Problems of Use of Route 2 & 7 Identified Interviewees
(Two major problems were selected by each interviewee)

Purpose	*Ypacarai*	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	Number	Number	Number	Number	Number	Number	Number
Traffic jam	25	21	0	3	13	0	20
Lack of traffic signals	9	13	12	11	12	9	18
Bad pavement	4	7	12	5	5	5	6
Traffic accident	21	40	11	26	27	17	26
Lack of road singes	3	11	5	5	5	5	3
Lack of pedestrians	22	30	10	22	18	8	7

(4) Social Consideration on the Road Improvement

a. Approval and Disapproval of the Projects

Table 19.7.20 Approval/disapproval Regarding Road Improvement Project

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Approves	42	100	60	98.4	23	92	36	100	40	100	22	100	40	100
Disapproval	0	0	1	1.6	2	8	0	0	0	0	0	0	0	0

Table 19.7.21 Major Reasons for the Approval

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
It represents a general welfare (?)	32	76.2	45	73.8	13	56.5	28	77.8	28	70	13	59.1	31	77.5
Improvement of access easiness	6	14.3	9	14.7	2	8.7	2	5.6	7	17.5	1	4.5	7	17.5
Increase of road safety	4	9.5	7	11.5	8	34.8	6	16.6	5	12.56	8	36.4	2	5

b. Necessary Requirements for Resettlement

Table 19.7.22 Necessary Requirements to be considered for Resettlement

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Compensation (monetary)	42	100	60	98.4	23	100	33	92	40	100	22	100	40	100
Employment	0	0	1	1.6	0	0	0	0	0	0	0	0	0	0
Basic Infrastructure	0	0	0	0	0	0	3	8	0	0	0	0	0	0

Table 19.7.23 Necessary Compensation Measures for Resettlement

	Ypacarai		*Caacupe*		*E. Ayala*		*Itacurubí*		*San José*		*C. Oviedo*		*Caaguazu*	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Indemnity	37	88	54	88.5	22	95.6	28	77.8	30	75	21	95.5	39	97.5
Alternative house	5	12	7	11.5	1	4.4	8	22.2	10	25	1	4.5	1	2.5

Table 19.7.24 Necessary Infrastructures in the Area to be resettled (Two major problems were selected by each interviewee)

	Ypacarai	*Caacupe*	*E. Ayala*	*Itacurubí*	*San José*	*C. Oviedo*	*Caaguazu*
	Number	Number	Number	Number	Number	Number	Number
Water supply	39	51	16	33	34	18	30
Power supply	20	35	12	18	18	16	15
Drainage	3	5	2	2	3	0	4
Communications	3	5	0	1	1	0	1
Health Care Centers	5	12	9	7	11	2	16
Educational Centers	4	6	4	5	5	3	8
Access road to routes	10	8	3	6	8	3	6

CHAPTER 20
ECONOMIC EVALUATION AND FINANCIAL ANALYSIS

20 ECONOMIC EVALUATION

20.1 Methodology and Assumptions

In this section, the proposed project will be evaluated from the viewpoint of the national economy, following a cost-benefit analysis. In the economic evaluation, the procedure illustrated below was taken, and costs and benefits of the project are converted into economic.

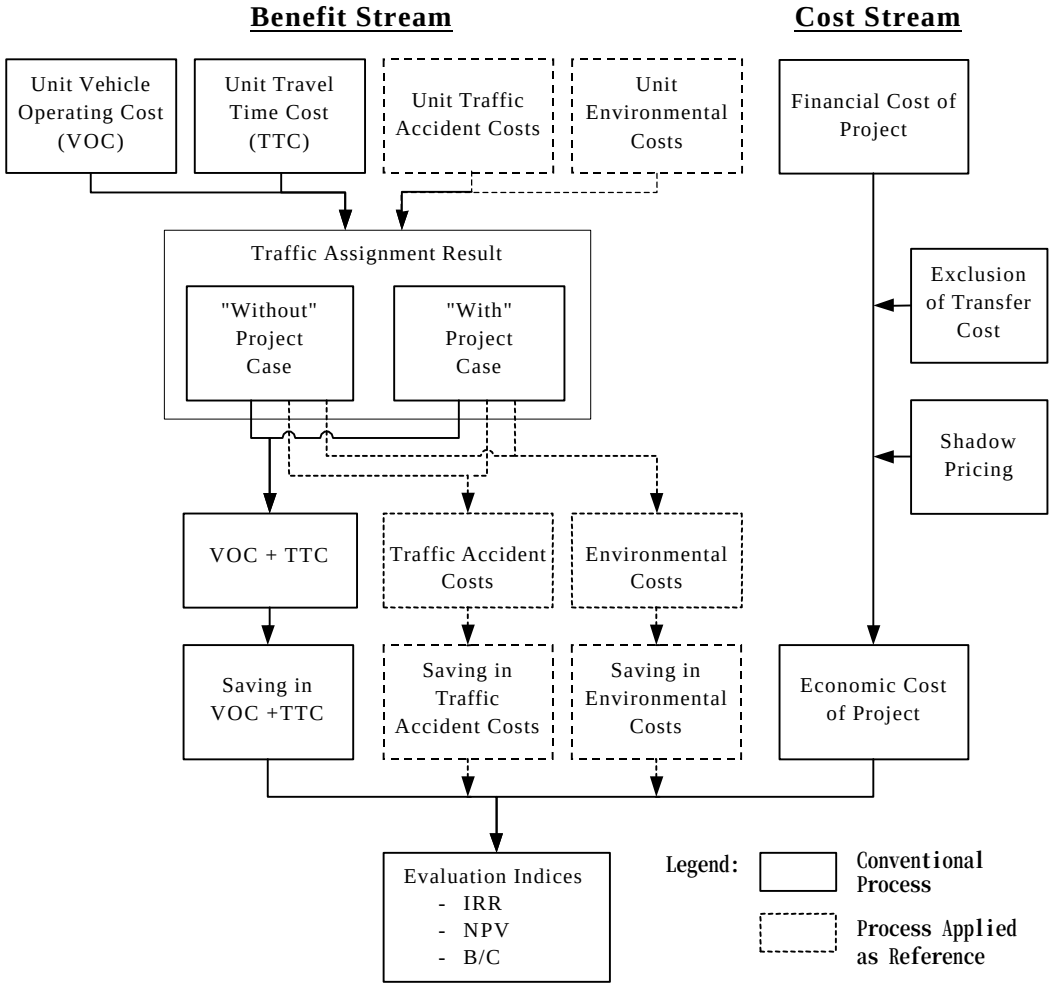


Figure 20.1.1 Procedure of Economic Evaluation

Economic evaluation only takes into account the proposed improvements and maintenance for those works. The urgent maintenance program, such as reconstruction of the two bridges and an overlay of the entire study section, is excluded in the economic analysis. However, this does not detract from the importance of the program. Rather, it is important to note that without the program, functions of the national road could be impaired, and the national economy would incur tremendous losses. Regardless of the results of the economic analyses, therefore, it is necessary to implement the urgent maintenance program immediately.

20.1.1 Benefits Counted

Improvement of the National Road 2 and 7 will bear various types of benefits. Among them, the following direct benefits are counted in this analysis.

1) Saving in Vehicle Operating Cost (VOC)
2) Saving in Travel Time Cost (TTC)
3) Reduction in Traffic Accident Cost
4) Environmental Improvement

The above 1) and 2) are conventionally studied in the economic evaluation of road investment projects, while recent intensive studies have been made for the above 3) and 4), especially in advanced countries. Although examples of counting benefits of 3) and 4) cannot be found in Paraguay, some studies have been made due to the characteristics of the improvement project proposed in this study.

Economic benefits are calculated through comparison of "with project case" and "without project case" for each type of costs mentioned above. The differences in costs among the two cases are counted as benefits when some saving or reduction in cost occurs.

(1) VOC Saving

Vehicle operating cost (VOC) is one of the main sources of economic benefits. The operating cost per unit distance is estimated by type of vehicle, such as passenger car, truck, and bus.

VOC is composed of the following components:

a) Fuel cost
b) Oil cost
c) Tire cost
d) Repair cost
e) Depreciation cost
f) Capital opportunity cost
g) Crew and administration cost

In Paraguay, Oficina de Palnificación Integral del Transporte (OPIT) in MOPC has been periodically updating VOC data in order to use an input to the HDM Model which is developed by the IBRD for the appraisal of highway development and maintenance projects. The VOC estimates in this study depend on the basic information and assumptions described in "Estrutura de los Costos de Funcionamiento de Vehículos Automotores" by OPIT.

The HDM Model is mostly applied to construction and pavement projects for inter-city or inter-regional highway projects where key factors affecting VOC are distance and surface conditions of the road. All the sections in the study area, however, are paved in fairly good condition, and thus the figures for the paved road are applied for the analysis. Traveling speed is an important factor because the operation efficiency of vehicles depends on how fast one drives. In other words, one

can drive a vehicle more efficiently up to a certain speed, but the operation efficiency gradually drops beyond that point. Therefore, the speed factor is taken into account in VOC estimation although the MOPC manual does not take it into account. An IBRD report ("Quantification of road user savings", IBRD Occasional Paper No.2, 1966) provides consumption rates or indices that can be used for the cost items from a) to e). They are employed to estimate VOC at estimated speeds of future travel with the results of traffic assignment in cases of "with the proposed project" and "without the proposed project".

Unit VOC of each component from a) to e) is expressed as a function of operating speed. A part of item e) and the others(items f) and g)) are not directly affected by operating speed but by travel time. Unit costs are estimated at market price and then converted into economic cost. They are mostly based on the MOPC, and are updated to current prices by taking into account inflation of 4.9% from November 1998 up to the present. Unit VOCs are investigated only for paved road. Aggregate unit VOCs, which consist of time-related and distance-related VOCs, are summarized as shown in Table 20.1.1 and Figure 20.1.2. At very low speeds of 5 km per hour, the time-related cost is higher than the distance related cost across all types of vehicles. The most economical speed is around 60 to 70 km per hour.

Table 20.1.1 Aggregate Unit VOC by Type of Vehicle and by Traveling Speed

(Unit: Gs./vehicle/km)

Speed	Car			Bus			Truck		
(Km/hr)	Distance-related	Time-related	Total	Distance-related	Time-related	Total	Distance-related	Time-related	Total
5	571	1,280	1,851	1,155	2,571	3,726	1,200	1,929	3,129
10	422	640	1,062	869	1,285	2,154	841	965	1,805
20	342	320	662	707	643	1,349	647	482	1,130
30	305	213	518	620	428	1,048	511	322	832
40	289	160	449	558	321	879	436	241	677
50	281	128	409	551	257	808	405	193	598
60	289	107	396	599	214	814	405	161	566
70	297	91	389	658	184	841	423	138	560
80	317	80	397	733	161	894	460	121	580
90	341	71	412	811	143	953	507	107	614

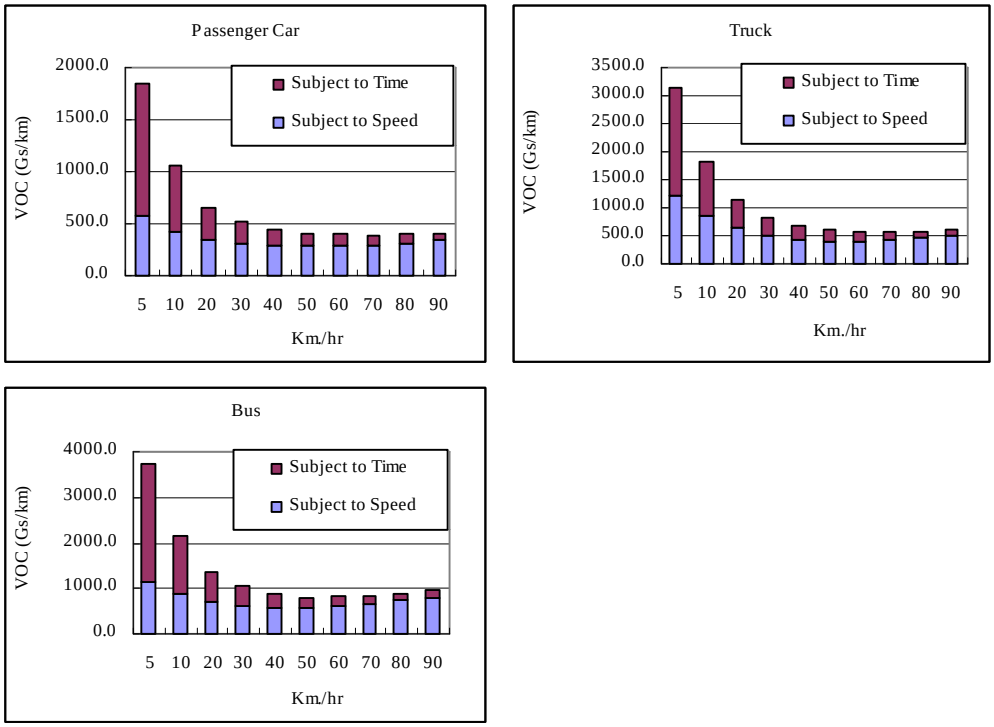


Figure 20.1.2 Aggregate Unit VOC

(2) TTC Saving

Saved costs of travel time for passengers are calculated according to the unit value given in the OPIT manual of 1998 with the same consideration of the inflation taken for the calculation of the unit VOCs.

In addition, time costs of cargo on trucks are taken into account. Although the value of faster delivery would be quite high for some types of cargo, such as fresh vegetables, a simple and conservative calculation was applied. Cargo in transportation can be regarded as stock of commodities, and a decrease in travel time of cargo will result in reduced costs for working capital by the cargo owner. The difference is counted as the value of travel time saving of cargo.

Data on volume and types of cargoes on trucks were obtained from the results of "Axle Load Survey" conducted by the JICA study team. Prices per ton of cargo were calculated with reference to statistics of external trade. FOB prices in 1997 in US dollars for export of agricultural products and for import of manufactured goods are referred to. For the conversion to Guaranis, the current exchange rate was applied. Since cargo transportation may include a large portion of domestic products to be consumed in Paraguay, price per ton of commodities was multiplied by 0.7. Economic interest rate of 12% and 2000 working hours of a truck were applied in the estimation of travel time cost of cargoes. Unit TTCs applied in the study are shown in the table below.

Table 20.1.2 Unit TTC by Type of Vehicle

		Car	Unit Cost	Total (Gs/hour)
P. Car	Driver	1	5,720	5,720
	Passenger	0.98	2,860	2,803
	Total	1.98		8,523
Bus	Passenger	22.3	876	19,535
Truck	Cargo		151	151

(3) Reduction in Traffic Accident Cost

At present, traffic accidents on National Road 2 and 7 are very frequent compared to other National Roads. Improvement of the road will result in a substantial decrease in traffic accidents.

Detail data on occurrence of traffic accidents in 1998 on National Road 2 and 7 were provided by OPIT and the Road Police, and analyzed for the study. Characteristics of traffic accidents in the study area can be summarized as follows. Although there may be many unreported accidents, they are ignored in this evaluation.

It is clear that the sections of the proposed flyover (Km 132) and the alignment improvement (Km 146 – 150) have larger numbers of traffic accidents compared to the neighboring sections with similar traffic volume.

In Japan costs of traffic accidents at some section or link are estimated using the following formula:

$$Y = a X_1 + b X_2$$

where Y: cost of traffic accidents
X_1: traffic volume (vehicle kilometer)
X_2: number of intersections number of vehicle at the intersections
a, b: coefficients given by; location of the section
(area of high density of population, city area, and other areas)
type of roads (2 lanes, 4 lanes or more, Expressway)

In this evaluation, the numbers of accidents in “with project case” were assumed to decrease to the same level as neighboring sections with similar conditions. The number of accidents in “with project case” and “without project case” on the project sections were estimated with present and future traffic volume (vehicle kilometer) as well as the current number of accidents on those sections and the neighboring sections.

As for the section of the flyover (Km 132), the number of accidents of this section after the project implementation is supposed to be reduced to the same level as that on section Km 133 – 134 because the section of Km 130 – 131 has many at-grade intersections with town roads and the conditions will not be similar to those of the flyover section after the project implementation. As for the section Km 146 – 150 of the alignment improvement, traffic accidents are deemed to decrease to the level of that in the section of Km 135 – 176 except itself.

Table 20.1.3 Characteristics of Traffic Accidents on National Road 2 and 7

Section	Km Point	Conditions of Traffic Accidents
San Lorenzo – Ypacarai	14 - 33	Number of accidents gradually decreases corresponding to the distance from Asuncion as follows due to the decreasing traffic volume: Km 14 – 18; 44.8 accidents/km/year 11.6 injured/km/year, 0.2 dead/km/year Km 19 – 23; 19.0 accidents/km/year 2.8 injured/km/year, 0.2 dead/km/year Km 24 – 28; 7.4 accidents/km/year 2.6 injured/km/year, 0.2 dead/km/year Km 29 – 33; 4.0 accidents/km/year 1.2 injured/km/year, 0.0 dead/year/km
Ypacarai (No.1 Bypass)	34 - 39	Number of accidents is slightly larger than that in the section of Km 29 – 33. 4.67 accidents/km/year, 1.2 injured/km/year, 0.0 dead/km/year
Ypacarai - Caacupe	40 - 48	Number of accidents is smaller than Ypacarai town as well as Km 29 – 33 corresponding to less traffic volume. One large accident of a bus at or near an intersection accounts for the high figures of injured and dead victims. 3.4 accidents/km/year, 2.5 injured/km/year, 1.0 dead/km/year
Caacupe (No. 2 Bypass)	49 - 57	Number of accidents is very small probably because of an well-organized one way system of the two parallel roads in the town. 0.8 accident/km/year, 0.2 injured/km/year, 0.0 dead/km/year
Caacupe – Eusebio Ayala	58 - 71	Number of accidents is higher that in the town area of Caacupe and lower than the section of Ypacarai – Caacupe with exception of Km 67-68 where a climbing lame is proposed. 1.7 accidents/km/year, 0.5 injured/km/year, 0.0 dead/km/year Km 67 - 68; 4.5 accidents/km/year 0.0 injured/km/year, 0.0 dead/year/km
Eusebio Ayala	72 - 73	Number of accidents in the town is close to the neighboring areas. 2.0 accidents/km/year, 0.0 injured/km/year, 0.0 dead/km/year
Eusebio Ayala - Itacurubi	74 - 83	Number of accidents is as follows. Number of accidents in the section of a proposed climbing lane is also close to the neighboring sections. Number of accidents in the section of Km 81-83 is higher than those in neighboring sections. 1.9 accidents/km/year, 0.9 injured/km/year, 0.2 dead/km/year
Itacurubi (No. 3 Bypass)	84 - 90	Number of accidents in the town (Km 86 – 90) is almost same as those in the sections of Eusebio Ayala and Eusebio Ayala - Itacurubi. 1.8 accidents/km/year, 0.0 injured/km/year, 0.0 dead/km/year
Itacurubi - San Jose	91 - 100	Number of accident is smaller than the above sections due to less traffic volume, including that in the section of a proposed bypass. 0.8 accident/km/year, 0.0 injured/km/year, 0.0 dead/km/year
San Jose (No. 4 Bypass)	101 - 104	Number of accident is very small. 0.8 accident/km/year, 0.0 injured/km/year, 0.0 dead/km/year
San Jose - Coronel Oviedo	105 - 130	Number of accidents is larger than that in San Jose and gradually increasing near Coronel Oviedo. 1.0 accident/km/year, 0.8 injured/km/year, 0.0 dead/km/year
Coronel Oviedo	131 - 134	Number of accidents is very large, and higher than that in Ypacarai. In the section of the proposed flyover, Km 132, 16 accidents were recorded. 7.0 accident/km/year, 2.8 injured/km/year, 1.0 dead/km/year
Coronel Oviedo - Caaguazu	135 - 176	Number of accidents is near to the section of San Jose - Coronel Oviedo 1.0 accident/km/year, 0.2 injured/km/year, 0.1 dead/km/year Section Km 146 – 150, where improvement in alignment is proposed, recorded very large number of accidents as follows. This section is famous for the frequent accidents, and called “S curve” among road policemen. 2.6 accident/km/year, 2.0 injured/km/year, 0.0 dead/km/year
Caaguazu	177 -	Number of accidents is as follows: 1.0 accident/km/year, 0.2 injured/km/year, 0.0 dead/km/year

From an analysis of records of the victims, injured or killed, through the sections of Km 40 – 180, the following figures are applied as the number of victims in the cost calculation. The figure of town areas is applied to the flyover section and that for rural areas to the section of the alignment improvement.

Table 20.1.4 Number of Victims in One Traffic Accident

Area	Injured	Dead
Town areas	0.25	0.06
Rural Areas	0.48	0.08

Since data on costs of traffic accidents does not seem to have been analyzed so far in Paraguay, international examples have to be referred to. First, reference for costs of death and injury caused by accidents is made as shown in the Table 20.1.5 because those costs share the major part of accident costs. The figures as well as the methods of estimation vary among countries. In this analysis the figures in the "draft of the guideline for evaluation of road investments in Japan" as shown in Table 20.1.6 is applied because of its moderateness. However, the figures are conservatively divided by 17 for the costs of victims, i.e. difference in travel time cost of car passengers to adjust the amount of income loss, and by 7 for physical loss of accidents, i.e. difference in depreciation cost of a truck, to adjust values of physical damage of vehicles. Since injured victims are not classified in the statistics of Paraguay, 10% of the injured victims are assumed to be heavily injured, according to the statistics of Japan.

Table 20.1.5 Examples of Costs of Death and Injury by Traffic Accidents

(Unit: US$ thousand = JP¥ 100,000)

Source		Costs		
		Dead	Heavily Injured	Lightly Injured
Japan	Administration Agency (1993)	315.3	93.7	6.4
Japan	Association of Insurance (1995)	294.3	103.9	6.3
German	EWS (1997)	1,168.0	51.1	5.1
U.K.	COBRA (1995)	2,310.0	24.1	2.0
U.S.	National Highway Traffic Safety Administration (1990)	878.0	73.6	-
U.S.	"Full Cost and Benefit of Transportation" (1997)	2,750.0	71.3	26.3
Australia	Ministry of Transport and Communication	558.1	84.0	8.8
New Zealand	-	2,400.0	-	-

Source: Draft Guideline for Evaluation of Road Investment Projects in Japan

Table 20.1.6 Unit Cost of Accidents

	One Dead Victim	One Heavily Injured Victim	One Lightly Injured Victim	Physical Cost for an Accident
Amount applied in Japan (JP¥ thousand)	33,965	10,170	1,185	447
Amount applied in this Study (Gs. thousand)	65,932	4,044		2,107

With the above tables, unit cost per traffic accident is estimated as follows:

- Sections in Town Areas; Gs. 7.04 million
- Sections in Rural Areas; Gs. 9.25 million

(4) Value of Improved Environment

Benefits from improved environment in terms of air pollution and noise are calculated after the estimation of the difference in environmental loads between "with project" and "without project", referring to unit value of environment costs studied, with required adjustment for the analysis. As shown in Chapter 16, following elements are considered for the measurement of environmental improvement.

1) NO_X
2) CO_2
3) Noise

In measurement of environmental benefits in monetary terms in Japan, the amount of emission of NO_X is used as a measurable representative indicator of air pollution. Economic value of air pollution per ton of NO_X emission applied in the draft guideline for evaluation of road investment is as follows.

Table 20.1.7 Unit Cost Air Pollution (NO_X) to be Applied in Japan

Roadside Condition	Densely Populated Area	Town Areas	Rural Areas (Plain)	Rural Areas (Mountainous)
Cost per ton of NO_X (US$)	29,200	5,800	2,000	100

Note: US$1=JP¥ 100
Source: Draft Guideline for Evaluation of Road Investment Projects in Japan

In this evaluation unit cost for town areas is applied to bypasses and that for rural areas (average of plain and mountainous areas) is applied for climbing lanes, including Coronel Oviedo alignment improvement. Since most of the cost incurred by air pollution would be caused by damage to health, economic costs of air pollution are supposed to be loss of production by health damage and cost of medical care. The above figure is adjusted for this analysis through dividing by 17, assuming a trade-off between expenditure for medical care and loss of production. The following unit costs are applied in this evaluation.

Table 20.1.8 Unit Cost Air Pollution (NO_X) Applied

Type of Component	Bypass	Climbing Lane
Cost per ton of NO_X (Gs. thousand)	341	59

Benefits of reduction in CO_2 emission is counted as reduced effect on global warming. International price of US$ 20/ton of carbon should be applied for CO_2 emission cost. The benefit, however, should be regarded not as a direct benefit to the national economy but as a contribution to the global economy.

Economic value of noise reduction should be considered as reduced damage and nuisance to residents along the road. Due to sparse population along the sections of the climbing lanes, the benefits borne by components of climbing lanes are ignored in this evaluation.

Noise reduction will normally result in increase in land price. Results of international studies regarding influence of 1 dB reduction in equivalent sound level (Leq) on land price in town areas are summarized in the table below. In this evaluation 0.1% increase in land prices is assumed for 1dB reduction of Leq. Annual value of the benefits of noise reduction is calculated with change in land prices multiplied by 12%, i.e., opportunity cost of capital in Paraguay.

Table 20.1.9 Influence of Noise Reduction on Prices of Residential Land

Country	City	Increase in Land Price by 1dB Reduction of Leq
U.S.A.	Various Cities	0.88% - 0.08%
Canada	Tront	1.05%
Japan	Tokyo	0.77%

Source: "Socioeconomic Evaluation of Road Investment Projects", Japan

Residential and commercial areas within 40m bands from road shoulder are assumed as affected area. Right of ways of 50m are planned for all bypasses and no residential or commercial areas are assumed in the right of way. Supposing that every person stays in a residential or commercial area half of a day, the benefit of each area is divided by two. Affected areas and land prices assumed in this analysis are as follows.

Table 20.1.10 Assumptions of Affected Areas

Bypass	% of Affected Area in 40m Band		Land Price (Gs. thousand/m^2)	
	Bypass (with Project)	Existing Road (with/without Project)	Bypass (with Project)	Existing Road (with/without Project)
Ypacarai	15%	80%	80	100
Caacupe	15%	70%	60	80
Itacurubi	5%	60%	40	50
San Jose	5%	50%	35	50

20.1.2 Economic Costs

Economic costs are estimated as of November 1999, same as those of financial costs. The following calculations are made when the financial cost of the project is converted to the economic cost.

1) Exclusion of Transfer Items (Taxes, duties and subsidies)
2) Shadow Pricing

Since border prices of tradable goods and services can be regarded as economic prices, the economic cost can be estimated by eliminating the transfer items from financial costs. As for non-tradable goods and services, shadow pricing is required to estimate their economic costs.

For non-tradable goods and services, whose portion is estimated as the local currency portion, the financial prices are calculated by a standard conversion factor (SCF) generally. The SCF is given in the following formula. The SCF, however, was calculated as almost one (96% to 97%) from data of the recent five years of external trades, and is negligible. The SCF was not applied in this analysis.

$$SCF = (Export + Im\ port) \Big/ (Export + Im\ port) + (Im.Duty + Ex.Subsidy) - (Ex.Duty + Im.Subsidy)$$

where,

SCF:	Standard Conversion Factor
Export:	Export Amount in a year
Import:	Import Amount in a year
Im. Duty:	Duties on Import in a year
Ex. Duty:	Duties on Export in a year
Ex. Subsidy:	Subsidy for Export in a year
Im. Subsidy:	Subsidy for Export in a year

Shadow wage of unskilled labor can be calculated with the following formula, known as Haveman's formula.

$$SWG = (wage\ in\ the\ market) \times (1.25 - unemployment\ rate / 0.2)$$

Although unemployment rate has reached nearly 14% recently with stagnant economy, 10% of unemployment rate is assumed during the construction period. The shadow wage of unskilled labor is estimated at 75% of the wage in the market. However, the costs of unskilled labor count only for a few percent and shadow pricing of unskilled labor may reduce the economic cost by one to two percent. Therefore, shadow pricing of unskilled labor was not carried out.

Shadow price or economic price of land can be defined as an opportunity cost, i.e., the value added from the current land use and foregone by the implementation of the project. The economic value of current land use at the project sites is considered as the opportunity cost.

$$Shadow\ Price\ of\ Land = Annual\ Value\ Added / Opportunity\ Cost\ of\ Capital$$

where,

Opportunity Cost of Capital: 12% is applied in this study as economic discount rate.

As for agricultural land, which constitutes most of the land to be acquired for the project, the value added by the current cultivation or livestock breeding in the land, i.e., sales minus expenditures for the cultivation or livestock breeding is required for the calculation of the opportunity costs. As for land other than that in agricultural use, rent for the land was treated as income subject to the land. However, the data on land rent was not available. Market prices, provided by real estate companies, are applied as economic cost of land.

Data on cultivation and livestock breeding was provided by MAG. Although there may be many types of crops cultivated, predominant part of agricultural lands of the projects sites to be acquired are used for livestock breeding, the economic cost of land is estimated as that for livestock breeding. According to the data on the products, sales and expenditure of livestock breeding, economic land price of one hectare of agricultural land is calculated as Gs. 1.25 million/ha. There is some land of insignificant use in the project sites. Its economic price is assumed as half of the land for livestock breeding, considering unintensive pasturing.

20.1.3 Indicators in the Economic Evaluation

As evaluation indicators, economic internal rate of return (EIRR), net present value (NPV) and benefit/cost ratio (B/C), as defined below, were calculated to show the economic viability of the project.

$$Internal\ \ Rate\ of\ \ Return(IRR):\ r\ satisfying:\ \sum \frac{B_n}{(1+r)^n} = \sum \frac{C_n}{(1+r)^n}$$

$$Benefit\ \ -\ Cost\ \ Ratio\ \ (B/C)\ \ = \sum \frac{B_n}{(1+DR)^n} \div \sum \frac{C_n}{(1+DR)_n}$$

$$Net\ Present\ Value\ (NPV) = \sum \frac{B_n - C_n}{(1+DR)^n}$$

where B_n: benefits in the nth year
C_n: costs in the nth year
DR: discount rate (12%)

Sensitivity tests are carried out in pessimistic cases where traffic demands decrease and costs of the project increase. The above three indicators are estimated in case of 10% decrease in traffic volume as well as 10% increase in project costs.

20.2 Results of the Evaluation

20.2.1 Economic Benefits

(1) VOC and TTC saving

Benefits in 2010 were estimated as described below. Benefits after 2010 are assumed to be constant. Benefits before 2010 are supposed to increase 20% a year by 20% of the benefits in 2010, because 10% reduction of traffic volume would result in around 40% decrease of benefits, as calculated for sensitivity tests, and the traffic volume will increase by nearly 5% a year. VOC and TTC saving was estimated after prediction of travelling speed in 2010.

Table 20.2.1 VOC and TTC Saving in 2010

(Unit: Gs. million/Year)

	VOC	TTC	Total
Bypass			54,310
Ypacarai	9,404	3,827	13,231
Caacupe	9,686	4,887	14,573
Itacurubi	10,194	3,982	14,176
San Jose	8,875	3,455	12,330
Climbing Lanes			11,814
Cnel. Oviedo	2,046	558	2,604
Others	7,674	1,536	9,210
Flyover	507	465	972
TOTAL	48,387	18,709	67,096

(2) Saving in Traffic Accident Cost

Comparisons of traffic volume and number of accidents in "with project" and "without project" cases at the section of flyover and the section of alignment improvement at present and in 2010 are as follows:

Table 20.2.2 Traffic Accidents in Sections of Flyover and Alignment Improvement

Section	Comparison of Traffic Volume		Number of Accidents (1999)		Number of Accidents (2010)		Number of Accidents (2020)	
	(2010/1999)	(2020/1999)	Proposed Section	Neighboring Section Referred	with Project	without Project	with Project	without Project
Flyover	1.70	2.05	16.00	2.00	3.40	27.18	4.10	32.80
Cnel Oviedo Climbing Lane	2.18	2.33	13.00	4.75	10.38	28.40	11.10	30.37

With the estimated unit cost of traffic accident, the following benefits can be estimated. Benefits in the years among 1999, 2010 and 2020 are interpolated.

Table 20.2.3 Reduction Accident Cost by Flyover and Alignment Improvement

(Unit: Gs. million/year)

	Benefits in 2010	Benefits in 2020
Flyover	167	202
Coronel Oviedo Climbing Lane	167	178

(3) Environmental Improvement

The amount of reduction in emission of NO_x, CO_2 and noise is discussed in Chapter 19. Benefits of reduced air pollution are estimated as follows. The benefits before and after 2010 are estimated in the same way as applied for estimation of VOC and TTC.

Table 20.2.4 Benefits of Reduced Air Pollution

(Unit: Gs. million/year)

Type of Air Pollution	Bypass	Climbing Lane	Total
NOx	79.2	4.6	83.8
CO_2	318.7	83.0	401.7

Benefits of noise reduction in 2010 by bypass components are estimated as follows. The values of the benefits are very low compared to other types of benefits and are neglected in this analysis.

Table 20.2.5 Benefits of Noise Reduction

(Unit: Gs. million/year)

	Ypacarai	Caacupe	Itacurubi	San Jose	Total
Noise Reduction	- 1.1	- 1.0	3.4	2.3	3.7

20.2.2 Economic Costs

Economic costs given by exclusion of the transfer costs, are given in Chapter 18.

According to the result of the "Environment Impact Assessment" survey and inquiry with real estate companies, current use of lands for the project site and average price of land for residential and commercial use are estimated as follows. With unit economic price of land mentioned above, the economic costs of land at project sites is estimated as shown in the table below.

Table 20.2.6 Economic Cost of Land

	Land Area to be Acquired	Proportion of Land Area (%)			Compen-sation	Economic Cost
	(ha.)	Residential or Commercial	Agri-cultural	Insignifi-cant Use	(Gs. million)	
Ypacarai Bypass	17.7	30%	30%	40%	660	3,348
Caacupe Bypass	18.0	50%	30%	20%	1320	5,465
Itacurubi Bypass	22.8	30%	50%	20%	400	3,289
San Jose Bypass	23.0	10%	90%	0%	40	671
Coronel Oviedo Climbing Lane	16.9	40%	50%	20%	660	2,247
Total	98.4					15,020

20.2.3 Economic Indicators

(1) Whole Project

Cost and benefit streams of the whole project as well as the three economic indicators, i.e., economic internal rate of return (EIRR), net present value (NPV) at 1999 prices and benefit-cost ratio (B/C) are shown in the table below, taking only VOC and TTC saving into account. The EIRR is estimated to exceed 12%, which is the opportunity cost of capital in Paraguay. The project is economically feasible. The implementation of the project will generate a benefit of Gs. 87 billion at current prices for the national economy.

Table 20.2.7 Cost-Benefit Stream and Economic Indicators of the Whole Project

(Unit: Gs millions)

Year	Benefit	Cost	B-C
2000			
2001			
2002			
2003		2,882	-2,882
2004		19,572	-19,572
2005		40,534	-40,534
2006	2,557	44,552	-41,995
2007	10,407	39,460	-29,053
2008	24,354	18,531	5,823
2009	43,813	8,631	35,182
2010	67,096	380	66,716
2011	67,096	380	66,716
2012	67,096	380	66,716
2013	67,096	380	66,716
2014	67,096	380	66,716
2015	67,096	380	66,716
2016	67,096	380	66,716
2017	67,096	380	66,716
2018	67,096	6,725	60,371
2019	67,096	380	66,716
2020	67,096	-118,854	185,950
Total	819,186	65,454	753,732
		IRR=	25%
		NPV=	87,069
		B/C=	2.3

The economic indicators for components of the project are computed as follows. The EIRRs of Coronel Oviedo Climbing Lane (alignment improvement) and Coronel Oviedo Flyover are lower than 12% with B/C less than 1.0 and negative NPV.

Table 20.2.8 Economic Indicators of the Project Components

	EIRR	NPV (Gs. million)	B/C
Whole Project	25%	87,069	2.3
Bypass	28%	73,585	2.5
Ypacarai	28%	20,957	2.6
Caacupe	18%	10,960	1.5
Itacurubi	43%	23,025	4.0
San Jose	54%	18,643	4.8
Climbing Lane	20%	14,173	1.8
Coronel Oviedo	8%	- 2,835	0.7
Others	32%	16,971	3.3
Flyover	9%	- 652	0.8

When reduction in traffic accident costs is taken into account for Coronel Oviedo Climbing Lane and Flyover, the economic indicators of those components would be as follows. The flyover component can be deemed almost feasible in economic terms, while the indicators for Coronel Oviedo Climbing Lane still shows lower feasibility. It should be noted, however, counting of accident cost reduction in this analysis might be too conservative.

Table 20.2.9 Economic Indicators with Consideration of Accident Cost Reduction

	EIRR	NPV (Gs. million)	B/C
Without Accident Cost Reduction			
Coronel Oviedo Climbing Lane	8.4%	-2,835	0.71
Flyover	9.4%	-652	0.80
With Accident Cost Reduction			
Coronel Oviedo Climbing Lane	9.1%	-2,294	0.76
Flyover	11.7%	-79	0.98
Difference			
Coronel Oviedo Climbing Lane	0.7%	541	0.06
Flyover	2.3%	573	0.18

Economic Indicators with consideration of benefits of environmental improvement are shown in the table below. Only very small increases in indicators occur.

Table 20.2.10 Economic Indicators with Accounting for Environmental Improvement

	EIRR	NPV (Gs. million)	B/C		EIRR	NPV (Gs. million)	B/C
Without Environmental Improvement							
Bypass	27.8%	73,585	2.50				
Climbing Lane	20.4%	14,137	1.83				
With NO_X Reduction				With CO_2 Reduction			
Bypass	27.8%	73,794	2.50	Bypass	27.8%	74,426	2.51
Climbing Lane	20.4%	14,149	1.83	Climbing Lane	20.5%	14,356	1.84
difference				difference			
Bypass	0.0%	209	0.00	Bypass	0.0%	841	0.02
Climbing Lane	0.0%	12	0.00	Climbing Lane	0.1%	219	0.01

20.2.4 Sensitivity Tests

When the traffic demands decrease by 10%, VOC and TTC saving will reduce to almost 55% as shown below. However, these benefits could increase even after 2010. In this test, the benefits are assumed to increase by 20% after 2010 up to 2013.

Table 20.2.11 VOC and TTC Saving in Case of 10% Decrease in Traffic Volume

(Gs. million/year)

	VOC	TTC	Total
Bypass			32,366
Ypacarai	6,852	2,697	9,549
Caacupe	5,337	2,864	8,202
Itacurubi	4,901	2,128	7,028
San Jose	5,366	2,221	7,587
Climbing Lane			4,868
Coronel Oviedo	866	257	1,123
Others	3,061	684	3,745
Flyover	456	418	875
TOTAL	26,840	11,269	38,109

The economic indicators are estimated as follows. The whole project still remains economically feasible. Caacupe Bypass is near the border of economic feasibility.

Table 20.2.12 Economic Indicators in Case of 10% Decrease in Traffic Volume

	EIRR	NPV (Gs. million)	B/C
Whole Project	18%	39,202	1.5
Bypass	22%	42,496	1.7
Ypacarai	25%	17,651	2.2
Caacupe	11%	-1,555	0.9
Itacurubi	29%	11,731	2.3
San Jose	44%	14,669	3.4
Climbing Lane	10%	-2,132	0.9
Coronel Oviedo	0%	-6,977	0.4
Others	19%	4,845	1.6
Flyover	6%	-1,161	0.7

Decrease of 10% in costs, including construction and O&M costs, will incur around 10% decrease of EIRRs. Sensitivity to costs is low compared to that of traffic volume.

Table 20.2.13 Economic Indicators in Case of 10% Increase in Costs

	EIRR	NPV (Gs. million)	B/C
Whole Project	23%	80,124	2.0
Bypass	26%	68,664	2.3
Ypacarai	26%	19,682	2.4
Caacupe	16%	8,580	1.3
Itacurubi	40%	22,252	3.6
San Jose	50%	18,150	4.3
Climbing Lane	19%	12,434	1.7
Coronel Oviedo	8%	-3,805	0.6
Others	30%	16,239	3.0
Flyover	8%	-974	0.7

20.3 Financial Analysis

A financial analysis is made to examine financial viability of improvement and maintenance of all the sections subject to the study on National Road 2 and 7 through operation by toll collection, while the economic evaluation described in Chapter 20 is made to examine economic feasibility of the proposed improvement for the national economy. Therefore the urgent maintenance including the overlay of all sections are taken into account in this financial analysis.

(1) Toll Revenue

The following conditions are assumed in the estimation of the toll revenue.

– Two cases of toll were assumed as follows. Case

Table 20.3.1 Applied Toll

	Passenger Car	Bus	Truck
Case-1	5,000	10,000	15,000
Case-2	6,000	12,000	18,000

– The toll is assumed to be collected at two gates, near current toll gates.
– At each gate, the toll is supposed to be charged one direction.
– The toll collection for improvement and maintenance is assumed to start in 2006.
– Annual traffic at toll gate is assumed to be 300 times the daily traffic volume estimated for the section near the gate.
– The revenue and expenditure are estimated at 1999 prices. Inflation is not taken into account.
– It is supposed that the Government will provide lands for right of way and the cost of land acquisition and compensation are excluded from the expenditure of the operator.

Estimated toll revenue at 1999 prices in each case is as follows. The revenue in years before 2010 and between 2010 and 2020 are extrapolated and interpolated corresponding to the volume of traffic estimated.

Table 20.3.2 Estimates of Toll Revenue

	Ypacarai	Coronel Oviedo	Total
Case-1			
2010	20,602	24,659	45,260
2020	21,938	27,055	48,992
Case-2			
2010	24,722	29,590	54,312
2020	26,325	32,466	58,791

(2) Results of the Analysis

The FIRR is 15% (Case-1), and 20% (Case-2) respectively. In case of 10% decrease in traffic volume at both gates, i.e. 10% decrease in toll revenue, FIRR will reduce by 3% in both Case-1 and Case-2.

Table 20.3.3 Estimates of Toll Revenue (Case-1)

Year	Inflow	Outflow	Balance
2000			
2001			
2002		4,390	-4,390
2003		4,390	-4,390
2004		46,430	-46,430
2005		66,796	-66,796
2006	43,561	49,779	-6,219
2007	43,986	46,804	-2,818
2008	44,410	23,941	20,470
2009	44,835	12,769	32,066
2010	45,260	3,412	41,848
2011	45,633	38,906	6,727
2012	46,007	3,412	42,595
2013	46,380	3,412	42,968
2014	46,753	3,412	43,341
2015	47,126	3,412	43,714
2016	47,499	3,412	44,087
2017	47,873	3,412	44,461
2018	48,246	38,906	9,340
2019	48,619	3,412	45,207
2020	48,992	3,412	45,580
	FIRR	15%	(Case-1)

The result would show that full cost recovery, including that for investment and financing costs, with toll collection will be possible.

In the current financial market of Paraguay, interest rates of Guarani currency from commercial banks to a large industry are 22% - 24%. Assuming 5% of annual inflation, the commercial interest rate in real terms might be 17% - 19%. The FIRR of the Case-1 might not be so attractive to private sectors.

CHAPTER 21
MAINTENANCE PLAN

21 MAINTENANCE PLAN

21.1 Recommendation for Road Maintenance

21.1.1 Necessity for Efficient Maintenance and Management

Roads perform a crucial role as vital socio-economic infrastructure and road transport is essential for the socio-economy of Paraguay. The trunk and municipal road networks stretch 25,901 km, assisting vigorous regional economy and greatly contributing to the socioeconomic development of the country.

Meanwhile, the efficient as well as economical maintenance and management of accumulated road assets, including the introduction of measures to properly maintain road stock and to revive aging roads, has become an important task for the government together with the construction of new roads.

21.1.2 Importance of Maintenance and Management

While roads are public facilities used for multiple purposes, they constantly face such adverse conditions as exposure to strong sunlight and severe weather, and repetitive load by travelling vehicles. In addition, the increasing road traffic demand, raised vehicle weight limit resulting from the internationalization of Paraguay's economy, and environmental conservation in recent years have made efficient road management increasingly difficult.

The absence of appropriate road maintenance and management, however, will gradually worsen the state of roads to the point of their becoming unfit for use and roads with deteriorated functions can cause traffic accidents as well as becoming sources of undesirable noise and vibration, creating a poor environment for people living along roadsides. Moreover, the increase of fuel consumption and slower travelling speed due to poor road conditions result in economic loss for all concerned.

The principles of road maintenance and management are outlined below.

1) The purposes of road maintenance and management are (i) to secure safe and smooth traffic, (ii) to ensure the daily lives of people living along roads and (iii) to prevent the deterioration of roads.
2) There are two types of road maintenance and management measures: (i) preventive measures and (ii) ex-post facto measures to minimize the adverse impacts of any abnormality.
3) The subject structures are road paving, slope vegetation, retaining walls, drainage facilities, bridges and all others which are considered to be road-related facilities.
4) Maintenance and management work principally consists of the following.
   - Regular work: cleaning of road surfaces/drainage channels and weeding and cutting of grass, etc.
   - Periodical work (every 5 - 10 years): repair of road paving and repainting of bridges, etc.
   - Occasional work: replacement of bridge joints, etc.

In recent years, particular attention has been paid to measures for the inspection of pavement, and to prevent bridge deterioration and technologies to prolong the life of bridges.

21.1.3 Maintenance and Management Cost Reduction Measures

The review of road paving is believed to be the most effective measure to reduce the road maintenance and management cost. In regard to the maintenance and management cost of ordinary national roads, road surface maintenance cost is 27% and road surface repair cost is 65%. Viable measures to reduce the road maintenance and management cost should be (i) the establishment of a reliable paving maintenance and management system, (ii) the introduction of a road structure which promises efficient and economical road maintenance and management and (iii) the use of highly durable paving materials.

(1) Systematization of Paving Maintenance and Management

The use of the Paving Management System (PMS) can prove advantageous to improve the efficiency of paving maintenance and management and to reduce the maintenance and management cost. The PMS was developed in California in the 1970's as a method for a road management body to objectively judge the necessity for road paving repair.

The PMS aims at greatly reducing paving maintenance and management work by means of the regular inspection of the road paving conditions. This system is still under further development and has two main objectives: (i) the establishment of an efficient road inspection method and (ii) the use of accumulated data through a databank. The application of the GIS (Geographical Information System) will further improve the efficiency of road maintenance and management based on gathered data.

(2) Efficient Road Structure for Maintenance and Management

The personnel expenses occupy 60% of the road maintenance and management budget. For this reason, it is required to promote laborsaving by mechanization. Mechanization requires the consideration of the road structure with maintenance and management work, and to actively promote a meeting in the planning and design of new roads when a maintenance administrator discusses with designer about a necessary road structure and economical road maintenance.

(3) Use of Durable Paving Materials

The improved durability of pavement material will lengthen periods between the routine work, thus reducing the repair cost. The following items are taken into consideration as promising technologies, (i) composite paving whereby an asphalt surface course is supported by ready-mix concrete compact pavement base course and (ii) the use of an admixture containing large size aggregate paving structure that has improved resistance to rutting.

CHAPTER 22
OVERALL EVALUATION AND RECOMMENDATIONS

22 OVERALL EVALUATION AND RECOMMENDATIONS

22.1 Overall Evaluation

22.1.1 Future Traffic Demand

The traffic demand forecast model indicates that the OD traffic volume will increase by 1.79 times in 2010 and by 2.16 times in 2020 from the level in 1999. This forecast is consistent with the projections of population, labor force, GDP, agricultural production, imports, exports, and car ownership as shown in the table below.

Table 22.1.1 Projection of Major Indices

Indices	(1997 = 1.00)	
	2010	2020
Population*	1.34	1.69
Labor Force	1.45	1.92
GDP	1.60	2.23
Agricultural Production (six major crops)	1.34	1.67
Exports	1.98	2.77
Imports	1.36	1.64
Car Ownership	1.77 (100)**	2.62 (121)**
Traffic Flow*	1.79	2.16

*Comparison with 1999 (=1.00)
**( ) indicates the number of cars owned per 1000 persons

22.1.2 Trip Distribution

Table 22.1.2 indicates the results of an analysis where future trips in each traffic zone are distributed to a network with the shortest travel time.

Table 22.1.2 Traffic Volume by Section

Location	2010	2020
San Lorenzo – Ypacarai	23,221	25,483
Ypacarai –Caacupe	13,267	14,704
Caacupe – Eusebio Ayala	17,765	20,907
Eusebio Ayala – Itacurubi	17,021	20,045
Itacurubi – San Jose	16,890	19,891
San Jose – Cnel. Oviedo	16,892	19,888
Cnel. Oviedo – Caaguazu	12,315	13,173

The traffic volume distributed shows little growth between 2010 and 2020. This is because traffic concentration on Routes 2 and 7 will be alleviated as a result of opening new comparable roads.

Currently, at intersections in the built-up areas between San Lorenzo and Ypacarai and of Coronel Oviedo and Caaguazu, traffic volume observed is 20 to 60% more than that on inter-city sections. After considering the volume of local traffic, daily traffic volume by section (PCU/day) has been modified. Table 22.1.3 shows locations where the current facilities are expected to perform under the service level of D.

Table 22.1.3 Existing Road Capacity and Traffic Demand

Location	Existing Road Capacity (C)	Traffic Demand (V)	V/C
Capiata built-up area intersection	45,000	47,000	1.04
Itagua built-up area intersection	45,000	47,000	1.04
Ypacarai city built-up area	32,000	42,220	1.31
Caacupe city built-up area	32,000	42,200	1.32
Sta 68 More than 3% grade	24,000	35,000	1.45
Sta 80 More than 3% grade	24,000	31,900	1.32
Itacurubi built-up area	20,000	29,300	1.47
Sta 92 More than 3% grade	24,000	31,500	1.31
San Jose city built-up area	20,000	30,600	1.50
Sta 120 More than 3% grade	24,000	34,100	1.42
Cnel. Oviedo Intersection	25,000	31,400	1.25
Sta 146, 154, 162, 166 More than 3% grade	24,000	27,600	1.15
Caaguazu built-up area intersection	25,000	27,900	1.16

22.1.3 Proposed Projects

National Road Route 2 and Route 7, two of the most important national highways in Paraguay, will perform near or under the service level of E for their entire section by 2020. Their importance in the national economy warrants the service level of D at least, which will require the provision of four lanes for the entire section.

The following projects have been proposed by taking into account the current road conditions, traffic accidents, and future traffic volume.

(1) Mini-bypasses

Since it is difficult to widen the existing road in the built-up areas of Ypacarai, Caacupe, Itacurubi, and San Jose because of the limited widths of the right-of-way, the construction of mini-bypasses is proposed to separate inter-city traffic from local traffic.

Table 22.1.4 Mini-bypass Projects

Location	Improvements	Length (m)
Ypacarai	Four lanes	5,175
Caacupe	Four lanes	7,000
Itacurubi	Two lanes (to be widened into four in future)	6,120
San Jose	Two lanes (to be widened into four in future)	5,420

(2) Climbing Lanes

In order to deal with heavy vehicles on steep slopes, climbing lanes will be provided in sections with gradient of over 3% continuing for more than 500m.

Table 22.1.5 Climbing Lane Projects

Location	Improvements to be made	Length (m)
Near STA 68	Extend the existing climbing lane	450
Near STA79	Climbing lane to Asuncion	1,000
STA91-93	Climbing lanes for both directions	1,400
STA119-123	Climbing lanes for both directions	1,900
STA146-150	Keep the existing road for Asuncion and build a new road for Caaguazu	3,985
STA154	Climbing lane to Asuncion	1,000
STA162	Climbing lane to Caaguazu	1,600
SAT166	Climbing lane to Caaguazu	2,000

(3) Grade Separation of Intersection

Coronel Oviedo is expected to grow further in future and increase traffic volume. Thus, the existing intersection, where the four national roads meet, will be upgraded into a diamond-shaped flyover.

(4) Urgent Maintenance

a. At-grade Intersection Improvements

The following at-grade intersections will be installed with left-turning lanes to increase the road capacity and reduce potential risks of traffic accidents.

Built-up area between San Lorenzo-Ypacarai:	5 locations.
Caaguazu :	1 location

b. Other Works

In addition, it is necessary to renovate or reconstruct the existing facilities that has exceeded their lifetime and pose problems of traffic safety. It would be more costly if accidents happened because of inadequate maintenance works.

- Improvements of the intersections of the new bypasses and the existing roads
- Installation of traffic safety devices
- Renovation of bridges
- Overlay throughout the entire section

22.1.4 Preliminary Road Design

Road designs have been made on the basis of an assumption that the entire study section will be widened into a four-lane road by 2020. The study section is part of the most important highway and contains a high percentage of international trips and heavy vehicles. Under these circumstances, the road design has adopted a general standard employed in Brazil and the United States as commonly practiced in Paraguay and attempted to provide adequate services to international freight transport as well as heavy vehicles.

22.1.5 Implementability

It is possible to complete all the works pertaining to the construction of the proposed projects with the standard specification of MOPC. Furthermore, it is also possible to procure required construction machinery and materials in Paraguay, and there seems to be no technical difficulties. The projects have been designed in such a way that they could be completed using common construction methods, and Paraguayan general contractors have sufficient technological capacities to accomplish the works.

22.1.6 Environmental Impact Assessment

Upon identifying the environmental characteristics of the study area and conducting relevant document researches, an initial environmental examination has been conducted. As a result, environmental items required for more in-depth examination have been selected in an environmental impact assessment (EIA), which include resettlement, air pollution, and noise. The evaluations and mitigation measures are described below.

- *Resettlement*: The construction of the mini-bypasses will affect residents along the project sites. According to the household survey, it is a consensus among these residents that compensation for resettlement should be made in a monetary form equivalent to the actual price of the property.
- *Impact on Public Facilities*: The proposed improvements will have little impact.
- *Impact on Communities*: The construction of the bypasses separates local from inter-city traffic and will reduce traffic accidents in built-up areas. In future, however, sections along the bypasses could be urbanized, and in that case, it will be necessary to mitigate impact of through traffic on residents.
- *Hazards*: Around Ypacarai Lake and the project site of the San Jose bypass, there are possibilities of flooding. Thus, the roadway is designed as an embankment structure, and culverts crossing the roadway will also be provided.
- *Air Pollution*: There will be little difference in traffic volume between before and after the road improvements. In sections of the new bypasses and climbing lanes, however, travel speed will be increased, and thus NOx and CO_2 will be reduced, which will generate some, if not large, environmental benefits.
- *Noise*: Although noise will increase on the new bypass sections, there will be little impact because they pass less populated areas. In view of future urbanization trends, it is necessary to consider some measures like buffer trees by taking advantage of the 50m right-of-way.

22.1.7 Economic Evaluation

An EIRR for the whole project, excluding the urgent maintenance, has been found to be 26%, and the benefit-cost ratio to be 2.4. Both indicators imply that the project is economically feasible. For each individual project, when not accounting for benefits of accident reduction, the climbing lane project in Coronel Oviedo and the flyover project register low EIRRs. Even with an inclusion of such benefits, the former indicates an EIRR of only 9.1%. However, in considering the importance of the road and the need for keeping consistency in the design standard, the improvement project is worth implementing.

22.1.8 Financial Evaluation

Project costs have been estimated based on the preliminary design that identifies the quantity of materials necessary to carry out the road improvements. Then, unit costs of each cost component, such as construction materials, machinery, and labor, are used to estimate the total project cost. The project cost in total, including the urgent maintenance works, amounts to Gs242,824 million in financial price.

Table 22.1.6 Project Costs

(Gs million)

	Financial Cost	Economic Cost
Construction Cost	242,824	241,530
Compensation Cost	26,730	26,730
Total Project Cost	269,544	241,530

Based on the assumption that the study section will be operated as a tolled highway with the same toll rate and collection method as today, a financial analysis has been conducted to compare toll revenues and project costs. The project costs include every cost item mentioned earlier except for land acquisition and compensation. As a result, the FIRR has been found to be around 15%. In case the toll is raised to a similar level currently employed in the tolled section on Route 7, it will increase to 20%. However, considering the current interest rate for private firms and the inflation rate, it may not be so attractive for a private venture. Instead, however, this figure indicates that with the introduction of public funds, this project would be perfectly feasible, and that the revenues from the current toll structure would be sufficient to implement the proposed improvements and maintenance works.

22.1.9 Impact on Regional Economy

The implementation of the proposed projects will bring about more economic development opportunities by improving the transport efficiency of roadside cities and towns between Asuncion and Ciudad del Este. Urban development will be fostered by the construction of new bypasses, and adjacent land will be put to more productive uses. Finally, construction activities will generate significant economic benefits to local communities along Route 2 and Route 7.

22.2 Recommendations

A rapid increase in traffic demand on National Road Route 2 and Route 7 requires the provision of four lanes for the entire section before 2020. For the target year, 2010, various road improvements have been planned in this Study on the basis of assumption of a complete four-lane road. The plan includes three project components, namely intersection improvements, climbing lane provision, and mini-bypass construction along roadside cities. Furthermore, urgent projects are proposed to renovate overage facilities and provide traffic safety devices in an attempt to reduce traffic accidents. It is also highly recommended to establish a database on current traffic conditions for an efficient operation and a better maintenance system of the road.

(1) Intersection Improvement

a. San Lorenzo - Ypacarai

The existing four-lane section between San Lorenzo and Ypacarai is highly urbanized. In future, the trend of increasing commuter traffic is expected to continue, and thus it is strongly recommended that the intersections that pose traffic bottlenecks be improved immediately.

The traffic volume in this section currently reaches 23,000 vehicles per day and will reach 32,000 in 2010. Although the future volume could be accommodated with the existing facilities, in San Lorenzo, Capiata, and Itagua, which are undergoing rapid urbanization, the capacity of Routes 2 and 7 is decreasing because of increasing access traffic. In order to maintain an adequate road capacity at those intersections, it is necessary to provide left-turning lanes by taking advantage of the large existing right-of-ways and to improve channelization with better markings.

b. Cnel. Oviedo

It is recommended that by 2010, the rotary intersection be grade-separated in order to accommodate an increase in future traffic volume. This intersection is a very important traffic node where National Road Routes 2, 7, 8, and 10 meet. Its structure, however, often causes traffic accidents and poses difficulty with handling future traffic, and thus its grade separation would alleviate these problems to a great extent. The construction cost for this project is 7,763 million Gs., and its EIRR is 12%.

c. Caaguazu

In the urbanized area of Caaguazu, an intersection will also be improved. This area has a 100m right-of-way, and local streets are connected to it without much planning consideration. The positions of intersections are not defined very clearly, which results in disorderly traffic flows. Thus, a new project is proposed to take advantage of the right-of-way and improve access roads to Route 7 and channelization at intersections with better markings.

(2) Mini-bypass Construction

The construction of mini-bypasses is planned along four cities, Ypacarai, Caacupe, Itacurubi, and San Jose, which should be completed by 2010. These cities are confronted with various traffic problems, such as congestion caused by the reduction in road capacity and safety endangered by the mixture of daily and through traffic. Nonetheless, the limits of road widths make it difficult to implement large-scale measures. In order to avoid these problems, therefore, mini-bypasses will be constructed. The structure of the bypasses takes into account future traffic volume. Those along Ypacarai, Caacupe will be provided with four lanes, whereas the other two along Itacurubi and San Jose will only have two lanes for the time being. The project cost of these bypasses amounts to 133,409 million Gs., and the EIRR is 28%.

(3) Climbing Lane Provision

Before 2010, those sections with gradient of over 3% continuing for more than 500m will be provided with a climbing lane. In such ascending sections, the road capacity inevitably lowers, and congestion is very likely to occur as a result. Moreover, the existing horizontal alignment of some sections causes traffic accidents. Thus, in order to increase the road capacity and improve safety, the horizontal alignment will be changed, and a lane will be provided for the ascending direction. This project altogether costs 85,766 million Gs., and the EIRR is 20%.

(4) Road Maintenance and Operation

The implementation of an efficient maintenance and operation system requires an accumulation of data on current traffic conditions. In order to ensure the safety of road operation, it is necessary to install traffic safety devices and improve the existing bridges.

The quantity of the existing data is very limited, which makes it difficult to construct an efficient operation and maintenance system. It is thus imperative to create a database on current traffic conditions with geographic information system (GIS). The system should be established in such a way as to enable users to make queries on conditions like priorities and improvement standards.

National Road Routes 2 and 7 are acknowledged as two of the most important principal roads in Paraguay. It is critical to design structures that can maintain safety and respond to needs of long-distance truck drivers. This brings up the following points for consideration:

1) Installation of traffic safety devices
   They are to catch the eyes of drivers and keep vehicles within the limits of the road especially in sections with sharp curves and approaches to the bridges.
2) Renovation of overage bridges
   Since accidents involving bridge collapse cause tremendous losses, it is extremely urgent to start taking action right away.
3) Overlay
   There are many places where the road surface is cracked and has pit holes because of age. It is crucial to start overlay works immediately.