

## **9-6 Environmental Management Plan**

### **9-6-1 Objectives**

The project will have some negative impacts on the surrounding environment, as well as great positive impacts. It is therefore necessary to mitigate such negative impacts, while promoting the positive impacts. This will be possible only through the adoption of integrated environmental management strategies based on a continuous monitoring of environmental impacts. The Environmental Management Plan proposed in this part is aimed at serving the above purposes, so that integrated management of the environment shall be possible in the project's surrounding areas. The Plan consists of the following programs.

- Environmental Auditory Program
- Environmental Mitigation Program
- Environmental Monitoring Program
- Ybycui National Park Conservation Program
- Social Development Promotion Program

### **9-6-2 Environmental Auditory Program**

#### **(1) Objectives**

The objectives of this program are as follows :

- i) To assess all activities under the Environmental Management Plan, and evaluate their progress periodically.
- ii) To give adequate instructions and/or directions to solve any problems that may arise with implementation of the plan.
- iii) To evaluate the results and their effects of the Plan as a whole at the end of target year.

#### **(2) Activities**

In order to achieve the objectives above, the following activities will be required:

- i) Elaboration of basic information regarding the area to be influenced by the project in the first year of the program.
- ii) Annual evaluation of the progress and effects of each Environmental Plan program.
- iii) Comprehensive evaluation of the entire Environmental Management Plan at the end of the target year.
- iv) Elaboration of basic information regarding environmental conditions in the target year, and identification of environmental differences between before and after the project

### **(3) Methodology**

The auditory activities shall be carried out by a firm with contract basis organizing professional personnel from interdisciplinary fields related to the important environmental items identified in the Environmental Assessment. The firm will audit once a year to discuss about the progress of sub-programs of the Environmental management Plan. Field surveys shall be carried out according to their necessity.

### **(4) Outputs**

The following reports shall be prepared as output of the Program.

- i) Report on existing environmental conditions
- ii) Reports on the annual evaluation of each program under the Environmental Management Plan
- iii) Final report on environmental conditions in the target year
- iv) Final report on the comprehensive evaluation of each program under the Environmental Management Plan
- v) Final report on the Environmental Auditory Program

### **(5) Personnel Required**

To implement the program, the professional from the following disciplines shall participate. All the personnel will be required to have at least 5 years experiences in their fields of experience.

- Biologist, specialized in forestation
- Geologist, specialized in natural geology
- Economist, specialized in agricultural economy
- Agricultural Engineer, specialized in agricultural production
- Sociologist, specialized in community development

## **9-6-3 Environmental Mitigation Program**

### **(1) Objectives**

The objectives of the Environmental Mitigation Program are to mitigate the direct negative impacts of project construction and operation, as well as to minimize the indirect negative influence of the project on areas affected by the project.

### **(2) Activities**

In order to achieve the objectives above, the following activities are proposed:

- Supervision of the ETAGs

- Mitigatory forestation
- Development of traffic safety facilities
- Traffic safety education programs
- Roadside planting in urban centers
- Construction of connection slopes with communities

### **(3) Supervision of the ETAGs**

MOPC already includes general specifications for the environmental mitigation (ETAG) into its contracts with contractors engaged in public works. It is necessary in this project also to monthly supervise mitigation and the monitoring works mentioned in ETAG as follows.

#### **Major ETAG Items**

- Careful allocation of construction camp sites
- Permission of land owners to enter their lands and properties
- Obligation to report whenever they find ruins or cultural properties
- Careful activities in forest areas
- Conservation of valuable woods and top soil
- Planting embankment slopes to protect against erosion
- Protection against contamination of surface water and ground water
- Prohibition against emission of chemical pollutants from construction camps
- Prohibition against air contamination by heavy machinery and dump trucks
- Mitigation of quarry sites after the completion of excavation
- Preparation of detour routes and guiding equipment
- Operation of heavy machinery under the environmental noise standards
- Monthly reporting of all environmental mitigatory works

### **(4) Mitigatory Forestation**

According to the project plan, about 25 ha of gallery forest shall be cleaved out to clear the right of way. Deforestation is a serious environmental problem in Paraguay. Therefore, mitigatory forestation is proposed for at least 2 times of area deforested by the project.

During the detailed design period, a forestation specialist shall study adequate locations and species for the purpose. The adequate lands, such as outside borrow pit, riverside and town entrances, shall be acquired and forestation works shall be started by the contractor in line with the construction of the road.

#### **(5) Development of Traffic Safety Facilities**

The traffic volume forecast for the planned road shows a rapid increase from 412 vehicles a day in 1996 to 2,372 vehicles in 2005 and 3,562 vehicles in 2015. It marks a six-fold in 9 years and a nine-fold in 19 years. One of the negative impacts of this situation can be forecast, that is, the number of traffic accidents is likely to increase. In order to mitigate this negative impact, countermeasures in terms of hardware (facilities) and software (education) are definitely necessary, especially to protect school children.

The following traffic safety facilities shall be provided at locations near schools and urban centers where the possibility of traffic accidents is high.

- Traffic signals and pedestrian path markings
- Traffic signs indicating caution
- Protected pedestrian walkways near school zones

Locational requirements were identified as follows:

- i) Traffic signals shall be installed at 2 crossing points in Paraguarí and Tebicuary where the planned road connects with the major road in the center of town.
- ii) Traffic signs and protected pedestrian walkways shall be facilitated at the 10 locations, where the planned road will pass close to the existing primary schools.

#### **(6) Traffic Safety Education Program**

School children usually walk in the roadside areas everyday near the project area, and this situation will not likely change in the near future. Therefore, educational programs regarding traffic safety will be necessary to avoid traffic accidents due to a lack of safety awareness. Compared with existing traffic conditions, future traffic speed will be higher and more vehicles will use the road. The main aim of the proposed traffic safety education program is to make children understand the situation that this will create.

Audio-visual materials will be effective for this purpose. The program shall include a specialist team that will make audio-visual tapes and visit all the schools along the planned road area, showing the tapes and giving instructions about traffic accidents and safety.

#### **(7) Roadside Planting in Urban Centers**

In order to mitigate the negative impacts of air contamination and noise that will cause the increase in future traffic flow, roadside planting in urban centers will be necessary. This will create a beautiful urban landscape along the planned road.

The necessary locations for this purpose are Paraguarí, Caballero and Villarrica, where the right of way of the planned road will be as small as 20 m, representing an adjustment to the existing road width. The estimated quantities are as follows, and the species of trees planted shall be carefully selected to protect against air and noise pollution, as well as to beautify the urban townscape.

#### **(8) Construction of Connection Slopes with Communities**

Most of the road sections of the planned road will be embanked to avoid inundation during the rainy season. Therefore, access roads to communities will be lower than the planned road, which is very inconvenient for pedestrians passing through junctions. Therefore, the entrance points to the communities will have to be embanked at least at less than a 5 % gradient of the slope from the access road to the junction. The 43 points must be embanked.

### **9-6-4 Environmental Monitoring Program**

#### **(1) Objectives**

The Environmental Monitoring Program is necessary for understanding the environmental conditions before and after the project, and for examining unexpected environmental changes during the construction period.

#### **(2) Activities**

The following items shall be monitored periodically.

- Topography, geology and soil - Periodical inspection of soil erosion and slope failure etc., five times before, during (once a year), and after construction
- Cultural properties - Periodical inspection of archaeological sites four times before, and during (once a year) construction
- Air quality - Periodical inspection and measurements of air quality in urban areas three times; before, during, and after construction
- Noise level - Periodical inspection and measurements of noise level in urban areas three times; before, during, and after construction
- Water Quality - Periodical inspection and measurements of water quality in major river points three times; before, during, and after the construction

#### **(3) Topography, Geology and Soil**

It will be necessary to periodically inspect the conditions of the topographic features and soil for erosion, slope failure, etc., along the project road and quarry sites during the road

construction period, especially during the rainy seasons and after construction is completed.

#### (4) Cultural Properties

No cultural properties have been identified in the area to be directly influenced by the project, however, they may exist. It is necessary, therefore, to inspect periodically the excavation sites in order to ensure that valuable archaeological sites or historical properties in the area are not lost. A special team consisting of archaeologists and their assistants is required. The inspection work will start with the collection of information about cultural properties in the project area at the beginning of the year, and an inspection shall be carried out once every three months. In the final year, they shall summarize their activities in a final report.

#### (5) Air Quality

It will be necessary to observe and measure air quality at fixed points in urban areas before starting construction works in order to clarify the existing level. Moreover, it will be necessary to measure air quality during the construction period in order to determine the impact of construction machinery, as well as after construction is completed in order to determine the impact of traffic flow. Mechanical equipment for measuring air quality will therefore be required with training programs to teach personnel to use that equipment.

#### (6) Noise Level

Just as in the case of air quality, it will be necessary to observe and measure noise levels at fixed points in urban areas before starting construction works in order to clarify the background noise level. Moreover, it will be necessary to measure the noise level during the construction period to determine the impact of construction machinery, as well as after construction is completed in order to determine the impact of traffic flow. Mechanical equipment for measuring noise levels will therefore be required together with training programs to teach personnel to use that equipment.

#### (7) Water

As same as the air quality, it will be necessary to observe and measure water quality of rivers that are located downstream-side of the construction sites before starting construction works in order to make clear the existing water quality. Moreover, it will be necessary to measure water quality during the construction period to determine the impact of construction machinery, as well as after construction is completed in order to determine the impact of traffic flow.

## **9-6-5 Ybycui National Park Conservation Program**

### **(1) Objectives**

Ybycui National Park is located 10 to 20 km south of La Colmena, in an area that will be indirectly influenced by the project. The planned road will have an indirect impact on park operations, including an a) increase in the number of tourists, b) increase in the possibilities of illegal deforestation and hunting, c) increase in the risk of fire, etc.

This aim of the Program is to minimize the negative impacts caused by the project, and to promote activities that will allow more people to enjoy the park's scenic beauty, as well as to recognize its ecological value.

### **(2) Activities**

To achieve the above objectives, the Program shall include the following activities:

- Improvement of visitors' service facilities in the Park
- Enrichment of basic equipment for inspection activities to prevent illegal activities in and around the Park.
- Preparation of colored brochure for promoting environmental education

### **(3) Improvement of Visitors' Service Facilities**

In order to promote tourism in the National Park, the following basic service facilities for park visitors shall be improved:

- Car parking
- Visitors' center facilities
- Gate facilities
- Administrative office for park maintenance and inspection

The detailed space program shall be defined in the detailed design period of the project.

### **(4) Enrichment of the Basic Equipment for Inspection to Prevent Illegal Activities**

It will be necessary to enrich basic equipment for inspection activities to prevent illegal deforestation in the park area. For the purpose, more equipment shall be needed. Since illegal activities are expected to increase after the project road is completed, this Program shall provide the basis for long-term activities, i.e., patrol cars, communication equipment, etc.

### **(5) Preparation of Colored Brochure for Promoting Environmental Education**

In order to avoid indirect but negative impacts on the National Park, educational efforts

about environmental conservation and protection shall be enforced. In this project, it is proposed to prepare colored brochure and to distribute them to the public.

#### **9-6-6 Promotion of Social Development Program**

##### **(1) Objectives**

The planned road will have great indirect positive impacts on the social and economic development of the project area. It is proposed that some measures be introduced in order to turn these indirect impacts into direct impacts to benefit the people in the affected communities. The aim of this Program is to realize the positive impacts of the road, which will provide better access to community facilities and equipment, and to promote social development. This Program is also intended to mitigate the burden on resettled households.

##### **(2) Activities**

Among the several positive impacts of the road, the following have been selected as basic and effective items for realizing the direct effects of road development:

- i) Improvement of bus services
- ii) Improvement of Primary Care Services

To mitigate the negative effects on households relocated as a result of land acquisition for the new road, assistance activities shall be proposed.

- iii) Assistance to resettled households

##### **(3) Improvement of Bus Services**

By improving the road, it will be possible to provide daily and punctual bus services. Therefore, the number of bus passengers will increase, and especially school children will have easy access to higher education facilities. To promote those positive impacts, if bus stops along the road are built with roofs, bus bays, and concrete surfaces to ensure convenience and safety, the number of users will increase even further, which will, in turn, increase the frequency of service. This will facilitate the movement of local peoples. Bus stops should be installed at 10 locations in major towns along the planned road.

##### **(4) Improvement of Emergency Care Services**

One of the most basic effects of the road will be the improvement in accessibility to hospitals in emergency cases. At the moment it is very difficult to access regional hospitals in Paraguarí or Villarrica from other towns and communities because of bad road



conditions and blockade in heavy rainy days. Therefore, an ambulance with medical instruments such as stretchers, oxygen masks, etc. should be provided. At this moment, it is recommended that one ambulance with necessary medical equipment be allocated to a town located central area between Paraguarí and Villarrica for upgrading emergency service level in the vicinity.

#### **(5) Assistance to Resettled Households**

According to the project plan, around 50 households will have to be relocated as a result of land acquisition for the expansion of the right of way. Sufficient compensation will be provided to them according to MOPC regulations. However, these households will be necessary assistance even after resettlement because they will have deal with several social and/or economic problems in rebuilding their lives at their new locations.

Social workers will be effective in assessing their problems, giving adequate advice or contacting the necessary officials. This Program shall start before resettlement and continue for at least two years after resettlement.

### **9-6-7 Summary of Work Schedule and Cost Estimate**

#### **(1) Work Schedule**

The work schedule for all the programs of the Environmental Management Plan is summarized in Figure 9.6.1.

#### **(2) Cost Estimate**

An estimate of the costs for all the programs of the Environmental Management Plan is provided in Table 9.6.1.

#### **(3) Work Organization**

The Environmental Management Plan shall be carried out under the control of the UA (Environmental Unit) of the MOPC, and progress reports shall be submitted to CI (Interministerial Committee). Each program under the Environmental Management Plan shall be carried out in close coordination with authorities concerned.

Sub Program	Year Period	1	2	3	4	5	6
		Design	Construction			Operation	
		Initial Investment				Aftercare Investment	
1 Environmental Auditory Program		■	■	■	■	■	■
2 Environmental Mitigation Program							
1 Supervision of ETAGs			■	■	■		
2 Mitigatory Forestation		■	■	■	■		
3 Traffic Safety Facilities					■		
4 Traffic Safety Education		■				■	
5 Roadside Planting					■		
6 Smoothing Connections with Communities					■		
3 Environmental Monitoring Program							
1 Topography, Geology, and Soil Conditions		■	■	■	■	■	
2 Cultural Properties							
3 Air Quality			■	■			■
4 Noise Level			■	■			
5 Water Quality							■
4 Ybycui National Park Conservation Program							
1 Visitors' Service Facilities					■		
2 Equipment for Patrols and Inspections		■				■	
3 Preparation of Educational Brochures			■	■	■		
5 Promotion of Social Development Program							
1 Improvement of Bus Services					■		
2 Improvement of Emergency Services						■	
3 Assistance to Resettled Households		■	■	■	■	■	■

Figure 9.6.1 Work Schedule for Environmental Management Plan

Table 9.6.1 Summary of Cost Estimate of Environmental Management Plan

		(Unit : US\$)			
Sub-Program		Total Amount	Share	Initial Investment	Aftercare Investment
1	Environmental Auditory Program	260,700	15.2%	154,550	106,150
2	Environmental Mitigation Program	830,033	48.4%	756,553	73,480
-1	Supervision of ETAGs	*1	-	-	-
-2	Mitigatory Planting	197,010	11.5%	197,010	0
-3	Traffic Safety Facilities and Education	165,000	9.6%	165,000	0
-4	Traffic Safety Facilities and Education	245,960	14.3%	99,000	73,480
-5	Roadside Planting	24,063	1.4%	24,063	0
-6	Smoothing Connections with Communities	198,000	11.5%	198,000	0
3	Environmental Monitoring Program	204,820	11.9%	176,660	28,160
-1	Topography, Geology and Soil	48,620	2.8%	36,740	11,880
-2	Cultural Properties	55,880	3.3%	55,880	0
-3	Air Quality	25,080	1.5%	21,010	4,070
-4	Noise Level	25,080	1.5%	21,010	4,070
-5	Water Quality	50,160	2.9%	42,020	8,140
4	Ybycui National Park Conservation	183,700	10.7%	162,800	20,900
-1	Visitors Service Facilities	55,000	3.2%	55,000	0
-2	Equipment for Patrols and Inspections	99,700	5.8%	78,100	20,900
-3	Preparation of Educational Brochures	29,700	1.7%	29,700	0
5	Promotion of Social Development	236,500	13.8%	190,300	46,200
-1	Improvement of Bus Services	11,000	0.6%	11,000	0
-2	Improvement of Emergency Services	88,000	5.1%	88,000	0
-3	Assistance to Resettled Households	137,500	8.0%	91,300	46,200
	<b>Grand Total</b>	<b>1,715,753</b>	<b>100.0%</b>	<b>1,440,863</b>	<b>274,890</b>
				84.0%	16.0%

Note: \*1 The cost for the Supervision of ETAGs will be included in the construction supervision cost.

## **9-7 Conclusion and Recommendations**

### **(1) Summary of Environmental Assessment**

All the studies conducted for the Environmental Assessment are summarized in Table 9.7.1.

### **(2) Conclusion**

The environmental impact assessment study concluded that the project, with its environmental management measures, will have significant direct and indirect positive impacts on the social environment in the project area. There will be no negative consequences for the natural environment if the environmental management plan is completed and the construction work follows the regulations of the ETAGs (General specifications for environmental protection in road construction works established by MOP in 1993).

### **(2) Recommendations**

As further recommendations, in order to promote the indirect positive impacts of the project, the effects of an all-weather road, the items mentioned below should be planned in coordination with the authorities concerned.

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

Table 9.7.1 Summary of Environmental Assessment (I)

Environmental Items	Environmental Factors	Environmental Forecast	Environmental Standards and Evaluation	Direct		Indirect		Environmental Management Plan
				P	N	P	N	
1. Topography	- Clearing of Woods	- Most forest area is located on the flat land.	Standard : To avoid substantial changes of the existing topography, and to prevent natural disasters. Evaluation : The project will not cause any substantial topographical changes. But, the continuous monitoring is necessary in the construction period.					Monitoring Program - Periodical inspection of soil erosion and slope failure in the earth work sites and quarries
	- Earth Work	- Displacement of embankment on soft soil layer is estimated less than 20 cm and it will be additionally embanked. - Cutting slopes has stable gradient according to ETAGs - Average depth of side-borrow pit is 30 - 60cm						
	- Quarry sites	- Total volume of rocky materials is 523,000 m <sup>3</sup> from two sites - Average depth of cut from outside borrow is 2m						
2. Geology and Soil	- Clearing of Woods	- Cleared area is generally flat	Standard : To prevent soil erosion and to preserve the present soil conditions. Evaluation : The project will not cause any large-scaled soil erosion if the work carried out according to ETAGs, therefore the monitoring is needed. The project will have positive impact to decrease existing erosion.	X				Monitoring Program - Periodical inspection of soil erosion and slope failure in the earth work sites and quarries
	- Construction Camp	- Construction camps will be separately located in 3 areas. All camps are in flat and unsteep area.						
	- Earth Work	- Embankment slopes shall be protected by vegetation						
	- Quarry sites	- Quarry sites shall be revegetated according to ETAGs.						
3. Water	- Drainage Facilities	- Road drainage facilities are planned on the basis of the adequate storm frequency period	Standard : To avoid causing any substantial hydrological changes of water stream. Evaluation : The project will not cause substantial changes of water stream on the conditions that road drainage facilities will be maintained sufficiently.					
	- Bridge construction	- There are no structures in the river stream at Tebicuary Mi River						
	- Existence of Road Facility	- Road embankment will not blockside flood water because of adequate drainage facilities are planned.						
4. Fauna and Flora	- Clearing of Woods	- Total deforested area is 25ha. Riverside forest along the Tebicuary Mi River is mostly influenced.	Standard : To avoid substantially affecting fauna and flora. Evaluation : The project will cause decreasing existing forest area, and increase illegal deforestation indirectly.	X		X		Mitigation Program Mitigatory Forestation  Park Conservation Program - Improvement of patrol system for illegal activities in the Park
	- Increase of Traffic Flow	- The possibilities of illegal deforestation will increase along with the increase of traffic in the surroundings						
5. Landscape	- Clearing of Woods	- Clearing woods within the right of way area of 30 - 40m is marginal change for landscape	Standard : To conserve an excellent landscape by not creating any incongruities in the area. Evaluation : The project will not greatly change the roadside landscape.					
	- Earth Work	- Most part of planned road will use existing road area, therefore, changes of landscape is very limited.						
	- Quarry sites	- The location of quarry sites is invisible from the road and local community areas						
	- Construction Plants	- The location of construction plants will be far from towns						
	- Existence of Road Embankment	- Road embankment height in low lied area is less than 2.5m, and slopes shall be vegetated, therefore landscape change is marginal.						
6. Resettlement	- Existence of Bridge	- The largest bridge structure will be hidden by gallery forest	Standard : To avoid serious influences on the living basis of inhabitants by resettlement. Evaluation : The project will affect around 50 households, therefore compensation and assistance are needed.					Social Development Program - Assistance for resettled households
	- Land Acquisition	- Land to be acquired is about 50% of total, 226 ha. - 54ha of agricultural land and around 50 buildings shall be relocated.						
7. Economic Activities	- Land Acquisition	- Income loss by acquired agricultural land shall be compensated by land acquisition procedure.	Standard : To promote a solid development of the economic activities without adversely affecting sustainable development. Evaluation : The project will have great direct and indirect positive impact on local economy such as promoting agricultural development. The negative impact such as decreasing agricultural lands will be negligible.					Park Conservation Program - Improvement of visitors service facilities for tourism promotion
	- Construction Camp	- Various sales to construction camps will be expected.						
	- Increase of Traffic Flow	- Increase of traffic flow is 10 to 20 times of the existing. - Various sales to passengers can be expected to increase.						
	- Improvement of Transportation	- Travel time saving is around 60 min. in average. - Transportation cost saving will diversify the agricultural products.						

P=Positive, N=Negative

Table 9.7.1 Summary of Environmental Assessment (2)

Environmental Items	Environmental Factors	Environmental Forecast	Environmental Standards and Evaluation	Direct		Indirect		Environmental Management Plan
				P	N	P	N	
8. Traffic and Community Facilities	- Heavy Machinery and Dump Trucks	- Daily traffic volume of dump trucks in western area of the Tebicuary Mi River is estimated as 466 trucks.	Standard : To avoid substantial affection on the traffic safety and the tranquil environment of community facilities  Evaluation : The project will increase quality of life through the all weather road services.  The project will affect traffic safety.	X	X			Mitigation Program - Development of traffic safety facilities such as signals and pedestrian way near schools - Traffic safety education with audio visual materials Social Development Program - Improvement of bus services - Improvement of Emergency care services
	- Increase of Traffic Flow	- Traffic volume and speed will increase rapidly, for example in section Sagual - Caballero, 94 to 3,730 vehicles in 2015						
	- Improvement of Transportation	- Several indirect positive influences are expected such as increasing school attendat ratio, decreasing death ratio, increasing living standard, etc.						
9. Split of Communitie	- Earth Work	- Detour routes in the construction period will be prepared.	Standard : To assist in the formation of harmonious and peaceful communities  Evaluation : The project will not make any serious split of existing communities, but will affect on connections with existing roads.			X		Mitigation Program - Construction of connection slopes with local roads
	- Existence of Road Embankment	- Embankment of new road will make level gap with existing road to connect with communities.						
	- Increase of Traffic Flow	- A few towns shall be affected on the unity of community by increase of traffic flow.						
10. Cultural Properties	- Earth Work	- There are no sites registered as historic ruins along the planned road. But, the possibility of existence is unknown.	Standard : To avoid damaging ruins and cultural properties in the area.  Evaluation : The project will not have large possibilities to damage cultural properties, but the unexcavated site is unknown.					Monitoring Program - Periodical inspection avoiding opportunities to loose valuable cultural properties in the earth
11. Waste	- Construction Camp	- Waste from construction camps will be very small volume.	Standard : To avoid affecting natural and living environment of the surroundings.  Evaluation : The project will not cause any serious affection by waste.					
	- Construction Works	- Waste from construction works will be reused and treated by the contractor.						
	- Increase of Traffic Flow	- Waste from car passengers will be very limited.						
12. Risk of Hazard	- Existence of Road Embankment	- In the case that road embankment blockado flood waters, there is no communities to be affected in the surroundings.	Standard : To avoid affecting natural and living environment of the surroundings.  Evaluation : The project will cause possibilities of risk of fire indirectly along with the increase of traffic volume				X	Park Conservation Program - Improvement of patrol system for illegal activities in the Park
	- Increase of Traffic Flow	- Fire risk of mountain forest shall be increased generally.						
13. Air Quality	- Earth Work	- Dust will be exposed especially during the dry season, if the earth work will not follow ETAGs.	Standard : To avoid exceeding the standard level of the average air quality as follows; CO : 9 ppm (8hours) NOx : 0.05 ppm (year)  Evaluation : The project will not exceed the standard level of air quality. But, the monitoring work shall be carried out for data collection.					Monitoring Program - Measurement of the air quality at before, intermediate and after the construction work
	- Heavy Machinery and Dump Trucks	- If the selection of machinery is adequate, the impacts shall be limited.						
	- Increase of Traffic Flow	- The concentration of CO and NOx are predicted at Paraguari for 2015 as follows in daily average ; CO : 0.0058 ppm, NOx : 0.0022 ppm						
14. Noise	- Heavy Machinery and Dump Trucks	- There are no works to create heavy noise.	Standard : To avoid exceeding the standard level of the average noise as follows; Day time : 55dB Night time : 45 dB  Evaluation : At the point having maximum traffic volume, there is a possibility to exceed the standard level of ETAGs, therefore some countermeasures are needed.				X	Mitigation Program - Roadside planting in urban area for mitigating traffic noise  Monitoring Program - Measurement of noise level at before, intermediate and after the construction work
	- Increase of Traffic Flow	- The noise levels by cars are predicted at Paraguari for 2015 as follows in 12 hours average ; Daytime : 61 dB, Nightime : 50 dB ppm						

P=Positive, N=Negative

**CHAPTER 10**  
**ECONOMIC EVALUATION**

## CHAPTER 10 ECONOMIC EVALUATION

This chapter describes the methodology, process, and results of an economic evaluation of the proposed road development project. The purpose of this economic evaluation is to provide the necessary criteria for determining whether the proposed project is economically feasible.

### 10-1 Methodology

A 'Benefit-Cost (B-C) analysis' was applied to evaluate the proposed road development project from a general economic viewpoint. This methodology is very commonly used for this purpose, and the general methodology of B-C analysis is explained as follows.

The benefits and costs, which would result from the implementation of the proposed project, are measured at current economic prices, and the cases 'with project' and 'without project' are compared.

As the benefits accruing from the road development project and contributing to the national/regional economy, some quantifiable factors are examined, such as reductions of vehicle operating costs and travel time costs, savings on road maintenance costs, and so on. On the other hand, the costs are the monetary expression of the real consumption of goods and services to implement the project. Therefore, all the transfer costs, such as taxes and subsidies, are deducted from the benefits and costs.

These benefits and costs are calculated in the form of cash flow during the project life, 20 years in the case of this road project, and the necessary indices are examined in order to judge the economic feasibility of the project.

They are;

- Economic Internal Rate of Return (EIRR),
- Benefit-Cost Ratio (B/C Ratio), and
- Net Present Value (NPV).

## 10-2 Summary of Traffic Demand

As the traffic demand along the proposed road has been explained in Chapter 5, basic information for the economic analysis, mainly a comparison between 'with project' and 'without project', is summarized in this section.

### 10-2-1 Traffic Volume by Section

The estimated traffic volume, in terms of vehicle-km, by section is summarized in Table 10.2.1. This reveals the importance of the project in terms of traffic volume ratio (with/without), 4.28 in 2005 and 5.79 in 2015.

**Table 10.2.1 Summary of Traffic Volume by Section**

2005		with Project				without Project				with - without			
		P. Car	Bus	Truck	Total	P. Car	Bus	Truck	Total	P. Car	Bus	Truck	Total
(Unit : vehicle-km/day)													
Section 1:													
Paraguari-Tebicuary	54,549	9,782	46,198	110,529	13,380	3,027	5,610	22,018	41,169	6,755	40,588	88,511	
Section 2:													
Tebicuary-Villarica	17,141	3,292	15,380	35,813	8,008	704	2,974	11,686	9,133	2,588	12,406	24,127	
Section 3:													
Tebicuary-La Colmena	5,750	3,126	780	9,656	2,361	109	297	2,767	3,389	3,017	483	6,889	
<b>Total</b>	<b>77,440</b>	<b>16,200</b>	<b>62,358</b>	<b>155,998</b>	<b>23,749</b>	<b>3,840</b>	<b>8,881</b>	<b>36,471</b>	<b>53,691</b>	<b>12,360</b>	<b>53,477</b>	<b>119,528</b>	
2015		with Project				without Project				with - without			
		P. Car	Bus	Truck	Total	P. Car	Bus	Truck	Total	P. Car	Bus	Truck	Total
Section 1:													
Paraguari-Tebicuary	86,349	23,317	76,100	185,766	14,907	5,295	7,113	27,315	71,442	18,022	68,987	158,451	
Section 2:													
Tebicuary-Villarica	29,603	10,542	25,631	65,776	8,580	1,980	4,221	14,781	21,023	8,563	21,410	50,995	
Section 3:													
Tebicuary-La Colmena	11,203	10,840	6,316	28,359	3,394	1,976	883	6,254	7,809	8,864	5,432	22,105	
<b>Total</b>	<b>127,155</b>	<b>44,699</b>	<b>108,047</b>	<b>279,901</b>	<b>26,881</b>	<b>9,251</b>	<b>12,218</b>	<b>48,350</b>	<b>100,274</b>	<b>35,448</b>	<b>95,829</b>	<b>231,551</b>	

### 10-2-2 Total Traffic Volume in the Study Area

The total volume of traffic assigned in each case of minimum-path simulation is summarized in vehicle-km and by type of vehicle, as shown in Table 10.2.2. The results reveal a certain reduction of total vehicle-km in the case of 'with project'; that is, some traffic is transferred from other existing routes to the project road because of the shortened travel time required.

**Table 10.2.2 Summary of Total Traffic Volume**

2005		vehicle-km/day	2015		vehicle-km/day
without	Pass. Car	3,089,436	without	Pass. Car	3,098,491
	Bus	580,340		Bus	554,239
	Truck	4,994,618		Truck	5,757,351
	<b>Total</b>	<b>8,664,394</b>		<b>Total</b>	<b>9,410,081</b>
with	Pass. Car	3,025,495	with	Pass. Car	3,049,229
	Bus	569,359		Bus	539,076
	Truck	4,933,701		Truck	5,717,555
	<b>Total</b>	<b>8,528,555</b>		<b>Total</b>	<b>9,305,860</b>
(w.o-w)	Pass. Car	63,941	(w.o-w)	Pass. Car	49,262
	Bus	10,982		Bus	15,163
	Truck	60,917		Truck	39,796
	<b>Total</b>	<b>135,840</b>		<b>Total</b>	<b>104,221</b>



### 10-3 Economic Benefits

A variety of benefits, both direct and indirect, can be expected by the implementation of the project. For example, a reduction in vehicle operating costs and an increase in travel speed resulting from the improvement of road conditions (from the existing dirt road to the planned paved road) are significant direct benefits. An improvement in transport conditions for agricultural goods, resulting in a decrease in damage to the products, punctuality of transport to the market/processing factory, variety of accessibility to alternative markets, etc., is also a considerable benefit. In addition to the above, the elimination of problems arising due to impassability caused by rainfall is an essential benefit especially to a certain section of the project. Moreover, the following benefits are also recognized; that is improvements of accessibility to/from existing communities, safety and comfort for users, and support to the regional development potential of the planning area.

In this economic analysis, however, the major items of quantifiable benefit, which are definitely known to exist and have been well studied are examined. That is, savings in vehicle operating costs (VOC) with passengers' travel time costs, elimination of impassability caused by rainfall, and a reduction in road maintenance costs.

#### 10-3-1 Unit Vehicle Operating Costs

Unit VOC is calculated based on various factors such as the price of fuel, lubricants, tires, vehicle maintenance, insurance, etc., and physical/geometric road conditions.

There is a very useful data regarding VOC in OPIT (Office of Integral Transport Planning) at the MOPC. This data is entitled 'Highway Vehicle Operating Cost, 1996', and applies the HDM - III model developed by the World Bank. Since this data is exactly for this purpose, and since it has been updated in November 1996, the results are applied as the unit VOC in this analysis.

**Table 10.3.1 Unit Vehicle Operating Costs  
with Passenger Time Cost**  
(Unit : Cs/veh.-km)

Vehicle Type	Paved	Dirt (1)	Dirt (2)
Passenger Car	393.01	617.47	672.09
Van	660.58	1,024.97	1,140.56
Small Truck	597.93	928.91	1,013.80
Medium Truck	872.71	1,364.01	1,487.45
Large Truck	1,172.00	1,755.13	1,864.63
Trailer	2,052.79	2,940.94	3,174.47
Bus, Inter-urban	1,516.49	1,862.86	2,359.19

Note : (1)= Regional Trunk Road, (2)= Local Road  
Source : OPIT, MOPC

Since in the traffic demand forecast vehicles are classified into three categories and other cost calculations in this study are done in US dollar, the above data has been modified and converted, and is shown in Table 10.3.2.

**Table 10.3.2 Modified Unit Vehicle Operating Costs**  
(Unit : US\$/km)

Vehicle Type	Paved	Dirt (1)	Dirt (2)
Passenger Car	0.279	0.434	0.480
Bus	0.740	0.909	1.151
Truck	0.572	0.853	0.918

### 10-3-2 Reduction of Existing Traffic's VOC by the Project

This benefit is calculated by multiplying the difference of unit VOC between a dirt road and a paved road by the traffic volume in the 'without' case. That is, the traffic on the existing road will receive a certain benefit by the reduction of VOC resulting from the paving of the road after completion of the project. Changes in road conditions are assumed; from 'Dirt(1) to Paved' for section 1 and 2, and 'Dirt (2) to Paved' for section 3.

**Table 10.3.3 Reduction of Existing Traffic's VOC by the Project**

2005	Vehicle-km in 'without Case				Reduction of Unit VOC			Reduction of VOC (US\$'000/year)			
	P. Car	Bus	Truck	Total	P. Car	Bus	Truck	P. Car	Bus	Truck	Total
Section 1											
Paraguari-Tebicuary	13,380	3,027	5,610	22,018	0.155	0.164	0.201	684.4	163.8	372.1	1,220.4
Section 2:											
Tebicuary-Villarica	8,008	704	2,974	11,686	0.155	0.164	0.201	409.6	38.1	197.2	644.9
Section 3:											
Tebicuary-La Colmena	2,361	109	297	2,767	0.201	0.411	0.345	156.6	14.8	33.8	205.3
Total	23,749	3,840	8,881	36,471				1,250.6	216.8	603.2	2,070.6
2015	Vehicle-km in 'without Case				Reduction of Unit VOC			Reduction of VOC (US\$'000/year)			
	P. Car	Bus	Truck	Total	P. Car	Bus	Truck	P. Car	Bus	Truck	Total
Section 1:											
Paraguari-Tebicuary	14,907	5,295	7,113	27,315	0.155	0.164	0.201	762.5	286.6	471.8	1,520.9
Section 2:											
Tebicuary-Villarica	8,580	1,980	4,221	14,781	0.155	0.164	0.201	438.8	107.1	280.0	826.0
Section 3:											
Tebicuary-La Colmena	3,394	1,976	883	6,254	0.201	0.411	0.345	225.1	268.0	100.6	593.8
Total	26,881	9,251	12,218	48,350				1,426.5	661.8	852.4	2,940.6

### 10-3-3 Saving of VOC by Network Improvement

The next benefit of VOC reduction is the result of diverting traffic from other roads to the proposed link due to the improved road network after completion of the project. Since the conditions of roads often than those in the project sections are assumed to remain the same in the 'with' and 'without' cases, the total reduction of vehicle-km is counted as a benefit of the project.

**Table 10.3.4 Saving of VOC by Network Improvement**

2005	Total Vehicle-km	unit VOC (US\$)	Total VOC (US\$1000/year)	2015	Total Vehicle-km	unit VOC (US\$)	Total VOC (US\$1000/year)
without				without			
Pass. Car	3,089,436	0.279	284,444	Pass. Car	3,098,491	0.279	285,278
Bus	580,340	0.740	141,719	Bus	554,239	0.740	135,345
Truck	4,994,618	0.572	942,784	Truck	5,757,351	0.572	1,086,758
Total	8,664,394		1,368,948	Total	9,410,081		1,507,381
with				with			
Pass. Car	3,025,495	0.279	278,557	Pass. Car	3,049,229	0.279	280,743
Bus	569,359	0.740	139,037	Bus	539,076	0.740	131,642
Truck	4,933,701	0.572	931,285	Truck	5,717,555	0.572	1,079,246
Total	8,528,555		1,348,880	Total	9,305,860		1,491,631
without-with			20,067.5	without-with			15,750.3

A comparison of the results of 2005 and those of 2015, shows that the total benefit in 2015 is smaller than that in 2005, even though traffic volume increases. The reason for this is that the impact of the project on the whole road network is expected to become less in 2015 than in 2005 because it is expected that other roads' will also be improved.

#### 10-3-4 Elimination of Time of Impassibility Caused by Bad

Though there is insufficient data about the duration of severe road conditions caused by heavy rainfall, normal traffic is sometimes suspended for 20 to 30 days a year, especially in the section between La Colmena and Tebicuary-mf. This problem will be eliminated by the development of the all-weather road through the project implementation. This benefit, therefore, is also quantified.

Since there is a model to examine this kind of benefit in Paraguay, in the feasibility study on 'Route No. 8: Cnel. Bogado - Caazapá' conducted by IBRD in December 1994, the same procedure/model is also applied in this case.

$$B = ADT \times (F - 1) \times C \times D \times 365$$

where

B : Benefit of elimination of impassability caused by rainfall

ADT : Average daily traffic volume

F : Factor of impassability

C : Vehicle Operating Costs

D : Distance of section

As a result of applying the above equation to La Colmena - Tebicuary-mf section, which measures 18.1 km, the benefit received from improving the road amounts to US\$ 1,597.1 thousand in 2005, although this amount will fluctuate in accordance with future traffic demand.

### 10-3-5 Reduction of Maintenance Costs for the Existing Road

Another benefit by the proposed project is that the necessary maintenance costs for the existing dirt road will be reduced. Although sufficient maintenance may not be provided to existing road sections, a certain amount of the maintenance budget will be saved after commencement of the project works. This amount which is examined in Chapter 8-3, a total of US\$ 197.2 thousand per year, is also counted as one of the benefits of the project.

### 10-3-6 Summary of Economic Benefits

The various economic benefits examined above are summarized in Table 10.3.5.

**Table 10.3.5 Total Economic Benefits**

Item	2005 (US\$1000)	Composition	2015 (US\$1000)	Composition
1) Reduction of Existing Traffic's VOC	2,070.6	8.7%	2,940.6	13.1%
2) Saving of VOC by Network Improvement	20,067.5	83.9%	15,750.3	70.0%
3) Elimination of Road Close by Rainfall	1,597.1	6.7%	3,611.0	16.0%
4) Saving of Existing Maintenance Cost	197.2	0.8%	197.2	0.9%
Total	23,932.4	100.0%	22,499.1	100.0%

According to the investment program in Chapter 8, construction work for the project is scheduled to commence in March 1999, with work being completed in March 2002. The benefit stream, therefore, is summarized in the form of an annual flow (Table 10.3.6), taking into consideration the traffic volume trends estimated in Chapter 5.

**Table 10.3.6 Economic Benefits of the Project**

(Unit : US\$1,000)

Year	VOC(1)	VOC(2)	All-weather	-M.Cost	Total
1993	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	197.2	197.2
2000	0.0	0.0	0.0	197.2	197.2
2001	0.0	0.0	0.0	197.2	197.2
2002*	1,136.3	13,761.4	937.8	197.2	16,032.7
2003	1,929.2	18,904.5	1,356.7	197.2	22,387.6
2004	1,998.6	19,477.3	1,472.0	197.2	23,145.2
2005	2,070.6	20,067.5	1,597.1	197.2	23,932.4
2006	2,145.1	20,358.5	1,732.9	197.2	24,433.7
2007	2,222.4	20,653.7	1,880.1	197.2	24,953.4
2008	2,302.4	20,953.2	2,040.0	197.2	25,492.7
2009	2,385.3	21,257.0	2,213.4	197.2	26,052.8
2010	2,471.1	21,565.2	2,401.5	197.2	26,635.0
2011	2,560.1	21,877.9	2,605.6	197.2	27,240.8
2012	2,652.3	22,195.1	2,827.1	197.2	27,871.7
2013	2,747.7	22,517.0	3,067.4	197.2	28,529.3
2014	2,846.6	22,843.5	3,328.1	197.2	29,215.4
2015	2,940.6	15,750.3	3,611.0	197.2	22,499.1
2016	3,046.5	15,978.7	3,918.0	197.2	23,140.3
2017	3,156.1	16,210.4	4,251.0	197.2	23,814.7
2018	3,269.8	16,445.4	4,612.3	197.2	24,524.7
2019	3,387.5	16,683.9	5,004.4	197.2	25,272.9
2020	3,509.4	16,925.8	5,429.7	197.2	26,062.1
2021	3,635.8	17,171.2	5,891.3	197.2	26,895.4
Total	52,413.3	381,597.4	60,177.2	4,535.6	434,010.7

Note: \* = 3/4(Apr.-Dec.)

## 10-4 Economic Costs

As project costs are examined in detail by item in Chapter 8, these costs represent the amount actually needed upon implementation. They are called the financial costs of the project. In order to convert these financial costs into economic costs, which are used in the economic evaluation, the following examination was conducted.

The basic difference between financial costs and economic costs in this project is summarized in Table 10.4.1.

**Table 10.4.1 Comparison of Financial Costs and Economic Costs**

Item	Financial Cost	Economic Cost
1. Taxes and Duties	○	×
2. Cost for Project Finance	○	×
3. Inflation	○	×
4. Cost for Studies before Conclusion*	○	×
5. Engineering Cost after Conclusion*	○	○
6. Cost for Usage of Untapped Resources	○	×
7. Compensation Cost	○	×

\* : The cost of studies made before decision of implementation of the project is not included in economic cost, but engineering cost, such as for final design, required after the decision must be added to economic cost.

The costs calculated in Chapter 8-7 do not include cost item No. 2 and No. 4, while cost item No. 6 is considered not to exist. 'Engineering Cost', 'Contingency' and 'Land acquisition' correspond to items No. 5, No. 3, and No. 7, respectively. Therefore, the economic costs of the project can be obtained by estimating the portion of 'Taxes and Duties' in the construction costs and environmental management costs.

The tax system in Paraguay has been comparatively simplified under the MERCOSUR Agreement, as described in Chapter 3-4-4. There are no import duties on any goods, including construction equipment and materials between MERCOSUR countries, and all equipment and materials required for the project can surely be procured from Brazil and Argentine.

Regarding the taxation system within the country, two tax items are related to the cost estimate of the project, since there is no income tax : IVA (Impuesto al Valor Agregado) and tax on petroleum products. The IVA tax rate is 10% of the amount of a commercial transaction, and the fuel tax on diesel is Gs. 80 per liter; retail price is Gs. 630, including tax at the time of cost estimation. The unit costs for road construction were re-estimated, using the price of diesel fuel without tax, Gs. 550 per liter, and the results are tabulated in Table 10.4.2 in comparison with the financial costs estimated in Chapter 8-1.

**Table 10.4.2 Unit Cost without Tax by for Road Construction Work Item**

Cost Item	Unit	Price in Table 8.1.2 (US\$)			Price (no tax) (US\$)		
		Section 1	Section 2	Section 3	Section 1	Section 2	Section 3
Mobilization		A×0.03			A×0.03		
Site clearing (normal)	km	1,371			1,348		
Site clearing (woods)	km	5,154			4,997		
Site clearing (dense woods)	km	12,884			12,492		
Embankment (Common Soil)	m <sup>3</sup>	3.89			3.79		
Embankment (Selected Soil)	m <sup>3</sup>	5.31			5.17		
Pipe Culvert (D1.2 x 24m)	place	9,355			9,336		
Box Culvert (3.0×3.0×24 m)	place	45,379			45,379		
Subbase	m <sup>3</sup>	36.42	37.06	48.72	35.83	36.46	47.66
Base	m <sup>3</sup>	37.71	38.35	50.00	37.10	37.73	48.93
Asphalt concrete	m <sup>3</sup>	116.05	116.70	128.35	115.31	115.93	127.14
Prime/Seal Coat	lts	0.57			0.57		
Transport (Selected Soil)	km·m <sup>3</sup>	0.35			0.33		
Transport (Site plant to site)	km·m <sup>3</sup>	0.27			0.26		
Others		B×0.12			B×0.12		

Note: 1) Transport cost from crushing plant to stockyard at site changed from US\$ 0.23/km·m<sup>3</sup> to US\$ 0.22/km·m<sup>3</sup>.

2) B is the total amount of items from site clearance to transport cost, and A means B plus the cost of others.

The total road construction cost based on the unit price without tax, in forms of economic costs, is US\$53,901 thousand, while in terms of financial costs, it is US\$54,749 thousand (see Table 8.1.3). The ratio of economic/financial costs is 98.5%. As the difference between economic and financial costs is very small in the case of road construction, it is assumed in this study that the above-described ratio (98.5%) will be applied both for bridge construction and environmental management costs in order to convert from financial costs to economic costs. According to this understanding, the total economic costs of the project are calculated as shown in Table 10.4.3. (The figures of financial cost in the table are the same as those in Table 8.7.2, but the cost of each item includes IVA, for easy comparison with its economic cost.)

**Table 10.4.3 Summary of Economic Costs of the Project**

(Unit: US\$1,000)

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

Finally, the total investment program in terms of economic costs for an economic evaluation is assessed in Table 10.4.4.

**Table 10.4.4 Economic Costs of the Project with Investment Program**

(Unit: US\$ 1,000)

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

## 10-5 Benefit-Cost Analysis

Annual benefits estimated for the project life period are compared with investment costs in the form of cash flow. As a result of this analysis, three indices, Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C) and Net Present Value (NPV), are calculated at a certain discount rate (in the case of this study 12% per year).

### 10-5-1 Project as a Whole

In terms of economic costs at 1996 prices, a total of US\$ 82.7 million will be required to complete the project and to maintain conditions during the project life.

Annual cash flow (benefit - cost) is analyzed during project life period as shown in Table 10.5.1. At a discount rate of 12%, the benefit-cost ratio (B/C) is 2.25 and the net present value (NPV) is US\$ 70.7 million, which assures quite high economic returns from the project. The economic internal rate of return (EIRR) is also high at 25.57%. Therefore, this project as a whole can be said to be economically feasible under these conditions.

**Table 10.5.1 Benefit-Cost Analysis of the Project**

(Unit : US\$ 1,000)

Year	Cost	Benefit	Balance
1998	2,285.5	0.0	-2,285.5
1999	17,014.7	197.2	-16,817.5
2000	22,661.7	197.2	-22,464.5
2001	23,111.7	197.2	-22,914.5
2002	5,950.3	16,032.7	10,082.4
2003	179.5	22,387.6	22,208.1
2004	90.1	23,145.2	23,055.1
2005	90.1	23,932.4	23,842.3
2006	90.1	24,433.7	24,343.6
2007	196.1	24,953.4	24,757.3
2008	196.1	25,492.7	25,296.6
2009	196.1	26,052.8	25,856.7
2010	306.0	26,635.0	26,329.0
2011	306.0	27,240.8	26,934.8
2012	4,481.7	27,871.7	23,390.0
2013	4,481.7	28,529.3	24,047.6
2014	90.1	29,215.4	29,125.3
2015	90.1	22,499.1	22,409.0
2016	90.1	23,140.3	23,050.2
2017	90.1	23,814.7	23,724.6
2018	90.1	24,524.7	24,434.6
2019	196.1	25,272.9	25,076.8
2020	196.1	26,062.1	25,866.0
2021	196.1	26,895.4	26,699.3
	-24,362.5	-	24,362.5
Discount Rate:		EIRR =	25.57
12%		B/C =	2.25
		NPV =	70,736



### 10-5-2 Sensitivity Analysis

In the course of the study, some factors, related with the benefit estimation, such as traffic demand, cost estimate, investment program, etc., would seem to be uncertain because each estimation was examined under various assumptions, although the strongest assumptions were applied to the base case. On the other hand, increase of cost might possibly arise from:

- Increase of job quantity by calculating based on the results of more detailed topographic, boring and material surveys in the final design stage.
- Disastrous eliminate unforeseen during the construction stage.

Therefore, a sensitivity analysis was carried out, taking into account the following conditions, which are more severe than those assumed in the base case:

Variation of benefits : -5%, -10% -15%, relative to the base case, and

Variation of costs : +5%, +10%, +15% relative to the base case.

The results are tabulated in Table 10.5.2, and show that the proposed project is economically feasible. That is, EIRR is 19.67% and B/C ratio is 1.62, even in the worst case; benefit = -15% and cost = +15%.

**Table 10.5.2 Summary of Sensitivity Analysis**

EIRR		(%)			
Cost \ Benefit	0%	-5%	-10%	-15%	
0%	25.57	24.47	23.37	22.26	
+5%	24.49	23.47	22.39	21.35	
+10%	23.57	22.57	21.57	20.47	
+15%	22.68	21.69	20.69	19.67	

B/C					
Cost \ Benefit	0%	-5%	-10%	-15%	
0%	2.25	2.08	1.97	1.86	
+5%	2.03	1.98	1.88	1.77	
+10%	1.99	1.89	1.79	1.69	
+15%	1.90	1.81	1.71	1.62	

NPV		(US\$ 1,000)			
Cost \ Benefit	0%	-5%	-10%	-15%	
0%	70,736	62,766	56,400	50,034	
+5%	66,222	59,856	53,491	47,125	
+10%	63,313	56,947	50,582	44,216	
+15%	60,404	54,038	47,673	41,307	

### 10-5-3 Comparison by Section

At the end of the economic evaluation, a comparative evaluation of the project by section was conducted for reference.

The proposed project consists of three major sections, 1, 2, and 3, although each of the three sections must be implemented together with the others.

- Section 1: Paraguarí - Tebicuary (58.0km)
- Section 2: Tebicuary - Villarrica (25.0km)
- Section 3: Tebicuary - La Colmena (38.1km)

Both the costs and benefits examined before were divided into three sections in accordance with the work volume and traffic volume by section. This examination was conducted assuming the same implementation program.

As shown in Table 10.5.3, sections of 1 and 2 indicate quite sound economic feasibility (EIRR of over 25%), though all the sections reveal certain feasibility in EIRR and B/C.

As section 3 indicates a relatively low feasibility compared with other two sections, further consideration including not only a B/C analysis but also a comprehensive evaluation, will be necessary. As described in Chapters 2 and 3, this road section will play an important role as a east-west regional arterial road in the planning area when it links Carapeguá, La Colmena, Iturbe, and national route No.8. Since development of these road sections were not confirmed in this stage, it was not possible to consider them in the traffic forecast as part of the future road network.

**Table 10.5.3 Comparative Evaluation by Section**

(Unit : US\$ 1,000)

Year	Section 1			Section 2			Section 3		
	Cost	Benefit	Balance	Cost	Benefit	Balance	Cost	Benefit	Balance
1998	1,013.8	0.0	-1,013.8	618.4	0.0	-618.4	653.2	0.0	-653.2
1999	7,653.8	102.8	-7,551.0	4,541.8	30.7	-4,511.1	4,819.1	63.8	-4,755.3
2000	10,224.7	102.8	-10,121.9	6,034.0	30.7	-6,003.3	6,402.9	63.8	-6,339.1
2001	10,481.7	102.8	-10,378.9	6,096.5	30.7	-6,065.8	6,533.4	63.8	-6,469.6
2002	2,717.4	8,253.8	5,536.4	1,554.4	5,970.6	4,416.2	1,678.5	2,117.1	438.6
2003	86.6	11,290.6	11,204.0	41.5	8,187.4	8,145.9	51.4	2,928.7	2,877.3
2004	43.1	11,619.9	11,576.8	18.6	8,431.3	8,412.7	28.4	3,103.3	3,074.9
2005	43.1	11,959.0	11,915.9	18.6	8,682.5	8,663.9	28.4	3,291.0	3,262.6
2006	43.1	12,140.0	12,096.9	18.6	8,814.8	8,796.2	28.4	3,470.4	3,442.0
2007	95.2	12,323.9	12,228.7	40.4	8,949.1	8,908.7	60.5	3,664.2	3,603.7
2008	95.2	12,510.7	12,415.5	40.4	9,085.5	9,045.1	60.5	3,873.7	3,813.2
2009	95.2	12,700.4	12,605.2	40.4	9,224.1	9,183.7	60.5	4,100.3	4,039.8
2010	147.4	12,893.0	12,745.6	62.3	9,364.9	9,302.6	96.3	4,345.5	4,249.2
2011	147.4	13,088.7	12,941.3	62.3	9,507.9	9,445.6	96.3	4,610.9	4,514.6
2012	1,950.0	13,287.4	11,337.4	1,151.7	9,653.1	8,501.4	1,380.0	4,898.4	3,518.4
2013	1,950.0	13,489.3	11,539.3	1,151.7	9,800.7	8,649.0	1,380.0	5,209.9	3,829.9
2014	43.1	13,694.3	13,651.2	18.6	9,950.6	9,932.0	28.4	5,547.6	5,519.2
2015	43.1	9,971.4	9,928.3	18.6	7,141.1	7,122.5	28.4	5,386.9	5,358.5
2016	43.1	10,125.9	10,082.8	18.6	7,252.8	7,234.2	28.4	5,776.5	5,748.1
2017	43.1	10,282.9	10,239.8	18.6	7,366.5	7,347.9	28.4	6,200.0	6,171.6
2018	43.1	10,442.4	10,399.3	18.6	7,481.9	7,463.3	28.4	6,660.2	6,631.8
2019	95.2	10,604.5	10,509.3	40.4	7,599.3	7,558.9	60.5	7,160.7	7,100.2
2020	95.2	10,769.2	10,674.0	40.4	7,718.6	7,678.2	60.5	7,704.9	7,644.4
2021	95.2	10,936.6	10,841.4	40.4	7,839.9	7,799.5	60.5	8,296.9	8,236.4
	-11,284.7	-	11,284.7	-6,025.1	-	6,025.1	-7,052.6	-	7,052.6
Discount Rate:	EIRR =	27.57		EIRR =	32.30		EIRR =	15.28	
12%	B/C =	2.35		B/C =	2.90		B/C =	1.29	
	NPV =	35,407		NPV =	29,185		NPV =	4,740	

## **10-6 Prospect of Diverse Economic Benefits**

The economic evaluation conducted in previous sections concluded that the proposed project was sufficiently economically feasible from the viewpoint of providing major tangible benefits such as a reduction of VOC, elimination of impassability by the construction of an all-weather road, and a reduction in current road maintenance costs. In addition to the above quantified benefits, the proposed project is expected to provide various other benefits, both direct/indirect and tangible/intangible. Although these benefits explained in the following complementary description are indirect and intangible, the economic feasibility of the project is thereby further strengthened.

### **(1) Agricultural Development**

As described in detail in Chapter 3, the proposed road will permit diversification of agriculture in the region. That is, evolution from traditional agricultural products to cash crops with a high market value will be possible as a result of improved accessibility, safety, comfort, and punctuality of transport to/from the alternative markets. The road will improve the possibility of urban-market-oriented farming and farming for food processing (not only sugar cane but also other fruits/vegetables) in the area, especially in the area along the Rfo Tebicuary-mi. As a result, this will raise farmers' income levels and the Gross Regional Product.

### **(2) Other Industries**

Improvement of the regional road network will create a different traffic flow into the area, as shown by the substantial increase in 'through traffic' along the proposed road, along the Paraguarí - Villarrica section. This will make it possible to introduce some transport-related facilities into the area such as gas stations, vehicle repair shops, rest areas, and shops/restaurants for passengers and drivers. Moreover, it will be possible to develop new industries combined with agriculture, thereby providing some new job opportunities within the area.

### **(3) Transport Operators**

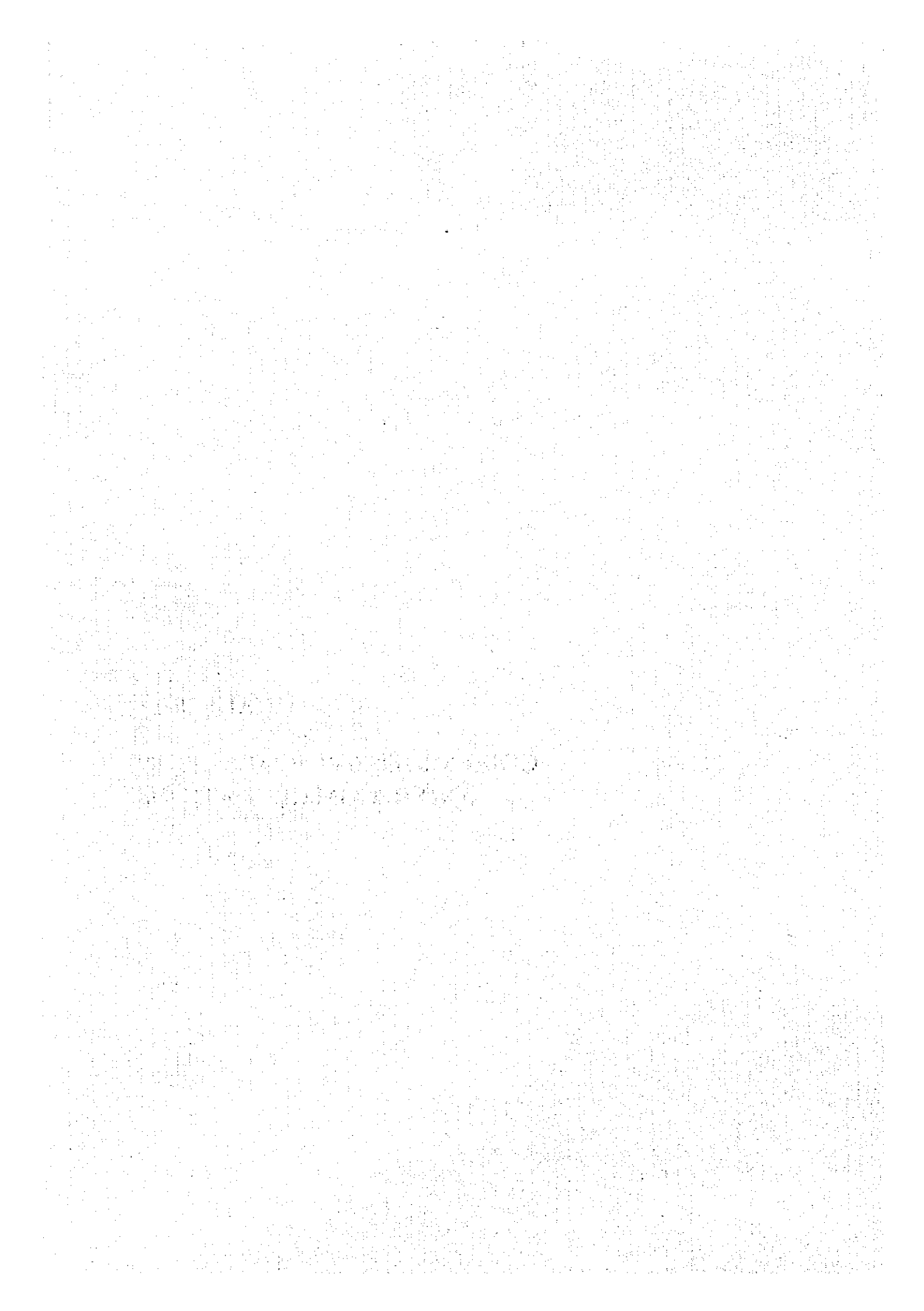
Both bus operators and freight forwarders operating in the area will be greatly benefited by the improvement of transport efficiency. Besides the reduction of various previously examined vehicle operating costs, other direct benefits should be considered, that is, saving of operating hours of both drivers/assistants and vehicles, reductions in freight damage and packing costs, comfort for passengers, etc. Moreover, as a result, better services such as the creation of alternative routes and an extension of service periods might also be possible. If these benefits are added to the general evaluation, the

economic feasibility of the project is even more ensured.

#### **(4) Community Structure**

Compared with the existing bad transport conditions, a more comprehensive/diversified social intercourse will be realized among the regional communities after the completion of the future road network. This will cause the region to expand/modify its community structure, leading to a restructuring of the regional distribution of community service facilities such as local government offices, educational/cultural facilities, health/welfare facilities, etc. This improvement in the community structure can be also considered one of the important benefits of the project.

**CHAPTER 11**  
**COMPREHENSIVE EVALUATION**  
**AND RECOMMENDATIONS**



## **CHAPTER 11 COMPREHENSIVE EVALUATION AND RECOMMENDATIONS**

### **11-1 Comprehensive Evaluation of the Project**

Before providing a comprehensive evaluation of the Project, the following three points, deduced from recent trends or movements, must be noted:

- i) In the road development sector in Paraguay, investment over the years has been concentrated on improvement/rehabilitation of existing paved roads, especially of so-called "export/import corridors" and of those necessary for facilitating the governability of the nation. Thereafter, the road development grade of the principal paved roads was also promoted. Now, therefore, it is time enter the next stage of road development, to upgrade unpaved national roads and principal secondary (department's) roads, and make them all-weather paved roads. A look at the contents of loan agreement for road development concluded in 1996 between IDB and Paraguay, seems to indicate that this indeed is the plan.
- ii) Agriculture and livestock farming in the planning area of the Project have been developed over the decades by deforestation to enlarge farm lands. Since past activities in this sector show this region's fairly high development potential, this area has been placed as one of the agricultural areas to be promoted selectively at the national level. At the same time, in order to obtain good results, a great deal of effort to change the historical production method, such as diversification of crops and products, enlargement of production units, establishment of a better marketing system, and etc., are pointed out as indispensable. Moreover, it is considered that the development of infrastructures, represented by the regional road network, is very important to support the above plan.
- iii) Forecasting the influence of and changes caused by the MERCOSUR agreement in Paraguay, they say that the maximum efforts of Paraguay must be first concentrated on the enforcement and enlargement of the market in Asunción, not only in sales or consumption scale, but also in capacity to collect/distribute goods and information. In this sense, the planning area of the Project is prospective and is expected to stand as a suburban area supporting the Asunción market, given its advantageous geographic location (50 - 150 km from Asunción). That is, the promotion and development of this area as described in the previous clause is strategically important from a national viewpoint considering the MERCOSUR system.

Given the above-described general circumstances, implementation of this Project can be

said to be timely and viable.

Firstly, the road from Paraguarí to Villarrica is now classified as a Departmental Road. However, it is said that it will become a national road in the new road categorization, which MOPC is now making out based on the road inventory results of 1995. As this indicates, it is natural to plan the construction of this road in succession to the improvement of existing paved roads, as it is expected to act as an arterial road, as well as a regional road. Its branch section, between La Colmena and Tebicuary, will work as a regional/collecting road supplementing the Paraguarí - Villarrica road, and after completion of the construction of these roads, all places in the region will have a paved road within 20km. Development of these two roads may not be sufficient for the region but it will produce drastic changes in various fields in the region. Above all, it will support the regional development given higher priority from the national level viewpoint as described in item ii) and iii) in the previous page. In other words, strategic development of the region would be impossible without these roads.

The Environmental Impact Study reveals that a few negative impacts, such as landscape change, cleaving trees in the natural environment and removal of houses, loss of farm land, increase in traffic accidents and noise in the social environment, would be caused by construction; however, at the same time, such problems would arise only in a limited area, and could therefore be minimized by taking appropriate measures. It is naturally expected that the negative impacts of the Project would be less than usual because the proposed road runs mostly along the existing road.

Contrary to the above, the Study also clearly shows that a relatively large number of positive impacts on the social environment could be expected as a result of the Project. Apart from the direct influence on the promotion of regional economic development, increase of opportunities for higher education, better emergency services and an increase of job opportunities would be caused by easy access to community centers provided by the developed road. These positive impacts would be significant and important because it would continue for a long time.

Finally, as described in the previous chapter, Chapter 10, this Project was evaluated to be sufficiently feasible from a socio-economic viewpoint.

Considering all the matters described up to this point, it is clear that the Project is surely feasible and viable. Therefore, the early implementation of the Project is recommended.



## **11-2 Recommendations for Further Studies and Implementation**

### **(1) On the Final Design**

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

### **(2) On Implementation**

- For earlier implementation of the Project, necessary administrative procedures and steps should proceed as soon as possible.
- Construction shall be executed under the contract(s) with private contractor(s) selected by international tender(s).
- The door for international tenders shall be opened wide to ensure adequate competition.
- The Project shall be divided into three sections and tenders and contracts for construction shall be made independently for each section.

### **(3) On the Environmental Management Plan**

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

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









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