The basic criteria for horizontal alignment design were:

- to comply with the design standards set out in the agreement with MOPC as described in 6-2.
- to utilize the existing road as much as possible to save on costs of land acquisition and to minimize possible environmental problems.

Similarly, the criteria for vertical alignment design were:

- to comply with the design standards set out in the agreement with MOPC as described in 6-2.
- to maintain the formation height of the road in the low flat land as higher than one meter from the high water level (H.W.L.) of flooding estimated by a hydrological analysis.
- to utilize the existing road as subgrade as much as possible, where its surface layer is evaluated as sufficiently good to act as a subgrade,
- to newly construct a sub-base course and upper pavement layers for all sections.

Drawing of the geometric design results of the road based on the above described criteria were prepared, and are included in a separate volume of this report. A general summary of the results by road segment is also provided in Table 7.1.2.

7-1-2 Earthwork

(1) General

Since the objective roads, in general, run through flat land, most earthwork is for embankments, and the volume of cut is relatively small. The entire embankment volume divided in two by soil material, that is, it was considered that a subgrade one-meter thick from the top had to be constructed by selected soil, and that the rest could be of common soil.

In road segments 1, 8, 9 and 11, the surface and embankment conditions of the existing road were evaluated as good enough to act as a subgrade. As a matter of course, however, even in those segments, embankment of selected soil and common soil will be required to widen the road and in some parts to maintain the smoothness of the vertical alignment.

The total volume of earthwork was estimated to be 1,566,000 m^3, and only 122,000 m^3 of this is cut volume. The remaining 897,000 m^3, an embankment volume of 1,444,000 m^3, is of selected soil, while 547,000 m^3 is the volume of common soil. Only 83,000 m^3 in the cut volume was considered to be available for selected soil embankment. These figures by road segment are tabulated in Table 7.1.3.

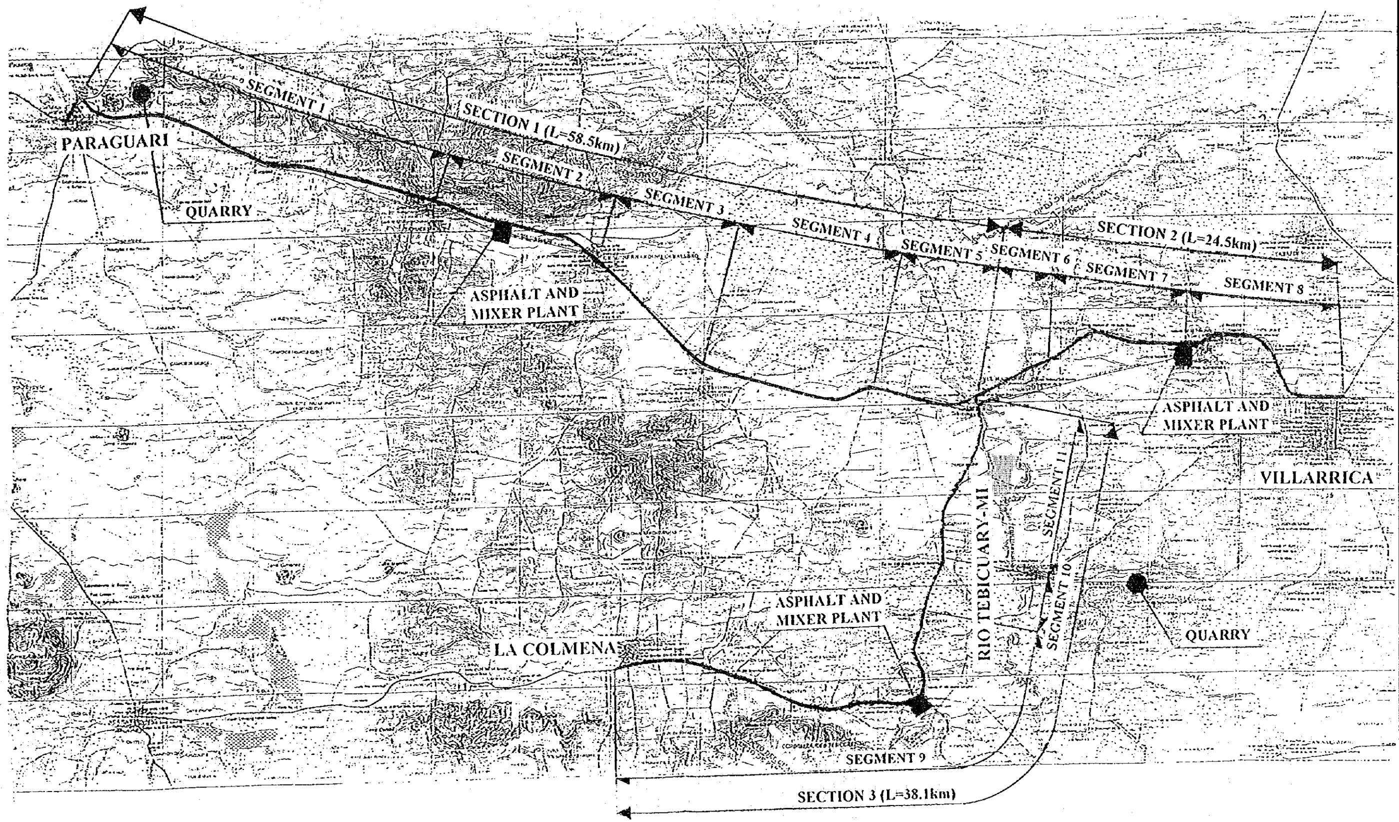


Figure 7.1.1 Division of Road into Section and Segment and Location of Quarry and Plant

Table 7.1.2 Results of Geometric Design by Segment (1)

Segment	Horizontal Alignment	Vertical Alignment	Measures for Urban Area
Section 1 : Paraguarí - Río Tebicuary-mí			
1	• Only minor modification of existing road alignment	• Existing road bed is excellent. Basically, only a pavement layer will be put.	Paraguarí: • About ten houses will be removed. • Two T-crosses will be required. • Sufficient ROW width can be obtained by widening the last street toward the northwest. Escobar: • ROW width is only 18.5m in the urban area.
2	• Half length of this segment is a new alignment passing a hilly zone to avoid passing a low wet area.	• On the east side of Sapucaí, 4.5% of the vertical slope continues for 350m. • Although no additional lane is needed, this section has the steepest slope in the Project. • Conformity of height between the road and street side must be checked in the urban areas of Sapucaí and Caballero.	Sapucaí: • Road passes a reserved but not developed street area. • At least 20m of ROW can be obtained. Caballero: • 25m of ROW can be obtained parallel to the railway without disturbing the street structure.
3	• The new alignment generally coincides with the existing one, running parallel to the railway.	• Drainage conditions of the existing road are not so good, so that the new formation level will be 1-1.5m higher than the existing one.	Ybytymí: • As a new route is adopted in segment 4, the road does not enter into the town.
4	• According to results of the alternative study, a new route is proposed. • It passes through a grassy plain, a part of which is low flood area. • However, the new road is almost straight and 8km shorter than the existing one.	• The embankment height is determined, mainly from hydrological analysis results, to be 1-1.5 m higher than natural ground.	
5	• From the west edge of Tebicuary town, the new route runs along the north side of town, reaching Río Tebicuary-mí, according to the alternative study result.	• At about 700m west of the river, a natural cliff exists with an elevation difference of 10m. • So, considerably deep cutting and a high bank are required here. • However, vertical curve is not so steep.	Tebicuary: • Road between Paraguarí and Villarrica does not pass through the town, but the branch road from La Colmena runs through the town, passing the T-cross at the center of town. Then joining with the Paraguarí-Villarrica road at the north edge of town. • However, this will not cause a problem because a sufficient width of ROW has already been prepared.
Section 2 : Río Tebicuary-mí - Villarrica			
6	• The west side half of this segment is in a low flood plain. Horizontal alignment here is determined to cross the plain along the shortest route from the selected bridge construction site, with a detour of the town of Martinez.	• Just as on the east end of segment 5, a fairly high embankment (>2.5m) is required in the flood plain. • This is a result of referring to hydrological analysis data and design codes. • In this way, the formation height of road will be about one meter higher than the highest point of the existing railway.	C. Martínez: • All streets in town are so narrow that it is impossible to make new road run through town. • Proposed alignment passes north side of town, but this area is relatively highly cultivated as farm. • Length of road in this farm area is 1.5km only, but the most utilized land is acquired here for road in whole Project.

Table 7.1.2 Results of Geometric Design by Segment (2)

Segment	Horizontal Alignment	Vertical Alignment	Measures for Urban Area
7	• The new horizontal alignment in this segment coincides the existing road in general. • Minor modifications are required. • Just before the town of Cardozo, the new road will separate from the existing road and join with another rural road, which runs parallel to the railway.	• A limited stretch of road passes through a low wet area, where the formation height of the new road is raised. • In general, vertical alignment is gentle.	Cardozo : • At the west end of town, the new road will detour far around the town, so that the town itself will not be greatly influenced by the Project.
8	• Conforming to results of the alternative study, the new road will run parallel to the railway from Cardozo until the entrance to Villarrica. • This route passes around the rim of a hilly, and highly cultivated and inhabited area. • Two crossings with the railway are inevitable. At the west side of Villarrica, the road will separate from the railway and run east to Road No.8, grazing the city.	• In general, vertical curve is gentle up to west end of the city. • Just after separating from railway, the road climbs up a hill, where the vertical gradient is 4.5%, but this continues for only 200m.	Villarrica : • The road comes into the city from the west, and the bypass of national road No.8 runs on the other side. • It is impossible for the new road to pass through the city. • The only way to connect them is to widen or partially reconstruct the street at the north end of the city.
Section 3 : La Colmena - Tebicuary			
9	• Though modification of the horizontal alignment is required at several points, where the existing road is at a right angle. The new road alignment will generally coincide with that of existing road.	• Vertical alignment is gentle, except in a few small sections. • Part of the detour at La Colmena and a small section near Tebicuary-mi have a 3.5% and 4.5% vertical gradient, respectively. • But the lengths are so limited that this poses no problem for drivers.	La Colmena: • It is impossible to make the road pass through the town due to the narrowness of the streets and difficulty of widening the central plaza, where the road must turn at a right angle. • Detour route passing the south side of the town is proposed. • As the detour crosses a valley, the road has a fairly steep vertical curve and a bridge.
10	• It can be said there is no difference between the alignment of the new road and existing road in this segment.	• The road crosses through a low flood area at Arroyo Tebicuary-mí. • As not only the drainage conditions of the existing road are considerably bad but also a segment of this road tends to be inundated with flood water, the new road will be nearly one meter higher than the existing road.	
11	• The new horizontal alignment here is exactly the same as that of the existing road. Like the existing road, the new road will also have a T-cross in the town of Tebicuary. • The Project road will turn to left there, then join with the Paraguarí - Villarrica road.	• As there is no flooding in this segment because the ground level is a little higher than the previous segment, the new road will be almost parallel to the existing road surface. • At the joining point with the Paraguarí - Villarrica road, this branch road is cut down about two meters from the existing level, because the Paraguarí - Villarrica road descends here to approach the river.	Tebicuary : • The road from La Colmena passes the east end of the residential area of the town, but the existing road here has a sufficient ROW width with median, so it can keep a sufficient distance between the new road and the residences. • At the south end of the sugar factory, the road has a T-shape crossing, which is indispensable because many trucks turn right at this cross to the gate of the factory during the sugar cane season. In other words, if a detour is constructed, the T-cross cannot be demolished. • Considering the traffic volume, the proposed alignment is optimal.

Table 7.1.3 Volume of Earthwork by Material and Segment

Road	Distance	Embankment (1000m³)				Cut (1000m³)				Side Borrow		Outside Borrow	
Segment	km	Selected	Common	Total	m³/m	Selected	Common	Total	m³/m	1000m³	m³/m	1000m³	m³/m
Parguari - Río Tebicuary-mí													
1	22.5	116	101	218	9.7	0	11	11	0.5	90	4.0	100	4.5
2	10.5	67	77	144	13.7	83	0	83	7.9	78	7.4	0	0.0
3	9.0	107	5	112	12.5	0	0	0	0.0	36	4.0	107	11.9
4	10.0	106	117	223	22.3	0	0	0	0.0	117	11.7	106	10.6
5	6.5	57	61	118	18.2	0	18	18	2.8	42	6.4	57	8.8
Total	58.5	454	362	816	13.9	83	30	112	1.9	362	6.2	371	6.3
Río Tebicuary-mí - Villarrica													
6	4.5	42	77	119	26.4	0	0	0	0.0	78	17.3	42	9.3
7	8.0	54	12	66	8.2	0	0	0	0.0	32	4.0	54	6.7
8	12.0	98	48	146	12.1	0	6	6	0.5	48	4.0	98	8.1
Total	24.5	193	137	330	13.5	0	6	6	0.3	158	6.4	193	7.9
La Colmena - Tebicuary													
9	25.3	103	23	126	5.0	0	0	0	0.0	101	4.0	103	4.4
10	2.4	59	19	78	32.5	0	0	0	0.0	19	8.0	59	3.1
11	10.4	89	6	95	9.1	0	4	4	0.4	42	4.0	89	14.3
Total	38.1	250	49	299	7.8	0	4	4	0.1	162	4.3	250	5.2
Grand Total	121.1	897	547	1,444	11.9	83	40	122	1.0	682	5.6	815	1.5

Total Earthwork Volume = 1,566 × 1,000 m³

(2) Borrow Pit for Embankment Material

The volume in the column, "Side borrow", in Table 7.1.3 represents the volume obtained from road side borrows. In other words, this is the volume of soil obtained by excavating the area in the right of way a maximum of one meter deep. As soil obtained by this manner was considered to be common soil, it would be used for the lower part of embankments (not as the subgrade).

Notwithstanding the above description, the side borrow area in a part of road segment No.6, Río Tebicuary-mí flood area, where a considerably large volume is needed for embankments, was planned in this Study to extend to outside the right of way up to 40 meters on either side of the road.

The column of "Outside borrow" in Table 7.1.3 shows the volume of soil which must be classified as selected soil for subgrade, and must be supplied from borrow pits outside the right of way. As a practical matter in the construction stage, the contractor would be responsible under the contract to find some adequate borrow pit site in order to get soil of the specified quality. However, in this Study, the candidate places were investigated as described in Chapter 6, 6-4-3, (1), and earthworks were designed and planned based on the data obtained from this investigation.

According to the data provided above, the average distance of transport of selected soil from outside borrow pits was calculated by segment. The results are shown in Table 7.1.4, and a more detailed calculation process is described in Annex E.

Table 7.1.4 Average Distance of Transport
(Selected Soil - Outside borrow)

Road Segment	Soil Volume (1000m³)	Average Transport Distance (km)
Paraguarí - Villarrica		
1	* 116	2.1
2	0	0.0
3	107	7.4
4	106	5.9
5	57	2.0
6	42	2.6
7	54	2.2
8	98	5.2
Branch to La Colmena		
1	103	3.5
2	59	7.5
3	89	3.7

Note: * = includes the selected soil volume from road segment 2.

(3) Site Clearance

The earth volume tabulated in Table 7.1.3 was calculated based on the actual ground level. In order to determine the embankment volume, the earth volume removed by site clearance must be added to the volume in Table 7.1.3.

The site clearance work was classified into the following three types:

• Site clearance (normal)	grassy	0.2 m thickness removed
• Site clearance (woods)	woods	0.3 m
• Site clearance (dense woods)	dense woods	0.5 m

According to this classification, calculations were done as in Table 7.1.5.

(4) Displacement of Ground Height by Consolidation of Subsoil

Soft ground stretches along both sides of Río Tebicuary-mí. As the required height of the embankment will be fairly high in this area, displacement of ground level by the load of the embankment may occur, leading to an increase in the embankment volume. The calculation of this volume is as follows:

1) Subsoil condition

Boring logs of BST 6 and BST 7 attached in Annex D were referred to.

- Soil : sandy soil
- Thickness of soft soil layer : 7 m (N<10)
- Water content of soft ground : 30.3 % (on average)

2) Relation between Water content (w_n) and Coefficient of volume compression (m_v)

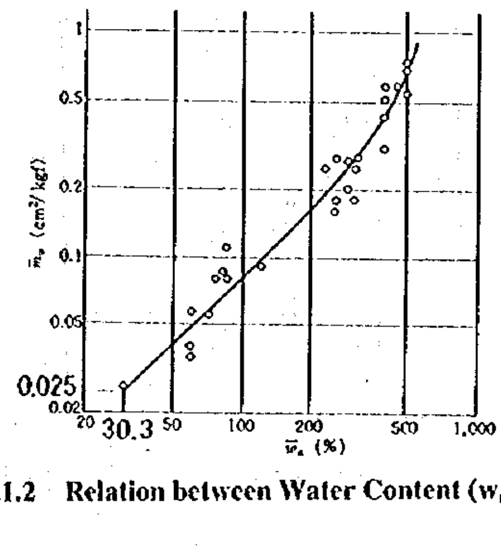


Figure 7.1.2 Relation between Water Content (w_n) and (m_v)

Table 7.1.5 Calculation of Earth Volume Removed by Site Clearance

Segment	Formation Height (m)	Min.Width of Clearance (m)	Soil Thickness Removed (m)	Length of Clearance (m)	Removed Volume (m^3)
Praguarí - Villarrica					
1	0.7	17.6	0.2	7,000	24,640
			0.3	1,240	6,547
			0.5	0	0
			Total	8,240	31,187
2	1.3	22.4	0.2	8,600	38,528
			0.3	1,300	8,736
			0.5	0	0
			Total	9,900	47,264
3	1	20.0	0.2	0	0
			0.3	0	0
			0.5	0	0
			Total	0	0
4	1.3	22.4	0.2	9,700	43,456
			0.3	300	2,016
			0.5	0	0
			Total	10,000	45,472
5	1.5	24.0	0.2	1,600	7,680
			0.3	300	2,160
			0.5	700	8,400
			Total	2,600	18,240
6	1.8	26.4	0.2	4,236	22,366
			0.3	0	0
			0.5	50	660
			Total	4,286	23,026
7	0.8	18.4	0.2	3,000	11,040
			0.3	0	0
			0.5	0	0
			Total	3,000	11,040
8	1.1	20.8	0.2	7,300	30,368
			0.3	550	3,432
			0.5	0	0
			Total	7,850	33,800
Total		172.0		45,876	210,029
Branch to La Colmera					
1	0.7	17.6	0.2	5,250	18,480
			0.3	900	4,752
			0.5	0	0
			Total	6,150	23,232
2	1.4	23.2	0.2	100	464
			0.3	0	0
			0.5	0	0
			Total	100	464
3	0.7	17.6	0.2	760	2,675
			0.3	660	3,485
			0.5	0	0
			Total	1,420	6,160
Total				7,670	29,856
Grand Total				53,546	239,885

Note : Formation Height is the difference on average between the actual ground height and the road formation height.

3) Calculation formula

- increment of stress

$\Delta p = h \times \gamma$

where,

h = average height of embankment = 3.1 m (for Segment 6),

=5.3 m (for Segment 5)

γ = unit weight of embankment material = 1.9 t/m³

- displacement

$S = m_v \times \Delta p \times H$

where,

H = thickness of soft soil layer = 7.0 m

4) Calculation

$\Delta p = h \times \gamma = 3.1 \times 1.9 = 0.6$ kgf/cm³ (for Segment 6)

$= 5.3 \times 1.9 = 1.0$ kgf/cm³ (for Segment 5)

$S = m_v \times \Delta p \times H = 0.025 \times 0.6 \times 700 =$ <u>10.5 cm</u> (for Segment 6)

$= 0.025 \times 1.0 \times 700 =$ <u>17.5 cm</u> (for Segment 5)

5) Earth volume

Assuming that the above calculated displacement would occur along the whole width of the embankment, the earth volume required to compensate for said displacement was calculated, and is shown in Table 7.1.6.

Table 7.1.6 Embankment Volume to Compensate for Ground Displacement

Segment No.	Ave. Embankment Height (m)	Width of Embankment (m)	Displacement S (m)	Length (m)	Volume (m³)
5	5.3	33.2	0.175	700	4,067
6	3.1	24.4	0.105	2,200	5,636

7-1-3 Drainage Facilities

As described before, drainage facilities with span of more than five meters were determined as bridges and are discussed in another section, while smaller facilities are discussed here. Smaller drainage facilities were standardized to two types; box culverts measuring 3.0 m×3.0 m, and pipe culverts with a diameter of 1.2 m. The required number of such culverts is shown in Table 7.1.7.

Table 7.1.7 Number of Drainage Culverts by Segment (except bridges)

Segment	Box Culvert 3.0×3.0 m	Pipe Culvert D = 1.2 m	Total Number
Paraguarí - Villarrica			
1	42	0	42
2	0	5	5
3	2	5	7
4	0	0	0
5	2	0	2
6	0	0	0
7	5	0	5
8	4	10	14
Branch to La Colmena			
1	4	16	20
2	0	0	0
3	4	0	4
Total	63	36	99

7-1-4 Pavement Design

The pavement structure to be applied to this Project was studied, and is discussed in Chapter 6, 6-4-3, (3). The study concluded that flexible pavement with an asphalt concrete surface would be adequate.

The pavement section and thickness of each layer by the road section are shown in Figure 6.4.9. The required thickness of overlay to be put down 10 years after the construction of the original pavement is also shown in 6-4-3, (3).

7-1-5 Construction Method

(1) Site Clearance

This work was classified into the three types mentioned previously.

1) Normal

This is for grassy plain. Work will be conducted by bulldozer, and a part of removed soil will be able to be replaced on embankment slope for vegetation.

2) Woods

This work is ; bringing down trees, digging up roots and removing them. All work will be done by bulldozer or front loader and dump trucks.

3) Dense woods

This type of work will be only for the area of right hand side of Río Tebicuary-mí, and the area stretches about 700 meters. Ground surface of this area looks to be soft and there exists a dense stand of trees, so some special equipment such as a bulldozer with wide caterpillar will probably be necessary.

(2) General Earthwork

Earthwork in sub-sections where the new road alignment coincides with that of the existing road will not be allowed to close the road for traffic. For this reason, it will be necessary to construct detours and to maintain them through the work period.

(3) Embankments for the Lowland (both sides of Río Tebicuary-mí)

This area, stretching 700 m on the right side of the river and 2.2 km on the other side, has a soft ground surface layer and will be the site of high embankments. Therefore, careful construction will be required.

Under such circumstances, the following two measures are recommended:

- to construct a first layer with sand or sandy material to keep the road open to traffic and ensure drainage,
- to adopt the so-called slow construction method in building embankments, thereby allowing the soft soil layer to increase its strength due to the embankment load (as soft soil layer seems to be sandy soil and to have large permeability, the necessary time for consolidation is not considered to be long.)

(4) Pavement

The construction of pavement is the biggest component of the construction work, and will greatly influence not only the construction period but also the quality of the road constructed. As described in Chapter 6, 6-4-3, (1), only two quarry sites, at Paraguarí and at Itapé, may be available for this Project.

The following construction method was recommended in this Study. Therefore, cost estimation, which is shown in Chapter 8, was based on it.

i) An asphalt concrete plant and a crushed-stone mixing plant shall be installed for each road section in the same place. (The assumed locations of the plants are indicated in Figure 7.1.1.)
ii) A crushing plant shall be installed at the quarry site.
iii) Graded crushed stone shall be transported from the crushing plant site (quarry site) to the mixing plant along each road section (from 1 to 3)
iv) For base course material, crushed stone shall be mixed with other sandy and/or fine

material at a crushed-stone mixing plant in order to comply with specifications

v) All stone material, for base, sub-base and asphalt concrete, shall be stocked at the mixing plant site

vi) Material for the base, sub-base, and asphalt concrete shall be transported from the mixing plant site to construction site

Distance of transport from the crushing plant to the mixing plant or the asphalt concrete plant (refer to, 3. above) was calculated based on Figure 7.1.1, and is shown in Table 7.1.8.

Table 7.1.8 Distance of Transport from Quarry to Mixing plant

Section	Distance (km)	Quarry Name
1	24.5	C-1 (Paraguarí)
2	27.0	C-3 (Itapé)
3	67.0	C-1 (Paraguarí)

Distance of transport from the mixing plant to the center of the road segment (refer to, vi) above) is shown in Table 7.1.9.

Table 7.1.9 Distance between Mixing Plant and Road Segment Center

Section 1	Segment	1	2	3	4	5
	Distance (km)	18.0	1.0	8.3	17.8	26.0
Section 2	Segment	6	7	8	--	--
	Distance (km)	10.0	3.8	6.3	--	--
Section 3	Segment	9	10	11	--	--
	Distance (km)	6.4	7.5	13.9	--	--

7-2 Preliminary Design of Bridges

7-2-1 Design Conditions for Bridges

In addition to the conditions for bridge design described in 6-2, the following detailed items were confirmed in the meeting with MOPC experts.

i) It is not necessary to consider a seismic coefficient for bridge design in Paraguay.

ii) Even though some piers will be constructed in the main flow of Río Tebicuary-mí, the obstruction of the river by these piers does not need to be taken into account, since there is a wide low flood plain adjacent to the main flow.

iii) The strength of cement concrete was decided taking the actual conditions and past experience in Paraguay into consideration, as well as the strength of steel (based on ASTM standards) to be adopted for this Project.

Table 7.2.1 Strength of Materials

Material		Strength		
Concrete for	Superstructure (PC)	fc =	350	kgf/cm²
	Superstructure (RC)	fc =	315	kgf/cm²
	Pier	fc =	270	kgf/cm²
	Foundation	fc =	210	kgf/cm²
	Prestressed Concrete	fc =	350	kgf/cm²
Reinforcing bar	(Grade 40)	fy =	2,800	kgf/cm²
Prestressing Steel	(Grade 270)	fv =	161	kgf/mm²
Structural Steel	(M-183)	fu =	4,000	kgf/cm²

Note : fc= Specified compressive strength of concrete at 28 days
fv= Specified yield strength of reinforcement
fu= Minimum tensile strength

7-2-2 Design Policy for Bridges

(1) Superstructure

As a result of a previous study, shown in 6-4-5, a total of 27 bridges were included in the Project. They are classified in Table 7.2.2 according to size and structure.

Table 7.2.2 Summary of Bridges in the Study Area

Span L (m)		Quantity	Superstructure
5		3	RC T girder
10		6	Ditto
15		8	Ditto
20		2	PC T girder
25		1	Ditto
30		5	Ditto
Ao. Tebicuary-mí L=2@25m (Bailey Bridge)		1	PC composite girder (girder connected type)
Rio Tebicuary-mí	River L=85m	1	Metal simple truss
	Flood plain L=5@26m	1	PC composite girder (girder connected type)

Note: refer to Table 6.4.18.

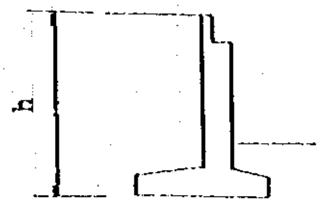
Hereinafter, the bridges from Paraguarí to Villarrica shall be named as No.1-No.17 except the bridge on Río Tebicuary-mí, and from La Colmena to Tebicuary, whey shall be named No.18-No.26. Bridge No. 25 is planned to have two spans on Arroyo Tebicuary-mí, where a metal Bailey bridge now exists. All bridges except No.25 and the one on Río Tebicuary-mí are planned to have a single span.

In the case of bridges with a span of 5m, construction costs were compared with those of a concrete culvert box measuring (3m×2.5m)×2. The details are shown in Annex F. As a result, the estimated construction costs of a culvert box were found to be very similar to those of 5-m bridge, i.e., the difference between them is in the tolerance of estimation at this stage, and hence this report will treat them as 5-m bridges hereinafter.

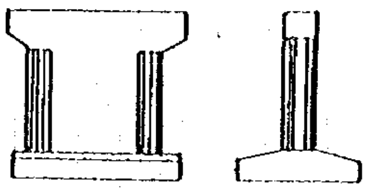
(2) Substructure

Topography and geology are the most important considerations in the planning of bridge substructures. The bridge substructure types were established as shown in Figure 7.2.1.

i) The inverted T-shaped abutment commonly used for bridges with an abutment height of up to 10 meters should be used.
ii) For the bridges on Río Tebicuary-mí and Ao. Tebicuary-mí (hereinafter, referred to as the Bailey bridge), piers must be built in the river and/or on the flood plain. An oval cantilever pier, shown in Figure 7.2.1, is the most commonly type at those places.



Inverted T-shaped Abutment



Oval Cantilever Pier

Figure 7.2.1 Type of Substructure

(3) Foundation

As a result of site reconnaissance, 10 boring stations at the principal bridge construction sites were selected. The results of boring test there, performed in this Study, are shown in Table 6.1.1 and Annex D. According to these data, as well as considerations regarding the topography and existing bridge, it is presumed that mostly shallow bearing layers will be used. As mentioned previously in (2), a direct foundation should be used when the depth from the formation level to the bearing layer is less than 10 meters. For foundations of more than 10 meters, concrete pile foundations which are the most popular and common types are adopted as shown in Table 7.2.3.

Table 7.2.3 Proposed Bridge and Foundation Types

(Paraguarí - Villarrica)

Bridge	Distance (km)	Bridge Length (m)	Bridge Type	Span (m)	Foundation Type	Bearing layer Depth (m)	Boring Station
No.1	14.395	10.00	RC	1×(10)	Direct	7.25	BST1
No.2	31.870	25.00	PCT girder	1×(25)	Direct	9.59	BST2
No.3	37.041	20.00	PCT girder	1×(20)	Direct	7.78	BST3
No.4	39.239	15.00	RC	1×(15)	Direct		
No.5	47.015	30.00	PCT girder	1×(30)	Direct	5.17	BST4
No.6	47.289	10.00	RC	1×(10)	Direct		
No.7	47.682	10.00	RC	1×(10)	Direct		
No.8	49.465	5.00	RC	1×(5)	Direct		
No.9	49.545	15.00	RC	1×(15)	C pile	17.57	BST5
No.10	50.679	15.00	RC	1×(15)	C pile	17.57	BST5
No.11	50.979	10.00	RC	1×(10)	C pile		
No.12	53.456	10.00	RC	1×(10)	Direct		
No.13	53.867	5.00	RC	1×(5)	Direct		
No.14	55.355	5.00	RC	1×(5)	Direct		
Tebicuary-mí Bridge	58.549	215.00	Truss + PC Composite girder	1×(85)+ 5×(26)	C pile	18.46 18.44	BST6 BST7
No.15	59.049	30.00	PCT girder	1×(30)	C pile		
No.16	59.449	30.00	PCT girder	1×(30)	C pile		
No.17	59.849	30.00	PCT girder	1×(30)	C pile		
(La Colmena - Tebicuary)							
No.18	2.105	30.00	PCT girder	1×(30)	Direct		
No.19	6.400	15.00	RC	1×(15)	Direct		
No.20	21.193	15.00	RC	1×(15)	Direct		
No.21	22.948	20.00	PCT girder	1×(20)	Direct		
No.22	25.756	15.00	RC	1×(15)	Direct		
No.23	26.190	10.00	RC	1×(10)	Direct		
No.24	26.603	15.00	RC	1×(15)	Direct		
No.25 Bailey site	27.536 7.536	50.00	PC composite girder	2×(25)	C pile	21.75 23.05	BST 9 BST 8
No.26	30.691	15.00	RC	1×(15)	Direct		

Note : C pile = Concrete pile. F.L = Formation Level of the road.
BST: site number of boring executed in this Study, details of which are in Annex D.

7-2-3 Designs

(1) Proposed Bridge and Foundation Types

The proposed types of bridges are shown in Table 7.2.3. For the bridge on Río Tebicuary-mí, the structure type was determined in the previous chapter. MOPC intends to standardize the bridge structure on highways and roads in Paraguay; however, this attempt is still under way and has not yet produced results. In this sense, a part of the bridge structure proposed here might be changed in the final design stage to comply with newly established Paraguayan standards.

(2) Location of Proposed Bridges

The locations of the proposed bridges are shown in Figure 7.2.2.

(3) Results of Preliminary Design

The results of the preliminary design are shown in Figures 7.2.3 to 7.2.11.

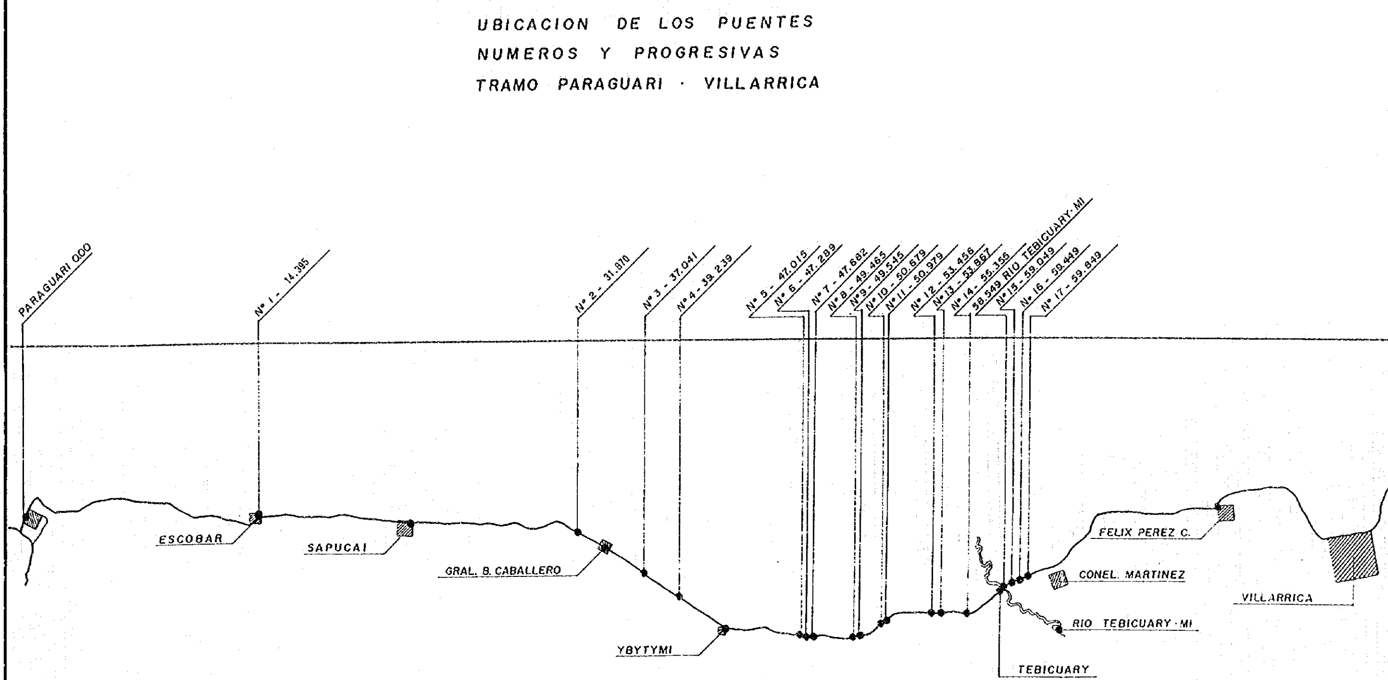


Figure 7.2.2 Location of Proposed Bridges (1) (Paraguari - Villarrica)

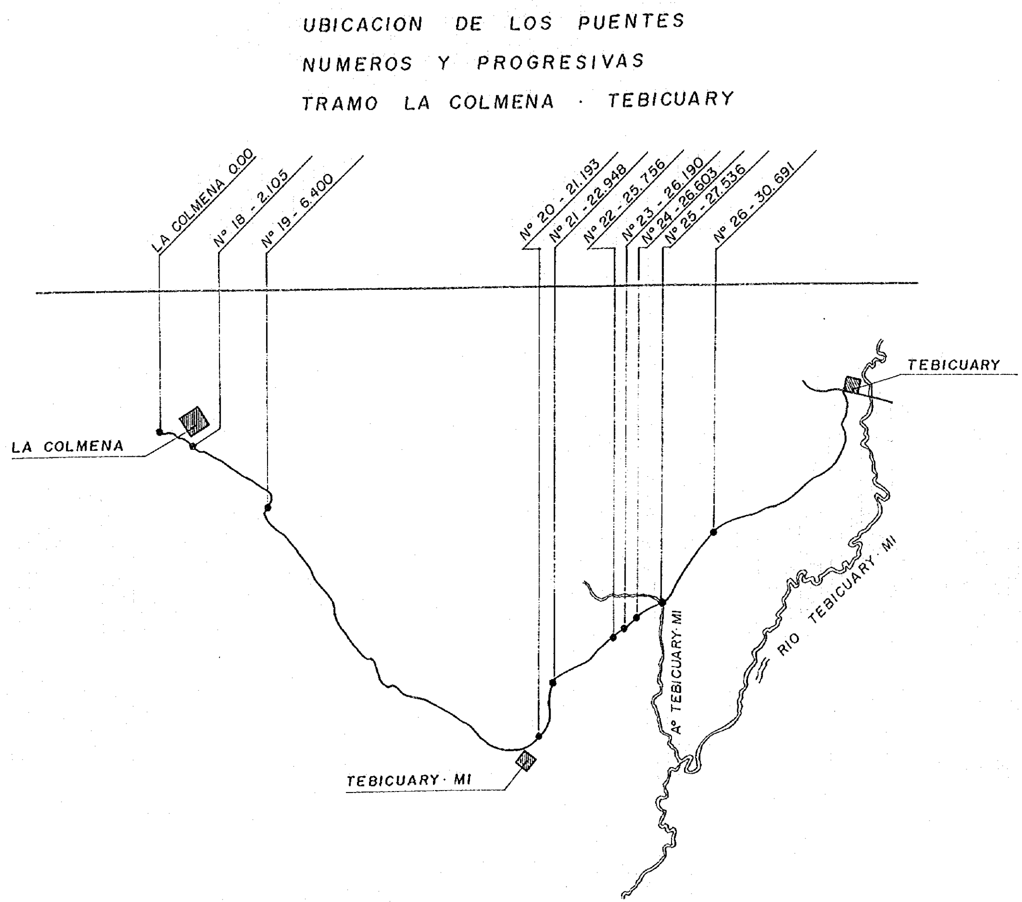
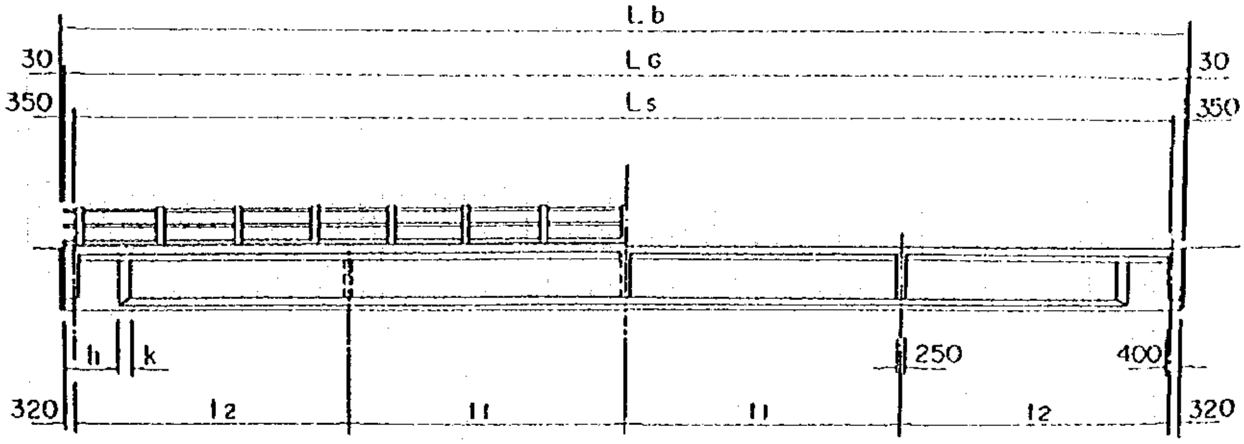


Figure 7.2.2 Location of Proposed Bridges (2) (La Colmena - Tebicuary)

① PC Composite Girder



Name of Bridge	Lb (m)	Width			Girder Spacing			Slab	Girder		
		B	b1	b2	S0	S1	S2	d	h	bf	n
Bailey	25.00	12.5	11.3	0.35	2.65	0.95	0.95	0.215	1.55	0.65	6
Tebicuary-mf	26.00	12.5	11.3	0.35	2.65	0.95	0.95	0.215	1.55	0.65	6

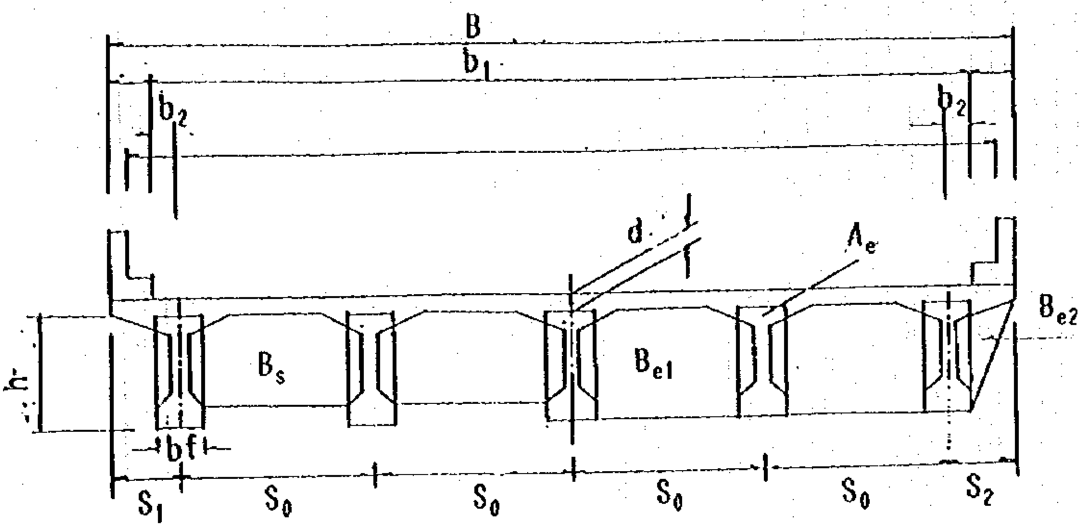
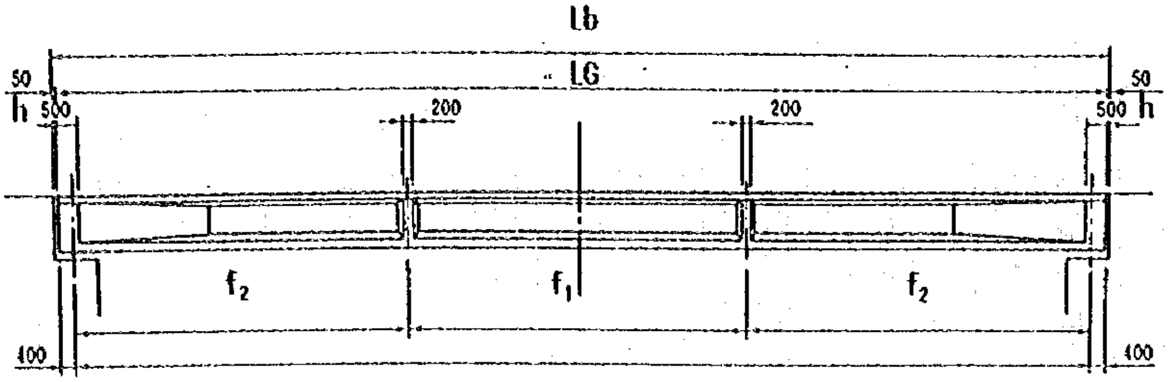


Figure 7.2.3 PC Composite Girder

② PC Simple T Girder



Lb	Width		Girder Spacing			Slab	Girder			
(m)	B	b1	S0	S1	S2	d	h	bu	bd	n
20.00	12.5	11.3	2.12	0.9	0.9	0.18	0.49	1.5	0.5	6
25.00	12.5	11.3	2.12	0.9	0.9	0.18	0.79	1.5	0.5	6
30.00	12.5	11.3	2.12	0.9	0.9	0.18	1.09	1.5	0.5	6

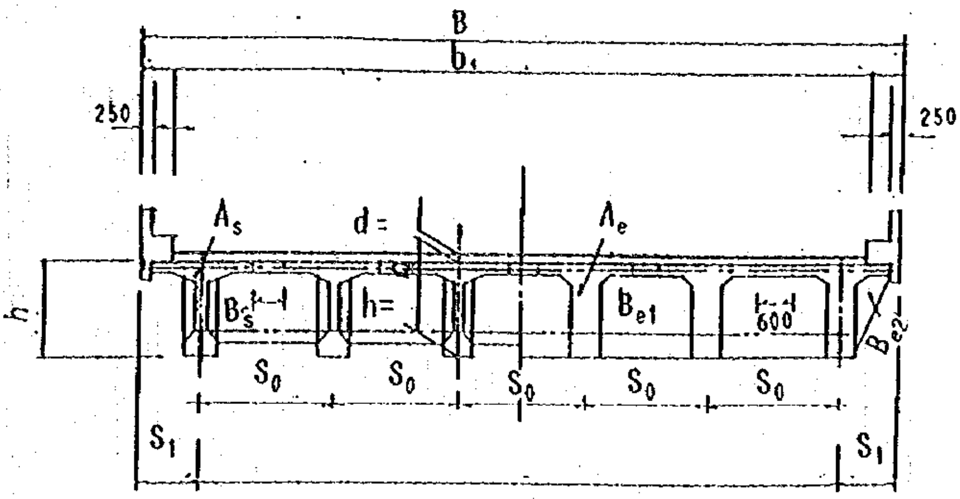
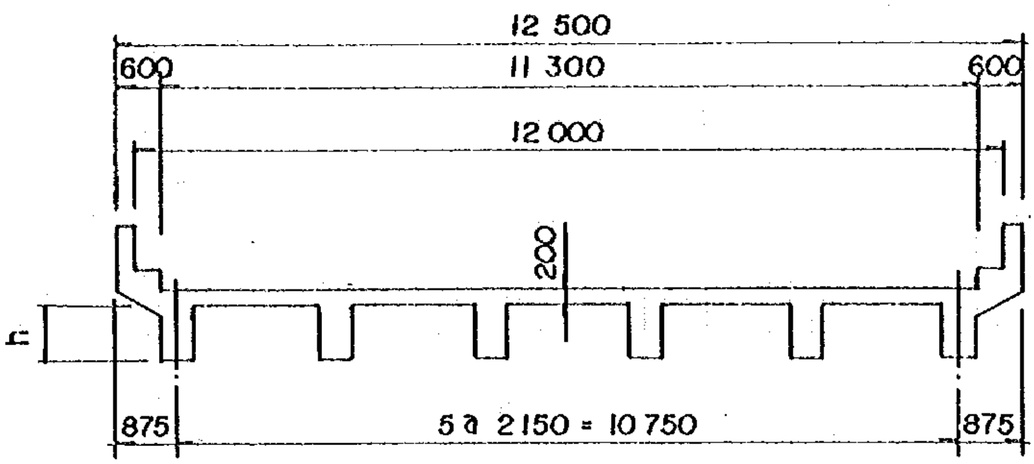


Figure 7.2.4 PC Simple T Girder

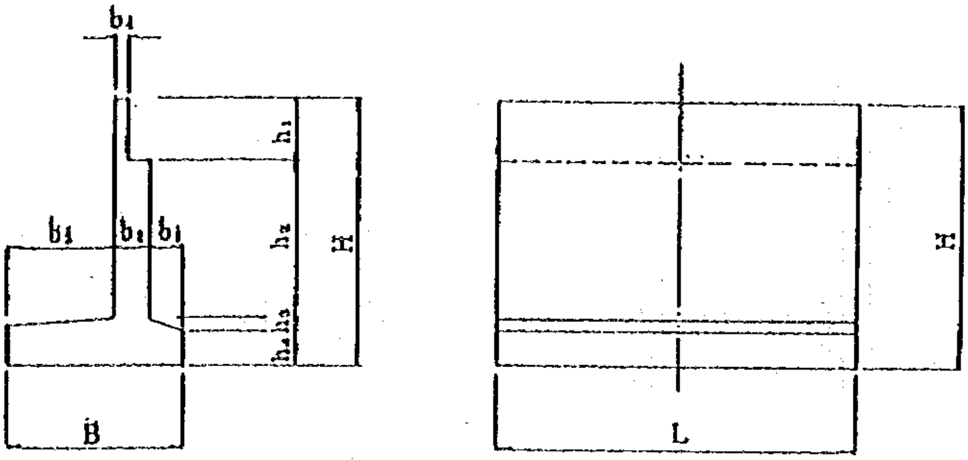
③ RC Simple T Girder



L (m)	L=5	L=15	L=15
h (m)	0.500	0.600	0.850

Figure 7.2.5   RC Simple T Girder

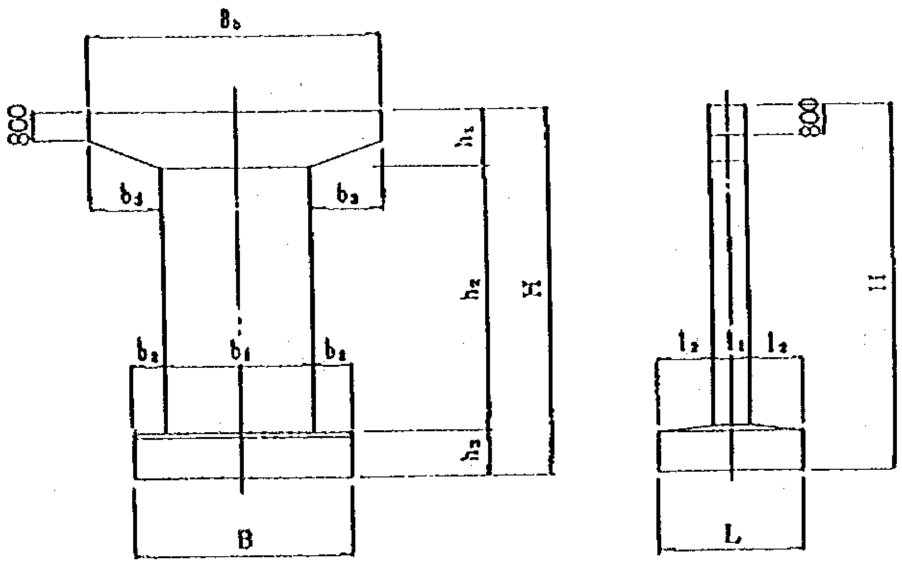
④ Abutment



Bridge No.	G.L. (m)	F.L. (m)	H	h1	h2	h3	h4	B	b1	b2	b3	b4	L	V (m^3)	V×2 (m^3)
1	121.791	121.350	7.30	0.80	5.30	0.20	1.00	4.00	1.00	1.00	2.00	0.40	12.50	126.50	253.00
2	138.450	140.830	9.60	1.58	6.82	0.20	1.00	5.00	1.30	1.20	2.50	0.40	12.50	180.45	360.90
3	139.437	140.830	7.80	1.28	5.32	0.20	1.00	4.50	1.20	1.00	2.30	0.40	12.50	136.03	272.05
4	141.510	142.397	7.00	1.05	4.75	0.20	1.00	3.50	0.70	1.00	1.80	0.30	12.50	112.69	225.38
5	142.658	144.830	5.20	1.88	2.12	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	76.05	152.10
6	128.177	129.430	5.00	0.80	3.00	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.00	166.00
7	127.032	128.407	5.00	0.80	3.00	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.00	166.00
8	119.266	119.626	5.00	0.70	3.10	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.88	167.75
9	119.152	120.600	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
10	120.040	120.600	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
11	120.671	121.462	5.00	0.80	3.00	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.00	166.00
12	116.480	119.013	7.00	0.80	5.00	0.20	1.00	3.50	0.70	1.00	1.80	0.30	12.50	114.88	229.75
13	117.950	119.219	5.00	0.70	3.10	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.88	167.75
14	120.635	122.148	5.00	0.70	3.10	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.88	167.75
15	104.612	107.500	5.00	1.88	1.92	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	73.55	147.10
16	104.700	107.500	5.00	1.88	1.92	0.20	1.00	3.00	0.5	1.00	1.50	0.30	12.50	73.55	147.10
17	104.740	107.500	5.00	1.88	1.92	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	73.55	147.10
18	151.077	151.600	5.00	1.88	1.92	0.20	1.00	3.00	0.50	1.00	1.5	0.30	12.50	73.55	147.10
19	147.721	148.509	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
20	117.740	118.246	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
21	115.924	116.431	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
22	106.547	108.200	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
23	106.738	108.200	5.00	0.80	3.00	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	83.00	166.00
24	106.621	108.200	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
25 A1	109.066	110.020	6.00	1.77	3.04	0.20	1.00	4.00	1.00	1.00	2.00	0.30	12.50	100.81	100.81
25 A2	109.066	110.020	6.00	1.77	3.04	0.20	1.00	4.00	1.00	1.00	2.00	0.30	12.50	100.81	100.81
26	108.789	109.290	5.00	1.05	2.75	0.20	1.00	3.00	0.50	1.00	1.50	0.30	12.50	80.81	161.63
Tebicuary-mf A1	104.369	107.500	8.00	1.77	5.04	0.20	1.00	4.50	0.70	1.50	2.30	0.40	13.70	183.01	183.01
Tebicuary-mf A2	104.300	107.500	8.00	1.77	5.04	0.20	1.00	4.50	0.70	1.50	2.30	0.40	12.50	166.98	166.98

Figure 7.2.6 Dimension of Abutment

⑤ Piers



Piers	B	b1	b2	b3	L	l1	l2	H	h1	h2	h3	Bb
Bailey Bridge	7.00	5.00	1.00	3.00	5.00	1.20	1.90	8.50	1.50	5.80	1.20	11.00
Tebicuary-mf P1	11.70	9.70	1.00	2.00	5.00	1.20	1.90	7.51	1.50	4.81	1.20	13.70
Tebicuary-mf P2-P5	7.00	5.00	1.00	3.00	5.00	1.20	1.90	4.65	1.50	1.95	1.20	11.00

Figure 7.2.7 Dimension of Pier

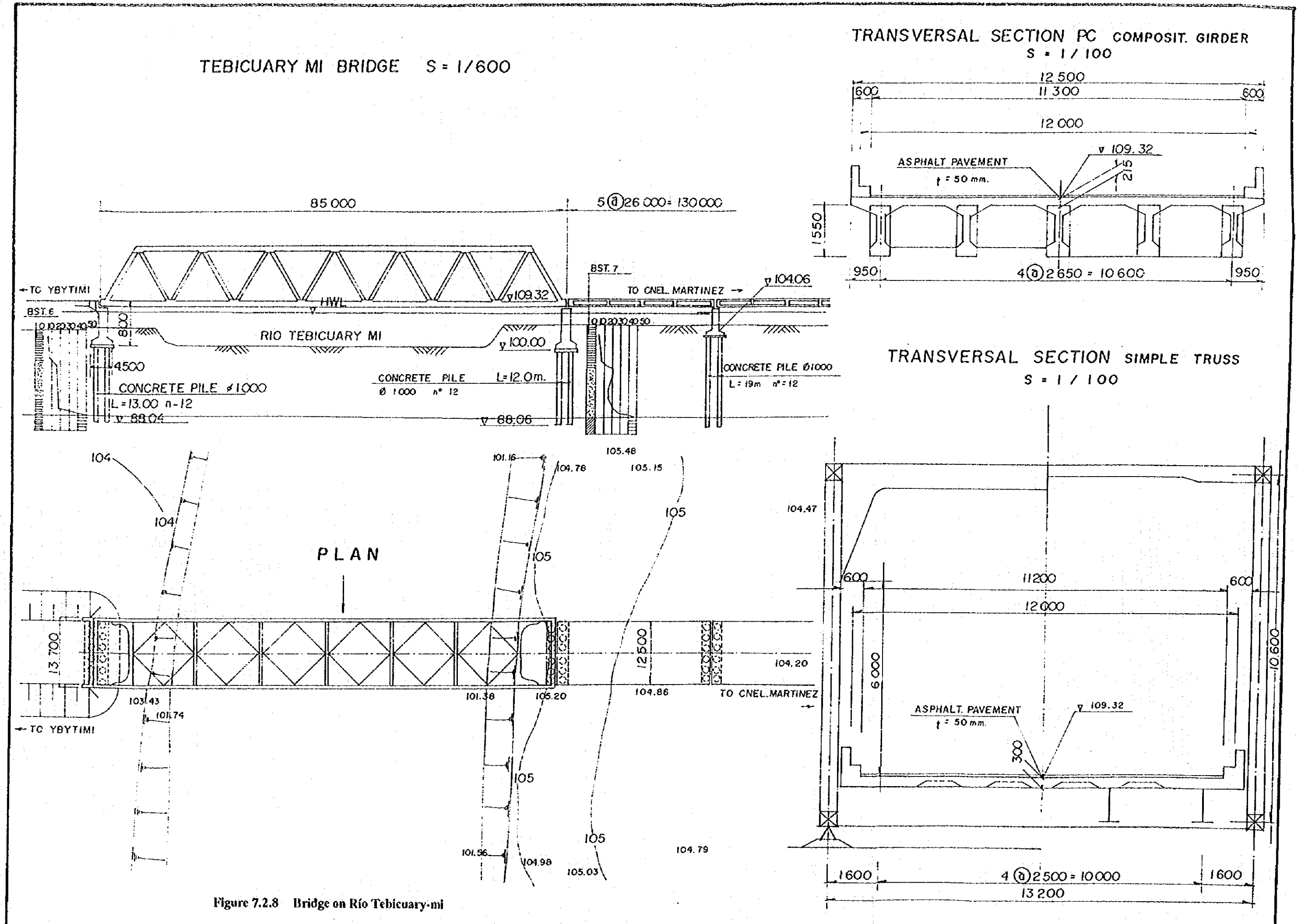


Figure 7.2.8 Bridge on Río Tebicuary-mi

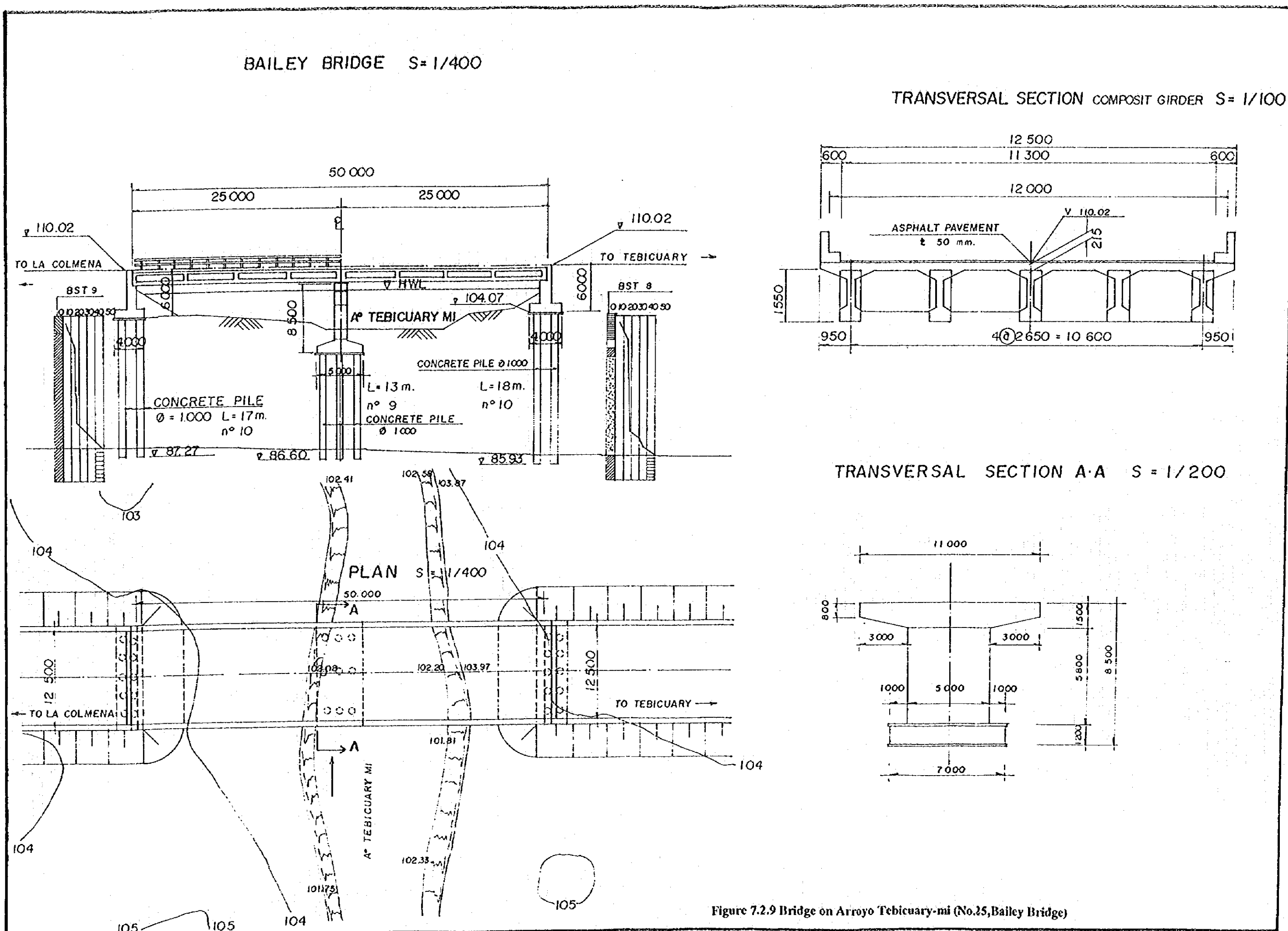


Figure 7.2.9 Bridge on Arroyo Tebicuary-mi (No.25,Bailey Bridge)

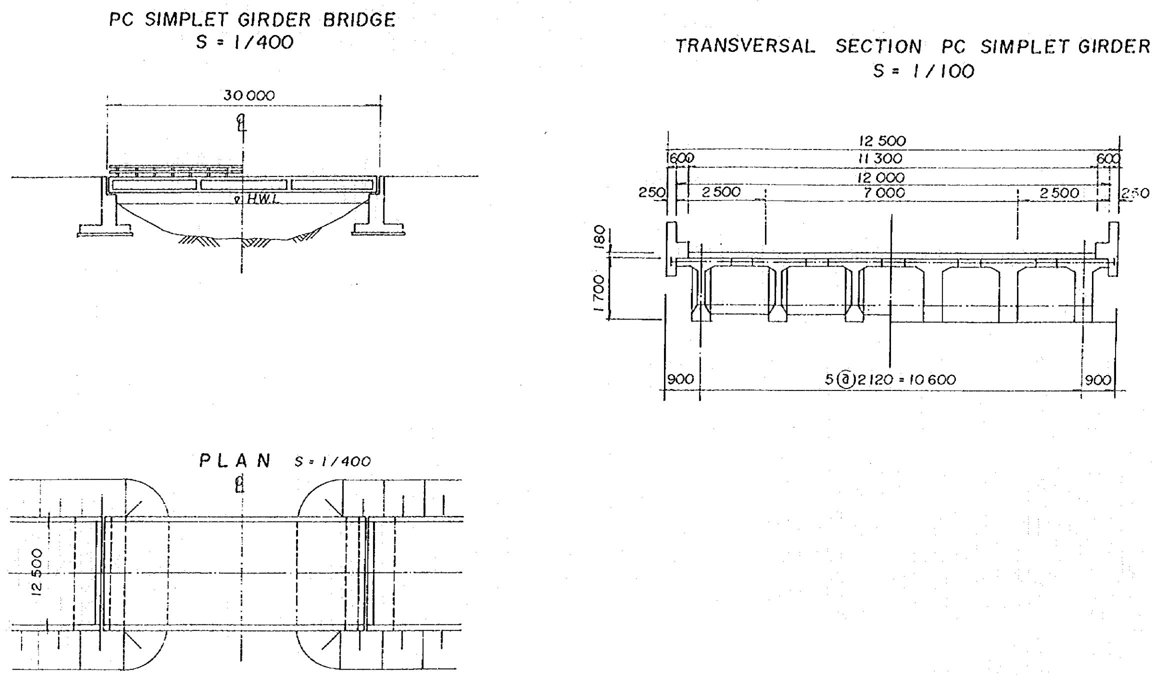
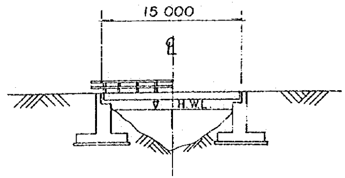
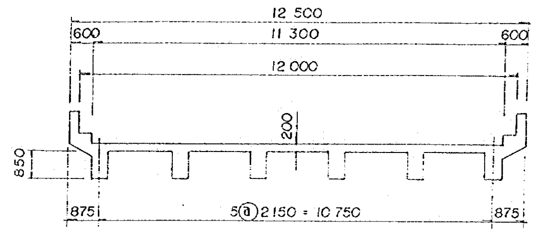


Figure 7.2.10 PC Simple T Girder Bridge

RC BRIDGE S = 1/400



TRANSVERSAL SECTION RC BRIDGE S = 1/100



PLAN S = 1/400

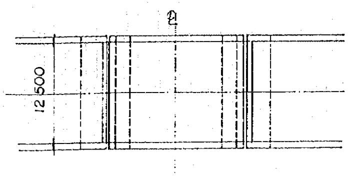


Figure 7.2.11 RC Bridge

7-2-4 Construction Method of Bridges

(1) Temporary Bridge

The route of the road determined in Chapter 6 is basically on the existing road alignment, where it will have to be passable even during the construction period of the Project. For this purpose, preparation of detour with a temporary bridge to handle actual traffic will be indispensable in constructing the bridges listed in Table 7.2.4.

Table 7.2.4 Bridges Requiring a Detour During Construction

Road Section	Bridge Name
Paraguarí - Villarrica	No.3, No.4, No.12, No.13, No.14
La Colmena - Tebicuary	No.20, No.21, No.22, No.23, No.24 No.25, No.26

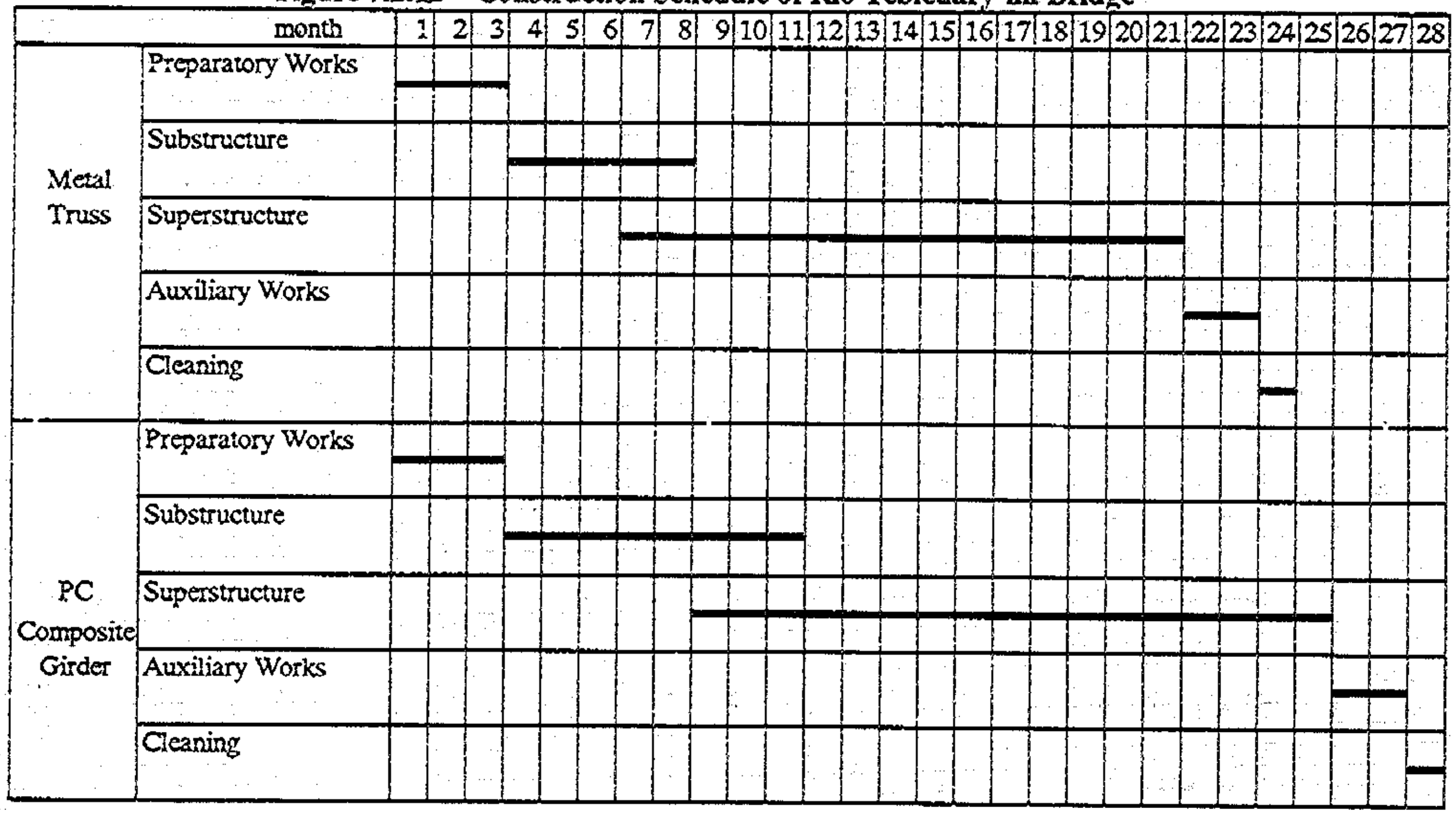
However, it must be noted that it may be possible to eliminate the need to construct detours and temporary bridges for bridges Nos. 19, 20, 25, 26, if slight modifications to the road alignment could be made at those bridge sites. That is, if the new road alignment could be offset a little from the existing road at the bridge site, the existing road and bridge could serve actual traffic, leading to a reduction in construction costs for detours and temporary bridges. This study must be conducted based on the more detailed topographic map prepared in the final design stage.

(2) Bridge on Río Tebicuary-mí

Since the construction of the bridge on Río Tebicuary-mi is the biggest job in the Project and requires considerably long time to finish, the schedule of it influences much to that of the whole Project. It shall not be practical to start the construction of this bridge after completion of the earthworks on either side of the bridge. If PC girders could be constructed on the embankment adjacent to abutments at a similar level of the bridge superstructure, it would be more advantageous for the bridge construction. However, the whole construction period of the Project would be longer and inpractical.

Therefore, the construction of the bridge shall be carried out independently of the road construction. Assuming this, it will be necessary to first construct the access road from the existing road to the bridge construction site. The best location of the access road is along the eastern rim of the river side woods on the left side of the river. Moreover, a temporary wharf on the river nearest to the existing road will also be required to transport, by river navigation, the material and equipment necessary for the job on the right side of the river, thereby supplementing the above-mentioned access road. As the construction period of this bridge noted in Table 6.4.21, was estimated only for the comparative study described in the footnote, a more detailed schedule was established here, including preparatory work such as access road construction. This is shown in Figure 7.2.12.

Figure 7.2.12 Construction Schedule of Rio Tebicuary-mi Bridge



7-3 Construction Plan

7-3-1 Basic Premises

(1) Expected Time of the Commencement of Construction

The Ministry (MOPC) intends to receive financing from some foreign financial resource for implementation of final design and constriction of the Project. If the Ministry will start the required procedures just after the completion of this Feasibility Study, it can be expected to conclude the financing by the end of August of 1997, based on the past experiences. Then, selection of consulting firm, execution of final design and tendering for construction must be carried out in succession.

Assuming that the required period for selection of consulting firm, execution of final design and tendering for construction would be 3 months, 10 months and 5 months, respectively, the time of commencement of constriction would be in March of 1999.

The study hereafter proceeded based on this assumption.

(2) Tender, Contract and Construction System

Taking a general view of the experiences over the past several decades in Paraguay, almost all of the road construction projects have been executed under the contract(s) with some foreign or local contractor(s), and financed by foreign financial resources such as the World Bank, the Interamerican Development Bank, OECF of Japan, etc. At the same time, MOPC now has two road construction projects proceeding under the ministry's direct construction system. (This system is called "Por Administración" in Paraguay.) However, MOPC intends to discontinue this system due to its low operation efficiency.

Given this situation, it is natural that the construction of this Project will also be carried out on a contract basis with private construction firm(s), and in that case, the tender to select contractor(s) must be a so-called international tender.

Since the Ministry (MOPC), as the implementing body of the Project, has much experience with this, and is well aware of the international tender process, it can be considered that the Project will be implemented with a international tender and on a contract basis without any problem. In conducting an international tender, it will be expected to make greater efforts to have many local and foreign contractors participate, in support of principles of competition.

Incidentally, the two on-going projects by "por administración" mentioned above are the construction of a local road in the Itapúa Department and National Road No. 5 between Pozo Colorado and Concepción. Recently, another project between San Ignacio and Pilar has been halted.

7-3-2 Construction Plan and Scheduling

(1) Division of the Project Road into Subsections

Assuming the construction of the Project will be carried out on a contract basis, it is necessary and meaningful in establishing the construction plan of the Project to evaluate the capability of contractors, that will probably participate in the tender.

The results of the investigation of the contractor's average production of road construction projects in Paraguay of the same kind as the one in this Project, which have been completed in recent years, are shown in the table below.

Table 7.3.1 Average Production of Contractor's Work

Project	Finance Source	Finished in	Distance	Construction Period		Ave. Real Production
			(km)	Contract (month)	Real (month)	(km/month)
Ñumí - S. J.Nepomuseno	Local	1996	25	24	18	1.39
Santa Rosa - Yby Yau:1st	IDB	1995	32	36	28	1.14
:2nd section	IDB	1996	30	36	48	0.62
:3rd section	IDB	1996	35.5	36	48	0.74
Ñumí - Caazapá	Local	1995	30	18	31	0.96
Filaderfia-M.Estigarribia	Fonplata	1993	84	36	48	1.75

From this table, it can be assumed that the average production of road construction in Paraguay might be 1.5 - 2.0 km/month, if it is controlled well.

On the other hand, the construction period of the bridge on Río Tebicuary-mí is estimated to be 28 months, as shown in Figure 7.2.12. Taking into consideration that it will be preferable for all construction works to be finished a few months after the completion of said bridge, the target construction period for the Project is considered to be 30 to 36 months, i.e., less than three years.

Combining this target construction period with the average production data previously noted, it is concluded that the whole Project must be divided into several subsections and each subsection should be less than 60 km long. Hence, it is recommended to divide the objective road into three subsections as follows:

- 1st subsection : Paraguarí - Right bank of the Tebicuary-mí River : 58.5 km

- 2nd subsection : Right bank of the River - Villarrica : 24.5 km
- 3rd subsection : La Colmena - Tebicuary : 38.1 km

As previously described, the construction of the bridge on the Tebicuary-mí River should be carried out independently from the earthwork. However, this does not mean that the work must be done by a different contractor. Nevertheless, the contractor working on the second subsection mentioned above will handle construction of that bridge.

(2) Construction Schedule

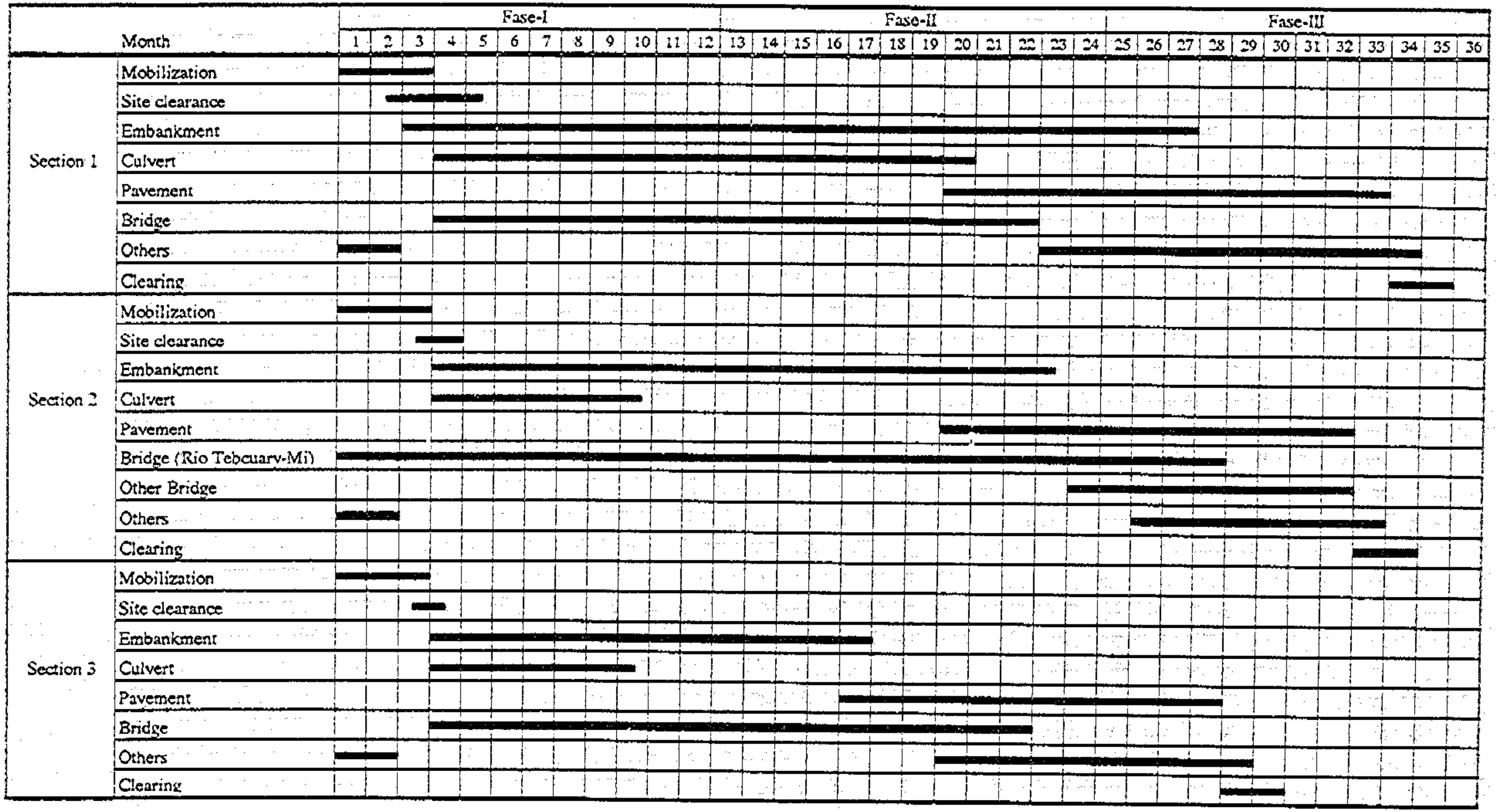
The construction schedule by section was estimated as shown in Figure 7.3.1.

(3) Others

Assuming the construction of above-mentioned three subsections will be implemented under separate contracts, the following should be noted:

- The same rock quarry should be used for the first subsection and the third subsection.
- In that case, the vehicles for transport of rock material from the quarry to the site of the third subsection will constantly pass the existing road in the first subsection. Good construction management and control will be required.
- Even though selection of the quarry site would probably be left entirely to the contractor, it is recommendable to study, in the construction stage, the possibility of using the quarry in "Cerro Itapé" for the third subsection, and to determine how to transport material from the quarry crossing Río Tebicuary-mí.

Figure 7.3.1 Construction Schedule by Road Section



7-4 Road Maintenance System

As described in Chapter 2, 2-1-4, (6), maintenance work on the existing roads is basically in charge of the Maintenance Department (Dpto. de Conservación) in the Directorate of Roads (Dirección de Vialidad) of MOPC. Actually, the District Offices, controlled by the Maintenance Department, carry out maintenance work. The objective roads of this Study will surely be included under this system after the completion of construction.

Two parts of the study roads will be included in the territory of the District Office No. 1; from Paraguarí to an intermediate point between Punto Unido and Tebicuary (54.5 km), and from La Colmena to Arroyo Tebicuary-mí (27.5 km). The remaining part, 39.1 km long, will be maintained by the District Office No. 8 at Ñumí. The actual forces and the roads handled by those two offices are shown in Tables 7.4.1 and 7.4.2.

Table 7.4.1 Equipment and Manpower Assigned to the District Offices

		District Office No. 1 (Itagua)	District Office No. 8 (Ñumí)
Equipment	Dump trucks	35 units	20 units
	Light trucks	6	3
	Motor graders	21	14
	Truck of other types	15	13
	Tractors	13	9
	Front loaders	13	5
	Bulldozers	7	4
	Scrapers (with tractor)	5	2
Total		125 units	70 units
Manpower	Engineers	4 persons	1 person
	For administration	56	27
	Mechanics	35	18
	Operators and laborers	168	79
Total		263 persons	125 persons
Total length of roads in territory		3,191 km	1,853 km

Table 7.4.2 Inventory of Roads in Territory

(Unit : km)

		District Office No. 1 (Itagua)	District Office No. 8 (Ñumí)
National Road	Paved	402	63
	Stone paved	0	0
	Gravel surface	15	0
	Dirt	323	99
Total		740	162
Department Road	Paved	307	58
	Stone paved	14	0
	Gravel surface	225	2
	Dirt	447	664
Total		993	724
Local Road	Paved	0	5
	Stone paved	0	0
	Gravel surface	228	0
	Dirt	1,229	963
Total		1,457	968
Total	Paved	709	125
	Stone paved	14	0
	Gravel surface	469	2
	Dirt	1,999	1,726
Grand Total		3,191	1,853

In general, it is said that the activities of the district offices have improved since 1994 or 1995 when new construction equipment purchased with Japanese credit was distributed to the offices and used to replace old machines. However, it has been pointed out as described in Chapter 2, 2-1-4, (6) that many problems still remain in actual road maintenance work. In response to this, the Directorate of Roads has been making an attempt in the last few years to improve the present efficiency of maintenance work carried out by the district offices. This attempt includes not only a restructuring of MOPC's organization but also changes in the operation system of road maintenance work.

As a result of this, all jobs in the district offices have been analyzed, standardized and categorized into seven groups and 63 activities. According to this categorization, activities regarding asphalt concrete paved roads are fairly limited. In other words, it seems that most of the district office's work is actually concentrated on unpaved roads.

The seven groups and the activities related to paved roads are as follows:

Table 7.4.3 Categorization of District Office's Work

Group	No. of Activity	Activities Related to Paved Roads
1.Routine maintenance	16	• Repair of damaged pavement with asphalt mix (code No.102 or 104) • Repair of damaged pavement of shoulders (code No. 122.0 or 122.1) • Maintenance of culverts (code No. 131 or 133) • Cutting of grass (code No. 134 or 135) • Maintenance of concrete bridges (code No. 137)
2.Special maintenance	11	• General cleaning of right-of-way zones (code No. 238 or 239)
3.Activities for collaboration (Municipality, etc.)	6	
4.Road improvement work	11	
5.Special services (plant, fab. of pipes, etc.)	8	
6.Road construction work	1	
7.Administration	10	

The following should be considered.

i) The functions of the district offices will probably be improved more in future through the efforts of MOPC.

ii) When maintenance work on the objective road is put under the control of District Offices No.1 and No. 8, it will mean simply switching from dirt or gravel surface roads to paved roads as well.

iii) Maintenance work of paved roads is easier than work on unpaved roads, especially just after pavement is put down.

It is considered that maintenance work on the objective road will not force the two district offices, No.1 and No. 8, to work more than now. Therefore, it can be expected that the Project road, after construction is completed, will be maintained well by the Ministry (MOPC).

Finally, the following must be noted although it is not clear if they will be dealt with as maintenance work by the district office or as the work of private firms under contract:

i) About 10 years after the completion of construction, overlay work on the pavement will be required.

ii) At about the same time, the metal structure of the bridge on Río Tebicuary-mí will also have to be repainted.

7-5 Summary of Work Quantity by Item

Based on the results of the preliminary design, the quantity of work to be required for each construction item was calculated. The following tables provide a summary. More details are included in Annex E (road construction) and Annex F (bridge construction).

(1) Road Construction

The quantity of work, including earthwork, drainage structure work, pavement work, is summarized in Table 7.5.1.

For the convenience of cost estimation, the volumes of earthwork and pavement materials, which will have to be transported, and the distance of transport were also estimated in the table. Moreover, additional embankment work calculated to compensate for site clearance and displacement of ground level was also included in the total value of Table 7.5.1

The quantities of other miscellaneous work, such as painting lines, traffic boards, fences, kilometer posts, grass plantation, mobilization, construction office, laboratory, etc., were not calculated in this study. However, since it could be confirmed by analyzing other projects in Paraguay, the cost of this miscellaneous work could be expressed as a percentage of the major work items shown in Table 7.5.1. The cost of these miscellaneous items was therefore estimated proportionally as described in Chapter 8.

(2) Bridge Construction

The quantity of works for bridge superstructure and substructure for each bridge are summarized in Tables 7.5.2 and 7.5.3, respectively.

Table 7.5.1 Summary of Quantity in Road Construction Work

Description	Segment	Unit	Paraguari to Rio Tebicuarymi						Rio Tebicuarymi to Villarrica				Brarch to La Colmera				Grand
			1	2	3	4	5	Total	6	7	8	Total	1	2	3	Total	Total
Earth	Site clearing(normal)	km	6.50	8.60	0.00	9.70	1.60	26.40	4.24	3.00	7.30	14.54	5.25	0.10	0.76	6.11	47.05
moving	Site clearing(middle)	km	1.04	1.30	0.00	0.30	0.30	2.94	0.00	0.00	0.55	0.55	0.90	0.00	0.66	1.56	5.05
	Site clearing(heavy)	km	0.00	0.00	0.00	0.00	0.70	0.70	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0	0.75
	Com Soil	m3	101,355	77,417	5,160	117,040	60,826	361,798	76,904	11,596	48,200	136,700	23,232	19,184	6,160	48,576	547,074
	Selected soil	m3	116,071	66,775	107,040	106,403	57,359	453,648	41,736	53,858	97,469	193,063	103,033	58,944	88,526	250,503	897,214
	Soil Transport Volume	m3	116,071	0	107,040	106,403	57,359	386,873	41,736	53,858	97,469	193,063	103,033	58,944	88,526	250,503	830,439
	Transport	km	2.1	0.0	7.4	5.9	2.0		2.6	2.2	5.2		3.5	7.5	3.7		
Drainage	Pile Culvert (D1.2)	NUS	0	5	5	0	0	10	0	0	10	10	16	0	0	16	36
	Box Culvert (3.0x3.0)	NUS	42	0	2	0	2	46	0	5	4	9	4	0	4	8	63
Pavement	SubBase	m3	48,038.0	22,418.0	19,215.0	21,350.0	13,878.0	124,899	12,893.0	22,920.0	34,380.0	70,193	54,016.0	5,124.0	22,204.0	81,344	276,436
	Transport	km	18.0	1.5	8.3	17.8	26.0		10.0	3.8	6.3		6.4	7.5	13.9		
	Base	m3	23,963.0	11,183.0	9,585.0	10,650.0	6,923.0	62,304	4,793.0	8,520.0	12,780.0	26,093	26,945.0	2,556.0	11,076.0	40,577	128,974
	Transport	km	18.0	1.5	8.3	17.8	26.0		10.0	3.8	6.3		6.4	7.5	13.9		
	Asphalt Concrete	m3	26,550.0	12,390.0	10,620.0	11,800.0	7,670.0	69,030	5,310.0	9,440.0	14,160.0	28,910	26,312.0	2,496.0	10,816.0	39,624	137,564
	Transport	km	18.0	1.5	8.3	17.8	26.0		10.0	3.8	6.3		6.4	7.5	13.9		
	Prime/Seal Coat	lt	415,125	193,725	166,050	184,500	119,925	1,079,325	83,025	147,600	221,400	452,025	466,785	44,280	191,880	702,945	2,234,295

Table 7.5.2 Quantity of Work for Bridge Superstructure

Bridge No.	Slab (m³)	Approach Cushion (m³)	Curb (m³)	Girder (m³)	Metal Fab. (tons)	Hand Rail (m)	Erection (m)	Erection (m²)
1	23.58	28.80	6.60	16.20		20.00		
2	56.03	28.80	16.50	98.26		50.00	150.00	
3	44.78	28.80	13.20	71.61		40.00	120.00	
4	35.36	28.80	9.90	34.43		30.00		
5	67.28	28.80	19.80	128.50		60.00	180.00	
6	23.58	28.80	6.60	16.20		20.00		
7	23.58	28.80	6.60	16.20		20.00		
8	11.79	28.80	3.30	6.75		10.00		
9	35.36	28.80	9.90	34.43		30.00		
10	35.36	28.80	9.90	34.43		30.00		
11	23.58	28.80	6.60	16.20		20.00		
12	23.58	28.80	6.60	16.20		20.00		
13	11.79	28.80	3.30	6.75		10.00		
14	11.79	28.80	3.30	6.75		10.00		
15	67.28	28.80	19.80	128.50		60.00	180.00	
16	67.28	28.80	19.80	128.50		60.00	180.00	
17	67.28	28.80	19.80	128.50		60.00	180.00	
18	67.28	28.80	19.80	128.50		60.00	180.00	
19	35.36	28.80	9.90	34.43		30.00		
20	35.36	28.80	9.90	34.43		30.00		
21	44.78	28.80	13.20	71.61		40.00		
22	35.36	28.80	9.90	34.43		30.00		
23	23.58	28.80	6.60	16.20		20.00		
24	35.36	28.80	9.90	34.43		30.00		
25	134.05	28.80	33.00	116.90		100.00	250.00	
26	35.36	28.80	9.90	34.43		30.00		
Tebicuary	667.32	28.80	141.90	301.76	480.00	430.00	650.00	1,020.00

Table 7.5.3 Quantity of Work for Bridge Substructure

Bridge No.	Excavation (m³)	Pile (m)	Pier (m³)	Abutment (m³)	Shoe (Unit)	Embankment Protection (m²)
1	775.04			253.00	12	131.67
2	1,169.64			360.90	12	113.98
3	951.44			272.05	12	118.50
4	742.73			225.38	12	124.75
5	327.02			152.10	12	173.03
6	404.68			166.00	12	52.136
7	391.50			166.00	12	57.19
8	250.56			167.75	12	82.99
9	383.62	179		161.63	12	60.17
10	479.52	179		161.63	12	23.28
11	454.57	145		166.00	12	32.85
12	542.74			229.75	12	105.26
13	250.56			167.75	12	52.72
14	250.56			167.75	12	62.86
15	228.10	282		147.10	12	39.90
16	228.10	282		147.10	12	36.18
17	228.10	282		147.10	12	34.58
18	483.52			147.10	12	41.50
19	454.90			161.63	12	32.74
20	485.35			161.63	12	21.04
21	242.62			161.63	12	82.99
22	178.52			161.63	12	68.68
23	382.10			166.00	12	60.75
24	369.47			161.63	12	65.62
25	862.62	467	156.68	201.61	15	188.33
26	485.89			161.63	12	20.91
Tebicuary	1,458.75	1,248	591.76	349.99	34	112.92

CHAPTER 8

COST ESTIMATION

CHAPTER 8 COST ESTIMATION

8-1 Road Construction

8-1-1 Basic Data for Cost Estimation

Although MOPC has a standard cost estimation method or standard unit prices for road construction work items, these are now too old and unrealistic in fact, and they are therefore now useless. Hence, the unit prices for cost estimation in this Study were calculated from scratch based on the data collected in the Study.

Because most of the data was collected in March of 1996, the exchange rate between US dollar and Guarani (local currency - Gs.) at that time, i.e.,

2,020 Gs./$

was adopted for the calculations.

Incidentally, costs were estimated according to the unit price method because, as this method is popular in Paraguay, all previous contracts for such projects as this have used it.

8-1-2 Work Items for Construction Cost Estimation

The work items in Table 8.1.1 were selected to determine unit price, and it was confirmed that the cost of these work items totals about 85 % to 90 % of the total construction cost, not including the cost of bridge construction.

Table 8.1.1 Cost Items for Unit Price Calculation

Item		Unit	Description
Site Clearance	Normal	km	Site clearance for grassy ground (20cm thick)
	Woods	km	Site clearance for woodlands (30 cm thick)
	Dense woods	km	Site clearance for dense woods located at Río Tebicuary-mí river bank
Embankment	Common soil	m^3	Embankment of the part beneath the subgrade
	Selected soil	m^3	Embankment for subgrade construction
Minor drainage	Pipe culvert	place	Concrete pipe (diameter: 1.2 m, 24 m long)
	Box culvert	place	Concrete box (3.0×3.0 m, 24 m long)
Pavement	Sub-base	m^3	Crusher-run. Finally, combined transport costs
	Base	m^3	Mechanically stabilized crushed stone. Combined with transportation costs later.
	Asphalt concrete	m^3	This is for binder and surface course.
	Prime/seal coat	lts.	
Transportation	Selected soil	km·m^3	Transport from the outside borrow to the site
	Quarry to site plant	km·m^3	Transport of crushed stone from the crushing plant at the quarry to the stockyard at the site plant.
	Site plant to site	km·m^3	After mixing at the site plant, transport to the site

Apart from the cost items shown in Table 8.1.1, the costs of other miscellaneous work items, such as road painting, kilometer posts, vegetation, construction of camp and laboratory, mobilization, etc. were calculated proportionally to the cost of the items above.

Analyzing six other road construction projects, which are scheduled to start in 1996, the proportion of the miscellaneous work was understood to be similar in those projects. Therefore, the following proportion was determined to apply in this case:

- Mobilization costs = 3 %×(total construction costs including other miscellaneous costs)
- Other miscellaneous costs = 12 %×(total construction costs - bridge construction cost - mobilization costs)

8-1-3 Unit Price of Work Item

Though calculation, the unit price of each cost item shown in Table 8.1.2 was obtained. More detailed calculation results are included in Annex E.

Table 8.1.2 Unit Price of Work Item for Road Construction

Cost Item		Unit	Unit Price (US$)		
			Section 1	Section 2	Section 3
Mobilization			A×0.03		
Earthwork	Site clearing (normal)	km	1,371		
	Site clearing (woods)	km	5,154		
	Site clearing (dense woods)	km	12,884		
	Embankment (Common Soil)	m³	3.89		
	Embankment (Selected Soil)	m³	5.31		
Drainage	Pipe Culvert (D1.2×24m)	place	9,355		
	Box Culvert (3.0×3.0×24 m)	place	45,379		
Pavement	Sub-base	m³	36.42	37.06	48.72
	Base	m³	37.71	38.35	50.00
	Asphalt concrete	m³	116.05	116.70	128.35
	Prime/Seal Coat	lts	0.57		
Transport	Transport (Selected Soil)	km·m³	0.35		
	Transport (Site plant to site)	km·m³	0.27		
Others			B×0.12		

Note: 1) Section 1 = Paraguarí - Río Tebicuary-mí
Section 2 = Río Tebicuary-mí - Villarrica
Section 3 = La Colmena - Tebicuary
2) A = (Earthwork cost including transport + Drainage cost+Bridge cost+Pavement cost including transport+Others cost)
B = (Earthwork cost including transport + Drainage cost + Pavement cost including transport)
3) Unit Prices of Subbase, Base and Asphalt concrete include transport cost from the crushing plant to the stockyard at the site (US$0.23/km·m³), denominated "transport cost (1)" shown in Figure 8.1.1.

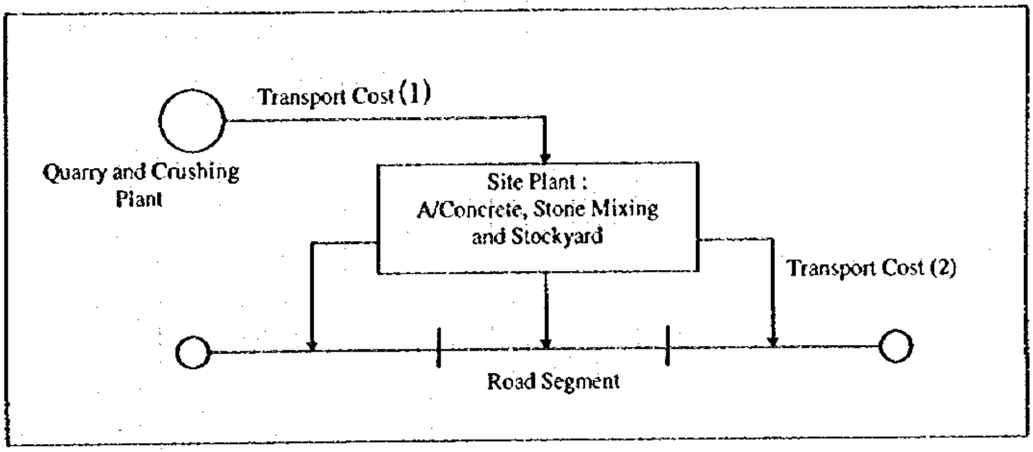


Figure 8.1.1 Schematic Chart of Material Transport

8-1-4 Road Construction Costs

The estimated cost of road construction by road segment and road section are summarized in Table 8.1.3.

Table 8.1.3 Construction Cost (1)

1$=2,020Gs.

Description \ Segment		Unit	Unit Price	Paraguari to Rio Tebicuarymi - Section 1 (L=58.5 km) 1	2	3	4	5	Total	Cost	Unit Price	Rio Tebicuarymi to Villarrica - Section 2 (L=24.5 km) 6	7	8	Total	Cost
Mobilization										822,554						440,533
Earth moving										4,357,743						1,784,862
	Site clearing(normal)	km	1,348	6.50	8.60	0.00	9.70	1.60	26.40	35,587	1,348	4.24	3.00	7.30	14.54	19,595
	Site clearing(middle)	km	4,997	1.04	1.30	0.00	0.30	0.30	2.94	14,691	4,997	0.00	0.00	0.55	0.55	2,748
	Site clearing(heavy)	km	12,492	0.00	0.00	0.00	0.00	0.70	0.70	8,744	12,492	0.05	0.00	0.00	0.05	625
	Embank.(com.DMT<0.5km)	m3	3.79	101,355	77,417	5,160	117,040	59,584	360,556	1,366,507	3.79	77,827	11,596	48,200	137,623	521,591
	Selected soil	m3	5.17	116,071	66,775	107,040	106,403	57,359	453,648	2,345,360	5.17	41,736	53,858	97,469	193,063	998,136
	Soil Transport — Volume	m3		116,071	0	107,040	106,403	57,359				41,736	53,858	97,469		
	Soil Transport — Transport	km		2.1	0.0	7.4	5.9	2.0				2.6	2.2	5.2		
	Soil Transport — Volume*Transport	m3*km	0.33	243,749	0	792,096	627,778	114,718	1,778,341	586,852	0.33	108,514	118,488	506,839	733,840.0	242,167
	Unit Price of Selected Soil	m3	6.46	5.86	5.17	7.61	7.12	5.83			6.42	6.03	5.90	6.89		
	Unit Price of Embankment	m3	5.28	4.90	4.43	7.44	5.37	4.79			5.33	4.57	5.52	5.86		
Drainage										2,181,024						501,816
	Pile Culvert(D1.2)	NUS	9,336	0	5	5	0	0	10.0	93,360	9,336	0	0	10	10.0	93,360
	Box Culvert(3.0x3.0)	NUS	45,384	42	0	2	0	2	46.0	2,087,664	45,384	0	5	4	9.0	408,456
Pavement										16,321,068						7,353,537
	Subbase	m3	35.83	48,038	22,418	19,215	21,350	13,878	124,899	4,475,131	36.46	12,893	22,920	34,380	70,193	2,559,237
	Transport	km		18.0	1.5	8.3	17.8	26.0				10.0	3.8	6.3		
	Volume*Transport	m3*km	0.26	864684	33627	159485	380030	360828	1,798,654	467,650	0.26	128930	87096	216594	432,620	112,481
	Unit Price of Subbase	m3	35.83	35.83	35.83	35.83	35.83	35.83			36.46	36.46	36.46	36.46		
	Base	m3	37.10	23,963	11,183	9,585	10,650	6,923	62,304	2,311,478	37.73	4,793	8,520	12,780	26,093	984,489
	Transport	km		18.0	1.5	8.3	17.8	26.0				10.0	3.8	6.3		
	Volume*Transport	m3*km	0.26	431334	16775	79556	189570	179998	897,232	233,280	0.26	47930	32376	80514	160,820	41,813
	Unit Price of Base	m3	37.10	37.10	37.10	37.10	37.10	37.10			37.73	37.73	37.73	37.73		
	Asphalt Concrete	m3	115.31	26,550	12,390	10,620	11,800	7,670	69,030	7,959,849	115.93	5,310	9,440	14,160	28,910	3,351,536
	Transport	m3		18.0	1.5	8.3	17.8	26.0				10.0	3.8	6.3		
	Volume*Transport	m3*km	0.26	477900	18585	88146	210040	199420	994,091	258,464	0.26	53100	35872	89208	178,180	46,327
	Unit Price of Asphalt	m3	115.31	115.31	115.31	115.31	115.31	115.31			115.93	115.93	115.93	115.93		
	Prime/Seal Coat	lt	0.57	415,125	193,725	166,050	184,500	119,925	1,079,325	615,215	0.57	83,025	147,600	221,400	452,025	257,654
Others		Gl								2,743,180						1,156,826
TOTAL										26,425,569						11,237,574

Table 8.1.3 Construction Cost (2)

1S=2020GS

Description \ Segment			Unit	Unit Price	La Colmena to Tebicuary - Section 3 (L=38.1 km)					Total
					9	10	11	Total	Cost	Cost
Mobilization									514,202	1,777,290
Earth moving									1,868,215	8,010,819
	Site clearing(normal)		km	1,348	5.25	0.10	0.76	6.11	8,236	63,418
	Site clearing(middle)		km	4,997	0.90	0.00	0.66	1.56	7,795	25,235
	Site clearing(heavy)		km	12,492	0.00	0.00	0.00	0.00	0	9,369
	Embank.(com.DMT<0.5km)		m3	3.79	23,232	19,184	6,160	48,576	184,103	2,072,201
	Selected soil		m3	5.17	103,033	58,944	88,526	250,503	1,295,101	4,638,596
	Soil Transport	Volume	m3		103,033	58,944	88,526			
		Transport	km		3.5	7.5	3.7			
		Volume*Transport	m3*km	0.33	360,616	442,080	327,546	1,130,241.7	372,980	1,201,999
	Unit Price of Selected Soil		m3	6.66	6.33	7.65	6.39			
	Unit Price of Embankment		m3	6.19	5.86	6.70	6.22			
Drainage									512,448	3,195,288
	Pile Culvert(D1.2)		NUS	9,336	16	0	0	16.0	149,376	336,096
	Box Culvert(3.0x3.0)		NUS	45,384	4	0	4	8.0	363,072	2,859,192
Pavement									11,658,470	35,333,076
	Subbase		m3	47.66	54,016	5,124	22,204	81,344	3,876,855	10,911,223
	Transport		km		6.4	7.5	13.9			
	Volume*Transport		m3*km	0.26	345702	38430	308636	692,768	180,120	760,251
	Unit Price of Subbase		m3	47.66	47.66	47.66	47.66			
	Base		m3	48.93	26,945	2,556	11,076	40,577	1,985,433	5,281,400
	Transport		km		6.4	7.5	13.9			
	Volume*Transport		m3*km	0.26	172448	19170	153956	345,574	89,849	364,943
	Unit Price of Base		m3	48.93	48.93	48.93	48.93			
	Asphalt Concrete		m3	127.14	26,312	2,496	10,816	39,624	5,037,795	16,349,181
	Transport		m3		6.4	7.5	13.9			
	Volume*Transport		m3*km	0.26	168397	18720	150342	337,459	87,739	392,530
	Unit Price of Asphalt		m3	127.14	127.14	127.14	127.14			
	Prime/Seal Coat		lt	0.57	466,785	44,280	191,880	702,945	400,679	1,273,548
Others			Gl						1,684,696	5,584,702
TOTAL									16,238,031	53,901,174

8-2 Bridge Construction

8-2-1 Basic Data for Estimating Each Unit Price

In Paraguay, MOPC does not have a standard unit price or cost estimation system. However, MOPC has had experience with such construction, including that of PC bridges. Given this, several meetings with MOPC structural engineers and local consulting firms were held regarding work items and the unit price to estimate the cost of the bridge structure in this Study. First, work items (cost items) to be applied in this case were determined and the jobs included in each item were confirmed, then the unit prices of those items were determined by referring to recent experiences with of similar work in Paraguay.

The price for the steel structure, i.e., for the metal truss bridge on Río Tebicuary-mí, was determined based on quotations obtained from two Brazilian firms, which had been collected in this Study. The quotations were prepared by referring to the basic information of the bridge, such as the size, structure type, location, etc., and included the costs of material, fabrication, transport, and erection. This was done because of a lack of data regarding the construction of steel structures in Paraguay.

8-2-2 Work Item Unit Price

The following unit prices, shown in Table 8.2.1, are those agreed to by MOPC to apply for the cost estimation of the bridge structures in this Study. The exchange rate for US dollar/ Guarani used in this price analysis is the same as that described in 8-1-1; US$1= 2,020Gs.

8-2-3 Construction Cost

Bridge construction costs were estimated as shown in Table 8-2-2. More detailed results of cost estimates on a bridge-by-bridge basis are shown in Annex F.

In terms of the cost of the bridge, which will necessitate a detour for actual traffic during the period of construction as described in Chapter 7, ten percent of the bridge construction costs will be incurred in the construction, maintenance, demolition of a temporary bridge, and the refilling of the detour.

Table 8.2.1 Bridge Construction Unit Cost

Bridge Type	Description	Unit	Unit Cost ($US)	Remarks
PC	Excavation	m^3	7.10	
	Concrete Piles(D=0.8m)	m	116.71	
	Concrete Piles(D=1.0m)	m	182.21	
	Pier	m^3	375.33	
	Cross Beam	m^3	375.33	
	Slab	m^3	375.33	
	Approach Cushion	m^3	375.33	
	Abutment	m^3	375.33	
	Curb	m^3	375.33	
	Neoprene	unit	102.97	
	PC girder	m^3	482.42	
	Girder Erection	m	64.72	
	Handrail	m	133.86	
	Embankment Protection	m^2	32.13	
RC	Excavation	m^3	7.10	
	Concrete Piles(D=0.8m)	m	116.71	
	Concrete Piles(D=1.0m)	m	182.21	
	Slab	m^3	321.78	
	Approach Cushion	m^3	321.78	
	Abutment	m^3	321.78	
	Curb	m^3	321.78	
	Neoprene	unit	102.97	
	Girder	m^3	321.78	
	Handrail	m	133.86	
	Embankment Protection	m^2	32.13	
Truss	Excavation	m^3	7.10	
	Concrete Piles(D=1.0m)	m	182.21	
	Pier	m^3	375.33	
	Slab	m^3	375.33	
	Approach Cushion	m^3	375.33	
	Abutment	m^3	375.33	
	Curb	m^3	375.33	
	Shoe	unit	1,540.00	
	Metal Fabrication/Transport.	T	3,500.00	
	Erection	m^2	155.32	
	Handrail	m	133.86	
	Embankment Protection	m^2	32.13	

Table 8-2-2 Bridge Construction Cost

Bridge No. (Section No.)	Length (m)	Structure	Pile Foundation	Detour	Total Cost (US$)	Cost/meter (US$)
1 (1)	10.0	RC	--	--	119,250	11,925
2 (1)	25.0	PC T girder	--	--	252,955	10,118
3 (1)	20.0	PC T girder	--	Yes	215,538	10,777
4 (1)	15.0	RC	--	Yes	134,164	8,944
5 (1)	30.0	PC T girder	--	--	194,493	6,483
6 (1)	10.0	RC	--	--	86,069	8,607
7 (1)	10.0	RC	--	--	86,138	8,614
8 (1)	5.0	RC	--	--	77,294	15,459
9 (1)	15.0	RC	Yes	--	129,458	8,631
10 (1)	15.0	RC	Yes	--	128,954	8,597
11 (1)	10.0	RC	Yes	--	102,687	10,269
12 (1)	10.0	RC	--	Yes	120,197	12,020
13 (1)	5.0	RC	--	Yes	83,954	16,791
14 (1)	5.0	RC	--	Yes	84,313	16,863
Sub-total (Section 1)	185.0	--	--	--	1,815,464	9,813
15 (2)	30.0	PC T girder	Yes	--	238,986	7,966
16 (2)	30.0	PC T girder	Yes	--	238,866	7,962
17 (2)	30.0	PC T girder	Yes	--	238,815	7,960
Tebicuary-mí (2)	215.0	Metal Truss + PC composite	Yes	Yes*	3,170,742	14,748
Sub-total (Section 2)	305.0				3,887,409	12,746
18 (3)	30.0	PC T girder	Yes	--	189,502	6,317
19 (3)	15.0	RC	--	--	106,098	7,073
20 (3)	15.0	RC	--	Yes	105,923	7,062
21 (3)	20.0	PC T girder	--	Yes	163,153	8,158
22 (3)	15.0	RC	--	Yes	105,208	7,014
23 (3)	10.0	RC	--	Yes	94,804	9,480
24 (3)	15.0	RC	--	Yes	106,592	7,106
25 (3)	50.0	PC Composite	Yes	Yes	439,032	8,781
26 (3)	15.0	RC	--	Yes	105,922	7,061
Sub-total (Section 3)	185.0				1,416,234	7,655
Total (US$)	675.0				7,119,107	10,547

Note : *- Access road will be required.

8-3 Other Costs

8-3-1 Maintenance Costs

The road maintenance system on a national level is described in Chapter 2, 2-1-4, while the system for the Project roads is mentioned in the previous chapter, 7-4. Based on this system, maintenance costs of the objective road after completion of construction are estimated here.

Unfortunately, little data is available regarding the budget and/or the money used for the maintenance work by the district offices in previous years. Although the road maintenance costs, for instance, cost per kilometer of paved, gravel, and dirt roads in the Chaco area, in suburbs of Asunción or in Itapúa might be different, all financial records are kept under one account, "cost of Department of Maintenance (Dpto. de Conservación)". One of the reasons for this seems to be that even after the annual budget is approved by the Parliament, the Ministry of Finance (Ministerio de Hacienda) often cuts it suddenly, making the program established under the planning budget incoherent. Moreover, the restructuring of district offices in recent years, from five offices to eight offices, with a change in the territories is also another reason. As a result, actual expenses in one account were actually dealt with outside the budget.

To improve this situation, MOPC is now preparing a computer program which makes more detailed analyses possible. This program will be handling all the accounting for 1997. These changes are proceeding in relation to the job categorization described in Chapter 7, and standard production and the cost of each activity are also being analyzed.

With respect to paved road maintenance, the following values were obtained after discussions with MOPC personnel:

Table 8.3.1 Maintenance Costs of Paved Road

Code	Activity	Gs./km/year	Remarks
102	Repair of damaged pavement with asphalt mix	12,000,000	for high-level damage *
122.0	Repair of damaged pavement of shoulder	563,700	
131	Maintenance of culverts	170,300	
134	Cutting of grass	74,700	
137	Maintenance of concrete bridges	350,000	Gs./time, 1-2 times/year
238	General cleaning of right-of-way zones	598,000	

Note : * - Corresponds to repairs using about 70 m³ of asphalt mix per km per year, which means that the roads may still have potholes here and there.

As described in the last paragraph of 7-4 in Chapter 7, the overlay work of pavement and the repainting of the bridge on Río Tebicuary-mí must be added to the maintenance costs of the objective roads.

Accordingly, the maintenance costs of the objective roads were calculated in the following manner:

i) Use the unit prices shown in Table 8.3.1.

ii) For five years after the completion of construction, it will not be necessary to call a "code 102". Then, for the following three years, and for the 4th and the 5th years, 15% and 30% of the unit price of "code 102" will be applied, respectively. Assuming one bridge per kilometer, requiring repair once a year, maintenance costs will be:

-1st - 5th : (563,700 + 170,300 + 74,700 + 598,000)/2,020 = US$ 696 /year/km

-6th - 8th : US$ 696 + 12,000,000/2,020×0.15 = US$ 1,587 /year/km

-9th - 10th : US$ 696 + 12,000,000/2,020×0.30 = US$ 2,478 /year/km

iii) For the work for bridges, "code 137" will be applied, and costs will be:

- Section 1-58.5 km, 14 bridges

350,000×1.0 time/year×14 bridges/2,020 = US$ 2,425 /year

- Section 2 - 24.5 km, 4 bridges- 9 span

350,000×1.0 time/year×9 spans /2,020 = US$ 1,559 /year

- Section 3 - 38.1 km, 10 bridges - 11 span

350,000×1.0 times/year×11 spans/2,020 = US$ 1,906 /year

iv) During the 11th and 12th years, the pavement will be overlayed. The costs for this are calculated by putting the unit prices calculated in 8-1 of this chapter into the relevant columns of Table 6.4.10 in Chapter 6. The result is a total of US$ 8,877,000. (see Annex E.)

- 11th - 12th: [Section 1] = 3,900,000/2 = US$ 1,950,000 /year

[Section 2] = 2,217,000/2 = US$ 1,108,500 /year

[Section 3] = 2,760,000/2 = US$ 1,380,000 /year

v) The repainting work will be done in the same years as the overlay work. The costs for this work are calculated in the following manner:

480 tons×US$ 180 /ton = US$ 86,400

- 11th - 12th: 86,400 /2 = US$ 43,200 /year

vii) During the overlay and repainting period, the activities outlined in Table 8.3.1 will not required.

viii) After overlaying is completed, the maintenance costs outlined in i) and ii) above will be incurred.

These results can be summarized as shown in Table 8.3.2:

Table 8.3.2 Maintenance Costs after Construction

(Unit : US$1,000)

Year after Completion	Annual Maintenance Costs	Section 1 58.5 km	Section 2 24.5 km	Section 3 38.1 km	Remarks
1st year - 5th year	90.1	43.1	18.6	28.4	0%×code 102
6th year - 8th year	196.1	95.2	40.4	60.5	15 %×code 102
9th year - 10th year	306.0	147.4	62.3	96.3	30 % of code 102
11th year - 12th year	4,481.7	1,950.0	1,151.7	1,380.0	add (43.2) to S.2
13th year - 17th year	90.1	43.1	18.6	28.4	
18th year - 20th year	196.1	95.2	40.4	60.5	

Note: Costs are for 1996.

Incidentally, the maintenance costs for unpaved roads (dirt) estimated as shown in Table 8.3.3, assuming Section 1 and 2 (Paraguarí - Villarrica), are in the same category, and in a lower category in the case of Section 3 (La Colmena - Tebicuary).

Table 8.3.3 Maintenance Costs of Unpaved Roads (Dirt)

Code	Activity	T.Princ. (Sec.1 & 2) Gs./km/year	T. A. Sec. (Sec.3) Gs./km/year	Remarks
111	Leveling and smoothing of road surface	410,700	616,000	
112	Repair of pot holes with dump trucks	1,216,000	1,459,200	
131	Maintenance of culverts	340,600	340,600	
132	Clearing and reforming of side ditches	102,700	102,700	
134	Cutting grass	74,700	74,700	
137	Maintenance of wood bridges	700,000 (22 bridges)	700,000 (17 bridges)	Gs./time, 3times/year
238	General cleaning of right-of-way zones	299,000	299,000	

The total sum of these works is calculated below:

- Section 1 - existing road = 66.9 km

  (410.7 + 1,216.0 + 340.6 + 102.7 + 74.7 +299.0)×66.9 km + 700.0×21 bridges×3

  = 207,583.5 thousand Gs./year = US$ 102,764 /year

- Section 2 - 24.5 km

  (410.7 + 1,216.0 + 340.6 + 102.7 + 74.7 +299.0)×24.5 km + 700.0×1 bridges×3

  = 61,970.7 thousand Gs./year = US$ 30,678 /year

- Section 3 - 38.1 km

  (410.7 + 1,216.0 + 340.6 + 102.7 + 74.7 +299.0)×38.1 km + 700.0×17 bridges×3

  = 128,805.0 thousand Gs./year = US$ 63,765 /year

- Total 102,764 + 30,678 + 63,765 = US$ 197,200 /year

8-3-2 Final Design

The final design cost for this Project consists of three components:

- Topographic survey,
- Road design, and
- Design of the bridge on Río Tebcuary-mí, and other bridges.

Since no maps are available to act as a basis for the final design, it will first be necessary to carry out topographic, centerline, vertical, and cross-sectional surveys over the whole stretch of the objective roads. The following must be carried out:

- Traverse survey
- Leveling
- Cross-sectional survey (50-m intervals on average)
- Centerline survey
- Creation of topographic maps along the road at a scale of 1:1,000
- Detailed survey of drainage and bridges

The costs for these works was estimated as follows:

- Survey described above	US$ 2,000 /km × 121,1 km	=	US$ 242,200
- Expert Supervision	US$25,000/month × 5 month	=	US$ 125,000
	Total	=	US$ 367,200

As local consultants have much experience with road design, including site investigation and material tests in laboratories, it is recommended that the work be carried out by local staff under the supervision of experts, that is, one highway engineer, one hydraulic engineer, and one material engineer. Assuming the period necessary for this design work will be six months, road design costs were calculated as below:

- Road design not including bridge design	US$ 5,000 /km × 121.1 km	= US$	605,500
- Highway eng. and Material eng.	US$ 30,000 /month × 6 month × 2	= US$	360,000
- Hydraulic engineer	US$ 30,000 /month × 3 month	= US$	90,000
	Total	= US$	1,055,500

It will be better to entrust the design of the bridge on Río Tebicuary-mí to foreign engineers, since local engineering firms have no experience in designing this kind of bridge. The design of some PC bridges should also be entrusted to foreign firms. Costs estimated based on this are as follows:

- Design of the bridge on Río Tebicuary-mi: 215 m	Global	= US$	160,000
- Design 9 PC bridges & 17 RC bridges: 460 m	Global	= US$	184,000
- Boring survey at 20 points, 10 m deep on average	US$ 220 × 200 m	= US$	44,000
	Total	= US$	388,000

Dividing the common portions into three sections accordingly proportionally according to section length, total costs for the final design by section are tabulated in Table 8.3.4.

Table 8.3.4 Summary of Final Design Costs

(Unit : US$)

Item	Section 1	Section 2	Section 3	Total Cost
Topographic survey	177,375	74,250	115,575	367,200
Road design (incl. material survey)	509,850	213,400	332,250	1,055,500
Bridge design (incl. boring survey)	91,600	204,800	91,600	388,000
Total	778,825	492,450	539,425	1,810,700

8-3-3 Construction Supervision

According to MOPC's usual practice, one gang carrying out construction supervision for one construction site will consist of:

- 1 Engineer and 1 vehicle
- 1 Assistant or Junior Engineer
- 1 Site Inspector
- 1 Surveyor and 2 Assistants
- 1 laboratory Worker and 2 Assistants
- 1 Driver and 1 Vehicle.

The cost of construction supervision in this case was estimated based on:

i) The three road sections will be constructed by three contractors independently.

ii) One supervision group will be assigned for each road section.

iii) Although road section 3 (branch to La Colmena) will not need an assistant engineer, for road section 2, which includes the construction of a big bridge, one structural engineer will be assigned rather than an assistant engineer.

iv) One resident supervising engineer will be assigned, besides the engineers assigned to the three gangs managing all the work.

The cost of one gang per month was estimated as below:

- 1 Engineer	= US$ 27,000 /month
- 1 Assistant or Junior Engineer	= US$ 10,000
- 1 Site Inspector	= US$ 2,500
- 1 Surveyor	= US$ 2,000
- 1 Laboratory Worker	= US$ 2,000
- 4 Assistants for labo. & topo.	= US$ 1,000
- 1 Driver	= US$ 800
- 2 Vehicle including operation cost	= US$ 3,600
Total	= US$ 48,900 /month

The cost of a gang for road section 3 is to be modified to US$ 38,900 /month, according to the above-mentioned condition 3. The cost of a gang for road section 2 is to be modified to 65,900 $/month, accordingly. Total costs for construction supervision were estimated as shown in Table 8.3.5.

Table 8.3.5 Estimated Construction Supervision Costs

	Unit	Unit Price (US$)	Month	Cost (US$)	Remarks	
[Central Office]						
Resident Engineer	month	30,000	36	1,080,000		
Accountant	month	2,500	36	90,000		
Secretary	month	800	36	28,800		
Vehicle	month	1,800	36	64,800	including fuel	
Office accommodation	month	1,500	36	54,000	including supplies	
Central office sub-total				1,317,600		
Gang for Section 1	month	48,900	36	1,760,400	439,900	2,200,300
Gang for Section 2	month	65,900	35	2,306,500	576,363	2,882,863
Gang for Section 3	month	38,900	31	1,205,900	301,337	1,507,237
Total				5,272,800	1,317,600	6,590,400

8-4 Re-adjustment of Contracted Amount (Price Contingency)

Looking at the previous road construction contracts between MOPC and contractors in Paraguay, a "readjustment of unit price" clause is always included even in the case of projects financed by multinational or bilateral financing. This clause permits adjustment of the unit price of the work item in the contract at the time of intermediate payment according to the formula described in the contract, referring to the prices of material, equipment and minimum salaries officially published by the Government.

The contents and formulas stipulated in the different contracts are not always the same, however, this clause aims, in most cases, to cover changes in price (from the moment the contract is concluded) of cement, petroleum products, construction machines, and salaries. Therefore, this clause aims to protect against inflation in prices during the contract period, and can considered a kind of financial contingency.

For instance, this stipulation in the contracts agreed to in 1994 and terminated in 1996 for the rehabilitation project of existing national roads, financed by OECF (Overseas Economic Cooperation Fund of Japan), is copied below:

__Increase in the construction cost, due to changes in consumption prices__

If after the fourteenth day before the opening of the offers and during the period after the termination of the official contractual period, the Government causes some changes in the costs of labor, petrol, lubricants, or equipment, and the general price index for consumers, granted by the Central Bank, after the fourteenth day before the opening of the sealed offer and during the following period until the termination of the contractual initial period, according to the formula as follows:

$$R = P_o(0.25\, S_j / S_o + 0.20\, G_i / G_o + 0.35\, E_i\, D_i / E_o / D_o - 0.80)$$

where

S_j= *Laborer's wages, established by the Ministry of Justice and Labor in the month of the work execution.*

S_o= *The same as the fourteenth day before the date of the offer opening or determined by the Directorate of Roads in the sealed document.*

G_i= *Official price for petrol in Asunción in the month of the work execution.*

G_o= *The same as the fourteenth day before the date of the offer opening or determined by the D.V. in a sealed document*

E_i= *Index corresponding to the construction of Machinery and Equipment Code 112, in the publication called "Producer Prices" from the U.S.*

Department of Labor Statistics.

E_o= *The same as the fourteenth day before the date of offer opening.*

D_i= *Quotation in Gs./USD granted by the Central Bank belonging to the sales rate.*

D_o= *The same as the fourteenth day before the date of offer opening.*

R = *Readjustment*

P_o= *Basic or contractual certificate.*

Other cost increases

Cost adjustment will be carried out due to changes in the prices of asphalt materials , subsequent to the fourteenth day before the offer opening and during the following period until the conclusion of the contractual initial period, according to the adopted procedure for each as detailed below.

The resulting adjustments will be paid exclusively in guarantes.

Bituminous Materials

Cost adjustments will be made if the prices of the following bituminous materials either increase or decrease:

1) Asphalt concrete

2) Emulsificated asphalt

The formula for the payment adjustments will be:

$$A_1 = M_1(C_1 - B_1)$$

$$A_2 = M_2(C_2 - B_2)$$

where

A_1, A_2= *Cost adjustment by increase or decrease in the prices of the different bituminous products, in guaranies.*

M_1, M_2= *Amount of the different kinds of bituminous products in each item of work conducted in the period considered in the certification from the month after the date when the prices would have been modified.*

B_1, B_2= *Prices of the different types of asphalt considered in this paragraph, increased or decreased, obtained by the government based on the minimum prices at the source of the bituminous product supply, on the fourteenth day before the offer opening.*

C_1, C_2= *Modified prices of the different types of asphalt considered in this paragraph, increased or decreased and obtained by the government based on the minimum prices at the supply source of the asphalt* *products.*

The consignment of a different type of asphalt gathered by the contractor before the date of the price modification will not be subjected to any cost adjustment.

The adjustment mentioned in the articles 108.10 and 108.11 will be applied to the amount of work that would have been carried out without any delay in relation to the Plan of Work Advancement.

If there is any delay, the adjustment will be applied when the percentage of the amount of the executed work reaches the foreseen Advancement Plan for the month when the greatest costs are incurred.

The total payment of adjustments will be anticipated by the issuance of each monthly certificate.

If the index or definitive values are not ready at that time, the adjustments will be calculated on the basis of the last known values. When the definite values are known, the corresponding amount difference will be included.

The contractor will present within the 20 days after the date of the commencement of work, the prices "B" for the study and acceptance by the Inspection Office. "B" prices should be attached to the corresponding documents and certificates.

No compensation or deductions due to any increase or decrease in ordinary transport tariffs, material costs or any other increase or cost that are not foreseen specifically in this article, will be made.

The amounts paid according to this clause in the four contracts, which were for the above-mentioned projects financed by OECF, are tabulated in Table 8.4.1.

Table 8.4.1 Final Amount of "Re-adjustment of Price" in Four Cases

Contract for Road Development (from --- to ---)	Original Contract Amount (US$): A	Readjustment Amount (US$): B	B / A (%)
Empalme Road No.1 - Villeta	5,034,800	632,700	12.6
Itacurubí - Colonel Oviedo	6,758,900	915,400	13.5
Río Negro - Pozo Colorado	10,499,900	606,200	5.8
Pozo Colorado - Río Verde	7,159,900	1,195,800	16.7
		Average =	12.1

Note: 1) Some of amounts above are in equivalent US dollars of the amount in local currency in the contracts.
2) Construction period of these projects will be 15 months.

Since the past data of similar projects, which were referred to or formed the basis of the cost estimation in this Study, described in 8-1, 8-2 and 8-3 of this chapter, were those conforming to original contract amount, it is considered that the costs incurred by this readjustment in construction and supervision costs must be included in the Project Costs as a contingency for the fluctuation of prices. The average value in Table 8.4.1, i.e., 12%, was applied to estimate the amount of readjustment in this Study.

8-5 Land Acquisition Costs

The land acquisition costs were also estimated. The results are summarized in Table 8.5.1.

Table 8.5.1 Land Acquisition Costs

Item	Unit	Total	(Share)	Section 1	Section 2	Section 3
Planned Road Area	ha	427.3	100.0%	222	91	114.3
(Share by Sections)				52.0%	21.3%	26.7%
(Planned Distance)	km	121.1		58.50	24.50	38.10
(Average R.O.W.)	m	35.28		37.95	37.14	30.00
Existing Road Area	ha	200.8	47.0%	98.6	25.9	76.3
Public Land	ha	0.6	0.1%	0.32	0.16	0.12
Land to be Acquired	ha	225.9	52.9%	123.08	64.94	37.88
Land Use	ha	225.9	100.0%	123.08	64.94	37.88
- Town Area	ha	7.39	3.3%	3.59	3.20	0.60
- Agricultural Land	ha	54.29	24.0%	1.42	30.50	22.37
- Ganaderia	ha	140.43	62.2%	102.40	29.80	8.23
- Forest	ha	23.79	10.5%	15.67	1.44	6.68
Land Cost : Total	1,000Gs	1,175,798	100.0%	582,314	531,238	62,246
Town Area	1,000Gs	897,300	76.3%	438,500	448,000	10,800
Agricultural Land	1,000Gs	81,431	6.9%	2,130	45,750	33,551
Ganaderia	1,000Gs	168,518	14.3%	122,882	35,760	9,876
Forest	1,000Gs	28,549	2.4%	18,802	1,728	8,020
Building cost : Total	1000Gs	2,832,000		1,215,000	1,260,000	357,000
Buildings to be relocated		47		17	23	7
Average cost per building	1,000Gs	60,255		71,471	54,783	51,000
Land and Building Cost : Total	1,000Gs	4,007,798	100.0%	1,797,314	1,791,238	419,246
(Share by Sections)				44.8%	44.7%	10.5%
Land Cost	1,000Gs	1,175,798	29.3%	582,314	531,238	62,246
(Share by Sections)				49.5%	45.2%	5.3%
Building Cost	1,000Gs	2,832,000	70.7%	1,215,000	1,260,000	357,000
(Share by Sections)				42.9%	44.5%	12.65
US$ US$1=2,020Gs.	US$1,000	1,984		890	887	208

Note : 1) Land Price (Gs./m²) in Town Area is 1,600 - 15,000, in which Paraguari 15,000, Villarrica 14,000, Escobar 4,000, Sapucaí 2,500, La Colmena and Tebicuary 2,000, Caballero 1,700, and Others 1,600.
2) Land Price (Gs./m²) of Agricultural land is 150 in all area
3) Land Prices (Gs/m²) of Ganaderia and Forest are 120 in all area
4) Building Price(Gs./building)
Paraguari, Sapucai and Villarrica 80,000,000 (A2 type 400,000Gs./m² × 200m²)
Other area 51,000,000 (B2 - C2 type 340,000Gs./m² × 150m²)

8-6 Environmental Management Costs

As a result of the Environmental Impact Assessment, an environmental management plan was established. The details are described in Volume II of this report, and a synopsis is provided in the next chapter, Chapter 9. The implementation cost of the environmental management plan is abstracted and summarized here.

Costs were divided into two types, that is, initial investment and aftercare investment. The former is to be implemented by the time construction is completed, while the latter is the cost for necessary measures after construction is completed.

This environmental management plan consists of five programs:
i) Environmental Auditory Program
ii) Environmental Mitigation Program
iii) Environmental Monitoring Program
iv) Ybycui National Park Conservation Program
v) Promotion of Social Development Program

Costs by program and by road section are tabulated in Table 8.6.1 and Table 8.6.2.

Table 8.6.1 Initial Investment for Environmental Management

(Unit : US$.)

Item		Year 1 (1998)	Year 2 (1999)	Year 3 (2000)	Year 4 (2001)	Total
1.Environmental Auditory Program		55,550	33,000	33,000	33,000	154,550
	Section 1	26,835	15,941	15,941	15,941	74,659
	Section 2	11,238	6,676	6,676	6,676	31,267
	Section 3	17,477	10,382	10,382	10,382	48,624
2.Environmental Mitigation Program		211,310	78,540	79,640	387,063	756,553
	Section 1	106,205	46,289	46,937	234,518	433,950
	Section 2	49,729	30,005	30,425	62,961	173,119
	Section 3	55,376	2,246	2,278	89,584	149,483
3.Environmental Monitoring Program		113,300	14,080	30,360	18,920	176,660
	Section 1	55,879	6,802	14,942	9,140	86,762
	Section 2	43,093	2,849	10,989	3,828	60,758
	Section 3	14,328	4,430	4,430	5,953	29,140
4.Ybycui National Park Conservation Program		48,400	19,800	19,800	74,800	162,800
	Section 1	23,381	9,565	9,565	36,134	78,644
	Section 2	9,792	4,006	4,006	15,133	32,936
	Section 3	15,227	6,229	6,229	23,533	51,219
5.Promotion of Social Development Program		46,200	45,100	0	99,000	190,300
	Section 1	22,703	22,162	0	48,649	93,514
	Section 2	12,146	11,857	0	26,027	50,030
	Section 3	11,351	11,081	0	24,324	46,757
Total Amount		474,760	190,520	162,800	612,783	1,440,863
	Section 1	235,003	100,759	87,385	344,382	767,529
	Section 2	125,999	55,392	52,095	114,625	348,110
	Section 3	113,759	34,369	23,319	153,776	325,223

Table 8.6.2 Aftercare Investment for Environmental Management and Grand Total

(Unit : US$)

Item		Year 5 (2002)	Year 6 (2003)	Total	Grand Total
1.Environmental Auditory Program		33,000	73,150	106,150	260,700
	Section 1	15,941	35,337	51,278	125,937
	Section 2	6,676	14,799	21,475	52,743
	Section 3	10,382	23,014	33,396	82,020
2.Environmental Mitigation Program		73,480	0	73,480	830,033
	Section 1	35,496	0	35,496	469,446
	Section 2	14,866	0	14,866	187,985
	Section 3	23,118	0	23,118	172,601
3.Environmental Monitoring Program		11,880	16,280	28,160	204,820
	Section 1	5,739	8,140	13,879	100,641
	Section 2	2,403	8,140	10,543	71,302
	Section 3	3,738	0	3,738	32,877
4.Ybycuí National Park Conservation Program		20,900	0	20,900	183,700
	Section 1	10,096	0	10,096	88,740
	Section 2	4,228	0	4,228	37,165
	Section 3	6,575	0	6,575	57,795
5.Promotion of Social Development Program		46,200	0	46,200	236,500
	Section 1	22,703	0	22,703	116,216
	Section 2	12,146	0	12,146	62,176
	Section 3	11,351	0	11,351	58,108
Total Amount		185,460	89,430	274,890	1,715,753
	Section 1	89,975	43,477	133,452	900,981
	Section 2	40,320	22,939	63,259	411,370
	Section 3	55,165	23,014	78,179	403,402

8-7 Summary of Costs

8-7-1 Summary of Project Costs

The total construction costs are tabulated in Table 8.7.1. The Project costs, including other costs, such as those for engineering services, environmental management, land acquisition and contingencies, are summarized in Table 8.7.2. The tentative investment program, including maintenance costs and aftercare investment for environmental management is shown in Table 8.7.3.

Table 8.7.2 Summary of Project Costs (Financial Costs)

(Unit : US$)

Code	Item	Section 1 Cost	Section 2 Cost	Section 3 Cost	Total Cost	Rate (%)	Remarks
A	Construction Cost	28,628,758	15,291,481	17,947,888	61,868,127	71.0	
B	Environ. Management Cost	767,529	348,110	325,223	1,440,863	1.7	Initial cost only
C	Engineering Cost	2,567,500	3,938,363	1,895,237	8,401,100	9.6	
C.1	- Final Design	367,200	1,055,500	388,000	1,810,700	2.1	
C.2	- Construction Supervision	2,200,300	2,882,863	1,507,237	6,590,400	7.6	
	Total (A+B+C)	31,963,787	19,577,954	20,168,348	71,710,090	82.3	
D	Land Acquisition	890,000	887,000	208,000	1,984,000	2.3	
E	Contingency	6,143,293	3,473,862	3,835,491	13,452,646	15.4	
E.1	- Price Contingency	3,791,590	2,222,695	2,373,642	8,387,927	9.6	(A+B+C.2)×12%
E.2	- Physical Contingency	2,351,703	1,251,167	1,461,849	5,064,719	5.8	(A+B)×8%
	Grand Total (A+B+C+D+E)	38,997,080	23,938,816	24,211,838	87,146,736	100.0	
	IVA (10%)	3,899,708	2,393,882	2,421,184	8,714,674		
	Total with IVA	42,896,788	26,332,698	26,633,022	95,861,409		

Note : The aftercare investment for environmental management plan is not included in item B.

Table 8.7.1 Summary of Construction Costs (Financial Costs)

Code	Item	Unit	Section 1			Section 2			Section 3			Total				Remarks
			Unit Price ($)	Quantity	Cost ($)	Unit Price ($)	Quantity	Cost ($)	Unit Price ($)	Quantity	Cost ($)	Average Unit Price ($)	Quantity	Cost ($)	Rate (%)	
A	Construction Cost															
A.1	Mobilization	global	--	1.00	833,847	--	1.00	445,383	--	1.0	522,754	--	1.0	1,801,984	2.9	(A.2,3,4,5,6) × 3%
A.2	Earthwork				4,494,219			1,840,775			1,931,133			8,266,127	13.4	
A.2.1	- Site Clearance (normal)	km	1,371.00	26.40	36,194	1,371.00	14.54	19,934	1,371.00	6.1	8,377	1,371.00	47.1	64,506	0.1	
A.2.3	- Site Clearance (woods)	km	5,154.00	2.94	15,153	5,154.00	0.55	2,835	5,154.00	1.6	8,040	5,154.00	5.1	26,028	0.0	
A.2.4	- Site Clearance (dense woods)	km	12,884.00	0.70	9,019	12,884.00	0.05	644	12,884.00	0.0	0	12,884.00	0.8	9,663	0.0	
A.2.5	- Embankment	m³	5.45	814,204.00	4,433,853	5.50	330,686.00	1,817,362	6.40	299,079.0	1,914,716	5.66	1,443,969.0	8,165,931	13.2	
A.3	Bridge Construction	place	--	14.00	1,815,464	--	4.00	3,887,409	--	9.0	1,416,234	--	27.0	7,119,107	11.5	
A.4	Minor Drainage	place	--	56.00	2,180,984	--	19.00	501,961	--	24.0	512,712	--	99.0	3,195,657	5.2	
A.5	Pavement				16,520,732			7,441,808			11,849,815			35,812,355	57.9	
A.5.1	- Sub-base	m³	40.31	124,899.00	5,034,458	38.72	70,193.00	2,718,160	51.02	81,344.0	4,150,127	43.06	276,436.0	11,902,745	19.2	
A.5.2	- Base	m³	41.60	62,304.00	2,591,736	40.01	26,093.00	1,044,088	52.30	40,577.0	2,122,155	44.64	128,974.0	5,757,980	9.3	
A.4.3	- Binder & Surface (A/Concrete)	m³	119.94	69,030.00	8,279,336	118.36	28,910.00	3,421,906	130.65	39,624.0	5,176,854	122.69	137,564.0	16,878,096	27.3	
A.5.4	- Prime/Seal Coat	m³	570.00	1,079.30	615,201	570.00	452.03	257,654	570.00	702.9	400,679	570.00	2,234.3	1,273,534	2.1	
A.6	Other Miscellaneous Work	global	--	1.00	2,783,512	--	1.00	1,174,145	--	1.0	1,715,239	--	1.0	5,672,897	9.2	(A.2,4,5) × 12 %
A	Total of Construction Cost				28,628,758			15,291,481			17,947,888			61,868,127	100.0	

Table 8.7.3 Investment Program with IVA (10%) (Financial Cost)

	From : To	Section 1 (US$)	Section 2 (US$)	Section 3 (US$)	Total (US$1,000)	Remarks
	Jan-98 : Dec-98	856,708	541,695	593,368	1,991.8	Final Design
	:	258,503	138,599	125,135	522.2	Environmental
	Total	1,115,211	680,294	718,502	2,514.0	
	Mar-99 : Dec-99	7,872,908	4,205,157	4,935,669	17,013.7	Construction: 9 months
	:	550,083	792,788	414,490	1,757.4	Supervision
	:	110,835	60,931	37,806	209.6	Environmental
	Total	8,533,825	5,058,876	5,387,965	18,980.7	
	Jan-00 : Dec-00	10,497,211	5,606,876	6,580,892	22,685.0	12 months
	:	806,776	1,057,049	552,653	2,416.5	Supervision
	:	96,124	57,305	25,651	179.1	Environmental
	Total	11,400,111	6,721,230	7,159,196	25,280.5	
	Jan-01 : Dec-01	10,497,211	5,606,876	6,580,892	22,685.0	12 months
	:	806,776	1,057,049	552,653	2,416.5	Supervision
	:	378,820	126,088	169,154	674.1	Environmental
	Total	11,682,808	6,790,013	7,302,699	25,775.5	
	Jan-02 : Mar-02	2,624,303	1,401,719	1,645,223	5,671.2	3 months
	:	256,695	264,263	138,164	659.1	Supervision
	:	0	0	0	0.0	Environmental
	Total	2,880,998	1,665,982	1,783,387	6,330.4	
1	Apl-02 : Dec-02	47,410	20,460	31,240	99.1	(Filling pot hole) × 0%
	:	98,973	44,352	60,682	204.0	Environmental
	Total	146,383	64,812	91,922	303.1	
2	Jan-03 : Dec-03	47,410	20,460	31,240	99.1	
	:	47,825	25,233	25,315	98.4	Environmental
	Total	95,235	45,693	56,555	197.5	
3	Jan-04 : Dec-04	47,410	20,460	31,240	99.1	
4	Jan-05 : Dec-05	47,410	20,460	31,240	99.1	
5	Jan-06 : Dec-06	47,410	20,460	31,240	99.1	
6	Jan-07 : Dec-07	104,720	44,440	66,550	215.7	(Filling pot hole) × 15%
7	Jan-08 : Dec-08	104,720	44,440	66,550	215.7	
8	Jan-09 : Dec-09	104,720	44,440	66,550	215.7	
9	Jan-10 : Dec-10	162,140	68,530	105,930	336.6	(Filling pot hole) × 30%
10	Jan-11 : Dec-11	162,140	68,530	105,930	336.6	
11	Jan-12 : Dec-12	2,145,000	1,266,870	1,518,000	4,929.9	Overlay & Re-painting
12	Jan-13 : Dec-13	2,145,000	1,266,870	1,518,000	4,929.9	ditto
13	Jan-14 : Dec-14	47,410	20,460	31,240	99.1	(Filling pot hole) × 0%
14	Jan-15 : Dec-15	47,410	20,460	31,240	99.1	
15	Jan-16 : Dec-16	47,410	20,460	31,240	99.1	
16	Jan-17 : Dec-17	47,410	20,460	31,240	99.1	
17	Jan-18 : Dec-18	47,410	20,460	31,240	99.1	
18	Jan-19 : Dec-19	104,720	44,440	66,550	215.7	(Filling pot hole) × 15%
19	Jan-20 : Dec-20	104,720	44,440	66,550	215.7	
20	Jan-21 : Dec-21	104,720	44,440	66,550	215.7	

Note : Cost for land acquisition is not included.

8-7-2 Division of Costs (Foreign Currency Portion and Local Currency Portion)

(1) Road Construction Cost

In order to break down road construction costs into foreign currency portion and local currency portion, the following form was applied to the calculation sheets in Annex E:

i) Equipment, Plant-- Foreign, Operator -- Local

ii) Other personnel :-- Local

iii) Steel products -- Foreign, Others materials -- Local, Petroleum products-- Foreign

iv) Division of general expenses, 40%, which is included in every cost item:

25% = Real general expenses -- Local

15% = Cost of miscellaneous jobs related to each cost item, broken down with the ratio of two portions of that the item itself calculated based on conditions i), ii), and iii), above.

v) For the cost of mobilization and other jobs calculated by percentage of the cost estimate, the average division ratio obtained by breaking down the other cost items was applied.

This is schematically shown in Figure 8.7.1, and the calculation results are tabulated in Table 8.7.4.

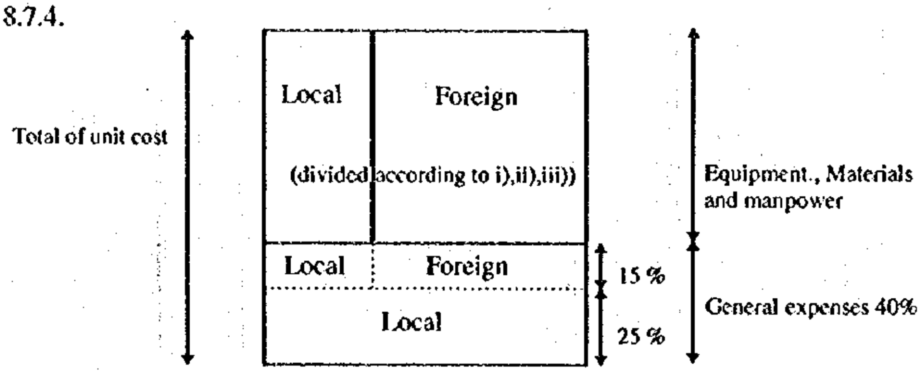


Figure 8.7.1 Division of Costs into Foreign and Local Portion

Table 8.7.4 Result of Division of Road Construction Cost

(Unit : US$1,000)

Cost Item	Local Portion	Foreign Portion		Total
		Cost	(%)	
Mobilization	477.7	1,324.3	73.5	1,802.0
Earthworks	2,223.5	6,042.6	73.1	8,266.1
Minor Drainage	2,528.1	667.6	20.9	3,195.7
Pavement	7,779.9	28,032.5	78.3	35,812.4
(Average)			(73.5)	
Other Works	1,503.8	4,169.1	73.5	5,672.9
Total Road Construction Costs	14,513.0	40,236.1	73.2	54,749.0

(2) Bridge Construction Costs

For bridge construction costs, the same proportion of foreign and local portions as in road construction, as calculated above, was applied. In that case:

- Foreign currency portion = US$ 7,119,107×73.5 % = US$ 5,232.5 in thousand
- Local currency portion = US$ 7,119,107×26.5 % = US$ 1,886.6 in thousand

(3) Environmental Management Costs

The following cost items of the environmental management plan were considered to be part of the foreign portion:

i) Traffic signals, monitoring equipment, traffic safety education equipment

ii) Patrol cars in the National Park, Ambulances

iii) Foreign specialists for monitoring air pollution and noise (2×2 = 4 man·month)

All of those items are part of the initial investment, i.e., the costs before completion of construction. The results of cost division are shown in Table 8.7.5.

Table 8.7.5 Division of Costs for Environmental Management

(Unit : US$1,000)

Sub-Program	Local Portion	Foreign Portion		Initial Cost	Aftercare (local)	Total Amount
		Cost	(%)			
1. Environmental Auditory Program	154.6	0.0	0.0	154.6	106.2	260.7
2. Environmental Mitigation Program	547.6	209.0	27.6	756.6	73.5	830.0
3. Environmental Monitoring Program	132.7	44.0	24.9	176.7	28.2	204.8
4. Ybycui National Park Conservation	129.8	33.0	20.3	162.8	20.9	183.7
5. Promotion of Social Development	102.3	88.0	46.2	190.3	46.2	236.5
Total Cost of Environmental Management	1,066.9	374.0	26.0	1,440.9	274.9	1,715.8
Initial, Aftercare /Total (%)				84.0	16.0	100.0

(4) Engineering Cost

Under the following conditions, the engineering costs described in 8-3-2 and 8-3-3 were divided:

i) Half of the direct survey costs and expert's costs in the final design stage are to be handled by the foreign portion.

ii) Direct costs for road design are to be handled by the local portion, while other costs for road design experts will be handled by the foreign portion.

iii) Bridge design costs will be in the foreign portion.

iv) As for cost of gangs to supervise construction.

- For Sections 1 and 3 : One engineer and two vehicles : foreign
- Section 2 : Two engineers and two vehicles : foreign

v) Regarding the central office

- One resident engineer and one vehicle : foreign
- 75 % of office accommodation costs : foreign

The results of the division calculated according to these conditions are tabulated in Table 8.7.6.

Table 8.7.6 Division of Engineering Costs

(Unit : US$1,000)

Item		Local Portion	Foreign Portion		Total
			Cost	(%)	
Final Design					
	Topo. Survey	121.1	246.1	67	367.2
	Road Design	605.5	450	42.6	1,055.5
	Bridge Design	0	388	100	388
	Total	726.6	1,084.1	59.9	1,810.7
Construction Supervision					
	Central Office	132.3	1185.3	90.0	1,317.6
	Gang for Section 1	658.8	1101.6	62.6	1,760.4
	Section 2	290.5	2016	87.4	2,306.5
	Section 3	257.3	948.6	78.7	1,205.9
	Total	1,338.9	5,251.5	79.7	6,590.4
Grand Total		2,065.5	6,335.6	75.4	8,401.1

(5) Summary of Project Costs Broken Down into Foreign and Local Portions

The divided project costs are summarized in Table 8.7.7, which corresponds to Table 8.6.2. Contingencies were broken down into foreign and local portions according to the same ratio as the average ratio for construction, environmental management, and engineering costs shown in the table.

Table 8.7.7 Summary of Divided Project Costs (Financial)

(Unit : US$1,000)

Item		Local Portion	Foreign Portion		Total Cost
			Cost	(%)	
Construction Cost		16,399.6	45,486.6	73.5	61,868.1
	Road Construction	14,513.0	40,236.1	73.5	54,749.0
	Bridge Construction	1,886.6	5,325.5	73.5	7,119.1
Environ. Management Cost		1,066.9	374.0	26.0	1,440.9
Engineering Cost		2,065.5	6,335.6	75.4	8,401.1
	Final Design	726.6	1,084.1	59.9	1,810.7
	Construction Supervision	1,338.9	5,251.5	79.7	6,590.4
Sub-total		19,532.0	52,178.2	72.8	71,710.1
Land Acquisition		1,984.0	0.0	0.0	1,984.0
Contingency		3,659.1	9,735.5	72.8	13,452.6
	For Readjustment	2,281.5	6,106.4	72.8	8,387.9
	Physical Contingency	1,377.6	3,687.1	72.8	5,064.7
Grand Total		25,175.1	61,971.7	71.1	87,146.8
IVA (10%)		8,714.7	0.0	0.0	8,714.7
Total with IVA		33,889.8	61,971.7	64.6	95,861.5

CHAPTER 9

ENVIRONMENTAL STUDY

CHAPTER 9 ENVIRONMENTAL STUDY

This chapter summarizes the results of the Environmental Study, that consists of two parts; a) Initial Environmental Evaluation (IEE) and b) Environmental Impact Assessment (EIA). The results of all the Environmental Study was compiled in the separated volume of the Report, since the procedure of EIA in Paraguay requires an independent document of environmental studies for a project.

9-1 Purpose and Methodology

9-1-1 Purpose of the Environmental Study

It is necessary for development projects to harmonize with the surrounding natural, social and living environments in order to ensure sustainable development in a country. As a result, the environmental impact must be examined at every stage of a project cycle, as shown on Figure 9.1.1.

In this regard, the Environmental Study of the Project includes the following two studies;

i) To conduct an Initial Environmental Evaluation (IEE) study to clarify the necessity of the Environmental Impact Assessment (EIA) for the Project.

ii) To conduct an Environmental Impact Assessment (EIA) for the Project.

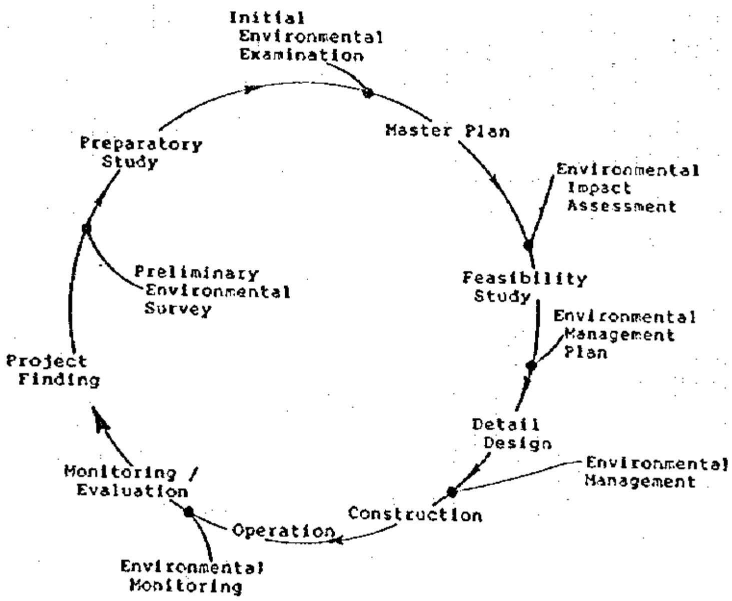


Figure 9.1.1 Environmental Considerations in the Project Cycle

9-1-2 Legal Framework for EIA in Paraguay

(1) Law No.294

In 1993, Law No.294 was instituted as the first law related to the EIA in Paraguay. Law No.294 identified the general objectives, contents, processes, and institutional framework of the EIA. Although the regulations set forth by this law are now being discussed in the Congress, MOPC control of the road project is required for the EIA.

(2) MAG (Ministry of Agriculture and Stock Farming)

The Ministry of Agriculture and Livestock (MAG=Ministerio de Agricultura y Ganaderia) is responsible for environmental protection and preservation in Paraguay. As one of the three subsecretariats under the minister, the subsecretariat for natural resources and environment has three departments in charge of national forests, national parks, and wildlife and environmental control, respectively, as shown in Figure 9.1.2.

The Department of Environmental Control (DOA=Direccion de Ordenamiento Ambiental) also has three subdepartments in charge of environmental control, environmental impact evaluation, and regional environmental control, respectively.

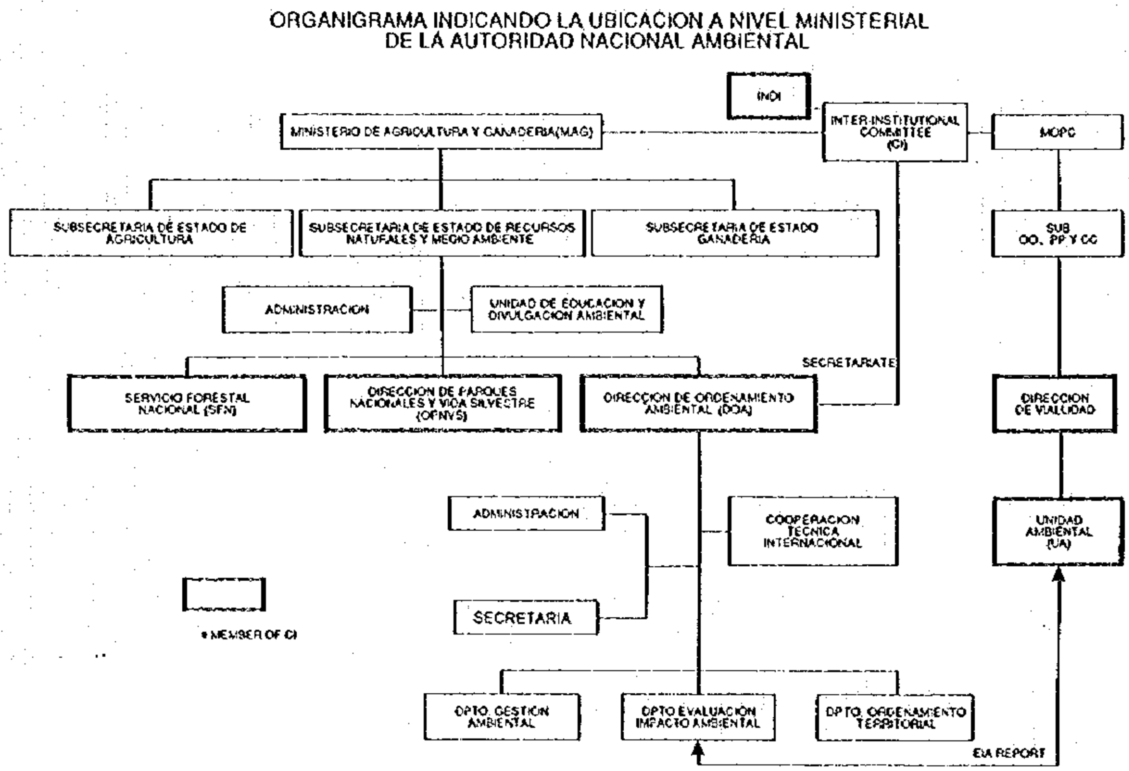


Figure 9.1.2 Organization Related to EIA in Paraguay

(3) DOA (Department of Environmental Control)

The DOA in MAG is responsible for evaluating all the EIAs in Paraguay. It also functions as a secretariat for the Inter-institutional Committee (CI = Commission Inter-institutional), which is in charge of evaluating and approving all the EIA reports submitted by the authorities responsible for the project.

(4) CI (Inter-institutional Committee)

Under Directive No.8462, issued in 1991, the Inter-institutional Committee for road development projects was established with members from the following authorities:
MOPC Road department, MOPC Environmental Unit, UNDI (Institute of the Paraguayan Indigenous People) Technical Coordinator, MAG Planning Coordinator, MAG Department of National Forests, MAG Department of National Parks and Wildlife, and MAG Department of Environmental Control.

(5) MOPC Environmental Unit (UA=Unidad Ambiental)

As the section responsible for the environmental aspects of the MOPC development projects, the Environmental Unit (UA=Unidad Ambiental) was established in 1993 in the ministry. To implement road development projects, environmental study reports shall be coordinated with UA, and submitted to the CI through the UA of MOPC and the DOA of MAG. These shall be finalized after CI will be obtained.

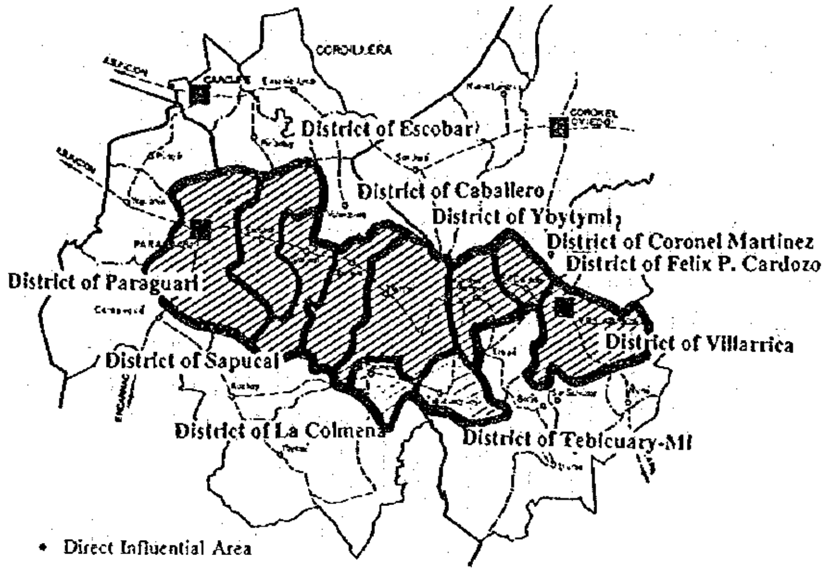
9-1-3 Objective Area of the Environmental Study

The objective area of the study was set in two levels as shown on Figure 9.1.3;

i) Directly Influenced Area : It is the area that the project will influence directly, limited by the boudaries of 10 Districts of two Departments of Paraguarí and Guairá.
ii) Indirectly Influenced Area : It is the area that the project will influence indirectly, limited by the boudaries of two Departments of Paraguarí and Guairá.

9-1-4 Basic Approach of the Environmental Study

The Environmental Study was conducted according to the procedure shown in Figure 9.1.4.



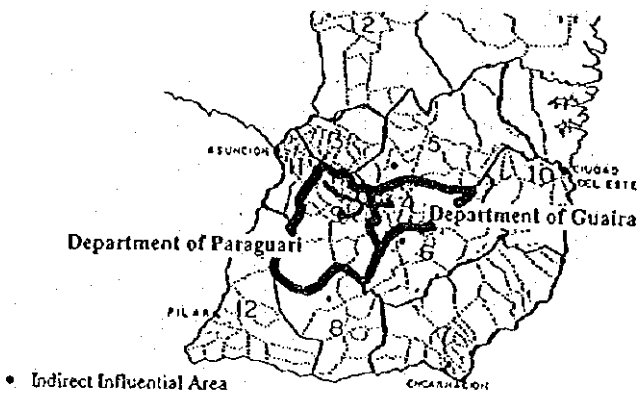


Figure 9.1.3 Objective Area of the Study

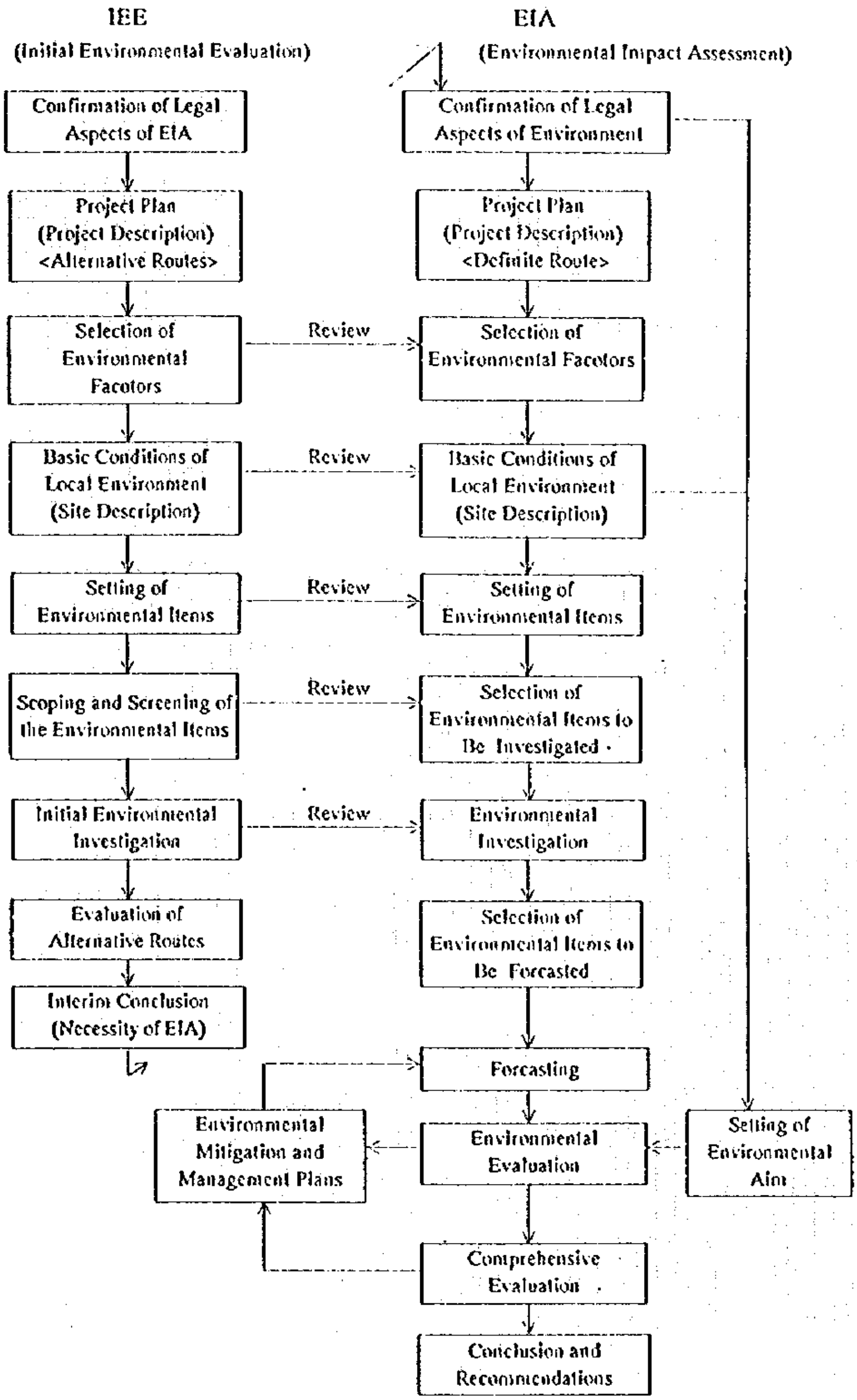


Figure 9.1.4 Basic Study Flow

9-2 Project Description

9-2-1 Environmental Location of the Study

The environmental location of the Project is as follows:

(1) Location of Hydrographical Boundaries

The water basins in the Eastern Region of Paraguay are divided into 21 parts as shown in Figure 9.2.1. The project road route will be limited to the water basin of the Río Tebicuary, which can be divided into five sub-basin : Caanabe, Paso Pypucu-Yhaca, Tebicuary-mí, Jhu, and Mitay-Bobo.

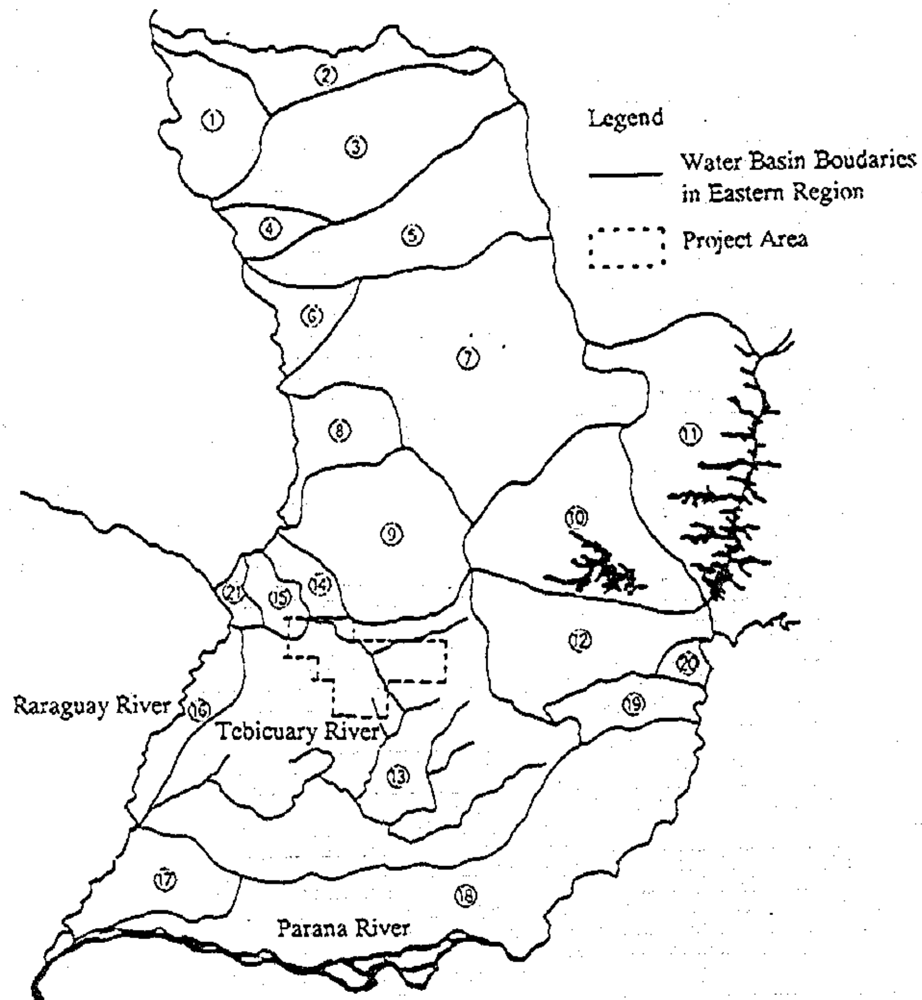
(2) Location of Eco-regional Boundaries

The Conservation Data Center (CDC = Centro de Datos para la Conservación) divided the Eastern Region of Paraguay into 6 parts in a study entitled "Priority Areas for Conservation in the Eastern Region of Paraguay". Eco-regions were determined by grouping natural conditions such as watersheds, soil types, and vegetation types into similar categories. Each eco-region has a different type of ecosystem.

The boundaries of the 6 Eco-regions are shown in Figure 9.2.2. It will be noted that the project road will pass through two Eco-regions, "Selva Central" which means "riverside area" and "Litoral Central" which means "forest area".

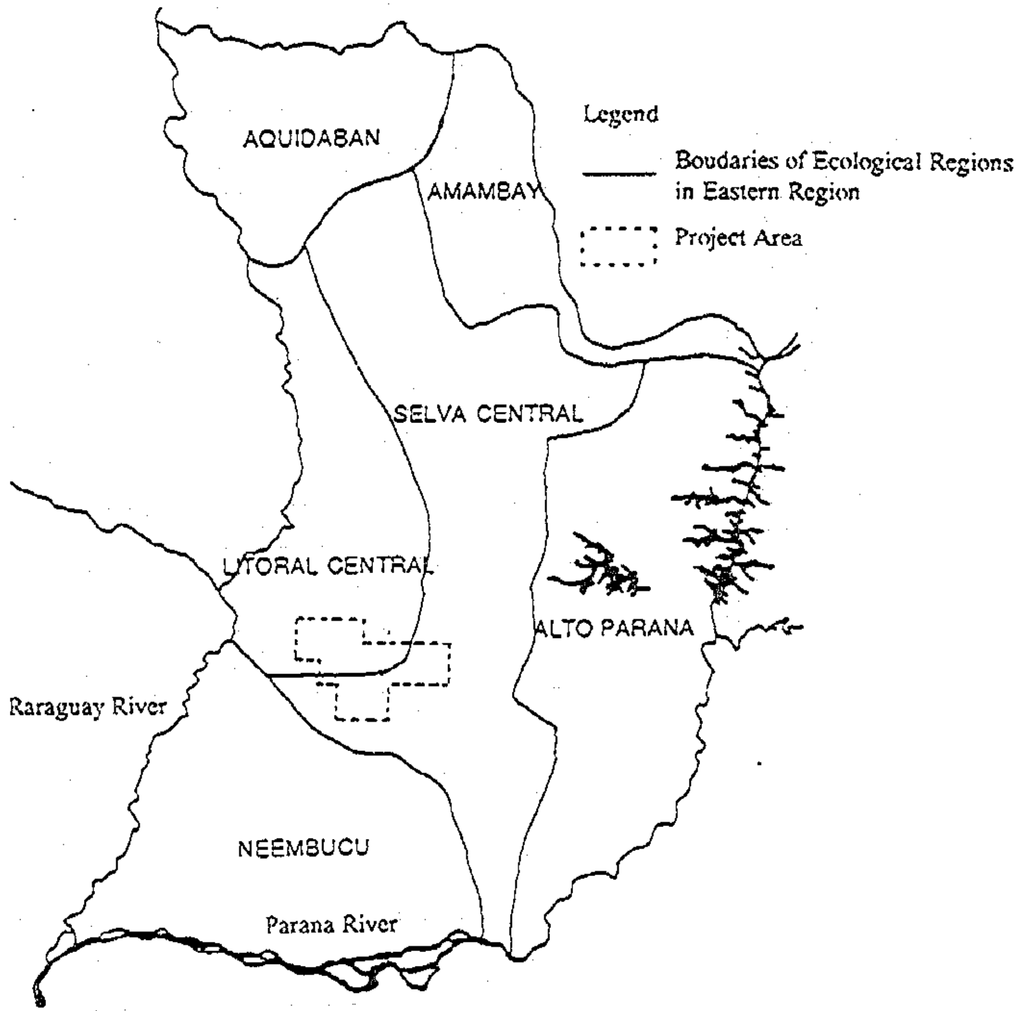
9-2-2 Project Outline

The outline of the project was summarized in Table 9.2.1.



(Source: BALANCE HIDRICO SUPERFICIL
DEL PARAGUAY, 1992, UNESCO/DMH/DINAO)

Figure 9.2.1 Location of Water Basin Boundaries



(Source: MAG/CDC, 1990)

Figure 9.2.2 Location of Ecological Regions

Table 9.2.1 Project Outline

Item		Contents
1	Background of the Project	-Development and promotion of agricultural and livestock products is an most important policy of Paraguay -Transportation facilities in Paraguay is not sufficient to satisfy demand -Paraguay has made great efforts to improve road conditions and networks
2	Project Purpose	-To mitigate the congestion of actual traffic on National Road No.2 as bypass a bypass of that route -To enable easy access from the project area to Asuncion -To contribute to the agricultural development of the area surrounding the project road.
3	Location	-Paraguarí (Department of Paraguarí) - Villarrica (Department of Guairá) -La Colmena (Department of Paraguarí) - the above road
4	Authority in charge of Execution	-Ministry of Public Works and Communications (MOPC) Directorate of Highways
5	Beneficiaries (1992)	-Total Population in the influenenced area : 587,612 -Department of Paraguarí 203,012 -Department of Guairá 384,600
6	Project Outline	
	6-1 Type	-New Development (Most of the road will utilize the existing right of way, but expansion and sections requiring new land acquisition are included)
	6-2 Character	-Arterial Road and also regional road, Out of Urban Area, Flat and Hilly Areas
	6-3 Road Level	-Provincial Road (Not a National Road)
	6-4 Target Year Traffic Volume	-2005 Maximum Volume : Section Paraguari -Escobar 2,372 vehicles / day -2015 Maximum Volume : Section Paraguari -Escobar 3,562 vehicles / day
	6-5 Design Speed	-80 km / h (Hilly land), 100 km/h (Flat land)
	6-6 Length	-121.1 km (Paraguarí - Villarrica 83.0 km) (Tebicuay - La colmena 38.1 km)
	6-7 Width & Lanes	- Right of Way : Paraguarí - Villarrica 40 m : Tebicuary - La Colmena 30m : Urban Areas 20m - 30m depending on the existing R.O.W -Road Width : 12m (Carriage 2×3.5m = 7m, Shoulder 2×2.5m = 5m) -Lane : 2 lanes
	6-8 Structures	-Formation height of road is at least 0.5m higher than the existing road level except for existing urban areas -2 Large Bridges -At Tebicuary on the Río Tebicuary-mí River (Length = 85 m for the river and 5×26m for the flood plain) -At Arroyo Tebicuary-mí (Length = 50m) -25 Small and Medium-size Bridges (Span of 5m to 30 m)

9-3 Site Description

9-3-1 Socio Economic Conditions

According to the national census taken in 1992, the total population of the Project Area (directly influenced area) is about 110,000. The Districts in the Departments of Paraguarí and Guairá have almost equal population; however, in Guairá, 80% of the total population lives in Villarrica.

This area is characterized as the sugar-cane production center of Paraguay. Along the Río Tebicuary-mí, most of agricultural land is used to grow sugar-cane, which is sent to sugar-cane factories in Tebicuary, Paraguarí, and Villarrica.

Other major products in this area include cotton, corn, cassava, and livestock. Some horticultural products such as vegetables and fruits can be found in La Colmena, thanks to the paved road that connects this town with Asunción, the country's largest market. Although other areas along the project road could produce similar products, existing road conditions do not permit them to be transported, especially in the rainy season.

Table 9.3.1 Population of the Project Area (1992)

Name of District	Population (Persons)			Households (No.)
	Urban	Rural	Total	
Paraguarí Department	44,035	163,178	207,213	43,872
1) Paraguarí	7,060	11,425	18,485	4,033
2) Escobar	427	8,012	8,439	1,840
3) Sapucaí	1,422	4,640	6,062	1,312
4) Caballero	943	5,541	6,484	1,365
5) Ybytymí	614	6,356	6,970	1,431
6) La Colmena	2,280	2,595	4,875	1,051
7) Tebicuary-mí	195	3,553	3,748	732
Subtotal	**12,941**	**42,122**	**55,063**	**11,764**
Guairá Department	46,782	113,777	160,559	33,554
1) Coronel Martínez	1,528	4,558	6,086	1,369
2) Félix Pérez Cardozo	633	4,011	4,644	951
3) Villarrica	27,381	15,457	42,838	9,729
Subtotal	**29,542**	**24,026**	**53,568**	**12,049**
Grand Total	**42,483**	**66,148**	**108,631**	**23,813**

Source: DGEEG (Directrate General de Estadisticas, Encuentas y Censos)

9-3-2 Natural Conditions

The Project Area is located beyond the central mountain range known as "Cordillera de los Altos", where the watershed dividing the water basin into that of the main stream of the Río Tebicuary-mí and that of Arroyo Caanabe is located. The highest point of the existing road is about 160-170 m at Sapucaí, which is located in the mountain range, and the lowest point is about 110m, which is located along the Río Tebicuary-mí River.

Land use in the area can be divided into four categories: lowlands, low hills, hills, and mountains. Of these, only the low hills and hills are settled and are used for agricultural activities. Part of the lowlands along the existing roads are used for pasture.

9-3-3 National Parks and Indigenous Communities

(1) National Park

Surrounding the objective area, there are three areas as below;

1) Natural Monument of Macizo Achahay
- Legal base : Decreto 13,682/92
- Area : 2,500 ha.
- Location : 30 km south of Praguarí

2) Natural Monument of Ybycuí
- Legal base : Decreto 32,772/73
- Area : 5,000 ha.
- Location : 23 km south of La Colmena

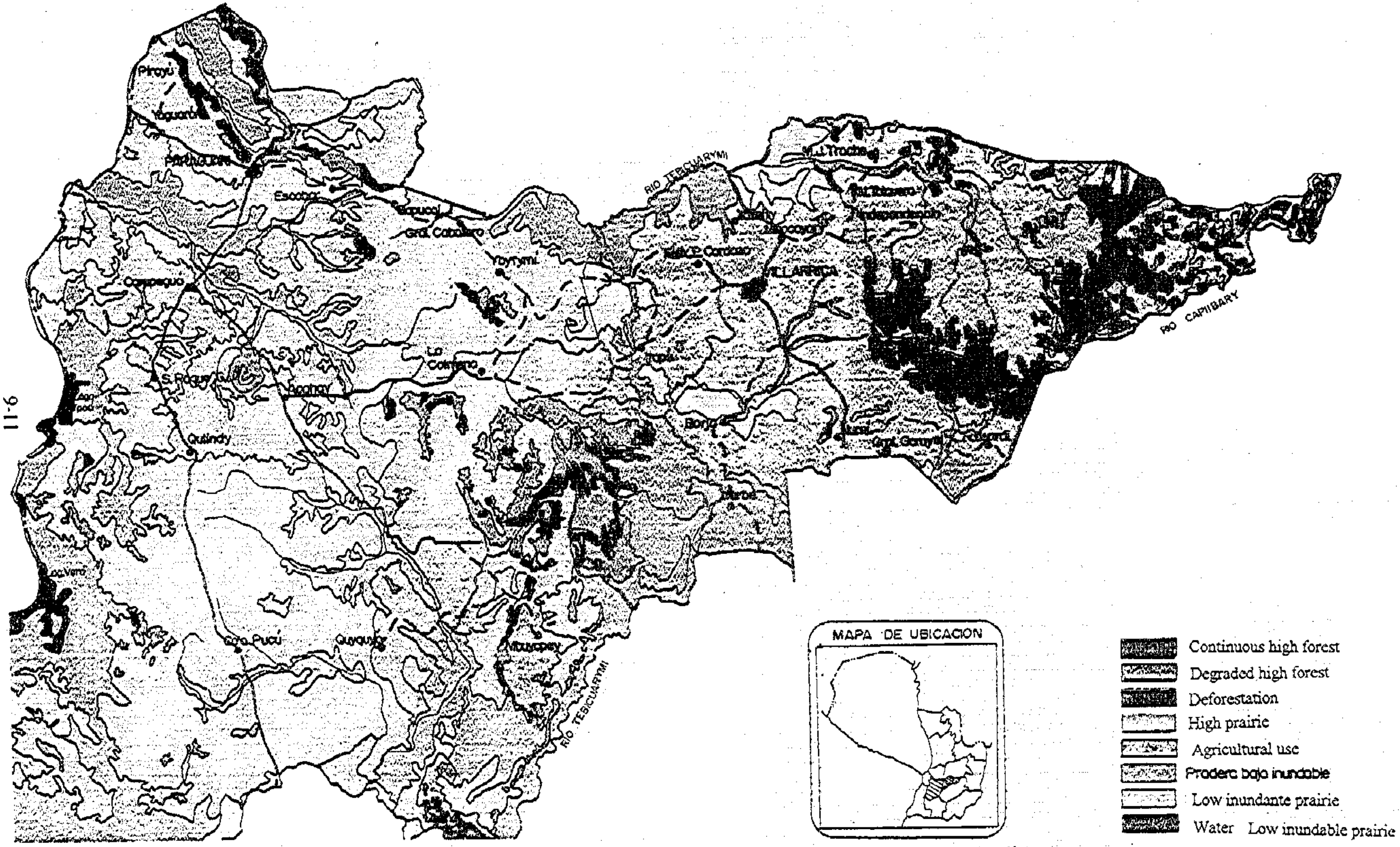
3) Ybytyruzu Resources Reserve
- Legal base : Decreto 5,815/90
- Area : 24,000 ha.
- Location : 14 km east of Villarrica

(2) Indigenous Communities and Reserves

The Paraguayan constitution talks about indigenous communities and their rights in Articles 62 to 67. At present, there are 17 indigenous groups in Paraguay, and their communities are protected by the law 904/81, which ensures the social and cultural preservation of native communities , and the defense of their traditions and patrimony. Regarding to their locations, they are concentrated in Chaco in the Western Region and on the eastern borders of the Eastern Region. According to the 1981 location map and confirmation received from INDI, there are no any Indigenous Communities in the Project area.

9-3-4 Summary of Site Investigation

The results of site investigation were summarized in Table 9.3.2 for each environmental item.



(Source; Uso de la Tiera y Deforestación en la Región Oriental del Paraguay period 1984 -1991, Universidad Nacional de Asunción)

Figure 9.3.1 Land Use in the Surrounding of the Project Road

Table 9.3.2 Site Description

Item		Contents
Social Environment		
	Communities	
	-Residents in the area	-Total population along the project road is 108,000 (1992)
	-Indigenous communities	-There are no indigenous communities in the project area
	-Attitude toward the project	-The local communities are strongly in favor of developing the project road
	Land Use	
	-Urban Area	-The following 11 town areas exist along the road : Paraguarí, Escobar, Sapucaí, Caballero, Ybytimí, Tebicuary Colonel Martínez, Félix Peres Cardozo, Villarrica La Colmena, Tebicuar-mí -Urbaniztion ratio is 40% on average (10 districts)
	-Rural Area	-Colonies are spread around the hilly areas along the road The lowlands are used for pasturage
	-Cultural properties	-There are no well-known historical sites except for Caballero
	-Scenic Areas	-There are no touristic scenic areas registered
	-Community Facilities	-Paraguari and Villarrica acr as provincial centers and have commercial centers, hospitals, colleges, etc. -Other towns have clinics, scools, and churches.
	Economy / Traffic Facilities	
	-Agriculture	-Major agricultural products are sugarcane and livestock
	-Industries	-There is a sugar factory in Tebicuary
	-Traffic Facilities	-There are no large-scale traffic facalities along the road
Natural Environment		
	Topography and Geology	
	-Steep Slopes	-Generally flat topography
	-Soft Soil Layor	-Highest point 185 m, Lowest point 110m
	-Wet Land	-Dominant soil is clay on the top and sand at the base -Lowlands become inundated during heavy rainfall
	Significant Fauna and Flora	
	-National Parks and Reserves	-No national parks or reserves are in the directly influenced area, but Ybycui National Park is near.
	-Habitats of Significant Species	-Ecosystem along the road is poor, and the populations of species are small -Forest area remians along the river stream (Gallery Forest)
Living Environment		
	Existing Pollution	-No serious pollution regarding air or noise -Water of the Río Tebicuary-mí is very contaminatd. contaminated by the inflow of eroded soil and factory waste
	Administrative Measures	-Environmental standard for water quality was legislated in 1996 1996 -Standard for air and noise is being prepared -Noise level is regulated in ETAGs. -MOPC has ETAGs (General specifications for environmental protection in road construction works)

9-4 Initial Environmental Evaluation (IEE)

9-4-1 Setting of Environmental Factors

The "Environmental Factors" of the Project was determined by the contents and activities identified in the Project Description. Based on the components of the project, the major Environmental Factors that are expected to affect the regional environment are as follows at each stage of the Project:

(1) Construction Stage

1) Preparation work

- Land acquisition
- Cleaning up R.O.W.(Removing obstacles, Cutting woods, and Removing top soil, etc.)
- Building construction yards and workers' camps

2) Construction work

- Earth work (cutting, filling embankments, etc.)
- Excavation of quarries
- Usage of heavy machines and dump trucks
- Waste disposal (domestic waste, dumping of unused soil, waste dump area)
- Construction and deconstruction of drainage facilities with water control
- Construction of bridges
- Paving
- Operation of plants (Batter, asphalt, concrete, etc.)

(2) Operation Stage

1) Existence of the road and road facilities

- Road embankment
- Road facilities (Bridges, culverts, etc.)

2) Utilization of the road

- Increase of traffic flow
- Transportation of people and goods

9-4-2 Setting "Environmental Items"

The following environmental items are listed up as "Environmental Items" to be evaluated for this Project considering the particular characteristics of Paraguay as well as general items related to road construction projects in general.

1) Natural environment

- Land (Topography and geology)
- Soil (Erosion)
- Underground water
- Water (Hydrology of rivers and lakes)
- Sea and seashore
- Fauna and flora
- Climate (Meteorology)
- Landscape

2) Social environment

- Resettlement
- Economic activities
- Traffic and community facilities
- Split of communities
- Cultural properties
- Water or common rights
- Sanitation
- Waste
- Risk of hazards
- Indigenous communities

3) Living environment

- Air quality
- Water quality
- Soil contamination
- Noise and vibration
- Land subsidence
- Odors

9-4-3 Evaluation of Magnitude of Impacts

(1) Methodology

To evaluate the magnitude of impacts for each item, a matrix method was applied. This method individually checks and estimates the contents and scales of environmental factors affecting the target environmental items, then evaluates the grade of magnitude of the impacts according to the estimated scale of environmental factors. The matrix is shown on Table 9.4.1.

Table 9.4.1 Matrix Evaluation of Environmental Factors and Items

Environmental Factors		Construction Stage												Operation Stage				
		Preparation				Construction								Exist	Use			
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o		
Environmental Items		Land Acquisition	Cleaning	Camp Yard	Detour Route	Earth Work	Quarry	Heavy machines	Waste	Water Control	Bridge	Pavement	Plant (conc. asph.)	Road Facilities	Traffic Flow	Transportation	Evaluation	Selection
(1) Natural Environment																		
1	Land (topography and geology)		B			B	B										B	O
2	Soil Erosion		C	C		C	C										C	O
3	Underground Water																D	
4	Water (hydrological situation)					C				B	B	*		C			B	O
5	Coastal Zone																D	
6	Fauna and Flora		C			*		*					*	*	*	C	C	
7	Climate																D	
8	Landscape		C	C		C	C				C		C	C			C	O
(2) Social Environment																		
1	Resettlement	B			C												B	O
2	Economic Activities	C		C	B		C							*	C	B	B	O
3	Traffic and Community Facilities				B			B						C	B		B	O
4	Split of Communities													C	C		C	O
5	Cultural Property		C			C	C								*	*	C	O
6	Water Rights/Rights of Common															*	D	
7	Sanitation								C							*	D	
8	Waste Disposal			C					C							*	C	O
9	Risk of Hazards					*	*			C				C		C	C	O
10	Indigenous Communities	*														*	D	
(3) Living Environment																		
1	Air Pollution		C	*		C	C	C	*				C		C		C	O
2	Water Pollution		*	C	*	*	*		*	*	*	*	*		*		D	
3	Soil Contamination			*								C	*		*		D	
4	Noise and Vibration						C	C					C		C		C	O
5	Land subsidence					*											D	
6	Offensive Odors								C			*					D	

Grade of Impact
A=Significant major impact
B=Significant but minor impact
C=Unknown impact
D=Insignificant impact

Environmental Factors
a=Land acquisition
b=Cleaning of ROW (plant cutting, removal of buildings, etc.)
c=Building construction yard and workers' camp
d=Construction of detours
e=Earth work (cut and fill)
f=Excavation of quarries
g=Usage of heavy machines and dump tracks
h=Waste from construction works
i=Water control for construction of drainage facilities
j=Bridge construction
k=Pavement works
l=Operation of construction plants
m=Existence of road and road facilities
n=Increase of traffic volume
o=Inflow of people and goods

The results of the evaluation were indicated by the following four (4) grades:

- Grade-A : Anticipating a major and serious impact
- Grade-B : Anticipating a small impact
- Grade-C : Unknown but requires more investigation
- Grade-D : Anticipating no significant effects and can be excluded from EIA targets

(2) Environmental Items to be Investigated and forecasted

As a result of the IEE, the following environmental items have been selected for detailed investigation and forecast.

a. Topography and geology
b. Soil erosion
c. Hydrology
d. Fauna and Flora (Vegetation only)
e. Landscape
f. Resettlement
g. Economic activities
h. Traffic and community facilities
i. Split of communities
j. Cultural properties
k. Waste
l. Risk of hazard
m. Air quality
n. Noise and vibration

(3) Environmental Items Not to Be Investigated

Below is a summary of the reasons for not selecting certain environmental items for further investigation.

a. Underground water

No wells will be dug and underground waters will not be affected..

b. Coastal zone

The project site is not near the sea.

c. Climate

There are no activities that will affect meteorological conditions.

d. Fauna

There is no valuable fauna living in the project area.

e. Water rights and rights of common

There is no water right authorized in the objective area and also there is very few opportunities that some of the land with right of common is in the proposed road area.

f. Sanitation

The project is not expected to cause sanitation conditions in the area to deteriorate.

g. Indigenous communities

There are no indigenous communities in the project area.

h. Water quality

There are some activities that will affect the quality of the surrounding waters for example, earth works near water streams, but counter measures will be required by ETAGs and the possibility of water contamination is very small.

i. Soil contamination

None of the work will cause soil contamination in the construction stage, except in the machine yard. The yard shall be protected against contamination by the ETAG regulations.

j. Land subsidence

There are no activities that will affect land subsidence.

k. Odors

Construction work and use of the road will cause no offensive odors.

9-5 Environmental Impact Assessment (EIA)

9-5-1 Investigation and Forecast

The environmental items selected in the previous chapter were investigated their existing conditions and were forecasted their future conditions impacted by the project. The summary results was shown in Table 9.7.1. in the end of this chapter. The target year for the forecasts is as follows;

i) Construction Period : 3 years (1999 - 2001)

ii) Operation Period : target year 2005 and 2015

9-5-2 Aims of Environmental Conservation

- Topography and Geology : To avoid substantially changing the present topography and geology, and to prevent natural disasters related to both topography and geology such as large-scale landslide and slope collapse.
- Soil : To prevent soil erosion and soil outflow, and to preserve present soil conditions.
- Hydrology : To avoid causing any substantial hydrological changes in rivers, underground water, or flood areas.
- Fauna and Flora : To avoid substantially affecting fauna habitats and to avoid substantially affecting existing flora.
- Landscape : To conserve the beauty of the landscape by avoiding incongruities in the area.
- Resettlement : To avoid serious influences on the living basis of inhabitants due to the resettlement caused by land and building acquisition.
- Economic Activities : To promote the solid development of economic activities in local communities, without adversely affecting sustainable development.
- Traffic and Community Facilities : To avoid a substantial adverse effect on traffic safety and the tranquil environment of community facilities such as hospitals, schools, and religious facilities.
- Split of Communities : To assist in the formation of harmonious and peaceful communities, without adversely affecting the living environment of said communities.
- Cultural Properties : To avoid damaging ruins and cultural properties in the area.
- Waste : To avoid affecting the natural and living environment through the generation of waste, and to promote the recycling of resources.
- Risk of Hazards : To prevent increasing the risk of hazards that could damage the natural and living environment.

- Air Quality : To avoid exceeding the National Ambient Air Quality Standards of the USA for the purpose of protecting the health of inhabitants (see Table 9.5.1). The U.S. standard is used because no standard has yet established in Paraguay.
- Noise ; To avoid exceeding the standard levels set by ETAG of the MOPC in 1995 (see Table 9.5.2).

Table 9.5.1 Environmental Air Quality Standards

Items	Standard Value
CO	10mg/m³/8hours (9ppm) 40mg/m³/1hour (35ppm)
SO_2	80ug/m³/day (0.03ppm) 365ug/m³/24hours (0.14ppm)
NOx	100ug/m³/year (0.05ppm) variable in 24hours with NO_2
HC	160mg/m³/3hours (0.24ppm)
O_3	235mg/m³/hours (0.12ppm)
Pb-Ps	1.5mg/m³/3months

Source : National Ambient Air Quality Standards of USA

Table 9.5.2 Environmental Noise Level Standards in Paraguay

Area	Standard Value	
	Daytime	Night time
Outdoor	55 dB	45 dB
Indoor	45 dB	-
Working Area	75 dB	-

Source : ETAGs (General Specifications f Environmental Protection) MOPC, 1995

Table 9.5.3 Environmental Noise Level Standards in Other Countries

Area		Standard Value	
		Daytime	Night time
Japan	Mixed Area with 2 lanes road	65 dB	55 dB
USA	Housing, Schools and Hospitals	67 dB	67 dB

Source : Environmental Standard of Japan in 1971
Ordinance of Federal Road Department of USA in 1976

9-5-3 Environmental Evaluation

(1) Topography

The project will not cause any substantially changes to the present topography and geology, and will prevent natural disasters related to topography such as large-scale landslides and slope collapse. However, it will be necessary to monitor topographical changes during the construction period.

(2) Geology and Soil

The project will not cause any large-scale soil erosion or soil outflow, if the earth works are carried out according to ETAG regulations. Therefore, it will be necessary to monitor erosion control during the construction period. Moreover, the project will have a direct positive impact by preventing the erosion of existing gullies in the road area.

(3) Hydrology

The project will not cause any substantial hydrological changes in rivers and underground water, provided that road drainage facilities are sufficiently maintained .

(4) Flora and Fauna

The project will have a small direct negative impact on the forest area, and have a small indirect negative impact due to the increase in the possibility of illegal deforestation in Ybycui National Park, which is near the project area. Therefore, countermeasures such as mitigatory forestation and inspection of the park area will have to be taken.

(5) Landscape

The project will not greatly change the beauty of the landscape along the roadside area, nor will create any incongruities in the area. However, the color of the bridge on the Río Tebicuary-mí will have to be selected so that it harmonizes with the surrounding environment.

(6) Resettlement

The project will have a small direct negative impact of causing about 50 households to resettle in their community. Therefore, adequate compensation shall have to be provided, and it will be necessary to assist resettled households to re-establish themselves in the community.

(7) Economic Activities

The project will have a large direct positive impact on the local economy through a) cash inflow by sales to construction workers, b) increase in cash-earning job opportunities due to the construction works, and c) decrease in traveling time and transportation costs. Based on these impacts, the project will have indirect positive impacts on the regional economy such as a) diversification of agro-products, and b) promotion of industrial development opportunities. Therefore, it is recommendable that agricultural technical assistance be provided to divert agro-production to daily foods, and to improve transportation facilities.

On the other hand, the project will have a small direct negative impact because some agricultural lands will have to be taken over, and traffic will be temporarily blocked during the construction period. However, these impacts are negligible compared with the positive impacts.

(8) Traffic and Community Facilities

The project will have a large direct positive impact on the improvement of quality of life through the year-round punctual commuting possibilities to neighboring center towns provided by buses and other public transportation services. The major improvements will be in a) school attendance to higher educational facilities, and b) primary health care services due to 24-hour ambulance services, etc. Therefore, it will be necessary to create the facilities that will make it possible to realize this improvement by promoting social development such as improvement of bus services and improvement of emergency health care services.

On the other hand, the project will have direct negative impacts on traffic safety. During the construction stage, the traffic volume of dump trucks will be relatively high, and during the operation stage, traffic flow and vehicle speed will greatly increase, thereby increasing the possibility of traffic accidents especially in nearby school zones and town centers. Therefore, it will be necessary to provide traffic safety facilities and traffic safety education.

(9) Split of community

The project will not cause any serious splitting of existing communities thanks to the careful selection of bypass routes. However, the project will have a direct negative impact by elevating the connection level of community access roads with the new road. Therefore, countermeasures to make connection slopes with communities will have to be taken.

(10) Cultural Properties

The project is very unlikely to damage ruins or cultural properties in the area. However, it will be necessary to monitor the existence of cultural properties during the construction period.

(11) Waste

Waste generated by the project will be a very small volume, and will not affect the natural and living environments of the surrounding area.

(12) Risk of Hazards

The project will not increase the risk of flooding, which could damage the natural and living environments. However, the project will have a indirect negative impact to increase the risk of fire in the forest area of the Ybycui National Park. Therefore, it will be necessary to periodically patrol the national park area.

(13) Air Quality

The level of air pollutants in Paraguarí, where maximum traffic volume is expected on the planned road, will remain under the environmental standard level. In the case of CO, the forecast level of 1 hour in 24 hours average is 0.0058 ppm against the standard level is 9.0 ppm in 8 hours on average. For NOx, the level of 1 hour in an annual average is 0.0009 ppm against the standard level of 0.05 ppm. But, this forecast result is based on model cases because there is no information on existing air quality or on auto emissions.

Therefore, it is needed to monitor air quality levels before, during, and after the construction period to collect more data.

(14) Noise

The forecasted noise level in Paraguarí is slightly above the environmental standard level. In the daytime, the forecast noise level is 61 dB against the standard of 55dB, while at night-time the forecast level is 50 dB against 45dB. Nevertheless, this is under usual international standard levels. The evaluation has shown that the project will have a small direct negative impact over a limited area. Therefore, it will be necessary to monitor noise levels before, during, and after the construction period to collect more data. Moreover, it is also recommended to plant roadside trees in selected urban areas to decrease the noise level. This would also have a positive impact on decreasing air pollutants and beautifying urban centers.