CHAPTER 9
ROADSIDE ENVIRONMENTAL SURVEY

9 ROADSIDE ENVIRONMENTAL SURVEY

9.1 Legislative and Institutional Framework related to Environment

The legislative and institutional framework related to the environment protection and the environmental impact assessment (EIA) in Paraguay can be summarized as follows.

9.1.1 Constitution

The first Constitution of Paraguay (*La Constitución Nacional Paraguaya*) was enforced in 1967 and it was revised in 1992. In the revised Constitution of 1992, there are many articles related to the environment. These articles, for instance, include quality of life (Article No.6), healthy environment (Article No.7), protection of environment (Article No.8), community property of native population (Article No.64), education and assistance to native population (Article No.66), cultural heritage (Article No.81) and so on.

9.1.2 Regulations and Laws

(1) Law No. 40/90

The Paraguayan Congress, in September of 1990, issued Law No. 40/90 to create the National Commission on Protection of the Natural Resources. The Commission has the objective to develop effective action for protecting the natural resources and the environment.

(2) Ordinance No.8462

Ministry of Agriculture and Stock Farming (*Ministerio de Agricultura y Ganaderia*: MAG) promulgated the Ordinance No.8462 in 1991 to set up an Inter-institutional Committee (*Comisión Inter-institucional*: CI). The CI is in charge of the study, evaluation of environmental impacts of a road development and coordination between the CI members and related entities of specific road development projects.

(3) Technical Norm on Environmental Impacts (NTA)

Ministry of Public Construction and Communication (MOPC) issued the "Technical Norm on Environment Impacts in Road Construction Project (*Normas Technicas Ambientales*: NTA)" in 1992. The NTA regulates technical norms on environmental impacts by road construction. General objective of NTA is to mitigate negative impacts and to generate possible positive impacts which would be caused by execution of road construction projects in Paraguay.

(4) General Technical Specification on Environment (ETAG)

The General Technical Specification on Environment (*Especificaciones Técnicas Ambientales Generales*; ETAG) was prepared by MOPC for preventing negative environmental impacts in a road construction project. The ETAG stipulates regulations on environmental protection which have to be followed by a contractor of a specific road project. The contents of ETAG consists of six sections; 1. Introduction, 2. Responsibility of Contractor, 3 . Objectives, 4. General Technical Specification, 5. Execution, Supervision and Control of ETAG, and 6. Sanctions.

(5) Law No. 294/93

Law No.294 enacted on 31st December 1993 is the first law related to Environmental Impact Assessment (EIA) system in Paraguay. The law has prescribed the procedures of EIA, projects and activities which require an EIA and so on.

(6) Others

Following is the list of other principal laws, decrees and ordinances related to the environmental protection in Paraguay.

Table 9.1.1 List of Other Laws, Decrees and Ordinances related to the Environment

No. of Law, Decree and Resolution	Contents
Law No. 42	Usage and deposit of toxic products
Law No. 92/92	Protection and conservation of the flora and wild fauna of the country
Law No. 352/94	National System of Protection of Wild Areas
Law No. 422/73	Rational management of forests and forest lands of the country
Law No. 716/95	Sanctions ecological crimes against the environment
Law No. 836	Sanitary code
Law No. 854/63	Agrarian status law
Law No. 904	Statutes of Indian communities
Law No. 1160/98	Punishment: water alteration, air contamination and spill of poisonous substances
Law No. 1183/85	Protection of the courses of water, avoiding their deterioration and contamination
Decree No. 18.831/86	Sources and hydraulic basin and protective forests
Decree No. 10.845/91	Environmental classification of the territory
Resolution No. 9 (MSPBS)	Sewerage system services and the house connections by CORPOSANA
Resolution No. 396 (MSPBS)	Hydraulic resources characteristics related to environmental sanitation
Resolution No. 397 (MSPBS)	Technical standard of quality of drinkable water and its distribution

Note: - MSPBS; Ministry of Public Health and Social Welfare (*Ministerio de Salud Pública y Bienestar Social*)
- CORPOSANA; Asuncion Sanitation Works Corporation (*Corporación de Obras Sanitarias de Asunción*)

9.1.3 International Convention and Treaty

Following is a list of principal International Conventions and/or Treaties concerning environmental conservation ratified and signed by the Government of Paraguay.

Table 9.1.2 International Conventions and Treaties

International Conventions and Treaties	Year Ratified
Convention on Prohibiting development, production and stockpiling of bacterial (biological) and chemical weapons, *Londres*	1975
Convention on International Trade in Endangered Species of Wild Flora and Fauna(CITES), (*Washington* Convention)	1976
Convention concerning the Protection of the World Cultural and Natural Heritage, (World Heritage Convention)	1986
United Nations Convention of the Law of the Sea, *Montego Bay* 1982	1986
Montreal Protocol: (Ozone Layer Protection Treaty)	1992
Vienna Convention on protection of Ozone layer	1992
United Nations Convention on Climatic Change Conference on the Environment and Development, Earth Summit, *Rio de Janeiro*, 1993	1993
United Nations Convention on Biological Diversity, Conference on the Environment and Development, Earth Summit, *Rio de Janeiro*, 1993	1993
Convention on Wetlands of International Importance Especially as Waterfowl Habitats, *Ramsar* Convention	1994
Basle convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	1995

9.1.4 Institutional Framework related to Environmental Impact Assessment

(1) Ministry of Agriculture and Stock Farming (*Ministerio de Agricultura y Ganaderia* : MAG)

The Ministry of Agriculture and Stock Farming (MAG) has responsibility for environmental protection in Paraguay. The Ministry consists of the following three sub-secretariats;

- Sub-secretariat of Agriculture (Subsecretaria De Estado De Agricultura)
- Sub-secretariat of Natural Resource and Environment (Subsecretaria De Estado De Resursos Naturales y Medio Ambiente)
- Sub-secretariat of Livestock.(Subsecretaria de Etado De Ganaderia).

Under the Sub-secretariat of Natural Resource and Environment, there are three Directorates: National Forestry Service Directorate (SFN), National Parks and Wildlife Directorate (DPNVS), and Environmental Control Directorate (DOA). The Environmental Control Directorate (DOA) is the only organization which has all the responsibility for appraisal of Environmental Impact Assessment (EIA) in Paraguay. And the DOA also has a role as secretariat of Inter-institutional Committee (CI). The organizational chart of DOA is shown in Figure 9.1.1.

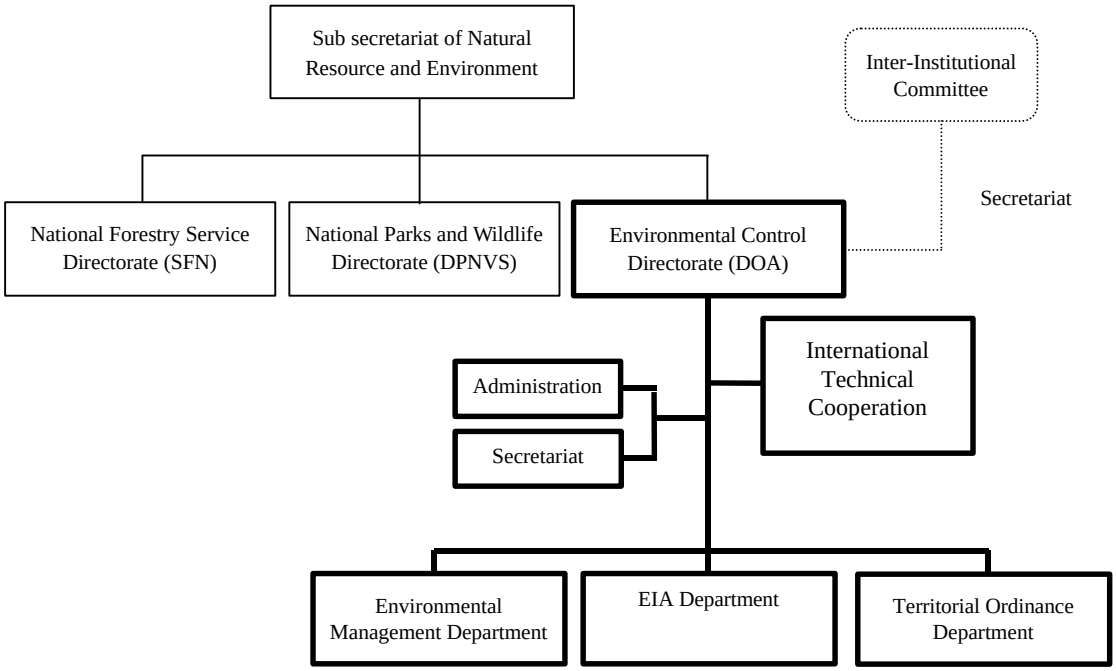


Figure 9.1.1 Organizational Chart of DOA

(2) Inter-Institutional Committee (*Comisión Inter-institucional*: CI)

Principal responsibilities and roles of Inter-Institutional Committee (CI) are regulated by Ordinance No.8462 as follow;

- To set up related standards and norms
- To study, evaluate and approve a technical proposal on environmental impacts.
- To make coordination among entities and organizations involved in study and evaluation of environmental impacts.
- To coordinate execution of final decision and recommendations

Director General of Sub-secretariat of Natural Resource and Environment (*Subsecretaria De Estado De Resursos Naturales y Medio Ambiente*: SSERNMA) has responsibility for controlling and coordinating all activities of the Committee. The Committee consists of the following members;

- Director of Road Department, MOPC
- Director of Road Network Department, MOPC
- Technical Director, Institute of Paraguayan Indigenous Peoples (INDI)
- Planning Director of Corporation of Rural Welfare (IBR), MAG
- Director of National Forestry Service Directorate (SFN), MAG
- Director of National Parks and Wildlife Directorate (OPNVS), MAG
- Director of Environmental Control Directorate (DOA), MAG

(3) Environmental Directorate (*Dirección de Medio Ambiente*: DMA) in MOPC

Under Vice-Minister (in charge of Road Directorate) for MOPC, Environmental Directorate (DMA) was set up in 1993 to deal with environmental issues related to road development. The DMA has principally the following two functions;

- To coordinate environmental study reports
- To plan, monitor and evaluate environmental protection plans

9.1.5 Other Entities related to Environmental Issues and Protection

Other official entities in charge of environmental issues and protection in Paraguay are summarized in following Table 9.1.3.

Table 9.1.3 Other Entities related to Environmental Issues and Protection

Entities	Duties
Ministry of Public Health and Social Welfare	- Drinkable Water - Disposal of Solid Waste - Control of Occupational Environment - Control of Industrial Waste - Public Health
National Service for Environmental Conservation (SENASA; which is affiliated with Ministry of Public Health and Social Welfare)	- Solid Waste Management - Water Quality - Preparation of Environmental Standards
Ministry of Industry and Trade (MIC)	- Industrial Pollution
Ministry of Education and Culture (MEC)	- Environmental Education
Ministry of Justice and Work	- Labor Environment
Military Geographical Institute (IGM), Ministry of National Defense	- Geographical and Topographical data
Meteorology and Hydrology Direction, Ministry of National Defense	- Meteorological data - Hydrological data
Corporation of Sanitary Works (CORPOSANA)	- Drinking water - Sewerage system

9.2 Environmental Characteristics in the Study Area

The study area of national road route 2 and route 7 covers three departments: *Central*, *Cordillera* and *Caaguazu*. The environmental characteristics in these three Departments can be summarized as follow.

9.2.1 Natural Environment

(1) Meteorological Conditions

Table 9.2.1 shows the meteorological conditions of each department of the Study Area. (See Figure 2.2.1 and Figure2.2.2 of section 2.2)

Table 9.2.1 Meteorological Conditions in the Study Area

	***Central* Department**	***Cordillera* Department**	***Caaguazu* Department**
Climate	The half of north and west of the Department belongs to the Aw (Tropical Savanna) of *Köppen* climatic classification and at the south-east is Cf (humid subtropical).	The half of north-west of the Department belongs to Aw (Tropical Savanna) of *Köppen* climatic classification and the remaining part is Cf (humid subtropical) .	The whole Department belongs to Cf (humid subtropical) of *Köppen* classification.
Temperature	- The annual average temperature is 22.5º C - The maximum is 37.5º C - The minimum is 6.9º C	- The annual average temperature is 22.5º C - The maximum is 39º C - The minimum is 3º C	- The annual average temperature is slightly higher than 22º C - The maximum is 32º C - The minimum is 0º C
Rainfalls	- The average rainfall is 1,400mm/year. The wettest month is January – April and the driest is July - August. - The annual average evapotranspiration is slightly lower than 1,200 mm.	- The annual average of precipitation is 1,400mm - 1,500mm and is higher in the east of the Department. The monthly average is 153 mm/month (except June - August with 80 mm/month) - The annual average evapotranspiration is between 1,150 mm and 1,200 mm	- This Department is one of the rainiest region in the country. And the annual rainfall is1,600 mm/year. - The annual average evapotranspiration is slightly higher than 1,100 mm.
Relative Humidity	According to *Thornthwaite* index, in the eastern half of the department is classified as B1 (humidity, slightly higher than 20%) and western half of the department is classified as C2 (humidity, slightly less than 20%).	According to *Thornthwaite* index, this department is classified as B1 (relative humidity is between 20% and 40%).	According to the *Thornthwaite* index, this department is classified as B1 (relative humidity is between 20% and 40%).
Winds	- The annual average wind velocity in 1998 was 12 km/h - Prevailing wind direction is from the north	- The average wind velocity is 2.4 km/h. - Prevailing wind direction is from the northeast	- The annual average wind velocity in 1998 was 7km/h. - Prevailing wind direction is from the northeast

Source: Environmental Atlas of the Region of Paraguay – Direccion de Meteorologia e Hidrologia, dependiente de la Dirección Nacional de Aeronáutica Civil (DINAC). Agronomic Institute of Caacupé

Note: Criteria for *Köppen* Classification (See Figure 2.2.1 of section 2.2)

- Aw: Average temperature of the coolest month 18℃ or higher + Precipitation in driest month < 10 - r/25 (r = average precipitation in cm)
- Cf : Average temperature of warmest month greater than 10℃ and of coldest month between 18℃ and 0℃ + Precipitation not meeting conditions of either (Precipitation in driest month of summer half of year less than 4 cm and < 1/3 the amount in wettest winter month) or (Precipitation in driest month of winter half of year less than 1/10 of amount in wettest summer month)

(2) Flora and Fauna

a. Flora

According to the Center of Data for Conservation (*Centro de Datos para la Conservación*, CDC, 1993), the departments of *Central*, *Cordillera* and approximately 2.500 km^2 area of the *Caaguazú* belong to the eco-region called "*Litoral Central*", the remaining area of the *Caaguazú* department belongs mainly to the eco-region called "*Selva Central*".

1) Litoral Central

Principal flora that has been seen in this region is: *Sapium haematospermum* (kurupika´y), *Pithecellobium scalare* (tatare), *Enterolobium contortisiliquum* (timbo), *Gleditsia amosphoides* (espina de corona), *Erythrina crista-galli* (ceibo), *Salix humboldtiana* (sauce), *Diplokeleba floribunda* (ybyra ita), *Schinopsis balansae* (quebracho colorado), *Copernicia alba* (Karanda´y) and so on.

2) Selva Central

The predominant flora species in this region are: *Tabebuia sp.*(lapacho), *Cedrela sp.* (cedro), *Peltophorum dubium* (ybyra pyta) , *Pterogyne nitens* (ybyra-ro), *Myrocarpus frondosus* (Incienso), *Balfourodeudron riedelianum* (Guatambu), *Alsibia hassleri* **(**Ybyra-yu) and *Cabralea sp.* (Cancharana).

3) Endangered species

- In *Cordillera* and *Central* department, endangered species which categorized by CITES (Washington Convention) as N1(Critically Danger) and N2 (Danger) are as follow;
  Peroba roja (Ybyra ysy), *Cedrela sp.* (cedro), *Mimosa altoparanaensis* (Yrupe), *Turnera aurelii* (Yby'a).
- In *Caaguazú* department, the following plants are considered as threatened species;
  Ybyra paje, Namdyta sp., *Simaba paecox*, *Piriqueta sudsessilis, Turnera aurelii*.

b. Fauna

Following is a list of critically endangered fauna seen in *Cordillera*, *Central* and *Caaguazú* department;

Table 9.2.2 List of Endangered Fauna

Central	***Cordillera***	***Caaguazú***
Lutra longicaudis (Lobope) *Ozotocerus bezoarcticus* (guasuti) *Caiman latirostris* (yacare overo) *Blastocerus dichotomus* (guasupucú)	*Lutra longicaudis* (Lobope) *Ozotocerus bezoarcticus* (guasuti) *Caiman latirostris* (yacare overo)	*Pteronura brasiliensis* (arira'y) *Felis tigrina* (tirica), *Felis wiedi* (margay) *Panthera onca* (yaguareté) *Mergus octosetaceus* (pato serrucho)

Source: Conservation Data, Center of Data, Ministry of Agriculture and Cattle raising. Undersecretary of Natural Resources and Environment, 1993

c. Field Reconnaissance Survey

Field reconnaissance survey on Fauna and Flora was executed at five points from *San Lorenzo* to *Caaguazú* along routes 2 and 7. As a result of the reconnaissance survey, the endangered fauna and flora classified by CITES has not been identified at the survey points. (See Appendix)

(3) National Park, Reservoir and Protected Area

Figure 9.2.1 shows national parks, reservoirs and protected areas of Paraguay. Among them, several natural reservoirs and park exist around the study area as shown in Table 9.2.3.

Table 9.2.3 Natural Reservoirs and Parks around the Study Area

Name of reservoir and park	Location	Total area (ha)	Legal Aspect
Reserva de Recursos Manejados Ypacarai	North of *Ypacarai* City	16,000	Decree No. 5686/90
Monumento Natural Cerros Kói y Chororí	South - west of *Ypacarai* Lake	17	*Ley* No. 179/93
National Park of Guayakí	169 km from *Asuncion*	4	MOPC (not protected area)

Source Direction of National Parks and Wild Life(DPNVS), MAG

Specially, lake (*lago*) *Ypacalai* is located to the north of route 2 in *Ypacarai* City and some surrounding areas of the lake are protected as *Reserva de Recursos Manejados Ypacarai* and *Monumento Natural Cerros Kói y Chororí* by Decree No. 5686/90 and Law (*Ley*) No. 179/93 respectively. Figure 9.2.2 is a distribution area of *Reserva de Recursos Manejados Ypacarai.*

(4) Topology and Geology

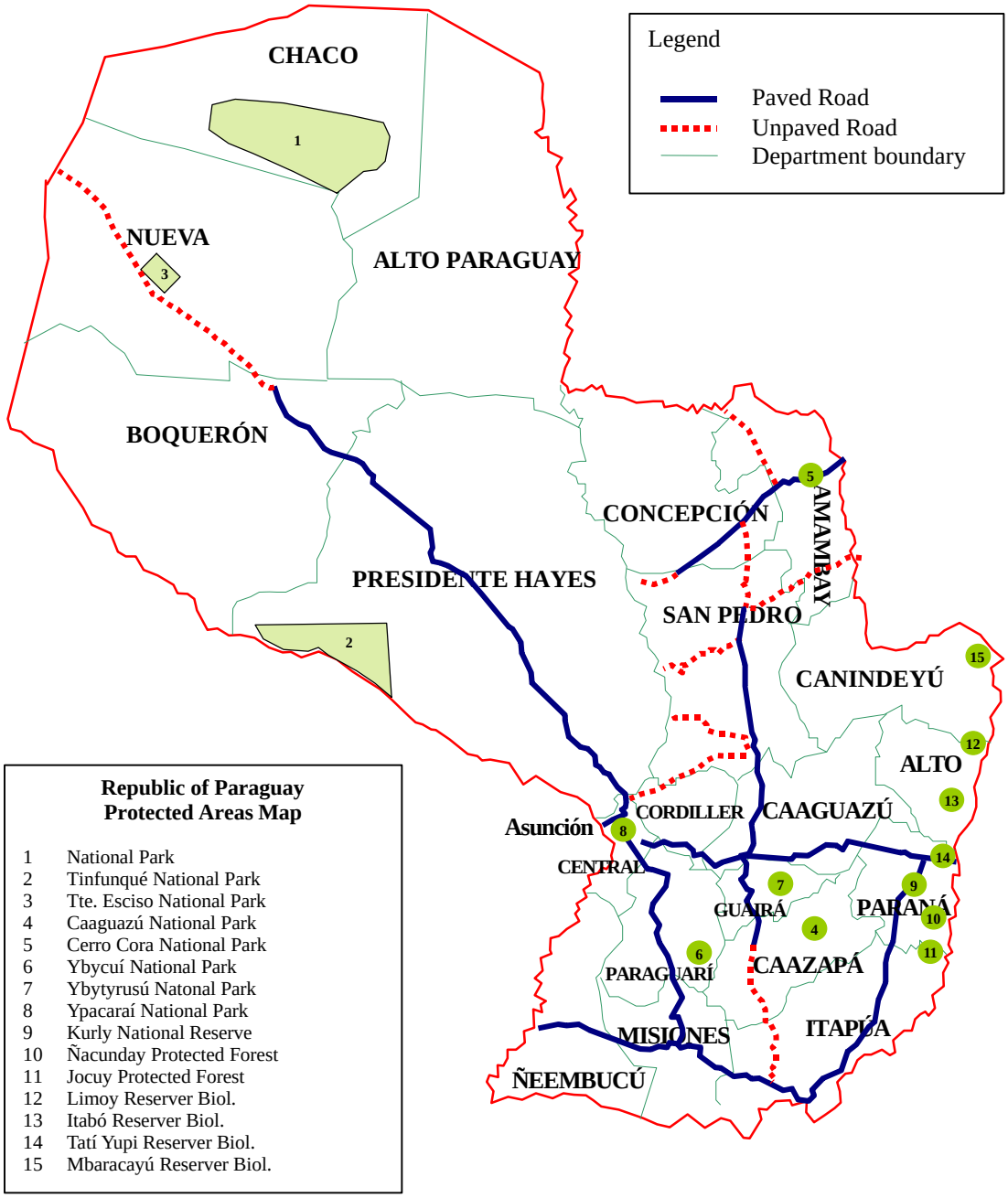
Figure 9.2.3 shows geology of the study area. (As for the geology of Paraguay, please refer Figure 2.3.1 and Figure 2.3.2.)

a. *Cordillera* Department

The oldest rocks are from the Silurian (Paleozoic) era deposited there through transgressive -regressive sea phenomenon that occurs from west to east in the following stratigraphic sequence; a basaltic conglomerate (*Paraguari* Formation Group), stratified arenite (*Cerro Jhu* Formation Group), friable arenite (*Tobati* Formation Group), mica arenite (*Eusebio Ayala* Formation Group), white lutitas (*Vargas Peña* Formation Group) and feldspathoid - mica arenite (*Carií* Formation Group) located in *Itacurubi de la Cordillera* city.

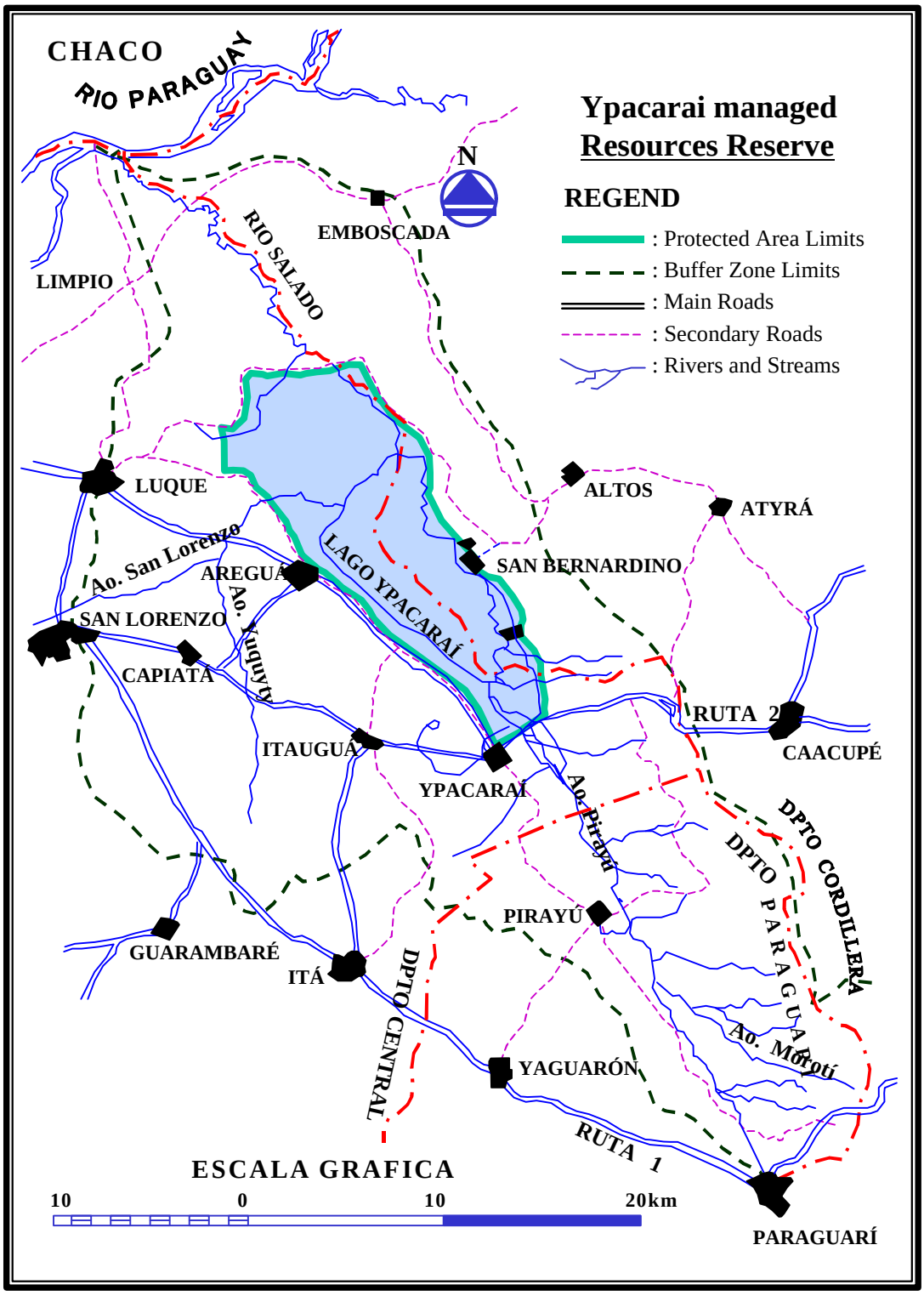
The geomorphology shows north-south direction following a line produced by a large fault which caused the depression of the basin and *Ypacarai* Lake, the elevation reaches 400 m above sea level with 20 to 70 % declivity. In the east, there is a sort of hill slightly wavy inserted in the alluvial inundation plain created by the *Piribebuy* and *Manduvira* Rivers.

The *Cordillera de Altos* Soil are sandy with quartz and litosoles, from the arenics of the hills and hydromorphic quartz, planosole and humic gley in the alluvial valley. In the east we find the most red-yellow podsolics and tley-humics planosoles and alluvial pintosol plains.



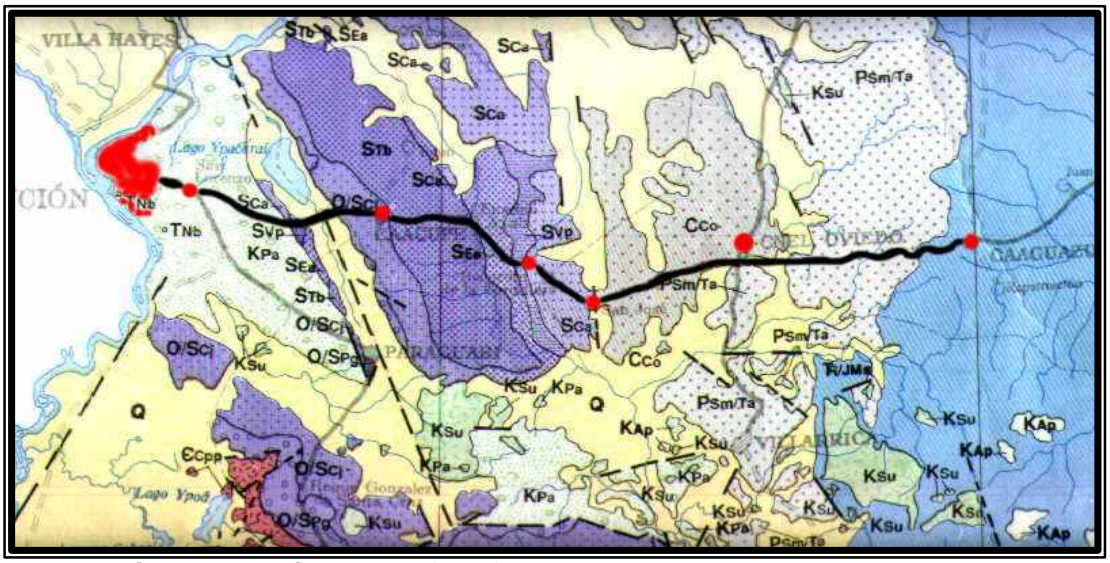
Source: National Parks and Wildlife Directorate (DPNVS), Conservation Data Center
Ministry of Agriculture and Stock Farming (MAG) MAG.

Figure 9.2.1 National Parks, Reservoirs and Protected Areas of Paraguay



Source : Strategy Plan of the National System of Wild Protected Areas ,National Parks and Wildlife Directorate (DPNVS),
Ministry of Agriculture and Stock Farming (MAG) MAG.

Figure 9.2.2 ***Ypacaraí* Managed Resources Reservoir**
(*Reserva de Recursos Manejados Ypacarai)*



Source: Military Geographic Service. (1.990) - Par. 83/005 - UNDP, VNN.

Figure 9.2.3 Geology of the Study Area

b. *Caaguazu* Department

At the west occurs the older Formation Group, the *Coronel Oviedo* Formation, with a fluvial-glacial origin for the Carbonic-Paleozoic with arenics and tillits. At east occur the *San Miguel* And *Tacuary* Formation Group with arenics and lutites of fluvial origin; lacustre, deltaico and marine in the second both of Permic - Paleozoic.

In the eastern part on the way to *Caaguazu* occurs eolics arenics of *Misiones* Formation Group (*Triasic-Mesozoic*) in this part of the department. The geomorphology of the *permo-carbonics* formation has many big valleys in a north-south directions with altitudes of 150-200 m above sea level.

In the San Miguel And Tacuary at the east part with 200 - 250 m.a.s.l. over the arenics of Misiones with 20-45 % declivity, at the east-north with 8-20 % declivity.

Arenics soils are red-yellow podsoles with an A + E thick horizon (8-120 cm) litosols and quartz arenics in the hilly parts and planosoles, plintosoles and humic gley in the alluvial plain.

In *Caaguazu* district between 160km and 180 km from *Asuncion*, there are possibilities of landslide due to an undulating configuration and greater use of the ground by the surrounding settlements at the edge of route 7 and cutting of the soil for the construction of the road without any installation of protection.

c. *Central* Department

The older formations are from Siluric-Paleozoic conform by a basalt conglomerate (*Paraguari* formation, Stratiphic arenis (*Cerro Jhu* Formation friables arenics (*Tobati* Formation), mica-arenics (*Eusebio Ayala* Formation) and white lutites

(*Vargas Peña* Formation) that were deposited by transgressives-regressives events. In the whole northern part, as far as the *Caañabé* basin, variable grains were deposited in a fluvial zone (*Formación Patiño*) during the *Cretacy* (*Mesozoic*) and the whole southern part bordering the *Ypoá* lake, is occupied by unconsolidated silts of the *Quaternary* (*Cenozoic*).

The highest elevations occur in the *Pirayú* hills in the western limit of the basin of *Ypacaraí* lake, with wavy relief (inclines of 8-20%) to strongly wavy (20-45%), in the whole north area, smoothly occurs wavy relief (inclines of 3 to 8%). The whole basin of *Ypacaraí* lake, the *Caañabé* river and the *Ypoá* lake, are characterized by a great flood plain (inclines of 0 to 1%), with small inclines (1-3%).

The main floors of *Pirayú* hills are Litosoles and derived Quartz-Sands of the gritty ones of *Patiño* and of *coluvios* of the gritty ones of *Tobatí* and *Cerro Jhú*. The Red-Yellow Podsólics floors of the gritty ones of *Patiño*, dominates the whole landscape of the high lands of the north of the Department, being alternated with Planosoles and plintics planosoles of the streams of the region. In the south plains of the Planosoles exists Plintosoles, Quartz-containing Sands Hidromórficas, little Gley Húmicos and Organic soils.

(5) Hydrology

Regarding the hydrological features of the study area, please refer to Figure 2.3.3 and Figure 2.4.2.

In the oriental region of Paraguay, there are two principal river water basins - the *Río Paraguay* and *Río Paraná* as shown in Figure 9.2.3.

Río Paraguay crosses the region from north to south with a total length of 1,017 km. The river basin consists of four sub-basins - *Río Manduvira, Arroyo Piribebuy, Río Salado* and *Río Tebicuary. Río Paraná* crosses the region from west to north east and has several sub-basins such as *Río Monday.* The routes 2 and 7 are located in the above noted sub-basins of *Río Manduvira, Arroyo Piribebuy, Río Salado ,Río Tebicuary* and *Río Monday.* The details of these five river sub-basins are shown in Table 9.2.4. Among these basins, the study area is located mainly in the river basin of *Río Manduvira* which originates in the *Cordillera de los Altos*.

Table 9.2.4 Five River Sub-basin in the Study Area

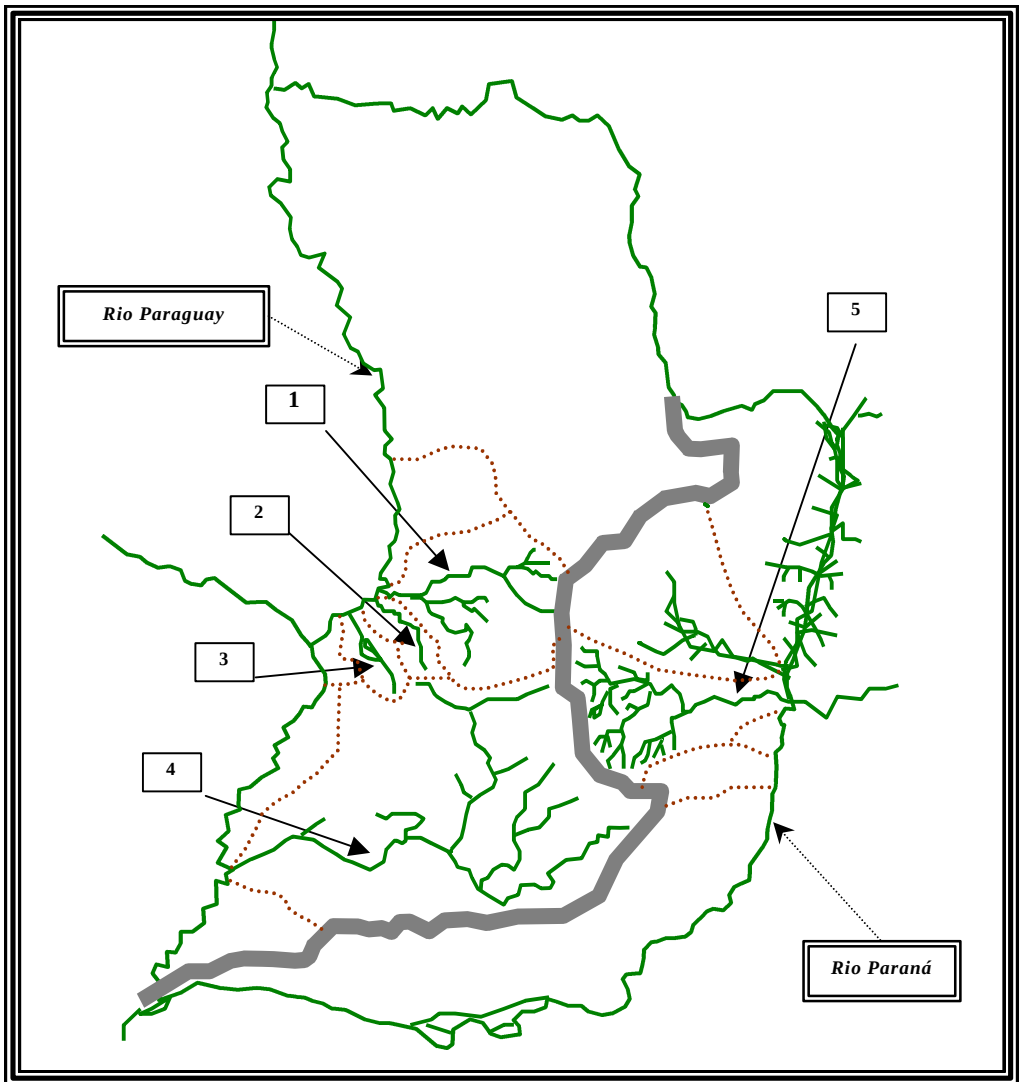
River Basin	Geographic Location		Maximum Altitude (m)	Minimum Altitude (m)	Basin Area (km²)	Basin perimeter (km)	Principal length (km)
	Latitude	Longitude					
Río Manduvira	24' 39' S	56' 29' 0	335	62	9,401	498	174
Arroyo Piribebuy	24' 59' S	57' 15' 0	405	62	1,405	114	114
Río Salado	25' 06' S	57' 26' 0	405	60	1,066	193	84
Río Tebicuary	26' 40' S	58' 10' 0	559	50	31,317	800	360
Río Monday	25' 01' S	56' 01' 0	402	195	6,557	800	240

Source: Direction de Meteorologia e Hidrología. Dependiente d e la Direction Nacional de Aeronautica Civil (DINAC)

In *Ypacarai*, 36 km from Asuncion, a flood plain extends on both sides of route 2. During periods of heavy rainfall, the level of the water in this area often reaches the road level.

At the end of 1980, the section of route 7 between *Cnel. Oviedo* and *Caaguazú* was submerged by flooding at the *Arroyo Guazú*, a tributary of the *Tebicuary* river and at a point 166 km from *Asunción*.

Other sections that are susceptible to flooding on route 7 are the reach of *Ypacaraí* where the road crosses the reach and the valley of *Arroyo Pirayú.*



Source: National Parks and Wildlife Directorate (DPNVS), Ministry of Agriculture and Stock Farming (MAG) MAG.

1 *Manduvirá* river basin
2 *Piribebuy* river basin
3 *Salado* river basin
4 *Tebicuary* river basin
5 *Monday* river basin

Figure 9.2.4 River Basins in the Oriental Region of Paraguay

9.2.2 Social Environment

(1) Population

a. Population by each District in the Study Area

According to the national census of 1992 as shown in Table 9.2.5, total population in the study area was 487,543. The population in the study area was 11.74 % of the total national population. The population living in urban areas of the study area was 16,36 % of the total national urban population. Approximately 40 % of the population in the study area is under fifteen years of age running from 36.8 % in *Ypacaraí* to 44.7 % in *Caaguazú*.

Table 9.2.5 Population by District

District	Total population (person)	Under the 15 years old (%)	Urban population (person)	Rural population (person)	Population density (person/km^2)
San Lorenzo	133,395	37.7	133,395	-	3,032
Capiatá	83,773	40.5	83,773	-	943
Itauguá	37,664	37.7	13,910	23,754	299
Ypacaraí	14,495	36.8	7,160	7,335	142
Caacupé	31,319	41.1	12,382	18,937	602
Eusebio Ayala	15,521	41.1	6,359	9,162	110
Itacurubí	6,733	37.6	3,677	3,056	73
San José	16,524	42.0	4,648	11,876	90
Coronel Oviedo	64,736	40.6	38.316	26,420	249
Caaguazú.	83,383	44.7	38.220	45,163	245
Total	487,543	40.0	341.840	145,703	107.46

Source Dirección General Estadísticas Encuestas y Censos, año 1992

b. Household and Family Size

Table 9.2.6 shows the statistical data on house and household in the study area. From this data shown in the Table 9.2.6, it can be estimated that each house in the study area has approximately five family members.

Table 9.2.6 House and Household

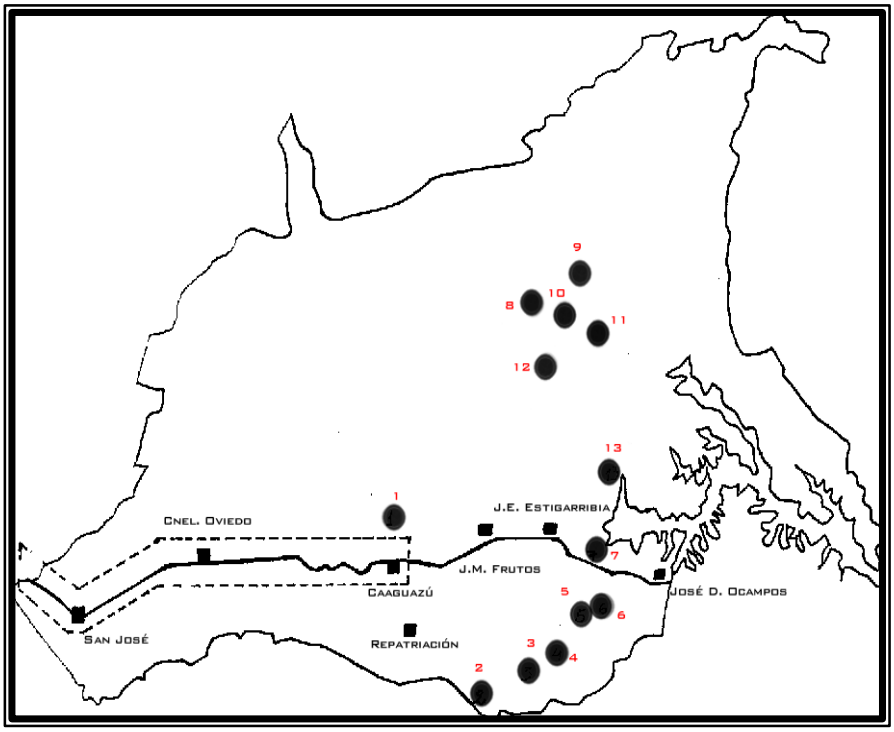
District	Total population	Number of houses	Household	Person/house
San Lorenzo	133,395	28,701	28,266	4.72
Capiatá	83,773	17,921	17,824	4.70
Itauguá	37,664	8,204	8,162	4.61
Ypacaraí	14,495	3,210	3,168	4.58
Caacupé	31,319	6,636	6,582	4.76
Eusebio Ayala	15,521	3,417	3,408	4.55
Itacurubí	6,733	1,537	1,534	4.40
San José	16,524	3,533	3,528	4.68
Coronel Oviedo	64,736	13,244	13,219	4.90
Caaguazú	83,383	16,362	16,317	5.11
Total	487,543	102,765	102,008	4.77

Source: Dirección General Estadísticas Encuestas y Censos, año 1992

c. Indigenous Communities

– In Central Department, there is *Maka* Community in *Mariano Roque Alonso*. However the community is located outside the study area.

- In *Caaguazú* Department, according to the Native's National Institute (INDI), there are thirteen *Mbya Guarani* communities claiming the right of ownership of more than 10,000 ha of land. However the communities are located outside the study area. (See Figure 9.2.5)
- No Indian communities along routes 2 and 7 in the study area have been identified, according to the Census on population and housing in1998.



Source:

No.	*Community*	No.	*Community*	No.	*Community*
1.	Kambay	6.	Mbarigui	11.	Zayas Cué
2.	*Señorita*	7.	*Km 225*	12.	*Toro Kangue*
3.	*Amambay*	8.	*Mbocayai*	13.	*Mbocayao Yguazú*
4.	*Teyú*	9.	*Santa Teresa*		
5.	*San Juan Yhory*	10.	*Planchada Julia*		

Note: ——— : Route ■ : Town

▭ : Study Area ● : Indigenous Community

Figure 9.2.5 Indigenous Communities in *Caaguazú* Department

d. Illegal Settlements

- On routes 2 and 7, illegal settlements have not been identified at present in the Municipalities located along the routes.

(2) Economic Activities

a. Economic Activities by Sectors

The economic activities in the study area are summarized as shown for the following sectors.

- **Primary sector**: agriculture, silviculture, hunting, cattle-breeding and fishing.
- **Secondary sector**: exploitation of mines and quarries, manufacturing and construction.
- **Tertiary Sector**: electricity, water supply, commerce, restaurant, hotel, finance, transportation, communication, insurance, real estate and other services.

Table 9.2.7 Economic Activities by Sectors

(%)

District	Primary	Secondary	Tertiary
San Lorenzo	2.3	32.8	64.9
Capiatá	6.2	39.3	54.6
Itauguá	16.7	44.6	38.7
Ypacaraí.	11.8	42.9	45.3
Caacupé	22.3	30.7	47.0
E. Ayala	43.8	22.5	33.7
Itacurubí	41.9	22.6	35.6
San José	67.5	11.3	21.2
Coronel Oviedo	32.7	25.7	41.6
Caaguazú	50.9	20.6	28.5

Source: Dirección General Estadísticas Encuestas y Censos, año 1992

b. Occupational Categories

- **Employee**: Person who is employed as intellectual worker in a company or institution with a salary.
- **Worker or day- laborer**: person who does a principally physical activity with a cash payment (daily, weekly or monthly).
- **Employer**: person who has his own business with one or more employees.
- **Independent Worker**: person who works in his own business or has a profession or occupation without an employer and remunerated employee.
- **Family worker**: member of a family who works for the family without payment.
- **Domestic worker**: person that provides personal and domestic services in a house.

Table 9.2.8 Occupational Categories

(%)

Districts	Employee	Worker or day laborer	Employer	Independent worker	Family worker	Domestic Worker
San Lorenzo	28.0	34.9	4.1	24.5	0.2	8.3
Capiatá	19.5	43.5	3.0	26.4	0.2	7.3
Itauguá	13.2	43.2	2.8	33.8	0.9	6.1
Ypacaraí	17.1	43.0	3.3	30.7	0.4	5.5
Caacupé	15.2	34.7	3.7	39.1	2.2	5.1
E. Ayala	11.4	27.8	3.1	46.6	6.8	4.4
Itacurubí	13.6	28.5	2.1	49.0	3.5	3.3
San José	6.5	36.4	2.8	42.9	9.0	2.4
Cnel. Oviedo	13.8	31.7	3.4	40.0	5.6	5.5
Caaguazú	6.9	27.3	2.9	50.9	8.0	4.1

Source: Dirección General Estadísticas Encuestas y Censos, año 1992

(3) Transport and Public Facilities

a. Transportation

National route 1 from *San Lorenzo* to the south of the country has a high traffic volume. *Capiata* is incorporated in a part of *Asunción* metropolitan public transportation system having 47 licensed lines. *Caacupé*, *Eusebio Ayala*, *Coronel Oviedo* and *Caaguazú* have bus terminals which are operated by each municipality. The bus terminals of *Caacupé* and *Caaguazú* are respectively located on the specific national route. In *San Lorenzo, Capiatá*, *Itauguá* and *Ypacaraí*, there are private bus terminals of transportation companies. The following Table 9.2.9 shows the number of public bus stops and taxis in each district of the study area.

Table 9.2.9 Number of Public Bus Stops and Taxis

District	Number of Bus Stop	Number of Taxi
San Lorenzo	54	456
Capiatá	27	228
Itauguá	12	101
Ypacaraí	5	26
Caacupé	14	65
Eusebio Ayala	2	10
Itacurubí	4	19
San José	3	12
Coronel Oviedo	24	90
Caaguazú	7	53

Source: *Each Municipality Office, 1999*

b. Public Infrastructure

Following is the service ratio of principal public infrastructures including water supply, electricity connection, solid waste collection and so on, for each district in the study area.

Table 9.2.10 Public Infrastructure

(%)

District	Water Supply	Electricity Connection	Solid waste Collection	On site waste water pit
San Lorenzo	22.9	99.6	45	59.8
Capiatá	20.7	98.7	45	53.1
Itauguá	63.2	99.3	36 (U)	54.8
Ypacaraí	0.3	99.5	46 (U)	56.2
Caacupé	56.5	95.2	31 (U)	63.8
E. Ayala	1.2	90.0	n/a	35.1
Itacurubí	60.0	87.6	36 (U)	46.7
San José	67.5	82.3	15 (U)	34.5
Cnel. Oviedo	47.2	90.5	10 (U)	38.2
Caaguazú	11.0	87.1	14 (U)	28.6

Source: General Direction of Statistical. Survey and Census 1992, Each Municipality of the Column
Note : n/a is no answer, (U) is Urban area

The solid waste collection service is conducted by each municipality. In areas where no solid waste collection service is available, field incineration of the waste has been seen often in the study area.

In addition to the above, several cemeteries are located along the routes in the study area such as "*Cementerio de Ypacaraí*" in *Ypacaraí*, the area of which is four hectares, and "*Cementerio de Caacupé*" in *Caacupé*, which has a length of 200 m.

(4) Historical and Cultural Property

1) ***San Lorenzo***: The city was founded on 10th August 1775. In the city, there are several cultural
properties such as *San Lorenzo* Church of neo-gothic style which was built in the beginning of the century, "*Centro Cultural Raíces*" which is a cultural center for protecting the inheritance and patrimony of the city, the "*Museo Antorpológico Guido Boggiani* which is an anthropological museum operated by a fellow citizens association, and so on.

2) ***Capiatá***: was founded in 2nd February 1640. It has a settlement of century-old houses around the *Nuestra* Señora *de la Candelaria* Church. Also there is a mythological museum called "*Museo Ramón Elías*" which is located near route 2.

3) ***Itauguá***: was founded in 1728. Next to the *Virgin del Rosario* Church, which is a big tower and is the city symbol, there is a historical property called "Latin-American workers houses" where there are houses of laborers who constructed the railway of *Paraguay* in the last century. Under "PRODEP (Project of decentralization of *Paraguay*)" supported by USAID (US Agency for International Development), an inventory study of the houses used by early skilled laborers in Latin America has been started to identify those to be selected as national heritage.

   A handicraft called "*Ñanduti*", which is a sort of traditional embroidery made by hand using needle and thread, is made in *Itagugá*. The city is also called "*Capital del Ñanduti*" and has one museum called "*Museo San Rafael*" where the handicrafts are displayed.

4) ***Ypacaraí***: was founded in 1887. The city was developed originally as a main railway station. The station dates from the beginning of the city.

5) ***Caacupé***: was founded in 4th April 1770. There is a famous church called "*Virgin de Caacupé Basillica*" to which many *Paraguayan* people make pilgrimage every 8th December. As a historical place in *Caacupé*, there is "C*ampamento Ascurra*" where part of the *Cordillera* battle took place during the Triple Alliance War (*Paraguay* alone confronted an alliance of *Argentina, Brazil* and *Uruguay*) from 1869 to 1870.

6) ***Eusebio Ayala****:* was founded in 1770 and was formerly called "*Barrero Grande*". There is a historical park called "*Parque Acosta Ñu*" located in the *Arroyo Yuquyry* basin, 15 km north of route 2. In the urban area, there are several old houses dating from the beginning of the century and a church called "*Iglesia San Roque*".

7) ***Itacurubi de la Cordillera***: There are many old buildings in the urban area. Some of them are made of uncut stones. There is a natural cave called "*Grout Ita Coty*" which is a place for tourism, specially in the summer season.

8) ***San José de los Arroyos***: was founded in 25th May 1884 and was formerly called "*Dos Arroyos*". The oldest buildings date from the beginning of the century and

9) ***Coronel Oviedo***: was founded in 1758. The urban area of the city was reconstructed and almost all the buildings in the area are relatively new. There is one church called "*Virgen del Rosario*" located 2 km from route 2.

10) ***Caaguazú***: was founded in 1592. It is famous for a traditional musical festival called "*Festival de la Madera y del Typoi-yegua*". A part of *Caaguazú* is the National Park of *Guayaki*, which is located on route 7, 15 minutes from *Caaguazú* city toward *Asunción*. The city has a cathedral called "*Iglesia de la Inmaculada*" which was built in the middle of this century.

(5) Land use

In the study area, the cities of *San Lorenzo* and *Capiata* are exclusively categorized as urban areas and the others have rural zones. Table 9.2.11 indicates total area of urban zone and rural area of each district in the study area.

Table 9.2.11 Urban and Rural Zones in the Study Area

(km^2)

District	Total Area	Urban area	Rural Zone
San Lorenzo	40	40	-
Capiatá	59	59	-
Itauguá	82	67	15
Ypacaraí	11	32	79
Caacupé	196	53	143
Eusebio Ayala	338	23	315
Itacurubí	262	14	248
San José	887	21	866
Coronel Oviedo	548	107	441
Caaguazú	2,014	128	1,886

Source: Military Geographical Institute, 1999

9.2.3 Pollution

(1) Air Pollution

In Paraguay, little research on atmospheric pollution has been carried out due to lack of monitoring equipment. However, a survey of air pollutants was executed by the National Commission of Atomic Energy of National University at *San Lorenzo* in 1992. The objective of the survey was to detect sulfide particulate substances and heavy metals in the air. The following are the survey results;

Table 9.2.12 Air Pollutant Survey Result (*San Lorenzo*), Average Value

($\mu g/m^3$)

	K	Ca	Ti	Cr	Mn	Fe	Ni	Cu	Zn	As	Pb	Br	Rb	Sr
Commercial or market area	0.580	0.340	0.130	0.100	0.640	1.009	0.065	0.220	0.130	0.060	0.180	0.040	0.035	0.040
Road side with heavy traffic	0.540	0.390	0.016	0.130	0.630	1.289	0.062	0.280	0.140	0.052	0.240	0.043	0.034	0.000
Residential area	0.720	0.350	0.160	0.210	0.630	1.000	0.094	0.250	0.160	0.051	0.250	0.022	0.033	0.040
Average	0.610	0.360	0.150	0.150	0.660	1.090	0.070	0.250	0.140	0.054	0.220	0.035	0.034	0.050

Sourece: "STUDIES OF ATMOSPHERIC POLLUTION: CONCRETATION OF SELECTED ELEMENTS IN THE LOWER ATMOSPHERE USING NUCLEAR - RELATED ANALYTICAL TECHNIQUES" 1994 *ATOMIC ENERGY NATIONAL COMMITTEE- ASUNCION NATIONAL UNIVERSITY of ASUNCION*

(2) Noise Level

According to result of noise level survey of "Diagnosis of the Noise in Main Avenues of *Asunción*" executed from 1993 to 1996, the average noise level of main avenues in *Asunción* showed 70.2dB(A) at L_{eq}.

(3) Water Pollution Situation

The National Service of Environmental Reparation (SENASA), which is affiliated with the Ministry of Health and Social Welfare, has carried out a monitoring of the water quality of the *Lago Ypacaraí* basin under a technical cooperation by JICA. The following is a summary of one of the analytic results of the monitoring activities.

Table 9.2.13 Water Quality of *Lago Ypacaraí*

Parameter	*Tayuasapé* bridge stream route 2	*Capiata* bridge stream route 2	*Mboi '* Stream	*Carumbe Cuá* stream	*Yuquyry* bridge stream route 2	*Ypucú* Bridge stream route 2	*Yagua resaú* bridge stream route 2
pH	6.9	7.0	6.9	7.0	6.9	6.2	6.4
Cond. (uS/cm)	180	140	100	120	100	50	40
Turbidity (NTU)	40	80	50	90	70	40	50
DO (mg/l)	7.1	6.0	7.2	7.1	5.6	4.9	5.6
Temperature (º C)	21	24	21	21	21	24	25
Total P (mg/l)	0.18	0.17	0.13	0.13	0.11	0.14	0.21
PO_4 - P (mg/l)	0.06	0.10	0.05	0.07	0.07	0.06	0.05
Total nitrogen (mg/l)	4.21	2.02	1.89	2.33	2.24	0.61	0.97
Total -N (*Kjeldahl*)(mg/l)	1.41	0.55	0.60	0.52	0.78	0.45	0.82
NH_4 - N (mg/l)	0.61	0.11	0.08	0.08	0.20	0.05	0.02
NO_2 - N (mg/l)	0.17	0.06	0.03	0.05	0.06	0	0
NO_3 - N (mg/l)	2.80	1.47	1.29	1.81	1.46	0.16	0.15
Total CD (mg/l)	21.3	12.2	15.0	13.4	12.2	27.0	22.5
BOD_5 (mg/l)	26.0	1.8	4.4	3.1	2.9	1.1	1.4
Total solids (mg/l)	302	196	156	186	150	130	126
SS (mg/l)	26.8	54.4	29.2	46.8	22.6	22.6	36.7
Fecal Colif. (Col./100cc)	1,700,000	2,000	70	1,300	1,900	280	100
Total Colif. (Col./100cc)	5,900,000	79,000	260,000	140,000	88,000	240,000	1,900,000

Source: SENASA-JICA, 1998, Sampling date: from 8th to 22nd October 1998
Note: *Kieldahl* method; boiling a water sample to eliminate total ammonia and inorganic compounds and then verifying chemical reaction of the sample in order to determine total amount of organic nitrogen.

(4) Soil Contamination

Soil contamination caused by agrochemical use is one of the environmental issues in Paraguay. The *Centros de Capacitación Agropecuaria Regionales* is in charge of research and surveys of contamination in the country. The use of pesticides is one of sources of soil contamination in *Paraguay*.

According to the *National Profile of Chemical Substances Management in Paraguay, MAG*, in 1992 totally 15,887 tons of pesticide were used for 2,270,000 ha, namely 7 kg/ha.; on the other hand in 1996, 8,100 ton of pesticide were used for 2,461,151 ha, namely 3.29 kg/ha. The principal agrochemicals used in Paraguay are listed as follow.

Table 9.2.14 Agrochemicals used in Paraguay

Abono Foliar	*Dementon-5-metil*	*Monocrotophos*
Aldrin	*Endosulfan*	*Oxicloruro de cobre*
Cabofuran	*Fosfamidon*	*Permetrina*
Catap	*Lindano*	*Profenoos*
Cipermetrina	*Metamidofos*	*Sulfato de estreptomicina*
Cloropicrina	*Methomyl*	*Terramicina*
Cobre metáico	*Metilparathion*	*Tiofanato metilico*

Source: National Profile of Chemical Substances Management in Paraguay, MAG

9.3 Air Pollution and Noise Level

9.3.1 Air Pollution

24 hours monitoring of air pollutants was carried out along the road at four leading cities of *San Lorenzo, Capiata, Itaugua* and *Ypacarai* in the study area. Following is the result of the air pollution survey.

Table 9.3.1 Survey results of Air Pollution

(μg/m³)

	SPM	TSP	Pb	NO_x
San Lorenzo	11.52	127	0.11	10.3
Capiata	8.99	214	0.23	11.7
Itaugua	35.24	234	0.15	11.6
Ypacarai	13.00	512	0.16	7.8

Note: The monitoring survey was carried out in May of 1999

As for environmental standards of SPM, TSP or Pb in Paraguay, such standards are not prepared yet. However, WHO (World Health Organization) standards and those of neighboring countries have been occasionally referred in Paraguay. Therefore, the results are compared with standards of WHO, USA and *Brazil* as follows.

(1) SPM (Suspended Particulate Matter)

As for the SPM value of *Itaugua*, it shows values above the California (USA) standard of 30 μg/m³ (as the geometric mean). However, all SPM values monitored at the four cities are less than the Federal (USA) environmental standard of 50 μg/m³ as PM_{10} (Particulate Matter less than 10 μm in aerodynamic diameter) as shown in Figure 9.3.1.

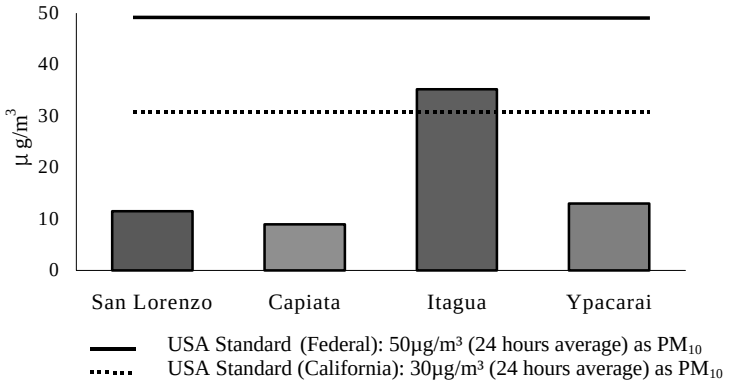


Figure 9.3.1 SPM Concentration in the Study Area

(2) TSP (Total Suspended Particulate Matter)

Regarding the TSP value in *Ypacarai*, which is relatively high compared with the values in other places, it is considered that the value in *Ypacarai* must be influenced by the rainy weather on the day previous to the monitoring date. In addition to this reason, generally, the value of TSP may be sensitively influenced by various circumstances and other factors such as temporary field incineration of solid waste and some stationary emission sources located in the area surrounding the monitoring point and so on.

From the viewpoint of traffic volume in those cities, it can be considered as another possible reason for the TSP value in *Ypacarai,* that it might be influenced not only by exhaust gases of vehicles, but also other emission sources.

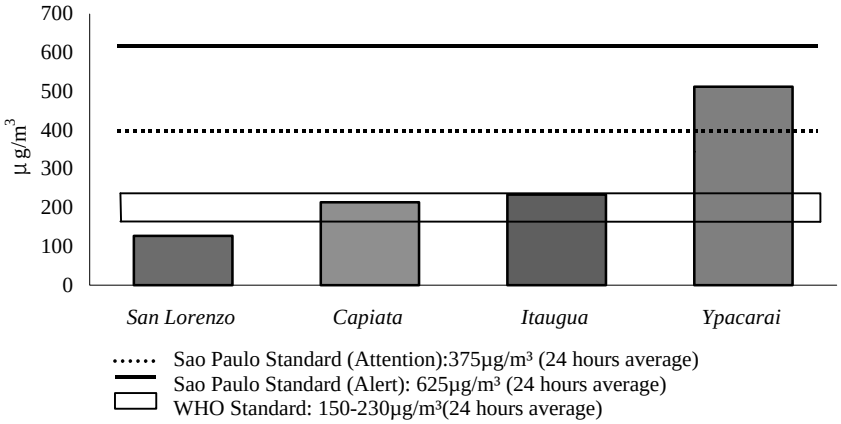


Figure 9.3.2 TSP Concentration in the Study Area

However, the TSP values in *Sao Lorenzo* and *Capiata* are under the WHO standard of 24 hours average (150-230µg/m³). And the value in *Itaugua* is slightly over the WHO standard, but under the *Sao Paulo* Standard of 24 hours average (375µg/m³).

(3) Pb (Lead)

The values of Pb (Lead) in the four cities are under the WHO standard (1 year average) of 0.5 - 1.0 µg/m³ and USA Standards (Federal and California) of 1.5 µg/m³ as shown in Figure 9.3.3.

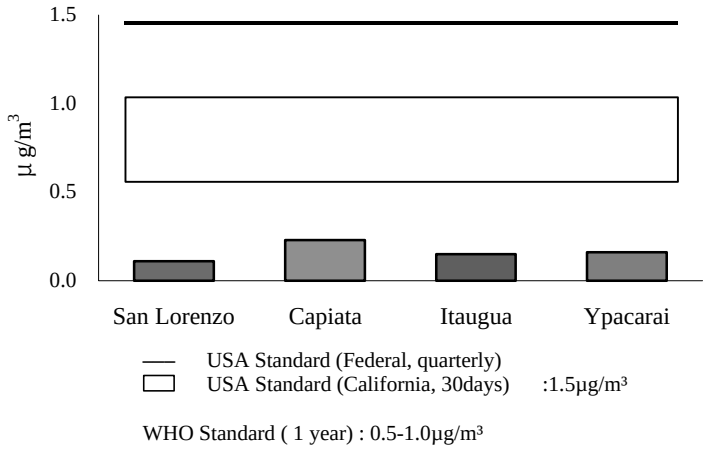


Figure 9.3.3 Pb Concentration in the Study Area

As mentioned already in section 9.3.3, the National Commission of Atomic Energy implemented a survey on pollutants in the air between March 30 and April 2nd of 1993 in *San Lorenzo*.

The survey result shows the Pb concentration in the air from 0.18 µg/m³ to 0.25 µg/m³, and the average is 0.22 µg/m³.

From the results of the survey in 1993 and JICA survey in 1999, it is observed that there is a decreasing trend of Pb concentration in the air between 1993 and 1999. It can be considered that the reason for the decrease is the increase of unleaded fuel use in recent years in *Paraguay*.

(4) NO_x (Nitrogen Oxides)

The levels of nitrogen oxides are below 100 µg/m³, the value limit adopted by the Agency of Environmental Protection (USA).

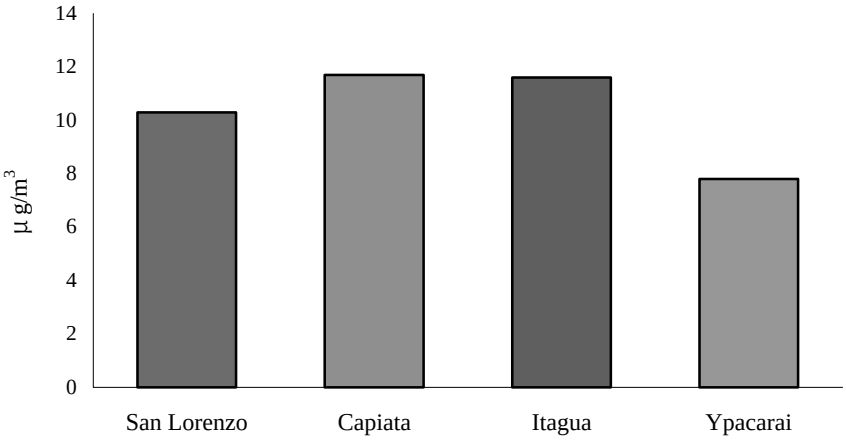


Figure 9.3.4 NO_x Concentration in the Study Area

According to "*Motor Vehicle Air Pollution, Public Health Impact and Control Measures*, WHO/PEP/92.4"(*François Cupelin & Olivier Zali*), the formation and emission of NO_x is mentioned as follow.

- The formation of NO_x
  The formation of NO_x results mainly from reaction between atmospheric oxygen and nitrogen during combustion process. A minimal proportion comes from oxidation of nitrogen containing compounds in the combustion materials themselves.
- The emission of NO_x
  NO_x include a large number of compounds of the N_yO_x type, although from point of view of air protection, the only significant ones are NO and NO_2. NO account for 90 to 95% of NO_x emissions, and it ultimately changes in the atmosphere into NO_2, which is the most toxic.

Due to the characteristic of formation and emission of NO_x mentioned above, a situation of NO_x in ambient can be evaluated in terms of an environmental standard of NO_2 from view point of human health.

9.3.2 Noise Level

In order to identify briefly road noise levels in the study area, a noise level monitoring survey was carried out at four locations of *San Lorenzo, Capiata, Itaugua* and *Ypacarai* for ten minutes monitoring in each hour from 7:00 to 18:00. Table 9.3.2 shows the results of the monitoring survey.

Table 9.3.2 Noise Level in the Study Area

(dB(A))

Monitoring Time	*San Lorenzo*		*Capiata*		*Itaugua*		*Ypacarai*	
	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
7:00 - 7:10	77.9	91.6	77.1	95.3	74.4	91.7	74.5	94.6
8:00 - 8:10	77.1	90.6	77.1	94.9	73.7	89.2	72.5	91.0
9:00 - 9:10	76.3	97.5	75.9	94.2	73.5	87.9	73.1	91.8
10:00 - 10:10	76.3	87.7	77.6	91.7	73.1	88.0	74.2	93.5
11:00 - 11:10	76.4	90.2	76.0	96.3	74.8	90.9	74.6	93.4
12:00 - 12:10	76.9	91.2	76.4	91.3	75.7	89.2	75.3	92.8
13:00 - 13:10	77.1	92.0	77.3	91.7	74.2	89.9	73.8	95.2
14:00 - 14:10	76.6	89.3	76.4	94.3	74.8	92.9	74.5	94.6
15:00 - 15:10	77.6	93.8	76.3	92.4	73.8	89.4	74.2	92.4
16:00 - 16:10	77.3	90.1	78.0	93.8	73.6	91.2	77.0	94.0
17:00 - 17:10	76.8	89.3	75.9	90.2	73.5	87.4	78.3	90.3
18:00 - 18:10	76.5	103.0	77.2	94.0	73.8	88.5	75.5	100.1
Maximum	77.9	103.0	78.0	96.3	75.7	92.9	78.3	100.1
Minimum	76.3	87.7	75.9	90.2	73.1	87.4	72.5	90.3
Average	76.9	92.2	76.8	93.3	74.1	89.7	74.8	93.6

Note: The survey was carried out on 6th (*Ypacarai*), 7th (*Itaugua*) , 11th (*Capiata*) and 12th (*San Lorenzo*) of May 1999

As illustrated in Figure 9.3.5, every minimum noise level in day time at each survey location is over 70 dB(A) at L_{Aeq}.

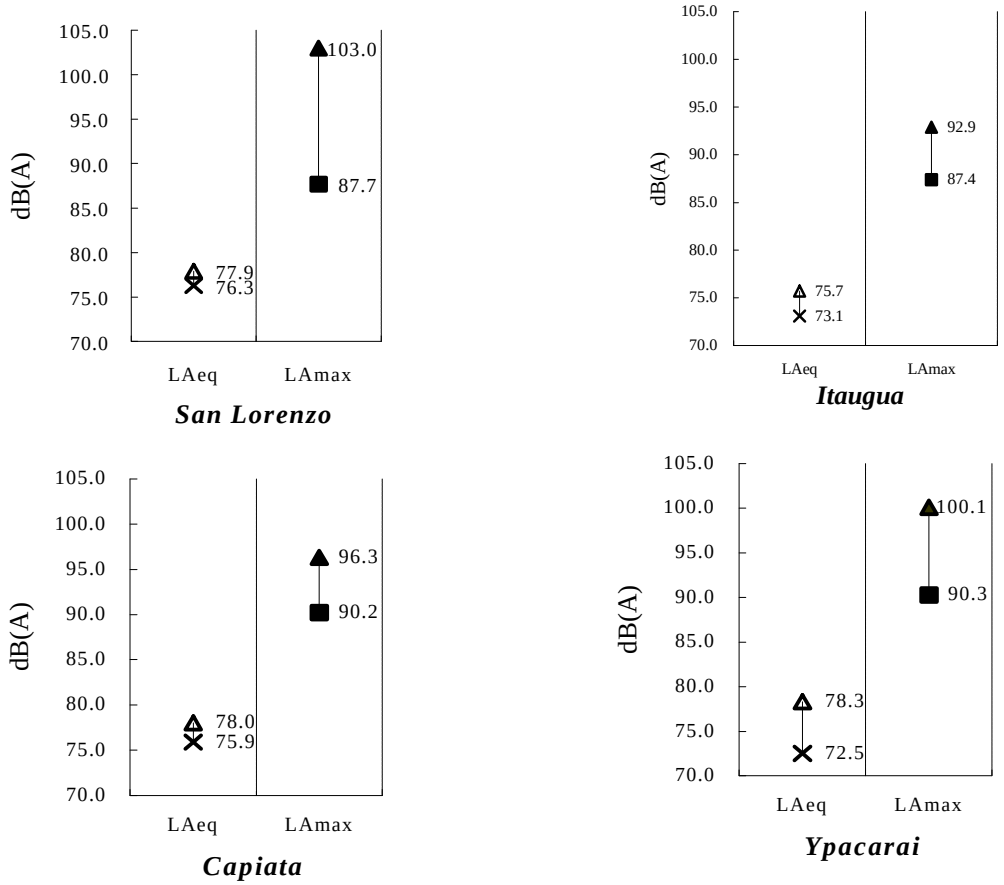


Figure 9.3.5 Noise Levels in the Study Area

Regarding national environmental standard of noise level, such a standard does not exist in *Paraguay* at present, except a noise regulation of *Asuncion* municipality and a criteria of noise level at construction stage regulated in ETAG of MOPC as shown in the following Tables. For reference, Table 9.3.5 shows the Environmental Quality Standards for Noise of *Japan*.

Table 9.3.3 Noise Level Standard of Asuncion Municipality

Zone	6:00-22:00(day time)	22:00- 6:00 (night time)
Residential Area	35 dB	45dB
Industrial Area	55 dB	65dB

Source: Ordinance No. 9928, year of 1978

Table 9.3.4 Noise Level Standard during Construction

Zone	Day time	Night time
Working Area	75 dB (A)(8hours)	
In house	45 dB (A)	
Out side	45dB (A)	55 dB (A)

Source: Regulated in ETAG of MOPC (as WHO Standard,1980)

Table 9.3.5 Environmental Quality Standard for Noise of Japan

(*Leq*)

Zone		Daytime max.	Nighttime * max.
1	Entirely residential area	60dB (A)	55dB (A)
	Mostly residential or mixed business and residential	65dB (A)	60dB (A)
2	Outside equivalent noise level of houses exposed to high levels of traffic noise	70dB (A)	65dB (A)

Note : 1; Areas facing roads of two lanes or more, 2; Areas adjacent to artery roads, * (10p.m.-6a.m.)
Source : Environmental Agency of Japan, EIC net(http://www/eic.or.jp/eanet/e/jeq/v003-04.html)

At the same time as the noise level survey, a traffic count survey was executed at each monitoring point of the noise survey for 10 minutes traffic count/hour by two vehicle types of light vehicle and heavy vehicle in both road directions. Table 9.3.6 shows the result of the traffic volume count survey.

Table 9.3.6 Traffic Volume at Noise Level Monitoring Point Both Directions

(vehicles/10 minutes)

Count Time	*San Lorenzo*		*Capiata*		*Itaugua*		*Ypacarai*	
	Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
7:00 - 7:10	405	114	239	83	139	52	85	34
8:00 - 8:10	283	106	176	97	145	52	80	37
9:00 - 9:10	233	107	175	75	103	54	65	45
10:00 - 10:10	256	102	185	103	94	58	69	49
11:00 - 11:10	235	102	181	90	128	64	81	45
12:00 - 12:10	271	102	148	92	125	88	70	49
13:00 - 13:10	237	135	163	92	125	63	71	47
14:00 - 14:10	289	116	186	84	146	75	98	40
15:00 - 15:10	248	104	173	93	113	64	90	42
16:00 - 16:10	284	105	221	123	152	69	115	60
17:00 - 17:10	320	98	198	93	152	64	99	46
18:00 - 18:10	311	101	211	94	163	67	98	40
Average/10minutes (by vehicle type)	281.00	107.67	188.00	93.25	132.08	64.17	85.08	44.50
Average/10minutes (total)	388.67		281.25		196.25		129.58	

Note: The survey was carried out on 6th (*Ypacarai*), 7th (*Itaugua*) , 11th (*Capiata*) and 12th (*San Lorenzo*) of May 1999

Based on the results from the noise level survey and the traffic count survey, correlation between arithmetical average value of the noise level, and arithmetical average value of the traffic volume (by the vehicle type and the total) at each survey point can be described as shown in Figure 9.3.6.

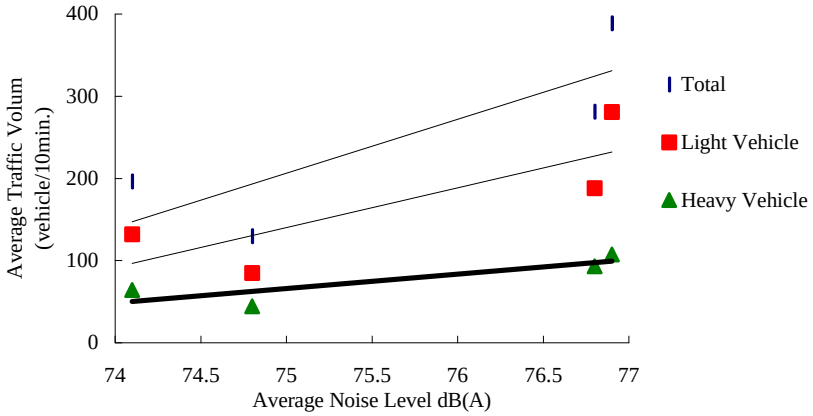


Figure 9.3.6 Correlation between Traffic Volume and Noise Level

As we understand from the Figure 9.3.6, it can be evaluated that there is an increasing trend of the noise level in accordance with increase of the traffic volume.

CHAPTER 10
REVIEW OF PRESENT DESIGN CONCEPT AND STANDARDS

10 REVIEW OF PRESENT DESIGN CONCEPT AND STANDARDS

10.1 Highway Design Standard

The road standard of Paraguay comprises Standards for Road Geometric Design "Normas para el Diseno Geometrico de Carreteras – 1985 " . However, it is generally not used. The reason is that it has not been authorized by law yet and the contents are only explanation of references and recommendations. The design standard for newly built road constructions has used the standard of the aid organization financing construction costs. Recently, the design standard of Brazil has been adopted because Paraguay is a country member of MERCOSUR.

1) The AASHTO standard used by many aid organizations has been adopted for this project.
2) A road standard adopts a district part principal road.
3) The right-of-way is to be 50m according to the road standard for a principal road law.

Regarding other factors related to the geometric characteristics of the road, the Environmental Unit Office (Unidad Ambiental) of the MOPC has the General Environmental Technical Specifications for Road Works (Especificaciones Tecnicas Ambientales Generales para Obras Viales) since December 1995, which covers items that have an environmental influence on road construction. This has not been authorized yet by any official administrative organization. Therefore, this project has been designed according to the environmental standards given in Chapter 9.

10.2 Structural Design Standards

10.2.1 Design Codes and Standards

(1) General

The design standards of bridge structures in Paraguay have been carried out in accordance with project standards such as Brazilian or USA standards, etc. The engineering design in this study does not determine structural details. Although the principal design work will be accomplished in accordance with Brazilian standards, USA and Japanese standards will also be applied as the need arises.

(2) Bridge Design Standard

The following standards will be applied for this study.

Brazil

- Standard Specifications for Highway Bridges, (1982 NBR)

USA

- Standard Specifications for Highway Bridges (1992 AASHTO)
- Building Code Requirements for Reinforced Concrete (ACI 318-83)

JAPAN

- Specifications for Highway Bridges,(1996 Japan Road Association)
- Design Standard for Highway and Bridges, (1994, Japan Highway Public Corporation)

10.2.2 Design Criteria

(1) Loading Specification

1) "A" Uniformly Distributed Load Class-I (45Ton)

Uniformly Distributed Load (UDL)

$p = 500kg/m^2$

$p' = 300kg/m^2$

$500kg/m^2$ of "p" loading shall applied on width of carriageway and $300kg/m^2$ on the remaining width of bridge.

The UDL may be applied in broken lengths to maximize its effects on continuous bridges or unusual structures.

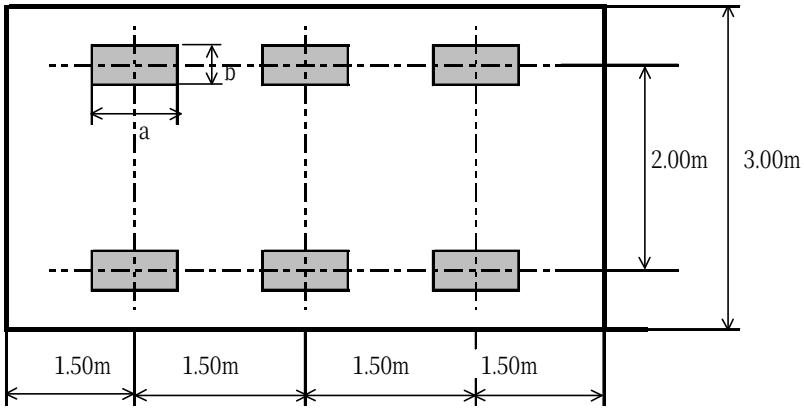
Knife Edge Load (KEL)

P = 45 ton

A single KEL perpendicular to the direction of traffic shall be placed in any position along the bridge. For continuous bridges, a second KEL shall be placed in the same lateral position on the bridge but in another span to produce the maximum negative bending moment.

2) "B" Truck Loading

The "B" truck loading is a single heavy vehicle with three axles shown in Figure 10.2.1 below, which shall be applied in any position in a design traffic lane.



Item	Width (mm)	Length (mm)	Load (t)
	a	b	p
Wheel Load	200	500	7.50

Figure 10.2.1 "B" Truck Loading

Only one "B" truck shall be placed in any design traffic lane, irrespective of the length of the bridge or the arrangement of spans.

3) Dynamic Load Allowance

$i = 1.4 – 0.007L \geq 1.0$

where, i : Dynamic load allowance
L : Span length (m)
For continuous spans, $L = \sqrt{(Lav \times Lmax)}$
Lav : Average span length of a group of continuously connected spans (m).
Lmax : Maximum span length of a group of continuously connected spans (m).

4) Braking Force

$Fb = P \times 0.30$ or
$= ((P/(L \times W) + p \times (LxW-18))$

P : Knife Edge Load (45t)
p : Uniform load ($500kg/m^2$)
L : Span length (m)
W : Width of Bridge

5) Centrifugal Force

$Fc = 7P$, $300m \geq R$
$Fc = 2100/R$, $300m < R$

where, Fc : Centrifugal force acting on a section of the bridge
P : Knife Edge Load (45t)
R : Radius of curve (m)

Centrifugal force shall be assumed to act at deck level in a radial outward direction.

6) Pedestrian Loading

$300kg/m^2$ of Uniformly Distributed Load (UDL) shall applied on width of sidewalk or pedestrian bridge which directly carry the pedestrian traffic.

7) Collision Loads on Bridge Supports

Vehicle impact - An equivalent static load of 80t shall be applied at an angle of 90 degrees from the direction of the center line of the road which passes under the bridge. The load shall be applied at 0.3 m above deck level.

8) Earth Pressure

The earth pressure coefficients shall be calculated by Coulomb's formula based on the soil properties obtained from the soil investigation.
The effect of ground water shall be taken into account.
Surcharge equivalent to an additional 0.6 m of soil shall be applied to the soil behind a wall if normal highway live loads can travel over any part of the theoretical failure zone.

9) Hydrostatic Pressure and Buoyancy

Hydrostatic pressure and buoyancy forces shall be calculated based on the high and low water levels.

10) Wind Loads

i) Wind Load on Bridge Structure

$Tew = W \cdot Ab$

where, Tew : Wind forces on a bridge structure (kN)
W : Force 150 (kg/m^2)
Ab : Equivalent side area of the bridge (m^2). The equivalent side area of the bridge shall be the total solid area of the bridge in normal projected elevation. For truss bridges, the equivalent side area may be assumed to be 30 % of the area bounded by the outer truss members.

ii) Wind Load on Vehicular Traffic

$Tew = W \cdot Ab1$

where, Tew : Additional uniform horizontal line load (kg) due to wind on vehicular traffic on bridge, applied at deck level.
W : $100kg/m^2$
Ab1 : Equivalent side area of the vehicular traffic bridge (m^2).

10.2.3 Load Combinations

The following load combinations shall be considered for the working stress design with permitted overstress due to low probability of occurrence and a short duration.

Table 10.2.1 Load Combinations for Working Stress Design

Load case	Load combinations						
	1	2	3	4	5	6	7
Dead loads	O	O	O	O	O	O	O
Traffic loads	O	O	O	O	-	-	O
Temperature effects	-	O	-	O	-	-	-
Buoyancy	O	O	O	O	O	-	-
Wind load	-	-	O	O	-	-	-
Collision loads	-	-	-	-	-	-	O
Construction loads	-	-	-	-	-	O	-
Permitted overstress	0 %	25 %	25 %	40 %	50 %	30 %	50 %

Traffic load combination above shall consist of ;

- "A" lane loading or "B" truck loading, + centrifugal force + pedestrian loading, or
- "A" lane loading or "B" truck loading, + braking force + pedestrian loading.