

*JAPAN INTERNATIONAL COOPERATION AGENCY
MUNICIPALITY OF ASUNCION, REPUBLIC OF PARAGUAY*

*AFTERCARE STUDY
ON URBAN TRANSPORTATION PLANNING
IN ASUNCION METROPOLITAN AREA*

*FINAL REPORT
SUMMARY*

October 1999

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Preface

In response to a request from the Government of the Republic of Paraguay, the Government of Japan decided to conduct the Aftercare Study on Urban Transportation Planning in Asuncion Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Yoshinori Tanaka of Yachiyo Engineering Co., Ltd., to Paraguay, two times between August 1998 and August 1999. In addition, JICA set up an advisory committee headed by Dr. Hisao Uchiyama, Professor of Science University of Tokyo between August 1998 and August 1999, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Paraguay, and conducted a field survey at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Paraguay for their close cooperation extended to the team.

October, 1999



Kimio Fujita

President
Japan International Cooperation Agency

Letter of Transmittal

October, 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency

Dear Sir,

It is a great honor for me to submit herewith the final reports of the Aftercare Study on Urban Transportation Planning in Asuncion Metropolitan Area.

A study team, which consists of Yachiyo Engineering Co., Ltd. and Central Consultant Inc. and headed by myself, conducted field surveys, data analysis and planning works of feasibility study in Asuncion based on the terms of references instructed by the Japan International Cooperation Agency (JICA) from August, 1998 to August, 1999.

The study team held thorough discussions and investigations with officials concerned of the Government of Paraguay, accordingly, various traffic surveys, present condition analysis, preliminary engineering design, conduct of environmental impact assessment, preparation of implementation program and project evaluation.
The results were collected in the final reports, main and summary reports.

On behalf of the team I wish to express my heartfelt appreciation to the Officials concerned of the Government of Paraguay for their warm friendship and cooperation extended to us during our stay in Paraguay.

Also, I wish to express my sincere appreciation to JICA, the Ministry of Foreign Affairs, the Ministry of Construction, the Ministry of Transport, the Embassy of Japan in Paraguay and other concerned government authorities for their valuable advice and cooperation given to us in the course of the site surveys and preparation of the final reports.

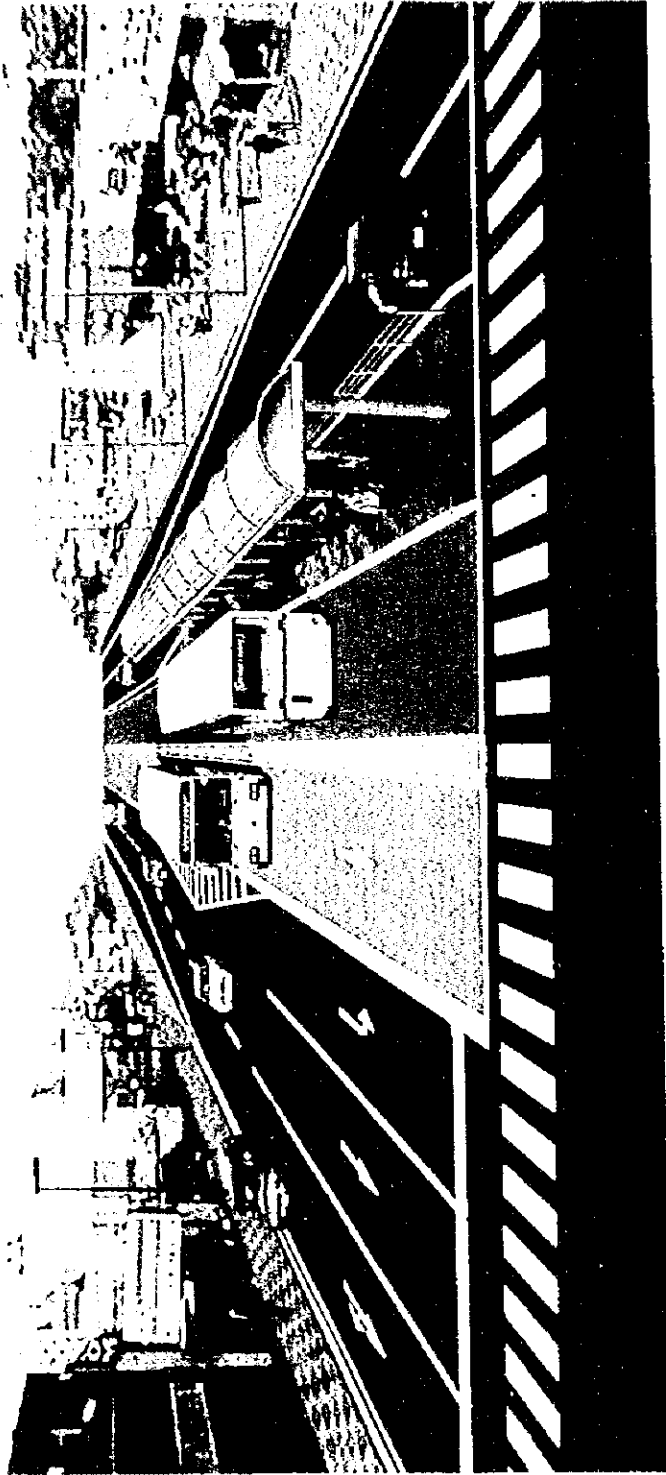
Yours Faithfully,



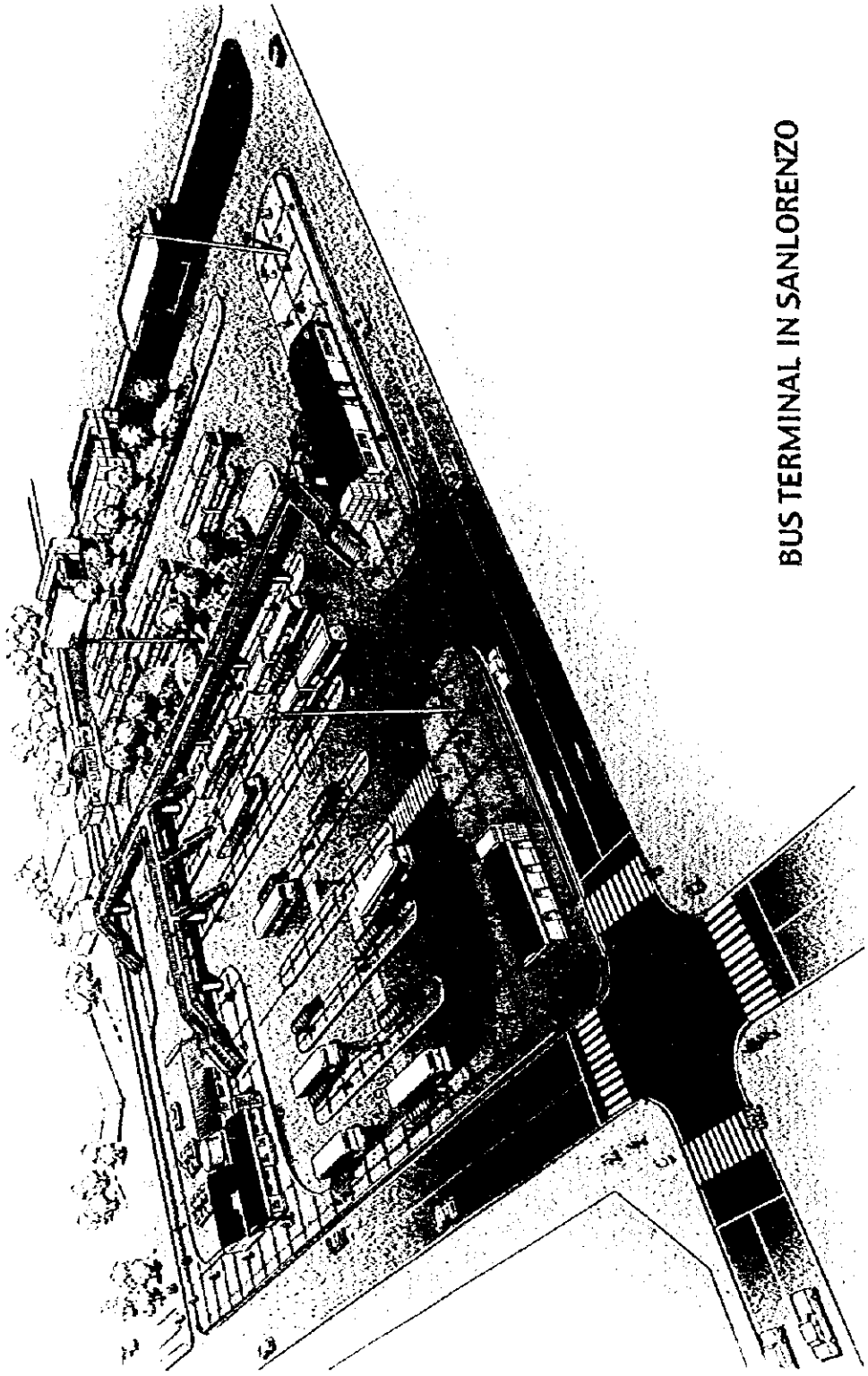
Yoshinori Tanaka

Team Leader

The Aftercare Study on Urban
Transportation Planning
in Asuncion Metropolitan Area in the
Republic of Paraguay



AVDA. EUSEBIO AYALA
TYPICAL CROSS SECTION WITH INTERSECTION



BUS TERMINAL IN SAN LORENZO



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INTRODUCTION

1. Background of the Study

In August 1984, "the Urban Transport Study in Asunción Metropolitan Area", assisted by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), was started, and the urban transportation master plan was adopted in August 1986 (This Study is called CETA84). Following the conclusion of CETA84, "the Feasibility Study on the Transportation Facilities Improvement Projects in the Asunción Metropolitan Area," also conducted by JICA, was completed in October 1988. Political, social and economic turmoil in Paraguay delayed the implementation of the proposed priority projects. In the meantime, the concentration of population and automobiles in the Asunción metropolitan area has increased more rapidly than projected, and transport problems have become one of the most serious social problems.

In response to the request of the Government of the Republic of Paraguay, the Government of Japan has decided to conduct "the Aftercare Study on Urban Transportation Planning in Asunción Metropolitan Area" (hereinafter referred to as "the Study") through JICA. The Japanese Preparatory Team led by Dr. Hisao Uchiyama was dispatched by JICA to Paraguay in December 1997, and after discussions with officials of the Government of Paraguay, the Scope of Work for the Study was agreed upon between both sides. The study team started the work in Paraguay in August 1998, and continued until August 1999.

2. Purposes and Scope of the Study

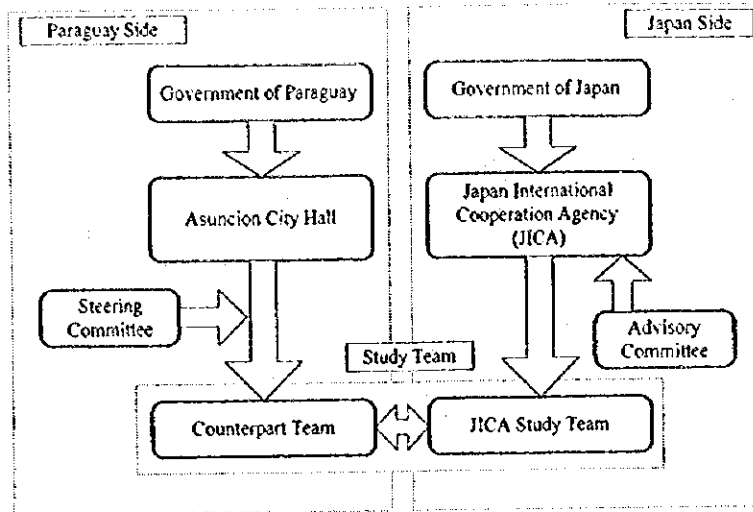
Purposes of the Study are as follows.

- 1) To revise the present Urban Transportation Master Plan for the period up to the year 2015.
- 2) To formulate short-term development plans up to the year 2005 and select high priority projects.
- 3) To conduct feasibility studies for the high priority projects.
- 4) To transfer technology during the course of the Study.

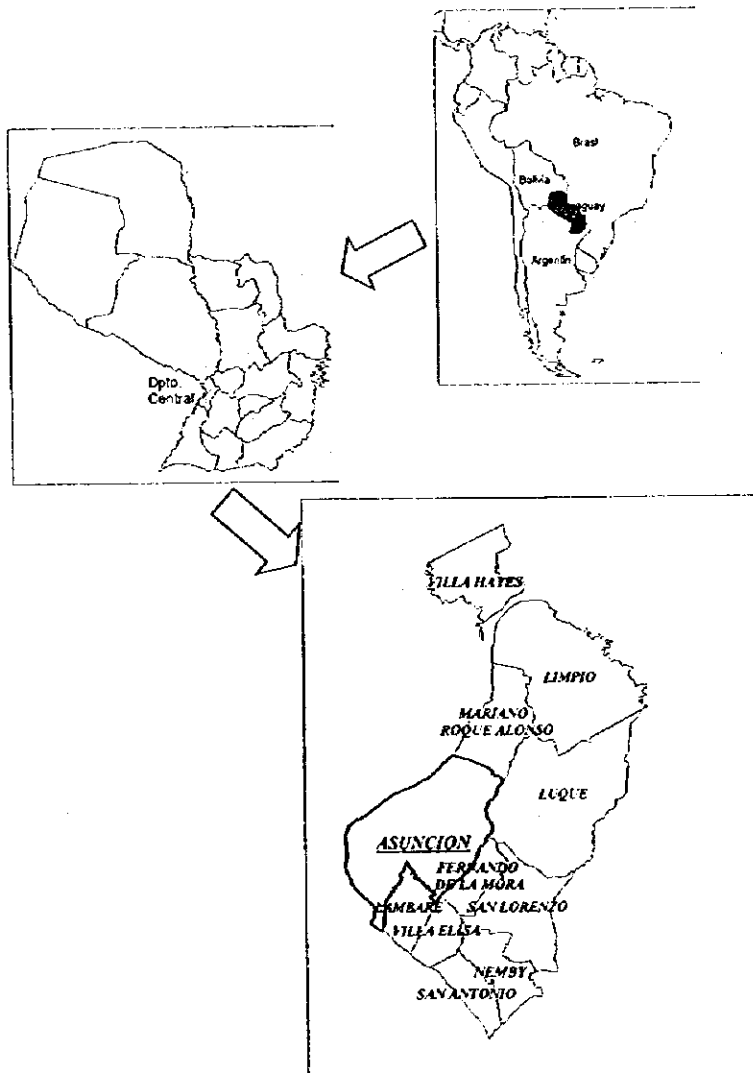
The study area covers the Municipality of Asunción and the surrounding ten cities, Fernando de la Mora, San Lorenzo, Luque, Mariano Roque Alonso, Limpio, Lambaré, Villa Elisa, Ñemby, San Antonio, and Villa Hayes. The area is called the Asunción Metropolitan Area and is the same as CETA84.

3. Study Organization

For the execution of the Study, JICA organized a study team led by Mr. Yoshinori Tanaka and an Advisory Committee chaired by Dr. Hisao Uchiyama. The Government of the Republic of Paraguay organized a counterpart team headed by Enrique J. Marin Fernandez of the Municipality of Asunción, requested their cooperation with the study team, and further established a steering committee composed of the relevant institutions for a smooth execution of the Study.



Study Organization



Study Area

PART I CURRENT CONDITIONS

I. CHARACTERISTICS OF PERSON TRIP

1.1 Population

The population in the Asunción metropolitan area increased by 3.4% during the 10-year period from 1982 to 1992. As of 1998, it is estimated at around 1.46 million, which accounts for 28% of the national figure. Since the Population Census of 1962, the trend of population growth in each municipality of the metropolitan area shows that the increase is more prominent in suburban cities, such as Luque, Fernando de la Mora, San Lorenzo, and Lambaré, than Asunción, which clearly indicates a tendency of urban sprawl. In 1992, the gross population density of the metropolitan area exceeded 40 persons/ha in Asunción, Fernando de la Mora, and Lambaré.

1.2 Number of Registered Vehicles

In 1996, the number of registered vehicles in the metropolitan area accounts for about 63% of the national figure, whereas only 28% of the national population reside in the area. The average number of vehicles per 1,000 persons is 160 in the metropolitan area, and it is even higher in such suburban cities as Fernando de la Mora, Lambaré, and M.R. Alonso, and Villa Elisa. This is 2.3 times higher than the national average. The number of registered vehicles increases each year, and it rose by 1.4 times between 1992 and 1996.

1.3 Trip Generation

The total number of trips generated, excluding pedestrians and bicycles, in the metropolitan area in 1998 is estimated at 2.3 million. It is 1.6 times higher than that of 1984 and exceeds by 1.03 times the figure CETA 84 estimated for the Year 2000.

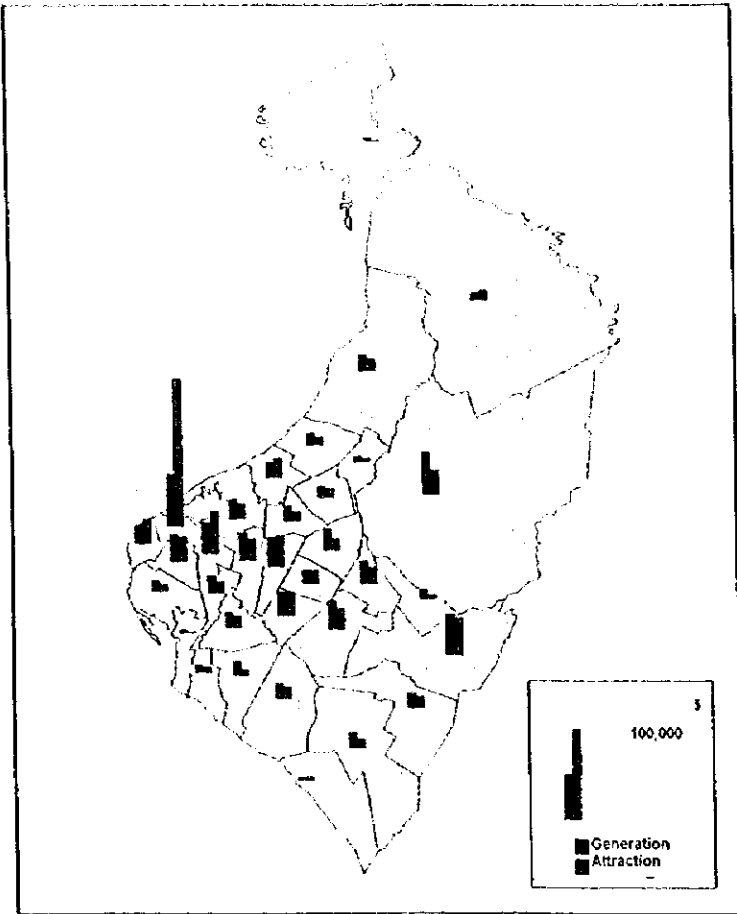
The highest figure of a generation-attraction ratio of "To Work" trips is observed in La Encarnacion, or 3.11. It is followed by 1.42 in San Roque, 1.36 in Carlos A. López, and 1.20 in San Rafael. All of these districts are located within or adjacent to Micro Centro (i.e. central business district) and contain active commercial centers.

1.4 Trip Distribution

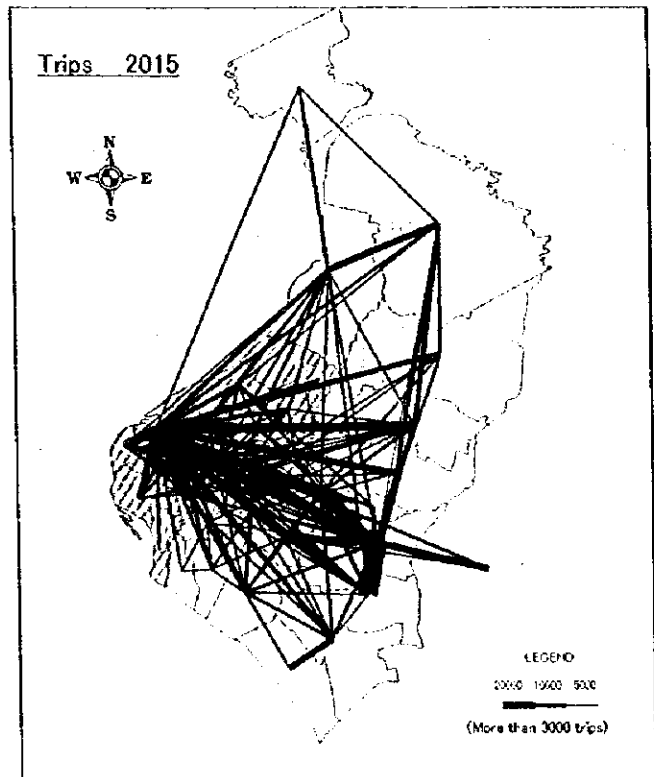
The highest traffic demand exists in sections from Micro Centro to Luque, and to San Lorenzo, respectively. Trips among suburban cities such as Limpio, Luque, San Lorenzo, and Nemby are not so great but were not foreseen by the CETA 84.

1.5 Modal Split

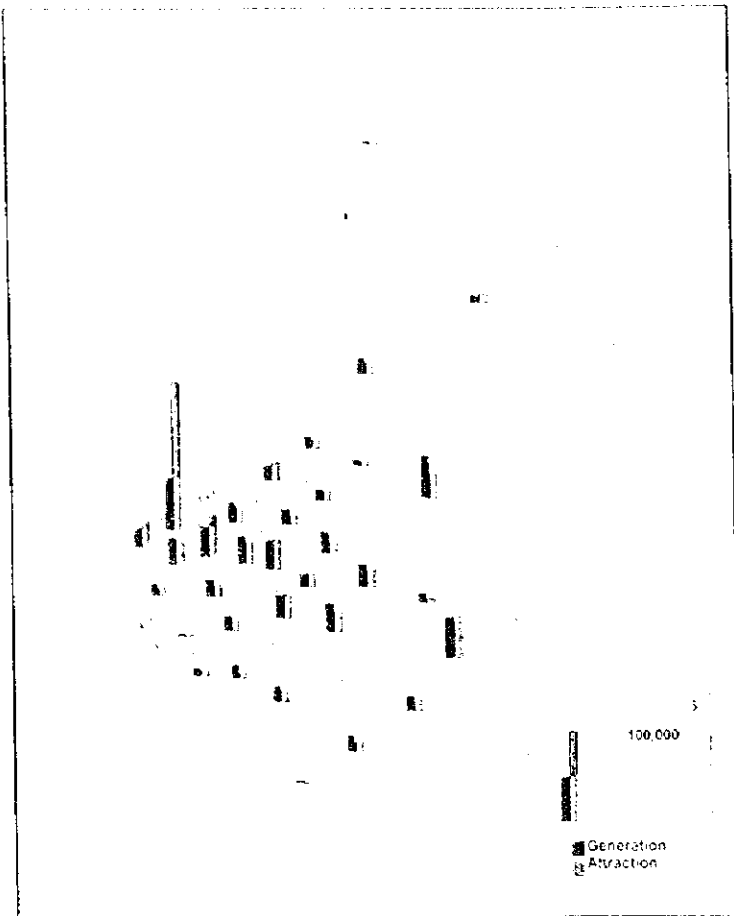
The ratio of private vehicles, including passenger vehicles, small- and large-scale trucks, to buses is 49.8 to 50.2 in 1998, and each splits the mode share almost equally. According to the mode preference survey conducted to examine the convertibility of modes from auto to bus, those factors producing greater impact on mode choice include in-bus time, time for egress, and in-bus comfort, i.e. air conditioning, congestion, and cleanliness. In particular, in-bus time and comfort are more influential than other factors, which therefore suggests that speeding up the operation and improvements of bus vehicles will contribute to the promotion of more bus use.



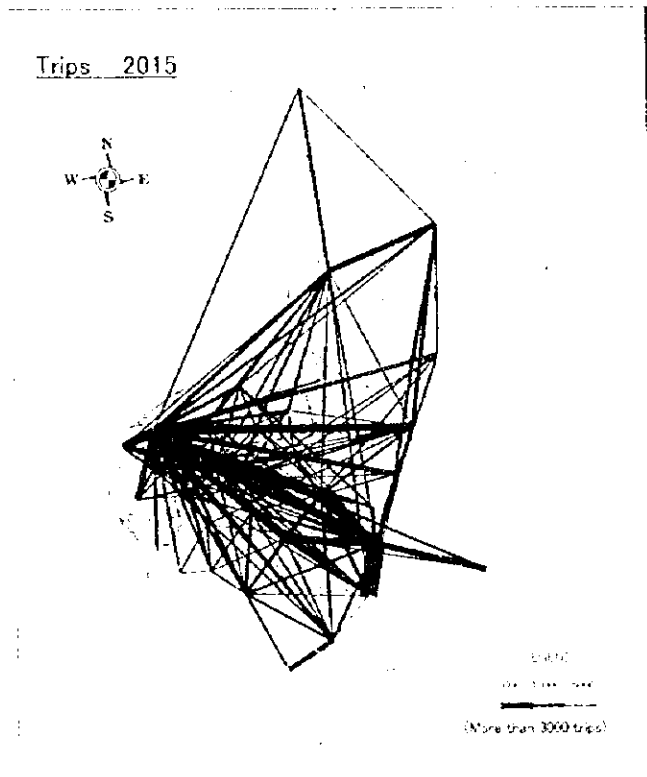
Trip Generation and Attraction (to Work Trip)



Desire Line (All Purposes)



Trip Generation and Attraction (to Work Trip)



Desire Line (All Purposes)

2. CURRENT ROAD NETWORK AND TRAFFIC CONDITIONS

The main road network in Asunción consists of six radial and six ring roads. The radial roads originate in Micro Centro and spread outward in fan shape, and each connects with national or departmental highways. Ring roads are spaced at 1 to 2km apart from each other, and the progress of their development is a little slower than for radial roads.

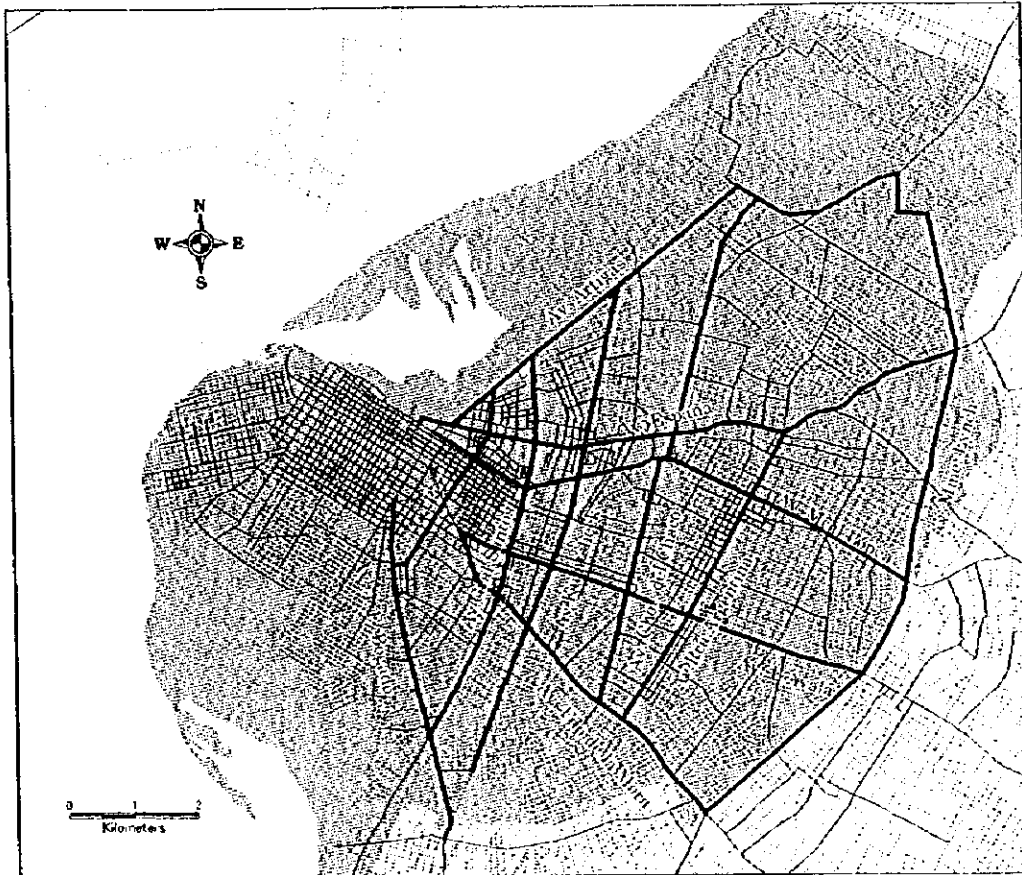
In Micro Centro, streets with the standardized width and pavement form a grid, and most of them are restricted to one-way traffic.

Except some trunk roads, most roads generally have widths of 24 to 26m with four lanes, whereas streets in Micro Centro have two lanes only.

Traffic volumes at five sections on the border of Asunción increased by about four times, compared to that in 1984. Transchaco and Av. Meal. López generate 33,700 and 29,200 vehicles (per 14 hours), and most traffic comes from the north or the east.

According to the screen-line survey on Av. Choferes del Chaco, Av. Meal. López is found to attract the largest number of vehicles, or 37,600 per 14 hours. Large traffic volumes are also observed in Av. Ayala, Av. Artigas, and Av. Fdo. de la Mora. Compared to 1984, the volume has increased by approximately 1.8 times.

In 1998, Av. Ayala shows the highest bus share. Compared to 1984, however, the share decreased on all roads.



Road Network in Asunción

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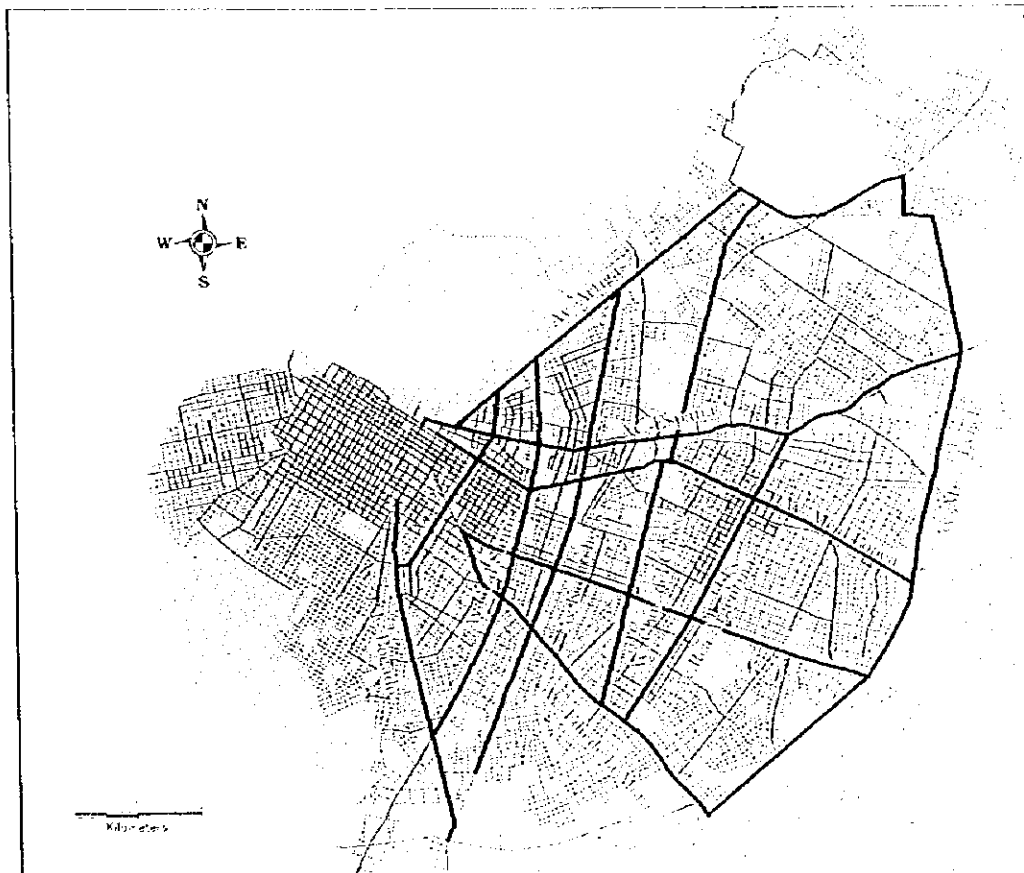
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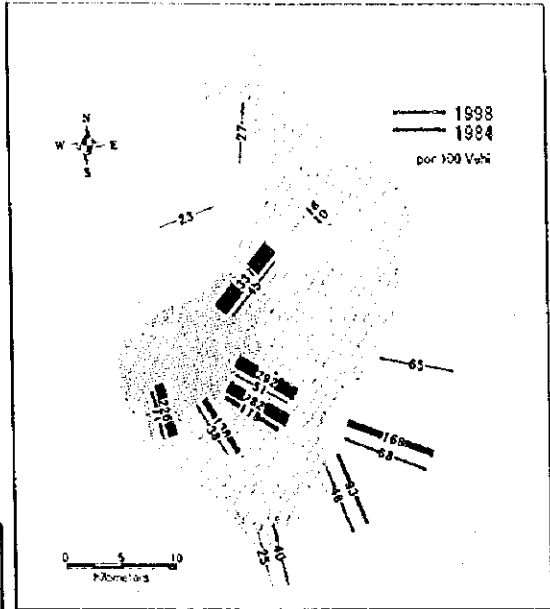
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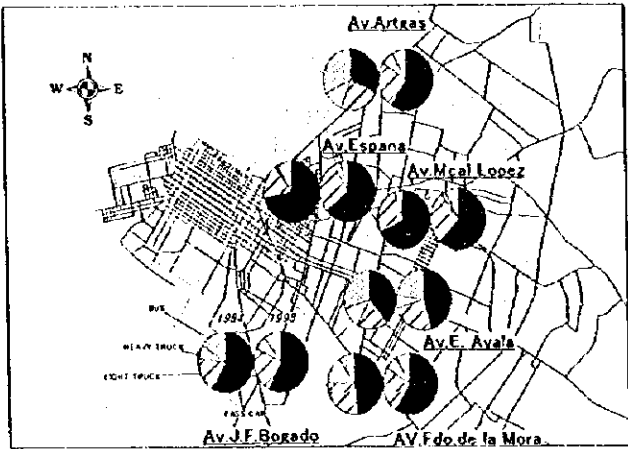
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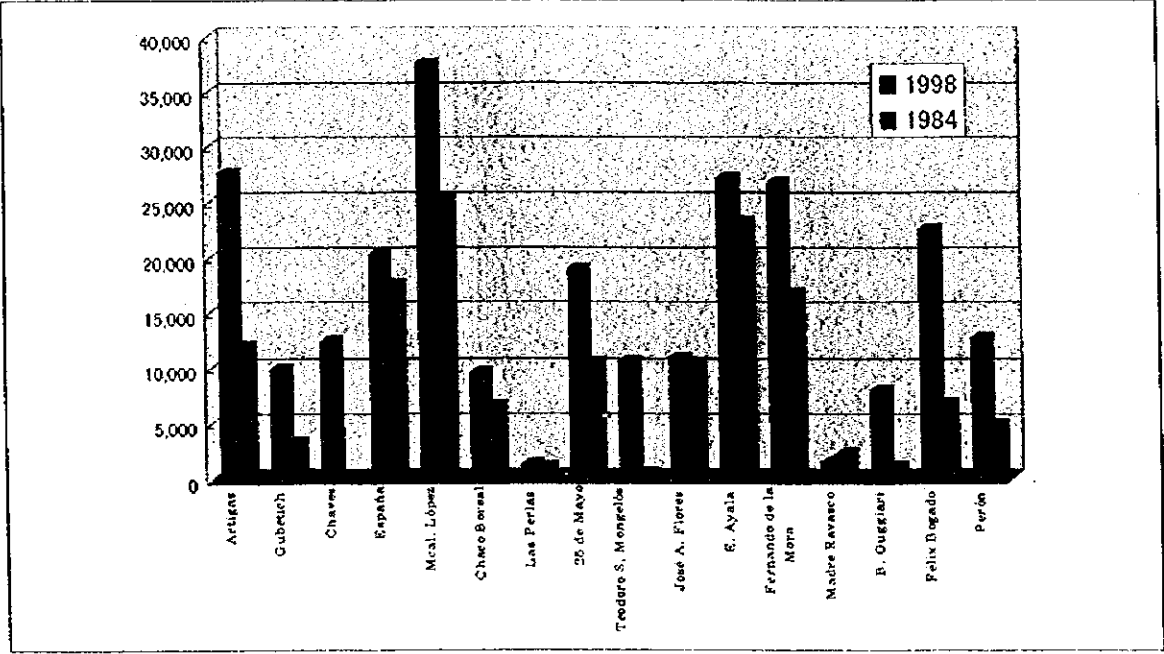
Road Network in Asunción



Traffic Volume on Asunción Border (14 Hours)



Composition of Vehicle Type



Traffic Volume on Screen-Line (14 Hours)

3. CURRENT CONDITIONS OF PUBLIC TRANSPORT

3.1 Summary

Bus service is the only mode of public transport in the metropolitan area. Although taxi services are available, people cannot rely on them because of the high fare. The railroad only makes only one round-trip between Asunción and Ypacarai on weekends and has not served as an urban transport mode to date. Trams used to be operated in Centro and surrounding areas but stopped its operation two years ago. There are no paratransit systems that can supplement the bus service. In sum, the bus is actually the only reliable mode of travel for those who do not own automobiles.

3.2 Bus Operation

The bus system is operated by the private sector. The corresponding municipality grants permission for bus operation within a single city, whereas those for operation over more than one city are issued by the Ministry of Public Works and Communications (MOPC). In either case, municipalities are responsible for bus operation registration, vehicle inspections, and the issuance of drivers' licenses and license plates.

3.3 Bus Operating Companies

Among bus companies in the metropolitan area, six are registered in Asunción and have 232 bus vehicles running on 12 routes. 53 are registered with MOPC and operate 2,274 buses on 96 routes. In general, bus companies are small in scale and consist of multiple owners of bus vehicles.

3.4 Problems with Bus Operation

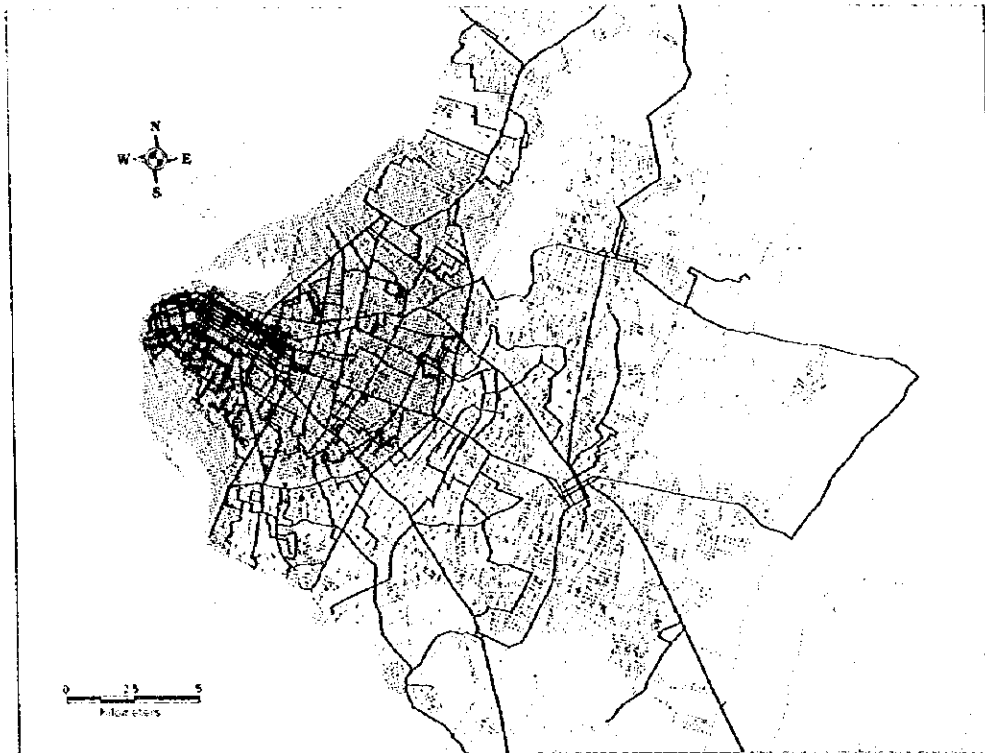
(1) Bus Route

Many bus lines originate in the suburbs and have their own routes, but on entering Asunción, they concentrate on the trunk roads. Bus services are very frequent and thus convenient for bus users on trunk roads, but they are scarce and unreliable on local roads.

The extension of bus routes is inevitably long and complex. Some of the routes include unpaved roads as well. The average round-trip distance is around 50km. Comparative cities have shorter distances of bus lines, such as 24km for Guatemala.

(2) Efficiency

As described above, the transport efficiency is rather low on trunk roads, and the operation of bus companies in general is inefficient as well. A basic index to measure bus service performance, a quotient of the number of daily passengers over the total number of operating buses (passenger/vehicle/day), is 551 passengers much lower than Guatemala's 854. It is much lower than what is recommended by the World Bank as a range of the required number of passengers, of between 1,000 to 1,200 passengers. A quotient of the total daily passengers over the total travel distance (passenger/vehicle km) is 1.7, lower than Guatemala's 4.5, and Panama's 3.7.



Bus Routes in Asunción Metropolitan Area

(3) Bus Fleet

Bus fleets have become larger and more modern. Thirty-six percent of the bus fleet are vehicles manufactured after 1996, but over 10% are still more than 20 years old. They often cause problems of noise and air pollution.

(4) Safety

Bus users often feel uncomfortable and unsafe because bus drivers tend to handle buses very roughly using high speeds. This is because salaries of bus drivers depend on how many round trips they make, and thus they tend to compete with each other.

(5) Fare Structure

Currently, the bus fare in the metropolitan area is uniformly set at Gs850. Since 1994, a committee within MOPC has reviewed and revised the fare.

Because of the simplicity of the fare structure, it is easy to understand for users, and operators could spare capital investment. On the other hand, further growth of the metropolitan area will probably generate more demands for transfers. In order to improve the convenience of the bus, it is important to introduce new measures. For instance, transfer tickets allow passengers to make transfers without any additional cost anywhere in the metropolitan area. One-day passes let users to ride buses freely for a day once they purchase one. A pass system would be very helpful for commuters and students who use the bus on a daily basis.

(6) Operation Feasibility

Because the fare is determined by only factoring in the average number of users and operation costs, many of the bus companies that have inefficient operation are not in good financial conditions. They often fall into a vicious cycle where they have no choice but to leave their buses deteriorate for aging, operational efficiency drops, and user credibility declines, which finally leads to further deterioration of their operation. Many of them are small-scale operators and have weak management basis. It is, therefore, necessary to encourage an integration of bus companies and create a decent management structure to provide reliable, regular services to citizens.

4. PLANNING ISSUES

4.1 Changes during the 14 years

It has been already 14 years since the Master Plan Study of CETA84 was completed. A comparison of socioeconomic indices and traffic conditions predicted 14 years ago with those of today leads to the following observations.

(1) Population

The population in the metropolitan area increased more rapidly than projected in CETA84, and in 1998 it was 1,457,000 and has already surpassed the forecast figure for the year 2000, 1,452,000. The population growth in suburban cities is more significant, which shows that urban sprawl has taken place more rapidly than expected.

(2) Trip Generation and Sectional Traffic Volume

The number of trips generated and the sectional traffic volume have already exceeded the projections. In particular, passenger vehicles have increased significantly, and the cordon-line traffic volume has grown rapidly, which shows an increase in traffic volume from outside the metropolitan area.

(3) Bus Transport

The total number of buses is almost the same as what was forecast. However, since the average length of bus routes increased, the number of passengers per vehicle-km decreased which makes bus transport less efficient.

4.2 Planning Issues

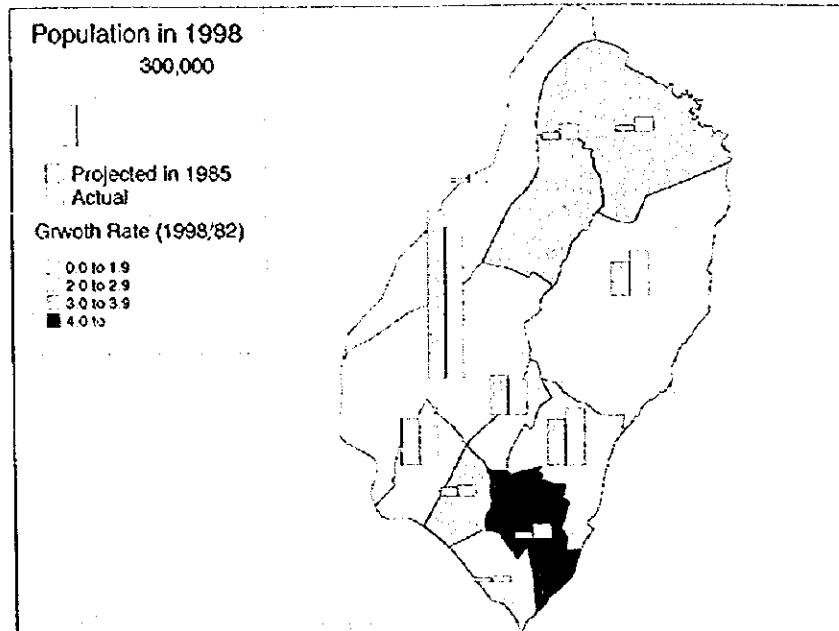
(1) Response to Changes in Socioeconomic Conditions

In considering the future urban structure and the transport system in the metropolitan area, it is necessary to question the viability of the area if the trend of motorization and low-density suburbanization continues.

Population actual and forecast in CETA84

	1992	1998	2000	Annual Average Growth Rate
Estimated in CETA84	1,141,320	1,367,570*	1,452,360	3.60
Actual Population	1,210,586	1,457,237	1,550,190*	3.14

Note: * Interpolated or extrapolated using projected or actual data



Population Growth by Municipality during 1982-1998

Comparison of Trip Generation

	1984(Actual)	1998(Actual)	2000(CETA84 Projected)
Car	521,099 (38.5%)	1,138,960 (49.8%)	813,823 (36.0%)
Bus	832,008 (61.5%)	1,150,214 (50.2%)	1,446,343 (64.0%)
Total	1,353,107 (100.0%)	2,289,174 (100.0%)	2,260,166 (100.0%)

Comparison of Cross Section Traffic Volume

	1998(Actual)	2000(CETA84 Projected)
Screen Line	297,894	259,835
Cordon Line	51,776	21,529

Comparison of Actual and Projected Bus Operation

Item	Unit	Actual in 1998	Projected for 2000 by CETA 84
No. of Bus Lines	Lines	58	41
Av. Operating Distance	Km	51.2	47.5
Total Daily Operation	Veh./day	8,107	8,685
Bus Fleet	Vehicles	2,350	2,398
Passengers /(Bus-km)	Pax/veh.-km	1.86	2.23

Note: Projection is in the case of "trend-pattern"

(2) Efficient Use of Existing Infrastructure

An increase in the use of private vehicles will lead to serious traffic congestion and eventually require huge road investment. This is the bitter experience of many motorized societies in developed countries. Despite the high density of roads in the metropolitan area and Asuncion in particular, they are not used efficiently. It is important to restructure the road network to form a hierarchy that consists of trunk roads, collector roads, and local streets. It is also critical to improve some existing roads found to be very important as trunk roads so as to maximize the use of the existing network.

(3) Examination of Strategic Public Transport Policies

In order to have citizens choose public transport as their preferred mode of travel, it is important to examine how to improve its service and encourage them to shift from private to public transport.

(4) Funding Sources and Institutional Reforms

The current budget of the cities in the Asunción metropolitan area is not enough to carry out large-scale transport projects. Thus, it is necessary to secure internal funding sources and gain funds from international assistance organizations as well as the private sector.

PART II: BASIC PLAN

5. FUTURE TRAFFIC DEMAND

5.1 Land Use Alternatives

(1) Setting Land Use Alternatives

Dispersion Pattern: the center of urbanization moves to the north where the density is relatively low (roadside area of Av. Artigas to M. R. Alonso to Limpio). Meanwhile, areas in between radial trunk roads will be gradually urbanized as well. This is very similar to the current urbanization pattern where urban sprawl takes place in all directions with low density.

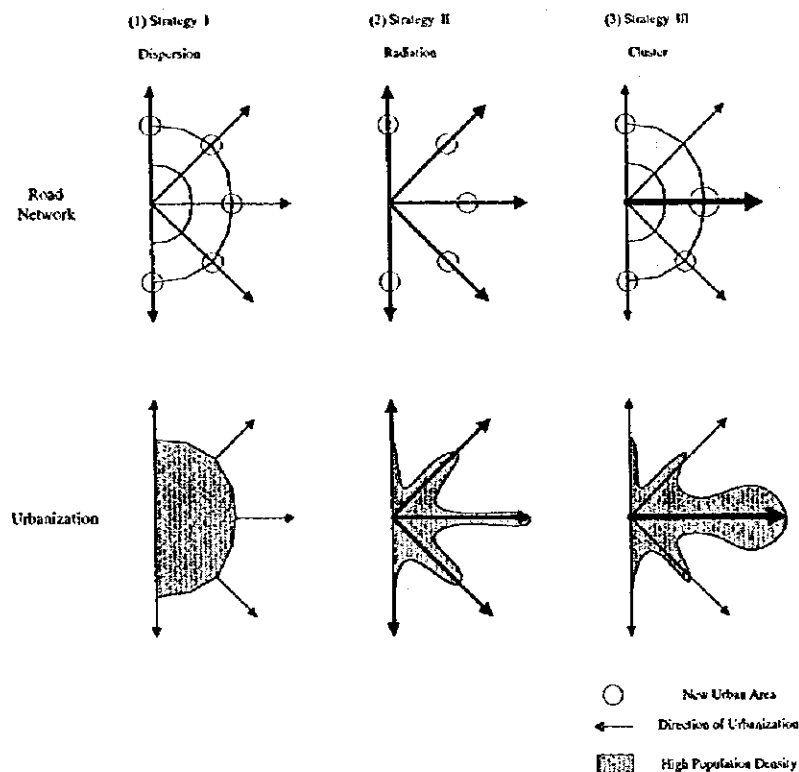
Radiation Pattern: high-density urbanization takes place along radial trunk roads.

Cluster Pattern: the primacy of Asunción will be reduced with new sub-centers, and the formation of a multi-core urban complex will be promoted.

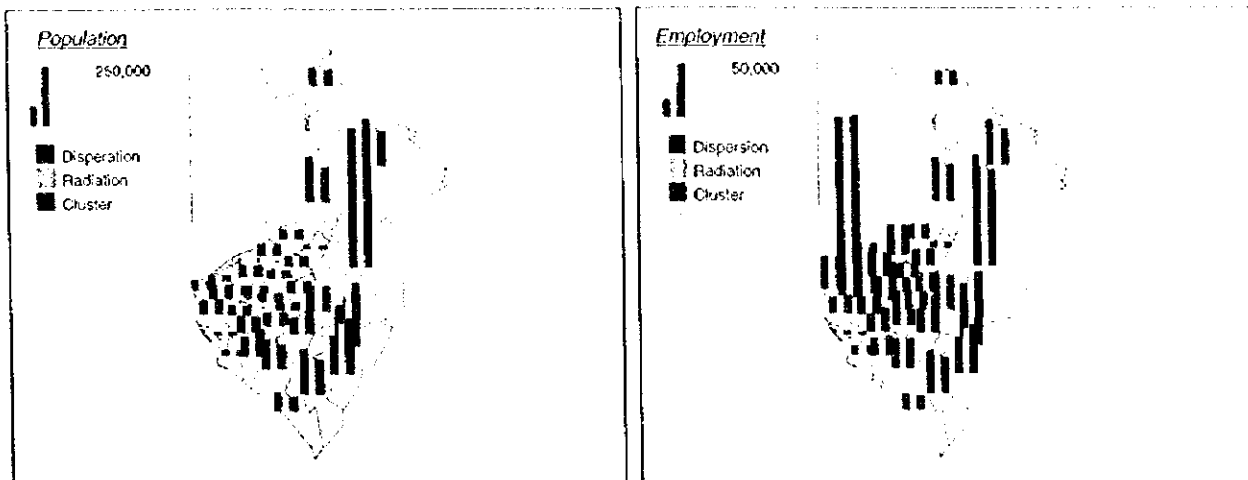
(2) Evaluation of Land Use Alternatives

This Study adopts the third, Cluster Pattern, for the following reasons.

- Ease of providing public services
- Proximity of home and workplace
- Use of the existing road network
- Ease of strengthening public transport functions



Land Use Alternatives



Population Distribution Plan of Each Land Use Alternative

5.2 Trip Generation

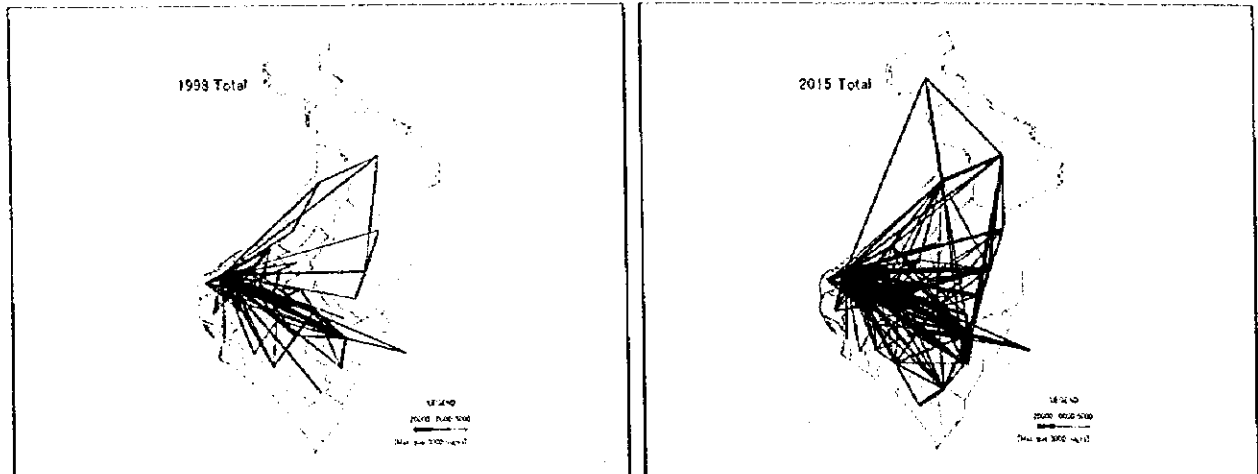
Traffic volume generated and attracted in the Asunción metropolitan area will increase by 1.77 times between 1998 and 2015, or from 2.2 million to 3.9 million trip ends. In particular, passenger vehicles will substantially increase, and their volume will become 1.92 times larger in 2015 than in 1998 and account for 52.5% of the total volume.

Results of Traffic Volume Forecast by Purpose and by Mode in Study Area

	To work	To study	Back home	Related to work	Others	Total	Share(%)
1998							
Car	365,768	91,817	430,249	65,533	119,198	1,072,565	48.5
Bus	340,550	64,396	556,236	32,590	146,328	1,140,100	51.5
Total	706,318	156,213	986,485	98,123	265,526	2,212,665	100.0
2015							
Car	641,773	130,173	958,292	124,200	204,696	2,059,134	52.5
Bus	572,070	86,530	904,316	61,880	237,998	1,862,794	47.5
Total	1,213,843	216,703	1,862,608	186,080	442,694	3,921,928	100.0
2015/1998							
Car	1.75	1.42	2.23	1.90	1.72	1.92	
Bus	1.68	1.34	1.63	1.90	1.63	1.63	
Total	1.72	1.39	1.89	1.90	1.67	1.77	

5.3 Trip Distribution

Comparison of the current and future trip distribution shows that the concentration of traffic in the center of Asunción will continue, but flows between suburban cities and from outside the metropolitan area will also increase.



Comparison of Trip Distribution

6. PLANNING POLICY

6.1 Planning Principle

The following points have been considered as principles for preparing a master plan.

(1) Comprehensive Principles

- To maintain the current level of service (operating speed)
- To consider the existing development plans
- To propose feasible plans
- To consider the environment
- To make the most of the existing stock

(2) Public Transport Planning Principles

- To resolve future public transport problems
- To introduce public transport axes onto most congested roads
- To review the functions of other public transport modes

(3) Road Planning Principles

- To improve radial trunk roads
- To improve ring trunk roads in suburban areas
- To reform the street network in Micro Centro

(4) Traffic Management Planning Principles

- To apply low-cost measures
- To introduce traffic demand management measures

6.2 Master Plan Formulating Policy

(1) To Support Appropriate Future Urban Structure

In low-density urban areas, the efficiency of public transport declines, and old vehicles continue to be used and provide fewer services. Like the case in Los Angeles, many people rely on private transport modes. The road network is not capable of handling traffic demand generated by suburban residential areas, which results in even worse traffic congestion.

In order to prevent this, the transportation network in Asunción should be developed to support the establishment of suburban cores, where businesses and commercial activities will be concentrated and medium- and high-rise residential buildings will be developed to absorb the increase in population and employment opportunities. Transportation facilities should be developed on links connecting these sub-cores, and public transport must be provided with greater capacity, higher speed, and more frequencies.

(2) Need for Comprehensive Transport System

The rapid motorization in recent years presupposes the continuation of national economic development and the stock of the existing roads constructed over time to date. However, now that it reaches a certain point of saturation, it is physically difficult to use automobiles, and it is necessary to take advantage of public transport in order to promote more efficient use of resources. In other words, it is critical to shift policy measures from the one reactive to the existing demand into another that acts upon demands proactively. Such policy measures need to realize an appropriate modal share of private and public transport users. Although the current system provides more bus service than forecast by CETA84, it nevertheless failed to stop private use of automobiles from increasing. Therefore, this Study needs to propose public transport service that can encourage the shift from private into public modes and policy measures to control the use of private vehicles.

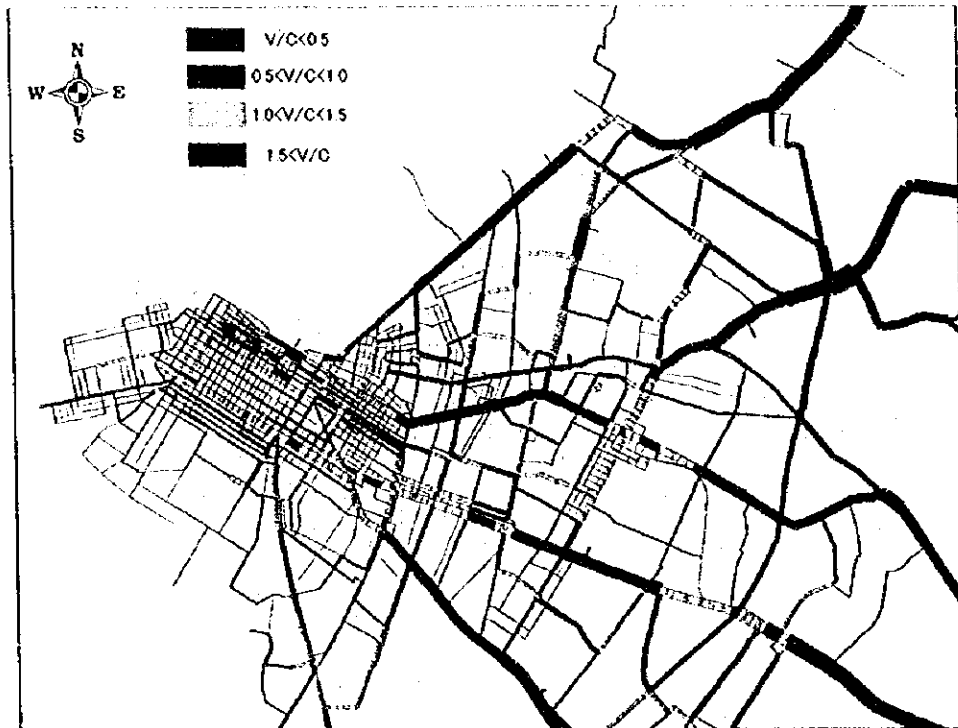
(3) Maintaining the Current Level of Service

The objective of this Study is to maintain the current level of transport service in the target year of the basic plan, 2015, when traffic demand is expected to increase further, by constantly improving road and traffic facilities. In other words, it is one of the goals of the basic policy to maintain the current operating speed for both public transport and automobiles.

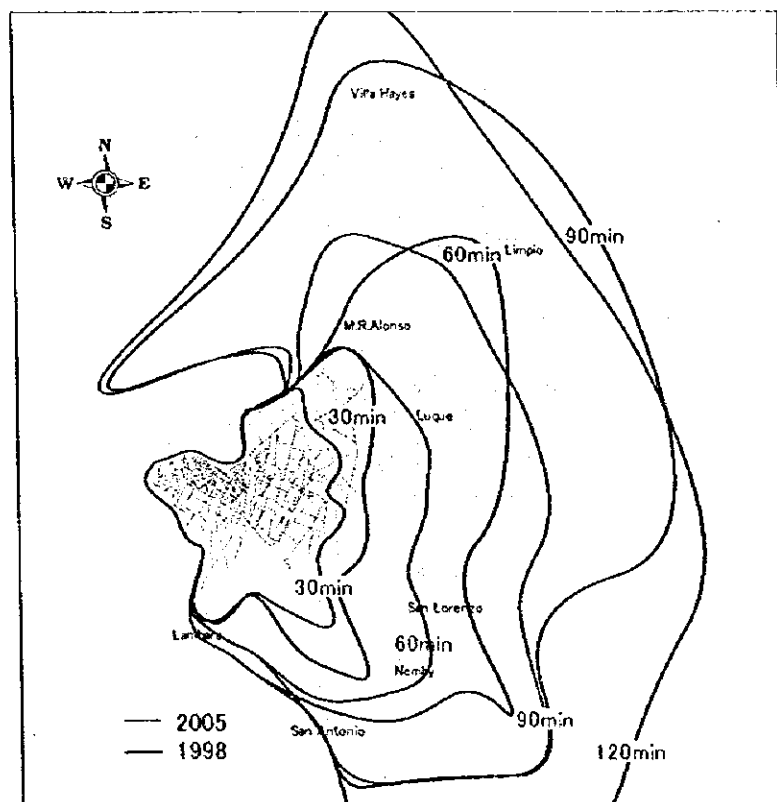
(4) Efficient Public Transport

One of the policies for improvement of public transport in the Master Plan is to introduce a system to separate line haul and area service to increase operational efficiency and to decrease the traffic congestion on the radial trunk roads, by introducing a trunk-feeder bus system. However, the present bus service in the metropolitan area is provided by the private sector, and there is few coordinating organizations among bus companies. Therefore, the public sector needs to take the initiative to establish a coordinating body and introduce trunk-feeder

service through such means as route licensing, fleet inspections, monitoring operation system, privileges for purchasing vehicles in terms of import tax, or soft loans, the provision of maintenance centers, and so forth.



Traffic Flow in 2015 under Do Nothing Case



Change in Travel Time under Do Nothing Case

7. URBAN TRANSPORT MASTER PLAN

7.1 Master Plan Alternatives

This Master Plan proposes two alternatives depending upon what type of mode share is envisioned for handling radial traffic flows, which are the primary flow direction in the Asunción metropolitan area.

- **Auto Priority Alternative:** the forecast volume of passenger vehicles will be handled with road improvements and construction, based on the mode share estimates of the trend line.
- **Public Transport Priority Alternative:** mode conversion from auto to bus will be rigorously encouraged by introducing a trunk bus system on Av. E. Ayala, implementing parking policies in Centro, and installing exclusive bus lanes on Av. Artigas, Av. Mcal. López, and Av. Fdo. de la Mora (radial trunk roads with over four lanes).

Master Plan Alternatives

	Auto Priority	Public Transport Priority	Remarks
Extension of Av. España	○	×	
BP on Av. España	○	×	
Six lanes on Av. E. Ayala	○	○ (bus improvement)	2 center lanes are exclusive for bus in public transport priority.
Trunk bus on Av. E. Ayala	×	○	
Exclusive bus lanes on main trunk roads	×	○	Av. Artigas, Av. Mcal López, Av. Fdo de la Mora
Parking policy in Centro	×	○	Raise in parking fees

7.2 Evaluation of Master Plan

The base case is defined as the existing road network plus the existing plans such as Mm Lynch widened into four lanes, and then economic benefits are calculated for each of the above two alternatives. Compared to the base case, both alternatives produce significant effects, but the public transport priority alternative does more, and the annual total benefit accrued from savings of vehicle operating costs and travel time costs will be about US\$177 million. The economic internal rate of return (EIRR) is estimated to be 34.7%, and with the discount rate of 12%, the net present value (NPV) will be US\$247 million, and the benefit-cost ratio (B/C) 2.60. Therefore, the Master Plan will adopt the public transport priority alternative.

Comparison of the Master Plan Alternatives

	Unit	Base case	Auto	Public Transport
Veh km	1,000veh km/yr	17,850	15,769	14,209
Veh time	1,000veh km/yr	2,128	566	588
Avg. Speed	Km/hr	8.4	27.9	24.2
Capital Cost	US\$ thousand	-	429,367	313,674
Benefit	US\$ thousand/yr	-	182,694	176,562
EIRR	%	-	27.1	34.7
NPV (r=12%)	US\$ thousand	-	203,894	247,017
B/C (r=12%)		-	1.96	2.60

7.3 Public Transport Plan

Up to the target year of 2015, the public transport plan proposes the use of buses as the most important policy measure. During this time, it is one of the most critical issues of this Study how to promote conversion from private to public transport. In doing so, a trunk bus system will be introduced to Av. E. Ayala, which has the highest concentration of bus lines, in order to improve the operating speed and comfort of riding. Moreover, the existing bus routes will be restructured to improve the efficiency of bus transport. Considering that air conditioning, in-bus congestion, and cleanliness are very influential to mode choice, the plan also proposes measures to encourage renovation of bus vehicles, such as an inspection system, the provision of common workshops, and so forth.

7.4 Road Network Plan

This Plan proposes measures to resolve bottlenecks that exist in the current road network, the improvement of drainage facilities and intersections, and the promotion of asphalt pavement.

7.5 Traffic Management Plan

It makes proposals for improving the system of traffic signals and revision of the parking policy to raise the fee in Micro Centro. These projects are not very costly but effective. In particular, in order to encourage more use of public transport, the parking fee policy should be accompanied with the trunk bus system to realize a public transport priority policy in the metropolitan area.

7.6 Summary of the Master Plan

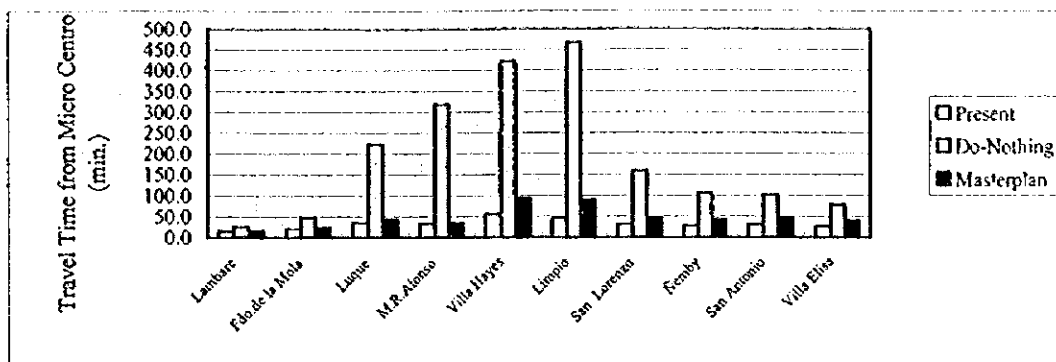
With the implementation of the master plan, the bus share would increase from 45.8% to 50.0%, and about 180,000 people in total would shift their transport modes from private vehicles into buses. Moreover, the time distance from Micro Centro to other cities would be significantly reduced.

Costs and benefits, i.e. savings in VOC and TTC, of these projects have been estimated for each project year. As a result, the EIRR have been found to be 29.4%, which shows that the master plan projects are feasible from a national economic viewpoint.

Change in Model Selection

(Unit: trips/day)

	Present (1998)	Do-Nothing (2015)	Masterplan (2015)
Car	1,138,960 49.8%	2,182,261 53.7%	2,001,644 49.3%
Bus	1,150,214 50.2%	1,879,831 46.3%	2,060,448 50.7%
Total	2,289,174	4,062,092	4,062,092



Change in Travel Time from Micro Centro in 2015

8. PRIORITY PROJECTS

8.1 Selection Criteria

- Priority on Public Transport (consistency with the policy)
- Priority on projects that will produce greater effects (high B/C)
- Feasibility (implementability)
- Environmental consideration (low emission)
- Priority on projects within Asunción

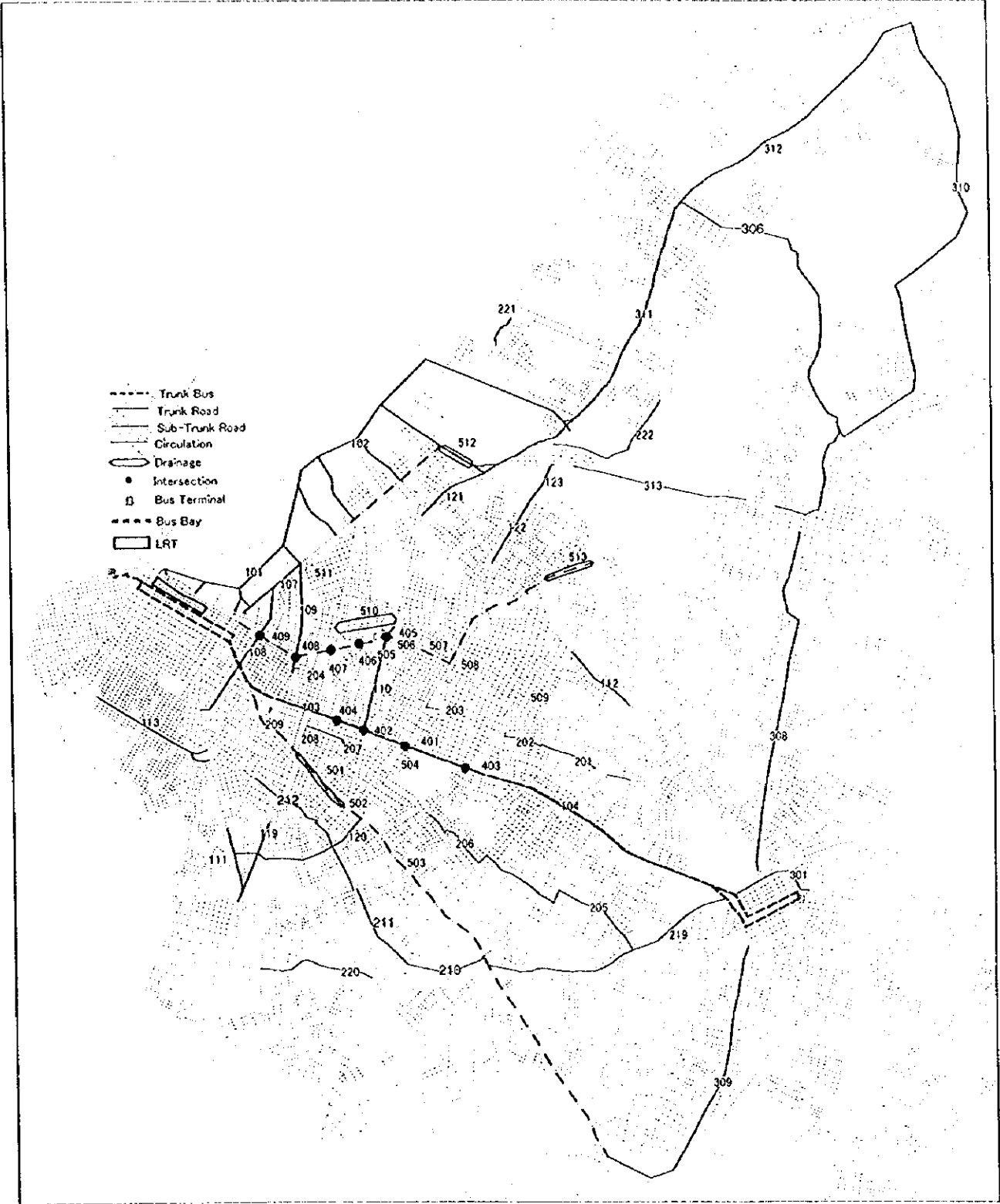
8.2 Selection Results

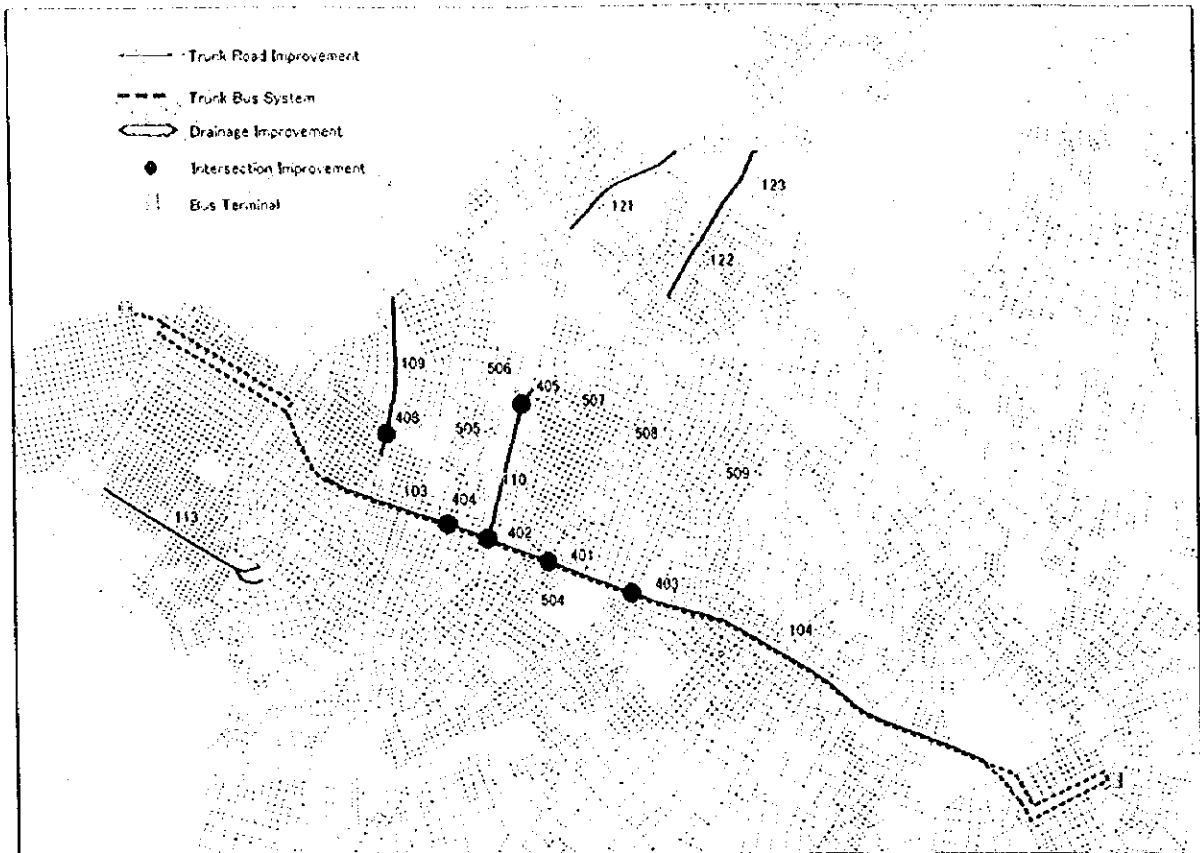
- (1) The trunk bus system on Av. E. Ayala is the most important project, and the construction of trunk bus terminals and exclusive bus lanes have been selected to improve the access to this new system. In addition, as measures to improve the road for the trunk bus, it is proposed to widen Av. E. Ayala, separate the grades of crossing roads, and improve drainage facilities.
- (2) The following projects have been chosen to improve sections on roads other than Av. E. Ayala.
 - Four-lane widening and intersection improvement on Av. Gral. Santos
 - Improvement of road drainage on Av. Mcal. López
 - Asphalt pavement of Av. Itá Ybaté
- (3) Traffic management requires immediate renovation of the traffic signal system and road markings at intersections. It is also necessary to examine parking policies in Centro and implementation measures for area licensing. Eventually, restrictions of traffic entering the district and plans for a transit mall with the restoration of trams will be introduced in Centro.
- (4) As inter-city roads outside Asunción, priorities are given to bypasses of Routes 1 and 2 where demand increases after 2006 and access roads of Luque to its surrounding cities where the population grows.
- (5) Collector roads will be improved one by one before 2015 as necessity arises. They will not employ the Frenquista system for funding but public funds in order to secure traffic functions.
- (6) Bus bays will be built on three bus lines that are expected to increase demands after 2006 in order to improve bus service and maintain smooth traffic flow.

List of Master Plan Projects

	Number	Name	Lanes	Length	Cost (1000US\$)			
					-2005	-2015	Total	
Av. E. Ayala	103	Av. Eusebio Ayala (General Aquino - Calle Ultima)	Widening	6	6.45	31,683	31,683	
	104	Av. Eusebio Ayala (Calle Ultima - San Lorenzo)	Widening	6	4.54	24,793	24,793	
Public Transportation	111	Av. J. F. Bogado (Iro. de Marzo)	Widening	4	1.65		2,353	
	113	Av. Itá Ybaté	Pavement	4	3.22	2,613	2,613	
From the South	101	Northern Esplanade	Detour	6	4.88		20,000	
	102	Northern Esplanade	Detour	4	16.32		40,000	
	107	Av. Artigas	Widening	4	1.68		2,396	
	121	Gral. Rafael Franco	Widening	4	2.04	3,970	3,970	
	122	Julio Cortés	Widening	4	1.61	3,376	3,376	
	123	Tte 2do M. Pino Gonzalez	Widening	4	0.99	2,076	2,076	
From the North	112	Av. Sta. Teresa	Widening	4	1.75		2,496	
	108	Av. Perú	Widening	4	3.28		4,677	
Circulation Road	109	Av. Gral Santos	Widening	4	2.41	5,002	5,002	
	110	Av. Chof. del Chaco	Widening	4	2.09	3,656	3,656	
	119	Av. Bruno Guggiari	Widening	4	1.62		2,310	
	120	Rca. Argentina	Widening	4	3.22		4,592	
	201	Las Residentas	Pavement	2	1.59		472	
Widening of the Arteries	202	Avelino Martínez	Pavement	2	1.11		330	
	203	Sub-Trunk Road	Pavement	2	0.27		80	
	204	Sub-Trunk Road	Connection	2	0.14		335	
	205	Avelino Martínez - Calle Última	Pavement	2	5.05		1,500	
	206	Calle Ultima - De la Victoria	Pavement	2	1.11		330	
	207	Sub-Trunk Road	Pavement	2	0.77		229	
	208	Sub-Trunk Road	Pavement	2	0.55		163	
	209	Sub-Trunk Road	Pavement	2	0.09		27	
	210	Fdo. de la Mora - Av. Def. del Chaco	Connection	2	2.44		5,836	
	211	Sub-Trunk Road	Pavement	2	1.44		538	
	212	Defensores del Chaco	Pavement	2	3.70		1,099	
	219	Avelino Martínez	Pavement	2	5.71		1,696	
	220	Av. San Isidro	Pavement	2	2.68		796	
	221	Esplanade of Fatima	Pavement	2	0.77		229	
	222	Av. 3 de Febrero	Pavement	2	3.06		909	
Connection of the Cities	301	Ruta 2 (San Lorenzo)	Detour	4	2.66		9,418	
	302	Road 1 (San Lorenzo)	Detour	4	8.62		29,644	
	306	M.R. Alonso - Luque	Detour	4	7.47		25,689	
	308	Luque - San Lorenzo	Widening	4	7.79		11,109	
	309	San Lorenzo - Nemby	Widening	4	6.84		9,754	
	310	Luque - Limpio	Widening	4	10.98		15,657	
	311	Ruta Trans Chaco	Widening	6	7.45		14,647	
	312	Ruta 3 (Limpio - M.R. Alonso)	Widening	4	6.54		9,326	
	313	Autopista Desvío (Luque - Mme. Lynch)	Detour	4	5.43		18,674	
Traffic Control	701	Signal Control System				2,497	2,497	
	702	Road and Traffic Signs				206	206	
	703	LRT in Micro-Centro	Renewal				11,340	
	704	Parking Restriction					11,340	
Intersection	401	Av. Eusebio Ayala / Av. Rca. Argentina	6x4(2)			2,729	2,729	
	402	Av. Eusebio Ayala / Av. Chof. del Chaco	6x4(2)			2,531	2,531	
	403	Av. Eusebio Ayala / De La Victoria	6x4(2)			2,167	2,167	
	404	Av. Eusebio Ayala / Kubitscheck	6x4(2)			2,921	2,921	
	405	Av. Mcal. López / Av. Chof. del Chaco	4x4			71	71	
	406	Av. Mcal. López / Venezuela	4x2				71	
	407	Av. Mcal. López / Av. Kubitscheck	4x4				71	
	408	Av. Mcal. López / Av. Gral. Santos	4x4			71	71	
	409	Av. Mcal. López / Av. Perú	4x4				71	
Drainage	501	Av. Fdo. de la Mora / Bartolomé de las Casas	4x2				18	
	502	Av. Fdo. de la Mora / From Kubitscheck to Gral. Santos	4				18	
	503	Av. Fdo. de la Mora / San Martín	4x4				18	
	504	Av. Eusebio Ayala (General Aquino - San Lorenzo)	6	10.99		11,548	11,548	
	505	Av. Mcal. López / Sta Rosa	4x2			1,338	1,338	
	506	Av. Mcal. López / Av. Chof. Del Chaco	4x4			1,337	1,337	
	507	Av. Mcal. López / Gral. Garay	4x2			716	716	
	508	Av. Mcal. López / Av. San Martín	4x4			2,130	2,130	
	509	Av. Mcal. López / Bernardino Caballero	4x2			3,328	3,328	
	510	Av. España / From Kubitscheck to Sacramento	2(4)				18	
	511	Av. Artigas / Av. Gral Santos	4x4				18	
	512	1er. Presidene / From Artigas to Transchaco	4				18	
	513	Av. Aviadores del Chaco	4				18	
Transport Facility	601	Bus Bay / Av. Artigas					734	
	602	Bus Bay / Av. Mcal. López					564	
	603	Bus Bay / Av. Fdo. De la Mora					828	
	604	Bus Terminal / San Lorenzo				4,421	4,421	
	605	Bus Terminal / Centro				1,665	1,665	
	606	Parking for Trunk Bus				766	766	
						117,611	251,116	368,727

Location Map of Master Plan Projects





Selected Priority Projects

PART III IMPLEMENTATION PLAN

9. TRUNK BUS PROJECT ON E. AYALA AVENUE

9.1 E. AYALA AVENUE WIDENING

In order for trunk buses to operate smoothly between Centro and San Lorenzo, exclusive trunk bus lanes will be provided on Av. E. Ayala.

Projects related to this widening project are described below.

- 1) Widening of Av. E. Ayala and Mcal. Estigarribia into six-lane roads.
- 2) Provision of exclusive trunk bus lanes.
- 3) Constructions of four viaducts at intersections with major trunk roads.
- 4) Improvements of road drainage facilities.

(1) Trunk Bus Section (Typical Cross Section)

The traffic demand forecast has found it necessary that Av. E. Ayala and Mcal. Estigarribia be widened into six-lane roads. Av. E. Ayala that currently has four lanes (six lanes in some sections) will be a six-lane road. The two central lanes in both directions will be exclusively used for the trunk bus and the outer four lanes by feeder buses and other vehicles. The road width will be 35m including sidewalks on each side. On the other hand, in Micro Centro and San Lorenzo, the existing two lanes of one-way traffic will be maintained as they are, and trunk buses will exclusively use the right lane.

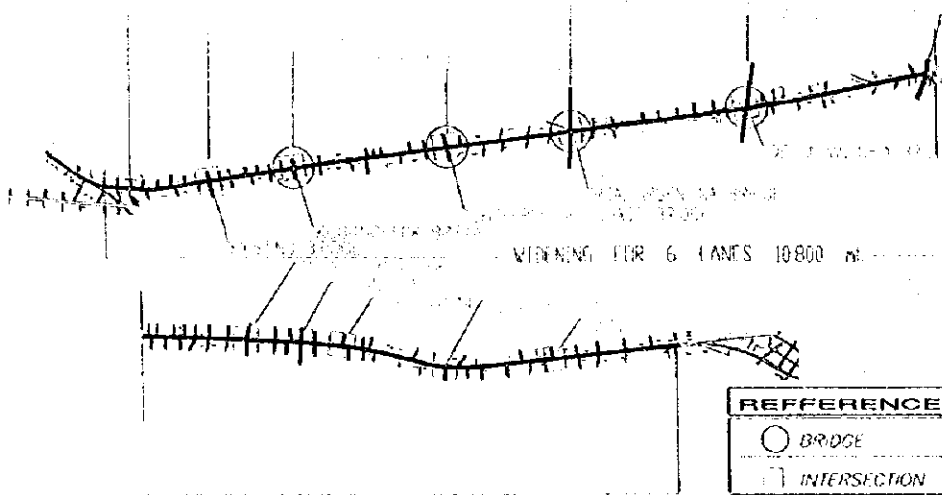
Widening will require replacement of 157 buildings, among which 112 are commercial facilities. Area-wise, the total floor area is 65,500m² and the total land area 27,500m², or about 93,000m² in total.

(2) Plan and Profile

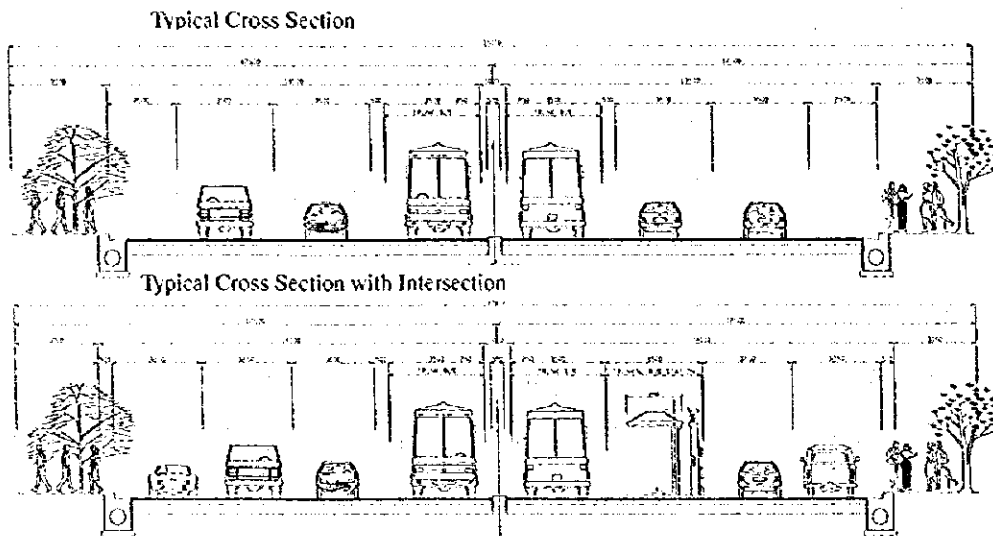
Since this is a widening project of the existing road, basically existing horizontal and vertical alignments will be maintained. It has been revealed, as a result of the future traffic assignment analysis, that six lanes, including the exclusive lanes for trunk buses, will be required on Av. E. Ayala and Mcal. Estigarribia. Moreover, at principal intersections, where Av. E. Ayala crosses four main streets, due to high traffic volume, it has been concluded that viaducts will be required. These four main streets are as follows:

- Kubitscheck
- Av. Choferes del Chaco
- Av. Rca. Argentina
- Av. De la Victoria.

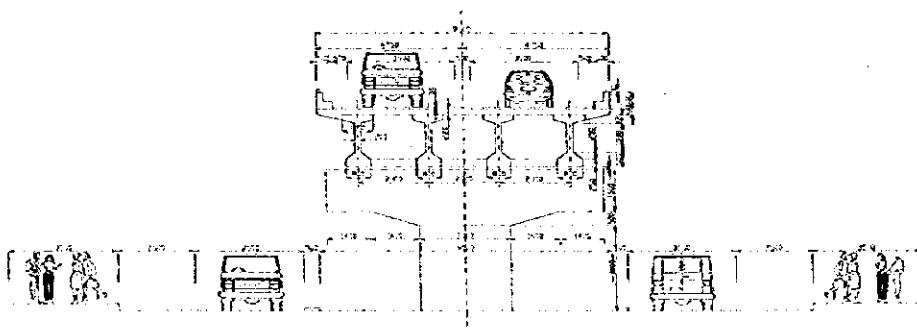
The above four main streets will be elevated in order to minimize obstructs of the trunk bus on Av. E. Ayala.



General Project of Eusebio Ayala and Mariscal Estigarribia Av.



Typical Cross Section of Eusebio Ayala Av.



Typical Cross Section with Bridge (Rca. Argentina)

9.2 PHYSICAL PLANNING OF TRUNK BUS PROJECT

For the trunk bus project selected as given the first priority, passenger demands, required functions and structures of the trunk bus, bus routes, and bus terminals have been determined as follows.

(1) Demands for the Trunk Bus

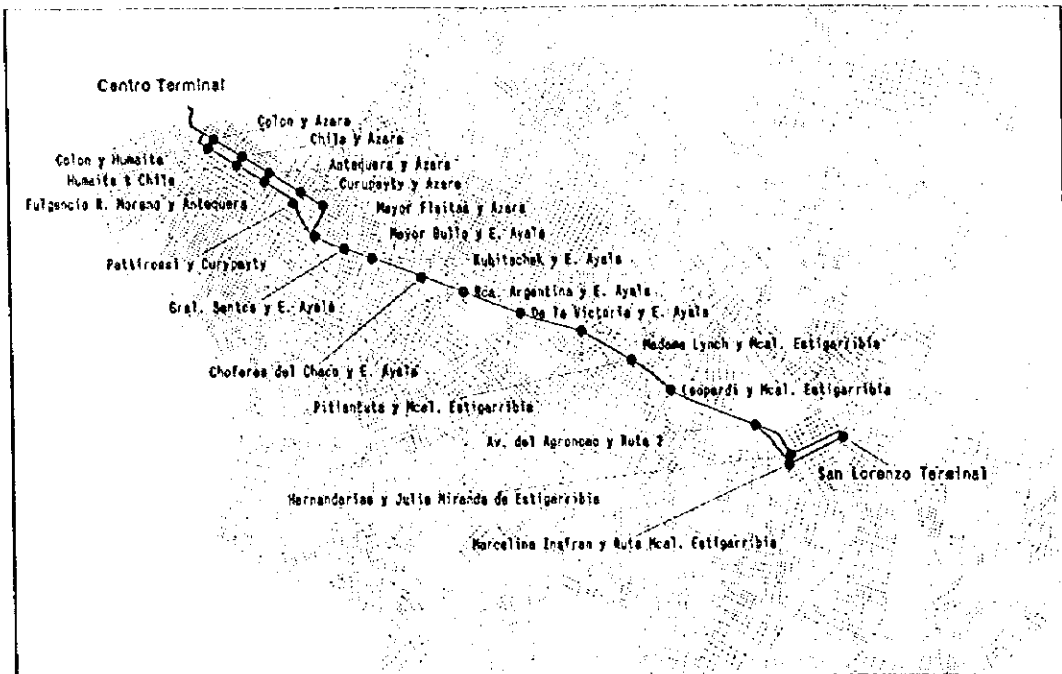
Items	Unit	2005	2015
Daily passengers	Persons/day	215,392	317,523
Users of San Lorenzo Terminal	Persons/day	86,251	122,001
Daily bus frequencies	Vehicles/day	523	755
Required number of vehicles	Vehicles/day	44	63

(2) Requirements of the Trunk Bus

Items	Requirements
Vehicle Capacity	Two-sections articulated bus. 160 passengers
Frequency	Headway of one minute at minimum.
Speed	The current bus speed is 23 km/h on average, and it is forecast to slow down to about 15km/h. For better performance than this, the new system is designed for 25 to 30km/h.
Operating Line	Exclusive lanes will be provided in the middle of the road beside the median strip. Linear bus service will be provided between San Lorenzo and Centro.
Spacing Between Bus Stops	1km on average. High-speed operation requires a longer spacing than the existing one. Between San Lorenzo and Mme. Lynch, it is planned to be longer. To increase the service level, in Asunción, the trunk bus stops at intersections with other trunk roads, and in Centro, it makes more frequent stops.
Bus Stop Facilities	Considering transfers to the existing lines, wide platforms are necessary. Good access to roadside facilities is needed as well.
Terminal	Built in San Lorenzo (19,700m ²) and Centro (6,200m ²). The terminal in San Lorenzo needs to respond to demands for transfers to suburban lines. The Centro terminal will be small and have facilities for turning buses and time adjustments only.
Storage Facility	Built in San Lorenzo for 24 trunk bus vehicles parking during nighttime

(3) Structure of Trunk Bus

- 1) Vehicle: two-sections, 4-door.
- 2) Passenger Capacity: 160 passengers (80% more capacity than the current buses with length of 12m and 90 passengers).
- 3) Vehicle Structure Standard: total length, 18m. height, 3.1m, width, 2.5m.
- 4) Minimum turning radius: 12m (same as 12-meter bus)
- 5) Exclusive lane: two lanes beside the median strip on Av. E. Ayala and Mcal Estigarribia with a width of 3.5m each.
- 6) Maximum gradient (road): 4.1%



Trunk Bus Route

(4) Bus Terminal in San Lorenzo

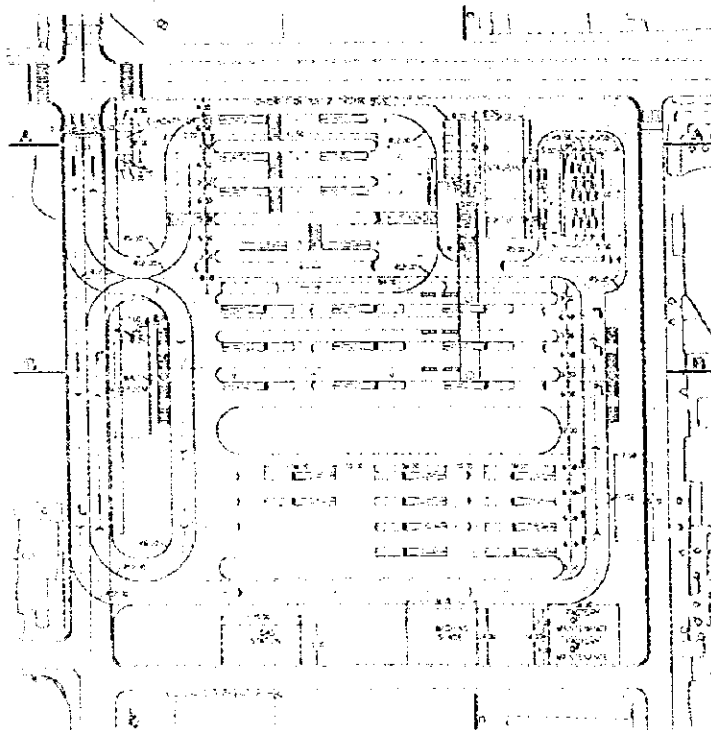


Image of Trunk Bus Vehicle



Legend

- Trunk Bus
- Feeder Bus
- Taxi

Number of bus bays for the trunk bus (articulated): 19 bays

Number of bus bays for the feeder bus: seven bays are found necessary from the calculation, but nine bays will be provided for the existing bus lines.

Number of taxi bays: 12 bays (two bays for passenger loading and unloading).

(5) Cost Estimation

Projects	(US\$ thousands)	
	Project Cost	Land Acquisition
Widening of Av. E. Ayala	66,816	8,180
Grade-separated intersections	10,348	2,018
Bus stops	1,208	-
San Lorenzo Bus Terminal	4,421	1,265
Centro Bus Terminal	1,666	723
Bus Storage Facilities	766	555
Total for Infrastructure	85,224	12,741
Purchase of Trunk Bus Fleet	14,460	-
Purchase of Feeder Bus Fleet	20,656	-
Total for Bus Fleet Purchase	35,116	-
Grand Total	120,340	12,741

9.3 OPERATION PLAN FOR TRUNK BUS PROJECT

(1) Project Scale

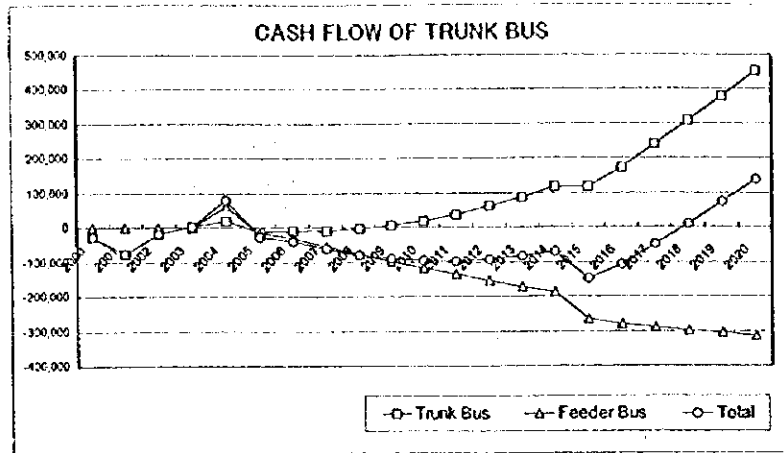
- The project period is 20 years from 2000 to 2020, with its preparation starting in 2000, and the operation launching in 2005.
- The total investment amounts to US\$85,224,000 for infrastructure and US\$35,116,000 for procuring the bus fleet.
- Two-section trunk bus: 49 vehicles (10 years of lifetime)
- Feeder bus: 311 vehicles (10 years of lifetime)
- Total annual travel distance: 6.9 million km by the trunk bus and 29.3 million km by feeder buses.
- Passengers using the trunk bus: 220,000 passengers/day (in 2005)
- Number of employees: approximately 1,000 persons

(2) Operational Figures

It is assumed that the public sector is responsible for building exclusive bus lanes, widening, and grade-separated intersections, and that a private operator will be in charge of other construction works. Cash flow of the project is calculated based on the assumption that the capital is 10% of the total construction cost, or US\$8,522,000, an interest of long-term borrowings of 8%, the trunk bus fare Gs1,000, and the feeder bus fare Gs850.

If it operates only the trunk bus, the cash flow turns positive after five years of operation, or 2009. On the other hand, if it operates only feeder buses, it will incur deficits every year during the project period. Joint operation of the trunk and feeder buses will make it profitable in the 14th year of the project, or in 2013, and its financial internal rate of return is 7.9%.

The FIRR increases to 27.1 to 44.2% when the public funding can be secured for the widening and a grade-separation of the intersection of Av. E. Ayala. In particular, when the public sector is in charge of the widening of Av. E. Ayala, including grade-separation of intersections, the FIRR will improve dramatically from 7.9 to 27.1%.



	Widening Av. E. Ayala (including grade-separated intersection)	Bus Terminal	Bus Bays	Bus Procurement	FIRR
Base Case	B	B	B	B	7.9%
Case 1	P	B	B	B	27.1%
Case 2	P	P	B	B	37.2%
Case 3	P	P	P	B	41.2%

Note: B = paid by the bus operator. P = paid by the public sector

(3) Alternatives for Operating Entity

The following schemes can be considered for construction and maintenance of trunk bus infrastructure and operation of the trunk buses.

Alternative A: Public Corporation

A public corporation will be established and funded by each municipality in the metropolitan area. It takes part in all the necessary functions, including building infrastructure and operating buses. Since it is a public institution, it is relatively easy to receive loans from international assistance organizations.

Alternative B: Public-Private Mixed Entity

A public-private entity will be formed by a group of municipalities with their own funds and the existing bus companies with their own financial resources as well. As in Alternative A, it builds infrastructure and operates buses. Bus companies in the entity will be integrated, and operation efficiency of the private sector can be gained as well. Public assistance is easily available. However, there are few past experiences of this kind in Paraguay.

Alternative C: Integration of Existing Bus Companies (or Cooperative)

Bus companies affected by the project will form a cooperative or consolidate themselves into a new company and then operate trunk and feeder buses. The municipality of Asunción will construct exclusive bus lanes and terminals, receive commissions from the association or new company, and supervise it.

Alternative D: Concession

Municipalities of the metropolitan area will construct exclusive bus lanes and terminals and procure bus fleet with low-interest public funds. They will open a tender for those facilities and the right of bus use and then give a concession to a private entity to operate the buses.

In Paraguay, there has been no experience in establishing a public corporation, and thus there is no accumulation of this know-how. The tertiary sector scheme has been implemented in some cases, which did not turn out to be very successful. In addition, there are problems of coordinating with the existing bus companies in adopting the concession scheme. However, the cash flow discussed above shows that this project is feasible for a private company if loans with low interest rate are available. By inviting them, it is possible to avoid unnecessary conflicts and make the most of their knowledge and experience accumulated to date. Therefore, among these alternatives, Alternative C has proved to be the most appropriate under the socioeconomic conditions of Paraguay. Nevertheless, it is imperative for the public sector like municipalities to take an initiative in securing funding sources and resolving any conflicts or interests among private bus companies.

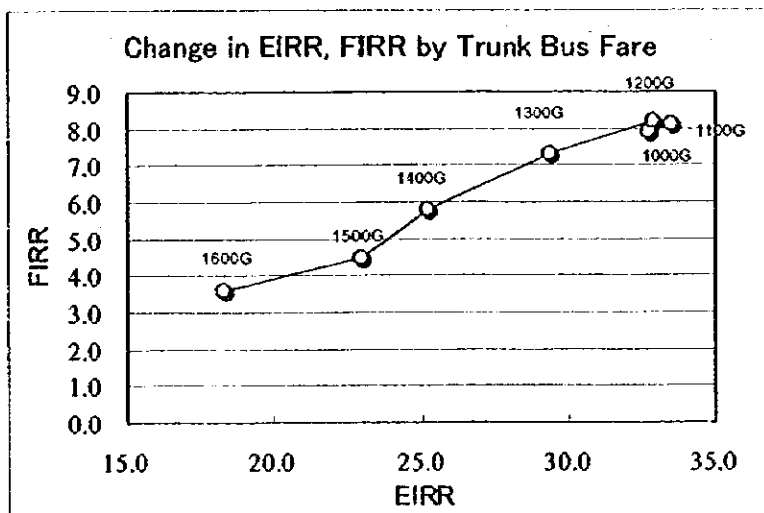
The comparison of the operation body alternatives is summarized as follows.

Item	Alter. A Public C.	Alter. B Mixed E.	Alter. C Integrated C.	Alter. D Concession	Remarks
Public fund requirement	B	F	G	G	Fund for establishment
Easiness of foreign fund procurement	G	G	F	F	Fund from World Bank etc.
Conflict with existing operators	B	F	G	B	Consensus
Efficient operation	B	F	G	G	Efficiency by private sector
Institutional conformity	B	F	G	G	Privatization is a recent policy of Government

Note, G: Good F: Fair B: Bad

(4) Fare System

The number of bus users varies with a bus fare, so do the FIRR of the trunk bus and EIRR of the metropolitan area as a whole. The results of the analysis show that if a fare remains between Gs1,000 and 1,200, the FIRR or EIRR does not change very much, but a fare of over Gs1,300 would reduce both of the indicators. Thus, it has been determined reasonable to set the fare around Gs1,000 to 1,200.



Moreover, in order to stop the trend of motorization and increase the attractiveness of public transport, it is necessary to simplify the bus fare structure and make it user friendly. For more efficient operation, it is justifiable to bus users to introduce a hierarchical route system and separate trunk lines from feeders if users are allowed to transfer with low costs. For example, transfer tickets that allow for transfer within two hours of the first ride will be introduced. A uniform fare system or a system with large fare zones must be adopted. Furthermore, sales of discounted tickets, such as one-day, one-month, and three-month passes, are considered for promotion. Tickets should be purchased before boarding at bus terminals, bus stations, or kiosks near bus stops.

(5) Issues for Project Implementation

Feasibility of this project is fairly good if a loan with low interest rate is available. However, capital demand and interest burden during the first few years of the project will be significant, and the largest amount of accumulated debt will reach about US\$25 million. There is no single bus company that can sustain itself in these financial conditions, and even an integration of some companies will be confronted with some difficulties. Therefore, it would be desirable for the public sector to take responsibility for infrastructure works such as the bus terminals. In this way, the private operator only pays fees for using them, and the public sector repays its debt each year and makes interest payments. Implementation of the project requires administrative initiatives by the public sector including municipalities.

10. OTHER ROAD IMPROVEMENT PROJECTS

Road improvement projects other than Av. E. Ayala are described below.

- Widening of four main trunk roads
- Improvements of intersections on trunk roads that currently experience bottlenecks
- Improvements of road drainage facilities
- Pavement improvements

10.1 Road Widening Projects

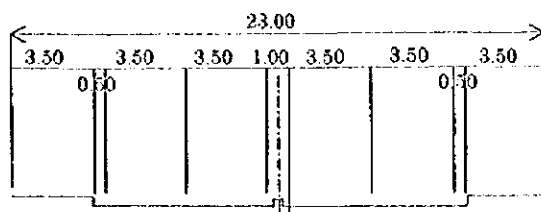
Taking future road network development into consideration, the widening of Av. Choferes del Chaco, Av. Gral. Santos, Av. Rafael Franco and Av. Julio Correa has been proposed.

Purposes and specifications of each trunk road are described in the table below.

Widening projects for 4 lane		Purposes	Extension (km)	Max. slope
Road Improvement from the North				
	Av. Rafael Franco	Road density of the northern part will be strengthened. Connection with Madame Lynch will be established.	2.43	1.68%
	Av. Julio Correa	Same as above	3.10	8.85%
Circulation Roads				
	Av. Gral. Santos	Designated as a four-lane road by ordinance, it requires improvements to play a role as an urban ring road. Connection with Franja Costera will be strengthened.	2.33	4.10%
	Av. Choferes del Chaco	Same as above	2.78	2.80%

(1) Component of Cross Section

The cross section of each road is shown below.



(2) Alignment

As for horizontal alignment, the existing alignment will be maintained. These roads will be evenly widened on both sides from two to four lanes. As for vertical alignment, the existing gradient will be maintained.

10.2 Intersections

There will be improvements to major intersections on Av. E. Ayala and intersections at start and end points of other roads which will be widened. Purpose of the improvements of intersections is, by setting up left-turning lanes with sufficient lengths, to remove obstructions for through traffic. Left-turning lane length has been calculated based on the future traffic volume. The cost of intersection includes each of the widening projects.

10.3 Rainwater Drainage Improvement

Rainwater drainage will be improved around the following intersections. Since few or no rainwater drainage facilities are actually provided at these sites, drainage facilities with adequate capacities for the runoff water volume will be constructed up to the downstream.

- Av. Mcal. López and Av. Choferes del Chaco
- Av. Mcal. López and Av.Gral. Garay
- Av. Mcal. López and Av. San Martin
- Av. Mcal. López and Bernardino Caballero

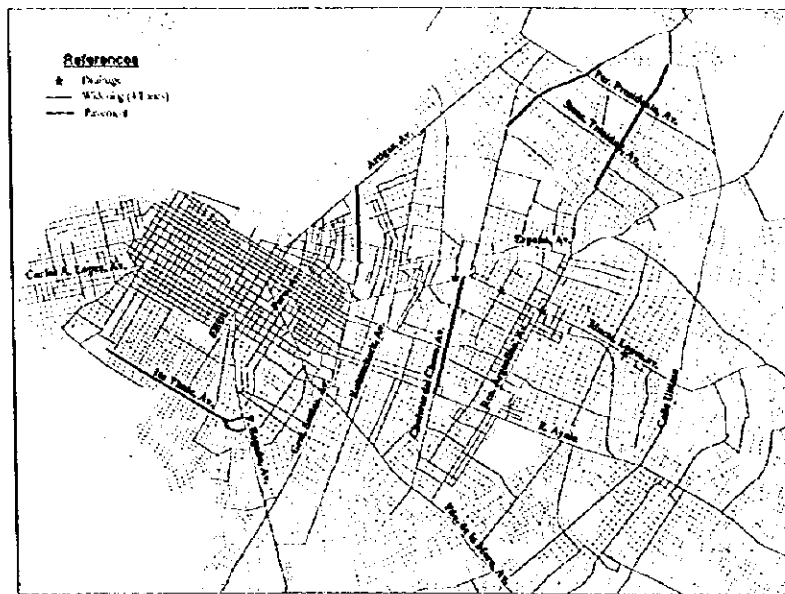
10.4 Pavement

In order to provide a new southern axis into Micro Centro, Itá Ybaté, currently a gravel road, will be paved with asphalt. Pavement component is shown in the table below.

Pavement Component			
Section	Pavement component	Method, Material	Thickness(cm)
Itá Ybaté	Surface Course	Hot-mixed asphalt mixture	8
	Base Course	Bituminous treated cement treated	14
	Sub-base Course	Crushed Stone	18
	Total		

10.5 Project Costs

		Unit: Cost(US\$1000)		
		Construction	Land	Total
Widening Project for 4 lane	Avenida Rafael Franco	2,986	984	3,970
	Avenida Julio Correa	3,804	1,648	5,452
	Avenida Maximo Santos	2,855	2,147	5,002
	Avenida Choferes del Chaco	3,412	244	3,656
	Total(4 Route)	13,057	5,023	18,080
Drainage Project	Avenida Mariscal López	8,849	-	8,849
Pavement Project	Itá Ybaté	2,613	-	2,613



11. TRAFFIC MANAGEMENT PROJECTS

Problems with the current traffic control system include visibility and recognition of traffic signals and a lack of good traffic data. The Study will propose improvement measures for traffic signal control using the central control scheme, taking into account current problems, future traffic demand, and the new trunk bus project.

Required system functions are:

- To obtain real-time data on traffic conditions in the city and constantly update the data for statistics;
- To introduce a man-machine system and respond to sudden changes in traffic flows and equipment troubles;
- To be prepared for upgrading in order to respond to future road plan and traffic demand; and
- To provide road users with information

The proposed system should upgrade the current control while utilizing the existing equipment. For example, the control center will feature the installation of additional central control equipment and keyboards and software improvements. Intersection projects include

the new installation and improvement of traffic signals and installation of additional vehicle detectors to collect information on traffic volume, congestion, and the like.

The target area for control is 44 intersections on radial trunk roads, namely Av. E. Ayala, Av. España, Av. Mcal. López, Av. Fdo. de la Mora, Av. J.F.Bogado, from Micro Centro to Av. Mme. Lynch.

In the meantime, in order to make the most of the signal control capacity, road markings and directional signs will be improved on those intersections. In particular, it is necessary to pay attention to markings in terms of visibility at night and under rainy conditions and channelization lines for left-turning vehicles. A standard manual will be produced, and periodical maintenance will be carried out.

These are designated as short-term projects targeting 2005 and will be implemented along with the trunk bus project.

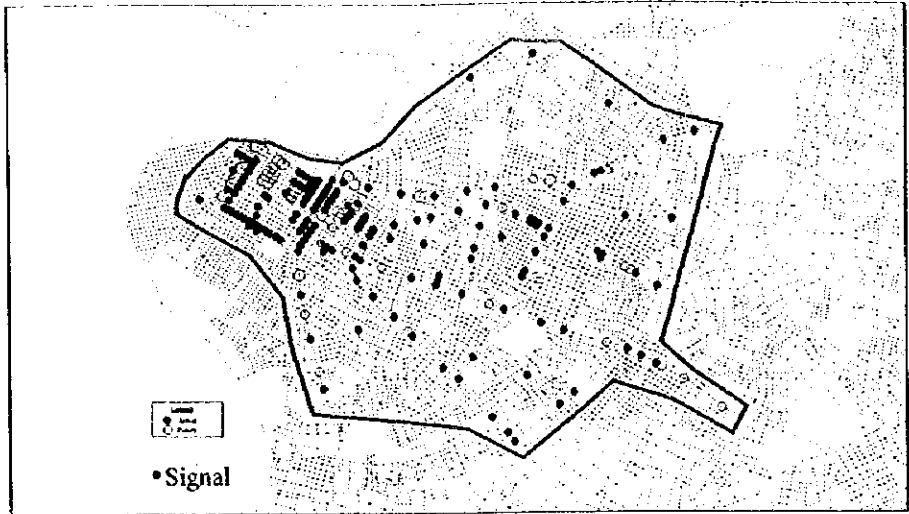
Project Cost

	Foreign(1000US\$)	Local(MillionGs)	Total(1000US\$)
Signal System Cost	2196.4	900.7	2496.6
Marking Cost	209.0		209.0
Regulatory Sign Cost	7.7	4.1	9.0
Project Cost	2413.1	904.8	2714.6

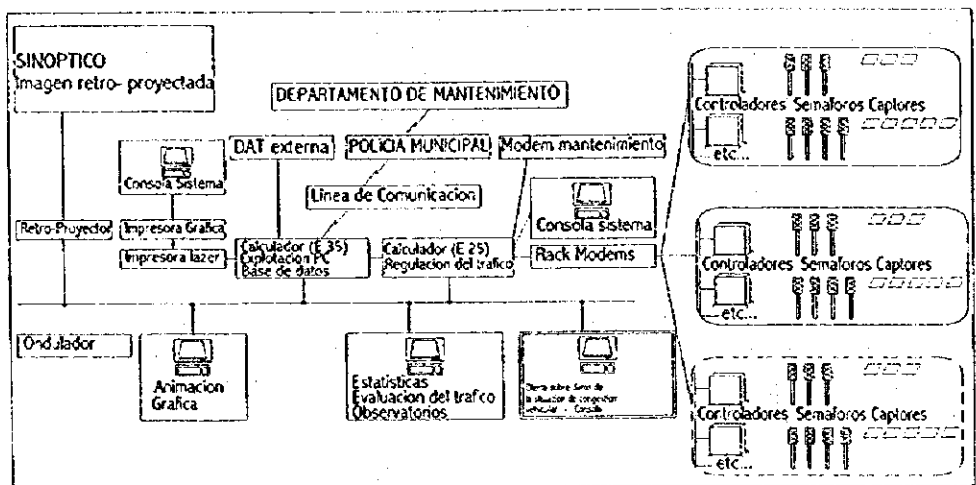
In order to control the use of private vehicles, it is proposed that parking fees in Micro Centro be raised. It has been found from the results of the traffic studies that 1.3% of the private vehicle trips would be converted into buses when the current fare, Gs1,000, were raised to Gs3,000. This rate is equivalent to the conversion brought about by the introduction of the trunk bus (1.5%), and it is necessary to consider the parking fee policy together with the new bus system.

Change in the Number of Trips after Parking Fee Policy

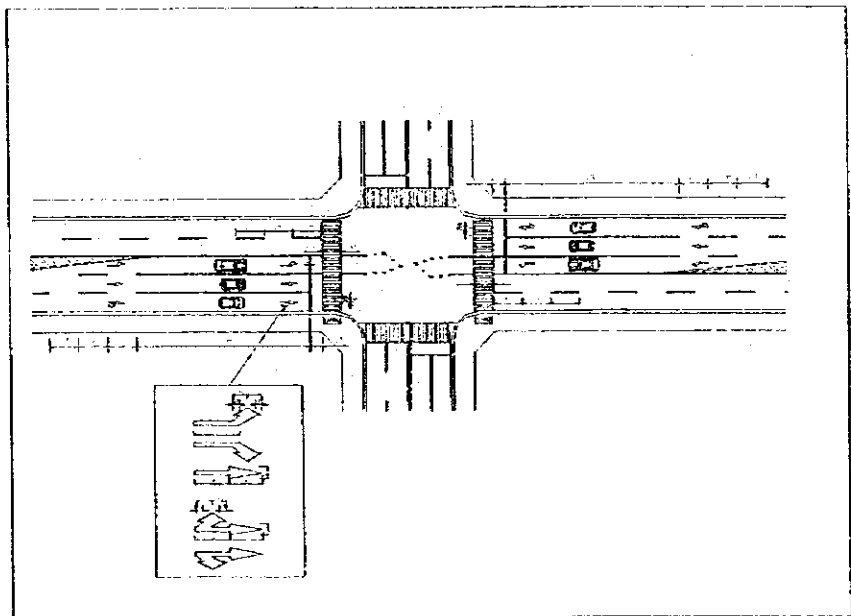
	1998	Trend	2015	
			Parking Fee in Centro 3000Gs.	(Reference) Trunk Bus on Av. E. Ayala
Car	1,138,960	2,182,261	2,125,559	2,115,727
	49.8%	53.7%	52.3%	52.1%
Car->Bus			56,702	66,534
			1.4%	1.6%
Bus	1,150,214	1,879,831	1,936,533	1,946,365
	50.2%	46.3%	47.7%	47.9%
Total	2,289,174	4,062,092	4,062,092	4,062,092



Target Area of Traffic Control Project



Central Center of Traffic Control System



Typical Plans for Marking at Intersection

12. ENVIRONMENTAL IMPACT STUDY

EIA of the Trunk Bus Project is summarized on only critical environmental impacts such as air quality, noise level and involuntary resettlement.

12.1 Impact

(1) Impact on Air Quality

The value of NO_x in the year 2015 was predicted using the air quality monitoring results, which were obtained by the Team.

NO_x Projection in the Year 2015 with and without Project

Eusebio Ayala/	Without Project				With Project			
	Traffic volume	Heavy vehicle ratio	Velocity	NO _x	Traffic volume	Heavy vehicle ratio	Velocity	NO _x
General Aquino	29,809	41	22.82	0.07	17,174	25	27.79	0.04
General Santos	56,937	69	16.22	0.11	31,134	17	45.25	0.06
Kubitscheck	73,345	51	7.43	0.11	47,166	10	29.79	0.06
Choferes del Chaco	64,752	53	11.15	0.11	50,311	7	26.32	0.06
Republica Argentina	49,483	71	22.85	0.11	51,711	7	24.83	0.06
De la Victoria	65,158	35	10.94	0.09	52,795	6	23.70	0.06
Madame Lynch	135,634	14	3.51	0.14	64,334	10	13.89	0.07
Juan Leopardi	136,463	10	3.43	0.14	61,391	8	15.99	0.07

It is implied that, with the introduction of trunk bus on Eusebio Ayala Avenue, the values of NO_x in the year 2015 will be significantly reduced, compared with the case in which there is no project.

(2) Impact on Noise Levels

The noise level (LEQ) at principal intersections on Eusebio Ayala Avenue in the year 2015 was predicted for the with and without project cases.

Value of LEQ in the year 2015 for with and without Project cases

Eusebio Ayala/	LEQ (present)	LEQ (without project)	LEQ (with project)
General Aquino	74.4	76.4	74.0
General Santos	79.8	81.6	79.0
Kubitschek	75.7	78.0	76.1
Choferes del Chaco	80.3	82.2	81.1
Republica Argentina	80.3	80.5	80.6
De la Victoria	78.9	80.7	79.8
Madame Lynch	79.6	83.7	80.4

It is implied that, at most intersections, where future traffic volume will increase, the introduction of the trunk bus system will contribute to minimizing the increase of noise level.

(3) Impact on Resettlement

With regard to the number of properties to be resettled by widening of Eusebio Ayala Avenue, 157 properties will be resettled or affected and 71% of them are commercial properties. On the other hand, in terms of San Lorenzo Bus Terminal construction, it is expected that ten

shops will be resettled. For the extension of Humaita Street, 8 shops and buildings will be affected.

Since most of the properties affected are for commercial purposes, it is extremely important to secure their economic activities by providing them with alternative places, which are convenient for them to continue their businesses.

A social survey, which was conducted by the study team, has implied that people are reluctant to be resettled.

12.2 Mitigatory Measure

(1) Impacts on Air Quality and Noise Level

As vehicular traffic in the proposed route will emit gaseous pollutants to the atmosphere mitigation of air pollution requires national, regional and local policies and their enforcement. Mitigation of excessive noise levels at the source also requires policy and enforcement at the above level.

Vegetation screens on both sides of the road may be used to attenuate air pollution and excessive noise.

(2) Minimizing Magnitude of Resettlement

In order to minimize this impact, the following measures should be taken.

- Explain and inform sufficiently to the people who will be resettled, about the nature and necessity of the project and gain consensus
- Conduct detailed household survey at detailed design stage in order to understand the exact magnitude of impact of resettlement
- Based on the above survey, prepare a detailed resettlement or expropriation plan and laws, which will minimize adverse impact of resettlement

(3) Monitoring Plan

A monitoring plan has been formulated under the categories: environmental monitoring and socio-economic aspects.

13. FINANCIAL AND ECONOMIC EVALUATIONS OF PRIORITY PROJECTS

13.1 Economic Evaluation of Priority Projects

Economic benefits and costs of the priority projects are estimated for each year, and the resultant economic internal rate of return (EIRR) is 29.3%, which proves that they are economically feasible. By looking at individual projects, it has been found that the trunk bus project on Av. E. Ayala yields much greater benefit than all the other projects. The other projects also produce relatively large benefits with low costs, each of which is thus proved to be economically feasible.

The conversion of auto uses into buses brought about by the introduction of the trunk bus should generate significant benefits, and thus policies for encouraging mode conversion are

the key to the success of the project. It is therefore critical to combine various policy measures such as parking fees in Centro, gasoline taxes, taxes on car ownership in order to generate the maximum benefits.

Economic Evaluation of Priority Projects

Projects	EIRR	NPV (1,000US\$)	B/C
All Projects	29.3	157,949	2.38
Ayala Trunk Bus Project	42.3	558,767	8.36
Road Improvement from the North	63.1	93,317	11.72
Circulation Roads	49.7	48,338	7.04
Pavement Project	40.6	10,864	4.76

13.2 Funding Sources

The 1998 budget of the municipality of Asunción is Gs219,000 million, or about US\$73 million. It is difficult with this budget to implement the recommended priority projects by 2005, which cost around US\$118 million. However, the trunk bus project on Av. E. Ayala accounts for two-thirds of the total project cost, and private operators of the trunk bus should share this financial burden. Furthermore, considering the importance of public transport to the metropolitan area, the public and private sectors should collaborate in order to execute the project.

The public sector should play a role in providing infrastructure. In so doing, Asunción and other municipalities should have their own funding sources. Funds can be obtained from users of private vehicles, such as fees for vehicle inspection and an increase in parking fees. In addition, the public sector should also ask for contributions from those who receive benefits from new transport facilities. Methods for this scheme can be to revise the existing "improvement contribution" system or raise property tax rates.

Even with own funding sources, it is still necessary to obtain grants and loans with favorable financial conditions from international and bilateral assistance organizations in order to collect sufficient funds in a short period of time. For this, the central government needs to promote this scheme and guarantee the repayment of loans.

On the other hand, the private sector should take an active part in improving the current operation and business practices and making its operation and management more efficient. The trunk bus project will be a great opportunity for facilitating this effort, and it is necessary to coordinate bus companies to take a full advantage of this in order to make the project successful.

CONCLUSIONS AND RECOMMENDATIONS

(1) Need for Public Transport Priority Policy

During the 14 years after CETA84, the population concentration in the metropolitan area has increased more rapidly than projected, and low-density urban sprawl has taken place. Population has been growing in suburban cities more rapidly than in Asunción. This phenomenon seems to have a correlation with the recent trend of rapid motorization where shares of transport modes of the residents have changed, and the use of private modes surged from 39% in 1984 to 50% in 1998. If this tendency is left untouched, urban sprawl continues, and the metropolitan area accelerates its dependence on private vehicles. It is evident that trunk roads and Centro will be even more congested, and that environmental deterioration will further progress.

Without policies that limit the use of private vehicles and prioritize public transport, travel speed of vehicles on trunk roads will be as slow as walking during peak hours in 2015, which inhibits efficient urban activities. Therefore, it is imperative to make a decision on these transport policies now.

(2) Implementation of Master Plan

One of the reasons for rapid motorization in the metropolitan area is that political and economic problems in Paraguay since 1989 impeded the implementation of major projects proposed in the 1984 Master Plan. The Master Plan of this Study emphasizes priority policies for public transport and proposes important programs and projects that will determine the destiny of the metropolitan area. They are worth implementing because not only will they produce significant economic impact on the area but bring about positive social impact such as the prevention of environmental degradation. Accordingly, it is strongly recommended that this Master Plan be adopted as a guideline, and that its proposed projects be carried out as scheduled.

(3) Early Implementation of Trunk Bus Project

The trunk bus project on Av. E. Ayala is the most important among the priority projects and should be executed promptly to show that the city is striving for public transport priority policies. Since the execution requires, among other things, to secure funding sources, revise institutions, and acquire right-of-ways, as described later, the decision needs to be made first now. In addition, it is necessary for the public sector and bus operators together to establish a commission or task force to examine the introduction of the trunk bus project on Av. E. Ayala and examine various measures to actually implement the project.

(4) Provision of Infrastructure Supporting Trunk Bus Project

For the trunk bus project to be successful, it is indispensable to carry out required works on Av. E. Ayala, such as widening and construction of viaducts. In the meantime, however, as measures to support public transport priority policies and manage road traffic in an orderly fashion, it is necessary to carry out other priority projects such as installing a centralized traffic signal control system.

(5) Traffic Demand Management

It is possible to impose restrictions on the use of vehicles, especially in particular districts, as they are carried out in Europe. In Micro Centro of Asunción, parking fees and fines for illegal parking should be raised by substantial amounts. Traffic control measures should be carried out with clear and specific purposes and strong determination and, if necessary, modified through many trials. It is recommended that stricter restrictions on vehicles driving into Centro, such as area pricing, be introduced eventually.

(6) Funding Sources

With the scale of municipal budgets in the metropolitan area, it is difficult to implement large-scale transport infrastructure projects. Each city, therefore, needs to secure its own fund from such sources as an increase in inspection fees by strengthening the inspection system and a raise in parking fees in order to provide transport facilities. In order to collect enough funds in a short period of time, it is also necessary to obtain grants and loans from international and bilateral assistance organizations that impose low interest rates. This requires the central government to promote this scheme and guarantee the repayment of loans. Furthermore, some projects need to consider private financing schemes such as BOT and PFI.

(7) Institutional Reform

The introduction of the trunk bus system requires revisions of the existing institutions, such as relevant laws and organizations. First, it is necessary to establish an organization that plans, promotes, regulates, and oversees projects. The surface transportation act currently under discussion in the parliament needs to be passed soon to promote this institutional reform. This act is aimed at establishing a committee that consists of MOPC, municipalities, and private enterprises to resolve various problems associated with bus transport from a comprehensive point of view. It also attempts to consolidate authorities to give permissions for bus operation, which are currently held separately by MOPC and the municipalities. The committee needs to clarify roles of the public and private sectors, respectively, and propose institutional reforms to secure funding sources. Finally, it is necessary to establish an organization that can plan, implement, and monitor urban transportation, including private transport, in the metropolitan area from a comprehensive standpoint and at the same time provide education and training on transport.

(8) Understanding and Cooperation of Citizens

Restructuring of the bus lines and a new ticket system introduced along the new trunk bus system will cause some confusion and questions among citizens. It is necessary, if such things occur, to help them understand that the benefits of the project and ask for their cooperation. Deeper understandings among citizens require periodic disclosure of information and public hearings where they can express their opinions.

(9) Further Study

CETA98 has examined how the future urban transport system should be in the Asunción metropolitan area. It has also proposed an urban transport master plan for the target year of 2015 and priority projects necessary to be implemented before 2005. The implementation of

the priority projects requires further considerations. They include:

- 1) Establishment of an operating body of the trunk bus and restructuring of bus lines
- 2) Bus ticket systems in the metropolitan area
- 3) Methods of securing funding sources
- 4) Establishment, form, and authority of an organization that deals with urban transport problems
- 5) Concrete measures of traffic demand management

When the Paraguayan economy recovers from the current recession, the Franja Costera project may launch soon, and if so, further studies and planning are required on coastal roads.

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