Chapter 15 Urban Transportation Master Plan

15.1 Policy for Master Plan Formulation

15.1.1 Response to Future Traffic Demand

It is difficult to accommodate the traffic demand of 2015 if the existing networks of roads and buses remain unchanged without any improvement measures. The 2015 traffic conditions under the do-nothing case are shown in Fig. 15-1-1. The congestion rate (Volume/Capacity Ratio: V/C) will exceed the allowable limit of 1.5 on most of the radial trunk roads, where the travel speed during peak hours will decrease below 5 km/h.

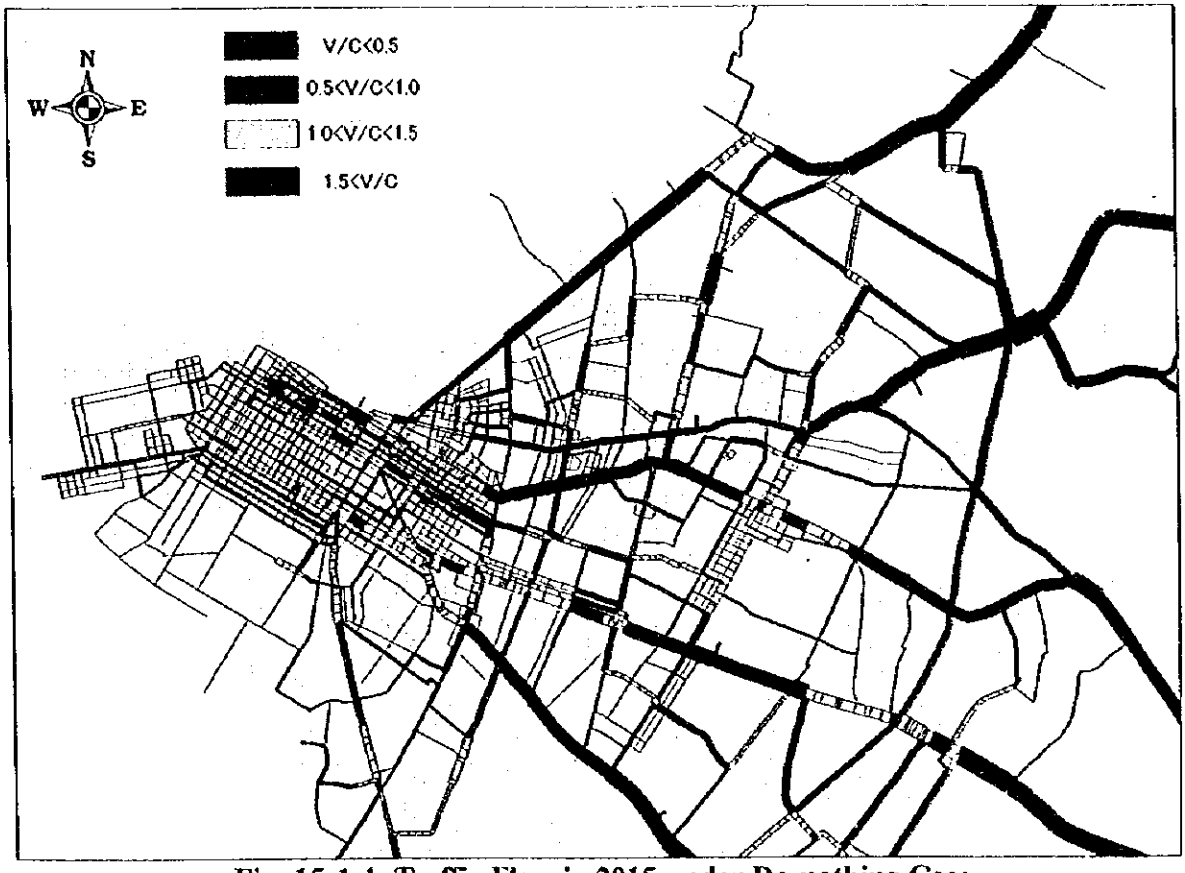


Fig. 15-1-1 Traffic Flow in 2015 under Do-nothing Case

Table 15-1-1 Congestion at Major Sections

Sections	Road Capacity	Number of Passing Vehicles			Congestion	Capacity Shortage
		Bus	Auto	Total		
1:Artigas – Gugeticht	73,800	13,068	106,195	119,263	1.616	-45,463
2:Chaves - 25 de Mayo	147,600	18,657	198,172	216,829	1.469	-69,229
3:T.S. Mongelos - E. Ayala	113,130	29,700	105,209	134,909	1.193	-21,779
4:Fdo. de la Mora - M. Ravasco	45,270	11,448	65,073	76,521	1.690	-31,251
5:Bruno Guggiari – Peron	115,110	11,259	88,516	99,775	0.867	15,335
Total	494,910	84,132	563,165	647,297	1.453	-201,878

15.1.2 Response to the Formulation of Comprehensive Transport Networks

The recent trend of rapid motorization is made possible by the development of the Paraguayan economy and the existing road system that has been constructed over a long period of time. However, now that it seems to have reached a saturation point, it is physically difficult to continue this trend of increasing usage of private vehicles. In order to increase the efficiency, moreover, it is necessary to make effective use of public transport. In other words, it is imperative to shift the current reactive transport policy into a proactive approach where traffic demands are strategically managed. Strategic planning policies are needed to achieve adequate modal shares of private vehicles and public transport.

The current bus system serves more passengers than projected in the 1986 Master Plan but has been unable to stop the increasing use of private vehicles. Thus, this Study proposes attractive public transport services that can encourage the modal conversion from auto to bus and recommends policy measures to restrain the use of private vehicles.

As discussed in Chapter 12, moreover, it is expected that a trunk bus system on Av. E. Ayala will not be able to meet the increasing demand in 2020, and thus a larger-scale transport system, such as LRT, needs to be considered as an alternative mode.

15.1.3 Maintaining the Current Level of Service

One of the objectives of this Study is to maintain the current level of transport service in 2015, the target year of the basic plan, by implementing measures to improve road and traffic facilities. In other words, it is the objective of this basic plan to keep the current speed level of both public transport (25km/h) and private vehicles (30km/h) .

15.2 Formulation of 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 three radial trunk roads with over four lanes, Av. Artigas, Av. Mcal López, and Av. Fdo. de la Mora.

Table 15-2-1 Mater Plan Alternatives

	Auto Priority	Public Transport Priority	Remarks
Extension of Av. España	○	×	
BP on Av. España	○	×	50,300 veh/day
Six lanes on Av. E. Ayala	○	○ (bus improvement)	2 center lanes are exclusive use for bus in public transp. 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

15.3 Economic Evaluation of the Master Plan

15.3.1 Evaluation Methodology and Assumptions

In this section, the Master Plan projects are evaluated from the economic viewpoint, following a cost-benefit analysis. To measure and compare costs and benefits of the projects in economic price, the procedure is shown in Fig. 15-3-1.

Economic cost is a monetary expression of goods and services to be actually consumed for implementation of a project. Then, all the transfer costs (taxes and subsidies) will be deducted from the costs measured in market price. In addition, shadow wage rates (SWRs) are applied to unskilled labor costs included in the project cost. The same process is taken to estimate unit costs of vehicle operation which are used to estimate economic benefits, by excluding all taxes and applying the SWRs to labor cost of mechanics and crews.

The implementation plan is preconditioned to identify the year when the project cost is generated or the benefit starts to accrue. Therefore, the evaluation results will be affected by a change in the implementation plan.

Economic benefit is defined as the amount saved in travel costs due to a project. Travel costs consist of two components, vehicle operating cost (VOC) and travel time cost (TTC). These are the benefits most direct and comparatively easy to quantify. It is obvious that there exist other benefits, such as safety improvement, inducement of urban development, and mitigation of traffic congestion. In this feasibility study, however, those kinds of benefits are difficult to quantify and thus excluded in order to avoid an arbitrary evaluation.
Benefits of a project are measured through so-called "with" and "without" comparison. Using the results of traffic assignment to a network with the project in question and also to the same network but without the project, total VOC and TTC of each case are calculated. And then, the benefit is regarded as the difference between "with" and "without cases.

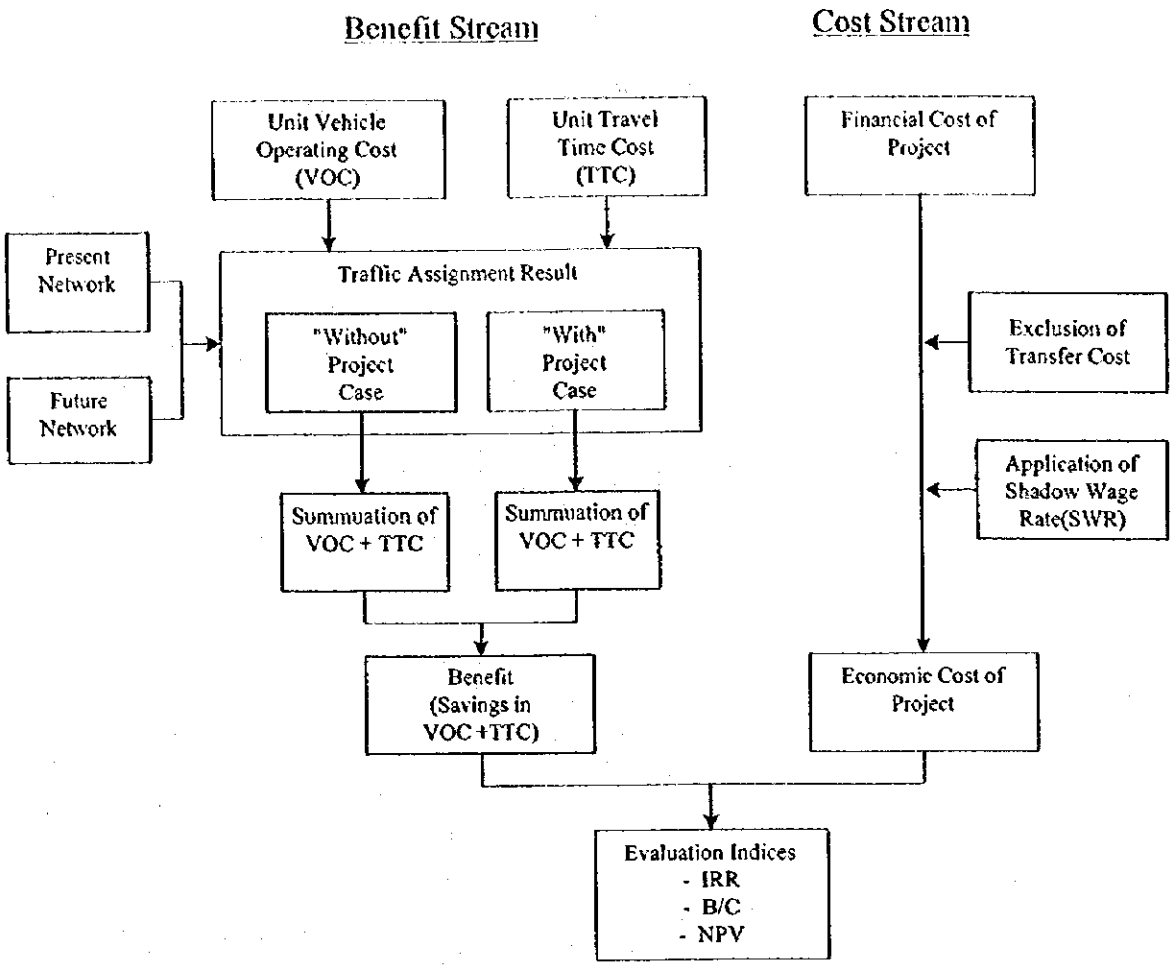


Fig. 15-3-1 Work Flow for Economic Evaluation

Economic cost and benefit are compared through a discount cash flow analysis. The discount rate (DR) is 12% which is widely used in Paraguay as an economic interest rate. The same rate is used in estimation of capital opportunity cost of VOC. As evaluation indicators, internal rate of return (IRR), benefit/cost ratio (B/C) and net present value (NPV) are calculated. They are defined as below:

Pro-forma cash flow of a project to be evaluated is prepared for the period of 2000 to 2015.

- Internal Rate of Return(IRR): r satisfying: $\sum \frac{B_n}{(1+r)^n} = \sum \frac{C_n}{(1+r)^n}$
- Net Present Value(NPV) = $\sum \frac{B_n - C_n}{(1+DR)^n}$
- B/C Ratio(B/C) = $\sum \frac{B_n}{(1+DR)^n} \div \sum \frac{C_n}{(1+DR)_n}$

Although the physical life of an infrastructure project is 50 to 60 years, economic life is assumed to be 15 years, taking into account future rapid urban growth and changes of socioeconomic conditions. Thus, every investment is not completely depreciated within the analytical period until 2015. Therefore, residual value of each project in 2016 is calculated and added to the benefit stream.

15.3.2 Estimation of Vehicle Operating Cost

Vehicle operating cost (VOC) is one of the main sources of economic benefit. The operating cost per unit distance is estimated by type of vehicle, such as passenger car, light truck, heavy truck, bus, and articulated bus. The last one does not exist at present in Paraguay but has been added for this project to determine the feasibility of the proposed project.

VOC is composed of the following components:
(a) Fuel cost
(b) Oil cost
(c) Tire cost
(d) Repair cost
(e) Depreciation cost
(f) Capital opportunity cost
(g) Crew and administration cost

In Paraguay, the Ministry of Public Works and Communications (MOPC) has been periodically updating VOC data in order to use as input to the HDM Model which is developed by IBRD for the appraisal of highway development and maintenance projects. The VOC estimates in this Study depend on the basic information and assumptions of the MOPC's data.

The HDM Model is mostly applied, however, to inter-municipal or inter-regional highway projects where a key factor affecting VOC is surface conditions of the road, especially in terms of roughness. On the other hand, unit VOC needed for this project are those applicable to urban roads which are mostly paved and where the key factor is not roughness but operating speed. Therefore, unit VOC of each component from (a) to (e) is expressed as a function of operating (travel) speed. A part of item (e) and the others (item (f) and (g)) are not directly affected by operating speed but by travel time.

Unit costs of each item are estimated at market price and then are converted into economic cost. VOC varies by road surface conditions. However, unit VOCs are investigated only for paved road because the roads examined in this Study are mostly in the urban area of Asunción and already paved.

(1) Characteristics of Representative Vehicles

Although there are many vehicles of different makes and models actually running in Asunción and unit VOC varies by makes and models and also changes by vehicle age, several popular models are selected as representative ones and their VOCs are studied and aggregated by taking an average. The economic cost of each representative vehicle is the market price less taxes.
Table 15-3-1 shows average costs and characteristics such as tire type, fuel type, operating distance, and hours.

Table 15-3-1 Characteristics of Representative Vehicles

		Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
1	Representative Model	VW-1800	M.B.1318	Express Articulated (Curitiba)	Toyota Hilux	M.B. 710/37
2	Price(Gs)					
	(1) Financial	25,365,000	199,256,340	851,724,000	66,634,000	114,366,600
	(2) Economic	23,061,000	174,421,618	741,000,000	53,209,500	99,518,973
3	No. of Tires	4	6	10	4	6
4	Fuel Type	Nafta comun	Diesel	Diesel	Diesel	Diesel
5	Annual Operation (km)	20,000	60,000	90,000	40,000	75,000
6	Average Speed	25	20	30	25	25
7	Annual using hours	800	3,000	3,000	1,600	3,000

(2) Fuel Cost

There are basically three types of fuel used in Paraguay, regular gasoline (nafta comun), super gasoline (nafta super), and diesel oil (gas-oil). Retail price of regular gasoline is Gs1,200 per liter. Deducting the tax amount from the financial price, economic price of regular gasoline is estimated to be Gs660 per liter. In the same way, economic price of super gasoline is Gs700 and diesel oil Gs639.

Table 15-3-2 shows the composition of fuel consumption by type of vehicle, which was estimated based on MOPC's data and interviewing survey of major gas stations in Asunción. Making averages of fuel prices weighted by these consumption rates, fuel costs of each vehicle have been estimated as indicated in the table.

Table 15-3-2 Composition of Fuel Type and Average Fuel Cost by Type of Vehicle

(%, Gs/liter)

Fuel Type	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Regular Gasoline	50				
Super Gasoline	20			20	
Diesel	30	100	100	80	100
Total	100	100	100	100	100
Av. Financial Cost(Gs/liter)	1084.0	680.0	680.0	824.0	680.0
Av Economic Cost(Gs/liter)	661.6	638.6	638.6	650.9	638.6

Fuel consumption rate of vehicle varies according to its running speed. The most economical speed is 45 to 50 km/hr for passenger car, and 50 to 60 km/hr for medium and large vehicles. Table 15-3-3 shows data concerning the fuel consumption rate by running speed and fuel costs/km by type of vehicle.

Table 15-3-3 Fuel Consumption Rate and Cost by Type of Vehicle

	Operating Speed (Km/hr)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Fuel Consumption Rate (Liter/1000Km)	5	212.6	672.7	1,210.9	605.2	1,210.4
	10	138.6	430.4	774.7	387.3	774.5
	20	100.2	311.2	560.2	280.0	560.0
	30	87.0	284.2	511.6	235.0	412.0
	40	80.2	264.5	476.1	225.0	342.0
	50	78.4	284.2	511.6	220.0	314.0
	60	81.0	326.1	587.0	225.0	303.0
	70	85.7	380.9	685.6	230.0	314.0
	80	92.7	438.1	788.6	250.0	340.0
	90	102.4	483.9	871.0	276.2	375.6
Financial Fuel Cost (Gs/1000km)	5	230,458.4	457,436.0	823,384.8	498,684.8	823,072.0
	10	150,242.4	292,672.0	526,809.6	319,135.2	526,660.0
	20	108,616.8	211,616.0	380,908.8	230,720.0	380,800.0
	30	94,308.0	193,256.0	347,860.8	193,640.0	280,160.0
	40	86,936.8	179,860.0	323,748.0	185,400.0	232,560.0
	50	84,985.6	193,256.0	347,860.8	181,280.0	213,520.0
	60	87,804.0	221,748.0	399,146.4	185,400.0	206,040.0
	70	92,898.8	259,012.0	466,221.6	189,520.0	213,520.0
	80	100,486.8	297,908.0	536,234.4	206,000.0	231,200.0
	90	111,001.6	329,052.0	592,293.6	227,588.8	255,408.0
Economic Fuel Cost (Gs/1000km)	5	140,656.2	429,586.2	773,255.2	393,924.7	772,961.4
	10	91,697.8	274,853.4	494,736.2	252,093.6	494,595.7
	20	66,292.3	198,732.3	357,718.2	182,252.0	357,616.0
	30	57,559.2	181,490.1	326,682.2	152,961.5	263,103.2
	40	53,060.3	168,909.7	304,037.5	146,452.5	218,401.2
	50	51,869.4	181,490.1	326,682.2	143,198.0	200,520.4
	60	53,589.6	208,247.5	374,845.4	146,452.5	193,495.8
	70	56,699.1	243,242.7	437,836.9	149,707.0	200,520.4
	80	61,330.3	279,770.7	503,587.2	162,725.0	217,124.0
	90	67,747.8	309,018.5	556,233.4	179,778.6	239,858.2

(3) Oil Cost

Retail price of lubricant oil for passenger cars is Gs7,404/liter and after deducting tax, economic cost is Gs6,100/liter, and those for heavy vehicles are Gs6,379 and Gs5,255, respectively. According to general experimental data, the relations between oil consumption and running speed are as shown in Table 15-3-4. From this information, economic oil cost can be calculated by running speed.

Table 15-3-4 Oil Consumption Rate and Cost by Type of Vehicle

	Speed (Km/hr)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Oil Consumption Rate(Liter/1000Km)	5	3.48	8.01	16.02	6.86	8.01
	10	2.24	5.14	10.28	4.40	5.14
	20	1.54	3.53	7.06	3.03	3.54
	30	1.27	2.92	5.84	2.50	2.92
	40	1.13	2.68	5.36	2.22	2.68
	50	1.10	2.58	5.16	2.08	2.58
	60	1.09	2.36	4.72	1.80	2.36
	70	1.07	2.14	4.28	1.68	2.14
	80	1.00	1.87	3.74	1.52	1.87
	90	0.90	1.68	3.36	1.37	1.68
Financial Oil Cost (Gs/1000km)	5	25,765.9	51,095.8	102,191.6	43,759.9	51,095.8
	10	16,585.0	32,788.1	65,576.1	28,067.6	32,788.1
	20	11,402.2	22,517.9	45,035.7	19,328.4	22,581.7
	30	9,403.1	18,626.7	37,253.4	15,947.5	18,626.7
	40	8,366.5	17,095.7	34,191.4	14,161.4	17,095.7
	50	8,144.4	16,457.8	32,915.6	13,268.3	16,457.8
	60	8,070.4	15,054.4	30,108.9	11,482.2	15,054.4
	70	7,922.3	13,651.1	27,302.1	10,716.7	13,651.1
	80	7,404.0	11,928.7	23,857.5	9,696.1	11,928.7
	90	6,663.6	10,716.7	21,433.4	8,739.2	10,716.7
Economic Oil Cost (Gs/1000km)	5	21,228.0	42,092.6	84,185.1	36,049.3	42,092.6
	10	13,664.0	27,010.7	54,021.4	23,122.0	27,010.7
	20	9,394.0	18,550.2	37,100.3	15,922.7	18,602.7
	30	7,747.0	15,344.6	30,689.2	13,137.5	15,344.6
	40	6,893.0	14,083.4	28,166.8	11,666.1	14,083.4
	50	6,710.0	13,557.9	27,115.8	10,930.4	13,557.9
	60	6,649.0	12,401.8	24,803.6	9,459.0	12,401.8
	70	6,527.0	11,245.7	22,491.4	8,828.4	11,245.7
	80	6,100.0	9,826.9	19,653.7	7,987.6	9,826.9
	90	5,490.0	8,828.4	17,656.8	7,199.4	8,828.4

(4) Tire Cost

Table 15-3-5 presents type of tire, market price and economic price by type of vehicle, for both new and used ones. Under the condition of average speed of 35 mile/hr (56 km/hr) on paved roads, average tire life can be assumed to be 40,000 km for passenger car and 80,000 km for heavy vehicle.

Table 15-3-5 Financial and Economic Cost of Tire

Item	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Numero de cubiertas		4	6	10	4	6
Cubiertas Nuevas						
Costo Fin.	(Gs)	421,800	4,531,500	7,552,500	1,173,400	2,154,600
Costo Econ.	(Gs)	276,280	2,971,068	4,951,780	769,652	1,413,834
Vida Util (km)		40,000	80,000	80,000	60,000	80,000
Tire Consumption Rate	(%/1000km)	2.5%	1.3%	1.3%	1.7%	1.3%
Cubiertas Recauchutadas						
Costo Fin.		157,004	1,643,400	2,739,000	422,400	633,600
Costo Econ.		155,428	1,494,000	2,490,000	384,000	576,000
Vida Util (km)	(km)	20,000	40,000	40,000	30,000	40,000
Tire Consumption Rate	(%/1000km)	5.0%	2.5%	2.5%	3.3%	2.5%
Porcentaje de utilizacion de cubierta recauchutada		56%	59%	59%	63%	56%

Thus, tire consumption rates per 1,000km are 2.5% and 1.3%, respectively. On the other hand, it is empirically known that this consumption rate becomes larger when average running speed rises. An IBRD report ("Quantification of road user savings", IBRD Occasional Paper No.2, 1966) shows the relationship as in Table 15-3-6. Based on this information, economic tire cost per km can be obtained as shown in the same table.

Since there are a significant number of vehicles using re-treaded tires, they are included in the analysis. The economic price of such a tire is about Gs155,000 for passenger cars and Gs576,000 for heavy trucks, and there are notable differences in the prices of new and used tires. According to MOPC, as shown in Table 15-3-5, the majority of vehicles across all types use retreaded tires. Therefore, costs of tire per 1,000km shown in Table 15-3-6 account for both types by taking weighted averages according to the shares of vehicles using retreaded tires.

Table 15-3-6 Tire Consumption Rate and Cost by Type of Vehicle

	Speed (Km/hour)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Tire Consumption Indices (56km/hr =100)	5	53	53	53	53	53
	10	56	56	56	56	56
	20	60	60	60	60	60
	30	67	67	67	67	67
	40	78	78	78	78	78
	50	92	92	92	92	92
	56	100	100	100	100	100
	60	107	107	107	107	107
	70	125	125	125	125	125
	80	151	151	151	151	151
	90	180	180	180	180	180
Financial Tire Cost (Gs/1000km)	5	4,789.0	25,156.0	41,926.6	8,536.4	10,982.0
	10	5,060.1	26,579.9	44,299.8	9,019.6	11,603.6
	20	5,421.5	28,478.5	47,464.1	9,663.8	12,432.4
	30	6,054.1	31,800.9	53,001.6	10,791.3	13,882.9
	40	7,048.0	37,022.0	61,703.3	12,563.0	16,162.1
	50	8,313.0	43,667.0	72,778.3	14,817.9	19,063.0
	56	9,035.9	47,464.1	79,106.8	16,106.4	20,720.7
	60	9,668.4	50,786.6	84,644.3	17,233.8	22,171.1
	70	11,294.9	59,330.1	98,883.5	20,133.0	25,900.9
	80	13,644.2	71,670.8	119,451.3	24,320.6	31,288.3
	90	16,264.6	85,435.4	142,392.3	28,991.5	37,297.3
Economic Tire Cost (Gs/1000km)	5	3,917.3	19,749.5	32,915.8	6,789.4	8,395.2
	10	4,139.0	20,867.4	34,779.0	7,173.7	8,870.4
	20	4,434.6	22,357.9	37,263.2	7,686.1	9,504.1
	30	4,952.0	24,966.4	41,610.6	8,582.8	10,612.9
	40	5,765.0	29,065.3	48,442.2	9,991.9	12,355.3
	50	6,799.8	34,282.2	57,136.9	11,785.4	14,572.9
	56	7,391.1	37,263.2	62,105.4	12,810.2	15,840.1
	60	7,908.4	39,871.6	66,452.7	13,706.9	16,948.9
	70	9,238.8	46,579.0	77,631.7	16,012.7	19,800.1
	80	11,160.5	56,267.5	93,779.1	19,343.4	23,918.5
	90	13,303.9	67,073.8	111,789.7	23,058.3	28,512.2

(5) Repair Cost

Calculating annual maintenance costs based on MOPC's VOC data, the ratio of annual maintenance cost to the vehicle price is estimated to be 4.0% for passenger cars, 6.0% for light trucks, and 8.0% for other heavy vehicles with large annual running distance. By assuming annual running distance, maintenance cost per kilometer can be calculated as shown in Table 15-3-7.

According to the same IBRD report referred to in the tire cost estimation, the relationship between maintenance cost and running speed shows that maintenance cost becomes lowest at around 50 km/hr. Using these conversion rates, maintenance cost can be obtained at different speeds (See Table 15-3-8).

Table 15-3-7 Assumptions for Repair Cost Estimation

	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Vehicle Cost						
Financial	Gs	25,365,000	199,256,340	851,724,000	66,634,000	114,366,600
Economic	Gs	23,061,000	174,421,618	741,000,000	53,209,500	99,518,973
Tire Cost						
Financial	Gs	527,250	5,286,750	8,307,750	1,466,750	2,513,700
Economic	Gs	345,350	3,466,246	5,446,958	962,065	1,649,473
Vehicle Cost w/o Tire						
Financial	Gs	24,837,750	193,969,590	843,416,250	65,167,250	111,852,900
Economic	Gs	22,715,650	170,955,372	735,553,042	52,247,435	97,869,500
Annual Repair Cost						
% of Vehicle Cost	%	4.0	8.0	8.0	6.0	8.0
Financial	Gs	993,510	15,517,567	67,473,300	3,910,035	8,948,232
Economic	Gs	908,626	13,676,430	58,844,243	3,134,846	7,829,560
Annual Operation.	Km	20,000	60,000	90,000	40,000	75,000
Average Speed	Km/Hr	25	20	30	25	25
Repair Cost At Average Speed						
Financial	Gs/1000km	49,675.5	258,626.1	749,703.3	97,750.9	119,309.8
Economic	Gs/1000km	45,431.3	227,940.5	653,824.9	78,371.2	104,394.1

Table 15-3-8 Financial and Economic Repair Cost by Type of Vehicles

	Speed (km/hr)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Repair Cost Rate by Speed	5	141	142	142	134	159
	10	133	131	131	126	147
	20	118	111	111	113	124
	30	105	89	89	100	100
	40	95	74	74	94	83
	50	94	72	72	93	81
	60	100	79	79	100	88
	70	108	88	88	107	98
	80	115	100	100	114	112
	90	122	112	112	120	125
Financial Repair Cost (Gs/1000km)	5	70,042.5	367,249.1	1,064,578.7	130,986.2	189,702.6
	10	66,068.4	338,800.2	982,111.3	123,166.1	175,385.4
	20	58,617.1	287,075.0	832,170.7	110,458.5	147,944.2
	30	52,159.3	230,177.2	667,235.9	97,750.9	119,309.8
	40	47,191.7	191,383.3	554,780.4	91,885.8	99,027.1
	50	46,695.0	186,210.8	539,786.4	90,908.3	96,640.9
	60	49,675.5	204,314.6	592,265.6	97,750.9	104,992.6
	70	53,649.5	227,591.0	659,738.9	104,593.5	116,923.6
	80	57,126.8	258,626.1	749,703.3	111,436.0	133,627.0
	90	60,604.1	289,661.2	839,667.7	117,301.1	149,137.3
Economic Repair Cost (Gs/1000km)	5	64,058.1	323,675.5	928,431.4	105,017.4	165,986.6
	10	60,423.6	298,602.1	856,510.6	98,747.7	153,459.3
	20	53,608.9	253,014.0	725,745.6	88,559.5	129,448.7
	30	47,702.9	202,867.0	581,904.2	78,371.2	104,394.1
	40	43,159.7	168,676.0	483,830.4	73,668.9	86,647.1
	50	42,705.4	164,117.2	470,753.9	72,885.2	84,559.2
	60	45,431.3	180,073.0	516,521.7	78,371.2	91,866.8
	70	49,065.8	200,587.6	575,365.9	83,857.2	102,306.2
	80	52,246.0	227,940.5	653,824.9	89,343.2	116,921.4
	90	55,426.2	255,293.4	732,283.9	94,045.4	130,492.6

(6) Depreciation Cost

Depreciable amount is defined as the vehicle economic cost (without tire cost) less salvage cost after usage during vehicle life. In Paraguay, where the market for secondhand vehicles and spare parts is well developed, salvage value rate should be assumed at rather high rate, namely, 25% for passenger car, 20% for light truck, and 15% for others (Table 15-3-9).

Vehicles are devaluated through their use in proportion to running kilometers, while their value will decrease as they become old, even without usage. Particularly, a passenger car loses its value rapidly as time passes. Therefore, the proportion of depreciation subject to use, and depreciation subject to time may be assumed as follows: 50:50 for passenger car and 70:30 for others.

Depreciation subject to use is furthermore subdivided into two parts. It is assumed that one third of this cost depends on the amount of distance driven and two thirds are affected by running speed, in the same way as maintenance cost. Costs of use-related depreciation and time-related depreciation are shown in Table 15-3-10 and Table 15-3-11, respectively.

Time related depreciation in the table presents daily depreciation cost which is the depreciable amount divided by number of days during life period. This cost is independent from driven distance and from running speed. Therefore, this cost shall be calculated separately based on the number of vehicles in the region and added to the other cost which is affected by running speed. The same thing can be said of the capital opportunity cost, crew cost and overhead cost.

Table 15-3-9 Assumptions for Depreciation Cost Estimation

	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Vehicle Cost						
Financial	Gs	25,365,000	199,256,340	851,724,000	66,634,000	114,366,600
Economic	Gs	23,061,000	174,421,618	741,000,000	53,209,500	99,518,973
Tire Cost						
Financial	Gs	527,250	5,286,750	8,307,750	1,466,750	2,513,700
Economic	Gs	345,350	3,466,246	5,446,958	962,065	1,649,473
Vehicle Cost w/o Tire						
Financial	Gs	24,837,750	193,969,590	843,416,250	65,167,250	111,852,900
Economic	Gs	22,715,650	170,955,372	735,553,042	52,247,435	97,869,500
Salvage Value						
% of Vehicle Cost	%	25.0	15.0	20.0	20.0	15.0
Financial	Gs	6,209,438	29,095,439	168,683,250	13,033,450	16,777,935
Economic	Gs	5,678,913	25,643,306	147,110,608	10,449,487	14,680,425
Annual Operation.	Km	20,000	60,000	90,000	40,000	75,000
Average Speed	Km/Hr	25	20	30	25	25
Vehicle Life	Year	7	10	10	7	9
% of Dep. of Use & Time						
Subject to use	%	50	70	70	70	70
Subject to time	%	50	30	30	30	30
Depreciable Amount						
Financial						
subject to use	Gs	9,314,156	115,411,906	472,313,100	36,493,660	66,552,476
subject to time	Gs	9,314,156	49,462,245	202,419,900	15,640,140	28,522,490
Total	Gs	18,628,312	164,874,151	674,733,000	52,133,800	95,074,965
Economic						
subject to use	Gs	8,518,369	101,718,446	411,909,704	29,258,564	58,232,353
subject to time	Gs	8,518,369	43,593,620	176,532,730	12,539,384	24,956,723
Total	Gs	17,036,737	145,312,066	588,442,434	41,797,948	83,189,075

Table 15-3-10 Financial and Economic Depreciation Cost Subject to Use

	Speed (Km/hour)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Indices for Depreciation Cost subject to Use (Av. Speed = 100)	5	136	131	131	126	146
	10	130	123	123	121	137
	20	119	108	108	110	119
	30	108	92	92	100	100
	40	100	81	81	96	86
	50	100	80	80	95	85
	60	104	84	84	100	90
	70	110	91	91	106	98
	80	116	99	99	111	109
	90	121	109	109	116	120
Financial Depreciation Cost subject to Use (Gs/1000km)	5	90,480.4	251,982.7	687,478.0	164,221.5	143,950.5
	10	86,488.6	236,594.4	645,494.6	157,704.7	135,076.9
	20	79,170.3	207,741.4	566,775.7	143,368.0	117,329.6
	30	75,843.8	192,353.2	524,792.3	136,851.2	108,455.9
	40	71,852.1	176,964.9	482,808.9	130,334.5	98,596.3
	50	66,529.7	155,806.1	425,081.8	125,121.1	85,778.7
	60	66,529.7	155,806.1	425,081.8	125,121.1	84,792.8
	70	66,529.7	153,882.5	419,833.9	123,817.8	83,806.8
	80	69,190.9	161,576.7	440,825.6	130,334.5	88,736.6
	90	73,182.7	175,041.4	477,561.0	138,154.6	96,624.3
Economic Depreciation Cost subject to Use (Gs/1000km)	5	82,749.9	222,085.3	599,557.5	131,663.5	125,954.4
	10	79,099.1	208,522.8	562,943.3	126,438.8	118,190.1
	20	72,406.1	183,093.2	494,291.6	114,944.4	102,661.5
	30	69,363.9	169,530.7	457,677.4	109,719.6	94,897.2
	40	65,713.1	155,968.3	421,063.3	104,494.9	86,270.2
	50	60,845.5	137,319.9	370,718.7	100,315.1	75,055.0
	60	60,845.5	137,319.9	370,718.7	100,315.1	74,192.3
	70	60,845.5	135,624.6	366,142.0	99,270.1	73,329.6
	80	63,279.3	142,405.8	384,449.1	104,494.9	77,643.1
	90	66,930.0	154,273.0	416,486.5	110,764.6	84,544.7

Table 15-3-11 Financial and Economic Depreciation Cost Subject to Time

	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Financial Cost						
Daily Cost	Gs/Day	3,645.5	13,551.3	55,457.5	6,121.4	8,682.6
Hourly Cost	Gs/Hr	1,663.3	1,648.7	6,747.3	1,396.4	1,056.4
Economic Cost						
Daily Cost	Gs/Day	3,334.0	11,943.5	48,365.1	4,907.8	7,597.2
Hourly Cost	Gs/Hr	1,521.1	1,453.1	5,884.4	1,119.6	924.3

(7) Capital Opportunity Cost

This cost is not affected by use but accrues only as time passes and is determined by vehicle price, life period, salvage value rate, and interest rate, using the following formula:

$C = P(1 - r)F - P/n + i\,r\,P$

$F = i(1 + i)^n / ((1 + i)^n - 1)$

Where,

C: Capital opportunity cost

P: Economic cost of vehicle
F: Capital recovery factor
r: Salvage value rate
i: Interest rate
n: Durability (Vehicle life)

Interest rate is 12% which is the same rate as the discount rate used in calculating evaluation indices. Table 15-3-12 presents daily capital opportunity cost.
Total capital opportunity cost in the study area is the product of this daily cost and total number of vehicles existing in the area. Therefore, in a with and without comparison for project evaluation, this cost will be cancelled out if in both cases the number of vehicles is the same.

Table 15-3-12 Capital Opportunity Cost by Type of Vehicle

	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Vehicle Cost						
Financial	Gs	25,365,000	199,256,340	851,724,000	66,634,000	114,366,600
Economic	Gs	23,061,000	174,421,618	741,000,000	53,209,500	99,518,973
Tire Cost						
Financial	Gs	527,250	5,286,750	8,307,750	1,466,750	2,513,700
Economic	Gs	345,350	3,466,246	5,446,958	962,065	1,649,473
Vehicle Cost w/o Tire						
Financial	Gs	24,837,750	193,969,590	843,416,250	65,167,250	111,852,900
Economic	Gs	22,715,650	170,955,372	735,553,042	52,247,435	97,869,500
Salvage Value						
% of Vehicle Cost	%	25.0	15.0	15.0	20.0	15.0
Financial	Gs	6,209,438	29,095,439	126,512,438	13,033,450	16,777,935
Economic	Gs	5,678,913	25,643,306	110,332,956	10,449,487	14,680,425
Annual Operation.	Km	20,000	60,000	90,000	40,000	75,000
Average Speed	Km/Hr	25	20	30	25	25
Vehicle Life	Year	7	10	10	7	9
Interest rate (i = 12%)		12%	12%	12%	12%	12%
Capital Opportunity Cost						
Financial	Gs/Day	5,103.6	36,668.2	159,440.3	12,854.9	21,144.8
	Gs/Hr	2,328.5	4,461.3	19,398.6	2,932.5	2,572.6
Economic	Gs/Day	4,667.6	32,317.6	139,049.8	10,306.3	18,501.4
	Gs/Hr	2,129.6	3,932.0	16,917.7	2,351.1	2,251.0

(8) Crew Cost and Overhead Cost

Also, this cost is not affected by driven distance but is proportional to time. According to information from interviews with vehicle owners, average annual wage of a bus driver is about Gs12 million, while that of articulated bus driver is higher than this amount, or Gs21 million. Average wage of a truck driver is Gs11 million as shown in Table 15-3-13. The same table show other costs for each type of vehicle. Such costs include inspections for passenger cars and others, and administrative costs for others.

Table 15-3-13 Crew Cost and Administrative Cost by Type of Vehicle

	Unit	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Annual Crew Cost						
Financial	Gs	0	12,012,572	21,143,967	3,412,513	11,375,026
Economic	Gs	0	8,964,605	15,779,075	2,649,725	8,832,421
Annual Other Cost						
Financial	Gs	617,030	12,581,447	34,094,071	4,270,715	10,231,610
Economic	Gs	475,425	11,639,647	30,894,771	3,591,285	9,227,850
Annual Total Cost						
Financial	Gs	617,030	24,594,019	55,238,038	7,683,228	21,606,636
Economic	Gs	475,425	20,604,252	46,673,846	6,241,010	18,060,271
Hourly Crew and OH Cost						
Financial	Gs	771.29	8,198.01	18,412.68	4,802.02	7,202.21
Economic	Gs	594.28	6,868.08	15,557.95	3,900.63	6,020.09

(9) Aggregate VOC

Aggregate unit VOCs are summarized as shown in Table 15-3-14. To calculate total VOC in a network, firstly, running speed of each link must be obtained from the traffic assignment result, secondly, total distance-related cost is calculated by summing up the cost in each link and finally, time-related cost calculated separately using total number of vehicles is added to the distance-related cost.

Fig. 15-3-2 illustrates the vehicle operating cost by type of vehicle and by operating speed. At very low speeds of 5 km per hour, the time-related cost is higher than the distance related cost across all types of vehicle. Most economical speed is around 60 to 70 km per hour.

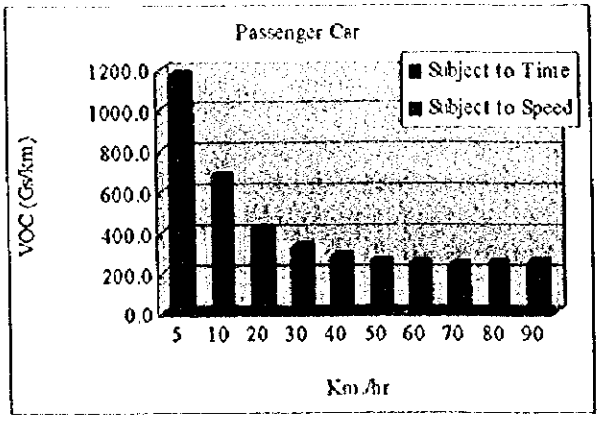
Table 15-3-14 Aggregate VOC by Type of Vehicle

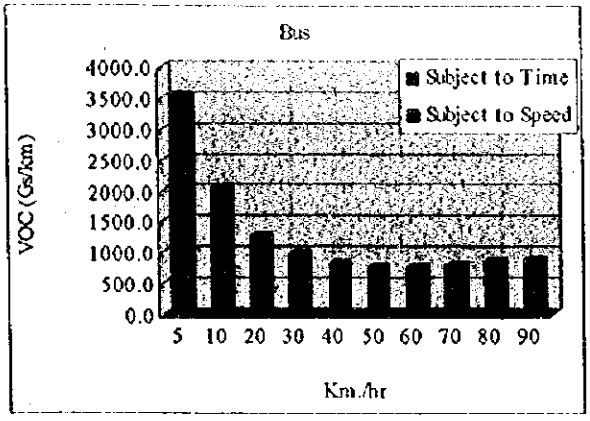
1) VOC subject to Use (Gs/Km)

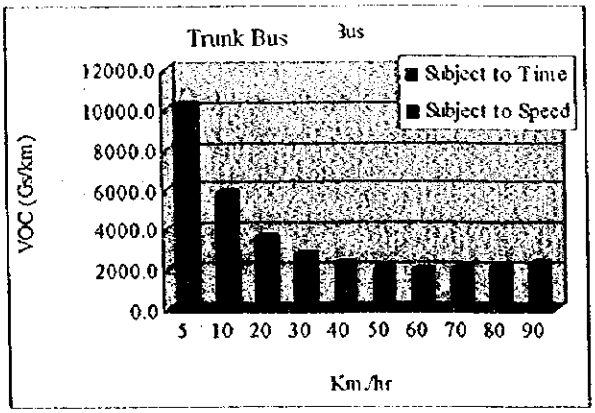
	Speed (Km/hour)	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Financial Cost	5	421.5	1,152.9	2,719.6	846.2	1,218.8
	10	324.4	927.4	2,264.3	637.1	881.5
	20	263.2	757.4	1,872.4	513.5	681.1
	30	237.8	666.2	1,630.1	455.0	540.4
	40	221.4	602.3	1,457.2	434.3	463.4
	50	214.7	595.4	1,418.4	425.4	431.5
	60	221.1	644.4	1,525.7	435.9	431.6
	70	230.7	704.9	1,657.7	445.9	450.1
	80	245.5	789.4	1,849.5	477.6	491.4
	90	265.1	876.1	2,050.4	516.1	543.2
Economic Cost	5	325.0	1,102.9	2,527.8	695.6	1,144.3
	10	248.8	828.7	2,001.1	507.2	801.7
	20	205.8	674.3	1,649.6	408.9	617.2
	30	186.8	591.6	1,434.2	361.9	487.2
	40	173.8	532.6	1,278.7	344.9	416.0
	50	167.9	525.6	1,243.7	337.3	386.0
	60	173.3	572.3	1,344.0	346.4	386.5
	70	180.5	628.0	1,463.9	354.5	403.2
	80	190.9	699.8	1,628.0	378.3	438.5
	90	204.8	774.0	1,800.3	407.8	483.5

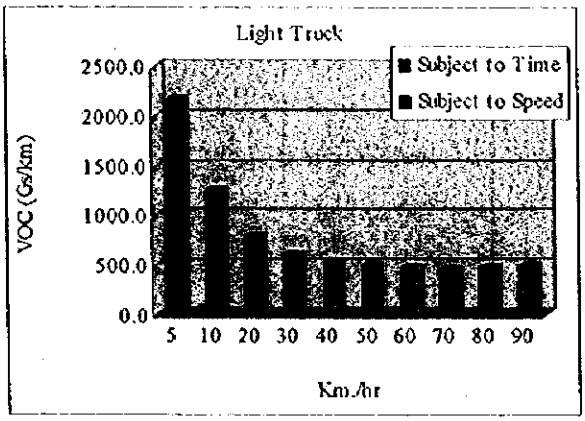
2) VOC subject to Time (Gs/Hour)

	Car	Bus (60 pax.)	Trunk Bus (160pax.)	Light Truck	Heavy Truck
Financial Cost					
Depreciation	1,663.3	1,648.7	6,747.3	1,396.4	1,056.4
Capital Opportunity Cost	2,328.5	4,461.3	19,398.6	2,932.5	2,572.6
Crew and Overhead Cost	771.3	8,198.0	18,412.7	4,802.0	7,202.2
Total	4,763.1	14,308.0	44,558.6	9,130.9	10,831.2
Economic Cost					
Depreciation	1,521.1	1,453.1	5,884.4	1,119.6	924.3
Capital Opportunity Cost	2,129.6	3,932.0	16,917.7	2,351.1	2,251.0
Crew and Overhead Cost	594.3	6,868.1	15,558.0	3,900.6	6,020.1
Total	4,245.0	12,253.2	38,360.1	7,371.3	9,195.4









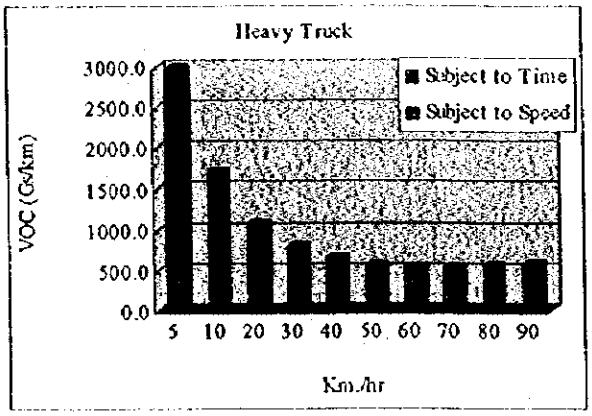


Fig. 15-3-2 Economic Vehicle Operating Cost by Speed

15.3.3 Travel Time Value

Travel time of car users and bus passengers is converted to monetary term using unit time value. Their time values are estimated based on their income that reflects their productivity. From the number of workers and gross regional products, the per-worker income is estimated to be about Gs19.6 million.

The number of workers in 1998:	507,500
Gross Regional Product in 1998.	Gs9,935,615 million
	Gs19,577,567/worker/year

From the 1996 household survey, the income share of car users is 63%, and that of bus users 37%. Then, their hourly monetary values are estimated as follows, using their mode shares and annual working hours of 2,000.

$$\text{Income of Car Users} = \frac{9{,}935{,}615 \times 10^6 \times 0.63}{507{,}500 \times 0.495 \times 2{,}000} = \text{Gs12,458/hour/person}$$

$$\text{Income of Bus Users} = \frac{9{,}935{,}615 \times 10^6 \times 0.37}{507{,}500 \times 0.505 \times 2{,}000} = \text{Gs6,978/hour/person}$$

All trips with "business" purpose are regarded as productive activities and thus the time spent for that purpose is given as the above values. The share of "business" trip is 2.9 to 16.5% depending on types of vehicle. "To work" trips (with a share of 29.4 to 40.7%) are assumed to have a half of the time value of "business," and "other" trips have no time value (Table 15-3-15).

The total TTC is estimated by multiplying these unit time values by the aggregate passenger-hours by mode obtained from the assigned traffic in the network.

Table 15-3-15 Travel Time Cost

	Hourly Income (Gs/hr)	Time Value (Gs/hr)		Trip Composition (%)		Weighted Average (Gs/hr)
		To Work (x0.5)	Business (x1.0)	To Work	Business	
Passenger Car	12,458	6,229	12,458	34.3	4.0	2,640.7
Light Truck *1	8,622	4,311.0	8,622	34.3	7.9	2,158.5
Heavy Truck	6,978	3,489.1	6,978	40.7	16.5	2,573.4
Bus	6,978	3,489.1	6,978	29.4	2.9	1,230.5
Trunk Bus *2	9,718	4,859.0	9,718	29.4	2.9	1,713.6

Note:

*1: It is assumed that 30% of the use is for private (time value equal to auto users) and the remaining 70% for work (equal to bus users).

*2: An average of time value for auto and bus users.

15.3.4 Evaluation Results

The baseline case is defined as the existing road network plus the existing plans such as Mme Lynch that will be 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 in vehicle operating costs and travel time costs will be about US$277 million. The economic internal rate of return (EIRR) is estimated to be 29.3%, and with the discount rate of 12%, the net present value (NPV) will be US$53 million, and the benefit-cost ratio (B/C) 2.38. Therefore, the Master Plan will adopt the public transport priority alternative.

Table 15-3-16 Comparison of Master Plan Alternatives

	Unit	Baseline case	Auto	Public Transport
Veh km	1,000 veh km/yr	17,850	15,769	14,209
Veh time	1,000 veh hr/yr	2,128	566	588
Avg. Speed	Km/hr	8.4	27.9	24.2
Capital Cost	US$ thousand	-	463,872	339,493
Benefit	US$ thousand/yr	-	182,694	176,562
EIRR	%	-	25.2	32.5
NPV (r=12%)	US$ thousand	-	186,872	234,280
B/C (r=12%)		-	1.82	2.40

15.4 Summary of the Master Plan

The Master Plan targeting 2015 has been formulated with a strong emphasis on projects on Av. E. Ayala, i.e. the trunk bus system and widening, and aims at resolving the lack of traffic capacity in the metropolitan area. In response to the future traffic demand, it also attempts to develop a balanced network of radial and ring trunk roads.

The Master Plan consists of (1) infrastructure development focusing on road development and (2) policy and planning measures stressing traffic management. These two measures must be combined together in a harmonious fashion to maximize their effectiveness.

Major components of the Master Plan are described below.

- Widening (six lanes) of Av. E. Ayala and new construction of exclusive bus lanes for introducing the trunk bus system
- Development of road networks in areas that expect rapid increases in future traffic demand, namely in a) the south, b) the north, and c) the east.
- Improvements of ring roads, especially their pavements
- Development of trunk road networks connecting each city in the metropolitan area
- Traffic management
- Improvements of intersections to resolve bottlenecks
- Improvements of drainage facilities, i.e. surface drainage on major trunk roads
- Provision of trunk bus facilities, e.g. terminals, and application of trunk bus on other roads

Table 15-4-1 and Fig. 15-4-1 show the summary of the Master Plan projects. The phased implementation plan is summarized in Table 15-4-2. The plan attempts to achieve a balance between short-term emergency projects and long-term measures.

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 (Table 15-4-3). Moreover, the time distance from Micro Centro to other cities would be significantly reduced (Fig. 15-4-2).

Table 15-4-3 Change in Model Selection

(Unit: trips/day)

	Present (1998)	Do-Nothing (2015)	Masterplan (2015)
Car	1,220,433 49.4%	2,314,298 54.2%	2,135,651 50.0%
Bus	1,248,335 50.6%	1,958,108 45.8%	2,136,755 50.0%
Total	2,468,768	4,272,406	4,272,406

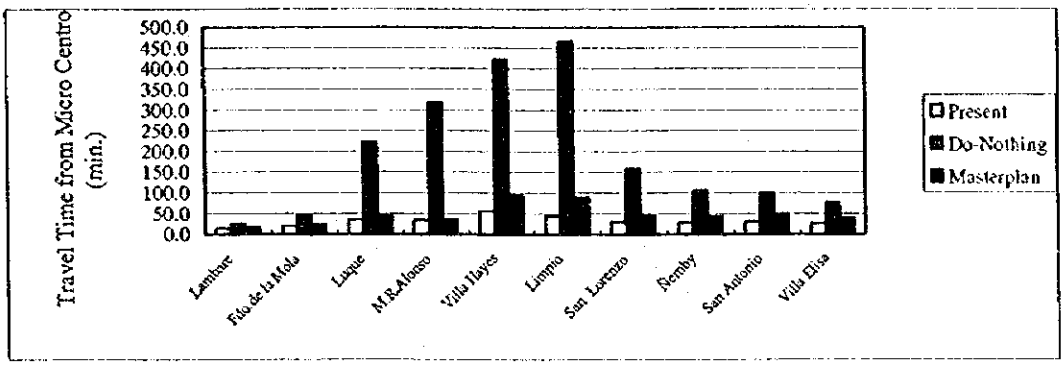


Fig. 15-4-2 Change in Travel Time from Micro Centro in 2015

Table 15-4-1 List of the Mater 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
Public Transportation	104	Av.Eusebio Ayala (Calle Ultima-San Lorenzo)	Widening	6	4.55	24,793		24,793
From the South	111	Av. J. F. Bogado (1ro. de Marzo)	Widening	4	1.65		2,353	2,353
	113	Av Itá Ybaté	Pavement	4	3.22	2,613		2,613
From the North	101	Northern Esplanade	Detour	6	4.88		20,000	20,000
	102	Northern Esplanade	Detour	4	16.32		40,000	40,000
	107	Av.Artigas	Widening	4	1.68		2,396	2,396
	121	Gral. Rafael Franco	Widening	4	2.04	3,970		3,970
	122	Julio Correa	Widening	4	1.61	3,376		3,376
	123	Tte 2do M.Pino Gonzalez	Widening	4	0.99	2,076		2,076
From the East	112	Av. Sta. Teresa	Widening	4	1.75		2,496	2,496
Circulation Road	108	Av.Perú	Widening	4	3.28		4,677	4,677
	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	2,310
	120	Rca. Argentina	Widening	4	3.22		4,592	4,592
Widening of the Arteries	201	Las Residentas	Pavement	2	1.59		472	472
	202	Avelino Martinez	Pavement	2	1.11		330	330
	203	Sub-Trunk Road	Pavement	2	0.27		80	80
	204	Sub-Trunk Road	Conection	2	0.14		335	335
	205	Avelino Martinez - Calle Ultima	Pavement	2	5.05		1,500	1,500
	206	Calle Ultima - De la Victoria	Pavement	2	1.11		330	330
	207	Sub-Trunk Road	Pavement	2	0.77		229	229
	208	Sub-Trunk Road	Pavement	2	0.55		163	163
	209	Sub-Trunk Road	Pavement	2	0.09		27	27
	210	Fdo de la Mora - Av. Def. del Chaco	Conection	2	2.44		5,836	5,836
	211	Sub-Trunk Road	Pavement	2	1.44		538	538
	212	Deffensores del Chaco	Pavement	2	3.70		1,099	1,099
	219	Avelino Martinez	Pavement	2	5.71		1,696	1,696
	220	Av.San Isidro	Pavement	2	2.68		796	796
	221	Esplanade of Fatima	Pavement	2	0.77		229	229
	222	Av. 3 de Defebrero	Pavement	2	3.06		909	909
Connection of the Cities	301	Ruta 2 (San Lorenzo)	Detour	4	2.66		9,418	9,418
	302	Road 1(San Lorenzo)	Detour	4	8.62		29,644	29,644
	306	M.R.Alonzo - Luque	Detour	4	7.47		25,689	25,689
	308	Luque-San Lorenzo	Widening	4	7.79		11,109	11,109
	309	San Lorenzo -Ñemby	Widening	4	6.84		9,754	9,754
	310	Luque-Limpio	Widening	4	10.98		15,657	15,657
	311	Ruta Trans Chaco	Widening	6	7.45		14,647	14,647
	312	Ruta 3 (Limpio-M.R.Alonso)	Widening	6	6.54		9,326	9,326
	313	Autopista Desvío (Luque-Mme.Lynch)	Detour	4	5.43		18,674	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	11,340
	704	Parking Restriction						
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. Chef. del Chaco		4x4		71		71
	406	Av.Mcal. López / Venezuela		4x2			71	71
	407	Av.Mcal. López / Av. Kubitscheck		4x4			71	71
	408	Av.Mcal. López / Av. Gral. Santos		4x4		71		71
	409	Av.Mcal. López / Av. Perú		4x4			71	71
Drainage	501	Av.Fdo. de la Mora / Bartolomé de las Casas		4x2			18	18
	502	Av.Fdo. de la Mora / From Kubitscheck to Gral.Santos		4			18	18
	503	Av.Fdo. de la Mora / San Martin		4x4			18	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 Martin		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	18
	511	Av.Artigas / Av. Gral Santos		4x4			18	18
	512	1er.Presidente / From Artigas to Transchaco		4			18	18
	513	Av.Aviadores del Chaco		4			18	18
Transport Facility	601	Bus Bay / Av. Artigas					734	734
	602	Bus Bay / Av. Mcal. López					564	564
	603	Bus Bay / Av. Fdo. De la Mora					828	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

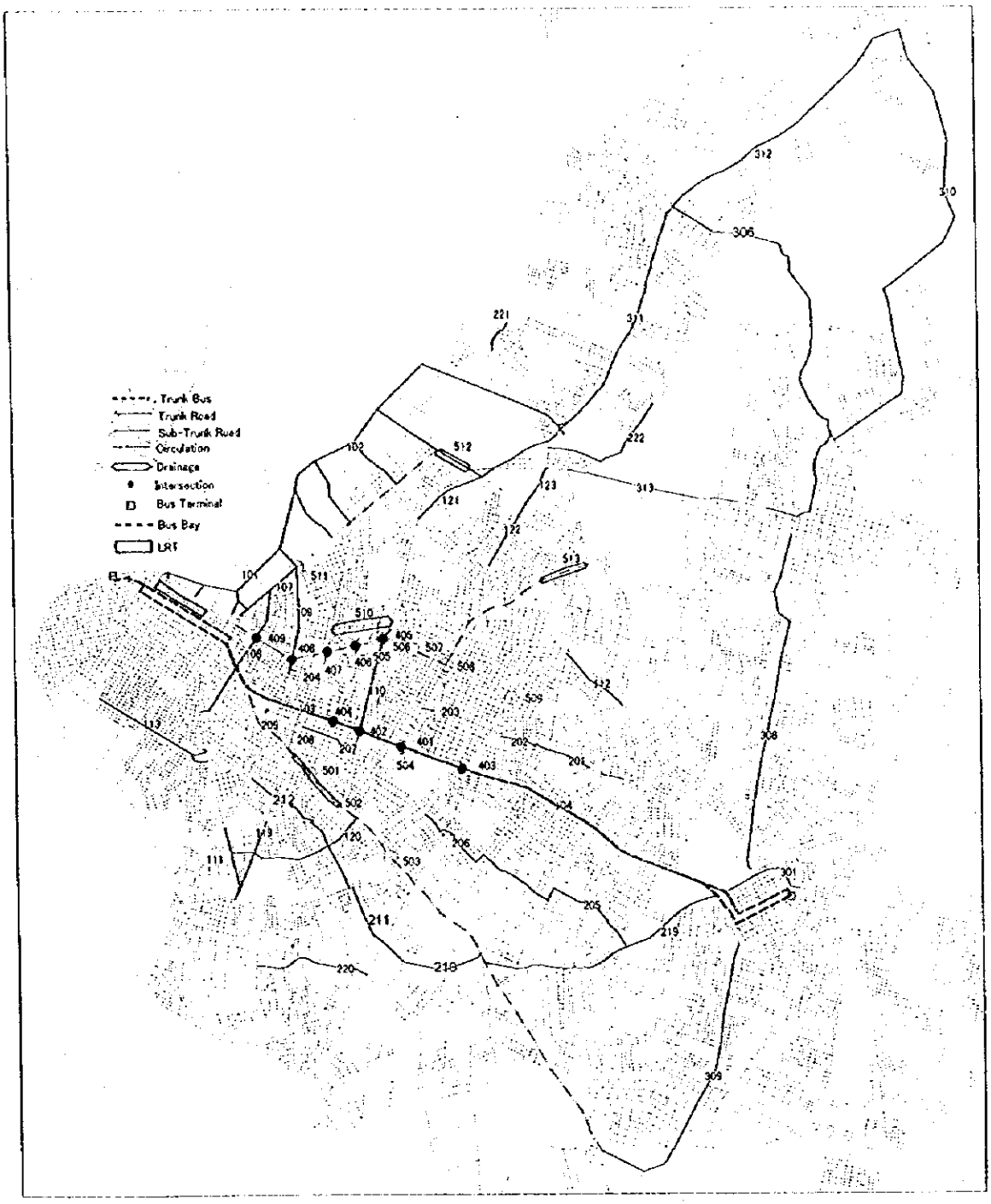


Fig. 15-4-1 Summary of the Mater Plan

Table 15-4-2 Phased Implementation Plan

	No	Name	Cost (1000US$) -2006	-2015	Total	2000 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Av. E. Ayala	103	Av Eusebio Ayala (General Aquino-Calle Ultima)	31,683		31,68	
Public Transportation	104	Av Eusebio Ayala (Calle Ultima San Lorenzo)	24,793		24,79	
From the South	111	Av. J.F. Dogado (Tro. de Marzo)		2,353	2,353	
	113	Av Isla Ybate	2,613		2,613	
From the North	101	Northern Esplanade		20,000	20,000	
	102	Northern Esplanade		40,000	40,000	
	107	Av Artigas		2,396	2,396	
	121	Gral Rafael Franco	3,970		3,970	
	122	Julio Correa	3,376		3,376	
	123	Tte 2do M Pino Gonzalez	2,076		2,076	
From the East	112	Av. Sta. Teresa		2,496	2,496	
Circulation Road	108	Av Perú		4,677	4,677	
	109	Av Gral Santos	5,002		5,002	
	110	Av. Chof. del Chaco	3,656		3,656	
	119	Av. Bruno Guggiari		2,310	2,310	
	120	Rca. Argentina		4,592	4,592	
Widening of the Arteries	201	Las Residentas		472	472	
	202	Avelino Martínez		330	330	
	203	Sub-Trunk Road		80	80	
	204	Sub-Trunk Road		336	336	
	205	Avelino Martínez - Calle Ultima		1,500	1,500	
	206	Calle Ultima - De la Victoria		330	330	
	207	Sub-Trunk Road		229	229	
	208	Sub-Trunk Road		163	163	
	209	Sub-Trunk Road		27	27	
	210	Fda de la Mora - Av. Def. del Chaco		5,836	5,836	
	211	Sub-Trunk Road		536	536	
	212	Defensores del Chaco		1,099	1,099	
	219	Avelino Martínez		1,696	1,696	
	220	Av San Isidro		796	796	
	221	Esplanade of Fatima		229	229	
	222	Av. 3 de Febrero		909	909	
Connection of the Cities	301	Ruta 2 (San Lorenzo)		9,418	9,418	
	302	Road 1(San Lorenzo)		29,644	29,644	
	306	M.R.Alonzo - Luque		25,689	25,689	
	308	Luque-San Lorenzo		11,109	11,109	
	309	San Lorenzo -Nearby		9,754	9,754	
	310	Luque-Limpio		13,657	13,657	
	311	Ruta Trans Chaco		14,647	14,647	
	312	Ruta 3 (Limpio-M.R.Alonso)		9,326	9,326	
	313	Autopista Desvío (Luque-Mme Lynch)		18,674	18,674	
Traffic Control	701	Signal Control System	2,497		2,497	
	702	Road and Traffic Signs	206		206	
	703	LRT in Micro-Centro		11,340	11,340	
	704	Parking Restriction		-	-	
Intersection	401	Av Eusebio Ayala / Av. Rca. Argentina	2,729		2,729	
	402	Av Eusebio Ayala / Av. Chof. del Chaco	2,531		2,531	
	403	Av Eusebio Ayala / De La Victoria	2,167		2,167	
	404	Av Eusebio Ayala / Kubitschek	2,921		2,921	
	405	Av.Mcal. López / Av. Chof. del Chaco	71		71	
	406	Av.Mcal. López / Venezuela		71	71	
	407	Av.Mcal. López / Av. Kubitschek		71	71	
	408	Av.Mcal. López / Av. Gral. Santos	71		71	
	409	Av.Mcal. López / Av. Perú		71	71	
Drainage	501	Av.Fdo. de la Mora / Bartolomé de las Casas		18	18	
	502	Av.Fdo. de la Mora / From Kubitschek to Gral Santos		18	18	
	503	Av.Fdo. de la Mora / San Martín		18	18	
	504	Av Eusebio Ayala (General Aquino - San Lorenzo)	11,548		11,548	
	505	Av.Mcal. López / Sta. Rosa	1,338		1,338	
	506	Av.Mcal. López / Av.Chof. Del Chaco	1,337		1,337	
	507	Av.Mcal. López / Gral. Garay	716		716	
	508	Av.Mcal. López / Av. San Martín	2,130		2,130	
	509	Av.Mcal. López / Bernardino Caballero	3,328		3,328	
	510	Av España / From Kubitschek to Sacramento		18	18	
	511	Av Artigas / Av. Gral Santos		18	18	
	512	Ter.Presidente / From Artigas to Transchaco		18	18	
	513	Av.Aviadores del Chaco		18	18	
Transport Facility	601	Bus Bay / Av. Artigas		734	734	
	602	Bus Bay / Av. Mcal. López		564	564	
	603	Bus Bay / Av. Fdo. De la Mora		828	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	

Chapter 16 Priority Projects and Programs

16.1 Traffic Demand Structure

Compared to the current traffic demand, the demand for public transport in 2005, 2010, and 2015, as shown in Fig. 16-1-1, concentrates on radial trunk roads, such as Av. E. Ayala and Mcal. López. In particular, Av. E. Ayala will have more than 10,000 vehicles per day in 2010. As Fig. 16-1-2 illustrates, higher demands for bus users are also observed on radial trunk roads, the highest on Av. E. Ayala, but unlike demands of traffic volume, there are also many bus users outside Asunción. This indicates that urban sprawl will be accelerating.

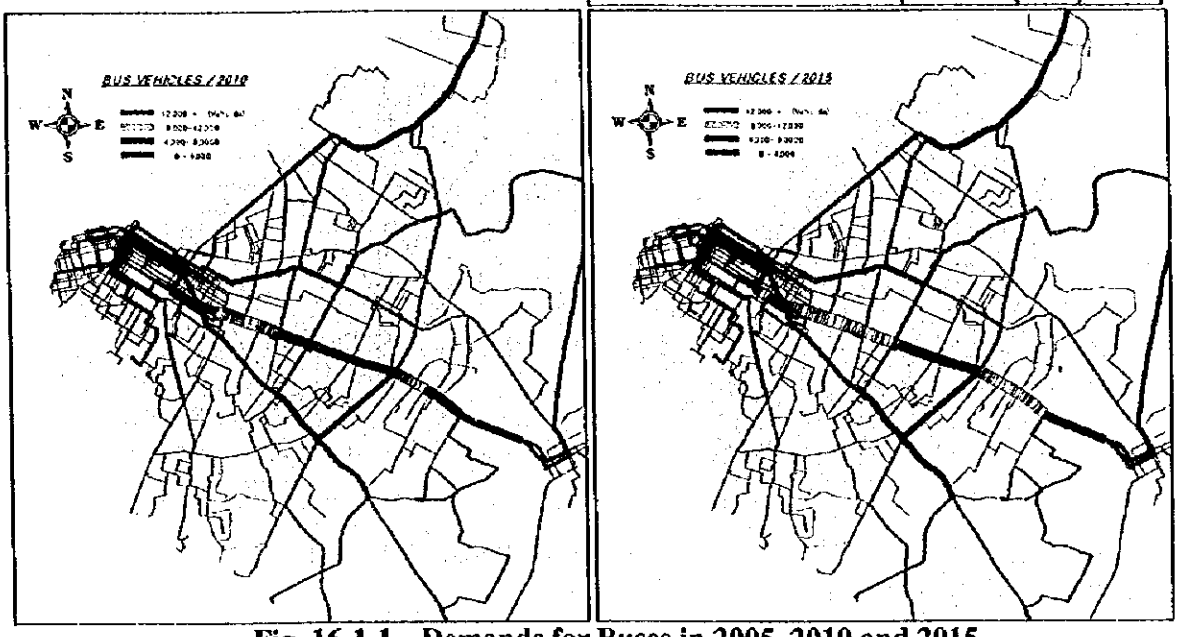


Fig. 16-1-1 Demands for Buses in 2005, 2010 and 2015

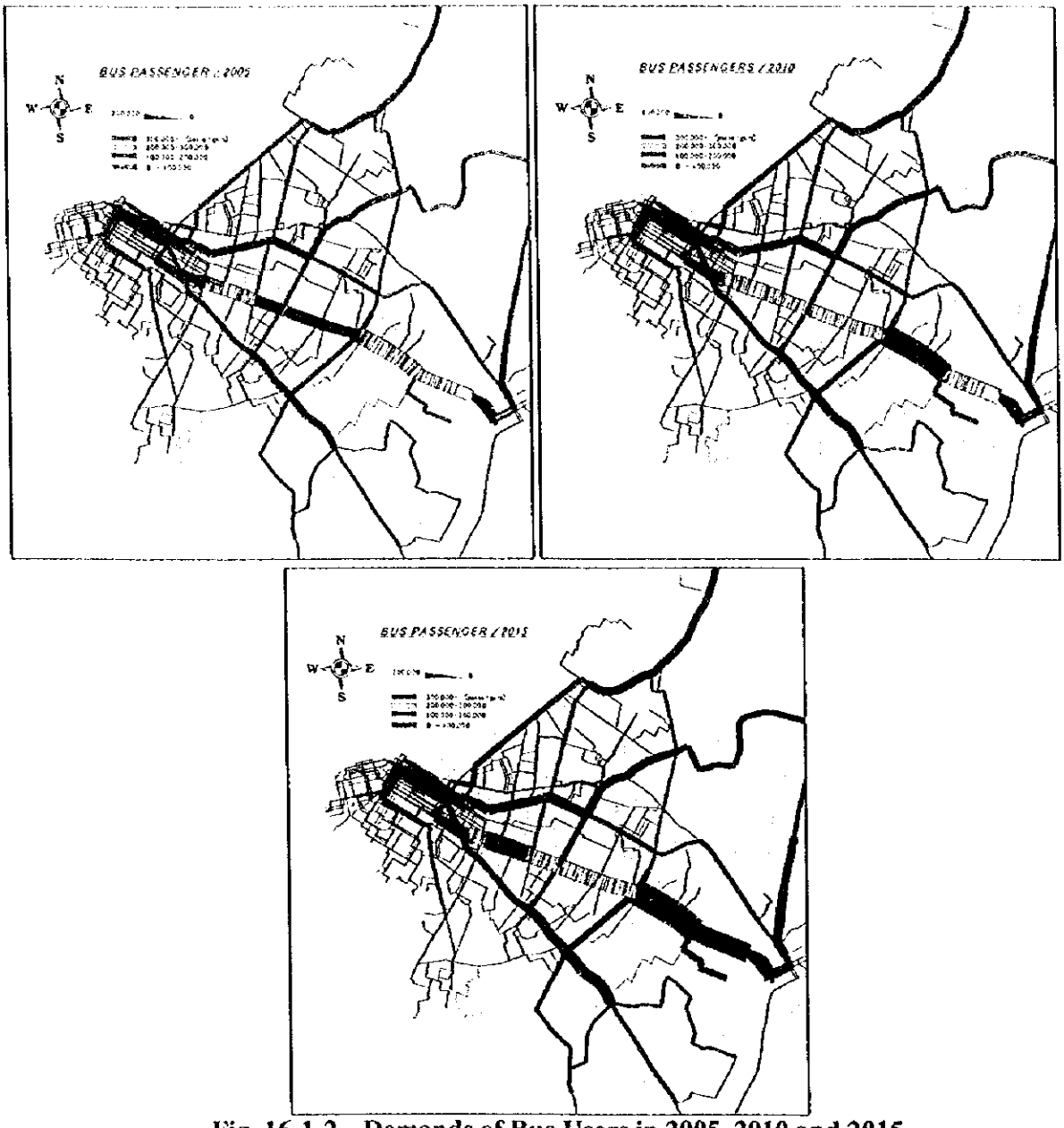


Fig. 16-1-2 Demands of Bus Users in 2005, 2010 and 2015

With the current trend unchanged, as shown in Fig. 16-1-3, Luque and San Lorenzo will be into the travel time area of 60 minutes from Centro.

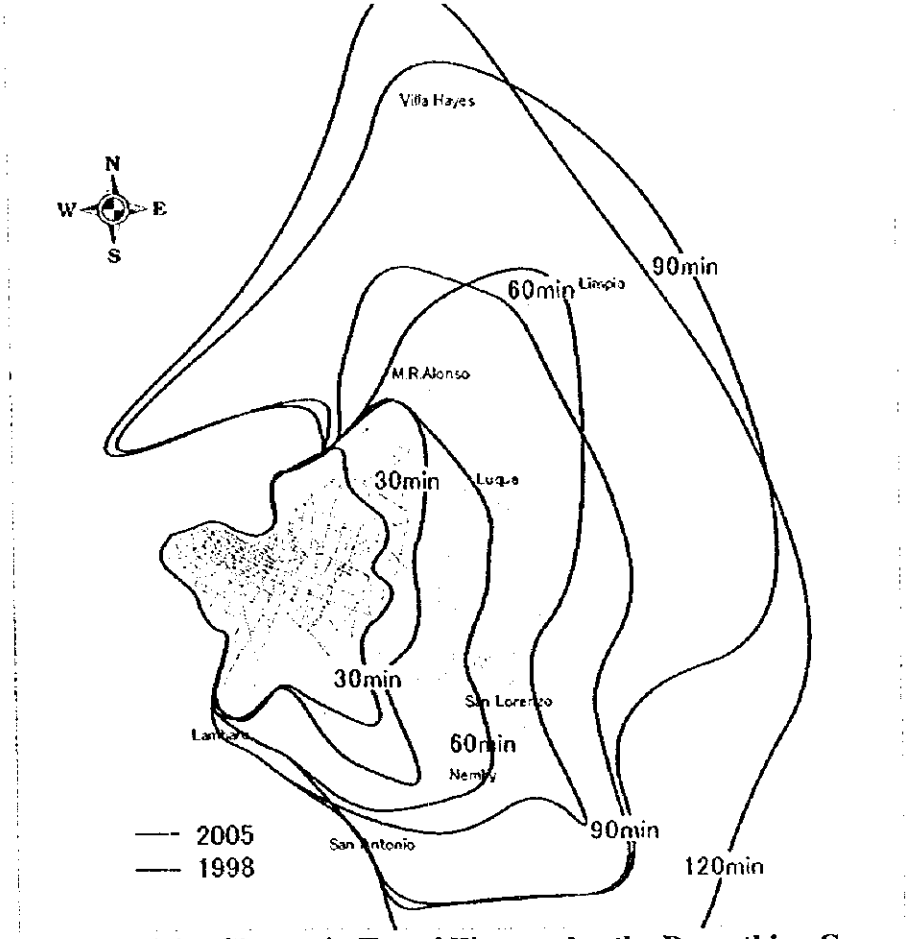


Fig. 16-1-3 Change in Travel Time under the Do-nothing Case

Table 16-1-1 shows changes in the traffic demand structure after introducing the trunk bus system. This assumes the following projects have been implemented.

- Parking restrictions in Centro
- Introduction of the trunk bus system and exclusive bus lanes
- Renovation of bus vehicles

Table 16-1-1 Change in the Number of Trips after Various Transport Projects

	1998	2005	2015					
		Trend	Trend	Parking fee in Centro Gs3,000	Trunk bus Av.Ayala	Trunk bus and bus lanes	Renovation 50%	Trunk bus ,bus lanes and Renovation 50%
Car	1,138,960	1,683,781	2,182,261	2,125,559	2,115,727	2,112,547	2,113,622	2,001,644
	49.75%	53.53%	53.72%	52.33%	52.08%	52.01%	52.03%	49.28%
Conversion to bus from car				**56,702**	**66,534**	**69,714**	**68,639**	**180,617**
				1.40%	**1.64%**	**1.72%**	**1.69%**	**4.45%**
Bus	1,150,214	1,461,702	1,879,831	1,936,533	1,946,365	1,949,545	1,948,470	2,060,448
	50.25%	46.47%	46.28%	47.67%	47.92%	47.99%	47.97%	50.72%
Total	2,289,174	3,145,483	4,062,092	4,062,092	4,062,092	4,062,092	4,062,092	4,062,092

If the current trend continues, in 2005 the share of car will surpass that of buses, and by 2015, the disparity between the two modes will become larger. Therefore, one of the project goals is to

select projects and policy measures that help maintain the current mode shares in future. And the introduction of a trunk bus system and renovations of bus vehicles are effective measures to realize this goal.

16.2 Phased Implementation Plan of Public Transport

In 2005 for the Do-nothing Case, significant increases in travel time can be expected in sections from the north to the east of M.R. Aronzo, Limpio, San Lorenzo, and Luque. Among those sections, Av. E. Ayala has the largest demand for buses and thus receives the first priority. Thus, in the first phase, it is necessary to introduce a trunk bus on this avenue.

In order to improve access to the north, exclusive bus lanes will be introduced on the four-lane section of Av. Artigas to Ruta Transchaco, which gives further priority to public transport. Then, exclusive bus lanes will be also installed on the sections from Autopista to Mcal. López and on Av. Fdo. de la Mora as access roads from Luque to Centro.

After 2015, it is predicted that the trunk bus system on Av. E. Ayala will not be able to accommodate the demand, and thus the avenue warrants a new public rail based system.

In the meantime, improvements in the comfort of riding buses require continuous renovations of bus vehicles and their conversions into larger vehicles. It is important, therefore, to establish organizations and formulate policies that encourage sharing the costs of purchasing, maintaining, and managing buses. Such policies require organizations, institutions, and budgets to supervise bus companies in terms of their management, operations, and the working conditions of their employees. Currently, there is an idea of establishing a metropolitan transport agency, and it needs to be realized immediately.

Table 16-2-1 Phased Implementation Plan of Public Transport

Year	Plans
2005	Trunk bus on Av. E. Ayala, establishment of a metropolitan transport agency, integration of bus operation, provision of bus bays on trunk roads
2010	Exclusive bus lanes on the four-lane sections of Av. Artigas, Ruta Transchaco, renovation of buses, and conversion into larger-scale vehicles
2015	Exclusive bus lanes on the four-lane sections on Autopista, Mcal. López, and Av. Fdo de la Mora, renovation of bus fleet, and conversion into larger-scale vehicles.
2020	Introduction of light rail transit (LRT) on Av. E. Ayala

16.3 Phased Implementation Plan of Road Network

First of all, in order to support the public transport plan, it is a first priority to widen Av. E. Ayala into a six-lane road and improve Mcal. Estigarribia into a six-lane road with sidewalks. Formation of a trunk road network in Asunción requires giving priorities to the improvements of ring trunk roads that have not been completed, namely Av. Gral Santos and Av. Chof. del Chaco. Moreover, it is necessary to pave Ita Ybate with asphalt and modify its connecting points so that a northern axis into Asunción can be strengthened.

In suburban areas, Ruta Transchaco has a high concentration of traffic. There is a pavement plan for the parallel roads in M.R. Aronzo, and priority is given to paving collector roads and connecting them with roads in Asunción. Furthermore, in order to distribute traffic demand from the north in Asunción, it is critical to improve trunk roads in the north. Pavement improvements are applied to other sections of collector roads with heavy congestion.

Considering the introduction of exclusive bus lanes on Av. Artigas to Ruta Tarnschaco requires widening of Ruta Transchaco into six-lanes.

Table 16-3-1 Phased Implementation Plan of Road Network

Year	Plans
2005	Widening of Av. E. Ayala and Mcal. Estigarribia for the introduction of the trunk bus Improvement of incomplete sections of major ring trunk roads Four-lane pavement of Ave. Ita Ybate as a southern access axis
2010	Widening of Trans Chaco Provision of an axis to the north by improving competing collector roads Improvement of a sub-network into Asunción Centro by paving and connecting collector roads
2015	Provision of suburban ring roads by widening inter-city trunk roads into four lanes San Lorenzo bypass Improvement of collector roads

16.4 Phased Implementation Plan of Traffic Management

In the 2005 short-term plan, it is planned to introduce a traffic signal control system with central control schemes on trunk roads to support the trunk bus on Av. E. Ayala. In Centro, the existing control area will be expanded, and the area will also improve its central control system and obtain the capacity of analyzing statistics of collected traffic data and providing information to road users.

To establish a well-developed traffic signal control system, major intersections will be improved for their markings, installed with directional signs and a coordinated control system. It is also necessary to have educational and training programs for traffic police officers to learn traffic rules and control in order to enforce this control system.

In 2010, the central control area will be expanded into ring trunk roads such as Mme Lynch where traffic signals will be centrally controlled as well. This will enable the system to control traffic from suburban areas. By introducing traffic demand management (TDM) measures such as staggered working hours and restrictions on traffic inflow to Centro, the total volume of private vehicles will be controlled.

In the target year of the Master Plan, 2015, a new system will be developed to alleviate the traffic concentration in Centro and to encourage mode conversion from private vehicle into bus with a more convenience public transport system like LRT. This will require such TDM measures as restrictions on parking that are coordinated with land use in Centro and controls on single-occupancy vehicles on trunk roads. For the establishment of a traffic police that makes comprehensive evaluations of urban transport and executes new traffic management, it is necessary to review the existing system and improve educational facilities of traffic police officers. In order to improve manners of drivers as well as the environment, the revision of the drivers' license system and reform of the vehicle inspection system will be carried out.

Table 16-4-1 Phased Implementation Plan of Traffic Management

Year	Plans
2005	Improvement of traffic signals (Av. E. Ayala with the trunk bus, Centro) (Other radial trunk roads) Markings at major intersections, improvements of traffic signs Education and training of traffic police officers
2010	Signal improvements (ring roads) Time for restrictions on traffic inflow to Centro

	TDM (staggered working hours)
2015	Parking restrictions in Centro Revision of traffic police organization and establishment of a training center Reforms of licensing system and vehicle inspection

16.5 Selection of Priority Projects and Programs

Priority projects and programs will be selected from the master plan. Selection criteria are described below.

- Priority on public transport (consistency with the policy)
- Priority on projects that will generate greater effects (high EIRR)
- Priority on particular projects that are relatively easy to implement (implementability) if they equally generate decent benefits
- Environmental considerations (low gas emission)
- Priority on projects within the Municipality of Asunción

Emergency projects subject to evaluation here are major trunk roads only. Projects for collector roads are excluded because most of them are pavement projects and only need to be executed gradually. Table 16-5-1 shows evaluation results.

Table 16-5-1 Evaluation Results of Priority Projects

No.	Project Name	EIRR	Within the Asunción	Facility	Policy of the M/P	Rank
101	Paseo Costanero Norte	30.4	*	X		B
102	Paseo Costanero Norte	15.4	*	X		C
103,104	Av.Eusebio Ayala(General Aquino-San Lorenzo)	34.1	*		OO	A
107	Av.Artigas	43.6	*	X		B
108	Av.Perú	10.4	*	OO	O	B
109	Av.Gral Santos	36.4	*		O	A
110	Av. Chef. del Chaco	52.8	*	O	O	A
111	Av. J. F. Bogado(1ro. de Marzo)	45.5		O		B
112	Av. Sta. Teresa	20.0	*			C
113	Av.Itá Ybaté	65.9	*	OO		A
119	Av. Bruno Guggiari	43.6				B
120	Rca. Agrentina	33.2				B
121	Gral. Rafael Franco	50.5	*	O		A
122	Julio Corréa	56.9	*	O		A
123	Tte.2do M.Pino Gonzalez	72.4	*	O		A
			* Yes	OO : Very Easy O : Easy X : Difficult	OO : Very Coincident O : Coincident	A : High B : Medium C : Low

Assumptions for the evaluation are summarized below.

- In calculating benefits, the do-nothing case is defined assuming the road networks including Mme Lynch, which will complete its widening in 2000.
- Annual benefits are calculated for 240 days x 3/24 hours
- Present values of annual project costs are estimated assuming the discount rate of 12%.
- The trunk bus project on Av. E. Ayala, No. 103, includes costs for the terminals and flyovers.
- Emissions of NOx and CO_2 for each project are evaluated with the do-nothing case as the baseline with the value of 1.0.

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 Frentista 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.

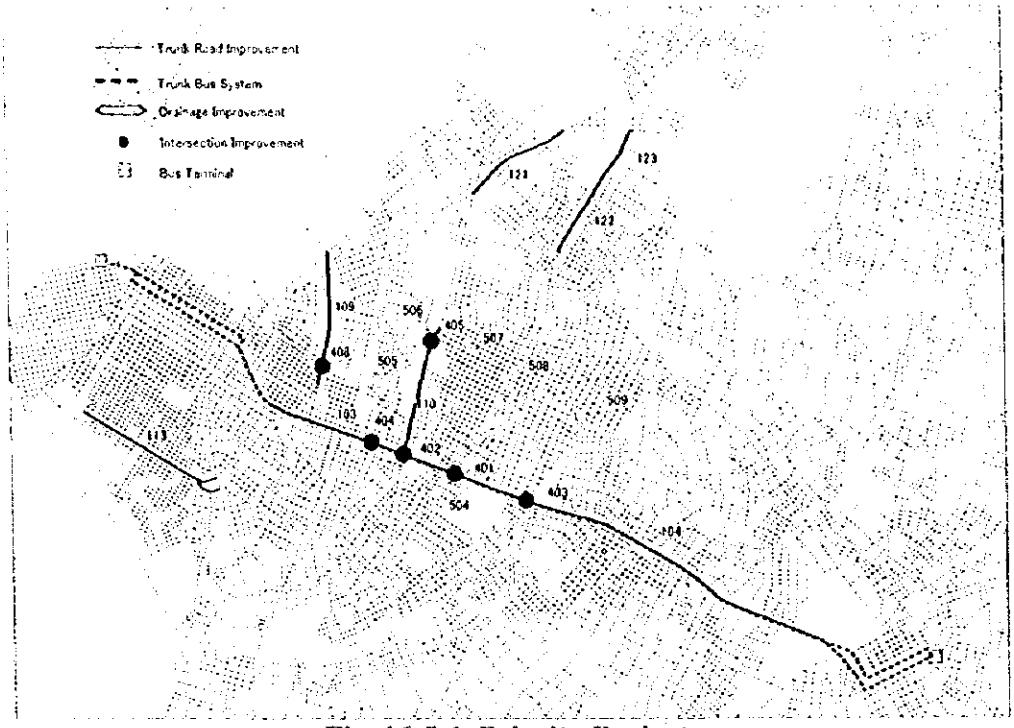


Fig. 16-5-1 Priority Projects

Table 16-5-2 List of Priority Projects

	Number	Name		Lanes	Length
AV. E. AYALA	103	Av.Eusebio Ayala(General Aquino-Calle Ultima)	Widening	6	6.45
	104	Av.Eusebio Ayala(Calle Ultima-San Lorenzo)	Widening	6	4.54
From the South	113	Av.Itá Ybaté	Pavement	4	3.22
From the North	121	Gral. Rafael Franco	Widening	4	2.04
	122	Julio Corréa	Widening	4	1.61
	123	Tte.2do M.Pino Gonzalez	Widening	4	0.99
Circulation	109	Av.Gral Santos	Widening	4	2.41
	110	Av. Chef. del Chaco	Widening	4	2.09
Traffic control	701	Traffic signal system			
	702	Sign posting			
Intersection	401	Av.Eusebio Ayala / Av. Rca. Argentina(bridge)		6x4(2)	
	402	Av.Eusebio Ayala / Av. Chef. del Chaco(Bridge)		6x4(2)	
	403	Av.Eusebio Ayala / De La Victoria(Bridge)		6x4(2)	
	404	Av.Eusebio Ayala / Bartolome de las Casas(kubitsheck bridge)		6x4(2)	
	405	Av.Mcal. López / Av. Chef del Chaco		4x4	
	408	Av.Mcal. López / Av. Gral. Santos		4x4	
Drainage	504	Av.Eusebio Ayala(General Aquino-San Lorenzo)		6	10.99
	505	Av.Mcal. López / Sta.Rosa		4x2	
	506	Av.Mcal. López / Av.Chef. Del Chaco		4x4	
	507	Av.Mcal. López / Gnal. Garay		4x2	
	508	Av.Mcal. López / Av. San Martin		4x4	
	509	Av.Mcal. López / Bernardino Caballero		4x2	
Transport facility	604	Bus Terminal / San Lorenzo			
	605	Bus Terminal / Centro			
	606	Parking for Trunk Bus			

Chapter 17 Public Transport Plan

17.1 Infrastructure Plan of Trunk Bus

17.1.1 Demand Structure of Trunk Bus

(1) Traffic Volume of Trunk and Feeder Buses

Fig. 17-1-1 shows the routes of trunk and feeder buses.

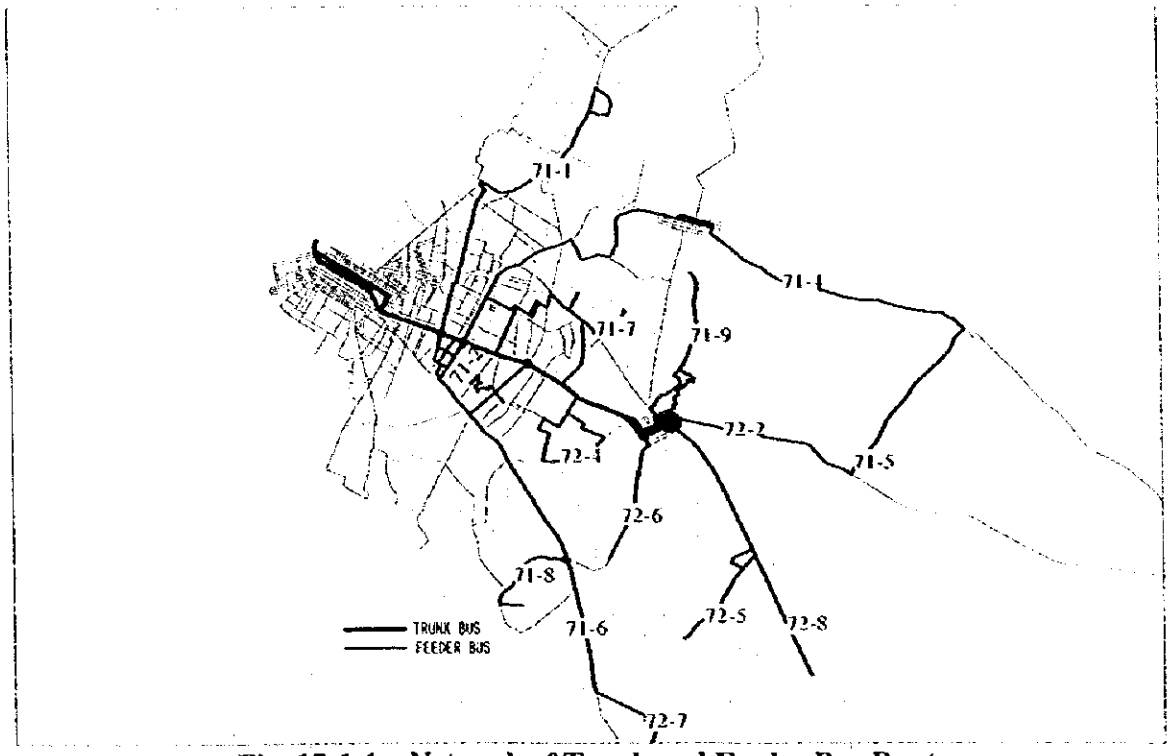


Fig. 17-1-1 Network of Trunk and Feeder Bus Routes

Fig. 17-1-2 and 17-1-3 show the number of passengers on trunk and feeder lines and the demand for buses in 2015. It is assumed that the fare of the trunk bus is Gs1,000, and its capacity is160 passengers.

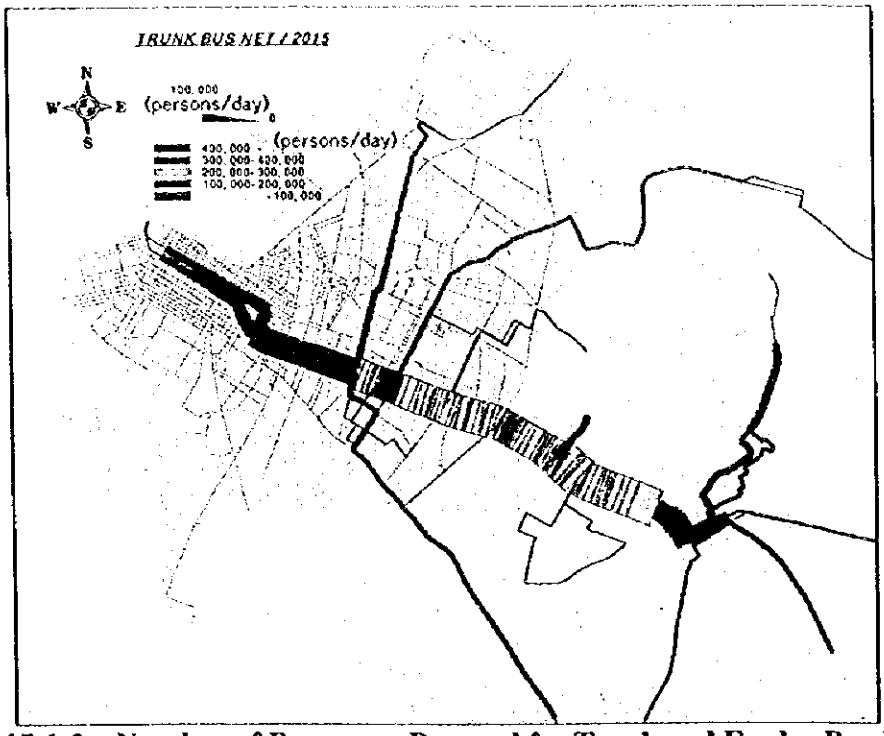


Fig. 17-1-2 Number of Passenger Demand for Trunk and Feeder Bus Lines

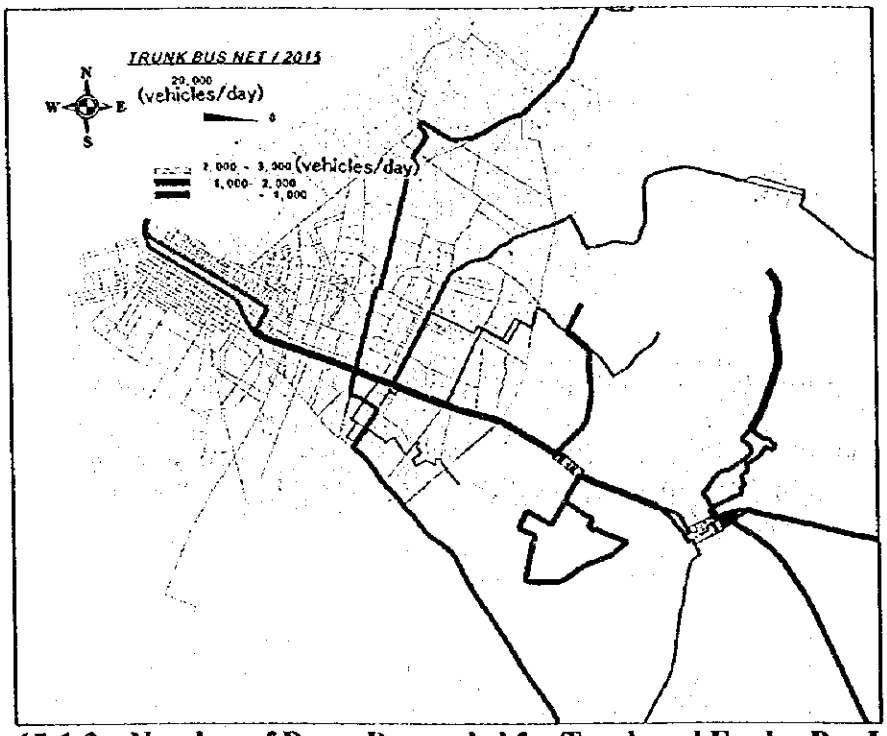


Fig. 17-1-3 Number of Buses Demanded for Trunk and Feeder Bus Lines

Fig. 17-1-4 and Table 17-1-1 indicate demands for the trunk bus for every five years from 2005 to 2020, assuming the fare remains unchanged at Gs1,000. In 2005, the demand is 215,000 passengers per day, and in 2015, 317,000. The section that carries the highest number of passengers is that between San Lorenzo and Mme. Lynch, or 8,700 per hour in 2005 and 12,500 in 2015. The required numbers of buses in these respective years are 36 and 52.

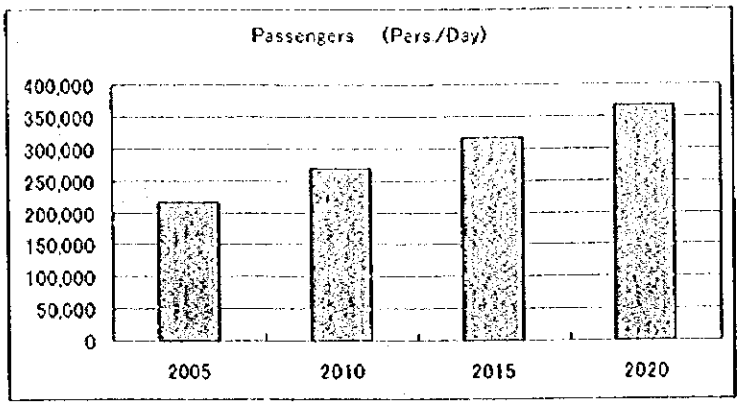


Fig. 17-1-4 Demand for Trunk Bus

Table 17-1-1 Demand Forecasts of Trunk Bus

Year	Passengers (Pers./Day)	Max Section Passengers (Pers/Hour)	Frequency (Vehi./Hour)	Vehicles	Persons /km	Average Trip Distance(km)
2005	215,392	8,676	36	44	5964.4	9.2
2010	268,254	10,700	44	53	7428.2	9.3
2015	317,523	12,484	52	63	8792.5	9.3
2020	367,571	14,451	60	73	10178.4	9.3

Operational frequencies during peak hours are headway of 100 seconds in 2005 and of 69 seconds in 2015. However, the bus system can hardly keep this level of frequency after 2015. Thus, it is necessary to examine possibilities of introducing larger-scale vehicles (three-section, 270 passengers) or a fixed guideway system.

Since it will take 1.2 hours to make a round trip, 63 vehicles will be required for the operation in 2015.

As shown in Table 17-1-2, the demand for feeder buses will increase from 259,000 passengers in 2005 to 392,000 in 2015, and it is larger than that for the trunk bus. This is because there are demands for transfers from feeder to local lines and between feeder lines. The required numbers of all types of buses during peak hours are 213 in 2005 and 298 in 2015. Of all bus lines, Line 71-9 (San Lorenzo-Luque) has the highest demand.

Table 17-1-2 Demand Forecasts of Feeder Bus

Linea	Distance (km)	Operate time (hour)	2005		2010		2015		2020	
			Passengers (Pers./Day)	Frequency (Vehi./Hour)	Passengers (Pers./Day)	Frequency (Vehi./Hour)	Passengers (Pers./Day)	Frequency (Vehi./Hour)	Passengers (Pers./Day)	Frequency (Vehi./Hour)
714	52.8	2.64	11875	9	15015	12	22969	21	26201	24
727	41.2	2.06	7183	4	8868	5	12990	7	14977	8
715	34.2	1.71	17623	16	23415	20	29890	24	34239	28
718	33.4	1.67	36223	20	43975	24	49431	25	56031	28
716	32.5	1.63	3005	2	3664	2	1674	2	1816	2
711	29.3	1.47	31814	23	37461	27	43611	31	48930	35
724	29.4	1.47	35832	31	42099	36	44454	37	50047	42
725	25.5	1.27	24199	21	31956	29	41526	39	47183	44
717	20.7	1.04	16781	11	19559	12	22993	15	25795	17
719	17.7	0.88	45751	52	60160	60	75332	60	89575	60
722	15.0	0.75	13108	12	18342	16	24789	20	28765	24
712	13.9	0.69	8103	5	9810	6	10537	6	11963	7
726	11.1	0.56	7015	7	9632	9	12201	11	14693	13
Total			258512	213	323956	258	392397	298	450215	332

Table 17-1-3 shows changes in the total number of transfers among all bus users after the trunk and feeder bus system is introduced.

Table 17-1-3 Number of Transfers

(Persons/day)

Transfer	Do nothing						Trunk Bus System					
Times	2005		2010		2015		2005		2010		2015	
0	1,002,017	72.1%	1,127,835	70.6%	1,251,571	69.5%	1,035,589	70.1%	1,217,581	69.6%	1,434,182	69.5%
1	379,793	27.3%	459,988	28.8%	538,008	29.9%	374,627	25.4%	447,989	25.6%	523,528	25.4%
2	8,432	0.6%	10,220	0.6%	11,963	0.7%	57,229	3.9%	70,527	4.0%	88,540	4.3%
3	4	0.0%	4	0.0%	4	0.0%	9,991	0.7%	12,728	0.7%	15,802	0.8%
4	0	0.0%	0	0.0%	0	0.0%	285	0.0%	416	0.0%	546	0.0%
Total	1,390,246	100.0%	1,598,047	100.0%	1,801,546	100.0%	1,477,721	100.0%	1,749,241	100.0%	2,062,598	100.0%

Table 17-1-4 and Fig. 17-1-5 show the number of bus users at each bus stop and terminal in 2015. The highest number is observed at the terminal of San Lorenzo (17), or 220,000 passengers. The terminal in Centro (1) has fewer users, and on the other hand, the bus stop on Colon (2) serves many transfer passengers. Other busy bus stops are on Av. Chof. del Chaco (8) and in Fdo. de la Mora (14), and in San Lorenzo (16), and their users are over 100,000.

Table 17-1-4 The Number of Users at each Bus Stop

Bus Stop	Passengers	Bus Stop	Passengers
1	3,407	10	16,663
2	127,194	11	75,390
3	48,504	12	43,206
4	28,097	13	42,306
5	47,890	14	151,681
6	33,260	15	93,623
7	10,277	16	151,906
8	28,900	17	222,275
9	169,070		

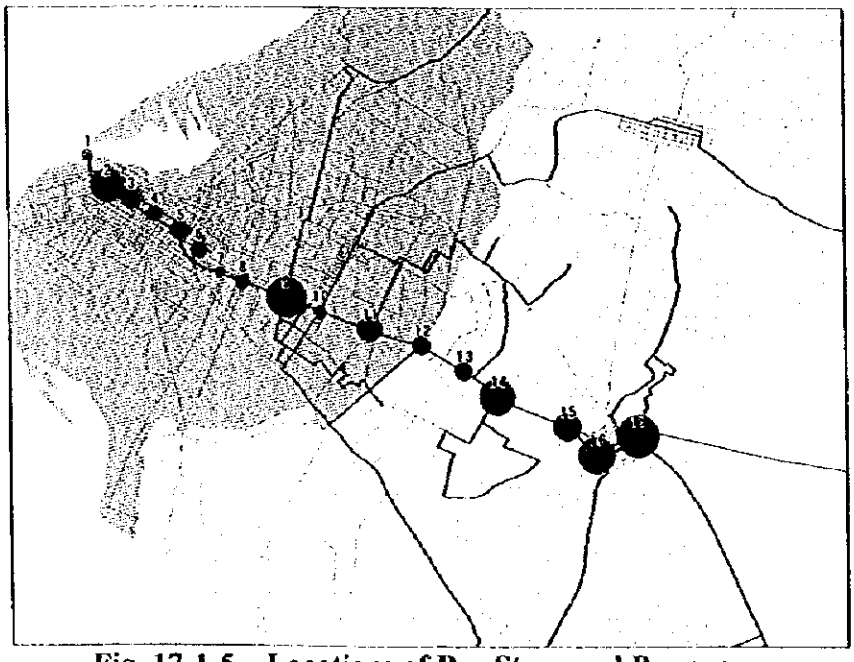


Fig. 17-1-5 Locations of Bus Stops and Passengers

(2) Geometric Structure of Trunk Bus

In view of the demands for buses in 2005 and 2015, it has been decided that two-section articulated buses will be used for the trunk bus system. The structure of vehicles and geometric structures necessary in designing them are described below. The trunk bus system in Curitiba, Brazil is taken as an example, and details of the information have been determined from interviews with the Municipality of Curitiba and vehicle manufacturers.

1) Plane Structure

According to the interview surveys and brochures from the manufacturer, the vehicle structure has been determined as follows. A detail plan is provided in Fig. 17-1-6.

Selected vehicle: two-section articulated bus
Length: L=18.0m
Height: H=3.1m
Width: W=2.5m
Wheelbase: L=5.5m
Front overhang: 2.45m
Rear overhand: 0.965m

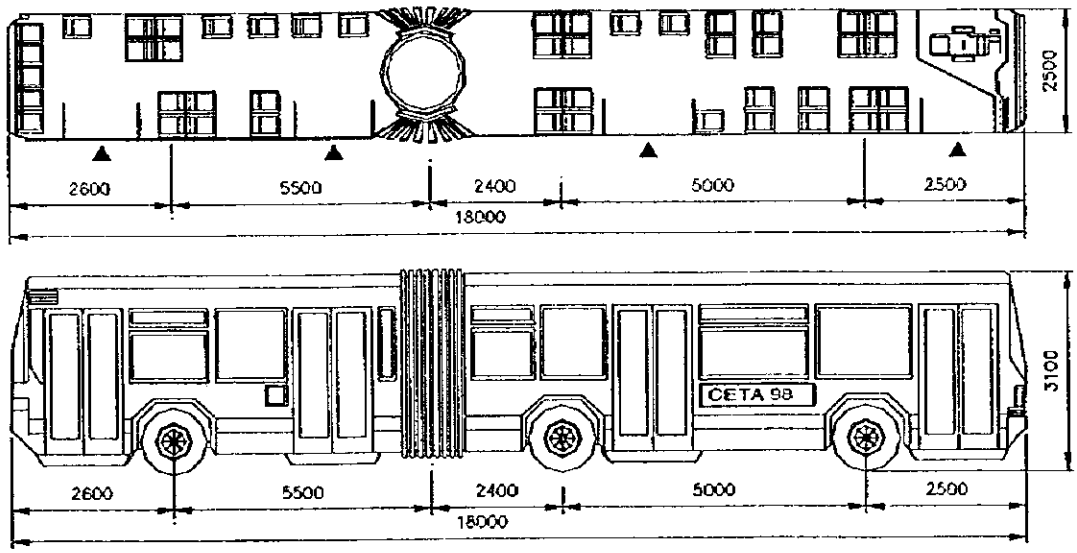


Fig. 17-1-6 General View of Two-Section Articulated Bus

2) Turning Circles and Type of Rear Axle

A two-section, three-axle bus will be adopted. The steered trailing axle enables it to turn with the same turning circle diameter of 12m as the current bus, and thus it has a high mobility. In other words, in making a turn at an intersection, it requires space equal to a bus of 12m length. The Turning circle of a two-section, three-axle articulated bus is provided in Fig. 17-1-7.

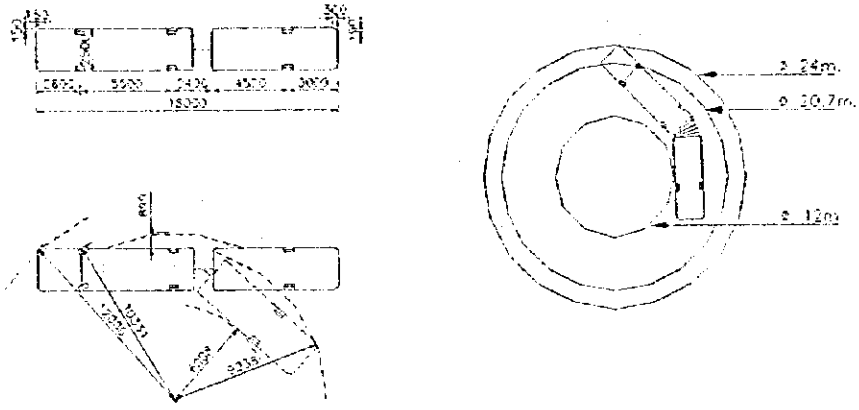


Fig. 17-1-7 General View of Sweep Area of Two-Section Articulated Bus

3) Passenger Capacity

A two-section articulated bus is capable of holding 160 passengers (53 seated and 196 standing), and the maximum occupancy rate is assumed to be 150%. Compared to the current bus with its capacity of 90 passengers (30 seated and 60 standing), the trunk bus has 80% more capacity.

4) Procurement Cost

According to the interview surveys with the manufacturer, a two-section articulated bus costs US$260,000. It takes about three months to manufacture a vehicle. It will be transported into Paraguay by land.

17.1.2 Roadside Conditions and Physical Feasibility

This section examines the current conditions of roadside use and physical feasibility of introducing a trunk bus system. The case to be examined is the section on Av. E. Ayala and Mcal. Estigarribia from Centro to San Lorenzo, which will be widened into a six-lane road with a cross sectional width of 35 meters, and it also includes the parts for bus terminals.

(1) General Description of Trunk Bus Route

The route proposed for the introduction of the trunk bus system is the section from Centro to San Lorenzo with a one-way distance of about 16km. A section to be widened into a six-lane road extends for 10km on Av. E. Ayala and Mcal. Estigarribia, which are divided into three types of road structure as described below.

1) Centro (Centro Terminal to Av. E. Ayala)
Inbound route (To Centro): L=4.4km
Outbound route (To San Lorenzo): L=4.5km

2) Av. E. Ayala and Mcal. Estigarribia (widened section. Gral. Aquino to San Lorenzo junction)

One way length: L=9.6km

3) San Lorenzo (the junction in San Lorenzo to the terminal in San Lorenzo)

Inbound: L=2.6km

Outbound: L=2.6km

Table 17-1-5 shows detail plans of each of the above cross sections.

Table 17-1-5 Distance of The Trunk Bus Route

Direction	Avenue	Section	Distance
San Lorenzo			
(Go)	Miranda Cueto	Terminal - Hernandarias	1360m.
		Hernandarias - University	1200m.
		Total	2560m.
(Back)	Av. Del Agrónomo	University - Marcelina Insfrán	1240m.
		Insfán - Terminal	1380m.
		Total	2620m.
(Go) and	Eusebio Ayala	Aquino - Gral. Santos	830m.
(Back)		Gral. Santos - Kubistcheck	650m.
		Kubistcheck - Choferes del Chaco	1200m.
		Choferes del Chaco - Rca. Argentina	1000m.
		Rca. Argentina - De la Victoria	1420m.
		De la Victoria - Defensores del Chaco	1450m.
		Defensores del Chaco - Leopardi	2450m.
		Leopardi - University	560m.
		Total	9560m.
Centro			
(Go)	Gral. Aquino	Pettirossi - Azara	680m.
	Azara	Aquino - Brasil	930m.
	Azara	Brasil - Colón	2030m.
		Colón - Terminal	800m.
		Total	4440m.
(Back)		Colón - Terminal	800m.
		Don Bosco -Humaitá - Colón	490m.
	Humaitá/Moreno	Colón - Brasil	2030m.
		Brasil - Aquino	1200m.
		Total	4520m.
		(Go) Total	16560m.
		(Back) Total	16700m.

(2) Selection of Trunk Bus Route and its Characteristics

1) Centro in Asunción

Pettirossi is currently a two-lane road and has one-way traffic restriction from Centro outward. Mecado 4 at the intersection of Av. E. Ayala is the largest commercial area, and thus Pettirossi has much demand for buses.

Converting this road into two-way exclusive bus lanes can make the shortest and efficient bus route. However, it has been determined to be inviable to revise the current traffic rules greatly, considering passenger and goods traffic to the market. Thus, an alternative route has been proposed as shown in Fig. 17-1-8.

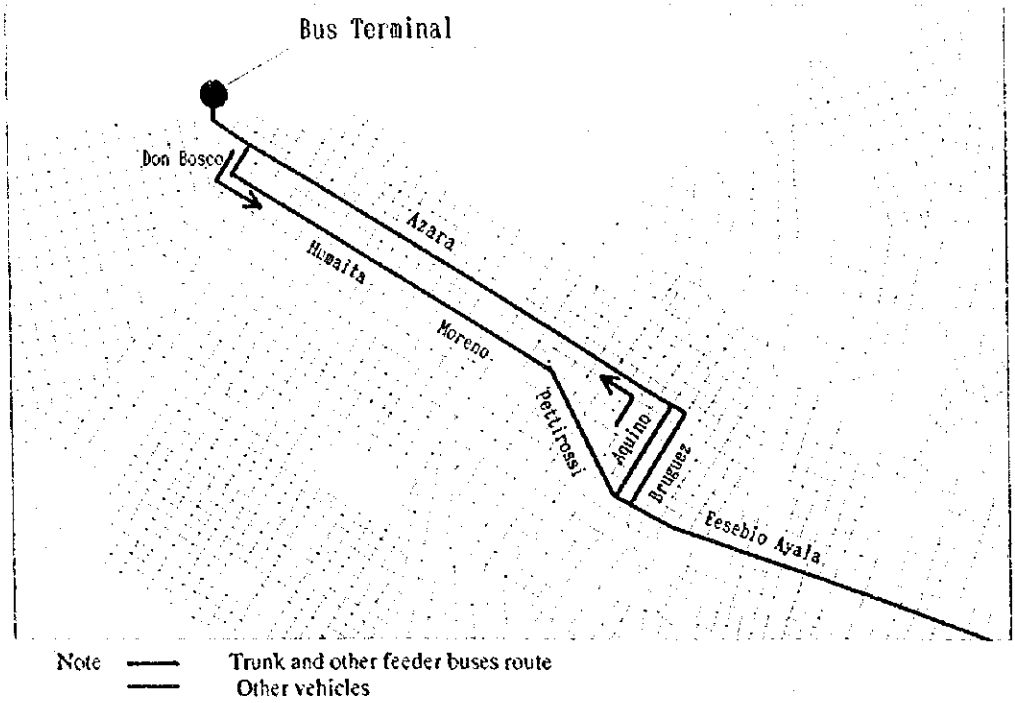


Fig. 17-1-8 Route of The Trunk Bus in Centro

Inbound: Passing Gral. Aquino, the current bus route, then making a left turn, and going through Azala.

Outbound: From the Centro terminal, passing Dos Bosco, going through Humaita, Pettirossi, and then connecting with Av. E. Ayala.

2) Av. E. Ayala and Mcal Estigarribia

They will be widened into six-lane roads. The following roads cross them.

- Gral Santos
- Av. Kubitschek
- Chof. del Chaco
- Argentina
- De la Victoria
- Mme. Lynch

3) San Lorenzo

As shown in Fig. 17-1-9, in San Lorenzo, the inbound and outbound roads are separated at the junction in front of the Asunción National University. Outbound traffic uses Mcal. Estigarribia, and inbound traffic passes Av. Miranda Cuento de Estigarribia, and both are restricted for one-way traffic only. In order to minimize changes in the current traffic rules, basically, the existing bus routes will be used.

Inbound: Same as the existing route, from the San Lorenzo terminal, passing Av. Miranda Cuento de Estigarribia and Hernandarias.

Outbound: From Av. Del Agronomo to Mcal. Estigarribia.and then to the San Lorenzo terminal.

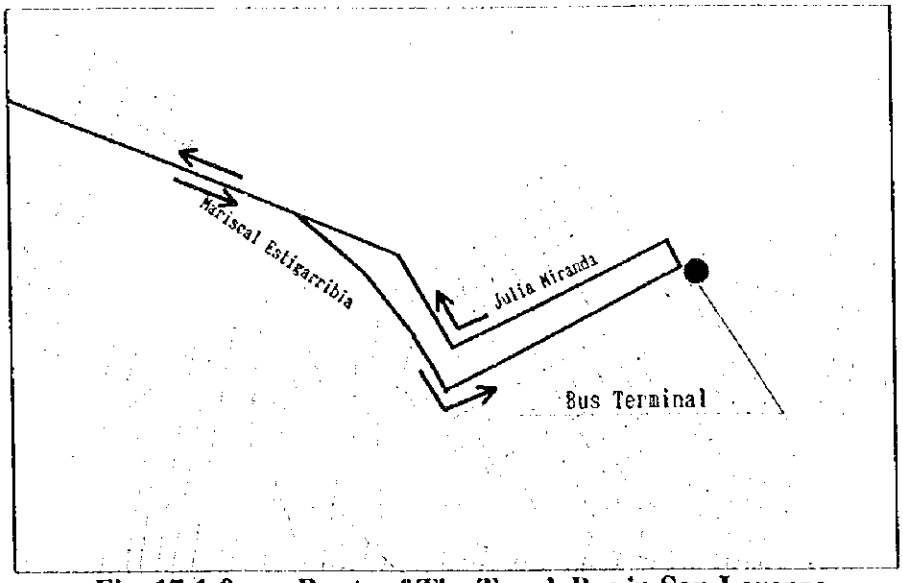


Fig. 17-1-9 Route of The Trunk Bus in San Lorenzo

(3) Roadside Conditions

A survey of roadside conditions has been carried out as follows.

- Survey Area: the 16km section where the trunk bus system will be introduced from Centro through Av. E. Ayala and Mcal. Estigarribia to San Lorenzo (32km for a round trip)
- Survey Method: field survey to check conditions of buildings and facilities on both sides of the road.
- Type of Survey: (1) road cross section and (2) survey of roadside conditions (buildings and facilities)

1) Considerations from the road section survey

Table 17-1-6 shows a cross sectional structure of major trunk roads based on the results of the survey.

Table 17-1-6 Cross Section of Trunk Bus Route (Present Condition)

Avenue	No.	Section	Total Width(m)	Average of Section(m)
Centro	1	Azara	14.20	14.20
Av.Eusebio Ayala	1	Gral.Aquino - Gral.Santos	34.90	33.87
	2		32.10	
	3		34.60	
	4	Gral.Santos - Av.Kubitscheck	35.10	34.78
	5		34.45	
	6	Kubitscheck - Choferes del Chaco	35.30	33.00
	7		30.70	
	8	Av.Choferes del Chaco - Rca.Argentina	33.70	33.70
	9	Rca.Argentina - De la Victoria	32.60	31.85
	10		31.10	
	11	De la Victoria - Madame Linch	35.10	33.37
	12		33.50	
	13		31.50	
Av.Mcal. Estigarribia	1	Madame Linch - Keopardi (San Lorenzo)	33.10	32.35
	2		33.50	
	3		30.35	
	4		32.45	
	5	Leopardi - San Lorenzo	29.85	29.85
San Lorenzo	1	San Lorenzo(AV.M.Estigarribia)	17.80	17.80

A. Centro

It has been found that on Gral Aquino, Azara, Colon, and Humaita, the typical section has a width of 13m, which consists of 9m for vehicles and 2m on both sides for pedestrians. The trunk bus can operate on the right lane of the two lanes for its exclusive use. Its width will be 3.5m.

B. Widened Section

a) Gral Aquino to Mme Lynch

This section has a lane width of 9m and two lanes for each direction. The AGA has a widening plan for Av. E. Ayala, and as of 1999, the section from Gral Aquino to Chof. del Chaco is currently under construction for widening. From Gral Aquino to Mme Lynch has a right-of-way of 35m, and through the Frentista system, land use restrictions are being imposed. However, the field survey has found that the required right-of-way is not exactly reserved for 35m but is short of 1 to 2m. It is difficult then to acquire rights-of-way for sidewalks. Thus, it is important to consider improvements of sidewalks as well as the widening.

b) Mme Lynch to Mcal Estigarribia to the San Lorenzo junction

Mcal Estigarribia in Fdo. de la Mora and San Lorenzo has three lanes for each direction with a width of 10 to 10.4m. However, since each lane is narrow, it is difficult to handle traffic for three lanes including a trunk bus. Some sections are actually used as if there were only two lanes.
Those cities do not have Frentista systems on right-of-ways like Asunción, and thus major improvements to be made are widening of sidewalks.
The width of the median strip is 1.1m in Asunción, and 0.65m on Mcal Estigarribia in Fdo de la Mora and San Lorenzo. There are no median strips at intersections and in front of major facilities, such as large-scale stores.

C. San Lorenzo

On Mcal Esitarribia in San Lorenzo and Av. Miranda Cuento de Estigarribia, the width of roads is 10 to 11m, that of sidewalks 2m, and thus the typical cross section has a width of 14 to 15m. As in Centro, it is necessary to reserve the right lane for the exclusive use of the trunk bus (3.5m) since this section has only two lanes.

2) Summary of Roadside Conditions

A. Blocks (manzana) along the trunk bus route

In Centro, a total of 131 blocks are facing the trunk bus route, 78 on the inbound route (to Centro) and 53 on the outbound (to San Lorenzo). Likewise, there are 134 blocks along Av. E. Ayala to Mcal Estigarria. In San Lorenzo, the inbound route faces 30, the outbound 35, for a total of 65. In sum, there are 329 blocks along the whole section of the trunk bus.

B. Observations from the current land use map

The current land use map classifies land use by nine types: comercial, servicios, militar y gobernamental, recreacional, industrial, residencial (dens. media), educacional, plazas, residencial (dens. alta), and area industrial. Proportion of each land use type along the trunk bus route has been computed on the land use map as shown in Fig. 17-1-10. It indicates that 79% of the section to be widened is designated for commercial use.

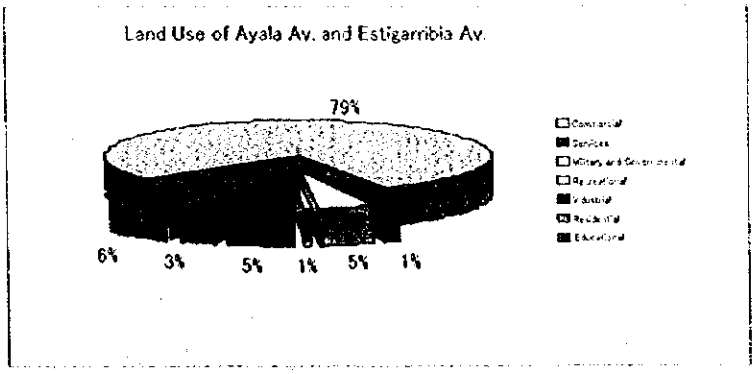


Fig. 17-1-10 Land Use on The Trunk Bus Route
(Widening Area: Gral Aquino to the San Lorenzo Junction)

C. Survey results of roadside buildings

The survey has been conducted for the following items and covers all the buildings along the road.

- Transport Facilities: lights, trees, signs, traffic signals, bus stops, parking meters, and drainage.
- Buildings: residential buildings, stores, storage, offices, and public facilities.

Table 17-1-7 shows existing transport infrastructure in the study area or along the trunk bus route. The route consists of ten sections: Centro, Pettirossi-Santos, Santos-Kubistcheck, Kubistcheck-Chofer, Chofer-Argentina, Argentina-La Victoria, La Victoria-Defensores, Defensores-Leopardi, Leopardi-San Lorenzo and San Lorenzo.
There are a large number of poles like telegraph poles and road signs, which are followed by manholes and signals. And there are 51 bus stops which consists of 13 with shelters and 38 without shelters.

Table 17-1-7 Existing Transport Infrastructure

Section	Telegraph and other poles	Road signs	Signals	Parking meters	Bus stop (with roof)	Bus stop (without roof)	Manholes	Drainages	Hydrants
Centro	500	109	41	36	2	17	73	46	4
Pettirossi-Santos	104	16	2	0	0	2	3	1	0
Santos-Kubistcheck	74	11	4	0	2	0	13	1	1
Kubistcheck-Chofer	139	11	9	0	0	4	23	1	0
Chofer-Argentina	111	9	3	0	1	0	14	0	0
Argentina-La Victoria	184	22	9	0	0	3	10	0	0
La Victoria-Defensores	113	16	3	0	1	0	8	0	0
Defensores-Leopardi	263	52	13	0	3	6	15	3	0
Leopardi-San Lorenzo	205	12	3	0	2	1	9	1	0
San Lorenzo	322	25	9	0	2	5	2	2	0
Total	2015	288	96	36	13	38	170	55	5

Regulation Plan of the Municipality of Asunción has the following land use designations: residential (R), commercial and services (C.B.), storehouse (D), industrial (I), community and institutional equipment (EQ), and mobility and transport (M.T.). Thus, roadside conditions are re-categorized in terms of the above designations. Table 17-1-8 shows the results.

The classification of the roadside survey and the official designations of Asunción are adjusted as follows:
Residential (R): apartments, private houses
Commercial and services (C.B.): stores
Storehouse (D): warehouse
Industrial (I): private offices
Community and institutional equipment (EQ): public offices, banks, and financial companies, and churches
Mobility and Transport (M.T.): others

Table 17-1-8 Properties by Classification along the Trunk Bus Route

Section	Residential (R)	Commercial (CB)	Deposit (D)	Community & Institutional (EQ)	Industries (I)
Centro	332	355	3	38	12
Pettirossi-Santos	10	52	0	0	0
Santos-Kubist.	17	17	56	1	1
Kubist.-Chofer	17	17	61	0	13
Chofer-Argentina	12	12	42	0	6
Argentina-Victoria	21	21	86	0	5
Victoria-Defensor	8	8	33	0	4
Defensor-Leopardi	28	28	110	1	18
Leopardi-Lorenzo	23	23	31	1	13
San Lorenzo	74	208	18	26	2
Total	542	741	440	67	74

(4) Implementability (the section to be widened and terminals)

1) Widened Section

A. Affected buildings

A map has been prepared to identify buildings and parcels of land to be affected by the

widening. Aerial photographs taken in 1999 are used to make a map with a width of the right-of-way of 35m. As a result, on the section that will be widened are 731 buildings. 157 of them, or 21%, will be affected by the project. Table17-1-9 and Fig. 17-1-11 show the numbers of the existing buildings and buildings to be affected by the project.

Table 17-1-9 Affected Buildings by Type Along the Trunk Bus Road

Section	Total Buildin	Affecte d	Affected area(m2	Average (m2)	Affecte d land	land area(m2	Average (m2)	(1)+(3)	(2)+(4)
Pettirossi-Santos	62	17	4,188	246	11	1,038	94	28	5,226
Santos-Kubist.	80	12	2,135	178	4	273	68	16	2,408
Kubist.-Chofer	95	18	6,916	384	11	2,027	184	29	8,943
Chofer-Argentina	61	16	6,363	398	4	939	235	20	7,302
Argentina-Victoria	115	6	1,001	167	13	4,283	329	19	5,284
Victoria-Defensor	62	9	3,553	395	12	3,632	303	21	7,185
Defensor-Leopard	183	57	28,239	495	28	6,613	236	85	34,852
Leopardi-Lorenzo	73	22	13,120	596	13	8,704	670	35	21,824
Total	731	157	65,515	417	96	27,509	287	253	93,024

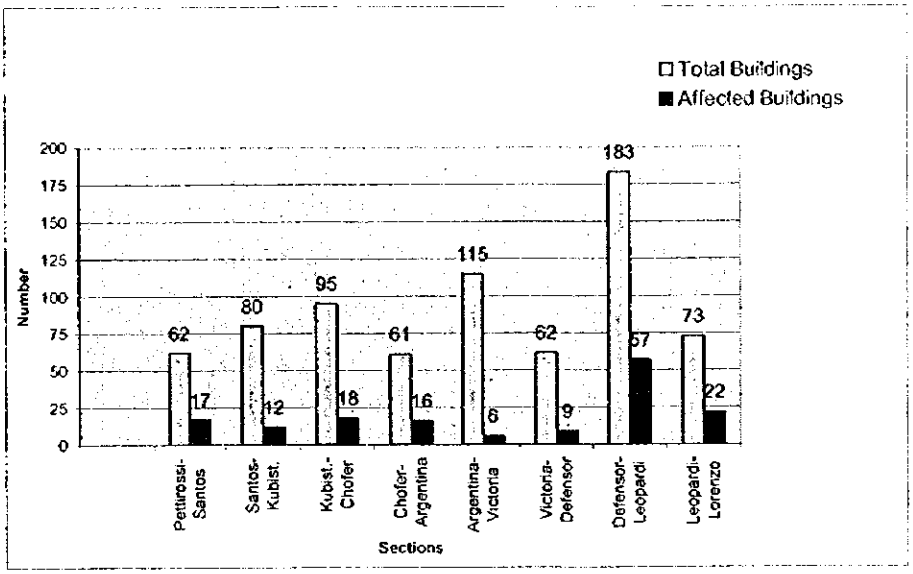


Fig. 17-1-11 Number of Affected and Unaffected Buildings

The number of buildings affected and the total number of existing buildings in each section can be summarized as follows.

1. Pettirossi to Gral Santos	17/62 (27.4%)
2. Gral. Santos to Kubitschek	12/80 (15.0%)
3. Kubitschek to Chof. del Chaco	18/95 (18.9%)
4. Chof. del Chaco to Rca de. Argentina	16/61 (26.2%)
5. Rca. de Argentina to De la Victoria	6/115 (5.2%)
6. De la Vistoria to Defensores	9/62 (14.5%)
7. Defensores to Leopardi	57/183 (31.1%)
8. Leopardi to San Lorenzo	22/73 (30.0%)

Since 35m right-of-ways on Av. E. Ayala up to Mme Lynch are reserved by the AGA agreement, the number of buildings affected is relatively low, and 10% will need to be replaced in Asunción, compared to 30% in Fdo. de la Mora and San Lorenzo. 70% of the 157 buildings to be affected are commercial-related.

From the above discussions, the chance of implementing the widening project is higher in the section up to Mme Lynch in Asunción than in the other sections.

B. Cost estimation for land acquisition for widening

Costs for land acquisition have been estimated for blocks at each intersection along Av. E. Ayala based on representative land prices obtained from the periodical, "costos."

Costs on houses have been estimated from the results of the survey by the agency responsible for land registration of Asunción. An average price of a house on Av. E. Ayala has been calculated by taking into account the number of roadside houses and their market prices. As a result, the price of a house is estimated at 280million Gs/m2 and will be adopted in this Study.

Although interview surveys of real estate companies have been carried out in Fdo. de la Mora and San Lorenzo regarding market prices of houses, their responses are that prices are almost the same as those on the border of Asunción. Thus, the price of a block near Mme Lynch is applied, and the price of a house is assumed to be similar to that in San Lorenzo.

On the widened section, affected buildings are summarized in terms of the number and the area, and affected areas of parking lots and empty lands are calculated as well. Table 17-1-10 shows the results.

Table 17-1-10 Affected Buildings on the Widening Section

Section	Direction	House			Land			Total		
		Total House(m2)	Total North-South(m2)	Total Cost(Gs)	Land(m2)	Total North-South(m2)	Total Cost(Gs)	Total Land and House	Cost(Gs)	Cost(US$)
Pettirossi-Gral Santos	North	2,350	4,188	1,172,736,330	921,160	1,038	622,702,200	5,226	1,795,438,530	598,480
	South	1,838			116,677					
Gral Santos-Av.Kubistcheck	North	2,135	2,135	597,917,860	272,988	273	126,256,950	2,408	724,174,830	241,392
	South	0			0,000					
Av.Kubistcheck-Av.Choferes	North	2,194	6,916	1,936,418,960	646,351	2,027	608,232,900	8,943	2,544,651,860	848,217
	South	4,722			1,381,092					
Av.Choferes-Rca.Argentina	North	2,977	6,363	1,781,778,320	812,019	939	176,039,436	7,302	1,957,817,756	652,606
	South	3,386			126,868					
Rca.Argentina-Av.De la Victoria	North	740	1,001	280,270,480	270,463	4,283	1,017,203,990	5,284	1,297,474,430	432,491
	South	255			4,012,501					
Av.De la Victoria-Av.Defensores	North	2,521	3,553	994,969,840	2,478,008	3,639	699,161,540	7,186	1,694,121,380	564,707
	South	1,032			1,154,000					
Av.Defensores-Leopardi	North	10,522	28,239	7,906,864,760	2,167,529	6,613	1,273,091,953	34,852	9,179,956,713	3,059,952
	South	17,717			4,445,624					
Leopardi-San Lorenzo	North	8,922	13,121	3,673,580,240	7,379,494	8,704	1,675,510,569	21,824	5,349,070,809	1,783,024
	South	4,199			1,324,457					
Total			65,518	18,344,496,800		27,509	6,198,139,488	93,025	24,542,636,258	8,180,879

2) Site Selection of Trunk Bus Terminal in Centro

A. Required functions of trunk bus terminal in Centro

The primary function of the terminal in Centro is to allow buses to make U-turns in order to ensure smooth transfers in the area around Colon in Centro. From the results of the traffic demand forecast, since it is found that there are few passengers who take buses to the terminal, the terminal only needs to have a function for time adjustment. Moreover, it is expected to vitalize the area induced by changes in land use resulting from the installation of the terminal in Centro.

B. Alternative sites for the trunk bus terminal in Centro

Based on field surveys and interviews with relevant organizations, six sites have been selected as shown in Fig. 17-1-12, and their characteristics and pros and cons are summarized.

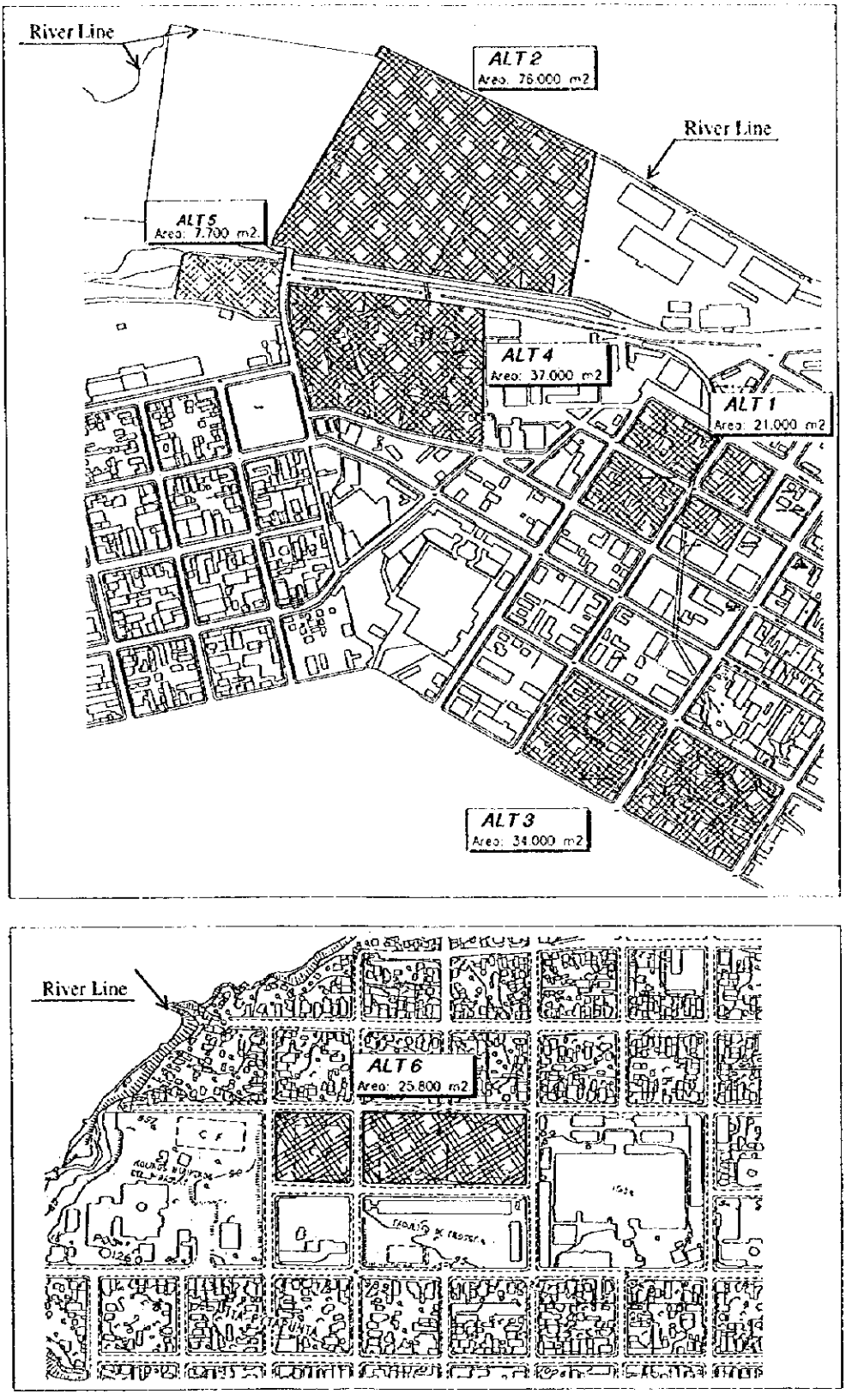


Fig. 17-1-12 The Alternative Location of the Trunk Bus Terminal in Centro

Alt 1: Vacant lot of a beer factory

Asunción is considering the relocation of a beer factory on Colon, and this alternative uses its vacant lot. The factory is built on a four-block area. The site is located near Colon and thus has good accessibility. However, the relocation requires a new site for the factory, and it has not been found yet. It takes some time to find such a site, and the costs will be high as well. In addition, near the site, there is a building that the beer factory built more than 100 years ago, which warrants preservation as an historic building.

Alt 2: Terminal site for the Port Authority of Asunción

This alternative uses the site currently utilized by the Port Authority of Asunción as a container terminal. Since it is public property of Asunción, land acquisition should not be a problem. However, the following problems can be expected.

- The site is adjacent to the Paraguay River and is directly affected by floods during the rainy season.
- The site already plays an important role as a container terminal, and it is difficult to change the existing plan.
- There is a plan to expand it westward, and that section is currently being paved.

Alt 3: Two-block area with Colon in the middle between Humaita and Haedo

This site is relatively compact, efficient in terms of the terminal function, and convenient as well. Nevertheless, it requires clearance of two residential blocks, and resettlement costs a lot in terms of alternative sites, land and construction costs, negative socioeconomic and environmental impacts.

Alt 4: Av. Republica in front of the container terminal

Located next to Talleres de Valores Fiscales on Av. Republica, this site is also public property, but low-income people form a squatter colony in this area. It has the advantage of securing parcels of land and acquiring land with little difficulty. However, this area is designated as a historic district for preservation, and thus changes in land use required for construction will cause many problems, and it is not possible to build a high-rise. At the same time, since it is also designated as a district for landscape preservation, it is difficult to construct a terminal.

Alt 5: "Laguna" in front of a navy base

Located at the mouth of River Ao Jaen, the site is used by the Navy for its training ground. It has been found from interviews with the Navy and the Municipality, it is public property, and land acquisition will not be a problem. This site is also compact and appropriate for providing spaces for buses to make U-turns. Although there are some restrictions from the Navy, there is a plan to move the military facility to the suburbs of Asunción, and thus the restrictions may be lifted soon. In addition, the terminal is expected to generate spillover effects on nearby commercial establishments.

On the other hand, the biggest problem of this site is possible floods from Asunción River. During the past 20 years, the water level has once risen by 30cm. Therefore, the entire parcel for the terminal needs to be raised by 1.0m.

Alt 6: Ita Pyta Punta. (Track field of National University of Philosophy)

The site is owned by National University of Asunción under the Ministry of Education. It is possible to acquire parcels of land. The site currently serves as a facility for buses to make turns and thus can use the existing bus routes.

However, according to the Ministry of Education, it would take a great deal of time to change its land use. In terms of the U-turn function and accessibility to Centro, it is not a desirable site because the distance to Centro is quite long. In sum, it makes bus routes longer, and it is difficult to keep to the schedule.

C. Selection of Bus Terminal in Centro

As shown in Table 17-1-11, a comprehensive evaluation of the above alternative sites has conducted in terms of locational conditions, land acquisition, economic and environmental aspects.

Alt 5, "Laguna," has been chosen because land acquisition will not be very difficult. It is also economical and will generate little adverse environmental impact, including resettlement.

Table 17-1-11 Evaluation of the Alternative Bus Terminal in Centro

Centro						
Alternatives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Denominations	Beer factory	Containers storehouse	Square that includes Humaita & Haedo	Municaipal land in front of Container	In front of the Navy	Itá Pytá Punta
Area that is meant to be obtained	21,000	76,000	34,000	37,000	7,700	25,800
Terminal funtion area	O	O	O	O	O	X
Land acquisition difficulty	Private land	Asunción municipal land	Private land	Asunción municipal land	Asunción municipal land	Land controled by MEC
land cost	X	O	X	O	O	X
Population resettlement	X	O	X	X	O	O
social environment	X	O	X	X	O	X
Ruling with regulation planning factory	O	X	O	X	O OK	X

Note: With regard to the land cost comparison, Alt5's evaluation includes of landfill (13,000m3).

3) Site Selection of Bus Terminal in San Lorenzo

A. Required functions of bus terminal

Not only is it a terminal for the trunk bus, but serves as a node for transfer passengers from feeder bus lines. Thus, transfer function is the most important evaluation criterion.

B. Alternative sites for bus terminal

Based on field surveys and interviews with relevant organizations, three alternative sites have been proposed as shown in Fig. 17-1-13. Their characteristics and advantages and disadvantages are described below.

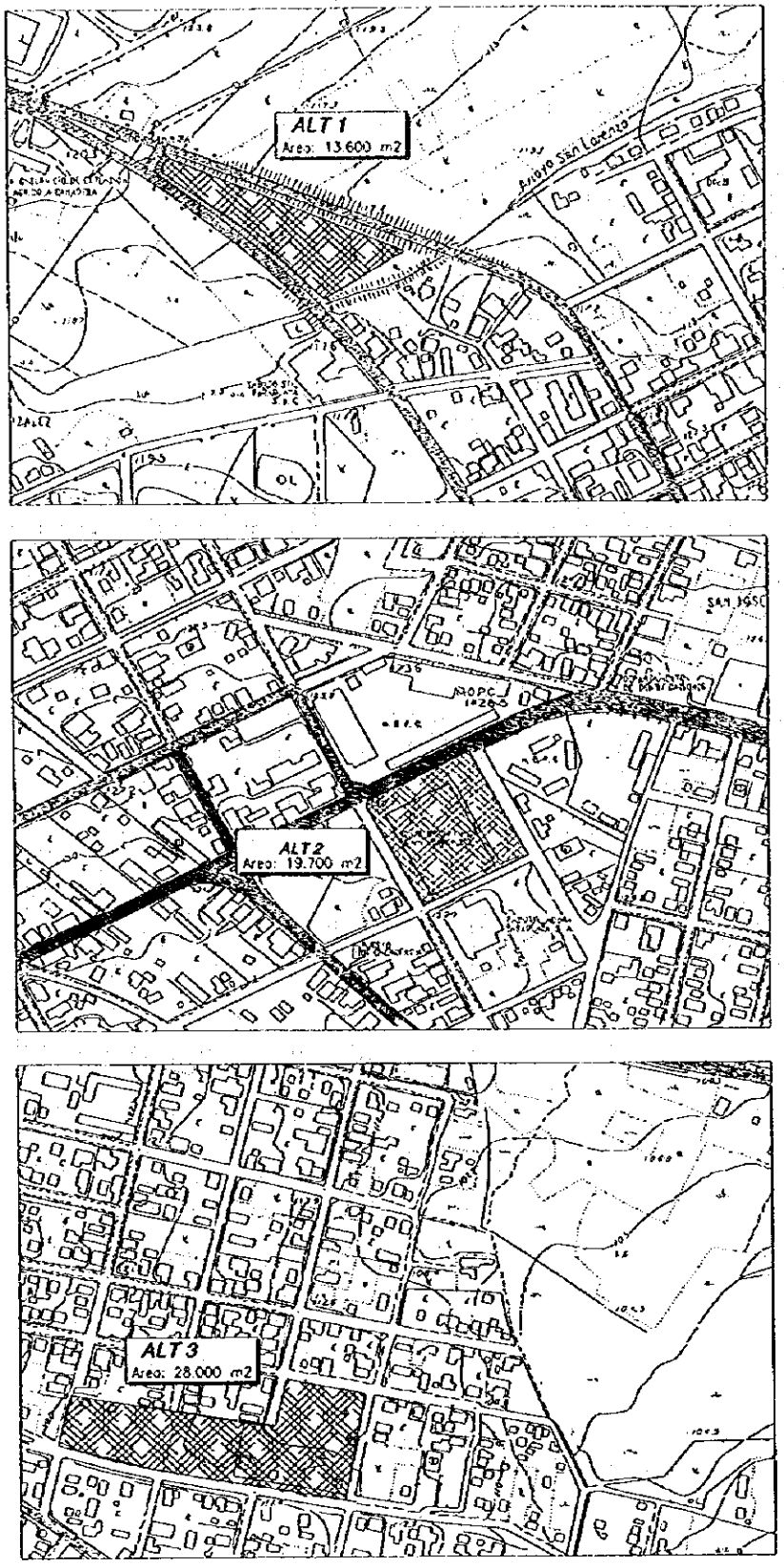


Fig. 17-1-13 The Alternative Location of the Trunk Bus Terminal in Centro

Alt 1: Junction of inbound and outbound bus lines in front of the National University of Asunción

This site is located at the triangular area where Mcal. Estigarribia diverges itself. Because of its location where traffic flows in and out of San Lorenzo, it can enjoy the convenience as a nodal facility. Since passengers can transfer from feeder to trunk buses, or vice versa, trunk buses do not need to pass the central district of San Lorenzo. Congestion can be avoided, and smooth movements of transfer can be maintained.

However, since the ground level of the sites is lower by about 2m than that of the road, it needs some fill and thus high construction costs will occur. According to the university, since there is a plan for a park and also a development plan for a fire station facility, it will take a good amount of time to change the land use designation into a bus terminal and adapt it to the existing plans.

Alt 2: Club San Lorenzo Stadium

The site is located next to the MOPC building at the center of San Lorenzo. It is also located at the junction point of Routes 1 and 2. It is possible to use the existing bus routes into and out of feeder bus lines, and the site is convenient as a nodal facility. In particular, the traffic movement of trunk buses will be the same as the existing buses and can enter and leave the terminal. San Lorenzo used to have traffic flows in opposing directions on the same road but separated them to alleviate congestion. In view of this past experience, the trunk bus will follow the existing traffic rules. Moreover, since there is a single owner of this football stadium, and the number of storeowners nearby is limited to about 10, it is relatively easy to acquire land through negotiations.

However, it is located very close to the junction of Routes 1 and 2, the intersection must be improved to minimize traffic congestion.

Alt 3: Public property of San Lorenzo

This site consists of blocks owned by the Municipality of San Lorenzo and is currently used as a park and houses or left as vacant land.

According to the agency for land registration, it is difficult to acquire parcels of land in San Lorenzo, but this alternative site is one of the few. It is located at the center of the area surrounded by Routes 1 and 2 and hence far from these two major roads. Its accessibility is a great problem for this site, and access roads will need to be improved by paving.

Since it will be located within a high-density residential area, it may negatively impact the roadside environment.

C. Selection of Bus Terminal

As shown in Table 17-1-12, a comprehensive evaluation of the above alternatives has been conducted in terms of its terminal function, economic feasibility, land acquisition, resettlement, social and environmental impact. The evaluation particularly stresses the implementability, the consistency with the existing plans, and harmony with roadside environments. As a result, Alt 2 has been selected because (1) there are no existing plans, (2)

it is not difficult to acquire land, and (3) it is convenient as a transport node.

Table 17-1-12 Evaluation of the Alternative Bus Terminal in San Lorenzo

San lorenzo			
Alternatives	Alternative 1	Alternative 2	Alternative 3
Denominations	In fron of UNA	football field	Municipal land in San Lorenzo
Area that is meant to be obtained	13,600	19,700	28,000
Terminal funtion area	○	○	△
Land acquisition difficulty	Land controlled by MEC	Private land	Municipal land in San Lorenzo
land cost	△	△	○
Population resettlement	○	○	X
social environment	X	○	X
Ruling with regulation planning factory	X	○ OK	○

Note: Since In point of view of terminal function ,Alt3 was inferior in the accessibility from a principal road as compared with other two alternatives.
About land price, it is evaluating on the basis of the hearing result of San Lorenzo Municipal.

17.1.3 Trunk Bus Facility Design

(1) Trunk Bus Project

Under the Master Plan of Urban Transportation in Asunción Metropolitan Area for the year 2015, a Trunk Bus Project, which consists of the introduction of trunk bus system on E. Ayala and Mcal. Estigarribia Avenues and their widening, has been recommended as an emergency project.

Accordingly a trunk bus route and the proposed sites of trunk bus terminals have been selected based on field study, which has been mentioned in the previous section 17.1.2.

1) The Trunk Bus Route

- From San Lorenzo to Centro
  San Lorenzo Bus Terminal (proposed site is a football field near to MOPC's maintenance garage in San Lorenzo City)- Mcal. Estigarribia -- E. Ayala – General Aquino – Azara – Centro Bus Terminal (proposed site is in front of a naval facility)

- From Centro to San Lorenzo
  Centro Bus Terminal (proposed site is in front of a naval facility) – Colon – Humaita – Pettirossi – E. Ayala – Mcal. Estigarribia - San Lorenzo Bus Terminal (proposed site is a football field near to MOPC's maintenance garage in of San Lorenzo City)

The Trunk Bus Route is shown in Fig. 17-1-14.

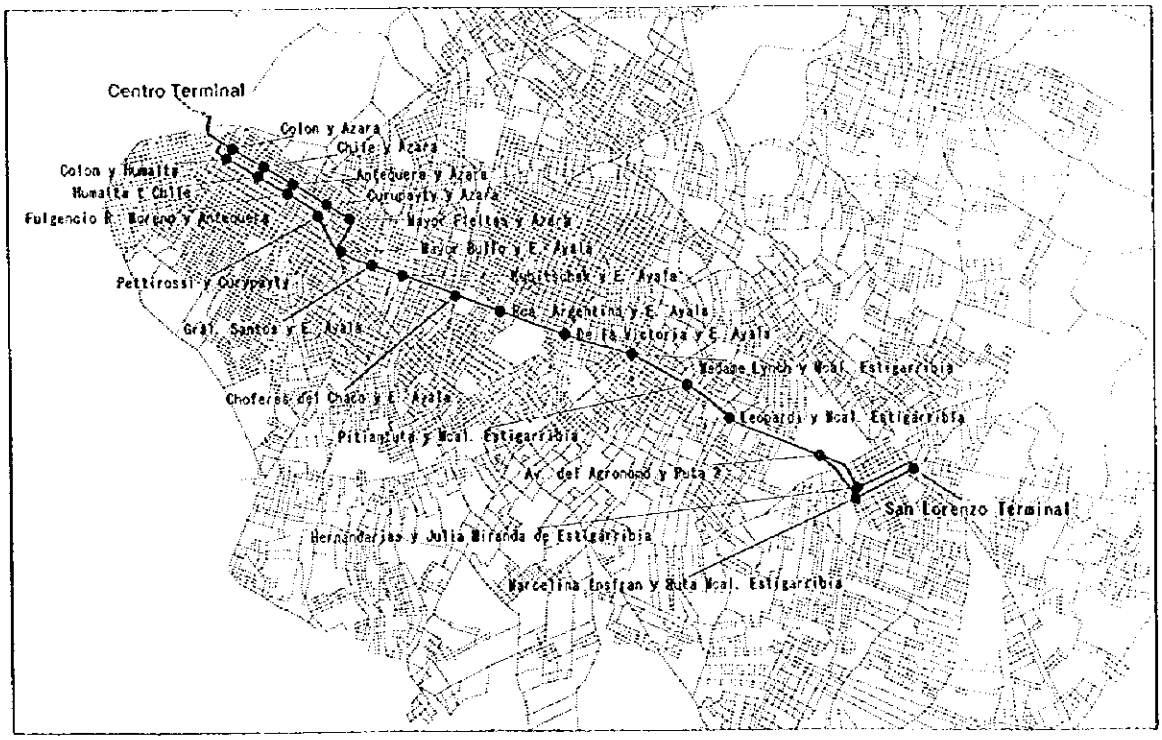


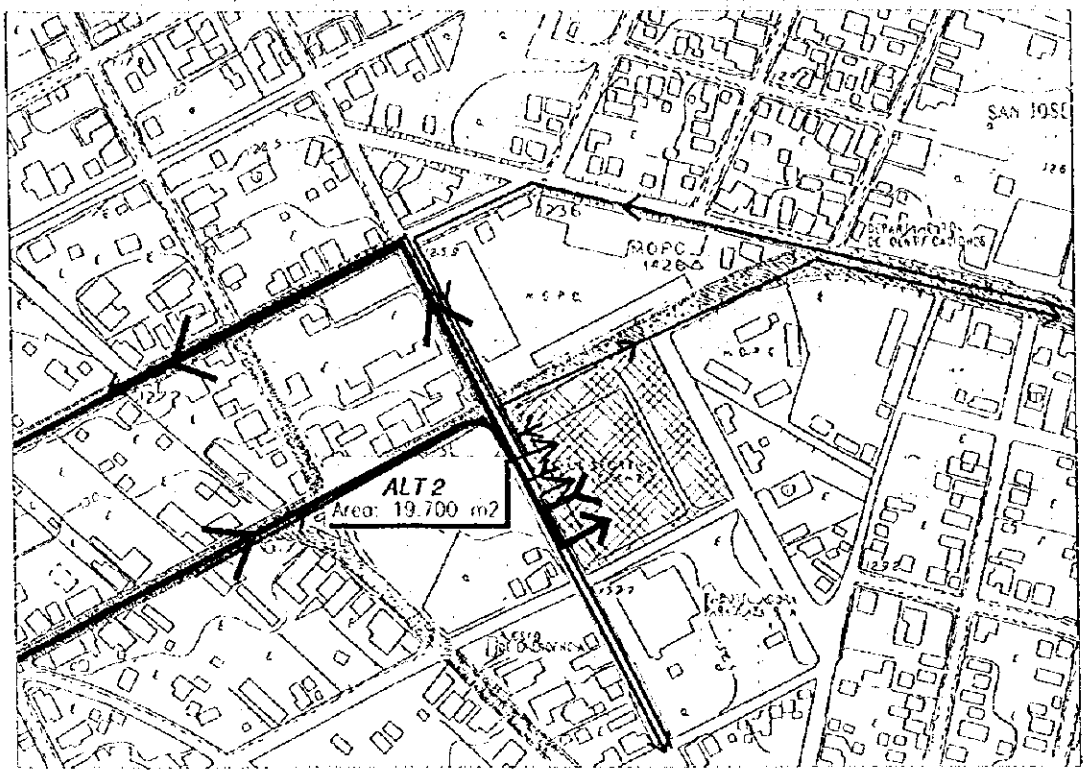
Fig. 17-1-14 The Trunk Bus Route

2) Proposed Sites for Bus Terminals

A. San Lorenzo

San Lorenzo Bus Terminal will be constructed to be utilized as a bus terminal for trunk buses as well as existing feeder buses, which have services to Centro, and national long-distance buses. A site, which is shown in Fig. 17-1-15 has been selected. It is actually a football field near MOPC's maintenance garage in San Lorenzo City and situated at the junction between the Route 1 and 2.

In the process of selection, a site, which is situated at a junction in front of the National University, had been also examined, however, it was eliminated for the following two reasons. Firstly it was found that there was already a park development plan at that particular site by the University and, secondly, the football field was more appropriate because it is expected to effectively function as a transport node.



Note: — Trunk Bus Route
— Feeder Bus Route

Fig. 17-1-15 Location of Trunk Bus Terminal in San Lorenzo

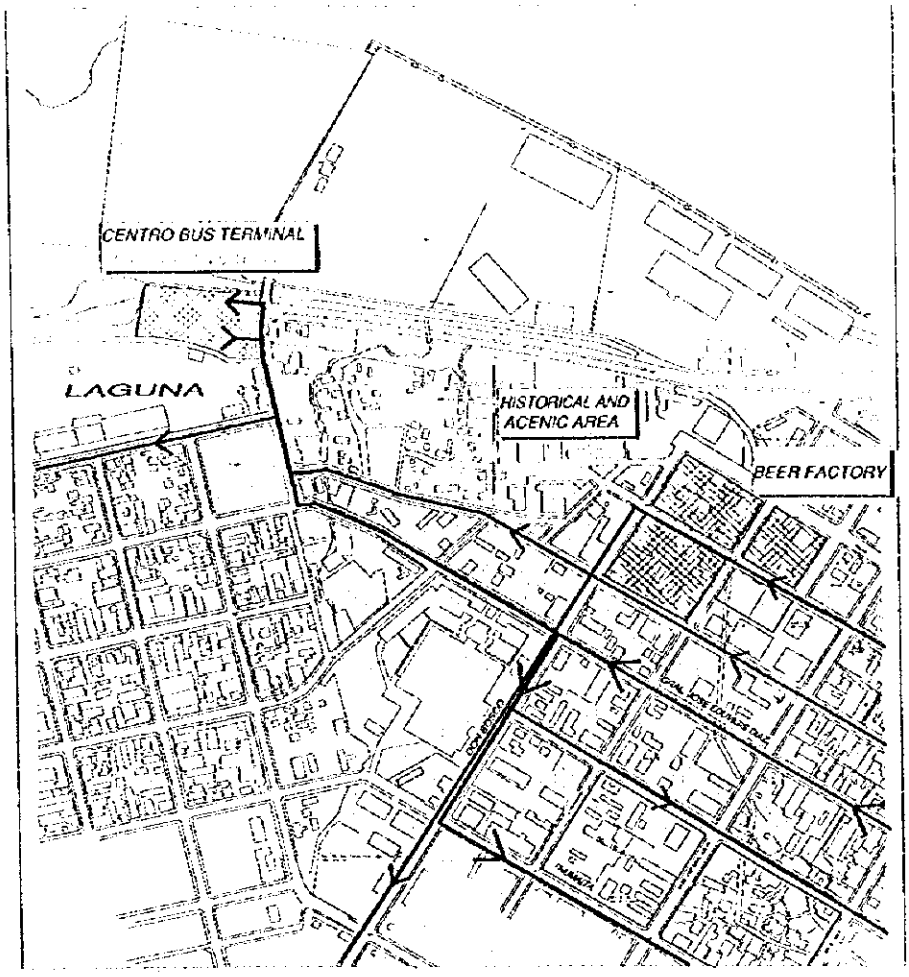
B. Centro

Trunk buses will use Centro Bus Terminal mainly in order to make U-turn. The proposed site is situated, as shown in Fig. 17-1-16, in a lot in front of a navy facility in harbor area, which faces Republica Street.

In the process of selection, a site of ex-beer factory, which is situated along Colon Street, had

also been examined. However, it was eliminated since expropriation would be costly and prolonged. On the other hand, the site, which is called Laguna, in front of the navy facility, was selected since the lot belongs to the Municipal Government and it would be comparatively easier to expropriate.

With regard to access route to the bus terminal, a route from Centro side was selected instead of Republica Street, taking into consideration the fact that the area, which faces Republica Street, is an historical and scenic monument and protected by law.



Note: About the Feeder Bus route, it is the same as that of present-condition bus route.

— Trunk Bus Route

— Feeder Bus Route

Fig. 17-1-16 Location of Terminal in Centro

3) Trunk Bus Section (Typical Cross Section)

A typical cross section of trunk buses on E. Ayala and San Lorenzo Micro Centro is shown in Fig. 17-1-17. On E. Ayala, there are six lanes, out of which trunk buses will exclusively use two centerlines for both directions and feeder buses and other vehicles will use the other four lanes. The road width is 35m including sidewalks on both sides.

On the other hand, in Micro Centro, the present two lanes of one-way traffic will be maintained as they are and trunk buses will exclusively use the right lane.

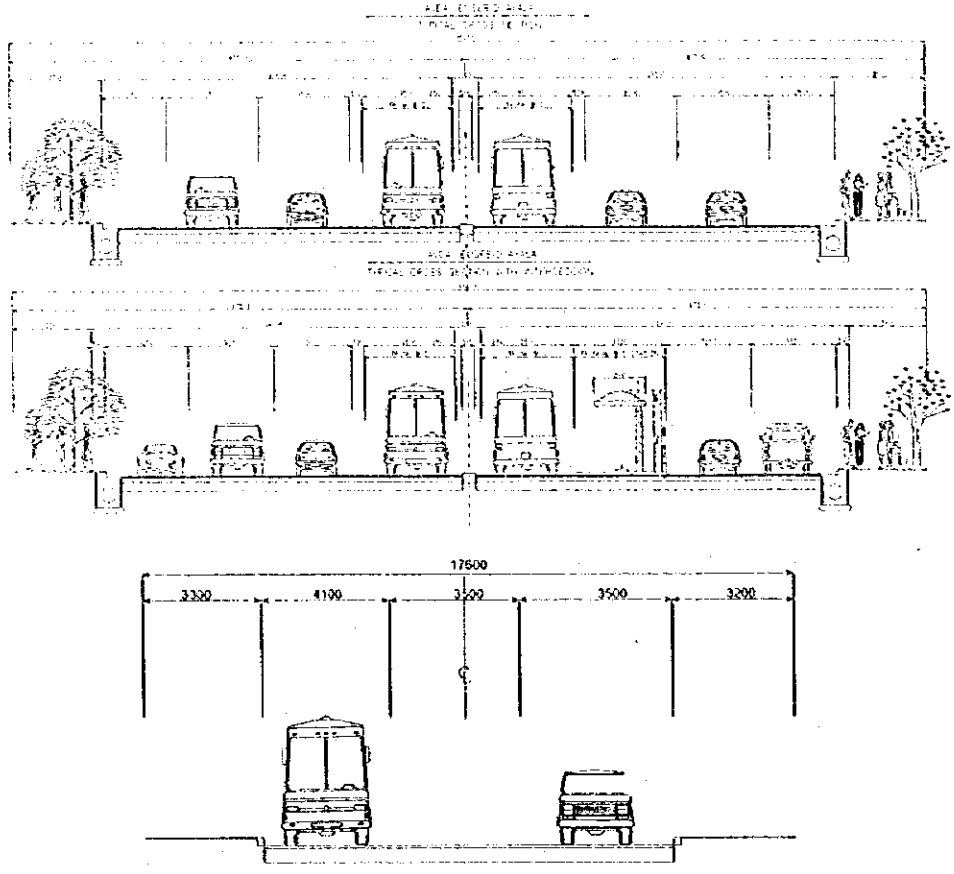


Fig. 17-1-17 Typical Cross Section of the Trunk Bus Route

4) Horizontal and vertical alignment plan for the trunk bus route (described in detail in section 18.2.1)

A. Abstract of horizontal alignment Plan

It has been revealed, as a result of future traffic assignment analysis, that six lanes, including an exclusive lane for trunk buses, will be required on E. Ayala and Mcal. Estigarribia Avenues. Moreover, at principal junctions, where E. Ayala Avenue crosses four main streets, due to high traffic volume, it is concluded that viaducts will be required. These four main streets are as follows:

- Kubitschcck Street
- Choferes del Chaco Street
- Argentina Street
- De la Victoria Street

The previous Feasibility Study, which was conducted in 1989, has concluded that E. Ayala Avenue should be elevated. However, in this Study, the above four main streets will be elevated due to the fact that trunk buses pass on E. Ayala and it is required to secure their smooth transit.

B. Abstract of vertical alignment plan

The vertical alignment of Eusibio Ayala and Mcal. Estigarribia Avenues has been designed to be consistent with actual ground height. The maximum and minimum gradients are 4.14% and 0.30% respectively. Moreover the detail for profile described in section 18.2.1

C. Change point from FS/89

a) Trunk bus route in Centro

On the other hand, with regard to the access from Ayala to Centro, the Feasibility Study conducted in 1989 had suggested that a bridge should be constructed in the area of Mercado Cuatro and connected to Rodriguez de Francia Avenue. However, this Study recommends another trunk bus route, which does not pass through Rodriguez de Francia Avenue for the following reasons.

- Future traffic volume on Rodriguez de Francia Avenue will be much higher than the present traffic volume on the avenue.
- There are already exclusive bus lanes on Rodriguez de Francia Avenue and many lines pass through the avenue. In case that an exclusive trunk bus lane will be introduced on the avenue, its road structure and existing feeder bus services will have to be drastically restructured.
- In particular, in the area where the viaduct was planned, many shops and houses exist and the magnitude of impact of resettlement of these buildings is such that it may cause significant social and economic problems to the owners and tenants.

b) To Centro

As mentioned above, since a bridge cannot be constructed, present feeder bus route (detour route), which passes General Aquino and Azara (General Dias), will be used for trunk bus. Though Haedo Street is the shortest route from Ayala, because the traffic volume on the street is significantly high, Azara has been selected instead.

c) To San Lorenzo

To San Lorenzo, a route, which starts at Centro Bus Terminal and passes General Dias, Don Bosco and Humaita Streets, has been selected as a trunk bus route. However, on this route, in case trunk buses make a left turn on the existing road at the intersection between Brasil and Pettirossi, severe traffic congestion composed of both buses and other vehicles is expected due to the fact that trunk buses will have to make a sharp turn at the intersection. Accordingly it has been decided to extend Humaita Street to Pettirossi Street by relocating existing buildings. Though there are 8 buildings affected in the area, based on the field study, it has been judged that the impact of relocation is relatively small and it can be opened to be used for a trunk bus route.

The 8 buildings which will be affected by the extension of Humaita, include Ministry of Public Health and seven shops. The Study Team conducted field survey on these building owners and tenants except Ministry of Public Health. However, most of the shop owners are living in remote areas and the tenants could not respond to questions on their willingness to relocate. Only two owners of shops responded that they were willing to move. The most significant economic impact is expected for a shop, which occupies the largest space in the

affected area. However, according to the interview with the owner of the shop, they will be willing to move provided that they will be well compensated and provided a convenient alternative site for them to operate their commercial activities.

(2) Design of Bus Terminal

1) Area Calculation of Trunk Bus Terminal (Required Facilities)

Required bus terminal facilities in Centro and San Lorenzo are shown in Table 17-1-13.

In Centro Bus Terminal, where trunk buses make U-turn, minimum terminal facilities will be constructed. On the other hand, in San Lorenzo Bus Terminal, apart from transfer facilities, as a base of trunk buses, facilities including a repair shop, an office, a gas station, a waiting room and a ticket office will be constructed.

Table 17-1-13 Required Bus Terminal Facilities

Terminal Facilities		Centro	San Lorenzo
Parking facilities	Trunk bus berth	X	X
	Feeder bus berth	-	X
	Transfer berth	X	X
	Taxi berth	-	X
Maintenance facilities	Repair shop	-	X
	Carwash	-	X
	Gas station	-	X
Service facilities	Ticket booths	X	X
	Waiting room	-	X
	Cafeteria	-	X
	Restaurant	-	X
	Telephone boxes	-	X
	Shops	-	X
	Toilet	X	X
Administrative facilities	Ticket office	X	X
	Office	-	X

Note: only a part for one berth is secured as a transfer berth(getting-on-and-off haunt).

2) Passenger Demand Calculation

A. Centro (Trunk Bus)

- Fixed number of passengers: 185 Efficiency at peak hours: 150%
- Number of trunk buses at peak hours: 60
- Service interval: 1 minute
- Number of passengers, who get on and off, at peak hours: 182
  (Colon Node 1828x10% [peak rate]=182)
- Number of passengers, who get on and off, per bus: 3

B. San Lorenzo

a) Trunk Bus

- Fixed number of passengers: 185 Efficiency at peak hours: 150%

- Number of trunk buses at peak hours: 60
- Service interval: 1 minute
- Number of passengers, who get on and off, at peak hours: 10005 ((194950+5150)/2x10% [peak rate]=10005)
- Number of passengers, who get on and off, per bus: 159

b) Feeder Bus

- Fixed number of passengers: 90 Efficiency at peak hours: 150%
- Number of feeder buses at peak hours: 48 (699x0.072=48)
- Service interval: 1 minute 15 seconds
- Number of passengers, who get on and off, at peak hours: 1724 (17240x10% [peak rate]=1724)
- Number of passengers, who get on and off, per bus: 36

3) Bus Berth Calculation

A. Centro

Since the number of passengers, who get on and off, is rather small in Centro Terminal, it will be given a function for trunk buses of adjusting time and making U-turn.

- Time between a bus arrival at the terminal and it halts at a berth: 18 seconds (100m: 20km/h)
- Time between a bus leaving the berth and its defarture from the terminal: 18 seconds (100m: 20km/h)
- Waiting time per bus: 2 minutes
- Time of getting on and off: 30 seconds (3 passengers x10 seconds)
  Since the Bus Terminal in Centro has the function as a street bus stop, time of getting on and off is giving the margin rather than that of the San Lorenzo.
- Total: 3 minutes 6 seconds
  If it is assumed that at peak hours 60 buses arrive per hour, it is estimated that four berth will be required.

B. San Lorenzo

In San Lorenzo bus terminal, berths for trunk bus, feeder bus and taxis will be required.

a) Trunk Bus

- Time between a bus arrival at the terminal and it halts at a berth: 54 seconds (100m: 20km/h)
- Time between a bus leaving the berth and its departure from the terminal: 54 seconds (100m: 20km/h)
- Waiting time per bus: 10 minutes
- Time of getting on buses: 160 seconds (80 passengers x2 seconds)

- Time of getting off buses: 280 seconds (80 passengers x3.5 seconds)
- Total: 19 minutes 8 seconds
  Refuel and other necessary maintenance will be conducted at off-peak hours. If it is assumed that at peak hours 60 buses arrive per hour, it is estimated that 19 berths will be required.

b) Feeder Bus

- Time between a bus arriving at the terminal and its halts at a berth: 54 seconds (300m: 20km/h)
- Time between a bus leaving the berth and its departure from the terminal: 54 seconds (300m: 20km/h)
- Waiting time per bus: 5 minutes
- Time for boarding on buses: 36 seconds (18 passengers x2 seconds)
- Time for getting off buses: 54 seconds (18 passengers x3.5 seconds)
- Total: 8 minutes 18 seconds
  If it is assumed that at peak hours 48 buses arrive per hour, it is estimated that seven berths will be required.

c) Taxi

- Berth for getting on: 2 berths
- Berth for waiting: 10 berths

4) Unit Area Calculation

A. Area of Bus Berth

Trunk bus: 182 m2
Feeder bus: 130 m2
Taxi: 38.5 m2

B. Space for Getting On and Off

With regard to space for getting on and off buses, Service Standard B of American Highway Capacity Manual (HCM) has been adopted and the area will be 0.93 m2/passenger. However, in case the calculated area of space is less than the length of bus berth, which is 3m, the areas of bus berth will be adopted.
For example, in centro:182person*0.93m2/person=169m2 <28m*4(berth)*3m=336m2

C. Maintenance Facilities

a) Repair shop

It is designed so that two buses can be repaired at a time.
Unit area: 18 m x 7 m = 126 m2/bus

b) Car wash

It is designed so that one bus can be washed at a time.
Unit area: 18 m x 14 m = 252 m2/bus

c) Gas station

Unit area: 20 m x 10 m = 200 m2

D. Service Facilities

a) Ticket Booth

It is assumed that it will take 30 seconds for a passenger to buy a ticket. Accordingly the area of booth will be 1.2 m2/passenger, based on Service Standard A of HCM.
S = (Number of bus passengers x 0.5)/60 x 1.2

b) Waiting Room

It is assumed that 20% of all the passengers will use the waiting room and average waiting time will be five minutes. Unit area of waiting room is determined as 2.0 m2/passenger.
S = (Number of bus passengers x 5)/60 x 2.0

c) Cafeteria

Unit area of cafeteria is 100 m2 (10 m x 10 m).

d) Restaurant

Unit area of restaurant is 200 m2 (10 m x 20 m).
Since in point of view of holding the equivalent institution of the existing international bus terminal, the restaurant and the cafeteria should be annexed as a result of the meeting of the Municipality.

e) Telephone Box

Unit area of telephone box is 0.6 m2 (0.6 m x 1 m).

f) Shops

Unit area of shops is 6 m2 (2 m x 3 m).

g) Toilet

Unit area of Toilet is 8 m2 (2 m x 4 m).

E. Administrative Facilities

a) Ticket Booths

Unit area of one booth is 6 m2 (2m x 3 m). Four booths for trunk bus and one booth for feeder buses will be constructed. S = 6 m2 x 5 = 30 m2

b) Office
The area of the office is 150 m2. In Centro bus terminal, a ticket office also serves as an office.

F. Others (Roadway)

20% of the total area of terminal facilities will be used for roadway.

5) Calculation of Required Area

A. Centro (Laguna)

Each facility area can be calculated based on the assumption that 182 passengers get on and off trunk buses per hour. Areas of each facility are shown in Table 17-1-14.

Table 17-1-14 Area of Centro Terminal

Place	Area per unit (m2)	Necessary Unit	Necessary Area	Clarification
Bus bay for Trunk Bus	182	4	728	
Space for getting on and off	-	1	336	169<336(28*4*3)
Waiting Room	-	1	30	It is in the ticket office because there are a few passengers
Toilet	8	1	8	
Ticket Office and Administration Off	6	2	12	Two ticket offices because there are a few passengers
Subtotal			1,114	
Lane	-	-	334.2	Subtotal*0.3
Total			1,448	

B. San Lorenzo

Each facility area can be calculated based on the assumption that 10,005 passengers for trunk buses and 1,724 passengers for feeder buses get on and off buses per hour. Areas of each facility are shown in Table 17-1-15.

Table 17-1-15 Area of San Lorenzo Terminal

Place	Area per Unit (m2)	Necessary unit	Necessary area	Clarification
Bus bay for trunk buses	182	16	2,912	3 platforms to get off and 5 to get on
Bus bay for feeder buses	130	7	910	1 platform to get off and 1 to get on
Platform for taxis	30.5	12	366	2 platforms to get off and 10 for waiting
Space to get off and on	-	3	3,543	2682 Trunk Bus,819 Common Buses,42 taxies
Maintenance place	126	2	252	
Laundry	224	1	224	
Gas Station	200	1	200	
Ticket Booth	-	2	33	24 Trunk Buses, 9 Common Buses
Waiting Room	-	1	123	
Coffee Shop	-	1	100	
Restaurant	-	1	200	
Public Telelphone	0.6	10	6	
Kiosk	6	2	12	
Toilet	8	3	24	
Ticket Office	6	5	30	4 Trunk Buses, 1 Common Bus
Administration Office	-	1	150	Only trunk buses
Subtotal			9,085	
Lane			2,726	Subtotal*0.3
Total			11,811	

(3) Design of Bus Terminal Facilities

Based on the above-mentioned calculation of both bus terminal areas, both Centro and San Lorenzo Bus Terminal have been designed as shown in Fig. 17-1-18 and 17-1-19. With movement plans by transportation in each terminal and. Detailed design conditions are described below.

Trunk bus (articulated):	Minimum radius of rotation:	12.0 m
Feeder bus:	Minimum radius of rotation:	12.0 m (same as trunk bus)

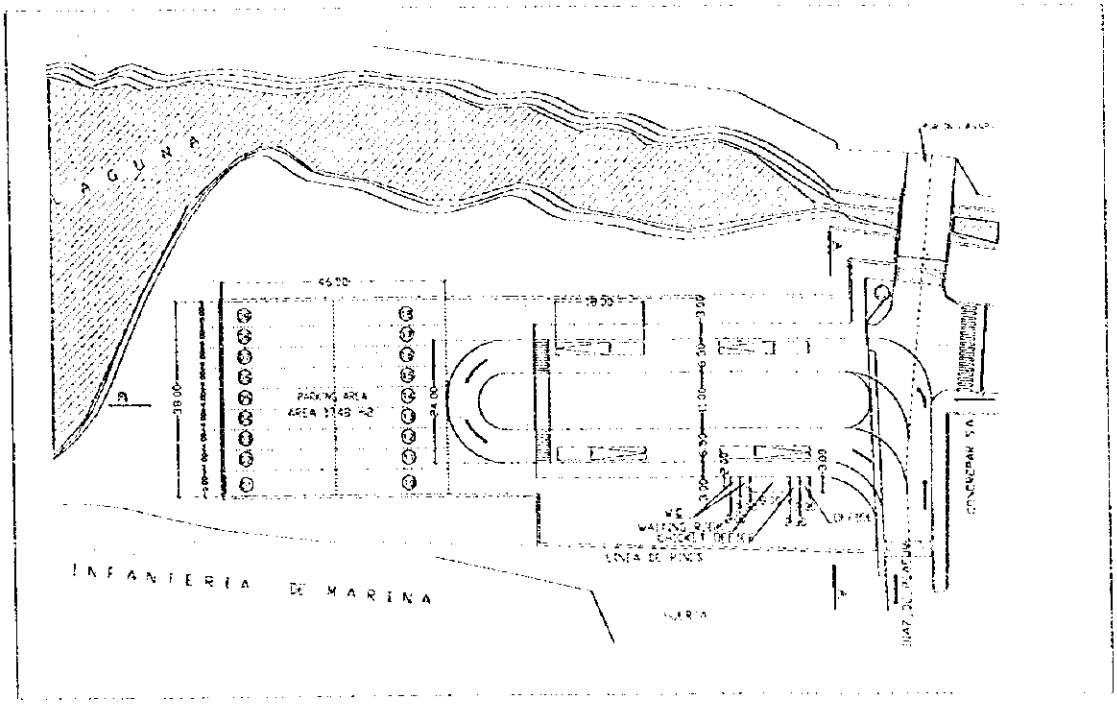


Fig. 17-1-18 Plan of the Trunk Bus Terminal in Centro

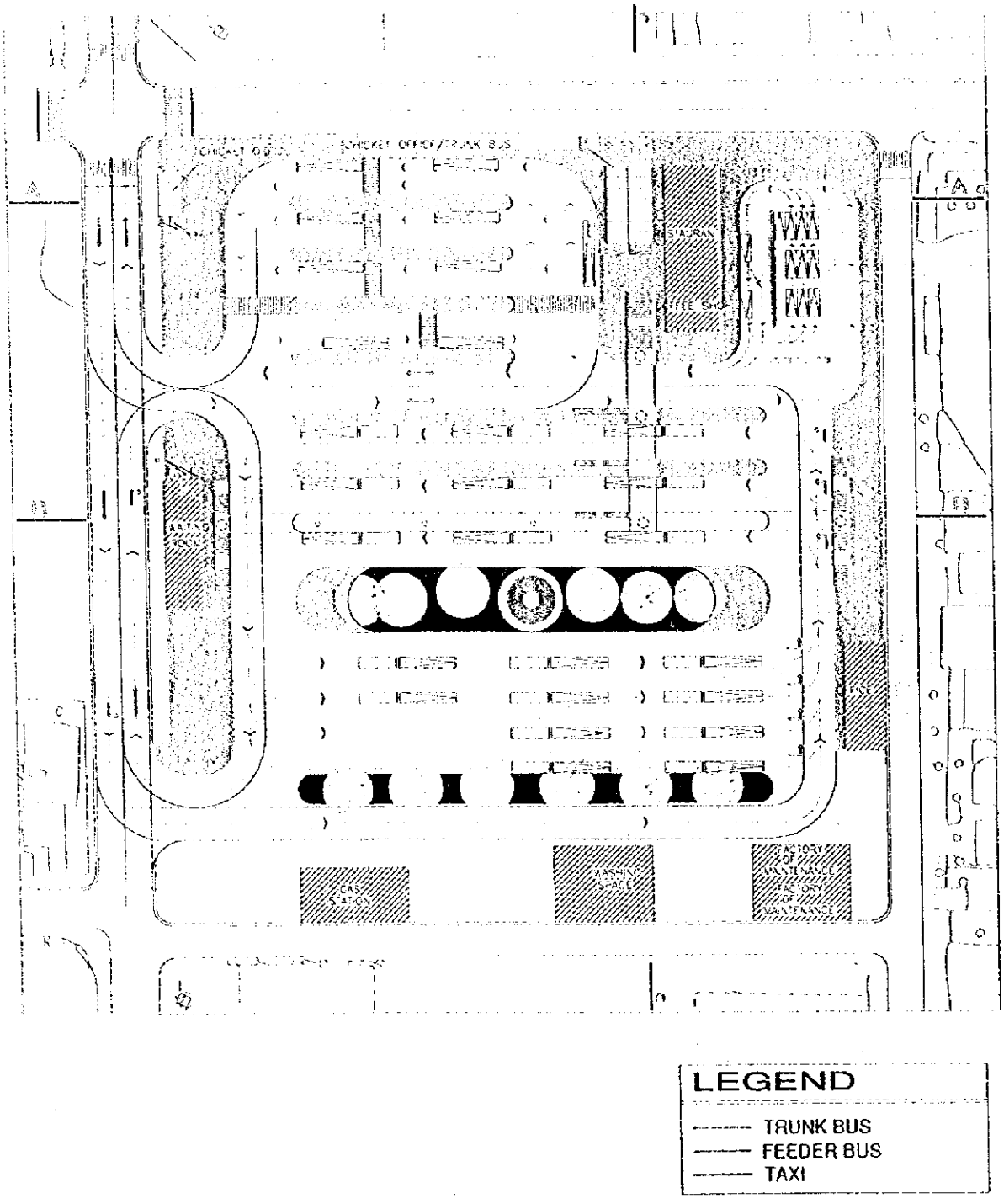


Fig. 17-1-19 Plan of the Trunk Bus Terminal in San Lorezo

A. Centro

According to information gathered at Asunción Port Authority, which is shown in Fig. 17-1-20, it has been revealed that, in the 20 years between 1979 and 1998, the maximum water level of Paraguay River at Centro Bus Terminal site was 9.01 m, which was recorded in 1984. Since this maximum level was also recorded in 1905, it can be concluded that a maximum water level of 9.01 m may be recorded every 100 years.

On the other hand, the ground height of a bridge, which is situated on a connecting road to a container terminal of the port, is 8.70 m, according to the result of survey by the Asunción Municipal Government. Accordingly, in order for the Centro Bus Terminal to clear the maximum river level 9.01 m, it is required to make an embankment of at least 0.3 m or 1.0m height with sufficient room.

Moreover, with regard to the construction work for the terminal, special consideration is required not to block the existing Jaen River. Accordingly a masonry wall of 1 m height will be constructed around the terminal, which will be connected to an access road.

Design requirements are summarized as follows.

- From the past experience of flooding, the site needs to be surrounded by a retaining wall of 1.0m in height.
- The site should not influence the river flow.
- The construction area should be limited to the minimum level necessary.
- Adequate parking spaces during night, including for time adjustment, are required.
- Parking spaces for 18 trunk buses are necessary.

If land acquisition is difficult, Av. Colon (Another Alternative :Alt 8) can be used for U-turns as a temporary solution. In such a case, spaces for four bus bays will be reserved on Av.Colon for the purpose of time adjustment.

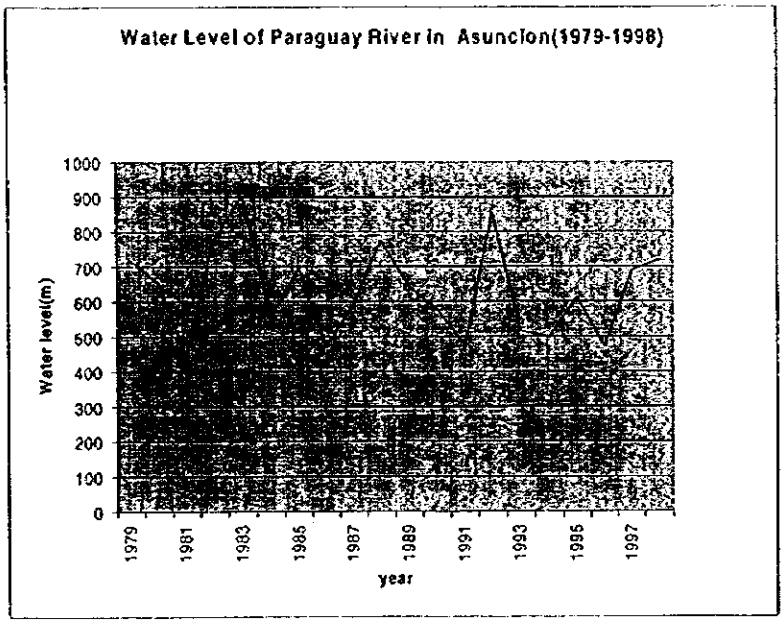


Fig. 17-1-20 Maximum Water Level of Paraguay River Past 20 yeares

A. Centro

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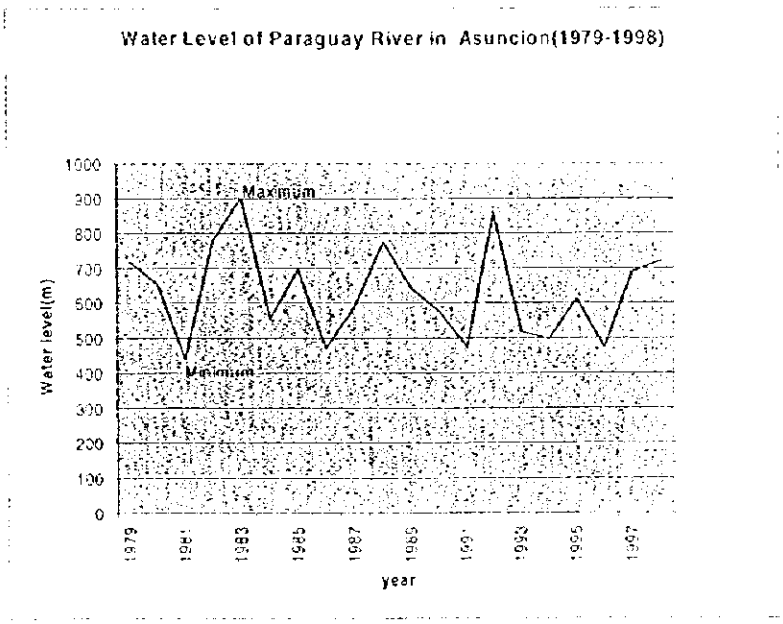


Fig. 17-1-20 Maximum Water Level of Paraguay River Past 20 yeares

B. San Lorenzo

Mariscal Estigarribia Avenue is a one-way road, which passes in front of MOPC's maintenance garage in San Lorenzo City, and is connected to National Route No.2. Accordingly, the direction of trunk buses will follow the same direction as this road and enter San Lorenzo Terminal.

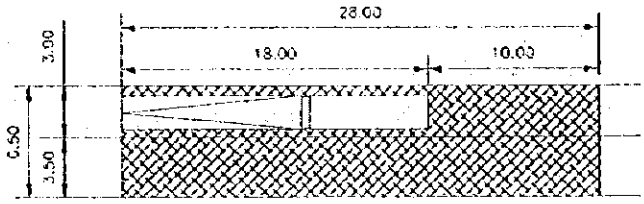
There have been two alternatives in terms of the position of entrance. In the first one an entrance will be set up on the northern side and trunk buses, feeder buses and taxis will use it. In the second alternative, there are two entrances, one of which will be set up at the southern side and exclusively used by trunk buses, and the other will be set up at northern side and used by feeder buses and taxis. The second alternative, which has an exclusive entrance for trunk buses, has been selected since trunk bus service interval is every 1minute at peak hours and it is important to avoid traffic congestion in the terminal.

Design requirements are described below.

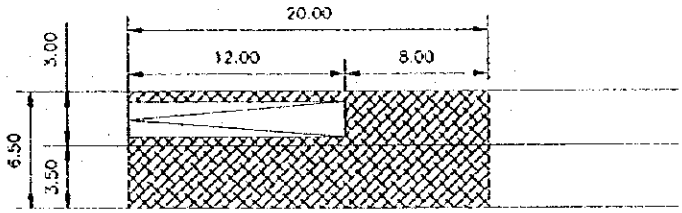
- Since trunk buses depart the terminal with headway of one minute, there is expected to be some jams at exits. Exits for trunk buses and those for others, such as feeder buses and taxis, need to be separated, and trunk buses should have exits for their exclusive use.
- Exits will be placed at two locations, one in the north for feeder buses and taxis and the other in the south for trunk buses only.
- The radius of the outer turning circle of two-section articulated buses is 12m, the same as for normal buses. The radius of the inner turning circle is 4.1m by design, but a radius of 6m will be required for safety. Hence, in making a U-turn, a bus will need a sweep area 24m in diameter.
- For overtaking, a bus needs space on its left side. As shown in Fig. 17-1-21, it is necessary to secure sufficient space for this.As shown in Fig. 17-1-22, a 7,000m^2 site in San Lorenzo is available for parking space for trunk buses. This site is adjacent to the terminal. It will be used for time adjustment during off-peak hours and at night. It is capable of holding 24 articulated buses.

At night, the terminal in San Lorenzo can hold 21 trunk buses, and in total 45 buses can be parked in San Lorenzo. The other 15 will be parked in Centro. The terminal in Centro is capable of holding 22 buses, and there are sufficient spaces for buses at night. The construction of parking spaces in the terminal in Centro will require the relocations of a brick factory and four houses.

Trunk Bus



Feeder Bus



Taxi

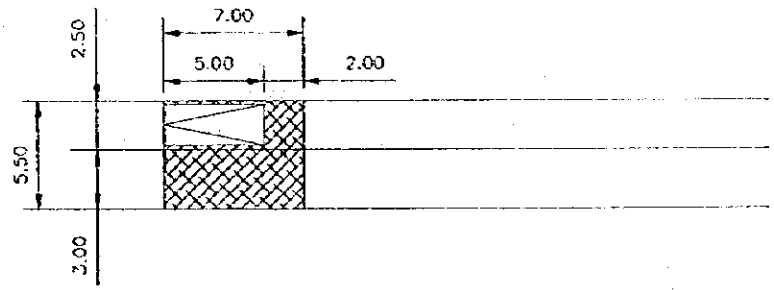


Fig. 17-1-21 Physical Condition of Space in the Trunk Bus Terminal

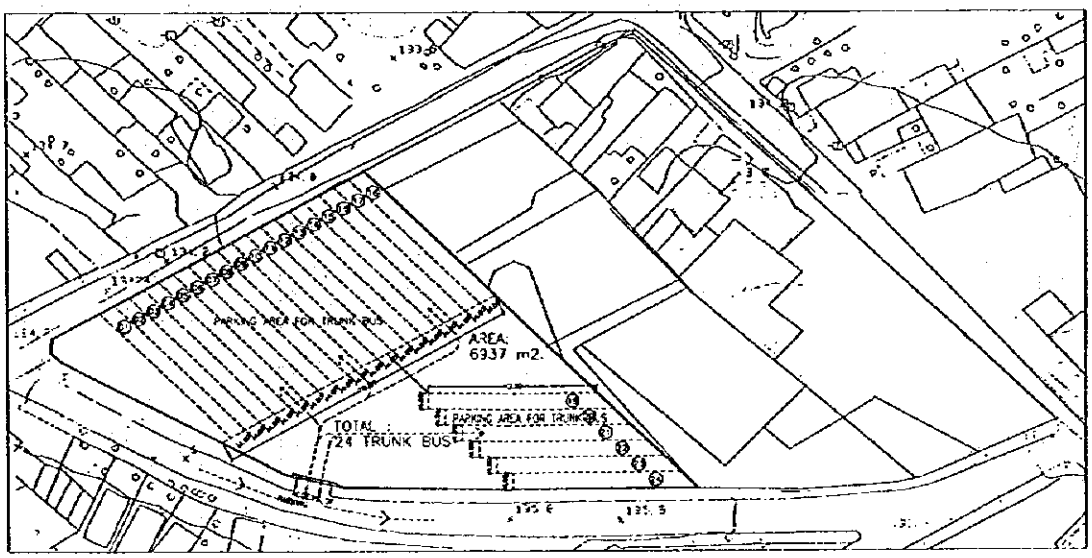


Fig. 17-1-22 Parking Area in the San Lorenzo Bus Terminal

(4) Transfer Facility Design

1) Calculation of Capacity of Transfer Facility

Table 17-1-16 shows the total number of passengers at each bus stop during peak hours in 2005 and 2015 by adding together the number of passengers on trunk bus lines and that of transfers between feeder and local bus lines. There will be the largest demand for transfers at intersections on Av. E. Ayala and Mcal. Estigarribia with Av. Chof. del Chaco and Azara in both 2005 and 2015. Among other roads that will not be widened, the section into San Lorenzo will have the highest demand, or 11,657 users in 2005 and 15,851 in 2015.

Table 17-1-16 The Number of Passenger Transfer (2005/2015)

Number of people setting on and making transfers in 2005

Bus Stop	Number of intersection	Boarding	Transfer	Total	Peak hour	Terminal Length	Terminal Area
1	Terminal(Centro)	3,330	0	3,330	333	1	3
201	Colon & Gral.Diaz	16,984	13,386	30,370	3,037	10	30
202	Colon & Humaita	34,499	13,386	47,885	4,789	16	48
301	Chile & Azara	0	12,716	12,716	1,272	4	13
302	Humaita & Chile	7,249	12,716	19,965	1,996	7	20
401	Antequera & Azara	0	15,694	15,694	1,569	5	16
402	Antequera & F.R. Moreno	13,705	15,694	29,399	2,940	10	29
501	Curupayty & Azara	826	16,075	16,901	1,690	6	17
502	Curupayty & Pettirossi	39,397	16,075	55,472	5,547	18	55
601	Mayor Fleitas & Azara	25	4,866	4,891	489	2	5
602	Mayor Bullo & Eusebio Ayala	12,526	4,866	17,392	1,739	6	17
7	Gral. Santos & Eusebio Ayala	8,396	0	8,396	840	3	8
8	Kubitscheck & Eusebio Ayala	14,057	5,691	19,748	1,975	7	20
9	Choferes & Eusebio Ayala	16,332	101,955	118,287	11,829	39	118
10	Rca. Argentina & Eusebio Ayala	12,664	0	12,664	1,266	4	13
11	De la Victoria & Eusebio Ayala	27,770	26,038	53,808	5,381	18	54
12	Madame Kynch & Eusebio Ayala	40,660	0	40,660	4,066	14	41
13	Eusebio Ayala & Pitiantuta	28,187	894	29,081	2,908	10	29
14	Eusebio Ayala & Leopardi	0	66,029	66,029	6,603	22	66
15	Av. Del Agronomo & Ruta 2	73,479	10,399	83,878	8,388	28	84
1601	Miranda Cueto & Hernandarias	0	69,547	69,547	6,955	23	70
1602	Av. Del Agronomo & Mcal. Estigarribia	47,022	69,547	116,569	11,657	39	117
17	Terminal (San Lorenzo)	1,175	27,655	28,830	2,883	10	29
Total		397,108	0	872,679	87,268	291	873

Number of people setting on and making transfers in 2015

Bus Stop	Number of intersection	Boarding	Transfer	Total	Peak hour	Terminal Length	Terminal Area
1	Terminal(Centro)	3,545	0	3,545	355	1	4
201	Colon & Gral.Diaz	23,601	18,843	42,444	4,244	14	42
202	Colon & Humaita	47,404	18,843	66,247	6,625	22	66
301	Chile & Azara	0	18,427	18,427	1,843	6	18
302	Humaita & Chile	8,324	18,427	26,751	2,675	9	27
401	Antequera & Azara	0	22,159	22,159	2,216	7	22
402	Antequera & F.R. Moreno	17,198	22,159	39,357	3,936	13	39
501	Curupayty & Azara	968	20,680	21,648	2,165	7	22
502	Curupayty & Pettirossi	47,526	20,680	68,206	6,821	23	68
601	Mayor Fleitas & Azara	29	6,698	6,727	673	2	7
602	Mayor Bullo & Eusebio Ayala	14,021	6,698	20,719	2,072	7	21
7	Gral. Santos & Eusebio Ayala	9,489	0	9,489	949	3	9
8	Kubitscheck & Eusebio Ayala	17,060	9,294	26,354	2,635	9	26
9	Choferes & Eusebio Ayala	20,279	69,433	89,712	8,971	30	90
10	Rca. Argentina & Eusebio Ayala	15,120	69,433	84,553	8,455	28	85
11	De la Victoria & Eusebio Ayala	33,365	36,700	70,065	7,007	23	70
12	Madame Kynch & Eusebio Ayala	41,635	0	41,635	4,164	14	42
13	Eusebio Ayala & Pitiantuta	37,687	1,579	39,266	3,927	13	39
14	Eusebio Ayala & Leopardi	0	84,494	84,494	8,449	28	84
15	Av. Del Agronomo & Ruta 2	142,871	15,636	158,507	15,851	53	159
1601	Miranda Cueto & Hernandarias	0	107,123	107,123	10,712	36	107
1602	Av. Del Agronomo & Mcal. Estigarribia	71,461	107,123	178,584	17,858	60	179
17	Terminal (San Lorenzo)	1,514	81,408	82,922	8,292	28	83
Total		553,097	755,834	1,308,931	130,893	436	1309

2) Size of Trunk Bus Stop

The required size of each bus stop is determined in terms of the number of buses necessary to occupy it at the same time. The above analysis of the transfer demand has indicated one Fig., and the analysis on operation frequencies has shown two buses. Now, it is necessary to determine the size of each bus stop from these two analyses. In so doing, the two approaches will be compared, and the bigger one will be regarded as the required size of each bus stop.

A. Transfer Demand Approach

In 2015, the number of passengers of the trunk bus on Av. Chof. del Chaco and Azala is 8,971 passengers per section during one peak-hour, and it is expected that the maximum number of passengers per minute could be as large as 150. The headway of the trunk bus is one minute during peak hours. Based on the assumption that the maximum waiting time is 2 minutes, and that one passenger occupies a space of 0.30 m^2, the required total area of a bus stop is 90m^2 (150 X 2 X 0.30m^2). Since it is difficult to secure a width of over 30m at intersections on Av. E. Ayala because of the Frentista system, the width of a bus stop is set at 3.0m, or about the size of one vehicle lane. Therefore, the length of a bus stop needs to be 30m. The required length becomes 15m if a bus stop is divided for each direction.

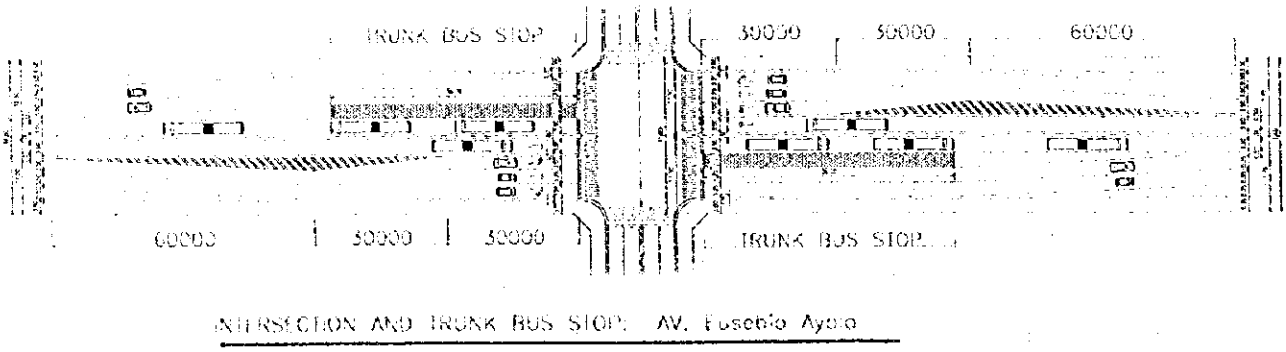
B. Operational Frequency Approach

During peak hours, the trunk bus will operate with one-minute headway. Assuming a waiting time of two minutes, and that each bus stop needs spaces for holding two buses simultaneously in each direction, the required space is 27m in length, or in addition to the vehicle length of 18m, and an extra space, 9m. The total space will be 56m (2 X 27m), and it can provide sufficient space for transfer demands at the busiest section.

Thus, each trunk bus stop requires a width of 3m and length of 56m on the widened sections.

3) Location of Trunk Bus Stop

Spacing between each bus stop is determined to be about 1.5km, and they will be installed at major intersections that will be widened. Since the widened trunk roads will all have left-turning lanes of 3m, bus stops are placed in opposite the turning lane so that the acquisition for right-of-way can be minimized. Moreover, since it can be chaotic and dangerous to move on a platform if passengers heading to either direction are mixed on a single platform, they need to be separated for one direction to Centro and the other to San Lorenzo. Fig. 17-1-23 shows a typical cross section and floor plan of an intersection on Av. E. Ayala. Fig. 17-1-24 shows movements of passengers when transferring between a trunk line and a feeder line.



INTERSECTION AND TRUNK BUS STOP AV. Fusebio Ayala

Fig. 17-1-23 Plan of the Trunk Bus Stops with Intersection

Normal Location of Bus Stop with Bridge

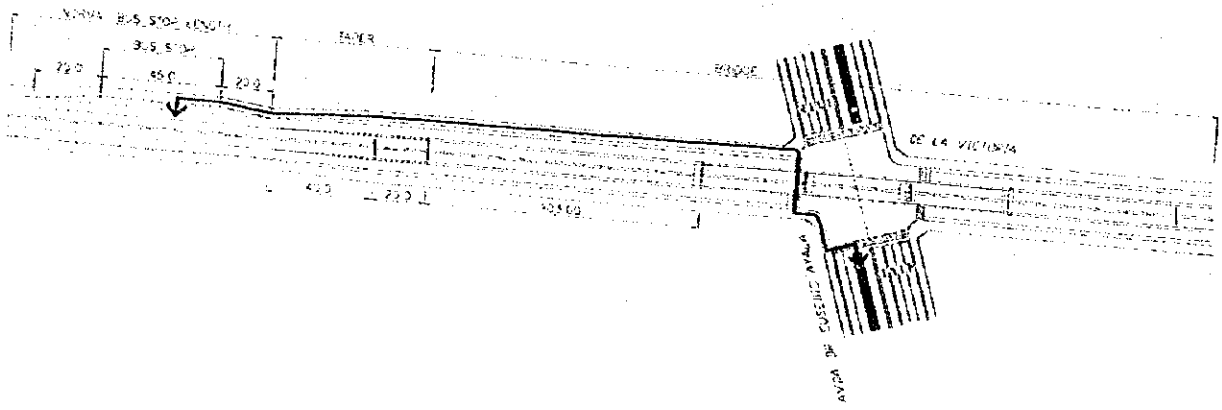


Fig. 17-1-24 Movement of Passengers between Trunk Bus and Feeder Bus with Bridges