4. CONSTRUCTION CONDITION

4-1 CONSTRUCTION FIELD

The total investment amount in the construction sector summarized by the Contraloria General is given for the public sector and the private sector in TABLE II-4-1.

TABLE II-4-1 INVESTMENT OF CONSTRUCTION SECTOR AND TYPE OF WORK

(Million B/.)

Sector and Type of Work	1977	1978	1979	1980	1981	1982	1983	1984	1985
Public Sector	169.9	263.4	180.3	251.8	251.3	323.1	240.6	230.7	129.9
Houses	43.1	37.7	24.0	15.2	17.6	18.5	10.9	17.1	18.4
Non Residential Building	35.6	63.6	47.3	20.5	21.0	48.5	19.6	26.5	16.1
Other Construction Works	91.2	162.1	109.0	216.1	212.7	256.1	210.1	187.1	95.4
Private Sector	95.1	114.1	239.3	311.0	430.9	528.2	373.4	269.2	371.6
Houses	41.7	48.5	72.4	78.1	99.8	103.2	108.8	111.8	173.8
Non Residential Buildings	41.8	51.5	139.8	199.2	204.8	187.5	202.3	118.8	149.6
Other Construction Works	11.6	14.1	27.1	33.7	126.3	237.5	62.3	38.6	48.2
TOTAL	265.0	377.5	419.6	562.8	682.2	851.3	614.0	499.9	501.5

p / Preliminary figures
Source: Contraloria General, Situacion Economica, Cuentas Nacionales 1977 - 1985

Investment in the construction sector had been increasing up to 1982, but it has now been on a downward trend for the past three years, except for the private investment in housing construction. This is attributable to the 1986, enactment of a law allowing even lower-income people to borrow housing loans up to B/50,000.

Concerning road investment in Panama City, the repavement, improvement and new road construction have been performed on the following roads since 1969:

a. Extension of Ave. 11 Octubre in 1969
b. Extension of Ave. Ernesto T. Lefevre in 1970
c. Extension of Ave. Nicanor de Obarrio (Calle 50) in 1971
d. Widening of Via Brasil in 1971
e. Widening of Via Bolivar in 1972
f. Construction of Via Ricardo J. Alfaro during the 1973 - 1978 period
g. Widening and repair of Via Cincuentenario and Via Israel during the 1973 - 1978 period
h. Extension of Via Domingo Diaz (Via Tocumen) in 1979
i. Widening of Via Belisario Porras in 1983
j. Construction of overpass/viaduct to improve the intersection of San Miguelito in 1985
k. Construction of overpass/intersection between Via Bolivar and Martin Sosa in 1985

The foregoing roads constitute a trunk road network for urban traffic.

At the beginning of 1987, the Corredor Norte Project was started.

This road will greatly help to eliminate the traffic congestion in the Panama Metropolitan Area. With BID aid, it is also planned to perform the road widening project between Arraijan and American Bridge within 1987.

Besides the foregoing, the government has carried out the construction and improvement projects of local roads. The survey, planning and designing have been performed partly by MOP, partly by domestic consultants and engineering firms, and partly by joint ventures with foreign enterprises.

Similarly, the construction work has been performed by domestic contractors under general bid contracts in the case of new roads and large projects, while road improvements (e.g, overlay) and small projects, such as the construction of a small road in a remote area, have been performed under direct management, using the construction equipment, materials and laborers of MOP.

An expressway (Autopista) was constructed for the first time in Panama in 1981 between Arraijan and Chorrera (20.7 km) with a total investment of B/38.7 million under BID aid.

The contractors in Panama are all registered with the Ministry of Commerce and a total of 1,506 firms are registered, as of 1985. The breakdown by region is as shown in TABLE II-4-2, from which it can be seen that more than 90% of all contractors are found in the Metropolitan Area.

TABLE II-4-2 NUMBER OF CONTRACTORS FOR EACH REGION

Name of Region	No. of Companies
Bocas Del Toro	4
Colon	33
Cocle	11
Chiriqui	40
Darien	-
Herrera	17
Los Santos	3
Panama	1388
Veraguas	10
Total	1506

Source : Contraloria General, Situacion Economica, 1985

The contractors by declared capital are tabulated in TABLE II-4-3, indicating that more than 50% of all registered contractors are small firms below B/5,000 in the capital declared.

TABLE II-4-3 NUMBER OF CONTRACTORS CATAGORIZED BY DECLARED CAPITAL

Declared Capital (Balboas)	Number of Construction Companies
501 - 5,000	800
5,001 - 10,000	416
10,000 - 50,000	222
50,001 - 100,000	39
100,001 - 250,000	12
250,001 - 500,000	11
500,001 -1,000,000	4
More than 1,000,000	1
Not Specified	1
Total	1506

Source : Contraloria General, Situation Economica , 1985

Only 12% of the contractors are members of CAPAC (Camara Panamena de la Construccion), and their number of permanent employees is shown in TABLE II-4-4. The average number of permanent employees is approximately 50, and the biggest has approximately 130 permanent employees. The majority of the contractors are believed to be small-scale contractors for certain projects.

TABLE II-4-4 NUMBER OF CONTRACTORS CATAGORIZED BY NUMBER OF PERMANENT EMPLOYEES

Number of Employees (persons)	Number of Construction Companies
1 - 4	7
5 - 10	11
11 - 19	16
20 - 49	43
50 - 99	25
100 - 150	14
Total	116

Source : CAPAC

On the other hand, Junta Tecnica de Ingenieria y Arquitectura is an entity created by Law 15 of 1959, to regulate the engineering and architectural professional activities and related fields of the construction work in Panama.

To be qualified as a construction company in Panama, companies must comply with the requirements of Law 15 of 1959, Article 24.

4-2 CONSTRUCTION MATERIALS

The yearly domestic production quantities of the major construction materials are shown in TABLE II-4-5. Cement production generally meets the demand. Pit sand represents 90% of sand used, the remaining 10% being sea sand, which must be desalinated before use for construction purposes. Almost all coarse aggregate used is crushed stone available from nearby quarries. Both round and irregular reinforcement bars are produced in Panama. Lumber and plywood for formwork are all domestic products, but imported products have also appeared in recent years.

TABLE II-4-5 ANNUAL PRODUCTION OF MATERIALS

Description	Unit	Amount
Cement	Ton	500,000
Deformed Bar	Ton	50,000
Concrete	Cuy	258,300
Wood	BF	19,165,000
Plywood	Sqf	947,300
Cement Block	Each	14,753,000
Cement Tile	Sqm	588,600

Source : Contraloria General, 1984

Of various concrete products used for the construction of roads, those which are domestically manufactured are: drainage concrete pipes with diameter of 600 to 1,500 mm., reinforced concrete piles with diameter of 200 to 300 mm, and prestressed concrete piles with 450 mm x 450 mm. Concrete curbstones, L-gutter, and prestressed concrete pipes are not made in Panama.

The products which are not produced locally can be imported easily. They are: high resistance cable for the prestressed, neoprene bearing plate, steel pile, additives to increase resistance or to accelerate concrete setting, epoxy resin for the sanitation of concrete structures, electrodes for electric arc welding. The import tax rates of some materials are given in TABLE II-4-6. The yard-pound system is applied to almost all the materials rather than the metric system.

TABLE II-4-6 IMPORT TAX RATE FOR VARIOUS MATERIALS

Description	Tax Rate
Gasoline 95 Oct.	70 % or 0.70 / gal
87 Oct.	70 % or 0.65 / gal
Diesel Oil	77.5 % or 0.65 / gal + 7.5 % VCIF
Kerosine	77.5 % or 0.70 / gal + 7.5 % VCIF
Heavy Oil	77.5 % or 0.40 / gal + 7.5 % VCIF
Asphalt	12.5 %
Cement	0.01 / Kg + 7.5 % VCIF
Explosive	27.5 %
Wood	66.5 % or 0.20 / BF + 7.5 % VCIF
Deformed Bar	0.35 % + 7.5 % VCIF
Round Bar	0.08 / Kg + 7.5 % VCIF
Steel Beam	0.01 / Kg + 7.5 % VCIF
Sheet Metal	0.04 / Kg + 7.5 % VCIF

Source : Aranceles de Importacion 1987.

III. ROAD PLANNING

1. PLANNING CONCEPT
2. TRAFFIC DEMAND FORECAST
3. ROAD FUNCTION
4. ROUTE ALTERNATIVE SELECTION
5. ACCESS CONTROL SYSTEMS
6. CROSS SECTION COMPONENTS

III. ROAD PLANNING

1. PLANNING CONCEPT

(1) Planning Themes

For the planning of Corredor Sur, it is necessary to examine previous issues such as the position of subject roads in the ESTAMPA Masterplan, conditions of geography, land use, roads and traffic, etc.

Roads subjected to the Study may be divided into three groups: Corredor Sur, Main Access Roads, and Corredor Sur Extension. These groups can also be divided into the built-up area and the suburban area, because the themes are different for areas where the route is located.

The following descriptions are themes to be examined in the road planning:

1) Corredor Sur

i) Built-up area

a. Traffic management for the huge volume of future traffic.
b. Intersection improvement planning.
c. Access control system in the commercial and business districts (Calidonia, Bella Vista, Punta Paitilla).
d. Coordination of road widening plan with existing right of way and construction line.
e. Preservation of landscape.
f. Technical examination of land reclamation on the sea.

ii) Suburban area

a. Establishment of road function for new construction road.
b. Determination of number of lanes and design speed for construction road.
c. Coordination of route selection with housing development projects.
d. Structure planning of bridges across rivers.
e. Coordination of route and road structure planning with soft ground area.
f. Preservation of mangrove area.

2) Main Access Roads

i) Built-up area

a. Establishment of road function as a north-south direction arterial road.
b. Coordination of road widening plan with existing right of way and construction line.
c. Intersection improvement planning with Via Espana.

ii) Suburban area

a. Clarification of functions of each road project.

b. Examination of number of lanes and cross section.
c. Route selection.
d. Planning of intersections with Via Jose A. Arango and Via Domingo Diaz.

3) Corredor Sur Extension

a. Coordination with San Felipe historical area preservation project.
b. Coordination with El Chorrillo and Santa Ana area urban renewal project.
c. Traffic demand analysis of through traffic and generated traffic.
d. Examination of solution of existing road network system problem.
e. Analysis of effects of new arterial introduction.
f. Examination of route alternatives.
g. Technical examination of land reclamation.

(2) Road Planning Purpose And Contents

The purpose of the road planning is to formulate and prepare a basic plan for the next step; the preliminary design stage with the consideration of the planning conditions and themes.

The contents of the road planning are as follows:

a. Establishment of road functions.
b. Traffic demand forecast.
c. Route alternative selection.
d. Proposal of access system control.
e. Proposal of cross section components.

For the road planning, it is important to use the traffic demand calculations as a tool.

2. TRAFFIC DEMAND FORECAST

2-1 SUBDIVISION AND INTEGRATION OF OD (ORIGIN - DESTINATION) ZONES

2-1-1 Principles For Subdivision And Integration

OD zones were established in the ESTAMPA Masterplan, as a total of 63 person trip zones (P.T. zones), in the entire nation. These consisted of 53 zones in the survey area, and 10 zones in the external area.

This study is a feasibility study on the individual road project proposed by the ESTAMPA Masterplan. Therefore, if direct use is made of the same P.T. zones used in the Masterplan, for the method of estimation of traffic demand on roads centering around the Corredor Sur, problems of forecast accuracy and calculation efficiency will occur. It is therefore necessary to adjust by subdividing and integrating OD zones as needed.

Subdivision of zones is done in order to increase forecast accuracy. The zone where the Main Access Roads related to Corredor Sur form a network, will be subject to subdivision. This is because, when 2 or 3 access roads are distributed in a single zone, it is difficult to do an even evaluation of the results of traffic assignment.

The integration of zones is executed to increase the calculation efficiency, and also to reduce the total number of zones as much as possible, by arranging together the zones which have no direct influence on the Study as a group.

2-1-2 Content of Subdivision and Integration

The zones which must be subdivided are four zones numbered 23, 24, 33, and 34. The access roads related to Corredor Sur are distributed in zones 23 and 24. Zones 33 and 34 both have several cores of large-scale housing developments. It is expected that these cores may affect the Main Access Roads related to Corredor Sur.

Zones 23 and 24 were subdivided into 7 zones and 4 zones respectively, with consideration given to the sphere of influence of related access roads and the future land use of each zone (including the mangrove area development plan). Zones 33 and 34 were subdivided into 3 zones and 2 zones respectively, according to the relationship between the road network and the cores of the large residential areas, as stated previously. FIGURE III-2-1 shows these subdivided zones.

The integration of zones delt with the area outside the urban area as the subject area, that is, the east side from Tocumen, the west side area from Puente de Las Americas, the north side area from Chilibre, and the south side area from Amador. A total of 23 zones in those 4 areas were combined into 5 zones. As a result of these operations, the total number of all zones after subdivision and integration comes to 57. Table III-2-1 shows the zone codes.

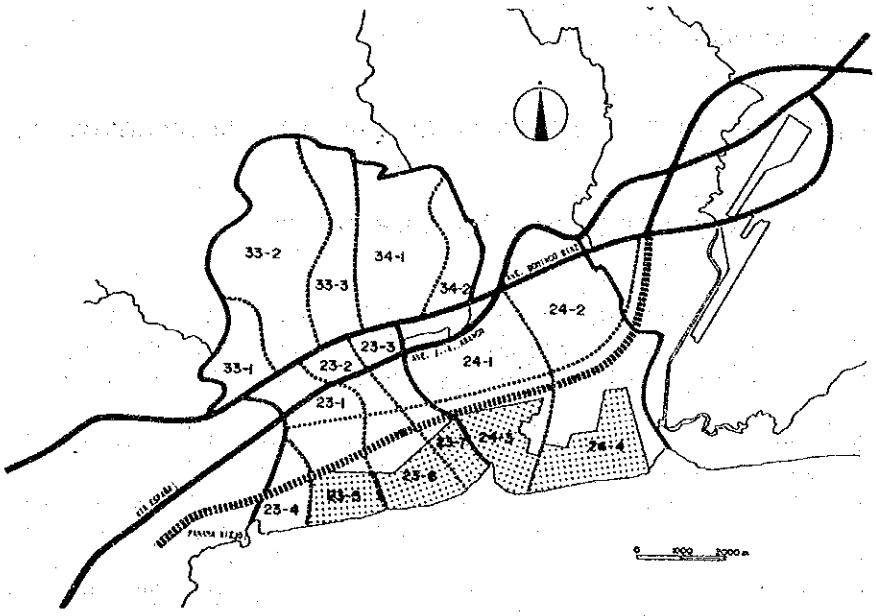


FIGURE III-2-1 MAP OF SUBDIVIDED ZONES

TABLE III-2-1 ZONE CODE

No.	Zone No. (ESTAMPA III)		Zone Name	Zone No. (Master Plan)	Integrated Zone (For Bus Facility Plan)
1	1		San Felipe	1	I. Centro
2	2		El Chorrillo	2	
3	3		Santa Ana	3	
4	4		Calidonia Sur	4	
5	5		Calidonia Norte	5	
6	6		Curundu	6	
7	7		La Cresta	7	II. Bella Vista
8	8		Urraca-Campo Alegre	8	
9	9		Obarrio	9	
10	10		El Cangrejo	10	
11	11		Punta Paitilla	11	III.Area Residencial
12	12		San Francisco	12	
13	13		El Golf	13	
14	14		Vista Hermosa	14	
15	15		Pueblo Nuevo	15	
16	16		Loceria	16	
17	17		El Dorado	17	
18	18		Betania	18	
19	19		Parque Lefevre	19	
20	20		Chanis	20	
21	21		Rio Abajo	21	
22	22		Villa Lorena	22	
23	23	231	Hipodromo(1)	23	IV. Juan Diaz
24		232	Hipodromo(2)	23	Pedregal
25		233	Hipodromo(3)	23	
26		234	Hipodromo(4)	23	
27		235	Hipodromo(5)	23	
28		236	Hipodromo(6)	23	
29		237	Hipodromo(7)	23	
30	24	241	Juan Diaz(1)	24	
31		242	Juan Diaz(2)	24	
32		243	Juan Diaz(3)	24	
33		244	Juan Diaz(4)	24	
34	25		Pedregal	25	
35	26		Nuevo Aeropuerto	26	V. Tocumen
36	27		Tocumen	27	
37	28		Area de Paraiso	28	VI. San Miguelito
38	29		Amelia Denis de Icaza	29	
39	30		Samaria	30	
40	31		San Isidro	31	
41	32		Los Andes No.2	32	
42	33	331	La Pulida(1)	33	
43		332	La Pulida(2)	33	
44		333	La Pulida(3)	33	
45	34	341	Cerro Viento(1)	34	
46		342	Cerro Viento(2)	34	
47	35		Las Cumbres	35	VII.Las cumbres
48	36		Chilibre, Colon	36,57,58,59	Chilibre,Colon
49	37		Fuerte Amador, Taboga	37,56	VIII.Ancon Este
50	38		La Boca	38	
51	39		Balboa	39	
52	40		Albrook Field	40	
53	41		Fuerte Clayton	41	
54	42		Pedro Miguel	42	
55	43		Cocoli,Veracruz	43,45	IX. Canal Oeste
56	44		Arraijan, Chorrera, Nuevo Emperador,Cocle	44,46,47,48,49,51 52,53,55,61,62,63	
57	45		Pacora, Darien	50,54,60	X. Pacora,Darien

Source: ESTAMPA

2-2 INDEX FOR SUBDIVIDED ZONES

"Worker's population" means the population which is the number of workers based on the living place, and "Employee's population" means the number of workers based on the working place.

The figures for the years 1990, and 2000, for each divided zone, will be estimated in the same manner as in the ESTAMPA Masterplan, as an index for input into the traffic demand forecast model. The value estimated for the Masterplan will be adopted as the value for the year 2000. However, the speed of housing develoment in Zone 23 (Hipodromo), 24 (Juan Diaz), 33 (La Pulida), and 34 (Cerro Viento) which are the areas subject to zone subdivision, show some difference, after 1980, from the estimation on the Masterplan. Therefore, each index for the above zones for 1990, will be modified in the Study. However, zones other than those mentioned above are proceeding with housing development as estimated in the Masterplan.

2-2-1 Population

The estimated value established in the ESTAMPA Masterplan for each zone, is set as the control total, and population distribution will be done according to the residential area ratio specified by the "Norma de Desarrollo". Zone 23 (Hipodromo) and Zone 24 (Juan Diaz) did not show progress as expected in the Masterplan. Therefore their populations in 1990, are expected to be lower than the previously estimated value. On the contrary, rapid housing development in zone 33 (La Pulida) and zone 34 (Cerro Viento) show a force which has almost absorbed the lower population growth which has occurred in zones 23 and 24. Therefore the values for zones 33 and 34 for 1990, must be adjusted upward considerably, to values higher than the values estimated in the ESTAMPA Masterplan. (See TABLE III-2-2.)

TABLE III-2-2 AREAS CATAGORIZED BY LAND USE ZONING IN ZONES 23 AND 24 (YEAR 2000)

ZONE 23 AREA BY ZONE (YEAR OF 2000)

ZONE	R-E	R1-E	R-1	R-2	R-M1	R-M2	R-M3	RESIDENCE S.TOTAL	C-2	C-3	COMMERCE S.TOTAL	IND	PUBLIC	ROAD	MANGROVE	UNUSABLE	TOTAL AREA	MIXED LANDUSE ZONE R%C2	R%SC2	IC2	DEVELOPED LAND AREA
231	36.86	0	0	15.33	0	0.53	3.29	54.15	19.3	0	19.3	27	111.99	12.75	0	9.82	220.21	11.88	0	2.92	0	210.39
232	27.41	0	30.29	47.29	3	1.03	0	106.51	24.22	0	24.22	34.95	3.31	9.89	0	4.75	170.83	41	0	0	21.8	166.03
233	28.15	0	19.4	7.32	3.38	2.62	0	60.86	11.05	0	11.05	17.38	5.13	7.12	0	31.65	122.95	6.5	2.35	0	8.81	91.9
234	0	0	155.71	0	0	0	0	155.71	0	0	0	5	0	9.57	0	0	165.28	0	0	0	0	165.28
235	0	0	127	9.81	0	0	0	136	8	0	8	0	0	8.36	213.79	0	358.15	8	0	0	0	144.36
236	6	0	133.58	21.44	3	0	0	125.81	19.04	0	19.04	0	0	7.68	282.87	0	616.76	19.06	0	0	0	152.69
237	0	0	56.63	5.83	0	0	0	59.86	3.4	0	3.4	0	0	2.45	145.51	0	187.82	3.4	0	0	0	42.31
TOTAL	92.42	0	472.5	102.25	3.38	4.27	3.29	678.1	155.81	0	155.01	79.33	120.43	57.82	641.37	45.62	1560	89.82	2.35	2.92	22.61	955.01

ZONE 24 AREA BY ZONE (YEAR OF 2000)

ZONE	R-E	R1-E	R-1	R-2	R-M1	R-M2	R-M3	RESIDENCE S.TOTAL	C-2	C-3	COMMERCE S.TOTAL	IND	PUBLIC	ROAD	MANGROVE	UNUSABLE	TOTAL AREA	MIXED LANDUSE ZONE R%C2	R%SC2	IC2	DEVELOPED LAND AREA
241	68.34	0	157.82	29.66	9.34	0	0	365.57	44.96	0.08	45.02	43.64	18.5	11.91	0	65.88	432.8	30.6	0	7.32	386.92
242	166.52	0	66.19	12.84	0.34	0	0	259.69	96.59	5.06	95.65	97.45	12.1	12.89	0	76.79	468.26	11.84	0	74.65	391.67
243	0	0	133.32	32.14	0	0	0	165.46	30.1	0	30.1	85	0	7.09	434.67	0	691.62	30.1	0	0	257.55
244	100.72	0	0	0	0	0	0	100.72	0	0	0	63.8	0	5.75	578.76	58.51	787.53	0	0	0	170.26
TOTAL	335.57	0	371.54	123.85	0.68	0	0	831.44	165.65	5.12	170.75	289.89	30.6	37.66	1012.85	161.18	2350.21	72.54	0	0	81.77	1256.2

1) Zones 23 and 24

Zones 231, 232, 233, 241 and 242, are zones neighboring Via Jose A. Arango, which is an extension of Via Espana. Therefore, 50% of the total increase by the year 2000, is expected to be effective by 1990. Zone 234 contains the former site of a waste disposal lot and development of the surrounding area has been delayed. Therefore, the population of zone 234 in the year 1990, is estimated as 40% of that in the year 2000.

Zones 235, 236, 237, 243, and 244 are close to the mangrove area. There are many problems here, such as access road improvements, drainage, and protection against flood water, etc. Therefore, it has been determined that there will be no development until 1990. Consequently, the modified estimates for population in 1990, are determined as 22,180 persons for zone 23 (a decrease of about 5,000 persons from the value in the ESTAMPA Masterplan), and 37,590 persons for zone 24 (a decrease of about 10,700 persons from the value in the Masterplan).

Corredor Sur will be opened before the year 2000, and urbanization will have advanced to near the mangrove area, outside the restricted development area. Considering the above, the values for the ESTAMPA Masterplan for the year 2000, will be determined as the population in the year 2000, distributed according to the ratio of housing areas in each of the subdivided zones.

2) Zones 33 and 34

Zones 33 and 34 have progressed rapidly in development since 1980. The areas where housing development authorization has been given by MIVI (the Ministry of Housing) after 1980, are 233.8 ha and 88.5 ha, respectively. These developments are progressing steadily, and it is expected that development will progress at this pace in future. Consequently, the values estimated for 1990, which were lower in the Master- plan, would be modified by the following procedure:

Assuming that the portion of the decrease in the estimated population in 1990 for the previously-mentioned zones 23 and 24, will be almost equal to the amount of increase in zones 33 and 34, a new estimate value will be assigned, using the ratio of authorized housing development areas to each subdivided zone.

The population in the year 2000, is considered to be the same as the estimated value used in the ESTAMPA Masterplan, assuming that housing developments have progressed to the extent estimated in the ESTAMPA Masterplan. The population is expected to be distributed according to the size of the areas available for development. (See TABLE III-2-3.)

TABLE III-2-3 DEVELOPABLE LAND AREA IN ZONES 33 AND 34

(Unit:ha)

Zone	Total Area	Developable Area	Undevelopable Area
ZONE 33			
331	312.7	274.3	38.6
332	432.0	244.2	187.8
333	805.3	490.3	315.0
Total	1550.0	1008.8	541.2
ZONE 34			
341	583.4	349.8	233.6
342	286.6	253.2	33.4
Total	870.0	603.0	267.0

Source: ESTAMPA

2-2-2 Worker's Population And Employee's Population

1) Zones 23 and 24

The Worker's population in the year 1990, will decrease by approximately 5,700 persons in comparison with the ESTAMPA Masterplan. This decrease is linked to the estimated population value. The worker's population after this decrease, classified by individual industry, will be divided according to the size of population estimated for each subdivided zone. Values in the year 2000, will be considered the same as the estimates in the Masterplan.

The employee's population for secondary and tertiary industries will change according to the modification of population in the year 1990. Non-manufacturing secondary industries will grow slowly. Local service industries in the tertiary sector will also show a small increase relative to population. Each proportionate response to population will be distributed in the following ratios, as determined from the ESTAMPA Masterplan study results:

a. Secondary Industries

a-1. Manufacturing industries ------ 60% of Secondary industry (Employees will be distributed to each zone in proportion to sites and stock of industry.)

a-2. Non-Manufacturing industries ------ 40% of Secondary industry (Employees will be distributed to each zone in proportion to population.)

b. Tertiary Industries

b-1. Service industries not limited to the area -- 45% of Tertiary ---(Commerce, public service etc., Employees will be distributed in proportion to site stock.)

b-2. Local service industries ---- 55% of Tertiary (Proportionate response to population)

As a result, the modified estimation of workers' population will be divided into a portion which responds to population and a portion which responds to stock, for each subdivided zone.

The employee's population for primary industry is considered to be the same as the estimated value used in the ESTAMPA Masterplan, according to stock division. Therefore, the value in the year 2000, will be considered to be the same as the value used in the Masterplan.

2) Zones 33 and 34

The amount subtracted from the worker's population in zones 23 and 24 during modification, is added to the working population in zones 33 and 34, to obtain the 1990, estimate, which is then distributed to each of the subdivided zones according to population ratios. The ESTAMPA Masterplan

values will be distributed to the divided zones according to their population ratios, as the value for the year 2000.

The employee's population in 1990, will be modified by adding the increase in employee's population in response to general population increase, to the ESTAMPA Masterplan estimate. Employee's populations for primary industries will be set at the same levels as the estimates in the Masterplan, and employee's population in the year 2000, will be set at the same value as estimated in the Masterplan.

Results of the above were sorted, collated and are shown in TABLE III-2-4, FIGURE III-2-2.

TABLE III-2-4 POPULATION, WORKERS, AND EMPLOYEES FOR EACH SUBDIVIDED DIVIDED ZONE (YEARS 1990 AND 2000)

	1980									1990									2000								
ZONE	POP	WORK	1ST	2ND	3RD	EMPLOY	1ST	2ND	3RD	POP	WORK	1ST	2ND	3RD	EMPLOY	1ST	2ND	3RD	POP	WORK	1ST	2ND	3RD	EMPLOY	1ST	2ND	3RD
231	3709	1205	25	250	930	1555	0	1005	550	6050	1485	20	250	1215	1665	0	930	735	6400	1685	15	255	1535	2370	0	985	1385
232	6107	1965	40	435	1509	2775	0	895	1580	6210	2270	25	385	1865	4820	0	1220	3600	6300	2575	20	365	2193	4585	0	1305	3580
233	3966	1278	25	265	988	1360	0	770	590	6020	1478	15	245	1205	1435	0	675	760	6100	1675	10	240	1425	1750	0	690	1060
234	2718	865	20	175	650	455	0	170	285	4170	1525	15	260	1250	735	0	215	520	6400	2585	20	365	2200	1358	0	225	1045
235	2495	758	15	155	550	565	0	150	415	3730	1565	15	230	1120	920	0	195	725	5900	2350	15	335	2030	1485	0	260	1225
236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5600	2299	15	325	1950	1830	0	255	1575
237	0	0	0	0	0	120	85	35	0	0	0	0	0	0	115	75	40	0	1700	730	5	100	595	540	65	75	400
TOTAL	18885	6015	125	1250	4648	6830	85	3825	3720	22180	8135	90	1370	6655	8900	75	3275	5550	34300	13980	100	1985	11895	14190	65	3855	10270
%		100	2	21	77	100	1	64	54		100	1	17	82	100	1	37	62		100	1	14	85	100	0	27	72
MASTERPLAN	18885	6015	125	1250	4648	6830	85	3825	3720	27200	9950	110	1680	8165	9770	75	3535	6180	34300	13980	100	1985	11895	14190	65	3855	10270
DIFFERENCE	0	0	0	0	0	0	0	0	0	-5020	-1835	-20	-310	-1510	-870	0	-260	-630	0	0	0	0	0	0	0	0	0
241	16538	4920	90	1160	3670	885	0	315	570	19270	6930	65	1325	5545	1875	0	780	1175	21900	8790	50	1410	7350	3490	0	890	2600
242	16241	5370	95	1270	4005	1815	0	715	1160	18520	6595	60	1260	5275	3925	0	1615	2310	20600	8205	50	1320	6835	6865	0	1275	3590
243	0	0	0	0	0	60	15	25	0	0	0	0	0	0	80	15	65	0	18500	6130	25	665	3440	2350	15	925	1410
244	0	0	0	0	0	20	20	0	0	0	0	0	0	0	15	15	0	0	8900	3575	20	575	2980	1400	15	725	660
TOTAL	32879	10290	185	2430	7675	2760	35	1055	1670	37590	13525	125	2585	10820	5895	30	2380	3485	61500	24700	145	3970	20585	12185	30	3015	8260
%		100	2	24	75	100	1	38	61		100	1	19	80	100	1	40	59		100	1	16	83	100	0	32	68
MASTERPLAN	52879	18290	185	2430	7675	2760	35	1055	1670	48300	17380	160	3320	13900	6610	30	2610	3970	61500	24700	165	3970	20585	12105	30	3815	8260
DIFFERENCE	0	0	0	0	0	0	0	0	0	-10710	-3855	-35	-735	-3080	-715	0	-230	-485	0	0	0	0	0	0	0	0	0
331	5275	1485	30	305	1070	490	0	125	365	8720	3130	35	555	2510	1590	0	625	965	16500	5870	15	1175	4660	6890	0	735	5355
332	5500	1610	20	260	730	530	0	85	245	7760	2760	30	495	2235	1255	0	480	775	14700	5235	15	1050	4170	5425	0	655	4770
333	4500	1260	20	325	915	435	0	105	310	14660	5220	60	960	4220	2865	0	755	1310	27600	9825	25	1970	7830	10185	0	1250	8935
TOTAL	15375	5755	70	970	2715	1235	0	315	920	31160	11080	125	1990	8965	4905	0	1855	3050	58800	20930	55	4195	16680	21700	0	2620	19060
%		100	2	25	72	100	0	26	74		100	1	18	81	100	0	38	62		100	0	20	80	100	0	12	88
MASTERPLAN	15375	3755	70	970	2715	1235	0	315	920	18760	5890	60	1355	4475	3640	0	1470	2170	58800	20930	55	4195	16680	21700	0	2620	19080
DIFFERE	0	0	0	0	0	0	0	0	0	12400	5190	65	635	4490	1265	0	385	880	0	0	0	0	0	0	0	0	0
341	3508	1400	30	190	1180	335	20	130	205	6880	3150	30	565	2555	1375	20	490	865	25900	10230	40	1875	9135	4210	20	970	3220
342	6516	2590	55	350	2185	645	30	240	375	7710	2750	35	495	2220	1660	25	640	995	17380	7430	25	775	6680	3056	15	705	2330
TOTAL	10024	3990	85	540	3365	1000	50	370	580	16590	5900	65	1060	4775	3035	45	1130	1860	43280	17630	65	1850	15715	7260	35	1675	5550
%		100	2	13	84	100	5	37	58		100	1	18	81	100	1	37	61		100	0	10	89	100	0	23	76
MASTERPLAN	10024	3990	85	540	3365	1000	50	370	580	13260	5400	75	650	6475	2695	45	1025	1625	41200	17630	65	1850	15715	7260	35	1675	5550
DIFFERE	0	0	0	0	0	0	0	0	0	3330	500	-10	410	100	340	0	105	235	0	0	0	0	0	0	0	0	0

SOURCE: ESTAMPA

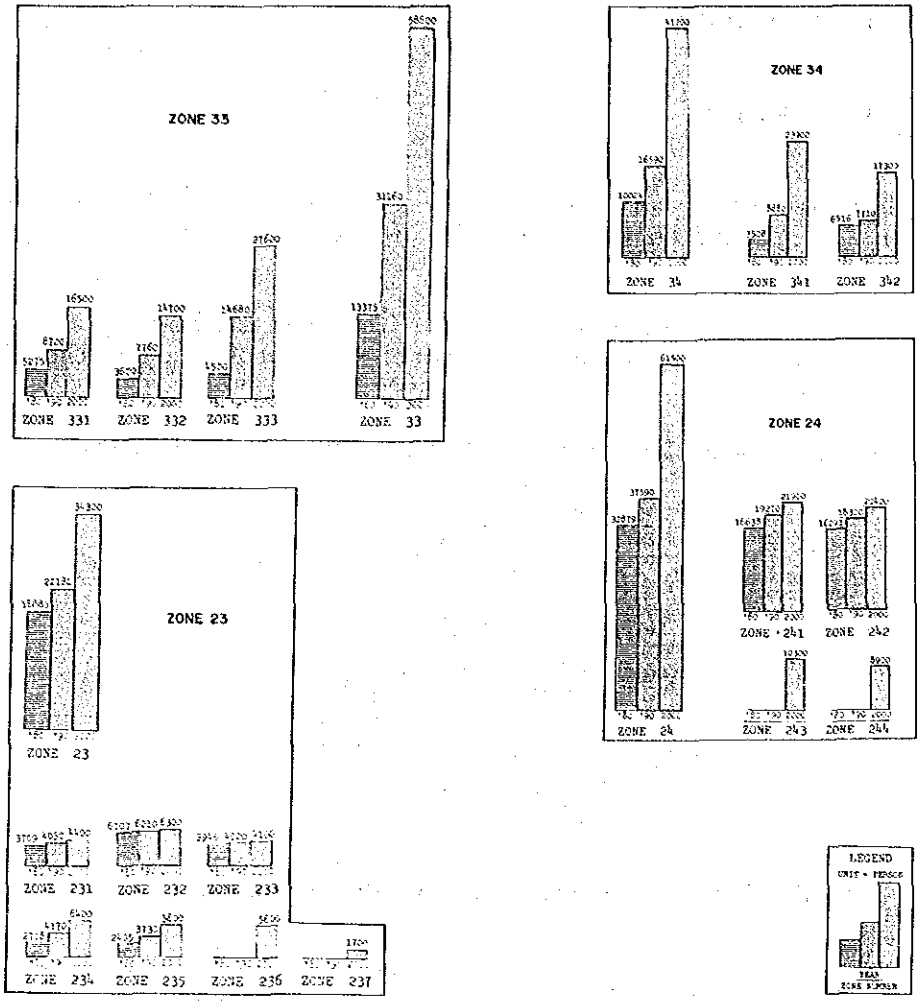


FIGURE III-2-2 POPULATION INCREASE BY SUBDIVIDED ZONES (YEARS 1980, 1990, AND 2000)

2-3 OD TABLE PREPARATION

2-3-1 Preparation Method

The OD table used for the Study is prepared by subdivision and integration of zones based on the future OD of the ESTAMPA Masterplan.

The method of zone unification simply involves summing up the trips for the subject zone. This creates no particular problem, so therefore, only the subdivision method will be stated here.

The process of zone subdivision is shown in FIGURE III-2-3.

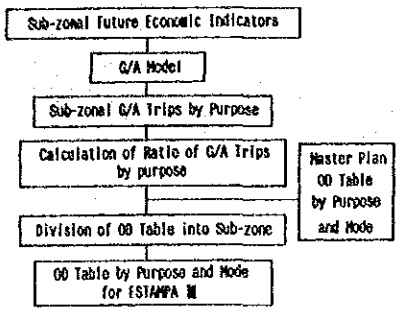
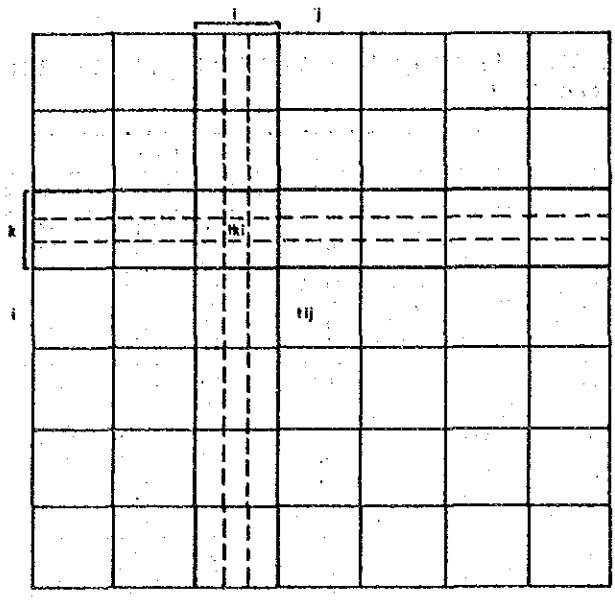


FIGURE III-2-3 FLOW CHART OF DIVISION OF O-D TABLE

In other words, first, the future population index, classified by divided zones, is applied to the generation attraction model (G/A model) developed by the ESTAMPA Masterplan, and generation attraction trips (G/A trips), classified by purposes, will be obtained for the divided zones. Next, the portion of G/A trips (division ratio classified by purpose) will be obtained for each divided zone of those subject to division. After this, the OD table for each purpose and each system, prepared in the ESTAMPA Masterplan, will be divided according to the division ratio for each purpose. At this time, it is considered that the division rate of the system for trip purposes will be the same after division of zones, and the same division ratio is applied to all trips made for the same purpose, regardless of the system used. The trip relationships between the zones subject to division, and the subdivided zones are shown in FIGURE III-2-4.

During preparation of the OD table for 1990, the estimated values from the ESTAMPA Masterplan were reviewed for the 4 zones ; 23, 24, 33, and 34, at the time of estimation of the future population index. Therefore, the previously described method of division was applied, for zone division, without modification of the values for total trips for these 4 zones, as these coincided with the values shown in the Masterplan.

The future OD table obtained by the above process was converted into an OD table classified by type of motor vehicle, to which PCU conversion was applied for the purpose of traffic assignment. The values shown in TABLE III-2-5 were used for the passenger car equivalent which is the same value as the ESTAMPA Masterplan P.T. survey.



For specific i and j; $t_{k,l} = T_{i,j} \times R_k \times R_l$

where, $T_{i,j}$: Original OD volume of inter-zone pair i and j

R_k : Division ration for the generation of trips from zone i

R_l : Division ration for the attraction of trips of zone j

FIGURE III-2-4 DIVISION METHOD OF O-D VOLUME

TABLE III-2-5 PASSENGER CAR EQUIVALENT

Mode	Average No. of Passengers per Unit	Passenger Car Equivalent
Car	1.5	1.00
Taxi	0.8	1.00
Truck	2.1	1.75
Bus(Public Use)	27.0	2.00
Bus(Private Use)	16.0	2.00

Source: ESTANPA

2-3-2 Preparation of OD Table

The division ratios classified by purpose, for the OD table, calculated as a result of application of the future population index to the G/A model are shown in TABLE III-2-6, III-2-7. The division ratios, classified by purpose, for 1990, are for the total trips in zones 23, 24, 33, and 34.

The future OD table (all purpose,all modes) obtained is shown in APPENDIX 1.

TABLE III-2-6 TRIP RATIO CATAGORIZED BY SUBDIVIDED ZONE AND BY TRIP PURPOSE (YEAR 2000)

Zone	Generation						Attraction					
	Work	School	Home	Business	Shopping	Private	Work	School	Home	Business	Shopping	Private
231	0.132	0.131	0.165	0.150	0.113	0.143	0.155	0.136	0.130	0.151	0.018	0.119
232	0.175	0.176	0.354	0.202	0.450	0.294	0.366	0.161	0.181	0.212	0.911	0.433
233	0.125	0.124	0.119	0.137	0.063	0.111	0.113	0.132	0.121	0.136	0.010	0.071
234	0.176	0.179	0.100	0.128	0.099	0.147	0.093	0.163	0.183	0.126	0.016	0.100
235	0.163	0.164	0.108	0.132	0.114	0.142	0.108	0.155	0.167	0.130	0.019	0.116
236	0.159	0.159	0.132	0.139	0.160	0.154	0.139	0.152	0.163	0.138	0.026	0.160
237	0.070	0.067	0.022	0.112	0.001	0.009	0.026	0.101	0.055	0.107	0.000	0.001
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
241	0.347	0.349	0.310	0.265	0.368	0.350	0.302	0.326	0.354	0.267	0.413	0.362
242	0.326	0.326	0.397	0.307	0.439	0.367	0.427	0.309	0.330	0.315	0.560	0.441
243	0.174	0.173	0.182	0.229	0.137	0.163	0.180	0.191	0.169	0.226	0.022	0.140
244	0.153	0.152	0.111	0.199	0.056	0.120	0.091	0.174	0.147	0.192	0.005	0.057
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
331	0.285	0.284	0.278	0.302	0.273	0.277	0.280	0.293	0.281	0.300	0.260	0.274
332	0.256	0.254	0.247	0.284	0.238	0.243	0.248	0.269	0.252	0.279	0.219	0.239
333	0.459	0.462	0.475	0.414	0.489	0.480	0.472	0.438	0.467	0.421	0.521	0.487
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
341	0.694	0.576	0.693	0.607	0.601	0.587	0.584	0.562	0.579	0.618	0.654	0.598
342	0.306	0.424	0.307	0.393	0.399	0.413	0.416	0.438	0.421	0.382	0.346	0.402
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: ESTAMPA

TABLE III-2-7 TRIP RATIO CATAGORIZED BY SUBDIVIDED ZONE AND BY TRIP PURPOSE (YEAR 1990)

Zone	Generation						Attraction					
	Work	School	Home	Business	Shopping	Private	Work	School	Home	Business	Shopping	Private
231	0.045	0.043	0.063	0.081	0.009	0.040	0.064	0.056	0.040	0.080	0.001	0.013
232	0.062	0.061	0.163	0.110	0.177	0.103	0.199	0.068	0.060	0.114	0.269	0.201
233	0.045	0.042	0.054	0.078	0.010	0.036	0.058	0.056	0.040	0.077	0.002	0.015
234	0.046	0.044	0.026	0.069	0.000	0.026	0.029	0.057	0.042	0.067	0.000	0.005
235	0.042	0.040	0.032	0.072	0.005	0.026	0.041	0.054	0.038	0.070	0.001	0.010
236	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
237	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
241	0.165	0.169	0.109	0.083	0.175	0.165	0.084	0.140	0.174	0.083	0.171	0.156
242	0.158	0.160	0.187	0.108	0.249	0.193	0.180	0.136	0.166	0.114	0.419	0.244
243	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
244	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
331	0.081	0.081	0.071	0.080	0.066	0.076	0.069	0.082	0.081	0.079	0.010	0.064
332	0.073	0.073	0.055	0.075	0.044	0.062	0.053	0.077	0.072	0.074	0.007	0.041
333	0.128	0.131	0.105	0.086	0.144	0.132	0.094	0.115	0.133	0.086	0.102	0.135
341	0.082	0.083	0.063	0.077	0.061	0.073	0.058	0.083	0.082	0.076	0.009	0.057
342	0.073	0.073	0.072	0.081	0.060	0.068	0.071	0.076	0.072	0.080	0.009	0.059
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: ESTAMPA

2-4 TRAFFIC ASSIGNMENT

2-4-1 Method and Condition of Traffic Assignment

(1) Traffic Assignment Model

Calculations of traffic assignments are made according to the network simulation method, wherein certain traffic capacities are established for road links and inter-zone trips are assumed to follow the quickest possible link. Using the passenger car conversion rate for each type of vehicle, all vehicle types, except for pedestrian traffic, are converted into the number of passenger cars, and this unit is called the passenger car unit (PCU). The traffic is assigned in five steps, and the quickest route within a road network is determined by the QV curve, which gives the relationship between increasing traffic volume, road capacity and running speed. The basic concept for establishing the QV curve follows that given in the Highway Capacity Manual.

(2) Condition of Traffic Assignment

The preconditions for the traffic assignment study are as follows:

a. The planning year is the year 2000

b. The future road network for the traffic assignment is based on the network of the ESTAMPA Masterplan except for rail transit system.

c. The number of lanes, road standards, and route locations are established as described later, after the examination of traffic assignment works for many cases.

2-4-2 Results of Traffic Assignment

The traffic assignment shall be conducted with the road network subject to assignment and their features as input data and the requirements for preliminary designs, such as traffic demand (planned traffic volume), and number of lanes, as output data.

The traffic assignment shall also be calculated for comparing the route alternatives for Corredor Sur and the Corredor Sur Extension, in addition to obtaining the foregoing outputs.

The following is a summary of the results.

a. Corredor Sur has a very small effect on traffic demand under the assignment conditions of Main Access Roads and Corredor Sur Extension.

b. Corredor Sur has a maximum traffic demand of about 85,000 vehicles near the border between the built-up and suburban areas. Traffic demands for each section are shown as follows;

	(unit: pcu)
* Maranon -- Federico Boyd	56,000
* Federico Boyd -- Brasil	55,000
* Brasil -- E.T.Lefevre	59,000
* E.T.Lefevre -- Cincuentenario	86,000
* Cincuentenario -- San Miguelito Chanis	69,000
* San Miguelito Chanis -- Ciudad Radial	79,000
* Ciudad Radial -- Pan American Highway	44,000

c. Since Corredor Sur in the suburban area receives directly the traffic demand from the Main Access Roads, as a trend, the traffic volume increases toward the built-up area, and afterward decreases slowly toward the center of Panama City. This indicates that vehicles flow in and out of the roads with access to Corredor Sur, i.e.

d. For the Main Access Roads, three basic cases are established by combining the 2 or 4-lane roads with 40km/h design speed and the 4-lane roads with 50km/h design speed. The traffic demand varies by raising the road standard on Via E.T. Lefevre, Via San Miguelito Chanis and Via Ciudad Radial, especially on Via E.T. Lefevre.

e. It is, therefore, preferable to establish higher road standards for Via E.T. Lefevre than for the other main acess roads.

		(unit:pcu)
i. Via E.T. Lefevre	50km/h, 4-lane	59,000
ii. Via San Miguelito Chanis	40km/h, 4-lane	18,000
iii.Via San Miguelito Hipodromo	40km/h, 4-lane	8,000
iv. Via Juan Diaz	40km/h, 2/4-lane	11,000
v. Via Ciudad Radial	40km/h, 2/4-lane	25,000
vi. Via Don Bosco	40km/h, 2/4-lane	13,000

f. Traffic demand of Corredor Sur Extension was calculated as from 6,000 pcu to 34,000 pcu.

Final result for the traffic demand volume is given in FIGURE III-2-5.

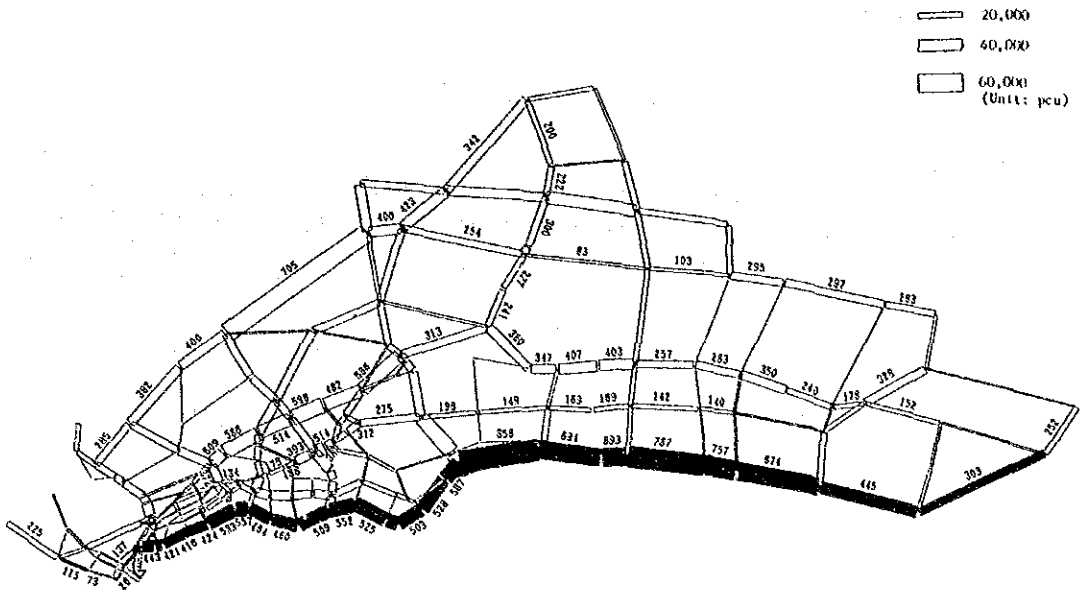


FIGURE III-2-5 TRAFFIC DEMAND IN THE YEAR 2000

3. ROAD FUNCTION

The ESTAMPA Masterplan positions Corredor Sur as follows:

"Corredor Sur, which can be predicted to bear a traffic demand greater than that in Corredor Norte in the future, is one of the vital principal arterial roads being a bypass at the south side of the Panama Urban Area, and functions to allow mass traffic of medium and long distances to be detoured and smoothed out without passing through the center of the city."

The road functions and maximum operating speed are examined by means of the traffic assignment.

3-1 ROAD FUNCTION

The traffic demand assignment (distance minimum method) for the "without-project" case (Corredor Sur is not constructed) is calculated to recognize the present situation (see FIGURE III-3-1-A). As a result of it, it can be seen that traffic going in the east-west direction will be concentrated in principal arterial roads (Ave. Transistmica, Via Espana, Via Domingo Diaz). The west part of Via Espana has a particularly large traffic demand.

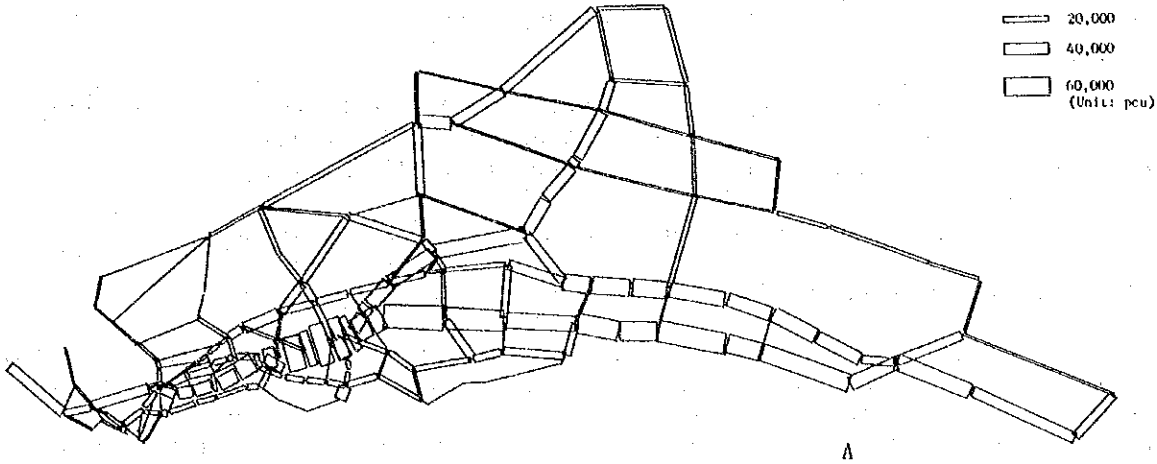
Next, the calculation of the traffic demand assignment for the "with-project" case (Corredor Sur is constructed) is done as shown in FIGURE III-3-1-B. According to the results shown in the figure, the demand pattern is different from FIGURE III-3-1-A. The traffic will change from Via Espana to Corredor Sur. Furthermore, 40% of the Corredor Sur's trips have lengths from 15 km to 20 km. Therefore, Corredor Sur will be used mostly for medium and long distance trips. In Ave. Balboa, however, the traffic will not change so much. The trip length in Ave. Balboa has a length of less than 12.5 km. Therefore, Ave. Balboa will be used mostly for short length trips.

(1) Corredor Sur and Corredor Sur Extension

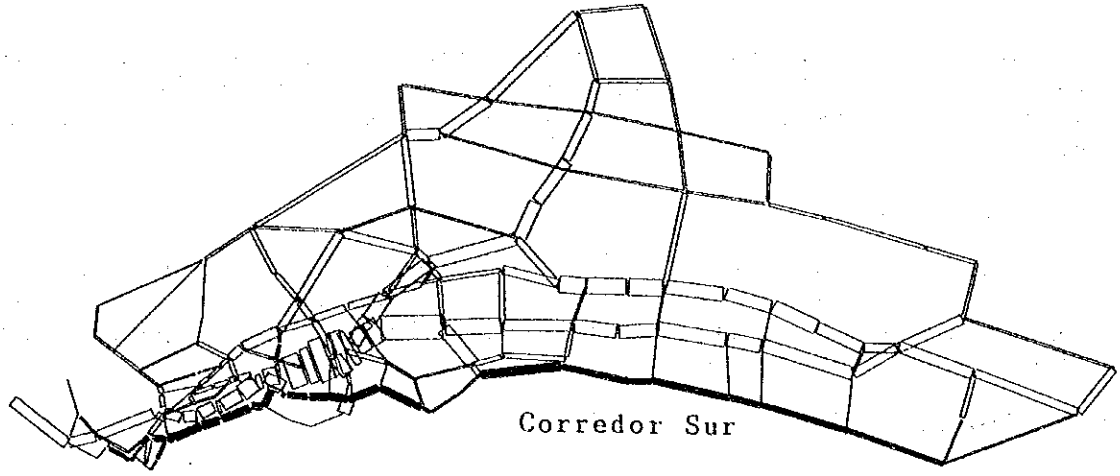
Calculation of the traffic demand assignment using a time minimum method (the calculations are performed considering operating speed but not considering the road capacity) is done. These calculations are based on a temporary operating speed of 80 km/h for the suburban area section (Panama Viejo - Tocumen) and 50 km/h for the built-up area sections. The results of these calculations are shown in FIGURE III-3-1-C.

These results show that most of the traffic which goes through Via Espana will clearly change to Corredor Sur. But the traffic that uses Ave. Domingo Diaz will remain little changed. Therefore, Corredor Sur will serve mainly the coastal area of Panamá City, will also have a large traffic demand from the northern part of Panama City . Nevertheless, in the business area, Calle 50 will have a larger traffic demand than Ave. Balboa.

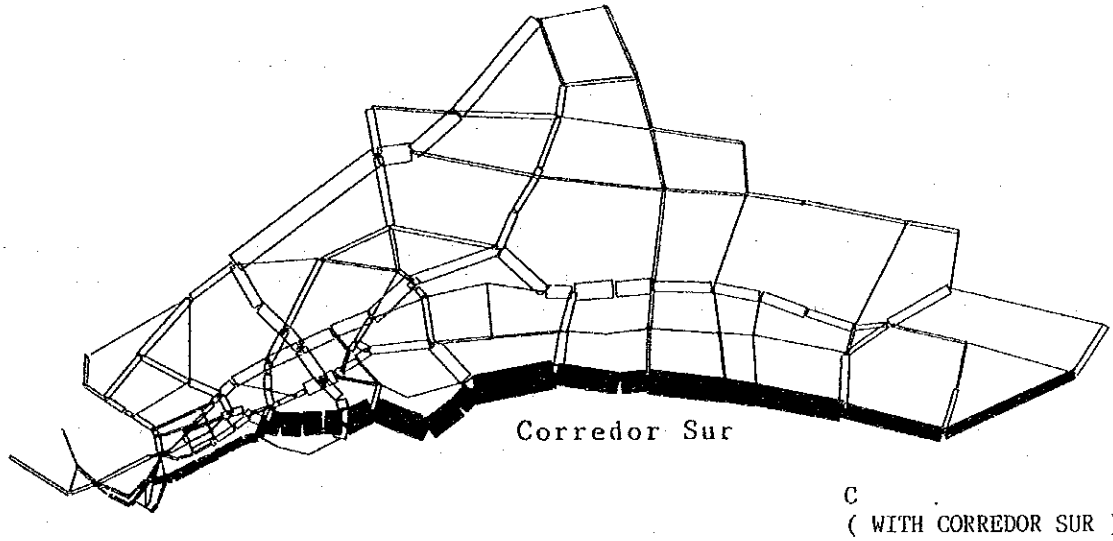
Concerning trip length distribution, in the new construction section, 20% of trips are long distance, having more than 20 km.



A
(WITHOUT CORREDOR SUR)



B
(WITH CORREDOR SUR)



C
(WITH CORREDOR SUR)

FIGURE III-3-1 TRAFFIC DEMAND WITH/WITHOUT CORREDOR SUR

Furthermore, trip length in the existing road sections increases up to 25 km.

From the OD details for the Corredor Sur Extension, it is noticed that most of the traffic comes from Panama City (from the eastern part of the central area), not from the west bank of the Panama Canal.

From an examination of the above, it can be concluded;

1) Suburban area section

This section has the function of serving as a Via Espana bypass. Also, this section has to have a high service level being a highway handling long distance trips. Therefore, a high design speed is recommended for this section as a function of a principal arterial road.

2) Built-up area section

This section has the function of serving the built-up area. General characteristics of trip lengths in this section show a mixture of short and long trips. This section therefore should function as a principal arterial road.

3) Corredor Sur Extension

This section mainly serves only the traffic of the Centro area and should function as a minor arterial road. A high service level and high design speed are not required of this road. However, more road space for local use should be provided in the area.

(2) Main Access Roads

The Main Access Roads consist of six roads that form the north-south arterials of the road network in the Panama Metropolitan Area. Summarizing their road functions based on the contents of the ESTAMPA Masterplan and other studies conducted till now results in the following:

1) Via E. T. Lefevre

This is an arterial road, connected to Ave. 11 de Octubre, which disperses the traffic coming in from east and west being a north-south axis outside Via Brasil within the built-up area.

2) Via San Miguelito Chanis

This is an arterial road passing through the center of the newly developed housing area for the north side of San Miguelito. The road forms the axis of San Miguelito development.

3) Via San Miguelito Hipodromo

This minor arterial road connects the east fringe of San Miguelito at the northern part to Juan Diaz at the southern part.

4) Via Juan Diaz

This is a minor arterial road which will function as an access road

to the Corredor Norte Extension in the future.

5) Via Ciudad Radial

This is an arterial road which has rather heavy traffic going in the north-south direction.

6) Via Don Bosco

This is a minor arterial road which allows traffic generated in this area to flow into a principal arterial road such as Corredor Sur.

3-2 OPERATING SPEED

It is necessary to examine the maximum operating speed applied on each road in order to clarify the function of each road. The results of these examinations will be used for the traffic assignment model and for the establishment of the geometric operating speed of each road.

(1) Corredor Sur

1) Suburban area section

FIGURE III-3-2 shows the variation of traffic demand caused by different maximum operating speeds. The influence of maximum operating speed is small, except in Via Domingo Diaz. Therefore, maximum operating speed can be established without the consideration of speed in other sections.

According to the TABLE III-3-1, at more than 80 km/h, the increase in traffic demand is small, but for less than 80 km/h, there is a big increase in traffic demand following an increase of maximum operating speed. However, average trip length does not vary with changes in maximum operating speed, which shows that even if maximum operating speed is changed, traffic will continue to use the same route. Therefore, for this section, a maximum operating speed of 80 km/h is recommended because it is the most effective speed.

TABLE III-3-1 TRAFFIC DEMAND AND AVERAGE TRIP LENGTH IN CORREDOR SUR FOR VARIOUS DESIGN SPEEDS

(Suburban Area)

	S 05	S 17	Average Trip Length (Km)
110 Km /h	103.989	121.908	9.7
80 "	88.806	111.473	9.5
60 "	37.519	92.170	9.3
40 "	25.795	71.592	9.3

(Built-up Area)

	Traffic Demand A S 17	Average Trip Length (Km)
110 Km / h	108.653	9.3
80 "	92.170	9.3
60 "	56.922	9.2
40 "	14.266	9.3

Source: ESTAMPA

2) Built-up area section

FIGURE III-3-3 shows changes in traffic demand for different maximum operating speeds in the built-up area sections. TABLE III-3-2 shows various maximum operating speeds, traffic demand and average trip length.

As TABLE III-3-1 shows, if the maximum operating speed is higher

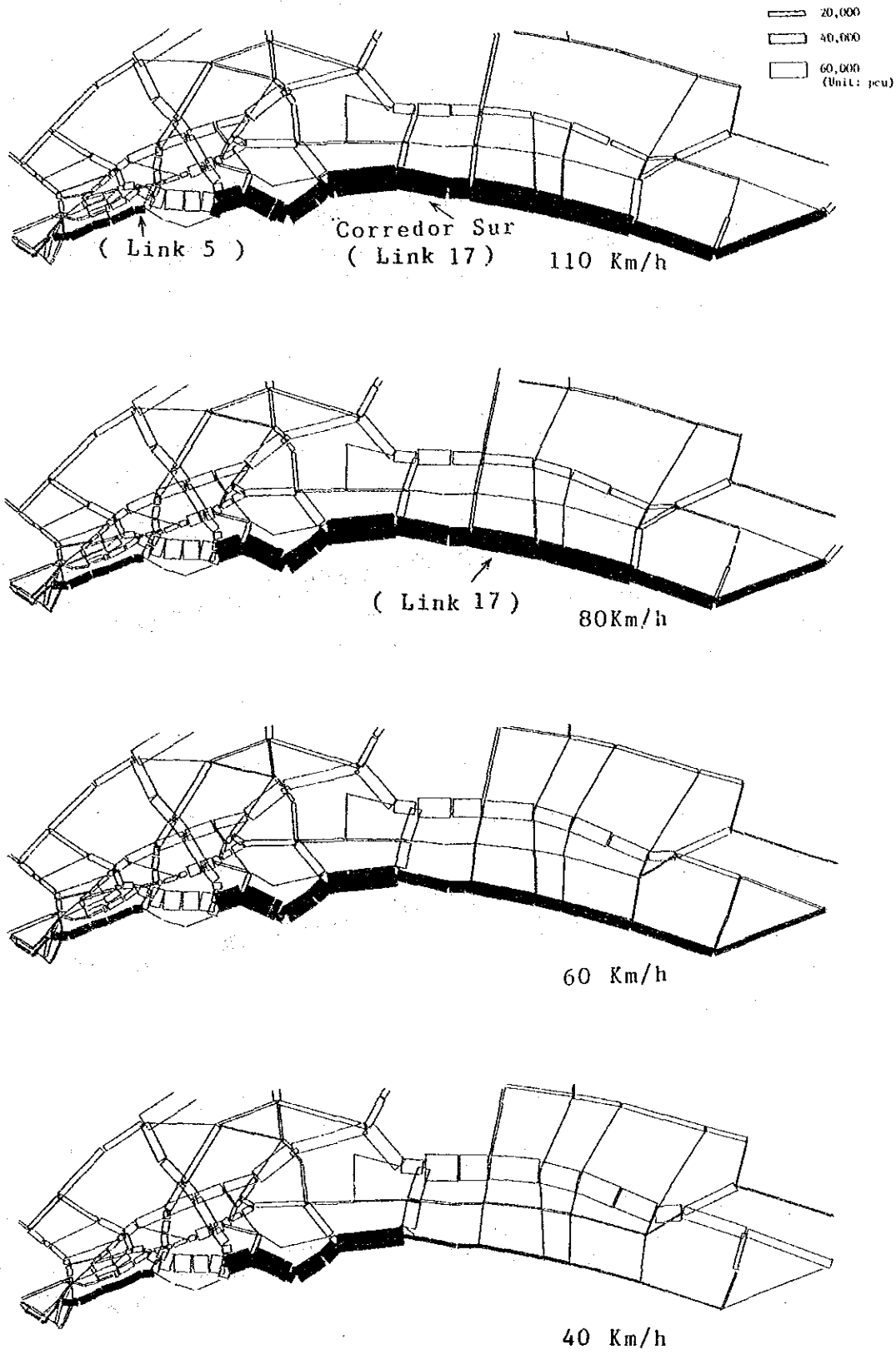


FIGURE III-3-2 TRAFFIC DEMAND CHANGES BY DIFFERENT DESIGN SPEEDS IN SUBURBAN AREA

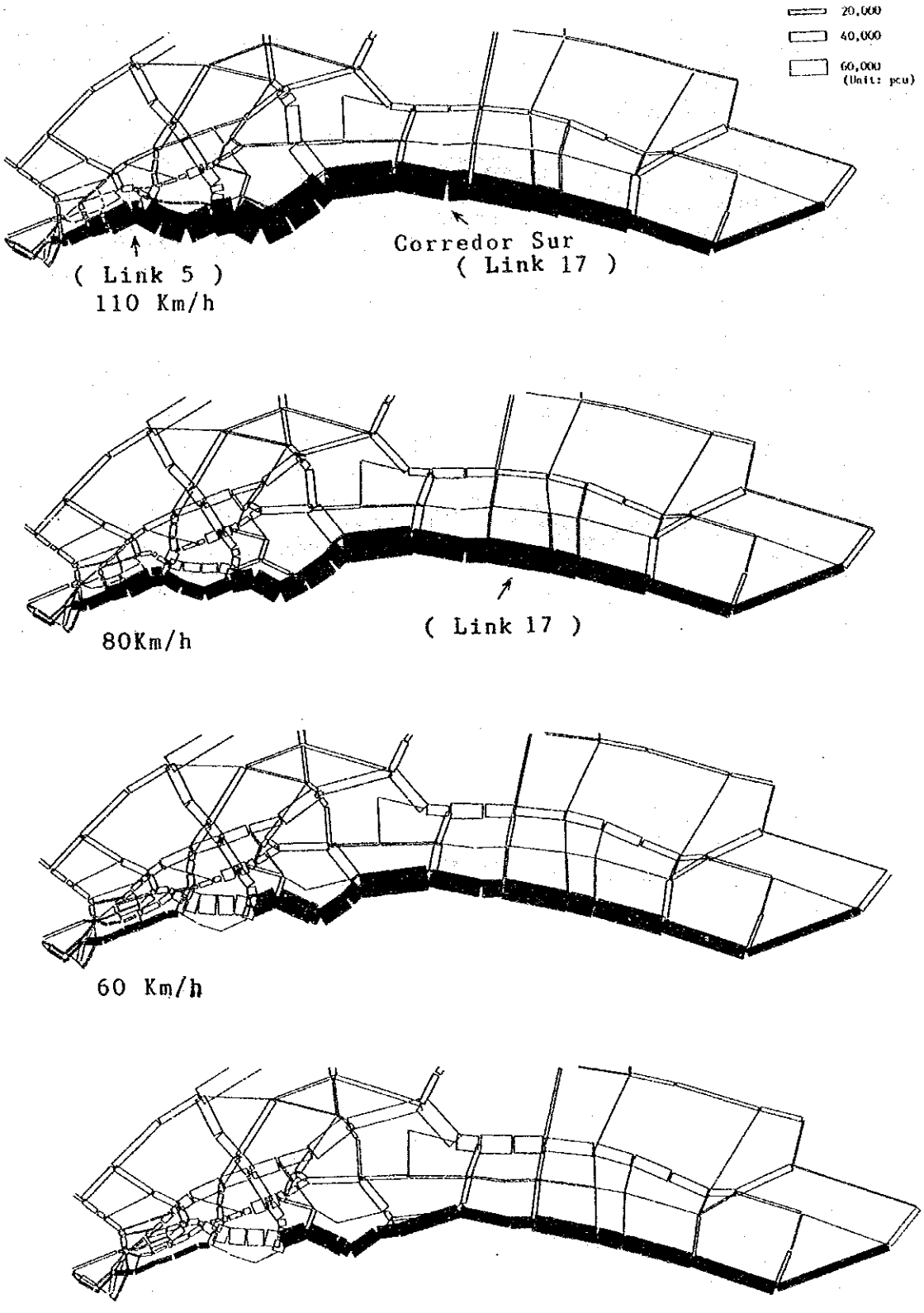


FIGURE III-3-3 TRAFFIC DEMAND CHANGES BY DIFFERENT DESIGN SPEEDS IN BUILT-UP AREA

than 80 km/h, the average trip length increases. This means that if a maximum operating speed of more than 80 km/h is selected, a considerable portion of traffic demand will take a round about way, and therefore, access roads of the north-south direction to these sections will have heavy loads of traffic. In addition, even if a maximum operating speed is increased to more than 80 km/h, traffic demands in the new construction sections are not influenced. In other words, if a maximum operating speed of 40 km/h is selected, traffic will deviate to Calle 50. Therefore, the desirable maximum operating speed is higher than 40 km/h, but less than 60 km/h. Based on the preceding explanation, a maximum operating speed will be recommended: 50 km/h for existing road sections, and 60 km/h for the new construction section near Panama Viejo.

(2) Corredor Sur Extension

Based on the road function, a maximum operating speed of 40 km/h is sufficient for this section. However, traffic demand is calculated using a maximum operating speed of 60 km/h in Ave. B and Ave. de Los Martires. (The calculations of traffic demand were completed using the traffic assignment considering speed and road capacity, because the central area is very complex and the length of each link is very small.)

The results of these calculations are shown in TABLE III-3-2. From the results, it can be seen that, even if maximum operating speed changes from 40 km/h to 60 km/h, there is not a big change in traffic. Therefore, a maximum operating speed of 40 km/h will be used for the Corredor Sur Extension.

TABLE III-3-2 TRAFFIC DEMAND FOR VARIOUS DESIGN SPEEDS IN CORREDOR SUR EXTENSION

		40 Km / h	60 Km / h
Traffic Demand	American Bridge	15.434	15.969
	S 01	36.886	39.341
	S 05	48.651	49.782
	S 08	45.638	45.342
	S 11	42.020	42.433
Average Trip Length (Km)		9.5	9.5

Source: ESTAMPA

3-3 ROAD STANDARD BY SECTION

(1) Division of Section

Since road function and traffic demand are changed by the positioning on the road network, it is necessary to examine the maximum operating speed and number of lanes for each section. Considering the situation of existing roads, the right of way, the division of projects on the ESTAMPA Masterplan, etc., Corredor Sur is divided into eight sections. (See TABLE III-3-3, FIGURE III-3-4)

TABLE III-3-3 DIVIDED SECTIONS FOR ROAD PLANNING IN THE STUDY

1. Main Point:	Ave. B	F. Boyd	Brasil	E.T.Lefevre	Cincuentenario		Panamericana	
2. Important Facility:		●Monumento de Balboa ●Monumento a la Madre		●Airport	●Panama Viejo			
3. Existing Lanes:		4			2			
4. Existing Median:		⊢———						
5. Right of Way: / Construction Line:	31.2 (41)	35 (30)	30 (30)		20 (30)	30		
6. Land Use:		Commercial High Level Residential		Educational Residential	Residential	Residential		
7. Master Plan Section (Lane):		I(6)		II(6)	III(6)	IV(6)	V(4)	VI(2)
8. Examination of Grade Separation in Feasibility Study:	○	○	○	○	○	○ ○ ○ ○ ○ Main Access Road		
9. Content of Road Project:		Improvement of Existing Road				New Road Construction		
10. Section of Feasibility Study:		I	II	III IV	V	VI	VII	VIII

Source: ESTAMPA

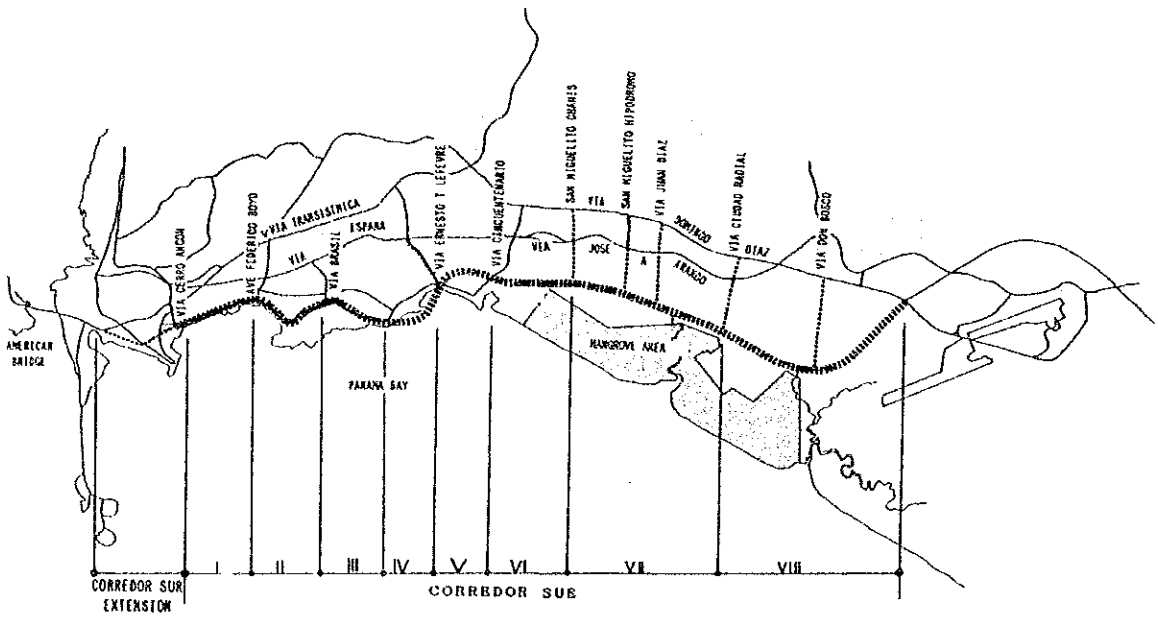


FIGURE III-3-4 DIVIDED SECTIONS OF CORREDOR SUR

The length of the Main Access Roads and Corredor Sur Extension is not too long, so that each road can become one section.

(2) Maximum Operating Speed and Number of Lanes by Section

1) Corredor Sur

The principal arterial road function of Corredor Sur is to service a large amount of high speed traffic. However, the quantity and quality of the traffic varies in the new construction sections in the suburban area and in the widening sections in the built up area. Therefore the following three types of the road standard are established and applied in each section:

* type A : Highway type of 80km/h
* type B : Semi-highway type of 60km/h
* type C : Street-type of 40-50km/h

Considering the future traffic demand, the number of lanes recommended between Maranon and Via Ciudad Radial is six lanes, and between Via Ciudad Radial and Pan American Highway the number of lanes recommended is four.

2) Main Access Roads

Since the Main Access Roads pass through the area which is built-up, they shall be characteristic of urban roads. Although all of the Main Access Roads are arterial streets going in a north-to-south direction, each road function is a little different from the others.

a. Via Ernesto T. Lefevre

Since this road is an important arterial street of north-south direction across the area with the most traffic in the Panama Urban Area, the maximum operating speed is established as 50km/h. The speed is higher than in the other access roads. Because of the large traffic demand, a six lane road was considered, but finally a four lane road was recommended because of the difficulty of the acquisition of land for road widening.

b. Via San Miguelito Chanis, Via Ciudad Radial

These two roads have a rather large amount of traffic going in the north-south direction, so that the number of lanes recommended is four. The maximum operating speed is 40km/h, as for a street.

c. Via San Miguelito Hipodromo, Via Juan Diaz, Via Don Bosco

These roads pass through the residential area and will not have a large amount of traffic. Therefore, they can be considered as two-lane streets for the short term, but four-lane streets are recommended as a long term plan. A maximum operating speed of 40km/h is enough for these roads (See TABLE III-3-4).

TABLE III-3-4 ROAD STANDARD TYPE ALTERNATIVES FOR EACH SECTION

Section	Corredor Sur			Main Access Road		Corredor Sur Extension
	I II III IV	V VI	VII VIII	Via E. T. Lefevre	Other Roads	
Type	C C C C	B B	A A	C	C	C
Maximum Operating Speed Km/h	50	60	80	50	40	40
Number of Lanes	6		4	4	4	4

A: Highway Type
B: Sub-Highway Type
C: Street Type
Source: ESTAMPA

4. ROUTE ALTERNATIVE SELECTION

4-1 CORREDOR SUR

4-1-1 Route Alternative Selection For Sections III and IV

This section was examined at two points on these route alternatives (See FIGURE III-4-1).

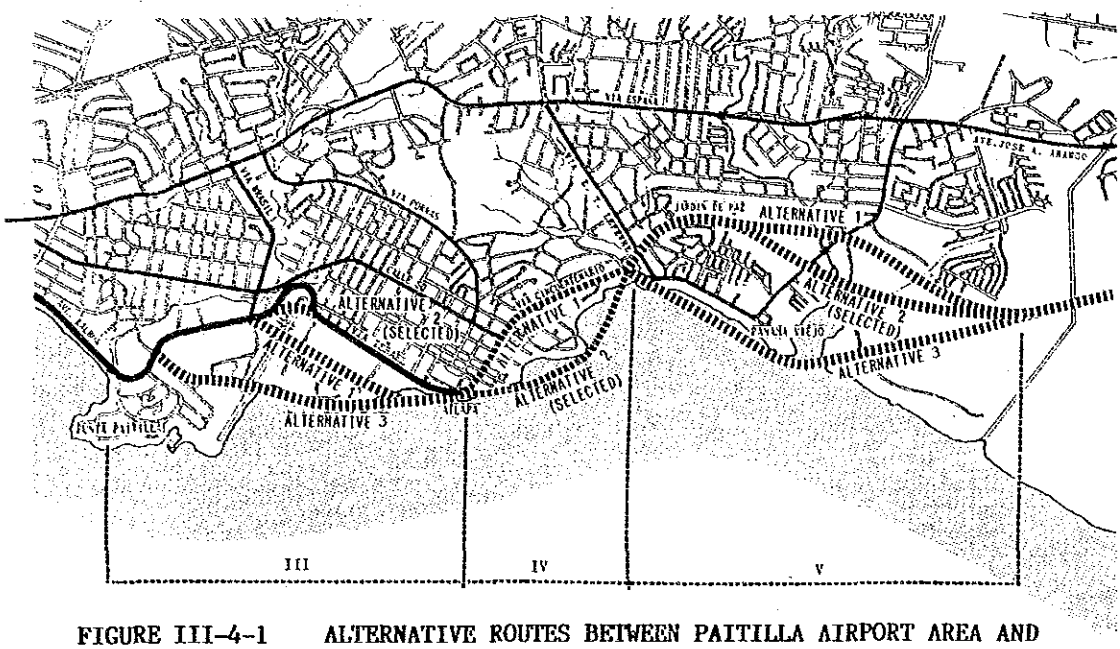


FIGURE III-4-1 ALTERNATIVE ROUTES BETWEEN PAITILLA AIRPORT AREA AND PANAMA VIEJO AREA

1) Around Paitilla Airport

It is proposed that all of the route alternatives cross the airport area under the premise that there are possibilities of removal or extension of the existing airport. (See FIGURE III-4-1). According to Aero Nautica Civil, a marine airport project will be studied to examine the possibility of the removal of the existing airport. The route alternative 1 will pass between two schools and follow Ave. 7B Sur, crossing the center of the airport. The route alternative 2 will chiefly follow Via Israel crossing north part of the airport. The route alternative 3 will follow Calle 56 Este and Ave 8B Sur and pass the seashore in front of Boca la Caja, crossing the south part of the airport. Alternative 2 was selected because this route can use many more existing roads than the other routes and will need the arrangement of only a small section crossing the airport.

Concerning structure alternatives for crossing the airport, a tunnel type structure alternative was examined, however, a tunnel crossing under the airport runway would be much more expensive compared to other structure types. Therefore an at-grade type was adopted for route alternative 2.

2) Between ATLAPA and Via E.T. Lefevre

There are two route alternatives for the captioned section, as shown in FIGURE III-4-1. One is the existing road (Via Cincuentenario) and the other is a road running along the seashore. The latter alternative was proposed because some questions remained on whether the road structure can be secured to allow large-volume traffic to be driven on Via Cincuentenario. TABLE III-4-1 is a comparison of the various factors relating to these two alternatives. As a result, it is judged that Alternative 2 is superior comprehensively, although the construction cost can be assumed to be slightly higher.

TABLE III-4-1 COMPARISON OF ROUTE ALTERNATIVES BETWEEN ATLAPA AND VIA E. T. LEFEVRE

	Alternative 1	Alternative 2
Route Characteristics	Widening of existing road.	New coastal road Requires land fill.
Route Length	1.7 Km.	1.7 Km.
Future Traffic Demand	69,000 (pcu)	59,000 (pcu)
Land Use	Residential and Commercial.	Residential. One side is seaside.
Environmental Impact	High (will affect houses along the route).	Low (constructed on new land).
Effect on Existing Houses	Big	Small
Horizontal Alignment	Bad	Good
Landscape of Road	No Change	Improved
Accessibility	Good	One side is sea.
Easiness of Construction for Interchange	Difficult	Easy
Project Cost		
1. Construction Cost	Low	High
2. Land Acquisition	Difficult	—
3. Compensation Cost	High	Low
4. Other Compensation	Transmission Line	Dock

Source: ESTAMPA

4-1-2 Route Alternative Selection for Sections V and VI

For these two sections, the study was made on two alternatives of inland routes and one alternative of a seaside route, as shown in FIGURE III-4-1, on the precondition that the route of Corredor Sur nearest to the ruins of the preservation area of Panama Viejo situated at mid-course, shall not be selected. A comparison of the various factors relating to these three alternatives is given in TABLE III-4-2. In the comparison between the inland and seaside route alternatives, the latter has more disadvantages, so the study was focused on the inland routes. Although it was very difficult to determine which of the two inland route alternatives is better, Alternative 2 was eventually selected because of its superiority in many social and environmental aspects despite the higher construction costs involved.

TABLE III-4-2 ROUTE ALTERNATIVES AT PANAMA VIEJO AREA

	Inland		Marine
	1	2	1
. Route Characteristics	Passes between Pma.Viejo residential area and cemetery, and continues north of Puente del Rey	Passes between Pma. Viejo residential area and cemetery, and continues south of Puente del Rey	Passes in front of Pma. Viejo coast and reaches land past old crematory
. Road Network	Traffic management is difficult because of six - branch intersection	Improvement of Via Cincuentenario is difficult because it would affect nearby ruins	Intersection at E.T. Lefevre is difficult to improve because of nearby ruins
. Future Traffic Demand	86,000	86,000	73,000
. Environmental Impact	Affects residential considerably	less than Alternative 1	Will Affect the view from Panama Viejo which is an important part of IPAT's project
. Land Use	Residential and Cemetery	Residential and Cemetery	------
. Accessibility	Good	Good	Bad
. Easiness of construction for Interchange	Difficult	Easy	------
. Total Construction Length	3.5 Km	3.6 Km	4.2 Km
. Project cost 1. Construction cost 2. Compensation	Low less than Alternative 2	Low High	high ------

Source:ESTAMPA

4-1-3 Route Selection for Sections VII and VIII

The route for these sections is connected to the Pan American Highway via the area around the mangrove area, from the connection between Corredor Sur and Via San Miguelito Chanis, an access road, and it runs in near parallel with Via Domingo Diaz and Ave. Jose A. Arango and the mangrove preservation area. The following items were, therefore, taken into account for this selection:

a. Trend of urbanization at the south side of Ave. Jose A. Arango
b. Mangrove preservation area
c. Rivers, topography and ground height (because of the flooding in this area at high tide)
d. MIVI's housing development plan around the mangrove area

4-2 MAIN ACCESS ROADS

The Main Access Roads consist of the six roads of Via E.T. Lefevre, Via San Miguelito-Chanis, Via San Miguelito Hipodromo, Via Juan Diaz, Via Ciudad Radial and Via Don Bosco, each being either an improvement of an existing road or a new construction. All routes except Via E.T. Lefevre must be selected by taking into account the road functions and the road and topographic conditions around the subject roads. TABLE III-4-3 gives the study results.

TABLE III-4-3 ROUTES OF MAIN ACCESS ROADS

Main Access Road	Improvement	New Construction	Bridge	Comment
E.T. Lefevre	○	-	-	Existing E.T. Lefevre is improved.
San Miguelito - Chanis	○	○	2	This Route connects San Miguelito Central area with Corredor Sur.
San Miguelito - Hipodromo	○	○	-	This route connects San Miguelito Este with Corredor Sur.
Juan Diaz Sur	○	○	1	This route connects Corredor Sur with Corredor Norte Extension and Domingo Diaz by way of Cerro Viento.
Ciudad Radial	○	○	1	This route connects Corredor Sur with Corredor Norte Extension and Domingo Diaz by way of Villa Flor.
Don Bosco	-	○	-	This route is entirely new road construction.

Source: ESTAMPA

The results of route selection for Main Access Roads (suburban area) are shown in FIGURE III-4-2.

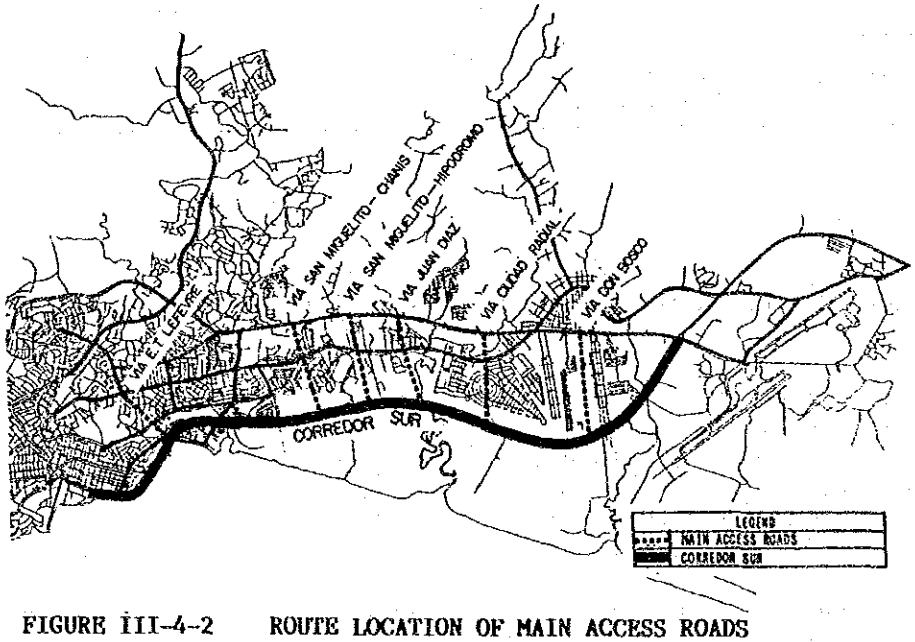


FIGURE III-4-2 ROUTE LOCATION OF MAIN ACCESS ROADS

4-3 CORREDOR SUR EXTENSION

4-3-1 Comparison of Route Alternatives

Alternative routes discused in this article are shown on FIGURE III-4-3.

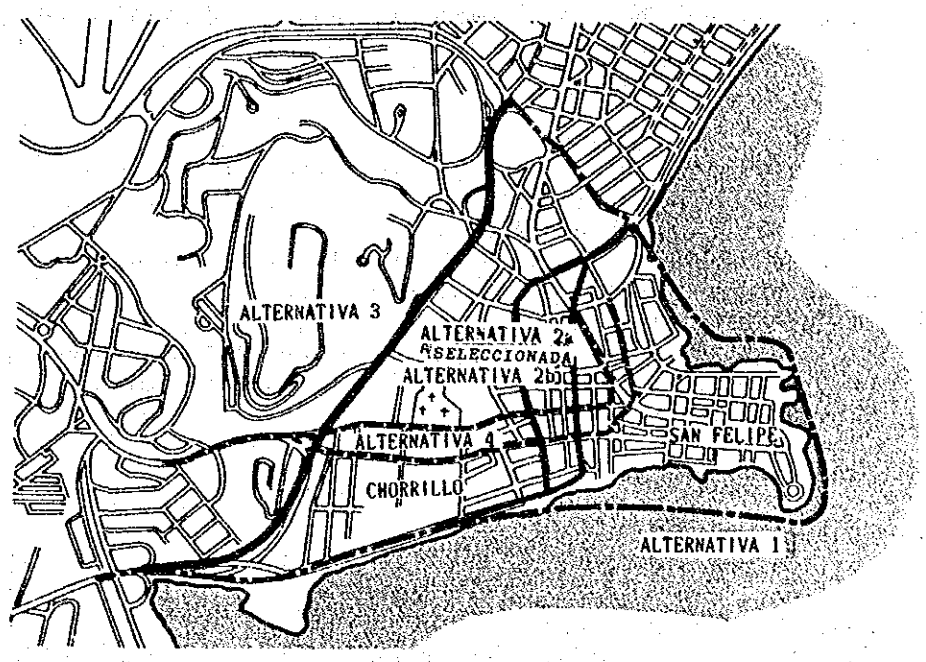


FIGURE III-4-3 ALTERNATIVE ROUTES FOR CORREDOR SUR EXTENSION

(1) Alternative 1

a. Route Alignment:
Coastal road bordering the San Felipe area.
b. Route characteristics:
New road construction, Coastal road. Bypass the Santa Ana area. Requires land reclamation.
c. Land Use and Related Projects:
Many public facilities along the coast. Historic preservation area. IPAT's Casco Viejo project.
d. Future Traffic Volume:
0 -- 16,000 P.C.U.
e. Effect on Environment and Site View:
Will require careful consideration to harmonize with marine view and IPAT's Casco Viejo project.
f. Impact Along the Route Area:
Land reclamation will make new land available.
g. Implementation:
Will require a change in the feeling of the population concerning the San Felipe area and its marine view.

(2) **Alternative 2a**

a. Route Alignment:
Ave. Balboa - Calle 14 - Ave. de los Poetas - Puente de las Americas.
b. Route Characteristics:
Use of existing road. Penetrates in the Santa Ana and Chorrillo commercial and residential areas.
c. Land Use and Related Projects:
Santa Ana and Chorrillo commercial and residential area. MIVI's urban renewal projects.
d. Future Traffic Volume:
6,000 -- 34,000 P.C.U.
f. Effect on Environment:
Will provide a vacant space for disaster prevention. Will help the urban renewal process.
g. Impact Along the Route Area:
Will presumably improve the level of commercial activity in the Santa Ana and Chorrillo commercial areas.
h. Implementation:
Will require the rearrangement of urban renewal projects, the removal of some commercial establishments and demolition of many superannuated buildings

(3) **Alternative 2b**

a. Route Alignment:
Ave. Balboa - Calle 17 - Ave.- de Los Poetas - Puente de las Americas.
b. Route Characteristics:
Use of existing roads. Penetrates in the Santa Ana and Chorrillo commercial and residential areas.
c. Land use and Related Projects:
Santa Ana and Chorrillo commercial and residential area. MIVI's urban renewal projects.
d. Future Traffic Volume:
9,000 § 21,000 P.C.U.
e. Effect on Environment:
Will provide a vacant space for disaster prevention. Will help the urban renewal process.
f. Impact Along the Route Area:
Will presumably improve the level of commercial activity in the Santa Ana and Chorrillo commercial areas.
G. Implementation:
Will require the rearrangement of urban renewal projects and the removal of some commercial establishments. Will be difficult to widen the existing road.

(4) **Alternative 3**

a. Route Alignment:
Ave. Balboa - Via Cerro Ancon - Ave. de Los Martires - Puente de las Americas.
b. Route Characteristics:
Use of existing roads. Bypass the Santa Ana area.
c. Land Use and Related Projects:
Commercial areas and public facilities. Reverted areas.

d. Future Traffic Volume:
   26,000 -- 36,000 P.C.U.
e. Effect on Environment:
   Bypass the Santa Ana area. Will not reduce congestion problem in the Santa Ana area.
f. Impact Along the Route Area:
   Will not be distinctive.
g. Implementation:
   Uses existing roads.

(5) Alternative 4

a. Route Alignment:
   One Way : Ave. Balboa - Ave. - Central - Calle B - Puente de las Americas
   One Way : Puente de las Americas - Calle A - Ave. B - Ave. Balboa
b. Route Characteristics:
   Use of existing roads. Penetrates in the Santa Ana and Chorrillo. Commercial and residential areas.
c. Land Use and Related Projects:
   Santa Ana and Chorrillo commercial and residential areas, and Cemetery.
d. Future Traffic Volume:
   5,000 -- 29,000 P.C.U.
e. Effect on Environment:
   Will not be distinctive.
f. Impact Along the Route Area:
   Will not be distinctive.
g. Implementation:
   Uses existing roads. Will require traffic control.

4-3-2 Alternative Selection

The comparison of route alternatives in paragraph 4-3-1 above discusses the problems, themes and features of each route to be grasped. Summarizing each route based on this comparison results in the following.

(1) Alternative 1

The road function of Corredor Sur Extension is not met because the volume of traffic demand is small. In addition, IPAT has designated San Felipe, which is directly related with this route, as an historical preservation area and is not likely to adopt a policy of allowing a large volume of traffic to enter this area.

(2) Alternative 2a

The complete provision of minor arterial roads in the three areas of Santa Ana, San Felipe and Chorrillo strengthens the road network and helps solve the traffic problems. This can be understood for the reason that this route has a larger traffic demand volume than the other alternative routes. Since the aged and low-rise buildings line this route, road expansion is relatively easy. Stimulation of the community environment and commercial activities can be expected as a result of the completion of this route.

(3) Alternative 2b

This route can also be expected to result in nearly the same effect as Alternative 2a above. In addition, this route can be assumed to be more suitable for forming the road network. Since this route passes through the medium-rise public buildings and existing redeveloped areas, road expansion is thereby more difficult.

(4) Alternative 3

This route is a vital trunk road in the road network of the Panama Metropolitan Area. Naturaly, the road functions of the Corredor Sur Extension cannot be met fully by this route, so that it may not be of help to solve the traffic problems in the foregoing three areas.

(5) Alternative 4

This route involves some repairs and improvement of traffic operation in the existing road as proposed by the ESTAMPA Masterplan and is the easiest and cheapest to implement amongst all the alternatives. The traffic demand is near those of Alternatives 2a and 2b above, but since this route will be based on the existing network, it will be of little assistance to solve the traffic problems in the foregoing three areas.

Based on the foregoing comparison of the features of each alternative, Alternative 2a was selected in view of the function, constructability and contribution to the three areas (complete provision of road network and community environment) of the Corredor Sur Extension.

5. ACCESS CONTROL SYSTEMS

5-1 METHODS OF ACCESS CONTROL SYSTEMS

The concept of " Access Control " in general is defined as follows:

" The situation such as that the access traffic flow generated from or attracted to adjacent lands, buildings and access roads is limited completely or partially ."

It is called " Full control " as its access is totally limited except the interchange with main crossing road like the concept of expressways. On the other hand, when at-grade intersections or at-grade access roads are provided at several points, it is called " Partial Control ". From this concept, the necessity of access control is less for roads of a lower level compared with expressways.

The purpose of the examination in this chapter is to establish the desirable access control method along Corredor Sur, Main Access Roads and Corredor Sur Extension for the sake of improving each road function and maintaining smooth traffic flow.

(1) Access Control Systems in the Study

Concerning the access control system in the Study, the following range of methods were examined:

1) Point Control Systems

   a. At-grade type:
      Access control at each access point by traffic regulations. (Direction Controls), Additional lanes, Signal Control.
   b. Grade separation type:
      Grade separation between Main traffic flow and access traffic at each crossing.

2) Line Control systems

   a. At-grade type:
      Limitation of access points by frontage road.
   b. Grade separation type:
      Separation of Main traffic flow from plural access traffic flows by sequence of elevated road.

(2) Provision of Frontage Road

The study on the grade separation type of point and line controls can be concluded through the traffic analyses taking into consideration the planned traffic condition, and topographic conditions, etc. For the issue of providing frontage roads, the features of Corredor Sur, the Main Access Roads and Corredor Sur Extension must be taken into account to prepare the standards.

The provision standard of a frontage road is shown in TABLE III-5-1

in consideration of the characteristics of each planned road. The role of a frontage road is mainly for the maintenance of smooth traffic flow on the main road, the provision of service traffic facilities with safety and convenience at the road side, and its use as an emergency road. Direct entrances and exits from and to frontage roads should be provided in the main road.

TABLE III-5-1 LOCATION STANDARD FOR FRONTAGE ROAD

Area	Road Improvement New Road Construction	Road Function	Land Use Along the Road	Number of Lanes 6	4	2	Operation of Frontage Road
Built-up Area	Improvement	Principal Arterial Road	Residential		X	-	One Way
			Business & Commercial		X	-	One Way
			Others	X	X	-	-
	New Road	Arterial Road	Residential	-	X	-	-
			Business & Commercial	-	X	-	-
	New Road	Principal Arterial Road	Residential	O		-	One Way
			Business & Commercial	O		-	One Way
			Others	X	X	-	-
Suburban Area	Improvement or New Road	Arterial Road	Residential	-		X	One Way
			Business & Commercial	-		X	One Way
			Others	-	X	X	-
		Minor Arterial Road	Residential	-		X	-
			Commercial	-		X	-

Note: O : Necessary
X : Not Necessary
no mark: Depends on condition

The frontage road should have a one-way system, in the same direction as the main road along the frontage road, by means of a particular traffic control. Should two-way frontage roads be provided, the function of the frontage road will decrease owing to the obstruction caused by the ingoing and outgoing traffic conflicting with traffic travelling in the reverse direction on the main road. Therefore, the two-way system for frontage roads should be avoided.

5-2 ACCESS CONTROL SYSTEMS

The proposal for the access control systems of Corredor Sur, Main Access Roads and Corredor Sur Extension is presented by the patterns of access control systems in FIGURE III-5-1. Table III-5-2 gives a proposal for the access control system and patterns required for each road.

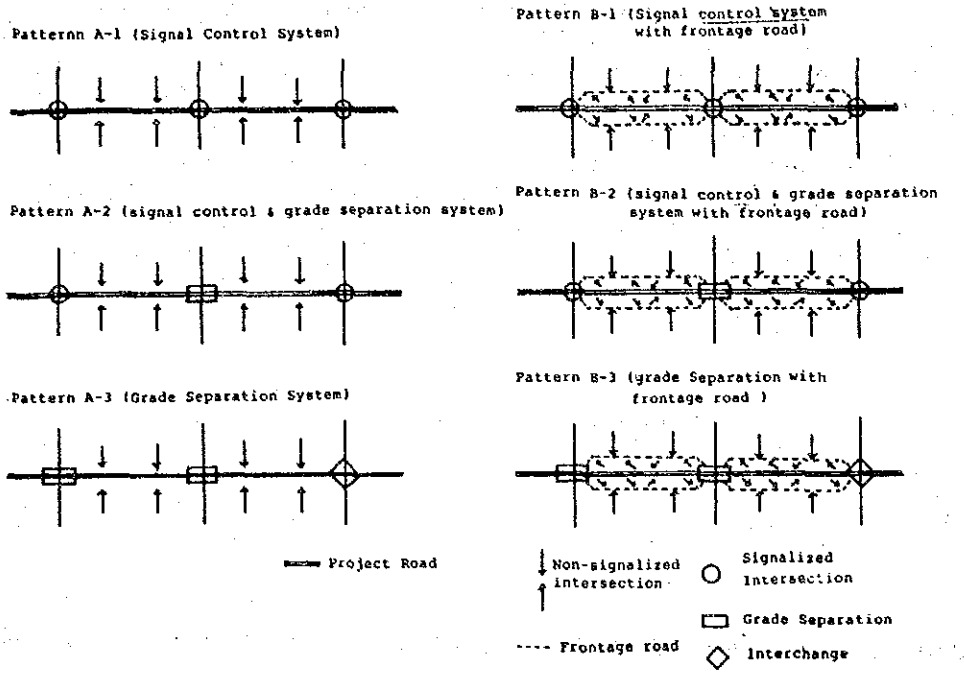


FIGURE III-5-1 ALTERNATIVE PATTERNS OF ACCESS CONTROL SYSTEMS

TABLE III-5-2 PATTERNS OF ACCESS CONTROL SYSTEM

	Road	Frontage Road	Pattern
Corredor Sur	I	O	B ~ 2
	II	X	A ~ 2
	III-IV	X	A ~ 2
	V	X	A ~ 3
	VI	X	A ~ 3
	VII	O	B ~ 2
	VIII	O	B ~ 2
Main Access Road	E.T. Lefevre	X	A ~ 2
	San Miguelito - Chanis	X	A ~ 1
	San Miguelito - Hipodromo	X	A ~ 1
	Juan Diaz Sur	X	A ~ 1
	Ciudad Radial	X	A ~ 1
	Don Bosco	X	A ~ 1
CORREDOR SUR EXTENSION		X	A ~ 1

O : Necessary
X : Not Necessary
Source: ESTANPA

The need for grade separation at major intersections is based on the results analyzed in the intersection planning, as discussed in the next Chapter.

5-2-1 Corredor Sur

(1) Section I

1) Roadside Land Use and Road Traffic Conditions

The roadside land in this section is now used as built up business and commercial area where there are banks, government offices, hospitals, restaurants, etc. As shown in FIGURE III-5-2, there are 21 feeder roads usually provided at intervals of about 100 meters. Three of these feeder roads are two-way roads and the rest are one-way roads. Of the former, the intersection with Ave. Ecuador is the only intersection controlled by signals. These feeder roads run north and south in the Calidonia area and have the role of interconnecting such main roads as Ave. Balboa, Ave. Peru and Ave. Central. The traffic volume (7 to 8 a.m.) can be classified into four groups: 100 to 200 vehicles, 200 to 300, 300 to 400 and 400 or more. The roads having a traffic volume of more than 300 vehicles are Calle 26 (E), Calle 31 (E), Ave. Ecuador, Calle 37 (E) and Calle 42 (E).

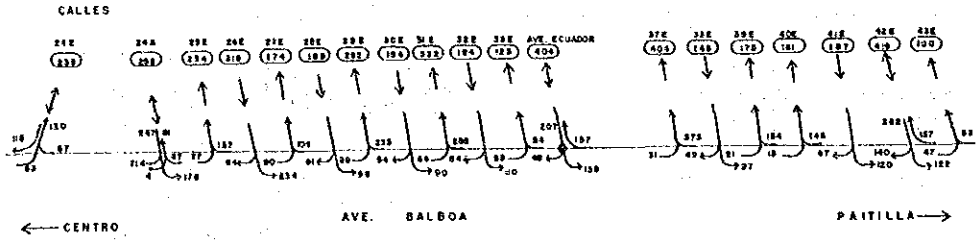


FIGURE III-5-2 ROAD AND TRAFFIC CONDITIONS OF ACCESS ROADS AT SECTION I

2) Subjects and Problems

For the future roadside land use, it can be assumed that commercial and business activities will be developed in the same manner as now and the traffic volume to increase slightly. If this section were to be operated as a 6-lane road instead of the present 4 lanes, evidently, the traffic volume on Corredor Sur would flow more smoothly. Since smooth traffic will be disturbed by the incoming and outgoing traffic of feeder roads which are to be connected to the expanded roads, the right and left-turn drives may become more difficult.

When examining FIGURE III-5-3, suppose that the peak-time traffic volume (one-way) in this section is 2,000 to 2,500 vehicles, the traffic incoming and outgoing to the feeder roads could be smooth for about 50 up to 100 vehicles, but if there were more than this, the smooth traffic on the trunk roads would be interrupted.

The subjects and problems for the access control are discussed below:

a. The feeder roads are densely allocated.

b. Most of the feeder roads are restricted as one-way because of a large volume of traffic, incoming from and outgoing to the wide Corredor Sur. It will become more difficult to access control and

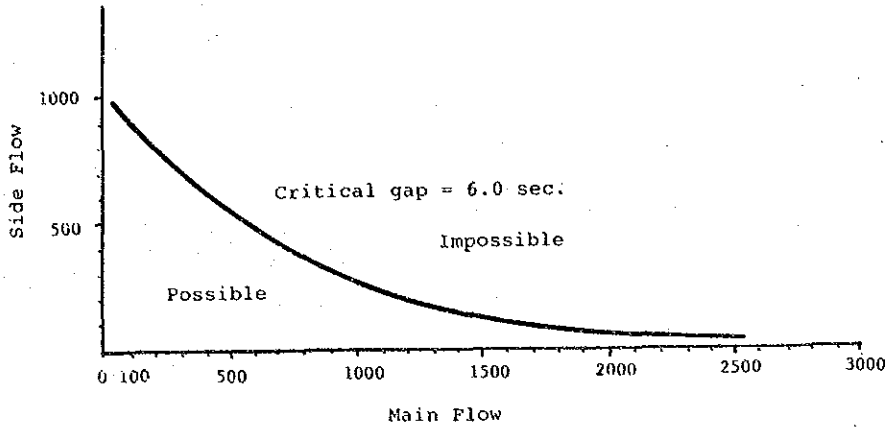


FIGURE III-5-3 NON-SIGNALIZED INTERSECTION CAPACITY

create dangerous conditions.

c. The smooth traffic flow onto Corredor Sur is disturbed by items (i) and (ii) above, thus reducing the road functions.

3) Access Control Systems

The foregoing subjects and problems shall be solved in accordance with the following methods:

a. Partial access control of traffic incoming from and outgoing to the feeder roads, and systems of possible all-directional traffic on the feeder roads

b. Signal control at intersections between the major feeder roads and Corredor Sur

c. Allocation of signalized intersections, in accordance with preferable signal intersection interval (150m at minimum), and existing signal intersection at Ave. Ecuador.

d. Therefore, in principle, the intersection with Ave. Balboa, which is currently fully open, will be made into the foregoing signal intersection in the future.

e. Provision of frontage roads to reduce the difference in the road standards between Corredor Sur and the feeder roads and to provide roadside services.

The results from the above examination are given in FIGURE III-5-4.

(2) Section II

1) Roadside Land Use and Road Traffic Conditions

The roadside land use in this section can be divided into an area having high-rise buildings (hotels, houses and business offices) represented by Punta Paitilla and areas for education and for general

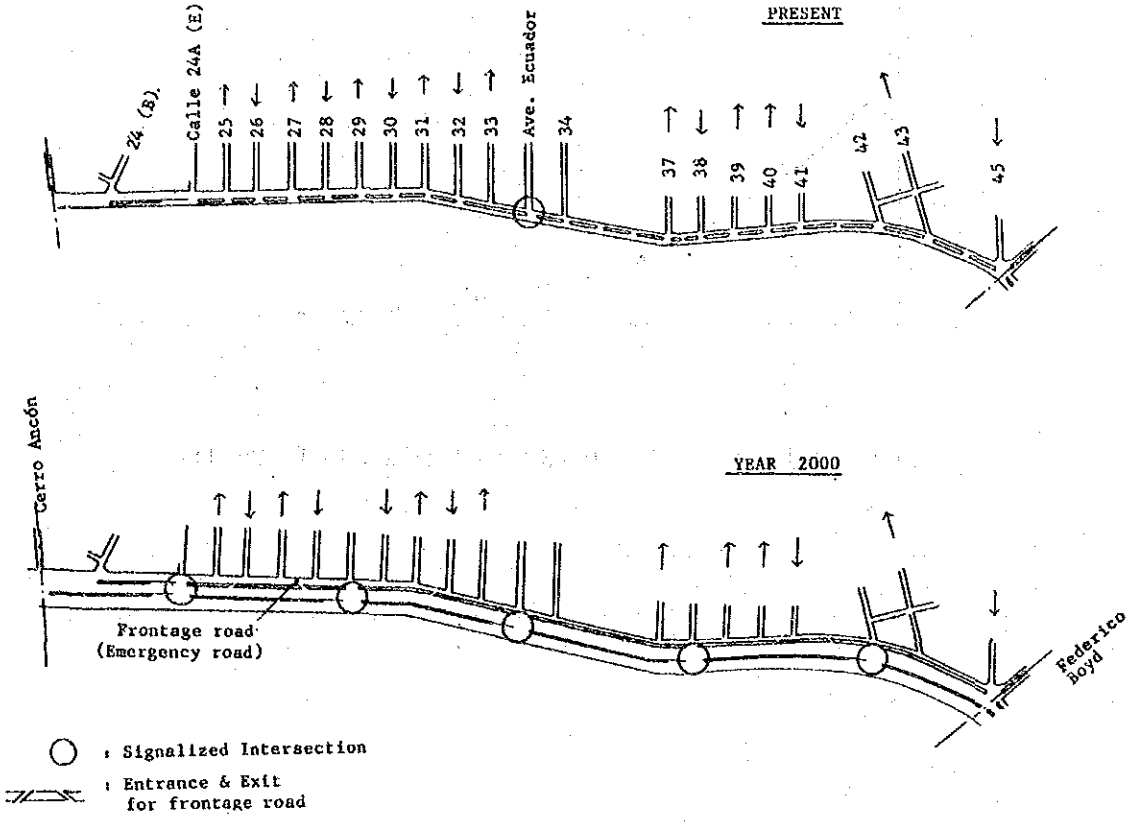


FIGURE III-5-4 ACCESS CONTROL SYSTEM AT SECTION I

commerce. The former especially, is found to have a large volume of traffic both in the Paitilla area and the feeder roads before it, as shown in FIGURE III-5-5, in addition to poor road alignment. This falls into the highest class in the traffic volume classification as defined in a former article, especially in Calle 49 (E).

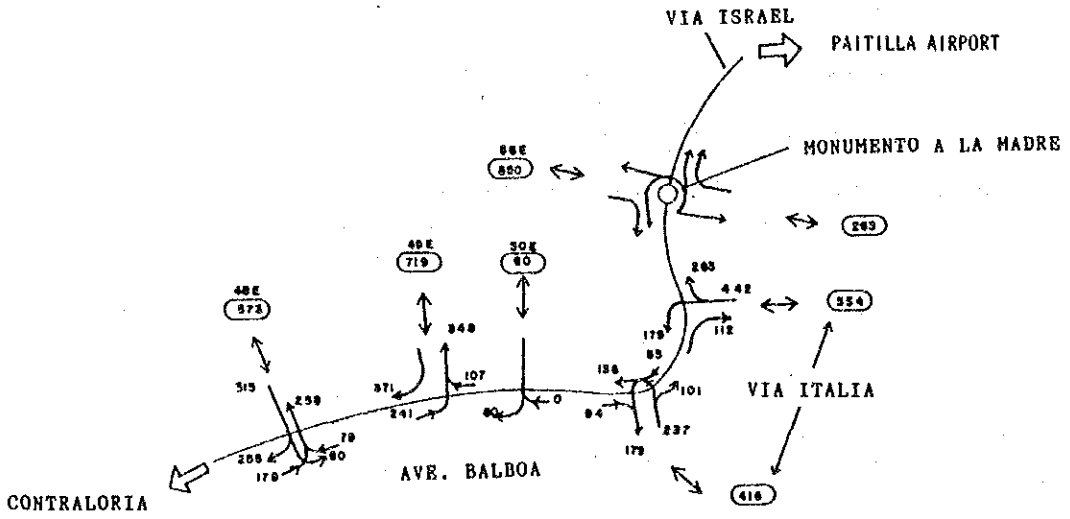


FIGURE III-5-5 ROAD AND TRAFFIC CONDITIONS OF ACCESS ROADS AT SECTION II

2) Subjects and Problems

For the future roadside land use, it can be assumed that commercial and business activities will become more active in the Punta Paitilla area and its vicinity, causing an increase in the traffic volume on Corredor Sur. Summarizing the subjects and problems results in the following:

a. Issue of traffic management, owing to a large volume of traffic in the feeder roads and collector roads between the starting point of this section (Ave. Federico Boyd) and Monumento a la Madre.

b. Difficulties in providing a smooth traffic flow in Corredor Sur due to a bad road alignment, and also in providing roadside service (especially to the commercial facilities)

c. The heavy traffic attracted to the educational area between Monumento a la Madre and Via Brasil with short peak periods.

3) Access Control Systems

Two alternative methods for a solution were considered. One is the widening of the existing road and intersections. The other is the introduction of a viaduct on the road.

a. The big scale improvement of the Monumento a la Madre intersection with the widening of the road and with the traffic concentration at this intersection.

b. Making Corredor Sur toward Centro an elevated road between Rio Mataznillo and Monumento ala Madre can provide a smoother traffic flow both in Via Italia and Calle 56 (E). The existing construction line and right-of-way in this section should be carefully considered.

(3) Section III and IV

1) Roadside Land Use and Road Traffic Conditions

This section can be divided into the portion that would expand and improve the existing road between Via Brasil and ATLAPA and the portion that calls for new construction between ATLAPA and E.T. Lefevre. The roadside land use in the former portion can be divided into the residential area and Paitilla airport, the educational and industrial areas. FIGURE III-5-6 gives the traffic volume (toward Panama at 7 to 8 a.m. and almost no traffic toward Tocumen) in the 10 feeder roads connected to Via Israel. Also, these roads not controlled for traffic, and Calle 68 (E) is only controlled by signals. This is attributable to the entrance to and exit from the foregoing airport of this road. The traffic volume falls in the lowest class in the traffic volume classification described above. Amongst all others, there is heavy traffic on Calle 77 (E) between Hotel Mariott and the International Convention Center.

The residential and commercial areas are located between ATLAPA and Via E.T. Lefevre. From about 300m before the intersection with Via E.T. Lefevre, the width of the road reduces to a 2-lane width. The important crossing road in this section is Calle 50 where the traffic is restricted to one-way toward Panama from 6 to 9 a.m. and toward its opposite direction from 4 to 7 p.m.

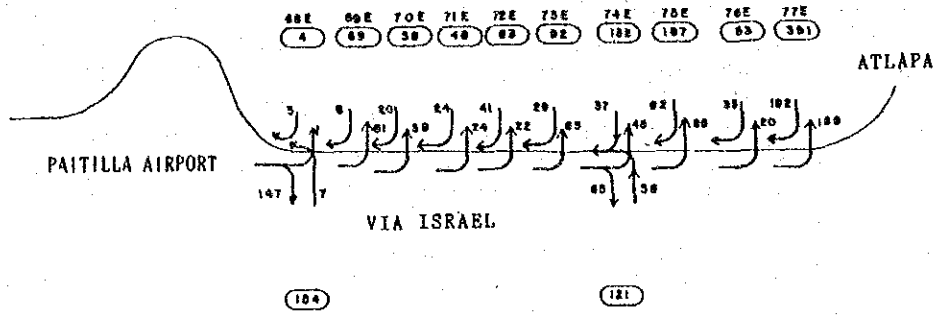


FIGURE III-5-6 ROAD AND TRAFFIC CONDITIONS OF ACCESS ROADS AT SECTION III

2) Subjects and Problems

The traffic volume on Corredor Sur will increase in the future, and that on the feeder roads will also increase slightly. It is, however, necessary that this section receives a smooth traffic flow on the coastal road between ATLAPA and Via E.T. Lefevre.

The route between ATLAPA and Via E.T. Lefevre along the seashore is selected, so as to eliminate the crossing road to be connected in this section, but this section must be connected to the minor arterial roads. Since this route results in connecting the present Via Cincuentenario to around where the foregoing two sections (between Via Brasil and Via E.T. Lefevre) are to be connected, consideration must be given to the traffic management around these sections (explained in "Intersection Planning" in Chapter V).

3) Access Control Systems

Between Via Brasil and ATLAPA, the partial control system shall be introduced on the traffic on the feeder roads to and from Corredor Sur, while the points to allow vehicles to come in and go out in all directions shall be specified in accordance with the methods as discussed in Section I above. Consequently, both Calle 68 (E) and Calle 74 (E) shall be controlled by signals. Although there is no connecting road between ATLAPA and Via E.T. Lefevre, as it runs along the seashore as mentioned above, it must at least be connected to Calle 50., which shall therefore, be extended and connected to Corredor Sur.

(4) Sections V and VI

1) Roadside Land Use and Road Traffic Conditions

These two sections cross over both the built-up and suburban areas, and are to be constructed anew. The former area consists of Cementerio Jardin de Paz on the inland side and a residential area at the seaside, while the latter area is a new residential or housing development project area. There is also an historical area of Panama Viejo along Ave. Cincuentenario. Corredor Sur in these two sections passes through the near

middle portion between the minor arterial roads of Ave. 6 Sur Santa Elena and Ave. Cincuentenario, once crossing Ave. Cincuentenario into the suburban area. The traffic jam occurs in the morning and evening peaks caused by the two-lane width.

2) Subjects and Problems

The residential area along these two sections will further expand. Since the implementation of the Panama Viejo ruins preservation project would prohibit traffic around the area on Ave. Cincuentenario, an alternative access road must be provided.

3) Access Control Systems

Since the roadside along Sections V and VI is a residential area, there is no need to provide direct access to/from Corredor Sur, which is a principal arterial road. Roads shall, therefore, be provided at certain intervals to act as collector roads. In Section V, one road each at least should be constructed to provide access at the 2km distance between Via E.T. Lefevre and Calle 102B (E) (See FIGURE III-5-7), and between Calle 102B (E) and Via San Miguelito Chanis. At these points, the need for control by signals shall be determined depending upon the traffic volume.

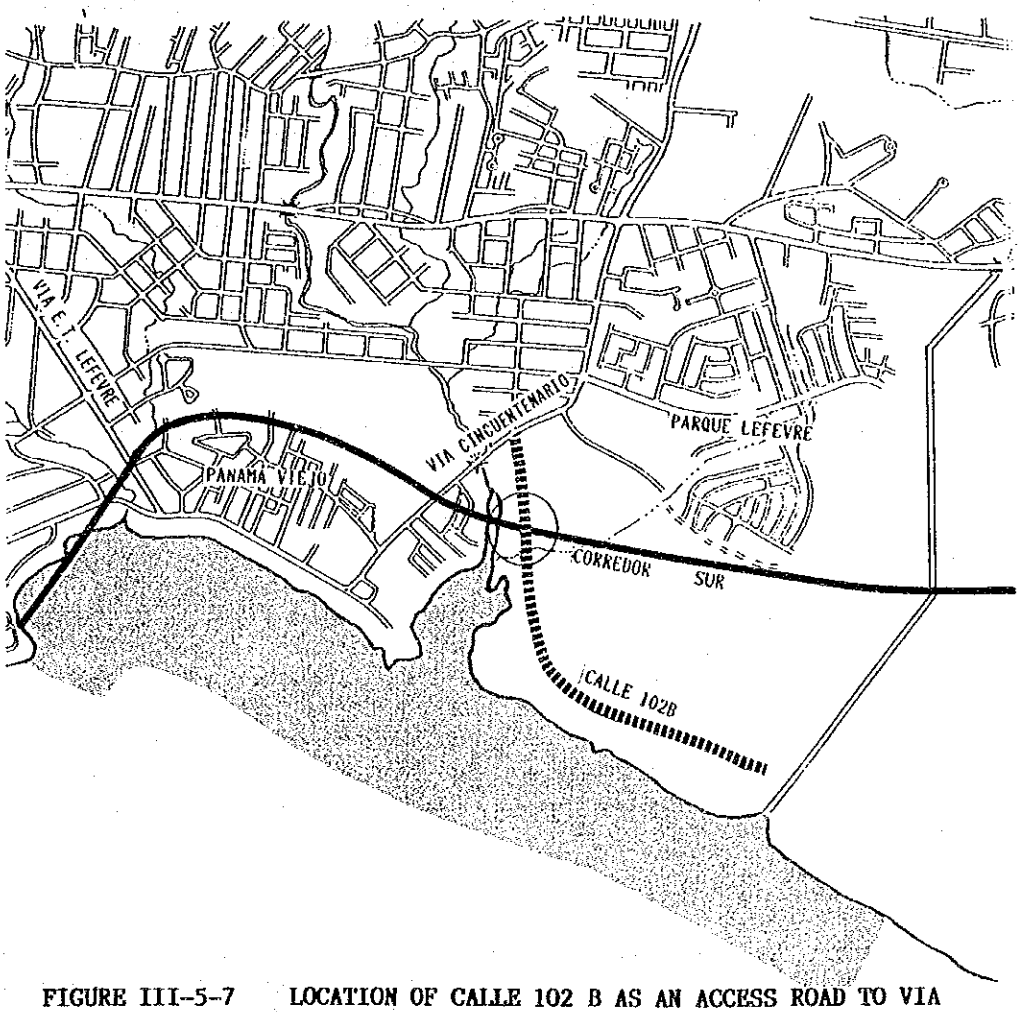


FIGURE III-5-7 LOCATION OF CALLE 102 B AS AN ACCESS ROAD TO VIA CINCUENTENARIO

(5) Sections VII and VIII

1) Current and Future Status of Roadside Land Use

This roadside is at present an empty space between such suburban residential areas extending east and west as Chanis, Hipodromo, Juan Diaz, Ciudad Radial, Don Bosco, and the mangrove preservation area. In the future, development plans mainly for housing with a commercial nucleus can assumed to be located south of the Hipodromo. As for the roads, Via Jose A. Arango and Via Domingo Diaz run in parallel with Corredor Sur, to which the feeder roads or collector roads have access in these sections.

2) Subjects and Problems

Five main access roads are planned to be connected to these sections, but this number is deemed as insufficient for providing access to Corredor Sur. Therefore, it is necessary to clarify the character of each main access road.

3) Access Control Systems

The concept of road network hierarchy is the same as the one proposed in ESTAMPA II Study Report. The idea was formulated by the integration of B-1, 2 and 3 patterns in FIGURE III-5-1. The principles are that the access roads should be located at intervals of 1 Km and the one way frontage roads should be connected to these.

In the sections providing a frontage road, the traffic from the Main Access Roads first enter the frontage road and then into Corredor Sur. In other sections which are not provided with frontage roads, the access traffic goes directly into Corredor Sur with a certain method of access control.

5-2-2 Main Access Roads

Six main access roads are planned, consisting of Via E.T. Lefevre in the built-up area and five, including Via San Miguelito Chanis, in the suburban area.

(1) Via E.T. Lefevre

1) Roadside Land Use and Road Traffic Conditions

The current use of roadside land along this section is mainly as a residential area. This road is situated between Via Espana and Ave. Cincuentenario, connecting to Ave. II de Octubre, and can be positioned as a circular road outside Via Brasil. The main access to this road is Ave. Santa Elena controlled by signals. All others are roads below the standards by one class.

2) Subjects and Problems

The future utilization of roadside land can also be assumed to be mainly as a residential area, but the traffic volume may be increased to more than three times the present level and strengthen its function as a

ring road. The access roads need, therefore, to be controlled in order to disperse this large traffic volume.

3) Access Control Systems

Because of the large traffic volume, no local road will have access to or cross this road. The present Ave. Santa Elena shall, therefore, be maintained as the only intersection controlled by signals, while incoming and outgoing traffic at all other intersections with the local roads shall be restricted.

(2) Other Main Access Roads

The routes of Via San Miguelito Chanis, Via San Miguelito Hipodromo, Via Juan Diaz, Via Ciudad Radial and Via Don Bosco shall be roughly divided into the portion of expanding and improving the existing roads and the portion of new construction, (see FIGURE III-4-2) as follows.

As determined merely by looking at the foregoing figure, there are a few improvement sections. The utilization of roadside land along these sections is of a residential nature, while that along the new construction has much more space. Even if it is utilized, it will be for a residential area. It assumed the trend for housing development will continue. These access roads have the functions of a trunk or collector road, but since they are access roads to Corredor Sur, servicing to the roadside is naturally required. Roads to be connected to these Main Access Roads shall, therefore, in principle, be positioned at intervals of 150 to 200m minimum, and controlled without signals.

5-2-3 CORREDOR SUR EXTENSION

(1) Roadside Land Use and Road Traffic Conditions

Corredor Sur Extension (Calle 14) passes through the center of the old Panama Urban Area, along which there are many aged low-rise buildings and commercial facilities. FIGURE III-5-8 gives the road network in the old urban area, indicating that there are very narrow streets with widths just sufficient to secure a 2-lane road, except for such minor arterial roads in this area as Ave. Central, Ave. A, Ave. B and Calle B. Most of them are, however, restricted to one-way. FIGURE III-5-9 gives the morning time (7 to 8 A.M.) traffic volume in the major roads; the number of vehicles incoming from Ave. Balboa and Ave. Central is high. The directions of most of the roads with access to the foregoing minor arterial roads, such as Calle 14 to 18, are restricted since the minor arterial roads are mostly one-way.

(2) Roadside Future, subjects and Problems

For the Calle 14 expansion, improvement and connections to Ave. Balboa and Ave. de los Poetas, the route shall be completed with a new road construction. The living environment would be completely changed by the new residential and commercial facility buildings. Consideration must, however, be given to traffic management at the intersections with the other minor arterial roads and access (zoning) roads, which may be affected by linking Calle 14 to a minor arterial road.

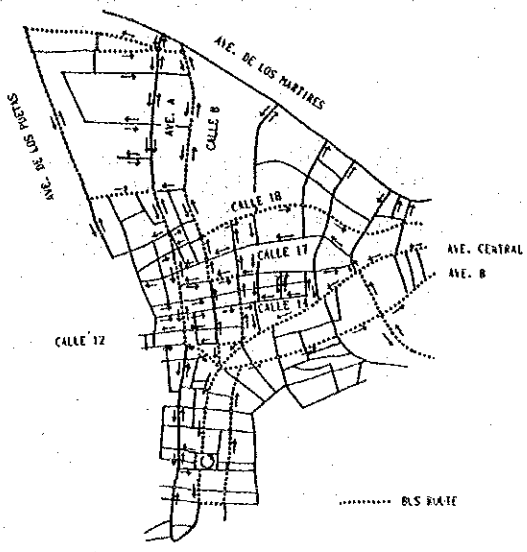


FIGURE III-5-8
ROAD NETWORK IN CENTRO

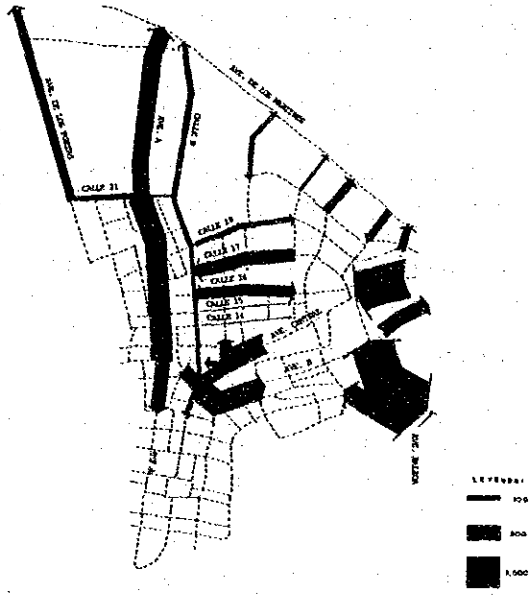


FIGURE III-5-9
MAIN ROAD TRAFFIC VOLUME (7 - 8 A.M.)
IN CENTRO

(3) Access Control Systems

The issue of managing the traffic at the intersections with the minor arterial roads will be discussed in Chapter V, "Preliminary Road Design." Calle 14 is currently a one-way street. Because it will become a two-way road, it is necessary to control the roads with access to Calle 14. Since such streets are currently restricted to one-way, however, in principle they shall be operated without control by signals for the local roads (see FIGURE III-5-10).

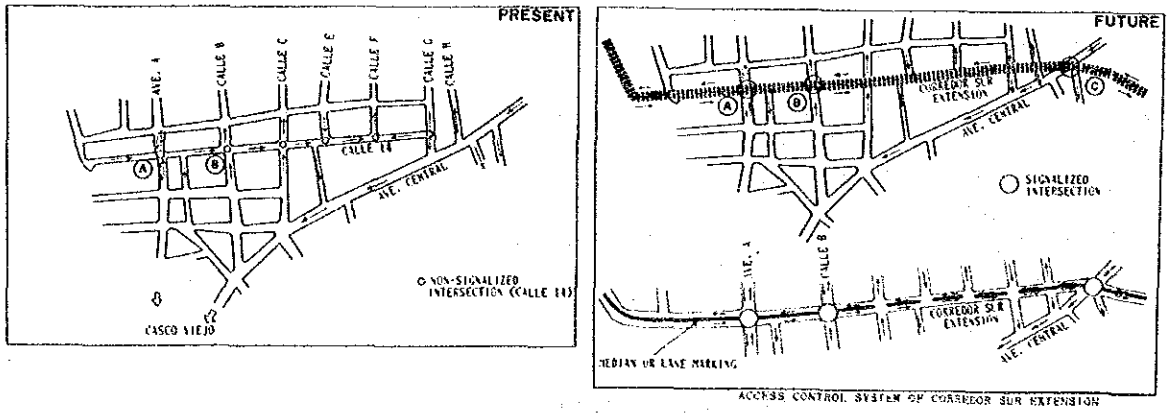


FIGURE III-5-10 ACCESS CONTROL SYSTEM OF CORREDOR SUR EXTENSION

6. CROSS SECTION COMPONENTS

6-1 ROAD CROSS SECTION PRINCIPLES

The road cross section shall be established by examining the traffic conditions of each road. The cross section of urban roads like the subject roads would necessarily be such that it would correspond not only to the traffic functions, but also to the traffic flow, as well as the function of inducing development generated by a rise of potential urban activities along the routes upon the road improvement and new road construction, and further to such urban space functions as disaster protection space within the area limited to public space, space to preserve the environment along the routes, or space to accommodate public and semi-public facilities.

The geometric structure of the roads shall be established in accordance with the land use, route characteristics and importance, topographic conditions, planned traffic volume and quality. For the sections where these considerations are approximately equal, however, it is advisable to apply the same design standards. Variations in the design standards and width of lane for short sections will make drivers confused, and are also not desirable from the viewpoints of safety and comfort. It is, therefore, preferable to make the components of road cross section as continuous as possible.

6-2 CROSS SECTION ELEMENTS

6-2-1 Roadway

The roadway is for vehicle traffic, consisting of vehicle lanes and shoulders.

(1) Lane Width

The width of lane has the highest effect on driving speed and comfort amongst all other components of road cross section.

The width of the lanes has to be wide enough so that vehicles in the same lane can pass one another. On the other hand, the lane should not be so wide such that it would make traffic flow difficult to control. For example, if there are two lanes, but the lanes are so wide that three vehicles can run side by side in them, many complex movements can occur which would increase the possibility of accidents. For this reason, excessive lane width is not good. Lane width will be decided based on vehicle size plus the necessary clearance.

According to AASHTO, the desirable width for lanes is 12 feet, so that initially 3.65m shall be applied to the lane width of Corredor Sur. However, Corredor Sur passes through urban areas, where land acquisition is very difficult. Also, the greater part of Corredor Sur consists of the widening of existing roads. In the built-up area, design speed may have to be low and, also, truck ratio will be less than 10%.

Therefore the lane width in the section of high design speed will be 3.65m and most of it in the built-up area will be 3.35m. (See TABLE III-6-1)

TABLE III-6-1 LANE WIDTH

Width	Remarks
3.65 m	High design speed High truck ratio
3.35 m	Medium design speed
3.05 m	Minimum width

Source: ESTAMPA

(2) Shoulders

Shoulders may be considered as:

a. Clearance space for securing necessary road capacity
b. Space for removing disabled or temporarily stalled vehicles from the edge of the lane
c. Space for installing such facilities as drainage systems

The following five types of shoulder width were discussed under the consideration of item (b) above based on the design vehicle dimensions, shown in TABLE III-6-2.

TABLE III-6-2 DESIGN VEHICLE DIMENSIONS

Design Vehicle	Wheel Base	Front Overhang	Rear Overhang	Overall Length	Overall Width	Height
1. Passenger Car	11' (3.35)	3' (0.91)	5' (1.52)	19' (5.79)	7' (2.13)	--
2. Single Unit Truck	20' (6.10)	4' (1.22)	6' (1.83)	30' (9.14)	8.5' (2.60)	13.5' (4.11)
3. Semitrailer Combination	40' (12.19)	4' (1.22)	6' (1.83)	50' (15.24)	8.5' (2.60)	13.5' (4.11)
4. Semitrailor Intermediate Combination	50' (15.24)	3' (0.91)	2' (0.61)	55' (16.76)	8.5' (2.60)	13.5' (4.11)

Note : ( ) ; Dimensions in Meters
Source: ESTAMPA

Case 1: Securing width of enough space to allow a large vehicle to park on the shoulder.

Case 2: Securing space so that if a large vehicle is stopped next to the curb, another large vehicle can pass along the parked vehicle, without its velocity being appreciably influenced by the parked vehicle, and without trespassing into the next lane.

Case 3: Securing space so that if a large vehicle is parked next to the curb, another large vehicle can pass beside the parked vehicle without changing lanes, even though the parked vehicle influences the velocity of the passing vehicle. In other words, the lane of the parked vehicle in Case 3 narrower than that of Case 2.

Case 4: Securing space for a situation in which a large vehicle is parked next to the curb, and another large vehicle can pass beside the parked vehicle with part of its body invading the next lane, yet a third large vehicle can still drive on alongside on the next lane.

Case 5: Securing space for a situation in which a large vehicle parks next to the curb, and another large vehicle can pass beside the parked vehicle while part of its own body is invading the next lane, yet a small vehicle can still drive on alongside on that next lane.

The relation between width of lanes and shoulders is tabulated in TABLE III-6-3 for each case stated above.

TABLE III-6-3 SHOULDER WIDTH

Lane Width (m)	Case 1	2	3	4	5
3.65	2.75	1.85	0.95	1.05	0.45
3.35	2.75	2.15	1.15	1.35	0.45
3.05	2.75	2.45	2.15	1.65	0.45

Source: ESTAMPA

For Corredor Sur, the width of shoulders is to be 2.75m in the high design speed section and 1.35m in the low design speed sections. The shoulder beside the median has 1.35m width for both cases. For the Main Access Roads, the width of shoulders is to be more than 1.35m except in the case of low traffic volume roads. On the Corredor Sur Extension, a shoulder width of more than 2.75m is recommended for the commercial activities.

6-2-2 Median

A median has the following functions:

a. To separate traffic flow and prevent one vehicle going in one direction from going into another lane with traffic in the opposite direction and thus prevent an accident.

b. To keep traffic efficiency from being reduced due to the "obstacle effect" created by a vehicle coming in the opposite direction.

c. To keep vehicles going in one direction from crossing to lanes of traffic going in the opposite direction (U-turns), and so increase safety.

d. To provide an area to place traffic control facilities, for example, lighting and traffic signals.

e. To provide for the space necessary for left turns.

Based on the functions mentioned above, the width of the median was examined as follows:

The minimum width of the median is 0.5 m. This minimum median is used for separation of traffic flow and maintainance of traffic efficiency (functions a, b and c mentioned above). The minimum width for placing traffic facilities is 1.0 m (function d mentioned above). The minimum width for providing a green area is 1.5 m. The minimum width for providing an area for left turns is 3.5 m (function e).

The median width of Corredor Sur shall be 3.5m as a desirable standard. For the other roads, the median width may be different, depending on traffic volume and the land use along the roads.

6-2-3 Sidewalks

Sidewalks have the important function of providing space not only for walking, but also for better urban scenery. For the sake of burying urban facilities or providing roadside services, sidewalks play a role of importance. Sidewalks shall be provided wherever vehicular traffic volume is high, even if few pedestrians pass, in areas where children pass to go to school (school zones), and wherever there are many pedestrians, taking the following into consideration:

a. Sufficient width shall be secured in commercial and business areas in order to achieve the safety of pedestrians and a smooth flow of vehicles, taking into consideration the number of pedestrians, time variation and walking conditions.

b. The width required to secure enough space around bus stops for bus users

c. The width necessary for achieving better-looking roads, preservation of roadside environment, accommodation of surface and underground facilities, etc.

d. At intersections, the width and shape shall be such as to ensure sufficent sight distance for traffic safety.

Above all, standard dimensions shown in TABLE III-6-4 are adopted to the foregoing. The standard width of sidewalks shall be five meters, particularly in all of the subject roads.

TABLE III-6-4 SIDEWALK WIDTH

Area	Remarks
Commercial and Business Area :	This type of area has many pedestrians therefore, sidewalks of more than 5 meters should be provided.
Bus Stops :	It is necessary to provide a sidewalk of more than 3 meters for passengers to get on and off the buses.
Intersections :	A width of 5 meters is necessary for sidewalks at intersections in order to provide for a safe sight clearance distance.
General :	A sidewalk more than 5 meter wide should be provided for the conservation of the living environment, but , in cases where some construction exists, the sidewalk width may be reduced to 2 meters.

Source: ESTAMPA

6-2-4 Frontage Roads

The frontage roads to be added to the trunk roads where there are relatively frequent medium and long-distance trips have the following functions:

a. To separate between the medium/long-distance trips and traffic within areas, in order to attempt to specialize the use of road functions and to increase the traffic function of the principal arterial roads.

b. To concentratedly control the access traffic from the areas around the routes, with the purpose of securing the smoothness and comfort in the vehicle run and maintaining a relatively high ease of driving.

c. To provide the services to the areas along the routes.

d. To play the role of an alternative road if an emergency should take place owing to an accident or because of work activities on the principal arterial roads.

e. To form a buffer zone between the areas along the routes and principal arterial roads, which helps to preserve the living environment in the areas along the routes.

The width of the frontage roads shall be 6.1m or more, with consideration given to the foregoing. Corredor Sur, to become a subject road, is situated on a flat land, so that the frontage road shall be

constructed on the same level and in parallel with Corredor Sur, the principal arterial road. For this reason, this frontage road shall, in principle, be restricted to one-way, because of a difficulty in disposing of the traffic at the intersections.

6-2-5 Others

A certain width of green belts or vacant land for public use should be provided according to the environmental conditions and for social facilities. Lighting facilities, trees, shrubs, electric poles, and other elements will be located with careful consideration from the view point of streetscaping.

Suitably sized buffer belts of shrubs or trees or mounds should be provided in front of the residential area along the roads. Especially, since the seashore area will be taking care of recreational activities, sufficient space for that purpose will have to be acquired.

6-2-6 Cross Section Components of Corredor Sur

The elements of the cross section within each divided section of Corredor Sur are discussed in TABLE III-6-5 in light of the function of road section, adjacent land use, topography and continuity of road section.

TABLE III-6-5 ROAD CHARACTERISTICS AND CROSS SECTION COMPONENTS

Section / Item	I	II	III IV	V	VI	VII	VIII
Length	2.2 Km	2.1 Km	3.6 Km	1.8 Km	3.2 Km	2.9 Km	8.3 Km
Existing Land Use Left	Business	Institution	Residential, Hotel, Const Convention	Cemetery			
Right	Const, Recreation	Const, Commercial, Education	Const, Education	Residential			
Future Land Use Left	Business	Institution	Residential, Hotel, Convention	Cemetery,	Residential	Commercial, Recreation, Residential	Residential
Right	Const, Recreation	Const, Commercial, Education	Const, Institution Education	Residential			
Traffic Volume (x 1000 Vehicles)	56	55	59	86	69	79	44
Volume of Local Trips	Large		Small				
Traffic Volume of Public Transport	Large		Small				
Type of Work	Widening		Widening, New Road Construction	New Road Construction			
Design Speed (Km/hr)	60		80				
Topography	Flat						
Number of Lanes	6 Lanes						4 Lanes
Width of Lanes	3.35 m (3.65m)		3.65 m				
Width of Shoulder	1.35 m (2.70m)		2.70 m				
Width of Median	3.50 m						
Sidewalks and Green Belt	5.00m (sidewalks)		6.60m (sidewalks)		5.00 m (Sidewalks) 2.95 m (Green Belt)		5.00 m (sidewalks) 6.60 m (Green Belt)
Frontage Roads	Provide	None			Provide		

IV. BUS FACILITY PLANNING

1. BUS SYSTEM PLANNING
2. BUS YARD IMPROVEMENT PLANNING
3. BUS STOP PLANNING

IV. BUS FACILITY PLANNING

1. BUS SYSTEM PLANNING

1-1 CURRENT STATUS OF BUS ROUTES

Although Panama City had 54 bus routes in 1981, by 1983, five bus routes were added and three others were abolished; as a result, 56 bus routes were in operation in 1983. Since seven bus routes were added while 11 others were abolished by 1986, the present number of active routes is 52 (TABLE IV-1-1). These can be assumed to reflect the natural-selection-like abolishment of unnecessary routes by a change in the demand structure and the addition of bus routes to the areas of increased demand. A specific trend can be seen in the addition of bus routes to the San Miguelito area, in the discontinuance of the short and medium distance routes in the east area, and the addition of long distance routes in the same area. Furthermore many routes were abolished because of frequent bus breakdowns caused by a shortage of spare parts.

A recent trend that should be noted is the birth of the minibus service provided by 15 to 25 passenger buses in the suburban residential areas. Currently 28 routes centering around San Miguelito, Alcalde Diaz, Pedregal, and Tocumen are being operated. The birth of the minibus service means the advent of the so-called "dispersed bus" system for providing area services in residential areas to transport passengers to the trunk bus routes, differing from the functions of conventional city and medium/long distance buses and thus indicating the progress of systemization in the city bus services.

TABLE IV-1-1 EXISTING BUS ROUTES, 1986

No.	Itinerary	Length (Km)	Registered Buses (Buses)	Operated Buses (Buses)	Total Buses (Turnover)	Piqueras location Turnover	Destination
1	Panama Viejo-V.Porras-Via Espana	30.0	15	13	58	COOMETRAP	Calle 12
2	Panama Viejo-Ave. Balboa	24.6	28	24	156	Ruinas de Panama Viejo	Calle 12
7	Parque Legislativo,Ave. Los Martires,Balboa	17.1				Parque Legislativo	
9	Boca la Caja, Ave. Balboa, Calle J	19.1	86	52	139	Boca la Caja	Chorrillo
11	Bethania, Transistmica	25.4	18	15	54	Santa Maria	Chorrillo
12	Villa Rica, Via Fernandez de Cordoba,Via Espana	23.9	21	13	28	Calle 16 Monte Oscuro	Chorrillo
13	V. Rica,Pulida,Calle 9,Via F.Cordoba,Via Espana	26.3	24	16	70	Calle 16 Monte Oscuro	Chorrillo
14	Loceria, Via Espana, Catedral	16.0	12	6	7	Loceria	Catedral
15	Veranillo,V. Cincuentenario,Rio Abajo,V. Espana	31.7	60	40	143	Centro de Salud-Veranillo	Chorrillo
17	Veranillo, Paraiso, Transistmica	31.3	65	47	169	Centro de salud-Veranillo	Chorrillo
18	Auto Motor, Via Domingo Diaz,A. Ricardo J. Alfaro	29.5	8	5	28	Entrada de V. Guadalupe	Calle 12
19	Samaria, Via Domingo Diaz,Ave. Ricardo J. Alfaro	31.0	20	15	56	Puente Rojo-Samaria	Calle 12
21	Veranillo, Paraiso, Ave. Ricardo J. Alfaro	30.9	15	8	53	Centro de Salud-Veranillo	Calle 12
23	Villa Lorena, Rio Abajo, Via Espana	23.0	10	10	16	Villa Lorena	Calle 12
26	Villa Lorena, Via Espana, Calle J.	24.0	1	1	3	Villa Lorena	Chorrillo
27	San Pedro, Rio Abajo, Via Espana	32.3	79	50	185	San Pedro	Calle 12
28	San Pedro, Via Espana, Rio Abajo	32.3	12	5	35	San Pedro	Chorrillo
30	Concepcion,Juan Diaz,Rio Abajo,Via Espana	39.9	86	64	175	Ciudad Radial	Chorrillo
31	Pedregal, Via Domingo Diaz, Transistmica	53.1	86	50	200	Entrada de Monteria	Chorrillo
32	Pedregal, Juan Diaz, Rio Abajo, Via Espana	50.1	82	50	198	Entrada de Monteria	Chorrillo
33	Manantas, V. Domingo Diaz,Ave. Ricardo J. Alfaro	53.8	40	36	130	Belen	Calle 12
37	Tocumen,V.Domingo Diaz,Juan Diaz,Via Espana	62.2	104	64	166	La Siesta	Chorrillo
38	24 de Dic.,Juan Diaz, Rio Abajo, Via Espana	61.2	19	16	59	Tocumen	Calle 12
39	Santa Librada, Ave. Ricardo J. Alfaro	38.8	28	21	34	Santa Librada(Intel)	Calle 12
40	Cerro Batea, Ave. Ricardo J. Alfaro	40.2	30	25	116	Torrijos Carter	Calle 12
41	El Valle, Trans., Via F. Cordoba, Via Espana	32.5	26	20	46	Via Principal-El Valle	Calle 12
42	El Valle, Transistmica	32.6	23	17	53	Via Principal- El Valle	Calle 12
43	Los Andes, Ave. Ricardo J. Alfaro	31.0	45	33	113	Los Andes No. 2	Calle 12
44	Alcalde Diaz, Transistmica	36.0	23	21	55	Entrada de Alcalde Diaz	Calle 12
45	Santa Librada, Transist.,Via F. Cordoba,Via Espana	35.3	18	14	41	Santa Librada (Intel)	Calle 12
46	Santa Librada, Transistmica	35.6	24	21	72	Santa Librada (Intel)	Calle 12
47	Cerro Batea, Transistmica	37.3	27	24	93	Torrijos Carter	Calle 12
48	Cerro Batea,Transist.,Via F. Cordoba,Via Espana	37.2	26	23	70	Torrijos Carter	Calle 12
49	Bello Horizonte, Via Domingo Diaz, Transistmica	53.0	28	22	57	Entrada Colonia del Prado	Chorrillo
50	Bello Horizonte,Juan Diaz,Rio Abajo,Via Espana	49.9	28	22	28	Entrada Colonia del Prado	Chorrillo
52	Chilibre, Transistmica, Calle H						
53	Manantas,V.Pedregal,Juan Diaz,Rio Abajo,V.Espana	62.7	16	13		Belen	Calle 12
55	Chilibre, Area del Canal, Calle H						
59	Ciudad Bolivar, Ave. Ricardo J. Alfaro	56.0	35	27	54	Ciudad Bolivar	Calle 12
60	Veranillo, Cincuentenario,Rio Abajo,V. Espana	30.0	45	32	78	Centro de Salud-Veranillo	Calle 12
61	Mano de Piedra, Transistmica	38.5	26	20	43	Cerro Coco Solo III ETAPA	Calle 12
62	Mano de Piedra, Ave. Ricardo J. Alfaro	40.2	28	17	54	Cerro Coco Solo III ETAPA	Calle 12
63	Mano de Piedra, V.F.Cordoba,Transist.,V.España	39.0	18	16	30	Cerro Coco Solo III ETAPA	Calle 12

Note: 1. Length, Registered Buses, Operated Buses : Inventory of the Month of July, 1986
2. Total Turn-over : Gauging of the day 16, 1985.

Source : Departamento de Planificacion. DIMTRAT.

1-2 BASIC CONCEPT OF BUS SYSTEM PLANNING

1-2-1 Purpose of Bus System Planning

A total number of 21 bus routes was recommended in the ESTAMPA Masterplan, for the planning year 1990 (see FIGURE IV-1-1, TABLE IV-1-2). The bus system planning of the Study will be conducted mainly in order to analyze the feasibility of bus routes on Corredor Sur in the planning year 2000.

TABLE IV-1-2 RECOMMENDED REROUTING IN ESTAMPA MASTERPLAN

Bus Base	Route Code	Routes
1	1	Ciudad Bolivar - Transistmica - San Miguelito Bus center
2	2	Cerro Batea - Corredor Norte - Universidad Bus Center
	3	Cerro Batea - Corredor Norte - 5 de mayo Bus Center
	4	Cerro Batea - Transistmica - Universidad Bus Center
	5	Cerro Batea - Ricardo J. Alfaro - Chanis Bus Center
	6	Cerro Batea - Ricardo J. Alfaro - 5 de Mayod Bus Center
3	7	Vila Guadalupe - Ave. Balboa - 5 de Mayo Bus Center
	8	Villa Guadalupe - Via Porras - 5 de Mayo Bus Center
4	9	Ave. Jose Torrijos - Ave. Balboa - 5 de Mayo Bus Center
	10	Via Domingo Diaz - Via Jose Arango - Chanis Bus Center
	11	Ave. Jose Torrijos - Via Espana - Universidad Bus Center
	12	Ave Jose Torrijos - Ave Justo Arosemena - 5 de Mayo Bus Center
5	13	Via Espana - Transistmica - Chanis Bus Center
	14	Via R. J. Alfaro - Via Manuel E. Batista - Universidad Bus Center
	15	Ave. Balboa - Via Manuel e. Batista - 5 de Mayo Bus Center
	16	Ave. "A" - Ave. Eloy Alfaro - 5 de Mayo Bus Center
	17	Ave. "A" - Ave. de Los Martires - 5 de Mayo Bus Center
6	18	Via Cincuentenario - Ave. Balboa - 5 de Mayo Bus Center
	19	Ave. Sta. Elena - Via 11 de Octubre - Universidad Bus Center
	20	Via Domingo Diaz - Via Argentina - Universidad Bus Center
	21	Via Cincuentenario - Calle 50 - 5 de Mayo Bus Center

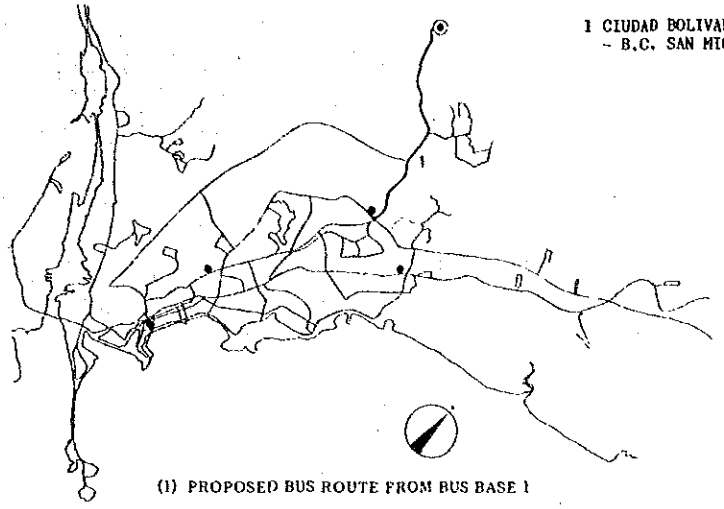
Source: ESTAMPA II

1-2-2 Basic Concept of Bus System Planning

(1) Future Public Transport Demand

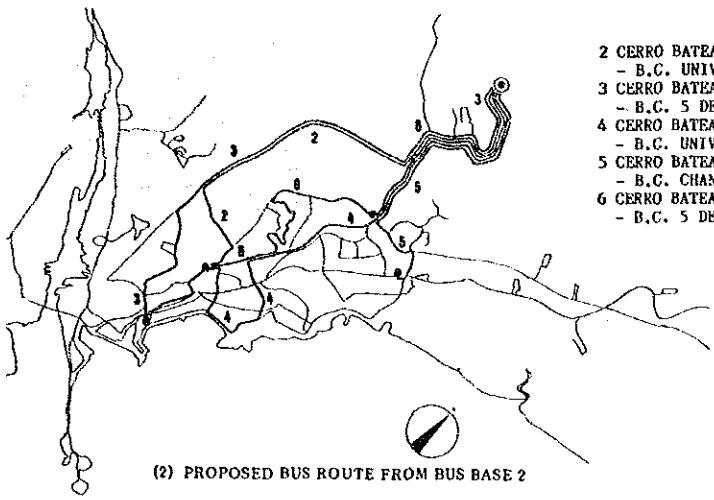
According to the traffic forecast in the ESTAMPA Masterplan, the demand for public transport in the year 1990, will be for about 850,000 people and, in the year 2000, it will be about 1,160,000. These figures correspond to 1.7 and 2.4 times the figures for the year 1980, respectively. The ratio for the increase from the year 1990, to the year 2000, is 1.4. The ratio for the increase in the period from 1990, to 2000, has been forecasted as lower than the ratio for the increase in the period from 1980, to 1990. However, the increase for the first period is about 710,000, while the increase in the second period is about 630,000. So, even while the ratio for the increase in the period from 1990, to 2000, is smaller than in the period from 1980, to 1990, the numerical increase is still very large.

Concerning the increase by zones (Hipodromo, Juan Diaz, Pedregal, Tocumen, La Pulida, Cerro Viento, etc.) in the period from 1990, to 2000, both the value and the ratio of the increase are very high in these zones (see TABLE IV-1-3). Concerning the tendency for increase in the trips between the integrated zones, the tendencies are as follows (see FIGURE IV-1-2):



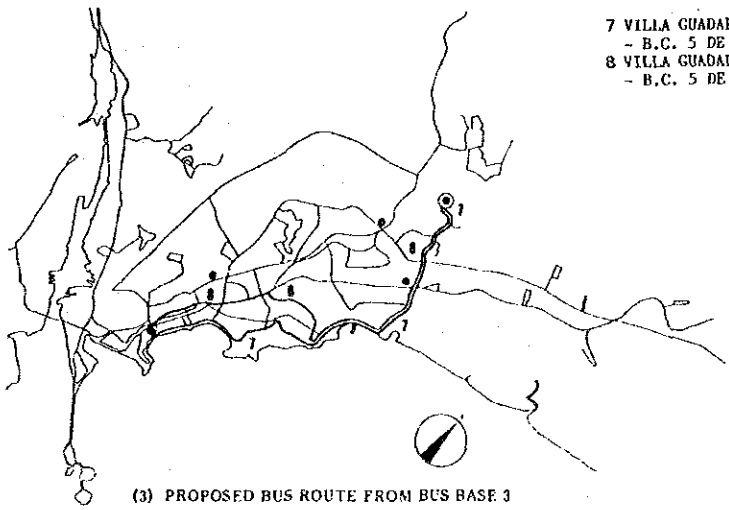
1 CIUDAD BOLIVAR - TRANSISTMICA
- B.C. SAN MIGUELITO

(1) PROPOSED BUS ROUTE FROM BUS BASE 1



2 CERRO BATEA - CORREDOR NORTE
- B.C. UNIVERSIDAD
3 CERRO BATEA - CORREDOR NORTE
- B.C. 5 DE MAYO
4 CERRO BATEA - TRANSISTMICA
- B.C. UNIVERSIDAD
5 CERRO BATEA - DOMINGO DIAZ
- B.C. CHANIS
6 CERRO BATEA - RICARDO J. ALFARO
- B.C. 5 DE MAYO

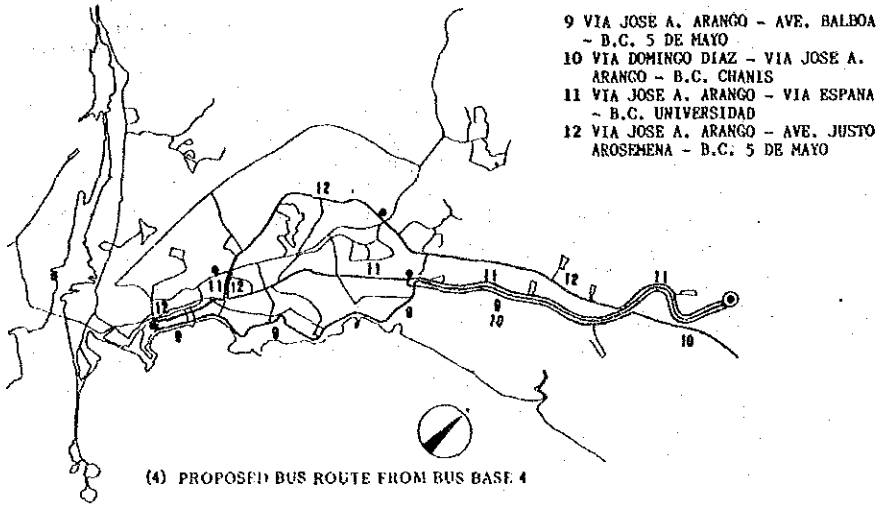
(2) PROPOSED BUS ROUTE FROM BUS BASE 2



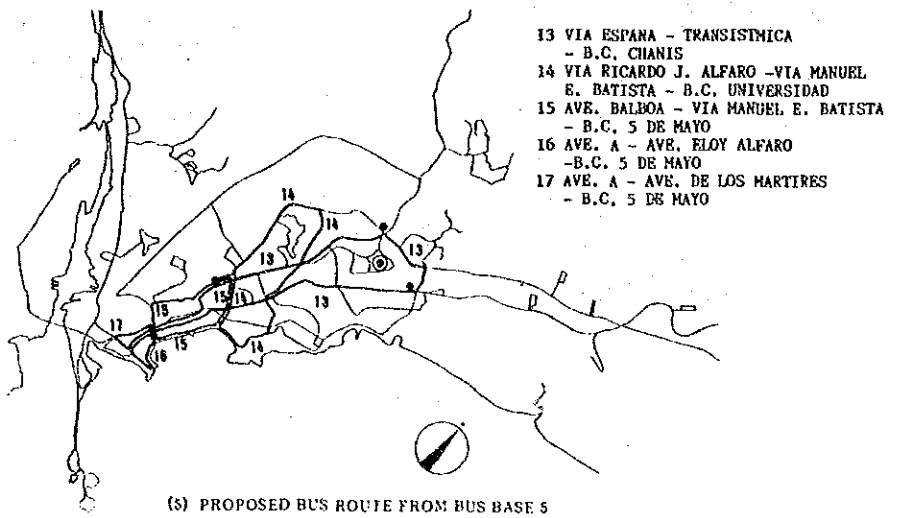
7 VILLA GUADALUPE - AVE. BALBOA
- B.C. 5 DE MAYO
8 VILLA GUADALUPE - VIA PORRAS
- B.C. 5 DE MAYO

(3) PROPOSED BUS ROUTE FROM BUS BASE 3

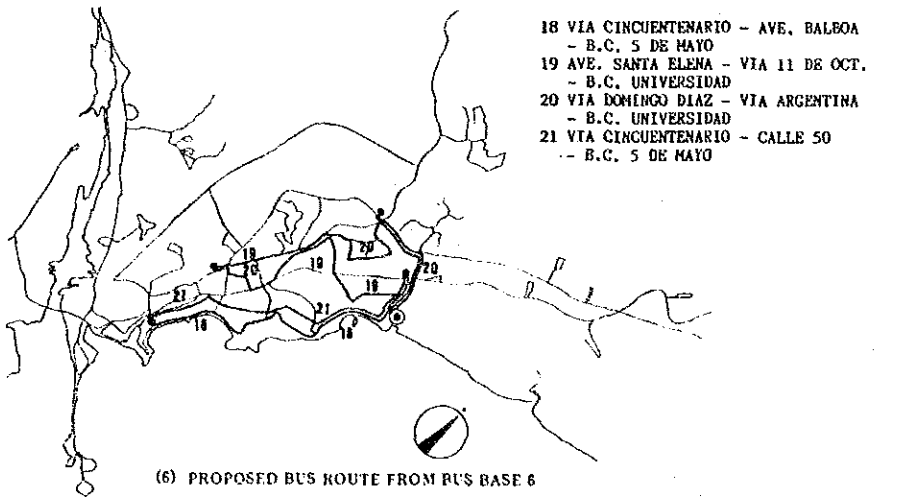
FIGURE IV-1-1(1) PROPOSED BUS ROUTES IN ESTAMPA MASTERPLAN II



(4) PROPOSED BUS ROUTE FROM BUS BASE 4



(5) PROPOSED BUS ROUTE FROM BUS BASE 5



(6) PROPOSED BUS ROUTE FROM BUS BASE 6

FIGURE IV-1-1(2) PROPOSED BUS ROUTES IN ESTAMPA MASTERPLAN II

TABLE IV-1-3 BUS PASSENGER GENERATION/ATTRACTION BY ZONE

Zone	Generation and Attraction			Difference in Period			Ratio of Change		
	Year 1981	Year 1990	Year 2000	1981/1990	1990/2000	1981/2000	1981/1990	1990/2000	1981/2000
1	24971	25589	23955	618	-1634	-1016	1.02	0.94	0.96
2	36787	49319	52535	12532	3216	15748	1.34	1.07	1.43
3	70568	90513	91091	19945	578	20523	1.28	1.01	1.29
4	29533	60379	66630	30846	6251	37097	2.04	1.10	2.26
5	73675	78264	75479	4589	-2785	1804	1.06	0.96	1.02
6	11001	16110	15063	5109	-1047	4062	1.46	0.94	1.37
7	53528	61082	67943	7554	6861	14415	1.14	1.11	1.27
8	19197	50360	69416	31163	19056	50219	2.62	1.38	3.62
9	10139	29229	38910	19090	9681	28771	2.88	1.33	3.84
10	17241	40724	50467	23483	9743	33226	2.36	1.24	2.93
11	28702	66061	85485	37359	19424	56783	2.30	1.29	2.98
12	8847	16404	18560	7557	2156	9713	1.85	1.13	2.10
13	18432	25993	29465	7561	3472	11033	1.41	1.13	1.60
14	15967	26313	28658	10346	2345	12691	1.65	1.09	1.79
15	20265	27609	31809	7344	4200	11544	1.36	1.15	1.57
16	17975	21347	22561	3372	1214	4586	1.19	1.06	1.26
17	24492	39942	45270	15450	5328	20778	1.63	1.13	1.85
18	24725	31469	34920	6744	3451	10195	1.27	1.11	1.41
19	31457	39301	42728	7844	3427	11271	1.25	1.09	1.36
20	10237	16635	19075	6398	2440	8838	1.62	1.15	1.86
21	22651	28763	31117	6112	2354	8466	1.27	1.08	1.37
22	18117	23446	27832	5329	4386	9715	1.29	1.19	1.54
23	30787	36560	59951	5773	23391	29164	1.19	1.64	1.95
24	31774	46322	81936	14548	35614	50162	1.46	1.77	2.58
25	27243	66550	110463	39307	43913	83220	2.44	1.66	4.05
26	2724	8829	11937	6105	3108	9213	3.24	1.35	4.38
27	17171	50473	91380	33302	40907	74209	2.94	1.81	5.32
28	37667	44942	53182	7275	8240	15515	1.19	1.18	1.41
29	22822	31496	40825	8674	9329	18003	1.38	1.30	1.79
30	29394	35492	43315	6098	7823	13921	1.21	1.22	1.47
31	22713	49495	67562	26782	18067	44849	2.18	1.37	2.97
32	14366	28735	44571	14369	15836	30205	2.00	1.55	3.10
33	18035	37195	94742	19160	57547	76707	2.06	2.55	5.25
34	7920	20313	41434	12393	21121	33514	2.56	2.04	5.23
35	23497	59569	84055	36072	24486	60558	2.54	1.41	3.58
36	16737	38910	49084	22173	10174	32347	2.32	1.26	2.93
37	1230	1659	1904	429	245	674	1.35	1.15	1.55
38	793	1274	1580	481	306	787	1.61	1.24	1.99
39	7089	12406	24739	5317	12333	17650	1.75	1.99	3.49
40	1320	12183	32405	10863	20222	31085	9.23	2.66	24.55
41	4134	45448	64339	41314	18891	60205	10.99	1.42	15.56
42	1567	8473	17812	6906	9339	16245	5.41	2.10	11.37
43	4984	15116	22130	10132	7014	17146	3.03	1.46	4.44
44	70747	172735	307299	101988	134564	236552	2.44	1.78	4.34
45	963	4085	5312	3122	1227	4349	4.24	1.30	5.52
Total	984184	1693112	2320926	708928	627814	1336742	1.72	1.37	2.36

Source: ESTAMPA MASTERPLAN

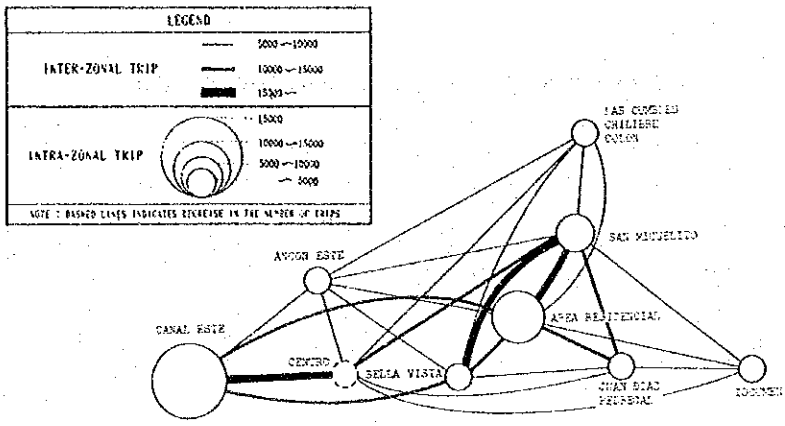


FIGURE IV-1-2(1) CHANGE IN PUBLIC TRANSPORT TRIPS FROM 1980 TO 1990

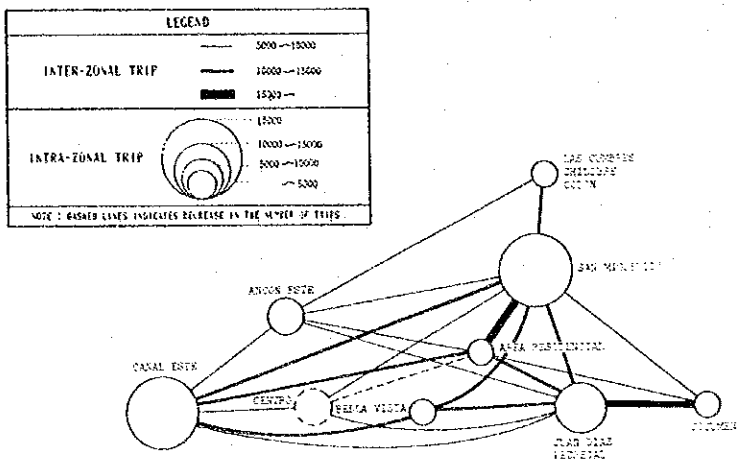


FIGURE IV-1-2(2) CHANGE IN PUBLIC TRANSPORT TRIPS FROM 1990 TO 2000

a. While the increase in the number of trips related to the Centro area is very small in all directions, the number of trips between the centro and urban areas tends to decrease.

b. In gerneral there is a very large increase in the number of trips not related to the Urban Areas.

c. The changes in the movement between the zones shown below are remarkable in their volumes and rates of increase after the year 1990, especially for the zones of Juan Diaz, Pedregal, and San Miguelito.

Bella Vista - Juan Diaz, Pedregal
Area Residencial - Juan Diaz, Pedregal
Juan Diaz, Pedregal - Tocumen
San Miguelito - Las Cumbres, Chilibre, Colon
San Miguelito - Canal Oeste

(2) Basic Concept for the Establishment of the Bus Network

The bus service, which should be added to the bus network in the year 2000, is as follows, based on the network recommended in the ESTAMPA Masterplan (see FIGURE IV-1-3):

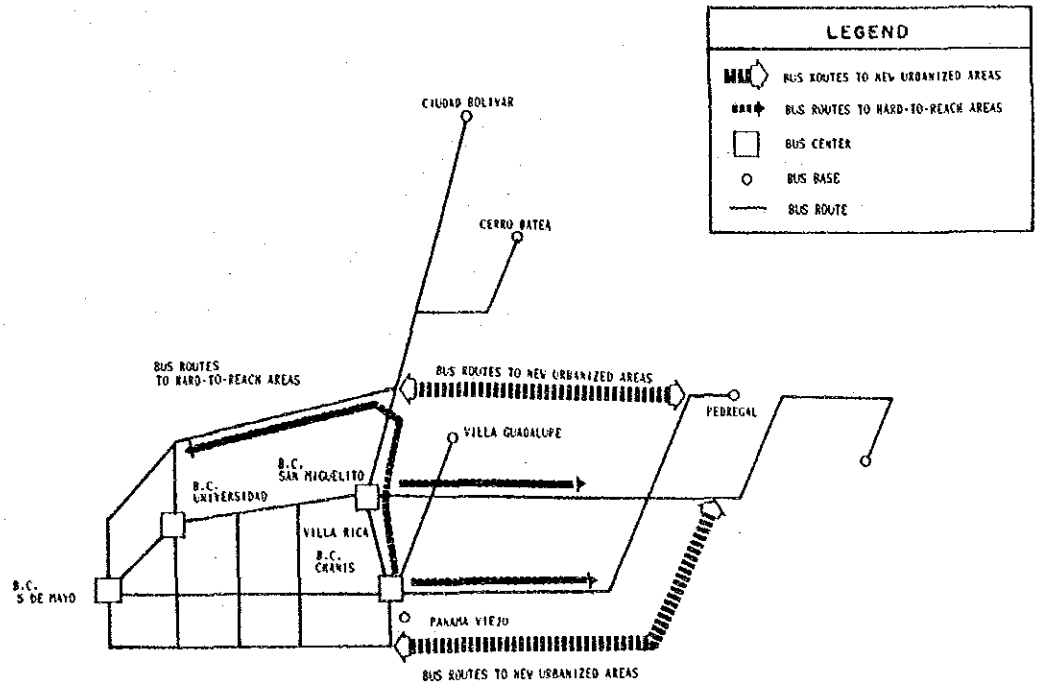


FIGURE IV-1-3 BUS SERVICE DIRECTIONS NECESSARY IN YEAR 2000

1) Bus Routes to the Newly Urbanized Areas

These bus routes are established according to the development of these areas. They are established mainly in the areas along Corredor Sur and Corredor Norte. The newly urbanized areas are Hipodromo, Juan Diaz, La Pulida, and Cerro Viento.

2) Bus Routes to Hard-to-Reach Areas

The introduction of this type of bus route is in order to strengthen the ties between the areas which are very difficult to reach using the bus routes recommended in the ESTAMPA Masterplan. These routes are introduced between the areas along Corredor Norte and the eastern areas.

(3) Network Alternatives for the Year 2000

According to the basic concept described above, the routes which should be established after the year 1990, are as follows (see FIGURE IV-1-4):

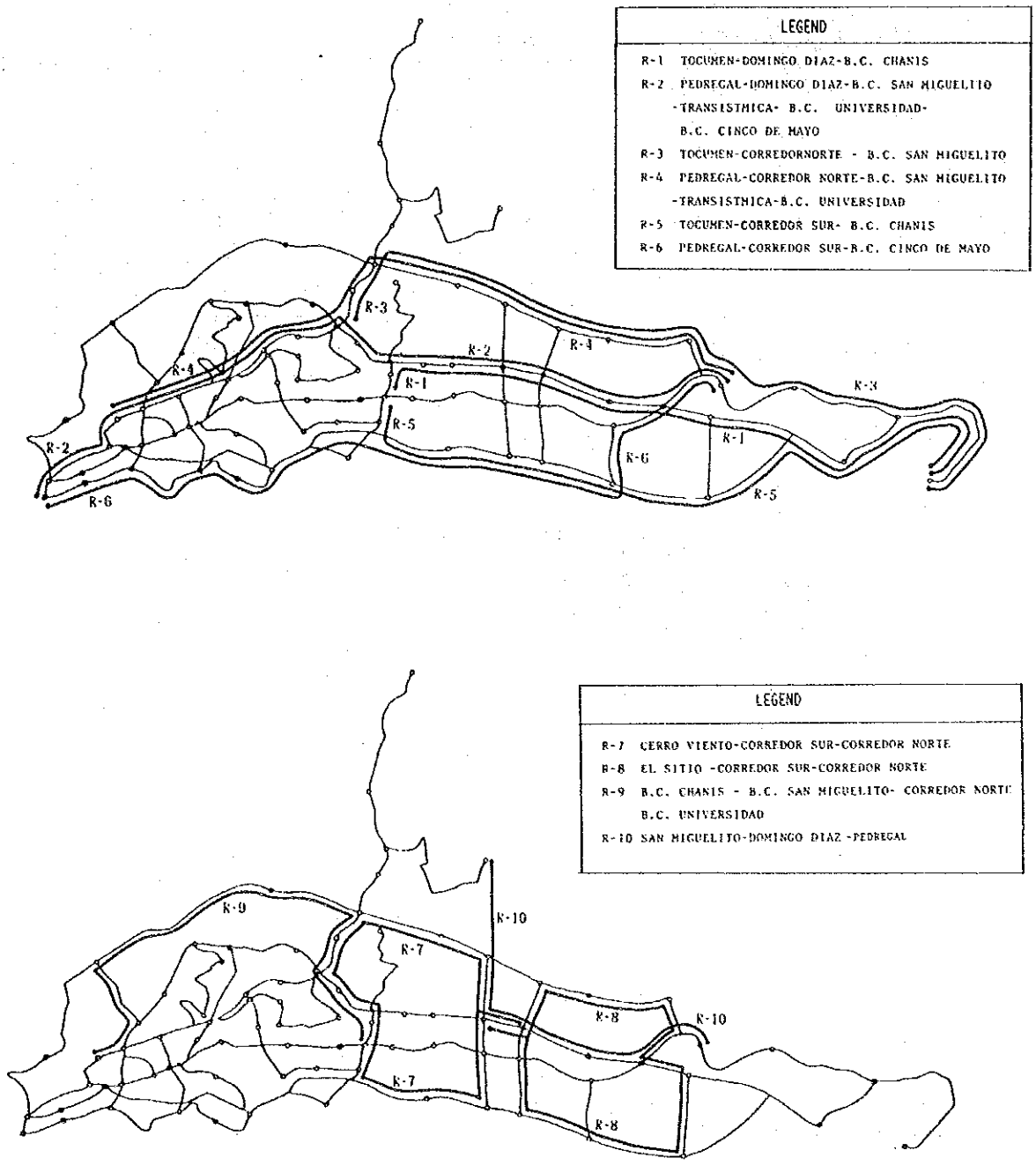


FIGURE IV-1-4 ALTERNATIVE BUS ROUTES ADDED FOR YEAR 2000

a. Routes to strengthen the bus routes in Via Domingo Diaz (R-1, 2)
b. Establishment of bus routes along Corredor Norte (R-3, 4)
c. Establishment of bus routes along Corredor Sur (R-5, 6)
d. Establishment of bus routes for circulation within the eastern areas (R-7, 8)
e. Establishment of combined bus routes between Los Andes and the eastern areas (R-9)
f. Establishment of combined bus routes between the suburban areas (R-10)

The main reason for establishing the bus routes is to strengthen the bus service to the area of Cerro Viento, where the establishment of a commercial area will be planned. Another reason is to create a core in the eastern area with the Pedregal area, where a commercial area has already appeared.

TABLE IV-1-4 PROPOSED BUS NETWORK IN YEAR 2000

Route No.	Distance (km)	Travel Time (min.)	Passengers (pas./day)	Fleet (buses)	Frequency (times/day)	Sales/Costs Ratio
1	26.5	53.0	49700	31	474	1.618
3	41.0	85.4	94100	78	750	1.015
4	40.4	107.7	65400	67	507	1.059
5	23.0	63.1	20800	15	189	1.506
6	39.5	110.7	25100	17	122	1.434
7	30.2	77.1	32700	14	151	1.338
8	30.6	102.3	150300	135	1082	1.217
9	46.5	111.6	29900	21	153	1.192
10	37.9	83.3	41700	34	329	1.388
11	40.7	103.4	93200	91	719	1.089
12	44.2	119.9	69700	59	404	1.131
13	44.3	128.1	185000	148	948	1.112
14	29.2	81.2	14400	10	99	1.265
15	16.0	50.6	20400	16	264	1.151
19	18.9	51.9	6400	3	52	1.720
20	26.0	80.4	31200	21	218	1.390
21	22.0	84.8	15600	15	148	0.655
R-1	39.3	84.0	41100	34	331	1.352
R-2	46.3	115.4	131200	127	900	1.053
R-3	45.8	101.0	23600	19	153	1.378
R-4	38.7	87.8	25000	19	179	1.268
R-5	41.8	86.7	17700	13	122	1.447
R-6	43.2	112.3	51100	45	326	1.275
R-7	39.6	97.8	21700	19	160	1.046
R-8	39.2	96.3	27100	27	225	0.936
R-9	31.6	71.0	26600	14	158	1.420
Total			1310700	1092	9163	1.175

Source: ESTAMPA

(4) Method of the Study

All bus routes on common segments have a competitive relationship with each other, and a complementing relationship in the sense of achieving the purpose of reaching a destination by transfer; therefore each route cannot be studied independently of the others.

The bus network, including the bus routes recommended in the ESTAMPA Masterplan and the alternative bus routes mentioned before, were analyzed, as well as the optimum bus network, in order to maximize operation efficiency, repeating the assignment with the Bus Trip OD Table for the year 2000. In the ESTAMPA Masterplan, 21 bus routes where recommended, but two of those routes are a minibus service within the Casco Viejo Area. As these two routes are not needed in the study of routes on Corredor Sur, only 19 bus routes are to be considered.

1-3 ASSIGNMENT METHOD OF BUS TRAFFIC DEMAND

(1) Bus Demand Forecasting Model

The bus demand assignment, has been done through the preparation of a model which permits the assignment of the demand for trips by buses, corresponding to each line, while considering the existing competition among the enterprises. The model used for calculating the demand by bus route, consists of four submodels (see FIGURE IV-1-5). These submodels are: 1) the calculation of the OD table; 2) the identification of bus routes; 3) the calculation of the demand; and 4) the calculation of the frequency.

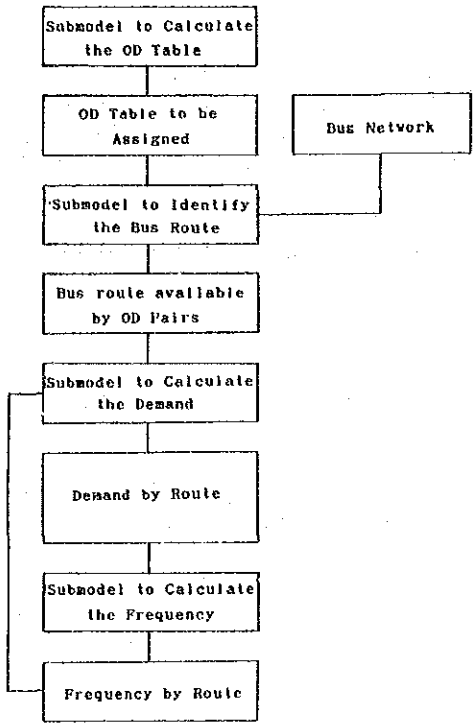


FIGURE IV-1-5 FLOW CHART OF BUS ASSIGNMENT MODEL

1) Submodel to Calculate the OD Table

The OD Table to be assigned is calculated in this submodel. First, the present OD table is calculated. Then, the future OD table is calculated using the FRATAR Method.

2) Submodel to Identify the Bus Route

The bus routes available by OD pairs are selected in this submodel. When there are some direct bus routes by OD pair, those bus routes are selected. When there are no direct bus routes, then the two bus routes selected are such that the trip time is minimum.

3) Submodel to Calculate the Demand

The bus routes selected in the submodel for identifing the bus route, are not always single. Bus demand is distributed to each bus route in proportion to the frequency of bus by the route.

4) Submodel to Calculate the Frequency

Frequency is calculated based on the maximum demand by section. At first, the assignment is conducted under the same conditions for the frequency by route. Then, the assignment is repeated until the balance between maximum demand by the section and service capacity is obtained.

(2) Zoning

The demand by section is a decision based on the bus routes. So, the 57 zones which were used in the road assignment are not convenient for the bus assignment. Used instead, are 63 zones in which some bus stops are integrated along the bus routes.(See TABLE III-2-1)

(3) Method for Calculating Various Parameters

1) Frequency

The frequency by route is calculated so that the average congestion rate becomes 80%, against the maximum demand by section.

$$\text{Frequency} = \frac{\text{Maximum Demand by Section (1 day, 1 way)}}{\text{60 passengers x 0.80}}$$

2) Necessary Bus Fleet

The bus fleet by route is calculated using the bus frequency during the peak hour and travel time.

$$\text{Bus Fleet} = (\text{Bus Frequency in Peak Hour} \times \text{Travel Time}) \times \text{Contingency}$$

Frequency during the peak hour is calculated using the maximum demand by section (one way), in the peak hour, and the bus capacity (60). The contingency is estimated to be 1.10.

$$\text{Frequency in the Peak Hour} = \frac{\text{Maximum Demand By Section in Peak Hour.}}{\text{60 x Planning Congestion Rate}}$$

Here, the planning congestion rate in the peak hour is selected to be 120%.

3) Total Vehicle-Kilometer and Total Vehicle-Hour

The total vehicle-kilometer and total vehicle-hour values are calculated by multiplying the route distance and the travel time by the frequency by route, respectively.

4) Sales/Costs Ratio

The only income, comes from the bus fare, and it is calculated by multiplying the bus fare by the number of passengers by route. Only 90% of this income is considered as actual income, taking into account the reduced fares for students.

Income = (Number of Passengers by Route x Bus Fare)
x 300 (days) x 0.90

The total costs were running costs (for example, fuel, oil, tires, parts, repairing, etc.) and fixed costs (for example, depreciation, capital cost, labor costs, tax, insurance, etc.). Total running costs were estimated by multiplying the unit running cost of 38.44 cents per km by total vehicle-kilometer per year (one year is equivalent to 300 days). While the total fixed costs were computed by the unit fixed cost of 12,310 balboas per year times the bus fleet.

1-4 BUS SYSTEM PLANNING

1-4-1 Bus System Planning in the Year 2000

The alternative bus network recommended in Section 1-2, was revised several times so as to maximize the total operational efficiency. In this form, the optimum bus network shown in FIGURE IV-1-6 was selected. Some bus routes are low in profitability, but these routes do not have alternatives. The elimination of these bus routes would be very inconvenient to their users. So, these routes were adopted with the purpose of achieving the transportation mission. Bus routes which exceed 100,000 passengers per day are; bus route #8 (Cerro Batea, Via Cincuentenario, Via Porras, Cinco de Mayo Bus Center) and #13 (Chanis Bus Center, Via Espana, Via Cincuentenario, Cinco de Mayo Bus Center). These bus routes receive 35.6% of all passengers and represent 37.5% of the total bus fleet. Bus routes which are very profitable are; routes #1 (Alcalde Diaz, San Miguelito Bus Center), #6 (Cerro Batea, Ricardo J. Alfaro, Universidad Bus Center) and #19 (Chanis Bus Center, Ave. Santa Elena, Via Once de Octubre, Universidad Bus Center).

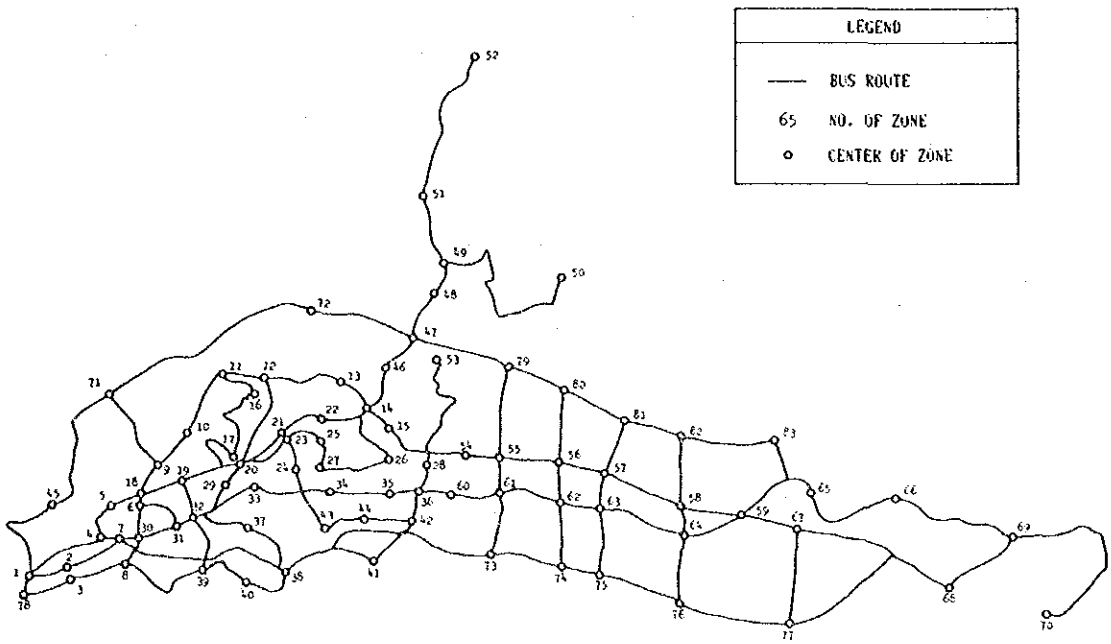


FIGURE IV-1-6 ZONING AND BUS NETWORKS

1-4-2 Characteristics of Bus Usage in Corredor Sur

The volume of passengers, the volume of buses, and the number of persons getting on/off in Corredor Sur are shown in FIGURE IV-1-7. It shows the volume of passengers increases in the direction going from the suburban area to Centro, and shows a maximum between Calle 50 and Via Cincuentenario (124,500 passengers/day). After Calle 50, the number of passengers decreases to a level between 40,000 and 60,000 passengers per day. The volume of buses also presents the same tendency, with an increase going in the direction from the suburban area to Centro, and also reaches a

maximum between Calle 50 and Via Cincuentenario (3,720 buses/day). There is a large number of persons getting on/off in the area between Ave. Federico Boyd and Via Cincuentenario, specially in the area along Via Brasil. The suburban areas where there is the largest number of persons getting on/off are along Via Ciudad Radial and Via San Miguelito-Chanis.

In the Study, the bus system planning considered mainly the feasibility of bus routes on Corredor Sur, with the year 2000, as the planning year. It was found to be clearly feasible to introduce bus routes on Corredor Sur, both in the suburban areas as well as in the built-up area. But, even if the bus routes were not so profitable, it is the mission of public transportation to secure the bus service, which is the only kind available, and to support adequate economic activities.

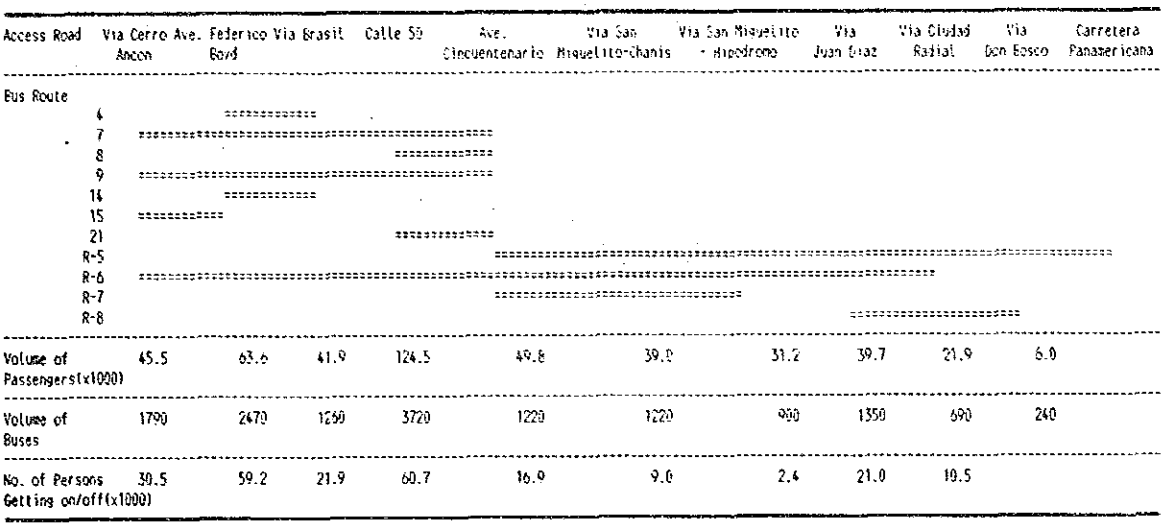


FIGURE IV-1-7 CHARACTERISTICS OF BUS SERVICE ON CORREDOR SUR

1-4-3 Consideration of Rail Transit

In the study, the system planning was performed without considering the introduction of a rail transit service recommended in the ESTAMPA Masterplan, but this is not to deny the necessity of a rail transit service. As shown in the three phases of ESTAMPA, the traffic movement and demand for public transport in Panama City has a characteristic which is suitable for the introduction of a rail transit service. That is the large volume of persons moving constantly in a particular direction. It has become apparent that answering the increasing demand for public transport solely with buses is very difficult. So it is very clear that there is a need to introduce a rail transit system in the near future before the year 2000.

A rail transit system has certain characteristics that are much better than those of the bus service, such as being able to run at high speed and provide a constant service; also, it is not subject to problems caused by traffic congestion. The introduction of a rail transit system

will definitely influence the system providing the bus service. Needless to say, the separation of functions will take place, with the rail transit system being the main form of transportation and the bus service providing a branch of transportation. To implement this separation of functions smoothly, it is important to change gradually to the form which is suitable for the introduction of the rail transit based transportation, and to minimize the friction with the organizations that operate the buses.

The introduction of bus routes in the planned future rail transit system, and the introduction of branch bus routes, were selected for change to a form suitable for the introduction of a rail transit system. In other words, the bus system planning recommended in the Study is an intermediary stage in the period of introduction of the rail transit transportation, and should be considered at the time of introduction of the rail transit system.

2. BUS YARD IMPROVEMENT PLANNING

2-1 PRESENT SITUATION

The bus transportation system in Panama operates with bus yards called "piqueras". The main function of these piqueras is to adjust the departure time of the buses from the piquera. These piqueras lack many facilities and many piqueras do not have their own parking area. In 1981, there were 25 piqueras. Between 1981, and 1986, 3 piqueras were established and 2 piqueras were eliminated. So, at the present time, there are 26 piqueras, as shown in FIGURE IV-2-1.

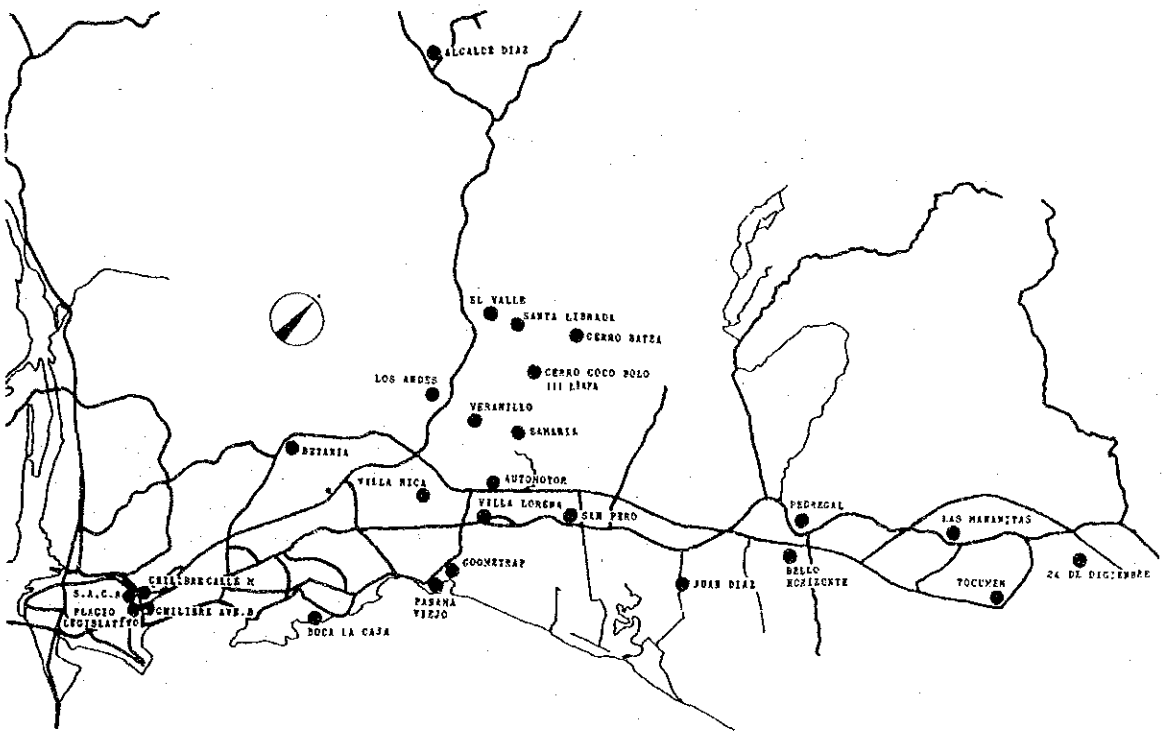


FIGURE IV-2-1 LOCATION MAP OF EXISTING PIQUERAS, 1986

The conditions of the facilities and the operations of those piqueras related to Corredor Sur (COOMETRAP, Panama Viejo, Boca La Caja, Bello Horizonte, and Juan Diaz) are shown in TABLE IV-2-1.

(1) Parking Space

The piquera of COOMETRAP has its own parking space in a private area, but the other four piqueras use the roadside areas as parking space.

(2) Facilities

The piquera of COOMETRAP has resting facilities, office, maintenance

TABLE IV-2-1 PRESENT CONDITIONS BY PIQUERAS IN YEAR 1986

Piqueras	Coometrap	Panama Viejo	Boca la Caja	Bello Horizonte	Juan Diaz
Parking spaces	P.A	P.R	P.R	P.R	P.R
Physical Facilities	A.F	N.F	N.F	N.F	N.F
Area (m)	25000	900	-	-	-
Route No.	1	2	9	49,50	30
Bus Fleet	12	26	55	40	50
Frequency	97	273	513	266	268
Departure	52	144	273	149	152
Arrival	45	129	240	117	116
Average Round Trip Time (min.)	131	100	87	165	164
Average Staying Time (min.)	36	38	39	58	72
Maximum Parking Buses	4	11	20	6	9

Note: P.A : Private area P.R : Public road
A.F : All facilities are available.
N.F : Has no facilities.
Source: ESTAMPA

facilities, gasoline pumps, and so on. This means that it has all the facilities necessary for a piquera. Nevertheless, the other piqueras have no such facilities.

(3) Bus Fleet and Frequency

According to the field survey, the piquera with the largest bus fleet is Boca La Caja (55 buses), then come Juan Diaz (50), Bello Horizonte (40), Panama Viejo (26), and COOMETRAP (12). Concerning frequency, Boca La Caja has the highest frequency (513 departures and arrivals from 5:00 a.m. to 9:00 p.m.), next come Panama Viejo (273), Juan Diaz (268), Bello Horizonte (266), and COOMETRAP (97). The round trip travel time for buses based on the piqueras of Bello Horizonte and Juan Diaz is about 3 hours. This is so because these piqueras are located in the suburban areas. Also, in these piqueras, the bus frequency is small compared to the bus fleet, and the average staying time at the piquera is long.

(4) Congestion

Except at the piquera of COOMETRAP, the maximum number of buses waiting to depart from the piqueras is very close to their capacity to hold the buses. So, in the future, those piqueras will not be able to accept an increase in the bus fleet. Even in COOMETRAP, where the present space is enough, parking space is occupied by around 100 buses which cannot operate because of mechanical problems and lack of spare parts.

2-2 ROLE AND FUNCTION OF BUS YARD

Most of the bus routes in Panama start from a suburban piquera, pass through the Plaza Cinco de Mayo, and reach the Casco Viejo. The departure time for the buses, resting time for the bus drivers, and so on, are arranged at the starting point, which is the piquera. There are no facilities available for bus passengers. At night, the buses are not parked at the piqueras. In the ESTAMPA Masterplan, 4 bus centers were recommended, and, in the ESTAMPA II, 6 bus bases were recommended. To provide a better bus service to passengers, it is desirable to establish the following facilities as bus operating facilities.

- Bus Center
- Suburban Bus Center
- Bus Base
- Satellite Bus Base

The role and function of each facility is as follows.

1) Bus Center

Bus Centers are established at the eastern and northern entrances to the Urban Area of the City from the suburban area, and at the center of the Urban Area. They will make it easier and more comfortable for passengers to wait and to transfer to the other routes.

2) Suburban Bus Center

Suburban bus centers are located at the main transferring points in the suburban areas. They will make it easier to transfer to other routes. They will also make it possible to reduce operating costs by being used as turning points between the route segments with larger demand. This will make it unnecessary to travel all the way back to the bus center. Also, they will make it possible to operate according to the demand.

3) Bus Base

Bus bases are the main departure point for the bus routes of a given sector. In these bus bases, the departure time for buses will be arranged, minor mechanical checking will be done, resting facilities will be available to the bus drivers, and so on. Also, these bus bases will provide parking space for the buses overnight.

4) Satelite Bus Base

It is difficult to provide efficient service for demand scattered in the suburban areas with only bus bases. Satellite bus bases will make it possible to establish efficient bus routes in the suburban areas.

The concept map for these facilities is shown in FIGURE IV-2-2. The bus centers will be located in Plaza Cinco de Mayo, Universidad, San Miguelito, and Chanis, as was recommended in the ESTAMPA Masterplan. The bus bases will be located in Ciudad Bolivar, Cerro Batea, Villa Guadalupe, Pedregal, Villa Rica, and Panama Viejo, as was recommended in ESTAMPA II. Some bus bases will make use of the existing piqueras; other bus bases will be newly established. Satellite bus bases may utilize existing piqueras,

except those used by the bus bases. The suburban bus centers will be constructed in San Isidro, Los Andes, Cerro Viento, and Pedregal Sur, where there will be many transferring passengers.

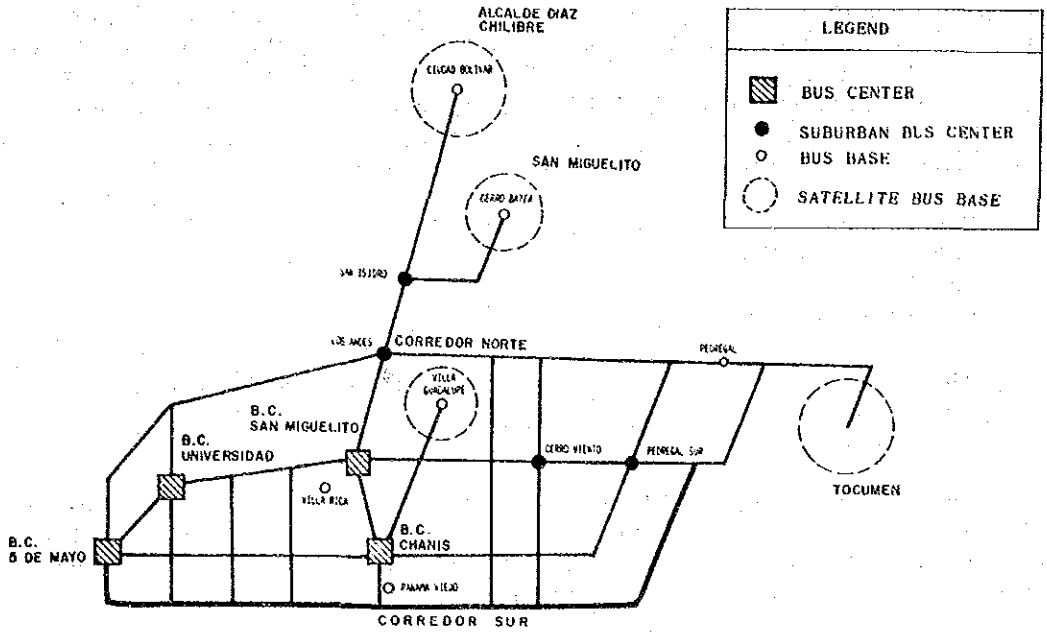


FIGURE IV-2-2 CONCEPT MAP OF BUS OPERATIONAL FACILITIES

2-3 ORGANIZATION OF PLANNING CONDITIONS

(1) Bus Yards Subject to the Study

For the bus yards examined in the Study, the following four places were chosen for their relationship with Corredor Sur (See FIGURE IV-2-3):

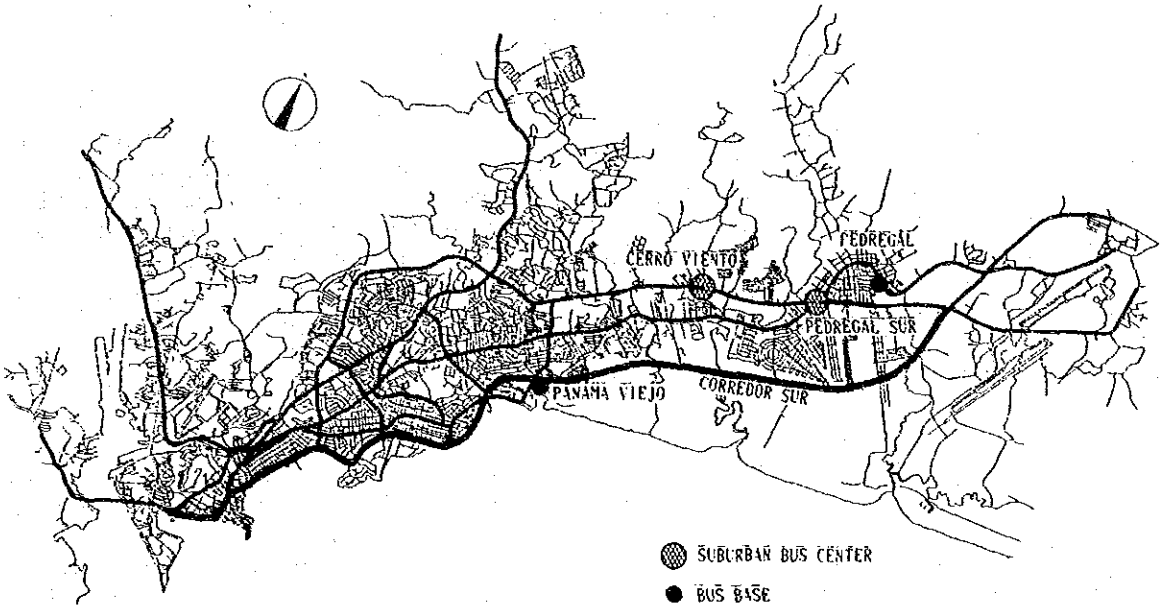


FIGURE IV-2-3 BUS YARDS SUBJECT TO STUDY

- o Pedregal (bus base)
- o Panama Viejo (bus base)
- o Pedregal Sur (suburban bus center)
- o Cerro Viento (suburban bus center)

These bus yards differ in nature and planning themes.

1) Pedregal

This is a bus base for eastbound city bus routes, and will accomodate the largest number of buses among the six bus bases proposed in ESTAMPA II. The bus base will basically function as a parking space for buses not in operation. For the Pedregal Bus Base, it may be possible to consider a scattered bus parking system in order to avoid a large investment.

2) Panama Viejo

This is a bus base for southbound city bus routes of Panama City. Its scale is not very big, and it is preferable to use the existing facilities effectively, because the base is planned in a fairly urbanized area.

3) Pedregal Sur

This is situated at the entrance of Pedregal and Tocumen where a population increase is a noticeable trend. Since many bus routes converge here, it is expected to have the highest number of bus transferers in the east area. A recent trend has been a dramatic increase in the construction of commercial facilities in this area, so that it is expected to become a commercial nucleus in the future. Especially important is the relationship with surrounding urban functions and population flow planning. This should be planned in conjunction with the overall plan for the surrounding areas.

4) Cerro Viento

At present there is little concentration of urban facilities, but there are plans to turn the area into a suburban type commercial area in the future. The area is also being considered as the beginning and ending points for a rail transit system, and has the potential to become a nucleus of the east area. In order to facilitate the introduction of a rail transit system, it is advisable to plan for facilities from a long-term standpoint rather than being limited to immediate measures.

(2) Demand of Bus Yards

For the bus bases, it is necessary to estimate the number of buses to be parked, and for the suburban bus centers, the number of berths required. TABLE IV-2-2 gives the design number of buses for the bus bases. TABLE IV-2-3 gives the number of berths required for the bus centers. For Pedregal (bus base), it was estimated assuming that 50% of the total number of buses to be operated in the east area will be accomodated. The number of berths for the bus centers is also estimated based on 30 buses/hour/berth.

TABLE IV-2-2 PLANNING CAPACITY OF BUS BASES

	Pedregal	Panama Viejo
No. of Buses *	250	39
Effect of the Railway Transit	-45%	-45%
Planning Capacity	140	25

Note: * No.of Buses :which may use the Bus Base based on the "without Railway Transit".
** 50% of Buses in the Eastern Area.
Source: ESTAMPA

TABLE IV-2-3 DEMAND FOR SUBURBAN BUS CENTERS

	Pedregal Sur	Cerro Viento
No. of Buses *	6800	4500
Effect of the Railway Transit	-35%	-25%
Planning Capacity	4400	3400
Peak Hour Traffic	440	340
Average Turn Over (min/bus)	2	2
Berths Required	15	12

Note: * No. of Buses: which may use the Suburban Bus Center, based on "Without Raiway Transit"
Source: ESTAMPA

(3) Bus Yard Facilities

The main facilities to be provided at the bus centers (terminals) can be enumerated as follows:

a. Passenger-related Facilities:

Embarkation/Disembarkation platform, concourse, shelter, etc.

b. Service-related Facilities:

Information booth, paging room, tea room, waiting room, kiosk, lavatory, public telephone booth, parcels office, locker room, etc.

c. Management-related Facilities:

Control room, administrative office, crew resting room, restaurants, guardmen's room, night duty room, etc.

d. Vehicle-related Facilities:

Terminal entrance/exit, guide ramp, driveway, bus start/stop space, non operating bus waiting space, simple repair/ adjustment space, bus washing space, fueling station, etc.

The possible facilities to be provided at the bus bases include a company administration office (headquarters functions) in addition to the management and vehicle-related facilities listed above. With reference to the contents of bus center facilities as proposed by the ESTAMPA II, the installation of facilities shown in TABLE IV-2-4 can be considered.

TABLE IV-2-4 FACILITIES FOR SUBURBAN BUS CENTERS AND BUS BASES

Facilities			
Facility Group	Facility	Suburban Bus Centers	Bus Bases
Facilities for Passengers	1.Platform	●	
	2.Concourse	●	
	3.Information Center	●	
	4.Lavatory	●	
	5.Cafeteria	●	
	6.Kiosk	●	
	7.Telephone Booth	●	
	8.Waiting Hall	▲	
	9.Restaurant	▲	
	10.Locker Room	▲	
Other Facilities	1.Traffic Sign	●	
	2.Sun/Rain Shade	●	
	3.Street Light	●	
	4.Green-belt	▲	
	5.Flower Bed	▲	
Facilities for Administration	1.Administration Office	●	●
	2.Operation Room	●	●
	3.Driver's Room	●	●
	4.Rest Room	▲	●
	5.Guardmen's Room	▲	▲
Facilities for Vehicles	1.Entrance/Exit Road	●	●
	2.Circulation Road	●	●
	3.Parking Space for bus	●	●
	4.Toll Gate	●	
	5.Mechanical Repair Shop	▲	●
	6.Fuel Stand	▲	●
	7.Bus Wash Stand	▲	●
	8.Parking Space for cars	▲	▲

Source: ESTAMPA ● : Necessary ▲ : Optional

(4) Design Criteria

1) Vehicle Types

Nearly 30 types of buses are now operating in Panama City. Various characteristics of the principal bus types are as shown in TABLE IV-2-5. Since Pegaso 600 of the cab-over type is the largest bus in size, although there are only a few of these, the size of this bus shall be used as the basis for the design of the bus yards. Since buses in the Panama Urban Area are expected to change to a larger type in the future, the foregoing assumption is adequate and necessary. The size of the buses for design shall be set at a 12m length, 2.5m width, 3.2m height, and 5.8m for the axle pitch.

TABLE IV-2-5 DIMENSIONS OF BUSES FOR DESIGNING BUS FACILITIES

Type	Model	Seat Capacity	Overall Length(L)	(wb)	(or)	(b)	(t)	(H)	(h)	Turning Radius (Mini)
Bonnet	Mitsubishi B-370	71	10.50	5.60	3.50	2.49	1.85	3.50	0.25	10.50
Bonnet	Thomas B. 325m	72	11.25							
Cab-Over	Isuzu BC151P	81	10.40	5.34	2.94	2.49	2.02	3.02	0.26	9.30
Cab-Over	Pegaso 6000	73	11.30	5.60	3.35	2.50	2.02	3.02		
Design Criteria			12.00	5.80	3.60	2.50	2.02	3.20	0.26	10.80

Source: ESTAMPA

2) Rotational Radius

Buses shall turn around a central point (point O in FIGURE IV-2-4) on a line extended from the rear axle. The loci drawn by every part results in concentric circles around point O as the center. Calculating the rotational radii based on the various factors of buses as set forth in subparagraph (a) above, results in; 10.8m for the minimum rotational radius (minimum distance from point O to the front outer projection tip), 9.7m for the rear outer limit radius and 5.8m for the inner limit radius.

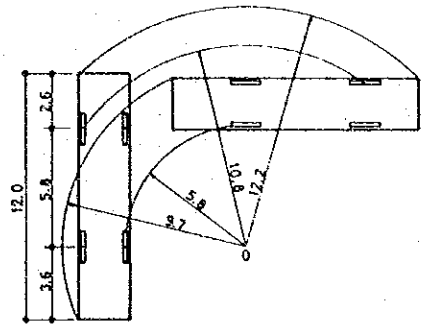
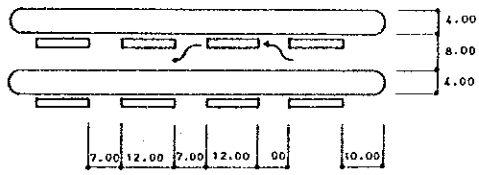


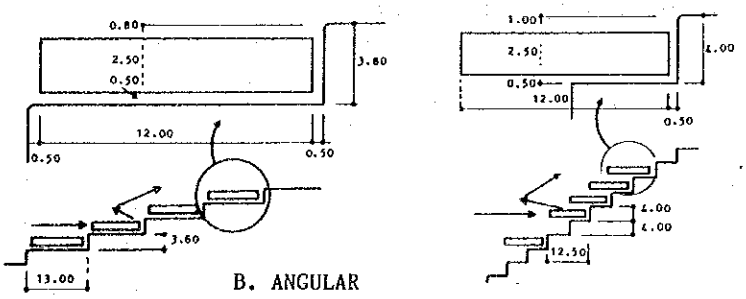
FIGURE IV-2-4 TURNING RADIUS OF BUSES

3) Bus Stops

Embarkation/disembarkation berths provided may be parallel or perpendicular to the platform. The former are not economical in terms of the use of space, but they are easier in operation and also advantageous timewise. The latter can achieve an economical use of space, but is both troublesome in the starting manipulation and dangerous, especially when the passengers tend to cross behind the bus by ignoring the moving line. The required dimensions in each case are given in FIGURE IV-2-5.



A. PARALLEL (FRONT IN-OUT)



B. ANGULAR

FIGURE IV-2-5 STANDARD DESIGN OF PLATFORMS

4) Arrangement of Parking Spaces

When determining the parking spaces, consideration must be given to the clearance between the bus and other buses or fence and to the width of the door opening/closing for the driver's embarkation/disembarkation. A clearance of 50cm and a width of 75cm for door opening/closing is generally considered to be sufficient. The dimensions (13.00L x 3.25W m) caculated by adding 100cm to the design vehicle length and 75cm to the width shall be determined as a parking space. The parking method consists of forward and backward parking. Backward parking has the advantage of requiring a narrower driveway width than for forward parking, but the disadvantage of being more hazardous. For large buses, therefore, forward parking and start are preferable. The parking space layout can be divided broadly into the parallel and angular types. The former requires parking vehicles either at one or both sides of the driveway in parallel to the length of the driveway. The latter entails parking vehicles at an angle to the length of the driveway. The parallel parking method which is chiefly used for bus terminals, requires a narrower driveway width, but a longer extension. The angular parking method has the advantage of allowing vehicles to be parked or started without relation to other vehicles. The driveway width, unit parking space width and required parking area per bus for each parking method are as shown in TABLE IV-2-6 and FIGURE IV-2-6.

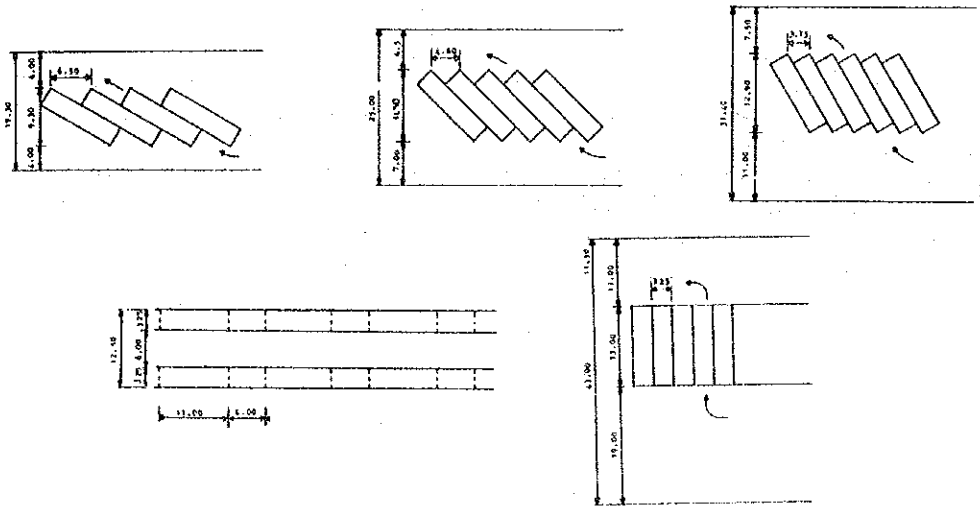


FIGURE IV-2-6 EXAMPLES OF PARKING LOT ARRANGEMENTS

TABLE IV-2-6 MINIMUM PARKING SPACE FOR BUSES

Parking Angle (deg.)	Parking Method	Path Width (Aw)	Length of Parking Space Measured Perpendicular to the Path (Sd)	Width of Parking Space Measured Parallel to the Path (Sw)	Unit Parking Length (W)	Unit Parking Area (A)	Remarks
30	Front-in	4.00	9.30	6.50	14.30	93.0	
	Front-out	6.00					W = (Aw1+Aw2)/2 + Sd
45	Front-in	7.00	11.50	4.60	18.25	84.0	
	Front-out	6.50					A = W x Sw
60	Front-in	11.00	12.90	3.75	22.15	83.1	
	Front-out	7.50					
90	Front-in	19.00	13.00	3.25	28.00	91.0	
	Front-out	11.00					
Parallel	Rear-in	6.00	3.25	19.00	6.25	118.8	
	Front-out						

Source: ESTAMPA

2-4 PRELIMINARY DESIGN

2-4-1 Suburban Bus Centers

For the rectangular space of land facing Via Domingo Diaz, five alternatives consisting of different bus berths and bus movement combinations were chosen, as shown in FIGURE IV-2-7.

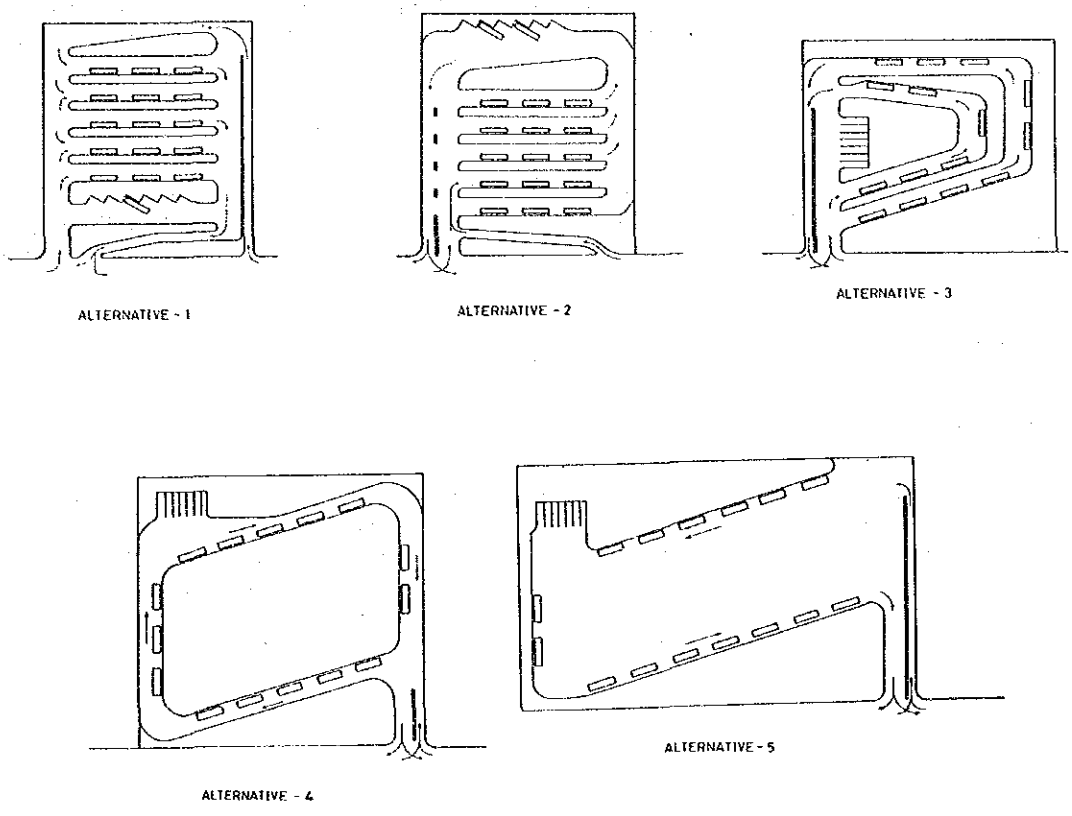


FIGURE IV-2-7 ALTERNATIVE PLANS FOR SUBURBAN BUS CENTERS

1) Alternative 1

This is a plan to arrange in parallel the bus berths of the parallel parking method with two entrances/exits, thus requiring the installation of a deck for pedestrians which will limit the passenger approach and make the bus moving lines complicated at the entrances to the bus stops.

2) Alternative 2

The bus moving lines in Alternative 1 are improved, resulting in a one-way bus flow, but the passenger approach remains limited, as in Alternative 1.

3) Alternative 3

This is a plan to arrange the bus berths in a curve to achieve a separation between the vehicle and passenger moving lines. Since a fair amount of unused space is generated, facing the road, it is possible to use this in combination with other facilities, thus allowing the achievement of the sophisticated use of land.

4) Alternative 4

This is a plan to integrate the bus berths into one, thus resulting in a reduction in the crossing between the vehicle and passenger moving lines, as in Alternative 3 above. This type needs more area than Alternative 1, 2 and 3.

5) Alternative 5

This is a plan to arrange the bus berths around the outside circle, thus completely eliminating the crossing between the vehicle and passenger moving lines, also making the bus flow simple. This type needs more area than others.

2-4-2 Bus Bases

(1) Pedregal

As many as 140 buses are to be accommodated in the Pedregal bus base. This means that 1 ha. or more of land is required for parking space only. How to reduce the required area and at the same time to assure the safety and convenience inside the base becomes, therefore, a key point in the planning. Assuming a square lot has only one side facing the road, FIGURE IV-2-8 gives an example of that design.

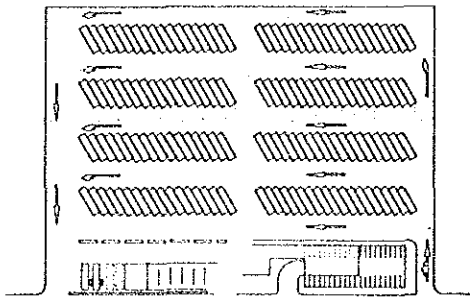


FIGURE IV-2-8 LAYOUT OF PEDREGAL BUS BASE

1) Entrance/Exit

The entrance/exit location is greatly affected by the surrounding road conditions, naturally restricting the planning of movement within the

parking yard. A bus base as such is a major source of traffic generation, so it is preferable to locate the entrance/exit along a road where it will cause no trouble to the vehicle traffic. Also, if there are many buses involved, it is necessary to separate the entrance and exit so that buses may not be jammed at either one. For Pedregal, it is therefore proposed to locate the entrance and exit separately in order to achieve a reduction of traffic jamming .

2) Bus Flow in Bus Base

Inside the bus base, a one-way circulating operation system shall be adopted in order to avoid the complication of moving lines. Since the walking distance to the administration building becomes longer owing to many parking buses occupying the driveway, a pedestrian line shall be provided at a right-angle to the driveways.

3) Arrangement of Parking Spaces

Because of the many parked buses, the parking method of a 60-degree angle to the driveways shall be adopted in order not to generate wasteful space (forward parking and start).

4) Facilities

Bus base related facilities are the administration building (administration offices, crew rest room, canteen, conference room, lavatory, etc.), parking lot for employees' vehicles, fuel station, car washing place, vehicle maintenance shop, etc. The vehicle maintenance shop will offer such light maintenance services as inspection, adjustment, replacement, oil change, repair of flat tires, etc. Maintenance services other than the foregoing shall be provided at the bus maintenance center proposed in ESTAMPA II.

(2) Panama Viejo

25 buses are to be accommodated at the Panama Viejo bus base. This number is smaller than that of the Pedregal bus base. However, it's bus turnover rate is assumed to be high. Ways to assure safety inside the base and how to arrange the entrance/exit in order not to affect the traffic in the connecting road, are key points in planning. FIGURE IV-2-9 shows an example of that design.

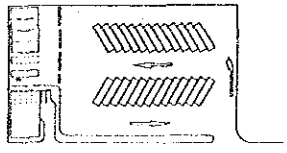


FIGURE IV-2-9 LAYOUT OF PANAMA VIEJO BUS BASE

1) Entrance/Exit

The number of buses to be accommodated in this base is small, and it is located in the Urban Area. Therefore, it is proposed to arrange only one entrance/exit in order to reduce the affect on traffic in the connecting road.

2) Disposition of Moving Lines

Since the number of parking buses is small, they can be parked in two lines. Only one driveway for parking is proposed, in order to reduce the area required.

3) Arrangement of Parking Spaces

The angular parking method of 60-degrees to the driveway shall be adopted. (Front-in, Front-out)

4) Facilities

The content of the facilities is similar to the Pedregal bus base, but smaller in scale.

3. BUS STOP PLANNING

3-1 PRESENT SITUATION

The present situation of bus stop facilities, and their use, are studied in this section. The results presented here are based on the survey of bus stops located along the existing route related to Corredor Sur. The summary of the bus stop survey is shown in TABLE IV-3-1.

TABLE IV-3-1 CONTENTS OF BUS STOP SURVEY

Items Surveyed	Contents of Survey	Bus Stops Surveyed
Bus Stop Facilities	Location Facilities	58 Bus Stops along the existing roads related to the Corredor Sur
Operational Conditions	Service Time Congestion	Plaza Amador(Ave.'A') Entrance of Pedregal (Ave.J.M.Torrijos) Teatro Opera(Via Espana) Clinica San Fernando (Via Espana)

Source: ESTAMPA

3-1-1 Bus Stop Facilities

According to the bus stop survey, among the facilities which should be in a bus stop, roof and bus bay are available in about 40% of the bus stops (See TABLE IV-3-2). "Bus Stop" sign exists in only 5% of the bus stops. Either a roof or a bus bay, or both of them, exist in about 64% of the bus stops. In the absence of a "Bus Stop" sign, the existence of any of those facilities (roof or bus bay) may indicate that a bus stop is located there. The other facilities considered in the survey (light, bench, trash can, ornamental plant, tree, advertisement, etc.) exist in about 20% of the bus stops. Also, there exists only one bus stop with a kiosk. On the other hand, there are no facilities in about 20% of the bus stops.

3-1-2 Operating Conditions of Bus Stops

(1) Persons Getting On/Off - Service Time

The histogram of persons getting on/off per bus, and the service time per bus are shown in FIGURE IV-3-1 and IV-3-2. In the bus stop of Pedregal, the number of persons getting on/off per bus ranges from 6 to 54. In the other bus stop, the number of persons getting on/off ranges from 1 to 20, and in most of these bus stops, this number is lower than 10 persons per bus. At the Pedregal bus stop, the service time per bus ranges from 33 seconds to 200 seconds. In the other bus stops, the service time per bus

TABLE IV-3-2 FACILITIES AT BUS STOPS

Facilities	Quantity	Percentage*
Roof	26	45
Bay	21	36
Stop Signal	3	5
Illumination	11	19
Seats	13	22
Rubbish Dump	9	16
Ornamental Plants	9	16
Trees	13	22
Publicity	9	16
Stand	1	2
Nothing	11	19

* Percentage means the bus stop rate related with the respective facilities.

Source: ESTAMPA

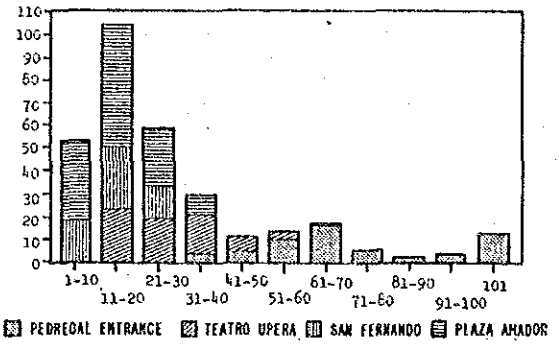


FIGURE IV-3-1
PASSENGERS GETTING ON/OFF PER BUS

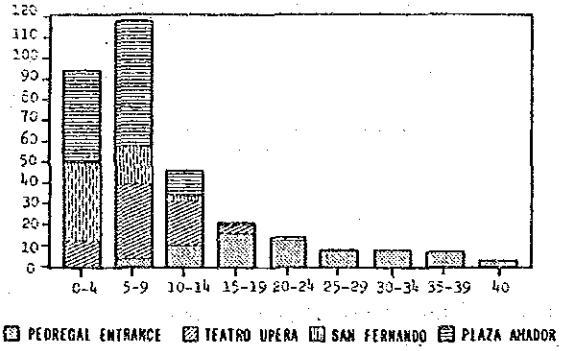


FIGURE IV-3-2
SERVICE TIME AT BUS STOPS

ranges from 1 second to 51 seconds. In the above, the Pedregal bus stop shows the widest range of values. The average service time per person is shown in TABLE IV-3-3. Most average service times per person range from 3 to 4 seconds. People who are getting on a bus take about the same amount of time as people who are getting off a bus. The increase in service time at the bus stop results in an increase in traffic congestion and a reduction in operating speed. So, it is desirable to design bus stops in such a way that they do not interfere with the flow of vehicles, especially those bus stops where there are many persons getting on/off. Also, it is desirable to use buses with one door for passengers to get on and another for passengers to get off.

TABLE IV-3-3 SERVICE TIME PER BUS PASSENGERS

Bus Stop Location	8:00-10:00		12:00-14:00		16:00-18:00		Total	
	Descent	Ascent	Descent	Ascent	Descent	Ascent	Descent	Ascent
Int.Pedregal	3.11	3.38	3.12	3.00	4.39	3.79	3.47	3.43
Teatro Opera	3.19	4.32	3.41	3.20	3.56	3.55	3.33	3.54
San Fernando	3.49	3.20	2.68	3.71	3.67	3.89	3.24	3.61
Plaza Amador	3.45	3.20	3.66	2.94	4.27	2.69	3.80	2.95

Source: ESTAMPA

(2) Congestion

1) Probability of Other Vehicles Waiting Behind the Bus

The relationship between bus volume at the bus stop and the probability of other vehicles waiting behind the bus is shown in FIGURE IV-3-3. It is apparent that the greater the number of buses, the greater the probability of other vehicles waiting behind a bus. Especially, if there is no bus bay, when the volume of buses is larger than 40 buses per each 30-minute period, the probability of waiting behind a bus increases abruptly. On the other hand, where there is a bus bay, the probability of waiting behind a bus does not increase, even if the volume of buses increases. This means that bus bays allow other vehicles to pass smoothly around the bus stop, and so, prevent an increase in traffic congestion. In cases where there are no bus bays, the probability of waiting behind a bus is much higher for the cases with two-lane roads than for those of four-lanes. Nevertheless, it is necessary to construct bus bays at all bus stops, even in four-lane roads, except when the volume of traffic in the road is minimal.

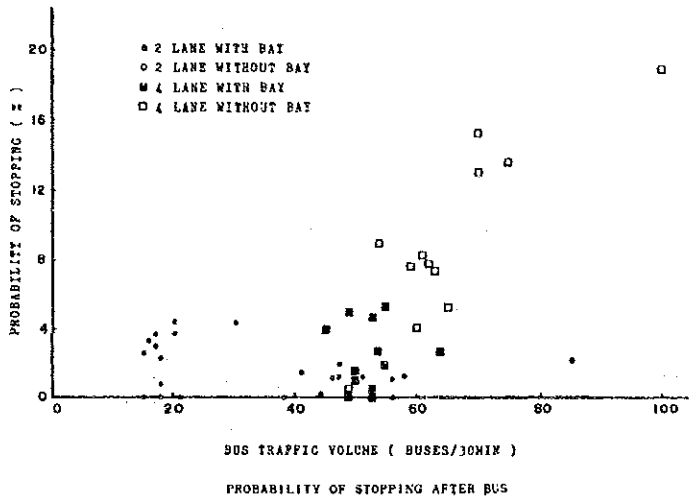


FIGURE IV-3-3 PROBABILITY OF WAITING VEHICLES BEHIND BUSES AT BUS STOPS

2) Number of Buses at the Bus Stop at the Same Time

The maximum number of buses converging at the same bus stop is shown in FIGURE IV-3-4. For a bus volume flow of above 50 buses per 30-minute period, the number of buses at the bus stop at the same time increases proportionally to the total volume of buses on the road. But below this volume, the number of buses waiting at the bus stop ranges from 2 to 4, independently of the bus volume.

FIGURE IV-3-5 gives a cumulative probability distribution of the number of buses that stop simultaneously at bus stops. This indicates that two or less buses provide for 90% of the total when the bus traffic is under 60 buses/30 min. (2,400 buses/day); if traffic is greater than this, the number of stopped buses increases, requiring space for five buses in order to provide for 90% of the total to be dispensed with smoothly.

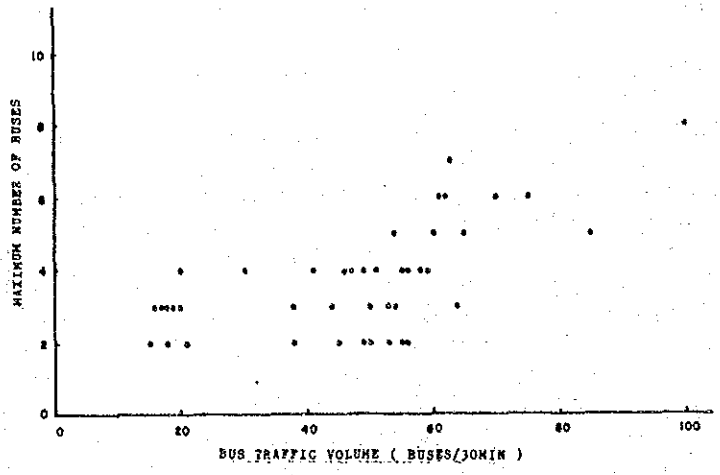


FIGURE IV-3-4 MAXIMUM NUMBER OF BUSES STOPPING AT BUS STOPS

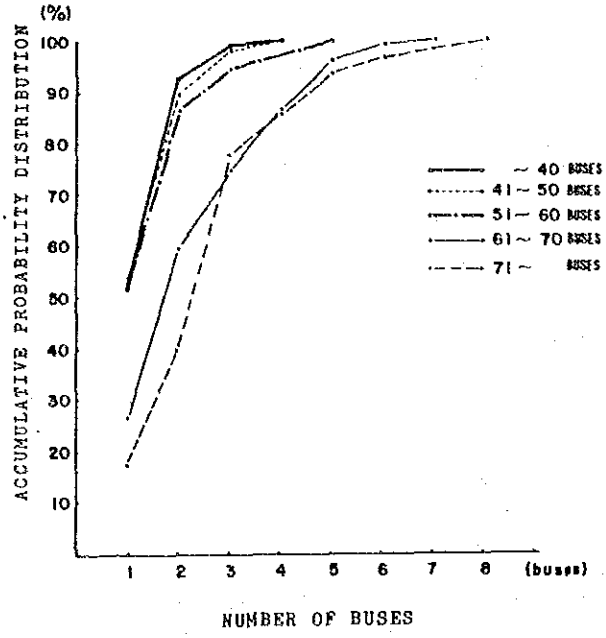


FIGURE IV-3-5 CUMULATIVE PROBABILITY DISTRIBUTION OF NUMBER BUSES AT BUS STOP BY BUS VOLUME

3-2 BASIC CONCEPT OF BUS STOP PLANNING

3-2-1 Distance Between Bus Stops

The distance between bus stops is related to the time it takes to to walk to the bus stop and the bus operation speed. That is, the longer the distance between the bus stops, the longer the time it takes for a person to walk to it, and the higher the bus operation speed. On the other hand, the shorter the distance between the bus stops, the shorter the walking time, and the lower the bus operation speed.

The average distance between bus stops for main routes is shown in TABLE IV-3-4. This distance is 220 meters in Ave. Central, 300 meters in Via Espana, 450 meters in Ave. Balboa, 500 meters in Via Ricardo J. Alfaro, and 720 meters in Via Simon Bolivar. As indicated, these distances are very different for each location.

TABLE IV-3-4 AVERAGE BUS STOP INTERVAL OF MAIN ROAD

	Bus Section Distance(Km)	Average Interval(m)
Ave. Centeral	1.1	220
Via Espana	9.4	300
Via Simon Bolivar	13.0	720
Via RIcardo J. Alfaro	10.1	500
Ave. Balboa	5.0	450

Source: ESTAMPA

FIGURE IV-3-6 shows the relationship between the bus stop distance and the average bus operation speed. On the assumption that maximum operation speed is 60 km/hr, and if the distance between bus stops is changed from 400 meters to 600 meters, the operation speed changes from 39.5 km/hr. to 44.5 km/hr., with acceleration and deceleration assumed to be 1.0 m/s2 and -2.0 m/s2, respectively. In the case of a 40 km-long bus route, the round-trip time decreases from 61 minutes to 54 minutes. This means that the bus fleet necessary to service this route is reduced from 9 to 8 buses, when the distance between bus stops is changed from 400 meters to 600 meters.

FIGURE IV-3-7 shows opinions concerning the time it takes to walk to the bus stop. When the walking time is 5 minutes, about 50% of the people felt this to be a very convenient distance. Beyond 5 minutes, the percentage of people who felt this was a convenient distance decreased abruptly. According to the above description, bus stops should be placed every 300 to 500 meters, and, in areas of low population density, the distance should be limited to 800 meters.

When the bus stop is placed near an intersection, it is desirable to place the bus stop after the intersection (going in the direction of the traffic flow) because the affect of this positioning usually reduces traffic congestion before the intersection.

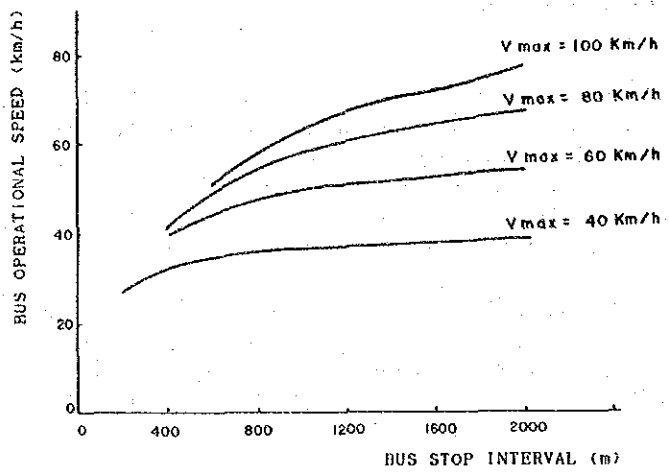


FIGURE IV-3-6 RELATIONSHIP BETWEEN BUS STOP INTERVAL AND BUS OPERATION SPEED

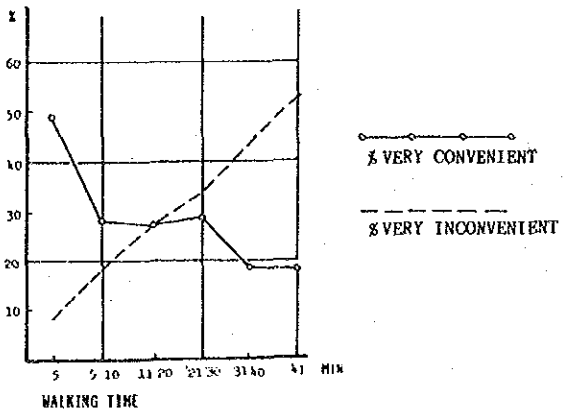


FIGURE IV-3-7 OPINIONS ON WALKING TIME TO BUS STOPS

3-2-2 Criteria for Establishing/Design Standards of Bus Bays

As shown in Section 3-1, the establishment of bus bays reduces traffic congestion near the bus stops. So, the establishment of bus bays is recommended in some cases.

(1) Criteria for Establishing Bus Bays

The bus bay should be established at bus stops where the bus volume is larger than 40 buses per 30-minute period (1,600 buses per day) because, at volumes higher than this, the probability of waiting increases abruptly. Nevertheless, if the congestion rate is high, or the level of safety is low, then bus bays should be established even for bus volumes lower than 40 buses per 30-minute period.

(2) Design Standard

The typical structure for a bus bay is shown in FIGURE IV-3-8. As a general rule, bus bays should be separated from the main lanes of the road by a refuge island.

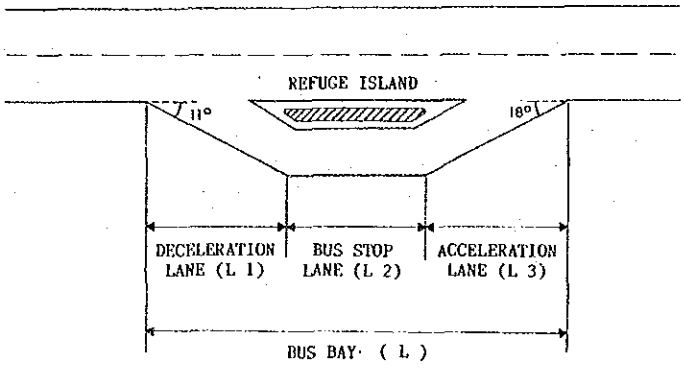


FIGURE IV-3-8 STANDARD DESIGN OF BUS BAYS

1) Length of Bus Bay

In Panama, the angles of the deceleration and acceleration lanes are 11 degrees and 18 degrees, respectively. So, the length of the deceleration and acceleration lanes are determined by the width of the bus stop lane. The length of the bus stop lane is determined by the waiting-bus capacity, and it should be at least 12 meters for each bus waiting in the bus bay.

2) Width

The width of the bus stop lane and the speed change lanes should be at least 3.5 meters. The width of the bus stop (including the waiting-passenger area) should be wide enough to allow an area for waiting passengers to get on/off and also for people who are walking on the sidewalk.

3) Number of Berths Required

Considering the service level required for the smooth operation of 90% of the total number of transit buses, the number of berths required shall be determined, based on the following standards.

a. 1,600 to 2,000 buses/day 2 berths
b. 2,000 to 2,400 buses/day 3 berths
c. 2,400 buses/day or more 5 berths

3-2-3 Facilities

The purpose of passenger action at the bus stop can usually be classified as follows:

a. Verification of the existence of the bus stop
b. Waiting for the bus
c. Verification of the bus
d. Getting on the bus
e. Getting off the bus
f. Walking to final destination (after getting off the bus)

TABLE IV-3-5 shows the purpose, actions, normal facilities, and required functions that are present at a bus stop. There are several bus stop related facilities, but it is difficult to decide which facilities should be made available. For example, the use of the bus stop is no problem to people who are familiar with taking a bus, even if there are no facilities at the bus stop. This familiarity, which permits them to be used without requiring special knowledge, is one of the merits of the bus system. However, owing to the considerable importance of bus service in Panama, it is necessary to provide a safer and more comfortable service. Also, it is desirable to construct some facilities which maintain or increase the status of the bus system.

The necessity, probability, and efficiency of several facilities are shown in TABLE IV-3-5.

TABLE IV-3-5 ACTIONS AND FACILITIES AT BUS STOP

(Purpose)	Recognition of Bus Stop	Waiting for Bus		Recognition of Bus	Getting on/off	Walking to the Final Destination
(Action)	-Looking for Bus Stop	-Placing of Objects Carried	-Using Telephone	-Noticing Bus	-Walking to Bus	-Checking of Destination
	-Walking to Bus Stop	-Sitting	-Reading Newspaper	-Verification of Bus Destination	-Waiting for Passengers Getting off	-Starting to Walk
	-Verification of Bus Destination	-Evading Pedestrian -Protecting from Rain and Wind	-Smoking -Eating Snack		-Getting on	
	-Checking of Arrival Time	-Protecting from Sun Rays	-Talking		-Paying Money	
	-Checking of How to Ride and Amount of Bus Fare Required	-Waiting Still			-Getting off	
	-Checking of Line and Determination of Waiting Period				-Walking from Bus	
(Facility)	-Bus Stop Sign	-Bench	-Telephone		-Map of Area around Bus Stop	
	-Pedestrian Bridge	-Shelter (Roof, Wall)	-Light		-Pedestrian Bridge	
	-Time Table	-Tree	-Trash Can			
	-Route Diagram	-Ornamental Plant	-Ash Tray			
	-Other Information	-Bus Bay	-Kiosk			
(Required Function)	-High Visibility -High Safety -Reliable Information	-Comfortable -Separation from Pedestrian		-High Visibility	-High Safety	-Reliable Information -High Safety

Source: ESTAMPA

1) Bus Stop Sign

Bus stop signs exist in 5% of the bus stops, according to the bus stop survey. Nevertheless, it seems that the locations of the bus stops are very well known. This is the reason why people often take buses, and why people who take a bus for the first time can get information from almost anyone. This is very effective, in the sense that no signs are required to indicate bus stops. On the other hand, some passengers take the bus at places other than the established (official) bus stops. This reduces road safety, and also reduces bus operation speed, owing to the frequent stops. However, this is a very convenient system for some people, in that it is similar to owning a car, where people can be transported almost from door to door. Nevertheless, this should be done only in the suburban areas, where the number of passengers is small, where the distances between the bus stops are long, and where there is a low frequency of service. It should not be policy in urban areas because it results in lower operation speed and reduced road safety. Therefore, bus stop signs should be placed for the purpose of indicating the location of bus stops and a bus service to passengers at places other than bus stops should be prohibited, especially in urban areas.

Signs such as orientation signs placed far from the bus stops should be planned in accordance with the sign system and rules set forth in the area, and used primarily to indicate main facilities such as bus centers.

2) Pedestrian Bridge

People must cross the street when they return to their initial point of departure in order to take the bus going in the opposite direction, or when they want to go to the bus stop on the other side of the road. In Panama City, there are few guard fences; so, many pedestrians (including people who have disembarked or who are going to take the bus on the other side of the road) cross the roads at many places. This is very dangerous, especially when crossing the road just in front or behind a bus (where the danger of crossing the road increases owing to the obstruction created by the bus in the field of vision for drivers on the road). It is desirable to establish guard fences at the bus stops to prevent bus passengers and other pedestrians from crossing just in front or behind the bus, and pedestrian bridges at bus stops where many passengers get on/off.

FIGURE IV-3-9 shows the standard design for a pedestrian bridge. The clearance under the girder is 4.0 meters. The floor slab height ranges from 4.5 to 5.5 meters because the girder height ranges from 0.5 to 1.5 meters, depending on the style. The pedestrian bridge has a gradient of 1/2 and a landing of 2.0 meters.

3) Various Information Facilities (Time Table, Bus Route Diagram, and Other Information)

Information concerning the bus route, fare, and how to ride in a bus is unnecessary for persons who are familiar with taking a bus, but, for a person who has never taken a bus before, this information requires a long text to be fully explained. Furthermore, it is very expensive to place this information in all the bus stops. So, this kind of information should be placed mainly in the bus centers and suburban bus centers, where most of the bus routes will be concentrated in the future. It is not necessary to provide this information at each bus stop. The time table cannot be placed while the present system of operation, where the departure times for the

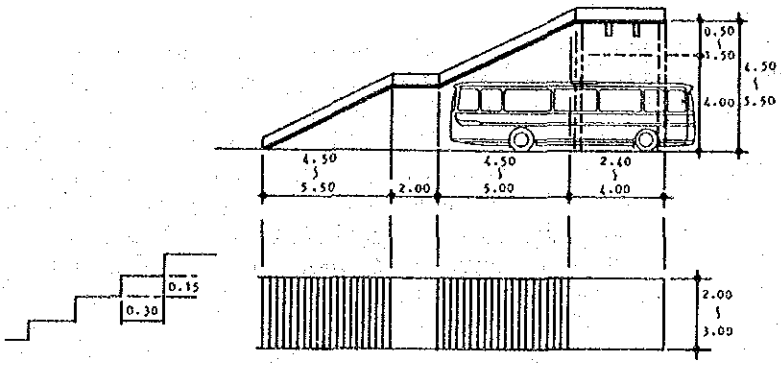


FIGURE IV-3-9 STANDARD DESIGN OF PEDESTRIAN BRIDGE AT BUS STOPS

buses are selected arbitrarily at the piquera, remains unchanged. The government should exert a greater control over the bus system network and require this network to provide a more effective and constant frequency of service.

4) Shelter (Roof and Wall)

It is desirable to place a roof at the bus stops to provide protection from the sun and rain. In a country such as Panama, which is both sunny and rainy, a roof is necessary. The roof also functions to designate the specific area of the bus stop because it makes it easier for pedestrians to distinguish between the bus stop and the sidewalk. The wall of a bus stop has the function of protecting the people from wind and rain. It can also be convenient as an information board. It prevents pedestrians from passing through the bus stop, and secures the waiting area. However, completely enclosing walls, can cause mental discomfort to some people; it is therefore necessary to consider that aspect. FIGURE IV-3-10 shows the standard design for a shelter adopted by DINTRAT.

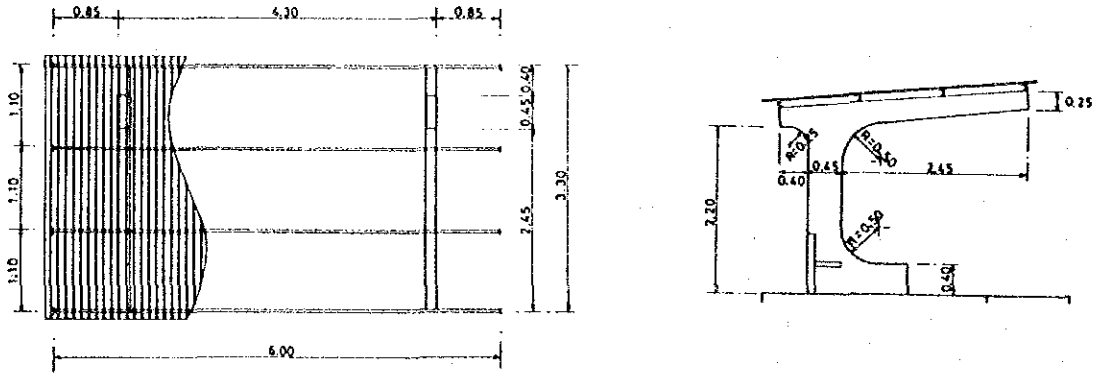


FIGURE IV-3-10 TYPICAL SHELTER FOR BUS STOPS IN PANAMA

5) Bench

People use benches as a place to put things on and to take a rest. According to the survey, there are benches only in some of those bus stops with a roof. The benches should be placed so that the rain cannot wet them.

6) Cleaning Facilities (Trash Can, Ash Tray etc.)

For keeping the bus stop clean, the establishment of a cleaning, maintenance program is more effective than placing cleaning facilities, such as a trash can or ash tray, in the bus stop. Nevertheless, if there are going to be cleaning facilities at the bus stop, then it is recommended that these facilities be of a long-lasting, strong kind.

7) Planting (Tree, Ornamental Plant etc.)

It is preferable to plant uniformly along the entire road, rather than at the bus stop only.

8) Service Facilities (Telephone, Kiosk, Map of Area around the Bus Stop)

It is not necessary to place these service facilities at the bus stop. It is better if they are placed in the surroundings of the bus stop because they (telephone, kiosk, etc.) are not only for the use of people at the bus stop but also for other people in the community.

3-3 IMPROVEMENT PLAN FORMULATION

3-3-1 Bus Stop Distribution Plan

FIGURE IV-3-11 gives the planned bus stop distribution map, the concept of which is explained as follows:

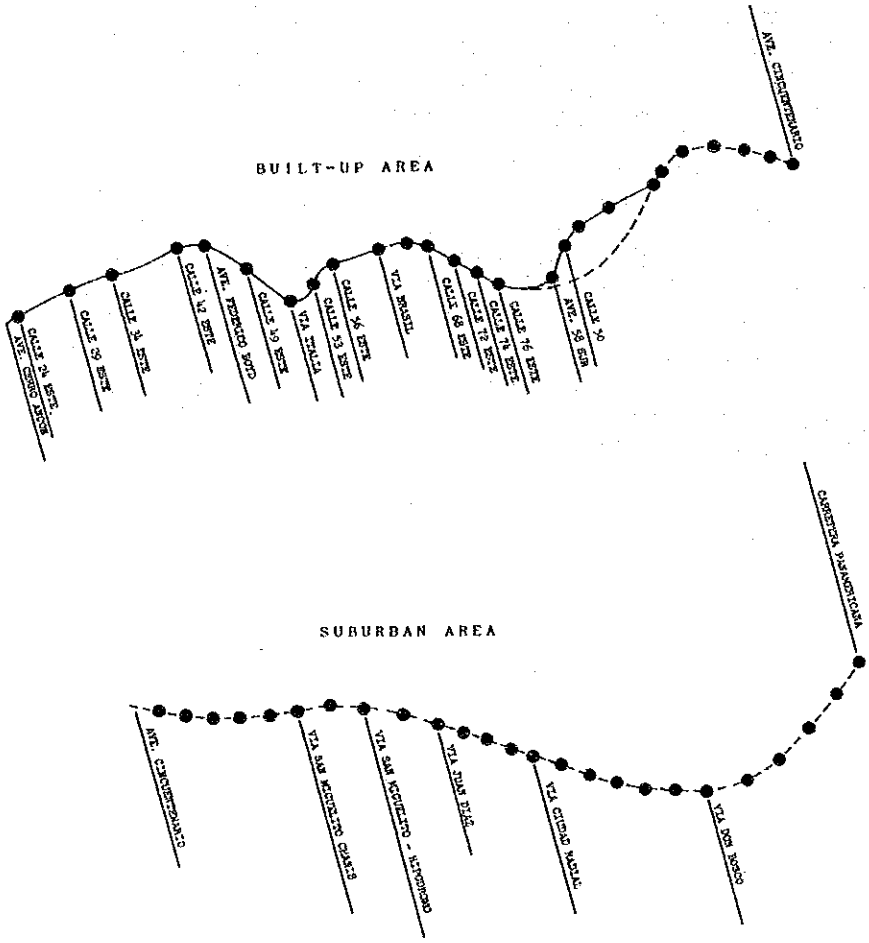


FIGURE IV-3-11 LOCATION PLAN OF BUS STOPS

(1) 5 de Mayo to Ave. Federico Boyd

The number of passengers can be estimated to be approximately 305,000/day. Examining the present number of passengers per bus stop reveals that the greatest number occurs around the intersections with Ave. Federico Boyd and fewer at all others. The bus stops shall, therefore, be installed at four locations, aiming at a 400m interval, which is slightly longer than at present.

(2) Ave. Federico Boyd to Via Brasil

Presently there are no bus stops in the 1km section between Ave. Federico Boyd and Via Italia. This is attributable to the fact that there are many private car-oriented buildings, such as expensive restaurants, along this route. It is planned that one bus stop be installed in the future. Since there are many facilities such as banks and schools in the area of Punta Paitilla and San Sebastian to the east of Via Italia, there are many bus users; it is estimated that 59,200 passengers/day would be concentrated in the 1km section. Four bus stops shall, therefore, be installed in this section, aiming at a 300m interval.

(3) Via Brasil to Calle 50

As a result of the number of schools, there are too many passengers relative to the number of buses operated in this section (large number of passengers per bus). The bus stop interval at present is usually within 200m. The minimum interval will be corrected to about 300m and seven bus stops will be provided, of which one will be in a new section (correction of detouring route in the airport) and two will be in the existing road section. In other words, while the route for Corredor Sur will be a new route along the seaside in the area of Coco Del Mar, instead of the existing road (Via Israel), the existing road shall be used as a bus route converging on Ave. E.T. fLefevre.

(4) Calle 50 to Ave. Cincuentenario

Corredor Sur in this section becomes a newly constructed route i.e. new routes at the seaside between Calle 50 and Ave. E.T. Lefevre and at the inland side between Ave. E.T. Lefevre and Ave. Cincuentenario. At present there are nearly 3 times the number of passengers between Ave. E.T. Lefevre and Ave. Cincuentenario. Reflecting this, the bus stop interval is 400m between Calle 50 and Ave. E.T. Lefevre and about 200m between Ave. E.T. Lefevre and Ave. Cincuentenario.

For the bus routes, the existing road (Ave. Cincuentenario) shall be used between Calle 50 and Ave. E.T. Lefevre, and Corredor Sur between Ave. E.T. Lefevre and Ave. Cincuentenario. Four bus stops (one per every 400m) shall be installed in the former section, and five (one per every 300m) in the latter section.

(5) Suburban Section (Ave. Cincuentenario to Corretera Panamericana)

The bus stops shall be installed at every intersection with the main access roads. For all other sections, considering the number of passengers, the number of bus stops to be installed shall be determined based on the intervals shown in TABLE IV-3-6.

3-3-2 Bus Bay Installation Plan

1) Bus Bay Intervals and Number of Buses Required

Considering the number of transit buses in each section of Corredor Sur as discussed in the "bus system plan" and the effects of introducing a

rail transit system, bus bays shall be installed in each section between Ave. Federico Boyd and Via Brasil and between Calle 50 and Ave. Cincuentenario, where bus traffic exceeds 1,600 vehicles/day (TABLE IV-3-7).

TABLE IV-3-6 AVERAGE INTERVAL OF BUS STOPS ON CORREDOR SUR BETWEEN EACH SECTION (SUBURBAN AREA)

Access Road	Average Intervals(m)	No. of Bus Stops
Via Cincuentenario	400	6
Via San Miguelito - Chanis	500	2
Via San Miguelito - Hipodromo	600	2
Via Juan Diaz	400	4
Via Ciudad Radial	400	6
Via Don Bosco	600	5
Pan American Highway		

Source: ESTAMPA

TABLE IV-3-7 BUS BAY ESTABLISHMENT PLAN

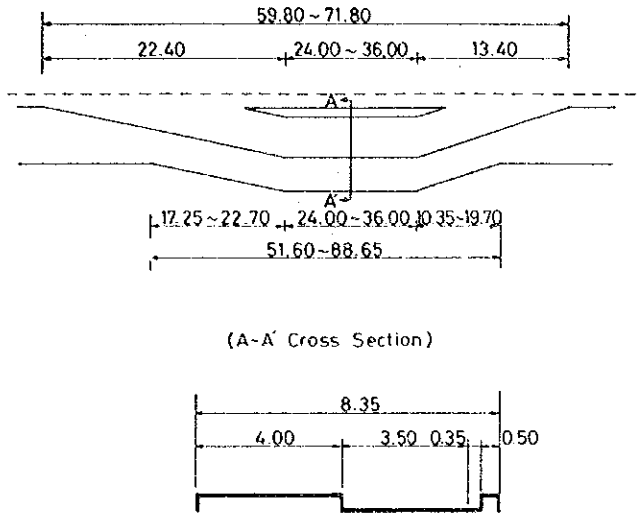
Access Road	No. of Volume	Affection by Railway Transit	Design Volume	Bus Bay	No. of Berth
Via Cerro Ancon	1790	-45%	990	No	-
Ave. Federico Boyd	2470	-20%	1980	Yes	2
Via Brasil	1260	-30%	890	No	-
Calle 50	3720	-35%	2420	Yes	3
Ave. Cincuentenario	1220	-15%	1040	No	-
Via San Miguelito - Hipodromo	900	-45%	500	No	-
Via Juan Diaz	1350	-20%	1080	No	-
Via Ciudad Radial	690	+15%	800	No	-
Via Don Bosco	240	-40%	150	No	-
Carretera Panamericana					

Note: * No.of Volume: which may pass the Corredor Sur based on 'without Railway Transit'.

Source: ESTAMPA

2) Bus Bay Installation Form

The standard configuration occurring where a bus bay is to be installed is given in FIGURE IV-3-12. The width of sidewalk where a bus bay is to be installed is 5.00m at maximum, but only 0.65m is available in the design cross section. Roads shall, therefore, be expanded to secure 3.00m for the sidewalk wherever a bus bay is to be installed. Since a frontage road is to be installed at the inland side between Maranon and Mataznillo, bus embarkation/disembarkation will be conducted along frontage roads; therefore, no bus bays will be provided.



(A~A' Cross Section)

FIGURE IV-3-12 STANDARD CROSS SECTION OF BUS BAYS

V. ROAD PRELIMINARY DESIGN

V. ROAD PRELIMINARY DESIGN

1. DESIGN CONDITIONS

1-1 GEOMETRIC DESIGN STANDARDS

(1) Geometric Design Speed

Most of the maximum operating speeds, which were used in the calculation of traffic assignment, were considered based on real speed regulations. Therefore, it is not proper to use them for the road design as the design speed, which should be greater than regulated speed. For this reason, the design speed was established in consideration with the desirable speed calculated in III-2-5, given the road functions and land use conditions along the roads, as shown in TABLE V-1-1.

TABLE V-1-1 DESIGN SPEED FOR EACH ROAD

Road Name	Section	Distance (Km)	Road Type	Design Speed (Km)
Corredor Sur	Maranon - ATLAPA	6.5	Improvement Road	60
	ATLAPA - Rio Abajo	3.2	New Construction Road	80
	Rio Abajo - Carretera Panamericana	11.7	New Construction Road	80
Via E.T. Lefevre	Corredor Sur - Via Espana	1.4	Improvement Road	60
Via San Miguelito - Chanis	Corredor Sur - Ave. 5A Sur	0.3	New Construction Road	
	Ave. 5A Sur - Ave. Jose A. Arango	0.8	Improvement Road	60
	ave. Jose A. Arango - Domingo Diaz	1.0	New Construction Road	
Via San Miguelito - Hipodromo	Corredor Sur - Ave. Jose A. Arango	1.1	New Construction Road	
	Ave. Jose A. Arango - STA.17 + 00	0.6	Improvement Road	60
	STA.17 + 00 - Ave. Domingo Diaz	0.3	New Construction Road	
Via Juan Diaz	Ave. Jose A. Arango-Ave. 10C Norte	0.7	Improvement Road	
	Ave.10C Norte-Domingo Diaz	0.2	New Construction Road	60
Via Ciudad Radial	Corredor Sur-Calle 144A Este	0.3	New Construction Road	
	Calle 144A Este-Ave.Jose A. Arango	1.2	Improvement Road	60
	Ave.Jose A. Arango-Ave.Domingo Diaz	0.7	New Construction Road	
Via Don Bosco	Corredor Sur-Ave. Domingo Diaz	2.2	New Construction Road	60
Corredor Sur Extension	Maranon - Ave. De Los Poetas	1.4	New Construction Road	40
	De Los Poetas	0.9	Improvement Road	

Source: ESTAMPA

1) Corredor Sur

a. Maranon -- ATLAPA:

60 km/h, keeping in mind that this section is part of the road improvement in the built-up area.

b. ATLAPA -- Rio Abajo:

80 km/h, since this transition section is located between the built-up and suburban areas , higher design speed should be introduced.

c. Rio Abajo -- Pan American Highway:

80 km/h, as this section in the suburban area with flat topographical conditions can be assigned a road function with the above-stated speed.

2) Main Access Roads

a. Via E.T. Lefevre

This road is important in that it connects the north and south parts of Panama City. However, the design speed was determined at 60 km/h, because the road must cross many other local roads within the built up area and because it can hardly be made into a high standard road.

b. Other Main Access Roads

Although the Main Access Roads to be connected to Corredor Sur will act as major trunk roads within the respective local areas, priority shall be given to the degree of service to the local areas, rather than to speed, in view of the nature of these roads. Therefore, the design speed was determined at 60 km/h.

3) Corredor Sur Extension

For the Corredor Sur Extension, frequent access rather than high design speed is required. In addition, the present concentration of houses and commercial buildings in this area creates a restriction.. Therefore, the design speed was set to 40 km/h, which is equivalent to that of intra-urban roads.

(2) Geometric Design

The standards of geometric design were established by the AASHTO calculation formula and with reference to the values adopted in Japan and Mexico, because Panama has no authorized design standard. The reference values are given in TABLE V-1-2. These geometric design standards shall be applied to the alignment of new construction roads. For the road improvement sections, the existing alignment will be kept as much as possible, except for roads with sections deemed to cause trouble in vehicle traffic, because of the restrictions arising from buildings, structures and land use along the routes.

TABLE V-1-2 GEOMETRIC DESIGN STANDARD

	Design Speed	80 Km / h 50 mph	60 Km / h 40 mph	30 Km / h 30 mph	40 Km / h 25 mph
I.	Horizontal Alignment				
1.	Minimum Radius				
	Minimum (e = 0.06)	250 m	130 m	80 m	50 m
	Absolute Minimum (e = 0.10)	210 m	110 m	70 m	40 m
	For Normal Crown	3500 m	2300 m	1750 m	1200 m
	For Remove Adverse Crown	2300 m	1800 m	870 m	450 m
	For Remove Transition Curve	2300 m	2300 m	1800 m	1200 m
2.	Minimum Curve Length				
	For Circular Curve	-----	-----	------	-----
	For Transition Curve 4 lane	70 m	60 m	50 m	45 m
II.	Sight Distance				
1.	Minimum Stopping Sight Distance	115 m	80 m	60 m	40 m
2.	Desirable Stopping Sight Distance	135 m	90 m	60 m	50 m
3.	Minimum Passing Sight Distance	540 m	400 m	300 m	270 m
III.	Vertical Alignment				
1.	Maximum Grade				
	Without Limitation	4 %	5 %	6 %	7 %
	With Length Limitation	F: 6 % 310 m R: 7 % 240 m H: 9 % 200 m	F: 7 % 160 m R: 8 % 130 m H:10 % 125 m	F: 8 % 130 m R: 9 % 110 m H:11 % 100 m	F : 9 % 350 m R :10 % 200 m H :12 % 100 m
	Minimum Vertical Curve				
	Crest	2600 m	1600 m	500 m	180 m
	Sag	2300 m	1700 m	600 m	200 m
	Desirable Vertical Curve				
	Curve Radius				
	Crest	4900 m	1900 m	600 m	200 m
	Sag	3000 m	2000 m	1000 m	500 m
	Minimum Vertical Radius	50 m	40 m	30 m	25 m

Note : F : Flat Area
R : Rolling Area
H : Hilly Area

Source : Policy on Geometric Standard for Rural Highway, AASHTO,
Manual del Proyecto Geometrico de Carreteras (Mexico) and Standard of Japan.