As the present one-way system which centers around the Centro area maintains a comparatively smooth flow of traffic, the improvement of the one-way system in the short-term perspective is considered to be unnecessary as the signal control plan and the widening of the approaches plan will solve many of the inadequate capacity problems.

14–1–5 Parking Lot Plan

1) Basic Policy

Since the demand for parking in the urban area is currently met by curb parking and illegal street parking, a parking problem is not particularly evident. If curb parking is not controlled, however, it will aggravate traffic congestion and will lead to frequent traffic accidents. The parking lot plan, therefore, is to supply the demand for parking which will become increasingly evident as the parking regulations necessary to fulfill the other plans are put into effect in the Centro and North Commercial areas.

2) Plan Conditions

Based on the short-term parking regulation plan, the volume of parking space required in the subject areas for the parking lot plan is given as follows.

- Centro area: 350 ha.
- North Commercial area: 140 ha.

3) Description of the Plan

a. Relationship between Parking Demand and Capacity

Table 14–1–6 shows the existing relationship between the demand for parking and the capacity by zone. The volume of the demand for parking by zone during the peak hours is based on the result of the parking survey which was carried out on streets in areas where there are parking problems.

b. Required Volume of Parking Space

The volume of parking space required in 1988 is shown in L–1. This volume reflects the shortage of parking space due to the implementation of no-parking regulations on the streets.

Parking space is classified into on-street curb parking and off-street parking. The off-street parking space plan is preferable but if it is not possible to provide this space then it will be possible to provide parking meters along relatively uncongested streets within a 350 m radius from areas that have parking problems.

As it will be difficult to provide the entire volume of space required of 8.22 ha. during as short a period as 5 years, it is recommended that parking space in Zone 3, the most important area and one which urgently requires parking space, be provided at the earliest possible opportunity.

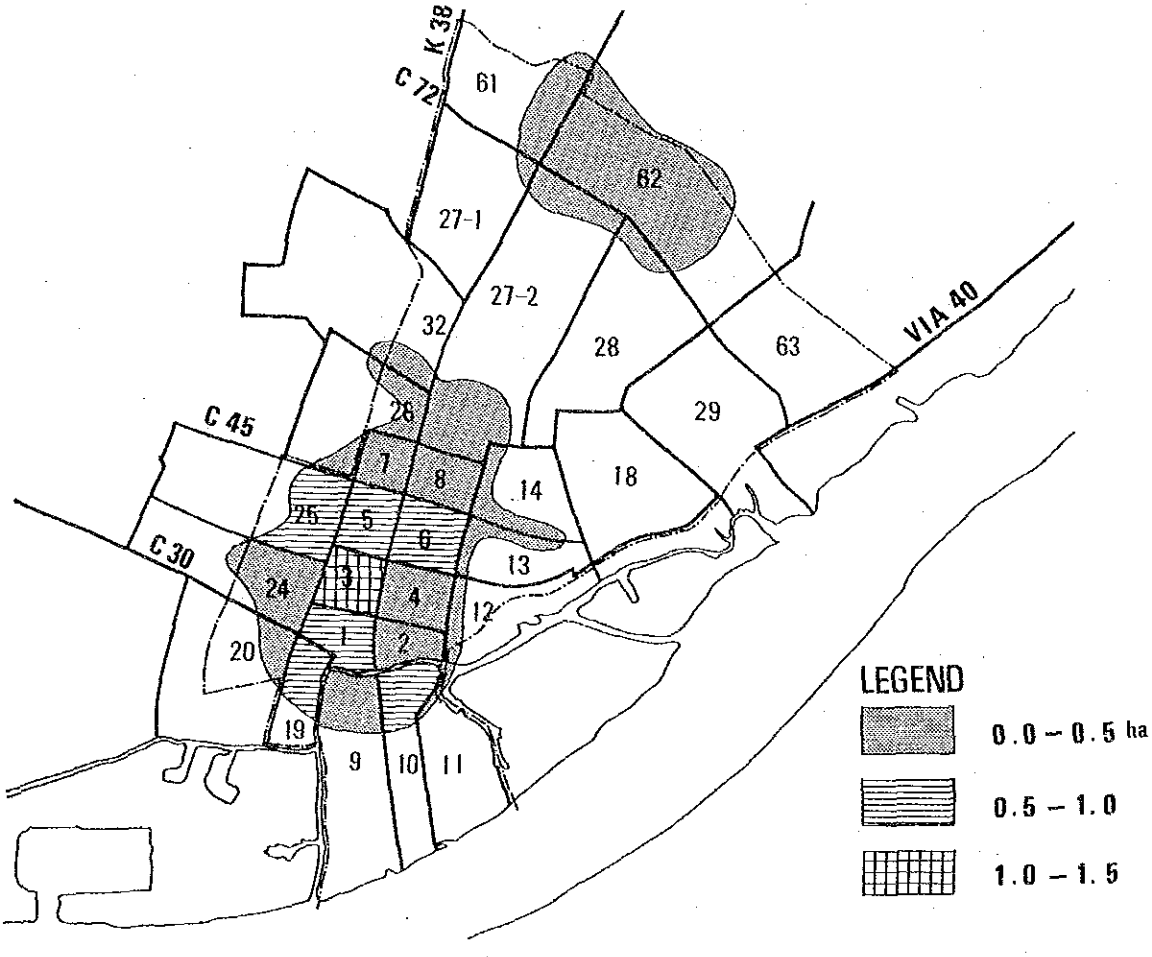


Fig. 14–1–12 Parking Space Development Need

14–1–6 Traffic Safety Facilities Plan

1) Basic Policy

The traffic safety facilities plan is the preparation of facilities for the safety of drivers and pedestrians in order to perfect road functions, including a smooth flow of traffic. Traffic safety facilities will include pedestrian crossings, guard fences, road markings and reflectors.

2) Planning Conditions

The points where both motor and pedestrian traffic intermingle to a high degree, thus

Table 14–1–6 Parking Space Development Need in 1988

P/T Zone	Existing Parking Condition (1983)				1988	
	Parking Capacity (vehicle)		Parking Demand (vehicle)		Quantity of Parking Demand (vehicle)	Parking Area of Development Need (ha.)
	On-Street	Off-Street	On-Street	Off-Street		
1	282	100	268	30	264	0.79
2	337	299	256	90	123	0.37
3	453	143	488	63	529	1.59
4	483	917	594	275	143	0.43
5	368	164	302	49	284	0.85
6	624	285	331	88	235	0.71
7	314	33	102	17	132	0.40
8	298	162	86	50	6	0.02
9	668	80	133	25	113	0.34
10	344	3	134	2	224	0.67
11	47	8	5	1	–	–
12	103	2	7	1	8	0.02
13	378	19	14	8	8	0.02
14	328	11	5	4	–	–
19	393	8	177	4	213	0.63
20	249	–	13	–	–	–
24	957	396	242	127	80	0.24
25	1,241	140	271	61	320	0.96
26	200	60	25	30	7	0.02
27	666	549	167	228	–	–
28	100	31	24	16	18	0.05
38	175	40	44	18	36	0.11
61	433	232	45	74	–	–
62	2,647	1,304	188	576	–	–
Total	12,088	4,976	3,971	1,837	2,743	8.22

Note: 1) Parking demand : peak hour
2) Off-Street : Bateria and Parking building

resulting in the need to achieve a smooth and safe flow of traffic, will be subject to this plan.

3) Description of the Plan

a. Pedestrian Bridges

The locations for the installation of pedestrian bridges will be determined by the following criteria.

(1) School and hospital locations with high pedesgrian crossing and vehicle traffic volumes.

(2) Bus transfer locations with high pedestrian and vehicle traffic volumes.

(3) Commercial areas with large buildings with high pedestrian and vehicle traffic volumes.

(4) Areas that have a high incidence of vehicle-pedestrian acciddents.

(5) Roads that have more than 2 lanes a side without a median or safety zone for pedestrians.

According to the above-mentioned criteria and the Travel Time Survey, the following 8 areas are considered to be possible sites for the installation of pedestrian bridges. With regard to some of these points, however, pedestrian safety measures are already included in the intersection improvement plan and as a result they are excluded from the possible installation points for pedestrian bridges.

(1) Cra. 46 Section Calle 50 – Calle 53 (university, shopping center, schools).

(2) Cra. 46 Section Calle 72 – Calle 74 (stadium).

(3) Cra. 54 Section Calle 53 – Calle 58 (university, theatre, cinema).

(4) Cra. 54 Section Calle 60 – Calle 62 (university).

(5) Cra. 43 Section Calle 50 – Calle 52 (university, schools).

(6) Cra. 38 – Calle 72 (schools).

(7) Circunvalar – Calle 30 (school).

(8) Cra. 38 – Calle 30 (bus transfer location).

Fig. 14–1–13 shows the installation locations of pedestrian bridges.

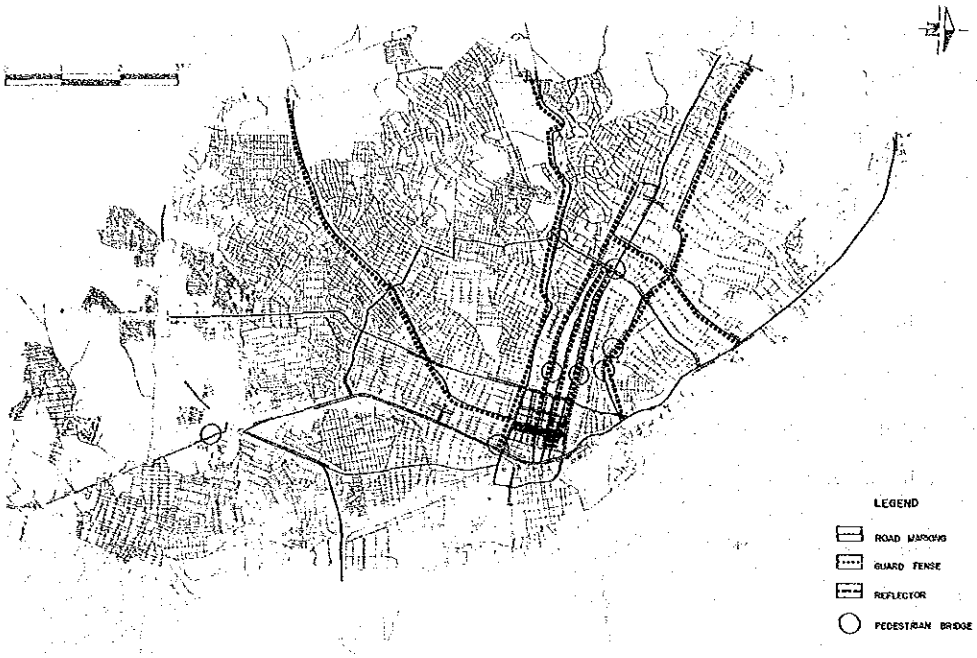


Fig. 14–1–13 Curb Parking Control Area

b. Guard Fences

As the indiscriminate crossing of streets by pedestrians obstructs the flow of traffic, thus causing traffic accidents, the object of this plan is to prevent the disorderly crossing of streets by pedestrians, the protection of the pedestrians themselves and the maintainance of a smooth traffic flow by means of installing guard fences.

The following criteria are used to select sites for the installation of guard fences.

(1) All sections near major signal intersections of arterial streets.
(2) Sections located on either side of pedestrian crossings.
(3) Sections located on either side of pedestrian bridges.
(4) Along the opposit side of the street from bus stops.

The length of guard fences to be installed at these points will be approximately 100 m. Fig. 14–1–13 shows the sites for guard fences.

c. Traffic Signs

Traffic signs are used to achieve the smooth flow of and safe road traffic while also aiming at the maximum use of the roads.

Traffic signs are classified into information, warning, regulation and direction signs and while they are all important for the management of traffic, the number of the existing road signs is insufficient. This number must be increased to achieve traffic safety.

With regard to regulation signs, "Stop" signs and "No-parking" signs in particular are low in number with the number of "Bus stop" signs and "Road" signs showing place names, etc. being low for direction signs. "Bus stop" signs should, therefore, be installed along bus routes which have an aggregate of 1,200 km in length according to the Public Transport Study. According to the plan, these signs will be installed for each bus stop, where the average distance is 350 m, totalling 3,400 signs in the Barranquilla urban area.

Guide signs will be located along arterial and semi-arterial roads which, according to the Roads, Inventory Study, have an aggregate of 62,84 km in length. They will be installed at approximately 2 km intervals, totalling 30 guide signs.

Among the various regulation signs, parking regulation signs will be installed at the rate of at least 4 per block for for the restricted areas, namely the Central District surrounded by Cra. 38, Cra. 46, Cra. 45 and Calle 30 and the northern commercial area around Calle 72 and Calle 76. A total of some 1,100 signs will be installed in some 270 blocks.

Mainly at intersections of arterial or semi-arterial roads with secondary roads or at intersections where there is a high rate of accidents, some 500 "Stop" signs will be installed.

d. Road Markings

Road markings will be installed at intersections, pedestrial crossings, center lines where a median is not installed and at places where there is a need to attract the attention of drivers. Roads with a high frequency of traffic accidents will be given priority (See Fig. 14–1–13).

e. Reflectors

Reflectors will be installed at the center lines as indicated by the Road Marking PLan (See Fig. 14–1–13).

14–2 Public Transport

14–2–1 Basic Policy

The short-term public transportation projects aim to adjust demand and to supply urban bus transportation in newly developed areas as well as eliminate traffic congestion caused by buses along the arterial roads. At the same time, the total cost of the projects should be minimized. Consequently, the short-term projects will be implemented depending upon present infrastructural conditions and the bus operational system. When implementing these project, coordination with the long-term plan is necessary such as the bus circulation system in the central area.

14–2–2 Supplementary Bus Services

According to the analysis of the present urban bus service area, the areas requiring bus services are scattered along the edges of the urbanized area of the city. In these areas, housing developments have been recently constructed, and the applications of the urban bus service to INTRA (now to the city) have not yeat been approved. There are 4 major areas which have poor bus service. They are as follows: the area around Villa Campestre (zone 69), the area around Los Olivos (zone 70), the area around El Pueblo, and the area around Soledad 2000 (See Table 14–2–1). Zone 69, the area around Los Olivos, needs at least one bus route, and zone 71, which

has a wide area including El Pueblo, needs either more routes than exist at present or improvement of service frequency of the existing route. Zone 73 which is around Soledad 2000, needs strengthening of the existing routes and/or new routes.

Table 14–2–1 Areas Requiring Bus Service

Zone	Urbanization in the area	Population 1983	Population Increase 1983–90 (%/annum)	Generation/ Attraction of Bus Psgr. 1983	Gen/Att in Peak Time	Peak hour Service Frequency Needed (service/hour)	Existing Bus Routes (original)	Present Service Frequency (service/hour)
69	Around Villa Campestre, Uninorte, and other Schools	138	83.0	11,155	1,673	27	R-18	26
770	Los Olivos	7,608	10.1	12.570	1,912	30	–	–
71	El Pueblo	10,754	18.9	14.005	2,100	34	R-38-B	9
73	Soledad 2000	8,678	35.7	24,266	3,639	58	R-65 and R-87-B	43

Depending on the introduction of new routes and/or improvement of existing service in the above-mentioned areas bus traffic volume near the central area will most likely increase. The countermeasures to prevent traffic jam caused by these buses near the center of the city should be considered together with the long term projects on the bus system in the city center.

14–2–3 Bus Facilities Plan

1) Bus Priority Lane

a. Basic Policy

The purpose of this plan is to control motor car and bus traffic, in order to mitigate traffic congestion on the street. In this study, the traffic management plan under discussion will be the use of bus bays and bus priority lanes. This plan will be a short term plan in connection with the public transport plan and should be carried out after more detailed survey.

b. Plan Condition

Location subject to this plan will be arterial streets regarded as bottlenecks due to bus congestion. These locations are shown in Fig. 14–2–1.

Permanent Improvement of the existing traffic peoblems in relation to bus transport requires long-term countermeasures, such as bus rerouting, etc. However, the short-term plan only is within the scope of this discussion. An early solution to the overall problem is difficult. Therefore, this plan is to mitigate the traffic near bus stops as much as possible.

Fig. 14–2–1 Traffic Congestion of Near Bus Stops

c. Description of Plan

The serious bus stop bottlenecks have been identified in the central area surrounded by Cra. 38 – Calle 45, Cra. 46 – Calle 30. The countermeasures of the bus priority lane system will be effective in this central area considering the geometric conditions, traffic flow conditions, and intensive serious sections. A lot of serious points in this central area will be mitigated by the countermeasure of bus priority lanes. On the other hand, the countermeasures of the bus bay will be more effective in other areas where there is a concentration of serious points.

d. Selection of Appropriate Locations for Bus Priority Lanes

Locations of the bus priority lane will be those serious sections selected on the basis of

the amount of congestion near the bus stop, traffic capacity, traffic regulations and existing geometric conditions.

The width allocated to a bus priority lane will be 3.5 m. The traffic capacities for the bus priority lane plan are shown in Tables 14–2–2 and 14–2–3.

Table 14–2–2 Demand Capacity Ratio for the Bus Priority Lane Plan (East-West)

Street	Approach				Remarks
	Calle 34	Calle 37	Calle 38	Calle 45	
Cra. 38	1.11 1.61	0.72 0.82	1.95 –	 –	Traffic volume is assumed Cra. 38 – Calle 37
Cra. 40	–	–	–	–	Impossible to make bus lane due to narrow street width
Cra. 43	0.37	0.30	0.50	1.00	Traffic volume is assumed Cra. 43 – Calle 37, Cra. 43 – Calle 38
Cra. 44	0.74	0.47	0.44	–	Traffic volume is assumed Cra. 45 – Calle 37, Cra. 44 – Calle 38

Note: – Traffic volume is forecast for 1988.
– Traffic signal system will be improved.

Table 14–2–3 Demand Capacity Ratio for the Bus Priority Lane Plan (North-South)

Street	Approach						Remarks
	Cra. 38	Cra. 40	Cra. 41	Cra. 43	Cra. 44	Cra. 45	
Calle 34	1.12	0.77 0.73	1.56 1.07	0.66 0.71	0.74 0.89	0.52 1.79	
Calle 37	0.46	0.44	0.72	0.12	0.46	0.56	Traffic volume is assumed Calle 37–Cra. 38; Calle 37–Cra. 40 Calle 37–Cra. 41; Calle 37–Cra. 43 Calle 37–Cra. 44; Calle 37–Cra. 45
Calle 38	0.90	0.53	0.56	0.61	0.44	0.73	Traffic volume is assumed Calle 38–Cra. 40; Calle 38–Cra. 41 Calle 38–Cra. 43; Calle 38–Cra. 44 Calle 38–Cra. 45

Locations of inadequate capacity will be Cra. 38, Cra. 40 and Calle 34. In consequence, possible locations for bus priority lanes are the 5 routes along Cra. 43, Cra. 44, Cra. 45, Calle 37 and Calle 38. However, bus priority lanes on Calle 37 and Calle 38 will hinder the flow distribution of motor cars at main intersections, since there are many intersections with arterial or semi-arterial streets. Therefore, the available locations for the bus priority lane plan will be the 3 routes of Cra. 43, Cra. 44 and Cra. 45.

Cra. 43 .... about 1.0 km from Calle 34 to Calle 45.
Cra. 44 .... about 1.0 km from Calle 35 to Calle 45.
Cra. 45 .... about 1.0 km from Calle 35 to Calle 45.

The traffic congestion at the intersection between Calle 30 and Cra. 38 is serious, therefore, the countermeasure should include such measures which can eliminate the services for bus passengers as Gran Parada, since the intersection is crowded with bus traffic. In order to install a bus exclusive lane on the road sections, where the road capacity is inqdequate, the rearrangement of bus routes, the widening of roads together with the construction of Gran Parada should be considered.

e. Time Control System

The bus priority lanes will only be used during peak hours. A time schedule for usage of these lanes is as follows:

Morning peak hours	7 – 9
Midday peak hours	12 – 2
Evening peak hours	17 – 19

Note: Cra. 45, Cra. 43 ..... Midday peak hours & Evening peak hours
Cra. 44 ..... Morning peak hours & Midday peak hours

f. Ancilliary Devices

Upon the implementation of the bus priority lane plan, parking restrictions must be carried out to maintain the bus lane capacity. Road markings and guide signs should also be installed for securing a smooth traffic flow.

2) Introduction of Bus Bays Along Arterial Roads

a. Introduction

More than 20% of the total traffic demand in terms of P.C.U. is bus traffic. Therefore, road traffic is substantially affected by the services for bus passengers at road-side bus stops.

In this sense, the arterial roads are required to have bus bays which will help to eliminate the interruption of traffic flow and facilitate bus passenger service.

b. Site Selection of Bus Bay

The bus stops in general, are likely to be provided with each 400 or 500 m along the major roads in the urbanized area. The bus bays should be installed at the selected bus stops where many passengers exist and the traffic is often interrupted due to bus passenger services.

The criteria for selecting bus bay locations are as follows:

(1) Bus stops serving more than 11,000 passengers as of 1983

(2) Bus stops where traffic interruptions occur due to bus passenger service (See Fig. 14–2–1).

(3) Bus stops located along those roads categorized as arterial roads

The bus stops identified through the above criteria are further prioritized as follows.

Criteria for Priority A:

I : Bus stops located at serious points of traffic congestion on an arterial raod with a large number of passengers.

II : Bus stops located at serious sections of traffic congestion on an arterial road with a large number of passengers.

Criteria for priority B:

III,IV : Bus stops located along the arterial roads, and accompanied by traffic congestion problems (IV) or a large number of passengers (III).

VI : Bus stops located along semi-arterial and/or collector roads accompanied by a large number of passengers.

Criteria for priority C:

All other cases not included in Categories A or B.

This priority process is summarized in Table 14–2–4. Beside this prioritization, the availability of the space for bus bay and the future changes in the function of the corresponding road are discussed.

The following 8 bus stop locations have been concluded to require bus bays for the short-term plan. See Table 14–2–5.

Table 14–2–4 Evaluation on Priority of Bus Bay Installation

	Bus Stop with Large Passenger Loads	Roadsection with Traffic Congestion Caused by Bus	Present Road Category	Priority	Availability of Space (m)	Future Road Category	Final Priority Evaluation
1.	Calle 81-Via 40	–	Arterial	III	–	Arterial	B
2.	Calle 59-Cra.54	–	Semi-arterial	VI	10≈ (Cra. 54)	Arterial (Calle 59)	B
3.	Calle 72-Cra.43	–	Semi-arterial	VI	5≈ 7.5(Calle 72)/ 10≈ (Cra. 43)	Arterial	B
4.	Calle 42-Cra.38				5≈ 7.5(Calle 72)	Arterial	B
5.	Calle 30-Cra.35	Serious section Calle 30 in Cra. 38-Cra.26	Arterial	II	–	Arterial	A
6.	Calle 30-Cra. 26	Serious section Calle 30 in Cra. 33-Cra. 26	Arterial	II	–	Arterial	A
7.	Calle 45-Cra. 30	–	Arterial	III	2≈ 5(Calle 45)	Arterial	B
8.	Calle 17-Cra.15	–	Semi-arterial	VI	–	Arterial (Cra. 15)	B
9.	Calle 30-Cra. 14	Serious point	Arterial	I	–	Arterial	A
10.	Calle 30-Cra. 11	–	Arterial	III	–	Arterial	B
11.	Calle 30-Cra. 4	–	Arterial	III	–	Arterial	B
12.	Calle 30-INEM	–	Arterial	III	–	Arterial	B
13.	Calle 18-Cra. 19 (sol)	–	Semi-arterial	VI	–	Semi-Arterial	B
14.	Calle 45-Cra. 14	Serious point	Arterial	I	7.5≈ 10 Calle 45/ 7.5≈ 10	Arterial	A
15.	Calle 45-Cra. 4	–	Arterial	III	5≦ <7.5 Calle 45	Arterial	B
16.	Calle 47-Cra. 21	Serious point, Serious section Calle 47 in Cra. 21B-Cra. 14	Arterial	I	5≦ <7.5 Calle 47	–	A
17.	Calle 47-Cra. 18	Serious section Calle 47 in Cra. 21B-Cra. 14	Arterial	II	5≦ <7.5 Calle 47	Arterial	A
18.	Calle 47-Cra. 14	Serious point, Serious section Calle 47 in Cra. 21B-Cra. 14	Arterial	I	5≦ <7.5 Calle 47	Arterial	A
!('	Calle 47-Cra. 1A	Serious point	Arterial	I	10≦ (Calle 47)	Arterial	A
20.	Calle 45D-Cra. 1B	–	Collector	VI	–	Collector	B
21.	Calle 70C-Cra. 15	–	Collector	VI	–	Arterial	B
22.	Calle 70B-Cra. 21B	–	Semi-arterial	VI	5≦ 7.5 (Calle 70B)	Semi-arterial	B
23.	Calle 70C-Cra. 21B	–	Semi-arterial	VI	–	Arterial	B
24.	Circ-El Pueblo	–	Arterial	III	2≦ 5 (El Pueblo)	Arterial	B
25.	Circ-Los Olivos	–	Arterial	III	–	Arterial	B
26.	Calle 84-Cra. 51B *1	Serious point	Semi-arterial	VII	10≈ (Calle 84)/ 10≈ (Cra. 51B)	Semi-arterial	C
27.	Calle 53-Cra. 45 *1	Serious point, Serious section Cra. 45 in Calle 45-Calle 53	Collector	VII	5≦ 7.5 (Cra. 45)	Collector	C
28.	Calle 64B-Cra. 14 *1	Serious point	Semi-arterial	VII	–	Arterial	B
29.	Calle 47-Cra. 4A *1	Serious point	Arterial	IV	10≦ (Calle 47)	Arterial	B
30.	Calle 47-Cra. 21B	Serious point, Serious section Calle 47 in Cra. 21B-Cra. 14	Arterial	IV	5≦ <7.5 (Calle 47)	Collector	B

Note: *1 ; These points are included because of the traffic congestion mentioned in the second column, not due to large passenger loads.

Table 14–2–5 Selected Bus Stops for Bus Bay Construction

No. of Point on Map	Location
5	Calle 30 – Cra. 35
6	Calle 30 – Cra. 26
9	Calle 30 – Cra. 14
14	Calle 45 – Cra. 14
16	Calle 47 – Cra. 21
17	Calle 47 – Cra. 18
18	Calle 47 – Cra. 14
19	Calle 47 – Cra. 1A

c. Bus Bay Facility Plan

The standard structure of the bus bay is indicated in Fig. 14–2–2. The length of the bus bay will be 85.0 m taking into account the space for bus arrival/departure. 4 berths will be sufficient at present. This means that the frequency of bus entry will be about 4 buses per minute in the most congested sections (about 270 buses per peak hour in each direcion). The total required time for each bus to stop will be about 40 seconds, explained as follows:

– Time required for passenger disembarkation and embarkation is 30 seconds.
– Time required for the entry and departure of the bus to and from a berth is 10 seconds

The typical length of bus bay classified by design speed of street is shown in Table 14–2–6. The number of berths at each bus stop will change depending on the frequency of bus entry. The bus traffic volume and necessary number of bus berths for each bus bay are summarized in Table 14–2–7.

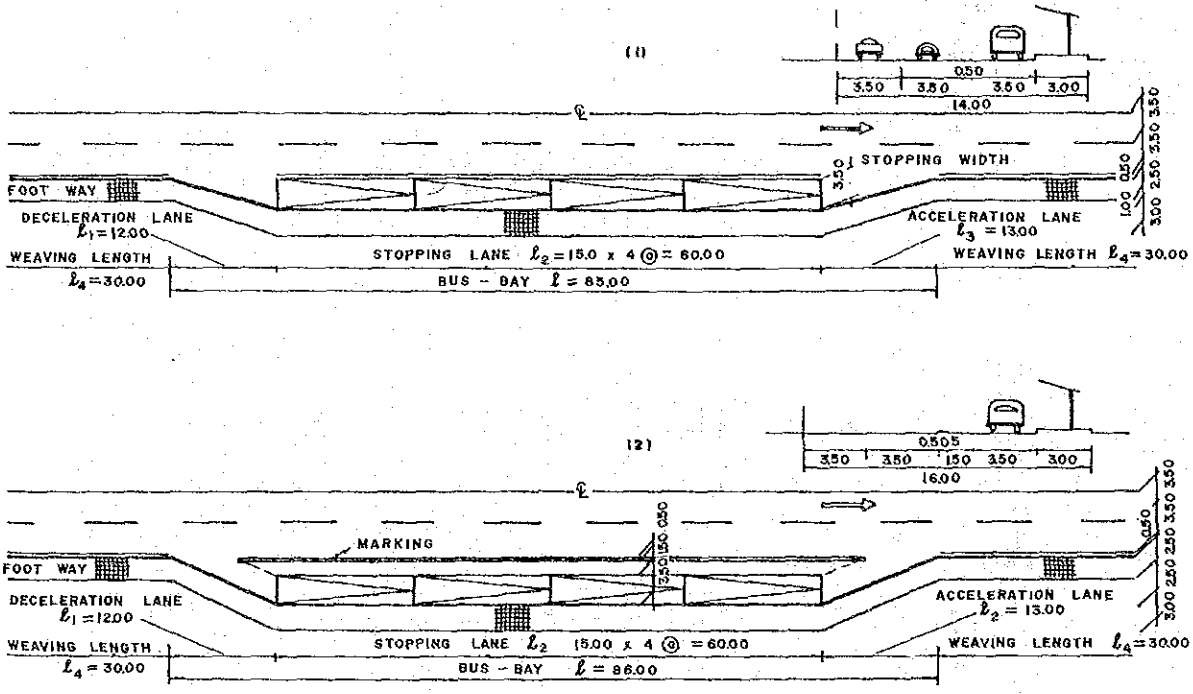


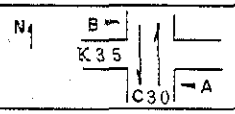
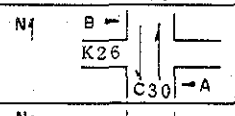
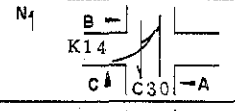
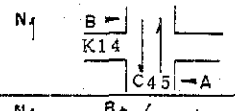
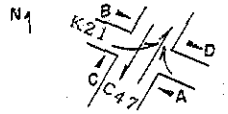
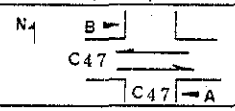
Fig. 14–2–2 Typical Bus-Bay Plan

Table 14–2–6 Typical Length of Bus Bay

Items			Design Speed	
			50 km/h	40 km/h
Deceleration Lane	L_1	(m)	15	12
Stopping Lane	L_2	(m)	60	60
Acceleration Lane	L_3	(m)	20	13
Bay Length	L	(m)	85	85
Weaving Length	L_4	(m)	40	30

Note: See Fig. 14–2–5 regarding L_1, L_2, L_3, L and L_4.

Table 14–2–7 Selection of Bus Bay Type

Point	Intersection Where Bus Stop is located	Bus Traffic Volume			Type of Bus Bay
5	Calle 30 – Cra. 35		A. 2564 Buses/13 hr.	267 Buses/hour	A = 3 Berths
			B. 1697	165	B = 2
6	Calle 30 – Cra. 26		A. 3038*	300	A = 4
			B. 3150*	315	B = 4
9	Calle 30 – Cra. 14		A. 2619	271	A = 3
			B. 2441	222	B = 3
			C. 51	6	
14	Calle 45 – Cra. 14		A. 700*	70	A = 1
			B. 1040*	104	B = 2
16	Calle 47 – Cra. 21		A. 1102	149	A = 2
			B. 971	125	B = 1
			C. 47	4	
			D. 623	48	D = 1
17	Calle 47 – Cra. 18		A. 1360	136	A = 2
			B. 1360	136	B = 2
18	Calle 47 – Cra. 14		A. 1096	170	A = 1
			B. 1280	123	B = 2
19	Calle 47 – Cra. 1A		A. 536*	40	A = 1
			B. 536*	40	B = 1

* Estimated

Chapter 15.

INVESTMENT PROGRAM

Chapter 15 INVESTMENT PROGRAM

15–1 Identified Projects

A project is defined as a minimum unit of the masterplan component, which can function of itself independently of other projects. For the analytical convenience, all the projects are classified into 5 categories; road projects, drainage projects, public transportation projects, urban renewal projects and traffic management projects.

15–1–1 Road Projects

All the roads which were proposed to be constructed or improved in the masterplan are divided into 39 sections from the viewpoint of their functions, work scale and characteristics such as improvement or new construction, widening of right of way or improvement without widening and with or without land acquisition. Each road section is regarded as a project. The road projects comprise 14 new road construction projects (total length of 67.0 km) and 25 existing road improvement projects (total length of 79.7 km) (See Fig. 15–1–1).

Of the new roads to be constructed, the important ones are the Byapss (C-01 and C-02), running parallel with the Magdalena River to connect Zona Franca, Barranquillita and La Loma 1 areas, and several major arterials to support the development of the south and north sub-centers.

Up-grading projects of existing roads are classified to some radial and ring type groups; 2 north-south radial road groups (Calle 30 and Ave. La Arenosa-Soledad Corridor), 2 east-west radial groups (Centro-north sub-center Corridor and Zona Franca-Juan Mina Corridor) and 2 ring road groups (Circunvalar and Inner Circunvalar consisting of Cra. 22 and Ave. La Arenosa). These groups are treated as the project packages in economic evaluation.

15–1–2 Drainage Projects

The drainage sector comprise 9 projects, which are proposed only from the viewpoint of solving traffic hindrance caused by flood in the trunk road network. Because they do not formulate a comprehensive urban drainage masterplan, a project not listed here is not necessarily unimportant nor unurgent. There are 3 large-scale construction projects of buffer reservoirs and spillways to protect Centro area from heavy rain water. Other 6 projects are to solve local problems at critical points and sections. Projects D-03 are included in the urgent proposals (See Fig. 15–1–1 (3)).

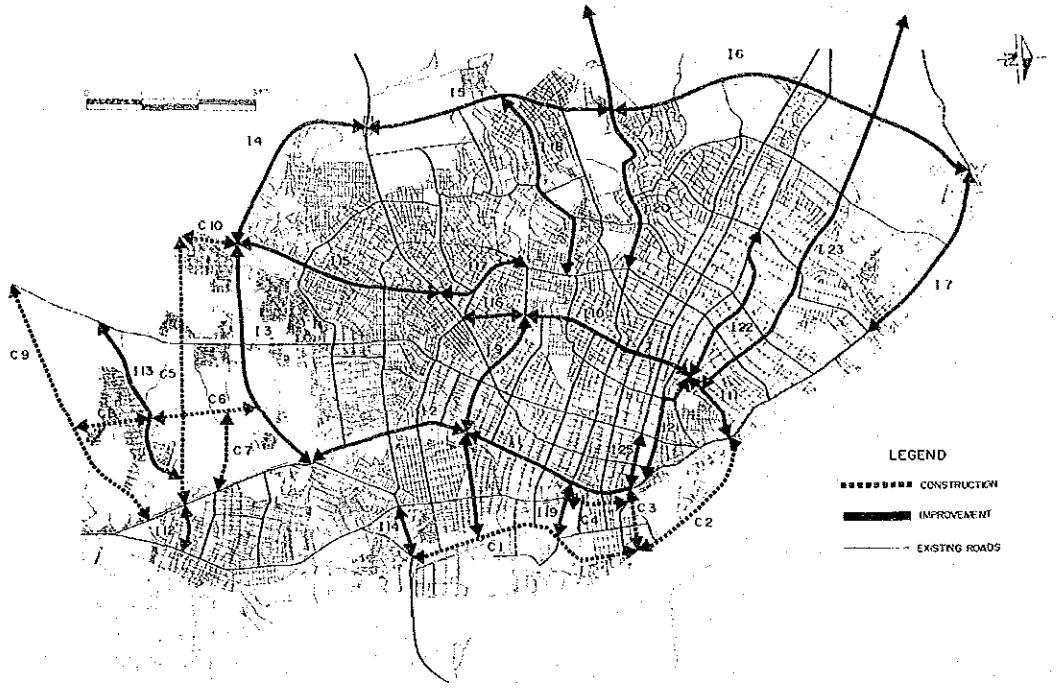


Fig. 15–1–1 (1) Project Location Maps

15–1–3 Public Transportation Projects

This sector comprise 8 projects. As urban bus facilities, is proposed the urgent project (P-01) to install several bus bays and the development of 8 Gran Paradas (off-street large bus stops) (P-02), aiming at mitigation of traffic congestion in the central district and also at improvement of passengers' convenience. To improve the quality of service and financial conditions of the urban bus operators, the bus inspection center project is proposed from long-term point of view (P-03).

2 bus terminals for long distance buses are proposed; one for interdepartmental buses (P-04) and the other for intermunicipal buses (P-05), with the purposes not only for improvement of passengers' convenience and provision for parking space, but for making urban core facilities to accelerate the development of Barranquillita and the south sub-center.

The rail transit projects (P-07 and P-08), which need a gigantic investment amount and imply also a financial difficulty as stated in Chapter 16, are presumably prematured to realize in this planning period, however, they are listed with the reason why the future introduction of a rail transit will require many preparatory works to do from now on, in the course of urban development and transportation facility development.

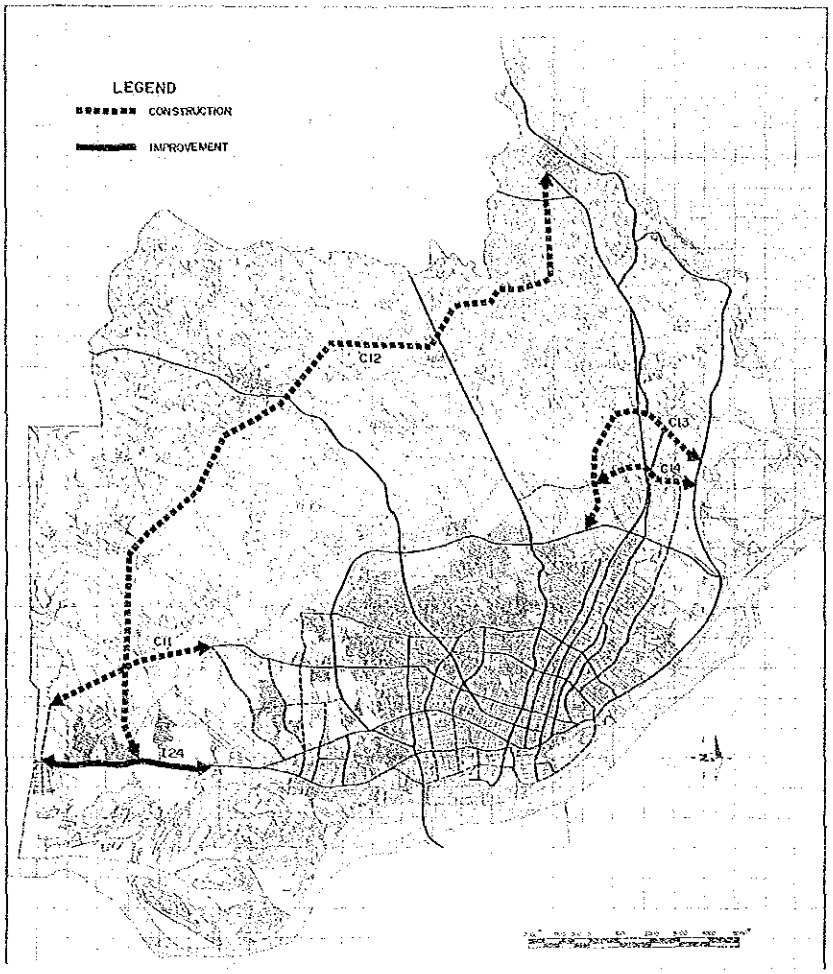


Fig. 15–1–1 (2) Project Location Maps

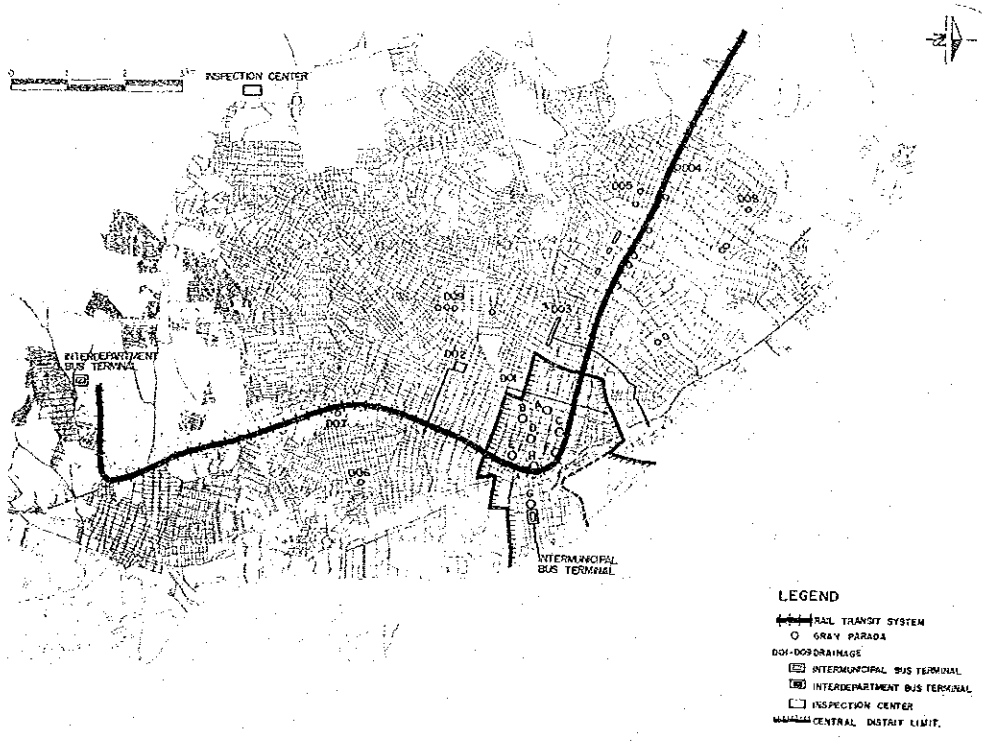


Fig. 15–1–1 (3) Project Location Maps

15–1–4 Traffic Control Projects

The urgent project to be realized in 1980s includes installation of traffic signals and traffic safety devices, intersection improvement and parking facility development.

A long-term guide is also shown in Chapter 11, on signal installation, traffic control system and parking plan, which is not regarded as a project as it does not specify the development cost needed, explicitly.

15–1–5 Central District Renewal Plan

The development and renewal proposal for Centro and Barranquillita is regarded as one project package for the convenience of grouping, although it is not a project but a comprehensive masterplan of itself. The project comprises many components in various fields such as street construction/upgrading, canal reform, land reclamation, drainage facility construction, parks and greenery development and various kinds of urban development projects by private sector.

15–2 Investment Schedule

In order to plan a well-balanced investment schedule by aligning many projects on the time axis, several conditions must be considered simultaneously. Here, an appropriate schedule was looked for through trial and error, keeping in mind the following conditions:

(1) Because a sudden expansion of investment budget is difficult to expect, the investment should be planned so as to make investment amount increase gradually in pace with economic growth and financial capacity increase of the government.
(2) A careful attention must be paid to the inter-relationship among projects, especially between a road project and a development project in another sector.
(3) A priority should be given to the projects aiming to solve already suffering problems.

In this study, the long-term traffic management projects are not specifically scheduled because they should be occasionally implemented in need, of their symptomatic treatment nature. The central district renewal project shall be continuously carried out from present until or beyond the year 2000, therefore, this project is neither discussed in this section.

15–2–1 Road Project Schedule

The total cost to realize the road masterplan is estimated to be 28,265 million pesos at 1984 price. Of this, 13,567 million pesos or 48% pertain to new road construction projects and 14,698 million pesos or 52% to existing road improvement projects. Foreign currency portion will be 114 million US dollars or 45% of the total at the current exchange rate.

Assuming the investment amount grows at the same rate of 5.5% as that of economic growth envisaged in this plan, the cumulative investment amount from 1986 to 1990 would be as much as 22% of total, from 1991 to 1995, 34% and from 1996 to 2000, 44%. These portions can be a guideline for scheduling.

Land acquisition and compensation for building will take a long time in the highly urbanized Centro area. Therefore, enough period should be allocated to widening projects there. Some projects are to be implemented not at one time, but by declaring the new right of way to prohibit any new construction inside there and waiting until most houses set back. Some sections of Cra. 22 and Ave. La Arenosa may require this kind of consideration.

Priority projects are i) Projects to mitigate traffic congestion in Centro, ii) Projects to support and accelerate the Barranquillita development and iii) Projects to improve the Centro-south subcenter corridor. Proposed schedule is shown in Table 15–2–1.

Table 15–2–1 Road Investment Schedule

(million pesos)

No.	Code	Project Name	Investment Amount	Economic Cost
1	C01	Bypass I	2,174.2	1,919.3
2	C02	Bypass II	1,686.3	1,480.1
3	C03	Cra. 46	313.3	270.4
4	C04	Calle 17	491.1	436.5
5	C05	Vía Caracolí I	619.3	556.4
6	C06	Transversal I	133.	155.3
7	C07	Ave. Las Moras	133.7	120.1
8	C08	Transversal II	113.9	97.2
9	C09	Vía Central de Abastos	409.8	352.2
10	C10	Calle 450 Ext.	104.2	90.5
11	C11	Calle 45 Ext.	1,633.8	1,404.2
12	C12	Carretera Metropolitana	3,785.9	3,272.8
13	C13	Anillo Rural	1,354.6	1,195.4
14	C14	Transversal Rural	608.4	523.0
15	I01	Calle 30 I	1,376.6	1,327.1
16	I02	Calle 30 II	301.1	264.9
17	I03	Circunvalar I	676.9	592.0
18	I04	Circunvalar II	404.9	401.6
19	I05	Circunvalar III	660.9	584.3
20	I06	Circunvalar IV	1,099.8	971.5
21	I07	Vía 40	404.5	353.7
22	I08	Cra. 22 I	409.4	376.7
23	I09	Cra. 22 II	432.5	394.9
24	I10	Ave. La Arenosa I	1,024.6	964.7
25	I11	Ave. La Arenosa II	343.6	319.7
26	I12	Vía Caracolí	150.9	139.3
27	I13	Vía Soledad 2000	317.5	286.6
28	I14	Acceso Pte. Pumarejo	136.9	119.5
29	I15	Calle 45D I	1,262.6	1,182.1
30	I16	Ave. La Arenosa III	874.2	850.5
31	I17	Calle 45D II	504.9	424.8
32	I18	Cra. 26-Calle 760	306.8	266.9
33	I19	Cra. 38	190.5	167.3
34	I20	Cra. 38 Occidente	1,027.9	879.0
35	I21	Cra. 50-Cra. 54	1,294.2	1,239.5
36	I22	Cra. 54-Cra. 51B	229.2	197.8
37	I23	Cra. 60-Cra. 64	731.6	636.8
38	I24	Carretera Oriental	258.1	220.7
39	I25	Cra. 46 Abajo	184.9	169.7
		Total	28,264.9	25,205.4

There are 4 projects to be completed in 1980's; new construction of Via Central de Abastos (C-09) and Bypass I (C-01) and existing road improvement of Soledad 2000 (I-13) and Calle 30 I (I-01).

C-09 : This section is in urgent need to make a new access to Gran Abastos (central wholesale market) which is planned to open in 1987.

C-01 : This project will support the development of Barranquillita as well as diversify traffic from south to Centro.

I-13 : This road is to accelerate the urbanization in Soledad 2000 already half fulfilled by present.

I-01 : This project aims at solving a present bottleneck and strengthening the Centro-Soledad corridor.

The proposed schedule allocates 16.5% of the total investment amount to the period of 1986–1990, 26.2% to 1991–1995 and 57.3% to 1996–2000. The share of the early stage is planned less than the share explained as a guideline. This is because the projects in the other sectors will concentrate to the early stage.

15–2–2 Drainage Project Schedule

Of the total drainage project cost of 4,767 million pesos, 3 buffer reservoir project will cost 4,300 million pesos. Feasibility studies should be made before the implementation for such large-scale projects as these, including a comparative study with other alternative solutions from the economic and technical point of view. The costs of other projects cover only facilities such as side drains and culverts on and around the related streets.

In the early stage, are scheduled the 3 reservoir projects, expecting they will function as one of the measures to prevent the economic stagnation in Centro and to revitalize the urban activities in the area enough to realize its renewal. These projects will take 4 to 6 years for construction. Other projects are scheduled in accordance with those of the related road projects (Table 15–2–2).

Table 15–2–2 Drainage Projects Investment Schedule

(million pesos)

No.	Code	Project Name	Investment Amount	Economic Cost	85	90	95	2000
40	D01	Parque Universal Reservoir	1,703.8	1,524.5				
41	D02	Talle E.M.P Reservoir	1,041.4	932.2				
42	D03	Cra. 41 Reservoir	1,543.6	1,381.4				
43	D04	Cra. 46	132.0	118.4				
44	D05	Cra. 48	166.6	141.9				
45	D06	Calle 17	19.8	17.9				
46	D07	Calle 30	24.6	22.4				
47	D08	Cra. 60-Cra. 64	108.5	98.9				
48	D09	Av. La Arenosa	41.6	38.1				
		Total	4,766.7	4,271.1				

15–2–3 Public Transportation Project Schedule

The total investment amount excluding the rail transit projects is estimated at 2,226 million pesos, out of which 1,540 pesos or 70% pertain to 8 Gran Parada projects. As the land acquisition of Gran Paradas, planned in the densely urbanized Centro area, takes many years, some of them will be presumably carried over to the next century.

The construction of the interdepartmental bus terminal is to be commenced in 1988 to start its service in 1990. This terminal is expected to be one of the urban core facilities in the south sub-center. Some supplementary facilities, however, such as commercial spaces and fuel station will be left to the second stage in the mid-1990's.

The intermunicipal bus terminal will be developed also in the middle of the last decade in pace with the urban development of Barranquillita.

Construction of 21 km rail transit will require a gigantic investment exceeding 37 billion pesos. The foreign currency portion would be 57% of the total. According to the results of economic and financial analysis, the realization of the entire line in this century is seemingly difficults. However, the Route I (10.4 km from Centro to Soledad at the cost of 20.6 billion pesos) would conditionally be feasible.

The schedule for the public transportation projects is proposed, based on the ideas above-mentioned, as shown in Table 15–2–3.

Table 15–2–3 Public Transportation Projects Investment Schedule

(million pesos)

No.	Code	Project Name	Investment Amount	Economic Cost	85	90	95	2000
49	P01	Urgent Projects	43.5	39.0				
50	P02	Gran Paradas	1,539.2	1,485.5				
51	P03	I. Municipal Bus Terminal	221.9	241.0				
52	P04	I. Departmental Bus Terminal 1	236.1	211.3				
53	P05	I. Departmental Bus Terminal 2	89.5	79.1				
54	P06	Inspection Center	95.3	84.9				
55	P07	Rail Transit System 1	(19,912.0)	(17,924.4)				(Conditional)
56	P08	Rail Transit System 2	(17,467.0)	(15,722.7)				(After 2000)
		Total	2,225.5	2,140.8				

15–3 Financial Source of Road Development

15–3–1 Road Financing System

In the Barranquilla Metropolitan Area, the agencies responsible for construction, improvement and maintenance of roads are MOPT (Ministerio de Obras Públicas y Transporte) of the Central Government, OPD (Obras Públicas Departamental) in the department level and OPM (Obras Públicas Municipal) in the municipal level.

OPM manages all the road, in principle, inside the Barranquilla metropolitan boundary designated by Agustín Codazzi (the Geographical Institute) under MHP. The boundary is drawn 3 to 5 km outside Circunvalar. Outside the boundary, MOPT manages all the national roads and OPD manages others. Generally, a national road is a trunk road connecting important cities each other.

Fig. 15–3–1 shows the sources of road found of each organization and money flow. FVN (National Road Fund) is the most important source, in the national level, for the national road development and subsidiary works of local roads. An 80 to 90% of the MOPT road fund is from FVN. The original financial sources of FVN are an allocation of the national budget, gasoline and diesel tax, tolls (roads, bridges and ferries), internal and external loans and grant. The total budget of FVN in 1984 was 28 billion pesos of which 118 million pesos were invested in Atlántico through Distrito 20 Vial (a branch of MOPT).

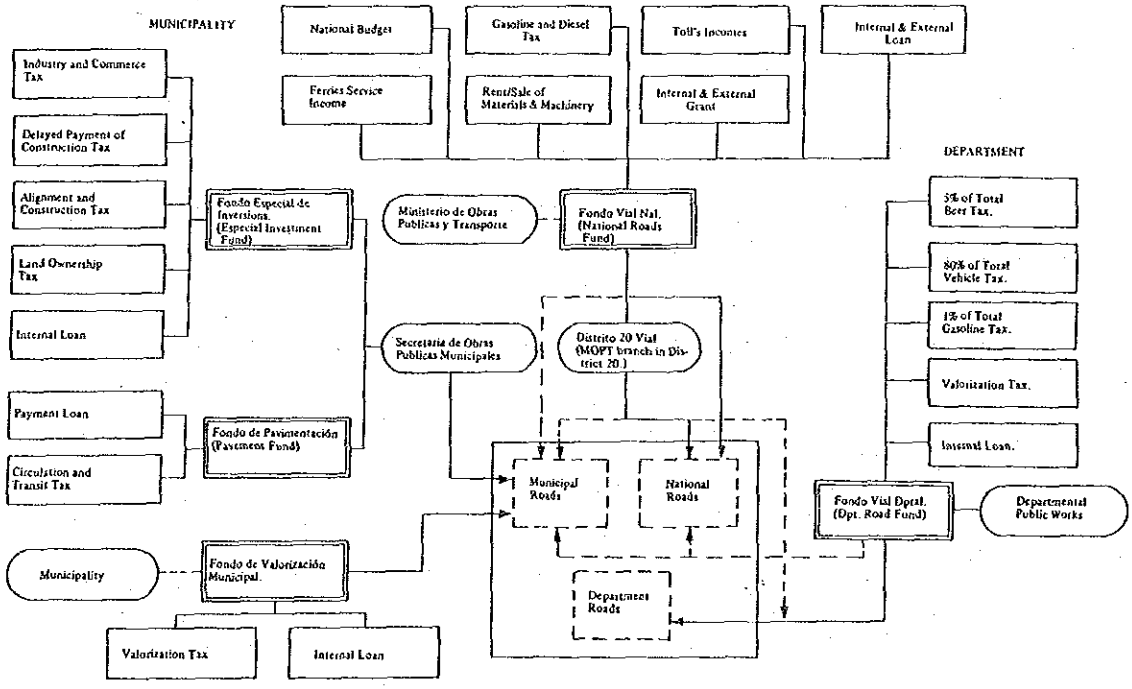


Fig. 15–3–1 Sources and Flows of Road Funds

Besides, the investments through the local branches, MOPT carries out directly most of important road projects. The construction of Circunvalar in 1980 is one of these projects. Like this example, MOPT will undertake a road project even inside the Metropolitan Area in response to the request of the Local Government. In this case, the investment will be made directly by MOPT, not in the form of a subsidy.

The sources of FVD (Departmental Road Fund) are vehicle tax, a part of bus tax and gasoline tax and valorization tax on beneficiaries of road projects. The budget of FVD in 1984 was 320 million pesos, most of which are from the vehicle tax. A road project in the urbanized area is occasionally financed with FVD fund.

As the municipal road fund, there are FEI (Special Investment Fund) and FP (Pavement Fund); the sources of the former are business tax, real estate acquisition tax and land ownership tax, and those of the latter are building ownership tax and vehicle registration tax. The road budget of FEI in 1985 is 215 million pesos and that of FP is 107 million pesos. The contribution of each financial sources is shown in Table 15–3–1.

Table 15–3–1 Municipal Financial Resource for Road Investment 1985

Financial Resource	Investment Item	Amount (million)	Composition (%)		Note (Tax levied to)
			Public Work Investment	Municipal Budget	
1) Industry & Commerce	Road Planning of the City	153.6	20.6	9.0	Persons which sale consumption goods & services. Depend on total capital invested.
2) Construction & alignment	Road Study Contracts.	31.0	4.2	1.8	Construction license and construction line alignment.
3) Industry & Commerce Tax Debt	Road Pavement in Barranquillita Area	30.0	4.0	1.7	Delayed payments of item 1 with interest.
4) Land Ownership Tax	Road Pavement in Barranquillita Area				Land ownerships, depend on the catastral land value.
5) Pavement Tax	Pavement in the City	76.7	10.3	4.5	Constructed property ownership.
6) Circulation & Transit Tax	Maintenance & Pavement	30.1	4.1	1.7	Vehicle ownerships. Applied to vehicles registered in the transit bureau.
Total Road Investment		321.4	43.2	18.7	
Total Investment of Public Works		743.9	100.0	43.4	
Total Municipal Budget		1,715.5	–	100.0	

Besides the road projects implemented by OPM, there exist road projects by FVM (Municipal Valorizatin Fund). In case of the municipality of Barranquilla, the agency of FVM is implementing road project independently from OPM. FVM is different from departmental valorization tax in this point.

In case of FVM project, the invested amount is to be covered by the beneficiaries payment afterwards. But, as the collection will not go always favorably, the fund tends to be exhausted. The aforementioned Circunvalar was carried out by MOPT with FVM fund and after completion, the road was transferred to FVM with the condition that the collected money should be re-invested in order for pavement in Barranquillita. This is regarded as a variation of subsidy from the Central Government to the municipality. The 1965 budget of FVM is about 17 million pesos.

In addition to above, some road is developed with donation by the private sector. For instance, in an industrial area and sparsely utilized area like Barranquillita, OPM collects contribution from enterprises and land owners to develop a road. Although it looks like the valorization system in the form of advanced payment if donators are beneficiaries, it is different in such that donators are not limited to beneficiaries and that the amount of contribution is not linked to the increment of land value.

15–3–2 Road Investment Achievement

The sum of 1,089 million pesos has been invested to the road projects in the Barranquilla Metropolitan Area during 6 years from 1979 to 1984 by the municipality and Atlántico Department. Details of the investment are shown in Table 15–3–2 and Fig. 15–3–2. As total number of projects (the number of contracts) is 121, the average investment amount per project is only 9 million pesos. In terms of project number, the municipality and the department share the projects half and half, but in terms of amount, the department shares only 25% of the total and its projects are smaller in scale.

Table 15–3–2 Road Investment in Barranquilla Metropolitan Area
1979 – 1984

(1) Investment Amount (million $)

Organization	1979	1980	1981	1982	1983	1984	Total
O.P.D.(1)	5.3	3.9	31.6	96.2	28.9	101.3	267.2
F.R.V.M.(2)	4.7	15.2	–	16.8	10.9	–	47.6
O.P.M.(3)	–	16.5	3.6	42.3	96.5	615.3	774.2
Total	10.0	35.6	35.2	155.3	136.3	716.6	1,089.0

(2) Number of Projects

Organization	1979	1980	1981	1982	1983	1984	Total
O.P.D.(1)	14	9	4	4	10	18	59
F.R.V.M.(2)	7	2	–	2	1	–	12
O.P.M.(3)	–	3	3	10	11	23	50
Total	21	14	7	16	22	41	121

(1) Obras Publicas Departamental (O.P.D.)
(2) Fondo Rotatorio de Valorización Municipal (F.R.V.M.)
(3) Obras Publicas Municipal (O.P.M.)

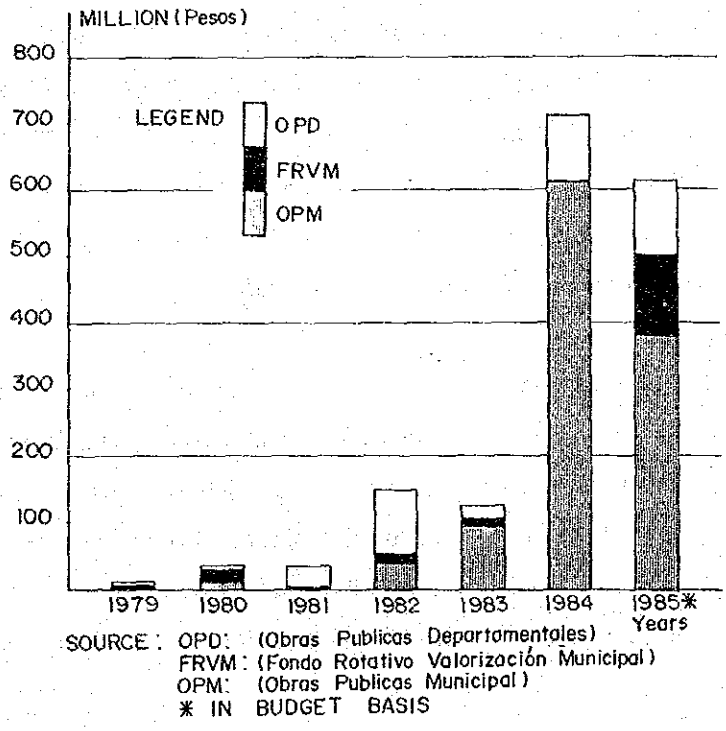


Fig. 15–3–2 Trend of Public Investment for Road Project in Barranquilla Metropolitan Area

During 1979 to 1983, the annual investment has been increasing gradually. Taking high rate of inflation, however, more than 20% per annum, this trend is regarded almost flat. In 1984, the investment by OPM shows a sudden increase by implementing resurfacing, drainage and channelization projects in the southern part of the city (Calle 38, 39, 47, 45, 8, 19). The fund was procured by BCH loan (1 year grace period, 24% interest rate). The 1985 budget of OPM is 321 million pesos which is also higher than the past trend.

Fig. 15–3–3 shows the geographical distribution of the road project in the past. Most of them are located in the area south of Centro. The DPW projects also concentrate to the urbanized zreas in the outskirt of Barranquilla sich as Puerto Colombia, Galapa and Malambo. As the figure shows clearly, most of projects are improvement or repair work for very short sections.

During the past 6 years, MOPT has invested a total amount of 1,294 million pesos for 43 projects, which is slightly higher than the total amount of the municipality and the department. However, many projects by MOPT are outside of the Metropolitan Area.

15–3–3 Prospect of Road Fund

The proposed road masterplan needs approximately the total amount of 23,000 million pesos to realize, which seems extraordinary comparing with the investment achieved in the past. But, if the road investment in 1984 (about 1,200 million pesos including MOPT's investment into the Metropolitan Area) is increased at the same rate as the future economic growth rate of 5.5%, the accumulated amount up to the year 2000 will be 27,103 million pesos which meet the demand. In this sense, the masterplan is not necessarily unrealistic.

Nevertheless, the present conditions of the municipal road fund sources will give no ground for optimism. The past investments by FRV and OPM varied the amount by year in a wide range, which suggests the unstability of fund sources. Therefore, what is primarily important is to establish a solid own sources of road fund, making effort to increase and stabilize the tax revenue concerned. For this it is also essential to build a consensus on the necessity and obligation of tax payment, appealing to citizens that no infrastructure development will result in no economic development.

In order to consolidate own sources of road fund, it is suggested to adopt more complete policy of the benefit principle that beneficiaries should pay for a project. The present valorization system meets this principle. Among the road projects in the masterplan, there are 10 to 13 projects to which this system is applicable. The cost of these projects accounts for 25% of the total cost. (The criteria of selection are (a) that many inhabitants capable to pay tax exist along the road, and (b) that the land price along the road is likely to rise by the project.

The most direct beneficiaries by a road project are undoubtedly car owners. In this respect, it should be examined if a local government can revise the vehicle tax and fuel tax in order to introduce new objective tax, under the current local tax law.

The financial analysis in Chapter 16 proved the interdepartmental bus terminal highly profitable. As a way to consolidate own sources of fund, this kind of transport-related project should be managed by a public entity to re-invest its surplus to another transportation project.

Secondly, it should be considered how to withdraw the development fund as much as possible from FVN of the Central Government. Atlántico Department has 5.0% of national population and 5.7% of the gross national products (GDP). In this respect, this department forms of itself more than 5% economic sphere. Nevertheless, less than 1% of FVN fund has been allocated to this department. Therefore, the Municipal and Departmental Governments ought to continue political efforts to get more development fund.

If the available fund does not meet the necessary amount after making all the aforementioned efforts, the schedule of the masterplan must be completely reviewed and revised. This kind of review and, if necessary, revise is recommended to undertake in the early 1990's.

In case it becomes clear, unfortunately, that the fulfillment of the masterplan schedule be impossible, the early introduction of rail transit is suggested as one of the way of changing policy. The rail transit project is, different from road projects, an income generating project, and can be implemented if the fund procurement and repayment are possible, even though its economic efficiency is lower than that of a road project.

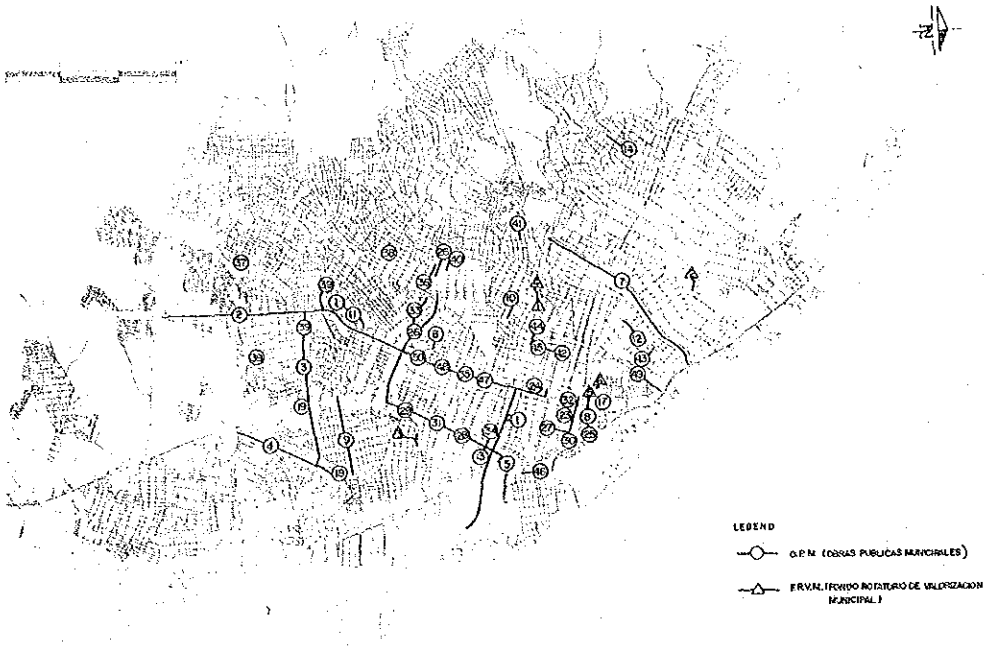


Fig. 15–3–3 (1) Geographical Distribution of Road Projects, 1979–1984

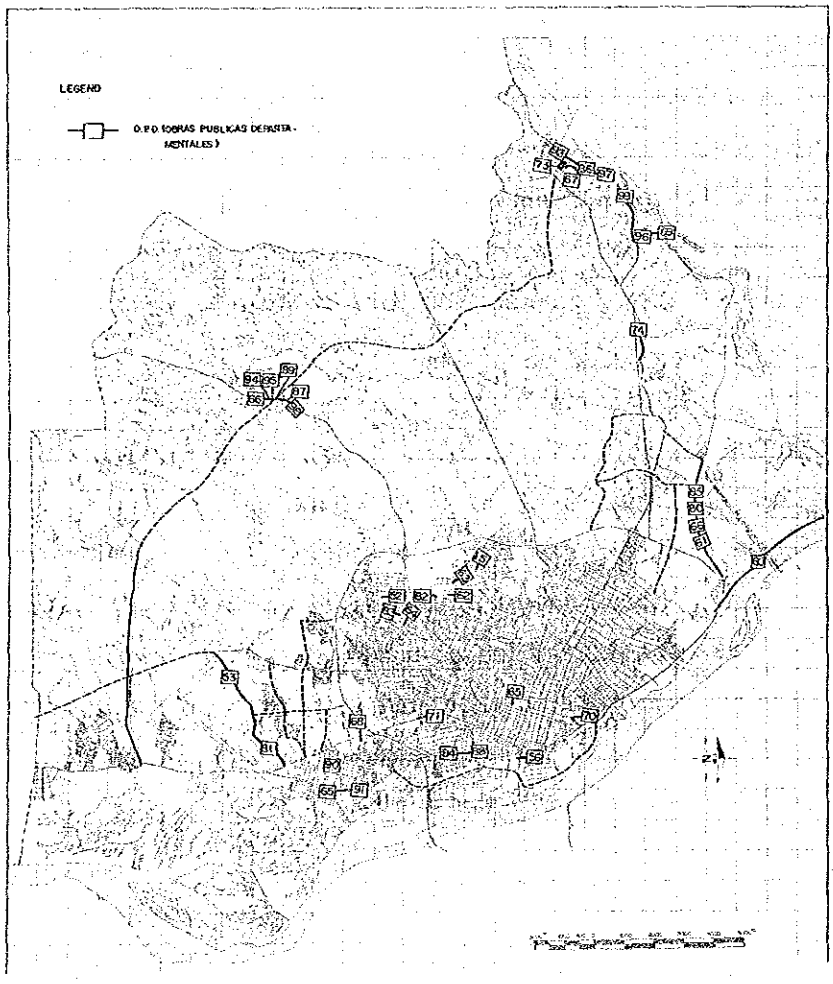


Fig. 15–3–3 (2) Geographical Distribution of Road Projects, 1979–1984

Chapter 16.

EVALUATION OF PROPOSED PLAN

Chapter 16 EVALUATION OF PROPOSED PLAN

Cost-benefit analyses from economic and financial standpoints are made on the projects mentioned in the previous chapter. Although both types of evaluation compare the benefits produced by the realization of a project with the costs required to achieve this, an economic evaluation measures the costs and benefits in terms of the national economy of Colombia or the regional economy of Barranquilla, while a financial evaluation measures the benefits (profits) and costs (investments) in terms of the project as a business. Therefore, the rail transit and bus terminal projects, which entail revenues and are clearly business-oriented, are taken up for financial evaluation. (The central district renewal project is not included in the evaluations because it involves a wide range of work and moreover its implementing body and work method have not been determined yet.)

Projects of strong public nature often have social impacts that cannot be measured in terms of money alone. Additional considerations are thus given to several areas of impact such as energy conservation, environmental protection, and new job opportunities, in section 3 of this chapter.

16–1 Economic Evaluation

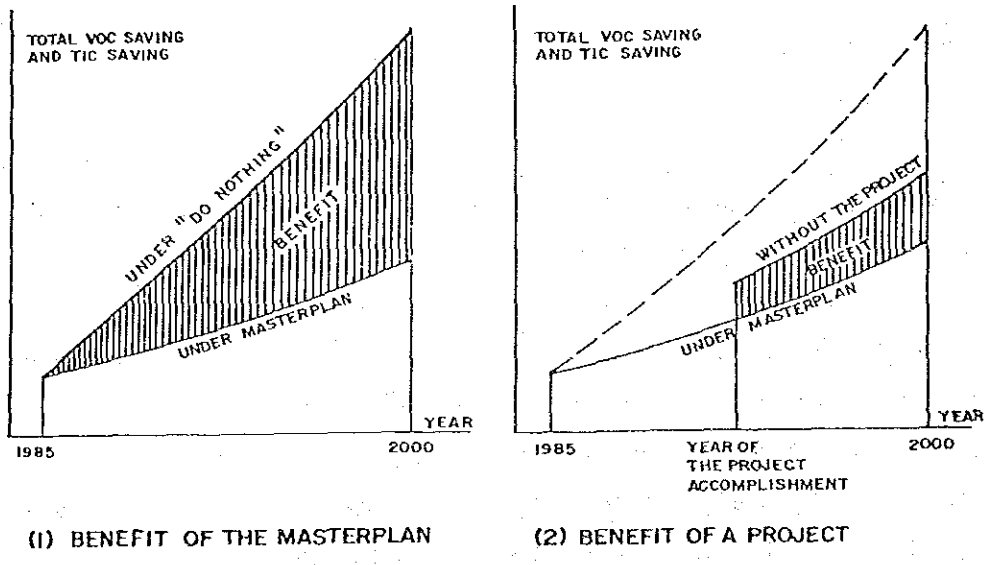
16–1–1 Methodology

The benefits which are produced by the construction or improvement of roads are varied. If roads with favorable alignments and pavement conditions and sufficient capacities to meet demand are provided, the vehicle running cost will decrease and safety will increase. If the time it takes to move from one place to another is shortened, the time saved can be partly applied to production activities, with the result that income may increase. Favorable traffic conditions also produce benefits to those who transport passengers and cargo, in the form of higher turnover, lower packing costs, and greater demand for their services. Such beneficial effects which are caused directly by the upgrading of traffic facilities are called direct benefits. At the same time, the construction of roads raises the value of nearby land by improving its accessibility and in the long run activates economic activity in terms of both production and consumption. Such beneficial effects to a region resulting from a change in land use triggered by the construction of new roads are called indirect benefits (or development benefits).

Some of the benefits mentioned above are difficult or nearly impossible to quantify. For

example, it is extremely difficult to quantify improvements in comfort and safety. In addition, it is impossible from a practical standpoint to accurately measure the long-term development benefits resulting from road improvement in urban areas. Even if it were possible, the results will be highly unreliable, and to compare cost and benefit figures that are low in accuracy will only decrease the reliability of the evaluation. From this standpoint, only the savings in vehicle operating cost and savings in trip maker travel time, both of which are definitely known to exist and are comparatively easy to quantify, are considered as direct benefits of the projects in question.

In the overall evaluation of the Road Masterplan, the benefit which accrues each year up to the year 2000 is defined as the difference between the sum of total vehicle operating cost (VOC) and total travel time cost (TTC) in the "do-nothing" case (in which no roads are constructed or improved and the existing road network is maintained up to the year 2000) and the sum of total VOC and total TTC if the Masterplan is implemented according to schedule (Fig. 16–1–1).



(1) BENEFIT OF THE MASTERPLAN (2) BENEFIT OF A PROJECT

Fig. 16–1–1 Economic Benefit of the Masterplan and Project

At the same time, in evaluating a project individually which is included in the Masterplan, the benefit resulting from the implementation of said project is considered to be the increase in total cost (VOC and TTC combined) that will arise if said project is omitted from the Masterplan. In other words, the basis for comparison in this case is not the "do-nothing" case but the Masterplan itself. This is in order to clarify the significance of said project in actualizing the overall Masterplan.

When conducting an economic evaluation of a project, benefits and costs are measured as economic cost rather than in market prices. For this reason, the project investment amounts given in the previous chapter are converted into economic cost prior to evaluation by deducting taxes and applying the shadow wage rate, etc. Vehicle operating cost per km and time value per hour used in benefit estimations are likewise adjusted to economic cost.

Benefit estimations are made up to the year 2000. So that the project costs correspond to these benefits, the costs are defined as depreciation expenses up to the year 2000, of the facilities constructed. In other words, the residual value (the non-depreciated part) of a project in the year 2000 is included in the year 2001 of the cost stream, as minus cost.

Benefits and costs thus quantified are used in the normal discounted cash flow analysis, and then the indices for project evaluation (Internal Rate of Return, Net Present Value, Benefit/Cost Ratio) are calculated.

16–1–2 Vehicle Operating Cost and Travel Time Cost

1) Vehicle Operating Cost

In Colombia, MOPT releases figures concerning average vehicle operating costs each year. However, these figures, which are vehicle operating costs per km by type of vehicle and by pavement condition and road gradient, are suitable for studies of inter-urban roads and not urban transport plans such as the present study. This is because the main purpose of improving or constructing intra-city roads is mainly to alleviate congestion, in other words to shorten travel time, so that there is no major decrease in the travelling distance. In fact, some projects actually increase the travelling distance by the provision of bypasses. Therefore, while referring to MOPT's calculation basis, the unit value of vehicle operating cost adjusted as given below is used.

The vehicle operating cost is divided into that which is proportionate to the running distance and that which is proportionate to the running time. The former includes costs of fuel, lubricating oil, tires, parts and repairs, etc. The latter includes interests, crew wages, insurance costs, company overhead, etc. Depreciation is considered to belong to both because vehicles depreciate due to both operation and the passage of time.

For convenience's sake, the cost which is proportionate to the running distance is called the running cost, and that which is proportionate to the running time is called the running time cost.

a. General Characteristics of Representative Vehicles

After observing the traffic of Barranquilla, those shown in Table 16–1–1 were selected as the representative vehicles. These include vehicles such as buses and passenger cars which at present do not represent a large share of traffic but is expected to do so in the future, for the reason that their assembly production has been started in Colombia.

Table 16–1–1 Vehicle Characteristics and Cost in Barranquilla 1984

Vehicles Characteristic	Car	Taxi	Light Truck	Truck	Bus
Make/Model	Renault 9 Chevrolet (Chevet)	Chevrolet Celebrity	Chevrolet C-10-Standard	Chevrolet C-70 189-D	Chevrolet P-60
Fuel Type	Gasoline	Gasoline	Gasoline	Diesel	Gasoline
Financial Cost	1,255	1,491	1,920	3,665	3,179
Economic Cost	455	823	691	1,769	1,780
Annual Operating (hrs)	1,200	2,500	1,500	1,500	3,000
Annual Operating (km)	15,000	25,000	45,000	45,000	57,000
Average Vehicle Life (year)	10	15	12	12	8.5

Source: Study Team

The economic cost is the financial cost (market price) from which import duty and sales tax have been deducted. The annual operating distance and operating hours of commercial vehicles such as taxis, buses and trucks are established with reference to interviews with operators, and hence the figures are considerably different from those of MOPT.

b. Fuel and Lubricating Oil Costs

The cost of gasoline in Barranquilla in mid-1984 was 94.14 pesos (the average of regular gasoline and super gasoline prices). Although Colombia imports some petroleum products, the country is basically able to satisfy its domestic needs itself, and the domestic consumer price is kept low. Therefore, the following formula is used to determine the economic cost of gasoline based on international market price:

Economic cost of gasoline

= (international price of crude oil) x (refinery loss coefficient)

x (exchange rate) + (oil refining cost)

$$= \frac{\text{US\$30.0/barrel} \times 1.10 \times 115 \text{ pesos/US\$}}{42 \text{ gallons/barrel}} + 47.6 \text{ pesos}$$

= 138.0 pesos/gallon

The economic costs of diesel oil and lubricating oil, estimated in the same way, are 132.7 pesos/gallon compared to the market price of 90.5 pesos/gallon for the former and 127.0 pesos/0.25 gallon compared to the market price of 152.5 pesos/0.25 gallon for the latter (See Table 16–1–1 (a)).

Fuel and oil consumption rates are determined on the basis of statistics compiled by INTRA, an agency of MOPT, together with information obtained through interviews with transport companies (See Table 16–1–2 (b)).

Table 16–1–2 Fuel and Lubricant Cost

(a) Price ($/Gallon)

	Financial	Economic
Gasoline	94.14	138
Diesel	90.50	132.66
Lubricant (1/4 gallon)	152.50	217

(b) Consumption Rate

	Car	Taxi	Light Truck	Truck	Bus
Gasoline (km/gl)	35	30	30	–	5
Diesel (km/gl)	–	–	–	6	–
Lubricant (gallon/5,000 km)	0.75	0.9	0.9	6.25	6.04

c. Tire Cost

Cars, taxis and light trucks have 4 wheels and the rest have 6 wheels. The economic cost of tires is obtained by deducting sales tax (6%) from the market price. The useful life of a tire is 15,000 km for cars, 17,000 km for taxis and light trucks and 30,000 km for trucks and buses (See Table 16–1–3).

Table 16–1–3 Tire Cost

Number of Tire	Car	Taxi	Light Truck	Truck	Bus
Number of Tire	4	4	4	6	6
Financial Cost/Tire ($)	5,500	5,500	5,500	16,000	16,000
Economic Cost/Tire ($)	5,188	5,188	5,188	15,094	15,094
Tire Life (1,000 km)	15	17	17	30	30

d. Cost of Parts and Repairs

The cost of spare parts is estimated by applying a fixed rate to the price of a new vehicle minus the tire cost, based on MOPT data and World Bank survey results (See Table 16–1–4).

Table 16–1–4 Spare Parts and Maintenance Labour Cost

Description	Car	Taxi	Light Truck	Truck	Bus
Spare Parts Requirement*	3.0	7.0	7.0	8.5	16
Maintenance Labour Required per Annum (hr)	30	80	80	250	380
Unit Labour Cost					
Financial ($/hrs)	150	150	150	220	180
Economic ($/hrs)	96	96	96	160	120

* % of new vehicle cost minus tire cost

The annual number of working hours of a mechanic is obtained by multiplying the average number of repairs made in a year by the number of working hours required per repair. Mechanics labor cost includes wages, workshop overhead and profit. Since mechanics include unskilled labor such as job assistants, the shadow wage rate is applied to obtain the economic cost.

e. Depreciation

Depreciation applies to the cost of a new car minus the tire cost. The residual value after the useful life of a mechine has passed is determined as 5% for taxis, 10% for light trucks and

15% for other types of vehicles. The reason why such high values are assumed is because there is a strong demand for used cars in Barranquilla, where even quite old cars are being sold (See Table 16-1-5).

Table 16-1-5 Depreciation

Description	Car	Taxi	Light Truck	Truck	Bus
Vehicle Life (years)	10	15	12	12	8.5
Residual Value Ratio (%)	15	5	10	15	15
Distance to Time Proportion	50:50	50:50	70:30	70:30	85:15

Depreciation is divided into that which applies to the running cost and that which applies to the running time cost. The ratio is normally established with reference to used-car market prices, but since such data are not adequately available in Barranquilla, the average of such ratios in developing countries as reported by the World Bank is used. In other words, the ratio is 50:50 for cars and taxis, 70:30 for light trucks and trucks and 85:15 for buses. The reason why a large proportion is applied to running time cost in the case of cars is because there is greater depreciation due to the passage of time than in the case of other types of vehicles.

f. Capital Opportunity Cost (Interest)

Interest rates currently charged by financial institutions in general in Barranquilla range between 33% and 36%. On the other hand, FFDU finances to urban development projects at an interest rate of 23% and CDV at the rate of 27%. Here, an interest rate of 24% is applied when calculating the capital opportunity cost. Since inflation is progressing at annual rates of 20% to 25% in Colombia, the interest rate in economic cost is considered to be more than 10%. Since MOPT uses 12%, the same is used here.

The capital opportunity cost is obtained by multiplying the residual value of a vehicles, or generally one half of the price of a new vehicle, by the above rate.

g. Crew Wages, Overhead and Insurance Cost

Crew wages, or wages paid to drivers and conductors of taxis, trucks and buses, are assumed to be as shown in Table 16-1-6. Since most light trucks are used for business purposes by private individuals and small retail shops, crew wages are not considered for these vehicles (the time savings benefit accrued to the driver is quantified as savings in travel time cost discussed

in 2) below). A shadow wage rate of 80% is applied to crew wages given in financial cost. Insurance costs and company overhead are obtained by converting MOPT's vehicle running cost per km into vehicle running cost per hour.

Table 16-1-6 Crew Cost, Overhead Cost, Insurance Cost

Description	Car	Taxi	Light Truck	Truck	Bus
Crew Cost ($/hr)					
Financial	–	120	–	180	140
Economic	–	96	–	144	112
Overhead Cost & Insurance ($/hr)					
Financial	6.69	298.7	122.9	1,351.6	316.4
Economic	6.02	268.8	110.6	1,216.4	284.7

h. Running Cost and Running Time Cost

The above-mentioned costs are listed in Table 16-1-7. In the case of cars, running cost on a financial cost basis is 11.15 pesos per km and 173.37 pesos per hour. Therefore, the vehicle operating cost per km when driving at an average speed of 25 km per hour is as follows:

Table 16-1-7 Summary of Vehicle Operating Cost in Barranquilla

(1) Running cost (distance related cost) ($/vehicle/km)

		Car	Taxi	Light Truck	Truck	Bus
Financial Cost	1) Fuel	2.69	3.14	3.14	15.08	18.83
	2) Lubricant Oil	0.09	0.11	0.11	0.76	0.74
	3) Tire	1.46	1.29	1.29	3.2	3.2
	4) Spare Parts	2.46	4.11	2.95	6.74	8.65
	5) Maintenance Labour	0.86	0.48	0.26	1.22	1.2
	6) Depreciation (distance related)	3.59	2.79	2.21	3.93	4.59
	7) Total	11.15	11.92	9.98	30.93	37.21
Economic Cost	1) Fuel	3.94	4.60	4.60	22.11	27.60
	2) Lubricant Oil	0.13	0.16	0.16	1.09	1.05
	3) Tire	1.38	1.22	1.22	3.02	3.02
	4) Spare Parts	0.86	2.20	1.04	3.22	4.74
	5) Maintenance Labour	0.18	0.3	0.17	0.88	0.80
	6) Depreciation (distance related)	1.33	1.01	0.78	1.87	2.56
	7) Total	7.72	9.53	7.97	32.19	39.77

(2) Fixed cost (time related cost) ($/vehicle/hr)

		Car	Taxi	Light Truck	Truck	Bus
Financial Cost	1) Depreciation (time related)	43.6	27.9	28.4	50.5	15.41
	2) Capital Opportunity Cost	123.26	70.46	15.18	285.5	123.3
	3) Crew Cost	–	*120.00	120.00	180.0	140.00
	4) Insurance and Overhead Cost	6.69	298.7	122.90	1,351.6	316.4
	5) Total	173.37	517.0	423.10	1,867.6	595.1
Economic Cost	1) Depreciation (time related)	15.57	10.15	10.05	24.15	8.4
	2) Capital Opportunity Cost	21.73	19.24	26.8	68.2	33.79
	3) Crew Cost	–	96.0	96.0	144.0	112.0
	4) Insurance and Overhead Cost	6.02	268.8	110.6	1,216.4	284.7
	5) Total	43.32	394.19	243.45	1,452.7	438.89

11.15 + 173.37/25 = 18.1 pesos/km

The vehicle operating cost of taxis is likewise calculated as 32.6 pesos, that of light trucks, 21.4 pesos, that of trucks, 109.4 pesos, and that of buses, 57.3 pesos. Fig 16–1–2 shows the per-km operating cost and its breakdown of each vehicle type at a speed of 25 km per hour. The reason why the operating cost is much larger for trucks than for buses is because buses have smaller overhead due to the fact that in many cases buses are operated by a syndicate of bus owners, each of whom own only one bus.

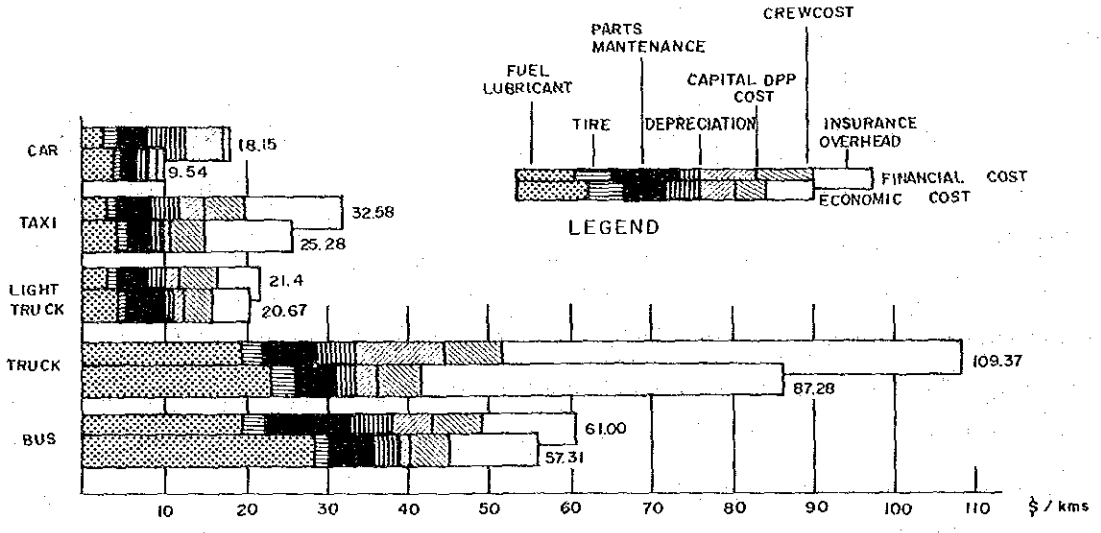


Fig. 16–1–2 Vehicle Operating Cost in Barranquilla

Total vehicle operating cost in the metropolitan area of Barranquilla is estimated by multiplying the total running distance and total running time of each vehicle type obtained from traffic assignment calculations, by the running cost and running time cost, respectively, of each vehicle type.

2) Trave Time Cost

The hourly value of Barranquilla inhabitants is estimated based on labor productivity as follows.

As discussed in Chapter 8 above, the 1983 Gross Regional Domestic Product (GRDP) of Atlántico was estimated to be 31,160 million pesos in terms of 1975 prices, which is equivalent to 179 billion pesos in terms of 1983 prices. At the same time, its employment ratio was 36.1% to the total population, and the number of employed was 509,000. Thus, the annual value added productivity comes to about 35,000 pesos per person. Dividing this figure by 2,072 hours of annual working time results in about 170 pesos of average hourly productivity. Since the current average income distribution is about 90–100 pesos per hour, this estimate is assumed to be appropriate.

For estimating the travel time cost, the value of 170 pesos per hour is applied to production-related trips only, i.e. only trips for business and work purposes shall be subject to this calculating and the time value of trips for school commutation, shopping and private purposes will be disregarded. For the benefit of calculating the time saving, half of the time saved in commutation trips is assumed to be spent in business activities. Converting the hourly productivity value of 170 pesos into the equivalent value for per pcu of vehicle results in Table 16–1–8 below. In other words, the 170 pesos is multiplied by the share of commutation and business trips and further by the average number of passengers per vehicle (excluding taxi drivers and truck drivers), and then the result is multiplied by the passenger car conversion coefficient (pcu coefficient), resulting in a passenger-car hourly value of 85 pesos and a bus hourly value of 55.2 pesos per pcu.

Table 16–1–8 Travel Time Cost by Type of Vehicle

	Car	Taxi	Light Truck	Truck	Bus
1. Trip Composition (%)					
Go to Work	19.9	10.5	16.1	16.1	18.0
Business	4.0	2.8	31.2	31.2	2.2
- Total	23.9	13.3	47.3	47.3	20.2
2. Average of No. Passengers	2.1	0.9	2.1	2.1	32.2
3. PCU Unit	1.0	1.0	1.0	2.0	2.0
4. Travel Time Cost (pesos/hr/pcu)	85.3	20.3	164.8	84.2	552.3

The factors affecting the time value include length of time, in addition to labor productivity and time spending purpose. Namely, the time value of a person spending 10 minutes is not the same as the time value of 10 persons spending a minute each. It is generally assumed that a time of a certain length has higher value than fractional time. Improved urban transportation usually results in a time saving of fractional lengths, and in this context have little useful value. The results of estimating the time saving distribution in the case where the overall required time is shortened by 15%, based on the current trip length distribution, are shown in Fig. 16–1–3. A time saving of 2–3 minutes represents the majority in both commutation and business trips, and trips expected to shorten by more than 10 minutes represent no more than 4%. For evaluating the road masterplan, a time saving of below 5 minutes is ignored, and the value of 170 pesos per hour is recognized for one-third of the total time saving.

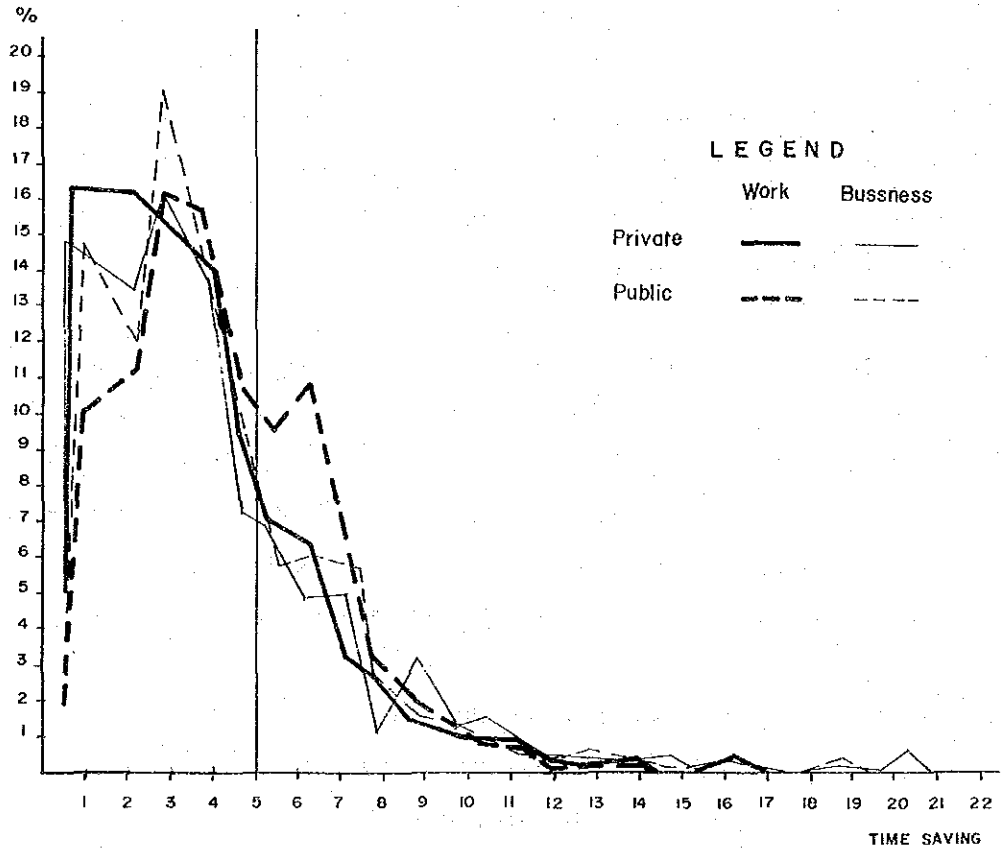


Fig. 16–1–3 Distribution of Saved Time

16–1–3 Economic Cost of the Project

The economic evaluation uses the economic cost converted from the project cost, which is calculated in market price, based on a review of the national and/or regional economies. What must be corrected in particular with regard to urban transport projects are the 3 points of: a) deduction of taxes contained in the financial post, b) re-evaluation of labor cost, and c) adjustment of land cost. For calculating the economic cost, the financial costs of all road construction projects are estimated by classifying the costs into equipment cost, materials cost and labor cost.

Main taxes are import duties on construction equipment and materials imported from overseas, and domestic sales tax. The current import tariff of Colombia, with regard to construction equipment, is relatively low, at 5%–10%. Major construction materials consist of steel, cement, fuel, aggregates, and so forth. Some of these materials are all or partly produced domestically. Comparing the volumes of domestic production and imports, it is assumed that one-third (amount-wise) comes from overseas. Since the import tariff on construction materials is about 15%–20%, the construction materials cost included an import tax of about 5%–7%, across-the-board. The domestic sales tax is 6%–8%. It is, therefore, estimated that both the equipment and the materials cost in financial cost include 13% tax.

The unemployment rate in Barranquilla has been showing a gradual upward trend and indicated 12% in 1983 (Fig. 16–1–4). At the same time, the minimum wage, set forth by the Presidential Decree of Colombia, stands at 12,400 pesos per month as of the end of 1984. As the labor cost estimated in the financial cost cannot, therefore, be said to duly reflect labor wages in the free market, it is necessary to correct it by applying the shadow price. According to the Haveman's formula, the shadow wage rate under a 12% unemployment rate is as follows:

$$\begin{aligned}\text{Shadow wage rate} &= (\text{Wage rate in the free market}) \times \\ &\quad (1.25 - \text{Unemployment rate}/0.20) \\ &= (\text{Wage rate in the free market}) \times 0.65\end{aligned}$$

Since about half of the workers to be engaged in this project are expected to be non-skilled workers, if 65% is assumed to be the shadow wage rate, the total labor cost must be adjusted by multiplying by 0.84

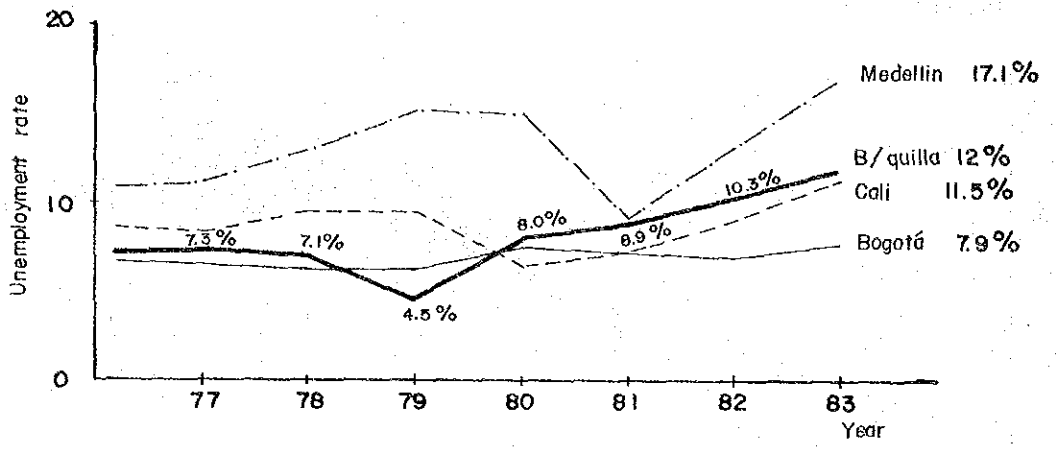


Fig. 16–1–4 Unemployment in the Principal Cities

Land is freely traded in Barranquilla and there are no special restrictions. The project land area partly includes national land, whose cost is not included in the financial cost. Since the cost is very little, however, no correction shall be made on the land cost.

Estimating the economic cost of the road projects through the foregoing procedure results in 25,205 million pesos, which is about 11% less than the financial cost. The economic cost of each project is given in Table 15–2–1. Supposing that the economic life of the road is 25 years, the residual value in the year 2001 comes to 14,715 million pesos, and the cost to be depreciated by the year 2000 is 10,490 million pesos.

16–1–4 Evaluation Result

1) Evaluation of Entire Masterplan

The sum of annual vehicle operating cost (VOC) and travel time cost (TTC) in the year 2000 would amount to 32,650 million pesos in case of the realization, according to the proposed schedule, the masterplan, while that would be 44,650 million pesos if the present road network remains as it is. Therefore, the social benefits in 2000 expected to derive by the masterplan is estimated to be 12,000 million pesos at 1984 price. Of this, 74% is attributed to the VOC savings, and 26% to TTC savings. In the same way, annual benefits of each year are expected as shown in Fig. 16–1–5, the accumulated benefits of which will reach 58,111 million pesos.

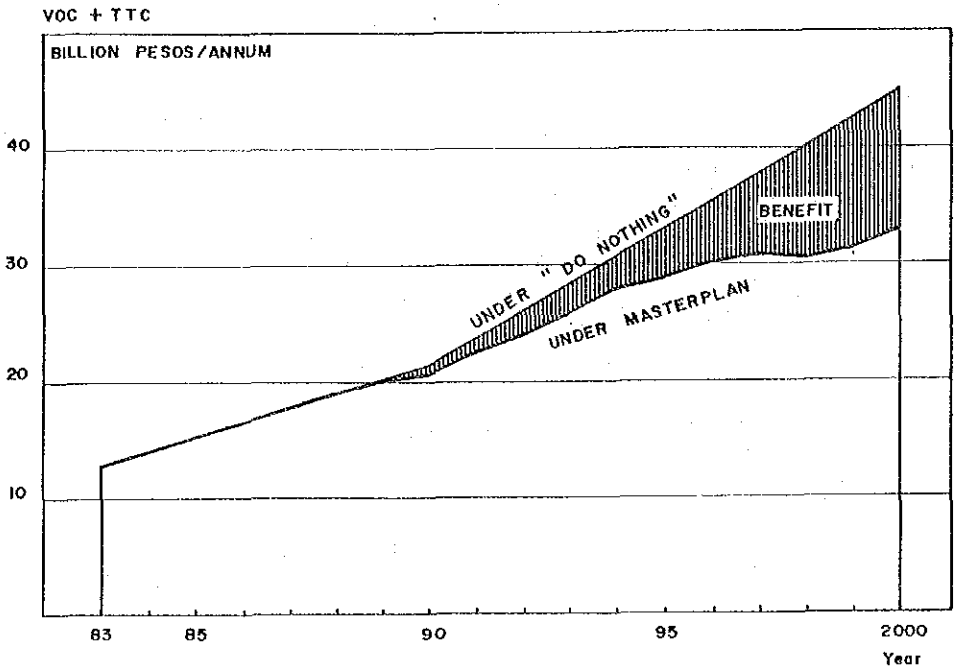


Fig. 16–1–5 Benefit of Road Masterplan

Table 16–1–9 Cost and Benefit of Road Masterplan

(million pesos)

No.	Year	Cost	Benefit	B-C	B-C discounted by 12%
1	1985	0	0	0	0
2	1986	21	0	−21	−15
3	1987	528	0	−528	−336
4	1988	624	43	−581	−330
5	1989	1,168	60	−1,108	−561
6	1990	1,336	753	−583	−264
7	1991	949	1,568	619	250
8	1992	1,290	2,053	763	275
9	1993	914	2,619	1,705	549
10	1994	1,194	3,154	1,960	563
11	1995	1,782	4,175	2,383	612
12	1996	2,303	5,201	2,898	664
13	1997	2,675	6,737	4,061	831
14	1998	2,193	9,474	7,281	1,330
15	1999	2,671	11,141	8,470	1,382
16	2000	3,259	11,999	8,740	1,273
	Total	22,907	58,967	36,060	8,137

Table 16–1–9 shows the cash flow, comparing the benefits above to the costs. Under the discount rate of 12%, the net present value (NPV) is 8,137 million pesos and the cost-benefit ratio (B/C) is 2.89, which assures the high economic return by the masterplan. The internal rate of return is also a favorable 39.7%, but this indicator is not reliable to the evaluation of the project under which costs are continuously incurred along with and in parallel to benefits throughout the entire period for evaluation, such as in the case of the masterplan (See Fig. 16–1–6).

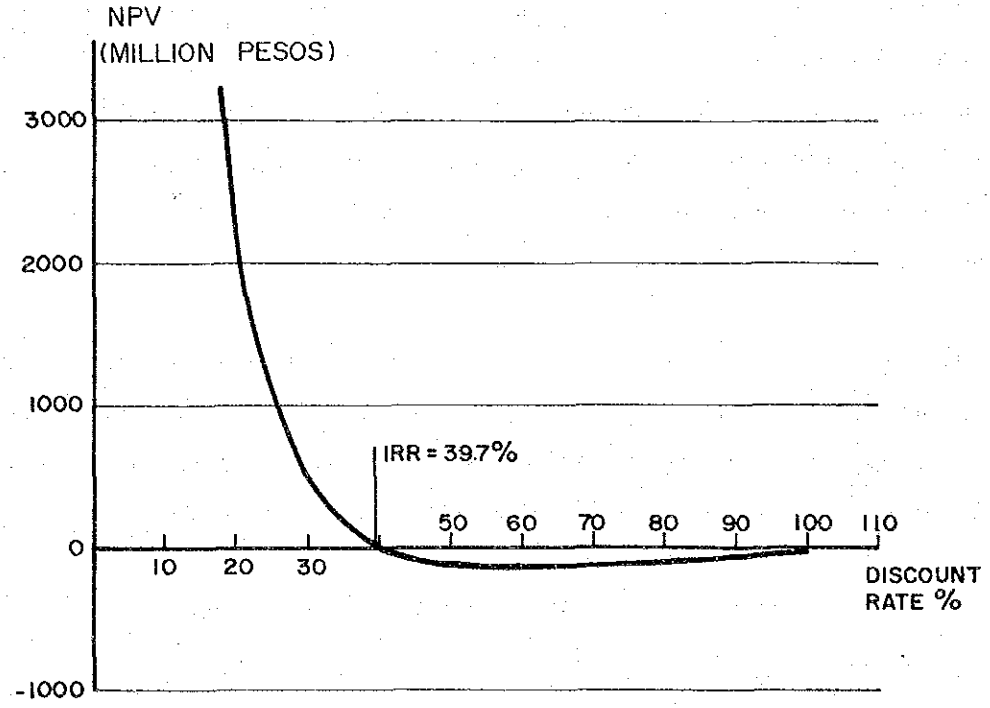


Fig. 16–1–6 Net Present Value and Internal Rate of Return

The sensitivity analysis was made of the construction cost and the future traffic demand to the evaluation indicators, the results of which were shown in Table 16–1–10. The sensitivity (the elasticity coefficient) of the B/C ratio of the construction cost is –0.84 and that of the traffic demand is 0.65, both of which are not much sensible. The masterplan will become unfeasible with the B/C ratio less than 1.0, only when the cost rises unexpectedly upto 2.9 time of the original estimate. Thus, the feasibility of the road masterplan is very favorable and stable.

Table 16–1–10 Sensitivity Analysis of Road Masterplan

Case	Condition	Evaluation Indicators		
		IRR (%)	B/C	NPV*
Base	–	39.7	2.89	8,137
1	Cost: 20% up	33.8	2.40	7,274
2	Demand: 20% down	35.2	2.51	5,979

* Million pesos at 1984 price.

2) Evaluation of Project Packages

For the purpose of evaluation of main projects individually, the project packages are composed as shown in Table 16–1–11. Case 1 and Case 2 are the comparison of new road construction projects and existing road improvement projects, and Case 3 and Case 4 are those grouped by the period. Case 5 consists of the projects with high priority, on which early implementation of feasibility study is recommended. Case 6 and Case 7 are ring road project packages and Case 8 to 12 are those of the radial type corridors.

The new road construction package and the road improvement package show the favorable feasibility more or less to the same extent. Separated into the periods of investment, the project group prior to 1996 shows a much higher investment efficiency than the other group. This fact proves that the proposed schedule is reasonable (See Table 16–1–12).

Table 16–1–11 Main Project/Package for Evaluation

No.	Project Package	Component Project
0	Masterplan as a whole	All the projects including Metropolitan Area.
1	New Road Projects	All new road construction project excluding C11, C12-C13, C14.
2	Road Improvement Projects	All road improvement projects excluding I24.
3	Project during 1987-1995	C01, C03, C04, C05, C06, C08, C09, C10, I01, I02, I03, I13, I14, I19, I21, I25.
4	Projects during 1996-2000	C02, C07, I04, I05, I06, I07, I08, I09, I10, I11, I12, I15, I16, I17, I18, I20, I22, I23.
5	Centro development roads	C01, C02, C03, C04, I01, I02, I14, I19, I21, I25.
6	Inner Circunvalar	I08, I09, I10, I11, I16.
7	Circunvalar	I03, I04, I05, I06, I07.
8	Centro-South Sub-center	C01, C03, C04, C05, C06, I01, I02, I03, I14.
9	Arenosa-West Soledad Corridor	C10, I10, I11, I15, I16, I17.
10	Centro-North Sub-center Corridor	I21, I22, I23, I25.
11	Juan Mina Corridor	I08, I09, I18, I20.
12	Central Adjacent area roads	C01, C02, C03, C04, I01, I02, I08, I09, I10, I11, I14, I16, I19, I21, I25.

Source: Study Team

Table 16–1-12 Evaluation of Road Projects

(million pesos)

No.	Project Package	Construction Period	Construction Cost		Indicators Evaluation		
			Financial	Economic	B/C	NPV	IRR(%)
0.	Masterplan as a whole	1987-2002	28,264.9	25,205.4	2.89	8,137.0	39.7
	Sensitivity I (20% up of Cost)	1987-2002	33,917.9	30,246.5	2.40	7,274.0	33.8
	Sensitivity II (20% down of Traffic)	1987-2002	28,264.9	25,205.4	2.51	7,529.0	35.2
1.	New road projects	1987-1998	6,223.5	5,478.0	3.58	5,017.9	45.1
2.	Road improvement projects	1987-2000	14,400.1	13,111.3	3.46	6,861.2	54.7
3.	Projects during 1987-1995	1987-1995	8,875.5	8,044.8	4.41	10,601.8	52.3
4.	Projects during 1996-2000	1996-2000	11,748.1	10,544.5	2.06	1,192.9	23.9
5.	Centro development roads	1987-1997	8,154.1	7,394.7	2.78	4,600.8	36.1
6.	Inner Circunvalar	1996-2000	3,084.1	2,905.5	1.57	345.2	21.8
7.	Circunvalar	1993-2000	3,300.4	2,903.1	4.82	1,050.9	74.6
8.	Centro-South subcenter	1987-1995	6,260.6	5,641.4	6.35	11,383.9	63.7
9.	Arenosa-West Soledad Corridor	1991-2000	4,113.9	3,832.3	1.78	545.6	28.8
10.	Centro-North Subcenter Corridor	1994-2000	2,439.9	2,243.8	2.74	1,155.6	37.1
11.	Juan Mina Corridor	1991-2000	2,176.6	1,917.5	1.53	59.7	20.5
12.	Centro & Adjacent area roads	1987-2000	11,238.6	10,301.2	3.44	7,796.5	46.9

Source: Study Team

All the packages of Case 5 to 12 are proved feasible. Particularly favorable are Centro-South Sub-center Corridor package (Case 8) and Circunvalar package (Case 7), while relatively low investment efficiencies are shown by Inner Circunvalar package (Case 6) and Juan Mina Corridor package (Case 11) which need a high land acquisition cost and compensation cost.

16–2 Financial Evaluation on Public Transportation Projects

16–2–1 Evaluation Method and Premises

Financial analyses were made on the income-generating public transportation projects from the standpoint if they are financially viable or not independently from others. Fig. 16–2–1 illustrates the structure of the computer model used to estimate their income statement and cash flow statement and to make a discounted cash flow analysis. Major points of the method and premises for analysis are explained below.

1) Inflation

The financial analysis is made in the nominal term, taking inflation into consideration. This is because the loan conditions are set already expecting future inflation. The trend of recent inflation in Colombia is shown in Table 16–2–1. It is assumed, in principle, that the inflation will continue at the average rate of those in the past.

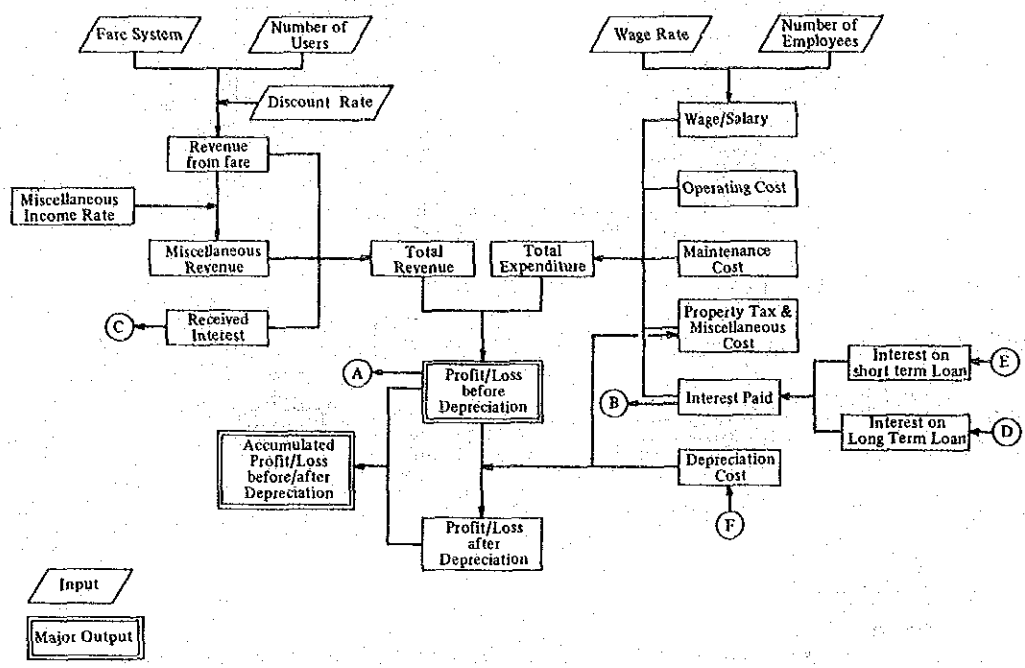
Table 16–2–1 Inflation Rate in Colombia

(percent/year)

Year	Consumer's Price	Capital Goods	Material & Intermediate Goods	Consumption Goods
1975	22.9	26.1	20.5	32.3
1976	20.3	20.2	24.4	21.4
1977	33.1	18.1	18.1	40.6
1978	17.8	25.2	16.4	16.9
1979	24.4	22.8	27.0	30.2
1980	26.0	20.0	19.5	30.4
1981	27.0	26.5	18.7	28.7
1982	24.1	19.2	19.5	32.7
Average	24.4	22.3	20.5	29.2

Source: DANE, (Departamento Administrative Nacional de Estadistica)

1. PROFIT/LOSS STATEMENT



2. CASH FLOW

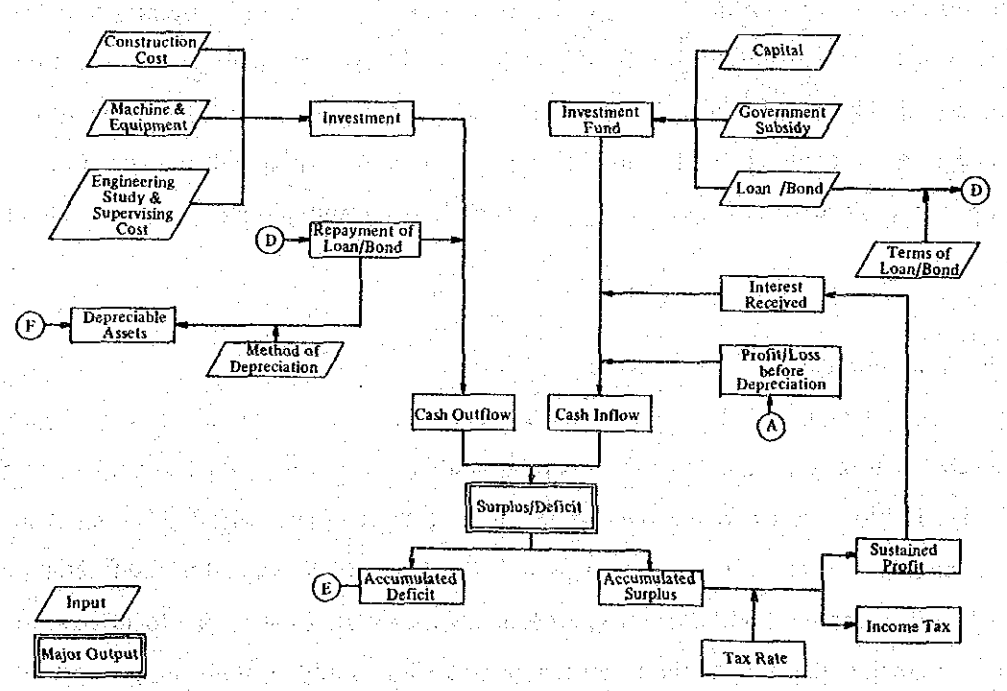


Fig. 16–2–1 (1) Procedure of Financial Analysis

3. DISCOUNTED CASH FLOW

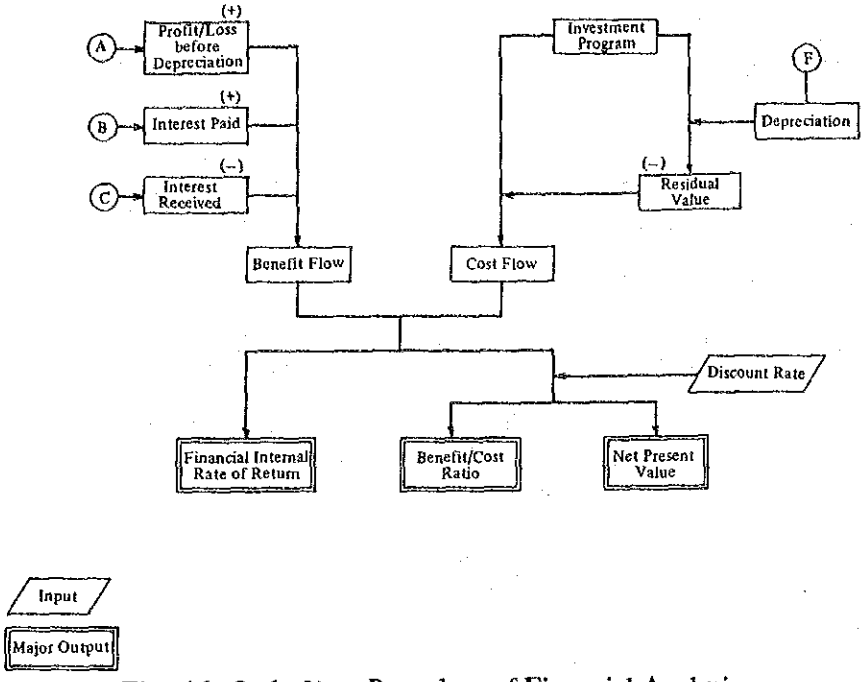


Fig. 16–2–1 (2) Procedure of Financial Analysis

It can be expected that the project cost will rise at the annual rate between that of capital/intermediate goods and that of consumption goods. On the other hand, income resources of facility tolls and transportation fares tend to inflate generally at the inflation rate of consumer goods. However, a constant inflation rate of 20% is assumed here, considering that a soft loan of the prime rate at 24% will be introduced to these kinds of public transportation projects. The inflation rate at 6% is assumed for the foreign currency portion. The condition of inflation will be taken up in the sensitivity analysis because of its high uncertainity and much influence on the results.

2) Fund Procurement

It is assumed that 10% for the terminal projects and 20% for the rail transit projects of the project cost will be prepared as an own capital, and the rest will be procured by internal or external loans. The loan terms are assumed to be 2 to 4 years as a grace period, 24% as the annual interest rate and 15 years of the repayment period. The loan shall be repaid in the fixed amount of principal repayment method. Currently, BCH lends its FFDU fund to the local government and another financing agencies at the interest rate of 23% and adding their margin to this, the fund is lent to a final borrower at the rate of 25%. Another interest rate of 12% is assumed to a foreign loan.

3) Depreciation

The durable life is assumed to be 25 years for civil constructions and 20 years for architectural structures, applying the fixed amount method for both of them. After their life, 5 to 10% of their costs are remained as the residual values. Machineries and equipments are depreciated for 10 years with 10% residuals, using the fixed rate method. Land is not depreciated. Engineering cost and contingencies are capitalized at the completion of construction and depreciated in the same way as the architectural structures.

4) Discounted Cash Flow Analysis

Inflation is disregarded to estimate the evaluation indicators such as the financial internal rate of return (FIRR) and the cost-benefit ratio in the discounted cash flow analysis. The same discount rate of 12% as used in the economic evaluation is adopted.

16–2–2 Interdepartmental Bus Terminal

1) Investment Schedule

In the first stage (1988–1989), is scheduled an investment of 236.1 million pesos at 1984 price and in the second stage, 89.5 million pesos. Construction will take 2 years in each stage. Design work and land acquisition will be made in the previous year of construction.

Although the foreign currency portion needed for imported equipments, machineries, materials and service is estimated at 38% of the total cost, all the fund is assumed to be procured internally, depending on no foreign loan, as the project is not too large. Annual investment amounts are estimated as shown in Table 16–2–2.

Table 16–2–2 Annual Investment Amount of Interdepartmental Bus Terminal

(million pesos)

	Item	1st Stage			2nd Stage		
		1987	1988	1989	1994	1995	1996
1.	Road & Parking		16.7	16.7		0.4	0.4
2.	Platform & Sidesalk			7.6			0.6
3.	Utilities	13	13.0				
4.	Planting			14.4			1.1
5.	Sign, Signals, etc.			10.9			
6.	Building		31.3	31.3		28.8	28.8
7.	Building Service			9.9			15.0
8.	Overhead		9.2	13.6		3.5	6.0
9.	Contingency		7.0	10.4		2.7	4.6
10.	Engineering	7.7	7.7	7.7	3.2	3.2	3.2
11.	Land Cost	21.0					
	Total	28.7	84.9	112.5	3.2	32.6	53.7

2) Revenue

This bus terminal will have several kinds of revenues, tolls, rentals of commercial facilities, fee for advertisement and baggage storage charges. In addition, a profit of land sales can be expected if this enterprise gets the land adjacent to the terminal before construction and sells it at a higher price after the area is highly urbanized. But this profit is not one through the proper activity of the terminal and is not considered here.

The terminal will charge on a bus passenger who will use the terminal at 0.04 pesos per km of his trip, according to the MOPT Resolution (no. 5220, June, 1984). The future revenue from these tolls are forecasted applying the average seat occupancy of 70% to the number of interdepartmental buses in 1984 and assuming 3.3% annual growth rate.

The terminal will charge also on a bus according to the MOPT Resolution (No. 5250, June, 1984), in such a way as; a) to charge 40% of the tariff to the final destination of the bus in case there is no terminal at the destination, b) to charge 35% of the tariff in case there is a terminal at the destination and c) to charge 24% of the tariff in case there is at least one terminal on the way to the destination. In the same way as that of tolls on the passengers, this revenue is forecasted based on the number of buses in 1984 and the growth rate of 3.3% which is the average increasing rate of bus passengers from 1984 to 2000.

The rentable area is planned to be 612 m^2 (half of which is for a coffee shop and the other for offices) in the first stage and 1,168 m^2 (of which, 320 m^2 for a diagnostic center and a fuel station and the others for a restaurant and/or offices) in the second stage. Tha annual rate is set uniformly at 10,000 pesos/m^2.

The area for advertisement is envisaged at 500 m^2 in the first stage and additional 135 m^2 in the second stage, with the charge of 800 pesos/m^2 per annum. 2% of the total passengers are assumed to use the baggage keeping service which will charge 30 pesos on each baggage.

Based on the conditions above, the revenues in the opening year of each stage are estimated as shown in Table 16–2–3. The revenue in 1990 will approximately be 99 million pesos, of which 90% will come from tolls on passengers.

In addition to above, 13.0 million pesos land sales in 1997 and 1998, respectively.

Table 16–2–3 Revenue of Inter-Departmental Bus Terminal

(million $ at 1984 price)

	1990	1997
Charge on passengers	46.6	58.5
Charge on buses	43.2	54.1
Rent	6.1	17.8
Advertisement	2.6	3.3
Baggage storage	0.4	0.4

3) Expenditure

The organization of the terminal is planned as in Fig. 16–2–2, following those of other terminals in Colombia. Under the general manager and the general secretary, are established 2 department; operational department and administration/financial department. The former is responsible for traffic control in the terminal and the maintenance of facilities while the latter will manage personnel affairs, accounting and other general affairs. A planning section and a juridical office will be put directly under the general manager. As a decision making unit other than the general assembly, is established a board of direction consisting of the representatives from agencies concerned.

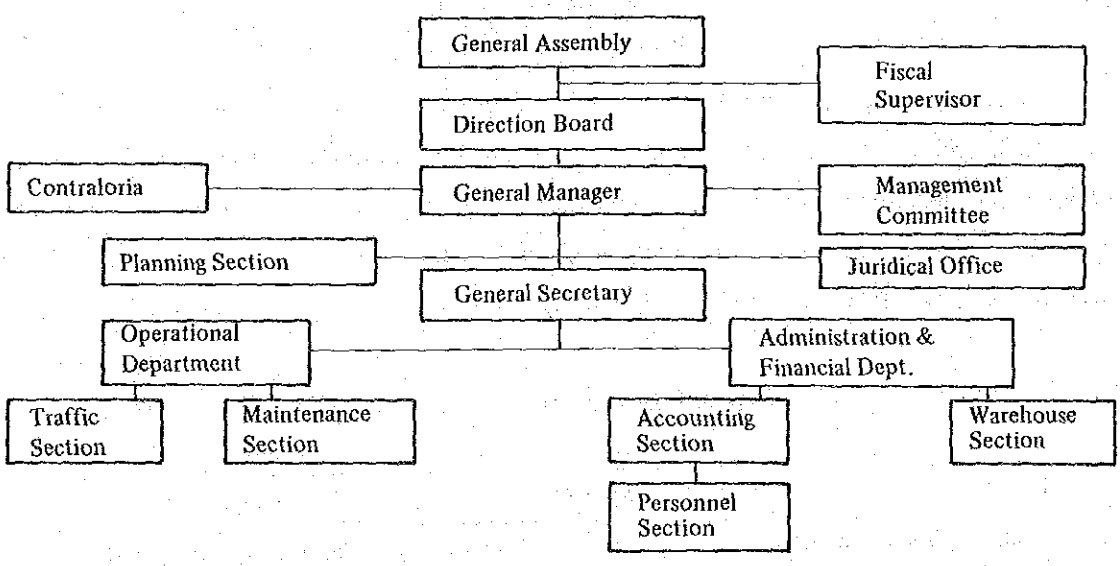


Fig. 16–2–2 Organization of Interdepartmental Bus Terminal

Table 16–2–4 shows the wages and other personnel expenses for 54 employees. In addition to wages, other personnel expenses comprising the reserved fund for retirement and vacation, bonus, insurance and tax will be needed as much as about 40% of the total amount of wages. The total personnel expenses will amount to 20.5 million pesos in the first year of operation.

Table 16–2–4 Annual & Monthly Wage of Inter-Departmental Bus Terminal in 1990

(thousand pesos)

	Number of Personnel	Monthly Wage	Annual Wage	Additional Personnel Cost	Total (a)
General Manager	1	80	960	384	1,344
Fiscal Supervisor	1	30	360	144	504
Secretary A	1	20	240	96	336
Typewriter A	1	20	240	96	336
Operation Section chief	1	70	840	336	1,176
Typewriter B	1	20	240	96	336
Traffic Section Chief	1	50	600	240	840
Typewriter C	1	20	240	96	336
Inspector	3	15	180	72	756
External Controller	10	15	180	72	2,520
Maintenance Section Chief	1	50	600	240	840
General Personnel	21	15	180	72	5,292
Guardman	5	15	180	72	1,260
Juridic Office Chief	1	60	720	288	1,008
Administration Section Chief	1	70	840	336	1,176
Typewriter D	1	18	216	86	302
Accounting Section Chief	1	60	720	288	1,008
Personnel Chief	1	50	600	240	840
Storekeeper	1	16	192	77	269
Total	54	692	8,328	3,331	20,479

Note: (a) Including: Retirement reserved fund with interest (112% of one salary, two remunerations (1 salary), Vacations (half salary), Social Security, 6% of annual salary (tax paid to SENA and Instituto de Bienestar familiar), Transport Subsidy (only applied for two times minimum salary).

The operating cost covering power, water, office supplies, transportation and communication, repair and maintenance are estimated, based on the assumptions in Table 16–2–5, at 32.4 million pesos. Future increase of this expenditure caused by the growth of passengers and buses is considered to be 2% per annum, lower than that of revenue because of the enterprise's effort to raise the working efficiency and to save the expenditure.

Table 16–2–5 Expenses of Inter-Departmental Bus Terminal in 1990

(million pesos)

	Items	Expenses	Remarks
1.	Salary & Social Security	20.5	Including all taxes & social security
2.	Utilities & Office Supply	2.4	Including water & electricity.
3.	Transportation & Communication	2.4	
4.	Maintenance & Reparation	4.3	Annumed 2.0% of total construction cost.
5.	Miscellaneous	2.8	10% of total of 1 to 4
	Total	32.4	

4) Analysis Result

In the first operation year of 1990, the total revenue will amount to 99 million pesos while the total expenditure will be 32 million pesos, resulting in the net income of 67 million pesos (at 1984 price). This surplus will grow at the annual rate of 4% and the accumulated surplus will reach after 17 years to 1673 million pesos which exceed the total investment of 326 million pesos by more than 5 times. Thus, the project is proven hihgly profitable. The FIRR is estimated at 26.7%, B/C ratio at 2.27.

Under 20% inflation, the project imply an apparent FIRR as high as 52.0% and can bear commercial loan conditions. In addition, the project can accumulate enough sustained profit for the second stage investment, not requiring any additional loan. With a favorably conditioned loan of 24% interest rate, the accumulated balance will exceed 13,000 million pesos (equivalent to 1,330 million pesos at 1984 price). Fig. 16–2–3 illustrates the trend of the accumulated balance under various rates of inflation. Even in the moderate inflation rate of 10% (which results in a heavier burden of interest), the project can be viable.

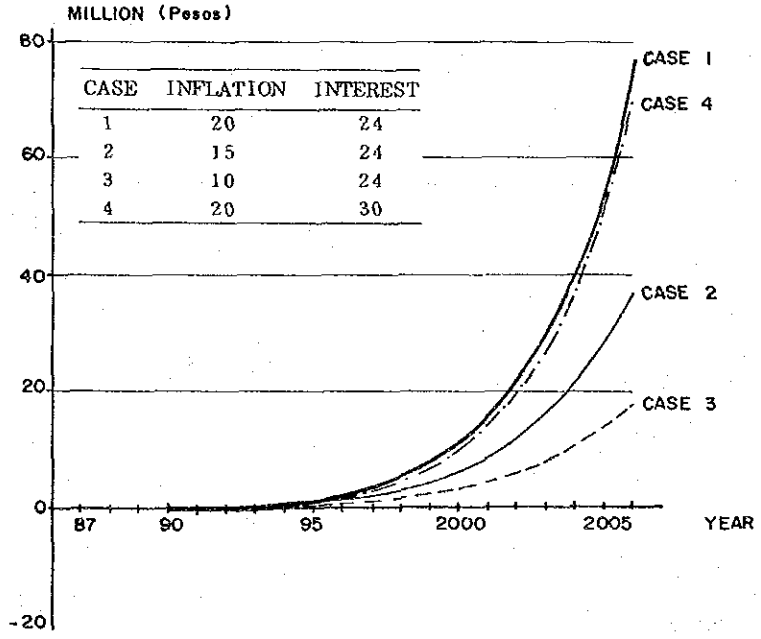


Fig. 16–2–3 Trend of Balance Carried Forward of Interdepartmental Bus Terminal

Table 16–2–6 shows the result of sensitivity analysis on revenue, expenditure and the project cost to the indicators for evaluation. Although among 3 factors, the revenue is the most sensitive to the result, more than 42% reduction of revenue will make B/C ratio less than 1.0 (or FIRR, lower than 12%), which proves that the investment to this project is highly safe.

Table 16–2–6 Sensitivity Analysis on Inter-Departmental Bus Terminal Project

Condition	Evaluation Indicators		
	IRR(%)	B/C	NPV (million $)
–	26.7	2.27	279.2
Revenue 20% down	19.8	1.63	139.0
Revenue 20% up	33.0	2.91	419.3
Const. cost 20% up	22.7	1.87	231.9
Const. cost 20% down	32.3	2.89	326.4
Operating cost 20% up	24.7	2.09	238.9
Operating cost 20% down	28.7	2.45	319.5

16–2–3 Intermunicipal Bus Terminal

1) Investment Schedule

The intermunicipal bus terminal will be developed in 1994 and 1995. Prior to this, land acquisition and design works will be done. The total project cost is 263.7 million pesos, of which 137.3 million pesos are for construction. Annual investment amounts are shown in Table 16–2–7.

Table 16–2–7 Annual Investment Amount of Inter-Municipal Bus Terminal

(million pesos)

Item	1993	1994	1995	Total
1. Site Preparation	–	1.5	–	1.5
2. Road & Parking	–	12.0	12.0	24.0
3. Platform & Sidewalk	–	–	4.3	4.3
4. Pedestrian Bridge	–	1.8	1.9	3.7
5. Utilities	–	3.4	3.4	6.8
6. Planting	–	–	3.2	3.2
7. Sign, Signals, etc.	–	–	7.7	7.7
8. Buildings	–	20.1	20.2	40.3
9. Buildings Services	–	–	9.0	9.0
10. Overhead	–	5.8	9.2	15.0
11. Contingency	–	4.5	7.1	11.6
12. Engineering	5.1	5.1	5.1	15.3
13. Land Cost	83.6	–	–	83.6
14. Compensation Cost	37.7	–	–	37.7
Total	126.4	54.2	83.1	263.7

2) Revenue

All the preconditions on revenue follows those for the interdepartmental bus terminal. As for the toll on a passenger, however, 10 cents/km is applied instead of 4 cents/km because this terminal cannot expect much passenger toll revenue under 4 cents/km due to its shorter bus routes. In case of 10 cents/km, for example, a passenger who travels from Barranquilla to Baranoa (25 km far from Barranquilla) must pay the terminal toll of 2.5 pesos which correspond to 9% of the bus fare to Baranoa of 28 pesos.

Opening the bus terminal in 1996, the total annual revenue will be 54.2 million pesos at 1984 prices, which comprise revenues from rentals of 613 m^2 commercial facilities of 6.3 million pesos and from advertisement fee of 0.4 million pesos. The accumulated revenue up to 2010 will amount to 70.2 million pesos under 3.3% increasing rate of tolls on passengers and on buses (See Table 16–2–8).

Table 16–2–8 Revenue of Inter-Municipal Bus Terminal

(million $ at 1984 price)

	1996	2010
Charge on passengers	32.3	50.9
Charge on buses	8.0	12.6
Rent	6.3	6.3
Advertisement	0.4	0.4
Total	47.0	70.2

3) Expenditure

Assuming the organization similar to that of the interdepartmental bus terminal, the number of employees will be 23 persons in total and the personnel cost for them will amount to 10.2 million pesos in 1996 (See Table 16–2–9). The other cost items are estimated, as shown in Table 16–2–10, at 15.2 million pesos in the first years, which is expected to rise up at 2.0% per annum in real terms.

4) Analysis Result

The terminal will have a surplus of 39.0 million at 1984 prices. As long as the toll system based on the bus tariff is adopted, this terminal is not so profitable as the interdepartmental bus terminal. Its FIRR of 11.6% and B/C ratio of 0.97 are in the marginally feasible range.

Table 16–2–9 Annual & Monthly Wage of Inter-Municipal Bus Terminal

(thousand pesos)

	Number of Personnel	Monthly Wage	Annual Wage	Additional Personnel Cost*	Total
General Manager	1	60.0	720.0	288.0	1,008.0
Fiscal Supervisor	1	30.0	360.0	144.0	504.0
Secretary 1	1	20.0	240.0	96.0	336.0
Administrative & Operation Chief	1	50.0	600.0	240.0	840.0
Secretary 2	1	17.0	204.0	81.6	285.6
Accountant	1	35.0	420.0	168.0	588.0
Treasurer	1	35.0	420.0	168.0	588.0
Traffic Coordinator	1	35.0	420.0	168.0	588.0
General Personnel	5	35.0	420.0	168.0	2,940.0
External Controller	5	15.0	180.0	72.0	1,260.0
Inspector	2	15.0	180.0	72.0	504.0
Guardman	2	15.0	180.0	72.0	504.0
Messenger	1	13.6	163.2	65.2	228.4
Total	23	375.6	4,507.2	1,802.8	10,174.0

*Taxes and social insurance charge by the companies.

Table 16–2–10 Expenses of Inter-Municipal Bus Terminal in 1996

(thousand pesos)

	Expenses Item	Annual Expenses	Note
1.	Salary & Social security	10,174.0	Including taxes & social security.
2.	Utilities & office supply	930.0	Including water & electricity supply.
3.	Transport & Communication	200.0	
4.	Maintenance	2,496.8	Assumed 2.0% of total construction cost.
5.	Miscellaneous	1,380.0	Assumed 10% of total, 1 to 4.
	Total	15,180.8	

However, as under a high inflation rate of 20%, the interest rate of 24% corresponds to the real term interest rate of only 3.3%, the project can change its accumulated balance from deficit to surplus within 9 years (by 2004). The maximum fund requirement (the maximum demand for short term borrowing) will come in 6th year after opening, at 515 million pesos (83 million pesos at 1984 price) (See Fig. 16–2–4). As Case 3 and Case 4 in the figure shows, this project cannot be viable unless the inflation continues at the rate higher than 13% per annum and even under 20% inflation, this project cannot bear the interest of commercial loan (Case 5).

Table 16–2–11 shows the results of sensitivity analysis on the revenue, expenditure and construction cost to the evaluation indicators. Among 3, the evaluation indicators are the most sensitive to the revenue. In this sense, the revenue must be paid attention not to fall down lower than the estimate.

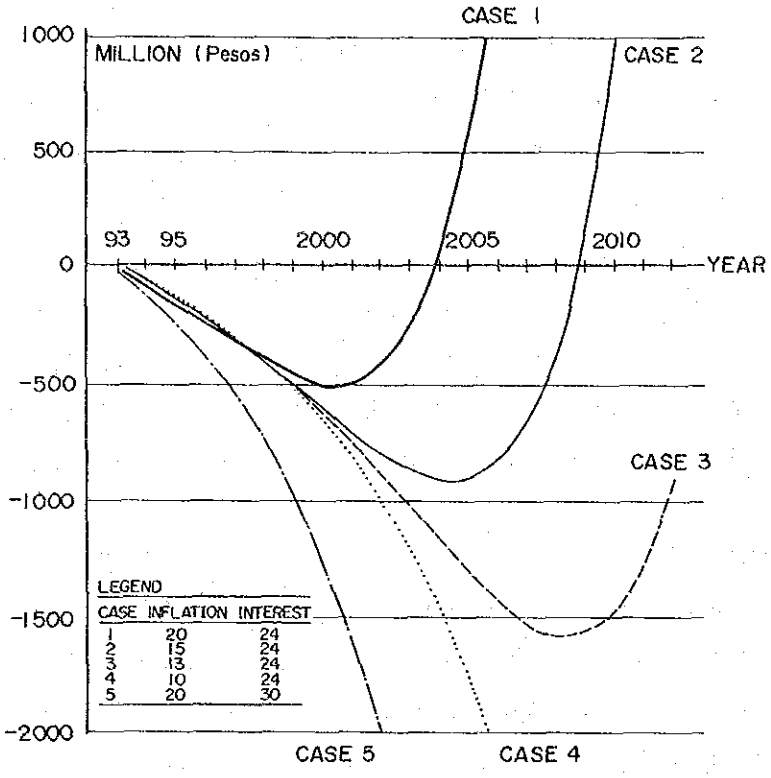


Fig. 16–2–4 Trend of Balance Carried Forward of Interdepartmental Bus Terminal

Table 16–2–11 Sensitivity Analysis on Inter-Municipal Bus Terminal Project

Condition	Evaluation Indicators		
	IRR(%)	B/C	NPV (million $)
—	11.6	0.97	11.6
Revenue 20% down	8.0	0.68	–71.1
Revenue 20% up	14.8	1.25	56.3
Const. cost 10% up	10.5	0.87	–31.5
Const. cost 10% down	13.0	1.08	16.7
Operating cost 20% up	10.5	0.88	–27.6
Operating cost 20% down	12.7	1.06	12.8

As a conclusion, this project is difficult to be managed by a private enterprise, then, it is recommendable to introduce significant amount of public capital, to finance with soft loan and/or to create additional income such as by managing wider space of commercial facilities or urban development project around the terminal.

In addition, it is worth considering the possiblity of managing both terminals, inter-departmental and intermunicipal, by one entity in order to make their service in the same level,

because a significant difference exists between their profitabilities. In this case, FIRR will be 23.6 and B/C ratio 1.96. Thus, remains high profitability and the sustained profit will be accumulated enough to invest to the second stage project of the interdepartmental bus terminal and also to the intermunicipal bus terminal.

16–2–4 Rail Transit System

Although this study does not specify the type of rail transit, the financial analysis will use the cost of monorail which can be regarded as a representative system of intermediate capacity transits. Assuming to open its service in the year 2000, 2 cases will be analyzed; in one case only route I (Centro-Soledad) is operated and in the other case both of route I and II are developed.

1) Investment Schedule

In order to commence its service in 2000, the project must be started in 1992, taking 4 years for preparatory works such as study, design, land acquisition, fund procurement, contract, etc. and another 4 years for construction. The investment amounts by item explained in Chapter 12 are allocated into the years when each works are most likely implemented, as shown in Table 16–2–12.

Table 16–2–12 Investment Schedule of Rail Transit Project

(million pesos)

	1992-95	1996	1997	1998	1999	Total
Case 1: Route 1	412	2,675	2,675	4,699	10,143	20,604
Case 2: Route 1 & 2	743	5,191	5,191	8,238	18,374	37,737

Note: Route 1: Centro-Soledad
Route 2: Centro-North-Sub-center

The foreign currency portion estimated to be 57% of the total cost, will be procured with a foreign loan (3 years of grace period, 12% interest rate and 20 years repayment) as an assumption. Own capital will be prepared as much as 20% of the total provject cost and the rest will be financed by an internal loan (3 years of grace period, 24% interest and 20 years repayment).

2) Revenue

If the same tariff system as that of bus is applied, daily passengers in the year 2000 will reach to 12,500 for the route I only (Case 1) and to 281,000 for the route I and II (Case 2). Considering 1 year is equivalent to 332.5 days (300 weekdays and half of holidays and weekend

days), the annual tariff revenue in 2000 will be about 970 million at 1984 prices in case I and 1,500 million pesos in Case 2. Adding to this, the other revenue, the total annual revenue in 2000 will be as shown in Table 16–2–13.

Table 16–2–13 Revenue of Rail Transit System in 2000

(million $)

		Case 1 (Route 1)	Case 2 (Route 1 & 2)
1.	Tariff	970.1	1,491.9
2.	Other Revenue	291.0	447.6
	Total	1,261.1	1,939.5

This revenue is expected to increase at the annual rate of 3.8%, which is the growth rate of demand.

Generally speaking, rail transit service is superior to bus service in its quality, which suggests the possibility to adopt a tariff system different from that of buses. For example, the average riding distance of a bus passenger is 4.8 km in Barranquilla, and he is charged 15 or 16 pesos. If he wants to travel for this distance by taxi, the tariff is 150 to 200 pesos. As the average number of taxi passengers is 1.84, taxi tariff per head will be 80 to 110 pesos, which means a taxi service is much more expensive than bus service by 5 to 7 times. Nevertheless, there are bus passengers as many as 10% of bus passengers.

With the reason why a rail transit provide better service than buses, 20 pesos per ride is assumed to the rail transit without changing demand.

4) Expenditure

The route 1 with 14 stations will need 140 station staff, 30 drivers and conductors, 60 staff for maintenance of tracks, rolling stocks and power supply facilities, and 25 staff for communication and signal control and in total 260 persons including managirial people. The personnel cost will amount to 107.3 million pesos in the year 2000.

Other expenses are estimated based on the average volumes of various inputs of the typical rail transits in Japan, applying unit costs in Barranquilla, the results of which are shown in Table 16–2–14. The total expenditure in 2000 is estimated to be 516 million pesos in case 1 and 940 million pesos in case 2, both of which are assumed to increase at 2.0% per annum.

Table 16–2–14 Operation Cost of Rail Transit System in 2000

(million $)

		Case 1 (Route 1)	Case 2 (Route 1 & 2)
1.	Personnel Cost	107.3	211.6
2.	Rail Maintenance	41.3	8.15
3.	Electricity Maintenance	10.8	21.3
4.	Rolling Stock Maintenance	95.6	152.8
5.	Electricity	145.5	275.0
6.	Miscellaneous	115.9	194.7
	Total Cost	516.4	936.9

4) Analysis Result

The total project cost of the route I and II will reach 37,737 million pesos. On the other hand, the revenue expected in 2000 is only 2,000 million pesos.

Deducting the operating cost of 940 million pesos from this revenue, the current surplus is lightly more than 1,000 million pesos. Before making detailed financial analysis, the project can be concluded not to be viable. The followings are the results of analysis on the route I (case 1).

While the construction cost of the route I is estimated at 20,600 million pesos, the current net income will be 746 million pesos (at 1984 prices), applying 16 pesos as tariff. Although the accumulated net income for 25 years after beginning operation will reach 34,620 million pesos or 1.7 times of the construction cost, FIRR is unfavorable 4.4%. Under a tariff of 20 pesos, FIRR will be 6.4% without much improvement. FIRR exceeds 12% only when the tariff is raised higher than 35 pesos per ride (See Table 16–2–15). Construction cost will not affect much on the result. If the construction cost can be reduced by 20%, 30 pesos per ride makes FIRR 12%.

Table 16–2–15 Sensitivity Analysis on Rail Transit Project (Centro-Soledad)

Case	Condition	Evaluation Indicators		
		IRR (%)	B/C	NPV*
Base	Fare: $ 16/ride	4.4	0.37	–6,511
1	Fare: $ 20/ride	6.4	0.51	–5,037
2	Fare: $ 25/ride	8.7	0.69	–3,181
3	Fare: $ 30/ride	10.7	0.87	–1,330
4	Fare: $ 35/ride	12.5	1.05	519
5	Fare: $ 40/ride	14.2	1.2	2,369
6	Fare: $ 16/ride Const. cost 20% down	5.9	0.46	–4,404
7	Fare: $ 30/ride Const. cost 20% down	12.9	1.10	776

* Million pesos at 1984 price

Taking inflation into consideration, the accumulated balance will change annually as shown in Fig. 16–2–5. If high inflation is assumed to continue at the rate of 20%, the project has a possibility to be feasible with a 24% interest internal loan and 12% interest external loan. As case 1 shows, the balance will change to surplus after 16th year, assuming 20% tariff. The maximum fund requirement is 6,660 million pesos at 1984 price in 2010. This fact indicates a possibility of introducing rail transit route I by the end of this century if such favorable conditions are realized as introduction of relatively low interest loan, rise of citizens' willingness to pay and preparation of sufficient own capital.

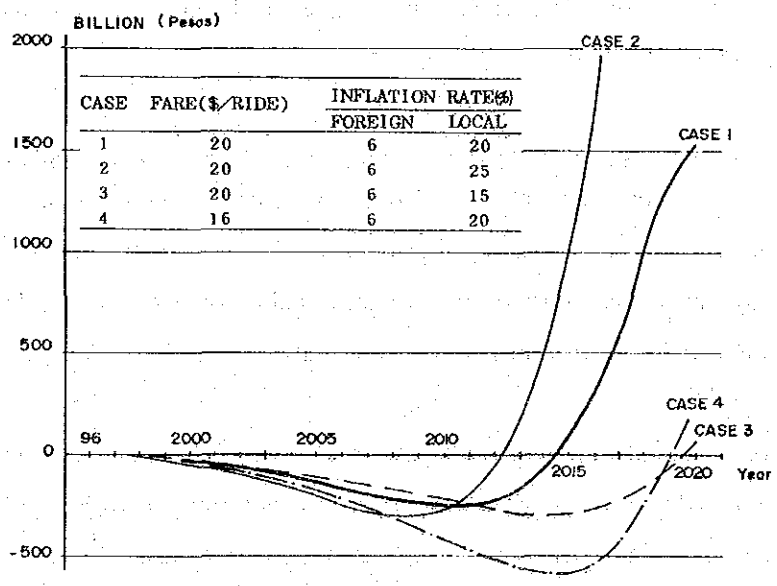


Fig. 16–2–5 Trend of Balance Carried Forward of Rail Transit (Centro-Soledad)

However, as long as the application of a tariff higher than that of bus by 2 or 3 times is unrealistic, this project will not be profitable enough to attract private capital. Therefore, the project should be planned from the standpoint of public investment in the same way as road projects.

16–3 Socio-Economic Impact of Masterplan

Implementation of the masterplan will certainly bring about many different socio-economic impact, directly or indirectly, and positive or negative. In the economic evaluation of road projects, only saving in vehicle operating cost and travel time cost were considered because they are most direct benefit as a return of the investment. Here, several other aspects will be reviewed.

16–3–1 Energy Conservation Effect of the Road Masterplan

Consumption of gasoline and diesel oil in Colombia reached to 97,000 barrels per day in 1980. More than half of them were probably consumed in the transport sector although no sectoral consumption data is available. Assuming the transport sector consumed a half, annual consumption in the sector is estimated to be 101.1 billion pesos, that is, 3,600 pesos per capita. (The average economic price of gasoline and diesel is estimated at 5,712 pesos per barrel at 1984 price.) (See Table 16–1–2)

The energy conservation effect of the road masterplan is estimated based on the result of traffic assignment, by comparing energy consumption in the case should the road network be left as it is until the end of this century (do nothing case) and energy consumption in the case should the masterplan be realized.

According to the result of traffic assignment to the masterplan road network, the total vehicle operation distance will be 4,450,000 pcu.km per day in 2000, about 15% less than that in the do nothing case. Average operation speed is 15.4 km/hr in the masterplan case, while 6.9 km/hr in the do nothing case. Therefore, it is reasonably assumed that in do nothing case, the fuel consumption rate be lower than that shown in Table 16–1–2 by 10%.

Based on these information, the total energy saving caused by less operation distance and lower fuel consumption rate in the master plan case is estimated to be 2,221 million pesos in 2000 in terms of economic price. The total savings of each year will reach to 10,915 million pesos which correspond to 38% of the total masterplan cost. Discounting these future benefits

to the 1984 value by 12%, the present value of this saving will be 2,582 million pesos. In short, the masterplan imply the foreign currency saving (or gain) effect of this amount at present, only from the viewpoint of energy conservation.

16–3–2 Job Creation

Currently, Barranquilla is suffering serious unemployment as other citites in Colombia. In the Barranquilla Metropolitan Area, the economic active population is 351,000 or 36.1% of the total population, 973,200. Among them, there are 42,000 unemployed persons which mean 12% unemployment rate.

Under such situation, job creation by implementation of the masterplan is significant. Based on the total personnel cost in the construction cost of the road masterplan, direct employment in the construction works is calculated to be 70,000 to 80,000 man-months. The total employment would be 3 to 4 times of this, adding to this, workers in the related business and industry. Such construction projects as road, drainage, terminals and urban renewal project are expected to trigger the vitalization of urban economy.

16–3–3 Solution of Drainage Problem

Solution of drainage problems on the arterial road in and around Centro would affect broadly on the economic activity and citizen's life as well as protect the traffic from flood. According to an estimate by a private company*, the annual diseconomy in Barranquilla by hindrance of economic activities caused by rain water flood will reach to 1,800 million pesos at 1982 price.

Drainage projects for Centro should be evaluated not only from the viewpoint of elimination of explicit damages such as hampered economic activity, submergence of property, traffic confusion and insanitary conditions, but also from the city image improvement of "area protected from flood", which would support indirectly the urban development of Centro.

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* Ing. Raúl Arzuza Cuesta and others, "Solución a los Problemas de los Arroyos de la Ciudad de Barranquilla", October, 1982.

APPENDICES

APPENDICES

Appendix A LIST OF MEMBERS FOR THE STUDY

1. Coordinating Committee, Government of Colombia
   (1) Dr. Guido Borrero Durán
   Alcalde de Barranquilla
   (2) Dra. Maite Fadul de Landaburo
   Jefe de la División de Cooperación Técnica
   Internacional D.N.P.

2. Technical Committee
   (1) Dr. Luis Antonio Cervantes Fajardo
   Secretario de Colpuertos
   (2) Dr. Adriano Movil Arias
   Director del INTRA
   (3) Capitan Pinilla Reyes Pedronel
   Policía Vial
   (4) Dr. Joaquín Facio Vergara
   Director del Ministerio de Obras Públicas
   (5) Dr. Hector Amarís Piñeres
   Director de Transporte y Tránsito
   (6) Dr. Mario Molinares Sarmineto
   Corporación Financiera de Transporte
   (7) Dra. Carmen Arévalo Correa
   Gerente Empresas Públicas Municipal

3. Colombian Counterparts of Study Team
   (1) Dr. Jaime Ujueta Smith
   Secretario de Obras Públicas y Planeación
   Municipal de Barranuilla
   (2) Dra. Mary Garcia de Biava
   Arquitecto - Asesora Ejecutiva del Proyecto
   (3) Dr. Gabriel Arévalo Quintero
   Jefe de Desarrollo Urbano del Municipio

(4) Dr. Mario Hernandez Sanchez
Arquitecto Planificador Urbano

(5) Dr. Armando Meza Campanella
Ingeniero de Transporte y Vías

(6) Dr. Rafael Peña de Castro
Ingeniero de Transporte

(7) Dr. Ricardo Fabregas Escorcia
Ingeniero Civil

(8) Dr. Oscar Narváez Martinez
Economista

(9) Dr. Luis Mercado Rodriguez
Arquitecto

(10) Dr. Ramón Vides Galvan
Economista

4. Supervisory Committee, Government of Japan

(1) Professor Kazuhiro Yoshikawa
Professor of Kyoto University

(2) Mr. Tatsuro Ogihara
Ministry of Construction

(3) Mr. Hirotake Omi
Ministry of Construction

(4) Mr. Akira Uezono
Ministry of Transport

(5) Mr. Hisaiki Takenaka
Ministry of Transport

(6) Mr. Kazuo Yamazaki
Metropolitan Expressway Public Cooperation

(7) Mr. Toshio Morooka
(Japan International Cooperation Agency)

5. Study Team

(1) Mr. Takeo Sato
Project Manager

(2) Mr. Toshisada Katsurada
Project Coordinator/Transportation Planner

(3) Mr. Yuji Morioka
City Planner

(4) Mr. Kanenari Ijuin
Highway Engineer

(5) Mr. Koichi Kaneko
Public Transport Planner

(6) Mr. Iwane Mizuno
Land Use Planner

(7) Mr. Kimio Kaneko
Traffic Engineer

(8) Mr. Tetsuo Wakui
Transport Economist

(9) Mr. Iwao Nakajima
Architect

(10) Mr. Isao Sagae
Traffic Survey Planner

(11) Mr. Yusuke Kajimura
Traffic Survey Planner

(12) Mr. Masayuki Ishiya
Computer Engineer

Appendix B ZONING SYSTEM

Zone No.	Zone Name		Zone No.	Zone Name	
1	Centro	B/Q	57	Nueva Colombia	B/Q
2	Centro	B/Q	58	Evaristo Sourdis	B/Q
3	Centro	B/Q	59	Mequejo	B/Q
4	Centro	B/Q	60	La Florida	B/Q
5	Rosario	B/Q	61	Ciudad Jardín	B/Q
6	Rosario	B/Q	62	Alto Prado	B/Q
7	Rosario	B/Q	63	La Concepción	B/Q
8	Rosario	B/Q	64	Unión Industrial	B/Q
9	Villanueva	B/Q	65	Urb. La Cumbre	B/Q
10	Villanueva	B/Q	66	El Golf	B/Q
11	Villanueva	B/Q	67	Paraíso	B/Q
12	Barlovento	B/Q	68	Las Flores	B/Q
13	Barrio Abajo	B/Q	69	Univ. del Norte	B/Q
14	Monte Cristo	B/Q	70	Los Olivos	B/Q
15	La Loma 1	B/Q	71	El Pueblo	B/Q
16	La Loma 2	B/Q	72	Gran Abastos	B/Q
17	Via 40	B/Q	73	Urb. La Arboleda	Soledad
18	María Modelo	B/Q	74	Hipódromo	Soledad
19	Cervecería Aguila	B/Q	75	Centenario	Soledad
20	Zona Negra	B/Q	76	Termonorte	Soledad
21	Puerto	B/Q	77	Centro	Soledad
22	Zona Franca	B/Q	78	Aeropuerto	Soledad
23	Rebolo	B/Q	79	Juan Mina	
24	San Roque	B/Q	80	Unknown	B/Q
25	Chiquinquira	B/Q	81	Unknown	Soledad
26	Chiquinquira	B/Q	82	Pto. Colombia	Atlántico
27	Boston	B/Q	83	Galapa	Atlántico
28	El Prado	B/Q	84	Malambo	Atlántico
29	Santa Ana	B/Q	85	Tubará	Atlántico
30	La Chinita	B/Q	86	Baranoa	Atlántico
31	Las Nieves	B/Q	87	Polo Nuevo	Atlántico
32	Boyacá	B/Q	88	Sto. Tomás	
33	San José	B/Q	89	Candelaria	Atlántico
34	Montes	B/Q	90	Sábana Larga	Atlántico
35	El Carmen	B/Q	91	Juan de Acosta	Atlántico
36	Alfonso López	B/Q	92	Remolino	Magdalena
37	San Felipe	B/Q	93	Fundación	Magdalena
38	Tanque El Recreo	B/Q	94	Ciénaga	Magdalena
39	Pasadena	B/Q	95	Santa Marta	Magdalena
40	Simón Bolivar	B/Q	96	Others	Magdalena
41	Urb. El Limón	B/Q	97	Guajira	
42	La Unión	B/Q	98	Cesar	
43	La Magdalena	B/Q	99	Cartagena	
44	El Campito	B/Q	100	Bolivar	
45	La Victoria	B/Q	101	Norte de Santander	
46	Cevillar	B/Q	102	Santander	
47	La Sierra	B/Q	103	Boyacá	
48	La Ceiba	B/Q	104	Antioquia	
49	El Valle	B/Q	105	Sucre	
50	José Antonio Galán	B/Q	106	Valle	
51	Estadio Metropolitano	B/Q	107	Bogotá	
52	El Santuario	B/Q	108	Amazonas	
53	Las Américas	B/Q	109	Venezuela	
54	Santa María	B/Q	110	Brasil	
55	El Bosque	B/Q	111	Ecuador	
56	Las Malvinas	B/Q	112	Panama	

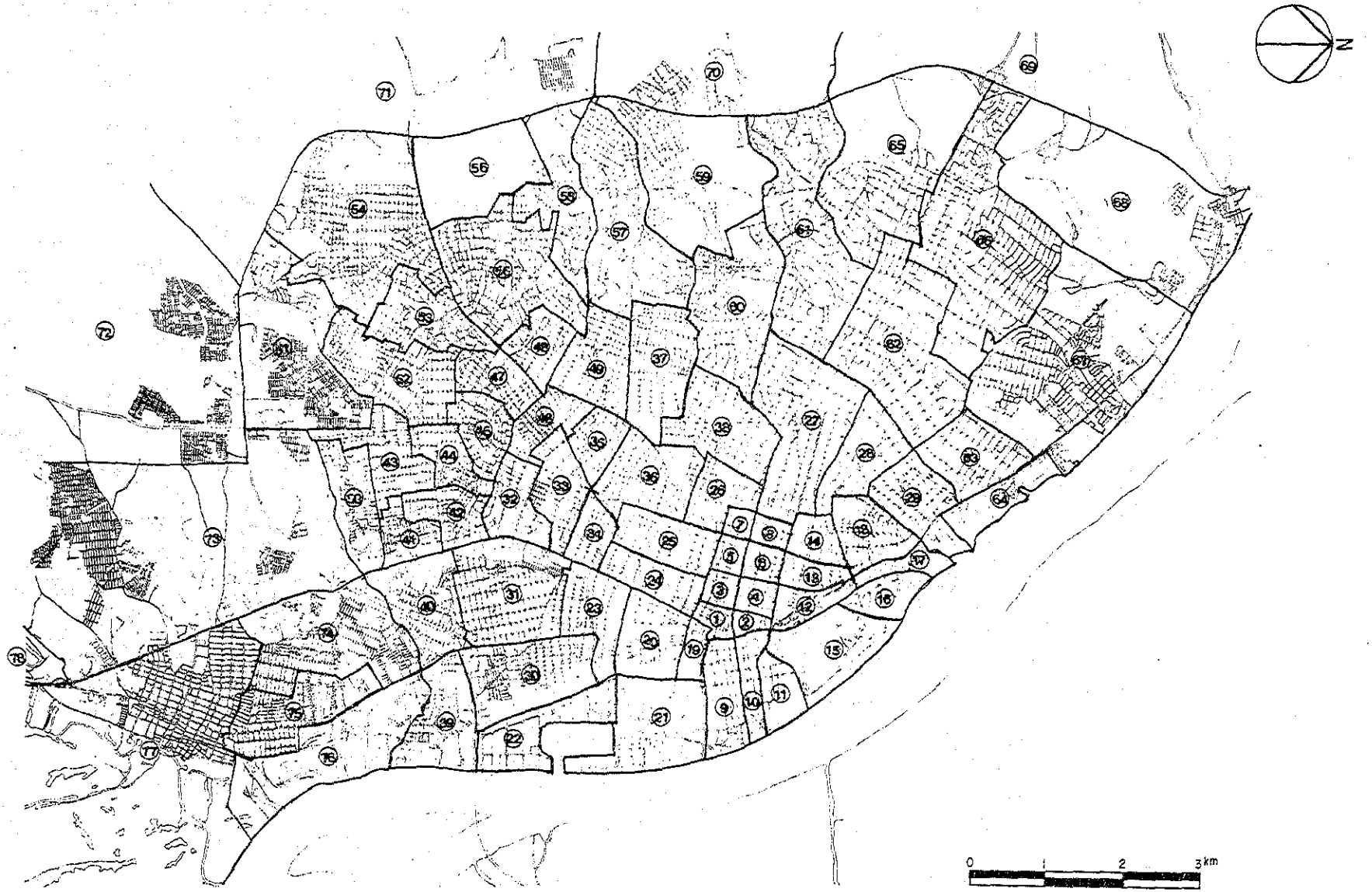

Fig. B–1–1 Zone Map (Barranquilla and Soledad)

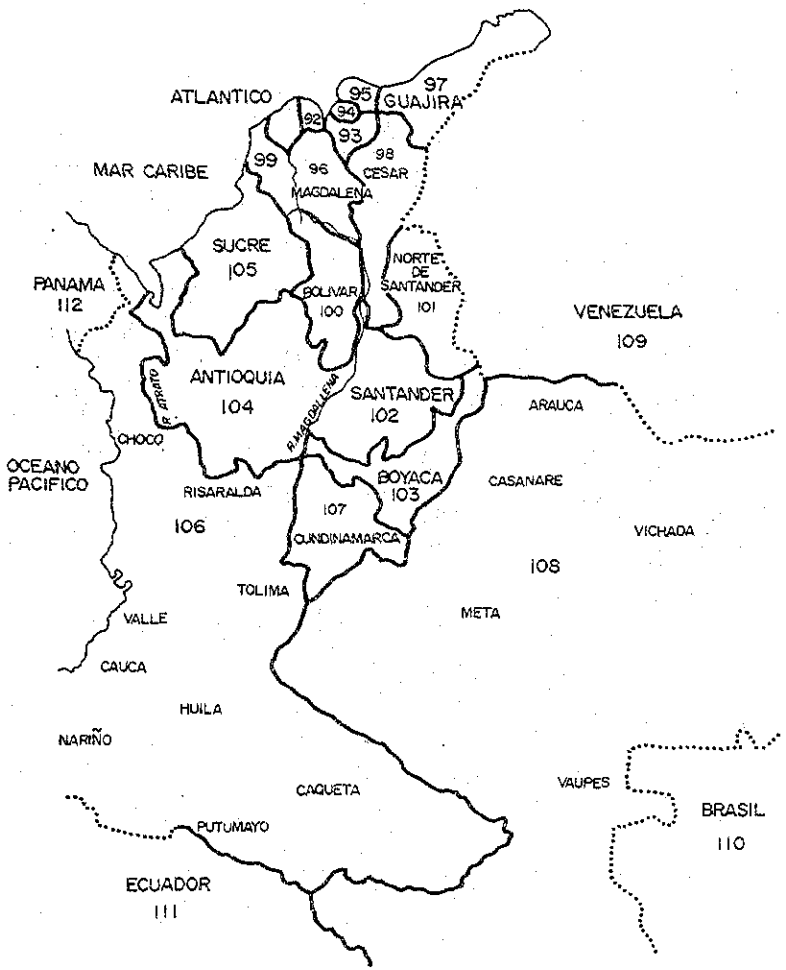

Fig. B–1–2 Zoning Map (Colombia)

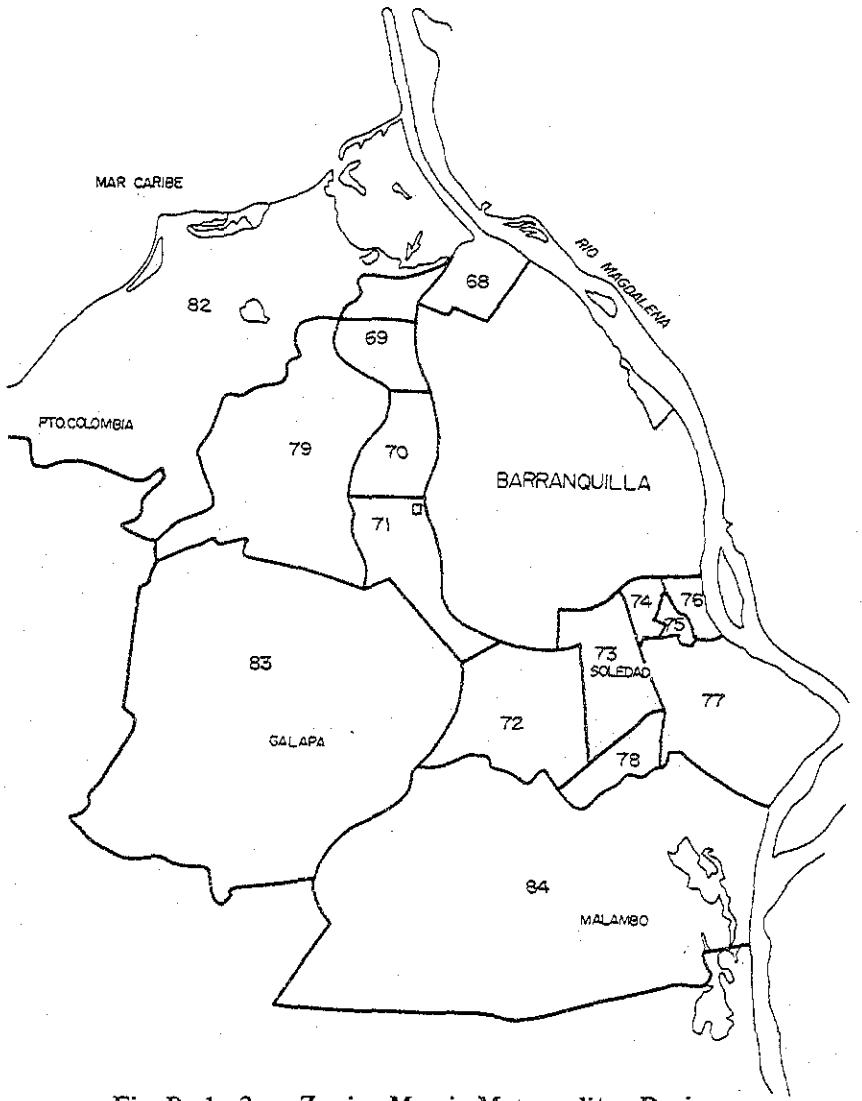

Fig. B–1–3 Zoning Map in Metropolitan Region

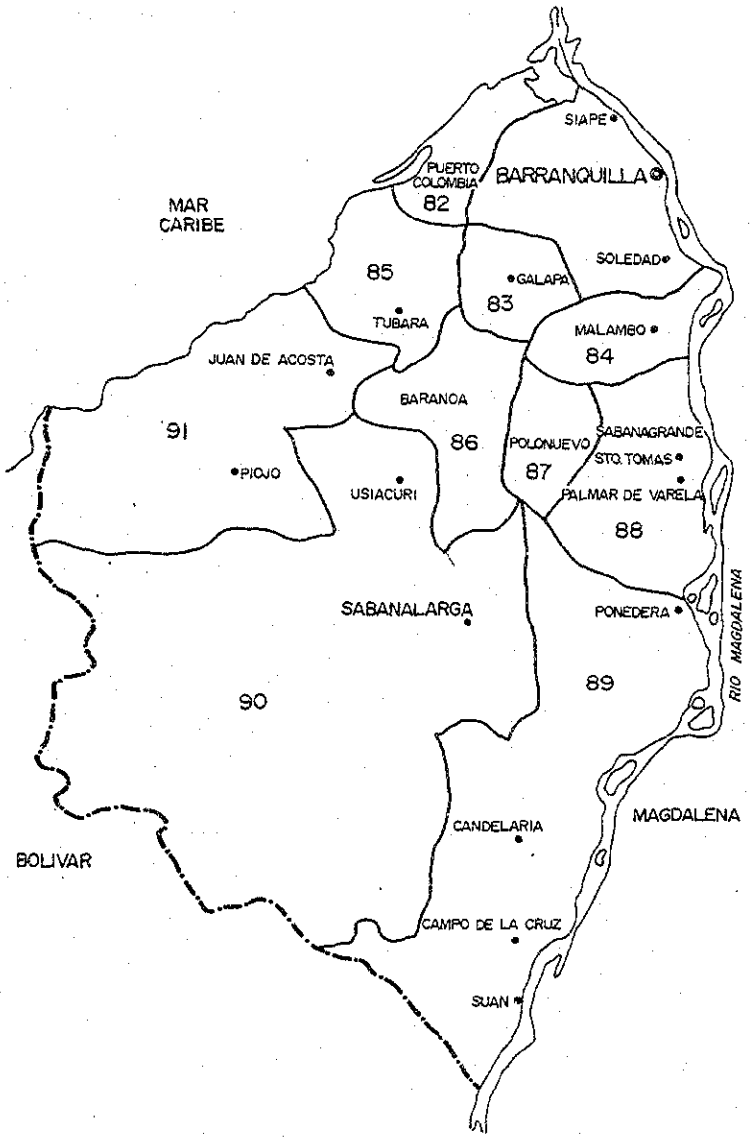

Fig. B–1–4 Zoning Map (Atlantico)

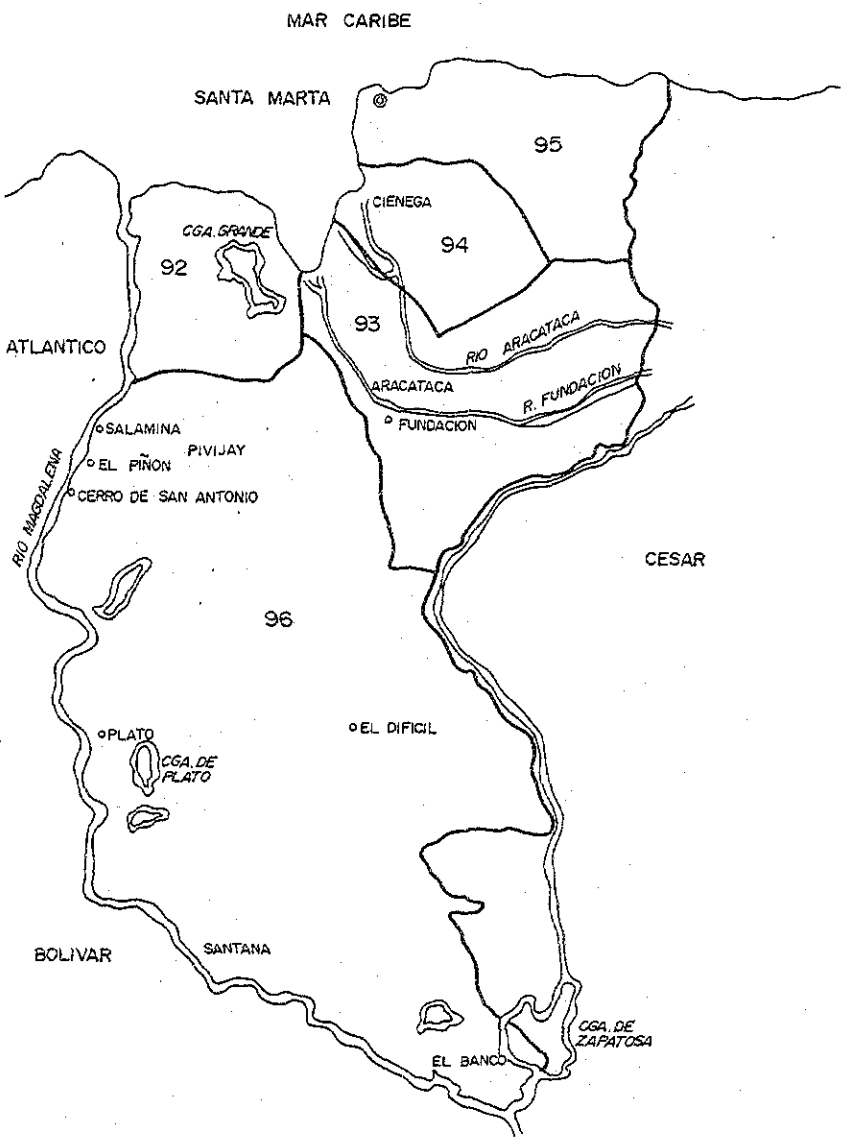

Fig. B–1–5 Zoning Map (Magdalena)

Appendix C–1 Average Vehicle Travel Speed

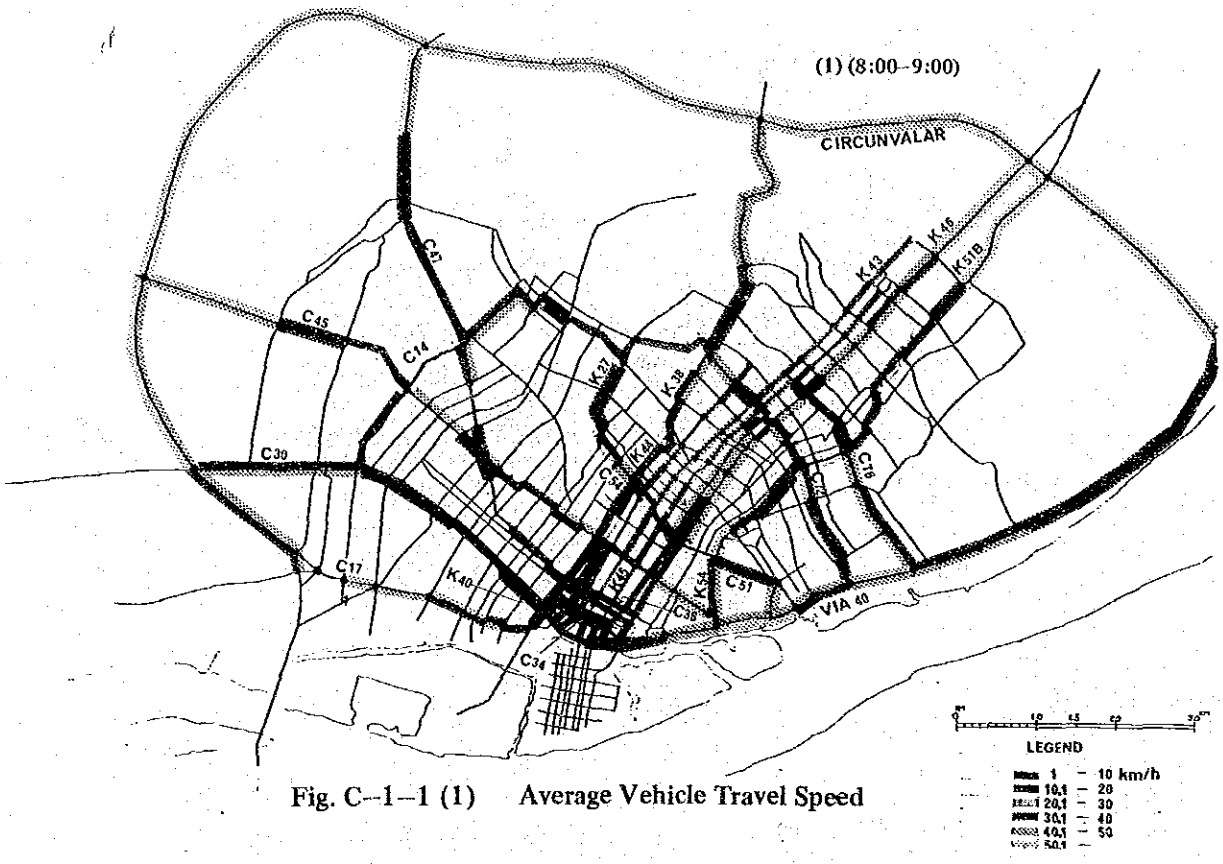

Fig. C–1–1 (1) Average Vehicle Travel Speed

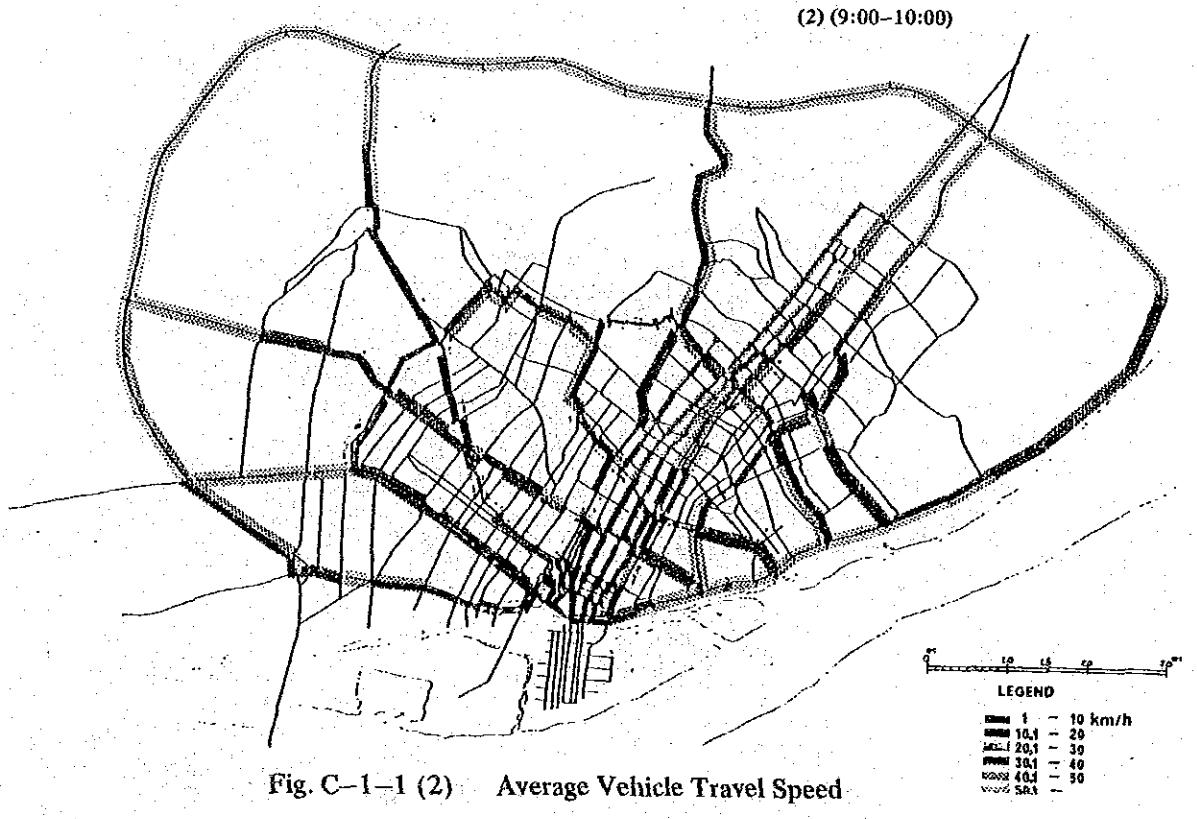

Fig. C–1–1 (2) Average Vehicle Travel Speed

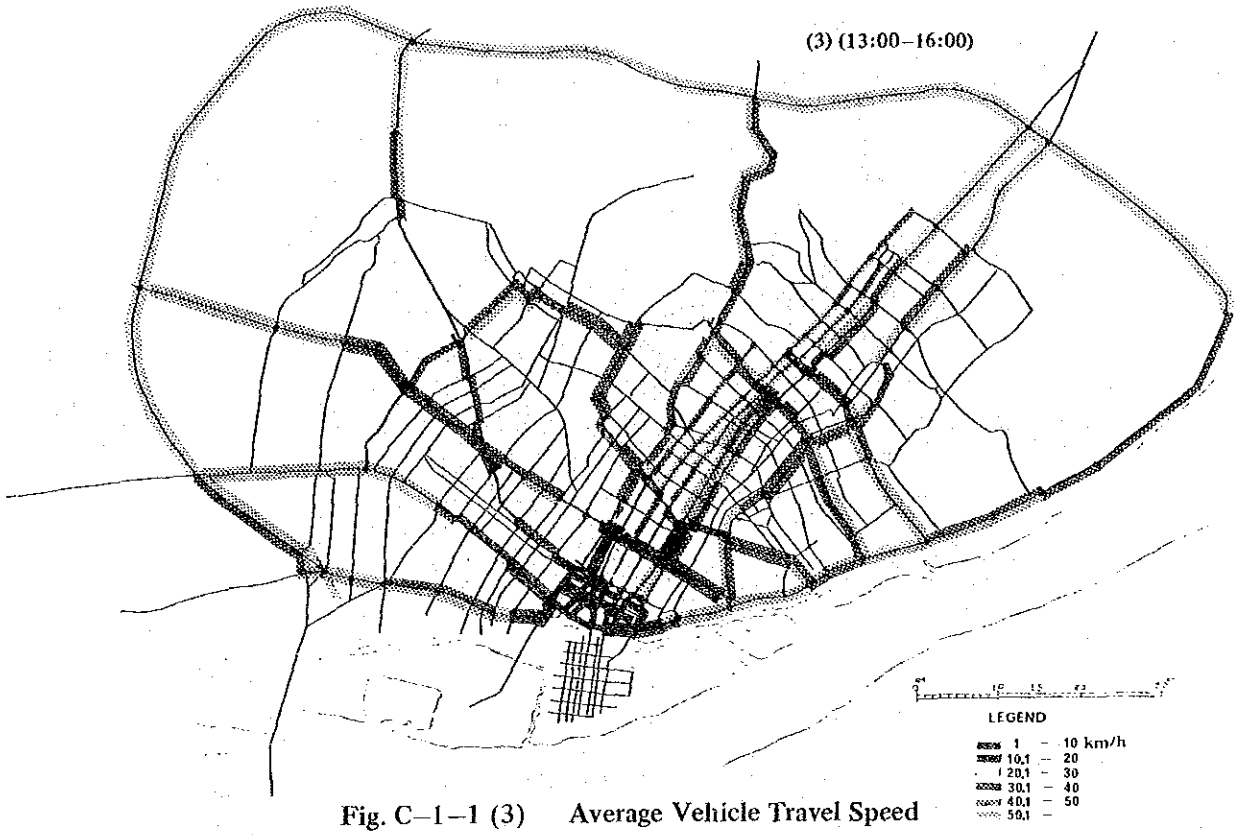

Fig. C–1–1 (3) Average Vehicle Travel Speed

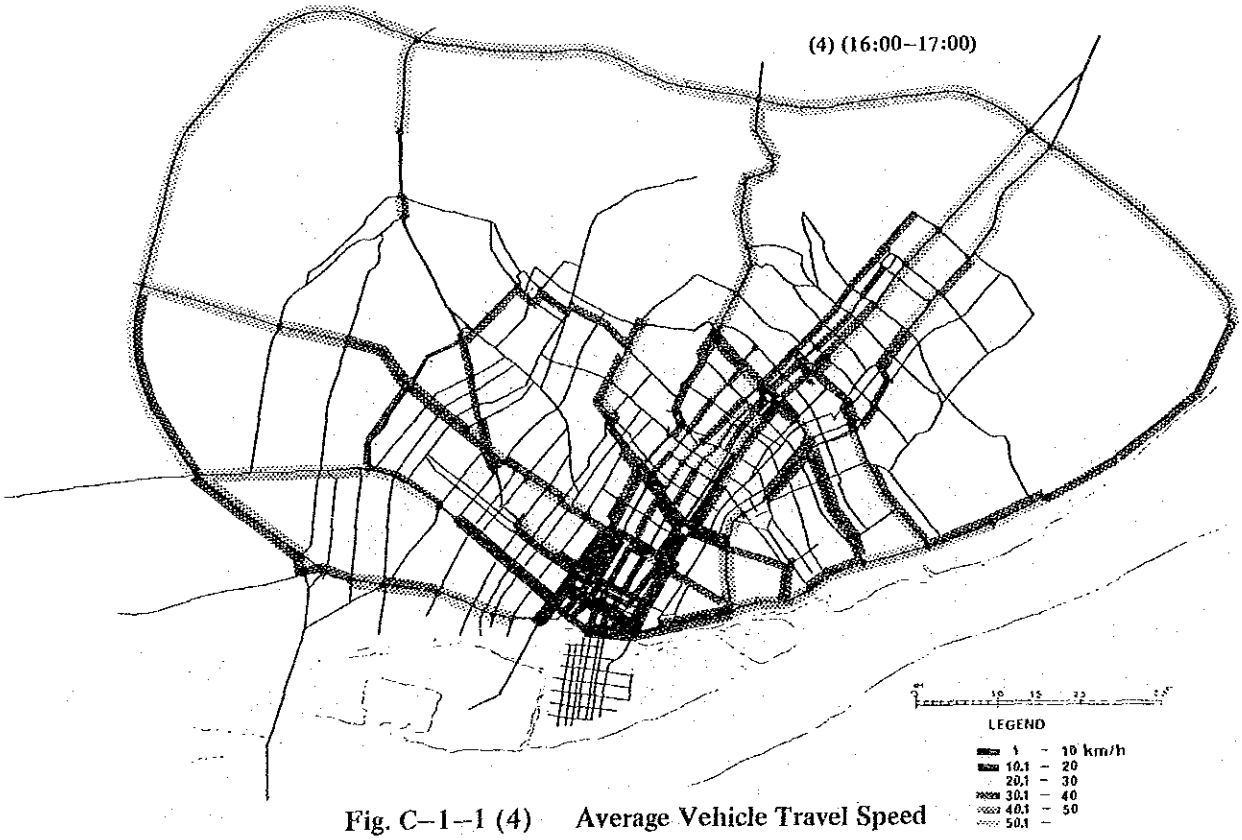

Fig. C–1–1 (4) Average Vehicle Travel Speed

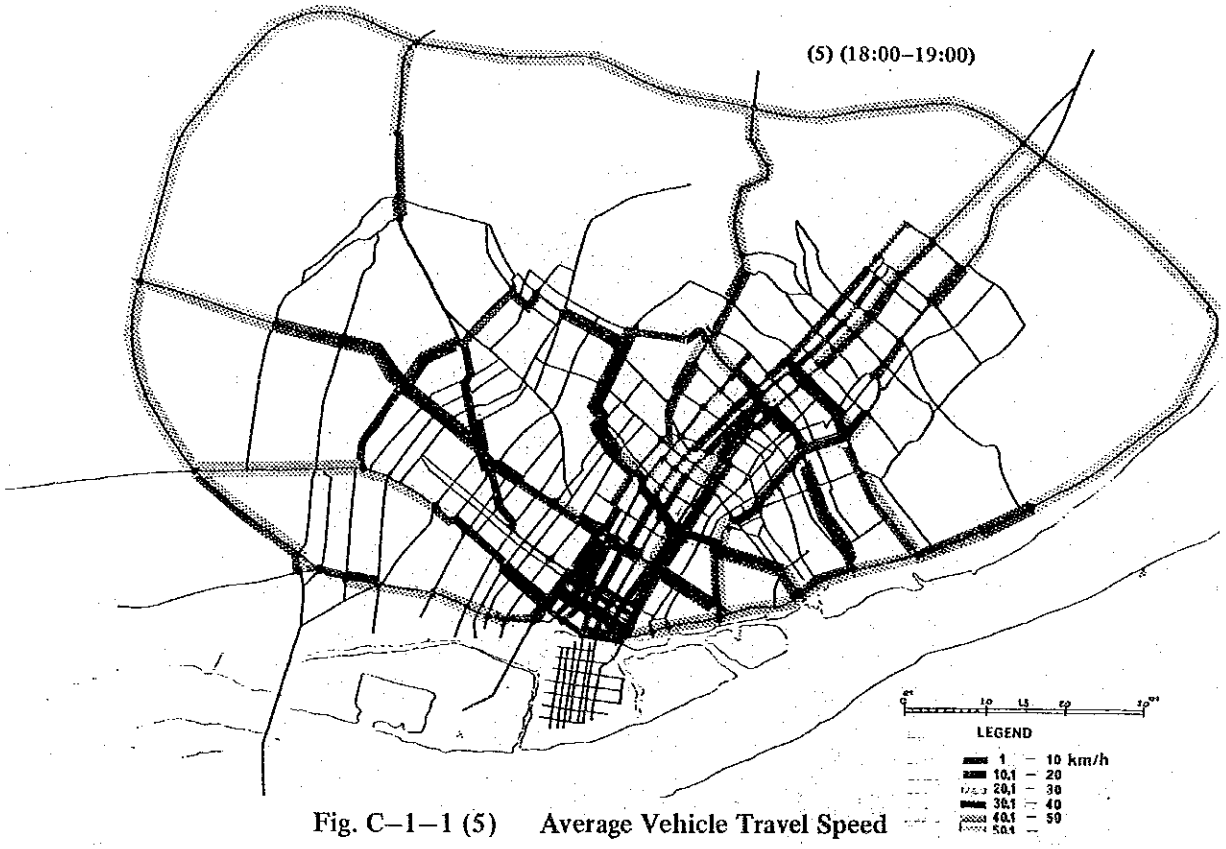

Fig. C–1–1 (5) Average Vehicle Travel Speed

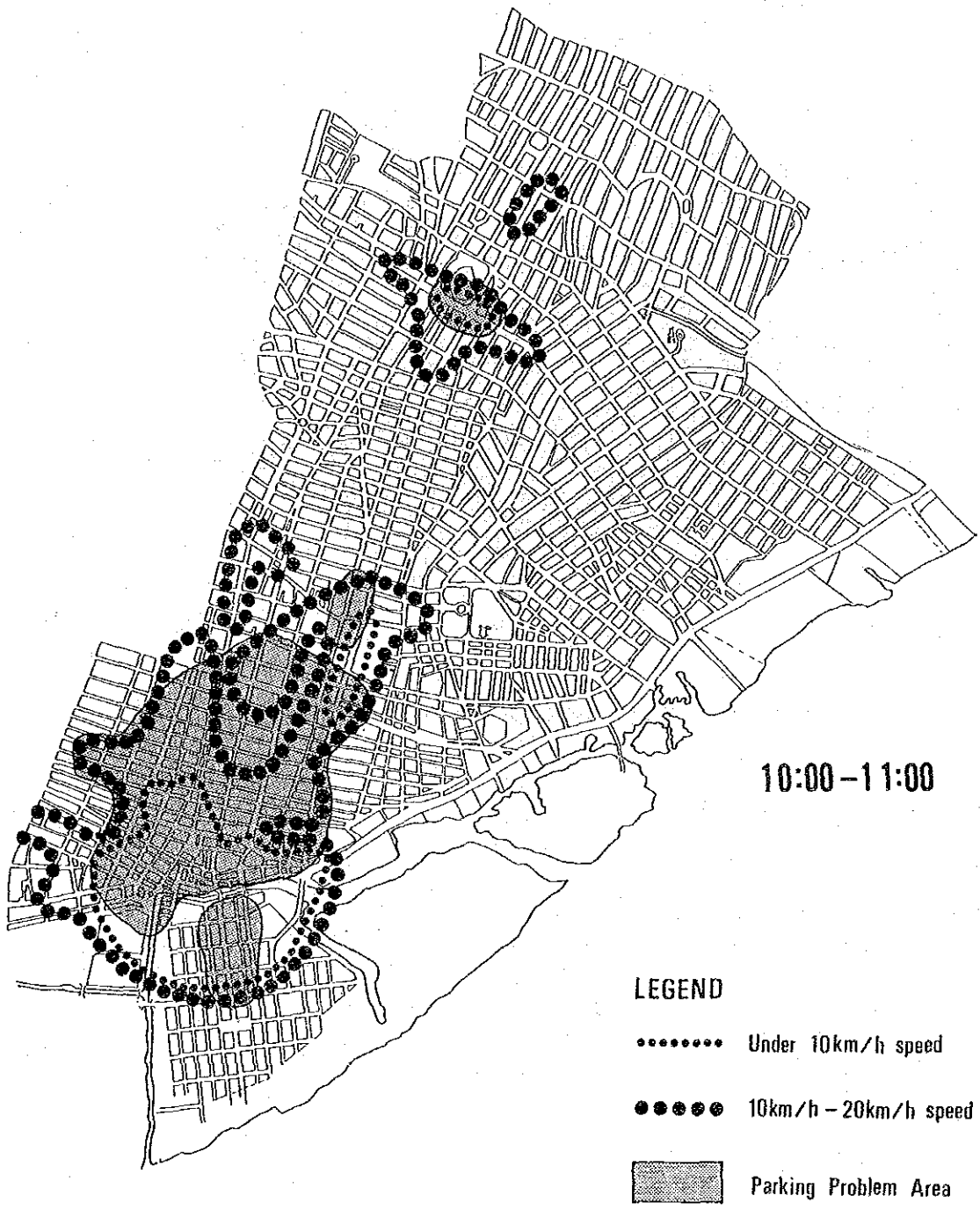

Fig. C–1–2 (1) Vehicle Travel Speed and Parking Problem Area

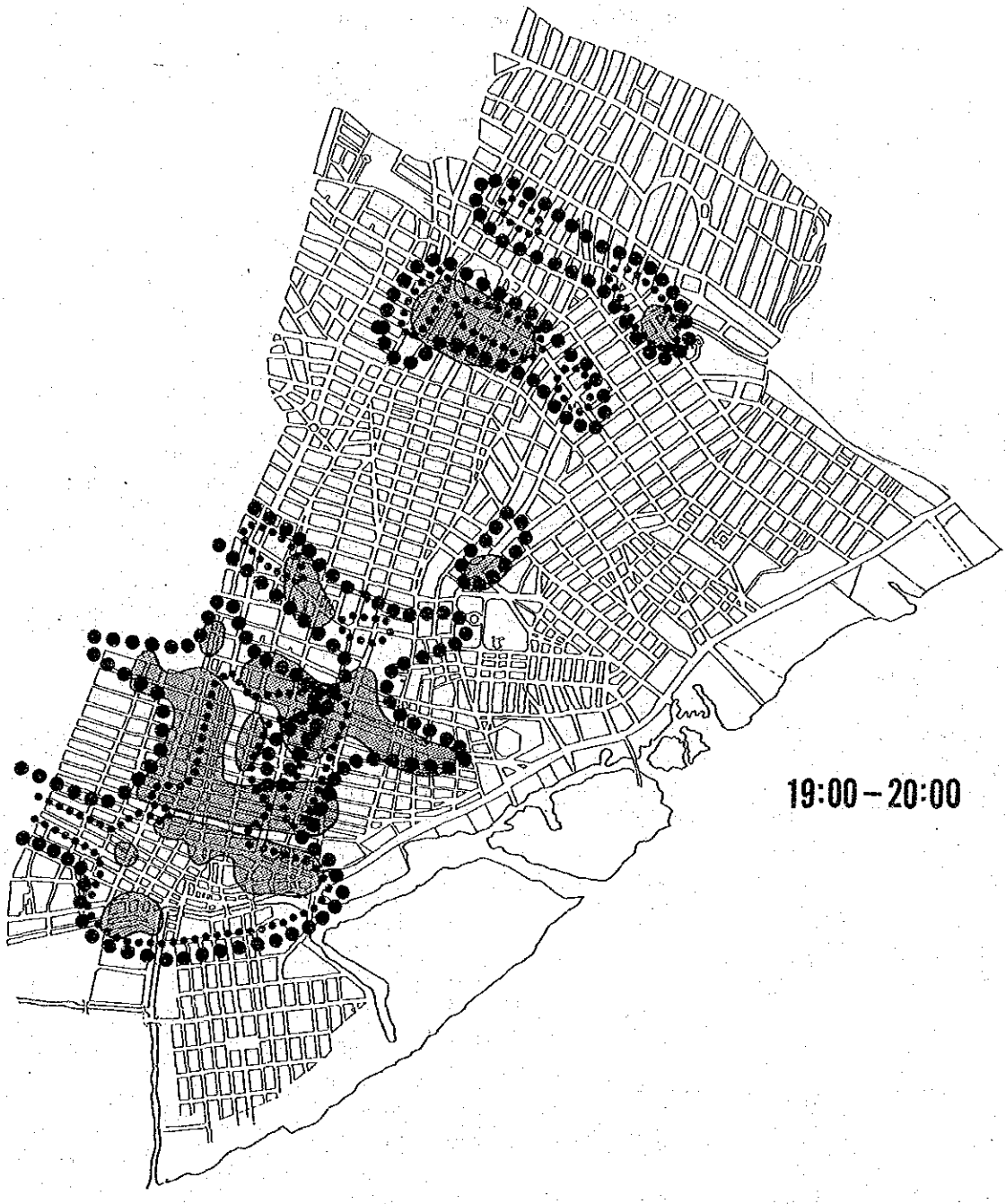

Fig. C–1–2 (2) Vehicle Travel Speed and Parking Problem Area

Appendix C–2 Major Congested Sections

Table C–2–1 Major Congested Sections

Hours	Street	Direction	Congested Section	Average Speed	Main Reasons for Stop									
					1	2	3	4	5	6	7	8	9	10
Midday hours 12 – 14	C 47	TO Circun.	K 30 – K 45	12 – 18 km/h	O									O
	C 53	TO K 38	K 46 – K 54	About 18 km/h	O									
		TO Via 40	K 45 – K 46	About 4 km/h	O									
	C 72	To Via 40	K 43 – K 46	8 – 15 km/h	O									
			K 53 – K 54	About 17 km/h	O									
		TO K 38	K 43 – K 45	6 – 18 km/h	O									
		TO K 38	K 53 – K 54	12 – 14 km/h	O									
	C 76	TO Via 40	K 43 – K 46	11 – 20 km/h	O									
Evening hours 16 – 19	K 38	TO Centro	C 17 – C 50	7 – 19 km/h	O			O	O	O			O	
		TO Circun.	C 17 – C 50	2 – 18 km/h	O			O	O	O				
	K 40	TO Centro	C 34 – C 45	3 – 15 km/h	O		O	O		O		O		
		TO C 45	C 34 – C 45	3 – 14 km/h	O		O	O	O	O				
	K 41	TO Centro	C 34 – C 45	2 – 20 km/h	O		O		O	O		O	O	
Midday hours 12 – 14	K 43	TO C 96	C 34 – C 45	5 – 20 km/h	O		O	O	O				O	
			C 70 – C 72	7 – 19 km/h	O			O	O					
	K 44	TO Centro	C 34 – C 53	5 – 20 km/h	O			O	O					
	K 45	TO C 45	C 34 – C 53	8 – 18 km/h	O			O	O	O				
		TO Centro	C 45 – C 53	About 19 km/h	O									
	K 46	TO Centro	C 45 – C 59	7 – 17 km/h	O				O					
			C 70 – C 72	About 16 km/h	O									
			C 76 – C 79	10 – 19 km/h	O									
Evening hours 16 – 19	K 46	TO Circun.	C 45 – C 59	14 – 20 km/h	O									
			C 70 – C 79	9 – 19 km/h	O									
	K 51 B	TO Centro	C 76 – C 80	About 18 km/h	O			O						
	K 14	TO C. 30	C 30 – C 45	About 16 km/h				O						O
		TO K 21 B	C 45 – C 47	About 19 km/h	O			O						O
	C 30	TO Centro	K 24 – K 38	5 – 20 km/h	O			O	O					O

1 Wating for signal light change 2 Traffic Accident 3 Pedestrian's crossing 4 Congestion of buses near bus stops. 5 Traffic congestion 6 Marging from alley 7 Diverging to alley 8 Influence of cars turning to the left 9 Parking on street 10 Poor condition of pavement maintenance

Table C–2–1 (Cont'd)

Hours	Street	Direction	Congested Section	Average Speed	Main Reasons for Stop									
					1	2	3	4	5	6	7	8	9	10
Midday Hours 12 – 14	K 43	TO C 96	C 30 – C 45	8 – 17 km/h	O		O	O	O	O				
			C 70 – C 74	11 – 19 km/h	O					O				
	K 44	TO Centro	C 34 – C 38	5 – 14 km/h	O		O	O		O				
	K 45	TO C 45	C 37 – C 45	8 – 14 km/h	O		O	O	O	O				
		TO Centro	C 45 – C 53	About 16 km/h	O									
	K 46	TO Centro	C 45 – C 53	About 15 km/h	O									
			C 70 – C 72	10 – 13 km/h	O									
			C 76 – C 79	10 – 15 km/h	O									
			C 84 – C 90	About 15 km/h	O									
			C 38 – C 45	About 19 km/h								O		
		TO Circun	C 30 – C 45	5 – 18 km/h	O									
			C 70 – C 72	16 – 19 km/h	O									
	K 51 B	TO Centro	C 76 – C 80	19 – 20 km/h	O									
	C 17	TO Centro	K 35 – K 38	About 12 km/h	O									
Midday Hours 12 – 14	C 30	TO Centro	K 24 – K 38	16 – 19 km/h	O	O		O				O		O
		TO Circun.	K 24 – K 38	18 – 19 km/h				O		O				O
	C 34	TO K 46	K 38 – K 45	3 – 20 km/h	O		O	O	O				O	
		TO K 38	K 38 – K 46	7 – 19 km/h	O		O	O	O	O				
	C 37	TO K 46	K 38 – K 44	8 – 18 km/h	O									
	C 38	TO K 30	K 38 – K 46	5 – 17 km/h	O									
	C 38	TO K 38	K 35 – K 38	About 16 km/h	O									
	C 45	TO Centro	K 31 – K 33	About 11 km/h	O									
			K 38 – K 40	About 16 km/h	O									
			K 43 – K 44	About 12 km/h	O									
			K 45 – K 46	About 11 km/h	O									
		TO Circun.	K 24 – K 27	10 – 20 km/h	O									
			K 45 – K 46	About 6 km/h	O									
		TO Centro	K 24 – K 45	About 16 km/h	O									

1 Wating for signal light change 2 Traffic Accident 3 Pedestrian's crossing 4 Congestion of buses near bus stops. 5 Traffic congestion 6 Marging from alley 7 Diverging to alley 8 Influence of cars turning to the left 9 Parking on street 10 Poor condition of pavement maintenance

Table C–2–1 (Cont'd)

Hours	Street	Direction	Confested Section	Average Speed	Main Reasons for Stop									
					1	2	3	4	5	6	7	8	9	10
Evening Hours 16 – 19	C 30	TO Circun.	K 24 – K 38	15 – 18 km/h				O						
	C 34	TO K 46	K 38 – K 46	3 – 17 km/h	O		O	O	O	O		O	O	
		TO K 38	K 38 – K 46	2 – 19 km/h	O		O	O	O	O			O	
	C 37	TO K 46	K 38 – K 41	About 3 km/h				O	O				O	
			K 43 – K 46	13 – 19 km/h	O			O					O	
	C 38	TO K 30	K 35 – K 46	7 – 20 km/h	O				O				O	
		TO K 38	K 30 – K 46	10 – 18 km/h	O			O		O				
	C 45	TO Circun.	K 35 – K 44	8 – 17 km/h	O				O					
			K 45 – K 46	About 17 km/h	O									
			K 24 – K 27	About 17 km/h						O				
		TO Circun.	K 24 – K 27	8 – 16 km/h	O									
			K 35 – K 38	About 18 km/h	O									
			K 41 – K 46	5 – 19 km/h	O									
	C 47	TO Centro	K 18 – K 30	13 – 20 km/h	O			O						
Evening Hours 16 – 19	C 47	TO Circun.	K 6 – K 14	About 15 km/h				O						
			K 21 – K 30	14 – 20 km/h	O									
	C 53	TO K 38	K 46 – K 53	12 – 18 km/h	O									
		TO Via 40	K 45 – K 46	About 9 km/h	O									
	C 72	TO Via 40	K 43 – K 46	3 – 17 km/h	O				O	O				
			K 53 – K 54	10 – 20 km/h	O									
		TO K 38	K 43 – K 45	9 – 14 km/h	O				O					
			K 46 – K 54	7 – 18 km/h		O	O							
	C 76	TO Via 40	K 44 – K 55	6 – 20 km/h	O				O	O		O		
		TO K 43	K 46 – K 51	14 – 20 km/h	O				O					

1 Wating for signal light change 2 Traffic Accident 3 Pedestrian's crossing 4 Congestion of buses near bus stops. 5 Traffic congestion 6 Margining from alley 7 Diverging to alley 8 Influence of cars turning to the left 9 Parking on street 10 Poor condition of pavement maintenance.

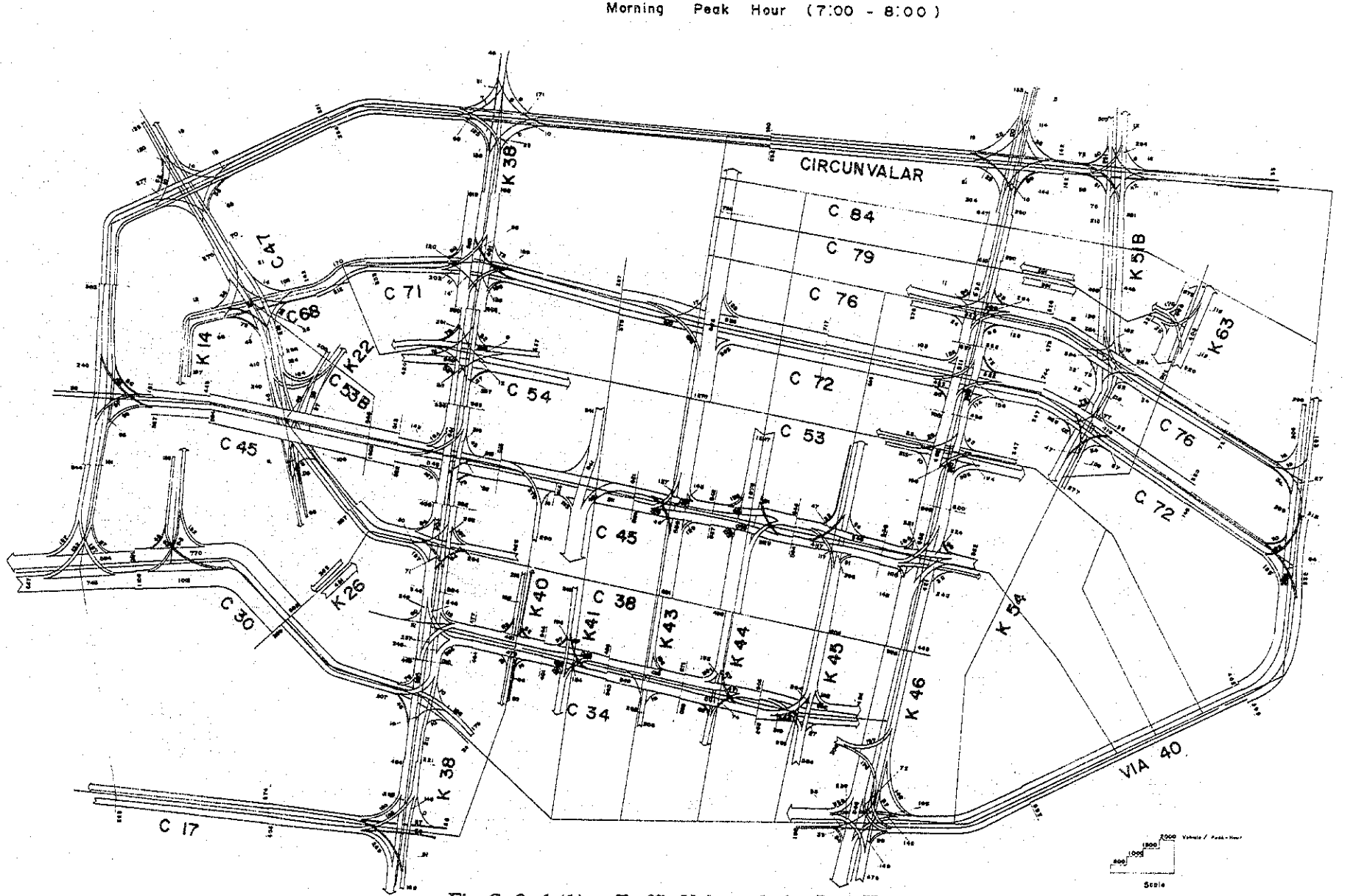

Fig. C–2–1 (1) Traffic Volume during Peak Hour

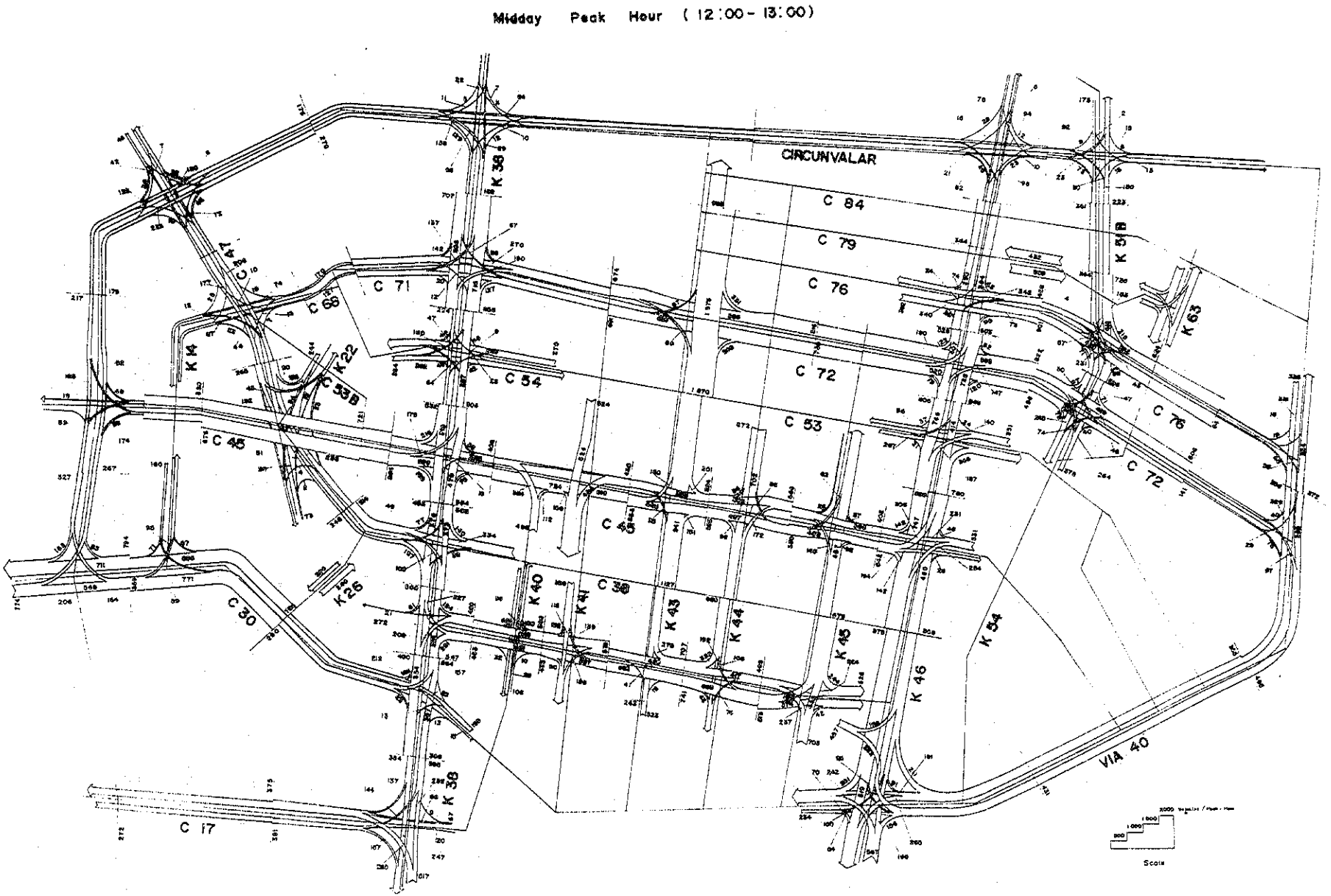

Fig. C–2–1 (2) Traffic Volume during Peak Hour

Evening Peak Hour (17:00 - 18:00)

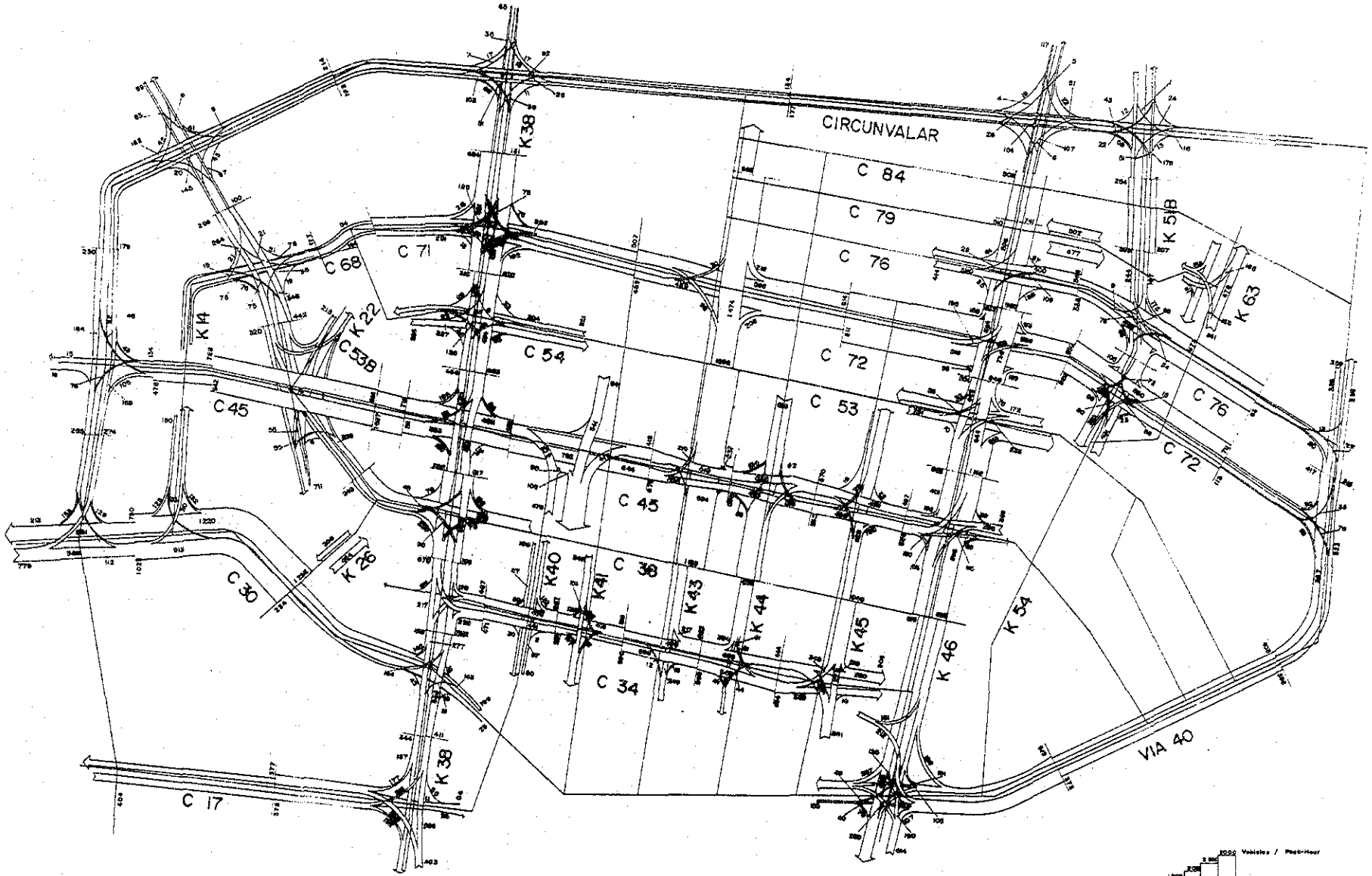

Fig. C–2–1 (3) Traffic Volume during Peak Hour