13.3.3 Estimation

724. The traffic flows of 'Do-Nothing' case and alternatives in year 2010, are shown in Figure 13.3-4,5 and 6. Estimating indices are shown in Table 13.3-2. The estimating indices are "Vehicles*Km", "Vehicles*Hr" and "Mixed Ratio" in the central area which is the area surrounded by Av. Bernardo Sayao, Boulevard Castilho Franco, Av. Pedro Cabral, Av. Dr. Freitas and Av. Perimetral.

Table 13.3-2 Estimation Index for Traffic Flow Plan

Case	Total Veh*Hr	Total Veh*Km (x 1,000)	Mixed Ratio of Public and Private Traffic Volume(%) (1)	(2)	(3)
Do Nothing	41,225	1,463	72.3	69.7	99.0
Alternative 1	44,552	1,536	43.7	42.6	56.7
Alternative 2	44,179	1,541	43.0	41.9	56.7

Note (1):(Mixed Public Traffic Volume + Mixed Private Traffic Volume)/Total Traffic Volume
(2):Mixed Private Traffic Volume/Total Private Traffic Volume
(3):Mixed Public Traffic Volume/Total Public Traffic Volume

725. According to the Table 13.3-2, alternatives increase "Veh*Hr" by approximately 7% and "Veh*Km" by about 5% compared with Do-Nothing case, however "Mixed ratio" of alternatives decrease by approximately 30 points. These estimated indices show the possibility to realize the traffic safety in spite of a slight economic loss attributed to the rate of accidents between buses and other vehicles which accounts for 14 % of all accidents in 1989 (refer to Figure 13.3-7).

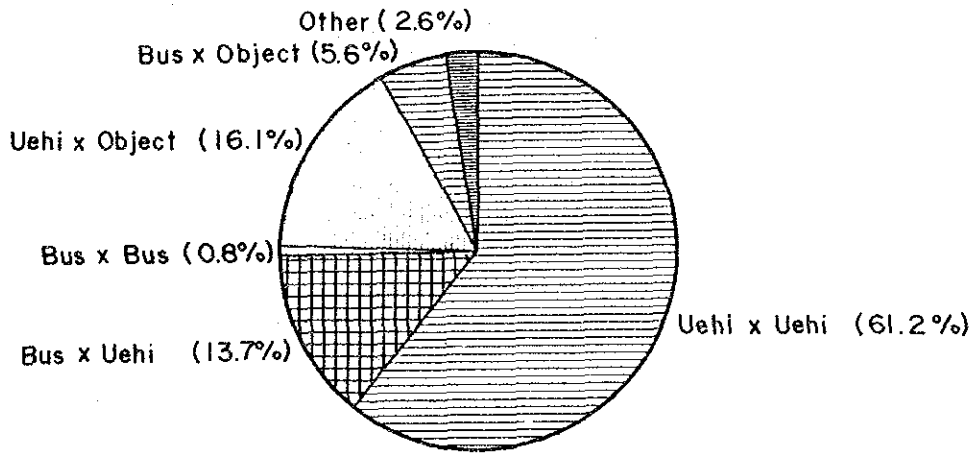


Figure 13.3-7 Type of Vehicles in Accidents in 1989

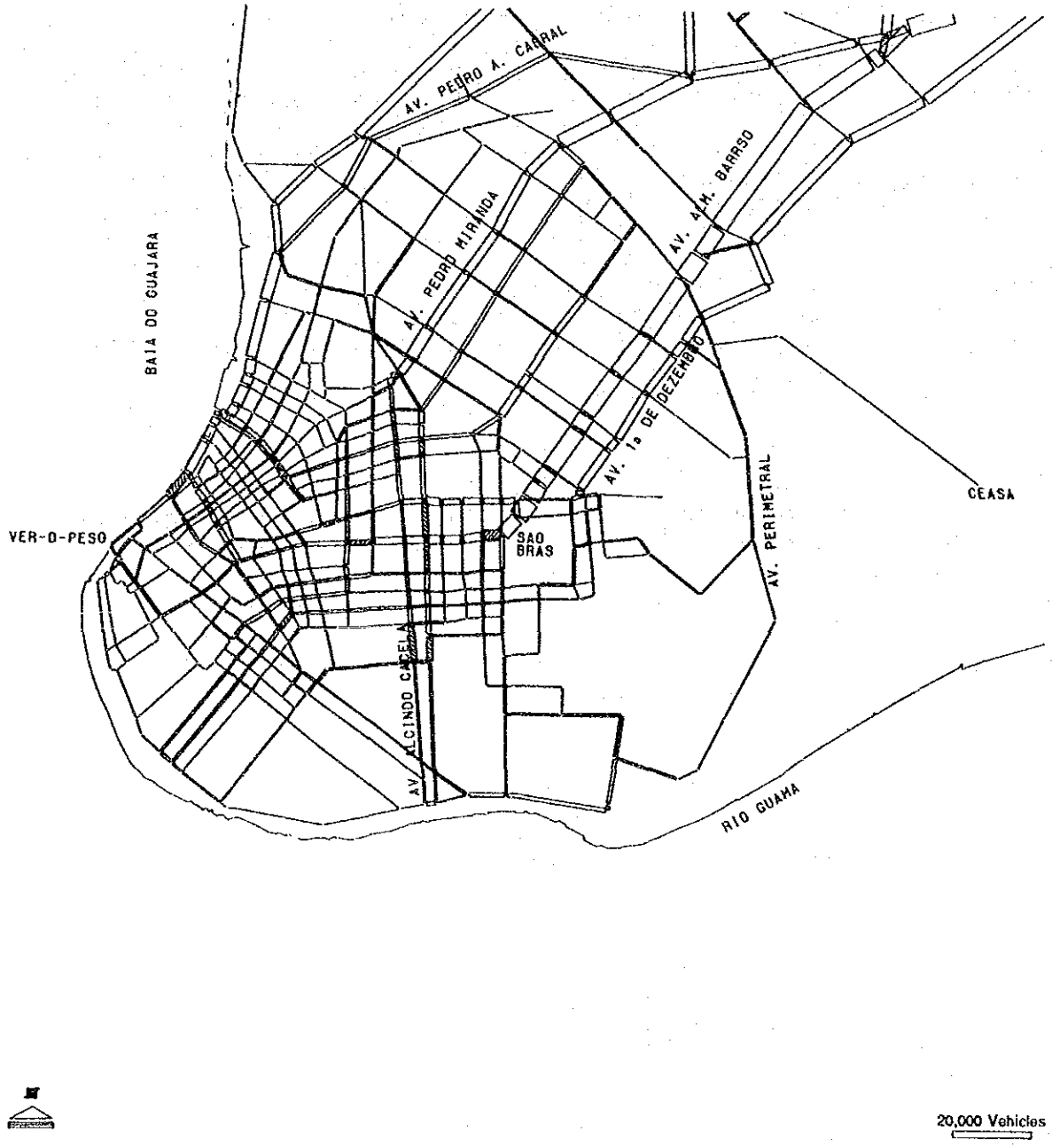


Figure 13.3-4 Future Traffic Flow
(Do-Nothing Case in Year of 2010)

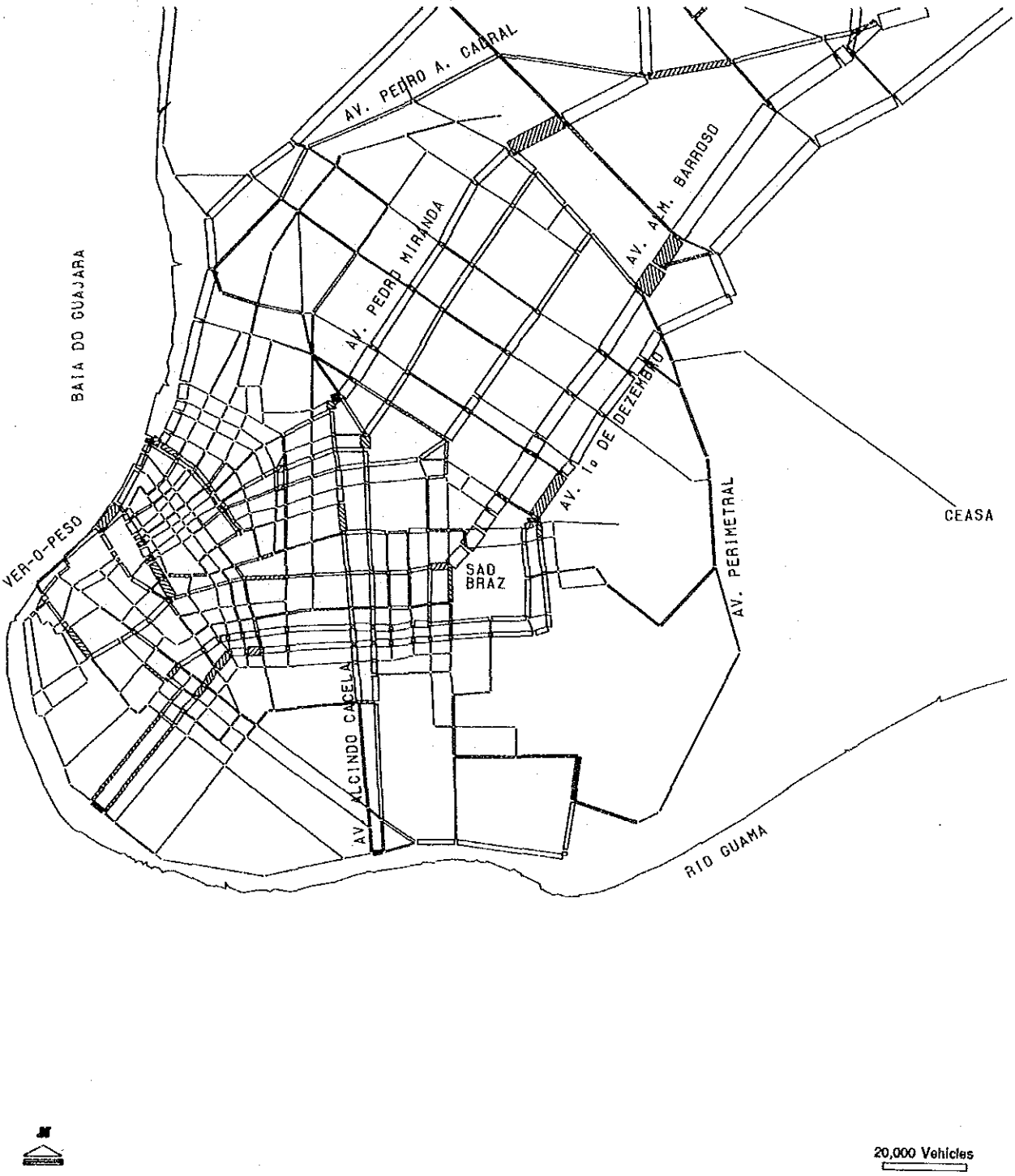


Figure 13.3-5 Future Traffic Flow
(Alternative 1 in Year of 2010)

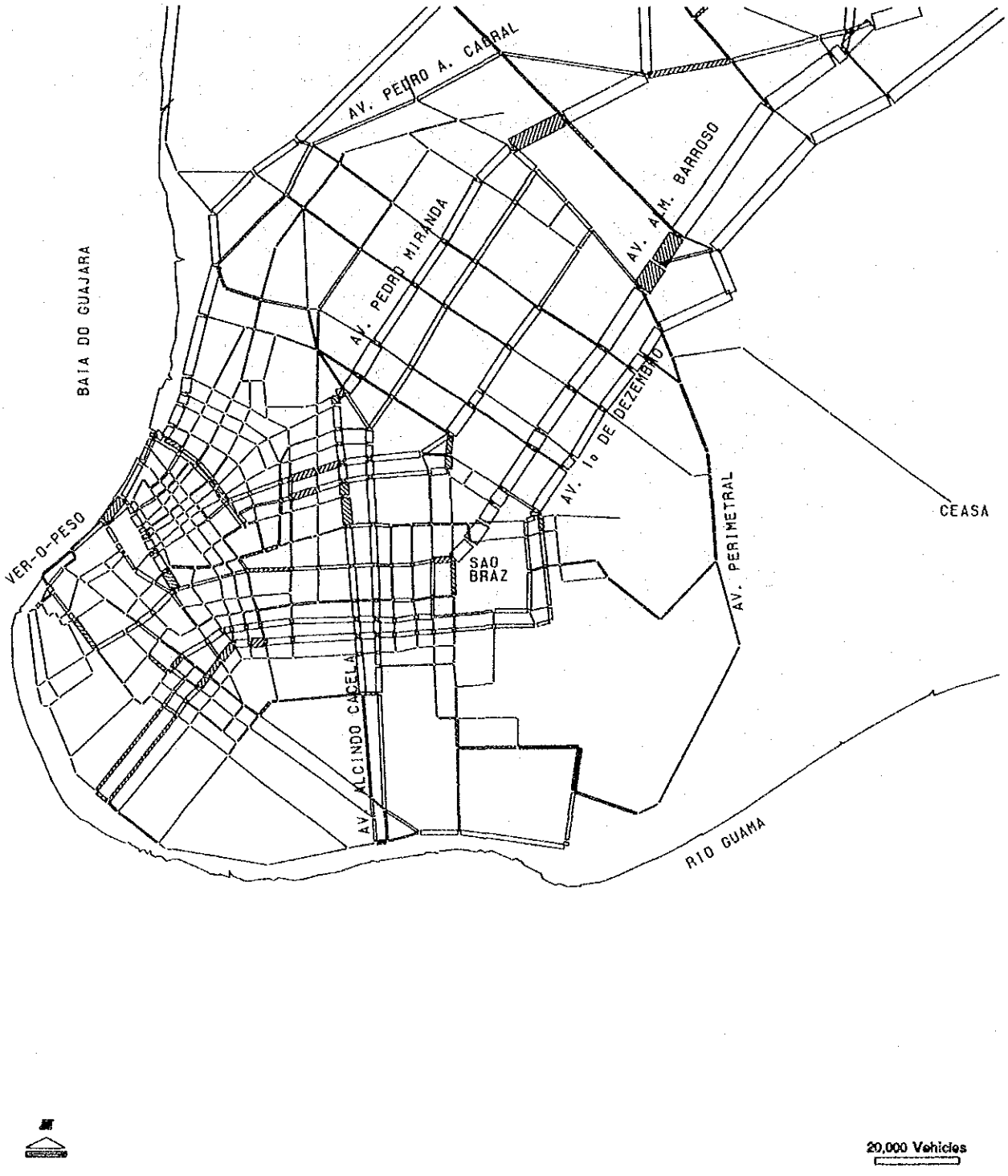


Figure 13.3-6 Future Traffic Flow
(Alternative 2 in Year of 2010)

726. Among Alternatives 1 and 2, there is little difference, however Alternative 2 makes private traffic artery more efficient than the former. Therefore Alternative 2 is selected for traffic flow plan.

13.3.4 Stage Plan

727. The stage plan depends on road network plan and public transportation plan. The condition of each stage is shown in Table 13.3-3.

Table 13.3-3 The Condition of Each Stage

Stage	Year	Road Condition	Public Transportation Plan
1	1995	Current Network	Introducing Trunk Bus Route
2	2000	Improvement in the central area Av. 1o de Dezembro (until Entroncamento)	Introducing Trunk Bus Route

728. Until 1995, there is no plan to improve Av. 1o de Dezembro and Tv. Gueiro Passos and Av. Almirante Barroso is still traffic artery. Therefore, the major object of traffic flow plan is how to distribute the private traffic from Av. Almirante Barroso to central area. The distribution routes from Av. Almirante Barroso are planned such two pairs of road as follows (refer to Figure 13.3-8);

a. - Av. Almirante Barroso - Av. Magalhaes Barata - Tv. Francisco Caldera Castelo Branco - Av. Conselheiro Furtado - Rua Dos Mundurucus - Av. Jose Bonifacio - Av. Almt. Barroso

b. - Av. Almt. Barroso - Tv. Antonio Baena - Rua Antonio Barreto - Rua Domingo Marreiro - Tv. Das Mercedes - Av. Almt. Barroso

729. Figure 13.3-9 shows traffic flow in 1995. In this case, there is no problem in central area, but the bottle-neck occurs the intersection of Av. Almirante Barroso.

730. In the year 2000, Av. 1o de Dezembro will be extended until Entroncamento, therefore this road can be defined as private traffic artery. Traffic flow plan in central ares in 2000 is same to that in 2010. Figure 13.3-10 shows the traffic flow in 2000.

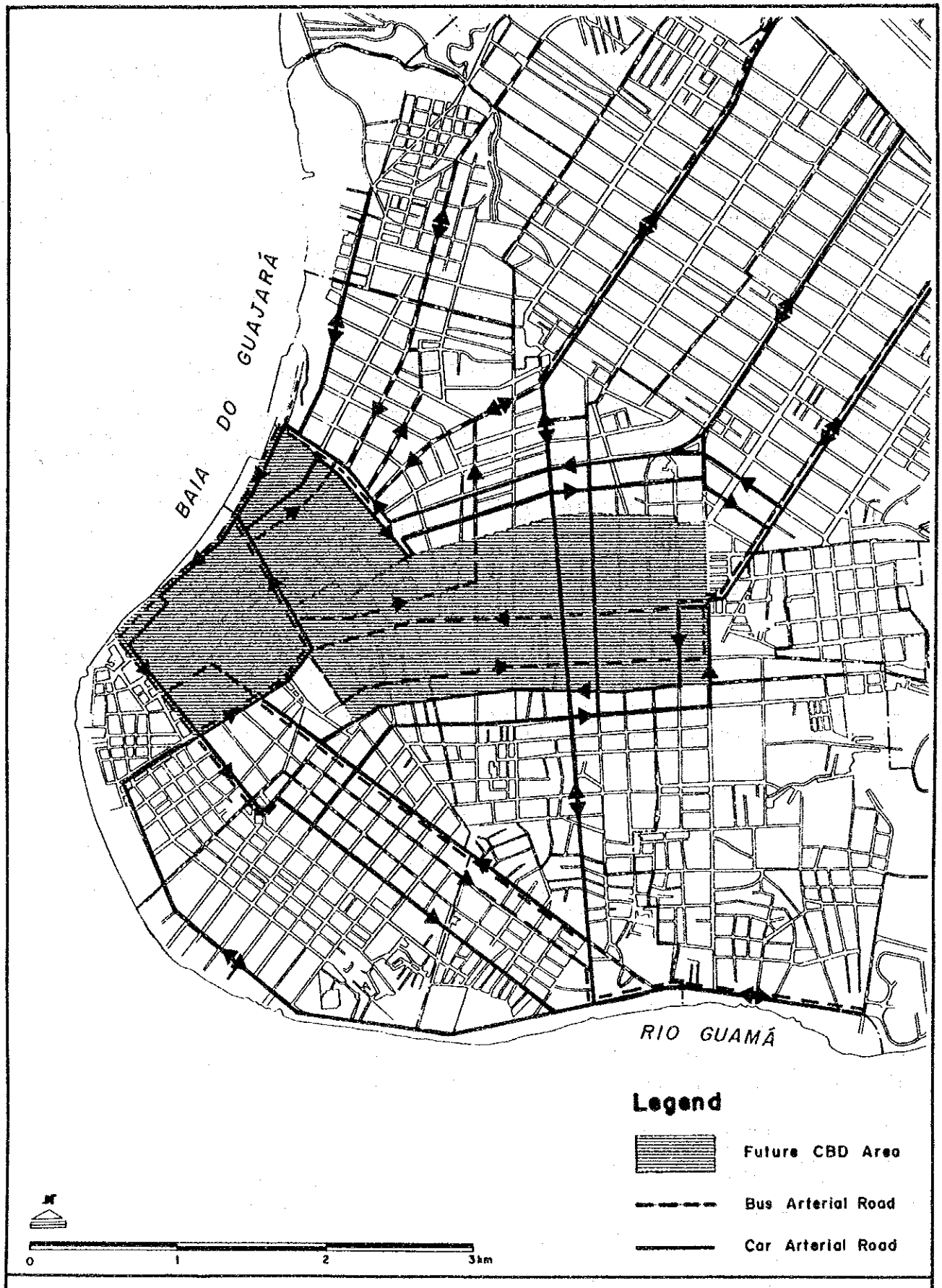


Figure 13.3-8 Traffic Flow Plan (Year 1995)

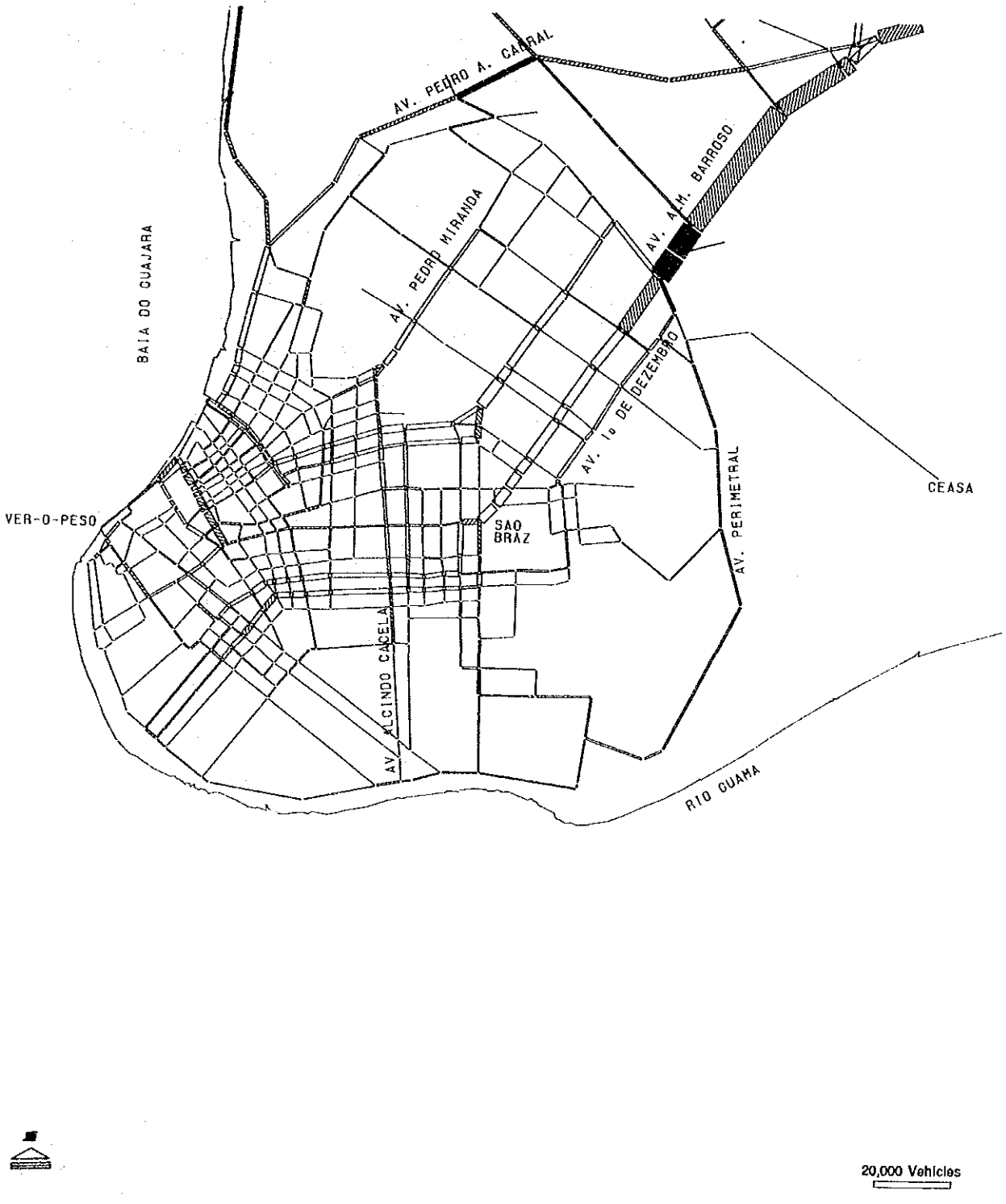


Figure 13.3-9 Traffic Flow (Year 1995)

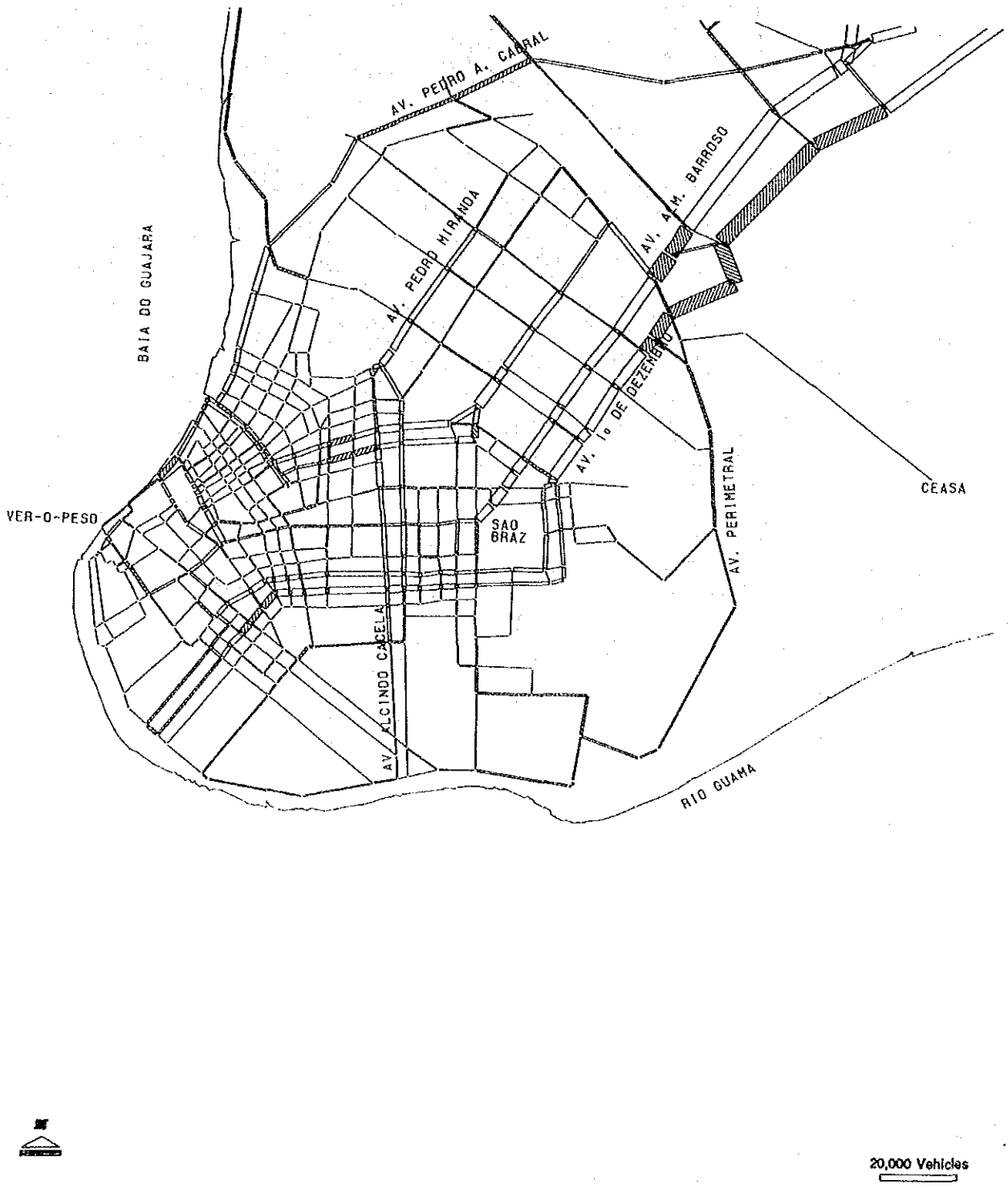


Figure 13.3-10 Traffic Flow (Year 2000)

13.4 Traffic Management Plan

731. This traffic management plan serves to realize the traffic flow plan. The plans are classified into soft-ware counterplans and hard-ware ones. The soft-ware plan represents regulation plans and the hard-ware one includes road improvement, signal system, parking bay, etc.

732. Each counterplan is specified for each road function and Table 13.4-1 shows the relation between the counterplan and type of roads.

Table 13.4-1 Relation between Counterplan and Type of Roads

Counterplan	Public Traf. Artery	Private Traf. Artery	Secondary Street
Soft-ware Plan			
(1)Exclusive Bus Lane	o		
(2)Traffic Regulation	o	o	o
(3)Parking Restriction	o	o	
(4)Speed Limit		o	o
Hard-ware Plan			
(5)Road Improvement		o	
(6)Intersection Improvement		o	
(7)Sidewalk Improvement		o	o
(8)Signal System		o	
(9)Parking Bay			o
(10)Bus Stop			o
(11)Marking/Vertical Sign		o	

13.4.1 Exclusive Bus Lane

733. Exclusive bus lane is planned in the public traffic arteries to maintain bus operating system punctuality. The criteria for establishment of exclusive bus lane are shown as follows;

a. Trunk Bus Route
b. Road of more than 2 lanes in one direction
c. No. of exclusive lane
   Bus volume >= 220 veh/h in one direction: 2 exclusive lanes
   Bus volume 220> >= 120 veh/h in one direction: 1 excl. lane

734. Figure 13.4-1 shows the exclusive bus lanes. Two exclusive bus lane roads are as follows;

a. BR-316(from Entroncamento to Ananindeua City,
b. Av. Almirante Barroso,
c. Av. Magalhaes Barata/Av.Nazare,
d. Av. Gentil Bittencourt,

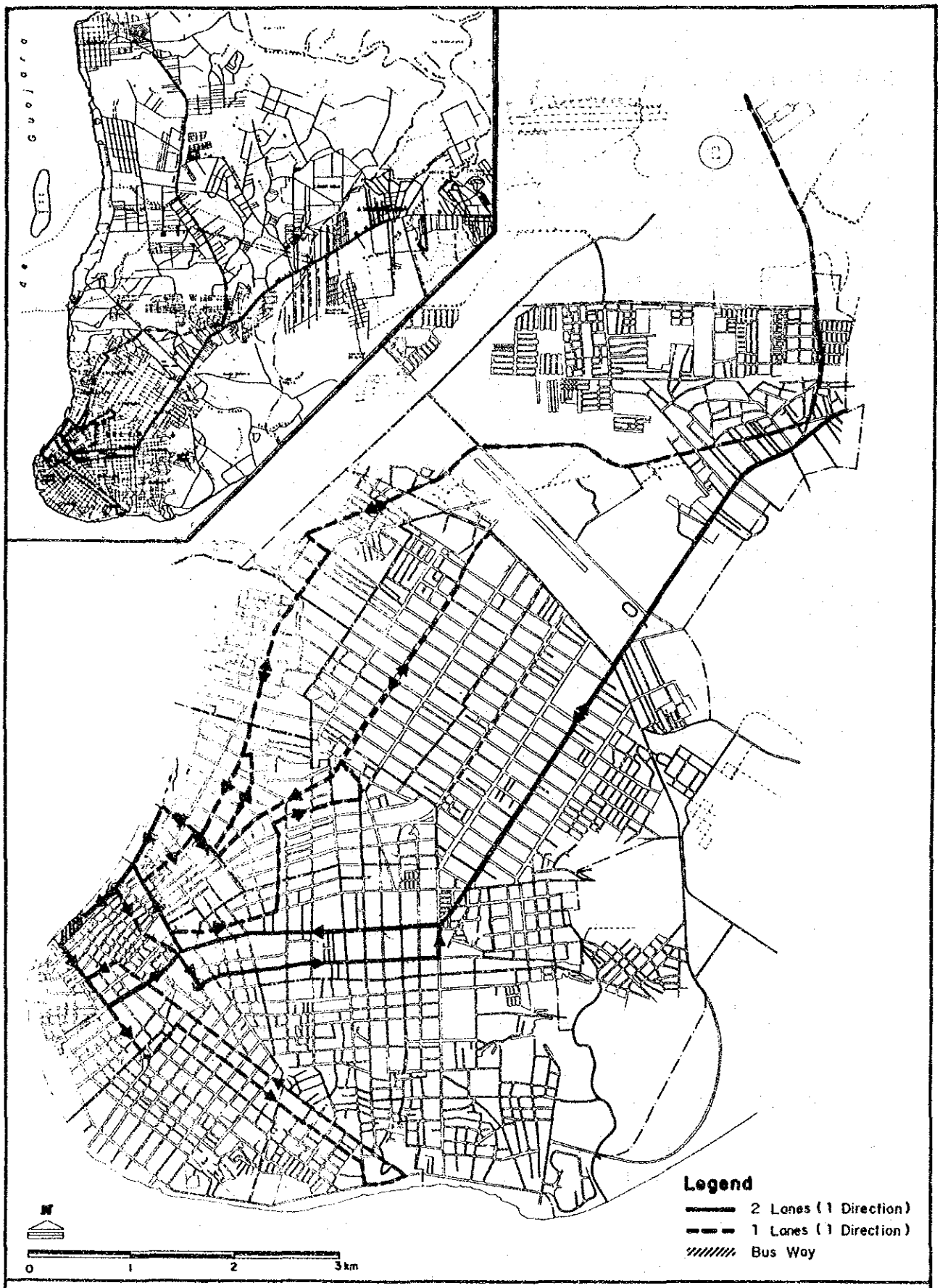


Figure 13.4-1 Exclusive Bus Lane

e. Av. Jose Bonifacio,
(from Av.Gentil Bittencout to Av. Magalhaes Barata)
f. Av. Serzedelo Correia,
(from Av. Gama Abreu to Av. Gentil Bittencout)
g. Av. Assis de Vasconcelos,
h. R.B. Castilho Franco,
i. Av. Portugal,
j. Av. Tamandare/Av. Gama Abreu, and
k. Av. Marchel Hermes

735. In the ring road surrounding Comercio area, Av. 16 de Novembro is only a two lanes road, therefore, this section is planned to have only one exclusive bus lane without bus stop.

736. Figure 13.4-2 shows the standard profile of exclusive bus lane, one is separated physically by a separator and the other is separated by marking with cat's eye. The exclusive bus lane with separator is planned only in Av. Almirante Barroso and BR-316 where there are already equipped, therefore it is not necessary to improve the road profile. In other roads it is difficult to separate the exclusive bus lane physically due to many road-side residences, therefore separating is planned by marking with cat's eye.

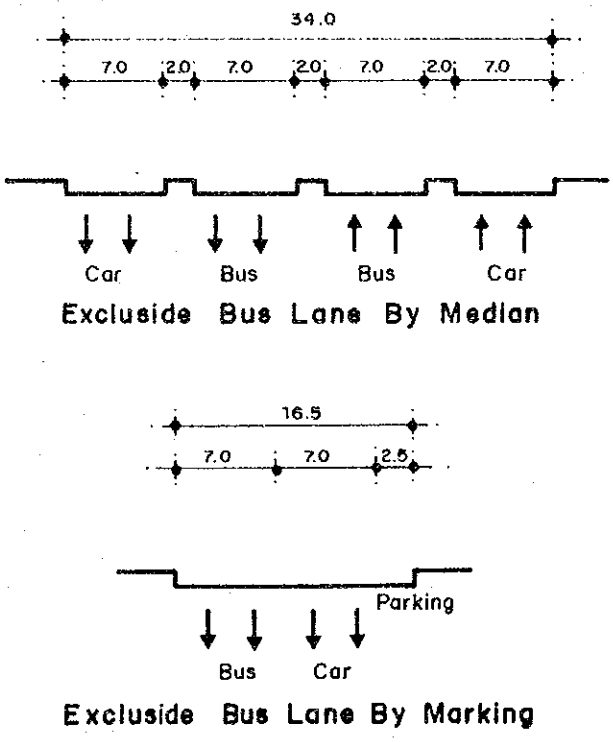


Figure 13.4-2 Standard Profile of Exclusive Bus Lane

13.4.2 Traffic Regulation

(1) One-way Regulation

737. For realizing the traffic flow plan, one-way regulation is changed through as little changes to the current one-way regulation as possible. Figure 13.4-3 shows one-way regulation plan. The regulation which differs from the current system is shown below;

a. Av. Alcindo Cacela and Tv. 9 de Janeiro are changed to one-way for the dual-way roads.
b. Av. Marechel Hermes is changed to one-way due south. The roads in the opposite direction are Rua. das Municipalidade and Rua Gaspar Viana, will be maintained for public traffic artery and private traffic artery.
c. The dual-way roads which are Tv. Guerras Passos and Tv. Teofilo Conduru are changed to one-way to provide for private arterial road.
d. The streets which cross Av. Assis de Vasconcelos are prevented from "through" traffic by the introduction of one-way regulation for keeping private traffic arterial function of Av. Assis de Vasconcelos.
e. Parts of Rua Bernardo Couto, from Av. Alcindo Cacela to Av. Generalissimo, are changed to one-way in order to introduce the exclusive bus lane.

(2) "Through" Prohibition

738. One of the ways for increasing running efficiency of vehicles is to decrease intersections. Therefore, "through traffic" prohibition, is planned at some intersections in order to provide private traffic artery. The criteria of "through traffic" prohibition is shown below;

a. The subject road is only private traffic artery.
b. To omit the intersection where the feeder bus passes.
c. To provide intersections at 1 km intervals.

739. Figure 13.4-3 shows the intersections which are planned to be adapted "through traffic" prohibition.

(3) Turn Prohibition

740. At intersections where there are two exclusive bus lanes, it is dangerous to turn right, so that traffic turning right is prohibited. Figure 13.4-3 shows the intersections where right turn is planned to be prohibited.

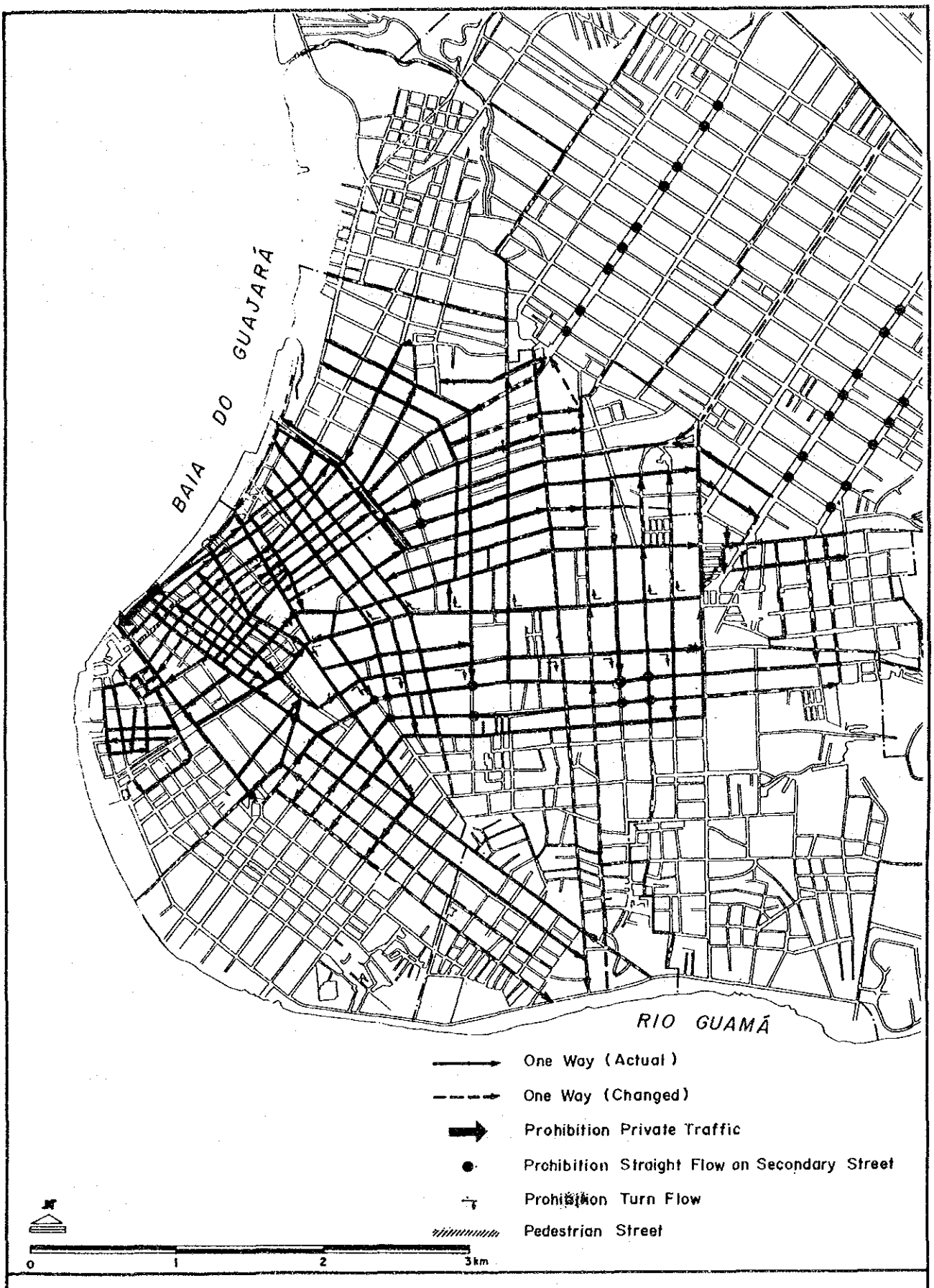


Figure 13.4-3 Traffic Regulation Plan

13.4.3 Parking Restriction

741. Parking restrictions are enforced for maintaining running functions on private traffic arteries and public traffic arteries. Figure 13.4-4 shows parking restriction blocks.

742. On private traffic arteries, parking restrictions are enforced along both road sides so that traffic will not disturbed by parking vehicles. On public traffic arteries with exclusive bus lane, parking on the right side is prohibited due to bus stopping.

13.4.4 Speed Limit

743. Under actual conditions, speed limit is 40 km/h in the central area except on some arteries. For maintaining superiority over secondary streets, the speed limit on private traffic arteries is changed to 50km/h.

13.4.5 Road Improvement Project

744. Figure 13.4-5 shows road improvement projects.

(1) Road Improvement

745. For constructing private traffic arterial network, some road sections are improved to make a continuous road. These projects are shown below, but these are included in road network project, therefore in this part the details are omitted.

a. Tv. Guerras Passos (No.1 in Figure 13.4-5)
b. Tv. 9 de Janeiro (NO.2 in Figure 13.4-5)

(2) Road Width Enlargement

746. For constructing private traffic arterial network, some road sections are widened. Table 13.4-2 shows the details.

Table 13.4-2 Road Enlargement Project

Road	Description	Length	Note
Rua Municipalidade	Width 5.0m --> 8.0m 2 Lanes for Private Traffic (Fig.13.4-5)	0.15km	No 3
Rua Gaspar Viana	Width 3.5m --> 8.0m 1 Lane for Private Traffic (Fig.13.4-5) 1 Lane for Public Traffics	0.26km	No 4

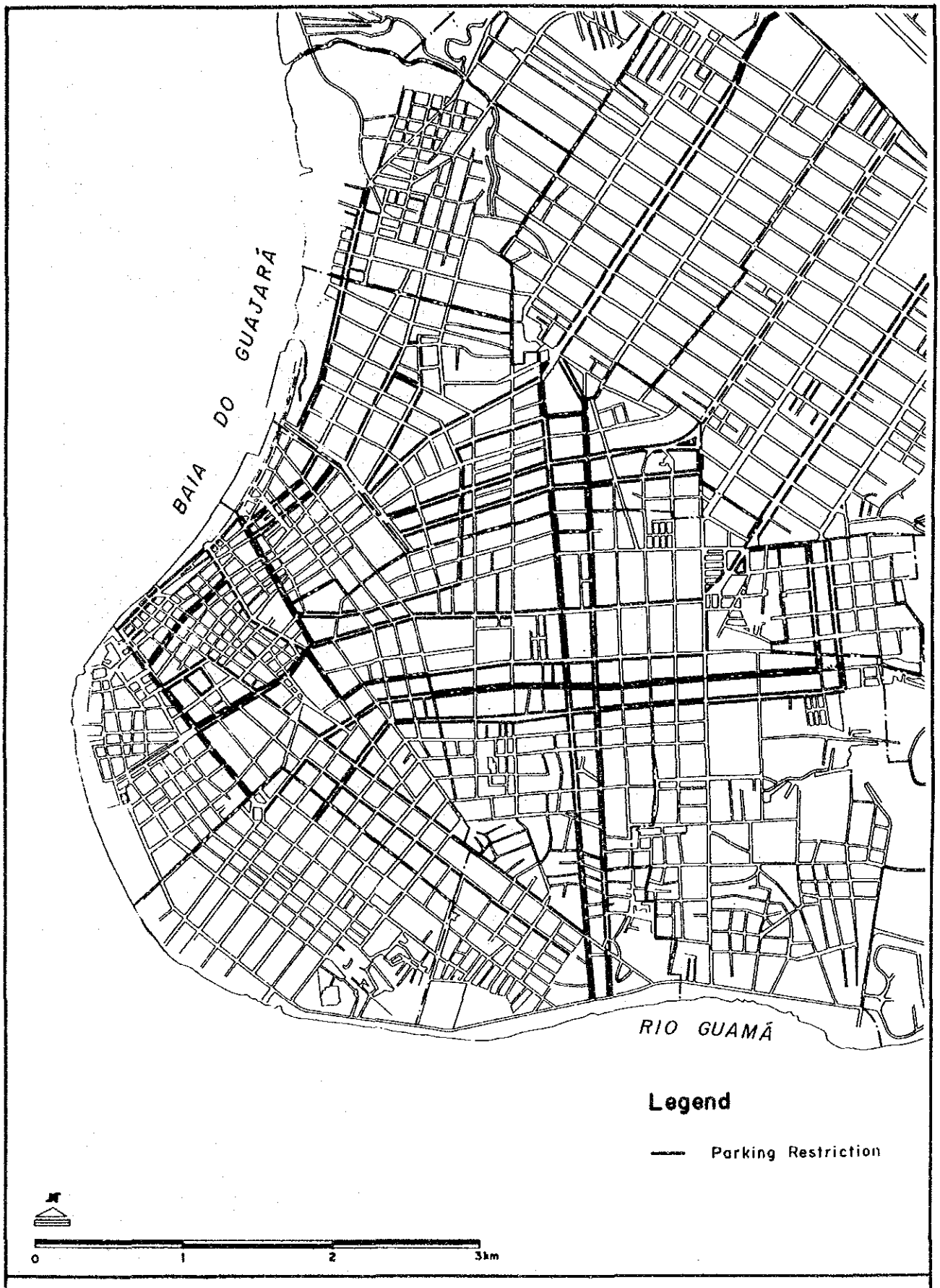


Figure 13.4-4 Parking Restriction Plan

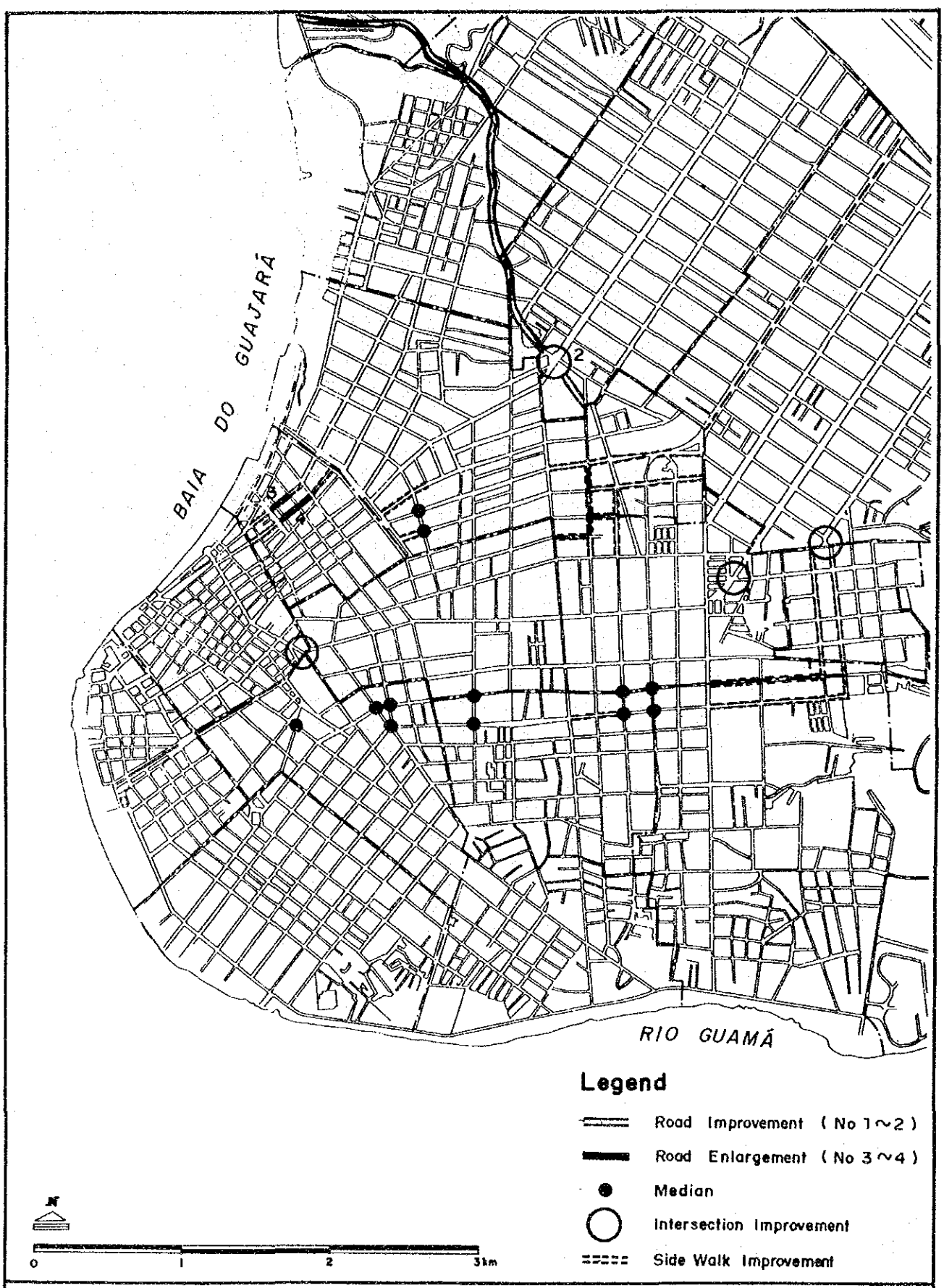


Figure 13.4-5 Road Improvement Projects

(3) Median

747. Median is installed at intersections where "through traffic" is prohibited on secondary streets. Those intersections are shown in Figure 13.4-5 and the standard design is shown in Figure 13.4-6.

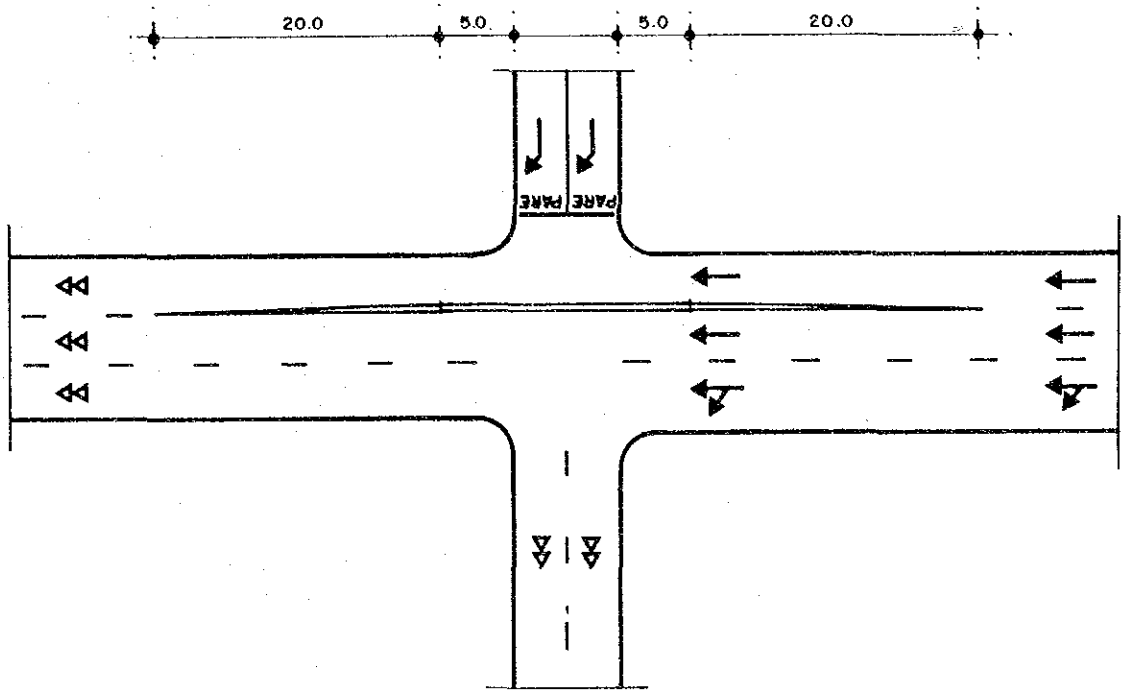


Figure 13.4-6 Standard Design of Median for Prohibition Through Traffic Flow

13.4.6 Intersection Improvement

748. The intersection improvement is planned at those intersections where traffic flow becomes complex when the traffic flow plan is adopted. Figure 13.4-5 shows the object intersections. Each intersection improvement plan is shown in Figures 13.4-7,8,9 and 10 with signal phase plans, respectively.

13.4.7 Sidewalk Improvement

749. Sidewalks provide pedestrian safety against the vehicles. Therefore especially in the private traffic arteries, sidewalks are required. In the public traffic arteries the sidewalk is also necessary because of many bus users.

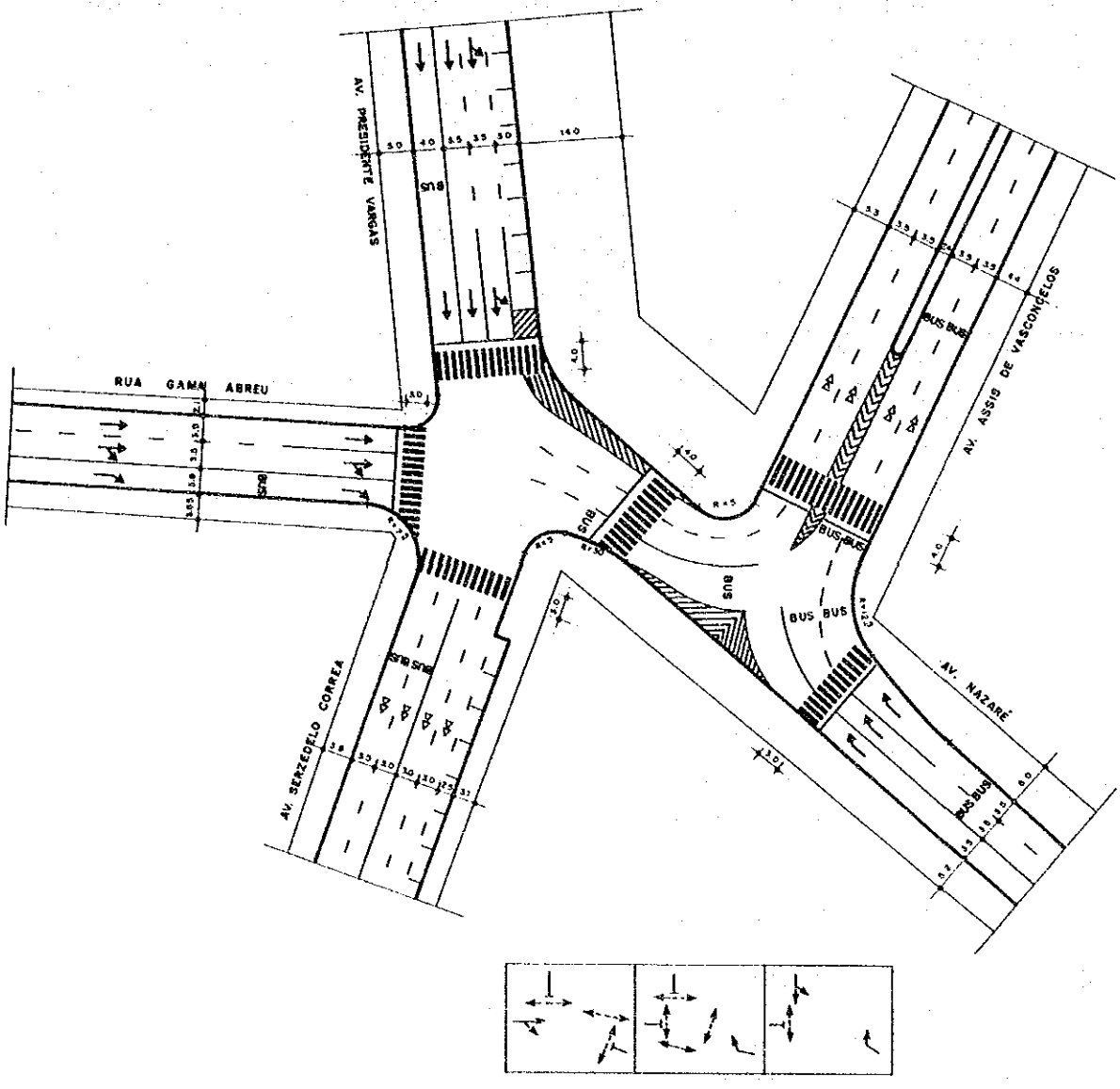


Figure 13.4-7 Intersection Improvement
(Av. Nazare/ Av. Pres. Vargas/ Av. Assis de Vasconcelos)

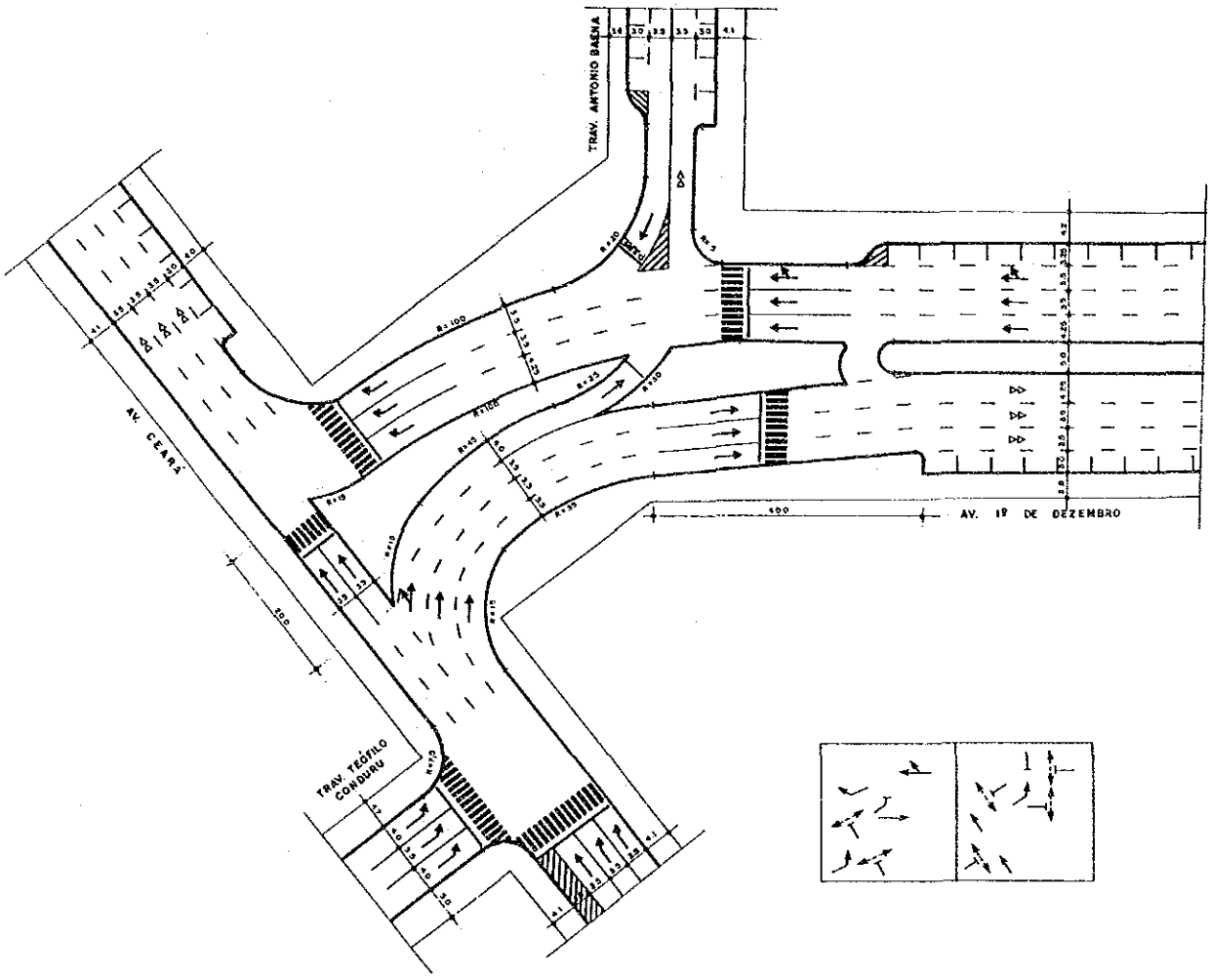


Figure 13.4-8 Intersection Improvement
(Av. 1o de Dezambro/ Av. Ceara)

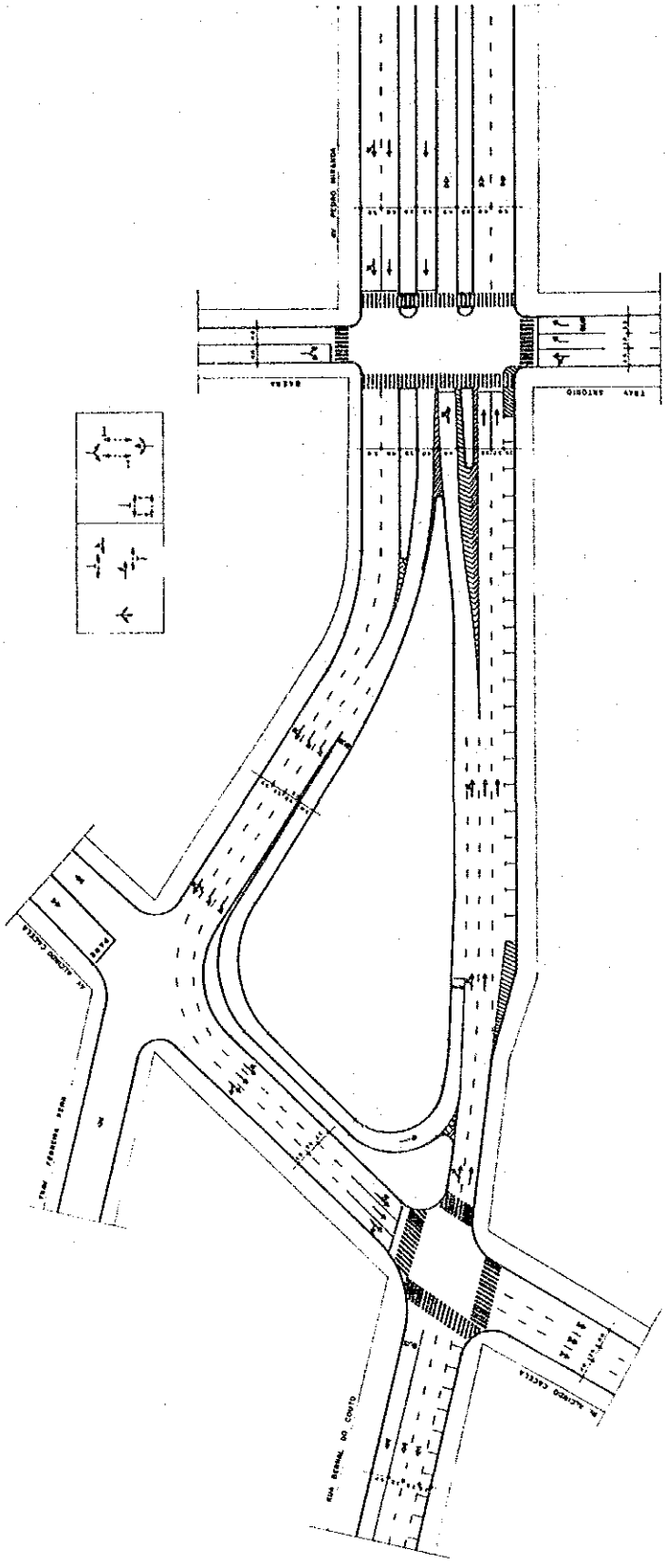


Figure 13.4-9 Intersection Improvement
(Av. Pedro Miranda/ Av. Alcindo Cacela)

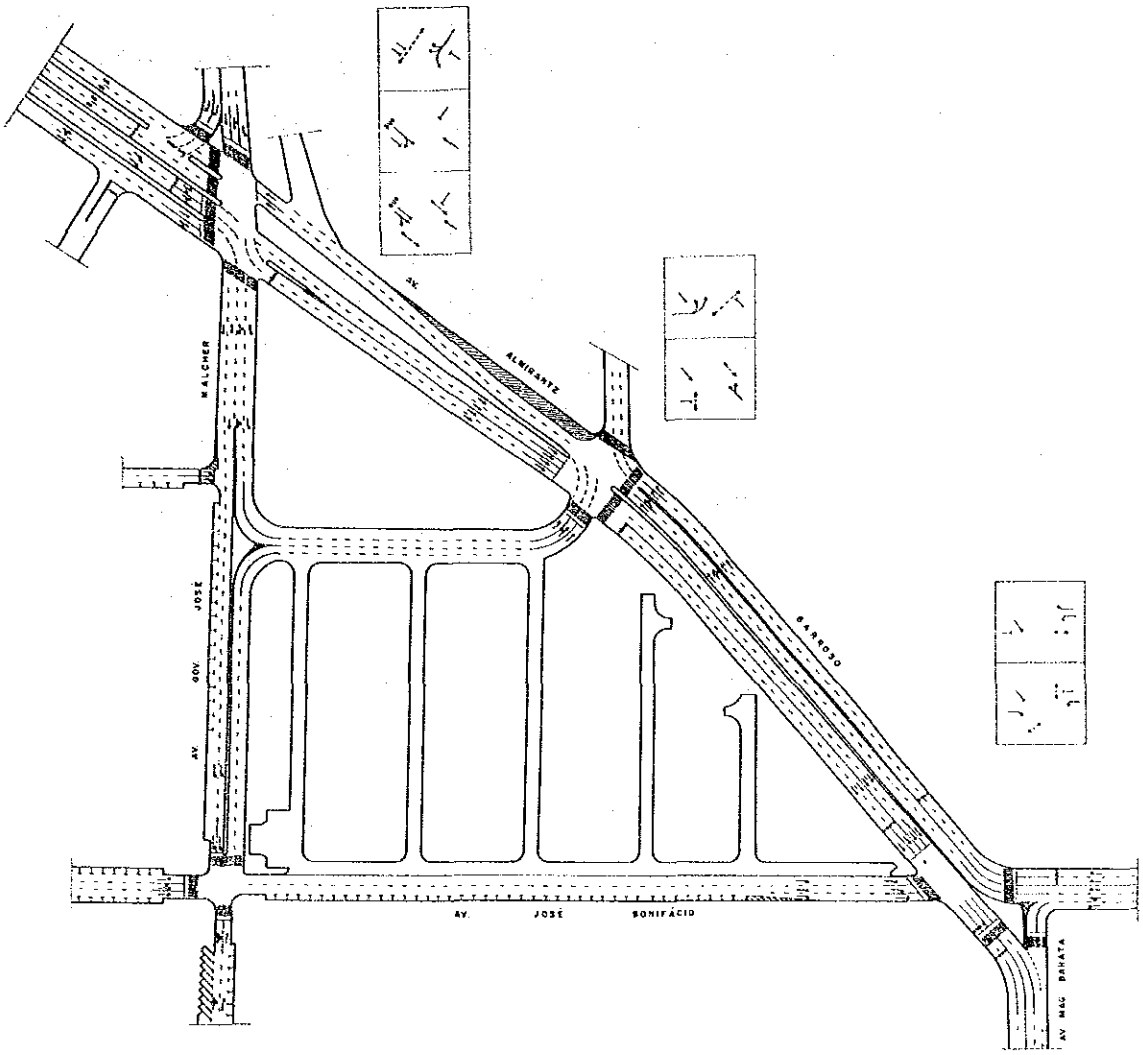


Figure 13.4-10 Intersection Improvement (Sao Braz)

750. In 2010 year the service level of sidewalk is shown in Table 13.4-3, where pedestrians include public traffic users. The service level is not low level as a whole, however in Fatima it is very low level because of no clear sidewalk resulting from few paved carriage ways. Therefore sidewalk improvement shall be carried out concurrent with paving carriage ways in this district. Figure 13.4-5 shows the locations of sidewalk improvements.

Table 13.4-3 Service Level of Side Walk(2010)

Zone	Pedestrian (peak hour)	Pedestrian (min.)	Side Walk (m2)	Density (m2/per.)	Service Level
Comercio	36882	7081	84130	11.88	B
Batista Campos	33852	6500	74150	11.41	B
Reduto	17980	3452	36395	10.54	B
Nazare	14120	2711	21510	7.93	B
Can	50900	9773	61350	6.28	B
Cremacao	25168	4832	34410	7.12	B
Umarizal	35492	6814	103266	15.15	A
Fatima	10567	2029	2340	1.15	E
Sao Braz	27797	5337	47970	8.99	B
Ropoviaria	14906	2862	12270	4.29	B
Pedeira	39809	7643	21990	2.88	C
Pedeira Norte	25590	4913	26250	5.34	B
Marco Sur	51398	9868	72550	7.35	B
Marco Norte	24860	4773	32025	6.71	B
Total	409321	78590	630606	8.02	B

Note;(1) Service level (by H.C.M.)

A		>= 12.08 m2/per.
B	12.08 >	>= 3.72
C	3.72 >	>= 2.23
D	2.23 >	>= 1.39
E	1.39 >	>= 0.56
F	0.56 >	

(2) Pedestrian(min.) = Pedestrian(hour)* Walking Time/60
Where: Walking Time = 11.5 min.(by PT Survey)

13.4.8 Signal System Plan

(1) Installation of signal sets

751. At non-signalized intersections it is impossible to cross the road when the moving traffic exceeds 650 vehicles per hour. Therefore signalized intersections are planned using the following criteria;

a. Central area — more than 650 veh/peak hour/1 approach (more than 10,000 veh/day/1 approach)

b. Suburban area — more than 1,000 veh/peak hour/1 approach (more than 15,000 veh/day/1 approach)

The volume of turn traffic and pedestrian in the central area should also be taken into consideration.

752. As for the existing signalized intersections, it is necessary to add pedestrian signal sets in the central area. In the year 2010 the signalized intersections which will be necessary are shown in Figure 13.4-11. Table 13.4-4 shows the summary of the installations.

Table 13.4-4 The Installation of Signal Sets

Type	Central Area	Suburban Area	Total
Actual signalized Intersection			
-No Change	24	14	38
-Add pedestrian signal sets	104	-	104
-Demolition	13	-	13
Planned Signalized Intersection	53	32	85
Total	181	46	227

Note :(1) Excluding Stop Signal
(2) Total excludes the demolition.

753. The intersections signal sets which will lose their necessity of existence should be replaced in accordance with the new traffic flow plan. Demolition of signal sets is executed in conjunction with traffic volume survey when the traffic flow plan is in implementation.

(2) Synchronization

754. In the private traffic arteries, the signalized intersections are planned to be synchronized to maintain smooth vehicle movement. Figure 13.4-11 shows synchronized intersections, and synchronized speed depends on speed limit.

755. In the public traffic arteries and the secondary streets, it is better not to plan synchronization and to keep low travel speed in order to remove inter-zone trips.

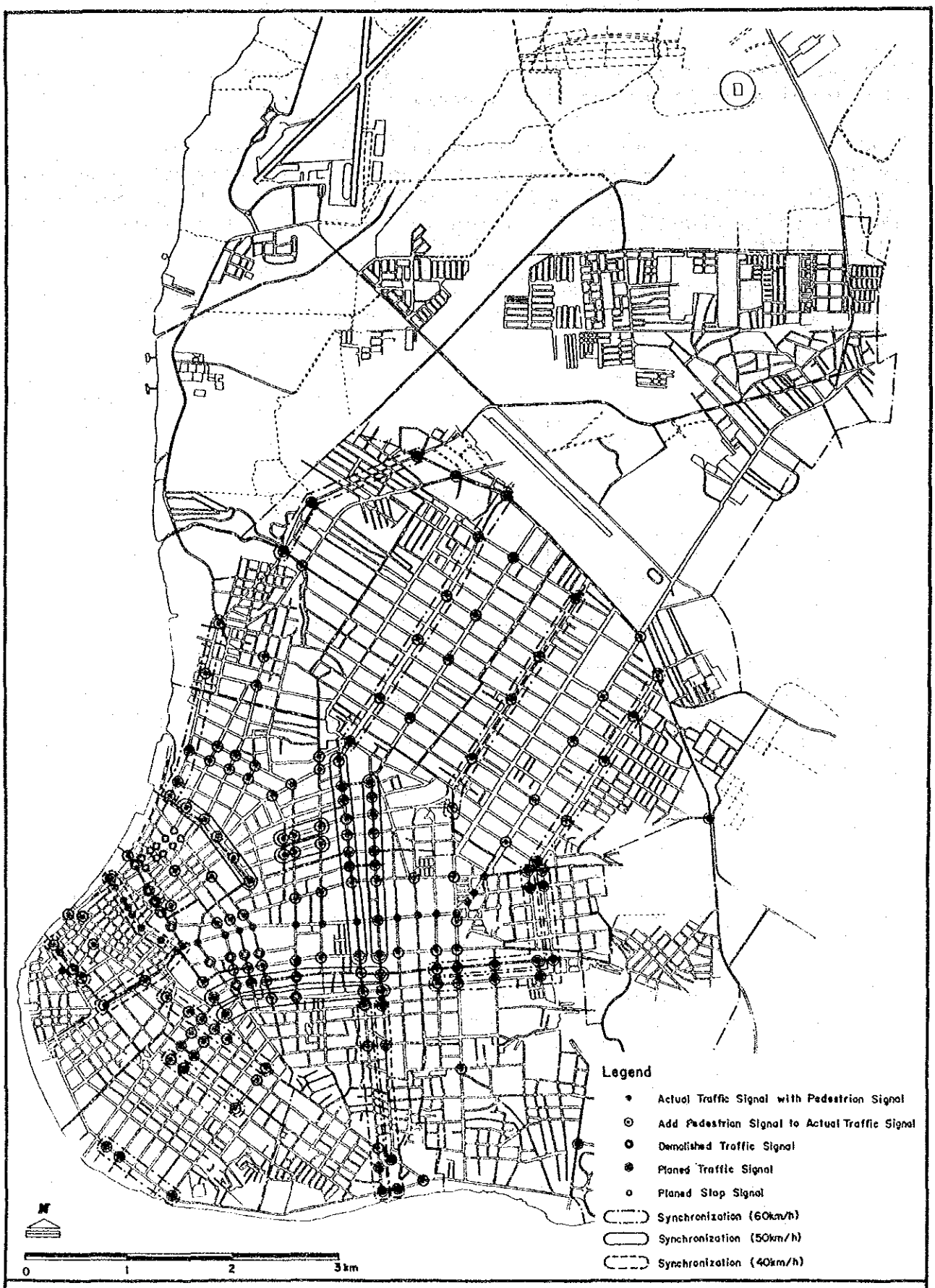


Figure 13.4-11(A) Location Plan of Traffic Signal (Central Area)

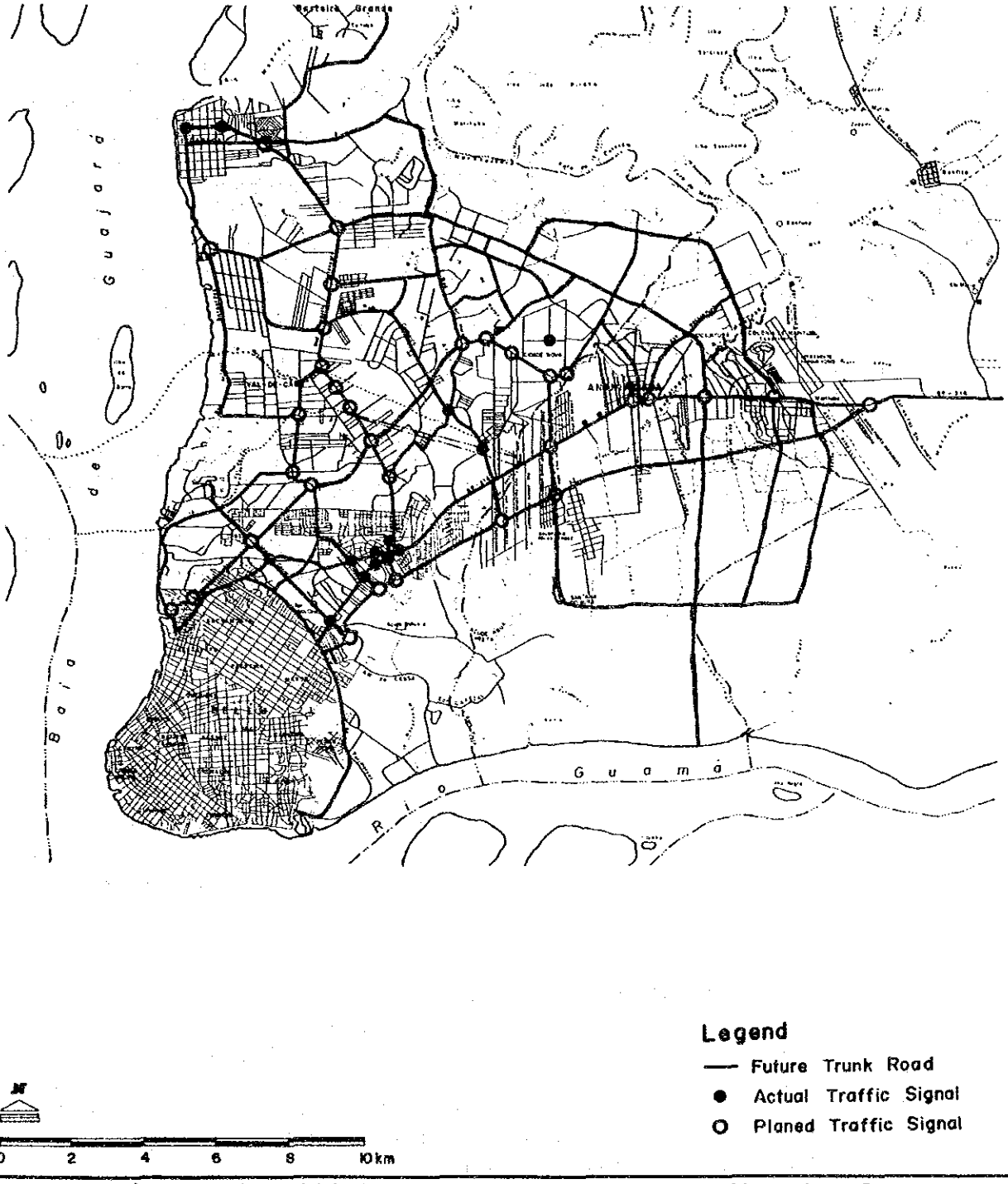


Figure 13.4-11(B) Location Plan of Traffic Signal (Sub-Urban Area)

(3) Signal System Improvement

1) Signal sets Installation Pattern

756. Signalization is required not only for vehicles but also for pedestrians, which means the necessity to install pedestrian signal sets. Figure 13.4-12 shows the standard installation of signal sets at intersections.

2) Improvement of Controller

757. The current signal controller can't adapt to the fluctuation of traffic flow due to fixed pre-timed control. It causes the loss time in signalized intersection and the driver may be encouraged to disregard traffic signals. Therefore the signal controller shall be changed to the new one which can adapt to the fluctuation of traffic flow. Table 13.4-5 shows the necessary functions of the controller and the reasons for such installation.

Table 13.4-5 The Function of Signal Controller

Function	Reason
Programming Control	To adapt to the fluctuation of traffic flow which has differences between morning, daytime and evening periods.
Flashing Control	At midnight and holiday when traffic volume is light. In this case signal control is good enough to control by yellow and red flashing.
Synchronized Control	In the private arteries the signalized intersections are synchronized.

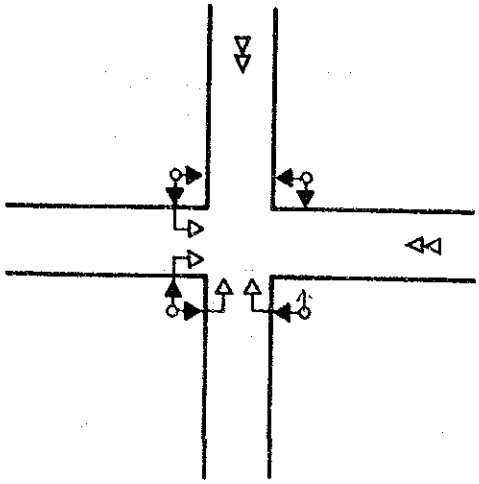
3) Signal System Center

758. Current signal sets are controlled by the controller at each intersections. However since signal sets trouble occurs almost daily in Belem, it is recommended to install a signal system center for maintenance. This signal control system is shown in Figure 13.4-13. The center is equipped with a micro computer whose functions are as follows;

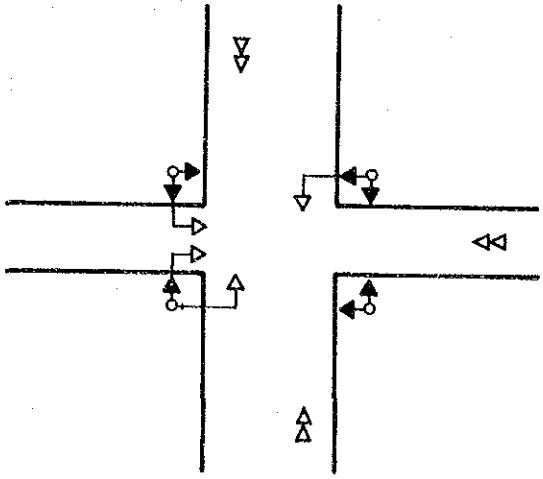
a. Observation of signal sets condition (detecting signal sets trouble)
b. Recording signal sets trouble condition
c. Changing signal parameter from signal system center

The necessary instruments in the signal system center are the micro computer, printers, operator consoles and the graphic panel or the large CRT display for observation.

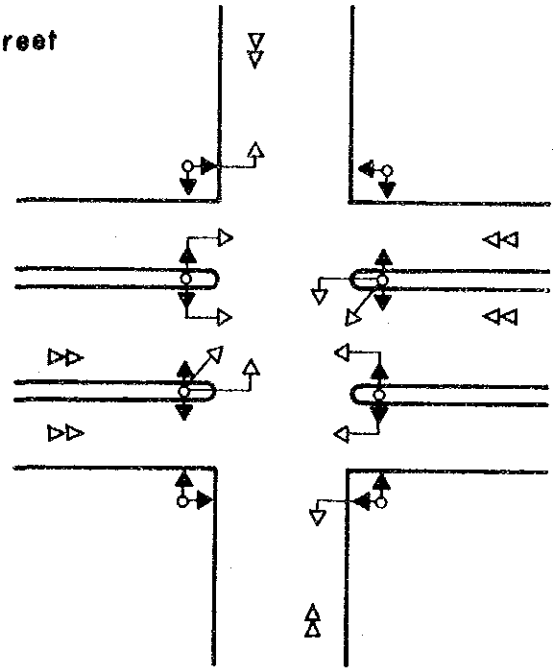
i) One-Way Street



ii) One-Way Street and Two-Way Street



iii) Two-Way Street



Legend

- Signal for Vehicles
- Signal for Pedstrians
- Direction

Figure 13.4-12 Standard of Signal Set Installation

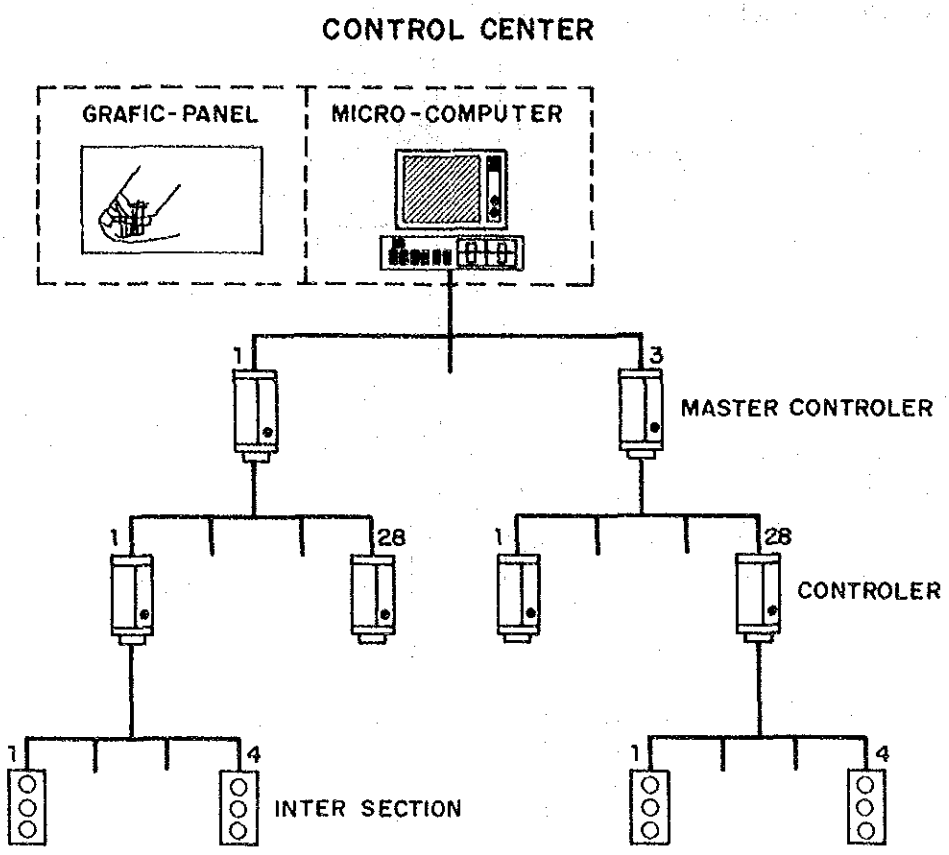


Figure 13.4-13 Signal Control System

13.4.9 Parking Bay

759. In the secondary streets the parking bay is provided for maintaining orderly curb-parking. The Parking bay can be identified by marking but around the intersection it should be blocked up clearly by widening the sidewalk as seen in Figure 13.4-14. Widening of the sidewalk decreases the intersection area, but it is effective in providing good traffic safety.

760. In the secondary street which has large carriage way width and little traffic flow, diagonal parking must be adopted for increasing curb-parking capacity. The diagonal parking adopting blocks are shown in Figure 13.4-15.

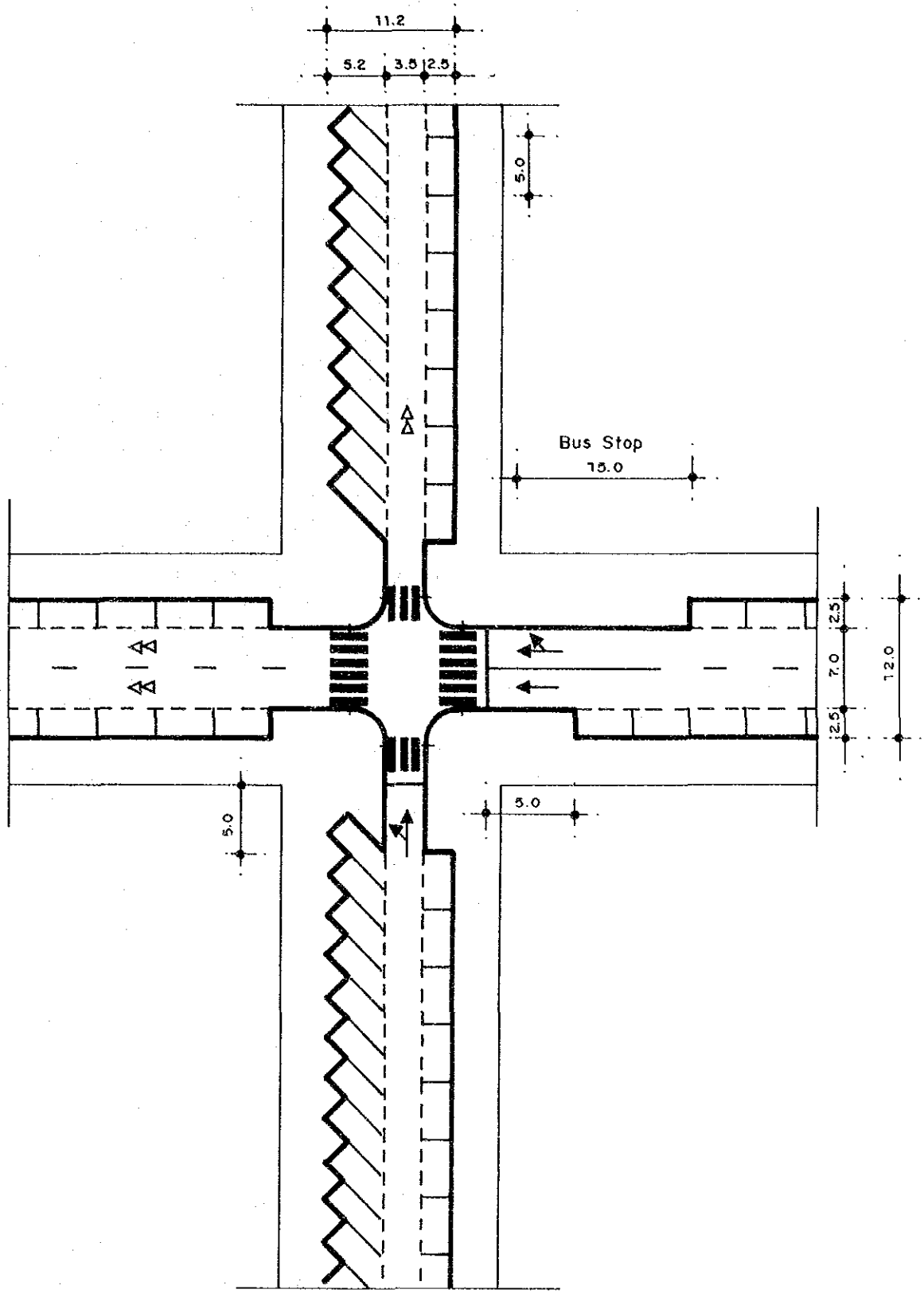


Figure 13.4-14 Standard Design of Parking Bay and Bus Stop

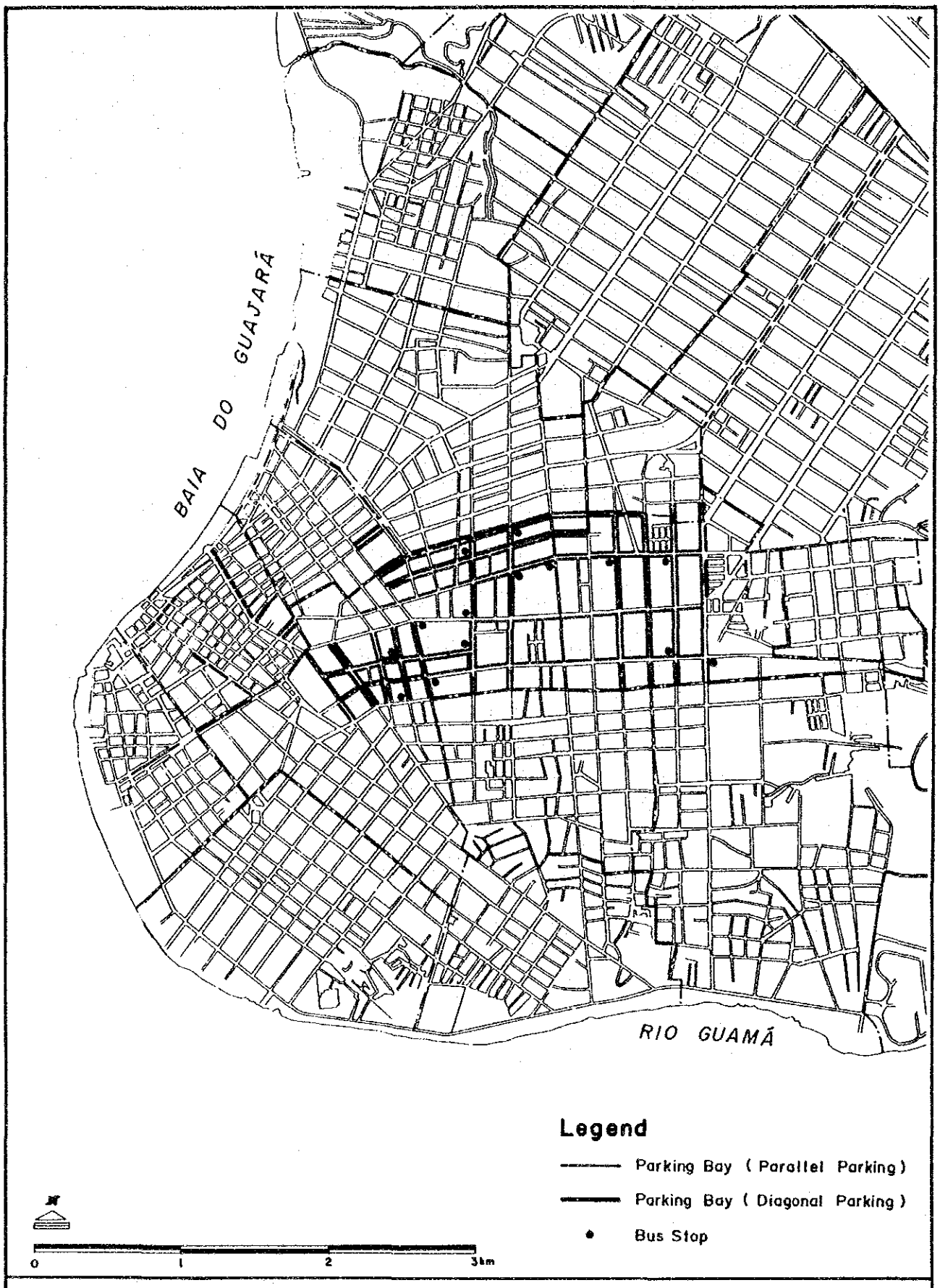


Figure 13.4-15 Parking Bay and Bus Stop

13.4.10 Bus Stop

761. The public traffic artery has the exclusive bus lane so that there is no problem regarding bus stop. However as for the feeder bus route which passes in the secondary streets bus stopping is disturbed by parking vehicles. Therefore in the secondary street enlarged sidewalk is extended for bus stop as shown in Figure 13.4-14.

762. Bus stop improvement plan is shown in Figure 13.4-15, which is decided based on the criteria of 1 bus stop for each 2 blocks on feeder bus route in the future CBD area.

13.4.11 Marking and Vertical Sign

763. Marking and vertical sign are provided based on changing one-way regulation, speed limit regulation and parking restriction. Especially as for one-way regulation it is necessary not only to provide the vertical sign but also to prepare the marking for clearing regulation.

764. Pedestrian crossing is necessary at every intersections where pedestrian signal sets are installed.

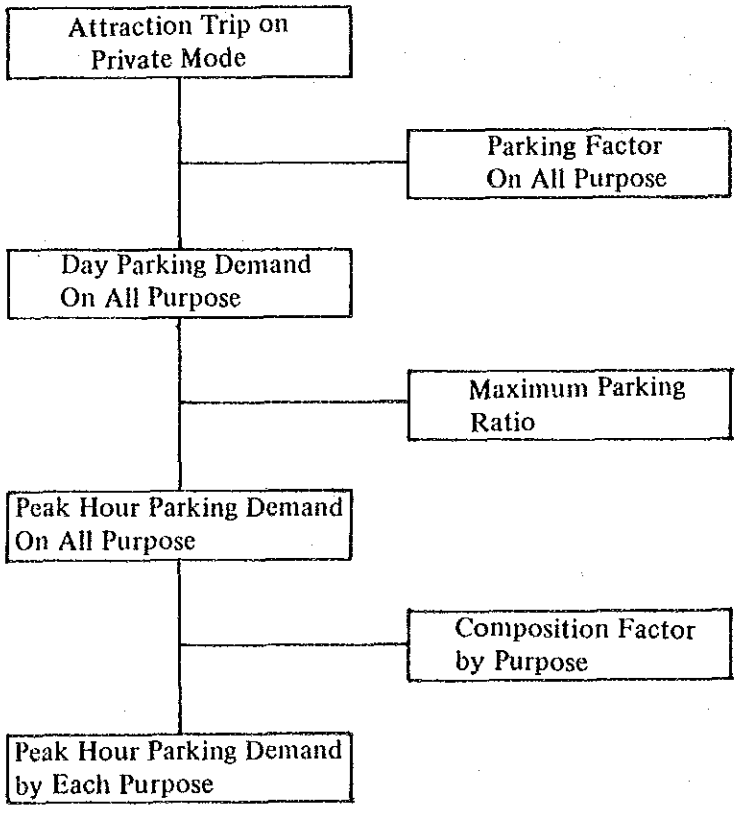
13.5 Parking Counterplan

765. Parking is one of the most important urban traffic problems in the world today. If parking demand is more than parking capacity, the traffic function of road decreases through illegal curb-parking and it contributes to a stagnant social economic activity. While parking demand is estimated for the future, evaluations are made as to whether or not there is a parking problem in the Study Area. If a parking problem is expected, counterplan will be prepared to handle it.

13.5.1 Parking Demand in The Future

(1) Measure of Estimating

766. The parking demand is estimated according to the flow chart shown in Figure 13.5-1. The area evaluated are Comercio, Batista Campos, Reduto, Nazare and Can. The parking volume is estimated by purpose at the peak hour.



Note; (1) All purpose is exclusive of "to home"

Figure 13.5-1 Flow Chart of Parking Demand Estimation

767. The day parking demand is estimated based on the attraction trips of private mode. The peak hour parking demand is estimated by multiplying daily demand by the maximum parking ratio. In this case, the parking demand excludes the 'To Home' purpose because it is assumed that the parking capacity for 'To Home' purpose is improved by the increase in the number of residences .

768. The parameters are explained below;

1) Parking Factor

769. Parking Factor is the ratio of day parking vehicles to attraction trips. Table 13.5-1 shows those based on person trip survey.

Table 13.5-1 Parking Factor

Zone	Parking Veh. (veh./day)(a)	Attraction Trips (trips/day)(b)	Parking Ratio (a)/(b)
Comercio	30,659	36,954	0.83
Batista Campos	8,427	13,838	0.61
Reduto	7,411	8,704	0.85
Nazare	8,168	9,953	0.82
Can	14,531	26,327	0.55
Total/Total(Comercio+Reduto+Nazare)			0.72/0.83

Note; Exclude 'To Home' purpose.

770. It is shown from the above Table that parking factors of Batista Campos and Can are lower than the other, however in future these areas will become higher, much like the other areas. Therefore average of Comercio, Reduto and Nazare is used for estimating the parking factor.

2) Maximum Parking Ratio

771. Maximum parking ratio is derived from the results of parking survey on on-street and off-street parking(refer to Figure 13.5-2,3,4). Maximum parking factor is the ratio of parking vehicles at 11 o'clock (11 o'clock a peak hour) to all daily parking vehicles. Maximum parking ratio is adjusted because parking vehicles surveyed only ten hours. Maximum parking ratio becomes 0.130, as shown in Table 13.5-2.

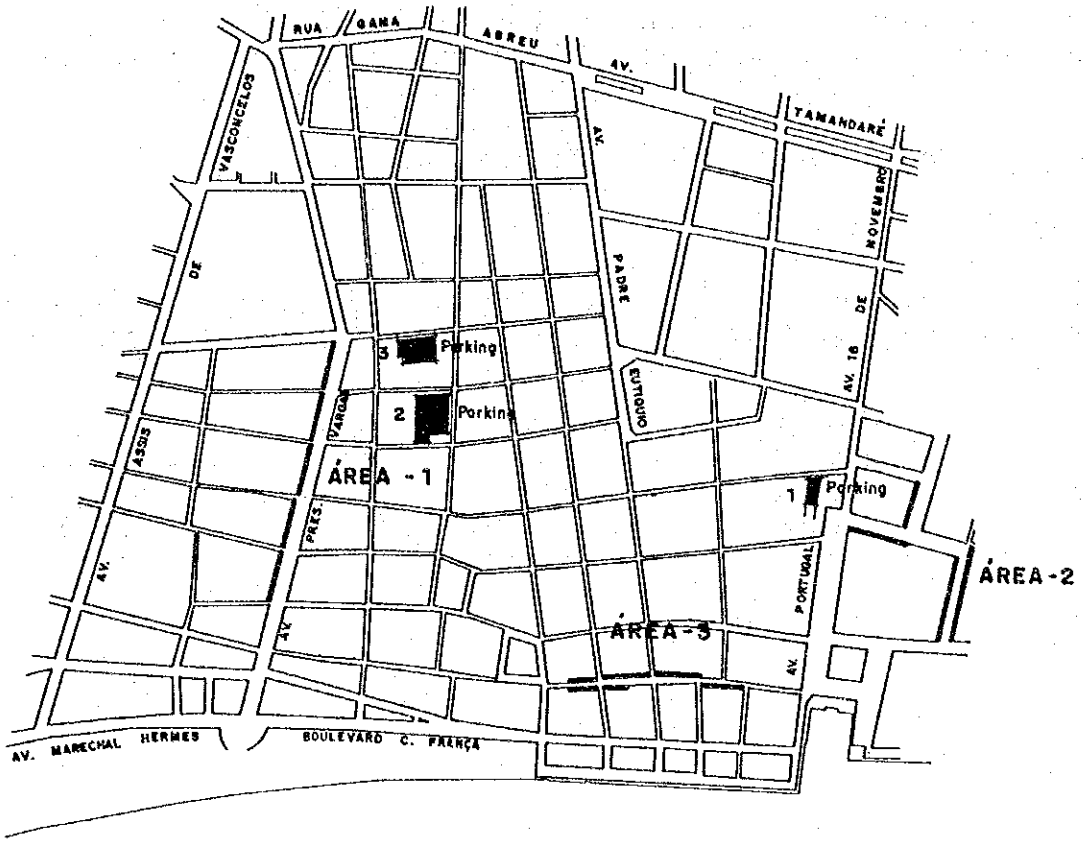


Figure 13.5-2 Parking Survey Points

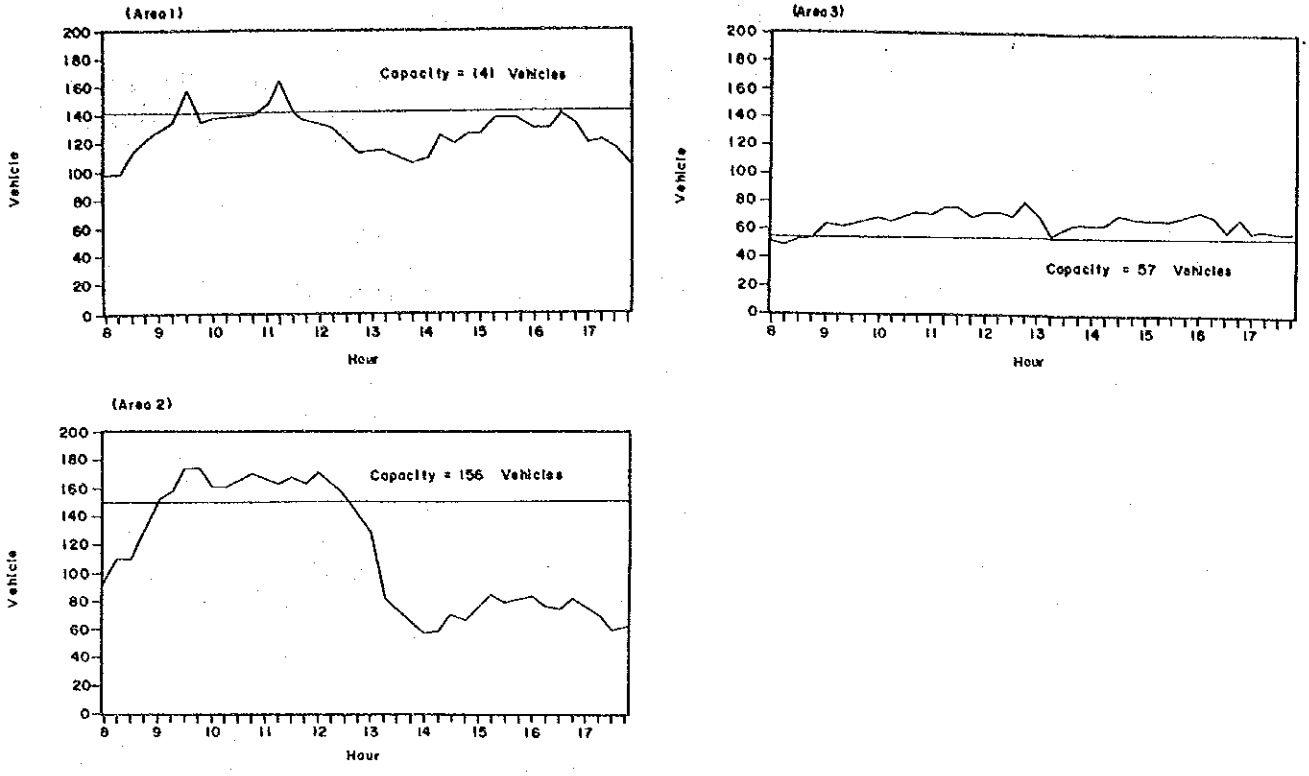


Figure 13.5-3 Fluctuation of On-Street Parking

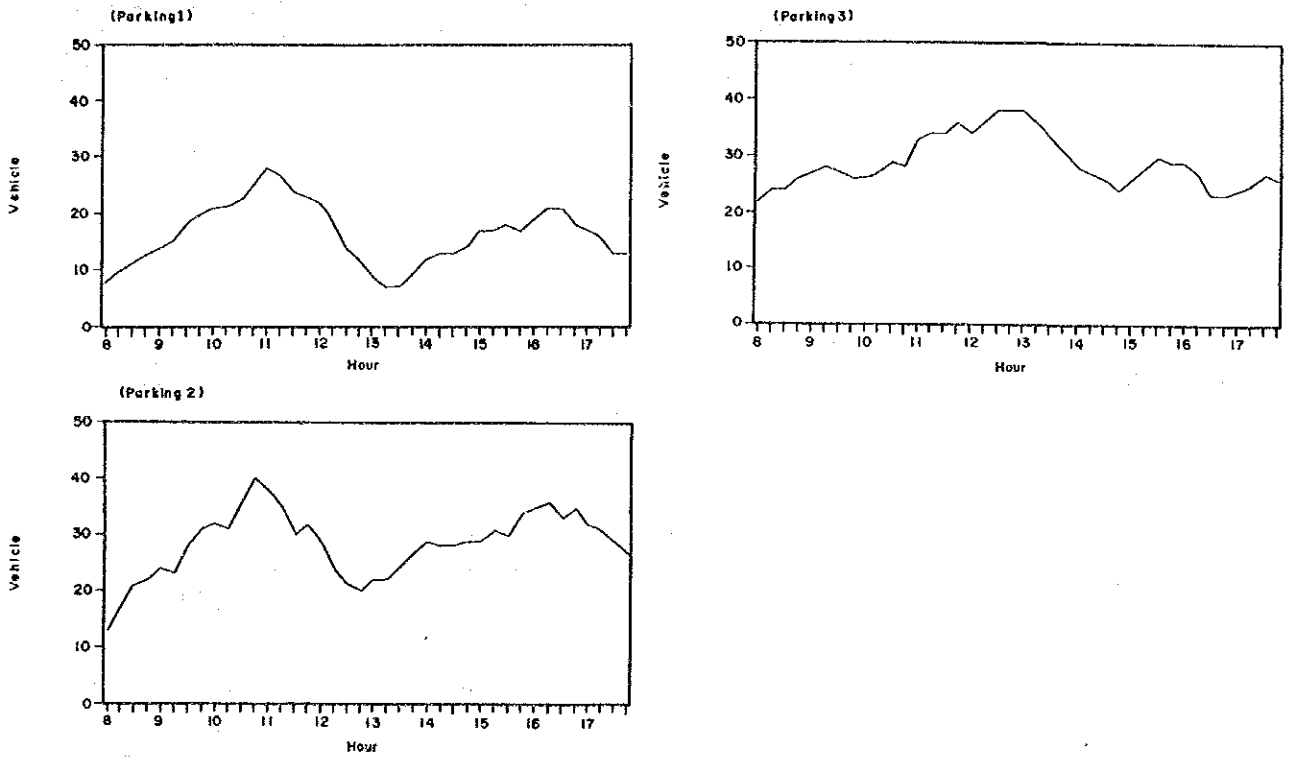


Figure 13.5-4 Fluctuation of Off-Street Parking

Table 13.5-2 Maximum Parking Ratio

Type	Parking Veh. (10 Hours)(a)	Max. Parking Veh.(11:00)(b)	Ratio (b)/(a)	Max. Parking Ratio(/day)
On-street				
Area 1	962	166	0.173	
Area 2	672	164	0.242	
Area 3	624	76	0.122	
Total	2,264	406	0.179	
Off-street				
Parking 1	71	27	0.380	
Parking 2	104	35	0.337	
Parking 3	64	34	0.531	
Total	239	96	0.402	
Total	2,503	502	0.201	0.130

Note: Attraction trips(10 hr.)/Attraction trips(day) = 0.649
where, Attraction trips exclude 'To Home' purpose

3) Composition Factor by Purpose

772. The parking vehicles at peak hour (11 o'clock) would have arrived before 11 o'clock. The parking duration is shown in Table 13.5-3. Therefore composition factor by purpose is calculated using attraction vehicles which arrived from the time before average parking duration until 11 o'clock. In this case, 'To Work' and 'Business' are summed because of the difficulty of separating 'To Work' and 'Business'. Table 13.5-4 shows composition factor by purpose.

Table 13.5-3 Average of Parking Duration

Type of Parking	Parking Duration (hour)			
	To Work	Business	To School	Private
On-street	2.78	0.98	0.38	1.01
Off-street	2.63	1.09	1.48	1.16

Table 13.5-4 Composition Factor by Purpose

Zone	To Work + Business	To school	Private
Comercio	0.933	0.002	0.064
Batista Campos	0.805	0.037	0.158
Reduto	0.861	0.018	0.120
Nazare	0.928	0.009	0.063
Can	0.911	0.039	0.085

(2) Parking Demand

773. Table 13.5-5 shows the parking demand in year 2010.

Table 13.5-5 Parking Demand in Year 2010

Zone	Parking Vehicles (vehi./day)	Parking vehicles(vehi./peak hr.)			
		To Work	To School	Private	Total
Comercio	30,672	3,720	8	255	3,983
Batista Campos	17,716	1,854	85	364	2,303
Reduto	12,218	1,367	29	191	1,587
Nazare	8,572	1,034	10	70	1,114
Can	30,792	3,647	156	200	4,003

Note; Excluding "To Home" Purpose, To work including Business

774. Table 13.5-6 and Figure 13.5-5 and -6 show the balance of parking demand and capacity. The balance between demand and capacity is examined each 500 m sub-zone because the average walking distance of person who parked is 450 m. The parking demand was divided in proportion to floor area in future and grouped into two purposes, 'Private' and 'Other' (To Work + Business + To School). The parking capacity is calculated by the condition as follows;

a. The vehicles 'Private' use only off-street parking facilities
b. Off-street parking facilities increase as the floor area increases, based on the city Act No. 7401.
c. The current off-street parking facilities which are publicly used are excluded because it isn't clear whether those will remain in the future.
d. On-street parking capacity is based on parking restriction plan. Diagonal parking is not considered.

775. Table 13.5-7 shows the relationship between parking purpose, floor use and parking type.

Table 13.5-6 Parking Demand/Capacity Balance

Area	Sub-zone	Demand	Capacity			Capacty-Demand	Demand Private	Capacity	Capacity-Demand
		To work Business To school (a)	Off-st. (2010) (b)	On-st. (2010) (c)	Total (2010) (d) (b)+(c)	(e) (d)-(a)	Private (f)	Shop (2010) (g)	(h) (g)-(f)
Comercio	1	922	393	605	998	76	53	75	22
	2	580	69	465	534	-46	8	30	22
	3	748	43	474	517	-231	68	81	13
	4	377	76	413	489	112	11	6	-5
	5	994	144	258	402	-592	90	179	89
	6	108	42	294	336	228	24	14	-10
	Total	3728	767	2509	3276	-452	255	385	130
B. Campos	1	546	396	257	653	107	127	762	635
	2	385	185	663	848	463	98	1316	1218
	3	303	323	453	776	473	50	277	227
	4	226	250	608	858	632	40	306	266
	5	52	72	203	275	223	10	62	52
	6	249	97	548	645	396	28	172	144
	7	179	105	433	538	359	11	68	57
	Total	1939	1428	3165	4593	2654	364	2963	2599
Reduto	1	822	565	635	1200	378	145	1270	1125
	2	574	420	708	1128	554	46	578	532
	Total	1396	985	1343	2328	932	191	1848	1657
Nazare	1	488	641	367	1008	520	40	458	418
	2	556	572	565	1137	581	30	356	326
	Total	1044	1213	932	2145	1101	70	814	744
Can	1	1456	913	846	1759	303	49	526	477
	2	579	579	509	1088	509	64	881	817
	3	971	770	735	1505	534	51	724	673
	4	797	285	507	792	-5	36	442	406
	Total	3803	2547	2597	5144	1341	200	2573	2373

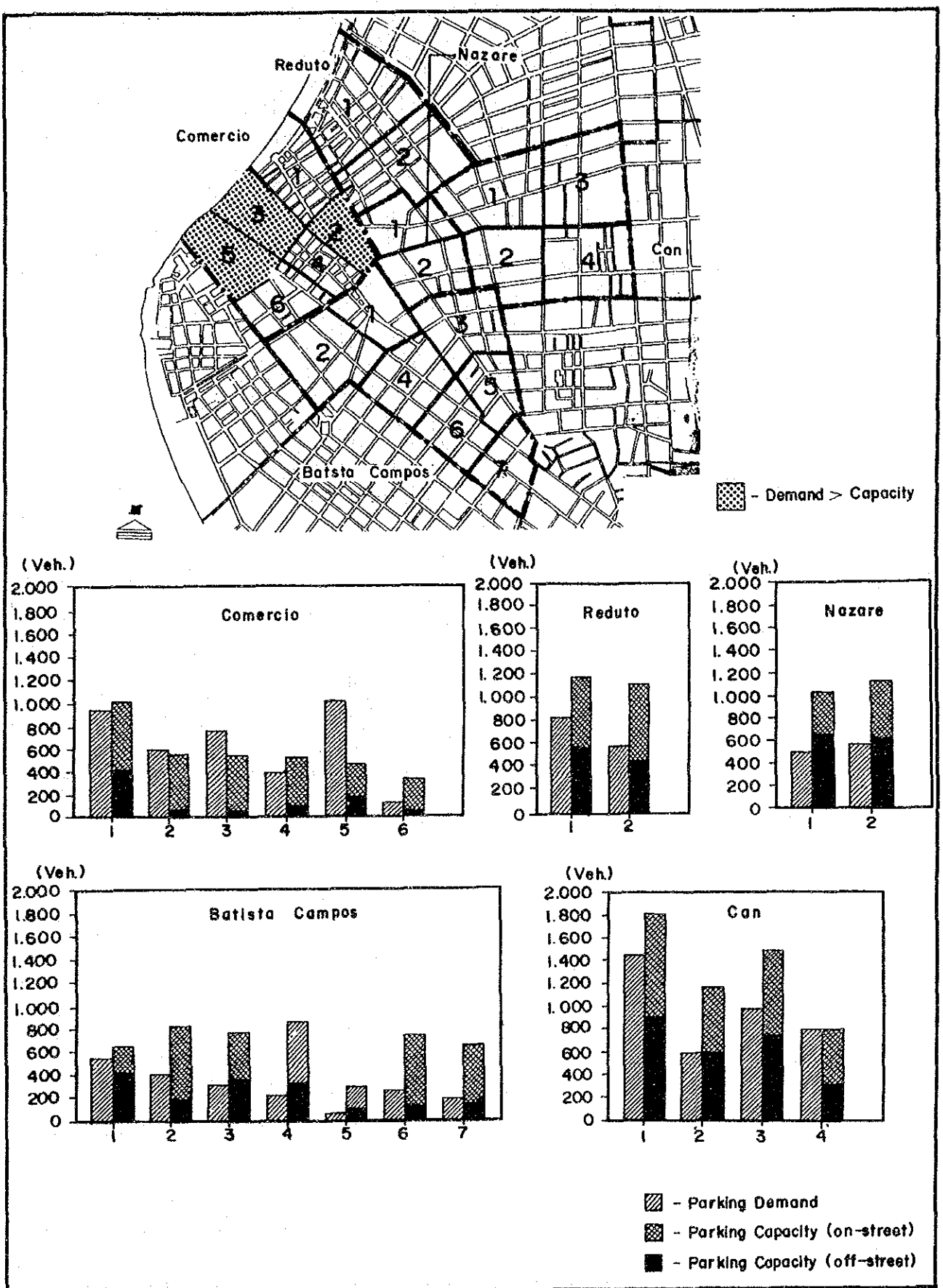


Figure 13.5-5 Parking Demand and Capacity in 2010
(Sum of To Work, Business and To School Trip Purposes)

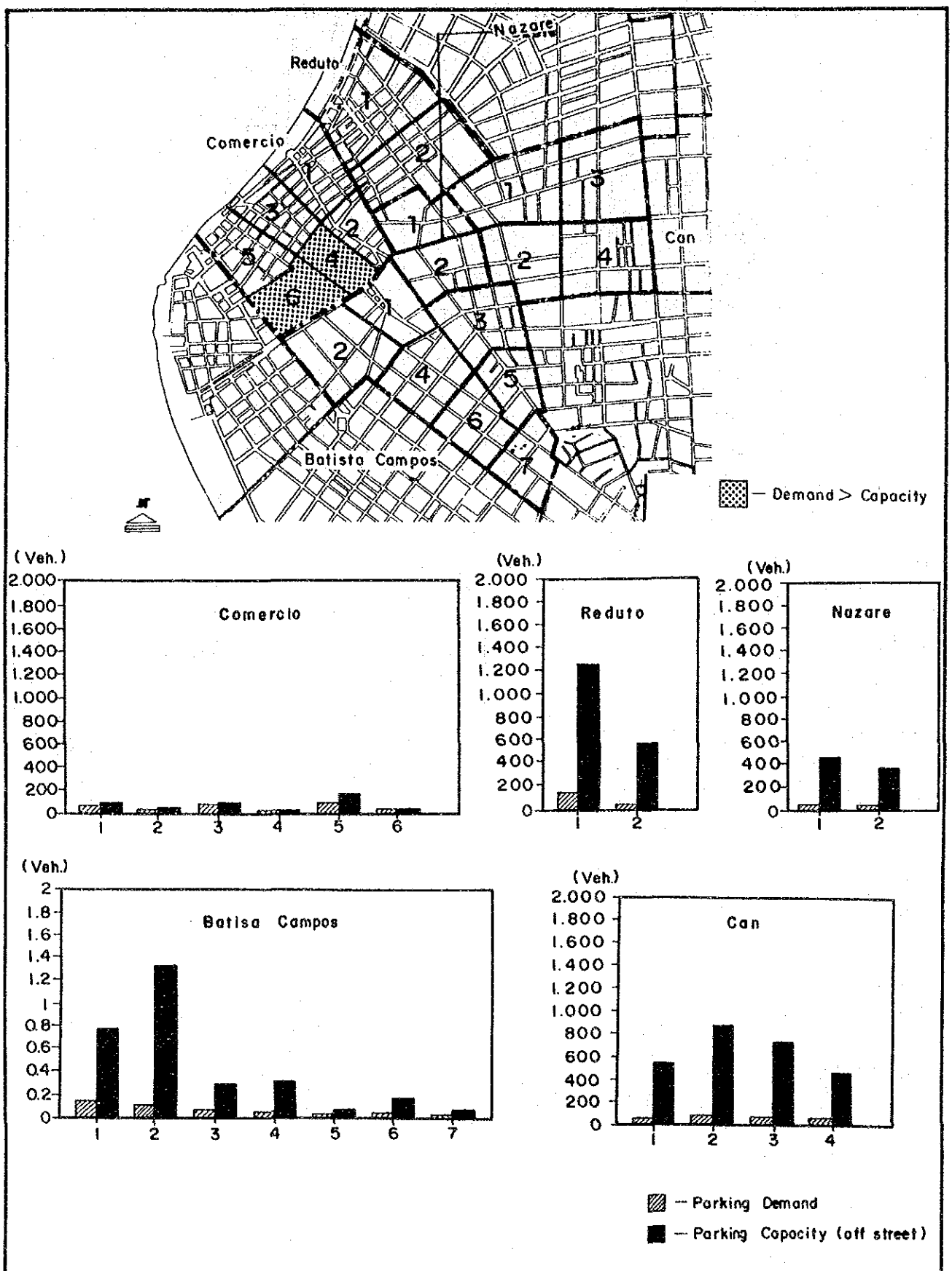


Figure 13.5-6 Parking Demand and Capacity in 2010 (Private)

Table 13.5-7 The Correspondence of Parking Purpose, Floor Use and Parking Type

Trip Purpose	Floor Use					Parking Type	
	Commerce	Service	Public Inst.	Education	Ind.	On-Street	Off-Street
To Work		o	o		o	o	Office
Business		o				o	Office
To School				o		o	School
Private	o						Shop

776. As for the balance between demand and capacity in 'Private' purpose, there are some sub-zones in Comercio where the parking demand exceeds the capacity, however those differences are less than 10 lots. Therefore it can be concluded that there is no parking problem in 'Private' purpose.

777. As for 'Other' purpose, there are sub-zones in Comercio and Can where the demand exceeds the capacity. Especially in Comercio the lack of capacity is approximately 450 lots in the whole. Therefore it is necessary to prepare a counterplan for solving the parking problem.

13.5.2 Counterplan for Parking Problem

778. Parking counterplan is necessary only in Comercio area. The check of the balance between demand and capacity is studied excluding the current capacity of public use facilities. There are approximately 1,150 parking lots for public in Comercio. If these lots remain in future, there will be no parking problem in Comercio. In general, parking facilities managed by private sector will be operated continuously if they are profitable. It is more practical to consider how to keep the current parking facilities open than how to construct new public parking facilities.

779. Therefore the counterplan involves the adoption of policies which favorably treat the current parking facilities. However the land which is presently used as "public use parking facility" might be rebuilt for an office building or a commercial one. In this case the policy should promote the retention of the current capacity by giving some concessions. Examples of such concessions are shown below;

a. Tax reduction or exemption
b. Alleviation of the building regulation
c. Exemption from other obligation

13.6 Traffic Management System

13.6.1 Task and Organization on Traffic Management

780. The tasks related to traffic management are indicated below:

a. Traffic control
   - Planning one-way regulation, parking restriction, speed limit, etc.
   - Planning road and intersection improvement in relation to traffic regulation

b. Construction of traffic management facilities
   - Installation of signals
   - Road and intersection improvement
   - Sidewalk improvement
   - Installation of parking bay etc.

c. Traffic law enforcement
   - Enforcement for violation of the traffic flow, illegal parking speeding, unlicensed driving, etc.

d. Maintenance
   - Maintenance of traffic management facilities
   - Control of signal parameter

e. Traffic accident treatment
   - Restoration of accident place

f. Traffic statistic and monitoring
   - Survey of traffic volume and congestion
   - Recording of traffic statistic
     traffic volume
     traffic accident

g. Traffic safety education
   - Life-long traffic safety education
   - Driver education
   - Administration of driver license

781. These tasks are divided among CTBEL, DETRAN and BATRAN. However traffic management is expected to combine these tasks. It is also very important to communicate between each organizations. Therefore it is recommended to organize an integrated committee, for example the committee on traffic safety.

13.6.2 Recommendation to Traffic Management Task

782. In the Study Area the functions of traffic monitoring, traffic safety education and maintenance in all traffic management tasks need strengthening. The followings are few recommendation to accomplish such objectives.

1) Traffic monitoring

783. The basic data for traffic management is traffic volume, which is used to plan traffic regulation and to renew signal parameter. It is therefore necessary to collect traffic volume data and traffic statistics. The traffic volume survey is conducted as follows:

- Traffic volume survey for 24 hours every year on arteries and major intersections
- Installation of traffic vehicle detector at some major points for gathering traffic statistics such as ADT (average daily traffic volume) and fluctuation by month, week and day.

2) Traffic safety education

784. Traffic accidents are largely caused by disregard of basic traffic rules which are the result of poor or lack of enforcement and drivers' lack of sensitivity for traffic safety. To solve this problem, traffic education is recommended. There are two types of traffic safety education: drivers' education and lifelong traffic safety education. These are shown below as example:

- Drivers' education
  A lecture held in order to improve the attitude toward driving aimed at those who violate the traffic rules.
- Lifelong traffic safety education
  Traffic safety education in schools
  A campaign for traffic safety by mass communication

3) Maintenance

785. As for the traffic management facilities in the Study Area, although those are normally improved, some of them do not function due to lack or little maintenance. Unless traffic management is executed continuously, traffic conditions become disorderly and it becomes difficult to develop confidence for traffic management. Therefore, maintenance is one of the most important tasks in traffic management.

786. Traffic facilities must be maintained at regular intervals, and it is necessary to prepare a budget for maintaining them. In the recommended traffic flow plan, it is important to maintain the facilities in the public traffic arteries and private traffic ones as well.

13.7 Project Cost and Implementation Schedule

787. The estimation of project cost is carried out by the same way as described in Section 13.3, the estimation of road project cost. Total cost for traffic management improvement projects is 10.1 million US$, of which 3.5 million US$ is for sidewalk improvement, 3.1 million US$ for signal system improvement, and the remain is others. Details are shown in Table 13.7-1. Implementation schedule is shown in Figure 13.7-1.

Table 13.7-1 Traffic Management Cost

Projects	Financial Cost		Economic	Total	
	Foreign (Us$)	Local (Cr$)	Local (Cr$)	Financial (Cr$)	Economic (Cr$)
1 Road Improvement					
1) Av. Municipalidade	13,933.66	17,346,385	12,109,570	18,572,546	13,335,732
2) R. Gaspar Viana	24,502.67	32,811,367	22,742,322	34,967,602	24,898,557
2 Int. Improvement					
1) Av. Nazare/P. Vargas	359.24	581,813	454,203	613,426	485,816
2) Av. 1 de Janeiro	137.33	1,640,909	1,311,441	1,652,993	1,323,526
3) Av. Pedro Miranda	1,370.89	2,079,121	1,567,325	2,199,759	1,687,963
4) Sao Braz	5,718.88	4,632,226	3,589,197	5,135,487	4,092,458
3 Exclusive Bus Lane	53,168.20	19,289,882	16,016,393	23,968,683	20,695,194
4 Sidewalk	9,300.00	104,160,000	82,894,000	104,978,400	83,712,400
5 Signal System	129,449.09	70,729,906	59,294,114	82,121,426	70,685,634
6 Parking Bay	1,233.98	17,892,710	14,415,130	18,001,300	14,523,720

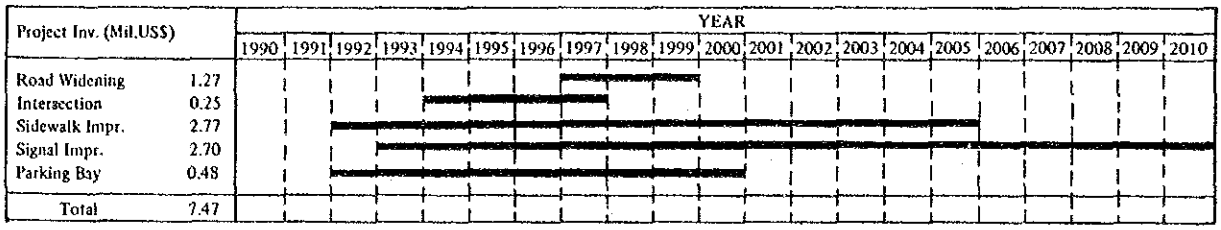
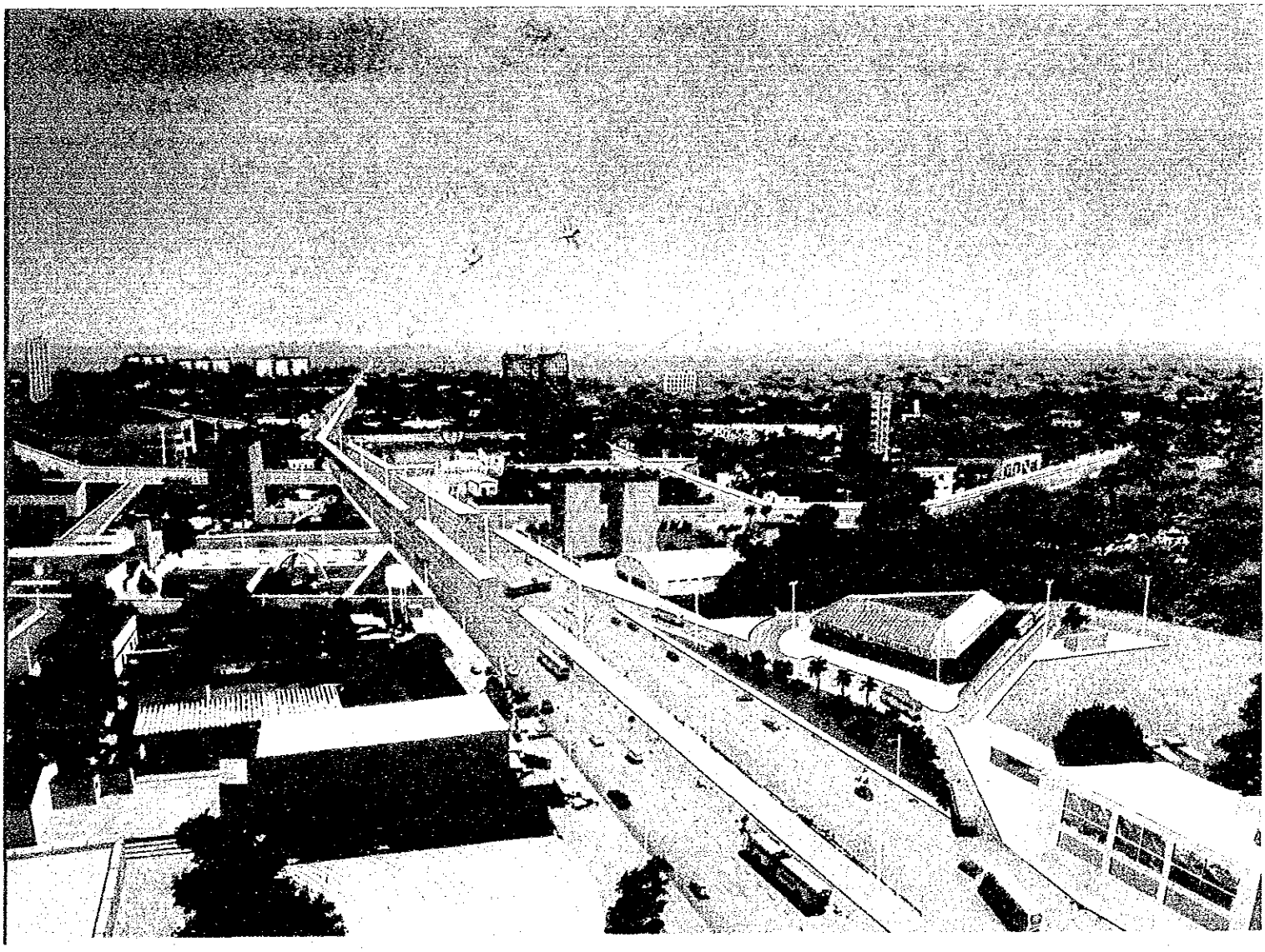


Figure 13.7-1 Traffic Management Investment Schedule

14. Investment Program

Anamindeua Bus Terminal ▼



14.1 Identified Projects

788. A project is defined as a minimum unit of the Masterplan component, which can function by itself independently from other projects. For analytical convenience, all the projects are classified into 3 categories; road projects, public transport projects and traffic management projects.

14.1.1 Road Projects

789. There are a total of 22 road projects proposed in the Masterplan. They comprise 11 new road construction projects(total length 125.7km) and 11 existing road improvement projects(total length 39.7km). (Refer to Figure 11.2-1)

790. Urgent completion of the BR-316 and Av. Almirante Barroso projects is needed in connection with the introduction of trunk/zone bus operation system for public transport into this traffic corridor.

14.1.2 Public Transport Projects

791. Public transport projects involve the establishment of implementation organization, bus fleet reinforcement, public bus exclusive lane construction and bus stop/terminal construction.

792. In order to introduce the trunk/zone bus operation system, the organization in charge of planning and controlling such system shall be established immediately.

793. Bus fleet reinforcement will be carried out by private bus operating companies year by year. Their implementation schedule shall be examined by the organization above mentioned.

794. Almost all bus stop/terminal facilities shall be completed by the year 1995 when the trunk/zone bus operation system is expected to be introduced in BMR.

14.1.3 Traffic management Projects

795. Traffic management projects include road widening, intersection improvements, sidewalk improvements, signal system improvements and parking bay constructions. Also included is the traffic flow improvement plan which is composed of separation of public traffic and private traffic artery and one way system alternation.

14.2 Investment Schedule

796. In order to plan a well balanced investment schedule by aligning many projects on time axis, several conditions shall be considered. The following conditions are taken into consideration.

a. balanced expenditure of annual investment,
b. inter-relationship among projects, and
c. priority of the projects

14.2.1 Road Project Schedule

797. A total of 341 million US$ is estimated to be needed to carry out the road Masterplan. Ninety (90) million US$ or 26% of the total pertains to the improvement projects of existing roads and 251 million US$ or 74 % to the new roads construction projects. Figure 14.2-1 shows the implementation schedule and cost of individual project.

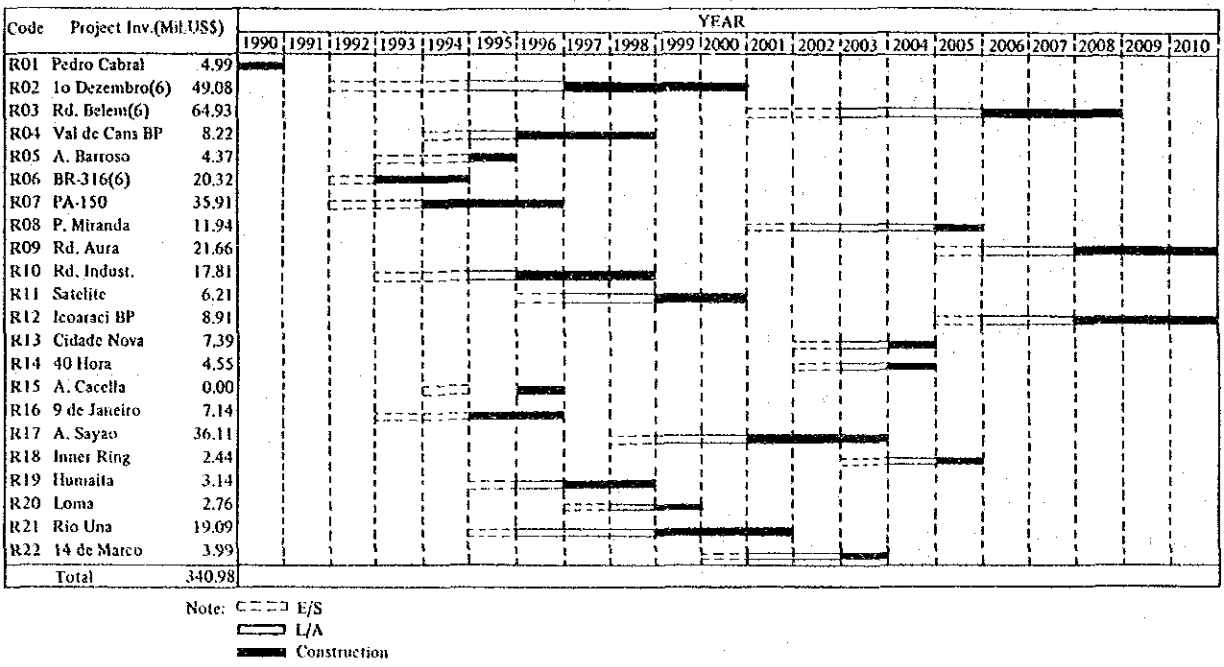


Figure 14.2-1 Road Investment Schedule

798. Although twelve(12) projects are expected to be completed by the year 2000, other ten(10) projects are planned to be implemented after the year 2000. Therefore, the rights of way of these projects are recommended to be announced in order to avoid occupancy by houses or shops at the time of project implementation.

14.2.2 Public Transport Project Schedule

799. Total investment amount excluding bus fleet reinforcement is estimated at 42.0 million US$, out of which 41.3 million US$ or 98% will be used for 7 bus terminals and 24 bus stops construction and 0.7 million US$ for the preparation of exclusive bus lanes (48.6 km). (refer to Figure 14.2-2)

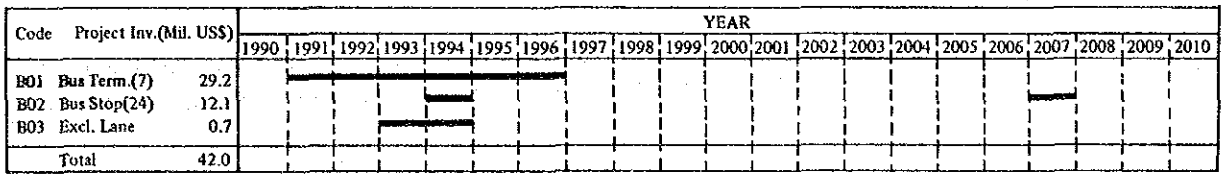


Figure 14.2-2 Public Transport Investment Schedule

14.2.3 Traffic Management Project Schedule

800. Total investment amount is estimated at 7.5 million US$, out of which 1.27 million US$ or 17% will be used for road widening, 0.25 million US$ or 3% for intersection improvement, 2.77 million US$ or 37% for sidewalk improvement, 2.70 million US$ or 36% for signal system improvement and 0.48 million or 7% for parking bay construction, respectively. Figure 14.2-3 shows the implementation schedule.

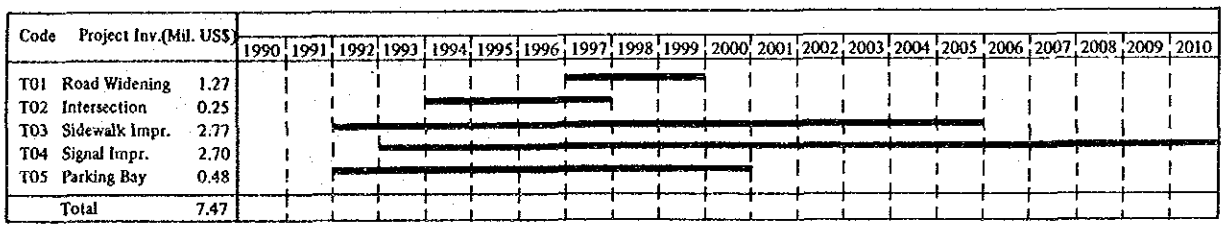


Figure 14.2-3 Traffic Management Investment Schedule

14.3 Government Financial Situation

801. In order to carry out the proposed Masterplan, it is important to examine the government financial situation to determine the financial capability for the projects.

802. As possible financial sources, Para state, Municipality of Belem and Municipality of Ananindeua are considered. Since, the development funds of these local governments are limited, capital intensive projects are usually co-financed by the Federal government as well as by international financing organizations.

803. The financial condition of the local governments is first examined. Other financial resources will be discussed later.

14.3.1 Financial Condition of Local Governments

(1) Para State

804. Table 14.3-1 shows the annual income and the investment to the transport projects in the Belem Metropolitan Region during the past several years.

Table 14.3-1 Annual Income and Expenditure of Para State related Transport Projects in BMR

	1985	1986	1987	1988	1989	1990
Annual (CR$'000)	1747	5194	16446	121133	1883767	14395391
Income (US$million)	282	381	418	461	663	327
Investment in BMR (CR$'000)						
1) Road	4.2	60.8	11.7	174.5	448.2	-
2) Signs & Signals	0.1	0.0	0.0	0.0	0.0	-
3) Bus Facilities	0.2	3.1	0.1	4.5	120.0	-
4) Institutional	0.7	2.2	1.2	0.0	330.9	-
Total (CR$'000)	5.2	66.1	13.0	179.0	499.1	-
(US$million)	0.8	4.8	0.3	0.7	0.3	-
% Share to Total	0.3%	1.27%	0.08%	0.15%	0.05%	-

Note: Figures for 1985-1989 : actual, for 1990 : provisional
The exchange rates between Cruzeiro and US dollar are based on the annual average of the official monthly rates published by Fundasao Getulio Vargas:

Year	CR$/US$	Year	CR$/US$
1983	0.00058	1987	0.03930
1984	0.00185	1988	0.2628
1985	0.00620	1989	2.841
1986	0.01365	1990(Apr.)	44.0

Source: Balanco Geral do Estado, Orcamento Programa Annal

805. The total income of Para state has been steadily increasing. The average growth rate is estimated at about 19% per year in real terms of US dollar for the period from 1985 to 1989. The annual income in 1990 is expected to be more than 600 million US$. The main sources of the income include sales tax on goods and services, income tax transfer from the Federal Government and industrial production tax.

806. On the other hand, the contribution of Para state to the transport projects in BMR is fluctuating from 0.3 million to 4.8 million US$ per year. The allocation for transport projects as a percentage of the total income (which is supposed to be almost equal to the total expenditure), is from 0.04% to 1.3%.

(2) Municipality of Belem

807. The annual income and expenditure of the municipality of Belem are shown in Table 14.3-2. The annual expenditure of Belem is almost equal to the annual income throughout the period.

808. Although the income and expenditure have been fluctuating widely, the trend indicates an increasing tendency.

809. Annual expenditure of Belem is approximately 60 million US$. In the years 1989 and 1990, about 10% of expenditures were allocated to transport sector. Due to the expansion of the urbanized area, some streets are developed under the category of housing and urbanization sector. Hence, the actual percent share of transport sector may reach nearly 20% of the total expenditure.

Table 14.3-2 Annual Income and Expenditure of Municipality of Belem

	1985	1986	1987	1988	1989	990
Annual (CR$'000)	204	550	1992	11339	185878	45380
Income (US$million)	33.0	40.3	50.7	43.1	65.4	14.7
Annual (CR$'000)	201	601	1991	11128	178535	645380
Expend.(US$million)	32.5	44.0	50.7	42.3	62.8	14.7
Expend.for Transp. (US$million)	9.1	8.9	11.5	8.6	5.9	1.7
% share to Total	28.0	20.3	22.7	20.2	9.4	11.4

Note: Figures for 1985-1989 : actual
Figures for 1990 : provisional
Source: Balanco Geral do Municipio, Orcamento Programa Anual

(3) Municipality of Ananindeua

810. In the case of Ananindeua, the income is about 5% of that of Belem, approximately 3 million US$ per year as shown in Table 14.3-3. In accordance with the income size, the expenditure is also US$ 2 or 3 million per year. Thus, the expenditure for the transport sector is also limited. There was an investment of 0.4 million US$ in 1983, and none during the years from 1984 to 1987.

Table 14.3-3 Annual Income and Expenditure of Municipality of Ananindeua

	1983	1984	1985	1986	1987
Annual Income (CR$'000)	0.8	3.8	14.3	40.6	125.0
(US$million)	1.3	2.0	2.3	3.0	3.2
Annual Expend.(CR$'000)	0.8	2.3	10.2	33.4	115.4
(US$million)	1.5	1.2	1.6	2.4	2.9
Expend. for Transport (US$million)	0.4	0.0	0.0	0.0	0.0
% Share to Total	25.8%	0 %	0 %	0 %	0 %

Source: Balanco Geral do Municipio

(4) Total Resources from the Local Governments

811. The total income and the expenditure for transport sector of the local governments are summarized as shown in Table 14.3-4.

Table 14.3-4 Total Income and Expenditure for Transport Sector of Local Governments (US$ million)

	1985	1986	1987	1988	1989
Total Income					
1) Para State	282	381	418	461	663
2) Belem	33	36	51	43	65
3) Ananindeua	2	2	3	-	-
Total	317	419	471	504	728
Expenditure to Transp.in BMR	9.9	13.7	11.8	9.3	6.2
% Share of Transp. to Total Income	% 3.3	% 3.3	% 2.5	% 1.8	% 0.9

812. The above table shows that the percentage share of the expenditure for transport ranges approximately from 1% to 3% of the total income.

14.3.2 Other financial Sources

813. In the case of a road project, Av.Pedro A.Cabral, which is located in the outskirts of the central district of Belem, Federal Government and IBRD (World Bank) assisted in financing for its implementation during the period from 1988 to 1989 as follows.

Federal Government	CR$ 3,071 thousand	(80%)
Para State	CR$ 609 thousand	(16%)
Belem Municipality	CR$ 160 thousand	(4%)
Total	CR$ 3,840 thousand	(100%)

814. The financial contribution of the Federal government, including the loan from IBRD, was 80 % of the total project cost.

815. Taking into consideration the financial condition as well as the recent policy of the Federal Government, it might be difficult to expect as much financing as in the above case.

14.4 Badgetary Consideration for Masterplan Implementation

816. The budgetary allowance for Masterplan implementation is the most important factor in planning the project scale of the Plan. As described in Chapters 2 and 8, the economic situation of Brazil is serious now but is forecasted to be improved somewhat within a decade.

817. Table 14.4-1 shows the annual financial budget of Para state and municipality of Belem in recent years. Compared with the budget size of the State, that of Belem is small and it is very difficult to assume that implement of the Masterplan can be carried out only by Municipalities of Belem and Ananindeua without any subsidies from State and Federal Governments.

Table 14.4-1 Financial Budgetary Scale

Year	Para State	Belem City
1988	461	43
1989	663	65

unit: million US$

818. Current expenditure for the transport sector represents 1 to 3% of the State and Municipality budget. Assuming the one percent share is distributed for the implementation of Masterplan, the total amount of budget available for the next two decades is estimated as shown in Table 14.4-2.

819. Total present value at 1990 means the available amount of financial resources subtracting the cost of borrowing when used at once in 1990. Since the actual expenditure for the implementation of Masterplan will be distributed over 20 years, the available amount becomes more than twice that shown above.

820. Accordingly, about 250 million US$ is estimated to be the financial fund available without the Federal Government subsidies derived from Federal fund or from official foreign loans. Assuming the Federal Government subsidies to be 30 to 50 percent of the total cost, the amount of budget available for Masterplan ranges from 350 to 500 million US$.

Table 14.4-2 Available Financial Resource

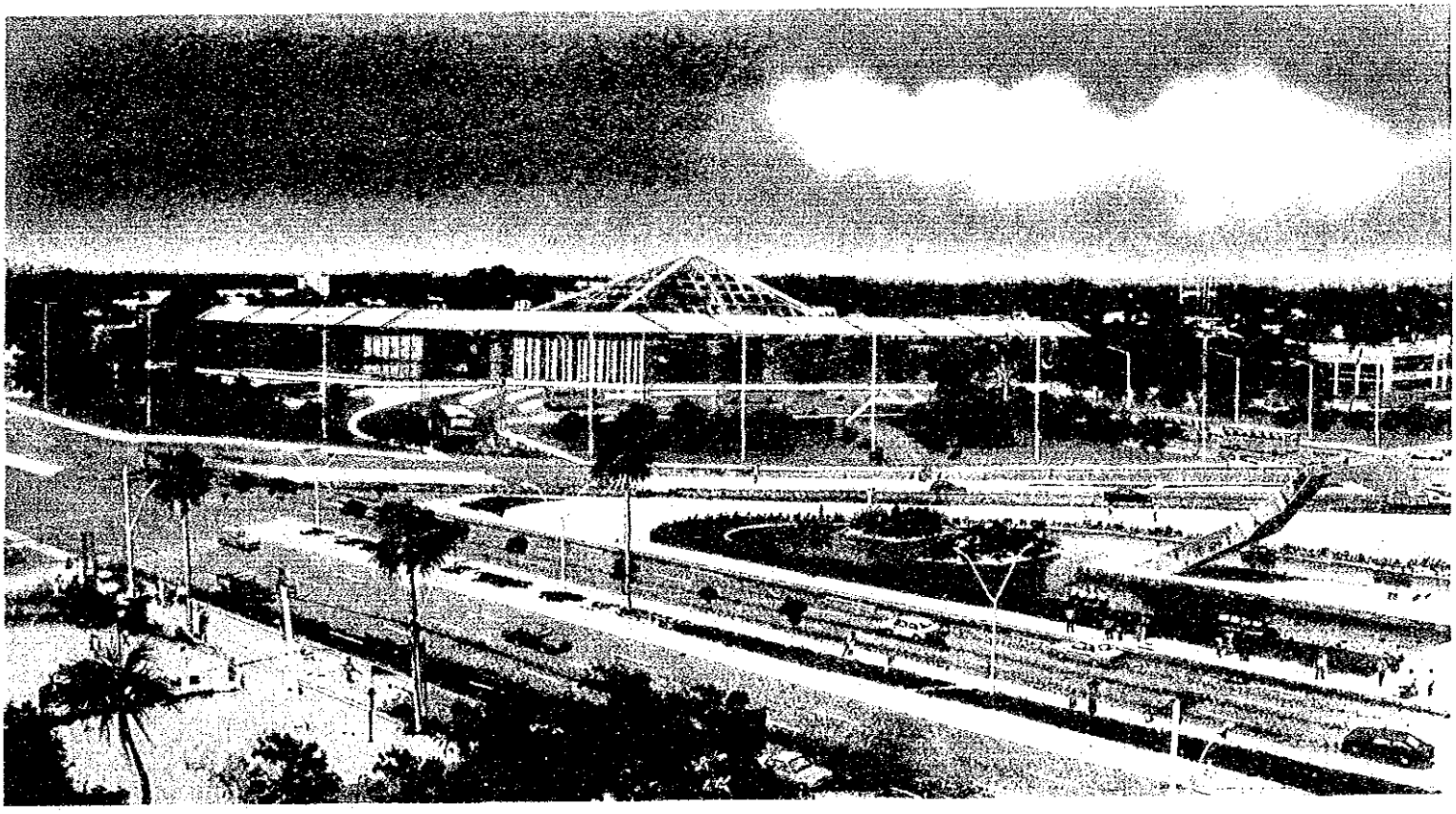
Year	Budget(Para/Belem)	Present Value(a)	1% of B
1990			
1991	750.0	694.4	6.94
1992	780.0	668.7	6.69
1993	811.2	644.0	6.44
1994	868.0	638.0	6.38
1995	928.7	632.1	6.32
1996	993.8	626.2	6.26
1997	1063.3	620.4	6.20
1998	1137.7	614.7	6.15
1999	1217.4	609.0	6.09
2000	1302.6	603.4	6.03
2001	1380.8	592.2	5.92
2002	1463.6	581.2	5.81
2003	1551.4	570.5	5.70
2004	1644.5	559.9	5.60
2005	1743.2	549.5	5.50
2006	1847.8	539.3	5.39
2007	1958.6	529.4	5.29
2008	2076.2	519.6	5.20
2009	2200.7	509.9	5.10
2010	2332.8	500.5	5.00
Total			118.0

Note: Economic growth assumption is based on the results of Chapter 8.
Discount rate is assumed as 8 % per annum.

821. The estimation above mentioned is based on many rough assumptions. The budget of US$350 to 500 million is to be considered as a variable number.

15. Evaluation of Transport Masterplan

Entroncamento Bus Terminal ▼



15.1 General

822. The transport masterplan proposed in the preceding Chapters is economically evaluated in this chapter. The transport development plans for roads, public transport and traffic management are evaluated as a whole.

823. Transport projects which requires large investment, usually have significant socioeconomic impacts that cannot be measured only in monetary terms. For example, the project may contribute to the in-crease of employment in the region. These impacts expected from the masterplan are also discussed in this chapter.

824. The sensitivity of the effectiveness of the proposed Masterplan will be examined by changing benefit/cost from the economic viewpoints.

825. In addition,the public transport system of the masterplan will be evaluated from the financial viewpoint. The evaluation aims to examine whether the whole bus transport system is financially feasible or not as a business.

15.2 Economic Evaluation

826. The evaluation of the Masterplan is made by comparing benefits with costs accrued from the implementation. In order to estimate the benefits and costs, the transport conditions should be compared between the case under the "Masterplan" and the case under "Do-nothing" as shown in Figure 15.2-1.

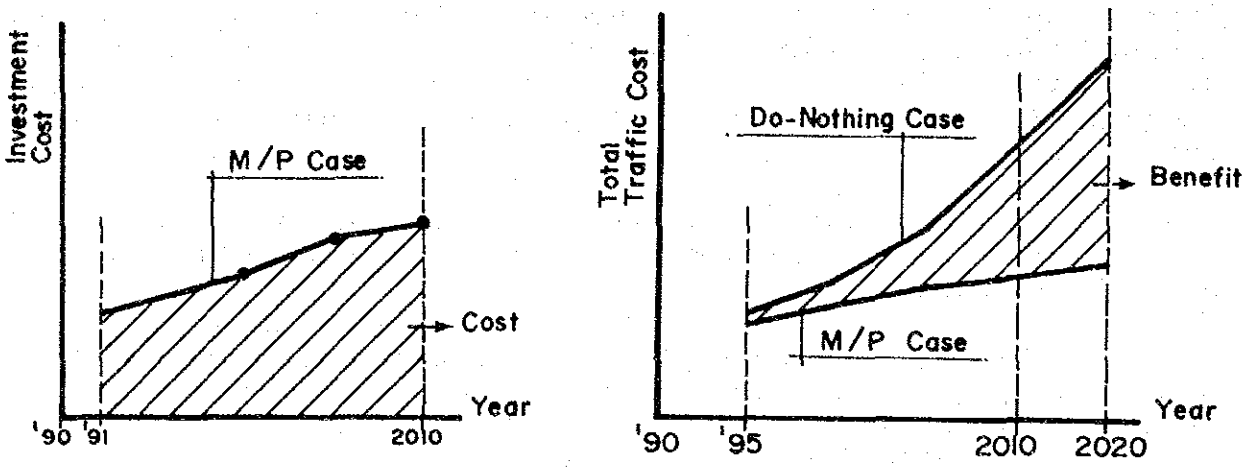


Figure 15.2-1 Cost and Benefit

827. The implementation period of the Masterplan is assumed to be 20 years from 1991 to 2010. Thus, the investment cost is incurred throughout this period. On the other hand, the benefit flow begins in 1995 and continues theoretically until the end of the project life. In this study, the benefits are counted up to the year 2020 for convenience sake, and in stead of counting the benefits thereafter, the residual value of the investment is taken into account.

828. Among the various benefits derived from the implementation of Masterplan, the following factors are counted as the economic benefit;

a. Savings in vehicle operating cost
b. Savings in travel time cost

829. In addition to these direct benefits, several other direct and indirect benefits can be identified, eg., increased comfort in vehicle operation, increased traffic safety, the promotion effect of regional development, increase in land price etc.. These benefits, however, are not counted in this study, since they are difficult to be measured in monetary term. Even though they could be quantified, the estimates are unreliable and sometimes may cause double counting of the benefits.

15.2.1 Vehicle Operating Cost

830. The vehicle operating cost is calculated for representative vehicles in Belem Metropolitan Region by conducting a survey on current market price, operation and maintenance cost for each type of vehicles.

831. The cost is assumed to consist of running cost and fixed cost. The former is the cost related to running distance, while the latter is the cost determined in proportion to running time.

(1) Vehicle Price

832. In Brazil, most of the vehicles running on the roads are regarded as a domestic product, and the imported cars are still very rare because importation has just been permitted in 1990.

833. As typical vehicles, the ones most commonly used in Belem are selected as shown in Table 15.2-1. As for passenger cars and trucks, several different types of vehicles are identified. After calculating the vehicle operating cost by each type, the average cost is figured out by using vehicle registration statistics.

834. The current market prices of the representative vehicles as of October 1990 were obtained through the interviews with dealers in Belem.

835. The economic cost is calculated by deducting tax portion from the financial cost i.e., the market price. Sales tax as much as 17 % is uniformly levied on all the vehicles, while the industrial production tax varies from 0 to 55 % according to the type and size of vehicle, and the type of fuel consumed.

Table 15.2-1 Representative Vehicles

Vehicle Type	Fuel	Model	Make	Comp %	Financial Cost(Cr$)	Economic Cost(Cr$)
Passengercar(M)	G	Santana	V.W.	6.5	2,227,800	913,400
Passengercar(M)	A	Santana	V.W.	14.5	2,054,000	944,800
Passengercar(S)	G	Chevette	G.M.	64.6	975,000	448,500
Passengercar(S)	A	Chevette	G.M.	14.8	926,000	472,000
Truck(Heavy)	D	14.140	V.W.	46.0	5,500,000	4,290,000
Truck(Light)	G	D-20	G.M.	31.2	1,962,000	1,530,000
Truck(Light)	A	D-20	G.M.	22.8	1,915,000	1,493,700
Bus	D	Torino OH1315U	M.B.	100.0	7,464,900	5,300,100
Articular bus	D	B58ART TH101GC	VLVO	100.0	18,987,000	13,480,800
Taxi	A	Santana	V.W.	100.0	2,054,000	944,800

Note: (M):Medium (S):Small G:Gasoline A:Alcohol D:Diesel
Source: Study Team

(2) Running Cost

1) Fuel and lubricant oil

836. The market price of gasoline as of Oct 15, 1990 was Cr$ 57.7 (US$0.626) per litter, which represents a 90 % increase (in US dollar), over the price during the first three months of this year. This increase may be caused by the undervalued exchange rate of US dollar as well as the Iraqi invasion into Kuwait occurred in Aug. 1990. The international crude oil price is fluctuating between US$25 and US$30 per barrel at present, however, once the crisis is settled, the price may go down again. Accordingly, the price level just before the crisis, i.e. US$20 per barrel is taken as the international crude oil price.

837. The economic cost of gasoline is estimated as follows, taking into account the refinery cost as well as distribution cost, which can be obtained from the past record of CNP (Conselho Nacional do Petroleo).

Economic Cost of Gasoline = International Mkt Price x (1 + Refine & Dist. Cost Factor)

= 20US$/barrelx(1+1.316)/(158.76lt/barrel)
= 0.292US$/lt (26Cr$/lt)

838. Likewise, diesel and lubricant oil costs are estimated in the same way. As for the alcohol, the economic cost is estimated by deducting sales tax from the market price (refer to Table 15.2-2).

Table 15.2-2 Fuel and Lubricant Oil Cost (Cr$/lt)

Fuel & Lubricant	Financial Cost	Economic Cost
Gasoline	57.7	26.0
Alcohol	43.4	23.0
Diesel	27.4	21.3
Lubricant Oil	208.8	173.3

Source: Study Team

2) Tire cost

839. The financial cost of tire is obtained through market price survey in Belem. Regarding the tax for tire, two kinds of taxes are equally levied, i.e., 20% for industrial production tax (IPI) and 17% for sales tax (ICM).(refer to Table 15.2-3)

Table 15.2-3 Tire Cost

Vehicle Type	Financial Cost(Cr$)	Economic Cost(Cr$)
Passengercar	20,000	12,600
Heavy Truck	200,900	126,600
Light Truck	33,700	21,200
Bus	213,600	134,600
Articular Bus	360,000	226,800
Taxi	20,000	12,600

Source: Study Team

3) Maintenance Cost

840. Maintenance cost consists of parts cost and maintenance labor cost. Parts cost is calculated by setting the parts cost ratio to vehicle price. Labor cost is calculated by using man*hour and unit Labor cost. These key factors and unit costs are determined on the basis of the field surveys conducted in Belem.

4) Vehicle Depreciation Cost

841. Vehicle depreciation cost is calculated by subtracting the salvage value from the price of the vehicle excluding tires. The vehicle life and the salvage value are assumed as shown in Table 15.2-4, taking into account the used car market in Belem.

842. Vehicle depreciation cost is normally divided into the portion applied to the time related cost and the portion applied to the distance related cost. The proportion usually used by the World Bank is employed in this study as shown in the table.

Table 15.2-4 Vehicle Life and Salvage Value

Vehicle Type	Life	Salvage Value	Proportion
Passengercar	10yrs	20%	50% : 50%
Heavy & Light Trucks	10yrs	20%	30% : 70%
Bus	7yrs	20%	30% : 70%
Articular bus	7yrs	20%	30% : 70%
Taxi	12yrs	10%	30% : 70%

Note: The figures under "proportion" show the time related and the distance related depreciation cost.

5) Unit Running Cost

843. The Unit running cost is calculated and summarized as shown in Table 15.2-5.

Table 15.2-5 Running Cost (Cr$/km)

	Cost Item	Car	Taxi	Truck	Bus	Articular
Financial Cost	Fuel Cost	5.40	5.43	8.73	10.54	18.27
	Lubricant Oil	0.21	0.21	0.50	1.67	2.09
	Tire Cost	1.33	1.00	4.30	7.91	12.00
	Maintenance	3.05	3.36	9.32	12.57	18.56
	Depreciation	3.21	1.25	6.68	7.28	18.52
	Total	13.20	11.24	29.52	39.98	69.44
Economic Cost	Fuel Cost	2.93	4.13	5.58	8.19	14.20
	lubricant Oil	0.17	0.17	0.41	1.39	1.73
	Tire Cost	0.84	0.63	2.71	4.22	7.56
	Maintenance	1.69	2.10	7.38	8.58	13.62
	Depreciation	1.48	0.64	5.21	8.58	13.15
	Total	7.10	7.66	21.29	27.55	50.27

Source: Study Team

The total running cost is estimated from the total vehicle running distance (veh*km) multiplied by the above unit running cost.

(3) Fixed Cost

1) Depreciation Cost

844. The time related depreciation cost is calculated by subtracting "the distance determined portion" from the total depreciation cost.

2) Capital Opportunity Cost

845. In the case of public investment, the interest rates between 6% and 12% added to BTN (Bonus do Tesouro Nacional) are applicable for the lending from a national bank. Since the BTN is regarded as an adjustment factor for the inflation rate, these rates are considered as a opportunity cost rate. Consequently, the annual rate of 8% is employed in this study. The capital opportunity cost is calculated by multiplying this rate by the residual value of a vehicle.

3) Crew Cost

846. The crew wage is also obtained through a truck company survey as well as a bus company survey.

4) Overhead and Insurance Cost

847. This cost includes insurance, vehicle owner tax and overhead cost for retaining the vehicle and drivers.

5) Unit Fixed Cost

848. The Unit fixed cost is calculated as shown in Table 15.2-6.

Table 15.2-6 Fixed Cost (Cr$/Hour)

	Cost Item	Car	Taxi	Truck	Bus	Articular
Financial Cost	Depreciation	40.1	8.7	34.6	53.3	135.6
	Capital Cost	40.1	15.4	57.6	62.2	158.2
	Crew Cost	0.0	104.4	147.9	208.8	313.2
	Overhead and Insurance Cost	34.3	69.3	144.5	174.4	261.6
	Total	114.5	197.8	384.7	498.7	868.7
Economic Cost	Depreciation	18.4	4.4	27.0	37.9	96.3
	Capital Cost	18.4	7.9	45.0	44.2	112.3
	Crew cost	0.0	85.6	121.3	171.2	256.8
	Overhead and Insurance Cost	28.4	57.0	119.2	143.7	215.6
	Total	65.3	154.9	312.4	397.0	681.0

Source: Study Team

The total fixed cost is estimated from the total vehicle running time (veh*hr) multiplied by the above unit fixed cost.

15.2.2 Travel Time Cost

849. The time value is assessed in terms of hourly productivity of vehicle passengers. There is no general theory by which portion of time savings should be considered in an economic evaluation of transport projects. In this study, the travel time savings for the following travel purposes are estimated.

a. Trips to work
b. Trips for business purpose

850. In the context of regional economics, the hourly productivity is calculated from per capita GRP, however, it may differ by worker depending on his contribution to GRP. For example, the hourly productivity of a skilled Laborer may be higher than that of an unskilled Laborer. Considering that wage is paid in proportion to the productivity, household income can be an indicator of the contribution to GRP.

851. The household income by car ownership in Belem can be obtained from the Person Trip Survey results. The average monthly household income as of March, 1990 is estimated to be approximately Cr$12,100 for non-car owner, and Cr$65,700 for car owner. The vehicle ownership ratio to the total household is 17.3%, the GRP of the study area in 1990 is US$3,553 million, the total number of workers in the study area in 1990 is 485,000, therefore, the time value is calculated as follows.

The workers of a car owner household : Cr$977.7/Hour
The workers of a non-car household : Cr$180.4/Hour

852. Assuming that the time value increases in accordance with the increase of the labor productivity, which is expressed by GRDP per worker, the time value in the future is estimated as shown in Table 15.2-7.

Table 15.2-7 Time Value

	1990	1995	2000	2010
GRDP (US$million)	3553	4320	6229	12027
No of Workers ('000)	485	589	798	1202
Productivity(US$/Worker)	7326	7334	7806	10006
Time Value (CR$/hr)				
Car Owner Household	977.7	978.8	1041.8	1335.4
Non-car Household	180.4	180.6	192.2	246.4

Source: Study Team

853. The unit travel time cost by type of vehicles is calculated by the following formula.

$$Ttk = Vtk \times Nk \times Rk$$

where Ttk : Unit time cost of vehicle type k in year t
Vtk : Time value of passengers for vehicle type k in year t
Nk : Number of passengers for vehicle type k
Rk : Percentage of work and business trips for vehicle type k

854. Thus, the unit travel time cost is estimated as shown in Table 15.2-8.

Table 15.2-8 Unit Travel Time Cost of Vehicles (Cr$/veh*km)

	1995	2000	2010
Passengercar	700.6	744.8	955.9
Taxi	138.1	146.8	188.3
Truck	61.9	65.8	84.3
Bus (Ordinary bus only)	1,295.9	1,377.8	1,766.0
Bus (Incl.articular bus)	1,952.3	2,075.7	2,663.6

Source: Study Team

855. When estimating the total travel cost, the length of the saved time was taken into account. Thus, the time cost of one hour saving by one person is not the same as the time cost of one minute saving by 60 persons. It is generally accepted that the former is assessed to have higher cost than the latter, since the saving of fractional time is sometimes of negligible value, particularly in economic sense in as much as it does not link with a contribution to additional GRDP.

856. Figure 15.2-2 shows the cumulative distribution of saved time by the Masterplan, which is estimated from the traffic assignment. It is recognized that the majority of "saved time" is less than 5 minutes, representing about 60% of the total saving.

857. There is no definite theory regarding which portion of the saved time should be counted for the economic evaluation. In this Study, the time saving less than 20 minutes is assumed to be ignored. Thus, 4.2% of the unit travel time cost in the above table is counted for estimating benefit. (In case of that time saving more than 10 minutes is considered, the travel time cost will rise to 25% in the estimating benefit.)

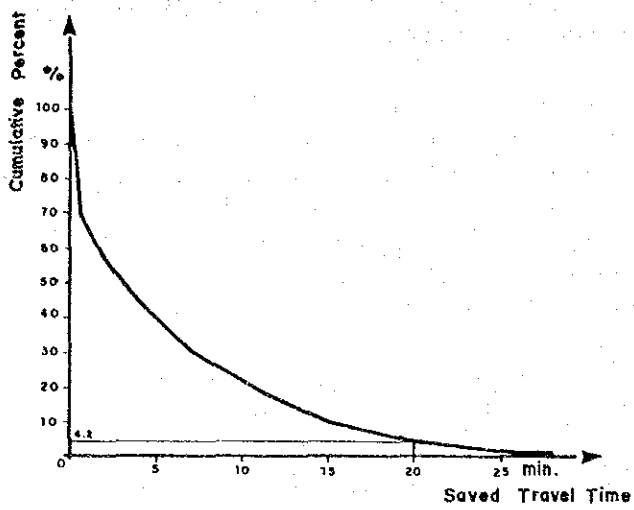


Figure 15.2-2 Cumulative Distribution of Saved Travel Time

15.2.3 Estimation of Economic Benefit

858. As explained in Chapter 14,the implementation schedule of the Masterplan is proposed. In order to assess the economic effects of the Masterplan, the future traffic flow is simulated by assigning the future traffic demand on the future network under the condition that the Masterplan for road and public transport is implemented according to the proposed schedule, and under the condition that nothing is done.

859. The simulation results are expressed in terms of the total running distance (veh*km) and the total vehicle running time (veh*hr).

(1) Total vehicle running distance

860. The total vehicle running distance in BMR is shown in Table 15.2-9. In any year of the planning period, the total veh*km will decrease significantly as the Masterplan is carried out. As much as 12 to 14% of the total veh*km is saved. This decrease however, is mainly due to the reduction in bus*km, even adding the articular bus*km. It indicates that the effects of the trunk/feeder bus system are extremely high in veh*km.

Table 15.2-9 Total Vehicle Running Distance (veh*km/day)

Year	Vehicle Type	Do-nothig	Masterplan	Difference
1995	passengercar	1,863	1,832	31
	taxi	299	296	3
	truck	300	294	6
	bus	743	117	626
	articular bus	-	248	-248
	Total	3,205	2,786	420
2010	passengercar	3,164	3,132	32
	taxi	468	473	-5
	truck	428	442	-14
	bus	1,200	198	1,003
	articular bus	-	420	-420
	Total	5,260	4,665	595

Source: Study Team

861. In the case of private cars,some slight increase in veh*km can be observed. This may be caused either by the reduction of the road capacity due to the introduction of bus lane or by the detour due to the completion of new trunk highway.

(2) Total Vehicle Running Time

862. The total veh*hr also significantly decrease in the Masterplan case; 20 to 30 % of the total veh*hr is saved (refer to Table 15.2-10). Similar to the veh*km, the larger part of the saving is attributed to bus transport.

863. Accordingly it can be said that the proposed Masterplan would contribute significantly to the improvement/development of bus transport, which has the predominant share at present, as well as in the future transport in BMR.

Table 15.2-10 Total Vehicle Running Hour (veh*hr/day)

Year	Vehicle Type	Do-nothing	Masterplan	Difference
1995	Passengercar	55,561	56,306	-745
	Taxi	10,629	9,830	799
	Truck	9,161	8,500	661
	Bus	30,504	3,353	27,150
	Articular bus	-	7,125	-7,125
	Total	105,855	85,114	20,740
2010	Passengercar	88,045	82,433	5,612
	Taxi	15,906	13,932	1,974
	Truck	12,253	12,200	53
	Bus	64,802	5,958	58,844
	Articular bus	-	12,660	-12,660
	Total	181,006	127,236	53,823

Source:Study Team

(3) Reduction of Delay Time due to Signal System Improvement

864. Since it is difficult to estimate the total effects of the Masterplan regarding road, public transport and traffic management simultaneously, the effects of traffic management are estimated separately.

865. Among the various factors of traffic management plan, signal system improvement is costly. Thus, the effects of the synchronized signal control are estimated.

866. The signal control system will be changed to a synchronized one at 115 intersections during the Masterplan period. By calculating the difference of the delay time at each intersections between the case under the existing control system and the case under the synchronized system, the effects of the new system can be estimated.

867. The difference of the delay time at an intersection during the peak hour was calculated as 5.26 sec/veh/intersection based on the Highway Capacity Manual. Hence, the total reduction of delay time is estimated as shown in Table 15.2-11.

868. When the economic benefit for this reduction of delay time is estimated, only the VOC saving is counted, whereas the passenger time saving is not counted, because the reduction of time per vehicle is too short.

Table 15.2-11 Reduction of Delay Time due to Synchronized Control (veh*hr/day)

	1995	2000	2010
Passengercar	48.0	110.3	145.2
Taxi	10.9	29.9	35.8
Truck	5.0	11.9	15.6
Total	63.9	152.1	196.6

(4) Economic Benefit

869. The economic benefit derived from the Masterplan is estimated as shown in Figure 15.2-3.

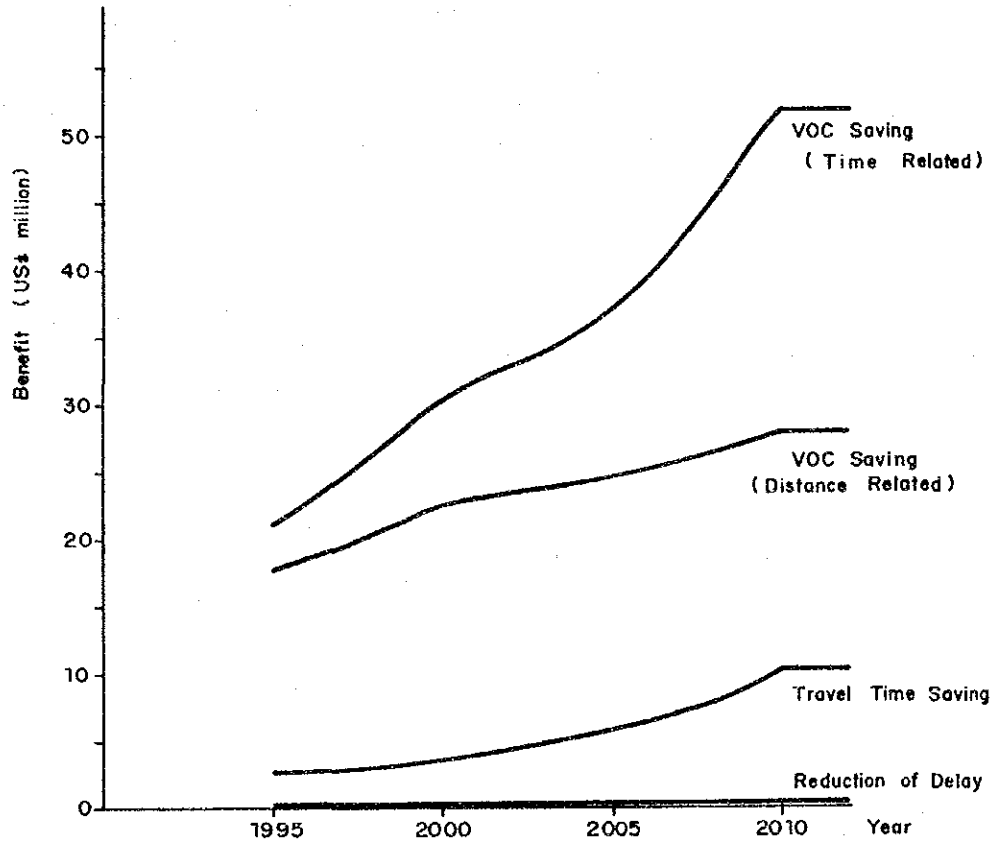


Figure 15.2-3 Economic Benefit

870. The total benefit is estimated at US$ 23 million in 1995 and US$ 75 million in 2010 at 1990 prices by assuming that the total number of effective working days is 300 days per year. About 90% of the benefit is realized from VOC saving and only 10% is from passenger's time saving.

871. The benefit after the year 2010 is assumed to be constant without growth, because it would be more conservative for economic evaluation.

15.2.4 Economic Cost

872. The economic costs of the Masterplan for road, public transport and traffic management were already described in the preceding chapters. The total economic cost is estimated at US$ 267.5 million, US$26.7 million and US$ 8.2 million respectively.

873. Assuming that the project life of roads and bus terminals is 25 years, the residual value in 2021 is calculated as US$ 86.1 million and US$ 6.2 million respectively.

15.2.5 Evaluation

874. Table 15.2-12 shows the benefit and cost streams of the Masterplan as a whole during the evaluation period. It is obvious from the table that the total benefit discounted is much higher than the total cost discounted at the rate of 12%.

875. The benefit-cost ratio (B/C) is calculated as 2.50, the net present value (NPV) is US$ 179 million,and the internal rate of return (IRR) is 33.7%. Thus, the Masterplan as a whole is highly economically viable (refer to Table 15.2-13).

876. In order to examine the influence of future uncertain factors, a sensitivity analysis is undertaken for the following cases.

a. 10% decrease in traffic demand
b. 10% increase in project cost

Table 15.2-12 Benefit and Cost Stream of Masterplan
(US$million)

Year	Total cost	Total Benefit	Discounted at 12% Cost	Benefit
1990	3.9	-	3.9	-
1991	6.05	-	5.40	-
1992	11.16	-	8.90	-
1993	14.48	-	10.31	-
1994	23.70	-	15.06	-
1995	22.52	41.51	12.78	23.55
1996	26.16	44.29	13.25	22.44
1997	18.17	47.27	8.22	21.38
1998	16.36	50.45	6.61	20.38
1999	19.09	53.86	6.88	19.42
2000	16.92	57.51	5.45	18.52
2001	13.04	59.30	3.75	17.05
2002	9.65	61.15	2.48	15.70
2003	12.84	63.07	2.94	14.45
2004	21.87	65.06	4.48	13.31
2005	9.58	67.13	1.75	12.26
2006	16.56	69.94	2.70	11.41
2007	18.49	73.04	2.69	10.64
2008	15.54	76.48	2.02	9.95
2009	11.27	80.26	1.31	9.32
2010	11.27	84.43	1.17	8.75
2011	-	84.43	-	7.81
2012-2019	-	675.44	-	38.83
2020	-82.49	84.43	-2.75	2.82
Total	236.15	1839.05	119.29	297.99

877. The results of the evaluation indicators are shown in Table 15.2-13 and Figure 15.2-4.

Table 15.2-13 Economic Indicators for Sensitivity Analysis

Case		B/C	NPV (US$million)	IRR (%)
Case 1	Original Case	2.50	178.7	33.7
Case 2	Demand -10%	1.99	117.9	26.8
Case 3	Cost +10%	2.27	166.8	30.8

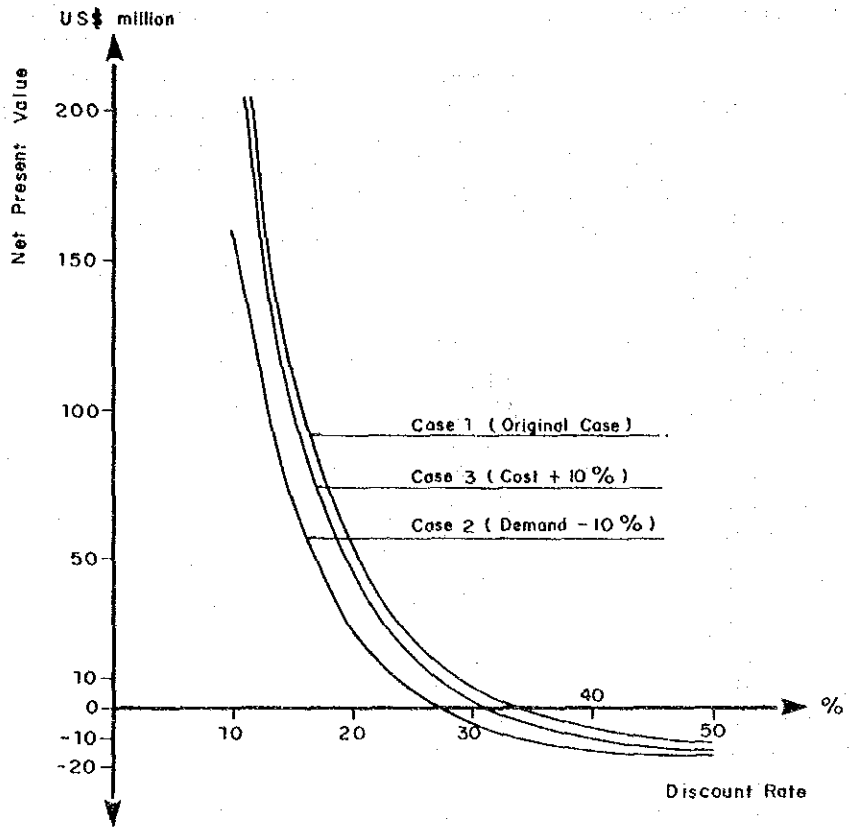


Figure 15.2-4 Net Present Value of Masterplan

878. In both cases, B/C ratio exceeds 1.0. The sensitivity of the future traffic demand decrease of 10% to B/C ratio is 2.04, which is much higher than the sensitivity of project cost increase of 10% to B/C ratio of 0.95.

879. The growth of the traffic demand from 1990 to 1995 is about 20%. If the traffic demand does not grow till the year 1995, and if the growth is low for the succeeding years including a 16.6% decrease in traffic demand throughout the evaluation period, the B/C will remain sufficiently high (1.66) to justify the Masterplan.

880. Accordingly, the sensitivity analysis assures the highly safe economic viability of the Masterplan.

15.3 Financial Evaluation

15.3.1 The Plan for Evaluation

881. In order to innovate the existing bus transport system, a trunk/feeder integrated system was proposed in this masterplan. To put forward this system, a new organization composed of the state, municipality and bus companies was proposed to be established and to be a sole wholesaler of bus tickets.

882. Actual bus operation is carried out by private bus companies. In return, the bus companies will receive operation fee corresponding to the vehicle operating distance. The fee may include not only the operation cost but a relevant amount of profit for running the company.

883. This bus transport system is financially evaluated in this section by examining the monetary inflow and outflow of the new organization.

15.3.2 Project Investment

884. The proposed system requires investment for the following projects in accordance with the proposed implementation schedule.

Table 15.3-1 Investment for New Bus Transport System

Project	Investment (US$million)	Implementation Period
1) Bus Stops along Alm.Barroso	7.121	1993-1994
2) Bus Stops along Pedro Cabral	4.984	2006-2007
3) Sao Braz Terminal	0.003	1992-1993
4) Entroncamento Terminal	12.116	1991-1992
5) Ananindeua Terminal	8.902	1995-1996
6) Telegrafo Terminal	0.433	1992-1993
7) Coqueiro Terminal	1.394	1994-1995
8) Doca Terminal	0.244	1994-1995
9) Intermunicipal Terminal	6.098	1991-1992
10) Bus Exclusive Lane	0.793	1993-1994
11) Widening of Alm.Barroso	4.370	1993-1995
Total	46.463	

885. The first nine projects are those identified in Chapter 12, while projects 10) and 11) are discussed in Chapter 13 and 11 respectively.

15.3.3 Revenue

886. As for the revenue of the new entity, the following items are considered.

(1) Ticket Sales

887. The bus fare is assumed as Cr$ 20 per passenger which is identical to the bus fare as of October, 1990.

888. It is also assumed that bus transfer is allowed without any extra-charge. The discount system for the old etc. is neglected for the sake of simplicity. Thus the total ticket sales are calculated from the total number of trips multiplied by the bus fare, estimated to be US$ 132 million in 1995, US$ 167 million in 2000 and US$ 216 million in 2010.

(2) Interest

889. Interest rate is closely linked with inflation rate. Since the New Brazil Plan has started in March 16, 1990, the inflation seems to have slowed down. Interest rates for various types of deposits including personal savings, trust deposit etc. during the period from Mar.19 to Dec.28, 1990 ranged between 235% and 264%, while the inflation factor, IPC (Indice de Preco ao Consumidor announced by Instituto Brasileiro de Giografia e Estadistica) was 281% in the same period.

890. This fact implies that it is difficult to expect a substantial income from the interest of deposits and even to cover the inflation loss in such a high inflation country. As a consequence, the interest for the retained earnings is assumed to be nil.

891. As another revenue source, advertisement and rent for commercial and service activities can be envisaged by making use of the advantageous conditions of bus terminals and ticket counters that provide in attracting many people. However, these are excluded from the analysis because it is more conservative from the financial viewpoint.

15.3.4 Operation Cost

892. For the operation cost of the entity, the following items are counted.

(1) Payment to Bus Operators

893. Bus operation fees are paid to bus companies according to the vehicle operating distance. The unit operation cost is calculated by converting the VOC mentioned in Section 2 of Chapter 5 into the unit cost per km. As for the additional portion which covers corporation tax and profit, 5% of the bus operating cost is assumed.

894. Accordingly the total payment to bus companies is estimated at US$ 120 million in 1995, US$ 152 million in 2000 and US$ 203 million in 2010.

(2) Personnel Expenses

895. The new entity requires more than 200 employees for route planning, supervision of bus operators, ticket sales etc.. The total expenses for the personnel is estimated at US$ 0.37 million per month as shown in Table 15.3-2.

Table 15.3-2 Personnel Expenses

Type of Employee	Salary (Cr$/month)	Number of Person	Total Expenses Cr$'000	Total Expenses US$'000
Aux.de Sevico	12,494	22	275	3.13
Motorista	24,989	10	250	2.84
Fiscal	41,648	90	3,748	42.59
Aux.Administrativo	49,977	18	900	10.23
Desenhista	49,977	3	150	1.70
Secretaria	49,977	11	550	6.25
Supervisor	49,977	9	450	5.11
Aux.Tecnico	58,307	17	991	11.26
Tecnico Nivel Medio	58,307	10	583	6.63
Tecnico NIv.Sup.I	99,955	28	2,799	31.81
Tecnico Niv.Sup.II	124,943	21	2,624	29.82
Tecnico Niv.Sup.III	166,591	4	666	7.57
Sub-total		243	13,985	158.93
Allowances for Qualification			6,546	74.39
Total			20,532	233.32
Social Cost (35%)			7,186	81.66
Total Personnel Expenses			27,718	314.98
Miscellaneous Administration Cost			5,000	56.82
Grand Total			32,718	371.80

Note: The figures in US$ are equivalent to those in Cr$.

(3) Operation and Maintenance Cost of Bus Facilities

896. The annual operation and maintenance cost of bus facilities is assumed to be 1% of the initial investment.

15.3.5 Other Conditions for Financial Evaluation

(1) Inflation

897. Inflation rate varies by from year to year and is influenced by various factors such as government policy, economic and financial conditions. According to the living cost index in Belem during the recent years, the inflation rate showed an increasing tendency till the year 1989, as shown in Table15.3-3.

898. As stated above, in 1990, the inflation was somewhat restrained by the government new policy, but resulted in around 800 % as an annual figure.

899. Although inflation has a significant influence on the financial analysis, it is almost impossible to forecast it for the long range under such circumstances.

900. Accordingly, it is determined that inflation factor is excluded from this study, considering that both the revenue and expenses may rise in accordance with the inflation, and that it is usually disregarded when the evaluation indicators are calculated.

Table 15.3-3 Living Cost Index in Belem

Year	Index (Base:Mar.'86=100)	Increase Rate to the Previous Year
1983	7.42	-
1984	22.13	298 %
1985	44.87	203 %
1986	107.59	240 %
1987	339.29	315 %
1988	2,383.50	702 %
1989	37,256.48	1,563 %

Source: IDESP/CEE/ICV

(2) Evaluation Indicators

901. Like the economic evaluation, the following three (3) are taken as the evaluation indicators; financial internal rate of return (FIRR) (also called as return of investment (ROI)), B/C ratio (also called as working ratio) and net present value (NPV).

902. As for the discount rate, the same rate 12% as used in the economic evaluation is applied.

(3) Own Capital and Loan

903. For the project investment, the entity should provide the capital. If the initial capital or paid-up equity is not sufficient for the project cost, a loan from a bank must be obtained. In this study, the paid-up equity is assumed to be 10% of the total investment, and the rest should be covered by a loan. The dividend for the equity is assumed as 10% per year.

904. As for the loan, the following long term soft loan is assumed to be available through BNDES (Banco Nacional de Desenvolvimento) or BEP (Banco Estado do Para), taking the past examples in BMR into account.

a. Interest Rate: 8 % p.a. (excl. BTN)
b. Repayment Period: 10 years
c. Grace Period: 4 years

905. The prevailing interest rate of short term loan is approximately 30% per month including the inflation. Hence, the interest rate is assumed as 10% per month, when excluding the inflation factor.

(4) Tax

906. For the bus companies in Belem, the following taxes and duties are levied at present.

a. Corporation Income Tax (Impost de Renda) : 30% of Profit
b. Service Tax (Impost sobre Servicos) : 10 x UFB per month (Cr$ 4,260/bus in Dec. 1990)
c. Duty for Social Integr.Program (Programa de Integracao Social) : 0.65% of Total Sales
d. Duty for Social Investm. Fund (Fundo de Investimento Social) : 1.2% of Total Sales
e. Duty for Social Contribution (Contribusao Social) : 10% of Profit
f. Others (FGTS and Previdencia Social) : 30.65% of Salary

907. Considering its public nature, it is assumed that the entity will be exempted from the duties (c) and (d) above. Service tax (b) is not applied to the entity, and the others (f) is already included in the personnel expenses. Thus, only the corporation income tax (a) and the duty for social contribution (e) are applied.

(5) Depreciation Cost

908. Project life is assumed to be 25 years for all the bus facilities and the residual value is estimated to be 10% of the initial investment.

15.3.6 Evaluation

909. In the first operating year of 1995, the total ticket sales will be US$132 million, while the total expenditure is estimated at US$ 126 million, thus the net profit before tax results in US$ 6.08 million and the cash surplus after deducting tax and dividends is calculated as US$ 3.38 million in 1990 prices. The accumulated cash surplus grows up to US$ 51 million after 25 years.

910. Throughout the 25 years, a shortage of cash does not occur, therefore, short term loan is not required in any year.

911. The FIRR is calculated at 14.7%, B/C ratio at 1.20. Hence, the proposed project is financially feasible.

912. However the followings are pointed out;

(1) After reaching the maximum in 2007, the net profit before tax gradually begins to decline because the profitability of the operation becomes lower due to the high increase in the payment to bus companies as a result of increase in veh*km.

(2) As long as the uniform tariff system is employed, the operating profit will decrease if the bus fare is fixed without raise. This condition is reached because the veh*km will increase in accordance with the expansion of urbanized area and the increase of population density in the outer area.

913. Table 15.3-4 shows the results of a sensitivity analysis regarding construction cost of bus facilities, additional payment of bus operation fee to bus companies, and bus fare.

914. As for the construction cost, the sensitivity is not so high, however, in the case of 20% increase, B/C ratio indicates that the project is in a marginally feasible range.

Table 15.3-4 Sensitivity Analysis

Case	NPV (US$million)	B/C	FIRR (%)
Original Case	5.78	1.20	14.7
Construction Cost +20%	0.15	0.996	11.9
-20%	11.70	1.49	18.3
Additional Payment to Bus Companies (Original:5%)			
Case 1 : 3 % of VOC	21.06	1.71	20.2
Case 2 : 7 % of VOC	-9.50	0.68	5.2
Bus Fare Cr$ 22/passenger	92.65	4.13	37.7
Cr$ 25/passenger	222.95	8.52	58.1

Note: Case 1 and 2 are corresponding to those illustrated in Figure 15.3-1.

915. In the case of additional payment to bus companies, however, if the payment reaches 7% of VOC, B/C ratio drops to 0.68, and FIRR to only 5.2%. In this case, the yearly financial situation becomes undesirable; the cash surplus turns out to be negative in the 4th year from the opening of operations because of the increase in the annual repayment of the long term loan. This negative situation grows year by year and changes the accumulated cash surplus to a negative one in the 6th year. Together with the expansion of the payment to bus companies, the shortage of the cash in hand will make it difficult for the entity to bear the high interest rate of short term loan, and only the debt will be accumulated at a rapid pace. (Refer to Figure 15.3-1)

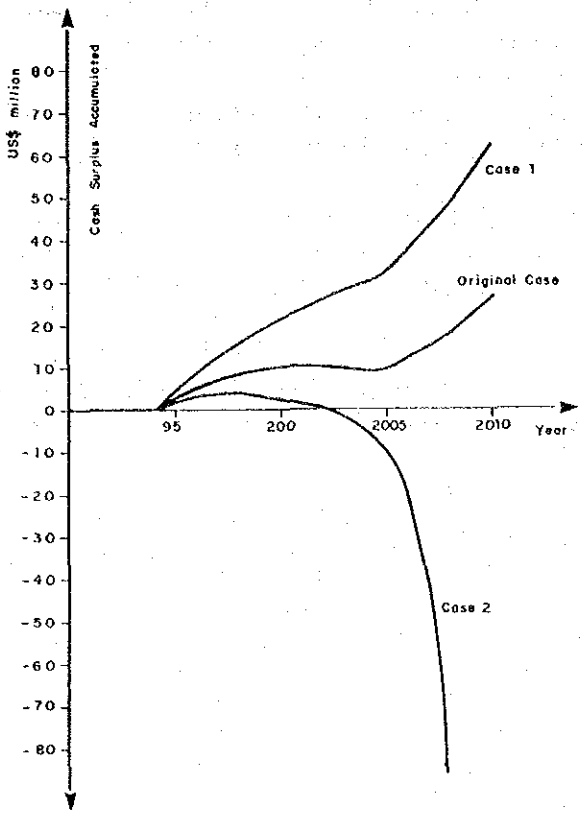


Figure 15.3-1 Cash Surplus Accumulated

916. If the bus fare is raised from Cr$ 20 per passenger to Cr$ 22 per passenger, the profitability of the entity will significantly increase. In the case of Cr$ 22, B/C ratio jumps up to 4.13, FIRR to 37.7%.

917. Even in the case that the payment to bus companies is 10% of VOC, only if the bus fare is raised to Cr$ 22, will a high return be guaranteed, namely B/C ratio is 2.84 and FIRR 29.5%.

918. As a conclusion, the proposed bus system is sufficiently profitable. However, it is important that the new entity must be an active organization with practical capability so as to be able to procure sufficient amount of own capital, seek additional income sources and accomplish a careful financial management including timely revision of bus tariff system. Otherwise, since the actual inflation rate is likely to continue to be at considerably high level, and once the entity relies on a short term loan, it may be difficult to recover from the build up of a growing debt burden.

15.4 Socioeconomic Impacts

919. As described above, as benefits of the Masterplan, the savings in vehicle operating cost and travel time are estimated. In addition to these effects, the Masterplan will also bring about many other impacts difficult to quantity in monetary terms, positive or negative. Some considerations from these points are discussed in this section.

15.4.1 Creation of Employment Opportunity

920. The implementation of the masterplan requires large number of workers such as general skilled and unskilled laborers, heavy equipment operators, foremen, drivers etc. for the construction.

921. The total labor cost is estimated at about Cr$ 500 million, thus, the total job opportunities created by the Masterplan will be 25,000 to 30,000 man-months.

922. Considering the forward and backward linkages of the national economy with the construction industry such as construction material/equipment industries, the creation of additional jobs can be expected.

923. The unemployment rate in BMR as of March 1990 was 8.6%, and 47 thousand persons were unemployed according to the Home Interview Survey. The unemployment rates in other major cities in Brazil might be even higher than BMR.

924. Taking these circumstances into account, the impact of the Masterplan to the regional socioeconomy is extremely beneficial.

15.4.2 Saving in Energy Consumption

925. The implementation of the Masterplan brings about a decrease in vehicle running distance, which results in a conservation of energy, i.e., fuel saving.

926. The total fuel saving is estimated at 390,000 liters/year in 1995 and increases to be 580,000 liters/year in 2010. About 18 % of this saving is gasoline, the rest is diesel oil.

927. Brazil is importing crude oil amounting to about 40 million cubic meters per year, which is more than half of the crude oil requirement in the domestic market.

928. Compared with the total imported volume, the fuel saving above may not be so large, however, it will be more meaningful when considering that it will surely contribute to the saving of foreign currency and that energy saving will be more important issue for Brazil in the face of the growth of the energy consumption.

15.4.3 Provision of Secure Public Transport

929. Most of the existing bus routes have their destinations in the Central District of Belem, therefore, they tend to concentrate in some trunk roads. The highest concentration is found in Av. Almirante Barroso, where 34 routes or 640 buses (the total of two directions) are operated in the morning peak hour at present.

930. In the year 2010, the number of buses will expand to 2,900 to accommodate all the peak demand. However, the operation of 2,900 buses is impossible, since it exceeds the capacity, which is determined by the service speed at bus stops. There is no alternative road to absorb the excessive buses unless Av. lo de Dezembro is constructed.

931. Taking 480 buses as the capacity for one direction, as explained in Chapter 12, the excessive number of buses would need to be delayed till the off-peak hours. Thus, the passengers are forced to either compete for the long hour trip in an over-crowded bus or wait for long time at bus stops.

932. Experimentally calculating the delay of passengers under the situation that the excessive buses are cut off, the total number of passengers who will constitute an overflow from the buses during the morning peak two hours is 416 thousand which is about 60% of the total passengers at the peak period. The total waiting time is estimated at 1.06 million passenger hours.

933. This is a chaotic situation, and the public transport system will be paralyzed. The social effect of the proposed bus system is extremely large in this sense, since it would prevent the above situation from happening and secure adequate public transport.

16. Coclusion and Recommendation

Meeting on Study Results ▼

934. The Masterplan Study of the Urban Transport in Belem has been carried out during the period November 1989 and March 1991, which included a number of surveys of existing socioeconomic, traffic and transport conditions in the Study Area. Based on those survey results obtained, a series of analyses and forecasting works were made and the Future Transport Masterplan for coming two (2) decades is proposed.

935. The public transportation system needs immediate improvement due to its low transport capacity relative to demand as well as its low transport efficiency resulting from current operation system. Trunk bus operation on several traffic corridors in combination with zone feeder bus operation is to be most feasible ways to meet the demand technically and economically.

936. Introduction of railway system was investigated as a possibility in BMR. It was found that its superiority in service such as safety and punctuality compared with bus system can hardly overcome the high cost of construction at present. However, its introduction (subway system or light railway system with bus system) seem to become necessary and is recommended to be examined again in the future.

937. In order to meet the future growing traffic demand, the following road network links are required to be improved;

a. road corridors connecting the central area and suburban area to increase their traffic capacity,

b. network system in suburban area to formulate the traffic network for the regional development, and

c. several road links so as to create the smooth traffic flow in the central area.

938. Traffic management is also required to be improved to use the existing traffic and transport facilities efficiently as much as possible. The followings are recommended to be implemented;

a. traffic flow improvement by separation of the public and private traffic/vehicle and pedestrians,

b. traffic signal system improvement by introducing the variable phase controller and central control system, and

c. parking regulation improvement by restricting the parking on major traffic corridors and creating the parking spaces on local roads/streets in the central area.

939. Land use alternative makes little impact on traffic flow. However, for better urban structure in BMR, the growth of sub-urban cores outside the central area is necessary and the areas of Entroncamento, Ananindeua and Icoaraci are to be promoted as sub-urban cores by giving them official support for infrastructure development and land use.

940. The proposed Transport Masterplan is examined from the view points of socioeconomic as well as transportation engineering. As a whole, the identified projects in the Masterplan are concluded to be economically and technically feasible and recommended to be implemented based on the implementation schedule indicated elsewhere in this report.

941. Until 1995 emphases should be given to the improvement of public transportation system because of the urgent need to enlarge its capacity. The construction of public transport facilities such as bus terminals and bus stops should be carried out, simultaneously with road improvements of Av.Almirante Barroso and BR-316 including the introduction of exclusive bus lanes.

942. During the period between 1995-2000, road network improvement should be initiated and several major projects such as extension of 1o de Dezembro and PA-150 be completed in order to strengthen the traffic corridor between the suburban and central area as well as to support the development in the suburban area.

943. During the period between 2000-2010, the Masterplan road network should be completed. The development of the whole suburban area will require the establishment of sufficient and effective road network.

944. Public transportation network should be reviewed and revised according to road network development and transport demand growth. The additional introduction of trunk bus routes on Belem Road and/or Pedro Miranda Extension will be very useful in lessening the loads on the corridor of BR-316/Av. Almirante Barroso.

945. Regarding to the traffic management, the improvement plan excluding the facilities investments shall be initiated as soon as possible. Traffic flow plan should be carried out at the time the trunk/feeder bus system is introduced.

946. The projects are scheduled during the next twenty (20) years, however, several projects are to be implemented as soon as possible from socioeconomic viewpoint. The following actions and projects are recommended to be made immediately;

a. establishment of public bus management organization responsible for planning, control and management of public bus operation in BMR, including ticket wholesale and distribution of the revenue to bus operators,

b. detailed study on introduction of new public bus operating system consisting of trunk/zone feeder bus operations, which include the detailed route alignment, bus service frequency, tariff system, facilities design, etc.,

c. feasibility study on road improvement projects such as;
   - extension of Av. 1o de Dezembro until Marituba,
   - widening of BR-316 for trunk public bus operation,
   - extension of PA-150 from BR-316 to Icoaraci
   - construction of Belem Road from Curucamba to Ver-O-Peso

d. Initiation of the improvement of traffic signal system such as;
   - establishment of traffic signal control center,
   - installment signal controller available for variable signal phase

e. budgetary resource examination for the implementation of Masterplan (resource and amount)
   - Municipalities
   - State
   - Federal government
   - Foreign countries and lending agencies

JICA