

3.5.2 Future Zone Capacity for Population Growth

103. The development scheme, titled "the Law of Urban Development of Belem Municipality" designates the population density standards, as a "minimum" and "maximum", in accordance with each classified zone.

Table 3.5-2 Density Standards for Population Carrying Capacity

Zone types (Subzones)	Population density		Ratio (%) of capable land for inhabitant
	Minimum	Maximum	
Commercial and services zone	300	375	30
Mixed-use zone:			
(M-1)	300	375	50
(M-2)	300	375	50
(M-3)	225	300	30
(M-4)	150	225	30
Habitational zone:			
(H-1)	50	150	100
(H-2)	110	170	100
(H-3)	110	170	100
(H-4)	150	225	100
(H-5)	225	300	100
(H-6)	300	375	100
(H-7)	300	700	100

Note: Following zones are assumed as non-inhabited areas; "Industrial", "Special functional", "Preservation" and "Rural land". (unit: persons/ha)

104. The Table 3.5-3 shows the assumption of capacity according to the codes of population density standards based on the development scheme. Population carrying capacity in the Study Area excluding "Island area" are estimated as 2.87 millions in "minimum case", and 3.57 millions in "maximum case". While actual number of population in the Study Area counted 1.40 millions in 1990.

Table 3.5-3 Assumption of Future Inhabitant Capacity (persons)

Areas	Population in actual		Population capacity	
	1980	1990	Minimum	Maximum
1. Central area	645,556	712,593	772,520	1,342,340
2. Transition area	150,000	205,818	245,610	372,615
3. Expansion area	203,114	484,107	1,854,120	(1,854,120)
Total	998,670	1,402,618	2,872,250	3,568,075

105. Table 3.5-4 shows the comparison between actual number of population in 1990 and carrying capacity of population in both cases of "minimum" and "maximum" in each area. In the Central and Transition area, the population reached almost the minimum density standard in 1990, but there is still capability in the case of maximum standard. In "Expansion" area, actual population has not reached the minimum density standard.

Table 3.5-4 Assumption of Allowance of Future Population Capacity

Areas	Capable inhabitants additionally (persons)		Carrying capacity index (%)	
	Minimum	Maximum	Minimum	Maximum
1. Central area	59,927	629,747	92.2	58.1
2. Transition area	39,792	166,797	83.8	55.3
3. Expansion area	1,370,013	(1,370,013)	26.1	(26.1)
Total	1,469,732	2,166,557	48.8	39.3

3.5.3 Inventory of Projects and Plans

106. The "Cooperative Habitation of the State of Para" (COHAB-Pa.) has been constructing the large-scaled housing development in Belem Municipality since 1970. Complex of Cidade Nova, Marambaia, Conjunto Icoaraci and Conjunto Providencia/Promorar were already completed. At present, COHAB-Pa. has the following projects for execution near the Complex of Cidade Nova. New development areas amount to 548.4ha, and involve the construction of 10,045 housing units (approximately 50 thousands inhabitants). (refer to Table 3.5-5 and Figure 3.5-2)

Table 3.5-5 Project List of Residential Estates

Project names	Area (ha)	Housing units	Development terms
Conjunto Icoaraci	58.4	1,200	completed
Marambaia	78.8	1,542	-do-
Complexo Cidade Nova	624.6	16,377	-do-
Parque Residencial Catalina	46.8	770	-do-
Conjunto Providencia/Promorar	70.4	2,511	-do-
Subtotal	879.0	22,400	
Conjunto Residencial P.A.A.R.	217.6	4,289	under constr.
Conjunto Integrado Rural/Urbano	297.0	4,984	
Antonio Gueiros (Lobel)	24.0	405	
Girassol (Viana Soares)	9.8	365	1992
Subtotal	548.4	10,045	

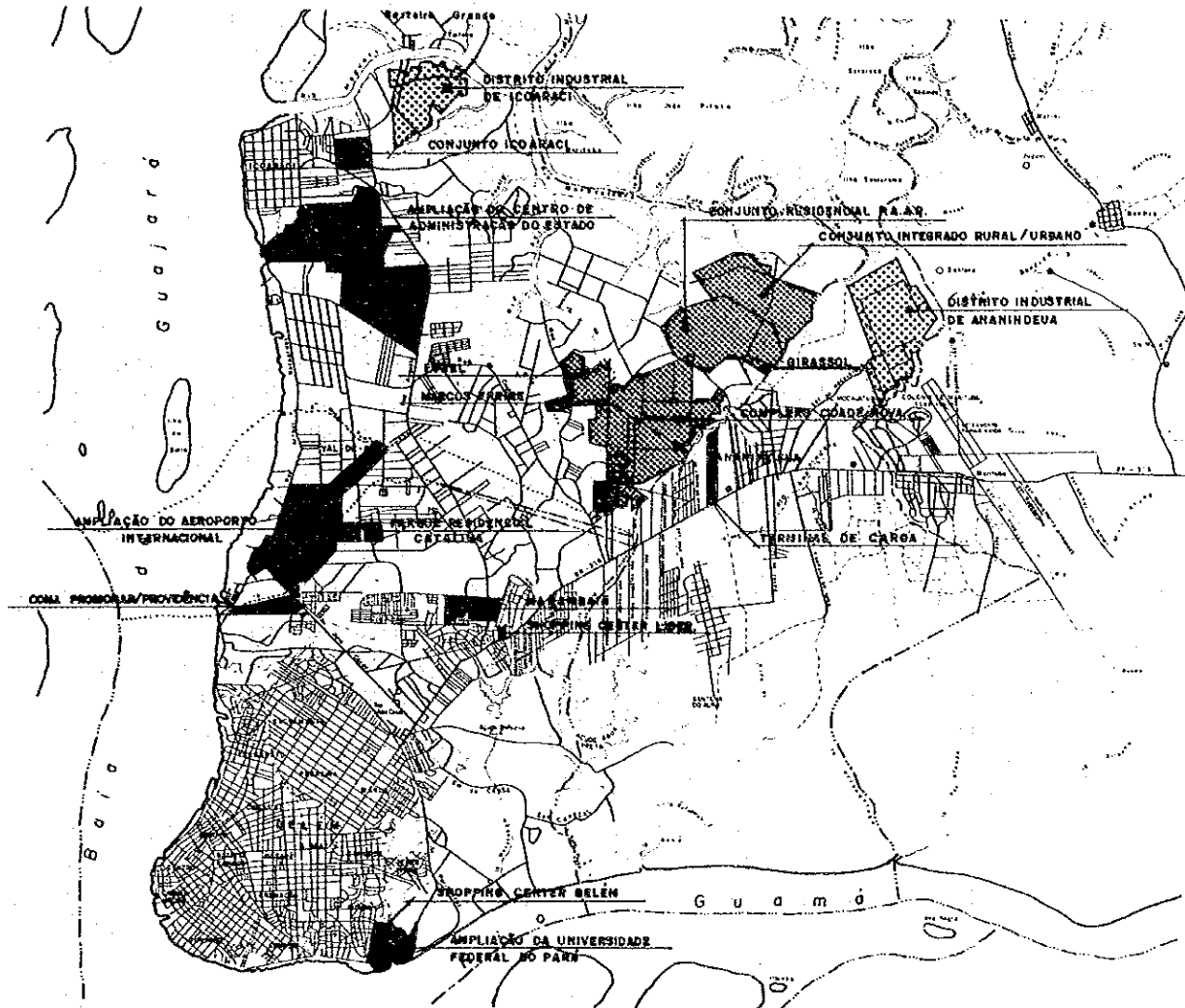


Figure 3.5-2 Major Project Locations

107. There are two (2) medium-scaled industrial districts under implementation in the Study Area, those are Ananindeua and Icoaraci. The organization in charge of the implantation is the "Company of Industrial Districts" (CDI-Pa.). The Table 3.5-6 shows the actual state of these areas.

Table 3.5-6 Industrial District

	Ananindeua	Icoaraci
Total area (ha)	454.5	204.1
Occupied area (ha)	211.4	173.6
Remaining area (ha)	243.1	30.5
No. of factories implemented	55	42
No. of employees (persons)	5,582	2,591

Source: CDI-Pa.

108. There are two shopping center buildings under planning in Belem. One will be located on Route BR-316, 1 km beyond from Entroncament, named "Shopping Lider" with a total of 153 stores. The other is named "Shopping Center Belem" in Guama area in front of the University with 253 stores, two cinemas, 1 theater, 8 restaurants including a parking area for 4,500 cars. It will be opened in 1992 or 1993.

109. There is a Project for the improvement of the Belem International Airport located in Val-de-Caes, which consists of the extension of the runway and the construction of the new terminal buildings for passengers up to the year of 2000. In this project, a new shopping complex located beside the terminal buildings is included.

110. In the project of expansion of the Federal University of Para all the courses that are being offered off the campus are expected to be transferred to the inside of the campus. In this project the construction of an University Hospital is included.

111. In the State Administrative Center located near Icoaraci, all the administrative organization sites from the central area of Belem will be placed. At the moment, the followings have already been located in this Center:

- a. The Secretary of Education (SEDUC);
- b. The Center of the State Data Processing (PRODEPA); and
- c. The Enterprise of Technical Assistance and Rural Extension of Para (EMATER-Pa.)

112. The truck terminal is in its final stage of construction. It is located on Route BR-316, 7 km beyond from Entroncamento and it aims to house all the private transport enterprise terminals, which are spread in the inland of Belem.

113. It is expected that there will be a road link from Belem to Barcarena and the Port of Vila do Conde. The project estimates the construction of bridges over Guama River, Acara River and Moju River. Its link with Belem will be through Route BR-316 in Ananindeua.

3.6 Major Issues on Existing Urban Structures

3.6.1 Concerning the Urban Structure

114. As mentioned in the previous sections, the Study Area has various structural problems. These problems have become larger and parallel the historical growth of this metropolis. It can be easily forecasted that they will be more serious in the process of the growth of the city size from 1.4 million to 2.4 million at the year of 2010.

115. The following are the problems and corresponding matters for consideration, especially related to the urban transport planning:

- a. Commercial, business and administrative activities are concentrated in the Central Area. Many workers have to commute every day from the suburban area into the Central Area mainly by bus. They are forced to waste the time and energy by long distance commuting.
- b. The segregation of residential area by income level is taking place in Belem Metropolitan Region. It will create for the poor by not having the adequate access to public transportation in the suburban area, and therefore, will become one reason of the social instability.
- c. The existence of the Institutional zone surrounding the Central Area make it difficult to build up the transport network between the Central Area and suburban area. The future development of the suburban area will produce the heavy traffic demand on the existing traffic network between two areas.

3.6.2 Concerning the Land Use

116. Ananindeua Municipality has no regulation or law regarding land use in its territory. The urbanization of this territory is foreseen to become wider and denser in the next century. The area of Ananindeua and Marituba is to be developed as an integrated part of the urban centers of the region.

4. Existing Road Condition

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4.2 Road Inventory.....	55

Av. Almirante Barroso ▼



4.1 Organizations related to Road Management

4.1.1 Federal Organizations

- (1) Departamento Nacional de Estradas e Rodagem (DNER)

117. A Department of Ministerio de Transporte, responsible for the construction and maintenance of the national highways. BR-316 is the only road that belongs to them in the Study Area.

4.1.2 State Organizations

- (1) Secretaria de Transporte do Estado do Para (SETRAN)

118. An organization responsible for the construction and maintenance of the state roads. Av. Pedro A. Cabral, which was financed by the World Bank (IBRD), was constructed by this organization and now transferred to the municipality. The road section from BR-316 to Mosqueiro is the only road under this organization in the Study Area. Departamento de Estradas e Rodagem (DER) in SETRAN is responsible for road planning.

- (2) Secretaria de Planejamento (SEPLAN)

119. A state organization in charge of proposing and assuring the execution of the state policy of planning and growth. In Belem Metropolitan Region, the organization is responsible for:

- a. Coordination between the governmental organizations for project planning and implementation.
- b. Coordination and determination of detailed land use pattern in urban area.
- c. Screening of Government sponsored projects inside BMR.
- d. Collection and analysis of the statistical data in BMR.

4.1.3 Municipal Organizations

(1) Secretaria de Saneamento (SESAN)

120. A municipal organization responsible for the drainage system. It encompasses part of the DMER, which has been discontinued, and part of SEMOB, also discontinued, which is in charge of maintaining and preserving the road network.

(2) Secretaria de Urbanismo (SEURB)

121. A municipal organization responsible for the inspection of buildings, accomplishment of the height restriction of building and land use code legislations, the urban development planning of municipal construction, etc.

4.2 Road Inventory

4.2.1 Road Classification

122. The existing roads in the Study Area can be classified jurisdictionally into Federal highways, State roads and Municipal roads, however there exist only one Federal highway (BR-316) and one State Road (Mosqueiro road). The City Act No. 7401 of Belem dated Jan. 29, 1988, Chap. 3, clause 9, regulates the future land use and the classification of future road network as below;

- a. Trunk Road: for motorized vehicle traffic. The minimum road width is 60m, including sidewalks for planning.
- b. Frame Road: to connect urban cores. The minimum width is 46m for planning.
- c. Primary Artery: minimum width of 40m for planning.
- d. Secondary Artery: minimum width of 34m for planning.
- e. Distributor: minimum width of 22m for planning.
- f. Local Road: minimum width of 12m for planning.

The above Act regulates also the minimum pedestrian sidewalk width of 1.5m and the minimum width of exclusive pedestrian street of 3m.

123. Figure 4.2-1, which is attached to the Act, shows the location of above classified road network for the future. The trunk roads are;

- a. Road from Av. Almirante Barroso to BR-316, which has 4 to 8 lanes at present.
- b. Road parallel with the road above, starting from the intersection of Av. 1 de Dezembro and Av. Perimetral (plan only)
- c. Transversal road in Ananindeua City (plan only)

The frame roads are;

- a. Av. Pedro A. Cabral
- b. Road composed of Artur Bernardes Road, the section from Belem Urban Area to the Airport, and Augusto Montenegro Road (existing) via Yamada Road (unpaved).
- c. Road linking Augusto Montenegro Road with Marituba City, planned to be extended up to Maraba City.

The primary arterial roads in Belem urban area are;

- a. Circumferential road composed of Av. Perimetral, Av. Dr. Freitas, Av. Senador Lemos, R. Municipalidade and Av. Bernardo Sayao and the following three radial roads;
- b. Road linking Av. Magalhaes Barata, Av. Nazare and Av. Assis de Vasconcelos.
- c. Av. Jose Malcher
- d. Av. Gentil Bittencourt

124. The primary arterial roads in the Belem suburban area are the following five roads and two cross roads in Outeiro;

- a. Av. Julio Cesar, which links Av. Almirante Barroso with the airport (existing).
- b. A half section of Augusto Montenegro road (existing)
- c. Road linking Coqueiro road with Coqueiro/Tapana road (existing)
- d. Road linking Trans Coqueiro road with 40 Horas road (existing)
- e. Road linking Augusto Montenegro road with a road in 40 Horas area (existing)

125. The following roads are defined as the secondary arterial roads in Belem urban area. They link the primary roads above mentioned.

- a. Road linking Av. Pedro Miranda with Av. Alcindo Cacela and Tv. 9 de Janeiro.
- b. Road linking Av. Duque de Caxias with Av. Jose Bonifacio.
- c. Road linking Av. 10. de Dezembro with Av. Conselheiro Furtado and R. Mundurucus.
- d. Av. Padre Eutiquio and R. Apinages.
- e. Road along Tucunduba Canal.

4.2.2 Pavement Condition

126. Figure 4.2-2 shows the paved road location in the Central urban area. Table 4.2-1 shows the road length by pavement condition and by zone. The total road length is 443 Km of which about 200 Km are unpaved. The paved road percentage in the Bairro of Comercio, Nazare and Reduto exceed 90%. The unpaved roads in these areas include the historic stone paved roads. Therefore almost all the normal roads in these areas are paved. On the other hand, the paved road percentage in the south east area of the city of Terra Firme, Guama and Condor is less than 30%.

Table 4.2-1 Pavement Condition

Bairro	Road Length (Km)			%
	Paved	Unpaved	Total	
COMERCIO	20.7	0.3	21.0	98.6
NAZARE	19.3	0.6	19.9	97.0
REDUTO	12.2	0.4	12.6	96.8
BATISTA CAMPOS	14.2	1.6	15.8	89.9
SAO BRAZ	17.7	2.5	20.2	87.6
UMARIZAL	24.5	3.9	28.5	86.0
CIDADE VELHA	10.9	3.5	14.4	75.7
CANUDOS	5.2	3.3	8.6	60.5
MARCO	35.5	24.6	60.0	59.2
PEDREIRA	22.1	18.0	40.2	55.0
CREMACAO	8.5	10.4	18.8	45.2
FATIMA	3.5	4.6	8.1	43.2
JURUNAS	13.0	18.0	31.0	41.9
TELEGRAFO	10.4	17.9	28.3	36.7
CONDOR	6.6	17.9	24.4	27.0
GUAMA	12.2	40.7	52.8	23.1
TERRA FIRME	6.8	31.9	38.6	17.6
Total	243.3	200.1	443.2	54.9

127. In the suburban Area of Belem, except for the local roads in the newly developed housing estates only the following few trunk roads are paved. All the rest are unpaved.

- a. BR-316,
- b. Augusto Montenegro road,
- c. Artur Bernardes road,
- d. Trans Coqueiro road - 40 Horas road,
- e. Coqueiro road - Coqueiro/ Tapana road, and
- f. Icoaraci - Outeiro road.

4.2.3 Road Width

128. The arterial roads in Belem urban area generally have a road width of 20m and are operated as 2 lanes streets in case of 2-way traffic, 3 lanes in case of one way traffic with little on-street parking, and 2 lanes in case of one-way traffic with much on-street parking.

129. Av. Almirante Barroso has a total road width of 45m with a median and side strips and is operated as 2-way 8 lanes street. BR-316, which is connecting road of this street, has 59m total width with a 13m wide median and is operated as 2-way 4-6 lanes road.

130. Rd. Augusto Montenegro can be divided into two sections; one with 56m total width and a 5.2m median, operated as 2-way 6 lanes road (from the intersection with BR-316 to Km 3.1), and another with 32m total width and a 4m median, operated as 2-way 4 lanes road.

131. Av. Pedro A. Cabral has 30m total width with a 3.3m median and 9.5m carriage ways on both sides and is operated as 2-way 4 lanes road.

132. Av. Pedro Miranda, which crosses the Pedreira area from north to south, has 45m total width with 8.2m wide 2-way carriage way at the center, 3.8m wide side strips on both sides and at the outside of these strips 8.2m one-way carriage ways. It is operated as a 6 lanes street.

133. Av. Duque de Caxias, which crosses the same area from north to south, has 45m total width with a wide 20m median and is operated as 2-way 4 lanes street.

134. Av. 1 de Dezembro, which runs parallel with Av. Almirante Barroso in the east, has total width of 45m, with a 4.7m median and 14m carriage ways on each side and is operated as 2-way 6 lanes street.

135. The width of the roads in Centro is normally 5m. The roads are exclusively used as one-way streets because of the existence of many on-street parking sometimes even on pedestrian sidewalks. The perimeter streets surrounding Centro are;

- a. A pair of one-way streets of Av. Assis de Vasconcelos and Av. Presidente Vargas with 30m total width, 20 m carriage way and 4 lanes operation,
- b. R. B. Castilho Franca/Av. Marechal Hermes with 17m total width, 12.5m carriage way and one-way 3 lanes operation

- in front of Ver-o-Peso Market,
- c. Av. 16 de Novembro/ Av. Portugal with 20m total width, 7m carriage way and one-way 2 lanes operation, and
 - d. Av. Almirante Tamandare with 37m total width, a 10m canal at the center, 7m - 8m carriage way, and 4 lanes operation (partially one-way and partially two-way).

4.2.4 Structures related to Road Network

136. The intersection on BR-316 with Coqueiro road to Cidade Nova is the only multi-graded intersection in the Study Area and is trumpet type with additional 2 loop ramps.

137. The main bridges in the Study Area are;

- a. One at Maguari River on the road from Icoaraci to Outeiro with a total length of about 300m, and,
- b. One at Furo das Marinhas on the road from BR-316 to Mosqueiro with a total length of about 1500m.

138. There are many small bridges and culverts crossing canals within the Urban Area and some of them are still wooden bridges.

5. Existing Traffic Condition

5.1 Traffic Volume	63
5.2 Travel Time	75
5.3 Traffic Management System	79
5.4 Parking	94

Traffic Flow on Av. Nazare ▼



5.1 Traffic Volume

5.1.1 Road Section Traffic Volume

139. The survey was carried out for three days between Nov. 27 (Mon.) and 29 (Wed.). At nine survey points out of the total 52 points, the survey was carried out for 24 hours, and 14 hours from 6:00 in the morning up to 20:00 in the evening for the rest. The vehicles were classified into four types of passenger car, taxi, bus and truck, and at the two survey points on Av. Arthur Bernardes (No. 17 and 18), bicycles and motor cycles were additionally counted.

140. Figure 5.1-1 shows the hourly fluctuation and Figure 5.1-2 shows the vehicle type composition at the main survey points. The peak hours at the survey point No. 15 (Rd. August Montenegro) are 7:00 - 8:00 in the morning and 17:00 - 18:00 in the evening, and the peak hour factors (PHFs) are 6.2% and 6.8% respectively. At the survey point No. 22 (BR-316), the peak hours are 7:00 - 8:00 in the morning and 18:00 - 19:00 in the evening, and the PHFs are 7.1% and 7.6%, respectively. Generally, the peak hours are not so significant and the mild peak hours are observed once in the morning and another in the afternoon. The ratio of traffic volume of 24 hr. count to 14 hr. count are in the range of 1.06 to 1.27 and approximately 1.2 in average.

5.1.2 Intersection Traffic Volume

141. The intersection traffic volume counting were carried out for 6 weekdays between Dec. 1 (Fri.) and 11 (Mon.), excluding Dec. 8 (Fri.) which was a holiday. At the 13 intersections out of total 62 intersections, the counting was carried out for 24 hours, and 14 hours from 6:00 in the morning to 20:00 in the evening for the rest.

142. Figure 5.1-3 shows the hourly fluctuations by each intersection approach. At the intersection No. 12 (Av. Pedro A. Cabral), the peak hour on the approach No. 3 (from BR-316 to the city center) is 7:00 to 8:00 and the PHF is 8.9%. The traffic of the opposite direction on the approach No. 1 (from the city center to BR-316) shows the peak hour at 12:00 to 13:00 and the PHF of 9.6% in the mid-day, and the another peak hour at 18:00 to 19:00 and the PHF of 8.3% in the evening, reflecting the life pattern of commuting from residents in the suburban area in the morning and going back to home in the mid-day and in the evening.

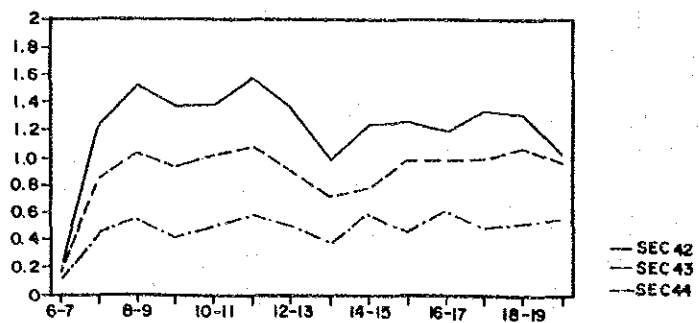
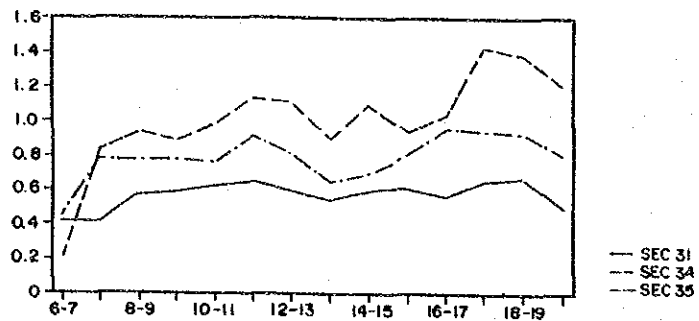
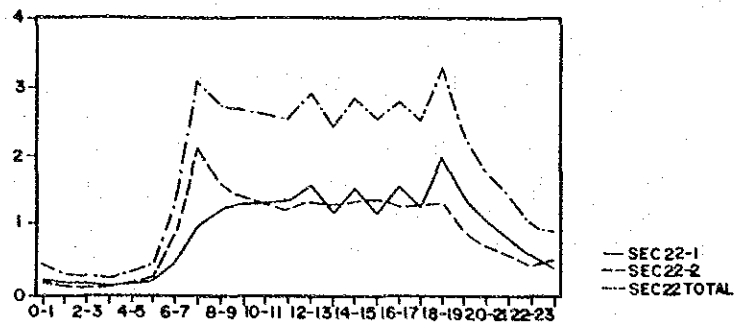
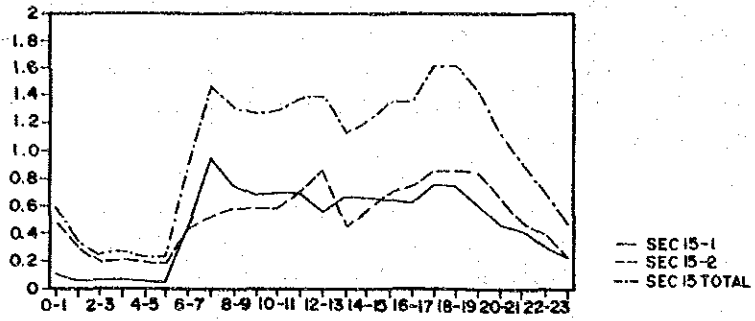
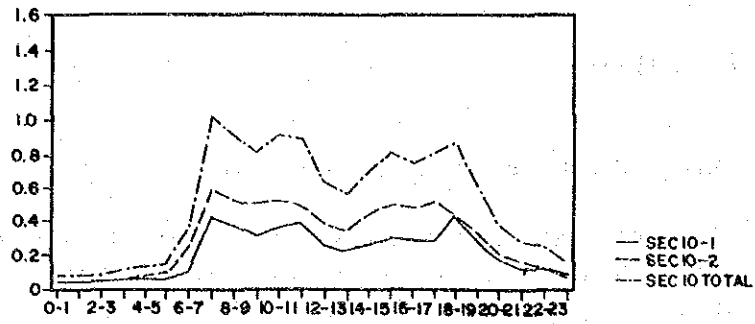


Figure 5.1-1 Traffic Volume Hourly Fluctuation

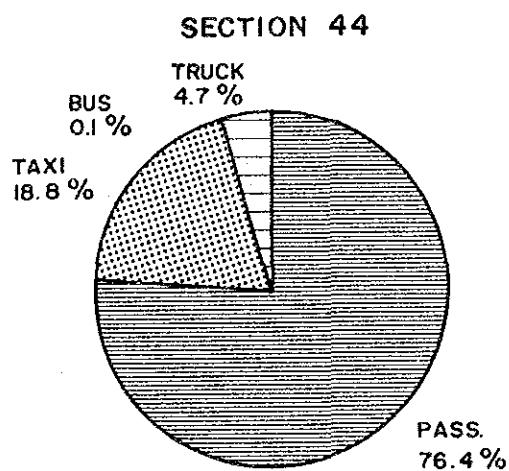
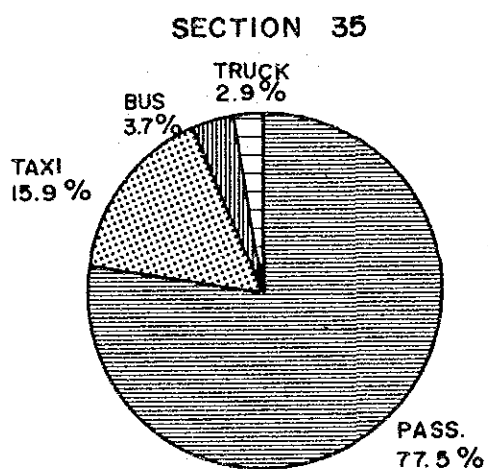
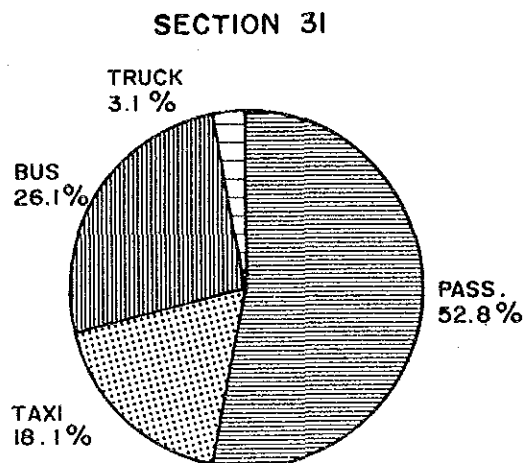
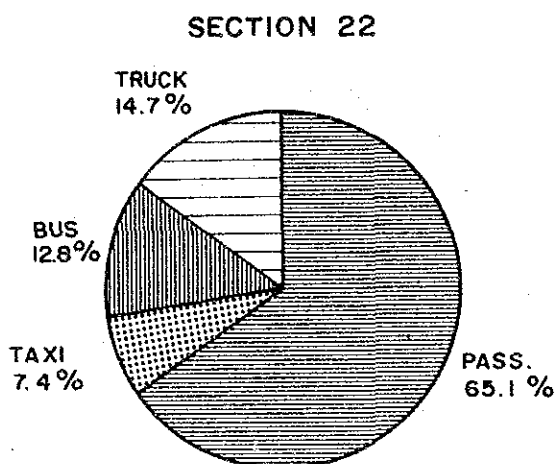
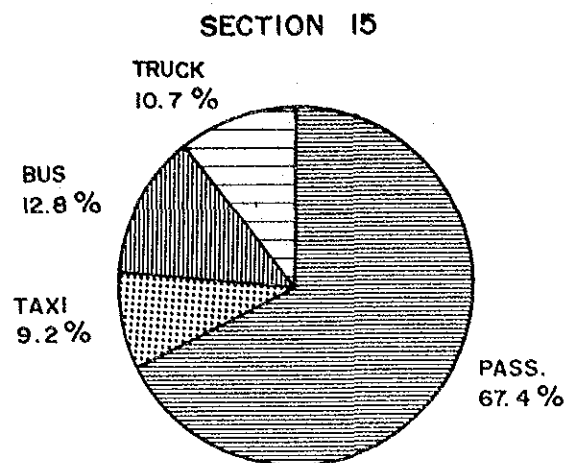
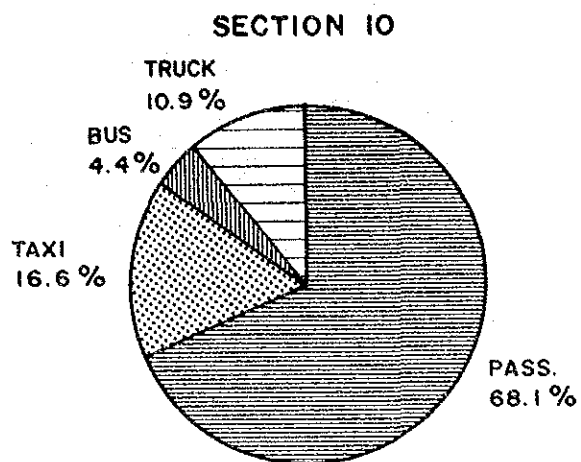


Figure 5.1-2 Vehicle Type Composition

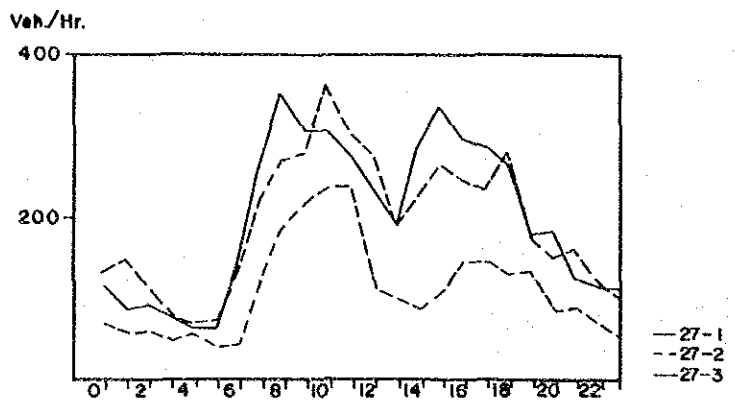
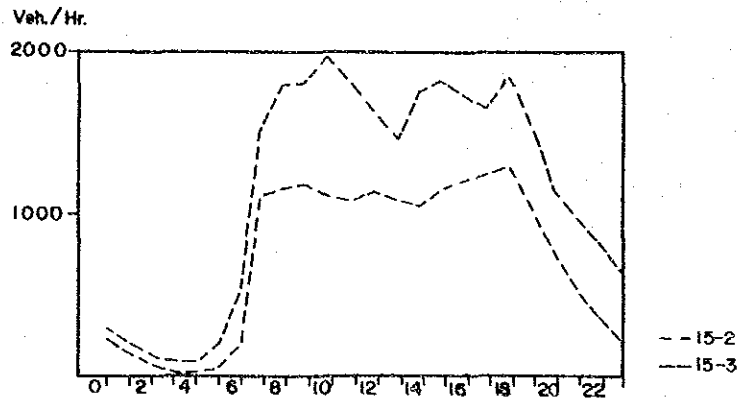
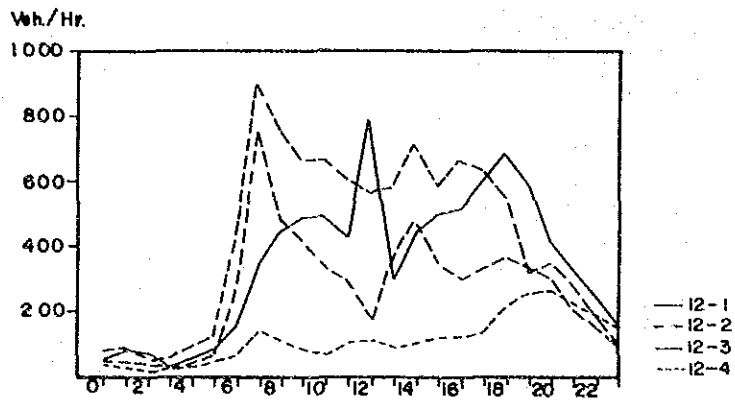
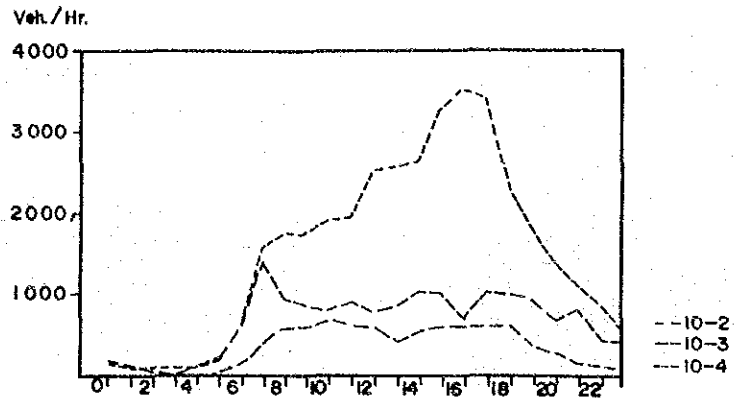


Figure 5.1-3 Hourly Traffic Fluctuation (Intersections)

143. At the intersection No. 15 (Av. Nazare/ Av. Generalismo) and No. 27 (Av. Alcindo Cacela/ Av. Padre Eutiquio) in the urban area, the hourly traffic volume at approaches show less fluctuations for the periods of 7:00 to 11:00 in the morning and 14:00 to 19:00 in the afternoon with the volume reduction at 12:00 to 14:00 in the mid-day.

144. Figure 5.1-4 shows the vehicle type composition of the survey points. The percentages of trucks on the streets in the urban area are small ranging around 2%, however those in the sub-urban area increase up to around 30% on BR-316 in Ananindeua City. The percentages of taxi are around 20% in the urban area.

145. Figure 5.1-5 shows the traffic volume in major intersections at 8 to 9 AM and 6 to 7 PM. It can be seen from this figure that:

- a. On Av. Almirante Barroso; the major traffic flow is for central area in the morning and for suburban area in the evening.
- b. Major traffic flow are strait. Comparative major turning traffic flows are;
 - from Av. Jose Bonifacio to Av. Almirante Barroso
 - from Av. Almirante Barroso to Av. G. Jose Malcher
 - from Av. Jose Bonifacio to Av. Magalhaes Barata
 - from R. Riachuelo to Av. Pres. Vargas

146. Figure 5.1-6 shows the flow rate of the major intersections at peak hour. The flow rate of the major intersections is less than 0.8, therefore it seems that there now are few congestion in the Study Area. However, in the intersection of Av. Assis de Vasconcelos and Rua Tiradentes, where the flow rate shows 0.91 in peak hour, it may get congested due to concentration of traffic flow in the central area in the near future.

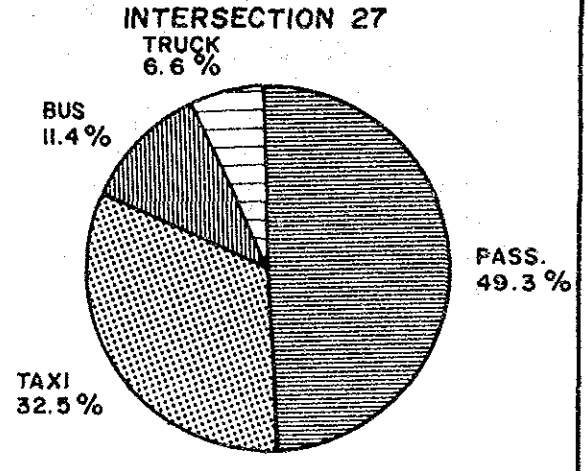
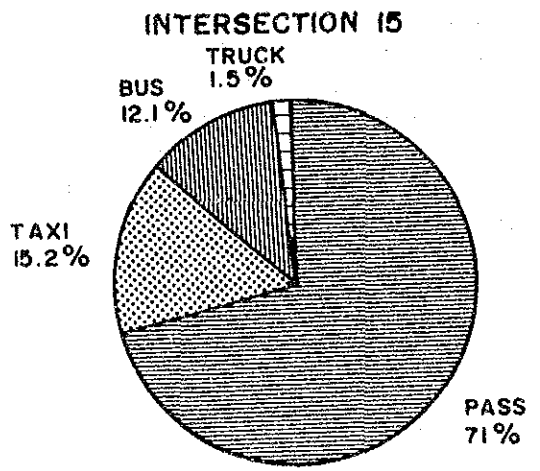
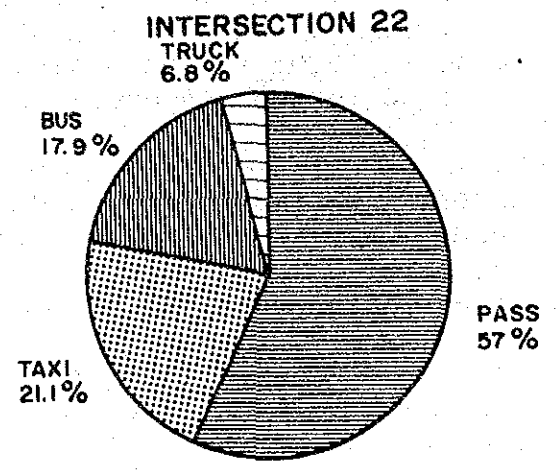
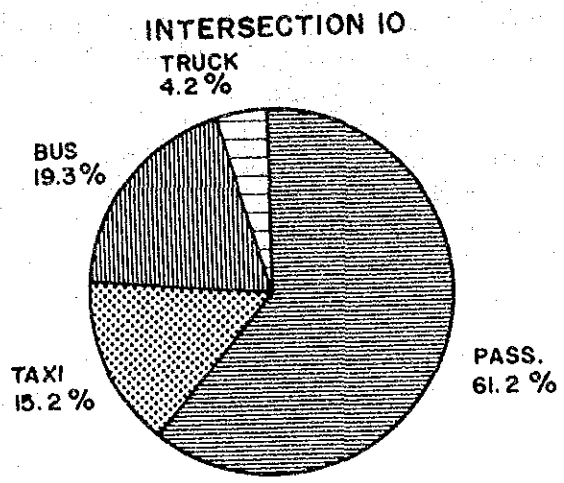


Figure 5.1-4 Vehicle Type Composition (Intersections)

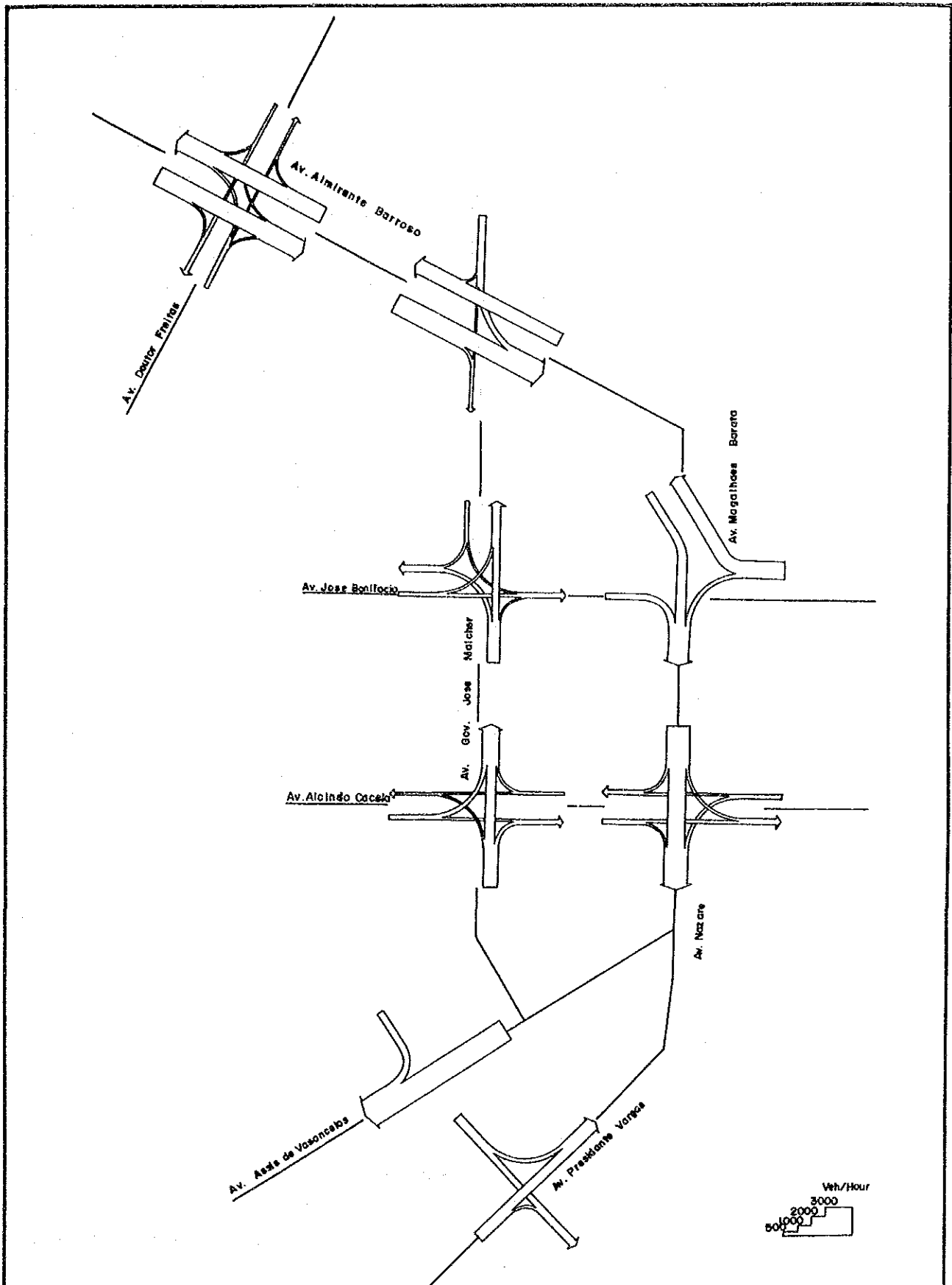


Figure 5.1-5(A) Traffic Volume in Major Intersections (8:00-9:00)

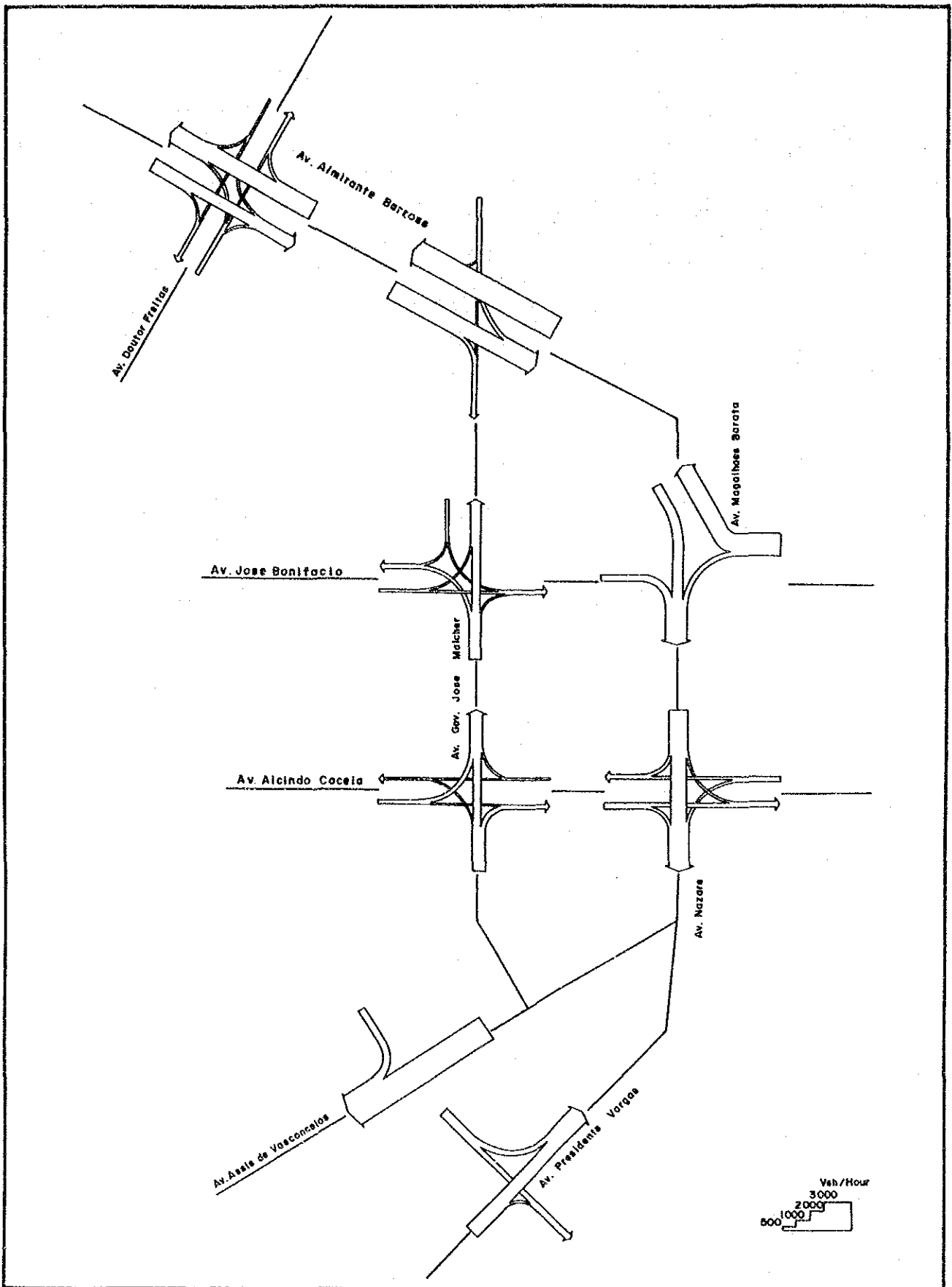


Figure 5.1-5(B) Traffic Volume in Major Intersections (18:00- 19:00)

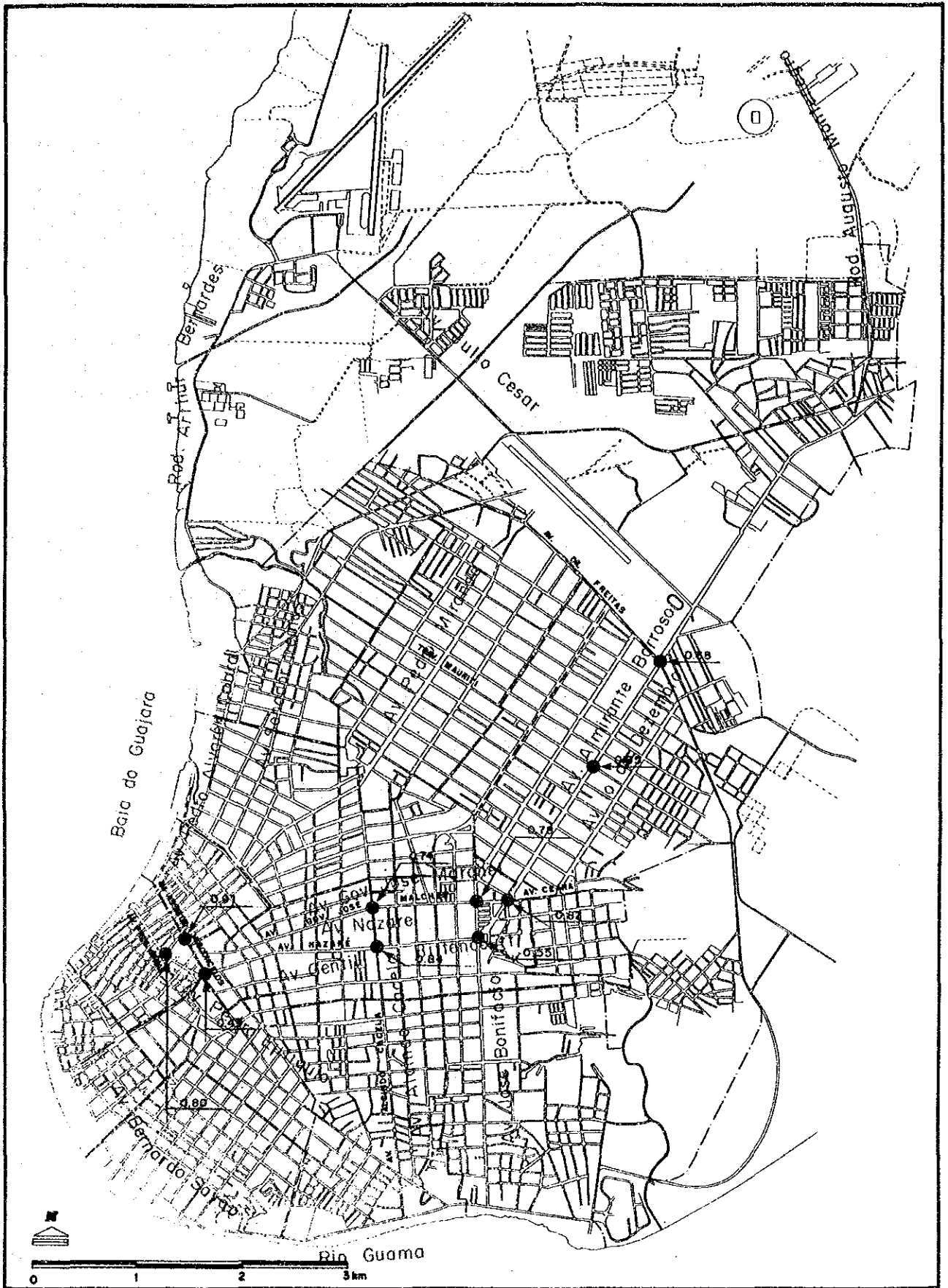


Figure 5.1-6 Ratio of Demand Flow Rate to Capacity at Peak Hour

5.1.3 Traffic Flow

147. The daily traffic flow based on the road section and intersection traffic counting, in the Study Area, is shown in Figure 5.1-7. The highest traffic flow is observed on the corridor of Av. Almirante Barroso - BR-316, and at the beginning point of BR-316 (Entroncamento), the daily volume is around 56,000 veh./day. This huge volume does not fluctuate much throughout the sections from Sao Braz to the intersection with Coqueiro road where the traffic from Cidade Nova estate merges.

148. Av. Pedro A. Cabral, which was constructed in order to divert the traffic from Av. Almirante Barroso, handles 1/3rd of the traffic on Av. Almirante Barroso or 17,000 veh./day because of the existence of unpaved section.(at survey time)

149. The streets with the higher traffic volume in the urban area are;

- a. Av.Nazare with 30,000 veh./day,
- b. Av.Padre Eutiquio, section between R.Mundurucus and Av. Alm. Tamandare with 28,000 veh./day,
- c. Av.Presidente Vargas in front of Praca da Republica with 30,000 veh./day, and
- d. Av.Generalissimo with 28,000 veh./day.

150. The roads with the higher traffic volume in the suburban area are;

- a. Rd. Augusto Montenegro with 8,300 veh./day, and
- b. Coqueiro road at the entrance of Cidade Nova estate with 16,000 veh./day.

The other roads in the suburban area accommodate small traffic volume such as;

- a. Trans Coqueiro road with 2,000 veh./day, and
- b. Coqueiro/ Tapana road with 4,000 veh./day.

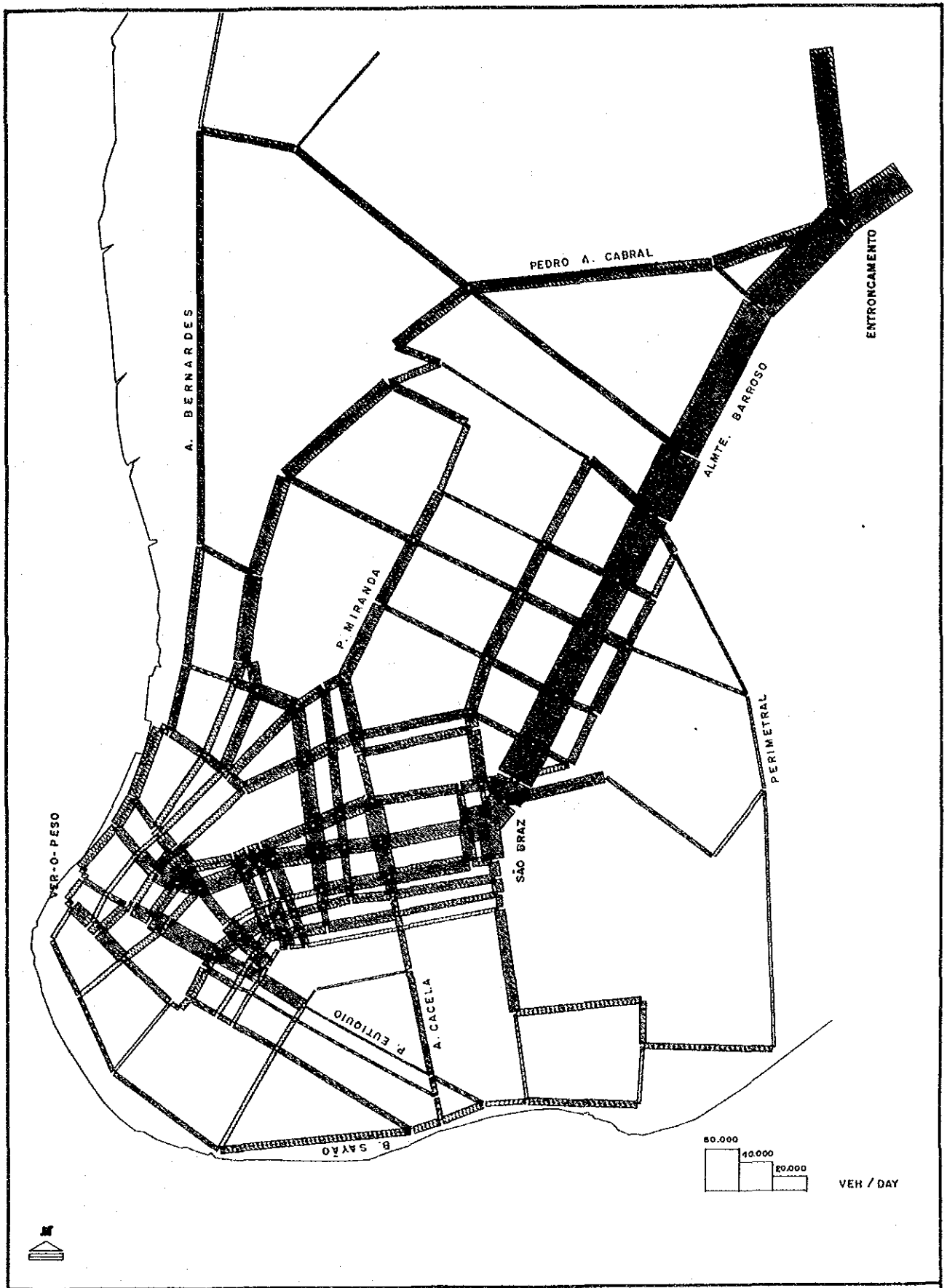


Figure 5.1-7(A) Traffic Volume Diagram on Major Roads (Urban Area)

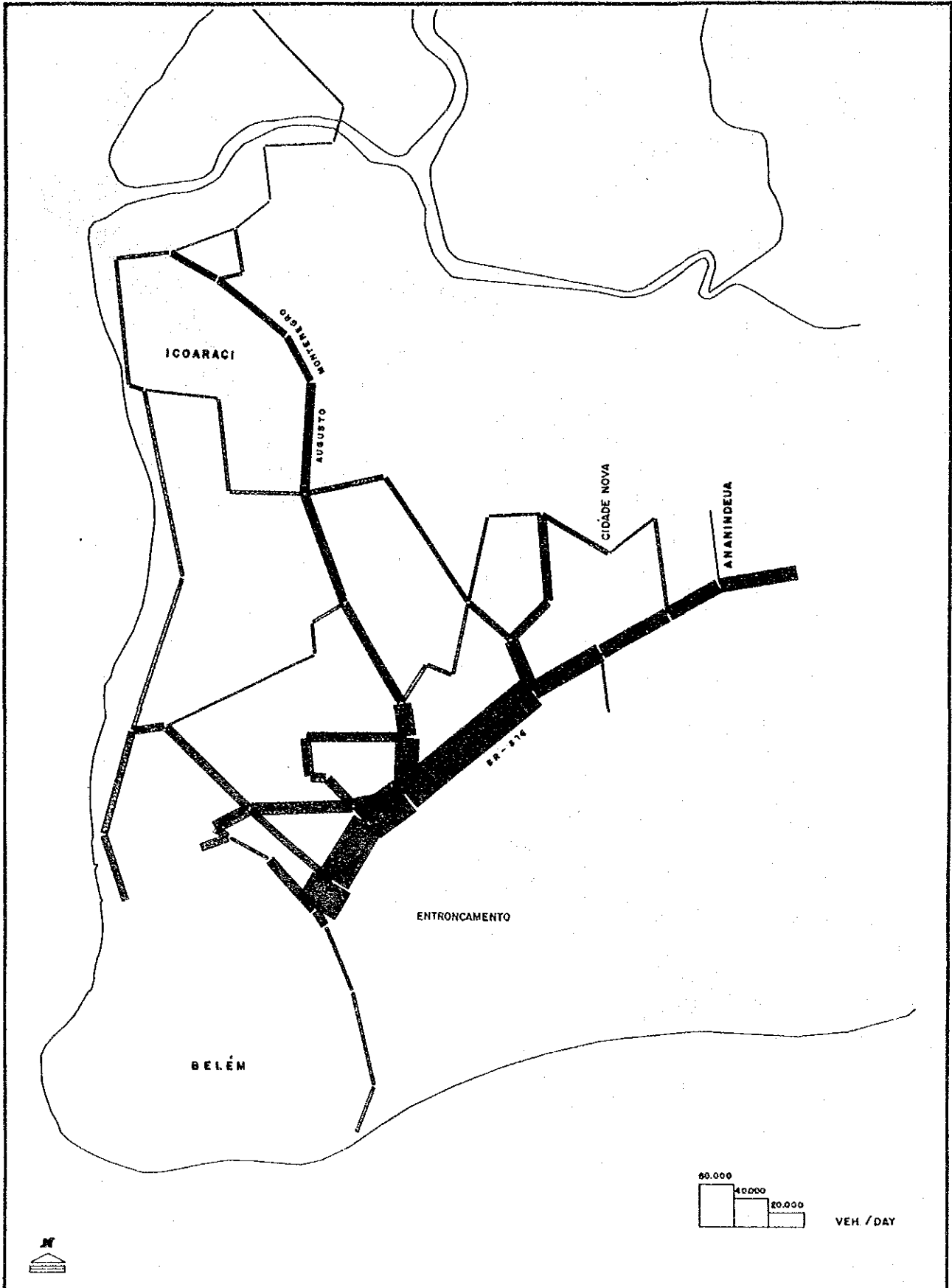


Figure 5.1-7(B) Traffic Volume Diagram on Major Roads (Suburban Area)

5.2 Travel Time

151. Travel time survey was carried out on the 6 corridors shown in Figure 5.2-1 for two days of Dec. 19 (Tue.) and 20 (Wed.). In order to collect information on the commuting time, the survey was started at 7:00 in the morning for the direction from suburban area to the city center, and both 12:00 in the mid-day and 18:00 in the evening in the direction from the city center to the suburban area.

152. Figure 5.2-2 shows the travel speed by survey corridor and by section. The travel time and the average travel speed by corridor are summarized in Table 5.2-1.

Table 5.2-1 Travel Time by Route

Route	To City Center 7:00			From City Center				
	Dist.	Hour	Vel.	Dist.	Hour	Vel.	Hour	Vel.
1 Ver-o-Peso - Entroncamento	11.5	19:07	36.1	11.6	37:21	18.6	31:28	22.1
21 B.Sayao - J. Malcher	3.4	6:03	33.7					
22 M. Barata - 16 de Novembro	4.6	9:32	29.0					
3 Vasconcelo - Entroncamento	11.0	18:44	35.2	9.9	21:43	27.4	22:12	26.8
4 Icoaraci - Doca	18.2	20:59	52.1	18.4	22:56	48.2	27:21	40.4
5 Pca. Relógio - Universidade	7.2	12:35	34.3	7.4	18:12	24.4	17:56	24.8
61 S.Lemos - Nazare	4.6	9:01	30.6	4.6	9:14	29.9	12:13	22.6
62 Sao Braz - Doca	2.9	4:58	35.1	2.6	4:57	31.6	6:13	25.1
7 Sao Braz - Castilhos				4.3	12:49	20.1	10:17	25.1

unit: Dist.(km), vel.(km/h), Hour(minutes/second)

153. The travel time and the average travel speed observed on the 11.5 km corridor from Entroncamento to the city center via Av. Almirante Barroso were 19 min. and 36.1 Km/h in the morning. From City Center to the suburban area, 37 min. and 18.6 Km/h (the lowest average travel speed in the observed) in the mid-day and 31 min. and 22.1 Km/h in the evening. The second lowest average travel speed was 20.1 Km/h in the mid-day on Av. Gentil Bittencourt in the direction from the city center to the suburban area.

154. The travel time between the city center and Entroncamento (11.0 Km) via Av. Almirante Barroso (corridor No. 1 and 8, refer to Figure 5.2-1) is 4 minutes shorter in the morning and 0 to 5 min. shorter in the mid-day and in the evening than through the way via Av. Pedro A. Cabral (corridor No. 3 and 10), because

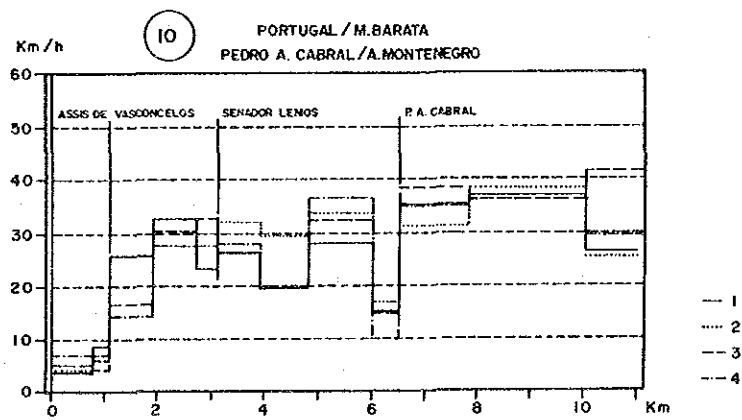
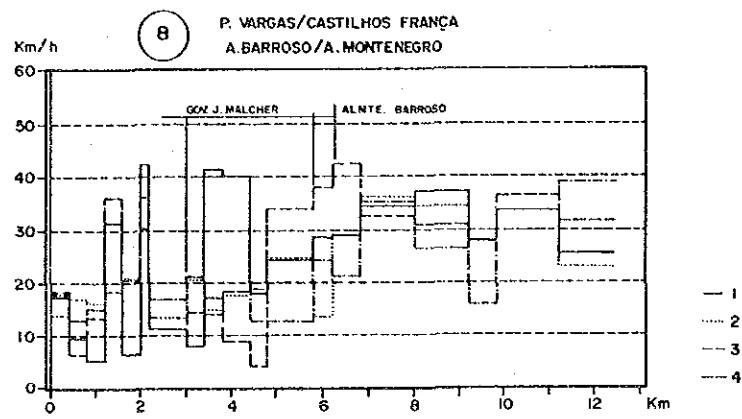
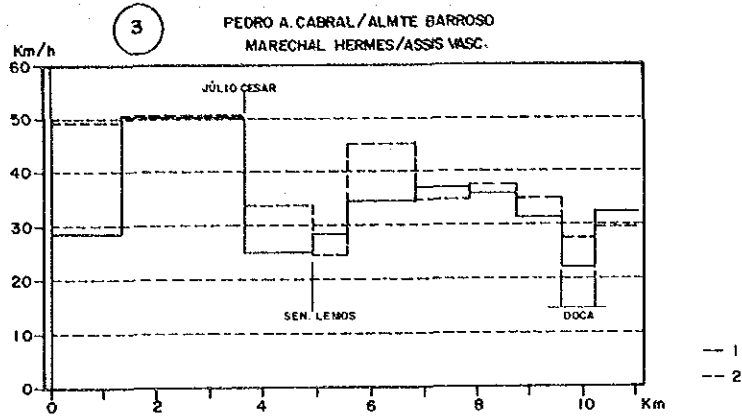
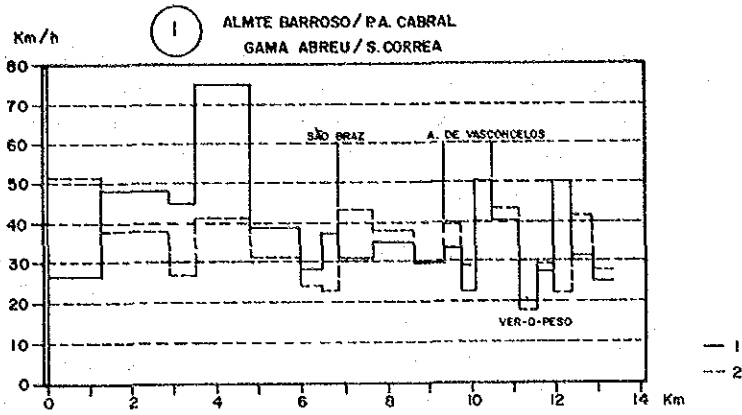


Figure 5.2-2 Travel Speed by Survey Corridor and by Section

of the speed reduction to 25 Km/h on Av. Doca de Souza Franco for the city center and to 10 - 15 Km/h before the intersection on Av. Senador Lemos with Av. Dr. Freitas in the mid-day and in the evening for Entroncamento.

155. The average speed on 1.1 Km R. Senador Barata (corridor No. 10), which crosses the central area from Av. Portugal to Av. Assis de Vasconcelos, is always around 5 Km/h because of the narrow road width and the road side friction by the commercial activities. The average speed on Av. Alcindo Cacela (corridor No. 11-b) at the section between Tv. Domingos Marreiro and Tv. Antonio Barreto reduces 8 to 15 Km/h in the mid-day and in the evening due to a number of traffic signals.

5.3 Traffic Management System

5.3.1 Organization

156. At present, there are two institutional organizations of Department de Transito (DETRAN) and Policia Militar (BATRAN) that are in charge of traffic control and enforcement. DETRAN plans the traffic management with approval by Para State Government. DETRAN also operates and maintains its system. BATRAN controls violations against traffic regulations.

157 . DETRAN has enforced traffic control on behalf of municipal government of Belem. But it was decided that municipal government of Belem would enforce traffic control in Belem city hereafter, and now they are preparing to establish the organization for traffic control .

5.3.2 Traffic Regulations

(1) One-Way Regulation

158. Figure 5.3-1 shows the present one-way regulation in the Study Area. The one-way regulation is enforced in the Bairros of Comercio, Reduto, Batista Campos, Nazare, Cremacao and Sao Braz. Most of the major streets in these areas are regulated to be one-way except for a few. Such as:

- Av. Alcindo Cacela
- Av. Visconde de Souza Franco

This one-way regulation creates additional traffic capacities in the streets of these area, although those carriageways are not wide enough for the traffic.

(2) Speed Limit

159. For Av. Almirante Barroso, between Sao Braz and Tv. Bastos, the speed limit is regulated as 60 km/h in middle lanes ,and 40 km/h in curb lanes. For the other roads, the speed limits are regulated by road types which are categorized in the road classification, as follows:

- | | |
|---------------|--------------------|
| - Express way | speed limit 80km/h |
| - Artery | speed limit 60Km/h |
| - Distributor | speed limit 40km/h |
| - Local | speed limit 20km/h |

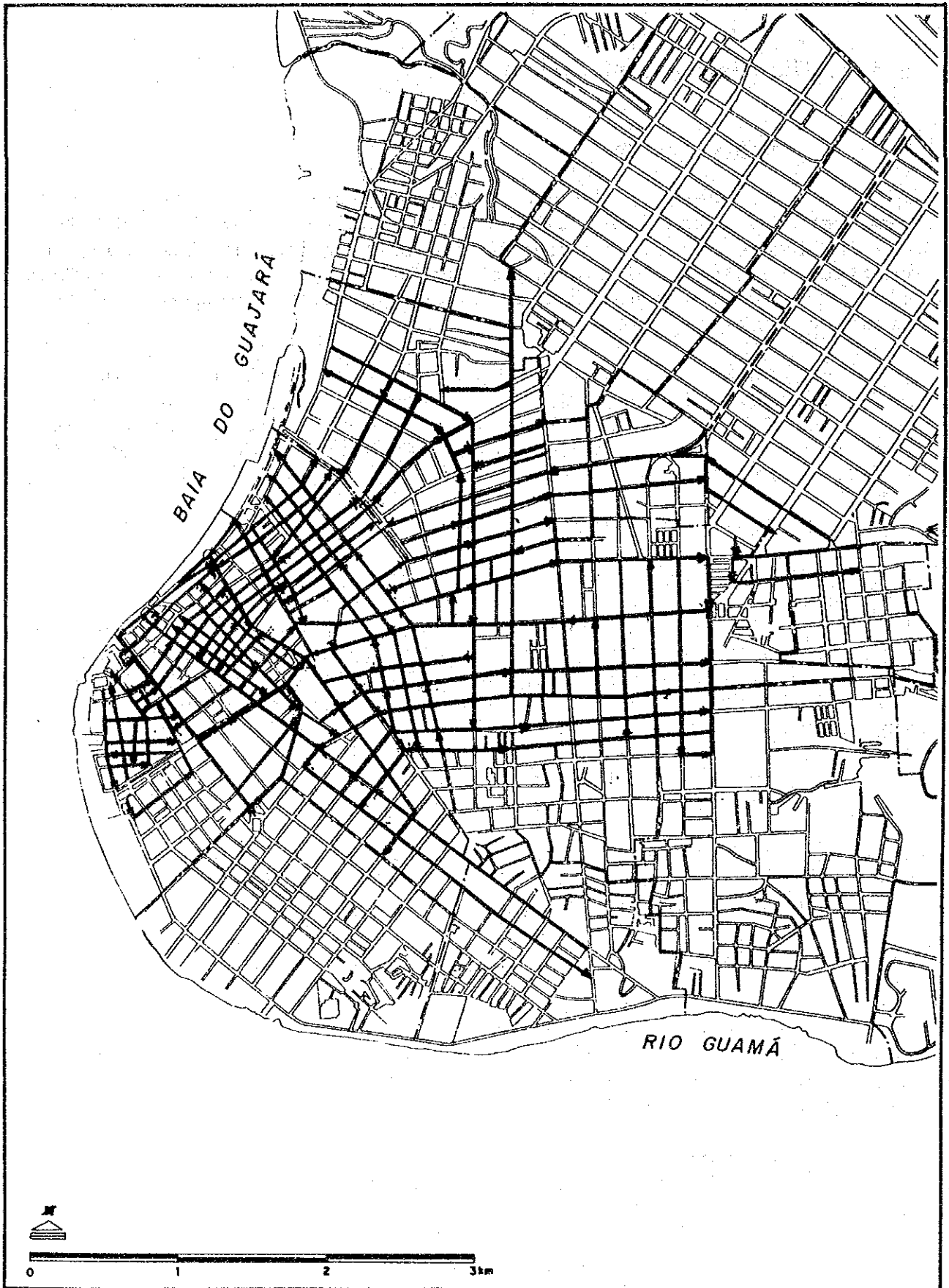


Figure 5.3-1 One Way Regulation in 1990

(3) Restrictions of Vehicle Operation

160. Heavy vehicles are restricted from operating within Comercio area for the whole day, where most of the streets are narrow. In Av. Almirante Barroso, heavy vehicle regulation is enforced at 11:30 - 13:30 and at 17:30 - 19:30 during weekdays. In Boulevard Castilho Franco, the section between Tv. Frutuoso Guimaraes and Av. Portugal, vehicles are prohibited to enter, except the public transport types such as taxis and buses.

(4) Major Street/Minor Street in Unsignalized Intersections

161. The order of major/minor street in unsignalized intersection is defined by hierarchy of streets. At the intersection where the same hierarchy streets cross, the order is decided by taking into account the road widths and the traffic volumes. In these unsignalized intersections, stop signals or stop signs are installed for traffic safety.

5.3.3 Traffic Sign

(1) Sign

162. There are three types of signs in the Study Area. Regulatory signs, warning signs and guide signs. The dimensions are shown as follows:

-	Regulatory sign	urban area	diameter 0.40m
		suburban area	diameter 0.75m
	(stop sign		a side 0.25m)
-	Warning sign	urban area	a side 0.45m
		suburban area	a side 0.60m

163. In urban area, the regulatory signs are installed on vertical poles, whose height are 2.0 m, or are installed on high-poles for mounting signal sets.

164. Traffic signs are hard to see in the night, because those are not reflector signs and are, in some cases, soiled. Regulatory signs for one-way regulation in urban area, are installed only on one roadside, therefore they are hard to be observed by motorist driving on right side of an intersecting street.

(2) Markings

165. In urban area, the road surface is marked for stop line, lane line, pedestrian crossing, and on-street parking. Most markings are missing especially pedestrian crossing markings which can seldom be seen.

5.3.4 Signal

(1) Locations

166. There are two types of signal sets, one is traffic control signal and the other is stop signal where a yellow lamp is used as stop sign. Figure 5.3-2 shows the locations of signalized intersection. There are traffic control signals at 179 intersections and stop signals at 9 intersections in the Study Area.

167. Synchronized control is operated only for seven (7) intersections on Av. Pres. Vargas, in COMERCIO area, where the synchronized velocity is set at 20 km/h. On Av. Alminante Barroso synchronized control had been operated, however when controllers was replaced, its operation was stopped. The criteria for signalizing is not defined and recently, the intersections are signalized without any traffic volume counting.

(2) Standard Installation of Signal Sets

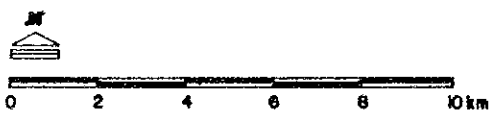
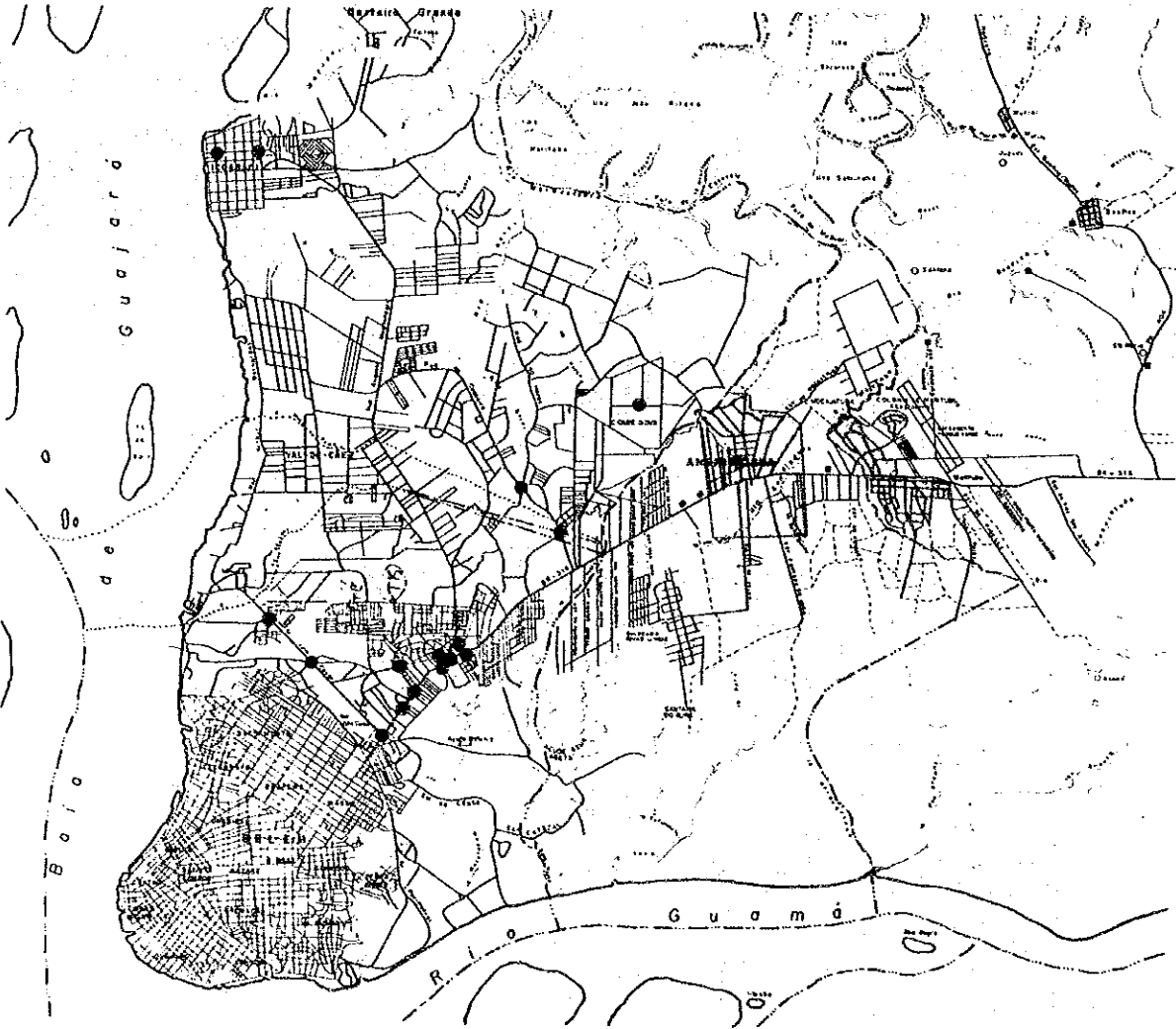
168. In general, two signal sets are installed for one approach on major road, while one signal set for one approach on minor road. This conditions can vary depending on road width and visibility.

169. Pedestrian signals are installed only at 21 intersections, equivalent to 11% of all signalized intersections. Generally they do not seem to give careful consideration to the safety of pedestrians in the Study Area.

(3) Parameter for Signal system

170. Figure 5.3-3 shows the distribution of cycle length. As can be seen, they are short at all signalized intersections; the composition rate of cycle length ranged from 40 seconds to 50 seconds in 35% of the total and under 60 seconds for about 73%.

171. Figure 5.3-4 shows platoon ratio and "arrival type" at major intersections. Arrival type is the general categorization that attempts to approximately quantify the quality of progression on the approach. Table 5.3-1 gives approximate ranges of platoon



- Traffic Signal
- Step Signal

Figure 5.3-2(B) Location of Signal Sets

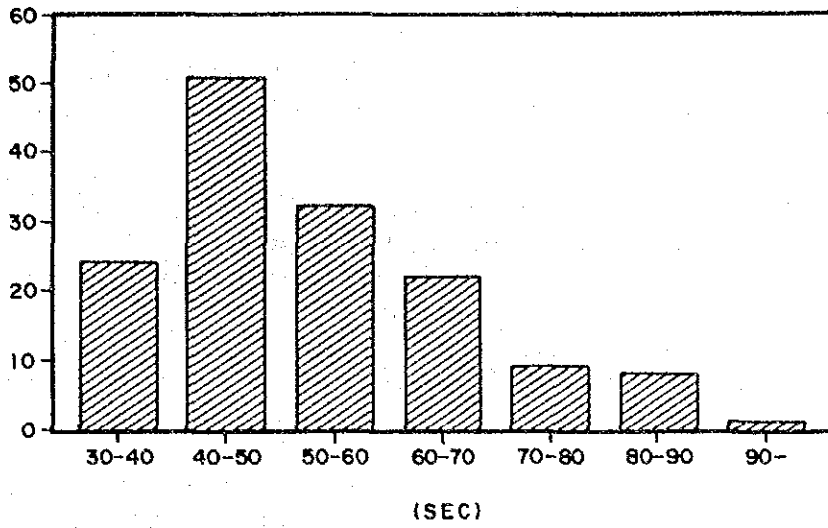


Figure 5.3-3 Distribution of Cycle Length

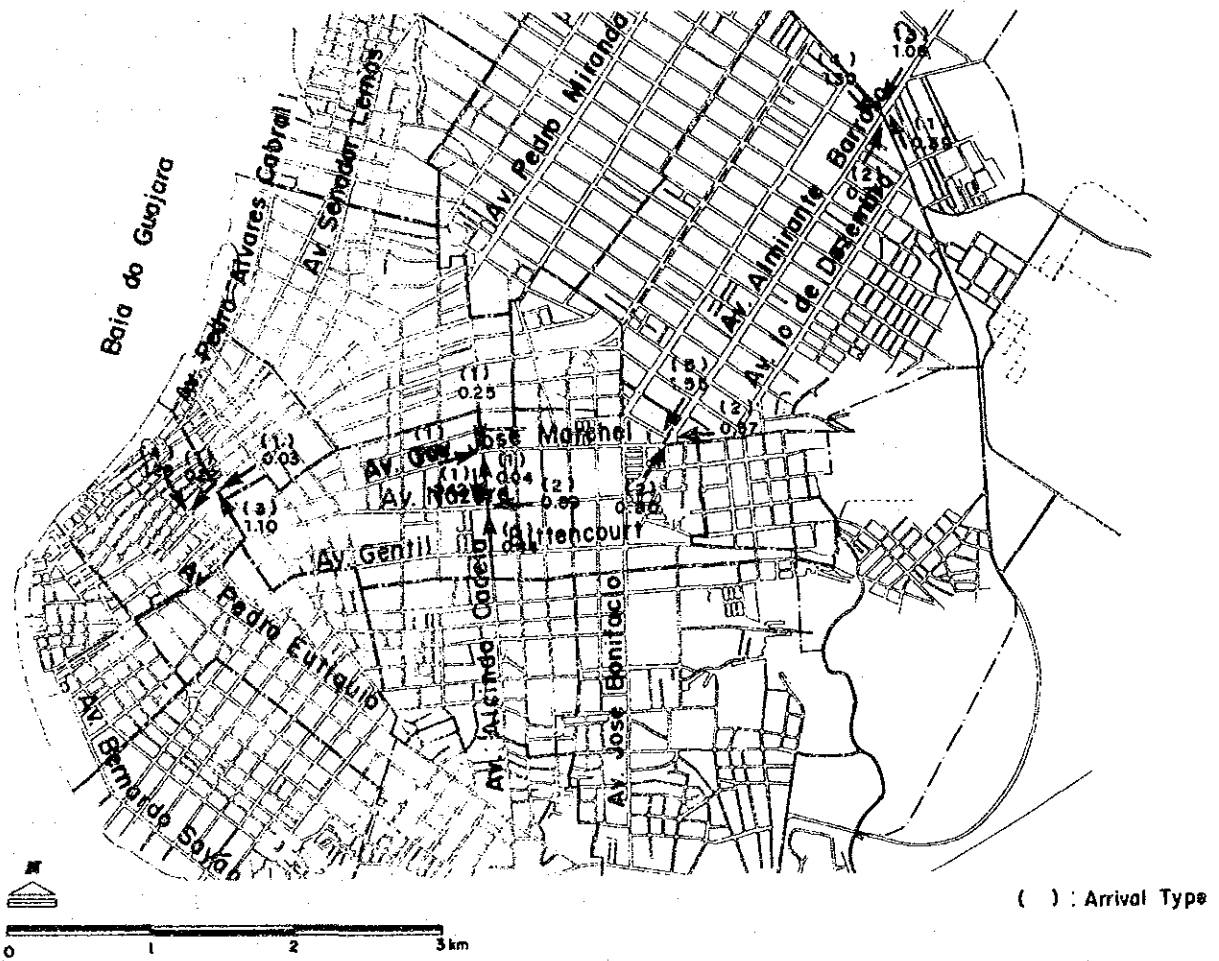


Figure 5.3-4 Platoon Ratio and Arrival Type in Major Intersection

ratio related to arrival type. It is recognized from the Figure 5.3-4, for example;

- Av. Almirante Barroso: progression on the approaches for the city center is good, but it is not so good for the suburban area.
- Av. Governador Jose Malcher and Av. Alcindo Cacela: the progression on the approach is bad.
- Av. Pres. Vargas: the progression on the approach is good due to the synchronized control.

It seems necessary to improve those parameters for independent signal control system considering their bad platoon condition.

172. Phase number is 2 for 90% of all signalized intersections, because almost all intersections are crossings of one-way roads.

Table 5.3-1 Relationship Between Arrival Type and Platoon Ratio

Arrival Type	Platoon Condition	Range of Platoon Ratio (Rp)
1	A dense platoon arriving at the beginning of the red phase	0.00 - 0.50
2	A dense platoon arriving during the middle of the red phase	0.51 - 0.85
3	Totally random arriving	0.86 - 1.15
4	A dense platoon arriving during the middle of the green phase	1.16 - 1.50
5	A dense platoon arriving at the beginning of the green phase	1.51 -

where : $R_p = \text{platoon ratio}; R_p = \text{PVG}/\text{PTG}$
 $\text{PVG} = \text{percentage of all vehicles in the movement arriving during the green phase}$
 $\text{PTG} = \text{percentage of the cycle that is green for the movement}; \text{PTG} = (\text{G}/\text{C}) \times 100$
 $\text{G} = \text{green time}$
 $\text{C} = \text{cycle length}$

(4) Controller

173. There are two types of local controllers in the Study Area, one is electro-mechanical controller and the other is electronic. In recent years, the former type has been replaced with the electronic one, whose composition rate is approximately 70% of the whole signalized intersections.

174. Table 5.3-2 shows the function of controllers by type. Their functions are subject to restriction in controlling the traffic flow in response to hourly fluctuation of traffic demand.

Table 5.3-2 Functions of Signal Controller

	Electro-Mechanical Controller	Electronic Controller
Control method	fixed-time	fixed-time
No. of signal sets	Maximum 40	ignorance
No. of phase	free	2
Flashing control	impossible	impossible
Synchronized control	possible	impossible

(5) Maintenance

175. Figure 5.3-5 indicates the daily number of break down of the signal systems in December, 1989. The break down for signal systems occurs every day in some sections.

Unit: Cases

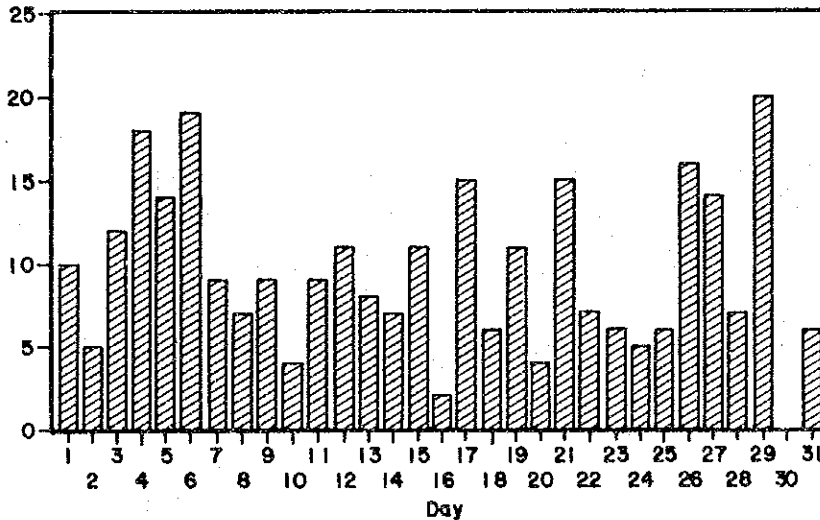


Figure 5.3-5 Signal Trouble in December, 1989

176. Figure 5.3-6 shows the causes of break downs of signal systems. The most frequent cause is burning out of the light bulb, which represents approximately 70% of all causes. The break down of the signal controller system is approximately 20 %.

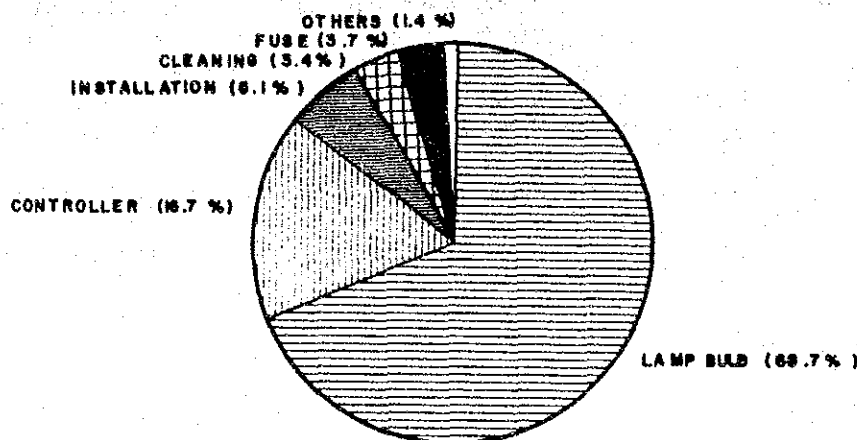


Figure 5.3-6 Causes of Signal Troubles in December, 1989

5.3.5 Traffic Accidents

177. Figure 5.3-7 shows the annual number of traffic accidents from 1971 to 1989 in Belem city. The number of traffic accidents decreased between 1981 and 1985, but in recent years the tendency for traffic accidents is increasing.

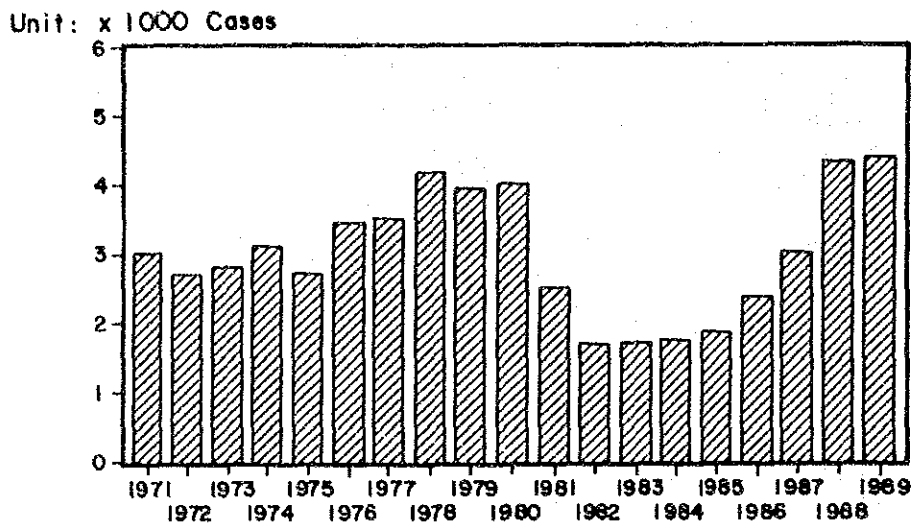


Figure 5.3-7 Annual Traffic accidents

178. Figure 5.3-8 shows the intersections of frequent traffic accidents between 1987 to 1989. From this figure the following can be noted:

- a. There are many accidents on the route of Av. Almirante Barroso
- b. Av. Governador Magalhaes Barata-Av. Nazare which form the major traffic corridor.
- c. The intersections of frequent traffic accidents (monthly average is more than 4 cases) are the following:
Av. Almirante Barroso / Av. Dr. Freitas
Av. Almirante Barroso / Av. Julio Cesar
Av. Almirante Barroso / Av. Tavares Bastos

179. Figure 5.3-9 shows the causes of traffic accidents in Belem city. It is noted that 20 percent (%) of the total traffic accidents occur by disregarding the signal and ignoring the stop sign.

180. Figure 5.3-10 shows the causes of traffic accidents in the intersections of frequent traffic accidents. It shows that disregarding signal reaches more than 20 % of all cases.

5.3.6 Major Issues on Traffic management

181. The major problems on traffic control are classified as follows:

(1) No clear hierarchy of streets in urban area

182. In urban area the streets have similar road width except some roads and there are many intersections because of high road density. Therefore, hierarchy of streets is not apparent. This is troublesome from the stand point of traffic safety.

(2) Low efficiency on traffic signal system

183. The following two cases are pointed out:

- a. Signals are operated by fix-time control system all day in spite of traffic volume fluctuation.
- b. Synchronized control is not operated in spite of continuous linked intersections.

(3) Insufficient maintenance

184. It is very difficult to expect through traffic control because of the insufficient maintenance of the traffic control facilities, markings, signs and signals. This condition decreases the reliability of traffic control.

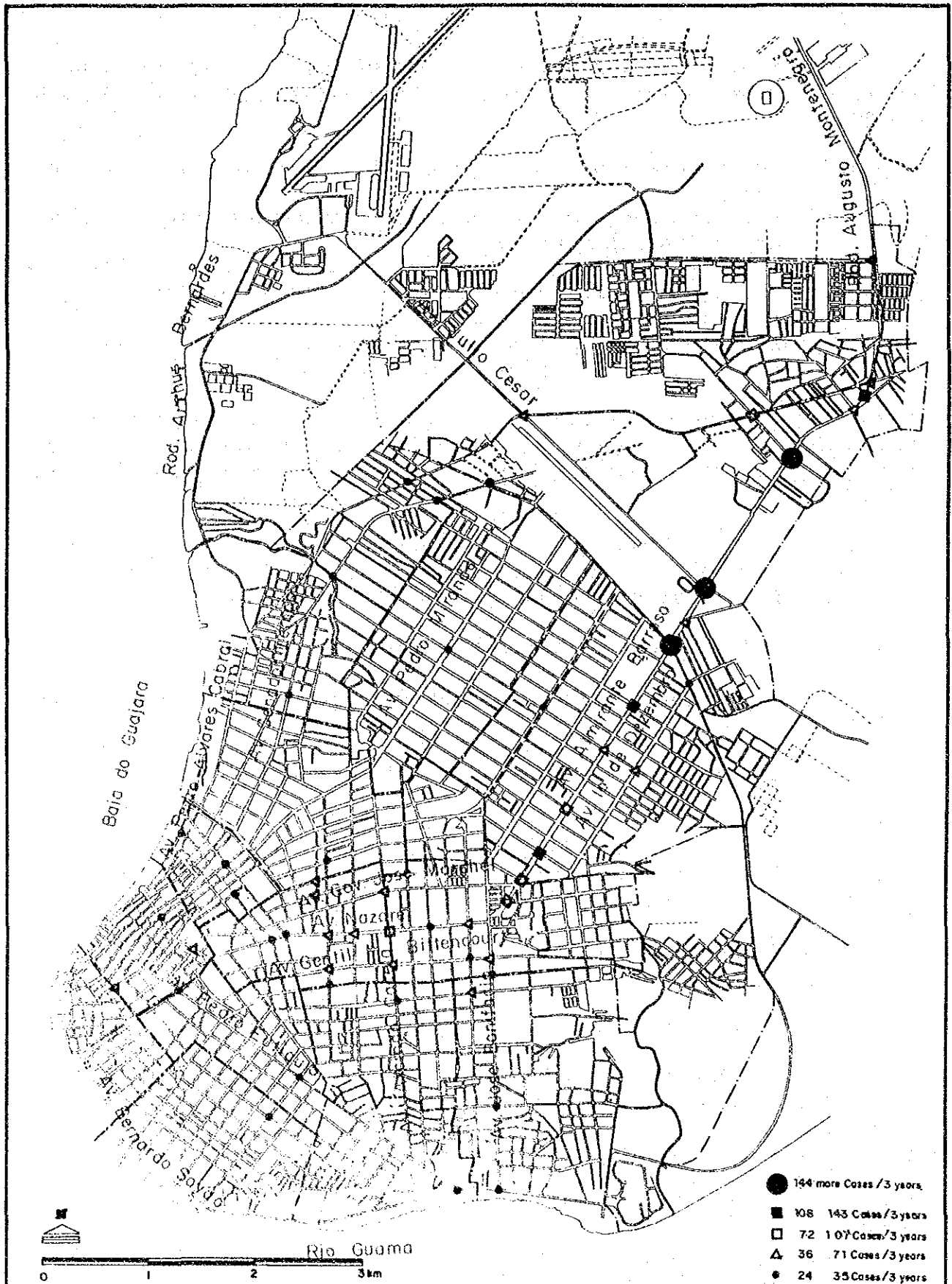


Figure 5.3-8(A) Intersections of Frequent Traffic Accident



Figure 5.3-8(B) Intersections of Frequent Traffic Accident

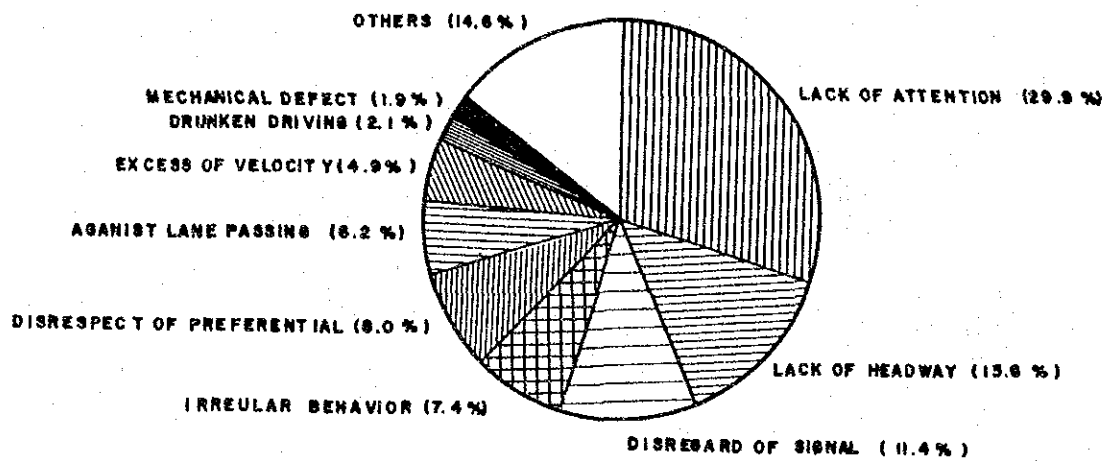


Figure 5.3-9 Traffic Accidents by Cause Type in Belem (1987-1989)

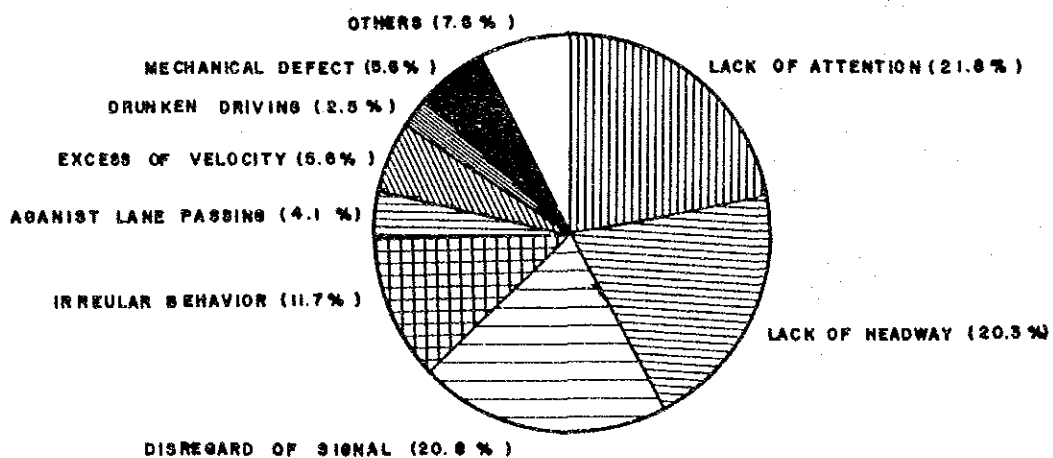


Figure 5.3-10 Traffic Accident by Cause Type
(Av. Alirante Barroso/ Av.Dr. Freitas)

(4) Little attention to traffic safety

185. The major causes of traffic accidents are disregarding the basic traffic rules, not following the traffic signal and no attention to the others. One of the causes for traffic accidents is considered to be insufficient traffic control facilities' maintenance, however the main reason seems to be lack of driver's concern about traffic safety.

(5) Lack of consideration for pedestrian's safety

186. There are few pedestrian crossings and signals in Belem. It is necessary to be concerned for pedestrian's safety, because they are the weakest in the traffic circumstances.

(6) Communication among organizations concerning traffic control

187. At present each organization executes its duties independently for traffic control, planning, maintenance and enforcing. In this condition, it happens to create the discrepancies between the planning and the enforcing agencies. Therefore, it is necessary to make a consensus for traffic control and management policies by sufficient communication among the agencies concerned.

5.4 Parking

5.4.1 Parking Restriction

188. There are two types of curb parking restrictions in the Study Area. One is the area where every vehicle is prohibited curb parking, and the other is the area where only taxi and vehicles for loading/ unloading are able to park. There is no toll system for curb parking.

189. Figure 5.4-1 shows the streets where curb parking is restricted in urban area. On Av. Nazare and Av. Governador Jose Malcher where a large number of passenger cars and buses are moving, curb parking is restricted against every vehicle in order to maintain road capacity for heavy traffic flow. Within Comercio area of the CBD of Belem, curb parking is restricted on many streets. On R.C.J. Alfredo S. Antonio where many commercial shops concentrate, curb parking is prohibited for all vehicles.

5.4.2 Parking Capacity

(1) Curb Parking

190. Table 5.4-1 shows the capacities of curb parking in Comercio, Batista Campos and Nazare. These are estimated by block length and 5 meters lot length excluding the spaces for entrances. As can be seen, there are many parking lots because of high road density in these areas.

Table 5.4-1 Capacity of On-street Parking

Area (Traffic Zone)	Capacity (lots)
Comercio (2)	2,724
B. Campos (3)	3,836
Nazare (6)	3,589
Total	10,149

(2) Off-Street Parking Facilities

191. Off-street parking lots for public use are concentrated in Comercio area. All of them are by private management. There are no off- street parking lots which are public managed.

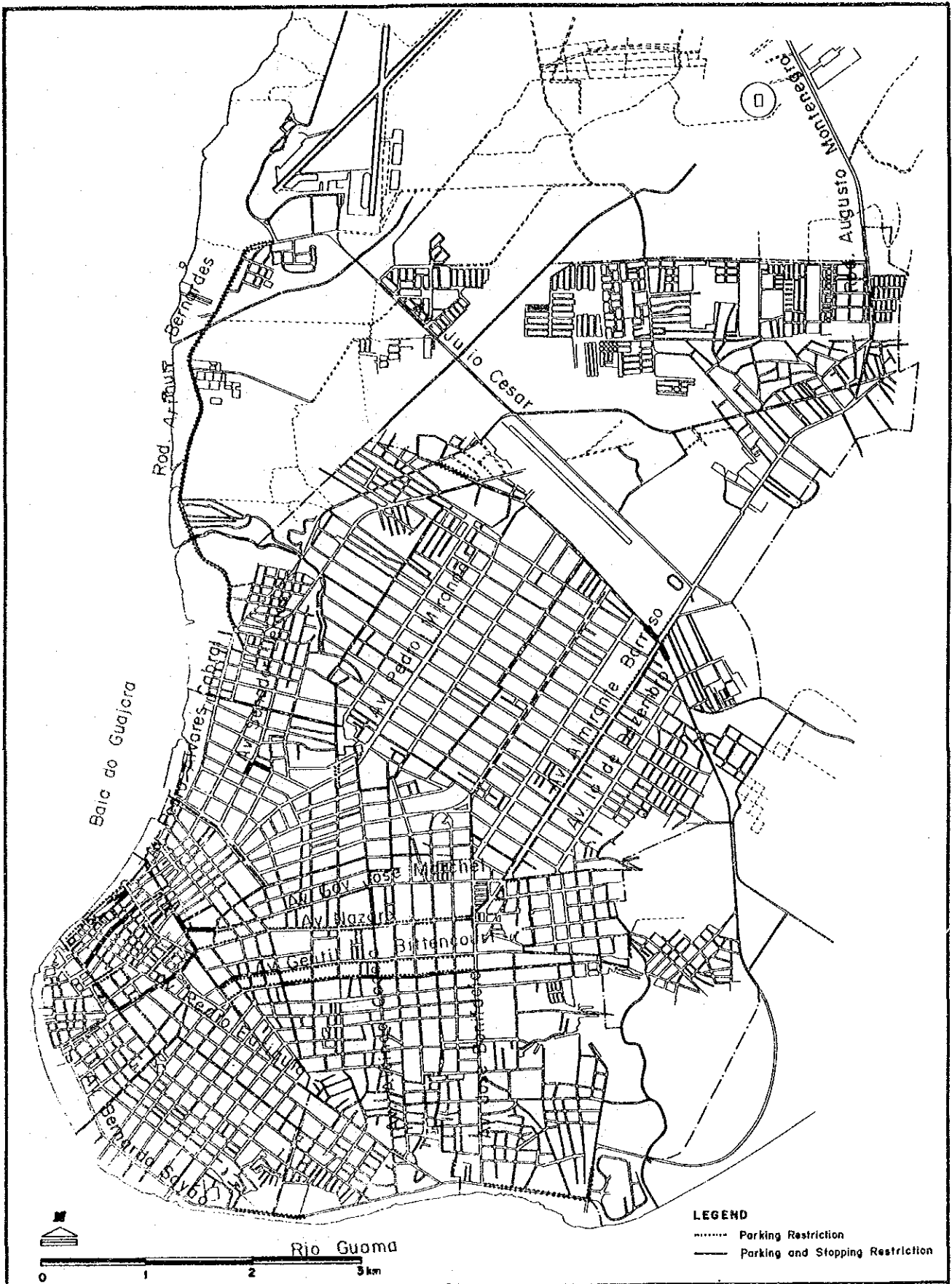


Figure 5.4-1 Parking Restrictions in Urban Area

192. Figure 5.4-2 shows the locations of current off-street parking lots and Table 5.4-2 shows their capacities in Comercio, Batista Campos and Nazare. There are 4,748 lots, about 40% of which are for public use. Some off-street parking lots for public use are available for monthly lease, and are used by residents. Others are used by hourly lease on daytime and by monthly lease on nighttime.

193. Parking lots which are used by public on hourly lease, concentrate in Comercio. They provide the temporary facilities on vacant area and are not so large, approximately 40 lots per one facility.

194. Parking fee in publicly used off-street parking lot is 0.6 US\$ per hour and 17.4 US\$ per month on the average (as of October 1990). Privately used off-street parking lots which belong to offices, banks, shops, hospital, etc., concentrate in Comercio and Nazare.

Table 5.4-2 Capacity of Off-street Parking

Zone	Public Use				Private Use				Total	
	Monthly Lease Only		Mon./Hourly Lease		Shop		Other		No	Lot
	No	Lot	No	Lot	No	Lot	No	Lot	No	Lot
Comercio	3	130	30	1,148	11	246	18	528	62	2,052
B. Campos	0	0	4	168	5	775	10	268	19	1,211
Nazare	4	107	10	376	2	97	36	905	52	1,485
Total	7	237	44	1,692	18	1,118	64	1,701	133	4,748

5.4.3 Parking Condition

(1) Parking Demand

195. Table 5.4-3 shows parking demand, excluding "To Home" purpose, in Comercio, Batista Campos and Nazare by PT survey. There is a high parking demand in Comercio and Nazare. As for the purpose, "To Work", "Business" and "Private", the demand is almost equal, occupying 98 % of the total. Parking demand for "To School" is generated in Batista Campos and Nazare, depending on the location of school. (refer to Figure 5.4-3)

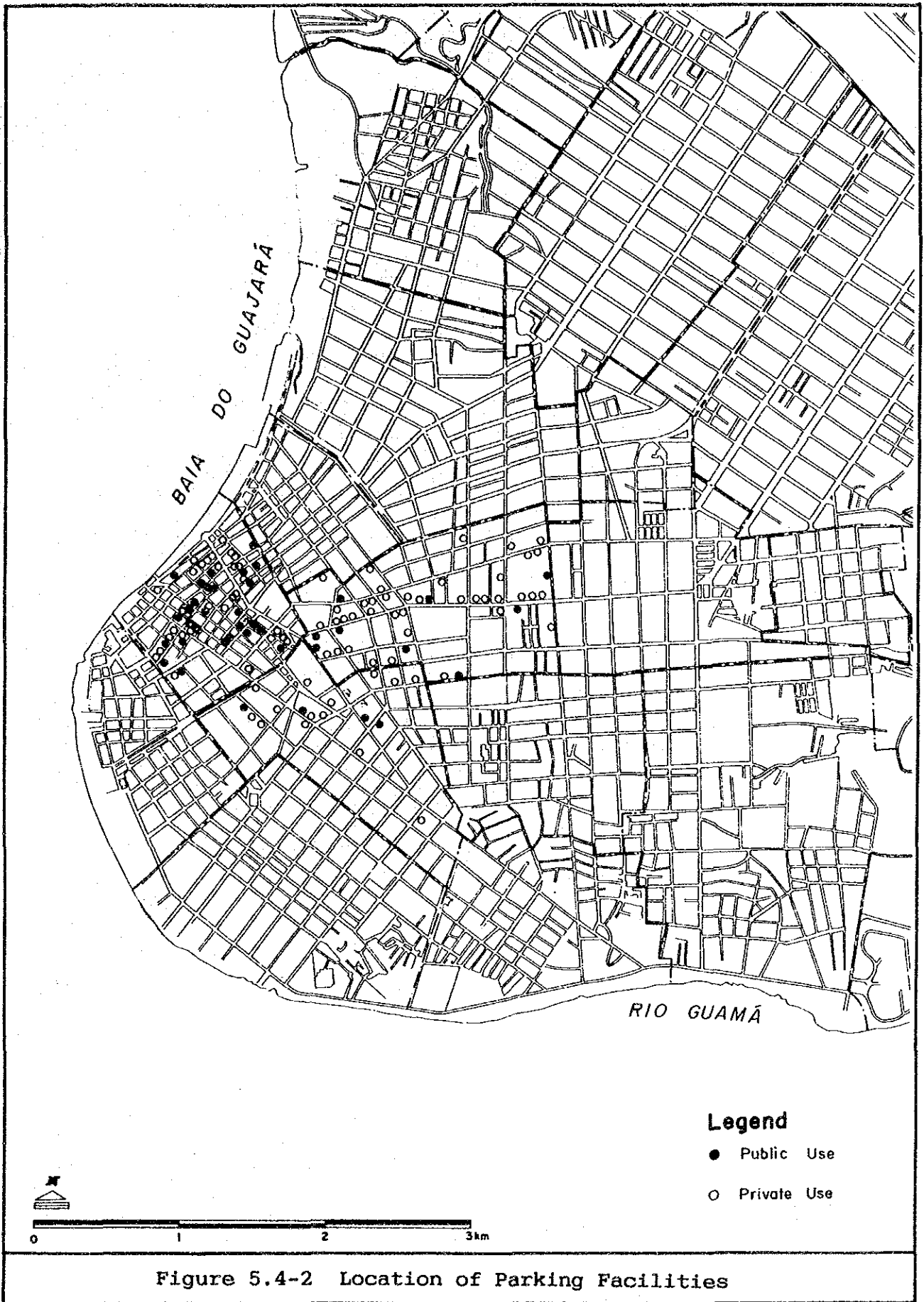


Figure 5.4-2 Location of Parking Facilities

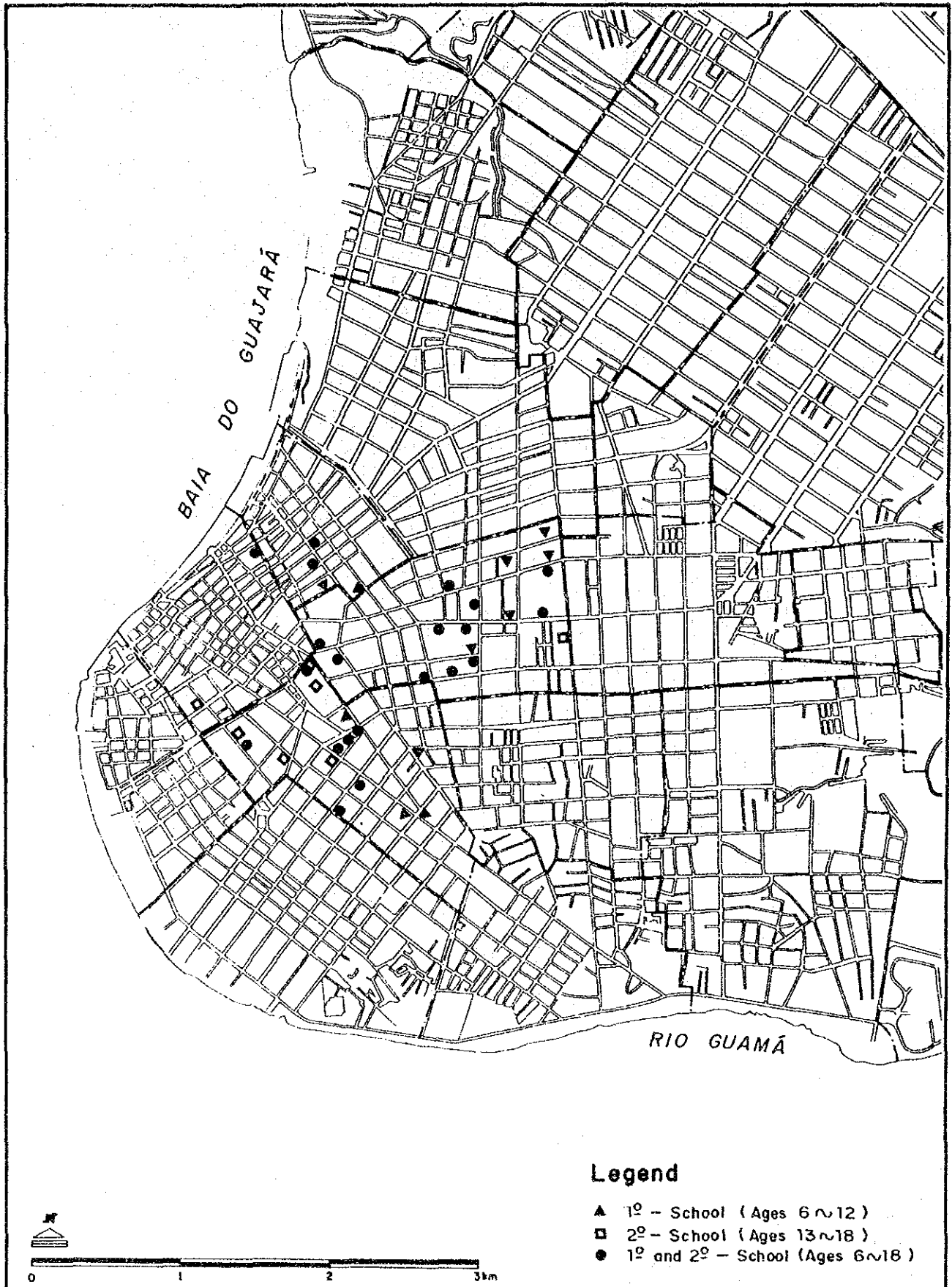


Figure 5.4-3 Location of School

Table 5.4-3 Parking Demand by PT-Survey (1990)

Area	To work	Business	To school	Private	Total
Comercio	11,288 (36.9)	10,652 (34.7)	39 (0.1)	8,680 (28.3)	30,659 (100.0)
Bat. Campos	2,067 (24.5)	3,012 (35.7)	318 (3.8)	3,030 (36.0)	8,427 (100.0)
Nazare	6,153 (27.1)	5,460 (24.1)	684 (3.0)	10,402 (45.8)	22,699 (100.0)
Total	19,508 (31.6)	19,124 (31.0)	1,041 (1.7)	22,112 (35.7)	61,785 (100.0)

Note: Composition Ratio in Parentheses

(2) Parking Density

1) Curb Parking

196. Table 5.4-4 shows the fluctuation of parking density on main streets in Comercio, Batista Campos and Nazare. As can be seen, the parking density in Comercio, is high, from 0.75 to 1.00 but in other areas it become less than 0.5. Therefore, there seems to be enough space for parking at present. Figure 5.4-4 shows the parking densities at peak hour on main streets.

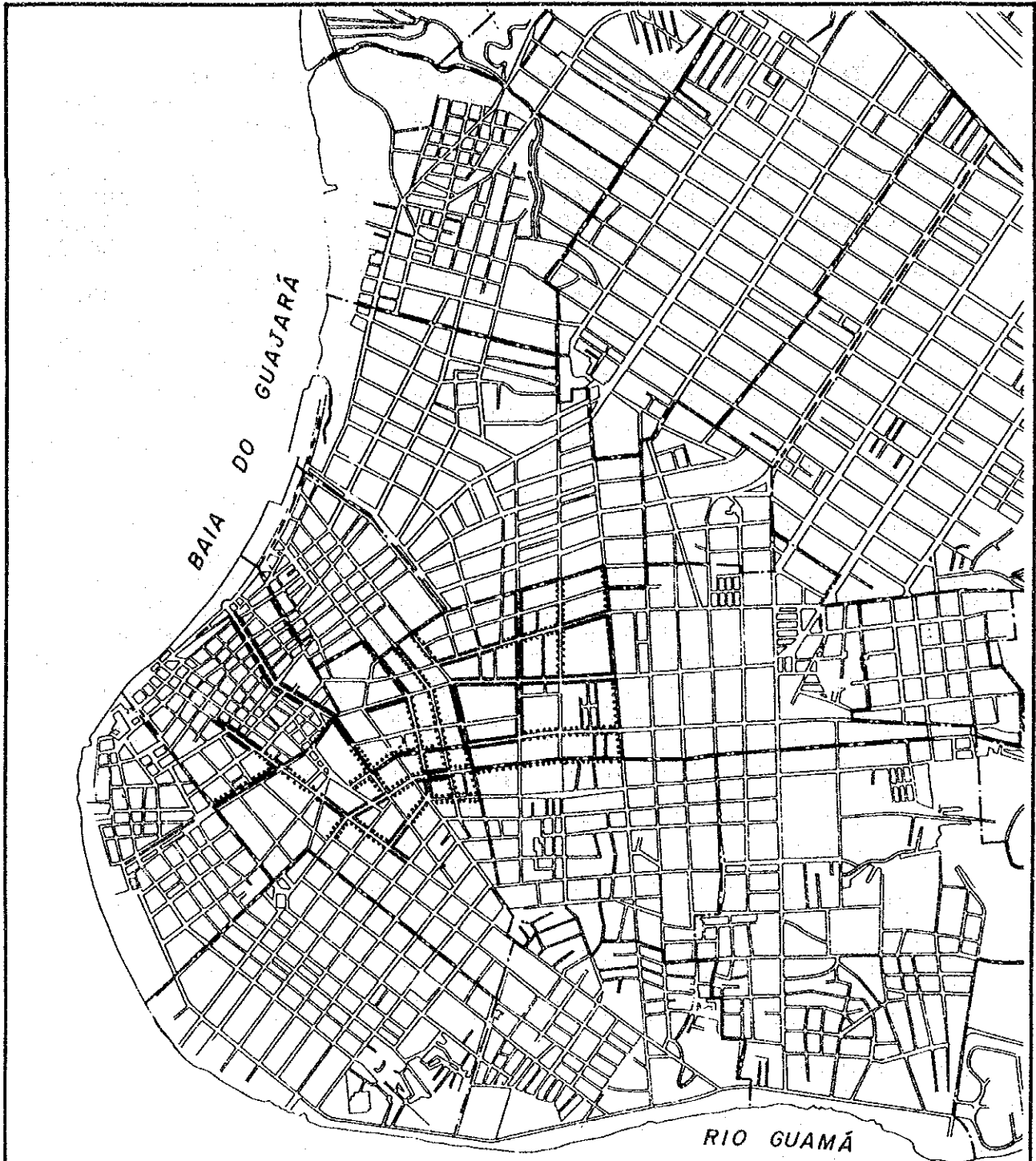
Table 5.4-4 Parking Density on Main Street

Area	10:00	12:00	14:00	16:00	18:00
Comercio	0.90	0.78	0.80	1.00	0.75
Bat. Campos	0.37	0.38	0.30	0.41	0.43
Nazare	0.46	0.36	0.35	0.41	0.45
Total	0.50	0.43	0.40	0.49	0.48

Note: Parking density = parking veh./capacity

2) Off-Street Parking

197. Table 5.4-5 shows the fluctuation of off-street parking. As can be seen, publicly used parking facilities show low parking densities, which means on-street parking is not saturated. The parking densities of the facilities belonging to offices are comparatively large, from 0.46 to 0.78, peak of which are at 10:00 and 16:00. Parking density of facilities belonging to shops increase in the evening, but is less than 0.5.



Legend

- Parking Vehicles / Capacity ≤ 0.5
- Parking Vehicles / Capacity $0.51 \leq < 1.00$
- Parking Vehicles / Capacity $1.00 <$



Note: Excluding Parking Restricted Street.

Figure 5.4-4 Parking Density on Main Street

Table 5.4-5 Parking Density on Off-street Parking Facility

Attribute	10:00	12:00	14:00	16:00	18:00
Public Use	0.27	0.29	0.24	0.29	0.23
Shop	0.27	0.17	0.13	0.31	0.40
Office	0.73	0.53	0.50	0.78	0.46

Note: Public use; average 3 facilities, total capacity 284
 Shop; average 3 facilities, total capacity 367
 Office; average 2 offices and 1 bank, capacity 103

3) Parking Duration

198. Parking survey was carried out at three areas for on-street parking and three lots for off-street parking in Comercio area, respectively, in order to investigate the parking characteristics. On-street parking areas were selected by such characteristics as office concentrated block (Area 1), public facility concentrated block (Area 2) and shopping street (Area 3).

199. Table 5.4-6 shows the average parking duration in each area. The average parking duration of on-street parking in Area 2 (public office area) is the longest one which is 1.73 hours, and in Area 3 (shopping street) is the shortest one which is 1.05 hours. The parking duration of off-street parking whose average is 1.76 hours, is longer than that of on-street parking.

Table 5.4-6 Average of Parking Duration

Type of Parking	To Work	Business	To School	Shopping	To Home	Others	Total
On-street							
Area 1	3.11	0.97	0.25	1.17	1.23	1.00	1.35
Area 2	2.74	1.29	-	1.27	2.77	0.86	1.72
Area 3	2.30	0.82	0.50	0.64	0.50	0.49	1.05
Total	2.76	0.98	0.38	1.01	1.47	0.84	1.36
Off-street							
Parking 1	2.04	1.09	-	0.99	0.88	0.35	1.34
Parking 2	3.02	0.76	1.48	1.45	1.08	1.15	1.73
Parking 3	2.67	2.04	-	0.33	3.82	1.08	2.51
Total	2.63	1.09	1.48	1.16	1.20	1.09	1.76

200. Figure 5.4-5 shows the cumulative curve of parking duration by purpose. The recognitions from figure are described as follows:

- a. As for the 85 percentile of the on-street parking duration, the duration for "To work" is the longest at 4.65 hours, followed by 1.68 hours for "Business" and 1.45 hours for "Shopping".

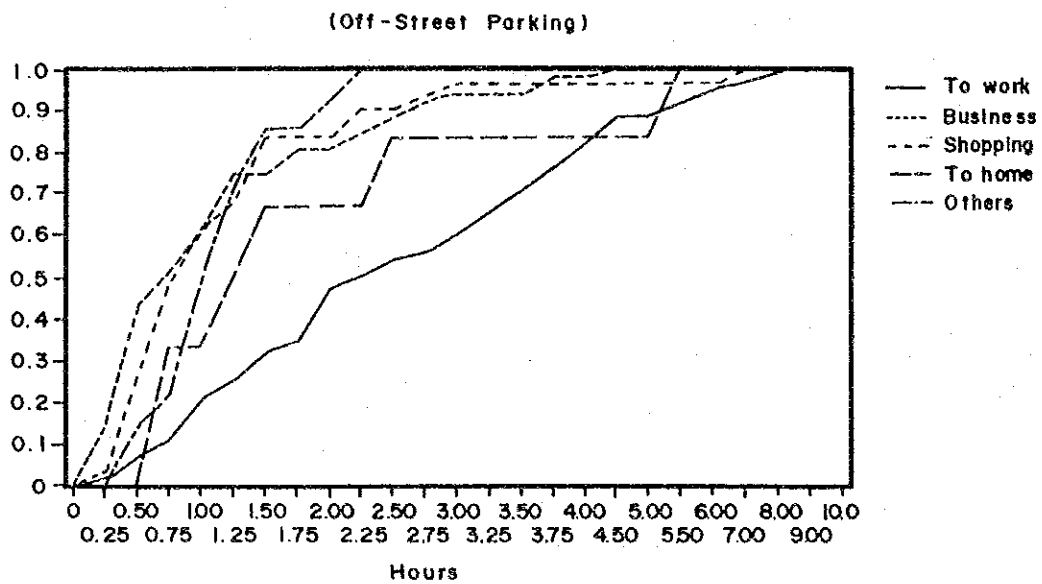
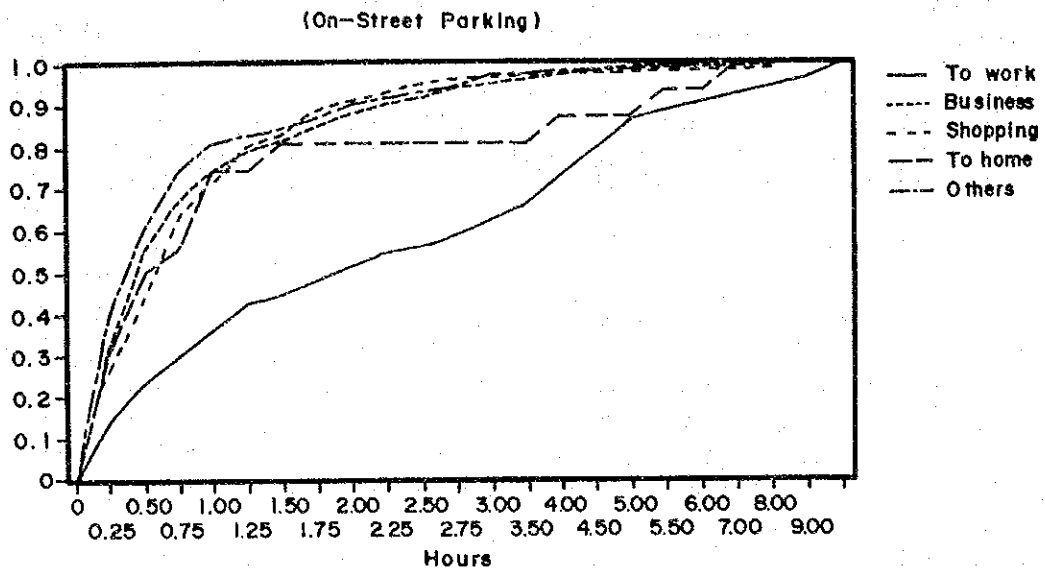


Figure 5.4-5 Distribution of Cumulative Parking Duration

- b. As for the 85 percentile of the off-street parking duration, the duration for "To work" is the longest at 4.09 hours, followed by 2.25 hours for "Business" and 1.95 hours for "Shopping". With regard to the purposes of "Business" and "Shopping", the off-street parking duration is shorter than that of the on-street parking.
- c. Most vehicles of "To work" do not park continuously all day, they break the parking at the lunch time.

4) Walking Distance

201. Figure 5.4-6 shows the cumulative curve of walking distance distribution by purpose. As for the walking distance on on-street parking, taking 85 percentile of distribution, the longest is 170 meters for "Shopping", followed by 117 and 102 meters for "To work" and "Business", respectively. On the other hand, in case of off-street parking, the longest is 475 meters for "Shopping" and 400 meters and 407 meters for "To home" and "Business", respectively.

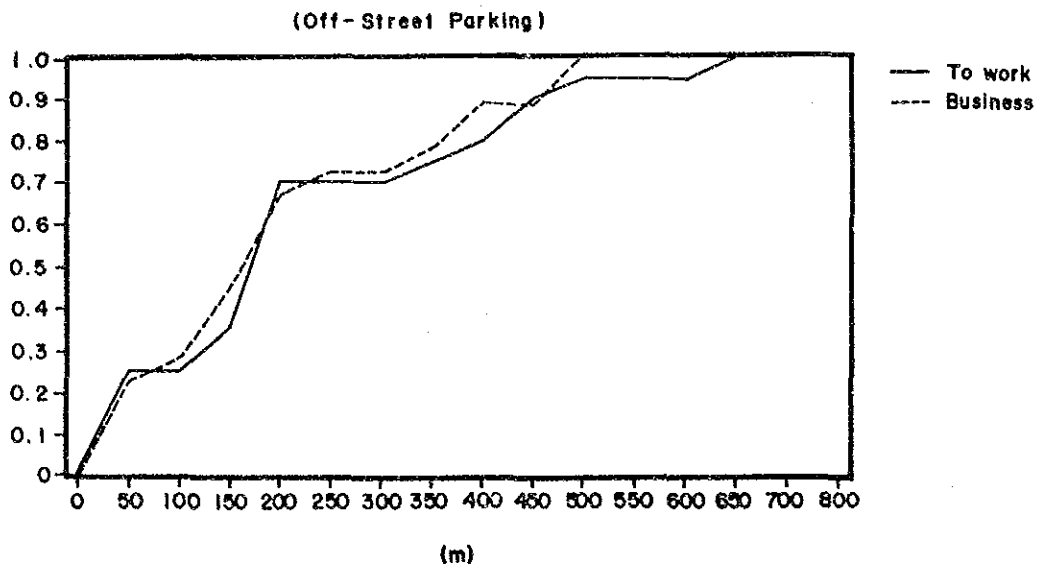
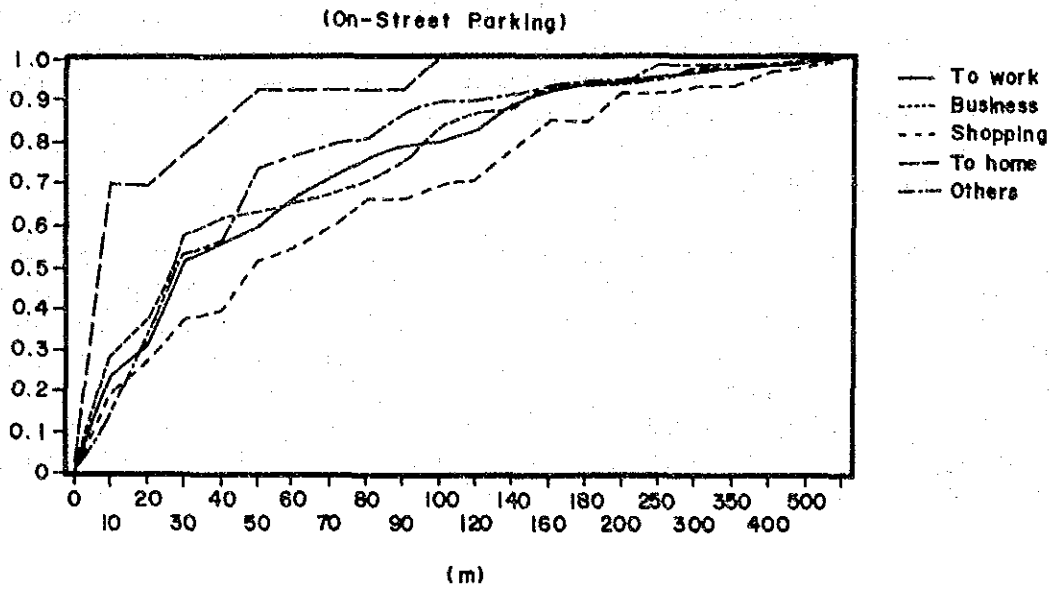


Figure 5.4-6 Distribution of Cumulative Walking Distance

5.4.4 Obligation on Parking

202. The city Act No. 7401 of Belem dated January 29, 1987 provided that parking lots be provided for buildings newly constructed. The details are explained in Table 5.4-7.

Table 5.4-7 Obligation of Parking Lots Belong to Building

Use	Scale	
House	until 150 m ²	1 lot
	150 to 300 m ²	2 lots
	more than 300 m ²	3 lots
Hotel	1 lot for every 5 guest rooms	
Supermarket	1 lot for every 10 m ²	
Hospital	1 lot for every 25 m ²	
Movie House/ Theater	1 lot for every 5 seats	
Wholesaler	1 lot for every 150 m ²	
Retail Trader	1 lot for every 100 m ²	
Others	1 lot for every 100 m ²	
Services	1 lot for every 100 m ²	
Industry	1 lot for every 20 employees	

Nbs: The buildings designated to business, services and industry should have a minimum area of 8.0 x 3.0 m for loading and unloading for every 1,000.0 m² floor areas.

Source: The City Act 7404 (29.01.1989)

5.4.5 Control of Curb Parking

203. Between 1984 to 1985 within Comercio area, curb parking had been controlled by introducing the toll system and the limited parking duration. Vehicles could park either for 6 hours in the area called "blue zone" or for 2 hours in the area called "Green zone". However, this system was abandoned due to the poor performance, because that curb parking was controlled by children as one of the counter plan against the poverty. At present, the policemen of BATRAN control the curb parking restriction. A penalty for the parking violation, such as double parking, on side walk parking or illegal parking, is the monetary charge of US\$ 40.9 (at October in 1990).

6. Public Transport Survey

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Public Bus Operation ▼



6.1 Overview

204. Major means of public transport are buses. Share of bus to the all of unlinked trips except "walk" trip is 77 percent (hereinafter unlinked trips are referred as trips without any notice. refer to Table 6.1-1).

Table 6.1-1 Share of Unlinked Trips by Transport Mode
(excluding walk trips)

Trip Purpose	Transport Mode				Total
	Bus	Taxi	Car	Others	
To Work	255764 0.75	7163 0.02	77476 0.16	31956 0.07	472359 1.00
To School	179520 0.84	2263 0.01	28866 0.14	1882 0.01	212531 1.00
Business	48085 0.37	1607 0.01	72347 0.56	7517 0.06	129556 1.00
Private & Others	447514 0.83	8523 0.02	75715 0.14	10629 0.02	542381 1.00
To Home	628453 0.77	20538 0.03	123563 0.15	40022 0.05	812576 1.00
Total	1659340 0.76	40094 0.02	377967 0.17	92002 0.04	2169403 1.00

205. Share of bus transportation is 7-8 % higher than average for "attending to a school" and for "on private trip". "Commuting to work" is 1 % lower than average.

206. Private companies provide bus transport. EMTU controls bus operation but after the state conceded control on bus operation to the municipality of Belem its capability on control has been decreasing.

6.2 Bus

6.2.1 Routes and Facilities

(1) Routes

207. Nineteen companies operate seventy routes. Additionally several routes operate only on weekends. Routes start from residential area at outskirts of the city, extend to the city center through several trunk roads, especially Av. Almirante Barroso and Av. Nazare/Av. Jose Malcher, and run around the Centro area and then return to starting points through same or adjacent roads (refer to Figure 6.2-1-A,B).

208. In the central area inside of Av. Dr. Freitas, bus route network is relatively dense, however in the suburban area it is sparse due to smaller demand and poor road network.

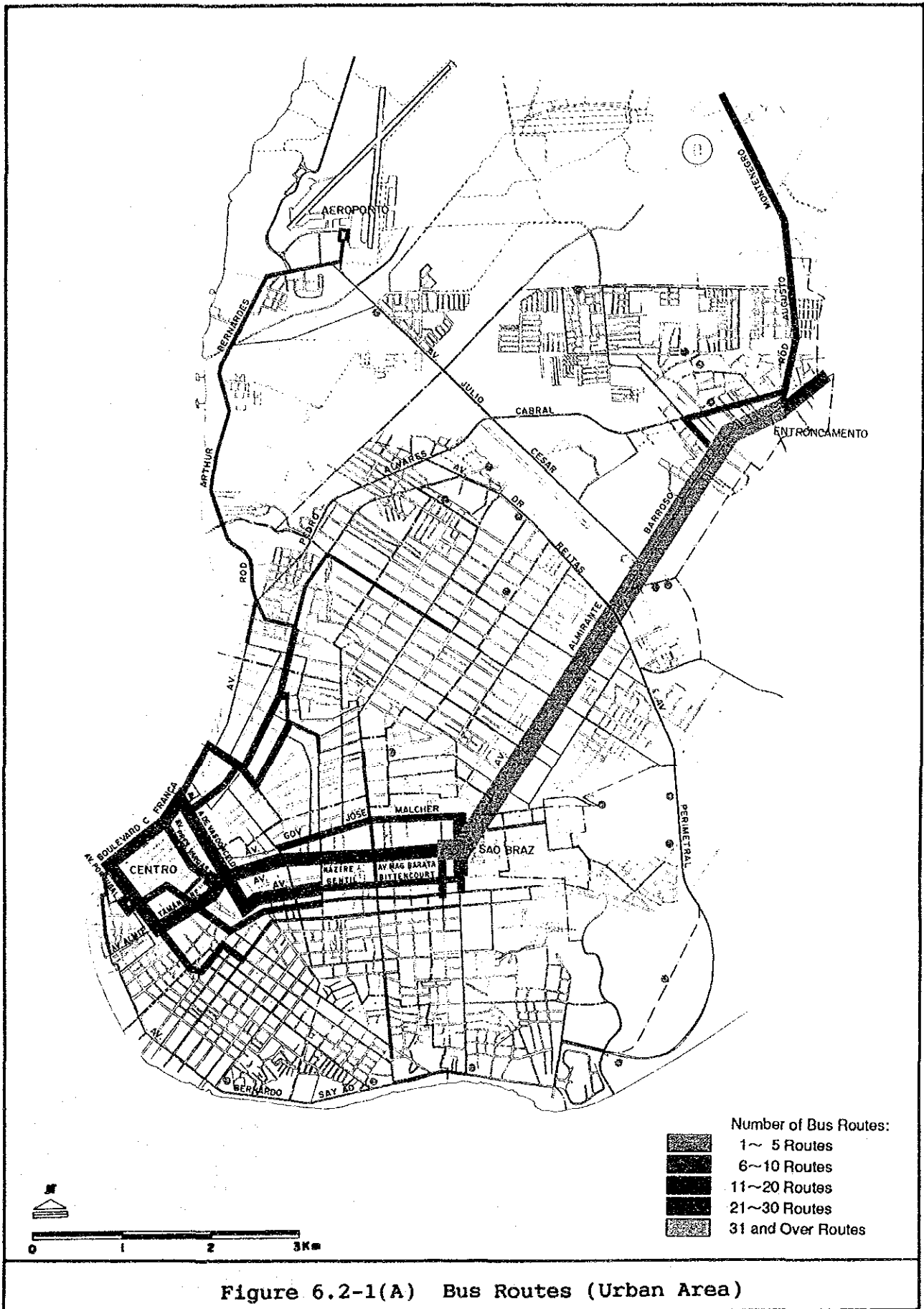
(2) Terminals and Bus Stops

209. Each route has a terminal at the end of the route. Facilities of these terminals are very poor and most terminals are located at roadsides. In the city center there are no terminals but "paradas seletivas" which are arranged in order to break up concentrations of bus fleets. At this moment (Jan. 1990), five "paradas seletivas" are located in the most congested areas (see Figure 6.2-2). As an example, "Paradas seletivas" of Sao Braz is shown in Figure 6.2-3. Terminals at ends of routes serve to regulate departure time.

210. The intercity bus terminal is located at Sao Braz. This terminal serves only intercity buses (including Belem-Mosqueiro) but not local buses. All passengers boarding and alighting at the intercity bus terminals are requested to walk to local bus stops along adjacent roads. (see Figure 6.2-3).

211. Bus stops are located at corners of most intersections along routes in the central part of the city and are designated with bus stop signs. Density of distribution of bus stops becomes lesser at the outskirts of the city but the location of bus stops is, in general, clearly marked with bus stop signs. Total number of bus stops in Belem Metropolitan Area (hereinafter refer to BMA) is 1657, in which 855 are at inside of Av. Dr. Freitas and the rest, 802, are at the outside (bus stops located in Outeiro and Mosqueiro area are excluded for counting).

212. Distribution of access time to a bus stop by foot is indicated on Figure 6.2-4. The figure shows that most trips are in



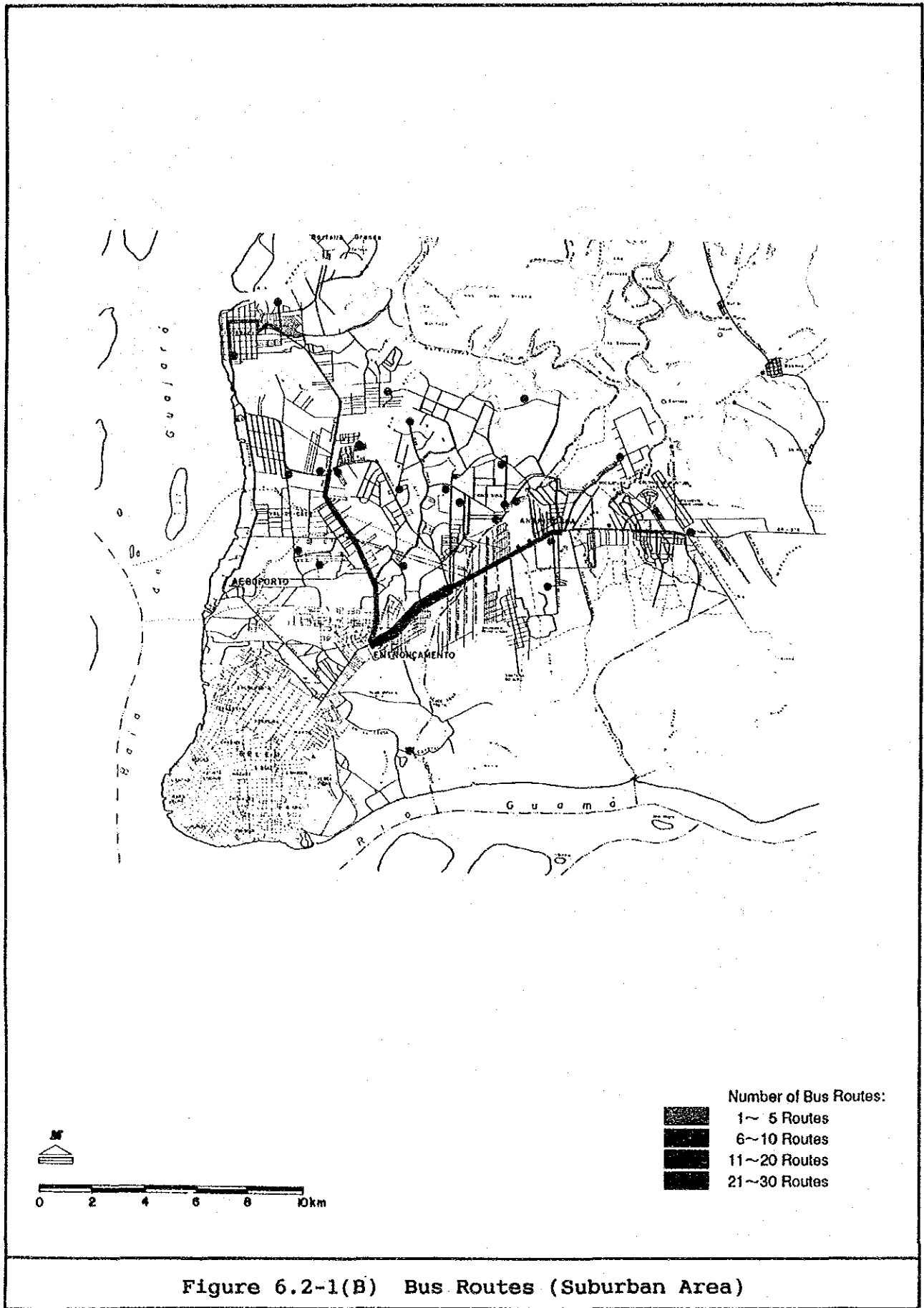


Figure 6.2-1(B) Bus Routes (Suburban Area)

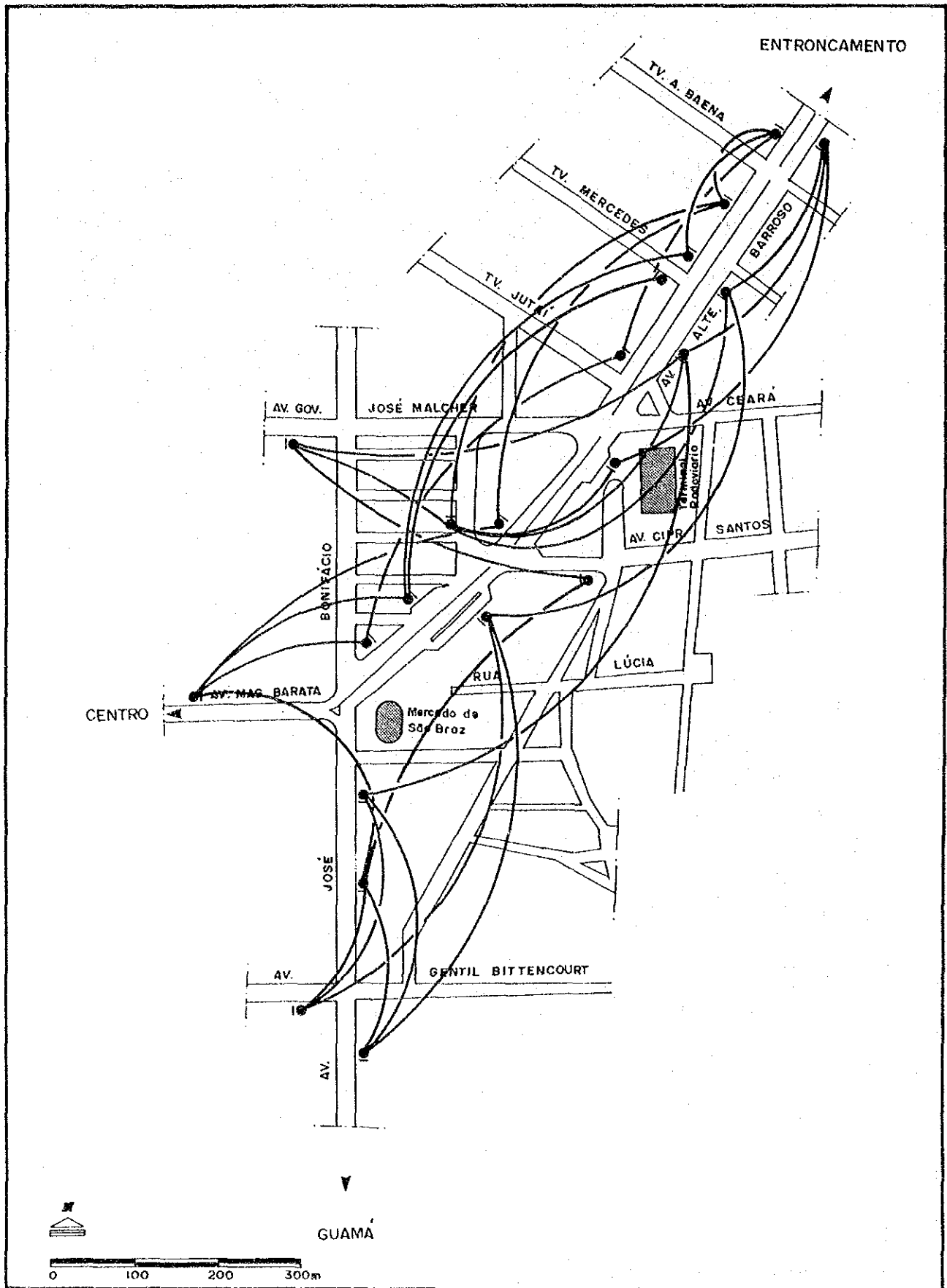


Figure 6.2-3 Parada Seletiva at Sao Braz

a range of five minutes walking distance. Percentage of walking distance more than fifteen minutes is 6.6 %. These results show that allocation of bus stops follows the demand.

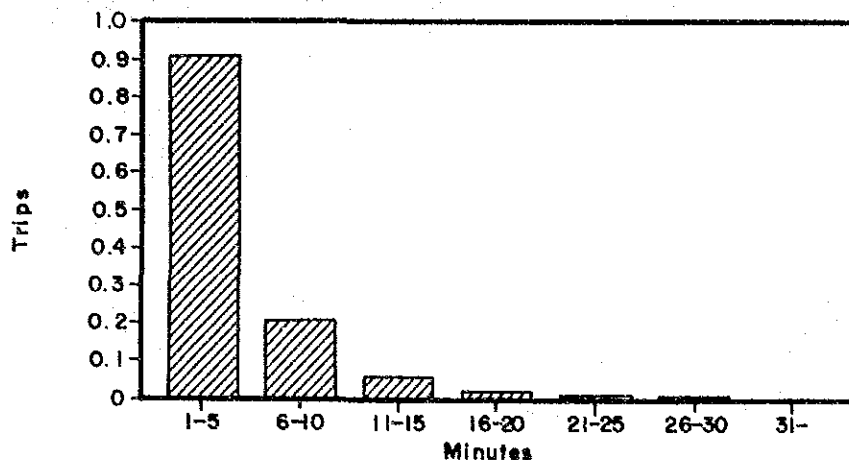


Figure 6.2-4 Access to Bus Stop

6.2.2 Demand

213. Field survey (executed March and April in 1990) covered 60 major routes (all routes except several local services) from 06:00 to 21:00. This time period applied to the departure time of buses from their terminals outside of the city. Demand data described hereinafter are based on this survey.

(1) Total Number of Transported Passengers and Monthly Fluctuation

214. Total daily demand counts 1.24 million. Monthly change of demand is generally in the range of 10 %. The total demand throughout year is shown in Figure 6.2-5 and Table 6.2-3.

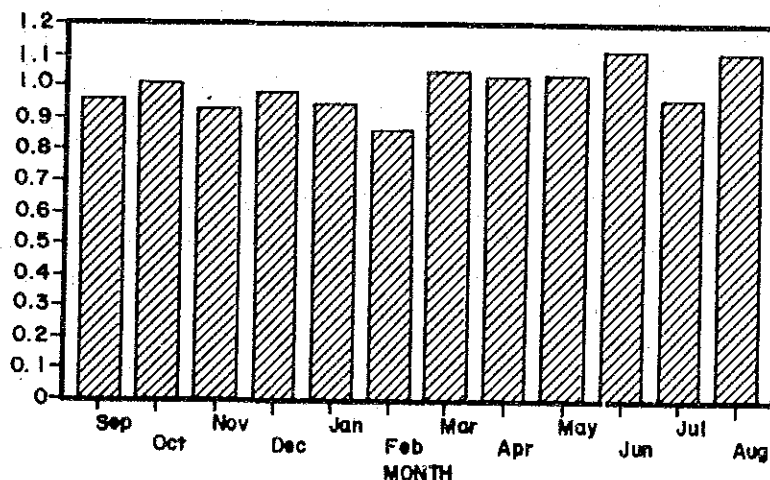


Figure 6.2-5 Monthly Fluctuation of Bus Passenger

(2) Demand by Route

215. The average number of passengers transported by route is 17 thousands a day. Figure 6.2-6 shows number of daily passengers of each route.

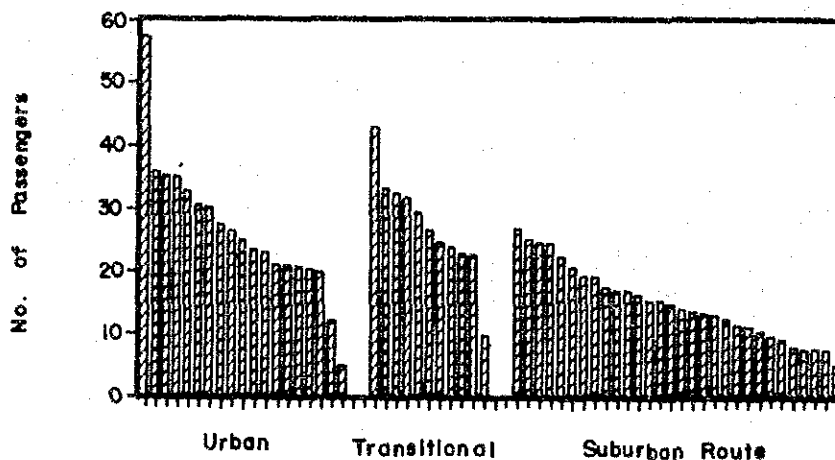


Figure 6.2-6 Daily Passenger on each Route

216. Bus routes are divided into three groups by terminal location at outside end. Urban routes start at inside of Av. Dr. Freitas (hereinafter urban routes) and suburban routes start at outside of Av. Augusto Montenegro (hereinafter suburban routes). Routes started at outside of Av. Dr. Freitas and inside at Av. Augusto Montenegro have intermediate nature of urban and suburban routes (hereinafter transitional routes).

217. Average numbers of transported passengers by each route group classified as urban, transitional and suburban routes are 26,266, 27,084 and 14,720 a day respectively. Suburban routes are composed of two types of routes. One is a suburb to the city center and another is intra-suburb. In general intra-suburb type routes serve small number of passengers with low frequency.

218. Share of passengers transported by each route group is illustrated in Figure 6.2-7. The urban route group and the suburban route group show almost same share, but the transitional route shows nearly half of the other two.

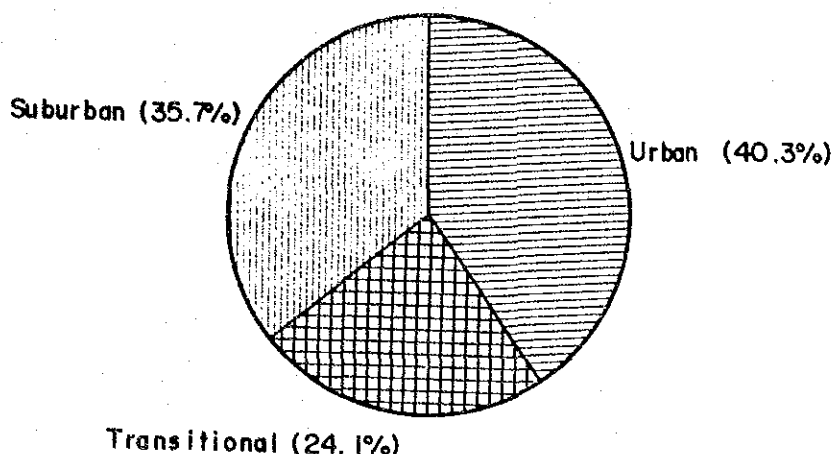


Figure 6.2-7 Share of each Route Group (passengers)

(3) Passengers Boarding and Alighting

219. Number of passengers getting on and off are summarized by "integrated bus stop" composed of several bus stops (hereinafter referred as "integrated bus stop"). Figure 6.2-8 illustrates integrated bus stops with large counts of passengers. Major integrated bus stops are lined along the trunk axis (Av. Almirante Barroso, Av. Gov. Jose Marcher/Av. Nazare and its extension to Av. Gentil Bittencourt and the outer ring of the Centro).

220. The largest five are Ver-o-Peso, Marechal Hermes/P. Vargas, Sao Braz, Nazare and Assis de Vasconcelos. In the case of Ver-o-Peso it shows 75,000 passengers boarding and alighting per day (Table 6.2-1).

221. From figure 6.2-8, it can be seen that Sao Braz, Alm. Barroso (Bosque Rodrigues Alves), Mag. Barata (Museu Emilio Guelde), Alm. Barroso/T. Bastos, Col. Lauro Sodre, Alm. Barroso/Julio Cesar, Mag. Barata/Castelo Branco and Entrocamento can be assumed to be major transfer points.

(4) Passengers on Board

222. Large on-board passenger flow are noticeable through Av. Almirante Barroso/Av. Nazare and roads parallel therewith. The number slightly decrease at inside of Sao Braz. The passenger flow observed at the links outside of Sao Braz was between 187,000-158,000 and inside of Sao Braz between 178,000-139,000.

223. The second large flow is from/to Icoaraci, Sacramento and Telegrafo direction.

224. Roads surrounding the Centro area show also noteworthy passenger flow. Av. Marechal Hermes shows especially large flow. (refer to Figure 6.2-9 and Table 6.2-2).

Table 6.2-1 Number of Passengers Boarding and Off

Seq. No.	Location Name	Number of Passengers		
		On	Off	Total
1	Ver-0-Peso	40723	33865	74588
2	Marechal Hermes/Pres. Vargas	28870	34374	63244
3	S. Braz(Terminal Rodoviario)	31038	29173	60211
4	Nazare	17851	34768	52619
5	Assis de Vasconcelos	19394	30149	49543
6	Praca Felipe Patroni	26426	22827	49253
7	S. Braz(Shopping)	18364	20298	38662
8	Presidente Vargas	22477	13828	36305
9	Alm. Barroso(Bosque Rodrigues Alves)	17499	16751	34250
10	Mag. Barata(museu Emilio Goeidi)	14505	18790	33295
11	Padre Eutiquip/Tamandare	21299	11977	33276
12	Pedro Miranda/Mauriti	14478	17956	32434
13	Alm. Barroso/Tavares Bastos	15068	16104	31172
14	S. Braz(mercado)	10056	18024	28080
15	Mauriti/Senador Lemos	14342	13064	27406
16	Bernardo Sayao/Conceicao	13053	13848	26901
17	Gentil/Quintino	16942	9439	26381
18	Colegio Lauro Sodre	12669	13061	25730
19	Jose Malcher/Alcindo Cacela	15190	9995	25185
20	Alm. Barroso/Julio Cesar	13528	11542	25070
21	Canudos	12128	11997	24125
22	Alm. Barroso/Mauriti	12355	10062	22417
23	Entroncamento	12433	9756	22189
24	Alm. Barroso/Humaita	9934	11999	21933
25	Assis de Vasconcelos/Marechal Hermes	11009	9845	20854
26	Senador Lemos/Luis Bentes	10299	10142	20441
27	Padre Eutiquio/Joao Diogo	7642	12213	19855
28	Universidade	9565	10098	19663
29	Pedro Miranda/Humaita	9671	9946	19617
30	Mag. Barata/Castelo Branco	11414	8159	19573

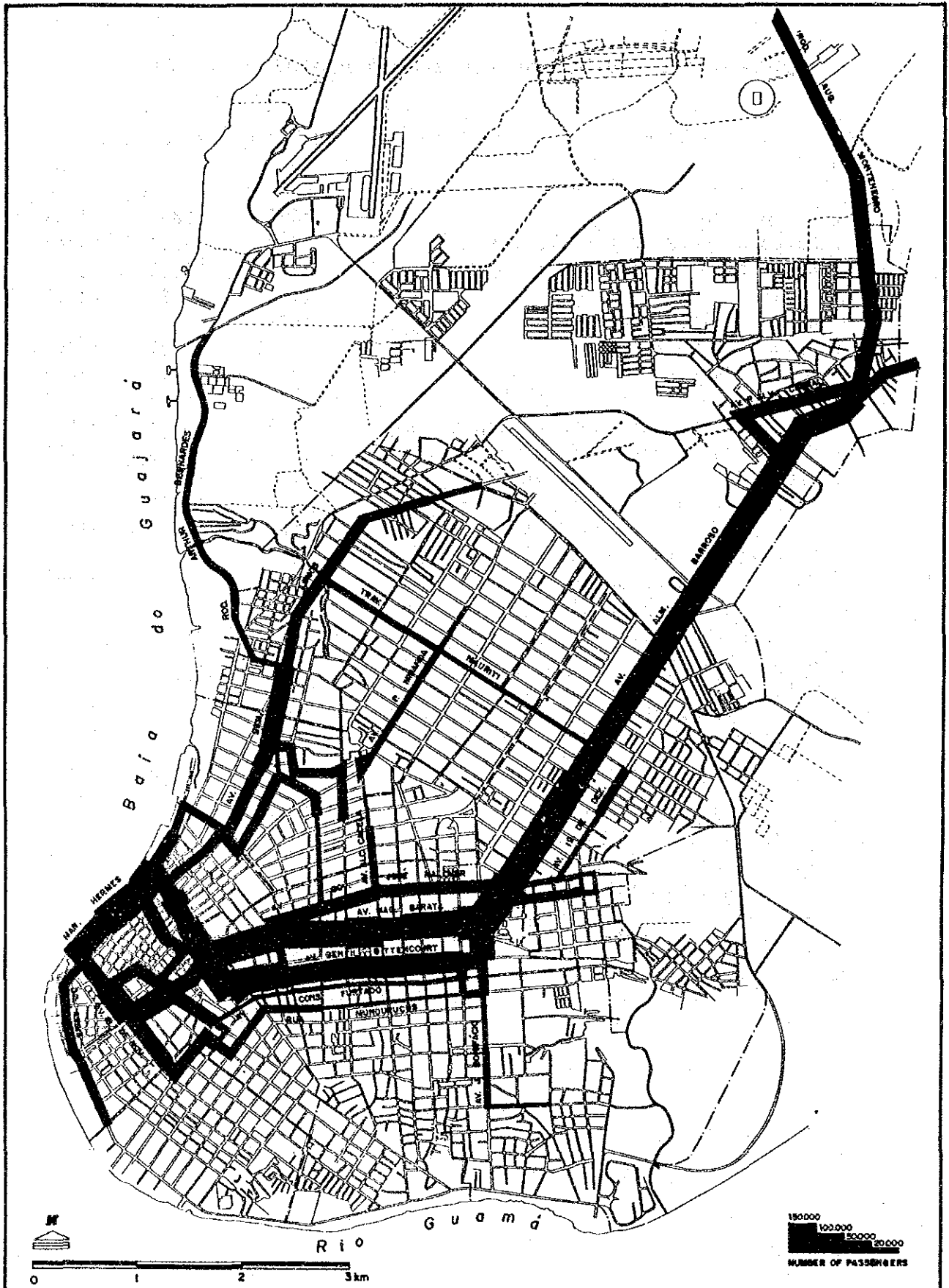


Figure 6.2-9 Passenger Flow

Table 6.2-2 Links with Large Passenger Volume

Seq. No.	Location Name	No. of Passenger	No. of Routes
1	S. Braz (Memorial Mag. Barata)	193929	40
2	S. Braz (Mercado)	186585	37
3	Mag. Barata (Jose Bonifacio/Castelo)	177516	34
4	Marechal Hermes (Assis Vasc./P. Var)	171421	42
5	Alm. Barroso (Merces/Jose Malcher)	169910	37
6	Assis de Vasc. (Nazare/Jose Malcher)	168744	40
7	Alm. Barroso (Umaita/Vileta)	165218	34
8	Alm. Barroso (Julio Cesar/Utinga)	163506	34
9	Alm. Barroso (Utinga/Dr. Freitas)	162668	34
10	Assis de Vasc. (Jose Malcher/Riach)	162601	39
11	Assis de Vasc. (28 de Set/G. Viana)	162205	39
12	Alm. Barroso (Curuzu/Humaita)	161469	34
13	Assis de Vasc. (Man Bar/28 de Set)	161419	39
14	Nazare (Alc. Cacela/14 de Marco)	158825	29
15	Alm. Barroso (Antonio Baena/Merces)	157547	34
16	Alm. Barroso (Viana/Humaita)	153554	32
17	Alm. Barroso (Dr. Freitas/Lomas)	153107	32
18	Alm. Barroso (Entroncamento)	151390	30
19	Alm. Barroso (T. Bastos/Entroncamento)	149999	30
20	Alm. Barroso (Mauriti/Lomas)	148810	31
21	Alm. Barroso (T. Bastos/Julio Cesar)	147432	30
22	Mag. Barata (9 de Janeiro/Castelo)	145972	26
23	Nazare (Generalissimo/Quintino)	143776	29
24	Mag. Barata (9 de Janeiro/Alc. Cacela)	141956	26
25	Nazare (14 de Marco/Generalissimo)	139401	27
26	Gentil (Rui Barbosa/Quintino)	133561	28
27	Gentil (Rui Barbosa/Benjamin)	131800	28
28	Nazare (Rui Barbosa/Quintino)	131635	27
29	Nazare (Rui Barbosa/Benjamin)	130542	27
30	Gentil (Dr. Morais/Benjamin)	130038	28