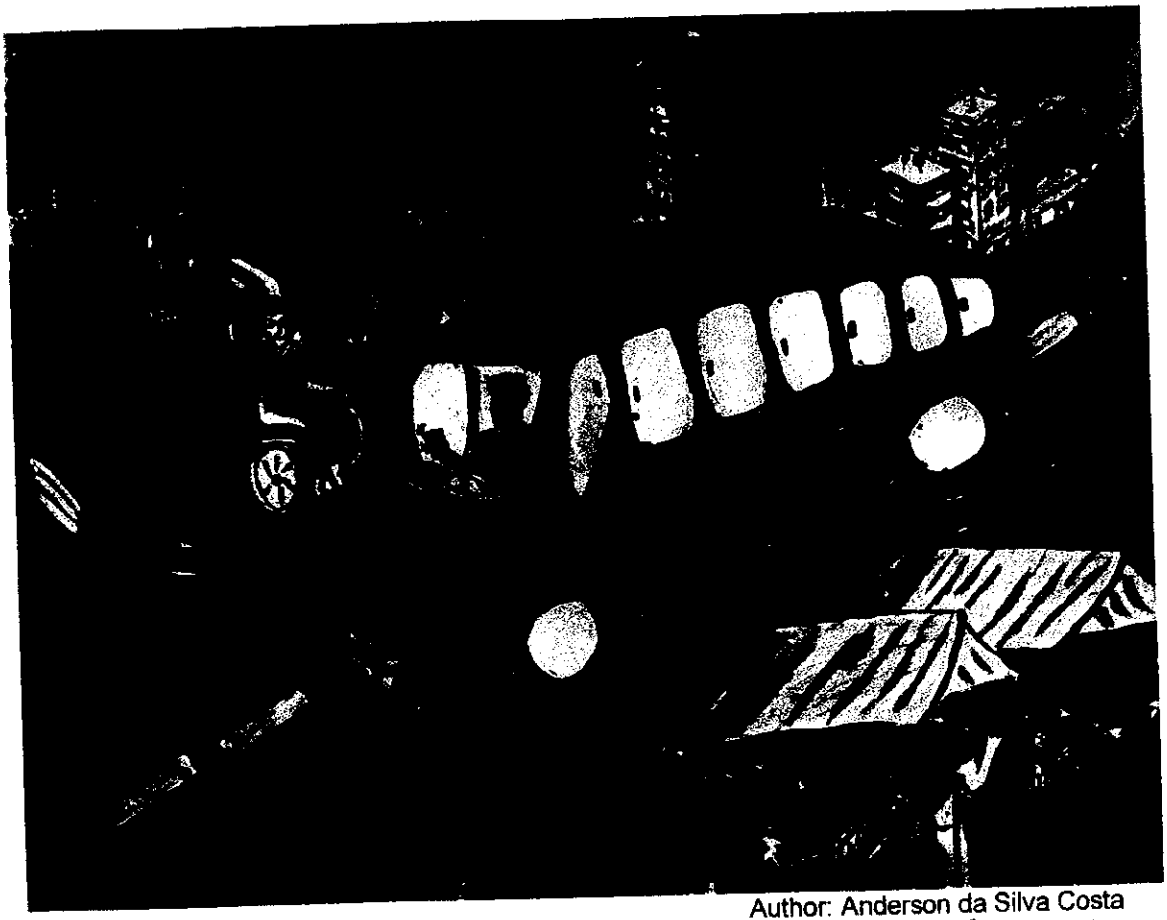


Author: Anderson da Silva Costa
Title: Ônibus Amigo
School: Prof. Antônio M. Júnior – 8th Degree
Classification: 4th

CHAPTER 4
RECOMMENDATIONS

4.1. ROAD SYSTEM

The road system proposed for the RMB was conceived from the report of the current situation presenting actual projects, the network problem, and the state of the present and future demand.

The road hierarchy and its proper management to attend all the transport modes proposed in PDTU/2001, should bring the following benefit:

- To assure the smooth traffic flows in the road system composed of structural, arterial, and collector road, through the changes of circulation, use and operation by decreasing the problems and increasing the security;
- To improve the accessibility (parking, loading and delivery) in the local road system with proper management in these functions;
- To improve the traffic flow quality with discrimination and segregation of road use in the arterial road system in the central area.;
- To construct bicycle paths in the main corridors through physical separation from the motor vehicle traffic, aiming minimization of traffic accidents, stimulating the use of bicycle;
- To attend mainly the public transport circulation, with measures not only for circulation but also for the user's comfort and security.

4.1.1 GUIDE LINES FOR PROJECT GROUPS

The recommendations aim to set up a set of new corridors that has as main functions:

- The enlargement of the capacity of the traffic between the Expansion Area and 1.ª Legua, with the construction and enlargement of the alternative axles to BR-316 and Augusto Montenegro Roads, since they will be priorities for the public transport system;
- The integration between these axles through a set of collecting roads;
- The consolidation of peripheral rings to Center, 1.ª Legua and to the Expansion Area;
- The road connection from the last ring through the complementary axles in north and south of the BR-316 Road. (FIGURE 4.1-1).
- Improvement on security for bicycle traffic

The construction program (item 3.4) sets up a priority *ranking* based on the performance evaluation of each group of road projects as indicated in TABLE3.4-6. Each of these groups has specific recommendations:

- Set of roads that has the Independencia Avenue as main axis that is in stage of implementation in the some segments by the Para Government. It creates the alternative route for accessing from the areas of Cidade Nova, PAAR and Curuçamba to the 1.ª Legua Patrimonial. This group includes the extension of the Marinha Street linking the BR-316 Road, and next to the Castanheira. In this group, the extension and enlargement of the Marinha Street is planned to the year of 2005 as alternative for traffic dispersion from the Almirante Barroso and Pedro Alvares Cabral Avenues.
- Set of roads that has the 1.° de Dezembro Avenue as main axis. The segment between Dr. Freitas Avenue and Alça Viaria is in stage of partial implementation by the Belem Municipality. It creates alternative route of the BR-316 Road. In this group there is a set of secondary roads that makes the link between 1.° de Dezembro Avenue and the areas of Cidade Nova, PAAR, Curuçamba and Augusto Montenegro Road. This project requires a careful study of the environmental impact, because the extension area is located close to Bolonha and Água Preta lakes which supply water to RMB.
- Liberdade Avenue - Although this project presented the third best performance in the economic evaluation, in this phase, only the necessary costs for the road work construction were estimated. It was not considered the costs for the mitigate actions of the environmental impact related to the improper road construction area near the lakes. These recommendations should be showed in the elaboration of the Avenue basic project.

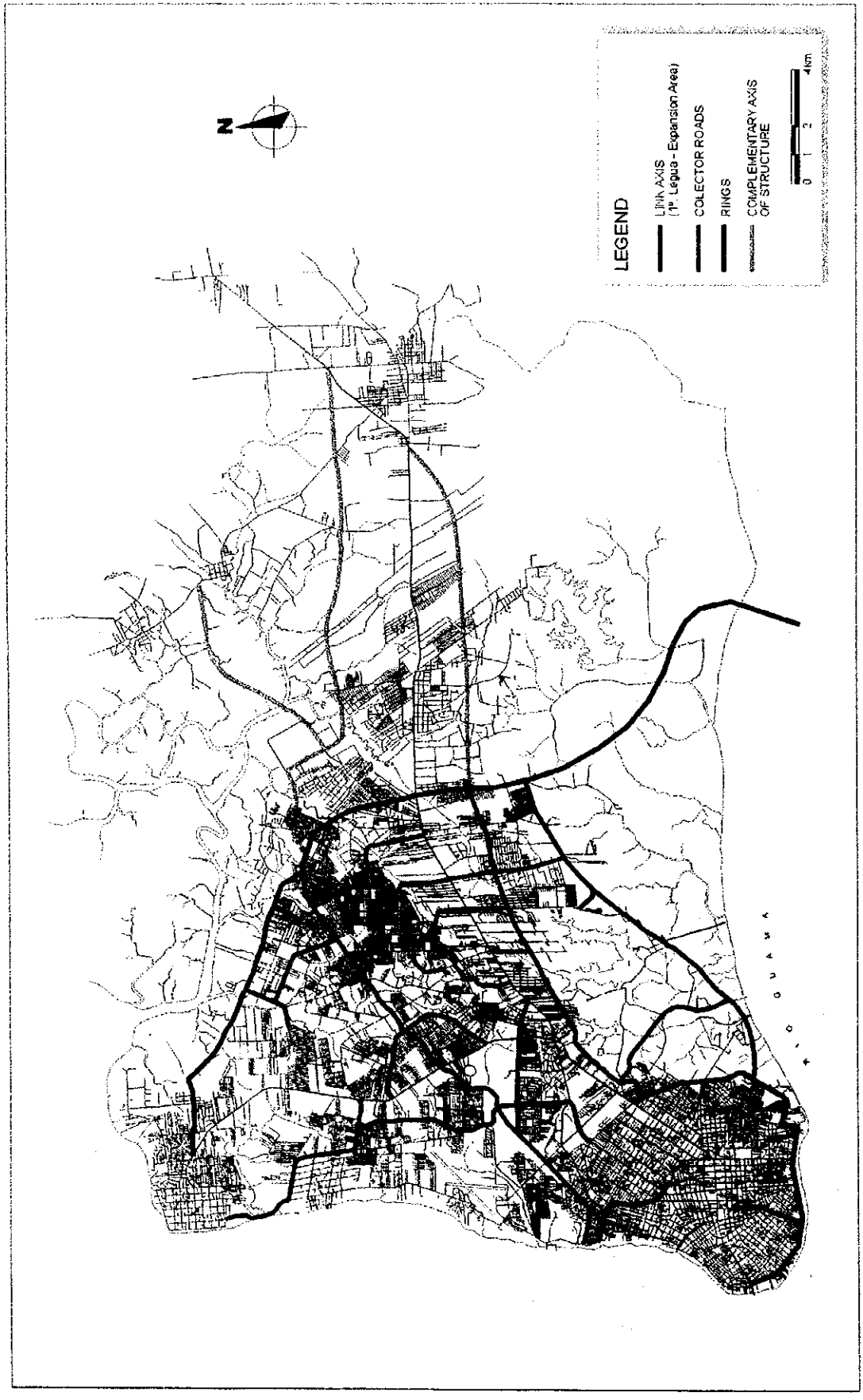


FIGURE 4.1-1 - Basic Model of Conception of Road Alternatives

Extension of the Pedro Miranda Avenue – The Pedro Miranda extension is foreseen in the Urban Plan of Belem Municipality (this project has a large difficulty in execution of section). The linking from Pedro Miranda Avenue and Rodolfo Chermont Avenue, foreseen in PDTU/2001, is of great importance for structural corridor continuity between Belem and Icoaraci. This section also will enable the connections between: Dr. Freitas, Julio Cesar and Pedro Alvares Cabral Avenues. This link construction (it is a new road) need dispossession and large road constructions, especially due to the transposition of the Julio Cesar Airport.

The following interventions are emphasize in this road projects(FIGURE 4.1-2):
1) Intersection Pedro Miranda x Dr. Freitas Avenues
Considering that the Dr. Freitas Avenue level is higher than the Pedro Miranda Avenue. It was proposed the transposition in different levels with the trench execution in Pedro Miranda Avenue(FIGURE 4.1-3 and 4.1-4);

2) Transposition of the Julio Cesar Airport Area
Continuing to the Pedro Miranda Avenue trench, (inside the airport area), this road will be through the "False Tunnel" ending next to the lane. From this point on, in Tunnel, aiming the transversal transposition of the airport lane(FIGURE 4.1-3 and 4.1-4);

3) Intersection with Julio Cesar Avenue
After the Tunnel, the link continue in trench passing under the Julio Cesar Avenue and connecting to this through rings. From this point, the road has a normal characteristic in the land level with two lanes separated by a central separator and lateral sidewalks(FIGURE 4.1-5);

4) Intersection with Pedro Alvares Cabral Avenue Pedro and connection to the Rodolfo Chermont Avenue
This link has again a medium dip, crossing this avenue through the trench until reach the Rodolfo Chermont Avenue. Due to the level problems at Marambaia channel, right after the intersection, it is necessary the elevation of the Pedro Alvares Cabral Avenue. The recommended way for elevation is to reclaim ground between the concrete walls which should be constructed along the road sides(FIGURE 4.1-6).

The big obstacle to the consolidation of this corridor is the transposition of the Navy and Aeronautic institutional areas. In the Aeronautic area it is recommended the construction of a tunnel under the Julio Cesar Airport lane preventing its expropriation. Referring to the section that crosses the Navy land. This area will be used also for the Independencia Avenue project that has the prior construction schedule to the extension of the Pedro Miranda Avenue. It is also important to preserve the dominion area of Yamada Avenue and Coqueiro Tapanã and Arthur Bernardes Roads

- Duplication of the Bernardo Sayão and Perimetral Avenues – Considering the high expropriation cost and low attraction, this project presented the worst economic performance. In the basic project elaboration it should be considered the possibility of some section duplication to improve the peripheral circulation in 1.ª Legua Patrimonial.
- The projects in the 5 and 6 groups have the road organization of the RMB peripheral areas as a main function until the year of 2020. Emphasizing, however, the necessity of preserving its guideline from now on.

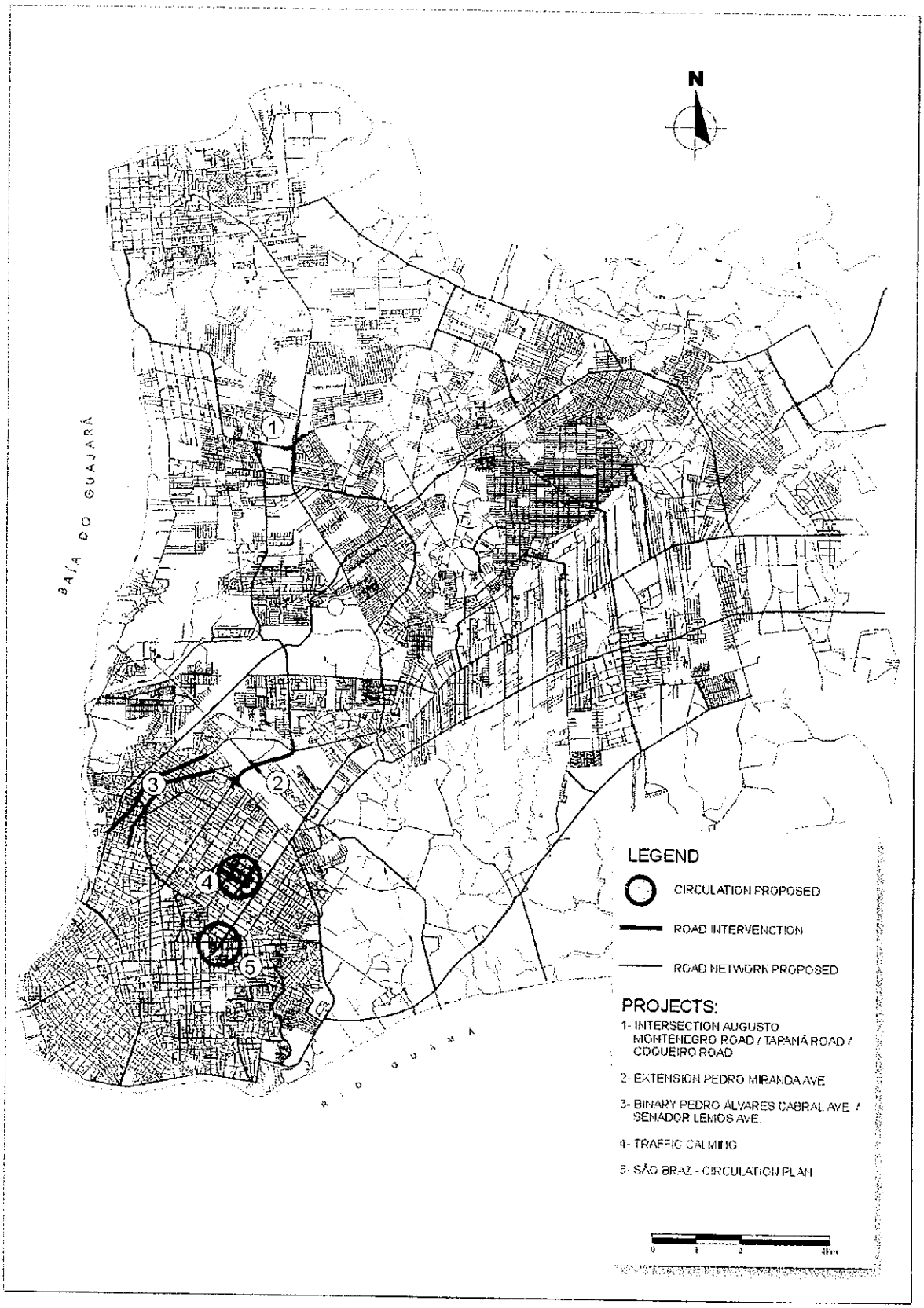


FIGURE 4.1-2 - Projects Location - Circulation System

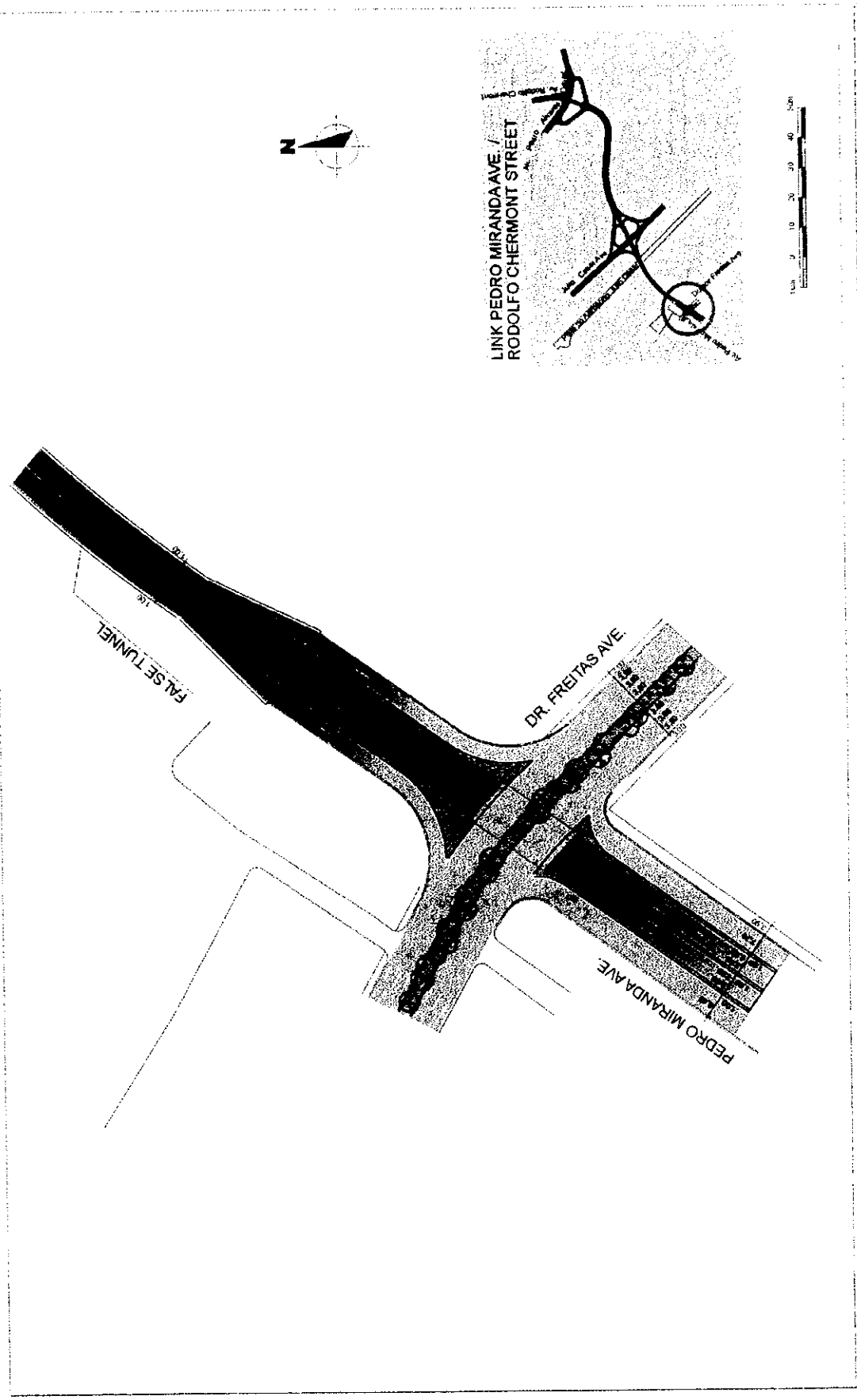
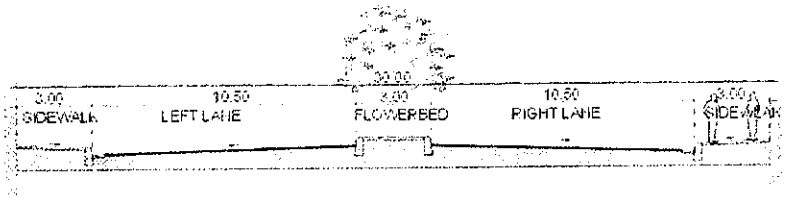
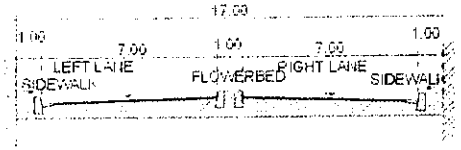


FIGURE 4.1-3 - Link Pedro Miranda Ave. / Rodolfo Chermont Ave. - Doutor Freitas Ave. Intersection Detail

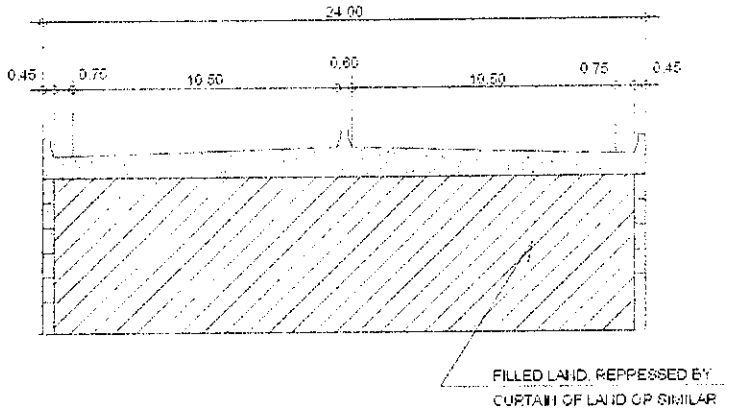
S-01 - SECTION TYPE(Link Rodolfo Chermont Ave.)



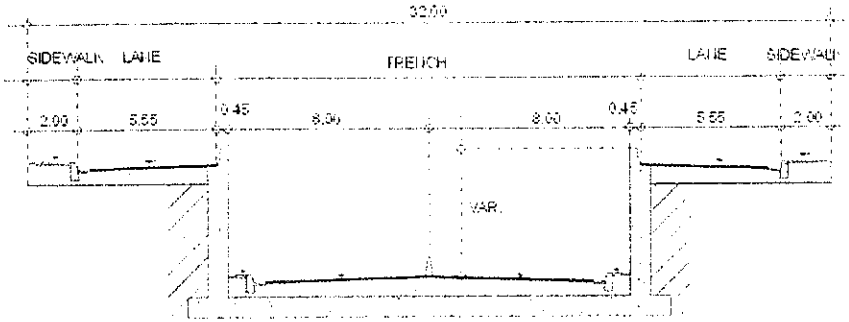
S-02 - SECTION TYPE(Link Pedro Miranda Ave.)



S-03 - LAND SECTION



S-04 - TRENCH SECTION



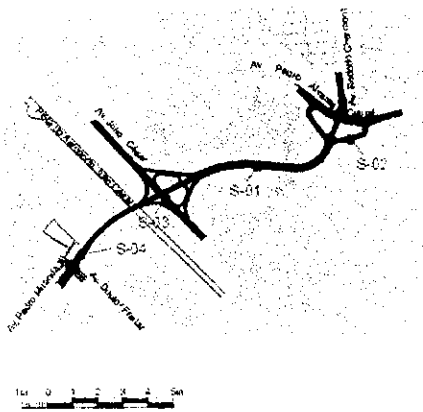


FIGURE 4.1-4 - Link Pedro Miranda Ave. / Rodolfo Chermont Ave. - SECTION TYPE

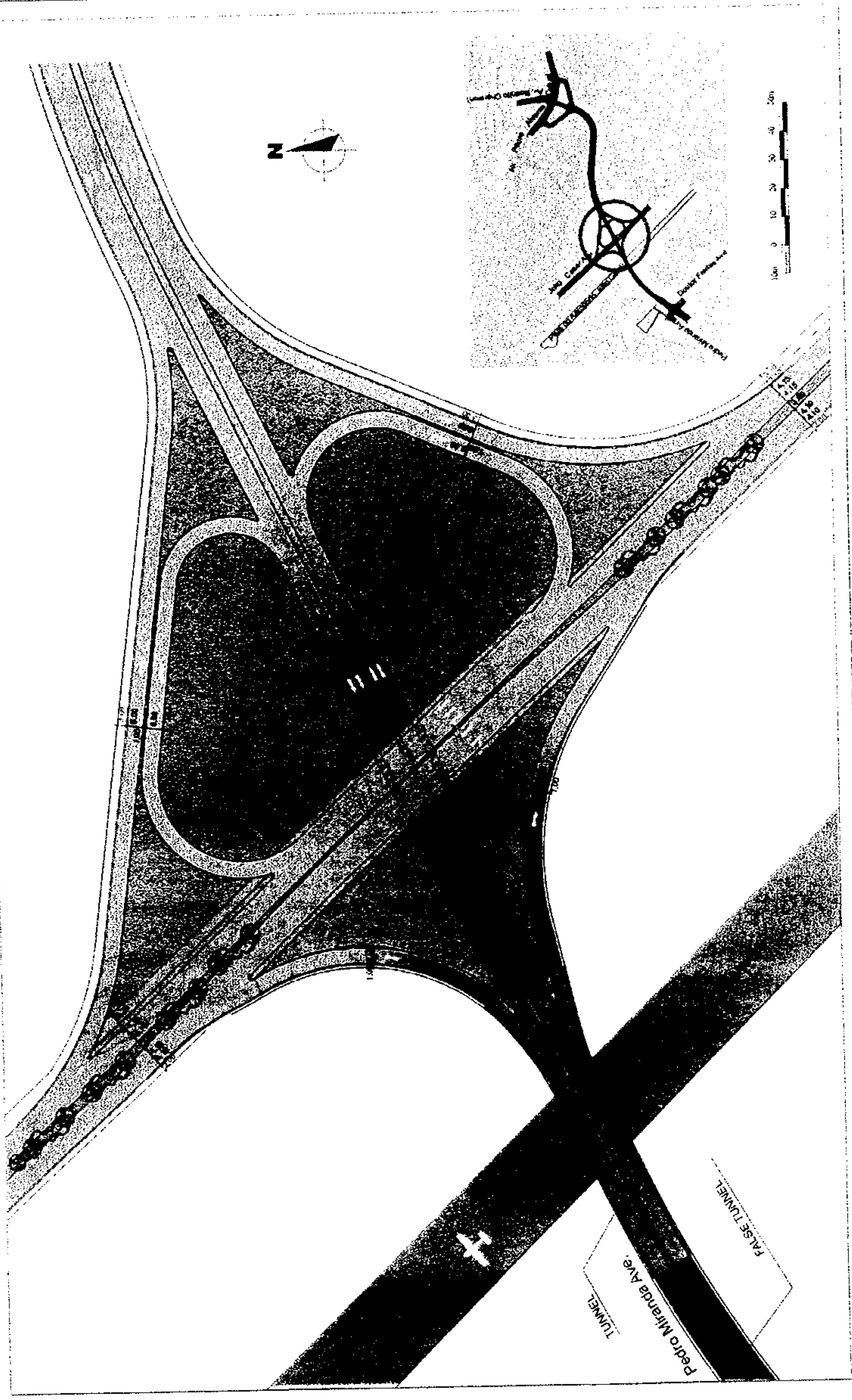


FIGURE 4.1-5 - Link Pedro Miranda Ave. / Rodolfo Chermont Ave. - Júlio César Ave. Intersection Detail

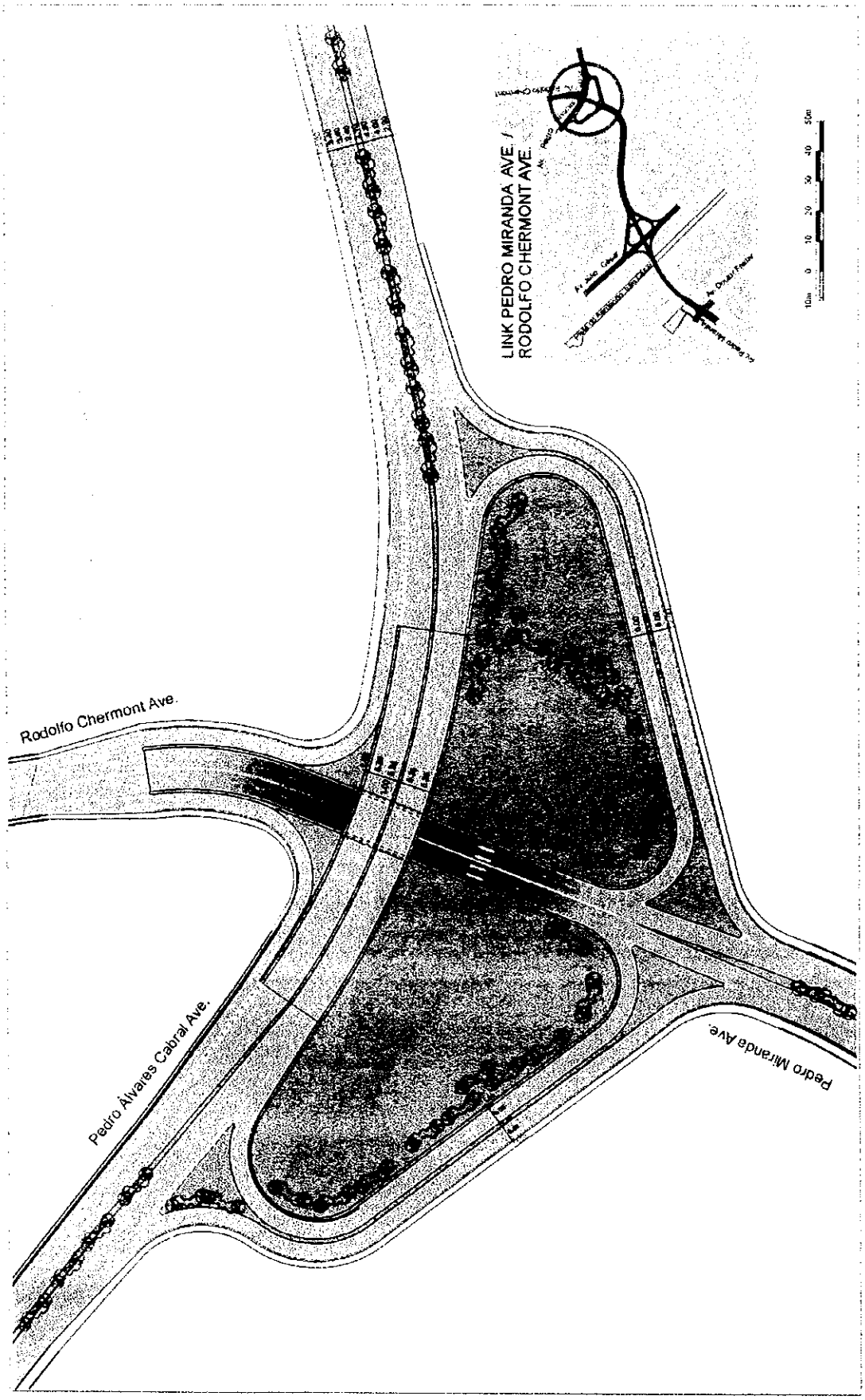


FIGURE 4.1-6 - Link Pedro Miranda Ave. / Rodolfo Chermont Ave. - Pedro Álvares Cabral Ave. Intersection Detail

FIGURE 4.1-7 shows proposed road system for the target year of the master plan with respective number of traffic lane. The remarkable roads are the BR-316, the Almirante Barroso Av., the Augusto Montenagro Av. and Independencia Av. with 6 lanes which tighten the connection between the 1ª Legua and the Expansion Area. Other roads with 4, 3 and 2 lanes were also proposed, and it stands out the continuity of 3 lanes for each direction of the Pedro Alvares Cabral Av. by the construction of binary road between this and the Senador Lemos Ave.

Finally, it is proposed the metropolitan road system hierarchy into three levels: structural, arterial, and collector (FIGURE 4.1-8). This hierarchy should be compatible with urban legislation of use and occupation of the land of each municipality. The metropolitan management organization also should accept it as structural element.

4.1.2. SPECIFIC RECOMMENDATIONS FOR BICYCLE TRAFFIC NETWORK

Another aspect to be mentioned is the recommendation for construction of a bikeroad to link the center-peripheral (FIGURE 4.1-9). Although this transport mode is not considered in the future molding, it deserves special attention since it has increased on last decade and reached now 7.52% of the total moving. This growth together with the lack of adequate spaces to the bikeroads contributed to the increase of the bicycle accidents in RMB as indicated by Detran/PA (372 collisions in 1990 and 440 in 2000). These data fortify the bicycle opinion survey results 54.7 % of the interviewed said that the main problem is "the lack of transit security".

The ideal distance for transport by bicycle is from 2 to 3 km, considering trip home/work from 5 to 6 km as normal. With bicycle equipped with gear change system, in good topographic conditions (e.g. Belem) and having adequate infrastructure these trips can reach 10 to 15 km.

The traffic agility is the great advantage of the bicycle over walking move. A cyclist is capable to move in a speed of 16km/h in urban area, that means four times faster than the pedestrian velocity. Besides, the bicycle used in good conditions, it improves the life quality for users and causes no environmental damage because it is economical, silent, healthy and a non pollutant vehicle.

The Person Trip Survey shows that the students are the main bicycle users, on moving for "school" and "home".

In the road system characteristics survey the studies corridors with bikeroads are: Augusto Montenegro Julio Cesar, Visconde Souza Franco and 1.º de Dezembro Avenues (FIGURE 4.1-9). These bikeroads are sub-dimensioned and away from the vehicle traffic only by the horizontal signs and chatter bar. Besides they are contrary to the current security rules, they are not utilized sufficiently because they were introduces without previous evaluation of origin and destination demand. The bikeroad system as transport way (except in a leisure bikeroad) should be directly related to the users' desire lines and be considered and treated with integration in the context of the transport and road system of the City. It is emphasized the need of installing the bikeroad system with the necessary infrastructure to the cyclist security. These infrastructures cover the physical protection, specific and adequate signs to the road circulation, security-parking, etc. These measures are highly positive because they promote the bicycle use.

Among these, there is necessity of:

- Creating spaces and equipment for parking;
- Assuring circulation through physical interventions and sign, mainly on the crossing roads. The streets (in majority) present better conditions for the bicycle traffic.

These actions together with educative campaigns are important for the reduction of the higher number of bicycle accidents.

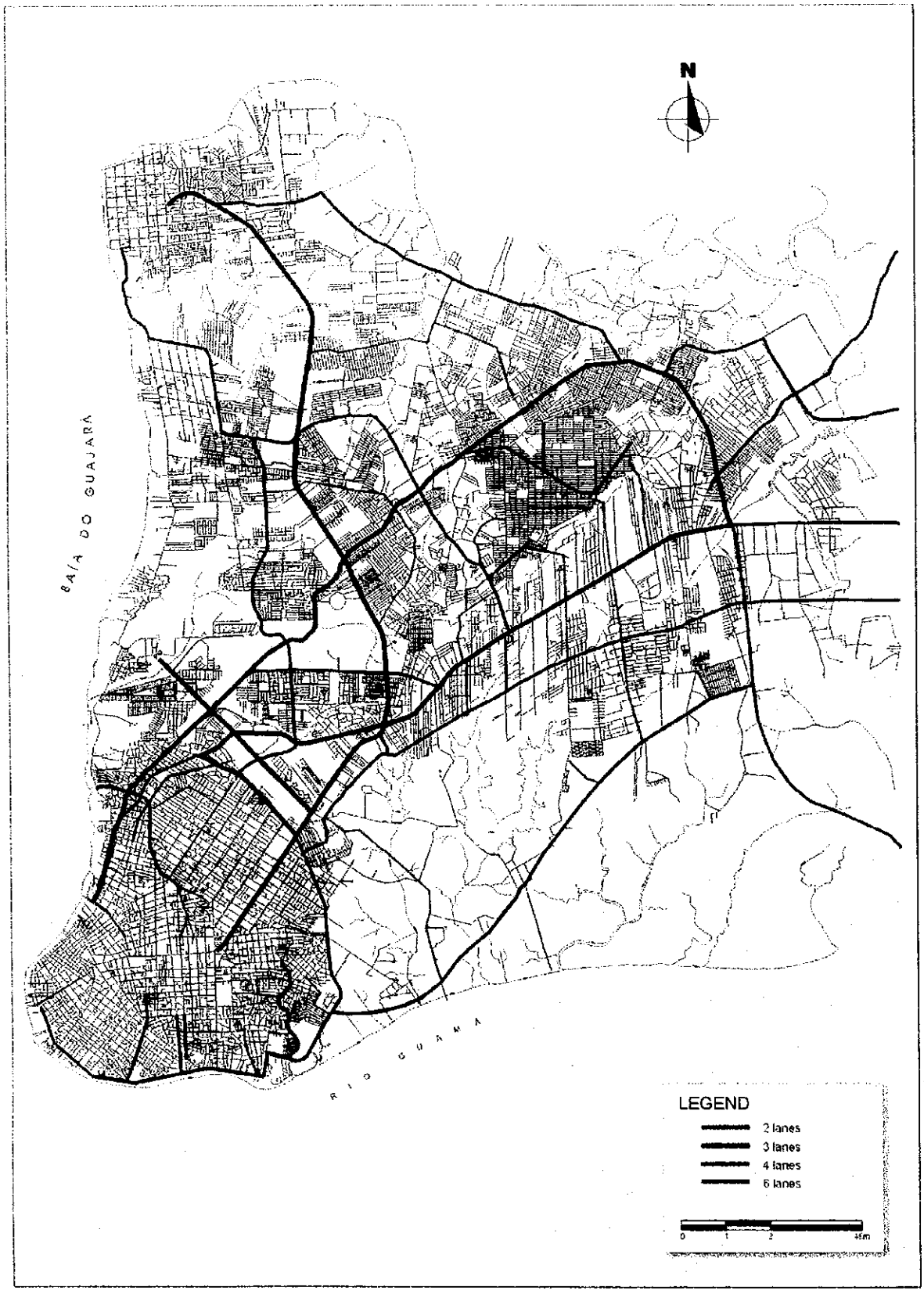


FIGURE 4.1-7 - Number of Traffic Lanes - Road Network 2020

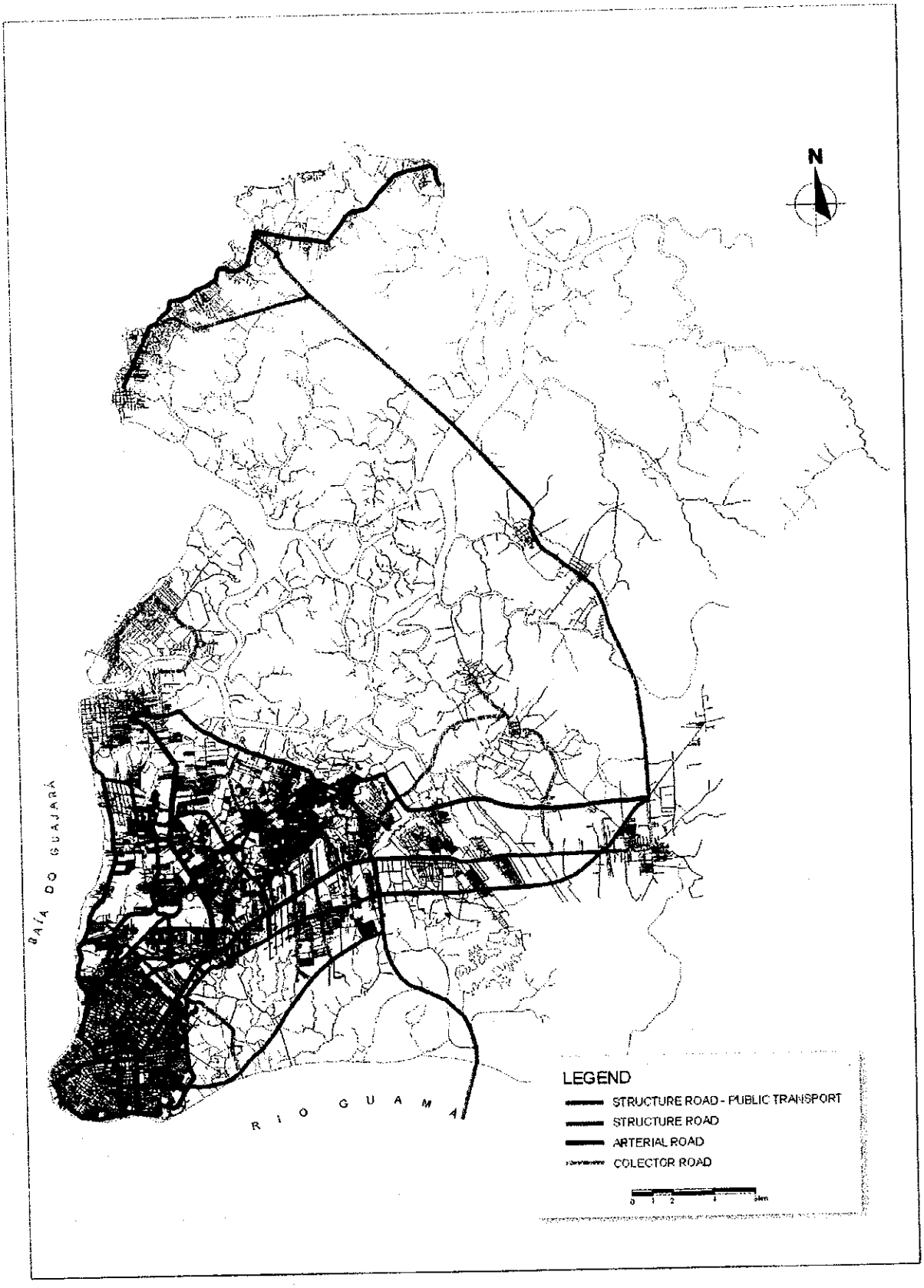


FIGURE 4.1-8 - Road Hierarchy Proposed for RMB

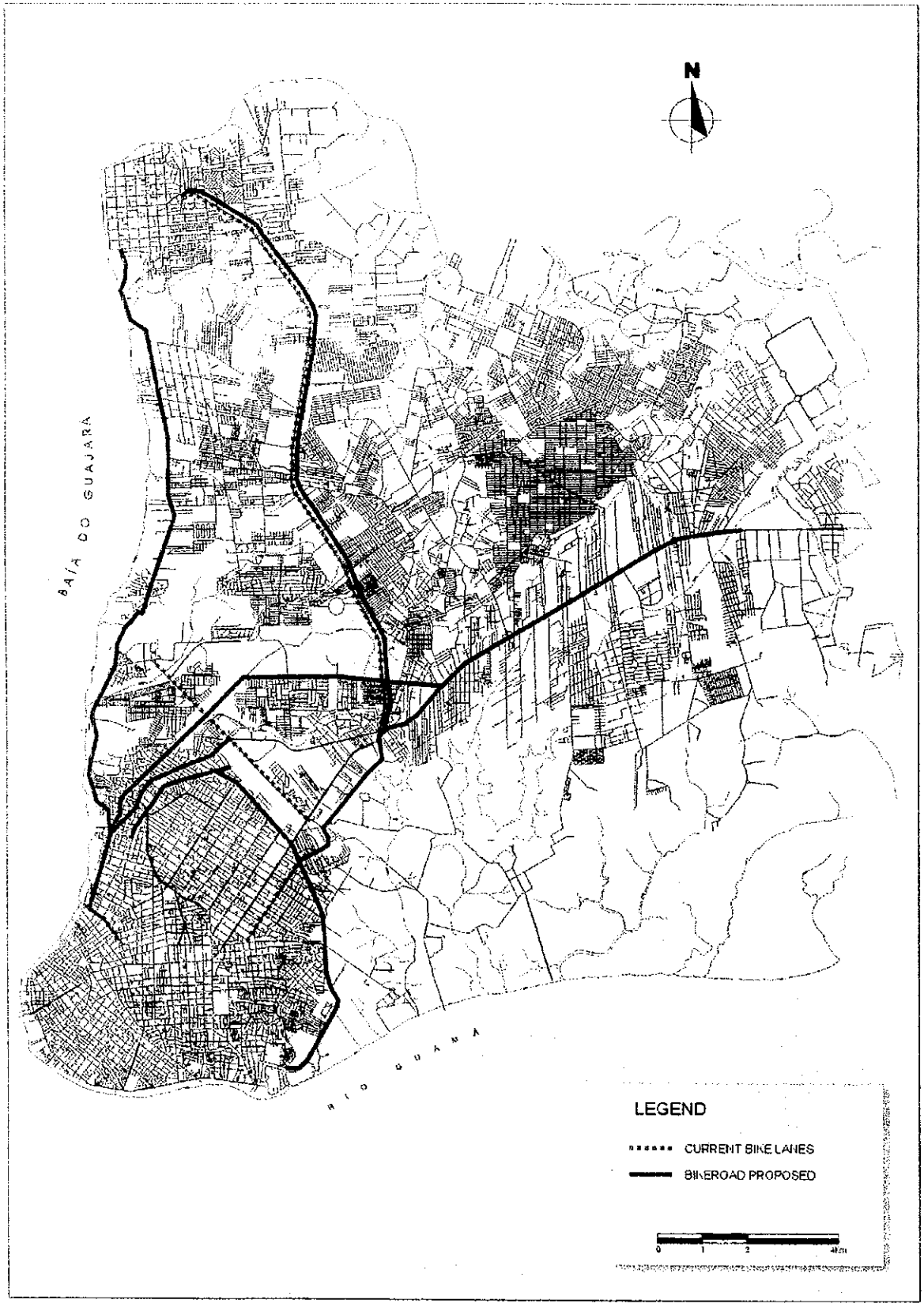


FIGURA 4.1-9 - Network of Bikeroads Current and Proposed

- Bicycle Parking

Referring to the parking, the surveys done in cities which have a large index of bicycle use, show that the parking is the major incentive to the bicycle use. This index is over the bikeroad one.

There are two types of parking: short duration (used in commercial and service areas) and long duration (used in factories, schools, bus terminals, train station, etc). Usually the long duration parking are covered with tools of anchorage of variable bicycle because of the security required. In the short duration parking it is used a simple support as an easel that allows to hang the bicycle preventing falls and with a chain to prevent from theft.

Aiming more security, these supports should be implemented:

- In areas with great movement , to enable the social control;
- Under marquees or in galleries internal areas, so that the users and their bicycles would be protected from the inclemency;
- As near as possible the trip destination;
- With simple supports and lower cost, easy for construction and use, occupying small spaces and built with high strength galvanized iron and great durability.

FIGURE 4.1-10 shows the size and the parking space distribution for bicycles (with easel support type).

In the elaboration of the mentioned bikeroad projects following parameters were considered:

- Cyclist's Useful Space (Quality of the project)

Accepts that the cyclist could be into of the followed dimensions:
- Width = 1.00 m;
- Length = 1.75 m
- High = 2.25 m

The width of 1.00 m results from the handlebar (0.60m), added to the necessary space to the arms and legs movement (0.20 m for each side). The quality to accept, however, is superior 0.50 m in width and 0.25 cm high (FIGURE 4.1-10).

- Lanes and Lanes for Cyclists

The lane as exclusive road for the cyclists circulation, should be separated from the street by a level and the sidewalks could be one-way lane or two-way lane. It is recommended the use of one-way l lanes whenever there is space for it. The two-way lanes would be accepted when the space is small not allowing the one-way lanes.

Due to security problems the implantation of cyclist lanes is only advisable in special cases to give continuity for the bikeroad system. These special cases are: the end of a lane, in a lane cross for the shared traffic or where the cyclist traffic needs, in areas with little lateral interference. The separation of cyclist and automobilist traffic is done by horizontal painting, with an uneven ground or chatter-bar.

Parking with support as easel type
Model of parking place distribution

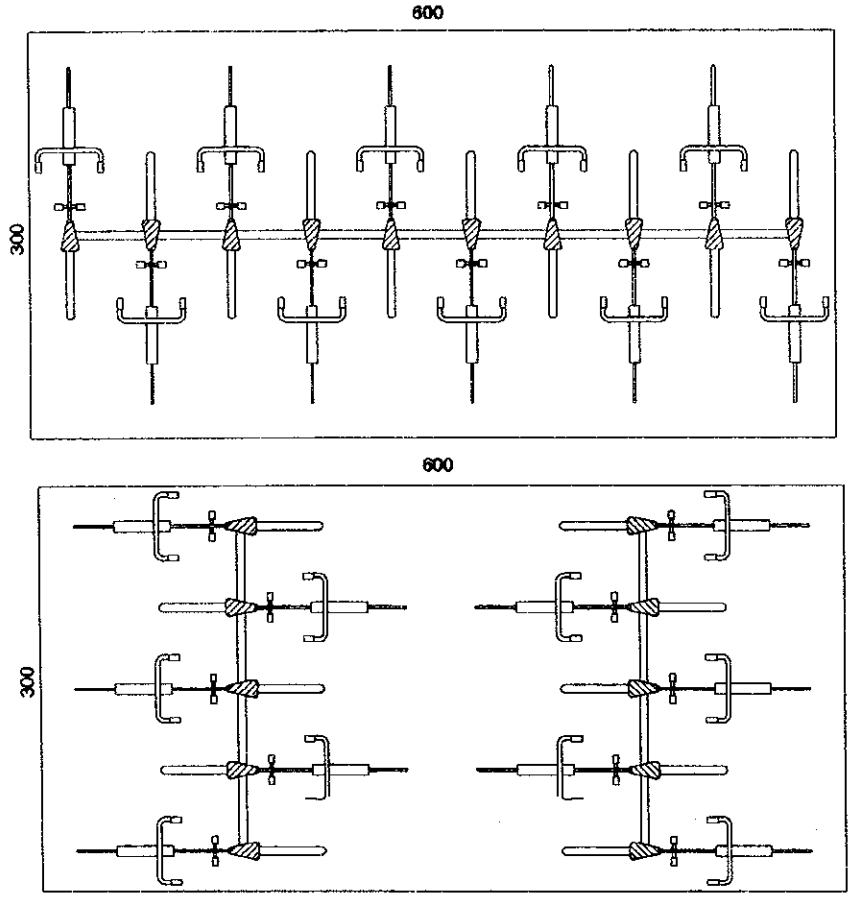


Figure 1 - Cyclist's useful space

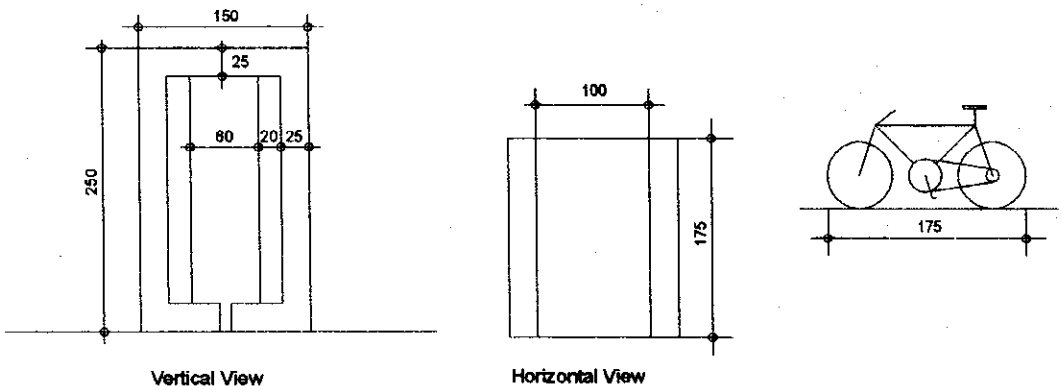


FIGURE 4.1-10 - Distribution of Parking Space and Cyclist's Useful Space

Width of One-way Lane
The minimum width for one-way lane is of 2.00 m. When it has an uneven edge up to 10 cm or on laterals obstacle, there is necessity of an increase of 0.50 m in width (FIGURE 4.1-11). This width due to the bicycle traffic volume per hour; in a busier day, should have the dimensions according to (TABLE 4.1-1)

TABLE 4.1-1 - Width of One-way Lane

Traffic Time	Effective Width
Until 5,000 bicycles per hour	2.00 to 2.50 m
More then 5,000 bicycles per hour	2.50 to 2.80 m

- Width of Two-way Lane

The twol-way lanes should have the minimum of 2.80 m effective width. When it has an uneven edge it has to be higher than 10 cm (sidewalk and others). In the case of obstacle on lateral the additional width of 0.50m is necessary (FIGURE 4.1-11). The width of a two-way lane based in bicycle traffic volume per hour, in a busier day, should have their dimensions as shows in (TABLE 4.1-2)

TABLE 4.1-2 – Width of Two-way Lane

Traffic Time	Effective Width
Until 5.000 bicycles per hour	2.80 to 3.50 m
More then 5.000 bicycles per hour	3.50 to 4.00 m

- Width of Lanes

The cyclist lanes should be always one-way. Its minimum width is of 2.00 m, adding 0.50 m more width to minimize the lateral friction made by the vehicles flow (FIGURE 4.1-11).

- Traffic Signs

In the Code of Brazilian Transit there are two rule regarding to bicycle traffic. One is prohibiting its circulation in certain roads (R-12), and the other is regulating the circulation only for the bicycle (R-34). The is only one kind of sign post which shows the presence of cyclist (A-30). It is recommended the use of an intense bikeroad, as well as indicating, informative and educating traffic signs.
Referring to the horizontal signs (lanes, symbols, and others), it is extremely useful especially near to crossing roads. And other tools can be used like chatter-bar, pre-molded separators, etc.

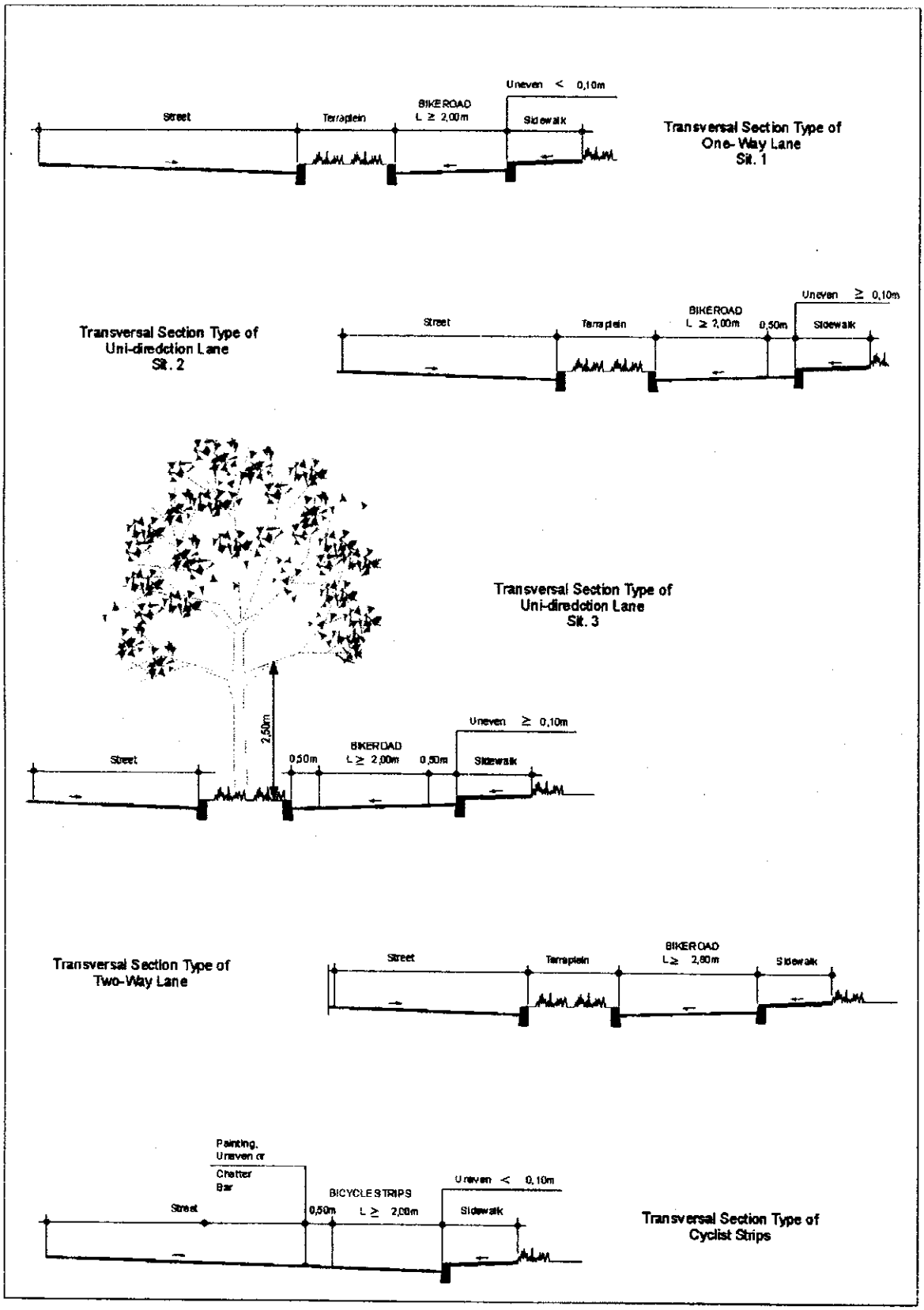


FIGURA 4.1-11 - Lanes Width in Bikeroad

4.2. PUBLIC TRANSPORT SYSTEM

The basic principle of proposed public transport system is the acceptance of a integrated transport network in the whole Belem Metropolitan Area to assure the large mobility of people avoiding lines from supersaturated. This integration should be done by introducing magnetic card, which will make possible for the user to do transference in any point of the system without additional cost.

It's proposed in this study the construction of new integration terminals, as well as the consolidation of some already existing terminals(FIGURE 4.2-1). The locations of terminals was proposed strategically considering the convergence of a large number of feeder lines with demand, and the inducement for secondary commercial nucleus and services from the peripheral area. These terminals should have commercial areas to gain additional income for maintenance, using attraction following the example of other Brazilian cities.

Ten integration terminals were proposed with the characteristics as follows (FIGURES 4.2-2 and 4.2-3):

- Marituba Terminal – Located near the crossing of Alça Viaria with BR-316 Road. This terminal will be the physical integration point between the metropolitan and intermunicipality systems, when the future metropolitan road terminal will transferred to this place. From the Marituba Terminal trunk lines to Center and Sao Braz destination would be introduced, integrated to urban feeder lines, originally from the several places located from this point as Benfica, Benevides, Santa Barbara do Para and Mosqueiro.

- Cidade Nova Terminal – Located in Arterial 18 between SN17 and SN3; this terminal will attend the integration of all feeder system from Cidade Nova, PAAR and surrounding areas, with trunk lines from this point to Center and Sao Braz(FIGURE 4.2-4).

- Icoaraci Terminal– Located in Soledade Street, between edge and Manoel Barata Street. This terminal will attend the integration of all feeder system from Icoaraci and Outeiro areas as well as the inter-modal integration of fluvial lines of Mosqueiro and Cotijuba. From Icoaraci Terminal there will be trunk lines to Center and Sao Braz(FIGURE 4.2-5).

- Entroncamento Terminal – This terminal attend especially trips change between Augusto Montenegro and BR-316 Roads, besides receive some feeder lines of Guanabara and Jaderlandia.

- Sao Braz Terminal– Using the current Terminal installations, this terminal is located in strategic point to integrate the districts of 1ª. Legua (located outside of trunk axles) as Guama, Condor, Terra Firme, Canudos and Pedreira to the RMB peripheral areas through the trunk system that cross Sao Braz(FIGURE 4.2-6).

- Porto da Palha Terminal – Located in Bernardo Sayao Avenue between Padre Eutiquio Street and Jose Bonifacio Avenue. This terminal will integrate conventional line, feeder lines and the fluvial road system(FIGURE 4.2-7).

- UFPA, Marex, Coqueiro and BR Terminals – They are existing terminals. Considering their location, they should integrate to the future system with some adaptations in their physical structures.

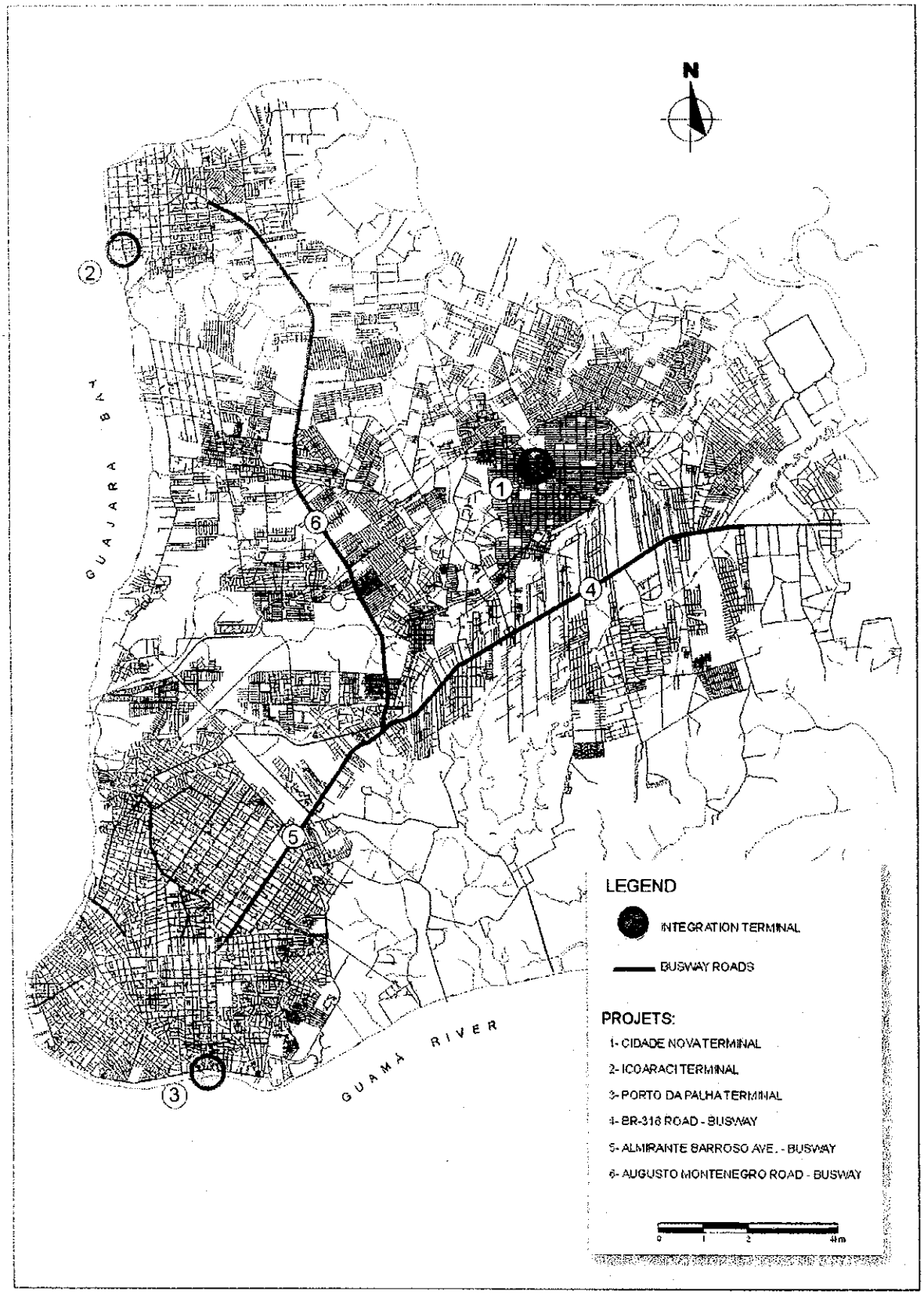


FIGURE 4.2-1 - Projects Location - Public Transport System

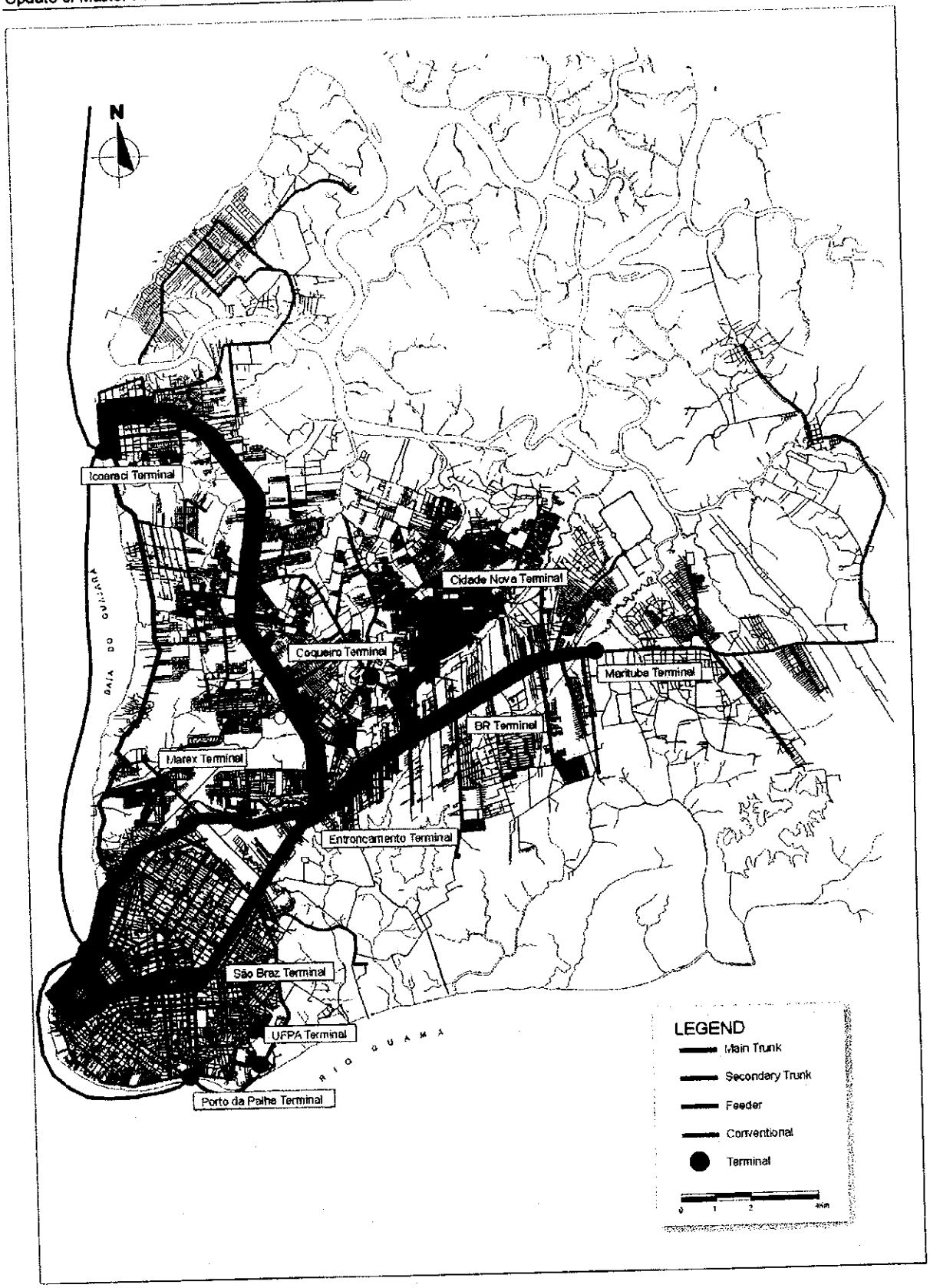


FIGURE 4.2-2 -Public Transport Network Proposed - 2005

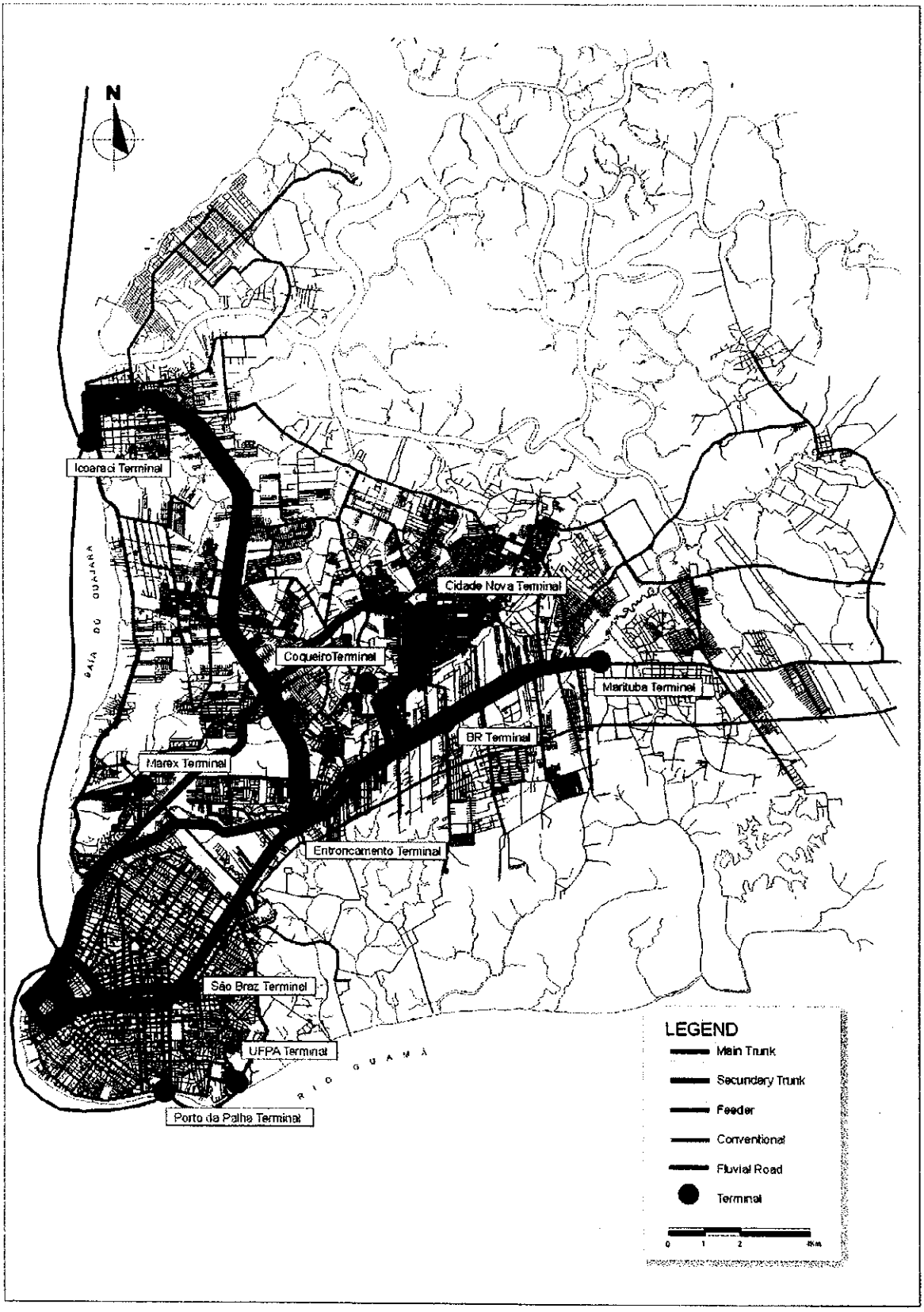


FIGURE 4.2-3 - Public Transport Network Proposed - 2020

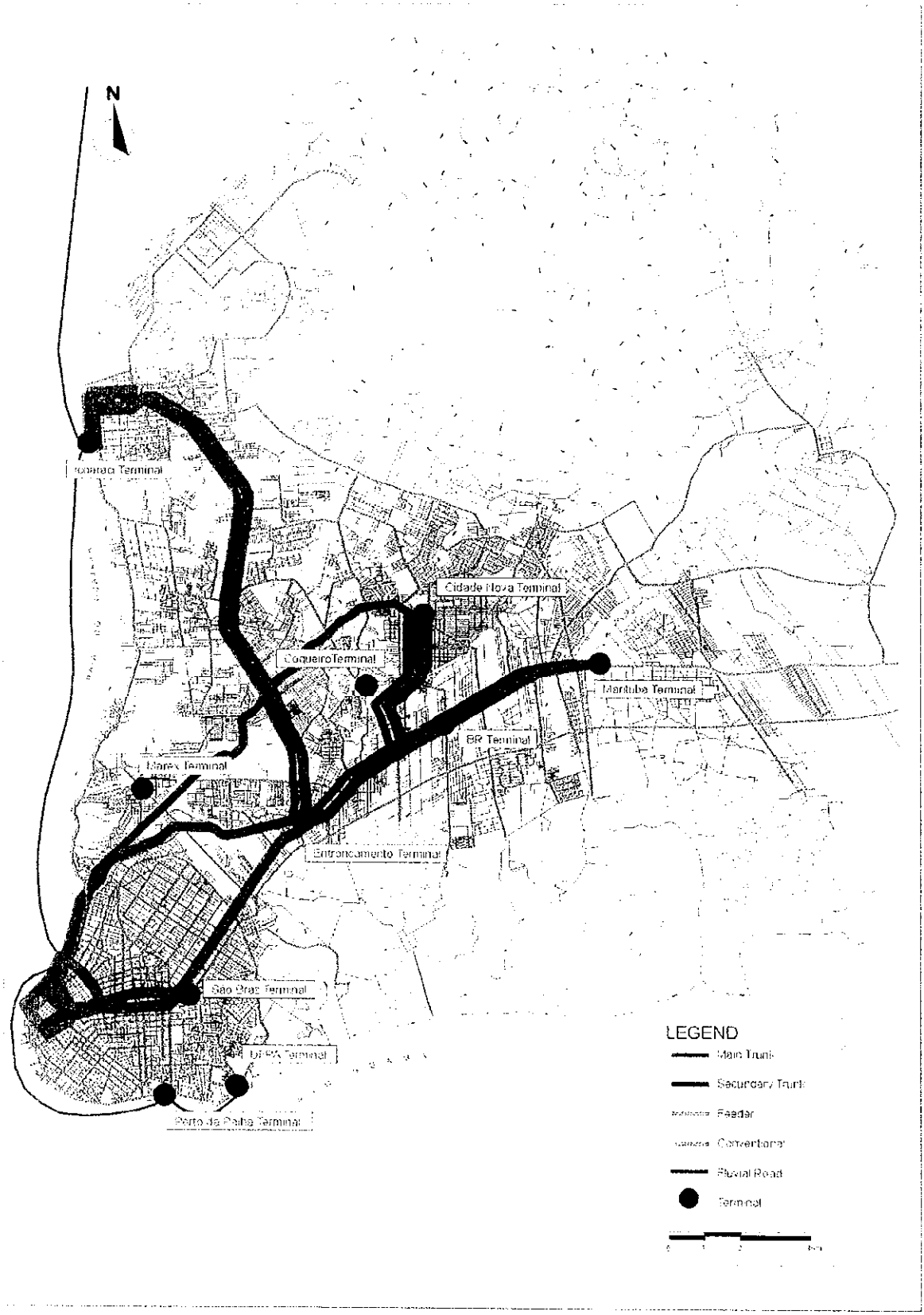


FIGURE 4 2-3 - Public Transport Network Proposed - 2020

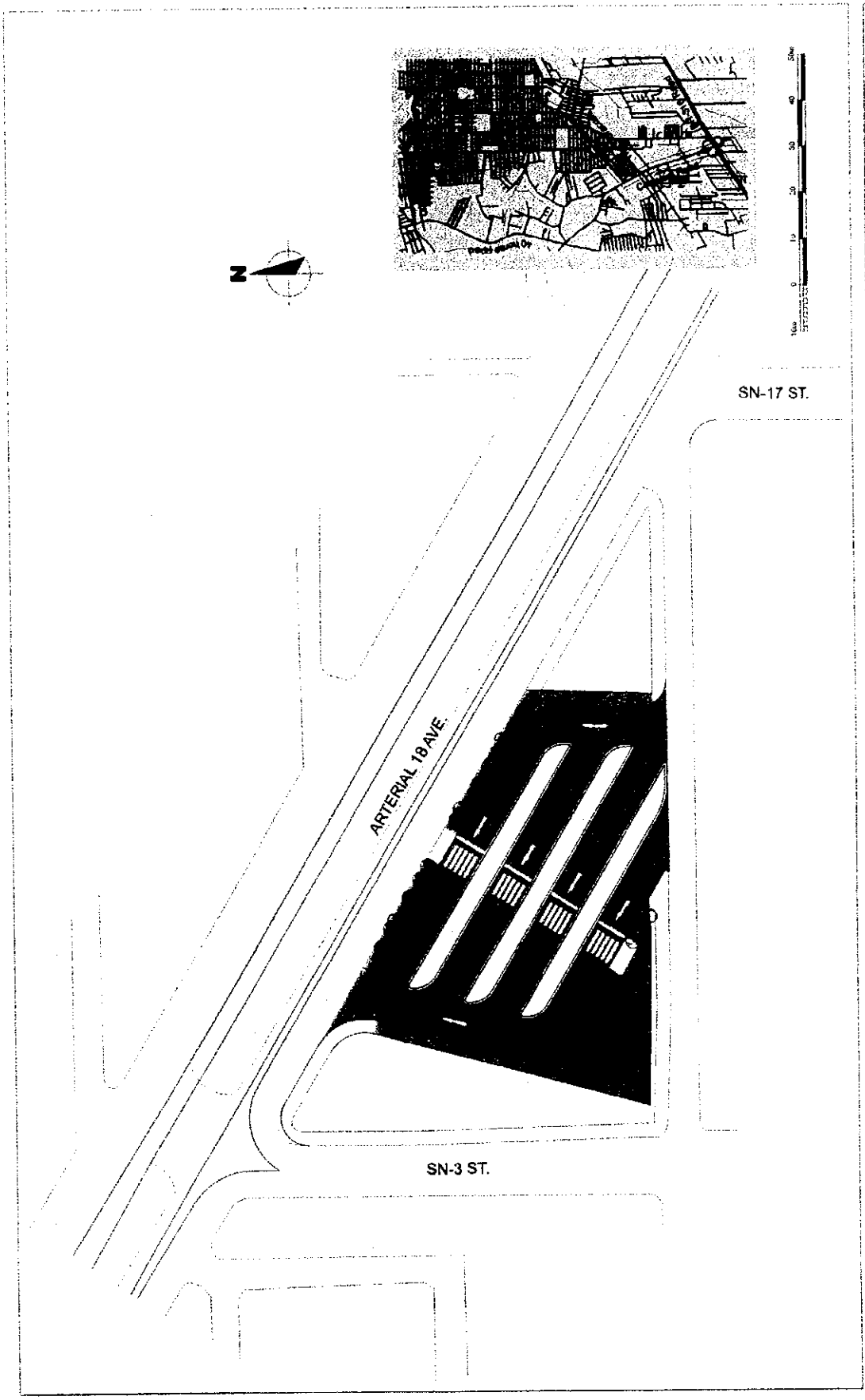


FIGURE 4.2-4 - Basic Horizontal Project of Cidade Nova Terminal

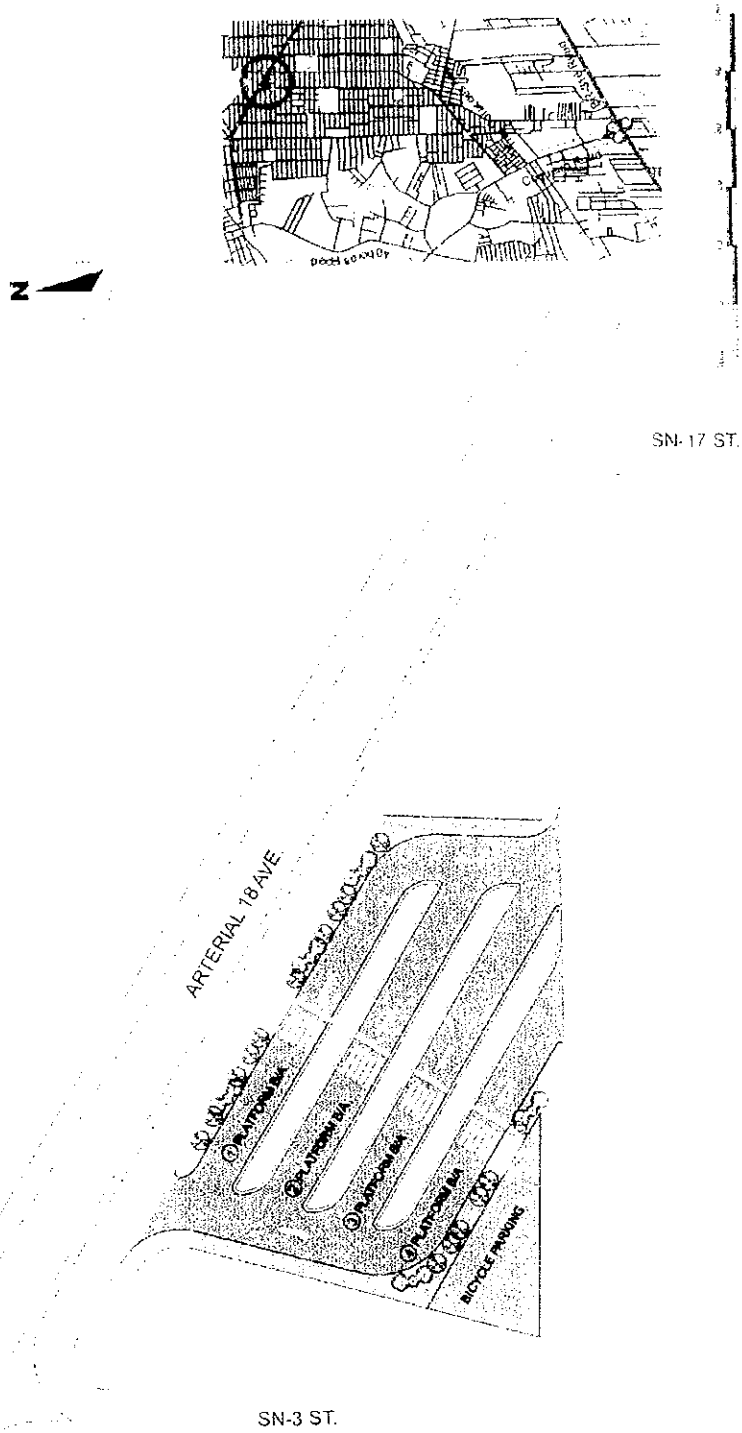


FIGURE 4.2-4 - Basic Horizontal Project of Cidade Nova Terminal

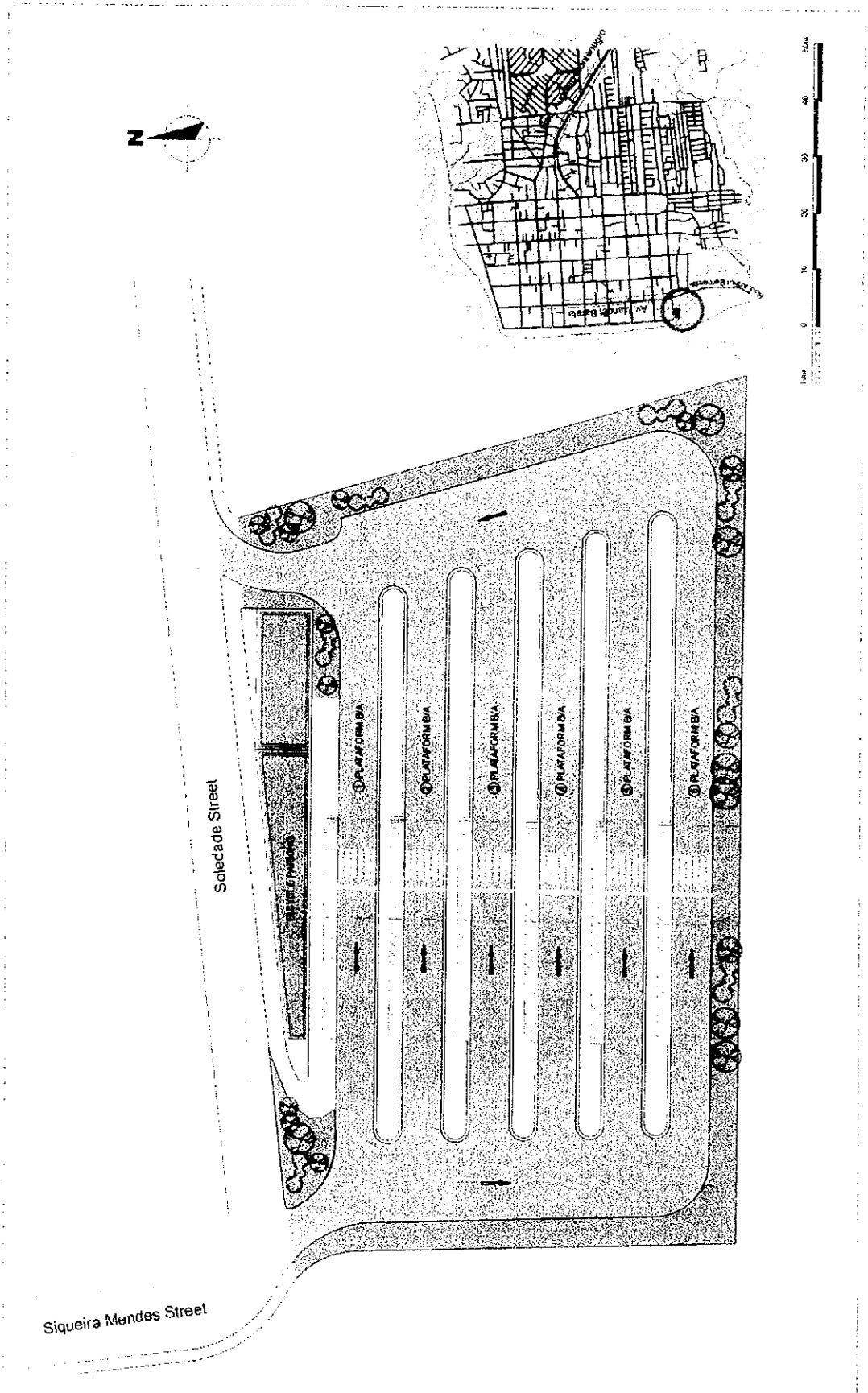


FIGURE 4.2-5 - Basic Horizontal Projetct of Icoaraci Terminal

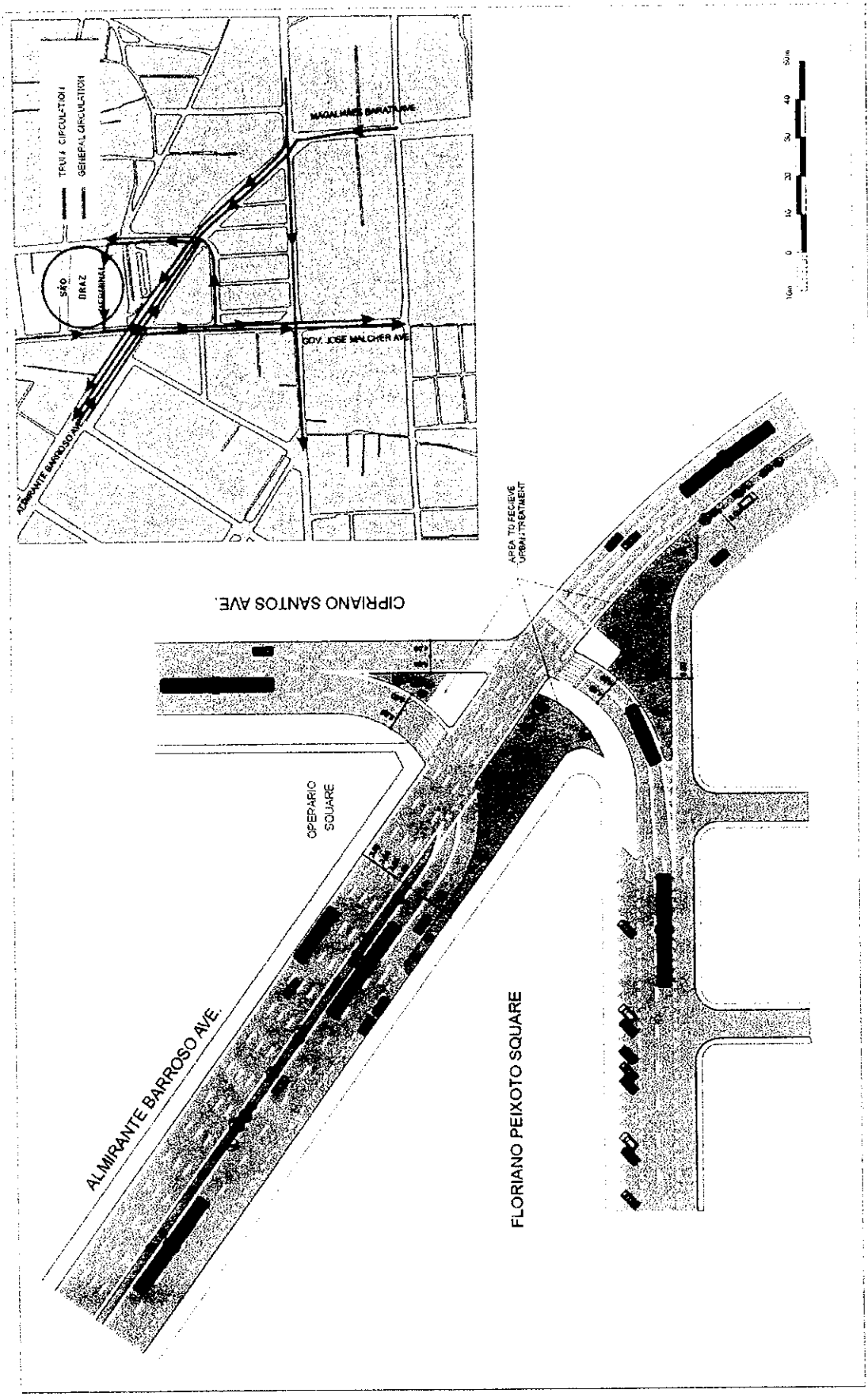


FIGURE 4.2-6 - Circulation on São Braz Terminal Surrounding

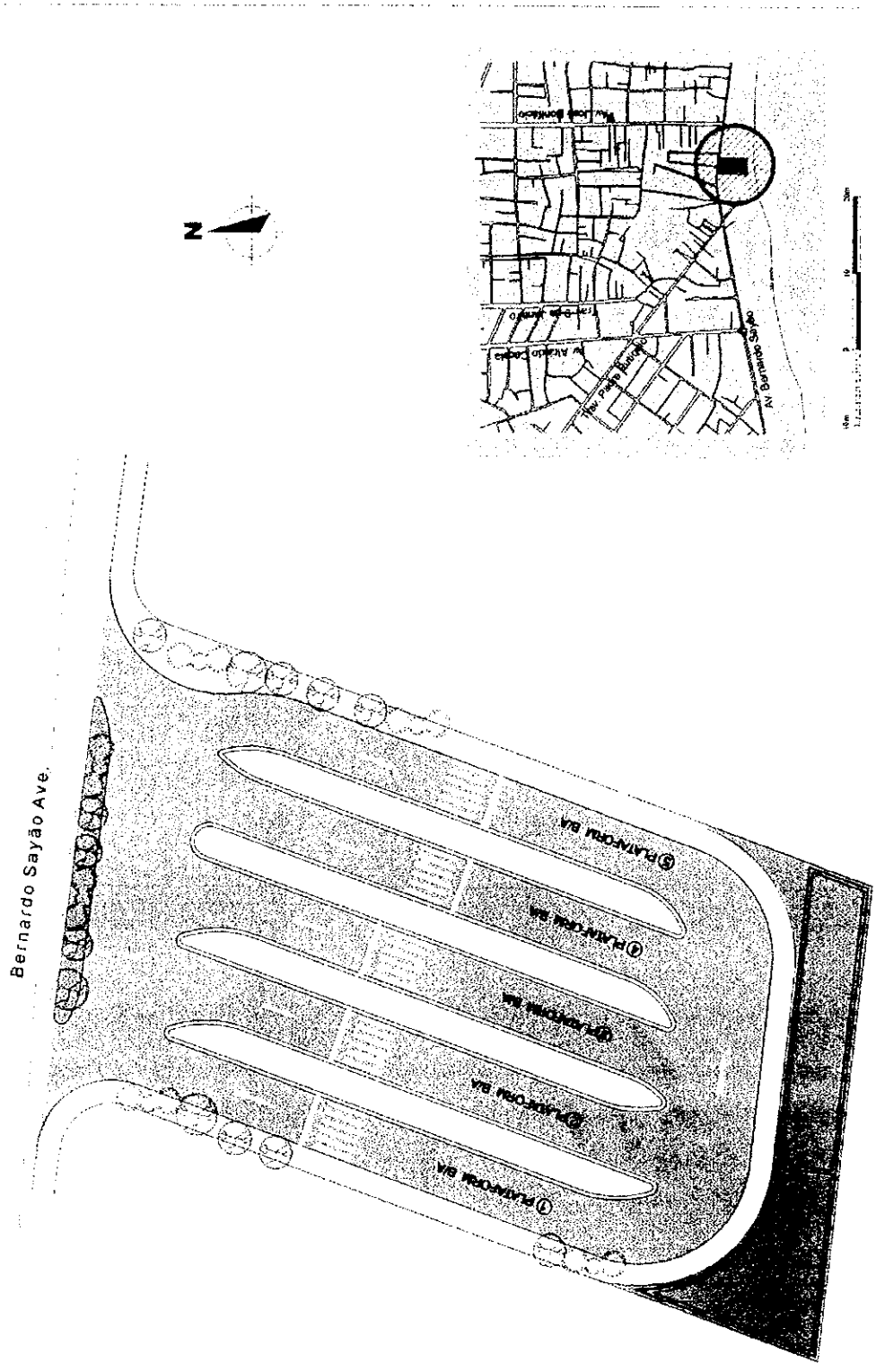


FIGURE 4.2-7 - Basic Horizontal Project of Porto da Palha Terminal

The trunk lines that compose the main structure of the system will work with articulated or bi-articulated buses and the other lines will use the conventional vehicles.

- Main trunk lines – used by larger capacity vehicles, in segregated corridors in BR-316, Augusto Montenegro Roads and Almirante Barroso Avenue, or corridors with exclusive lane in others sections, making the links of Expansion Area – Main Center and Expansion Area– Sub-Center of Sao Braz;
- Secondary trunk lines – used by larger capacity vehicles, in segregated corridors in BR-316, Augusto Montenegro Roads or corridors with exclusive lane in others sections, making the links between Expansion Area – Main Center through Pedro Alvares Cabral and Arthur Bernardes;
- Feeder lines – used by conventional vehicles, making the link between areas located outside of main corridors and some point where the trunk lines pass by;
- Conventional lines– used by conventional vehicles, linking several peripheral areas of 1ª. Legua Patrimonial to the Main Center.

The Almirante Barroso Avenue and BR-316 and Augusto Montenegro Roads would be re-planned to accept exclusive lanes for the trunk lines of the public system, which should have priory treatment.

4.2.1. ALMIRANTE BARROSO AVENUE

The main structural corridor in Belem is actually the Almirante Barroso Avenue, considering its direct link between Center and BR-316 and Augusto Montenegro Roads, which is the main road axle of metropolitan expansion area. This avenue has variable forms of platform, width between 41.20m and 42.40m, with lateral sidewalks and four traffic lanes in one direction divided by physical separator.

Considering the construction of trunk lines in this corridor and the demand of future traffic, it's proposed the re-structure of all infrastructure with the construction of an segregated busway in the central lane with total width of 16.50m, separated physically from the vehicle lanes(FIGURES 4.2-8 and 4.2-9).

The segregated busway would have one traffic lane per direction with bays for boarding and alighting, with a spacing of 600.00m. It should be located near the road intersections for better integration and large accessibility of the users to the boarding and alighting points, through the traffic lights crossing.

For the pedestrian crossings over the segregated busway, a physical separator from bus flow is necessary. This measure is essential for the pedestrian security. Traffic signal with pedestrian push-button should be installed at pedestrian accesses to the segregated lane and consequently to the bus stops (outside of vehicles crossing). These crossing should be interconnected to the intersections of traffic, for not to brake the corridor synchronism when crossing signal is on.

The entrance and exits of the exclusive lane should be treated with physical induct measures for access in a speed of 60 km/h, without traffic interruptions (FIGURE 4.2-10).

Traffic light will be installed at all crossing points with segregated busway. The access to road should be confined to channelized paths to maintain the smooth traffic flow with protection for the pedestrian lanes. At the intersection with dual-way road three-phase traffic light should be avoided. Then, in this case, the flow to the left turn, will be attended through *"looping"* a block on the right side.

Considering the physical limits of the Almirante Barroso Avenue, the two vehicles roads, one in district/center direction and other center/district direction, will have three traffic lanes each without extra lane for stop and/or parking. This fact should provoke a reduction of the lane capacity close to sidewalk considering the passengers boarding and landing. Than, the medium and long duration parking would be only on transversal roads to the Almirante Barroso Avenue.

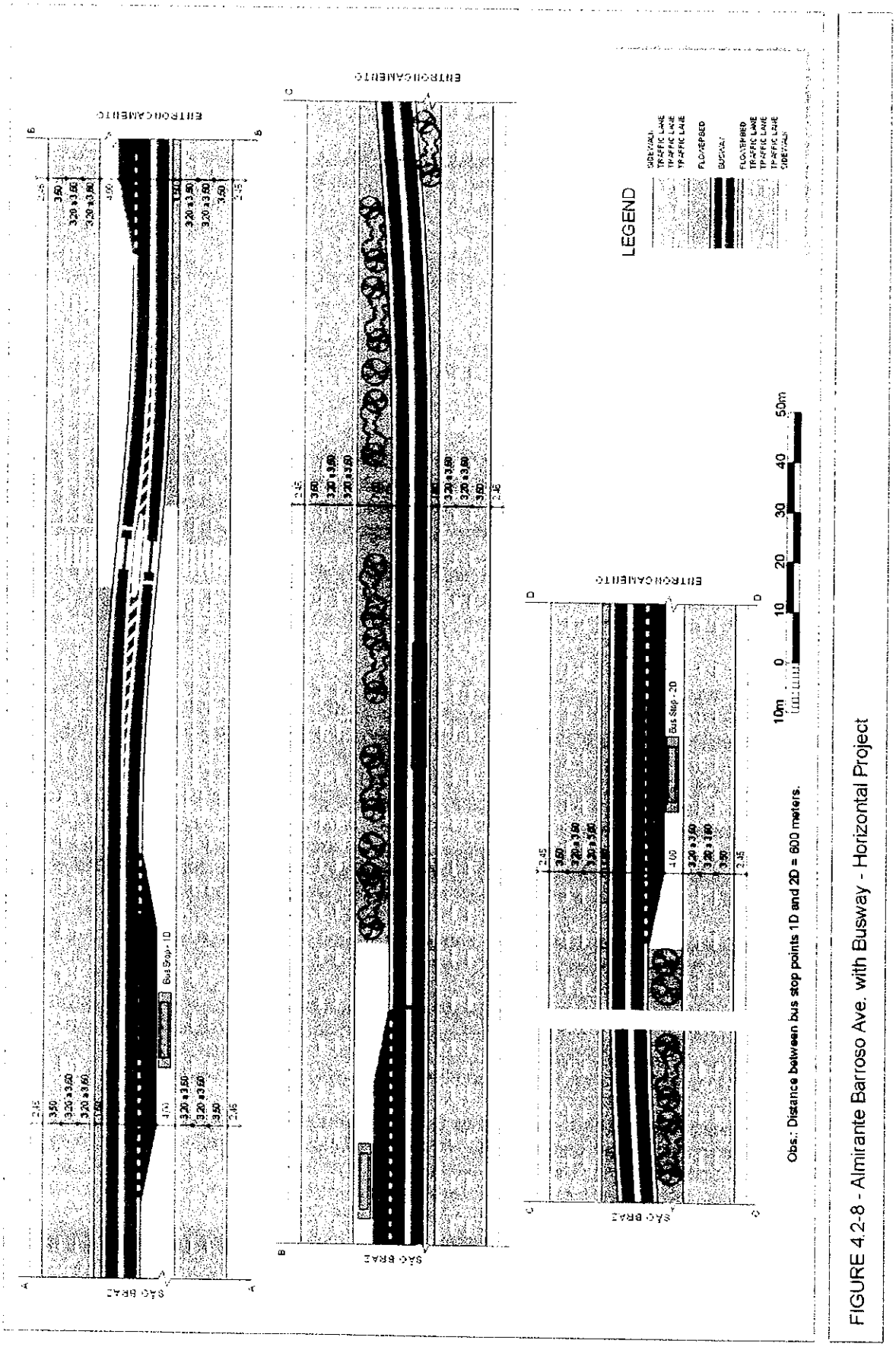
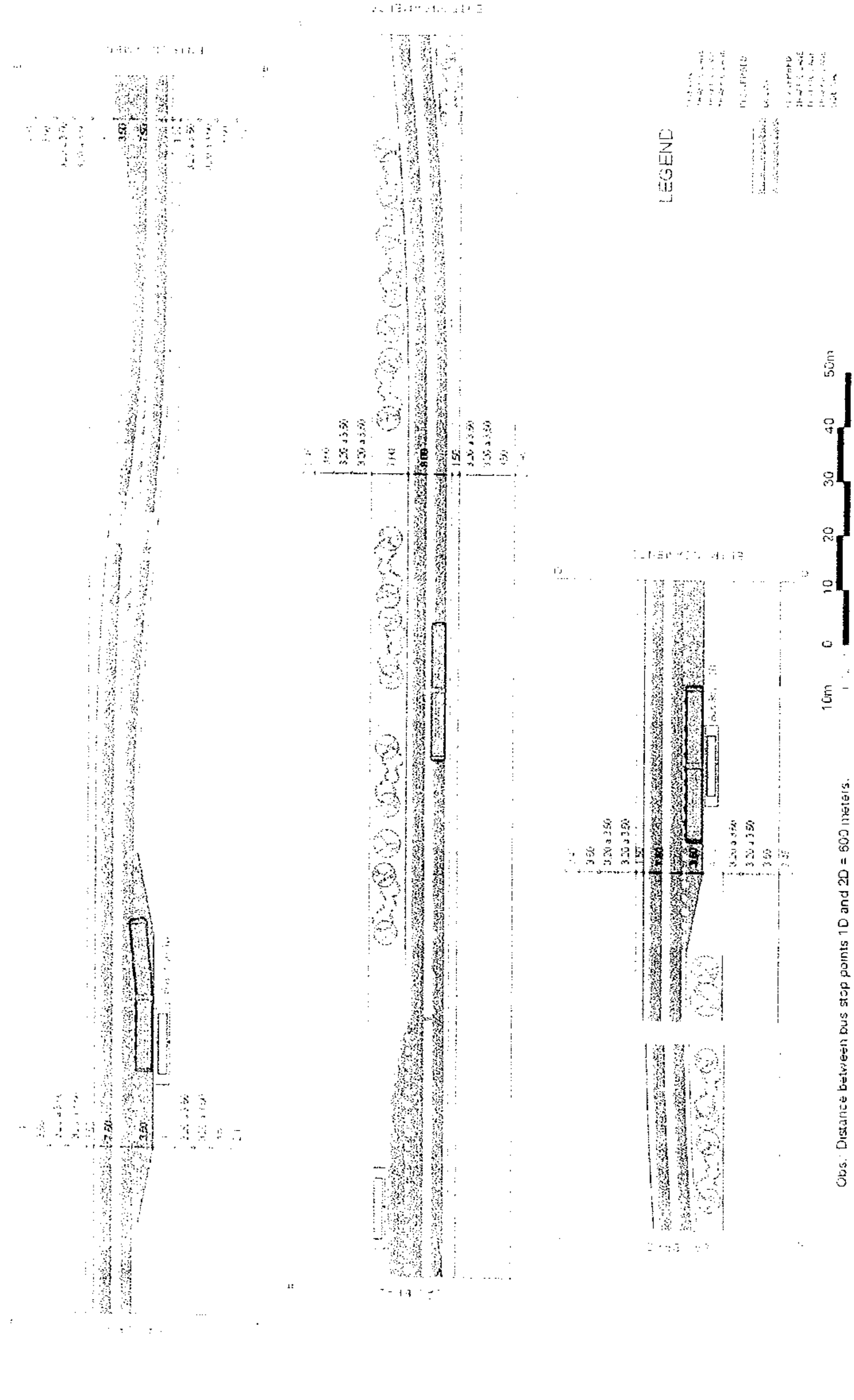


FIGURE 4.2-8 - Almirante Barroso Ave. with Busway - Horizontal Project



Obs.: Distance between bus stop points 1D and 2D = 600 meters.

FIGURE 4.2-8 - Almirante Barroso Ave. with Busway - Horizontal Project

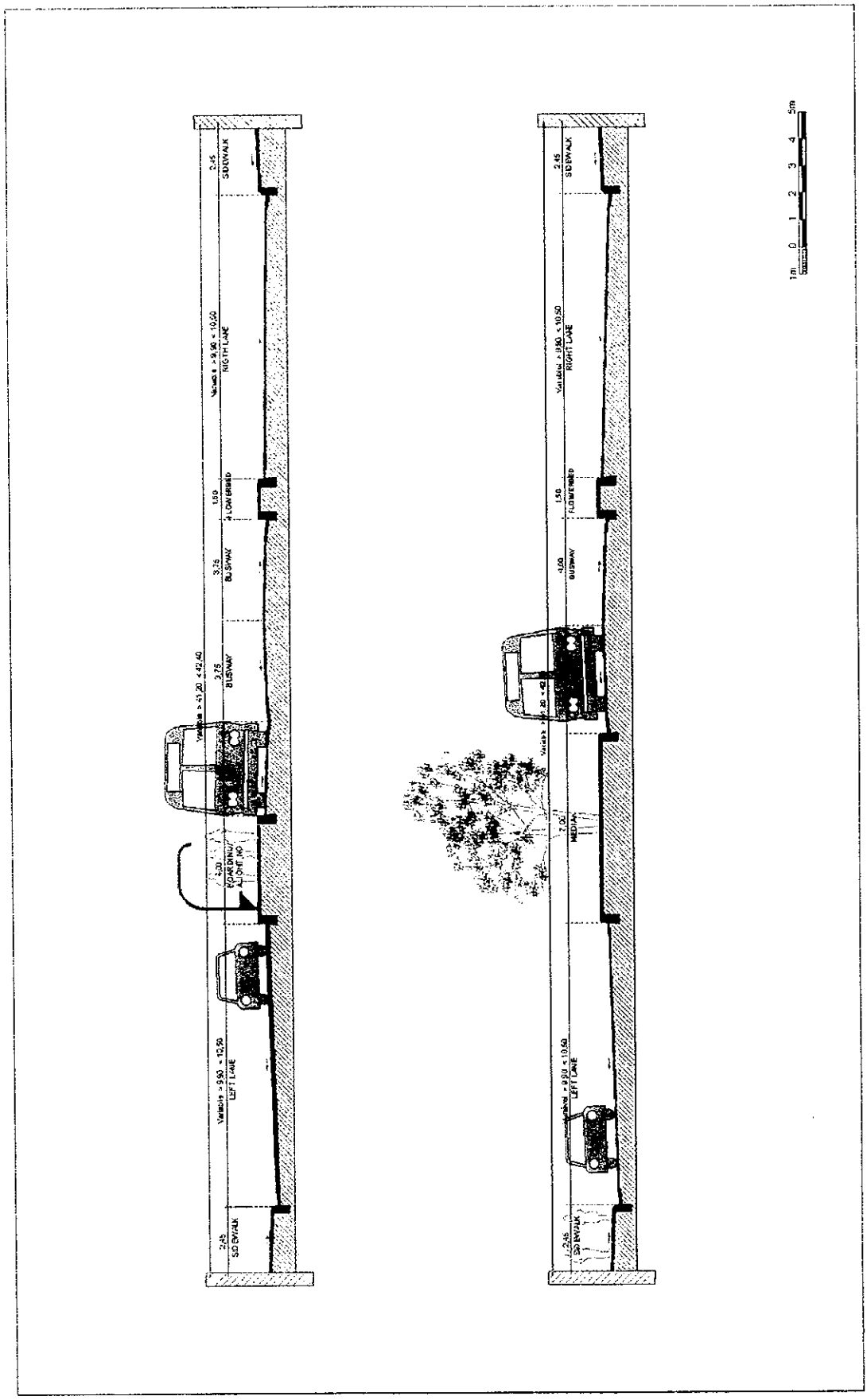


FIGURE 4.2-9 - Almirante Barroso Ave. - Transversal Sections Type

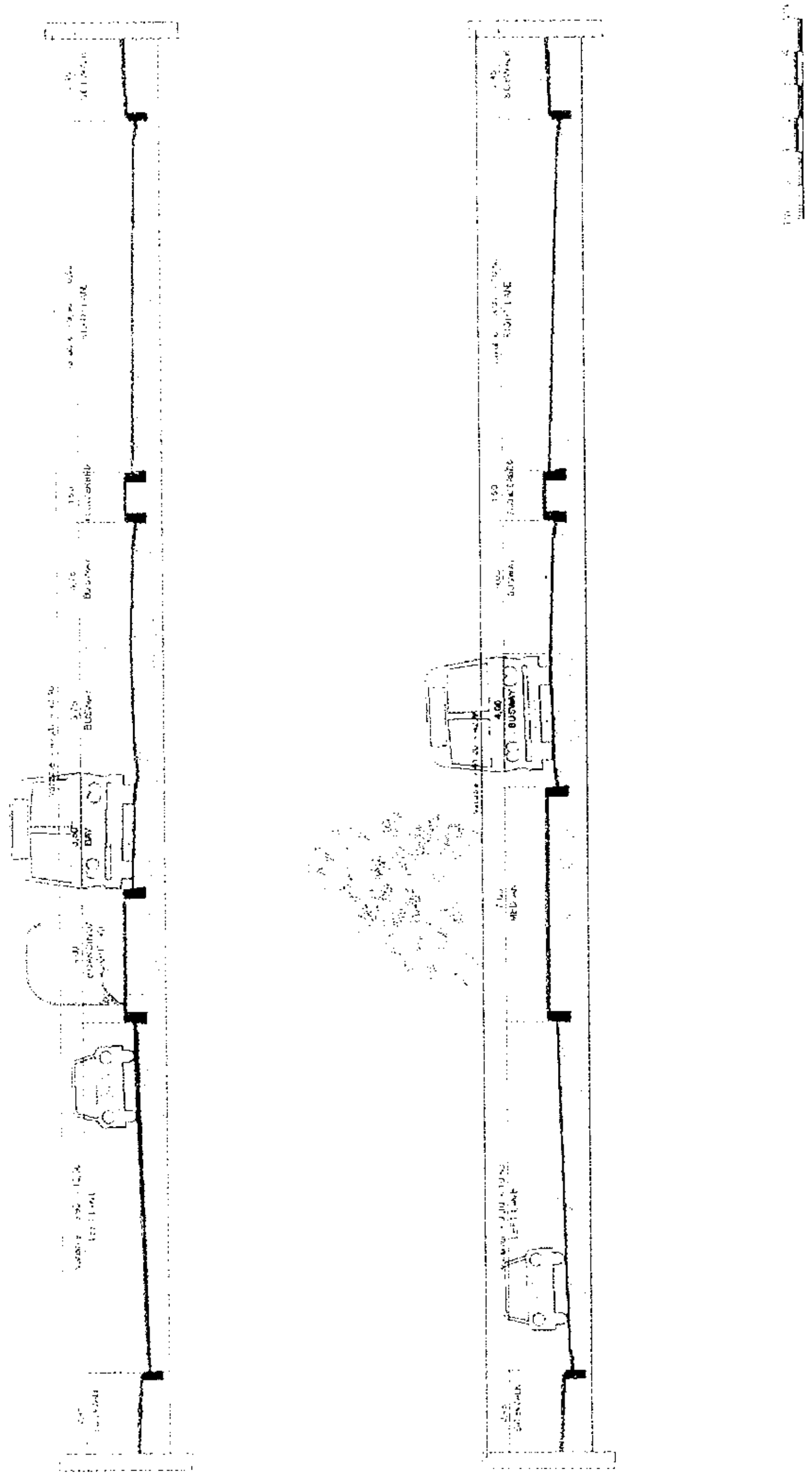


FIGURE 4.2.9 - Almirante Barroso Ave. - Transversal Sections Type

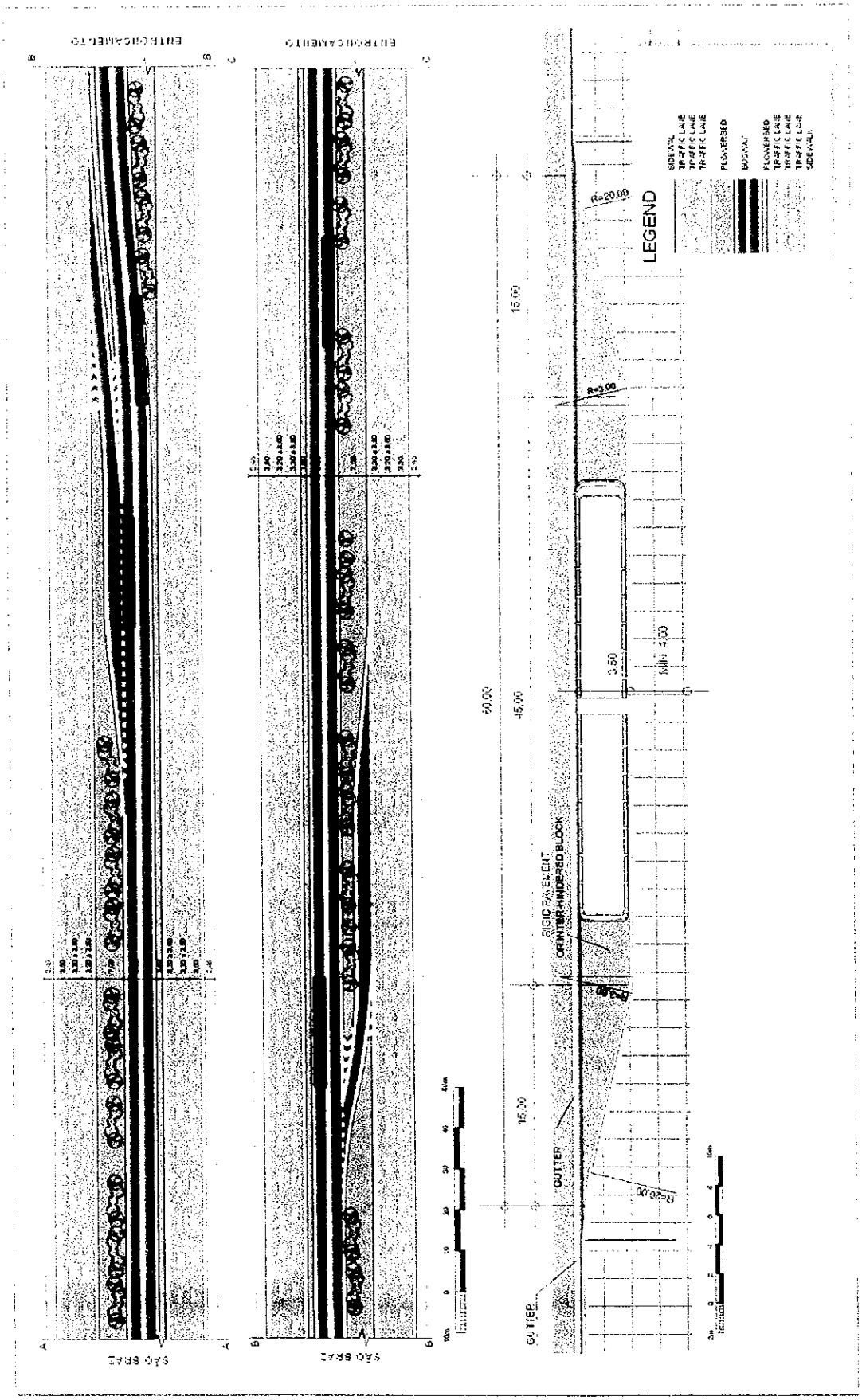


FIGURE 4.2-10 - Almirante Barroso Ave. - Detail of Busway Entrance and Exit and Bus Bay

4.2.2. BR-316 ROAD

The traffic on BR-316 is mixed (urban/long distance) since it is the only access axle to RMB. This fact contributes to the raising of accident potentiality because of the distinct behavior of the drivers. It deserves special attention in its project.

In the area of the segregated busway implementation (KM 0 until the Marituba Terminal), the BR-316 road has platform of 50.00m with the lateral sidewalks in some segments and sideway lane and/or bus stop in other segments. Each direction has three traffic lanes (KM 0 until Coqueiro Road) and two lanes (Coqueiro Road until Marituba Terminal), besides sideway and median, and these lanes operate toward district/center and center/district directions.

For construction of the segregated busway in a central lane of the road, width 16.50m, separated physically from the vehicle lanes, it is necessary to review the entire actual infrastructure. This segregated lane would have one traffic lane per direction, with boarding and alighting bays of 800.00m which should be installed next to the intersections of large traffic volume road. This aim for better conditions of accessibility to the boarding and alighting points through traffic light crossings (FIGURE 4.2-11 and 4.2-12).

The entrance and exits of the exclusive lane, should be treated with physical induct measured for access in a speed of 60 km/h, without traffic interruptions (FIGURE 4.2-13).

Traffic lights will be installed at all vehicle access points by crossing segregated lane. The accesses without crossing road should be confined by channelized paths to maintain smooth traffic flow with protection for the pedestrian lanes. At the intersection with dual-way road, left turn should not be allowed. Then, in this case, the flow to the left turn, is be attended through the *"looping"* a block.

In some segments the circulation would be complemented through installing a lane for return on the left of the Road. All the return operation should be possible using traffic lights (FIGURE 4.2-13).

For the pedestrian crossings over the exclusive lane, there is a physical separator from bus flow. This measure is essential for the pedestrian security. Traffic lights with pedestrian push-button are installed at pedestrian accesses to the segregated lane and consequently to the boarding and alighting bus stop (outside of vehicles crossing). These crossing should be interconnected to the intersections of traffic, for not to brake the corridor synchronism when crossing signal is on (FIGURE 4.2-14 and 4.2-15).

The vehicle road for each direction would have three traffic lanes, with additional lane for sideway. There is suggestion for installation of a bikeroad in the middle of sidewalk.

4.2.3. AUGUSTO MONTENEGRO ROAD

The extension of Augusto Montenegro Road is around 13.90 km. Actually it is considered the second most important structural corridor of RMB, linking the Center of Belém to the Icoaraci District.

The Augusto Montenegro Road platform is variable between 35.80m and 52.40m, with one road per direction and number of lanes variable, separated by physical flowerbed and lateral sidewalks. Due to the big difference of width on the platform, the exclusive lane is chosen at next to the central flowerbed so as to serve the Trunk System.

One busway lane will be installed for each direction, with boarding and alighting bays of approximately 600.00m located in the central median. It should be located near the road intersections for better integration and large accessibility of the users to the boarding and alighting points, through the crossing traffic lights.

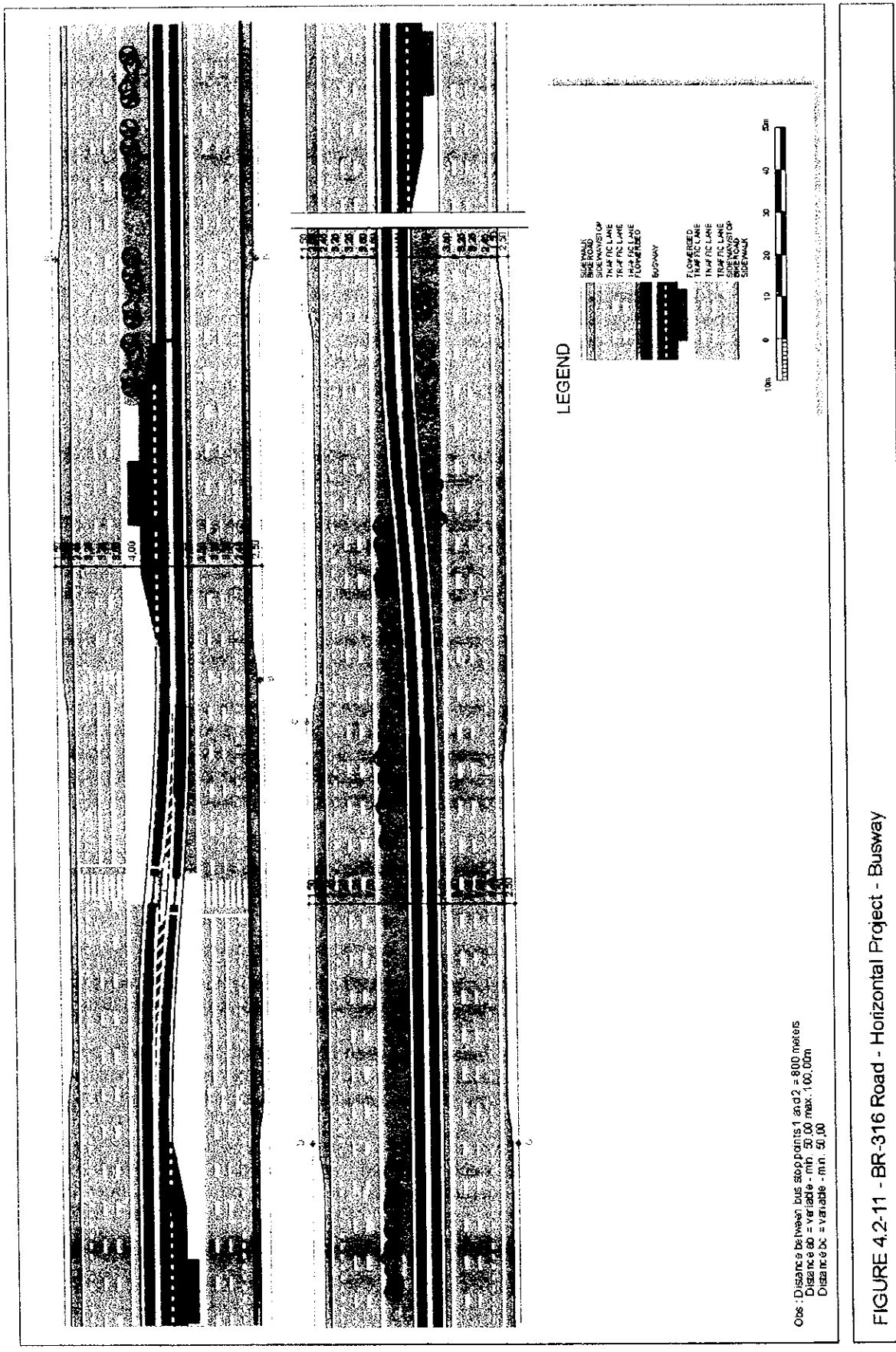


FIGURE 4.2-11 - BR-316 Road - Horizontal Project - Busway

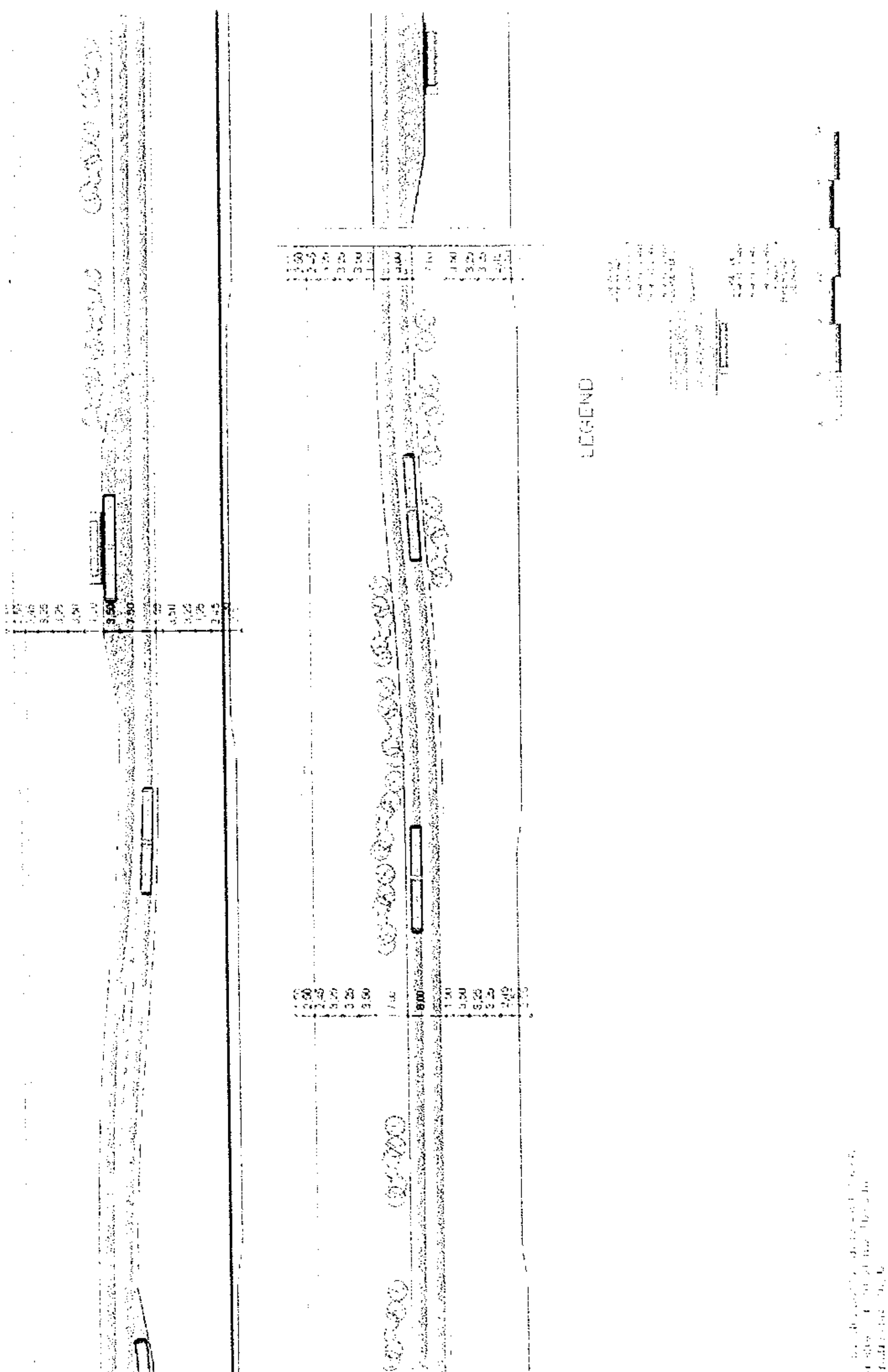


FIGURE 4.2.11 - BR 316 Road - Horizontal Project - Busway

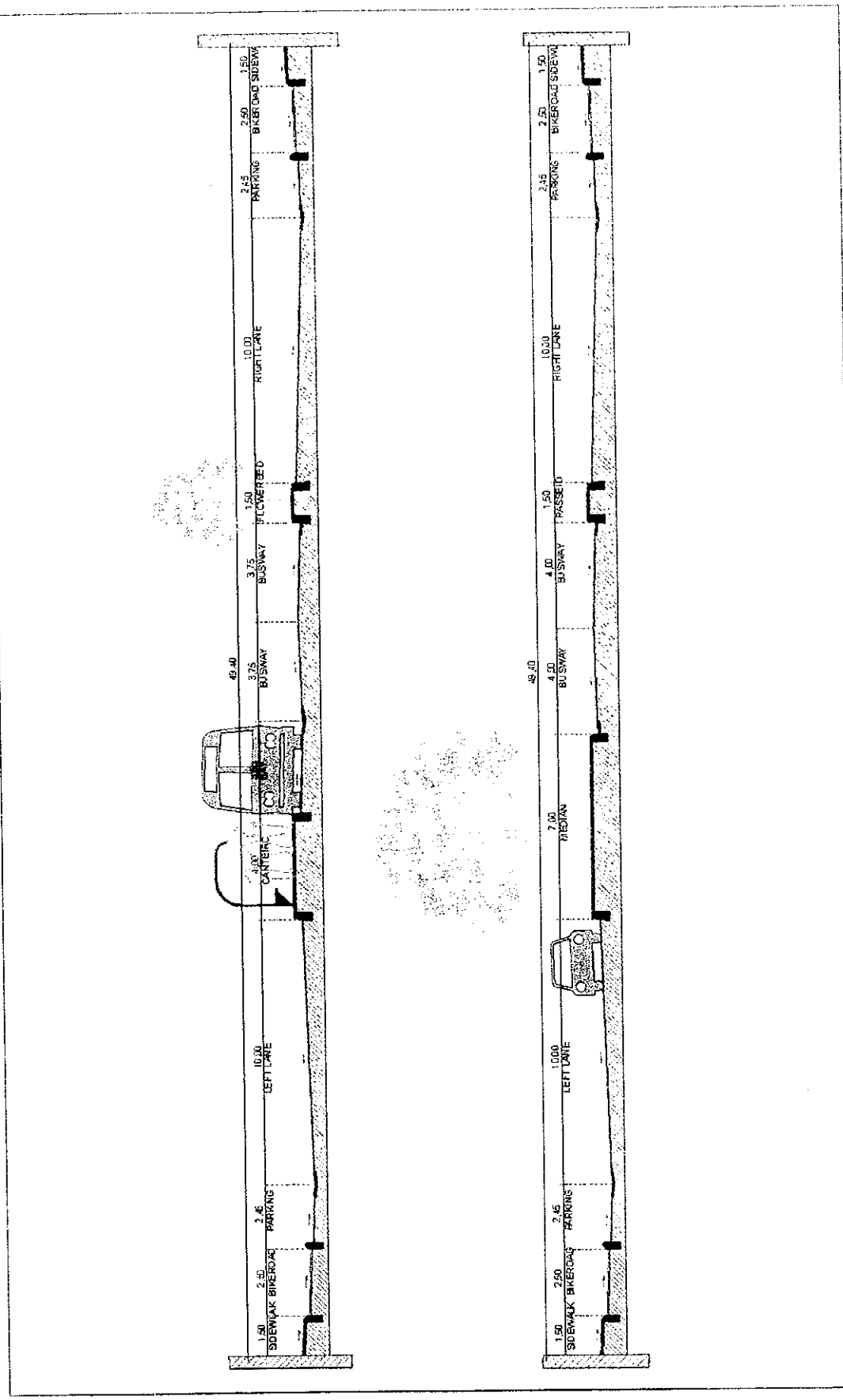


FIGURE 4.2-12 - BR-316 Road - Detail of Transversal Section Type

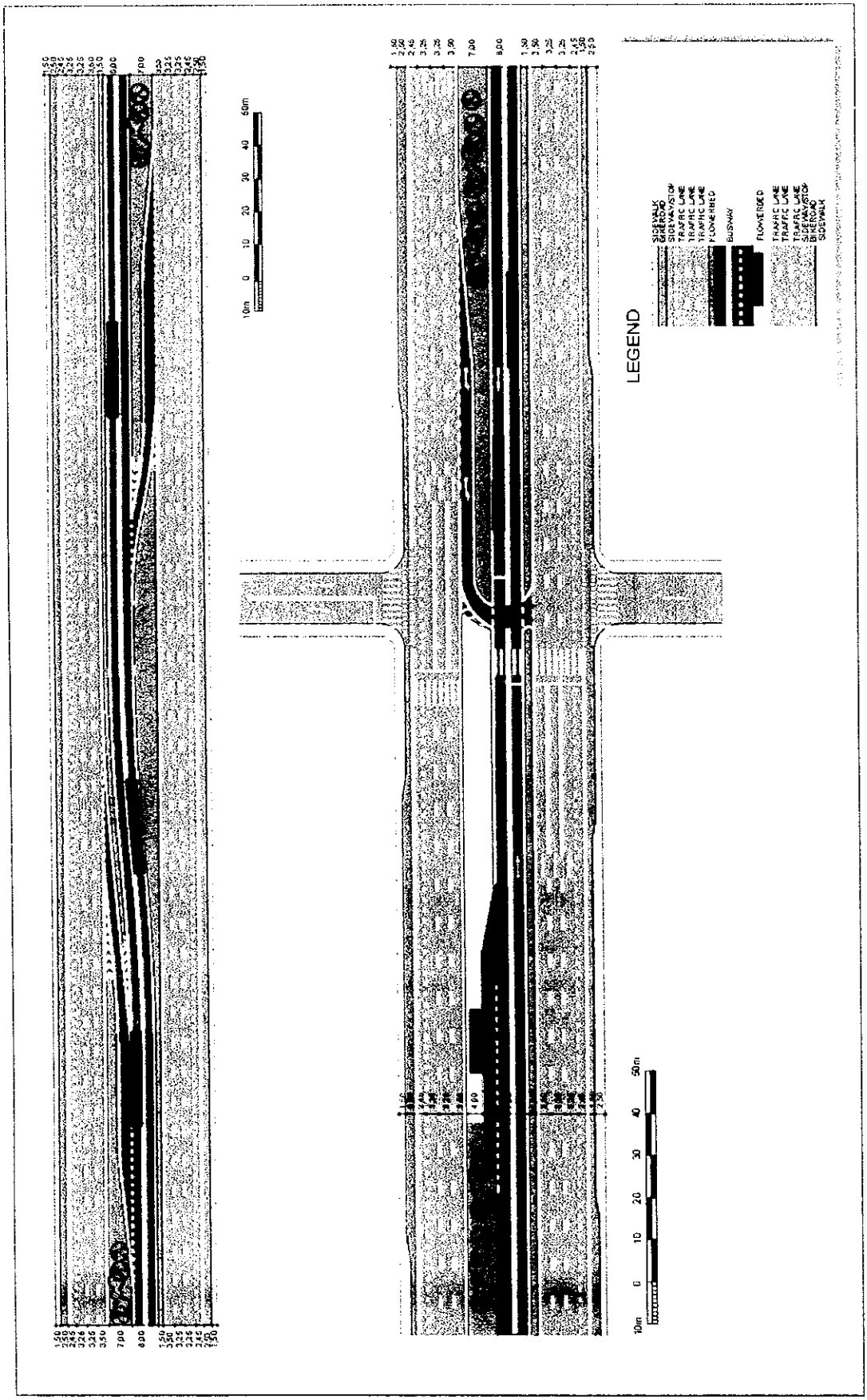


FIGURE 4.2-13 - BR-316 Road - Details of Entrance and Exit of Busway and Return

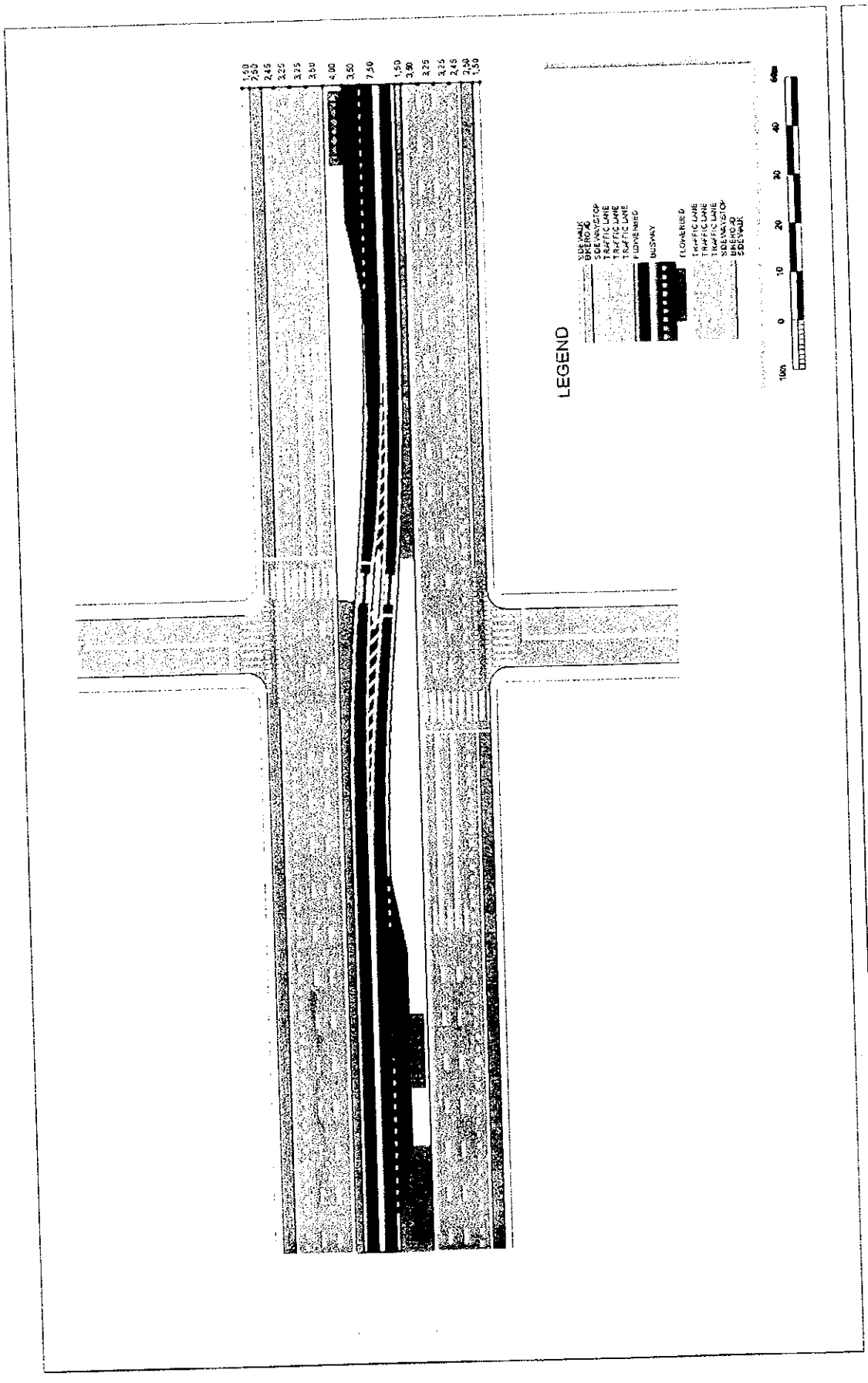


FIGURE 4.2-14 - BR-316 Road -Details of Access Road Type 1

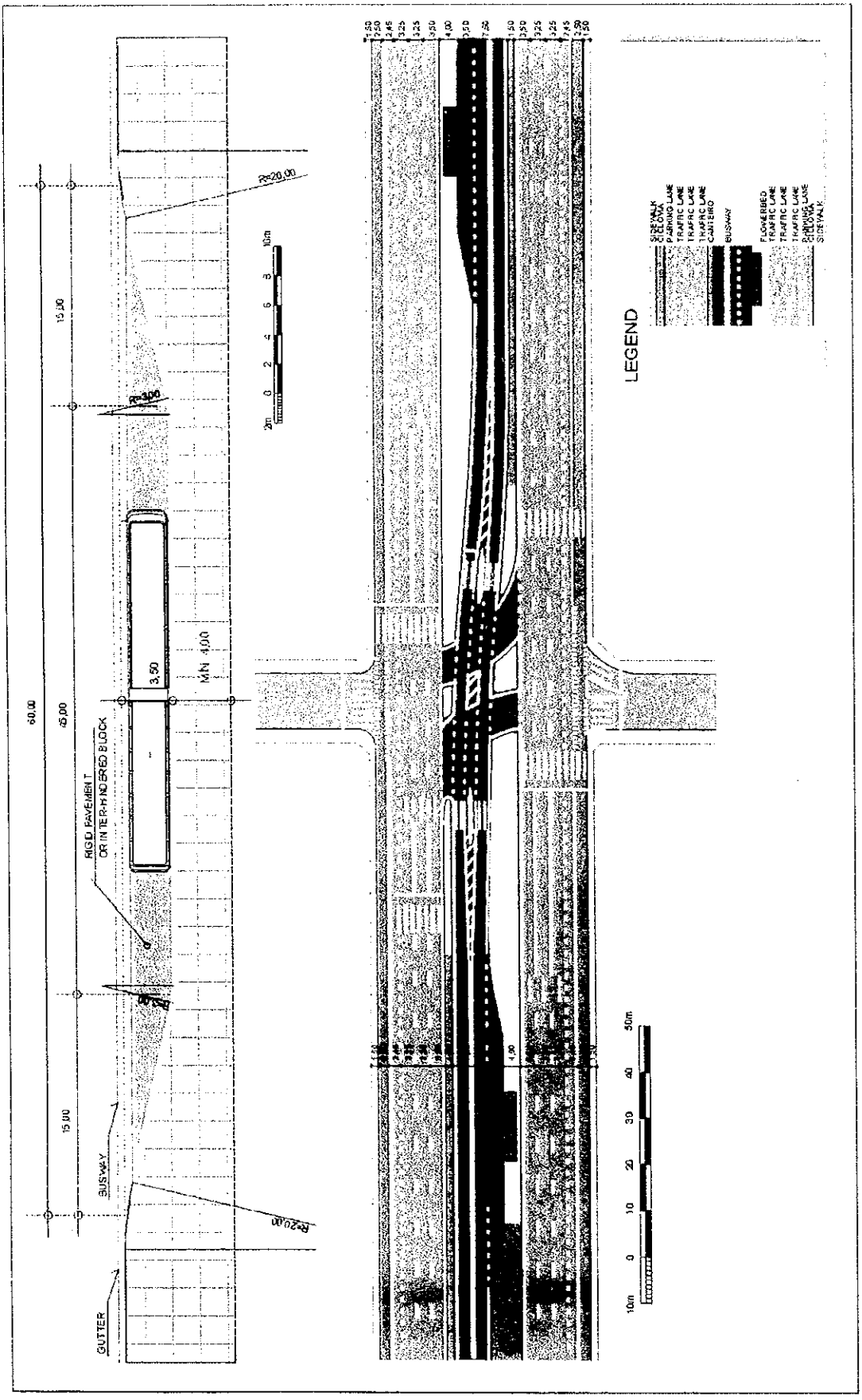


FIGURE 4.2-15 - BR-316 Road - Detail in Horizontal Projection of Bus Bay and Detail of Access Road Crossing BR-316

FIGURE 4.2.15 BR 316 Road Detail in Horizontal Projection of Bus Bay and Detail of Access Road Crossing BR 316

Although it forces the user to cross the road to board and alight; the exclusive lane next to the central median, is of extreme important for maintaining the operational velocity of the public transport due to the elimination of obstacles caused by stopped, parking and interlacing the traffic lane next to the lateral sidewalk. However, it should be emphasized that the exclusive lanes to the left, requires the adaptation of bus with installation of the doors to the left side.

All the accesses crossing Augusto Montenegro Road should be done through traffic light. The accesses without crossing should be confined by channelized paths to maintain smooth traffic flow with protection of the pedestrian crossings.

At the intersection crossing with dual-way road, the three-phase traffic light to allow left turn should be avoided, except in special cases where the road system do not permit to select alternative roads to destination.

For the pedestrian crossings over the exclusive lane, there is a physical separator from bus flow. This measure is essential for the pedestrian security. Traffic lights with pedestrian push-button are installed at pedestrian accesses to the exclusive lane and consequently to the boarding and alighting bus stop (outside of vehicles crossing). These crossing should be interconnected to the intersections of traffic, for not to brake the corridor synchronism when crossing signal is on.

Due to the total platform variation of Augusto Montenegro Road, the following geometric sections are proposed:

1) Segment with platform between 35.80m and 40.00m:
   Central median to have the boarding and alighting points with minimum width of 4.40m; For each direction, a busway lane, two more traffic lanes with minimum width of 11.00m (FIGURE 4.2-16); Bikeroad with physical separation from the vehicles lane with minimum width of 2.50m; Variable sidewalk with minimum width of 2.20m and maximum of 4.30m.

2) Segment with platform between 40.00m and 52.20m:
   Central median to have the boarding and alighting points with minimum width of 4.40m (FIGURE 4.2-17); For each direction, a busway lane, two more traffic lanes with minimum width of 11.00m; Expansion lane located between lane and bikeroad with variation between 1.80m and 7.90m, it can be used for installation of parking and/or additional traffic lane; Bikeroad with physical separation from the vehicles lanes with minimum width of 2.50m; Variable sidewalk with minimum width of 2.50m.

In this corridor stands out the junction of Coqueiro Road and Tapana Road. In this point due to the oblique in both roads at Augusto Montenegro Road, and to the lack of space to develop an appropriate connection, It is proposed the geometric treatment in different levels. Since the connection point of Tapana Road at Augusto Montenegro Road is located approximately 200.00m away from that of Coqueiro Road, and they are situated in plain topography area, it's proposed the elevation of Augusto Montenegro Road. This elevation should be done by reclaiming ground between the concrete walls which should be constructed along the road sides interrupting the intersection points of the roads described above. Then Augusto Montenegro Road goes through small fly over and other two roads crossing inferior. This solution does not interrupt the Augusto Montenegro Road traffic, and the secondary flows will be attended through the geometric channelization (FIGURE 4.2-18 and 4.2-19)

4.2.4 BINARY SENADOR LEMOS-PEDRO ALVARES CABRAL

This item shows the necessity of the binary construction between Pedro Alvares Cabral and Senador Lemos Avenues in section between Dr. Freitas Avenue and Arthur Bernardes Road/Cel. Luis Bentes (FIGURE 4.2-20). This will enlarge the capacity of the two roads, eliminating the current restrictions of Pedro Alvares Cabral Avenue. Presently this road has only two lanes per direction in this section. Traffic conditions is aggravated by the insufficient sidewalk and by the great flow of cyclists and pedestrians in the lane.