

CHAPTER 8
Conceptual Planning For Trunk Bus System

8. CONCEPTUAL PLANNING FOR TRUNK BUS SYSTEM

8.1. BASIC PLANNING POLICY AND STRATEGY

8.1.1. BASIC PLANNING POLICY

As discussed in Section 7.11 of Chapter 7, the most serious problem in the existing bus transport system in the study area is the direct outcome of the existing road network that forces the bus traffic to use a single route in the Centro. There are a total of 165 bus lines in the BMA, and more than 70 of them, or about 42%, run on Av. Almirante Barroso. Moreover, most of these bus lines are inefficiently operated in the central built-up area of Belem City, because passengers they pick up within the Centro are generally small in number. The concentration of bus lines on one route or in one area of service causes extreme traffic congestion on Av. Almirante Barroso and other related arterial roads in the Centro. This inevitably lowers the bus operating speed and lengthens the travel time (or commuting time) for bus passengers. Bus companies find it extremely difficult to run their bus services on schedule. The efficient and effective bus operation is practically out of question under the present circumstances. The inefficient bus operation means the superfluous deployment of bus fleet relative to the effective demand. This further exacerbates the traffic congestion in the Centro, together with the rapidly growing use of private automobiles. In the end, the traffic congestion seriously harms the smooth running of urban functions by reducing the speed, and increasing the travel time to destination, of all motorized traffic.

The current bus fleet is relatively new, averaging 3.5 to 4.0 years in service. However, their superfluous operation unnecessarily adds to the worsening air pollution.

The introduction of a trunk bus system offers a solution to the current problem of bus transportation mentioned above. The new system will ensure functionally efficient bus operation and thereby help ensure the sound functioning of Belem City. As shown in Figure 8.1-1, the basic planning policy for the proposed trunk bus system takes into full account the expected benefits and advantages to (i) bus passengers, (ii) bus companies, (iii) urban citizens in general, and (iv) the urban environment.

From the vantage point of bus passengers, the planning of the new system aims at (i) reduction of travel time, (ii) regular bus service on schedule, (iii) wider mobility on bus and (iv) increased safety of bus travel. For bus companies, the new system is designed to achieve (i) increased bus passengers, (ii) an efficient bus operation system that enables a significant reduction of bus fleet in operation and (iii) regular bus service on schedule that simplifies the bus operation and management. For urban citizens as a whole, the system planning aims at (i) substantial alleviation of chronic traffic congestion in order to restore sound urban transportation and reduce travel time, (ii) improved traffic safety and (iii) better accessibility to bus transport. From the environmental perspective, the system is planned to contribute to the amelioration of air pollution and noise levels.

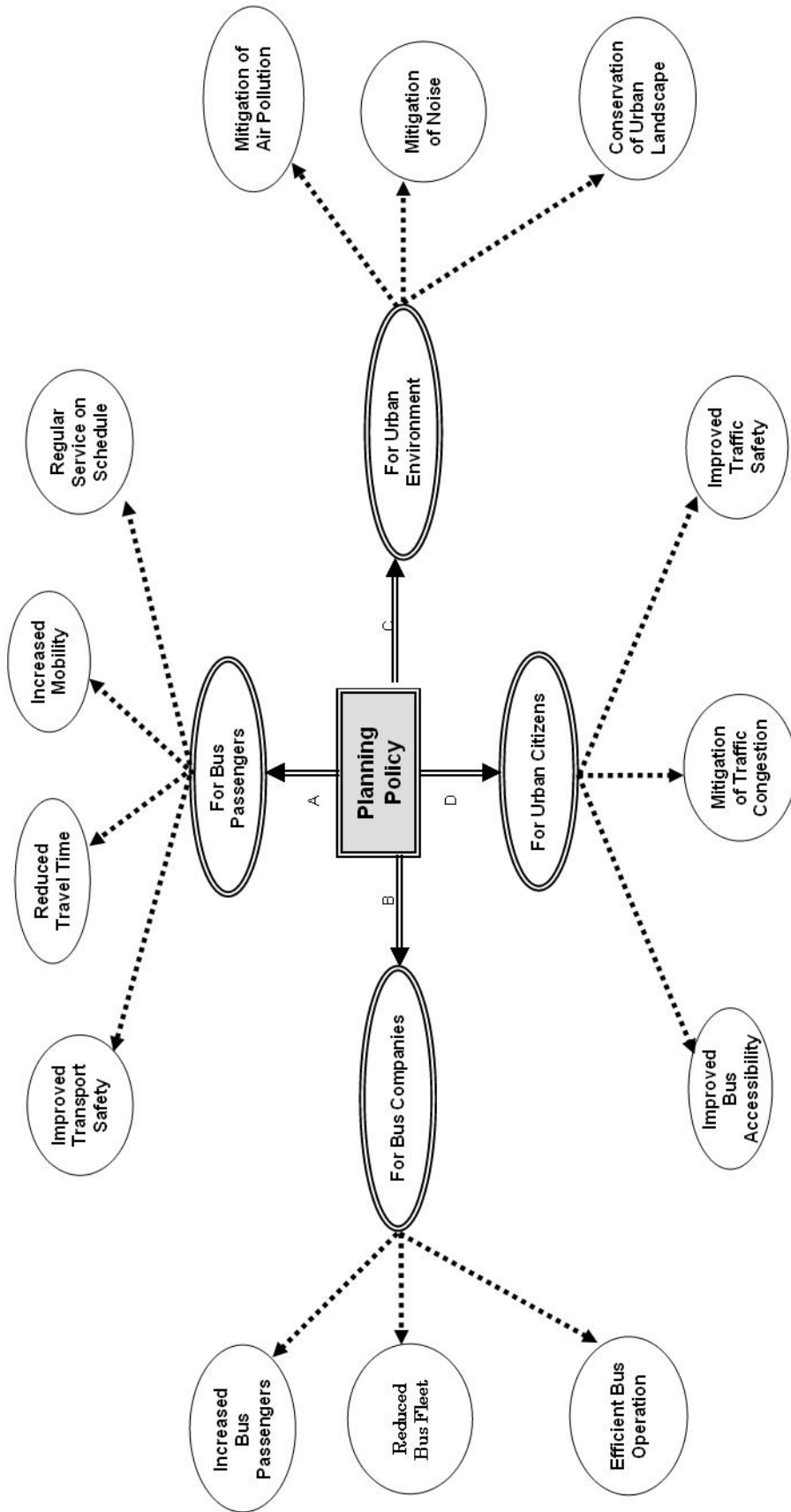


Figure 8.1-1 Basic Planning Policy

8.1.2. STRATEGY OF PLANNING

The strategy to pursue the basic planning policy comprises the following actions.

- 1) To identify the problems and issues of the existing bus transport system;
- 2) To analyze the factors that lie at the root of these problems and issues;
- 3) To plan various projects to solve the problems and to cope with the issues; and
- 4) To examine and propose the institutional, or software, measures (e.g., bus operation and management) and the physical, or hardware, requirements (e.g., roads for bus transport) that are considered necessary to establish a sound urban transport system.

The institutional measures directly concern the existing bus companies. Therefore, the planning closely examines the details of the existing practices to offer feasible proposals on bus operation and management that will be acceptable to these companies. Given the urgency of improving the existing bus transport, the physical planning assumes that the proposals on construction and improvement conform to the rights of way of the existing roads without involving any new land acquisition.

(1) Problems, Causes and Solutions

Figure 8.1-2 shows the major problems in the existing bus transport system, the major factors that cause such problems and the approaches to solve the problems. As shown in the figure, the problems are numbered from A-1 through A-7, the causal factors from B-1 through B-8 and the solutions from C-1 through C-8. The arrows indicate the relationships between the respective problems, factors and solutions.

The gravest problems that call for urgent solution are the traffic congestion (A-1) and the concentration of bus lines (A-4). There are a number of factors that combine to cause the traffic congestion, but two important ones are the low transport capacity due to the shortage of available lanes and the reduction of transport capacity caused by the mixed traffic. The construction of new roads and the widening of the existing roads will solve the shortage of lanes. It is possible to separate the mixed traffic by running speed into bikes, automobiles, buses, and pedestrians and provide each with its own lane or lanes.

(2) Proposed Projects and the Beneficiaries

Figure 8.1-3 shows the proposed projects (D-1 through D-7) relative to the respective solutions (C-1 through C-8) and the expected effects of the proposed projects (E-1 through E-8), with arrows indicating their relationships. The beneficiaries (F-1 through F-4) are also indicated relative to the effects of the proposed projects. Regarding the solutions C-1 and C-2 that concern the availability of roadway, for example, the proposals consist of the new road construction on three routes and the widening of the existing roads, either from four lanes to six or from two lanes to four. The solution C-3, or the re-routing of bus lines, is provided by the integration of bus lines (D-2), the introduction of the trunk bus system (D-3), the construction of busways (D-4) and so on. To restore the proper functioning of urban transport, the present Study formulates the project proposals D-1 through D-7 to the problems identified with regard to the present bus operation system. The seven proposed projects are as follows.

- 1) Construction and improvement of roads (D-1)
- 2) Integration of bus lines (D-2)
- 3) Introduction of the trunk bus system (D-3)
- 4) Construction of trunk busways (D-4)

- 5) Introduction of the pre-paid card system (D-5)
- 6) Introduction of larger buses and related facility improvement (D-6)
- 7) Reorganization of bus operation (D-7)

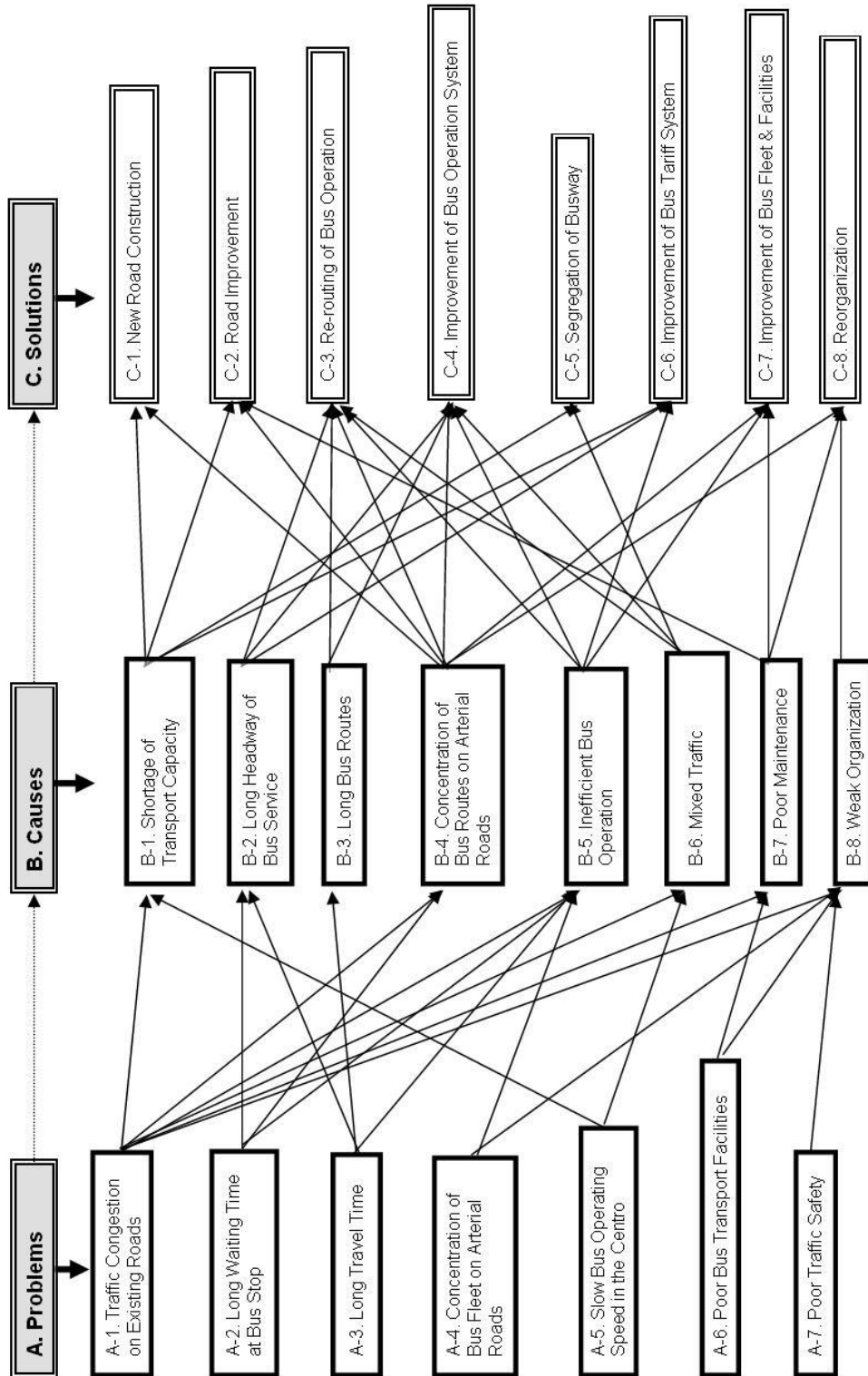


Figure 8.1-2 Problems, Causes and Solutions in Bus Transportation

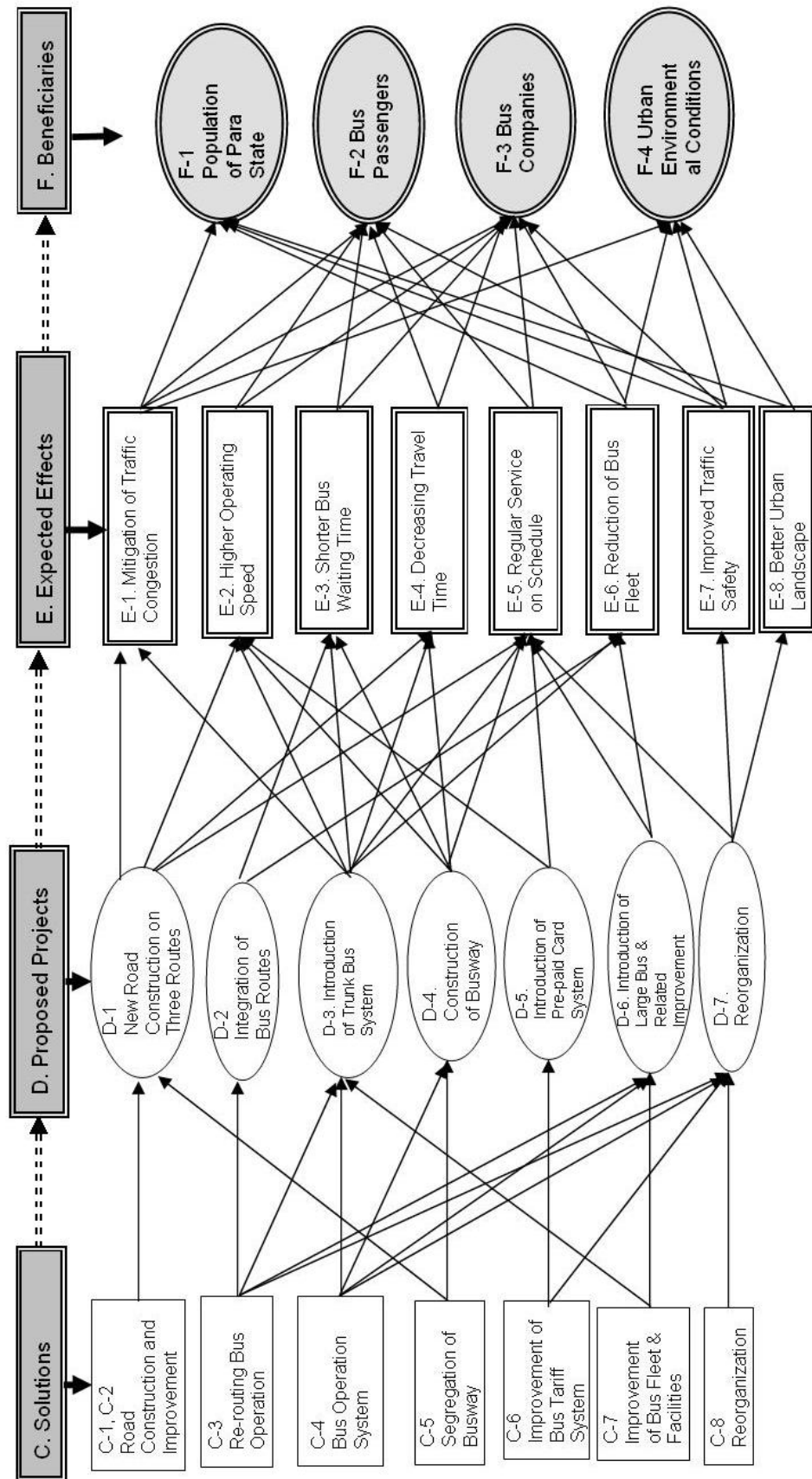


Figure 8.1-3 Proposed Projects, Expected Effects and Beneficiaries

8.2. CONCEPTUAL PLANNING FOR TRUNK BUS SYSTEM

This section describes the conceptual plan of the trunk bus system that integrates six proposed projects (D-2 through D-7) mentioned above. The planning approach to the road construction and improvement is detailed in Chapter 13.

8.2.1. BUS SYSTEM IN THE STUDY AREA

Five lines of minibuses with 40-passenger capacity and 165 lines of conventional buses with 100-passenger capacity are currently in operation in the study area. There were 25 minibus lines in service five years ago. Because their fare of R\$1.7 was nearly twice as high as the conventional bus fare of R\$1.00, they rapidly lost their passengers and are now operated only on five lines. The bus companies intend to stop their minibus services entirely in the future. Through the process of analyzing the present bus transport system and searching solutions to the existing problems vis-a-vis the framework of the stated basic planning policy and strategy, the present Study proposes a new bus transportation plan that combines (i) a trunk bus system, (ii) a conventional bus system and (iii) a feeder bus system. Details of the conceptual plan will be explained below.

(1) Trunk Bus System

The proposed trunk bus system is divided into three components depending on the type of lane, or of road structure, it utilizes: i.e., trunk busway, exclusive trunk bus lane and trunk bus priority lane. The proposed plan calls for the introduction of larger buses in order to reduce the number of bus fleet in operation and thereby to alleviate the traffic congestion. Specifically, the new bus is the two-bus articulated type of 200-passenger capacity that is already in use in Sao Paulo, Curitiba and elsewhere.

1) *Trunk Busway*

The trunk busway is introduced to the following existing roads: namely, (i) those route segments where bus passenger demands are very high (10,000 or more passengers per hour), (ii) the existing arterial roads that have the rights of way wide enough to construct the two-way trunk busway (about 10m in width) without additional land acquisition, and (iii) the two-way arterial roads that have six or more lanes. The trunk busway is segregated by some concrete structure from the through traffic lane in order to ensure the regular trunk bus service according to schedule and the traffic safety. The busway is closed to pedestrians, bicycles, taxis and other motor vehicles throughout the day. The arterial roads that introduce the trunk busway will have two to three lanes one way on both sides of the busway for regular motorized traffic. Bikeways are provided for bicycles and sidewalks for pedestrians.

2) *Exclusive Trunk Bus Lane*

The exclusive trunk bus lane is introduced to the following existing roads: namely, (i) those route segments where bus passenger demands are fairly high (from 8,000 to less than 10,000 passengers per hour), (ii) the existing or planned arterial roads that have the rights of way wide enough to construct two trunk bus lanes (about 7m in aggregated width) without additional land acquisition, and (iii) the two-way arterial roads that have six or more lanes. The exclusive trunk bus lane is introduced on both sides of the median on the two-way roads with six or more lanes. The lane is segregated by some lane marking like delineators from the through traffic lane. The exclusive trunk bus lane is closed to pedestrians, bicycles, taxis and other motor vehicles. Bikeways are provided for bicycles and sidewalks for pedestrians. Two or more lanes one way are provided on both sides of the bus lanes for the through traffic of taxis and other motor vehicles.

3) Trunk Bus Priority Lane

The trunk bus priority lane is introduced to the following roads: namely, (i) those route segments where bus passenger demands are fairly high (from 8,000 to less than 10,000 passengers per hour), (ii) the two-way arterial roads that have four or more lanes, (iii) those roads on which the traffic load is large enough to reduce the bus operating speed, and (iv) those roads with no possibility of widening. The trunk bus priority lane is introduced next to the right-side sidewalk. The lane is not segregated by any structure, but paved in distinct color to attract attention.

(2) Conventional Bus System

The conventional bus system operates the bus lines other than the trunk bus and the feeder bus lines. The present operation system, including bus lines, service frequency, bus companies and so forth, is retained without any change. The fleet consists of conventional buses with 100-passenger capacity.

(3) Feeder Bus System

The feeder bus system operates in an area around a trunk bus terminal to carry passengers to and from the terminal. Its service area is limited to a relatively small area in the suburbs, with relatively short route length and smaller number of passengers per bus. Because feeder buses probably run on narrower roads, the fleet consists of smaller buses with 70-passenger capacity.

(4) Hierarchy of Three Bus Systems

Table 8.2-1 shows the hierarchy of three bus systems in terms of their respective planned elements and the bus fleet requirements.

Table 8.2-1 Hierarchy of Three Bus Systems

Bus System	Means of Segregation	Effective Hours	Type of Traffic	Roads for Introduction			Bus Fleet		Guideline Bus Passenger Traffic (persons/hour)
				No. of Lanes	Right of Way	Road Classification	Bus Type	Bus Capacity (persons)	
Trunk Busway	Fully segregated (divider)	All day	Buses	Six or more lanes	35.0m or wider	Principal arterials	Articulated	200	10,000 or more
Exclusive Trunk Bus Lane	Partially segregated (lane marking by delineators)	All day or peak hours	Buses	Six or more lanes	30.0m or wider	Principal arterials	Articulated	200	10,000 or more
Trunk Bus Priority Lane	Partially segregated (colored pavement)	All day or peak hours	Buses, private cars & taxis	Four or more lanes	25.0m or wider	Secondary arterials	Articulated Conventional Small conventional	200 100 70	Less than 10,000
Conventional Busway	No segregation (same as present)	All day (same as present)	All motor vehicles	*****	*****	*****	Conventional	100	*****
Feeder Busway	No segregation (same as present)	All day (same as present)	All motor vehicles	*****	*****	*****	Small conventional	70	*****

8.2.2. ROADS SELECTED FOR TRUNK BUS SYSTEM

The selection of roads for the trunk bus service is done in accordance with the aforementioned planning policy and the hierarchy of three bus systems. By analyzing the findings of the screen line survey conducted by the JICA team in June 2002 and the other relevant information collected, eleven roads are chosen for the reasons already stated, such

as the frequent use by many bus lines and the heavy traffic of bus passengers. Table 8.2-2 lists the selected roads. The other roads excluded from the list have only three to five bus lines operating on them and carry 2,000 passengers or even less per hour one way. In other words, the bus lines and the bus passenger demand are concentrated on ten existing roads shown in Table 8.2-2.

Table 8.2-2 Selected Roads for Trunk Bus System

Roads	No. of Bus Lines	Bus Passengers per Direction (persons/hour)	No. of Lanes	Traffic Condition	Possibility of Widening	Remarks
1. Av. Almirante Barroso	60 to 70	35,000 to 40,000	8	Congested	Difficult	
2. Rodovia BR-316	15 to 20	5,000 to 22,000	6	Congested	Difficult	
3. Rod. Augusto Montenegro	15 to 20	5,000 to 20,000	6	Congested	Difficult	
4. Av. Pedro Alvares Cabral	25 to 30	6,000 to 10,000	4 to 6	Congested	Extremely difficult	
5. Av. Senador Lemos	10 to 15	3,000 to 5,000	4	Congested	Extremely difficult	
6. Av. Marechal Hermes	65	5,000 to 10,000	3	Congested One way	Extremely difficult	
7. Av. Magalhaes Barata/Nazare	30 to 35	5,000 to 10,000	3	Congested One way	Extremely difficult	
8. Rod. Mario Covas	18	3,000 to 5,000	4	Congested	Difficult	
9. Trav. Cristovao Colombo	9 to 12	1,000 to 2,000	4	Congested	Difficult	
10. Trav. Sao Roque	5 to 10	1,000 to 2,000	4	Congested	Difficult	
11. Av. Independencia	Under construction		6	----	----	

(1) Roads Selected for Trunk Busway

The following three roads are selected for the introduction of the trunk busway.

- 1) Avenida Almirante Barroso
- 2) Rodovia BR-316
- 3) Rodovia Augusto Montenegro

There are three reasons to justify the selection as shown below.

- a) Three roads respectively have heavy bus passenger traffic exceeding 20,000 persons per hour per way and are most heavily bus-operated routes.
- b) Three roads have marked concentration of bus lines: Rodovia BR-316 and Rodovia Augusto Montenegro each with 20 lines, and Av. Almirante Barroso with more than 70 lines.
- c) Three roads are principal arterial roads with six or more lanes, and are wide enough to introduce the two-way trunk busway.

(2) Road Selected for Exclusive Trunk Bus Lane

The exclusive trunk bus lane is introduced to Av. Independencia. There are three major reasons to justify the decision as shown below.

- 1) Avenida Independencia now under construction is a two-way road with four lanes. Because the avenue runs through residential areas, the demand for trunk bus service is expected to be sufficiently large.
- 2) The four-lane northern segment of Av. Independencia will be completed by 2003. The widening of the avenue into six lanes is planned to begin shortly afterwards and the construction is expected to be over by 2006. The avenue is designated as principal arterial road, but there is no room to secure the right of way wide enough to introduce the trunk busway (width of 10m). Therefore, the

exclusive trunk bus lanes (aggregated width of 7.0m) will be provided on the avenue.

- 3) As mentioned above, the widening of the avenue is planned to follow closely after the completion of the four-lane roadway. The exclusive trunk bus lane is more suitable and less costly than the trunk busway, because it will require less undoing and redoing on the roadway structure next to the median.

(3) Roads Selected for Trunk Bus Priority Lane

The following six roads are selected for the introduction of the trunk bus priority lane.

- 1) Avenida Governador Jose Malcher
- 2) Avenida Magalhaes Barata/Nazare
- 3) The road link to connect Av. Governador Jose Malcher (one-way road) to Av. Magalhaes Barata/Nazare (one-way road)
- 4) Rodovia Mario Covas
- 5) Travessa Cristovao Colombo
- 6) Travessa Sao Roque

There are four reasons to justify the selection as shown below.

- a) Six roads respectively have smaller bus passenger traffic, but the number of bus lines operating on them suggests their relative importance.
- b) Six roads are surrounded by the areas of sizable bus traffic generation and attraction.
- c) Six roads respectively have the right of way too narrow to allow the introduction of the trunk busway or the exclusive trunk bus lane.
- d) It is extremely difficult to widen six roads that pass through well-developed commercial cum residential areas.

Figure 8.2-1 shows the location of the trunk busway, the exclusive trunk bus lane and the trunk bus priority lane.

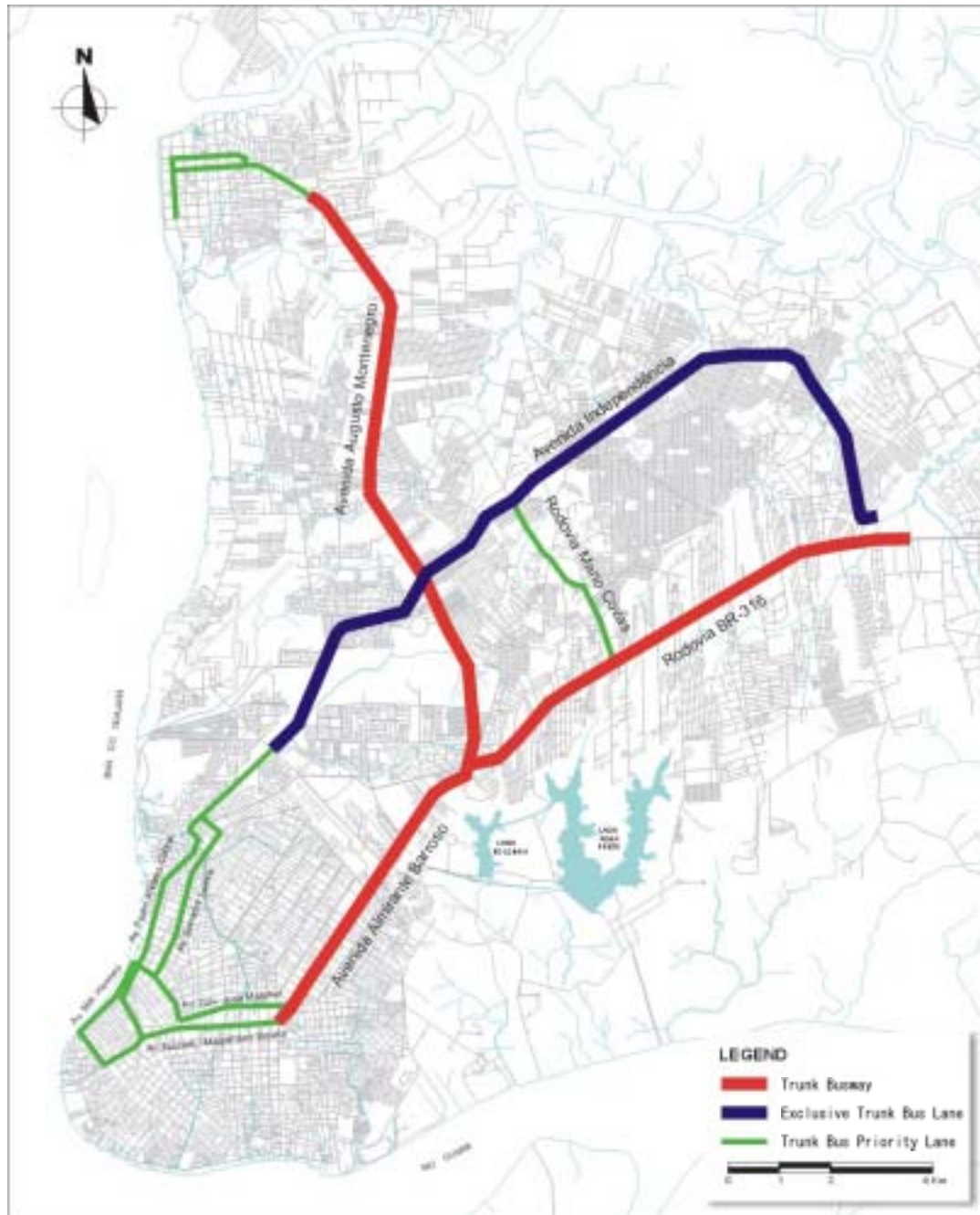


Figure 8.2-1 Network of Trunk Busway, Exclusive Trunk Bus Lane and Trunk Bus Priority Lane

8.2.3. BUS CAPACITY AND TRUNK LINE CAPACITY

(1) Bus Capacity

The currently operated fleet consists of buses with 43 to 45 seats and the transport capacity of about 100 persons including standing passengers. The average passengers per bus vary by hour of the day and by area of service. The existing bus operation is hardly efficient, because the average passengers during the peak hours range from 60% to 70% of the bus capacity on Rodovia Augusto Montenegro, Rodovia BR-316 and Avenida Almirante Barroso.

The proposed trunk bus system aims at increasing the average passenger per bus of larger capacity to reduce the fleet in operation, to alleviate traffic congestion and ultimately to create an efficient bus operating system. The fleet of articulated buses (two buses linked together) has been already in service in Sao Paulo, Curitiba, Goiania and elsewhere, contributing significantly to the alleviation of traffic congestion. The proposed system for the BMA introduces the type of articulated buses operating in Curitiba City. The transport capacity per articulated bus (vehicle length of 18.0m) is 200 persons including standing passengers.

(2) Trunk Line Capacity

Table 8.2-3 shows the trunk line capacity per hour by different service frequency (headway). When articulated buses are operated every 30 seconds, the hourly transport capacity per line comes to 24,000 passengers. When the headway is 20 seconds, the hourly capacity theoretically rises to 36,000 passengers, but this is extremely difficult to put into practice, given, *inter alia*, the time needed for passenger boarding and alighting and the number of available berths at every bus stop. In the event that the passenger demand on the trunk busway should become large enough to require the headway shorter than 30 seconds, it would be more appropriate to introduce the articulated bus linking three vehicles (capacity of 270 passengers).

Table 8.2-3 Service Frequency and Transport Capacity of Trunk Bus Line

Service Frequency (Headway)	Operatable Buses (units/hour) (A)	Capacity per Articulated Bus (B)	Transport Capacity per Hour (persons/direction/line) (A x B)	Remarks
20 seconds	180	200	36,000	Difficult in operation
30 seconds	120	200	24,000	
45 seconds	80	200	16,000	
60 seconds	60	200	12,000	
90 seconds	40	200	8,000	
120 seconds	30	200	6,000	

8.2.4. PLANNING POLICY FOR BUS RE-ROUTING

(1) Bus Lines for Trunk Busway

Table 8.2-4 shows major routes between important nodes or major service areas, and the number of bus lines in operation and major road links for each route or area. As clearly indicated in the table, the concentration of bus lines are especially marked in 2) the Icoaraci – Centro route, 3) the Cidade Nova – Centro route, 5) the Marituba – Centro route and 1) the Centro area.

Table 8.2-4 Existing Bus Lines and Service Areas

Bus Operating Routes or Areas	No. of Bus Lines	Major Bus Operated Roads
1) Belem Centro (intra trips)	40	Streets within the Centro
2) Icoaraci – Centro	20	Rod. Augusto Montenegro – Av. Almirante Barroso
3) Cidade Nova – Centro	20	Rod. BR-316 – Av. Almirante Barroso
4) Cidade Nova (intra trips)	10	Streets within Cidade Nova
5) Marituba – Centro	20	Rod. BR-316 – Av. Almirante Barroso
6) Pratinha and Tapanã Area	10	Rod. Arthur Bernardes

7) Aguas Lindas – Centro	10	Rod. BR-316 – Av. Almirante Barroso
8) Marambaia – Centro	5	Av. Pedro Álvares Cabral
9) Elsewhere in the Study Area	30	Available roads
Total	165	

1) *Bus Lines for Trunk Busway of Rodovia Augusto Montenegro*

About 20 bus lines are currently operating on Rod. Augusto Montenegro. These lines are classified into three groups by route: (1) Rod. Augusto Montenegro – Av. Almirante Barroso – Centro, (2) Rod. Augusto Montenegro – Av. Pedro Álvares Cabras – Centro and (3) other routes. The first of the three is by far the main bus route. Accordingly, those bus lines on this route will be assigned to the trunk busway on Rod. Augusto Montenegro. The remaining two groups of bus lines are included in the conventional bus system and will continue to service the present routes without any change. Their bus fleet uses the right side lane of the through traffic roadway next to the sidewalk instead of the trunk busway provided on both sides of the median.

2) *Bus Lines for Trunk Busway of Rodovia BR-316*

The bus lines on Rodovia BR-316 are classified into six groups by route: (1) Cidade Nova – Av. Almirante Barroso – Centro, (2) Cidade Nova – Av. Pedro Álvares Cabral – Centro, (3) Marituba – Av. Almirante Barroso – Centro, (4) Marituba – Av. Pedro Miranda – Centro, (5) Aguas Lindas – Av. Almirante Barroso – Centro and (6) other routes. The bus lines on Routes (1), (3) and (5) that connect three agglomerations (Cidade Nova, Marituba and Aguas Lindas) to the Centro by using Av. Almirante Barroso are assigned to the trunk busway on Rod. BR-316. The remaining bus lines on Routes (2), (4) and (6) are included in the conventional bus system and will continue to service the present routes without any change.

3) *Bus Lines for Trunk Busway of Avenida Almirante Barroso*

The bus lines assigned to the trunk busway on Av. Almirante Barroso are the same lines assigned respectively to Rod. Augusto Montenegro and Rod. BR-316.

The bus lines assigned to the trunk busway will be in the range of 60 to 70 lines, which correspond to those indicated for the operating routes 2), 3), 5) and 7) in Table 8.2-4. The remaining bus lines of about 95 belong to the conventional bus system without changing their operating conditions (e.g., routing, bus fleet, service frequency, bus stops, etc.). Figure 8.2-2 shows the proposed trunk bus system superimposed on the network of the existing bus routes.

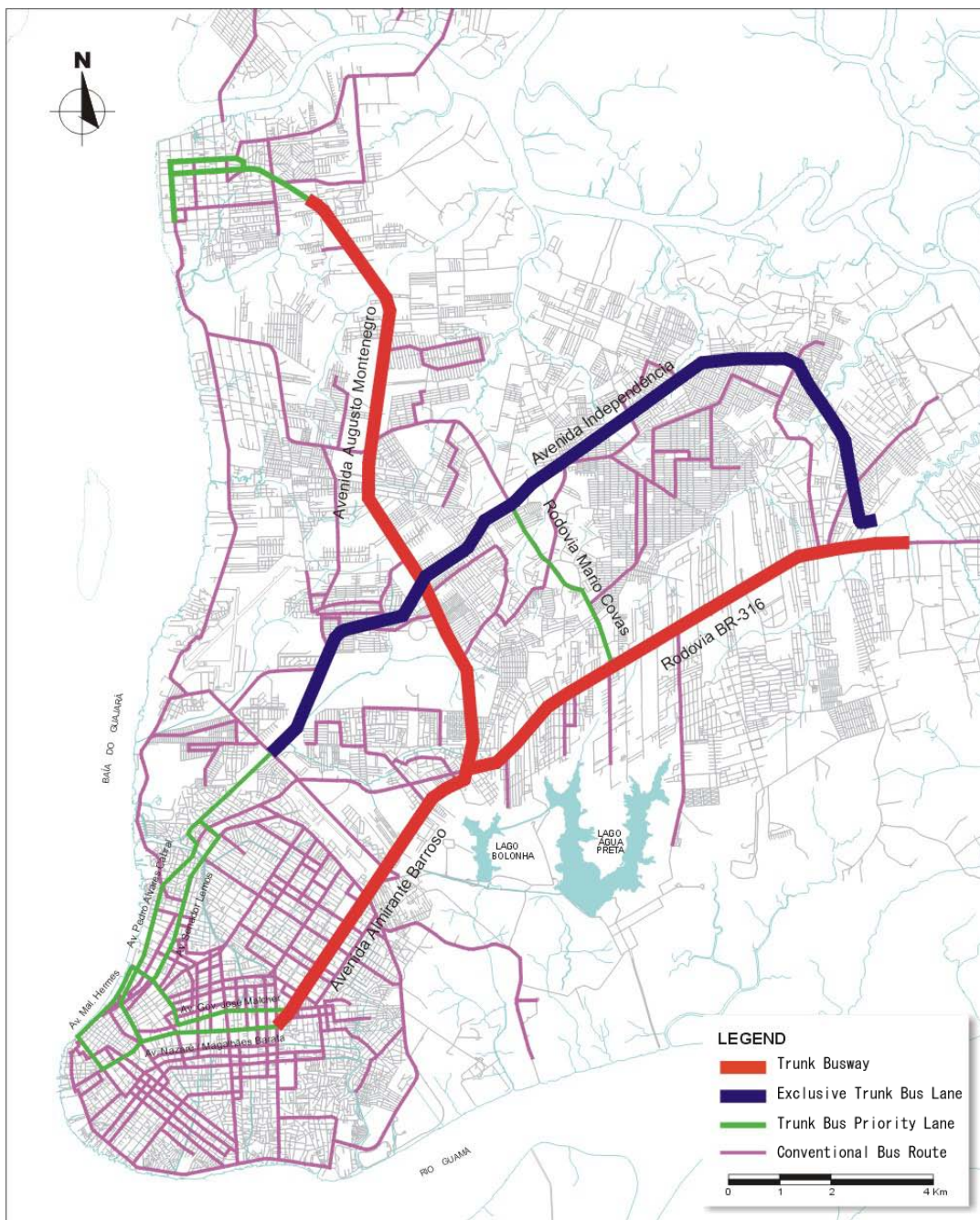


Figure 8.2-2 Proposed Trunk Bus System in the Network of Existing Bus Routes

(2) Networks of Trunk Bus System for 2007 and 2012

As mentioned earlier, those bus lines that are not assigned to the trunk bus system belong to the conventional bus system and will continue to operate without any change. Given the present network of bus routes, the expected completion of some arterial road segments under construction or improvement and the future implementation of the planned road construction and improvement projects, the network of the trunk bus system can be mapped respectively for the target years of 2007 and 2012, as shown in Figure 8.2-3 and Figure 8.2-4. The forecast of the future bus passenger demand will be based on the expected networks for two target years.

(3) Routing System for Trunk Bus Service

1) Routing System for 2007

The network of the trunk bus system in 2007 is shown in Figure 8.2-3. The routing from and to each trunk bus terminal is proposed in Table 8.2-5.

2) Trunk Bus Lines in 2012

The network of the trunk bus system in 2012 is shown in Figure 8.2-4. The routing change in the network comes from the completion of Av. Independencia, which adds the western route segment of the trunk bus system. The additional routing from and to each trunk bus terminal is proposed as shown in Table 8.2-5.

Table 8.2-5 Trunk Bus Routes Targeted for 2007 and 2012

Terminals	No. of Routes in 2007	No. of Routes in 2012	Trunk Bus Routing System
A	2	4	Rod. A. Montenegro – Av. A. Barroso – Centro Rod. A. Montenegro – Av. Independencia – Centro
B	2	4	Rod. A. Montenegro – Av. A. Barroso – Centro Rod. A. Montenegro – Av. Independencia – Centro
C	2	4	Rod. A. Montenegro – Av. A. Barroso – Centro Rod. A. Montenegro – Av. Independencia – Centro
D	2	4	Rod. Mario Covas – BR-316 – Av. A. Barroso – Centro Rod. Mario Covas – Av. Independencia – Centro
E	2	4	Rod. BR-316 – Av. A. Barroso – Centro Rod. Mario Covas – Av. Independencia – Centro
F	2	4	Rod. BR-316 – Av. A. Barroso – Centro Av. Independencia – Centro
G	2	4	Av. Independencia – Rod. A. Montenegro – Av. A. Barroso – Centro Av. Independencia - Centro
H	2	4	Av. Independencia – Rod. A. Montenegro – Av. A. Barroso – Centro Av. Independencia – Centro
Total	16	32	

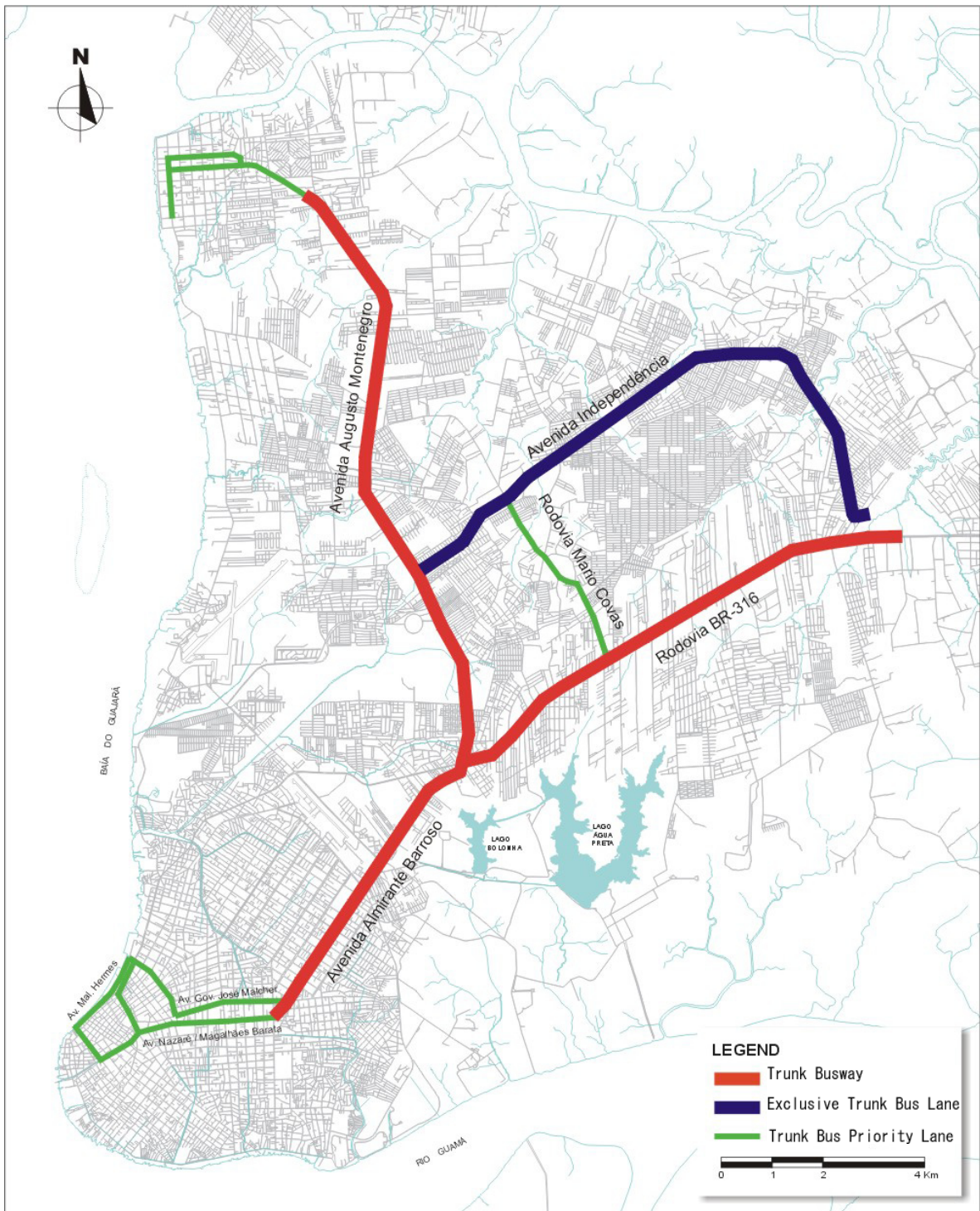


Figure 8.2-3 Network of Trunk Bus System in 2007

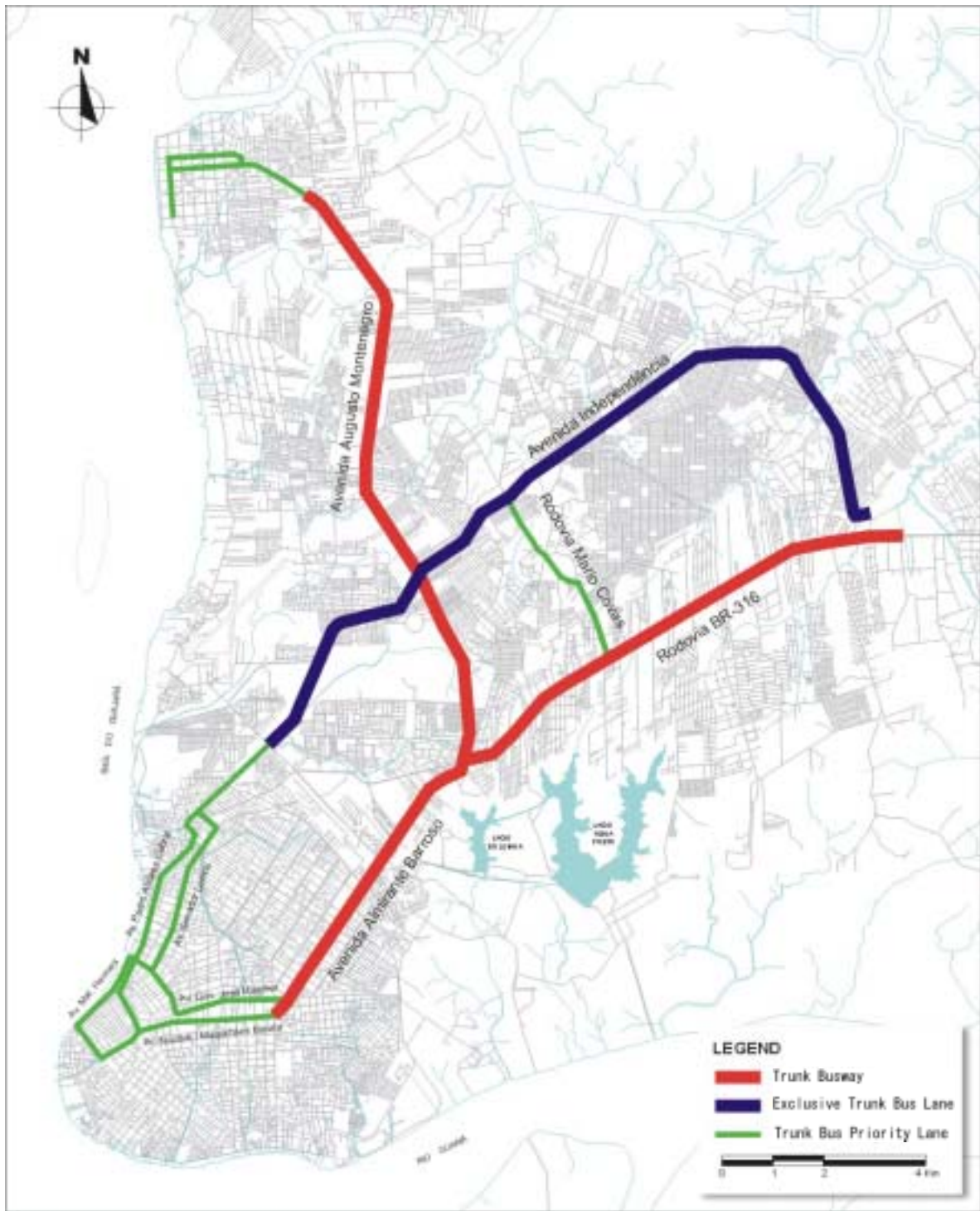


Figure 8.2-4 Network of Trunk Bus System in 2012

8.2.5. TRUNK BUS OPERATION PLAN

(1) Policy for Operation Planning

The operation plan for the trunk bus and the conventional bus systems are proposed on the basis of the trunk bus network for 2012 shown in Figure 8.2-4. The policy for operation planning assumes the following conditions.

- 1) Those bus lines that are not assigned to the trunk bus system belong to the conventional bus system and will keep the existing operating conditions (i.e., operating routes, service frequency, bus companies, etc.)
- 2) The conventional buses will not use the trunk busway provided next to the median but runs on one of the roadway lanes for through traffic as they have been doing under their present operating systems.
- 3) The bus lines in the trunk bus system that connect either Icoaraci, Cidade Nova or Marituba to the Centro will divide their respective routes to the trunk and the feeder services. A feeder bus line picks up passengers to transport them to the nearby trunk bus terminal, where passengers can transfer to a trunk bus line.

(2) Trunk Bus Operation Plan for 2007

The proposed operation plan for 2007 consists of the following components (see Figure 8.2-5).

- 1) The trunk bus system divides its service area into two zones: namely, Bus Zone A that connects the Centro and Icoaraci, and Bus Zone B that connects the Centro to Cidade Nova and Marituba.
- 2) Three integrated bus terminals A, B and C will be constructed along Rodovia Augusto Montenegro in Bus Zone A.
- 3) Five integrated bus terminals D, E, F, G and H will be constructed along Rodovia BR-316 and Avenida Independencia in Bus Zone B.
- 4) A feeder bus system will be provided around Terminal A to transfer passengers to a trunk bus line at the terminal. The feeder bus service is strictly limited to the surrounding area of the terminal. Passengers pay their through fares when they board a feeder bus.
- 5) Passengers transfer from the feeder bus to an articulated trunk bus at the terminal. They do not need to pay their fares at this juncture, as they have already done so at the time of boarding the feeder bus.
- 6) The trunk bus from Terminal A run through the trunk busway to be built on Rod. Augusto Montenegro and Av. Almirante Barroso. The bus uses the trunk bus priority lane provided on the selected roads in the Centro to return to Terminal A.
- 7) The bus lines in the Icoaraci area that do not belong to the trunk bus system will continue their respective services without any change in their present operation systems.
- 8) Terminals B and C in Bus Zone A will function exactly like Terminal A as mentioned in 3) through 6) above.
- 9) The operation plan for Bus Zone B is the same as the one proposed for Bus Zone A. For example, passengers use the feeder bus system provided around Terminal D and transfer to a trunk bus line at the terminal. The trunk bus runs

from Terminal D to the Centro via the trunk busway, and on its return trip uses the trunk bus priority lane in the Centro back to Terminal D. The same applies to Terminals E, F, G and H.

- 10) Integrated terminals from A through H connect feeder bus lines to trunk bus lines on the one hand and between different trunk bus lines on the other, but do not integrate trunk bus lines with conventional bus lines. The trunk bus lines using Terminals A, B and C are integrated within Bus Zone A. In a similar vein, the trunk bus lines using Terminals D through H are integrated within Bus Zone B. However, no trunk bus lines integration are planned to exist between two zones.
- 11) The trunk and the conventional bus services allow no integrated transfer at their respective bus stops.

(3) Trunk Bus Operation Plan for 2012

The operation plan for 2012 consists of the same plan components proposed for 2007. Avenida Independencia now under construction will be completed in 2010, provided with the exclusive trunk bus lane. This adds the western route segment along the new avenue to the network of trunk bus lines in 2007 (see Figure 8.2-6).

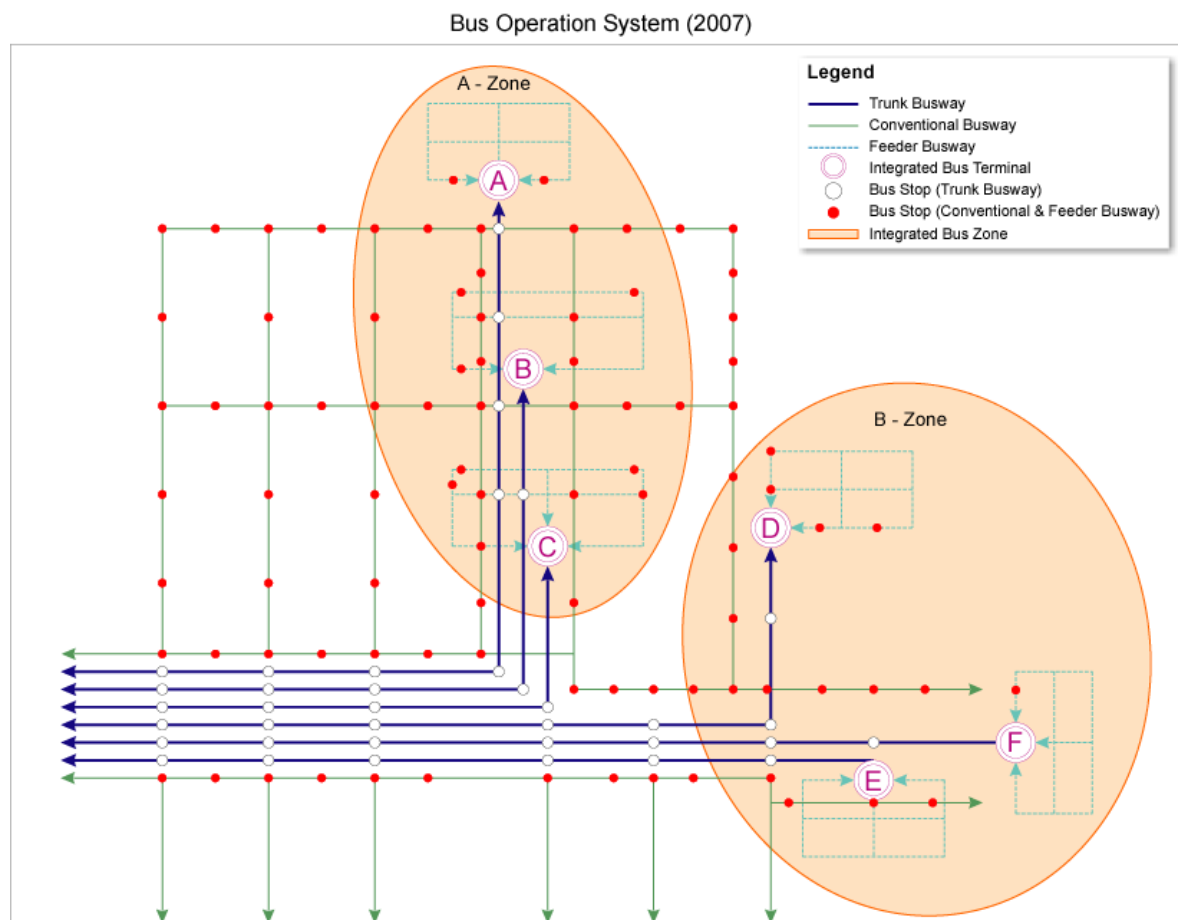


Figure 8.2-5 Trunk Bus Operation Plan for 2007

Bus Operation System (2012)

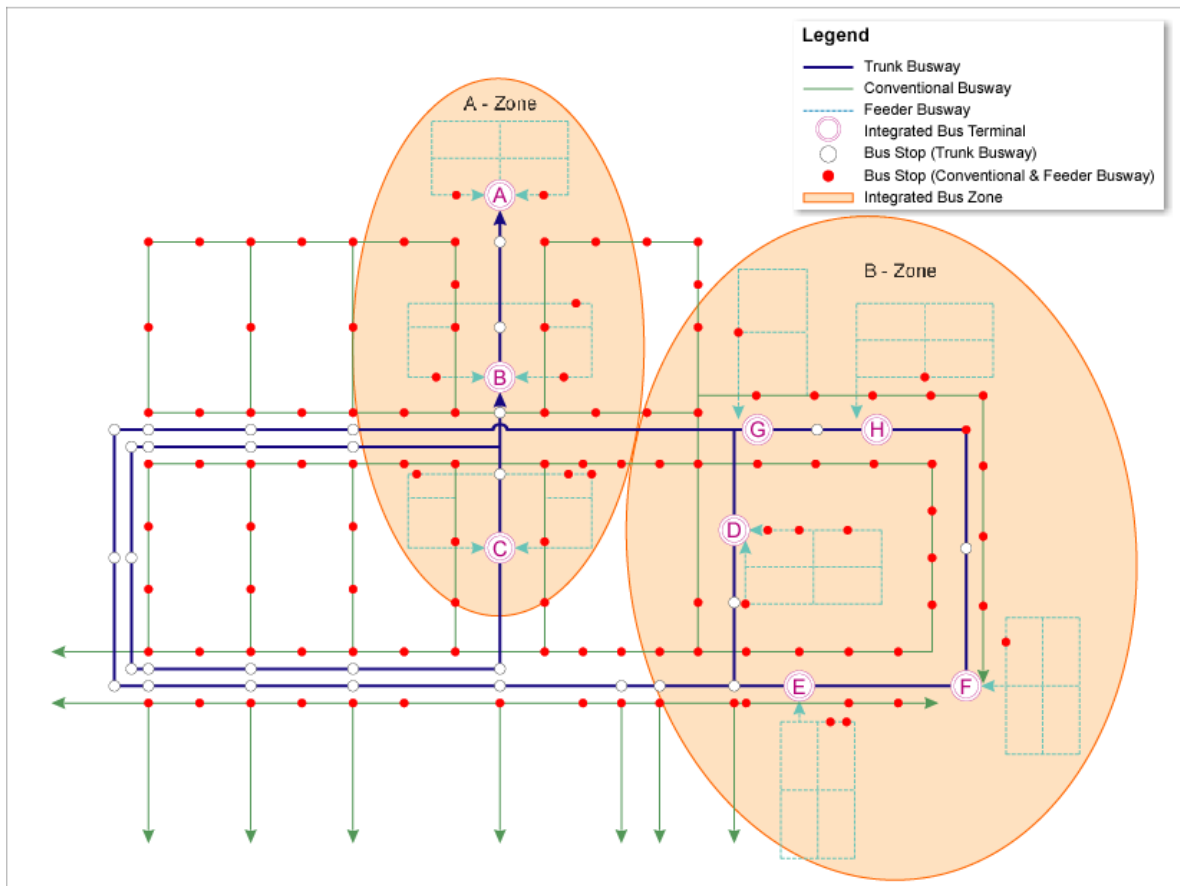


Figure 8.2-6 Trunk Bus Operation Plan for 2012

8.2.6. TRUNK BUS TERMINAL PLAN

There are five bus terminals in the study area as shown in Table 8.2-6.

Table 8.2-6 Five Existing Terminals

Bus Terminals	Managing Body	Nature of Service	Scale of Service	Remarks
UFPA Terminal	CTBel (Municipal Traffic Bureau)	Only for intra-city bus lines Not integrated	About 15 berths	Outside the scope of the present Study
Sao Braz Terminal	Private Company	Only for inter-city bus lines Not integrated	About 24 berths	To be moved to Marituba; Outside the scope of the present Study
MAREX Terminal	Private Bus Company	Only for intra-city bus lines Integrated	About 15 berths	Outside the scope of the present Study
Coqueiro Terminal	Private Bus Company	Only for intra-city bus lines Integrated	About 5 berths	Outside the scope of the present Study
BR-316 Terminal	Private Bus Company	Only for intra-city bus lines Integrated	About 10 berths	The present Study proposes expansion

The present Study proposes to establish eight trunk bus terminals. As shown in Figure 8.2-7, three terminals (A, B and C) are along Rodovia Augusto Montenegro, two (E and F) along Rodovia BR-316, one (D) on Avenida Mario Covas and two (G and H) along Avenida Independencia, now under construction. The functions and characteristics of these terminals are summarized in Table 8.2-7.

Table 8.2-7 Functions and Characteristics of Trunk Bus Terminals

Terminals	Functions	Nature of Transfer	Remarks	Standard Terminal Facilities
A	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	<ul style="list-style-type: none"> - Home berths for feeder bus - Home berths for trunk bus - Workshop for simple repair - Management Office - Marshaling yard - Ticket Office - Shops - Toilets - Bicycle parking lot - Standby Bays - Wickets - Other necessary facilities
B	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	
C	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	
D	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	
E	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	Improvement of BR-316 Terminal	
F	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	
G	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	
H	Transfer between the trunk and the feeder bus services and between trunk bus lines	Integrated	New construction	

8.2.7. PLANNING POLICY FOR BUS STOPS

(1) Bus Stops for Trunk Busway

1) Structure

Bus stops are constructed on the right side of the busway (buses normally have their doors on the right side of their body). Each stop has a platform of 2.5m in width and 40m to 50m in length (to accommodate two articulated buses simultaneously). The platform is elevated by 15cm from the busway surface level. The trunk busway is segregated from the through traffic roadway by the concrete divider of 1.1m to 1.7m in width, which is used as part of the bus stop platform.

2) Location

To accommodate for transferring passengers between the trunk bus and the conventional bus services, trunk bus stops are located immediately before major intersections where conventional bus lines are operating. In other segments of the trunk busway, bus stops are provided roughly at the ratio of one per two conventional bus stops. The spacing of conventional bus stops ranges from 350m to 400m. Therefore, trunk bus stops are spaced from 700m to 800m.

3) Crossing for Passengers

Trunk bus passengers must cross the three-lane roadway for through traffic to reach the sidewalk when alighting or the bus stop when boarding. The pedestrian crossing is provided at grade from each trunk bus stop to the sidewalk. At bus stops located near intersections, passengers can use the already available pedestrian crossings. New at-grade pedestrian crossings are provided at bus stops located elsewhere. For the bus stops with many boarding and alighting passengers, pedestrian traffic signals are installed for passenger safety.

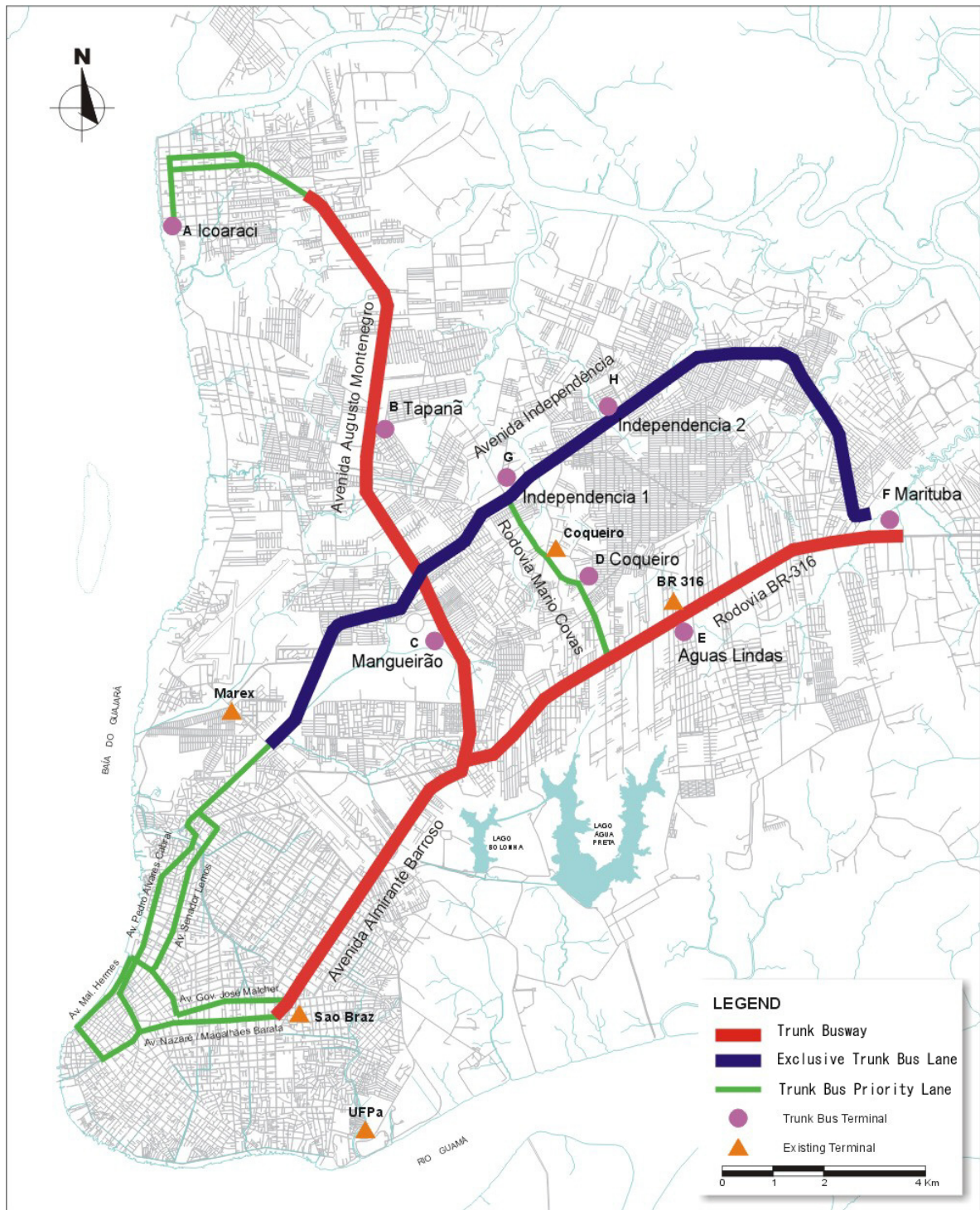


Figure 8.2-7 Existing Terminals and Proposed Trunk Bus Terminals

(2) Bus Stops for Exclusive Trunk Bus Lane

1) Structure

The exclusive trunk bus lane is segregated from the through traffic roadway by the lane marking like delineators instead of the concrete divider used in the trunk busway. Therefore, it is not possible to construct bus stops on the right side of the exclusive lane. Bus stops are located on the left side of the exclusive lane with approach space (in order to

accommodate for buses with right-side doors. The structural elements like platform width and length are the same as in the trunk busway.

2) Location

There is no existing yardstick like conventional bus stops with which to judge the detail of bus stop spacing for Av. Independencia, because the avenue is yet under construction, all too evidently with no operating bus line. Therefore, the spacing proposed for the trunk busway will be applied to the bus stops for the exclusive lane.

3) Crossing for Passengers

Pedestrian crossings are provided at every bus stop in the same way as in the trunk busway.

(3) Bus Stops for Trunk Bus Priority Lane

The trunk bus priority lane is provided on the existing multi-lane roadway, using the right-side lane next to the sidewalk. The existing conventional bus stops are utilized.

8.2.8. OPERATING ORGANIZATION FOR TRUNK BUS SYSTEM

As shown in Figure 8.2-8, the trunk bus system is divided into two zones for separate operation. Because there is no planned integration between Bus Zones A and B, two separate managing bodies will be established to run the system. Each managing body is organized from the bus companies that currently operate bus lines in the zone. Bus tariffs are collected by the managing body and then distributed to the member bus companies. This type of operating system is already put into practice in Porto Alegre City and elsewhere in Brazil. The basic components of management are as follows.

- 1) The Zone-A managing body is organized by a number of bus companies (members) that operate the trunk bus service in the zone.
- 2) The Zone-B managing body is organized by a number of bus companies (members) that operate the trunk bus service in the zone.
- 3) Bus passengers pay their tariff (i) at the time of boarding a feeder bus, (ii) at the time of boarding at a trunk bus stop, (iii) at a trunk bus terminal, (iv) at kiosks or (v) other designated ticket counters.
- 4) Collected tariffs are pooled by the zone managing body.
- 5) The zone managing body distributes the revenue to the member companies.

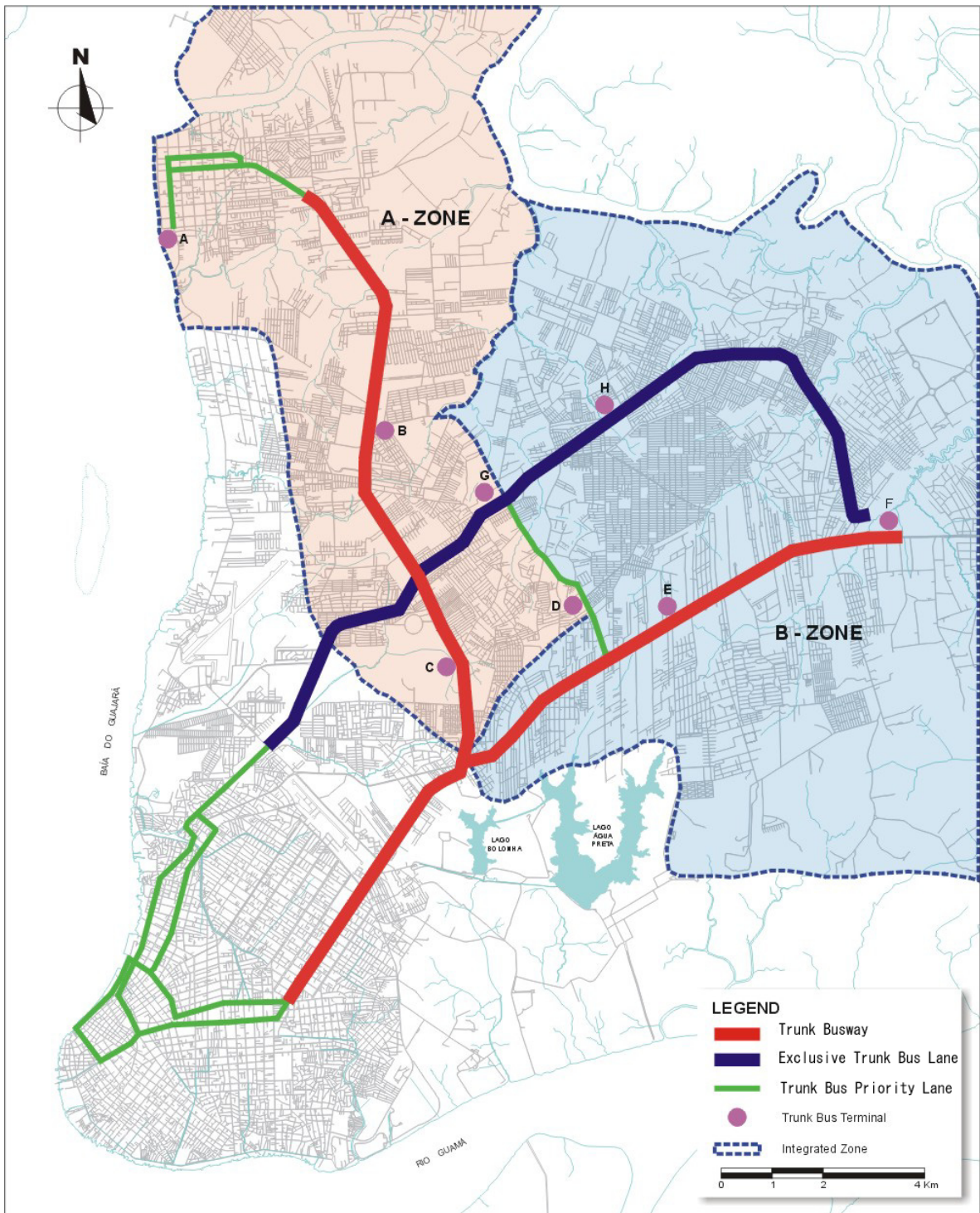


Figure 8.2-8 Bus Zones A and B of Trunk Bus System

8.2.9. TYPICAL CROSS SECTION OF TRUNK BUS ROUTES

(1) Trunk Busway

The roads selected for the introduction of trunk busway are principal two-way arterials of 42m to 45m in width with six or more lanes. There are two alternatives for the busway location: (i) next to the median and (ii) on the right-side lane of the roadway next to the sidewalk. The present Study proposes the first alternative for the following reasons, as shown in Figure 8.2-9.

- 1) The roads selected for the trunk busway, especially Av. Almirante Barroso, are located in the midst of densely built-up areas of mixed land use such as office buildings, retail shops and residential buildings. The traffic between the arterial roadways and local roads to access the roadside areas are quite heavy. Therefore, the trunk busway is located next to the median not to obstruct such traffic.
- 2) The outer lane next to the sidewalk of the arterial roadways is frequently used by taxis, small trucks and other vehicles for short stops. Therefore, the location next to the median is effective to avoid possible frictions with these vehicles and ensure traffic safety.
- 3) The trunk busway next to the median leaves enough space along the concrete divider for constructing bus stops without additional land acquisition, although this is not the primary reason for selecting the location.

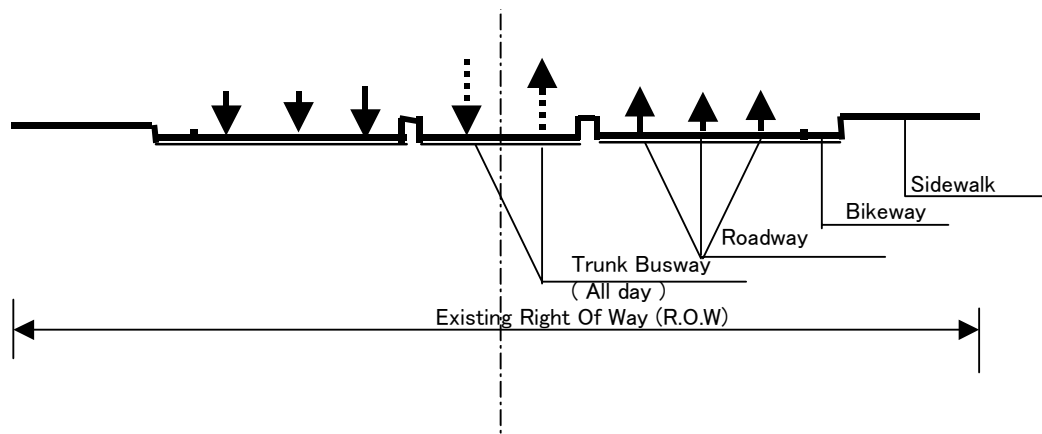


Figure 8.2-9 Typical Cross Section Location of Trunk Busway

(2) Exclusive Trunk Bus Lane

The exclusive trunk bus lane is introduced only on Av. Independencia. The exclusive lane is provided on the median-side of roadway, as shown in Figure 8.2-10. The reasons for the location are the same as in the trunk busway.

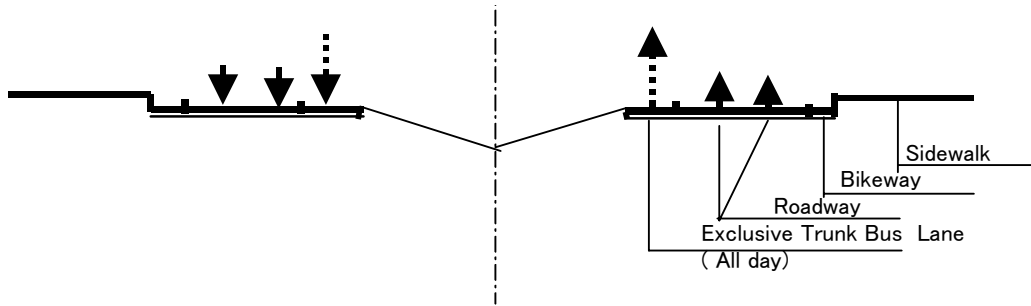


Figure 8.2-10 Typical Cross Section Location of Exclusive Trunk Bus Lane

(3) Trunk Bus Priority Lane

The roads selected for the introduction of trunk bus priority lane run through densely built-up areas of mixed land use such as retail shops and residential buildings. These roads are too narrow to introduce a new exclusive lane, but no roadside space is easily available for the widening of their rights of way. Furthermore, the frequent roadside parking reduces the effective roadway width available for motorized traffic. Partly considering these road and traffic conditions and partly aiming to reduce the expected obstructive effect on the through traffic as much as possible, the trunk bus priority lane uses the right-side lane next to the sidewalk, as shown in Figure 8.2-11.

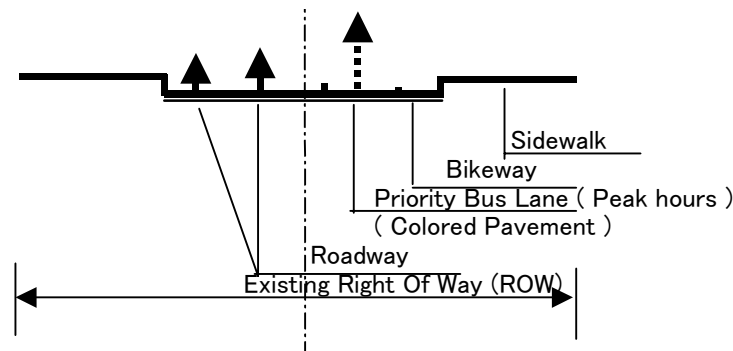


Figure 8.2-11 Typical Cross Section Location of Trunk Bus Priority Lane