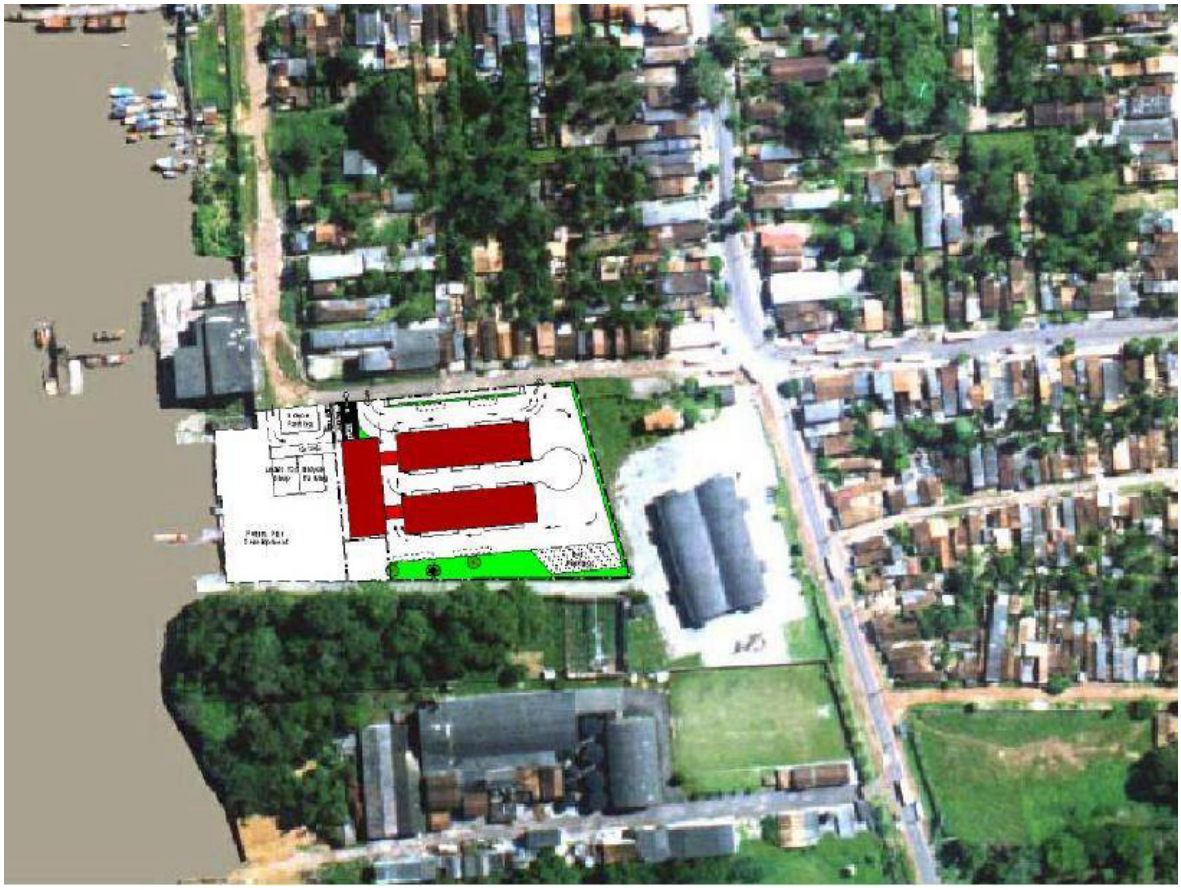

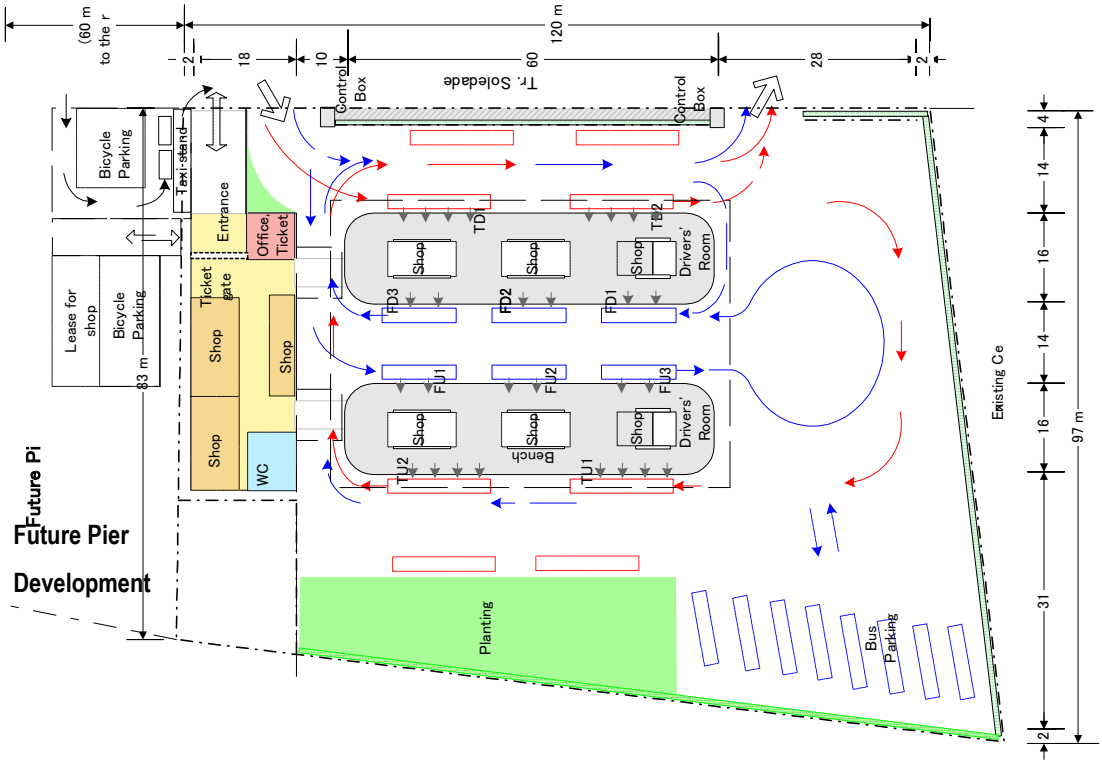

Figure 14.5-6 Plan of Terminal A: Icoaraci (not to scale)

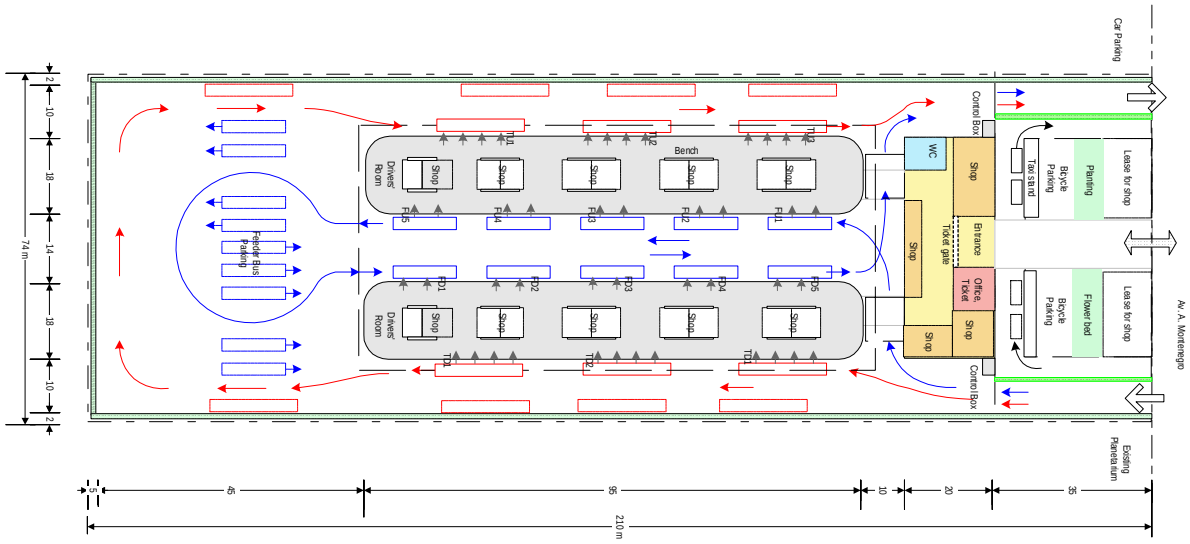

Figure 14.5-7 Plan of Terminal B: Tapana (not to scale)

Figure 14.5-8 Plan of Terminal C: Mangueirao (not to scale)

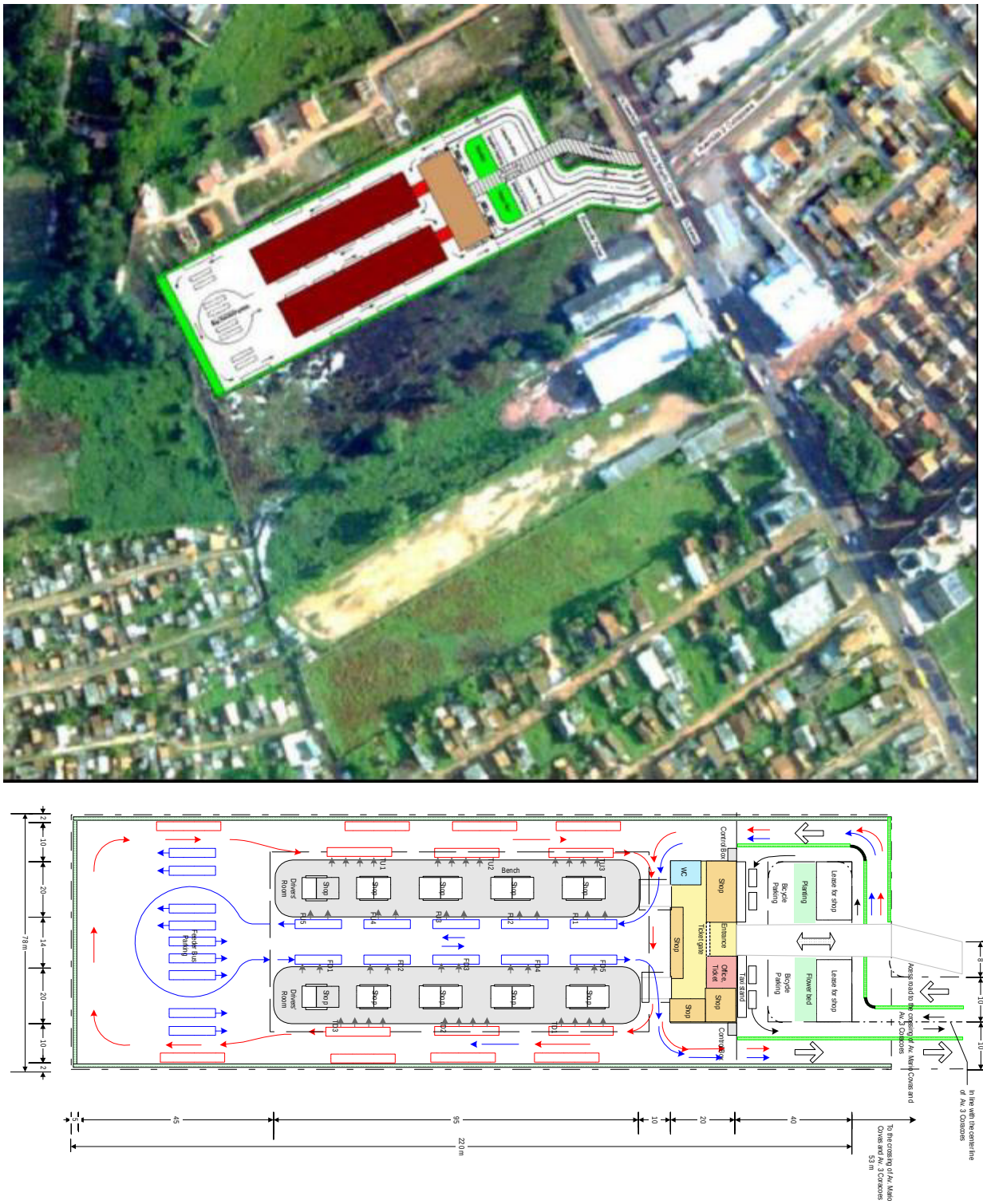

Figure 14.5-9 Plan of Terminal D: Coqueiro (not to scale)

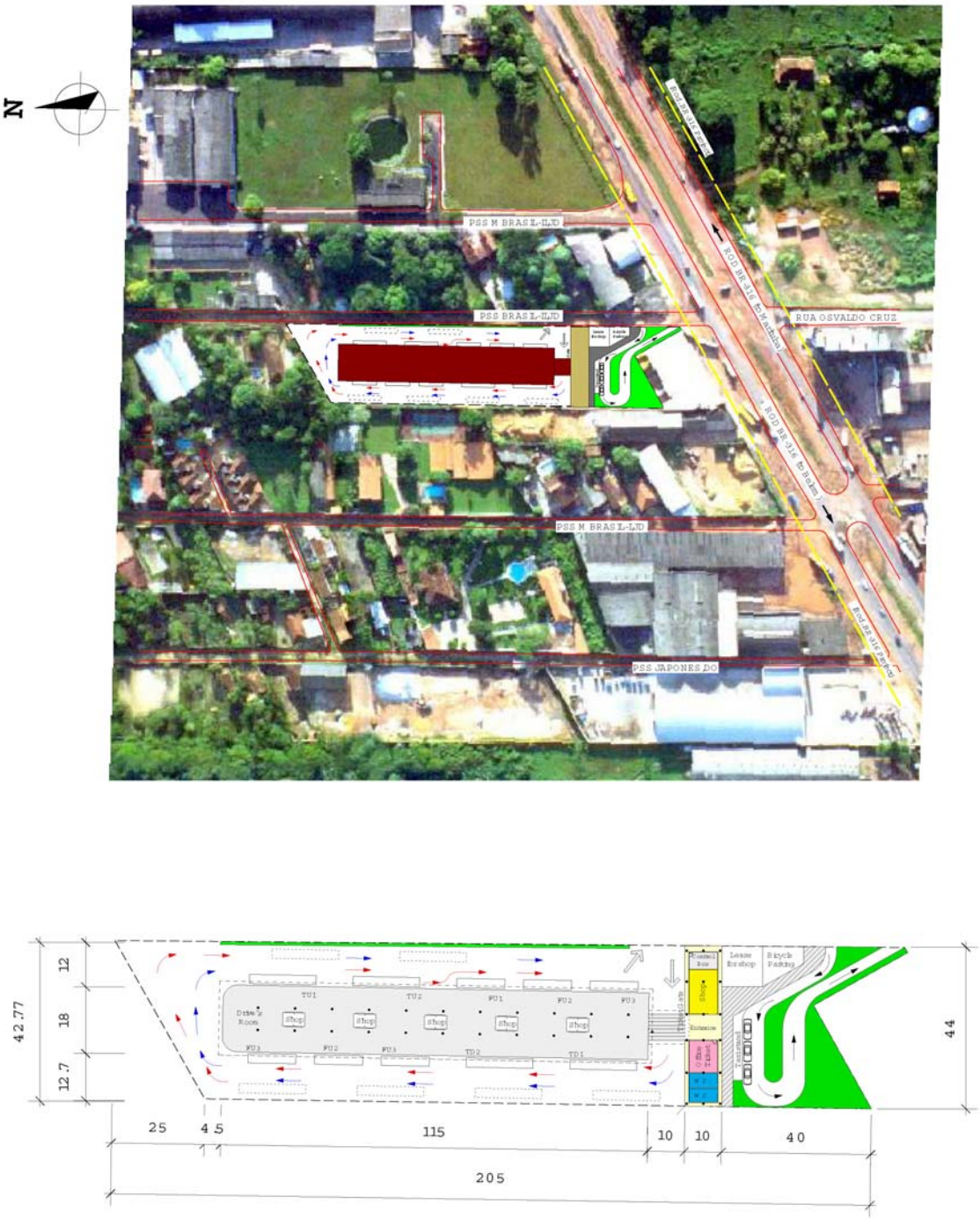

Figure 14.5-10 Plan of Terminal E: Aguas Lindas (not to scale)

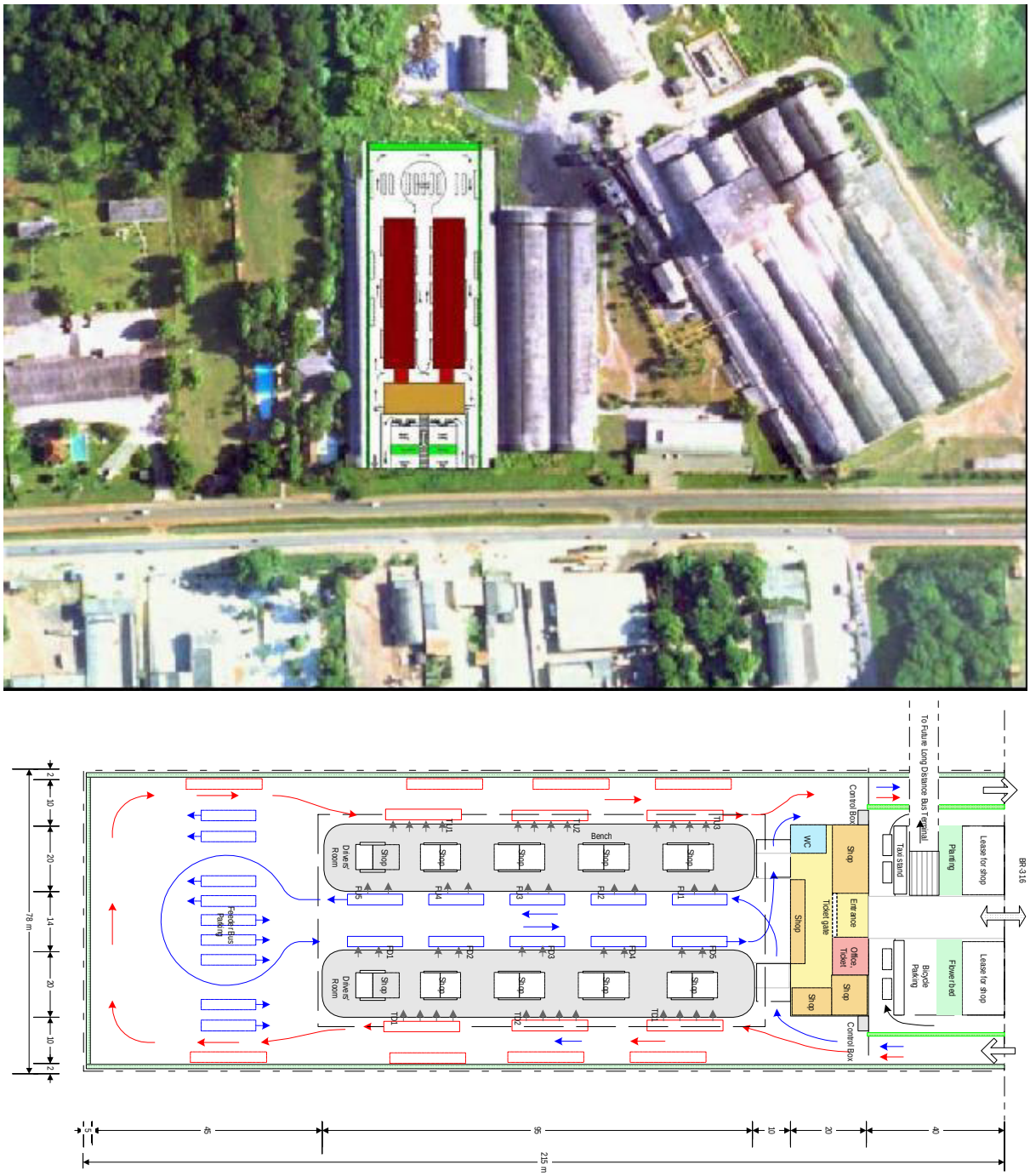

Figure 14.5-11 Plan of Terminal F: Marituba (not to scale)

Figure 14.5-12 Plan of Terminal G: Independencia 1 (not to scale)

Figure 14.5-13 Plan of Terminal H: Independencia 2 (not to scale)

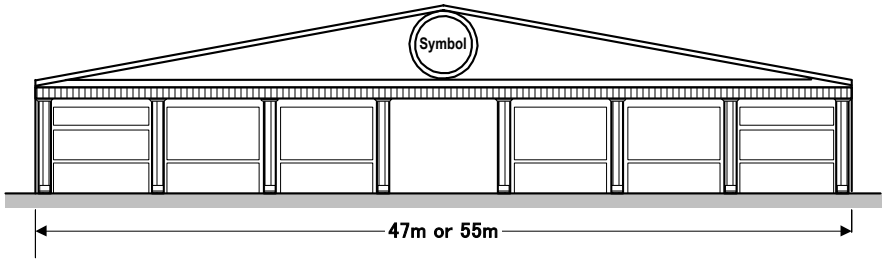

Figure 14.5-14 Elevation of Passenger Building (not to scale)

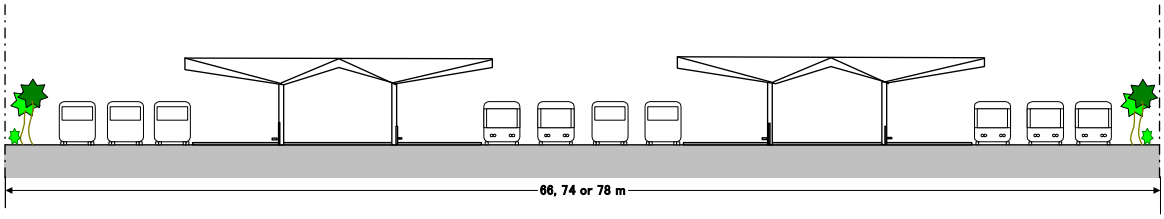

Figure 14.5-15 Section of Terminal Platform (not to scale)

(10)Structure and finish materials of the bus terminal

The structure and finish materials of the bus terminal should be chosen and decided from the following points of view:

- Safety: No damage to people (not slippery, etc.)
- Durability: Long life with good performance
- Appearance: Beautiful and nice to see
- Economy: Small initial cost and good value in the long run (low maintenance cost)

The outline of the specification is as shown in Table 14.5-6.

Table 14.5-6 Outline of Specification for Bus Facilities

Item	Unit	Specification
Bus Terminal		
Exterior		
Bus road and parking	m^2	Concrete paving
Surrounding wall	m	RC frame, block, 2m high, 20cm thick
Gate	No.	Steel door, 7m wide, 2m high, paint (two units)
Control box	No.	Panel, doors/window, insulated metal roof, foundation, tile floor, $2m^2$
Planting (perimeter area and front)	m^2	Trees and shrubs
Pedestrian crossing	m^2	Concrete, 7 cm high, marking
Drainage	each	Whole site
Passenger building	m^2	RC structure; Roof: insulated sheet metal; Wall: block + mortar + paint
Entrance hall and passage	m^2	Floor: tile
Ticket office and window, information	m^2	Floor: tile; Wall: block + mortar + paint; Steel door: steel sash + glazing
Ticket gate	No.	Concrete wall, 90cm high, mortar + paint; Low steel door
Toilet	m^2	Floor: tile, Wall: block + tile (inside), mortar + paint (outside), perforated block
Shop	m^2	Floor: tile; Wall: block + mortar + paint; Ceiling: RC + mortar + paint
Platform (structure and roof)	m^2	Steel structure; Roof: insulated aluminum panel (10cm thick)
Platform (passenger area)	m^2	Floor: brick, 15 cm high
Waiting room for drivers	m^2	Floor: tile; Wall: RC frame, block + mortar + paint; Ceiling: RC + mortar + paint
Storage	m^2	Floor: mortar; Wall: block + mortar + paint; Ceiling: RC + mortar + paint
Shop	m^2	RC side wall 1.5m high + mortar + paint; brick floor
Coffee shop, snack	m^2	RC side wall 1.5m high; Kitchen with counter and shelves; Floor: mortar, drain
Bench	m	Punched stainless steel seat attached to low wall of the shop
Front area		
Passenger way	m^2	Asphalt paving
Bicycle parking	m^2	Asphalt paving, marking
Taxi stand and road	m^2	Asphalt paving, marking, curb stone, taxi stand 12 cm high
Bus road	m^2	Concrete paving
Space for lease to shops	m^2	Grading and cleaning
Utilities		
Water supply and sanitation	each	Kitchen in office, and rest room, toilet, coffee shop

Electricity	each	Including connection, whole site
Telephone and telecommunication	each	Including connection, office, shop and rest room
Others		
Sign and road marking	each	Refer to the sign plan
Site preparation and cleaning	each	All temporary, miscellaneous works
Bus shelter (busway, exclusive lane)		
Paving of platform (incl. curb)	m^2	Brick 8cm thick
Slope	m^2	Asphalt paving, marking
Shelter structure	m^2	RC foundation, steel structure
Shelter wall	m^2	Block + mortar + paint, perforated block
Shelter roof	m^2	Insulated aluminum panel
Bench	m	Punched stainless steel seat attached to the wall
End Fence	m	Steel fence, 1.5m high
Sign	each	Refer to the sign plan
Lighting	each	Lights, electricity connection
Bus shelter (priority lane, open type)		
Paving of platform (incl. curb)	m^2	Brick 8cm thick
Slope	m^2	Asphalt paving, marking
Shelter structure	m^2	RC foundation, steel structure
Shelter wall	m^2	Block + mortar + paint, perforated block
Shelter roof	m^2	Insulated aluminum panel
Bench	m	Punched stainless steel seat attached to the wall
End Fence	m	Steel fence, 1.5m high
Sign	each	Refer to the sign plan
Lighting	each	Lights, electricity connection
Bus stop sign		
Foundation	each	Reinforced concrete, excavation, backfilling, repair
Sign (incl. printing)	each	Steel work, paint, information printing
Lighting	each	Pole, lights, electricity connection
Sidewalk construction	m^2	Av. Visconde de Sousa Franco, Block
São Braz Terminal rehabilitation		
Demolition and repair (entrance)	each	Demolition of existing ticket box and repair, two places, 20m long in total
Gate (exit gate)	each	Steel door, 7m wide, 2m high
Control box (exit gate)	No.	Panel, doors/window, insulated metal roof, foundation, tile floor, $2m^2$
Paving of platform extension	m^2	Brick, 8cm thick
Shelter wall (extension)	m^2	Block + mortar + paint, perforated block
Shelter structure (platform extension)	m^2	RC foundation, steel structure
Shelter roof (platform extension)	m^2	Insulated aluminum panel
Bench	m	Stainless steel without backs
Fence (all platform) (removal and resetting)	m	Removal and resetting of the existing platform fence
Marking (pedestrian crossing, etc.)	each	Road marking
Sign (stop sign, information boards, etc.)	each	Same as the integrated bus terminals

(11)Sign plan

Table 14.5-7 shows the signs to be designed and provided.

Table 14.5-7 Outline of Sign Plan for Bus Facilities

Location	Contents
Façade	Name of system, name of terminal

Above ticket gate	Name of route, destination, major stops
Above ticket window	Fare, various discounts by type
Before platform	Name of route, destination, major stops, list of berths (number, destination)
Platform (transversal)	Number of berth, destination
Platform (side, above berth)	Route (destination, name of stops en route, transfer points)
Others	Toilet, public telephone, information

The wall space such as the side wall of the shops will be leased for advertisement.

(12)Conversion of Sao Braz Terminal

The existing Sao Braz long-distance bus terminal will be converted to a transfer terminal of the trunk buses and the conventional buses mainly serving the central area. This terminal will not be an "integrated" one and the transfer will not be free of charge. The terminal will not be enclosed without ticket gates. Figure 14.5-16 shows the rehabilitation plan of São Braz Terminal.

The direction of buses will be reversed from the present way. The buses will enter from Av. Cipriano Santos and exit to Av. Ceara. A new exit gate will be made to Av. Ceara. Thus, the fences on the platform will be relocated to the other side. One platform with a roof will be extended in the east.

Pedestrian crossings will be provided, as the existing stairs from the underpass are narrow. The pedestrian crossings will be raised for safety. The opening to the platform area in the passenger building will be widened, demolishing the existing ticket boxes.

New signs and information will be prepared in the passenger buildings and the platforms.

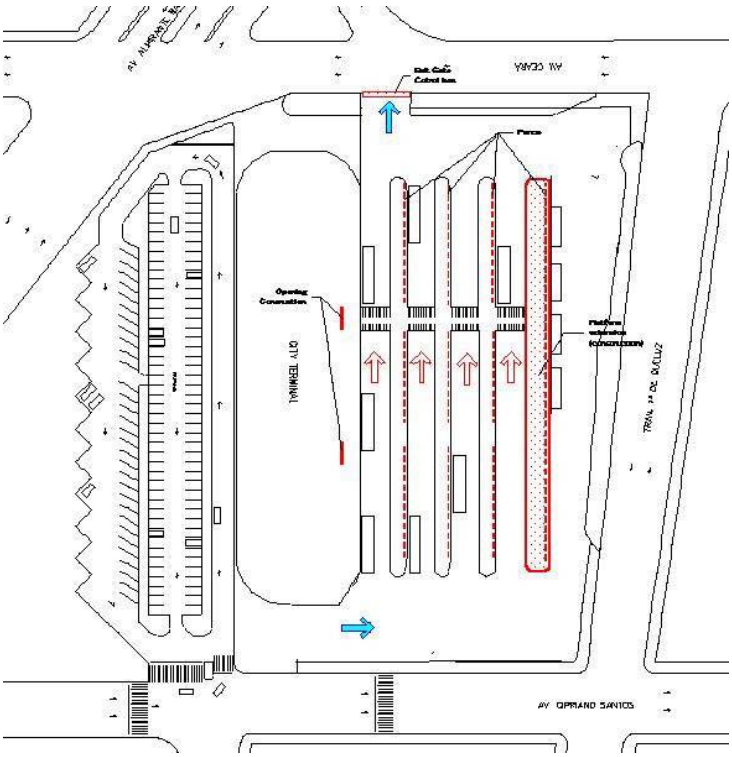

Figure 14.5-16 Rehabilitation of Sao Braz Bus Terminal

14.6. TRUNK BUS STOPS

14.6.1. BUS STOP LOCATION AND INTERSECTION LAYOUT

(1) Bus Stop Location

According to the public transport facility survey in the study, the bus-stop spacing of the existing conventional buses range from approximately 300m (CBD) to 500m (suburban and rural areas). The average bus stop spacing is approximately 350m. Since the proposed trunk busway project provides a high level of service in terms of trunk bus operation speed, a longer distance than that of the conventional buses should be considered in deciding the trunk-bus-stop spacing. Therefore, taking into account intersected roads and land use along a road, a distance of 600m to 1,000m for bus-stop spacing was adopted in the study. This is approximately two (2) times the distance of existing conventional bus-stop spacing.

The locations of the proposed bus terminals and bus stops were identified based on the existing and future road network, as well as expected land use along the busway corridor. In order to minimize the number of intersections and pedestrian crossings, and to secure the safety of bus passengers, the locations of trunk bus stops were planned at existing intersections as much as possible. Figure 14.6-1 shows the bus stop location and type of bus stop along busway. Table 14.6-1 summarizes the types of bus stops and integrated bus terminals that are shown in Figure 14.6-1.

(2) Intersection Layout

Figure 14.6-2 and Figure 14.6-3 show trunk bus and ordinary traffic flows with the types of bus stops along busways indicated in Table 14.6-1.

Many bus stop types are located at an intersection before crossing the street (near-side). This type is common in many cities. The mid-block type (MB) that is away from intersections is not proposed in the study because it is easy to find suitable intersections. Bus stops with pedestrian overpasses (type BS-8) were planned to secure traffic safety on Av. Almirante Barroso (two stops), Rodovia Augusto Montenegro (two stops) and Av. Independencia (one stop). Two overpass stops (bus stop Nos. ABR-10 and AMN-1) along these roads are located at Entroncamento grade-separated intersections. At these intersections it is difficult to safely cross the road with busy traffic.

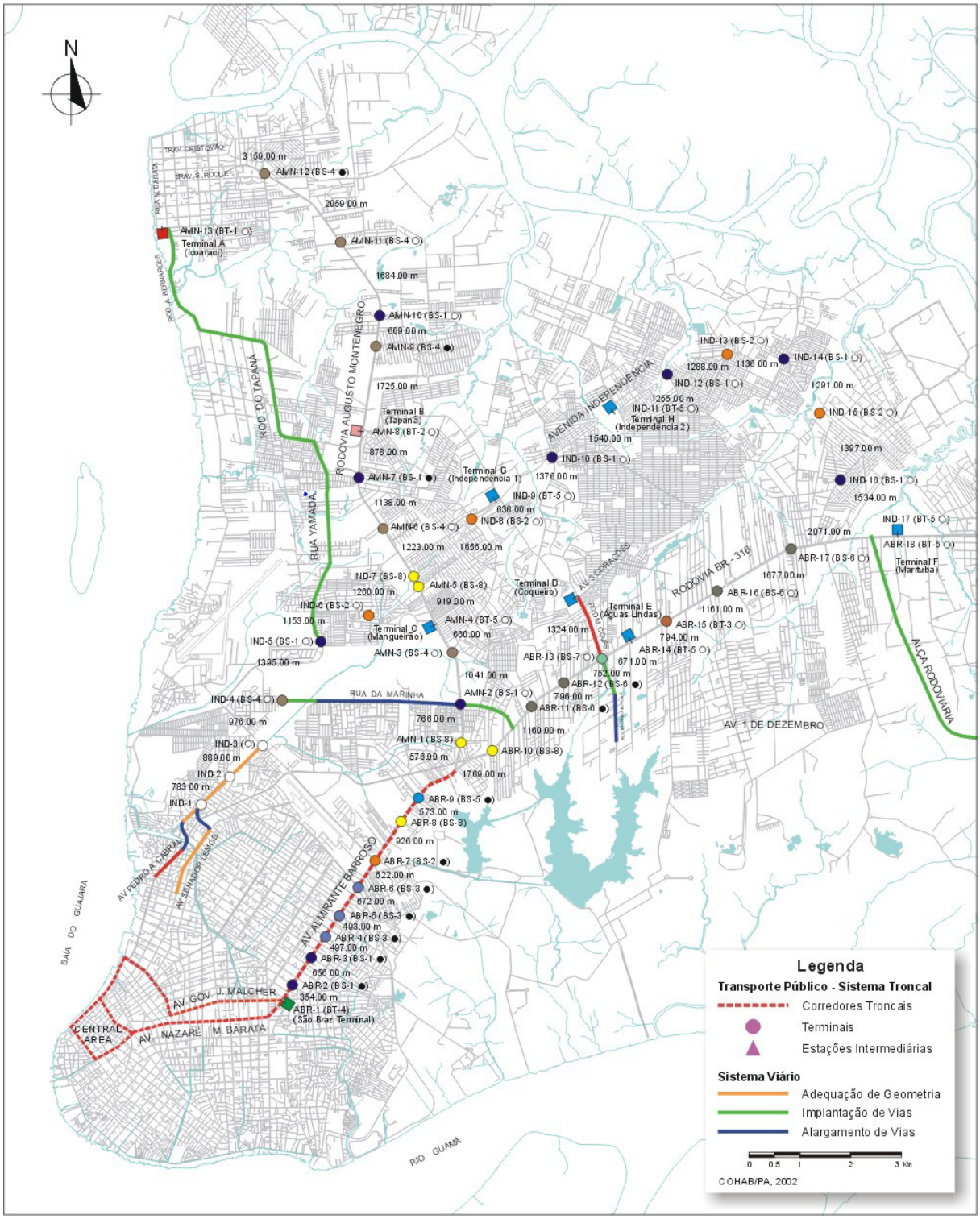

Figure 14.6-1 Bus Stop Spacing, Location and Type of Bus Stops on the Trunk Busway

Table 14.6-1 Summary of Bus Terminals/Bus Stops on the Trunk Busway

Route Name	Bus terminal/ Bus stop no.	Distance (m)	Bus terminal type	Bus stop type	Traffic signal ＊1	Remarks
Almirante Barroso - BR316	ABR - 1		BT - 4		●	Sao Braz Terminal
	ABR - 2	354		BS - 1	●	
	ABR - 3	656		BS - 1	●	
	ABR - 4	497		BS - 3	●	
	ABR - 5	493		BS - 3	●	
	ABR - 6	672		BS - 3	●	
	ABR - 7	622		BS - 2	●	
	ABR - 8	926		BS - 8		Replace existing pedestrial deck by new one
	ABR - 9	573		BS - 5	●	
	ABR - 10	1,769		BS - 8		Pedestrian overpass connects to SC
	ABR - 11	1,160		BS - 6	●	
	ABR - 12	796		BS - 6	●	
	ABR - 13	752		BS - 7	○	
	ABR - 14	671	BT - 5		○	
	ABR - 15	794		BS - 3	○	
	ABR - 16	1,161		BS - 6	○	
	ABR - 17	1,677		BS - 6	○	
	ABR - 18	2,071	BT - 5		○	Marituba Terminal, Same as IND-17
	TOTAL	15,644				
Augusto Montenegro	AMN - 0					Entroncamento, No bus stop
	AMN - 1	576		BS - 8		Replace existing pedestrial deck by new one
	AMN - 2	766		BS - 1	○	
	AMN - 3	1,041		BS - 4	○	
	AMN - 4	660	BT - 5		○	
	AMN - 5	919		BS - 7		Intersection with Independencia
	AMN - 6	1,223		BS - 4	○	
	AMN - 7	1,138		BS - 1	●	
	AMN - 8	878	BT - 2		○	
	AMN - 9	1,725		BS - 4	●	
	AMN - 10	609		BS - 1	○	
	AMN - 11	1,684		BS - 4	○	
	AMN - 12	2,059		BS - 4	●	
	AMN 13	3,159	BT - 1		○	Icoaraci Terminal
	TOTAL	16,437				
Independencia	IND - 1					
	IND - 2	783				
	IND - 3	889			○	
	IND - 4	976		BS - 4	○	
	IND - 5	1,395		BS - 1	○	
	IND - 6	1,153		BS - 2	○	
	IND - 7	1,260		BS - 7		Intersection with A. Montenegro
	IND - 8	1,656		BS - 2	○	
	IND - 9	636	BT - 5		○	
	IND - 10	1,376		BS - 1	○	
	IND - 11	1,540	BT - 5		○	
	IND - 12	1,255		BS - 1	○	
	IND - 13	1,288		BS - 2	○	
	IND - 14	1,136		BS - 1	○	
	IND - 15	1,291		BS - 2	○	
	IND - 16	1,397		BS - 1	○	
	IND - 17	1,534	BT - 5		○	Marituba Terminal, Same as ABR-18
	TOTAL	19,565				

Note: ＊1 ●Existing traffic signal
○Proposed traffic signal

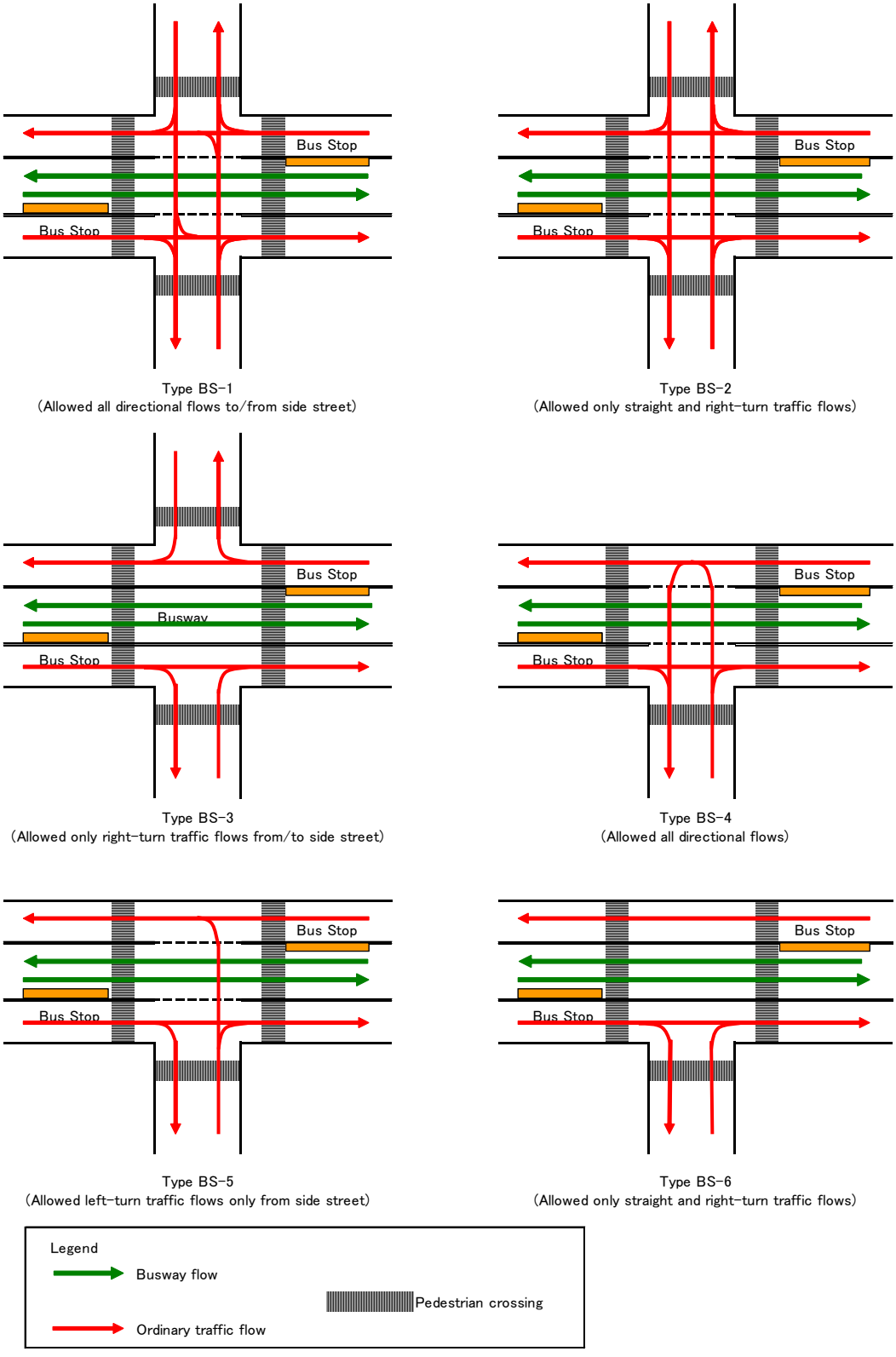

Figure 14.6-2 Type of Bus Stops on the Trunk Busway (1)

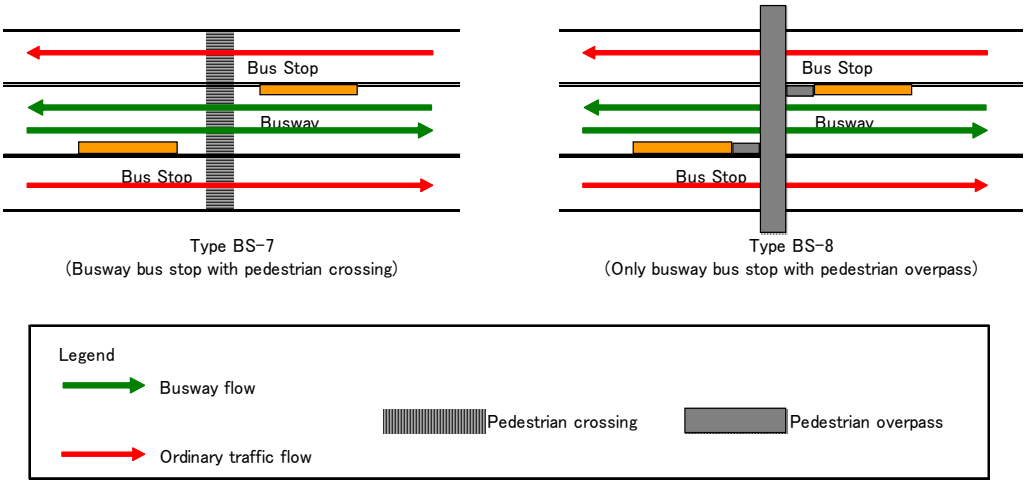

Figure 14.6-3 Type of Bus Stops on the Trunk Busway (2)

14.6.2. PLAN OF TRUNK BUS STOPS

(1) Functions for the trunk bus stops

The following functions are expected from the bus stops:

- Information (symbol mark, name of stop, name of route, destination, fare, related bus route, time table [at least starting and terminating time, and major interval], contact telephone number and address, whole bus network if possible); Recognizable and secure at night (sign, lighting)
- Shelter from rain and sunshine (roof); resting place (bench)
- Safety (platform or sidewalk; connection to pedestrian crossing)
- Barrier-free access (slope etc.)
- Advertisement (for extra income)

(2) Capacity and scale of bus stops

At a bus stop on a busway, the passengers will get off from two doors and get on through two doors at the same time. The boarding and the alighting time would be 2.0 sec/person. The time for door opening and closing, bus starting and reaching of the next bus would be 15 seconds. The number of boarding or alighting passengers would be 20% of the bus capacity (200 x 0.2 = 40). The interval time would be as follows:

2 x 40 / 2 + 15 = 55 (sec) [Maximum frequency: 3600 / 55 = 65 per hour]

Assuming that the time allocated to the direction of buses should be 2/3 at the signalized crossing, the capacity of boarding at the bus stop is as follows:

40 x (3600 x 2/3) / 55 = 1,740 (passengers)

Where the estimated passengers will exceed the above capacity, the bus stop will have the length for two buses (long type). The estimated maximum number of passengers at bus stops on busway will be less than double of the capacity (two berth length will be enough).

The platforms on Av. Almirante Barroso will be long type to cope with the waiting time during stop signal and the large number due to concentration.

The dimensions of the platform and roof of each shelter are as shown in Table 14.6-2.

Table 14.6-2 Dimensions of Platform and Roof of Each Shelter

	Platform		Roof		
	Width	Length	Width	Length	Height clearance
Shelter on busway (short)	2.5 m	22.0 m	3.5 m	20.0 m	3.6 m
Shelter on busway (long)	2.5 m	42.0 m	3.5 m	40.0 m	3.6 m
Shelter (open type) (Av. Independência) *	2.0 m	42.0 m*	2.0 m	40.0 m	2.2 m
Shelter (open type) (central area)	2.0 m	18.0 m	2.0m	18.0 m	2.2 m

* The estimate number of passengers will be large and the bicycle way will run besides. Therefore the length of the platform should be that for two berths.

The length of the slope will be 5m (height of platform 15cm, incline 1:20 with transition landing) or 8m (height of platform 30cm). The height of platform could be as high as about 30cm for easier boarding and alighting.

(3) Plan of bus stops

Table 14.6-3 shows the three types of bus stops to be introduced.

Table 14.6-3 Bus Stop Types

Type	Contents
Shelter on busway (center)	Platform (brick), steel structure, roof (insulated aluminum panel), wall (block), bench, sign, lighting
Shelter on bus priority lane (curb), the east part of Av. Independência	Steel structure, roof (insulated aluminum panel), bench (without back), sign, lighting (open type without side wall)
Bus stop sign in the central area	Sign, lighting

1) Bus stop on busway

The bus stop on busway should be located just before a pedestrian crossing so that the following bus could queue. The platform will be raised. The roof will cover the platform. The side wall will separate the waiting space from the carriage way. The bench will be attached on the wall. Figure 14.6-4 and Figure 14.6-5 show the plan of the bus stop on the busway.

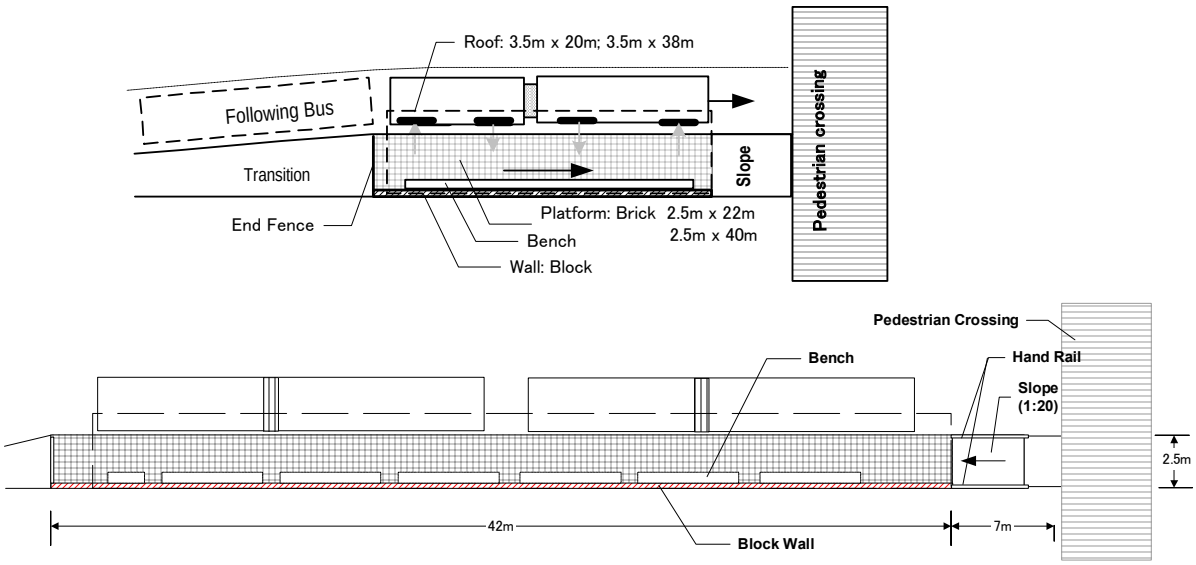

Figure 14.6-4 Plan of Bus Stop on Busway (not to scale)

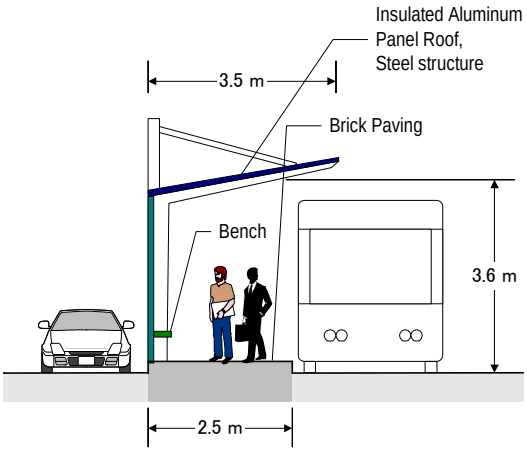

Figure 14.6-5 Section of Bus Stop (Shelter on Busway)

2) Bus stop on bus priority lane (Av. Independência)

The bus stop on the bus priority lane will be 15 ~ 20m distant from the pedestrian crossing considering right turning vehicles and the transitional section of the bicycle way. The length will be 40m for two buses.

The roof will be supported with poles without side walls. The bench will have only seats without backs, placed in between the location of bus doors.

Figure 14.6-6 shows the plan of a bus stop on a bus priority lane.

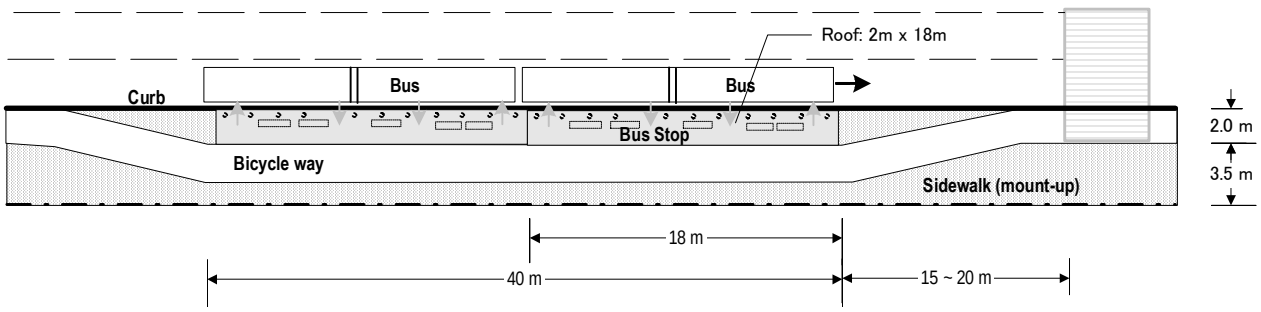

Figure 14.6-6 Plan of Bus Stop (Open Type Shelter) on Bus Priority Lane (Av. Independencia)

3) Bus stop shelter in the central area (Ver-O-Peso and Porto on Av. Marechal Hermes)

The open type shelter will be same as the bus stop for the bus priority lane. The roof will be supported with poles without side walls. The bench will have only seats without backs. The shelters will be provided next to the routes (via Av. Almirante Barroso and Av. Independencia).

Figure 14.6-7 shows the plan of a bus stop on a bus priority lane in the central area.

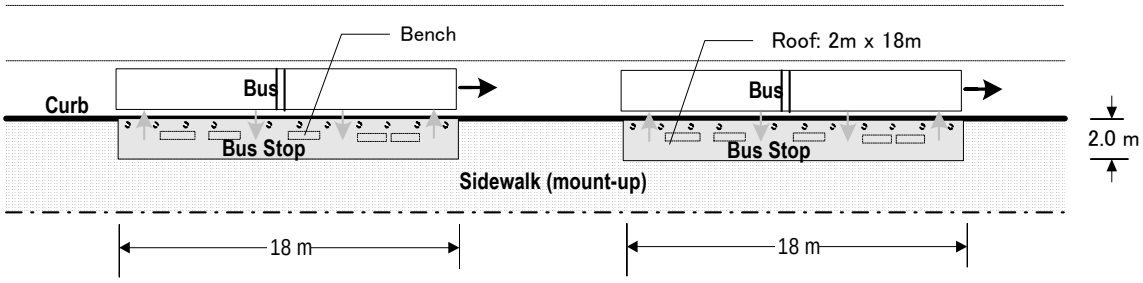

Figure 14.6-7 Plan of Bus Stop (Open Type Shelter) on Bus Priority Lane (Central Area)

4) Bus stop signs for trunk buses in the central area and Icoaraci

In principle a bus shelter (roof and bench) should be provided at each bus stop. However, it would be difficult to build the shelters in the central area where the width of the sidewalk is mostly narrow and operating shops and business facilities are in front. Therefore, at first it is planned that the signposts with necessary information (name of stop, name of route, destination, fare, related bus route, time table [at least starting and terminating time, and major interval)], contact telephone number and address) will be prepared by destination (via Av. Almirante Barroso and via Av. Independencia) at an interval of 500m. Figure 14.6-8 shows the design of a bus stop sign in the central area.

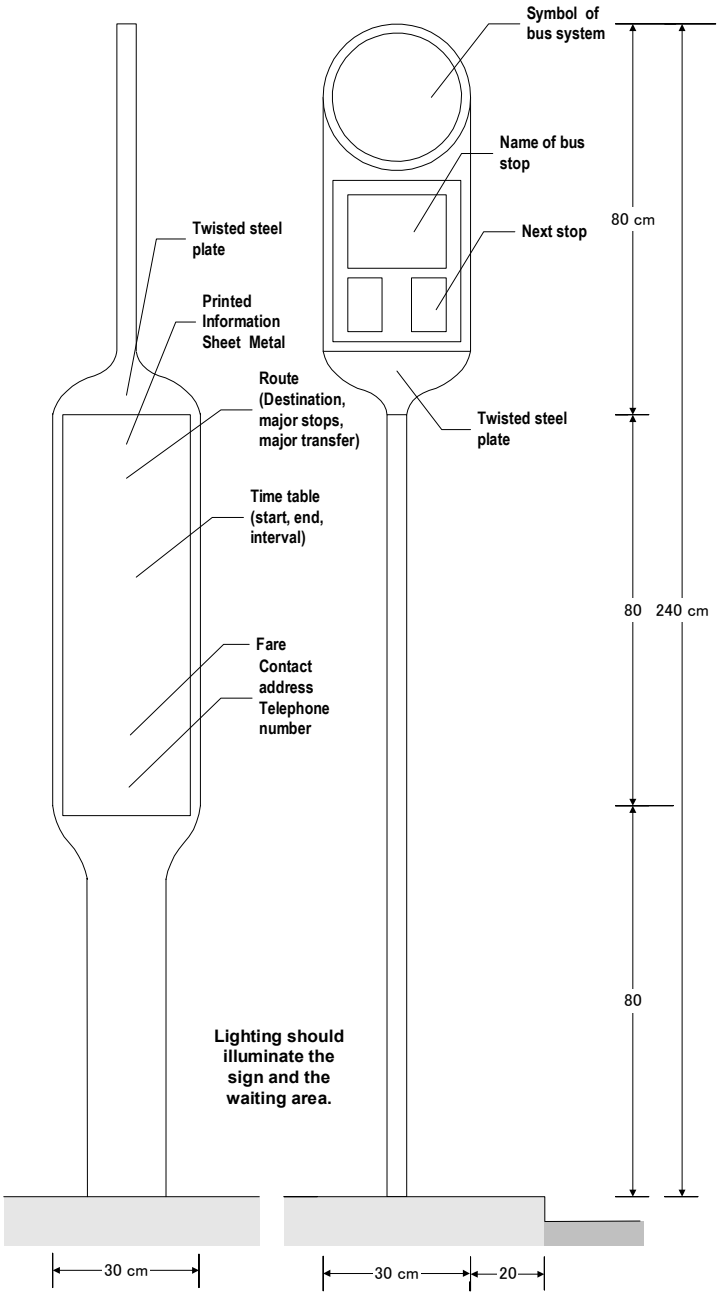

Figure 14.6-8 Design of Bus Stop Sign (Central Area)

14.7. TRAFFIC SAFETY FACILITY FOR TRUNK BUS PASSENGERS

The trunk bus system in which a trunk bus operates on the segregated busway introduced on the median side of the road is a newly introduced public transport system in Belem. An important consideration of this system is the generation of traffic conflict between trunk bus passengers and ordinary private vehicles when trunk bus passengers cross a roadway to access the bus stop installed in the middle of a road. In the integrated bus terminal, which is a transfer area between trunk and feeder buses, the bus passengers are put at risk when crossing bus fleets. On the other hand, traffic conflict between bus passengers and bicycles occurs at the bus stop of conventional buses located on the sidewalk, because the bike lane is located between the sidewalk and traffic lane. From the viewpoint of traffic safety

between bus passengers, pedestrians and trunk bus operation, it is indispensable to establish the following traffic safety measures:

- Pedestrian crossings should be marked so that bus users can safely access the bus stops.
- A safety barrier should be installed on the island type bus stop at the vehicular traffic lane side to secure the safety of waiting bus passengers. (see Figure 14.7-1)
- A bike lane is developed and planned along the sidewalk with conventional bus stops. The bike lane is located between the sidewalk and traffic lane. Therefore, conflict flows generate between conventional bus boarding/alighting passengers and bicyclists. It is necessary to re-designate the existing bike lane in front of bus stops to avoid the danger occurring between conventional bus passengers and bicyclists.
- Transfers between trunk buses and feeder buses are generated in the integrated bus terminals. It is desirable to separate pedestrians and bus traffic flow to avoid the conflicting flow between them, but grade separation such as a pedestrian deck causes up and down movement. Therefore, at-grade crossings should be prepared for bus passengers. However, the island type of bus bay should be decentralized to several islands to avoid the heavy bus traffic volume caused by concentrating on one or two bus bays for the safe crossing at passageways. The markings for pedestrian crossings should be prepared to indicate pedestrian/ passenger crossing points.
- There should be provision of rampway from the sidewalk to the pedestrian crossing and to the bus stop to allow easy access for physically handicapped persons. Figure 14.7-2 shows the ramps from the sidewalk to the bus stop for physically handicapped persons. The same consideration for the handicapped should be given for boarding/alighting from the bus body side, for instance, using a removable board attached in an inclined position.
- The trunk bus system is the new type of public transport to be introduced in the Belem Metropolitan Area. Therefore, it is strongly recommended to conduct traffic safety education by DETRAN, CTBel, etc. not only for bus passengers, pedestrians, bus drivers and private car drivers, but also for all the people in the Belem Metropolitan Area.

Figure 14.7-1 Safety Barrier at Bus Stop on Busway in Curitiba

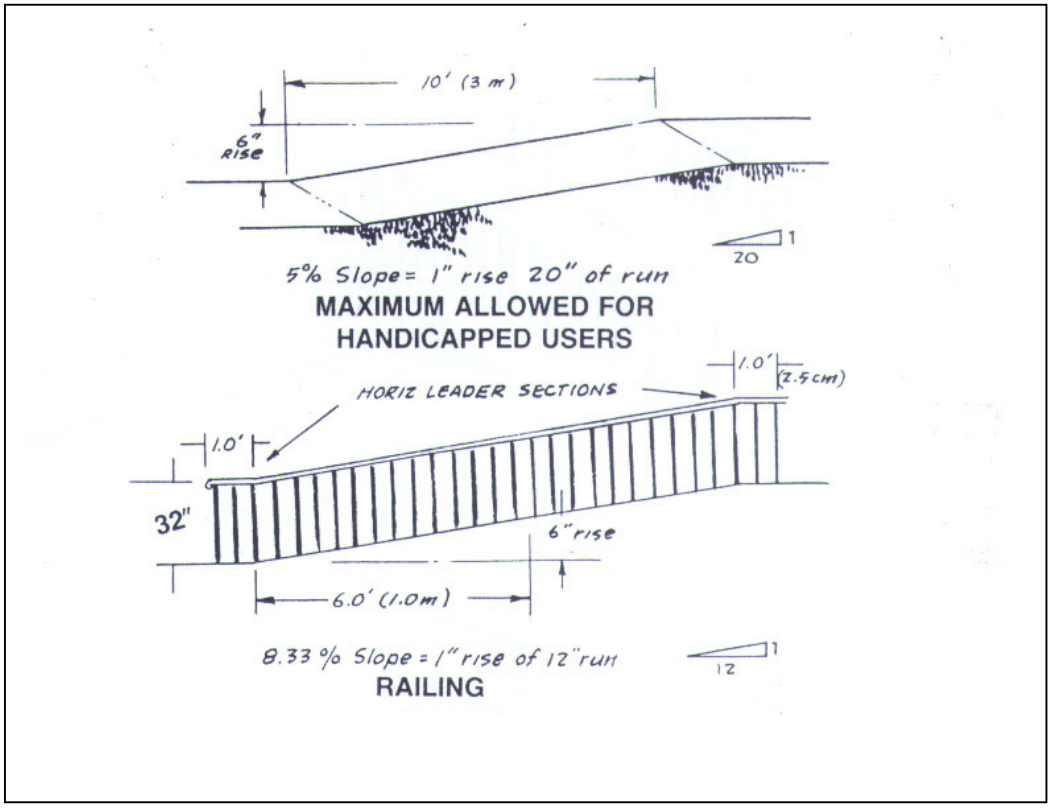

Figure 14.7-2 Ramps from the Sidewalk to Bus Stop for Physically Handicapped Persons