CHAPTER 14

Trunk Bus Transport Sector Plan

14. TRUNK BUS TRANSPORT SECTOR PLAN

14.1. GENERAL

Buses are one of the most space-efficient and cost-efficient means of transporting large numbers of people. Where traffic flows are well below the capacity of the road network, buses can share road space with other traffic and, in general, there is little need for special priorities for buses. However, in the Lima metropolitan area where road traffic volume is high in relation to road capacity, buses suffer from the congestion and delay caused by bus traffic and other road users, and priority measures are needed to release buses from congestion of traffic and bus transport itself.

In the Master Plan, the trunk bus system as a public transport option was recommended as a high priority project taking into consideration the importance of strengthening the public transport system in the study area.

In general, there are mainly two bus priority measures: bus lanes and busway. Bus lanes are road lanes reserved for the use of buses only. There are two main types of bus lanes: with-flow and contra-flow.

A busway involves construction where schemes may be partially segregated from other traffic or fully segregated from other traffic by curbs or fences. A basic busway is essentially a traffic engineering measure. However, performance of this basic busway can be enhanced substantially by adopting various “special operational measures” in order to form a “**busway transit system**”.

Trunk-and-feeder operation also offers good performance as one of a busway transit system. In this system, feeder buses collect passengers and bring them to a transfer terminal, where they transfer to trunk buses. In the Lima metropolitan area, busways have been constructed as traffic management measures without any substantial modifications to bus operations. Busways must be introduced in conjunction with special operation measures to form a mass transit system.

Figure 14.3-1 shows the outline of a proposed trunk bus system in the master plan study. As can be seen, a trunk bus, conventional bus and feeder bus are operated on a bus route. The conventional bus service is operated on the same system (route) as that at the present, but bus routes diverted to trunk busways will be abolished by degree of competition with the trunk bus route. The conventional buses will be operated outside of segregated busways on roads.

The trunk bus operating system divides its service into two organizations: trunk bus company and current conventional bus company. The trunk bus company will operate the trunk bus and feeder bus without an additional bus fare when passengers transfer to a conventional bus.

A trunk bus operates on a busway, which may be partially segregated from other traffic or fully segregated from other traffic by curbs or fences to secure operation conditions such as speed, punctuality and safety. At the same time, bus terminal and bus stop facilities are constructed to ensure a smooth bus operation. The operated bus fleet introduces a large articulated bus with a capacity of 150 passengers to offer both lower operating costs and higher service reliability. Bus operating organization is also recommended.

The study covers the following.

1) Type of bus service: trunk bus, conventional bus and feeder bus are operated
2) Operation system: bus integrated operation system and fare system

3) Busway facility: including trunk busway, segregated bus lane and bus priority lane related to service frequency
4) Introduction of large bus fleet: articulated bus, conventional bus and small bus
5) Construction of bus facility: bus stop and bus terminal
6) Reorganization of trunk bus operation: including administration and bus company

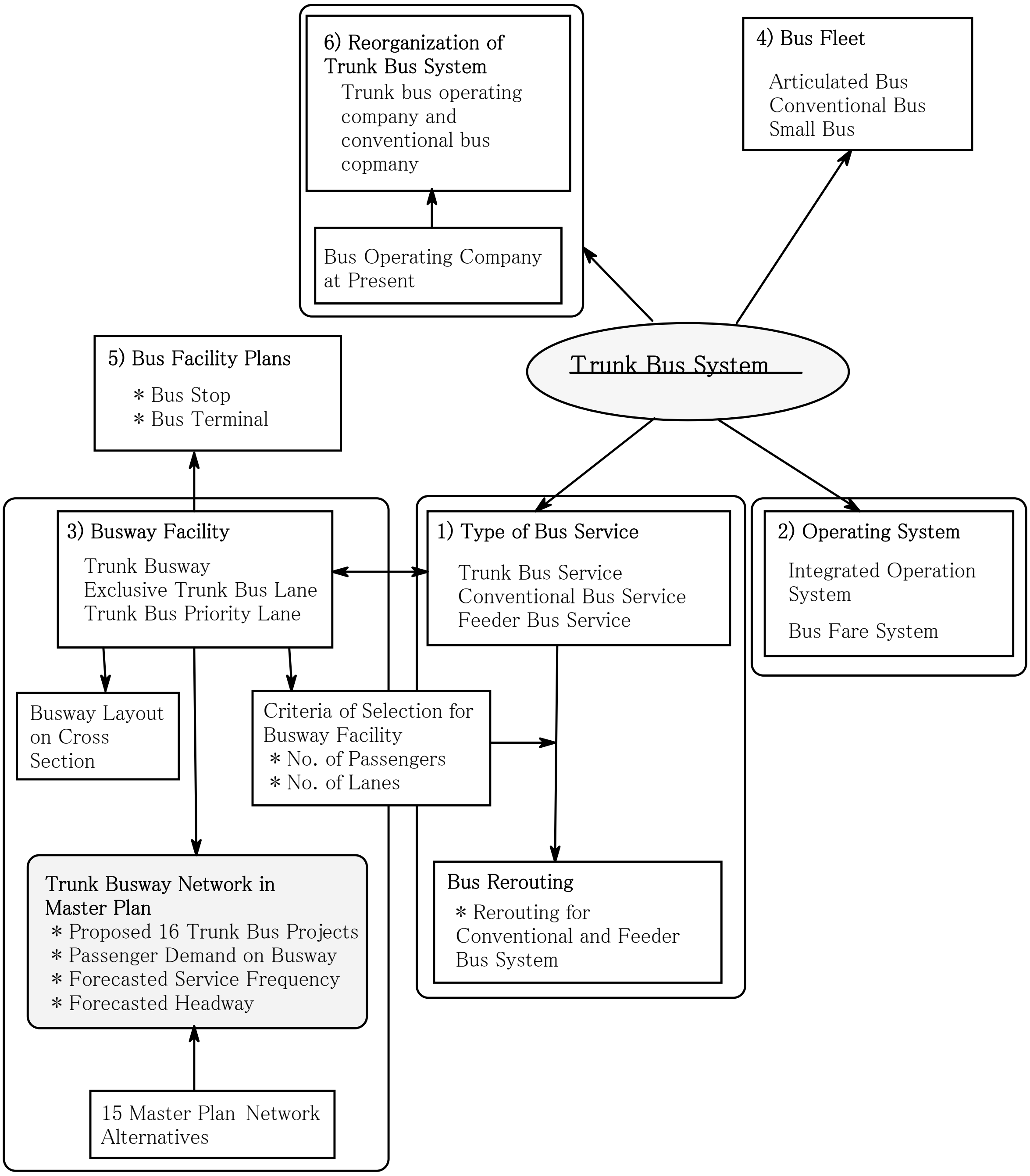


Figure 14.1-1 Outline of Trunk Bus System

14.2. ENVIRONMENTAL CONSIDERATION

The trunk bus system uses the available road space of the existing trunk roads. Because the widening of road space is not required, the proposed system is unlikely to do additional damage to the current situation of the surrounding environment. The trunk busway is planned on major roads in the Lima metropolitan area and its roads run through the high-density populated area. Therefore, the busway construction needs to minimize the relocation of roadside communities from the environmental viewpoint.

In the study, trunk busway network is proposed in consideration of environmental aspect. When the segregated busway is proposed on the road location to need widening of roadway due to narrow road width, the busway plan will be changed to the plan of bus priority lane in order to avoid the relocation of roadside communities.

In Lima, at the present, the average bus ages of Omnibus, Microbus and Camioneta are approximately 20 years, 18 years and 15 years, respectively. Omnibuses over 15 years old account for 78% of the total. Microbus and Camioneta total 68% and 53%, respectively. Therefore, the old buses are close to being scrapped because their maintenance is too expensive. As a result of this situation, the environmental conditions become worse. Air and noise pollution are especially severe.

Moreover, there are many small buses: Camioneta, operated on roads. Those small buses increase in number year by year. The maximum number of buses on the road is approximately 1,600 vehicles/hour/direction in the morning peak. Approximately 50% of the total on average are Camioneta. This causes heavy traffic congestion.

Since a large bus fleet is operated in the trunk bus system, the number of operated buses will be reduced and old-fashioned buses will be replaced by new large buses. Therefore, traffic congestion will be alleviated and gas emissions from buses will also be reduced by the introduction of the trunk bus system.

14.3. TYPE OF BUS SERVICE

(1) Conceptual Planning for Trunk Bus System

Through the process of analyzing the present bus transport system and searching for solutions to the existing problems vis-à-vis the framework of the stated basic planning policy and strategy, the Master Plan Study proposes the new bus transport plan generally called the trunk bus system generally. The Trunk bus system is composed of busway infrastructure and special operational measures as follows:

Trunk Bus System	=	Busway Infrastructure	+	Special Operational Measures

1) Busway Infrastructure

a) Partial or full segregation from other traffic by “ paint and sign “, fences or curbs.
b) Island bus stops / off-road bus stops.
c) Terminals

2) Special Operational Measures

a) Bus overtaking facilities at stops
b) Trunk and feeder operations
c) High capacity buses
d) Off-board ticketing

e) Bus-priority signal at intersections.

Line-haul capacity on the trunk busway can be enhanced by the use of high-capacity buses, including articulated, or double-deck. However, passenger transfer capacity at bus stops is often the constraint on system performance, and door configuration and ticketing arrangements are often more important than bus capacity alone.

The main advantages of a busway system are:

a) Flexibility
b) Affordability
c) Self-enforcement
d) Scope for incremental development
e) Existing experience

Busway can be introduced along existing roads, and can run along the middle of the carriageway (median busway) or next to the curb (lateral busway).

(2) Trunk Bus System

When a busway is to be inserted into an existing right-of-way, difficult issues arise over the allocation of road-space between the buses and private car users. Those road capacities are reduced by construction of busway and traffic congestion will be more severe after the construction, while travel conditions of bus passengers are improved.

Figure 14.3-1 illustrates the trade-off between traffic flow and bus flow: the chart indicates that this trade-off can be classified into four basic categories. The urban areas in Lima and Callao is Case 4: this is where bus priority is most needed, but other road users must accept the severe traffic conditions caused by allocation of road-space to buses.

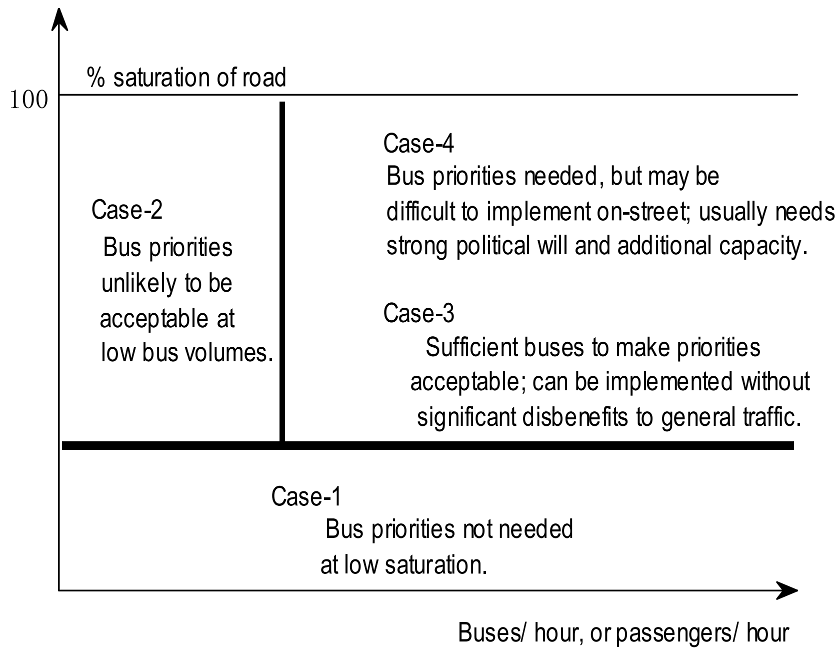


Figure 14.3-1 Feasibility and Warrants of Busway

In the study, the trunk busway is planned on major roads in the Lima metropolitan area and its roads run through the high-density populated area. Therefore, the busway construction needs to minimize the relocation of roadside communities from the environmental viewpoint. Since the trunk busway uses the available road space of the existing trunk roads, the road capacity for a private vehicle will not be reduced by construction of busway.

Type of bus service in the trunk-feeder bus system will consist of a trunk bus, conventional bus and feeder bus, which are operated on busway or bus priority lane. The outline of bus services is shown in the following section.

1) Trunk Bus Service

The trunk bus service is operated with higher operation speed on the busway, which may be partially segregated from other traffic or fully segregated from other traffic by curbs or fences to secure operating conditions such as speed, punctuality and safety. The trunk bus system results in higher volumes of bus passenger flows. In general, measured peak hour passenger flows range from 20,000 to 25,000 passenger/hour/ direction on the trunk bus system.

In many cases, the capacity constraint on the system will be the bus stop. It depends on the number of bus bays provided, facilities for buses to overtake one another, etc. Bus stop spacing provides for a distance of 0.8km or 1km to secure operation speed and line-haul capacity. Intersections influence the flow of buses along at-grade busways and consequently affect both capacity and speed of bus operation. A particularly busy intersection may be the busway bottleneck. The capacity of intersections and bus stop may influence bus flows. In most cases, since intersection capacity will be greater than that of the most critical bus stop, a grade-separated intersection is prepared in a major intersection on a trunk busway.

In order to be enhanced by the use of high-capacity buses, whether articulated or double-deck buses, bus fleet introduces a large articulated bus with a capacity of 150 passengers to offer lower operating costs and higher service reliability, and to reduce the number of bus fleets in operation and thereby to alleviate the traffic congestion. Specifically, the new bus is the two-bus articulated type that is already in use in Sao Paulo, Curitiba and elsewhere.

2) Feeder Bus Service

The function of feeder buses is to supplement a trunk bus service. The feeder buses serve within some areas where no trunk buses operate. 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 15-30 passenger capacity, like a microbus or Camioneta.

The feeder bus competes with moto-taxis in its operation area. It is necessary to identify each function of public transport when the feeder bus is introduced. In low-income residential areas a bus route network has several problems. The extreme low-income people (2.3% of the total population in 2002 by statistical data of INEI) live on the slope of hilly terrain and mountains far away from a major road. Since the current bus is not directly operated into this low-income area, the residents in the area must use a moto-taxi to reach home after alighting from a bus.

Therefore, in the study, the feeder bus route network is proposed for the (extreme) low-income people. In the begining of the introduction of the trunk-feeder bus system, the feeder bus will compete with moto-taxis in the same area. The feeder bus will gradually have the advantage over moto-taxis in conjunction with time. And in the area where the feeder bus operation can not operate due to geographical features, moto-taxi service will continue in future.

3) Conventional Bus Service

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 80-passenger capacity.

The conventional bus service is operated on the same system (route) as that at the present, but bus routes diverted to trunk busways will be abolished by degree of competition with the trunk bus route. The conventional buses will be operated outside of segregated busway on roads.

(3) Rerouting of Conventional Bus Route

When the trunk busway is constructed on major roads, conventional bus routes assigned on those roads must be rerouted by eliminating those which overlap with trunk bus lines, as well as small demand routes. On the eliminated and integrated bus routes from among the conventional bus routes, the conventional bus is operated.

Those reroutings will be implemented in accordance with the progress of the trunk busway network. The integration of the conventional bus routes gives priority to the following.

a) Bus routes overlapped with the same trunk bus lines
b) Bus routes with small demand when trunk bus operates
c) Long and winding bus routes on which it is possible to divert bus passengers to trunk bus routes

14.4. BUS OPERATION SYSTEM

(1) Integrated Bus Operation System

The Master Plan study proposes new bus terminals for trunk bus operation. The terminal provides integrated transfers between trunk and feeder bus lines. In this study, the conventional bus lines will not be integrated with the trunk bus system. Accordingly, the bus terminals will be so structured as to segregate the integrated trunk and feeder bus services from the conventional bus lines and other private transport means. Passengers of conventional bus lines can transfer to trunk bus lines at trunk bus stops but they have to pay the fare again. Passengers of a trunk bus line do not have to pay the fare when they transfer to another trunk bus line at a trunk bus stop.

Since the current bus is not directly operated into this low-income area (Estrato-E), the residents in the area must use a moto-taxi to reach home after alighting from a bus. And they need to pay an additional transpot fare to a moto-taxi.

In the study, since the feeder bus service is indispensable for (extreme) low-income people without payment of an additional fare when they transfer between buses, it is necessary to plan a feeder bus route in the (extremely) low-income area and introduce an integrated operation system to allow transfer between buses without fare payment.

(2) Bus Tariff System

1) Typical Tariff System

At present, the bus company can decide the bus fare rate under the law. However, the rate is somewhat dependant on the travel distance, i.e., the fare rate between Centro and suburb of Lima is a range of $1.5 to 1.8 sol, equivalent to a travel distance of 15km. The actual fare rate varies according to the travel conditions such as morning peak hour and travel distance. Approximately 70% of the total are less than a paid fare of S/. 2.0. Almost all passengers pay in a range of S/. 1.0-1.9. According to the interview survey, approximately 70% of the passengers are satisfied with the present fare rate. The bus company must closely manage income and expenditure because of keen competition.

However, this current tariff system does not have a systematized fare rate and depends on travel conditions. Therefore, when the trunk bus system is introduced, this tariff system must be improved.

Two types of tariff system are considered for the trunk bus system as follows:

a) A flat rate system, which is the same rate regardless of travel length.
b) A zone fare system in which the fare rises according to trip length

In the Study, alternative cases will be set on the flat rate system because the zone fare system is difficult in the actual application, especially ticket sale, fare collection and ticket validation. It is difficult to verify the ticket under the zone fare system without any fare collecting equipment.

2) Alternative Cases

Two alternative cases are considered as follows:

a) Alternative-A: a flat rate system with an additional fare at every transfer point
b) Alternative-B: a flat rate system without payment of an additional fare when transferring

Alternative-B allows transfer without payment of an additional fare when passengers transfer from/ to feeder bus or trunk bus at terminal or bus stop. However, it is also difficult to verify the passengers who transfer or not by the validation of tickets only. If such a system is actually introduced, some segregated structures like railway stations need to validate the passengers.

In the Master Plan study, alternative-B is proposed in the trunk bus system under the integrated operation system mentioned above.

3) Integrated System for Intelligent Ticket

In order to accomplish high performance in the trunk and feeder bus system, an efficient ticketing system is needed. Boarding times per passenger in a fare collection system in which entry to a bus is unobstructed by fare collection or ticket validation, are lower than that of the current system in which entry is restricted.

The off-board ticketing system is an intelligent ticketing system. It offers the possibility to reduce passenger service time and thereby to reduce bus waiting time and increase commercial speed. Such a system will not be effective on only a few busways. The integrated system to be applied in the whole city will enhance the performance of the trunk and feeder bus system, if no attention is paid to the cost.

The proposed integrated system is considered as follows:

a) Trunk bus – trunk bus: applied integrated system
b) Trunk bus – feeder bus: applied integrated system
c) Trunk and feeder buses – conventional bus: no applied integrated system
d) Trunk bus and feeder buses – railway: no applied integrated system

14.5. BUS FLEET

In Lima, bus transport is the main mode for public transport and public transport demand is heavy, especially in the peak hours. When the trunk bus system is introduced in the Lima metropolitan area, larger buses on the trunk busway will offer both lower operation cost and higher service reliability.

The general merits of large buses are as follows.

1) Operation costs per unit of offered capacity decrease as bus fleet size increases.
2) Line capacity increases nearly linearly with bus size. With larger buses, street congestion decreases and reliability of service increases.
3) Vehicle maneuverability decreases with bus size.
4) Riding comfort increases with the bus size of single-body buses, but is lower with articulated and double-decker buses.

The bus capacity proposed in the trunk bus system is shown as follows: A single-body bus with a bus capacity of 80-100 passengers is used for trunk bus priority lane. An articulated bus with two bodies whose capacity is 150 is used for the trunk busway. The passenger capacities of the trunk bus are almost 2 – 5 times, compared to the current Omnibus and Micro bus capacities.

1)	Trunk bus:	150 - 200 passenger / unit for articulated bus 80-100 passenger / unit for single-body
2)	Feeder bus:	20 – 30 passenger / unit
3)	Conventional bus:	80 –100 passenger / unit

Major specifications are as follows.

1) Four doors, or two per body, are available for passenger boarding and alighting.
2) The doors are provided on the left side of the bodies due to the island type bus stop facility on the trunk busway.
3) As for operation on the bus priority lane, the doors are provided on the right side due to the fact that single-body or articulated buses run on the right-side lane next to the sidewalk.

14.6. BUSWAY FACILITY

14.6.1. TRUNK BUSWAY

Trunk busway facility for the trunk bus system in the study involves three types of busways.

1) Busway: bus facility, which is partially or fully segregated from other traffic by curbs or fences.
2) Exclusive Bus Lane: road lane, which is reserved for the use of buses only by road markings or separators.
3) Bus Priority Lane: road lane, which is essentially reserved for the use of buses by paint and sign in the morning and evening peak hours.

(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 rights of way wide enough to construct the two-way trunk busway (about 10m in width) /dual-way 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 that the regular trunk bus service complies with schedule and traffic safety requirements. 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.

(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) /dual-way 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. 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 that can not be widened. The trunk bus priority lane is introduced next to the right-side sidewalk. The lane is not segregated by any structure, but paved in a distinctive color to attract attention.

(4) Hierarchy of Trunk Busway

Table 14.6-1 shows the hierarchy of three busway and lanes in terms of their respective planned elements and the bus fleet requirements.

Table 14.6-1 Hierarchy of Trunk Busway

Bus System	Means of Segregation	Effective Hours	Type of Traffic	Roads for Introduction			Bus Fleet		Guideline Bus Passenger Traffic (persons/hour)
				No. of Lanes (No.)	Right of Way (m)	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	150	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	150	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 Single-body	150 80	Less than 10,000
Conventional Busway	No segregation (same as present)	All day (same as present)	All motor vehicles	*******	*******	*******	Conventional	80	*******
Feeder Busway	No segregation (same as present)	All day (same as present)	All motor vehicles	*******	*******	*******	Small conventional	30	*******

14.6.2. BUS STOP SPACING

The main physical determinations of average bus commercial speed appear to be bus stop and intersection spacing. Bus stop capacity is an important determinant of overall bus system performance. Bus stop spacing also influences performance. The longer the stop spacing is, the higher the commercial speed is.

The spacing for the trunk bus service employs an average spacing of 0.8- 1.0 km. As for the Key Bus System in Nagoya, Japan, the average spacing for the express bus is approximately 700m and 400m for the key bus.

14.6.3. TRUNK BUS NETWORK

(1) Trunk Busway Network (16 Bus Projects)

The trunk busway network in the Master Plan is formulated in accordance with the aforementioned planning policy and the hierarchy of three busways, by analyzing the alternative transport network plans. Sixty (16) trunk busway projects are chosen for the reasons already stated, such as the frequent use by many bus lines and the heavy traffic of bus passengers in 2004 and 2025.

Table 14.6-2 lists the selected busway projects. Selection of busway, exclusive trunk bus lane and trunk bus priority lane will be made in the next stage, a feasibility study. Figure 14.6-1 shows the proposed trunk busway network. The busway project outline such as a busway location, a typical cross section, construction works and cost estimation is shown in section 14.9.

Table 14.6-2 List of Trunk Busway Network Projects

Project Name		Length	
		Section	(km)
1	Av. Nestor Gambeta Trunk Busway	Av. Argentina – Pan. Norte (22.55 km)	22.55
2	Av. Panamericana Norte Trunk Busway	Cabueta – Ancon (23.90 km)	23.9
3	Av. Universitaria Norte Trunk Busway	Metropolitana – Manuel Prado (7.27 km)	7.27
4	Av. Canta Callao Trunk Busway	Av. Elmer Faucett – Av. Panamericana Norte (9.13 km)	9.13
5	Av. Universitaria Trunk Busway	La Marina – Panamericana Norte (12.66 km)	12.66
6	Av. Tomas Valle Trunk Busway	Av. Nestor Gambeta – Av. Universitaria (2.84 km)	2.84
7	Av. Elmer Faucett Trunk Busway	Av. La Marina – Av. Nestor Gambeta (8.81 km)	8.81
8	Paseo de la República Trunk Busway	Pan. Sur – Av. Universitaria Norte (29.02 km)	29.02
9	Proceres de la Independencia Trunk Busway	Av. Grau – Bayovar (11.23 km)	11.23
10	Av. Venezuela Trunk Busway	Paseo de la República – Grau (9.05 km)	9.05
11	Av. Brasil Trunk Busway	Paseo de la República – Av. Angamos (4.84 km)	4.84
12	Av. Javier Prado Trunk Busway	Av. Elmer Faucett – Av. Carretera Central (21.07 km)	21.07
13	Av. Angamos Trunk Busway	Av. La Marina- Av. Javier Prado (15.96 km)	15.96
14	Av. Grau Trunk Busway	Paseo de la República – Proceres de la Independencia (2.27 km)	2.27
15	Carretera Central Trunk Busway	Av. Grau – Av. Haya de la Torre (8.36 km)	8.36
16	Av. La Molina Trunk Busway	Carretera Central (6.54 km)	6.54
17	Av. Panamericana Sur	Paseo de la República – Av. Huaylas (25.60 km)	25.60
	Total		221.1

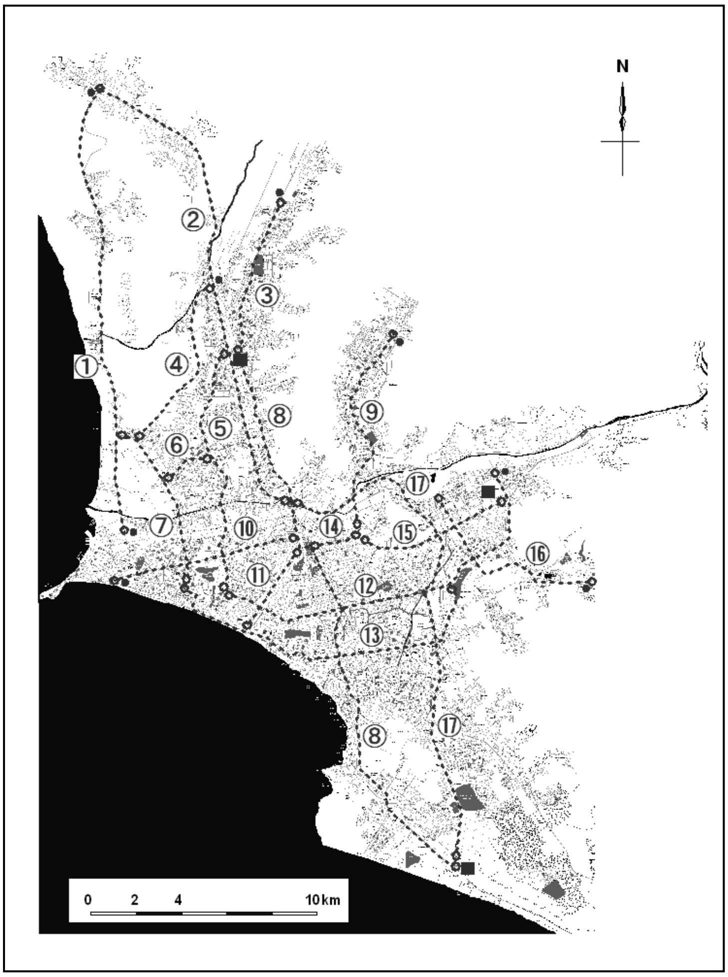


Figure 14.6-1 Trunk Busway Network in the Master Plan

(2) Typical Busway Cross Section

In the Study, the busway track is located along an existing right-of-way. For an existing right-of-way, the bus track is generally both in the center of the road (median) and along the sides (lateral), depending on the road width. The busway exclusive of private vehicles with fence and cube at present is constructed at approximately 30km. The busway on those roads is located in the center of the road (median).

The degree of grade separation between buses and other traffic can have a major influence on performance. The proposed busways physically segregate buses and other traffic along their entire length using curbs or fences except for some roads where segregation is only at island bus stops.

In general, a segregated busway decreases turbulence in traffic flow of both cars and buses and therefore, often increases speeds of not only buses, but of the car traffic in other lanes as well. A disadvantage of segregated busways is, however, that they tend to discourage mutual overtaking of buses from different routes. Normally, overtaking reduces their delays. However, since a large bus is operated with off-board ticketing under the less turbulent flow of the segregated busway, as well as less delay by grade-separate plan at major intersections, the delay will be kept at a minimum.

Therefore, the 1-lane busway per direction located on the median is proposed for the Study. In the case of insufficient busway capacity in consideration of future travel demand, the proposal will replace it with the railway, not on the 2-lane busway per direction.

1) Trunk busway

Figure 14.6-2 shows a typical cross section of a trunk busway, located next to the median, proposed in the study.

1) The roads selected for the trunk busway 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 so as 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.
4) Bus operation speeds on such median lanes are faster than in the lateral lanes. But pedestrian islands must be provided at all stops for safety and convenience.

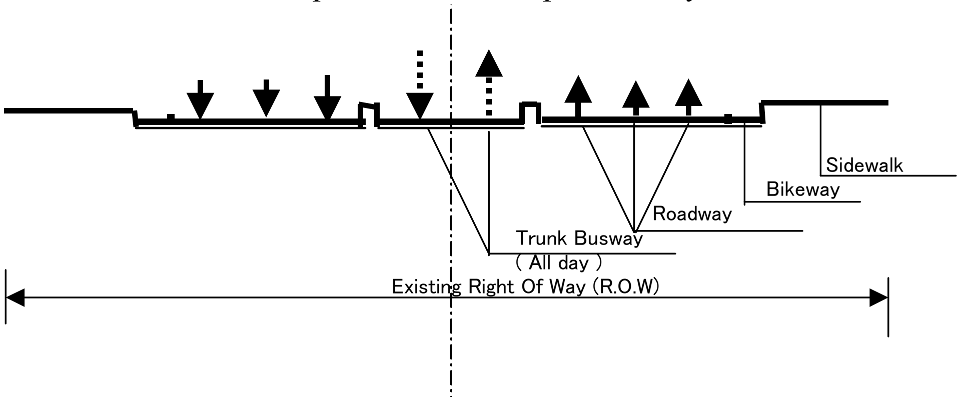


Figure 14.6-2 Typical Cross Section Location of Trunk Busway

2) Exclusive Trunk Bus Lane

The exclusive lane is provided on the median-side of the roadway, as shown in Figure 14.6-3. The reasons for the location are the same as in the trunk busway.

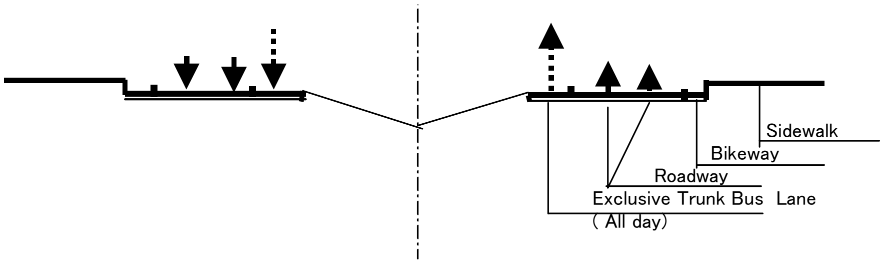


Figure 14.6-3 Typical Cross Section Location of Exclusive Trunk Bus Lane

3) Trunk Bus Priority Lane

The roads selected for the introduction of trunk bus priority lanes 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, 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 14.6-4.

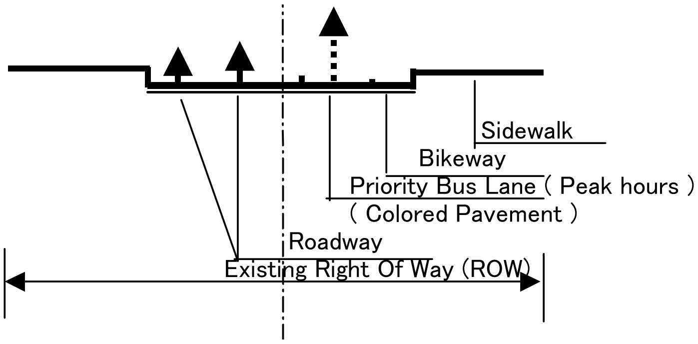


Figure 14.6-4 Typical Cross Section Location of Trunk Bus Priority Lane

14.6.4. BUSWAY CAPACITY

(1) Line Capacity

Vehicle line capacity or passenger line capacity (C) is the maximum number of buses or passengers that can be transported on one bus line (route) past a fixed point during one hour.

Scheduled line capacity C_O is the number of passengers that are transported past a fixed point under a given operating schedule. Obviously,

$$Co \leq C$$

Table 14.6-3 shows the guideline for frequency and scheduled passenger line capacity. The line capacity is computed as the bus capacity, multiplied by frequency, on the assumption that buses are operated with a headway of 1 minute or less.

The number of buses that pass a point on a line during an hour is the *service frequency f*, which is the inverse of *service headway h*, the average time interval between two successive buses:

$$f = \frac{3600}{h}$$

Table 14.6-3 Guideline of Scheduled Passenger Line Capacity

Type of Bus	Bus Capacity (No. of passengers per unit)	Headway (sec.)	No. of passengers transported (No. of passengers per/hour/dir.)
Trunk Bus	150	45 - 60	9,000 - 12,000
Conventional Bus	80	45 - 60	5,000 - 6,000
Feeder Bus	20	45 - 60	1,200 -1,600

(2) System Criteria of Trunk Busway

In the Lima metropolitan area, the maximum passenger flows recorded by the Study team are approximately 38,000 passengers/hour/dir in the inbound direction on Av. Tupac Amaru with mixed traffic lane and 5 lane/dir (3 lanes for through traffic lane and 2 lanes for frontage road) in the period of 8:00 and 9:00 a.m. These figures are estimated by multiplying the number of buses by the average number of passengers on board in the corresponding hour. The number of buses is approximately 1800 vehicles, of which 860 vehicles are Camioneta, 670 are Microbus, 120 are Omnibus and 150 are Colectivo. The passenger flows on Av. Tupac Amaru are classified into the highest group in the world. Other maximum passenger flows are approximately 20,000-25,000 passengers/hour/dir in the inbound direction on the mixed traffic lane, not on the segregated busway.

In Bogota, the maximum passenger flows recorded in 1998 by the Study team before implementation of Transmilenio Project were approximately 30,000–33,000 passengers/hour/dir in the inbound direction on Av. Caracas with bus segregated busway and 2 lane/dir in the period of 7:00 and 8:00 a.m.

Therefore, the busway flow capacity will be able to transport a passenger flow of 25,000 p/h/d on a consistent basis. The scheduled line capacity on the busway in the Study will be approximately 25,000 p/h/d under a given operating schedule.

Table 14.6-4 shows the trunk line capacity per hour by different service frequency (headway). This capacity is calculated on the assumption that the number of bus operation frequencies derived from headway and bus passenger capacity. This shows the relationship between service headway and its transport capacity. When articulated buses are operated every 30 seconds, the hourly transport capacity per line comes to 18,000 passengers. When the headway is 20 seconds, the hourly capacity theoretically rises to 27,000 passengers, but this is somewhat 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 became large enough to require a headway shorter than 30 seconds, it would be more appropriate to introduce the articulated bus linking three vehicles (capacity of 200 or 240 passengers).

Table 14.6-4 Service Frequency and Transport Capacity of Trunk Bus Line

Service Frequency (Headway)	No. of Buses operated (units/hour) (A)	Capacity per Articulated Bus (B)	Transport Capacity per hour (persons/direction/line) (A x B)	Remarks
20 seconds	180	150	27,000	Difficult in operation
30 seconds	120	150	18,000	
45 seconds	80	150	12,000	
60 seconds	60	150	9,000	
90 seconds	40	150	6,000	
120 seconds	30	150	4,500	

14.6.5. TRUNK BUS DEMAND

In chapter 12, future transport network analysis, the alternative-N is chosen as a Master Plan network. Table 14.6-5 shows passenger demand in each project by the alternatives M, N and L in which daily passenger demands per direction in the range of minimum and maximum passengers in each project are shown, as well as peak hour volume on the assumption of a peak hour ratio of 10%. As can be seen, the passenger volumes on several segments in the alternatives-L and M exceed a bus line capacity of 25,000 pax/hour/dir.

In the chosen master plan, further study is necessary based on passenger demand in the morning peak hour. According to the peak hour analysis, the railway and trunk bus projects finally decide.

Table 14.6-5 Passenger Demand in Each Project

Project Number	Project Name	(km)	Alternative-M			Alternative-N			Alternative-L			Alt-M	Alt-N	Alt-L
												Peak Ratio=		0.1
			Travel Demand (1000 passenger/dir/day)									(1000 passenger/dir/hour)		
No- 1	Av.Nestor Gambetta Trunk Busway	22.55	100	-	310	125	-	200	115	-	275	31	20	28
No- 2	Av.Panamericana Norte Trunk Busway	23.9	90	-	225	120	-	200	100	-	225	23	20	23
No- 3	Av.Universitaria Norte Trunk Busway	7.27	95	-	160	90	-	140	90	-	160	16	14	16
No- 4	Av.Canta Callao Trunk Busway	9.13	35	-	85	-	-	-	35	-	70	9	-	7
No- 5	Av.Universitaria Trunk Busway	12.66	110	-	150	50	-	-	80	-	125	15		13
No- 6	Av.Tomas Valle Trunk Busway	2.84	50	-	55	-	-	-	50	-	55	6		6
No- 7	Av.Elmer Faucett Trunk Busway	8.81	175	-	300	-	-	-	180	-	290	30		29
No- 8	Paseo de Republica Trunk Busway	29.02	175	-	200	165	-	195	80	-	275	20	20	28
No- 9	Proceses De La Independencia Trunk Busway	11.23	-	-	-	-	-	-	30	-	85	-		9
No- 10	Av.Venezuela Trunk Busway	9.05	80	-	120	35	-	95	45	-	155	12	10	16
No- 11	Av.Brasil Trunk Busway	4.84	80	-	110	50	-	100	85	-	120	11	10	12
No- 12	Av.Javier Prado Trunk Busway	21.07	105	-	155	-	-	-	120	-	160	16		16
No- 13	Av.Angamos Trunk Busway	15.96	180	-	250	100	-	220	145	-	250	25	22	25
No- 14	Av.Grau Trunk Busway	2.27		-	330	180	-	280	340	-	450	33	28	45
No- 15	Carretera Central Trunk Busway	8.36	50	-	175	20	-	155	100	-	220	18	16	22
No- 16	Av.La Molina Trunk Busway	6.54	15	-	140	15	-	105	15	-	130	14	11	13
No- 17	Av.Panamericana Sur	25.6	60	-	145	50	-	140	85	-	160	15	14	16
	Railway Line No.1-1	11.7	150	-	560	150	-	600				56	60	
	Railway Line No.1-2	13	235	-	475	240	-	475				48	48	
	Railway Line No.2	29	185	-	490	235	-	495				49	50	
	Railway Line No.3-1	16.2	-	-	-	300	-	330					33	
	Railway Line No.3-2	11.9	-	-	-	120	-	170					17	
	Railway Line No.4-1	14.5	-	-	-	140	-	265					27	
	Railway Line No.4-2	10.1	-		-	-	-	-						
Total Length		327.5												

14.7. IDENTIFICATION OF PROJECTS

As proposed in Section 14.6.3, the proposed trunk busway network is introduced at the maximum level necessary for the trunk bus system in the conceptual plan. The proposed trunk Busway network is proposed on the existing expressway and the major arterial road in Lima and Callao density area. (Figure 14.7-1)

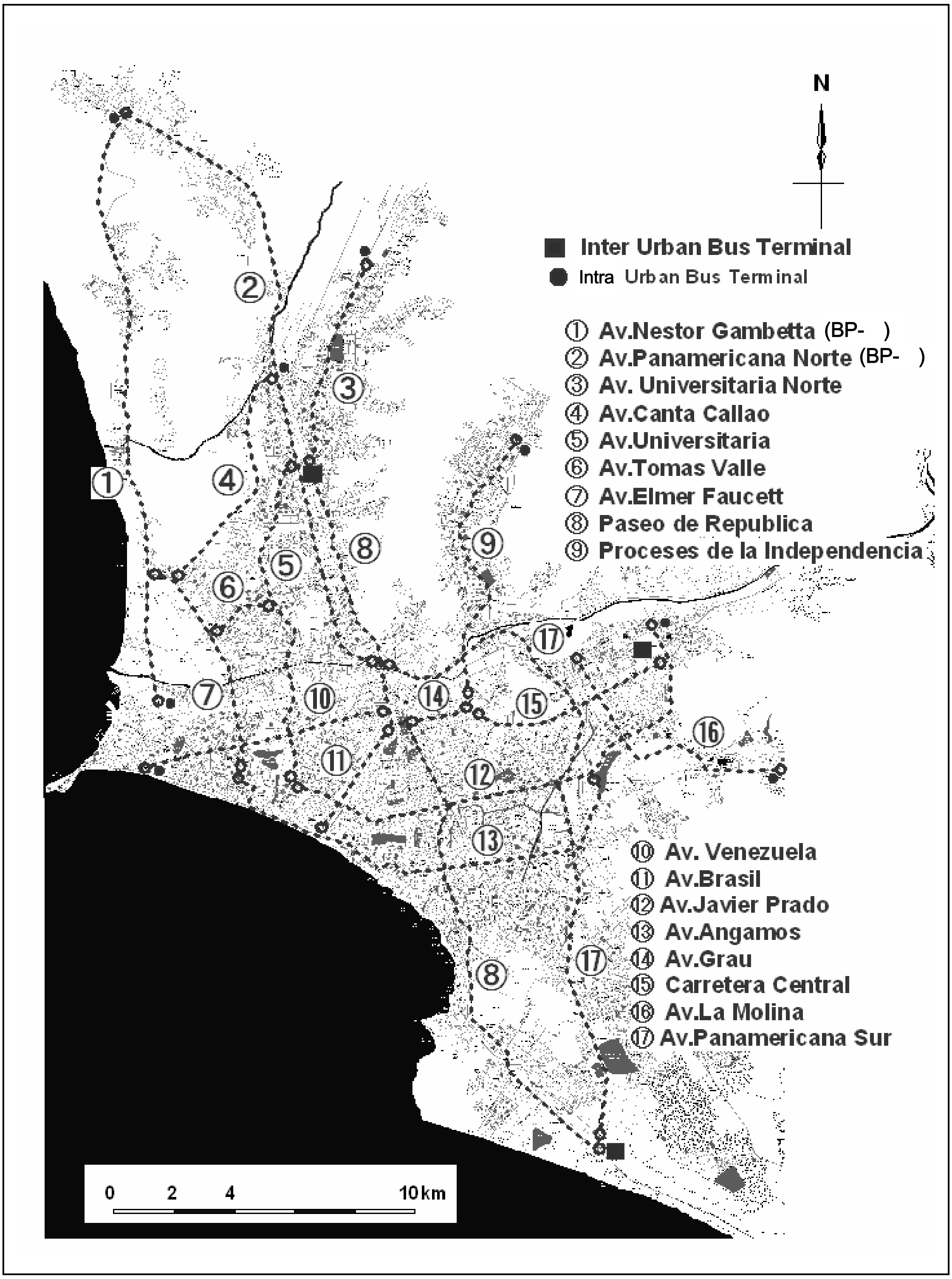


Figure 14.7-1 Proposed Trunk Busway Network

(1) Assumption

The trunk busway will be constructed on the existing road space, because the selected expressway and the arterial road are located in the midst of dense urban land use for commerce, business and housing. On the selected road, the possibility of widening these roads is extremely limited. The two-lane trunk busway is constructed by utilizing the existing median.

1) Horizontal Alignment

Because the trunk busway is constructed on the median of the existing roads, its horizontal design follows the respective alignments of these roads.

2) Vertical Alignment

The vertical design follows the respective alignments of the expressway and the arterial road since the trunk busway is constructed with their respective horizontal alignments. Its selected road in Lima and Callao is built on flat ground with a longitudinal slope of less than 3.0%. Therefore, the slope of the trunk busway is also less than 3.0%.

3) Cross Section

The right of way of the Expressway is varied from 80.0m to 100.0m, with segregated by the median. As shown in Figure 14.7-2, six carriage lanes with four side lanes.

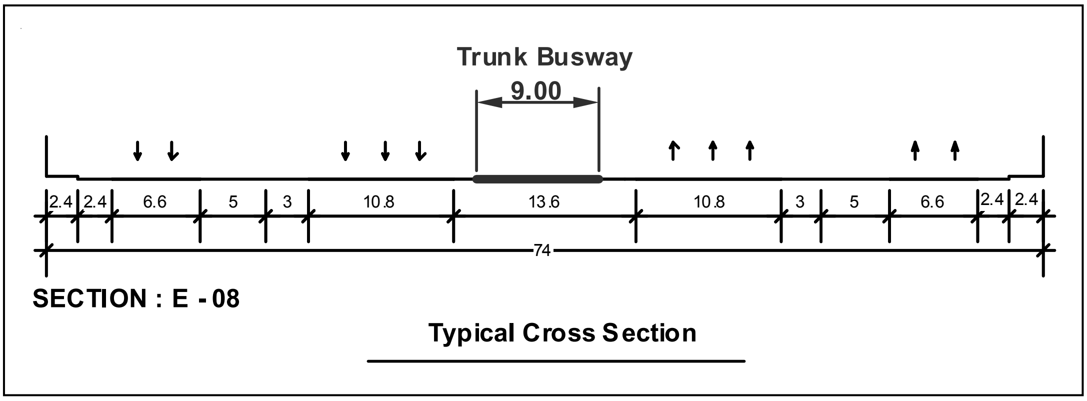


Figure 14.7-2 Typical Cross Section of Trunk Busway on Expressway

Table 14.7-1 Before and After Busway Construction

Cross Section Element	Before	After	Remarks
Width of Right of Way (m)	80-100	80-100	Unchanged
Width of Trunk Busway (m)	0	9.0	Two lanes of 3.5m each with shoulder 1.0m
Width of Median (m)		1.0	Used for both sides of the Trunk busway
No. of Carriage Lanes (No.)	6	6	Unchanged
Width of Carriage Way (m)	10.5	10.5	Unchanged
No. of Right-side Lanes (No.)	4	4	Unchanged
Width of Right-side Roadway (m)	7.2	7.2	Unchanged (4 lanes of 3.6m each)
Width of Right-side Sidewalk (m)	2.4	2.4	Unchanged

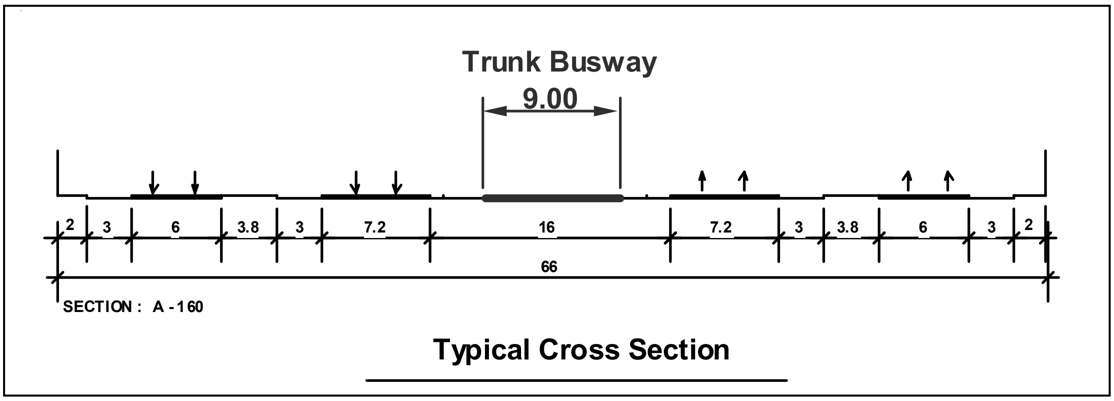


Figure 14.7-3 Typical Cross Section of Trunk Busway on Arterial road

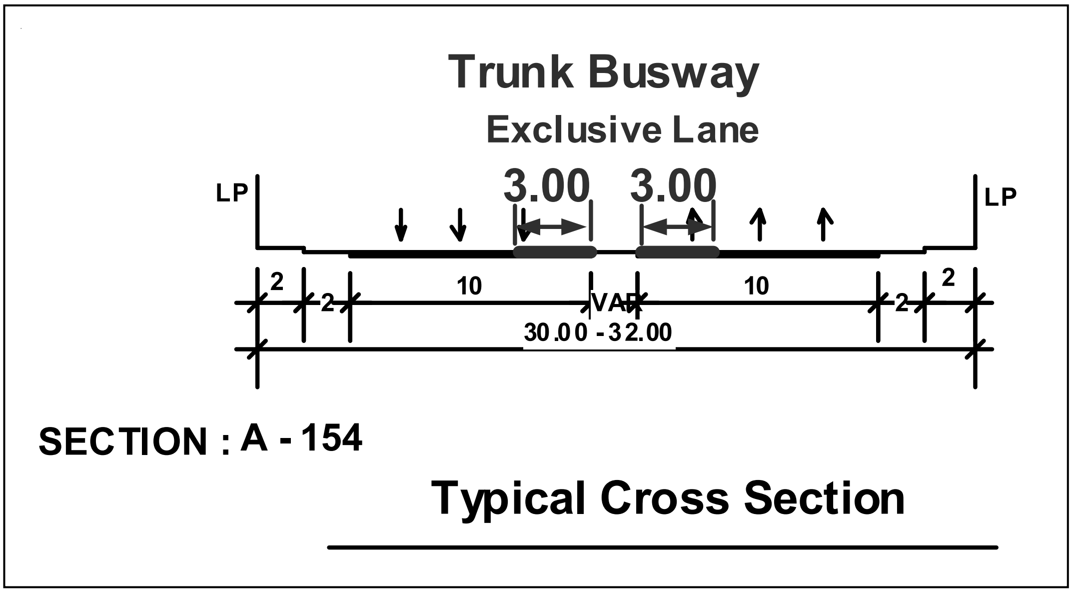


Figure 14.7-4 Typical Cross Section of Trunk Busway on Arterial road (Av. Universitaria)

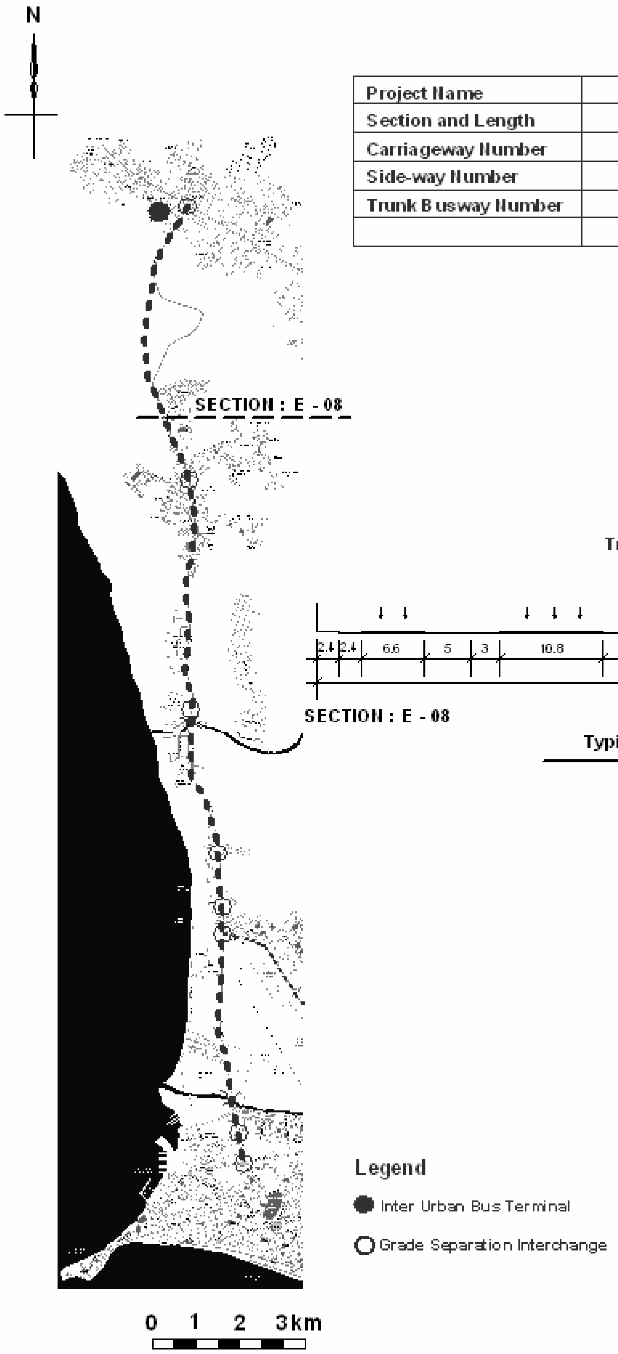
Table 14.7-2 Before and After Busway Construction on Arterial Road

Cross Section Element	Before	After	Remarks
Width of Right of Way (m)	30-70	30-70	Unchanged
Width of Trunk Busway / Exclusive Lane (m)	0	9.0 / 6.0	Two lanes of 3.5m each with shoulder 1.0m / Exclusive lane each 3.0m
Width of Median (m)		1.0	Used for both sides of the Trunk busway
No. of Carriage Lanes (No.)	4 or 6	4	Used for the Exclusive lane
Width of Carriage Way (m)	7.2 / 10	7.2 / 7.0	Used for the Exclusive lane
No. of Right-side Lanes (No.)	4 / 6	4 / 4	Unchanged
Width of Right-side Roadway (m)	7.2 / 0	7.2 / 0	Unchanged (4 lanes of 3.6m each)
Width of Right-side Sidewalk (m)	2.4	2.4	Unchanged

Figure 14.7-5 to Figure 14.7-21 show the outline of proposed 17th route trunk Busway.

① Av.Nestor Gambetta

Project Name	① Av.Nestor Gambetta
Section and Length	Av. Argentina – Pan. Norte (22.55km)
Carriageway Number	6 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines



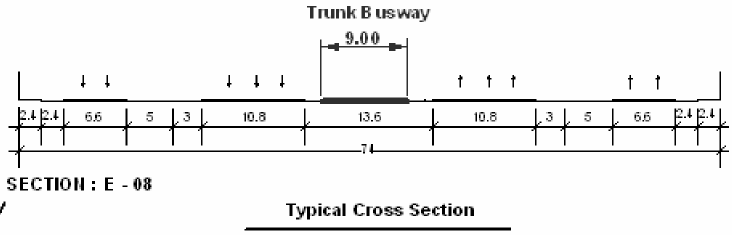


Figure 14.7-5 Trunk Busway Av. Nestor Gambetta

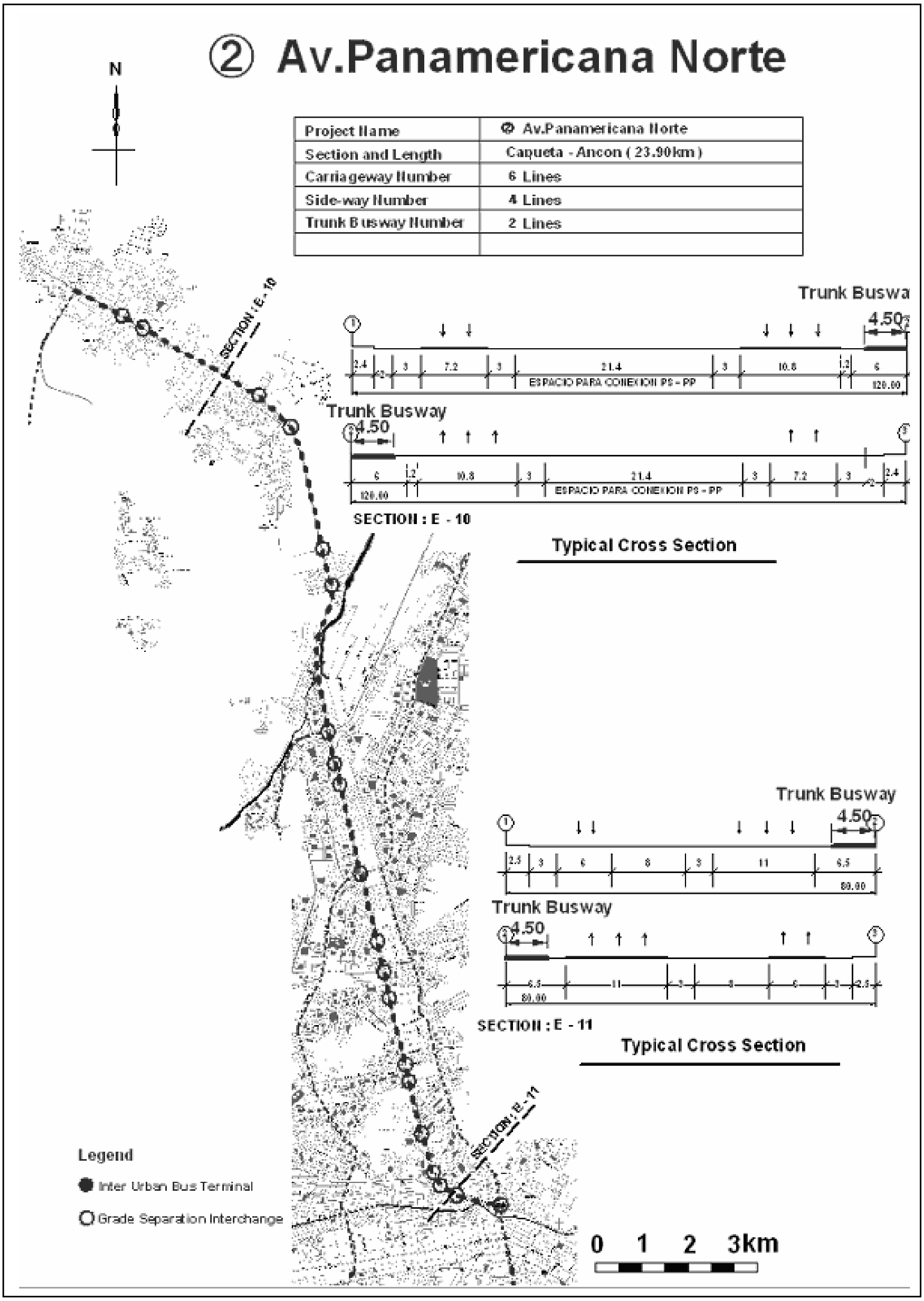


Figure 14.7-6 Trunk Busway Av. Panamericana Norte

③ Av. Universitaria Norte

Project Name	③ Av. Universitaria Norte
Section and Length	Metropolitana - Manuel Prado (7.27km)
Carriageway Number	4 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines

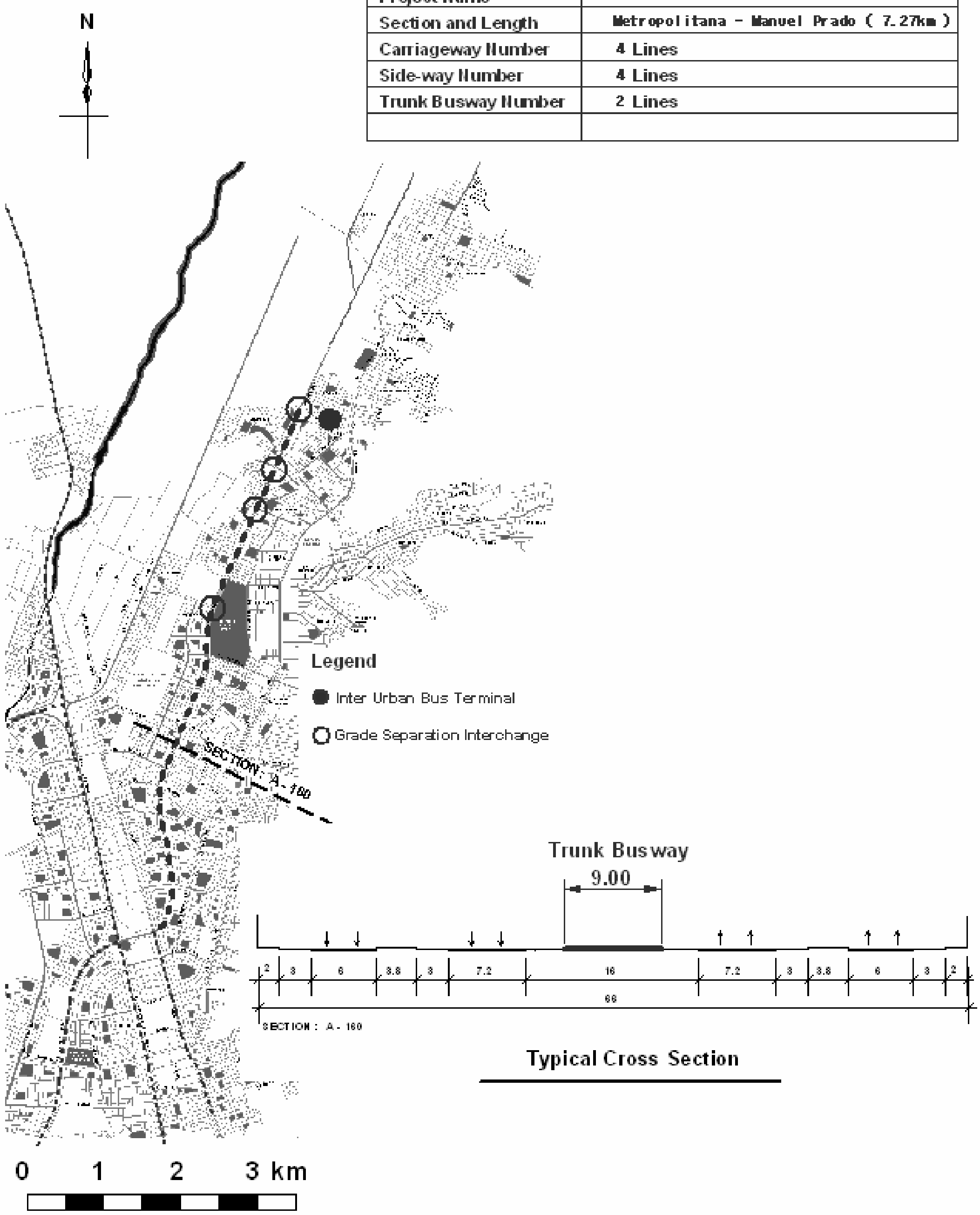


Figure 14.7-7 Trunk Busway Av. Universitaria Norte

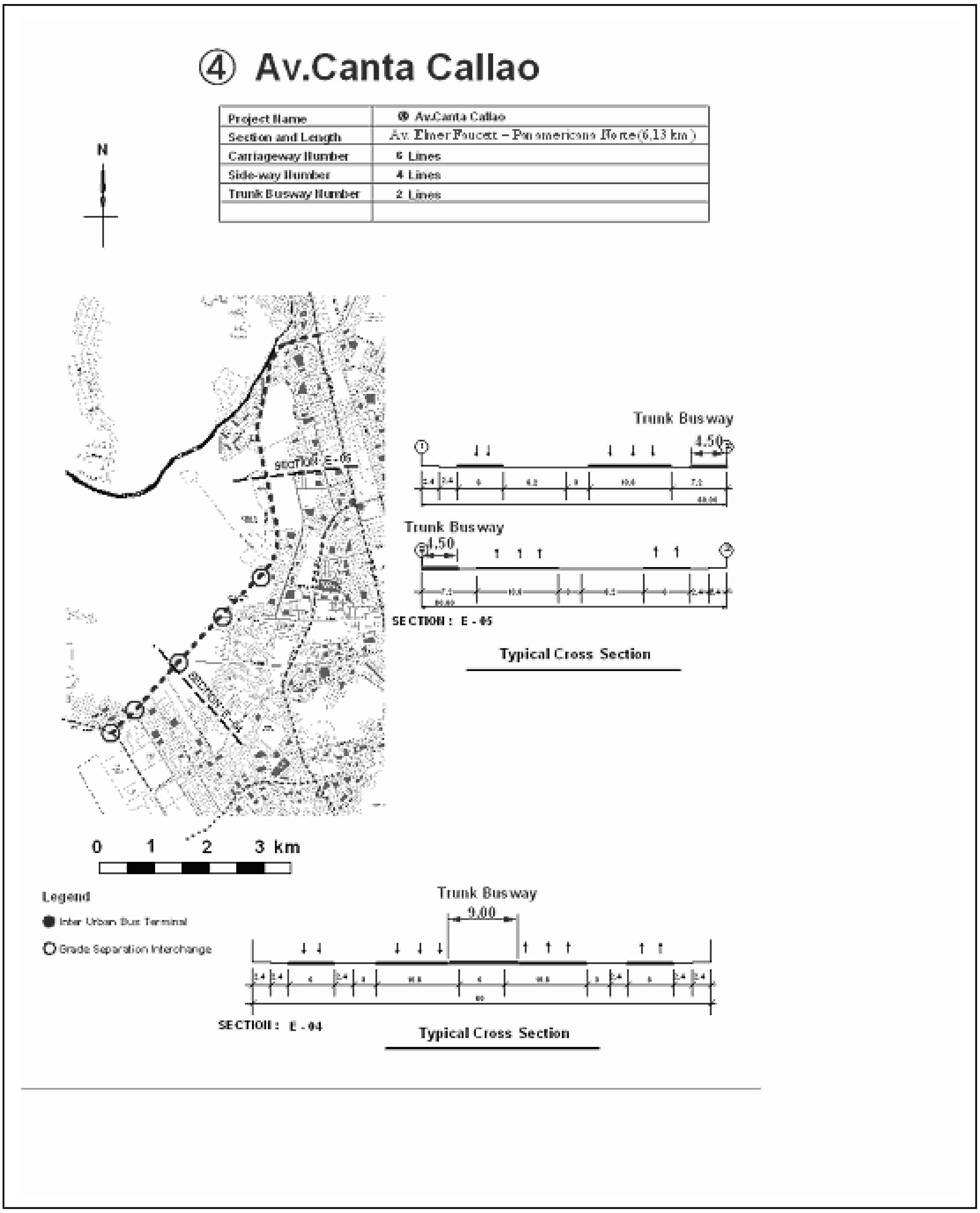
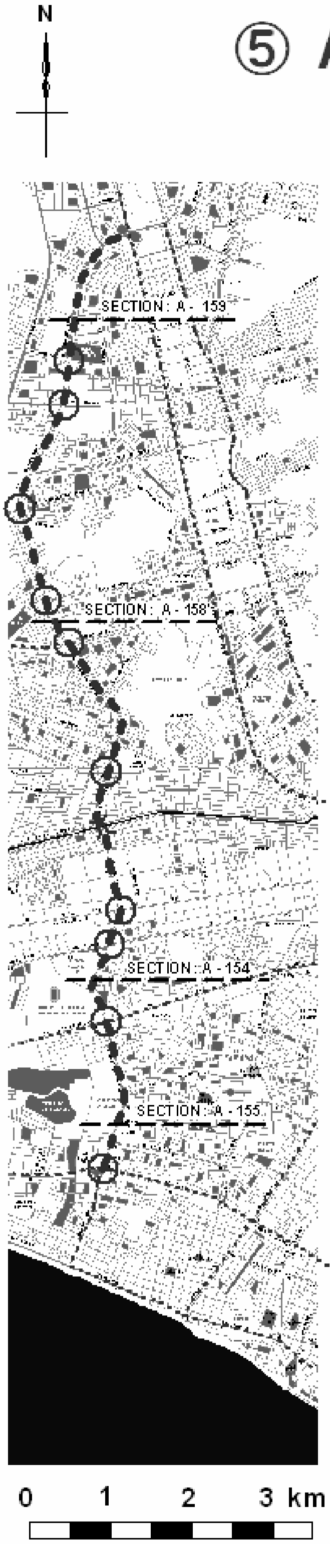
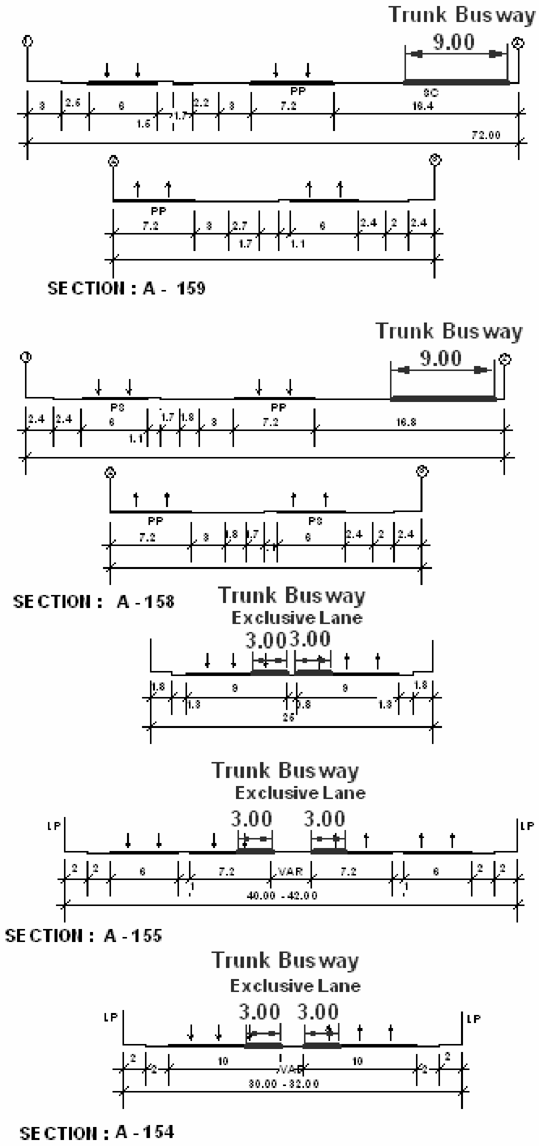


Figure 14.7-8 Trunk Busway Av. Canta Callao

⑤ Av.Universitaria

Project Name	⑤ Av.Universitaria
Section and Length	La Marina – Panamericana Norte (12.66km)
Carriageway Number	6 Lines / 4Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines / Exclusive Lanes





Typical Cross Section

Legend
● Inter Urban Bus Terminal
○ Grade Separation Interchange

Figure 14.7-9 Trunk Busway Av. Universitaria

⑥ Av.Tomas Valle

Project Name	⑥ Av.Tomas Valle
Section and Length	Av. Elmer Faucett – Av. Universitaria (2.84 km)
Carriageway Number	6 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines

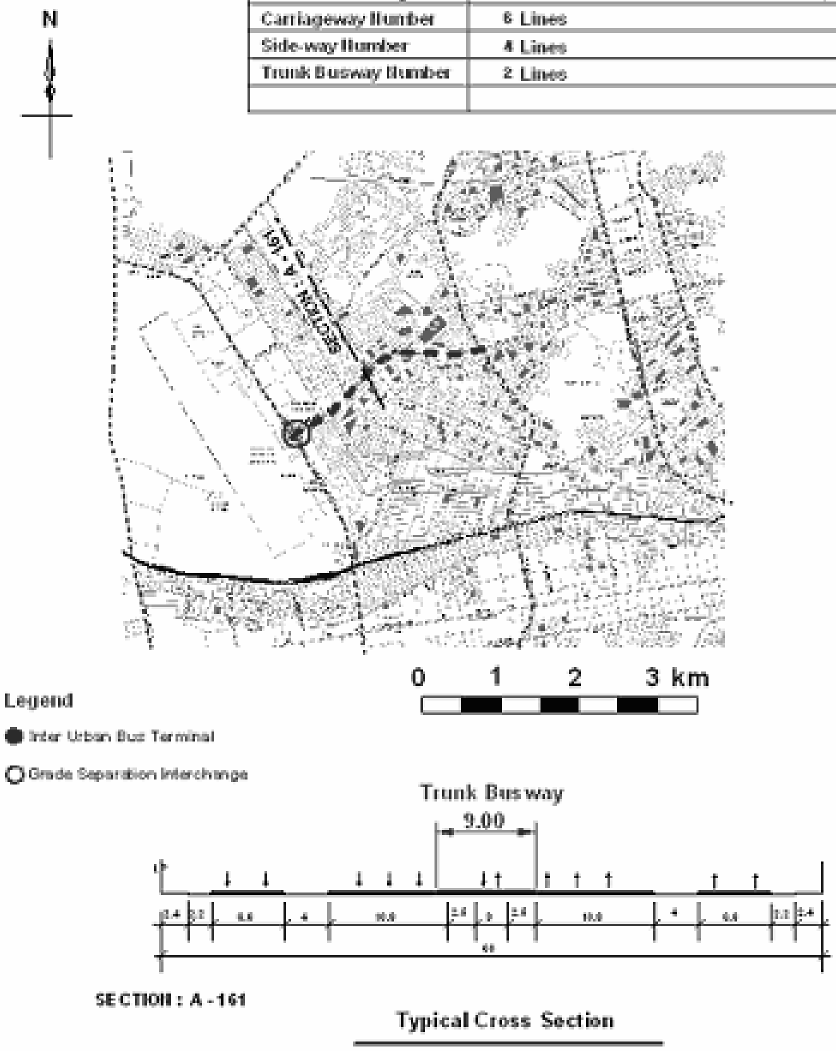
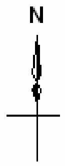
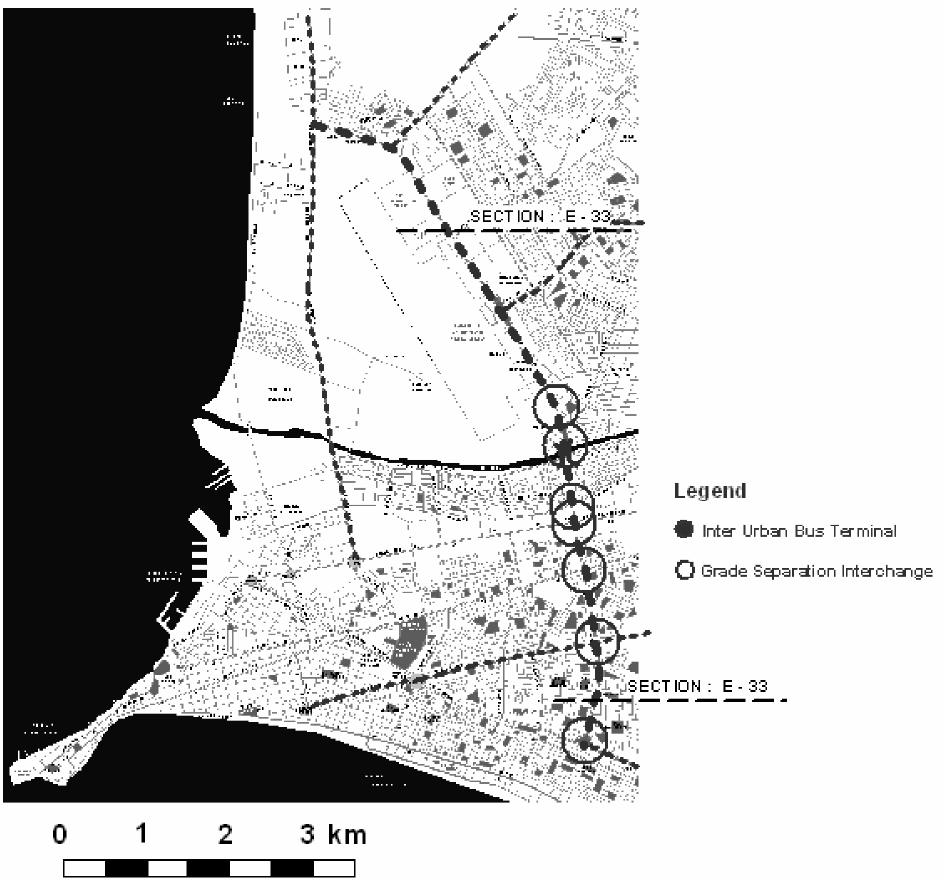


Figure 14.7-10 Trunk Busway Av. Tomas Valle

⑦ Av.Elmer Faucett



Project Name	⑦ Av.Elmer Faucett
Section and Length	Av.La Marina - Av.Nestor Gambetta (8.81km)
Carriageway Number	6 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines



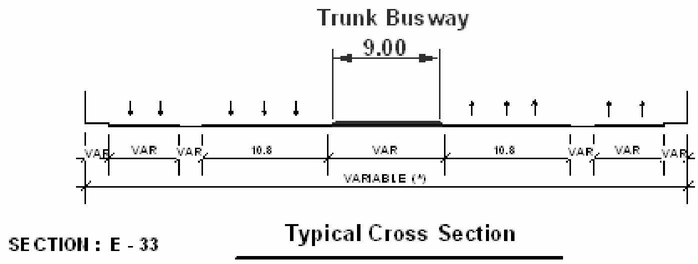


Figure 14.7-11 Trunk Busway Av. Elmer Faucett

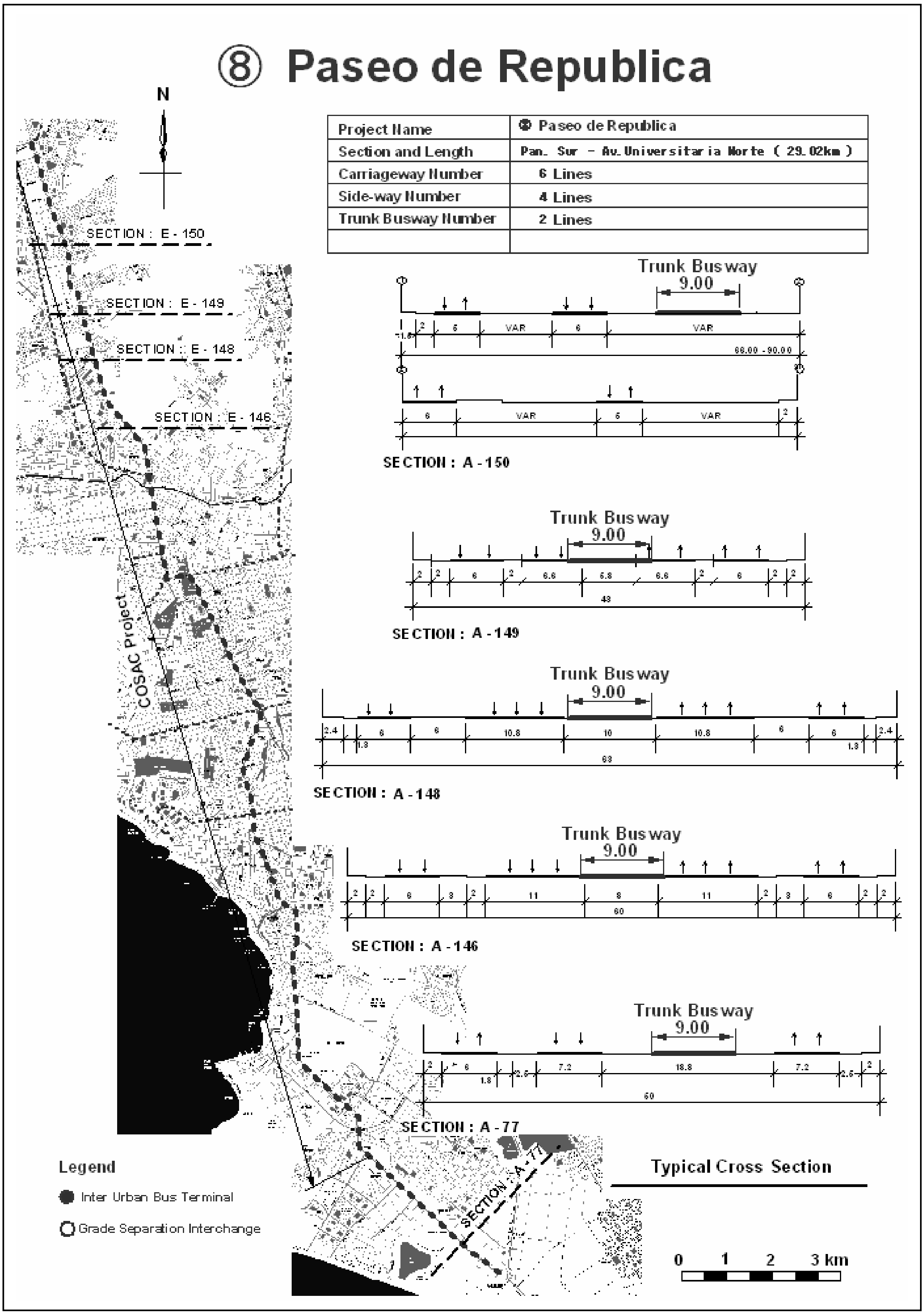


Figure 14.7-12 Trunk Busway Paseo de la República

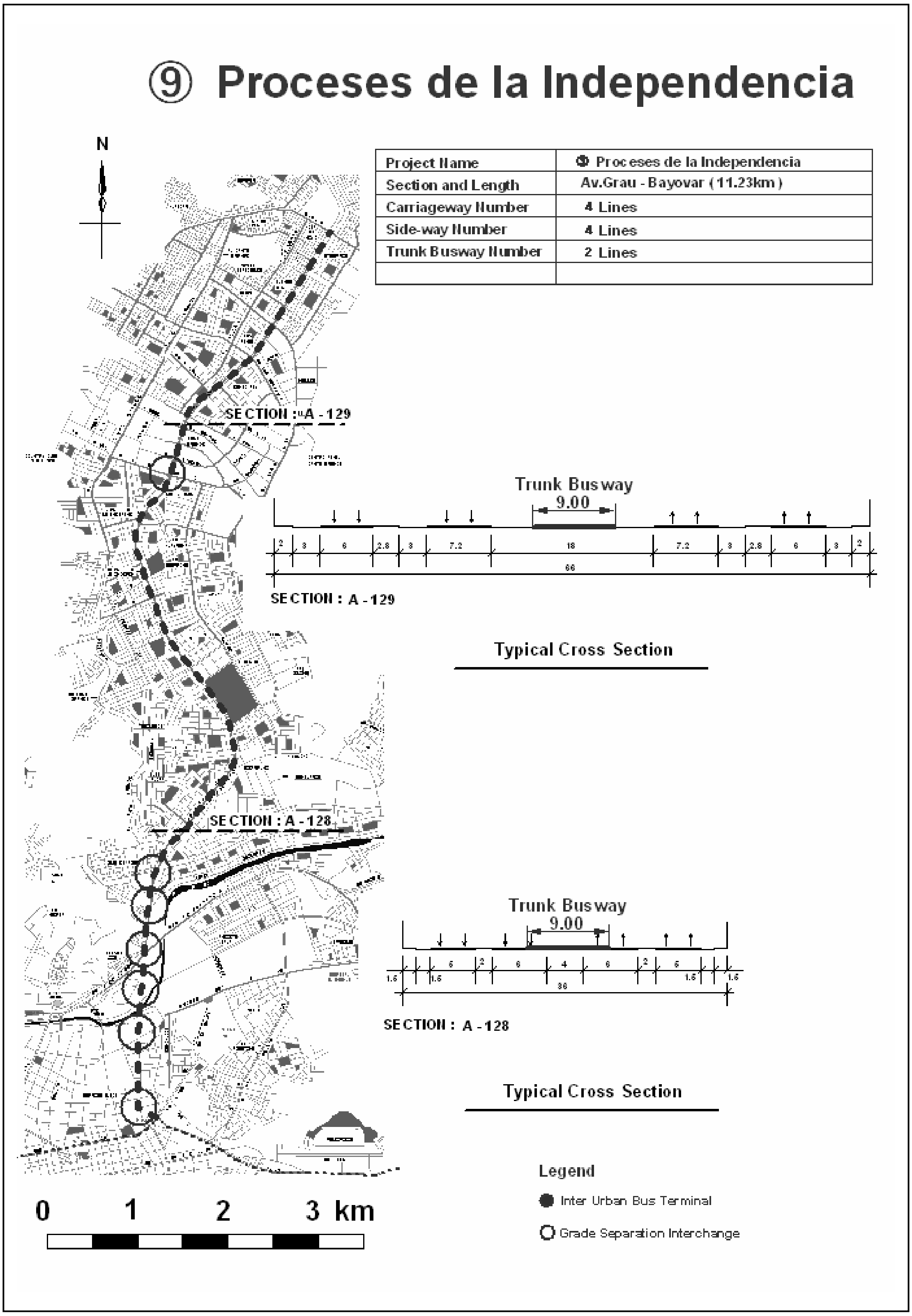


Figure 14.7-13 Trunk Busway Próceres de la Independencia

⑩ Av. Venezuela

Project Name	● Av. Venezuela
Section and Length	Ovalo Saloom –Av. Alfonso Ugarte(8.49 km)
Carriageway Number	6 Lines
Side-way Number	
Trunk Busway Number	2 Lines

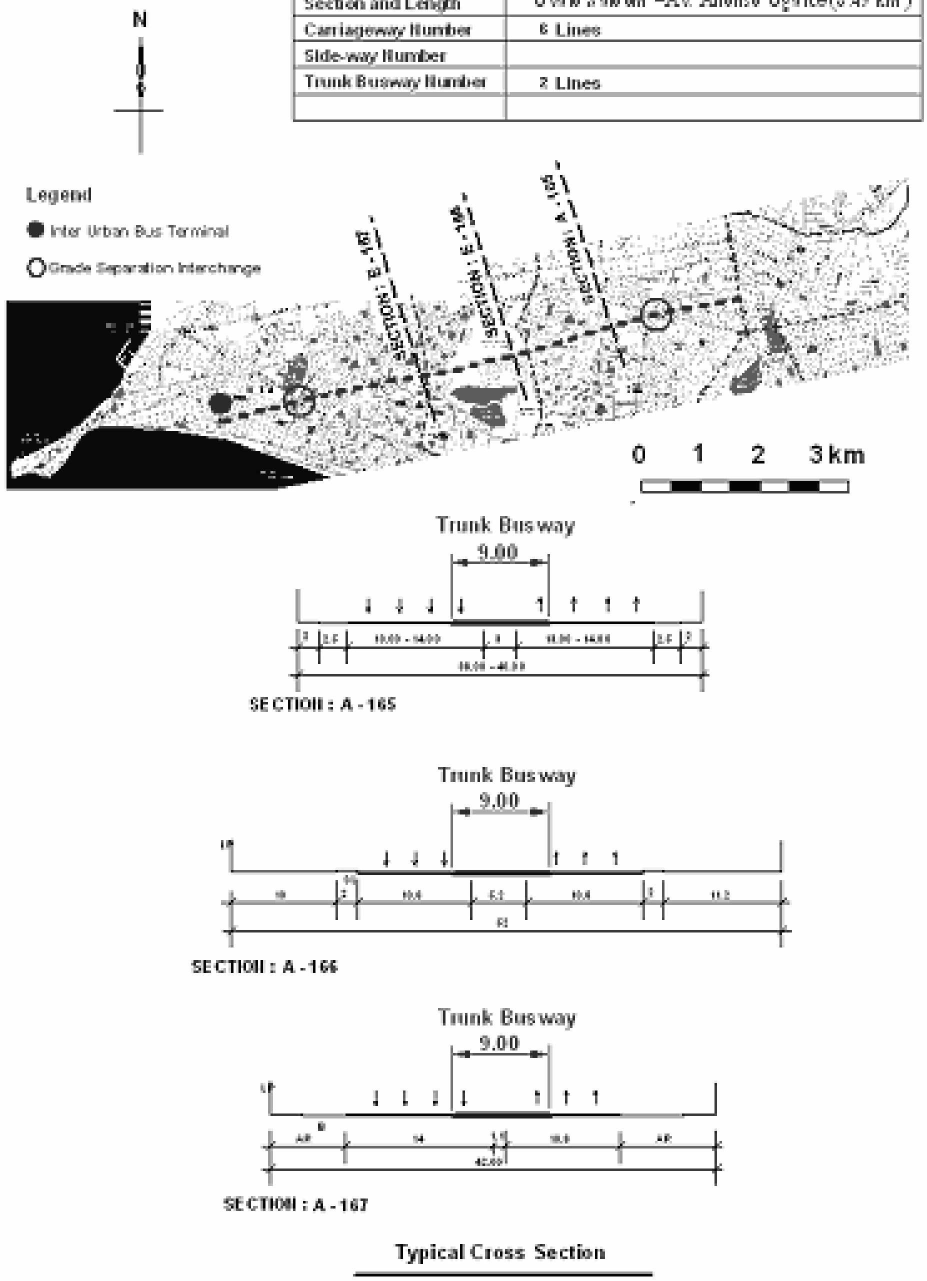
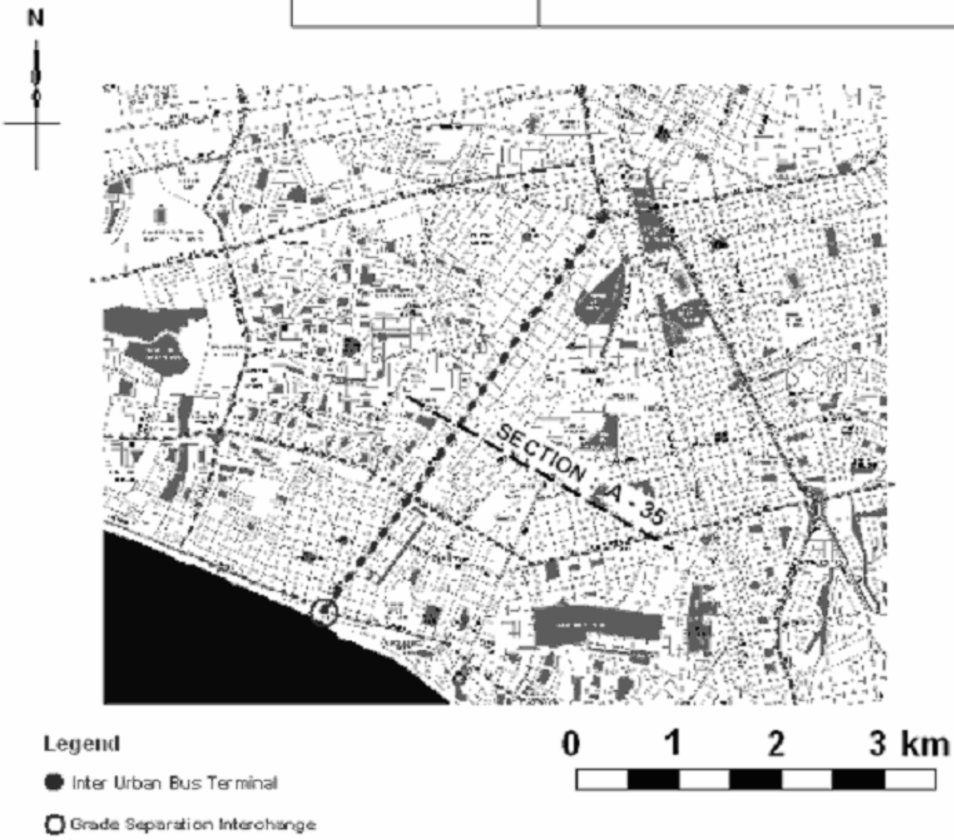


Figure 14.7-14 Trunk Busway Av. Venezuela

⑪ Av.Brasil

Project Name	Av.Brasil
Section and Length	Av. Del Ejercito – Plaza Bolognesi (5.12 km)
Carriageway Number	4 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines



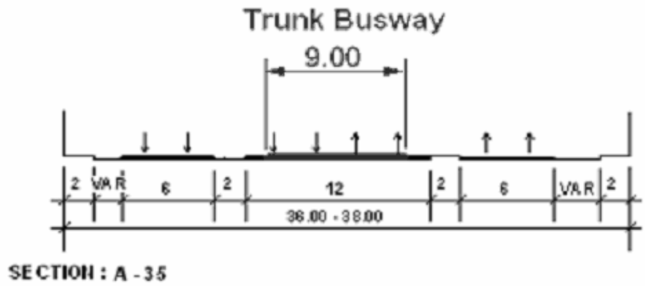


Figure 14.7-15 Trunk Busway Av. Brasil

⑫ Av.Javier Prado

Project Name	⑫ Av.Javier Prado
Section and Length	Av.Elmer Faucett - Av.Carretera Central (21.07km)
Carriageway Number	6 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines

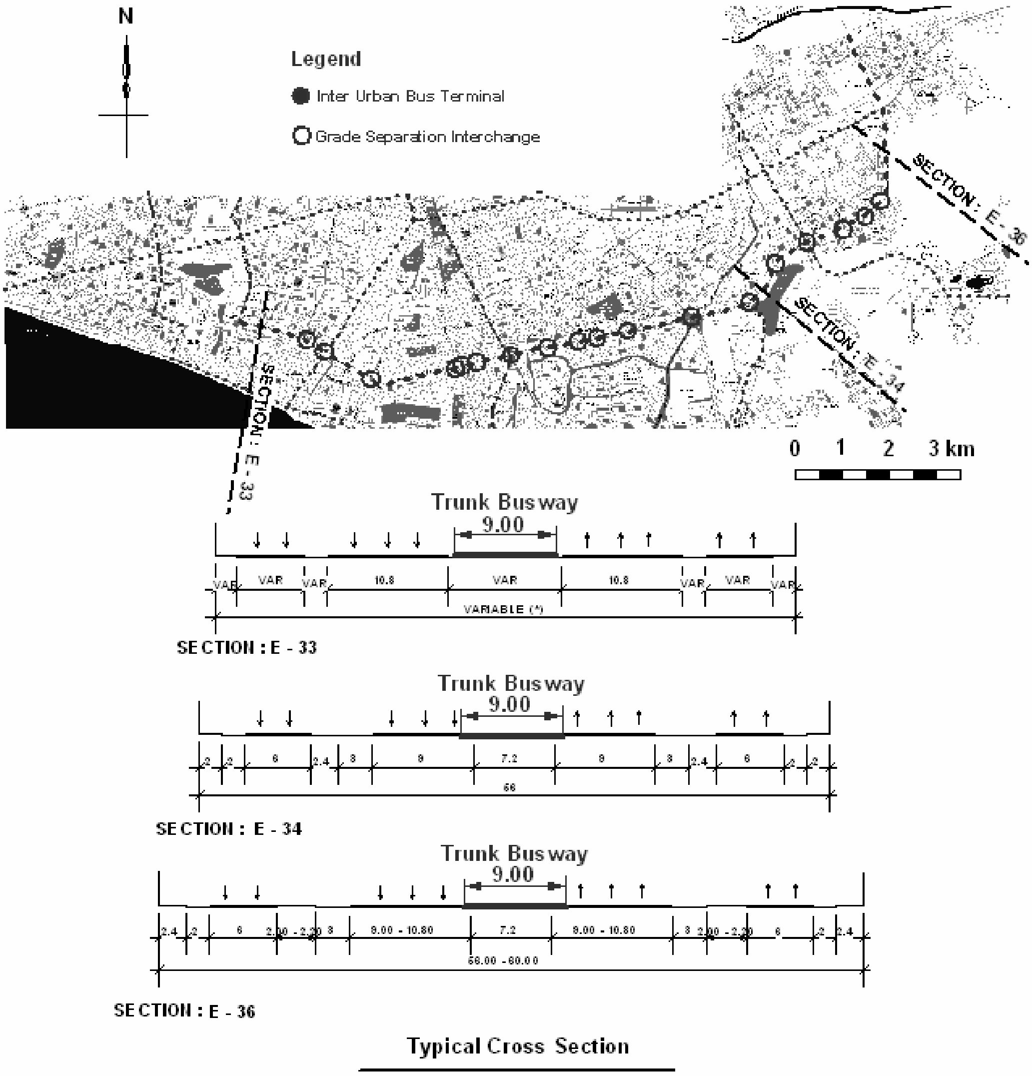


Figure 14.7-16 Trunk Busway Av. Javier Prado

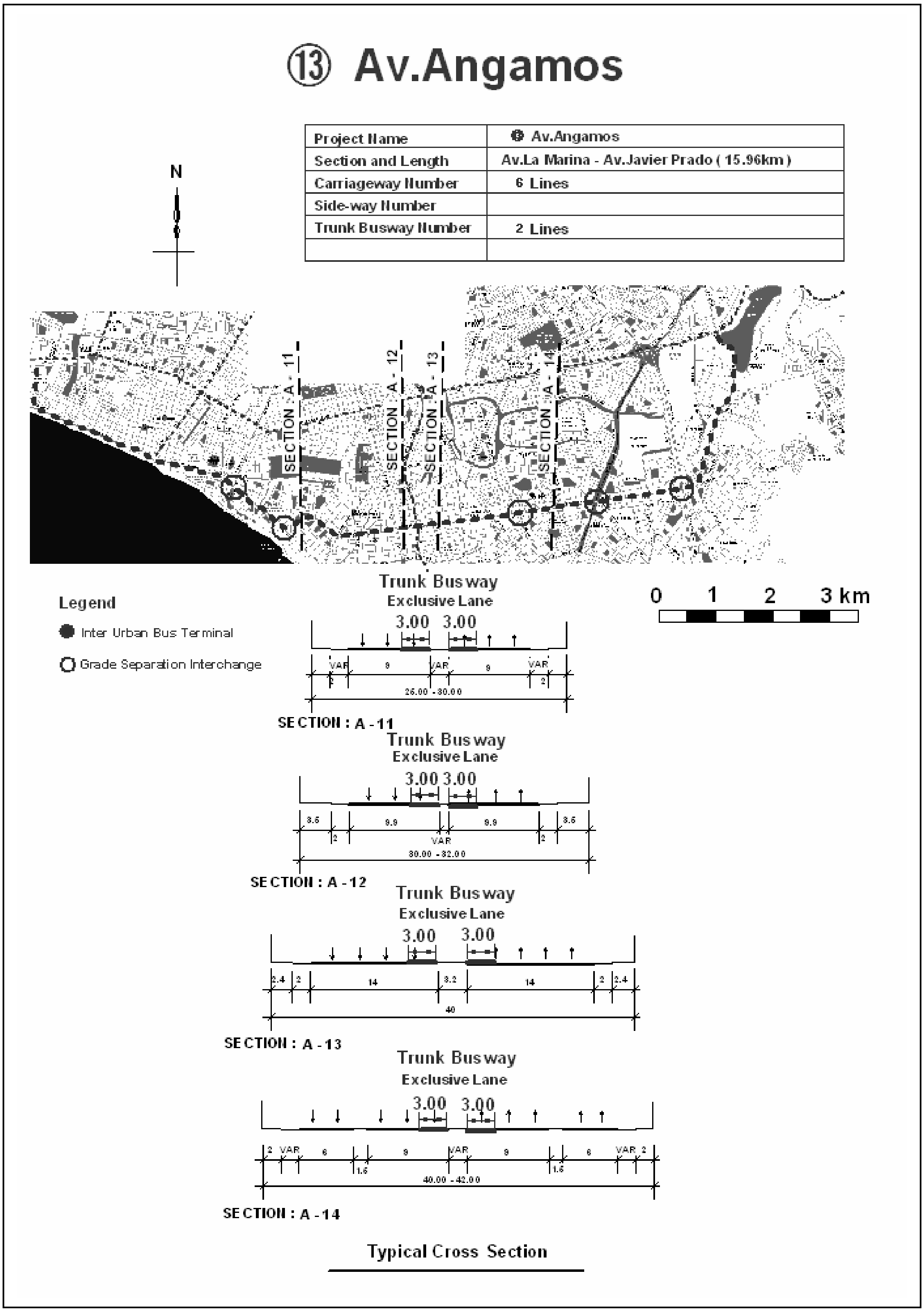
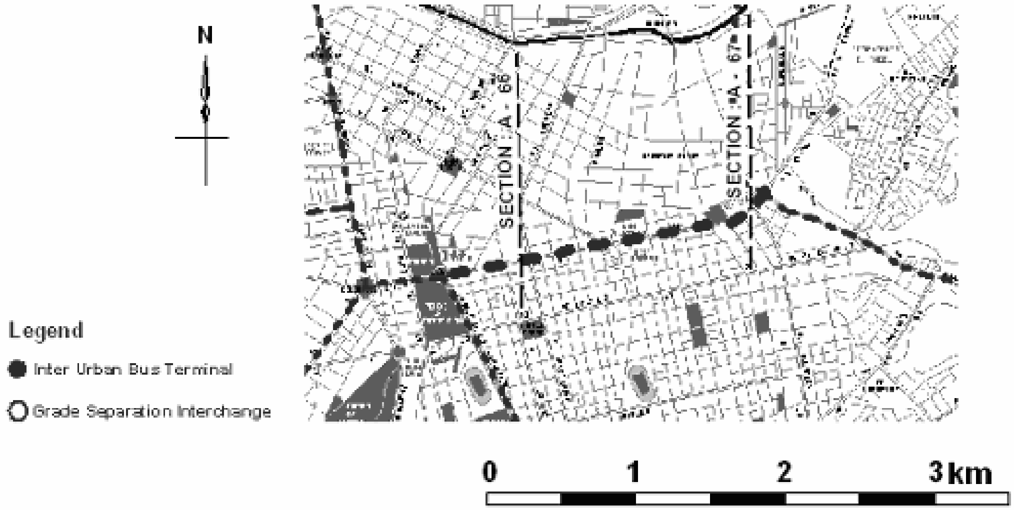


Figure 14.7-17 Trunk Busway Av. Angamos

⑭ Av.Grau

Project Name	❶ Av.Grau
Section and Length	Paseo de la Republica Av. Nicolas Ayllón (2.52 km)
Carriageway Number	6 Lines
Side-way Number	6 Lines
Trunk Busway Number	2 Lines / Exclusive Lanes



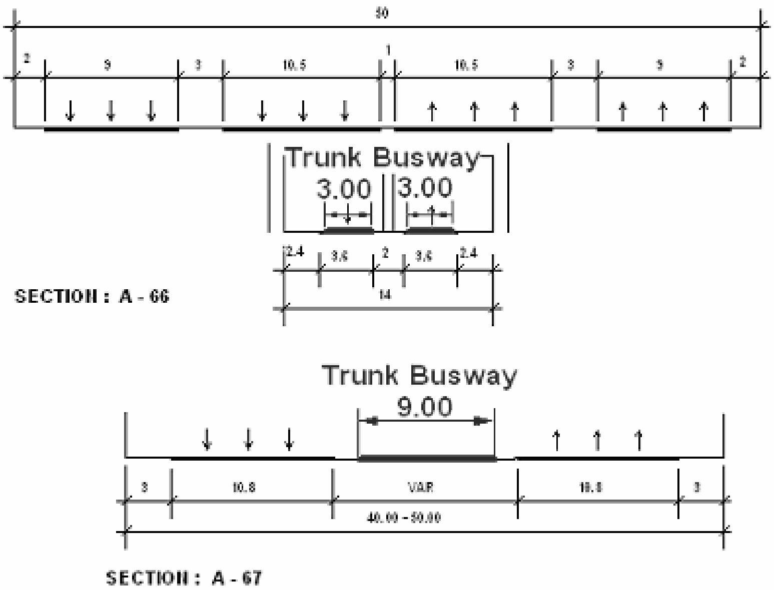
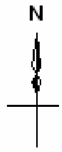
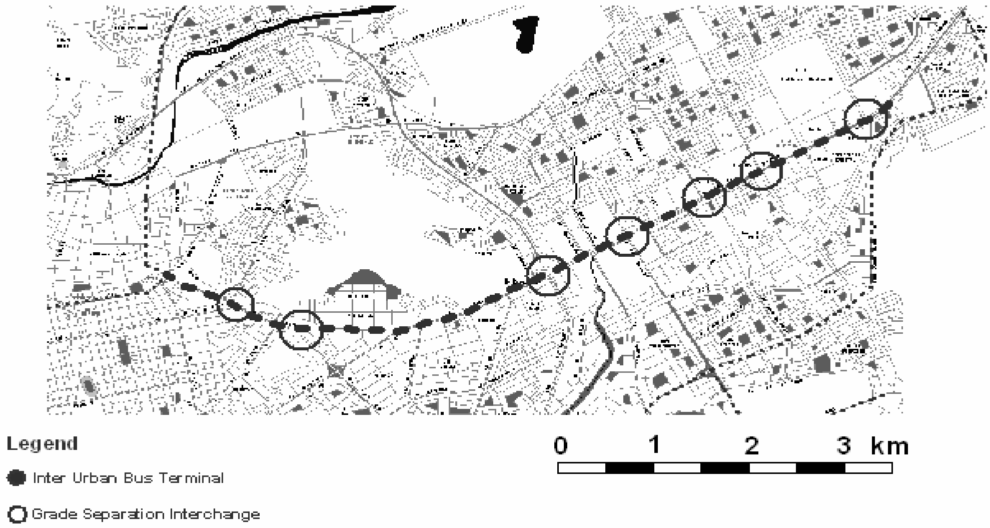


Figure 14.7-18 Trunk Busway Av. Grau

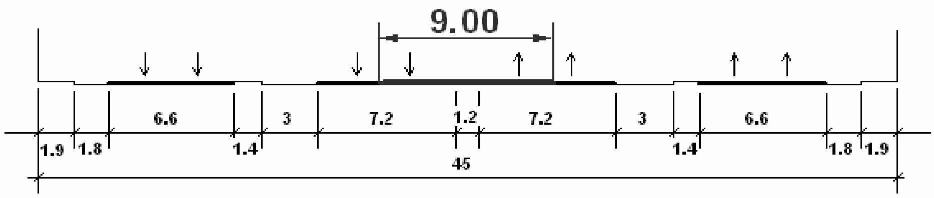
⑮ Carretera Central



Project Name	⑮ Carretera Central
Section and Length	Av.Grau - Av. Haya de La Torre (8.36km)
Carriageway Number	4 Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines



Trunk Busway



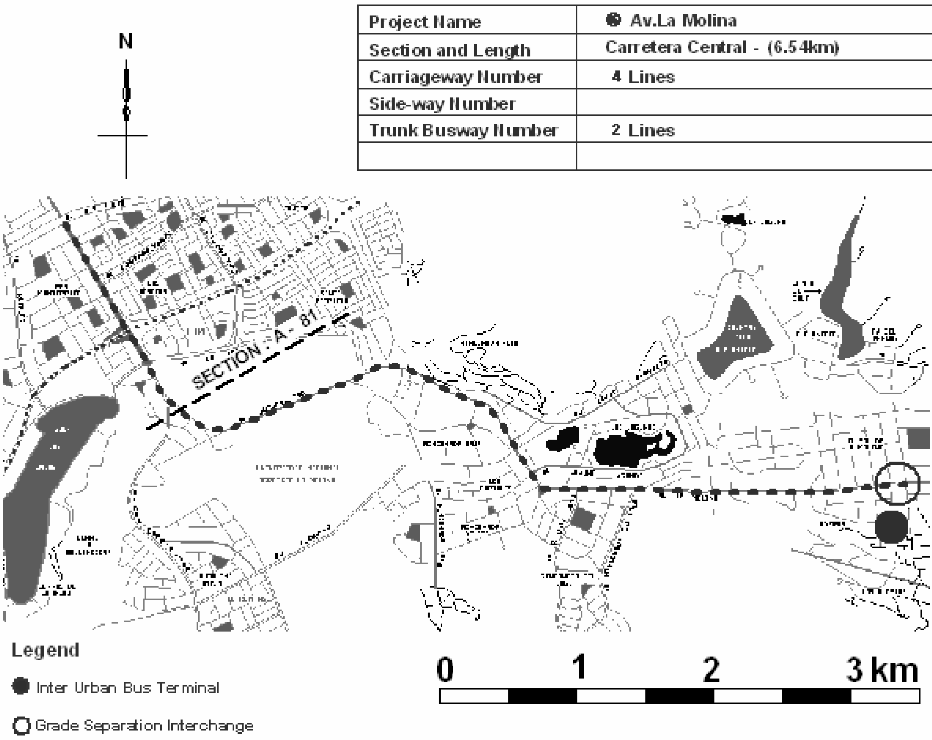
SECTION : A - 40

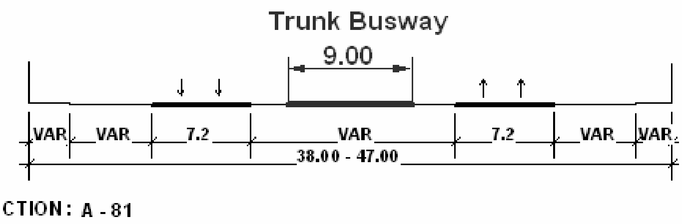
Typical Cross Section

Figure 14.7-19 Trunk Busway Carretera Central

⑯ Av.La Molina

Project Name	● Av.La Molina
Section and Length	Carretera Central - (6.54km)
Carriageway Number	4 Lines
Side-way Number	
Trunk Busway Number	2 Lines





Typical Cross Section

Figure 14.7-20 Trunk Busway Av. La Molina

⑰ Av.Panamericana Sur

Project Name	⑰ Av.Panamericana Sur
Section and Length	Puente del Ejercito – Puente Villa/Av. Huaylas
Carriageway Number	6 Lines / 4Lines
Side-way Number	4 Lines
Trunk Busway Number	2 Lines

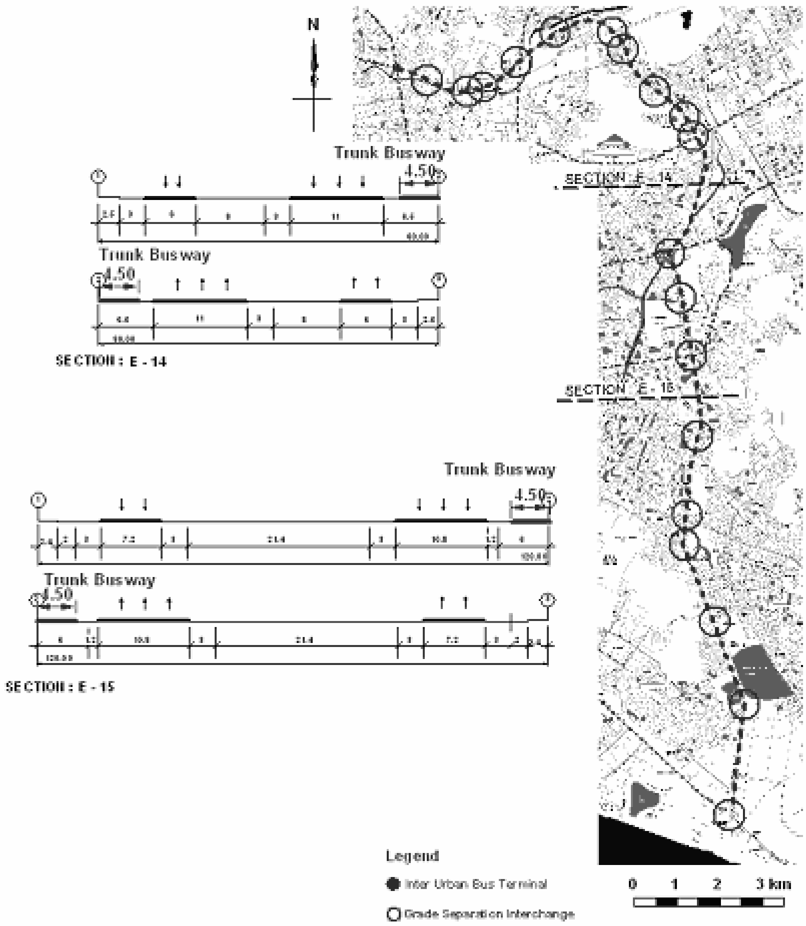


Figure 14.7-21 Trunk Busway Av. Panamericana Sur

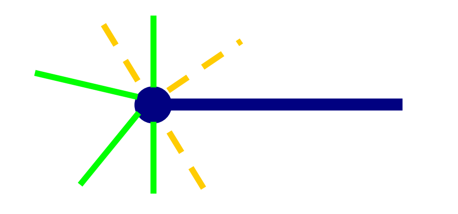
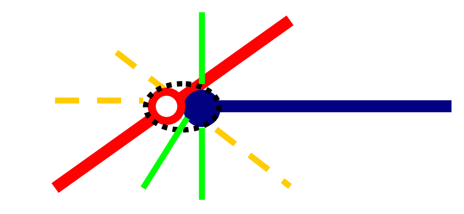
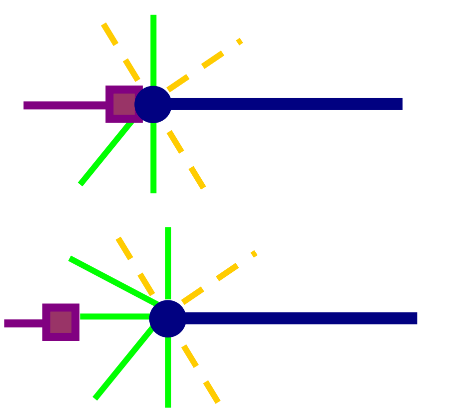
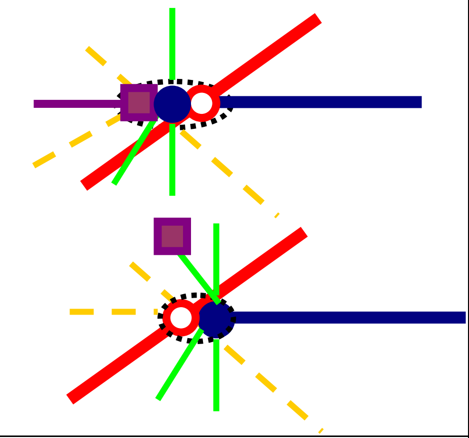
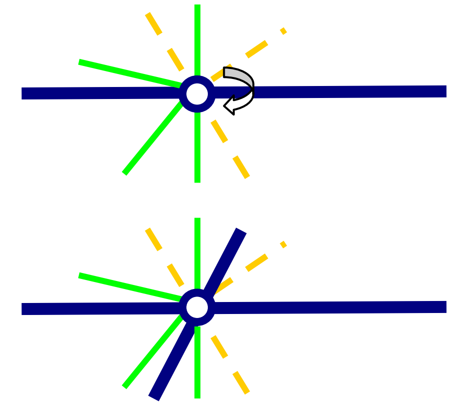
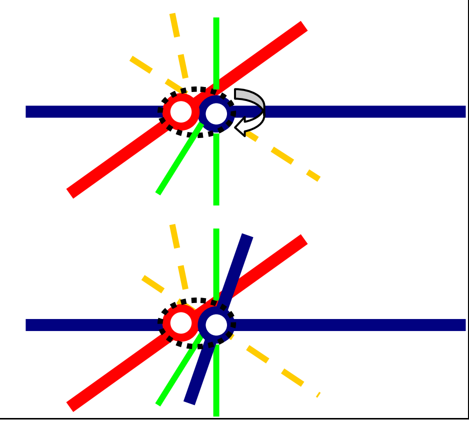
14.8. BUS FACILITIES

14.8.1. Importance of Transfer Facilities

According to restructuring of bus system with trunk bus – feeder bus, transfer between trunk buses and ordinary buses (feeder bus and conventional bus) will increase. The transfer should be safe, smooth, quick, comfortable, cheap and convenient for every passenger and user. Otherwise the passengers will not enjoy using the new trunk bus system.

14.8.2. Type of Bus Facilities

Bus facilities are classified into the following types, with emphasis on the transfer between trunk bus – feeder bus and trunk bus – railway. The terminal will be at the ends of a route and the station will be on a route. Both the terminal and the station will have integrated transfer systems with trunk bus and feeder bus inside the platform (inside the ticket gate). The busway stop will not have a feeder bus transfer. The stops of conventional buses should be conveniently located around the terminals and stations.

	Without Railway Station	Connection with Railway Station
Busway Terminal		
Comprehensive Busway Terminal (with connection to a long distance bus terminal: by feeder bus / shuttle bus or pedestrian way)		
Busway Station A: U-turn of trunk bus B: Connection of 2 routes of trunk buses C: Connection between busway and railway	Busway Station A, B 	Busway Station C 

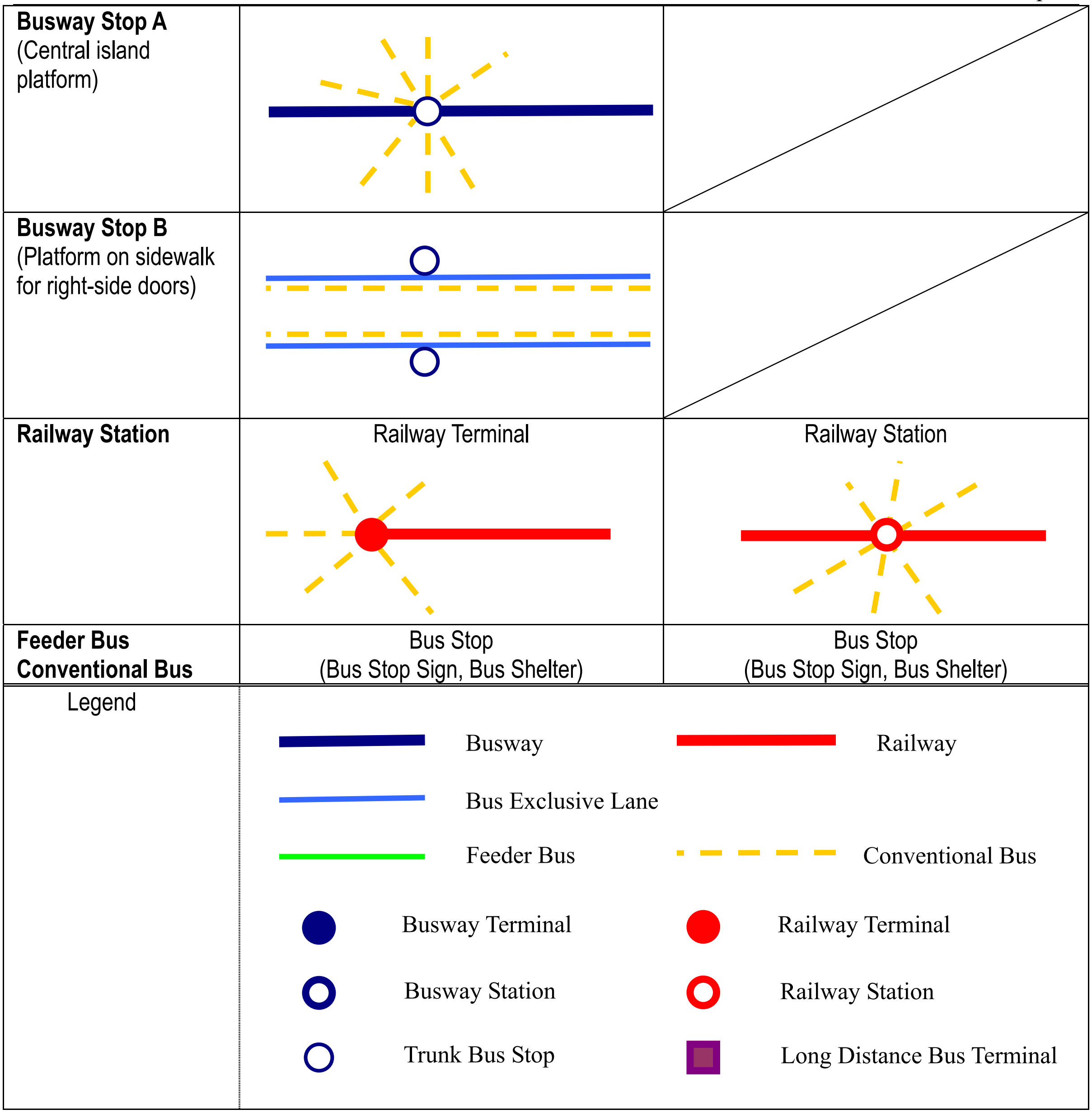


Figure 14.8-1 Types of Terminals, Stations and Busway Stops

14.8.3. Location of Bus Facilities

The location of busway terminals/stations, railway terminals/stations and long distance bus terminals is shown in the following figure with the condition of mutual connections. The busway stops will be provided at intervals of about 800m (500m~1000m) at major crossings on the busway.

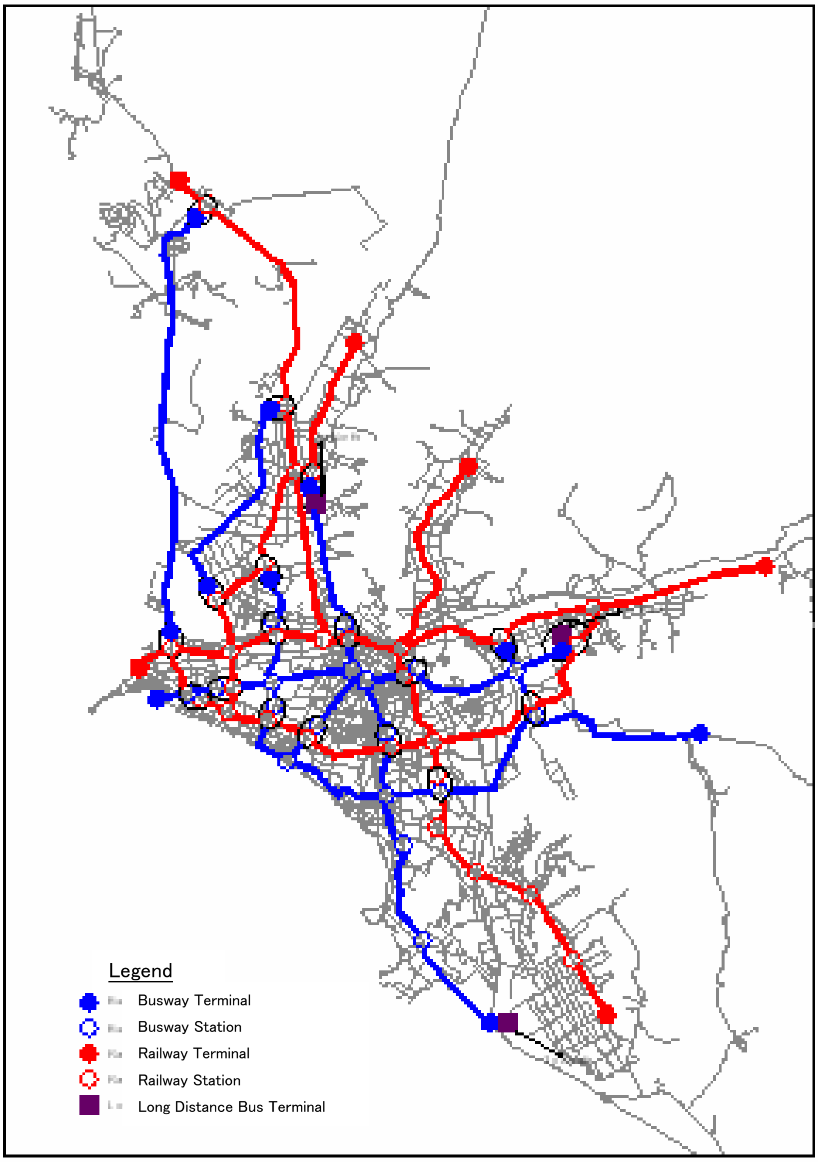


Figure 14.8-2 Location of Terminals and Stations

14.8.4. Design Concept of Busway Facility

In view of the requirement for the transfer facility and increase of amenity and attractiveness, the following design concept is proposed:

a) **Safety**: Grade separation of passengers and buses, handrails etc.
b) **Low fare:** Integrated fare with trunk bus and feeder bus, income from lease and advertisement etc.
c) **Quick and efficient**: Short distance for the transfer, etc.
d) **Universal design:** Barrier-free for everyone including the mobility impaired, aged and children; that is also necessary for smooth movement and use by all passengers.
e) **Convenient**: Facilities for the passengers should be provided such as kiosks, benches, information and bicycle parking etc.
f) **Sustainable:** Easy operation and maintenance
g) **Urban development**: The area around the facility should be developed with commercial, business and cultural facilities, etc. taking advantage of large people flows. Such buildings should have parking and elevators etc. and be connected with the station by a pedestrian bridge.

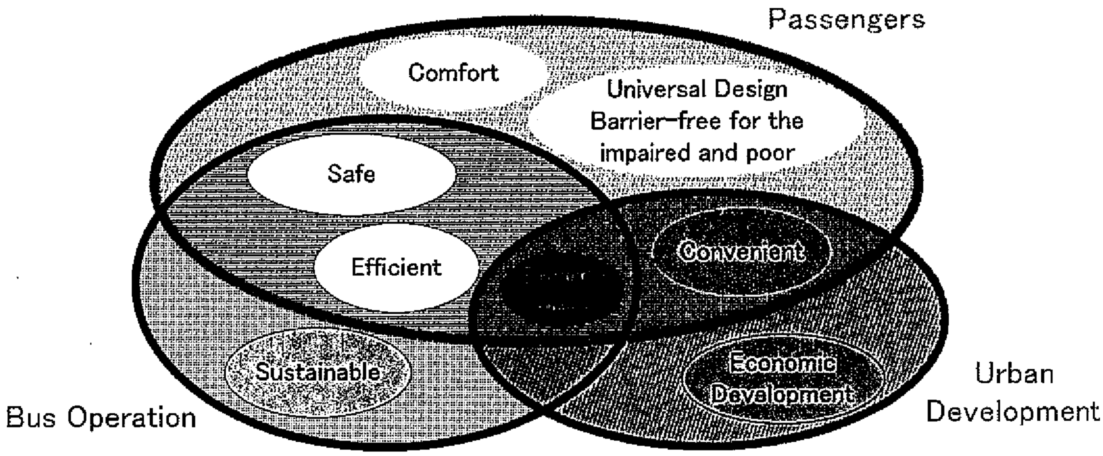


Figure 14.8-3 Design Concept for Busway Facility

14.8.5. Plan of Busway Facilities

The terminals are at the ends of a route and the stations are on a route. The busway terminal and the busway station will provide integrated transfer between the trunk buses and the feeder buses. There is no essential difference in functions between the terminal and the station. The busway stops will be prepared on a route but not integrated with feeder buses.

The design of the busway facility depends on the type of trunk bus introduced; size of body, location of doors and height of floor etc. Here following the preceding COSAC, the trunk bus is assumed to be an articulated bus with left side doors and the floor level 90cm above the ground. Thus the platform should be central island type with a height of 90cm. The island type platform has the advantage of using the area for both morning and evening rush hours. It should not be less than 4m wide. The ticket gates and ticket window will be provided before the platform. The facilities for passengers such as kiosks, cafeteria, toilets, bicycle parking will be prepared according to requirements and site availability. In order to ensure safety, grade separation of passengers and buses/vehicles by means of a pedestrian bridge should be provided. As most passengers would dislike long slope, stairs and elevators should be provided to the pedestrian bridges. Elevators might be added later, the space for which should be allocated from the initial design.

(1) Busway Terminal (without Long Distance Bus Terminal)

There are 11 busway terminals in the master plan Alternative O2, of which 8 terminals will not be connected with the long distance bus terminal.

(2) Comprehensive Bus Terminal (with Long Distance Bus Terminal)

For passengers' convenience, the long distance bus terminal should be connected with the busway terminal or the railway station. Preferably they should be constructed in the same site and be joined by a pedestrian way.

CEPRI has a concession project for the development of long distance (inter-provincial) bus terminals, however the location of the site has not been decided but the zoning has been recommended. It also might not coincide with the location proposed in this study, partly because of differences in the preconditions.

In case the project for the long distance bus terminal proceeds, the site would be different from the busway terminal site. This might occur due to different site acquisition. In this case connection by feeder bus or shuttle bus may be a solution.

The following 3 comprehensive bus terminals are proposed according to the 3 main routes to north, east and south to receive long distance buses before they enter the city center.

1) North Comprehensive Bus Terminal

The proposed site is near the intersection of Av. Tupac Amaru and Av. Naranjal. The busway terminal on Av. Tupac Amaru, the railway station on Av. Naranjal, the long distance bus terminal and the large-scale commercial development will be connected by pedestrian bridges. An alternative idea is a terminal building at the corner of the block with the long distance bus terminal on the first floor, busway terminal on the second floor and the railway station on the third floor.

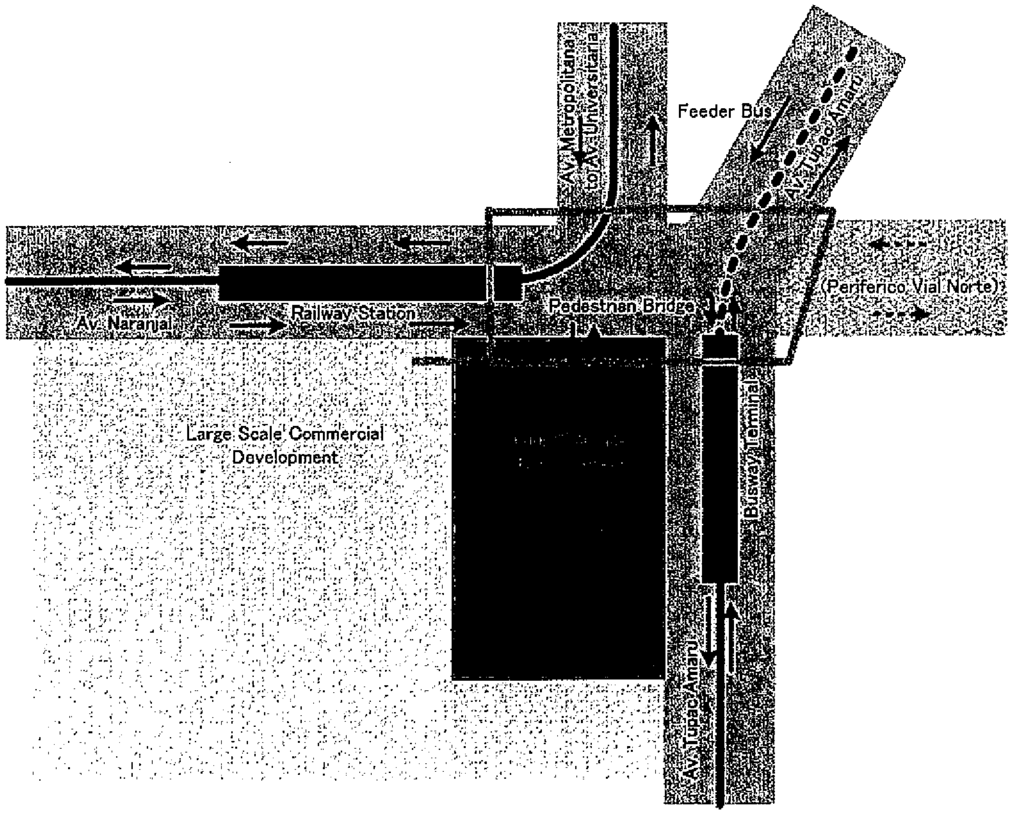


Figure 14.8-4 Conceptual Location of North Comprehensive Bus Terminal

2) East Comprehensive Bus Terminal

The proposed site is near the intersection of Av. N. Ayllon and Av. Separadora Industrial. The busway terminal on Av. N. Ayllon, the railway station on Av. Separadora Industrial, the long distance bus terminal and the wholesale market development will be connected by pedestrian bridges. An alternative idea is a terminal building at the corner of the block with the long distance bus terminal on the first floor, busway terminal on the second floor and the railway station on the third floor.

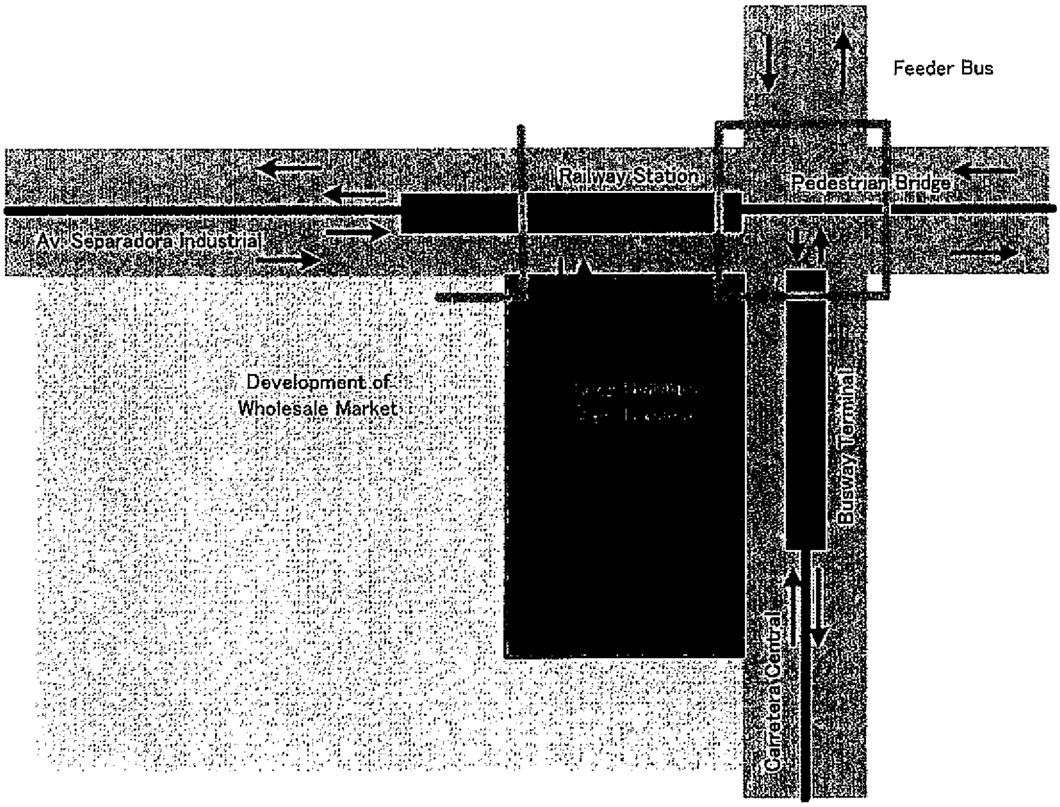


Figure 14.8-5 Conceptual Location of East Comprehensive Bus Terminal

3) South Comprehensive Bus Terminal

The proposed site is near the intersection of Av. Pan-Americana and Av. Huaylas, or to the east of Av. Huaylas. The busway terminal and the long distance bus terminal will be connected by a pedestrian deck. The busway route of COSAC will be extended to this location, where it would be advantageous to receive the feeder buses from Villa El Salvador.

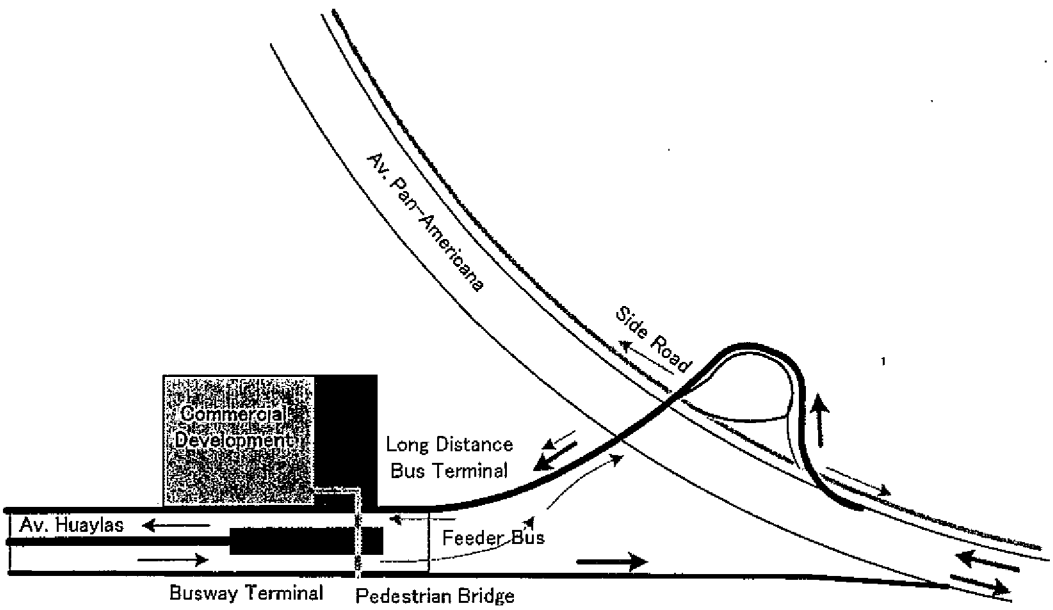


Figure 14.8-6 Conceptual Location of South Comprehensive Bus Terminal

(3) Busway Station

1) Busway Station A (Trunk Bus ↔ Feeder Bus)

The platform will be sided by inbound trunk bus berths and descending feeder bus berths, and by outbound trunk bus berths and boarding feeder bus berths for easy transfer. The level of the platform will be 90cm higher than the trunk bus road and 20cm higher than the feeder bus road (see an example of road level difference of the terminal in Santa Fe de Bogotá in Colombia).

2) Busway Station B (Trunk Bus ↔ Trunk Bus ↔ Feeder Bus)

This station is integration of the above station and other busway stop.

3) Busway Station C (Trunk Bus ↔ Trunk Bus)

This station is only a connection of 2 busway stops without transfer of feeder buses.

(4) Busway Station / Terminal Connection with Railway Station / Terminal

Trunk bus and railway will not have an integrated ticket system due to the difference in organization. They should have their own ticket gates. But the transfer should be easy and safe. The busway station and railway station should be directly connected by pedestrian bridges.

(5) Busway Stop

The busway stop will be of the central island platform type with ticket gates. In principle, the station should be connected by a pedestrian bridge with stairs and elevators. Slope and pedestrian crossing would be provided for at grade type. (See an example of a busway stop of central island platform at grade type in Santa Fe de Bogotá in Colombia)

(6) Bus Stop (Ordinary bus, Feeder bus)

At least the signpost with necessary information [name of stop, name of route, destination, fare, related bus route, time table (at least starting and terminating time, major interval), contact telephone number and address] and lighting should be provided. Bus shelters with benches, information and advertisement should be prepared at major stops.

14.8.6. PASSENGER FACILITIES IN BUSWAY TERMINAL / STATION

The following functions are expected for the busway terminals, stations and stops:

a) Efficient and convenient transfer between the trunk bus and the feeder bus (free transfer)
b) Collection of bus fare from entering passengers and sales of tickets
c) Safety of passengers
d) Smooth driving and stopping of buses
e) Parking of buses for adjustment of time and rest of drivers
f) Administration of bus operation
g) Consideration for use by people with a mobility impairment (elderly people with walking sticks, wheelchair etc.)
h) Amenity in use (bench, floor finish design, design of signs, design of architecture,

toilets, parking for bicycles etc.)

i) Passengers' convenience (shop, coffee shop, information, lottery, recycling commission space, exhibition space etc.)

j) Contribution to urban development (commercial, business, cultural, public services etc.)

Based on the above functions, the following facilities will be required for the busway terminals, stations and stops.

Table 14.8-1 Facilities in the busway terminals, stations and stops

Facilities	Busway Terminal	Comprehensive Bus Terminal	Busway Station	Busway Stop	Remarks
Platform					Roof, fence / panel, floor
Trunk Bus only	△	△	△	○	
Trunk/Feeder bus	○	○	○		Integrated transfer
Conventional bus	Connection	Connection	Connection	Connection	Should be located in the vicinity
Railway	Connection	Connection	Connection	Connection	Connection should be designed
Long distance bus		Connection			Connection should be designed
Concourse/Passage	○	○	○	○	Minimum clearance width 2m, non-slippery floor finish, handrail
Ticket Gate	○	○	○	○	Depends on ticket system
Ticket Window/Office	○	○	○	○	At least one attended window
Information	○	○	○	○	Board, electronic screen etc.
Drivers' Room	○	○	○		Waiting, resting
Shop, Kiosk	○	○	○	○	Space leased
Shopping Arcade	○	○	○		Space leased
Cafeteria	○	○	○		Space leased
Bench	○	○	○	○	Space not to obstruct passengers traffic
Bus road	○	○	○	○	Road level should be adjusted
Bus parking	○	○	○		For time adjustment and rest
Taxi Stand	○	○	○		Parking and boarding for taxi
Porch (for private car)	○	○	○		Getting on and off
Bicycle Parking	○	○	○	○	It is necessary for bicycle use.
Car Parking	△	△			Large area considered
Toilet	○	○	△		Multi-purpose large toilet for wheelchair, handicapped with helper, family with small children etc. should be prepared.
Elevator	○	○	○	○	Space should be reserved from the initial design.

14.8.7. Model Plan of Busway Terminal/Station/Stop

(1) Busway Station of road center type

The busway station will be located in the center of the road directly leading to the busway. Two platforms will be provided in the direction of the route. The central area will be for the feeder buses. Alighting berths of feeder bus and inbound trunk bus berths should be paired and vice versa. Thus the distance for transfer will be minimal.

The ticket gates, office and concourse will be prepared on the second level connected with stairs and an elevator. The passengers will use a pedestrian bridge open to the public.

Direct connection to neighboring buildings will be considered both for the convenience of passengers and the building.

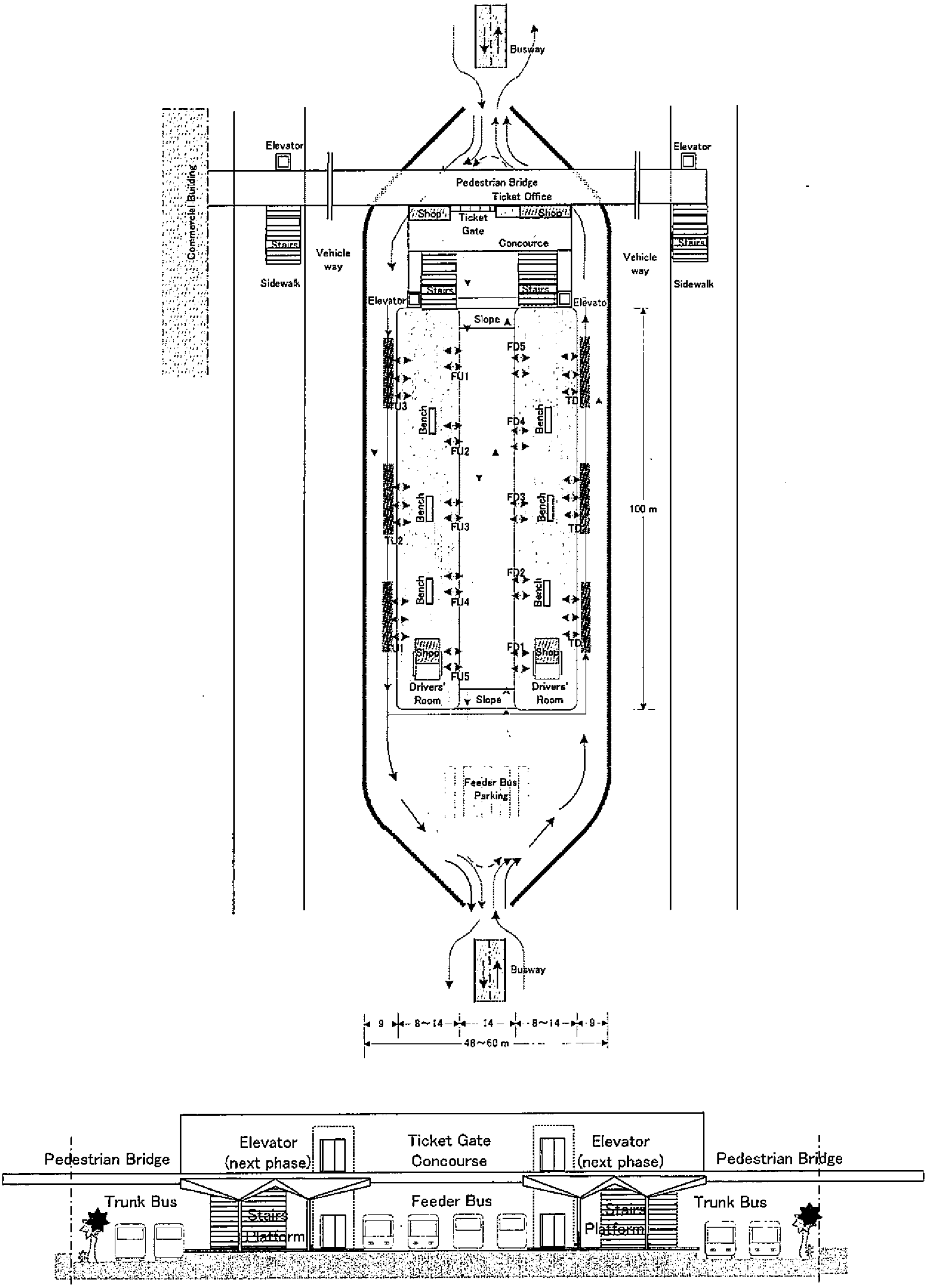


Figure 14.8-7 Busway Stop of Road Center Type

(2) Busway Station of At Grade Separated Site Type

The busway station will be located in a site on the road. The trunk bus and the feeder bus will enter the station from the road by means of traffic lights. The ticket gates and the office will be a single story building. In front of the building will be plants, land for lease for shops, bicycle parking, taxi stand and loading/unloading area for private cars. This design will make site acquisition possible when the road width is limited. The passengers will walk to the platforms by a pedestrian crossing where the feeder buses will pass.

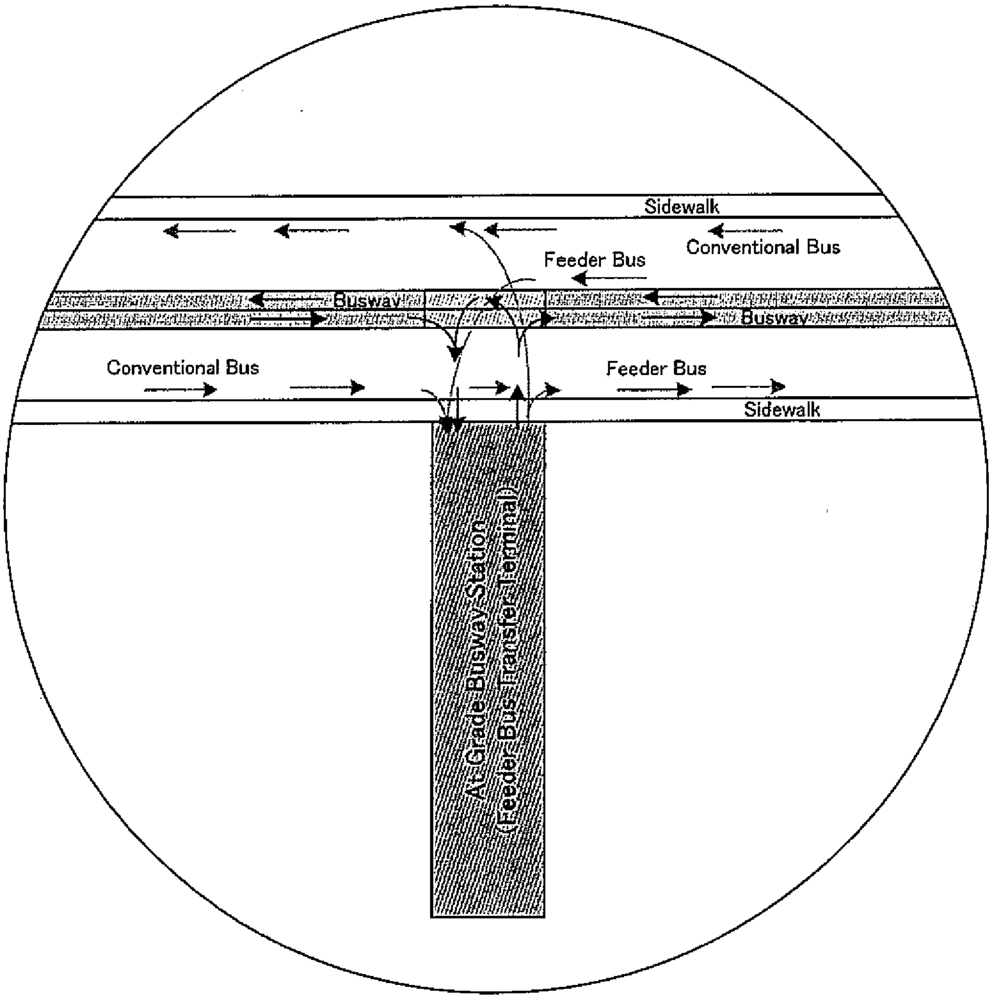


Figure 14.8-8 Conceptual Location of At Grade Busway Station in a Site on the Road

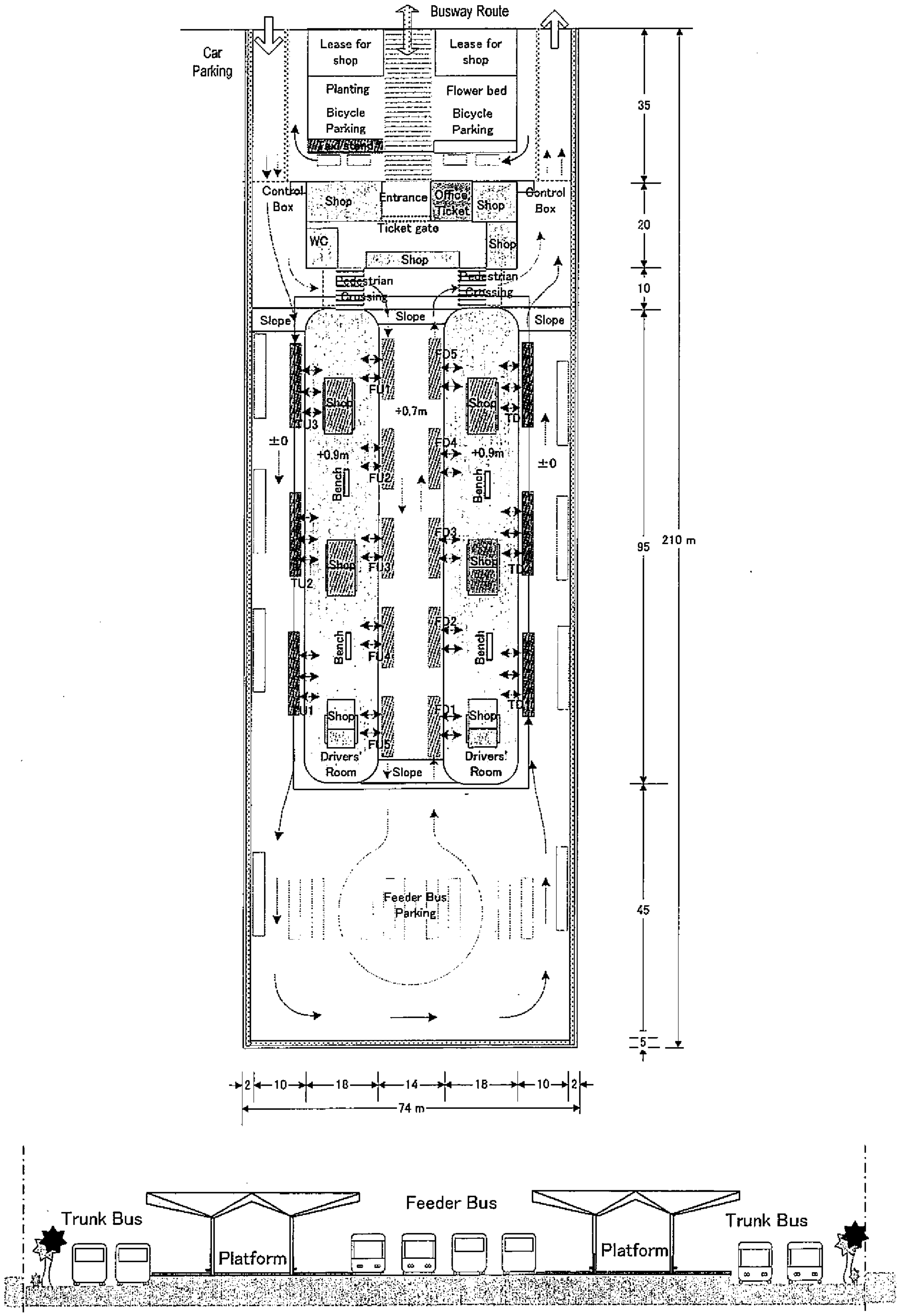


Figure 14.8-9 Conceptual Plan of At Grade Busway Station in a Site on the Road

(3) Busway Stop

The busway stop will be located in the center of the road on the busway. The ticket gates, office and concourse will be prepared on the second level connected by stairs and an elevator. The passengers will use a pedestrian bridge open to public.

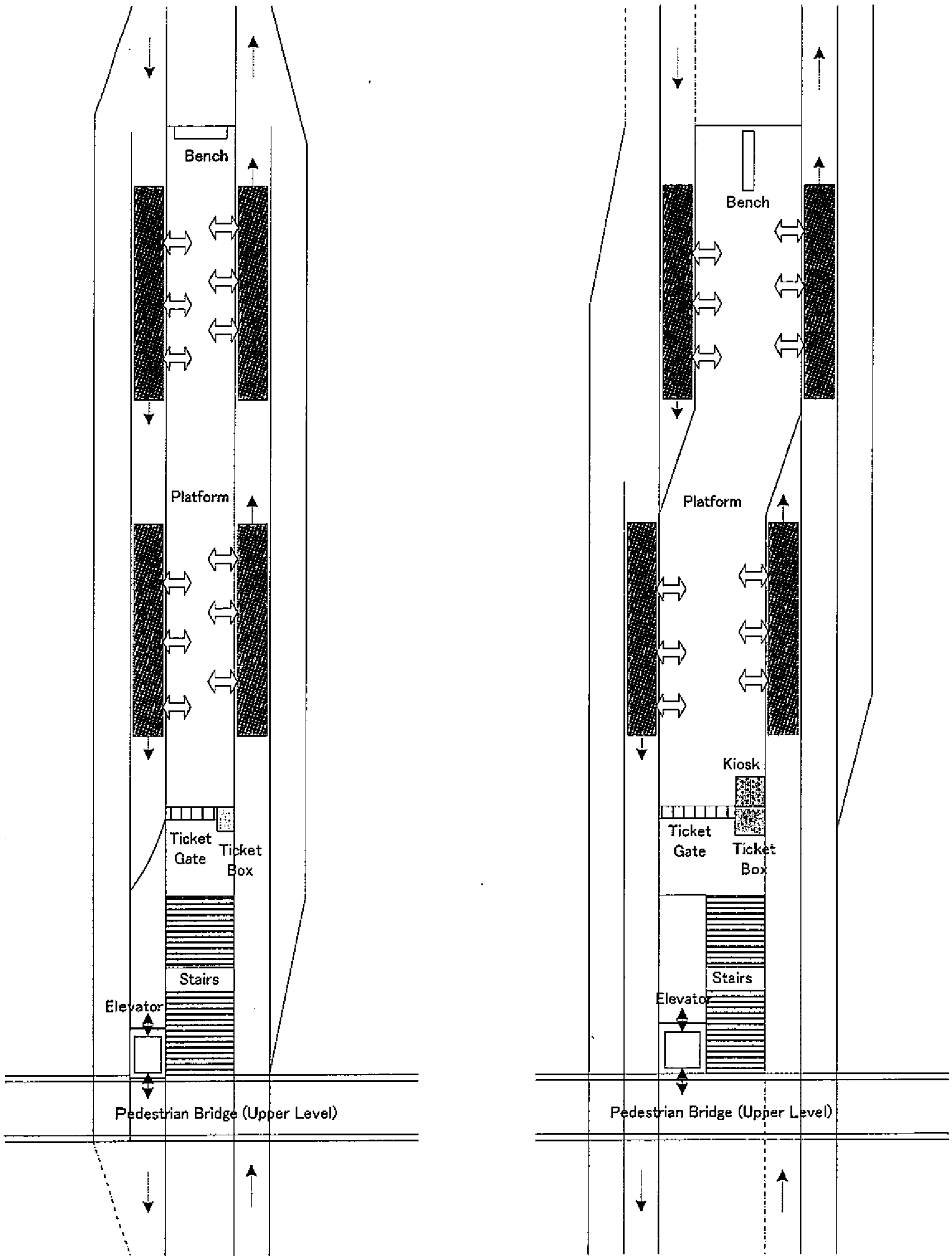


Figure 14.8-10 Conceptual Plan of Busway Stop

14.9. PROJECT COST ESTIMSTE FOR TRUNK BUS PROJECTS

14.9.1. CONDITIONS OF PROJECT COST ESTIMATE

The each trunk bus project cost among 17-project is estimated based on the past experience of construction cost in the Study area and discussion with the Peruvian counterparts. The construction cost of the trunk bus project is covered to construct the only 2-Lane trunk bus road, and without improvement of the existing road construction cost. The construction cost oh the trunk bus projects are including the following construction items.

a) Construction of only 2-Lane bus exclusive road on the center of the existing road
b) Construction of only 2-Lane grate separated intersection needed for only 2-lane trunk bus operation.
c) Construction of bus stop, small bus terminal, and related facilities such as traffic signals installation.
d) Without construction cost for the improvement or betterment of existing road such as sidewalk, widening, and over-lay of passenger car's carriageway.

The construction cost including direct construction cost such as material cost, labor cost, and construction machine cost, as well as land acquisition and compensation, and indirect cost such as administrative cost and profits. The project cost consists of the following items.

a) Construction cost (A)
b) Engineering Cost (A*10%)
c) Administration Cost (A*10%)
d) Contingency (A*15%)
e) Article bus fleets purchase cost

The numbers of bus fleet needed in 2025 are estimated based on the comparison between the future passenger demand in 2025 and the transport capacity of article bus.

14.9.2. UNIT COST OF EACH WORKING ITEMS

The unit cost of major working items are adopted based on the past experience of similar projects in the Study area. The adopted unit cost of the major working items is shown in Table 14.9-1.

Table 14.9-1 Unit cost of Major Working Items

Items	Unit	Unit Cost US$	Calculation Basis
1. Excavation			
Asphalt/Concrete	m^3	15.0	10.0m(2 lines width) x 0.5m(Excavation depth) x Project Length
Excavation/Fill	m^3	5.0	10.0m(2 lines width) x 0.6m(Excavation depth) x Project Length
2. Pavement			
1) Crregeway			
Asphalt t=10	m^2	45.0	10.0m(2 lines width) x Project Length
Base course t = 20	m^2	22.0	10.2m(2 lines width) x Project Length
Sub-base course t = 30	m^2	10.0	10.4m(2 lines width) x Project Length
2) Overlay			
Asphalt t = 5	m^2	25.0	2.0m(width) x Both sides x Project Length
3. Drainag			
U Concrete 0.30 x 0.30 m	m	50.0	Both sides x Project Length
4. Facilities			
Median Plantation 2.5	m	12.0	Trunk Busway Both sides x Project Length
Bus Sidewalk 3.0m	vol	13,000.0	Project Length/1.0km x Both sides
Bus stop facilities	vol	6,000.0	Project Length/1.0km x Both sides
Lighting	vol	2,400.0	Project Length/20m
Lane Marking	km	125.0	Project Length/1.0km x Both sides
Traffic Signs	vol	60.0	Project Length/500m x Both sides
5. Intersection			
At-grade signalized	vol	120,000.0	Improvement of Existing At-grade Intersection (New construct a Signal and Pavement for Trunk Busway)
Grade Separated Overpass	vol	350,000.0	Improvement of Existing Grade Separated Overpass Intersection (New construct a Bus stop and Pavement for Trunk Busway)
Interchange	vol	600,000.0	Improvement of Existing Interchange Intersection (New construct a Bus stop and Pavement for Trunk Busway)
6. Bridge			
Concrete 5m <L<20m	m^2	2,800.0	New construct Bridge of Post tension Type for Trunk Busway (10.0m width x Bridge Length
7. Inter Urban Trunk Bus Terminal	vol	1,000,000.0	New construct a Bus terminal (without land compensation)
Sub Total (A)			Direct Cost = A
Engineering Fee (B)			10%*(A)
Administration(C)			10%*(A)
Contingency(D)			15%*(A)
Project Cost Total			A+B+C+D

14.9.3. PROJECT COST BY EACH TRUNK BUS PROJECT

Based on the unit cost of major working items and each project characteristics, the project cost is estimated. The project cost is estimated by two classifications based on the i) is project cost of infrastructure and ii) is articulated bus fleets purchase cost. The detailed project cost for construction of infrastructures by each trunk bus project is shown in Table 14.9-2 to Table 14.9-7. The total project cost including infrastructure cost and articulated bus fleets purchase cost by each project is summarized in Table 14.9-8.

Table 14.9-2 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost						
			Av.Nestor Gambetta (22.55km)		Av.Panamericana Norte (23.90km)		Av.Universitaria Norte (7.27km)	
		(US$)	Quantity		Quantity		Quantity	
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0	26,500.0	397,500	119,550.0	1,793,250		
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0	36,780.0	183,900			43,620.0	218,100
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	225,200.0	10,134,000	239,100.0	10,759,500	72,700.0	3,271,500
Base course t = 20	m^2	22.0	229,704.0	5,053,488	243,882.0	5,365,404	74,154.0	1,631,388
Sub-bace course t = 30	m^2	10.0	234,208.0	2,342,080	248,664.0	2,486,640	75,608.0	756,080
Overlay								
Asphalt t = 5	m^2	25.0						
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	44,400.0	2,220,000	47,820.0	2,391,000	14,540.0	727,000
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	44,600.0	535,200	47,820.0	573,840	14,540.0	174,480
Bus Sidewalk 2.5	vol	9,400.0						
Bus Sidewalk 3.0	vol	13,600.0	44.0	598,400	46.0	625,600	14.0	190,400
Bus stop facilities	vol	6,000.0	44.0	264,000	46.0	276,000	14.0	84,000
Guard Rail	m	200.0						
Lighting	vol	2,400.0	1,120.5	2,689,200	1,180.0	2,832,000	350.0	840,000
Lane Marking	km	125.0	44.2	5,525	47.2	5,900	14.0	1,750
Traffic Signs	vol	60.0	80.0	4,800	120.0	7,200	20.0	1,200
8.Intersection								
At-grade signalized	vol	120,000.0	10.0	1,200,000	5.0	600,000	6.0	720,000
Grade Separated Overpass	vol	350,000.0	1.0	350,000	20.0	7,000,000	4.0	1,400,000
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0	1.0	600,000				
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0	4,000.0	11,200,000	1,000.0	2,800,000		
PC 20m <L<40m	m^2	3,300.0						
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0	2.0	2,000,000			1.0	1,000,000
Sub Total (Direct Cost+Indirect Cost= A)				39,778,093		37,516,334		11,015,898
Engineerring Fee 10%*(A)				3,977,809		3,751,633		1,101,590
Administration 10%*(A)				3,977,809		3,751,633		1,101,590
Contingancy 15%*(A)				5,966,714		5,627,450		1,652,385
Total				53,700,426		50,647,051		14,871,462

Table 14.9-3 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost	Av.Canta Callao (9.13km)		Av.Universitaria (12.66km)		Av.Tomas Valle (2.84km)	
		(US$)	Quantity		Quantity		Quantity	
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0			35,000.0	525,000		
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0	54,780.0	273,900	3,396.0	16,980	17,040.0	85,200
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	91,300.0	4,108,500	126,600.0	5,697,000	28,400.0	1,278,000
Base course t = 20	m^2	22.0	93,126.0	2,048,772	129,132.0	2,840,904	28,968.0	637,296
Sub-bace course t = 30	m^2	10.0	94,952.0	949,520	131,664.0	1,316,640	29,536.0	295,360
Overlay								
Asphalt t = 5	m^2	25.0			7,520.0	188,000		
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	18,260.0	913,000	25,320.0	1,266,000	5,680.0	284,000
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	18,260.0	219,120	25,280.0	303,360	5,680.0	68,160
Bus Sidewalk 2.5	vol	9,400.0			4.0	37,600		
Bus Sidewalk 3.0	vol	13,600.0	18.0	244,800	22.0	299,200	6.0	81,600
Bus stop facilities	vol	6,000.0	18.0	108,000	26.0	156,000	6.0	36,000
Guard Rail	m	200.0						
Lighting	vol	2,400.0	455.0	1,092,000	633.0	1,519,200	150.0	360,000
Lane Marking	km	125.0	18.0	2,250	26.2	3,275	6.0	750
Traffic Signs	vol	60.0	40.0	2,400	35.0	2,100	5.0	300
8.Intersection								
At-grade signalized	vol	120,000.0	6.0	720,000	9.0	1,080,000	4.0	480,000
Grade Separated Overpass	vol	350,000.0	5.0	1,750,000	10.0	3,500,000	1.0	350,000
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0						
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0			2,000.0	5,600,000		
PC 20m <L<40m	m^2	3,300.0						
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0	1.0	1,000,000				
Sub Total (Direct Cost+Indirect Cost= A)				13,432,262		24,351,259		3,956,666
Engineerring Fee 10%*(A)				1,343,226		2,435,126		395,667
Administration 10%*(A)				1,343,226		2,435,126		395,667
Contingancy 15%*(A)				2,014,839		3,652,689		593,500
Total				18,133,554		32,874,200		5,341,499

Table 14.9-4 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost	Av.Elmer Faucett (8.81km)		Paseo de Republica (29.02km)		Proceses De La Independencia (11.23km	
		(US$)	Quantity		Quantity		Quantity	
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0						
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0	52,860.0	264,300	24,780.0	123,900	67,380.0	336,900
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	88,100.0	3,964,500	41,300.0	1,858,500	112,300.0	5,053,500
Base course t = 20	m^2	22.0	89,862.0	1,976,964	42,126.0	926,772	114,546.0	2,520,012
Sub-bace course t = 30	m^2	10.0	91,624.0	916,240	42,952.0	429,520	116,792.0	1,167,920
Overlay								
Asphalt t = 5	m^2	25.0						
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	17,620.0	881,000	8,260.0	413,000	22,460.0	1,123,000
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	17,620.0	211,440	8,260.0	99,120	22,460.0	269,520
Bus Sidewalk 2.5	vol	9,400.0						
Bus Sidewalk 3.0	vol	13,600.0	18.0	244,800	8.0	108,800	22.0	299,200
Bus stop facilities	vol	6,000.0	18.0	108,000	8.0	48,000	22.0	132,000
Guard Rail	m	200.0						
Lighting	vol	2,400.0	450.0	1,080,000	206.5	495,600	561.5	1,347,600
Lane Marking	km	125.0	18.0	2,250	8.0	1,000	22.0	2,750
Traffic Signs	vol	60.0	40.0	2,400	20.0	1,200	40.0	2,400
8.Intersection								
At-grade signalized	vol	120,000.0	2.0	240,000	3.0	360,000	5.0	600,000
Grade Separated Overpass	vol	350,000.0	7.0	2,450,000	1.0	350,000	7.0	2,450,000
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0						
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0						
PC 20m <L<40m	m^2	3,300.0	2,000.0	6,600,000			500.0	1,650,000
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0					1.0	1,000,000
Sub Total (Direct Cost+Indirect Cost= A)				18,941,894		115,135,412		17,954,802
Engineerring Fee 10%*(A)				1,894,189		11,513,541		1,795,480
Administration 10%*(A)				1,894,189		11,513,541		1,795,480
Contingancy 15%*(A)				2,841,284		17,270,312		2,693,220
Total				25,571,557		155,432,806		24,238,983

Table 14.9-5 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost (US$)	Av.Venezuela (9.05km) Quantity		Av.Brasil (4.84km) Quantity		Av.Javier Prado (21.07km) Quantity	
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0	18,500.0	277,500				
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0	26,750.0	133,750				
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	90,500.0	4,072,500				
Base course t = 20	m^2	22.0	92,310.0	2,030,820				
Sub-bace course t = 30	m^2	10.0	94,120.0	941,200				
Overlay								
Asphalt t = 5	m^2	25.0						
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	18,100.0	905,000				
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	18,100.0	217,200				
Bus Sidewalk 2.5	vol	9,400.0						
Bus Sidewalk 3.0	vol	13,600.0	18.0	244,800			40.0	544,000
Bus stop facilities	vol	6,000.0	18.0	108,000	10.0	60,000	40.0	240,000
Guard Rail	m	200.0						
Lighting	vol	2,400.0	452.5	1,086,000				
Lane Marking	km	125.0	18.6	2,325			42.0	5,250
Traffic Signs	vol	60.0	45.0	2,700			50.0	3,000
8.Intersection								
At-grade signalized	vol	120,000.0	8.0	960,000				
Grade Separated Overpass	vol	350,000.0	3.0	1,050,000	1.0	350,000	19.0	6,650,000
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0						
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0						
PC 20m <L<40m	m^2	3,300.0						
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0	1.0	1,000,000			1.0	1,000,000
Sub Total (Direct Cost+Indirect Cost= A)				13,031,795		410,000		8,442,250
Engineerring Fee 10%*(A)				1,303,180		41,000		844,225
Administration 10%*(A)				1,303,180		41,000		844,225
Contingancy 15%*(A)				1,954,769		61,500		1,266,338
Total				17,592,923		553,500		11,397,038

Table 14.9-6 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost	Av.Angamos (15.96km)		Av.Grau (2.27km)		Carretera Central (8.36km)	
		(US$)	Quantity		Quantity		Quantity	
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0	79,800.0	1,197,000	11,350.0	170,250		
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0					50,160.0	250,800
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	159,600.0	7,182,000			83,600.0	3,762,000
Base course t = 20	m^2	22.0	162,792.0	3,581,424			85,272.0	1,875,984
Sub-bace course t = 30	m^2	10.0	165,984.0	1,659,840			86,944.0	869,440
Overlay								
Asphalt t = 5	m^2	25.0						
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	31,920.0	1,596,000			16,720.0	836,000
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	31,920.0	383,040	4,540.0	54,480	16,720.0	200,640
Bus Sidewalk 2.5	vol	9,400.0						
Bus Sidewalk 3.0	vol	13,600.0	32.0	435,200	6.0	81,600	16.0	217,600
Bus stop facilities	vol	6,000.0	32.0	192,000	6.0	36,000	16.0	96,000
Guard Rail	m	200.0						
Lighting	vol	2,400.0	798.0	1,915,200			418.0	1,003,200
Lane Marking	km	125.0	32.0	4,000	6.0	750	16.0	2,000
Traffic Signs	vol	60.0	50.0	3,000	6.0	360	30.0	1,800
8.Intersection								
At-grade signalized	vol	120,000.0	6.0	720,000			4.0	480,000
Grade Separated Overpass	vol	350,000.0	5.0	1,750,000			7.0	2,450,000
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0						
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0						
PC 20m <L<40m	m^2	3,300.0						
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0						
Sub Total (Direct Cost+Indirect Cost= A)				20,618,704		20,010,107		12,045,464
Engineerring Fee 10%*(A)				2,061,870		2,001,011		1,204,546
Administration 10%*(A)				2,061,870		2,001,011		1,204,546
Contingancy 15%*(A)				3,092,806		3,001,516		1,806,820
Total				27,835,250		27,013,644		16,261,376

Table 14.9-7 Construction Cost by Each Trunk Bus Project

Items	Unit	Unit Cost						
			Av.La Molina (6.54km)		Av.Panamericana Sur (25.60km)			
		(US$)	Quantity		Quantity			
1.Site Clearning and Demolition								
Residential	ha							
Field	ha							
2.Excavation								
Asphalt / Concrete	m^3	15.0						
Soil (Waste)	m^3	3.0						
Exc./ Fill	m^3	5.0	39,240.0	196,200	153,600.0	768,000		
Transported soil	m^3/km							
3.Embankment								
Borrowed Fill	m^3	3.0						
Selected Material	m^3	7.0						
Plantation	m^2	4.0						
4.Pavement								
Carriageway								
Asphalt t = 10	m^2	45.0	65,400.0	2,943,000	256,000.0	11,520,000		
Base course t = 20	m^2	22.0	66,708.0	1,467,576	261,120.0	5,744,640		
Sub-bace course t = 30	m^2	10.0	68,016.0	680,160	266,240.0	2,662,400		
Overlay								
Asphalt t = 5	m^2	25.0						
Sidewalk								
Asphalt t=3cm	m^2	20.0						
Base course t = 10	m^2	10.0						
Plantation	m	7.0						
5.Drainage								
U Concrete 0.30 x 0.30 m	m	50.0	13,080.0	654,000	51,200.0	2,560,000		
U Concrete 0.50 x 0.50 m	m	78.0						
Pipe culvert o 300	m	50.0						
Pipe culvert o 600	m	90.0						
Pipe culvert o 1000	m	120.0						
Box culvert 2.00 x 2.00 m	m	1,050.0						
Box culvert 3.00 x 3.00 m	m	1,750.0						
Manhole H<6m	vol	2,000.0						
6.Additional								
Storm Sewage	m	20.0						
7.Facilities								
Median Plantation 2.5	m	12.0	13,080.0	156,960	51,200.0	614,400		
Bus Sidewalk 2.5	vol	9,400.0						
Bus Sidewalk 3.0	vol	13,600.0	12.0	163,200	50.0	680,000		
Bus stop facilities	vol	6,000.0	12.0	72,000	50.0	300,000		
Guard Rail	m	200.0						
Lighting	vol	2,400.0	327.0	784,800	1,280.0	3,072,000		
Lane Marking	km	125.0	12.0	1,500	50.0	6,250		
Traffic Signs	vol	60.0	10.0	600	100.0	6,000		
8.Intersection								
At-grade signalized	vol	120,000.0	3.0	360,000				
Grade Separated Overpass	vol	350,000.0	1.0	350,000	14.0	4,900,000		
Grade Separated Underpass	vol	220,000.0						
Interchange	vol	600,000.0			5.0	3,000,000		
9.Bridge								
Concrete 5m <L<20m	m^2	2,800.0			3,000.0	8,400,000		
PC 20m <L<40m	m^2	3,300.0						
40m<PC<200m	m^2	4,000.0						
200m<PC	m^2	6,000.0						
10.Tunel								
Concrete Box Type	m	5,000.0						
11.Walls								
Concrete gravity Type H<5m	m	400.0						
Concrete block Type H<7m	m	600.0						
12.Inter Urban Trunk Bus Termi	vol	1,000,000.0						
Sub Total (Direct Cost+Indirect Cost= A)				7,829,996		44,233,690		
Engineerring Fee 10%*(A)				783,000		4,423,369		
Administration 10%*(A)				783,000		4,423,369		
Contingancy 15%*(A)				1,174,499		6,635,054		
Total				10,570,495		59,715,482		

Table 14.9-8 Project Cost By each Trunk Bus Project

Project Number	Name of Trunk Bus Project	Section and Length		Infrastructure	Bus Fleet	Total
		Section	(km)	US$ (Million)	US$ (Million)	US$ (Million)
BP-1	Av. Grau	Paseo de la Republica - Av. Independencia	2.27	27.01	5.39	32.40
BP-2	Paseo de la Republica	Pan. Sur - Av. Universitaria Norte	29.02	155.43	66.77	222.20
BP-3	Carretera Central	Av. Grau - Av. Haya de La Torre	8.36	16.26	19.25	35.51
BP-4	Av. Venezuela	Paseo de la Republica - Av. Grau	9.05	17.59	20.84	38.43
BP-5	Av. Brasil	Paseo de la Republica - Av. Angamos	4.84	0.55	11.14	11.70
BP-6	Av. Angamos	Av. La Marina - Av. Javier Prado	15.96	27.84	36.75	64.58
BP-7	Av. La Molina	Carretera Central	6.54	10.57	15.06	25.63
BP-8	Av. Universitaria	Av. La Marina - Panameriacana Norte	12.66	32.87	29.15	62.02
BP-9	Av. Canta Callao	Av. Elmer Faucett - Av. Panamericana	9.13	18.13	25.68	43.81
BP-10	Av. Nestor Gambetta	Av. Argentaina - Av. Pan Americana Norte	22.55	53.70	54.15	107.85
BP-11	Av. Javier Prado	Av. Elmer Faucett - Av. Carretera Central	21.07	11.40	48.51	59.91
BP-12	Av. Panamericana Norte	Cabueta - Ancon	23.90	50.65	55.03	105.67
BP-13	Av. Panamericana Sur	Paseo de la Republica - Av. Huaylas	25.60	59.72	58.94	118.66
BP-14	Av. Universitaria Norte	Metropolitana - Manuel Prado	7.27	14.87	16.74	31.61
BP-15	Av. Tomas Valle	Av. Nestor Gambetta - Av. Universitaria	2.84	5.34	6.54	11.88
BP-18	Terminal A		1 unit	3.00		3.00
BP-19	Terminal B		1 unit	3.00		3.00
BP-20	Terminal C		1 unit	3.00		3.00
Sub Total				510.92	469.94	980.86

*Cost of Av. Grau trunk busway include construction cost of Av.Grau