QUITO BUSWAYS, ECUADOR

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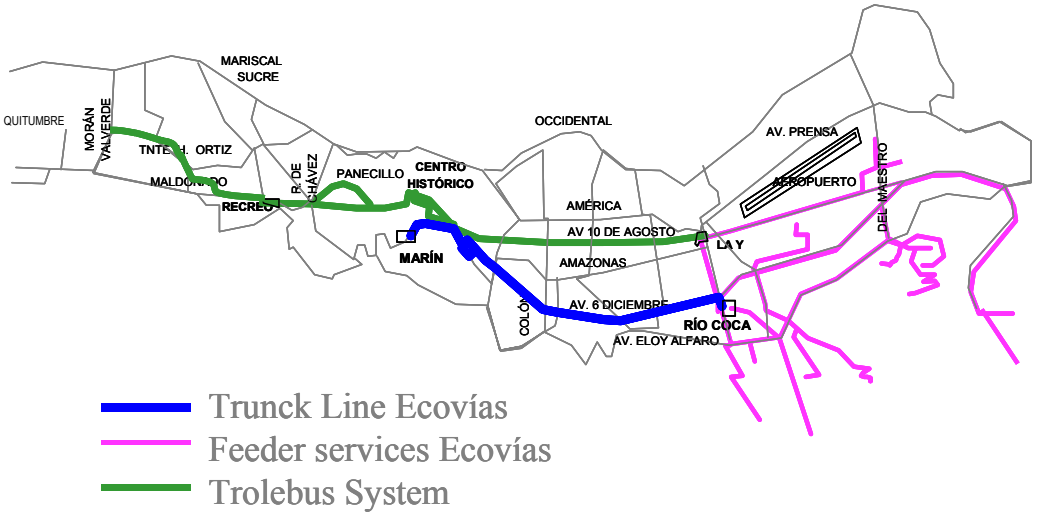
CITY AND TRANSPORT CONTEXT	
City context	• Quito, the capital of Ecuador, is located at an altitude of 2,800 m in a narrow valley. The city center is one of the most extensive 16th century sites in Latin America and was designated a World Cultural Heritage. The center remains an important business area and attracts 14% of motorized trips. Outside the center, the topography has constrained the city to grow northwards and southwards in a linear form. The city is approximately 44 km long and 3 to 8 kms wide. • **Population:** 1.464 million (in 2000)[1].
	• **Car ownership:** 250,000 vehicles in 2002[2].
	• **Modal split:** Approximately 75% of the motorized trips were carried out by bus and 25% by car (in 2000)[3].
Public transport context	• Various types of buses and trolley buses provide urban public transport services. There is no rail-based system.
Bus transport context	• Prior to 1996, different types of buses with varying passenger capacity supplied all bus services. These included regular buses and smaller buses, called "*colectivos"* and "*busetas"*. The estimates for the operational bus fleet varied: one author[4] gives 2,500 buses but concedes that many unlicensed buses operated[5]. Other estimates placed the fleet at about 4,700 officially licensed buses but reported that the fleet in operation was nearer to 6,000 buses[6]. • Buses were predominantly privately operated through cooperatives and private companies as well as unlicensed private operators, which operated particularly at night and in the outer "marginal" areas of the city. Some services, carrying about 5%-10% of passenger demand, were provided by the Municipal Transport Company (Empresa Municipal de Transportes). • The privately operated bus services were divided into different types each with different fares depending on type of service, bus age, seating and routing. • The bus fleet was old and in 1991 averaged about 18 years with a large number in excess of 20 years, which was the official scrapping age for buses in the mid 1990s. Standards of bus service were low with slow journey times, chaotic service levels, overcrowding, and official services tended to terminate at 8 PM (Photos 1 and 2). • Fares were fixed by the National Transport Council and applied nationally. The lack of investment in bus fleet renewal was due in part to the controlled fare policy. • In addition to poor service levels for passengers, the old, poorly maintained diesel bus fleet coupled with the geographic location of the city resulted in emission and noise problems (Photo 3). • The practice in which bus owners hired their vehicles to drivers on a daily basis was common and resulted in intense competition at stops, called "*la guerra del centavo*" (the cents war). It contributed to the low quality of service offered to passengers. • In the past, buses had been rotated on a weekly basis to different routes throughout the city in an effort to equalize income between operators, but the practice was declining. • In effect, although fares were controlled, the bus system operated more or less in a deregulated manner. Improvements in public transport became a political imperative as passengers became increasingly critical of the system and the pollution caused by excessive volumes of old polluting buses. • An efficient, affordable, "clean" public transport option was sought to address public

discontent and to prevent further damage to the historic city. In fact, the Quito Trolebus System, and its follow-on, the Ecovía System, have made a valuable contribution to improve the chaotic conditions of bus transport in Quito.

- The busway-based Trolebus System, constituting the main subject of this Fact Sheet, was implemented in two stages; the first in 1996 and the second, an extension in the south, was commenced in 1999 and is operational since June 2000. A new extension of 2 km from Avenida Morán Valverde to Quitumbre is planned[7].
- The Ecovía busway, on Avenida 6 de Diciembre, a corridor to the east of the Trolebus System was commenced in 1999 and is now operational (for more details see Chapter "Description of Ecovía").

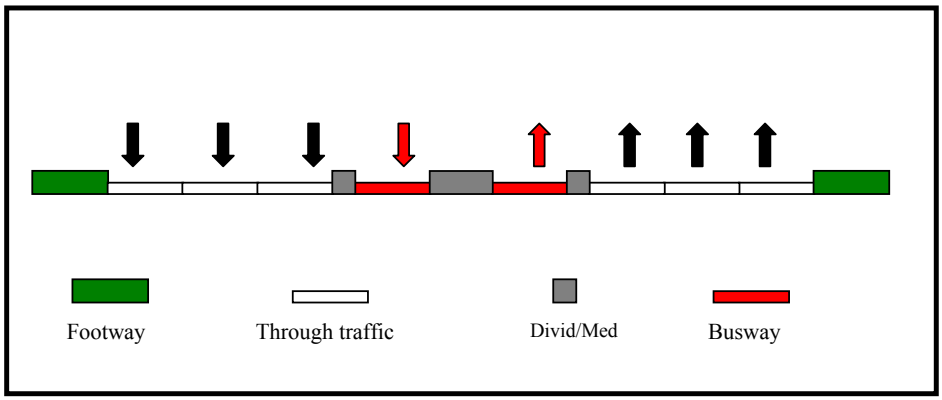


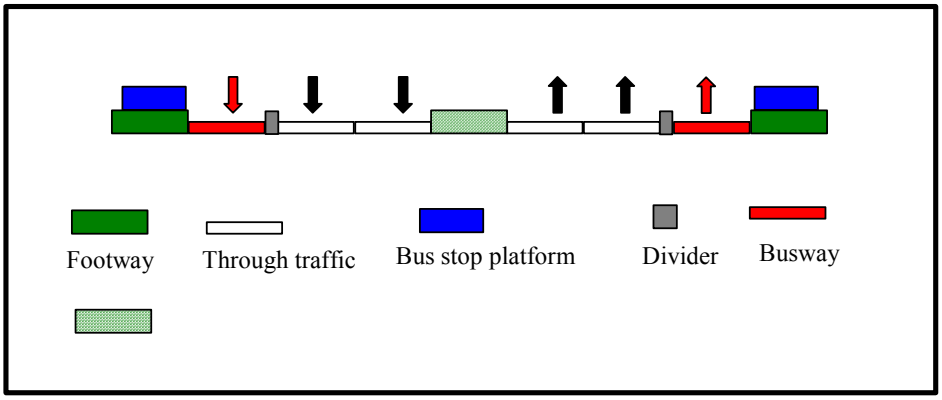
By Courtesy of Cesar Arias

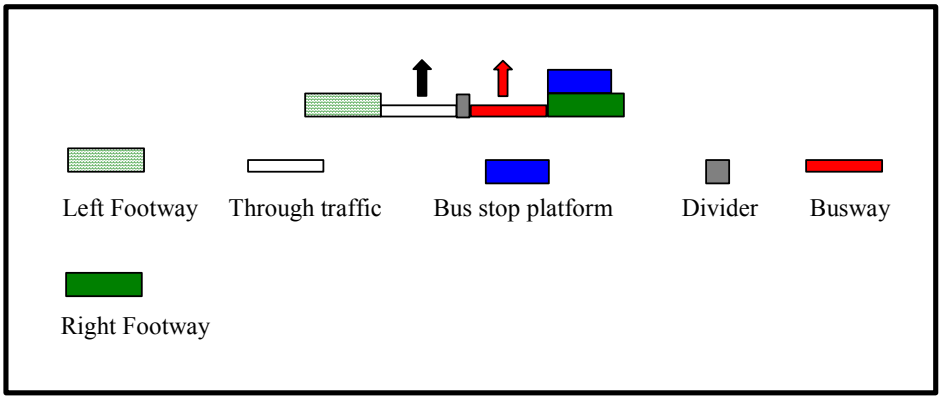
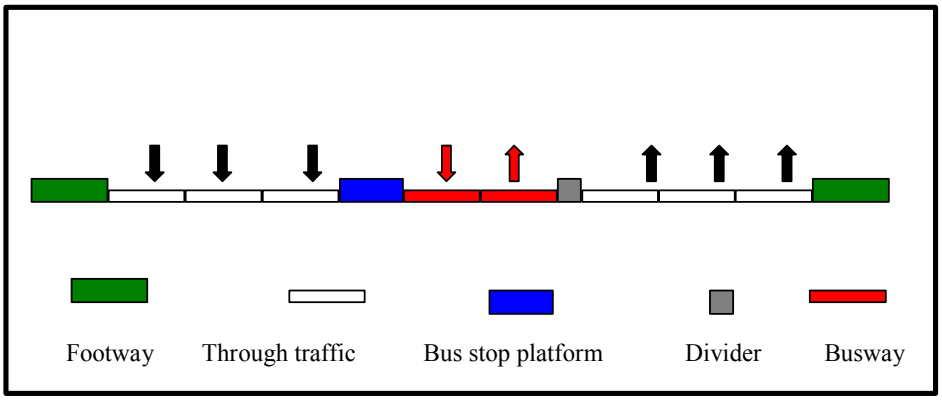
- In addition to the trolley buses and the Ecovía buses serving these busway systems, there are three classes of buses currently operating in the city of Quito: "*Populars*", operating a low fare service; "*Especials*", providing upgraded urban service; and "*Escolars*" for school services.
- Seven new trunk lines are planned. One concrete example is the busway on Avenida America, a corridor to the west of the Trolebus System, requiring 70 articulated buses[8].

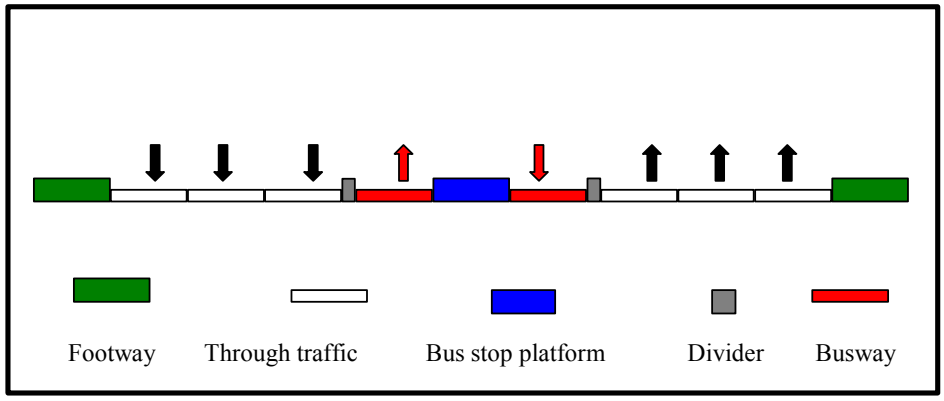
DESCRIPTION OF THE TROLEBUS SCHEME	
Busway scheme	• The Quito Trolebus System uses electrically-powered trolleybuses and operates on a segregated busway located in the centre of a wide arterial road (the north-south spine of the city: Avenida 10 de Agosto) over the majority of its length. Standard traffic management-exclusive bus lanes are used for a short section in the historic city centre (centro histórico), where road right-of-way is narrower (see the map in the previous Chapter “”City and Transport Context”). • The first stage of the scheme comprises 11.2 km from La Y in the north to El Recreo in the south (Photos 4, 5, 6 and 7), the second stage 4.9 km between El Recreo and Moran Valverde (Photos 8 and 9). • The busway operates as a trunk-and-feeder system in which passengers pay on entry to the system and are able to transfer between feeder and trunk line buses without further fare payment. • The trunk line services of the first stage busway was initially operated by a dedicated fleet of 58 articulated trolleybuses and the feeder service was provided at terminals by 64 conventional buses. The articulated trolleybus fleet for the combined first and second stage comprises now 113 vehicles and the feeder bus fleet consists of 100 vehicles. • The exclusive busway comprises one lane in each direction; this and the use of trolleybuses do not permit bus overtaking at stops. • Bus stops are island platforms. There is no facility for bus-bus overtaking at stops and the arrangements vary from first to second stage (see "Trolley bus – traffic segregation" and "Passenger facilities" in Chapter "Busway Design"). • The articulated trunk line trolleybuses are high floor vehicles but level, gap-less boarding for passengers is achieved at stops through raised stop platforms (accessed by ramps) and fold down steps from bus doors onto the stop platform (Photos 18, 20 and 21). • General traffic along the segregated busway sections is normally provided with 2-3 lanes in each direction (Photos 4 and 5). • The busway system enhances the level of service to passengers by much increased operational hours compared to the pre-busway system, which terminated officially at 8.00 PM.

BUSWAY DESIGN	
Road width and configuration	

Basic mid block cross section - First stage scheme	
	• The overall width is approximately 29.5 m:
	  ○ traffic lanes 6 @ 3.25 = 19.5 m
	  ○ busway 2 @ 3.5 = 7.00 m
	  ○ median = 2.0 m (in some parts)
	  ○ bus-traffic dividers 2 @ 0.5 = 1 m
	• Median and/or bus traffic dividers accommodate trolley bus catenary's supports.
	• All trolley lanes are 3.50 m wide. The cross section changes along the route but the 3.50 m are maintained.
	• This is an example of a typical cross section. Measures and characteristics vary with road width and location. For instance, in the centre of the city (see "Cross section Historical center" in the same Chapter), the busway is discontinued and bus lanes on roads are used (Photos 6 and 7).

Cross section El Ejido Park	
	• The overall width of the cross section is approximately 36.50 m:
	  ○ Through traffic 3.40 m @ 4 = 13.60 m
	  ○ Busway 3.50 m @ 2 = 7.0 m
	  ○ Bus stop platform 3.0 m
	  ○ Divider 0.20 m @ 2 = 0.40 m
	  ○ Central garden 4.50 m @ 1 = 4.50 m
	  ○ Footway 4.0 m @ 2 = 8.0 m

Cross section Historical centre	 • The overall width of the cross section is approximately 13.00 m: ○ Through traffic 3.30 m @ 1 = 3.30 m ○ Busway 3.50 m @ 1 = 3.50 m ○ Bus stop platform 3.0 m (they are located in squares, plazas) ○ Divider 0.20 m @ 1 = 0.20 m ○ Left Footway 1.50 m @ 1 = 1.50 m ○ Right Footway 1.50 m @ 1 = 1.50 m
Typical cross section at stops – First stage scheme	 • The overall width is approximately 34 m: ○ traffic lanes 6 @ 3,50 = 21 m ○ busway 2 @ 3,50 = 7,00 m ○ bus stop platform = 3.0 m (length 24 m) ○ median = 2.0 m ○ bus-traffic divider 1 @ 1.0 = 1.0 m • The median and/or bus traffic dividers accommodate trolley bus catenary's supports. • Again, this is an example of a typical cross section, with measures and characteristics varying with road width and location.

Typical cross section at stops – Second stage scheme	
	• The overall width is approximately 32.0 -33.5 m
	  ○ traffic lanes 6 @ 3.25 – 3.5 = 19.5 – 21 m
	  ○ busway 2 @ 3.5 = 7.00 m
	  ○ bus stop platform = 3.5 m (length 24 m)
	  ○ bus-traffic divider 2 @ 1.0 = 2.0 m
	• Busways are "contra flow" to maintain bus doors next to stop platform.
	• Once more, this is a typical section, as cross sections vary with road width and location.

Trolley bus – traffic segregation	
Along running sections	• Trolley bus-traffic separation varies according to road width constraints; the majority of the separation is provided by continuous raised, about 1 m wide, physical islands (Photo 4). Generally, on a wide road, either this island separation or the median itself is necessary to locate the poles for the trolleybus power supply catenaries. • Trolley bus-trolley bus separation along busway varies according to road width constraints from wide central medians (about 2 m) to a single line/road marking at stops (Photo 4).
At bus stops	• Bus stops are of two configurations. For the first stage busway, bus stop platforms are located between the central busway and the traffic lanes for each direction of bus travel and are usually at the far end of the intersections (Photos 4, 5 and 10). In this case the bus stop platform island forms the trolley bus-traffic separation on one side of the road. Bus stops platforms are not directly opposite each other in order to save road space and thus on the opposite site to the stop platform the busway is usually separated from traffic by a narrow (about 0.5 m) raised continuous island (Photos 4 and 5). Within the busway, trolley bus-trolley bus separation is provided by a single line road marking. • For the second stage busway, a single bus stop platform is located at the median to be used by trolley buses in both travel directions(Photo 8). To maintain bus doors on the "right" side of the vehicles, buses must operate "contra flow" (see the next "Location of stops"). Trolley bus-traffic separation is usually provided by a raised continuous island.
Passenger facilities	
Location of stops	• The first 11.2 km of busway included 40 stops with an average stop spacing of about 500 m. The 4.9 km second stage busway has 10 stops.

	• Where bus stops are located on both sides of the busway, as in the first stage busway, it is often necessary to stagger stops longitudinally in each direction by 50 to 100 m, depending on the situation, rather than locate them opposite each other. This limits the amount of road width required but inconveniences passengers because journeys cannot be made more-or-less from the same location for the inward and outward journey. It also means that additional facilities are required for passengers to cross the road to access the two separate stops. • With the single median bus stop platform, as in the second stage busway, trolley buses must make a cross over to use these stops since doors are only on one side of the vehicle (the conventional "right" side). In effect, the trolley buses on this section of the busway operate "contra flow", which could constitute a traffic and pedestrian crossing hazard. Nevertheless, there have been very few pedestrian accidents, especially due to a communication campaign in schools and for the public in general[9]. This arrangement has the advantage that the bus stop for each direction is at the same location and requires only one road crossing facility.
Access to stops	• Access to trolley bus stops is normally possible at signal-controlled pedestrian crossings (Photo 8). Many traffic signals are actuated by pedestrians. In other cases there are pedestrians overpasses. The signal system along the way is fully actuated and has a control center.
Boarding and alighting facilities	• All on line stops and stations are provided with "fully enclosed" passenger shelters of modernist design (Photos 11, 12, 13 and 14) to protect passengers from the weather. They allow the operation of the "closed" system in which bus-bus interchange can take place without fare payment. • The first stage busway bus stop platforms are 3.0 m (external measure) wide and 24 m in length. • The second stage busway median bus stops are 4.0 m wide (and in two places 5.0 m) and 30 m long (shelters); they have two pedestrian ramps with a length of 5 meters and a gradient of 7% on each side. • All stop and station shelters have 3 bus access doors spaced to correspond to the 3 doors on the articulated trunk line trolley buses that serve the route. • Stops can only serve one bus at a time; however, since the busway operates as a "closed system" (only the trunk line articulated trolley buses can use the busway), bus headways can be managed more readily than with a free-entry busway system and trolley bus-trolley bus congestion should not apply at stops. For the near future, bus stops will be doubled in its length in order to use a trolley bus "convoy" to improve capacity. • The trunk line articulated trolley buses are high floor but level passenger boarding and alighting has been achieved by raising the stop platform to the same floor height as the buses. Passengers access the raised stop platform (about 0.70 m high) via a low-gradient ramp (see "Disabled access" in the same Chapter). While this is a simple, low cost facility, the ramps increase the length required for stops, which may be an issue in sections where intersections are more closely spaced (such as a city center). A fold down ramp deploys as bus doors open from buses to stop platform and so boarding-alighting is gap-less as well as level. • Passenger entry to stops is via turnstiles, which accept pre-paid tickets, tokens and coins (see "Fare collection" in Chapter "Bus System").

	• Passengers are effectively separated from moving vehicles. For first stage busway bus stop platforms, on the general traffic side of the platforms, passengers are separated from traffic by the back wall of the enclosed shelter. On the bus side of the platforms, passengers are separated from buses by the front shelter wall but this includes the 3 doors noted above, which operate synchronously with bus doors on bus arrival at the stops. There have been reports that the stop doors are not always fully functional. • For the second stage busway median bus stops, passengers are separated from buses by the shelter walls: each side is equipped with 3 doors which as noted above operate synchronously with bus doors on bus arrival at the stops.
Passenger information	• Bus stops are provided with pay telephones, television monitors with service information and public information; staff is available to respond to passenger queries (Photos 13 and 14). During planning-implementation, customer service and convenience were stressed and this attention has proven a major factor in the system's success, in addition to the good public communication plan, targeting especially young people.
Disabled access	• The ramp access to stop platforms and level boarding of high floor buses provides good disabled passenger access to the trunk line trolley buses (Photos 14 and 18).
Arrangements for general traffic	
Moving vehicles	• Typically 2 or 3 lanes each way are provided outside central busways for residual traffic, with the exception of the city center with only one lane (Photos 6 and 7). • Provision of more than one lane for residual traffic means that vehicle stopping to load (legally or illegally), to pick-up/set down (such as taxis) or in emergency situations (break down), does not affect busway operations. Curbside, obstructive parking, which can otherwise be an issue for bus priority introduced into an existing road, has no impact.
At major intersections	• **Spacing of intersections:** The general pattern of the city is a block length of 80 m but this varies especially in the northern part. Main intersections with high traffic volumes differ widely in spacing. • **General arrangement:** Generally left turns are banned and thus signal operations are simple and typically as follows: (i) main road traffic and busway straight-ahead, (ii) side road 1 and (iii) side road 2. • **Signal control:** As part of the busway project, 144 intersections were signalized / re-signalized (Photo 8). The system is computer controlled and the intersections are fully actuated. They can operate independently and can give preference to trolleybuses. • **Traffic turning facilities:** Left turns at main intersections are banned and Q or G turns on surrounding local roads are necessary to maintain access as left in and left out cannot take place to/from side roads as vehicles cannot cross the "barrier" which the central busway creates.
Frontage servicing and local access	• **Frontage servicing:** It has different characteristics according to the section of the city. In the city center area loading and unloading is done during night hours and usually the side streets are used. If there is a vehicle access to the property, the owner has a special permit to use the busway to access it. Moreover it is possible to use the busway in the downtown area for regular traffic after 9.00 PM and until 5.00 AM. In the northern part,

	frontage service/loading takes place from the inner of the three residual lanes (in each direction) in the inter-peaks without causing serious problems. • **Local access:** The extensive use of continuous islands creates a physical, central barrier/median to cross traffic movement and may have severance implications for local access but this has not been a very serious issue for the Trolebus System[10].
Enforcement of the busway	• In most parts of the busway the physical separation helps to maintain its exclusive use by trolley buses. There is a special police group that enforces the busway. • The most important problem is the use of the busway by the police, emergency vehicles, and also by "official caravans" or demonstrators going to the Government Palace (Photo 41).
Taxis	• Taxis are not permitted in the busway and remain with the general traffic; however, with three residual lanes in each direction outside the busway, there is little obstruction from a stopped vehicle (taxi) and no special facilities or restrictions are required.
Cycles	• Cycles are not permitted in the busway and remain with the general traffic.

INSTITUTIONAL ARRANGEMENTS	
Planning, implementation and operation	• The key policy change to achieve the successful planning and implementation of the Quito busway based Trolebus System was a fundamental change in the transport law. In the mid 1990s, after two years of lobbing, the Ecuadorian Congress approved a law making the Municipality responsible for "the planning, regulation, and co-ordination of all matters related to public and private transport". This law consolidated responsibilities, previously in the remit of a number of agencies, under a single agency and is the foundation on which the Quito scheme is based. • To meet the obligations required by the change in the transport law, in 1995 the Municipality created a Transport Planning Department (Unidad de Planificacion y Gestion de Transporte - UPGT) as a single entity with the powers to overcome the administrative gridlock in the development and integration the transport sector. • UPGT regained control of the largely unregulated transit system and was able to pilot the new Trolebus System through planning to implementation. • A major achievement was to introduce the regulated Trolebus System against considerable opposition of the private sector bus operators and staff. It culminated in a week long strike. However, the public supported the Trolebus proposals and a state of emergency was called by the Government, which enabled strong measures to be taken to re-establish the transport system and the new Trolebus System. • As UPGT's remit did not extend to bus operation, the Municipality created a special trolleybus operating Municipal Department (Unidad Operadora del Sistema Trolebus - UOST) with the aim of establishing the system and transferring operations to the private sector after a two-year period; this has not yet happened.
BUS SYSTEM	

Vehicle characteristics	• Vehicles operating the trunk line service are dedicated to the busway and comprise articulated electric trolleybuses (Photo 20), which:
	  • are equipped with an emergency-auxiliary diesel engine;
	  • are 17.8 m in length and 2.5 wide;
	  • have a maximum capacity is about 180 passengers per vehicle;
	  • are equipped with three doors each, with an extendable bridge/step that synchronizes with bus stop doors/platforms and allows level and gap-less passenger boarding and alighting.
	• The feeder buses to end terminals and intermediate stops are conventional diesel buses.

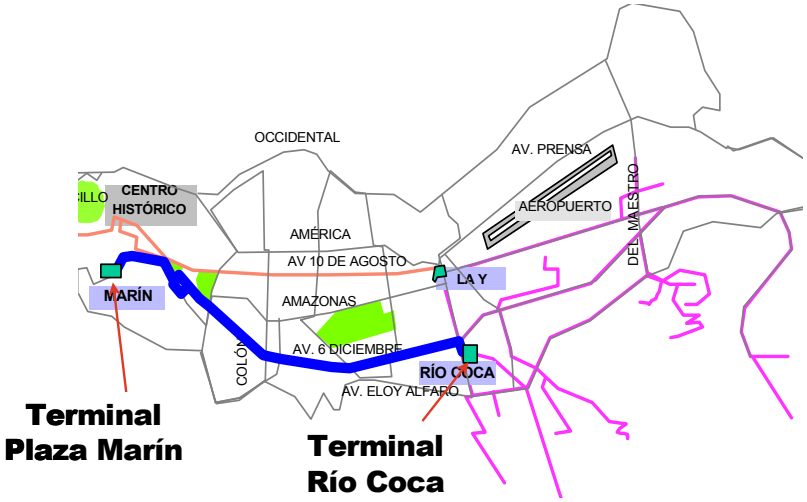
Operational system	• The Quito Trolebus System consists in trunk-and-feeder operations, where the use of the system requires payment of only one flat fare and allows interchange between the trunk and feeder buses at interchange terminals. The system is similar to that in Curitiba, although it covers only one route, unlike Curitiba that is city wide, covering all bus services. • Major interchange terminals (Photos 16, 17, 18 and 19) are provided at the out-of-city ends of the route. These terminals and some intermediate smaller integration terminals are accessed by feeder bus services operated by conventional buses. Thus, passenger demand is consolidated onto high passenger capacity trunk line trolley buses. This allows maintaining the

	numbers of trolley buses using the busway per hour at a level, which permits good commercial speeds and does not cause stop congestion. Compared to the "pre-busway" situation, it also reduces the number of buses entering the city center.
Services operated	• Trunk line services operate at about 1½ minutes in peak periods and 3 minutes in off peak periods. • Operating hours are from 5.00 AM to 0.40 AM on weekdays and from 6:00 AM to 10:40 PM on Saturday/Sunday[11].
Fare collection	• The Trolebus System uses the concept of "paid area", where passengers pay one fare to use the trunk-and-feeder system; thus they may pay on a feeder bus and then, within a closed terminal, transfer "free" to a trunk line bus or passengers may pay on entry to a trunk line terminal or trunk line intermediate stop; fares are paid at coin-in-the-slot turnstiles, which are also equipped to take a fare card. No fares are collected on the trunk line buses.
Bus breakdown	• Trolley buses have an emergency diesel motor that ensures reliability of the vehicle. In case of breakdown, if the driver cannot fix the damage, there is an emergency vehicle that tows the trolley bus. Other trolley buses can overtake the broken-down vehicle by either using the remaining space of the busway or by claiming the mountable dividers (curbs).

PERFORMANCE AND COSTS	
Throughput	**Passenger throughput:** • Busway average passenger throughput is 170,000 passengers/weekday. • Busway maximum passenger throughput is about 8,000 passengers/hr/direction. **Bus throughput:** • Busway peak period bus flow is about 40 buses/hr/direction. • Busway inter peak period bus flow is about 20 buses/hr/direction.
Bus commercial speed	• Busway peak period commercial speed is 18-20 kph. • Busway inter peak period commercial speed is 20-25 kph (bus stop dwell times and intersection delays are lower in the inter peak periods).
Average bus productivity	• The daily trolleybus occupancy is 3500 passengers/vehicle/day on average.
Environmental performance	• The busway based Trolebus System has positive impacts on the environment since: o Trolley buses are electric, thus bus emissions per bus-km are reduced; o major trunk line passenger movements to/from the center of the city are catered for with considerably fewer buses than previously; o there has been an increase in car operating speeds due to the absence of old buses stopping everywhere, which led to an increased capacity in the traffic lanes; o there is anecdotal evidence that some car-bus mode transfer may have taken place.
Operating costs and financial performance	• The Trolebus System's standard fare in August 2003 was US$ 0.25. • The Trolebus System's fare box revenue in 2000 was reported at US$ 10.5 million, covering the full system operating and maintenance costs including the feeder services.
Construction and vehicle cost	• Costs for the first stage of the Trolebus System (including 11.2 km busway) were reported as a gross cost per km of about US$ 5.0 m divided as: o Articulated trolleybuses and electric hardware – US$ 46.3m o Terminals, bus lanes and stops – US$ 7.0 m o Traffic signals – US$ 2.3 m o Ticket system – US$ 2.0 m o Total – US$ 57.6 m

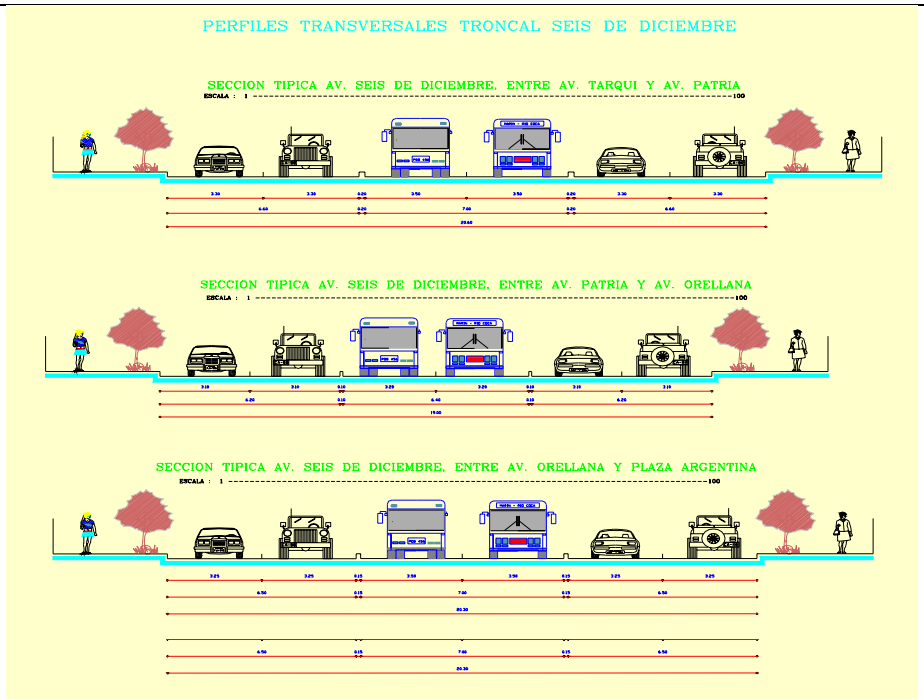
DESCRIPTION OF ECOVÍA

The 9-km service on the Ecovía busway began operations in 2002. It runs on Avenida 6 de Diciembre, in a corridor to the east of the Trolebus route, in which in the past 340 buses circulated[12].



By Courtesy of Cesar Arias

- The Ecovía System was designed as a project operated by private operators. The eight operators that previously served the corridor formed a company (Tranasoc SA) that is operating the new service on the busway based on an agreement with the municipality. This constitutes an important milestone because it incorporates the bus operators directly into a new and more efficient way of operation. It tackles one of the problems of the old system that lay in the poor level of organization of the cooperatives and so-called bus companies and is expected to produce a change in the institutional organization of operators.
- The busway is located in the center of the road and usually comprises a 3.5 m wide lane for each direction. Normally there are two lanes for the general traffic in each direction (Photos 23, 24, 25 and 26). At certain section, such as when approaching the terminal, the busway becomes one-way (Photo 27). Typical cross sections of the Ecovía trunk line are shown in the drawing below.



By courtesy of Cesar Arias

- The busway is separated from the general traffic via curbs (Photos 25 and 28). Bus-bus separation is provided by a double line/road marking (Photos 24 and 30).
- The busway has 15 central stops. Thus, each stop serves buses operating in both directions (Photos 33 and 34). As already mentioned, this is unlike most of the route on Avenida 10 de Agosto (see for First stage Trolebus System in "Locations of stops" of Chapter "Busway Design"), where separate stations serve each busway lane. Since Ecovía buses must accommodate passengers from the center stops, the doors on the Ecovía buses are on the left side of the vehicles.
- There are two terminals (Photo 37) are located at the end of the Ecovía busway, Río Coca and La Marín, and two interchange stations, E. Espejo and Benalcázar.
- 42 articulated Euro II diesel buses satisfy the demand on this corridor (Photo 38 and 39).
- 100 feeder buses (Photo) operate 20 services (routes) and take the passengers to the transfer stations and terminals. They also link Ecovía with the Trolebus System and serve 35 districts.
- Suburban-area buses also use terminals and stations, and passengers can easily transfer to outlying communities.
- The estimated demand is of 140.000 passengers/week day. The design demand is of 6.000 passengers per hour per direction.
- The operating speed during peak hour is 20 km/h and trunk line services operate at about 2 minutes in peak periods.

DISCUSSION

The Quito Trolebus and Ecovía schemes are more than two busways; they already represent the first steps of a bus-based mass transit system in Quito. Even if the two schemes are not integrated and the system does not yet cover the whole city, with many buses operating outside, it embodies important elements of a mass transit system, which are:

- high capacity vehicles;
- frequent services provided by trunk line buses;
- rapid and reliable services obtained through the use of segregated trunk (busways);
- a high level image and the appearance of a "quality mode" with well designed bus stops with appropriate signage, bus livery, publicity, passenger assistance, etc. These are aspects that are often missing from bus schemes;
- a increased service speed on busways, with conventional buses in mixed traffic still suffering from heavy congestion (Photos 44 - 46).

The Quito Trolebus system has many positive attributes.

- It uses road space efficiently by carrying 8,000 passengers/hour in one road lane.
- It provides a high level of service to bus users with a bus headway of 1½ minute and a commercial speed of 18 - 20 kph in the peaks and 3 minutes at 20 – 25 kph in the inter peaks.
- The system is highly cost effective and provides a level and quality of service at least equivalent to any tramway or LRT system at a fraction of the cost: about US$ 5 million/km, including all vehicles, busway track, stops and other infrastructure, electric power supply, etc.
- It meets the unique requirements of Quito, a linear city with a vehicle-related pollution problem. The system provides a high capacity trunk line passenger service and has reduced bus volumes in the city centre with consequent reductions in vehicle emissions. Moreover, using clean motive power, i.e. hydro generated electricity, there is no transferred effect of increased pollution due to power generation. This has further contributed to the amelioration of air pollution.
- It has surpassed predicted demand of 140,000 passengers/day by carrying an average of 170,000 passengers/day; such volumes have enabled operation and maintenance costs to be met by fare box revenues. With the extension of the Trolebus line to the southern part of the city, the volume is expected to increase to 230,000 passengers per day.
- It allows to speed passenger boarding/alighting through the use of integrated services (trunk and feeder) and cashless on-bus fares payment, as in Curitiba and Bogotá. This increases the efficiency of bus operations.

The Trolebus scheme has some similarities to the Curitiba model. However, like TransMilenio in Bogotá, it is a "retrofit" system with its main feature, the busways, introduced into an existing road network. Although the Quito Trolebus scheme lacks the integrated land use transport approach, which makes Curitiba unique, it was introduced over a very short time once UPGT was formed, whereas Curitiba was a slower, long-term development. This has demonstrated that it is possible to develop a bus-based, high capacity, high quality mass transit system in a very short time. The Quito Trolebus scheme itself has some unusual operational and design characteristics. Some key points are:

- the second stage scheme utilisation of median bus stops used by buses in both directions, made possible by a bus-bus crossover and is believed to be unique. Usually the use of median stops is accomplished by providing doors on the "wrong" side of buses, as in the busways of Curitiba;
- the use of ramped stops to allow level passenger boarding/alighting to/from high floor buses was the first application, but is now used for TransMilenio in Bogotá.

A key lesson from the Quito Trolebus experience is the manner in which the institutional problems of improving bus services were overcome. Formerly, the Quito bus system was a *de facto* unregulated system with bus license/franchise conditions barely enforced and bus services in decline, particularly in terms of service quality. The creation of a single agency, UPGT, with powers to plan, design, implement and regulate the new bus system was the fundamental technical reason why the Trolebus System was successfully introduced. Nevertheless, the resolution of technical issues was only part of the answer. The proposed scheme was met by resistance from existing private bus operators, and to overcome that resistance, considerable political will was necessary. This was supported by the Quito traveling public who perceived that transit was in crisis, it offered an inferior service and there was no sign of improvement by existing operators, and thus gave its support to the political action to implement the new system. It is also instructive to note that the innovative Trolebus System could only have been implemented under a regulated bus system environment. It was originally proposed that the system should be privately operated but this has not taken place and the system remains under the day-to-day operation of the municipal department UOST.

The Trolebus scheme is undoubtedly a great operational success but some potential issues could be addressed to increase the efficiency and quality of the busway. For example:

- the centrally located busways, particularly with physical bus-traffic separation, result in severance by preventing traffic movements, including local buses, across the main corridor, both by left turns at main intersections and directly across the busway at local roads;
- "tracking" is taking place in the busway. This is not usual if heavy road vehicles run in a confined lane, but is a greater issue in Quito where the axle weights of the large articulated buses is greater than conventional buses in the city. Thus pavement design needs attention.
- in this respect, the main problem encountered was the low quality of asphalt produced by the local petroleum company PETROECUADOR. The lack of rigidity of the asphalt mix has been blamed for routing on the pavement;
- there have been reports of (i) overcrowding at stops and (ii) doors on the stop not fully functional. Furthermore, pedestrian-passenger access to/from stop platforms may be an issue.

As with any scheme, there is a need for constant upgrading, management and improvement and, in this regard, Curitiba sets a model example for cities such as Quito.

The positive attributes of the Ecovía scheme are very similar to those of the Trolebus system and include, among others, the efficient road space use by carrying 6,000 passengers/hour in one road lane and the high level of service to bus users with a bus headway of 2 minutes and a commercial speed of 20 kph in the peaks. It is interesting to notice that the Ecovía buses have their doors on the "left" side (Photos 38 and 39) Another important difference between the two systems is the fact that Ecovía involves private bus operators and so increases the efficiency of operations, with a potential large impact on the future institutional organization of the whole sector.

PHOTO GALLERY

1. Quito Before the Introduction of the Busway System (Photos 1 -3)
2. Trolebus: Busway Layout (Photos 4 - 9)
3. Trolebus: Bus Stops and Terminals (Photos 10 - 19)
4. Trolebus: Vehicles (20 -22)
5. Ecovía: Busway Layout (Photos 23 - 29)
6. Ecovía: Physical Way Separation (Photos 30 - 32)
7. Ecovía: Stations, Terminals, and Passenger Facilities (Photos 33 - 37)
8. Ecovía: Vehicles (Photos 38 - 39)
9. Ecovía: Use of Busway (Photos 40 - 43)
10. Ecovía: Convetional Bus Traffic in Quito (Photos 44 - 47)

1. Quito Before the Introduction of the Busway System (Photos 1 -3)

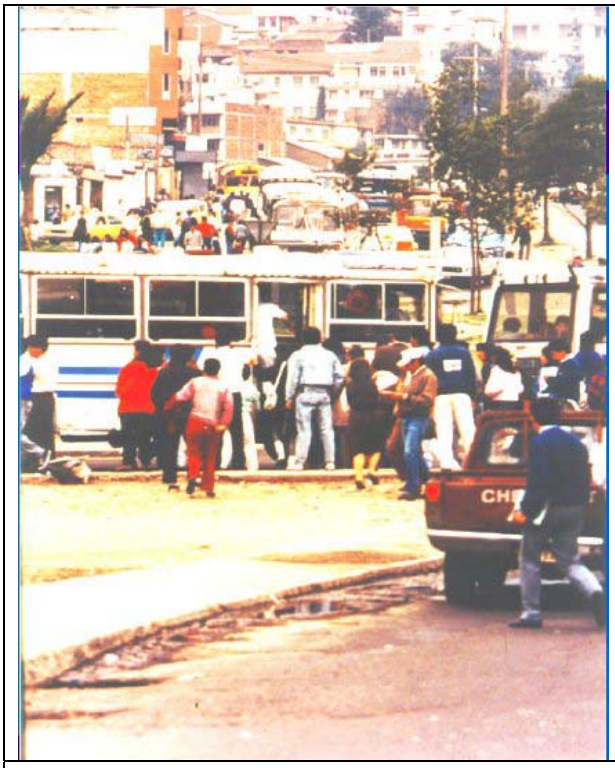


Photo 1 - Quito

By courtesy of Cesar Arias

Key point:

- Quito before the introduction of the new busway system

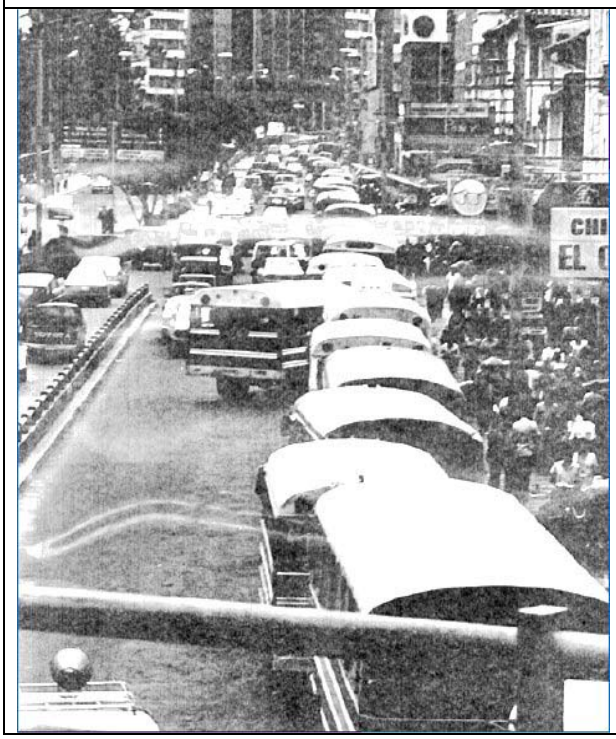


Photo 2 - Quito

By courtesy of Cesar Arias

Key point:

- Quito before the introduction of the new busway system

Photo 3 - Quito

By courtesy of Cesar Arias

Key points:

- Quito before the introduction of the new busway system
- Air polution in the city

2. Trolebus: Busway Layout (Photos 4 - 9)

Photo 4 – First Stage Busway - Av 10 de Agosto - General Configuration

By courtesy of Allen Morrison (http://www.tramz.com/ec/q/00.html)

Key points:

- Physical separation of busway from traffic
- Side road access is right in-right out – crossing of the busway by traffic not possible
- 3 residual lanes for traffic
- Bus stop in background with marked passenger crossing from busway side

Photo 5 – First Stage Busway - Av 10 de Agosto – Bus Stop

By courtesy of Allen Morrison (http://www.tramz.com/ec/q/00.html)

Key points:

- Bus stop platforms are staggered by direction
- Ramp access to stop area to provide level bus-stop for efficient boarding-alighting with high floor buses
- No buses overtaking at stops
- Passenger crossing to stops visible in background but some distance from stop platforms
- Fully enclosed passenger shelter – waiting passengers protected from influence of general traffic
- Single bus-bus line marking separator

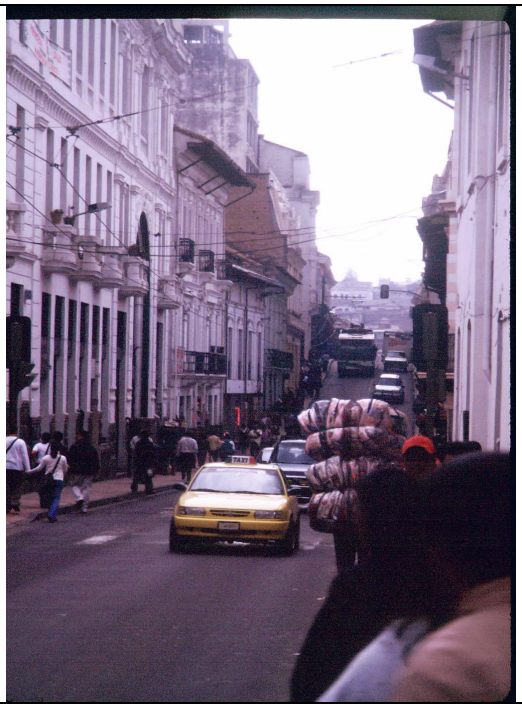


Photo 6 – First Stage Busway (Trolebus) – Crossing the City Center

By courtesy of Cesar Arias

Key point:

- One-way buslane crossing in the city center

Photo 7 –First Stage Busway (Trole bus) – Busway in the City Center

By courtesy of Cesar Arias

Key points:

- One-way buslane in the city center
- Mountable curb separation
- Fully enclosed passenger shelter

Photo 8 – Second Stage Busway (Trolebus) – Bus Stop Platform

By courtesy of Cesar Arias

Key point:

- Single central bus stop for both directions of the busway that requires circulation in "contra flow"

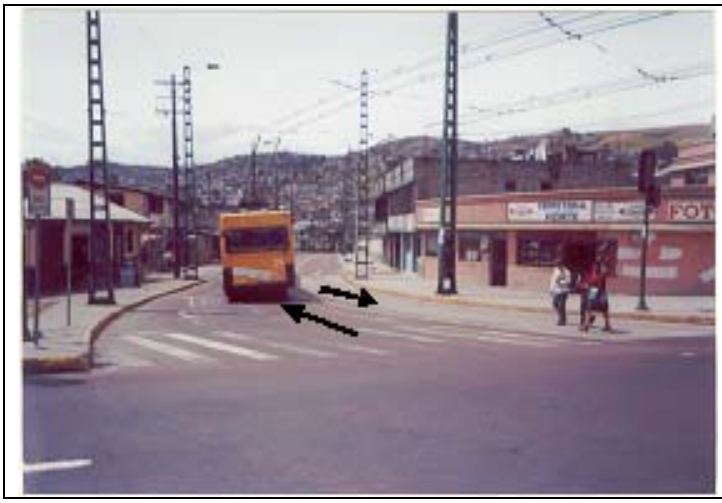


Photo 9 –Second Stage Exclusive Busway (Trolebus)

By courtesy of Cesar Arias

Key point:

- Two-way busway without additional lanes for residual traffic

3. Trolebus: Bus Stops and Terminals (Photos 10 - 19)

Photo 10 –First Stage Busway - Cumanda Station (Trolebus)

By courtesy of Allen Morrison (http://www.tramz.com/ec/q/00.html)

Key points:

- Ramp access to stop (not an on line stop)
- Fully enclosed passenger shelter
- Bus stop on both directions of the busway

Photo 11 –Second Stage Busway - Bus Stop Platform (Trolebus)

By courtesy of Allen Morrison (http://www.tramz.com/ec/q/00.html)

Key points:

- Median bus stop used by buses in both directions after bus-crossover; the power pick up arms of a bus in the other direction can just be seen in the top left of the photo
- Synchronized bus stop doors with passenger loading step deployed on bus

Photo 12 – Trolebus Station

By courtesy of Gerhard Menckhoff

Key points:

- Station with raised stop platforms
- Shelter

Photo 13 – Trolebus Shelter

By courtesy of Gerhard Menckhoff

Key point:

- Bus stop shelter inside

Photo 14 – Trolebus System

By courtesy of Cesar Arias

Key points:

- Inside of the bus stop shelter
- Pay phones and other facilities

Photo 15 – Trolebus System

By courtesy of Cesar Arias

Key points:

- Busway in the city center
- Bus stop shelter

Photo 16 – Trolebus Transfer Station/Terminal

By courtesy of Gerhard Menckhoff

Key points:

- Access ramps
- Protection between vehicles and passenger area
- Timetable information

Photo 17 – Trolebus Transfer Station/Terminal

By courtesy of Gerhard Menckhoff

Key points:

- Level passenger boarding and alighting
- Access ramps

Photo 18 – Trolebus Transfer Station

By courtesy of Gerhard Menckhoff

Key point:

- Level passenger boarding and alighting

Photo 19 – Trolebus System

By courtesy of Cesar Arias

Key point:

- Transfer station/terminal

4. Trolebus: Vehicles (20 -22)

Photo 20 – Trolebus System

By courtesy of Cesar Arias

Key point:

- Articulated Trolley Bus

Photo 21 – First Stage Busway - Approach to Estación Sur (Southern Trunk-Feeder Transfer Terminal) (Trolebus)

By courtesy of Allen Morrison (http://www.tramz.com/ec/q/00.html)

Key point:

- 3 high level doors on bus to provide level floor inside bus and synchronize with stop platforms

Photo 22 – Trolebus System

By courtesy of Cesar Arias

Key point:

- Feeder bus

5. Ecovía: Busway Layout (Photos 23 - 29)

Photo 23 – Ecovía Central Bus Stop

By courtesy of Cesar Arias
Key points:

- One-lane busway in each direction
- Central bus stop serving both directions of bus travel
- Level passenger crossing

Photo 24 – Ecovía

By courtesy of Gerhard Menckhoff

Key points:

- One-way busway in each direction and two residual lanes for general traffic in each direction
- Low-cost physical separation of busway from general traffic

Photo 25 – Ecovía

By courtesy of Gerhard Menckhoff

Key points:

- Central bus stop serving both directions of bus travel
- One-lane busway in each direction and also at stops

Photo 26 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- One-way busway to the terminal

Photo 27 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- One-way busway near the terminal

Photo 28 – Ecovía

By courtesy of Gerhard Menckhoff

Key points:

- Busway cutting through roundabout
- Busway separation from general traffic via curbs

Photo 29 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Busway cutting through roundabout

6. Ecovía: Physical Way Separation (Photos 30 - 32)

Photo 30 – Ecovía Exclusive Central Busway

By courtesy of Cesar Arias

Key point:

- No physical bus-bus separation and separation from general traffic via curbs

Photo 31 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Mountable curbs

Photo 32 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Low-cost busway separation

7. Ecovía: Stations, Terminals, and Passenger Facilities (Photos 33 - 37)

Photo 33 – Ecovía

By courtesy of Gerhard Menckhoff

Key points:

- Central bus stop serving both directions of bus travel
- Traffic light controlled pedestrian crossing

Photo 34 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Spaced pair of stations, station shelter and pedestrian rump

Photo 35 – Ecovía

By courtesy of Gerhard Menckhoff

Key points:

- Central bus stop serving both directions of bus travel
- Traffic light controlled pedestrian crossing

Photo 36 – Ecovía Bus Stop

By courtesy of Gerhard Menckhoff

Key point:

- Narrow shelter

Photo 37 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Terminal

8. Ecovía: Vehicles (Photos 38 - 39)

Photo 38 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Articulated bus with three doors on the left side (note that you are looking at the back of the bus)
- Access ramps

Photo 39 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Articulated trunk line bus with doors on the left side

9. Ecovía: Use of Busway (Photos 40 - 43)

Photo 40 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Taxis not allowed to use the busway

Photo 41 – Ecovía Exclusive Central Busway

By courtesy of Gerhard Menckhoff

Key point:

- Infringement of busway by an "official caravan"

Photo 42 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Police using busway

Photo 43 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Motorcycle infringes busway

10. Ecovía: Convetional Bus Traffic in Quito (Photos 44 - 47)

Photo 44 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Conventional buses stuck in traffic congestion

Photo 45 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Conventional buses stuck in traffic congestion

Photo 46 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Conventional buses stuck in traffic congestion

Photo 47 – Ecovía

By courtesy of Gerhard Menckhoff

Key point:

- Passengers of conventional buses having to cross the Ecovía busway in order to board and alight

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[8] This busway is expected to cost US$12 million, or less than US$1 million a kilometer. Buses International. December 2002. "The way to go in Quito, Ecuador". Spokane, Washington, USA. P. 2. Available online [August 19, 2004] at: http://www.busesintl.com/Dec_2002.htm

[9] It is noted that the TransMilenio scheme in Bogotá uses median stops but they are used for all the busways and thus buses are equipped with doors on the "left" side in a similar way to Ecovía in Quito.

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