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## **A Review of Bus Rapid Transit**

Calgary Transit  
Transit Planning

2002 March

## A Review of Bus Rapid Transit

### Summary

To achieve Calgary Transportation Plan (CTP) objectives requires increased use of transit and decreased travel by private automobile. The CTP recognizes that in order to increase its attractiveness transit travel should be faster, provide a higher level of service and be more convenient. LRT provides these attributes in three quadrants of the city. LRT offers high capacity, frequent service with limited stops, operating within an exclusive right-of-way with grade separations or priority over automobiles. However, in other transportation corridors, it is not expected that LRT will be constructed for quite some time. In other areas, a suitable right-of-way may not be available.

Bus Rapid Transit (BRT) is emerging in North and South America as a relatively low cost means of providing a faster, higher capacity, bus-based transit service along urban transportation corridors. Experience shows that BRT is attractive to urban travelers since it reduces transit travel times and provides frequent, high capacity service. BRT is proving effective in the South American cities of Curitiba, Brazil and Bogata, Columbia. Here BRT services transport over one million passengers a day. The United States government's Federal Transit Administration has sponsored BRT demonstration projects in ten US cities. In Canada, BRT services are operating in Quebec City, Montreal, and Vancouver.

The key elements of BRT are a distinctive and frequent, limited stop service, generally operating on regular roads with transit priority at traffic signals and in areas of congestion. Capital costs for these enhancements are comparatively low. The flexibility of this type of bus service permits the various BRT elements to be phased in as required along a corridor.

Additional features such as enhanced passenger-waiting areas, exclusive bus lanes/roadway sections, higher capacity vehicles and passenger information systems can be added as required or only in selected locations along a route.

Depending on the BRT elements in the design and the type of buses used, BRT passenger capacities will exceed conventional bus service and can approach LRT capabilities. BRT service can accommodate between 5,000 to 8,000 peak hour / direction transit trips without higher capacity buses or provision of a separate right-of-way. Buses capable of accommodating up to 120 passengers can boost this capacity to 12,000 peak hour / direction trips. In comparison, during the peak hour / direction, Calgary's C-Train carries about 6,000 customers on the South Line, 3,700 on the Northeast Line and 3,200 on the Northwest Line. Ultimately, with five car trains, LRT in Calgary is capable of carrying about 30,000 peak hour / direction.

Capital and operating cost data indicate that Bus Rapid Transit applications are significantly less expensive to construct than LRT – i.e. as little as \$0.1 million (Cdn) per kilometre. Due to lower passenger capacities and shorter life expectancy of buses, total vehicle costs would be similar to LRT. However, the operating costs of BRT are considerably higher than LRT on a per passenger basis. Overall, BRT applications on urban arterial streets can be more economical as an interim measure or where demand is not expected to justify LRT service capacities.

## Potential Application of BRT in Calgary

In Calgary, potential BRT applications are corridors where LRT will not be constructed for many years or where demand is not forecast to be sufficient to justify LRT construction. Likely corridors for BRT service include Centre Street N., Richmond Rd. SW, Bow Trail, 17 Avenue SW, Elbow Drive and Southeast Calgary.

Current transit demand projections, based on a 1.5 million population level for Calgary, indicate the following peak hour / direction transit passenger volumes

### Peak Hour / Peak Direction Transit Trips

#### On Major Corridors Entering Downtown

Corridor	Projected Trips 1.5 million	Current Trips
Centre Street N.	10,700	4,300
Bow Trail / 17 Ave SW	4,500	2,200
SE LRT Corridor	5,800	1,200
Elbow Drive	1,300	500

It is important to recognize that BRT requires more vehicles and, when operating in mixed traffic, these buses and transit priority measures will displace some roadway capacity for autos. Planning for BRT applications in Calgary must consider this impact, particularly in the downtown.

## **Introduction**

The Calgary Transportation Plan (CTP) is based on achieving a balance between the community, environment, mobility, and affordability values that were expressed by Calgarians during creation of the plan. CTP objectives rely on Calgarians using their cars less and using other forms of transportation, particularly transit, more. To increase the attractiveness of transit, the CTP recognizes that transit must offer frequent, reliable, and high capacity service that is competitive in speed with the private auto.

In Calgary, LRT service embodies these attributes and has been successful in attracting people to transit. Calgary's LRT provides an economical service that has convenient access and offers travel time and cost saving advantages over the private auto. Travel time saving is attributed to limited stops, a separate right-of-way and priority over traffic outside of the downtown. LRT also provides an attractive travel environment with accessible stations where customers have shelter, security and information.

The CTP transit network recognizes that LRT will not serve all quadrants of the city. Some areas will not generate sufficient travel demand to warrant LRT construction and, in other travel corridors, a continuous right-of-way may not be available. In these corridors other solutions are required to increase the attractiveness and capacity of transit service.

## **Rapid Transit Alternatives**

Typical solutions for providing attractive, efficient and effective transit service in medium and large cities include LRT and busways. Recently, Bus Rapid Transit (BRT) is emerging as an viable alternative.

Calgarians are generally familiar with the concept of LRT. The City of Calgary has one of the most successful LRT applications in the world. The C-Train provides fast, reliable, economical and efficient service to nearly 200,000 customers each day. The strength of LRT is its ability to move large numbers of people over considerable distance in a short period of time. LRT has a relatively low, per passenger operating cost but LRT construction requires a separate right-of-way and a substantial capital investment.

Busways have been built in several North American cities such as Ottawa and Pittsburgh. Essentially, busways are a separate transit right-of-way, but, instead of rails, an exclusive roadway is provided for buses. Like LRT, busways have stations that provide for passenger access to a limited stop service. Passengers access busway service via feeder buses, park'n'ride, and walking. Busways have similar capital costs and operating speeds, but, higher operating costs due to lower vehicle capacities. Busways provide construction and operating flexibility because they can be build in stages, often, only where it is necessary to bypass traffic congestion and buses can operate on regular roadways along other, less congested segments of a route.

The purpose of this report is to provide an overview of the Bus Rapid Transit service concept and describe briefly, how BRT could be applied in Calgary.

## **Bus Rapid Transit**

The concept of BRT is relatively new and its application is evolving following successful applications in South America and several North American cities. Essentially, BRT involves "coordinated improvements in a transit system's infrastructure, equipment, operations and technology that give preferential treatment to buses on urban roadways"<sup>1</sup>. In most applications, BRT is a collection of elements that, collectively, provide a frequent, higher speed, limited stop bus service on existing urban roads.

Interest in BRT is growing because, where it has been implemented, BRT services are approaching the passenger carrying of LRT. BRT service can be initiated at much lower capital cost and with a lesser impact since it is not necessary to create a separate, continuous right-of-way.

In 2000, the United States Federal Transit Administration (FTA)<sup>2</sup> initiated sponsorship of BRT demonstration projects in ten U.S. cities. As well, several other American cities have initiated their own BRT type projects. BRT planning projects are underway in many United States cities including Eugene Oregon, Minneapolis, Boston, Cleveland, Chicago, Honolulu, Miami, Santa Clara and Los Angeles.

Information regarding BRT is available via the Internet and references are included in the Appendix at the end of this report. The following information regarding BRT was obtained from transit industry contacts including the FTA and a recent paper entitled "Mass Transit – Bus Rapid Transit Shows Promise" as referenced above.

### **BRT Features**

BRT is a transit service concept that relies on a number of strategies and design features to achieve an enhanced operating environment for buses and a faster, more convenient trip for transit customers. Depending on local objectives, priorities, budget and environment, a BRT service can include some or all of the following features:

- Bus service strategies that include line haul (buses operate only along major routes similar to LRT) and/or express services that start on neighbourhood streets with limited stops along the main corridors.
- Limited stops (e.g. stops spaced every 1000 to 1500 metres vs 300 metres for local service)
- Enhanced distinctive bus stops, larger shelters and stations.
- Park'n'Ride lots.
- Transit priority at intersections with adaptive signal timing and queue jumpers.
- Bus-only or HOV lanes on existing roadways.
- Exclusive bus roadways or guideways to enable buses to bypass congested areas.
- Pre-boarding fare payment at stops/stations.
- Advanced, real-time passenger information based on automatic vehicle location (AVL) systems.
- Distinctive buses and/or unique higher capacity low floor buses or trams.
- Alternate vehicle power sources for cleaner, quieter operation.
- Guided steering for buses, particularly at stations or in exclusive lanes.

<sup>1</sup> "Mass Transit, Bus Rapid Transit Shows Promise, United States General Accounting Office, Report to Congressional Requesters, GAO-01-984, 2001 September. p5

<sup>2</sup> The FTA is a division of the U.S. Department of Transportation.

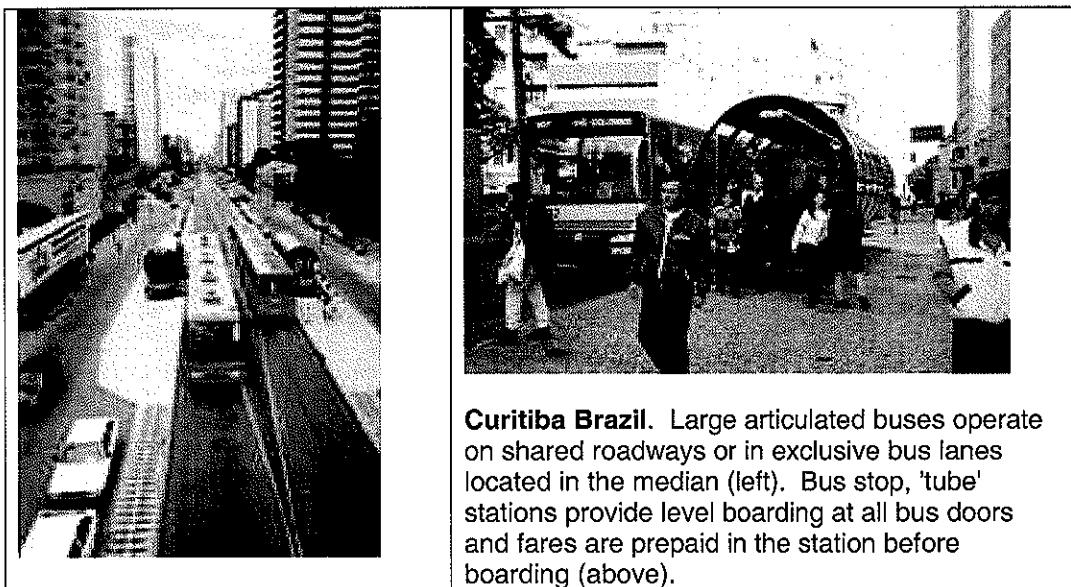
The BRT concept offers significant implementation and operating flexibility. The above features can be added incrementally, as required or incorporated from the outset of operation. BRT services can evolve from a basic bus service over a period of years as demand grows or it can be introduced as a major service improvement for an entire corridor. BRT does not require the significant capital cost of acquiring and constructing a separate right-of-way along its entire length.

Depending on the need and availability of funding, BRT can be implemented in short segments or over considerable distance. Some or all of the key elements of BRT can also be staged depending on local needs and roadway environment. For example, the service could start by using standard buses with signal priority and limited stops. Exclusive bus lanes and higher capacity vehicles could be added as the demand grows.

Bus priority is a key feature of BRT. This contributes to shorter transit travel times and more reliable transit service. The nature and scale of bus priority measures may be dependent on the local street and operating environment. Examples of bus priority applications range from elaborate peak period bus-only lanes using movable barriers, permanent bus only lanes, contra-flow bus operation with separate traffic signals, traffic signal preemption or just special pavement markings or turn restrictions.

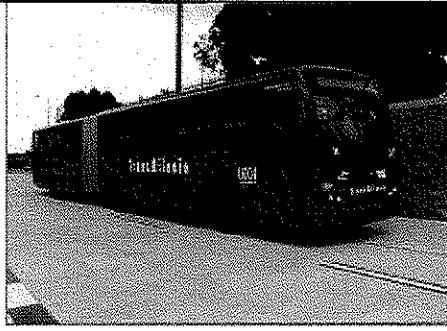
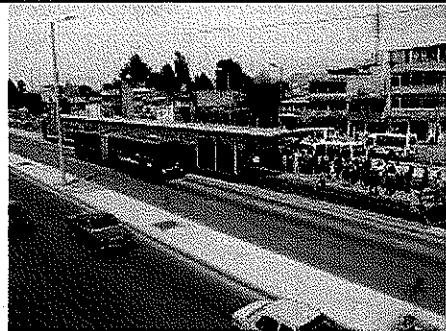
### BRT Examples

The most commonly cited BRT example is found in Curitiba, Brazil, a city of 1.6 million. Here, a BRT network on 5 major roadways is the backbone of a transit system that transports more than 1.3 million passengers per day. High capacity, articulated buses (up to 270 passengers) provide frequent service in exclusive bus lanes located in the middle of the street. Bus stops (or bus stations) are built into the urban streetscape and offer distinctive, enhanced waiting amenities, passenger information, pre-boarding fare payment, wheelchair lifts and raised platforms to facilitate rapid boarding and alighting at all bus doors.



**Curitiba Brazil.** Large articulated buses operate on shared roadways or in exclusive bus lanes located in the median (left). Bus stop, 'tube' stations provide level boarding at all bus doors and fares are prepaid in the station before boarding (above).

In December 2000, Bogata, a city of five million in Columbia, began operating its 42 kilometre 'Transmilenio' BRT system. The system took just two years to construct at a cost of \$8 million (Cdn) per kilometre. Like Curitiba, the system uses high capacity, articulated buses that run on exclusive lanes located in the median of major roads. After one year of operation, the system carries more than 800,000 passengers per day, 45,000 in the peak hour / direction.



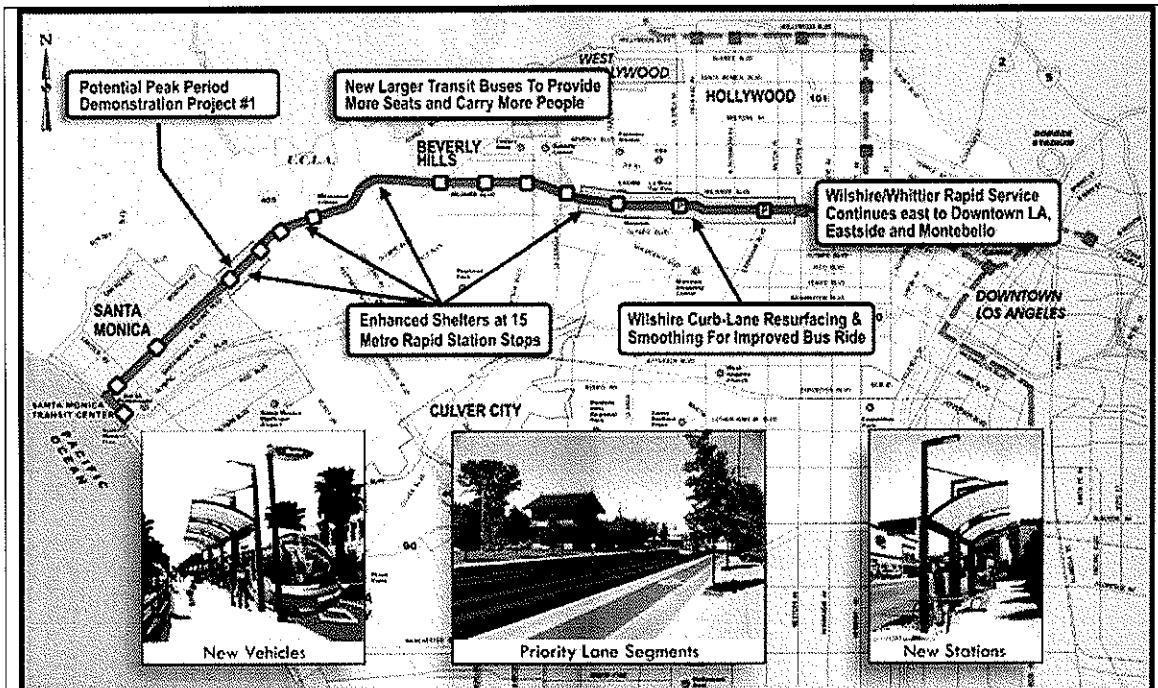
**Bogata, Columbia.**  
Articulated buses operate in exclusive bus lanes with stations located in the roadway medians.

Each of these South American examples represents the application of all BRT elements to a maximum advantage in terms of passenger capacity and operating speed. Costs represent the construction of facilities and purchase of special buses. Sufficient roadway width was available to permit dedication of exclusive lanes for buses and stations. This application of BRT is approaching the scale of a busway operation.

In North America, current BRT examples can be found in Los Angeles, Quebec City, Vancouver and Montreal. These include features such as frequent service, limited stops, traffic priority, enhanced passenger waiting areas, distinctive (and in some cities) higher capacity buses. However, in comparison to the South American examples, these North American examples are on a much smaller scale in terms of infrastructure, vehicles, cost and passenger capacity.

Recently, the City of Los Angeles implemented two significant BRT services – 'Metro Rapid' - along nearly 70 kilometres of two urban arterial roads. The two BRT routes operate on Whittier-Wilshire Blvd. and Ventura Blvd. These services began operating in 2000 June, in less than a year from the initiation of these demonstration projects. Total cost was \$13 million, or \$0.18 million (Cdn) per km.

The Los Angeles Metro Rapid service uses standard, low floor buses with a distinctive paint scheme. Traffic signal priority is provided at all intersections outside of the downtown. Enhanced bus stops are being constructed at a spacing of 1.4 kilometres. The Los Angeles BRT service has been very successful in achieving its goals over a short period of time. Corridor ridership has increased by 27 percent and transit travel time has decreased by 25 percent. These services carry about 40,000 passengers per day. Phase II is underway to construct exclusive bus lanes within these corridors.

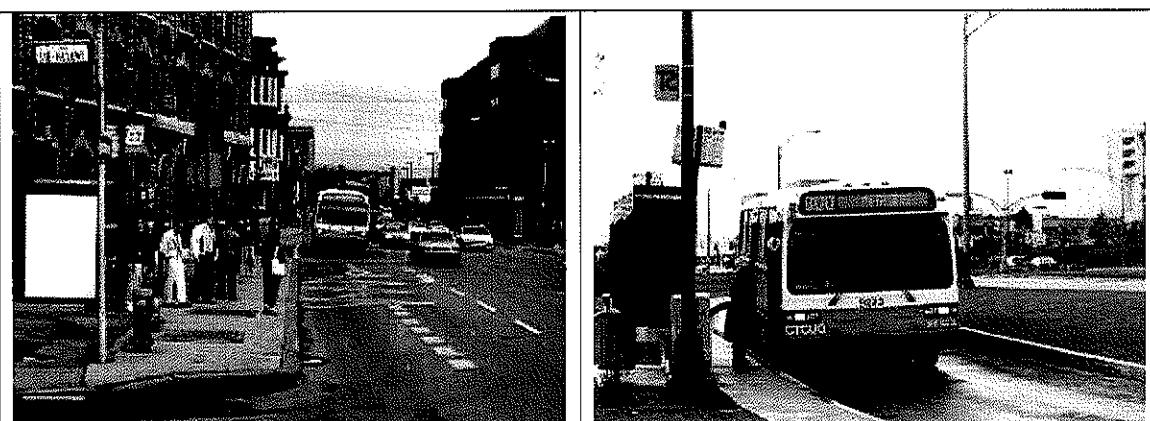


## **M** MIDLITY/WESTSIDE TRANSIT CORRIDOR

## **WILSHIRE BUS RAPID TRANSIT (BRT) PROJECT**

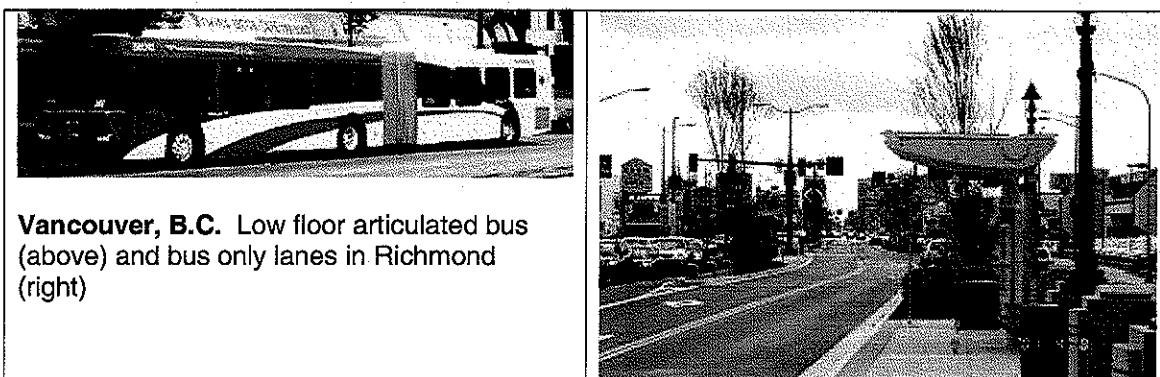
### **Los Angeles – Wilshire Blvd- Metro Rapid Service**

In Quebec City, Metro Bus service was implemented along 3 corridors in 1992. Standard, high floor buses with a distinctive colour-scheme, operate in exclusive, curbside bus-only lanes on three major roadways serving the city centre. Service is every 2.5 to 5 minutes during the peak periods and 10 to 15 minutes in the off-peak. Buses receive priority at some traffic signals. Enhanced bus stop facilities are located at some stops and waiting amenities are being constructed within new commercial or institutional developments along the route. The system carries approximately 2,000 passengers in the peak hour / direction.



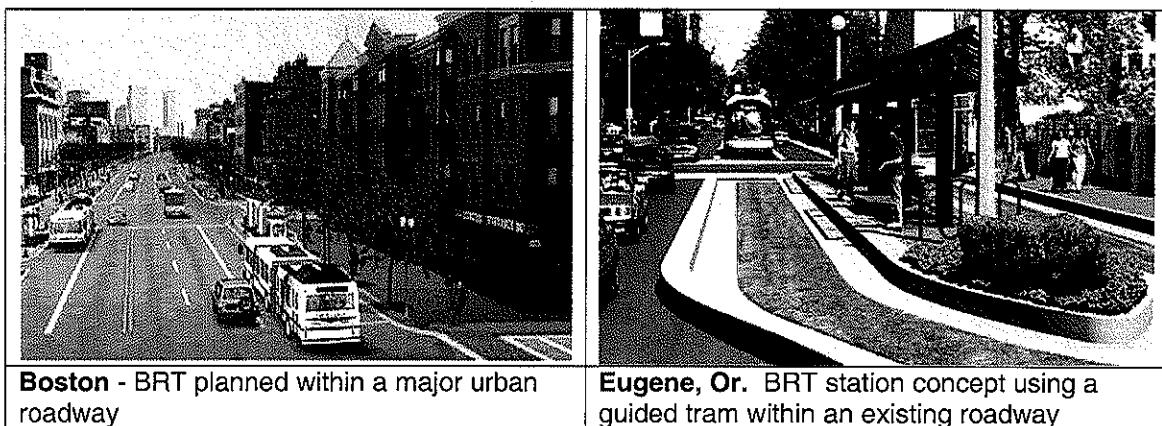
**Quebec City - Metrobus  
Bus Only Lanes and Enhanced Passenger 'Stations'**

In Vancouver, British Columbia, the first phase of 'Rapid Bus' service – 'B-Line' began operating in 1996 September between the downtown and the University of British Columbia. 'B-Line' service is provided using standard and articulated low floor buses operating every 4 minutes in the peak and 8 minutes in the off-peak. The service was successful in increasing ridership (20% of new customers were previous auto users), and reducing travel times by 20 to 40 percent. The service averages 62 boarding passengers per hour. A new 'B-Line' service is being implemented between Richmond and Vancouver via Granville Street. Exclusive bus lanes have been constructed in the Richmond commercial district. Rapid Bus service is planned to provide 3 minute peak and 10 minute off-peak service with a proof of payment system for faster boardings.



### Other BRT Projects

BRT is being examined or planned in a number of United States cities. Each study is reviewing BRT in comparison to LRT. The higher capital costs of LRT and the somewhat disappointing performance of some recent LRT systems in the USA has increased focus on BRT. In each city, the BRT concept is being adapted to the local environment and conditions to address unique situations and opportunities. In addition to the typical BRT transit priority measures and limited stop routes, these projects include elements such as guided busways, new fare systems, high capacity electric trams, and buses with hybrid diesel/electric power



## **BRT Capacity**

The passenger capacity of BRT depends on the frequency of service, speed of travel, number of stops, and vehicle capacity. BRT services using standard buses operating with headways of less than one minute, and limited stops, can carry upwards of 7,000 passengers in the peak hour / direction. By using higher capacity buses (120 to 200 per vehicle) a BRT service could accommodate from 10,000 to 15,000 peak hour passengers in the peak direction. A more likely scenario would involve a BRT service using high capacity buses operating every 3 to 5 minutes on a limited stop route supplemented by express buses serving communities that are outside of walking distance or a short feeder bus ride.

In comparison, during the peak hour / direction, Calgary's C-Train carries about 6,000 customers on the South Line, 3,700 on the Northeast Line and 3,200 on the Northwest Line. Ultimately, with five car trains, LRT is capable of carrying about 30,000 peak hour / direction.

The following section provides comparisons of BRT, busway and LRT capital and operating costs in several cities.

## **Capital and Operating Cost Comparison – LRT / Busway / BRT**

### **Capital Costs**

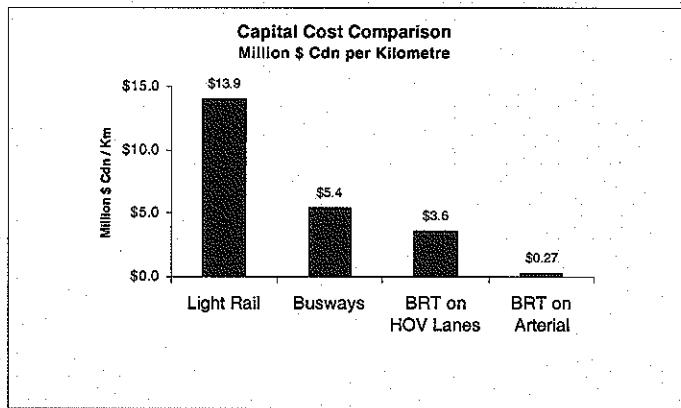
The purpose of this section is to compare the capital vs operating costs of three urban transit system solutions.

It is difficult to compare transit facility construction costs among North America cities due to the influence of each city's local environment and policies on each project. Various design criteria including accessibility, land/right-of-way availability, operating speeds, transit priority features, degree of grade separation, vehicle type, interface with other modes, and availability of funding also affect costs.

The following graph compares the average capital costs for recent projects involving LRT, busways, buses on HOV lanes and rapid bus operations on arterial roads. Costs are based on averages from 13 LRT projects, four busways, eight HOV lanes, and three cities with BRT applications<sup>3</sup>. The data have been converted to year 2000 Canadian dollars per kilometre. These figures include land, stations, park'n'ride, traffic signals, power supply, improved traffic signals, maintenance facilities and special vehicles (if required). BRT costs include roadway modifications, including bus bays, passenger waiting amenities, signage, lane markings, and traffic signal equipment. It is noted that average LRT construction costs for Calgary have been about \$15 million per kilometre.

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<sup>3</sup> "Mass Transit, Bus Rapid Transit Shows Promise", United States General Accounting Office (GAO), Report to Congressional Requesters, GAO-01-984, 2001 September.



#### Range of Capital Costs - \$Cdn per Kilometre

- LRT \$5 to \$48 million
- Busway \$3 to \$22 million
- BRT on HOV \$0.7 to \$15 million (includes physical separation of expressway lanes)
- BRT on Arterial \$0.1 to \$4 million

#### Operating Costs

The following table provides a comparison of LRT and Bus Rapid Transit operating costs (2000) in six United States cities that provide both types of transit services<sup>4</sup>. Operating costs are also included for Calgary LRT and regular bus operations.

#### Operating Cost Comparison – LRT vs BRT (2000 \$Cdn)

	Cost per Revenue Hour		Cost per Passenger*	
	LRT	BRT	LRT	BRT
Dallas	\$310	\$150	\$0.48	\$4.15
Denver	\$190	\$120	\$1.88	\$2.60
Los Angeles	\$670	\$40	\$1.64	\$3.72
Pittsburgh	\$350	\$220	\$3.35	\$5.87
San Diego	\$140	\$160	\$8.68	\$1.84
San Jose	\$310	\$170	\$7.91	\$6.31
Calgary	<b>\$113</b>	<b>\$49</b>	<b>\$0.25</b>	<b>\$0.89<sup>5</sup></b>

\* per boarding passenger

<sup>4</sup> Ibid. GAO-01-984 Bus Rapid Transit

<sup>5</sup> Regular and express bus operation

These data show that in all cities, except San Jose and San Diego, BRT hourly operating costs are approximately half of LRT costs. However, more importantly, the cost per passenger data shows the advantage of LRT, i.e., LRT is considerably cheaper to operate when there is a high passenger demand.

The above capital and operating cost data indicate that Bus Rapid Transit applications are significantly less expensive to construct. Due to a lower passenger capacity and shorter life expectancy of buses, total vehicle costs would be similar. The operating costs of BRT are considerably higher on a per passenger basis. Overall, BRT applications on urban arterial streets can be more economical provided that street space is available for exclusive or priority bus operations.

## **BRT Vehicle Options**

BRT service can be provided using a wide variety of vehicles. These vehicles range from the conventional 12 metre, 60 to 80 passenger buses (low or high floor) to electrically powered, 40 metre trams capable of carrying 120 to 200 passengers. Articulated buses can carry up to 270 passengers. BRT operations can have a mixture of vehicle types. Higher capacity or new technology vehicles can be introduced as passenger demand grows.

The following discussion provides a brief description of the types of vehicles in use or being developed for BRT applications.

### **Typical Urban Transit Bus**

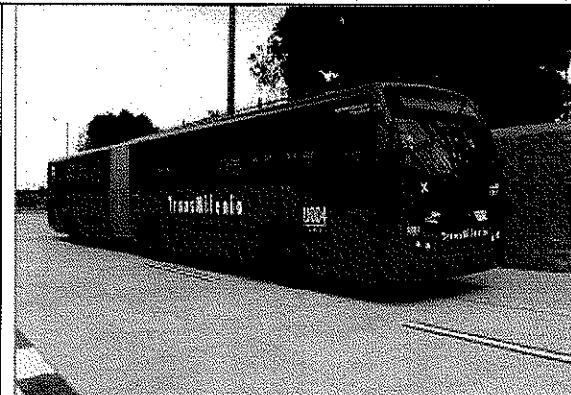
A typical urban transit bus is about 12 metres long (40 ft), with high or low floor designs, 35 to 50 seats and configured to accommodate between 60 to 80 passengers. The most common power source is a diesel engine although other power sources are available (e.g. electric or CNG). These vehicles cost approximately \$400,000 (Cdn.) and have a life expectancy of about 15 years. They are designed to operate on urban collector and arterial standard streets. The cost of an electric trolley bus version of the standard bus is about \$850,000.

### **Articulated Bus**

Longer, articulated versions of the standard bus are available in both high or low floor designs. One or more articulated sections are added to the rear of a standard bus to increase passenger capacity. In Canada, articulated buses operating in Vancouver, Edmonton and Ottawa are 18 metres long (60 ft) and can carry up to 110 passengers (57 seats). These vehicles cost approximately \$700,000 (Cdn.). Use of articulated buses can increase passenger capacity by about 30 percent without increasing the number of buses. Therefore, these buses are best used on high demand routes. In Brazil, buses manufactured by Volvo have multiple articulations and can carry up to 270 passengers. The common power source is a diesel engine. Electric trolley versions are also available at about double the cost of the diesel articulated bus.



**Edmonton's Articulated Bus**



**Bogota Columbia - Articulated Bus**

### **Double Decker Bus**

The double decker bus has been a mainstay of British bus services for many decades. Recently, Victoria, B.C. introduced low floor double decker buses with a capacity of 113 passengers (84 seats + 29 standing). The bi-level design essentially provides a low floor bus seating configuration on the lower level and a high floor bus layout on the upper deck. These buses are the same length as a standard bus (12 metres) with a height of just 4.3 metres (14 ft). Advantages of the double decker bus are: 1) an increased customer capacity; 2) able to use a regular length bus zone; 3) more seats and greater capacity than an articulated bus, and 4) operate as efficiently as a standard bus on congested roadways. Double decker buses are best suited to longer distance, express services where vehicle height is not restricted. Cost of these buses is approximately \$600,000 (Cdn.).



**Dennis Manufactured Bus as Used in Victoria B.C.**

### **Electric Street Car**

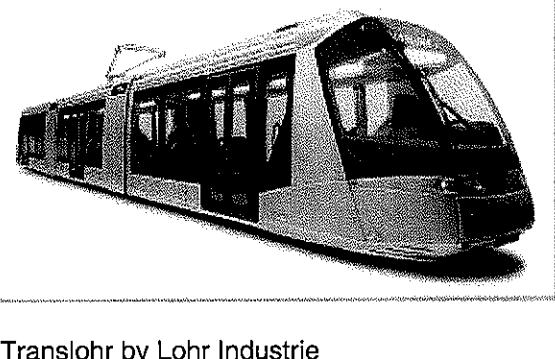
In 1909, the Calgary Municipal Railway began operating and developed a system that had twelve, 40 passenger electric streetcars on 26 kilometres of track. Streetcars operated in mixed traffic, although other vehicle traffic volumes were low compared with today's streets. Electric streetcars served cities throughout the world until the 1950s when they were generally replaced by diesel or electric trolley buses. Some electric streetcar operations continue today, primarily

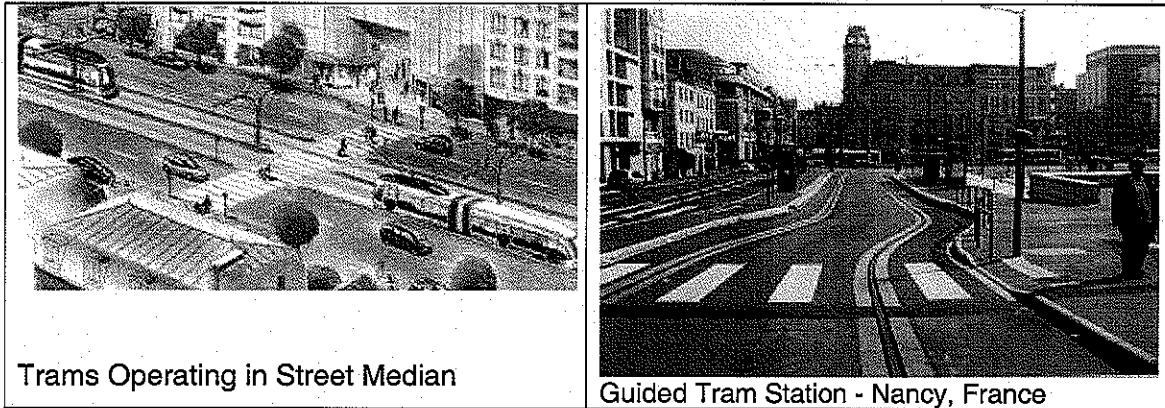
in Europe and, closer to home, in Toronto. The Toronto Transit Commission (TTC) has continued to upgrade its streetcar fleet and today it operates 248 streetcars on major streets. These cars 15 and 27 metres long and have capacity for up to 150 passengers. Cost of these units about \$1.8 million. Higher capacity streetcars are operated in some European cities.

	
<b>Toronto Streetcar</b>	<b>Montpellier France</b>

### Electric Tram

Electric trams are being developed, primarily by manufacturers for European markets. These vehicles are similar in appearance to Light Rail Vehicles (LRVs) but operate on rubber tires versus rail. Examples of this new technology are typically articulated with capacity for up to 200 passengers. Rubber tire trams can operate on separate or shared rights-of-way with electric power provided by an overhead catenary or via an innovative in-ground power supply. Some vehicles under development have the option of being 'guided' by a single street track or via video camera to facilitate operation in narrow rights-of-way and at stations where precision stops are required. Although, most of these trams are being developed and tested in Europe, the City of Los Vegas has purchased new technology trams for a short demonstration service to start in 2002. These vehicles are still under development but are likely to cost approximately \$3.0 million per unit.

	
<b>TVR by Bombardier</b>	<b>Translohr by Lohr Industrie</b>



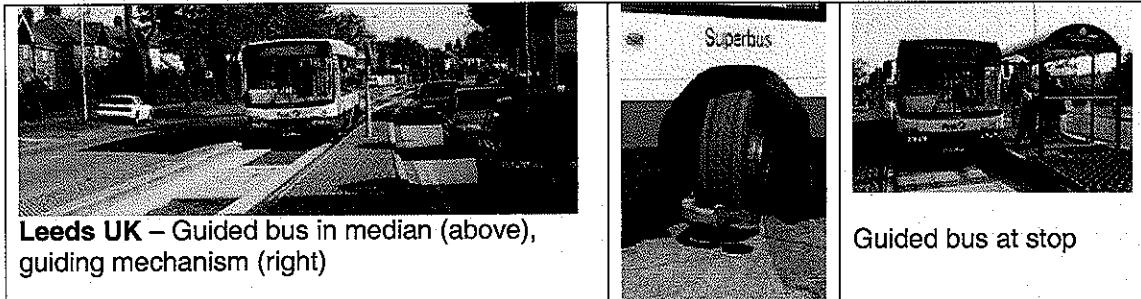
### Alternate Power

There are several power sources available for urban transit vehicles as alternatives to the common diesel engine. The most common alternative is electric motor driven vehicles with power supplied by an overhead catenary. As noted previously, Edmonton, Toronto and Vancouver have operated trolley buses for many years. Electric trolleys provide a cleaner, quieter operation with a smoother ride. However, these vehicles are about double the cost of a diesel bus, are about 25 percent more costly to operate and require a substantial investment in an overhead catenary system that limits the flexibility of operations.

Other alternatives for transit vehicle power include CNG (Compressed Natural Gas), hydrogen fuel cells and hybrid power. These technologies are in various stages of development. CNG powered buses are available and are in use in some cities on a trial basis. However, some concerns with CNG vehicles include bulky fuel storage tanks, a shorter operating range than diesel buses, and more complicated refueling and vehicle storage considerations. Hydrogen powered vehicles are in early stages of development but share some of the limitations inherent with CNG power. Hybrid powered buses run on electricity generated by a small onboard gasoline or diesel engine.

### Guided Vehicles

Vehicle guidance systems permit a steerable vehicle to operate within a narrow roadway or exclusive guideway with nominal clearances. These vehicles are usually regular buses or trams equipped with a physical or electronic guidance system to steer the vehicle. Guided applications in Europe and Australia are typically used along route segments where right-of-way space is restricted (i.e. road medians or tunnels). As well, a vehicle guidance system provides for precision station or platform stops similar to a train operating on rails. The guided vehicles are able to operate using conventional steering for driving to and from the garage and on non-guided route segments, including detours.



### Summary of BRT Vehicle Types

The following table provides a brief summary of various transit vehicle types, passenger capacity, costs, and operating environment.

Comparison of Transit Vehicle Technology

Type	Operating Environment	Power Source	Passenger Capacity	Service Life (years)	Unit Cost (2000 \$Cdn)
Standard Bus	Urban roadway	Diesel	60 - 80	15+	\$400,000
Trolley Bus	Urban roadway with catenary	Electric	60 - 80	20+	\$850,000
Articulated Bus	Urban roadway	Diesel	110 - 120	15+	\$700,000
Articulated Trolley Bus	Urban roadway with catenary	Electric	110 – 120	20+	\$1.8 million
Double Decker Bus	Urban roadway with 14.3' vertical clearance	Diesel	110 - 120	15+	\$600,000
Electric Street Car	Urban roadway with catenary	Electric	100 - 150	25+	\$1.8 million
Tram	Urban roadway with overhead or in-ground power	Electric	150 - 200	30+	\$3.0 million
Light Rail Vehicle	Separate R.O.W with track & catenary	Electric	180 - 220	30+	\$4.0 million

## Conclusion

Bus Rapid Transit is a relatively low cost means of providing a faster, higher capacity transit service along urban transportation corridors. World experience shows that BRT is attractive to urban travelers since it reduces transit travel times and provides higher capacity service. The key elements of BRT are a distinctive and frequent, limited stop service, generally operating on regular roads with transit priority at traffic signals and in areas of congestion.

Capital costs for these enhancements are comparatively low. The flexibility of this type of bus service permits the various elements of BRT to be phased in. Additional features such as enhanced passenger-waiting areas, exclusive bus lanes/roadway sections, higher capacity vehicles and passenger information systems can be added as required or only in selected locations along a route.

Depending on the features incorporated in the design and the vehicles used, BRT passenger capacities will exceed conventional bus service and can approach LRT capabilities. BRT service can accommodate between 5,000 to 8,000 peak hour / direction transit trips without higher capacity buses or provision of a separate right-of-way. Buses capable of accommodating up to 120 passengers can boost this capacity to 12,000 peak hour / direction trips.

## Potential Application of BRT in Calgary

In Calgary, potential BRT applications are corridors where LRT will not be constructed for many years or where demand is not forecast to be sufficient to justify LRT construction. Likely corridors for BRT service include Centre Street N., Bow Trail, 17 Ave. SW, Richmond Rd. SW, Elbow Drive and Southeast Calgary.

Current transit demand projections, based on a 1.5 million population level for Calgary, indicate the following peak hour / direction passenger volumes

### Peak Hour / Peak Direction Transit Trips

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Elbow Drive	1,300	500

It is important to recognize that a BRT operating costs on a per passenger basis will be considerably higher than LRT. However, capital costs are much less and a separate right-of-way is not necessary. BRT requires more vehicles and, when operating in mixed traffic, these buses and transit priority measures will displace some roadway capacity for autos. Planning for BRT applications in Calgary must consider this impact, particularly in the downtown.

## Appendix

### **Internet References for BRT**

FTA – BRT	<a href="http://www.fta.dot.gov/brt/index.html"><u>http://www.fta.dot.gov/brt/index.html</u></a>
BRT Projects	<a href="http://www.fta.dot.gov/brt/projects/index.html"><u>http://www.fta.dot.gov/brt/projects/index.html</u></a>
Bogata Transmilenio	<a href="http://pages.infinit.net/colombia/bogota/trans/transmil.htm"><u>http://pages.infinit.net/colombia/bogota/trans/transmil.htm</u></a>
Leeds, UK Superbus	<a href="http://www.firstleeds.co.uk/index.html"><u>http://www.firstleeds.co.uk/index.html</u></a>
GAO Report on BRT	<a href="http://www.gao.gov/new.items/d01984.pdf"><u>http://www.gao.gov/new.items/d01984.pdf</u></a>