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# Hamilton Rapid Transit Preliminary Design and Feasibility Study

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## B-LINE & A-LINE

### SYSTEM DESIGN GUIDE

Version: 1.0





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### SYSTEM DESIGN GUIDE

Version: 1.0

January 2012

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# 1

## Introduction

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Grand Café  
de la  
Préfecture

DEMOS

Petit  
Casino

# 1

## Introduction

### INTRODUCTION & OVERVIEW

In recent years Metrolinx, as the Regional Transportation Agency for the Greater Toronto and Hamilton Area (GTHA), and the City of Hamilton have produced new visions for how their respective areas will develop in the 21st century. Their focus is on creating a sustainable and attractive GTHA and City.

A set of complementary policy documents have been adopted to help frame the way forward. The regional Land Use and Transportation Plans (Places to Grow and The Big Move) set the context for a set of complementary City plans including the Urban Hamilton Official Plan and the Transportation Master Plan. These in turn support the B-L-A-S-T Rapid Transit network and supporting Nodes & Corridor Plans and Transit Oriented Development (TOD) Guidelines. In combination, all these policy documents provide an integrated approach for the future development of the city. Initial studies have focused on the B-Line with concept plans developed for the corridor. Metrolinx has also

carried out an initial Benefit Case Assessment that concluded that the B-Line should be progressed as a Light Rail Transit (LRT) project. The development of the B-Line has now moved on to the Preliminary Planning Engineering & Design (PDE) phase. At the same time, an A-Line pre-feasibility study is examining alignment and technology (LRT) or Bus Rapid Transit (BRT) options.

A prime focus for the B-Line and A-Line is to use Rapid Transit as a catalyst for achieving wider land use and urban development objectives. The importance of rapid transit and its wider “city shaping” role is highlighted in the Rapid Transit Vision, developed and endorsed by Council:

“Rapid Transit is more than just moving people from place to place. It is about providing a catalyst for the development of high quality, safe, environmentally sustainable and affordable transportation options for our citizens, connecting key destination points, stimulating economic development and revitalizing Hamilton”.



PROPOSED B-L-A-S-T NETWORK

## AIMS AND OBJECTIVES OF THE HAMILTON RAPID TRANSIT NETWORK

The Vision Statement is based on the following core principles supporting the development of a high quality urban style rapid transit network:

- » Fully Accessible
- » Safe
- » Efficient
- » Environmentally Sustainable
- » Maximizing Passenger Convenience
- » Supporting Economic Prosperity
- » Linked to Transit-Oriented Land Use Policies

## THE ROLE OF THE SYSTEM DESIGN GUIDE

This document has been developed to set out the principal components of an urban style approach to LRT in Hamilton, that merges the wider planning and economic development objectives with contemporary best practice LRT design standards. The intention is to combine wider land use, urban design and public realm principles with the detail of the LRT system components, resulting in a “complete street” design guide.

The approach is focused on the B-Line LRT project, with its particular constraints and opportunities, but the principles are applicable to other parts of the B-L-A-S-T network, whether LRT or BRT technologies are selected.

Use and application of the System Design Guide will enable the City of Hamilton to support the development process, in accordance with the Rapid Transit Vision Statement, and City-wide planning and LRT objectives.

The Guide contains examples of urban style LRT projects from a wide range of cities. The intention of these examples is to highlight the principles used to develop urban style LRT, but each city has its own particular requirements (existing urban form, topography, socio-demographics, development opportunities, available corridors, climate etc.). Hamilton will need to apply the urban style LRT design principles to develop specifications that will meet its own requirements.

This Guide sets out the basis for development of proposals, planning and design for an urban style

“Rapid Transit is more than just moving people from place to place. It is about providing a catalyst for the development of high quality, safe, environmentally sustainable and affordable transportation options for our citizens, connecting key destination points, stimulating economic development and revitalizing Hamilton”.

LRT in the B-Line corridor. It provides general design guidance for the LRT system and addresses the key themes necessary to ensure a high quality design. It discusses the relevant strategic system and urban design principles and the key components.

The Guide is to be used to:

- » better inform decision-makers, stakeholders, the public and developers of the design principles applied to the B-Line LRT corridor;
- » illustrate the desired outcomes for the B-Line LRT, in particular its physical form and integration with the City and streetscape;
- » better inform subsequent project stages- detailed design, construction and operation of the B-Line; and
- » aid and inform those involved in future development of the wider Rapid Transit network for Hamilton to ensure a consistent urban style planning approach is applied.

This document is intended to be the primary guidance resource for Rapid Transit system design principles for Hamilton. There are, however, a number of more detailed documents which have

been produced for the B-Line LRT which contain more specific details of engineering and operational design and the land use context. These include:

- » Environmental Project Report
- » B-Line Opportunities and Challenges Study
- » Design Workbooks
- » Plan, Profile and Cross Section Drawings
- » Design Criteria Report
- » Preliminary Operations and Maintenance Plan
- » Transit Oriented Development Guidelines (Volumes 1 and 2)
- » B-Line LRT Opportunities & Constraints report

The Guide draws on and includes selected material from these where appropriate, but should not be taken to provide the same level of detail as the main documents.

### **URBAN STYLE LRT- AN AREA-WIDE APPROACH**

In response to the Rapid Transit Vision the development of the B-Line LRT is focussed on a comprehensive approach that integrates the LRT infrastructure within the existing built form of the corridor, minimizing property take. This

approach retains the relatively tight dimensions of the existing street pattern, safeguarding neighbourhoods as the basis for future Transit Oriented Development (TOD) initiatives.

This results in an urban style LRT design, based on a “complete street” approach that integrates all the LRT system components into the streetscape. The approach to developing the B-Line LRT also applies the hierarchy of transportation users, contained in the City’s Transportation Master Plan (TMP):

- » People
- » Cycles
- » Transit
- » Local Vehicular Traffic
- » Goods Movement
- » Through Traffic

To accommodate these land use and transportation hierarchy priorities an area-wide planning approach has been adopted that provides alternative routes for through traffic and includes a re-cast local transit (bus) network to provide a complementary and comprehensive service when combined with the B-Line LRT.

## URBAN STYLE LRT –AN OVERVIEW

As demonstrated in many cities around the world, modern LRT can help to shape cities, communities and neighbourhoods, with LRT often becoming a focal point for new, higher density, mixed use development. This “Transit Oriented Development” (TOD) becomes an important part of the planning process resulting in a higher proportion of the population living within easy access of LRT allowing a higher proportion of walk and bike trips to access LRT, with less reliance on buses or cars to access the LRT system.

This integration of LRT and land use planning requires a different approach to the development the LRT system components with a greater emphasis on urban design and the fit of the LRT components within the urban form.

In response to the Rapid Transit Vision an integrated approach has been developed for the B-Line LRT corridor. This focuses on the development of a “complete street” design approach and the development of an LRT system designed to “put the passenger first” in terms of convenience, affordability, safety and efficiency.



LRT IS AN ATTRACTIVE TRAVEL ALTERNATIVE  
DUBLIN



HIGH QUALITY URBAN DESIGN IS A KEY FEATURE  
LYON

### KEY FEATURES OF THIS URBAN STYLE LRT APPROACH

- » Using the flexibility of modern LRT systems (gradients, minimum radius curves etc.) to provide alignments that minimize property acquisition
- » Using urban design, landscaping and high quality way-finding to integrate LRT stops with local neighbourhoods, communities and surrounding higher density TOD
- » Using high quality system LRT design and identity (including public art) to help achieve the goal of making Hamilton an attractive and accessible city
- » Comprehensive “complete street” designs integrating the LRT alignment and stops with priority and facilities for pedestrians and cyclists
- » Using the same LRT characteristics to design LRT alignments that provide direct access to and from residential areas and a range of key destinations (shops, places of work, universities, schools, hospitals, entertainment centres etc.) with the aim of maximizing direct walk and cycle access to the LRT system, and minimizing the need for bus connections or park and ride
- » A greater focus on urban design with minimal clutter in the LRT design
- » Low floor LRT stop locations, integrated with surrounding development, to support Transit Oriented Development (TOD), and support local communities and neighbourhoods

### KEY FEATURES OF THIS URBAN STYLE LRT APPROACH

- » A safe and secure LRT design achieved through the adoption of Crime Prevention Through Environmental Design (CPTED) standards, with integrated designs generating a more active setting for LRT stops
- » Modern low floor modular Light Rail Vehicles
- » Segregated LRT alignments, designed within the roadway and primarily at-grade, reducing construction costs
- » Priority for LRT at all traffic intersections
- » A re-structuring of local bus services to provide a complementary network with simple cross-platform transfer.
- » Transit Centres (and park and ride facilities) limited to the outer ends of LRT corridors or at strategic crossing points, but with long-term priority always safeguarded for TOD



**LOW FLOOR STOP INTEGRATED WITH  
SURROUNDING DEVELOPMENT**  
MONTPELLIER



URBAN STYLE LRT INTEGRATED INTO THE STREETScape  
PORTLAND

## STRUCTURE OF THE SYSTEM DESIGN GUIDE

The Guide has been structured to address all the key aspects of the Urban Style LRT approach outlined in this Introduction. The Guide includes the following sections:

- » Section 2: System and Urban Design Principles
- » Section 3: Urban Style LRT
- » Section 4: Creating an Integrated Transit Network
- » Section 5: LRT Stops and their Setting
- » Section 6: LRT Vehicles
- » Section 7: The LRT Alignment
- » Section 8: Other LRT System Components
- » Section 9: Bus Rapid Transit (BRT)
- » Section 10: Next Steps



# 2

## System and Urban Design Principles

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## 2

System and  
Urban Design  
Principles**URBAN DESIGN APPROACH**

The City of Hamilton has chosen an Urban-style LRT approach to the B-Line Rapid Transit design, to serve the city's wider, economic and city-shaping objectives. This approach requires an emphasis on Urban Planning and Design to form the link between the City's Official Urban Plan, Transportation Master Plan, TOD Guidelines and its Rapid Transit network.

Beyond the B Line, subsequent development of the Hamilton B-L-A-S-T network does not yet have a defined mode. LRT is the 'highest-order' mode being considered for Hamilton and can deliver the full range of benefits in city-shaping and transportation terms. That said, given the objectives for LRT in Hamilton, for routes where BRT is chosen as the preferred technology the same approach to the urban realm will be needed.

The approach in developing this System Design Guide has been multi-disciplinary, guided by the principle of 'putting the passenger first' as passengers are the link between transit facilities and transit-oriented regeneration and development. If design is of high quality and considers the 'whole trip' (information, ticketing, safety, convenience,

ease of access, quality of service), then walking, cycling and transit become the easiest and most attractive way for people to travel. Using transit then becomes a lifestyle choice and the many benefits gained include health, sustainability, reduced automobile use and efficient transit operation.



LRT ADDS TO URBAN LIFESTYLE  
MONTPELLIER

The design of the public realm is as important as the design of the transit facilities themselves, as it forms the physical link between transit and the existing and planned developments and communities. In this context, the public realm is defined as the space between and around buildings, in streets and squares, accessible and usable by people.

Its elements include the spaces, building frontages, landmarks and views that define it, as well as the roads, footways, surfaces, hard and soft landscaping, water features, lighting, public art which help to populate it. Together, these elements give the public realm its identity, character, real value and a 'sense of place'. Importantly, the public realm is also dynamic space, used for a purpose; it is not merely a static concept, without a use, rather being enlivened by movement, by activities and by people. World-wide experience shows that such an integrated approach to the urban design and LRT planning will attract more passengers and add value to its urban context.

Opportunities which exist from the introduction of an integrated Urban-style LRT system include:

- » Develop streets as dynamic spaces, including LRT stops as people-generators and city-shapers, particularly in relation to TOD developments;
- » Theme sections of the LRT route, using lighting, colour, materials, landscaping and water features;
- » Develop an integrated lighting strategy, to provide the LRT route with a unique and strong identity, while also enhancing the urban fabric of the city;
- » Facilitate city-shaping at important intersections and locations, as well as at LRT stops, with features identifying the location, physical and visual links, directions and inclusion of urban spaces;
- » Create destinations, using distinctive designs for LRT stops, creating or reflecting area identities, potentially related to facilities such as entertainment, open space, exhibition areas etc.;
- » Locate LRT stops to take advantage of views; to create identity and a sense of place at specific locations; and to maximize views of key landmarks;

- » Integrate LRT with the urban design of the public realm, providing opportunities to justify both public and private sector investment in LRT and the associated corridors.
- » Incorporate public art in formal and informal ways along the route, at stops, on the pedestrian links to the route.”

Another key difference to the Urban-style LRT approach to design is a greater emphasis on urban design and TOD integration with land use. These aspects are fundamental to the success of the approach and are not to be considered optional aspects of urban style LRT design. Rather, the design approach should be considered as an urban design process that includes the key LRT components.

### **TRANSIT ORIENTED DEVELOPMENT (TOD) COMPONENT**

TOD can be defined by four key characteristics:

- » compactness of development
- » mixed uses
- » proximity to transit facilities
- » a high quality pedestrian environment.

The benefits are those associated with ‘smart growth’, a more even balance between automobile use and other modes (transit, walking and cycling), a reduced need to travel in general, and a more intensive land use pattern:

- » reduced automobile traffic
- » reduced energy use and emissions
- » opportunities for Transport Demand Management (TMD)
- » health benefits from increased exercise
- » revitalization of urban communities

The City has developed TOD guidelines that establish principles for the implementation of general policies in land use planning, zoning and development. They are set out in TOD Guidelines for Hamilton (Volumes 1 and 2) published in 2010 and are discussed later in this section.

Transit Oriented Development will form an integral part of delivering the B-L-A-S-T network for Hamilton, focusing higher density residential and employment growth around transit. It will therefore be essential that development is intensified around LRT stops in the B-Line corridor.



USING LRT TO ENHANCE EXISTING URBAN AREAS  
PORTLAND

Transit oriented development needs to create attractive, liveable, compact neighbourhoods with housing, jobs, shopping, community services and recreational opportunities within convenient walking distance of a node.

The introduction of LRT, brings opportunities for Transit Oriented Development (TOD) in two ways:

- » As a means of servicing, supporting and sustaining existing and currently proposed developments; and
- » As a means of stimulating development which might not otherwise take place, change land use, or instigate development earlier.

Transit Oriented Development needs to be considered throughout the LRT implementation process. It will be important to identifying appropriate locations, considering various land uses and scales of development at an early stage in system development to ensure the LRT infrastructure is designed to accommodate demand and provide integration.

The quality of design of the LRT system and the way in which it is integrated with its surroundings will add further value and increase potential for developments. In turn, the design of any higher density, mixed use developments should generate more LRT riders.

TOD developments linked to LRT should be designed to:

- » Be walkable, livable communities with development and activity focused on LRT stops and transit centres;
- » Minimize the need for automobile travel, by providing an attractive transit alternative;
- » Link LRT investment to higher density, mixed-use, smart growth development and land-use; and
- » Integrate Transportation Demand Management policies with LRT investment.

The TOD design approach also requires a focus on high quality urban design to set the context for the detailed design of the LRT system components. The following table summarizes the principles set out in the City's TOD Guidelines.

PRINCIPLES	SUMMARY OF GUIDELINES
1. Promote place making – creating a sense of place	<ul style="list-style-type: none"> <li>» Transit stations/stops part of a focal point</li> <li>» Unique buildings or designs</li> <li>» Encourage public spaces and public interaction</li> <li>» Buildings and public spaces oriented to the street</li> </ul>
2. Ensure a Mix of Appropriate Land Uses	<ul style="list-style-type: none"> <li>» Mixture of land uses</li> <li>» Travel in both directions along a transit line</li> <li>» Diversity in housing types/tenures</li> <li>» Discourage auto-oriented uses</li> </ul>
3. Require Density and Compact Urban Form	<ul style="list-style-type: none"> <li>» Density conform with the Official Plan/Secondary Plans</li> <li>» Densities can be provided by a variety of building types</li> <li>» Cluster mixed uses and density within 400m</li> </ul>
4. Focus on Urban Design	<ul style="list-style-type: none"> <li>» Design should be context-specific and respecting existing character and heritage</li> <li>» High degree of urban design and architectural variety</li> <li>» Positive pedestrian environments and transit access</li> </ul>
5. Create Pedestrian Environments	<ul style="list-style-type: none"> <li>» Sidewalks accessible to all; allow ease of movement</li> <li>» Safe and inviting places for pedestrians</li> <li>» Plan transit stations and developments for pedestrians</li> </ul>



USING LRT TO CREATE A PLACE. UNIVERSITY CAMPUS LYON

PRINCIPLES	SUMMARY OF GUIDELINES
6. Address Parking Management	<ul style="list-style-type: none"> <li>» Innovative parking management strategies</li> <li>» Appropriate balance of parking</li> <li>» Parking not be the focus within TOD areas</li> </ul>
7. Respect Market Considerations	<ul style="list-style-type: none"> <li>» Leverage increased land values</li> <li>» Transit alone will not drive market demand</li> </ul>
8. Take a Comprehensive Approach to Planning	<ul style="list-style-type: none"> <li>» Transit and LU planning decisions made in conjunction</li> <li>» Coordinate development of stations based on role in broader urban structure and City-wide initiatives</li> </ul>
9. Plan for Transit and Promote Connections (for all modes)	<ul style="list-style-type: none"> <li>» TOD areas should have a high degree of connectivity</li> <li>» Higher order TOD areas provide for integration and transfer between modes</li> </ul>
10. Promote Partnerships and Innovative Implementation	<ul style="list-style-type: none"> <li>» Establish partnerships when developing TOD areas to leverage the strengths of different groups (private, public, community)</li> </ul>

SOURCE: TOD GUIDELINES FOR HAMILTON

## URBAN DESIGN COMPONENTS

The proposed B-Line LRT provides the opportunity to integrate transit with improvements in the urban environment along the proposed corridor to maximize the benefit both in term of transit provision but also community and urban cohesion. The application of urban design principles to the development of modern urban-style LRT will ensure that the LRT connects with people and places and meets the need of the people of Hamilton and the City’s wider planning objectives.

The consistent application of the urban design principles will be central to the successful development of the LRT system and its integration within the corridors and communities through which it runs.

The urban design aspects of LRT system design are important to support the development process, providing general urban design guidance for the introduction of LRT to existing urban settings, and setting out the principles that should be applied throughout the design development, implementation and operation of the LRT system.



LRT SUPPORTING TOD DEVELOPMENT  
DUBLIN

## URBAN DESIGN PRINCIPLES

The City of Hamilton’s approach to Urban Design follows the overarching principles of Urbanism; of Design Excellence; and of Scale, Connections and Context.

### APPLYING THE PRINCIPLES

The B-Line LRT, and the other B-L-A-S-T routes, will operate in a constrained corridor where there are many competing demands for the limited space that exists. Within this context, and as far as is practicable and deliverable, an integrated approach to the wider urban design and public realm should be applied, with the following features:

- » **People-generating and City-shaping:** To use the introduction of LRT both to stimulate and to maximize its role in people-generating and city-shaping, including at Stops, Mobility Hubs and for Transit Oriented Development (TOD).
- » **Integration with the Public Realm:** To fully integrate Rapid Transit into key urban situations, taking advantage of opportunities to improve the urban realm, attracting ridership and increasing value in its surroundings. Special attention should be placed at priority locations such as key nodes, rapid transit stops, community destinations and major pedestrian traffic areas.

## URBAN DESIGN PRINCIPLES

**Urbanism:** Enhancing the City; the Neighbourhood, the District, the Corridor; the Street, the City-block and the building;

- » Restoring and enhancing the urban fabric; Developing sustainable communities and diverse districts; Conserving the natural environment; Respecting Hamilton’s historic and built legacy.

**Design Excellence:** Exemplifying design excellence by incorporating, interpreting and integrating design principles of Quality; Innovation; Sustainability and Durability to the greatest extent possible, consistent with best contemporary practice:

- » Sustainability as an integral component of the Design; Appropriate use of Innovation;
- » Integration and encouragement of Public Art and Culture;
- » Use of durable, permanent and timeless Materials.

**Scale, Connections and Context:** Reflecting Location, Human Scale and Neighbourliness; Respecting Heritage and Environment; Making Connections:

- » Demonstrating appropriate scale, integration of design elements and fit within the context of the precinct;
- » Celebrating Hamilton as ‘the Community of Communities’; exemplifying Neighbourliness; celebrating, engaging and enhancing the specific context of Location;
- » Celebrating and respecting Heritage;
- » Enhancing and preserving Connections.

- » **High Quality Public Spaces:** To create attractive, efficient, usable public spaces, including public art.
- » **Integration with Environmental, Historic and Heritage settings and Development context:** To respond sensitively to the surrounding built environment and to contribute to the setting of important and historic buildings, spaces and parks, as well as of proposed new developments.
- » **Improving Pedestrian, Cyclist and Public Accessibility and Environment:** To improve the pedestrian, cyclist and public environment, including its safety, climate and weather protection and usability, including fully accessible barrier-free street environments.
- » **Zoning Streetscape/ Minimizing Street Clutter:** To optimize usability through zoning of infrastructure and activities across the street cross-section; minimizing the impact of signage, signalling, lighting, overhead catenary system (OCS/ OLE), utilities and general street furniture within the streetscape, through rationalization and combining of these elements.



USING SURFACE TEXTURES AND LANDSCAPING TO ZONE THE STREETScape

LYON



BORDEAUX

» **Appropriate Materials and Landscape:**

To use materials (natural and man-made) and landscape appropriate to context and sustainability.

» **Sustainability and Energy-efficiency:**

To adopt low-maintenance and sustainability principles, including cost and energy-efficiency, durability, cost-in-use and whole-life-costing approaches.

**LANDSCAPE DESIGN**

The “urban fit” of the LRT within communities is a key aspect of the urban style integrated approach. Retention of existing features (buildings, trees etc.) is encouraged to generate a high quality design that complements existing assets. In this regard opportunities should be taken to strengthen and improve the streetscape through additional tree planting, and hard and soft landscaping. The focus should be on the application of the urban design principles to produce a high quality design, and at the same time ensure that materials and planting are durable and appropriate for the

Hamilton context. Where any tree removal is required efforts should be made to provide like-for-like replacements within the LRT corridor.

Rapid Transit should use the landscaping and use of trees to generate or reinforce civic spaces and activities, improving the streetscape and public realm and developing a sense of place and integrating movement within transit oriented development.

All transit passengers are pedestrians at some stage in their journey. Stop areas and public plazas are key locations in which to provide accessibility, amenity and attraction for transit. Similarly, streetscapes should be the gateways to cities, and neighbourhoods; their ability to include transit and provide “transit-oriented communities” with a wider transportation choice (walk, bike, transit) will be central to the success of the Hamilton project and fulfilling the Rapid Transit Vision Statement.



PUBLIC ART CAN ADD ENTERTAINMENT TO THE STREETScape  
DUNDEE



LOCAL PUBLIC ART CAN ENHANCE THE STREETScape  
PORTLAND

## PUBLIC ART

Public Art should be an integral component of the comprehensive “complete street” design approach for LRT. Many LRT systems around the World have used public art as a design component to help promote a city image. This can be achieved through “statement public art” initiatives at major focal points on the LRT corridor.

Alternatively, or as a complement, smaller scale public art can also be incorporated along the alignment or along links to the alignment. This smaller scale approach has been used as a focus for community engagement, encouraging a sense of community identity and “ownership” of the LRT system. This community-based public art can take many forms including the design of stops, the livery and branding of Light Rail Transit vehicles, and local installations, including lighting and other features. A Hamilton-specific Public Arts LRT Strategy should be developed for the B-Line, linked to wider urban design and public arts initiatives in the corridor.







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## Urban Style LRT

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# 3

## Urban Style LRT

### WHAT IS URBAN STYLE LRT ?

This section of the System Design Guide provides an overview of the components of Urban style LRT and the principles that need to be applied for it to be a success in Hamilton. Subsequent sections of the Guide provide further detail of the main system components.

Older style LRT systems introduced in North America during the late 1970s/early 1980s were based on heavy rail technology, featuring separate railway rights of way. The LRT alignment would commonly consist of ballasted track, with signals and barriers at traffic intersections, or major grade-separated structures.

The Light Rail Transit vehicles were normally around 30 metres in length and were operated in coupled trains. With their mechanical and electrical equipment placed around the vehicle bogies the result was a “high floor” system, with the passenger area commonly being around 0.6-0.7 metres above track height.

This resulted in the need for high platforms, with ramp and step access to provide level, step-free boarding and alighting to and from the vehicle at platform level. As a consequence LRT stops became major station structures that were difficult to design into

downtown streetscapes. This often resulted in high platforms being eliminated, with normal passenger access being via 2-3 internal steps inside the Light Rail Transit vehicle. Limited ramps and/or lifts were supplied at the ends of platforms for wheelchair users.



Due to the tighter street layouts commonly found in European cities, and the greater difficulty in designing LRT into these streetscapes, the approach to LRT system design has been more integrated, leading to an approach termed “Urban style LRT”. Over the last 20 years this has become a common standard for many of the modern LRT systems around the World.

which are often integrated into the sidewalk. This provides much more scope for high quality streetscapes, without the intrusion and barrier effect of high platforms. The modular LRT vehicle is also better able to serve key downtown locations directly, providing more convenient and efficient services for passengers.



The main technical change to the urban style Light Rail Transit vehicle has been to store its mechanical and electrical equipment on the roof of the vehicle. This has allowed the development of “low floor” vehicles, with a floor height of around 300-350mm above the track. In addition, Light Rail Transit vehicles, have been designed in a modular form, with multiple articulated joints,. This allows the vehicle to run on tighter curved track.

Urban style LRT is a flexible mode that can operate in many environments, varying from an equivalent of suburban rail or subway operation, through segregated on-street operation, to shared routing through pedestrian areas. This enables the form of the infrastructure to be tailored to the urban fabric on each section of route, in turn permitting complementary measures to be applied to the rest of the street environment, to the benefit of all users.



Both of these innovations have allowed a new approach to the design of LRT into urban areas. Low floor LRT only requires low floor platforms



URBAN STYLE LRT FOR HAMILTON

As demonstrated in many cities around the world, the flexibility of urban style LRT can help to shape cities, communities and neighbourhoods, with LRT often becoming a focal point for new, higher density, mixed use development. This “Transit Oriented Development” (TOD) becomes an important part of the planning process resulting in a higher proportion of the population living within easy access of LRT allowing a higher proportion of walk and bike trips to access LRT, with less reliance on buses or cars to access the LRT system. This integrated approach to land use and transportation requires an area-wide planning approach that considers LRT as part of a wider set of transportation choices.

### AN AREA-WIDE APPROACH TO LRT PLANNING

To complement the links with land use, for many cities the introduction of urban style low floor LRT has also been part of a shift to creating an Integrated Transit Network. The key to this approach is the development of a wider transportation hierarchy. For different parts of the transportation network priority is given to different modes. In urban areas the priority is now often for pedestrians, cyclists,

transit users and local traffic over through traffic. The needs of servicing and delivery vehicles and the emergency services also have to be accommodated within the transportation hierarchy.

The overall aim of the transit-focussed land use with priority to the pedestrian, cyclist and transit-user is to create a more sustainable, attractive and lively city that is not dominated by the needs of the automobile. The auto is not excluded, but forms part of a more balanced transportation network.

One of the key design principles for urban style LRT is to maximize the journey speed, reliability and punctuality of the new system. This is achieved by providing a segregated, dedicated right of way for the LRT within the street space, and by providing priority for the LRT at signal-controlled junctions.

In situations such as the B-Line corridor, where there is also a wider need to safeguard existing properties and the wider urban form, including trees and landscaping, there is a need to consider the re-allocation of road space. With the transportation hierarchy giving priority to pedestrians, cyclists, and transit there is a need to develop a comprehensive area-wide set of measures.



CLEAR DELINEATION OF STREET COMPONENTS

LYON

These including alternative routes for through traffic, and revisions to the local transit (bus) network to restructure bus services so that they complement the LRT, eliminate duplicate services, and provide a comprehensive and convenient integrated transit network, designed to offer a high quality service for as many passengers as possible. The design of the Integrated Transit Network should also include consideration of comprehensive information systems and way-finding and be designed applying CPTED guidelines to ensure that the network is safe and secure for users.

### URBAN STYLE LRT DESIGN PRINCIPLES

This integration of LRT and land use planning requires a new approach to the development the LRT system components with a greater emphasis on urban design and the fit of the LRT components within the urban form. Amongst the most successful and best regarded LRT systems, particularly in Europe and North America, are those which have been designed as “complete streets”, fully integrated into the streetscape and public realm through which they pass and to which they add real value.



A COMPLETE STREET DESIGN INCLUDING URBAN STYLE LRT  
LYON

The proposed routes will run in highly visible alignments, along existing streets. The design of the route infrastructure, including track, overhead line and stops needs to reflect this visual prominence, and be fully integrated into the surrounding urban fabric. In particular, many of the LRT stops will form an integral part of the sidewalk or other pedestrian realm. The needs of LRT passengers are similar to those of other pedestrians, and a single approach to pedestrian needs is appropriate. This will include an integrated approach to way-finding to assist all pedestrians.

**URBAN-STYLE LRT- KEY COMPONENTS**

The key features of this urban style LRT approach are summarised in the following table. This is followed by a table providing further details of the design components of an urban style LRT. In combination these tables provide the core information needed to develop the detail of an Urban Style LRT project. They should be used as a checklist to guide the next stages of project development for the B-Line, and other parts of the B-L-A-S-T network.

DESIGN COMPONENT	DESIGN PRINCIPLE
Vehicle	<ul style="list-style-type: none"> <li>» Form: multi-section articulated, to minimize swept path</li> <li>» Low floor (~350mm at doors)</li> <li>» Length: typically 30 metres or 40 metres</li> <li>» Width 2.65 metres</li> </ul>
Alignment	<ul style="list-style-type: none"> <li>» Alignment width 7 metres with widening through curves</li> <li>» Running at grade</li> <li>» Central or side running within street</li> <li>» Minimum curve radius: 25 metres</li> <li>» Maximum gradient: 8%</li> </ul>
Segregation	<ul style="list-style-type: none"> <li>» Target of 100% segregation (reserved space within the road)</li> <li>» Reallocation of road space for the exclusive use of the LRT system, whilst retaining appropriate levels of road capacity and accessibility to meet the differing local needs along the length of the route</li> </ul>

DESIGN COMPONENT	DESIGN PRINCIPLE
Priority	<ul style="list-style-type: none"> <li>» 100% priority at signalled intersections</li> <li>» Automatic Vehicle Location System employed to provide priority through signalled intersections to help facilitate reduced journey times and greater journey time reliability</li> </ul>
Stops	<ul style="list-style-type: none"> <li>» Platform height ~350mm above top of rail (level boarding)</li> <li>» End ramps at 5% gradient</li> <li>» Fully integrated with adjacent pedestrian areas (e.g. at rear of platform) where possible</li> <li>» Step-free access</li> <li>» Length: as required to accommodate the longest vehicle in use</li> <li>» Width:               <ul style="list-style-type: none"> <li>3 metres, side platform</li> <li>4 metres, island platform</li> </ul> </li> <li>» Integrated with existing pedestrian crosswalks at intersections as appropriate</li> </ul>

DESIGN COMPONENT	DESIGN PRINCIPLE
<p><b>Stop Infrastructure</b></p>	<p>Stop facilities to provide a distinct image for the system with the stop infrastructure built up from a standard kit of parts to meet the expected demand.</p> <p>Stops elements to include:</p> <ul style="list-style-type: none"> <li>» Dedicated stop infrastructure;</li> <li>» Branding;</li> <li>» Shelters;</li> <li>» Seating;</li> <li>» Ticketing;</li> <li>» Passenger Information;</li> <li>» Real Time Information;</li> <li>» CCTV;</li> <li>» Help Points;</li> <li>» Passenger Announcements</li> </ul>
<p><b>Roadway</b></p>	<p>Where possible, development of the route to minimize impacts to parking and access or provide alternative arrangements where required.</p> <p>Design to minimise cross-corridor traffic impacts, though a number of more minor intersections may need to be converted to 'right-in, right-out' to provide greater length of segregated running.</p>

## URBAN STYLE LRT AND CITY IMAGE

### SYSTEM IDENTITY

To reinforce and create an iconic LRT system a brand identity should be developed to maximise the benefits from the network. For the LRT system to compete with the automobile, it needs to be perceived as more than just functional. LRT vehicles, product and graphic design should create a visually coherent whole that is modern, functional, simple and elegant. A distinctive system identity that communicates the core system vision, matched by a consistent quality of service delivery, will help build customer trust and reinforce the system objectives.

In creating a brand it will be important to ensuring that the design of the LRT system takes a comprehensive approach to create a unique, universally identifiable system that is fully integrated and compatible with its surroundings.

In order to achieve this unity the identity has to be consistent and followed through in the design of the fixed infrastructure. This includes the masts and overhead power supply for LRT, the segregated right of way/track-bed, stops, lighting, signing,

equipment cabinets, sub-stations for LRT and other related infrastructure which will form part of the streetscape, and other integrated developments including the Maintenance & Storage Facility.

In addition the branding, while clearly marking out LRT as a distinct mode, should also emphasise the complementary nature of the LRT and local transit (bus) networks, to encourage their perception of an integrated transit network available for a wide range of trips.

The system brand should include:

- » LRT Vehicles - Livery designs for vehicle interiors and exteriors/ Internal vehicle layouts that ease overcrowding and are fully accessible
- » Signing & Passenger Environments - Sign guidelines covering way-finding, graphic information and product design/ intuitive design for passenger interfaces
- » Customer Information Systems - Simple, customer focused information including maps/ real time displays/ timetables/ audio visual systems/ new media



**DISTINCTIVE SYSTEM IDENTITY**  
MONTPELLIER



INDIVIDUAL LINES CAN HAVE DIFFERENT LIVERY  
MONTPELLIER

### VEHICLE LIVERY

Branding of the LRT vehicles will be important in order to help to draw together all system elements and to create a positive image and overall identity. A key factor in branding will be the vehicle livery. Livery can provide a point of conversation about a system and contribute to the overall image of a City.

A well-designed livery can significantly improve the appearance, visual impact and attractiveness of an otherwise undistinguished vehicle. Equally, a poorly designed livery can be detrimental to otherwise sophisticated and elegant system elements.

As part of the branding strategy consideration should be given to whether a consistent vehicle livery is to be applied across each of the B-L-A-S-T network routes as they are delivered or whether distinct liveries, to identify individual routes, are preferred.

### ADVERTISING AND BRANDING

Using LRT vehicles for advertising can help offset some of the operating costs of the system, but excessive advertising can create a downmarket or commercial image.

It is important that advertising displays do not affect the visibility of lights, signals or route signs inside or outside the vehicles.

Advertising could be located externally or internally. External 'all over' displays would have the greatest impact on the image of the vehicle. If advertising is restricted to the vehicle sides then it will have less impact on the image of the system.

Any internal advertising would have a minimal image impact. Advertising at stops is an option as long as the displays are well managed and maintained.



STRASBOURG





# 4

## Creating an Integrated Transit Network

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- ▶ 4 **CREATING AN INTEGRATED TRANSIT NETWORK**
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- 8 OTHER LRT SYSTEM COMPONENTS
- 9 BUS RAPID TRANSIT (BRT)
- 10 NEXT STEPS



## 4

# Creating an Integrated Transit Network

Previous sections of the Guide has established the key system and urban design principles that frame the approach to designing an urban style LRT system. These principles stress the need for a comprehensive design approach to create an Integrated Transit Network- integration with land use and integration between transportation modes. For LRT the prime relationships are with pedestrians, cyclists and other transit users.

Reflecting the Rapid Transit Vision Statement, the aim is to create vibrant neighbourhoods and communities along the B-Line corridor, with integrated designs including facilities for pedestrians, cyclists, LRT and other transit users. This section examines the wider components of the Integrated Transit network in more detail.

## THE URBAN REALM

In accessing the LRT system, whether by foot or cycle, the appearance and quality of the surrounding streetscape will be a key aspect determining the attractiveness of the area and its real and perceived safety and security for users of the space. A low quality, uninteresting streetscape can act as a barrier and can also contribute to feelings of insecurity.

In this regard consideration should be given to the quality of access routes which link the LRT network to its communities to create a high quality, safe environment which in turn helps to contribute towards a positive identity for transit and fosters community pride. The application of Crime Prevention through Environmental Design (CPTED) principles, including clear pedestrian and cycleways, well-lit and sign-posted access routes, and development that provides active frontages with a high level of pedestrian activity will all contribute to making the LRT corridor and its catchment areas safe and pleasant urban neighbourhoods, with low crime and perceived crime rates.

Quality can be enhanced by elements such as the surfacing and form of materials used on access routes. In addition, improvements such as the quality and frequency of lighting, public art features, hard and soft landscaping and areas of green space can all make a contribution to the quality and “feel” of a space and a journey through that space. Integrating these features can enhance the journey experience, creating engaging, public spaces; and can reflect and enhance the physical and cultural identity of the neighbourhood.



HIGH QUALITY PUBLIC REALM WITH CLEAR PEDESTRIAN ROUTES TO LRT  
LYON

## PEDESTRIAN ACCESS

Pedestrian routes and facilities to stops must be as direct, clear and as safe as possible to provide good connection to the surrounding community, encouraging walk-in catchment to the stop and vice versa from the stop to local facilities and destinations. This may require the improvement of existing routes or the creation of new pedestrian routes. For the B-Line corridor a minimum sidewalk width of 2.5m should be included to facilitate walking and pedestrian comfort. Particular attention should be paid to the avoidance or removal of poor sight lines, narrow alleys and blind corners which can all contribute to make the pedestrian feel unsafe.

Intersections that are redesigned as part of the introduction of LRT should introduce improved pedestrian crosswalks to enhance road safety and reduce severance. Consideration should be given to provide precedence to signalled pedestrian crosswalks to RT stops over general road users. Active frontages at LRT stops and key junctions will also add to the vibrancy of the LRT corridor and help with security and safety issues.

Pedestrian routes may require signposts or other information (way-finding) to provide for easy navigation and inform people of the direction and distance to the nearest stop. Way-finding is more than just signing. It is a system of information elements that support movement at all stages of a trip.

Successful way-finding strategies integrate and utilize signage, spatial planning, lighting, structural elements and surface finishes, alongside other building elements, to create a coherent whole, communicating clear and consistent messages and directions. Signage within the catchment area for the stop should indicate the most direct pedestrian route, as well as the distance to the stop. Introduction of signage in turn provides the opportunity for it to be co-ordinated and combined with other street infrastructure, reducing clutter.

Other improvements, such as improved lighting on pedestrian routes, should also be included. Lighting quality can play a central role in creating safe and pleasant environments. Lighting appropriate to its location and function will result in increased safety, legibility, accessibility, security, and ambience.



**WELL DESIGNED PEDESTRIAN CROSSWALK  
WITH MINIMAL STREET CLUTTER**  
PORTLAND



**LEGIBLE LONDON**



MONTPELLIER

New TOD development, particularly within LRT stop catchments should take into account the need to maintain and create direct routes to LRT system stops. To make these routes safe, development should provide active frontage to the streets, with windows and front doors providing informal surveillance, both during the day and evening.

### CYCLE ACCESS

Cycling can be an important complementary mode to access RT and it can be a convenient way to access an LRT stop.

The City of Hamilton currently provides traffic-free off-road paths and on-street lanes for cyclists, together with signed routes. The development of the City's cycle facilities is set out in the cycling master plan *Shifting Gears 2009*.

Designs for LRT implementation should take account of *Shifting Gears 2009* and consider access by and facilities for cyclists. Many of the components listed above for pedestrians are also applicable to cyclists. This includes the enhancement of existing routes and/or the

provision of new designated cycle routes and signing and way-finding. Infrastructure should be cycle friendly to make the road network as convenient and safe as possible for cyclists.

The development of LRT needs to take account of a number of cycling design issues, especially within LRT corridors. These include:

- » Angle of crossing - where a cycle path crosses the LRT railhead at a near-90° angle the risk of a cycle wheel slipping or dropping into the rail groove is minimized;
- » Large areas of railhead, particularly at points and crossings, may result in a slip hazard;
- » Cyclists sharing reduced road space - where an LRT line runs in the road and reduces the number of lanes available for other users, the cyclists may have to share one lane with other vehicles; and
- » Cyclists sharing lanes with LRT vehicles may be intimidated or have increased safety concerns, and locations where shared use is required should be minimized.

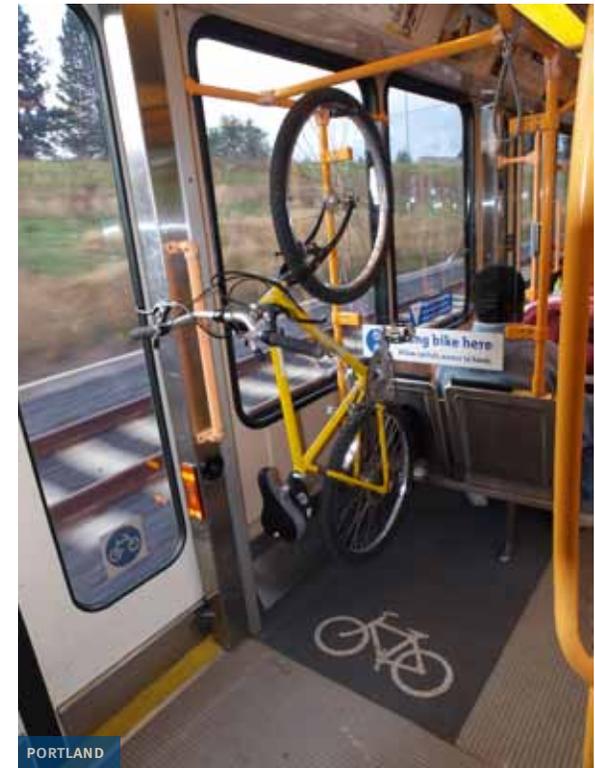


LRT AND CYCLE SAFETY IS A KEY ISSUE

To assist in addressing these design issues, segregated cycle lanes should be provided where possible. For the B-Line these should be on parallel streets due to the limited roadspace and the need to provide for segregated LRT operation. Local provision should be developed to provide safe routes across LRT tracks at all locations where cycle would have to cross the tracks at less than 45°.

Where possible and where demand is identified, secure cycle parking should be provided at LRT stops, to encourage sustainable multi-modal trips.

At subsequent detailed design stages for LRT, when light rail transit vehicle specifications will be determined, decisions will also need to be made regarding the carrying on cycles on LRT, and if they are to be carried whether specific facilities will be required. Many urban style LRT systems provide designated space within LRT vehicles for cycle storage, but this is usually limited to space for 1-2 cycles, with restrictions during peak period operation.



CYCLE STORAGE FACILITY ON URBAN STYLE LRT



SEGREGATED CYCLE FACILITIES PREFERRED, WHERE SPACE ALLOWS  
AMSTERDAM

## OTHER TRANSIT ACCESS

With high quality and frequent LRT operating in a corridor, along with a greater walk-in and cycle catchment there is an opportunity to review the role of local bus services. The introduction of modern urban style LRT provides an opportunity to restructure local bus services to play a complementary role supporting the new LRT service. Major bus transfer centres can often be removed and replaced by smaller scale (cross platform) facilities, or with local bus services designed to service cross streets with simple bus shelter facilities and coordinating crossing providing easy access to and from the LRT stop.

Bus stops should be sited to provide connections at intersections of the LRT and bus routes with the bus stops sited in the cross streets or alongside the LRT platforms to provide convenient cross platform connections.



SIMPLE AND EASY CONNECTIONS BETWEEN LRT AND BUS  
BORDEAUX



**CROSS PLATFORM TRANSFER**  
SAN DIEGO

For bus services which terminate at the LRT stop, a waiting and turning area should be provided at a location away from the LRT stop to prevent the loss of valuable (TOD) development opportunities. On-street bus stops should be located in positions with clear access to the LRT stop, with buses “stored” at a remote location until their timetabled arrival time. Passenger access facilities are not required at the bus waiting and turning area, and hence its size can be minimized.

#### **PARK & RIDE AND DROP OFF (KISS AND RIDE)**

The B Line between McMaster University and Eastgate Square is primarily an urban corridor and does not present major opportunities for Park & Ride. However, other parts of the B-L-A-S-T network may include opportunities for the provision of P&R facilities, either at the outer ends of the LRT/Rapid Transit corridors or at strategic road crossing points. Nevertheless, there will need to be a balance between the competing needs for TOD opportunities adjacent to Rapid Transit stops and Park and Ride space. Where possible preference should be given to TOD, or integrated designs, consistent with the Rapid Transit Vision Statement.

Within any Park and Ride sites clear, direct, and safe pedestrian routes from the parking areas to the Rapid Transit platforms should be provided.

Park and Ride facilities should be designed so that entry/exit routes to the parking lot and internal circulating routes do not cross the Rapid Transit right of way. If such crossings are unavoidable, they should be located adjacent to the Rapid Transit stop.

It may be also appropriate to include local scale park and ride adjacent to some of the stops. In these locations the same design principles should be adopted, in a manner appropriate to the scale of the facility provided.

Drop off facilities, or Kiss and Ride, can be formal or informal facilities. Formal facilities should be located within close proximity of the Rapid Transit stop being accessed and be off the main traffic lane to prevent standing stationary traffic posing a hazard to other road users.



# 5

## LRT Stops and their Setting

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Fitness First  
0900-  
222 7777

# 5

## LRT Stops and their Setting

The LRT stops are one of the most important elements of any system, being a passenger's first point of contact with the network. The design of stops provides opportunities to create more vibrant, active people-focused areas integrated within the community. Stop designs can:

- » Define the system as modern, state-of-the-art;
- » Reinforce the system identity;
- » Create community focal points and/or destinations using distinctive designs for LRT stops;
- » Create, reinforce or reflect an image for an area (with the potential for area-specific stop design in key locations);
- » Be integrated with public spaces;
- » Be integrated with parks or open spaces;
- » Incorporate public art;
- » Provide connections with other transportation modes;
- » Be integrated with Transit Oriented Development and related to wider community facilities such as entertainment, open space, and exhibition areas.

When new transit infrastructure (or renovations) are designed, full advantage should be taken of the opportunities provided to focus passenger and general public activities to develop a sense of place, recognizing that responsibility for achieving this focus is shared between the City of Hamilton, adjacent property owners and the community.



A DOWNTOWN LRT STOP BECOMES A FOCAL POINT  
STRASBOURG

## STOP FACILITIES

LRT stops will require a range of facilities and equipment. Many of these will be common to all stops and are recommended to be standardised as a “kit-of-parts”, not all of which may be required at each stop, but which can be co-ordinated and integrated to form a common design across the LRT network.

This approach will allow stops to be designed to support the location and context of each stop. Design of these facilities will need to consider the following factors:

- » Provide a safe waiting environment for passengers, appropriate to the climatic conditions in Hamilton;
- » Provide service information facilities for passengers;
- » Be clearly visible and identifiable as LRT-related (and by line/route, as the B-L-A-S-T network grows);
- » Reflect the image of a reliable, safe, fast and of a modern LRT system.

- » Be co-ordinated with general street infrastructure to minimise street clutter and to make minimal adverse impact on the street environment; and
- » Be constructed from robust materials which are vandal resistant, durable and easily cleaned and maintained.

## TYPES OF LRT STOPS

This System Design Guide has identified three classifications for stops: Downtown, Out of Downtown and Terminus. The discussion here focuses on the B Line but these classifications will also be applicable to other future B-L-A-S-T lines.

The following characteristics can be identified:

- » Downtown stops: Stops in the Lower City Downtown area, general with concentrated ridership levels and in close proximity to adjacent land uses and frontages.
- » Out of Downtown stops: A standard design covering the majority of stop locations outside Downtown, built using a standard kit-of-parts.
- » Terminus stops: Those stops where large numbers of transfers occur (generally to/from bus) and/or where LRT terminates.

5 LRT STOPS AND THEIR SETTING



A LOW FLOOR LRT STOP INTEGRATED IN STREETScape



STOP SEATING, BRANDED TO FORM A COHERENT KIT OF PARTS,



TYPICAL OUT OF DOWNTOWN LRT STOP, WITH SHELTER TICKET MACHINE, PASSENGER INFORMATION

STOP DETAILS  
MONTPELIER

Although all the LRT stops will be based upon a standard stop design to maximize visibility and help generate a strong 'brand' image, the individual designs may vary according to their function and local surroundings.

### DOWNTOWN STOPS

Downtown stops will be important in terms of their contribution to the urban realm, but space considerations may limit the scope for individual designs. Where space is constrained, or where the frontage at the back of the stop is sufficiently important that it must remain visible, a minimalist or 'transparent' design approach may be appropriate for the main stop infrastructure, with the system identity being asserted by the logo and stop name. In other locations, a strong design statement may be called for. There may be opportunities for stops to be fully integrated within Downtown redevelopment sites. In all cases it will be important to ensure that the stops remain highly visible, while still enhancing their surroundings where possible.

The Downtown stop locations also need to reflect their setting with a higher concentration of higher density development, including regionally

significant features including City Hall, the Hamilton Convention Centre/Hamilton Place, and Copps Coliseum. The designation in the Metrolinx Regional Transit Plan of Downtown Hamilton as a Mobility Hub also needs to be recognized in the planning of the B-Line's downtown LRT stops. Connections to future B-L-A-S-T lines need to be taken into consideration as part of this Mobility Hub status.

### OUT OF DOWNTOWN STOPS

The majority of stops outside of Downtown will follow a standard design. Because of the longer stop spacing and higher boardings per stop compared with HSR buses, the shelters are likely to have a higher capacity than a standard bus stop, and may also be provided with more comprehensive climate protection. They should fit in well with the scale of adjacent commercial and residential properties or development without dominating the environment. Identity and variation between stops can be achieved by means of different materials, colours, landscaping, information totems and art features.



INTELLIGENT STOP DESIGN SAFEGUARDS EXISTING TREESCAPE  
MONTPELLIER



BORDEAUX

## TERMINUS STOPS

A special approach will be appropriate at route termini and other locations where large numbers of passengers are expected to transfer, requiring increased facilities for both LRT and bus passengers. In general these locations will take the form of transfer points that provide access to the LRT system for passengers whose journey origin or destination lies beyond the extent of the walkable catchment of the B-Line LRT, as well as allowing convenient transfers between local bus services. Where possible the bus services feeding into these larger facilities should be arranged so that passengers travel to a transfer point in generally the same direction as their onward journey.

These stops will need to have the capacity for greater numbers of passengers waiting and moving through them than out of downtown stops. There will be need for more comprehensive passenger service information and displays, not only for LRT but also for bus services, as well as possible provision for Kiss & Ride and taxi facilities.

Depending on the specific location, there may also be commercial opportunities, for example for retail, food and drink kiosks, to provide for passengers'

needs. All these facilities will increase the attractiveness of the stops for LRT passengers and other users, and by providing additional facilities will also increase security by encouraging use at all times of the day. There will also be advantages in developing LRT and bus facilities together, resulting in a co-ordinated, integrated facility which, in turn, could form the basis for wider development activity.

The following should generally be provided at each location to facilitate passenger movement and transfer:

- » Facilities to enable accessibility (ramps, handrails, etc.)
- » Facilities to enable access by the sensory impaired (colour contrasting surfaces, tactile surfaces, etc.)
- » Clear way-finding signage from LRT stops to bus stops, including directional/destination information
- » Clear sightlines from transit stops to LRT stops
- » Adequate weather protection and seating provision at each stop and
- » Safe pedestrian crossing provision across local road network and within transit centre (where applicable).

The table shows an initial allocation of stops to classifications.

DESIGN COMPONENT	B-LINE
Downtown Stops	MacNab Walnut First Place
Terminus Stops	McMaster University Eastgate Square
Out of Downtown Stops	All others

As an overlay to the three Stop Types described above, there may be specific locations where modifications to the standard approach will be appropriate:

- » TOD-related stops
- » Local LRT/bus transfer points
- » Park & Ride stops

### TOD-RELATED STOPS

Stops directly related to new developments or redevelopments which are brought forward as TOD initiatives provide opportunities to be fully incorporated and integrated within the development footprint. This will optimise accessibility and patronage between the development and LRT and will allow design of the stop to reflect the identity of the development.

In such cases, use of the standard LRT kit-of-parts may be enhanced to include elements to provide greater connection to the TOD development. These could include passenger information within the TOD (retail/commercial facilities), way-finding and local area maps, signing and branding and public art..

### LOCAL LRT/BUS TRANSFER POINTS

Where bus routes cross the LRT at intersections, standard Outside of Downtown stops may be appropriate, but with additional provision to facilitate transfers. Bus stops should be reviewed, and if necessary re-sited to provide convenient transfers, with the bus stops sited either in the cross street or, if possible without circuitous bus

routings, alongside the LRT platforms to provide cross-platform transfer. Examples of such stops on the B Line include Ottawa and Kenilworth (routes 41/41A) and Parkdale (route 11).

### LRT STOP COMPONENTS

The components and facilities to be provided will vary depending on the stop type, location and function. A “kit of parts” approach is proposed, that draws components or facilities from a common checklist and which are then applied to each stop location.

The table lists the kit of parts that would typically be provided at each type of stop. The kit of parts checklist should be used during subsequent design phases to develop site-specific layouts for each of the B-Line LRT stops. The same principles should be applied to future B-L-A-S-T network extensions.

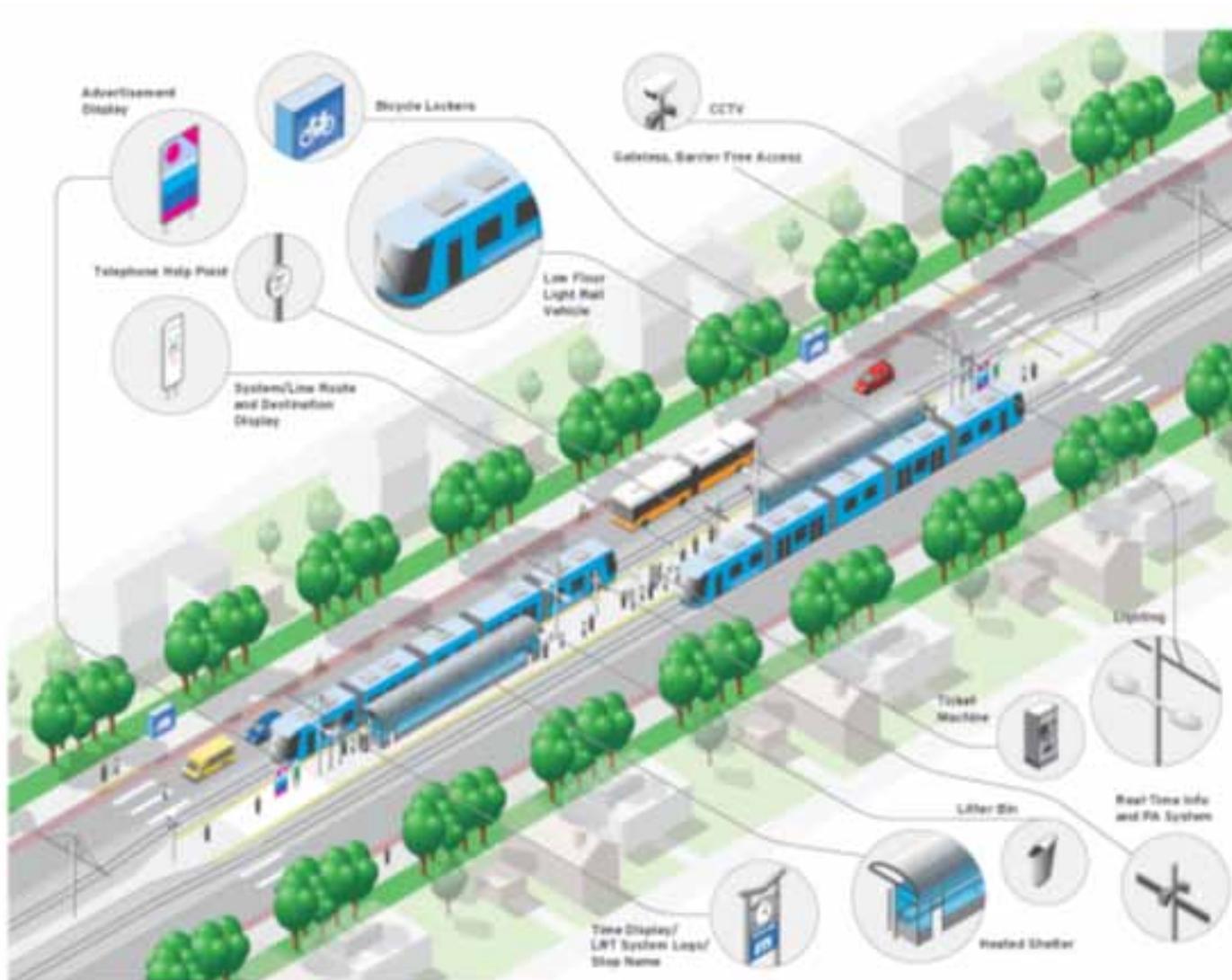
5 LRT STOPS AND THEIR SETTING

	DOWNTOWN STOPS	OUT OF DOWNTOWN STOPS	TERMINUS/ TRANSFER STOPS
Low Level Platforms With Step-Free Access To/ From Lrt Vehicles And The Surrounding Area	●	●	●
Facilities To Enable Access For Sensory Impaired People (Colour Contrasts, Tactile Surfaces Etc.)	●	●	●
Integrated Sidewalk Design	●	◐	◐
Shelters	●	●	●
Enclosed, Heated Waiting Areas	As Option	As Option	As Option
Seating, Inside And/Or Outside Shelters (Comfortable But Segmented To Prevent Sleeping)	●	●	●
Lighting, Inside Shelters	●	●	●
Lighting, On Platforms	✘	●	●
Ticket Machine/Card Reader/Validator	●	●	●
System Logo/Identification And Stop Name	●	●	●
Transit System Route And Fare Information	●	●	●
Local Area Wayfinding Information	●	◐	●
Clear Wayfinding Signage Between Rapid Transit And Bus Stops, Including Directional/Destination Information	◐	◐	●
Real-Time Information Displays & Public Address System	●	●	●
Clock	●	●	●
CCTV	●	●	●
Help Point	●	●	●
Garbage Bin	●	●	●
Advertisement Displays	●	◐	●
Cycle Parking/Storage	✘	◐	◐
Auto Parking	✘	◐	✘
Taxi/Kiss & Ride	✘	◐	◐
Retail Kiosk	✘	✘	●
Public Art	◐	✘	◐

● : GENERALLY PROVIDED

◐ : MAY BE PROVIDED DEPENDING ON LOCAL CIRCUMSTANCES

✘ : NOT GENERALLY PROVIDED



URBAN STYLE LRT STOP- STANDARD KIT OF PARTS



LOCAL AREA MAPS AT LRT STOPS  
BORDEAUX

## DETAILED DESIGN CONSIDERATIONS

### LRT STOP PLATFORMS

The platform position and height should provide nominally step-free and gap-free boarding between the platform edge and the vehicle door threshold. For LRT the horizontal clearance is typically specified as 40mm to allow for tolerances in track and platform construction, wheel and rail wear, movement of the vehicle body on its suspension and the precise positioning of the wheels on the rail head. The platform height should normally be designed so that the door threshold is level with the platform edge when the body is at the lowest position of the vehicle suspension, with a slight step up into the vehicle when the suspension is higher.

The paving of the stop should be sustainable and of high quality, in terms of materials, workmanship and durability. Particular requirements include:

- » Paving materials should be cost-effective in the long term, considering both capital and life-cycle costing, as well as sourcing;
- » Contrasting colours and tactile paving should be used to mark platform edges (although such measures are necessarily less effective in winter);

- » Where possible, subtle natural tones should be used, rather than bright colours, which can impair the visual quality of the street;
- » Only one principal paving material should be used at each stop location; in Downtown and new development areas, paving should match or be closely similar to materials used in the adjacent context;
- » Tactile paving should complement the principal paving material;
- » Tactile surface treatments should comply in scope, colour, texture and slip-resistance with City of Hamilton and Hamilton Street Railway (HSR) accessibility and disability design guidance and legislation.

#### PEDESTRIAN FACILITIES AND ACCESS AT LRT STOPS

Pedestrian facilities should be enhanced around stop locations to improve the connection to the surrounding community, encouraging walk-in catchment to the stop and vice versa from the stop to local facilities and destinations. Way-finding signage should be employed to and from the stop to provide for easy navigation.

Where platforms form part of sidewalks (usually with near-side platforms), the surface profile of the platform should, where possible, be blended in gradually to the adjacent pedestrian areas, to avoid steps, minimise gradients and maximise permeability. Drainage issues and extent of platform and ownership/maintenance issues should be addressed when detail designs are being developed.

Stops should be accessible from both sides of streets, with pedestrian crosswalks of adjacent roadways provided at the intersection end of the platform. Street crosswalks should be direct rather than off-set; should not fence pedestrians into a “pen”; should be located along pedestrian desire-lines; and should be wide enough to provide a perception of safety;

Accessibility to stops will be optimised where barriers to pedestrian movement are minimized. In Downtown areas the preferred design solution for the B-Line is for LRT rails flush with the road surface where pedestrians can cross the street without pedestrian guardrails or similar obstructions.



INNOVATIVE STOP ADVERTISING



**CLIMATIC FACTORS ARE AN IMPORTANT DESIGN CONSIDERATION**  
MINNEAPOLIS



Signage and way-finding in the vicinity of stops is also important to consider as part of their wider accessibility. Signage within the catchment area for the stop should indicate the most direct pedestrian route, as well as the distance to the stop. Introduction of signage in turn provides the opportunity for it to be co-ordinated and combined with other street infrastructure, reducing clutter;

The safety of access routes and of stops can also be achieved using the principles of CPTED, such as:

- » good standards of lighting
- » active frontages which provide overviews
- » avoidance or removal of poor sight-lines, narrow alleys and blind corners
- » avoidance of blank or day-time only frontages.

### CLIMATE FACTORS AT LRT STOPS

The LRT system design needs to take account of the climatic conditions of Hamilton, providing protection against the effects of cold and snow but also shelter from the sun. As a minimum, shelters of adequate size and providing protection from precipitation will be required at all stops. However, consideration should be given to enhanced facilities, possibly at busier stops only, providing fully-enclosed, heated waiting areas.

Additional weather protection is most likely to be required at Terminus/Transfer stops and at the busier Out of Downtown stops, especially those where transfers occur.

Facilities to be considered include:

- » Fully enclosed shelters or waiting areas, with easy entry and exit for boarding and interchanging passengers, without conflicting flows;
- » Possible heating of shelters, for winter conditions;
- » Natural ventilation of shelters; alternatively, provision of shade structures for summer conditions.

Any enclosed and/or heated facilities will need to be monitored to ensure that they are used by bona fide transit passengers only, and the costs of this will need to be taken into account when specifying the facilities.

### LIGHTING AT LRT STOPS

The lighting of the stop environment is an important element of its identity and the safety of its users. Stop lighting should form an integrated component of a lighting strategy for the whole B-Line LRT, particularly in Downtown locations. Principles include:

- » Lighting should be fully integrated into the stop design, particularly for the shelter;
  - » Platform lighting should be co-ordinated and possibly combined with adjacent street and sidewalk lighting, as well as with other street infrastructure to minimise street clutter.
- In Downtown areas, and probably in some locations cases elsewhere, the general lighting may provide sufficient illumination so that additional platform lighting is not required;



HIGH QUALITY LIGHTING CAN ENHANCE LRT STOP APPEARANCE

STRASBOURG



**STREET CLUTTER SHOULD BE MINIMIZED**  
SAN DIEGO



**LEGIBLE LONDON**

- » Lighting should provide good colour rendition (“white” light source) with low energy characteristics, to provide a good level of personal safety. Use of LEDs (white and yellow colour combinations) may be appropriate, particularly in combination with solar energy panels on shelters;
- » Lighting levels should comply with appropriate local practice or guidelines. As a guide Transit City in Toronto proposed 110 lux at stop edge, 55 lux in shelter and for sidewalk areas, a default level of 33 lux was specified;
- » Lighting should be designed to avoid glare for passengers, LRT drivers and other road users; and
- » Lighting should be designed to avoid nuisance and light spillage for local residents and building occupiers and to minimise night sky pollution.



# 6

## LRT Vehicles

- 1 INTRODUCTION
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- ▶ 6 **LRT VEHICLES**
- 7 THE LRT ALIGNMENT
- 8 OTHER LRT SYSTEM COMPONENTS
- 9 BUS RAPID TRANSIT (BRT)
- 10 NEXT STEPS



# 6

## LRT Vehicles

### INTRODUCTION

The LRT Vehicles will play a significant role in establishing the visual identity and attractiveness of the B-Line LRT, being the most obvious symbol of the system, seen along the full length of the corridor. This is especially true for LRT where vehicles can be used as City identifiers. The vehicles used will need to provide the required capacity and must be:

- » fully accessible;
- » safe;
- » comfortable;
- » equipped to provide passenger information; and
- » reliable.

Accessible – LRT systems should be fully accessible to all members of the community, including wheelchair and mobility scooter users and others with mobility impairments, as well as passengers with strollers or luggage. The specification of the proposed system will meet these requirements with the provision of level boarding from low platforms.



**MODERN LOW FLOOR LRT: ACCESS FOR ALL**  
LYON



MODERN URBAN STYLE LIGHT RAIL VEHICLE  
MONTPELLIER

Safe – The LRT vehicles should provide a safe passenger environment, with interiors designed to provide open, legible surroundings. Help points and onboard CCTV should be employed. Light Rail vehicles operating on-street should be fitted with skirts to provide protection for pedestrians and other vehicles. Driver training should be to a high standard to reinforce the safety of the system

Comfortable - Vehicles should provide a well-lit, temperature-controlled environment. The internal layout should provide for seating, facilities for strollers and wheelchair users and standing passengers. An internal aisle along the length of the vehicle should be provided to allow people to move within the vehicle. Doors should automatically close when not in use. The seating where possible should be cantilevered from the vehicle sides to aid cleaning, with flip down seating or rests employed in stroller and wheelchair zones when they are not being utilized.



HIGH QUALITY INTERIOR DESIGN FOR LRT  
MONTPELLIER



LRT INTERIOR PROVIDES FLEXIBLE SPACE  
BORDEAUX

The vehicle should be equipped throughout with sufficient handholds to enable people to stand throughout. The vehicle interior should be simple and practical, with light colours employed to improve the perception of space.

Passenger Information - Vehicles should be fitted with an audio visual passenger information system which clearly states the destination both internally and externally, announcements should be given as vehicles arrive at and depart from stops

Reliable - Vehicles must be cost effective to purchase and to operate, and should have proven reliability in commercial service.

### VEHICLE DESIGN

The size, configuration and general appearance of the vehicles account for a large part of the public face of the transit system, and will make a significant contribution to the nature and quality of the streetscape. External design and styling will therefore play an important part in ensuring that this contribution is positive.

The introduction of an Urban Style LRT using low floor vehicles serving low platforms will allow the passenger waiting areas to be treated as a permeable part of the pedestrian environment together with sidewalks, maximizing accessibility and minimizing severance.

The length of the LRT vehicles will influence the length of platforms and the size and locations of shelters, which in turn will affect the impact of the system on the streetscape and on other traffic, particularly at road crossings.

Most modern vehicle manufacturers supply a range of standard products, which can be customised in terms of internal layout and fittings and external colour/livery. For LRT vehicles some manufacturers also offer options for external vehicle end styling and will consider bespoke designs to suit a particular City.



ON-BOARD ROUTE INFORMATION AND CCTV SECURITY, MONTPELLIER



TICKET VALIDATOR, ROUTE INFORMATION AND ADVERTISING, BORDEAUX

LRT VEHICLE INTERIOR

5 LRT STOPS AND THEIR SETTING



LYON



MONTPELLIER



PORTLAND

LRT STYLING AND LIVERY WILL MAKE A BIG IMPACT ON URBAN STREETScape

## EXTERNAL DESIGN

Vehicles are likely to be based on a supplier's standard product with a customised internal layout and fitting out. There may be some element of bespoke external styling, perhaps to the nose cone and certainly to the livery, colours and decorative treatments. To ensure that the vehicles form a clearly identifiable part of the 'Hamilton Transit' brand, the design of the customised elements of vehicles will require careful integration with the rest of the system.

There are a range of LRT designs available from manufacturers. The choice of particular style will be important for a number of reasons including:

- » The visual impact on the areas of the City that the LRT vehicle goes through – the design should fit into and complement all environments along the route;
- » The ability of the design to attract patronage, especially from current non-users of public transit;
- » The ability of the design to convey a message or image about the City.

Designing of exterior vehicle livery or statement artwork could be undertaken as part of a community project which would help people to take ownership of the system and deter vandalism.

## INTERNAL DESIGN

The internal layout of the passenger seating, aisles and access to and from doors should address the needs of all passengers, including those with mobility impairments. The internal layout of the vehicles will enable access to all passengers consistent with the relevant access and mobility guidance.

Dedicated space will be provided for those with wheelchairs and priority seating will be allocated for mobility impaired passengers. The internal fit-out of the vehicles should include ample provision of handles, bars and rails to ensure comfort and safety without restricting passenger accessibility.

A policy on the transportation of bikes on Hamilton Rapid Transit has not yet been defined. However, all HSR buses currently carry external racks for up to two bikes, and if these are full it is possible for a bike to occupy wheelchair space with the operator's permission. Most North American LRT systems allow bikes on board (though sometimes at certain times only). Space should also be provided onboard LRT vehicles to enable the storage of bicycles.



DUSSELDORF

## KEY VEHICLE PARAMETERS

The table sets out key LRT vehicle and vehicle-related parameters. These are typical values to be used for outline design, and will accommodate a range of vehicle types currently available from a number of manufacturers. These generic parameters should be reviewed and updated at the subsequent detailed design stage when an LRT vehicle has been selected/procured, the specific vehicle parameters are known and final detailed alignment and system design is undertaken.

PARAMETER	ALL SUBJECT TO REVIEW
Vehicle Height	3.6 metres
Floor configuration	100% low floor, with level boarding at all doors
Vehicle Floor Height (above top of rail)	350 mm at doors
Door configuration	Multiple electrically controlled doors both sides
Driving cabs	Both ends
Multiple Operation	For recovery only
Nominal Passenger Capacity (per vehicle), seated + standing	Approx. 200 (30m vehicle) Approx. 260 (40m vehicle)
Minimum Horizontal Curve Radius (on passenger lines)	25 metres
Track gauge	1,435 mm
Maximum Gradient	8%
Traction voltage	750V DC
Maximum Speed	70-80 km/h

**LIGHT RAIL VEHICLES – SELECTED DESIGN PARAMETERS**  
(TYPICAL VALUES)

### LRT VEHICLE AND ROUTE CAPACITY

The vehicle capacity and service frequency will be determined based upon the identified demand for the corridor concerned. The capacity of a vehicle is determined by the number of seats provided plus the number of standing passengers that can be comfortably accommodated within the unobstructed floor space. The theoretical line capacity is equal to this capacity multiplied by the service frequency, but in practice it is normal to plan for a lower average load per vehicle to allow for short-term ridership peaks and uneven loads between individual trips. For the B Line LRT, an average loading of 130 per LRV has been assumed as a loading standard for measuring practical hourly line capacity.



DUBLIN





# 7

## The LRT Alignment

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- 9 BUS RAPID TRANSIT (BRT)
- 10 NEXT STEPS



# 7

## The LRT Alignment

### INTRODUCTION

Urban style LRT is characterized by its use of a set of flexible design components that can be combined to adapt to the urban corridors in which the LRT will operate. Earlier Sections of this Guide have established the wider urban design and TOD design principles that set the context for the introduction of urban style LRT, with a focus on comprehensive Complete Street standards.

Earlier sections of the Guide have also set out key system requirements for urban style LRT, one of which is the need to provide a separate right of way for LRT, to allow efficient operation, with competitive and reliable journey times, to retain existing transit users, and also attract new users. In typical urban corridors this will require the re-allocation of road space to pedestrians, cyclists and transit.

This Section provides further details on the types of LRT alignment that can be used to fulfill the Complete Street and LRT operating requirements. This approach aims to reduce the scale of LRT infrastructure, integrate the LRT with the existing and future urban environment, serve people and places more directly and achieve this in the most cost effective way.



URBAN STYLE LRT DESIGN- FLUSH TRACK, ALIGNMENT TEXTURE, LANDSCAPING, AND BARRIER-FREE LEVEL SURFACES ALL CONTRIBUTE TO A HIGH QUALITY DESIGN  
BORDEAUX

## LRT ALIGNMENT DESIGN -COMPLETE STREET CONTEXT

### STREETScape

Attractive, vibrant urban realm will be vital to ensure that the full Vision for LRT to attract development and stimulate economic regeneration is achieved. To create a high quality urban style LRT corridor streets should be easy to use and visually appealing. To ensure that this is achieved:

- » Design of street furniture and signage should be co-ordinated;
- » The street should contain minimal clutter from street furniture;
- » Infrastructure should be non-intrusive;
- » There should only be use of railings to restrict pedestrian movement where absolutely necessary; and
- » Subtle natural colours used in paving and other street infrastructure should be in good quality, durable materials.

### TRAFFIC INTERFACES

The reliable operation of LRT services requires maximum separation from general traffic. For an Urban-style LRT system the LRT right of way

should be separate from roadways, where feasible. LRT can be fully integrated with pedestrian sidewalks and with all modes at street crossings, particularly in Downtown and other densely-developed areas, where LRT speeds will be lower.

Urban-style LRT routes have to cross roads at grade. In many locations there will also be the need for service vehicles to cross LRT tracks, also at grade, (possibly also restricted by time and location), so that adjacent buildings and properties can function efficiently. Where LRT tracks at sidewalk level cross roads, the crossings should be formed on raised tables, flush with the sidewalk surfaces.

### SIDEWALKS, STREET PARKING & SERVICING

As a part of the urban style LRT alignment design process, opportunities should be taken, where space permits, to widen sidewalks to a minimum width of 2.5 metres. Where space constraints do exist, consideration should be given to the scope for reducing traffic lanes to gain extra sidewalk width having considered likely traffic volumes and impacts of issues such as parking and loading.

The use of bump outs to form servicing and parking areas may be appropriate and their inclusion



COMPLETE STREET URBAN STYLE LRT- CURB-SEGREGATED LRT, RE-ALLOCATED ROADSPACE INCLUDING STREET PARKING  
MONTPELLIER

should be considered an opportunity to include additional hard or soft landscaping features.

The design should also provide designated automobile parking bays, where authorised on-street, and designated servicing and delivery bays for regulated, time-restricted access to businesses and properties.

Together these factors require an appropriate allocation of street space between LRT and other users, including general traffic, pedestrians and cyclists, as well as urban design of the LRT track so that all surfaces:

- » are safe to use for those who need to;
- » are clearly defined and delineated; and
- » form a part of a coherent, high quality streetscape.

Any LRT system running within the road network space could result in the loss of on-road parking, both as a result of the physical removal of spaces for the LRT alignment and when the LRT prevents safe access to parallel parking spaces.

In the vicinity of proposed LRT stops, it may be appropriate to reduce the overall parking provision, or implement time restrictions, to prevent the parking spaces being used as unofficial park and ride facilities.

### LANDSCAPING & TREES

Soft landscaping, in the form of street planting, planters and street trees, and hard landscaping in the form of features, materials and finishes should form an integral part of the street design. This can include areas and opportunities for related urban design features such as areas of green and/or open space and public seating.

Trees and landscaping can provide an enlivening of the street scene as well as enclose and reduce the impact of traffic on the residential and commercial buildings. New planting and complementary design and positioning of LRT features, such as masts, lights and stops, should seek to enhance the local street scene. Each section of route should be individually assessed and options and opportunities explored and identified to enhance their inherent qualities.



COMPLETE STREET DESIGN INCLUDES URBAN DESIGN AT JUNCTIONS  
BORDEAUX

Where routes have existing trees then LRT alignment design should seek to minimise the impact on these. Where trees need to be removed then replacements should be provided in accordance with current City policy. These should be semi-mature to deter vandalism and give the trees the best opportunity to establish themselves. Existing trees alongside the LRT right of way should be well maintained for safety and operational reasons. Branches will need to be trimmed to ensure they do not interfere with LRT overhead power lines and tracks will need to be cleared of fallen leaves.

### **LRT-ALIGNMENT TYPES**

The LRT alignment has to clearly delineate the “swept path” of the LRT vehicle. This includes the dynamic envelope of the vehicle when it is moving through the street, including end-throws as the vehicle runs around tighter curves in the track layout. The swept path is conventionally marked by road markings, use of different surface textures and colours, or physical separation with the use of curbs, landscaping or fencing.

For urban style LRT the use of fencing is often not appropriate, and a more open design is used, including track that is laid flush with the road surface. Ballasted track and other “rail-type” design solutions, included barriers at street crossings would not be used for urban style LRT.

Urban style LRT can use a range of alignment types can be categorised according to the degree of segregation as shown in the table.

	PEDESTRIAN AREA	SHARED RUNNING	PARTIALLY SEGREGATED ON STREET RUNNING	FULLY SEGREGATED ON STREET RUNNING	FULLY SEGREGATED OFF STREET RUNNING
Track and LRT lanes	Flush with general paving	Flush with road surface	Flush paving (for LRT- between and adjacent to the rails). Usually raised above other traffic lanes by 75-100mm to discourage but not prevent incursion by other vehicles. May also be surfaced in different materials, colour or texture, to differentiate from general traffic lanes	Flush with the surface (for LRT - between and adjacent to the rails) (median or lateral alignment). May be paved in a variety of materials.	Fully segregated alignment, generally away from road corridors. (For LRT can be railway-type ballasted or concrete trackform, with the rails raised above the surface).
Vehicular access	None, or limited access by road vehicles for deliveries, garbage collection, building maintenance etc.	Unrestricted	Dedicated LRT lanes, not normally used by other traffic, but accessible to other vehicles for occasional use, e.g. to pass a stationary vehicle, or use by the emergency services	Dedicated lanes, not available to other traffic (although can be used by emergency vehicles). Separated from other traffic lanes by a full height curb or other features, e.g. bollards, tree or shrub planting or other landscape features. Continuous fences or similar barriers not normally used (retains permeability).	Fully fenced with no vehicular access. Crossings either grade separated or at-grade, with grade crossings controlled by barriers or traffic signals.
Pedestrian Access	Pedestrians can walk anywhere across the RT route	Pedestrians normally cross the LRT and traffic lanes at designated pedestrian crosswalks, but there are no physical barriers to crossing elsewhere.	Pedestrians normally cross the LRT and traffic lanes at designated pedestrian crosswalks, but there are no physical barriers to crossing elsewhere.	Pedestrians normally cross the LRT and traffic lanes at designated pedestrian crosswalks. No physical barriers to crossing elsewhere, but landscaping etc. may be used to encourage use of crosswalks.	Not permitted. Crossings either grade-separated or at-grade with warning signs or pedestrian signals. Deterrent paving or other devices may be provided at the sides of crossings to prevent pedestrian access to the segregated alignment.

	PEDESTRIAN AREA	SHARED RUNNING	PARTIALLY SEGREGATED ON STREET RUNNING	FULLY SEGREGATED ON STREET RUNNING	FULLY SEGREGATED OFF STREET RUNNING
Control	Line of sight	Line of sight	Line of sight	Line of sight	Either (a) line of sight or (b) railway-type interlocked signalling
Signals	Dedicated aspects at signal-controlled intersections	Dedicated aspects at signal-controlled intersections	Dedicated aspects at signal-controlled intersections	Dedicated aspects at signal-controlled intersections	Either (a) traffic signals with dedicated LRT aspects at crossings, track junctions and similar locations only, or (b) fixed railway signals at regular intervals along the route
Speeds	Typically 12-15 km/h maximum	General traffic speed for the road concerned.	General traffic speed for the road concerned.	General traffic speed for the road concerned.	Limited by the capability of the vehicles – typically 70-80 km/h maximum.
Swept path delineation	Painted road markings, changes in surfacing materials, colour or texture	Where the LRT swept path follows traffic lanes, no specific demarcation is required. Elsewhere it is usually indicated by painted road markings, a change in surfacing material, colour or texture, or by bollards.	Painted road markings, changes in surfacing materials, colour or texture		

In such cases, vehicular access should be controlled to minimize the numbers of vehicles permitted, and where possible vehicular movements should be restricted to times of day when there are fewer pedestrians.

To minimize the impacts of other traffic on LRT operation it is desirable to limit shared running to sections of route which are used only by limited types of traffic, such as bus services, taxis and vehicles accessing frontage properties, with through traffic diverted to other routes.



LRT IN PEDESTRIAN AREA  
AMSTERDAM



SHARED RUNNING  
BILBAO



PARTIALLY SEGREGATED ON-STREET RUNNING

LYON



**FULLY SEGREGATED ON-STREET RUNNING**  
BORDEAUX

### SEPARATING THE LRT ALIGNMENT

In support of the principle of 100% segregation, use of the Shared Running category will be minimized. On the B Line between McMaster and Eastgate Square, Fully Segregated Off Street Running will be limited to a relatively short section crossing Highway 403, but further opportunities for this type of operation may arise on other sections of the B-L-A-S-T network.

The design approach used for urban style LRT aims to minimize the alignment width to help facilitate the integration of the alignment within existing corridors. Segregation would be achieved firstly through the clear delineation of the LRT corridor without using physical segregation measures such as fencing. In some locations a continuous or intermittent curb detail along the edge of the LRT alignment can be used to provide greater differentiation and discourage vehicular traffic from encroaching on the LRT route. Where the LRT alignment runs between a roadway and a pedestrian sidewalk, raised curbs may be provided on both sides of the LRT route

Where a greater level of segregation is desirable, deterrent planting should be considered before fencing or concrete barriers. If fencing is employed this should be appropriate to the urban environment.

### **LRT TRACK SURFACING AND DELINEATION**

LRT tracks should be flush with the roadway or sidewalk surfaces, as appropriate to the specific section of the alignment. Where LRT tracks at sidewalk level cross roads, crossings should be formed on raised tables, flush with the sidewalk surfaces.

Surfacing of the LRT track should complement and, if possible, improve the quality of paving of the street generally. The LRT swept path should be clearly delineated and differentiated by texture or by tone of colour from surrounding paving or road surfacing, particularly where LRT operations are not fully segregated from general traffic, such as at pedestrian, cyclist and road crossings.



**SURFACE FINISH AND CURB DETAILS DELINEATE THE LRT ALIGNMENT**

BORDEAUX



HIGH QUALITY URBAN DESIGN- TRACK, LANDSCAPING, AND LEVEL SURFACES  
BORDEAUX

Subtle natural tones should be used for all surfacing, rather than bright colours, which can impair the visual quality of the street. Surfacing and paving materials should be sustainable and cost-effective in the long term, considering durability, capital and life-cycle (maintenance) costing, as well as sourcing, quality and appearance.

In many urban style LRT systems “grass track” has been used, to add to the green-space within the corridor. If the use of grass track is to be considered in Hamilton particular attention will need to be given to the type grass (or equivalent-sphagnum moss etc) due to local climatic conditions and the need for snow clearance, and general maintenance.



GRASS TRACK CAN ENHANCE THE STREETScape  
LYON





# 8

## Other LRT System Components

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## Other LRT System Components

### INTRODUCTION

Urban style LRT systems require an electric power supply, with LRT vehicles powered via overhead lines, and also need a Maintenance and Storage Facility for the LRT vehicle fleet and supporting equipment. This section of the Guide describes the main requirements, all of which should be given the same level of design attention as the LRT stops, vehicles, and alignment, and wider urban setting.

### LRT POWER SUPPLY-

#### OVERHEAD LINE ELECTRIFICATION

The overhead lines, which provide electric power to the Light Rail Vehicles, are an integral component of the LRT route alignment. The arrangement of the overhead line can impact on views along, across or outwards from streets and spaces within the public realm, and the location of the poles impacts on the detailed alignment and clearance requirements. The system must be appropriate for the operational power supply requirements and also must be resilient and durable in all weather conditions. For Urban-style LRT it should be of much lighter and more elegant design than typical arrangements used on railways and

fully segregated LRT systems. The design should minimize the visual impact of the poles, contact wire and electrical feeding within the streetscape.

The main components of an overhead system are:

- » Supports, which can comprise of building fixings or poles and cantilever arms;
- » Contact conductor support, cantilever arms, cross-span wires, where appropriate, together with draw-off and tensioning wires; and
- » Longitudinal contact conductor.



**OVERHEAD WIRES ATTACHED TO BUILDINGS REDUCES CLUTTER**  
NOTTINGHAM

## DESIGN REQUIREMENTS

In Canada, wire heights of approximately 4.2 metres above rail level have been used for LRT systems within streets. Lower wire heights may be appropriate where routes are fully segregated from vehicles and people, subject to the minimum that pantograph design will allow.

On LRT alignment sections fronted by medium to high rise buildings the overhead line should, where possible be supported from span wires attached to building facades. This arrangement is less intrusive visually, avoids the 'clutter' and spatial requirements of poles at street level and also avoids the need to divert or protect utilities apparatus to accommodate pole foundations. However, not all building sizes, types and structures will be capable of such attachments.

Overhead line poles can be located either side of the LRT alignment, or between the two tracks. Side poles can be fitted with cantilever arms to support the conductor over one or both tracks, or with a span wire to a pole or building fixing on the opposite side, which in turn supports overhead lines over two (or more) tracks. Centre pole layouts generally have fewer

poles, but the double cantilever arrangements may be regarded as more intrusive.

Within an urban street environment where building fixings are not possible the overhead poles should be combined with the street lighting to minimise street clutter.

Street lighting and other electrical equipment should be designed and installed so that it can be maintained safely without affecting the LRT system. Where overhead line poles are used to support street lighting or other electrical equipment, precautions should be taken so that even under fault conditions, one power system cannot adversely affect the other.

The design of the overhead line supports should aim to minimise the vulnerability of each support to damage. The loss of any one support (e.g. as a result of a pole being struck and damaged by a road vehicle or a fire loosening a building fixing) may release tension in the overhead line system but the design should allow other supports to prevent live equipment from sagging below a minimum wire height. This approach is aided by having an increased standard wire height, compared with current Canadian practice.



COMBINED LIGHTING AND OVERHEAD WIRES REDUCES CLUTTER



COMBINED USE OVERHEAD WIRES AND TRAFFIC SIGNALS  
PORTLAND

The design of the overhead line should take full account of the requirements of the public realm and the character and context of each location or section of the alignment.

Tapered poles are sometimes considered more elegant than plain or stepped cylindrical poles, but can result in unsightly attachments for fittings. A more flexible approach may be to consider, changing between tapered and stepped poles as appropriate to particular locations.

A light grey or other colour or metallic, reflective finish for overhead line poles often appears visually dominant and obtrusive. A darker grey matt finish is often more successful in allowing the overhead poles to have a discreet, acceptable visual impact.



SIDE POLES  
LYON



**CENTRE POLES**  
LYON

### **SUBSTATIONS AND OTHER TRACKSIDE EQUIPMENT**

An electrically powered LRT system requires Traction Power Sub-Stations (TPSS) at intervals along the route to step down the high voltage AC supply to the 750v DC that is fed to the overhead line

The exterior design of the substations should be sympathetic to the surroundings and appropriate to the streetscape. The locations should allow for access for maintenance and in case of emergency (including Fire Service access).

Irrespective of traction power supply, other plant will also need to be accommodated in trackside cabinets. Signal control equipment will be integrated with general traffic signal control and the design and location of cabinets will follow City practice. Power supply equipment for stops will also be required, and the cabinets housing this should be located so that they are clear of pedestrian flows wherever possible and designed to harmonize with the overall stop design.



TRACKSIDE POWER CABINETS INTEGRATED INTO STOP DESIGN  
BORDEAUX

**MSF SITE****REIMS**

PHOTO COURTESY OF SNC LAVALIN

**MAINTENANCE AND STORAGE FACILITY (MSF)****GENERAL REQUIREMENTS**

The MSF is to provide full administration, storage, cleaning, maintenance, overhaul and support services for the system. It is to be designed to accommodate the initial needs of the system. Additional MSF facilities may however be required as the B-L-A-S-T system expands.

The site should be reasonably level, to minimize earthworks, and with good road access for heavy trucks, both for the initial delivery of LRT vehicles to the site, and for the collection and delivery of components which may be maintained or repaired off-site. Suitable emergency access will also be required.

The MSF location and design should also minimize the impact on adjacent properties and neighbourhoods as far as possible, in particular the noise of LRT vehicle movements at night and site floodlighting. Landscaping and tree planting should be used to screen the site from residential property.

The design should reflect the environmental values of the project. This can encompass a range of attributes such as energy efficient design of the MSF buildings and minimizing use of resources, for example recycling of water used in the LRT vehicle wash plant. The City's Corporate Energy Policy is designed to facilitate the achievement of City-wide energy reduction targets, and requires that new municipal buildings are designed and built to LEED (Leadership in Energy and Environmental Design) standards.

The site also needs to be secure, with a perimeter fence and controlled access points for the Rapid Transit vehicles themselves and for general traffic/pedestrians. Gates should be provided to prevent unauthorized access, with entry control by CCTV/intercom or direct supervision.

**MSF FACILITIES**

The facilities required at the MSF are those necessary to service, maintain, overhaul and repair the full range of systems and infrastructure for the LRT system. The systems include rolling stock, revenue collection equipment, track, signalling and vehicle control, communications,

power supply, and civil works. In addition, the MSF has to provide a full range of management, administration and logistics support, and provide a base for operations staff (drivers etc.).

The following provides a summary of the overall facilities to be provided:

- » General office and staff amenity areas
- » Control centre
- » Stabling - for light rail vehicles, shunting tractors, track maintenance vehicles etc.
- » Main workshop
- » Paint shop
- » General workshop
- » Inspection and servicing shed
- » Wheel lathe
- » Vehicle washing machine and sanding plant
- » Staff and visitor auto parking
- » General storage area
- » Electrical substation (to supply domestic and traction power to the MSF).

The stabling sidings may be open or enclosed, depending on local environmental and climatic factors. An enclosed stabling area will significantly



HIGH QUALITY MSF DESIGN INCLUDING SYSTEM BRANDING AND LANDSCAPING  
NOTTINGHAM

add to project costs but will reduce the amount of external lighting required, and may also result in some noise reductions, which would be of particular benefit if the MSF is located in an area where disturbance to neighbours is an issue.

#### **OTHER MSF DESIGN OPPORTUNITIES**

The construction of a major new facility for storage and maintenance of LRT vehicles brings opportunities for incorporating advanced techniques in sustainable building, not only minimizing environmental impacts but also raising the public profile of Hamilton's Rapid Transit system. Techniques that could be assessed for suitability include:

- » Solar energy and other methods of local energy production
- » Rainwater collection and recycling for vehicle washing
- » Low energy consumption lighting
- » Use of natural light wherever possible
- » Natural heating and ventilation
- » Energy-efficient and sustainable materials
- » Recycled materials
- » Green roofs



# 9

## Bus Rapid Transit

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- 4 CREATING AN INTEGRATED TRANSIT NETWORK
- 5 LRT STOPS AND THEIR SETTING
- 6 LRT VEHICLES
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- 9 BUS RAPID TRANSIT (BRT)**
- 10 NEXT STEPS



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SPEED  
25

## 9

## Bus Rapid Transit

**INTRODUCTION**

The Hamilton Rapid Transit B-L-A-S-T network may contain a range of transit modes. LRT has been selected for the first line to be implemented, the B-Line. Future lines may also use LRT technology. Alternatively, Bus Rapid Transit (BRT) may be selected.

Although the main focus of this System Design Guide has been on LRT, the main principles are also applicable to BRT. If BRT is to be considered for future extensions of the network the same urban design, TOD and system design standards (segregated right of way, high quality design, easy access etc) should all apply.

The main differences between LRT and BRT technology lie between the vehicles. LRT vehicles have steel wheels running on rails, and are electrically powered. Their modular design also allows for longer, higher capacity vehicles than those used for BRT.



**BRT**  
BRAMPTON



MODERN BUSES CHARACTERIZE BRT SYSTEMS

FASTRACK, KENT

BRT vehicles are generally articulated 18m long with a capacity of around 120 passengers (combined seated and standing). They are generally diesel or diesel-hybrid powered. There are a range of BRT vehicles on the market, ranging from standard rigid bodies to the more usual articulated and stylised BRT. The table sets out some typical parameters.

The design parameters to be applied to any B-L-A-S-T BRT corridors follow the same principles as applied for LRT on the B-Line. The main characteristics are summarised in the table.

PARAMETER	ALL SUBJECT TO REVIEW
Vehicle Type	Rigid or articulated
Vehicle Length	Ranging from 11.4 m to 18.5m
Floor configuration	100% low floor, with level boarding at all doors
Door configuration	Multiple entry/exit doors from 2-4
Nominal Passenger Capacity (per vehicle), seated + standing	Approx. 50 (11.5m vehicle) Approx. 120 (18.5m vehicle)

**BRT VEHICLES – TYPICAL PARAMETERS**



**HIGH QUALITY BRT STOP**  
EUGENE



SEGREGATED BRT RIGHT OF WAY  
ISTANBUL

DESIGN ELEMENT	DESIGN PRINCIPLE
Vehicle	<p>Articulated to maximise passenger carrying capacity</p> <p>Low floor</p> <p>Length: Typically 18.3 metres but bi-articulated can be around 25 metres</p>
Alignment	<p>Running at grade</p> <p>Central or side running within street</p> <p>Alignment width 7.3 metres with widening through curves</p> <p>Minimum curve radius: 15 metres</p> <p>Maximum gradient: 11%</p>
Segregation	<p>Target of 100% segregation (reserved space within the road)</p>
Priority	<p>100% priority at signalled intersections</p> <p>Automatic Vehicle Location System employed to provide priority through signalled intersections to help facilitate reduced journey times and greater journey time reliability</p>
Stops	<p>Platform height ~300mm above adjacent roadway (level boarding)</p> <p>End ramps at 5% gradient</p> <p>Fully integrated with adjacent pedestrian areas (e.g. at rear of platform) where possible</p> <p>Step-free access</p> <p>Length: as required to accommodate the longest vehicle in use</p> <p>Width: 3 metres, side platform, 4 metres, island platform</p> <p>Integrated with existing pedestrian crosswalks at intersections as appropriate</p>

**BRT DESIGN PARAMETERS**

DESIGN ELEMENT	DESIGN PRINCIPLE
<p><b>Stop Infrastructure</b></p>	<p>Stop facilities to provide a distinct image for the system with the stop infrastructure built up from a standard kit of parts to meet the expected demand</p> <p>Stops elements to include:</p> <ul style="list-style-type: none"> <li>» Dedicated stop infrastructure;</li> <li>» Branding;</li> <li>» Shelters;</li> <li>» Seating;</li> <li>» Ticketing;</li> <li>» Passenger Information;</li> <li>» Real Time Information;</li> <li>» CCTV;</li> <li>» Help Points;</li> </ul>
<p><b>Roadway</b></p>	<p>Where possible, development of the route to minimize impacts to parking and access or provide alternative arrangements where required.</p> <p>Design to minimise cross-corridor traffic impacts, though a number of more minor intersections may need to be converted to 'right-in, right-out' to provide greater length of segregated running.</p>



# 10

## Next Steps

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- 10 **NEXT STEPS**



# 10

## Next Steps

### INTRODUCTION

This System Design Guide has been produced as part of a wider set of reports and plans developed for the Preliminary Design & Engineering work for the B-Line LRT. This work takes the project to a 30% design stage. In parallel, pre-feasibility studies have been completed for the A-Line corridor.

The System Design Guide provides a comprehensive set of guiding principles designed to respond to the Rapid Transit Vision developed and endorsed by Council is expressed as follows:

“Rapid Transit is more than just moving people from place to place. It is about providing a catalyst for the development of high quality, safe, environmentally sustainable and affordable transportation options for our citizens, connecting key destination points, stimulating economic development and revitalizing Hamilton”.

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AN INTEGRATED DESIGN APPROACH RESULTS IN A CIVILIZED STREETSPACE

LYON

## INTEGRATION OF THE SYSTEM AND DESIGN COMPONENTS

The merging of the outline rapid transit system components and the wider urban design, public realm and transit oriented development aspects of the project has been deliberate, with the aim of developing the basis for an Integrated Transit Solution- providing integration of LRT with other transportation modes, and integration with land use and development. The outcome from this integrated approach provides the basis for a Complete Street design for Hamilton, providing an attractive, vibrant and high quality streetspace with more sustainable transportation choices.

### NEXT STEPS

The integrated approach should form the basis for moving forward to the next stages of the project. The Vision has been established, and the initial concept designs produced for the project have now been developed to the 30% design stage, with the aid of the general design parameters contained in this System Design Guide. The key phases that follow are:

- » Rapid Transit Vision- COMPLETE
- » Network Definition (B-L-A-S-T) and Concept Designs- COMPLETE



INTEGRATING LRT WITH LANDSCAPING AND HIGH QUALITY URBAN DESIGN

AMSTERDAM



A COORDINATED APPROACH LINKS LRT AND TOD DEVELOPMENT  
DUBLIN

- » Preliminary Design & Engineering (30% design), based on System Design Guide- COMPLETE
- » Detailed Design- -Next stage of development for System Design Guide to include Design Standards, including detailing related to LRT vehicle selection and Operational Specification.
- » Final Design- System design Guide to include details of Design Specifications for all system components and wider stop area planning and TOD requirements
- » Post-Construction/System Opening- Manuals for Operations and Maintenance of the LRT system and wider streetscape.



LRT PROVIDES OPPORTUNITIES FOR WIDER STREET DESIGN