



steer davies gleave

Hamilton Rapid Transit Preliminary Design and Feasibility Study

B-LINE AND A-LINE

INTEGRATED TRANSIT SYSTEM OPERATIONS PLAN

Version:1.0

METROLINX
An agency of the Government of Ontario

RAPIDTransit
moving HAMILTON forward

Hamilton
Public Works

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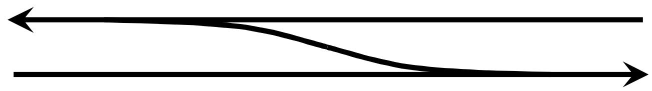
Glossary/Abbreviations

BRT	Bus Rapid Transit
Crossover	A connection between two parallel tracks enabling a vehicle to cross from one to the other
Trailing Crossover	A crossover where a vehicle moving in the normal direction of travel must reverse to cross to the other track, as shown here:



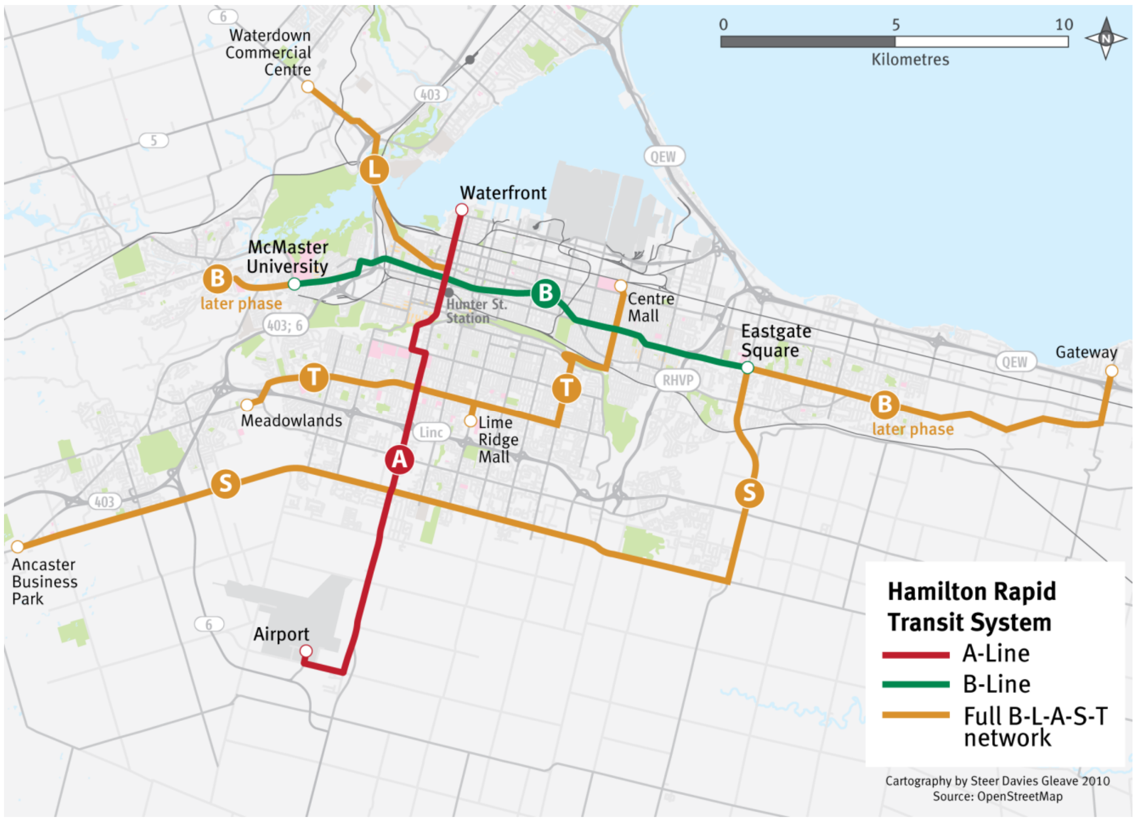
Double run	A journey that diverts off the main line of route to serve a key location before doubling back and continuing in its original direction
DW2 (v2.0)	B-Line Design Workbook 2 (version 2.0), dated March 2011, containing the alignment designs on which demand modelling, operational planning and detailed design are based
Interlining	The practice of running through buses between one route and another, changing route number but carrying through passengers
LRT	Light Rail Transit
MSF	Maintenance and Storage Facility
pph/bph/vph	Passengers/buses/vehicles per hour (always quoted per direction)
RTP	Regional Transportation Plan for the Greater Toronto and Hamilton Area (The Big Move)

1 Introduction

Background

1.1 The City of Hamilton is proposing to develop a five-line rapid transit network within the framework of the Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area, otherwise known as The Big Move. The proposed system is referred to as B-L-A-S-T and is shown in Figure 1.1.

FIGURE 1.1 HAMILTON RAPID TRANSIT – PROPOSED NETWORK



1.2 The B-Line from McMaster University, via the Downtown to Eastgate Square has been identified as the first route. Possible extensions to the east and west have been identified, as shown above, but are not included in current planning. The second route is the A-Line which is currently the subject of studies to identify a preferred route and mode but will run along the James Street / Upper James Street corridor from the Waterfront, via the Downtown to Hamilton International Airport. The L, S and T lines are longer term projects.

1.3 Light Rail Transit (LRT) has been selected as the preferred mode for the B-Line with LRT and Bus Rapid Transit (BRT) both under consideration for the A-Line. At present the other routes do not have a defined mode.

1.4 The development and implementation of a rapid transit system in Hamilton is much more than a transit project. 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".

Design and Service Principles

1.5 Steer Davies Gleave has been appointed by the City of Hamilton and Metrolinx to undertake the Preliminary Design and Feasibility Study for Hamilton Rapid Transit, covering detailed development of the B-Line and preliminary assessments of the A-Line. One of the main aims set out for the Study is to "take the project to a maximum state of implementation readiness". To this Steer Davies Gleave has added a demand-led, network-wide approach which emphasises "putting the passenger first".

1.6 The overall design concept that has been adopted for the B-Line is 'European, urban-style, city-scale LRT'. The detailed application of this concept in terms of design principles and guidelines is presented in the System Design Guide (in preparation). Under the concept, LRT is conceived in the context of a hierarchy of users of the roadway and other public space, in accordance with the Rapid Transit Vision, which is particularly appropriate for the Downtown areas of Hamilton:

- People
- Cycles
- Transit
- Local Vehicular Traffic
- Through Traffic

1.7 Working within the hierarchy of users, and in order to achieve the overall project aims, Steer Davies Gleave's approach is to seek to ensure that the whole transit system, of which rapid transit is a component, follows the principles of "putting the passenger first". This includes the design of an LRT alignment that features a series of "best practice" design principles, and the specification of a network that is passenger-friendly. The aim is produce a comprehensive Integrated Transit Solution.

1.8 An integrated solution requires consideration of the design of the rapid transit not only as an infrastructure project but also as a working system. From the passenger viewpoint, the transit network as a whole should have the following attributes, with the objective of attracting existing transit users, existing car users in the transit corridors and (importantly for revitalization) people who currently do not travel in the transit corridors:

- Competitive and consistent journey times;
- Short and predictable waiting times for 'turn up and go' services (frequent enough that there is no need to consult a timetable);
- Punctual departures and arrivals in the case of less frequent, timetabled, services;
- 'Seamless' journeys from origin to destination (making any transfers as simple as possible by means of physical design, ticketing, security and information);
- Maximum comfort, safety and security;
- Affordable fares; and
- Low operating costs (to maximise the available service)

1.9 Operational measures which help to achieve these attributes include:

- 100% segregation of rapid transit from other traffic (or as close as can be achieved);
- Designing for an optimum "whole trip" experience from origin to destination, including wayfinding, walking to/from stops and a high quality passenger waiting environment;
- Direct services where possible;
- Convenient transfers where these are required;
- Changes to bus routes (to provide a complementary and integrated transit network);
- An easily understood network and fares system; and
- A high standard of staff training.

Objectives of the Integrated Transit System Operations Plan

1.10 This Integrated Transit System Operations Plan has been prepared as part of the development of the rapid transit project and stands alongside the Design Workbook process, which sets out preliminary alignment designs for the B-Line.

1.11 It has three main subject areas:

- The long-term issues associated with the development of the five-line B-L-A-S-T rapid transit network in the City;
- The operation of the two rapid transit lines currently being brought forward – namely the B-Line and the A-Line; and
- The integration of the rapid transit lines with each other and with the bus network.

1.12 Like the Design Workbooks, this Operations Plan is an evolving document, but takes account of the most up-to-date alignment designs, traffic circulation proposals, ridership forecasts and traffic microsimulation.

1.13 Table 1.1 sets out some of the areas where the operational information is dependent on the outputs from other work and will be refined during project development to enable a more robust and detailed plan to be established.

TABLE 1.1 OPERATIONAL INFORMATION AND DEPENDENCIES

Information	Required for	Dependent on
B-Line		
Preferred option including alignment, segregation, stop locations etc.	Run times and service planning	Design studies
Signal priority plan	Run times	* Traffic modelling for the B-Line
LRV specification	Service planning and capacity analysis	System technical specification
Demand review	Service planning	* Demand modelling of the B-Line
Bus network changes	Service planning and operating costs	Further investigations of bus network re-structuring
A-Line		
Recommendations for the preferred mode	Run times and service planning	Design and technology studies for the A-line
Recommendations for the preferred mode	Integrated B-Line and A-Line service plan	Investigations of maintenance facilities for both lines
Recommendations for preferred routing	Run times and service planning	* Design and technology studies for the A-Line, including economic impact and land use assessments
General		
MSF location(s)	Service planning and fleet deployment	MSF planning
Phasing of lines	Implementation plan	Benefits Case Analysis
* These work elements are complete and the results have been used to have inform the operational analysis presented in this Operations Plan		

Operating and Maintenance Plan

1.14 Further information on the organizational structure and operating costs of the LRT operation is contained in the Preliminary Operations and Maintenance Plan prepared by SNC-Lavalin.

2 The B-L-A-S-T Network

Introduction

2.1 In this chapter we discuss the network planning issues associated with the B-L-A-S-T rapid transit routes, in the context of the RTP. More specific design issues associated with the A-Line and B-Line, including proposals for changes to the bus network, are discussed in subsequent chapters.

RTP Context

2.2 Table 2.1 summarises the projects in the RTP that are relevant to the development of Hamilton's transit system, with their reference numbers as shown in the Schedules to the RTP. For completeness, the project to extend regular Express Rail services to Hamilton (GO Centre/James Street North), and the potential eastward extension from the latter, are included.

2.3 The numbered projects in Table 2.1 are also illustrated in Figure 2.1 and Figure 2.2, which are extracted from the diagrammatic schedules in the RTP document showing the projects included in the 15 Year Plan and 25 Year Plan respectively.

TABLE 2.1 SUMMARY OF RTP PROJECTS AFFECTING HAMILTON

15 Year Plan		25 Year Plan (Years 16-25)		Longer Term (Year 25+)
(1) Lakeshore Express Rail from Oshawa GO to Hamilton	➔	(3) Regional Rail from Hamilton James Street North to Stoney Creek		
(19) Hamilton King/Main Rapid Transit **(B-Line)**				
(18) Hamilton James St Rapid Transit **(A-Line)**				
		(49) Hamilton Mohawk Rapid Transit **(T-Line)**		
			⇦	Hamilton Centennial/ Rymal Rapid Transit **(S-Line)**
(21) Rapid transit on Dundas Street in Halton and Peel	➔		⇦	Dundas Street Rapid Transit extension to Waterdown, with a connection to Downtown Hamilton **(L-Line)**

➔ Sequentially dependent projects
⇦ Possible earlier implementation
Numbers in parentheses indicate reference numbers in RTP Schedules as shown in Figure 2.1 and Figure 2.2

FIGURE 2.1 RTP 15-YEAR PLAN PROJECTS IN HAMILTON AND SURROUNDING AREA

Source: RTP (The Big Move), Schedule 1

FIGURE 2.2 RTP 25-YEAR PLAN PROJECTS IN HAMILTON AND SURROUNDING AREA

Source: RTP (The Big Move), Schedule 2

Review of B-L-A-S-T Routes

2.4 This section provides a brief review of the B-L-A-S-T corridors and the current transit provision in each.

B-Line

2.5 The B-Line is an east-west route following the major corridor of existing transit demand through Hamilton. The LRT is planned to run from McMaster University to Eastgate Square, with possible long term extensions westward towards Dundas and eastward into Stoney Creek.

2.6 The corridor is currently served by an intensive bus service on a number of routes, which together provide 22 to 24 buses per hour on the core sections in peak periods (all figures quoted here are for the peaks). Two of these routes follow the whole length of the corridor, namely:

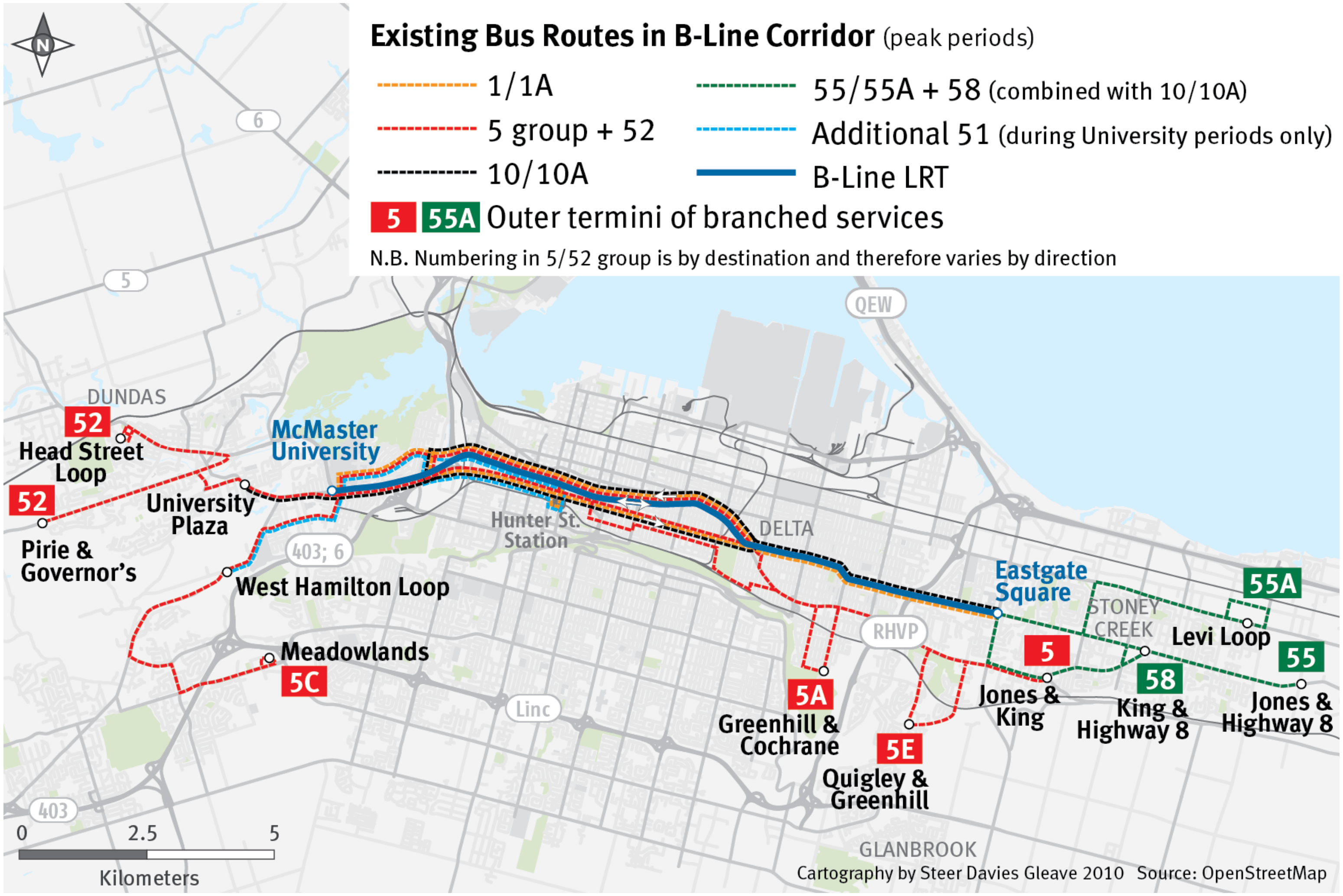
- 1A: McMaster University Medical Centre to Eastgate Square (4 bph local; runs via Sterling Street); and
- 10/10A: University Plaza/McMaster University Medical Centre to Eastgate Square (6 bph, B-Line Express).

2.7 Several other routes serve parts of the corridor, including:

- 1: GO Centre to Eastgate Square, supplementing the 1A (4 bph)
- the complex 5/5A/5C/5E/52 group from Dundas (2 termini), University Plaza, West Hamilton or Meadowlands to Greenhill/Cochrane, Quigley/Greenhill or Jones/King (8 bph in total)
- 51: West Hamilton to Hamilton GO Centre (4-6 bph, except summer and Christmas University vacations).

2.8 The existing pattern of these routes in peak periods is shown in Figure 2.3 - there are slight variations in detailed routings at other times. For clarity other routes are omitted.

FIGURE 2.3 EXISTING BUS ROUTES IN B-LINE CORRIDOR



2.9 The distances and scheduled morning peak run times between selected timing points over the section in common with the B-Line LRT (McMaster to Eastgate) are shown in Table 2.2 for local route 1A and express route 10A. In some cases the two routes use different timing points. It should be noted that these times are derived from public timetables which do not separate out running time from dwell time. The timings can be taken as departures from each stop except for the final destination.

TABLE 2.2 DISTANCES AND SCHEDULED AM PEAK RUN TIMES BETWEEN SELECTED TIMING POINTS - ROUTES 1A AND 10A

Direction	Timing Points		Route 1A		Route 10A	
	From	To	Distance (km)	Scheduled Time (min)	Distance (km)	Scheduled Time (min)
Eastbound	McMaster	Longwood	1.55	9	1.53	4
	Longwood	MacNab	2.51	8	-	-
	MacNab	Wellington	1.05	6	-	-
	Wellington	Ottawa	3.43	10	-	-
	Ottawa	Kenilworth	0.82	4	-	-
	Longwood	Queen	-	-	1.82	5
	Queen	John	-	-	1.12	4
	John	Wentworth	-	-	1.54	3
	Wentworth	Sherman	-	-	0.88	2
	Sherman	Kenilworth	-	-	2.46	6
	Kenilworth	Parkdale	1.59	4	1.59	2
	Parkdale	Nash	1.61	4	1.61	4
	Nash	Eastgate Sq.	0.85	2	0.85	2
	Total		**13.4**	**47**	**13.4**	**32**
Westbound	Eastgate Sq.	Nash	0.74	3	0.74	3
	Nash	Parkdale	1.62	4	1.62	3
	Parkdale	Kenilworth	1.54	4	1.54	3
	Kenilworth	Sherman	-	-	2.72	6
	Sherman	Wentworth	-	-	0.87	2
	Wentworth	Hughson	-	-	1.59	5
	Hughson	Queen	-	-	0.96	3
	Queen	Longwood		-	2.26	4
	Kenilworth	Ottawa	0.83	2	-	-
	Ottawa	Wentworth	2.76	9	-	-
	Wentworth	Wellington	0.84	3	-	-
	Wellington	Hughson	0.76	4	-	-
	Hughson	Longwood	2.86	12	-	-
	Longwood	McMaster	1.99	7	1.53	5
	Total		**13.9**	**48**	**13.8**	**34**

2.10 In the morning peak, route 1A has a run time of 47 minutes eastbound and 48 minutes westbound between McMaster Medical Centre and Eastgate Square. The compares with 32 minutes eastbound and 34 westbound between the same points for B-Line Express route 10A. The difference is mostly the result of the limited stops on the B-Line route, which are spaced on average about 4.5 times as widely as those in the local route.

2.11 These are scheduled times which do not take account of variations caused by traffic conditions or delays at stops (e.g. while loading cycles onto external racks or mobility scooters via ramps, or because of obstruction by parked vehicles). We have analysed data from the HSR Transit Survey carried out between October 2008 and February 2009 to assess the variability of actual journey times, and present the results in Table 2.3, which shows the range of times observed between McMaster and Eastgate Square on routes 10 and 10A. The analysis proved complex because of the way that some timings were recorded and a considerable amount of filtering was required. For this reason, the numbers should be taken as indicative of the level of variation and not necessarily statistically accurate.

TABLE 2.3 OBSERVED JOURNEY TIME VARIABILITY - ROUTES 10 AND 10A BETWEEN MCMASTER MEDICAL CENTRE AND EASTGATE SQUARE

		Minimum	Mean	Maximum	Standard Deviation
AM Peak	Eastbound	28.4	33.3	37.2	2.9
	Westbound	29.1	32.8	39.9	2.7
PM Peak	Eastbound	29.5	33.8	38.1	3.0
	Westbound	31.8	34.8	40.0	2.7
Offpeak	Eastbound	28.4	33.1	39.5	2.8
	Westbound	28.9	34.3	41.8	3.0

2.12 The data in the table shows that the mean observed times are very close to the scheduled time of 32-34 minutes, but that individual journeys vary considerably.

2.13 In the case of LRT, these variations will be minimized through the use of signal priority, level boarding platforms, internal storage of bikes instead of external racks (subject to confirmation) and an unobstructed right of way.

2.14 While the observed route 10/10A journey times in Table 2.3 are not estimated on a basis that is comparable with the simulated LRT journey times presented later in this document (Table 5.2), it is clear that the forecast level of variation for LRT, as measured by the standard deviation of the results, is considerably lower than for bus (0.9 minutes compared with 2.9).

A-Line

2.15 The A-Line follows a north-south route between the Waterfront and Hamilton International Airport via the James Street and Upper James Street corridor.

2.16 The A-Line route includes the ascent of the Niagara escarpment to the south of the Downtown. The different technical capabilities of LRT and BRT affect the choice of alignment on this section, and preliminary engineering studies have generated different preferred routes for the two technologies:

- LRT via:
  - James Street N
  - King Street E (shared alignment with the B-Line)
  - Wellington Street S (southbound) or Victoria Street S (northbound)
  - Claremont Access
  - Claremont Drive
  - W 5th Street
  - Fennell Avenue W
  - Upper James Street;
- BRT via:
  - James Street N
  - James Street S
  - James Mountain Road
  - W 5th Street
  - Fennell Avenue W
  - Upper James Street.

2.17 More details of the engineering issues associated with the Niagara escarpment section are included in the A-Line Opportunities Report.

2.18 The corridor served by the A-Line is less developed in transit terms than the B-Line corridor. Although ridership on the Mountain routes is high, it is distributed between ten bus routes that fan out from the top of the escarpment, of which the A-Line covers only two.

2.19 At present there is no bus route that covers the whole length of the A-Line corridor, but the section from Downtown southwards is covered by the following routes:

- 20: Downtown to Hamilton International Airport (A-Line Express, peaks only; runs via James Mountain Road); and
- 27: Downtown to Mountain Transit Centre (Local; runs via Jolley Cut).

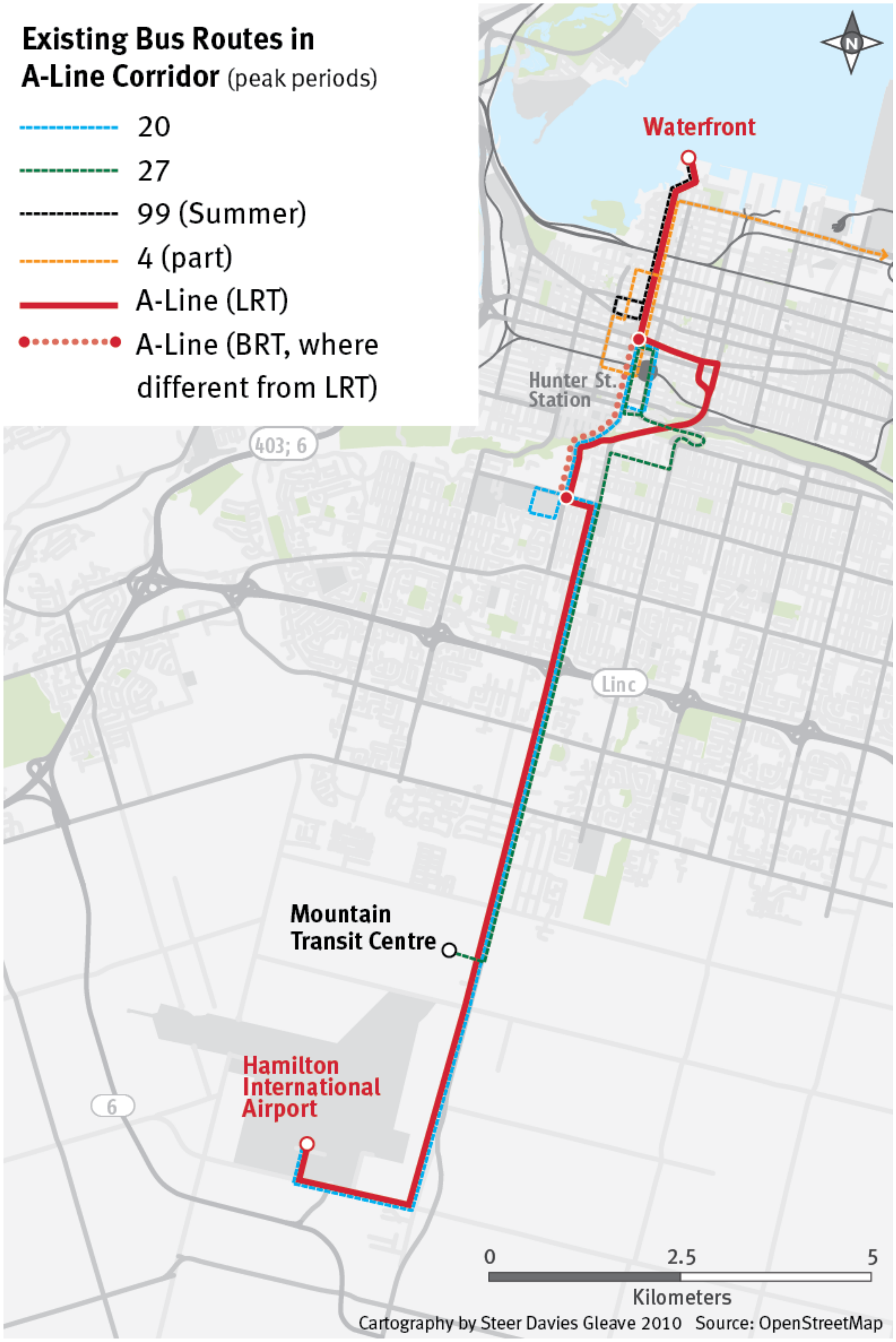
2.20 Together these routes provide six buses per hour in peak periods and three per hour in the base service periods (route 27 only).

2.21 The section of the corridor between Downtown and the Waterfront is served by the summer-only Waterfront Shuttle 99 between 10 AM and 9 PM, plus route 4 as far as Burlington Street.

2.22 The existing pattern of these routes is shown in Figure 2.4.

2.23 Other routes serve relatively short sections of the A-Line corridor, notably a number of Mountain routes that ascend and descend the Escarpment via James Mountain Road or Jolley Cut.

FIGURE 2.4 EXISTING BUS ROUTES IN A-LINE CORRIDOR



T-Line

2.24 The T-Line is defined in the RTP as a rapid transit service along the Mohawk Road corridor between Centre Mall and Meadowlands/Ancaster, and has been identified as a project for possible implementation in years 16-25 of the RTP.

2.25 The T-Line corridor is currently traversed by bus route 41/41A, which operates at a frequency of three buses per hour between Gage & Industrial and Meadowlands or Sanatorium Brow Building alternately, serving Lime Ridge Mall as a double run.

2.26 Transfers with the B-Line would be at Kenilworth Avenue, and with the A-Line at Upper James and Mohawk.

S-Line

2.27 Both the S-Line and the L-Line are included in the RTP among a number of projects to be examined in the first comprehensive review of the Plan, for possible implementation in the period beyond the 25-year period currently covered. Depending on the results of the analysis in the review, some of these projects may be brought forward for earlier implementation.

2.28 The RTP defines the S-Line as a rapid transit service along the Centennial Parkway - Rymal Road corridor, corresponding to the existing bus route 44, which runs between Eastgate Square and Ancaster Business Park. This route was introduced only in 2008, being extended to its current termini in 2009, and currently runs twice per hour in peak periods only. Clearly this is a new corridor for transit and its evolution as a rapid transit corridor will depend heavily on development and travel patterns that are different from those of today.

L-Line

2.29 Unlike the other lines in the B-L-A-S-T network, the L-Line is not free-standing but is linked to another project in the RTP, namely the Dundas Street rapid transit corridor running south-west from Toronto. Among the longer-term projects (25+ years), the RTP specifies an extension of this corridor to Waterdown, with a connection between Waterdown and Downtown Hamilton. The latter connection is embodied in the B-L-A-S-T network as the L-Line, which extends out from Downtown Hamilton as far as Waterdown Commercial Centre.

2.30 It is assumed here that the Hamilton-Waterdown section would not justify a free-standing rapid transit line, even if connected to the rest of the Hamilton network, for three reasons. First is its short length of only about 8 kilometres. Secondly, the central section between Dundurn Street and Plains Road has a very limited catchment, so that intermediate demand on this section will always be low. Secondly, the outer end at Waterdown Commercial Centre is only about 1 kilometre short of the start of the existing developed area of Waterdown, and in itself is unlikely to be a major ridership generator. For these reasons, and because the L-Line is specified in the RTP as an extension of the Dundas Street project, it is further assumed that through running between the Dundas Street corridor and Downtown Hamilton would be essential, to maximise the range of transfer-free journey opportunities. The choice of mode for the L-Line is therefore tied to that of the Dundas Street project.

2.31 The direct corridor between Downtown Hamilton and Waterdown is not currently served by transit, except for the Hamilton - York Boulevard section as far as Plains Road, which is covered by Burlington Transit route 1.

3 Network Development

3.1 At this stage in the process, with one line being planned at an increasing level of detail, another developed to the broad corridor stage but pending a decision on actual route and mode, and the three remaining lines defined as routes but still at the very early stages of development, it is not possible or desirable to be prescriptive about the way that the lines will interact at a local level. However, future network development will have an impact on the infrastructure now being planned and implemented, so it is necessary to consider how this can be handled.

3.2 Given the long timeframe for the RTP and the B-L-A-S-T network, flexibility is important. The RTP is not a rigid programme of works but a series of coordinated projects with a common aim, and the details and timing of each project will change and evolve during the plan period. Care therefore needs to be taken not to design for specific future developments that may not happen, or may happen in a different form, resulting in a sub-optimal layout or facility. Rather, the planning of the early lines should allow for the needs of the future network in a general way, such as by reserving space for expansion on a particular axis.

Passenger Interfaces

3.3 Table 3.1 shows the build-up of key locations where the lines in the B-L-A-S-T network interface with buses, other rapid transit lines and regional rail.

TABLE 3.1 MAJOR TRANSIT NETWORK INTERFACES

Lines in Operation	Rapid Transit - Bus*	Rapid Transit - Rapid Transit	Rapid Transit - Regional Rail
B	• McMaster • Downtown‡ • Eastgate Square	-	• GO Centre (~400m)
B + A	• McMaster • Downtown‡ • Eastgate Square • Mohawk College	• Downtown	• GO Centre • Proposed James St North GO Station
B + A + T	• McMaster • Downtown‡ • Eastgate Square • Mohawk College • Centre Mall • King/Kenilworth • Lime Ridge Mall • Meadowlands	• Downtown • Main/Kenilworth • James/Mohawk	• GO Centre • James St North Possibly: • Centre Mall • Centennial Parkway
B + A + T + S + L	• McMaster • Downtown‡ • Eastgate Square • Mohawk College • Centre Mall • King/Kenilworth • Meadowlands • Ancaster • Waterdown Commercial Centre	• Downtown • Main/Kenilworth • James/Mohawk • Eastgate Square • James/Rymal	

McMaster Locations in grey are carried through from earlier stages
* Excludes individual intersections with rapid transit crossing a single bus route
‡ Includes MacNab terminal, GO Centre and other Downtown bus stops

3.4 Table 3.1 lists the locations of the major transfer points, identified as those with a concentration of bus routes, based on the current network. However, there will be numerous other locations where rapid transit will intersect with individual bus routes, and where designs will need to facilitate easy transfer. For each stage of network development, Figure 3.1 to Figure 3.4 illustrate the locations of the major transfer facilities and these smaller but nonetheless important locations (often at simple street intersections) where rapid transit lines intersect with bus routes and transfers will need to be facilitated.

FIGURE 3.1 TRANSIT NETWORK INTERFACES: B-LINE

FIGURE 3.2 TRANSIT NETWORK INTERFACES: B-LINE + A-LINE

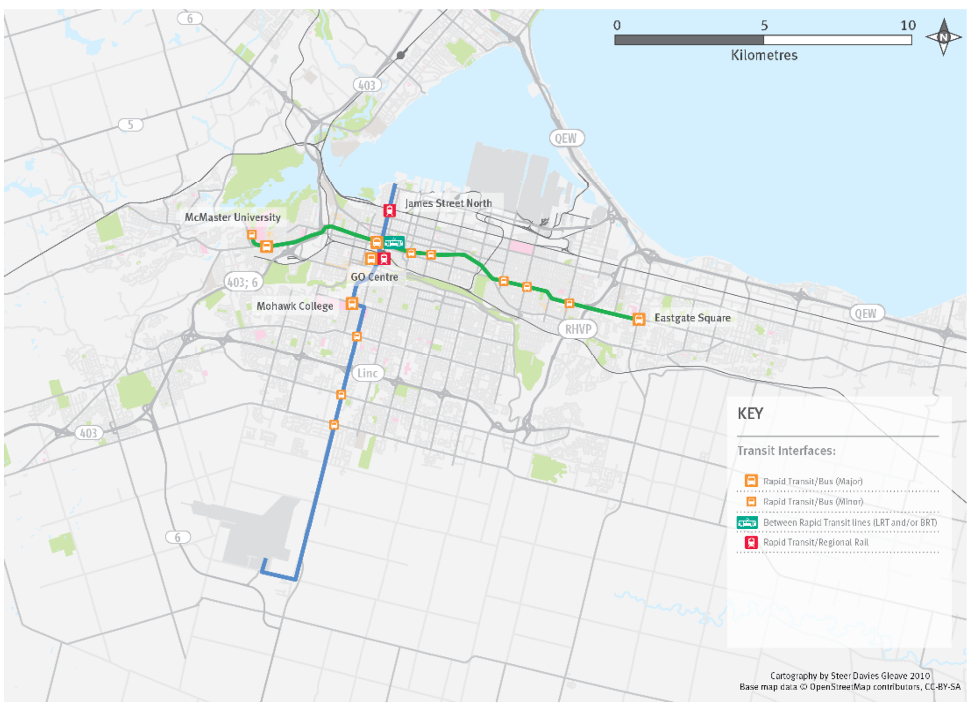


FIGURE 3.3 TRANSIT NETWORK INTERFACES: B-LINE + A-LINE + T-LINE

FIGURE 3.4 TRANSIT NETWORK INTERFACES: COMPLETE B-L-A-S-T NETWORK

3.5 In designing the network and its infrastructure, the key aim should be to present a seamless journey, irrespective of mode, with as far as possible equal quality throughout in terms of waiting facilities, information, vehicle standards (allowing for different technologies) and ease of transfer, so that passengers perceive differences between routes more in terms of the quantity of the service, rather than the quality.

Operational Interfaces

3.6 The term 'operational interfaces' is used here to mean the interactions between the rapid transit lines from the operator's perspective – such as service planning and timetabling, interlining, fleet deployment, storage and maintenance facilities.

3.7 The operational planning of the network will be dependent on choices that have not yet been made, but for simplicity it is assumed that all the new rapid transit routes will use a generic technology in the form of either light rail or bus transit (i.e. we have not distinguished between different types within each of these, such as 'BRT-lite'). However, the choice between these two basic modes will still affect the way the network develops, and it is not possible to explore every combination. We have therefore made the following assumptions on mode choice for the purposes of exploring network operations:

- The B-Line will be LRT;
- The A-Line may be LRT or BRT;
- The S-Line and T-Line are most likely to be BRT, since it would be very unusual for orbital demand in a city of Hamilton's size to support LRT. However, the possibility that either or both could be LRT needs to be recognised;
- The Dundas Street corridor rapid transit through Halton and Peel will be BRT, given its length (around 50km from Kipling subway station to Waterdown) and development density[1];
- Through running between the Dundas Street corridor rapid transit and Hamilton will drive the mode choice for the L-Line, and hence the latter will almost certainly also use BRT technology. However, if the Dundas Street corridor rapid transit were to be curtailed before it reaches Waterdown, the L-Line could alternatively be conceived as a branch of the B-Line or A-Line, and thus could be LRT (see also paragraph 2.30 above).

B-Line + A-Line

3.8 Figure 3.2 shows the configuration of the network at this stage. These two lines intersect in the Downtown area and it is here that the main issues arise.

[1] This assumption matches the options considered in the Dundas Rapid Transit Benefits Case, which assumed that LRT, if employed at all on that corridor, would not extend west of Hurontario Street in Mississauga.

3.9 If the A-Line uses LRT technology, a connection between the two lines will be required for operational reasons even if no through services are planned, because:

- The two lines will need to share a single MSF, since the costs of such facilities are significant; and
- LRVs will need to be transferred between the routes to cope with variations in traffic (likely to be the case even if they have different vehicle specifications).

3.10 Alternative Downtown layouts are being examined as part of the ongoing feasibility work for the A-Line, and this process will include consideration of connections between the two lines. Some options incorporate a section of shared route with the B-Line, which would automatically provide for movements between the two lines, in some directions at least. However, if a simple crossing of the A- and B-Lines emerges as the preferred option, it will be necessary to provide specific connecting tracks.

3.11 If both lines were to be LRT, and subject to the provision of suitable connections, it would be possible to run through services between them, for example between McMaster University and the Mountain. This would offer a wider range of transfer-free journeys, but the operation of through services between the lines of a cross-shaped network does have some disadvantages:

- Timetabling is made more complex and even headways are more difficult to achieve on common sections;
- Passenger information and signage is also more complex, especially if the through services operate only at certain times;
- At the central location it may be impossible to provide common stops for all outbound boardings, reducing the effective frequency for some passengers;
- Services are more sensitive to disruption, as delays on one line may affect the whole network rather than being containable to that line;
- Cross-city passengers may have to wait longer or make a transfer;
- Uneven loadings may result.

3.12 As a base assumption, it is recommended that the network is planned on the basis that the A- and B-Lines will operate as two separate services, even if they are of the same mode, with emphasis on easy transfer in the Downtown. This assumption would need to be reviewed in the light of the findings of the review of demand.

3.13 If the A-Line is BRT, the two lines will run as separate services and there is clearly no need for a physical connection to the B-Line.

3.14 Irrespective of the mode chosen for the A-Line, a key objective will be to enable easy transfers between the lines, and with buses, in the Downtown.

3.15 It has already been suggested that LRT is unlikely to be chosen for the orbital routes. If this is assumed to be the case, the B-Line MSF will not need to be designed for expansion to accommodate LRVs for additional lines. However, there will still be a need to allow for B-Line expansion in the form of capacity increases (more or longer vehicles) and route extensions.

B-Line + A-Line + T-Line

3.16 Figure 3.3 shows the configuration of the network at this stage.

3.17 The addition of the orbital T-Line results in two additional intersections between rapid transit lines, at Main/Kenilworth and James/Mohawk. Both of these are minor rapid transit/bus transfer points on the B- and A-Lines respectively, and the arrival of the T-Line will trigger a need to upgrade them in addition to any work for the T-Line itself.

3.18 Main and Kenilworth is an urban intersection with frontages adjoining the sidewalks at all corners. In DW2, the preferred option here has an LRT reservation on the south side of Main Street East and westbound-only traffic lanes to the north. The LRT platforms are close to the intersection and, with careful attention to pedestrian facilities, a simple on-street transfer point with the T-Line could be provided here.

3.19 Much depends on the design for the T-Line, however, since the layout could involve full segregation, bus-only lanes or mixed traffic operation depending on the detailed design approach.

3.20 If the T-Line is implemented as BRT, there is no requirement for through running at this location. This would need to be reconsidered if an LRT solution were to be chosen, but it is suggested that no allowance should be made for this in the current process.

3.21 At James and Mohawk, the layout is much more open, with wider roadways and car-oriented retail development set well back from the road, surrounded by parking lots. This is a much less pedestrian-friendly environment for transfers between rapid transit lines and would benefit from being designed to minimise walk distances. One option would be to provide a combined stop for both lines by diverting one of the routes (probably the T-Line), making transfers in all directions possible without crossing the road. This would be simpler with a BRT/BRT solution but might still be possible with the A-Line as LRT, especially with an off-street stop.

3.22 If both lines are BRT, then there are opportunities for through running. Here there is a stronger case for this than between the A- and B-Lines in the Downtown, since the demand will be starting to taper off here and hence there is scope for diverting part of the service to exploit additional markets. Possible destinations could include Lime Ridge Mall, Meadowlands or Ancaster.

3.23 Such through running might make the location and design of the stops at this point more complex, since it would be desirable to provide a common departure point for all vehicles towards each destination.

3.24 One of the advantages of BRT is the opportunities it offers for staged implementation, with more lightly-used sections being operated with less fixed infrastructure and priorities, thus enabling through services to be introduced at relatively low cost.

3.25 The results of ongoing work on the A-Line will enable some of these issues to be resolved.

3.26 Given the low density of current development, James/Mohawk would be a potential TOD location, especially with two rapid transit lines intersecting here. As well as intensifying demand, this could provide more flexibility for designing a high quality transfer facility.

B-Line + A-Line + T-Line + S-Line

3.27 Figure 3.4 shows the configuration of the network at this stage (plus the L-Line, which is discussed in the next section).

3.28 The T-Line and S-Line do not meet, so this section considers the additional interactions produced by the addition of the S-Line to the two-line network of B- and A-Lines. The T-Line interactions would remain as discussed above.

3.29 The S-Line meets the B-Line at Eastgate Square and the A-Line at James and Rymal. The first of these is already a major bus terminal and will become more important with the construction of the B-Line, while the second will be a minor rapid transit/bus transfer point with the implementation of the A-Line.

3.30 At Eastgate Square, the DW2 layout incorporates a B-Line terminus in the centre of Queenston Road, allowing for a future extension to the east with minimal alterations. The bus terminal remains on the north side but is relocated slightly. However, there is an aspiration to develop an integrated LRT/bus terminus on the north side of Queenston Road, on part of the Eastgate Square car park, and the layout will therefore be reconsidered as the B-Line alignment is refined.

3.31 If the S-Line terminates at Eastgate Square as BRT, the simplest arrangement would be for it to use the bus facility – the DW2 design allows more stands to be provided as required.

3.32 With the S-Line as LRT, the two lines would need to connect at Eastgate Square, and the optimum way of achieving this would be to connect the S-Line ‘end-on’ to the B-Line, thus allowing through running. Depending on the relative frequencies of the two lines, some or all of the service could then interline, with the balance terminating at Eastgate Square or being extended to an alternative reversing point.

3.33 In addition, there is a proposal under the RTP to establish regular regional rail services from Toronto to Hamilton and eastward, and these could serve a station at Centennial Parkway, only about 1.5 km north of Eastgate Square. There would be considerable advantages in extending the rapid transit network to serve this station, which could be accomplished by extending the B-Line (as has been suggested), the S-Line or both lines.

3.34 Extending both the B-Line as LRT and the S-Line as BRT would raise some additional design issues, particularly in respect of any shared stops. Here the different platform heights typical of LRT and BRT and the need to retain step-free boarding would probably mandate separate sections of platform for the two modes. However, the straight alignment of Centennial Parkway and the low density of adjacent development mean that there are fewer constraints on the design than elsewhere in the City and it is likely that such stops could be accommodated.

3.35 An extension of this kind would require a revision to the arrangements at Eastgate Square to allow through running, while retaining convenient transfers and minimising the journey times for through passengers.

3.36 The intersection of James and Rymal is very similar to James and Mohawk in its layout and surrounding land uses. The options for the design are therefore the same as at Mohawk, and if the A-Line and the S-Line are of the same mode there are similar opportunities for through running between Downtown and Rymal Road East and West. By the time the S-Line is implemented, developments along the Rymal Road corridor may present opportunities for additional destinations for part of the A-Line service.

All Lines (B-L-A-S-T)

3.37 Figure 3.4 shows the configuration of the full five-line network.

3.38 The final line of the five is assumed here to be the L-Line, dependent as it is on the establishment of 50 km of rapid transit from Kipling to Waterdown. However, since it does not interface with either the T-Line or the S-Line, the order of these projects is not critical.

3.39 The L-Line would add a third rapid transit radial approach to Downtown Hamilton, from the north west. It would be important to provide for easy transfers in the central Downtown area to the A- and B-Lines and to local buses. However, depending on service patterns, operators and funding authorities, it could be integrated with a BRT option for the A-Line, to provide through services to St Joseph's Hospital, Mohawk College or possibly all the way to Hamilton International Airport. At weekends, the service could be extended to the Waterfront. Given the length of the Dundas Road corridor, consideration would need to be given to the reliability of such through services, as at least part of the A-Line would be dependent on the punctual arrival in Hamilton of vehicles after a journey of over 50 kilometres.

3.40 The L-Line is sufficiently far in the future not to influence the detailed design of the Downtown infrastructure for the A- and B-Lines. However, the existence of the long term aspiration for a rapid transit to the Hamilton-Waterdown corridor should be acknowledged in the processes established for the future development of the Downtown highway and rapid transit network. In this way, decisions can be made that, as far as possible, will preserve the ability to accommodate full implementation of the B-L-A-S-T network.

4 B-Line Service Specification

Introduction

4.1 In this chapter we discuss the service specification for the B-Line LRT project as a stand-alone route between McMaster University and Eastgate Square. The interactions between the B-Line and the A-Line, other B-L-A-S-T routes and bus network were discussed in outline in Chapter 1, while initial the planning of the wider bus network is discussed in Chapter 8 onward.

4.2 An integrated approach has been adopted, drawing together the engineering designs (compatible with the Design Workbook 2 alignment), ridership forecasts and urban design.

Infrastructure Configuration

4.3 The stand-alone B-Line project will consist of a simple end-to-end route with double track throughout. In the stand-alone case, it will have no branches, other than a connection to the MSF and crossovers between the tracks.

4.4 All stops will be configured either as twin side platforms or island platforms, depending on the opportunities and constraints at the individual locations. In some cases side platforms will be staggered, generally each side of an intersection, to reduce the width of the alignment and/or provide space for left turn lanes.

4.5 LRVs will reverse in the platforms at each terminus, using pairs of crossovers on the approaches. The system is being designed with two-platform termini, which are expected to be sufficient to accommodate the planned headways. Terminal stations are planned with double length platforms to allow a vehicle to be temporarily parked out of use, for example following a failure in service (pending removal to the MSF) or to allow rapid introduction to service to meet peaks in demand.

4.6 Design Workbook 1 included terminal stops at McMaster University and Eastgate Square in the medians of Main Street West and Queenston Road respectively. Such layouts allow the route to be extended beyond the initial termini with a minimum amount of disruption and abortive work. However, alternatives involving off-street terminals are possible and would have advantages in terms of ease of transfer to/from buses and proximity to these key nodes for passengers. The selection of the final design will need to balance the likelihood and timescale of the line being extended versus the achievement of an optimum design for the initial project. While extendibility is an important consideration, it should not result in a sub-optimal solution from the passenger's point of view being implemented in the short term and possibly remaining indefinitely.

4.7 At McMaster University, DW2 v2.0 incorporates a westward extension from McMaster Medical Centre to an additional McMaster University stop alongside Cootes Drive, which provides for better penetration of the University campus and an opportunity for closer integration with GO bus terminal.

4.8 Stop locations are subject to refinement but those in DW2 are shown in Table 4.1, together with distances measured in the eastbound direction from McMaster University. Because some stops have staggered platforms, distances in the westbound direction may vary slightly. In addition, the distances shown here are measured for the purposes of operations and run times, and therefore differ slightly from those shown in the DW2 report, which are measured between stop centres (midway between the platforms if they are staggered).

TABLE 4.1 B-LINE STOPS AND INTER-STOP DISTANCES

From stop	To stop	Distance (metres)	
		Stop to Stop	Cumulative
McMaster University	McMaster Medical Centre	415	415
McMaster Medical Centre	Longwood	1,385	1,800
Longwood	Dundurn	1,180	2,980
Dundurn	Queen	820	3,800
Queen	MacNab	780	4,580
MacNab	Walnut	550	5,130
Walnut	First Place	455	5,585
First Place	Wentworth	760	6,345
Wentworth	Sherman	940	7,285
Sherman	Scott Park	655	7,940
Scott Park	Delta	750	8,690
Delta	Ottawa	410	9,100
Ottawa	Kenilworth	830	9,930
Kenilworth	Queenston Circle	870	10,800
Queenston Circle	Parkdale	770	11,570
Parkdale	Nash	1,640	13,210
Nash	Eastgate Square	570	13,780
Total McMaster to Eastgate Square		13,780	
Average stop spacing		811	

Intermediate Reversing Facilities

4.9 While it is planned that the normal service will operate the full length of the route between McMaster University and Eastgate, facilities for turning back LRVs at intermediate points will also be required. The reasons for this are:

- to provide for scheduled short turn workings, perhaps operating at certain times on certain days, particularly at start and end of the operating day service or at transitions between different headways;
- to allow services to be maintained over part of the route during disruption affecting a local area - either planned maintenance or caused by incidents such as equipment failure, road accidents etc.;
- to allow a disabled vehicle to be returned to the MSF by the shortest practical route.

4.10 Where LRVs are required to terminate in normal service, an offline reversing track, either at or beyond a stop, may be provided to allow LRVs to lay over and reverse without obstructing other LRVs. However, if only occasional reversals have to be accommodated, particularly at less busy times, simple trailing crossovers are adequate and these are the standard facility proposed here. These would normally be located adjacent to a stop, and would be controlled from the MSF.

4.11 A crossover does not require additional space compared with plain track but does require a section of straight track with a minimum length of about 30m under normal circumstances. Although crossovers on curves are possible, they may involve non-standard components, increasing the stock of spare parts that must be held. The crossover should also be located on a traffic-free section of route, clear of road crossings and areas with intense pedestrian activity.

4.12 LRVs passing over crossovers may generate increased noise, even when not using the crossover itself, and the selection of locations therefore needs to take account of the sensitivity of the surrounding area, particularly at night.

4.13 Indicative locations of reversing facilities are shown in the Track Plan Report, which proposes that three intermediate crossovers should be located at approximately equal intervals along the route. Crossovers will also be required at the connection to the MSF, the location of which is yet to be determined. The final arrangement of crossovers may therefore need to be amended when this has been fixed.

Segregation and Priority

4.14 Among the essential attributes of any LRT system are competitive and reliable journey times to maximise ridership, mode shift and operational efficiency (hence minimising operating costs). A key measure in achieving these is segregation from other traffic wherever possible, so that LRVs are not subject to delays and variable journey times. DW2 is based on this principle and incorporates a segregated alignment wherever possible, with mixed traffic operation confined to a short section in Downtown where traffic is limited to local access and speeds are in any case relatively low.

4.15 An urban LRT system is by its nature only partly segregated from pedestrians, and its design must respond to the varying needs of different areas in retaining local accessibility and minimising severance. The DW2 design again reflects this in its treatment of suburban, urban and Downtown sections.

4.16 Segregation from general traffic also requires the LRT system to be insulated as far as possible from the effects of traffic signal delays, which means a high degree of priority. The situation is different from a railway, which is usually completely separate from the street network and interacts with traffic only at defined crossing points, usually no closer than several hundred metres apart, where it generally has absolute priority. In contrast, an urban LRT system interacts with its surroundings throughout its length, with more closely spaced intersections, parallel, crossing and turning traffic, and pedestrian crossing movements. Because of the complexity of these competing demands, the degree of signal priority can only be finally determined by detailed modelling.

4.17 Sophisticated control systems are available to maximise the priority to LRT while maintaining overall road capacity as far as possible. Examples include a facility for approaching LRT vehicles to call a priority phase, or extend the current phase, to avoid being delayed by the signals. Any green time taken from another traffic stream as a result of the priority call is then generally restored in the next signal cycle to maintain capacity. Where a stop is immediately upstream of a signal, it is possible to call the phase when the vehicle arrives at the stop so that the signals change as the vehicle is ready to depart. Similarly, when two signals are close together, they are normally linked so that once a vehicle has been given a green phase at the first junction, it has a clear run through the second.

4.18 However, because of the complexity of the signal phases it is not always possible to give priority to every LRT vehicle, depending in part on the point in the cycle at which it arrives. In particular, if another LRT vehicle has recently passed in the opposite direction (or even in the same direction) the system may already be compensating other traffic streams and may not be able to respond to a new priority request immediately. As a result of this, the ease of achieving a high level of signal priority decreases as the frequency of the LRT service increases.

Maximum Permitted Speeds

4.19 It has been assumed initially that the LRT system will be subject to the same maximum speeds as general traffic where it operates within the road right of way, even where it is segregated. There may be sections where higher speeds will be possible, but experience suggests that unless a higher speed can be sustained over a significant distance, the reductions in overall run time are not significant.

Vehicle Configuration

4.20 A detailed vehicle specification is not yet required, but the outline characteristics shown in Table 4.2 below are assumed for operational purposes. A full specification would include considerably more detail such as (for example) the number and widths of doors, interior layout, passenger facilities, alarms and security equipment, end loadings, axle weights etc.

4.21 The passenger capacity of around 200 for a 30m LRV is rounded from a figure of 194 supplied by TTC for the Sheppard-Finch Benefits Case Analysis for Metrolinx. The vehicles for Hamilton are likely to be of broadly similar dimensions and configuration so that a similar figure is appropriate. However, a lower capacity is appropriate for the assessment of the relationship between demand and capacity, and this is discussed later in this chapter.

TABLE 4.2 OUTLINE REFERENCE LRV CHARACTERISTICS

Characteristics	Assumption	Notes
Length	30m assumed; infrastructure designed for 40m	Block lengths do not allow platforms for 2 coupled 30m vehicles
Passenger capacity including standing	~200 (30m vehicle) ~260 (40m vehicle) as an option	Lower figure used for peak hourly planning capacity
Doors	Multiple doors for rapid boarding and alighting (minimizes dwell times)	
Configuration	Double ended (driving cabs each end) Double sided (doors both sides) - both required for system without reversing loops.	
Floor height	Low floor: ~300mm at doors	Likely to be 100% low floor
Maximum speed	70 km/h	
Performance	To be determined	Run times assume typical acceleration of 1.0 to 1.1 m/s^2 (up to ~40 km/h, then decreasing), service braking 0.9 m/s^2 throughout range
Couplers	Emergency couplers only	Possibly no couplers

Service Plan and Line Capacity

Service Patterns

4.22 Preliminary ridership forecasts for the B-Line suggest that the largest flows in the AM peak are at the western end of the route, between the Downtown and McMaster University. However, the pattern is likely to be different in other time periods. Because of this and the importance of the major traffic generator Eastgate Square, it is assumed that all LRT journeys will operate the full length of the route under normal circumstances.

4.23 Some scheduled short turn trips are possible to/from the stop nearest the MSF, but only for LRVs entering or leaving service at the beginning or end of the operating day and at any changes in service level during the day. Depending on the MSF location and the distance from the required start/finish point, such trips could run out of service. Special occasions, such as festivals or sporting events, may require different patterns to be operated either to meet heavy demand or because part of the line is inaccessible.

Line Flows, Service Frequency and Capacity

4.24 Ridership forecasts have been prepared as part of the B-Line Transportation Case Review and these are set out as line flows for the AM peak period in Table 4.3.

4.25 The definition of the term ‘capacity’ is flexible and depends on the loading standard that is assumed. This operational analysis is based on a more detailed assessment of capacity than that included in the Transportation Case Review, and for this reason the figures quoted may not be consistent.

TABLE 4.3 FORECAST LINE FLOWS – B-LINE 2021 AND 2031

		AM Peak Hour Flow 2021		AM Peak Hour Flow 2031	
Between	**and**	**Eastbound**	**Westbound**	**Eastbound**	**Westbound**
McMaster University	McMaster Medical Cent	*	*	*	*
McMaster Medical Cent	Longwood	268	1323	359	1429
Longwood	Dundurn	290	1310	373	1424
Dundurn	Queen	334	1464	438	1641
Queen	MacNab	375	1263	482	1415
MacNab	Walnut	354	1598	494	1707
Walnut	Wellington	425	1650	564	1898
Wellington	Wentworth	453	1547	580	1799
Wentworth	Sherman	437	1464	523	1708
Sherman	Scott Park	447	1517	532	1763
Scott Park	Glendale	509	1410	594	1640
Glendale	Ottawa	531	1303	613	1531
Ottawa	Kenilworth	520	1091	613	1277
Kenilworth	Queenston Circle	563	1032	668	1213
Queenston Circle	Parkdale	527	740	630	884
Parkdale	Nash	431	434	537	521
Nash	Eastgate Square	306	356	363	428

* This short extension (~400m) has not been modelled in the Transportation Case Review

4.26 A peak headway of 4 minutes, providing a service of 15 LRVs per hour, has been assessed as the central case, and is the basis of the ridership and operating cost forecasts. In theory this would provide a line capacity of around 3,000 passengers per hour (based on 200 per vehicle) but in practice it is not possible to sustain this level of loadings and it is usual to adopt a lower capacity for practical purposes.

4.27 The capacities specified by TTC for the Sheppard-Finch work are shown in Table 4.4. These are based on a vehicle of approximately 30m length with 27.42m^2 of usable standing space. The last column of the table shows the line capacity (theoretical and practical) that would be provided if every LRV carried these numbers of passengers.

TABLE 4.4 LRT VEHICLE CAPACITIES

Loading criterion	Persons standing per m^2	Seated capacity	Standing capacity	Total capacity	Line capacity (passengers per hour, 4 minute headway)
All seats occupied, no standing	N/A	66	0	66	990
W-4A loading (capacity)	4.67	66	128	194	2,910 *
W-5 loading (crush)	7.14	66	196	262	3,930 *
Peak load standard	2.34	66	64	130	1,950

* Theoretical figures only – not sustainable in practice

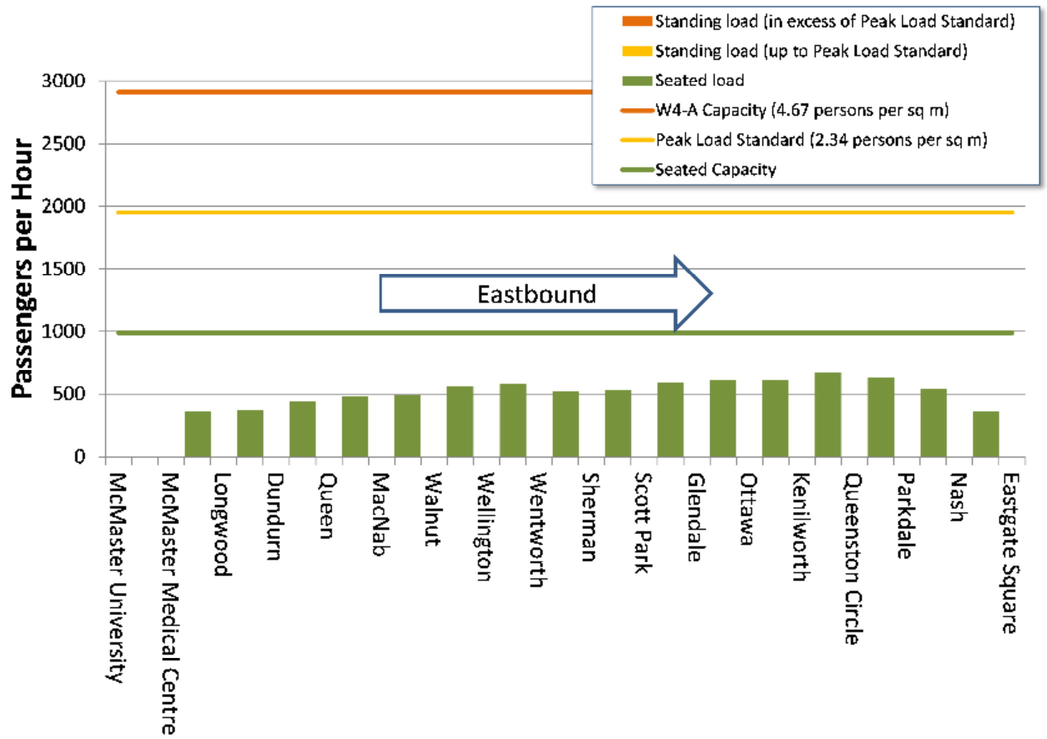
4.28 W-4A capacity represents the practical maximum load that is planned to be carried in normal circumstances. W-5 is an extreme loading that is severely uncomfortable for passengers and is not normally planned for, but may be tolerated on an occasional basis – e.g. when clearing large crowds after sporting event, or in adverse weather when the entire transportation system (including both auto and transit) is under exceptional stress.

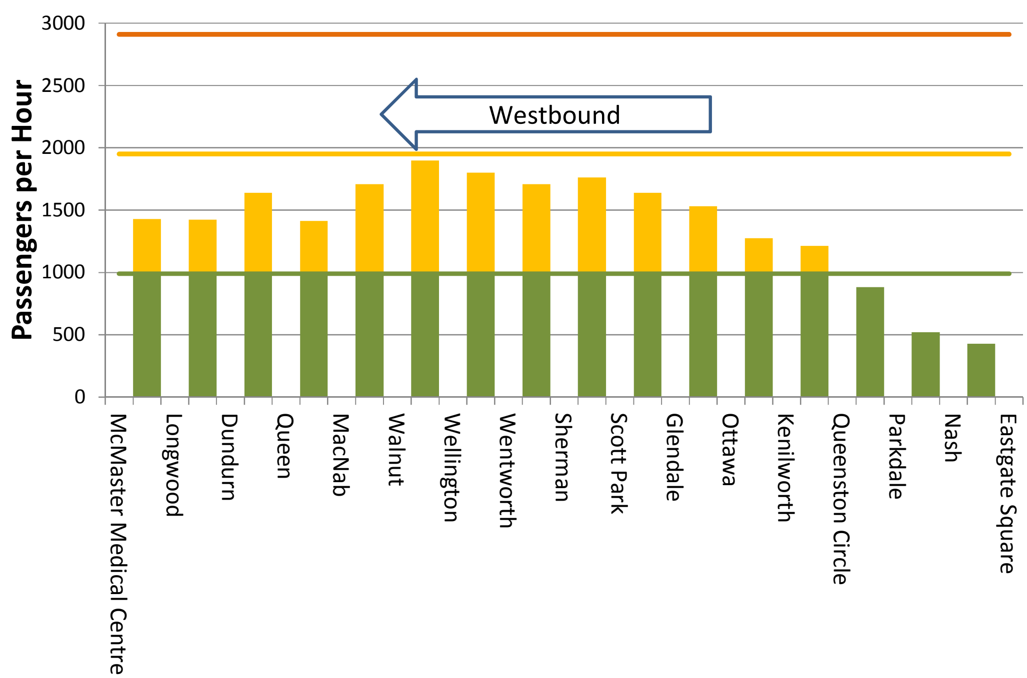
4.29 For practical purposes, however, even the W-4A loading cannot be sustained over a full peak hour or period, because of uneven loadings caused by short-term ‘spikes’ in demand, slight variations in headway, unbalanced distributions of passengers within vehicles etc. It is common, therefore, to assume a lower capacity on average when comparing ridership and capacity, to represent the practical line capacity that is sustainable over a period without adverse effects on the quality of service.

4.30 TTC supplied a figure of 130 passengers for Sheppard-Finch, as shown in Table 4.4 above. This is based on seating capacity plus 50% of the W-4A standing capacity. Given the similarity between the size and configuration of the Toronto LRV and the Hamilton reference vehicle, we have adopted this number as a planning standard for ridership comparisons.

4.31 The 2031 ridership forecasts in Table 4.3 are plotted in Figure 4.1 along with the seated, peak load standard and W-4A capacities for comparison.

FIGURE 4.1 B-LINE AM PEAK LINE FLOWS & CAPACITY 2031 (4-MIN HEADWAY)

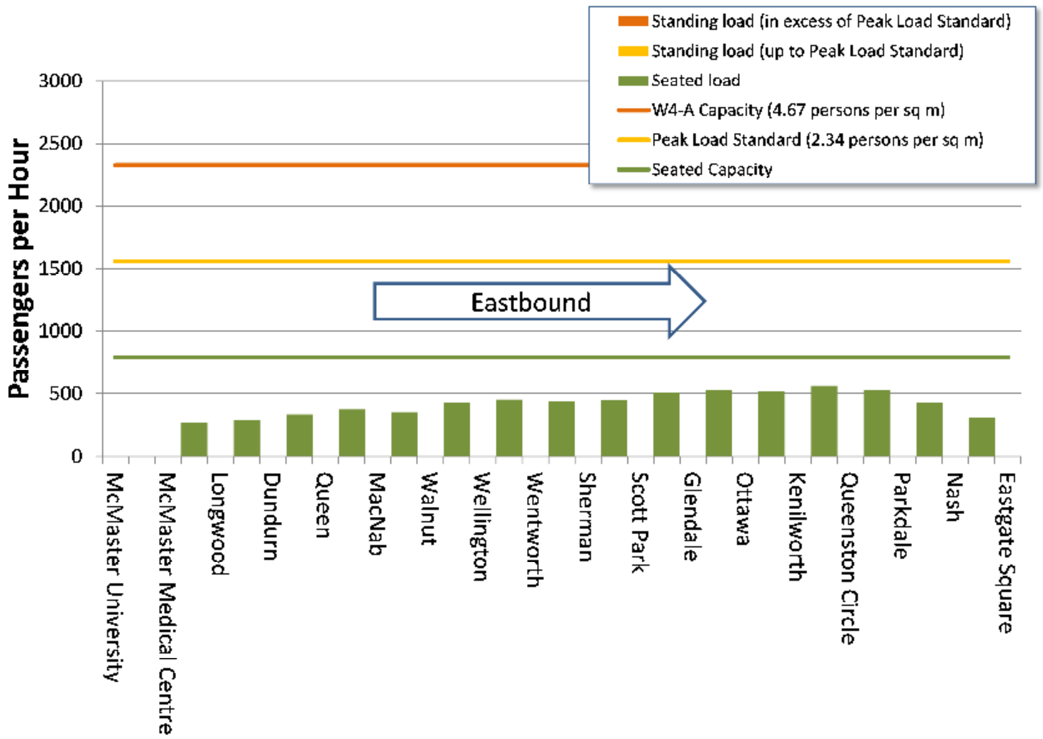


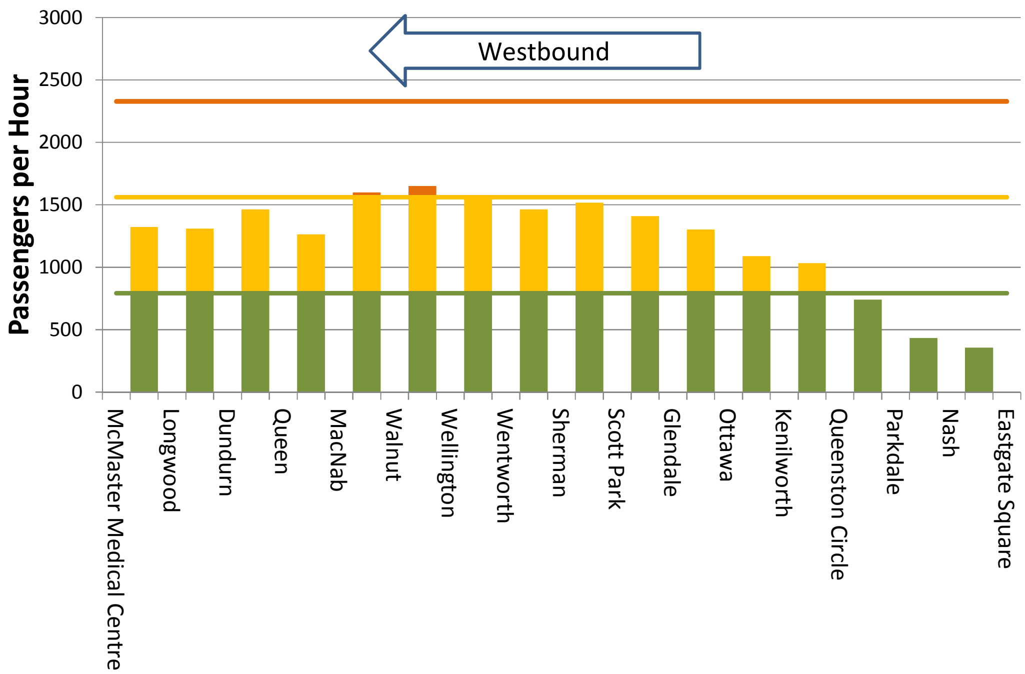


4.32 Figure 4.1 shows that the ridership forecasts for 2031 and the capacity provided by a 4-minute headway are well-balanced, with maximum flows remaining just below the peak load standard in the busier westbound direction. This means that there is adequate capacity 'headroom' to cope with short term peaks, exceptional loadings and the extra space demands of wheelchairs, strollers and mobility scooters. In the eastbound direction, loadings remain within seating capacity throughout.

4.33 Forecast loadings in 2021 are somewhat lower than in 2031, but the difference in maximum loadings is relatively small at around 15%. It is therefore recommended that a 4-minute headway be operated from the outset, although consideration could be given to a slightly wider headway in the early years of operation if desired, depending on actual ridership build-up. Based on the 2021 projections, a 5-minute headway would provide enough capacity to meet the peak load standard except for a short section in Downtown. This is illustrated in Figure 4.2.

FIGURE 4.2 B-LINE AM PEAK LINE FLOWS & CAPACITY 2021 (5-MIN HEADWAY)





Service Profile

4.34 During weekday daytimes, existing bus routes in Hamilton follow one of three profiles: a flat frequency all day, an increased frequency in the peaks or operation in the peaks only. The majority of routes are in the second category, including the B-Line Express route 10 and the 5/52 group, but route 1 operates at 8 buses per hour throughout the day. The question therefore arises as to whether the LRT should operate at a flat frequency all day or whether the service should step down in the interpeak.

4.35 The existing demand profile across the day appears to vary between different bus routes, with some exhibiting a peak in mid-afternoon and other showing a more conventional two-peak profile. In the B-Line corridor, routes 1 and 5/52 fall into the first category, while B-Line Express route 10 falls into the second[2].

4.36 Given that the peak LRT headway of 4 minutes will provide a substantial capacity uplift in the corridor, we have assumed for operational planning purposes that the LRT service will be reduced between the peaks rather than operating a constant profile throughout weekday daytimes.

4.37 The length of the operating day should be at least as long as the current bus service day, which means broadly from 05:00 to 01:30 (starting times of first and last journeys) on weekdays and Saturdays, with a slightly later start and earlier finish on Sundays.

4.38 Table 4.5 brings together the above assumptions and shows the service profiles by day of the week that have been assumed for operational planning and cost estimation.

[2] Source: Hamilton Street Railway Operational Review, Appendix A, IBI Group, March 2010

TABLE 4.5 PRELIMINARY B-LINE SERVICE PROFILE

Day	Period	Times	Service Frequency (LRVs per hour)	Headway (minutes)
Weekday	Early	05:00-07:00	8	7.5
	AM peak	07:00-10:00	15	4
	Interpeak	10:00-14:00	10	6
	PM Peak	14:00-18:30	15	4
	Evening	18:30-01:30	8	7.5
Saturday	Early	05:00-09:00	6	10
	Daytime	09:00-18:00	10	6
	Evening	18:00-01:30	8	7.5
Sunday	Early	05:00-11:00	6	10
	Daytime	11:00-18:00	8	7.5
	Evening	18:00-00:30	6	10

Bus Substitution

4.39 At certain times it may be necessary to substitute buses for LRVs, either because of essential maintenance on the track, overhead or power supply, or in an emergency. Replacement buses may also need to be used in the late evenings (after midnight) to allow for infrastructure maintenance. Along most of the B-Line, it is possible for buses to use parallel traffic lanes in such circumstances, stopping at the nearest normal bus stop. However, depending on the final design, there may be sections where this is difficult or impossible, for example where traffic paralleling to the LRT is one-way. In such cases, replacement bus services will need to run on the appropriate parallel street as used by local buses, and local publicity will need to direct intending passengers to this location in advance.

4.40 In any event, bus stops that are served by LRT replacement buses should be distinctively identified, so that passengers are in no doubt about where they can board or alight when LRVs are not running.

Planning for Growth

4.41 As discussed above, the planned 4-minute peak headway is adequate to meet projected ridership up to 2031, so there is no indication at present that the system capacity will need to be increased during the appraisal period. However, since one of the objectives of the LRT is to contribute to the revitalization of Hamilton, and LRT projects frequently exceed their initial ridership forecasts, it is prudent to anticipate how capacity might be increased after system opening.

4.42 Clearly there are two basic options for expanding capacity: increasing the capacity of the vehicles or increasing the frequency of operation. With LRT the former may, depending on system design, include the option of coupling vehicles together[3]. All these options require additional vehicles plus associated storage and maintenance space, roughly in proportion to the capacity increase, but they differ in some operational respects. Table 4.6 below summarises the advantages and disadvantages of each.

[3] Although this option is not considered feasible on the B-Line, as discussed in paragraphs 4.45 to 4.47, it is included here for completeness.

TABLE 4.6 OPTIONS FOR INCREASING CAPACITY

	Advantages	Disadvantages
Increase frequency	Reduced passenger waiting time - more attractive service. Additional vehicles can differ from original fleet – opportunity for competitive pricing. Additional vehicles can incorporate latest technical developments.	More pressure on signal capacity; may reduce level of LRT priority, possibly leading to 'bunching'. More pressure on terminal capacity. More drivers required - increased operating costs.
Operate coupled vehicles	Less impact on signal capacity (though can still be significant because of greater intersection clearance times for longer consists). No additional driver costs. Can tailor capacity to demand by operating single vehicles at quiet times, reducing operating costs, while maintaining service frequency.	Double length may be problematic for stop and intersection design. Requires early commitment and at least passive provision. 'Double or nothing' increase in capacity unless single and coupled vehicles are mixed in service (leading to uneven loadings). Requires vehicles to be fitted with full couplers and multiple unit control. Later batches must be mechanically and electrically compatible with originals, unless sub-fleets are kept separate.
Lengthen existing vehicles	Less impact on signal capacity (though can still be significant because of greater intersection clearance times for longer vehicles). No additional driver costs.	Commits to higher capacity at all times, even when demand is low. Normally restricted to original supplier. May require maintenance facilities to be reconfigured (though not an issue in Hamilton, since MSF planning is based on 40m vehicles.) Requires vehicles to be taken out of service for insertion of additional sections (a once-only issue, but may reduce fleet availability for a period).

4.43 The central assumption for B-Line service frequency is 15 vehicles per hour, or one every four minutes. It would be possible to operate an increased frequency, to a maximum of around 24 vehicles per hour (one every 2½ minutes), but this would require increased levels of priority to prevent LRVs being delayed excessively at signal-controlled junctions. As discussed in 4.17 - 4.18 above, increased LRT priority may also have impacts on the capacity of the network for other flows, including major cross-flows and buses, and the disbenefits of this could be substantial.

4.44 While increased frequencies can make the service more attractive by reducing wait times, the effect tends to be small when headways are as narrow as 4 minutes, since waiting times are already short. In addition, any increase in headway irregularity caused by signal delays would tend to erode this advantage.

4.45 The operation of coupled vehicles has advantages in terms of flexibility, since in theory capacity can be added only when required. However, this may require procedures for doing this during the operating day, perhaps involving empty running to/from the MSF and coupling during turnback time, with consequent staff costs and potential for delays.

4.46 In Hamilton, however, the key argument against this option is that, at a number of locations on the B-Line route, the distance between cross streets is too short to accommodate 60m platforms (given that the actual length required is increased by platform ramps and pedestrian crosswalks) without closing adjacent cross streets and employing mid-block crosswalks, which are not favoured.

4.47 A further difficulty with the operation of coupled pairs or LRVs would be the disruption associated with the later construction of platform extensions. It is very unlikely that 60m platforms could be justified as part of the initial project, except at certain specific stops as discussed in the DW2 report (paragraph 1.35) , given that there is no evidence that the additional capacity will be required in the future. The platforms would therefore need to be lengthened at a later stage. Unless the initial project was specifically designed to enable these extensions, which would probably make many initial stop designs sub-optimal, the extension works would be very disruptive.

4.48 The current stop designs in DW2 are based on 40m platforms, except at the termini where 85m is provided to allow an out-of-service vehicle to be berthed. This allows for vehicle lengthening from the initial 30m (or the provision of 40m vehicles from day one if this is more cost-effective).

4.49 Bearing in mind the above, it is suggested that at this stage the preferred option for additional capacity, if such is required, should be based on some combination of longer vehicles and a modest increase in frequency, to which end:

- the vehicle specification and procurement should include a costed option for the supply and insertion of additional sections; and
- tests should be undertaken to estimate the maximum practical LRT frequency.

5 B-Line Timetabling

Run Times

General Assumptions

5.1 Run times are an important input to the assessment of the case for LRT, affecting:

- ridership and revenue forecasts, through the competitive position of LRT with respect to other modes;
- operating costs, through the efficiency in the use of vehicles and human resources; and
- capital costs, through the number of vehicles required to operate a given level of service.

5.2 In addition, a predictable run time, with the smallest possible variations between individual trips, is required to ensure an attractive service by minimizing passenger wait times and ensuring even loadings between consecutive vehicles.

5.3 With this in mind, the B-Line LRT project is being developed with maximum segregation from road traffic to ensure that speed and reliability are maintained with LRT vehicles operating in the street environment. On systems of this type, LRT vehicles are treated as other road vehicles in that:

- they are driven 'on sight' – i.e. the driver must adopt a speed such that he/she is able to stop short of any obstruction;
- they are generally subject to the same maximum speeds as other road traffic; and
- they are subject to traffic signal control (generally with their own distinct signals).

5.4 The run time from stop to stop and the total run time for the route are affected by:

- the geometry of the alignment itself (including gradient);
- applied speed limits;
- the performance of the vehicle (acceleration, deceleration and maximum speed);
- the time spent at stops (dwell); and
- the delays encountered at signal-controlled intersections.

5.5 The last of these depends on intersection designs, signal phasings and LRT signal priority, and is the most difficult to forecast in the early stages in project development. However, preliminary estimates can be prepared using experience of what can be achieved in practice, taking account of the conflicting demands on finite capacity made by LRT and other road users such as buses, pedestrians and general traffic.

5.6 The estimates prepared for the purposes of appraisal have been confirmed by comparison with the results of traffic microsimulation, as discussed later in this chapter.

Run Time Model

5.7 Estimated run times for the B-Line have been prepared using a spreadsheet model based on the following key inputs:

- Vehicle performance – acceleration and deceleration rates;
- Link characteristics – distances, curvature, maximum speed; and
- Delay characteristics – stop dwell times, signal intersection delays.

5.8 Given an alignment design and an outline vehicle specification, most of these inputs can be defined to degree of certainty that is sufficient for operational planning purposes. Intersection delays, however, are more difficult to define and require assumptions to be made about the level of signal priority that can be achieved in practice, balancing the competing needs of different road users.

5.9 To allow a range of priority levels to be investigated, three scenarios for signal priority have therefore been defined. The first is an 'Absolute' priority scenario, based on an LRV receiving no restrictive signals and being able to proceed through all intersections without delay. The second scenario is 'Moderate' priority and is based on a more cautious approach with signal delays dependent on the size and functions of individual intersections. The third is a compromise 'Moderate-Plus' level of priority based on improvements over the Moderate level at certain locations, but retaining some signal restrictions.

5.10 The Moderate-Plus priority level has been used as the central case for operational planning and for the ridership forecasting reported in the Transportation Case Review (August 2011). The journey time of 31 minutes from McMaster Medical Centre to Eastgate Square, as quoted in the PIC documentation, is based on this level of priority, though the total end-to-end journey time for the B-Line is now slightly longer than this because of the short extension at McMaster University introduced in DW2 v2.0.

5.11 The run time modelling covers the route from McMaster University to Eastgate Square in the eastbound direction, based on the DW2 v2.0 alignment drawings and including the stops listed in Table 4.1.

Run Time Forecasts

5.12 Table 5.1 presents the results of the run time model based on the three levels of signal priority. Link times are quoted mid-dwell to mid-dwell, i.e. with stop dwell times distributed equally to the adjacent links. The table shows the full DW2 v2.0 route including the extension from McMaster Medical Centre to McMaster University, so that the total journey time for the Moderate-Plus priority assumption is 32.5 minutes instead of the 31 minutes quoted in the PIC documentation and used in the Benefits Case Analysis, which applies to the shorter route.

5.13 The figures apply to the eastbound direction; the westbound end-to-end times can be expected to be similar, but timings at intermediate points may vary slightly because of the different order in which curves, stops and signals etc. are approached and the fact that some stops have platforms staggered each side of an intersection.

TABLE 5.1 B-LINE RUN TIME MODEL RESULTS

From stop	To stop	Journey Time (mid-dwell to mid-dwell)		
		Absolute Priority	Moderate Priority	Moderate-Plus Priority
McMaster University	McMaster Medical Centre	1.5	1.5	1.5
McMaster Medical Centre	Longwood	2.3	3.2	3.0
Longwood	Dundurn	1.8	1.8	1.8
Dundurn	Queen	1.6	1.6	1.6
Queen	MacNab	1.6	2.4	2.0
MacNab	Walnut	2.3	2.5	2.4
Walnut	First Place	1.9	2.4	2.1
First Place	Wentworth	1.6	1.8	1.8
Wentworth	Sherman	1.7	2.1	1.9
Sherman	Scott Park	1.5	1.6	1.6
Scott Park	Delta	1.5	1.9	1.9
Delta	Ottawa	1.1	1.1	1.1
Ottawa	Kenilworth	1.6	1.7	1.7
Kenilworth	Queenston Circle	1.7	1.8	1.8
Queenston Circle	Parkdale	1.5	1.5	1.5
Parkdale	Nash	2.4	3.4	3.0
Nash	Eastgate Square	1.6	1.7	1.7
Total		**29.3**	**34.1**	**32.5**
Distance		**13.78 km**	**13.78 km**	**13.78 km**
Average Speed		**28.3 km/h**	**24.3 km/h**	**25.4 km/h**

5.14 These times do not include any specific recovery margins within the journey. While some variations in run time between individual trips are inevitable, an effective signal priority plan will minimise these. The addition of specific recovery time would lead to some trips running early or 'waiting time' at an intermediate point. It is therefore assumed that any minor delays can be recovered within the turnback times at each end of the route (discussed in the next section).

5.15 It is recommended that continuing development of the alignment design and traffic signal strategy for the B-Line should use the Absolute priority scenario as an ideal target, with departures from it accepted, on a case-by-case basis, only after it is demonstrated that such a high level of LRT priority cannot be achieved at a particular location without unacceptable impacts on other users. Achieving the Absolute level would require:

- a high degree of signal priority;
- the removal of as much as possible through traffic;
- no shared running with buses;
- no additional stops.

5.16 It is recognised that compromise will be required at various locations and that absolute priority is unlikely be achievable throughout the route - this is why the benefits case and operational assessments are based on a cautious assumption of a lower priority level. The Moderate priority figures in Table 5.1 illustrate the adverse effect of a much lower overall level of priority than is ideal, and we would recommend that the Moderate-Plus timings are adopted as a minimum standard to pursue.

Run Time Comparisons

5.17 For comparison, Table 5.2 shows the end-to-end times from the run time model together with LRT estimates obtained from:

- the Metrolinx HRT Benefits Case report;
- the Hamilton Rapid Transit Feasibility Study; and
- VISSIM modelling of the B-Line. This simulates both LRT and general traffic in the B-Line corridor, enabling an individual LRT trip to be ‘followed’ through each signalled intersection along the route. Multiple runs (>100) were undertaken to measure the impact of variations in individual signal delays on end-to-end times. Full details can be found in the VISSIM Model Report (July 2011).

5.18 Because the precise routes and route lengths vary between these cases, particularly in the location of the McMaster terminus, the times have been normalised where possible to apply to the section between McMaster Medical Centre and Eastgate Square. In some cases (as indicated) the available data does not allow this, and here the times are therefore quoted for the full route. However, in all cases the average operating *speeds* take account of the slight differences in route length and can therefore be directly compared.

TABLE 5.2 B-LINE RUN TIME COMPARISONS - MCMASTER MEDICAL CENTRE TO EASTGATE SQUARE

Source	Direction	McMaster (Medical Centre unless otherwise noted) to Eastgate Square		
		Distance (km)	Time (min)	Average Speed (km/h)
Run Time Model – Absolute Priority	E/B	13.4	27.6	29.1
Run Time Model – Moderate Priority	E/B	13.4	32.4	24.8
Run Time Model – Moderate-Plus Priority	E/B	13.4	30.9 ‡	26.0
# Benefits Case[4]	Not specified	14.2	26	33
* RT Feasibility Study[5]	Not specified	14.2	30	28
VISSIM simulations (AM Peak)				
Minimum			29.3	27.4
Mean	E/B	13.4	31.7	25.4
Maximum			33.8	23.8
Standard deviation			0.9	
5th to 95th percentile range			30.3-33.6	
95th percentile excess over mean			+1.9	

‡ Corresponds to 31 minutes quoted in PIC documentation

Time from McMaster University terminus

* Time from McMaster University GO Bus Terminal, which is approximately 0.8 km from the Medical Centre. Distance estimated by Steer Davies Gleave as 13.4 + 0.8 = 14.2.

5.19 The run time used in the benefits case was based on an assumed operating speed agreed with Metrolinx and was established in advance of any feasibility or design work on the alignment and traffic interfaces. Furthermore, it was defined before the concept of European-style low floor LRT was applied to Hamilton. Subsequent work has confirmed that an operating speed of 33 km/h could only be achieved through a combination of absolute priority at all traffic signals and some maximum speeds higher

[4] Hamilton Rapid Transit Benefits Case, Final Report, Steer Davies Gleave, November 2009 (Table 4)

[5] Hamilton Rapid Transit Feasibility Study, McCormick Rankin, May 2008 (Table D12)

than the general traffic speed, which would not be compatible with the overall concept now being developed.

5.20 Both the run time model and the VISSIM simulations suggest a run time of 31-32 minutes from McMaster Medical Centre to Eastgate Square. We have adopted the run time model results as a central working assumption, since the signal phasings and timings inherent in the VISSIM modelling are subject to refinement. However, the simulation results also give a measure of the *variability* of these times in response to traffic signal delays, which will affect individual trips differently. This is important in planning the service, in particular in determining the turnback times to be allowed in vehicle resourcing.

5.21 The VISSIM results indicate that 90% of journeys will be completed in the range 30.6 to 33.6 minutes, and no journey should take more than 33.8 minutes (unless affected by a major delay cause such as a vehicle breakdown, accident or traffic system failure, in which case a degraded service plan will be implemented until normal operation is restored). Relating these to the mean suggests that 95% of journeys will be completed with a maximum of 1.9 minutes excess over the mean journey time.

Turnback Times

5.22 Before estimating fleet size and operating costs it is necessary to add turnback (or lay-up) times at each end of the route to allow for small natural variations in run time and provide time for the operator to change ends, enter trip data, reset destination displays and carry out a brief ‘sweep’ for lost property etc. Depending on staffing arrangements, a comfort break may also be allowed for, but this may be accommodated by operator changeovers. Scheduled turnback times can be as short as 1-2 minutes, but it is usual to allow several minutes more than this.

5.23 For planning purposes an initial assumption of around 10 minutes turnback time per round trip is likely to be appropriate for the B-Line LRT, given that under normal circumstances the run time in each direction will not exceed the planned time by more than about 2 minutes as discussed above. This should enable almost all trips to start on schedule. The turnback time could be divided evenly between the ends of the routes or biased towards one end depending on the expected sources of any minor delays.

5.24 In practice the round trip or cycle time (the sum of the end-to-end time in both directions plus the sum of the turnbacks at each end) must be a multiple of the headway. The turnback time is therefore also influenced by the actual values of the end-to-end time and headway, and is therefore generally adjusted accordingly when planning the timetable.

5.25 Furthermore, as both run times and service patterns may vary over the day, turnback will also tend to vary, particularly at transitional times when vehicles being added to or removed from the service. At this stage a detailed timetable plan has not been prepared to establish the precise distribution of turnbacks.

Cycle Times and Fleet Sizes

5.26 Table 5.3 shows estimates of the B-Line LRT vehicle requirement and fleet size for each priority assumption and run time. This includes run times rounded up to whole minutes for scheduling, plus a minimum of 5 minutes turnback time at each end of the route, selected to produce cycle times as a multiple of the headway. The results illustrate the effect of the different priority assumptions on the resulting fleet size.

TABLE 5.3 B-LINE VEHICLE REQUIREMENT AND FLEET SIZE

	Absolute Priority	Moderate Priority	Moderate-plus Priority
End-to-end run time McMaster University-Eastgate Square (both directions assumed equal):			
Run time model	29.3 min	34.1 min	32.5 min
Scheduled time for operational planning	30 min	35 min	33 min
Turnback time (total both termini)	12 min	10 min	10 min
Total round trip time (cycle time)	72 min	80 min	76 min
Peak frequency	15 vph	15 vph	15 vph
Peak headway	4 min	4 min	4 min
Number of LRVs for service	18	20	19
Maintenance and standby spares cover (minimum)	3	3	3
Total number of LRVs required for B-Line (minimum)	21	23	22

5.27 The number of spare vehicles shown above is the minimum for operation of the B-Line LRT service. It would be prudent to allow additional vehicles over and above this number, which would increase the ability of the system to cope with:

- short-term or lasting increases in run times caused by such things as exceptional traffic delays (including road construction), special event traffic, difficulty in achieving the require signal priority;
- vehicles out of service for accident repairs;
- some growth in ridership.

5.28 These numbers, particularly the spares cover, assume a stand-alone operation on the B-Line. With a larger network, it might be possible to share some of the spares cover, allowing some economies to be made.

Outline Timetables

5.29 In advance of finalised run times, we have not prepared a detailed timetable plan at this stage. When the final run time forecasts are available, together with a preferred location for the MSF, a full working timetable will be prepared to enable resources to be quantified. At present we have simply set out a provisional estimate fleet size, based on the preliminary run times quoted above.

6 A-Line Service Specification

Introduction

6.1 In this chapter we discuss the service specification for the A-Line LRT project as a stand-alone route between the Waterfront and John C. Munro Hamilton International Airport. The interactions with the B-Line, other B-L-A-S-T routes and bus network were discussed in outline in Chapter 1, while initial the planning of the wider bus network is discussed in Chapter 7 onward.

6.2 The A-Line is at an earlier stage of development and hence the service specification cannot yet be defined to the same degree of detail as for the B-Line. However, work on the A-Line Benefits Case enables the key elements of the service to be specified.

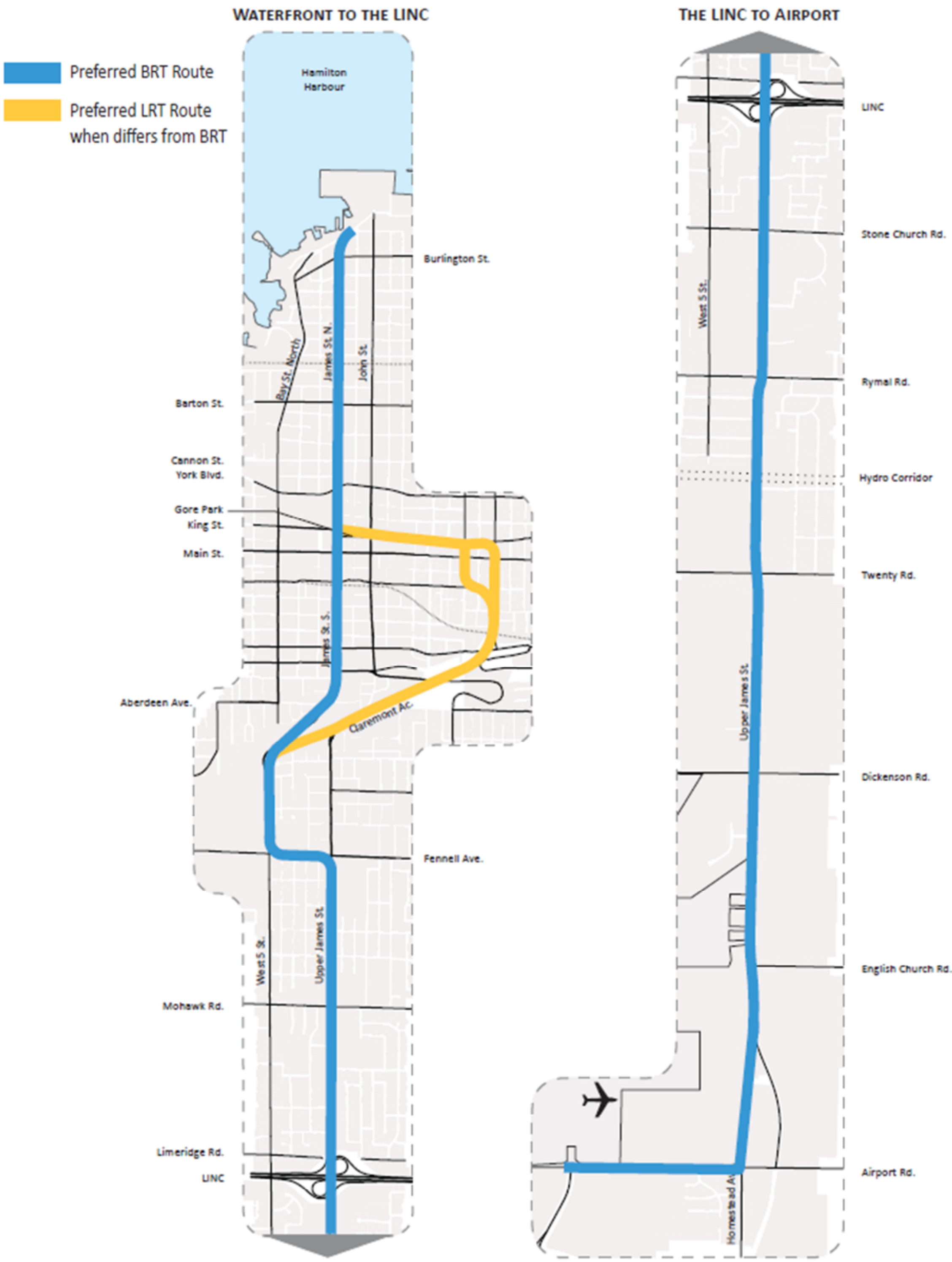
6.3 With both LRT and BRT in the frame as possible technologies for the A-Line, this chapter covers both modes.

Infrastructure Configuration

6.4 Preliminary conceptual alignments for the A-Line have been defined in sufficient detail to enable key operational parameters to be established and to provide inputs to ridership forecasts and capital cost estimates. Engineering designs have not been prepared except where necessary to investigate alternative alignments and arrive at a preferred option. This means the critical section between Downtown Hamilton and the top of the Niagara Escarpment, where the landscape dictates different solutions for LRT and BRT. More details of the engineering issues associated with this section are included in the A-Line Opportunities Report.

6.5 The A-Line route runs from the Waterfront to Hamilton International Airport, with different routes between the James Street/King Street intersection and Mohawk College depending on whether LRT or BRT technology is chosen. The routes are illustrated in Figure 6.1.

FIGURE 6.1 A-LINE OPTION ALIGNMENTS



Source: Dialog

6.6 The LRT option starts at the Waterfront stop, located to the north of Guise Street East, and runs along James Street North to the Downtown where it turns east to share the B-Line tracks as far as Wellington Street or Victoria Street. An additional stop on the B-Line is provided at Gore Park to allow for transfers to/from bus services at MacNab terminal and B-Line services west of the Downtown.

6.7 The route then runs via Wellington Street (southbound) or Victoria Street (northbound) and ascends the Escarpment via Claremont Access, using the ramp alongside Claremont Drive to gain access to West 5^{th} Street. From here it runs via Fennell Avenue and then Upper James Street to Mount Hope, before turning west on Airport Road to reach Hamilton International Airport.

6.8 The BRT option follows the same alignment as LRT on James Street North as far as King Street, and then continues via James Street North and James Mountain Road to West 5^{th} Street. From here it follows the same alignment as the LRT option to the Airport.

6.9 Table 6.1 shows the assumed stops and inter-stop distances for the A-Line.

TABLE 6.1 A-LINE STOPS AND INTER-STOP DISTANCES

From stop	To stop	Distance (metres)			
		LRT		BRT	
		Stop to Stop	Cumulative	Stop to Stop	Cumulative
Waterfront	Picton	520	520	520	520
Picton	James North GO	480	1,000	480	1,000
James North GO	Cannon	580	1,580	580	1,580
Cannon	Gore Park (LRT)	580	2,160	-	-
Gore Park (LRT)	Walnut (LRT)	390	2,550	-	-
Walnut (LRT)	First Place (LRT)	440	2,990	-	-
First Place (LRT)	St Joseph's Mountain Campus	2,715	5,705	-	-
Cannon	Gore Park (BRT)	-	-	530	2,110
Gore Park (BRT)	Hunter Street GO (BRT)	-	-	365	2,475
Hunter Street GO (BRT)	St Joseph's Hospital (BRT)	-	-	445	2,920
St Joseph's Hospital (BRT)	St Joseph's Mountain Campus	-	-	1,135	4,055
St Joseph's Mountain Campus	Mohawk College	465	6,170	465	4,520
Mohawk College	James & Fennell	405	6,575	405	4,925
James & Fennell	James & Mohawk	965	7,540	965	5,890
James & Mohawk	Aldridge/Linc	950	8,490	950	6,840
Aldridge/Linc	Stone Church	1,110	9,600	1,110	7,950
Stone Church	Rymal	1,010	10,610	1,010	8,960
Rymal	Twenty Road	1,340	11,950	1,340	10,300
Twenty Road	MTC	830	12,780	830	11,130
MTC	Dickenson	620	13,400	620	11,750
Dickenson	English Church	1,250	14,650	1,250	13,000
English Church	Mount Hope	1,365	16,015	1,365	14,365
Mount Hope	Warplane Museum	1,000	17,015	1,000	15,365
Warplane Museum	Airport	535	17,550	535	15,900
Total Waterfront to Airport		17,550		15,900	
Average stop spacing		878		795	

Service Plan and Line Capacity

6.10 Preliminary ridership forecasts for the A-Line are set out in the Hamilton A-Line Benefits Case Report (in preparation). The line flows are set out for BRT and LRT in Table 6.2.

TABLE 6.2 FORECAST LINE FLOWS – A-LINE 2031

Between	and	AM Peak Hour Flow 2031			
		LRT		BRT	
		Southbound	Northbound	Southbound	Northbound
Waterfront	Picton	16	28	22	31
Picton	James North GO	269	128	271	129
James North GO	Cannon	269	128	271	129
Cannon	Gore Park (LRT)	261	188	-	-
Gore Park (LRT)	Walnut (LRT)	104	827	-	-
Walnut (LRT)	First Place (LRT)	222	1,065	-	-
First Place (LRT)	St Joseph's Mountain Campus	618	1,407	-	-
Cannon	Gore Park (BRT)	-	-	262	191
Gore Park (BRT)	Hunter Street GO (BRT)	-	-	344	925
Hunter Street GO (BRT)	St Joseph's Hospital (BRT)	-	-	462	1,368
St Joseph's Hospital (BRT)	St Joseph's Mountain Campus	-	-	577	1,481
St Joseph's Mountain Campus	Mohawk College	502	1,407	461	1,481
Mohawk College	James & Fennell	413	1,849	371	1,786
James & Fennell	James & Mohawk	505	1,750	452	1,750
James & Mohawk	Aldridge/Linc	559	1,752	536	1,751
Aldridge/Linc	Stone Church	588	1,655	559	1,685
Stone Church	Rymal	327	949	314	944
Rymal	Twenty Road	132	588	127	590
Twenty Road	MTC	122	214	118	215
MTC	Dickenson	120	52	116	54
Dickenson	English Church	120	52	116	54
English Church	Mount Hope	110	51	106	52
Mount Hope	Warplane Museum	109	49	105	50
Warplane Museum	Airport	109	49	105	50

6.11 These figures show a maximum AM Peak line flow of around 1,800-1,850 passengers per hour in 2031, with the highest loadings between Downtown Hamilton and Stone Church. Under the current land use assumptions, the demand drops off rapidly south of the Stone Church stop and is very low south of Mountain Transit Centre. A stepped service profile has therefore been assumed, with part of the service terminating at MTC.

6.12 Demand is also considerably lower between Downtown Hamilton and the Waterfront, but at this stage the full service has been assumed to operate to the latter point.

6.13 For LRT, the Benefits Case assessment for the A-Line is based on 5-minute peak headway on the main part of the route from Waterfront to MTC. However, for the purposes of operational analysis and the assessment of line capacity we have assumed a 4-minute peak headway, since emerging ridership forecasts suggest that the maximum line flow is very similar to that projected for the B-Line. However, the A-Line forecasts are predicated on the emergence of a land use and growth scenario for the A-Line corridor that supports rapid transit, in contrast to the case for the B-Line, which is based on a more modest change to current land use patterns. Hence the BCA is based on a lower level of service than that analysed here.

6.14 For BRT, similar remarks apply – the BCA is based on a 3-minute peak headway but for capacity analysis we have assumed a headway of 2.5 minutes. In practice, such close headways may lead to problems in achieving the desired level of signal priority, but the implications of this have not been assessed here.

6.15 As mentioned in the discussion of the B-Line, the definition of the term 'capacity' is flexible and depends on the loading standard that is assumed. As with the B-Line, this operational analysis is based on a more detailed assessment of capacity than that included in the BCA, and for this reason the figures quoted here may not be consistent with those reported elsewhere.

6.16 As mentioned above, a lower frequency of service is assumed between MTC and the Airport, as set out in Table 6.3.

TABLE 6.3 PEAK HEADWAYS - A-LINE

Times	LRT		BRT	
	Frequency (LRVs per hour)	Headway (minutes)	Frequency (buses per hour)	Headway (minutes)
Waterfront to MTC	15	4	24	2.5
MTC to Airport	5	12	8	7.5

6.17 For LRT on the A-Line, the same capacity assumptions have been used as for the B-Line, as set out earlier in Table 4.4. For BRT, such detailed numbers are more difficult to establish and it has been necessary to estimate equivalent figures. Table 6.4 shows the assumed numbers for BRT, based on low floor, 60-foot (18.3m) articulated buses. An explanation of the loading criteria appears in paragraphs 4.26 to 4.30.

TABLE 6.4 BRT VEHICLE CAPACITIES

Loading criterion	Persons standing per m^2	Seated capacity	Standing capacity	Total capacity	Line capacity (passengers per hour, 2.5 minute headway)
All seats occupied, no standing	N/A	40	0	45	1,080
W-4A loading (capacity)	4.67	40	70	110	2,640 *
W-5 loading (crush)	7.14	40	100	140	3,360 *
Peak load standard	2.34	40	35	75	1,800

* Theoretical figures only – not sustainable in practice

6.18 The 2031 A-Line ridership forecasts in Table 6.2 are plotted in Figure 6.2 (LRT) and Figure 6.3 (BRT) along with the seated, peak load standard and W-4A capacities for comparison.

FIGURE 6.2 A-LINE AM PEAK LINE FLOWS & CAPACITY 2031 (LRT, 4-MIN HEADWAY)

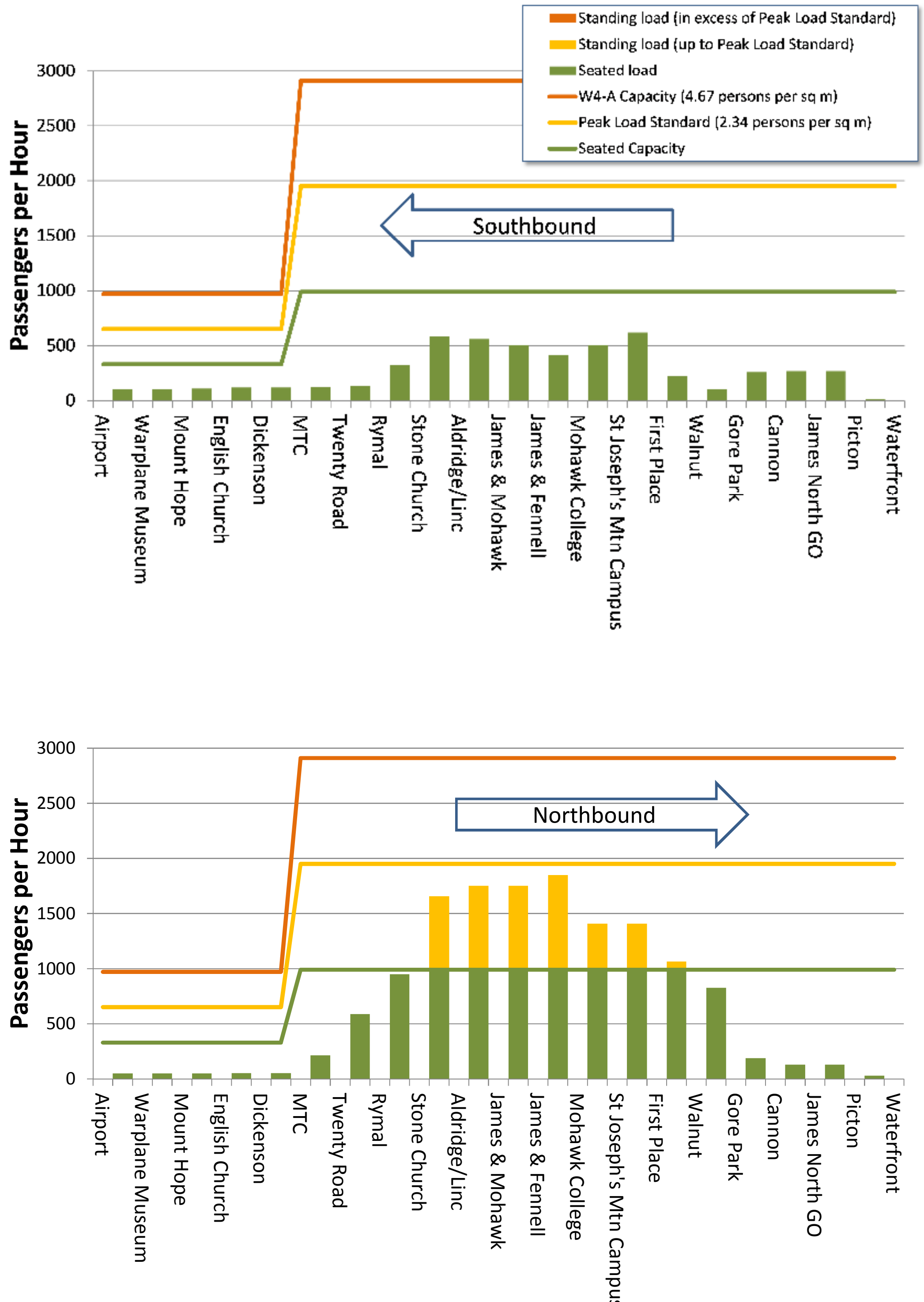
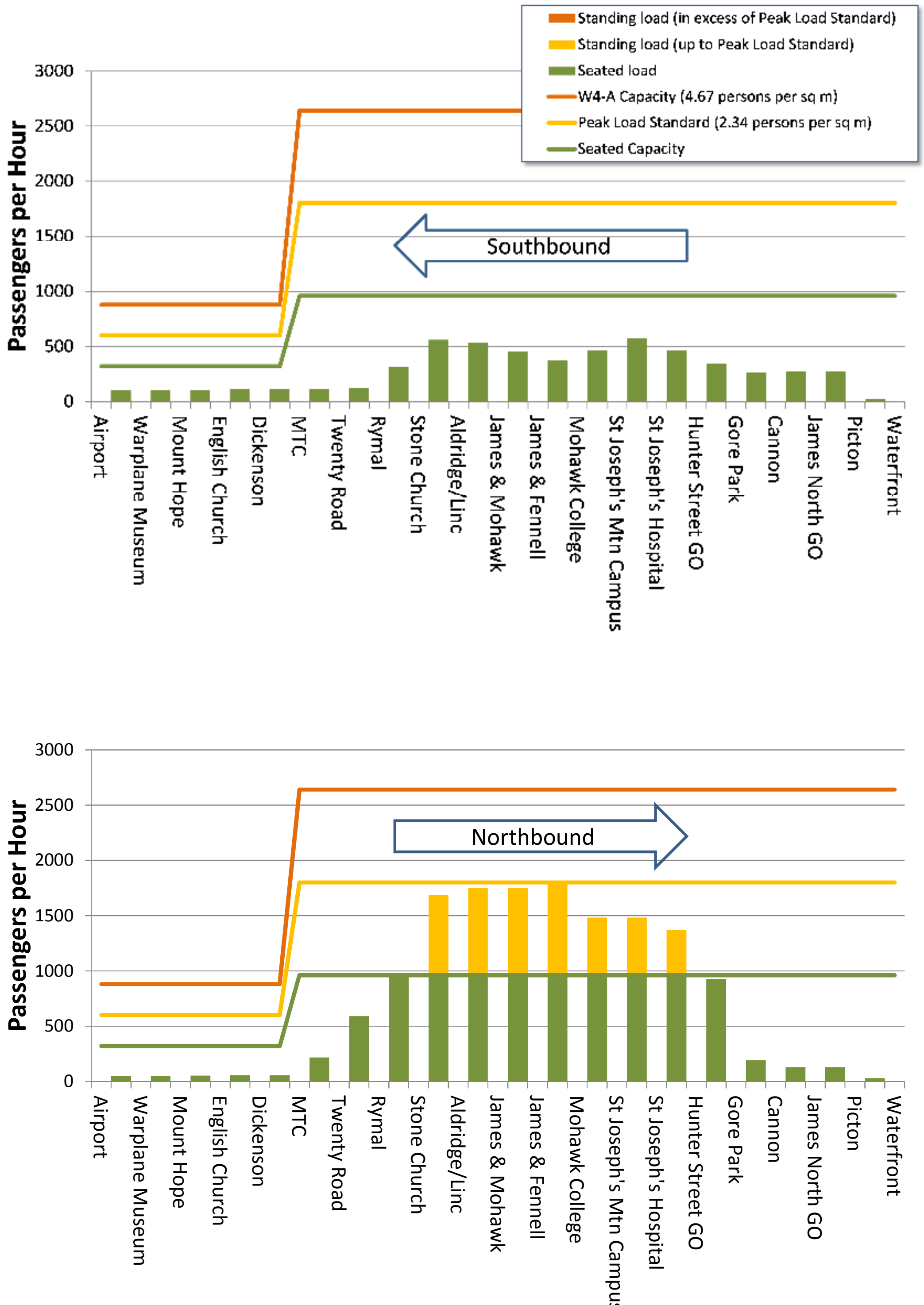


FIGURE 6.3 A-LINE AM PEAK LINE FLOWS & CAPACITY 2031 (BRT; 2.5-MINUTE HEADWAY)



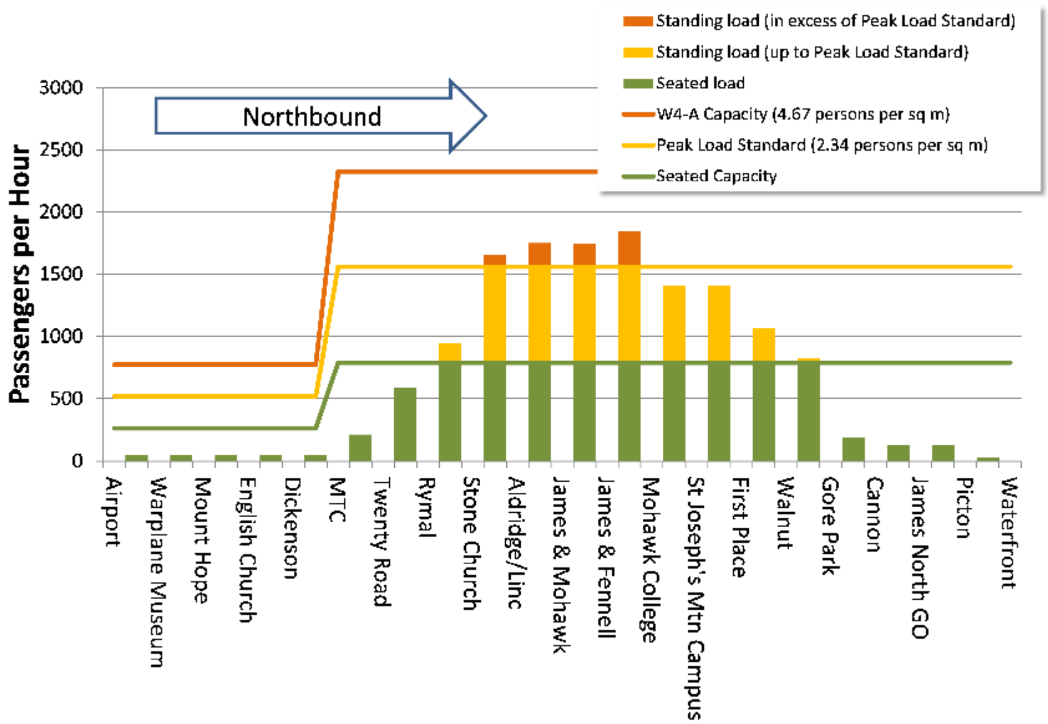
6.19 As for the B-Line, these plots show that the maximum AM peak ridership forecast for 2031 and the capacities provided by headways of 4 minutes (LRT) or 2.5 minutes (BRT) are well-balanced, with maximum flows remaining just below the peak load standard in the busier northbound direction. This means that there is adequate capacity 'headroom' to cope with short term peaks, exceptional loadings and the extra space demands of wheelchairs, strollers and mobility scooters. In the southbound direction, AM peak loadings remain within seating capacity throughout.

6.20 However, the line flow profile for the A-Line differs from the B-Line in that the highest loadings are sustained over a smaller proportion of the route – broadly between Rymal and Downtown. In contrast, B-Line loadings are sustained at a high level over most of the route. Some account of this has already been taken by assuming a lower frequency south of MTC, but it would also be possible to tailor the service more closely to ridership patterns. Two options are possible:

- Operate a reduced service level between Downtown and Waterfront (as already mentioned); and/or
- Operate a reduced service level throughout and accept a higher loading standard.

6.21 At this stage, given the fluidity of growth forecasting for the A-Line, we have not attempted to optimize the service level to the ridership forecasts. However, as an illustration for LRT in the northbound direction, Figure 6.4 shows the effect of operating a peak headway of 5 minutes in place of 4 minutes on the main route. (A similar pattern emerges for BRT with a headway of 3 minutes instead of 2.5 minutes.)

FIGURE 6.4 A-LINE AM PEAK LINE FLOWS & CAPACITY 2031 (LRT; 5-MINUTE HEADWAY)



6.22 Figure 6.4 shows that a 5-minute headway would result in loadings in excess of the defined peak load standard, but only over the section between Stone Church and Mohawk College (a journey time of about 7.5 minutes).

7 A-Line Timetabling

Run Time Forecasts

7.1 Run time estimates for the A-Line have been prepared using the same model as used for the B-Line, based on initial assumptions for the alignment characteristics, stop locations and signalled intersections. A single level of signal priority has been used, corresponding broadly to the 'Moderate' priority on the B-Line.

7.2 At this stage the run time forecasts do not differentiate between LRT and BRT except in the route taken; hence the timings on common sections are identical. Table 7.1 presents the results. As for the B-Line, link times are quoted mid-dwell to mid-dwell, i.e. with stop dwell times distributed equally to the adjacent links.

7.3 The figures apply to the southbound direction; the northbound end-to-end times can be expected to be similar, but timings at intermediate points may vary slightly because of the different order in which curves, stops and signals etc. are approached and the fact that some stops may have platforms staggered each side of an intersection.

TABLE 7.1 A-LINE RUN TIME MODEL RESULTS

Between	and	Journey Time (mid-dwell to mid-dwell)	
		LRT	BRT
Waterfront	Picton	1.6	1.6
Picton	James North GO	1.2	1.2
James North GO	Cannon	1.9	1.9
Cannon	Gore Park (LRT)	2.9	-
Gore Park (LRT)	Walnut (LRT)	1.9	-
Walnut (LRT)	First Place (LRT)	2.4	-
First Place (LRT)	St Joseph's Mountain Campus	4.6	-
Cannon	Gore Park (BRT)	-	2.7
Gore Park (BRT)	Hunter Street GO (BRT)	-	2.4
Hunter Street GO (BRT)	St Joseph's Hospital (BRT)	-	1.5
St Joseph's Hospital (BRT)	St Joseph's Mountain Campus	-	2.3
St Joseph's Mountain Campus	Mohawk College	1.4	1.4
Mohawk College	James & Fennell	1.6	1.6
James & Fennell	James & Mohawk	1.8	1.8
James & Mohawk	Aldridge/Linc	2.1	2.1
Aldridge/Linc	Stone Church	2.0	2.0
Stone Church	Rymal	1.7	1.7
Rymal	Twenty Road	2.6	2.6
Twenty Road	MTC	1.5	1.5
MTC	Dickenson	1.2	1.2
Dickenson	English Church	1.8	1.8
English Church	Mount Hope	2.2	2.2
Mount Hope	Warplane Museum	2.0	2.0
Warplane Museum	Airport	1.7	1.7
Total		40.1	37.2
Distance		17.6 km	15.9 km
Average Speed		26.5 km/h	25.9 km/h

Cycle Times and Fleet Sizes

7.4 Timetable planning for the A-Line is slightly more complex than for the B-Line because of the need to accommodate two parallel services (Waterfront-MTC and Waterfront-Airport). Since the two will not have the same frequency, the MTC-terminating service will need to run at irregular headways to provide evenly-timed ‘slots’ for the Airport journeys. This means that the usual method of calculating vehicle requirements (cycle time divided by headway) may not apply precisely. However, we have used this method to prepared estimates based on a simple regular headway on each service, which is sufficient for planning purposes at this stage. Table 7.2 shows the results.

TABLE 7.2 A-LINE VEHICLE REQUIREMENT AND FLEET SIZE

	LRT		BRT	
	Waterfront-Airport	Waterfront-MTC	Waterfront-Airport	Waterfront-MTC
End-to-end run time (both directions assumed equal):				
Run time model	40.1 min	31.2 min	37.2 min	28.3 min
Scheduled time for operational planning	41 min	32 min	38 min	29 min
Turnback time (total both termini)	14 min	14 min	14 min	13.25 min
Total round trip time (cycle time)	96 min	78 min	90 min	71.25 min
Peak frequency (vph/bph)	5	10	8	16
Peak headway	12 min	6 min *	7.5	3.75 min *
Number of vehicles for service	8	13	12	19
	21		31	
Maintenance and standby spares cover (minimum)	3		4	
Total number of vehicles required for A-Line (minimum)	24		35	

* Assuming regular headways for simplicity (see text)

7.5 The numbers in this table show separate peak vehicle requirements for each service. In practice it would be possible to operate a combined allocation so that a vehicle arriving at Waterfront from the Airport could depart to MTC or vice versa. Such interworking can result in slightly more efficient fleet utilization, but the results of some initial timetabling tests suggest that this is not the case here, and that the numbers of vehicles would remain as shown above.

7.6 These numbers, particularly the spares cover, assume a stand-alone operation on the A-Line. With a larger network, it might be possible to share some of the spares cover, allowing some economies to be made.

8 Transit Integration

Background and Objectives

8.1 Historically the City of Hamilton has seen a significant increase in the use of private vehicles with a corresponding decrease in the use of transit. Between 1986 and 2001 the transit mode share of trips made by Hamilton residents in the morning peak hour declined by half from 12% to 6% - it has since increased to 7%.

8.2 The City of Hamilton has established targets (established through the Phase 2 Policy Papers) and a vision for transportation demand for the City, which are based on a significant increase in the share of trips made by transit, walking and cycling as well as reducing trips by demand management. To support this the Transportation Masterplan states that it is necessary to implement an 'aggressive transit strategy' which has the following primary objectives:

- To develop a layer of bus routes connecting major transit nodes that are isolated from the effects of congestion;
- To encourage transit-supportive development around nodes and corridors;
- To provide a seamless transit system; and
- To facilitate travel to/from surrounding regions.

8.3 It aims to achieve a long-term target of doubling transit ridership.

8.4 Consequently, in line with this, the primary objectives of this preliminary design and feasibility study are:

- To provide an integrated network wide solution that puts the passenger first;
- To grow transit ridership overall, both on bus transit as well as rapid transit;
- To provide passengers with a seamless journey;
- To maintain accessibility;
- To achieve network efficiency;
- Passengers on the transit network (LRT and buses) to have the same quality of journey experience; and
- To provide a network that meets current and future passenger needs.

Existing Bus Network

8.5 Hamilton Street Railway (HSR) operates a network of transit services within the City of Hamilton. It provides regular fixed route services in the former City of Hamilton, Dundas, Ancaster and Stoney Creek. No service is currently provided in Flamborough.

The Trans-Cab service of shared taxis connecting with buses operates in a number of areas of Glanbrook and Stoney Creek.

8.6 As a result of the physical geography of the City, there are two distinct sections of the transit network, namely the mountain area and the Downtown area. Downtown routes typically operate east-west via King/Main, Cannon, Barton, Burlington and Delaware. The King/Main routes form a complex group, which currently provide a total corridor flow in the central section of 22 to 24 buses per hour (bph) in the peak west of Gore Park and 22 bph east of Gore Park.

8.7 The mountain area operates a comprehensive grid based network, with most buses (nine routes) running north-south to/from Downtown via either James Mountain Road or Jolley Cut to ascend/descend the Escarpment. The Downtown terminus of these nine routes moved from Gore Park to the new MacNab terminal in January 2011. The east-west routes pass the north and south ends of the MacNab facility, which is where transfers are made.

8.8 A number of feeder services operate in the former municipalities and serve Stoney Creek, Dundas and Ancaster, providing links into key hubs such as Meadowlands and Eastgate Square.

8.9 Connections are also made via several orbital routes, which negate the need for some passengers to transfer in the Downtown area, such as route 44 that links Ancaster to Eastgate Square.

8.10 The operation of routes ranges from 22 hours a day, 7 days a week to peak hour Monday to Friday services.

8.11 Five bus hubs are provided throughout the network, located at MacNab, Lime Ridge Mall, Eastgate Square Mall, Hamilton GO Centre and Meadowlands.

Transfers

8.12 Transfer usage occurs to the largest extent in the Downtown area along King, Main and Barton on the east-west routes and at the hubs of Eastgate Square, Gore Park, GO Centre and also at McMaster. The Downtown area is an easy place to transfer between the mountain routes that serve the area and lower city routes serving Downtown, Stoney Creek and Dundas, though the latter routes stop on-street and passengers may need to cross streets to make the transfer. Eastgate Square is a hub where local services intersect with the east-west services, and here all routes call in at the off-street terminal or at the adjacent stops on the near side of Queenston Road.

8.13 Transfers are also possible in the mountain area and at the intersection of routes as passengers transfer between north-south and east-west routes. Lime Ridge Mall and Mohawk College are nodes with concentrations of routes.

Operating Speeds

8.14 In general the average speed of vehicles in service is less than 40 km/h; however, in the Downtown area this falls to less than 20 km/h. Given the high number of routes that operate to/from and through Downtown, the average speed of HSR's network is 18.7 km/h.

Fleet

8.15 The main bus fleet comprises 215 low floor transit buses, of which 25 are 18.1 metre articulated vehicles (used on routes 1/1A and 10/10A) and 190 are 12.2m standard vehicles. In addition there two 10.7m buses for seasonal tourist service and 66 buses for specialized transit service (DARTS).

Transit Service Guidelines

8.16 HSR's 1996 service guidelines are detailed in Table 8.1. A set of exceptions to the guidelines were developed in 2004 following the City of Hamilton encompassing several former municipalities. These are provided in Table 8.2.

TABLE 8.1 TRANSIT SERVICE GUIDELINES (1996)

Service Parameter	Monday to Saturday	Sunday and Holiday
Hours of operation	06:00 to midnight	06:00 to 18:00
Maximum headway	30 minutes	60 minutes
Walking distance	400 metres for 90% of the population, where permitted by the local street network	
Revenue/cost ratio	Greater than 50% for entire system. Minimum 30% for individual routes, otherwise basic Monday to Friday rush hour only service to be provided every 30 minutes	

TABLE 8.2 SERVICE STANDARD EXCEPTIONS (2004)

Community	Headway	Hours of Operation
Old City of Hamilton	Monday to Friday 09:00-15:00 (base period): 20 minutes Sunday/holiday until 18:00: 30 minutes	Monday to Friday: until 01:00 Sunday/Holiday: until midnight
Ancaster	Feeder route operates every 60 minutes in base period	No evening service on Mon/Tue/Wed as of Jan/10 No service on Sunday/Holiday
Dundas	Base period: 60 minutes	
Flamborough		No service in Waterdown since 1994
Glanbrook		No Trans-Cab service after 19:00 No Trans-Cab service on Sunday/Holiday

Alterations to the Bus Network

8.17 Preliminary proposals for bus network changes to accompany the introduction of rapid transit have been developed using the following key design principles:

- The objective of an integrated network wide solution;
- Maintain key links and accessibility;
- Through services retained wherever possible, although perhaps at reduced frequency and/or with an increased journey time;
- Where transfers are necessary, the facilities are of a high quality;
- Does not force transit passengers to transfer unnecessarily, or for short distances;
- Provide a network that links people to jobs, homes, leisure and key services;
- Meets current and future passenger needs;
- Adheres to HSR's service standards;
- Creates space for rapid transit;
- Ensures that feeder services to the LRT and bus network are provided where necessary; and
- Provides cost savings (when set against additional revenue generated).

9 B-Line Complementary Bus Network

Network Changes

9.1 A preliminary set of transit network changes was developed early in the project to inform the modelling and LRT design work and to provide the basis for estimating future operating costs of the combined LRT and bus network. These changes have been modified in the light of ridership modelling results and the current assumptions are discussed here. However, it is important to note that these are not definitive proposals for bus network changes but working assumptions for planning purposes.

9.2 The main focus of the proposed alterations is the east-west pattern of bus routes on King and Main. As well as the B-Line Express 10/10A, which would be directly replaced by the B-Line LRT, these include a number of local routes that parallel all or part of the LRT route. Together, the express and local routes provide a total peak period corridor flow of 22 to 24 buses per hour (bph) in each direction west of Downtown and 22 bph east of Downtown. The route groups and existing peak frequencies are:

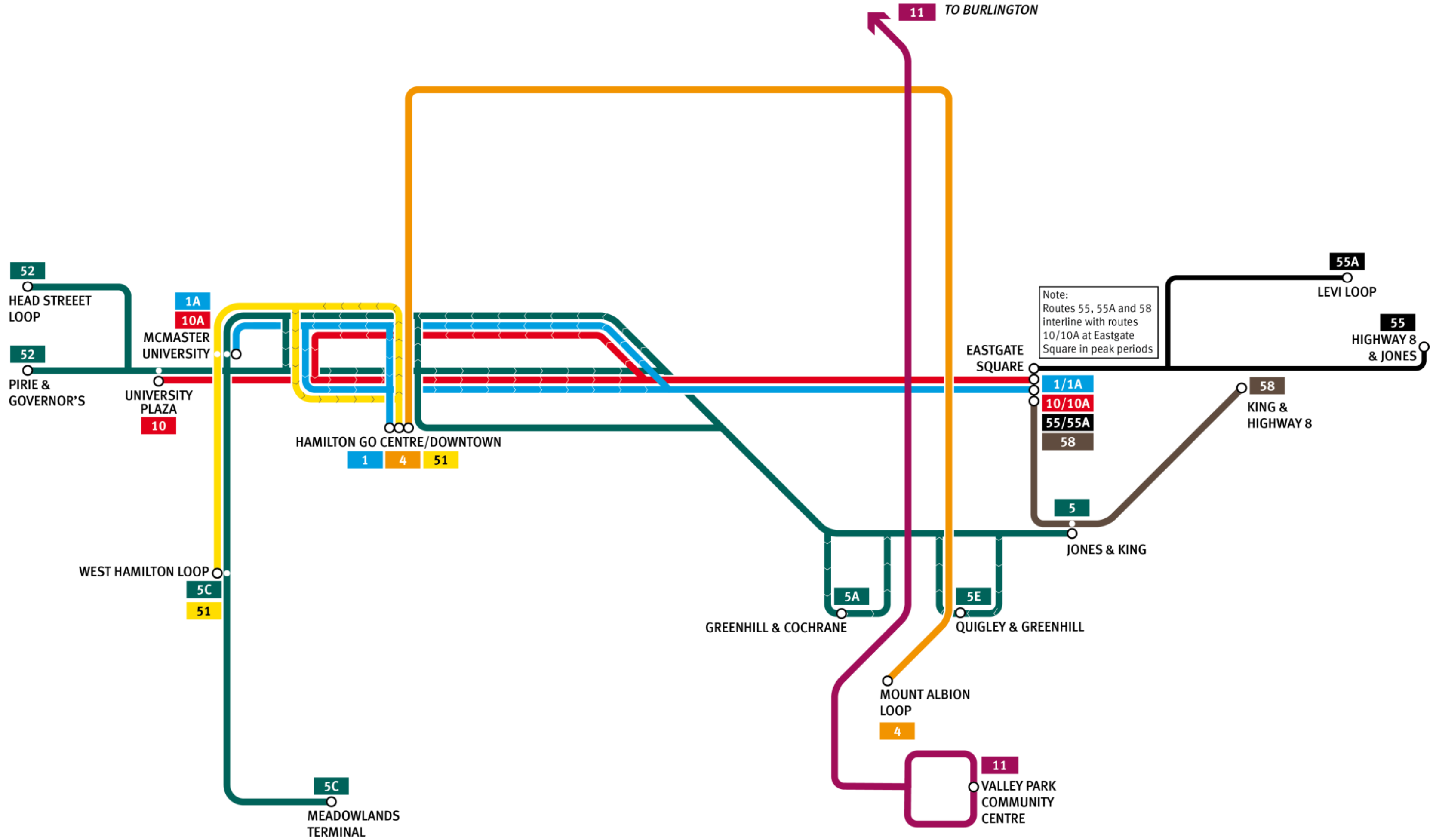
- 1/1A: McMaster Medical Centre or Hamilton GO Centre to Eastgate Square (4 bph each route);
- 10/10A B-Line Express: McMaster Medical Centre or University Plaza to Eastgate Square (3 bph each route);
- 5/5A/5C/5E/52: Dundas (two termini), University Plaza, West Hamilton Loop or Meadowlands to Greenhill/Cochrane, Quigley/Greenhill or Jones/King (8 bph in total, of which 6 bph run via Delaware and 2 bph via King/Main);
- 51: West Hamilton Loop to Hamilton GO Centre (4-6 bph, except summer and Christmas vacations).

9.3 Of these, routes 1A and 10/10A follow the whole length of the B-Line LRT corridor currently under development between McMaster and Eastgate Square; the others follow part of the corridor only, terminating or diverging part-way. Several routes also extend beyond the ends of the LRT route.

9.4 The proposed changes also include some changes to existing routes that do not parallel the LRT directly, to improve frequencies on routes that could act as feeders. There are clearly other routes that could perform this role, but many connections already exist and at present we have concentrated on those where a change in route pattern appears beneficial and where ridership modelling indicates that additional capacity is required.

9.5 Figure 9.1 illustrates the existing network of routes in the corridor, comprising the main east-west routes as discussed above together with routes 4 and 11, which are included in the network changes and are therefore shown in their current form.

FIGURE 9.1 B-LINE EXISTING BUS NETWORK



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9.6 In addition to the general principles set out in Chapter 8, the following assumptions have been made in defining the proposed bus network changes:

- traffic circulation on the B-Line corridor as in DW2, with westbound traffic including buses retained on King Street East between the Delta and Downtown;
- a reduced level of bus services within the LRT corridor between McMaster and Eastgate, but frequencies maintained to outer destinations;
- through services beyond the ends of the corridors (e.g. Stoney Creek) retained wherever possible, though sometimes with an increased journey time to Downtown as a result of being interlined with local bus services rather than B-Line expresses as now;
- bus services on Main Street East and Queenston Road east of the Delta diverted via King Street East and Parkdale Avenue (in accordance with the preferred DW2 design).

9.7 The proposals for the LRT design and traffic circulation are still evolving and it is recognised that some of the assumptions here will need to change in response.

9.8 Table 9.1 and Figure 9.2 detail the proposed changes. The figure is based on the preferred DW2 design, in which the residual bus service on Main Street East between the Delta and Parkdale is diverted via King Street East and Parkdale Avenue. The frequencies in the table refer to the weekday AM peak; base service levels would be lower in some cases, but the same pattern would apply. Where a specific change to the base service is proposed, separately from the peaks, this is highlighted.

9.9 The operating cost savings resulting from these changes have been included in the B-Line Benefits Case work, as documented in the B-Line Transportation Case Review.

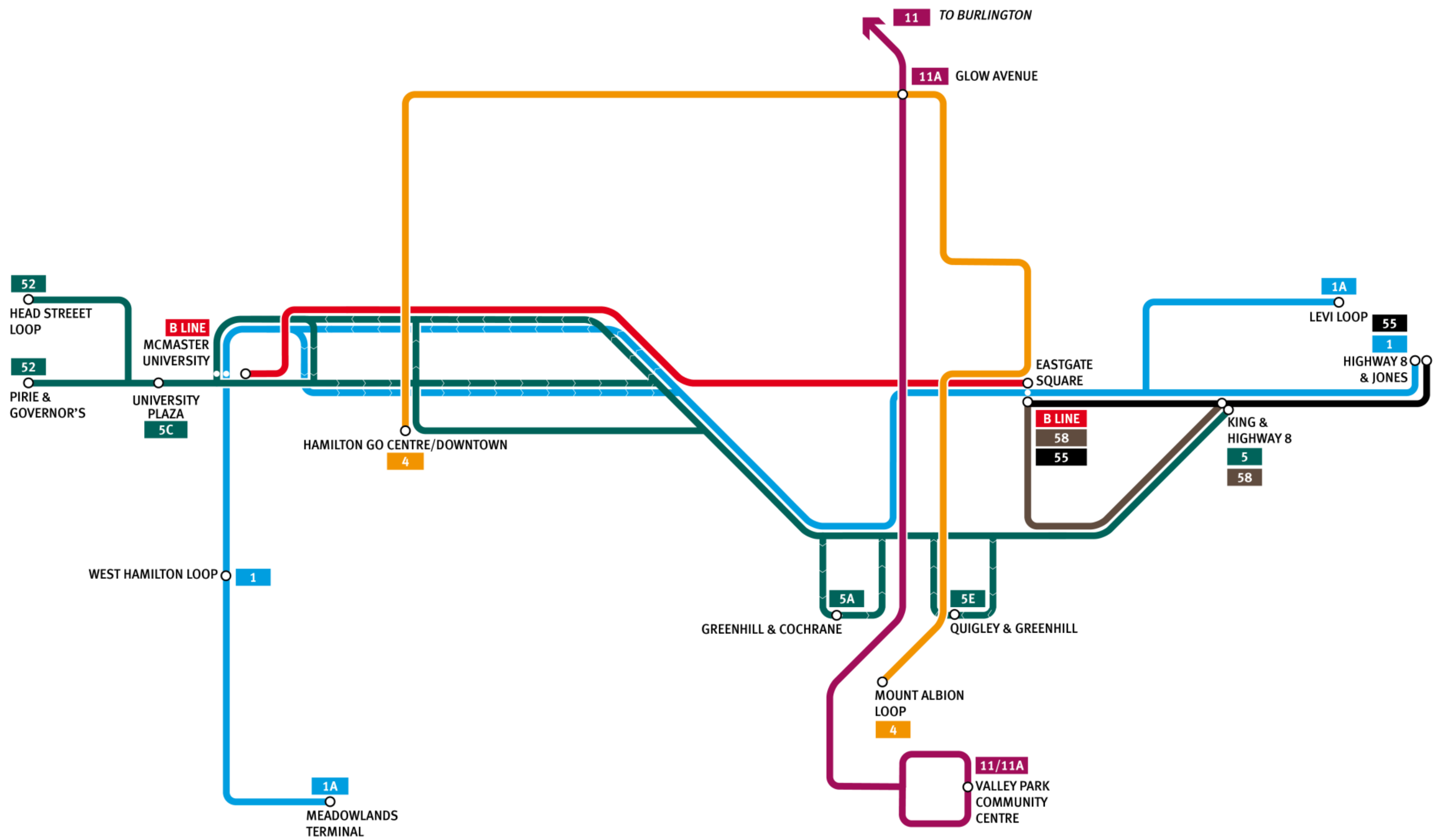
TABLE 9.1 B-LINE: BUS NETWORK CHANGES

Route	Name	Change	New bph
B-Line Corridor Routes:			
1	King	Revised to run West Hamilton Loop - Highway #8 & Jones	2
1A	King	Revised to run Meadowlands – Levi Loop	2
5 (E/B only)	Delaware	Extended to King & Highway #8	N/C
5A (E/B only)	Delaware	Diverted to start at University Plaza	N/C
5C (W/B only)	Delaware	Diverted to end at University Plaza	N/C
10/10A	B-Line Express	Withdrawn (replaced by LRT) Interlining to Stoney Creek on 55/55A transferred to local route 1/1A Interlining to Stoney Creek on 58 replaced by extended route 5/52	-
51	University	Removed (ridership modelling indicates B-Line LRT supplies sufficient capacity – see text)	
52	Dundas	Jones & King journeys extended to start at King & Highway #8	
55A	Stoney Creek Central	Withdrawn (absorbed by 1A)	
58	Stoney Creek Local	Retained to provide local link to Eastgate Square but no longer interlines there with services to Downtown	N/C
Other Routes:			
2	Barton	No change to route but frequency reduced (from 8 bph)	6
3	Cannon	No change to route but frequency reduced (from 4 bph)	3
4	Bayfront	Divert at Barton/Nash to run via Centennial Parkway, Eastgate Square and Queenston Road to Nash Road then via existing route	N/C
11A	Parkdale	New route providing increased frequency between Valley Park and Glow Avenue	6

Notes:

Route 55 is retained at 2 bph in parallel to revised route 1, providing additional capacity in Stoney Creek but not interlining with services to Downtown

FIGURE 9.2 B-LINE COMPLEMENTARY BUS NETWORK



9.10 Route 51 (University) currently supplies additional capacity between Downtown Hamilton, McMaster Medical Centre and West Hamilton Loop during McMaster University periods. The ridership model results indicated that the large capacity increase supplied by the B-Line LRT between Downtown and McMaster would enable the removal of the 51 over this section. However, it is possible that some residual extra capacity would be necessary over the short distance between McMaster and West Hamilton Loop to supplement the 4 bph all-year service. If this were the case, a shuttle service could be provided at relatively low cost.

Resultant Frequency Changes

9.11 The change in total frequency to key locations in the B-Line corridor itself is illustrated in Table 9.2, which shows the existing and proposed AM peak buses per hour. These figures illustrate the reductions in the core section, where the LRT will provide a substantial increase in capacity, while retaining service levels on the outer branches. The frequency shown is the total for the routes that partly or wholly parallel the LRT alignment, namely:

- 1/1A (existing and LRT-complementary)
- 10/10A (existing only)
- 5/52 group (existing and LRT-complementary)
- 51 (existing only)
- 55/55A and 58 (existing and LRT-complementary)

TABLE 9.2 B-LINE FREQUENCY CHANGES (AM PEAK)

	Between Downtown and	Existing total bph	Revised total bph	Notes
West	Head Street Loop	2	2	
	Pirie & Governors	2	2	
	University Plaza	7	8	
	Meadowlands	2	2	
	West Hamilton Loop	8	4	Removal of 51 (see para. 9.10)
	McMaster Medical Centre via Sterling Street	8	8	
	McMaster Medical Centre via Main Street	14	4	Paralleled by LRT
	Paradise via King/Main	22	12	Paralleled by LRT
	Delta via King/Main	16	6	Paralleled by LRT
	Eastgate Square	14	4	Paralleled by LRT
	Delaware-Maplewood-Lawrence	8	8	
	Cochrane & Greenhill	4	4	
	Greenhill & Quigley	2	2	
	Highway #8 & Jones	2	2	
	Levi Loop	2	2	To Eastgate Square only
	Jones & King	2	2	Additional 2 bph on 55 to Eastgate Square only
East	King & Highway #8	2	2	Additional 2 bph on 58 to Eastgate Square only

Services are available to/from Downtown Hamilton without transfer unless otherwise noted

10 A-Line Complementary Bus Network

Network Changes

10.1 As for the B-Line, a preliminary set of transit network changes was developed early in the project to inform the modelling and LRT design work and to provide the basis for estimating future operating costs of the combined LRT and bus network. Although less development work has been carried in the case of the A-Line, these changes have also been modified in the light of ridership modelling results and the current assumptions are discussed here. Again, these are not definitive proposals for bus network changes but working assumptions for planning purposes.

10.2 The existing route pattern in the A-Line corridor is much simpler than in the B-Line corridor, and the route alterations in the complementary network are also simpler. The key routes in the corridor, with existing peak frequencies, are as follows:

- 20 A-Line Express: Downtown to Hamilton International Airport (2 bph)
- 21: Downtown to Mountain Brow Loop (4 bph)
- 27: Downtown to Mountain Transit Centre (4 bph)
- 33: Downtown to Scenic & Lavender (4 bph)
- 35: Downtown to St Elizabeth Village (4 bph)

10.3 Two other routes are also covered by the suggested changes, the 16 and 43:

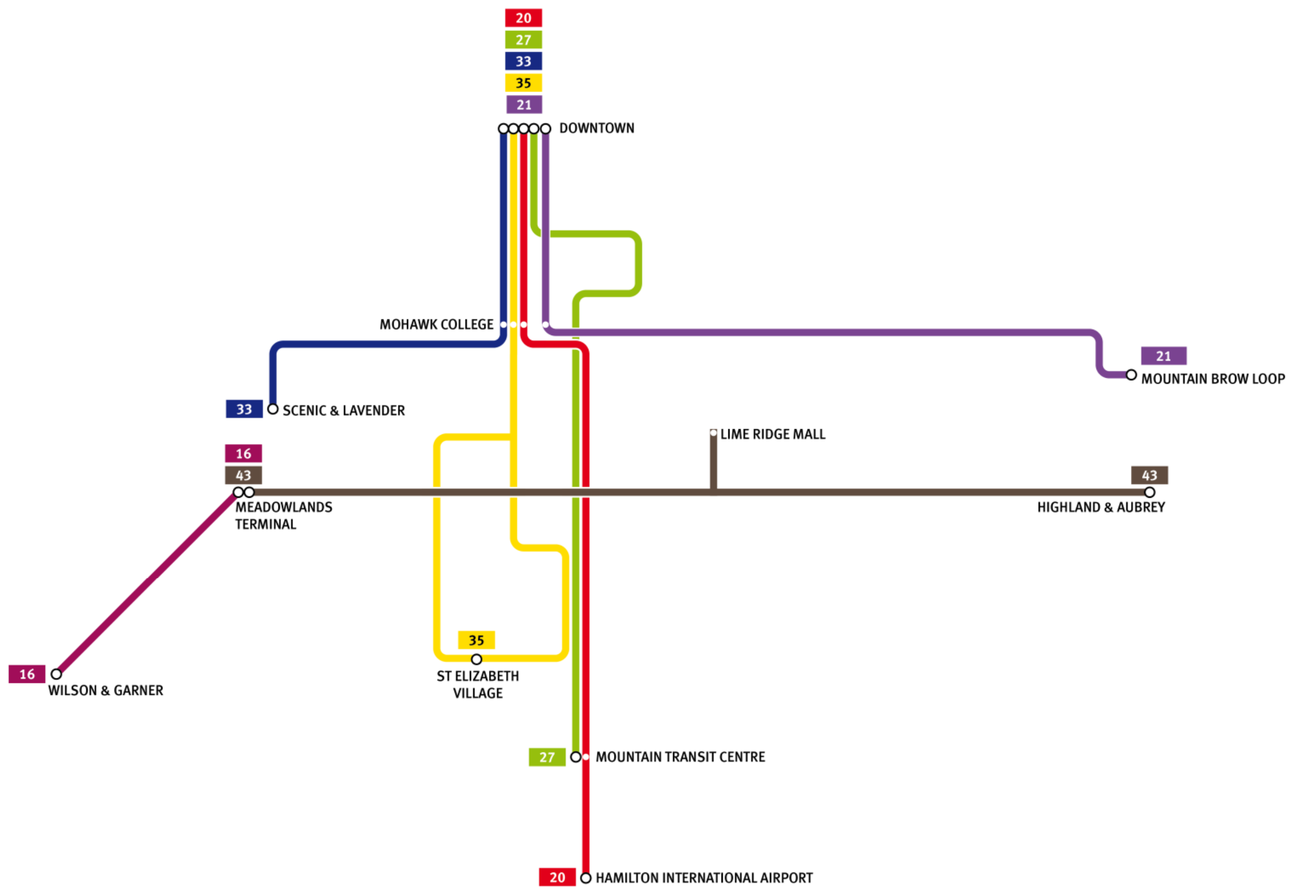
- 16: Ancaster to Meadowlands (2 bph)
- 43: Meadowlands to Highland & Aubrey (2 bph)

However, the proposed change involves simply linking them as a single route.

10.4 The Mountain section of the A-Line on Upper James Street is currently served by the regular local route 27 between Downtown and Mountain Transit Centre, supplemented in peak periods only by A-Line Express route 20, which extends further to serve the Airport. The two routes differ on the Escarpment section, with the 27 running via Jolley Cut and Inverness Avenue and the 20 via James Mountain Road and Mohawk College. A short section of Upper James Street between Stone Church and Rymal is also served by route 35.

10.5 Figure 10.1 illustrates the existing network of routes.

FIGURE 10.1 A-LINE EXISTING BUS NETWORK



10.6 Table 10.1 and Figure 10.2 detail the preliminary proposals for bus network changes to accompany the introduction of the A-Line.

TABLE 10.1 A-LINE BUS NETWORK CHANGES

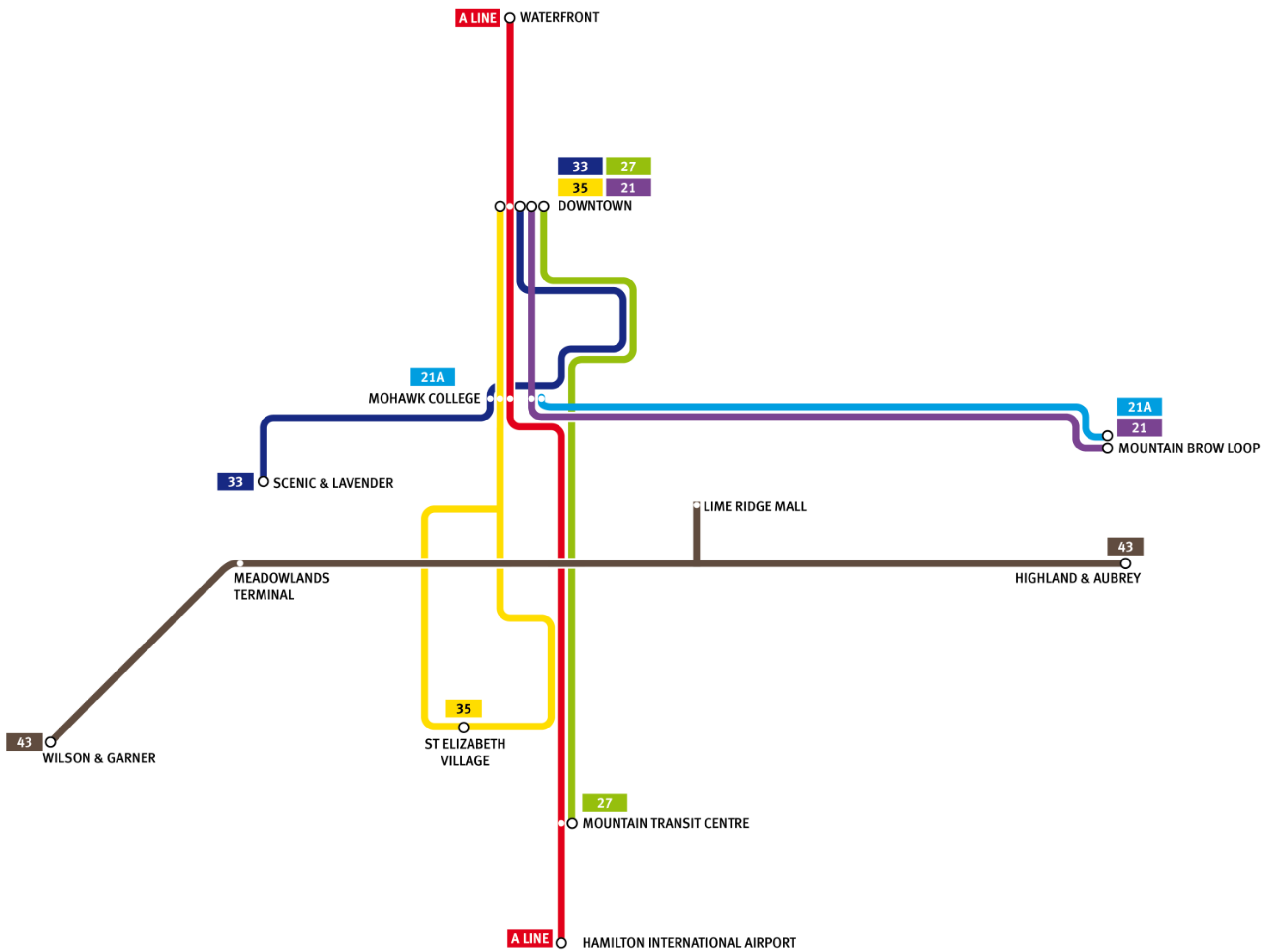
Route		Change	New bph
20	A-Line Express	Withdrawn (replaced by LRT/BRT)	-
21	Upper Kenilworth	No change to route but frequency reduced	2
21A	Upper Kenilworth	New route between Mohawk College and Mountain Brow Loop, maintaining frequency with 21 on this section	2
33	Sanatorium	Divert via Fennell, Upper James, Inverness, Jolley Cut and Arkledun Ave	N/C

10.7 Initial proposals for bus services in the A-Line corridor included the withdrawal of route 27 between Downtown and MTC. However, this route provides the only local service on most of Upper James Street and modelling suggested that its removal would generate significant disbenefits because of the larger stop spacing on the LRT/BRT route. The revised network used for the Benefits Case Assessment therefore retains route 27.

10.8 Initial proposals also included the formal linking of routes 16 and 43, which interline at Meadowlands on weekdays. While not vital to the modelling and assessment, it would be advantageous to link these routes permanently to provide a through link between Ancaster and Highland & Aubrey, promoting single transfer trips between Ancaster (which has no through services to Downtown Hamilton) and the A-Line. We understand that this is already an aspiration of HSR, but that it is currently complicated by funding issues including Area Rating.

10.9 The operating cost savings resulting from these changes have been included in the A-Line appraisal, as documented in the A-Line Benefits Case Report.

FIGURE 10.2 A-LINE COMPLEMENTARY BUS NETWORK



11 Conclusions

11.1 This Integrated Transit System Operations Plan report presents the results of the operational planning work to date, which can be summarized as:

- A review of B-L-A-S-T network and its relationship with other Metrolinx projects in the Regional Transportation Plan;
- A review of existing bus routes in the B-Line and A-Line corridors;
- A discussion of the development of the full B-L-A-S-T network and the relationships and interfaces between the B-Line, the A-Line and the other, longer term, routes;
- Service and operational planning for the B-Line (LRT);
- Service and operational planning for the A-Line (LRT and BRT alternatives);
- Analysis of the relationship between forecast ridership and capacity; and
- Integrated bus network planning for the B-Line and A-Line corridors.

11.2 The document complements those prepared for other workstreams, including the Design Workbooks, ridership forecasts, Benefits Case Analysis and the draft Operations and Maintenance Plan. It sets out the operational parameters for all lines of the Hamilton Rapid Transit system and the future bus network, and has helped inform the design and development of the B-Line and A-Line as part of this PDE study.

11.3 However, as the Rapid Transit project is taken forward, the operational plan will need to be updated and refined to take account of continuing work on the engineering and urban realm design, network planning, implementation plans and programmes, land use planning and organizational structure.

11.4 To date the detailed analysis has been applied only to the B-Line and A-Line corridors, as defined in this phase of study, but as other parts of the B-L-A-S-T network are brought forward, there will be a need to expand the operational planning work to encompass the additional lines, the interactions and the changes to the Hamilton transit network as a whole.

11.5 Furthermore, as other projects such as the GO Train service to James Street North station and the Dundas Street Rapid Transit line are developed, there will be a need to re-examine the planning of the network in Hamilton to maximize the use and benefits of the transit network and promote the objectives of the City and Region.

CONTROL SHEET

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