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APPENDIX E: RIDERSHIP MODELLING AND TRAFFIC

APPENDIX E-1: EMME RIDERSHIP FORECASTING REPORT

PART 1/1

METROLINX

HAMILTON LRT LIGHT RAIL TRANSIT

Hamilton

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EMME Ridership and Forecasting

City of Hamilton

Report

December 2016 v2a

Our ref: 22879302

Client ref:

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City of Hamilton

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Executive Summary

Overview

In May 2015 $1 billion funding was announced for the Hamilton LRT project. The project that had previously received TPAP approval has been reconfigured with its eastern terminus now being at Queenston Traffic Circle (replacing Eastgate Mall), and with a new section of alignment on James Street linking West Harbour GO Station and the Waterfront.

The updates to the LRT route(s) and alignment have also created changes to the surrounding road network- some minor intersections have had turning movement restrictions introduced- to improve priority for the LRT and realize journey time and service reliability benefits. Along much of the LRT route on King Street single lane, two-way traffic movements and access have been introduced, and the LRT has also been complemented by a review of local transit (bus) services, removing duplicate services and amending services to feed into new transfer facilities at McMaster University, MacNab, and Queenston.

All of these changes result in the need to update the TPAP approval for the LRT project. This includes long term ridership forecasting, and an assessment of traffic impacts, along with consideration of other environmental factors. This report documents the work undertaken to develop the EMME model to produce ridership forecasts and traffic volumes.

Coding

The EMME models developed for the LRT project used the updated models provided by the TMP team as a basis to ensure consistency of approach. Two models were developed for each scenario year – a Business as Usual (BAU) 'Without LRT' scenario and a 'With-LRT' scenario. The scenario years were 2031 and 2041 based on the existing EMME forecast years and were undertaken for the AM peak period (3-hour). Peak hour and annual numbers were developed using factors derived based on observed data.

A number of updates were required within the models due to changes implemented between the 2011 Base Model and the current 2015/2016 situation, as well as committed improvements between the present day and the forecast years as set out in the TMP. The Consultant team worked with City/Metrolinx staff to agree on appropriate assumptions for the modelling work. Coding updates included road network changes, e.g. one-to-two-way conversions, the latest GO Rail frequency plans for Hamilton, bus network changes (provided by HSR), local transit (bus) frequency changes and the coding of the updated (centre-running) LRT designs.

Results

Scenarios

The 2031 and 2041 EMME models were run for two headway scenarios covering the 3-hour AM peak period:

- Central scenario – B-Line – 6-minute interval and
- High frequency scenario – B-Line – 4-minute interval.

B-line Peak Hour Boardings

The table below shows that for the B-line, the central scenario sees 2031 AM peak hour boardings of 800 in the eastbound direction and 2,625 in the westbound direction. These numbers increase to over 900 and 3,700 respectively in 2041.

Peak direction peak load is what determines the vehicle and headway requirements. With a peak direction peak load of 1,500 in 2031 and 2,350 in 2041, that means that that two-car Light Rail Vehicles (LRVs) are required. This assumes a single car planning capacity of 130 and a headway of 6 minutes.

Peak Hour Boardings – derived by applying a factor of 0.5 to the AM peak period EMME outputs

	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
Peak Hour Boardings						
B-line Eastbound			800	925	1,125	1,300
B-line Westbound			2,625	3,725	3,050	4,300
B-line Total			**3,425**	**4,650**	**4,175**	**5,600**
HSR	12,575	15,350	13,475	17,600	13,225	17,350
TOTAL	12,575	15,350	16,900	22,250	17,425	22,950
Peak Hour Peak Load						
B-line Eastbound			400	425	475	625
B-line Westbound			1,500	2,350	1,625	2,550

The higher frequency LRT service scenario results in higher passenger numbers due to the added convenience of the higher frequency service. The benefits of this increased LRT service need to be balanced against the more frequent LRVs passing through intersections and the potential delays this may cause to local area traffic movements. Greater LRT priority and therefore greater journey time reliability may be provided with the slightly lower frequency service, which would also have lower impact on the operation of traffic in the wider area.

Annual Boardings

The table below sets out annual boardings for the LRT in 2031 and 2041 under the two frequency scenarios.

Annual Boardings	HSR Data	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
B-line Eastbound				2.94 M	3.30 M	4.04 M	4.73 M
B-line Westbound				9.52 M	13.50 M	11.07 M	15.57 M
HSR	30.2M	45.63M	55.81M	48.77M	63.69M	47.84M	62.76M
Total	**30.2M**	**45.6M**	**55.8M**	**61.2M**	**80.5M**	**63.1M**	**83.06M**

Vehicular Mode Split

The mode split table below sets out the number of linked trips rather than boardings. (a linked trip may have more than one boarding e.g. a bus trip that transfers to LRT). The table below sets out the mode shift following the introduction of the LRT. In 2031 the mode share for local transit increases by 0.42 percentage points in the central scenario, and by 0.46 percentage points in the high frequency scenario. This is a 10% increase in transit mode share. In 2041 the mode share for local transit increases by 0.67 percentage points in the central scenario, and by 0.71 percentage points in the high frequency scenario. This is a 14% increase in transit mode share. This indicates that the majority of boardings on the LRT are existing riders transferring from other HSR services. The mode share for GO Transit remains constant in the scenarios.

Mode Split – AM Linked Trips Peak Hour

	2011	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
Number of Linked Trips							
Car	191,700	253,575	269,125	252,175	267,250	252,125	267,200
Hamilton Transit	9,050	11,475	14,025	12,600	15,950	12,700	16,075
GO Transit	3,200	4,350	4,400	4,325	4,375	4,325	4,375
Mode Split							
Car	93.99%	94.13%	93.59%	93.71%	92.93%	93.67%	92.89%
Hamilton Transit	4.44%	4.26%	4.88%	4.68%	5.55%	4.72%	5.59%
GO Transit	1.57%	1.61%	1.53%	1.61%	1.52%	1.61%	1.52%

Final EA Run

Following the public consultation sessions undertaken in September 2016, there were a number of changes made to the design and alignment in response to comments that had been received. The key changes that impacted on the modelling included the addition of a stop at the Delta (Gage Park stop), increasing the number of lanes on the Main Street (West) portion of the alignment, and edits to the turning movements at James and King.

The results from this phase of the work are presented as an additional final chapter appended to the main report and are summarized below.

Peak Hour Boardings – derived by applying a factor of 0.5 to the AM peak period EMME outputs

	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
Peak Hour Boardings						
B-line Eastbound			825	925	1,125	1,325
B-line Westbound			2,650	3,725	3,050	4,275
B-line Total			**3,475**	**4,650**	**4,175**	**5,600**
HSR	12,575	15,350	13,400	17,550	13,175	17,250
TOTAL	12,575	15,350	16,875	22,200	17,375	22,850
Peak Hour Peak Load						
B-line Eastbound			400	425	475	600
B-line Westbound			1,500	2,350	1,650	2,525

Annual Boardings	HSR Data	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
B-line Eastbound				3.03 M	3.36 M	4.07 M	4.75 M
B-line Westbound				9.59 M	13.51 M	11.08 M	15.47 M
HSR	32M	45.63M	55.81M	48.62M	63.50M	47.76M	62.59M
Total	**32M**	**45.6M**	**55.8M**	**61.2M**	**80.4M**	**63.0M**	**82.76M**

Mode Split – AM Linked Trips Peak Hour

	2011	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
Number of Linked Trips							
Car	191,700	253,575	269,125	252,200	267,300	252,150	267,225
Hamilton Transit	9,050	11,475	14,025	12,600	15,925	12,675	16,050
GO Transit	3,200	4,350	4,400	4,325	4,375	4,325	4,400
Mode Split							
Car	93.99%	94.13%	93.59%	93.71%	92.94%	93.68%	92.89%
Hamilton Transit	4.44%	4.26%	4.88%	4.68%	5.54%	4.71%	5.58%
GO Transit	1.57%	1.61%	1.53%	1.61%	1.52%	1.61%	1.53%

Conclusions

The key points to note are:

- These changes have little effect on the overall mode shares
- These changes have little effect on traffic impacts in Hamilton
- These changes have little effect on traffic impacts observed within the EMME model

1 Overview

Project Background

1.1 In May 2015 $1 billion funding was announced for the Hamilton LRT project. The project that had previously received TPAP approval has been reconfigured with its eastern terminus now being at Queenston Traffic Circle (replacing Eastgate Mall), and with a new section of alignment on James Street linking King Street with West Harbour GO Station or the Waterfront.

1.2 Over the last 12 months the design of the LRT alignment along these revised routes, and their stop locations have been the subject of a detailed review. This has resulted in a re-configured alignment with twin LRT tracks running in the centre of the road. Many LRT stops have also been redesigned, with platforms staggered either side of main intersections. Known as 'far-side' stops- the platforms are placed at the far-side of intersections- they maximize passenger catchments, and allow left-turning and u-turning traffic movements to also be accommodated.

1.3 The updates to the LRT route(s) and alignment have also created changes to the surrounding road network- some minor intersections have had turning movement restrictions introduced- to improve priority for the LRT and realize journey time and service reliability benefits. Along much of the LRT route on King Street single lane, two-way traffic movements and access have been introduced, and the LRT has also been complemented by a review of local transit (bus) services, removing duplicate services and amending services to feed into new transfer facilities at McMaster University, MacNab, and Queenston.

1.4 All of these changes result in the need to update the TPAP approval for the LRT project. This includes long term ridership forecasting, and an assessment of traffic impacts, along with consideration of other environmental factors. This report documents the work undertaken to develop the EMME model to produce ridership forecasts and traffic volumes.

1.5 Common with other modern urban style LRT projects, and following the approach used for the original Hamilton LRT TPAP- the assessment of ridership and traffic uses a set of computer models to understand the benefits and impacts of the proposed LRT project. The results go through a process of testing, modification, iteration and refinement to achieve a balance of competitive LRT performance and efficient traffic operation. This has been completed as part of the updated TPAP process, alongside the development of project details for the Reference Case Design (RCD) and procurement documentation (Project Specific Output Specification- PSOS).

Modelling Suite

1.6 A series of models have been built in EMME, VISUM and VISSIM to provide tools to examine LRT ridership, and traffic impacts. These help inform the design and operation of the LRT system and the wider highway and local transit network. This section of the report provides an overview of each of those models and their specific purpose within the modelling suite.

1.1 The methodology builds on the approach developed to support the business case and traffic impact assessment for the previous B-Line project that received TPAP approval. The updated approach makes best use of available models and data, providing consistency with wider Transportation Master Plan (TMP) activities, and also uses updated versions of software packages to examine area-wide and local traffic impacts.

1.2 The figure below shows the different models used to analyse the project.

Figure 1.1: Modelling Geographic Overview

- Regional level modelling – EMME
  - Covers the geographic area of Hamilton and beyond
  - Consistent with the models used for the Hamilton Transportation Masterplan (TMP)
  - Includes information on both Transit and Highways
  - Source of LRT Ridership forecasts
  - Provides Information on traffic patterns for more detailed modelling (inputs to VISUM model)

- Hamilton Area model - VISUM
  - Traffic demand based on regional information (EMME model outputs) and local context
  - Able to look at the changes in traffic network flows in the Hamilton area
  - Identify issues, develop measures to limit the impacts and test these measures
  - Incorporates detailed signal timing and road capacity information

- LRT Corridor model - VISSIM
  - Models how the LRT and traffic will interact on the corridor
  - Used to understand the measures required for LRT priority
  - Provides more detailed information on LRT runtimes

Regional level modelling – EMME

1.7 The City of Hamilton has developed a model, using EMME software, as part of its Transportation Master Plan Update. This includes 2011 base data and projections for 2031. This model is used as the basis for developing LRT ridership forecasts.

1.8 Land use projections to 2041, as provided by the City as well as changes to the supporting transit (bus) network and GO services, are also considered using the EMME model. The model has a regional coverage and has been developed to assess AM peak period conditions (for baseline and future conditions).

1.9 The assessment of traffic impacts has been undertaken using two software packages. The first, VISUM, examines area-wide traffic impacts around the LRT alignments. Signal timings, and area-wide changes to traffic flows and intersections are assessed using this model.

1.10 The second model, VISSIM, a 'micro-simulation' model, focuses on the detail of the LRT alignment, and changes to traffic arrangements. This 'micro-simulation' model allows a detailed review of the performance of the LRT alignment, including LRT run times. Both traffic models examine 2011 and 2031 scenarios. They also examine AM and PM time periods.

1.11 The following traffic models for base and future years (2031) have been developed:

- Regional AM EMME model for transit and highways (using the TMP study model as the basis);
- Area wide AM VISUM model for highways;
- Area wide PM VISUM model for highways;
- Corridor AM VISSIM model; and
- Corridor PM VISSIM model.

1.12 This combination of models allows the development of ridership forecasts, provides an understanding of the traffic impacts along the LRT corridor and gives the ability to produce VISSIM videos showing traffic and LRT operation on the LRT corridor, and the basis for developing an area traffic management plan.

1.13 As stated above, the modelling approach for this project uses EMME, VISUM and VISSIM models. The approach benefits from using updated software, updated data, and by using the City's EMME model, will provide consistency with wider transportation policies the City is formulating through its TMP Update.

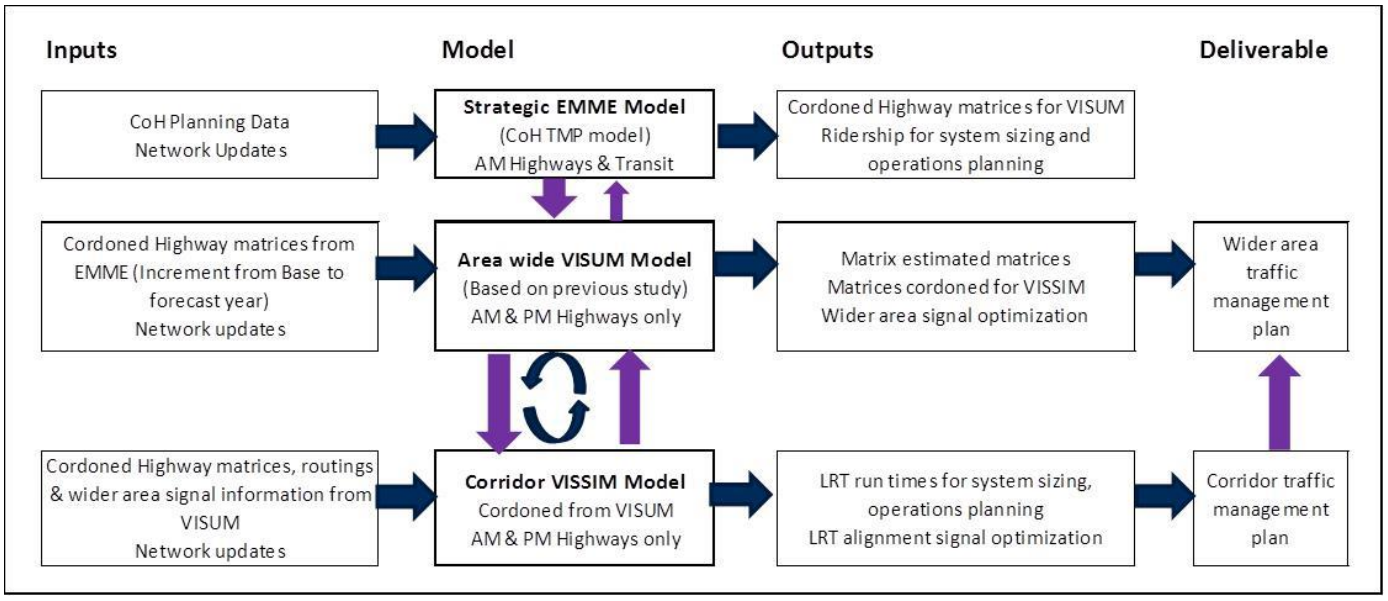
1.14 The EMME model has been used to produce the ridership forecasts for the project. Cordoned highway matrices have been extracted from EMME as the basis for the VISUM highway matrices.

1.15 VISUM has significantly better intersection modelling capabilities than existed during the previous phase of the work. The VISSIM model is focused on the LRT corridor, reducing data requirements and ensuring the effort is focused around the operation of the LRT.

1.16 The linkages between the models and a summary of the key outputs are shown in the figure below. Each of the models has a distinct function:

- EMME – Full area; Ridership and traffic forecasting; Cordoned prior traffic matrix for VISUM
- VISUM – Cordon area; traffic demand (EMME prior matrix estimated and calibrated), cordoned matrix for VISSIM
- VISSIM – LRT corridor, corridor operation, LRT runtimes and visual output,

Figure 1.2: Model Structure



EMME

1.17 The existing City of Hamilton EMME model has been updated based on 2011 TTS data as part of the Transportation Master Plan (TMP) process. This model has been used for transit ridership forecasting and it provides cordoned (prior) highway matrices for the VISUM model.

1.18 All transit network analysis is undertaken in EMME including wider area bus network changes and GO Rail (where services fall within the modelled time period).

1.19 The current forecast year for the EMME model is 2031 and this will be used for the traffic impacts work. An EMME model has also been generated for the forecast year of 2041, but this will not be used as part of the traffic forecasting work.

EMME Model Background

1.20 The EMME model is primarily used for transit (bus & LRT) ridership forecasting, although it also supplies incremental traffic demands to be used in the VISUM and VISSIM models. This report sets out the coding assumptions and ridership results for the Hamilton LRT design. (Version 1.0.9 dated April 27, 2016).

1.21 The model is based on the 2031 TMP model provided by Cole Engineering on April 10, 2016. The scenario used is 31000.

1.22 It was agreed with the City of Hamilton and Metrolinx that for the new scenarios that straight 2031 GRIDS land use would be used. For the 2041 work, the City of Hamilton Planning Department has produced an extrapolation of the GRIDS data to 2041 and it was agreed that this would be used in the EMME model for ridership and system sizing work.

1.23 Between the base model year of 2011 and the traffic impacts forecast year of 2031, there is forecast to be a significant amount of background traffic growth. The tables below illustrate the changes in the planning data inputs into the model between 2011 and 2031. Population and employment growth leads to an increased number of linked trips (both auto and transit) within the network and congestion is expected to increase.

Table 1.1: Planning Data Increases between 2011 and 2031

Year	Description	Value	Change from 2011	Change (%) from 2011	Change from 2031	Change (%) from 2031
2011	Population	531,100	-	-	-	-
2011	Employment	233,900	-	-	-	-
2031	Population	659,700	128,700	24%	-	-
2031	Employment	301,000	67,100	29%	-	-
2041	Population	779,100	248,000	47%	119,400	18%
2041	Employment	340,800	106,900	46%	39,800	13%

Figure 1.3: Figure showing Population Density in 2011

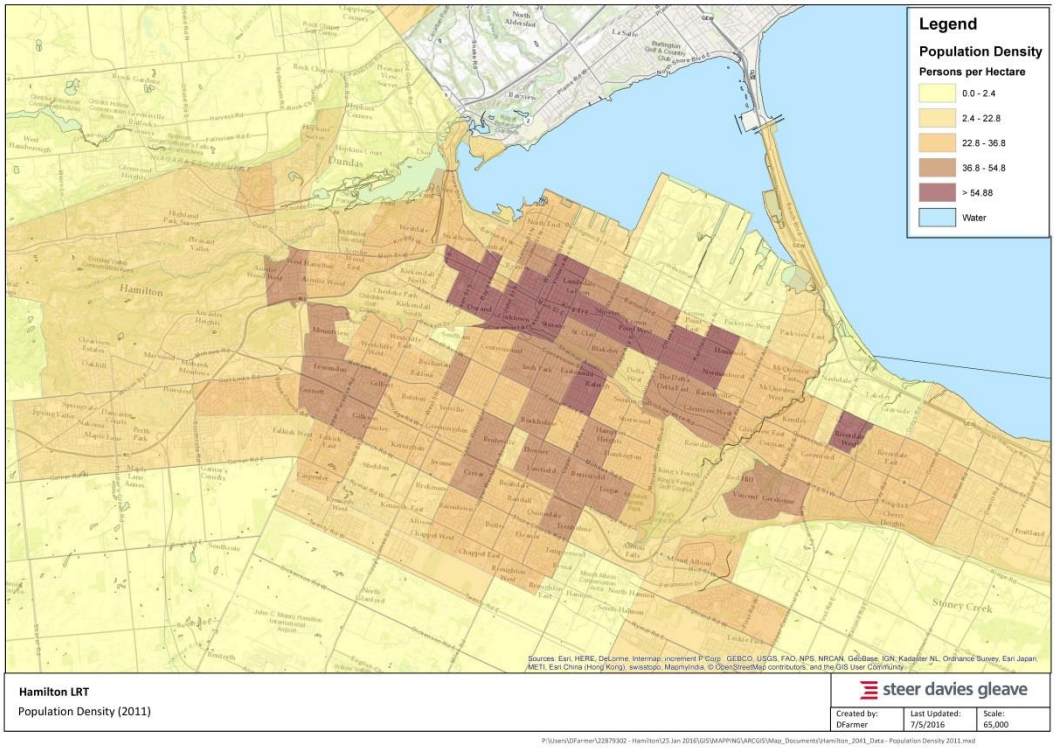


Figure 1.4: Figure showing Population Density in 2031

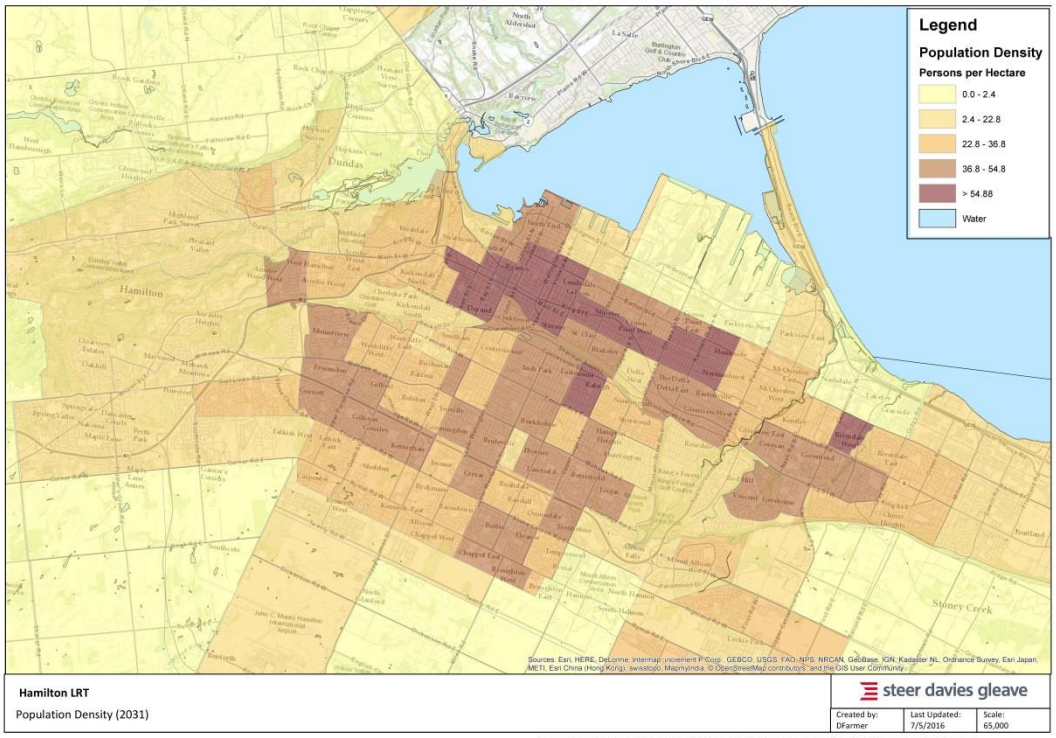


Figure 1.5: Figure showing Employment Density in 2011

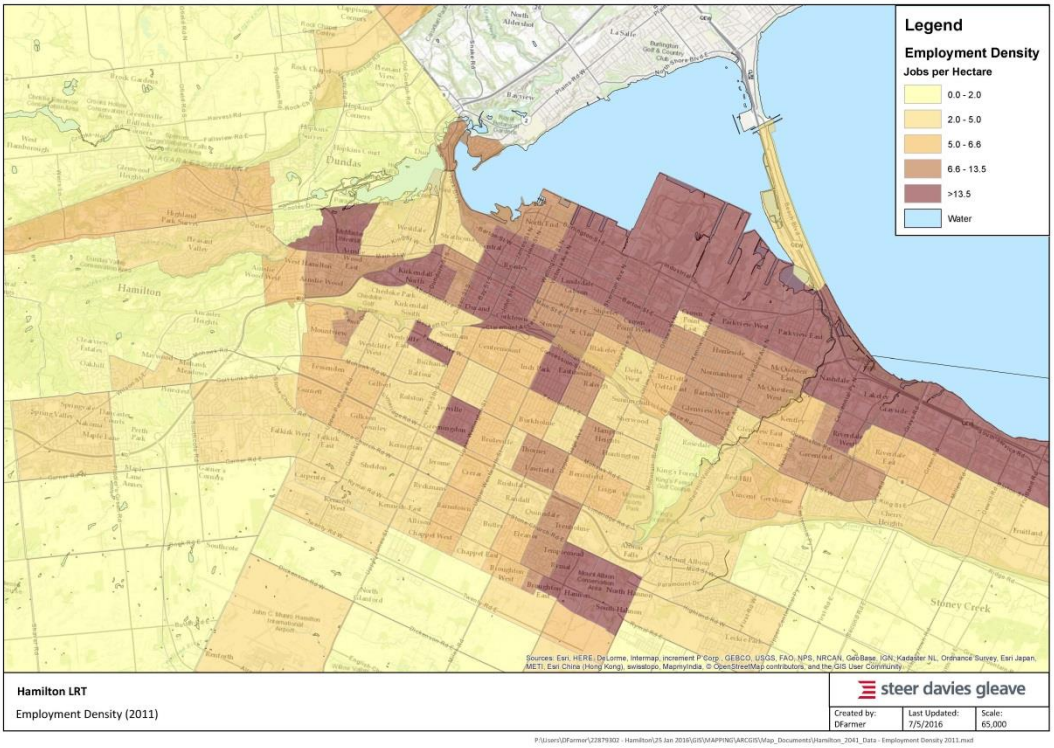
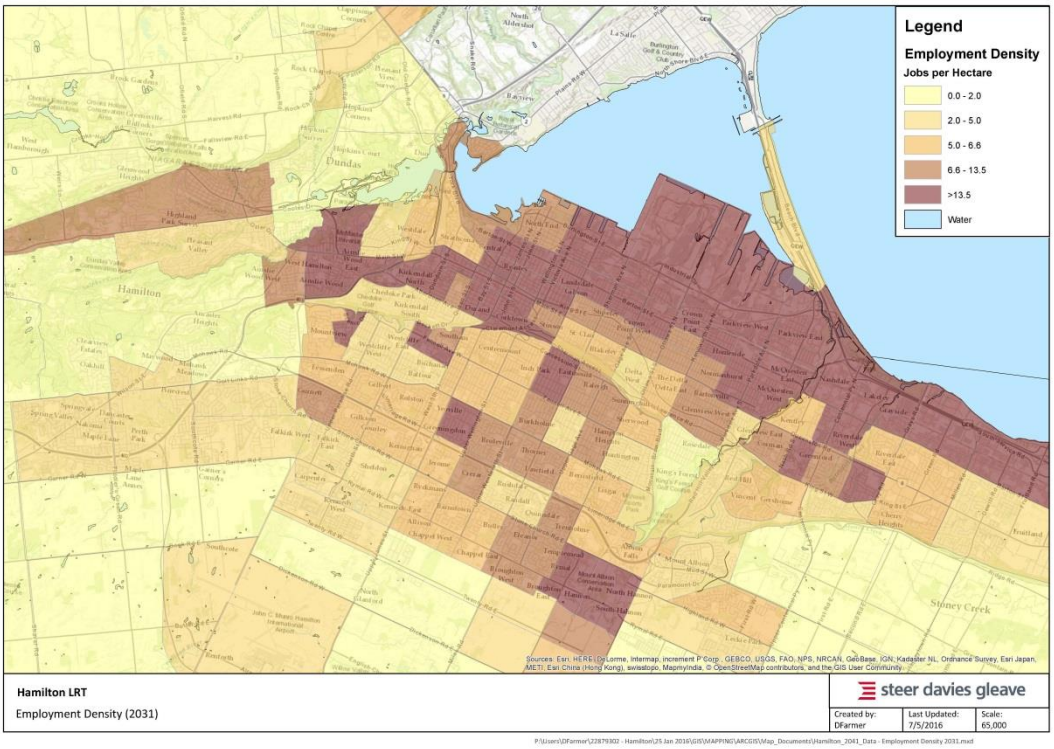


Figure 1.6: Figure showing Employment Density in 2031



Report Structure

1.24 Following this introductory section, the report is structured as follows:-

- Chapter 2: Business As Usual (BAU) Scenario Coding
- Chapter 3: 'With LRT' Scenario Coding
- Chapter 4: BAU Model Results
- Chapter 5: 2031 LRT Model Results
- Chapter 6: 2041 LRT Model Results
- Chapter 7: Sensitivity Test Results
- Chapter 8: Discussion of Results
- Chapter 9: Final EA Model Run (2031 LRT)
- Chapter 10: Final EA Model Run (2041 LRT)

2 BAU Scenario Coding

Summary

2.1 The EMME models developed for the LRT project used the updated models provided by the TMP team as a basis to ensure consistency of approach. Two models were developed for each scenario year – a Business as Usual (BAU) 'Without LRT' scenario and a 'With-LRT' scenario. The scenario years were 2031 and 2041, based on the existing EMME forecast years and were undertaken for the AM peak period (3-hour).

2.2 A number of updates were required within the models due to changes implemented between the 2011 Base Model and the current 2015/2016 situation, as well as committed improvements between the present day and the forecast years as set out in the TMP. The Consultant team worked with City/Metrolinx staff to agree appropriate assumptions for the modelling work.

2.3 Coding updates included road network changes, e.g. one-to-two-way conversions, the latest GO Rail frequency plans for Hamilton, bus network changes (provided by HSR), local transit (bus) frequency changes and the coding of the updated (centre-running) LRT designs.

Network Changes

Road Network

2.4 Road network changes, including 1 to 2-way conversions, are shown in Table 2.1 below. Note that due to the regional nature of the EMME model, not all streets are represented and therefore short sections of changes may not be fully reflected.

Table 2.1 Road Network Changes (BAU Scenario)

Street	Direction	From	To	Changes
Wentworth	NB	Delaware	Barton	Converted to two way from Delaware to Barton
Wentworth	SB	Barton	Cannon	Changed lanes from 3 to 2 from Barton to Delaware
Hughson	NB	Wilson	Barton	Changed lanes from 2 to 1 from Wilson to Barton
Hughson	SB	Barton	Wilson	Converted to two way from Barton to Wilson
Gage	NB	Cumberland	Industrial	Changed lanes from 2 to 1 from Cumberland to Industrial
Gage	SB	Industrial	Cumberland	Changed lanes from 2 to 1 from Industrial to Burlington
Locke	NB	Main	King	Changed lanes from 2 to 1 from Main to King
Victoria	NB	Claremont	Main	Changed lanes from 5 to 4 from Claremont to Main

Street	Direction	From	To	Changes
Victoria	NB	Main	Cannon	Changed lanes from 4 to 3 from Main to Cannon
Victoria	NB	Cannon	Burlington	Changed lanes from 3 to 2 from Cannon to Burlington
Victoria	SB	Burlington	Barton	Converted to two way from Burlington to Barton
Cannon	EB	Melrose	Kenilworth	Changed lanes from 2 to 1 from Melrose to Kenilworth
Cannon	WB	Kenilworth	Melrose	Changed lanes from 2 to 1 from Kenilworth to Melrose
MacNab	SB	King	Main	Added bus-only lanes from King to Main
MacNab	NB	Main	King	Changed lanes from 2 to 1 from Main to King

Transit Network

GO Rail Network

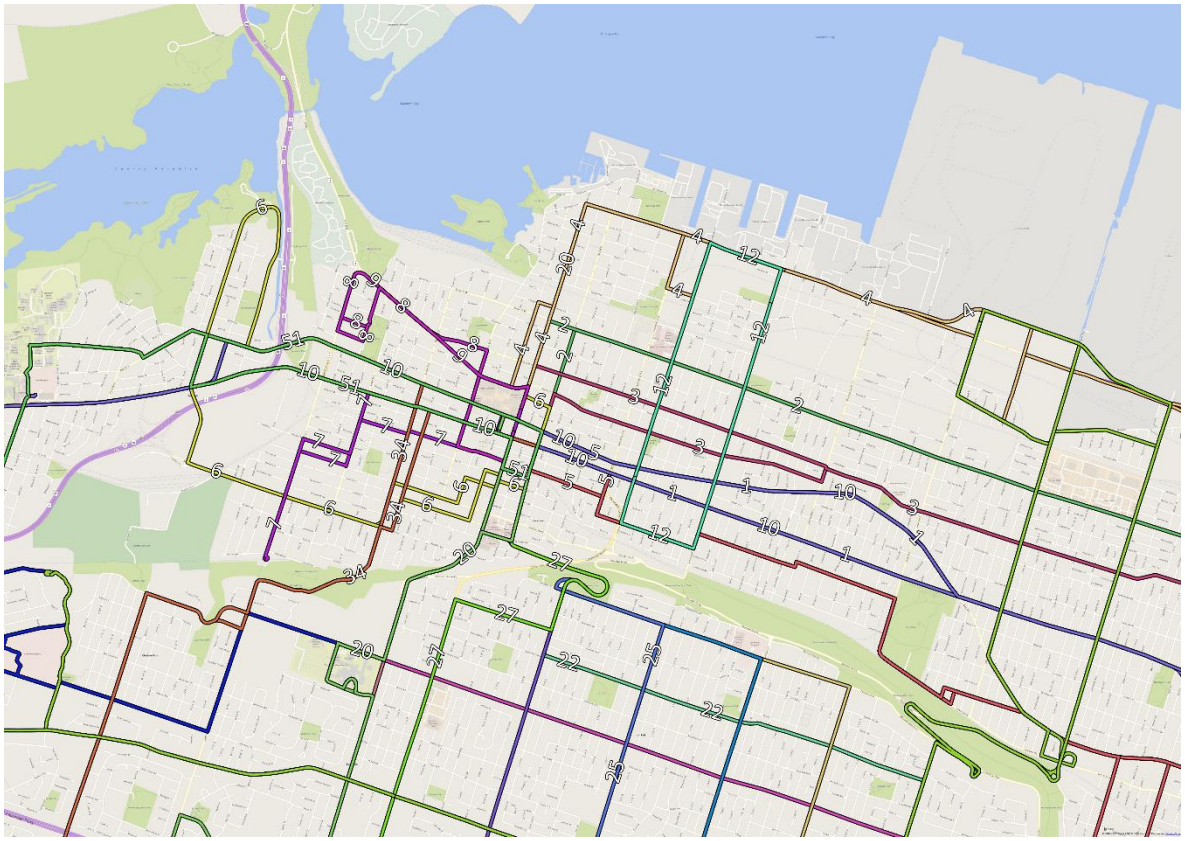
2.5 The latest GO Rail frequency plans for Hamilton have been updated in the EMME model:

- From Hunter: 12 trains in AM Peak Period
- To Hunter: 3 trains in AM Peak Period
- From West Harbour: 4 trains in AM Peak Period

Bus Network

2.6 The original 2011 bus network from the TMP model was used as the BAU bus network.

Figure 2.1: HSR Future Bus Network Business as Usual (GIS)



Parking Charges

2.7 Parking charges are applied using a matrix, and it is assumed that parking charges are held at the 2011 values apart from in the downtown and at McMaster University.

2.8 For Downtown, the assumption is that parking charges between 2011 and 2031 increase by 20% and do not increase between 2031 and 2041. At McMaster University it is assumed that between 2011 and 2031 parking changes will increase by 30 percent and will not increase between 2031 and 2041.

3 'With LRT' Scenario Coding

Summary

3.1 As part of the LRT implementation, there are a number of changes required to the highway network, including capacity reduction and lane removal. This section of the report sets out the coding assumptions for the latest Hamilton LRT design. (Version 1.0.9 dated April 27, 2016). Note that due to the regional nature of the EMME model, not all streets are represented and therefore short sections of changes may not be fully reflected.

3.2 In addition, there are also changes to the bus network, including a slight reduction of service on the LRT route and parallel corridors and integration with the end of the route at Queenston. These changes are set out below.

Network Changes

Road Network

Table 3.1: Road Network Changes With LRT Scenario – in addition to BAU Changes

Street	Direction	From	To	Changes
Main	EB	Leland	Paradise	Changed lanes from 3 to 2 from Leland to Paradise
Main	EB	Paradise	Macklin	Changed lanes from 5 to 2 from Paradise to Macklin
Main	EB	Macklin	Frid	Changed lanes from 5 to 3 from Macklin to Frid
Main	EB	Kensington	Rosewood	Changed lanes from 2 to 1 from Kensington to Rosewood
Main	WB	Strathearne	Kensington	Changed lanes from 2 to 1 from Strathearne to Kensington
Main	WB	Gary	Leland	Changed lanes from 3 to 2 from Gary to Leland
King	EB	Dundurn	Queen	Converted to two way from Dundurn to Queen
King	EB	Queen	Hess	Added new walk link from Queen to Hess
King	EB	Hess	Kensington	Converted to two way from Hess to Bay
King	WB	Kensington	East Ave	Changed lanes from 4 to 1 from Kensington to East Ave
King	WB	East Ave	Victoria	Changed lanes from 4 to 2 from East Ave to Victoria
King	WB	Victoria	West Ave	Changed lanes from 4 to 1 from Victoria to West Ave
King	WB	West Ave	Wellington	Changed lanes from 4 to 2 from West Ave to Wellington
King	WB	Wellington	Catharine	Removed auto link from Wellington to Catharine
King	WB	Catharine	John	Changed lanes from 3 to 1 from Catharine to John
King	WB	John	MacNab	Changed lanes from 4 to 1 from John to MacNab

Street	Direction	From	To	Changes
King	WB	MacNab	Bay	Changed lanes from 4 to 2 from MacNab to Bay
King	WB	Bay	Locke	Changed lanes from 4 to 1 from Bay to Locke
King	WB	Locke	Dundurn	Changed lanes from 5 to 1 from Locke to Dundurn
King	WB	Dundurn	Breadalbane	Changed lanes from 5 to 2 from Dundurn to Breadalbane

Transit Network

3.3 The latest GO Rail frequency plans for Hamilton have been updated in the EMME model:

- From Hunter: 12 trains in AM Peak Period
- To Hunter: 3 trains in AM Peak Period
- From West Harbour: 4 trains in AM Peak Period

3.4 Bus routes were updated as per the HSR-provided GIS files, shown in Figure 3.1 and

Table 3.2. The tables relate the HSR routes to the EMME coding. Generally, EMME names can be converted to HSR names by considering the number in the name.

Figure 3.1: HSR Future Bus Network LRT Scenario (GIS)

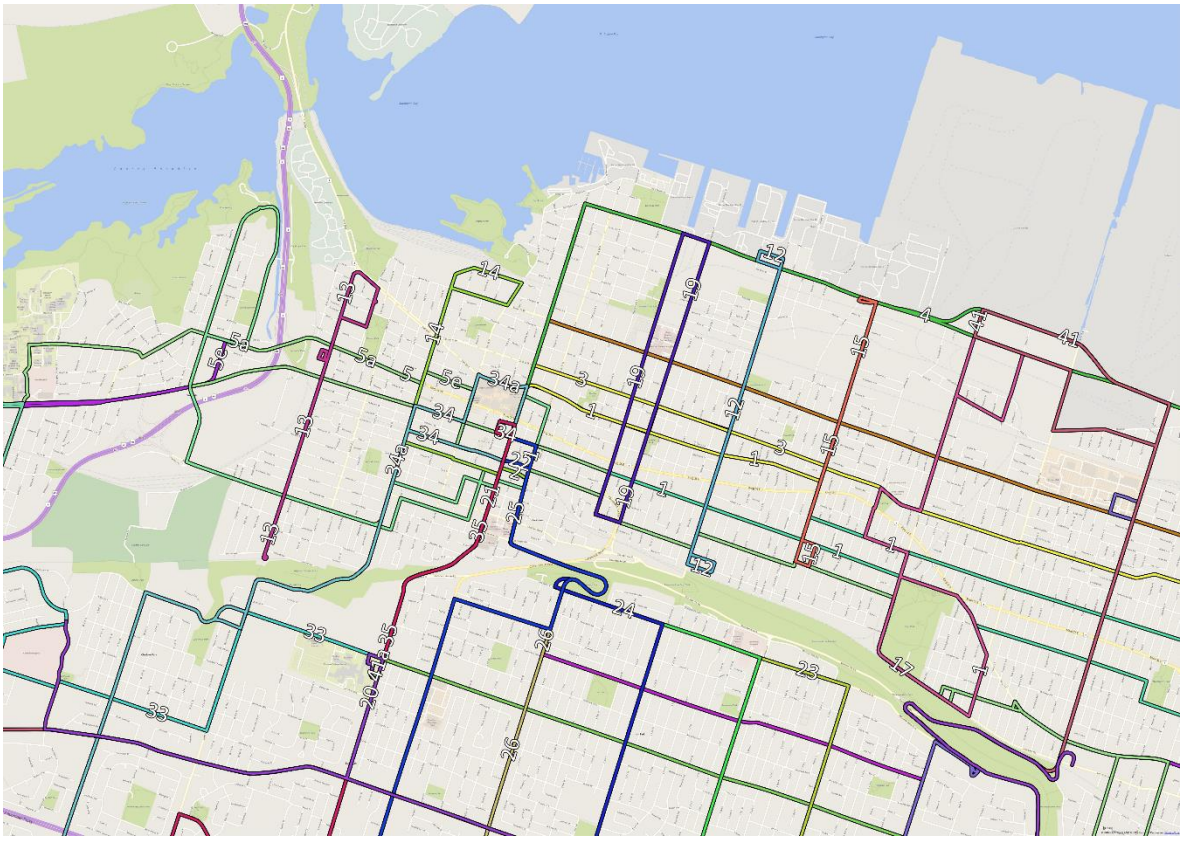


Table 3.2: Bus Network Changes (With LRT Scenario)

EMME Future line name	2011 EMME Line Name	Description	Comments
WW001/WW001A	WW001/W001A	King	Minor modification at eastern end, moved to parallel roads from King, terminated at James
WW002	WW002	Barton	Minor modification at eastern end
WW003	WW003	Cannon	Minor modification at eastern end
WW004	WW004	Bayfront	
WW005/WW005A /WW005E	WW005C	Delaware	Runs WB on Hunter and Market near downtown, extended western terminus. No WHL short turns
WW006	WW006	Aberdeen	
-	WW007	Locke	Removed route 7
-	WW008	York	Removed route 8
-	WW010/WW010A	B-Line Express	Removed route WW010/WW010A
WW011	WW011/WW011A	Parkdale	Minor modifications to southern end, added diversion to Queenston
WW012	WW012	Wentworth	Runs north and south on Wentworth
WW013	-	Dundurn	Added route 13
WW014	-	Queen	Added route 14
WW015	-	Sherman	Added route 15
WW016	WW016	Ancaster	
WW017	-	Gage	Added route 17
WW018	-	Waterdown	Added route 18
WW019	-	Victoria-Wellington	Added route 19
WW020	WW020	A-Line	Short-turned at downtown exchange
WW021	WW021	Upper Kenilworth	Minor modification at northern end, extended southern end
WW022	WW022	Upper Ottawa	Minor modification at northern end, extended southern end
WW023	WW023	Upper Gage	Minor modification at northern end
WW024	WW024	Upper Sherman	Minor modification at northern end
WW025	WW025	Upper Wentworth	Minor modification at northern end
WW026	WW026	Upper Wellington	Minor modification at northern end
WW027	WW027	Upper James	Minor modifications at northern end
WW030	**New in 2031**	T-Line	Added route 30
WW033	WW033	Sanatorium	Extended southern end
WW034/WW034A	WW034/WW034A	Upper Paradise	Minor modification at northern end, extended southern end
WW035/WW035A	WW035/WW035A	College	Minor modifications at northern end, extended southern end

EMME Future line name	2011 EMME Line Name	Description	Comments
WW041/WW041A	WW041	Mohawk	Will continue to serve both Kenilworth Avenue and Ottawa Street, with deletion of #41 service on Beach Road, west of Ottawa Street
WW043	WW043	Stone Church	Modifications to eastern end
WW044	WW044	Rymal	Extended northern terminus
WW045	**New in 2031**	Heritage Green Local	Added route 45
WW051	WW051	University	Shortened eastern terminus to McMaster Terminal
WW052A	WW052A/WW052G/WW052H	Dundas - P. Valley and Uni. Gardens	Continues to serve Pleasant Valley and Watson's Lane Loop. It is also extended into the University Gardens neighbourhood and then it is routed to McMaster Terminal.
WW055/WW055CW	WW055	Stoney Creek Central	Modified eastern end, interlined with Route #1
WW056			Removed route 56
WW058	WW058	Stoney Creek Local	

3.5 Bus headway changes are listed in the table below.

Table 3.3: Bus Headway Changes (With LRT Scenario)

Route Number	Route Name	Headways		Route Number	Route Name	Headways	
		2031	2041			2031	2041
1	King	8.9	8	23	Upper Gage	9.3	7.6
2	Barton	5.4	4.9	24	Upper Sherman	9.3	7.8
3	Cannon	15	12.5	25	Upper Wentworth	10	7.5
4	Bayfront	13.3	12	26	Upper Wellington	10	8.3
5/5A/5E	Delaware	5.4	4.5	27	Upper James	10.5	8.7
6	Aberdeen	20	15	30	T Line	9.2	7.9
11	Parkdale	17.8	16	33	Sanatorium	10.7	9.6
12	Wentworth	20	20	34/34A	Upper Paradise	12	9
13	Dundurn	20	20	35/35A	College	10.5	8.4
14	Queen	20	20	41/41A	Mohawk	11.1	9.6
15	Sherman	20	20	43	Stone Church	20	13.3
16	Ancaster	20	12	44	Rymal	18	12.9
17	Gage	20	15	45	Heritage Green Local	29	24.2
18	Waterdown	15	10	51	University	7.5	4.3
19	Victoria-Wellington	20	20	52	Dundas - P. Valley & U. Gardens	30	15
20	A Line	9	8.2	53	Dundas - York Heights	30	15
21	Upper Kenilworth	10.9	9.2	55/55CW	Stoney Creek Central	8.6	7.5

Route	Route Name	Headways		Route	Route Name	Headways	
22	Upper Ottawa	10.9	8.6	58	Stoney Creek Local	20	13.3

LRT Lines

3.6 Two LRT lines have been coded into the model – the B-line from McMaster University to Queenston Traffic Circle and the A-line from McNab Bus Terminal to the Waterfront. The A-Line LRT spur was subsequently removed from the project scope in February 2017. Results presented in this report are for the B-line only.

Model Parameters

3.7 Within the model there are some parameters that have been applied to the LRT mode to differentiate it from the bus mode in terms of its quality and reliability. The parameters were discussed in advance with Metrolinx and are presented in the table below.

Table 3.4: Model Parameters

Category	Modelling Parameter	Assumed Value
Quality [IVT factor based on FTA guidance for Ride Quality (0.95) and Vehicle Amenities (0.95)]	Boarding penalty (generalized minutes) Compared to 2.5 for bus in BAU	0 minutes for LRT
	In vehicle time weighting	0.9 (0.95 x 0.95)
Reliability (based on FTA guidance)	In vehicle time weighting	0.9
Quality and Reliability combined	In vehicle time weighting	0.81 (0.9 x 0.9)

3.8 It should be noted that while the boarding penalty for LRT is not ideal at zero, this was required in order to have a boarding penalty differential between bus and LRT modes. Under normal circumstances it would be usual for the bus boarding penalty to be higher and therefore a differential could be established without a reduction to zero.

LRT Network Coding

3.9 Lengths and original runtimes have been taken from the SDG developed runtime model. It should be noted that the runtimes listed below do not have the in-vehicle time factor of 0.81 applied.

Table 3.5: B-line LRT Attributes

From	To	Length	Run-	Dwell
McMaster	Longwood	1.388	2:25	0:15
Longwood	Dundurn	1.214	1:47	0:20
Dundurn	Queen	0.895	1:34	0:20
Queen	James	0.844	2:02	0:20
James	Mary	0.317	1:21	0:15
Mary	Wellington	0.524	1:47	0:15
Wellington	Wentworth	0.842	1:54	0:15
Wentworth	Sherman	0.859	1:25	0:20
Sherman	Scott Park	0.536	1:04	0:15
Scott Park	Ottawa	1.245	2:10	0:15

From	To	Length	Run-	Dwell
Ottawa	Kenilworth	0.812	1:23	0:20
Kenilworth	Queenston	0.882	1:47	

3.10 The table below shows the headways that were used for the two ridership tests.

Table 3.6: LRT Headways

Line	Test	Headway
B-line	1	6 mins
B-line	2	4 mins

Zone Connections along the LRT

McMaster University

3.11 A key consideration for usage of the LRT versus bus at McMaster University is how each of the stops are coded in relation to the zone access. This was in particular around the fact that currently there are buses which operate within the campus, whereas the LRT will stop on the edge of the site and to ensure the walk access to the main focus of the campus was appropriately reflected. McMaster was unable to provide any additional information on future development plans, so no changes have been assumed.

3.12 McMaster University is represented by a single zone – 2501- see figure below, and it can be accessed from three locations - three centroids connected to the road network. Upon review, the existing bus routes that serve the campus have a stop directly where the centroid connector links with the network. The LRT (shown at the bottom of the figure) has a longer access to the zone, via a link in the road network, prior to linking with the connector – this equates to just under an additional 4 minutes for access. This reflects the fact that walk access to the LRT is currently assumed to be longer.

3.13 This is as representative as is feasible in a regional model such as this, and should not bias demand towards the LRT. It also has the advantage that no changes are made to the network or zone access from the 2011 calibrated base.

Figure 3.2: McMaster University Zone Access

Annualization

3.14 The EMME model outputs are for the AM peak period. Factors have been derived based on HSR data to convert the peak period numbers to daily and annual numbers.

Table 3.7: Table showing AM peak to daily factors based on HSR data

	Corridor Boardings	Corridor Portion of Period	Corridor Period Portion of Total	Corridor Peak Factor	Non - Corridor Boardings	Non-Corridor Portion of Period	Non-Corridor Period Portion of Total	Non-Corridor Peak Factor	System Total Boardings	System-wide Period Portion of Total	System-wide Peak Factor
Early AM	412	36.10%	0.40%		728	63.90%	0.70%		1,140	1.00%	
AM Peak	6,621	36.70%	6.10%	7.05	11,415	63.30%	10.50%	5.44	18,036	16.60%	6.03
Mid	19,705	44.80%	18.10%		24,279	55.20%	22.30%		43,984	40.40%	
PM Peak	11,284	39.60%	10.40%	4.14	17,177	60.40%	15.80%	3.62	28,461	26.20%	3.82
Eve	8,685	50.50%	8.00%		8,514	49.50%	7.80%		17,199	15.80%	
Total	46,707	42.90%	42.90%		62,113	57.10%	57.10%		108,820	100.00%	

Table 3.8: Comparison of Previous and Proposed Annualization Factors

Time Period	Factor
AM Peak Period to AM Peak Hour	0.5
AM Peak Period to Weekday	6.03
Daily to Annual	300
AM Peak to Annual	1,809

4 BAU Model Results

2031 BAU

4.1 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

Table 4.1: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km (Peak Hour)	Pass. Hrs (Peak Hour)
Buses	12,575	25,225	152,100	45,632,000	65,050	2,725

Table 4.2: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	253,575	94.13%
Transit	11,475	4.26%
GO Transit	4,350	1.61%
Total	269,375	

2041 BAU

4.2 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

Table 4.3: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km (Peak Hour)	Pass. Hrs (Peak Hour)
Buses	15,350	30,850	186,300	55,808,000	81,450	3,850

Table 4.4: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	269,125	93.59%
Transit	14,025	4.88%
GO Transit	4,400	1.53%
Total	287,525	

5 2031 LRT Model Results

Overview

5.1 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

5.2 The results are presented for the following scenarios:

- Central scenario – B-Line – 6 minute frequency
- High frequency scenario – B-Line – 4 minute frequency

5.3 For each scenario the following information is presented:

- AM peak hour B-line East and Westbound boardings, alightings and loadings
- AM peak hour bus route boardings by line (see appendix)
- Peak hour, daily and annual bus, LRT and total transit boardings (see appendix)

5.4 The capacity assumptions are derived using the Metrolinx standard capacity assumption of 130 persons per Light Rail Vehicle (LRV), which when multiplied by the headways of 6 and 4 minutes gives capacities of 1300 and 1950 persons per LRV/hour.

5.5 This approach is a conservative estimate of capacity used for planning purposes as most modern LRT systems would carry higher passenger volumes in peak hour conditions.

LRT Scenario 1 (B-line Headway = 6 minutes)

Table 5.1: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km (Peak Hour)	Pass. Hrs (Peak Hour)
B-Line EB	800	1,625	9,800	2,938,000	3,275	100
B-Line WB	2,625	5,275	31,700	9,523,000	13,250	375
Buses	13,475	26,950	162,500	48,769,000	58,475	2,725

Table 5.2: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	252,175	93.71%
Transit	12,600	4.68%
GO Transit	4,325	1.61%
Total	269,100	

Figure 5.1: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

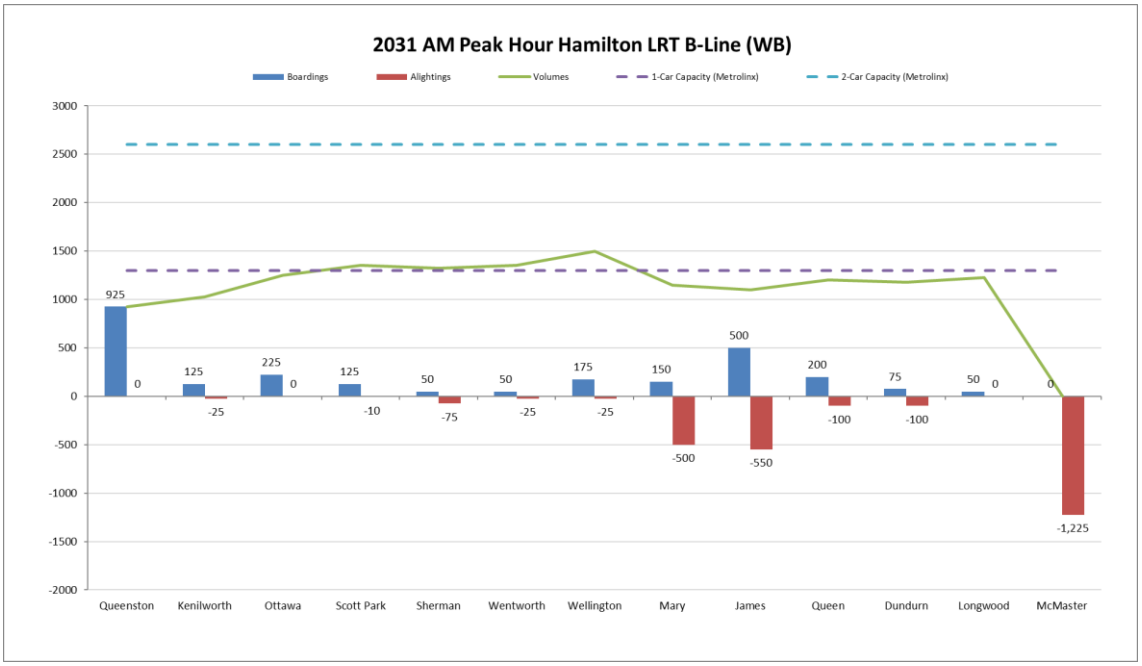
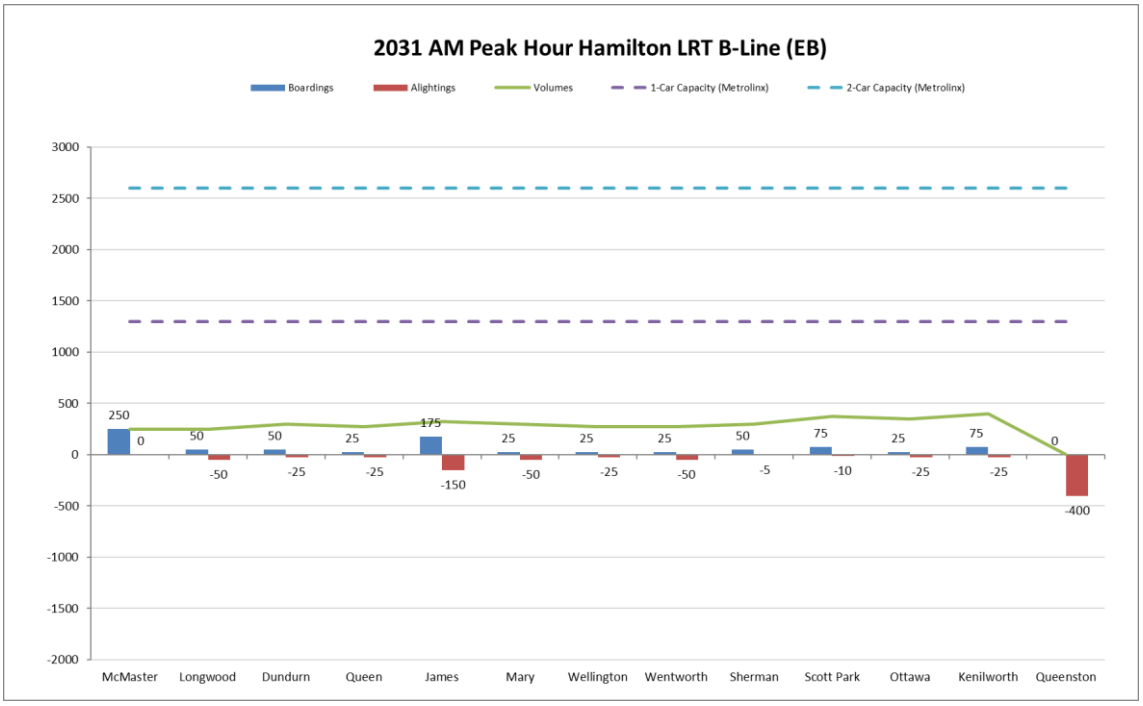


Figure 5.2: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



5.6 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton.

The maximum loadings on the B-line are forecasted to be 1,500 Westbound and 400 Eastbound during the AM Peak Hour. Under these conditions, the B-line would be over the Metrolinx single LRV Planning Capacity.

5.7 The busiest LRT stops are the two termini of the B-line. Queenston stop is forecasted to have 925 boardings and 400 alightings during the AM Peak hour and McMaster has 1,225 alightings and 250 boardings during the AM Peak hour.

LRT Scenario 2 (B-line Headway = 4 minutes)

Table 5.3: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km (Peak Hour)	Pass. Hrs (Peak Hour)
B-line EB	1,125	2,225	13,500	4,036,000	4,075	125
B-line WB	3,050	6,125	36,900	11,067,000	14,675	425
Buses	13,225	26,450	159,300	47,835,000	57,050	2,650

Table 5.4: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	252,125	93.67%
Transit	12,700	4.72%
GO Transit	4,325	1.61%
Total	269,150	

Figure 5.3: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

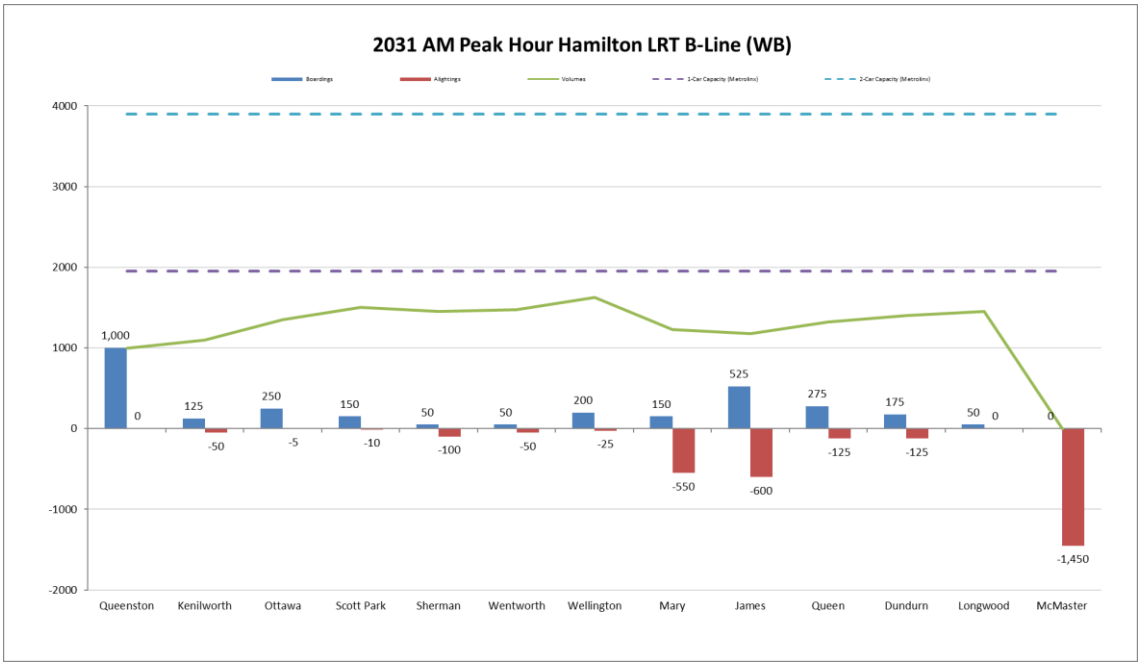
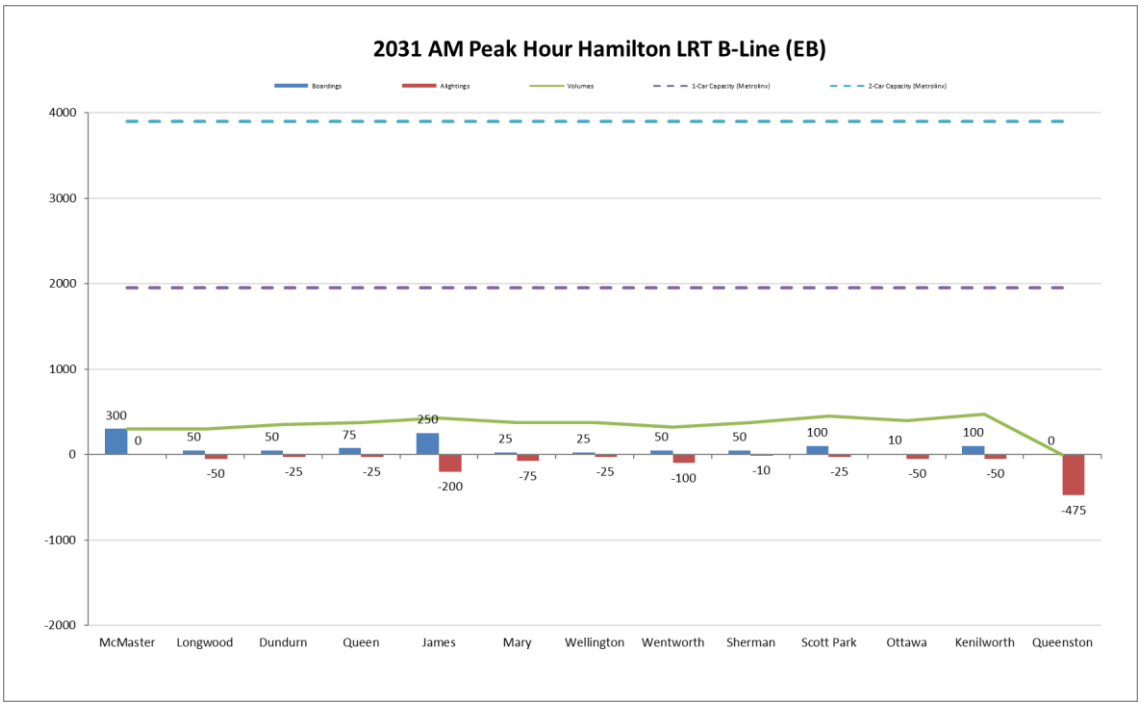


Figure 5.4: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



5.8 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton. The maximum loadings on the B-line are forecast to be 1,625 Westbound and 475 Eastbound during the AM Peak Hour. Note that as the frequency of the LRT is increased, the capacity is higher as there are more LRV trips each hour.

5.9 The busiest LRT stops are the two termini of the B-line. The Queenston stop is forecasted to have 1,000 boardings and 475 alightings during the AM Peak hour and McMaster has 1,450 alightings and 300 boardings during the AM Peak hour.

6 2041 LRT Model Results

6.1 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

6.2 The results are presented for the following scenarios:

- Central scenario – B-Line – 6 minute frequency
- High frequency scenario – B-Line – 4 minute frequency

6.3 For each scenario the following information is presented:

- AM peak hour B-line East and Westbound boardings, alightings and loadings
- AM peak hour bus route boardings by line (see appendix)
- Peak hour, daily and annual bus, LRT and total transit boardings (see appendix)

6.4 In the graphs presented below, there are two indicative capacity lines shown. These represent the Metrolinx interpretation of the planning capacity of the proposed LRT vehicles which is equal to 130 passengers per vehicle.

LRT Scenario 1 (B-line Headway = 6 minutes)

Table 6.1: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	925	1,825	11,000	3,305,000	3,750	100
B-line WB	3,725	7,450	45,000	13,495,000	19,475	550
Buses	17,600	35,200	211,900	63,687,000	75,975	3,475

Table 6.2: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	267,250	92.93%
Transit	15,950	5.55%
GO Transit	4,375	1.52%
Total	287,575	

6.5 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton.

6.6 The maximum loadings on the B-line are forecasted to be 2,350 Westbound and 425 Eastbound during the AM Peak Hour. Under these conditions, the B-line will be well over the Metrolinx Planning Capacity for a single LRV.

6.7 The busiest LRT stops are the two termini of the B-line. Queenston stop has 1,450 boardings and 350 alightings during the AM Peak hour and McMaster has 1,650 alightings and 375 boardings during the AM Peak hour.

Figure 6.1: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

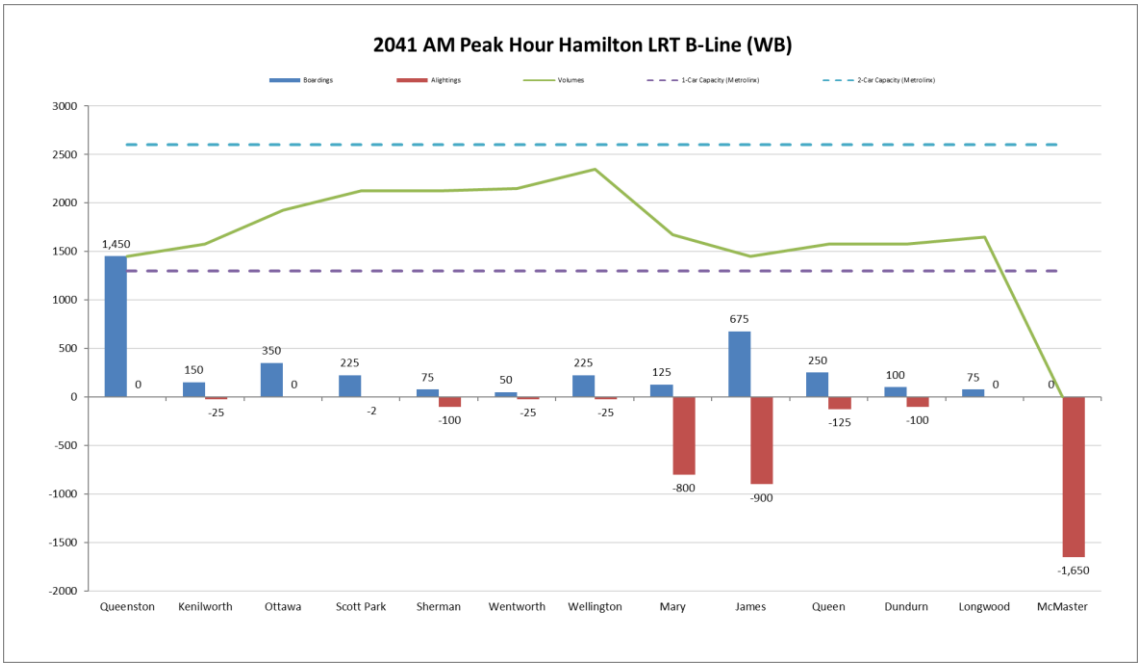
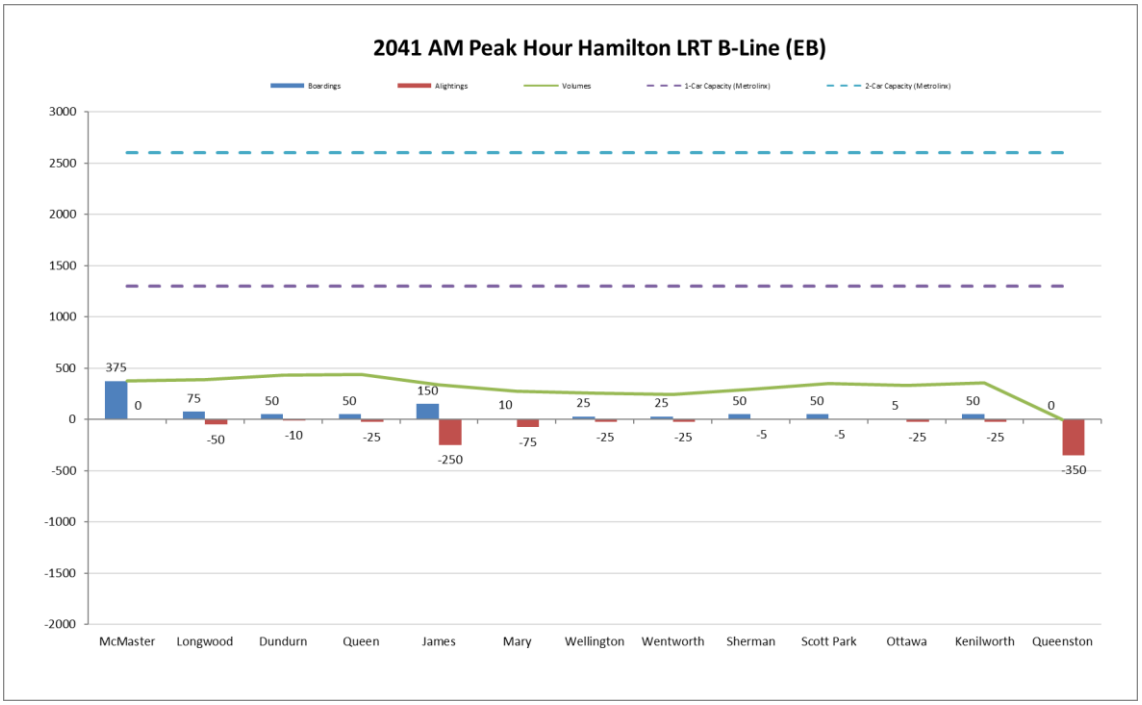


Figure 6.2: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



LRT Scenario 2 (B-line Headway = 4 minutes)

Table 6.3: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	1,300	2,600	15,800	4,725,000	5,175	150
B-line WB	4,300	8,600	51,900	15,572,000	21,550	600
Buses	17,350	34,700	209,200	62,758,000	73,550	3,350

Table 6.4: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	267,200	92.89%
Transit	16,075	5.59%
GO Transit	4,375	1.52%
Total	287,650	

6.8 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton.

6.9 The maximum loadings on the B-line are forecasted to be 2,550 Westbound and 625 Eastbound during the AM Peak Hour. Under these conditions, the B-line will be over the Metrolinx Planning Capacity for a single LRV.

6.10 The busiest LRT stops are the two termini of the B-line. The Queenston stop is forecasted to have 1,575 boardings and 500 alightings during the AM Peak hour and McMaster has 1,925 alightings and 525 boardings during the AM Peak hour.

Figure 6.3: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

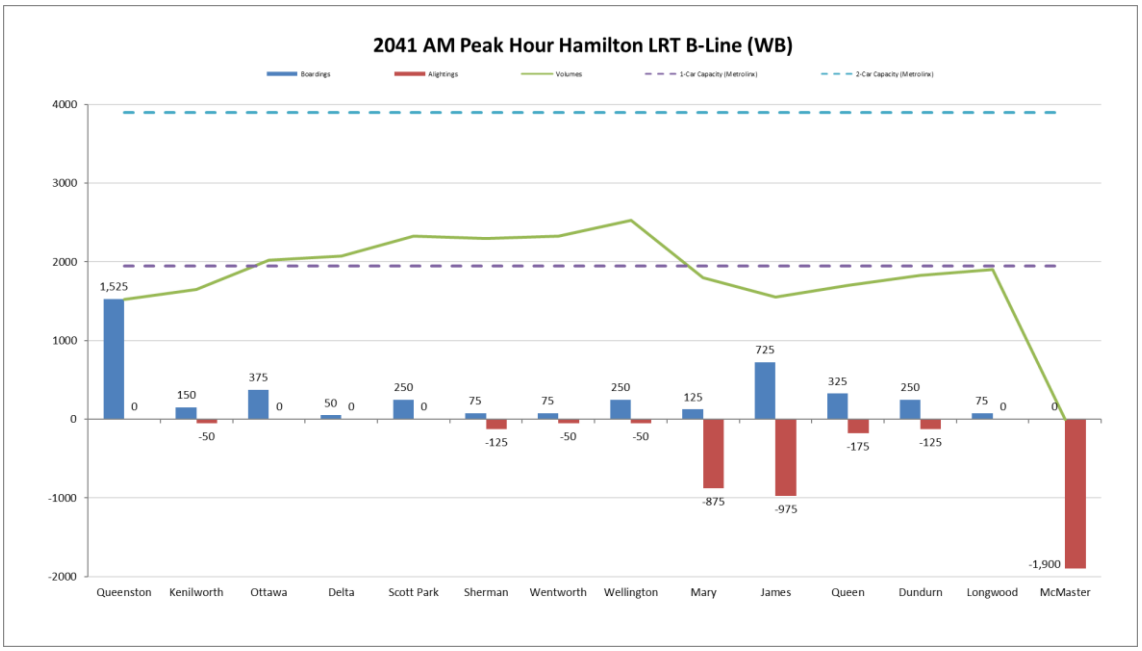
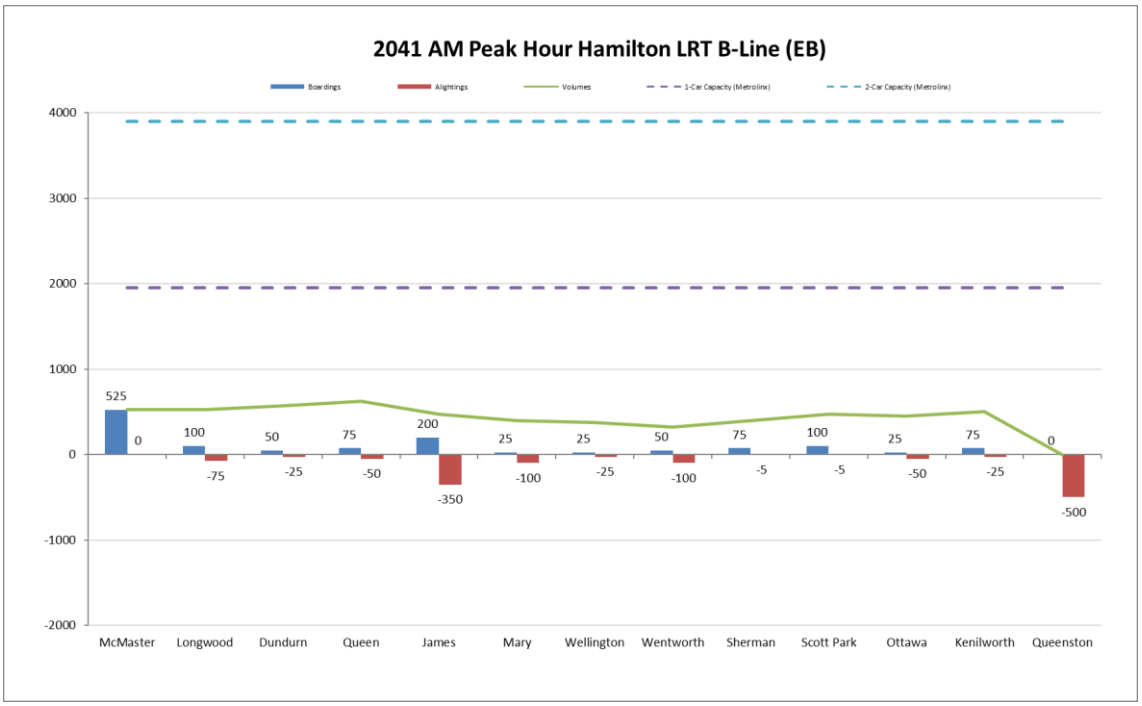


Figure 6.4: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



7 Sensitivity Test Results

7.1 For this project three sensitivity tests were run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied. The three sensitivity tests ran were:

- 2031 'With LRT' Scenario with LRT Boarding Penalty = 2.5 minutes
- 2031 'With LRT' Scenario with Buses Short-turned at James St
- Combination of both these sensitivities

LRT Sensitivity 1 – LRT Boarding Penalty = 2.5 minutes

7.2 This test involved altering the boarding penalty from a value of zero back to be consistent with the boarding penalty for the bus of 2.5 minutes.

Table 7.1: Summary of Results - LRT Sensitivity 1

	Before		After		Change	
	Peak Period Boardings	*Peak Hour Boardings*	*Peak Period Boardings*	*Peak Hour Boardings*	*Peak Hour Boardings*	*%*
B-Line EB	1,625	800	1,150	575	-225	-28%
B-Line WB	5,275	2,625	4,575	2,275	-350	-13%
Buses	26,950	13,475	27,325	13,650	+175	+1%
Total	**33,850**	**16,900**	**33,050**	**16,500**	**-400**	

LRT Sensitivity 2 – Buses Short-turned at James St

7.3 This test removed all buses from the James Street, instead stopping them at the point they intersect it.

Table 7.2: Summary of Results - LRT Sensitivity 2

	Before		After		Change	
	Peak Period Boardings	*Peak Hour Boardings*	*Peak Period Boardings*	*Peak Hour Boardings*	*Peak Hour Boardings*	*%*
B-Line EB	1,625	800	1,750	875	75	+9%
B-Line WB	5,275	2,625	5,475	2,750	125	+5%
Buses	26,950	13,475	25,550	12,775	-700	-5%
Total	**33,850**	**16,900**	**29,775**	**16,400**	**-500**	

LRT Sensitivity 3 – Sensitivity 1 and 2 Combined

7.4 This tests applies the changes from both of the sensitivity tests above in a single test.

Table 7.3: Summary of Results - LRT Sensitivity 3

	Before		After		Change	
	Peak Period Boardings	*Peak Hour Boardings*	*Peak Period Boardings*	*Peak Hour Boardings*	*Peak Hour Boardings*	*%*
B-Line EB	1,625	800	1,200	600	-200	-25%
B-Line WB	5,275	2,625	4,800	2,400	-225	-9%
Buses	26,950	13,475	26,000	13,000	-475	-4%
Total	**33,850**	**16,900**	**32,000**	**16,000**	**-900**	

8 Discussion of Results

Peak Hour Boardings - B-line

8.1 The table below shows that for the B-line, the central scenario sees 2031 AM peak hour boardings of 800 in the eastbound direction and 2,625 in the westbound direction. These numbers increase to over 900 and 3,700 respectively in 2041.

8.2 Peak direction peak load is what determines the vehicle and headway requirements. With a peak direction peak load of 1,500 in 2031 and 2,350 in 2041, that means that two-car Light Rail Vehicles (LRVs) are required to meet the forecast demand. This assumes a single car capacity of 130 and a headway of 6 minutes.

Table 8.1: Summary of Peak Hour LRT Demand

	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
Peak Hour Boardings						
B-line Eastbound			800	925	1,125	1,300
B-line Westbound			2,625	3,725	3,050	4,300
B-line Total			**3,425**	**4,650**	**4,175**	**5,600**
HSR	12,575	15,350	13,475	17,600	13,225	17,350
TOTAL	12,575	15,350	16,900	22,250	17,400	22,950
Peak Hour Peak Load						
B-line Eastbound			400	425	475	625
B-line Westbound			1,500	2,350	1,625	2,550

Peak Hour Boardings – derived by applying a factor of 0.5 to the AM peak period EMME outputs

8.3 The higher frequency LRT service scenario results in higher passenger numbers due to the added convenience of the higher frequency service. The benefits of this increased LRT service need to be balanced against the more frequent LRVs passing through intersections and the potential delays this may cause to local area traffic movements. Greater LRT priority and therefore greater journey time reliability may be provided with the slightly lower frequency service, which would also have lower impact on the operation of traffic in the wider area.

Annual Boardings

The table below sets out annual boardings for the LRT in 2031 and 2041 under the two frequency scenarios.

Table 8.2: Summary of Annual Boardings

Annual Boardings	HSR	2031 BAU	2041 BAU	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes
B-line Eastbound				2.94 M	3.30 M	4.04 M	4.73 M
B-line Westbound				9.52 M	13.50 M	11.07 M	15.57 M
HSR	32M	45.63M	55.8M	48.77M	63.69M	47.84M	62.76M
Total	**32M**	**45.63M**	**55.8M**	**61.2M**	**80.5M**	**62.06M**	**83.06M**

Mode Split

8.4 The mode split table below sets out the number of AM Peak hour linked trips rather than boardings. (a linked trip may have more than one boarding e.g. a bus trip that transfers to LRT). The table below sets out the mode shift following the introduction of the LRT. In 2031 the mode share for local transit increases by 0.42 percentage points in the central scenario, and by 0.46 percentage points in the high frequency scenario. This is a 10 percent increase in transit mode share. In 2041 the mode share for local transit increases by 0.67 percentage points in the central scenario, and by 0.71 percentage points in the high frequency scenario. This is a 14% increase in transit mode share. The mode share for GO Transit remains constant in the scenarios.

Table 8.3: Mode Split (Linked Trips)

	2031 B-line - 6 minutes	2041 B-line - 6 minutes	2031 B-line - 4 minutes	2041 B-line - 4 minutes	2031 BAU	2041 BAU
Number of Linked Trips						
Car	252,175	267,250	252,125	267,200	253,575	269,150
Hamilton Transit	12,600	15,950	12,700	16,075	11,475	14,000
GO Transit	4,325	4,375	4,325	4,375	4,350	4,375
Mode Split						
Car	93.71%	92.93%	93.67%	92.89%	94.13%	93.59%
Hamilton Transit	4.68%	5.55%	4.72%	5.59%	4.26%	4.88%
GO Transit	1.61%	1.52%	1.61%	1.52%	1.61%	1.53%

Sensitivity Testing

8.5 Three sensitivity tests were undertaken following discussion with Metrolinx. The three sensitivity tests were:

- 2031 'With LRT' Scenario with LRT Boarding Penalty = 2.5 minutes (previously 0)
- 2031 'With LRT' Scenario with Buses Short-turned at James St
- Combination of both these sensitivities

8.6 The results indicated that LRT ridership is sensitive to the value used for the boarding penalty. The results indicate a 30% reduction in the B-line eastbound ridership and a 13% reduction in the B-line westbound ridership when the LRT boarding penalty is set to be equal to the bus boarding penalty.

8.7 Originally the value had been reduced to represent the 'quality' of the stop and boarding experience, something which is common in the modelling of projects such as this. However, in the majority of projects and models, the bus boarding penalty would usually be higher, potentially in the region of 7 to 10 minutes. When the values are within this range it is easier to have a 2.5-minute differential between bus and LRT boarding penalties. It is considered reasonable to maintain the boarding penalty differential in this instance, now that an awareness has been established of the sensitivity of ridership to the value.

8.8 The sensitivity test to see the impact of short turning buses at James Street was to establish an upper bound of the potential ridership on the line as it is very unlikely that all buses could be completely removed from the corridor. The test indicated that even if buses are removed from the corridor this does not translate into a significant jump in ridership for the LRT.

8.9 This indicates that the ridership on the corridor is likely to be customers who already have passes where they do not have to pay for the journey, off-peak ridership and customers who take the LRT as it is arriving rather than customers that are captive to the route.

9 Final EA Model Run (2031 LRT)

Overview

9.1 Following the public consultation sessions undertaken in September 2016, there were a number of changes made to the design and alignment in response to comments that had been received. The key changes that impacted on the modelling included the addition of a stop at the Delta (Gage Park stop), increasing the number of lanes on the Main Street (West) portion of the alignment, and edits to the turning movements at James and King.

9.2 The design assumptions were sourced from the preliminary design plans and profile drawings HALRT-RD-NC001-NC062, prepared by AECOM.

9.3 The runtimes were revised for this final model run using the following:

Table 9.1: Revised runtimes and lengths for Final EA Run

Stop (From)	Stop (To)	Length	Run Time	Dwell
McMaster	Longwood	1.388	02:25	00:15
Longwood	Dundurn	1.214	01:47	00:20
Dundurn	Queen	0.895	01:34	00:20
Queen	James	0.844	02:02	00:20
James	Mary	0.317	01:21	00:15
Mary	Wellington	0.524	01:47	00:15
Wellington	Wentworth	0.842	01:54	00:15
Wentworth	Sherman	0.859	01:25	00:20
Sherman	Scott Park	0.536	01:04	00:15
Scott Park	Delta	0.778	01:29	00:15
Delta	Ottawa	0.533	00:55	00:15
Ottawa	Kenilworth	0.812	01:23	00:20
Kenilworth	Queenston	0.882	01:32	00:00
		Total	**24:03**	
		Previous	**23:49**	
		Difference	**00:14**	

9.4 The results from this phase of the work are presented as an additional final chapter appended to the main report and are summarized below.

9.5 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

9.6 The results are presented for the following scenarios:

- Central scenario – B-Line – 6 minute frequency
- High frequency scenario – B-Line – 4 minute frequency

9.7 For each scenario the following information is presented:

- AM peak hour B-line East and Westbound boardings, alightings and loadings
- AM peak hour bus route boardings by line (see appendix)
- Peak hour, daily and annual bus, LRT and total transit boardings (see appendix)

9.8 The capacity assumptions are derived using the Metrolinx standard capacity assumption of 130 persons per Light Rail Vehicle (LRV), which when multiplied by the headways of 6 and 4 minutes gives capacities of 1300 and 1950 persons per LRV/hour/train.

9.9 This approach is a conservative estimate of capacity used for planning purposes as most modern LRT systems would carry higher passenger volumes in peak hour conditions.

LRT Scenario 1 (B-line Headway = 6 minutes)

Table 9.2: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	825	1,675	10,100	3,030,000	3,350	100
B-line WB	2,650	5,300	32,000	9,588,000	13,325	375
Buses	13,400	26,875	162,700	48,616,000	58,275	2,725

Table 9.3: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	252,200	93.71%
Transit	12,600	4.68%
GO Transit	4,325	1.61%
Total	269,125	

Figure 9.1: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

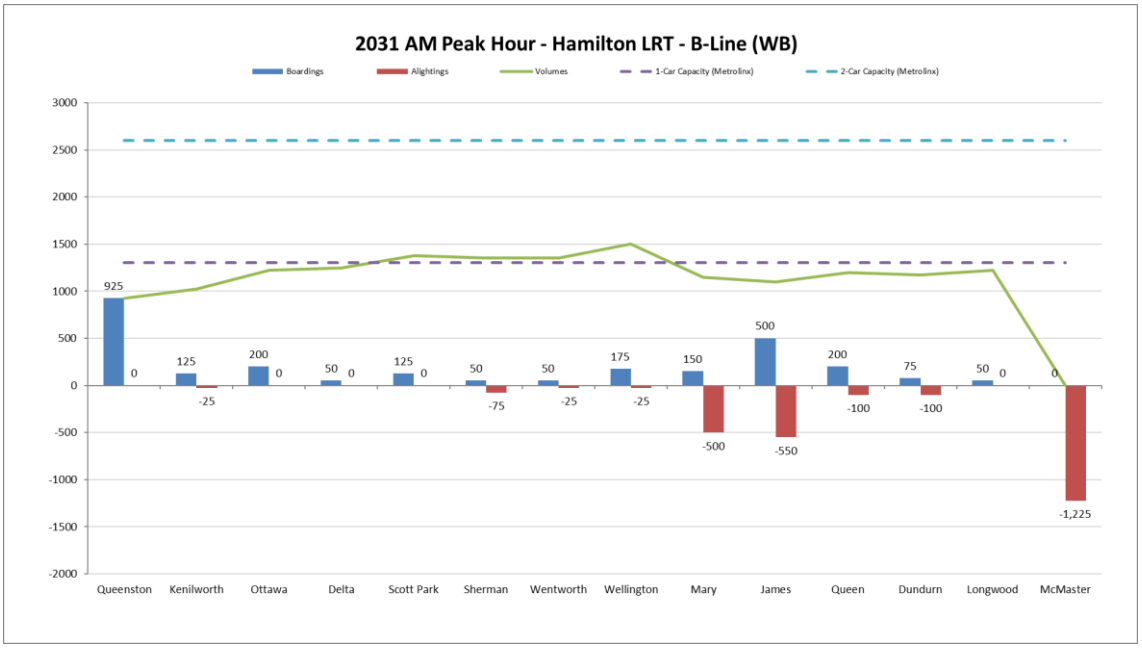
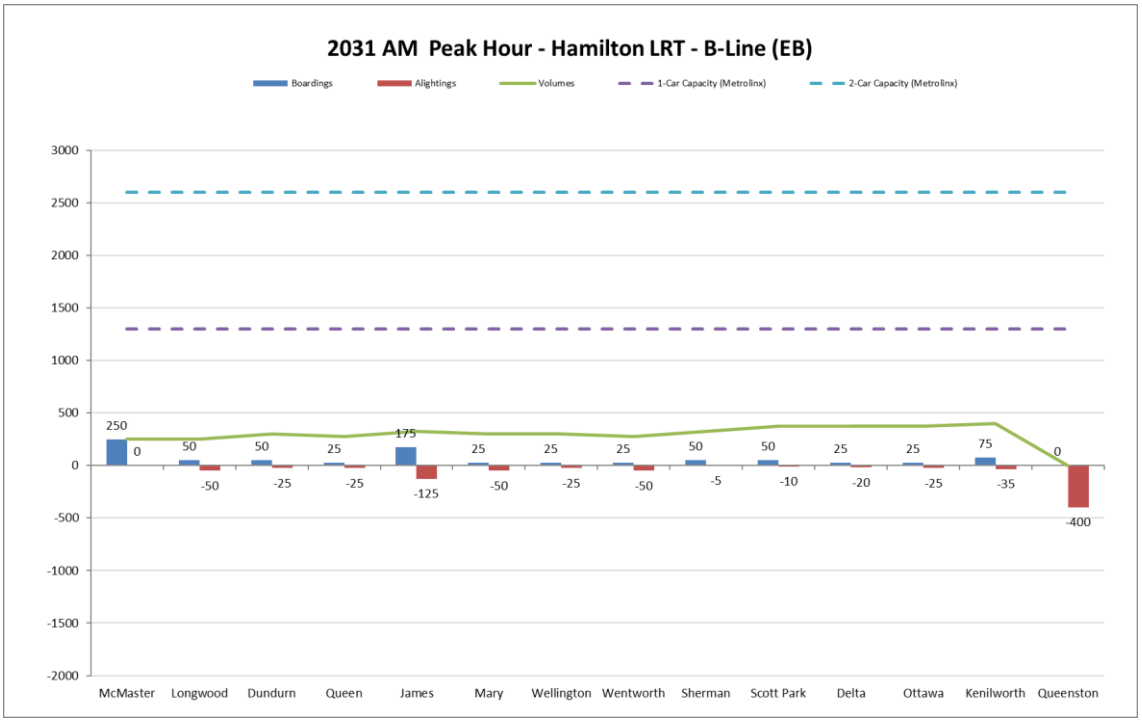


Figure 9.2: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



9.10 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton. The maximum loadings on the B-line are forecasted to be 1,500 Westbound and 400 Eastbound during the AM Peak Hour. Under these conditions, the B-line would be over the Metrolinx single LRV Planning Capacity.

9.11 The busiest LRT stops are the two termini of the B-line. Queenston stop is forecasted to have 925 boardings and 400 alightings during the AM Peak hour and McMaster has 1,225 alightings and 250 boardings during the AM Peak hour.

9.12

LRT Scenario 2 (B-line Headway = 4 minutes)

Table 9.4: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	1,125	2,250	13,600	4,070,000	4,075	125
B-line WB	3,050	6,125	36,900	11,080,000	14,725	425
Buses	13,175	26,400	159,700	47,756,000	56,950	2,625

Table 9.5: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	252,150	93.68%
Transit	12,675	4.71%
GO Transit	4,325	1.61%
Total	269,150	

Figure 9.3: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

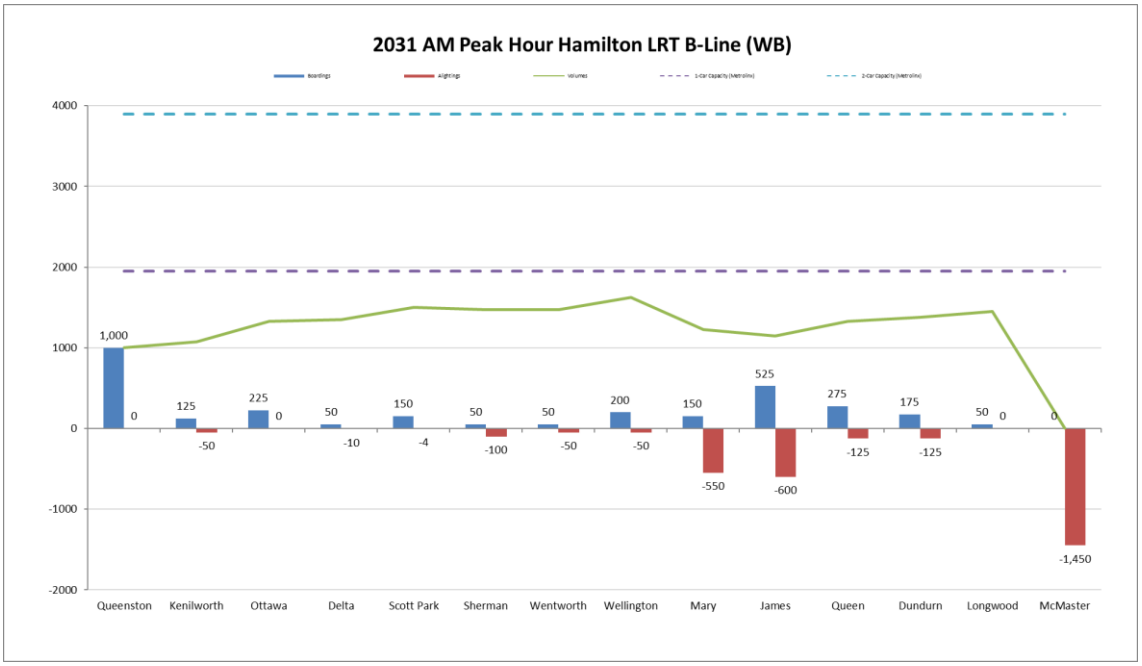
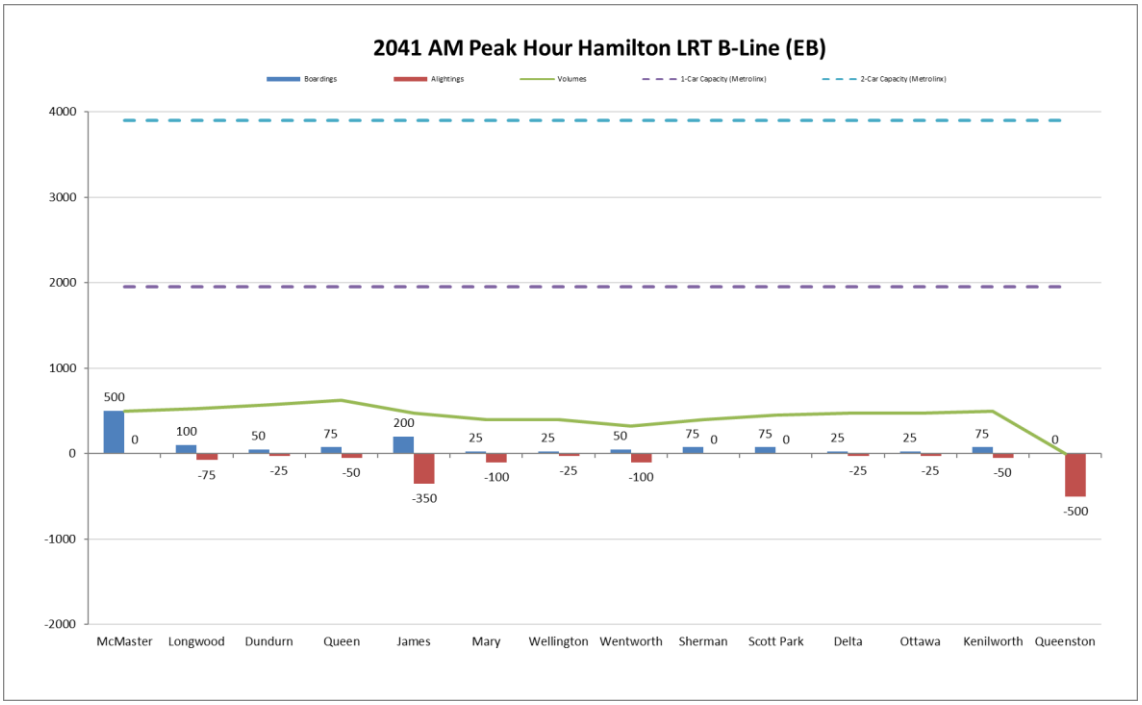


Figure 9.4: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



9.13 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton. The maximum loadings on the B-line are forecast to be 1,625 Westbound and 575 Eastbound during the AM Peak Hour.

9.14 The busiest LRT stops are the two termini of the B-line. The Queenston stop is forecasted to have 1,000 boardings and 500 alightings during the AM Peak hour and McMaster has 1,450 alightings and 500 boardings during the AM Peak hour.

10 Final EA Model Run (2041 LRT)

10.1 The EMME AM 3-hour peak period model has been run and the results extracted. The numbers below have had the peak period to peak hour factor of 0.5 applied.

10.2 The design assumptions were sourced from the preliminary design plans and profile drawings HALRT-RD-NC001-NC062, prepared by AECOM.

10.3 The runtimes were revised from this final model run using the following:

Table 10.1: Revised runtimes and lengths for Final EA Run

Stop (From)	Stop (To)	Length	Run Time	Dwell
McMaster	Longwood	1.388	02:25	00:15
Longwood	Dundurn	1.214	01:47	00:20
Dundurn	Queen	0.895	01:34	00:20
Queen	James	0.844	02:02	00:20
James	Mary	0.317	01:21	00:15
Mary	Wellington	0.524	01:47	00:15
Wellington	Wentworth	0.842	01:54	00:15
Wentworth	Sherman	0.859	01:25	00:20
Sherman	Scott Park	0.536	01:04	00:15
Scott Park	Delta	0.778	01:29	00:15
Delta	Ottawa	0.533	00:55	00:15
Ottawa	Kenilworth	0.812	01:23	00:20
Kenilworth	Queenston	0.882	01:32	00:00
		Total	**24:03**	
		Previous	**23:49**	
		Difference	**00:14**	

10.4 The results are presented for the following scenarios:

- Central scenario – B-Line – 6 minute frequency
- High frequency scenario – B-Line – 4 minute frequency

10.5 For each scenario the following information is presented:

- AM peak hour B-line East and Westbound boardings, alightings and loadings
- AM peak hour bus route boardings by line (see appendix)
- Peak hour, daily and annual bus, LRT and total transit boardings (see appendix)

10.6 In the graphs presented below, there are two indicative capacity lines shown. These represent the Metrolinx interpretation of the planning capacity of the proposed LRT vehicles which is equal to 130 passengers per vehicle.

LRT Scenario 1 (B-line Headway = 6 minutes)

Table 10.2: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	925	1,850	11,200	3,356,000	3,775	100
B-line WB	3,725	7,475	45,000	13,511,000	19,525	550
Buses	17,550	35,100	211,900	63,497,000	75,825	3,425

Table 10.3: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	267,300	92.94%
Transit	15,925	5.54%
GO Transit	4,375	1.52%
Total	287,600	

Figure 10.1: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

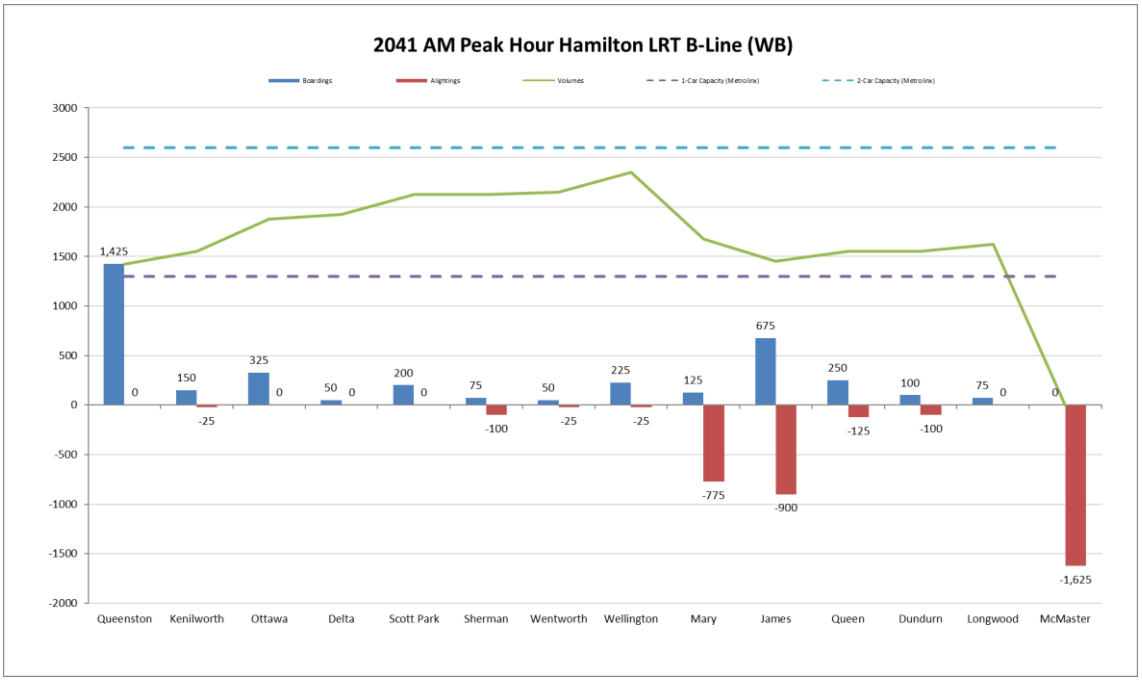
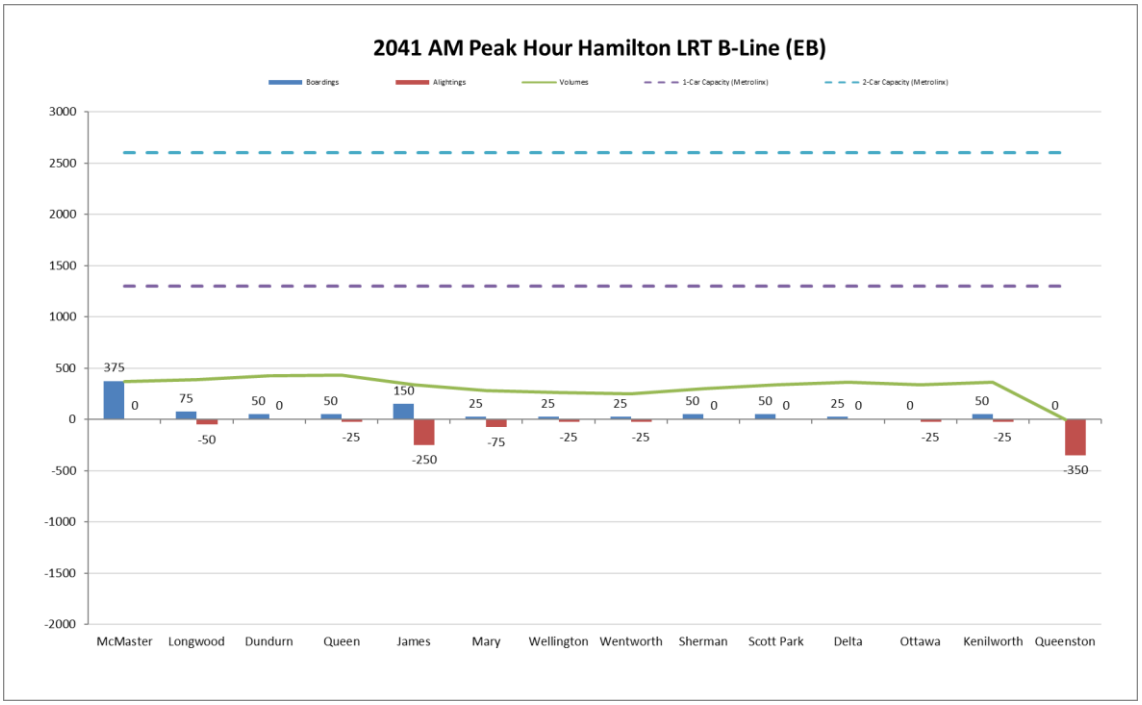


Figure 10.2: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



10.7 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton.

10.8 The maximum loadings on the B-line are forecasted to be 2,350 Westbound and 425 Eastbound during the AM Peak Hour. Under these conditions, the B-line will be well over the Metrolinx Planning Capacity for a single LRV.

10.9 The busiest LRT stops are the two termini of the B-line. Queenston stop has 1,425 boardings and 350 alightings during the AM Peak hour and McMaster has 1,625 alightings and 375 boardings during the AM Peak hour.

LRT Scenario 2 (B-line Headway = 4 minutes)

Table 10.4: Summary of Results

Line	Peak Hour Boardings	Peak Period Boardings	Daily Boardings	Annual Boardings	Pass. Km	Pass. Hrs
B-line EB	1,325	2,625	15,800	4,749,000	5,175	150
B-line WB	4,275	8,550	51,600	15,467,000	21,400	600
Buses	17,250	34,600	208,900	62,592,000	73,525	3,350

Table 10.5: Mode Split (AM Peak Hour)

Type	Linked Trips	Portion
Car	267,225	92.89%
Transit	16,050	5.58%
GO Transit	4,400	1.53%
Total	287,675	

Figure 10.3: AM Peak Hour B-line, Westbound Boardings, Alightings and Loadings

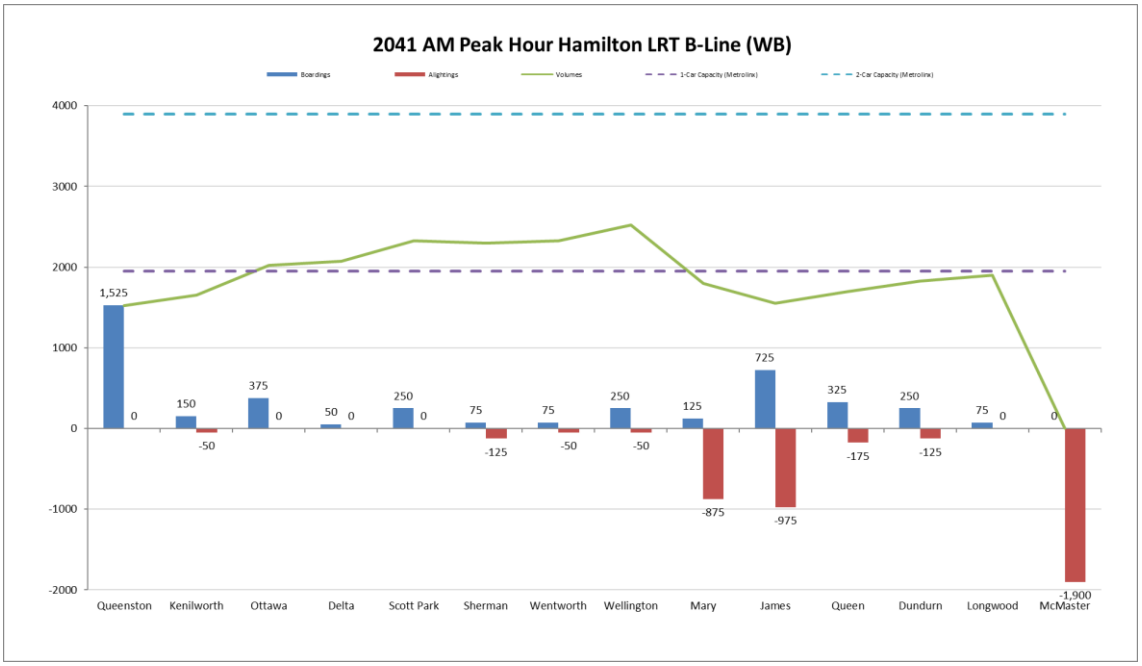
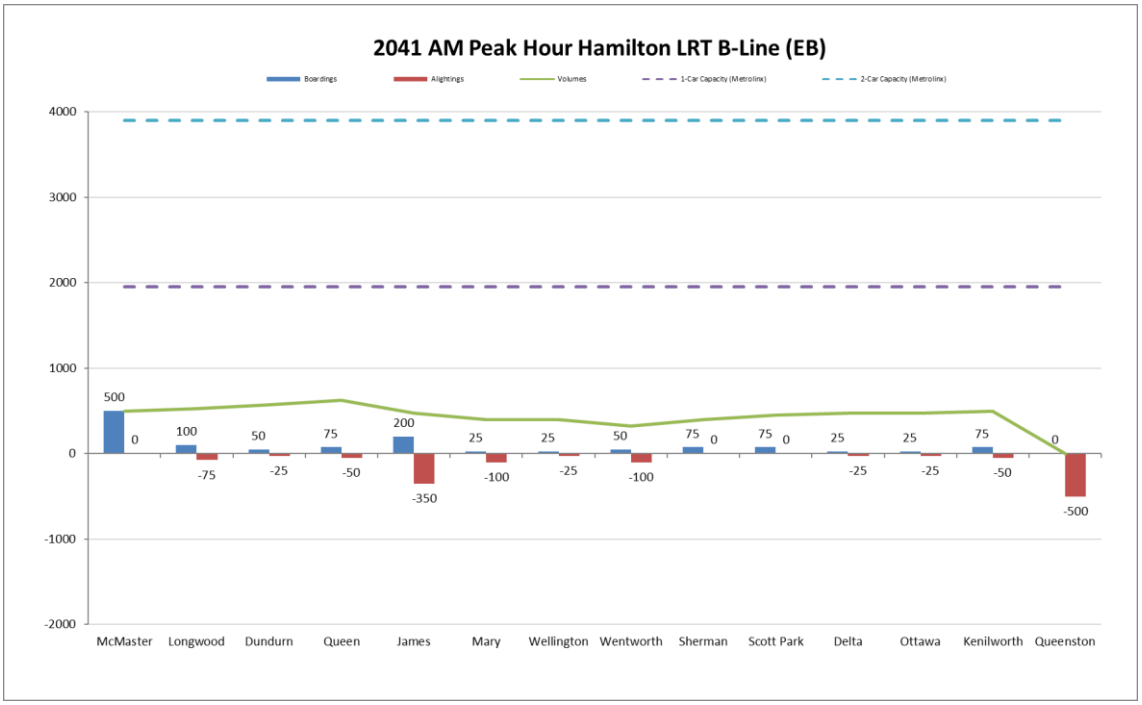


Figure 10.4: AM Peak Hour B-line, Eastbound Boardings, Alightings and Loadings



10.10 The modelled results indicate that the maximum load during the AM Peak Hour will occur on the B-line, in the Westbound direction, between Wellington and Mary stops in downtown Hamilton. The maximum loadings on the B-line are forecast to be 2,525 Westbound and 625 Eastbound during the AM Peak Hour.

10.11 The busiest LRT stops are the two termini of the B-line. The Queenston stop is forecasted to have 1,525 boardings and 500 alightings during the AM Peak hour and McMaster has 1,900 alightings and 500 boardings during the AM Peak hour.

B Appendix A - Transit Demand Tables

2031 'With LRT'

2031 Scenario 1: B-line = 6 minutes

Table B.1: AM Peak Hour Bus Route Results by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	67	525	1,250	75
WW002	5.4	80	1,100	3,800	200
WW003	15	60	50	100	0
WW004	13.3	103	400	1,700	75
WW005	16.2	152	700	2,925	175
WW005A	16.2	157	600	1,975	125
WW005E	16.2	155	650	2,425	150
WW006	20	43	75	150	0
WW011	17.8	115	625	3,725	150
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	20	53	125	550	25
WW017	20	23	50	100	0
WW018	15	60	0	25	0
WW019	20	18	25	75	0
WW020	9	51	675	4,125	125
WW021	10.9	81	350	1,800	100
WW022	10.9	83	375	1,450	75
WW023	9.3	62	525	2,800	125
WW024	9.3	61	550	2,550	125
WW025	10	38	150	400	25
WW026	10	61	450	1,600	75
WW027	10.5	62	425	2,150	100
WW030	9.2	122	1,050	3,700	200
WW033	10.7	86	175	700	50
WW034	24	76	150	700	25
WW034A	24	58	150	900	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	425	1,550	75

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW041A	22.2	96	250	825	50
WW043	20	92	350	2,325	100
WW044	18	105	900	6,175	175
WW045	29	35	50	100	0
WW051	7.5	21	275	500	25
WW052	30	27	25	75	0
WW053	30	33	50	150	0
WW055	17.2	53	375	1,975	100
WW055A	17.2	60	375	1,575	75
WW058	20	47	225	750	50

Table B.2: Peak hour, Daily and Annual Bus, LRT and Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	825	1,675	10,100	3,030,000
L-1WB	2,650	5,300	32,000	9,588,000
WW001	500	975	5,900	1,764,000
WW002	1,100	2,200	13,300	3,980,000
WW003	50	75	500	136,000
WW004	400	775	4,700	1,402,000
WW005	675	1,375	8,300	2,487,000
WW005A	575	1,175	7,100	2,126,000
WW005E	625	1,250	7,500	2,261,000
WW006	75	125	800	226,000
WW011	625	1,250	7,500	2,261,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	125	250	1,500	452,000
WW017	50	75	500	136,000
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	675	1,350	8,100	2,442,000
WW021	350	700	4,200	1,266,000
WW022	375	775	4,700	1,402,000
WW023	525	1,075	6,500	1,945,000
WW024	550	1,100	6,600	1,990,000
WW025	150	300	1,800	543,000
WW026	450	925	5,600	1,673,000
WW027	425	825	5,000	1,492,000
WW030	1,050	2,125	12,800	3,844,000
WW033	175	375	2,300	678,000
WW034	150	275	1,700	497,000
WW034A	150	325	2,000	588,000

WW035	100	225	1,400	407,000
WW035A	125	250	1,500	452,000
WW041	425	825	5,000	1,492,000
WW041A	250	525	3,200	950,000
WW043	350	725	4,400	1,312,000
WW044	900	1,825	11,000	3,301,000
WW045	50	75	500	136,000
WW051	275	525	3,200	950,000
WW052	25	50	300	90,000
WW053	50	100	600	181,000
WW055	375	750	4,500	1,357,000
WW055A	375	725	4,400	1,312,000
WW058	225	450	2,700	814,000

2031 Scenario 2: B-line = 4 minutes

Table B.3: AM Peak Hour Bus Route Results by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	67	425	875	50
WW002	5.4	80	1,025	3,450	175
WW003	15	60	25	25	0
WW004	13.3	103	375	1,650	75
WW005	16.2	152	625	2,400	150
WW005A	16.2	157	550	1,800	100
WW005E	16.2	155	575	2,150	125
WW006	20	43	75	150	0
WW011	17.8	115	650	3,800	150
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	20	53	150	650	25
WW017	20	23	50	100	0
WW018	15	60	0	25	0
WW019	20	18	25	75	0
WW020	9	51	675	4,100	125
WW021	10.9	81	350	1,750	100
WW022	10.9	83	400	1,475	75
WW023	9.3	62	525	2,800	125
WW024	9.3	61	550	2,575	125
WW025	10	38	150	400	25
WW026	10	61	450	1,600	75
WW027	10.5	62	425	2,150	100
WW030	9.2	122	1,075	3,700	200
WW033	10.7	86	175	725	50
WW034	24	76	125	700	25
WW034A	24	58	150	900	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW041	22.2	134	425	1,575	75
WW041A	22.2	96	250	825	50
WW043	20	92	350	2,325	100
WW044	18	105	900	6,025	175
WW045	29	35	50	125	0
WW051	7.5	21	275	550	25
WW052	30	27	25	75	0
WW053	30	33	50	150	0
WW055	17.2	53	400	2,075	100
WW055A	17.2	60	400	1,675	100
WW058	20	47	250	850	50

Table B.4: Peak hour, Daily and Annual Bus, LRT and Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	1,120	2,250	13,600	4,070,000
L-1WB	3,060	6,125	36,900	11,080,000
WW001	400	800	4,800	1,447,000
WW002	1,025	2,050	12,400	3,708,000
WW003	25	50	300	90,000
WW004	375	750	4,500	1,357,000
WW005	625	1,225	7,400	2,216,000
WW005A	525	1,075	6,500	1,945,000
WW005E	575	1,150	6,900	2,080,000
WW006	75	150	900	271,000
WW011	650	1,300	7,800	2,352,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	150	275	1,700	497,000
WW017	50	75	500	136,000
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	675	1,350	8,100	2,442,000
WW021	350	700	4,200	1,266,000
WW022	400	775	4,700	1,402,000
WW023	525	1,075	6,500	1,945,000
WW024	550	1,100	6,600	1,990,000
WW025	150	300	1,800	543,000
WW026	450	925	5,600	1,673,000
WW027	425	825	5,000	1,492,000
WW030	1,075	2,150	13,000	3,889,000
WW033	175	375	2,300	678,000
WW034	125	275	1,700	497,000
WW034A	150	300	1,800	543,000
WW035	100	225	1,400	407,000
WW035A	125	250	1,500	452,000

Line	Peak Hour	Peak Period	Daily	Annual
WW041	425	850	5,100	1,538,000
WW041A	250	525	3,200	950,000
WW043	350	725	4,400	1,312,000
WW044	900	1,800	10,900	3,256,000
WW045	50	75	500	136,000
WW051	275	550	3,300	995,000
WW052	25	50	300	90,000
WW053	50	100	600	181,000
WW055	400	775	4,700	1,402,000
WW055A	400	775	4,700	1,402,000
WW058	250	500	3,000	905,000

2041 'With LRT'

2041 Scenario 1: B-line = 6 minutes

Table B.5: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8	67	575	1,375	75
WW002	4.9	80	1,375	4,500	250
WW003	12.5	60	50	100	0
WW004	12	103	475	1,850	100
WW005	13.5	152	850	3,625	200
WW005A	13.5	157	775	2,625	150
WW005E	13.5	155	875	3,650	200
WW006	15	43	125	325	25
WW011	16	115	750	4,125	175
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	12	53	300	1,150	50
WW017	15	23	25	100	0
WW018	10	60	0	25	0
WW019	20	18	25	75	0
WW020	8.2	51	1,075	6,800	200
WW021	9.2	81	275	1,325	75
WW022	8.6	83	700	3,750	175
WW023	7.6	62	575	2,350	100
WW024	7.8	61	650	3,150	150
WW025	7.5	38	225	575	25
WW026	8.3	61	575	1,875	75
WW027	8.7	62	575	2,875	150
WW030	7.9	122	1,175	4,075	200
WW033	9.6	86	200	725	50
WW034	18	76	225	1,075	50
WW034A	18	58	200	950	50
WW035	16.8	94	150	375	25

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW035A	16.8	91	200	525	25
WW041	19.2	134	450	1,700	75
WW041A	19.2	96	275	850	50
WW043	13.3	92	575	3,300	125
WW044	12.9	105	1,500	9,300	275
WW045	24.2	35	50	100	0
WW051	4.3	21	425	825	25
WW052	15	27	50	125	0
WW053	15	33	75	225	0
WW055	15	53	450	2,575	125
WW055A	15	60	425	1,850	100
WW058	13.3	47	350	1,125	50

Table B.6: Peak hour, Daily and Annual Bus, LRT and Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	925	1,855	11,200	3,356,000
L-1WB	3,725	7,469	45,000	13,511,000
WW001	550	1,075	6,500	1,945,000
WW002	1,375	2,750	16,600	4,975,000
WW003	50	100	600	181,000
WW004	475	950	5,700	1,719,000
WW005	850	1,700	10,300	3,075,000
WW005A	775	1,525	9,200	2,759,000
WW005E	850	1,725	10,400	3,121,000
WW006	125	275	1,700	497,000
WW011	725	1,425	8,600	2,578,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	300	600	3,600	1,085,000
WW017	25	50	300	90,000
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	1,075	2,125	12,800	3,844,000
WW021	275	575	3,500	1,040,000
WW022	675	1,375	8,300	2,487,000
WW023	575	1,175	7,100	2,126,000
WW024	650	1,300	7,800	2,352,000
WW025	225	450	2,700	814,000
WW026	575	1,125	6,800	2,035,000
WW027	575	1,175	7,100	2,126,000
WW030	1,175	2,350	14,200	4,251,000
WW033	200	400	2,400	724,000
WW034	225	450	2,700	814,000
WW034A	200	400	2,400	724,000

Line	Peak Hour	Peak Period	Daily	Annual
WW035	150	325	2,000	588,000
WW035A	200	400	2,400	724,000
WW041	450	900	5,400	1,628,000
WW041A	275	550	3,300	995,000
WW043	575	1,125	6,800	2,035,000
WW044	1,500	2,975	17,900	5,382,000
WW045	50	75	500	136,000
WW051	425	850	5,100	1,538,000
WW052	50	100	600	181,000
WW053	75	150	900	271,000
WW055	450	900	5,400	1,628,000
WW055A	425	825	5,000	1,492,000
WW058	350	700	4,200	1,266,000

2041 Scenario 2: B-line = 4 minute

Table B.7: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8	67	550	1,175	75
WW002	4.9	80	1,250	3,800	200
WW003	12.5	60	25	50	0
WW004	12	103	475	1,875	100
WW005	13.5	152	750	2,875	175
WW005A	13.5	157	700	2,300	125
WW005E	13.5	155	775	2,950	175
WW006	15	43	150	325	25
WW011	16	115	775	4,200	175
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	12	53	300	1,125	50
WW017	15	23	25	100	0
WW018	10	60	0	25	0
WW019	20	18	25	25	0
WW020	8.2	51	1,075	6,775	200
WW021	9.2	81	275	1,325	75
WW022	8.6	83	700	3,775	175
WW023	7.6	62	575	2,350	125
WW024	7.8	61	650	3,150	150
WW025	7.5	38	225	600	25
WW026	8.3	61	575	1,900	75
WW027	8.7	62	575	2,875	150
WW030	7.9	122	1,200	4,075	200
WW033	9.6	86	200	725	50
WW034	18	76	225	1,075	50
WW034A	18	58	200	950	50
WW035	16.8	94	150	375	25

WW035A	16.8	91	200	525	25
WW041	19.2	134	450	1,650	75
WW041A	19.2	96	275	850	50
WW043	13.3	92	550	3,275	125
WW044	12.9	105	1,500	9,200	275
WW045	24.2	35	50	100	0
WW051	4.3	21	425	825	25
WW052	15	27	50	125	0
WW053	15	33	75	225	0
WW055	15	53	500	2,725	125
WW055A	15	60	450	1,950	100
WW058	13.3	47	400	1,225	75

Table B.8: Peak hour, Daily and Annual Bus, LRT and Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	1,325	2,625	15,800	4,749,000
L-1WB	4,275	8,550	51,600	15,467,000
WW001	500	1,000	6,000	1,809,000
WW002	1,275	2,525	15,200	4,568,000
WW003	25	50	300	90,000
WW004	475	975	5,900	1,764,000
WW005	750	1,475	8,900	2,668,000
WW005A	675	1,375	8,300	2,487,000
WW005E	750	1,525	9,200	2,759,000
WW006	150	300	1,800	543,000
WW011	775	1,550	9,300	2,804,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	300	575	3,500	1,040,000
WW017	25	50	300	90,000
WW018	0	25	200	45,000
WW019	25	50	300	90,000
WW020	1,050	2,125	12,800	3,844,000
WW021	275	575	3,500	1,040,000
WW022	675	1,375	8,300	2,487,000
WW023	575	1,175	7,100	2,126,000
WW024	650	1,300	7,800	2,352,000
WW025	225	475	2,900	859,000
WW026	575	1,125	6,800	2,035,000
WW027	575	1,175	7,100	2,126,000
WW030	1,175	2,375	14,300	4,296,000
WW033	200	400	2,400	724,000
WW034	225	425	2,600	769,000
WW034A	200	400	2,400	724,000

WW035	150	325	2,000	588,000
WW035A	200	400	2,400	724,000
WW041	450	900	5,400	1,628,000
WW041A	275	525	3,200	950,000
WW043	575	1,125	6,800	2,035,000
WW044	1,500	3,000	18,100	5,427,000
WW045	50	100	600	181,000
WW051	425	850	5,100	1,538,000
WW052	50	100	600	181,000
WW053	75	175	1,100	317,000
WW055	500	975	5,900	1,764,000
WW055A	450	900	5,400	1,628,000
WW058	400	775	4,700	1,402,000

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Table B.9: Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	30	163	1,175	6,175	350
WW001A	30	207	1,225	6,300	275
WW002	10	75	1,150	5,050	75
WW003	20	57	250	1,350	125
WW004	15	122	475	2,550	25
WW0055	30	35	125	525	250
WW005C	15	45	1,100	5,000	0
WW006	20	41	50	175	0
WW007	20	24	50	150	0
WW008	20	20	25	75	125
WW010	20	99	400	2,025	0
WW011	30	74	100	300	175
WW011A	10	46	825	4,725	0
WW012	30	21	25	25	25
WW016	30	46	125	600	0
WW018	15	60	0	50	75
WW020	20	66	350	2,350	75
WW021	15	65	325	1,625	175
WW022	12	55	775	4,250	50
WW023	15	55	200	1,075	150
WW024	15	56	500	3,075	25
WW025	15	31	150	475	50
WW026	15	56	300	1,250	125
WW027	12	52	600	3,000	50
WW033	15	61	200	1,025	75
WW034	30	51	225	1,375	50
WW034A	30	52	175	1,050	50

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW035	30	54	200	975	25
WW035A	30	54	125	550	75
WW041	30	110	325	1,825	125
WW043	20	96	475	3,325	125
WW044	20	168	525	2,675	0
WW052A	30	27	0	0	0
WW058	30	26	25	75	0

Table B.10: Peak hour, Daily and Annual Bus Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
WW001	1,175	2,325	14,000	4,206,000
WW001A	1,225	2,450	14,800	4,432,000
WW002	1,150	2,325	14,000	4,206,000
WW003	250	500	3,000	905,000
WW004	475	950	5,700	1,719,000
WW0055	125	250	1,500	452,000
WW005C	1,100	2,175	13,100	3,935,000
WW006	50	125	800	226,000
WW007	50	100	600	181,000
WW008	25	50	300	90,000
WW010	400	825	5,000	1,492,000
WW011	100	200	1,200	362,000
WW011A	825	1,650	9,900	2,985,000
WW012	25	25	200	45,000
WW016	125	250	1,500	452,000
WW018	0	25	200	45,000
WW020	350	700	4,200	1,266,000
WW021	325	650	3,900	1,176,000
WW022	775	1,550	9,300	2,804,000
WW023	200	400	2,400	724,000
WW024	500	975	5,900	1,764,000
WW025	150	300	1,800	543,000
WW026	300	625	3,800	1,131,000
WW027	600	1,225	7,400	2,216,000
WW033	200	400	2,400	724,000
WW034	225	450	2,700	814,000
WW034A	175	350	2,100	633,000
WW035	200	375	2,300	678,000
WW035A	125	275	1,700	497,000
WW041	325	675	4,100	1,221,000
WW043	475	950	5,700	1,719,000
WW044	525	1,050	6,300	1,899,000
WW052A	0	0	0	0
WW058	25	50	300	90,000

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Table B.11: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	30	163	1,525	8,425	475
WW001A	30	207	1,550	8,100	450
WW002	10	75	1,375	5,950	300
WW003	20	57	325	1,975	125
WW004	15	122	525	3,175	150
WW0055	30	35	150	575	25
WW005C	15	45	1,425	6,850	325
WW006	20	41	75	225	0
WW007	20	24	75	250	25
WW008	20	20	50	100	0
WW010	20	114	400	2,125	125
WW011	30	74	125	425	25
WW011A	10	46	875	4,950	200
WW012	30	21	25	25	0
WW016	30	46	150	775	25
WW018	15	60	25	50	0
WW020	20	66	425	2,975	100
WW021	15	65	275	975	50
WW022	12	55	950	5,300	200
WW023	15	55	225	1,325	50
WW024	15	56	625	4,200	200
WW025	15	31	175	575	25
WW026	15	56	350	1,525	75
WW027	12	52	850	4,725	200
WW033	15	61	225	1,125	50
WW034	30	51	275	1,800	75
WW034A	30	52	225	1,350	75
WW035	30	54	225	1,250	50
WW035A	30	54	150	625	25
WW041	30	110	375	2,000	100
WW043	20	96	525	3,700	125
WW044	20	168	775	3,925	200
WW052A	30	27	0	25	0
WW058	30	26	25	75	0

Table B.12: Peak hour, Daily and Annual Bus Total Transit

Line	Peak Hour	Peak Period	Daily	Annual
WW001	1,525	3,025	18,200	5,472,000
WW001A	1,550	3,125	18,800	5,653,000
WW002	1,375	2,775	16,700	5,020,000
WW003	325	675	4,100	1,221,000
WW004	525	1,075	6,500	1,945,000
WW0055	150	300	1,800	543,000
WW005C	1,425	2,875	17,300	5,201,000
WW006	75	150	900	271,000
WW007	75	175	1,100	317,000
WW008	50	100	600	181,000
WW010	400	800	4,800	1,447,000
WW011	125	250	1,500	452,000
WW011A	875	1,750	10,600	3,166,000
WW012	25	25	200	45,000
WW016	150	325	2,000	588,000
WW018	25	25	200	45,000
WW020	425	875	5,300	1,583,000
WW021	275	525	3,200	950,000
WW022	950	1,875	11,300	3,392,000
WW023	225	475	2,900	859,000
WW024	625	1,225	7,400	2,216,000
WW025	175	325	2,000	588,000
WW026	350	725	4,400	1,312,000
WW027	850	1,725	10,400	3,121,000
WW033	225	450	2,700	814,000
WW034	275	550	3,300	995,000
WW034A	225	450	2,700	814,000
WW035	225	475	2,900	859,000
WW035A	150	325	2,000	588,000
WW041	375	775	4,700	1,402,000
WW043	525	1,050	6,300	1,899,000
WW044	775	1,525	9,200	2,759,000
WW052A	0	0	0	0
WW058	25	50	300	90,000

Sensitivity Tests

Test 1: LRT Boarding Penalty = 2.5 minutes

Table B.13: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	67	525	1450	75
WW002	5.4	80	1150	4075	225
WW003	15	60	50	100	0
WW004	13.3	103	375	1700	75
WW005	16.2	152	800	3575	200
WW005A	16.2	157	650	2325	125
WW005E	16.2	155	700	3050	175
WW006	20	43	75	150	0
WW011	17.8	115	600	3650	150
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	5	0
WW015	20	17	10	25	0
WW016	20	53	125	550	25
WW017	20	23	50	100	5
WW018	15	60	5	25	0
WW019	20	18	25	75	5
WW020	9	51	675	4125	125
WW021	10.9	81	350	1775	100
WW022	10.9	83	400	1475	75
WW023	9.3	62	525	2800	125
WW024	9.3	61	550	2550	125
WW025	10	38	150	400	25
WW026	10	61	475	1600	75
WW027	10.5	62	425	2150	100
WW030	9.2	122	1050	3750	200
WW033	10.7	86	175	700	50
WW034	24	76	150	700	25
WW034A	24	58	150	900	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	425	1600	75
WW041A	22.2	96	250	850	50
WW043	20	92	375	2400	100
WW044	18	105	925	6425	200
WW045	29	35	50	100	5
WW051	7.5	21	250	500	25
WW052	30	27	25	50	5
WW053	30	33	50	125	5
WW055	17.2	53	325	1825	75
WW055A	17.2	60	325	1450	75
WW058	20	47	200	700	25

Test 2: Buses Short-turned at James St

Table B.14: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	65	525	1,250	75
WW002	5.4	69	675	1,950	100
WW002A	5.4	4	5	0	0
WW003	15	53	25	25	0
WW004	13.3	88	250	925	50
WW005	16.2	152	700	2,900	175
WW005A	16.2	157	600	1,975	100
WW005E	16.2	155	650	2,425	150
WW006	20	42	75	150	0
WW011	17.8	115	650	3,850	150
WW012	20	20	50	100	5
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	25	50	5
WW016	20	53	125	575	25
WW017	20	23	50	125	5
WW018	15	60	5	25	0
WW019	20	18	50	100	5
WW020	9	51	650	3,950	125
WW021	10.9	81	350	1,750	100
WW022	10.9	83	375	1,400	75
WW023	9.3	62	525	2,700	125
WW024	9.3	61	525	2,500	125
WW025	10	38	150	375	25
WW026	10	61	450	1,575	75
WW027	10.5	62	400	2,125	100
WW030	9.2	122	1,125	3,925	200
WW033	10.7	86	175	700	50
WW034	24	76	150	700	25
WW034A	24	58	150	900	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	475	1,825	75
WW041A	22.2	96	250	825	50
WW043	20	92	350	2,275	75
WW044	18	105	900	6,150	175
WW045	29	35	50	100	5
WW051	7.5	21	275	500	25
WW052	30	27	25	75	5
WW053	30	33	50	150	5
WW055	17.2	53	400	2,000	100
WW055A	17.2	60	375	1,625	75
WW058	20	47	250	775	50

Test 3: Combination of Sensitivity 1 and 2

Table B.15: AM Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	65	575	1,600	100
WW002	5.4	69	775	2,325	125
WW002A	5.4	4	0	0	0
WW003	15	53	25	25	0
WW004	13.3	88	250	975	50
WW005	16.2	152	775	3,525	200
WW005A	16.2	157	625	2,300	125
WW005E	16.2	155	700	2,975	175
WW006	20	42	75	150	0
WW011	17.8	115	625	3,725	150
WW012	20	20	50	75	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	25	50	0
WW016	20	53	125	575	25
WW017	20	23	50	100	0
WW018	15	60	0	25	0
WW019	20	18	50	125	0
WW020	9	51	650	3,950	125
WW021	10.9	81	350	1,725	100
WW022	10.9	83	375	1,425	75
WW023	9.3	62	525	2,675	125
WW024	9.3	61	525	2,500	125
WW025	10	38	150	375	25
WW026	10	61	450	1,550	75
WW027	10.5	62	400	2,125	100
WW030	9.2	122	1,100	3,925	200
WW033	10.7	86	175	675	50
WW034	24	76	150	700	25
WW034A	24	58	150	875	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	450	1,875	75
WW041A	22.2	96	275	850	50
WW043	20	92	375	2,375	100
WW044	18	105	925	6,400	200
WW045	29	35	50	100	0
WW051	7.5	21	250	500	25
WW052	30	27	25	50	0
WW053	30	33	50	125	0
WW055	17.2	53	350	1,850	100
WW055A	17.2	60	350	1,475	75
WW058	20	47	225	725	25

C Appendix B – Transit Demand Table (Final EA Model Run)

2031 'With LRT'

2031 Scenario 1: B-line = 6 minutes

Table C.1: Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	67	500	1,175	75
WW002	5.4	80	1,100	3,775	200
WW003	15	60	50	100	0
WW004	13.3	103	400	1,700	75
WW005	16.2	152	675	2,900	175
WW005A	16.2	157	575	1,950	100
WW005E	16.2	155	625	2,400	150
WW006	20	43	75	150	0
WW011	17.8	115	625	3,725	150
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	20	53	125	575	25
WW017	20	23	50	100	0
WW018	15	60	0	25	0
WW019	20	18	25	75	0
WW020	9	51	675	4,100	125
WW021	10.9	81	350	1,800	100
WW022	10.9	83	375	1,450	75
WW023	9.3	62	525	2,800	125
WW024	9.3	61	550	2,550	125
WW025	10	38	150	400	25
WW026	10	61	450	1,600	75
WW027	10.5	62	425	2,150	100
WW030	9.2	122	1,050	3,700	200
WW033	10.7	86	175	700	50
WW034	24	76	150	700	25
WW034A	24	58	150	900	50

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	425	1,550	75
WW041A	22.2	96	250	825	50
WW043	20	92	350	2,325	100
WW044	18	105	900	6,200	175
WW045	29	35	50	100	0
WW051	7.5	21	275	500	25
WW052	30	27	25	75	0
WW053	30	33	50	150	0
WW055	17.2	53	375	1,975	100
WW055A	17.2	60	375	1,575	75
WW058	20	47	225	750	50

Table C.2: Peak hour, Daily and Annual Bus Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	825	1,675	10,100	3,030,000
L-1WB	2,650	5,300	32,000	9,588,000
WW001	500	975	5,900	1,764,000
WW002	1,100	2,200	13,300	3,980,000
WW003	50	75	500	136,000
WW004	400	775	4,700	1,402,000
WW005	675	1,375	8,300	2,487,000
WW005A	575	1,175	7,100	2,126,000
WW005E	625	1,250	7,500	2,261,000
WW006	75	125	800	226,000
WW011	625	1,250	7,500	2,261,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	125	250	1,500	452,000
WW017	50	75	500	136,000
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	675	1,350	8,100	2,442,000
WW021	350	700	4,200	1,266,000
WW022	375	775	4,700	1,402,000
WW023	525	1,075	6,500	1,945,000
WW024	550	1,100	6,600	1,990,000

Line	Peak Hour	Peak Period	Daily	Annual
WW025	150	300	1,800	543,000
WW026	450	925	5,600	1,673,000
WW027	425	825	5,000	1,492,000
WW030	1,050	2,125	12,800	3,844,000
WW033	175	375	2,300	678,000
WW034	150	275	1,700	497,000
WW034A	150	325	2,000	588,000
WW035	100	225	1,400	407,000
WW035A	125	250	1,500	452,000
WW041	425	825	5,000	1,492,000
WW041A	250	525	3,200	950,000
WW043	350	725	4,400	1,312,000
WW044	900	1,825	11,000	3,301,000
WW045	50	75	500	136,000
WW051	275	525	3,200	950,000
WW052	25	50	300	90,000
WW053	50	100	600	181,000
WW055	375	750	4,500	1,357,000
WW055A	375	725	4,400	1,312,000
WW058	225	450	2,700	814,000

2031 Scenario 2: B-line = 4 minutes

Table C.3: Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8.9	67	400	850	50
WW002	5.4	80	1,025	3,450	175
WW003	15	60	25	25	0
WW004	13.3	103	375	1,650	75
WW005	16.2	152	625	2,400	125
WW005A	16.2	157	525	1,775	100
WW005E	16.2	155	575	2,125	125
WW006	20	43	75	150	0
WW011	17.8	115	650	3,825	150
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	20	53	150	650	25
WW017	20	23	50	100	0
WW018	15	60	0	25	0

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW019	20	18	25	75	0
WW020	9	51	675	4,100	125
WW021	10.9	81	350	1,750	100
WW022	10.9	83	400	1,475	75
WW023	9.3	62	525	2,800	125
WW024	9.3	61	550	2,575	125
WW025	10	38	150	400	25
WW026	10	61	450	1,600	75
WW027	10.5	62	425	2,150	100
WW030	9.2	122	1,075	3,700	200
WW033	10.7	86	175	725	50
WW034	24	76	125	700	25
WW034A	24	58	150	900	50
WW035	21	94	100	325	25
WW035A	21	91	125	375	25
WW041	22.2	134	425	1,575	75
WW041A	22.2	96	250	825	50
WW043	20	92	350	2,325	100
WW044	18	105	900	6,025	175
WW045	29	35	50	125	0
WW051	7.5	21	275	550	25
WW052	30	27	25	75	0
WW053	30	33	50	150	0
WW055	17.2	53	400	2,075	100
WW055A	17.2	60	400	1,675	100
WW058	20	47	250	825	50

Table C.4: Peak hour, Daily and Annual Bus Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	1,120	2,250	13,600	4,070,000
L-1WB	3,060	6,125	36,900	11,080,000
WW001	400	800	4,800	1,447,000
WW002	1,025	2,050	12,400	3,708,000
WW003	25	50	300	90,000
WW004	375	750	4,500	1,357,000
WW005	625	1,225	7,400	2,216,000
WW005A	525	1,075	6,500	1,945,000
WW005E	575	1,150	6,900	2,080,000
WW006	75	150	900	271,000
WW011	650	1,300	7,800	2,352,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	150	275	1,700	497,000
WW017	50	75	500	136,000

Line	Peak Hour	Peak Period	Daily	Annual
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	675	1,350	8,100	2,442,000
WW021	350	700	4,200	1,266,000
WW022	400	775	4,700	1,402,000
WW023	525	1,075	6,500	1,945,000
WW024	550	1,100	6,600	1,990,000
WW025	150	300	1,800	543,000
WW026	450	925	5,600	1,673,000
WW027	425	825	5,000	1,492,000
WW030	1,075	2,150	13,000	3,889,000
WW033	175	375	2,300	678,000
WW034	125	275	1,700	497,000
WW034A	150	300	1,800	543,000
WW035	100	225	1,400	407,000
WW035A	125	250	1,500	452,000
WW041	425	850	5,100	1,538,000
WW041A	250	525	3,200	950,000
WW043	350	725	4,400	1,312,000
WW044	900	1,800	10,900	3,256,000
WW045	50	75	500	136,000
WW051	275	550	3,300	995,000
WW052	25	50	300	90,000
WW053	50	100	600	181,000
WW055	400	775	4,700	1,402,000
WW055A	400	775	4,700	1,402,000
WW058	250	500	3,000	905,000

2041 Scenario 1: B-line = 6 minutes

Table C.5: Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8	67	550	1,300	75
WW002	4.9	80	1,375	4,500	250
WW003	12.5	60	50	100	0
WW004	12	103	475	1,925	100
WW005	13.5	152	850	3,600	200
WW005A	13.5	157	775	2,600	150
WW005E	13.5	155	850	3,600	200
WW006	15	43	125	325	25
WW011	16	115	725	4,100	175
WW012	20	20	25	25	0
WW013	20	23	0	0	0
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	12	53	300	1,150	50

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW017	15	23	25	100	0
WW018	10	60	0	25	0
WW019	20	18	25	75	0
WW020	8.2	51	1,075	6,800	200
WW021	9.2	81	275	1,325	75
WW022	8.6	83	675	3,700	175
WW023	7.6	62	575	2,450	125
WW024	7.8	61	650	3,150	150
WW025	7.5	38	225	575	25
WW026	8.3	61	575	1,875	75
WW027	8.7	62	575	2,875	150
WW030	7.9	122	1,175	4,050	200
WW033	9.6	86	200	725	50
WW034	18	76	225	1,075	50
WW034A	18	58	200	950	50
WW035	16.8	94	150	375	25
WW035A	16.8	91	200	525	25
WW041	19.2	134	450	1,700	75
WW041A	19.2	96	275	850	50
WW043	13.3	92	575	3,300	125
WW044	12.9	105	1,500	9,275	275
WW045	24.2	35	50	100	0
WW051	4.3	21	425	800	25
WW052	15	27	50	125	0
WW053	15	33	75	225	0
WW055	15	53	450	2,575	125
WW055A	15	60	425	1,850	100
WW058	13.3	47	350	1,125	50

Table C.6: Peak hour, Daily and Annual Bus Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	925	1,855	11,200	3,356,000
L-1WB	3,725	7,469	45,000	13,511,000
WW001	550	1,075	6,500	1,945,000
WW002	1,375	2,750	16,600	4,975,000
WW003	50	100	600	181,000
WW004	475	950	5,700	1,719,000
WW005	850	1,700	10,300	3,075,000
WW005A	775	1,525	9,200	2,759,000
WW005E	850	1,725	10,400	3,121,000
WW006	125	275	1,700	497,000
WW011	725	1,425	8,600	2,578,000
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0

Line	Peak Hour	Peak Period	Daily	Annual
WW015	0	25	200	45,000
WW016	300	600	3,600	1,085,000
WW017	25	50	300	90,000
WW018	0	25	200	45,000
WW019	25	75	500	136,000
WW020	1,075	2,125	12,800	3,844,000
WW021	275	575	3,500	1,040,000
WW022	675	1,375	8,300	2,487,000
WW023	575	1,175	7,100	2,126,000
WW024	650	1,300	7,800	2,352,000
WW025	225	450	2,700	814,000
WW026	575	1,125	6,800	2,035,000
WW027	575	1,175	7,100	2,126,000
WW030	1,175	2,350	14,200	4,251,000
WW033	200	400	2,400	724,000
WW034	225	450	2,700	814,000
WW034A	200	400	2,400	724,000
WW035	150	325	2,000	588,000
WW035A	200	400	2,400	724,000
WW041	450	900	5,400	1,628,000
WW041A	275	550	3,300	995,000
WW043	575	1,125	6,800	2,035,000
WW044	1,500	2,975	17,900	5,382,000
WW045	50	75	500	136,000
WW051	425	850	5,100	1,538,000
WW052	50	100	600	181,000
WW053	75	150	900	271,000
WW055	450	900	5,400	1,628,000
WW055A	425	825	5,000	1,492,000
WW058	350	700	4,200	1,266,000

2041 Scenario 2: B-line = 4 minutes

Table C.7: Peak Hour Bus Route Boardings by Line (Bi-Directional)

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW001	8	67	500	1,100	75
WW002	4.9	80	1,275	4,000	225
WW003	12.5	60	25	50	0
WW004	12	103	475	1,875	100
WW005	13.5	152	750	2,875	175
WW005A	13.5	157	675	2,275	125
WW005E	13.5	155	750	2,900	175
WW006	15	43	150	325	25
WW011	16	115	775	4,200	175
WW012	20	20	25	25	0
WW013	20	23	0	0	0

Line	Headway	Line Time	Board	Pass. Km	Pass. Hrs
WW014	20	26	0	0	0
WW015	20	17	0	25	0
WW016	12	53	300	1,125	50
WW017	15	23	25	100	0
WW018	10	60	0	25	0
WW019	20	18	25	25	0
WW020	8.2	51	1,050	6,750	200
WW021	9.2	81	275	1,325	75
WW022	8.6	83	675	3,725	175
WW023	7.6	62	575	2,450	125
WW024	7.8	61	650	3,175	150
WW025	7.5	38	225	600	25
WW026	8.3	61	575	1,900	75
WW027	8.7	62	575	2,875	150
WW030	7.9	122	1,175	4,025	200
WW033	9.6	86	200	725	50
WW034	18	76	225	1,075	50
WW034A	18	58	200	950	50
WW035	16.8	94	150	375	25
WW035A	16.8	91	200	525	25
WW041	19.2	134	450	1,675	75
WW041A	19.2	96	275	850	50
WW043	13.3	92	575	3,275	125
WW044	12.9	105	1,500	9,175	275
WW045	24.2	35	50	100	0
WW051	4.3	21	425	825	25
WW052	15	27	50	125	0
WW053	15	33	75	225	0
WW055	15	53	500	2,725	125
WW055A	15	60	450	1,925	100
WW058	13.3	47	400	1,225	75

Table C.8: Peak hour, Daily and Annual Bus Total Transit Boardings

Line	Peak Hour	Peak Period	Daily	Annual
L-1EB	1,325	2,625	15,800	4,749,000
L-1WB	4,275	8,550	51,600	15,467,000
WW001	500	1,000	6,000	1,809,000
WW002	1,275	2,525	15,200	4,568,000
WW003	25	50	300	90,000
WW004	475	975	5,900	1,764,000
WW005	750	1,475	8,900	2,668,000
WW005A	675	1,375	8,300	2,487,000
WW005E	750	1,525	9,200	2,759,000
WW006	150	300	1,800	543,000
WW011	775	1,550	9,300	2,804,000

Line	Peak Hour	Peak Period	Daily	Annual
WW012	25	25	200	45,000
WW013	0	0	0	0
WW014	0	0	0	0
WW015	0	25	200	45,000
WW016	300	575	3,500	1,040,000
WW017	25	50	300	90,000
WW018	0	25	200	45,000
WW019	25	50	300	90,000
WW020	1,050	2,125	12,800	3,844,000
WW021	275	575	3,500	1,040,000
WW022	675	1,375	8,300	2,487,000
WW023	575	1,175	7,100	2,126,000
WW024	650	1,300	7,800	2,352,000
WW025	225	475	2,900	859,000
WW026	575	1,125	6,800	2,035,000
WW027	575	1,175	7,100	2,126,000
WW030	1,175	2,375	14,300	4,296,000
WW033	200	400	2,400	724,000
WW034	225	425	2,600	769,000
WW034A	200	400	2,400	724,000
WW035	150	325	2,000	588,000
WW035A	200	400	2,400	724,000
WW041	450	900	5,400	1,628,000
WW041A	275	525	3,200	950,000
WW043	575	1,125	6,800	2,035,000
WW044	1,500	3,000	18,100	5,427,000
WW045	50	100	600	181,000
WW051	425	850	5,100	1,538,000
WW052	50	100	600	181,000
WW053	75	175	1,100	317,000
WW055	500	975	5,900	1,764,000
WW055A	450	900	5,400	1,628,000
WW058	400	775	4,700	1,402,000

CONTROL INFORMATION

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