steer davies gleave

Réseau Électrique Métropolitain (REM)

REM Summary Forecasting Report
February 2017

CDPQ Infra Inc.

Our ref: 22951103
Client ref: BC-A06438

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Contents

1 Introduction 1

Report Structure 1

Disclaimer 2

2 Project Definition 3

Stations and Alignment 3

Park & Ride Network 5

Rail Network Reorganization 6

Bus Network Reorganization 7

Fare Assumptions 8

3 Current situation 9

Background 9

South Shore/A10 Market 9

West Island/Deux-Montagnes Line Market 12

Aéroport Pierre-Elliott-Trudeau Market 16

Downtown Montréal Market 18

Existing Fares 19

4 Modelling approach 22

Model Overview 22

Network Development 23

Corridor Demand Choice Models 24

Airport Model 26

Expansion Factors 28

Ramp Up 30

5 Demand Development 31

2015 Demand Base Year 31

Demand Growth 32

Future Transit Matrix Development 37

Auto Future Matrix Development 37

6 Model Calibration 38

Introduction 38

Traffic Model 38

Transit Model 40

7 REM Sponsor Case Forecasts 46

Sponsor Case Definition 46

Sponsor Case Forecast Review (2015) 48

Sponsor Case Forecasts (2021 and 2031) 50

8 Sensitivity Tests 58

Identified risks 58

Low and High Case Definition 58

Ridership Forecasts 61

Figures

Figure 2-1: REM Network 3

Figure 3-1: Saint Lawrence River Crossings 10

Figure 3-2: Saint Lawrence River Crossing Transit Alternatives 11

Figure 3-3: West Island Auto Screenlines 13

Figure 3-4: Rail and Métro Network in the West Island/Deux-Montagnes Line Corridor 14

Figure 3-5: AMT Fare Zone Map (August 2016) 20

Figure 4-1: Corridor Demand Choice Model Overview 22

Figure 4-2: Transit Services Coded by Mode 24

Figure 4-3: Weekday to Annual Expansion Analysis 29

Figure 5-1: West Island/Deux-Montagnes Line Transit Ridership and Socio-economic Growth 33

Figure 5-2: West Island/Deux-Montagnes Growth Model Results 34

Figure 5-3: South Shore/A10 boardings and Socio-economic Parameters Growth 35

Figure 5-4: South Shore/A10 Growth Model Calibration 36
Figure 5-5: ADM Airport Growth Forecast (Passenger Millions) 36
Figure 6-1: Deux-Montagnes Line Load Profile – AM Peak towards Montréal 41
Figure 6-2: Deux-Montagnes Line Load Profile – Interpeak towards Montréal 41
Figure 6-3: Deux-Montagnes Line Load Profile – Interpeak from Montréal 42
Figure 6-4: Transit Boarding Calibration – AM Peak Average Hour 42
Figure 6-5: Transit Boarding Calibration – Interpeak Average Hour 43
Figure 6-6: South Shore/A10 Transit Calibration 44
Figure 7-1: Annual Ridership Profile (with ramp up) 57
Figure 7-2: Annual Passenger Kilometres Profile (with ramp up) 57
Figure 8-1: Annual Boardings – Low and High Cases (with Ramp Up) 61
Figure 8-2: Annual Passenger Kilometre – Low and High Case (with Ramp Up) 61
Figure 8-3: REM AM Peak Boardings with Differing Mode Shift 63

Tables

Table 2-1: REM Stations and Travel Times 4
Table 2-2: REM Operating Assumptions 5
Table 2-3: Park & Ride Assumptions 6
Table 3-1: 2013 Saint Lawrence River Crossing Traffic Volumes 11
Table 3-2: South Shore/A10 Corridor Demand (October Weekday in 2015) 12
Table 3-3: South Shore Park & Ride Spaces and Occupancy (2015) 12
Table 3-4: West Island Corridor Traffic Demand (2013) 14
Table 3-5: AMT Average Ridership (2015) 15
Table 3-6: West Island/Deux-Montagnes Line Bus Demand (October 2015 weekday) 15
Table 3-7: West Island/Deux-Montagnes Park & Ride sites 16
Table 3-8: 2015 In-Scope Airport Passenger Demand– AM Peak and Interpeak 18
Table 3-9: Metro Daily Demand (October 2015) 19
Table 3-10: AMT Average Fare (2015 $) 21

Table 3-11: Average Fare per Trip – CIT (2015 $) 21
Table 3-12: Average Fare per Trip – STM (2015 $) 21
Table 4-1: Corridor SP Results 25
Table 4-2: Generalized Cost Components for Existing Modes 27
Table 4-3: Airport Factors Results Summary 28
Table 4-4: Expansion Factor Analysis 29
Table 4-5: REM Ramp Up Factors 30
Table 5-1: MOTREM Demand Total (2016) 31
Table 5-2: Matrix Data Source Summary 32
Table 5-3: Socio-economic Variables and Forecasts 37
Table 5-4: Transit Ridership Growth Estimates 37
Table 6-1: Bridge Crossing Screenline (AM Peak) 39
Table 6-2: Bridge Crossing Screenline (Interpeak) 39
Table 6-3: West Island Screenline (AM Peak) 40
Table 6-4: West Island Screenline (Interpeak) 40
Table 6-5: AM Peak Metro Station Calibration (2015) 43
Table 6-6: Interpeak Metro Station Calibration (2015) 44
Table 6-7: Transit Demand Matrices by Forecast Year 45
Table 7-1: Sponsor Case Project Definition 46
Table 7-2: Sponsor Case Model Assumptions 47
Table 7-3: REM Demand Captured by Market 48
Table 7-4: REM Airport Demand Capture (2015) 48
Table 7-5: REM Airport Demand Split 49
Table 7-6: REM Car Shift Capture (2015) 49
Table 7-7: REM Transit Demand Shift Capture (2015) 50
Table 7-8: 2015 AM Peak and Interpeak REM Boardings 50
Table 7-9: AM Peak and Interpeak REM Boardings 51
Table 7-10: AM and Interpeak Station Boardings and Alightings (2021 and 2031) 52
Table 7-11: REM Section Load Flows 53
Table 7-12: REM Daily and Annual Boardings (No Ramp Up) 55

Table 7-13: REM Annual Passenger Kilometres (no Ramp Up) 56
Table 7-14: Sponsors Case Overall Ramp Up Factors 56
Table 7-15: REM Ridership and Passenger Kilometres Summary (with ramp up) 56
Table 8-1: Sensitivity Test Definition 59
Table 8-2: Ramp Up Assumptions – Low and High Case 60
Table 8-3: Low and High Case Ridership Comparison 62
Table 8-4: Low and High Case Peak Loads 62
Table 8.5: REM AM Peak Boardings with Differing Mode Shift 63

Appendices

A REM Forecasting Changes

B REM Mode Constant Summary

1 Introduction

1.1 Steer Davies Gleave was appointed by CDPQ Infra Inc. to develop investment grade forecasts for the Réseau Électrique Métropolitain system (REM), a 67 kilometre light rail network in Metropolitan Montréal. This report represents the summary of the Forecasting Report dated February 2017.

1.2 This forecasting work was summarized in a preliminary report dated November 2016. A number of project changes (including 3 additional REM stations, revised travel times and headways amongst others) means that additional analysis was undertaken and this is included in the work reported in this summary document and the full report. Summary of mode constant changes and forecasting differences resulting from these changes are included in Appendix A and B.

Report Structure

1.3 Following this introduction, this report includes the following:

- Section 2 describes the proposed REM project and plans for reorganising the bus and rail services in the REM corridor including proposed Park & Ride sites at REM stations
- Section 3 presents the current transport situation in Montréal and defines the 3 in-scope markets for REM (South Shore/A10 Corridor; West Island/Deux-Montagnes Line and Airport Corridor)
- Section 4 explains our modelling approach, the existing models and bespoke models prepared for this study
- Section 5 describes how we constructed the 2015 base year demand for the existing in-scope ridership, historic growth of public transport ridership in Montréal and future demand growth models
- Section 6 presents the model calibration (how well the model simulates reality in terms of demand by transport mode and travel times in 2015)
- Section 7 shows the REM sponsor case forecasts for 2015 (assuming REM was in place today) and for 2021 and 2031
- Section 8 defines the Low and High scenarios and the forecasts.

Disclaimer

This document is solely for the benefit of CDPQ Infra Inc. ("the Client"). No other person or entity may rely upon this document without the prior written consent of Steer Davies Gleave ("the Company") which may be granted or withheld in the Company's sole discretion.

This document contains projected information and data (financial and otherwise), and other forward-looking information, that may or may not occur or prove to be accurate. Such projected and forward-looking information is based on current expectations and projections about future events, many of which are beyond the control of the Company, the Client or any other participant in the Project, and such projections and forward-looking information can be affected by inaccurate assumptions. The projections and forward-looking information were prepared in good faith, but no assurance can be given as to the accuracy or adequacy of such projections and forward-looking information, or the assumptions underlying such projections and forward-looking information.

This document speaks only as of the date thereof and the Company does not undertake any responsibility for updating this document for any reason, including as a result of new information, future events or otherwise.

2 Project Definition

Stations and Alignment

2.1 REM will be a fully automated transportation system, 67 km long, which will provide access to 27 stations. Figure 2-1 shows the extent of the REM network.

Figure 2-1: REM Network

2.2 With a frequent and reliable service running from 5:00 am to 1:00 am, 20 hours a day, every day, REM will provide a significantly enhanced travel experience for commuters and non-commuters in Metropolitan Montréal.

2.3 In the West Island, REM will provide services to those stations currently served by the Deux-Montagnes AMT line and it will substantially increase rail coverage with new stations in the South Shore, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau. On the South Shore, REM will provide services to major interchange stations with the South Shore bus network and Park & Ride facilities. In the Downtown area, REM will serve major destinations (McGill, Édouard-Montpetit, Gare Centrale and Bassin Peel) and will connect with the Métro Orange, Green, and Blue lines.

2.4 The travel times between stations are shown in Table 2-1.

Table 2-1: REM Stations and Travel Times

Station	Station	Distance (m)	Travel time (mins)	Speed (km/h)
DEUX-MONTAGNES				
Gare Centrale	McGill	506	01:30	20
McGill	Édouard-Montpetit	3,174	03:13	59
Édouard-Montpetit	Canora	1,730	02:12	47
Canora	Mont-Royal	820	01:33	32
Mont-Royal	Correspondance A40	1,470	01:58	45
Correspondance A40	Montpellier	940	01:37	35
Montpellier	Du Ruisseau	1,460	01:58	45
Du Ruisseau	Bois-Franc	1,720	02:05	50
Bois-Franc	Sunnybrooke	6,390	05:04	76
Sunnybrooke	Roxboro-Pierrefonds	2,170	02:25	54
Roxboro-Pierrefonds	Île-Bigras	3,450	03:11	65
Île-Bigras	Sainte-Dorothée	930	01:36	35
Sainte-Dorothée	Grand-Moulin	2,700	02:43	60
Grand-Moulin	Deux-Montagnes	2,200	02:26	54
Total		**29,660**	**33:31**	**53**
RIVE-SUD				
Gare Centrale	Bassin Peel	1,400	01:58	43
Bassin Peel	Île-des-Sœurs	3,600	03:43	58
Île-des-Sœurs	Panama	5,410	04:37	70
Panama	Du Quartier	3,670	03:22	65
Du Quartier	Rive-Sud	1,440	01:32	56
Total		**15,520**	**15:12**	**61**
SAINTE-ANNE-DE-BELLEVUE				
Bois-Franc	Autoroute 13	4,440	04:01	66
Autoroute 13	Des Sources	3,780	03:20	68
Des Sources	Pointe-Claire	4,130	03:49	65
Pointe-Claire	Kirkland	2,580	02:44	57
Kirkland	Sainte-Anne-de-Bellevue	4,280	03:46	68
Total (from Gare Centrale)		**31,030**	**33:46**	**55**
AÉROPORT PIERRE-ELLIOTT-TRUDEAU				
Autoroute 13	Technoparc Saint-Laurent	2,500	02:52	52
Technoparc Saint-Laurent	Aéroport Pierre-Elliott-Trudeau	2,780	03:01	55
Total (from Gare Centrale)		**21,540**	**26:00**	**50**

Dwell time assumed is 30 seconds for all stations except for Gare Centrale and Panama where it is 40 seconds

2.5 REM will provide enhanced frequencies to the Deux-Montagnes corridor (services every 12 minutes) compared to the existing AMT rail service, with frequencies of 20 minutes in the peak and hourly in the Interpeak period and on weekends. It will also introduce very frequent services to the South Shore area (every 2 minutes and 40 seconds) replacing the existing express bus services on the Champlain Bridge. It will also include new rail services to the Aéroport Pierre-Elliott-Trudeau and Sainte-Anne-de-Bellevue (every 12 minutes, respectively), which will provide an alternative to the existing express bus services and other local services feeding the Métro Orange Line. Table 2-2 shows the key frequency assumptions.

Table 2-2: REM Operating Assumptions

Route	Headway (mins)		Travel Time (mins)
	AM Peak (6am-9am)	Interpeak (9am-3pm)	
Deux-Montagnes to Rive-Sud	12	15	48:43
Roxboro-Pierrefonds to Rive-Sud	12	-	38:47
Sainte-Anne-de-Bellevue to Rive-Sud	12	15	48:58
Aéroport Pierre-Elliott-Trudeau to Rive-Sud	12	15*	41:12
Correspondance A40 to Rive-Sud**	20	-	25:38
Peak Headways per period	**2 mins 40 sec. From Correspondance A40 to Rive-Sud**	**5 mins From Gare Centrale to Rive-Sud**	-

** Interpeak service from Aéroport Pierre-Elliott-Trudeau is express from Bois-Franc to Gare Centrale*

*** Additional service from Correspondance A40 in the AM peak to cover the demand disembarking from the Mascouche Line service*

2.6 In summary, REM will not only provide an additional service along important transport corridors in the Metropolitan area (Deux-Montagnes, Rive-Sud, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau), but it will also provide new alternatives and connectivity to the Métro network (with connections to the Orange, Green, and Blue lines) and provide Montréal's first north-south, high frequency, rapid transit corridor in the Downtown area, linking Bassin Peel, downtown, McGill, and the Université de Montréal area.

Park & Ride Network

2.7 Another change brought about as a result of the introduction of the REM network is changes to Park & Ride provision. Table 2-3 provides a summary of the current and future Park & Ride provision for stations that will form part of the REM network.

Table 2-3: Park & Ride Assumptions

Station	Current Capacity	REM Capacity
Gare Centrale	-	-
McGill	-	-
Édouard-Montpetit	-	-
Canora	-	-
Mont-Royal	-	-
Correspondance A40	-	-
Montpellier	-	-
Du Ruisseau	1,063	1,060
Bois-Franc	742	740
Sunnybrooke	515	400
Roxboro-Pierrefonds	918	1,040
Île-Bigras	65	45
Sainte-Dorothée	1,101	975
Grand-Moulin	304	230
Deux-Montagnes	1,256	1,160
Bassin Peel	-	-
Île-des-Sœurs	-	-
Panama	962	700
Du Quartier	-	-
Rive-Sud	-	3,000
Autoroute 13	-	500
Des Sources	-	500
Pointe-Claire	-	700
Kirkland	-	500
Sainte-Anne-De-Bellevue	-	2,000
Technoparc Saint-Laurent	-	-
Aéroport Pierre-Elliott-Trudeau	-	-
TOTAL	**6,926**	**13,550**

Rail Network Reorganization

2.8 The introduction of REM will result in the following changes to the rail network:

- Deux-Montagnes existing rail service will cease to operate and will be replaced by the REM
- Mascouche Line will be terminated at Correspondance A40 station and will cease to provide services to Gare Centrale. An additional REM service from A40 has been introduced in the operating plan in order to cover this demand and ensure full integration and capacity of the system (see Table 2-2).

Bus Network Reorganization

The bus network assumptions presented in this report are preliminary and based on draft assumptions regarding the routeing and frequencies of series. As the REM project progresses, further bus network analysis and optimization will be required.

2.9 The introduction of REM will be complemented with a full reorganization of the transit network in the South Shore/A10 Corridor, and the West Island/Deux-Montagnes Corridors. A preliminary bus reorganization plan has been defined by the Société de Transport de Montréal (STM), and was used by the Agence Métropolitaine de Transport (AMT), along with those of the Société de Transport de Laval (STL), the Réseau de Transport de Longueuil (RTL), and other Autorités Organisatrices de Transport (AOTs) in order to conduct simulations and in context of the Transition Committee. The intent of the plan is to optimize the system by avoiding duplication of services and increasing the network coverage and service levels.

South Shore/A10 Corridor

2.10 The South Shore bus network reorganization is based on assumptions developed by AMT in February 2016. The main objective of the reorganization is to truncate all express bus services that currently cross the Champlain Bridge, in order not to duplicate services and eliminate bus traffic on the Bridge. The approach adopted by AMT was to terminate these services at the most accessible REM station.

West Island/Deux-Montagnes Line

2.11 Assumptions regarding the West Island bus network reorganization are based on the preliminary assumptions and subject to further discussion and analysis with STM. The approach was to develop a new feeder bus system for the West Island that avoids duplication of services and is better integrated with the REM.

2.12 A summary of Steer Davies Gleave's bus network reorganization assumptions are provided below:

- **Route assumptions:**
  - Most routes are maintained with some alignment modifications that better serve existing communities and feed the REM service.
  - In the preliminary scenario, certain lines will be abolished, modified or created. These new services directly feed REM stations.
- **Level of service:**
  - For most of the remaining services, levels of service during peak periods increase and stay relatively the same during the Interpeak.
  - Levels of service for the new routes during the AM Peak period used in the preliminary scenario are similar to current express services headways.

2.13 STM also operates the 747 Express Airport Shuttle. However, STM has not provided assumptions for the level of service when the REM starts operation, which will have a significant impact in

ridership on the Aéroport Pierre-Elliott-Trudeau branch. For the base case, as requested by the client, it was assumed that this service will be terminated when REM starts operating.

Fare Assumptions

2.14 It is expected that the current fare structure will remain in place and the REM will be fully integrated into Metropolitan Montréal's transit fare structure.

2.15 The only major modification would be related to the REM airport branch, where fares have been assumed to be $5 higher compared to the current 747 Express Airport Shuttle average fare.

3 Current situation

Background

3.1 The REM project will transform the transit offer in the Metropolitan Montréal area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal, the West Island, Deux-Montagnes and the Aéroport Pierre-Elliott-Trudeau.

3.2 Although REM will be fully integrated, it will service different markets:

- **South Shore/A10**: clearly dominated by a commuting demand which is very high in the AM Peak in the Montréal direction. This demand is currently served by express bus services that cross the Champlain Bridge using dedicated bus lanes.
- **West Island/Deux-Montagnes Line**: similar to the above, this is a very strong commuting market. However, this demand is served by a variety of services, including rail services and express and local bus services that feed the Orange Line into Montréal.
- **Airport**: very specific demand driven by the Aéroport Pierre-Elliott-Trudeau activity, with a flatter daily profile and peak in the afternoon between 3pm and 6pm.
- **Downtown**: internal demand in downtown area, currently served primarily by Métro lines and STM bus services.

South Shore/A10 Market

3.3 The REM will provide a frequent and reliable rail link between the South Shore and Downtown Montréal (as well as the rest of the West Island corridor and the airport corridor). As a result, there is a very strong commuter-driven demand between the South Shore and the Montréal Downtown area, with high peaks in the AM Peak towards Montréal and in the PM peak towards the South Shore.

3.4 Given the natural barrier of the Saint Lawrence River, the river crossing alternatives are limited and, as a result, the South Shore/A10 is one of the highest demand corridors in Metropolitan Montréal for auto and transit users. We describe the existing auto and transit users and current transport provision in the following sections.

Auto Users

3.5 Figure 3-1 shows the most important five crossings from the South Shore.

Figure 3-1: Saint Lawrence River Crossings

Source: Steer Davies Gleave

3.6 The Champlain Bridge carries approximately 28% of the total traffic crossing to/from the South Shore. Although there is a strong component of commuting traffic heading to Downtown Montréal during the AM Peak period, Table 3-1 also shows significant demand levels in the Interpeak period.

Table 3-1: 2013 Saint Lawrence River Crossing Traffic Volumes

Screenline Num.	Name	Direction	6am-9am (3 hours)	9am-3pm (6 hours)
1	Louis Hippolyte Lafontaine Bridge-Tunnel (A25)	To Montréal	13,364	19,939
		From Montréal	11,450	20,830
2	Jacques Cartier Bridge (R134)	To Montréal	12,757	13,863
		From Montréal	5,530	12,663
3	Victoria Bridge (R112)	To Montréal	6,765	4,043
		From Montréal	-	3,697
4	Champlain Bridge (A10)	To Montréal	17,046	17,956
		From Montréal	6,750	18,003
5	Honoré Mercier Bridge (R138)	To Montréal	7,285	9,040
		From Montréal	3,152	8,803
	TOTAL	**To Montréal**	**57,217**	**64,841**
		From Montréal	**26,882**	**63,996**

Transit Users

3.7 Transit options are also limited to the crossings along the Saint Lawrence River. The key existing transit options are shown in Figure 3-2.

Figure 3-2: Saint Lawrence River Crossing Transit Alternatives

South Shore/A10 corridor

3.8 These 48 routes provide a combined frequency over the Champlain Bridge of approximately 200 services in the AM Peak hour. However, this frequency drops to approximately 21 services in the Interpeak period (9am–3pm), which clearly shows that the service is driven by the commuter needs of residents of the South Shore.

3.9 These express bus services provide competitive travel times in the peaks (despite high levels of congestion on Champlain Bridge) as transit services use segregated bus lanes across the bridge. As a result, travel times only increase from 19 minutes in the Interpeak direction to 24 minutes in the peak direction.

3.10 The competitiveness and convenience of the South Shore/A10 transit corridor has encouraged the use of transit, presenting very high transit market share compared to other corridors. Table 3-2 presents the demand in the corridor per transit agency and for those bus routes that cross the bridge to access Downtown Montréal.

Table 3-2: South Shore/A10 Corridor Demand (October Weekday in 2015)

Transit agency	Peak (6am-9am)	Interpeak (9am-3pm)
RTL	9,557	6,399
AMT	2,768	783
Ville de Saint-Jean-sur-Richelieu	1,336	958
CIT Le Richelain	2,025	476
CIT Vallée-du-Richelieu	149	64
CIT Chambly-Richelieu-Carignan	1,577	286
CIT Roussillon	875	214
OMIT Sainte-Julie	481	20
TOTAL	**18,768**	**9,200**

3.11 Within the South Shore/A10 transit corridor, Park & Ride facilities are provided at the critical transit interchange stations. Currently Panama and Chevrier stations have a total capacity of 3,275 spaces (see Table 3-3). These facilities are currently free of charge and are typically at full capacity from early in the AM Peak which suggests that there is unsatisfied demand due to parking capacity constraints.

Table 3-3: South Shore Park & Ride Spaces and Occupancy (2015)

Location	Size	Occupancy
Panama	962	100%
Chevrier	2,313	89%
Total	**3,275**	**92%**

West Island/Deux-Montagnes Line Market

3.12 The REM will provide a frequent and reliable rail link between the West Island/Deux-Montagnes Line and Downtown Montréal (as well as the South Shore/A10). It will not only improve the

service currently provided by the Deux-Montagnes Line, but it will also extend its alignment to the Pointe-Claire and Sainte-Anne-de-Bellevue areas.

3.13 As a result, there is a very strong commuter-driven demand between the West Island/Deux-Montagnes corridor and the Downtown Montréal area, with high peaks in the AM Peak towards Montréal and in the PM peak in the reverse direction.

Auto Users

3.14 The REM Line will operate in parallel to the A40 for a great part of its alignment, although the A20 could also provide an alternative route for some destinations. Total traffic volumes from the two screenlines by direction are detailed in Table 3-4. The location of the screenlines is shown in Figure 3-3.

Figure 3-3: West Island Auto Screenlines

3.15 Traffic volumes peak between 6am and 9am heading into the Montréal area, as a result of the high proportion of commuting traffic. Screenline 2, which lies closer to Downtown Montréal displays significantly higher traffic volumes (approximately twice as high) as Screenline 1.

Table 3-4: West Island Corridor Traffic Demand (2013)

Direction	Screenline 1		Screenline 2	
	6am-9am	9am-3pm	6am-9am	9am-3pm
To Montréal	21,893	26,476	43,385	55,860
Towards West	10,489	23,818	19,424	42,008

Transit Users

3.16 The West Island of Montréal covers a very large area. To cater for this demand, there is an extensive transit network of commuting rail (Deux-Montagnes Line and Vaudreuil-Hudson Line) and bus services that provide access to Downtown Montréal either directly or via the Orange Line.

Rail Network

3.17 The West Island/Deux-Montagnes Line Corridor is currently served by two rail commuting services and one Métro Line as shown in Figure 3-4.

Figure 3-4: Rail and Métro Network in the West Island/Deux-Montagnes Line Corridor

3.18 Currently, the Deux-Montagnes Line (DM) has the highest ridership, with almost 32,000 daily riders. Table 3-5 shows that most of the rail services have a strong component of commuting demand demonstrated by the majority of demand travelling in the peak periods.

Table 3-5: AMT Average Ridership (2015)

AMT commuter rail	6am-9am	9am-3pm	Daily
Deux-Montagnes Line	14,371	4,580	31,835
Vaudreuil-Hudson Line	8,450	1,238	17,588
Mascouche Line	2,421	199	4,905
Saint-Jérôme Line	6,792	1,068	13,709

Bus Network

3.19 STM is the main bus service provider in the western part of the Island of Montréal. It operates 53 in-scope bus services, which cover both express and local services. Frequencies vary depending on the route.

3.20 Table 3-6 presents the demand for each type of bus route and for an average weekday in October 2015. The express routes have higher demand in the peak period, as expected, while the non-express routes have higher demand in the Interpeak period due to shorter trips on these services.

Table 3-6: West Island/Deux-Montagnes Line Bus Demand (October 2015 weekday)

	Peak (6am-9am)	Interpeak (9am-3pm)	Daily
Express routes in scope	12,580	10,611	41,404
Non-express routes in scope	42,392	50,902	174,782
747 Express Airport Shuttle*	493	1,730	5,304
Total	**55,465**	**63,243**	**221,490**

Park & Ride Facilities

3.21 In the West Island/Deux-Montagnes Line Corridor, many of the rail stations currently have Park & Ride facilities. Stations on the Deux-Montagnes Line provide a total capacity of 5,964 spaces (see Table 3-7). These facilities are currently free of charge and are typically at full capacity from the early peak hour period (average occupancy of 91%), which suggests that there is unsatisfied demand due to the capacity constraints of the car parks.

Table 3-7: West Island/Deux-Montagnes Park & Ride sites

Deux-Montagnes Line	Size	Occupancy
Du Ruisseau	1,063	82%
Bois-Franc	742	91%
Sunnybrooke	515	98%
Roxboro–Pierrefonds	918	92%
Île-Bigras	65	99%
Sainte-Dorothée	1,101	92%
Grand-Moulin	304	96%
Deux-Montagnes	1,256	92%
Total	**5,964**	**91%**

Aéroport Pierre-Elliott-Trudeau Market

3.22 The REM will provide frequent and reliable access to/from Aéroport Pierre-Elliott-Trudeau for air passengers and staff travelling from the South Shore, Downtown Montréal, the West Island and Deux-Montagnes. At the moment, the majority of people drive and park at the airport. There is also a significant number of people who are driven to the airport either by a friend/family member or in a taxi.

3.23 The only current public transport option is the 747 Express Airport Shuttle operated by STM. The 747 Express Airport Shuttle service runs 24 hours a day, 7 days a week, between Aéroport Pierre-Elliott-Trudeau and Berri-UQAM Métro station, east of Downtown Montréal. Frequencies vary through the day, from one bus every 7-10 minutes to two buses per hour.

3.24 The total end to end travel time ranges from 45 minutes to 60 minutes, depending on traffic conditions. Travel times vary particularly on the A20 and on René-Lévesque, the main road through Downtown Montréal.

Demand

3.25 Aéroport Pierre-Elliott-Trudeau passenger demand is based on the actual number of air passengers flying into or out of Aéroport Pierre-Elliott-Trudeau using information directly from Aéroports de Montréal (ADM).

3.26 The total passenger demand for the airport is estimated to be 15.5 million passengers in 2015. This includes:

- 5.87 million passengers on Domestic flights
- 3.70 million passengers on Transborder flights
- 5.93 million passengers on International flights

3.27 Airport staff demand has also been calculated using information from ADM; there were around 27,000 employees in the airport and its hinterland in 2015. ADM also provided details of roles and working patterns, which showed that in 2015, 41% of staff worked “normal hours”, 46% worked long shifts and 13% were pilots or cabin crew.

3.28 In order to convert the number of employees into the number of trips to/from Aéroport Pierre-Elliott-Trudeau we estimated employees in the airport area made 8.8 million trips to/from the Aéroport Pierre-Elliott-Trudeau in 2015.

Distribution of demand

3.29 The airport model includes a number of different levels of segmentation. This allows us to have different profiles for different types of people. The profiles determine how likely someone is to switch to REM given their current travel time (which includes walk time, wait time, in vehicle travel time and fare (if they use public transport).

3.30 Table 3-8 provides a summary of total airport passengers demand by market segment in the AM Peak and Interpeak periods.

Table 3-8: 2015 In-Scope Airport Passenger Demand– AM Peak and Interpeak

		Bus		Taxi	Car Park & Fly		Car Kiss & Fly
		747 Passengers	Airport Staff Local Bus	Passengers	Passengers	Airport Staff	Passengers
Time of Day	AM Peak (6am-9am)	493	122	1,362	889	1,095	1,973
	Interpeak (9am-3pm)	1,730	122	3,234	1,685	1,095	4,456
Journey purpose	Business	509	-	1,824	1,007	-	922
	Non Business	1,714	-	2,772	1,567	-	5,507
	Airport staff	-	122	-	-	1,095	-
Residency	Non-resident	342	37	966	105	-	686
	Resident	1,881	207	3,630	2,469	2,190	5,743
Group size	Alone	1,917	210	2,868	1,167	2,190	3,743
	In a group	306	34	1,728	1,407	-	2,687
Total		**2,223**	**244**	**4,596**	**2,574**	**2,190**	**6,429**

Existing 747 Express Airport Shuttle Demand

3.31 The main transit access to the Aéroport Pierre-Elliott-Trudeau is the 747 Airport Express Shuttle service. This service registered an average daily demand of 5,300 passengers for an average weekday in October 2015 (493 passengers in the AM Peak and 1,730 in the Interpeak). The peak demand for this service occurs between 2pm and 5pm, which partially overlaps with the commuting PM peak.

Downtown Montréal Market

3.32 Downtown Montréal is the main employment hub of the metropolitan area. With more than 250,000 jobs and the highest employment density in Québec, the Downtown far outweighs other employment concentrations in the region and in the province as a whole. In the Montréal region, one in five jobs is located downtown. In addition, most international conventions, headquarters of international organizations and consulates are located downtown.

3.33 Downtown Montréal is also home to three major universities and multiple colleges and CEGEP. These include:

- Université du Québec à Montréal (UQAM) (about 66,000 students)

- McGill University (about 40,000 students)
- Concordia University (about 44,000 students)
- Cégep du Vieux-Montréal (about 6,100 students)

3.34 Université de Montréal's main campus (about 55,000 students) is located on the northern slope of Mount Royal and is one of the main destinations of the downtown area.

Transit Demand

Métro Demand

3.35 The Métro Orange Line is the busiest line of the entire network. In 2015, passenger demand on the line was near to 114.1 million, while 98.5 million rode the Green Line, 25.6 million the Blue Line and 10.8 million the Yellow Line. Table 3-9 shows the average daily demand for each line in October 2015.

Table 3-9: Metro Daily Demand (October 2015)

Métro Line	Average Daily Demand
Orange Line	343,700
Green Line	286,500
Blue Line	79,100
Yellow Line	32,100
TOTAL	**741,400**

Bus Demand

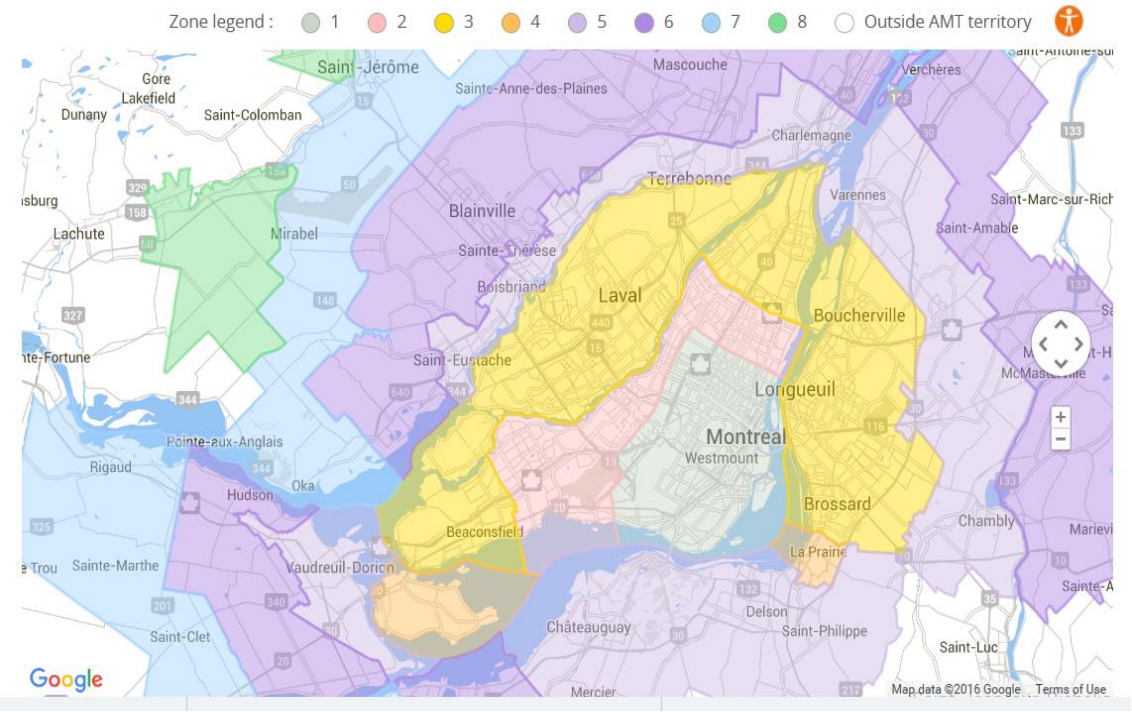
3.36 Downtown is currently served by more than 60 bus routes which are operated by STM. Most routes provide access to Downtown from the north and west. No route serves Downtown exclusively. There are four bus routes that would be in competition with the McGill to Édouard-Montpetit segment of REM. These include:

- Bus route 165 – Côte-des-Neiges (north-south service)
- Bus route 80 – Du Parc (north-south service)
- Bus route 435 – Express Du Parc/Côte-des-Neiges (north-south service)
- Bus route 51 – Édouard-Montpetit (east-west service)

Existing Fares

3.37 The REM area of influence is covered by the AMT TRAM integrated ticketing structure, which allows passengers to use the whole transit network in the Montréal Region. AMT fares are classified according to a zoning system of 8 zones. Figure 3-5 shows the fare zone map.

Figure 3-5: AMT Fare Zone Map (August 2016)



3.38 AMT has a wide range of products and concessions, with fares differentiated by:

- **Zones**: Fares differ depending on the origin and destination of the trip according to the 8 zone system;
- **Type of user**: Fares are split into regular (*ordinaire*), reduced (*réduit*) and student (*étudiant*);
- **Mode**: There are different products available depending on the mode used; TRAM (Commuter rail, bus and Métro) and TRAIN (Commuter rail only); and
- **Products**: Tickets are available for different frequency users; monthly (*mensuel*), 6-ticket booklets (*carnet*) and individual tickets (*billet*).

3.39 Table 3-10 shows the average fare estimated for each zones for adults and students.

Table 3-10: AMT Average Fare (2015 $)

ADULT Zone	AVERAGE ADULT	AVERAGE STUDENT
1	$2.01	$1.66
2	$2.38	$1.95
3	$2.77	$2.34
4	$3.02	$2.52
5	$3.47	$2.92
6	$4.14	$3.49
7	$5.19	$4.00

3.40 On the **South Shore/A10,** more than 50% of the total transit demand that cross the Champlain Bridge has an origin or destination within AMT fare zone 3. However, for other areas, in addition to AMT products, there are a number of agencies that also provide products for users that only use that specific transit agency service (products are not integrated with AMT or STM services). These are shown in Table 3-11.

Table 3-11: Average Fare per Trip – CIT (2015 $)

AV FARE	CIT Chambly-Richelieu-Carignan		CIT Vallée-du-Richelieu		OMIT Sainte-Julie		CIT Roussillon		CIT Le Richelain	
Zone	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT
4									$2.65	$2.24
5	$3.23	$2.78	$3.71	$2.78	$3.42	$2.78	$2.90	$2.58	$2.71	$2.29
6	$3.48	$3.28	$4.25	$3.28	$3.69	$3.27	$3.04	$2.99	$2.75	$2.60

3.41 Table 3-12 shows the average fare estimated for the whole Montréal Island and by ticket type.

Table 3-12: Average Fare per Trip – STM (2015 $)

Fare	Monthly	Weekly	Single	2 trips	10 trips	TOTAL
Adult	$1.58	$2.10	$3.21	$2.93	$2.35	**$1.93**
Student	$1.02	$1.29	-	-	-	**$1.03**

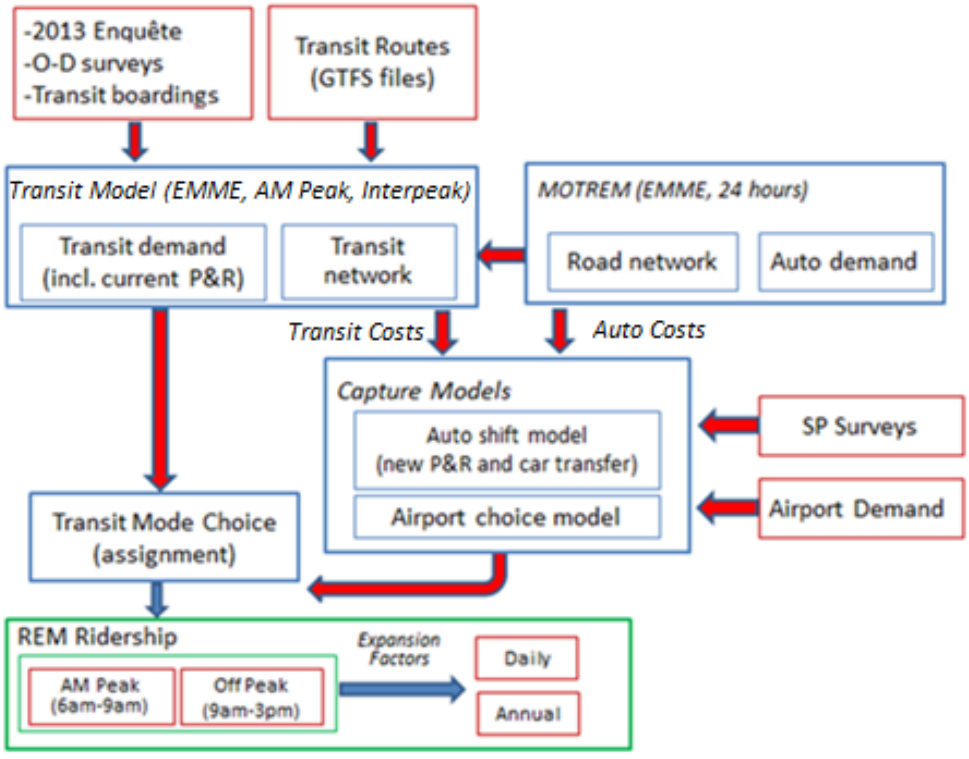
3.42 The STM 747 Express Airport Shuttle service is the only service that has a different fare structure. The average fare is $3.15, which has been calculated based on ticket type sales and usage data provided by STM.

4 Modelling approach

Model Overview

4.1 An overview of the forecasting model framework is shown in Figure 4-1.

Figure 4-1: Corridor Demand Choice Model Overview



4.2 To support all models, a road and transit network in EMME has been developed including the following features:

- Base year (2015) and two future years (2021 and 2031)
- Two time periods
  - AM Peak: 6am to 9am

- Interpeak: 9am to 3pm

Network Development

Road Network

4.3 In order to characterize the existing road network, the team has used the MOTREM model, a road transportation model developed for the Montréal region, using the EMME software platform. MOTREM is owned and maintained by MTQ and it was provided to CDPQ Infra Inc. for the purposes of this study.

4.4 MOTREM is disaggregated geographically into 1,766 traffic zones. MOTREM includes auto Origin-Destination (OD) demand matrices for the zones identified above for the base and future years (2008, 2016, 2021 and 2031). The demand matrices are split into four vehicle types; cars, commercial cars, light goods vehicles and heavy good vehicles.

4.5 The model road network is represented as nodes, links and zones. Links contain network information such as the number of lanes per direction and the volume delay function (vdf). This function estimates the average speed on that particular link depending on the volume of traffic- and could be different depending on the road characteristics, maximum speed limit, etc.

4.6 MOTREM assigns auto and goods vehicle demand to the road network via a series of iterations designed to reach convergence or equilibrium based on the Generalized Costs which account for travel time, operating costs and tolls (on the A25 and A30 and not very relevant to REM).

Future Road network

4.7 MOTREM includes a number of future road network improvements. Of particular interest to this project are the following:

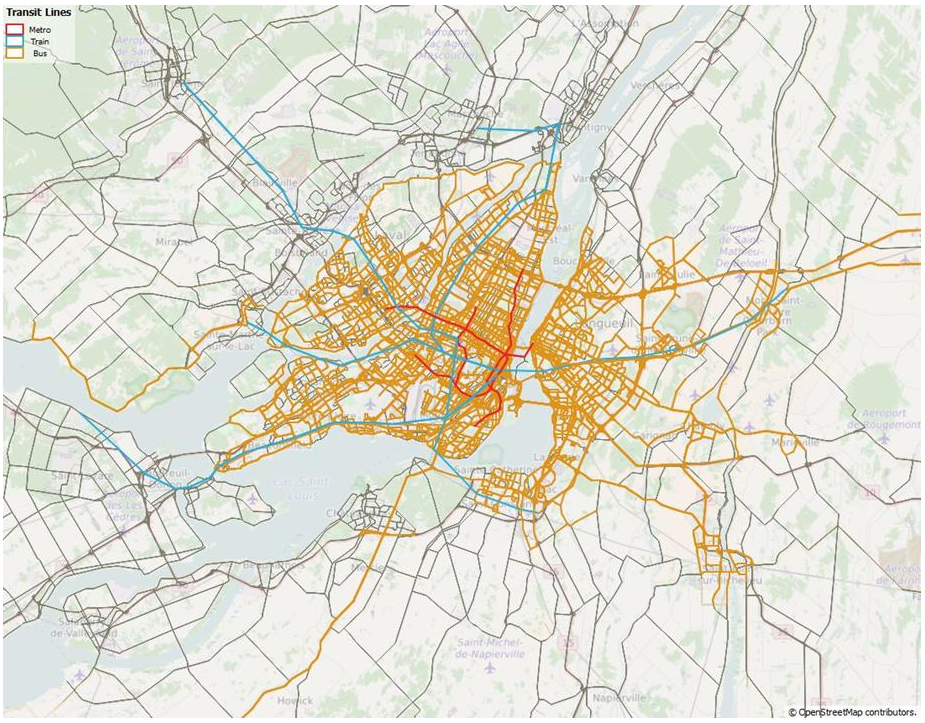
- Champlain Bridge replacement: Construction of new 6 lane bridge across the Saint Lawrence River and access roads to replace existing bridge (currently under construction)
- Turcot Interchange: Reconstruction of the interchange for Highways 15, 20 and 720. This includes the introduction of reserved bus lanes along Highway 20 (between the St-Pierre and Turcot Interchanges), inside lane of the Ville-Marie in the eastbound direction and the new Pullman Boulevard.

Transit Network

4.8 MOTREM only represents the road network relevant to auto users and it has been necessary to incorporate all the transit network links (rail and Métro) and transit services. Rail and Métro lines have been coded as separate links and stations have been 'connected' to the street network as required.

4.9 Transit service route GTFS files were downloaded from the different transit agencies in the Montréal region and imported as transit routes to EMME. 852 transit routes were coded into EMME. **Figure 4-2** shows a plot with the transit services by mode.

Figure 4-2: Transit Services Coded by Mode



Corridor Demand Choice Models

Model Overview

4.10 In order to predict REM ridership, estimates of future demand and capture from alternative modes for the REM "corridor" were required. Two separate choice models have been developed.

- ***Auto shift model***: Estimates the demand that shifts from auto to REM
- ***Transit mode choice model***: Estimates the redistribution of demand between the different transit modes (bus, rail, Métro and REM).

Generalized Cost

4.11 The key attributes for ***transit users*** include:

- Fare of the trip (in Canadian Dollars)
- In-vehicle travel time (in minutes)
- Access/egress time (in minutes)
- Waiting time (in minutes)
- Transfer time (in minutes)
- Perceived quality of the service: There are intrinsic and intangible benefits perceived by passengers between rail-based modes and conventional bus related to the quality and reliability of the service.

4.12 The attributes included to estimate the Generalized Costs of ***Park & Ride users*** are the same parameters as those described for transit users, but they also include the auto travel times and costs associated with accessing the Park & Ride station. The monetary costs include fuel and parking costs (if applicable).

4.13 The attributes used to estimate the Generalized Costs of ***Auto users*** include travel time, fuel, parking and tolls.

4.14 Given that some of the Generalized Cost components are measured in time and others in monetary values, the ***value of time*** (VoT) is used to homogenize the different costs in the same units (minutes or CAD$). The value of time provides an indication of how much an individual is prepared to pay in order to save a given amount of journey time.

Generalized Cost Parameters

4.15 In order to assess the specific model parameters (values of times, weights and mode preference) associated with the different users in the corridor, a number of Stated Preference (SP) surveys were carried out by Steer Davies Gleave in May and June 2016.

4.16 Respondents were presented with 8 cards with different hypothetical scenarios where REM was compared to other modes. These scenarios were designed for each individual respondent based on their existing trip patterns (origin-destination, mode used and existing trip travel time). The behaviour parameters and value of time for each type of user were estimated based on the responses to these scenarios.

4.17 Table 4-1 shows the behaviour parameters extracted from the SP analysis.

Table 4-1: Corridor SP Results

Parameter	Transit Users	Car Users
VoT Work	$7.37	$14.85
VoT Non-Work	$7.91	$14.85
Access Time Factor	1.6	2.7
Wait Time Factor	1.6	1.8
Transfer Penalty	+4 min	
Mode Penalties	REM vs Rail/Métro: +11 min REM vs Bus: +6min	REM with transit access (vs Car): +21 min REM with Park & Ride (vs Car): +4 min

4.18 The model developed only with “traders” (eliminating both current mode and REM non-traders) results in a REM mode constant in line with the expectation that REM is perceived as favorable as commuter rail and Métro, and a 5-minute penalty for bus users when compared to REM. We believe the trader model shows a more realistic estimation for the REM characteristics with similar

quality and reliability characteristics to the existing rail and Métro services, and therefore we expect a similar mode constant and in line evidence observed in other studies/applications.

Airport Model

Model Overview

4.19 The Airport model is a standalone spreadsheet model, which estimates the level of demand that will switch to REM to access Aéroport Pierre-Elliott-Trudeau from each of the existing modes (bus, car Park & Fly, car Kiss & Fly and taxi). Note: Airport staff are only assumed to use local bus (not 747 Airport Shuttle Express) and car Park & Fly currently.

4.20 REM capture is calculated by comparing the Generalized Cost for travel using the existing mode with the Generalized Cost for travel using REM. Generalized Cost includes:

- Walk time
- Wait time (which for transit includes any interchange time)
- In-vehicle time
- Mode constants
- Fare or parking charge

4.21 Airport passenger and staff demand has been estimated and distributed by market segment using the assumptions in Section 3, (see Table 3-8 for the distribution of in-scope demand by market segment). A binary choice model is then used to understand how each market segment reacts to the change in Generalized Cost when comparing their existing mode to REM. The greater the Generalized Cost advantage of REM compared with the existing mode, the more capture is likely to be abstracted.

4.22 REM capture is calculated for an average hour in the AM Peak (6am-9am) and an average hour in the Interpeak (9am-3pm).

Generalized Cost Components

4.23 Table 4-2 shows the Generalized Cost components for each mode and their source.

Table 4-2: Generalized Cost Components for Existing Modes

Component	Mode	Value	Source
Walk Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	0 minutes	
	Car (Park & Fly)	10 minutes	Based on data on car parks on ADM website.
	Car (Kiss & Fly)	0 minutes	
Wait Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	5 minutes	Assumed wait time
	Car (Park & Fly)	10 minutes	Based on data on car parks on ADM website.
	Car (Kiss & Fly)	0 minutes	Assumed no wait time
In-vehicle Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi		
	Car (Park & Fly)	Same times for all of these modes	Estimated in Network Model
	Car (Kiss & Fly)		
Mode constants	Bus	$25	Assumed for airport staff
	Taxi Car (Park & Fly) Car (Kiss & Fly)	Business/non-resident -$3.12 Non-Business/non-resident -$8.90 Business/resident -$3.12 Non-Business/resident -$8.90	Based on SP survey (see description below)
Fare or parking charge	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	$40 fixed downtown fare $17 + $4.86 per km	Based on *Steer Davies Gleave* online research of standard taxi fares in Montréal
	Car (Park & Fly)	$140 parking charge for passengers $- for staff	Passenger charge based on an assumed average 9 nights stay at the Aéroport Pierre-Elliott-Trudeau (using 2016 SP survey data) and average $16 per night from *Steer Davies Gleave* online research of Aéroport Pierre-Elliott-Trudeau car park charges.
	Car (Kiss & Fly)	$-	Assumed no charge for drop off at the Aéroport Pierre-Elliott-Trudeau.

Generalized Cost Parameters

4.24 In order to assess the specific model parameters (values of times, weights and mode preference) associated with the different type of Airport users, Stated Preference interviews were undertaken with passengers in the departure lounge of Aéroport Pierre-Elliott-Trudeau in July 2016.

4.25 Respondents were presented with eight cards with different hypothetical scenarios where REM was compared to the current mode used to access the Aéroport Pierre-Elliott-Trudeau (Park & Fly, Dropped-off, Taxi or 747 Express Airport Shuttle). These scenarios were designed for each individual respondent based on their existing trip patterns (Origin/Destination, mode used and existing trip travel time). The behaviour parameters and value of time for each type of user were estimated based on their responses to these scenarios.

4.26 Table 4-3 shows the behaviour parameters used in the model.

Table 4-3: Airport Factors Results Summary

Parameter	Car Park & Fly	Car Kiss & Fly	Taxi	747	Airport Staff
VoT Business	$166.6	$37.5	$52.80	$13	$65.0
VoT Non-Business	$58.3	$33.3	$28.10		
Access Time Factor	1.0	1.3/1.4 (Business/Non business)	2.8	1.0	1.0
Wait Time Factor	1.0	2.6/2.9 (Business/Non business)	5.6	4.4	1.0
In Vehicle Time Factor	1.0	1.0	1.0	1.1	Bus (1.1)
Transfer Penalty (mins)	0.0	0.0	0.0	7.5	Bus (7.5)

Expansion Factors

4.27 The demand modelling has been carried out for the AM Peak period (6am-9am) and the Interpeak period (9am-3pm). In order to translate into daily and annual ridership, we have estimated the following factors:

- Weekday factor: Translates AM Peak and Interpeak demand into an average week day, using the following:
  - AM Peak (6am-9am) to Peak (6am-9am & 3pm-6pm) factor
  - Interpeak (9am-3pm) to Off Peak (before 6am, 9am-3pm, & after 6pm) factor
- Annual factor: Translates average weekday demand into annual demand.

4.28 In order to estimate the potential annualization factors to apply to the REM forecasts, Steer Davies Gleave has reviewed the most recent factors for the most relevant services in the corridor.

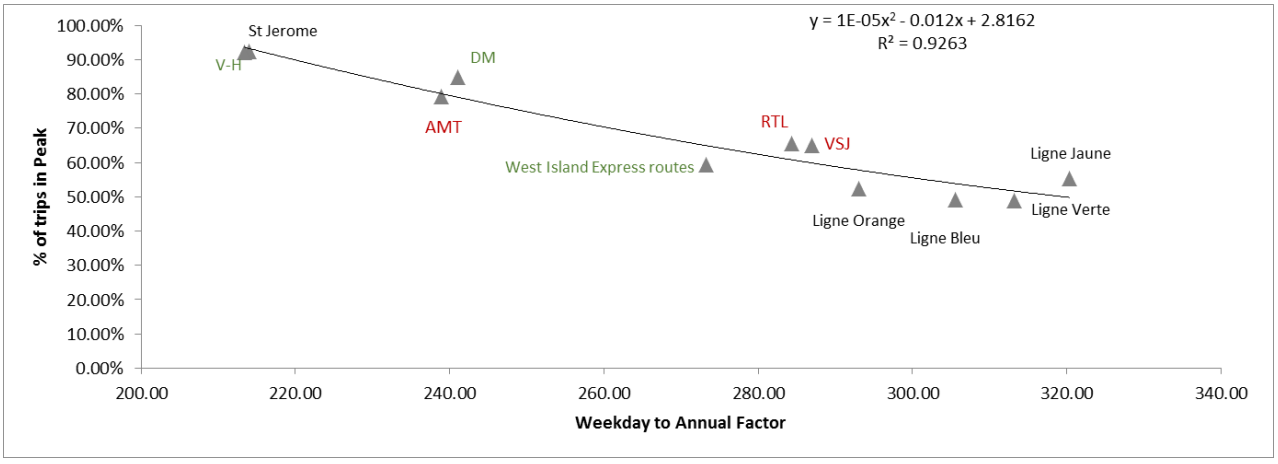
Table 4-4: Expansion Factor Analysis

West island/Deux Montagnes	AM PEAK TO PEAK	INTERPEAK TO OFF PEAK	WEEKDAY TO ANNUAL	% PEAK
DM	1.88		241	85%
Express routes	1.95	1.59	273	59%
Orange Line	2.18	1.78	293	52%
ESTIMATED REM	**1.94**	**1.63**	*	*
South Shore/A10	**AM PEAK TO PEAK**	**INTERPEAK TO OFF PEAK**	**WEEKDAY TO ANNUAL**	**% PEAK**
RTL	1.98	1.55	284	66%
AMT	1.83	1.70	239	79%
Ville de Saint-Jean-sur-Richelieu	2.09	1.58	287	65%
CITs	1.90	2.15	192	81%
Total	**1.94**	**1.63**	**258**	**70%**
ESTIMATED REM	**1.94**	**1.63**		

4.29 The annual factor reflects the multiplier that should be applied to convert weekday demand into annual demand. This incorporates weekend, public holidays and seasonality (with commuter service demand reducing over the Christmas and summer holidays).

4.30 There is normally a correlation between the level of service provision/demand in the Peak period of a weekday and that over the weekend and low season. Figure 4-3 plots the correlation between the percentage of demand in the peak periods over the average weekday, and the annual factor for some of the key services in the corridor. The correlation was applied to estimate the REM expansion factor.

Figure 4-3: Weekday to Annual Expansion Analysis



4.31 The 747 Express Airport Shuttle service has a very different hourly profile, since it reflects the airport demand based on flight schedules, instead of commuting demand. Based on the 747 Express Airport Shuttle data above, the following expansion factors have been estimated for the 747 Express Airport Shuttle:

- AM Peak + Interpeak to weekday: 2.38
- Daily to annual: 277

Ramp Up

4.32 Ramp up is the reduction in potential ridership during the first years of operation as users gradually become fully aware of the alignment, service patterns and benefits of the new system. The extent of the ramp up depends on the type of user captured and is unique to every transport infrastructure project. While users from the existing transit system are expected to transfer almost immediately if the existing rail/bus routes are removed, shifts from competing transit modes or from car will take longer to occur.

4.33 We have applied the following ramp up factors for the REM system.

Table 4-5: REM Ramp Up Factors

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing DM	New	Existing	New	Existing Express (eliminated)	New
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%

5 Demand Development

5.1 The existing and future demand is incorporated in the model in the form of an OD matrix, which defines the demand between each origin and destination, and in some cases segregated by type of user. Different sources have been used in order to define the base matrices, which in some cases have been complemented with data collection (described in the Data Collection report).

2015 Demand Base Year

Auto Demand

5.2 The MOTREM model auto demand OD matrix was used as the basis to estimate auto demand. MOTREM was calibrated to the 2013 Enquête OD survey, traffic counts, and matrix developed for 2016, summarized in Table 5-1.

Table 5-1: MOTREM Demand Total (2016)

	AM Peak (6am-9am)	Interpeak (9am-3pm)	24 Hours
Auto	1,166,657	1,350,718	4,800,628
Auto Commercial	146,799	664,107	1,057,953
Light Goods Vehicles	61,210	141,535	308,561
Heavy Goods Vehicles	20,272	55,763	127,309
TOTAL	**1,394,938**	**2,212,122**	**6,294,451**

5.3 The MOTREM auto demand was reviewed and auto calibration is presented in Section 6.

Demand Development

Data sources

5.4 Demand matrices were developed by combining data from the sources indicated above and following an extensive process to review and check the accuracy and validity of each data source. The matrices were developed into:

- 3 demand segments (Work, Student and Other)
- 2 time periods: AM Peak from 6am-9am and Interpeak from 9am-3pm

5.5 Table 5-2 summarizes the data sources by mode and period.

Table 5-2: Matrix Data Source Summary

Mode	Period	Direction	Source
AMT Rail	AM Peak	All	2015 AMT OD survey
	Interpeak	All	2013 Enquête OD survey
Express 90 Chevrier	AM Peak	To Montréal	2015 AMT OD survey
		To Chevrier	2013 Enquête OD survey
	Interpeak	To Montréal	2015 AMT OD survey
		To Chevrier	2013 Enquête OD survey
West Island/Deux-Montagnes Line and South Shore/A10 in-scope buses	AM Peak and Interpeak	All	2016 Steer Davies Gleave OD surveys and 2013 Enquête OD survey
Métro and other	AM Peak and Interpeak	All	2013 Enquête OD survey

Airport demand

5.6 The spatial distribution of Montréal resident air passenger trips was distributed according to an aggregated version of the Network EMME Transit Mode Choice Model zones and 68 zones were created in the airport model where each station is assigned to an individual zone.

5.7 The distribution of staff demand has been taken from the ADM staff survey of 2008. This survey contains staff postcodes, which have been mapped to the Airport model zoning system. This distribution has then been applied directly to the total annual staff trips. 3% of staff trips were found to be from areas outside of our zoning system and have thus been excluded.

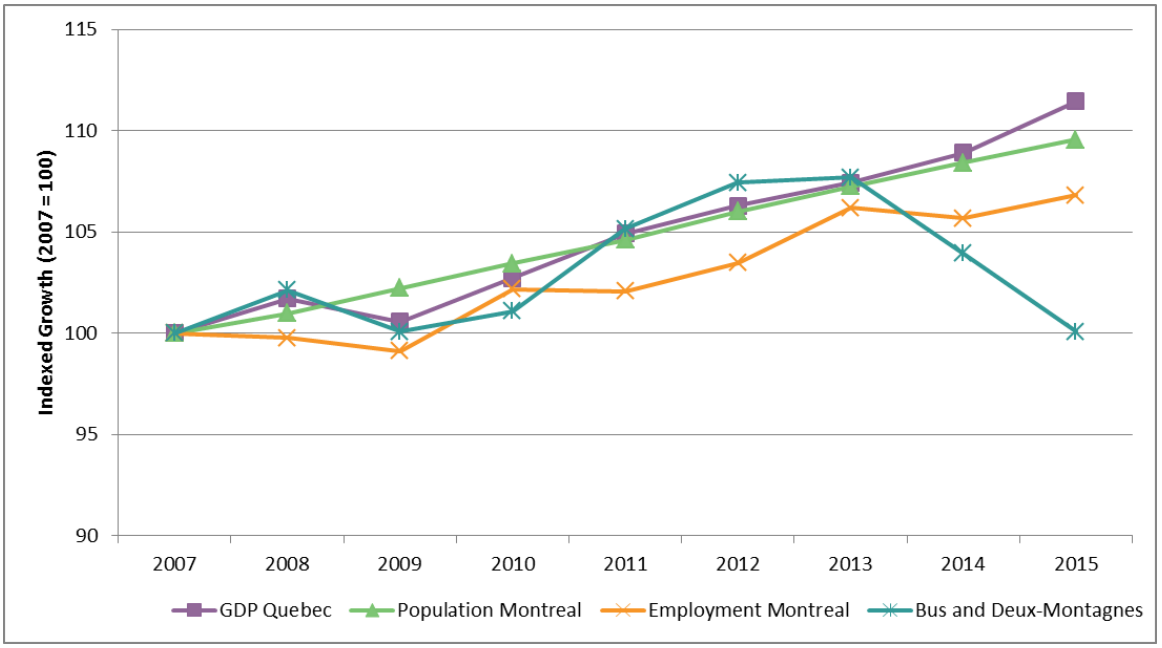
Demand Growth

West Island/Deux-Montagnes Line Transit Growth

Historical Growth

5.8 Steer Davies Gleave has analysed how transit demand has grown in the West Island/Deux-Montagnes Line corridor since 2007 and this has been compared to a range of socioeconomic parameters and shown below.

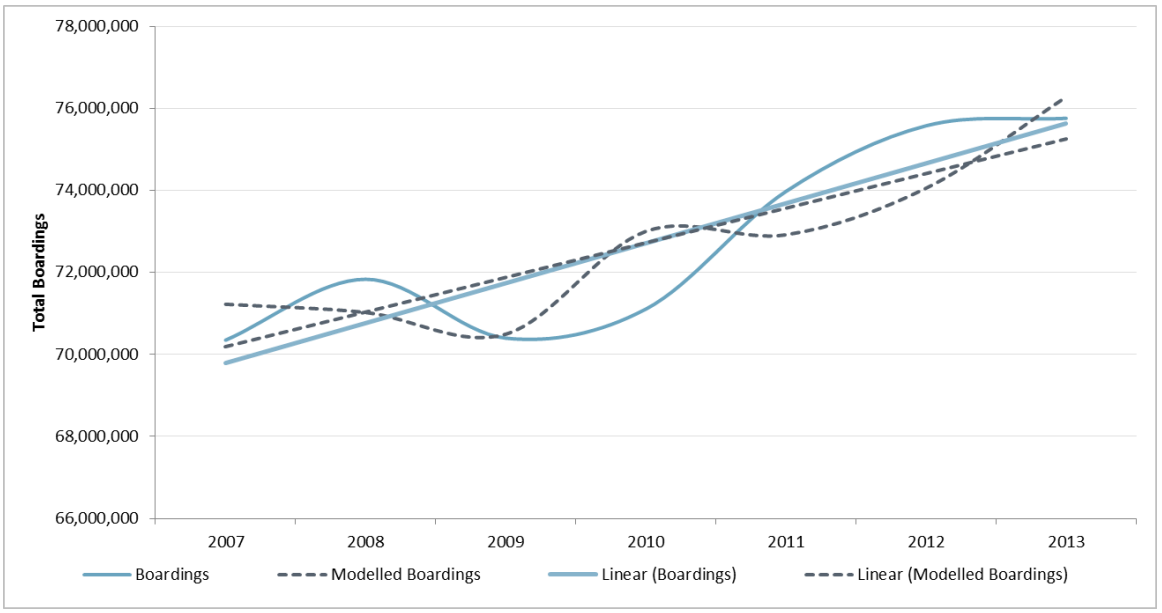
Figure 5-1: West Island/Deux-Montagnes Line Transit Ridership and Socio-economic Growth



Growth Model

5.9 Based on the relationship observed between transit boardings and the socio-economic indicators, a regression model was developed. Figure 5-2 shows the comparison of observed and modelled boardings for reference and the considerable year-to-year variations. We have also presented the growth as linear between 2007 and 2013 and this shows a close growth match.

Figure 5-2: West Island/Deux-Montagnes Growth Model Results

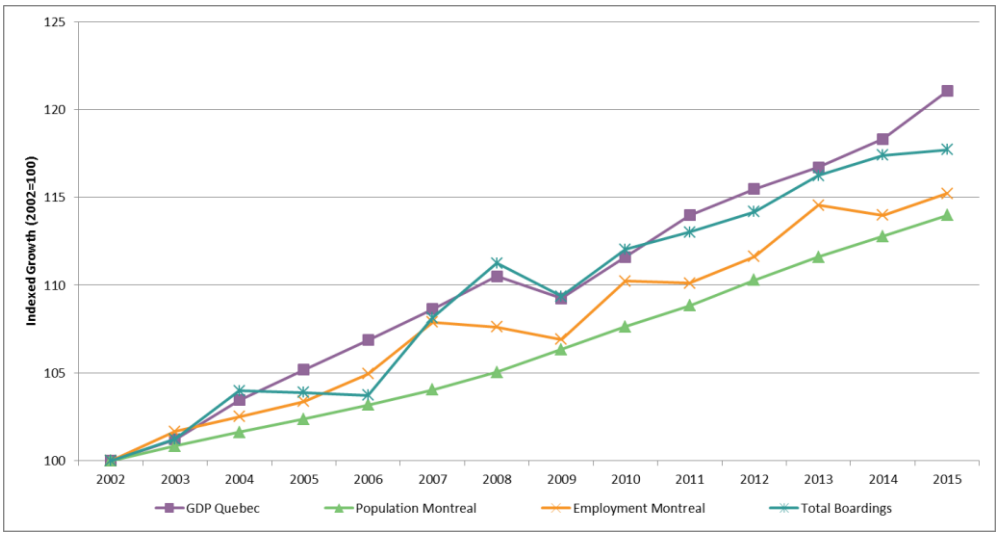


South Shore/A10 Corridor Transit Growth

Historical growth

5.10 Figure 5-3 shows a close correlation between boardings (for buses) and the various socio-economic parameters.

Figure 5-3: South Shore/A10 boardings and Socio-economic Parameters Growth

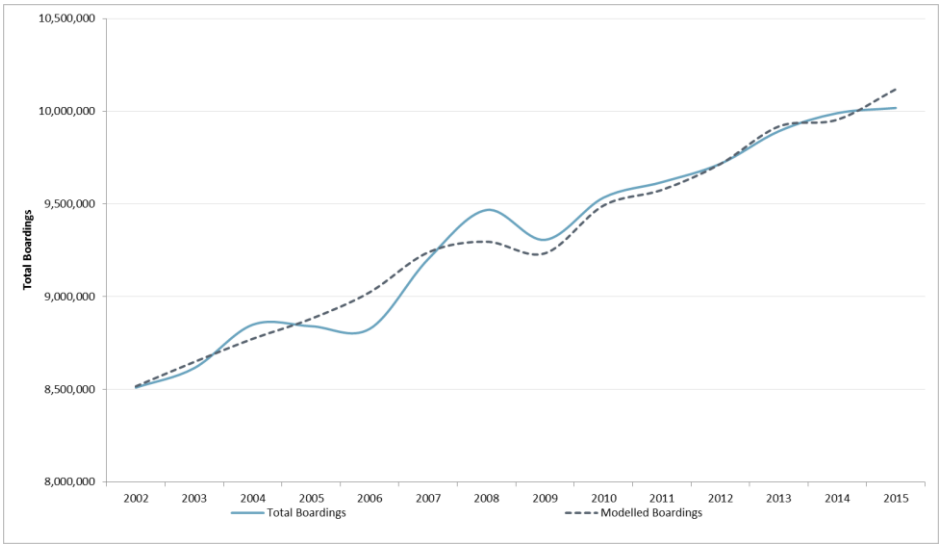


Growth Model

5.11 As with West Island/Deux-Montagnes Line passenger travel, a regression model has been developed between historical boardings and socio-economic indicators. Québec GDP and Greater Montréal's population and employment provided the best fit and the R^2 of the modelled versus observed ridership based on these parameters was estimated to be 0.97, which indicates a very close correlation of these parameters to transit demand.

5.12 Figure 5-4 shows the comparison of observed and modelled boardings for reference.

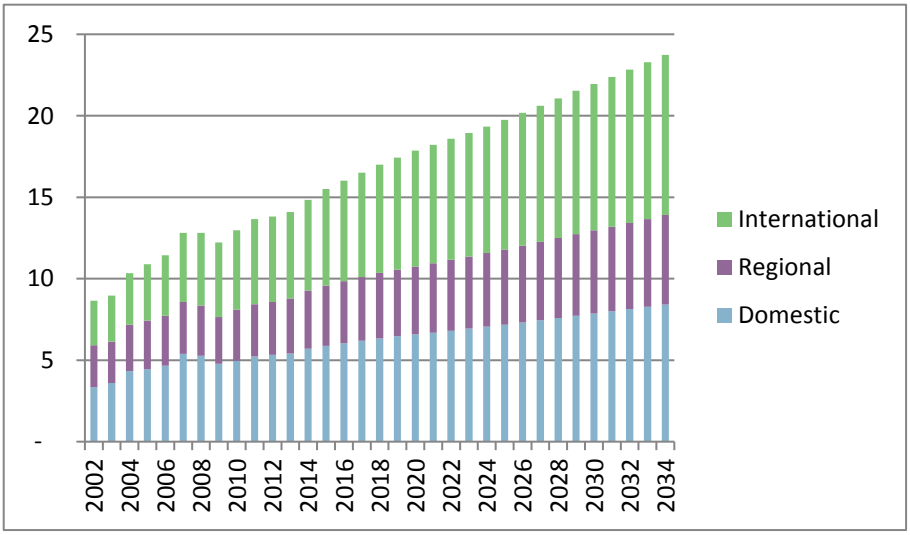
Figure 5-4: South Shore/A10 Growth Model Calibration



Airport Demand Growth

5.13 The Airport demand growth has been based on the forecasts provided by ADM as shown in Figure 5-5.

Figure 5-5: ADM Airport Growth Forecast (Passenger Millions)



Future Transit Matrix Development

Corridor Transit Growth

5.14 A transit growth base case scenario was developed using the regression models described above based on the identified key demand drivers - the independent variables. Socio-economic growth forecasts have been collected from different reliable sources and summarized in Table 5-3.

Table 5-3: Socio-economic Variables and Forecasts

Annual Growth	2016	2017	2018	2019	2020	2021	2021-2031
GDP	2.2%	1.8%	1.9%	2.0%	2.0%	1.9%	0.7%
Population	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.6%
Employment	0.8%	1.1%	1.0%	0.9%	0.8%	0.8%	0.6%

5.15 The application of the input parameters identified in Table 5-3 results in the following transit growth estimates as shown in Table 5-4.

Table 5-4: Transit Ridership Growth Estimates

CAGR	2015-2021	2021-2031
South Shore/A10 corridor	1.4%	0.9%
West Island/Deux-Montagnes Line corridor	1.0%	0.7%

Future Transit Matrix Development

Auto Future Matrix Development

5.16 Future auto matrices have been based on MTQ's forecast growth as contained in MOTREM. This distribution represents an in-depth analysis of land use and population changes across Metropolitan Montréal.

6 Model Calibration

Introduction

6.1 Calibration refers to the process undertaken to optimize the model performance by comparing the observed against modelled travel data to ensure the model represents current travel demand patterns in Metropolitan Montréal accurately. The calibration process is iterative and involves a review of network coding, demand levels and mode constants.

6.2 In order to represent more accurately the demand and transfers observed in the existing bus, rail and Métro network, the bus was penalized with increased mode constant and transfer penalties.

6.3 The changes included:

- Modal Constant
  - Rail/Métro: 0 minutes
  - Bus: 7.5 minutes
- Transfer Penalty
  - To rail modes: 4-minute transfer penalty (as per SP survey)
  - To bus: 7-minute transfer penalty

Traffic Model

6.4 MOTREM is a 24-hour traffic forecasting model. However, the focus of our work has been on the AM Peak (6am-9am) and Interpeak (9am-3pm) periods and these were calibrated to a 2015 fall weekday base year.

6.5 The calibration was carried out for the two screenlines shown previously. This allows us to understand the main auto demand on the REM corridors across each major screenline.

6.6 Table 6-1 to Table 6-4 show the resulting AM Peak and Interpeak auto traffic flow calibration. Note that calibration to individual road links can be challenging. We captured the overall traffic crossing the various screenlines to ensure a good match between modelled and observed total flows across screenlines and time periods (between -17% and +14% is the range of differences for the screenline totals by direction).

Table 6-1: Bridge Crossing Screenline (AM Peak)

AM PEAK	Direction	Observed Counts	Modelled Counts	Difference	% Difference
Champlain Bridge	To Montréal	18,275	17,558	-717	-4%
Champlain Bridge	From Montréal	7,961	7,255	-706	-9%
Honoré Mercier Bridge	To Montréal	9,801	10,273	472	5%
Honoré Mercier Bridge	From Montréal	3,735	4,496	762	20%
Victoria Bridge	To Montréal	7,120	7,472	352	5%
Victoria Bridge	From Montréal	One way only		-	-
Jacques Cartier Bridge	To Montréal	13,276	16,307	3,031	23%
Jacques Cartier Bridge	From Montréal	5,847	7,197	1,350	23%
Louis-Hippolyte Lafontaine Bridge-Tunnel	To Montréal	14,652	14,978	327	2%
Louis-Hippolyte Lafontaine Bridge-Tunnel	From Montréal	13,124	13,217	92	1%
Subtotal	*To Montréal*	*63,123*	*66,588*	*3,465*	*5%*
Subtotal	*From Montréal*	*30,668*	*32,166*	*1,498*	*5%*
TOTAL		**93,791**	**98,754**	**4,963**	**5%**

Totals may vary due to rounding

Table 6-2: Bridge Crossing Screenline (Interpeak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Difference
Champlain Bridge	To Montréal	20,807	18,397	-2,410	-12%
Champlain Bridge	From Montréal	20,584	21,231	647	3%
Honoré Mercier Bridge	To Montréal	11,882	12,164	282	2%
Honoré Mercier Bridge	From Montréal	11,280	14,795	3,515	31%
Victoria Bridge	To Montréal	3,815	2,028	-1,787	-47%
Victoria Bridge	From Montréal	3,887	1,148	-2,739	-70%
Jacques Cartier Bridge	To Montréal	14,664	16,110	1,446	10%
Jacques Cartier Bridge	From Montréal	13,594	20,169	6,575	48%
Louis-Hippolyte Lafontaine Bridge-Tunnel	To Montréal	20,366	19,059	-1,308	-6%
Louis-Hippolyte Lafontaine Bridge-Tunnel	From Montréal	20,799	22,959	2,160	10%
Subtotal	*To Montréal*	71,534	67,757	-3,777	-5%
Subtotal	*From Montréal*	70,144	80,303	10,159	14%
TOTAL		**141,678**	**148,060**	**6,382**	**5%**

Totals may vary due to rounding

Table 6-3: West Island Screenline (AM Peak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Diff
Pointe-Claire	EB1	11,316	14,374	3,058	27%
Pointe-Claire	EB2	10,741	12,046	1,305	12%
Pointe-Claire	WB	10,567	8,504	-2,064	-20%
Des Sources	WB1	7,357	6,226	-1,131	-15%
Des Sources	WB2	12,213	10,346	-1,867	-15%
Des Sources	EB1	12,718	13,686	967	8%
Des Sources	EB2	12,721	12,855	134	1%
Des Sources	EB3	18,270	14,872	-3,398	-19%
Subtotal	To Montréal	65,766	67,833	2,067	3%
Subtotal	From Montréal	30,137	25,076	-5,061	-17%
TOTAL		**95,903**	**92,909**	**-2,995**	**-3%**

Totals may vary due to rounding

Table 6-4: West Island Screenline (Interpeak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Diff
Pointe-Claire	EB1	15,522	15,157	-365	-2%
Pointe-Claire	EB2	10,954	10,433	-521	-5%
Pointe-Claire	WB	23,818	23,302	-516	-2%
Des Sources	WB1	14,942	12,661	-2,281	-15%
Des Sources	WB2	27,066	28,511	1,445	5%
Des Sources	EB1	28,229	11,486	-16,743	-59%
Des Sources	EB2	13,734	11,486	-2,248	-16%
Des Sources	EB3	13,897	24,891	10,994	79%
Subtotal	To Montréal	82,336	73,452	-8,884	-11%
Subtotal	From Montréal	65,826	64,474	-1,352	-2%
TOTAL		**148,162**	**137,926**	**-10,236**	**-7%**

Totals may vary due to rounding

Transit Model

Rail Loadings

6.7 AMT provided the loading profiles for all the rail lines in Montréal. A comparison of modelled versus observed rail loadings for Deux-Montagnes line are shown below. Note that the loading profile calibration focussed on the AM peak direction towards Montréal (as very limited services out of Montreal in the AM peak) and the inter peak.

Figure 6-1: Deux-Montagnes Line Load Profile – AM Peak towards Montréal

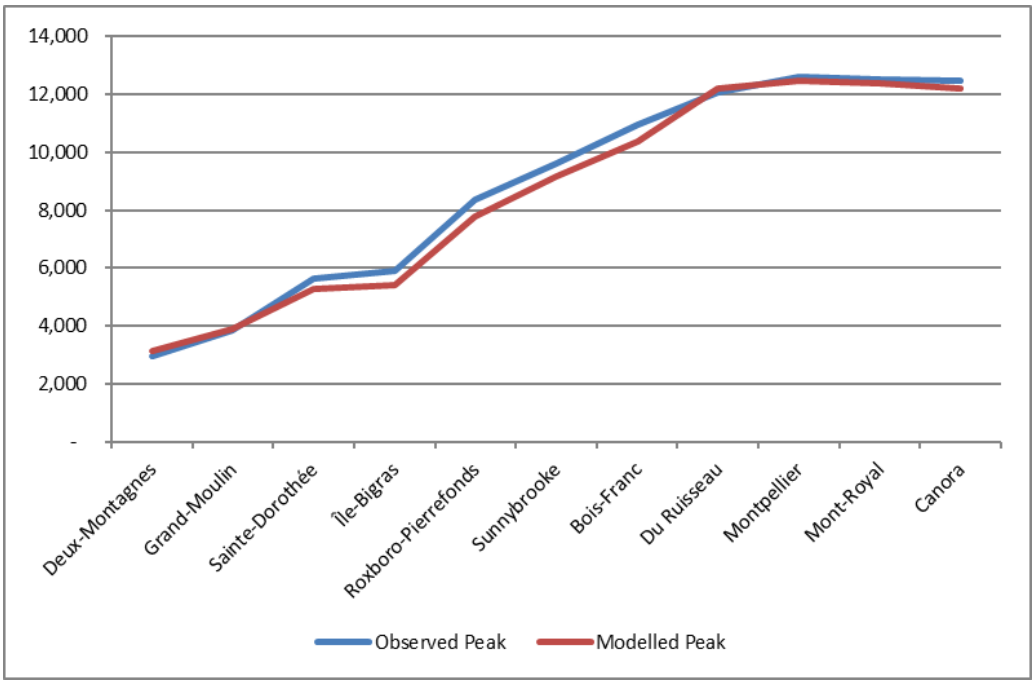


Figure 6-2: Deux-Montagnes Line Load Profile – Interpeak towards Montréal

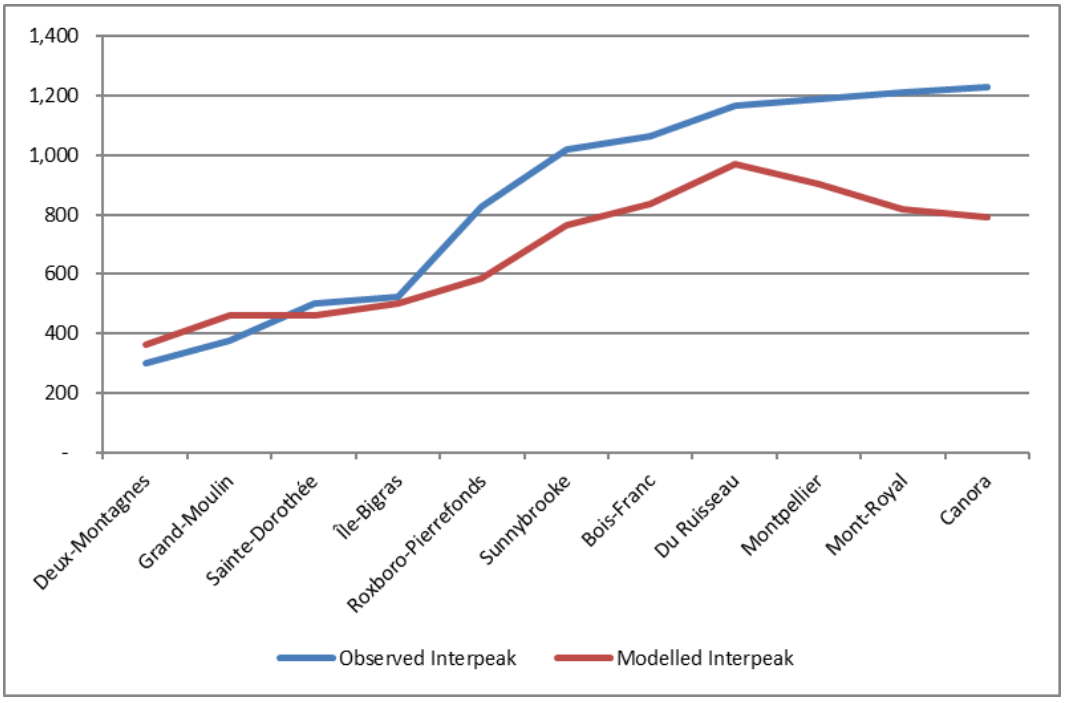
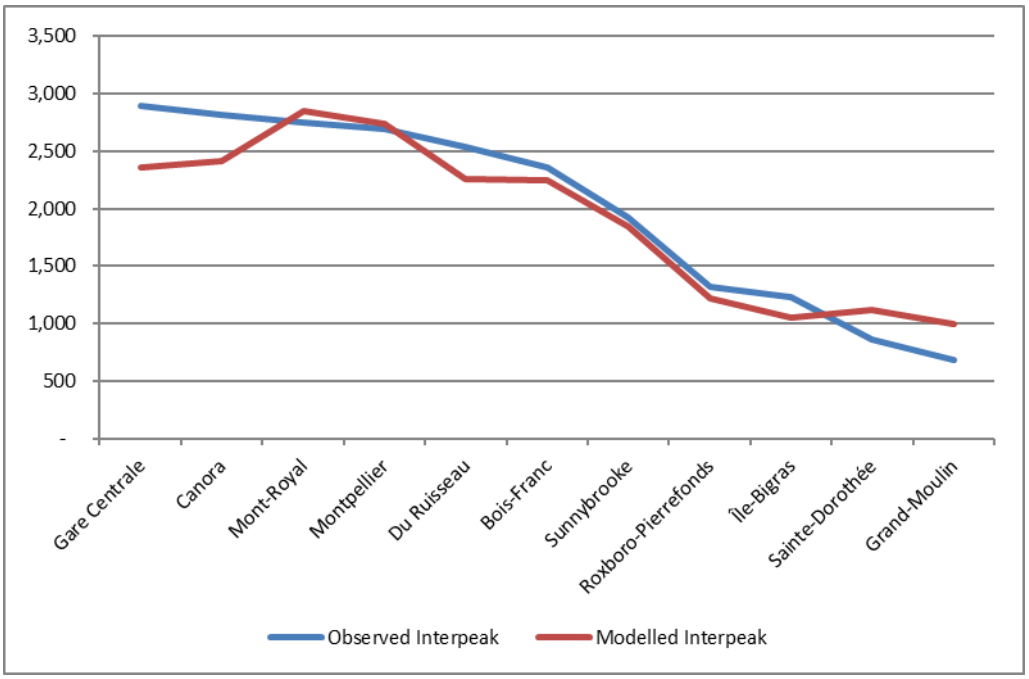


Figure 6-3: Deux-Montagnes Line Load Profile – Interpeak from Montréal



West Island/Deux-Montagnes Line Transit Boardings

6.8 Scatter plots comparing modelled and observed results for the AM Peak and Interpeak are shown below.

Figure 6-4: Transit Boarding Calibration – AM Peak Average Hour

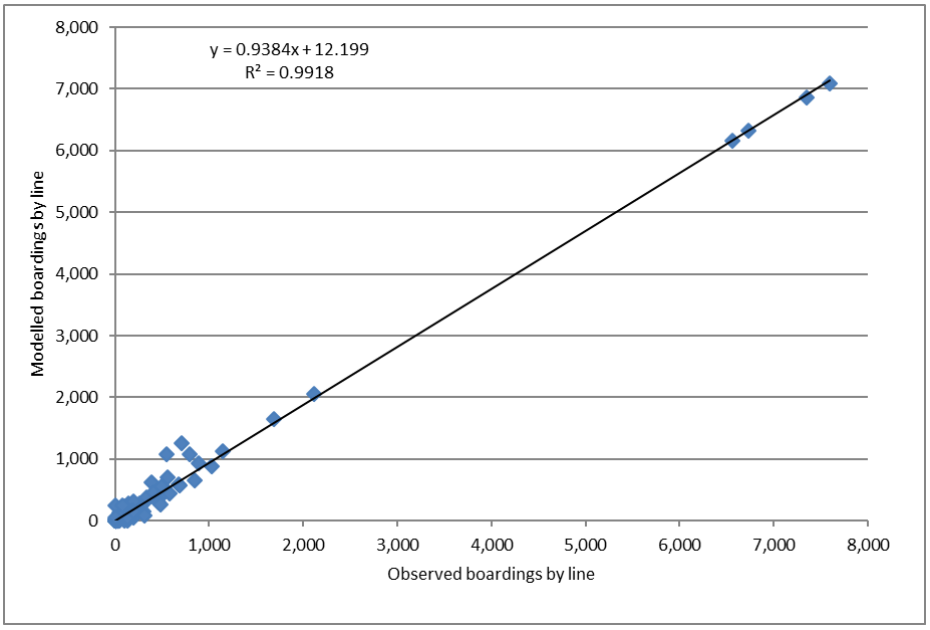
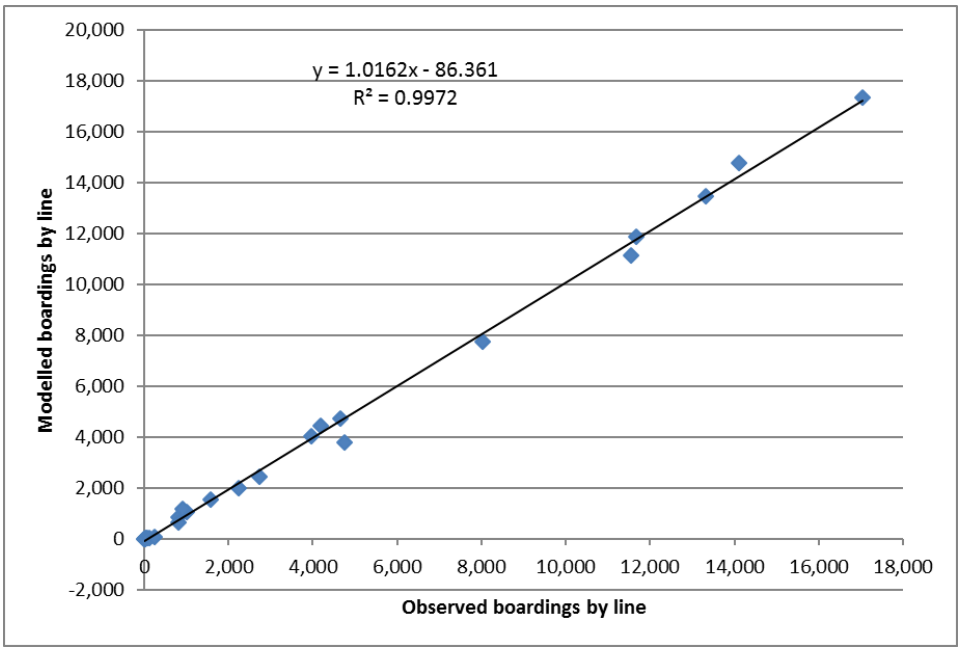


Figure 6-5: Transit Boarding Calibration – Interpeak Average Hour



Métro Station Calibration

6.9 Table 6-5 and Table 6-6 present the calibration of 3 Metro stations. The tables show a close match between modelled and observed volumes, with the exception of AM Peak boardings at McGill which are over-estimated.

Table 6-5: AM Peak Metro Station Calibration (2015)

Hourly	Modelled	Observed	Difference	Percentage	GEH
BOARDINGS					
Université de Montréal	125	145	-20	-14%	2
Édouard-Montpetit	77	104	-37	-26%	3
McGill	609	305	303	99%	14
ALIGHTINGS					
Université de Montréal	2,421	2,337	84	4%	2
Édouard-Montpetit	711	641	69	11%	3
McGill	5,379	5,379	238	5%	3

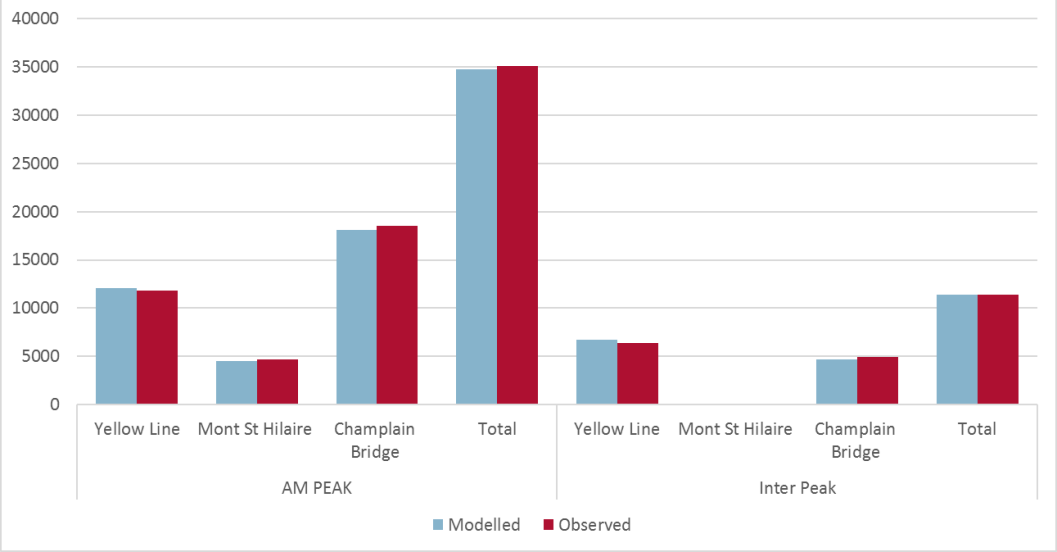
Table 6-6: Interpeak Metro Station Calibration (2015)

Hourly	Modelled	Observed	Difference	Percentage	GEH
BOARDINGS					
Université de Montréal	497	501	-4	-1%	0
Édouard-Montpetit	234	266	-32	-12%	2
McGill	1,119	1,282	-163	-13%	5
ALIGHTINGS					
Université de Montréal	965	1,082	-116	-11%	4
Édouard-Montpetit	385	432	-48	-11%	2
McGill	2,325	2,461	-136	-6%	3

Saint Lawrence River Transit Screenline

6.10 The South Shore/A10 screenline comparison is displayed in Figure 6-6 and it shows the model is predicting total transit demand across the Saint Lawrence accurately (within 5%) for the AM Peak and Interpeak periods, and just as importantly, with the correct assignment to each transit link across the river.

Figure 6-6: South Shore/A10 Transit Calibration



** Champlain Bridge observed demand includes all boardings on Saint Lawrence services*

Calibrated Transit Demand

6.11 The calibration of the various transit services presented above required the review and adjustment of transit services, travel times, mode constants and network coding (station connections, transfer distances, etc.) and a number of demand matrix adjustments.

6.12 The growth factors presented in Table 5-4 were applied to the 2015 final calibrated matrix and the totals are shown below.

Table 6-7: Transit Demand Matrices by Forecast Year

Period	Purpose	2015	2021	2031
AM Peak	Work	193,556	206,694	222,689
AM Peak	Study	116,224	124,542	134,368
AM Peak	Other	21,822	23,376	25,242
AM Peak Total		**328,069**	**331,602**	**354,612**
Interpeak	Work	69,225	74,914	81,429
Interpeak	Study	66,260	71,070	76,900
Interpeak	Other	232,730	249,427	269,525
Interpeak Total		**367,560**	**368,215**	**395,411**

7 REM Sponsor Case Forecasts

Sponsor Case Definition

7.1 REM competitiveness and resulting ridership forecasts will depend to a large extent on the various forecasting assumptions undertaken. These relate not only to the REM service itself, but also to the bus and rail network services and fares.

7.2 Table 7-1 describes the Sponsor Case Project Definition. This reflects the Sponsor assumptions of the most likely scenario, given the current engineering and operations analysis to date as well as discussions with a range of organizations (AMT, STM, Aéroports de Montréal) regarding bus restructuring and fare integration.

Table 7-1: Sponsor Case Project Definition

	Description	Assumption
Travel times	Deux-Montagnes to Rive-Sud	48:43
(includes dwell times)	Roxboro-Pierrefonds to Rive-Sud	38:47
	Sainte-Anne-de-Bellevue to Rive-Sud	48:58
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	41:12
	Correspondance A40 to Rive-Sud	25:38
Headways (AM Peak)	Deux-Montagnes to Rive-Sud	12
	Roxboro-Pierrefonds to Rive-Sud	12
	Sainte-Anne-de-Bellevue to Rive-Sud	12
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	12
	Correspondance A40 to Rive-Sud	20
Headways (Interpeak)	Deux-Montagnes to Rive-Sud	15
	Roxboro-Pierrefonds to Rive-Sud	-
	Sainte-Anne-de-Bellevue to Rive-Sud	15
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	15
	Correspondance A40 to Rive-Sud	-
Fares	As per current AMT fares	$2.01 to $5.19 (adult) $1.66-$4.00 (student)

	Description	Assumption
Fare, Airport	Current average airport fare ($3.15) with $5 premium	$8.15
Bus Re-Structuring	South Shore services re-directed to REM stations STM West Island bus network reconfigured	-
747 Express Airport Shuttle	Eliminated from service	-

7.3 In addition to REM and the bus service and fare assumptions identified above, there are a number of other model assumptions included in the Sponsor Case and these are detailed in Table 7-2.

Table 7-2: Sponsor Case Model Assumptions

Model Assumptions	Sponsor Case
Users' perception of REM	REM mode constant cannot be calibrated, but as mentioned in Section 4, given the reliability and quality of the system, it is expected that the mode constant should be similar to that observed to rail and Métro (0 minutes). However, given the uncertainty and the bias observed in the survey results, for the Sponsor Case we have assumed a mode constant penalty of 2 minutes against rail and Métro. Impact of mode constant penalty of 1 minute and 3 minutes on REM demand are presented in Appendix D.
Corridor growth (see Table 5-4)	CAGR / 2015-2021 / 2021-2031 South Shore/A10: 1.4% / 0.9% West Island/DM: 1.0% / 0.7%
Aéroport Pierre-Elliott-Trudeau Growth	CAGR / 2015-2020 / 2020-2034 Aéroport Pierre-Elliott-Trudeau: 2.9% / 2.1%
Expansion Factor (see Figure 4-3)	Varies depending on the AM Peak and Interpeak demand breakdown.
Ramp up	See below

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing DM	New	Existing 747	New	Existing Express (truncated)	New
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%

Sponsor Case Forecast Review (2015)

7.4 REM is expected to start operation in 2021 (February 2017 Report's base case assumptions). However, it is good practice to understand the impacts of REM in the base year (2015) to compare demand levels directly with the current situation and therefore assess and understand the robustness of the results.

7.5 REM will provide the Metropolitan Montréal region with a new, fast and reliable transit service with an enhanced level of service in the peak and Interpeak periods. As a result, it is expected that the new mode will capture demand not only from existing transit users, but also from other competing transit modes. Table 7-3 shows the total REM demand and where the trips have transferred from.

Table 7-3: REM Demand Captured by Market

	AM Peak		Interpeak		AM Peak + Interpeak	
	Passengers	Percentage	Passengers	Percentage	Passengers	Percentage
Airport Capture	927	2%	2,384	9%	3,311	4%
Auto Capture	3,467	6%		0%	3,467	4%
Transit Capture	50,688	92%	24,296	91%	74,984	92%
TOTAL	**55,082**	**100%**	**26,680**	**100%**	**81,762**	**100%**

7.6 The airport demand captured from existing competing modes has been estimated with the Airport model. Table 7-4 shows the majority of the demand is captured from the 747 Express Airport Shuttle and a considerable proportion (30%) is expected to shift from taxi and car Park & Fly passengers.

Table 7-4: REM Airport Demand Capture (2015)

AM Peak+ Interpeak	Bus		Taxi	Car Park & Fly		Car Kiss & Fly	Total
	747 passengers	Airport staff Local Bus	Passen-gers	Passen-gers	Airport Staff	Passengers	
Existing Demand	2,223	243	4,597	2,574	2,190	6,429	18,257
Demand which transfers to REM	1,859	26	761	331	5	331	3,312
REM Capture	**84%**	**11%**	**17%**	**13%**	**0%**	**5%**	**18%**

7.7 As shown in Table 7-5, it is expected that over 56% of REM demand will be existing transit demand that will shift from the 747 Airport Express Shuttle when the service ceases operation.

7.8

Table 7-5: REM Airport Demand Split

AM Peak and Interpeak	Passengers	Proportion
Existing 747	1,859	56%
Other modes	1,454	44%
Total	**3,313**	**100%**

7.9 Mode transfer from car to REM has been estimated with the auto shift model which estimates the user choice between auto, REM with transit access and REM with Park & Ride access. While the model shows a higher demand for Park & Ride access, this demand is constrained by the capacity of existing facilities in most of the corridor. The only exceptions are the new or extended facilities in the South Shore/A10 area and in some locations in the West Island (mostly along the Sainte-Anne-de-Bellevue Corridor). Table 7-6 shows the car shift demand estimates.

Table 7-6: REM Car Shift Capture (2015)

	AM Peak Boardings
South Shore/A10	360
West Island	1,740
Park & ride access	**2,100**
South Shore/A10	*540*
West Island	*820*
Transit access	**1,360**
TOTAL	**3,460**

7.10 Most of the REM demand is captured from existing transit services. This is particularly the case from those services that are replaced (for example the Deux-Montagnes Line) or truncated (South Shore/A10 express bus services) in order to be fully integrate with the REM. Table 7-7: shows that the demand currently using the A10 and Deux-Montagnes Line services represents over 60% of the total transit demand shifting to REM.

Table 7-7: REM Transit Demand Shift Capture (2015)

	AM Peak	Interpeak	AM Peak + Interpeak
A10 Express services*	16,458	8,262	24,721
Deux-Montagnes**	14,371	4,802	19,173
Other	19,858	11,232	31,091
REM Transit Capture* **	**50,688**	**24,296**	**74,984**
% Existing A10 and DM	61%	54%	59%

** Observed Data-Estimated number of passengers crossing Champlain Bridge (includes boardings at Gare Centrale)*
*** Observed Data-Number of boardings on DM (includes boardings at Gare Centrale)*
**** REM Modelled data-excludes car mode shift and demand from airport (including 747 Express Airport Shuttle)*

7.11 In summary, Table 7-8 shows the estimated number of boardings in the AM and Interpeak periods should the REM have been implemented in 2015. The number of boardings have been aggregated for all the stations located in the South Shore/A10 and West Island/Deux-Montagnes corridors. Gare Centrale has been included separately.

Table 7-8: 2015 AM Peak and Interpeak REM Boardings

REM section	AM Peak	Interpeak
South Shore/A10 stations*	22,425	6,129
West Island/Deux-Montagnes stations*	32,097	17,623
Gare Centrale	561	2,928
Total	**55,082**	**26,680**

** Data does not include boardings at Gare Centrale*

7.12 In summary:

- The South Shore/A10 corridor incremental demand is more moderate and in part driven by the additional Park & Ride capacity.
- However, it is the West Island/Deux-Montagnes corridor where the REM captures more additional demand, not only from car Park & Ride users, but mainly from transit users.

Sponsor Case Forecasts (2021 and 2031)

Peak and Interpeak Forecasts

7.13 The 2021 and 2031 REM demand has been estimated using the same methodology as the 2015 estimation presented above. The main differences are that demand has been increased to account for socio-economic growth in the region together with road and transit network changes identified.

7.14 Table 7-9: shows the AM and Interpeak REM demand captured from transit for 2021 and 2031.

Table 7-9: AM Peak and Interpeak REM Boardings

Period	REM Section	Demand by period			CAGR	
		2015	2021	2031	2015-2021	2021-2031
AM Peak	South Shore/A10 Stations	22,425	24,121	26,155	1.22%	0.81%
	West Island/Deux-Montagnes Stations	32,097	33,798	36,060	0.86%	0.65%
	Gare Centrale	561	596	637	1.01%	0.67%
	Total	**55,082**	**58,515**	**62,852**	**1.01%**	**0.72%**
Interpeak	South Shore/A10 Stations	6,129	6,652	7,220	1.37%	0.82%
	West Island/Deux-Montagnes Stations	17,623	19,162	20,649	1.41%	0.75%
	Gare Centrale	2,928	3,102	3,309	0.97%	0.65%
	Total	**26,680**	**28,916**	**31,178**	**1.35%**	**0.76%**

7.15 The resulting boardings and alightings for each station for 2021 and 2031 (AM and Interpeak) are shown below.

Table 7-10: AM and Interpeak Station Boardings and Alightings (2021 and 2031)

	2021				2031			
	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings
Bassin Peel	28	1,452	439	622	30	1,556	450	664
Île-des-Sœurs	286	522	21	91	306	560	24	100
Panama	14,049	303	3,412	1,964	15,298	337	3,749	2,152
Du Quartier	4,665	245	752	519	4,916	257	805	558
Rive-Sud	5,094	0	2,027	130	5,606	0	2,191	144
Technoparc Saint-Laurent	7	190	6	123	8	204	6	131
Aéroport Pierre-Elliott-Trudeau	718	659	1,225	1,618	851	872	1,474	1,959
Autoroute 13	339	424	123	151	445	536	137	167
Des Sources	765	293	917	706	823	311	987	751
Pointe-Claire	2,321	687	1,092	682	2,463	732	1,170	737
Kirkland	1,262	0	134	0	1,421	0	144	0
Sainte-Anne-de-Bellevue	1,048	39	337	35	1,114	42	358	37
Deux-Montagnes	3,326	94	543	1,161	3,483	100	599	1,260
Grand-Moulin	779	5	102	129	803	5	109	137
Ste-Dorothée	1,619	55	87	934	1,646	60	92	995
Île-Bigras	511	22	116	213	548	25	130	230
Roxboro-Pierrefonds	3,367	176	261	1,063	3,536	190	276	1,124
Sunnybrooke	1,743	89	236	757	1,823	94	251	787
Bois-Franc	4,083	1,021	2,515	1,563	4,361	1,113	2,732	1,757
Du Ruisseau	2,193	478	582	727	2,222	518	528	742
Montpellier	2,461	1,826	991	1,175	2,654	1,969	1,027	1,268
Mont-Royal	920	927	1,518	944	1,006	996	1,582	1,012
Correspondance A40	1,544	866	175	156	1,682	936	190	170
Canora	1,090	985	678	304	1,180	1,058	731	338
Édouard-Montpetit	2,217	5,001	2,046	2,280	2,382	5,387	2,173	2,443
McGill	1,483	15,005	5,480	5,358	1,606	15,982	5,953	5,583
Gare Centrale	596	27,151	3,102	5,511	637	29,011	3,309	5,931
TOTAL	**58,515**	**58,515**	**28,916**	**28,916**	**62,852**	**62,852**	**31,178**	**31,178**

Totals may vary due to rounding

7.16 The peak loads for 2021 and 2031 and in both the AM and Interpeak periods are observed on the link between Correspondence A40 and Mont-Royal. The link loads are summarized in Table 7-11.

Table 7-11: REM Section Load Flows

	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Rive-Sud - Du Quartier	5,094	2,027	5,606	2,191
Du Quartier - Panama	9,759	2,779	10,522	2,997
Panama - Île des-Sœurs	23,744	6,019	25,753	6,558
Île-des-Sœurs - Bassin Peel	23,899	6,028	25,919	6,571
Bassin Peel - Gare Centrale	23,035	6,202	24,990	6,752
Autoroute 13 - Technoparc Saint-Laurent	835	1,730	1,060	2,079
Technoparc Saint-Laurent - Aéroport Pierre-Elliott-Trudeau	659	1,618	872	1,959
Bois-Franc - Autoroute 13	1,946	3,157	2,159	3,603
Autoroute 13 - Des Sources	898	1,411	956	1,513
Des Sources - Pointe-Claire	726	717	774	774
Pointe-Claire - Kirkland	39	35	42	37
Kirkland - Sainte-Anne-De-Bellevue	39	35	42	37
Gare Centrale - McGill	8,851	4,714	9,591	5,074
McGill - Édouard-Montpetit	5,142	8,271	5,589	8,912
Édouard-Montpetit - Canora	3,175	8,347	3,461	8,989
Canora - Mont-Royal	3,103	8,434	3,385	9,084
Mont-Royal - Correspondance A40	2,856	8,545	3,115	9,194
Correspondance A40 - Montpellier	2,508	8,495	2,738	9,143
Montpellier - Du Ruisseau	2,071	7,890	2,276	8,515
Du Ruisseau - Bois-Franc	2,091	7,163	2,301	7,773
Bois-Franc - Sunnybrooke	294	4,182	318	4,454
Sunnybrooke - Roxboro-Pierrefonds	262	3,427	285	3,669
Roxboro-Pierrefonds - Île-Bigras	175	2,383	190	2,566
Île-Bigras - Ste-Dorothée	153	2,208	164	2,376
Ste-Dorothée-Grand-Moulin	98	1,290	106	1,397
Grand-Moulin - Deux-Montagnes	94	1,161	100	1,260
Gare Centrale – Bassin Peel	1,436	2,877	1,545	3,151
Bassin Peel - Île-des-Sœurs	875	2,520	948	2,756
Île-des-Sœurs - Panama	484	2,441	528	2,667
Panama - Du Quartier	245	650	257	703
Du Quartier - Rive-Sud	0	130	0	144
Aéroport Pierre-Elliott-Trudeau - Technoparc Saint-Laurent	718	1,225	851	1,474
Technoparc Saint-Laurent - Autoroute 13	711	1,221	843	1,469
Sainte-Anne-De-Bellevue - Kirkland	1,048	337	1,114	358
Kirkland - Pointe-Claire	2,310	471	2,535	502
Pointe-Claire - Des Sources	4,631	1,563	4,998	1,672
Des Sources - Autoroute 13	5,275	2,468	5,692	2,646
Autoroute 13 - Bois-Franc	6,114	3,676	6,587	4,096
Deux-Montagnes - Grand-Moulin	3,326	543	3,483	599

	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Grand-Moulin - Ste-Dorothée	4,105	645	4,286	708
Ste-Dorothée - Île-Bigras	5,723	715	5,932	783
Île-Bigras - Roxboro-Pierrefonds	6,235	793	6,480	873
Roxboro-Pierrefonds - Sunnybrooke	9,512	1,035	9,922	1,128
Sunnybrooke - Bois-Franc	11,197	1,269	11,684	1,377
Bois-Franc - Du Ruisseau	20,225	5,720	21,343	6,164
Du Ruisseau - Montpellier	21,920	6,302	23,021	6,692
Montpellier - Correspondance A40	22,991	6,725	24,169	7,080
Correspondance A40 - Mont-Royal	24,018	6,793	25,292	7,150
Mont-Royal - Canora	24,259	7,256	25,573	7,611
Canora- Édouard-Montpetit	24,436	7,542	25,771	7,909
Édouard-Montpetit-McGill	23,620	7,233	24,894	7,562
McGill-Gare Centrale	13,807	3,798	14,520	4,094

Daily and Annual Forecasts

7.17 The model estimates boardings by station and loadings per line section and direction for the AM Peak (6am-9am) and the Interpeak (9am-3pm) periods. We have applied the expansion factors presented previously to the AM Peak and Interpeak boardings extracted from the Transit Mode Choice Model and these are presented in Table 7-12.

Table 7-12: REM Daily and Annual Boardings (No Ramp Up)

	Daily		Annual	
	2021	2031	2021	2031
Bassin Peel	2,301	2,446	643,961	681,266
Île-des-Sœurs	875	941	193,128	208,082
Panama	18,303	19,975	4,525,585	4,945,106
Du Quartier	5,798	6,130	1,361,283	1,442,288
Rive-Sud	6,699	7,341	1,690,109	1,846,841
Technoparc Saint-Laurent	296	318	75,373	81,050
Aéroport Pierre-Elliott-Trudeau	4,606	5,648	1,275,913	1,564,506
Autoroute 13	964	1,199	236,716	288,131
Des Sources	2,349	2,516	820,635	878,667
Pointe-Claire	4,364	4,654	1,170,956	1,251,941
Kirkland	1,333	1,495	288,581	322,831
Sainte-Anne-De-Bellevue	1,359	1,443	331,359	351,941
Deux-Montagnes	4,705	4,991	1,221,885	1,305,696
Grand-Moulin	949	985	226,460	236,285
Ste-Dorothée	2,455	2,541	663,249	693,035
Île-Bigras	786	850	212,845	231,041
Roxboro-Pierrefonds	4,517	4,755	1,116,463	1,176,370
Sunnybrooke	2,586	2,705	682,340	713,647
Bois-Franc	8,274	8,968	2,374,394	2,589,817
Du Ruisseau	3,658	3,693	946,796	946,496
Montpellier	5,924	6,355	1,542,224	1,649,128
Mont-Royal	3,798	4,056	1,258,623	1,331,542
Correspondance A40	2,607	2,833	574,627	624,742
Canora	2,814	3,043	723,907	784,052
Édouard-Montpetit	10,527	11,299	2,834,121	3,036,463
McGill	24,826	26,462	6,815,345	7,260,882
Gare Centrale	33,934	36,289	8,159,512	8,730,753
TOTAL	**161,606**	**173,931**	**41,966,392**	**45,172,601**

Totals may vary due to rounding

7.18 With the ridership data extracted from the Transit Mode Choice model we can then estimate the passenger kilometres on REM by factoring individual link loads by the corresponding distance. The passenger kilometres estimates are shown below.

Table 7-13: REM Annual Passenger Kilometres (no Ramp Up)

	2021	2031
TOTAL	**608,453,632**	**653,748,003**

Ramp up

7.19 The ramp up has been applied to each of the initial years of operation. The application has been based on the estimation of the split between existing demand and new demand as different ramp up rates applied to reflect the fact that existing users are more likely to adopt and use the REM at a faster rate. The application of the assumptions shown above result in the estimated ramp up factors for the Sponsors Case shown in Table 7-14.

Table 7-14: Sponsors Case Overall Ramp Up Factors

	2021	2022	2023	2024
Annual Demand	74%	87%	94%	100%
Annual Passenger-Km	74%	87%	94%	100%

Ridership and Passenger Kilometres profile

7.20 Table 7-15 shows a summary of the ridership and passenger kilometres totals for 2021, 2026 and 2031 with the ramp up applied.

Table 7-15: REM Ridership and Passenger Kilometres Summary (with ramp up)

	2021	2026	2031
Daily			
Boardings	119,467	167,637	173,931
Passenger kilometres	1,743,484	2,428,409	2,517,174
Annual			
Boardings	30,961,199	43,535,017	45,172,601
Passenger kilometres	452,753,922	630,655,913	653,748,003

7.21 Figure 7-1 and Figure 7-2 show the resulting ridership and passenger kilometres forecast profiles accounting for ramp up which explains the high growth in the 2021 to 2024 period when the ramp up is applied as the REM starts operations and it becomes an integral part of Montréal's transit network.

Figure 7-1: Annual Ridership Profile (with ramp up)

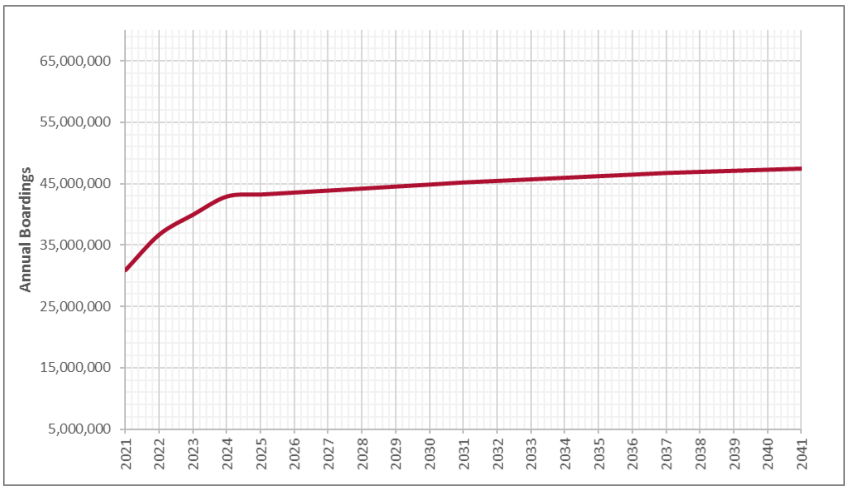
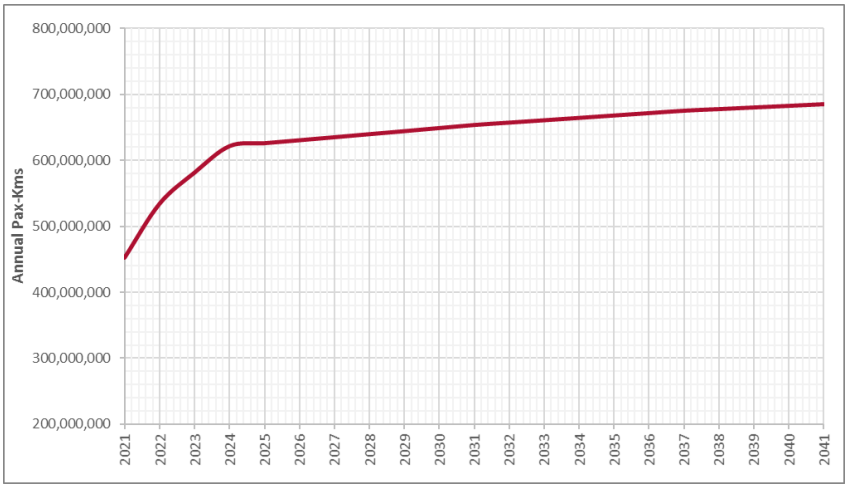


Figure 7-2: Annual Passenger Kilometres Profile (with ramp up)



8 Sensitivity Tests

Identified risks

8.1 REM is a transformational project that has been a priority project (separately as Champlain LRT, Train de l'Ouest and Aerotrain projects) for a long time. However, its development has stalled due to funding constraints.

8.2 The Sponsor Case reflects the sponsor assumptions of the most likely scenario, given the current engineering and operations analysis to date and latest discussions with a range of organizations. It also includes the consultant base assumptions for the model parameters and expected transit growth. However, there are a number of risks in any transit project and these need to be clearly identified to understand their potential ridership and operational impact. These include:

- Transit network: transit agencies (AMT, STM and CITs) are cooperating with CDPQ Infra Inc. to develop an integrated transit network. However, there is a risk on the level of transit integration and/or level of service to be implemented.
- Fare: there is some uncertainty with regards to the fare that will be charged on REM. The Sponsor Case assumes the REM fare will be similar to the current fare structure in Metropolitan Montréal. However, if different fares are assumed, for example if STM fares are applicable at REM stations on Montréal Island, REM fares will reduce overall and result in an increase in REM ridership at the expense of express buses and Métro lines.
- Demand growth: there are some concerns with regards to the recent decline in transit ridership observed in the last couple of years (especially on STM bus services). This may be a temporary effect (particularly cold recent winters, employment reductions and low gas prices) or a more fundamental shift resulting from competition from alternative modes (car sharing, cycling) or changes in travel patterns (working from home, online shopping, etc).
- Model parameters: this study has included a substantial data collection exercise and development of a demand forecasting model. However, every model requires a number of assumptions related to the behaviour of passengers, how they value the different travel components and passengers' perception of REM compared to other modes (bus, rail and Métro).

Low and High Case Definition

8.3 Following the various sensitivity tests indicated above, we developed Low and High cases to understand the combined effect of various assumptions and to aid understanding of the range in ridership forecasts around the Sponsor Case.

8.4 Table 8-1: presents the assumptions adopted for the Sponsor Case, compared to the High and Low Cases. Each case includes the combination of all the different assumptions adopted for each variable.

Table 8-1: Sensitivity Test Definition

	Description	Sponsor Case	Low Case	High Case
Travel times	Deux-Montagnes to Rive-Sud	48:43	56:01	Same as sponsor
	Roxboro-Pierrefonds to Rive-Sud	38:47	44:36	Same as sponsor
	Sainte-Anne-de-Bellevue to Rive-Sud	48:58	56:19	Same as sponsor
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	41:12	47:23	Same as sponsor
	Correspondance A40 to Rive-Sud	25:38	29:29	Same as sponsor
Fares	South Shore fares	As per current fares	Same as sponsor	Same as sponsor
Fares	West Island fares	As per current fares (REM as AMT in Montréal Island)	Same as sponsor	STM fares on REM in Montréal Island
Fare, Airport	Current average airport fare ($3.15) with premium	$8.15 ($5 premium)	Same as sponsor	$5.65 ($2.50 premium)
Bus Restructuring	South Shore services	South Shore services re-directed to REM stations	Same as sponsor	Same as sponsor
Bus Restructuring	STM West Island services	Bus network reconfigured	Bus network reconfigured with 20% decrease in frequency (if wait time is 10 mins or lower no decrease applied)	Bus network reconfigured with 10% increase in frequency
747 Express Airport Shuttle	Eliminated from service	Removed	Remains as current	Same a sponsor
REM perception	REM mode constant vs Metro/Rail	2 minutes	4 minutes	0 minutes
Growth		As modelled	-50% of modelled	+30% of modelled
Ramp up		See Table 8-3 below	See Table 8-3 below	See Table 8-3 below
Car shift		Auto Shift Model	30% reduction	30% increase

Table 8-2: Ramp Up Assumptions – Low and High Case

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing Deux-Montagnes Rail	New	Existing	New	Existing Express (Eliminated)	New
SPONSOR CASE						
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%
2025	100%	100%	100%	100%	100%	100%
LOW CASE						
2021	100%	55%	55%	55%	85%	55%
2022	100%	75%	75%	75%	90%	75%
2023	100%	85%	85%	85%	95%	85%
2024	100%	95%	95%	95%	100%	95%
2025	100%	100%	100%	100%	100%	100%
HIGH CASE						
2021	100%	70%	85%	70%	95%	70%
2022	100%	85%	95%	85%	100%	85%
2023	100%	90%	100%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%
2025	100%	100%	100%	100%	100%	100%

Ridership Forecasts

8.5 The full profile for ridership and passenger kilometres for the Low and High cases are shown in Figure 8-1 and Figure 8-2. Note that ramp up has been applied to these forecasts and hence the steep growth during the first few years of REM operations.

Figure 8-1: Annual Boardings – Low and High Cases (with Ramp Up)

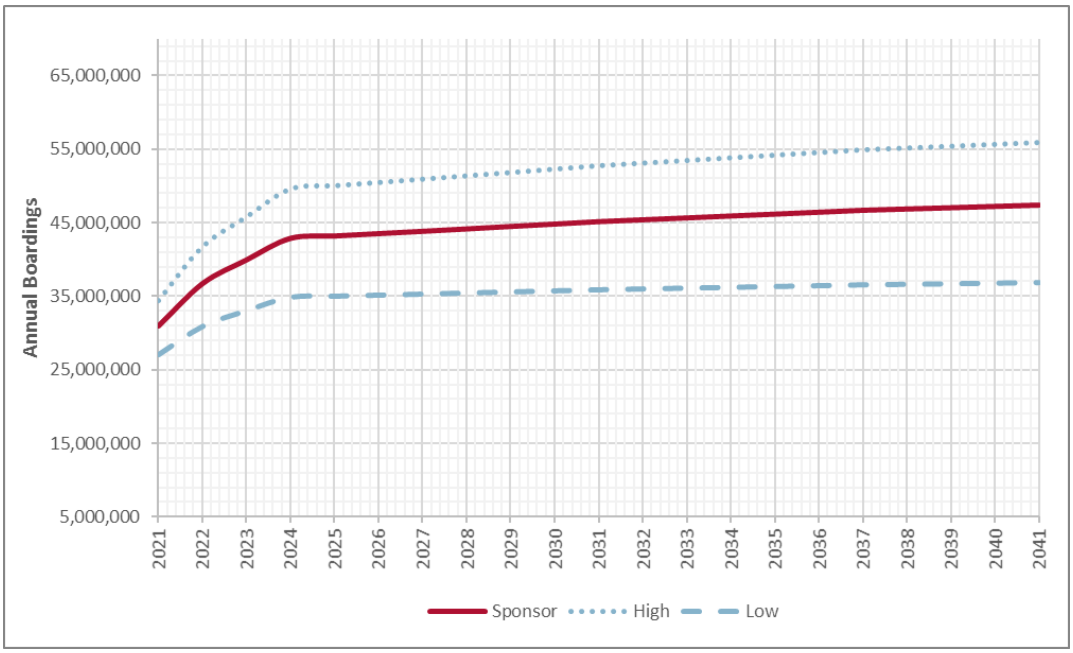
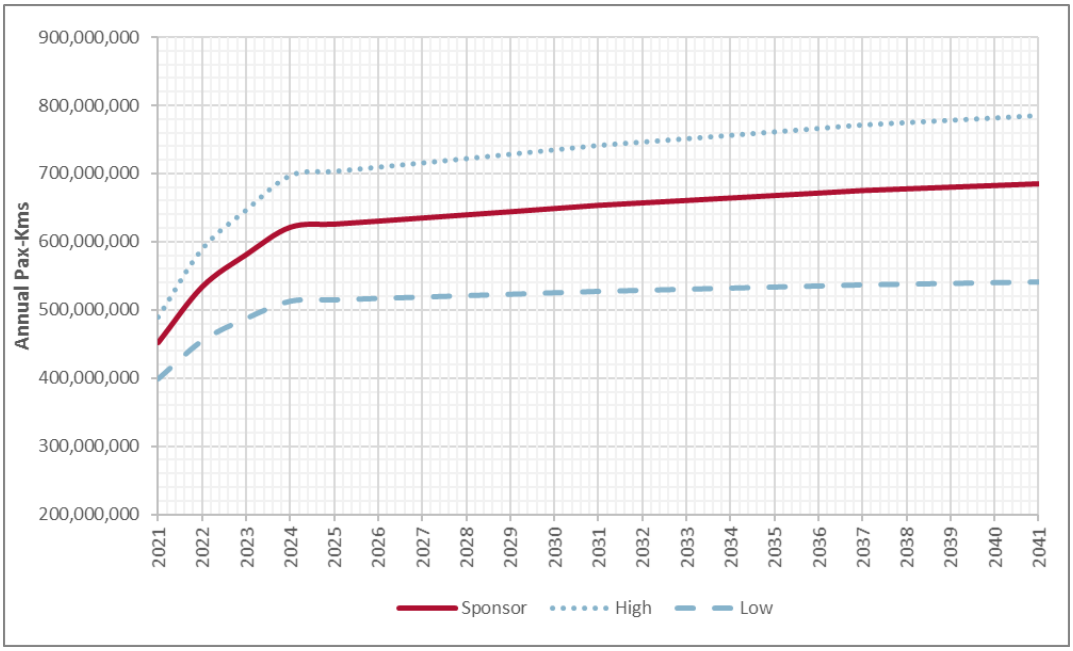


Figure 8-2: Annual Passenger Kilometre – Low and High Case (with Ramp Up)



8.6 Table 8-3 compares the results for 2021 and 2031. The larger difference observed in 2021 is due to the ramp up impact. Note that the change in boardings and passenger kilometres are closely aligned.

Table 8-3: Low and High Case Ridership Comparison

	Boardings		Passenger Kilometres	
	2021 (With Ramp Up)	2031	2021 (With Ramp Up)	2031
Sponsor	-	-	-	-
Low	-13%	-20%	-12%	-19%
High	+10%	+17%	+8%	+13%

8.7 Finally, we have reviewed the peak loads for the various cases to understand the impact on REM operations. The peak loads are detailed in Table 8-4.

Table 8-4: Low and High Case Peak Loads

	AM Peak Load (No Ramp Up)		Difference from Sponsor Case	
	2021	2031	2021	2031
Sponsor	23,899	25,919	-	-
Low	22,400	23,394	-6%	-10%
High	24,675	27,315	+3%	+5%

8.8 Due to the existing transit system being close to capacity in the peak periods, particularly on the Deux-Montagnes Line and the Terminus Centre Ville (TCV) for buses originating from the South Shore, the potential for growth in demand on these transit services is limited. The mode shift calculated could therefore hypothetically be more important than the forecasted demand growth due to the introduction of REM, which will result in a considerable increase in transit capacity that could hypothetically transfer additional demand from auto-based transportation to transit. Figure 8-3 and Table 8.5 show the impact of a range of mode transfer scenarios.

Figure 8-3: REM AM Peak Boardings with Differing Mode Shift

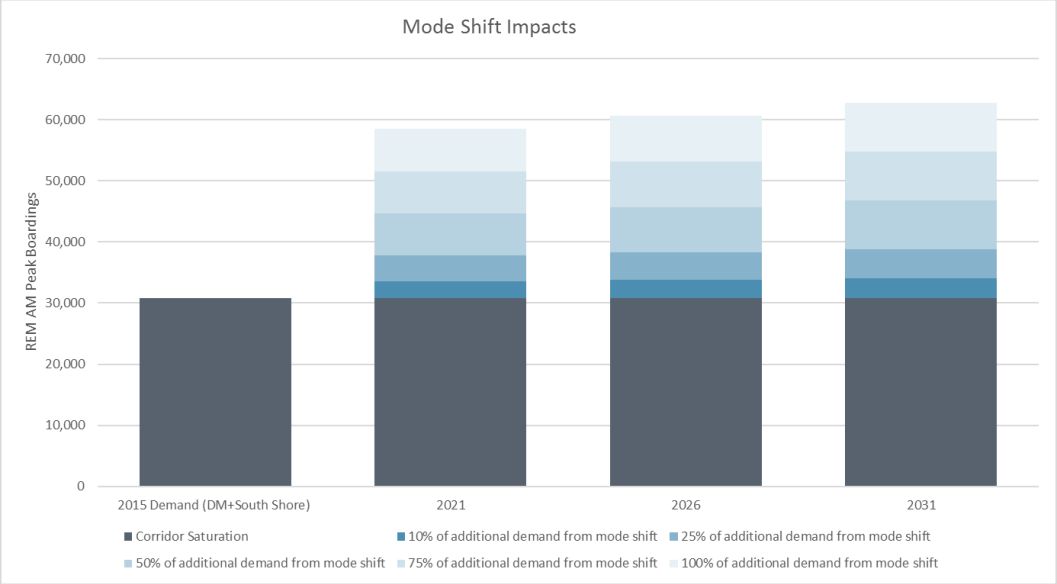


Table 8.5: REM AM Peak Boardings with Differing Mode Shift

	2015	2021	2026	2031
Demand (DM and South Shore)	30,829	30,829	30,829	30,829
10% of additional demand from mode shift		2,769	2,981	3,202
25% of additional demand from mode shift		4,153	4,471	4,803
50% of additional demand from mode shift		6,921	7,452	8,006
75% of additional demand from mode shift		6,921	7,452	8,006
100% of additional demand from mode shift		6,921	7,452	8,006
TOTAL	30,829	58,515	60,638	62,852

A REM Forecasting Changes

Background

This memo details the changes between the November 2016 and February 2017 reports and the impact on the REM ridership forecasts.

Steer Davies Gleave was appointed by CDPQ Infra Inc. to develop investment grade ridership forecasts for the Réseau Electrique Métropolitain (REM), a 67 kilometres light rail network in Metropolitan Montréal. This work was summarized in a preliminary report dated November 2016. Prior to the announcement of 3 additional REM stations, Steer Davies Gleave also developed preliminary demand forecasts which included these additional stations. The main objective of that work was to inform the initial dimensioning of REM to proceed with the engineering work required. Preliminary results indicated an overall increase in annual ridership ranging between 10% and 15%.

Network changes have occurred since the November report including:

- Three additional REM stations at Bassin Peel, McGill and Édouard-Montpetit. Two of which are major trip generators (McGill and Édouard-Montpetit)
- Revised REM travel times
- Two new connections between REM and Montréal Métro (Blue and Green lines)
- Refinement of bus connectivity at some stations
- Included Park & Ride capacity constraints

As a result of the various changes indicated above, a review of the forecasting model was carried out in order to account for the revised network and enlarged in-scope demand and revised forecasts were developed and included in the February 2017 ridership report.

Worth highlighting REM's impact on transit ridership:

- An estimated 10% demand capture from passengers transferring from the Orange Line to REM in the AM peak and Interpeak periods
- An improved transit demand distribution in the downtown area between Édouard-Montpetit, McGill and Gare Centrale stations
- An improved transit service throughout the day, particularly in the Interpeak
- Providing a better access to the East of the Island as result of connectivity to Blue and Green Metro lines

Model Re-Calibration

In order to reflect the new scope accurately, new transit data was gathered and collected, and the transit mode choice forecasting model was recalibrated accordingly:

- The introduction of the 3 additional REM stations expanded the previous in-scope demand to areas and services that were not calibrated in detail in the original model (Downtown and Université de Montréal areas).
- The new calibration includes a more detailed review of the demand associated with bus and Métro services in the Downtown and Université de Montréal areas. Passenger counts were

also undertaken to represent more accurately boarding and alighting at McGill (Green Line), Université de Montréal and Édouard-Montpetit (Blue Line) Métro stations.

- A more detailed review of the overall demand, particularly in the downtown area, showed that the model was overestimating bus boardings compared to Metro, and the model was not representing accurately the higher penalty that users allocate to bus due to service unreliability, especially when transferring to another bus service. Therefore, the recalibration process included adjustments to the bus mode constant to represent more accurately the overall network demand, and with an special focus in the downtown area (new in-scope demand).

Table 1 summarizes the mode constant changes.

Table 1: Mode Constant Adjustments

	November 2016	February 2017
Metro/Rail	0	0
Bus vs Metro/Rail	5	7.5
REM vs Metro/Rail	2	2

A memo summarizing the REM Mode Constant estimation is also available. Please refer to that document for further information.

Total Demand and Passenger-km Impact

Table 2 shows the impact on REM forecasts of the various model changes. There is an overall increase in daily and annual ridership (approximately 4 % and 6% in 2026 respectively). This demand includes:

- New demand captured by REM due to the improved accessibility to major destination centres; either University hubs or other destinations on the Blue and Green Metro lines. This is especially the case for South Shore trips.
- New demand generated between the REM and Metro connectors (McGill, Édouard-Montpetit, Gare Centrale).
- Lower demand in the South Shore due to Park & Ride capacity restrictions.

Table 2: February 2017 Ridership Summary

	2015 Current Ridership on existing networks *	2021 Projected ridership	2026 Projected ridership	2031 Projected ridership
AM Peak	43,902	58,515	60,638	62,852
Daily	119,688	161,606	167,637	173,931
Annual	30,730,985	41,966,392	43,535,017	45,172,601
Passenger-km	--	608,453,632	630,655,913	653,748,003

* Includes demand in the following services: 747, West Island Express Services, Deux-Montagnes, and A-10 bus services

Demand Impacts

The addition of the 3 stations not only results in an overall ridership increase, but also leads to a demand re-distribution between stations. Previously most of the demand from/to Downtown was concentrated in Gare Centrale station (and to lesser extent to Canora and Mont-Royal for access to universities) and now there is a major shift of demand to the new stations at McGill and Édouard-Montpetit. This is related to the major access benefits for users heading to the university hubs (Université de Montréal, HEC Montréal and École Polytechnique), transfers to the Blue and Green Metro lines and access to the northern section of the downtown core from McGill station.

The main differences between the November 2016 and February 2017 reports include:

- A large shift of demand from Gare Centrale, Canora, Correspondance A40 and Mont-Royal to the new stations at McGill and Édouard-Montpetit. The new stations provide direct connectivity to the Université de Montréal area, while in the November forecasts REM passengers needed to either walk a long distance or transfer to a bus. The new stations also improve substantially the access to other destinations along the Blue and Green Metro lines.
- Increased demand in South Shore stations due to the improved accessibility to universities and other destinations Downtown.
- The estimated demand in Rive-Sud station with Park & Ride access (in the AM peak) is lower than estimated in November 2016. While previous results showed total potential Park & Ride demand (for dimensioning purposes), the new results account for Park & Ride capacity constraints. This is consistent with a desire not to increase the interchange capacity other than for transit needs.
- Shift of demand (AM peak) between Bois-Franc and Du Ruisseau stations. This has been the result of demand adjustments and refinement of bus connectivity to each station.

- 2015 demand data used in the calibration of the Mascouche base model demand does not reflect the ramp up as the service opened in December 2014. Therefore, forecast boardings at Correspondence A40 station may be potentially underestimated although the impact on overall REM demand will be limited. Ridership data from AMT shows approximatively 80% of Mascouche Line alightings at Gare Centrale in the AM peak and the ridership projections show almost 80% of the Mascouche line users will transfer to the REM to get to Downtown Montreal.
- The slight decrease in demand observed between the two studies on Deux-Montagnes stations is the result of the new calibration, where the modelled demand for Deux-Montagnes is slightly lower than the observed demand. Note there is a considerable increase in ridership on the line with an increase by 2021 of 90% over 2015 demand levels for all Deux-Montagnes stations, including new stations at McGill, Édouard-Montpetit and Correspondence A40 (the increase is 54% when those stations are excluded).

B REM Mode Constant Summary

Introduction

The mode constant determines the mode preference of users to different transit modes (Metro, rail, REM and bus) given similar travel times and cost conditions. This memo provides a summary of the mode constant estimation and assumptions. All the material in this memo is included in the February 2017 forecasting report.

Mode Constant Estimation

The Stated Preference (SP) surveys enable to gauge passenger perceptions to current and 'new' transit modes (such as REM) and is one of the many components in a ridership study. SP survey responses were not in line with our professional experience or with extensive experience worldwide showing that passengers prefer rail-based to bus-based transit systems as result of the higher reliability, comfort (a smoother ride) and station facilities (shelter, lighting, seats, passenger information) of rail-based systems. While attempts were made to represent REM accurately in the SP survey, it is a 'new' mode in the region and respondents may be biased in their response or have a misconception of REM's potential benefits and scope. A critical review of SP survey results is an inherent part of the development of demand forecasts to ensure results are robust and in line with professional experience and results from other studies and therefore adjustment/review of SP survey results is a relatively common occurrence.

Table 1 summarizes the mode constant values presented in the February 2017 report.

Table 1: Mode Constant Assumptions

	Minutes
Metro/Rail	0
Bus vs Metro/Rail	7.5
REM vs Metro/Rail	2

Further analysis on survey responses presented in the report showed the survey results of only selecting 'traders' (people that chose the REM at least 1 time in the survey) and how the REM perception was more in line with our professional experience showing the likelihood that REM is perceived similarly to commuter rail and Métro and a 5 minute penalty for bus users to account for the reliability, comfort and station facilities offered by rail-based systems. The final bus, rail and Metro mode constant values were estimated as part of the base model calibration process where the observed and modelled traffic data is compared to ensure that current transit demand patterns in Metropolitan Montreal are replicated accurately.

Mode Constant Benchmarking

Appendix B in the February 2017 report presented evidence on rail mode constants from other studies and jurisdictions and a summary is presented in table below.

Table 2: Mode Constant Benchmarking

Source	Description	Values
Currie (2005)	Peer review of 9 different studies worldwide comparing Bus Rapid Transit, Light Rail and Heavy Rail versus On-Street Bus	Light Rail preferred to On-Street bus by an average of 10 minutes (range between 2 and 20 minutes)
Federal Transit Administration (2007)	Transit forecasting advice for US federal funding applications	Rail based modes specific effect over local bus by up to 15 minutes
SDG experience	5 LRT studies in the UK and Canada	Consistent passenger preference of Light Rail versus On-Street Bus

Source: Appendix B of February 2017 REM Forecasting Report

The table shows there is no 'standard' or 'exact' value on what a rail-based mode constant should be, but shows there is overwhelming experience confirming passenger preference of rail-based versus bus-based systems.

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