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Projet de réseau électrique métropolitain de transport collectif
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steer davies gleave

# Réseau électrique métropolitain (REM)

REM Forecasting Report
November 2016

CDPQ Infra Inc

Our ref: 22951101
Client ref: BC-A06438

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Prepared by:

Steer Davies Gleave
Suite 970 - 355 Burrard Street
Vancouver, BC V6C 2G8
Canada

+1 (604) 629 2610
na.steerdaviesgleave.com

Prepared for:

CDPQ Infra Inc
1000 Place Jean-Paul-Riopelle
Montréal QC H2Z 2B3

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# 1 Introduction

1.1 Steer Davies Gleave was appointed by CDPQ Infra Inc. to develop investment grade forecasts for the Réseau Electrique Métropolitain system (REM), a 67 kilometre light rail network in Métropolitan Montréal.

1.2 This report represents the study's third major deliverable and follows the Data Collection Report dated August 2016 and the Base Model Development report dated September 2016.

1.3 This report describes the REM specification, the existing in-scope demand, the methodological approach, data collection, demand forecasting framework and ridership forecasts. To provide context and added detail, some materials from the previous reports have been reproduced in this report.

## The Project

1.4 REM will be a fully automated transportation system, 67 km long, which will provide access to 24 stations. REM will transform the transit offer in the Greater Montréal Area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal and the West Island and Aéroport Pierre-Elliott-Trudeau.

1.5 Moreover, the definition of the project does not only include the REM network but will be complemented with a bus and rail reorganization and a Park & Ride network, which will fully integrate the REM with the rest of the transit and road network, increasing significantly its attractiveness.

## Report Structure

1.6 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 (Rive-Sud); 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 have 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, that is, 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 the system was in place today), 2021 and 2031;
- Section 8 defines the Low and High scenarios and the forecasts.

## Disclaimer

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*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 transform the transit offer in the Greater Montréal Area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal and the West Island and Montréal-Trudeau Aéroport Pierre-Elliott-Trudeau (referred to as the Aéroport Pierre-Elliott-Trudeau).

2.2 Moreover, the definition of the project does not only include the REM network but will be complemented with a bus and rail reorganization and a Park & Ride network, which will fully integrate the REM with the rest of the transit and road network, increasing significantly its attractiveness.

2.3 This section of the report describes the full specification of the project, including the characteristics of the REM, the Park & Ride network and the bus and rail restructuring.

2.4 REM will be a fully automated transportation system, 67 km long, which will provide access to 24 stations. Figure 2.1 shows the extent of the REM network.

**Figure 2.1: REM Network**

2.5 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 the Montréal Métropolitan region.

2.6 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 Rive-Sud, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau areas. Moreover, the dedicated tracks will allow for quick and uninterrupted travel and passengers will enjoy substantial travel time savings. The location of the stations and 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 | Canora | 5,410 | 05:05 | 64 |
| Canora | Mont-Royal | 820 | 01:30 | 33 |
| Mont-Royal | Correspondance A40 | 1,470 | 01:58 | 45 |
| Correspondance A40 | Montpellier | 940 | 01:37 | 35 |
| Montpellier | Du Ruisseau | 1,460 | 02:00 | 44 |
| Du Ruisseau | Bois-Franc | 1,720 | 02:07 | 49 |
| Bois-Franc | Sunnybrooke | 6,390 | 05:13 | 73 |
| Sunnybrooke | Roxboro-Pierrefonds | 2,170 | 02:50 | 46 |
| Roxboro-Pierrefonds | Île-Bigras | 3,450 | 02:58 | 70 |
| Île -Bigras | Sainte-Dorothée | 930 | 01:42 | 33 |
| Sainte-Dorothée | Grand-Moulin | 2,700 | 02:47 | 58 |
| Grand-Moulin | Deux-Montages | 2,200 | 02:33 | 52 |
| **Total** | | **29,660** | **32:20** | **55 (average)** |
| ***RIVE-SUD*** | | | | |
| Gare Centrale | Île-des-Soeurs | 5,050 | 04:57 | 61 |
| Île-des-Soeurs | Panama | 5,410 | 04:36 | 71 |
| Panama | Du Quartier | 3,670 | 03:20 | 66 |
| Du Quartier | Rive-Sud | 1,030 | 01:34 | 55 |
| **Total** | | **15,570** | **14:27** | **65 (average)** |
| ***SAINTE-ANNE-DE-BELLEVUE*** | | | | |
| Bois-Franc | Autoroute 13 | 4,440 | 03:58 | 67 |
| Autoroute 13 | Des Sources | 3,780 | 03:25 | 66 |
| Des Sources | Pointe-Claire | 4,130 | 03:42 | 67 |
| Pointe-Claire | Kirkland | 2,580 | 02:49 | 55 |
| Kirkland | Sainte-Anne-de-Bellevue | 4,280 | 03:45 | 68 |
| **Total** | | **19,210** | **17:39** | **65 (average)** |
| ***AÉROPORT PIERRE-ELLIOTT-TRUDEAU*** | | | | |
| Autoroute 13 | Technoparc Saint-Laurent | 2,500 | 02:55 | 51 |
| Technoparc Saint-Laurent | Aéroport Pierre-Elliott-Trudeau | 2,780 | 02:53 | 58 |
| **Total** | | **5,280** | **5:48** | **55 (average)** |
| ***REM NETWORK*** | | | | |
| **TOTAL** | | **67,200** | **70:14** | **60 (average)** |

*Note: Dwell time assumed is 30 seconds for all stations except for Gare Centrale and Panama where it is 40 seconds*
*The total distance accounts for double tracking*

2.7 REM will provide enhanced frequencies to the Deux-Montagnes corridor (services every 12 minutes) compared to the existing AMT rail service. It will also introduce very frequent services to the Rive-Sud 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 Orange Lineline. Table 2.2 shows the key frequency assumptions.

**Table 2.2: REM Operating Assumptions**

| Route | Headway (mins) | | Travel time (mins) |
|---|---|---|---|
| | AM (6am-9am) | Inter Peak (9am-3pm) | |
| Deux-Montagnes to Rive-Sud | 12 | 15 | 46:47 |
| Roxboro-Pierrefonds to Rive-Sud | 12 | - | 36:47 |
| Sainte-Anne-de-Bellevue to Rive-Sud | 12 | 15 | 46:23 |
| Aéroport Pierre-Elliott-Trudeau to Rive-Sud | 12 | 15* | 38:30 |
| Correspondance A40 to Rive-Sud** | 20 | - | 23:00 |
| **Peak Headways per period** | **2mins 40sec. From Correspondance A40 to Rive-Sud** | **5 mins From Gare Centrale to Rive-Sud** | - |

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

*** In the AM peak it is assumed a new additional service from Correspondance A40 to cover the demand alighting from the Mascouche Line service*

2.8 As a result of this operating plan, the headway from Bois Franc to Correspondance A40 is 3 minutes in the AM peak and this improves further to 2 minutes 40 seconds between Correspondance A40 and Rive Sud. In the Inter Peak period the peak headway is 7 minutes and 30 seconds from Bois Franc to Gare Centrale and this increase to 5 minutes between Gare Centrale and Rive Sud). Therefore, the REM network will provide a new, direct and frequent transit alternative to users with an origin or a destination within the 2 branches of the U-shaped Orange Line as shown in Figure 2.2.

**Figure 2.2: REM and Montréal's transit network**


*Note: Map includes potential station locations*

2.9 In summary, REM will not only provide an additional service to critical corridors in the Métropolitan area (Deux-Montagnes, Rive-Sud, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau), but it will also provide a new alternative to the Métro Orange Line to access Downtown Montréal.

## Park & Ride network

2.10 Another change brought about as a result of the introduction of the REM network is changes to the Park & Ride provision. Table 2.3 provides a summary of the current and future Park & Ride provision for the REM network.

**Table 2.3: Park & Ride Assumptions**

| Stations | Current Capacity | REM Capacity |
|---|---|---|
| Gare Centrale | 0 | 0 |
| Canora | 0 | 0 |
| Mont-Royal | 0 | 0 |
| Correspondance A40 | - | 0 |
| Montpellier | 0 | 0 |
| 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 |
| Île-des-Soeurs | - | 0 |
| Panama | 962 | 700 |
| Du Quartier | - | 0 |
| Rive-Sud | - | 3,000 |
| Autoroute 13 | - | 500 |
| Des Sources | - | 500 |
| Pointe-Claire | - | 700 |
| Kirkland | - | 500 |
| Sainte-Anne-De-Bellevue | - | 2,000 |
| Technoparc Saint-Laurent | - | 0 |
| Aéroport Pierre-Elliott-Trudeau | - | 0 |
| **TOTAL** | **6,926** | **13,550** |

*Source: CDPQ technical team and AMT 2015 annual report*

## Rail Network Reorganisation

2.11 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 service 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

2.12 The introduction of REM will be complemented with a full reorganization of the transit network in the South Shore/A10 and the West Island/Deux-Montagnes Corridors. The extent of the bus reorganization has been defined by the Agence métropolitaine de transport (AMT) in collaboration with the various Conseil intermunicipal de transport (CITs) and Société de transport de Montréal (STM) in order to optimize the system by avoiding duplication of services, and increasing the network coverage and service levels. This section summarizes the future bus network reorganization assumptions.

### South Shore/A10 Corridor

2.13 The South Shore bus network reorganisation 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 in the most accessible REM station.

2.14 Since February 2016, the definition of the REM alignment and the location of some of the stations has been optimized. At the time of writing this report, AMT has not been able to account for the optimized REM network, therefore, adjustments to the original AMT assumptions have had to be undertaken. The key assumptions include:

- ***Station Assumptions***
  - Our approach has been to maintain AMT assumptions, unless the terminal station had been modified with the new scope of REM. Table 2.4 summarises the key changes in stations since February 2016, which has been the basis for our adjustments.

**Table 2.4: REM Station Changes**

| Initial REM Assumptions (basis for AMT restructuring proposal) | Current REM Design |
|---|---|
| Grande-Allée | Rive-Sud |
| Du Quartier | Du Quartier |
| Chevrier | Chevrier (potential) - not included in scope |
| Panama | Panama |
| Île-des-Soeurs | Île-des-Soeurs |
| Saint-Patrick | Du Havre (potential) - not included in-scope |
| Griffintown | Griffintown (potential) - not included in-scope |
| De la Cathédrale | Gare Centrale |

*Note: Stations might not be at exactly the same location.*

  - When no information was available for a specific service between the South Shore and Centre-Ville, it has been assumed that the service will be truncated, terminating at the closest REM station[1].
- ***Level of service***:
  - There are gaps in the AMT plan with regards to the level of service during the off-peak period. It has been assumed that headways will remain as current.

**West Island/Deux-Montagnes Line**

2.15 Assumptions regarding the West Island bus network reorganisation are based on the preliminary assumptions provided by STM in September 2016. 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.

2.16 The following summarizes Steer Davies Gleave's understanding of the STM proposed bus network reorganisation:

- **Route assumptions:**
  - Most routes are maintained with some alignment modifications that better serve existing communities and feed the REM service.
  - 17 services are deleted (8 of them are express services) and 14 new services are created. These new services directly feed REM.
- **Level of service:**
  - For most of the remaining services, levels of service during peak periods increase and stay relatively the same during the inter peak.
  - Levels of service for the new routes during the peak period are high and similar to current express services headways (lower than 12 minutes and average of 8 minutes).

2.17 STM did not provide Inter Peak frequencies for the new routes. A factor based on current peak and inter peak levels of service in the West Island has been assumed. Table 2.5 shows the changes introduced to Express services.

[1] This assumption might impact parking demand and number of bus terminals required for each station.

**Table 2.5: West Island Express Service Modifications**

| Express routes in Scope | Route deleted in 2021 | Current Connections to Deux-Montages Line (DM) and Orange Line (OL) | Assumed connections with REM in 2021 | Assumed connections with the Orange Line in 2021 | Daily demand (October 2015) |
|---|---|---|---|---|---|
| 401 | YES | None | None | None | 277 |
| 405 | YES | None | None | None | 2,495 |
| 407 | NO | Roxboro-Pierrefonds (DM) | Roxboro-Pierrefonds & Pointe-Claire | None | 414 |
| 409 | YES | Du College (OL) | None | None | 1,442 |
| 411 | YES | Lionel-Groulx (OL) | None | None | 1,333 |
| 419 | NO | None | Sainte-Anne-de-Bellevue, Kirkland & Pointe-Claire | None | 1,929 |
| 425 | YES | None | None | None | 1,053 |
| 460 | NO | Du College Sud (OL) & Crémazie (OL) | Technoparc Saint-Laurent | Du College Sud & Crémazie | 7,192 |
| 468 | YES | Roxboro-Pierrefonds (DM) | None | None | 2,715 |
| 470 | NO | Côte-Vertu (OL) | Pointe-Claire & Des Sources | Côte-Vertu | 10,701 |
| 475 | YES | Côte-Vertu (OL) | None | None | 374 |
| 485 | YES | Lionel-Groulx (OL) | None | None | 2,090 |
| 491 | NO | Lionel-Groulx (OL) | None | Lionel-Groulx | 2,106 |
| 495 | NO | None | Aéroport Pierre-Elliott-Trudeau | None | 2,977 |
| 496 | NO | Lionel-Groulx (OL) | Aéroport Pierre-Elliott-Trudeau | Lionel-Groulx | 4,306 |
| **Total** | | | | | **41,404** |

2.18 As previously mentioned, STM's future network in the West Island is designed to feed REM. 46 routes of 55 have a connection with at least one REM station and 13 of them connect with 2 or more stations. Table 2.6 summarizes the number of routes that serve each REM station in West Island.

**Table 2.6: Bus connections with REM stations (2021)**

| Station | Number of connections at each station |
|---|---|
| Roxboro-Pierrefonds | 6 |
| Sunnybrooke | 2 |
| Bois-Franc | 3 |
| Du Ruisseau | 4 |
| Montpellier | 4 |
| Correspondence A40 | 3 |
| Mont-Royal | 2 |
| Canora | 1 |
| Autoroute 13 | 5 |
| Des Sources | 4 |
| Pointe-Claire | 13 |
| Kirkland | 4 |
| Sainte-Anne-de-Bellevue | 4 |
| Technoparc Saint-Laurent | 2 |
| Aéroport | 5 |
| **total** | **62** |

*Note: There are more connections than bus routes in the West Island because some routes have multiples connections to REM.*

2.19 STM also operates 747 Express Airport Shuttle. However, it has not provided any assumption 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 has assumed that this service will be eliminated from service.

## Fare Assumptions

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

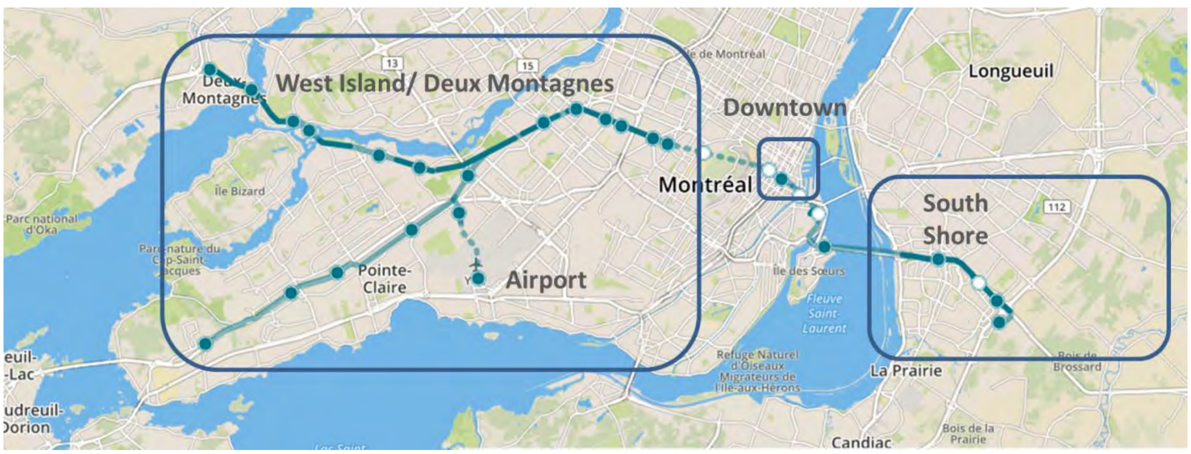
2.21 The only major modification would be related to the REM airport branche, where fares have been assumed to be $5 higher compared to the current 747 average fare.

# 3 Current situation

## Background

3.1 The REM project will transform the transit offer in the Greater Montréal Area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal, the West Island, City of Deux-Montagnes and the Aéroport Pierre-Elliott-Trudeau (ADM).

**Figure 3.1: REM project**




3.2 Although REM will be fully integrated, it will service three very 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.

3.3 This section describes the characteristics of each of these markets, the existing demand patterns for transit and auto, how this demand is currently served by the transport network and current transit fares. We discuss each market separately by auto and transit mode in the following sections.

## South Shore/A10 Market

### Introduction

3.4 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).

3.5 The South Shore is the general term for the suburbs of Montreal located on the southern shore of the Saint Lawrence River opposite the Island of Montreal. It includes 26 municipalities and covers 1640.05km[2]. With a total population of 919,000 residents, the South Shore represents 23% of the population in the Greater Montréal. Near half of the population of the South Shore is located in Longueil agglomeration which includes the cities of Longueil, Brossard, Boucherville, Saint-Bruno-de-Montarville and Saint-Lambert. According to the most recent estimates from the Institut de la Statistique du Québec, the demographic growth rate in the South Shore is greater than on the Island of Montréal. The population is expected to gain 127,950 new residents by 2031[2].

3.6 In 2011, 298,200 jobs (16 % of the employment of the Greater Montréal region) were located in the South Shore while more than two third of the total employment (1,86 million) is located on the Island of Montreal. With more than 250,000 jobs within less than 18km$^2$, Downtown Montreal is the biggest employment hub of the region and the province[3].

3.7 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.

3.8 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 the region for auto and transit users. We describe the existing auto and transit users and current transport provision in the following sections.

### Auto Users

3.9 There are limited crossings across the St Lawrence River, which results in bottlenecks to access Downtown Montréal at these locations, especially during the peak periods.

3.10 Figure 3-2 shows the most important five crossings from the South Shore.

[2] Communauté métropolitaine de Montréal. 2016. *Portrait of Greater Montréal*. Issue Nº5, p.41.
[3] Ville de Montréal. 2013. *Analyse économique: L'emploi à Montréal de 1981 à 2011*, p.2

**Figure 3-2: Saint-Laurent River Crossings**


*Source: Steer Davies Gleave*

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

**Table 3-1: 2013 Saint-Laurent River crossing traffic volumes**

| Screenline Num. | Name | Direction | 6am-9am (3 hours) | 9am-3pm (6 hours) |
|---|---|---|---|---|
| 1 | Louis Hippolyte Lafontaine 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** |

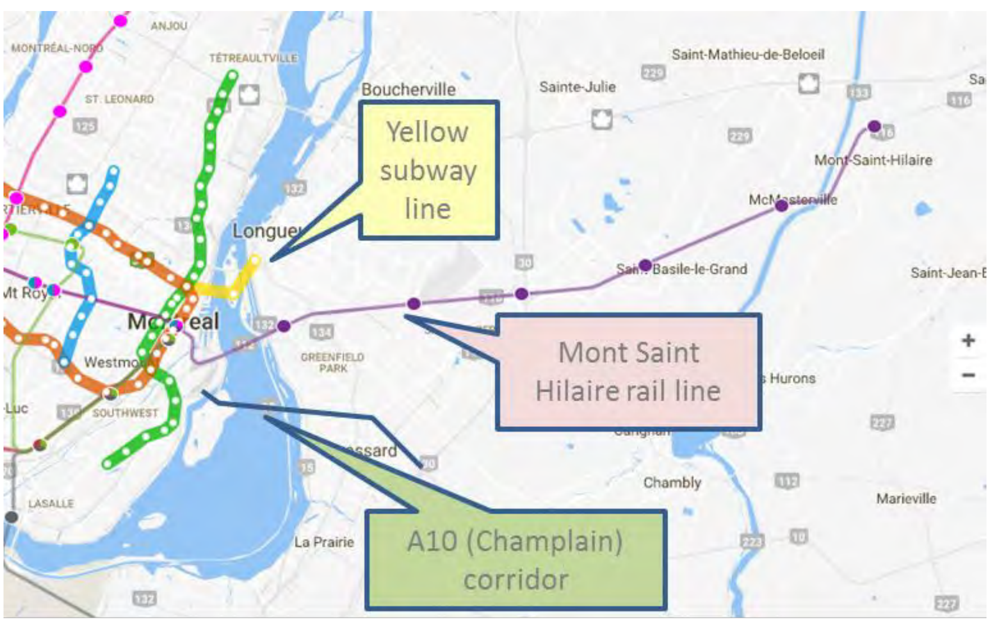
*Source: MTMDET and Steer Davies Gleave analysis*

**Transit Users**

3.12 Transit options are also limited to the limited crossings along the St Lawrence River. The key existing transit options are shown in Figure 3-3 and summarized below:

- ***Express Bus services***
  - ***South Shore/A10***: is the key transit corridor to access Montréal island by bus, with more than 48 bus routes providing services from the South Shore to Downtown Montreal (Terminus centre-ville).
  - ***Other bus services***: There are other bus routes that use alternative crossings. However these routes service areas away from the REM area of influence and present a much lower levels of service:
    - Honoré-Mercier Bridge: 15 routes
    - Jacques Cartier Bridge: 3 routes
    - Tunnel L-H La Fontaine: 1 route
    - Victoria Bridge: 1 route
- ***Métro Yellow line***: Provides a reliable transit service between Longueuil and Downtown Montréal. Travel time between Longueuil–Université-de-Sherbrooke station and Berri/UQAM station is 9 minutes, whereas travel time to Bonaventure station is approximately 17 minutes. The Line has a frequency of 5 minutes during the AM peak period.
- ***Mont-Saint-Hilaire:*** This AMT commuter rail Line provides a direct service to Downtown Montréal (Gare Centrale) from Mont-Saint-Hilaire. Six of the seven stations are located on the South Shore. Travel time from Mont-Saint-Hilaire to Gare Centrale is 50 minutes, whereas travel time from Saint-Lambert station, which is the last station before Montréal, is 11 minutes. This commuter rail runs every 25 to 30 minutes in the AM peak period.

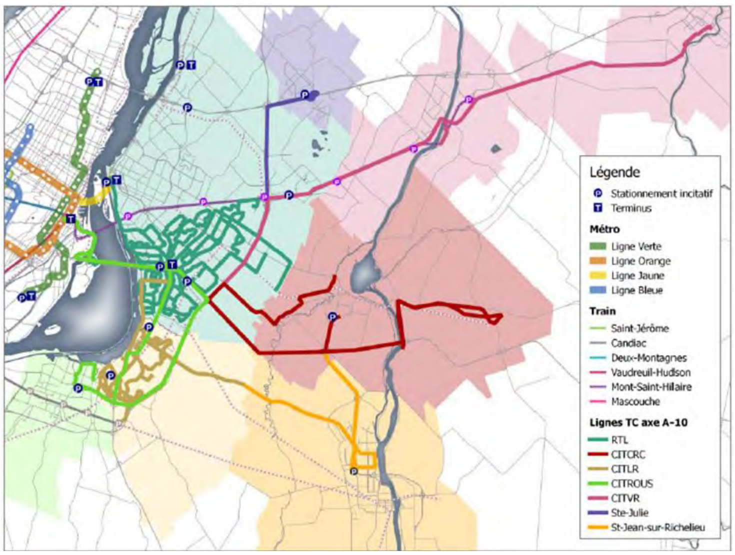
**Figure 3-3: Saint-Laurent River crossing transit alternatives**



*South Shore/A10 corridor*

3.13 The transit demand in the **South Shore/A10 corridor** is currently served by 48 bus routes operated by different transit service providers. These routes provide direct access to Downtown Montréal from different areas within the South Shore, providing very good transit coverage. The operator with greatest demand is RTL (shown in dark green in Figure 3-4) that provides service to the Agglomération de Longueuil.

**Figure 3-4: Current Transit Network (Rive-Sud)**




*Source: Agence métropolitaine de transport*

3.14 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 Inter Peak period (9am–3pm), which clearly shows that the service is driven by the commuter needs of residents of the South Shore.

3.15 These express bus services provide very 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 Inter Peak direction to 24 minutes in the peak direction.

3.16 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) | Inter Peak (9am-3pm) |
|---|---|---|
| RTL | 9,557 | 6,399 |
| AMT | 2,768 | 783 |
| Ville de Saint-Jean-sur-Richelieu | 1,336 | 958 |
| CITLR | 2,025 | 476 |
| CITVR | 149 | 64 |
| CITCRC | 1,577 | 286 |
| CITROUS | 875 | 214 |
| OMITSJU | 481 | 20 |
| **total** | **18,287** | **9,180** |

*Source: Steer Davies Gleave analysis based on data from RTL, AMT, Ville de Saint-Jean-sur-Richelieu, Gestrans and OMITSJU*

3.17 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%** |

*Source: Agence métropolitaine de transport.2015. Rapport annuel de 2015*

## West Island/Deux-Montagnes Line Market

### Introduction

3.18 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 Point Claire and Sainte-Anne-de-Bellevue areas.

3.19 The West Island is the unofficial name given to the cities, towns and boroughs at the western end of the Island of Montreal. It is a large territory of low-density middle and upper-middle class housing, and low and medium density commercial sectors. In 2011, the total population of West Island was approximately 236,000 residents[4]. The second biggest employment hub (Saint-Laurent/Dorval) in Greater Montréal is located in the West Island. This hub counts more than

[4] Communauté métropolitaine de Montréal. 2016. *Portrait of Greater Montréal*. Issue Nº5, p.41. This excludes Saint-Laurent borough and the borough to its northern and eastern end.

190,000 jobs and is home to the Aéroport Pierre-Elliott-Trudeau, John Abbott College, Cégep Gérald-Godin, the Macdonald Campus of McGill University, the Fairview Pointe-Claire and Galeries des Sources malls, STM Fairview bus Terminal, as well as Montreal's largest park, the Cap-Saint-Jacques Nature Park.

3.20 The Deux-Montagnes Line crosses part of the West Island, Laval, and ends in the North Shore in the City of Deux-Montagnes. Residential areas along the Deux-Montagnes Line, especially in the North Shore are among the fastest growing in terms of population in the region. In 2011, the North Shore had 208,400 jobs which equates to 11.6% of the total employment in the Greater Montréal region[5].

3.21 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 towards Montréal and in the PM in the reverse direction.

**Auto Users**

3.22 The REM Line will operate in parallel with the A40 for a great part of its alignment, although the A20 could also be an alternative for some of the destinations.

3.23 In order to understand the auto demand in the West Island/Deux-Montagnes Line corridor, two screenlines have been created that include the Autoroute Du Souvenir (commonly called A20) and Autoroute Felix-Leclerc (A40):

- Screenline 1 is located between Pointe-Claire and Des Sources stations along Autoroute Felix-Leclerc and Autoroute du Souvenir.
- Screenline 2 is positioned between Des Sources and Autoroute 13 stations.

3.24 Total traffic volumes from the two screenlines by direction are detailed in Table 3-4. The location of the screenlines is shown in Figure 3-5.

[5] Ville de Montréal. 2013. *Analyse économique: L’emploi à Montréal de 1981 à 2011*, p.2

**Figure 3-5: West Island auto screenlines**


3.25 Traffic volumes peak between 6am to 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 | 9:00 am to 15:00 pm | 6am-9am | 9:00 am to 15:00 pm |
| To Montréal | 21,893 | 26,476 | 43,385 | 55,860 |
| Towards West | 10,489 | 23,818 | 19,424 | 42,008 |

*Source: MTMDET*

### *Transit Users*

3.26 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*

3.27 The West Island/Deux-Montagnes Line Corridor is currently served by two rail commuting services and one Métro Line as shown in Figure 3-6.

- ***Deux-Montagne Line*** is currently owned and operated by AMT. Although services are relatively fast, the frequencies are poor with three services per hour in the peak and less than one service per hour in the Inter Peak period.
- ***Vaudreuil-Hudson Line*** provides services in the southern part of the West Island/Deux-Montagnes Line Corridor. At present, the Vaudreuil-Hudson Line operates at or near capacity during peak hours and offers a very limited service during off-peak hours. In addition to a relatively early termination of service in the evening, current priority of freight transport over commuter traffic limits expansion of services along the southern rail corridor.

3.28 The ***Métro Orange Line*** is a key component of the existing transit network, since many of the express and local buses in the West Island terminate at an Orange Line station which provides access to Downtown Montréal and the Métro network. The Orange Line provides services every 4 minutes during the morning peak period (every 8 minutes during the off-peak period) and travel times are relatively long due to the high number of stations (average speed of 40km/h). Moreover, the eastern branch of the service is currently congested in the peak hour.

3.29 Although they do not operate directly in the West Island/Deux-Montagnes Line Corridor, the following rail services are also relevant to the study since they can feed demand to REM.

- The ***Mascouche Line***, which currently provides direct access to Gare Centrale using the Mount Royal tunnel, will terminate in future at a station near Autoroute 40 and is expected to feed demand to the REM network. This service started operation in 2014, and currently has 13 stops and offers 8 departures in each direction on weekdays, mainly during the peak hour.
- The ***Saint-Jérôme Line***, which currently terminates at Lucien L'Allier, could also potentially feed demand to the REM network if it is integrated. The current Mount Royal tunnel and Gare Centrale conditions do not allow the Saint-Jérôme Line to use the tunnel and it has to detour 20 minutes via Lachine. However, this rail Line provides three connections with the Métro network - De La Concorde station in Laval (Orange line), Parc (Blue line) and Lucien L'Allier (Orange line). The frequency of service is every 25–45 minutes during the peak hour and one service every two hours outside of the peak hour, of which five services continue to, or begin at, Lucien-L'Allier station. All other trips begin or end at Parc Métro station.

3.30 Figure 3-6 shows the rail and Métro Line alignments and stations on the West Island/Deux-Montagnes Line Corridor.

**Figure 3-6: Rail and Métro network in the West Island/Deux-Montagnes Line Corridor**


3.31 Currently, the Deux-Montagne 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, with majority of demand in the peak periods.

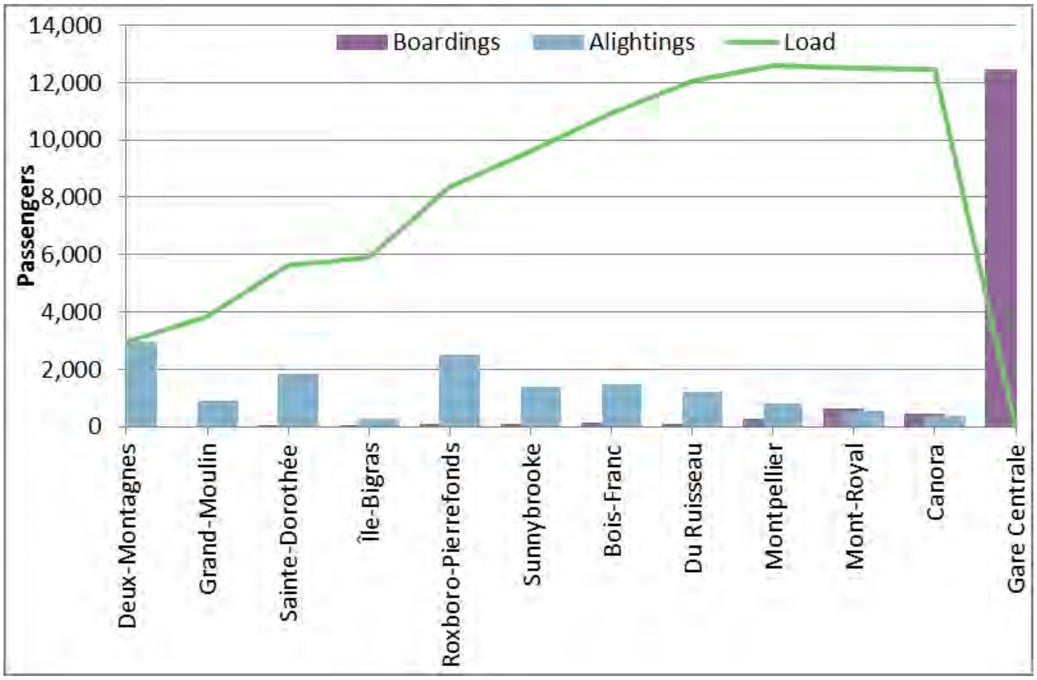
**Table 3-5: AMT average ridership (2015)**

| 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 |

*Source: Agence Métropolitaine de Transport*

3.32 Figure 3-7 shows the boardings and alightings of the DM Line per station for the AM peak. Figure shows the majority of demand alights at Gare Centrale with very limited activity at intermediate stations. The peak load is around 12,000 passengers in the AM peak hour.

**Figure 3-7: Deux-Montagnes Line AM Peak Profile (Sept 11th 2014) – Towards Downtown Montréal**




*Source: AMT*

*Bus Network*

3.33 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.

3.34 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 off-peak period due to shorter trips on these services.

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

| | Peak (6am-9am) | Inter Peak (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* | 493 | 1,730 | 5,304 |
| **Total** | **55,465** | **63,242** | **221,490** |

*Source: STM and Steer Davies Gleave analysis*

** 747 is the express service to the Aéroport Pierre-Elliott-Trudeau: More details are provided in the airport section*

3.35 The express routes currently provide longer distance services with a lower number of stops. Some routes terminate at an interchange station, mainly with the Orange Line or at Terminus Fairview. Table 3.7 shows the demand for each of the express routes in the West Island/Deux-Montagnes Line corridor, as well as their key connections with other rail modes to access Downtown Montréal. Some of the areas served by these routes in the future will be covered by the REM network or they will feed passengers to REM stations with minor modifications to their layout:

**Table 3.7: Express Service Demand in the West Island of Montréal (October 15 weekday)**

| Express routes in Scope | Current Connections | Assumed connections with REM | Peak (6am-9am) | Off-peak (9am-3pm) | Daily demand |
|---|---|---|---|---|---|
| 401 | None | None | 106 | - | 277 |
| 405 | None | None | 609 | 1,004 | 2,495 |
| 407* | Roxboro-Pierrefonds (DM) | Roxboro-Pierrefonds & Pointe-Claire | 185 | - | 414 |
| 409 | Du College (OL) | None | 650 | 147 | 1,442 |
| 411 | Lionel-Groulx (OL) | None | 516 | 395 | 1,333 |
| 419* | None | Sainte-Anne-de-Bellevue, Kirkland & Pointe-Claire | 495 | 815 | 1,929 |
| 425 | None | None | 258 | 377 | 1,053 |
| 460* | Du College Sud (OL) | Technoparc Saint-Laurent | 3,049 | 411 | 7,192 |
| 468 | Roxboro-Pierrefonds (DM) | None | 811 | 1,018 | 2,715 |
| 470* | Côte-Vertu (OL) | Pointe-Claire & Des Sources | 2,241 | 3,267 | 10,701 |
| 475 | Côte-Vertu (OL) | None | 235 | 24 | 374 |
| 485 | Lionel-Groulx (OL) | None | 548 | 723 | 2,090 |
| 491* | Lionel-Groulx (OL) | None | 798 | 512 | 2,106 |
| 495* | None | Aéroport Pierre-Elliott-Trudeau | 697 | 874 | 2,977 |
| 496* | Lionel-Groulx (OL) | Aéroport Pirre-Elliott-Truedeau | 1,380 | 1,045 | 4,306 |
| **Total** | | | **12,578** | **10,612** | **41,404** |

*Note: Routes without asterisks are not in service in 2021. They are replaced by 14 new services serving REM stations*

*Park & Ride Facilities*

3.36 In the West Island/Deux-Montagnes 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 3.8). 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 3.8: West Island/Deux Montagnes Park & Ride sites**

| Deux-Montagnes Line | Size (and occupancy) | Occupancy |
|---|---|---|
| Du Ruisseau | 1063 | 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 | 1256 | 92% |
| **Total** | **5,964** | **91%** |

*Source: AMT Annual Report*

## Aéroport Pierre-Elliott-Trudeau Market

### Introduction

3.37 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.

3.38 The only current public transport option is the 747 bus route operated by STM. The 747 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. The 747 bus route is shown in Figure 3.8.

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

**Figure 3.8: 747 route alignment and stations**


*Source : STM Website (http://www.stm.info/en/info/networks/bus/shuttle/more-about-747-aeroport-p-e-trudeau-centre-ville-shuttle)*

### Demand

3.40 Demand for travel to the Aéroport Pierre-Elliott-Trudeau includes:

- Aéroport Pierre-Elliott-Trudeau passenger demand; and
- Aéroport Pierre-Elliott-Trudeau staff demand

3.41 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).

3.42 This demand has been estimated differently from the rest of the transit network demand in order to include passengers who currently travel by car (either Park & Fly, Kiss & Fly or take a taxi). We consider that for the airport,these car drivers/passengers are 'in-scope' to possibly switch to REM, as well as bus users who are considered to be the primary target for REM.

3.43 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

3.44 Clearly not all Airport passengers could use REM for their journey to/from the Aéroport Pierre-Elliott-Trudeau. Some passengers were excluded from our analysis for the following reasons:

- Passengers who are using Aéroport Pierre-Elliott-Trudeau to connect to another flight and do not leave the Airport (18%).
- Passengers who were arriving/leaving the Aéroport Pierre-Elliott-Trudeau while REM is not in operation (e.g. in the middle of the night) (7%).

3.45 Airport staff demand has also been calculated using information from ADM. This estimated that 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.

3.46 In order to convert the number of employees in to the number of trips to/from the Aéroport Pierre-Elliott-Trudeau, we made the following assumptions:

- Each Airport employee works 46 weeks per year.
- Employees who work normal working hours travel to or from the Airport 10 times a week.
- Employees who work long shifts travel to or from the Airport 6 times a week.
- Pilots and cabin crew travel to or from the Airport twice a week.

3.47 Based on this, we estimated employees in the airport area made 8.8 million trips to/from the Aéroport Pierre-Elliott-Trudeau in 2015. As with Airport passengers, we also excluded Airport staff who:

- Travelled to/from the Aéroport Pierre-Elliott-Trudeau outside REM operating hours (7%)
- Live outside the Montréal area (3%)

3.48 In order to improve the mode choice preferences by market segment in the model, we have developed a number of market segmentations of the air passenger and Airport staff demand. The market segmentations have been generally estimated from ADM surveys.

**Distribution of demand**

3.49 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).

3.50 Our segmentation is explained below:

- Spatial segmentation: We developed a zoning system of 68 zones across Montréal and distributed Airport passengers and staff so that each person travels between the Airport and one of these zones. Our segregation varies for:
  - Airport passenger residents: based on the demand distribution in the EMME model
  - Airport passenger non-residents: based on the Steer Davies Gleave 2016 Airport survey
  - Airport staff: based on the ADM 2008 staff survey.
- Passenger type segmentation based on the ADM surface access survey. This includes:
  - Splitting passengers by their current mode of transport to/from the Aéroport Pierre-Elliott-Trudeau (including Bus, Taxi, Car Park & Fly and Car Kiss & Fly.)
  - Residents of Montréal and non-residents
  - Purpose of travel: Business and non-business.
  - Whether passengers are travelling alone or in a group

  - Time of travel: AM peak (3 hours 6am to 9am) and Inter Peak (6 hours 9am to 3pm)[6]
- Staff type segmentation based on the 2008 ADM staff survey. This includes:
  - Splitting staff by their current mode of transport to/from the Aéroport Pierre-Elliott-Trudeau (including Bus and Car Park & Fly)
  - Time of travel: AM peak and Off-Peak[6]

3.51 Table 3.9 provides a summary of total airport passengers demand by market segment in the AM Peak and Interpeak periods.

**Table 3.9: 2015 In-scope airport passenger demand by market segment- AM peak and Interpeak periods**

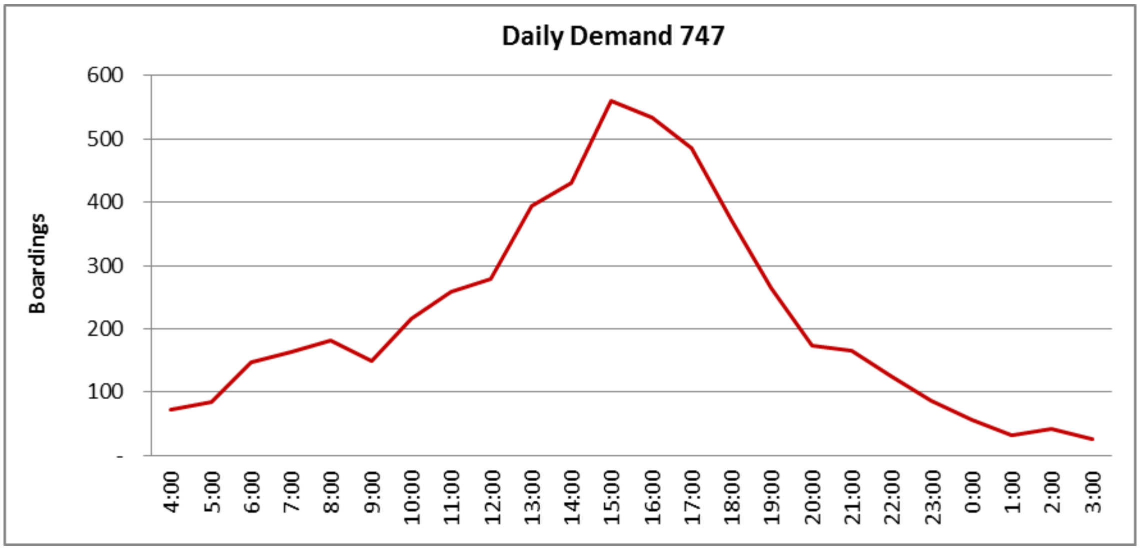
| | | Bus | Taxi | Car Park & Fly | Car Kiss & Fly |
|---|---|---|---|---|---|
| Time of Day | AM peak (6am-9am) | 493 | 1,362 | 1,072 | 1,973 |
| | Inter peak (9am-3pm) | 1,730 | 3,234 | 1,502 | 4,456 |
| | | | | | |
| Journey purpose | Business | 509 | 1,824 | 1,007 | 922 |
| | Non Business | 1,715 | 2,772 | 1,567 | 5,507 |
| | | | | | |
| Residency | Non-resident | 342 | 966 | 57 | 686 |
| | Resident | 1,881 | 3,630 | 2,517 | 5,743 |
| | | | | | |
| Group size | Alone | 1,917 | 2,868 | 1,814 | 3,743 |
| | In a group | 306 | 1,728 | 760 | 2,687 |
| Total | | **2,223** | **4,596** | **2,574** | **6,429** |

*Existing 747 bus demand*

3.52 The main transit access to the Aéroport Pierre-Elliott-Trudeau is the 747 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 5 pm, which partially overlaps with the commuting PM peak. Figure 3-9 shows the hourly profile of the service

[6] Only AM peak and Inter Peak travel modelled in detail. The PM peak is included in our annualisation factors of the AM and Inter Peak results

**Figure 3-9: 747  Weekday Hourly demand profile**




*Source: STM*

3.53 As shown in Table 3-10, the hourly demand in the AM peak period is much lower than the Inter Peak hour demand.

**Table 3-10: 747 demand (October 2015 weekday)**

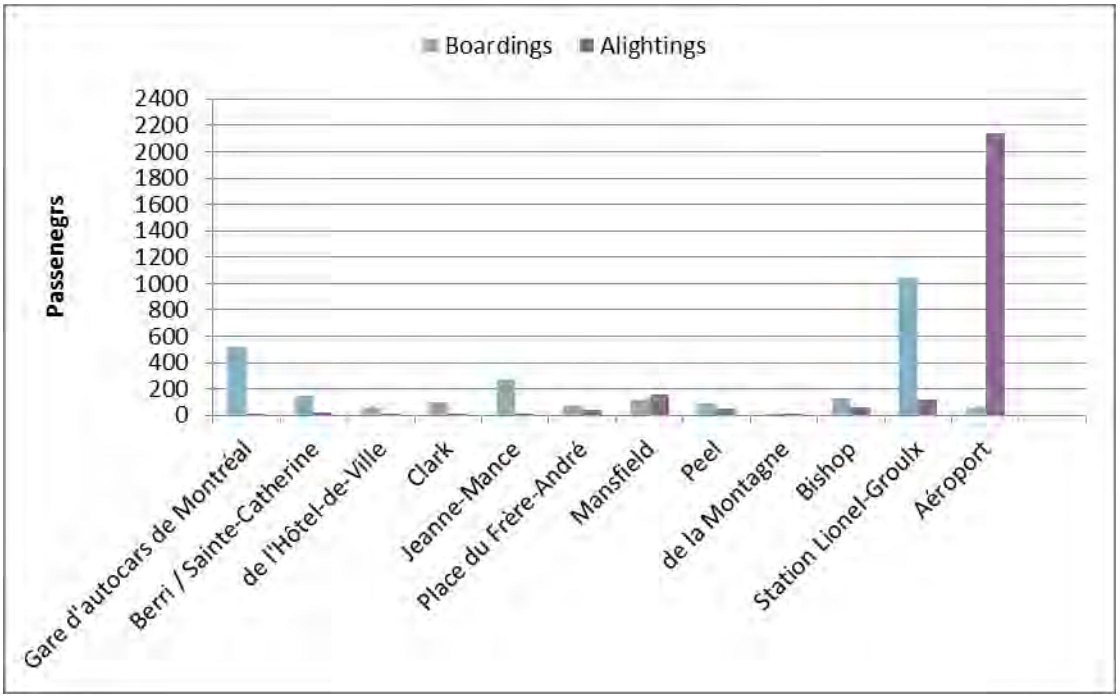
| Route | Peak (6am-9am) | Inter peak (9am-3pm) |
|---|---|---|
| 747 | 493 | 1,730 |

*Source: STM*

3.54 Figure 3-10 shows the boardings and alightings of the 747 bus service per stops and direction. Most users board at Lionel-Groulx Métro station. It is observed, that very few people board or alight in the heart of downtown on René-Lévesque.

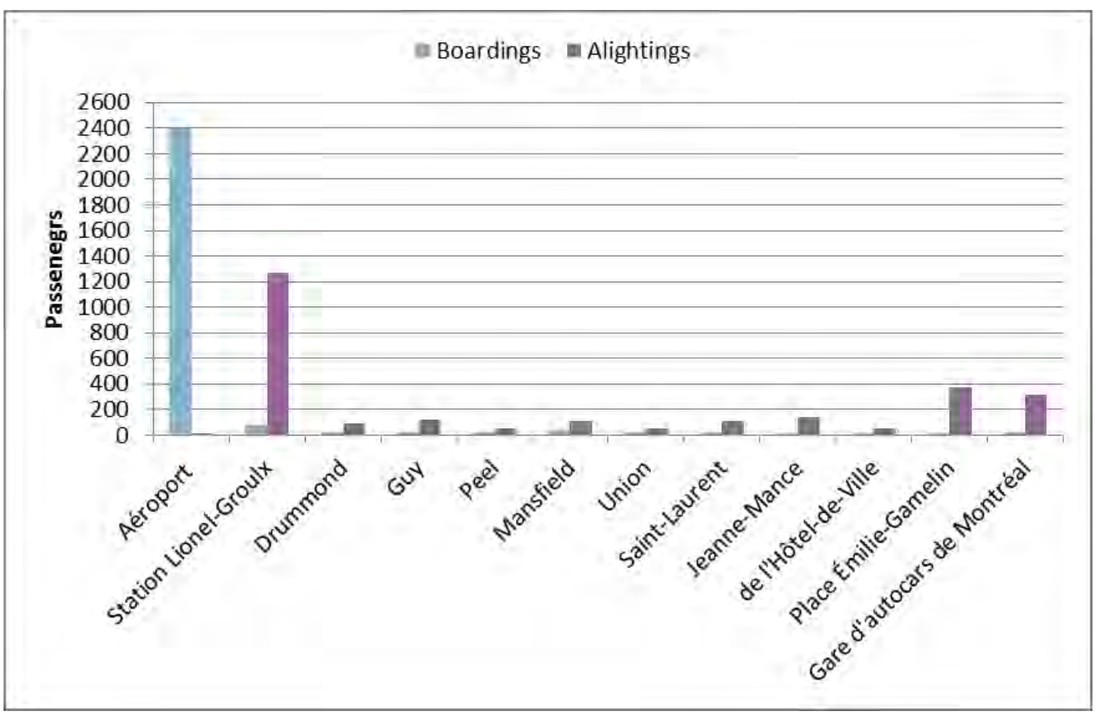
**Figure 3-10: Average 747 Daily Boardings and Alightings per Stop (March-June 2015)**

*Westbound (to Aéroport Pierre-Elliott-Trudeau)*




*Source: STM, Steer Davies Gleave analysis*

*Eastbound (from Aéroport Pierre-Elliott-Trudeau)*

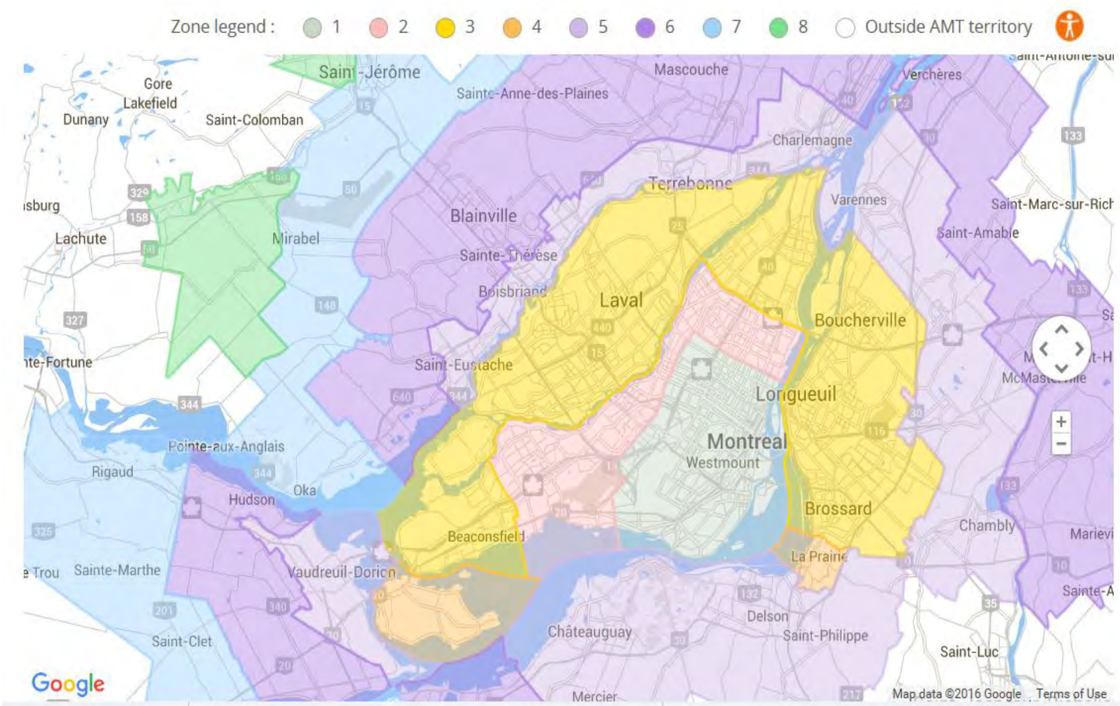



Source: STM, Steer Davies Gleave analysis

## Existing Fares

3.55 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 3.11 shows the fare zone map.

**Figure 3.11: AMT Fare Zone Map (August 2016)**




3.56 AMT has a wide range of products and concessions, with fares differentiated by[7]:

- **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)
- **Products**: Tickets are available for different frequency users; monthly (*mensuel*), 6-ticket booklets (*carnet*) and individual tickets (*billet*)

3.57 Table 3.11 shows the average fare estimated for each zone for adults and students.

[7] https://www.amt.qc.ca/fr/titres-tarifs/titres-Métropolitains

**Table 3.11: Average fare – AMT Adults (2015 $)**

| ADULT Zone | TRAM Fare SINGLE TICKET | TRAM Fare 6-TICKET BOOKLET | TRAM Fare MONTHLY FARE | TRAIN Fare SINGLE TICKET | TRAIN Fare 6-TICKET BOOKLET | TRAIN Fare MONTHLY FARE | AVERAGE ADULT |
|---|---|---|---|---|---|---|---|
| 1 | $4.43 | $2.83 | $1.92 | $3.91 | $2.51 | $1.75 | **$2.01** |
| 2 | $5.44 | $3.30 | $2.33 | $4.40 | $3.01 | $2.06 | **$2.38** |
| 3 | $6.37 | $3.96 | $2.77 | $5.38 | $3.56 | $2.45 | **$2.77** |
| 4 | - | - | $2.95 | $5.91 | $3.84 | $2.67 | **$3.02** |
| 5 | - | - | $3.45 | $6.89 | $4.48 | $3.09 | **$3.47** |
| 6 | - | - | $4.12 | $8.38 | $5.44 | $3.71 | **$4.14** |
| 7 | - | - | $4.82 | $9.57 | $6.16 | $4.20 | **$5.19** |

**Table 3.12: Average fare – AMT Students (2015 $)**

| STUDENT Zone | TRAM Fare SINGLE TICKET | TRAM Fare 6-TICKET BOOKLET | TRAM Fare MONTHLY FARE | TRAIN Fare SINGLE TICKET | TRAIN Fare 6-TICKET BOOKLET | TRAIN Fare MONTHLY FARE | AVERAGE STUDENT |
|---|---|---|---|---|---|---|---|
| 1 | - | - | $1.67 | - | - | $1.42 | **$1.66** |
| 2 | - | - | $1.97 | - | - | $1.67 | **$1.95** |
| 3 | - | - | $2.34 | - | - | $2.00 | **$2.34** |
| 4 | - | - | $2.52 | - | - | $2.15 | **$2.52** |
| 5 | - | - | $2.93 | - | - | $2.50 | **$2.92** |
| 6 | - | - | $3.50 | - | - | $2.98 | **$3.49** |
| 7 | - | - | $4.02 | - | - | $3.41 | **$4.00** |

** Monthly average fare by trip is based on the assumption of an average usage of 44 trips/ month*

*** There are only monthly passes with student discount*

*Source: AMT data and Steer Davies Gleave analysis*

3.58 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) including:

- CIT Chambly-Richelieu-Carignan (CITCRC)
- CIT Vallée-du-Richelieu (CITVR)
- OMIT Sainte-Julie (OMITSJU)
- CIT Roussillon (CITROUS)
- CIT Le Richelain (CITLR)

3.59 For those areas, the estimated weighted average fare by trip has been estimated based on the distribution of demand per ticket type:

**Table 3.13: Average Fares per trip – CIT (2015 $)**

| AV FARE | CITCRC | | CITVR | | OMIT-SJU | | CITROUS | | CITLR | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

*Source: CITs data and Steer Davies Gleave analysis*

3.60 In the Montréal Island area, STM fares apply exclusively to users of the STM transit services (bus and Métro on the Montréal Island) and fares are different to those for AMT. The main characteristics of STM fares are:

- **Flat fee**: Montréal Island represents one fare zone, while AMT has 3 fare zones on the island
- **Type of user**: Fares are split into regular (*ordinaire*) and reduced (*réduit*). Student specific fares are not available and are included within the reduced fares.
- **Mode:** Tickets can be used on bus or Métro (and allow transfers between them)
- **Products**: Tickets are available for different frequency users; monthly (*mensuel*), weekly (*Hebdo*), 3 days (*3 jours*), 1 day (*1 jour*), evening (s*oirée illimitée*), weekend (week-end illimité) and 1, 2 and 10 ticket booklets.

3.61 In order to estimate the number of trips and average fare for adults and students, the following assumptions have been adopted:

- Trips for monthly pass holders: 48 trips/month (it is a less commuter-oriented service than AMT and therefore a higher number of monthly trips assumed)
- Trips for weekly pass holders: 12 trips/week
- Trips using the 747 service have been excluded
- Number of student trips within the "discounted" trips: 65% of monthly pass holders
  This assumption has been based on the observed AMT distribution between students and other discounted monthly pass holders

3.62 **Table 3.14** shows the average fare estimated for the whole Montréal Island and by ticket type.

**Table 3.14: Average Fare – STM (2015 $)**

| Fare | Monthly | Hebdo | 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** |

3.63 It is worth noting that 78% of demand currently uses monthly or weekly passes, with a higher use of single tickets and carnets on AMT, probably related to the higher use of the service by infrequent users such as tourists.

3.64 The STM 747 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.

**Table 3.15: 747 Average Fare Estimate**

| Ticket Type | Ticket Sales ($) | Sales Breakdown | Trips per ticket type | Fare |
|---|---|---|---|---|
| Titres 747 | 78,104 | 5.4% | 1.10 | $9.00 |
| 1 jour | 469,272 | 32.4% | 1.72 | $9.00 |
| 3 jours | 96,596 | 6.7% | 6.73 | $18.00 |
| Weeek-end illimité | 17,541 | 1.2% | 5.22 | $12.00 |
| Mensuel ordinaire | 552,714 | 38.2% | 48.43 | $77.00 |
| Mensuel réduit | 159,386 | 11.0% | 44.24 | $45.00 |
| Hebdomadaire ordinaire | 68,083 | 4.7% | 12.75 | $23.75 |
| Hebdomadaire réduit | 1,855 | 0.1% | 11.43 | $14.00 |
| Gratuités - Autres | 3,975 | 0.3% | 0 | $0 |
| **TOTAL** | **1,447,525** | **100%** | - | - |

*Source: STM*

# 4 Modelling approach

## Overview

4.1 REM will completely transform the transit offer in the Greater Montréal Area. The new system will be complemented by the following interventions:

- Restructuring of the ***bus network*** in the corridor: with the elimination of the express routes directly competing with REM, the transit agencies will introduce a frequent and improved bus feeder network that will substantially reduce the access and egress time to REM stations.
- Re-structuring of ***rail services*** in the corridor: REM will substitute the existing Deux-Montagnes commuter rail service, providing an improved service in terms of frequency and travel time. The Mascouche Line will be truncated to feed the REM.
- Improvement of the ***interchange facilities*** to fully integrate the REM with the rest of the transit network and with new Park & Ride facilities.

4.2 As a result, the project as a whole, is expected to have an important impact on:

- ***Corridor demand*** (South Shore/A10 and West Island/Deux-Montagnes Line)***:*** Existing transit and auto travellers within the area of influence of the REM – mainly residents; commuters in the peak periods and non-commuters in the Inter Peak periods.
- ***Airport demand:*** Demand to and from the Aéroport Pierre-Elliott-Trudeau, currently using; transit, auto, taxi, Kiss & Fly, etc. This includes both Airport passengers and staff.

## Model overview

4.3 For this study, we have designed a demand model structure to provide the most practical framework to address the different markets. This has been achieved by optimizing the use of existing information and modelling work, and complementing it with additional data collection and the development of new modelling features.

4.4 In order to assess the critical markets, different models have been developed. The models are fully integrated and consistent:

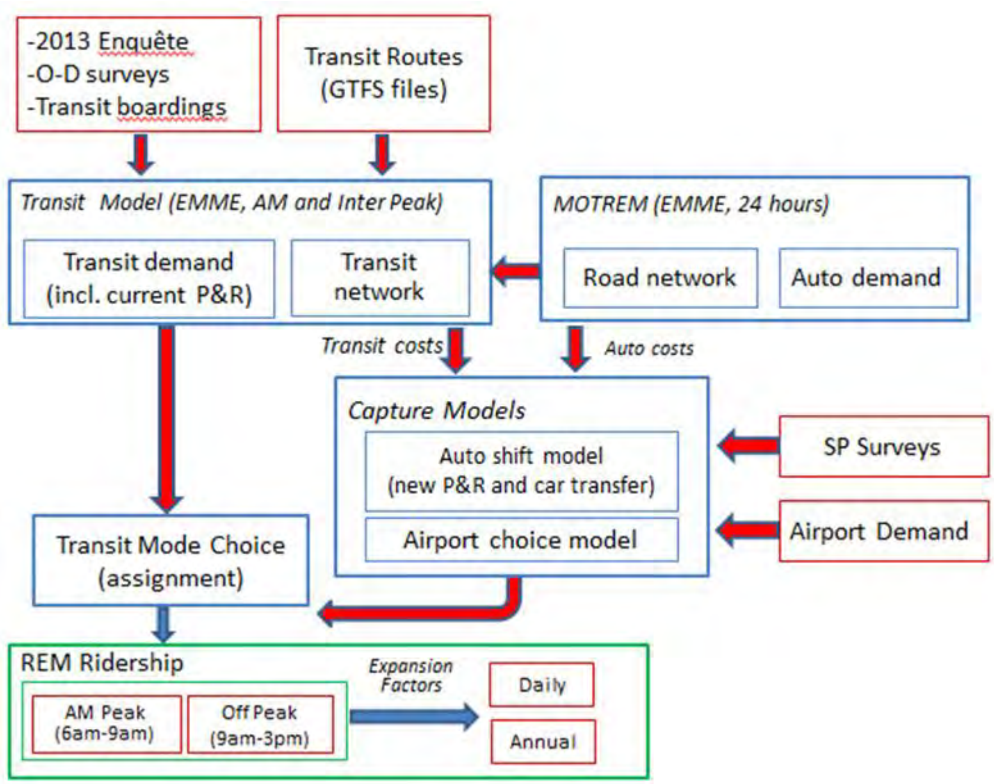
- ***Corridor demand choice model:*** In order to estimate REM future demand and capture from alternative modes for the "corridor" demand, two separate models have been developed.
  - ***Auto shift model***: estimates the demand that shifts from auto to transit and REM given the future improved competitiveness of the transit modes compared to auto. This includes two sub-models:
    - Shift from auto to REM with Park & Ride (Park & Ride) access (bi-modaux)

  - Shift from auto to REM with transit/walking access
- ***Transit mode choice model*** estimates the redistribution of demand between the different transit modes (bus, rail, Métro and REM) given the current and future competitiveness for each of the modes.

4.5 In addition, the **Airport demand choice model** estimates Airport demand mode choice using a broader variety of competing modes including bus, taxi, Car Park & Fly and Car Kiss & Fly.

4.6 An overview of the forecasting model framework is shown below.

**Figure 4.1: Forecasting Model Overview**




*Note: General Transit Feed Specification (GTFS) refer to publicly available transit schedules and routes.*

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

- Base year (2015) and two future years (2021 and 2031)
- Two time periods
  - AM Peak: 6 to 9am
  - Inter Peak: 9am to 3pm

4.8 REM demand estimates from the Auto Shift Model and Airport Choice Model have been consolidated into the assignment model, in order to calculate total REM demand by station, section loads, etc.

4.9 The following sections describe the network development in more detail and the approach adopted for the Corridor demand choice model.

## Network development

### Overview

4.10 In order to forecast the future demand for the REM, a number of models have been developed to estimate the redistribution of the existing and future demand, within the different modes available. The redistribution is based on the attractiveness of each option.

4.11 Given the high level complexity of the road and transit network in Métropolitan Montréal, it was considered that a Network (assignment) Model was required to represent more accurately the complex interaction between the different modes. This has been built in the EMME software package.

4.12 Although different models and approaches have been adopted to estimate different types of demand (corridor and Aéroport Pierre-Elliott-Trudeau demand), all models have based the calculation of Generalized Times on the Travel Times and Fares extracted from the Network Model.

4.13 The Montréal network is complex and developing a new auto and transit model would be a challenging task that could take many months. In order to provide results within the required timescales, we have relied upon existing models (road network only), which have been adapted and complemented with additional features to represent the transit network characteristics with a particular focus on the REM corridors.

4.14 The following sections describe the existing model sources and the additional work carried out to develop an auto and transit model for the study area. A Network Model has been developed for an average fall week day and includes an average hour in the AM peak (defined as 6am-9am) and an average hour in the off-peak period (defined as 9am-3pm).

4.15 The Network Model includes a road and a transit network, which are described below.

### Road Network

4.16 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 for the purposes of this study.

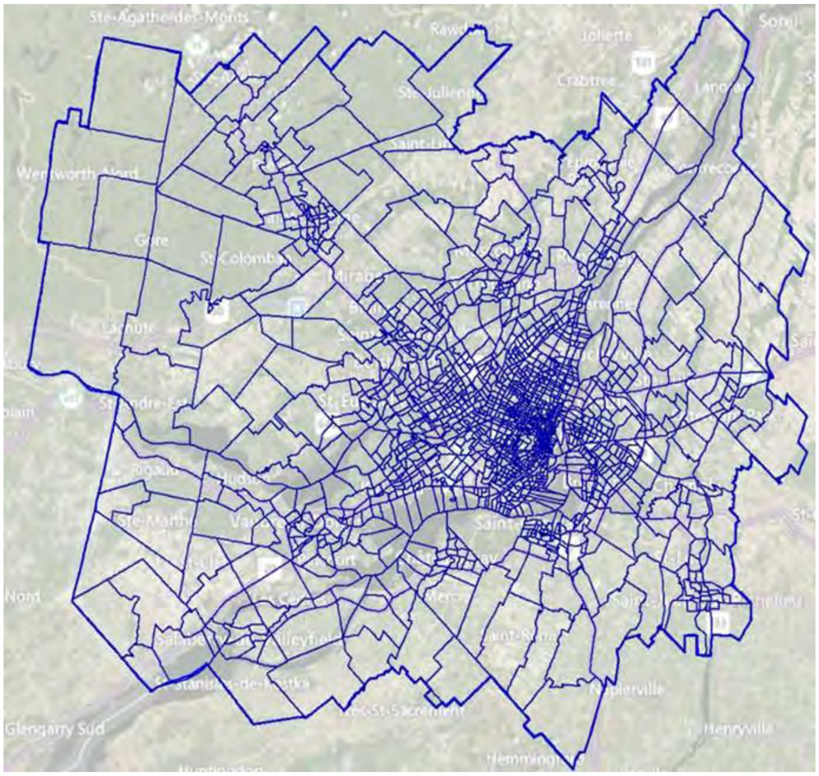
4.17 This model has then been upgraded in order to include “bus only lane” links, which are extremely important to define the road characteristics for transit services. This is especially relevant for South Shore/A10 users.

*MOTREM*

4.18 The MOTREM model includes a very detailed representation of the existing and future road network and produces auto traffic simulations for a range of years (2008, 2016, 2021 and 2031). The model estimates the demand of a typical weekday in the fall and across a 24-hour time period (12am-12pm).

4.19 MOTREM is disaggregated geographically into 1,766 traffic zones. Figure 4.2 shows the detailed zoning system covered in the model.

**Figure 4.2: MOTREM zoning system**




4.20 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.

4.21 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.

4.22 Figure 4.3 shows the extent of the road network in MOTREM.

**Figure 4.3: MOTREM road network**


4.23 The model assigns demand to each route depending on the Generalized Costs associated with each alternative. The MOTREM model was calibrated to a 2008 base year, using the demand OD matrices available from the Enquête 2008 household OD survey, and traffic screenline counts for different vehicle types.

4.24 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).

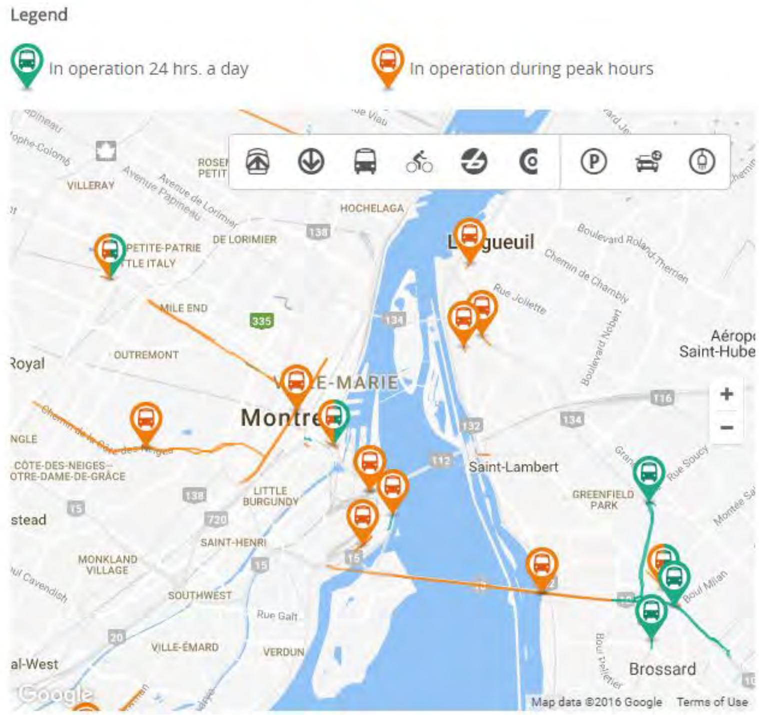
*Bus Only Lanes*

4.25 MOTREM is not a transit model and therefore does not include bus lanes i.e. Champlain Bridge is represented as 3 lanes to Montréal and 2 lanes to the South Shore direction in the AM peak period for example and the bus lane is not included.

4.26 Since bus lanes are critical for the existing transit network, especially for demand from the South Shore/A0 corridor, selected bus only lanes have been included in the model and shown in Figure 4.4[8].

[8] https://www.amt.qc.ca/en/trip-planner/bus/reserved-lanes

**Figure 4.4: Bus only lanes**




*Future Road network*

4.27 MOTREM includes a number of road network changes which are detailed in Appendix A.

4.28 Of particular interest to this project are the following:

- Champlain Bridge replacement[9]: construction of new 6 lane bridge across the Saint-Laurent River and access roads to replace existing bridge (currently under construction)
- Turcot Interchange[10]: 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**

4.29 Since MOTREM only represents the road network relevant to auto users, it has been necessary to incorporate all the transit network links (rail and Métro) and transit services.

*Transit Links*

4.30 The current MOTREM model includes a range of modes (link characteristics). These have been maintained in order to retain consistency with MOTREM work done to date. Note that MOTREM

[9] http://www.newchamplain.ca

[10] https://www.turcot.transports.gouv.qc.ca/en/Pages/default.aspx

includes transit mode variables already even though it is a road-traffic based model (it is presumably a long term aim of MTQ to develop a transit model component of MOTREM).

4.31 Table 4.1 details the various modes included. Note that the only additional that we have incorporated in MOTREM is the inclusion of REM as a specific mode to ensure it can be coded separately and extract relevant statistics more efficiently.

**Table 4.1: Model Link Modes**

| MOTREM Mode | MOTREM Description | MOTREM Type | Comment |
|---|---|---|---|
| a | Automobile | Auto | Main mode for autos and buses |
| z | CamLourd | Aux. auto | Mode to allow Heavy Truck link bans |
| y | CamLeger | Aux. auto | Mode to allow Light Truck link bans |
| v | AutoPrive | Aux. auto | Mode to allow Private Car link bans |
| w | AutoComm | Aux. auto | Mode to allow Commercial Veh. link bans |
| m | Métro | Transit | Métro transit mode |
| t | Train | Transit | AMT Commuter Rail transit mode |
| l | Bus-stl | Transit | RTL bus transit mode |
| s | Bus-strsm | Transit | STL bus transit mode |
| b | Bus-stcum | Transit | STM bus transit mode |
| c | Bus-cit | Transit | CIT bus transit mode |
| i | Inter-urbn | Transit | Other bus transit mode |
| **r** | **REM** | **Transit** | **REM (new mode)** |
| p | Pieton | Aux. transit | Pedestrian |
| x | Transfert | Aux. transit | Pedestrian transfer link |

*Transit Links Coding*

4.32 Rail and Métro lines have been coded as separate links and stations have been 'connected' to the street network as required.

4.33 Bus routes have been coded using, as a base, the road network represented in MOTREM. Transit service route GTFS files were downloaded from the different transit agencies in the Montréal region and imported as transit routes to EMME.

4.34 Table 4.2 summarizes the total transit routes downloaded as GTFS files by agency and coded into EMME.

**Table 4.2: Transit services coded**

| Agency | Number of services included |
|---|---|
| AMT Bus | 2 |
| CIRLR | 36 |
| CITCRC | 33 |
| CITHSL | 7 |
| CITROUS | 16 |
| CITVR | 46 |
| MRC2M | 4 |
| RTL | 195 |
| Ville de Saint-Jean -sur-Richelieu | 16 |
| STL | 93 |
| STM | 387 |
| OMITSJU | 17 |
| Total | 852 |

4.35 Figure 4.5 shows a plot with the routes included in the model and Figure 4.6 shows the transit services by mode.

**Figure 4.5: Transit services coded by agency**

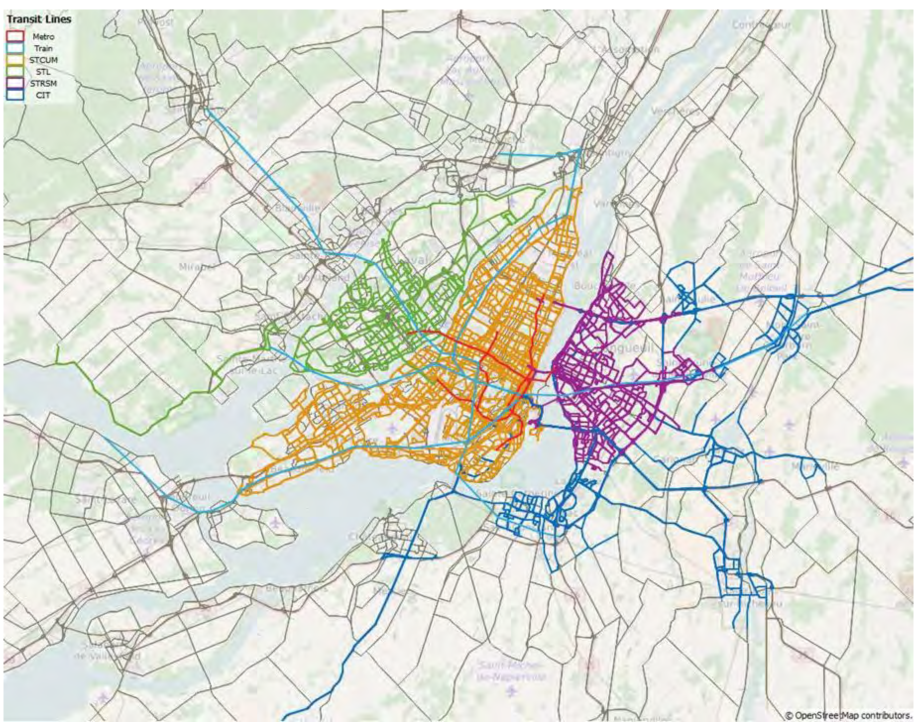
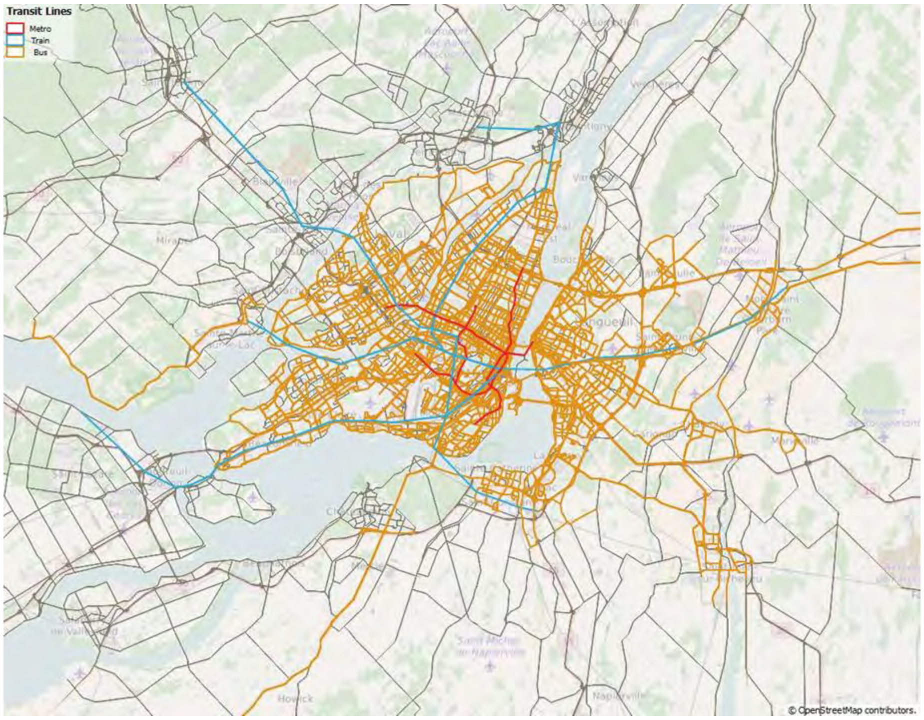


**Figure 4.6: Transit services coded by mode**




*Future transit network*

4.36 No changes have been made to the transit network with the exception of ensuring buses are using the new bus lanes on the Turcot Interchange.

## Corridor Demand Choice Models

### Model Overview

4.37 In order to estimate REM, future demand and capture from alternative modes for the "corridor" demand, 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).

*Auto shift model*

4.38 The auto shift model is integrated within the Network Model (EMME) and estimates the demand that would be captured from auto in the AM peak and Inter Peak periods based on:

- The *in-scope market*: estimation of the auto traveler demand in the corridor (described in Section 3)
- The *key benefits of REM* compared to auto: this is measured in terms of Generalized Costs for each particular OD (including time and monetary costs) and period, and is covered in the following sub-sections

- The *auto shift model*: is an incremental binary logit model, where the demand captured by REM is estimated based on the incremental Generalized Costs for auto and transit compared to the existing situation

4.39 This model has been developed in the EMME platform (using macros) to ensure consistent car and transit assumptions are applied. The Generalized Cost (including total travel time and cost) for the auto alternative is compared with the best transit alternative Generalized Cost, and this is applied for each Origin-Destination pair for each time period.

4.40 It is worth noting that the REM option for auto users presents two potential alternatives:

- REM with Park & Ride access (bi-modaux)
- REM with transit/walking access

*Transit mode choice model*

4.41 The transit mode choice model is also integrated within the Network Model (EMME) and estimates the demand that REM could capture from other transit modes based on:

- The *in-scope market*: estimation of the transit traveler demand in the corridor (Section 3)
- The *key benefits of REM* compared to other transit modes: this is measured in terms of Generalized Costs per time period (see following sub-sections)
- The *transit model choice model:* is a transit mode choice and assignment model in EMME where the total transit demand for each OD is assigned to a transit network which represents all the major transit alternatives (Commuter Rail, Métro lines and bus services) and combinations of these modes.

4.42 Since the transit capture is expected to be the most relevant component in the REM demand, the transit mode choice has been based on a more detailed segmentation not only by OD pair, but also by type of user, which has been classified by trip purpose (work, student and other).

**Generalized Cost**

4.43 The mode choice model assigns the demand to the different mode alternatives based on the Generalized Costs associated to each of them. The Generalized Cost does not relate strictly to monetary cost, but instead incorporates a wide array of journey attributes (such as in-vehicle travel times, access times and costs, transfers, wait times, etc.) all of which are combined with different weighting factors depending on user preferences.

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

- **Fare of the trip** (in 2015 Canadian Dollars): this represents the monetary component of the cost, and includes the average fare paid by each type of user (adult/student) from origin to destination.
- **In-vehicle travel time** (in minutes): represents the time spent in the specific mode or combination of modes (if it is a multimodal trip). This is estimated using the Network Model for the AM Peak and Inter Peak periods.
- **Access/egress time** (in minutes): includes the access time (walking/bus) from the origin of the trip to the main mode station/stop. Access time is perceived by users at a higher rate than in-

vehicle time, and therefore Generalized Costs typically include a 'penalty' multiplier factor compared to in-vehicle travel time (Section 5)

- **Wait time** (in minutes): depends on the frequency of the service and estimated as half of the headway. The uncertainty related to wait time also results in penalty multiplier factor compared to in-vehicle travel time.
- **Transfer time** (in minutes); estimated time transferring between stops/stations when a combination of modes is used. Transfers are also penalised by users and an additional transfer time penalty is included (Section 5).
- **Perceived quality of the service (mode penalty):** 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. These benefits are generally included in the Generalized Cost as a time penalty/bonus depending on the perceived value of the users. For example, at equal travel time and cost, transit users typically prefer riding in a train compared to a bus.

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

4.46 The attributes used to estimate the Generalized Costs of ***Auto users*** include travel time, fuel, parking and tolls (currently A25 and A30 are tolled in the region and outside the REM study area).

4.47 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.

4.48 The Generalized Cost is a combination of travel time and costs associated with each mode and these are described below. The behavioural parameters associated to the Generalized Cost calculation have also been addressed in this section.

**Travel time attributes**

*In-vehicle Travel Time*

4.49 *Auto* in-vehicle travel times are estimated in the Network Model based on the estimated demand on each particular link and the link attributes (number of lanes per direction, vdf, etc.)

4.50 Transit travel times are estimated from the Transit Model Choice Model (EMME) by applying a Transit Time Function (ttf) to links to ensure transit travel times account for the type of transit service provided (commuter, express, local) and the road type the service operates on (transit only, mixed traffic).

4.51 Table 4.3 summarizes the various ttfs applied in the model. These were estimated based on the scheduled bus travel times and auto travel times to ensure an accurate representation of travel times was obtained.

**Table 4.3: Model Transit Time Functions (ttf)**

| Transit service | Transit time function (ttf) |
|---|---|
| All road transit links in Downtown Montréal | ttf= 1.10 * timau<br>*where timau represent car travel time* |
| Local transit links outside Downtown Montréal | ttf= 1.17 * timau<br>*where timau represent car travel time* |
| Express bus services | ttf= 1.09 * timau<br>*where timau represent car travel time* |
| Champlain Bridge bus lane | ttf= us2<br>*where us2 represents bus travel time* |
| Other bus only lanes | ttf= average speed to ttfs |
| Rail and Métro | Based on scheduled travel time |

*Transit Wait Times*

4.52 Wait times are an important component of the Generalized Cost calculation and typically penalizes users compared to the in-vehicle time. The values estimated are presented later in this section and these are applied to the wait times (half the headway) estimated in the Transit Model Choice (EMME) model.

*Transit Station Access and Interchange times*

4.53 Access time to stations and transfer times between stations or between modes are also important components of the Generalized Cost calculation, since it is typically heavily penalized by users.

4.54 A site visit was carried out during the second week of August 2016 to measure the main interchange and street access locations. 32 stations and corresponding platform and street accesses were surveyed with a total of 350 measurements. These included the following:

- 23 Métro stations
- 8 AMT rail stations
- 11 of the main interchange locations

4.55 The survey involved registering walking time to each location. This was translated into walking distance in order to be coded into the EMME Transit Mode Choice Model. The following assumptions were adopted:

- Walking speed
  - Average walking speed estimated at 1.12 m/s
- Access times
  - Walking times were measured from the street access door to the entrance of the platform
  - Where available, the surveyor stood (and not walked) on escalators
- Transfer times
  - Transfer times between two lines were calculated from the exit of one platform to the entrance of the other platform
- Commuter rail interchange stations

- Access times and transfer times between rail lines at Gare Centrale, Lucien L'Allier and Vendôme were based on an average travel time on all possible platforms because commuter rail lines do not have a designated platform and arrival and departure platforms change frequently.

4.56 For stations where no travel times were recorded, an average street access distance of 180 metres (160 seconds) was applied based on the average of the measurements obtained during the survey. These estimates were revised and updated as required during the calibration process presented in Section 6.

**Monetary Cost attributes**

*Auto and Park & Ride costs*

4.57 Monetary costs for auto and Park & Ride users include operating costs, parking and toll costs (if applicable, currently applied on the A25 and A30).

*Transit costs*

4.58 Another key component to the Generalized Cost calculation is the monetary cost associated to the transit trip. The complexity of estimating this parameter relates to the availability of a wide range of ticket products and concessions which result in a different trip unit fares i.e. frequent users use monthly cards with reduced unit fares and fare discounts are applied to student or seniors.

4.59 For the purposes of simplicity and applicability to the Transit Mode Choice Model (EMME) we have estimated an weighted average transit fare matrix for each user type (student and adult) covering all the zones in the model (a total of 1766 zones).

4.60 In order to estimate this matrix, we have analysed in detail the different ticket types and fares available in the study area, and what is the market share of those for the key market segments (student and adult). This has been discussed in Section 3.

4.61 This section includes the assumptions adopted based on the analysis of the demand and revenue datasets provided by AMT, STM, RTL and CIT transit agencies.

4.62 The model has been developed for 2 type of users; adults and students (adults include regular fares while reduced fares include seniors, children, etc.).Table 4.4 and Table 4.5 summarise the fare assumptions adopted for each market.

- ***STM Montréal Island trips***: the average fare estimated for the whole Montréal Island and by ticket type based on the analysis of STM current fares:
  - $1.93 for Adults
  - $1.03 for Students
- ***CIT trips (South Shore/A10)***: Table 4.4 shows the average fare estimated for each CIT and by ticket type.

**Table 4.4: Average Fares – CITs (2015 $)**

| AV FARE | CITCRC | | CITVR | | OMITSJU | | CITROUS | | CITLR | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | $2.30 |
| 6 | $3.48 | $3.28 | $4.25 | $3.28 | $3.69 | $3.27 | $3.04 | $2.99 | $2.75 | $2.60 |

- ***Ville de Saint-Jean-sur-Richelieu:*** also provides services to the South Shore and Montréal Island. Ticket sales and revenue was analyzed and the following fares were estimated for trips to Montréal:
  - $4.93 for adult
  - $3.28 for student
- ***RTL***: fare for internal trips in Longueil was based on the average fare extracted from the ticket sales and revenues information. This was estimated as $1.99 for regular and $1.14 for students.
- ***Rest of Trips***: For the rest of the trips, the average fare has been estimated based on the existing average fare by zone for AMT users as shown in Table 4.5.

**Table 4.5: Average fare – AMT (2015 $)**

| 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 |

4.63 The fares estimated above have been used as a base to define the 2015 average transit fare matrix. The calculation of the Fare OD matrix was based on the zone location and the number of zones travelled between each OD pair.

4.64 On Montréal Island, STM and AMT services have different fares. To reflect the differential fares between STM and AMT commuter rail services, the following approach was adopted in modelling terms (only applied for ODs in Montréal Island):

- A 'base' fare matrix was created based on the STM fares for adult and students (see paragraph 4.62).
- An 'incremental fare' was introduced in the model to represent the additional cost of commuter rail trips on Montréal Island. This has been included in the model by increasing the walk access time to the various AMT stations based on the zone the station is located in (and

ensuring the additional access time was only applied once per trip). Table 4.6 shows an example of how this was applied.

**Table 4.6: AMT and STM fare differential application**

| Montréal Island AMT Fare Zone | STM Adult Fare | AMT Adult Fare | VoT ($/hr) | Equivalent Additional Travel Time (mins) | Additional Distance Coded (m) |
|---|---|---|---|---|---|
| 1 | $1.94 | $2.01 | $8 | 0.5 | 40 |
| 2 | $1.94 | $2.38 | $8 | 3.3 | 240 |
| 3 | $1.94 | $2.77 | $8 | 6.3 | 450 |

### Generalized Cost Parameters

*Stated Preference Surveys*

4.65 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 surveys were carried out by Steer Davies Gleave in May and June 2016.

4.66 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.

4.67 The analysis of the survey presented in Table 4.7: shows that 60% of the respondents 'traded' during the SP exercise i.e. they chose their current mode at least once and they chose the new REM service at least once out of the 8 choices. However, 40% of respondents always chose the same mode (23% always chose their existing mode and 16% always chose REM).

**Table 4.7: Corridor SP Traders Summary**

| Trading | Car | Park & Ride | Transit | Total |
|---|---|---|---|---|
| Traders(1) | 67% | 59% | 57% | 60% |
| Always REM | 12% | 18% | 18% | 16% |
| Always Current Mode | 20% | 24% | 25% | 23% |

(1) Traders chose their current mode at least once and chose the new REM service at least once out of the 8 choice exercises.

4.88 The overall analysis suggests a resistance to change from the existing mode to REM as evidenced by the higher proportion of Current Mode non-traders (23%). Although this resistance is typically observed for auto users around the world, the analysis also showed a resistance for existing transit users to remain on their existing transit modes. This is somewhat surprising for existing bus users, where the REM service will provide an improved level of service in terms of quality (smooth ride in a clearly identified network with multi-door loading/unloading) and reliability (service operates completely segregated from car traffic) on a service much more akin to a Métro or rail service.

4.89 Table 4.8 shows the behaviour parameters extracted from the SP analysis:

- Value of Time (VoT): shows how much an individual is prepared to pay in order to save an hour of journey time and it is applied to convert fares and other costs into travel time. This has been estimated for work and non-work users separately.
- Access and Wait time factors: represent the perceived penalty for the time spent to access and to wait for the main mode compared to the in-vehicle time. This is included as a multiplier to the estimated access/wait times.
- Transfer penalty: additional time added to the Generalized Cost calculation as a penalty for the transfer. This penalty is added for each transfer required for the full trip.
- Mode constant: additional time added to the Generalized Cost calculation to represent passenger's quality and reliability perceptions of different modes.

**Table 4.8: 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<br>REM vs Bus: +6min | REM with transit access (vs Car): +21 min<br>REM with Park & Ride (vs Car): +4 min |

4.90 Table 4.8 shows some preference of existing transit modes to their current mode compared to REM. Typically for a system like REM (guided rail and completely segregated from traffic), we would expect REM to be as attractive as Métro or rail and therefore all sharing the same mode constant. Furthermore, we would expect REM to be perceived as 'better' than bus which is not as comfortable and subject to traffic unreliability. However, the Transit Users SP results are showing the opposite trend, with an estimated penalty for using the REM of 6 minutes compared to the bus i.e. a trip of 20 minutes travel time between bus and REM would be perceived by bus passengers as 6 minutes faster than by REM.

4.91 On the other hand, a model developed only with "traders" (eliminating both "always current mode and always REM" non-traders) results in a REM mode constant in Line with expectations with an estimated penalty to the bus of 5 minutes compared to the REM and indifference between rail, Métro and REM at equal time and costs. This tends to indicate the existence of a bias in the SP responses.

4.92 There are a number of possible reasons for this response to REM including:

- Opposition to the elimination of direct express routes to their final destination

- Misunderstanding of the REM project and potential association with a service of lower service quality and reliability (streetcar)
- Resistance to change

4.93 It is unclear how each of these possible reasons contributed to the selection of the bus versus REM in the Corridor SP results. In light of our professional experience and extensive past LRT and rapid transit work in Canada and around the world, we believe the non-trader model shows a more realistic estimation for the REM characteristics.

4.94 Table 4.8 also displays a low VoT for Park & Ride users, especially when compared to pure transit users. We believe the pure transit users VoT model shows a more realistic estimate of the Park & Ride VoT.

4.95 The VoT and modal constant assessments and adjustments made are discussed below.

*Value of Time Assessment*

4.96 The value of time is an important parameter of the Generalized Cost, since it converts the various cost components into a unified time value to be compared across alternative modes. The higher the value of time, the more users are willing to pay to save time.

4.97 In order to assess the reasonableness of the estimated Value of Time, it is common practice to compare it to half the hourly wage rate. In this case it is $10.4 (half the Quebec hourly wage of $20.8/hour estimated from Statistics Canada data).

4.98 On this basis:

- Auto users ($14.5) values of time seem to be within the higher range, which is consistent with a typical higher income level. Moreover, it is very similar to the MOTREM assumption of $14/hour.
- Transit users ($7.9-$7.4) values are however within the lower range of what would be expected for Transit and Park & Ride users. However, these values seem to be consistent with previous SP surveys carried out in Montréal which have resulted in low VoT.

*Modal Constant Assessment*

4.99 The modal constant is another particularly important component of the Generalized Cost, since it determines the mode preference of users given similar travel time and cost conditions.

4.100 The results obtained from the SP surveys show a consistent preference of rail modes versus bus (on-street bus mode constant has a 5 minute penalty compared to Métro and rail modes) and in Line with expectations. However, the Stated Preference survey, when using the entire sample is showing biased results against REM.

4.101 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 minutes penalty for bus users when compared to REM (see Table 4.9).

**Table 4.9: Corridor SP results**

| Parameter | All Transit Users | Only Traders |
|---|---|---|
| REM vs Rail/Métro | +11min | 0 |
| REM vs Bus | +6min | -5min |

4.102 We believe the non-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.

4.103 While this assumption is reasonable, it is important to understand and compare with evidence observed in studies/applications. Appendix B describes our review of literature and applications to similar projects.

4.104 The analysis confirms the reasonableness of a 5 minute mode constant against bus users in favor of REM. However the uncertainty of this parameter should be taken into account when developing the reference case and carrying out the risk assessment and defining sensitivity analysis as described in Section 7.

## Airport model

### Model Overview

4.105 The Aéroport Pierre-Elliott-Trudeau model is a standalone spreadsheet model, which estimates the level of demand that will switch to REM 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 Express) and Car Park & Fly currently.

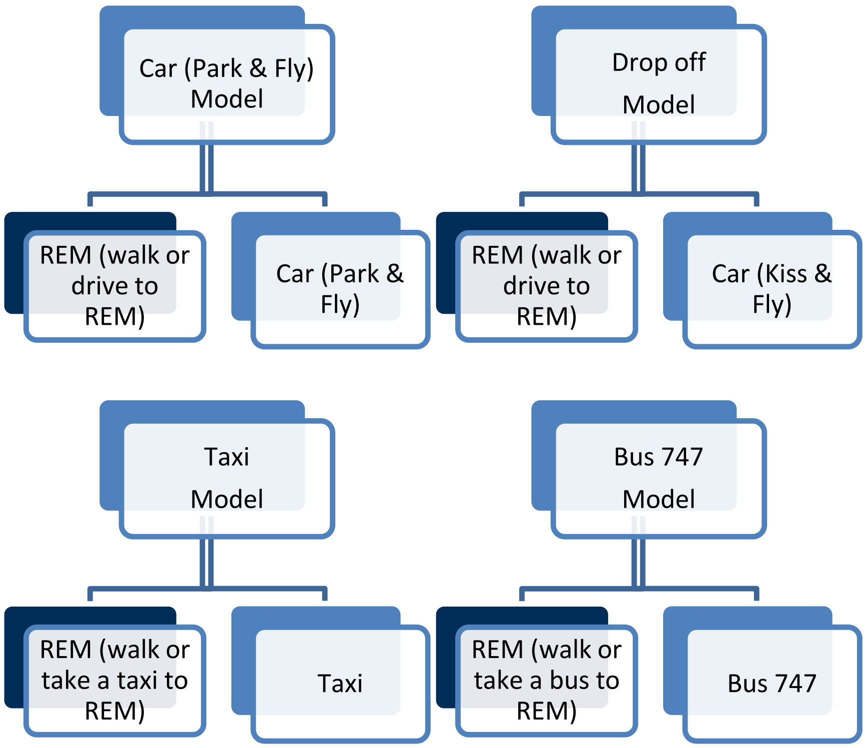
4.106 REM capture is calculated by comparing the Generalized Cost for travel using the existing mode with the Generalized Cost for travel using REM. Generalized cost includes:

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

4.107 Airport passenger and staff demand has been estimated and distributed by market segment using the assumptions in Section 3, (see Table 3.9 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.

4.108 The greater the Generalized Cost advantage of REM compared with the existing mode, the more capture is likely to be abstracted.

**Figure 4-7: Logit Model Structure used for the Air Passengers Mode Choice Model**




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

### Generalized Cost components

4.110 Table 4.10 shows the Generalized Cost components for each mode and their source.

**Table 4.10: Generalized Cost components for existing modes**

| | | | 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 | 0 minutes | Assumed no 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 | Same times for all of these modes. | Estimated in Network Model |
| | Car (Park & Fly) | | |
| | Car (Kiss & Fly) | | |
| **Fare** | Bus | Varies for each trip | Estimated in Transit Mode Choice model |
| | Taxi | $40 fixed downtown fare<br>$4.86 + $1.7 per km | Based on *Steer Davies Gleave* online research of standard taxi fares in Montréal |
| | Car (Park & Fly) | $140 parking charge for passengers<br>$0 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) | $0 | Assumed no charge for drop off at the Aéroport Pierre-Elliott-Trudeau. |

4.111 Components are weighted according to their relative importance. For example, time spent walking or waiting is usually perceived as more than time spent travelling in a vehicle. These weights have been estimated from our Stated Preference work and benchmarked against experience elsewhere. Given that some of the Generalized Cost components are measured in monetary values, a value of time (which varies for each mode and market segment) is used to convert these in to time values.

4.112 The auto and transit travel time and cost components used to generate Generalized Costs have been estimated from the Network Model. This allows us to maintain consistency between the two models and ensure that any REM configuration or service changes can be reflected in the Airport access model.

### Generalized Cost Parameters

4.113 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[11].

4.114 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 bus). 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.

4.115 The analysis of the Airport survey sample showed that, overall 62% of the respondents chose the hypothetical scenario ('traded') during the SP exercise. However, 38% of respondents always chose the same mode (26% always chose their current mode and 12% always chose REM).

4.116 Respondents who used auto-based modes (Park & Fly, Drop off and Taxi) have a higher share of respondents who always chose their existing mode (41%, 28% and 26% respectively) compared with 747 bus users who were less likely to remain loyal to their current mode (only 3% of bus respondents always chose to stay on the bus).

**Table 4.11: Airport SP Traders Summary**

| Tradings | Car Park & Fly | Car Kiss & Fly | Taxi | 747 | Total air travelers | Airport Staff |
|---|---|---|---|---|---|---|
| Traders | 51% | 58% | 66% | 77% | **62%** | **58%** |
| Always REM | 8% | 14% | 8% | 20% | **12%** | **1%** |
| Always Current Mode | 41% | 28% | 26% | 3% | **26%** | **41%** |

4.127 The analysis suggests:

- **Auto-based modes** have an intrinsic predisposition against the REM with a resistance to change from their existing mode. This is evidenced by the high level of non-traders in favour of the Current Mode. This resistance is typically observed for auto users around the word and is an expected result.
- **Existing bus users** are more likely to favour REM, perceiving a benefit from an improved level of service in terms of quality (smooth ride in a clearly identified network with multi-door loading/unloading) and reliability (service operates completely segregated from car traffic) in a service much more akin to a Métro or rail service. It is therefore reassuring to see that 747 bus users have an intrinsic predisposition in favor of the REM.

[11] Summer is not an ideal time to undertake research. However choosing summer is unlikely to affect passengers' willingness to pay values, which is more affected by the mixture of journey purposes of the passengers interviewed.

4.128 Table 4.12 shows the behaviour parameters extracted from the SP analysis:

**Table 4.12: Airport SP results summary**

| Parameter | Car Park & Fly | Car Kiss & Fly | Taxi | 747 Bus | Airport Staff |
|---|---|---|---|---|---|
| VoT Business(1) | $166.6 | $37.5 | $52.80 | $13 | $65.0 |
| VoT Non-business(1) | $58.3 | $33.3 | $28.10 | | |
| Access time factor | 1.0 | 1.3 (Business) 1.4 (Nonbusiness) | 2.8 | 1.0 | 1.0 |
| Wait time factor | 1.0 | | 5.6 | 4.4 | 1.0 |

(1) VoT is for Business and Non-business separately for Park & Fly, kiss & Fly, Taxi and Staff. 747 bus splits the markets into AM Peak and Inter Peak, and does not distinguish business and non-business trips.

4.129 While the value of times obtained from the SPs are very high, experience in other jurisdictions shows that these values for air travelers are typically much higher than those observed for other trip purposes (i.e. commuter travel). For example, the US Department of Transport [12] guidelines provide an average value of time of $44/$60 (in 2012 USD) for all purpose and business air travel ($56/$72 in 2016 USD).

4.130 While the average VoTs for air travelers seem to be within acceptable ranges, the ***Park & Fly*** values appear to be extremely high, especially for Business users ($166.6 per hour). It is also worth noting that a similar effect is observed with ***airport Staff*** that are currently using the Airport parking facilities.

4.131 However, business travellers and Airport staff are reimbursed for the parking costs and therefore there is a resulting bias against any other mode, with a very high component of non-traders who always chose the car or taxi, no matter how attractive the new transit system is (41% of surveys).

4.132 This reflects a clear resistance of existing car users (both air travelers and Airport staff) to shift modes unless they are asked to pay for a parking fee.

4.133 ***Drop off and Taxi users*** present a high value of time, as well as a penalty to the access and wait time, which is in Line to what is expected.

4.134 ***747*** bus users present a value of time which is almost double to that observed in the corridor transit system. This is in Line to what it is expected, given the different trip purpose and different type of users. It also reflects the preference of users to REM, although it has been reflected in a higher value of time.

4.135 As discussed, the Stated Preference parameters are a result of preferences stated by the users of each mode, which could be biased. The application process of these variables is an iterative process, where the different parameters are adjusted in order to better reflect the expected diversion propensity of current demand by mode.

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[12] https://www.transportation.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf

4.136 As mentioned above, the uncertainty of these parameters will be taken into account when developing the risk assessment and defining sensitivity analysis and low case scenarios.

## Expansion factors

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

- Weekday factor: translates AM peak and Inter Peak demand into an average week day, using the following:
  - AM Peak to Total Peak factor
  - Inter Peak to Total Off Peak factor
- Annual factor: translates average weekday demand into annual demand.

**Corridor expansion factors**

4.138 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.

4.139 The estimated existing weekday and annual expansion factors are shown in Table 4.13.

**Table 4.13: Expansion factor analysis**

| Mode | AMT Rail | AM PEAK TO PEAK | INTER PEAK TO OFF PEAK | WEEKDAY TO ANNUAL | %PEAK |
|---|---|---|---|---|---|
| RAIL | **Deux-Montagnes Line** | **1.88** | **-** | **241** | **85%** |
| | Vaudreuil-Hudson Line | 1.92 | - | 214 | 92% |
| | Saint-Jérôme Line | 1.86 | - | 213 | 92% |
| **Mode** | **West Island Bus** | **AM PEAK TO PEAK** | **INTER PEAK TO OFF PEAK** | **WEEKDAY TO ANNUAL** | **%PEAK** |
| STM | Non-express routes | 2.13 | 1.66 | 277 | 52% |
| | **Express routes** | **1.95** | **1.59** | **273** | **59%** |
| **Mode** | **Métro** | **AM PEAK TO PEAK** | **INTER PEAK TO OFF PEAK** | **WEEKDAY TO ANNUAL** | **%PEAK** |
| MÉTRO | Green Line | 2.50 | 1.86 | 313 | 49% |
| | Orange Line | 2.18 | 1.78 | 293 | 52% |
| | Yellow Line | 1.54 | 1.77 | 320 | 55% |
| | Blue Line | 2.43 | 1.73 | 306 | 49% |
| | **Total** | **2.27** | **1.81** | **-** | **51%** |
| **Mode** | **Line** | **AM PEAK TO PEAK** | **INTER PEAK TO OFF PEAK** | **WEEKDAY TO ANNUAL** | **%PEAK** |
| EXPRESS BUSES (SOUTH SHORE/A10 corridor) | 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%** |

*Source: AMT, STM and CITs data*

*West Island/Deux-Montagnes Line Corridor*

4.140 The expansion factor on the Deux-Montagnes, as in the other rail lines, is currently very low. This reflects the commuting nature of the corridors, which are mainly used for trips to work. Furthermore the service provision in the non-peak hours and weekends is limited (60 minute headways on Deux-Montagnes).

4.141 The bus demand observed in the DM corridor has a higher daily factor than rail, related in part to the higher frequency of Inter Peak services. However, it is also worth noting, that Inter Peak demand is partly comprised of shorter distance trips related to local access (shopping, errands, etc.) that will not be captured by the DM rail service.

4.142 Most of the demand for REM in West Island/Deux-Montagnes Line Corridor will be captured from the Deux-Montagnes Line, express bus services and local bus services feeding the Orange Lineline. Therefore, a combination of the three has been taken into account in order to estimate expansion factors.

**Table 4.14: West Island/Deux-Montagnes Line Expansion Factor Analysis**

| | AM PEAK TO PEAK | INTER PEAK 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** | * | * |

** The % of the peak periods compared to the total weekday demand will vary in each case*

*South Shore/A10 Corridor*

4.143 The expansion factors on the express bus routes are higher, especially on the RTL services that provide a higher level of service in the Inter Peak periods. Since most of the REM demand in this corridor will be captured from the existing bus demand, we have estimated similar expansion factors to those observed on the express bus services today.

**Table 4.15: South Shore/A10 Corridor Expansion Factor Analysis**

| Line | AM PEAK TO PEAK | INTER PEAK 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** | | |

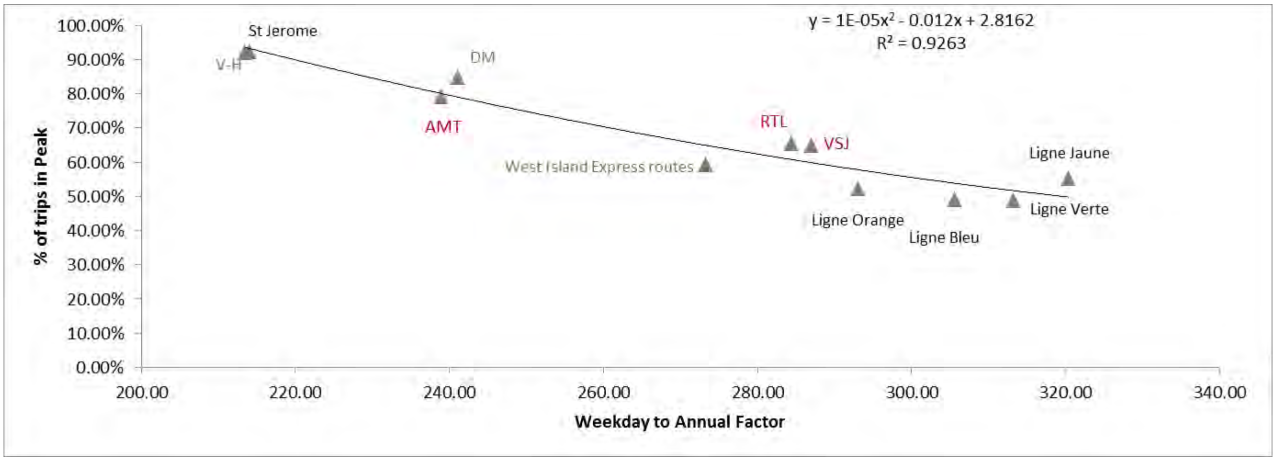
*Annual factor*

4.144 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 Xmas and summer holidays).

4.145 The very low annual expansion factors on the Deux-Montagne Line and some of the bus express services (Express 90 Chevrier, etc.) reflect, in part, the low service provision of those services in the Inter Peak periods and during weekends and holidays. However, it is also worth noting, that Inter Peak demand is mostly comprised of local short distance trips related to shopping, errands, etc., that are less likely to be captured by REM due to the larger distance between stations.

4.146 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 4.8 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.

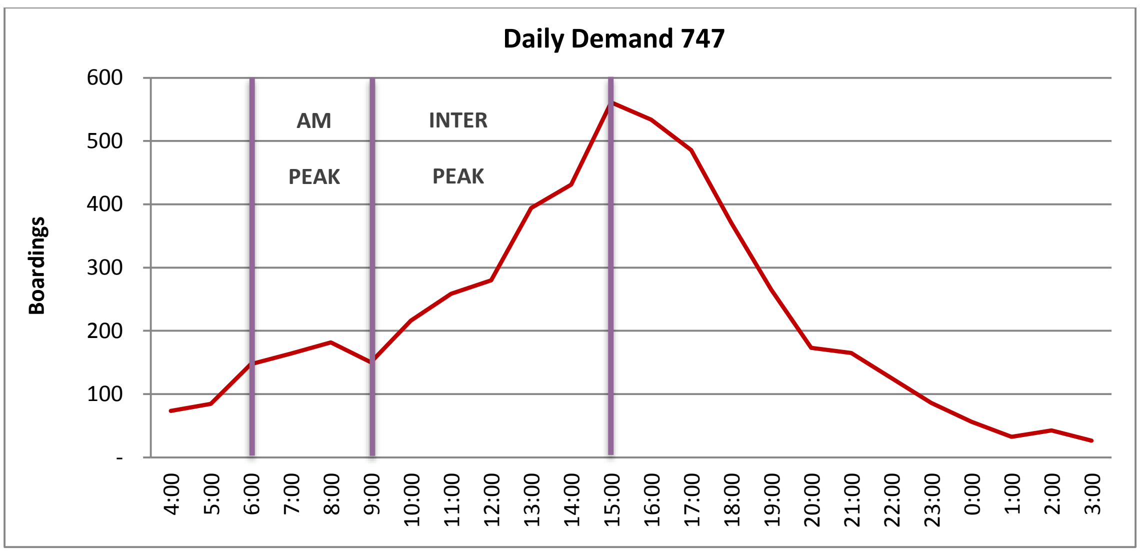
**Figure 4.8: Weekday to Annual Expansion Analysis**




### Aéroport Pierre-Elliott-Trudeau

4.147 The 747 bus service has a very different hourly profile, since it reflects the Airport demand based on flight schedules, instead of commuting demand. Figure 4.9 shows that the actual peak period for the 747 bus service is between 3pm and 4pm on a weekday.

**Figure 4.9: 747 Demand Profile**




4.148 Based on the 747 bus data above, the following 747 expansion factors have been estimated:

- AM peak + Inter Peak to weekday: 2.38
- Daily to annual: 277

## Ramp up

4.149 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.

4.150 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 be implemented.

4.151 Table 4.16 shows some examples of ramp up rates for LRT systems and it also includes an estimation of the ramp up when the 747 Aéroport Pierre-Elliott-Trudeau express service was introduced.

**Table 4.16: Ramp Up in LRT Systems**

| | London, UK (Croydon) | Nottingham Line 1, UK | Manchester Métrolink, UK | Tren Urbano, Puerto Rico | 747 bus service |
|---|---|---|---|---|---|
| Year 1 | 74% | 83% | 60% | 75% | 80% |
| Year 2 | 83% | 96% | 84% | 83% | 90% |
| Year 3 | 85% | 99% | 92% | 89% | 95% |
| Year 4 | 90% | 100% | 94% | 100% | 100% |
| Year 5 | 100% | 100% | 100% | 100% | 100% |

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

**Table 4.17: REM Ramp Up Factors**

| Year | West-Island/Deux-Montagnes Line Corridor | | Airport Corridor | | South Shore/A10 Corridor | |
|---|---|---|---|---|---|---|
| | Existing DM | New | New | New | Existing Express (eliminated) | New |
| 2022 | 100% | 60% | 80% | 60% | 90% | 60% |
| 2023 | 100% | 80% | 90% | 80% | 95% | 80% |
| 2024 | 100% | 90% | 95% | 90% | 100% | 90% |
| 2025 | 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 Enquête 2013 and matrix developed for 2016 which is summarized in Table 5.1.

**Table 5.1: MOTREM Demand Total (2016)**

| | AM (6am-9am) | Inter Peak (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.

### Transit demand

5.4 The transit demand matrix was developed using the following data sources:

- 2013 Enquête origine-destination
- 2015 AMT on-board survey
- 2016 Steer Davies Gleave on-board survey
- 2015 bus boarding data

*2013 Enquête origine-destination*

5.5 The survey covers almost 79,000 households and provides origin-destination data for the AM peak period and 24 hours for all modes of transportation. The expanded matrix, based on estimated population in 2013 is shown in Table 5.2. Note that Inter Peak demand is not estimated specifically as part of the Enquête process.

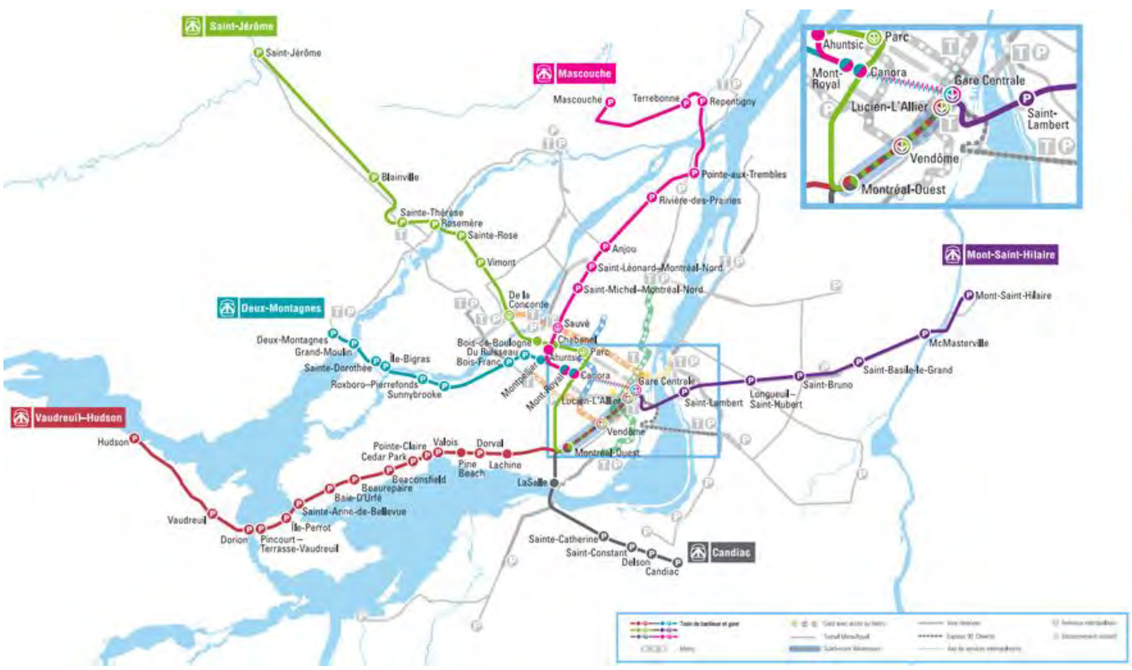
**Table 5.2: 2013 Enquête origine-destination – Trips by Mode**

| Mode | AM Peak | 24 Hour |
|---|---|---|
| Auto (driver) | 1,140,253 | 5,069,864 |
| Auto-passenger | 251,262 | 1,216,957 |
| *Auto subtotal* | *1,391,515* | *6,286,821* |
| Transit | 399,677 | 1,363,795 |
| Park & Ride | 44,856 | 123,397 |
| Auto-passenger + transit (kiss & ride) | 23,694 | 55,536 |
| *Transit subtotal* | *468,227* | *1,542,728* |
| **Total** | **1,859,742** | **7,829,549** |

*2015 AMT on-board survey*

5.6 AMT undertakes on-board OD surveys at regular intervals on the six commuter rail lines and the Express 90 Chevrier bus service. AMT provided origin-destination data for all rail lines and the Express 90 Chevrier. These were carried out in September 2015 in the AM peak and were collected via postcards which passengers returned as they alighted from the train. Figure 5.1 shows the AMT train network.

**Figure 5.1: AMT Rail network**




5.7 The train survey was conducted in the AM peak period and the bus survey was conducted all day. Passengers were asked about their origin and destination in addition to access and egress mode, ticket type used and socio-economic background. The observations were expanded by the number of passengers (boarding) and the boarding station. Table 5.3 shows a summary of the survey sample.

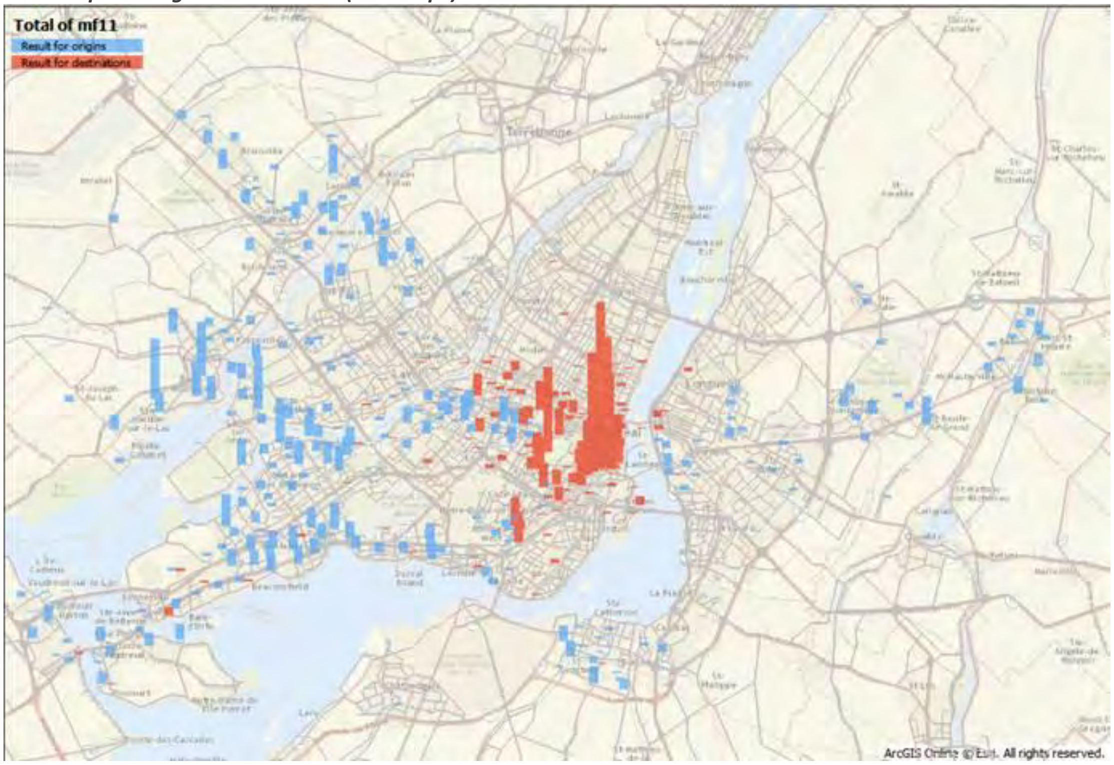
**Table 5.3: 2015 AMT – Survey Sample**

| Line | Date | Responses | Passenger counts | Initial Passenger Sample | Valid responses | Revised Passenger Sample |
|---|---|---|---|---|---|---|
| Deux-Montagnes Line | Sep 2015 | 8,030 | 14,186 | 57% | 7,482 | 53% |
| Vaudreuil-Hudson Line | Sep 2015 | 5,610 | 8,285 | 68% | 5,217 | 63% |
| Mascouche Line | Sep 2015 | 2,649 | 3,388 | 78% | 2,470 | 73% |
| Saint-Jérôme Line | Sep 2015 | 4,821 | 6,788 | 71% | 4,558 | 67% |
| Express 90 Chevrier | Nov 2015 | 2,106 | 3,424 | 62% | 1,893 | 55% |
| Mont-Saint-Hilaire Line | Sep 2015 | 3,729 | 4,739 | 79% | 3,544 | 75% |
| Candiac Line | Sep 2015 | 1,938 | 2,412 | 80% | 1,795 | 74% |
| **TOTAL** | | **28,883** | **43,222** | **67%** | **26,959** | **62%** |

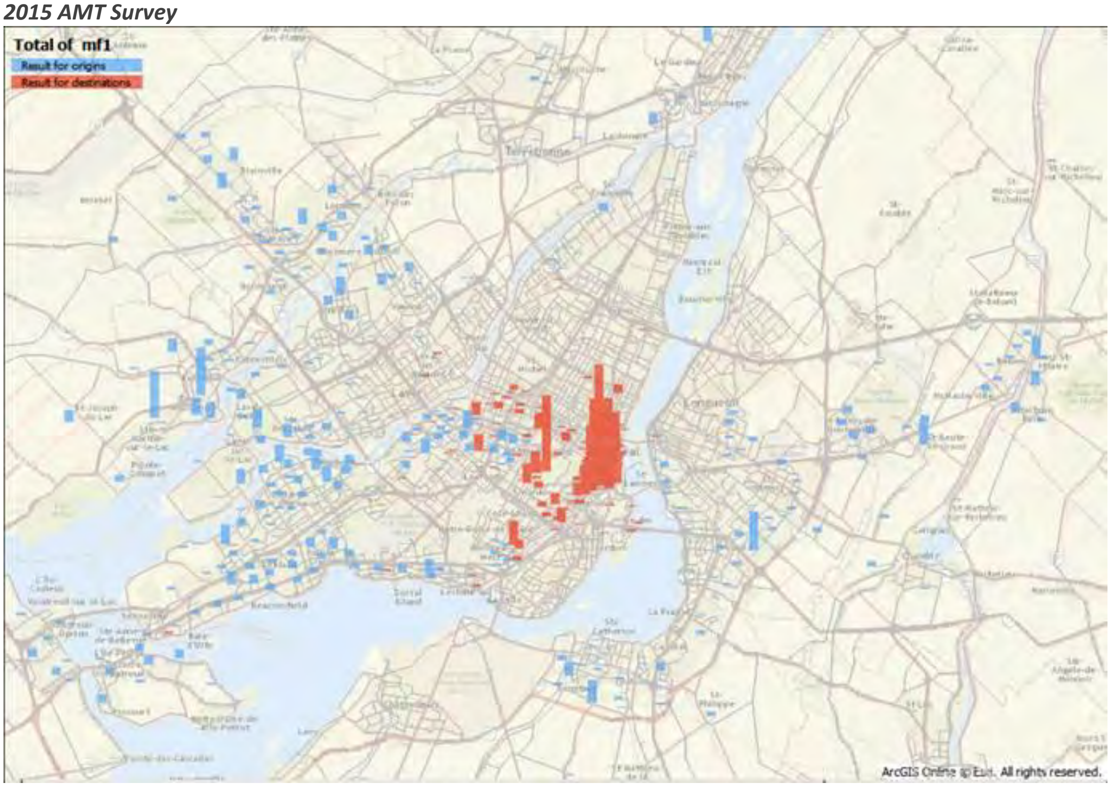
5.8 The overall survey sample was very high (62%) considering it relied on passengers returning the survey form. Figure 5.2 shows a comparison between the AM peak AMT trips from the 2013 Enquête origine-destination and the 2015 AMT survey.

**Figure 5.2: 2013 Enquête origine-destination  and 2015 AMT Survey Comparison (AM peak)**

***2013 Enquête origine-destination  (AMT trips)***




***2015 AMT Survey***



5.9 The survey data shows the 2013 Enquête origine-destination has more AMT trips than the 2015 AMT survey (51,000 vs 40,000) with both datasets having similar trip patterns.

5.10 An important proportion of trips to the train station are by car (car-driver access mode). Table 5.4 shows the number and proportion of car-driver access mode trips. Note that the AMT survey did not specify whether the car driver access was to an 'official' Park & Ride site or drivers parked on the surrounding streets around the station.

**Table 5.4: AMT Car Driver Access Mode Trips (AM Peak)**

| Variable | Trips | % |
|---|---|---|
| Car-driver access mode | 22,066 | 55% |
| All other modes | 17,875 | 45% |
| **Total Trips** | **39,941** | **100%** |

*2016* Steer Davies Gleave *on-board bus survey*

5.11 Steer Davies Gleave conducted an on-board OD survey on some of the West Island/Deux-Montagnes Line and South Shore/A10 bus services in May and June 2016 in the AM peak and Inter Peak periods (described in the Data Collection Report). The bus OD matrix was estimated based on:

- OD surveys expanded; and
- Additional transit demand to account for services, direction of travel and other areas not included on the survey. This demand was based on the 2013 Enquête origine-destination and 2015 bus boarding data.

Table 5.5 summarises the estimated trip totals.

**Table 5.5: Bus trip totals**

| Period | Steer Davies Gleave OD Survey boardings | Total boardings |
|---|---|---|
| AM Peak | 28,618 | 76,413 |
| Inter Peak | 17,982 | 68,273 |

### Demand development

*Data sources*

5.12 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 inter peak from 9am-3pm

5.13 Table 5.6 summarizes the data sources by mode and period.

**Table 5.6: Matrix data source summary**

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

5.14 The parking location was used as the origin from the AMT OD survey with a car driver access mode i.e. a Park & Ride trip.

### Initial demand

5.15 Table 5.7 shows the initial demand totals estimated by Steer Davies Gleave and compares them to the 2013 Enquête origine-destination results. The following figures show the trip pattern for each matrix.

**Table 5.7: Initial and AMT 2013 enquête transit demand comparison**

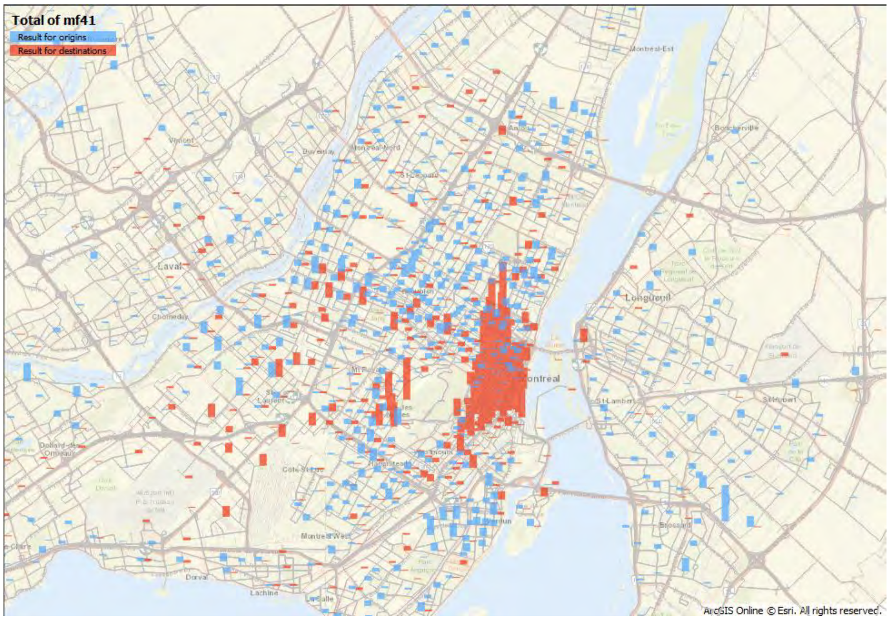
| Period | Purpose | Initial (A) | 2013 Enquête origine-destination (B) | Difference (A-B) | ((A-B)/A)% |
|---|---|---|---|---|---|
| AM Peak | Work | 220,470 | 265,899 | (45,429) | -21% |
| | Study | 137,483 | 173,582 | (36,099) | -26% |
| | Other | 24,982 | 28,746 | (3,764) | -15% |
| | **Total** | **382,935** | **468,227** | **(85,292)** | **-22%** |
| Inter Peak | Work | 72,120 | 53,978 | 18,142 | 25% |
| | Study | 80,811 | 65,236 | 15,575 | 19% |
| | Other | 254,724 | 204,182 | 50,542 | 20% |
| | **Total** | **407,656** | **323,396** | **84,259** | **21%** |

5.16 Table 5.7 shows that the initial demand estimates have reduced considerably the number of AM peak trips in the 2013 Enquête while the opposite is the case in the Inter Peak. This is a common occurrence with household surveys which are generally developed on a 24-hour basis and where respondents include their AM peak trips (more regular and predictable) but can under-report non-peak trips which are more infrequent and therefore not reported.

5.17 Figure 5.3 to Figure 5.8 show the trip patterns for the initial estimated demand. Note that this demand was refined in the calibration process to ensure that road and transit flows on the network reflected observed boardings and peak loads and therefore further adjustments were carried out as reported in Section 6.

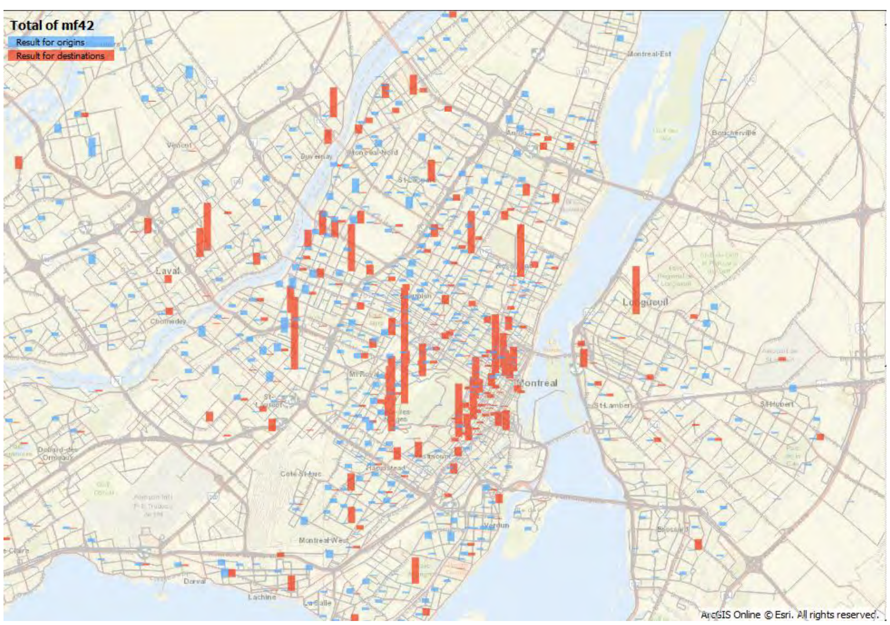
5.18 Figure 5.3 shows how the trip pattern for the AM peak work trips shows a large number of trips with destination in downtown Montréal.

**Figure 5.3: Work trip distribution (AM Peak)**



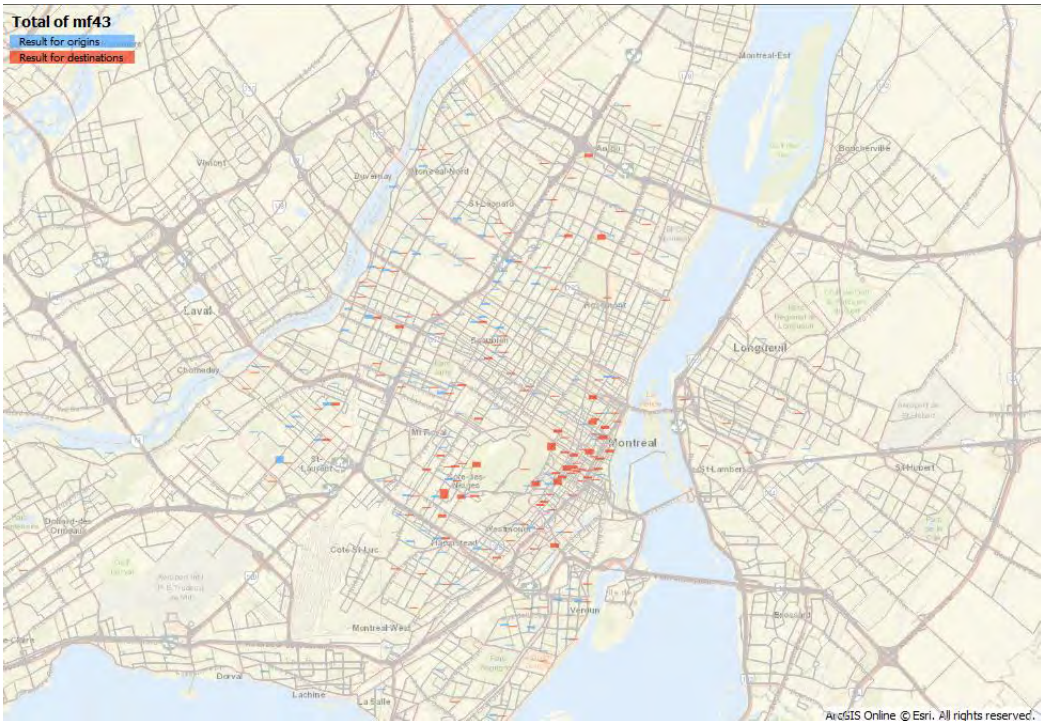

5.19 Study trips shown in Figure 5.4 display a much more diverse trip pattern and are linked to the location of the various universities and colleges e.g. Université de Montréal west of Mont-Royal.

**Figure 5.4: Study trip distribution (AM Peak)**



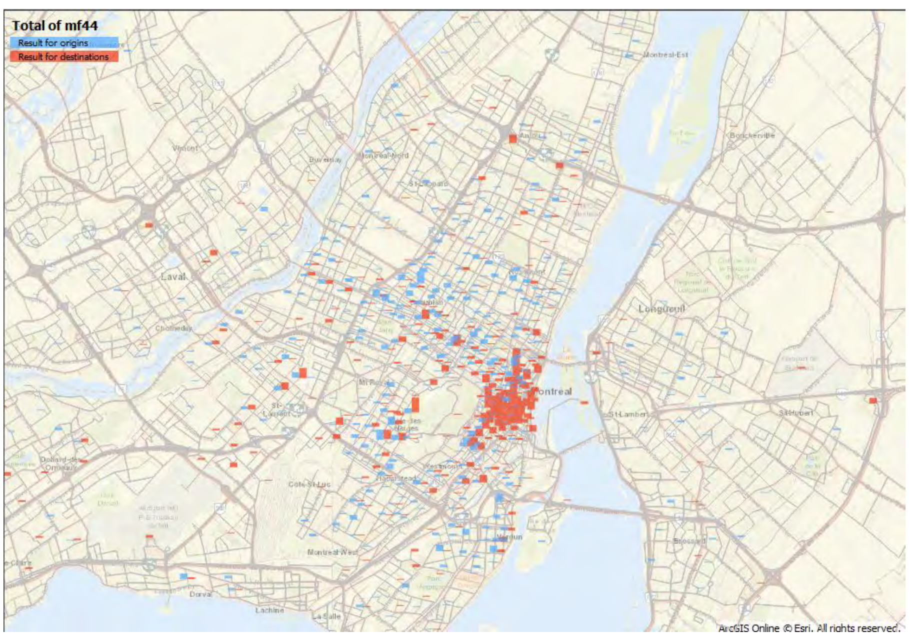

5.20 Other AM peak trips are considerably less than Work and Study trips in volume and show a wide geographical distribution as shown in Figure 5.5.

**Figure 5.5: Other trip distribution (AM Peak)**



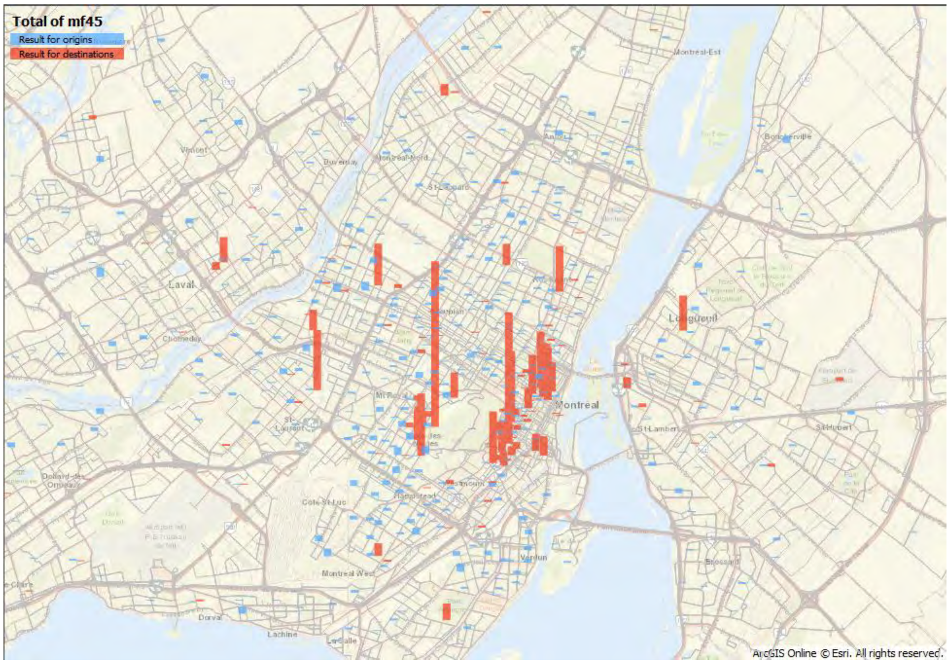

5.21 The Inter Peak Work trip pattern is still concentrated in the downtown area but patterns are more dispersed distribution than in the AM peak as shown in Figure 5.6.

**Figure 5.6: Work trip distribution (Inter Peak)**



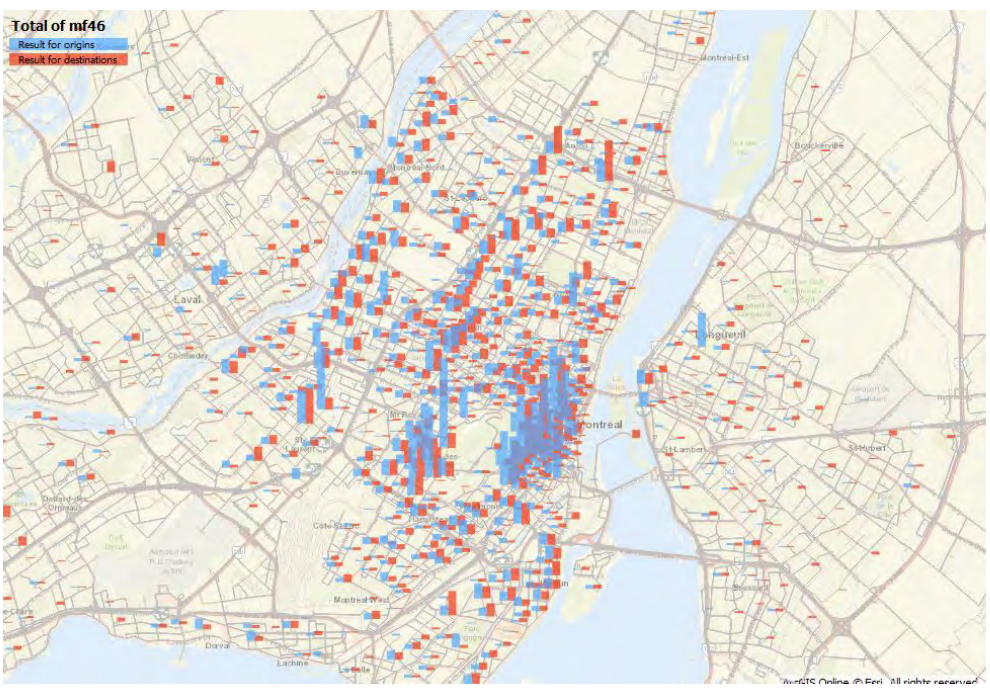

5.22 Figure 5.7 shows that Inter Peak Study trips show a higher concentration of destinations at university locations than the AM Peak, likely as a result of high schools generating limited demand after the AM Peak.

**Figure 5.7: Study trip distribution (Inter Peak)**




5.23 Figure 5.8 shows the largest geographical spread of origins and destinations for Other trips, in Line with the variety of trip purposes and the non-work nature of Inter Peak trip-making.

**Figure 5.8: Other trip distribution (Inter Peak)**

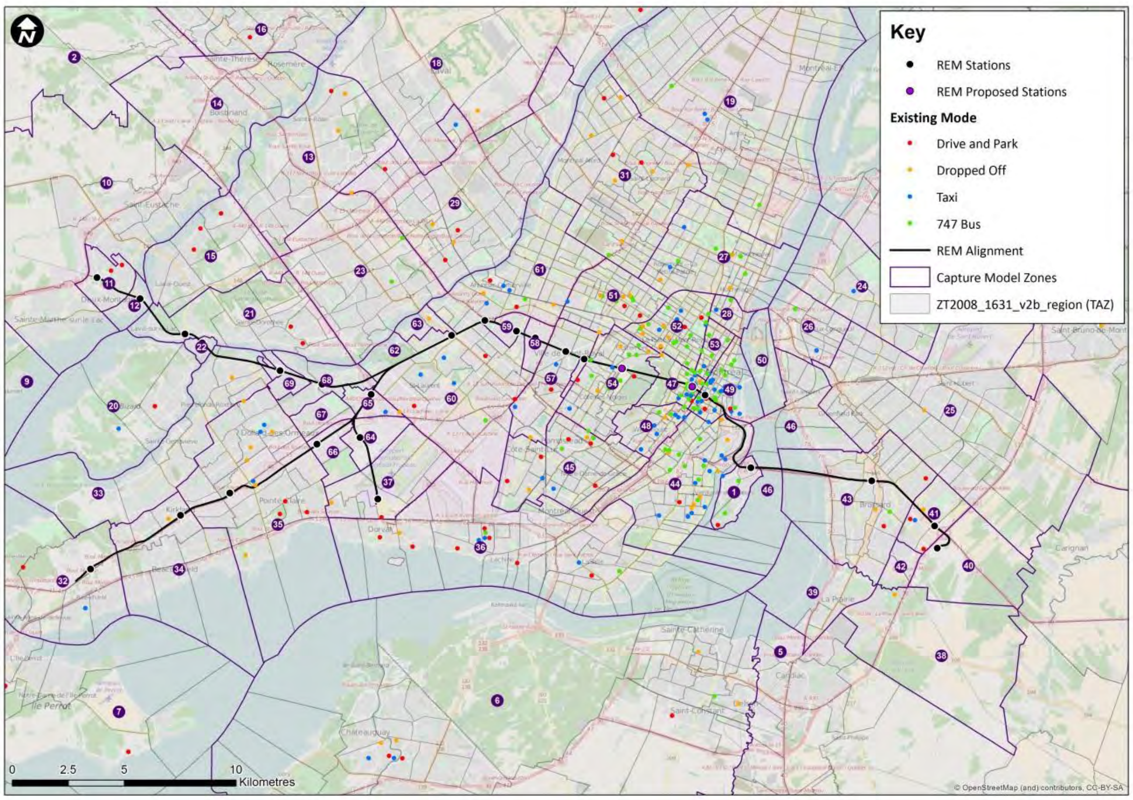


### Airport demand

5.24 The Airport demand has been assessed separately from the rest of the demand, since the Household Surveys (Enquête) do not capture the Airport market. The Enquête is based on surveys to Montréal residents and focusses on day to day trips as described earlier in this section.

5.25 The spatial distribution of Montréal resident air passenger trips were distributed according to an aggregated version of the Network EMME Transit Mode Choice Model zones. There are 68 zones in the Airport model (Figure 5.9) where each station is assigned to an individual zone. The spatial distribution of non-resident air passenger trips was taken from the Steer Davies Gleave Airport SP survey.

**Figure 5.9: Airport model zoning system**




5.26 The EMME demand distribution resulted in some gaps in the distribution. Where the equivalent area in the ADM surface access surveys was found to be non-zero, demand has been 'in filled'[13].

[13] Zones with zero demand have been compared in the ADM surface access data with their contiguous neighbours to establish their relative importance. Using this we have estimated a relative importance factor for the 'zero zone' which has been applied to the distribution in our Aéroport Pierre-Eliot-Trudeau model. As a final step the whole EMME based demand matrix has been re-scaled to maintain its overall size and to ensure that some zones do not become unduly represented.

5.27 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

5.28 In this section, Steer Davies Gleave has analysed how auto and transit demand has grown in the past, both in the South Shore/10 and West Island/Deux-Montagnes Lines corridors.

5.29 This section also includes the development of models to estimate future growth based on observed historic trends and their correlation with the key socio-economic variables, in order to estimate future matrices

### West Island/Deux-Montagnes Line Transit Growth

*Historical Growth*

5.30 Steer Davies Gleave has analysed how transit demand has grown in the West Island/Deux-Montagnes Line corridor since 2007. This has been based on historical ridership on the West Island bus routes, Deux-Montagnes Line (DM) and Vaudreuil-Hudson Line (V-H) rail lines and Métro Orange Line. The data is shown in Table 5.8.

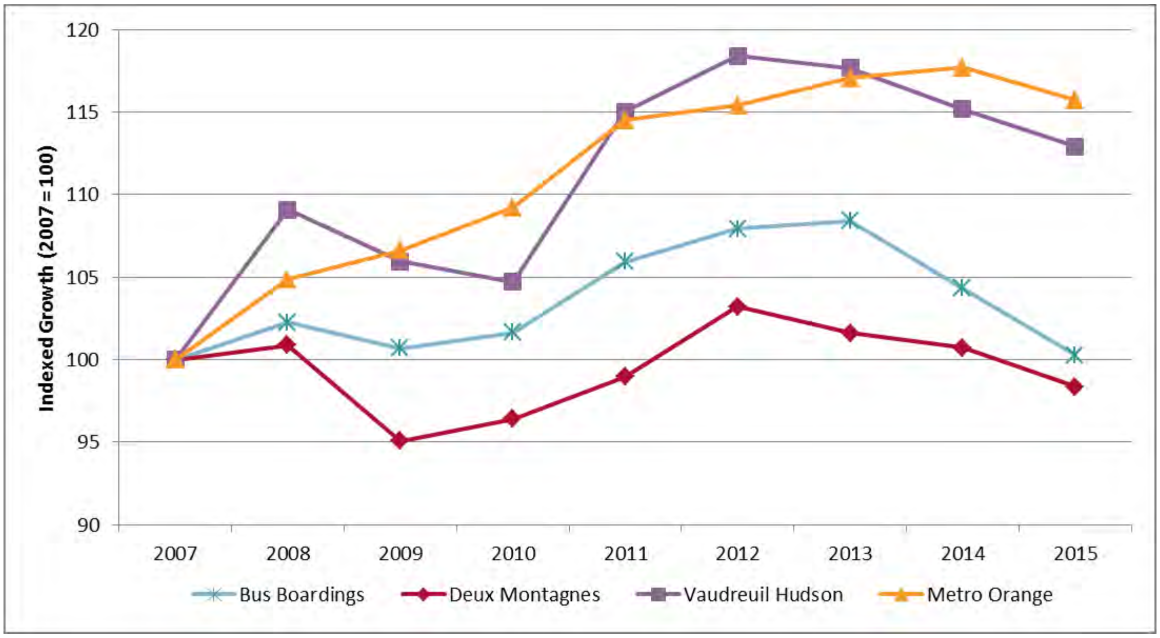
**Table 5.8: Historical Transit Demand (Annual)**

| | Deux-Montagnes Line | Vaudreuil-Hudson Line | Bus | Orange Line |
|---|---|---|---|---|
| 2007 | 7,620,800 | 3,267,900 | 62,726,469 | 98,587,989 |
| 2008 | 7,687,200 | 3,565,000 | 64,145,817 | 103,377,436 |
| 2009 | 7,245,600 | 3,462,600 | 63,151,709 | 105,113,052 |
| 2010 | 7,347,200 | 3,421,700 | 63,758,197 | 107,681,830 |
| 2011 | 7,543,300 | 3,759,000 | 66,432,141 | 112,882,353 |
| 2012 | 7,864,800 | 3,869,500 | 67,711,050 | 113,768,470 |
| 2013 | 7,744,800 | 3,845,300 | 68,011,631 | 115,415,163 |
| 2014 | 7,675,000 | 3,763,500 | 65,443,879 | 116,033,440 |
| 2015 | 7,495,900 | 3,689,800 | 62,906,809 | 114,098,821 |

*Source: AMT and STM*

5.31 Figure 5.10 shows the data presented as growth from 2007. This shows quite a variable growth pattern with the 2008-09 recession clearly identified with a reduction in demand across all services (with the exception of the Orange Line).

**Figure 5.10: West Island/Deux-Montagnes Line Historical Ridership Growth**




*Source: AMT and STM*

5.32 Figure 5.11 shows a consistent pattern between transit growth on the Deux-Montagnes Line and West Island buses and the employment growth in Montréal until 2013. However, the correlation breaks in 2014, with a much higher than expected reduction in transit boardings.

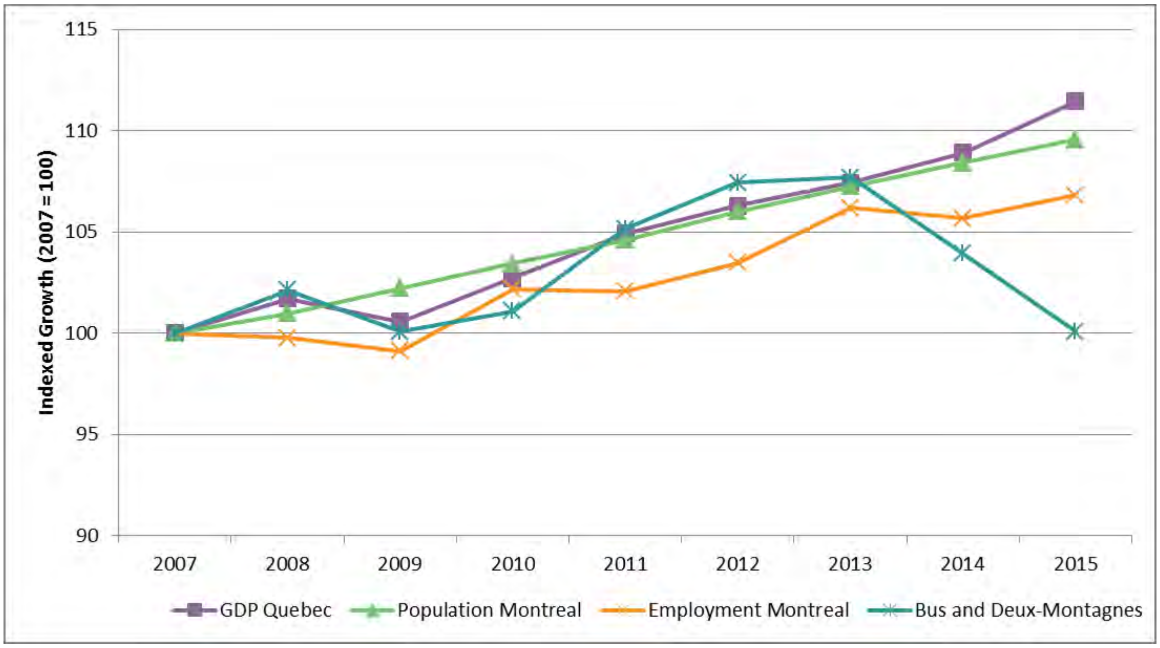
5.33 STM in their annual report has identified a number of potential factors for this reduction including[14]:

- An increase in the number of active trips (walking and cycling)
- An increase in new mobility options (car sharing, taxi industry transformation etc.)
- Decline in the cost of gas
- Difficult winter conditions

5.34 This represents a potential risk area for the forecasts and alternative transit growth scenarios should be considered when reviewing REM forecasts.

[14] STM 2015 Annual Report

**Figure 5.11: West Island/Deux-Montagnes Line transit ridership and socio-economic parameters growth**




*Source: AMT, STM and Statistics Canada*

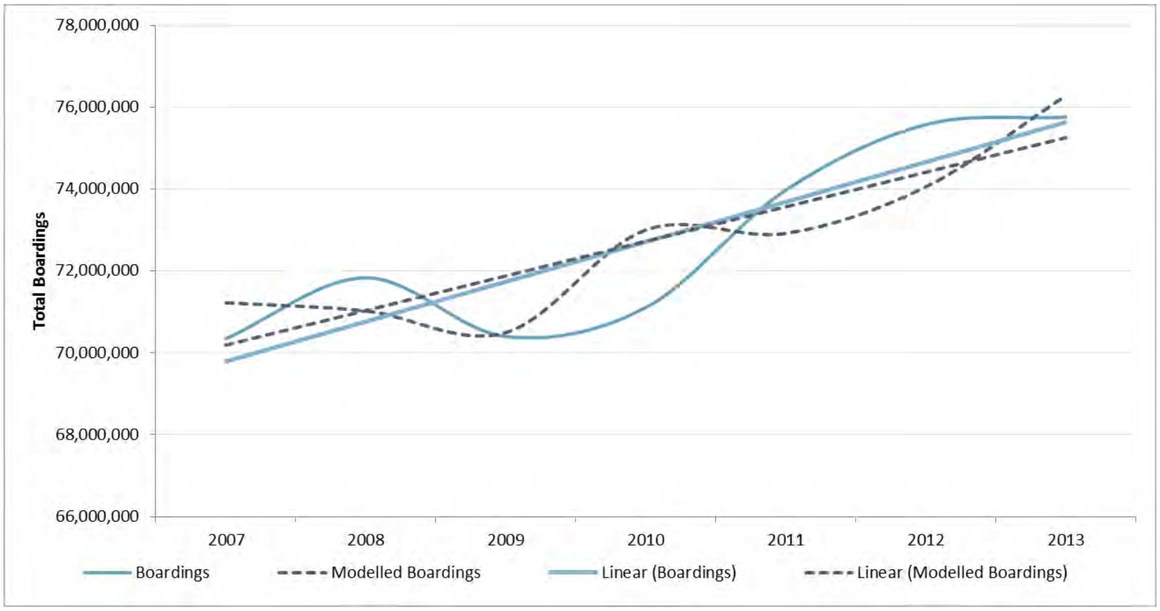
*Growth Model*

5.35 Based on the relationship observed between transit boardings and the socio-economic indicators, a regression model was developed. In order to select the best indicators of transit ridership, several statistical analyses were compared including Quebec GDP and Greater Montréal's population and employment statistics.

5.36 The analysis showed that the highest explanatory variable was employment in Greater Montréal. Note that the ridership decline in 2014 and 2015 is challenging to model, considering all the socio-economic variables examined increased and the model was therefore developed by using data up to 2013 data only.

5.37 The $R^2$ value of the modelled versus observed ridership based on these parameters was estimated to be 0.74, which indicates an acceptable correlation of this parameters to transit demand. Figure 5.12 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 5.12: West Island/Deux-Montagnes Growth Model Results**




*Source: Steer Davies Gleave and Statistics Canada*

## South Shore/10 Corridor Transit Growth

### *Historical growth*

5.38 Steer Davies Gleave has analysed how transit demand has grown since 2005 in the corridor based on historical ridership in the A-10 corridor and Métro Yellow Line. Table 5.9 shows the historical boardings for each of the service providers in the A-10 corridor.

**Table 5.9: South Shore/A10 Corridor Historical Transit Demand (Annual passengers)**

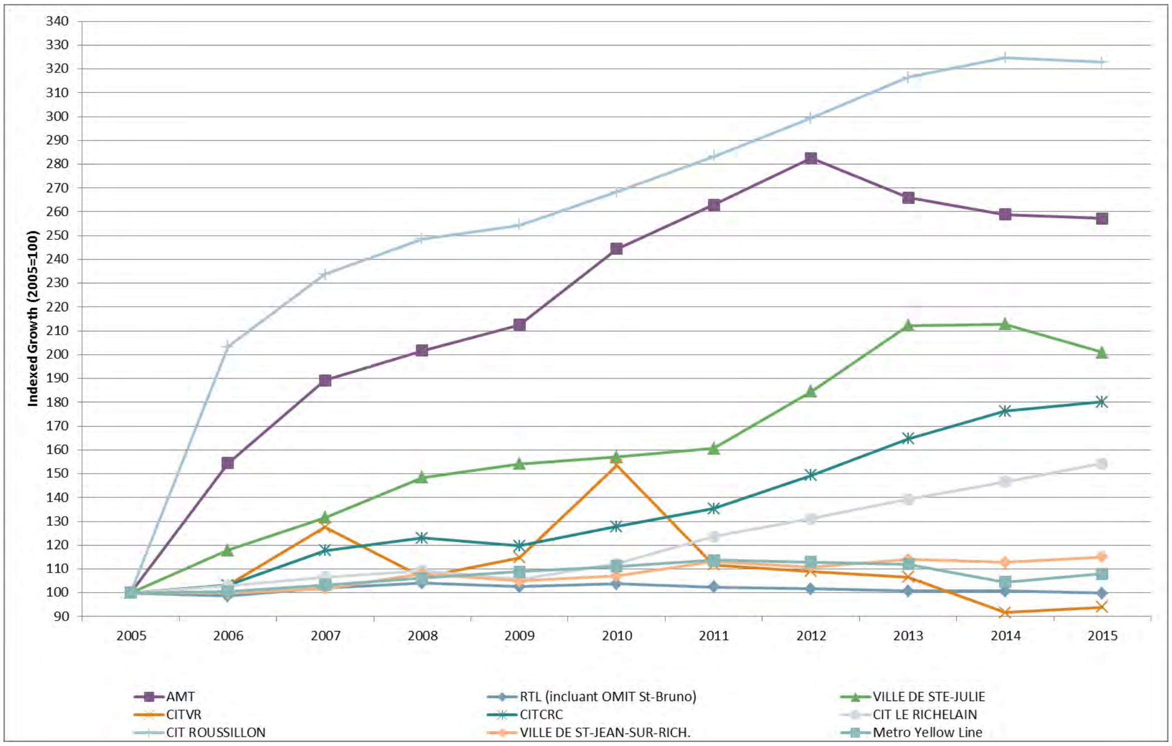
| | AMT | RTL | OMITSJU | CITVR | CITCRC | CITLR | CITROUS | VILLE DE SAINT-JEAN-SUR-RICHELIEU | MÉTRO YELLOW LINE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 593,062 | 6,224,758 | 172,998 | 67,960 | 550,281 | 753,206 | 185,019 | 1,071,772 | 10,066,518 | 19,685,574 |
| 2006 | 916,148 | 6,139,549 | 204,059 | 70,122 | 567,481 | 776,123 | 376,358 | 1,069,337 | 10,127,509 | 20,246,686 |
| 2007 | 1,122,160 | 6,345,889 | 227,607 | 86,713 | 648,065 | 803,367 | 432,361 | 1,090,937 | 10,399,207 | 21,156,306 |
| 2008 | 1,195,941 | 6,480,234 | 256,849 | 72,324 | 676,836 | 823,849 | 460,163 | 1,157,501 | 10,681,822 | 21,805,519 |
| 2009 | 1,260,126 | 6,381,705 | 266,713 | 78,007 | 658,508 | 796,242 | 470,628 | 1,125,371 | 10,963,981 | 22,001,281 |
| 2010 | 1,449,774 | 6,462,624 | 271,631 | 104,343 | 703,337 | 844,584 | 496,450 | 1,147,555 | 11,182,389 | 22,662,687 |
| 2011 | 1,559,593 | 6,376,363 | 277,884 | 75,887 | 745,051 | 931,249 | 524,036 | 1,211,282 | 11,447,724 | 23,149,069 |
| 2012 | 1,675,488 | 6,325,821 | 319,382 | 74,132 | 821,812 | 988,197 | 553,906 | 1,187,341 | 11,374,094 | 23,320,173 |
| 2013 | 1,577,400 | 6,275,680 | 367,077 | 72,418 | 906,482 | 1,048,628 | 585,479 | 1,221,997 | 11,276,937 | 23,332,098 |
| 2014 | 1,535,500 | 6,275,687 | 368,085 | 62,358 | 970,384 | 1,104,991 | 600,959 | 1,208,283 | 10,519,144 | 22,645,391 |
| 2015 | 1,525,800 | 6,218,338 | 347,693 | 63,874 | 991,891 | 1,162,551 | 597,182 | 1,233,393 | 10,868,701 | 23,009,423 |

**The historical demand and the demand presented in this report do not necessarily match because the annual data provided by the various transit agencies includes all their services whereas the demand estimated by Steer Davies Gleave for the South Shore/A10 corridor is only for the routes in scope.*

*Source: AMT, RTL and CITs*

5.39 Figure 5.13 shows graphically the boarding data in Table 5.9 since 2005.

**Figure 5.13: South Shore/A10 Historical Ridership Growth**




*Source: AMT, RTL and CITs*

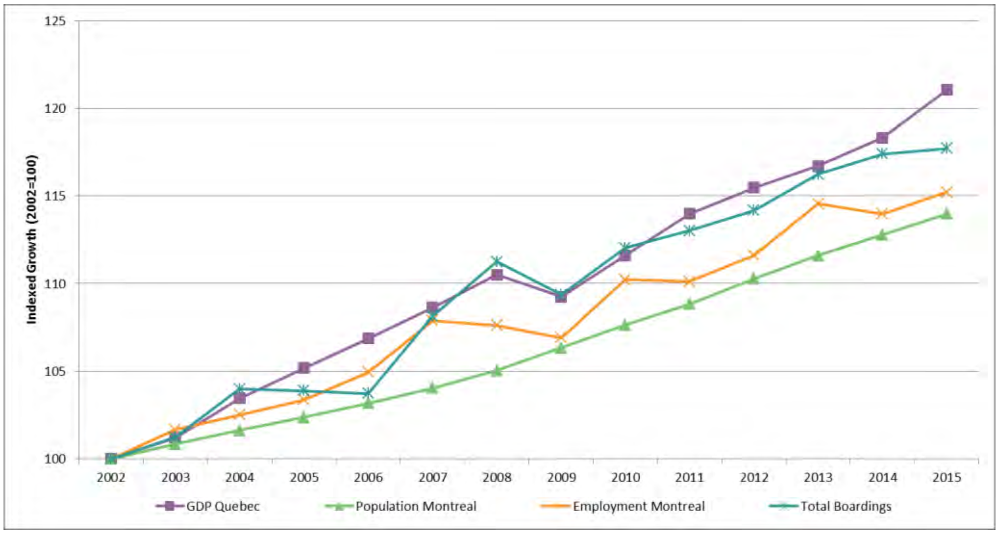
5.40 The data presents some surprising behaviour:

- Very large ridership increases for AMT (basically the Express 90 Chevrier) and CITROUS between 2005 and 2006, which is likely a result of significant improvements in service. Since the purpose of this analysis is to develop a long term econometric analysis, these changes in service provision will distort the results and those two observations have been removed from further analysis.
- The Yellow Line was also closed for extensive re-construction over weekends in 2014 resulting in a considerable reduction in boardings[15].
- In a similar pattern to the West Island/Deux-Montagnes Line transit services, the data shows boarding reductions over the last few years for a number of services (AMT, Sainte-Julie, and Vallé de Richelieu).

5.41 Figure 5.14 shows a close correlation between boardings (for buses) and the various socio-economic parameters.

[15] https://www.stm.info/fr/presse/communiques/2013/travaux-sur-la-ligne-jaune-du-Métro-en-2014---25-fins-de-semaine-de-fermeture-a-prevoir

**Figure 5.14: South Shore/A10 boardings and socio-economic parameters growth**



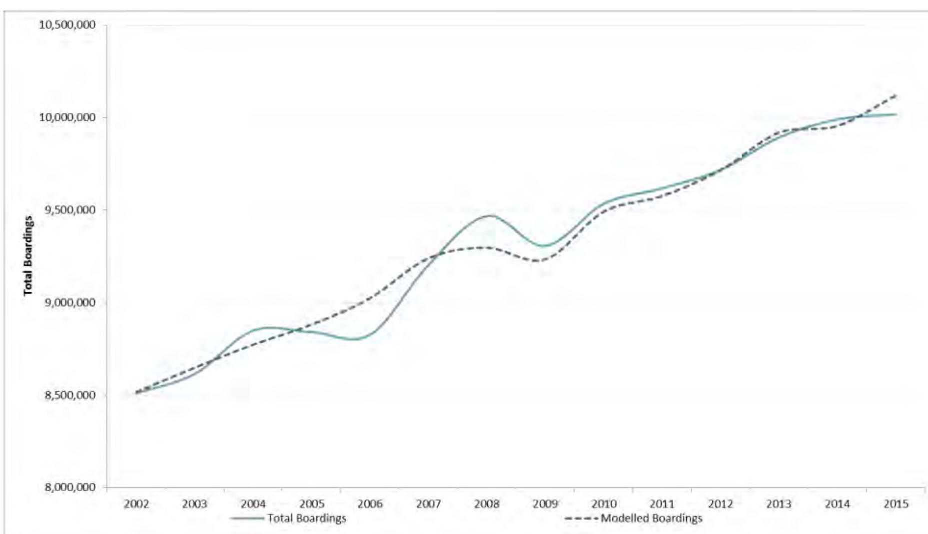

*Source: AMT, RTL, CITs and Statistics Canada*

*Growth Model*

5.42 As with West Island/Deux-Montagnes Line passenger travel, a regression model has been developed between historical boardings and socio-economic indicators. Quebec 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.

5.43 Figure 5.15 shows the comparison of observed and modelled boardings for reference.

**Figure 5.15: South Shore/A10 Growth Model Calibration**




*Source: Steer Davies Gleave and Statistics Canada*

### Airport demand growth

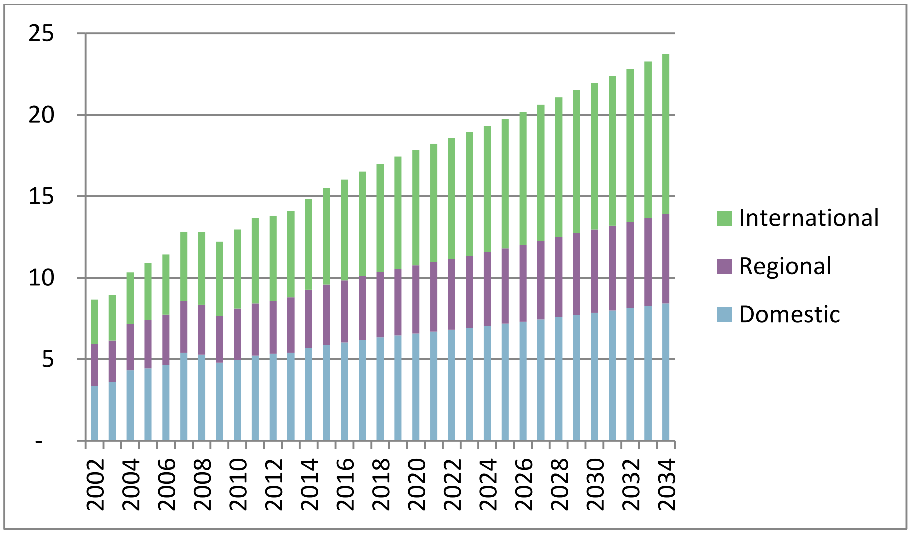
5.44 The Airport demand growth has been based on the forecasts provided by ADM as shown in Table 5.10 and Figure 5.16.

**Table 5.10: Airport growth forecast**

| ADM | 2015-**2020** | 2020- **2034** |
|---|---|---|
| Domestic | 2.3% | 1.8% |
| Regional | 2.4% | 2.0% |
| International | 3.7% | 2.3% |
| Total | 2.9% | 2.1% |

*Source : ADM*

**Figure 5.16: ADM Airport growth forecast**

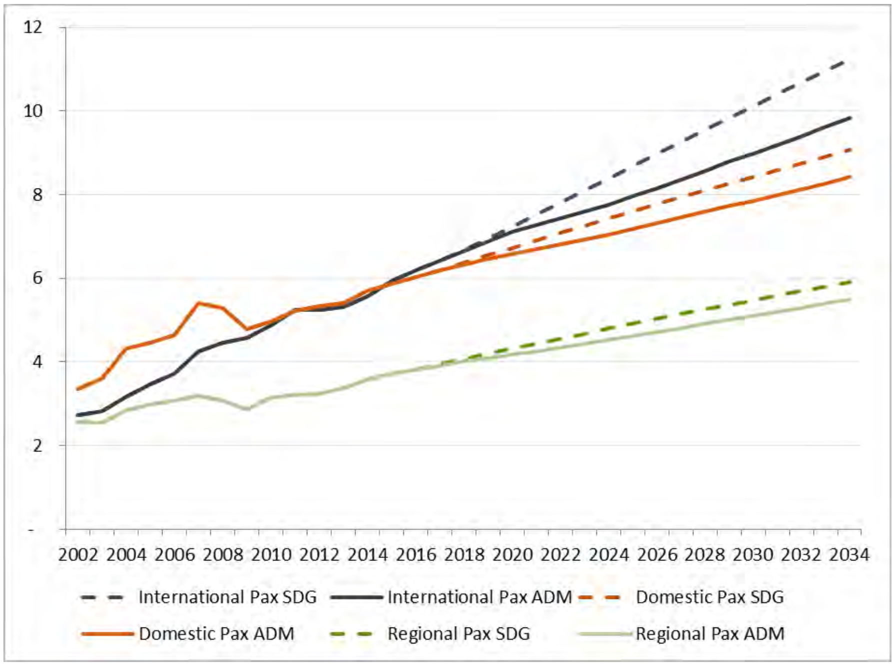



5.45 In order to validate this growth and provide reassurance of these estimates, Steer Davies Gleave carried out a simple GDP-driven forecast. The methodology and assumptions adopted to develop these models were as follows:

- 2016 has been used as the base year and demand based on ADM's Business Plan (September 2015).
- Growth models have been estimated for each traffic segment using regression analysis based on historic data.
  - Regional traffic forecasts (US only) have been correlated to a combination of Canada GDP (for outbound traffic) and US GDP (for inbound traffic)
  - For international traffic we have used a combination of Canada GDP (for outbound traffic) and a mix of Europe/LATAM and AsiaPac GDPs (for inbound traffic)
- GDP forecasts have been obtained from reliable sources: Global Insight Oct 15 for long term forecast and short term updates from April 16 IMF updates.

5.46 The following figure shows the growth estimates of ADM for each market segment compared to the GDP elasticity model developed.

**Figure 5.17: Comparison of ADM forecasts and GDP-Elasticity model**




5.47 The result of this analysis estimates CAGRs that are 30% higher than forecasted by ADM. However, it needs to be highlighted this is a high level and unconstrained assessment, which does not take into account the maturity or saturation of the Airport.

## Future Transit Matrix Development

### Corridor Transit Growth

5.48 A transit growth base case scenario was developed using the models described above based on the identified key demand drivers - the independent variables.

5.49 Socio-economic growth forecasts have been collected from different reliable sources and summarized in Table 5.11.

**Table 5.11: 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% |

*Sources: Quebec GDP (Moody's), Montréal population (Institute de la Statistique du Quebec Référence case), Montréal employment (Moodys)*

5.50 The application of the input parameters identified in Table 5.11 results in the following transit growth estimates as shown in Table 5.12.

**Table 5.12: Transit ridership growth estimates**

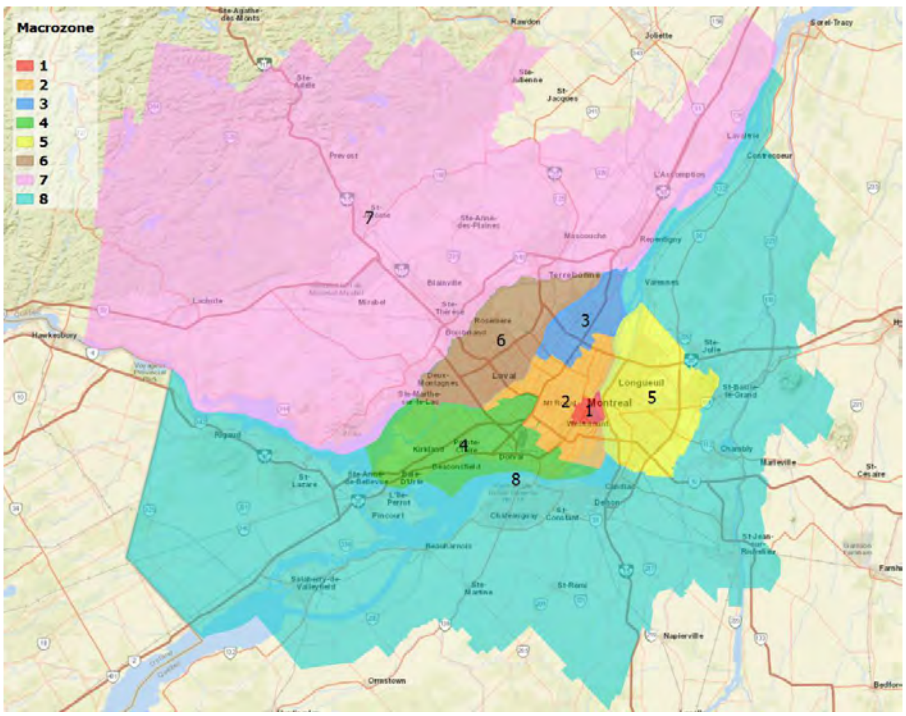
| CAGR | 2015-2021 | 2021-2031 |
|---|---|---|
| South Shore/A10 corridor | 1.4% | 0.9% |
| West Island/Deux-Montages Line corridor | 1.0% | 0.7% |

### Future Transit Matrix Development

5.51 These growth forecasts represent an estimate of overall average growth in the corridor. However, growth per Origin and Destination will vary based on more localized growth patterns.

5.52 In order to estimate specific growth per OD, we have used the distribution of demand growth estimated by MTQ for the auto OD matrices[16]. This distribution represents an in-depth analysis of land use and population changes across Greater Montréal and has been presented in terms of the macro-zones shown geographically in Figure 5.18.

**Figure 5.18: Macro-zones of Greater Montréal**




5.53 Demand growth for the 'work' trip purpose by macro-zone for 2021 is shown in Table 5.13 and Table 5.14.

[16] Demand growth patterns of auto matrices except for the declining of trips to downtown and surroundings (macro zones 1 and 2) was considered as increasing in transit

**Table 5.13: Transit demand growth for 2015 to 2021, work trip purpose, AM Peak**

| | 1 Downtown | 2 | 3 | 4 West Island | 5 South Shore | 6 Laval | 7 | 8 South Shore |
|---|---|---|---|---|---|---|---|---|
| 1- Downtown | 1.17% | 1.12% | 1.12% | 0.75% | 1.31% | 1.12% | 1.12% | |
| 2 | 1.16% | 1.21% | 1.14% | 0.95% | 1.30% | 1.14% | 1.12% | 1.31% |
| 3 | 1.18% | 1.20% | 1.26% | 0.92% | 1.31% | 1.12% | 1.12% | |
| 4- West Island | 0.83% | 0.93% | 0.93% | 1.04% | 1.51% | 0.94% | 1.25% | 1.31% |
| 5- South Shore | 1.20% | 1.32% | 1.14% | 1.26% | 1.42% | 1.31% | | 1.31% |
| 6 Laval | 0.95% | 1.07% | 1.00% | 0.80% | 1.27% | 1.34% | 1.10% | |
| 7 | 0.82% | 0.87% | 1.03% | 1.28% | 0.81% | 1.40% | 1.18% | |
| 8 South Shore | 1.11% | 1.16% | 1.11% | 1.19% | 0.73% | 0.39% | 1.22% | 1.66% |

*Source: Steer Davies Gleave and MTQ*

**Table 5.14: Transit demand growth for 2015 to 2021, work trip purpose, Inter Peak**

| | 1 Downtown | 2 | 3 | 4 West Island | 5 South Shore | 6 Laval | 7 | 8 South Shore |
|---|---|---|---|---|---|---|---|---|
| 1 Downtown | 1.15% | 1.18% | 1.15% | 0.98% | 1.34% | 1.15% | | 1.34% |
| 2 | 1.19% | 1.23% | 1.04% | 1.01% | 1.34% | 1.18% | 1.15% | 1.34% |
| 3 | 1.15% | 1.19% | 1.17% | 0.98% | | 1.47% | 1.15% | |
| 4 West Island | 0.99% | 1.00% | 0.98% | 0.99% | | 2.65% | 0.98% | 1.34% |
| 5 South Shore | 1.38% | 1.32% | 1.34% | 1.34% | 1.35% | | | 1.34% |
| 6 Laval | 1.15% | 1.15% | 1.15% | 0.98% | | 1.75% | | |
| 7 | 1.15% | 1.25% | 1.15% | | | | 1.32% | |
| 8 South Shore | 1.37% | 2.23% | 1.34% | 1.34% | 1.53% | | | 1.66% |

*Source: Steer Davies Gleave and MTQ*

5.54 Total transit demand growth by macro-zone for 2031 is shown in Table 5.15 and Table 5.16.

**Table 5.15: Total transit demand growth for 2021 to 2031, AM Peak**

| | 1 Downtown | 2 | 3 | 4 West Island | 5 South Shore | 6 Laval | 7 | 8 South Shore |
|---|---|---|---|---|---|---|---|---|
| 1 Downtown | 0.91% | 0.88% | 0.87% | 0.71% | 1.02% | 0.89% | 0.87% | 1.02% |
| 2 | 0.91% | 0.95% | 0.89% | 0.77% | 1.03% | 0.89% | 0.89% | 1.02% |
| 3 | 0.92% | 0.93% | 0.95% | 0.75% | 1.04% | 0.88% | 0.90% | |
| 4 West Island | 0.69% | 0.76% | 0.76% | 0.87% | 1.08% | 0.68% | 0.50% | 1.05% |
| 5 South Shore | 0.94% | 1.04% | 0.95% | 1.01% | 1.09% | 1.02% | 1.02% | 1.04% |
| 6 Laval | 0.78% | 0.88% | 0.89% | 0.85% | 1.03% | 1.09% | 0.86% | |
| 7 | 0.67% | 0.70% | 0.84% | 0.77% | 0.76% | 0.88% | 1.18% | 1.05% |
| 8 South Shore | 0.92% | 0.92% | 0.92% | 0.97% | 0.94% | 0.97% | 0.96% | 1.17% |

*Source: Steer Davies Gleave and MTQ*

**Table 5.16: Total transit demand growth for 2021 to 2031, Inter Peak**

| | 1 Downtown | 2 | 3 | 4 West Island | 5 South Shore | 6 Laval | 7 | 8 South Shore |
|---|---|---|---|---|---|---|---|---|
| 1 Downtown | 0.90% | 0.90% | 0.86% | 0.75% | 1.06% | 0.85% | 0.86% | 1.06% |
| 2 | 0.93% | 1.01% | 0.89% | 0.79% | 1.06% | 0.88% | 0.86% | 1.06% |
| 3 | 0.88% | 0.94% | 0.93% | 0.75% | 1.04% | 0.71% | 0.87% | 1.06% |
| 4 West Island | 0.82% | 0.84% | 0.75% | 0.84% | 1.06% | 0.89% | 1.04% | 1.07% |
| 5 South Shore | 1.05% | 1.06% | 1.06% | 1.05% | 1.16% | 1.06% | | 0.96% |
| 6 Laval | 0.92% | 0.89% | 0.88% | 0.72% | 1.06% | 1.10% | 0.96% | |
| 7 | 0.88% | 0.88% | 0.88% | 0.82% | 1.06% | 0.80% | 1.13% | |
| 8 South Shore | 1.05% | 1.08% | 1.01% | 1.04% | 1.02% | | | 0.75% |

*Source: Steer Davies Gleave and MTQ*

5.55 The resulting transit demand totals for 2021 and 2031 are shown below.

**Table 5.17: Transit demand matrices by forecast year**

| Period | Purpose | 2015 | 2021 | 2031 |
|---|---|---|---|---|
| AM | Work | 207,734 | 221,944 | 239,027 |
| AM | Study | 132,500 | 141,963 | 153,366 |
| AM | Other | 24,223 | 26,068 | 28,170 |
| **AM TOTAL** | | **364,457** | **389,975** | **420,563** |
| Inter Peak | Work | 84,073 | 90,195 | 97,569 |
| Inter Peak | Study | 93,151 | 99,953 | 108,139 |
| Inter Peak | Other | 289,974 | 311,037 | 336,420 |
| **Inter Peak Total** | | **467,198** | **501,185** | **542,128** |

## Auto Future Matrix Development

5.56 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 Greater Montréal.

# 6 Model Calibration

6.1 Calibration refers to the process undertaken to compare observed against modelled travel data to ensure the model represents current travel demand patterns in Greater Montreal accurately. The calibration process is iterative and involves a review of network coding and demand levels. This section presents the model calibration undertaken and includes:

- Traffic flow
- Rail loadings
- West Island transit boardings
- St Lawrence transit screenline

## Traffic Model

6.2 MOTREM is a 24-hour traffic forecasting model. However, the focus of our work has been on the AM Peak (6:00am-9:00am) and Inter Peak (9:00am-3:00pm) periods and these were calibrated to a 2015 fall weekday base year.

6.3 The calibration was carried out for he two screenlines shown in Figure 6-1 and Figure 6.2. This allows us to understand the main auto demand on the REM corridors across each major screenline.

**Figure 6-1: St Lawrence River crossing auto screenline**


**Figure 6.2: West Island auto Screenlines**


6.4 **Table 6.1** to **Table 6.4** show the resulting AM Peak and Inter Peak auto traffic flow calibration. Note that calibration to individual road links can be challenging and ensured we captured the overall traffic crossing the various screenlines to ensure a good match between modelled and observed screenline 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)**

| Location | Direction | Observed Counts | Modellel Counts | Abs. Diff | % Diff |
|---|---|---|---|---|---|
| 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 tunnel | To Montréal | 14,652 | 14,978 | 327 | 2% |
| Louis Hippolyte Lafontaine 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%** |

**Table 6.2: Bridge Crossing Screenline (Inter Peak)**

| Location | Direction | Observed Counts | Modelled Counts | Abs. Diff | % 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 tunnel | To Montréal | 20,366 | 19,059 | -1,308 | -6% |
| Louis Hippolyte Lafontaine 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%** |

**Table 6.3: West Island Screenline (AM Peak)**

| Location | Direction | Observed Counts | Modelled Counts | Abs. Diff | % 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%** |

**Table 6.4: West Island Screenline (Inter Peak)**

| Location | Direction | Observed Counts | Modelled Counts | Abs. Diff | % 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%** |

6.5 Note that as result of the analysis and calibration shown above, there was some adjustments made to the overall MOTREM demand and this is shown below.

**Table 6.5: Auto Demand Total – After Calibration**

| | AM (6am-9am) | Inter peak (9am-3pm) |
|---|---|---|
| Auto | 1,123,178 | 1,350,718 |
| Auto Commercial | 146,799 | 664,107 |
| Light Goods Vehicles | 60,591 | 141,535 |
| Heavy Goods Vehicles | 19,610 | 55,763 |
| **TOTAL** | **1,350,178** | **2,212,122** |

## Transit Model

### Rail Loadings

6.6 AMT provided the loading profiles for all the rail lines in Montréal as shown in Figure 5.1.

6.7 A comparison of modelled versus observed rail loadings for each Line are shown in Figure 6.3 to Figure 6.8. Note that the loading profile calibration focussed on the AM peak direction towards Montréal as this is when the largest proportion of the rail demand is present (which then returns from Montréal in the evening). The demand levels on services from Montreal are either very low or there are no services (Candiac Line and Mont-Saint-Hilaire Line).

**Figure 6.3: Deux-Montagnes Line Load Profile – AM Peak towards Montréal**

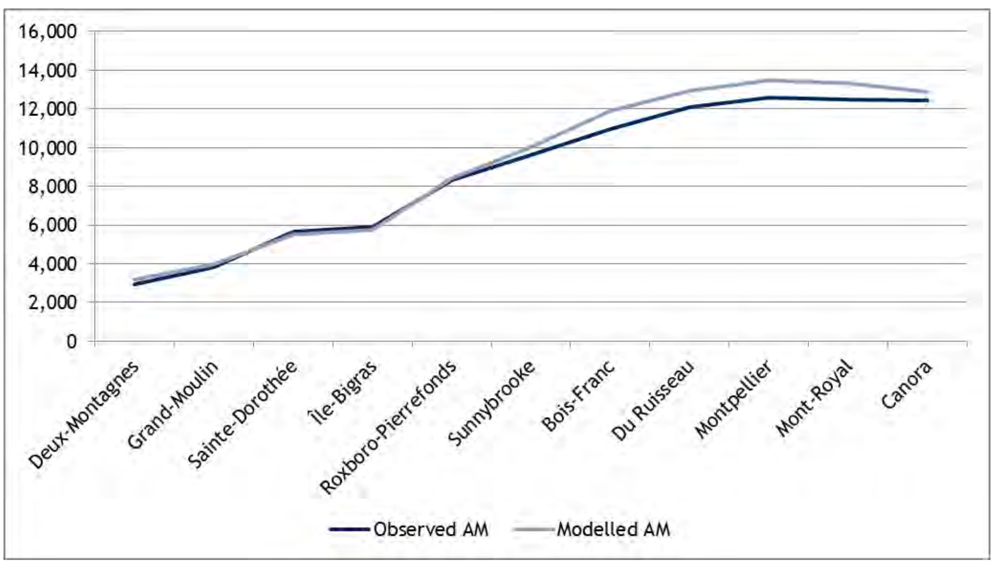


**Figure 6.4: Mascouche Line Load Profile – AM Peak towards Montréal**

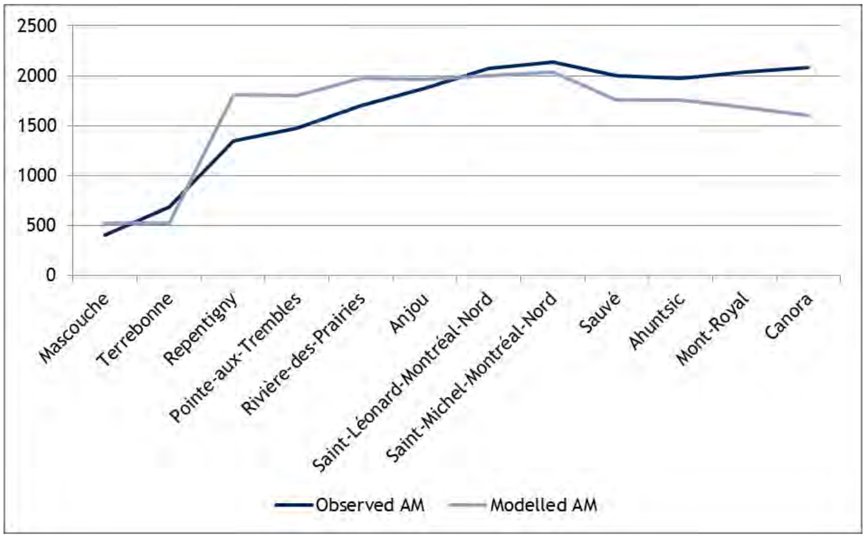



**Figure 6.5: Saint-Jérôme Line Load Profile – AM Peak towards Montréal**

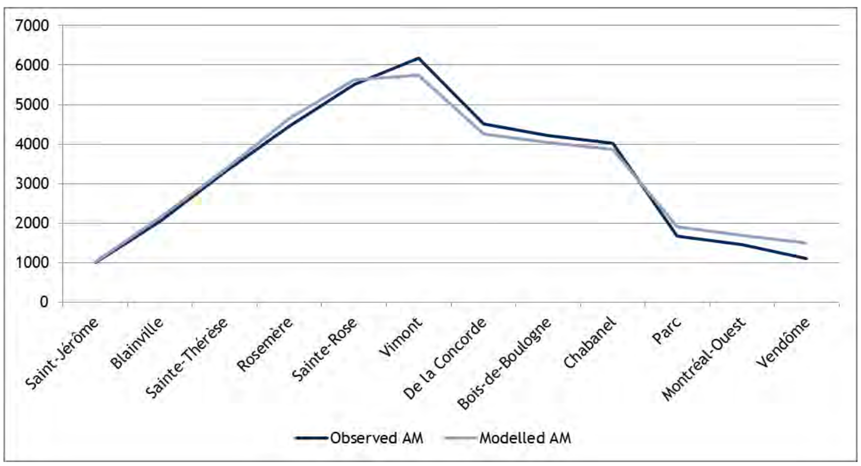



**Figure 6.6: Vaudreuil-Hudson Line Load Profile – AM Peak towards Montréal**

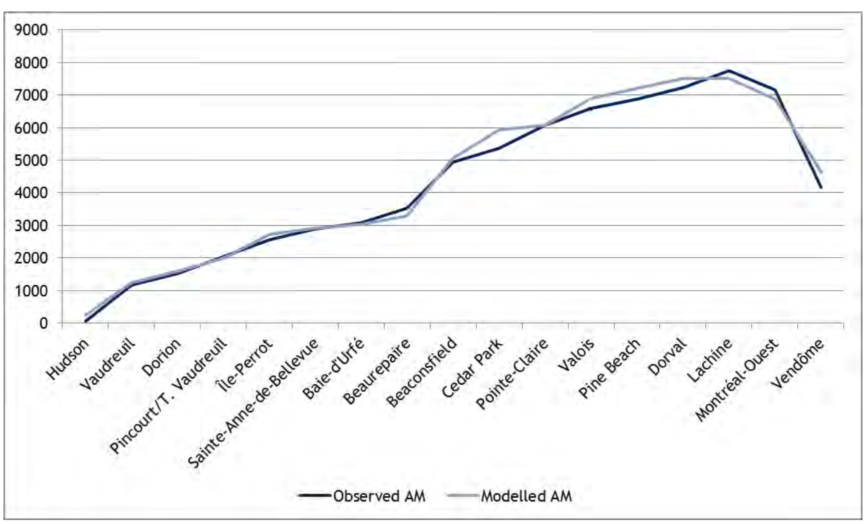


**Figure 6.7: Candiac Line Load Profile – AM Peak towards Montréal**

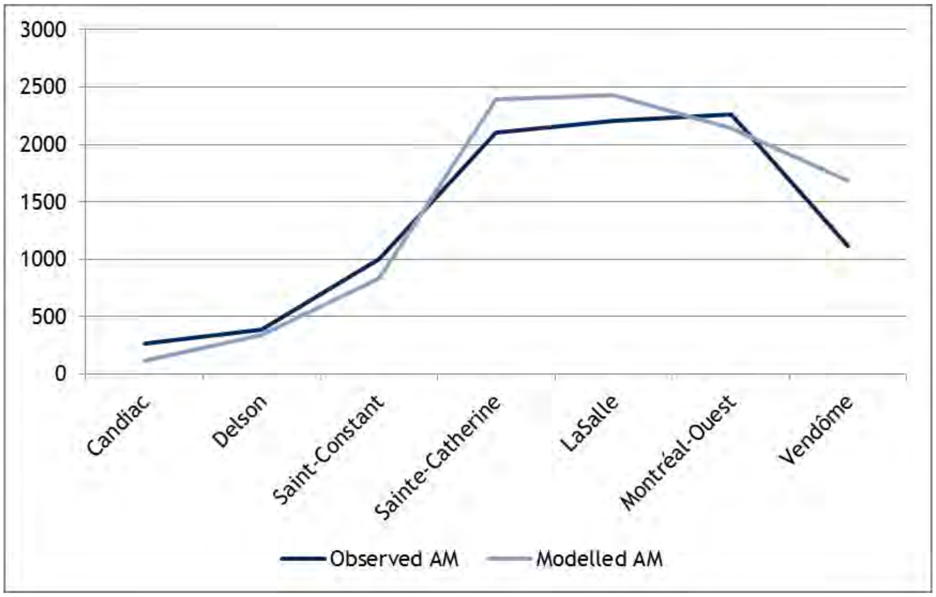
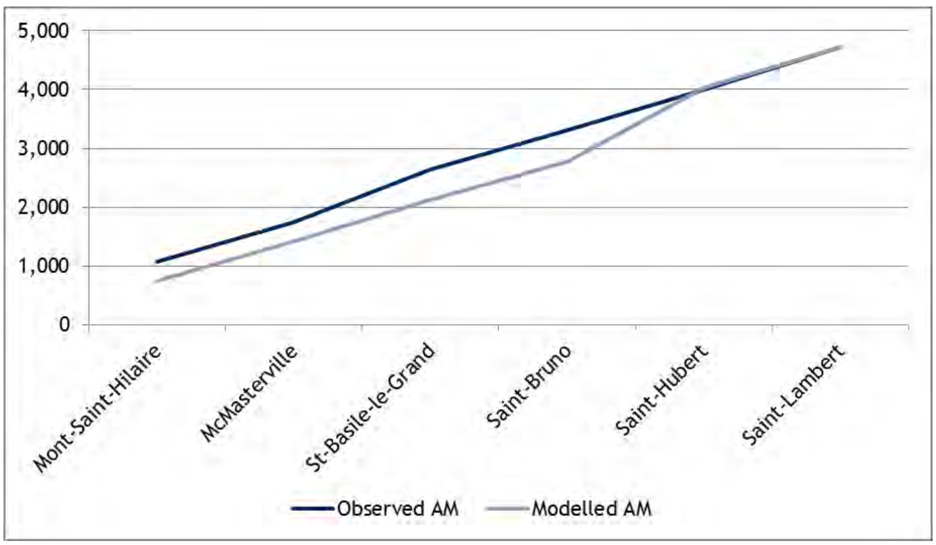



**Figure 6.8: Mont-Saint-Hilaire Line Load Profile – AM Peak towards Montréal**




6.8 The AM profile figures show the model provides an accurate representation of rail boardings and peak loads across all lines. Figure 6.9 to Figure 6.14 present the Inter Peak for a number of lines. Note that a large number of Inter Peak routes provide a very low service provision leading to very low demand levels and no attempt has been made to calibrate such low demand levels e.g. peak load on Mascouche is 23 passengers inbound and 159 outbound.

**Figure 6.9: Deux-Montagnes Line Load Profile – Inter Peak towards Montréal**

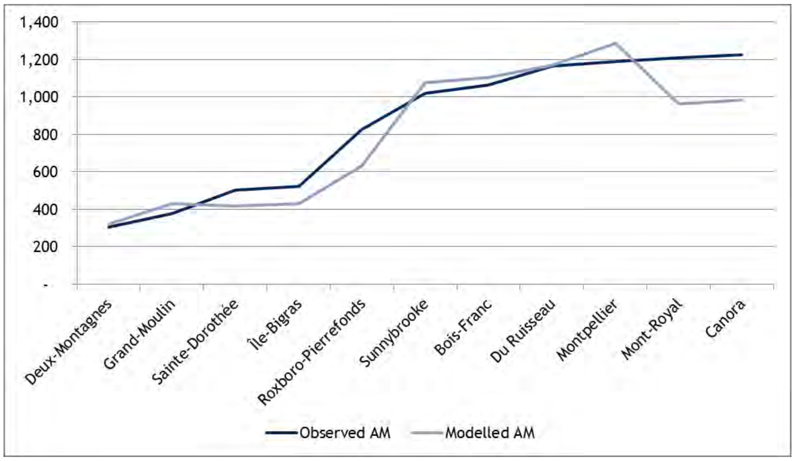



**Figure 6.10: Deux-Montagnes Line Load Profile – Inter Peak from Montréal**

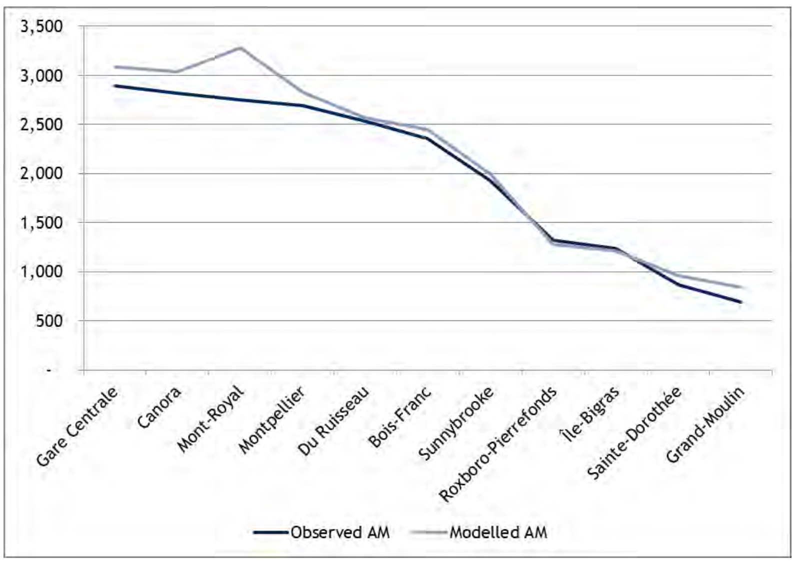



**Figure 6.11: Vaudreuil-Hudson Line Load Profile – Inter Peak towards Montréal**

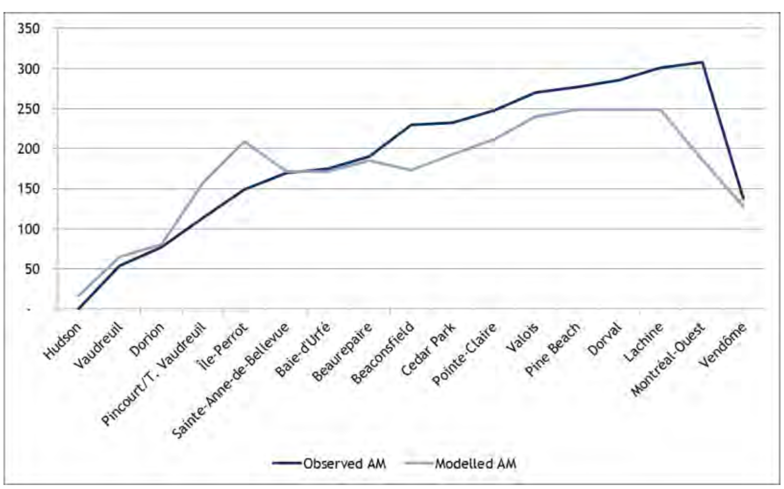


**Figure 6.12: Vaudreuil-Hudson Line Load Profile – Inter Peak from Montréal**

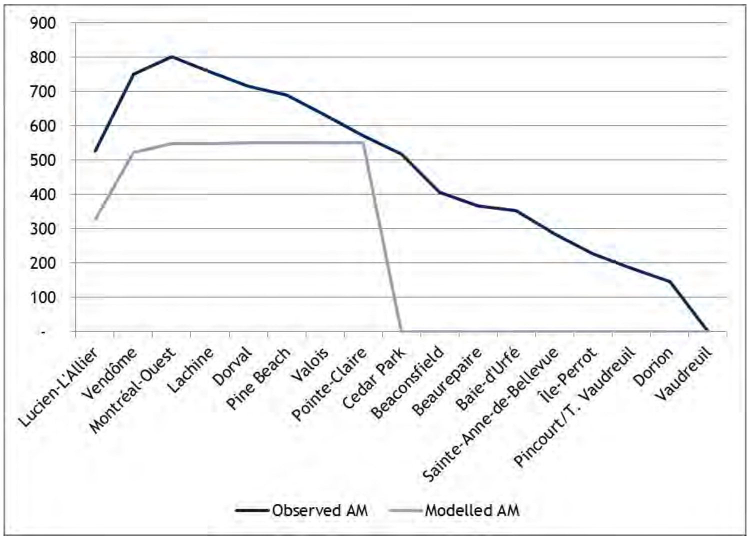



**Figure 6.13: Saint-Jérôme Line Load Profile – Inter Peak towards Montréal**

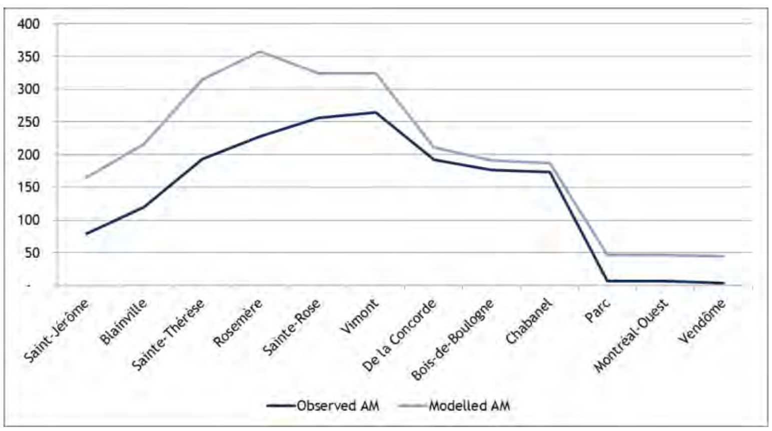
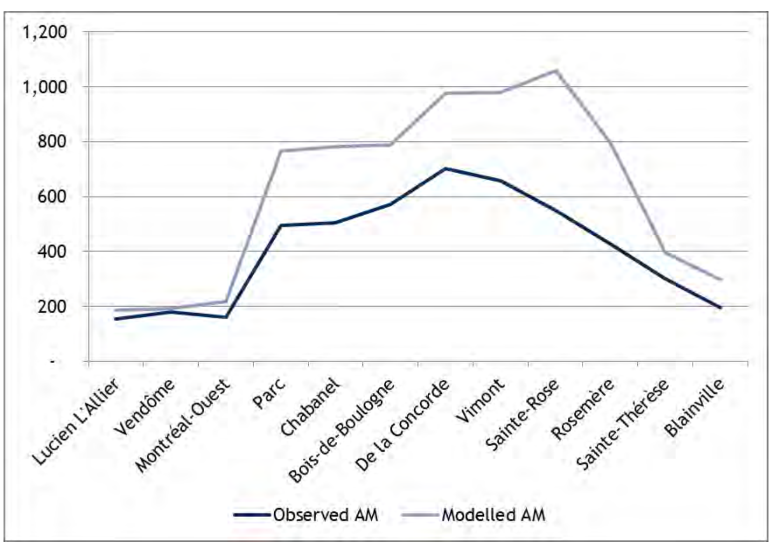



**Figure 6.14: Saint-Jérôme Line Load Profile – Inter Peak from Montréal**



### West Island/Deux-Montagnes Line Transit Boardings

6.9 A summary of rail, Métro and bus boardings for the West Island /Deux-Montagnes Line Corridor is included in Table 6.6. Note that Métro peak loads were not available. Non-peak direction AMT rail data (the OUT services) is included for reference, but as indicated limited effort and resources were allocated due to the very low demand levels observed on those particular services resulting from very low services being provided (in italics).

**Table 6.6: Transit boarding calibration – Average AM Peak Hour**

| Line | Modelled | Observed | Difference | Percentage | GEH[17] |
|---|---|---|---|---|---|
| Métro Blue Line | 4,725 | 6,198 | -1,473 | -23% | 20 |
| Métro Green Line | 19,939 | 20,544 | -606 | -3% | 4 |
| Métro Orange Line | 29,813 | 30,717 | -903 | -3% | 5 |
| Métro Yellow Line | 4,288 | 4,079 | 209 | 5% | 3 |
| Candiac Line IN | 896 | 804 | 92 | 11% | 3 |
| Candiac Line OUT | No service | - | - | - | - |
| Deux-Montagnes Line IN | 4,927 | 4,746 | 181 | 4% | 3 |
| *Deux-Montagnes Line OUT* | *29* | *45* | *-16* | *-35%* | *3* |
| Mont-Saint-Hilaire Line IN | 1,566 | 702 | 863 | 123% | 26 |
| Mont Mont-Saint-Hilaire Line OUT | No service | - | - | - | - |
| Mascouche Line IN | 722 | 800 | -78 | -10% | 3 |
| *Mascouche Line OUT* | *1* | *7* | *-6* | *-90%* | *3* |
| Saint-Jérôme Line IN | 2,066 | 2,229 | -163 | -7% | 4 |
| *Saint-Jérôme Line OUT* | *129* | *35* | *94* | *270%* | *10* |
| Vaudreuil-Hudson Line IN | 2,662 | 2,742 | -80 | -3% | 2 |
| *Vaudreuil-Hudson Line OUT* | *27* | *75* | *-48* | *-64%* | *7* |
| West Island bus routes[18] | 13,522 | 13,370 | 151 | 1% | 1 |
| West Island express bus routes | 3,643 | 4,193 | -550 | -13% | 9 |

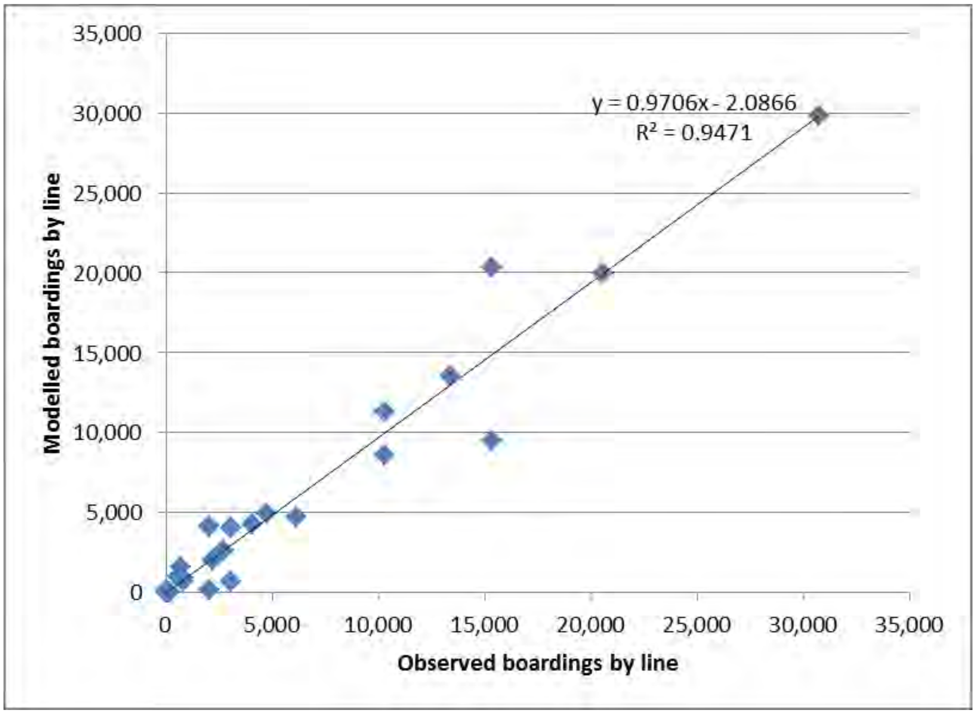
6.10 A scatter plot comparing modelled and observed results presented in Table 6.6 is shown in Figure 6.15

[17] The GHE statistics used to compare two sets of volumes. Values closer to zero indicate a best fit.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$ The GEH formulas gets its name from Geoffrey E. Havers.

[18] List of route provided in Appendix C.

**Figure 6.15: Transit boarding calibration – AM Peak Average Hour**

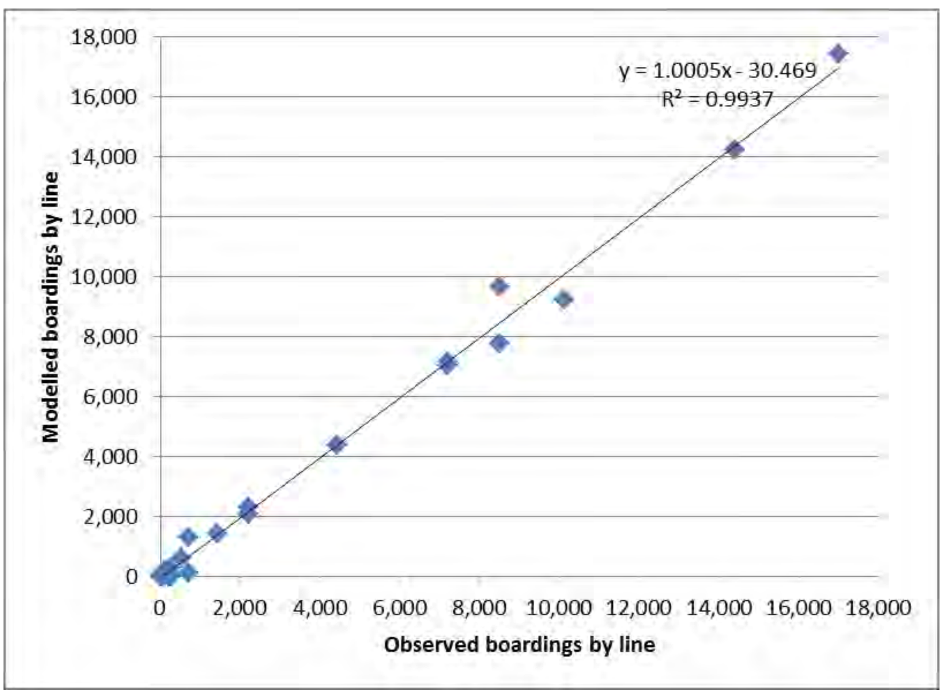



6.11 The same statistics are included for an average Inter Peak hour. As indicated in the AM calibration section, all AMT rail services are included for reference, but as indicated limited effort and resources were allocated due to the very low demand levels observed on those particular services resulting from very low services being provided (in italics).

**Table 6.7: Transit boarding calibration – Average Inter Peak Hour**

| Line | Modelled | Observed | Difference | Percentage | GEH |
|---|---|---|---|---|---|
| Métro Blue | 4,402 | 4,424 | -22 | -1% | 0 |
| Métro Green | 14,216 | 14,380 | -164 | -1% | 1 |
| Métro Orange | 17,409 | 16,987 | 421 | 2% | 3 |
| Métro Yellow | 1,435 | 1,426 | 9 | 1% | 0 |
| Deux-Montagnes Line IN | 273 | 234 | 39 | 17% | 2 |
| Deux-Montagnes Line OUT | 607 | 529 | 78 | 15% | 3 |
| *Mascouch Linee IN* | *12* | *5* | *8* | *170%* | *3* |
| *Mascouch eLine OUT* | *9* | *29* | *-20* | *-70%* | *5* |
| *Saint-Jérôme Line IN* | *81* | *47* | *34* | *73%* | *4* |
| *Saint-Jérôme Line OUT* | *193* | *131* | *62* | *47%* | *5* |
| *Vaudreuil-Hudson IN* | *63* | *62* | *0* | *1%* | *0* |
| *Vaudreuil-Hudson Line OUT* | *93* | *144* | *-51* | *-35%* | *5* |
| West Island bus routes[19] | 9,211 | 10,120 | -909 | -9% | 9 |
| West Island express bus routes[13] | 1,457 | 1,888 | -431 | -23% | 11 |

**Figure 6.16: Transit boarding calibration – Inter Peak Average Hour**




[19] List of services included in Appendix C

### St Lawrence River Transit Screenline

6.12 The Saint-Laurent River screenline includes the Champlain Bridge transit services. We have estimated the peak load crossing the river from the following data sources:

- Métro Yellow Line peak load from the number of boardings at Longueil station (first station on the line) provided by STM for an average day in 2015
- Saint Hilaire Line peak load between Saint Lambert and Lucien L'Allier
- Estimation of Champlain Bridge transit load

6.13 The estimation of transit passages over the Champlain Bridge was challenging due to the number of potential data sources available. Table 6.8 summarizes the various data sources consulted and it shows the high level of divergence between the estimates. For the purposes of our calibration we have assumed the Terminus Centre Ville estimates as they:

- Represent a number of years rather than one year only
- Acknowledge issues with the other 2 methods of estimation

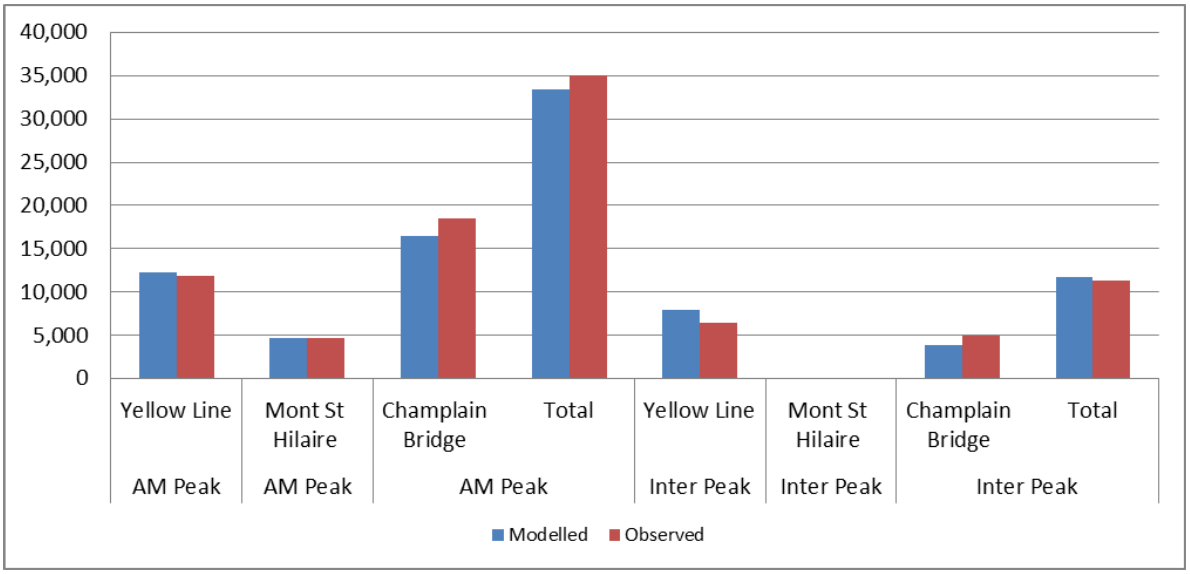
**Table 6.8: Champlain Bridge Transit Estimates – AM Peak Period (6am-9am)**

| Source | Estimate | Comment |
|---|---|---|
| 2013 Enquête origine-destination | 22,500 | Acknowledged by AMT as potentially high due to Terminus Centre Ville surveys |
| Terminus Centre-Ville surveys | 18,532 | Average of one day counts from 2011 to 2015[20]<br>Does not include CIT Haut-St-Lawrence and CIT Sud-Ouest passengers as they use the Honoré Mercier Bridge<br>It might include some boardings in stops in Montréal Island (trips did not cross the Saint Laurent) |
| 2015 transit count estimate | 18,287 | Includes all bus boardings on bus services crossing the Champlain Bridge. However, not all boardings will cross the river (although the majority do) |

6.14 The South Shore/A10 screenline comparison is shown in Figure 6.17 and it shows the model is predicting total transit demand across the St Lawrence accurately (within 5%) for the AM and Inter Peak periods, and just as importantly, with the correct assignment to each transit link across the river.

[20] Passenger counts of 19,473 (in 2011), 18,800 (in 2012), 18,771 (in 2013), 16,834 (in 2014) and 18,780 (in 2015).

**Figure 6.17: South Shore/A10 Transit Calibration**




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

### Calibrated Transit Demand

6.15 The calibration of the various transit services presented above required the review and adjustment of transit services, travel times and network coding (station connections, transfer distances, etc.) and a number of matrix adjustments. The final total base transit demand is presented below.

**Table 6.9: Transit Demand Total – After Calibration**

| Period | Purpose | Initial (A) | Final (B) | Difference (A-B) | ((A-B)/A)% |
|---|---|---|---|---|---|
| AM Peak | Work | 220,470 | 207,734 | 12,736 | -5.8% |
| | Study | 137,483 | 132,500 | -4,983 | -3.6% |
| | Other | 24,982 | 24,223 | -759 | -3.0% |
| | **Total** | **382,935** | **364,457** | **-18,478** | **-4.8%** |
| Inter Peak | Work | 72,120 | 84,073 | -11,953 | -14.2% |
| | Study | 80,811 | 93,151 | -12,340 | -13.2% |
| | Other | 254,724 | 289,974 | -35,250 | -12.2% |
| | **Total** | **407,656** | **467,198** | **-59,542** | **-12.7%** |

## Airport Model

6.16 The Airport model is a spreadsheet based 'logit' model which takes time and cost inputs from EMME Transit Mode Choice Model and Network Model. The Airport Model itself contains a set of binary or pair-wise choices between the current mode of travel and REM. The model then forecasts the likely take up of REM in the future according to the assumptions made on the level of service on both REM and the existing current modes.

6.17 As such the calibration is less ‘formal’ than with a traditional network based model. Indeed, pairwise choices mean that there is no requirement to replicate the current situation. Instead the effort goes into establishing the size and market segmentation of the base demand, as has been described in Section 5.

6.18 Calibration type tasks are then more focussed on checking the sensitivity of the model to a range of factors including:

- Stress testing the model to cases where REM has very low or zero fares compared with cases when the fare is relatively high to understand the likely range of capture
- Checking implied fare and journey time elasticities are appropriate
- Understanding the impact of the behavioural parameters and testing the model sensitivity to these
- Checking that the ‘logit curve’ is not forecasting high levels of diversion from current modes when the generalized time advantage is small and making suitable adjustments.

# 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 assumptions undertaken. These relate not only to the REM service itself, but also to the bus network services and fares.

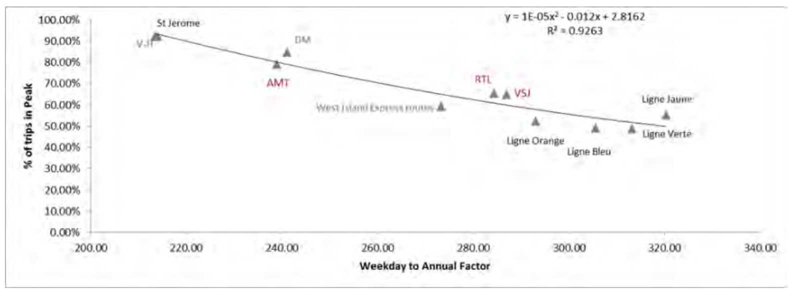
7.2 Table 7.1 describes the Sponsor Case Project Definition. This reflects the Sponsor assumptions of the most likely scenario, given the current engineering and operations analysis to date as well as discussions with a range of organizations (AMT, STM, Aeroport de Montréal) regarding bus restructuring and fare integration.

**Table 7.1: Sponsor Case Project Definition**

| | Description | Assumption |
|---|---|---|
| Travel times | Deux-Montagnes to Rive-Sud | 46:47 |
| | Roxboro-Pierrefonds to Rive-Sud | 36:47 |
| | Sainte-Anne-de-Bellevue to Rive-Sud | 46:23 |
| | Aéroport Pierre-Elliott-Trudeau to Rive-Sud | 38:30 |
| | Correspondance A40 to Rive-Sud | 23:00 |
| 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 (Inter Peak) | 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 fares | - |
| Fare Airport | Current average airport fare ($3.15) with $5 premium | $8.15 |
| Bus Re-Structuring | South Shore services re-directed to REM stations<br>STM West Island bus network reconfigured | - |
| 747 | Eliminated from service | - |

7.3 In addition to REM, 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**

<table>
<tr><th>Model Assumptions</th><th>Sponsor Case</th></tr>
<tr><td>Users perception of REM</td><td>REM mode constant defined as 3 minutes (lower than Métro and rail).</td></tr>
<tr><td>Corridor growth<br>(see Table 5.13 to Table 5.16)</td><td><table>
<tr><th>CAGR</th><th>2015-2021</th><th>2021-2031</th></tr>
<tr><td>South Shore/A10</td><td>1.4%</td><td>0.9%</td></tr>
<tr><td>West Island/DM</td><td>1.0%</td><td>0.7%</td></tr>
</table></td></tr>
<tr><td>Aéroport Pierre-Elliott-Trudeau growth</td><td><table>
<tr><th>CAGR</th><th>2015-2020</th><th>2020-2034</th></tr>
<tr><td>Aéroport</td><td>2.9%</td><td>2.1%</td></tr>
</table></td></tr>
<tr><td>Expansion Factor<br>(see Figure 4.8)</td><td>Varies depending on the AM Peak and Inter Peak demand breakdown.<br>
</td></tr>
<tr><td>Ramp up</td><td>See below</td></tr>
</table>

| Year | West-Island/Deux-Montagnes Line Corridor | | Airport Corridor | | South Shore/A10 Corridor | |
|---|---|---|---|---|---|---|
| | Existing DM | New | Existig 747 | New | Existing Express (truncated) | New |
| 2022 | 100% | 60% | 80% | 60% | 90% | 60% |
| 2023 | 100% | 80% | 90% | 80% | 95% | 80% |
| 2024 | 100% | 90% | 95% | 90% | 100% | 90% |
| 2025 | 100% | 100% | 100% | 100% | 100% | 100% |

## Sponsor Case Forecast Review (2015)

7.4 REM is expected to start operation in 2021 (first full year of operation). 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 This section presents the results of the analysis of this hypothetical scenario in which REM's Sponsor Case is applied to the base year (2015).

### Demand captured by market and mode

7.6 REM will provide the Greater Montréal region with a new, fast and reliable transit service with an enhanced level of service in the peak and the off peak 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 | | Inter Peak | | AM Peak + Inter Peak | |
|---|---|---|---|---|---|---|
| | Passengers | Percentage | Passengers | Percentage | Passengers | Percentage |
| Airport Capture | 1,022 | 2% | 1,974 | 8% | 2,997 | 4% |
| Auto Capture | 5,520 | 10% | - | 0% | 5,520 | 7% |
| Transit Capture | 47,924 | 88% | 21,750 | 92% | 69,673 | 89% |
| **TOTAL** | **54,466** | **100%** | **23,724** | **100%** | **78,189** | **100%** |

7.7 The table shows clearly that the majority of the REM demand is transferring from other transit modes (almost 90%) and the rest is made of airport (60% of which is also transit demand in the 747) and auto capture. Each of these markets is described below.

### Airport capture

7.8 The airport demand captured from existing competing modes has been estimated with the airport choice model. Table 7.4 shows the majority of the demand is captured from the 747 bus service and a considerable proportion (24%) is expected to shift from taxi and car Park & Fly passengers.

**Table 7.4: REM airport demand capture (2015)**

| AM PEAK+ INTER PEAK | 747 bus passengers | Taxi | Airport staff Local Bus | Car Park & Fly Passengers | Car Park & Fly Airport Staff | Car Kiss & Fly Passengers | Total |
|---|---|---|---|---|---|---|---|
| Existing Demand | 2,223 | 4,597 | 243 | 2,574 | 2,190 | 6,429 | 18,257 |
| Demand which transfers to REM | 1896 | 586 | 72 | 271 | 0 | 172 | 2,997 |
| REM Capture | 85% | 13% | 29% | 11% | 0% | 3% | 16% |

7.9 It is expected that over 60% of REM demand will be existing transit demand that will shift from the 747 as the service is not operational as shown in Table 7.5.

**Table 7.5: REM Airport Demand Split**

| AM Peak and Inter-Peak | Passengers | Proportion |
|---|---|---|
| Existing 747 | 1,896 | 63% |
| Other modes | 1,101 | 37% |
| **Total** | **2,997** | **100%** |

### Auto Capture

7.10 Demand shift 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 P&R 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 branch). Table 7.6 shows the car shift demand estimates.

**Table 7.6: REM Car shift capture (2015)**

| Auto capture | AM peak boardings |
|---|---|
| Park & ride access | 4,360 |
| *South Shore/A10* | *2,600* |
| *Other* | *1,760* |
| Transit access | 1,160 |
| *South Shore/A10* | *420* |
| *Other* | *740* |

### Transit Capture

7.11 As indicated previously, most of the REM demand is captured from existing transit services. This is particularly the case from those services that are replaced (Deux Montagnes rail service) or truncated (South Shore/A10 express bus services) in order to be fully integrated with the REM. Table 7.7: shows that over 60% of the total transit demand shifting to REM are currently using the A10 and Deux Montagnes services.

**Table 7.7: REM transit shift capture (2015)**

| | AM Peak | Inter Peak | AM Peak+ Inter Peak |
|---|---|---|---|
| A10 Express services* | 16,458 | 8,262 | 24,721 |
| Deux Montagnes* | 14,371 | 4,802 | 19,173 |
| Other | 17,094 | 8,685 | 25,779 |
| **Transit Capture** | **47,924** | **21,750** | **69,673** |
| % Existing | 64% | 60% | 63% |

** Data includes boardings at Gare Centrale*

7.12 In summary, the following table shows the estimated number of boardings in the AM and Inter Peak 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 corridor. Gare Centrale has been included separately.

**Table 7.8: 2015 AM Peak and Inter Peak REM Boardings**

| REM section | AM Peak | Interpeak |
|---|---|---|
| South Shore/A10 stations* | 22,614 | 5,281 |
| West Island/Deux-Montagnes stations* | 30,328 | 10,723 |
| Gare Centrale | 1,524 | 7,720 |
| **Total** | **54,466** | **23,724** |

** Data does not include boardings at Gare Centrale*

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

### Additional transit demand capture

7.14 Table 7.3 showed that REM will attract around 54,500 boardings in the AM peak and almost 24,000 in the Inter Peak. Over 60% of that demand is expected to shift from existing services running on the Deux-Montagne Line or express buses in the A10 corridor. This section describes the nature of the additional transit demand (defined as 'Other' in Table 7.7:) and has been split into the West Island/Deux-Montagne and South Shore/A10 corridors.

*West Island/Deux-Montagne corridor:  AM Peak capture (to Gare Centrale)*

7.15 Table 7.9: shows the number of AM peak boardings on the West Island/Deux-Montagnes Line corridor and the increase of REM over the existing Deux-Montagne Line demand. This demand will include capture from transit (bus, rail and metro), Park & Ride and airport demand and represents a considerable proportion of the total REM demand.

**Table 7.9: West Island/Deux-Montagnes Line Boardings (to Gare Centrale, 2015)**

| Station | AM Peak Period (6am-9am) | | | Inter Peak Period (9am-3pm) | | |
|---|---|---|---|---|---|---|
| | DM Modelled | REM Sponsor Case | Difference | DM Modelled | REM Sponsor Case | Difference |
| Technoparc Saint-Laurent | | 2 | 2 | | 12 | 12 |
| Aéroport Pierre-Elliott-Trudeau | | 723 | 723 | | 1,002 | 1,002 |
| Autoroute 13 | | 324 | 324 | | 98 | 98 |
| Des Sources | | 780 | 780 | | 655 | 655 |
| Pointe-Claire | | 1,839 | 1,839 | | 755 | 755 |
| Kirkland | | 1,216 | 1,216 | | 162 | 162 |
| Sainte-Anne-De-Bellevue | | 1,009 | 1,009 | | 314 | 314 |
| Deux-Montagnes | 3,156 | 3,307 | 151 | 323 | 455 | 132 |
| Grand-Moulin | 829 | 844 | 15 | 106 | 107 | 1 |
| Sainte-Dorothée | 1,532 | 1,643 | 111 | 28 | 60 | 32 |
| Île-Bigras | 256 | 429 | 173 | 11 | 48 | 37 |
| Roxboro-Pierrefond | 2,776 | 3,434 | 658 | 203 | 421 | 218 |
| Sunnybrooke | 1,688 | 1,692 | 4 | 476 | 448 | -28 |
| Bois-Franc | 2,037 | 4,637 | 2,600 | 112 | 2,002 | 1,890 |
| Du Ruisseau | 1,065 | 1,441 | 376 | 71 | 77 | 6 |
| Montpellier | 881 | 2,430 | 1,549 | 292 | 923 | 631 |
| Mont-Royal | 395 | 751 | 356 | 68 | 1,185 | 1,117 |
| Correspondance A40 | | 2,659 | 2,659 | | 1,321 | 1,321 |
| Canora | 193 | 1,169 | 976 | 182 | 677 | 495 |
| **TOTAL** | **14,800** | **30,300** | **15,500** | **1,900** | **10,700** | **8,900** |

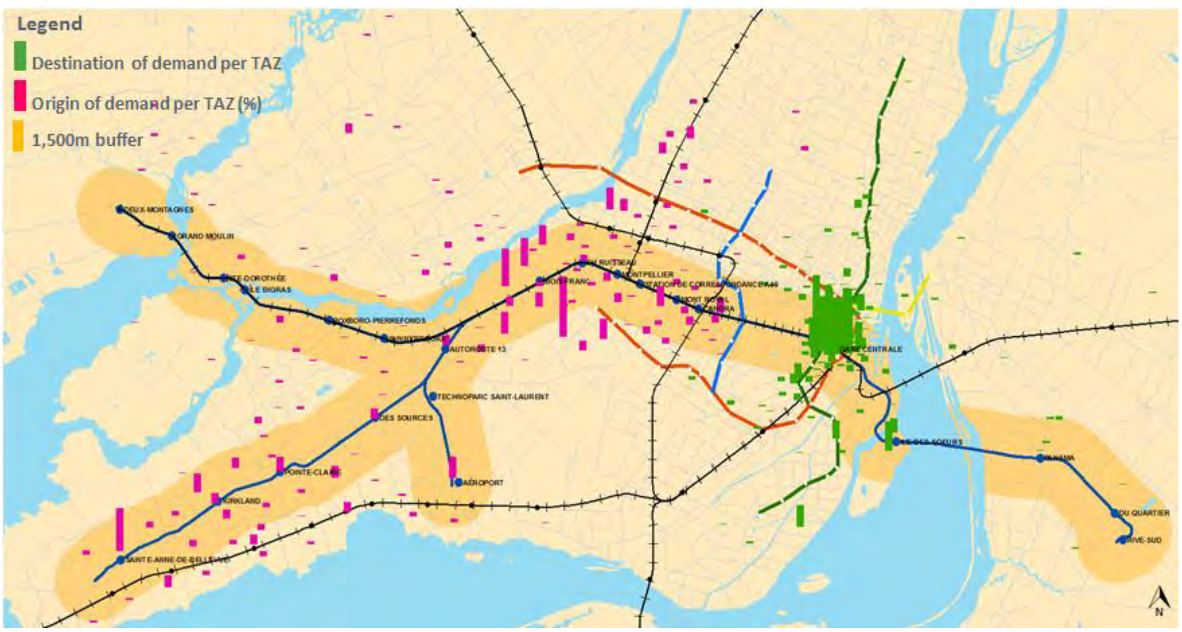
** Forecasts include transit capture, Park & Ride capture and Aéroport Pierre-Elliott-Trudeau demand.*

7.16 Excluding the demand captured from the new Park & Ride facilities, the stations that register the highest growth are those located in the 'core' section where all the three branches converge (from Bois-Franc to Canora Stations). This is the section where REM provides very high frequencies (2 minutes and 40 seconds between Correspondance A40) and fast travel times compared to other transit alternatives and this makes REM very competitive compared to other options increasing capture from other transit modes between Bois-Franc and Canora stations.

7.17 Most of the additional trips during the AM peak period are commuting trips to Downtown Montréal. Some of these (around 1,700 trips) are expected to shift from car and will be using the new Car P&R facilities to access REM. However, the majority of the additional demand are existing transit users that currently access the Downtown Montréal with a combination of express bus service and the Orange Metro line.

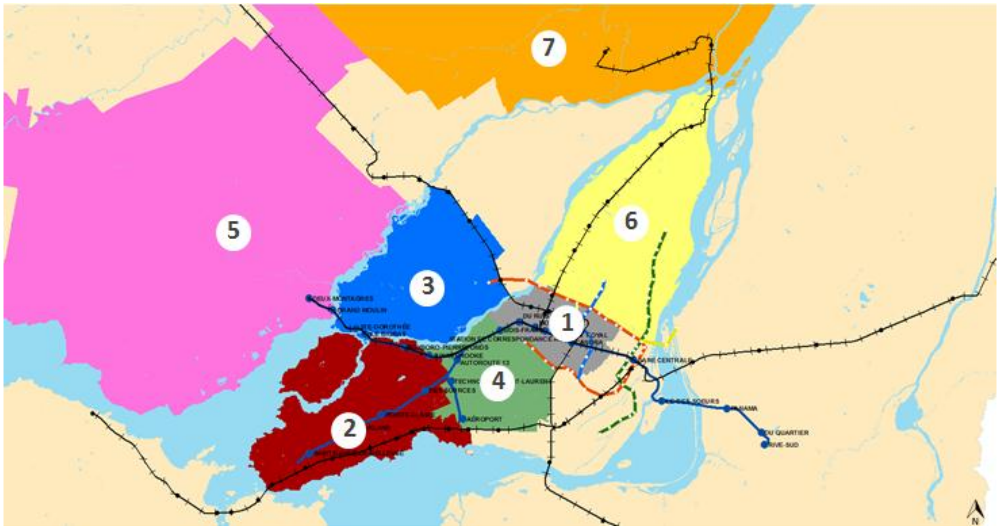
7.18 Further analysis was carried out to understand more clearly the origin and destination of these additional trips (this was carried out with a select link analysis for all the trips that cross the Mont-Royal Tunnel in the AM peak period and in the Montreal direction). Figure 7.1: shows that most of the destinations are concentrated in the Downtown area, and most of the origins (64%) are located within 1.5km of the REM alignment.

**Figure 7.1: AM Peak origin and destination of trips at Mont-Royal tunnel (to Gare Centrale, 2015)**




7.19 To facilitate the analysis, the data has been aggregated in 7 areas identified in Figure 7.2:.

**Figure 7.2: Zone Analysis Definition – West Island/Deux-Montagnes Line Corridor**




7.20 Table 7.10 shows the split of the additional demand using the Mont-Royal Tunnel in the AM peak period.

**Table 7.10: AM Peak additional demand origin on Mont-Royal tunnel (to Gare Centrale, 2015)**

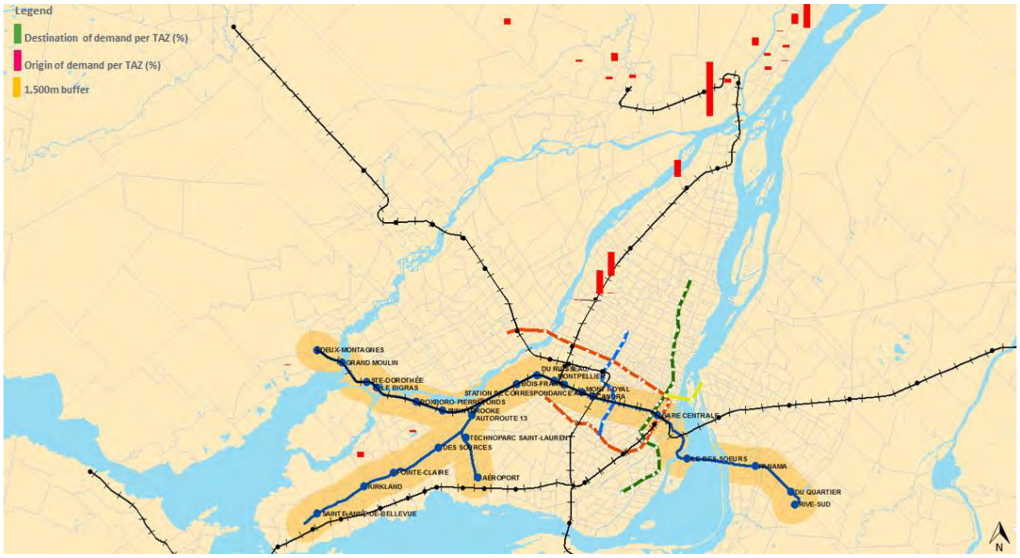
| Area | Trips | Proportion |
|---|---|---|
| 1 | 2,041 | 26% |
| 2 | 2,719 | 35% |
| 3 | 634 | 8% |
| 4 | 2,299 | 30% |
| 5 | 120 | 2% |
| 6 | 311 | 4% |
| 7 | -385 | -5% |
| Other | 17 | 0% |
| TOTAL | 7,757 | 100% |

7.21 The table shows :

- 35% of the additional REM demand has its origin from the Sainte-Anne-de-Bellevue branch (zone 2) as a result of the introduction of a new rail service offering a high speed and 12 minute headway service direct to Downtown
- 30% of the additional demand originates from the airport branch and Orange Métro Line (zone 4) and
- 26% in the area between the western and eastern branches of the Métro Orange Line (zone 1).

7.22 The implementation of REM also leads to a reduction of the existing demand that currently crosses the Mont-Royal Tunnel on the Mascouche Line (with origin in zone 7). Some of current users are expected to shift to other modes as a result of the termination of the Mascouche Line at Correspondance A40 and therefore not providing a direct link to Downtown. Figure 7.3 identifies the location of the trips where REM demand decreases (focussed on zone 7).

**Figure 7.3: Origins of REM AM Peak demand reductions (to Gare Centrale, 2015)**




7.23 Although great part of the additional demand will be commuting trips to Downtown, it is also expected that the REM will attract a significant number of trips to access key Educational centres in the Greater Montreal Area. The implementation of REM will provide a very competitive alternative to access the Université de Montréal and other Colleges in the area, using frequent bus connections from Mont-Royal, Canora and Montpellier.

7.24 As a result, it is expected that the demand to those stations will increase significantly. And it has been estimated that Mont-Royal station will attract around 2,900 trips in the AM peak, Canora 2,600 trips and Montpellier 1,350. Further analysis from the model was undertaken to understand the demand generated at these locations.

*Mont-Royal*

7.25 With the demand being generated from West Island and the South Shore, this station is used as an interchange with bus services (routes 435 and 165) offering a good level of service to access the Université de Montréal as shown below.

**Figure 7.4: Select link of REM demand - Mont-Royal**

*Montpellier*

7.26 The majority of the demand originates on the West Island/Deux-Montagne corridor and a large proportion of these passengers use Montpellier as an interchange to access Vanier College using a short bus service, as shown below.

**Figure 7.5: Select link of REM demand - Montpellier**


*Canora*

7.27 Demand to Canora is split evenly between the West Island and South Shore. Some of the demand alight in this station to access the Université de Montréal campus by walking. Others use the station to access bus routes along Rue Jean Talon (routes 92 and 372).

**Figure 7.6: Select link of REM demand - Canora**

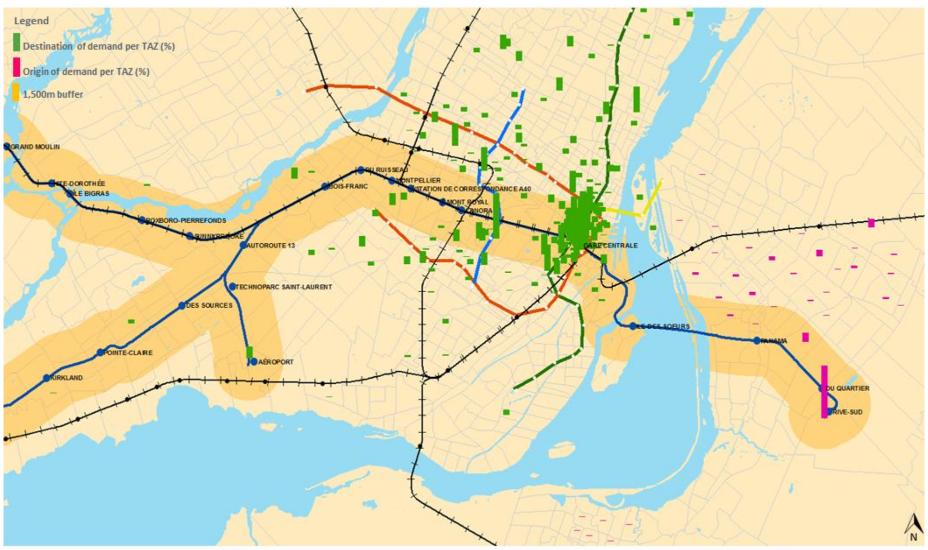
*South Shore/A10 corridor: AM Peak capture (to Gare Centrale)*

7.28 The introduction of REM, and the comprehensive bus reorganisation on the South Shore will also increase the number of REM boardings over existing transit demand by over 5,500 passengers during the AM peak period.

7.29 Almost 50% of this increase is due to the new Park & Ride facility at Rive-Sud station (with 3,000 spaces) while the analysis shows that most of the transit demand shift is originating from the Longueuil and Brossard areas.

7.30 Figure 7.7 presents the origins and destinations of the additional demand that crosses the Champlain Bridge in the AM peak. While a considerable number of the trips go to Downtown, the trip destinations are spread throughout the Island of Montréal. The REM provides a more direct and frequent link from the South Shore to the Downtown and especially those areas surrounding the core section of the REM (i.e. UdM).

**Figure 7.7: AM Peak origin and destination of trips at Champlain Bridge (to Gare Centrale, 2015)**




## Sponsor Case Forecasts (2021 and 2031)

### Peak and Inter Peak Forecasts

7.31 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 socioeconomic growth in the region together with road and transit network changes identified in 4.27 and 4.28. A similar pattern to the capture rates and type of trips identified in the 2015 analysis was observed.

7.32 Table 7.11: shows the AM and Inter Peak REM demand captured from transit for 2021 and 2031. It shows that REM growth rates are in line with the overall demand growth identified in Section 5, with growth slightly higher in the Inter Peak period.

**Table 7.11:AM Peak and Inter Peak REM Boardings**

| Period | REM section | Demand by period | | | CAGR | |
|---|---|---|---|---|---|---|
| | | 2015 | 2021 | 2031 | 2015-2021 | 2021-2031 |
| AM PEAK | South Shore/A10 stations | 22,614 | 24,262 | 26,269 | 1.2% | 0.8% |
| | West Island/Deux-Montages stations | 30,328 | 31,909 | 33,875 | 0.9% | 0.6% |
| | Gare Centrale | 1,524 | 1,611 | 1,727 | 0.9% | 0.7% |
| | **Total** | **54,466** | **57,782** | **61,871** | **1.0%** | **0.7%** |
| INTER PEAK | South Shore/A10 stations | 5,281 | 5,741 | 6,253 | 1.4% | 0.9% |
| | West Island/Deux-Montages stations | 10,723 | 11,713 | 13,059 | 1.5% | 1.1% |
| | Gare Centrale | 7,720 | 8,208 | 8,804 | 1.0% | 0.7% |
| | **Total** | **23,724** | **25,663** | **28,117** | **1.3%** | **0.9%** |

7.33 The airport demand is highlighted below. A similar pattern to the 2015 analysis was observed with bus passengers representing the bulk of the demand generated for the airport station.

**Table 7.12: REM capture - Airport demand (2021 and 2031)**

| AM PEAK + INTERPEAK | Bus passengers | Taxi | Car (Park and Fly) | Car (Kiss and Fly) | Total |
|---|---|---|---|---|---|
| 2021 | 2,295 | 679 | 316 | 199 | 3,488 |
| 2031 | 2,789 | 823 | 376 | 236 | 4,224 |

7.34 The resulting boardings and alightings for each station for 2021 and 2031 (AM and Inter Peak) are shown below.

**Table 7.13: AM and Inter Peak Station Boardings and Alightings (2021 and 2031)**

| | 2021 | | | | 2031 | | | |
|---|---|---|---|---|---|---|---|---|
| | AM Peak Boards | AM Peak Alights | Inter Peak Boards | Inter Peak Alights | AM Peak Boards | AM Peak Alights | Inter Peak Boards | Inter Peak Alights |
| Île-des-Soeurs | 153 | 553 | 22 | 121 | 162 | 593 | 25 | 132 |
| Panama | 13,739 | 344 | 3,464 | 2,370 | 14,977 | 388 | 3,797 | 2,603 |
| Du Quartier | 3,787 | 241 | 642 | 587 | 3,991 | 252 | 688 | 631 |
| Rive-Sud | 6,583 | - | 1,614 | 112 | 7,138 | - | 1,744 | 122 |
| Technoparc Saint-Laurent | 2 | 166 | 13 | 71 | 3 | 178 | 14 | 76 |
| Aéroport Pierre-Elliott-Trudeau | 816 | 583 | 1,160 | 1,115 | 952 | 706 | 1,397 | 1,608 |
| Autoroute 13 | 338 | 376 | 104 | 125 | 360 | 402 | 116 | 134 |
| Des Sources | 818 | 282 | 697 | 541 | 880 | 298 | 749 | 575 |
| Pointe-Claire | 1,944 | 539 | 794 | 411 | 2,065 | 575 | 853 | 437 |
| Kirkland | 1,276 | - | 172 | 79 | 1,356 | - | 183 | 84 |
| Sainte-Anne-de-Bellevue | 1,053 | 99 | 309 | 26 | 1,120 | 106 | 354 | 27 |
| Deux-Montagnes | 3,431 | 138 | 489 | 1,044 | 3,590 | 149 | 533 | 1,127 |
| Grand-Moulin | 866 | 5 | 114 | 128 | 892 | 5 | 122 | 136 |
| Sainte-Dorothée | 1,661 | 77 | 64 | 491 | 1,684 | 83 | 68 | 489 |
| Île-Bigras | 456 | 71 | 55 | 94 | 490 | 77 | 84 | 104 |
| Roxboro-Pierrefonds | 3,597 | 190 | 448 | 856 | 3,782 | 202 | 511 | 910 |
| Sunnybrooke | 1,773 | 94 | 476 | 554 | 1,859 | 99 | 509 | 589 |
| Bois-Franc | 4,913 | 910 | 2,409 | 1,375 | 5,243 | 989 | 2,736 | 1,358 |
| Du Ruisseau | 1,475 | 339 | 82 | 297 | 1,517 | 368 | 87 | 317 |
| Montpellier | 2,586 | 1,435 | 985 | 1,273 | 2,779 | 1,540 | 1,105 | 1,292 |
| Correspondance A40 | 2,851 | 1,805 | 1,419 | 240 | 3,085 | 1,961 | 1,540 | 267 |
| Mont-Royal | 803 | 3,059 | 1,192 | 3,114 | 866 | 3,285 | 1,305 | 3,338 |
| Canora | 1,250 | 2,719 | 732 | 420 | 1,352 | 2,914 | 793 | 458 |
| Gare Centrale | 1,611 | 43,756 | 8,208 | 10,219 | 1,727 | 46,702 | 8,804 | 11,303 |
| TOTAL | 57,782 | 57,782 | 25,663 | 25,663 | 61,871 | 61,871 | 28,117 | 28,117 |

7.35 The peak loads for 2021 and 2031 and in the AM and Inter Peaks are observed at the link between Correspondence A40 and Mont Royal. The link loads are summarized in Table 7.14.

**Table 7.14: REM Section Load Flows**

| Section | 2021 AM Peak | Inter Peak | 2031 AM Peak | Inter Peak |
|---|---|---|---|---|
| RIVE-SUD-DU QUARTIER | 6,583 | 1,614 | 7,140 | 1,744 |
| DU QUARTIER-PANAMA | 10,370 | 2,256 | 11,130 | 2,431 |
| PANAMA-ILE-DES-SOEURS | 24,064 | 5,626 | 26,058 | 6,128 |
| ILE-DES-SOEURS-GARE CENTRALE | 24,063 | 5,634 | 26,055 | 6,138 |
| AUTOROUTE 13-TECHNOPARC SAINT-LAURENT | 744 | 1,180 | 879 | 1,678 |
| TECHNOPARC SAINT-LAURENT-AÉROPORT | 583 | 1,115 | 706 | 1,608 |
| BOIS-FRANC-AUTOROUTE 13 | 1,800 | 2,350 | 2,001 | 2,918 |
| AUTOROUTE 13-DES SOURCES | 795 | 1,056 | 846 | 1,124 |
| DES SOURCES-POINTE-CLAIRE | 638 | 516 | 680 | 549 |
| POINTE-CLAIRE-KIRKLAND | 99 | 105 | 106 | 112 |
| KIRKLAND-SAINTE-ANNE-DE-BELLEVUE | 99 | 26 | 106 | 27 |
| GARE CENTRALE-CANORA | 5,124 | 7,129 | 5,563 | 7,662 |
| CANORA-MONT ROYAL | 4,288 | 7,281 | 4,670 | 7,831 |
| MONT ROYAL-CORRESPONDANCE A40 | 3,373 | 6,543 | 3,675 | 7,081 |
| CORRESPONDANCE A40-MONTPELLIER | 2,755 | 7,490 | 3,016 | 8,150 |
| MONTPELLIER-DU RUISSEAU | 2,516 | 6,546 | 2,765 | 7,217 |
| DU RUISSEAU-BOIS-FRANC | 2,465 | 6,260 | 2,711 | 6,914 |
| BOIS-FRANC-SUNNYBROOKE | 357 | 3,099 | 385 | 3,283 |
| SUNNYBROOKE-ROXBORO-PIERREFONDS | 325 | 2,578 | 351 | 2,729 |
| ROXBORO-PIERREFONDS-ÎLE BIGRAS | 253 | 1,728 | 273 | 1,825 |
| ÎLE BIGRAS-STE-DOROTHÉE | 219 | 1,634 | 237 | 1,721 |
| STE-DOROTHÉE-GRAND MOULIN | 143 | 1,172 | 155 | 1,263 |
| GRAND MOULIN-DEUX-MONTAGNES | 138 | 1,044 | 149 | 1,127 |
| GARE CENTRALE-ILE-DES-SOEURS | 939 | 3,083 | 1,018 | 3,371 |
| ILE-DES-SOEURS-PANAMA | 541 | 2,975 | 591 | 3,255 |
| PANAMA-DU QUARTIER | 240 | 699 | 253 | 753 |
| DU QUARTIER-RIVE-SUD | 0 | 111 | 0 | 123 |
| AÉROPORT-TECHNOPARC SAINT-LAURENT | 816 | 1,160 | 952 | 1,397 |
| TECHNOPARC SAINT-LAURENT-AUTOROUTE 13 | 813 | 1,168 | 949 | 1,405 |
| SAINTE-ANNE-DE-BELLEVUE-KIRKLAND | 1,053 | 309 | 1,120 | 354 |
| KIRKLAND-POINTE-CLAIRE | 2,330 | 481 | 2,476 | 536 |
| POINTE-CLAIRE-DES SOURCES | 4,274 | 1,276 | 4,541 | 1,390 |
| DES SOURCES-AUTOROUTE 13 | 4,967 | 1,973 | 5,289 | 2,139 |
| AUTOROUTE 13-BOIS-FRANC | 6,003 | 3,233 | 6,473 | 3,642 |
| DEUX-MONTAGNES-GRAND MOULIN | 3,431 | 489 | 3,590 | 533 |
| GRAND MOULIN-STE-DOROTHÉE | 4,297 | 603 | 4,482 | 655 |

| Section | 2021 AM Peak | Inter Peak | 2031 AM Peak | Inter Peak |
|---|---|---|---|---|
| STE-DOROTHÉE-ÎLE BIGRAS | 5,957 | 638 | 6,165 | 692 |
| ÎLE BIGRAS-ROXBORO-PIERREFONDS | 6,375 | 692 | 6,615 | 776 |
| ROXBORO-PIERREFONDS-SUNNYBROOKE | 9,854 | 1,134 | 10,272 | 1,280 |
| SUNNYBROOKE-BOIS-FRANC | 11,565 | 1,578 | 12,067 | 1,755 |
| BOIS-FRANC-DU RUISSEAU | 21,880 | 6,656 | 23,120 | 7,487 |
| DU RUISSEAU-MONTPELLIER | 23,066 | 6,726 | 24,323 | 7,564 |
| MONTPELLIER-CORRESPONDANCE A40 | 24,454 | 7,382 | 25,811 | 8,307 |
| CORRESPONDANCE A40-MONT ROYAL | **26,120** | **7,613** | **27,595** | **8,513** |
| MONT ROYAL-CANORA | 24,780 | 6,430 | 26,171 | 7,230 |
| CANORA-GARE CENTRALE | 24,146 | 6,588 | 25,502 | 7,395 |

### Daily and Annual Forecasts

*Daily and Annual expansion factors*

7.36 The model estimates boardings by station and loadings per line section and direction for the AM peak (6am-9am) and the Inter Peak (9am-3pm) periods. In order to translate this into weekday and annual figures, expansion factors have been applied as discussed in section 5 of this report.

7.37 The weekday factors have been based on those observed in the existing services in the corridors. Estimated factors for both corridors (South Shore/A10 and Deux-Montagne/West Island) are very similar, and therefore we have used the same weekday factors for all the stations in the corridor, with the exception of the airport demand. The estimated resulting weighted average for the total boardings in the corridor are:

| DM | AM PEAK TO PEAK | MIDDAY TO OFF PEAK |
|---|---|---|
| Average | 1.95 | 1.64 |

7.38 For estimating annual demand, we have analyzed the observed annual factors in the various corridors and have developed a formulae that estimates annual factors based on the weight of the peak demand on an average week day (see Figure 4.8). We have applied this approach to estimate the annual demand for each REM station based on the AM peak and Inter Peak demand forecasted from the Transit Model choice model.

7.39 The following table shows the (weighted) annual factors for the stations located in the different corridors. Note that Gare Centrale is not included in the analysis and has been estimated based on the REM weighted average. The Airport factor has been estimated independently as the travel patterns there are quite different to regular commuters and students.

**Table 7.15: Annual Factor Estimate (2021)**

| | Annual Factor | Peak Proportion |
|---|---|---|
| South Shore/A10 | 245 | 77% |
| Deux-Montagnes/West Island | 263 | 70% |
| Sainte-Anne-de-Bellevue | 264 | 70% |
| Airport | 277 | |
| REM WEIGHTED AVERAGE | 255 | |

7.40 Note the following impacts:

- Better service in the Inter Peak: The proportion of demand in the Inter Peak has increased in most stations as a result of the much improved level of service. This results in higher capture from other transit services in the Inter Peak and therefore a lower weight of the peak period (from the current 85% peak factor in Deux Montagnes Rail Line compared to estimated 70% with REM). As a result, a higher annual factor is estimated, which is consistent with the estimated capture from express buses and the Orange Line.
- Impact of Park and Ride: Demand in the AM peak increases significantly in some stations with the introduction of P&R demand. This results in a higher weight of the peak period and a reduction of the annual factor. This seems to be the case in the South Shore area, where the expected capture in the peak is higher than in the Inter Peak, resulting in lower annualization factors

**Daily and Annual Ridership Forecasts**

7.41 We have applied the expansion factors presented previously to the AM peak and Inter Peak boardings extracted from the Transit Mode Choice Model and these are presented in table below.

**Table 7.16: REM Daily and Annual Boardings (no ramp up)**

| | Daily | | Annual | |
|---|---|---|---|---|
| | 2021 | 2031 | 2021 | 2031 |
| Île-des-Soeurs | 804 | 862 | 183,779 | 197,334 |
| Panama | 18,413 | 20,116 | 4,627,687 | 5,060,300 |
| Du Quartier | 4,905 | 5,191 | 1,176,460 | 1,248,228 |
| Rive-Sud | 7,792 | 8,446 | 1,832,264 | 1,985,210 |
| Technoparc Saint-Laurent | 232 | 249 | 60,478 | 64,614 |
| Aéroport Pierre-Elliott-Trudeau | 4,106 | 5,148 | 1,137,358 | 1,425,996 |
| Autoroute 13 | 862 | 929 | 208,662 | 225,226 |
| Des Sources | 2,075 | 2,223 | 652,018 | 697,789 |
| Pointe-Claire | 3,391 | 3,612 | 876,176 | 934,606 |
| Kirkland | 1,442 | 1,533 | 328,274 | 348,939 |
| Sainte-Anne-de-Bellevue | 1,390 | 1,500 | 331,208 | 360,691 |
| Deux-Montagnes | 4,712 | 4,980 | 1,191,501 | 1,266,472 |
| Grand-Moulin | 1,042 | 1,080 | 246,852 | 257,083 |
| Sainte-Dorothée | 2,138 | 2,168 | 516,192 | 522,415 |
| Île-Bigras | 633 | 703 | 150,198 | 170,690 |
| Roxboro-Pierrefonds | 4,736 | 5,022 | 1,156,047 | 1,232,189 |
| Sunnybrooke | 2,651 | 2,795 | 701,626 | 742,414 |
| Bois-Franc | 8,746 | 9,396 | 2,394,114 | 2,578,122 |
| Du Ruisseau | 2,067 | 2,155 | 473,692 | 494,974 |
| Montpellier | 5,741 | 6,144 | 1,525,359 | 1,628,658 |
| Correspondance A40 | 6,431 | 7,051 | 1,640,798 | 1,808,594 |
| Mont-Royal | 7,250 | 7,808 | 2,271,671 | 2,448,214 |
| Canora | 4,788 | 5,159 | 1,140,604 | 1,231,145 |
| Gare Centrale | 58,466 | 62,777 | 14,676,856 | 15,816,417 |
| **TOTAL** | **154,812** | **167,045** | **39,499,876** | **42,746,320** |

7.42 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 kilometre estimates are shown in Table 7.17. The highest passenger kilometres are observed on links with high ridership and long length. These include Gare Centrale to Canora (5.4 kilometres), Bois Franc to Sunnybrooke (6.4 kilometres), Ile des Soeurs to Gare Centrale (5.4 kilometres) and Panama to Ile des soeurs (5.4 kilometres).

**Table 7.17: REM Annual Passenger-Kilometres (no ramp up)**

| | 2021 | 2031 |
|---|---:|---:|
| RIVE-SUD-DU QUARTIER | 5,752,091 | 6,258,004 |
| DU QUARTIER-PANAMA | 23,896,130 | 25,747,316 |
| PANAMA-ILE-DES-SOEURS | 85,648,247 | 93,242,693 |
| ILE-DES-SOEURS-GARE CENTRALE | 81,190,746 | 88,373,387 |
| AUTOROUTE 13-TECHNOPARC SAINT-LAURENT | 4,391,915 | 5,519,210 |
| TECHNOPARC SAINT-LAURENT-AÉROPORT | 4,580,515 | 5,810,505 |
| BOIS-FRANC-AUTOROUTE 13 | 27,597,965 | 31,008,646 |
| AUTOROUTE 13-DES SOURCES | 15,619,591 | 16,750,806 |
| DES SOURCES-POINTE-CLAIRE | 13,182,430 | 14,120,541 |
| POINTE-CLAIRE-KIRKLAND | 3,748,128 | 4,025,180 |
| KIRKLAND-SAINTE-ANNE-DE-BELLEVUE | 3,051,173 | 3,302,517 |
| GARE CENTRALE-CANORA | 109,778,731 | 118,061,568 |
| CANORA-MONT ROYAL | 16,554,889 | 17,804,499 |
| MONT ROYAL-CORRESPONDANCE A40 | 30,262,034 | 32,561,703 |
| STATION DE CORRESPONDANCE A40-MONTPELLIER | 18,565,649 | 20,017,457 |
| MONTPELLIER-DU RUISSEAU | 26,677,415 | 28,796,054 |
| DU RUISSEAU-BOIS-FRANC | 30,114,219 | 32,571,068 |
| BOIS-FRANC-SUNNYBROOKE | 50,379,826 | 53,216,740 |
| SUNNYBROOKE-ROXBORO-PIERREFONDS | 14,351,932 | 15,153,923 |
| ROXBORO-PIERREFONDS-ÎLE BIGRAS | 14,861,810 | 15,624,019 |
| ÎLE BIGRAS-STE-DOROTHÉE | 3,739,650 | 3,912,774 |
| STE-DOROTHÉE-GRAND MOULIN | 7,965,319 | 8,421,096 |
| GRAND MOULIN-DEUX-MONTAGNES | 5,314,852 | 5,637,721 |
| **TOTAL** | **597,225,258** | **645,937,430** |

### Annual Profiles

7.43 We have developed annual demand and passenger kilometre profiles for every year from 2021 to 2041. These have been based on the following assumptions:

- Forecasts between 2021 and 2031 have been interpolated
- Forecasts from 2031 to 2041 have been extrapolated based on observed growth between 2016 and 2031 and reduced to reflect long term forecasting uncertainty and lack of long term socioeconomic data

*Ramp up*

7.44 The ramp up has been applied to each of the initial years of operation according to Table 4.17 (base assumptions). 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.

7.45 We have included as existing demand those users that are currently using a transit service in the corridors that are either going to be eliminated or truncated in order to feed the REM system. The following table shows the estimated existing demand for the Sponsor Case.

**Table 7.18: Existing Demand Estimates**

| Corridor | Total Corridor Demand | In Scope | Existing | Boardings (assumed half of Existing) |
|---|---|---|---|---|
| South Shore | 13,052,269 | 90%* | 11,747,042 | 5,873,521 |
| Deux Montagnes | 7,495,900 | 100% | 7,495,900 | 3,747,950 |
| 747 | 1,471,637 | 85%** | 1,250,891 | 625,446 |

** Estimated that 90% of the boardings on the South Shore express buses cross the Champlain Bridge to access Montreal Island*

*** Estimated that only 85% of the 747 demand will shift to REM*

7.46 The application of the assumptions shown above result in the estimated ramp up factors for the Sponsors Case shown in Table 7.19.

**Table 7.19: Sponsors Case ramp up factors**

| | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|
| Annual Demand | 78% | 89% | 96% | 100% |
| Annual Pax-Km | 75% | 87% | 94% | 100% |

### Ridership and Passenger Kilometre profile

7.47 Table 7.20 shows a summary of the ridership and passenger kilometre totals for the first full year of operation (2021), 2026 and 2031 with the ramp up applied.

**Table 7.20: REM Ridership and Passenger Kilometre Summary (with ramp up)**

| | 2021 | 2026 | 2031 |
|---|---|---|---|
| Daily | | | |
| Boardings | 120,441 | 160,796 | 167,045 |
| Passenger kilometre | 1,750,240 | 2,430,558 | 2,524,216 |
| Annual | | | |
| Boardings | 30,657,333 | 41,086,677 | 42,746,320 |
| Passenger kilometre | 446,567,748 | 621,058,891 | 645,937,430 |

7.48 Figure 7.8 and Figure 7.9 show the resulting ridership and passenger kilometre 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 Montreal's transit network.

**Figure 7.8: Annual Ridership Profile (with ramp up)**

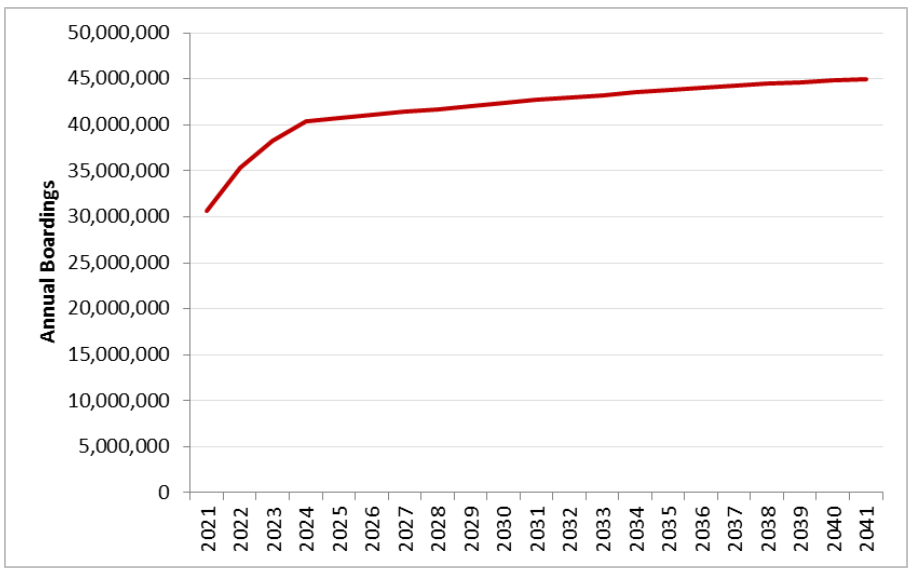
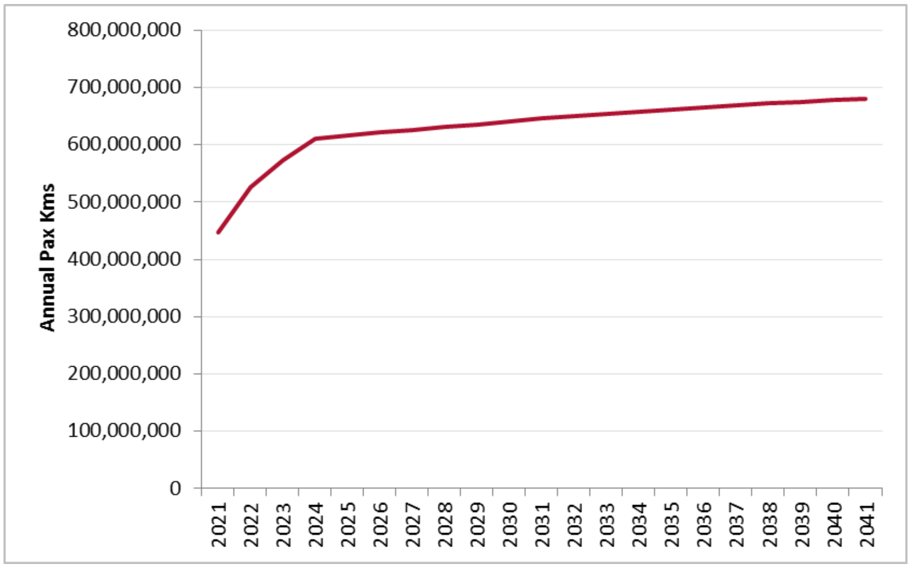


**Figure 7.9: Annual Passenger Kilometre Profile (with ramp up)**



# 8 Sensitivity Tests

## Identified risks

8.1 REM underlying projects (separately as Champlain LRT, Train de l'Ouest and Aerotrain projects) have been priorities for a long time.

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 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 Greater Montreal. However if different fares assumed e.g. STM fares applicable on REM stations in Montréal Island will reduce overall fares and will increase 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 like competition from alternative modes (taxi industry transformation, 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 forecasting model. However every model requires a number of assumptions related to the behaviour of passengers and how they value the different travel components and REM perceptions compared to other modes (bus, rail and Métro).

## Sensitivity Tests

8.3 In order to assess the extent of the impact of these risks, a number of sensitivities have been carried out. The sensitivities were undertaken for Transit Mode Choice and the Airport models separately due to the different characteristics of both markets.

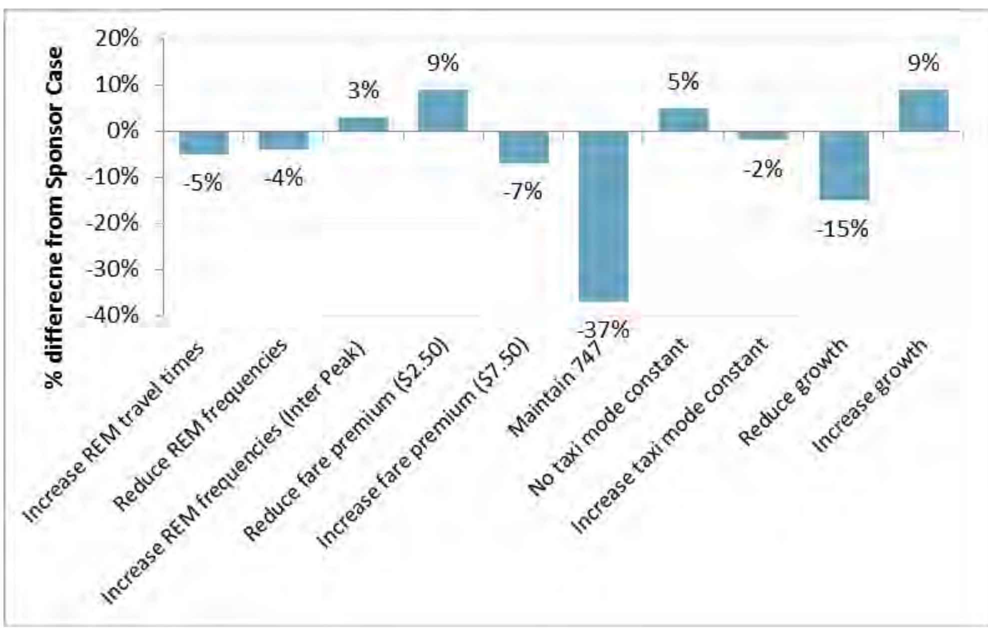
8.4 Table 8.2: presents the assumptions that have been adopted for the Sponsor Case, and high and low sensitivities to those variables:

**Table 8.1: Sensitivity tests**

| | Base | Sensitivity Low | Sensitivity High |
|---|---|---|---|
| **REM Service** | | | |
| Travel times longer | Average speed of 56kph | Average speed 49kph (15% slower) | - |
| Wait times longer/ shorter | AM: 12 mins<br>OP: 15 mins | AM: 18 mins<br>OP: 20 mins | AM: 12 mins<br>OP: 10 mins |
| **Airport** | | | |
| Fare Airport | $5 | $7.50 | $2.50 |
| 747 | No service | Same as current | N/A |
| **Users perception of REM** | | | |
| Transit users mode constant vs bus | 3 min | 0min | 5min |
| Growth | As modelled | -50% of modelled | +30% modelled |

8.5 Figure below shows the impact of the sensitivities on the Airport demand

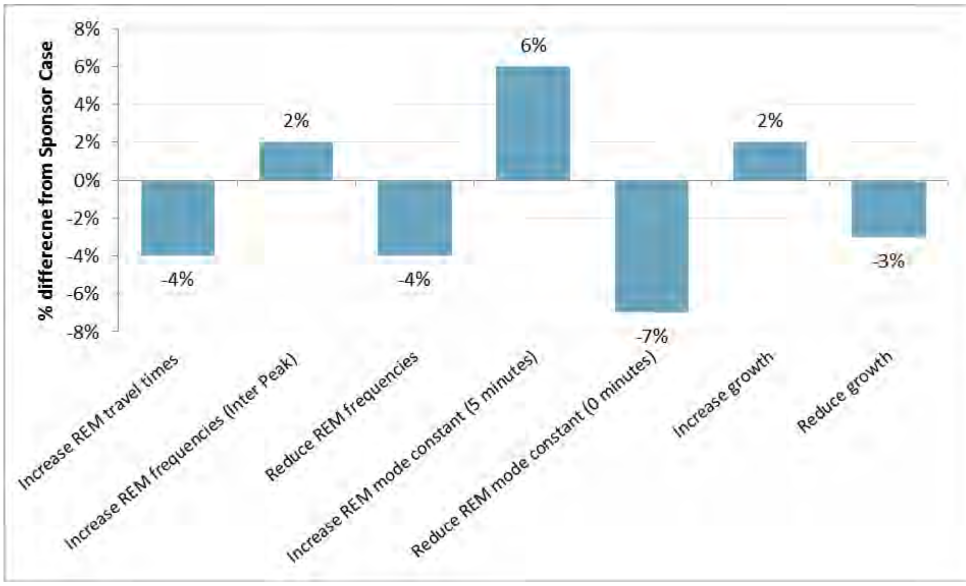
**Figure 8.1: REM Airport Station Ridership Sensitivity Tests (2031)**




8.6 The figure shows clearly the existence of the 747 bus service is by far the one variable which has the largest impact on REM ridership.

8.7 Tests were also carried out on transit demand using the Transit Mode choice model. The results are shown in the figure below

**Figure 8.2: REM Transit Ridership Sensitivity Tests (2031)**




8.8 Compared to the removal of the 747 bus service in the Airport case, the impact of the various variables is generally less dramatic. However, it affects to a larger number of trips.

## Low and High Case Definition

8.9 Following the various sensitivity tests indicated above, we developed Low and High cases to understand the combined effect of various assumptions and enable to understand the range of ridership on the Sponsor Case.

8.10 Table 8.2: 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 8.2: Sensitivity test definition**

| | Description | Sponsor Case | Low Case | High Case |
|---|---|---|---|---|
| Travel times | Deux-Montagnes to Rive-Sud | 46:47 | 51:28 | Same as sponsor |
| | Roxboro-Pierrefonds to Rive-Sud | 36:47 | 40:28 | Same as sponsor |
| | Sainte-Anne-de-Bellevue to Rive-Sud | 46:23 | 51:01 | Same as sponsor |
| | Aéroport Pierre-Elliott-Trudeau to Rive-Sud | 38:30 | 42:21 | Same as sponsor |
| | Correspondance A40 to Rive-Sud | 23:00 | 25:18 | 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 Montreal Island) | STM fares on REM in Montreal Island | Same as sponsor |
| Fare Airport | Current average airport fare ($3.15) with premium | $8.15 ($5 premium) | $5.65 ($2.50 premium) | Same as sponsor |
| Bus Re-Structuring | South Shore services | South Shore services re-directed to REM stations | Same as sponsor | Same as sponsor |
| Bus Re-Structuring | STM West Island services | Bus network reconfigured | Bus network reconfigured with 20% reduction in frequency | Bus network reconfigured with 10% increase in frequency (if wait time is 10 mins or lower no reduction applied) |
| 747 | Eliminated from service | Removed | Remains as current | Same a sponsor |
| REM perception | Transit users mode constant vs bus | 3 minutes | 0 minutes | 5 minutes |
| Growth | | As modelled | -50% modeled | +30% modeled |
| 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 8.3: 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% |
| 2024 | 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

8.11 Table below shows the 2021 annual station boardings for the Low and High Case compared to the Sponsor Scenario.

8.12 There are large differences across the various stations as result of the considerable number of variables changed and their different impact by trip Origin and Destination. The large reduction in the boardings at Aéroport Pierre-Elliott-Trudeau is the result of maintaining the 747 route with the existing level of service and fare, which becomes a direct competitor to REM.

**Table 8.4: REM Station Annual Boardings – Low and High Cases (2021)**

| | Sponsor | Low Case | High Case | Difference (Low vs Sponsor) | Difference (High vs Sponsor) |
|---|---|---|---|---|---|
| Île-des-Soeurs | 155,280 | 116,461 | 166,946 | -25% | 8% |
| Panama | 3,910,041 | 3,522,208 | 4,276,282 | -10% | 9% |
| Du Quartier | 994,019 | 941,960 | 1,068,584 | -5% | 8% |
| Rive-Sud | 1,548,123 | 1,357,558 | 1,786,862 | -12% | 15% |
| Technoparc Saint-Laurent | 43,784 | 31,892 | 48,982 | -27% | 12% |
| Aéroport Pierre-Elliott-Trudeau | 823,413 | 238,615 | 989,599 | -71% | 20% |
| Autoroute 13 | 125,197 | 127,547 | 197,115 | 2% | 57% |
| Des Sources | 391,211 | 276,477 | 480,310 | -29% | 23% |
| Pointe-Claire | 525,705 | 354,310 | 702,616 | -33% | 34% |
| Kirkland | 196,964 | 115,702 | 244,506 | -41% | 24% |
| Sainte-Anne-de-Bellevue | 198,725 | 141,073 | 275,938 | -29% | 39% |
| Deux-Montagnes | 856,314 | 814,862 | 948,244 | -5% | 11% |
| Grand-Moulin | 177,409 | 174,285 | 199,034 | -2% | 12% |
| Sainte-Dorothée | 370,980 | 353,249 | 407,982 | -5% | 10% |
| Île-Bigras | 107,945 | 80,609 | 128,022 | -25% | 19% |
| Roxboro-Pierrefonds | 830,834 | 726,407 | 921,072 | -13% | 11% |
| Sunnybrooke | 504,249 | 448,179 | 555,559 | -11% | 10% |
| Bois-Franc | 1,720,614 | 1,050,639 | 2,120,069 | -39% | 23% |
| Du Ruisseau | 340,436 | 283,128 | 408,732 | -17% | 20% |
| Montpellier | 1,096,253 | 794,534 | 1,268,852 | -28% | 16% |
| Correspondance A40 | 1,179,217 | 885,362 | 1,394,970 | -25% | 18% |
| Mont-Royal | 1,632,616 | 1,380,687 | 2,054,731 | -15% | 26% |
| Canora | 819,736 | 644,968 | 1,070,440 | -21% | 31% |
| Gare Centrale | 12,108,269 | 10,131,648 | 13,729,549 | -16% | 13% |
| TOTAL | 30,657,333 | 24,992,362 | 35,444,998 | -18% | 16% |

8.13 The full profile for ridership and passenger kilometres for the low and high cases are shown in Figure 8.3: and Figure 8.4. Note that ramp up has been applied to these forecasts and hence the steep growth during the first few years of REM operations.

**Figure 8.3: Annual boardings – Low and High Cases (with ramp up)**

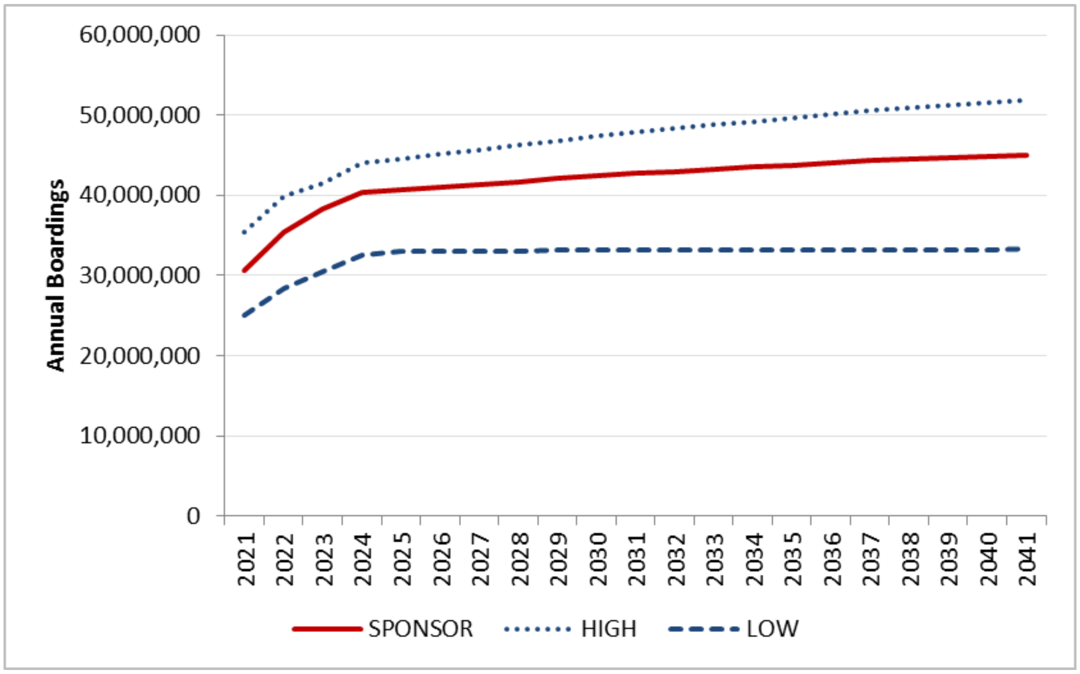
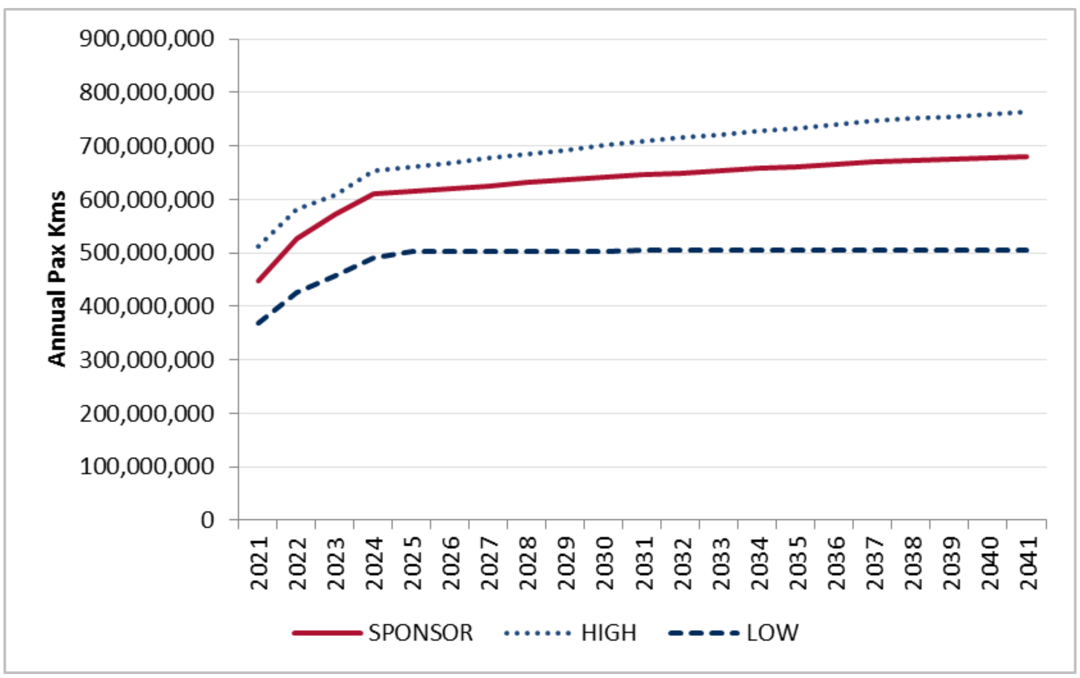



**Figure 8.4: Annual Passenger Kilometres – Low and High Case (with ramp up)**



8.14 The table below 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 8.5: Low and High Case Comparison**

| | Boardings | | Passenger Kilometres | |
|---|---|---|---|---|
| | 2021 (with ramp up) | 2031 | 2021 (with ramp up) | 2031 |
| Sponsor | - | - | - | - |
| Low | -18% | -22% | -17% | -22% |
| High | +16% | +12% | +15% | +10% |

8.15 Finally, we have reviewed the peak loads for the various cases to understand the impact on REM operations. The peak loads are detailed below.

**Table 8.6: Low and High Case Peak Loads**

| | AM Peak Load (no ramp up) | | Difference from Sponsor Case | |
|---|---|---|---|---|
| | 2021 | 2031 | 2021 | 2031 |
| Sponsor | 26,120 | 27,595 | - | - |
| Low | 22,689 | 22,950 | -13% | -17% |
| High | 28,614 | 31,113 | 10% | 13% |

# Appendices

# A List of Road Network Changes

| Projets inclus à partir de l'horizon 2016 | | | Modification d'horizon |
|---|---|---|---|
| No | Nom | Horizon | |
| 171 | R-337 Élargissement à 2 voies en direction Nord entre les rues Rodrigue et Philippe Chartrand | 2016 | 2018 |
| 172 | R-335 Réaménagement de l'intersection avec le boulevard Industriel à Bois-des-Filions et ajout d'une entrée à Henry-Bessemer vers A-640 Ouest | 2016 | 2018 |
| 215 | Réaménagement de la rue Viau et St-Clément entre Pierre-de-Coubertin et Notre-Dame | 2016 | |
| 221 | Réaménagement du carrefour Pie-IX / Henri-Bourassa | 2016 | |
| 225 | Réaménagement de l'échangeur Décarie | 2016 | |
| 290 | Projet complexe autoroutier Turcot phase I - Construction | 2016 | |
| 291 | Projet échangeur Dorval – état fin 2015 («Phase I») | 2016 | |
| 330 | Réaménagement échangeur A20 / A-30 | 2016 | 2017 |
| 333 | Voie supplémentaire dans la bretelle A-30 O vers R-116 | 2016 | 2018 |
| 334 | A-30 E+O : Élargissement de la chaussée de droite (entrecroisement) entre la R-116 et le boul. Clairevue | 2016 | 2018 |
| 501 | A-15 nouvel echangeur entrees/sorties rue Notre-Dame - Mirabel | 2016 | |

| Projets inclus à partir de l'horizon 2021 | | | Modification d'horizon |
|---|---|---|---|
| No | Nom | Horizon | |
| 294 | Projet autoroute Bonaventure | 2017 | |
| 331 | Voie supplémentaire dans la bretelle A-30E vers A-20 | 2017 | |
| 296 | Nouveau pont Champlain (version déc 2015) | 2018 | |
| 335 | A-30 O: Élargissement de la chaussée de droite (entrecroisement) entre Grande-allée et l'A-10 | 2018 | |
| 211 | Prolongement du boul. Cavendish | 2020 | |
| 222 | Réaménagement du pont Pie-IX entre Montréal et Laval | 2020 | 2022 |
| 336 | Parachèvement de l'A-35 entre St-Sébastien et St-Armand | 2020 | |
| 129 | A-640 Nouvel échangeur avec Urbanova - Terrebonne | 2021 | |
| 133 | A-440 Nouveau viaduc et bretelles entre A-19 et A-25 | 2021 | |
| 146 | A-19 Parachèvement entre Laval et la Rive-Nord | 2021 | 2031 |
| 170 | Prolongement du boul. René-Laennec | 2021 | |
| 212 | Prolongement boul. L'Assomption et Souligny avec lien direct au Port de Montréal | 2021 | |
| 216 | Réaménagement A-25 et accès au Port de Montréal | 2021 | |
| 226 | Boulevard urbain entre Gouin et l'A-40 dans l'emprise de l'A-440 (sans échangeur) | 2021 | |
| 293 | Projet complexe autoroutier Turcot phase II (version 5.1) | 2021 | |
| 332 | A-20 / R-132 : Construction bretelle F, à Longueuil | 2021 | |
| 601 | Réaménagement de la rue Charles à Mirabel entre l'A-15 et le chemin Ste-Henriette | 2021 | |
| 608 | Contournement de St-Lin - Laurentides | 2021 | |
| 610 | Élargissement du ch. St-Simon entre l'A-50 et le boul. St-Canut | 2021 | |
| - | Projet échangeur Dorval –« Phase I » finale | - | Ajouté: 2019 |

| Projets inclus à partir de l'horizon 2031 | | | Modification d'horizon |
|---|---|---|---|
| No | Nom | Horizon | |
| 337 | A-10 : Élargissement entre A-30 et A-35 | 2025 | |
| 338 | A-20 : Élargissement entre Sainte-Julie et Saint-Hyacinthe | 2025 | |
| 339 | A-30 : Élargissement entre A-10 et A-20 | 2025 | |
| 134 | Parachèvement du boul. Dagenais à 2 voies/dir entre Des Laurentides et Industriel | 2026 | |
| 292 | Projet échangeur Dorval – Phase II (finale) | 2026 | Enlevé |
| 606 | LEOS - Lien Est-Ouest Sud entre les R-333 et R-117 à St-Jérôme, secteur de Lafontaine | 2026 | |
| 609 | Prolongement de l’A-13 à 4 voies entre l’A-640 et le chemin de la Côte-Nord | 2026 | |
| 604 | Ajout d’une 3e voie sur l’A-15 (deux directions) entre l’entrée km 60 à St-Sauveur et l’échangeur de la R-117 à St-Jérôme (km 46) | 2031 | |
| 607 | Doublement des voies de l’A-50 entre Mirabel et Lachute | 2031 | |

# B SP Research Review

# Quality and Reliability Assessment

## Introduction

1.1 There are intrinsic and intangible benefits perceived by passengers between rail-based modes (such as REM) and conventional bus. These benefits are generally categorized as “quality and reliability benefits” and reflect a key component of mode choice.

1.2 Quality benefits arise from parameters associated with modelling “quality” aspects of the transit system and these include trip ambience (generally vehicle characteristics), ride quality and stop attributes.

1.3 Traditionally, ‘quality’ is incorporated as part of a mode-specific perception factor which is applied in a model. The application of quality parameters in a model has traditionally been done either through a ‘fixed’ mode constant (applied to in-vehicle travel time or a mode specific boarding penalty) or a ‘factor’ on in-vehicle travel (IVT) time. The difference between the application of these parameters means that the impact of each factor will vary considerably based on trip length e.g. a short trip will be impacted by a ‘fixed’ variable more than an IVT ‘factor’ while the opposite will be true for longer trips.

1.4 In practice the most accurate measure would likely be a mixture of both, with fixed constants reflecting stop related attributes (shelter, CCTV, real time information) and variable constants reflecting journey ambience (ride quality, climate control).

1.5 Mode-specific factors can be estimated through a variety of methods including as a calibration parameter (for existing transit networks), a review of values applied in other studies/models or based on stated preference surveys.

1.6 Finally, it is important to note that quality and reliability represent two different aspects of a trip but it can sometimes be challenging to distinguish between them, particularly when transit users are asked about a ‘new’ transit mode in the region and have limited experience with it.

## Quality Impact

1.7 Mode-specific perception factors can be applied at the mode-choice and/or assignment stages and are largely accepted in the transportation modelling community[1 2 3].

1.8 Currie[1] extensively examined how passengers valued trip attributes for on-street bus, BRT, LRT and heavy rail systems, compiling information from a range of studies and sources. The conclusion was that BRT, LRT and heavy rail are all favoured relative to conventional bus. Based on Currie’s analysis, BRT and LRT mode constants could be up to 20 minutes relative to conventional bus and heavy rail could be up to 33 minutes. These results, together with results of others studies are included in Table 1.

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1 G. Currie, "The Demand Performance of Bus Rapid Transit", Journal of Public Transportation, vol. 8, no. 1, pp. 41-55, 2005.

2 Department for Transport (UK), "Transport Analysis Guidance (TAG) UNIT M3.2", London, UK, 2014.

3 T. Litman, "Evaluating Public Transit Benefits and Costs," Victoria Public Transport Policy Institute, Victoria, BC, 2015

**Table 1. Quality benefit estimates**

| Source | Location/ Case | *Transit Modes*<br>Bus Rapid Transit vs. On-Street Bus | Light Rail vs. On-Street Bus | Heavy Rail vs. On-Street Bus |
|---|---|---|---|---|
| Halcrow Fox (1995)[1] | Manchester/Car Available Passengers | | 20 | |
| | Manchester/Car Not Available Passengers | | 0 | |
| Bray (1995)/Transfund NZ (2000)[1] | Adelaide/All Trips | 20 | | |
| Ableson (1995)/Fouracre et al. (1990)[1] | International/All Trips | | | 4-6 |
| Van Der Waard (1988)[1] | Holland/All Trips | | 2-3 | 2-3 |
| Kilvington (1991)[1] | UK Several Studies/Car Available Passengers | 9 | 15 | 12 |
| Kilvington (1991)[1] | Dublin/Bus Users | 12 | 16 | 16 |
| London Railplan Review[1] | UK Several Studies/Bus Users | 9 | 8 | 7 |
| Prosser et al. (1997)[1] | Sydney/A.M. Peak | | 4 | 9 |
| Wardman (1997)[2] | Study 19 (B) 1989 | | | -56 |
| | Study 19 (B) 1989 | | | -27 |
| | Study 7 (B) 1992 | | | -5 |
| | Study 4 (B) 1993 | | | 0 |
| | Study 17 (B) 1987 | | | 0 |
| | Study 8 (B) 1988 | | | 3 |
| | Study 20 (B) 1989 | | | 4 |
| | Study 20 (B) 1989 | | | 6 |
| | Study 3 (B) | | | 10 |
| | Study 28 (B) 1989 | | | 11 |
| | Study 28 (B) 1989 | | | 11 |
| | Study 4 (B) 1993 | | | 22 |
| | Study 23 (B) 1990 | | | 33 |
| | Study 13 (B) 1991 | | 1 | |
| | Study 9 (B) 1989 | | 10 | |
| | Study 12(B) 1990 | | 18 | |
| | Average of values | 12 | 10 | 4 |
| | Range of values | 9 to 20 | 2 to 20 | -56 to 33 |

1.9

| | | |
|---|---|---|
| Leeds New Generation Transit, UK (2010) | 2.8 to 5.6 | |
| | 20 (stop) | |
| Manchester Metrolink Revealed Preference, UK (2005)<br>*CA=Car Available*<br>*NCA=non Car Available* | | 15 to 19 (CA) |
| | | 5 to 6 (NCA) |
| Hurontario LRT (2013) | | 0.85 of bus time |
| Surrey LRT (2015) | | 4.5 |
| Hamilton LRT (2015) | | 0.81 of bus time |

1.17

1.18 Furthermore the US's Federal Transit Administration also provides some guidance on the range of mode constants expected which are generally in line with the values presented in the table above. This is shown in Table 2[4].

**Table 2. FTA Mode Constant Recommendations**

| Guideway attributes that are different from local bus | Maximum Alternative specific effects vs. local bus (mins) | | Maximum Guideway - in-vehicle time factor |
|---|---|---|---|
| | Guideway only | Guideway + local bus | Any guideway |
| Guideway like characteristics | 8 | 3 | 0.85 |
| - *Reliability of vehicle arrival, travel time* | *4* | *2* | *0.90* |
| - *Branding/visibility/learnability* | *2* | *1* | - |
| - *Schedule-free service* | *2* | *0* | - |
| - *Ride quality* | - | - | *0.95* |
| Span of good service | 3 | 0 | - |
| Passenger facilities | 4 | 3 | - |
| - *Amenities at stops/stations* | *3* | *2* | - |
| - *Dynamic schedule information* | *1* | *1* | - |
| Vehicle amenities | - | - | 0.95 |
| Availability of seat | - | - | 0.95 |
| **Maximum effect** | 15 | 6 | 0.75 |

## Reliability Impact

1.19 It is common that the average travel time varies from hour to hour on any given day, and to a large extent the service timetable can reflect this. Passengers take this into account when planning their travel.

1.20 What passengers cannot predict is the day-to-day variation in travel times for making the same travel at the same time of day, and regularly arrive at their destination later or earlier than desired. This is clearly an inconvenience to passengers, and reliability is often a factor for users to choose to make the trip by car rather than transit.

1.21 In the context of this report, travel time reliability is defined as the variation in travel times that passengers cannot predict as measured by the standard deviation of travel time compared to the average travel time. As with the average travel time, this can vary by time of day.

[4] Travel Forecasting for New Starts, Federal Transit Administration, September 2007

1.22 Rail-based systems will generally improve both journey time reliability and headway reliability. While journey time benefits are captured within conventional modelling and evaluation (which are based on ‘average’ journey times), reliability benefits are associated with the reduction in day-to-day journey time variability for similar times of travel.

1.23 Journey time variability is particularly important for transit riders who need to arrive at a given time (e.g. to get to work, to make on onward transport connection) and in these cases people often need to ‘factor in’ additional time to ensure they compensate for unreliability.

1.24 Traditionally, the impacts of transit unreliability have not been explicitly accounted for in transport models and the benefits from improved reliability did not have a formal role in the evaluation of transit projects. However, the fact that travellers do respond to the level of reliability (and the existence of economic benefits or costs associated with this response) has recently been acknowledged by transportation planners and economists.

1.25 There has been significant research into reliability. In the UK this research has been used to develop an approach to value and monetize reliability benefits that form part of UK’s TAG[5]. The approach used is to estimate the ‘average lateness’ based on the standard deviation of arrival times (compared to the timetable or schedule), and to value this ‘unreliability’ by a higher perception factor based on research.

1.26 Given the availability of data, two key components of journey reliability can be measured:

- In-vehicle time variability – passengers experiencing unpredictable journey times; and
- Headway variability – passengers experiencing unpredictable wait times

1.27 Improvements in travel time reliability can also help deliver second order benefits (but are not generally accounted for). These include:

- Having variable travel times can lead to bunching of services, meaning:
  - Passengers experience longer average wait times than implied by the timetabled headway
  - Passengers experience higher levels of crowding, as passenger loads are not evenly spread between services
- Reliable travel times mean that the operating efficiency can be improved and the level of service capacity can be delivered more consistently.

1.28 A literature review of reliability inputs has confirmed that the average-lateness method is the preferred method for determining reliability benefits in benefits-cost-analyses[6]. Reliability effects of transit projects are captured in various forms of evaluation practices in the USA, UK, Australia, New Zealand, Sweden and the Netherlands[7].

1.29 However this value can also be included in models as part of the mode constant.

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[5] Department for Transport (UK), "Transport Analysis Guidance (TAG) UNIT A1.3", London, UK, 2014.

[6] D. Carlos & L. Carrion, "Value of travel time reliability: A review of current evidence," Transportation Research Part A, no. 46, pp. 720-741, 2012.

[7] Transportation Economics Committee Wiki, "Reliability and BCA," [Online]. Available: http://bca.transportationeconomics.org/benefits/travel-time-reliability/reliabilityandbca. [Accessed 2015].

# C Bus Services in Calibration

## List of Bus Routes in Scope

| Transit agency | Route | Name |
|---|---|---|
| STM | 64 | Grenet |
| STM | 68 | Pierrefonds |
| STM | 69 | Gouin |
| STM | 70 | Bois-Franc |
| STM | 72 | Alfred-Nobel |
| STM | 90 | Saint-Jacques |
| STM | 100 | Crémazie |
| STM | 110 | Centrale |
| STM | 115 | Paré |
| STM | 121 | Sauvé / Côte-vertu |
| STM | 128 | Ville-Saint-Laurent |
| STM | 164 | Dudemaine |
| STM | 170 | Keller |
| STM | 171 | Henri-Bourassa |
| STM | 174 | Côte-Vertu-Ouest |
| STM | 175 | Griffith / Saint-François |
| STM | 177 | Thimens |
| STM | 180 | De Salaberry |
| STM | 191 | Broadway / Provost |
| STM | 195 | Sherbrooke / Notre-Dame |
| STM | 196 | Parc-Industriel-Lachine |
| STM | 200 | Sainte-Anne-de-Bellevue |
| STM | 201 | Saint-Charles / Saint-Jean |
| STM | 202 | Dawson |
| STM | 203 | Carson |
| STM | 204 | Cardinal |
| STM | 205 | Gouin |
| STM | 206 | Roger-Pilon |
| STM | 207 | Jacques-Bizard |
| STM | 208 | Brunswick |
| STM | 209 | Des Sources |
| STM | 211 | Bord-du-Lac |
| STM | 213 | Parc-Industriel-Saint-Laurent |
| STM | 215 | Henri-Bourassa |
| STM | 216 | Transcanadienne |
| STM | 217 | Anse-à-l'Orme |
| STM | 219 | Chemin Sainte-Marie |
| STM | 225 | Hymus |
| STM | 401 | Express Saint-Charles |
| STM | 405 | Express Bord-du-Lac |
| STM | 407 | Express Île-Bizard |
| STM | 409 | Express Des Sources |
| STM | 411 | Express Lionel-Groulx |
| STM | 419 | Express John Abbott |
| STM | 425 | Express Anse-à-l'Orme |
| STM | 460 | Express Métropolitaine |
| STM | 468 | Express Pierrefonds / Gouin |

| Transit agency | Route | Name |
|---|---|---|
| STM | 470 | Express Pierrefonds |
| STM | 475 | Express Dollard-des-Ormeaux |
| STM | 485 | Express Antoine-Faucon |
| STM | 491 | Express Lachine |
| STM | 495 | Express Lachine / LaSalle |
| STM | 496 | Express Victoria |
| STM | 747 | Aéroport P.-E.-Trudeau / Centre-ville |
| RTL | 5 | |
| RTL | 15 | |
| RTL | 30 | |
| RTL | 31 | |
| RTL | 32 | |
| RTL | 33 | |
| RTL | 34 | |
| RTL | 35 | |
| RTL | 37 | |
| RTL | 38 | |
| RTL | 42 | |
| RTL | 44 | |
| RTL | 45 | |
| RTL | 46 | |
| RTL | 47 | |
| RTL | 49 | |
| RTL | 50 | |
| RTL | 55 | |
| RTL | 59 | |
| RTL | 60 | |
| RTL | 86 | |
| RTL | 87 | |
| RTL | 90 | |
| RTL | 100 | |
| RTL | 115 | |
| RTL | 132 | |
| RTL | 135 | |
| RTL | 142 | |
| RTL | 144 | |
| RTL | 150 | |
| AMT | 90 | Express Chevrier |
| Ville de Saint-Jean | 96 | |
| OMIT Saint-Julie | 600 | |
| CITLR | 121 | |
| CITLR | 122 | |
| CITLR | 123 | |
| CITLR | 124 | |
| CITLR | 132 | |
| CITLR | 133 | |
| CITLR | 321 | |
| CITLR | 323 | |

| Transit agency | Route | Name |
|---|---|---|
| CITLR | 340 | |
| CITLR | 341 | |
| CITLR | 343 | |
| CITVR | 300 | |
| CITCRC | 400 | |
| CITCRC | 401 | |
| CITCRC | 500 | |
| CITCRC | 600 | |
| CITROUS | 100-115 | |
| CITROUS | 130 | |