PRELIMINARY DESIGN STUDIES

FOR A LIGHT RAIL TRANSIT SYSTEM

(LRT)

Highway 10 / Downtown Montréal corridor

SUMMARY OF STUDIES

Québec

Canada

Project Manager:

AMT
Agence métropolitaine de transport

PRELIMINARY DESIGN STUDIES

LRT SYSTEM IN THE HIGHWAY 10 / DOWNTOWN MONTRÉAL CORRIDOR

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THE CONTEXT
OF THE PRELIMINARY DESIGN STUDIES

> PREVIOUS STUDIES

From 1998 to 2000, l'Agence métropolitaine de transport (AMT) carried out opportunity and feasibility studies concerning the implementation of a light rail transit (LRT) system in four traffic corridors in the metropolitan region:

- Highway 10 / Downtown Montréal corridor;
- Park Avenue corridor
- Henri-Bourassa Blvd. corridor;
- Roland-Therrien Blvd. corridor.

These four corridors were studied based on:

- the importance of the transit corridor;
- the operating problems related to certain corridors;
- the development of an LRT system;
- a vision of urban development.

As a result of these initial studies, the Highway 10/Downtown Montréal corridor was selected as the priority corridor for the implementation of an LRT system in the Montréal region.

In 2001, the federal government, through Economic Development Canada and the Federal Bridge Corporation Limited (FBCL), and the Québec government, through the Ministère des Transports du Québec (MTQ), agreed to finance, in equal shares,

preliminary design studies for the implementation of an LRT system in the Highway 10/ Downtown Montréal corridor that would use the infrastructure of the Ice Bridge and Champlain Bridge. L'AMT was mandated to act as general contractor, and a steering committee, chaired by a representative of Transport Canada and a representative of the MTQ, provided guidance for the studies. An amount of $14 million was set aside to defray the cost of these studies.

THE CONGESTION PROBLEMS IN THE CHAMPLAIN BRIDGE / HIGHWAY 10 CORRIDOR

The contra-flow bus lane on Champlain Bridge, was put in place in 1978 as a pilot project. Over the years, there have been successive enhancements, such as adding preferential measures, extending the bus lanes in the middle of Highway 10 as far as the Chevrier parking lot, enlarging and/or building terminuses and park-and-ride lots, etc.

Nevertheless, several significant problems remain, and they affect the operations of transit operators and the capacity for growth in ridership on the Champlain Bridge corridor:

Safety aspects related to the bus lane

Originally, the contra-flow bus lane was set up in its current configuration as a temporary measure. Because of Champlain Bridge's geometric constraints, it is not possible to physically isolate the bus lane from the other lanes of traffic with a rigid barrier. The absence of a permanent, impassable physical feature setting off the bus lane weakens the very existence of this public transit system.

The Downtown terminus's capacity has already been reached

The Downtown terminus (terminus Centre-ville or TCV), which is located in the block formed by de la Cathédrale, Saint-Antoine, Mansfield and de la Gauchetière streets and serves as the unloading point for all buses coming from the South Shore, is operating at

Downtown terminus

full capacity. The passenger waiting areas on the platform are saturated.

With close to 385 buses arrivals and departures during peak periods, there is little room available to add new departures.

The lack of flow control areas for buses and the congestion of the roads accessing the TCV cause operating problems for the transit operators. Among other things, travel time is very variable, which undermines the reliability and regularity of bus services. When we cumulate the closure times for Champlain Bridge bus lane with periods when traffic density affects bus travel times, public transit service is currently disrupted for 10% of the total operating time.

The Champlain Bridge has also reached its full capacity

In addition to the problems related to the operation of the contra-flow bus lane, there are other problems. Champlain Bridge, which is the busiest in the Montréal area, is experiencing ever-longer periods of congestion. Line-ups even form in the opposite-to-peak direction. In this context, the Jacques Cartier and Champlain Bridges Incorporated (JCCBI) would like to reclaim the traffic lane on the Champlain Bridge that is now reserved for buses. Moreover, the opportunity to make use of an under-used piece of existing infrastructure, the Champlain Bridge's Ice Bridge, makes other solutions possible.

The increasing road congestion on the South Shore bridges is weakening the Montréal area's competitiveness and damaging the environment because of greenhouse gas emissions. Population and employment growth over the next few years will mean that the various problems that have been identified will not go away of their own accord in the short and medium term.

> THE MANDATE AND SCOPE OF THE STUDIES

The main objective of the preliminary design studies was to develop a sustainable solution to the problem of traffic congestion in the Champlain Bridge corridor, based on the concept of an LRT system.

The specific goals of the preliminary design studies were to optimize the concept of the LRT and its components, as proposed by the earlier opportunity and feasibility studies; create preliminary and final plans and specifications; issue cost estimate for building and operating the system with ±10% accuracy; and obtain the necessary government authorizations to carry out the project.

The studies were also intended to identify the potential for commercial operation of the LRT; review the economic analysis of the project; prepare the documentation related to performance specifications for an international call for tenders concerning construction and operation of the LRT system; and prepare scenarios for financing the LRT project. All recommendations made with regard to technologies and the system had to correspond to proven solutions in use elsewhere in the world and available from at least three manufacturers.

In the course of these studies, an analysis of alternative solutions was conducted, including a busway on the Ice Bridge.

Changes in the mandate over time

The project has evolved since the studies were initiated in 2001. Following the preparatory studies and the comparative analysis of alternative solutions to the LRT project, and given the foreseeable financial magnitude of the project, the steering committee amended the mandate for the studies.

The steering committee also reassessed the progress of the technical studies by identifying project components that could be deferred, while still meeting the goal of fulfilling the requirements of the environmental process (preliminary concept at ±20%). The technical studies were completed up to the stage of preliminary plans and specifications.

In addition, the steering committee requested an analysis of possible cost-cutting measures that would not adversely affect the performance and attractiveness of an LRT project whose performance would surpass that of the current bus system.

It also asked AMT to flesh out its analysis of the alternative scenario for a busway on the Ice Bridge.

Finally, in addition to the final plans and specifications, the initiation of federal and provincial environmental procedures, the development of financing scenarios and the process of acquiring land were deferred until the final decision concerning the project should have been made.

THE COST OF THE STUDIES

Given the changes that occurred during the mandate, not all of the budget for studies was spent. A reserve of $2 million was retained from the initial $14-million budget. The table below provides details on the amounts allocated to the preliminary design studies:

PRELIMINARY STUDIES	$356,034
RELATED STUDIES	$2,179,051
Value analysis	
Transportation study	
Marketing studies	
Impact studies	
Urban design study	
Traffic study	
Justification and environmental impact study	
Economic study	
RELATED ACTIVITIES	$207,225
Acquisition of rights-of-way and land	
Joint action	
TECHNICAL STUDIES (PRELIMINARY PLANS AND SPECS)	$6,583,754
Technical studies	
Expert appraisals	
OTHERS	$2,660,765
Project management and technical support	
Study of a busway on the Ice Bridge	
Jean-Drapeau Park / Downtown Montréal corridor	
Service to Old Montréal / Old Port	
RESERVE	$2,013,171
TOTAL	**$14,000,000**

THE PROJECTS **STUDIED**

> COMPARATIVE ANALYSIS OF SCENARIOS

Seven transit service intervention scenarios were analyzed in detail:

1. Baseline scenario (status quo)
2. Addition of a bus lane on Clément Bridge
3. Bus lane on Champlain Bridge in the direction of traffic and on Clément Bridge
4. New metro line linking the Chevrier parking lot with Lionel-Groulx metro station
5. New LRT line with five stations
6. New busway on the Ice Bridge and on Clément Bridge
7. New road bridge between the Taschereau Interchange and the Bonaventure Expressway

The comparative analysis revealed that the status quo is one of the least satisfactory options considered.

Of all the scenarios evaluated, scenario 5 (new LRT line) obtained the best grade (86%) for most of the criteria related to both public transit and the community. The development of a new busway on the Ice Bridge is the second-best option (73%).

RANKING OF ALTERNATIVE SCENARIOS

SCENARIO	%	RANKING
1. Baseline scenario for 2006 (status quo)	47%	6
2. Bus lane on Clément Bridge	56%	4
3. Bus lane on Champlain Bridge in the peak direction	52%	5
4. New metro line	65%	3
5. Light rail transit system on the Ice Bridge	**86%**	**1**
6. New busway on the Ice Bridge	73%	2
7. New bridge between the South Shore and Montréal	46%	7

NEW BUSWAY ON THE ICE BRIDGE

Given the good result for scenario 6 (73%), the steering committee requested that this option be studied in more depth. These analyses made it possible to better define the cost of implementing it, and its operating limits. By 2016, the potential ridership in this scenario is estimated at 25,270 trips during the morning rush hour, compared to 17,000 for the baseline scenario.

However, the main operating constraints for a busway on the Ice Bridge reside in the limited capacity of the TCV and the municipal road system adjacent to this terminus to handle more buses. The possibilities for growth would require modifications of the road system and a decrease in the number of bus routes going to the TCV, which is already used to capacity: the impact of these measures would be an expansion of the TCV's operations in downtown Montréal.

The study identified the feasibility of creating a one-way bus lane on the Champlain Bridge's Ice Bridge, but the results show that the width of the useable corridor would not allow for the safe operation of buses in both directions.

It should be added that this option, the preliminary cost of which is estimated at $300 million (±50% accuracy), also has disadvantages related to its impacts on air quality and development capacity in the medium and long term. It could be considered as an interim solution between the status quo and the creation of an LRT system.

THE LRT:
AN EXCELLENT SOLUTION
TO THE PROBLEMS OF THE HIGHWAY 10 / DOWNTOWN MONTRÉAL CORRIDOR

> DESCRIPTION OF THE LRT PROJECT

Light rail transit systems are light weight trains that run on electricity, so that they are quiet and non-polluting. They can reach speeds of 100 km/h if the trains travel on a track that is exclusively dedicated to them. More than 30 systems using this technology are in operation in Europe, the United States and Canada.

The Highway 10 LRT project would involve replacing the buses that now use the bus lane on the Champlain Bridge by a modern light train on an exclusive right-of-way that would take the Ice Bridge and a new bridge over the St. Lawrence Seaway. The existing bus lane on Champlain Bridge would be abandoned, which would free up a lane on the bridge going in the opposite-to-peak direction.

The LRT

The alignment

The LRT would link Central Station, in downtown Montréal, to the Chevrier park-and-ride lot, located northwest of the intersection of highways 10 and 30 in Brossard on the South Shore. The LRT would run in an exclusive right-of-way, that is to say, the tracks would be reserved for its use. The total length of the route is 12.86 km.

The potential alignment retained was carefully chosen in order to avoid level crossings and minimize physical barriers in the host environment. Interfaces with the existing public transit systems will facilitate transfers and integration into the urban

fabric. There would be five stations: the Downtown and Chevrier terminuses and the Multimédia, Île-des-Sœurs and Panama intermediate stations.

This initial route could be extended at both ends. In downtown Montréal, it could connect to the Green line of the metro underneath McGill metro station. From the Chevrier terminus, it would be possible to extend the LRT tracks northeast.

The map below shows the complete LRT route and the locations of the five stations.

The roadbed and the Ice Bridge

The LRT tracks would be overhead or ground-level for most of the route. Only a few short sections would be in cuttings or tunnels. The Ice Bridge would be reclaimed and modified to support the LRT by adding rock bolts, a new concrete covering, etc.

A bridge 360 metres long is planned to be built across the Seaway.

On the South Shore, the LRT route would be inserted into the median strip of Highway 10. Traffic safety barriers with glareshields would be placed on both sides of the tracks to prevent any intrusions into the right-of-way.

The tunnel sections would cross underneath Highway 10, Lapinière Blvd. and the CN right-of-way just before reaching the Chevrier terminus.

The LRT at a glance

Total route	***12.86 km***
Number of stations	***5 stations***
Total travel time	***13 minutes***
Frequency of service at rush hour	***every 3 minutes***
Capacity of each car	***131 passengers***
Capacity of each train	***655 passengers***
Maximum speed	***100 km/h***

The stations

The LRT stations would generally have five elements: the reception area, the bus terminus, the passenger centre, the platform accesses, and the platform itself. They would all be designed to protect passengers from bad weather while travelling and would be accessible to persons with reduced mobility.

Multimédia Station

The Downtown terminus is unique because it would be inserted into an existing station, Central Station, whose waiting room is a historic, listed and protected site. Several specific facilities must therefore be planned to integrate the LRT route through Place Bonaventure, Saint-Antoine Street, Central Station and Place Ville-Marie.

The Réseau de transport de Longueuil (RTL) and Conseils intermunicipaux de transport (Intermunicipal transit councils, CIT) bus lines that now go to downtown Montréal would go to the Chevrier and Panama LRT stations in Brossard. Similarly, some Société de transport de Montréal (STM) bus lines would extend to the Île-des-Sœurs LRT station.

The service

The LRT would offer service between the Chevrier and Downtown terminuses, seven days a week, from 5:45 a.m. to 1:15 a.m.; the total travel time would be 13 minutes. The interval between trains would be adjusted during service hours to respond to actual demand. Given the demand that must be satisfied during the peak period, the interval would be 3 minutes, which is comparable to the metro's service level. In off-peak periods, weekends and holidays, the maximum interval would be 10 minutes.

The rolling stock

Each train would be made up of five cars that are semipermanently connected, with free passenger movement from one car to another. Automatic or semiautomatic train operation would allow for reduced service intervals and running times, while offering the necessary flexibility for adjustments of timetables. Each train would be able to accommodate 655 passengers.

The trains would run on electric power, transmitted by a catenary. A 100% traction system has been retained because of local weather conditions and the long slopes existing on the route.

Sliding doors

The automated doors

Automated sliding doors would be planned for each platform: they would prevent unauthorized access to the track from the platform and make it possible to control ambient conditions within the closed space of the platform.

These sliding doors open when a train is stopped in the correct position next to the platform. They are designed so that fingers, hands and clothing cannot be trapped when the doors open and close.

THE LRT'S RIDERSHIP

Ridership simulations have been done with a 2016 scenario, when the system would be integrated into its urban environment. The evaluation of demand for 2016 takes account of an analysis of the potential for residential, commercial, industrial and institutional development along the study corridor, in order to take into consideration the impact on ridership of the urbanization of the zones bordering on the LRT route.

By 2016, the LRT would have an estimated potential ridership of 27,320 trips in the morning rush hours, or 22,795 trips in the peak direction and 4,525 trips in the opposite direction. At present, ridership in Champlain Bridge corridor is approximately 17,000 trips during the morning rush hours. Without any intervention, it is estimated that bus ridership would total 21,750 trips in 2016. The LRT would therefore make it possible to increase public transit ridership in the corridor by 26%.

Champlain Bridge

By 2016, the LRT would attract 4,150 new northbound customers, or 15% of predicted ridership in this corridor. This modal transfer from cars to the LRT would help to remove close to 2,460 cars from the bridges between the South Shore and Montréal, in both directions.

ADVANTAGES OF THE LRT PROJECT

The preliminary design studies for the LRT system in the Highway 10/Downtown Montréal corridor, especially the analysis of comparative scenarios, have confirmed that this transportation solution would be the best.

The advantages of the LRT project over the other alternatives studied are considerable. The LRT scenario is the one that generates the greatest ridership in both directions and favours the most modal transfers. This system, which would run all day long, with its automatic or semiautomatic operation, would have optimum reliability and regularity.

The LRT's high transportation capacity and the way it is implemented would ensure the long-term effectiveness and service life of public transit in the Champlain Bridge corridor. This mode of transportation is also known to be a structuring element for urban development.

Thus, the LRT project offers a range of advantages, such as:

- *Potential for 4,150 new public transit users and the removal of 2,460 cars from the South Shore bridges (2016 horizon);*
- *Elimination of the problem of reliability of Champlain Bridge bus lane;*
- *Elimination of the problem of saturation of access to downtown and the Downtown terminus;*
- *Construction of a public transit bridge that offers a transportation capacity equivalent to more than two road bridges with three lanes in each direction;*
- *Contribution to major environmental goals such as reduction in greenhouse gases and other problems related to automobile use (parking spaces, traffic management, other pollutants, etc.);*
- *Improvement in the quality of life and the environment in the cities served (fewer buses and cars).*

Finally, as the economic analysis shows (see next section), the project would be profitable for the community and would generate major economic spinoffs.

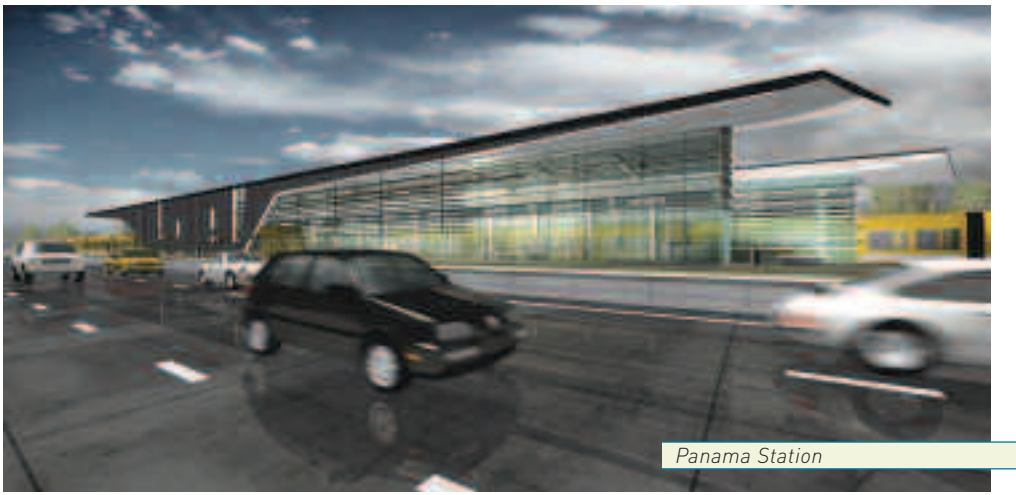
CONSTRUCTION AND OPERATING COSTS

The overall project costs are based on a Class C cost estimate; they are estimated at ±20% for most of the components, except the stations, passenger cars, signal system and automated doors. For the stations, the accuracy is less than 20%, while for the passenger cars, signal system and automated doors, it is ±10%, in light of the advancement of the preliminary design studies.

Capital costs for the LRT project break down as follows:

TOTAL CAPITAL COSTS IN 2003 $ *(± 20% accuracy)*

DESCRIPTION	PRELIMINARY PROJECT RETAINED *(in millions of dollars)*
Infrastructure and engineering works	261.1
Stations	98.8
Other buildings	36.5
Rolling stock	225.0
Track	66.3
Traction power supply	37.3
Telecommunications	16.7
Signal system and automated doors	97.2
Sale and control of tickets	2.1
Other (integration, manuals, tests and trials)	19.4
Land and running rights (purchase)	9.5
TOTAL	**869.9**



Panama Station

Our working assumption was that project implementation would begin in 2008 with the preparation of final plans and specifications. Project construction, which would take four years, would therefore end in late 2011 and commissioning would take place in 2012.

Thus, the cost of implementing the project would be $1,001.5 million (in current dollars). The design assumptions are summarized in the table below.

PROJECT IMPLEMENTATION COST

(in millions of current $)	**2008**	**2009**	**2010**	**2011**	**Total**
Construction costs[1]	$141.8	$360.9	$267.1	$100.1	**$869.9**
Inflation (2%)[2]	$14.8	$45.5	$39.7	$17.2	**$117.2**
Financing costs					
Interest on short-term financing (5.5%)	$0.7	$1.9	$1.4	$0.5	**$4.5**
Long-term note issuing expenses	$1.6	$4.0	$3.1	$1.2	**$9.9**
Total	**$158.9**	**$412.3**	**$311.3**	**$199.0**	**$1001.5**

[1] Excluding taxes

[2] Rate forecast by the Conference Board of Canada for the period

The preliminary schedule for construction of the project is estimated at 52 months. During this period, the bus lane on Champlain Bridge could continue to be operational, with mitigation measures while the LRT tracks were being installed in the middle of Highway 10.

As for the average annual operating costs for the LRT, they are estimated at $41.38 million (in 2003 dollars) over a 40-year operating period. These costs are subdivided into four major categories:

- $17.76 million for operations;
- $13.33 million for preventive and corrective maintenance;
- $4.00 million for insurance;
- $6.29 million for major capital asset rehabilitation and replacement.

Revenue for the LRT system's first full year of operation is estimated at $21 million.

> ECONOMIC ANALYSIS

Cost-benefit analysis

The project's cost-benefit ratio is 1.11. Such a result shows that, on the basis of elements that were able to be recorded, the project is profitable for the community. It should also be mentioned that some benefits could not be quantified, in particular the improvement in user comfort, increased productivity, impact on the soundscape, and impact on economic development.

Analysis of economic spinoffs

The capital expenditures for the LRT project would make it possible to create and maintain a number of jobs equivalent to 9,027 person-years and generate $571.9 million of added value in salaries, wages and gross revenues for the Québec economy. The tax and quasi-tax revenue would amount to $99.4 million for the Québec government and $42.8 million for the federal government.

The project's operating costs would result in the creation or maintenance of jobs equivalent to 724 person-years with an added value of $86.3 million in salaries, wages and gross revenues. The tax and quasi-tax revenue would amount to $13.7 million for the Québec government and $6.2 million for the federal government.

> THE NEXT STEPS

The preliminary design studies carried out by the AMT have been submitted to the federal and Québec governments for analysis and decision-making. In the event that a decision is made to carry out the project, several steps will have to be taken before construction of the LRT begins.

Financing

The LRT project for the Montréal metropolitan area will demand significant human and financial resources if it is to be created and operated. It will therefore be important to identify how it will be financed and which parties may become involved in the project.

Obtaining environmental and other authorizations

The project will have to obtain a certificate of authorization under Québec's environmental assessment process and will in all likelihood be subject to a review by the Bureau d'audiences publiques sur l'environnement (BAPE). The project will also have to respect the requirements of the federal environmental assessment process governed by the Canadian Environmental Assessment Act.

Completion of the project will also require a new act by the Parliament of Canada authorizing the construction of a new bridge over the St. Lawrence seaway. In addition, amendments to zoning by-laws will have to be obtained wherever the route retained crosses zones where it is forbidden to construct public transit infrastructure.

Preparation of performance specifications with a view to international calls for tenders

When the environmental and other authorizations required have been obtained, the final preliminary design study will be done in order to complete the preliminary plans, set out the project costs and develop the performance specifications allowing international calls for tenders to be issued for the construction of the LRT and potentially for its operation.

Québec

Canada

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