



A Demonstration with a Vancouver Olympic Streetcar Demonstration Project Gold Medal Performance

2011 Canadian Consulting Engineering Awards
Vancouver Olympic Streetcar Demonstration Project

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Two Page Description

2011 Canadian Consulting Engineering
Awards



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NEW APPLICATION OF EXISTING TECHNIQUES/ORIGINALITY/INNOVATION

In 2007, the City of Vancouver engaged Hatch Mott MacDonald (HMM) to provide preliminary engineering services in support of a long-term plan to re-introduce streetcars to downtown Vancouver. The preliminary design scoped out various route and construction options, and definitively established the rail right-of-way next to the Olympic Village.

While the preliminary engineering was underway, the City of Vancouver saw an opportunity to demonstrate modern streetcars during the 2010 Olympic and Paralympic Winter Games. The project's objective thereby changed to include the detailed design, procurement, and construction management of upgrades to the 1.8 km rail corridor between Granville Island and the Canada Line's Olympic Village Station. This section of track was re-named the 'Olympic Line', and was previously used by the Downtown Historic Railway, which ran restored heritage streetcars in summer.

This project involved HMM successfully negotiating with the BC Safety Authority to allow the streetcars to cross Moberly Road using only traffic lights without gates or other train signals. This is a first for Vancouver and an important precedent for transit in BC.

The design represented an advanced approach in that it merged a variety of modern elements with an old system. Re-using the existing infrastructure was more than just a goal; it was a necessity, as there wasn't the time or funding to do more.

We selected some uncommon materials and equipment for the project. The Flexity streetcars are of European design, and the flange-bearing frogs we specified represent a modern design for rail turnouts that is not yet common in North America.

The Canadian Urban Transit Association (CUTA) presented Bombardier Transportation with a 2010 National Transit Corporate Recognition Award - The Exceptional Performance / Outstanding Achievement Award for The Olympic Line - Vancouver's 2010 Streetcar. This award recognizes exceptional performance and outstanding achievement in the areas of technological advancement, new product or service development, and productivity and cost-effectiveness, among others. The project also won the UK's Light Rail Transit Awards' 2010 Worldwide Supplier of the Year Award.

COMPLEXITY

While no individual part was complex on its own, the project as a whole dealt with the unusual demands of anticipating and implementing the requirements of a modern system while maintaining old equipment and racing to be ready for the Winter Games on a limited budget.

Site issues included identified obstructions near the Olympic Village Station, which we were able to bypass by revising the design. We also avoided sewer connections by introducing natural drainage features.

Threats to the schedule included the long lead-time delivery of special trackwork for the passing track turnouts, heavy snow in the winter of 2008 that shut down construction for several weeks, recurring vandalism of the overhead contact wire, feeder cable and track bonding cables, and negotiating approvals from the BC Safety Authority. We addressed these challenges through concerted effort and foresight, which included ordering track materials before hiring a rail contractor to ensure that they were available when needed, quickly redesigning the electrical elements for security, and increasing security presence during construction.

Critical to the demonstration line was the ability to obtain access to at least one and ideally two modern streetcars for the duration of the games, along with operational assistance. Through the City's and

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HMM's contacts in the light rail industry it was possible for the City to develop a strategy for delivering the vehicles and operations support.

ENVIRONMENTAL IMPACT

The project promotes sustainability and supports the City of Vancouver's vision for a green city. The re-use of materials and infrastructure, the natural drainage system, and the use of electric power all promote sustainable transportation. The Olympic Line won a Sustainability Star from the Vancouver Organizing Committee for the Olympic Games, which celebrated leading examples of innovation in sustainability during the Winter Games.

SOCIAL AND ECONOMIC BENEFITS

The demonstration was a huge success. The two Bombardier Flexity streetcars operated 18 hours per day and 7 days a week over the 60-day demonstration period. The streetcars travelled 24,760 km and transported over 550,000 passengers. This demonstration allowed Vancouverites, our funding partners – and the world – to experience modern streetcars within the community and has helped to validate Vancouver's acceptance of streetcars as a viable means of transit.

As a result of the demonstration, we have prepared a rail corridor for modern streetcar use in a high-density part of Vancouver. The Downtown Historic Railway streetcars now have a new track, power supply and stations, and they represent a transit option between the Canada Line and Granville Island during summer weekends.

Perhaps most importantly, the use of traffic lights for road crossings sets an important precedent for future streetcar use in downtown Vancouver.

As a result of the preliminary design phase a significant amount of the infrastructure works that would have been required for the streetcar have been accommodated at minimal cost to the project. As the City of Vancouver were also a major partner to the South East False Creek development project the approach and results demonstrate that the City have planned for the future and have been spending valuable tax payers money in a cost effective manner.

MEETING AND EXCEEDING CLIENT'S NEEDS

The HMM team focused on ensuring that infrastructure constructed in advance of the streetcar project was completed to fit with the streetcar minimizing future effort, community impacts, and cost.

The concept for the demonstration line and the goals were well intentioned, but could only be delivered if a viable case was made to spend extra public funds at a time when the City was already committing significant sums to the Olympic effort and in which public scrutiny was high. HMM considered various options to determine what provided a best value solution for the demonstration line. While the full streetcar proposals previously approved by Council would require the existing single line track to be converted to double track, such a provision was not required for the demonstration line. This could be fulfilled by two vehicles shuttling between the termini at Granville Island and the new Canada Line station on single line track with a passing track at midway between stations. As such, the extent of new track and other infrastructure works could be optimized. Developing the approach further our designers looked to maximize the infrastructure gain and reduce future effort in implementing the full streetcar.

We completed the project on a very tight schedule of 21 months and a budget of \$8.5 million.

Full Description

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INTRODUCTION

Surrounded by water on three sides and nestled alongside the Coast Mountain Range, Vancouver, the largest city in BC, is home to spectacular natural scenery and a bustling metropolitan core. The Greater Vancouver region has a population of more than two million people in 21 municipalities, making it the third largest metropolitan area in Canada and was the home of the 2010 Olympic and Paralympic Winter Games.

Like many North American cities, Vancouver relied on rail in the early part of the last century for its transportation needs. Trams and streetcars were widely used from 1890 to 1958 before being replaced by cars and buses. In 1998 however, two of these streetcars returned to Vancouver on a 3.6 km dedicated track along the south shore of False Creek known as the Downtown Historic Railway. The track was a former freight line that the City of Vancouver had acquired for this purpose. The Downtown Historic Railway was operated by volunteers on Sunday afternoons in the tourist season and enjoyed strong public support.

At this time the City of Vancouver were also considering options for the re-introduction of modern streetcars to the city. In 1999, City Council approved routes and phasing for a downtown streetcar system.

In 2002, City Council approved both the Downtown Transportation Plan and the Vancouver Transit Strategy recommending implementation of a downtown streetcar network with possible extensions to the False Creek Flats, Vanier Park, and along the Arbutus Corridor.



A Downtown Historic Railway streetcar operating along 1st Avenue prior to the redevelopment for the 2010 Olympics



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Downtown Streetcar Network

By 2004, City Council had commissioned further studies on route alignments, ridership, market research, capitals and operational costs, in order to develop a business case.

However, in late 2007 the Downtown Historic Railway service had to be discontinued as a result of the redevelopment of the former industrial and commercial lands of South East False Creek. Some of the new developments were to serve as the Vancouver Athlete's Village for the 2010 Olympic and Paralympic Winter Games. There was a commitment to re-establish the Downtown Historic Railway, but also a need to better understand how the Downtown Historic Railway could be preserved and the aspiration of a modern Downtown Streetcar progressed.



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In 2007, Hatch Mott MacDonald was appointed by the City of Vancouver to provide preliminary engineering services which would ultimately determine how the Downtown Historic Railway and the Streetcar Demonstration project would progress.

The preliminary design scoped various route and construction options, and definitively established the rail right-of-way next to the Olympic Village, which was then under development adjacent to the 1st Avenue tracks.

Our preliminary design accommodated modern streetcars while preserving the existing infrastructure wherever possible. For example, we confirmed that the new street-lighting poles adjacent to the tracks had the structural capacity to hold span wires for the streetcar's overhead contact system, minimizing the need for new, dedicated poles. Our design also anticipated the future needs of a permanent streetcar fleet in order to minimize future effort, community impacts, and re-work costs. Provisions for the future included expanding a major communications duct bank under the north sidewalk of 1st Avenue to accommodate CCTV, electronic ticketing, signals, and communications equipment; installing traction power conduits at new road crossings; and selecting appropriate sub-grade materials that could withstand modern streetcar loads.



Proposed Vancouver Downtown Streetcar Demonstration Line



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While the preliminary engineering was underway, the City of Vancouver saw an opportunity to demonstrate modern streetcars during the 2010 Olympic and Paralympic Winter Games. The project's objective thereby changed to include the detailed design, procurement, and construction management of upgrades to the 1.8 km rail corridor between Granville Island and the Canada Line's Olympic Village Station. This section of track was re-named the 'Olympic Line', which was previously used by the Downtown Historic Railway. The upgraded line would need to re-accommodate the heritage streetcars after the demonstration was over.

To meet the client's objectives, it was necessary to remove the existing track; upgrade the rail bed, power supply and utilities; install new track; build a passing track; and build two new stations.



The rail corridor to Granville Island was dilapidated and unsuitable for modern streetcar use at the start of the project

We were supported by sub-consultants Thurber Engineering Inc., who provided ground investigations and substation slab design, PBA Engineering Inc., who designed the platform and signal lighting, and VIA Architecture who contributed to the design of the station platforms.

The City of Vancouver partnered with Bombardier to borrow two Flexity streetcars from Belgium's Brussels Transport Company for use during the demonstration.

Our design had to work with heritage and modern streetcars and preserve as much of the existing infrastructure as possible. We upgraded the traction power system by installing two 500-V substations as needed by the modern streetcars, and designed the



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stagger in the overhead power cable to work with both the pantograph of modern streetcars and the single trolley pole of heritage streetcars. We designed the station platforms to have removable wooden bumpers to accommodate the difference in width between the modern and wider historic streetcars.

This project provides a link with the past and a glimpse of the future. It provides a new track for the Downtown Historic Railway and their heritage streetcars, while being ready for modern streetcar service. The demonstration itself served the community by carrying 550,000 passengers between the Olympic Village Station and Granville Island during the Winter Games.



Downtown Streetcar at Granville Island stop during the 2010 Winter Olympic Games



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NEW APPLICATION OF EXISTING TECHNIQUES / ORIGINALITY / INNOVATION

The timely and economical completion of the project from detailed design to commissioning represents an outstanding engineering achievement. Despite these limitations, we managed to maintain much of the original infrastructure and introduce modern features, such as flange-bearing frogs that produce a smooth ride when transitioning over a turnout, a flexible overhead power cable design, and two aesthetically pleasing shelters to grace the streetcar stations.



Modern, flange-bearing frogs smooth turnout transitions



The demonstration line's two station platforms include aesthetically pleasing shelters that complement the modern European styling of Bombardier's Flexity streetcar



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Another significant engineering achievement involved negotiating with the BC Safety Authority to allow the streetcars to cross Moberly Road using only traffic lights without gates or other train signals. This is a first for Vancouver and an important precedent for transit in BC. We have experience through many projects in North America and Europe. Our knowledge of European streetcars and their operating standards was essential in negotiating with the BC Safety Authority that regular traffic lights are a safe means for streetcars to cross roads.



Vancouver's first road crossing by a light rail vehicle that relies on traffic lights without gates or other railway signals

The design represented an advanced approach in that it merged a variety of modern elements with an old system. Re-using the existing infrastructure was more than just a goal; it was a necessity, as there wasn't the time or funding to do more. Technical excellence is evident in the details of the project, which diligently addressed all of the project constraints in creative, cost-effective, and environmentally friendly ways.



The overhead contact system re-used existing poles along the rail corridor wherever possible, and was designed to work with both the single trolley poles of heritage streetcars and the modern pantographs of modern streetcars



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The Flexity streetcars arrive in Vancouver

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COMPLEXITY

The project was of medium complexity. While no individual part was complex on its own, the project as a whole dealt with the unusual demands of anticipating and implementing the requirements of a modern system while maintaining old equipment and racing to be ready for the Winter Games on a limited budget. Balancing these varied requirements introduced complexity and raised technical challenges.

The project had to overcome a variety of site and scheduling problems. Site issues included identified obstructions near the Olympic Village Station, which we were able to bypass by revising the design. We also avoided sewer connections by introducing natural drainage features. This is also a sustainability issue as the system is designed to be self contained and does not impact loads on the existing city drainage or sewer system.



Environmentally friendly drainage measures

Threats to the schedule included the long lead-time delivery of special trackwork for the passing track turnouts, heavy snow in the winter of 2008 that shut down construction for several weeks, recurring vandalism of the overhead contact wire, feeder cable and track bonding cables, and negotiating approvals from the BC Safety Authority. We addressed these challenges through concerted effort and foresight, which included ordering track materials before hiring a rail contractor to ensure that they were available when needed, quickly redesigning the electrical elements for security, and increasing security presence during construction.

Strong project management was essential to the success of the project. We had to reach consensus on the scope of work and



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project boundaries with the City of Vancouver, the Downtown Historic Railway, Bombardier Transportation, and the Canada Mortgage and Housing Corporation. We had to manage the construction contractors, and ensure that the system was fully commissioned and operating safely in time for the Winter Games.

Critical to the demonstration line would be the ability to obtain access to at least one and ideally two modern streetcars for the duration of the games, along with operational assistance. Initially a full range of options were considered, including the purchase of a small number of vehicles, possibly by being included as an option on other vehicle procurement orders. However, considering the likely cost and the long term complexity of ongoing maintenance and operation of such a small fleet this option was quickly discounted. A potentially greater obstacle was the right to permanently operate a streetcar as part of a passenger service. In the Greater Vancouver area public transport is regulated by a transport authority, TransLink, and the City of Vancouver would not be authorized to fully promote and operate the streetcar permanently, nor were TransLink in a position to directly promote the scheme as it was not formally part of their current transport plans. Therefore, it was decided to promote the demonstration line with the supply of temporary streetcars that would most likely be returned upon completion of the demonstration period. Through the City's and Hatch Mott MacDonald's contacts in the light rail industry initial inquiries were made in 2007 to vehicle suppliers and other operating systems to determine if there would be support to form a partnership to bring modern streetcars to Vancouver for the games, and provide operations support if required. While the number of possible partners was small, support was strong and it was possible for the City to develop a strategy for delivering the vehicles and operations support with such a partnership.



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Flexity streetcar at the Olympic Village Station

Construction Complexities

The track construction started in November, 2008 and was due to be completed October, 2009. The biggest impact on the track construction was one of the worst winters in the lower mainland for 50 years. Due to heavy snow falls and unusually low temperatures the construction had to be shut down for a number of weeks.



Heavy snowfalls and unusually low temperatures created construction delays

Due to the delays from the track construction the start of the power systems work on site was delayed. While the existing poles and contact wire were being utilized where possible, there were a number of locations where the alignment had been improved which resulted in the track being further from the existing pole locations. These poles required to be relocated or in some instances the contact wire support arms extended. The introduction of the passing track also required new contact wire and poles.

While the heritage vehicles could operate with the existing substation, upgraded power was required on the line to



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accommodate the modern vehicles. The existing substation was decommissioned and reinstalled in the existing car barn (storage facility). Two new 500-V substations were procured for the new system.



Installing one of two new 500-V substations

The greatest impact on the entire construction phase came during the power systems work. There was continued vandalism of the overhead contact wire, feeder cable and track bonding cables. This required a redesign of the feeder cable location and protection of the track bonding. The City also responded by providing 24-hour security on the line and obtaining increased patrols by the Vancouver Police Department.

Due to the delays caused by the vandalism on the line and the redesigns required there was a major push by all involved to ensure that the works were completed in time for the modern vehicles arrival and to allow sufficient time for testing and commissioning of the vehicles and the line. Construction was completed on time for the testing and commissioning of the vehicles in late 2009.



Laying trackwork



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ENVIRONMENTAL IMPACT

Rail is one of the world's most sustainable modes of transportation. It enables lower energy consumption, decreased land usage, less congestion, fewer accidents and greater accessibility than other modes of transport.

“For every passenger-mile travelled, public transportation produces 95 per cent less carbon monoxide, more than 92 per cent fewer volatile organic compounds and nearly half as much carbon dioxide and nitrogen oxides as private vehicles.”

*Source: Conserving Energy and Preserving the Environment: The Role of Public Transportation
American Public Transportation Association (APTA)*

The project promotes sustainability and supports the City of Vancouver's vision for a green city. The re-use of materials and infrastructure, the natural drainage system, and the use of electric power all promote sustainable transportation. The Olympic Line won a Sustainability Star from the Vancouver Organizing Committee for the Olympic Games (VANOC), which celebrated leading examples of innovation in sustainability during the Winter Games.

The project illustrates engineers' expanding role in society as it combines expert technical knowledge with a broad understanding of the interplay of all project elements. Our engineers took into account the needs of the client, while maintaining the perspective of users and complying with regulatory requirements. In the end, we produced an innovative combination of refurbished infrastructure with new construction that is ready for future expansion.



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SOCIAL AND ECONOMIC BENEFITS

The demonstration was a huge success. The two Bombardier Flexity streetcars operated 18 hours per day and 7 days a week over the 60 day demonstration period. The streetcars travelled 24,760 km and transported over 550,000 passengers. This demonstration allowed Vancouverites, our funding partners – and the world – to experience modern streetcars within the community and has helped to validate Vancouver’s acceptance of streetcars as a viable means of transit.



Passengers ride between Granville Island and the Olympic Village Station during the 2010 Olympic and Paralympic Winter Games

As a result of the demonstration, we have prepared a rail corridor for modern streetcar use in a high-density part of Vancouver. The Downtown Historic Railway streetcars now have a new track, power supply and stations, and they represent a transit option between the Canada Line and Granville Island during summer weekends.

Perhaps most importantly, the use of traffic lights for road crossings sets an important precedent for future streetcar use in downtown Vancouver.

As a result of the preliminary design phase a significant amount of the infrastructure works that would have been required for the streetcar have been accommodated at minimal cost to the project. As the City of Vancouver were also a major partner to the South East False Creek development project the approach and results demonstrate that the City have planned for the future and have been spending valuable tax payers money in a cost effective manner.



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MEETING AND EXCEEDING CLIENT'S NEEDS

The Hatch Mott MacDonald team focused on ensuring that infrastructure constructed in advance of the streetcar project was completed to fit with the streetcar minimizing future effort, community impacts, and cost.



New concrete ties provide better tolerances, reduce vibration and last longer than wood ties

The concept for the demonstration line and the goals were well intentioned, but could only be delivered if a viable case was made to spend extra public funds at a time when the City was already committing significant sums to the Olympic effort and in which public scrutiny was high. Hatch Mott MacDonald considered various options to determine what provided a best value solution for the demonstration line. While the full streetcar proposals previously approved by Council would require the existing single line track to be converted to double track, such a provision was not required for the demonstration line. This could be fulfilled by two vehicles shuttling between the termini at Granville Island and the new Canada Line station on single line track with a passing track at midway between stations. As such, the extent of new track and other infrastructure works could be optimized. Developing the approach further our designers looked to maximize the infrastructure gain and reduce future effort in implementing the full streetcar.

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