CITY OF VANCOUVER

CITY CLERK'S DEPARTMENT
Access to Information & Privacy

File No.: 04-1000-20-2019-401

January 14, 2020

s.22(1)

Dear s.22(1)

RE: Request for Access to Records under the Freedom of Information and Protection of Privacy Act (the "Act")

I am responding to your request of June 28, 2019 under the ***Freedom of Information and Protection of Privacy Act*** for:

> **Request for Proposal Number PS2017149, Streetcar Feasibility Study on page B-12 stated that the Draft Report is to be presented in October of 2018 and the Final Report to be presented November 2018. Request is for the copy of each Report.**

Upon further consideration of your request, the City has decided to disclose responsive records to you.

Please note, the reports dated November 15, 2019 is considered the final.

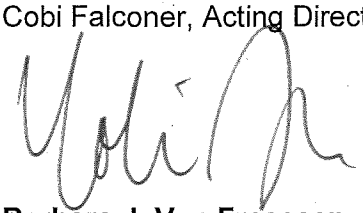
The OIPC Investigator has been cc'd on this file for their information.

Under section 52 of the Act, and within 30 business days of receipt of this letter, you may ask the Information & Privacy Commissioner to review any matter related to the City's response to your FOI request by writing to: Office of the Information & Privacy Commissioner, info@oipc.bc.ca or by phoning 250-387-5629.

If you request a review, please provide the Commissioner's office with: 1) the request number (#04-1000-20-2019-401); 2) a copy of this letter; 3) a copy of your original request; and 4) detailed reasons why you are seeking the review.

Yours truly,

Cobi Falconer, Acting Director, for



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By Email: tmots@oipc.bc.ca

*If you have any questions, please email us at foi@vancouver.ca and we will respond to you as soon as possible. Or you can call the FOI Case Manager at 604.871.6584.

:records placed on ftp site

:cf

City of Vancouver Streetcar Feasibility Study

Feasibility Study Report

November 15, 2019

City of Vancouver

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City of Vancouver Streetcar Feasibility Study

Feasibility Study Report

November 15, 2019

City of Vancouver

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Executive Summary

The City of Vancouver Streetcar Feasibility Study builds on the wealth of previous work completed to imagine a comprehensive future streetcar network for Vancouver. It incorporates the latest technology trends, planning visions for different areas, and City policies. Modern streetcar systems in North America are best described within the class of modern low floor, urban style Light Rail transit (LRT). The vehicles are sleek and modular, typically with higher capacity, possibly increased speed, a smoother ride, and improved accessibility compared to older style streetcar systems. They are sometimes laid out with fewer stops and more definitive physical segregation from other road users to provide a high level of service reliability. The planned Vancouver Streetcar Network is important as its delivery would provide a new, desirable, high capacity transit mode that would compliment the local bus and regional rapid transit network well.

This study looks to re-establish a consistent level, relative to 2018, of design and planning considerations for the downtown streetcar network based on the latest land use and planning information, transportation network and City policies. These are provided in the *Design Considerations Report* (388583-MMD-00-P0-RP-TR-0001) which is a complementary document and can be utilized to understand the wide range of considerations that need to be made in the implementation of a streetcar system. The study will assist the City of Vancouver ("the City") to plan and futureproof its streets and development to facilitate the introduction of streetcar in the future. Implementation of the streetcar network will be another component of the City's multimodal transportation network to help move people efficiently and comfortably around the growing city and helping meet the City's *Transportation 2040* goal of having two-thirds of all trips made by non-auto modes.

Overall, this study: provides an update to previous work completed to optimize alignment options for the Council-approved streetcar network, updates ridership forecasts and appraises cost estimates based on the latest information available, with recognition for the evolving city and region, and provides a consistent list of design considerations and parameters.

Figure 1 Council-Approved Downtown Streetcar Network

Alignment Options

Building upon previous work and beginning with examining the Council-approved routing shown in Figure 1, several alignment and station location options were optimized and developed for each area of the downtown streetcar network. The options include some variations in the Arbutus Greenway to Granville Island connection, and in the Gastown area.

Overall, the streetcar network has been organized into eight segments and includes options as follows:

Table 1-1 Network Segments and Alignment Options

Network Segment	Subsegment	Options
Arbutus Greenway and Connection	Arbutus Greenway	As proposed for the Arbutus Greenway Project
	Arbutus Connection	• Option 1: Fir Street to West 2nd Avenue avoiding impact to the building on 1500 West 2nd Avenue • Option 2: Fir Street to West 3rd Avenue • Option 3: Fir Street to West 2nd Avenue impacting the building at 1500 West 2nd Avenue
False Creek South	Lameys Mill Road & Charleson Road	
	Canada Line Connection	• Option 1: Following Existing Rail ROW • Option 2: Cambie Street stop located closer to Canada Line Olympic Village Station
Southeast False Creek	West 1st Avenue from Wylie Street to Columbia Street	• Option 1: Original Southeast False Creek alignment • Option 2: Future Complete Street concept
	West 1st Avenue from Columbia Street to Quebec Street	• Option 1: Original Southeast False Creek alignment • Option 2: Future Complete Street concept
False Creek Flats	East 1st Avenue / Industrial Avenue	• Option 1: East 1st Avenue connection to OMF site • Option 2: Industrial Avenue connection to OMF site • Option 3: BNSF ROW connection to OMF site
	Quebec Street / National Avenue Extension	
Gastown		• Option 1: Water Street and Cordova Street Couplet • Option 2: Two-way Streetcar on One-Way Eastbound Cordova Street • Option 3: Two-way Streetcar on Two-way Hastings Street
Waterfront and Coal Harbour		• Option 1: Single track on West Georgia Street • Option 2: Dual track on West Georgia Street
Northeast False Creek		As proposed for the Northeast False Creek Project
Yaletown		• Option 1: Optimize existing street elements • Option 2: Maintaining existing curbs and sidewalks

Overall, the alignment options are adaptable and each option could be paired with the options in adjacent areas. They have been developed to provide guidance and enable the City to futureproof streets and development within Vancouver so that a streetcar system could be implemented in the future. In November 2019, Council directed City staff to expedite the development of a city-wide plan to create a long-term, positive and proactive vision for the City. As this more comprehensive vision is developed for the City, the vision and objective of the streetcar network will need be confirmed, and alignment options can be further evaluated.

Operations and Maintenance Facility

As briefly discussed in the *Design Considerations Report* (388583-MMD-00-P0-RP-TR-0001), streetcar vehicles require an operations and maintenance facility (OMF). This OMF must be in close proximity to the streetcar network and tailored to the streetcar vehicle fleet, which will be different to the SkyTrain and Canada Line vehicle fleets. Space requirements for such a facility are determined by fleet size and required maintenance intervals. General considerations for facility planning include the size and type of vehicles, the requirements for staff facilities and whether an operations control centre is required. Previously, 800 Quebec Street was identified as the preferred OMF site. However, this site is now slated to be developed as part of the Northeast False Creek (NEFC) project. Thus, it is necessary to identify a new maintenance facility location based upon the latest sizing requirements, which are related to the latest fleet size estimate.

The latest fleet size estimation is based upon conservative streetcar routing and operations assumptions including frequency, and transit priority. The ultimate fleet size including the Arbutus Greenway is estimated at 22 vehicles. The site size is then dependent on OMF site variables and whether the facility is split up between two or more properties.

Four sites were carried forward to examine potential site layouts. They each have trade-offs such as the location, connections to other key destination (e.g. Broadway Subway Great Northern Way Station, or the new St. Paul's Hospital campus), property being city-owned with existing tenants (i.e. towing yard or works yard) or privately owned, storage capacity, site operational flow, impacts to other modes, and urban integration.

As the potential trade-offs for each site are also linked to the False Creek Flats Plan and the City's vision for the area, a site recommendation has not been determined. As further work is done progressing the streetcar network, the potential for site storage or a portion of the maintenance facility in another neighbourhood should be examined.

Ridership

Ridership forecasts have been completed for this feasibility study, and uses assumptions based on the latest alignment options. The ridership forecasts were developed for 2016 and 2050 using the Regional Transportation Model (RTM) Phase 3.2 and its BAU future road network and land use information.

The two potential streetcar service routes were analyzed:

- West Broadway to Chilco (Arbutus Street/Broadway to Chilco Street)
- Thornton St to Granville St (1st Ave/Thornton Street to Granville Street/Drake Street)

It has been assumed for this study that both services would operate with 8-minute peak headways at an average speed of 14 kph.

The annual boardings are estimated at between 12.8 to 18.8 million on the West Broadway-Chilco line and 3.6 to 5.2 million between Thornton Street-Granville Street line by 2050. The maximum peak hour volume by 2050 would be about 1,400 passengers during the PM peak on the section between Granville Island and Science World. This exceeds the planning capacity of the Olympic Demonstration vehicle (at an 8-minute headway) in certain sections of the route. However, the Olympic Demonstration Line vehicle is atypically narrow and higher capacities could also be achieved with different headways operated on West Broadway-Chilco and Thornton St-Granville St lines to optimise system performance if necessary.

The high streetcar boardings are the result of:

- Extensive connections to the regional transit network including:
  - Canada Line (Olympic Village, Yaletown and Waterfront stations)
  - Expo Line (Main St-Science World, Stadium-Chinatown and Waterfront stations)
  - SeaBus and WCE at Waterfront station
  - 99 B-Line (at Arbutus), 95 B-Line (at Hastings) and services to/from North Shore (at West Georgia)
- High expansion factors reflecting high weekend and summer demand on routes #19 and #50 as they serve key tourist destinations (Granville Island, Gastown, Waterfront and Stanley Park)
- Large proportion of relatively short trips on the streetcar reflecting use of streetcar as access mode to other transit services
- Alignments along consistently dense, urban corridors

Current work assumes that passengers will perceive streetcar as rail (SkyTrain) and reality is that it will fall somewhere between bus and SkyTrain. Further work should review the potential passenger perceptions to the streetcar as it is a new transport mode in the region and the passenger perception of streetcar will affect the overall travel cost (and attractiveness) of the streetcar. This will impact the large proportion of short trips forecasted and the overall demand levels. Further in-depth review of RTM calibration and performance in the study area would also be useful in further study stages.

Capital Cost Estimate

The capital cost estimates are based on the three alignment options laid out in this report. The estimates are conceptual and prepared in advance of preliminary or detailed design, but are all prepared on the same basis, to provide a direct comparison of costs. The major items include stops, tracks, electrification, vehicles and roadworks. The costs include percentages applied to account for engineering, management, bonding, insurance and contingency.

The capital cost of the network ranges from $1.062 billion to $ 1.070 billion in 2018 dollars. The following table summarizes the costs for the options including the whole network and OMF.

Table 1-2 Capital Costs Summary

		Option 1	Option 2	Option 3
Construction Estimate				
Stops		$25,368,000	$25,368,000	$26,046,000
Track and track-bed		$261,439,000	$257,042,000	$263,853,000
Systems		$65,754,000	$60,832,000	$61,847,000
Roadworks		$70,288,000	$71,283,000	$65,896,000
Utility Relocation Allowance		$91,734,992	$90,581,248	$92,716,192
Landscaping		$7,144,000	$7,836,000	$6,705,000
Vehicle Maintenance and Storage Facility		$34,464,000	$38,860,000	$39,887,000
Construction Estimate		**$556,191,992**	**$551,802,248**	**$556,950,192**
Testing and Commissioning		$3,000,000	$3,000,000	$3,000,000
Design and Engineering	7%	$39,143,439	$38,836,157	$39,196,513
Project Management	7.5%	$41,939,399	$41,610,169	$41,996,264
Construction Management	6.5%	$36,347,479	$36,062,146	$36,396,762
Environmental		$5,000,000	$5,000,000	$5,000,000
Operations preparation		$8,000,000	$8,000,000	$8,000,000
Bonding and Insurance	2%	$13,792,446	$13,686,214	$13,810,795
Subtotal with Mobilization and Program Costs		***$703,415,000***	***$697,997,000***	***$704,351,000***
Contingency	25%	$175,853,750	$174,499,250	$176,087,750
Property - Excluded from the Construction Estimate		*Separate Budget*	*Separate Budget*	*Separate Budget*
Subtotal with including Mobilization, Program Costs and Contingency		***$879,269,000***	***$872,497,000***	***$880,439,000***
18 Vehicles with fare card readers		$100,800,000	$100,800,000	$100,800,000
Vehicle Contingency	5%	$5,040,000	$5,040,000	$5,040,000
Vehicle Cost with Contingency		***$105,840,000***	***$105,840,000***	***$105,840,000***
Financing Interest During Construction - 4% Borrowing Interest		***$83,927,000***	***$83,350,000***	***$84,026,000***
Total Capital Cost		**$1,069,036,000**	**$1,061,687,000**	**$1,070,305,000**

Operations and Maintenance Costs

With implementation of the Vancouver Streetcar network including the two lines (Arbutus Street/Broadway to Chilco Street; and East 1st Avenue/Thornton Street to Granville Street/Drake Street), up to 15 streetcars would be operating during peak periods. The extent of service would be:

- 20 hours per weekday and on Saturdays
- 19 on Sundays and holidays

Assuming that service in the off-peak period would be minimum 15-minute headways (in alignment with the Frequent Transit Network), the total revenue vehicle hours for the system would be 60,150 per year. Applying the average cost from above and adding a 20% allowance for other O&M costs results in a total annual cost of approximately $11.84 million.

Phasing

A minimal initial phase could include The Granville Island Stop to The Cambie Street Stop. This is similar to the Olympic Streetcar Demonstration in 2010 that had great success in connecting Canada Line to Granville Island. It would require a minimum of three (3) vehicles. The ROW for this portion of the network is owned by the City of Vancouver and is fully segregated. This means that the construction of this initial phase could proceed with minimal impacts to the public. There is potential to add vehicle storage in the False Creek South area and near the Cambie Street Stop. This would have sufficient storage capacity for the vehicles required for this initial phase but does not facilitate sufficient space for a maintenance facility. However, with the limited fleet size and length network, 600 West 6th Avenue where the heritage streetcar shed is located may be sufficient to maintain the three vehicles on a temporary basis until the network was expanded further.

A more preferable first phase could be from the Arbutus at Broadway Stop to The Science World Stop. It would provide connection between the Broadway Subway Millennium Line extension, Canada Line and Expo Line. It also enables connection to the potential OMF sites that were explored in False Creek Flats. This portion of the network would require a minimum of eight (8) vehicles. This first phase would likely have more ridership than the minimal initial phase due to the additional SkyTrain connections.

Later phases would extend this system north and west, through Gastown, Waterfront and to Stanley Park (Stanley Park Extension), west from the Science World area through False Creek North into Yaletown (Pacific Boulevard Extension), and south along the Arbutus Greenway to Milton Street.

The infrastructure capital cost of Phase 1 from Arbutus at The Broadway Stop to Science World Stop could cost between approximately $487,500,000 and $501,200,000. As discussed, further investigation is required to accurately estimate the Phase 1 cost as well as each of the potential extensions.

Funding Mechanisms

There could be a combination of a range of funding mechanism options available to procure the streetcar network. Different procurement models and markets, such as Public Private Partnerships, are continually evolving and becoming better established. The advantages and potential issues of the five main procurement models were considered but more detailed analysis should be conducted during the business case stage.

Business Case

A business case focuses on appraisal and includes five cases (strategic, economic, financial, commercial and management) that are revisited iteratively during three stages (strategic, outline and full). The outcome of the business case, no matter the framework used, should be to identify a structured process to identify solutions, and plan for their implementation so that the City's objectives are met. At this time, it is recommended that the City proceed with developing a Strategic Business Case which will inform future business case development and funding applications.

Next steps

Throughout the Streetcar Feasibility Study, questions about how the currently planned streetcar network would operate and be prioritized have been raised. This has prompted consideration of possible updates to, and further exploration of, the current, Council-approved streetcar network. In order to continue to support the implementation of a future streetcar system, it would be beneficial to look at other routing options and phasing with this Streetcar Feasibility Study Report providing a 'base case' to which other routing options can be compared. As a first step, a planning-level streetcar network assessment should be carried out. Alternative streetcar routing options building on the current network should be considered, and the overall streetcar networking routing and operations of multiple lines examined.

Additionally, other technical work should continue to be carried out in tandem. Conceptual and functional design of specific segments of the network or at specific locations should be completed as needed to support neighbourhood and community plans. Other planning studies are continuously ongoing throughout the City and ensuring that they continue to futureproof for streetcar should be an ongoing exercise.

As a part of the business case development, the ridership forecasts would need to be further refined. As design and engineering progresses the ridership forecasts can be updated. The service frequency should be examined further and balanced to meet ridership demands along with operations requirements and costs. The updated forecasts should also include a review the potential passenger perception of streetcar as a mode. As a new type of transit in the region, passenger perception will affect the overall attractiveness in the demand model. Further in-depth review of RTM calibration and performance in the study area would also be useful in further study stages.

Overall, the Vancouver Streetcar Network can be developed as an integrated and integral part of the city and region. The next stages of the project should work to reconfirm the vision and objectives of the project on a city and regional level. It should factor in changes within the region, including the latest Mayor's Council decision regarding rapid transit South of the Fraser River, as well as the evolution that Vancouver is currently going through. There are several large transportation projects within the city, such as Arbutus Greenway, Granville Bridge Greenway, NEFC, consideration of car-light streets in Gastown, and cycling network expansion, that will have an influence on the streetcar network. In addition to the envisioned streetcar network playing a significant role in helping the City to meet its *Transportation 2040* goals, the implementation of streetcar will support the City's policies around climate change and Greenest City 2020, and the City-wide plan.

1 Introduction

Streetcar was a common fixture in Metro Vancouver and the City of Vancouver between 1897 and 1958, when the last interurban service was discontinued. The City of Vancouver began contemplating a reimagined streetcar in the mid-1990s. Since then, the City has continued to pursue a streetcar network throughout the city by purchasing segments of former rail right-of-way, studying options, costs, benefits and impacts, and including the streetcar network in City policies like *Transportation 2040*. Some of the key steps and studies to date are:

- False Creek Heritage Streetcar and Transit Centre Development Feasibility Report (1991)
- False Creek South Rail Line Study (1994)
- Purchase of the 1.5 km False Creek South rail corridor from Canadian Pacific Railway (CPR) in 1995
- Vancouver Downtown Streetcar Study (*Baker McGarva Hart with SNC-Lavalin and Ward Consulting,* 1998)
- Operation of the Downtown Historic Railway from 1998 to 2011
- Arbutus Corridor Official Development Plan (2000) identified rail transit for the future Greenway
- PPP Review of the Vancouver Streetcar Project (*Macquarie North America*, 2002)
- Southeast False Creek Transportation Study (*IBI Group with Ward Consulting and the Boulevard Group,* 2002)
- Downtown Streetcar Benchmarking Report (*Halcrow and TSi Consultants,* 2004)
- Tourist and Recreational Usage of Proposed Downtown Streetcar (*Mustel Group and TSi Consultants,* 2004)
- The Downtown Streetcar Design, Layout and Ridership Study (*IBI Group*, 2005)
- Streetcar and Local Bus Comparative Review (*IBI Group*, 2006)
- Downtown Streetcar Project Update Administrative Report to Standing Committee on Planning and Environment *(City of Vancouver, 2006)*
- Downtown Streetcar Project – Preliminary Design Report (*Hatch Mott MacDonald,* 2008)
- Central Waterfront Hub Framework (2009)
- Operation of Olympic Demonstration Line in 2010
- Transportation 2040 (2012)
- Purchase of the 9 km Arbutus Greenway corridor from CPR in 2016
- Northeast False Creek Project (NEFC) Streetcar Considerations (*Mott MacDonald,* 2016 and *WSP (MMM Group,* 2017)
- Arbutus Greenway Project (AGP) (*Mott Macdonald,* 2017 and 2018)

With the depth of work done to-date, layers of detail have been added and different portions of the network have progressed in further design detail than others. Additionally, the city has evolved drastically in the intervening period and is continuing to change to meet growing population and employment demand (and associated increased travel demand) and emerging environmental, economic and technology trends. This feasibility study looks to re-establish a consistent level, relative to 2018, of design and planning considerations for the Council-approved downtown streetcar network based on the latest land use and planning information, transportation network, and City policies. Details are provided in the

Design Consideration Report (388583-MMD-00-P0-RP-TR-0001), a complementary document that can be utilized to understand the wide range of considerations required for the implementation of a streetcar system.

The study also re-visited the alignment options and maintenance facility location within the identified corridors of the downtown streetcar network. Figure 1-1 shows the Council-approved routing for the downtown network and explicitly calls out the Olympic Demonstration Line portion of the network. The imagined Vancouver streetcar network has since evolved to include the Arbutus Greenway as shown in Figure 1-2.

Figure 1-1 Downtown Streetcar Network

Figure 1-2 Current Imagined Streetcar Routing

For this feasibility study, alignment options were explored for the streetcar network connecting from the Arbutus Greenway Project (AGP) at West Broadway, to Stanley Park and Yaletown. Additionally, several new sites were examined for the operations and maintenance facility (OMF), as the previously identified site is no longer available.

With the updated routing options and OMF location options, the ridership forecasts have been updated, capital costs and operations and maintenance costs have been appraised.

2 Alignment Options

This section describes the optimization of each of the alignment segments, and the alignment options within each area, that have been considered for the potential streetcar network. Seen in Figure 2-1, the segments connect the Arbutus Greenway Project (AGP) at West Broadway to Stanley Park, at West Georgia Street and Chilco Street, and to Yaletown at Drake Street and Granville Street. The potential network also includes potential extensions into the False Creek Flats Area.

Figure 2-1 Downtown Streetcar Network, including potential False Creek Flats Extensions

Appendix A summarizes the routing proposed in the 2005 *Downtown Streetcar Design, Layout & Ridership Study*, the 2008 *Preliminary Design Report* as well as work done for NEFC, AGP and in False Creek South. A review of this previously proposed routing was carried out prior to the development of the alignment options described below, and potential new alignment options were discussed with the City's team. The result of design development and exploration is outlined in the following section and the potential alignment drawings for each option are included in Appendix B. The alignment segments are discussed progressing

south to north along the streetcar network, from Arbutus Greenway at West Broadway to Stanley Park and then following the Pacific Boulevard extension. Although some discussion on potential phases has occurred and led to the inclusion of the Arbutus Connection, it has been assumed that phasing would be similar to that previously imagined, as seen in Figure 1-2.

2.1 Arbutus Connection

See drawing 388583-MMD-00-P0-DR-TR-1100 in Appendix B.

With the upcoming construction of the Broadway Subway Project extension of the Millennium Line SkyTrain, it was determined that it would be sensible to consider an extension of the Council-approved streetcar route, which began at Granville Island. When delivered, an early stage of the streetcar network could connect to the Broadway Subway Project at its terminus at Arbutus Street, prior to later extensions south along the Arbutus Greenway.

Between this potential interim streetcar terminus, at Arbutus Street and West Broadway, and Fir Street at West 6th Avenue, the streetcar alignment is planned to be segregated double track with a center loading stop at Burrard Street and West 6th Avenue. As per the AGP design, West 6th Avenue would be reduced to one eastbound vehicle lane with a parking lane along the south existing curb, which would remain in its current position. The westbound track would be green track with the eastbound (southern) track being embedded in order to provide sufficient space (minimum 6 m) from the edge of the parking lane for the outriggers of fire ladder trucks.

The proposed AGP design for the section from West 6th Avenue to West Broadway assumed that the two tracks would cross each other, forming a couplet with one in the greenway and the other on Arbutus Street, and the associated stops would be on each side of the planned station headhouse of the SkyTrain station. The interim terminus streetcar stop would include only a single platform. The two streetcar tracks that follow the curve of the existing AGP ROW, on the eastern edge of Delamont Park, would become a single track at West 8th Avenue and into the interim terminus stop. The single-track length would be kept to a minimum in order to minimize the amount of infrastructure that would need to be reconstructed when the streetcar route is extended south of Arbutus Street at West Broadway, requiring the second track to be constructed. With the single-track portion starting at West 8th Avenue, a switch could be placed roughly where the two future streetcar tracks are to cross over each other (a diamond crossing) in the full AGP streetcar build out. Thus, only the turnout and minimal track on either side would need to be replaced. This would also allow for the two streetcar tracks through the Delamont Park curve to be located in their ultimate locations.

At the end of the AGP section, where the streetcar would turn to the north, three options, discussed further below, were considered between West 6th Avenue at Fir Street to the potential Granville Island stop location. These options were completed taking into consideration previous City work to establish the potential additional right of way required to enable the Arbutus connection.

As the streetcar alignment options pass the West 4th Avenue off-ramp at Fir Street and the main bridge approach at Anderson Street, photographic reality capture techniques were used to approximate the position of the Granville Street Bridge column locations. The streetcar options considered the West 4th Avenue off-ramp to remain in place, but the City has discussed the potential to normalize the Granville Street Bridge ramps with the road grid. As the area of Anderson Street and between West 4th and West 2nd Avenue has several bridge column locations and is constrained, further investigations and surveys will need to be

undertaken. Existing road elevations would also need to be investigated to ensure grades are within streetcar design criteria. All options on Fir Street have considered the Granville Street Bridge columns and allowed for streetcar, bike lanes and sidewalks.

In addition to the technical streetcar design, the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, and could be considered going forward:

- Enhance the connection to Granville Island along the Old Bridge Walk, to the potential Granville Island Streetcar stop, bringing the materials and character of Granville Island to meet the Streetcar.
- Incorporate artistic, creative signage and wayfinding that is in keeping with the character of Granville Island.

2.1.1 Option 1: Fir Street to West 2nd Avenue avoiding impact to the building on 1500 West 2nd Avenue

See drawings 388583-MMD-00-P0-DR-TR-1101 and 388583-MMD-00-P0-DR-TR-3100 in Appendix B.

The potential streetcar alignment would include two in-street shared running tracks connecting from the AGP segregated tracks on West 6th Avenue running along Fir Street and turning onto West 2nd Avenue towards Granville Island. To the west of Anderson Street, the tracks would move to double segregated before passing underneath the Granville Street Bridge, joining the existing railway corridor where the Granville Island centre loading stop is to be located, in a similar location to the 2010 Olympic Demonstration Line Granville Island terminus stop. Additional ROW would be required to the east of Fir Street to enable space for a 3 m bi-directional protected bikeway on the east of Fir Street and a minimum 2.5 m sidewalk, a 2.5 m parking lane where applicable and a 2.5 m sidewalk to the west of Fir Street (see Figure 2-2 for reference). The streetcar alignment through West 2nd Avenue, east of Mariner Walk, as described here would not require any property take, but the cross section does not include a continuous bike lane throughout. Property take of the currently city-owned land to the north of West 2nd Avenue would enable space for shared streetcar tracks, parking, a bi-direction protected bike lane and sidewalks.

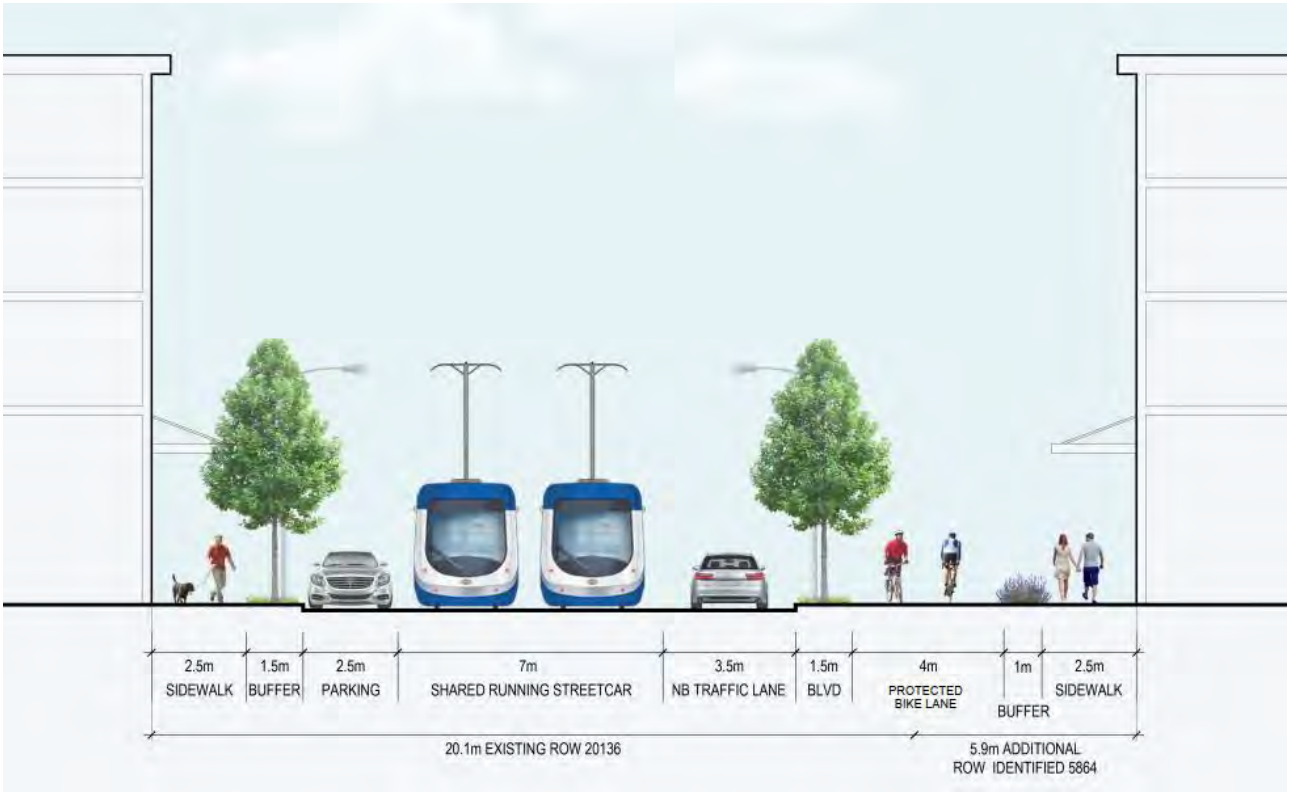


Figure 2-2 Fir Street – Option 1 (facing north)

2.1.2 Option 2: Fir Street to West 3rd Avenue

See drawing 388583-MMD-00-P0-DR-TR-1201 and 388583-MMD-00-P0-DR-TR-3100 in Appendix B.

The potential streetcar alignment includes two in-street shared running tracks connecting from the AGP segregated tracks on West 6th Avenue, running along Fir Street and turning onto West 3rd Avenue towards Granville Island. A new intersection will be introduced as the tracks move to being segregated while passing underneath the Granville Street Bridge. The streetcar would then join the existing railway corridor, again where the Granville Island centre loading stop is to be located. Additional ROW to the east of Fir Street would be required to enable space for a 2.5 m uni-directional protected bikeway and minimum 2.5 m sidewalk each side of Fir Street. Space has also been allocated for a 2.5 m parking lane to the west of Fir Street. Refer to Figure 2-3 below for typical cross section details.

It is proposed that protected bike lanes will continue on Fir Street towards West 2nd Avenue, Granville Island and the seawall. Current turn lanes from Fir Street east to West 3rd Avenue ensure that the streetcar can easily pass through without affecting any properties. No vertical clearance issues have been identified for passing under the Granville Street Bridge although this section brings both horizontal and vertical design challenges due to the existing grade of Anderson Road and the positioning of the Granville Street Bridge columns. A new intersection in this location would also require road re-configuration of West 3rd Avenue and Anderson Road. Further investigation will be required to provide greater confidence that the streetcar alignment can pass through this challenging area. Compared to Option 1, Granville Island centre loading stop would be placed slightly further east due to the turn required to reach West 3rd Avenue.

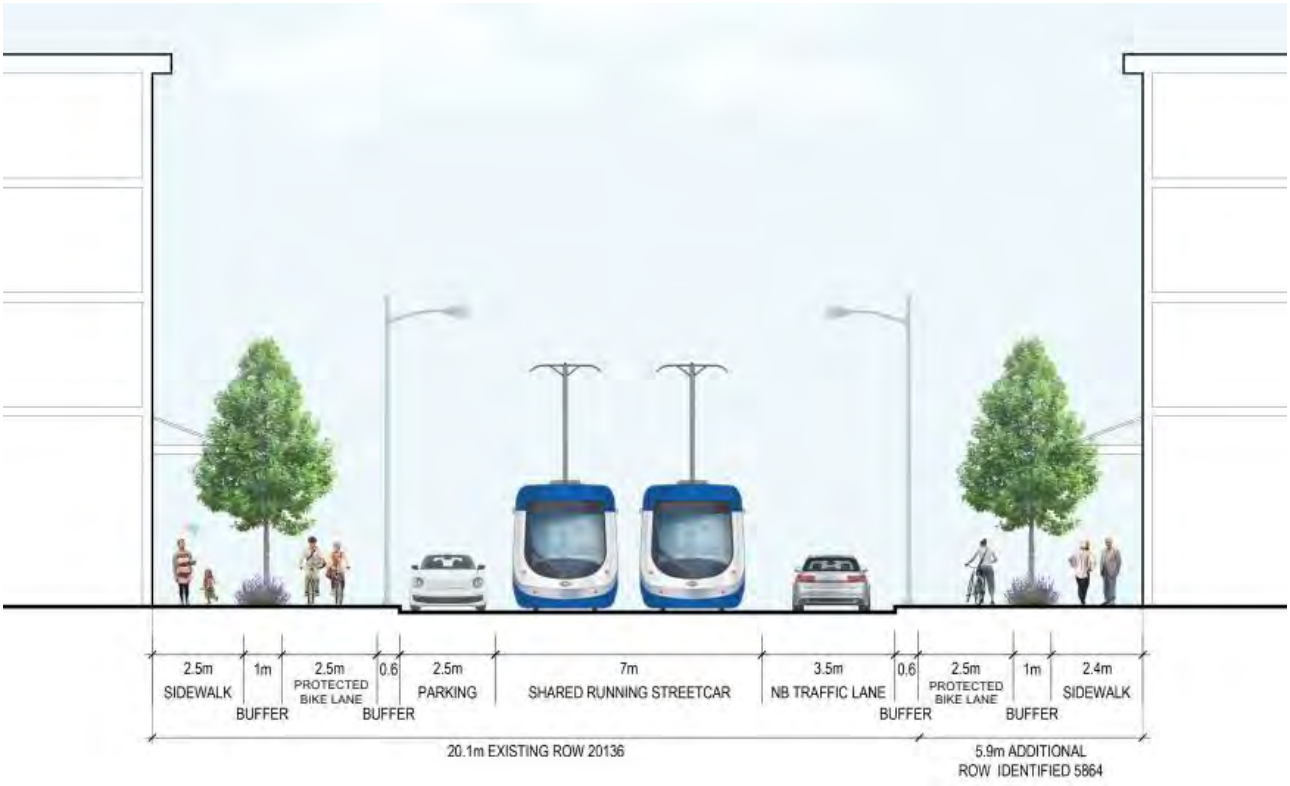


Figure 2-3 Fir Street – Option 2

2.1.3 Option 3: Fir Street to West 2nd Avenue impacting the building at 1500 West 2nd Avenue

See drawing 388583-MMD-00-P0-DR-TR-1301 and 388583-MMD-00-P0-DR-TR-3101 in Appendix B.

Similar to Option 1 this potential streetcar alignment includes two in-street shared running tracks connecting from the AGP segregated tracks on West 6th Avenue along Fir Street and turning onto West 2nd Avenue towards Granville Island. Tracks would move to be segregated to the west of Anderson Street before passing underneath the Granville Street Bridge. The streetcar would then join the existing railway corridor where the Granville Island centre loading stop is to be located. Additional ROW to the East of Fir Street would be required to enable space for the proposed cross section. A 3 m bi-directional protected bikeway on the west of Fir Street would ensure bike lanes do not have to cross the streetcar tracks throughout this section and allow easy access to Lameys Mill, Granville Island and the seawall. The property take would also allow for large sidewalks to the east. On the east of Fir Street, a 2.5 m parking lane can be provided between 2nd and 4th Avenue and a right turn lane provided between West 5th Avenue and West 4th Avenue to permit turning onto West 4th Avenue. Parking lanes to the east could be permitted between West 4th and West 3rd Avenue. Refer to Figure 2-4 below for typical cross section details.

The streetcar alignment through West 2nd Avenue as described requires property take to the south and north adjacent to Mariner Walk lane. This property take would allow for through bike lanes leading to Lameys Mill, sidewalks and segregated streetcar tracks. These properties have been identified as potential future ROW dedication. Property take of the currently city-owned land to the north of West 2nd Avenue would enable space for shared in-street streetcar tracks, parking, a bi-direction protected bike lane and sidewalks.

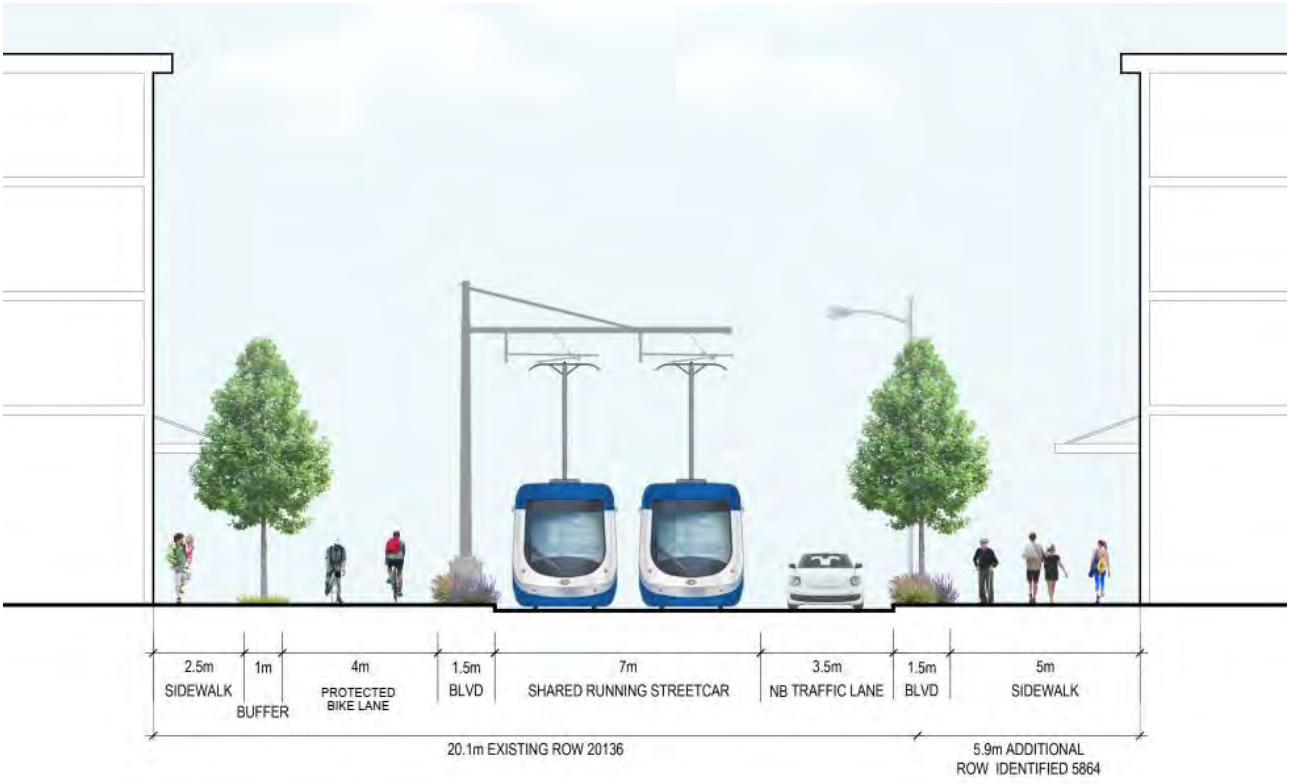


Figure 2-4 Fir Street – Option 3

2.2 False Creek South

False Creek South was reviewed in two portions. One referring to the re-development of Lameys Mill Road, the second reviewing options for connections to the Canada Line Olympic Village station. Planning work on False Creek South completed to date has influenced some of the considerations described below.

In addition to the technical streetcar design, the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, and maybe considered going forward:

- A potential new pedestrian overpass connecting West 4th Avenue, under the Granville Bridge, to Lameys Mill Road
- Plans to reimagine Lameys Mill Rd as a pedestrian-oriented, multi-modal road with widened sidewalks, and space for large street trees to maintain the green, park-like quality of this area. The difficult grade change between the existing rail corridor and Lameys Mill Road would be a challenge. There may be an opportunity to enhance the area with a mural on the retaining wall under Lameys Mill Road, visible to streetcar passengers.

- Passing by the location of lost streams (approximately at Hemlock Court, Fountain Way Court, Spruce Street, Heather Street, Olympic Village Station, and Wylie Street) provides an opportunity to connect with natural and cultural heritage and local First Nations history by potentially exposing the stream or acknowledging its previous existence using signage or public realm improvements.
- Enhancements to the Charleson Park interface with native plantings and improved pedestrian trail connections with consideration of incorporating active recreation amenities that complete the amenities in the park, such as a bike pump track or dog agility course
- A possible closure of Charleson since there are no residences adjacent, with buses rerouted onto West 6th Avenue
- An integrated multi-modal transit station at Olympic Village stop with clear pedestrian and cycling connections to Charleson Park and the seawall
- Connections to the Heather Street bikeway

2.2.1 Lameys Mill Road & Charleson Road

See drawing 388583-MMD-00-P0-DR-TR-1102 and 388583-MMD-00-P0-DR-TR-3102 in Appendix B.

Following on from the Granville Island stop the potential streetcar alignment would continue along the existing dedicated rail right of way with two segregated tracks. The streetcar tracks would have no effect on West 6th Avenue or Lameys Mill Road, including being grade separated from Alder Crossing. However, there are significant elevation gradients on either side of the existing ROW, effectively siting the streetcar in a trench, which creates a significant barrier to providing connections from False Creek South to West 6th Avenue. The existing ROW is approximately 15 m and proposed streetcar with centre Overhead Catenary System (OCS) requires a total width of 8 m and would require additional space for retaining structures, see Figure 2-5 for a typical cross section. A side loading stop could potentially be located to the east side of Spruce Street, in the same location as previously proposed in the 2005 study. Streetcar would continue along the existing ROW parallel to Charleson until Heather Street. Also similar to the 2005 study, there is an option to include a storage siding within this corridor for streetcar storage along the network (see Section 3.3 for more details).

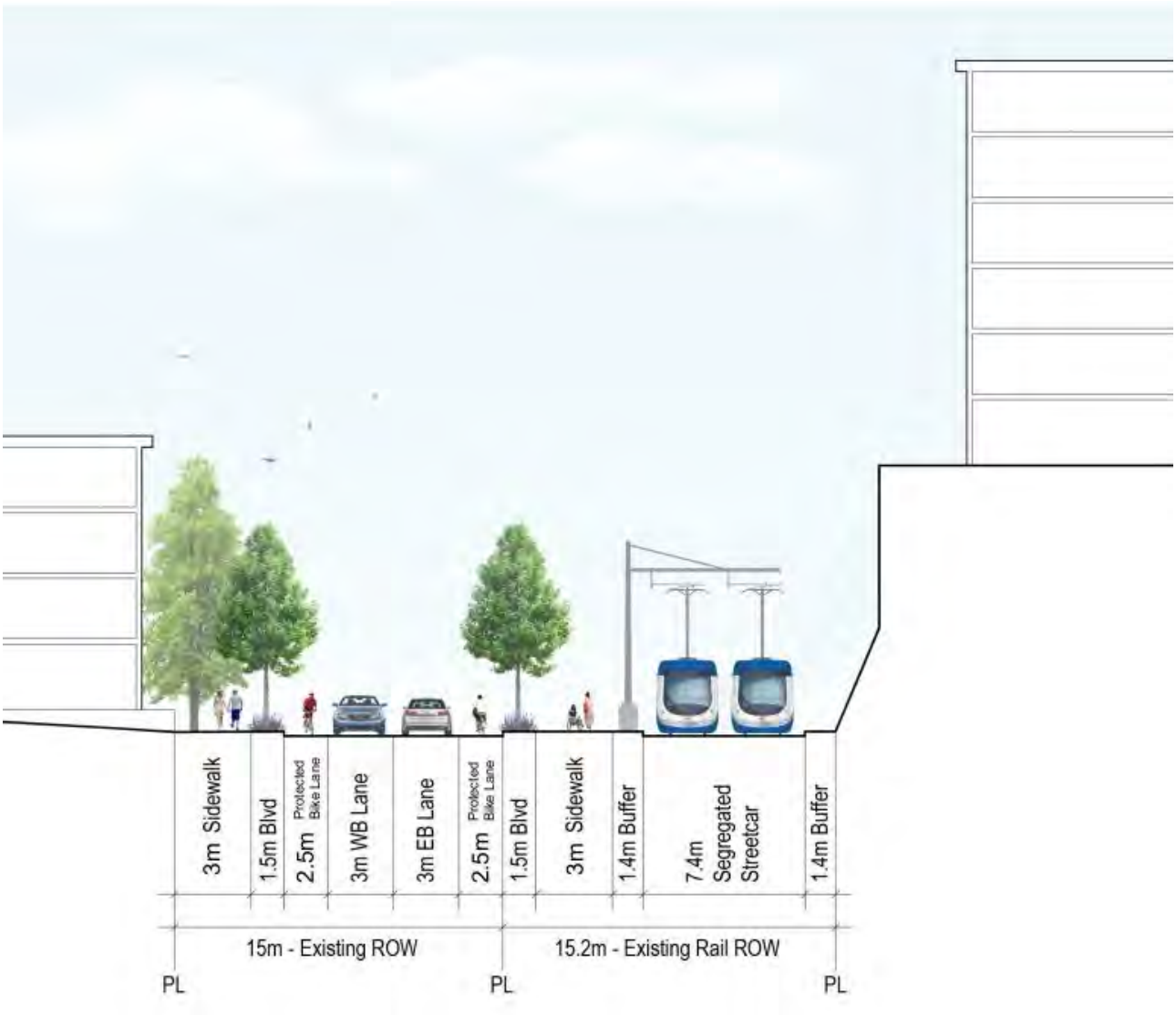


Figure 2-5 Lameys Mill Road at Fountain Avenue – Option 1 at Fountain Avenue

2.2.2 Canada Line Connection

Two alignment options were considered between Heather Street and West 1st Avenue where the streetcar would connect to the Canada Line at Olympic Village Station. These build on several alignment options being considered by the City who have looked at the potential future development parcels available and multi-modal connections that could be made. The other alignment option that was examined by the City, but is not captured in this report, is one that uses the existing rail ROW and a portion of Commodore Road ROW. This could be considered further in the future but would require the stop to be located further from the Canada Line Station and would need to consider the grade differential between the existing Rail ROW/Commodore Road and the existing parking lot. The existing rail ROW is also currently home of the heritage streetcar vehicle shed.

In addition to the technical streetcar design parameters, project stakeholders have identified the following public realm considerations going forward:

- Integration with the Olympic Village Station, through development of the parking lot to create a walkable, transit-oriented community. This would include pedestrian-oriented commercial on the corner of West 6th Avenue and Ash Street.
- The possibility of redeveloping the parking lot and the False Creek Public Tennis Club as part of a redevelopment of the Olympic Village Station area.
- Pedestrian and cyclist connections to Commodore Road, Moberly Road, the Stamp's Landing Ferry Dock and Market Hill Plaza on the seawall.
- Improved pedestrian and bike connections to Spyglass Place, and the Spyglass Ferry Dock.
- Incorporating interactive public art under the Cambie Bridge.

2.2.2.1 Option 1: Following Existing Olympic Demonstration Line Alignment

See drawings 388583-MMD-00-P0-DR-TR-1103 and 388583-MMD-00-P0-DR-TR-3103 in Appendix B.

The proposed segregated dual track alignment from Heather Street would continue along the dedicated right of way to the north of the Canada Line Station parking lot and pass underneath the Cambie Bridge following the alignment of the existing parking lot access road. The streetcar would then transition onto West 1st Avenue with in-street shared running. A potential side loading Cambie Street stop would be located approximately where the existing 2010 Olympic Demonstration Line terminus stop is located. This differs from the two stops identified before the Canada Line was planned, which were at Moberly Road and another just west of the Cambie Street Bridge. Locating the streetcar stop closer to the Canada Line station will ensure streetcar users gain easy access to the wider regional transit network. Siting the stop away from West 6th and W 2nd Avenue would allow for development to take advantage of the frontage space and activate the street. There is an option to include a storage siding to the north side of the Cambie Street stop for streetcar storage along the network (see section 3.3 for more details).

2.2.2.2 Option 2: Cambie Street stop located closer to Canada Line Olympic Village Station

See drawing 388583-MMD-00-P0-DR-TR-1203 and 388583-MMD-00-P0-DR-TR-3103 in Appendix B.

In this option, two segregated tracks continue from Heather Street parallel to West 6th Avenue until Ash Street where the tracks continue through the existing Olympic Village Station parking lot. Being closer to 6th Avenue as it approaches the Olympic Village Station, this alignment would not provide sufficient space on the corner of West 6th Avenue and Ash Street for development to occur. To the northeast of the Canada Line Station, the streetcar would navigate between existing infrastructure associated with the Canada Line and continue underneath the Cambie Street Bridge along the existing road alignment to finally transition onto West 1st Avenue as in-street shared running. A side loading Cambie Street stop is proposed at the rear of the existing Canada Line station. This would allow easy access for transferring passengers. The Canada Line station has significant mechanical and electrical infrastructure located at the rear wall of the existing station and therefore would not permit a new entrance to be constructed for entry to the Canada Line station. Further investigation would be required on Canada Line infrastructure (vents and emergency access) located within the existing parking lot to confirm there are no conflicts with the potential streetcar alignment.

2.3 Southeast False Creek

The Southeast False Creek (SEFC) streetcar alignment along West 1st Avenue was reviewed in two segments. The first being from Wylie Street to Columbia Street and the second from Columbia Street to Quebec Street. For both segments of SEFC, segregated tracks were investigated as per the Official Development Plan (ODP) and upon review, and accounting for the latest design parameters and standards, it was discovered that the existing right of way would allow for segregated tracks, drive lanes, segregated uni-directional bike lanes and sidewalks for the majority of its length, but it could not accommodate all of these street elements and platforms at stop locations. Thus this option was not progressed further. An option was developed which adheres to all the standards and parameters in the Design Considerations Report. This is the original option that was identified for the Southeast False Creek alignment. Subsequently, a second option was developed that aligns with City of Vancouver's Future Complete Street concept for West 1st Avenue. However, this option does not match with all the design parameters and standards set out in the Design Considerations Report.

In addition to the technical streetcar design the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, may be considered going forward:

- The need for connections to the Yukon Street bikeway
- Integration of the streetcar and active transportation into potential future developments along the north side of East 1st Avenue, with wide sidewalks, separated bike lanes, and street trees
- The potential opportunities for passive and active recreation amenities along West 1st Avenue, including playgrounds, spray park, nature play, tennis, ping pong, basketball, and community gardens (to replace the Southeast False Creek Temporary Community Garden)
- The incorporation of public art inspired by the Wilkinson Building, drawing inspiration from the building and history to define the character of the street
- Connection of the potential Cook Street streetcar stop with Hinge Park, including seating elements and separated pedestrian and cycling connections to the Seawall through the park
- Widened sidewalks and added street trees, wherever possible
- Signalizing the mid-block crossing of West 1st Avenue between Columbia Street and Manitoba Street
- Only providing for one-way traffic on 1st Avenue with segregated streetcar tracks, which would required additional work to assess the vehicle circulation
- Connection of the potential Manitoba Street streetcar stop, outside Craft Brewery (heritage Salt Building), with improved pedestrian circulation along Manitoba Street and Salt Street to Olympic Village Square, the seawall and Village Dock False Creek Ferries and Aquabus stop
- Connection of the Ontario Street bikeway with separated bike paths from 1st Avenue to the seawall
- Linkages to the Central Valley Greenway at East 1st Avenue and Ontario Street

2.3.1 Option 1: Original Southeast False Creek alignment

2.3.1.1 West 1st Avenue from Wylie Street to Columbia Street

See drawings 388583-MMD-00-P0-DR-TR-1104 and 388583-MMD-00-P0-DR-TR-3104 in Appendix B.

Segregated streetcar tracks from False Creek South would transition onto West 1st Avenue and become in-street shared running within the 22 m ROW available. The proposed cross section also includes segregated 2.5 m wide uni-directional bike lanes and sidewalks on either side. When buffers and boulevards are included, this cross section would utilize the full space available, including the centre median and the existing parking lanes. The existing sidewalk to the north side of West 1st Avenue is partially placed in a 4 m easement as identified from the City cadastral data. There is potential that the 4 m easement could be allocated to the road cross section to permit some parking and allow the required widening at the stop location. The identified 4 m easement is not continuous for the full length of this segment due to the heritage building located north of Cook Street. Additionally, 1715 Cook Street is currently under development and the proposal includes a setback to match with the adjacent properties, 288 West 1st Avenue and 1768 Cook Street. This property line realignment would ensure a constant 22 m width is available throughout this segment. A centre loading stop location is proposed between Crowe Street and Cook Street. The westbound in-street shared track, protected bike lane and sidewalk would shift north by approximately 4 m to create space for the centre load platform, while the eastbound in-street shared running track would continue straight. The westbound track would then transition back to the original cross section to ensure there is no conflict with the heritage building opposite Cook Street. See Figure 2-6 below for plan details.

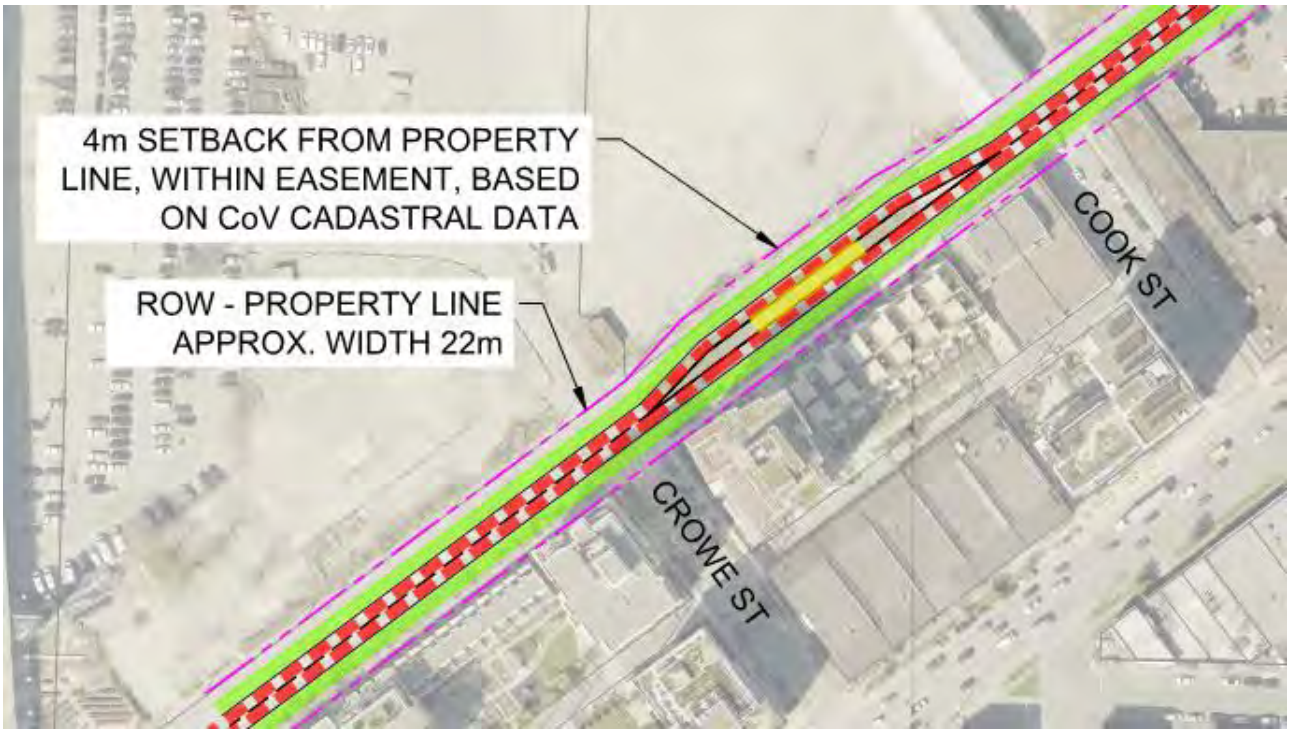


Figure 2-6 1st Avenue Stop Location – Option 1

2.3.1.2 West 1st Avenue from Columbia Street to Quebec Street

See drawings 388583-MMD-00-P0-DR-TR-1104 and 388583-MMD-00-P0-DR-TR-3104 in Appendix B.

This portion of West 1st Avenue has an increased ROW of 25.4 m. After the Columbia Street intersection, a 2.5 m parking lane could be introduced to the south side of West 1st Avenue (see Figure 2-7 for typical cross section details). This parking lane would allow space for the first of two side loading platforms staggered over Manitoba Street. The first stop platform location would serve the eastbound streetcar on the west of Manitoba Street. East of Manitoba Street to Quebec Street the added parking lane is located on the north side of 1st Avenue. Therefore, the two shared in-street streetcar tracks would shift south over the Manitoba Street intersection and create space for the second stop platform for the westbound streetcar outside the existing Salt Building. The positioning of this stop means there would no longer be through access on the one-way southbound Salt Street. Alternatively, traffic could be fully restricted in the block from Manitoba Street to Ontario Street or for other portions of 1st Avenue. The streetcar would continue to be shifted to the south side of 1st Avenue, which would assist with the turning movement onto Quebec street. Depending on which site is selected for the operations and maintenance facility (OMF), the streetcar may continue east towards the future Broadway Subway station at Great Northern Way to access a site in the False Creek Flats area.

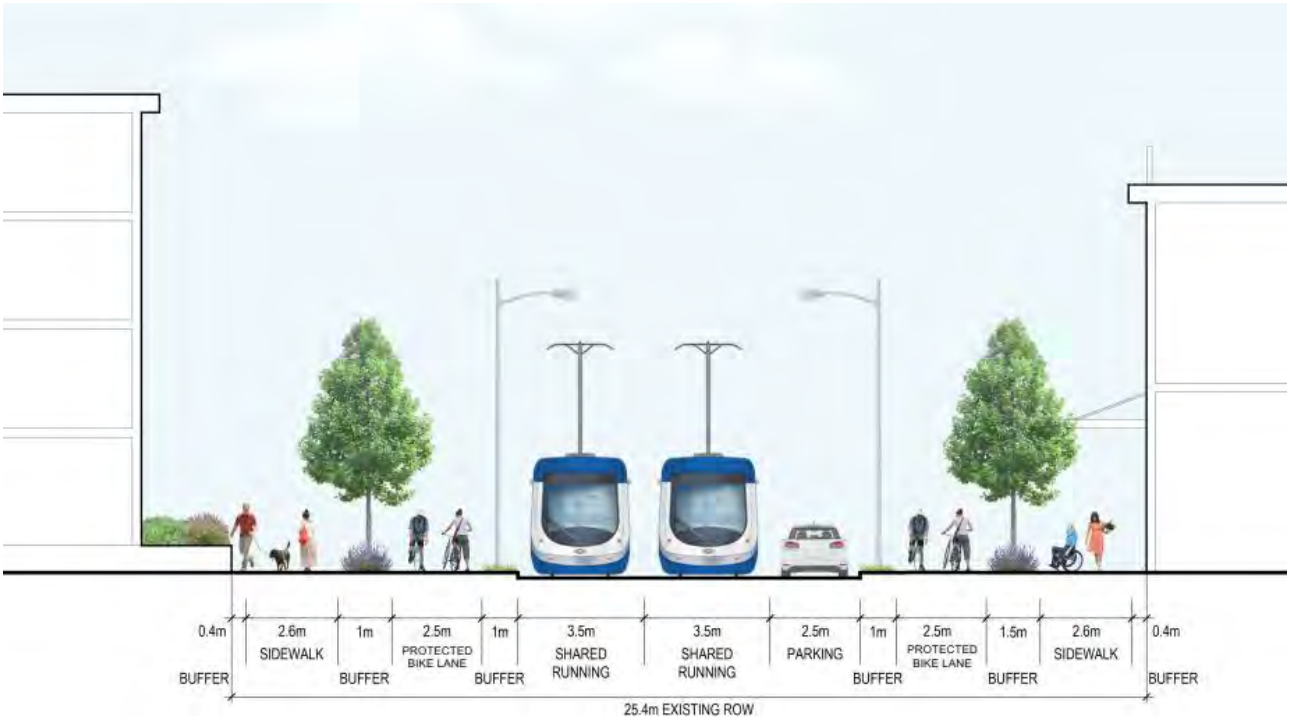


Figure 2-7 West 1st Avenue – Option 1

2.3.2 Option 2: Future Complete Street concept

Option 2 was originally excluded because it does not comply with the design criteria set out in the Design Considerations Report. Upon the request of the City of Vancouver, this option was added to demonstrate how the streetcar could fit within their Future Complete Street concept for West 1st Avenue. However, the option has narrower lane widths for several modes such as parking lane and includes a narrower boulevard. The Future Complete Street concept showed parking on the south side in line with the parking that exists today along 1st Avenue. However, in order to locate the streetcar tracks in the optimal position within the road ROW for the turn at Quebec Street the streetcar tracks need to be on the south side of the road. Thus

Option 2 has utilized the Future Complete Street concept but has mirrored it so that the parking is on the north side where space permits, and the streetcar tracks are along the south side of the road.

2.3.2.1 West 1st Avenue from Wylie Street to Columbia Street

See drawings 388583-MMD-00-P0-DR-TR-1204 and 388583-MMD-00-P0-DR-TR-3104 in Appendix B.

Similar to Option 1, this cross section would also utilize the full space available within the 22 m ROW available, however with slightly reduced sidewalk, boulevard and protected bike lane widths to accommodate for 2.5 m parking lane on the north side of the in-street shared streetcar track. The 4 m easement on the north side of West 1st Avenue could be used to widen some of the protected bike lanes, sidewalks and/or boulevards. The westbound in-street shared track would shift north by approximately 4 m to create space for the centre platform between Crowe Street and Cook Street, using the 4 m easement. If this easement would be more limited, the parking lane could be removed at the stop. The westbound track will then transition back to the original cross section to ensure there is no conflict with the heritage building opposite Cook Street. See Figure 2-8 below for plan details.

Figure 2-8 1st Avenue Stop Location – Option 2

2.3.2.2 West 1st Avenue from Columbia Street to Quebec Street

See drawings 388583-MMD-00-P0-DR-TR-1204 and 388583-MMD-00-P0-DR-TR-3104 in Appendix B.

This section of West 1st Avenue applies a similar cross-section as west of Columbia Street. However, the increased ROW of 25.4m is used to add a drive lane on the north side of the in-street running shared streetcar. Since the parking is moved away from the streetcar, the parking lane can be narrowed to 2.2m. In sections where the 25.4m ROW is reduced, the parking lane is removed.

This layout allows for a centre platform stop located between Ontario Street and Salt Street. This space is created by removing parking and the drive lane at this segment. The benefit of this over Option 1 is that the stop does not block through access on the one-way southbound Salt Street. Past the Salt Street stop, the westbound streetcar track would return to the south side of 1st Avenue to assist with the turning movement from Quebec Street onto 1st Avenue, and to create space for adding the drive lane and parking. Depending on which site is selected for the Operations and Maintenance Facility (OMF), the streetcar may continue east

towards the future Broadway Subway station at Great Northern Way to access a site in the False Creek Flats area. With the 3 m additional westbound drive lane being discontinuous through SEFC, consideration should be given to its purpose or if the space can be reallocated to public realm. Alternatively, if having a discontinuous westbound vehicle lane is acceptable and having a segregated westbound streetcar track is preferred than shared running, as we have proposed, then the 3 m can provide local access where it is in place.

2.4 False Creek Flats

At the beginning of this study, a need to investigate a potential streetcar extension on Quebec Street from East 1st Avenue to East Broadway was identified in order to provide a connection to the Broadway Subway at Main Street. A cursory investigation of the grades on Quebec Street showed that the grade on Quebec Street between East 8th Avenue and East Broadway is approximately 8-12%. As outlined in *Design Consideration Report* (388583-MMD-00-P0-RP-TR-0001), the grade through a streetcar stop is to be a maximum of 2%, thus the streetcar alignment would either need to turn onto East Broadway or significantly regrade Quebec Street to build a terminus. Siting a streetcar stop on East Broadway would not be not ideal as it is a major road and is already constrained for space. Regrading Quebec Street, or even trenching the streetcar stop into Quebec Street, would not be acceptable either as this would significantly impact the urban realm and hinder accessible connections to the surrounding area. Thus, an alternate connection to Broadway Subway at Great Northern Way is recommended. This connection could also be coordinated with the access/extension to some of the potential operations and maintenance facility sites.

The False Creek Flats streetcar routing was reviewed in two portions. The first portion continued along East 1st Avenue or Industrial Avenue for a potential connection to Broadway Subway and/or an OMF. The second portion involved the alignment on Quebec Street leading to North East False Creek (NEFC) with the potential for an extension along National Avenue to access another potential OMF site and connect to the future St. Paul's hospital campus.

2.4.1 East 1st Avenue / Industrial Avenue

As part of the False Creek Flats plan it has been acknowledged that there is potential for East 1st Avenue, Industrial Avenue, Station Street and Lorne Street to be re-aligned. The re-alignment would bring East 1st Avenue, west of Main Street, to meet Industrial Avenue. See Figure 2-9 below for approximate re-alignment plans.

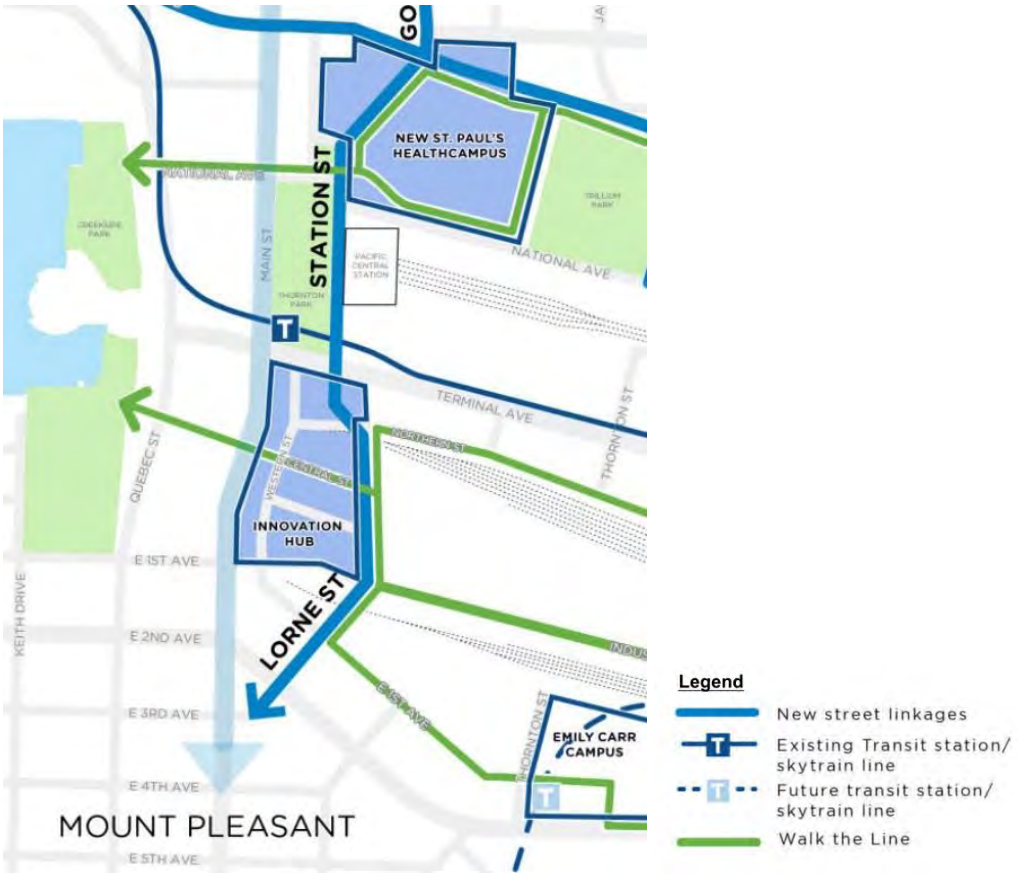


Figure 2-9 Industrial Avenue Re-Alignment Sketch

(Source: False Creek Flats Area Plan page 66 – May 17, 2017)

2.4.1.1 Option 1: East 1st Avenue

See drawing 388583-MMD-00-P0-DR-TR-1105 and 388583-MMD-00-P0-DR-TR-1105 in Appendix B.

From the intersection of East 1st Avenue at Quebec Street, where a set of turnouts would be required to provide a connection between the different routing options, the in-street shared running tracks from SEFC would continue east on East 1st Avenue past Main Street where the two in-street shared running tracks would transition to a single segregated running track to the north over the Scotia Street intersection. The single segregated track would facilitate the streetcar being able to run both directions on the track to and from the terminus stop. Streetcar would continue east to reach a side loading terminus stop located to the west of Thornton Street. This stop location would provide easy access to the Broadway Subway Great Northern Way Station. The segregated track would therefore mean Scotia Street to Thornton Street would become a one lane eastbound road, ensuring that access is maintained to the existing properties. The segregated track as described may limit access to 339 East 1st Avenue, and access to 375 East 1st Avenue would need to be via Thornton Street. The ROW on East 1st Avenue would be reduced from 25.4 m to 20.1 m east of Main Street. Therefore, further assessment needs to be done to look at East 1st Avenue east of Main Street to consider if the south side uni-directional protected bike lane could be removed, and a 3 m wide bi-directional protected bike lane placed to the north side of East 1st Avenue. Parking lanes are proposed to the south side of East 1st Avenue. See Figure 2-10 for a typical section. Access to a potential OMF site (Site 1) located at 274 and 273 East 1st Avenue would be provided between Lorne Street and Scotia Street. Refer to Section 0 for details.

In the future, if the City wanted to extend the streetcar network further, a second track through stop and second platform could be added. At the time of expansion, consideration for the road layout and network would need to be assessed to address any access constraints.

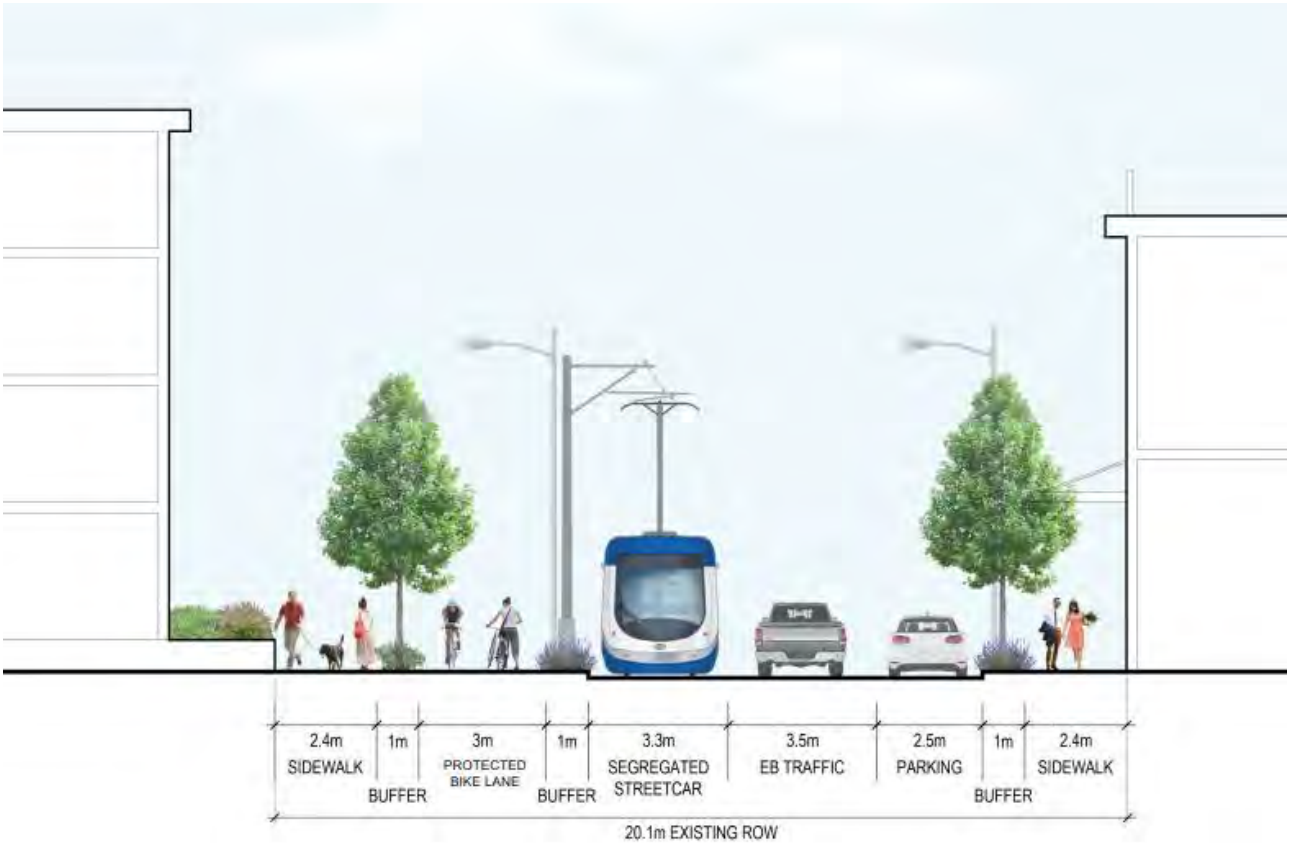


Figure 2-10 East 1st Avenue at Scotia Street

2.4.1.2 Option 2: Industrial Avenue

See drawing 388583-MMD-00-P0-DR-TR-1205 in Appendix B.

From the intersection of East 1st Avenue at Quebec Street, where a set of turnouts are located to provide a connection between the different routing options, the in-street shared running tracks from SEFC would continue east on East 1st Avenue past Main Street. It has been assumed from the False Creek Flats Plan that the proposed road re-alignment would consist of East 1st Avenue continuing east past Main Street to create a new intersection with Western Street and Industrial Avenue. Further east is another proposed intersection connecting Industrial Avenue with Station Street and Lorne Street. The streetcar would continue on Industrial Avenue towards Scotia Street where the two in-street shared running tracks would transition to a single segregated track on the north side of Industrial Avenue and continue east to reach a side loading terminus stop location opposite Thornton Street. The streetcar tracks would be located along the north side of Industrial Avenue to provide a close connection to the potential OMF site (Site 2). A new pedestrian-bicycle bridge connection utilizing the Thornton Street road ROW could provide access over the BNSF rail yard to the Broadway Subway Great Northern Way Station. Access to a potential OMF site (Site 2) located at 425,455 Industrial Avenue would be gained near the Scotia Street intersection. Refer to Section 3.1.2 for details.

In the future, if the City wanted to extend the streetcar network further, a second track through stop and second platform could be added. At the time of expansion, consideration for the road layout and network would need to be assessed to address any access constraints.

2.4.1.3 Option 3: BNSF ROW

See drawing 388583-MMD-00-P0-DR-TR-1305 in Appendix B.

This alignment option would provide access to the OMF site 1 (235, 247 and 273 East 1st Avenue) from the back side of the property. This alignment option removes the streetcar from East 1St Avenue and in doing so would eliminate any bicycle-track crossings that would be necessary to access the OMF site 1 from East 1st Avenue. However, this alignment alternative would require the purchase of lands/ROW from BNSF, making it unlikely to be selcected.

From the intersection of East 1st Avenue at Quebec Street, where a set of turnouts are located to provide a connection between the different routing options, the in-street shared running tracks from SEFC would continue east on East 1st Avenue past Main Street. It has been assumed from the False Creek Flats Plan that the proposed road re-alignment would consist of East 1st Avenue continuing east past Main Street to create a new intersection with Western Street and Industrial Avenue. At this new intersection the streetcar alignment would transition from in-street shared running to segregated in the BNSF ROW. This option is only feasible if land is acquired from BNSF, thus effort has been made to minimize the amount of land that would be required. Given the need to minimize land impact and that streetcar would be minimally impeded by vehicle traffic at the new Lorne Street, the two streetcar tracks could transition to one track. This track would be located along the southern edge of the BNSF ROW.

This alignment option would provide access to the OMF site 1 (235, 247 and 273 East 1st Avenue) from the back side of the property. Refer to Section 3 for details. It would also continue east to Thornton Street where a platform would be placed within 1802 Thornton Street, which is city-owned. By locating the stop here, an enhanced pedestrian realm connection could be made to the Broadway Subway Great Northern Way Station utilizing 1802 Industrial Avenue and the east side of Thornton Street. This alignment option removes the streetcar from East 1St Avenue which would eliminate any bicycle-track crossings that would otherwise be necessary to access the OMF site 1. With the new intersection of East 1st Avenue, Industrial Avenue and

Western Avenue the bike lane crossing of the streetcar tracks could be located at an intersection and could consist of facilities using a two-stage turn and ideal crossing geometry.

In the future, if the City wanted to extend the streetcar network further, a second track through stop and second platform could be added. At the time of expansion, consideration for the road layout and network would need to be assessed to address any access constraints.

2.4.2 Quebec Street (and National Avenue Extension)

See drawing 388583-MMD-00-P0-DR-TR-1106 and 388583-MMD-00-P0-DR-TR-3106 in Appendix B.

The City has produced a detailed 2018 interim construction plan of Quebec Street and its surrounding streets. As part of these plans a future streetcar alignment was included to ensure the area was futureproofed for streetcar. As noted in previous studies the streetcar alignment requires a significant amount of land for the East 1st Avenue and Quebec Street turn. This land allowance has been accounted for in the interim construction plan to enable the streetcar turn. The interim construction plan provides two through northbound lanes, two through southbound lanes, and left and right turn lanes where required. Separated bike lanes and sidewalks were also identified. The southbound streetcar alignment would be in-street shared running and follow the western curb through lane and the northbound streetcar alignment would be in-street shared running following the eastern curb through lane, see Figure 2-11 below for Quebec Street typical cross section.

Figure 2-11 Quebec Street – Option 1

This streetcar configuration would continue north along Quebec Street until the intersection at Pacific Boulevard. North of Pacific Boulevard until Keefer Street the ROW is reduced to approximately 21 m. This ROW would allow for two shared streetcar lanes with 2.5 m uni-directional protected bike lanes and 2.4 m sidewalks on either side. Two side loading stop locations are proposed north of Terminal Avenue. This would provide connections to the seawall, Science World and The Expo Line Main Street-Science World SkyTrain Station. The southbound side loading stop would be placed on the west of Quebec Street, with space for separated bike lanes and a sidewalk to the west. The northbound stop location would be placed in the median of Quebec Street, which has a proposed width of approximately 5.4 m. The placement of this stop utilizes the median where the existing SkyTrain columns are located and further investigation of the column locations is required to ensure this stop location is feasible and sufficient clear space can be provided around the SkyTrain columns for passenger loading. Alternatively, the northbound stop location could

potentially be placed in the median south of Terminal Avenue. However, due to the current road alignment the stop location would not have enough tangent track extending past to the south of the 35 m stop to comply with the design standards.

There is also an alternative that would allow for more park space in the future on the southwest corner of Quebec Street at Terminal Avenue and allow for the street space to widen approximately where the old streetcar stop is. This would allow for the potential streetcar stop platforms to be located on the south side of the Terminal Avenue intersection. This would remove any conflicts with the SkyTrain guideway but would move the stop further from the Expo Line Main Street-Science World SkyTrain Station. Additionally, it could allow for the southbound streetcar stop to be tied into future potential park space. Overall, further investigation of the intersection and of area layout (including future park space, various cycling facilities/connections, pedestrian movements/desire lines, traffic movements, etc.) would give a better indication of the operations of the intersection and streetcar, and how much space would be needed.

Progressing north along Quebec Street, the streetcar alignments shown are as per the NEFC design with one amendment to the alignment from Quebec Street onto the realigned Pacific Boulevard. The existing NEFC design shows the northbound track on Quebec Street separating to two tracks to the south of the new intersection to allow the streetcar to continue towards Gastown on Columbia Street or turn left to the Yaletown extension. This track transition would need to be completed over an intersection, rather than south of the intersection. Thus an adjustment is shown on the proposed routings drawings in Appendix B. This alignment would require specialized signalling to allow the streetcar to go either straight or left from the left turn vehicle lane.

Another stop location is to be staged over the Quebec Street and Prior Street intersection, as laid out by the NEFC project. The southbound stop would be placed on the south side of the intersection on the west side of Quebec Street. This stop location would serve both of the two routes, from Yaletown and Stanley Park. Northbound, one stop is to be placed to the north of the intersection on the east side of Quebec Street serving only the northbound mainline towards Stanley Park. Ongoing discussions are taking place as part of the NEFC development to ensure that there is adequate space to the east of Quebec Street for the stop location as well as sidewalks and protected bike routes. The other northbound stop, serving the Yaletown mainline, is placed along Pacific Boulevard at the southwest corner of the existing sports fields. This split stop configuration is consistent with the NEFC project.

For a potential OMF site (Site 4) located at 701 National Avenue, access would need to be provided via National Avenue from Quebec Street. This potential connection has not been drawn and is not shown as a part of the potential routing on drawing 388583-MMD-00-P0-DR-TR-1106. Refer to Section 3.1.3 for details of this potential OMF connection. As part of the new St. Paul’s Hospital at 1002 Station Street, National Avenue is to be re-aligned and would enable streetcar access to the area, see Figure 2-12 below for approximate proposed National Avenue road re-alignment. The potential access off Quebec Street would primarily be for OMF access. However, providing a St Paul’s Hospital stop location could be beneficial.

Figure 2-12 New St Paul's Hospital and Health Campus – Transportation and Circulation Map

(Source: New St. Paul's Hospital + health Campus Policy Statement page 56 – June 2017)

In addition to the technical streetcar design the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, could be considered going forward:

Quebec Street to Terminal Avenue:

- Widen sidewalks and add street trees, where possible
- Add mid-block pedestrian-controlled crossings to improve walkability
- Include a public plaza space with pavilion near the water with seating and views of the North Shore Mountains
- Explore potential for transit-oriented, multi-use development on the southeast corner of Quebec Street and Terminal Avenue
- Incorporate ideas from the False Creek Flats Area Plan, which envisions the area as a "thriving, flexible and diverse economic zone" and key to the "innovation economy." This could include shared office

spaces for start-ups, studio spaces for artists and craftspeople, artist live-work spaces, public festival space to celebrate arts and innovation, and/or a farmer's market supporting local food production

Terminal Avenue to Pacific Boulevard:

- As per the NEFC Plan: “The Park District will be a commons for people from local neighbourhoods to meet and mingle every day, and for other residents and visitors to come and enjoy or celebrate a special event.”
- In keeping with the NEFC Plan: celebrate the history of this part of Vancouver in the public realm design, create a vibrant waterfront destination, and explore opportunities for interactive public art installations
- Integrate the streetcar and active transportation into the future expanded Creekside Park
- Add mid-block pedestrian controlled crossings on Quebec Street to improve walkability
- Install public art under the SkyTrain guideway
- Celebrate water by incorporating a water feature or spray park, and stormwater management features

2.5 Gastown

The Gastown portion of the network is considered from Columbia Street at Keefer Street extending to Cordova Street at Waterfront Station. Three options were identified in the Gastown area. Options include a Cordova Street and Water Street streetcar couplet (as identified in previous studies), a two-way streetcar with eastbound vehicular traffic on Cordova Street and finally, two-way streetcar, two-way vehicular traffic on Hastings Street turning onto Cambie Street and then joining Cordova Street to reach Waterfront Station.

Columbia Street between Keefer Street and Hastings Street is consistent for all three options through Gastown. See drawing 388583-MMD-00-P0-DR-TR-1107 and 388583-MMD-00-P0-DR-TR-3107 in Appendix B.

Columbia Street currently carries two-way traffic between Keefer Street and Pender Street. North of Pender Street, Columbia Street becomes one way northbound. This is maintained in the potential streetcar alignment options and is the only option considered for this portion of Columbia Street. The potential streetcar would be in-street shared running in both directions between Keefer Street and Pender Street. North of Pender Street the southbound streetcar on Columbia Street would be segregated whereas the northbound streetcar would continue as in-street shared running. The proposed cross section would retain the east parking lane on Columbia Street. Due to the segregated track on the west side, parking would be reduced to only being accommodated between Keefer Street and Pender Street.

North of Pender Street a wider sidewalk is proposed in place of the west parking lane, see Figure 2-13 below for cross section details. Two 2.5 m wide side loading platforms would be placed on the south side of the Hastings Street at Columbia Street intersection. The southbound platform would be placed in the widened sidewalk space and the northbound platform would be placed in the parking lane space.

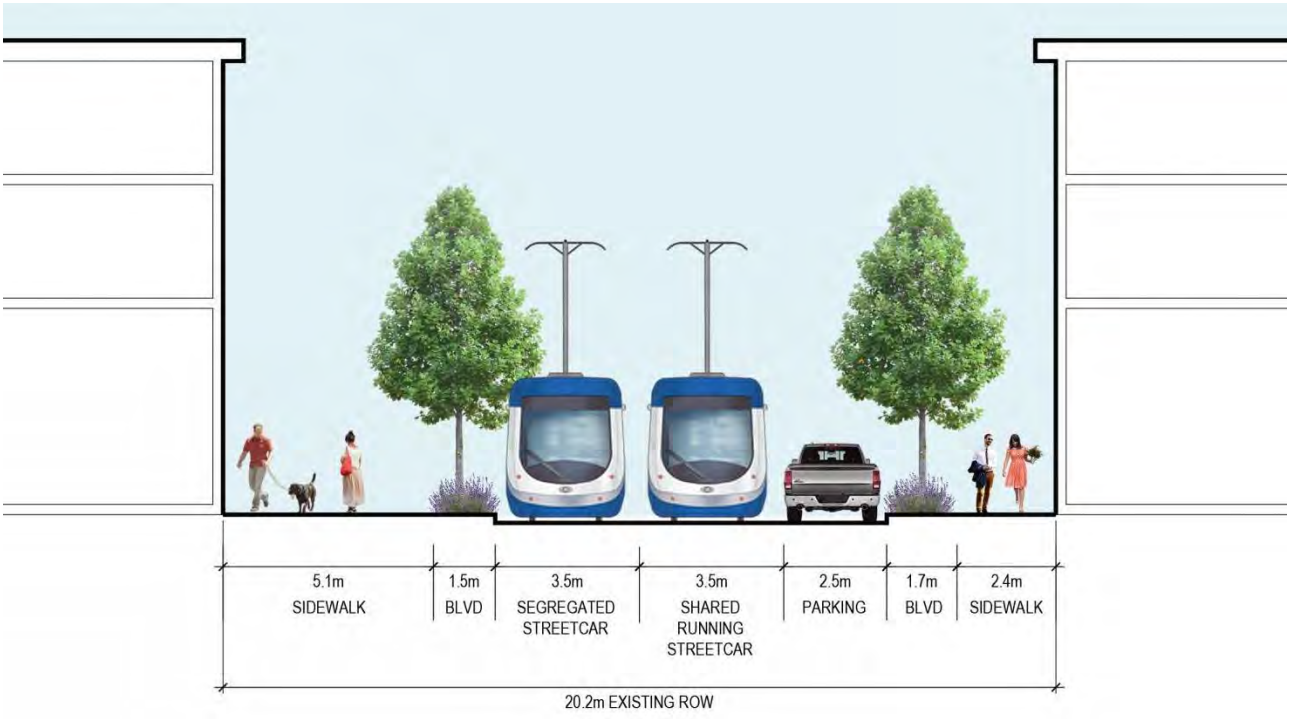


Figure 2-13 Columbia Street – Option 1

During internal stakeholder meetings, it was identified that the Chinatown community has a desire to close Columbia St from Keefer to the lane (south of Pender) to vehicular traffic. This was trialed during the VIVA Vancouver “Hot and Noisy” test event. It was suggested that a transit plaza and/or pedestrian mall model may be desirable and should be considered further in the future. There are many examples of streetcars and LRT traversing pedestrian plazas around the world, although the potential for impacts to reliability need to be considered. It was also suggested that to serve Chinatown better, the proposed streetcar stop at Columbia Street at Hastings Street be moved closer to the Chinese Cultural Centre, Sun Yat Sen and Chinatown Memorial Plaza, along Columbia Street between Keefer Street and Pender Street. Additionally, it was noted that NEFC is looking to include a left turn lane from Pacific Boulevard onto Columbia Street to provide access to Chinatown, which conflicts with the idea of pedestrianization. A bike facility on Columbia Street as far as Keefer Street may conflict with the Vancouver cycling network, as cyclists often continue north on Columbia into Gastown. With these comments and the potential for the City to change the traffic patterns on Columbia Street there are a few potential future configurations of Columbia Street that may be considered prior to the implementation of streetcar. Further investigation of the potential future considerations is required and should consider the implementation of streetcar as well as the broad context of the area and multi-modal transportation network. Once conclusions are reached on these issues the streetcar alignment can be adjusted to respond to the confirmed decisions.

2.5.1 Option 1: Water Street and Cordova Street Couplet

See drawings 388583-MMD-00-P0-DR-TR-1108, 388583-MMD-00-P0-DR-TR-3108 and 388583-MMD-00-P0-DR-TR-3109 in Appendix B.

The City is currently undertaking a comprehensive transportation study and engagement process for this area (2019 to 2020). As such, the following options presented in this section present a starting point in terms of preserving for streetcar opportunities. In this option, the alignment is proposed to be in-street shared running northbound track to the east side of Columbia Street which would continue north and turn west onto

the existing one-way westbound, Powell Street. The southmost drive lane on Powell Street would permit left turns onto Carrall Street with the north lane accommodating in-street shared running streetcar. This configuration would allow the streetcar to turn onto Powell Street without property take to the southwest of the Columbia Street and Powell Street intersection. The westbound streetcar would continue onto Water Street on a single in-street shared running lane and rejoin with the eastbound track on Cordova Street at the Richards Street intersection to reach Waterfront Station. To the north of the single track in-street shared running lane on Water Street, a 3.5 m wide lane is proposed for loading bays, parking and stop locations as required. The Water Street ROW of approximately 20.1 m which also enables7.6 m of width to be allocated for public realm. A westbound 3 m wide side loading stop platform is proposed to the east of Abbott Street on the north side of Water Street. See Figure 2-14 below for the Water Street typical cross section.

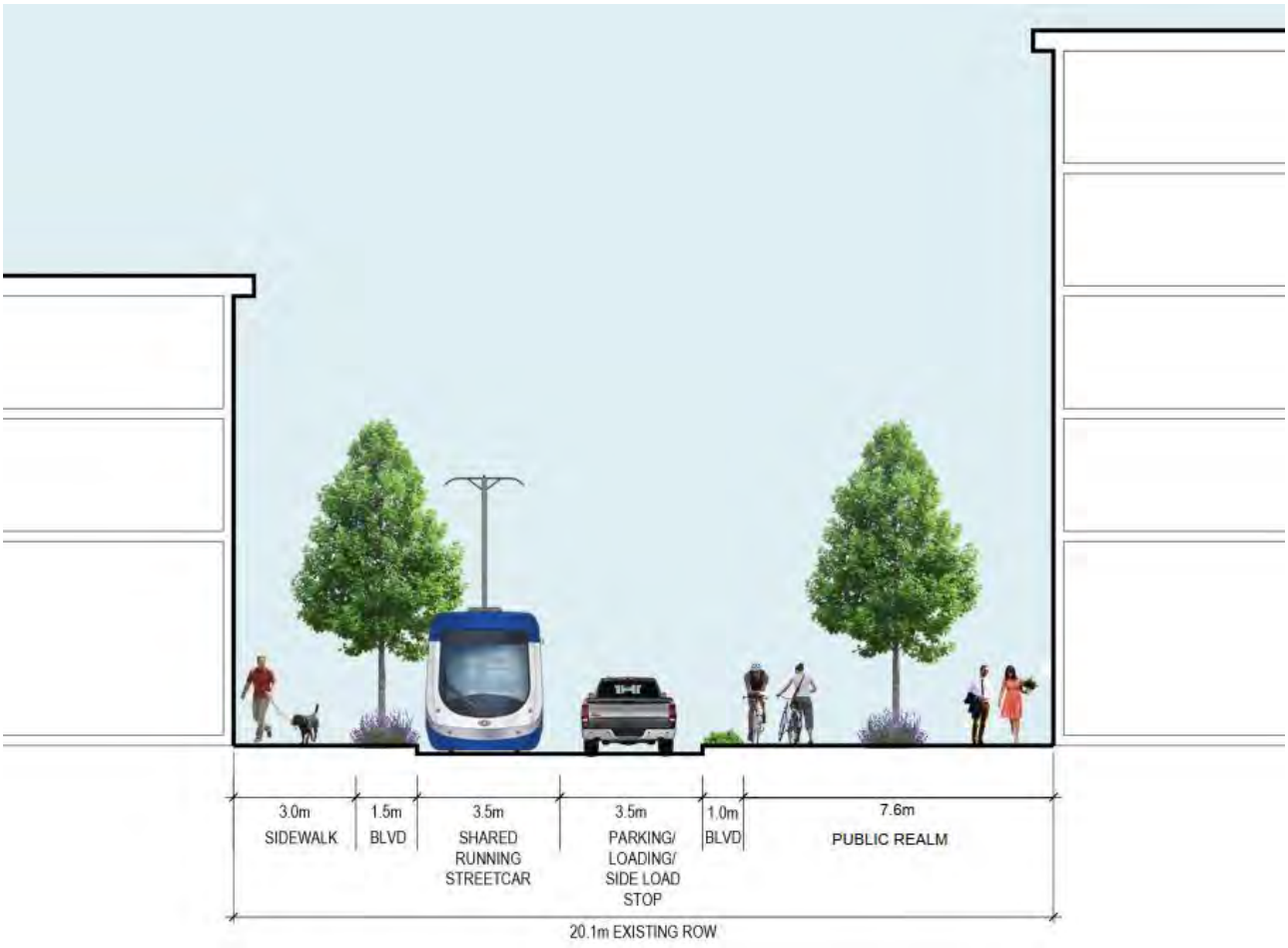


Figure 2-14 Gastown – Option 1, Water Street

In the eastbound direction, the track of the couplet would traverse from Waterfront Station as an in-street shared running streetcar lane in the north drive lane on Cordova Street, retaining eastbound through vehicle traffic. The south drive lane will provide through vehicle access. A 3 m parking lane is proposed for the north side and a 2.5 m parking lane to the south side. Sidewalks of 2.4 m with 1.5 m boulevards are proposed on both sides of Cordova Street.

The streetcar is proposed to turn south from Cordova Street to join the segregated track on the west side of Columbia Street. This turn is a significant constraint on this option for two reasons. Turning from the northern most travel lane of Cordova Street across other eastbound traffic means that it would require specialized advanced streetcar signaling to enable the streetcar to cross the eastbound traffic lane. It is also a tight turn with a heritage property up to the back of side walk on the south west corner of the intersection meaning that property take is not a possibility. Making the turn appears feasible if design parameters are compromised and a small turning radius (18 m) is used. Additionally, transitioning the track north into the parking lane on the north side of Cordova Street would further ease the space constraints on the inside of the corner. If this option is pursued, more detailed investigation would be required to ensure no property take is necessary although an initial assessment shows that it is likely that the existing curb position can be maintained. An eastbound 3 m wide side loading stop platform is proposed to the east of Abbott Street on the north side of Cordova Street. See Figure 2-15 below for the Cordova Street typical cross section.

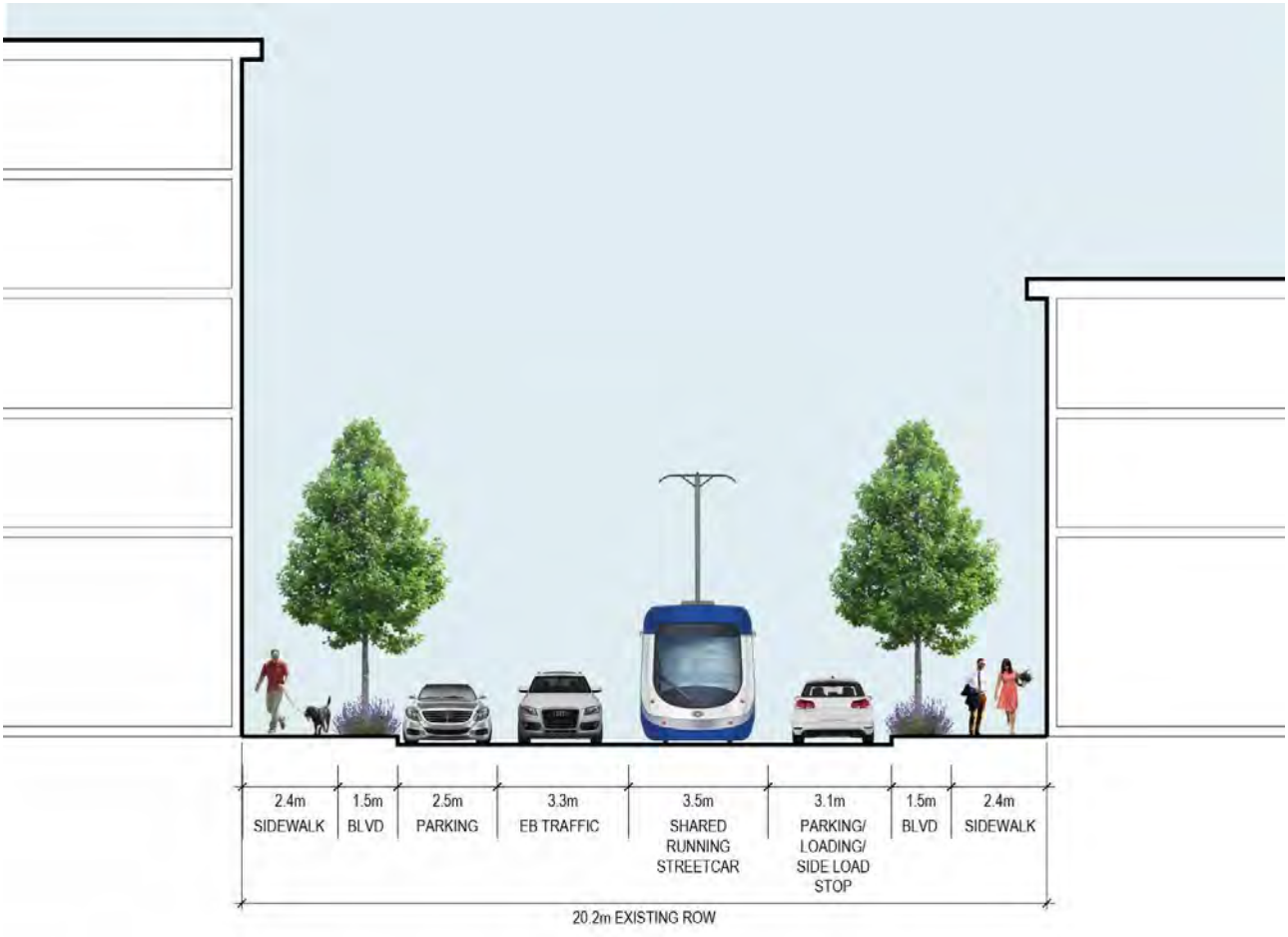


Figure 2-15 Gastown – Option 1, Cordova Street

2.5.2 Option 2: Two-way Streetcar on Cordova Street with One-Way Eastbound Traffic

See drawing 388583-MMD-00-P0-DR-TR-1208 and 388583-MMD-00-P0-DR-TR-3109 in Appendix B.

Achieving an option to place two tracks on Cordova Street is likely to require property take on the southwest corner of the Cordova Street and Columbia Street intersection. Due to there being two tracks making the turn, unlike the previous option, utilizing a smaller turning radius (18 m) would not provide sufficient clearance to the building to provide an acceptable sidewalk on the corner. If, prior to the development of the streetcar network, there were significant redevelopment plans for the area then it may be feasible to consider some building modifications to permit the solution. As shown in Figure 2-16, on a recent tramway project in the UK, a heritage building was modified to colonnade a sidewalk under the building. However, these solutions can be expensive and difficult to achieve depending on the status and historical importance of the building. It is recommended that one of the other two options in this area are pursued.

Figure 2-16 Midland Metro – Heritage building modification to provide more pedestrian realm

For the remainder of this option, the northbound track from Columbia Street is proposed to turn west onto the north side of Cordova Street to a segregated track. This segregated track would continue to the Richards Street intersection where it would transition into an in-street shared running track to connect to Waterfront Station. The eastbound track is proposed to be in the southern lane of Cordova Street. Refer to Figure 2-17 below for a typical cross section on Cordova Street. 3.4 m sidewalks with 1.5 m boulevards are proposed on both sides of Cordova Street. The additional sidewalk width would allow for a 2.5 m wide stop location while maintaining a 2.4 m sidewalk.

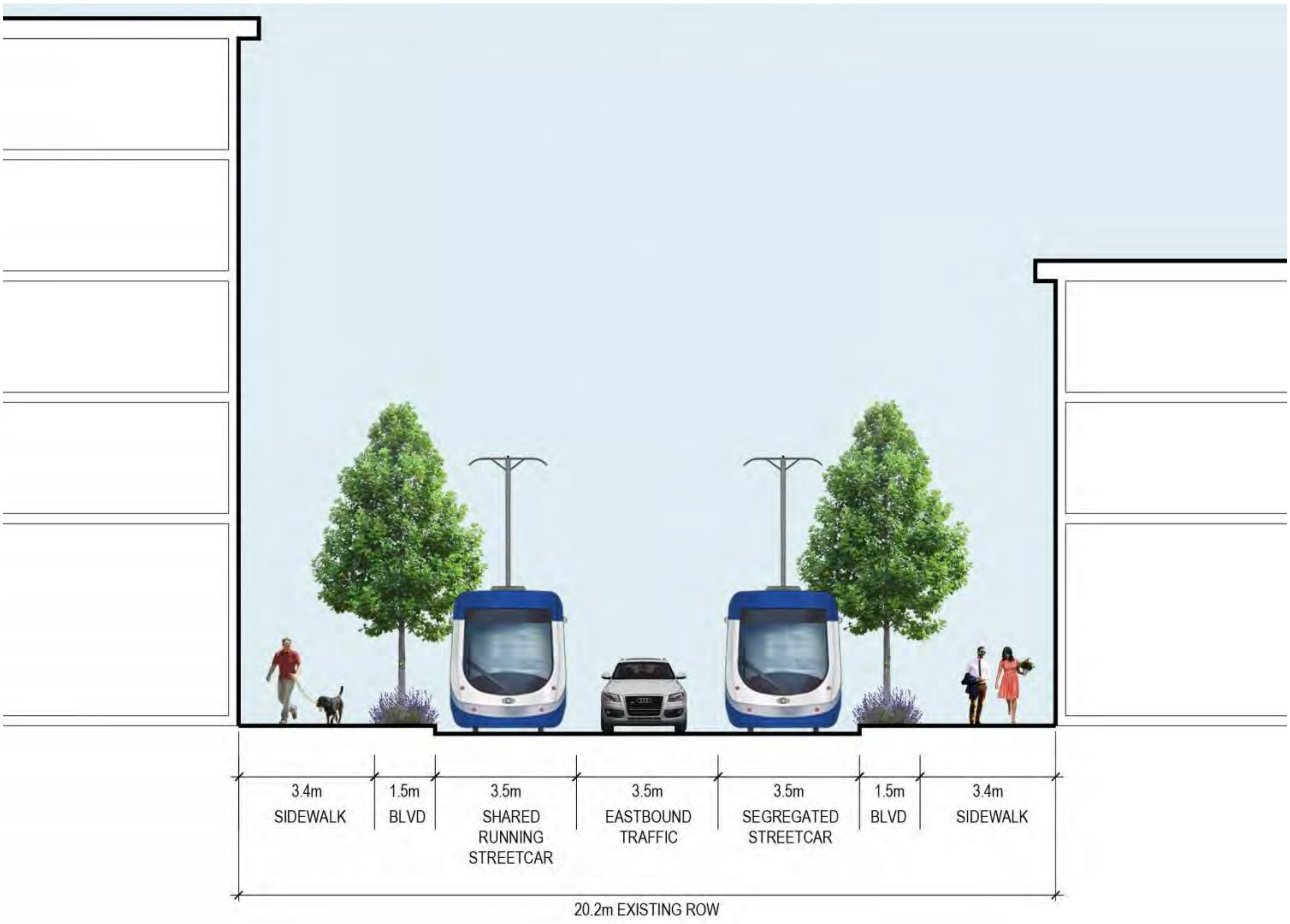


Figure 2-17 Gastown – Option 2, Cordova Street

2.5.3 Option 3: Two-way Streetcar on Two-way Hastings Street

See drawings 388583-MMD-00-P0-DR-TR-1308, 388583-MMD-00-P0-DR-TR-3108 and 388583-MMD-00-P0-DR-TR-3110 in Appendix B.

Due to the challenges identified at the intersection of Columbia Street and Cordova Street, a third option utilizing Hastings Street was assessed. From Columbia Street both streetcar tracks would turn onto Hastings Street with eastbound and westbound in-street shared tracks running in each curb lane. The streetcar would then turn north onto Cambie Street and finally turn west onto Cordova Street to reach Waterfront Station.

The Hastings Street lane configuration is proposed as four lanes with two in-street shared running lanes and two vehicle traffic lanes. Between Columbia Street and Carrall Street, a wider sidewalk would be included to the south to position the tracks for the turn from Hastings Street to Columbia Street with no impact to the existing properties. Hastings Street is wider than Cordova Street meaning this is feasible although further analysis is required to find the correct balance between track geometry and sidewalk widths.

In order facilitate the proposed streetcar alignment, the existing drive lanes on Cambie Street would become in-street shared running and the parking lane and existing uni-directional protected bike lane on the east would be replaced with a 3 m wide bi-directional protected bike lane. The existing parking to the west would remain in place. See Figure 2-18 for a typical section. As Cordova Street is one-way eastbound, the westbound track turning from Cambie Street to West Cordova Street would become a segregated track

running on the north side of Cordova Street and continuing on to reach Waterfront Station. This would provide space for two eastbound lanes on West Cordova Street. The northmost lane would be shared with the in-street running eastbound streetcar track. This track layout along West Cordova Street enables the turn from Cambie Street to West Cordova Street to avoid impacting any properties although again, clearances are tight, so additional assessment is recommended to optimize the layout. However, with another eastbound vehicle lane to the south of the streetcar tracks an advanced streetcar signalization would be required at this intersection to allow the streetcar to turn from West Cordova Street to Cambie Street.

Figure 2-18 Gastown – Option 3, Hastings Street

2.6 Waterfront and Coal Harbour

See drawings 388583-MMD-00-P0-DR-TR-1109, 388583-MMD-00-P0-DR-TR-1110, 388583-MMD-00-P0-DR-TR-1111 and 388583-MMD-00-P0-DR-TR-3111 in Appendix B.

The previous 2005 study only included alignment options as far as Waterfront Station, but it did include the potential for a future streetcar network extension through Coal Harbour to Stanley Park. Subsequently the Central Waterfront Hub Framework was completed in 2009 and looked to outline a vision for the creation of a world-class transportation interchange and new extension to downtown. The Central Waterfront Hub Framework reviewed several streetcar layout options which tested different anticipated streetcar and platform lengths to determine what was feasible and would fit within the context of the multi-modal station area. It was determined that a 35 m platform was preferred as it allowed for bicycle connections and a track terminus. These findings have been incorporated into the latest potential routing drawing set.

All of the streetcar alignment options from the Gastown portion include in-street shared running tracks through the Richards Street and West Cordova Street intersection due to the limited ROW. A centre loading Waterfront stop location is proposed to the east of Seymour Street which could be a possible interim terminus stop if the streetcar network is not extended to Stanley Park initially. With the potential for this stop to be an interim terminus a storage track has been sited to the west of Seymour Street to allow for streetcars to reverse directions.

From Waterfront Station, it is proposed that both the eastbound and westbound streetcar tracks follow the existing road alignment as in-street shared running. The tracks alignments would follow the existing vehicle lanes and navigate around the underground parkade access ramps just west of Granville Street and east of Thurlow Street. Side loading stops are proposed to the east of Burrard Street and to the west of Thurlow Street. At the stop locations parking lanes would be used to allow space for the platforms. At the east end of the Canada Place stop, a signalized pedestrian crossing would be placed on the end of the platforms to replace the existing non-signalized crossing at Hornby Street. The figure below shows a typical section along West Cordova Street.

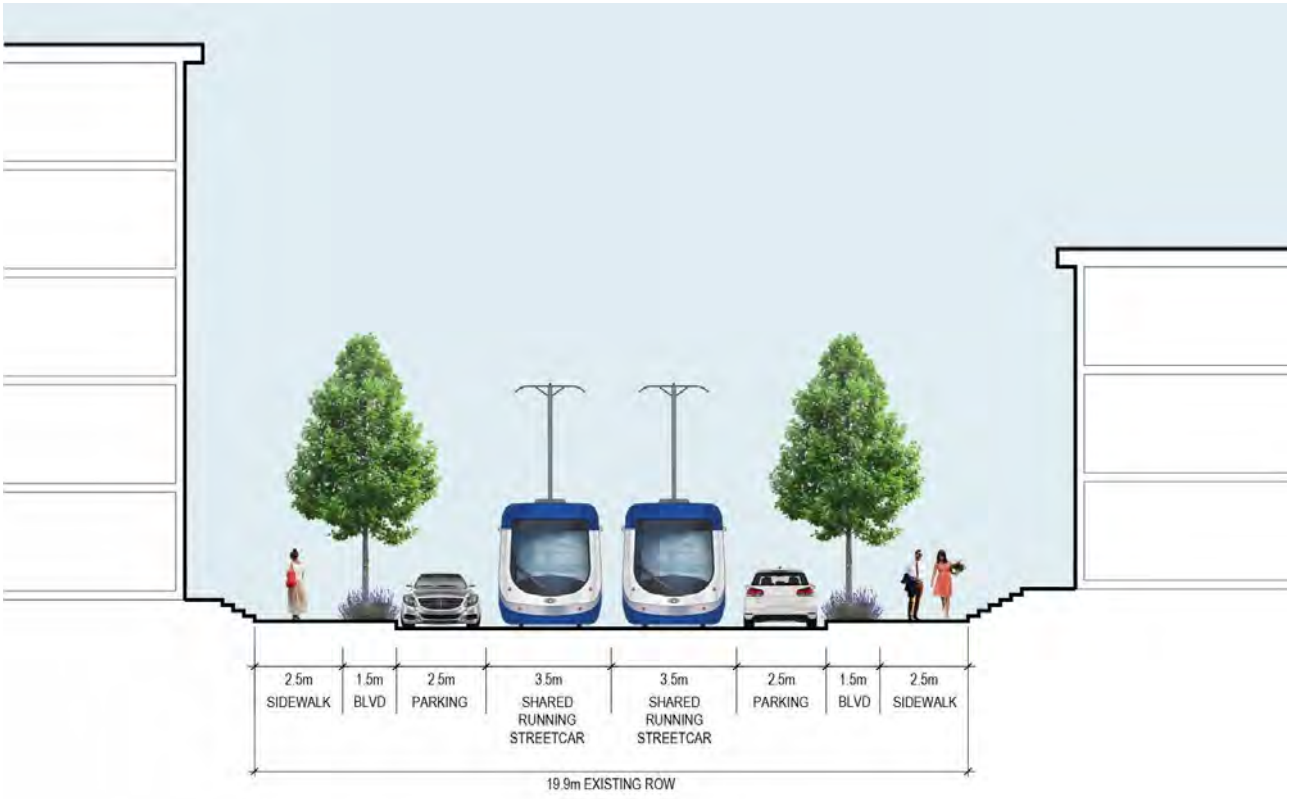


Figure 2-19 Cordova Street Typical Section

The streetcar is proposed to continue on West Cordova Street and after a stop near Thurlow Street, turn onto Bute Street, where the gradients and existing road layout is most favourable to reach West Hastings Street. The intersection of West Cordova Street and Bute Street would require signalization to allow for streetcar turning. The streetcar would continue as in-street shared running on Bute Street and then on Hastings Street where it would again follow the existing road alignment. On West Hastings Street, a stop location is proposed to the east of Nicola Street and the side loading platforms would utilize the parking lane space.

Two options were identified for the West Georgia Street section between the Cardero Street stop location and the terminus stop at Chilco Street, including a segregated single track and partially segregated dual track option (one of two streetcar tracks shared with bus traffic). Both options align with the Georgia Street Gateway concept but will require significant further study to navigate the complex alignment connecting West Hastings Street with West Georgia Street through Cardero Street. These options have been developed in such a way that it allows for a phased implementation by converting the single track option into the dual track option with minimum impact on the initial rail infrastructure. This phased approach may be beneficial if the streetcar frequencies were increased to beyond the capacity of the single track option, or the streetcar is extended further to the west.

Alternative fully segregated dual track options were not considered feasible in the current and planned alignment. These segregated dual track options on West Georgia Street were not carried forward because they either required removing a protected bike lane or shifting the complete road alignment of the Georgia Street Gateway layout.

In addition to the technical streetcar design the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, could be considered going forward:

- Waterfront Station to Burrard Street:
  - Widen sidewalks and plant street trees along West Cordova St at the Waterfront Station
  - Improve the Granville Street pedestrian overpass with public art or mural
- Burrard Street to Bute Street:
  - Consider pedestrian and cyclist circulation to the Convention Centre and Seawall
  - Frame views to the North Shore Mountains
  - Provide connection from Thurlow Street stop to Portal Park and enhance the park with updated public seating elements
  - Install additional public seating, facing towards the North Shore Mountains and the Seawall at Harbour Green Park
  - Investigate the potential to close Bute St between Hastings St and Cordova St to create an extension to Harbour Green Park.
- Coal Harbour:
  - Build the Jervis Street streetcar stop adjacent to Coal Harbour Park to connect people with green space and add additional seating elements
  - Draw inspiration and programming from the Coal Harbour Community Centre. Potential opportunity to redevelop the Community Centre parking lot
  - Maintain views to Stanley Pak and the North Shore Mountains at Broughton Street
- Devonian Harbour Park:
  - Integrate with Cardero Street bikeway
  - Explore the potential to close Cardero Street between West Hastings Street and West Georgia Street except to localized access
  - Investigate development opportunities and opportunities to create a dynamic pedestrian-oriented streetwall along West Georgia Street
  - Celebrate the end of the streetcar line and the arrival to Stanley Park with a public plaza at Devonian Harbour Park, near Chilco Street, with creative wayfinding and signage orienting people towards Stanley Park and the Seawall

2.6.1 Option 1: Single track on West Georgia Street

The first option includes a segregated single track streetcar alignment on West Georgia Street. This option aligns with latest concept and layout for Georgia Street Gateway, but reduces the sidewalk width on the north side to 4.3m and substitutes the boulevard for the streetcar track. West of Denman Street the streetcar track is proposed to shift north by approximately 10.4 m into the city-owned Devonian Harbour Park. This shift would allow for a platform at the south side of the track, approximately 40 m west of Denman Street. This platform can be converted to a centre platform if at a later time the single track would be converted to the double track in Option 2. The westbound protected bike lane, on the northern side of the track, crosses to the southern side after crossing Denman Street in order to better align with the bike lanes through Stanley Park and over the Lions Gate Bridge. The design will need to accommodate barriers at the corner of West Georgia Street and Denman Street to prevent cyclists from shortcutting the bike lane and crossing the streetcar track while crossing Denman Street. West of this intersection, there will be significant free space between the track and the bike lane to accommodate a potential future conversion to dual track. This space can be laid out as a boulevard until such a conversion is implemented.

The main advantage of this option is that it minimizes the impact on the latest concept and layout for Georgia Street Gateway and maximizes opportunities to maintain space for other modes on Georgia Street. However, it also imposes several challenges to streetcar operations. The return travel time between Cardero Street stop and Chilco Street terminus, including a 3-minute turnaround time, is approximately 8.5 minutes. This would mean the anticipated peak-hour headway of 8 minutes cannot be achieved. In addition, to achieve regular timetable departures (e.g. always leaving 5 minutes past the hour), the 3-minute turnaround time could typically be longer, worsening the conflict with the 8-minute headway. This would also impact the robustness of the service, since any delay will cause a knock-on effect to the rest of the network with vehicles waiting to enter the single track section before it has cleared, without any flexibility to recover from the disrupted timetables. Another challenge is that this 700-m single track section can not be operated on line-of-sight principles and would require a signal block operation to avoid vehicle movement conflicts and ensure safety.

In order to significantly reduce these operational challenges, this single track option includes a double track platform at the Chilco Street terminus to mitigate the above operational challenges. A double track platform negates the impact on the 8-minute headway as the travel time over the single track section is reduced to only 2.8 minutes. This improves service robustness and recovery time in case of disrupted timetables. The track will diverge into dual track west of Gilford Street, with the northern track shifting north by approximately 1.6 m to reach the proposed 6 m wide, centre loading, terminus stop opposite Chilco Street at the edge of Stanley Park.

Another significant challenge for this option is in the section between the Cardero Street stop location and turning onto West Georgia Street. To the west of Nicola Street, the streetcar tracks would become segregated through the currently pedestrianized portion of Hastings Street and return to shared in-street running on West Hastings Street before turning onto Cardero Street and finally onto West Georgia Street. The current ongoing development at 1575 West Georgia Street has outlined new curb lines on West Hastings Street in order to provide access to the building’s underground parking. Thus, the first 25 m of Hastings Street would be open to vehicles for access with an approximate curb to curb width of 10.8 m. Within this width, there are two 1.8 m uni-directional bicycle lanes on either side with 0.6 m buffers, leaving two 3 m wide vehicle lanes, See Figure 2-20 below for details.

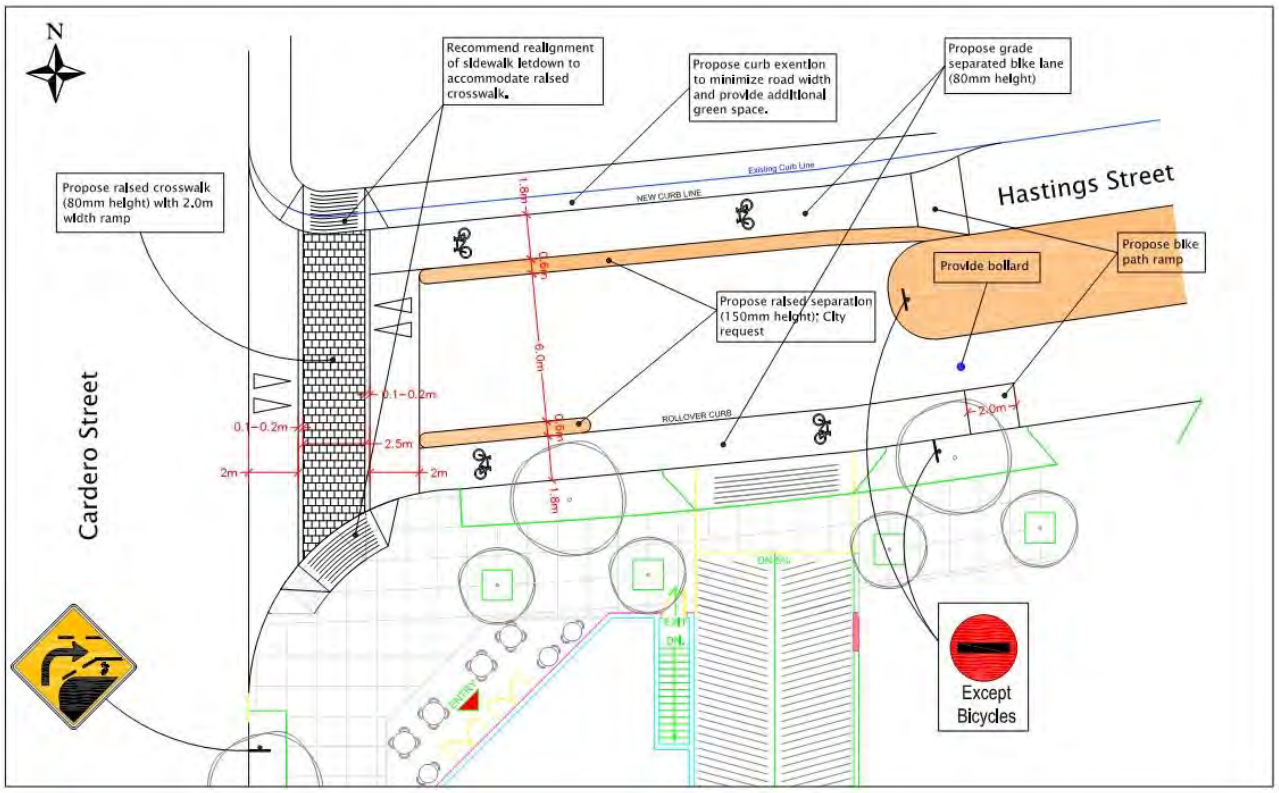


Figure 2-20 1575 West Georgia Street Development Plans

(Source: 1575 West Georgia Street Development Transportation Assessment, Exhibit 4.4 , Bunt & Associates Engineering Ltd for Bosa Properties)

This new configuration at the Cardero Street and West Georgia Street intersection would prove very difficult for the streetcar to maneuver and maintain the existing sidewalks. The streetcar tracks would need to shift to the north curb, eliminating the proposed protected bike lane space. This would assist the turning movement onto Cardero Street and maintain sidewalk space to the southeast of the intersection. The streetcar would remain in-street shared running on Cardero Street and immediately turn onto the north side of West Georgia Street. This turning movement may require some property easement at 699 Cardero Street. In this single track option, the streetcar would have to shift from dual track on West Hastings Street to single track on West Georgia Street. There is not enough space available within the tight curves navigating through Cardero Street to include the required turnout. This is further compounded by some significant grade changes which would require careful consideration.

The streetcar would therefore have to shift to single track prior to Cardero Street. The most obvious location for this turnout is the segregated track section on West Hastings Street. However, this creates other challenges, because it introduces a single track section that is in-street running in a section shared with other traffic. This means that the streetcar would run in the opposite direction of traffic flows, creating a safety risk. An advanced and integrated streetcar and traffic signalling system would need to be installed that controls the full single track section between West Hastings Street, through Cardero Street and up to West Georgia Street. This signalling system would need to ensure that there is no other traffic on this section before the streetcar proceeds. Given the tight curves and relative length of this section, this would result in long red cycles at traffic lights for road traffic. Furthermore, if road traffic is held up at Cardero Street due to congestion on West Georgia Street, streetcar vehicles are also blocked, significantly reducing service

reliability. The protected westbound bike lane on West Georgia Street will also need to cross the streetcar tracks in a safe location, preferably after crossing Cardero Street.

This area of the Coal Harbour alignment is challenging for the streetcar track to navigate through while accommodating for all other modes and accesses. A more detailed investigation would be required in this area to fully determine the solutions to the constraints and challenges presented by the street configuration. This should include investigating transport demand management measures to minimize road traffic on Cardero Street and the angle of cyclist crossings with the streetcar track.

2.6.2 Option 2: Dual track on West Georgia Street

The second option includes dual track along Georgia Street West. The alignment of one track is the same as for the single track option but converts the bus lane to a shared streetcar and bus lane travelling west. The bus lane would need to be widened from 3.2m to 3.5m to accommodate the streetcar, moving the curb line 0.3m north. This space has been accommodated for in the shyway of the single track option. The conversion of the bus lane to a shared bus and streetcar lane will therefore not impact the layout of the other road lanes, protected bike lanes and sidewalks. This allows for a phased implementation of dual track on West Georgia Street and thus requiring two lanes, for example if the network is extended to the west. However, to minimize construction impact, the bus lane construction should already account for streetcar track requirements, for example to accommodate the increased streetcar axle loads. In addition, the conversion of the bus lane to a shared bus/streetcar lane will impact bus operations and road traffic during the construction period.

West of Denman Street, the streetcar tracks will shift north and operate as segregated tracks. The alignment of the northern track (the eastbound track) is the same as in the single track option, while the alignment of the southern track (the westbound track) will fill the boulevard space between the other track and the bike lane. The Denman Street stop will be converted to a centre platform, as was already accommodated for in the single track option. At the 6m wide Chilco Street terminus centre platform stop, a crossover will be needed to shift operation direction after turnaround.

In this dual track option, the streetcar operates in the opposite direction on West Georgia Street compared to the rest of the network (i.e. westbound vehicles drive on the left track instead of the right track). This introduces multiple challenges, such as:

- Wayfinding and passenger orientation will be confusing at the Denman Street stop, because vehicles will depart from the ‘wrong’ platform. This is partially mitigated through a centre platform at this stop and can be further mitigated with clear signage at the stop.
- Pedestrian and cyclist crossings will need clear signage and/or pavement marking to indicate which way the vehicles come from. Further safety measures may include streetcar warning lights to advise cyclists and pedestrians that a vehicle is approaching.
- The streetcar terminus stop cannot be shared with bus traffic, because streetcar vehicles would block bus traffic during turnaround times (this has been mitigated by offsetting the streetcar track to the north past Denman Street).

In addition to the above, the largest challenge would be to shift the operation direction from West Hastings Street to West Georgia Street. As discussed for the single track option, the Cardero Street navigation is already highly complicated and shifting the operation direction will further complicate this alignment. However, running in opposite direction on the in-street shared Cardero Street section is also not desirable as streetcars would run opposed to road traffic, creating an unsafe situation. This necessitates a similar complex integrated traffic and streetcar signalling system managing the West Georgia Street – Cardero Street – West Hastings Street section as a single traffic area.

With such a system in place, the streetcar operation direction can be shifted either by a short single track section between West Hastings Street and West Georgia Street or a diamond crossing to the east/north of West Georgia Street. The drawings included in Appendix B include the single track option between West Hastings Street and West Georgia Street, because this utilizes the single track configuration of option 1 and has less impact on operation and other traffic during construction if the system is expanded from single to dual track. Since this section would need to be operated as a single traffic zone in order to avoid conflicts with other traffic, the impact on streetcar operations is limited. After turning onto West Georgia Street, a turnout from the segregated streetcar track to the shared bus/streetcar lane would revert operation back to dual track. As an alternative, a diamond crossover could be installed on Cardero Street if the alignment permits this. This would allow for continuous dual track operation, but would require more construction works on Cardero Street if Option 2 is implemented in a phased approach to extend option 1. Furthermore, this diamond crossover would still require the same traffic and streetcar signalling system to ensure safe operation between West Hastings Street and West Georgia Street as vehicles will switch operation direction.

Similar to Option 1, this area of the Coal Harbour alignment is challenging for the streetcar track to navigate through while accommodating for all other modes and accesses. A more detailed investigation would be required in this area to fully determine the solutions to the constraints and challenges presented by the street configuration. This should include investigating transport demand management measures to minimize road traffic on Cardero Street and the angle of cyclist crossings with the streetcar track.

2.7 Northeast False Creek

See drawings 388583-MMD-00-P0-DR-TR-1112 and 388583-MMD-00-P0-DR-TR-1113 in Appendix B.

The network segment of Northeast False Creek (NEFC) extends from Quebec Street at Prior Street to Pacific Boulevard at Cambie Street. The NEFC project has undertaken design for the removal of the Georgia and Dunsmuir Viaducts and consequently, through realignment, combining Expo Boulevard and Pacific Boulevard into a two-way street that connects into a new intersection configuration at Quebec Street and Prior Street.

The potential streetcar alignment through NEFC is in-street shared running and generally follows the curb side lane. There are a few occasions where right turn lanes are provided and therefore the streetcar would continue in the through lane. At the new Pacific Boulevard and West Georgia Street intersection, two right turn lanes from westbound Pacific Boulevard onto West Georgia Street are provided for. In order to accommodate these lanes, the streetcar track would transition through the Abbott Street and West Georgia Street intersections. This was identified as a challenging situation during the NEFC design work and would need to be closely studied during future development. The streetcar would then continue along Pacific Boulevard through the Cambie Street intersection into the Yaletown portion as detailed in Section2.8.

There are several stop locations in the NEFC portion, allowing easy access for users to Andy Livingstone Park, Rogers Arena, BC Place and Cambie Street. All platforms are 3 m wide side loading platforms. The streetcar would stop in the outmost vehicle lane and platforms placed between the vehicle lane and the segregated uni-directional protected bikes lanes, which are intended to be provided for the full length of Pacific Boulevard on both sides of the street. The NEFC area is home to several key event destinations and

parks; thus integration of the platforms with the adjacent pedestrian realm would provide potential additional event capacity and passenger waiting space.

In addition to the technical streetcar design the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, could be considered going forward:

- Explore a connection between the Cambie Street stop, Coopers Park and the Cambie Bridge pedestrian and bike ramp
- Incorporate public art and cultural programming under the Cambie Bridge, like the *Uninterrupted* video about salmon spawning that was projected under the bridge during the summer of 2017

2.8 Yaletown

See drawings 388583-MMD-00-P0-DR-TR-1113, 388583-MMD-00-P0-DR-TR-1123, 388583-MMD-00-P0-DR-TR-3112 and 388583-MMD-00-P0-DR-TR-3113 in Appendix B.

The Yaletown portion continues along Pacific Boulevard as in-street shared running in the curb lane similar to NEFC. The streetcar is proposed to turn west onto Drake Street. Each portion, Pacific Boulevard and Drake Street, were examined.

2.8.1 Pacific Boulevard

2.8.1.1 Option 1: Optimize Existing Street Elements

See drawings 388583-MMD-00-P0-DR-TR-1113 and 388583-MMD-00-P0-DR-TR-3112 Appendix B.

This option looks to maintain the existing street elements including left turn bays based upon the minimum design parameters. The proposed Pacific Boulevard cross section, with ROW of approximately 37.6 m is detailed in Figure 3-1 below. On either side of the street there would be 2.4 m sidewalks with 1.5 m buffers and 2.5 m unidirectional protected bike lanes with 1 m boulevards. Parking lanes would also be provided on either side leaving space for two eastbound and westbound lanes. Curb side lanes would be for shared in-street streetcar use. A 2.6 m median would allow space for a left turn lane for eastbound traffic from Pacific Boulevard to Cambie Street. The median space may also be allocated to left turn lanes at the Davie Street and Pacific Boulevard intersection.

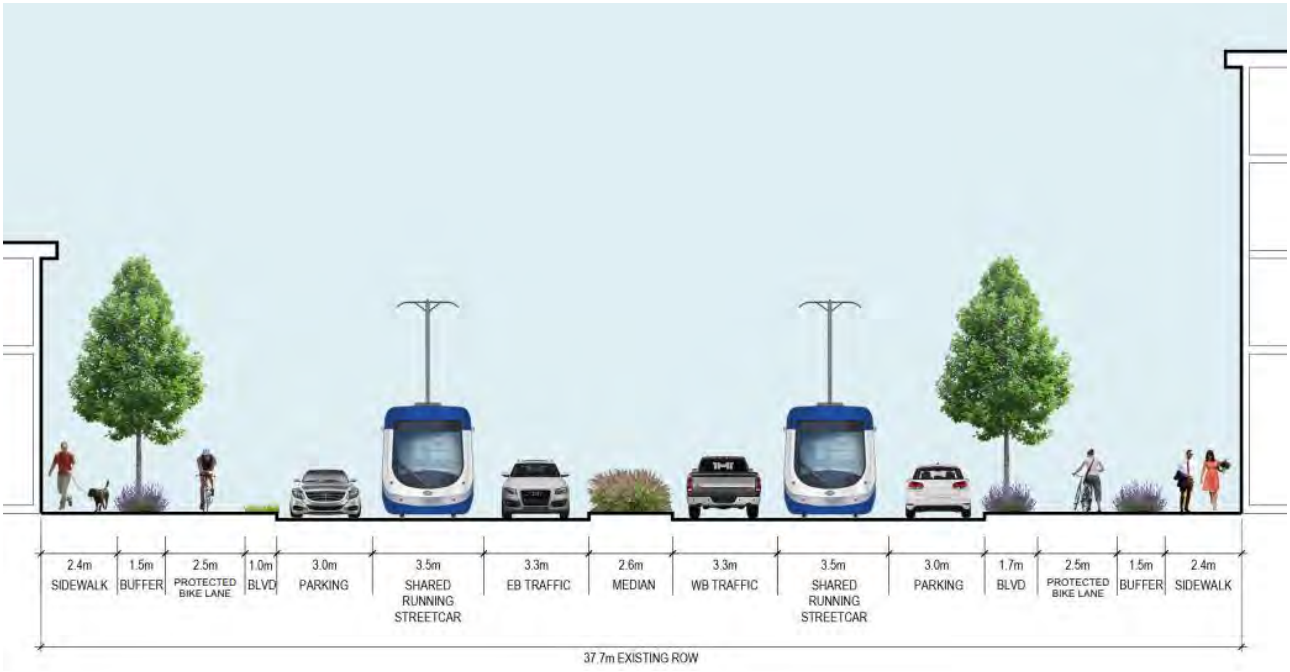


Figure 2-21 Pacific Boulevard – Option 1

Two 3 m wide side loading platforms are proposed to be staggered across the Davie Street intersection. This would provide an easy connection to the Canada Line Yaletown-Roundhouse Station. The platforms would be located on the far side of the intersection and would utilize the proposed parking lane space.

2.8.1.2 Option 2: Maintaining existing curbs and sidewalks

See drawings 388583-MMD-00-P0-DR-TR-1123 and 388583-MMD-00-P0-DR-TR-3112 Appendix B.

This option looks to maintain the existing sidewalks, street trees and curbs along Pacific Boulevard. It would place the bicycle lanes immediately adjacent to the existing curbs and include two vehicle lanes in each direction. This would eliminate the median space, and allowance for left turn lanes at key intersections would need to be looked at. The proposed Pacific Boulevard cross section, with ROW of approximately 37.6 m is detailed in Figure 3-1 below. The existing “grand” sidewalks with 1.5 m buffers would be maintained. Then 2.5 m protected bike lanes with 1 m boulevards are proposed on either curb. Parking lanes will also be provided on either side leaving space for two eastbound and westbound lanes. Curb side lanes will be for shared in-street running with streetcar.

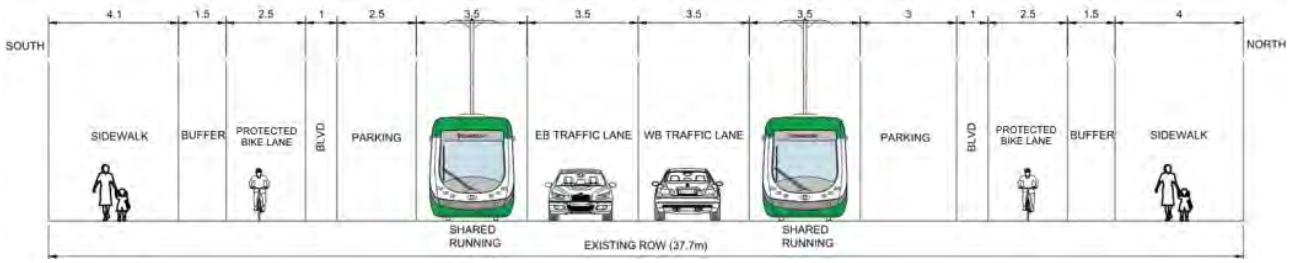


Figure 2-22 Pacific Boulevard – Option 2

Two 3 m wide side loading platforms are proposed to be staggered across Davie Street, this would permit easy connection to the Canada line, Yaletown Roundhouse Station. The westbound stop would be located to

the west of Davie Street and the eastbound stop to the east. Stop locations would be placed in the proposed parking lanes.

2.8.2 Drake Street

As the intersection of Pacific Boulevard at Drake Street is wide, the streetcar turn onto Drake Street would be feasible without any major constraints or any property impacts. As design progresses, bike lane crossing angles of the streetcar tracks would need to be considered. The streetcar would continue along Drake Street as in-street shared running until Seymour Street. To the west side of Seymour Street, the two tracks would transition to a single segregated running track to reach a single side loading terminus stop located at Granville Street. The block of Drake Street between Seymour Street and Granville Street would therefore become closed to vehicular traffic to accommodate the segregated streetcar track and stop platform.

Drake Street has an existing ROW of 20.1 m which currently includes for one lane each direction, parking and sidewalks. The proposed cross section includes 2 m sidewalks with 1 m buffers and 2.5 m protected bike lanes with 1 m boulevards on both sides. Then there are two 3.5 m in-streetcar shared running lanes. See Figure 2-23 below for details.

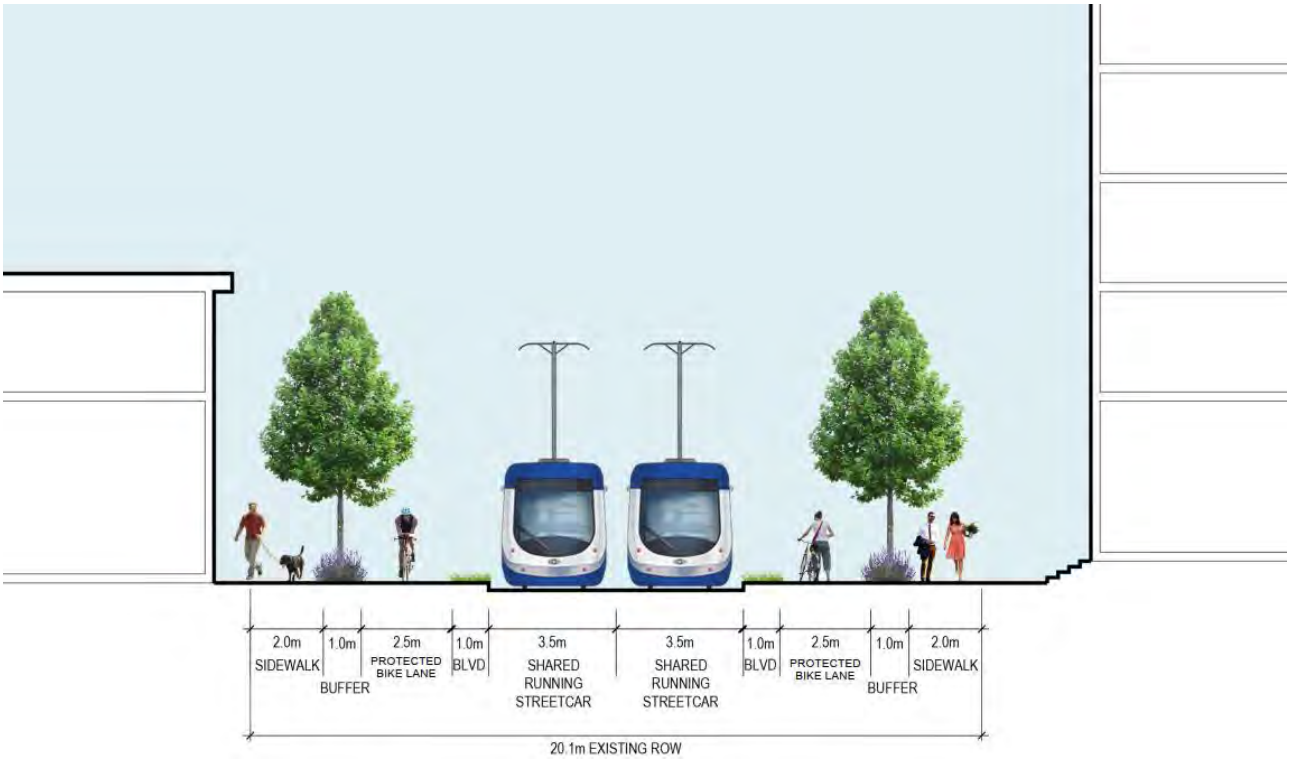


Figure 2-23 Drake Street – Option 1

It has been noted that this streetcar alignment option, which proposes to close one block of Drake Street to vehicle traffic, does have access implications in particular at Rolston Street. As part of future cycling network, it is envisioned that a protected bike lane would be provided for on Rolston Street to connect to seawall. Additionally, Granville Bridge Greenway and Rolston Street is not wide enough for two-way traffic with the normalization of the Granville Street Bridge cloverleaf ramps.

As there are several major projects along Drake Street and near the terminus at Granville Street, it is recommended that the streetcar routing be reassessed in the Yaletown neighbourhood. If further extensions to the streetcar network are to be considered, then Drake Street is not an ideal corridor as there is limited

opportunity for connections and right-of-way west of Burrard Street. Utilizing Davie Street or Pacific Boulevard to Beach Avenue may be better options for continuing the streetcar route into the West End.

In addition to the technical streetcar design the following public realm considerations have been identified by internal City project stakeholders (representatives from different City departments) or have been suggested by the urban realm consultant team, could be considered going forward:

- Draw inspiration and programming from the Roundhouse Community Arts and Recreation Centre
- Consider pedestrian and cyclist connections to David Lam Park, the Seawall and the David Lam Park Ferry Dock
- Provide cycling connections to the Granville bridge Greenway at the Drake Street at Granville Street intersection as well the seawall via Rolston Street
- Drake Street bike facilities could either be two uni-directional protected bike lanes on each curb or one bi-directional protected bike lane on the south side of the street; however, it is currently understood that bidirectional facilities are preferred
- With the Granville Bridge cloverleaf ramp replacement, the access and circulation changes and becomes very constrained for Drake Street as well as other streets in the area such as Rolston Street
- Several other major transportation projects are being implemented in the area of Drake Street at Granville Street

3 Operations and Maintenance Facility

As briefly discussed in the *Design Consideration Report* (388583-MMD-00-P0-RP-TR-0001), streetcar vehicles require a facility in which they are to be stored and maintained. This operations and maintenance facility (OMF) must be in close proximity to the streetcar network and is tailored to the streetcar vehicle fleet, which would be different to the SkyTrain and Canada Line vehicle fleets. Space requirements for such a facility are determined by fleet size and the required maintenance intervals. General considerations for facility planning include the size and type of vehicle, the requirements for staff facilities and whether an operations control centre is required. These considerations and sizing information were developed and are captured in *Operations and Maintenance Facility Sizing Information Memo* (388583-MMD-00-P0-MO-TR-0002) in Appendix C. The memo was developed as a high-level guide to advise on the potential size and requirements to be factored in when determining a site location for an OMF within close proximity of the potential Vancouver streetcar network. It also includes how the OMF site could be broken into two locations if additional land is found elsewhere along the network.

The City has grown and developed over the past couple of decades and the property that was previously identified to house the maintenance facility, 800 Quebec Street, is now slated to be developed as part of the Northeast False Creek (NEFC) project. Additionally, the planning vision and area plans for NEFC and the False Creek Flats area have gone through significant changes. Thus, it has been necessary to identify a potential new maintenance facility location. This study has updated the size requirements to be based on the latest industry best practices and the latest fleet size estimation for the streetcar network and looked to identify some potential OMF site options.

As outlined in the *Operations and Maintenance Facility Sizing Information Memo* (388583-MMD-00-P0-MO-TR-0002) the following items are considered key components for the OMF site:

- Storage tracks for an assumed ultimate fleet size of 22 cars (includes vehicles required for the AGP, whereas only 18 cars, including spares, are required in the interim)
- Maintenance bays for minimum three cars, up to a fleet of 30 cars
- In-floor wheel lathe, with space for two cars (preferred) or mobile wheel lathe
- Wash plant with plant room
- Traction power substation
- Office space and crew facilities, including control room and storage
- Staff parking

For the OMF site to operate efficiently, minimizing reversing movements are preferred where possible. In particular, the following processes are recommended to be completed in one movement:

- Entry from mainline – Wash Bay – Stabling
- Entry from mainline – Stabling
- Entry from mainline – Workshop
- Stabling – Workshop
- Stabling – Exit to mainline

3.1 Options

Several site options were initially identified for the OMF as outlined in Table 3-1 below. These options were identified as to test the size and shape of potentially available land, and to showcase the suitability of some parcels over others. Four sites were selected as suitable sites in the False Creek Flats area for these exploratory purposes. The four sites chosen were located off the main network line and would require a network extension to gain access. Although a network extension would be required, each site and its associated extension has added benefits to the overall streetcar network by allowing for an additional stop and connection to either the Broadway Subway Great Northern Way Station or the new St. Paul's Hospital campus. Ultimately, the OMF site should be selected based on site availability as well as evaluating the False Creek Flats neighbourhood connections. The site options could be looked at further through a multiple account evaluation if the City wants to understand the trade-offs of the different sites. Site availability and costs are not the sole governing criteria in determining which OMF site option to carry forward. It is also likely that the OMF site selection would be tied to the ongoing False Creek Flats and Eastern Core Strategy development.

Table 3-1 Identified Potential OMF Sites

Site	Site Location	Size (m^2)	Considered Further?	Reason not considered further
1.	235, 247 and 273 East 1st Avenue	11,700	Yes	-
2.	425 & 455 Industrial Avenue	21,900	Yes	-
3.	459 & 649 Industrial Avenue	18,900	No	Unlikely to obtain property from existing owners, Canadian National Railway
4.	701 National Avenue	23,000	Yes	-
5.	525 W 6th Avenue, 550 Commodore Road, 510 Commodore Road and 2132 Ash Street (Canada Line Parking Lot)	26,000	No	Site has high development potential and currently has modular housing.
6.	1850 Spyglass Place, partial area (East side of Cambie Street Bridge)	12,500	No	Property currently has proposed development plans under the SEFC plan
7.	Lorne St to 336 E 1st Ave	10,600	No	These properties are residential and to be mixed-use as part of the False Creek Flats plan.
8.	339 and 375 East 1st Ave	14,700	No	Site has development permit application in progress
9.	247, 273 and 339 E 1st Ave	14,300	No	339 East 1st Avenue has development permit application in progress
10.	1802 Thornton Street and PCI (475 E 1st Ave)	7,290	No	Site is constrained as Broadway Subway passes diagonally through PCI site
11.	302 and 460 Industrial Avenue and 235 East 1st Avenue	4,900	No	Constrained site size and would require land acquisition from Canadian National Railway
12.	1100 Station Street, (Partial area of Pacific Central parking lot)	650	Yes	-
13.	800 Quebec Street	5,900	No	Land to be developed as part of the NEFC project

The following sections describe the potential OMF sites that have been considered further.

3.1.1 Site 1 - 235, 247 & 273 East 1st Avenue

See drawing 388583-MMD-00-P0-DR-TR-4101 in Appendix D.

Site 1 is situated at 235, 247 and 273 East 1st Avenue. This property is not owned by the City of Vancouver and land acquisition would be required.

Streetcar access to Site 1 is assumed to be from a new signalized intersection, joining Lorne Street and Station Street (see Figure 2-9 for details), to the west side of the site. Upon entry the streetcar could continue on the main line to the wheel lathe and workshop or take the first switch to the wash bay or the second switch to the bypass track. From the washing bay or bypass track, this track would lead to the storage tracks on the north of the site. The proposed stabling would allow for storage of 15 cars which is split by the access track. Nine spaces would be available to the east and an additional six cars to the west which would require reverse movements to gain access.

A large building to the south of the site would accommodate the workshop and in-floor wheel lathe which would have bays for five streetcar vehicles. This brings the total site capacity to a total of 20 cars. The building would also provide office space including storage and a control room. Staff parking would be placed in the middle of the site between the main workshop-office building to the south and the stabling to the north. Access to the parking area would be from the west of the building, across the maintenance bay lead track, off of East 1st Avenue. It is not ideal to have the parking access cross the tracks, but with the constrained site there are limited locations to place the parking.

Site 1 only has storage for 15 cars in the stabling area and additional storage would need to be found elsewhere along the network. From an operational point of view the site could function but requires several reverse movements, particularly when accessing the workshop from the stabling area. The total site area is approximately 11,730 m^2, which is below the recommended area of 12,320 m^2, and does not offer room for future expansion.

The track extension on East 1st Avenue to access the OMF site would provide an opportunity to place a stop location at Thornton Street. This stop would provide easy access to the Broadway Subway Great Northern Way station and create an overall improved transit network with multiple connections to another rail rapid transit services.

3.1.1.1 Alternative Access via BNSF ROW

See drawing 388583-MMD-00-P0-DR-TR-4102 in Appendix D.

As discussed in Section 2.4.1.3, an alternative alignment to connect to this OMF site is via the BNSF ROW located along the southern edge of the BNSF ROW. This alignment option would provide access to the OMF site 1 (235, 247 and 273 East 1st Avenue) from the back side of the property. This alignment option removes the streetcar from East 1St Avenue which would eliminate any bicycle-track crossings that were necessary to access the OMF site 1 from East 1st Avenue. However, this alignment alternative is unlikely due to requiring the purchase of lands/ROW from BNSF.

With the alternative streetcar track alignment to access the site, a new layout would be necessary to provide the ideal operational efficiency. This alternative site layout would have storage for 13 cars in the stabling area and additional vehicle storage would need to be found elsewhere along the network. From an operational point of view the site could function but requires several reverse movements, particularly when accessing the workshop from the stabling area. The total site area is approximately 11,730 m^2, which is below the recommended area of 12,320 m^2, and does not offer room for future expansion.

The track extension via BNSF ROW to access the OMF site would provide an opportunity to place a stop location at Thornton Street in 1802 Industrial Avenue. This stop would provide easy access to the Broadway

Subway Great Northern Way Station and create an overall improved transit network with multiple connections to another rail rapid transit services.

3.1.2 Site 2 – 425 & 455 Industrial Avenue

See drawing 388583-MMD-00-P0-DR-TR-4102 in Appendix E.

Site 2 is situated at 425 and 455 Industrial Avenue. This property is owned by the City of Vancouver and is currently occupied by several tenants including Busters Towing.

Streetcar access to Site 2 would be from the Industrial Avenue at Scotia Street intersection, to the southwest of the site. Two switches placed on the main line would allow for entry and exit to the site and a further access could be considered from the end of the tracks at any adjacent stop location. Upon entry via the eastern lead the streetcar would first pass through the wash plant, with an option to use a bypass track. The streetcar would continue around a 25 m radius curve to reach the stabling yard or the maintenance bays. The stabling would consist of nine tracks which could store up to 17 cars and would lead back to the main service line. The in-floor wheel lathe would be placed to the north of the stabling area off the maintenance bays lead. Access to the workshop and wheel lathe could be complete in one movement on arrival to the OMF site. Reverse movements would be required to access the workshop and wheel lathe from the stabling area. The workshop and wheel lathe would provide additional storage for five cars taking the site total capacity to 22 cars.

The workshop-office area and staff parking are to be located to the northwest corner of the site. The building shall be split over two floors to ensure sufficient office space, storage and a control room can be provided for. The staff parking can be accessed from Scotia Street.

Site 2 would only have storage for 17 cars in the stabling area and would require additional storage to be located elsewhere along the network. From an operational point of view the site could function well with few reverse movements needed. Although reverse movements would be required to access the workshop from the stabling area, the track length between the wash bay and stabling (approximately 85 m) would provide ample space for car movements. The total site area is approximately 21,895 m^2, which is above the recommended area of 15,280 m^2 for double ended storage. However, due to the orientation of the site layout, the area to the southeast is not fully utilized. This space gives the City an opportunity to potentially lease this area to a new tenant or the City could combine this remaining space with the adjacent property, 457 Industrial Avenue, which would increase the area making the space more appealing to potential tenants or a developer. If 401 Industrial Avenue or 457 Industrial Avenue were to be acquired, a new site layout could be explored and room for future expansion could be accommodated.

The track extension on Industrial Avenue to access the OMF site would provide an opportunity to place a stop location near Thornton Street. A pedestrian and bicycle bridge over the existing BNSF rail tracks through the Thornton Street corridor would be beneficial to provide access to the Broadway Subway Great Northern Way Station and Emily Carr campus. This element would create an overall improved transit network with multiple connections to another rail rapid transit services.

3.1.3 Site 4 – 701 National Avenue

See drawing 388583-MMD-00-P0-DR-TR-4103 in Appendix F.

Site 4 would be situated on part of 701 National Avenue, mainly utilizing the southern half of the site. This property is owned by the City of Vancouver and is currently occupied by the National Works Yard. This site has several existing uses as well as has potential for additional uses prior to the implementation of the streetcar network. It is anticipated that the existing works yard would be reconfigured to enable placement of

the OMF site. However, it is unlikely for the works yard to be reconfigured or relocate as the City is looking to expand the facility.

Streetcar access to Site 4 would be from the National Avenue at the Thornton Street intersection, to the southwest of the site. As there are no stop locations to the east of Thornton Street both tracks would continue directly into the OMF site. Upon entry via the eastbound track, the streetcar would first pass through the wash plant, with an option to use a bypass track. The streetcar would then use a 25 m curve to connect to the stabling yard and maintenance bays. The stabling yard consists of seven tracks, storing three cars each, to store a total of 21 streetcar vehicles. From the stabling area an exit track leads back to the main service line. Access to the workshop and wheel lathe could be complete in one movement on arrival to the OMF site. Reverse movements would be required to access the workshop and wheel lathe from the stabling area. The workshop and wheel lathe would provide additional storage for five cars taking the site total capacity to 26 cars.

The staff parking to the north west of the site could be accessed from Thornton Street. The proposed, single floor office space to the southwest of the site workshop would provide sufficient room for administration staff, storage and a control room. The wheel lathe and workshop are proposed in-between the parking area and office space.

Site 4 stabling area would reach the suggested storage capacity of 22 cars. From an operational point of view the site could function well with few reverse movements needed. Although reverse movements would be required to access the workshop from the stabling area, the track length between the wash bay and stabling (approximately 150 m) would provide ample space for car movements. The total site area required for the OMF is approximately 23,040 m^2, which is above the recommended area of 15,280 m^2 for double ended storage. This would leave approximately 28,260 m^2 of the site for the works yard. Ultimately Site 4 offers the recommended storage capacity and has potential for future expansion on 701 National Avenue. Operationally the site would have good functionality and provide good access to the office and parking area.

The track extension on National Avenue required to access the OMF site provides an opportunity to place a stop location for the new St Paul's Hospital. This additional stop location would be beneficial and create an overall improved streetcar network.

3.1.4 Site 12 - Pacific Central Site – 1100 National Avenue

See Figure 3-1 below for layout details.

It is preferred that OMF sites contain all facilities required for the network within one location. However, this is not always possible due to land availability and potential site locations. An area was identified at 1100 National Avenue, where the current Pacific Central parking lot is located, as a potential area to provide streetcar stabling. This site is not owned by the City of Vancouver and land acquisition would be required.

Site access is proposed from National Avenue. The stabling area would consist of six tracks which could store up to 24 cars. The southmost track, shortest length, could store three cars and the longest, northmost track could store five cars. Entry to the site could be from either side is streetcar tracks are provided along National Avenue to Thornton Street. This would assist with operations as it would allow cars to enter and exit from either side back to the main service line. Ideally the full maintenance workshop would be located at a nearby site to reduce the amount of unnecessary long empty runs. There is potential that the full maintenance workshop could be placed at Site 4, 701 National Avenue. This would reduce the area required at 701 National Avenue and provide easy access between the stabling area and workshop area.

Ultimately this site would provide more than the recommended storage capacity. However, this additional storage capacity assists with any future expansion of the streetcar network. The operation of the stabling

area would have good functionality but depending on where the full maintenance workshop is located functionality could be affected.

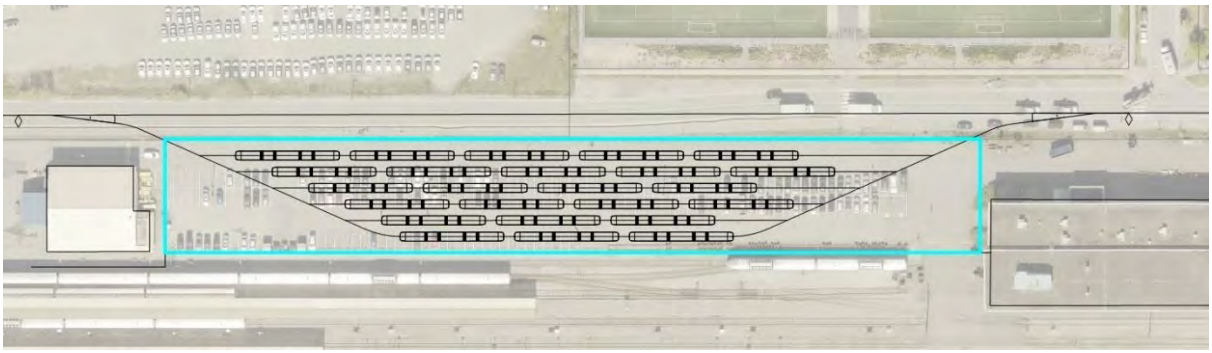


Figure 3-1 Pacific Central Site Layout

3.2 Overbuild

Given land availability and affordability in Vancouver, there is also a possibility of creating an overbuild development on top of any OMF site. This type of construction does come with its limitations, however, in that the required footprint of the site is likely to increase given the additional structural supports that would be required to support the overbuild development, limited ability to expand in the future, blocking out of natural light and less flexibility in terms of track layout and flexibility. Covered storage facilities are also a possibility for additional protection of the cars overnight and when not in service. This type of storage can then lead to a smaller development over the top such as car parking. Generally, overbuild considerations can be applied to any OMF site location and would need to be tailored to the context of the site.

Overbuild was not originally considered for the OMF site option layouts. However, in recognition of the False Creek Flats Plan, and the economic significance of the False Creek Flats area, where most of the potential OMF sites are located, it has been explored further. Site 1 and Site 2 are zoned I-3, which means that the sites are zoned for intensified employment via office development and a part of the Creative Campus area of False Creek Flats.

With the high development potential of these sites it is recommended that accommodating a multi-storey (4-6 storeys) building over the OMF be evaluated further. Initial alternative layout for Site 1 and 2 have been developed using basic assumptions but as further details of the False Creek Flats Plan are realized and evaluation of all OMF site options is looked at, refinement of these layouts should be progressed. An overbuild structure could include either steel or concrete (0.9 m diameter) columns typically spaced at 6-7.5 m centres in each direction of a grid or use larger steel columns and portal frames with larger spans over multiple tracks. Steel construction could also be conducive to larger column spacing and portal frames to provide higher vertical clearance. However, there are concerns regarding the crash resistance of the steel columns. Also, consideration for the noise and vibration in the facility and the office space use will help to determine what construction type should be used for the facility.

At a minimum, the foundations of the OMF should be futureproofed in case the overbuild use changes or has permission to be increased at some point in the future. There should also be considerations for the access and egress, including emergency egress, of the overbuild space. If the overbuild space needs parking for tenants, how and where this parking is to be provided should be considered. There could be a possibility to place the parking underground but ground conditions in the False Creek Flats areas would need to be carefully considered in addition to accommodating the access to the parking and overbuild space. These accesses would likely occupy space within the OMF site boundary and constrain the OMF layout and

functionality. As design progresses, detailed OMF site layouts considering overbuild and all the potential requirements of the overbuild space will need to be further investigated.

For Site 1, the overbuild layout considered the alternative site access via the BNSF ROW. As the site is smaller and constrained, the potential layout is conducive to utilizing larger columns that are spaced further apart, spanning multiple tracks or maintenance bays at a time. This layout can be seen in 388583-MMD-00-P0-DR-TR-4102 in Appendix D. This layout would have storage for 13 cars in the stabling area and additional vehicle storage would need to be found elsewhere along the network. From an operational point of view the site could function but would require several reverse movements, particularly when accessing the workshop from the stabling area

For Site 2, the overbuild layout considered a regular grid of columns spaced throughout the site. This required the track layout to include as much uniform and parallel trackwork as possible that is also parallel to the site property lines. Non-parallel trackwork would be concentrated in one area that could be bridged by the overbuild structure. This layout can be seen in 388583-MMD-00-P0-DR-TR-4202 in Appendix E. The layout would have storage for 22 cars in the stabling area and additional vehicle storage would need to be found elsewhere along the network. From an operational point of view, access from the mainline directly into the maintenance bays or stabling yard could be accommodated easily. However, to move from the stabling yard to the storage bays or wheel lathe would require a reverse movement.

3.2.1 Interim use of space

As the timelines for the streetcar are unknown and the redevelopment of False Creek Flats is likely to occur before its implementation, should the City decide to pursue the use of one of these sites, some consideration should be given to the use of the potential OMF sites prior to the streetcar implementation . Otherwise, the City can consider the availability and suitability of other sites once and if the project progresses.

Of the sites that were fully considered, two are already city-owned with existing uses and tenants. These tenants could remain in place on the sites as they are today, with redevelopment of the site occurring at the time of streetcar network implementation. Another possibility is for the City to redevelop the site and allow for overbuild. The office space could be utilized by its ultimate tenement, with an interim use occupying the first storey that would eventually become the OMF.

For the two sites the City does not own, there are several possible options for how the City could pursue acquiring the property. One option would be to wait until the site is put on the market by current owners. Another option would be to more actively pursue the acquisition of the property. Once acquired the City could then redevelop the site with overbuild and an interim use on the first storey or lease it temporarily until the streetcar is implemented.

Potential interim uses of the first storey of the structure should consider the False Creek Flats plan and the temporary nature of the tenancy. It is not ideal to locate something in the space that would become a community asset that the public would not want to see removed. Nor should the interim use have the potential to damage or destroy the integrity of the final OMF space. Thus, interim uses that support the functioning of the city would be recommended. These could include, but are not limited to, bus and/or HandyDart vehicle storage, electric bus storage and charging, or a towing yard. As the streetcar network design is further progressed and False Creek Flats Plan becomes realized, further discussion will be necessary.

3.3 Vehicle Storage along network

In addition to the storage of vehicles at the OMF, there could be an opportunity to store vehicles along the network. The *Streetcar Design Considerations Report* (388583-MMD-00-P0-RP-TR-0001) describes what needs to be considered for the design of such storage. Potential locations that have been identified for

vehicle storage along the network are in the False Creek South section of the alignment along the existing railway corridor. This location on the network provides the advantage of being closer to the western end of the network than the OMF site options, and thus providing faster service start-up and ramp-down. The potential maximum storage capacity for these locations has been determined, but the actual length that will be required needs to be determined based on the selected OMF location and its storage capacity and the service plan.

The first potential vehicle storage location is between the Sitka Square stop and Moberley Road. This siding has a potential length of up to 480 m that would provide storage capacity for up to 14 vehicles. This siding is in a segregated area, which simplifies implementing security measures. A crossover on the west side of the siding would allow for vehicles to continue operations in both the west and east direction. See drawing 388583-MMD-00-P0-SK-TR-4401 and -4402 in Appendix G.

The second potential vehicle storage location is between Heather Street and Cambie Bridge. This siding has a potential length of up to 285m that would provide storage capacity for up to 8 vehicles. Security measures such as fencing could be implemented in this location to protect stored vehicles from vandalism. This siding location is in a highly visible and developable location within the City, and it may not be an ideal location to have a fenced vehicle storage area. A crossover on the west side would allow for vehicles to access the storage siding when their service has ended at the west end of the line. However, the eastern end of the siding track is constrained by the Cambie Street bridge piers/columns and the existing pathways that are located under the bridge. Further investigation is required in order to confirm if there is sufficient space for the eastern end to tie in while accounting for the horizontal and vertical geometry of the mainline tracks. If the eastern tie in is not feasible then this siding could be installed as dead-end track that is able to store 8 vehicles, however there are challenges with a dead-end track as noted in the Streetcar Design Considerations Report. Further consideration for the placement of fencing around this storage track is needed due to the higher pedestrian traffic in the area who are connecting from the SEFC neighbourhood to south of the storage and mainline tracks. See drawing 388583-MMD-00-P0-SK-TR-4402 in Appendix G.

4 Ridership

This section provides an overview of the assumptions and results of the ridership forecasting completed for this feasibility study. It outlines the streetcar service and operations assumptions, based on travel times and traffic operations. It also outlines land use assumptions including streetcar stops population and employment catchment analysis.

Ridership forecast was done using Regional Transportation Model (RTM) Phase 3.2 which is maintained by TransLink. The RTM is a four-step multi-modal transport model with 2011 and 2016 base years and 2035 and 2050 horizon years.

4.1 Streetcar Modelling Assumptions

4.1.1 Service Frequency

The 2004 Benchmarking Exercise: 6 Streetcar Systems Around the World Report stated that frequencies at peak service typically operate between 6–10 minutes and 12–20 minutes during off-peak service while the Tourist and Recreational Usage of Proposed Downtown Streetcar Report recommends service frequency to be 10 minutes or less. For the purposes of this feasibility study, it is recommended that the Vancouver Streetcar operates an 8-minute peak service headway for ridership forecasting. This aligns with the assumptions in the 2005 Downtown Streetcar Design, Layout and Ridership Study and Arbutus Greenway Project. Additionally, an 8-minute peak service aligns with TransLink's frequent transit network service definition. An 8-minute peak service is similar to many European tramways' peak frequency but higher than most North American streetcar systems. The service frequency should be examined further and adjusted to balance further ridership forecasting efforts with system service, operations and objectives.

4.1.2 Alignment and Stops

Based upon the alignment options developed and presented in Section 2, two streetcar routes were developed. These streetcar alignments and stops are shown in Figure 4-1. Two streetcar services were modelled and described as follows:

- Broadway/Arbutus to Chilco Street: Arbutus Street at West Broadway through False Creek South, Southeast False Creek, Gastown, Waterfront and Coal Harbour to Chilco Street
- Thornton Street to Granville Street: East 1st Avenue at Thornton Street through False Creek Flats, Northeast False Creek and Yaletown to Drake Street at Granville Street

While the alignment is bi-directional dual track for most of the network, the Broadway/Arbutus to Chilco Street service would be one-way between Columbia Street and Richards Street if using couplet options through Gastown. The northbound service would run on Powell Street/Water Street and the southbound service would run on Cordova Street.

Both services operate with 8-minute headways for the AM peak and PM peak (with 4 minutes in the shared section between Main St/Science World and Prior St), and 16-minute headway for the midday period (with 8 minutes in the shared section between Main St/Science World and Prior St).

Figure 4-1 Streetcar Alignment, Stops and Routing

4.1.2.1 Distance and Runtime

The station-to-station distances and runtimes are shown in Table 4-1. Dwell times of 20 seconds are assumed at each station. It is assumed that the travel time would be the same in both directions.

Table 4-1 Station-to-Station Distances and Runtimes

Station	Distance (m)	Travel Time (min)	Dwell Time (min)	Total Time (min)	Average Speed (kph)
ARBUTUS					
West Broadway	-	-	-	-	-
Burrard Street	707	2.43	0.33	2.8	15
Granville Island	955	4.67	0.33	5.0	11
Total	**1,662**	**7.10**	**0.66**	**7.8**	**13**

Station	Distance (m)	Travel Time (min)	Dwell Time (min)	Total Time (min)	Average Speed (kph)
PHASE 0					
Granville Island	-	-	-	-	-
Sitka Square	796	1.23	0.33	1.6	30
Cambie Street	908	1.80	0.33	2.1	26
Cook Street	495	1.30	0.33	1.6	18
Manitoba Street	335	1.72	0.33	2.1	10
Science World	623	1.90	0.33	2.2	17
Prior Street	407	1.37	0.33	1.7	14
Total	**3,564**	**9.32**	**2.00**	**11.3**	**19**
PHASE 1					
Hastings Street	526	2.22	0.33	2.6	12
Gastown/Abbott	415	1.82	0.33	2.2	12
Waterfront	455	1.87	0.33	2.2	12
Total	**1,396**	**5.90**	**1.00**	**6.9**	**12**
STANLEY PARK EXTENSION					
Canada Place	383	2.05	0.33	2.4	10
Thurlow Street	300	0.80	0.33	1.1	16
Jervis Street	468	1.43	0.33	1.8	16
Cardero Street	369	1.77	0.33	2.1	11
Denman Street	438	1.40	0.33	1.7	15
Chilco Street	266	0.77	0.33	1.1	15
Total	**2,224**	**8.22**	**2.00**	**10.2**	**13**
PACIFIC BLVD EXTENSION					
Prior Street	-	-	-	-	-
Pat Quinn Way	376	1.77	0.33	2.1	11
West Georgia Street	269	1.65	0.33	2.0	8
Nelson Street	401	1.80	0.33	2.1	11
Davie Street	568	2.00	0.33	2.3	15
Granville Street	544	1.10	0.33	1.4	23
Total	**2,158**	**8.32**	**1.67**	**10.0**	**13**
THORNTON STREET EXTENSION					
1st Avenue/Thornton	-	-	-	-	-
Science World	986	3.38	0.33	3.7	16
Total	**986**	**3.38**	**0.33**	**3.7**	**16**

Table 4-2 summarizes the total length and travel times for the two services.

Table 4-2 Streetcar Operation Assumptions

Line	Distance (m)	Travel Time (min)	Dwell Time (min)	Total Time (min)	Average Speed (kph)
Broadway/Arbutus – Chilco Street	8,846	30.54	5.66	36.2	15
Thornton Street – Granville Street	3,551	13.07	2.33	15.4	14

4.1.3 Streetcar Traffic Segregation

As outlined in the Design Consideration Report (388583-MMD-00-P0-RP-TR-0001) there are various levels of segregation that can be provided for streetcar when it operates in an urban environment such as Vancouver. As determined through the preliminary development of the alignment options, the traffic segregation for the potential alignment is described in Table 4-3. Note that streetcar travel times have been 'hard coded' based on the streetcar runtimes developed from a high-level calculation which considered the level of segregation, the prevailing street conditions and the number of intersections on the route.

Table 4-3 Streetcar Traffic Segregation

From	To	Phase	Segregation
Broadway / Arbutus	6th Avenue / Fir Street	Arbutus	Fully segregated
6th Avenue / Fir Street	Granville Island	Arbutus	Shared in-street
Granville Island	2nd Avenue / Quebec Street	Phase 0	Fully segregated
2nd Avenue / Quebec Street	Main Street / Pacific Boulevard	Phase 0	Shared in-street
Main Street / Pacific Boulevard	Main Street / Powell Street	Phase 1	Shared in-street
Main Street / Cordova Street	Cordova Street / Richards Street	Phase 1	Shared in-street (one way)
Main Street / Powell Street	Cordova Street / Richards Street	Phase 1	Shared in-street (one way)
Cordova Street / Richards Street	W Georgia Street / Denman Street	Stanley Park Extension	Shared in-street
W Georgia Street / Denman Street	W Georgia Street / Chilco Street	Stanley Park Extension	Fully segregated
Main Street / Pacific Boulevard	Drake St/Granville St	Pacific Blvd Extension	Shared in-street
1st Avenue / Thornton Street	1st Ave/Quebec St	False Creek Flats Extension	Shared in-street

4.1.4 Road Network Changes

No lane reductions have been assumed at this point of the planning process and have not been included in the modelling.

4.1.5 Transit Integration Changes

As part of the modelling assumptions, several bus routes were modified in the modelling process to reduce duplication of bus service with the potential streetcar. These included:

- #019 Metrotown/Stanley Park; Serviced truncated at Main St SkyTrain station. Service would operate between Metrotown and Main St SkyTrain station
- #023 Main St Station/Yaletown/Beach; Service truncated at Pacific & Drake. Service would operate between Yaletown and English Bay
- #050 Waterfront Station/False Creek South; Service eliminated. Coverage to downtown from Granville Island via the Granville Bridge would be provided by parallel routes (#004, #007, #010, #014, #016)
- #084 UBC/VCC Clark Station; Service unchanged but has been identified for future consideration based on capacity of streetcar and the Broadway Subway Project

4.1.6 Transit Fares

Streetcar transit fares are assumed to be integrated with the regional fare system and consistent with current fare structure i.e. there is no additional fare to use the streetcar if you are transferring from another service.

4.2 Future Network Assumptions

4.2.1 Road and Transit

RTM contains a Business As Usual (BAU) future road and transit networks and these incorporate new projects to be implemented in the region. The 2050 RTM networks assumes the following:

- Road network assumptions
  - Viaducts are still in place
  - Tolls removed from all river crossings
- Transit network assumptions
  - Broadway Subway Project
  - Surrey-Newton-Guildford LRT
  - Surrey-Langley LRT

The BAU network does NOT include any streetcar lines.

It should be noted that several of these assumptions are no longer correct and a new Regional Transportation Strategy (RTS) is being developed but the RTM has not been updated. The updated RTM would need to include the latest transit network assumptions for South of the Fraser River as well as account for Northeast False Creek (NEFC) plans and the removal of the viaducts as a part of the road network assumptions.

4.2.2 Land Use

Future land use in the form of population and employment forecasts are incorporated into RTM. The population and employment forecasts are developed by Metro Vancouver in consultation with all municipalities in the region and consistent with the Regional Growth Strategy. Note that population and employment forecasts for 2050 in RTM are currently interim forecasts. A final set of land use forecasts is slated for release in a future version of the model.

Table 4-4 summarizes the 2016 and 2050 population and employment for the City of Vancouver and Metro Vancouver. Figures showing the 2050 population and employment for the corridor are shown in Appendix H.

Table 4-4 2016 and 2050 Land Use

	2016 Population	2016 Employment	2050 Population	2050 Employment
City of Vancouver	684,000	460,000	851,000	526,000
Metro Vancouver	2,888,000	1,469,000	4,298,000	2,014,000

Source: RTM Phase 3.2

Additionally, a ridership and population catchment analysis in 2050 for the two routes has been done and compared to the original route. Originally a 400 m catchment analysis was completed as this is what is typically used for transit services to illustrate the catchment within 5 minutes of a stop location. However, as TransLink is currently using 600 m for catchment analysis for new B-Lines services and the streetcar service is comparable, a 600 m employment and population catchment analysis was also completed. This analysis is included in Appendix I.

4.3 Ridership Forecasts

Streetcar ridership were estimated for the year 2016 and 2050. The 2016 results represent "current day" streetcar demand based on 2016 network assumptions. The 2050 results forecast future streetcar demand to understand streetcar future demand and growth.

Phase 3.2 of the RTM generates assignment results for three one-hour periods:

- Morning (AM) 07:30-08:30
- Midday (MD) 12:00-13:00
- Afternoon (PM) 16:30-17:30

4.3.1 2016 Model Results

Table 4-5 shows the AM, MD and PM peak ridership summary for the two services by direction.

Table 4-5 AM, Midday and PM Peak Hour Ridership Summary (2016)

Description	AM		MD		PM	
	Total Boardings	Max Volume	Total Boardings	Max Volume	Total Boardings	Max Volume
Broadway/Arbutus – Chilco Street	1,850	850	990	370	2,900	1,380
Chilco Street – Broadway/Arbutus	2,640	1,450	1,020	380	2,560	1,090
Total	4,490		2,010		5,460	
Thornton Street – Granville Street	400	310	240	160	550	400
Granville Street – Thornton Street	380	270	230	160	500	340
Total	780		470		1,050	
Total Streetcar	5,270		2,480		6,510	

2016 PM peak hour ridership charts are shown in Figure 4-2 to Figure 4-5. Ridership charts for the AM and MD hours are shown in Appendix J.

Capacity analysis based on AW2 capacity (fully loaded streetcar with all seats occupied and a standing capacity of 4 people per square metre) of 178 passengers per streetcar vehicle which is based on the demonstration vehicle for the Olympic streetcar. The planning capacity show in the charts represents 85% of the AW2 capacity and represents a planning capacity and consistent with TransLink practice.

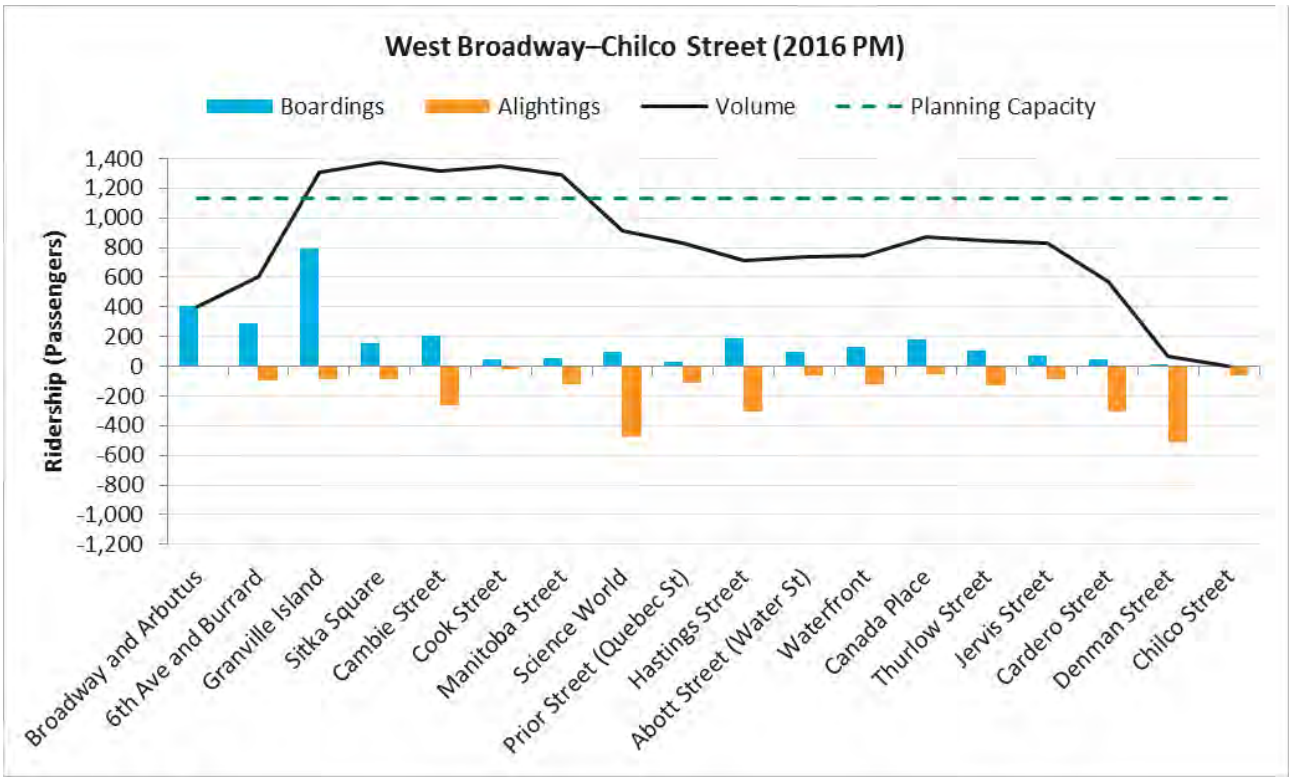


Figure 4-2 2016 PM Peak Ridership: West Broadway-Chilco Street (Northbound)

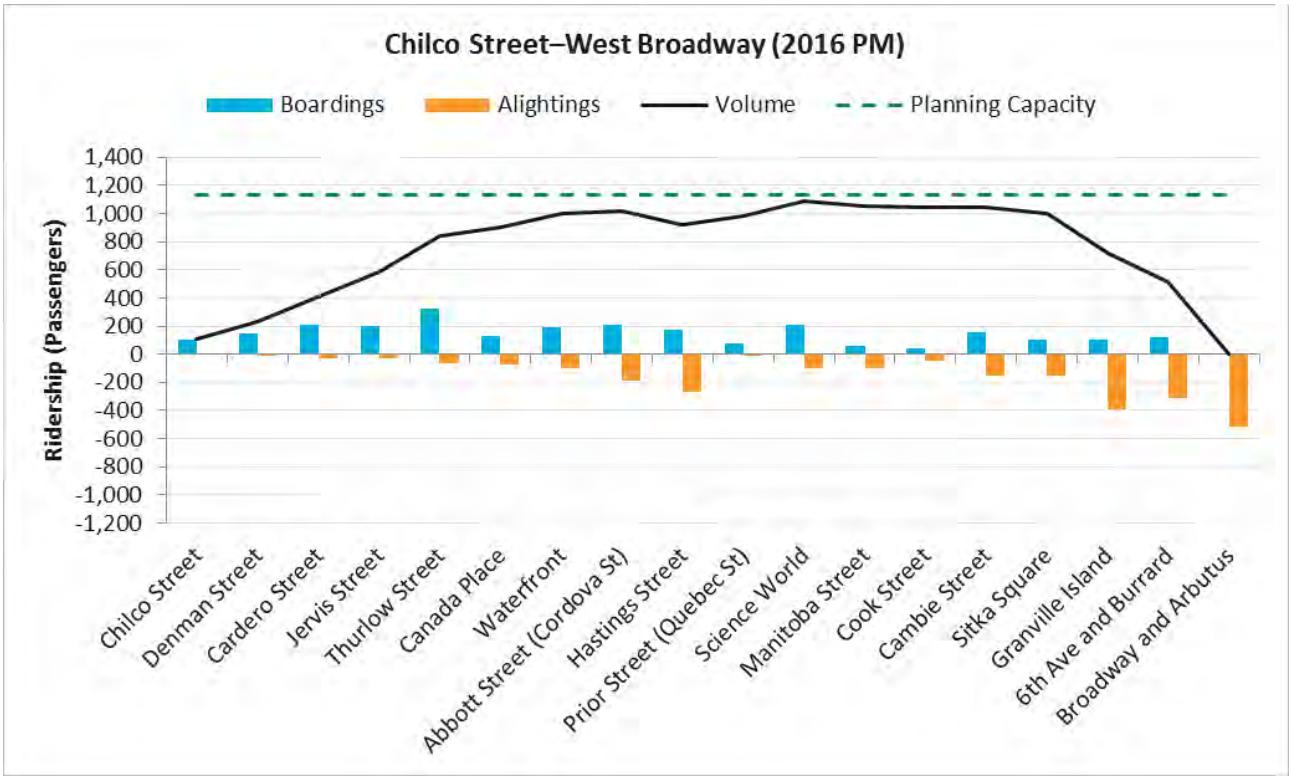


Figure 4-3 2016 PM Peak Ridership: Chilco Street-West Broadway (Southbound)

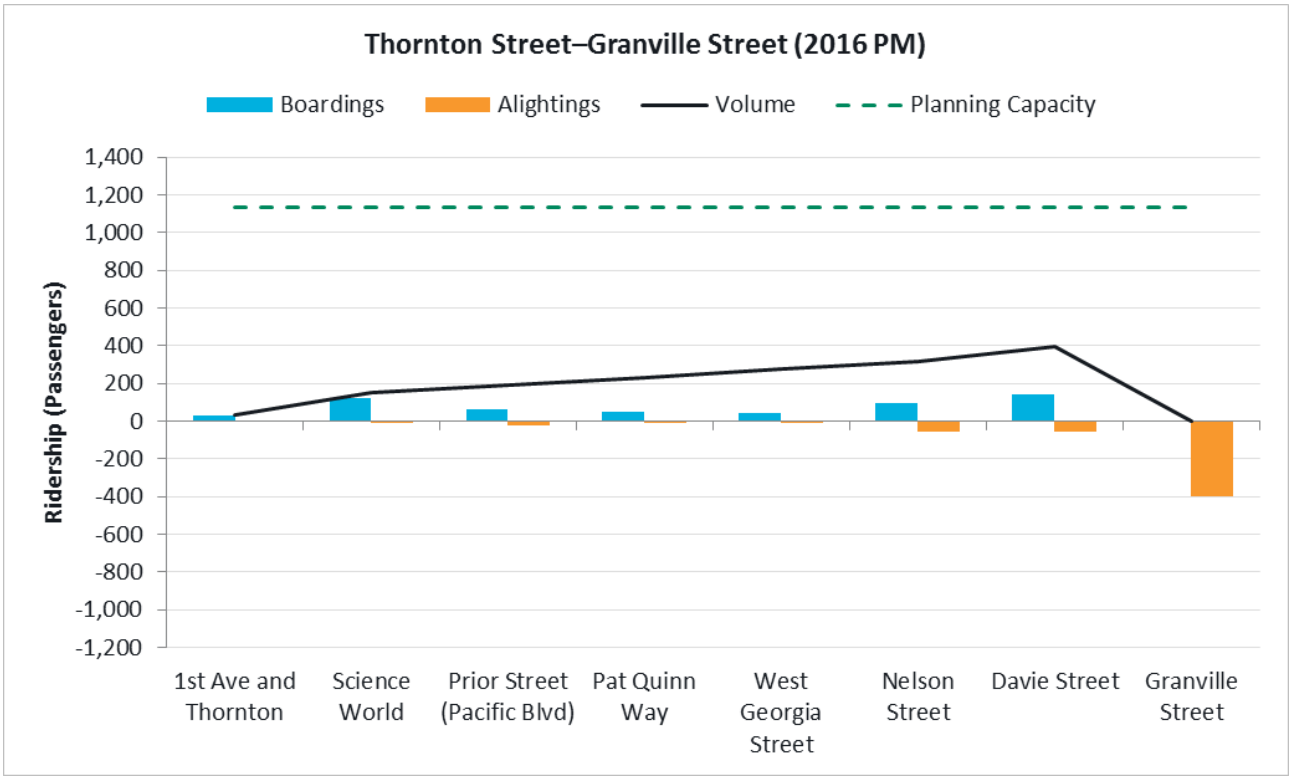


Figure 4-4 2016 PM Peak Ridership: Thornton Street-Granville Street/Drake Street (Northbound)

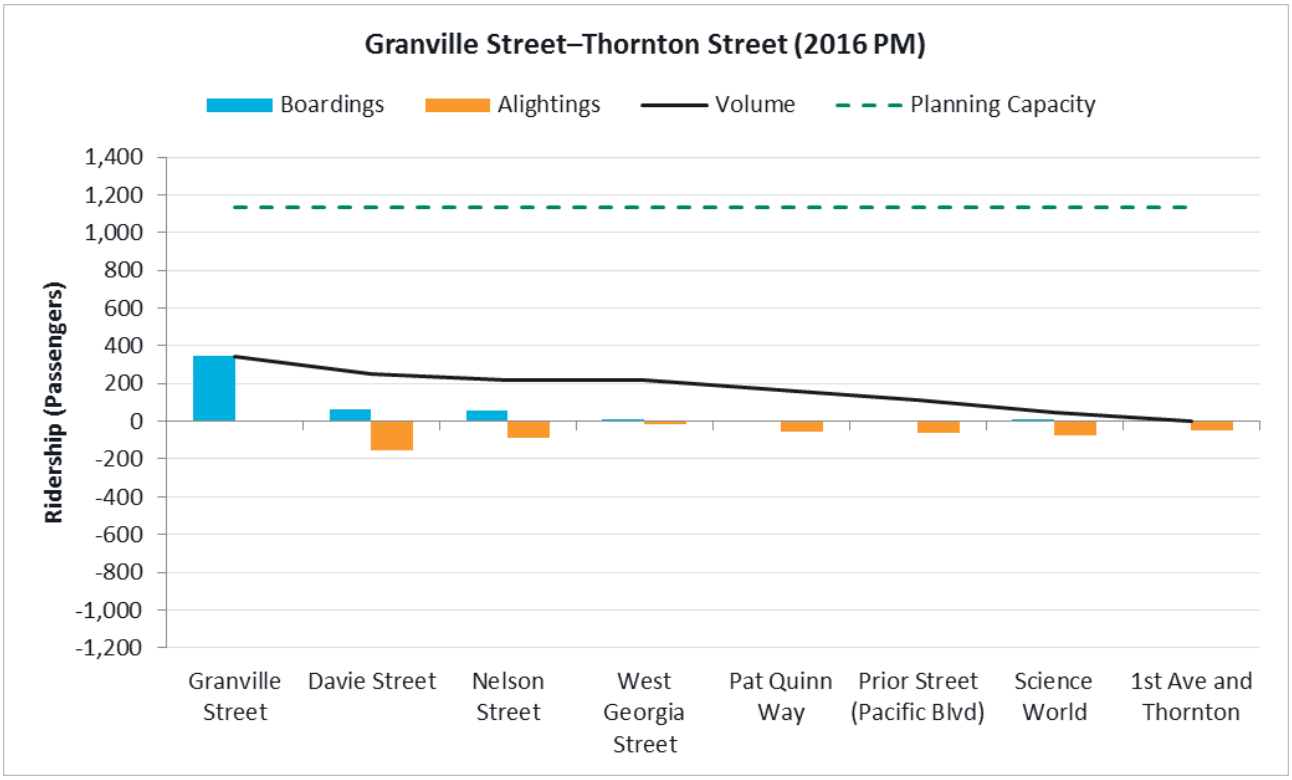


Figure 4-5 2016 PM Peak Ridership: Granville Street/Drake Street-Thornton Street (Southbound)

The Northbound service between West Broadway and Chilco Street shows the highest level of demand during the PM Peak hour. Starting from Broadway-Arbutus, boardings increase with the highest volume of boardings at Granville island. The volume briefly exceeds the planning capacity between Granville Island and Science World stops. There are large alighting volumes at Cambie Street and Science World stops as the service connects to the Canada Line at Olympic Village station and Expo Line at Main Street-Science World station respectively. The volume for the remaining section towards Chilco Street stays below the planning capacity with considerable alightings at Hasting Street (connecting to 95 B-Line) and Cardero & Denman Streets connecting to buses to the North Shore.

On the Southbound direction the volume is under the planning capacity between Thurlow Street and Granville Island. The boardings are generally lower in the southbound direction with the highest volumes at Thurlow Street. Highest passenger alighting volumes at Granville Island, 6th Ave/Burrard and Arbutus/Burrard.

Ridership volumes on the Thornton Street to Granville Street service are lower. This could be due to the relatively low employment along Pacific Boulevard (see Appendix H for land use figures). The travel pattern on this line is large boarding at the terminus on Granville and Davie followed by gradual off-loading along the line in the southbound direction and the reverse (gradual loading followed by large terminus alighting) in the northbound direction.

The results show a relatively even distribution of boardings and alightings for each station and a consistent peak load for all the routes. This represents a significant proportion of short distance trips using the streetcar as detailed below where a distance of less than 800 metres (approximately 10 minutes walk) is defined as a short trip.

Table 4-6 Trip Length Analysis

	Percentage trips less than 800m
AM	26%
MD	49%
PM	30%
TOTAL	32%

4.3.2 2050 Model Results

Table 4-7 provides the AM, MD and PM peak ridership summary for the two services by direction.

Table 4-7 AM, Midday and PM Peak Hour Ridership Summary (2050)

	AM		MD		PM	
Description	Total Boardings	Max Volume	Total Boardings	Max Volume	Total Boardings	Max Volume
West Broadway – Chilco Street	2,110	1,050	1,200	430	3,090	1,390
Chilco Street – West Broadway	2,720	1,330	1,210	430	3,050	1,380
Total	**4,830**		**2,410**		**6,140**	
Thornton Street – Granville Street	480	340	450	290	950	630
Granville Street – Thornton Street	630	470	440	270	760	460
Total	**1,110**		**890**		**1,710**	
Total Streetcar	**5,940**		**3,300**		**7,850**	

2050 PM peak hour ridership charts are shown in Figure 4-6 to Figure 4-9. Ridership charts for the AM and MD hours are shown in Appendix K.

The modelled ridership profiles in 2050 are similar to the 2016 profiles with higher boardings reflecting population and employment growth. The Broadway/Arbutus-Chilco line carries more passengers with peak hour volume exceeding the planning capacity between Granville Island and Main Street station in both directions by 2050.

The number of boardings on the shorter Thornton Street–Granville Street service increased considerably from 2016 to 2050 but there are no capacity issues.

With the Broadway Subway Project assumed in the 2050 scenario, the subway service may have abstracted ridership from the streetcar when compared to the 2016 scenario without the Broadway Subway Project.

Note the following with regards to the capacity constraints:

Olympic demonstration vehicle is atypical, as “most modern Streetcars/LRVs are typically either 2.4 m or 2.65 m wide rather than the 2.3 m of the demonstration LRV, as the 2.3 m wide LRV was developed specifically for the Brussels application.” as described in the Design Consideration Report. Higher capacities could be achieved with different vehicle dimensions and layout.

Different headways could be operated on Broadway/Arbutus-Chilco and Thornton St-Granville St lines to optimise system performance e.g. 6 minutes and 10 minutes respectively.

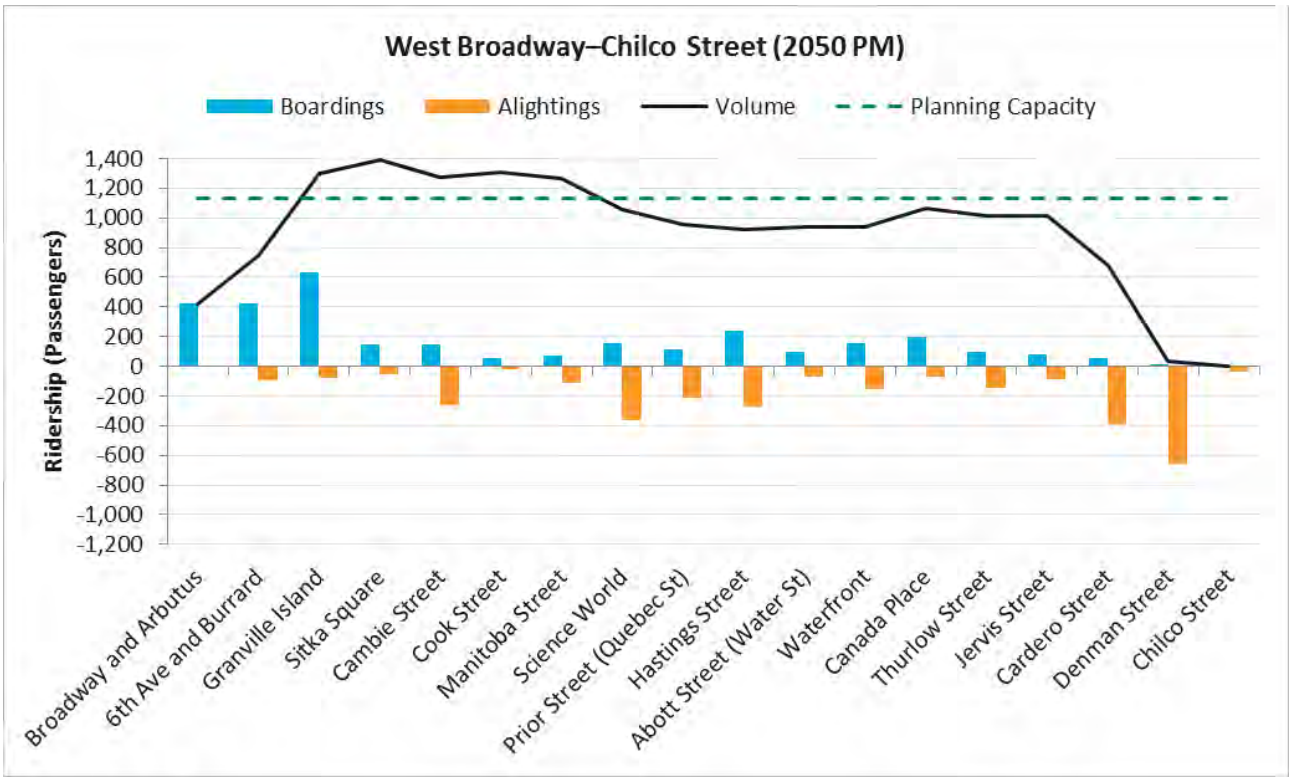


Figure 4-6 2050 PM Peak Ridership: West Broadway-Chilco Street (Northbound)

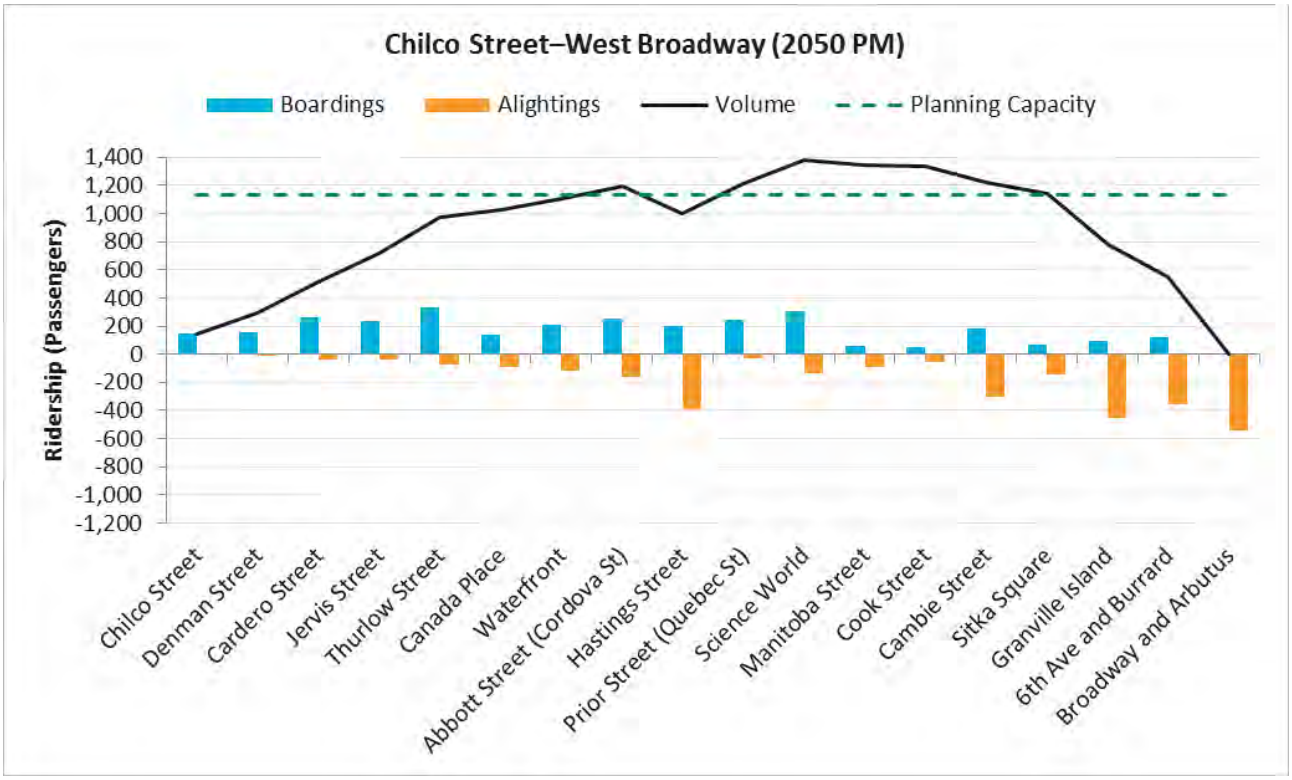


Figure 4-7 2050 PM Peak Ridership: Chilco Street-West Broadway (Southbound)

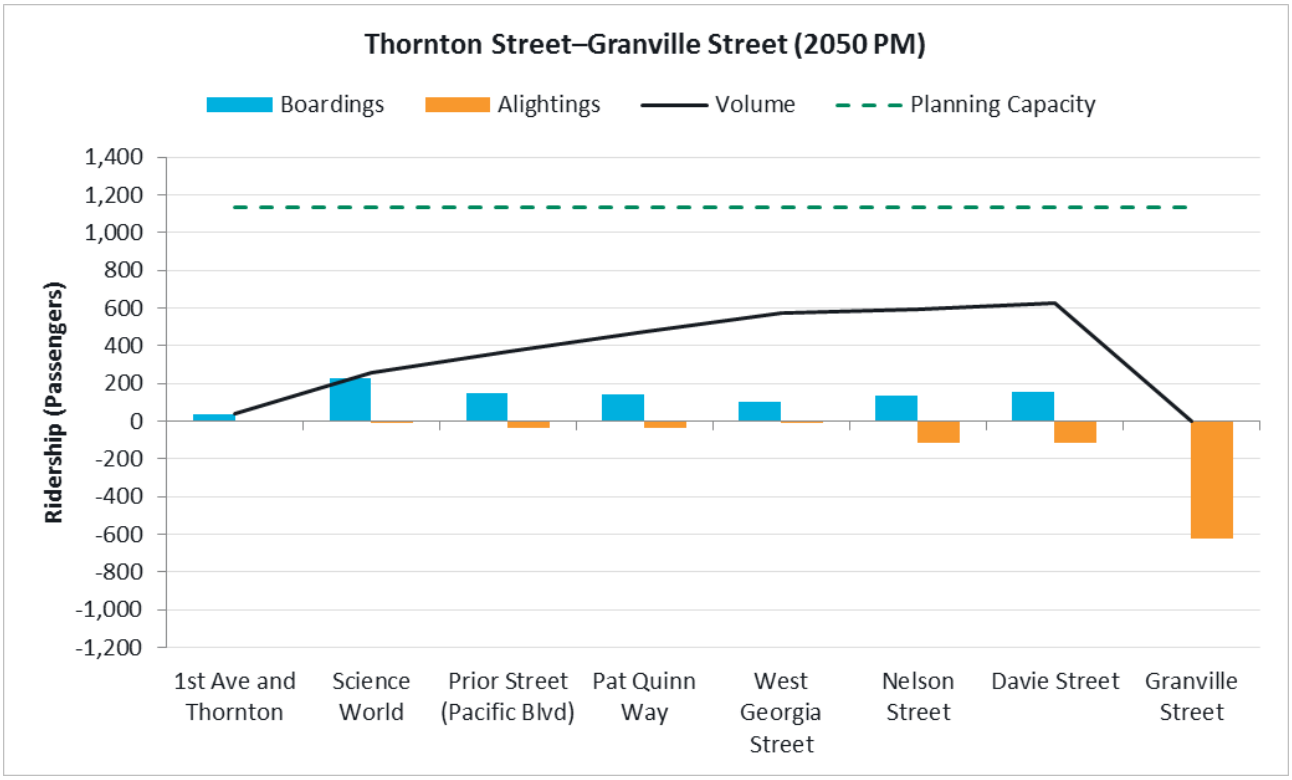


Figure 4-8 2050 PM Peak Ridership: Thornton Street-Granville Street/Drake Street (Northbound)

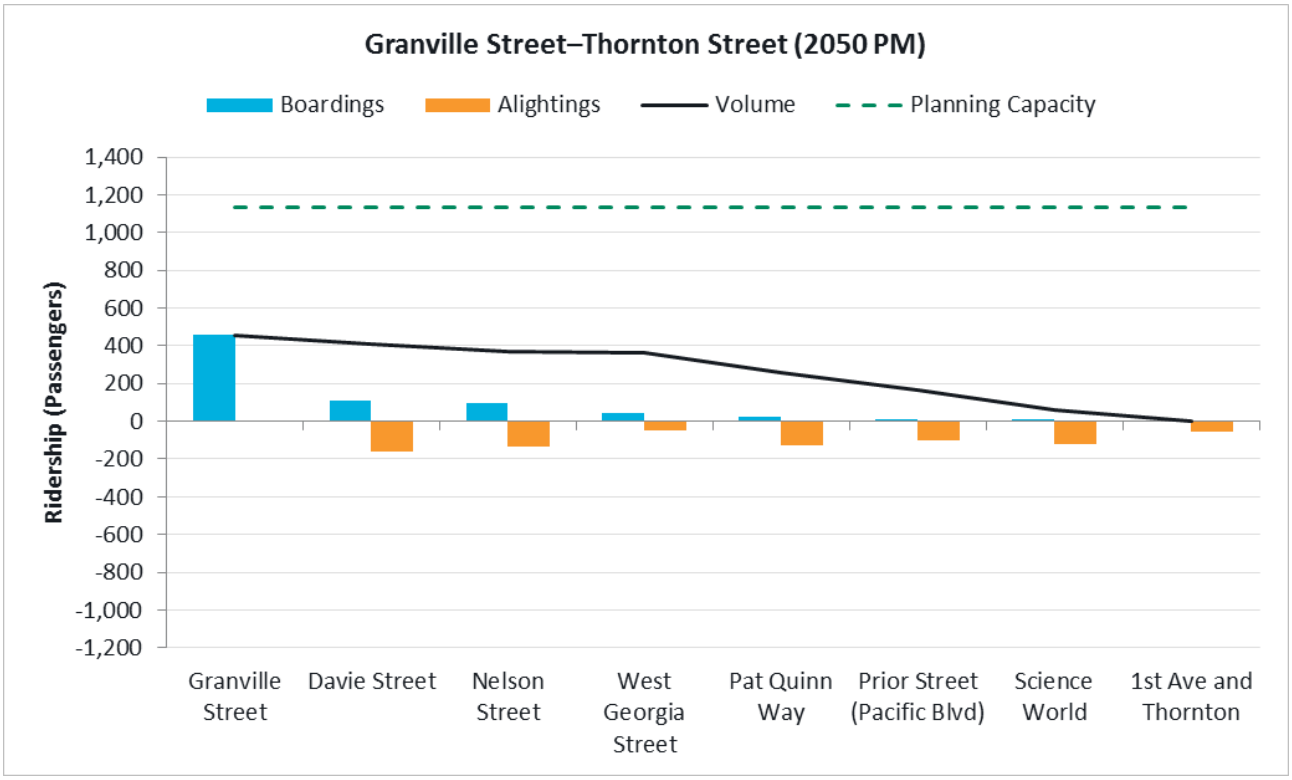


Figure 4-9 2050 PM Peak Ridership: Granville Street/Drake Street-Thornton Street (Southbound)

4.3.3 Daily and Annual Ridership Estimation

The RTM provides AM, MD and PM ridership forecasts. To estimate daily, weekend, summer and annual demand expansion factors we reviewed the following data sources:

- Summer and Fall average hourly and average daily APC passenger boardings for bus routes 19 and 50 provided by TransLink
- Annual boardings for bus routes 19 and 50 from the 2017 Transit Service Performance Review (TSPR)1

Table 4-8 compares the expansion factors based on the 19 and the 50 bus routes to reflect the higher weekend and summer factors for tourist ridership serving Granville Island, Waterfront and Stanley Park.

Table 4-8 #019 and #050 Expansion Factors

3 hr RTM to Fall Weekday	4.60
Fall Weekday to Fall Saturday	0.88
Fall Weekday to Fall Sunday	0.77
Fall Weekday to Summer Weekday	1.18
Fall Weekday to Summer Saturday	0.99
Fall Weekday to Summer Sunday	0.94
Fall Weekday to Annual	305

Figure 4-10 illustrates the process used to convert the RTM forecasts to daily and annual values and is described in further detail below.

The RTM daily factor was determined by the sum of boardings for the three RTM hours. This was compared to the Fall APC data for the same time period and to the average Fall daily APC data. Fall weekend factors and Summer daily factors were obtained by comparing Fall weekday daily APC boardings with that for Fall Saturday, Fall Sunday, Summer weekday, Summer Saturday and Summer Sunday.

Table 4-4-9 2016 Daily Boardings and Table 4-10 show the model data expanded to daily boardings for both Fall and Summer. The higher Summer ridership on routes 19 and 50 is reflected in these results. Do note that an additional short turn service currently operates between Stanley Park and downtown during the Summer for bus route 19. This additional frequency is not accounted for in this analysis, though it does indicate the potential demand for the Stanley Park extension of the streetcar.

Annual boardings from the 2017 TSPR data for route 19 and 50 was used to calculate the daily-to-annual expansion factors. It was compared to Fall daily APC data for the full service. Table 4-11 shows the forecasted annual boardings.

1 https://www.translink.ca/Plans-and-Projects/Managing-the-Transit-Network/Transit-Service-Performance-Review.aspx

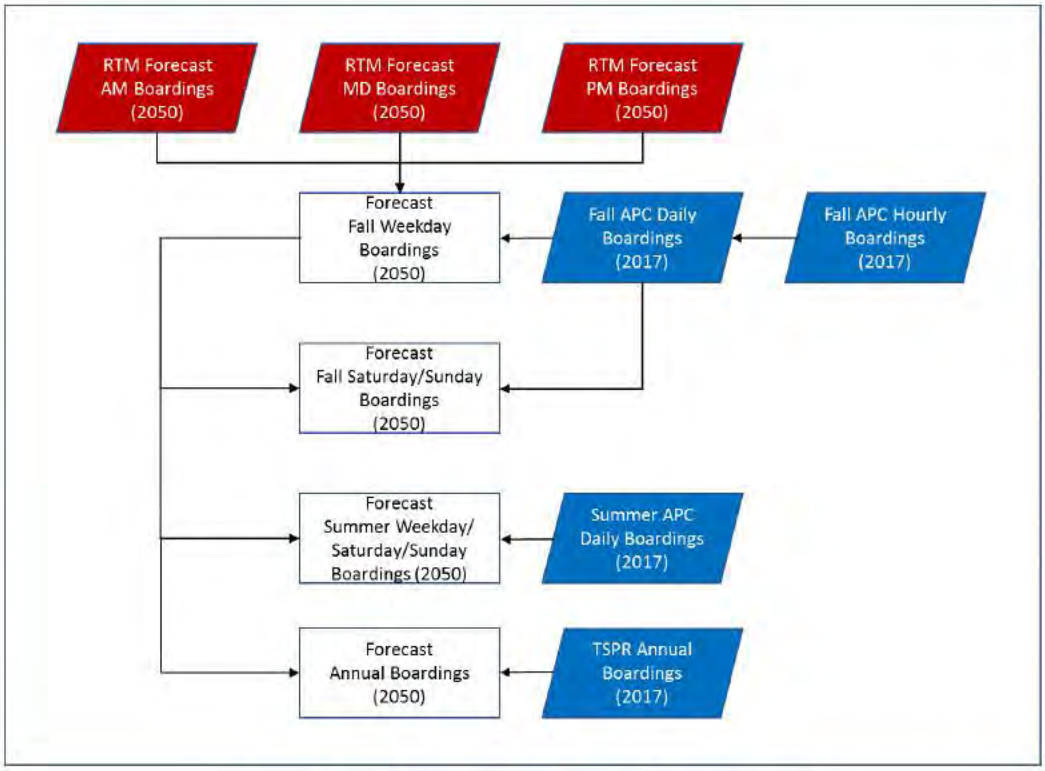


Figure 4-10 Ridership Expansion Flow Chart

Table 4-4-9 2016 Daily Boardings

Line	Direction	Description	Fall Weekday	Fall Saturday	Fall Sunday	Summer Weekday	Summer Saturday	Summer Sunday
S_1N	Northbound	West Broadway–Chilco Street	26,400	23,200	20,300	31,300	26,200	24,900
S_1S	Southbound	Chilco Street–West Broadway	28,600	25,200	22,000	33,900	28,400	27,000
Total			**55,000**	**48,400**	**42,300**	**65,200**	**54,600**	**51,900**
S_2N	Northbound	Thornton Street–Granville Street	5,400	4,800	4,200	6,400	5,400	5,100
S_2S	Southbound	Granville Street–Thornton Street	5,100	4,500	3,900	6,000	5,100	4,800
Total			**10,500**	**9,300**	**8,100**	**12,400**	**10,500**	**9,900**
Total Streetcar			**65,500**	**57,700**	**50,400**	**77,600**	**65,100**	**61,800**

Table 4-10 2050 Daily Boardings

Line	Direction	Description	Fall Weekday	Fall Saturday	Fall Sunday	Summer Weekday	Summer Saturday	Summer Sunday
S_1N	Northbound	West Broadway–Chilco Street	29,400	25,900	22,600	34,800	29,200	27,800
S_1S	Southbound	Chilco Street–West Broadway	32,100	28,300	24,700	38,000	31,800	30,300
Total			**61,500**	**54,200**	**47,300**	**72,800**	**61,000**	**58,100**
S_2N	Northbound	Thornton Street–Granville Street	8,600	7,600	6,600	10,200	8,600	8,200
S_2S	Southbound	Granville Street–Thornton Street	8,400	7,400	6,500	10,000	8,400	8,000
Total			**17,000**	**15,000**	**13,100**	**20,200**	**17,000**	**16,200**
Total Streetcar			**78,500**	**69,200**	**60,400**	**93,000**	**78,000**	**74,300**

As mentioned previously, the model forecasts a high proportion of short distance trips (32% as shown in Table 4-6) and the annual forecasts include a lower demand forecast to reflect short distance trips not using the streetcar. These are shown in table below.

Table 4-11 Annual Boardings (million) for the streetcar Network

Line	Direction	Description	2016	2050
S_1N	Northbound	West Broadway–Chilco Street	5.5 - 8.1	6.1 - 9.0
S_1S	Southbound	Chilco Street–West Broadway	6.0 - 8.7	6.7 - 9.8
S_1 Total			**11.5 - 16.8**	**12.8 - 18.8**
S_2N	Northbound	Thornton Street–Granville Street	1.1 - 1.6	1.8 - 2.6
S_2S	Southbound	Granville Street–Thornton Street	1.1 - 1.6	1.8 - 2.6
S_2 Total			**2.2 - 3.2**	**3.6 - 5.2**

Table 4-12 compares the 2016 annual streetcar ridership with the ten busiest bus routes according to the 2017 TSPR. On a boarding basis, the streetcar service will be one of the busiest routes in the bus network. The high streetcar boardings are due to:

- Extensive connections to the regional transit network including:
  - Canada Line (Olympic Village, Yaletown and Waterfront stations)
  - Expo Line (Main St-Science World, Stadium-Chinatown and Waterfront stations)
  - SeaBus and WCE at Waterfront station
  - 99 B-Line (at Arbutus), 95 B-Line (at Hastings) and services to/from North Shore (at West Georgia)
- High expansion factors reflecting high weekend and summer demand on routes #19 and #50 as they serve key tourist destinations (Granville Island, Gastown, Waterfront and Stanley Park)
- Relatively short trips on the streetcar reflecting use of streetcar as access mode to other transit services
- Alignments along consistently dense, urban corridors

Further work should review potential passenger perceptions to the streetcar as it is a new transport mode in the region. This may impact the large proportion of short trips forecasted and overall demand levels. Further in-depth review of RTM calibration and performance in the study area would also be useful in the further study stages. Streetcar has been coded as a rail mode in transit assignment to reflect the inherent attractiveness of rail (SkyTrain) compared to bus in terms of comfort and perception. This is reflected in differences in travel times based on perceived in-vehicle travel time where a transit perception factor of 1.25 is added to bus travel time to reflect the rail preference over bus. In reality streetcar is likely to lie somewhere between SkyTrain and bus and further research to estimate that factor would be useful. Based on the above the current assumptions represent a 'best case' for streetcar in terms of forecasts.

Table 4-12 Annual Boardings (million) Comparison to 10 Busiest Bus Routes

2017 Rank	Route	Region	Annual Boardings
1	099	Vancouver/UBC	17,421,000
N/A	S_1 West Broadway-Chilco	Vancouver/UBC	11.5M-16.8M
2	041	Vancouver/UBC	8,918,000
3	020	Vancouver/UBC	8,630,000
4	049	Vancouver/UBC	8,034,000
5	025	Vancouver/UBC	7,642,000
6	016	Vancouver/UBC	7,549,000
7	009	Vancouver/UBC	7,273,000
8	003	Vancouver/UBC	6,724,000
9	SeaBus	North Shore	6,343,000
10	106	Burnaby/New Westminster	6,212,000
15	019	Vancouver/UBC	5,734,000
N/A	S_2 Thornton St-Granville St	Vancouver/UBC	2.2M-3.2M
49	050	Vancouver/UBC	1,641,000

Source: TransLink 2017 TSPR

It is challenging to compare these results to the previous streetcar report ('Downtown Streetcar Design, Layout & Ridership Study') in 2005 due to the considerable changes in the region since then and the difference in the forecasting horizons. The differences are shown in table below.

Table 4-13 Forecasting Differences

	2005 Report	2018 Analysis
Forecast Year	2021	2050
Streetcar Ridership	5.0M (Granville-Island-Waterfront) 9.1M (with extensions) All refer to Central Case	12.8M-18.8M (West Broadway-Chilco Street) 3.6M-5.2M (Thornton Street-Granville Street)
Alignment	Granville Island-Waterfront Extensions to Stanley Park at Chilco Street and Pacific Boulevard	West Broadway-Chilco Street Thornton Street-Granville Street
Future Network	Canada Line included	Broadway Subway (connection at West Broadway and Thornton Street)
Model	Regional Model (2005)	RTM Phase 3.2
Speed	18 kph	14-15 kph
Frequency	8 mins	8 mins
Regional transit ridership	277 million (2005)	407 million (2017)

4.3.4 Ridership Summary

Ridership forecasts have been completed for this feasibility study, and uses assumptions based on the latest alignment options. The ridership forecasts were developed for 2016 and 2050 using the Regional Transportation Model (RTM) Phase 3.2 and its BAU future road network and land use information.

The two potential streetcar service routes were analyzed:

- West Broadway to Chilco (Arbutus Street/Broadway to Chilco Street)
- Thornton St to Granville St (1st Ave/Thornton Street to Granville Street/Drake Street)

It has been assumed for this study that both services would operate with 8-minute peak headways at an average speed of 14 kph.

The annual boardings are estimated at between 12.8 to 18.8 million on the West Broadway-Chilco line and 3.6 to 5.2 million between Thornton Street-Granville Street line by 2050. The maximum peak hour volume by 2050 would be about 1,400 passengers during the PM peak on the section between Granville Island and Science World. This exceeds the planning capacity of the Olympic Demonstration vehicle (at an 8-minute headway) in certain sections of the route. However, the Olympic Demonstration Line vehicle is atypically narrow and higher capacities could also be achieved with different headways operated on West Broadway-Chilco and Thornton St-Granville St lines to optimise system performance if necessary.

The high streetcar boardings are the result of:

- Extensive connections to the regional transit network including:
  - Canada Line (Olympic Village, Yaletown and Waterfront stations)
  - Expo Line (Main St-Science World, Stadium-Chinatown and Waterfront stations)
  - SeaBus and WCE at Waterfront station

- 99 B-Line (at Arbutus), 95 B-Line (at Hastings) and services to/from North Shore (at West Georgia)
- High expansion factors reflecting high weekend and summer demand on routes #19 and #50 as they serve key tourist destinations (Granville Island, Gastown, Waterfront and Stanley Park)
- Large proportion of relatively short trips on the streetcar reflecting use of streetcar as access mode to other transit services
- Alignments along consistently dense, urban corridors

Current work assumes that passengers will perceive streetcar as rail (SkyTrain) and reality is that it will fall somewhere between bus and SkyTrain. Further work should review the potential passenger perceptions to the streetcar as it is a new transport mode in the region and the passenger perception of streetcar will affect the overall travel cost (and attractiveness) of the streetcar. This will impact the large proportion of short trips forecasted and the overall demand levels. Further in-depth review of RTM calibration and performance in the study area would also be useful in further study stages.

Ridership forecasts, alongside the capital costs and operating and maintenance costs which are discussed in the following section, would form the basis for a business case. The business case would reflect further design and engineering developments and updated ridership forecasts incorporating the further work identified in the paragraph above.

5 Cost Estimate

This section summarizes the cost estimates that have been prepared for this feasibility study. High level capital cost estimates have been prepared for each of the alignment options, for each segment of the network, as well as the OMF sites. These network segments and their options are as laid out in Section 2 and shown in Appendix B, and the OMF site layouts are in Appendices D, E and F. A general operating and maintenance cost was estimated based upon available data from other modern streetcar networks, such as Portland, Oregon.

The cost estimates are expressed in 2018 Canadian dollars thus unit rates for operating cost elements were converted using an average exchange rate of $1.33 CAD = $1.00 USD.

5.1 Capital Cost Estimate

The capital cost estimates are based on the alignment options laid out in this report. The estimates are conceptual and prepared in advance of preliminary or detailed design, and all are prepared on the same basis, to provide a direct comparison of costs. The Basis of Estimate, in Appendix L, sets out the basis and assumptions included within the estimates, and the basis of the costs used.

It is understood that it is not likely that the work will be carried out in the immediate future, and although the estimates represent the costs as if the project was commenced in early 2019, these costs will need to be updated to reflect the actual commencement date. This update will reflect inflation, changes in by-laws, changes in environmental requirements, the market conditions at the time of project implementation, and the current codes at the time it is intended to proceed with the project.

Previously an estimate for a City of Vancouver Streetcar Downtown Network was prepared in June 2005, which set out a lower estimate for this project. The reasons for the increase between the 2005 work and this estimate include the following factors:

- General construction inflation which is estimated to be between 55% and 65%
- The total length of the network is approximately 2.5 times longer
- The number of vehicles has increased from 6 to 18. 18 vehicles (15 vehicles for operation plus 3 spares) would be sufficient for Vancouver Streetcar network excluding the AGP. Note that the proposed ultimate fleet size including AGP is 22 vehicles.
- Previously, the vehicles were semi-low floor of a basic simple design, the current vehicle assumption is full low floor, with a more modern design
- The utility relocation estimate has increased considerably due to current trends of utility companies requiring extensive relocation work, and the work becoming more complex
- The maintenance facility was assumed to be a minimal facility to store 6 cars, less than 30% of the size included within the current estimate
- Financing interest during construction has been increased from 3% to 4% to reflect current trends in financial forecasting
- The trend since 2005 for construction to be subject to stricter by-laws, less tolerance for traffic impact, and increases in environmental requirements.

The following table summarizes capital cost estimates for each network section and by alignment option within each section. below indicates each of the proposed alignment options. It is presented with the approximate cost per kilometre for each portion of the alignment or alignment option. The per km cost varies based upon the cross section with the lowest per route kilometre cost being for Option 1 through False Creek South as the streetcar tracks would be segregated and the adjacent roads, requiring minimal reconfiguration as a part of the streetcar project. The highest per route kilometre costs occur in areas where the road ROW is wider, such as on Quebec Street between East 1st Avenue and Pacific Boulevard, which would require more extensive reconstruction of surrounding infrastructure for the streetcar implementation. The table breakdown will allow for an approximate cost estimate to be carried out for any combination of the proposed options.

Table 5-1 Capital Cost Estimate by Route Potion and Alignment Options

Route Portion and Routing Options	Total Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	Unit Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	
Arbutus Greenway from Arbutus Street & West Broadway Terminus to W 6th Avenue at Fir Street	$66,068,829	per route km	$65,074,000
Arbutus Connection			
Option 1: Fir Street to West 2nd Avenue avoiding impact to the building on 1500 West 2nd Avenue	$43,049,316	per route km	$67,345,000
Option 2: Fir Street to West 3rd Avenue	$36,145,330	per route km	$66,306,000
Option 3: Fir Street to West 2nd Avenue impacting to the building on 1500 West 2nd Avenue	$43,054,476	per route km	$67,595,000
False Creek South	$106,732,387	per route km	$63,799,000
Southeast False Creek	$76,912,800	per route km	$68,849,000
False Creek Flats Connection to OMF			
Option 1 - 1st Avenue	$40,996,250	per route km	$60,700,000
Option 2- Industrial Avenue	$40,737,690	per route km	$63,204,000
Option 3 - National Avenue	$46,700,899	per route km	$66,925,000
False Creek Flats - Quebec Street	$53,795,777	per route km	$71,231,000
Quebec Street at Pacific Boulevard to Columbia Street at Hastings Street	$31,431,625	per route km	$69,984,000
Gastown			
Option 1: Water Street and Cordova Street Couplet	$73,582,588	per route km	$90,412,000
Option 2: Two-way Streetcar in Cordova Street with One-Way Eastbound Traffic	$59,016,078	per route km	$70,354,000

Route Portion and Routing Options		Total Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	Unit Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	
	Option 3: Two-way Streetcar on Two-way Hastings Street	$60,665,979	per route km	$69,714,000
Waterfront and Coal Harbour		$155,059,025	per route km	$69,145,000
Northeast False Creek and Yaletown		$158,405,719	per route km	$71,642,000
Maintenance Facility				
	Site 1 – 235, 247 & 273 East 1st Avenue	$53,243,929		
	Site 2 – 425 & 455 Industrial Avenue	$60,036,061		
	Site 4 – 71 National Avenue	$61,621,902		
Vehicles				
18 Street Cars with Fare Card Readers		$105,840,000	per car	$5,880,000
Fixed Costs that only marginally change unless there is a very large change in the size of the project				
	Environmental	$6,250,000		
	Testing and Commissioning	$3,750,000		
	Operations Preparation	$10,000,000		

Table 5-2 presents the overall the capital cost estimate for the downtown streetcar network including an OMF, the vehicles and other costs including engineering, management, bonding, insurance and contingency, The costs are presented as 3 potential options which are calculated using option 1 as a base. See Figure 5-1 for alignment options. Costs for option 2 includes the base cost from option 1 and where option 2 is proposed the option 2 cost for this section replaces option 1 to give a full network cost. Option 3 has been priced following the same principal. The table shows that these costs could range from approximately $1.062 billion to $ 1.070 billion.

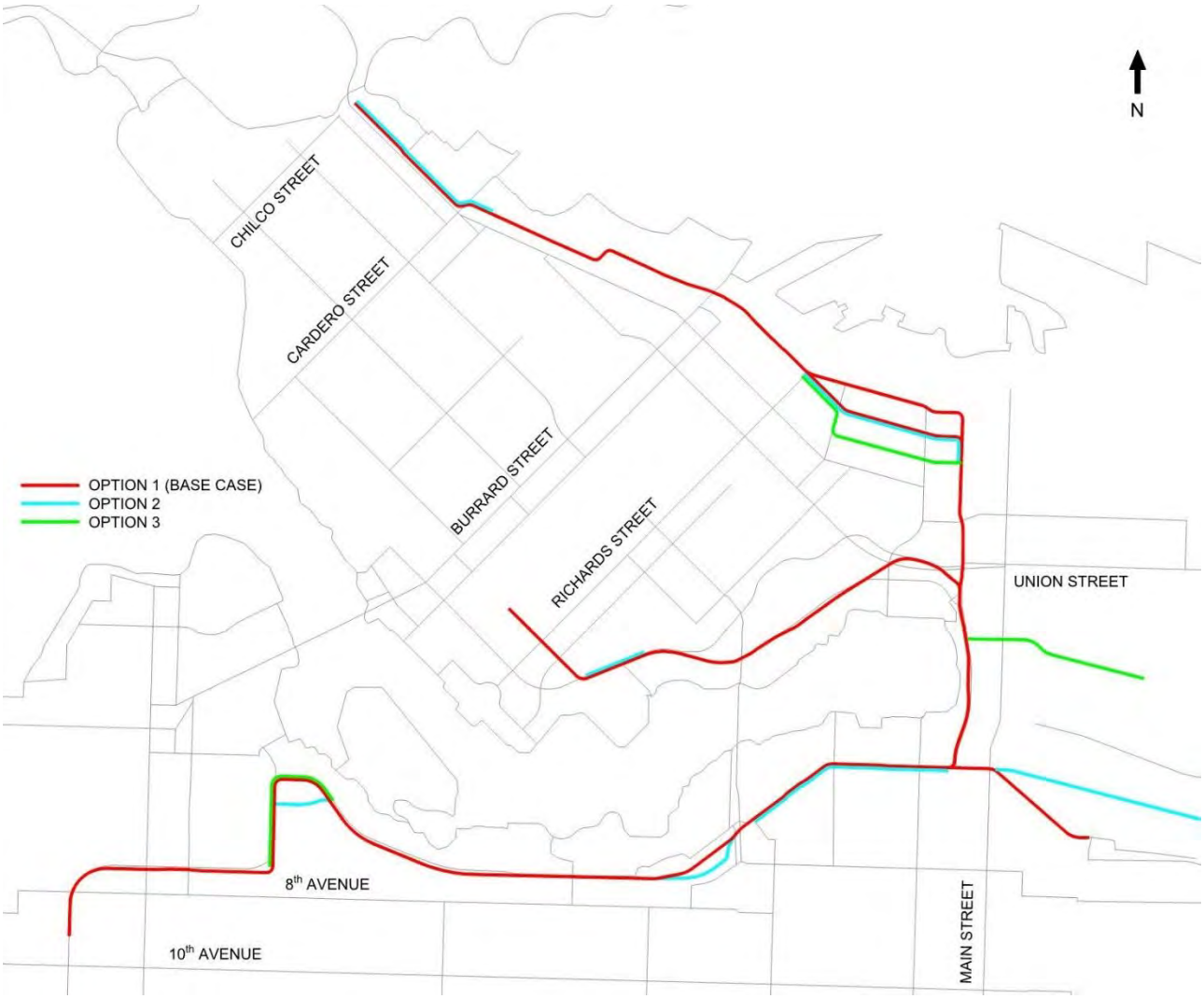


Figure 5-1 Proposed Streetcar Alignment Options

Table 5-2 Capital Cost Estimates based on Options

		Option 1	Option 2	Option 3
Construction Estimate				
Stops		$25,368,000	$25,368,000	$26,046,000
Track and track-bed		$261,439,000	$257,042,000	$263,853,000
Systems		$65,754,000	$60,832,000	$61,847,000
Roadworks		$70,288,000	$71,283,000	$65,896,000
Utility Relocation Allowance		$91,734,992	$90,581,248	$92,716,192
Landscaping		$7,144,000	$7,836,000	$6,705,000
Vehicle Maintenance and Storage Facility		$34,464,000	$38,860,000	$39,887,000
Construction Estimate		**$556,191,992**	**$551,802,248**	**$556,950,192**
Testing and Commissioning		$3,000,000	$3,000,000	$3,000,000
Design and Engineering	7%	$39,143,439	$38,836,157	$39,196,513
Project Management	7.5%	$41,939,399	$41,610,169	$41,996,264
Construction Management	6.5%	$36,347,479	$36,062,146	$36,396,762
Environmental		$5,000,000	$5,000,000	$5,000,000
Operations preparation		$8,000,000	$8,000,000	$8,000,000
Bonding and Insurance	2%	$13,792,446	$13,686,214	$13,810,795
Subtotal with Mobilization and Program Costs		***$703,415,000***	***$697,997,000***	***$704,351,000***
Contingency	25%	$175,853,750	$174,499,250	$176,087,750
Property - Excluded from the Construction Estimate		*Separate Budget*	*Separate Budget*	*Separate Budget*
Subtotal with including Mobilization, Program Costs and Contingency		***$879,269,000***	***$872,497,000***	***$880,439,000***
18 Vehicles with fare card readers		$100,800,000	$100,800,000	$100,800,000
Vehicle Contingency	5%	$5,040,000	$5,040,000	$5,040,000
Vehicle Cost with Contingency		***$105,840,000***	***$105,840,000***	***$105,840,000***
Financing Interest During Construction - 4% Borrowing Interest		***$83,927,000***	***$83,350,000***	***$84,026,000***
Total Capital Cost		**$1,069,036,000**	**$1,061,687,000**	**$1,070,305,000**

5.2 Operating and Maintenance Cost Estimates

As done for the 2005 study, operating and maintenance (O&M) costs are typically estimated using an average cost per vehicle service hour. The amount of service is closely related to vehicle costs and to the maintenance requirements of the alignment (tracks, signals and electric power distribution systems).

The following were used to determine an average streetcar operating cost for the Vancouver Area:

- Compare most recently published and publicly available costs from Portland and Tucson, converted to Canadian dollars
  - Portland's July 2017 – June 2018 O&M costs = $138 USD ($184 CAD) per revenue hour
  - Tucson = $112 USD (or $148.50 CAD) per revenue hour
- Compare the operating cost used in 2005 accounting for inflation
  - Inflated 2005 dollars ($123 CAD) to year 2018 dollars = $159 CAD

From these references an average O&M cost per revenue service hour would be $164 CAD.

These average O&M costs are then applied to the quantity of annual system revenue service. Table 5-3 gives an approximate of annual revenue service kilometres and hours along the Arbutus Street/Broadway to Chilco Street streetcar route.

Table 5-3 Revenue Service Hours and Kilometres for Arbutus/Broadway to Chilco Street

Period	From	To	Hours	Headway (mins)	Daily One-way trips / period	Daily trips in both directions / period	Annual Trips (in both directions)	Daily LRV revenue Km's in both direction	Annual revenue Km's	Daily LRV hours	Annual LRV Hours
Weekday 1	5:00:00	7:00:00	2	16	8.50	17.00	4233.00	150	37,445	10	2,554
Weekday 2	7:00:00	10:00:00	3	8	22.50	45.00	11205.00	398	99,119	27	6,760
Weekday 3	10:00:00	15:00:00	5	16	18.75	37.50	9337.50	332	82,600	23	5,634
Weekday 4	15:00:00	20:00:00	5	8	37.50	75.00	18675.00	663	165,199	45	11,267
Weekday 5	20:00:00	23:00:00	3	16	11.25	22.50	5602.50	199	49,560	14	3,380
Weekday 6	23:00:00	1:00:00	2	16	7.50	15.00	3735.00	133	33,040	9	2,253
TOTAL Weekday			20			212.00	52788.00	1,875	466,963	128	31,849
Saturday 1	5:00:00	8:00:00	3	16	12.25	24.50	1274.00	217	11,270	15	769
Saturday 2	8:00:00	18:00:00	10	16	37.50	75.00	3900.00	663	34,499	45	2,353
Saturday 3	18:00:00	22:00:00	4	16	15.00	30.00	1560.00	265	13,800	18	941
Saturday 4	22:00:00	1:00:00	3	16	11.25	22.50	1170.00	199	10,350	14	706
TOTAL Saturday			20			152.00	7904.00	1,345	69,919	92	4,769
Sunday / Holiday 1	6:00:00	8:00:00	2	16	8.50	17.00	1088.00	150	9,624	10	656
Sunday / Holiday 2	8:00:00	18:00:00	10	16	37.50	75.00	4800.00	663	42,461	45	2,896
Sunday / Holiday 3	18:00:00	22:00:00	4	16	15.00	30.00	1920.00	265	16,984	18	1,158
Sunday / Holiday 4	22:00:00	1:00:00	3	16	11.25	22.50	1440.00	199	12,738	14	869
TOTAL Sunday			19			144.50	9248.00	1,278	81,808	87	5,580
TOTAL									**618,689**		**42,197**

Table 5-4 gives an approximate of annual revenue service kilometres and hours along the East 1st Avenue/Thornton Street to Granville Street/Drake Street streetcar route

Table 5-4 Revenue Service Hours and Kilometres for East 1st Avenue/Thornton Street to Granville Street/Drake Street

Period	From	To	Hours	Headway (mins)	Daily One-way trips / period	Daily trips in both directions / period	Annual Trips (in both directions)	Daily LRV revenue Km's in both direction	Annual revenue Km's	Daily LRV hours	Annual LRV Hours
Weekday 1	5:00:00	7:00:00	2	16	8.50	17.00	4233.00	60	15,031	4	1,086
Weekday 2	7:00:00	10:00:00	3	8	22.50	45.00	11205.00	160	39,789	12	2,876
Weekday 3	10:00:00	15:00:00	5	16	18.75	37.50	9337.50	133	33,157	10	2,397
Weekday 4	15:00:00	20:00:00	5	8	37.50	75.00	18675.00	266	66,315	19	4,793
Weekday 5	20:00:00	23:00:00	3	16	11.25	22.50	5602.50	80	19,894	6	1,438
Weekday 6	23:00:00	1:00:00	2	16	7.50	15.00	3735.00	53	13,263	4	959
TOTAL Weekday			20			212.00	52788.00	753	187,450	54	13,549
Saturday 1	5:00:00	8:00:00	3	16	12.25	24.50	1274.00	87	4,524	6	327
Saturday 2	8:00:00	18:00:00	10	16	37.50	75.00	3900.00	266	13,849	19	1,001
Saturday 3	18:00:00	22:00:00	4	16	15.00	30.00	1560.00	107	5,540	8	400
Saturday 4	22:00:00	1:00:00	3	16	11.25	22.50	1170.00	80	4,155	6	300
TOTAL Saturday			20			152.00	7904.00	540	28,067	39	2,029
Sunday / Holiday 1	6:00:00	8:00:00	2	16	8.50	17.00	1088.00	60	3,863	4	279
Sunday / Holiday 2	8:00:00	18:00:00	10	16	37.50	75.00	4800.00	266	17,045	19	1,232
Sunday / Holiday 3	18:00:00	22:00:00	4	16	15.00	30.00	1920.00	107	6,818	8	493
Sunday / Holiday 4	22:00:00	1:00:00	3	16	11.25	22.50	1440.00	80	5,113	6	370
TOTAL Sunday			19			144.50	9248.00	513	32,840	37	2,374
TOTAL									**248,357**		**17,951**

This gives results in total annual revenue service hours of 60,150. Table 5-5 shows the calculation of how this was applied to the quantity of service being provided by the Vancouver Streetcar network, excluding the AGP extension from West Broadway to Milton Street.

Table 5-5 Estimated Vancouver Streetcar Operations and Maintenance Costs

Estimated Vancouver Streetcar revenue hours (RVH)		
Total system RVH		**60,150**
Operations and Maintenance Costs		
Estimated Vancouver Streetcar cost per revenue hour (year 2018)	$164.00	
O&M costs using RVH		$9,864,600
Miscellaneous O&M costs (+20%)		$1,972,920
Total O&M Costs ($CAD)		$11,837,520

With implementation of the Vancouver Streetcar network including the two lines (Arbutus Street/Broadway to Chilco Street; and East 1st Avenue/Thornton Street to Granville Street/Drake Street), up to 15 streetcars would be operating during peak periods. The extent of service would be:

- 20 hours per weekday and on Saturdays
- 19 on Sundays and holidays

Assuming that service in the off-peak period would be 16-minute headways (matching lower demand), the total revenue vehicle hours for the system would be 60,150 per year. Applying the average cost from above and adding a 20% allowance for other O&M costs results in a total annual cost of approximately $11.84 million.

The total estimated O&M costs can be compared to other North America systems which have publicly available O&M costs as summarized in the following table.

Table 5-6 Summary of North American Streetcar System's O&M costs

Location	Streetcar Name	Total Fleet Size	Frequency (min)	Average Daily Ridership	Total Length (km)	O&M Cost ($ CAD)
Vancouver	Vancouver Street	18	8 16 off-peak	80,300	12.4	$11.84 MPY[1] $164 CPRH[2]
Portland	Portland Streetcar	17	12-15	15,139	19.3	$184 CPRH[2]
Seattle	Seattle Streetcar	10	10-15	4,436	6.1	$16-24 MPY[1]
Toronto	Toronto Streetcar	204	10	292,100	83	
Tucson	Sun Link	8	10 during the day 15 min early morning/evening 30 min midnight - 2am	2,613	6.3	$3.6 MPY[1] $148.48 CPRH[2]
Cincinnati	Cincinnati Bell Connector	5	12-20	1,585	5.8	$4.2 MPY[1]
Detroit	Q Line	6		3,000	5.3	$6 MPY[1]

[1] MPY = Millions Per Year

[2] CPRH = Cost Per Revenue Hour = Cost of operating one streetcar in service for one hour

6 Phasing of the Network

Similar to the 2005 Study, phasing the implementation of the streetcar network can be considered. Phasing would allow for gradual implementation of the network to suit the City's needs and transformation while progressing in alignment with funding as it could be secured. An initial phase of the network should be examined and considered through business case development. The first phase should have a good business case and help set a base case for the rest of the network to be built from. It should provide flexibility for the implementation of future extensions to be implemented.

This section discusses potential initial phases and future extensions. However, the ridership and capital cost estimates have not been developed with a specific focus and on a phased approach. In order to fully understand the ridership and costs of a phased approach to the streetcar network, these should both be re-examined in a next stage.

6.1 Initial Phase

A minimal initial phase could include Granville Island Stop to Cambie Street Stop. This is similar to the Olympic Streetcar Demonstration in 2010 that had great success in connecting Canada Line to Granville Island. It would require a minimum of three (3) vehicles. The ROW for this portion of the network is owned by the City of Vancouver and is fully segregated. This means that the construction of this initial phase could proceed with minimal impacts to the public. As discussed in Section 3.3, there is potential to add vehicle storage in the False Creek South area and near the Cambie Street Stop. This would have sufficient storage capacity for the vehicles required for this phase but does not facilitate sufficient space for a maintenance facility. However, with the limited fleet size and length network, 600 West 6th Avenue where the heritage streetcar shed is located may be sufficient to maintain the three vehicles on a temporary basis until the network was expanded further.

However, there are challenges with only implementing this 1.7 km portion of the network. It is likely that ridership will be primarily generated by tourists visiting Granville Island, and commuter ridership would be limited. Additionally, if 600 West 6th Avenue is utilized for the OMF of the initial phase's three vehicles, expansion of the site to become the OMF for the rest of the network is constrained. The Canada Line parking lot was initially explored as an OMF site option (Site 5 in Table 3-1) but it was not explored further as it has high development potential and currently has modular housing in place. It would need to be re-examined to determine its storage capacity and develop a potential layout of the OMF, and consideration for overbuild would be needed due to the high development potential.

A more preferable first phase could be Arbutus at Broadway Stop to Science World Stop. It would provide connection between the Broadway Subway Millennium Line extension, Canada Line and Expo Line. It also enables connection to the potential OMF sites that were explored in False Creek Flats. This portion of the network would require a minimum of eight (8) vehicles. Thus one of the OMF sites that was explored could be utilized but not built out to the full extent as required by the full network and its vehicle fleet. This first phase would likely have more ridership than the minimal initial phase due to the connections to the SkyTrain and Canada Line Systems.

The OMF sites, as described in Section 3.1, need to be further examined to understand how they could be phased. A phased approach to the OMF site build out may require a different layout

6.2 Cost Estimate of initial phase

The following outlines the infrastructure cost estimate of proposed Phase 1: Arbutus at Broadway Stop to Science World Stop:

Table 6-1 Capital Cost Estimate of Phase 1

Route Portion and Routing Options		Total Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	Unit Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	
Arbutus Greenway from Arbutus Street & West Broadway Terminus to W 6th Avenue at Fir Street		$66,068,829	per route km	$65,074,000
Arbutus Connection				
	Option 1: Fir Street to West 2nd Avenue avoiding impact to the building on 1500 West 2nd Avenue	$43,049,316	per route km	$67,345,000
	Option 2: Fir Street to West 3rd Avenue	$36,145,330	per route km	$66,306,000
	Option 3: Fir Street to West 2nd Avenue impacting to the building on 1500 West 2nd Avenue	$43,054,476	per route km	$67,595,000
False Creek South		$106,732,387	per route km	$63,799,000
Southeast False Creek		$76,912,800	per route km	$68,849,000
False Creek Flats Connection to OMF				
	Option 1 - 1st Avenue	$40,996,250	per route km	$60,700,000
	Option 2- Industrial Avenue	$40,737,690	per route km	$63,204,000
	Option 3 - National Avenue	$46,700,899	per route km	$66,925,000
False Creek Flats - Quebec Street		$53,795,777	per route km	$71,231,000
Maintenance Facility				
	Site 1 – 235, 247 & 273 East 1st Avenue	$53,243,929		
	Site 2 – 425 & 455 Industrial Avenue	$60,036,061		
	Site 4 – 71 National Avenue	$61,621,902		
Vehicles				

Route Portion and Routing Options	Total Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	Unit Cost Including Engineering, Management, Bonding, Insurance and Contingency (Excludes borrowing interest)	
8 Street Cars with Fare Card Readers	$47,040,000	per car	$5,880,000

Note:

- The Maintenance Facility costs have not been scaled down as a more in-depth examination of the OMF sites is required to determine how they layout could be phased.
- Costs for environmental, testing and commissioning, and operations preparation have not been included as the Phase 1 portion of the network is a large change from the original estimate which had included allowances for these items.

Based on the above table, the infrastructure capital cost of Phase 1 from Arbutus at Broadway to Science World Stop could cost between approximately $487,500,000 and $501,200,000. As discussed, further investigation is required to accurately estimate the Phase 1 cost as well as each of the potential extensions.

6.3 Future Expansions of the Network

Later phases would extend this system north and west, through Gastown, Waterfront and to Stanley Park (Stanley Park Extension), west from the Science World area through False Creek North into Yaletown (Pacific Boulevard Extension), and south along the Arbutus Greenway to Milton Street. The network could possibly be expanded via the following extensions but requires further study to define future staging:

- Science World Stop to Waterfront Stop
- Waterfront Stop to Chilco Street Stop
    - Initially as the single track option for along Georgia Street and then the dual track could be implemented at a future date.
- Science World Stop to Granville Street Stop (on Drake Street)
- Arbutus Greenway – from Arbutus at Broadway to Milton Street Stop

Each of the extensions could happen in a phased approach of a couple stops being built at a time, or a longer extension could be put in place. However, further examination of the network ridership will be needed to fully understand what the ridership would be for potential phases, extensions or portions of the network. The ridership modelling done to date has been done for the entire network and has not considered phased implementation.

Based on the ridership modelling and what are confirmed to be future phases and extensions, potential interim stops will need be laid out to facilitate the necessary turnaround movements of a terminus stop. This consideration was made at the Waterfront Stop and the phased single to dual track approach for Georgia street was considered. The Science World Stop is not currently laid out in an efficient interim terminus stop layout and both tracks are in-street shared running. This stop would need to be re-examined with discussion around the trade-offs of an interim terminus layout versus the future vision of the street.

In order to maintain service on Phase 1, or established portions of the network, while the expansion is being constructed interface considerations and planning is required. At interim terminus stop locations, the tracks

can be extended by some distance beyond the stop to allow for track infrastructure tie-in. Careful consideration for the signalling, communications and electrification systems interface will also be needed.

7 Funding Mechanisms and Business Case

7.1 Funding Mechanisms

7.1.1 Background

In May 2002, Macquarie North America produced the report titled “PPP Review of Vancouver Streetcar Project”. The insights, recommendations and conclusions presented in the report largely hold today. The main difference is the maturity of the alternatively financed project market in 2018. Canada now has world leading expertise across a range of sectors, including transit and transportation. The alternatively financed project market in Canada continues to evolve, building on lessons learned and new innovative financing options.

At the core of PPP or alternatively financed projects is the transfer of risk to the party best positioned to mitigate or manage the risk to improve the value for money delivered. Although it has a private finance component, it should not be considered a project financing solution, rather be selected based on the value it brings to an investment.

A range of financing and procurement models have been adopted in recent years to deliver transit projects in the Lower Mainland. TransLink is an example of an organization that considers how the infrastructure will be operated and maintained, and the procurement model trade-offs, to inform the selection of the financing mechanism. As a result the Canada Line was delivered as a Design-Build-Finance-Operate-Maintain with a 35 year operating term, the Evergreen Expansion was delivered as a Design-Build-Finance with operations and maintenance being delivered by TransLink, and the Surrey-Newton-Guildford Line (prior to the project cancellation) was going to be a Design-Build-Finance-Operate-Maintain with a condensed 7-year operating term.

7.1.2 Available Funding Mechanisms

The funding structure will be determined by considering the available funds as well the procurement model that is determined to deliver the greatest value for money. The funding mechanism could include one or some of the following:

- Senior government funding: The publicly funded component of transit infrastructure projects is typically a combination of senior government, both Federal and Provincial. As of Budget 2017, Infrastructure Canada has allocated the Public Transit Infrastructure Fund (PTIF) to the Provinces based on ridership and population. The Province will then enter into agreements with eligible recipients to manage projects. Public transit projects (new projects and expansions) are eligible for up to 40% funding through the PTIF program.
- Short term private finance: A private sector project company will raise project finance that could be a combination of short-term debt and/or equity to be paid of at substantial or total completion. Typically, the private finance sector considers short-term finance less desirable than longer-term, private finance options due to the lower returns. This option aligns with a Design-Build-Finance procurement model.

- Long term private finance: A private sector project company will raise a combination of long-term debt (loans, bonds or other financial instruments) and equity from the project company shareholders. Long term private finance aligns with procurement models that have extended operations and/or maintenance contracts, such as Design-Build-Finance-Maintain and Design-Build-Finance-Operate-Maintain.
- Canadian Infrastructure Bank: The Canadian Infrastructure Bank (CIB) was established in 2017, and with the intent to attract private finance to bring new, revenue generating projects to market. The CIB will invest $35 billion from the federal government, including $5 billion specifically for pubic transit systems.

The funding options should be considered by project component – for example capital costs versus operating costs, and eligible costs versus ineligible costs (in the context of Federal and Provincial funding).

7.1.3 Considerations to Secure Project Financing

There are a number of funding considerations that the next stage of the streetcar development process could explore to clarify the requirements of currently identified funding options and to understand the trade-offs between each one. This section focuses on the next steps for three funding mechanisms; public funding, private financing (both short and long term) and unsolicited proposals.

By demonstrating how a streetcar project or projects could deliver on regional, provincial and/or federal objectives, the City of Vancouver streetcar would increase public funding opportunities. A focus of the business case process proposed in Section 7.2 is to develop a strategic foundation to support future funding applications, and to identify new public funding eligibility criteria such as Climate Lens assessments. Solely publicly funded large infrastructure projects are often delivered using the Design-Build procurement model, and this model has been considered in the analysis of advantages and issues in Section 7.1.4.

The business case process will also consider opportunities to fund the project using private finance. Following the identification of project risks, the business case process will determine a funding and procurement approach that delivers value for money. Private financing partners want high value, long term sustainable infrastructure outcomes, and with mitigated risk that provides a consistent return on investment. The public sector can support this objective through structured project planning and preparation processes, appropriate risk allocation, and by confirming funding availability and project approvals prior to procurement.

A key risk of transit projects is revenue generated from ridership. In Canada revenue risk is typically retained by the procuring authority as public financing is required to cover operating costs. The private sector risk during operations (if there is an operational term) focuses on the availability of the infrastructure and quality of service delivery.

Unsolicited private sector proposals are an emerging funding mechanism for transit infrastructure in other jurisdictions. This is when a private party makes a proposal to undertake a PPP project. It is submitted at the initiative of the private firm, rather than in response to a request from the Government. The private party initiates the project, that is, acts as a promoter and proposes to the government the delivery of a project to solve a specific need. The REM project in Montreal is a Canadian example of an unsolicited private sector proposal that is now being implemented. This project was also the first project to receive a loan from the Canadian Infrastructure Bank. Given the current market, as the streetcar project is developed, it would be worthwhile for the City to consider how it would respond to an unsolicited proposal, and how the merits of a proposal would be evaluated to validate value for money, innovation and service delivery benefits.

7.1.4 Advantages and Potential Issues of Different Delivery Mechanisms

Funding mechanisms are a key component of a business case, and without understanding the strategic and economic cases, it is difficult to accurately refine the list of possible or preferred options, which could be a combination of a range of options. The PPP market in BC is well established but is constantly evolving. Shorter contract periods are being considered, as are the less traditional Design-Build-Finance models. For this level of assessment, the advantages and potential issues of the five main procurement models are considered in Table 7-1 but should be addressed in more detail during the business case stage:

Table 7-1 Advantages and concerns with different procurement models

Objective	Design Build Separate Operate and Maintain	Design Build Finance Operate Maintain	Design Build Finance Separate Operate and Maintain	Design Build Finance & Maintain Separate Operations	Design Build Finance & Maintain Separate Rolling Stock & Operate
Financing - Ability to maximize private capital	○	●	◖[3]	●	◖
Flexibility - Supports expansion and phasing	●	○[1]	●	◖	●
Cost - Price certainty	◖	●	◖	◖	◖
Competition - Market appetite and capability	●	◖	●	◖	●
Risk - Interfaces are minimized	◖	●	◖	◖	○[5]
Operations – Link between system performance/design and payment	○	●[2]	○[4]	◖	◖
Operations – Integrate with existing systems or use existing providers	◖	○[1]	◖	●	●

Legend: ● Mostly fulfills objective ◖ Partially fulfills objective ○ Does not fulfill objective

Notes:

[1] – Suitable for standalone projects where client as limited experience delivery and/or operating a transit system.

[2] – Requires minimum revenue guarantee or for the Authority to retain ridership/revenue risk.

[3] – Generally construction will need to be paid down at the end of commissioning process.

[4] – Payment structure during operations does not incentivize design and construction quality.

[5] – Design interface risks (e.g. wheel/rail interface) are not allocated to one party.

7.2 Business Case Approach

7.2.1 Background

The business case approach outlined below builds on the City's work to-date to confirm the technical feasibility of streetcar in Vancouver and the policy tools in place that supports its implementation. The business case approach confirms the City is pursuing 'the right project' by identifying objectives, demonstrating alignment with other organizations and levels of government and demonstrating the projects value. It promotes appraisal, rather than advocacy, of options using a structured decision-making framework, allowing projects to progress based on their merits. Finally, the business case supports 'delivering the project right' by developing an implementation strategy focusing on the commercial, management and governance aspects.

The objective of this streetcar feasibility study was to validate that the work completed by 2005 is still valid in 2018 and allows the City to futureproof its streets for streetcar development. Through this process, opportunities to consider new routes have been identified. The business case process provides the decision-making framework to validate why particular routes are considered, to document objectives that reflect a wide range of stakeholders, to communicate a clear rationale that can be used in future consultation exercises, and to plan for the next steps (whether continued development by the City or transfer to another authority).

7.2.2 The Business Case Framework

Whether adopting an existing City of Vancouver business case framework or recommended industry guidelines, the outcome of the business case should be the same: a structured process to identify solutions, and plan for their implementation, so that the City's objectives are met. For the purpose of detailing the business case scope, and the intended objectives of the business case at different stages of the project, the internationally recognized Green Book framework has been adopted. The Green Book model considers five 'cases' and includes an iterative approach as the project evolves or as the business case is developed over time. The following information is largely extracted from the Green Book guidance, and it has been adapted to meet the needs of the City. Following the development of the Strategic Business Case, or when preferred funding options have been identified, the business case scope should be adapted to meet the needs of the specific funding agency.

Figure 7-1 below shows the iterative business case approach and the change in focus from identifying the right project to the implementation strategy.

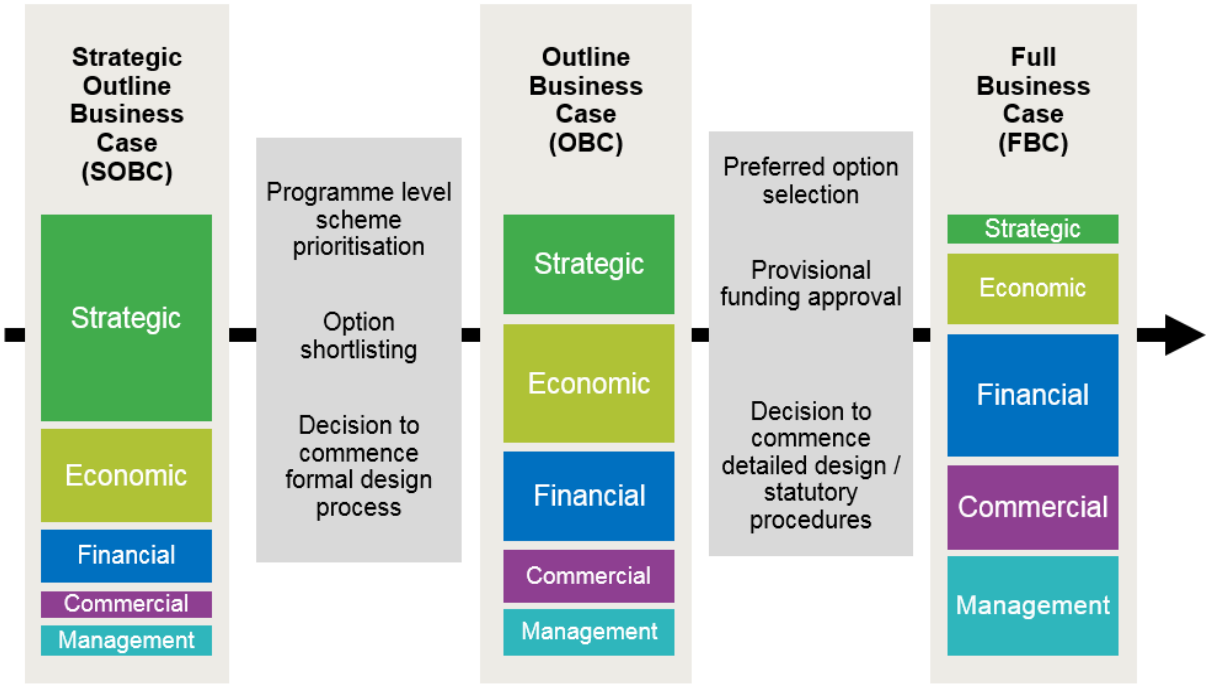


Figure 7-1 Overview of the 'five cases' business case process

The business case approach focuses on the appraisal of options rather than advocacy, with the five cases providing the following evidence:

1. That the intervention is supported by a compelling case for change that provides holistic fit with other parts of the organisation and public sector– the "**strategic case**"
2. That the intervention represents best public value – the "**economic case**"
3. That the proposed spend is affordable – the "**financial case**"
4. That the proposed deal is attractive to the market place, can be procured and is commercially viable – the "**commercial case**"
5. That what is required from all parties is achievable – the "**management case**"

There are then three business case stages, each requiring an increased level of effort. The three stages are intended to:

1. Develop a robust case for change and an early indication of the preferred option (the "**Strategic Business Case**")
2. Revisit assumptions and analysis in the Strategic Business Case to identify a preferred option that demonstrates value for money using a structured decision-making framework. It sets out the likely deal, and demonstrates affordability by considering financing options (the "**Outline Business Case**")

3. Fulfil the obligations of funding agreements which could include the procurement strategy, contract structure and planning for successful delivery (the "**Full Business Case**")

7.2.3 Business Case Scope

The recommended approach is to proceed with the development of the Strategic Business Case which will inform future business case development and funding application requirements. An outline of the Strategic Business Case scope with estimated duration and fee for the streetcar project is provided below. It is presented in the structure of the final document and includes stakeholder engagement. The time and effort to complete assumes technical design work is undertaken separately and will depend on the extent of the stakeholder engagement, and a fee contingency has been included. It is anticipated to take approximately 20 weeks to complete a conservative schedule which accounts for interim review of deliverables but is contingent on the availability of stakeholders.

Table 7-2 Outline of the Strategic Business Case Scope

Section	Description	Duration	Approximate fee
1.0 Strategic Case			
1.1 Strategic Context			
Organizational Overview	Brief profile of the City of Vancouver, with a statement of what the City is seeking to achieve. Outlines the nature and scope of the City and the experience delivering infrastructure projects and transportation services.	3 weeks	$10,000
Demonstrate Strategic Alignment	Research strategies, policies and projects to demonstrate links and dependencies between organizations.		
1.2 The Case for Change			
Objectives	Document where we want to be by developing three to five SMART objectives. Demonstrating the investment is supported by key stakeholders is beneficial at this stage, and the objectives are typically developed through a facilitated workshop process.	3 weeks	$10,000
Existing Arrangements	Briefly describe the current situation including any challenges or opportunities. This would include a description of how transit is provided in Vancouver.	3 weeks	$10,000
Business Needs	The business need is the gap between the objectives and the existing arrangements. Briefly describe what needs to change to meet the objectives and is used as a basis to identify options.		

Section	Description	Duration	Approximate fee
Potential Scope	Identify the boundaries or limitations to avoid scope creep as the develop processes progresses		
Benefits and Risks	Identify benefits (both quantitative and qualitative) and risks that could impact the ability to deliver the objectives.	2 weeks	$10,000
Constraints and Dependencies	Identify the constraints in which the project would be developed and the dependencies with actions or requirements outside the scope of the project.		
2.0 Economic Case			
2.1 Critical Success Factors			
	The critical success factors form the framework to evaluate the long list of options. They are the criteria to narrow down why particular routes should be considered and are used to facilitate structure decision making. The business case team would develop the critical success factors and then seek validation from key stakeholders.	2 weeks	$5,000
2.2 Explore the Preferred Way Forward			
Long listed options	The process to develop the long-list of options is typically completed as a workshop and provides a chance for all possible options to be documented. The intent is to quickly document, and then potentially discard, a range of options to avoid future 'what ifs'. It should include 'do nothing' and 'do minimum' options as baselines to demonstrate value for money. Options can include extent of infrastructure/network, service delivery, phasing/implementation and management approaches.	2 weeks	$5,000
Determine the short list of options	The process to identify the shortlisted options can vary depending on the objectives, anticipated benefits and risks. The process is largely qualitative to allow a large number of options to be quickly evaluated, prior to completing more detailed analysis at future stages.	2 weeks	$5,000

Section	Description	Duration	Approximate fee
2.3 Appraisal of Options			
	The appraisal of options could be completed now or during the next stage of the business case. The appraisal of options includes cost benefit analysis, optimism bias, and risk assessment. Based on our knowledge of the Vancouver Streetcar Project, we consider the most value to be from the strategic case and a structure approach to develop additional options. As the project progresses options to complete additional appraisal could be considered.	N/A	N/A
3.0 Commercial Case			
Outline the Commercial Case	Identify the procurement options for each short-listed option briefly describing the scope, interfaces, observations of market capability and supply chain constraints, level of complexity and price certainty/competitiveness.	1 week	$3,000
4.0 Financial Case			
Outline the Financial Case	Provides an initial assessment of the overall affordability of the shortlisted options and possible funding sources and requirements.	1 week	$3,000
5.0 Management Case			
Outline the Management Case	Outline the history of the project, the next steps to develop the business case, and potential governance and management arrangements.	1 week	$3,000
	Estimated total	**20 weeks**	**$64,000**
		Including contingency	**$76,800**

Note: Contingency allows for uncertainty relating information availability and stakeholder engagement.

8 Next Steps

In the Streetcar Feasibility Study to date, questions about how the currently planned streetcar network will operate and be prioritized have been raised. As well, as the transportation system in and around the approved network continues to evolve, new challenges and opportunities arise. This has prompted thought regarding possible updates to and further exploration of the current, Council-approved streetcar network. In order to continue to support the implementation of a future streetcar system, it would be beneficial to look at other routing options and phasing. The Feasibility Study of the Council-approved network captured in this report form the foundation for further study.

As a first step, a planning-level streetcar network assessment should be carried out. Alternative streetcar routing options building on the current network should be considered, and the overall streetcar networking routing and operations of multiple lines examined. Potential alternative streetcar routes and additional extensions considered to date include:

- Alternative routing:
  - in the West End
    - Davie Street (instead of Drake Street)
    - Denman Street (instead of or in addition to the Stanley Park extension)
    - Pacific Boulevard to Beach Avenue
  - Into the Downtown Core:
    - Granville Street Bridge Greenway
  - False Creek Flats
    - Main Street (instead of Quebec Street)
- Additional extensions:
  - Stanley Park (from Chilco Street into the park, possibly the existing bus loop)
  - Vanier Park (from Granville Island)
  - Further north with False Creek Flats (to service the new St. Paul's Hospital campus and other nearby destinations)
  - South extension to connect AGP to Canada Line Marine Drive Station
  - West 4th Avenue

In addition, other technical work should continue to be carried out in tandem. Conceptual and functional design of specific segments of the network or at specific locations should be completed as needed to support neighbourhood and community plans. Other planning studies are ongoing throughout the City and it is important that they consider futureproofing for streetcar on an ongoing basis. Specific segments of the streetcar network where there are more active planning studies in progress include:

- Gastown – Gastown Multi-Modal Study, which will feed into the Gastown Complete Streets Plan
- False Creek South – The False Creek South Neighbourhood Planning Program and the False Creek South Multi-Modal Transportation Study are both ongoing and active studies. As they progress, streetcar futureproofing should be accounted for.

- Broadway – The Broadway Area Plan has recently started. The boundaries of the area are 1st Avenue, 16th Avenue, Vine Street and Clark Drive. It will be important to ensure streetcar is considered in the plan.
- Waterfront Hub Study

There may also be significant development that occurs along the potential streetcar route that should be reviewed with a streetcar lens to protect the ability to efficiently deliver the City's streetcar vision in the future.

As identified in Section 3, further work should be done to confirm a preferred OMF site in False Creek Flats, and the potential for a secondary site along AGP or another part of the streetcar network. The OMF site should be selected based on site availability as well as the evaluating the options based on multiple account criteria or a holistic evaluation to ensure it will fit in with the ultimate build out of False Creek Flats and the developing areas in the City. As the OMF site location is linked to a few streetcar route extensions and stop locations, these should also be factored into the evaluation and it could even be determining the factors in the final selection of a property.

Another initiative that the City is currently undertaking is a joint submission to the Canada Smart Cities Challenge with the City of Surrey. As part of the submission, the City has identified False Creek South and SEFC (1st Avenue) as a corridor in which they envision "implementing a collision-free multi-modal transportation corridor, leveraging autonomous vehicles and smart technologies to demonstrate the path to safer, healthier and more socially connected communities while reducing emissions, improving transportation efficiency and enhancing livability". As this initiative continues to develop and the City begins to implement solutions that work towards achieving a collision-free corridor, the incorporation of the streetcar design principles which allow for its futureproofing for streetcar should be considered.

With the recent City commitment to developing a new city-wide plan, the incorporation of streetcar into the long-term vision may take on a renewed focus. Futureproofing for streetcar should be undertaken to ensure that the vision and objectives of the streetcar network continue to align with the City's overarching objectives.

The coordination with the city-wide plan will also feed into the development of a strategic business case, as outlined in Section 7.2, noting the recommendation to undertake a planning level streetcar network assessment, and is a critical next step that would allow the City to confirm that the potential streetcar network is 'the right project' for the City, other stakeholders, such as Mayor's Council and TransLink, the Metro Vancouver region and other levels of government. It will enable the City to propose that the Vancouver Streetcar network be a component of the Regional Transportation Strategy (RTS) and the next Mayor's Council Plan. The business case will also enable the planning of other next steps, whether continued development by the City or transfer to another authority (such as TransLink).

As a part of the business case development, the ridership forecasts would need to be further refined. As design and engineering progresses the ridership forecasts can be updated. The service frequency should be examined further and balanced to meet ridership demands along with operations requirements and costs. The updated forecasts should also include a review the potential passenger perception of streetcar as a mode. As a new type of transit in the region, passenger perception will affect the overall attractiveness in the demand model. This could impact the large proportion of short trips currently forecasted and the overall demand levels. Further in-depth review of RTM calibration and performance in the study area would also be useful in further study stages.

Overall, the Vancouver Streetcar Network is important as its delivery will provide a new and complementary transit mode with a capacity and desirability in between a local bus and regional rapid transit. It can be developed to be an integrated and integral part of the city and region. The next stages of the project should work to reconfirm the vision and objectives of the project on a city and regional level. It should factor in the changes in the region, including the latest Mayor's Council decision regarding rapid transit South of the Fraser River, as well as the evolution that Vancouver is currently going through. There are several large transportation projects within the city, such as Arbutus Greenway, Granville Bridge Greenway, NEFC, car-light/car-free Water Street, and cycling network expansion, that will have an influence on the streetcar network. Additionally, similar to how the streetcar is envisioned to play a significant role in helping the city meet its Transportation 2040 goals, the streetcar will be able to support the City's policies around climate change, Greenest City 2020, and City-wide plan.

Appendices

A. 338583-MMD-00-P0-LG-XD-0001 – Current Proposed Routing Tabulated Summary

B. 388583-MMD-00-P0-DR-TR-1100, 1200, 1300 and 3100 series – Proposed Streetcar Routing

C. 388583-MMD-00-P0-MO-TR-0002 – Operations and Maintenance Facility Sizing Information Memorandum

D. 388583-MMD-00-P0-DR-TR-4101 and -4102 – OMF Site 1 Layout Options

E. 388583-MMD-00-P0-DR-TR-4201 and -4202 – OMF Site 2 Layout Options

F. 388583-MMD-00-P0-DR-TR-4301 – OMF Site 4 Layout Option

G. 388583-MMD-00-P0-SK-TR-4401 and -4402 – Vehicle Storage Track

H. Land Use

I. Employment and Population Catchment Analysis

J. 2016 Midday and PM Hourly Ridership

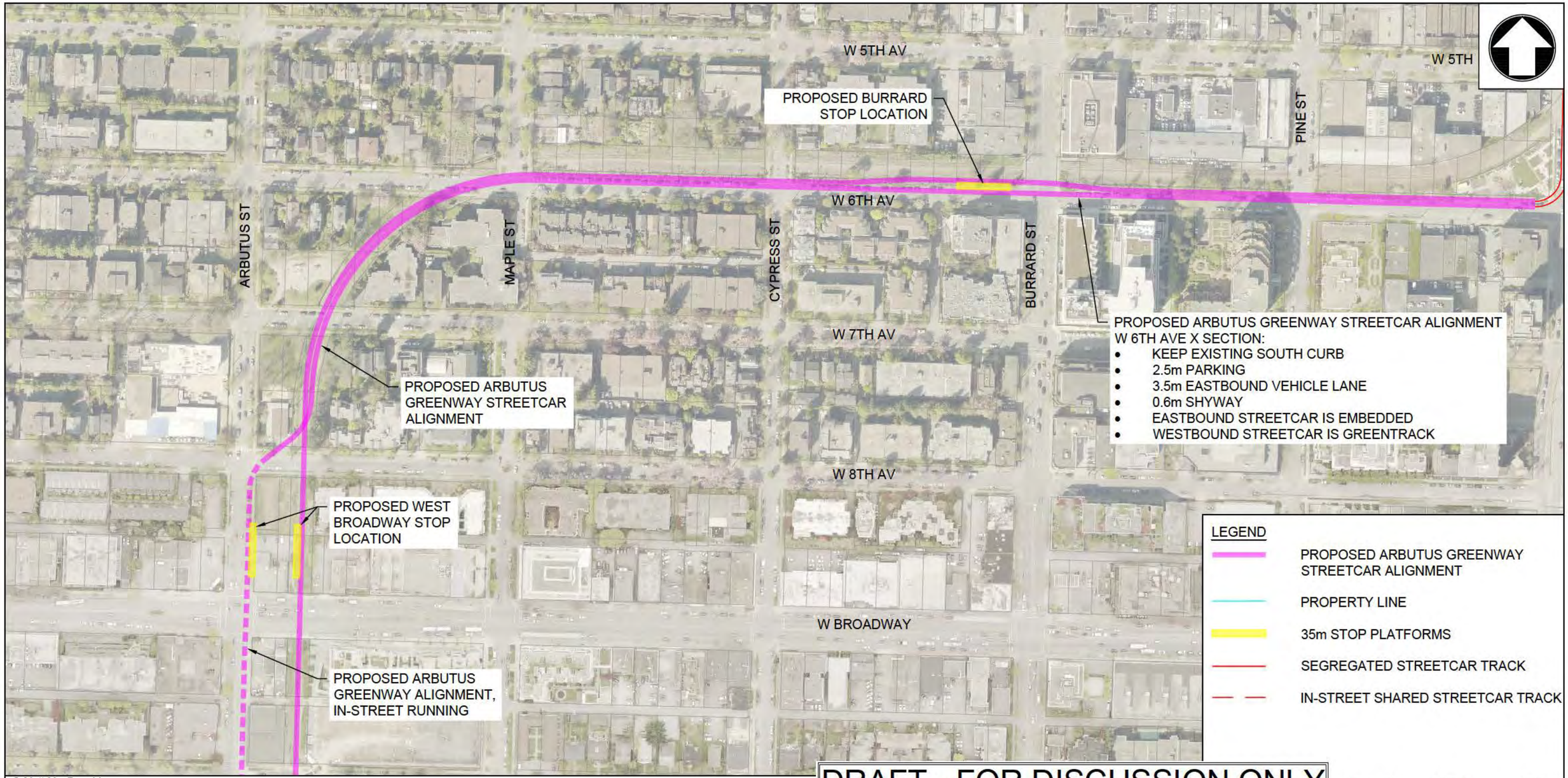
K. 2050 Midday and PM Hourly Ridership

L. Basis of Estimate

A. 38583-MMD-00-P0-LG-XD-0001 and 388583-MMD-00-P0-SK-XD-0100 – Current Proposed Routing Tabulated Summary

Portion of Route	Proposed Configuration					Additional Comments	Configuration to investigate during 2018 Feasibility Study
	2005 IBI Report	2008 HMM Preliminary Design	NEFC	AGP	South False Creek		
Arbutus Greenway - along West 6th Avenue	N/A	N/A	N/A	Proposed Arbutus Greenway Streetcar Alignment W 6th Ave Cross-Section: - Keep existing south curb - 2.5m parking lane - 3.5m Eastbound Vehicle Lane - 0.6m shyway - Eastbound streetcar track is embedded - Westbound streetcar track is green track	N/A		- Keep layout along West 6th Avenue and to West Broadway Stop - Look at the West Broadway Stop being an interim terminus for Phase 1 to allow for connection with MLBE
Connection to Arbutus Greenway	N/A	N/A	N/A	N/A	N/A	City (Simon Mueller) has prepared two memorandums outlining potential routing on Fir Street and 2nd Avenue	Investigate design options further whether on Fir Street or another route
Granville Island to Cambie St Bridge	- Segregated double tracks following existing railway corridor, between Lameys Mill Rd./Charleson Rd. and West 6th Avenue - Grade crossing of Moberly Road, operating as part of Moberly/6th intersection	- Segregated double tracks on dedicated railway ROW	N/A	N/A	- Shared running on realigned Lameys Mill Road		Look at two options: - Two track segregated within rail ROW - Two tracks on realigned Lameys Mill Road Look at a streetcar alignment that places stop closer to CanadaLine station and how it can cross under the Cambie Bridge
Southeast False Creek (1st Avenue from Wylie to Ontario Street)	- Alignment in First Avenue corridor, street to be widened in Southeast False Creek development - Mostly segregated 6.8 m double track section, with 4 5m traffic/bike lane and 2 5 m parking south of streetcars; 4.5 m traffic/bike lane north — fairly wide sidewalks/landscaping either side - Traffic only crosses tracks at intersections, left turns across tracks only at signals	- Segregated centre running double tracks (based on 2005 IBI Report)	N/A	N/A	N/A		Look at options: - segregated running in median - shared running Consider: - AAA bicycle lanes - traffic management solutions (i.e. one-way streets)
Quebec Street Connection	N/A	N/A	N/A	N/A	N/A		New connection in order to provide a connection/transfer point to the Millennium Line Broadway Extension at Main Street
Quebec Street from 1st Avenue to Pacific Boulevard	- Alignment is on west side of Quebec Street from First Avenue to Pacific Boulevard - Segregated 7 0 m double track section using westernmost existing traffic lane and off-street area (southbound Quebec Street becomes 2 through lanes) - South of Terminal Avenue, 4 0 m pedestrian/biking area west of the tracks, and 1.0 m buffer on east separating it from southbound traffic - North of Terminal Avenue, existing parking is west of tracks and 1 0 m buffer again separates them from southbound traffic - Pacific Boulevard realigned northeast into existing triangular median area, and narrowed to two lanes, allowing streetcar to turn and make perpendicular crossing at Pacific/Quebec signal - At intersection, northbound track joins mixed traffic in curb lane of Quebec Street; southbound track is segregated with one southbound traffic lane and bike lane east of it	- Segregated west side running double tracks Note: The recommended alignment requires a significant corner cut of land at 1st Avenue and Quebec St. Land is also required west of the additional property from 1st Avenue to Science World	From (at least) National to Union St it is assumed the streetcar tracks in in-street shared running within each curb lane	N/A	N/A		Account for new Quebec Street layout that accommodates AAA protected bike lanes - Adopt NEFC design in some areas near Prior St intersection - may need to come up with new alignment options from 1st Ave to Prior St
800 Quebec Street	Maintenance Facility with storage capacity of 6-7 vehicles if include shop bays	Identified site layout operational performance issues in 2005 layout Proposed new layout that accommodates six 25 m streetcars 400 sq. m security and office building, 600 sq. m maintenance building, staff parking	Property redeveloped as a part of project - has constraints that have been laid out to accommodate a streetcar stop platform	N/A	N/A	Property is to be redeveloped for NEFC and is no longer available for the maintenance facility or vehicle storage	Need to investigate new possible maintenance facility locations within False Creek Flats and options for vehicle storage, including online storage along the entire network.
Pacific Boulevard to Keefer Street	*Split* - Northbound track in mixed use lane on Quebec Street - Southbound track in segregated lane, with sidewalk west of the track and bike/traffic lanes east of the track	N/A	- In-street shared running accounting for turn lanes	N/A	N/A		Look at proposed alignments as well as consider more segregation - dependent on tie-in with NEFC and Gastown

Portion of Route	Proposed Configuration					Additional Comments	Configuration to investigate during 2018 Feasibility Study
	2005 IBI Report	2008 HMM Preliminary Design	NEFC	AGP	South False Creek		
Keefer Street to Cordova Street	*Split* - From Keefer to Pender, northbound and southbound tracks in mixed use lanes of Columbia Street (traffic is two-way) - North of Pender, northbound track in mixed use middle lane with lanes on right and left for parking and turns - Southbound track from Cordova to Pender in segregated guideway (contra-flow to northbound traffic) - westernmost (fourth) existing traffic lane converted to streetcar trackway	N/A	N/A	N/A	N/A		Look at proposed alignments as well as consider more segregation - dependent on tie-in with NEFC and Gastown
Gastown (Cordova Street and Water Street Couplet)	- Westbound track in north curb lane of Powell Street and Water Street, mixed use with traffic — some parallel parking pockets on right side of tracks - Eastbound track in north curb lane of Cordova Street, possible mixed use with traffic (allowing left turns, but may wish to segregate from traffic approaching Columbia Street to facilitate signal priority for right turn across all traffic into segregated SB trackway) - Double track median alignment on Cordova between Seymour and Richards/Water — exclusive in western two-thirds of block because of interim terminus station and placement of crossover tracks	N/A	N/A	N/A	N/A		-Revisit couplet evaluation - Look at Water Street, Cordova Street, Couplet on both Water Street and Cordova Street, and On Hastings Street (using transit priority lanes)
Cordova Street (Waterfront Hub to Bute Street)	N/A	N/A	N/A	N/A	N/A	Waterfront developed a concept layout that accounted for streetcar tracks and stop	Incorporate Waterfront Hub design
Hastings Street (Bute Street to Cardero Street)	N/A	N/A	N/A	N/A	N/A		Look at options for segregated running and shared running
West Georgia (Cardero Street to Chilco Street)	N/A	N/A	N/A	N/A	N/A		- Streetcar to be on north/east side of Georgia St - Consider terminus at Denman or if to carry further into Stanley Park rather than Chilco St
Pacific Boulevard from Quebec Street to Nelson Street	N/A	N/A	- Split curb in-street shared running with accommodation for turn lanes	N/A	N/A		Maintain NEFC design and only provide commentary
Pacific Boulevard from Nelson Street to Drake Street	N/A	N/A	N/A	N/A	N/A		Look at alignment options and consider tie-in with NEFC design - look at potential terminus near CanadaLine Yaletown-Roundhouse Station - look at turning on Davie instead of Drake
Drake Street	N/A	N/A	N/A	N/A	N/A		Need to look at where to end (Drake at Granville, on Davie, along Pacific to Beach Ave)



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Title
CITY OF VANCOUVER
STREETCAR STUDY
CURRENT PROPOSED ROUTING

Drawn	L. ANDERSON	
Checked	K. MILLER	
Approved	G. FARMER	

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Drawing Number
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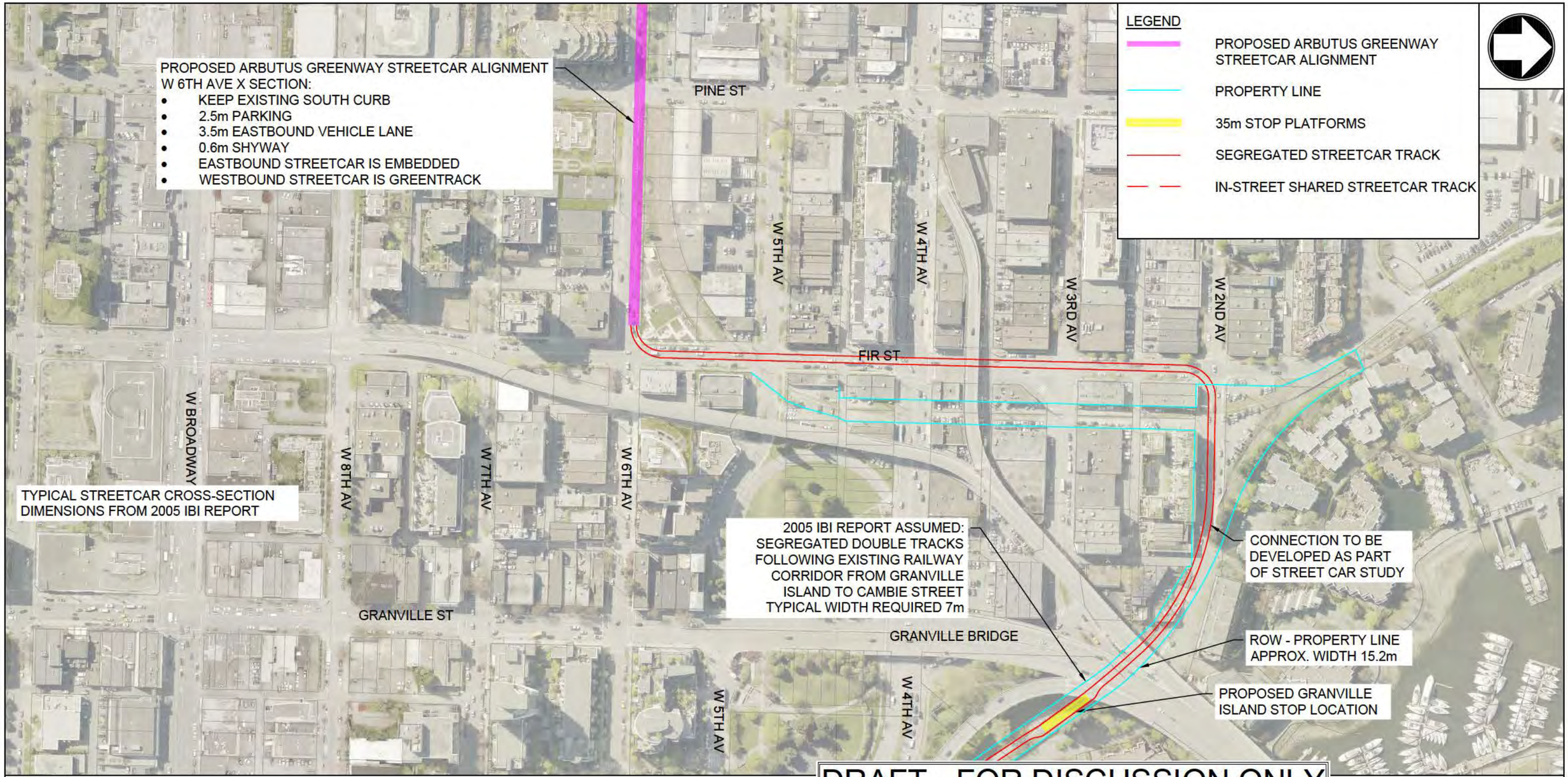

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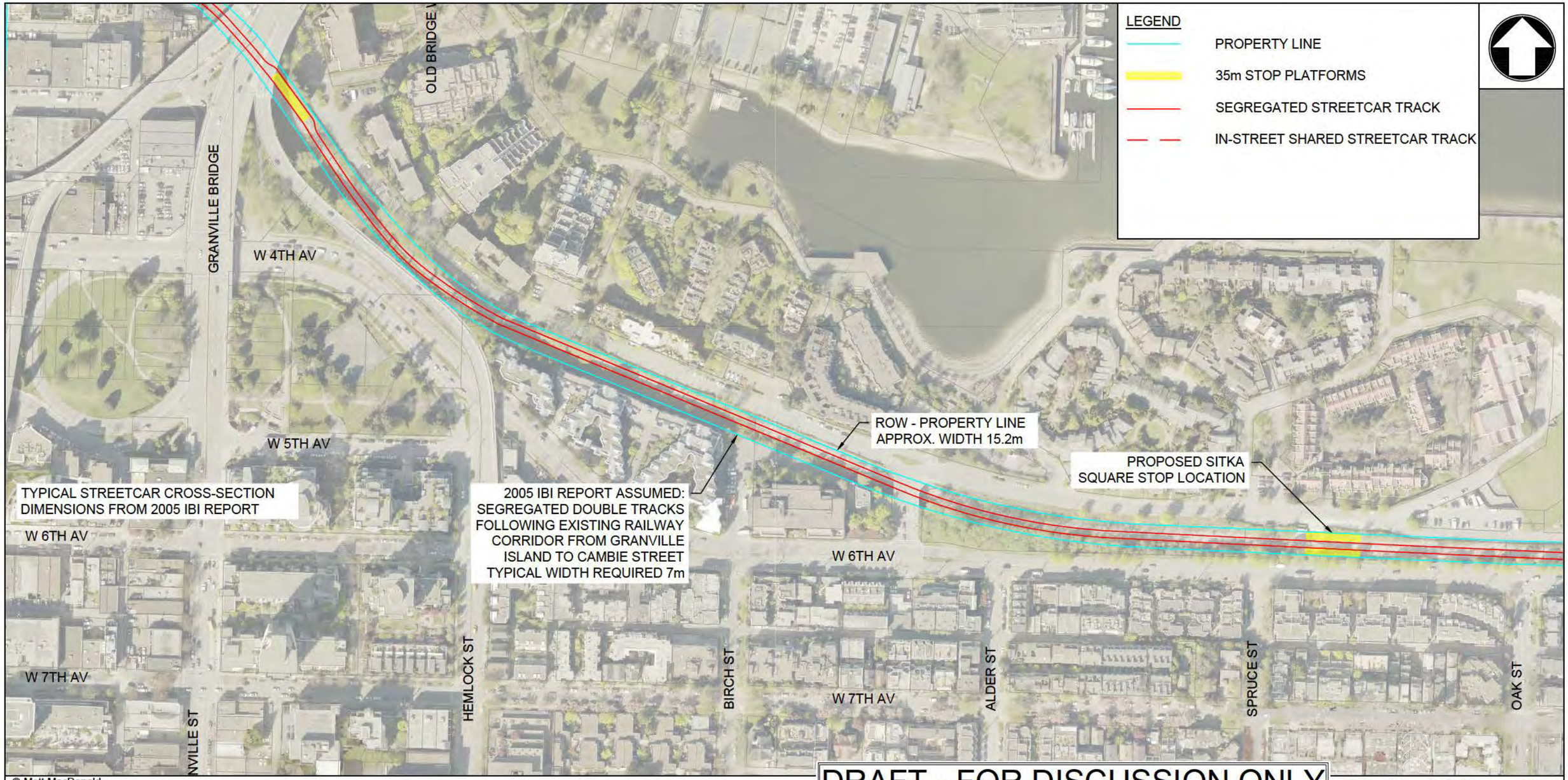

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LEGEND

- PROPERTY LINE
- 35m STOP PLATFORMS
- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK

PROPOSED CAMBIE STREET STOP LOCATION

STREETCAR TO FOLLOW EXISTING TRACK

PROPOSED MOBERLY ROAD STOP LOCATION

TYPICAL STREETCAR CROSS-SECTION DIMENSIONS FROM 2005 IBI REPORT

2005 IBI REPORT ASSUMED: SEGREGATED DOUBLE TRACKS FOLLOWING EXISTING RAILWAY CORRIDOR FROM GRANVILLE ISLAND TO CAMBIE STREET TYPICAL WIDTH REQUIRED 7m

ROW - PROPERTY LINE APPROX. WIDTH 15.2m

CAMBIE BRIDGE

W 2ND AV

CHARLESON

W 6TH AV

W 7TH AV

OAK ST

LAUREL ST

WILLOW ST

HEATHER ST

ASH ST

CAMBIE ST

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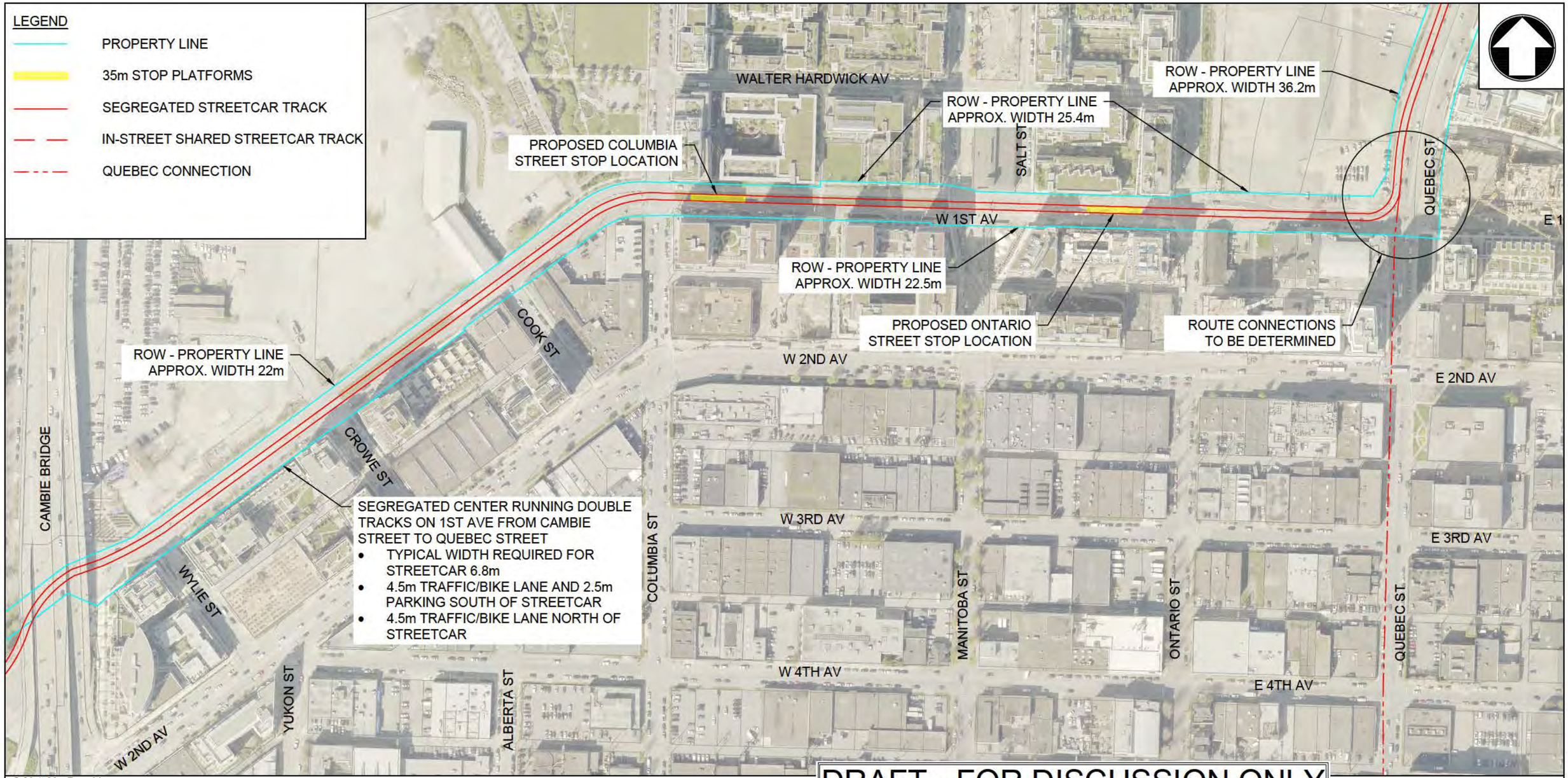

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CITY OF VANCOUVER
STREETCAR STUDY
CURRENT PROPOSED ROUTING
QUEBEC STREET CONNECTION

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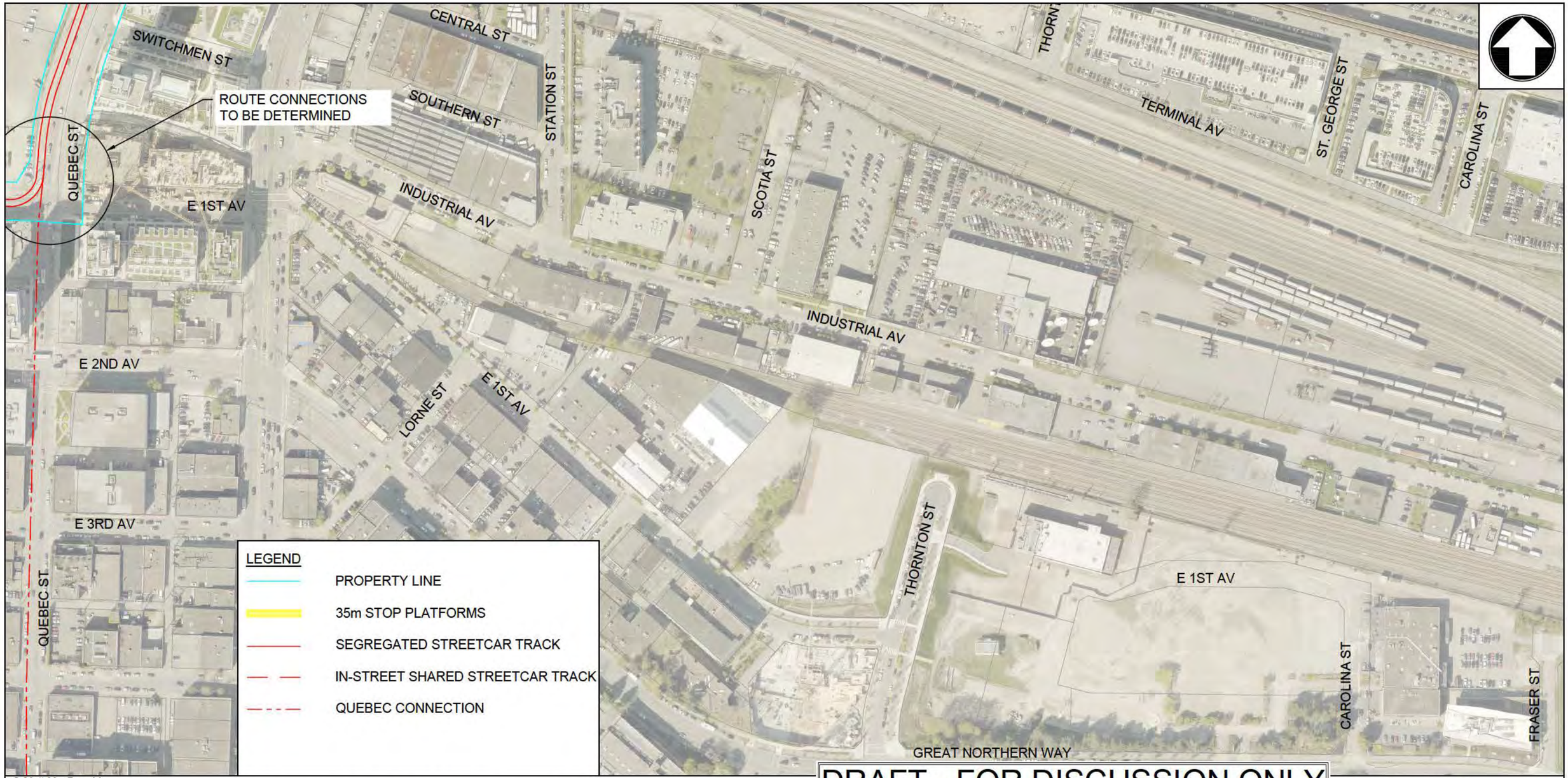

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Title
CITY OF VANCOUVER
STREETCAR STUDY
CURRENT PROPOSED ROUTING
FALSE CREEK FLATS
MAINTENANCE FACILITY

Drawn	L. ANDERSON	
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Approved	G. FARMER	

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Drawing Number
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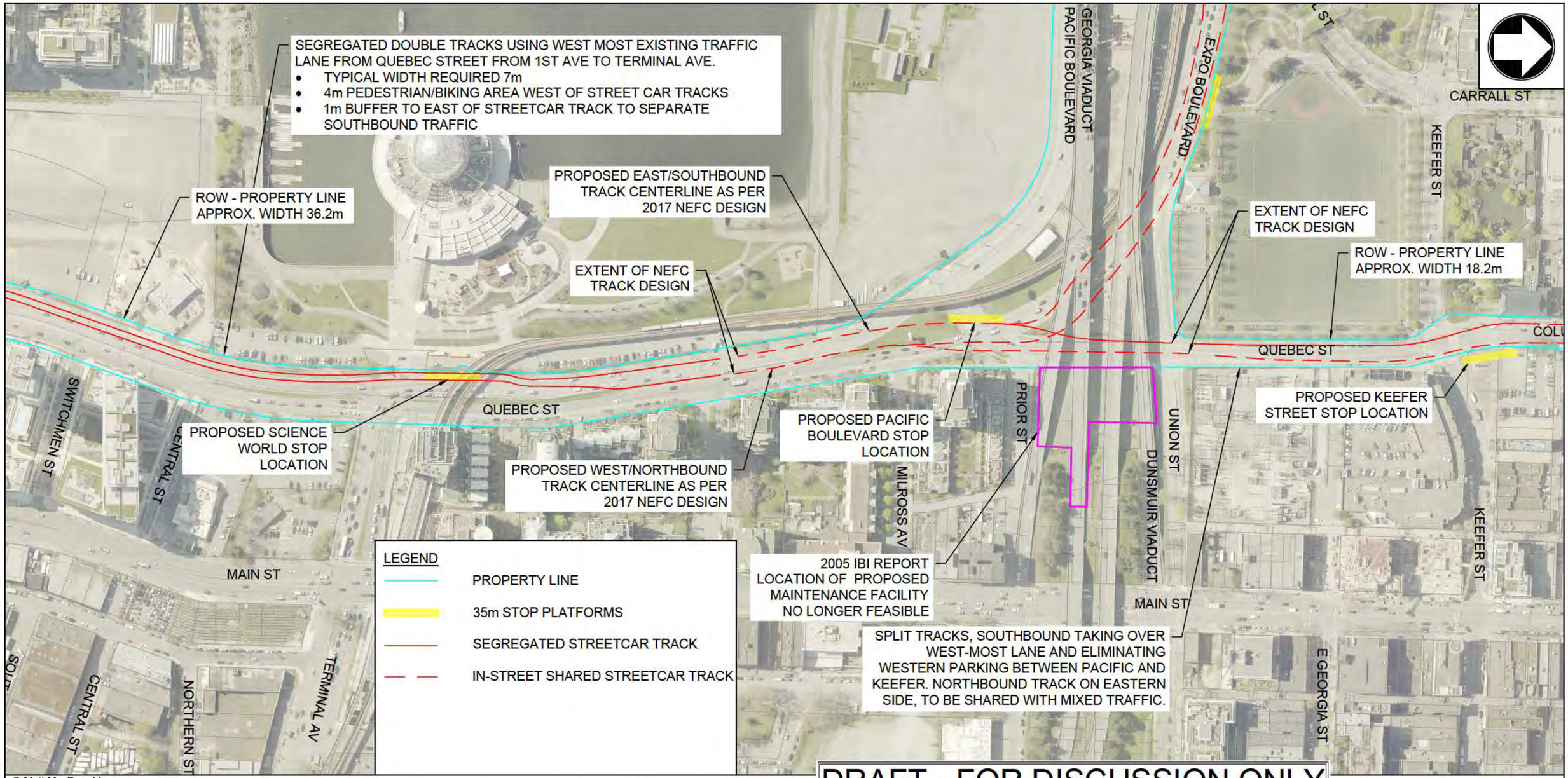

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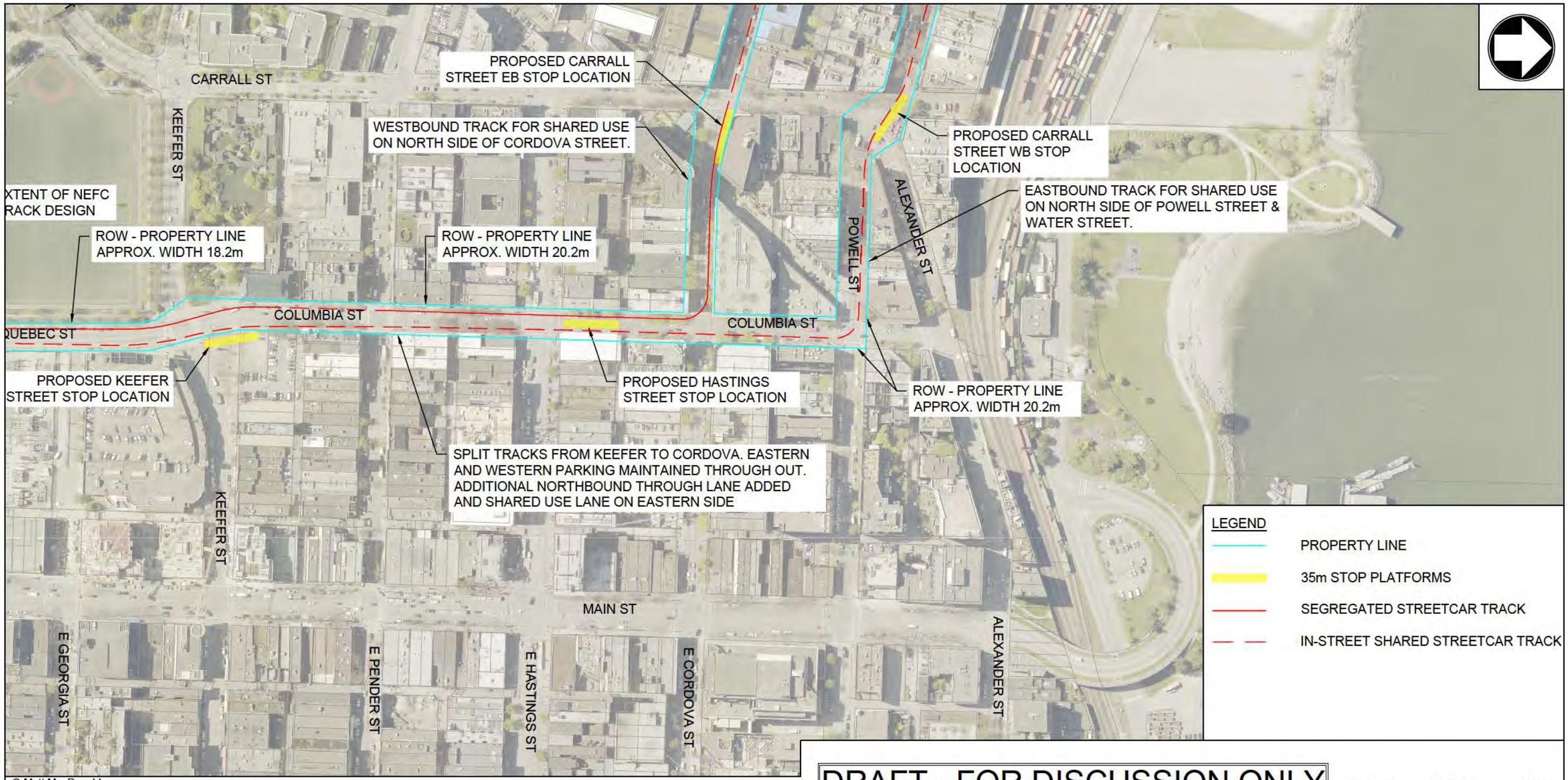

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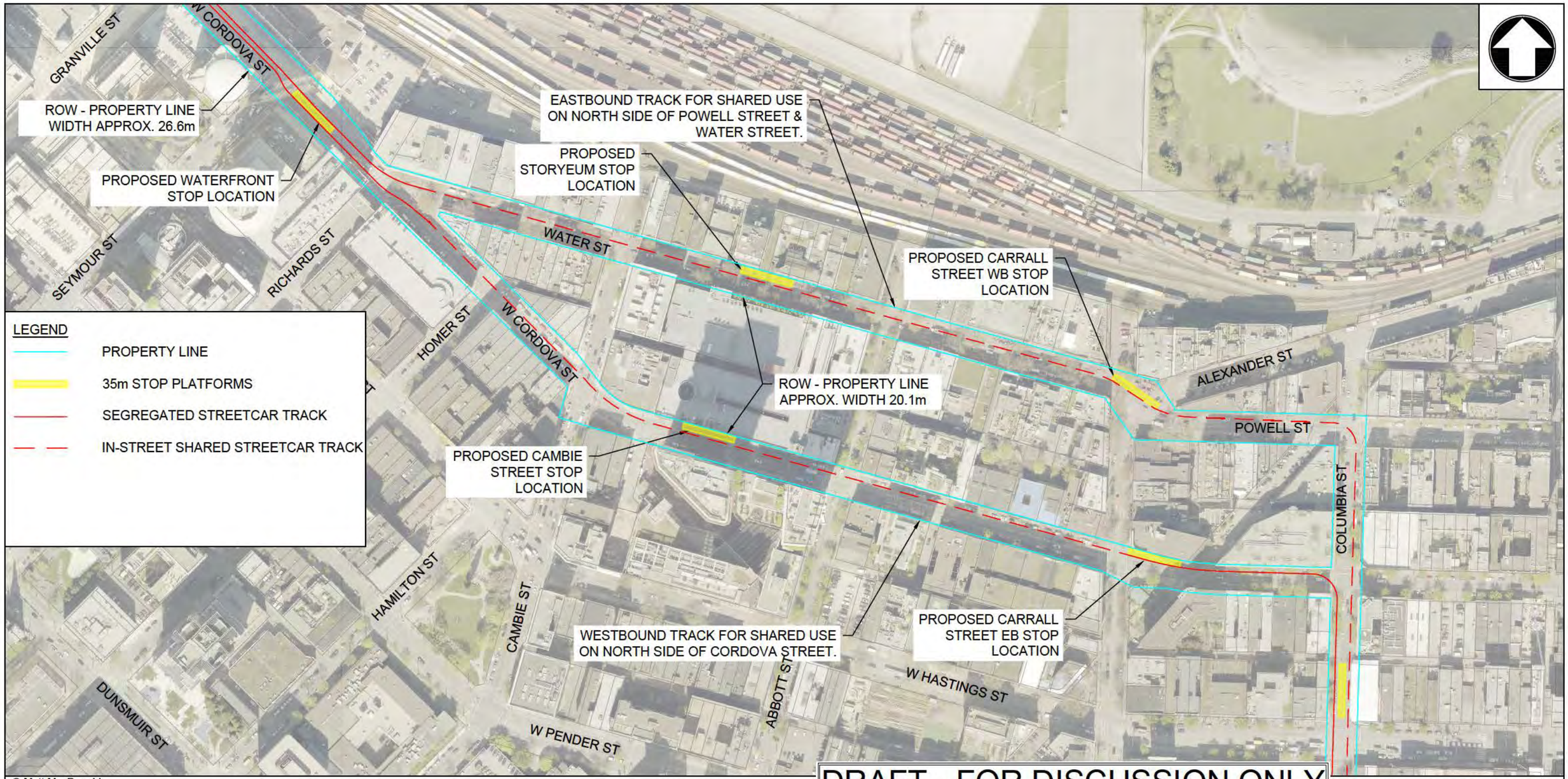

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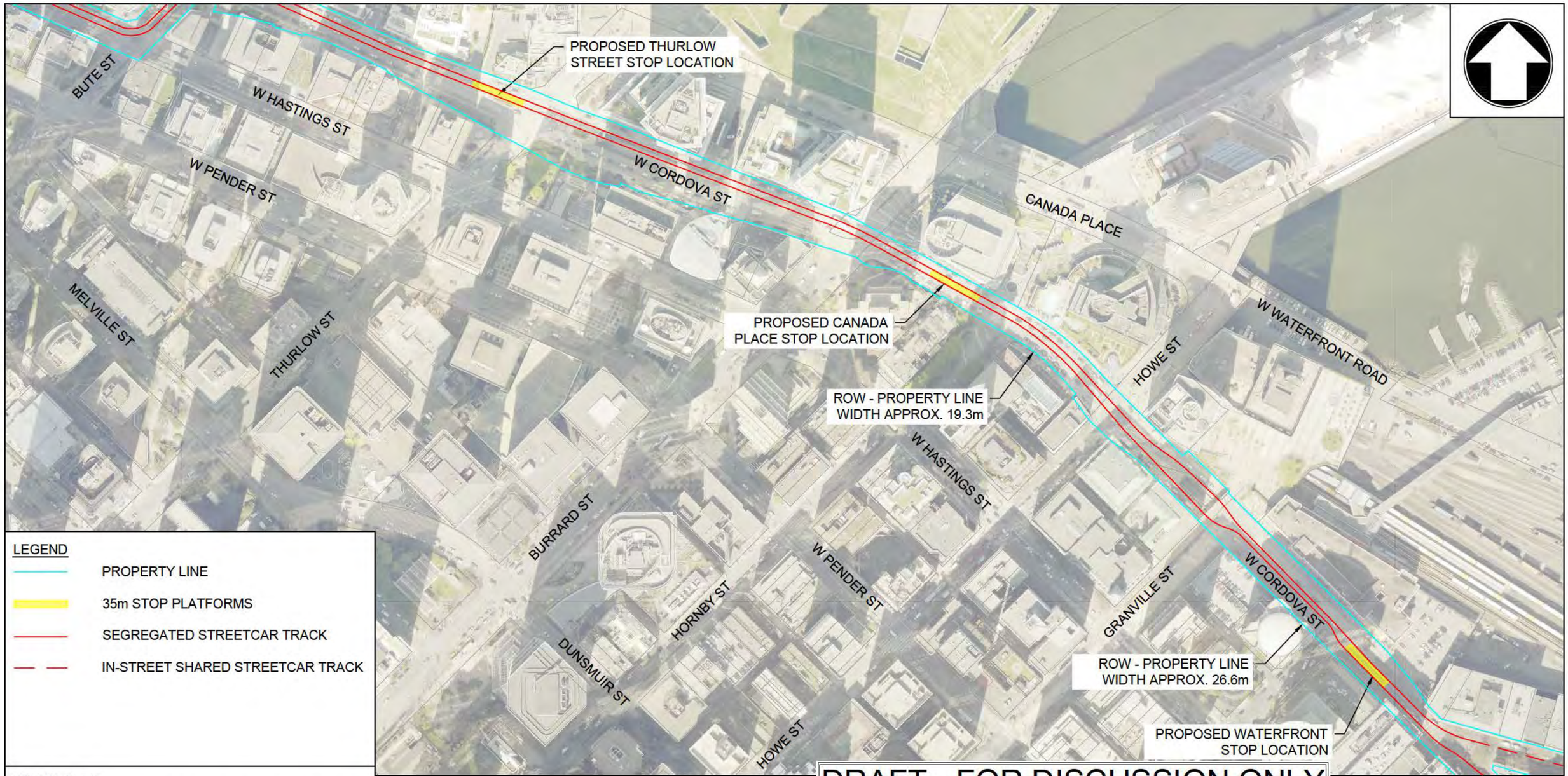

LEGEND

- PROPERTY LINE
- 35m STOP PLATFORMS
- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK

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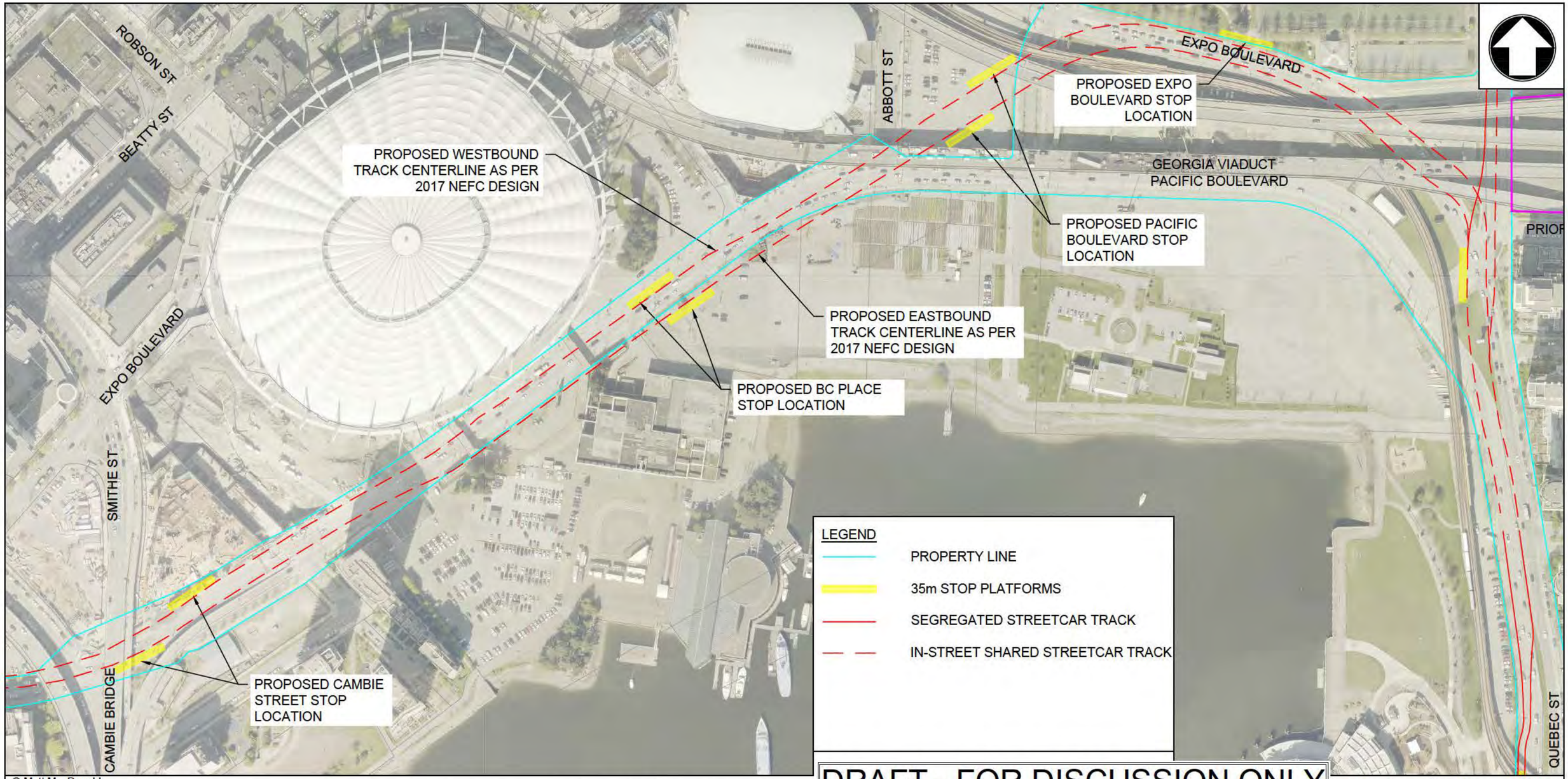

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Client
City of Vancouver
453 West 12th Ave
Vancouver, BC
V5Y 1V4

Rev	Date	Drawn	Description	Ch'k'd	App'd
A	2018-06-26	LJA	PRELIMINARY SUBMISSION	KHM	GBF
B	2018-07-13	LJA	ISSUED FOR INFORMATION	KHM	GBF

Title
CITY OF VANCOUVER
STREETCAR STUDY
CURRENT PROPOSED ROUTING
NEFC - SHEET 1 OF 2

Drawn	L. ANDERSON	
Checked	K. MILLER	
Approved	G. FARMER	

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-SK-XD-0113

Security	Status	Rev
STD	PRE	P1

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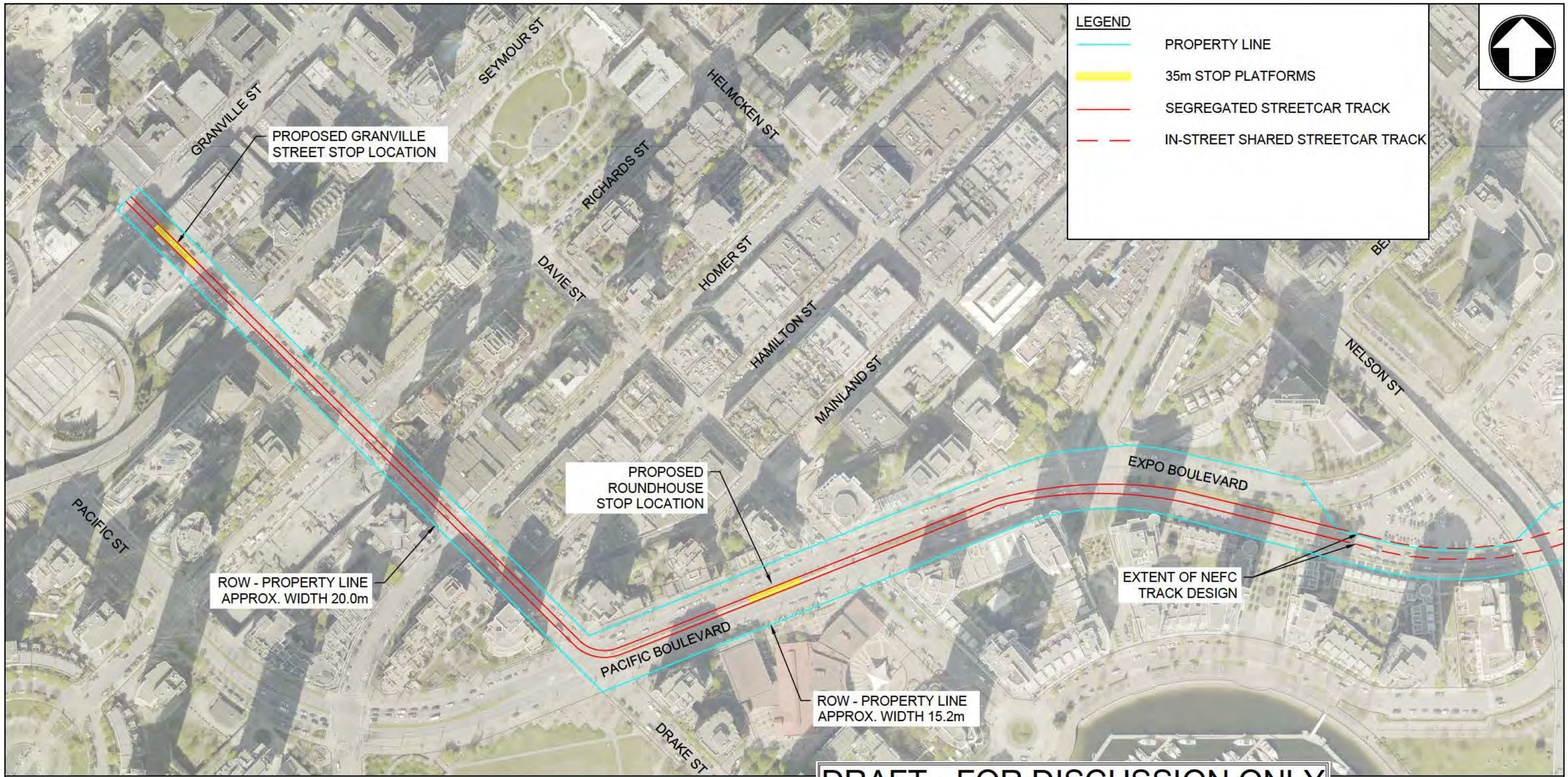

DRAFT - FOR DISCUSSION ONLY

20 m 0 1:2500 100 m

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Title
CITY OF VANCOUVER
STREETCAR STUDY
CURRENT PROPOSED ROUTING
NEFC - SHEET 2 OF 2

Drawn	L. ANDERSON	
Checked	K. MILLER	
Approved	G. FARMER	

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-SK-XD-0114

Security	Status	Rev
STD	PRE	P1

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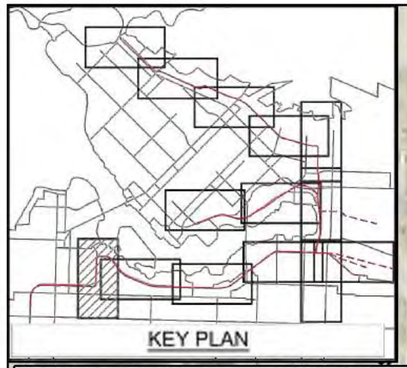
B. 388583-MMD-00-P0-DR-TR-1100, 1200, 1300 and 3100 series – Proposed Streetcar Routing



NOTE: ROAD AND TRACK DESIGN AS PER ARBUTUS GREENWAY PROJECT

W 5TH AV

W 5TH

PROPOSED BURRARD STREET STOP LOCATION

CYCLE LANES AND PEDESTRIAN FOOTWAYS FROM ARBUTUS GREENWAY PROJECT

PINE ST

W 6TH AV

MAPLE ST

CYPRESS ST

BURRARD ST

PROPOSED ARBUTUS GREENWAY STREETCAR ALIGNMENT
W 6TH AVE X SECTION:

- KEEP EXISTING SOUTH CURB
- 2.5m PARKING
- 3.5m EASTBOUND VEHICLE LANE
- 0.6m SHYWAY
- EASTBOUND STREETCAR IS EMBEDDED
- WESTBOUND STREETCAR IS GREEN TRACK

W 7TH AV

PROPOSED ARBUTUS GREENWAY STREETCAR ALIGNMENT

W 8TH AV

PROPOSED WEST BROADWAY STOP LOCATION - INTERIM TERMINUS

W BROADWAY

LEGEND

- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK
- 35m STOP PLATFORM
- PROPOSED CURB LINE
- PROPOSED BACK OF SIDEWALK
- PROPOSED CYCLE LANE □UNI-DIRECTIONAL□
- PROPOSED CYCLE LANE □BI-DIRECTIONAL□
- PARKING LANE
- ROAD MARKING
- PEDESTRIAN FOOTWAY FROM ARBUTUS GREENWAY PROJECT

DRAFT - FOR REVIEW

20 m 0 1:2500 100 m

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CITY OF VANCOUVER

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B	2018-10-15	LJA	ISSUED FOR DISCUSSION - DRAFT	KHM	GBF
C	2018-12-21	LJA	ISSUED FOR CLIENT REVIEW	KHM	GBF
D	2019-10-23	SMV	ISSUED FOR CLIENT REVIEW	KHM	GBF

Title
CITY OF VANCOUVER
STREETCAR STUDY
PROPOSED ROUTING
OPTION 1 - ARBUTUS GREENWAY
SHEET 1 OF 41

Drawn	L. ANDERSON	18-10-04
Checked	K. MILLER	18-10-04
Approved	G. FARMER	18-10-04

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-DR-TR-1100

Security	Status	Rev
STD	PRE	D

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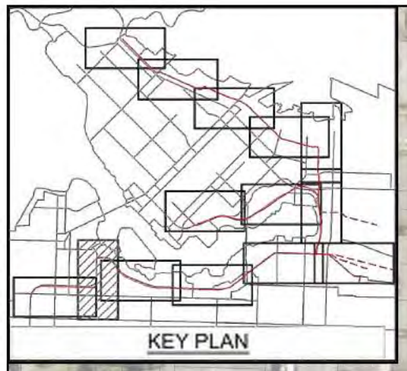

PROPOSED ARBUTUS GREENWAY STREETCAR ALIGNMENT
W 6TH AVE X SECTION:

- KEEP EXISTING SOUTH CURB
- 2.5m PARKING
- 3.5m EASTBOUND VEHICLE LANE
- 0.6m SHYWAY
- EASTBOUND STREETCAR IS EMBEDDED
- WESTBOUND STREETCAR IS GREENTRACK

PINE ST

CYCLE LANES AND PEDESTRIAN FOOTWAYS FROM ARBUTUS GREENWAY PROJECT.

W 5TH AV

W 4TH AV

W 3RD AV

W 2ND AV

W 1ST AV

ROW - PROPERTY LINE
APPROX. WIDTH 25.0m

A 3100

FIR ST

W BROADWAY

W 8TH AV

W 7TH AV

W 6TH AV

ADDITIONAL ROW IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

SEGREGATED DOUBLE TRACKS FOLLOWING EXISTING RAILWAY CORRIDOR

POTENTIAL FUTURE ROW DEDICATION IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

GRANVILLE BRIDGE

APPROX. GRANVILLE STREET BRIDGE COLUMNS (TYP)

PROPOSED GRANVILLE ISLAND STOP LOCATION

W 5TH AV

W 4TH AV

LEGEND

- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK
- 35m STOP PLATFORM
- PROPOSED CURB LINE
- PROPOSED BACK OF SIDEWALK
- PROPOSED CYCLE LANE (UNI-DIRECTIONAL)
- PROPOSED CYCLE LANE (BI-DIRECTIONAL)
- PARKING LANE
- ROAD MARKING
- APPROXIMATE COLUMN LOCATIONS

DRAFT - FOR REVIEW

20 m 0 1:2500 100 m

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CITY OF VANCOUVER

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C	2018-12-21	LJA	ISSUED FOR CLIENT REVIEW	KHM	GBF
D	2019-10-23	SMV	ISSUED FOR CLIENT REVIEW	KHM	GBF

Title
CITY OF VANCOUVER
STREETCAR STUDY
PROPOSED ROUTING
OPTION 1 - ARBUTUS GREENWAY
SHEET 2 OF 41

Drawn	L. ANDERSON	18-10-04
Checked	K. MILLER	18-10-04
Approved	G. FARMER	18-10-04

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-DR-TR-1101

Security	Status	Rev
STD	PRE	D

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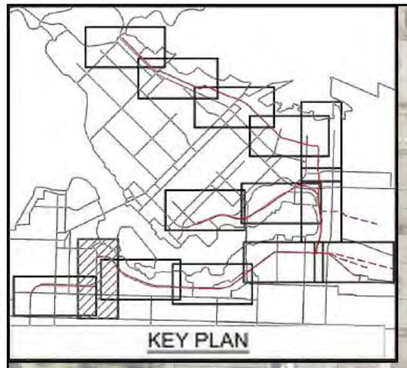

PROPOSED ARBUTUS GREENWAY STREETCAR ALIGNMENT
W 6TH AVE X SECTION:

- KEEP EXISTING SOUTH CURB
- 2.5m PARKING
- 3.5m EASTBOUND VEHICLE LANE
- 0.6m SHYWAY
- EASTBOUND STREETCAR IS EMBEDDED
- WESTBOUND STREETCAR IS GREENTRACK

PINE ST

CYCLE LANES AND PEDESTRIAN FOOTWAYS FROM ARBUTUS GREENWAY PROJECT.

W 5TH AV

W 4TH AV

W 3RD AV

W 2ND AV

W 1ST AV

ROW - PROPERTY LINE APPROX. WIDTH 25.0m

A 3100

FIR ST

W BROADWAY

W 8TH AV

W 7TH AV

W 6TH AV

ADDITIONAL ROW IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

SEGREGATED DOUBLE TRACKS FOLLOWING EXISTING RAILWAY CORRIDOR

POTENTIAL FUTURE ROW DEDICATION IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

GRANVILLE BRIDGE

APPROX. GRANVILLE STREET BRIDGE COLUMNS (TYP)

PROPOSED GRANVILLE ISLAND STOP LOCATION

W 5TH AV

W 4TH AV

LEGEND

- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK
- 35m STOP PLATFORM
- PROPOSED CURB LINE
- PROPOSED BACK OF SIDEWALK
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- PROPOSED CYCLE LANE (BI-DIRECTIONAL)
- PARKING LANE
- ROAD MARKING
- APPROXIMATE COLUMN LOCATIONS

DRAFT - FOR REVIEW

20 m 0 1:2500 100 m

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CITY OF VANCOUVER

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C	2018-12-21	LJA	ISSUED FOR CLIENT REVIEW	KHM	GBF
D	2019-10-23	SMV	ISSUED FOR CLIENT REVIEW	KHM	GBF

Title

CITY OF VANCOUVER
STREETCAR STUDY
PROPOSED ROUTING
OPTION 2 - ARBUTUS GREENWAY
SHEET 3 OF 41

Drawn	L. ANDERSON	18-10-04
Checked	K. MILLER	18-10-04
Approved	G. FARMER	18-10-04

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-DR-TR-1201

Security	Status	Rev
STD	PRE	D

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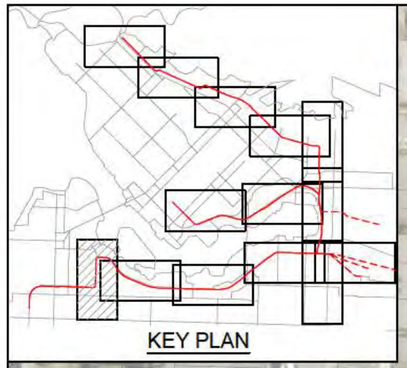

PROPOSED ARBUTUS GREENWAY STREETCAR ALIGNMENT
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- 0.6m SHYWAY
- EASTBOUND STREETCAR IS EMBEDDED
- WESTBOUND STREETCAR IS GREENTRACK

PINE ST

CYCLE LANES AND PEDESTRIAN FOOTWAYS FROM ARBUTUS GREENWAY PROJECT.

W 5TH AV

W 4TH AV

W 3RD AV

W 2ND AV

W 1ST AV

ROW - PROPERTY LINE APPROX. WIDTH 25.0m

APPROX. BRIDGE COLUMN LOCATION □TYP□

FIR ST

W BROADWAY

W 8TH AV

W 7TH AV

W 6TH AV

ADDITIONAL ROW IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

SEGREGATED DOUBLE TRACKS FOLLOWING EXISTING RAILWAY CORRIDOR

POTENTIAL FUTURE ROW DEDICATION IDENTIFIED IN CoV FIR STREET ALIGNMENT MEMO

GRANVILLE BRIDGE

APPROX. GRANVILLE STREET BRIDGE COLUMNS □TYP□

PROPOSED GRANVILLE ISLAND STOP LOCATION

W 5TH AV

W 4TH AV

LEGEND

- SEGREGATED STREETCAR TRACK
- IN-STREET SHARED STREETCAR TRACK
- 35m STOP PLATFORM
- PROPOSED CURB LINE
- PROPOSED BACK OF SIDEWALK
- PROPOSED CYCLE LANE □UNI-DIRECTIONAL□
- PROPOSED CYCLE LANE □BI-DIRECTIONAL□
- PARKING LANE
- ROAD MARKING
- APPROXIMATE COLUMN LOCATIONS

DRAFT - FOR REVIEW

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D	2019-10-23	SMV	ISSUED FOR CLIENT REVIEW	KHM	GBF

Title
CITY OF VANCOUVER
STREETCAR STUDY
PROPOSED ROUTING
OPTION 3 - ARBUTUS GREENWAY
SHEET 4 OF 41

Drawn	L. ANDERSON	18-10-04
Checked	K. MILLER	18-10-04
Approved	G. FARMER	18-10-04

Scale at ANSI B
1:2500

Drawing Number
388583-MMD-00-P0-DR-TR-1301

Security	Status	Rev
STD	PRE	D

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